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Building Stock Activation 2007 (BSA 2007)

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Preface

As part of Tokyo Metropolitan University's 21st Century COE Program, Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis, academic staff of the Department of Architecture and Building Engineering have been conducting research on the theme of "Activation of Existing Building Stock" in a spirit of close cooperation since the program's selection in FY 2003. The interim assessment process was successfully completed and we entered the final year of the program in FY 2007. In this final year, the international conference Building Stock Activation 2007 (BSA 2007) is being held on the theme of activating existing building stock. The main aims of BSA 2007 are to widely publicize the research results of this five-year program and to provide opportunities for exchange among researchers and experts in Japan and overseas, and thereby promote the further development of global research on the activation of building stock.

BSA 2007 is being held jointly not only by the Meta-technology Center for Metropolitan Metamorphosis Methods (4-Met Center), the research base for this program, and Tokyo Metropolitan University, but also by the International Council for Research and Innovation in Building and Construction (CIB). As expected, many papers were submitted both from Japan and overseas, and this collection of papers contains those selected through the peer review conducted by the International Scientific Committee.

The peer review process consisted of two stages: the peer review of abstracts followed by the peer review of full papers. Of the full papers selected, outstanding papers whose contents were in accord with the aims of BSA 2007 were to be granted the Best Activation Award and outstanding papers by authors aged 35 or under as of 5 November 2007 were to be granted the Young Researchers Award. A total of 80 abstracts, 31 from overseas and 49 from Japan, were submitted. As a result of strict peer review by the International Scientific Committee, a total of 60 papers, 21 from overseas and 39 from Japan, were selected. Two of these papers were granted the Best Activation Award and four were granted the Young Researchers Award.

The papers in this collection examine building stock activation from various viewpoints in a wide range of fields, including architectural and urban planning, architectural history and design, building structures and materials, and architectural environment and building services. It is particularly noteworthy that many of these papers are based on actual projects conducted through coordination between different fields, which shows the importance of cooperation with other fields in promoting research on building stock activation. We believe that this collection of papers will be of great global significance.

We would like to express our heartfelt thanks to all those who submitted papers and to the committee members who took part in the peer review process. We very much hope that this collection of papers will be of great help to the researchers, architects and experts involved.

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Chair, Organizing and Executive Committee

Yoshinori KITSUTAKA
Chair, International Scientific Committee

Tokyo, November 2007

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Transfer of Offices to Housing for the Senior Citizen and Citizen depending on intensive health Care.

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Keywords: Transfer, Potential measuring, Offices, Housing for the elderly

Abstract
In recent years the market for newly built offices decreased dramatically in most European countries. The economic recession was a major factor, but also overproduction by project developers was an important cause of the oversupply. And as construction projects take a long lead time, many new office buildings came on the market, years after the oversupply was first noticed. Not only new buildings, but also buildings used before remained vacant for an unusual long period.

Also recently, the market for housing for elderly citizen started to grow, and it is expected to grow further over the forthcoming decades. Especially the housing for seniors in need of intensive health care grown strongly. Reason for developers and owners to investigate the potential of vacant offices for transfer into residential buildings for the senior citizen and citizen depending on intensive health care.

In 2006 BAM, the market leader among construction companies in the Netherlands, decided to invest in the development of an office transfer program. Students of the Eindhoven University of Technology were invited to a research project for the development of an instrument to assess and quantify the potential for transfer.

Based on the outcome of the project a transfer potential measuring instrument was developed and tested. Valuation of the instrument was performed by the assessment of the transfer potential of one sample building by 3 experts independently of each other. Beside this the potential of the building was assessed in a traditional way. The instrument proved to assist project developers in their assessment of the potential of an office block. Assessment took only a few hours per project.

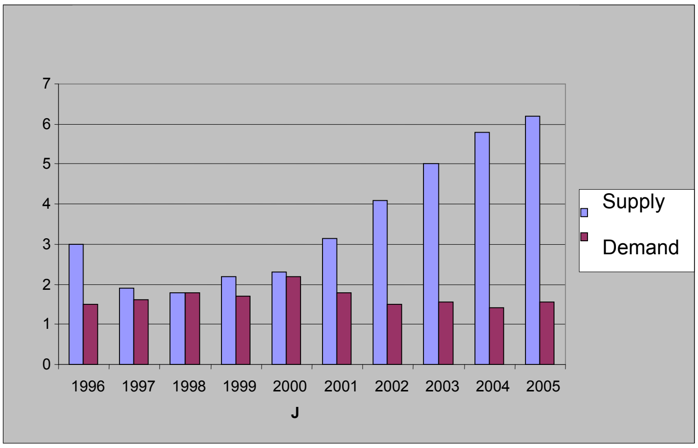
1. Introduction

In Europe many office buildings are vacant. A vacancy rate of 2 to 4 % is considered normal. This percentage is required to allow interested parties sufficient choice. In recent years the European average vacancy rate increased quickly to approximately 15%. For The Netherlands, after an all time high of 6.1 million m2, in early 2006 the vacant office building stock amounted to about 5,5 million square meters. An average office employee in Western Europe occupies 20 m^2. So to occupy this stock about 275.000 new jobs should be created. In ideal economic circumstances such a growth takes at least 4 years. We must take into account that even with a high vacancy rate many real estate clients prefer to build a new, client specific, office building. So even while many offices are vacant the construction of new offices continues, be it at a reduced annual volume. As a result the market cannot absorb the stock in 4 years time. It is more likely that it will take over 10 years before the vacancy rate is back to normal.

The aging population of Europe is another important factor in the development of the real estate market. The number of children per woman is in many western countries below the rate of 2.2. This is considered to be the minimal rate required to stabilize the population. The rate is decreasing world wide and some EU-countries like Italy are already below that figure. As a result of this demographic change the need for housing for senior citizen is growing while low quality single family houses stay vacant. Especially the housing for the elderly depending on intensive health care is dramatically legging behind the growth of the needs of the population.

These two independent developments, oversupply of office buildings on one side and undersupply of housing for seniors on the other, were a reason for BAM group to investigate the transferability of the vacant building stock into housing units. BAM is the biggest Dutch based contracting firm. On an European scale BAM is number 5 in terms of annual turnover and globally it is ranked 32nd. The company is among others active in housing, general contracting and project development. By the end of 2006 the study was started and in August 2007 it was finalized.

Fig. 1: Supply and demand of office space in The Netherlands (Million m2) (DTZ 2006)



For this study figures from diferent sources were used, causing slight differences in data on vacancy and market size.

2. Methods

The study started with an investigation into the size and quality of the available building stock. A web search and study of literature provided data on the amount of square meters waiting for new users. Interviews with real estate agencies gave an insight in the quality of the building stock. The need for housing by the growing number of senior citizens was investigated in a comparable way.

In the second stage of the study the possibilities and constraints for transfer of function were investigated. Again literature was an important source, but also interviews with relevant parties provided useful data. The research was in this stage mainly focusing on legal constraints, public funding options, functional requirements and performance specifications for the care sector.

Research by the Delft University of Technology focusing on the potential of offices for regeneration without a change of function appeared to be very helpful in this project. Our research could build on the findings of this recent study. In particular the instrument developed to measure the potential for transfer appeared to be very useful. (Hek, 2004)

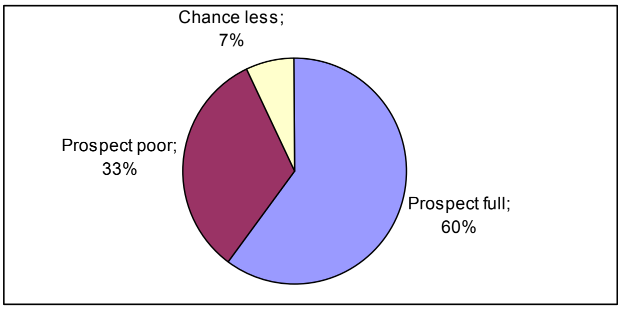
Based on the collected information a list was composed of conditions that are to be met to enable a successful transfer of offices into apartments. The list was divided in two sections. The "Veto conditions" and the "gradual conditions". If veto conditions cannot be met, the project is not suitable for a transfer of function. If gradual conditions are not met, transfer may still be an option, provided that modification of the building and its surroundings are financially feasible. As not all conditions will have the same impact on the transformability it was decided to assess the relative weight of each of the gradual conditions. Therefore an expert panel was invited to rank the conditions on a scale of 1 to 5. A value 5 indicates that the condition is of major importance. Value 1 was given to conditions with a minimal impact on the transferability.

To validate the results of this research a vacant office complex was scored with the developed transfer measurement instrument. Minor modifications to the instrument appeared to be required to guarantee an adequate performance of the tool.

3. The oversupply of offices.
Between 2000 and 2006 the office market in Western Europe decreased gradually but steadily. In 2006 a turning point was reached. The economy became stronger. Employment statistics started to rise again. And the vacancy rate dropped from 15% in January to 13% in December. In the Netherlands in 2006 1 million m^2 of new office space was completed while the market absorbed a 1.6 million m^2. Predictions for 2007 are even better. It is expected that by the end of 2007 only 9.7% of the office stock will be vacant. (ABF Research, 2006) In this figures is taken into account that there will be new vacancies due to loss of employment for office workers caused by transfer of tasks to low income countries. (Jones Lang Lasalle, 2006)

One may say that if this economic growth continues the vacancy rate will be back to normal in a few years. But more detailed study of the stock revealed that 40 % of the vacant offices is of an unacceptable low quality. It is not very likely that this 40% will ever be re-rented or sold. 7% Is qualified as “impossible” to rent out. 33% is qualified in the category “very unlikely”. (Dynamis 2006) For the Dutch market this means that 2,2 million square meters will remain available for transfer. Even under continued high economic growth the offices concerned will not come back into exploitation. With an average size of 100 m^2 per housing unit this stock may be transferred into approximately 22.000 units. So in conclusion we may say that availability for transfer depends heavily on economic factors such as economic growth, employment and outsourcing to low income nations. But a substantial part of the stock will never be reoccupied as offices again. Even under the best economic conditions this will not be the case. (Source: www.dynamis.nl)

Fig. 2: Overview of categories of vacant offices (Dynamis, 2006)



When looking on an European level we find comparable figures for the original 16 old member states of the EU. The new members, mainly former east block countries, are in a different economic process. Though little figures are available on the eastern European stock the impression is that in general less office stock is vacant, but a bigger part fits in the category “ unlikely to re-rent”.

4. Locations of vacant offices
To better estimate the size of the stock available for transfer an inventory was made of the locations of the vacant offices. The table below shows 5 categories (REN 2003). The quantification (Hek 2004) reveals that only 29% of vacant offices in The Netherlands is located on the least suitable highway

locations. Only 4% is found in the most appreciated typical housing districts. The remaining 67% is located in or near city centers and may be transferable, depending on the quality of other factors.

Table 1, Locations of vacant Offices (REN 2003 and Hek 2004)

Area	Qualification	%
Housing district	Excellent	4
Around city center	Good	26%
Rail station area	Sufficient	18%
City center	Insufficient	23%
Highway location	Bad	29%

The inventory also listed the cities where vacancies occurred. As could be expected a vast majority of vacant offices was found in the big cities. This should not be a problem as it was also assessed that many seniors return to big cities - with their cultural and health care facilities - after growing their children in smaller villages, though others - more vital seniors - move to quiet places in the country side, far from the busy city life. A more in depth investigation into these migrations would be useful.

5. Characteristic of chanceless offices

The investigation also assessed why some office buildings are chanceless on the market. The major factors were divided in location quality and building quality. For the location we found:

- Area with more outdated empty stock (1960-1980)
- Area with cheap office buildings (75-90 € per m^2)
- Office in a housing area
- Low level of nearby facilities (banks, restaurants, shops)
- Too far away from highway or rail connections
- Parking facility missing
- Poor maintenance, (graffiti, vandalism, waste)

For the building quality the following constraints were identified:

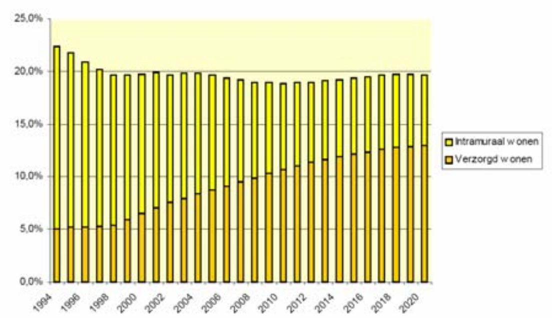
- Unattractive appearance of building
- Vandalism
- Low level of thermal insulation
- Low outdated services.

6. The housing needs of senior citizen

Research by others (ABF 2004) found that the need for senior care housing in the Netherlands alone will grow by 10.000 units annually till 2020. That is a need for 1.000.000 m2 new floor space per annum. The growth is caused by a variety of factors.

- Growing population, 0,25% per year till 2035
- Increased percentage of elderly citizens in this population
- Policy shift from hospitalization to extended home care
- Wealthy seniors prefer private care in stead of public services

Fig. 3: Percentage of population (75+) hospitalized and living in intensive care housing (ABF Research, 2004)

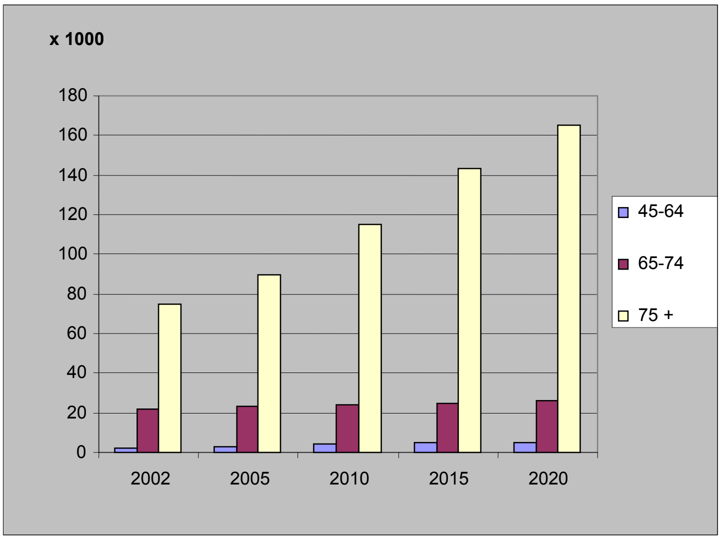


The Dutch shortage for senior care housing was estimated on 40.000 units in 2002 and is expected to be reduced marginally to 30.000 units by 2020. We may conclude that a new source of housing units for seniors will be very welcome. The need is of a temporary character. It is expected that the population of The Netherlands will decrease slowly from an all time high of 17.1 million inhabitants in 2035. And the baby boomers will not be a dominant factor in the statistics anymore from 2040. But for the forthcoming 20 to 30 years the need for is very pressing. So housing units specially designed for senior citizens with a high demand for care may be in oversupply from 2040.

Table 2, Population Development in The Netherlands (CBS 2006)

Year	Population The Netherlands In millions	over 55 in %	Over 65 in %
2005	16.3	25.8	14.0
2020	16.8	32.7	19.0
2030	17.0	35.6	22.2
2040	17.0	30.5	25.0
2050	16.8	29.7	23.6

Fig. 4: Occupants of special care housing per age category 2002-2020 (ABF research, 2004)



To be able to assess to the potential for function transfer insight in the performance requirements for senior care housing is needed. The most important requirements are:

- 24 hours care on demand

- 80 m^2 for low budget up to 120 m^2 for above average budget
- Accessible for wheelchairs
- Distance to rail station < 1000 m
- Distance to public transport < 200 m
- Distance to daily shops < 500 m

7. Investment opportunities
Availability of capital is another important condition for a successful transfer. The book value of long time vacant offices is usually low. Often not more than the value of the land. But the cost of transfer and refurbishment may be considerable. The total investment is therefore an important factor in the assessment of the transferability. The level of the rent after transfer is dictated by the market. The cost for redesign and reconstruction can be estimated. Based on this two data the market value of a vacant office can be calculated. If this value is higher than the market value before transfer, then transfer is an option.
Luijten 2006, reported that between 30 and 50% of the real estate investment funds active in The Netherlands and surrounding countries, are prepared to invest in office transfer for the housing of senior citizens, provided that the rent will be conform market prices.

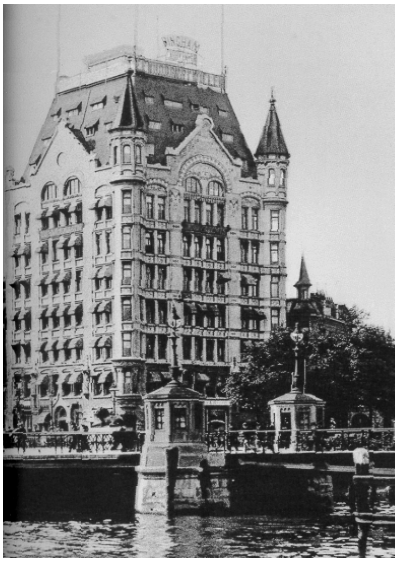
8. The need for refurbishment
8.1. Architectural aspects
From an architectural point of view the brick buildings built in the first half of the twentieth century or even earlier are considered to be very attractive. Many of these brick buildings are now listed as monuments. So major changes to facades are not allowed but often not needed. These buildings have typically high ceilings and massive constructions. This type of high quality buildings are favored by seniors for their apartments. Buildings from the second half of the 20th century are often characterized by light constructions and glass facades. Partition walls are too light to serve as an apartment separation or are not made at all. The architecture of these later buildings is far from typical for housing and function transfer is only possible if a complete new façade is made. These buildings are seldom listed. A new façade is expensive. In newly built offices facades require between 25 and 33 % of the construction cost.

Fig. 5 Example of successful transfer

8.2. Services
Most offices in Europe are centrally heated and ventilated. Also power and water supply are centralized services. In new apartment buildings the cost of utilities are measured and billed individually, per apartment. When it is considered necessary to replace centralized building services by de-centralized systems this may lead to the conclusion that a functional transfer is not feasible. But building services are supposed to last 15 - 20 years. Therefore many vacant offices need new services anyhow. In such cases transfer into apartments is not more expensive than continued use as an office. In new buildings services account for approximately 40% of building cost.

8.3 Environmental aspects
Insulation is another important cost element. Older buildings were designed before environmental awareness led to high standards for insulation of facades and roofs. Additional insulation, including double glazing is inevitable in almost every office transfer. But older offices need post-insulation anyhow. As said above for services, also without transfer of function investments in upgrading of the insulation will be inevitable.

Fig 6, Examples of traditional office architecture, feasible for transfer



9. Result and discussion
To prevent loss of time in an assessment of conditions for a building that after all clearly doesn't meet the required level it was decided to split the assessment in 4 stages.

1. Check on veto conditions,
2. Check on financial feasibility,
3. Check on gradual conditions
4. Check on investments opportunities.

The study resulted in a list of only 5 veto conditions.

1. There is a local need for housing for senior citizen.
2. The local authorities are prepared to make a change of function legally possible.
3. The location is typical for housing; green, clean, quite, cozy and safe.
4. The sound level of traffic and other activities is below 50dB
5. The remaining free available space between floors and ceilings is, after transfer, at least 260 cm.

The list of gradual conditions is much longer. In total gradual 54 conditions were identified. The 54 multiplied with their relative weight made a maximum score of 270 points achievable. The gradual conditions were divided into 4 catagories.

1. Location
2. Building
3. Legal aspects
4. Financial feasibility

From a commercial point of view it is not cost effective to spend time and money on assessments of small projects. It was decided that a building should allow for at least 2.500 m^2 for housing purposes, otherwise an investigation into the transferability would be too costly.

10. Conclusions

In Europe there is a big stock of vacant offices. In the old EU-member states the vacancy rate for office buildings is approximately 10%. Even in an economic recovery as we experience nowadays, this stock will not be absorbed by the market completely. Main reasons why a part of the stock will not be re-rented are an inadequate location and outdated design of structure and/or services. Some of these locations suit apartment buildings much better. The older buildings are often characterized by their attractive architecture It is very likely that an important part of the vacant offices are transferable into apartments for senior citizen. Especially for those in need of 24 hours care on demand the market is growing rapidly and there is already a considerable undersupply.

In the study some veto-conditions were identified: conditions that must be met in order to stand a chance for a successful transfer of functions. Other identified conditions are qualified as desirable. Not all of these desirable conditions are of the same importance. Therefore these "gradual" conditions have been ranked by a team of experts. Quick assessment of the possibility to meet these gradual conditions is enabled by an instrument recently developed by Eindhoven University of Technology and BAM Contractors Group in The Netherlands.

11. Acknowledgement

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12. References

1. ABF Research, 2004, Vergrijzing en de gevolgen voor het woonbeleid. (Dutch) Amsterdam.
2. CBS 2006, www.CSB.nl , Statline
3. DTZ 2006, www.DTZZadelhoff.nl
4. Dynamis 2006, Sprekende Cijfers, page 8 (Dutch) www.dynamis.nl
5. Evans, W.A., 1994. Approaches to intelligent information retrieval. Information processing and Management 7(2), 147-168
6. Geraedts, R.P. and Voordt, D.J.M. van der, 2006.Geloof in Transformatie? (Dutch) Delft, BOSS Magazine 2006/4
7. Hek. M, 2004, Herbestemmingswijzer (Dutch) Delft University of Technology, Editors office faculty of Architecture, Delft
8. Jones Lang Lasalle, 2006, Off Shoring: Threat or opportunity for Dutch Corporate Real Estate? Office Market Special 2006, Amsterdam.
9. Luijten, A, 2006, Vastgoedeigenaren tegen wil en dank (Dutch), Building 1 (2), page 21- 25
10. REN 2003, Real Estate Norm.

Sustainability driven stock activation – case studies from Australia

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Keywords: sustainable, refurbishment, urban renewal, green refurbishment

Abstract

It is much easier to implement sustainability in new buildings and settlements than in improving existing ones. When considering resource inputs such as water and energy, outputs such as emissions and waste together with other impacts associated with buildings and cities there is more opportunity for 'making better cities' than 'making cities better'. However unless existing cities and buildings are considered there is little chance of meeting much of the sustainability criteria such as emissions reduction and the waste chain. This paper is a brief description of an oral keynote presentation on 'making cities better' through stock improvements. The author contends that in many cases having been resource wasteful for decades and the economy and society having been accustomed to this will mean that there will need to be a 'significant correction' in economic and social impacts of having to readjust to a more environmentally sustainable future.

Introduction

'The battle for sustainable development, for delivering a more environmentally stable, just and healthier world, is going to be largely won and lost in our cities'.

Klaus Toepfer, Executive Director, United Nations Environment Program. (UNEP, 2005)

Cities today are the centres' of economic, environmental, social, cultural and political focus in most countries. The wealth and health of cities reflect upon the status they add to their countries however their liveability and the well-being they provide to their citizens reflects upon the quality of life therein. Giradet (2003) points out that '….cities of the 21st century are where the human destiny will be played out, and where the future of the biosphere will be determined. There will be no sustainable world without sustainable cities'.

Urbanisation is now occurring at unprecedented rates globally and particularly in the rapidly developing countries. One may argue that this requires increasing inputs of resources, leaving increasing levels of waste and other impacts. Hence it may seem contradictory that a sustainable city is achievable. However, there are considerable opportunities for all settlements to achieve a level of harmony between the natural and the built environments and to achieve an appropriate level of balance between economic, environmental and social impacts of development. This harmony needs to be both within city boundaries and between the city and the outside world.

Giradet (2003) defines a sustainable city as '*A sustainable city is organised so as to enable all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future'*. In comparing the impacts of urbanisation in different cities one needs to be particularly careful and distinguish between the old and the new cities, between mega cities and the smaller ones and between cities in the developing world and the developed world. New cities can be planned to deal with the fundamental issues of transport, land-use, water, air/emissions and other flows from the onset. They can be made people-oriented and quality of life focussed. Mega-cities pose much higher levels of constraints in achieving that balance. Mega-cities in developing economies not only have added level of difficulty in achieving that balance but pose a much higher level of complexity if sustainability has not been a part of their early development strategies. They do however have considerable opportunity for improvement (low hanging fruit).

In most cities it is apparent that improving the existing stock of built environment has the highest impact possibility in terms of indicators such as energy use and greenhouse gas emissions. In Australia for instance a benchmark study in 1999 (AGO, 1999) found that for most building types unless existing building performance against these indicators are improved that there may be little chance meeting the sectoral emission targets for reductions. In fact of the total building stock in year 2010 (Kyoto reference) about 85% would have been existing at the time of that study.

In addition to environmental benefits it is now evident that there are also social (more comfortable to work in and hence more worker productive) and economic advantages (return on investment and productivity gains) in improving the building stock. In many cases there is evidence of marketing advantages such as better appeal to a customer base of being ‘green’. This paper covers three case studies, one a university campus and two individual office buildings to demonstrate scale and scope of improvements and their impacts. The presentation at the conference will cover more detail on these and other cast studies.

Neighbourhood Scale Activation: UNSW Case Study

The University of New South Wales in Sydney has a campus with buildings of varying ages dating back to over 50 years. About ten years ago the management decided to upgrade the buildings with new masterplan to both place the university as a global scale and to improve its facilities for better management, including environmental impacts such as energy/GHG and water issues. These initiatives has seen a marked improvement in both the architectural of the spaces and buildings and the environmental performance.

In dealing with water efficiency a base line consumption was established in 2004 by the facilities group as 1,110Kl daily leading to a 405ML annual consumption at a cost of AUD650,000.00. Conservation practices since 1999 has seen a 33% drop in consumption through use of bore water for non-potable uses, installation of water saving devices and an active maintenance program (UNSW Water Saving Action Plan, 2004).

A similar action plan was done for energy savings (UNSW Energy Saving Action Plan, 2005) which highlighted potential for efficiencies. In 2004 total energy consumption was 64,241MWh of electricity and 53,562 GJ of natural gas with a total cost bill of AUD4,035,901 for electricity and AUD357,515 for gas. Initiatives such as installation of energy efficient equipment, use of automatic controls, application of new energy guidelines and including behaviour change actions have led to in excess of 3.3% decrease in electricity consumption relative to increase in gross floor area during this time of 6.6%.

There are a number of initiatives underway for water and energy savings as well as implementing ‘green building’ systems which will further improve performances over time. Figures 1 & 2 illustrate an old and a new image of the campus.

Figure 1 Aerial view of the UNSW campus late 1990's (Source UNSW Facilities)

Figure 2 Modern improved campus (2006) (Source UNSW Facilities)

Building Scale Improvement:

Case Study 1: CH2

The Council House 2 is a project of the City of Melbourne housing their offices as well as ground floor retail spaces. This building has been rates at the highest level using the Australian 'GreenStar' Rating Tool. It is not only regarded for a holistic approach to building improvement but also a testimony for the design processes employed. Many of its statistics can be found at www.melbourne.vic.gov.au/info.cfm?top=171&pg=1941. With a total building cost of AUD51.045m it claims a payback on sustainability features of about ten years. It contains vertical landscapes, to water treatment onsite, PCM modules, chilled ceiling panels, co-generation plants and PV integration. Figure 3 illustrates a bioclimatoc section of the building.

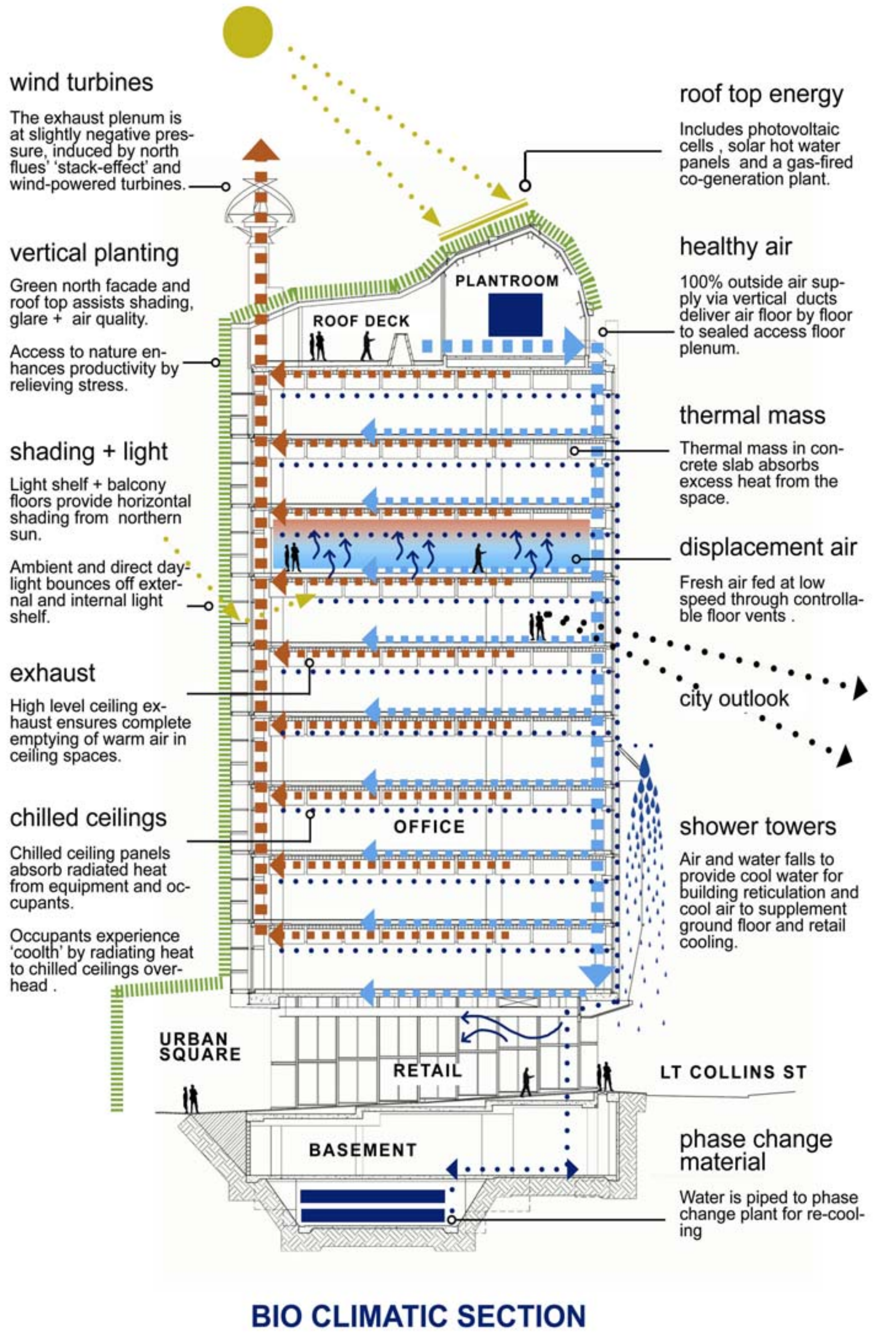

Figure 3: Bioclimatic section of CH2 (Source Mick Pearce Architect)

Case Study 2: ACF Building

The Australian Conservation Foundation decided to undertake a showcase refurbishment of its 60 Leicester St Building in Melbourne with a holistic range of considerations from perspectives of water, energy, materials, occupant health and comfort and other behaviour issues. It received a number of awards for its effort in demonstrating the level of improvement for sustainability of an otherwise old office building. Further details can be found at: http://www.60lgreenbuilding.com/ and Figure 4 illustrates a internal section with daylighting.

Figure 4: The ACF building at 60L (Source 60L website as above)

Conclusion

Improvement of existing building stock in most cities of the world is a key requirement for achieving a sustainable pathway. In meeting targets for GHG emissions and other water and waste efficiencies it is absolutely necessary that there be economic as well as social and environmental enhancements for existing stock of buildings for improvement actions to be supported.

References

AGO, (1999); Commercial sector energy use and greenhouse gas emissions 1990-2010 (www.greenhouse.gov.au)
http://www.60lgreenbuilding.com/.
www.melbourne.vic.gov.au/info.cfm?top=171&pg=1941.
Giradet, H. (2003); Creating Sustainable Cities, Schumacher Briefings, Green Books.

"REFINING ARCHITECTURE"

From "REFINED" to "REFINING"

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Keywords: Re-fine, Re-fining, Renovation, Building Stock, Activation

Fig. 1 "Forest for Coexistence" –Yame City Communication Center for Multiple Generations, Renovated in 2001, Yame City, Fukuoka

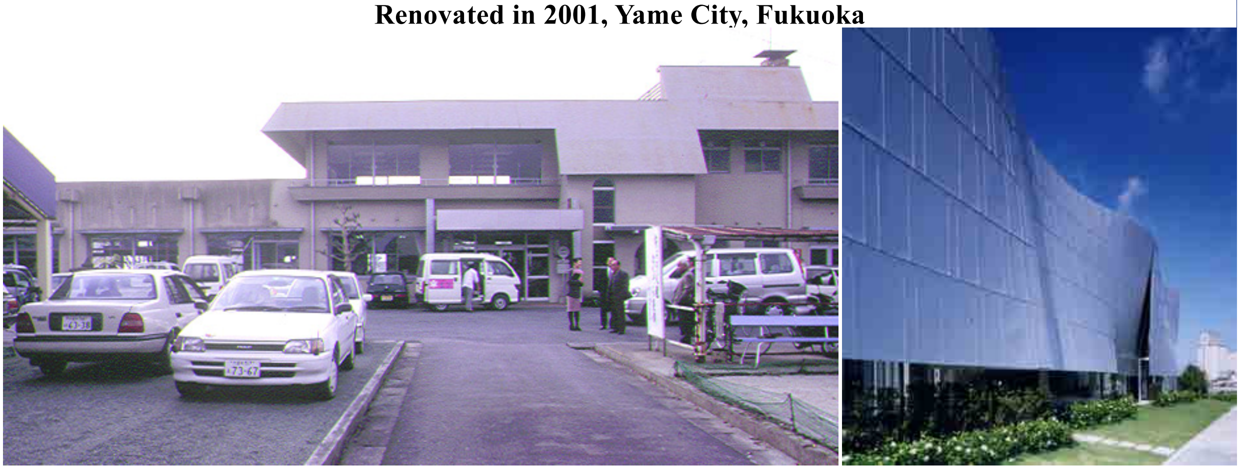

Fig. 2 Before and after "REFINED ARCHITECTURE"

A Second Life for Residential Buildings

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Keywords: Second Life, Residential Building, Rehabilitation, Restructuring

Fig. 1 Complex 50, Amsterdam (after rehabilitation)

Fig. 2 Enschedlaan, The Hague (before and after rehabilitation)

Thermal Insulation Improvement; Learning from Activation Projects by the TMU COE Program

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Keywords: thermal insulation, building improvement, collaboration with specialists

Abstract
Improving the thermal performance of the building stocks, especially the thermal insulation improvement, is one of the important objects of the Activation and Renewal of Building Stocks, where immediate action is required to sustain the global environment. However, building stocks are very diverse and, therefore, appropriate means of improving thermal insulation have yet to be clarified. In this paper, three improvement examples, namely a Japanese traditional wooden house, a RC detached house with outside-insulation and a RC building with inside-insulation, are presented. These examples were actually designed and built as the results of the research projects of the Tokyo Metropolitan University 21st Century Center of Excellence Program (21st century COE program). The problems and the solutions of the thermal insulation improvement, which were determined during work on the projects, are mentioned. In addition, the major factors used to select the insulation method are explained. Finally, the importance of the collaboration between architects and specialists in architectural environment is discussed.

1. Introduction
To improve the thermal performance of buildings is essential in order to conserve global environment and thermal insulation is the most effective means to improve the thermal performance. In Japan, the Standard and Guidelines for Energy Conservation of Residence, which is equal level with the European high quality ones, was enforced in 1999 (1999 Standard), but it is only for newly constructed residences. To take the effect of improving the building performance on the global environment into consideration, the promotion of thermal insulation improvement for building stocks should take priority over that for new buildings, because pre-existing stocks have poorer thermal performance and their number is huge.
In the interests of promoting thermal insulation improvement, there is a need to clarify the problems, solutions, and appropriate methods for improvement. However, there is a very diverse range of building stocks, and, furthermore, there is some potential for the appropriate improvement method to differ even if the buildings are of the same type of construction. On the other hand, to enhance the effect of promotion, it is vital that owners, architects and contractors have sufficient knowledge about building and thermal insulation, however, at present, most people lack sufficient understanding.
We carried out several projects, in which thermal insulation improvement was the major theme, in the 21st

century COE program, 'Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis'. In this paper, issues that were clarified from the major three projects are shown, indicating the problems and solutions to thermal insulation improvement, the main factors governing decisions to select the means of thermal insulation, and the importance of collaboration between architects and architectural environment specialists.

2. Learning from the Three Projects

The summaries of three projects are illustrated in Figures 2 to 4.

2.1 Japanese Traditional Wooden House (Project 1)

2.1.1 Building outline and pre-improvement thermal condition

This building is a priest's living quarters at a temple in Yokohama, which was built about 30 years ago. It features a wooden structure and Shinkabe (plastered walls with exposed columns). The thermal insulation was poor and the windows were single glazed, which kept the clients feeling cold throughout the winter.

2.1.2 Requirements and problems for renewal

The clients' requirements for renewal were that the appearance of the external surface and Shinkabe to be left unchanged, while the residents are kept warmer in winter. On the other hand, our team's aim in terms of thermal performance was to meet the 1999 Standard, including the prevention of heat-bridges between the insulation material and the wood column.

2.1.3 Study of thermal improvement and decisive factors to select the insulation method

To meet the 1999 Standard by applying the fill insulation method to the Shinkabe, we required a high performing insulation material, because of the very limited space in the wall. The heat conductivities of insulation materials are compared in the Figure 1. There is a significant difference of 2.5 times between the values of the highest and lowest materials, and only phenol foam had met the standard in this case.

To reduce the influence of heat-bridge, urethane foam is usually used. However, since it is impossible to remove the urethane foam from other materials, the materials will become wastes at destruction. Therefore, we designed and examined the use of plastic liners between the phenol foam and wood column. Regrettably, this method was not adopted for the actual building due to cost and labor reasons.

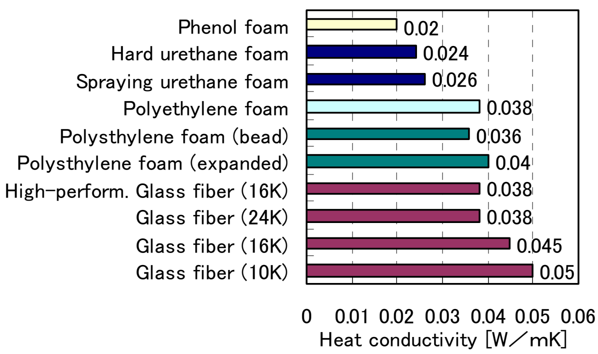


Fig. 1 Heat Conductivity of Insulation Materials

2.1.4 Solution

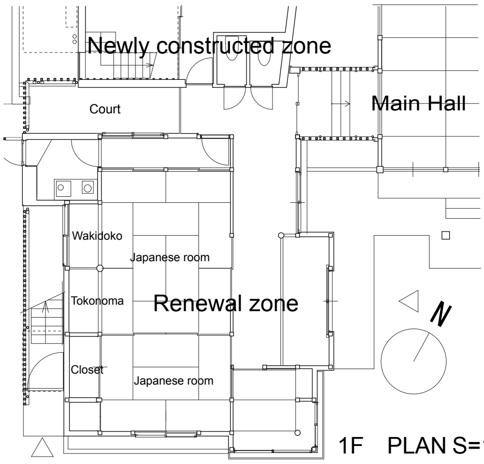
The total thickness of used phenol foam is 45 mm and the phenol foam was divided into two layers to reduce the workloads. Firstly, it was applied in a layer 25 mm thick to make it even with the diagonal beams, and then a further 20 mm was applied between the diagonal beam and the column. The windows were changed to a vacuumed or normal pair glazing with an insulation-frame.

2.1.5 Effects of Improvement

The U-value of the test piece of this wall was 0.53W/m^{2}K, to just met the 1999 Standard, and the value for

Japanese Traditional Wooden House (Project 1)

■ Building Outline / Requirements and Problems for Renewal



1F PLAN S=1/200

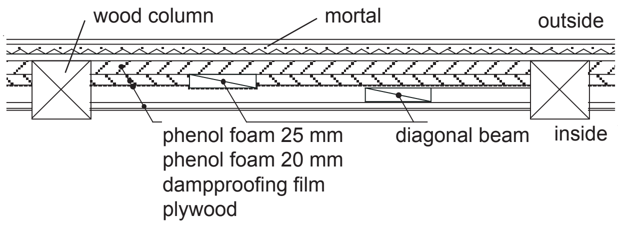
- -Priests' living quarters of temple
- -Wooden column structure with Shinkabe
- -No insulation
- -Single glazing
- -Do not change the outside of wall and Shinkabe

Outside view of the renewal zone (The right-side building is Main Hall)

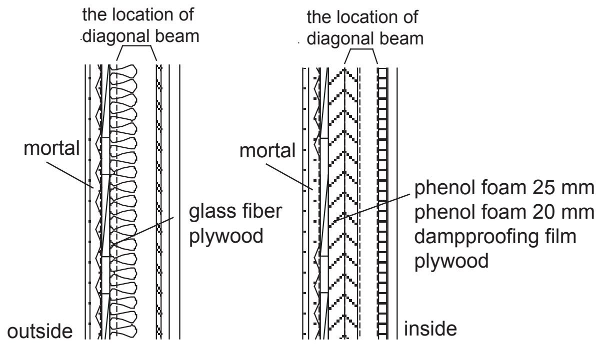
■ Study of Thermal Improvement and Solutions

- -The outside surface and Shinkabe to be left unchanged
- -To clear the 1999 Insulation Standard by applying the fill insulation method to Shinkabe
  - >> Phenol foam was selected
- -To reduce the workload
  - >> The phenol foam was divided in to two layers, 25 mm thick and 20 mm
- -To reduece heat-bride and waste by spraying urethane foam
  - >> Tried to use plastic liners

Examination of plastic liners



Horizontal section of Shinkabe after renewal

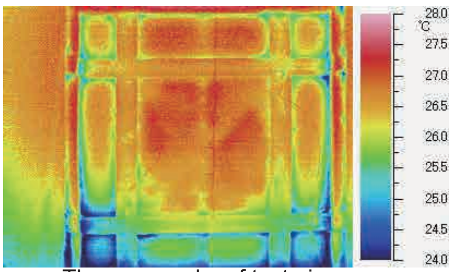


Section of Shinkabe before renewal

Section of Shinkabe after renewal

■ Effects of Improvement

Test piece of Shinakabe



Thermo-graphy of test piece

The U-value of the test piece was 0.53 W/m2K, just meet for the 1999 Standard, and the actual wall was 0.6 – 0.7 W/m2K.
The heat-bridge of diagonal beam and metal fittings was not appeared in the area of insulation material.
However, consequently, the heat-bridge of the wood columns against the plastered wall came into prominence.

■ Learning form the Project

It is difficult to clear the 1999 Standard by applying the fill insulation method to Shinkabe. We need high-performance insulation material to keep walls slim. The cost of insulation material must be reduced. The client selected renewal based on his belief. The architect has sufficient understanding of passive design, so that this Shinkabe wall could meet the 1999 Standard. General clients and architects should underestand the benefit of thermal insulation improvement.

Fig. 2 Japanese Traditional Wooden House (Project 1)

the actual wall was 0.6-0.7 W/m^{2}K. The heat-bridge was not appeared in the area of insulation material. However, consequently, the heat-bridge of the wood columns against the plastered wall came into prominence, because the heat conductivity of wood is about 20 times higher than that of phenol foam.

2.1.6 Learning from the project

It is difficult to meet the 1999 Standard by applying the fill insulation method to the Shinkabe. We require the use of high-performance insulation material, such as phenol foam, not only for column-appearing structures but also all others, to retain slimline walls. And reducing the material's cost is equally important. In this project, the client selected renewal, rather than reconstruction, based on his belief that the building must be used with fondness over an extended period. The client's understanding is important to ensure effective improvement. On the other hand, the architect of this project has sufficient understanding of passive design, so that this Shinkabe wall could have the high insulation performance. For general clients and architects, the benefit of thermal insulation improvement should be understood.

2.2 RC Detached House with Outside-Insulation (Project 2)

2.2.1 Building outline and pre-improvement thermal condition

This RC building was built in Toyama city about 30 years ago. Most of the walls had 30 mm glass fiber insulation on the inner side of the RC wall, while the windows were single glazed. The room temperature in winter was low and condensation appeared in many places, which was caused by insufficient thermal insulation and the use of an open-burner type gas heater.

2.2.2 Requirements and problems for renewal

The clients are an aged couple, and they requested that the problems of cold and condensation during winter be solved. With the clients' conditions in mind, the architect judged that the renewal construction works should be performed without the clients having to move. As for the thermal performance, the heat-bridges caused by the RC structure, the steel handrails and drains were the big problems.

2.2.3 Study of thermal improvement and decisive factors to select the insulation method

The outside-insulation was selected based on the grounds that the construction works should be performed without the clients having to move. Subsequently, many insulation methods were compared, and finally, the urethane foam spraying method was chosen because of the high insulation performance, the advantageous to heat-bridge resistance and the easy finish by coating and the cost.

2.2.4 Solutions

The thickness of the urethane foam was fixed as 30 mm by the architect, in consideration of its high insulation performance, namely heat conductivity of 0.018 W/mK, and the cost, although some architectural environment specialists suggested that the thickness of insulation material should be increased. However, in this case, the reinforcement of insulation was well considered, for example, short eaves were fully wrapped by urethane foam, and windows were changed to pair glazing except small ones.

2.2.5 Effects of improvement

The U-value of this wall is 1.15 W/m^{2}K, which is fit for the 1999 Standard. No heat-bridge appeared, except for two spots where the drains traverse the concrete from the roof to the wall. These spots were covered with polystyrene-foam boards from inside.

The clients are satisfied with a warmer environment and no condensation.

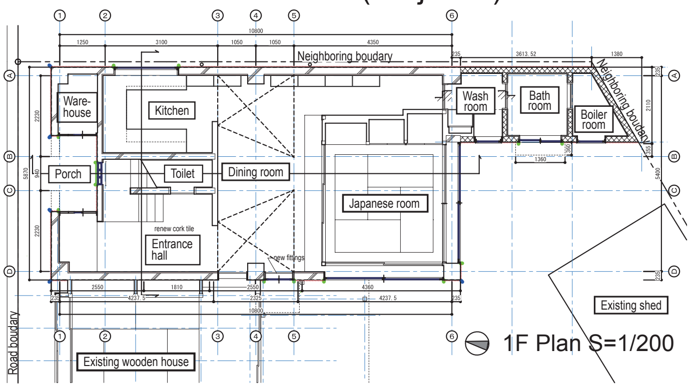
2.2.6 Learning from the project

Outside-insulation method makes it possible to perform construction works without the clients having to move, which is desirable for aged people. In this case, the cost was the major factor used to decide the thickness of insulation, and it is considered the thickness was insufficient to get better environment. Architects should have a greater understanding of passive design.

RC Detached House with Outside-Insulation (Project 2)

■ Building Outline

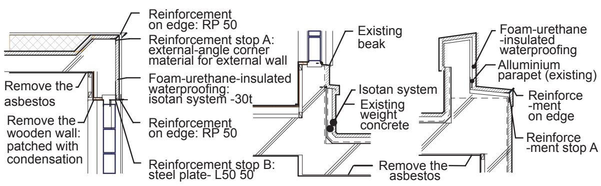
- Residence
- 3 storied RC house
- Low insulation (G.F.30, partly no insulation)
- Single glazing
- Heat-bridge (RC fames, eaves, handrails, etc.)
- Coldness in winter
- Condensation



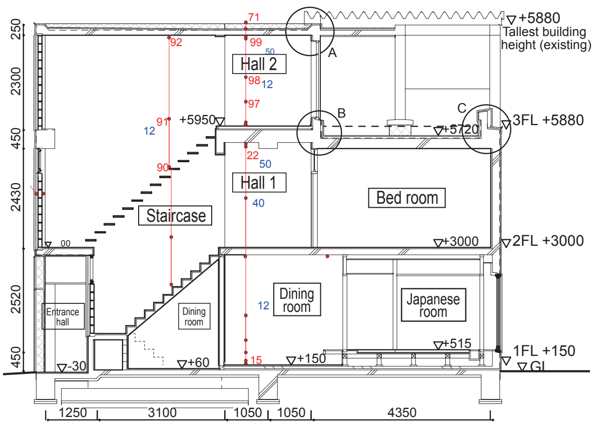
■ Requirement and Problems for Renewal

- Construction without clients' move
- Resolution of coldness and condensation
- Reduction of heat-bridges
- Saving cost

■ Study of Thermal Improvement and Solutions



Section Detail A   Section Detail B   Section Detail C



Section Detail

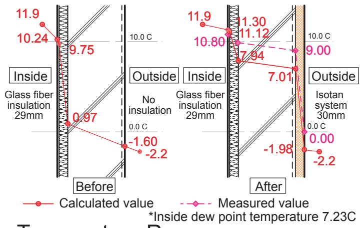
Setting Guides

Spraying Insulation

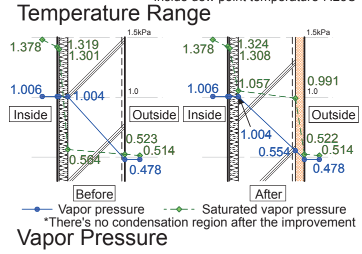
Fixing Edges

Construction Photos

[Selection of Insulation Method]
- Construction without clients' move
- Resolution of coldness and condensation
  >> outside-insulation method
- Reduction of heat-bridges
  >> spraying method
- Saving cost, waterproof improvement
  >> waterproof insulation



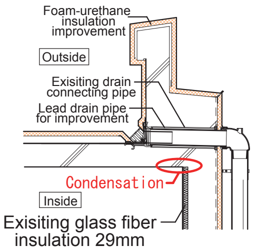
Temperature Range



Vapor Pressure

Wall Section (12/18 3:00 North Wall)

■ Effects of Improvement



Drain Section

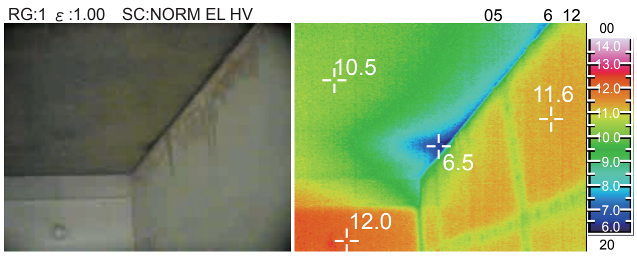


Photo and Thermo-Graph of Drain Area (2F Atelier)

After Improvement

■ Learning from the Project

Outside-insulation method makes a construction without residents having to move, which is desireble for aged clients. The spraying method was chosen because of the high insulation performance of the insulation material, the advantage against heat-bridge, the easy finish by coating and the cost. It was best cellection, but the thickness of insulation material was insufficient, and also small windows remained single-glazed due to the cost of the construction. Architects should fully understand how much they need as a sufficient insulation performance for the building.

Fig. 3 RC Detached House with Outside-Insulation (Project 2)

2.3 RC Building with Inside-Insulation (Project 3)

2.3.1 Building outline and pre-improvement thermal condition

This RC building was built in central Tokyo about 30 years ago and is a four stories building. The ground floor is used as a factory, while the first floor is for storage, and the upper two stories are for residence. The renewal of the second floor flat was planed. This building had no insulation, and the windows were single glazed, hence it was hot in summer and cold in winter, and condensation is the biggest problem.

2.3.2 Requirements and problems for renewal

The clients' requirements were the followings: to get well communication among family, to have sufficient storage space, to solve the problems of hotness, coldness and condensation, to prevent the traffic noise and to avoid neighbors' eyes.

2.3.3 Study of thermal improvement and decisive factors to select the insulation method

Since the renewal was limited only to the second floor, the inside-insulation construction method was selected. With the cost in mind, we thoroughly examined the effect of insulation. The simulation results revealed that the heat load of the building, when all parts of the ceiling, wall and floor were insulated with thinner material, was almost equivalent to that when insulating the wall and the perimeter zones (0.6 m) of the ceiling and floor with twice the thickness of insulation material. Therefore, the construction method to insulate all parts was selected. Also, the double-glazing windows were adopted.

The architects proposed a plan utilizing the buffer zone in response to the clients' request and to reduce the heat load. In the first plan, the study/work spaces were located in the buffer zone, but the thermal condition in the buffer zone was assessed as unacceptable.

2.3.4 Solutions

Following this project, the client changed the renewal from the second floor to the top floor, and the architect re-planned. The urethane foam spraying method was also selected to insulate most parts of the flat. The thickness of the insulation is 40 mm for walls and 70 mm for ceilings. The floor was filled with 75 mm of glass fiber. As for the windows, pair-glazing wood-frame windows were added to the existing single-glazing windows.

The idea of buffer zone was examined carefully so that the study/work space was changed to the storeroom in the final plan. Furthermore, the architects proposed an exhaust system utilizing the roof-space, where the skylights made by glass-blocks are provided. This roof-space is also another buffer zone.

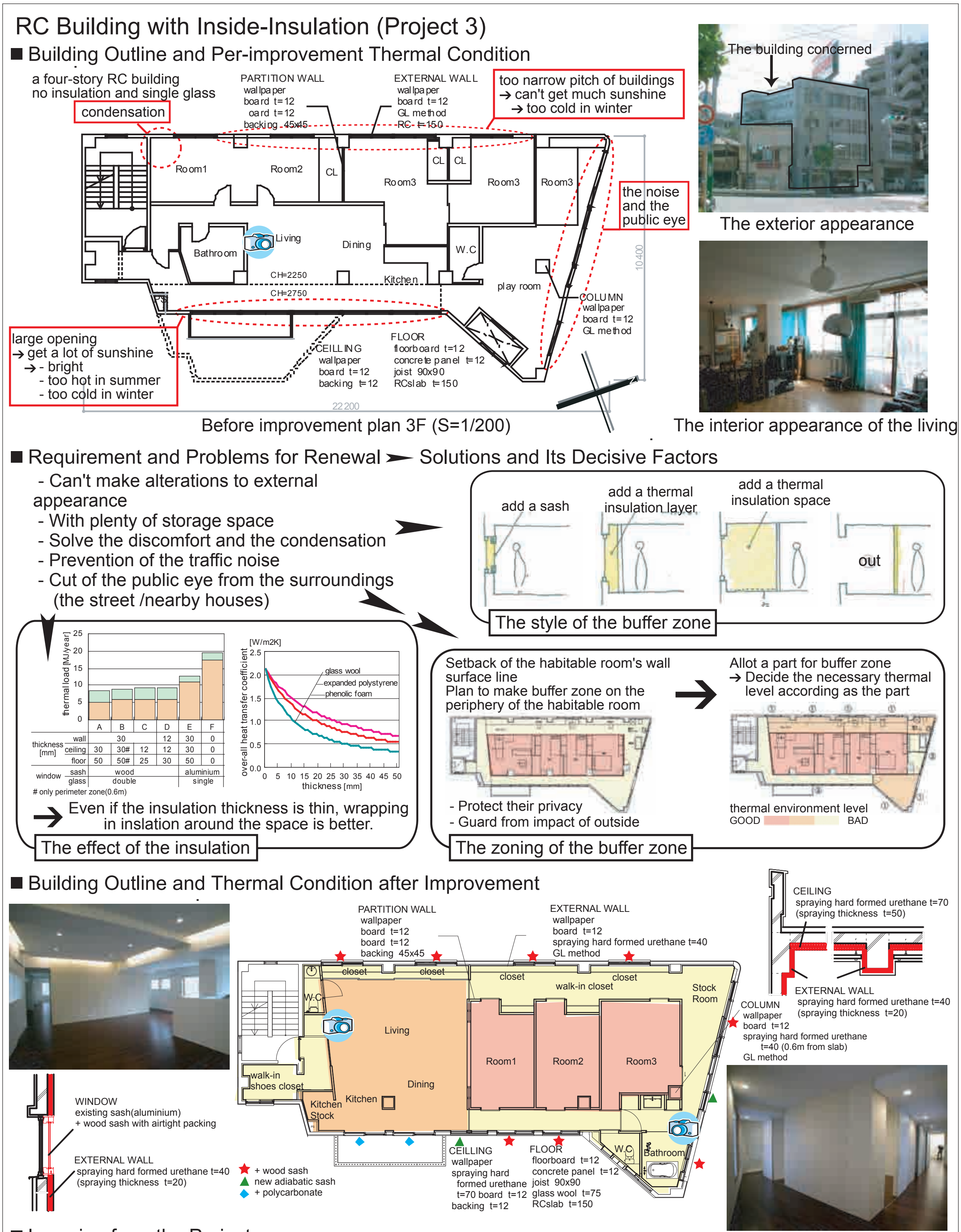
2.3.5 Effects of improvement

This residence is fit for the 1999 Standard. The completion of building was May this year, so that the performance of this residence is not clear yet. But it is expected we have a good result.

2.3.6 Learning from the project

When the inside-insulation method is used, it is difficult to use thick material, so that high performance insulation material is needed. The method to install new pair-glazing windows onto existing windows is effective to enhance the performance. The creation of a buffer zone also presents a good solution, although attention must be paid to the temperature change of the zone itself.

At the beginning of the project, the architects had relatively little understanding of passive design, but they eventually came up with the proposed high-level design within a thermal environment. Therefore, it is considered that general architects, especially the younger among them, will be capable of mastering actual passive design methods, provided they can practice several projects collaborating with architectural environment specialists. This highlights the need for actual exercises, like our COE projects, which is effective in enlightening architects who have insufficient understanding of passive and low energy architecture. Furthermore, after the clients moved to the new residence, they understood the advantage of thermal insulation improvement well, and are planning to apply it for another building.



Learning from the Project

When the inside-insulation method is used, it is difficult to use thick material, so that high performance insulation material is needed. The method to add new pair-glazing windows onto existing windows is effective. The creation of a buffer zone also presents a good solution, although attention must be paid to the temperature change of the zone itself. It is considered that general architects will be capable of mastering actual passive design methods, provided they can practice several projects collaborating with architectural environment specialists, like our COE program.

Fig. 4 RC Building with Inside-Insulation (Project 3)

3. Conclusion

From the three projects relating to thermal insulation improvement, the following can be clarified.

Concerning the insulation materials, methods and planning,

(1) The thickness of the insulation material is required to be minimized, therefore, high-performance insulation material is needed, and also the reducing cost of them is equally important.

(2) The use of the outside-insulation construction method makes it possible to perform construction work without clients having to move, which is desirable for aged people.

(3) In the inside-insulation project, insulating all parts of the ceiling, wall and floor is better than insulating walls and perimeter zones (0.6 m) of the ceilings and floors.

(4) The method of adding a new pair-glazing window to the existing window is an effective way not only to enhance the thermal performance, but also to reduce the working load and the cost.

(5) The creation of buffer zone is one of good solutions, but attention must be paid to the temperature change of the zone itself.

Concerning the means popularizing the thermal insulation improvement,

(6) For effective improvement, it is very important that the clients understand the advantage of thermal insulation.

(7) There is a need for architects to have a greater understanding of passive design and a stronger spirit to promote the sustainable idea in actual projects.

(8) Actual exercises like our COE projects are needed and are effective in enlightening architects who have insufficient understanding of passive and low energy architecture.

In order to popularize environmentally friendly architecture, there is a need to produce many architects who have good understanding of passive design. Throughout the projects, it is clarified that the architects who have insufficient knowledge of passive and low energy architecture will be able to master the actual passive design methods if allowed to practice a few projects in collaboration with architectural environment specialists. It is hoped that considerable collaboration between architects and specialists will be carried out on a wider basis. Of course, at the same time, efforts to produce many engineers capable of understanding architectural design are also needed.

Acknowledgements

This paper is based on the results of the Tokyo Metropolitan University 21st COE Program, 'Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis'. We appreciate all those concerned in these projects, especially clients, Prof. M. Koizumi, Prof. A. Nagata, Mejiro Studio and students; K. Nemoto, A. Yokota, A. Suzuki and S. Matsumoto.

References

IBEC. 1999. Standard and Guideline of Residents' Energy Conservation into the Next Future. *Institute for Building Environment and Energy Conservation*.

Koyama, Y., A. Nagata and et al. 2005. The Performance Assessment Study of Heat Insulation at Timbered House. *Summaries of Technical Papers of Annual Meeting, A.I.J., D-2*: 205-206.

Yokota, A. N. Sunaga and et al. 2006. Effect of outside-insulation repairing to the RC detached house in Toyama. *Proceedings of JSES/JWEA Joint Conference (2006)*: 389-392

Yokota, A. N. Sunaga and et al. 2006. Simulation study on improvement of thermal performance of housing stocks by insulation - Effect of inside-insulation on thermal performance of a RC residential building -. *Summaries of Technical Papers of Annual Meeting, A.I.J., D-2*: 103-104

The New Transformation Meter; A new evaluation instrument for matching the market supply of vacant office buildings and the market demand for new homes

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Keywords: Transformation, Quick Scan, Feasibility, Office Building Activation

Abstract

It is important to have an effective means of determining the transformation potential of office buildings that are unoccupied or are likely to become unoccupied in the near future. We need to be able to measure this transformation potential both at location and at building level, and it will be convenient to be able to carry out both a quick, superficial appraisal (which we may call a 'quick scan') and a more thorough, detailed study (a 'feasibility scan'). To this end, we have developed what we call a 'transformation potential meter' (Geraedts and Van der Voordt, 2000, 2003). The meter has been tested in practice by a number of market players, and has also been widely used by students of architecture who are nearing the end of their degree course. As befits good students, they have subjected the instrument to critical appraisal. This practical application has allowed the transformation potential meter to be evaluated and refined in 2006. Two new steps - the financial feasibility scan and the risk assessment checklist – have also been added to permit further investigation of the feasibility of a transformation project. In this paper, we describe the principle of the new transformation potential meter and its position in the Go/No Go decision-making process in the initial phase of a transformation project.

1. The transformation prospects of unoccupied office buildings

According to experts from the world of professional practice, the transformation prospects of the current offering of office buildings depend primarily on the following three factors:

1 *Duration of vacancy:* The longer an office building is unoccupied, the readier the current owner will be to convert it so that it can be used for another purpose.

2 *Reason for vacancy: market, location or building:* When an office building is unoccupied because of market factors, transformation would not seem to be an attractive option from the owner's viewpoint if the market is strengthening. If the location is unsuitable for office purposes and/or the building does not meet (or no longer meets) the requirements for office use, transformation may be a good idea. If the vacancy is due to building-related factors, the transformation potential is highly dependent on the extent to which the building can be converted by design interventions into an attractive residential property meeting the requirements and wishes of local target groups. Financial feasibility and permission to modify the zoning plan are critical factors for success in this context.

3 *Municipal policy:* When the office building in question lies in an area that has been prioritised for residential use by the municipal authorities, transformation into residential housing would seem to be an obvious solution since this is in line with municipal policy. If on the other hand the building is in an area earmarked for (re)development for office use, renovation and reuse for office purposes would seem to be more appropriate.

2. Demand for housing

Transformation of unoccupied offices into housing only makes sense if the dwelling units produced meet a need. The supply must be in line with the demand, as regards both the location – which should be a residential environment – and the features of the building (an office building will in general be converted into a block of flats comprising individual dwelling units). Since nearly a quarter of people looking for housing are under 25 (including many students), transformation into low-cost accommodation may be a good choice. Where high-rise office buildings are concerned, transformation into accommodation for families with young children is less appropriate. Conversion into flats for senior citizens might be a good choice here. Tests of the ability of a transformed building to meet the desires and preferences of potential target groups may be based on the results of various studies of the factors determining the choice of dwelling (see e.g. De Jong, 1997; Priemus, Wassenberg and Van Rosmalen, 1995). Where possible and appropriate, such studies differentiate between the various target groups concerned. The type and size of the housing, an attractive, safe dwelling environment and affordability are important criteria for all target groups. The main differences concern such matters as price and quality level, preference for a family house or a flat, and the desire to live in a lively environment with plenty of facilities or in a more peaceful environment.

Table 1 Relevant Aspects on Demand Side Residential Accommodation

Location (dwelling environment)	Building (residential)
1. Tone	1. Dwelling type
a. Nature of built environment	2. Access
b. Social image	3. Dwelling size
c. Liveliness	a. Number of rooms
d. Amount of green space	b. Living room
2. Amenities	c. Kitchen
a. Shops	d. Bedrooms
b. Restaurants, bars etc.	e. Sanitary facilities
c. Schools	f. Storage space
d. Bank/Post Office	4.Arrangement of dwelling
e. Medical facilities	5. Level of facilities
f. Recreative facilities	6. Outside space (garden etc.)
3. Accessibility public transport	7. View from dwelling + privacy
a. Distance to bus stop	8. Evnironmental aspects
b. Frequency and times	a.Heating
c. Distance to tram or underground	b. Ventilation
d. Frequency and times	c. Noise
e. Distance to railway station	d. Exposure to sun and daylight
f. Frequency and times	e. Energy consumption
4. Accessibility by car	f. Materials used
a. Distance to motorway	9. General conditions
b. Congestion level	a. Accessibility
c. Parking facilities	b. Safety
	c. Flexibility
	d. Adequate management
	10.Costs
	a. Purchase price/rent
	b. Other costs

If one wishes to use a Quick Scan to determine whether an unoccupied (office) building is suitable for transformation to residential accommodation for one or more specific target groups, a demand profile must first be created for each target group. This is also necessary when looking for a suitable building for a specific target group. The five target-group profiles shown in Table 2 have been defined on the basis of the dwelling preferences of the persons concerned.

Table 2 Five Target-group Profiles with dwelling preferences for inner-city transformations

Target group 1: Starters	Target group 2: Starters	Target group 3: Young, two-income
Young, low-income singles Shared accommodation	Young, low-income singles Semi-independent accommodation	Young couples with two incomes
Location (dwelling environment)	**Location (dwelling environment)**	**Location (dwelling environment)**
1. Urban environment 2. Plenty of amenities	1. Urban environment 2. Plenty of amenities	1. Urban environment 2. Plenty of amenities 3. Suburban (more space, green) 4. Easily accessible by car 5. Good parking facilities
Building (features of dwelling)	**Building (features of dwelling)**	**Building (features of dwelling)**
3. Unit in group of 3-7 occupants 4. Bedsit, average 22 m2 5. Shared sanitary facilities 1 shower/toilet per 4 units 6. Shared kitchen with table for meals 7. Shared outside space (garden, etc.) 1.5 m2/unit 8. Shared cycle storage 9. Shared washroom 10. Total 50 m2; useful floor area 35 m2	3. Semi-independent unit with shared facilities 4. Bedsit, average 22 m2 5. Sanitary facilities for 2 persons 6. Kitchen for 2 persons 7. Shared outside space (garden, etc.) 1.5 m2/unit 8. Shared cycle storage 9. Shared washroom 10. Total 50 m2; useful floor area 35 m2	6. Big luxury flat 7. Own outside space (garden, etc.)
Costs	**Costs**	**Costs**
11. Max. rent 160 - 220 Euro	11. Max. rent 220 - 320 Euro	8. Max. rent 550 - 750 Euro 9. ditto 750 - 1000 Euro for top flat 10. Purchase 100,000 - 200,000 Euro

Target group 4: Senior citizens 55+	Target group 5: Senior citizens 55+
Low to modal income	Above-modal income
Location (dwelling environment)	**Location (dwelling environment)**
1. Safe dwelling environment (social safety) 2. Shops, daily amenities and public trans- port within walking distance (<500 m) 3. Urban environment 4. Suburban (more space, green)	1. Safe dwelling environment (social safety) 2. Shops, daily amenities and public trans- port within walking distance (<500 m) 3. Easily accessible by car 4. Good parking facilities 5. Some like urban, some like suburban
Building (features of dwelling)	**Building (features of dwelling)**
5. Preferably not on ground floor 6. With lift in building 8. Preferably not with internal staircase 8. At least 3 rooms 9. Living room 25 - 30 m2; bedroom > 11.5 m2 10. Direct link living room, bedroom, bathroom 11. Extra attention to acoustic insulation 12. Adaptable for disabled occupants	6. Preferably not on ground floor 7. With lift in building 8. Preferably not with internal staircase 9. Access via entrance hall, not via gallery 10. 4 - 5 rooms 11.Living room 30 - 40 m2; big kitchen 12. Direct link living room, bedroom, bathroom 13. Amply sized bathroom 14. Balcony or roof garden 10 - 15 m2 15. Extra attention to acoustic insulation 16. Adaptable for disabled occupants
Costs	**Costs**
13. Max. rent 400 Euro 14. Purchase 75,000 - 110,000 Euro	17. Rent 550 - 1100 Euro 18. ditto > 1100 Euro for top flat 19. Purchase 110,000 - 500,000 Euro

3. The New Transformation Potential Meter

The information collected about the transformation prospects, the housing requirements of potential occupants and the target-group profiles has been used as a basis for a number of checklists that can be used to appraise the potential of the stock of unoccupied office buildings for transformation into residential housing. This appraisal takes place in a number of steps, from more superficial to more detailed and specific. Step 0 is the inventory of the unoccupied office space. Step 1 is a Quick Scan of the transformation potential of this stock, with reference to a limited number of veto criteria which fall under the headings Market, Location, Building and Organisation. Failure of a building to meet these criteria means that it does not have sufficient transformation potential and thus leads to a NO GO decision. Step 2 is a more detailed feasibility scan, which shows with reference to appropriate criteria which features of the location and the building lend themselves to transformation and which do not. This then leads in step 3 to the assignment of an overall score expressing the transformation potential of the building(s) in question on a scale varying from non-transformable to highly suitable for transformation. Depending on the results, this leads either to a NO GO decision or to further refinement of the feasibility study in two subsequent phases: step 4 (financial feasibility scan) and step 5 (risk assessment checklist). Depending on the nature of the project involved, step 5 may come before step 4. The transformation potential meter is particularly intended for use in the initial phase of the plan development process, from the first quick scan to the taking of a well-based decision as to whether or not to proceed with the project.

Table 3 The various steps of the New Transformation Potential Meter

Step	Action	Level	Outcome
Step 0	Inventory market supply of unoccupied offices	Stock	Location of unoccupied offices
Step 1	Quick Scan: initial appraisal of unoccupied offices using veto criteria	Location Building	Selection or rejection of offices for further study; GO / NO GO decision
Step 2	Feasibility scan: further appraisal using gradual criteria	Location Building	Judgement about transformation potential of office building
Step 3	Determination of transformation class	Location Building	Indicates transformation potential on 5-point scale from very good to NO GO
Further analysis (optional, and may be performed in reverse order if so desired):			
Step 4	Financial feasibility scan using design	Building	Indicates financial/economic feasibility Sketch and cost-benefit analysis
Step 5	Risk assessment checklist	Location Building	Highlights areas of concern in transformation plan

Step 0: Inventory of supply at district level

Before starting to use the transformation potential meter proper, an inventory should first be taken of the market supply of office buildings in a given municipality that have been unoccupied in the long term or may be expected to become unoccupied in the near future. Information for this purpose may be obtained from literature surveys, data from estate agents or the investigator's own observations. If adequate information is already available about a given unoccupied building, this step can be skipped.

Step 1: Quick Scan; first impression, evaluation with aid of veto criteria

The instrument offers the user the possibility of performing a quick initial appraisal of the transformation potential, which is not very labour-intensive and does not require much data. This quick scan makes use of eight veto criteria that fall under the headings Market, Location, Building and Organisation.

Table 4 Step 1 – The Quick Scan with the aid of Veto Criteria

STEP 1 QUICK SCAN: INITIAL ASSESSMENT USING VETO CRITERIA		
ASPECT	**VETO CRITERION**	**DATA SOURCE**
MARKET		
1 Demand for housing	1 There is no demand for housing from local target groups	Estate agent/municipality
LOCATION		
2 Urban location	2 Zoning plan does not permit modification 3 Serious public health risk (pollution, noise, odour)	Zoning plan/munic. policy Estate agent/on-site inspect.
BUILDING		
3 Dimensions of skeleton	4 Free ceiling height < 2.60 m	Estate agent/on-site inspect.
ORGANISATION		
4 Backer for transformation plan	5 There is no enthusiastic, influential backer	Local investigation
5 Internal veto criteria of property developer	6 Does not meet criteria for region/location/accessibility 7 Does not meet criteria on size and character of building	Property developer Property developer
6 Owner/investor	8 Not willing to sell office building	Owner

A veto criterion is a criterion which if satisfied (if the answer to the relevant question is 'Yes') leads to immediate rejection of the idea of transforming the office premises in question into residential accommodation. Further detailed study is then no longer necessary. This is thus an effective means of picking out promising candidates for transformation quickly from the overall potential market.

The veto criteria apply to all target groups. Veto criteria 2 and 3 at location level concern the situation of the building within the urban fabric. If for example the office building is located on an industrial site where serious public-health hazards have been discovered, or if the municipal authorities do not allow any modification of the zoning plan at this location, there is little point in taking the investigation of the transformation potential any further.

Step 2: Feasibility scan based on gradual criteria

If the results of the Quick Scan indicate that there is no immediate objection to transformation (no single question is answered 'Yes'), the feasibility of transformation can be studied in greater detail with reference to a number of 'gradual' criteria, i.e. criteria that do not lead to a GO / NO GO decision but that express the transformation potential of the building in question in terms of a numerical score. Taken together, these criteria allow a more rounded picture to be built up of the feasibility of the transformation project under consideration.

Table 5 Step 2a – Appraisal of suitability of an office building for transformation to residential housing with reference to features of its location

STEP 2 FEASIBILITY SCAN USING GRADUAL CRITERIA			
LOCATION			
ASPECT	**GRADUAL CRITERION**	**DATA SOURCE**	**Appr Yes**
FUNCTIONAL			
1 Urban location	1 Building in industrial estate or office park far from town centre	Town map	
	2 Building gets little or no sun	On-site inspection	
	3 View limited by other buildings on > 75% of floor area	On-site inspection	
2 Distance and quality of amenities	4 Shops for daily necessities > 1 km.	On-the-spot investigation	
NB:	5 Neighbourhood meeting-place (square, park) > 500 m.	ditto	
The quality of amenities can be described	6 Hotel/restaurant/snackbar > 500 m.	ditto	
in terms of number, variety and level	7 Bank/Post Office > 2 km.	ditto	
of services provided.	8 Basic medical facilities (practice, health centre) > 5 km.	ditto	
	9 Sports facilities (fitness, swimming pool, sports park) > 2 km.	ditto	
	10 Education (from kindergarten to university) > 2 km.	ditto	
3 Public transport	11 Distance to railway station > 2 km.	Town map	
	12 Distance to bus/underground/tram > 1 km.	Map or transport services	
4 Accessibility by car and parking	13 Many obstacles; traffic congestion	On-the-spot investigation	
Obstacles: narrowing of road, speed bumps, bridge	14 Distance to parking sites > 250 m.	Inspection/new design	
Congestion: 1-way traffic, no parking, tailbacks	15 <1 parking space/100 m2 road surface	Inspection/new design	
CULTURAL			
5 Tone of neighbourhood	16 Situated on or near edge of town (e.g. near motorway)	Map or estate agent	
NB:	17 No other buildings in immediate vicinity	Map or estate agent	
Assessment depends on target group, e.g.:	18 Dull environment	On-the-spot investigation	
young people not in monofunctional neighbourhood	19 No green space in neighbourhood	On-the-spot investigation	
55+ not on edge of town	20 Area has poor reputation/image; vandalism	Inspection and local press	
	21 Dangerous, noise or odour pollution (factories, trains, cars)	On-the-spot investigation	
LEGAL			
6 Urban location	22 Noise load on façade > 50 dB (limit for offices 60dB)	Municipal authorities	
7 Ownership of ground	23 Leasehold	Estate agent	

The feasibility scan at location level (Table 5) comprises 7 main criteria, subdivided into functional, cultural and legal aspects, and 23 sub-criteria. The feasibility scan at building level (Table 6) comprises 13 main criteria, subdivided into functional, technical, cultural and legal aspects, and 13 sub-criteria. An answer 'Yes' to any question indicates somewhat lower suitability for transformation – though not severe enough for out-and-out rejection. At the end of the scan, the Yes's are added up to obtain the overall transformation potential score – the lower the better. This is described under step 3 below. It may be noted that the criteria vary somewhat, depending on the target group under consideration. For example, students will prefer to live in the city centre where there is more night life, while young families with children will tend to opt for a peaceful suburban environment.

Table 6 Step 2b - Appraisal of suitability of an office building for transformation to residential housing with reference to features of the building itself

BUILDING			
ASPECT	GRADUAL CRITERION	DATA SOURCE	Appr Yes
FUNCTIONAL			
1 Year of construction or renovation	1 Office building recently built (< 3 years)	Year of construction	
	2 Recently renovated as offices (< 3 years)	Year of renovation	
2 Vacancy	3 Some office space still in use	e.g. NEPROM	
	4 Building unoccupied < 3 years	ditto	
3 Features of new dwelling units	5 ≤ 20 -person units (50 m2 each) can be made	≤ 1000 m2 useful area	
	6 Layouts suitable for local target groups can't be implemented	Design sketch	
4 Extendability	7 Not horizontally extendable (neighbouring buildings)	On-the-spot investigation	
	8 No extra storeys (pitched roof; insufficient load-bearing cap.)	On-the-spot investigation	
	9 Basement cannot be built under building	Inspection and/or estate agent	
TECHNICAL			
5 Maintenance	10 Building poorly maintained/looks in poor condition	External visual inspection	
6 Dimensions of skeleton	11 Office depth < 10 m	Estate agent or inspection	
Module of façade determines placing of walls	12 Module of support structure < 3.60 m	On-site or estate agent	
	13 Distance between floors > 6.00 m	On-site or estate agent	
7 Support structure (walls, pillars, floors)	14 Support structure is in poor/hazardous condition	On-site inspection	
8 Façade	15 Can't be made to blend with surroundings or module > 5.40 m	On-site or estate agent	
External spaces dependent on target group	16 Façade (or openings in façade) not adaptable	On-site inspection	
Protected monuments: limits on adaptation	17 Windows cannot be reused/opened	Inspection/new design	
9 Installations	18 Impossible to install (sufficient) service ducts	Inspection/new design	
CULTURAL			
10 Character	19 No character in relation to surrounding buildings	On-site inspection	
cf. Location, 'Tone of neighbourhood'	20 Impossible to create dwellings with an identity of their own	Inspection/new design	
11 Access (entrance hall/lifts/stairs)	21 Unsafe entrance, no clear overview of situation	Inspection/new design	
LEGAL			
12 Environment	22 Presence of large amounts of hazardous materials	On-site or municipality	
Exposure to sunlight, air and noise	23 Acoustic insulation of floors < 4 dB	Inspection/new design	
pollution, hazardous materials	24 Very poor thermal insulation of outer walls and/or roof	On-site or municipality	
	25 < 10% of floor area of new units gets incident daylight	On-site inspection	
13 *Requirements of Bouwbesluit (Dutch official regulat*	26 No lifts in building (> 4 storeys), no lifts can be installed	On-site or estate agent	
and standards for the building industry)	27 No (emergency) stairways	Inspection/new design	
concerning access and escape route	28 Distance of new unit from stairs and/or lift ≥ 50 m	Inspection/new design	

Step 3: Determination of the transformation class

The results of the feasibility scan can be used to calculate a transformation-potential score for the building in question, on the basis of which the building can be assigned to one of five transformation classes ranging from 'ideal for transformation' to 'not suitable for transformation'.

Total number of Yes's (Location):	8	x
Default weighting:	5	=
Score (Location):	40	A
Max. possible score (23x5):	115	

Total number of Yes's (Building):	11	x
Default weighting:	3	=
Score (Building):	33	B
Max. possible score (28x3):	84	

Fig. 1 The total transformation-potential scores at Location and Building level are determined by multiplying the number of Yes's in the Appraisal column by the default weighting factor

The total scores for the location and the building are determined by multiplying the number of Yes's in the respective tables by a weighting factor, which has provisionally been chosen as 5 for the location and 3 for the building to reflect the greater relative importance of the location in these considerations. The maximum possible score for the location is thus 23 x 5 = 115, and that for the building 28 x 3 = 84, to give a grand total of 115 + 84 = 199 (see Fig. 1). The minimum score is zero, which would indicate that no single feature of the location or the building is considered unsuitable for transformation. On the basis of the transformation-potential score, the building can be assigned to one of five Transformation classes. Buildings in Transformation Class 1 (score lower than 40), are highly suitable for transformation to residential accommodation, while those in Class 5 (score higher than 161) are totally unsuitable for transformation. All five Transformation classes are given in Table 7.

Table 7 Transformation classes for office buildings; in the example shown, a total score of 77 corresponds to Transformation class 2 (transformable)

STEP 3: DETERMINATION OF TRANSFORMATION CLASS OF OFFICE BUILDING		
Transformation score Location + Building = 0 - 40	Transformation class 1: Excellent transformability	Total Score A + B: 77
Transformation score Location + Building = 41 - 80	Transformation class 2: Transformable	Max. Score Location + Building
Transformation score Location + Building = 81 - 120	Transformation class 3: Limited transformability	= 115 + 84 = 199
Transformation score Location + Building = 121-160	Transformation class 4: Very poor transformability	
Transformation score Location + Building = 161-199	Transformation class 5: Not transformable	TRANSFORMATION CLASS: 2

Determination of the transformation class of a building completes the first three steps of the transformation potential measurement. If the results indicate that the building lends itself to transformation (i.e. that it falls into transformation class 1 or 2), the analysis can continue in two additional steps, aimed at studying the financial feasibility of the transformation project and carrying out a risk assessment for use in further planning.

Step 4: Financial feasibility scan

If the transformation project is not financially feasible, there is no point in taking the plans any further. The financial feasibility depends among other things on the acquisition costs, the current condition of the building, the amount of renovation or modification work required, the number of dwelling units that could be created in the building and the project yield in the form of rental income and/or sales prices.

In order to determine the financial feasibility, answers must be obtained to a number of questions concerning both the project costs and the expected revenue. On the revenue side, we need to know how many dwelling units can be created and for what target groups they are intended. These questions can only be answered if a sketch has been made of the intended layout of the building after transformation. The financial feasibility can be raised by increasing the size of the building, e.g. by adding extra storeys on top, or by the inclusion of commercial functions alongside the residential ones.

On the expenses side, it is necessary to know the acquisition costs for the premises, including the cost of the ground. Building and installation costs are also an important factor. What is the current condition of the building? Which parts can be reused, and which will have to be demolished? What is the ratio of façade surface area to gross floor area (GFA)? To what level should the building be finished? To what extent can the existing stairways, lifts and other means of access and façade proportions be maintained?

Table 8 Expected investment costs per dwelling unit and per m2 GFA for student accommodation created by transformation of office buildings (ref. Stadswonen Rotterdam, index April 2006)

Type of construction project		Type of budget	Costs per unit	Costs per m² GFA
Transformation	Much demolition and modification	Acquisition budget for student unit	10,000 - 15,000	
		Residual budget for renovation costs	27,000 - 33,000	540 - 660
	Much reuse (including façade)	Acquisition budget for student unit	20,000 - 25,000	
		Residual budget for renovation costs	21,000 - 26,000	420 - 540
New construction		Student unit	36,000 - 39,000	720 - 780
		Social housing		890 - 970
		Luxury flat		1.100

Table 8 gives some key figures that can be used for a quick cost-benefit analysis based on initial design sketches. It shows the estimated range of total investment costs (acquisition and building costs) for the transformation of existing (office) buildings to student accommodation, per dwelling unit and per m2 of GFA, compared with the costs of comparable new buildings. After a rough cost-benefit analysis has been made on the basis of a sketch of the way in which various dwelling types and lay-outs can be fitted into the existing office building, these data can be used as input for the development plans of the property developer.

Step 5: Risk assessment checklist

When the Quick Scan indicates that the office building in question has transformation potential at both the location and the building level and the results of the initial financial feasibility analysis are also encouraging, work may proceed on the subsequent development phases. It is of great importance to be aware of the possible bottlenecks and risks that can occur during this process. Two checklists, based on experience gained in a large number of projects, that can prove useful in this context have been developed.

4. Conclusions

Practical trials of the Transformation potential meter in practice have revealed its utility for mapping the potential of given office buildings for transformation into residential accommodation in a number of steps from global to more detailed. It was found, however, that a number of veto criteria included in the original version of the meter were too stringent. Some buildings that failed to pass these criteria on paper were found in practice to lend themselves well to transformation to residential accommodation. For example, a project size of less than 20 dwelling units (2000 m2), a building that was still partially occupied, a duration of vacancy of less than three years or an age of less than three years for the building in question were not necessarily reasons for rejecting the idea of transformation. It was moreover found to be highly desirable to combine the first three stages of the Transformation potential meter (Quick Scan, feasibility scan and determination of transformation class) with a financial feasibility scan and a risk assessment (the readiness of the municipal authorities to approve any changes in the zoning plan required for success of the project is one of the points that needs to be thoroughly explored in advance in this context). Additional literature review is required to cover the international state of the art of the topic discussed in this paper.

References

Boer, K.J. (2004), *Tijdelijk transformeren van kantoren naar woningen.* Master’s thesis, TU Delft

Geraedts, R.P. and D.J.M. van der Voordt (2003), *Offices for living in.* An instrument for measuring the potential for transforming offices into homes. Open House International Vol. 28 No. 3, 80-90.

Jongeling, N. (2006), *Transformationpotentie van Rabo Bank kantoren*. Master’s thesis, TU Delft.

Magielsen, J. (2004). *Transformeren: interessant voor beleggers*? Master’s thesis, TU Delft.

Pang, K. (2006), *Niewe woningen in een oud kantoor*. Master’s thesis, Faculty of Architecture, TU Delft.

Vrij, N. de (2004), *Transformationpotentie: meten is weten*. Master’s thesis, Faculty of Architecture, TU Delft.

Voordt, D.J.M. van der, et al (2007), *Transformation of Office Buildings*, Book (Dutch), 010 Publishers, Rotterdam.

Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo Part 5 Application of Microtremor Measurement

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Abstract
This paper presents the results of microtremor measurements of timber houses. The aim of this research is to clarify the structural performance from the fundamental vibration characteristics. Authors obtained microtremor measurements on eleven timber detached houses of either conventional timber frame construction or traditional timber construction. The houses are located in Tokyo, Gifu prefecture, and Yamaguchi prefecture. In this research, several houses that differ in construction type, year of construction and building configuration are categorized into a house type. The results of the microtremor measurements are evaluated for each category. Finally the validity of the microtremor measurements in the evaluation of structural performance of timber structures is discussed in detail.

1. Introduction
Microtremor measurement is a nondestructive inspection method and a simple method to evaluate the vibration characteristics of structures. Therefore microtremor measurement is expected to play an effective role in the structural evaluation of existing timber houses because the measurement results can be used to calculate the natural frequency and damping factor. Many researchers have performed microtremor measurements of timber houses in the past, and the fundamental vibration characteristics of timber detached houses by microtremor measurement have been investigated. This study evaluates the results of microtremor measurement performed by the authors [1)-4)].

The first purpose of this study is to reveal the relation between the vibration characteristics and the building configuration and year of construction. This is done by classifying structure into categories. The second purpose of this research is to compare the results of microtremor measurements performed by the authors with those obtained in previous researches. By a discussion of the study results, the validity of microtremor measurement as a nondestructive inspection method is clarified.

2. Microtremor Measurement of Timber Houses

2.1 Outline

Microtremor measurements and forced vibration tests by human power were performed to clarify fundamental vibration characteristics such as the natural frequency, damping factor, and vibration mode of selected houses. This section explains the investigated houses subjected to microtremor measurements by the authors. The results of the microtremor measurements clarify the fundamental characteristics of vibration. Finally the differences according to house type are evaluated using the results of the microtremor measurements and the forced vibration tests.

2.2 Investigated Houses

The investigated houses are listed in Tables 1 and 2. Table 1 shows the houses of conventional timber frame construction and Table2 shows the houses of traditional timber construction. The houses in Table 1 are categorized as conventional or urban houses. The houses in Table 2 are categorized as farmhouses or folk houses. Brief descriptions of each investigated houses are described below.

1) **House *A* and *B*** : These houses are located in Shinagawa and Suginami in Tokyo. The construction method is conventional timber frame with plywood walls or mud hanging walls with covered plaster board. The roof is composed of clay tiles. They are common two-story detached houses. The authors categorize these houses as Conventional Houses. Reinforcement[1)] on these houses was performed in 2006 (House *A*) and 2005 (House *B*).
2) **House *C*, *D*, *E* and *F*** : These houses are located Kanda,[2)] in Tokyo. The construction method is conventional timber frame with walls of plywood, plaster board and mortar plastering. The roof is composed of clay tiles. The authors categorize these houses as Urban House. Urban House is known as *Machiya* in Japan. The majority of *Machiya* have the characteristic in which the narrow frontage side and the opening face a road. House *C* was rebuilt in 2003.
3) **House *a*, *b* and *c*** : These houses are located Takayama city in Gifu prefecture. Takayama city is located in the Hida region, in central Japan. The construction type is traditional timber. These are post and beam structures with timber siding walls and mud hanging walls. The roofs are either a half-hipped roof thatched with reed (house *a*), a gabled roof wooden with singles (house *b*) or a steep rafter thatched roof (known as *Gassho-zukuri* in Japan). The year of construction is between 17th to 18th century. The authors categorize these houses as a Farmhouse.

Table 1 The Characteristics of Investigated Houses (By Conventional Timber Frame Construction)

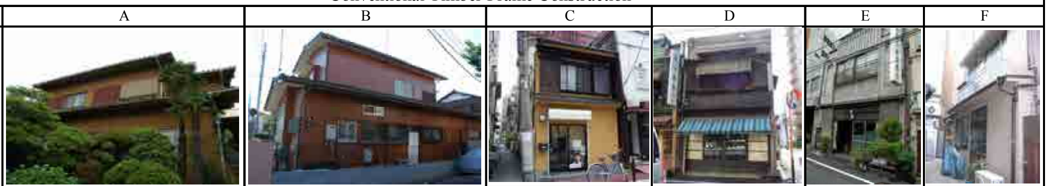
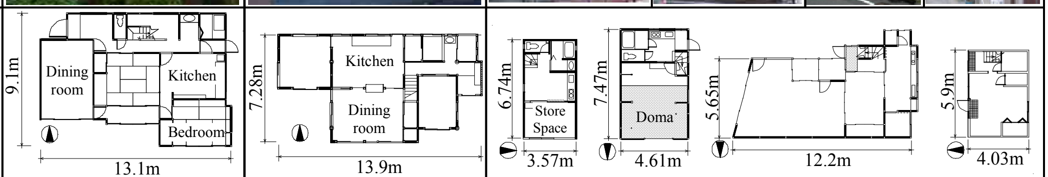
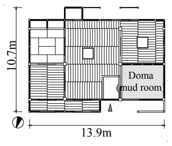
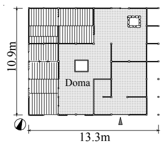
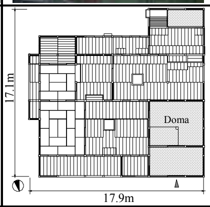
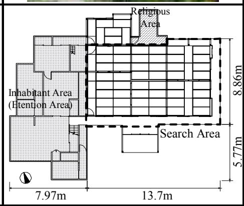
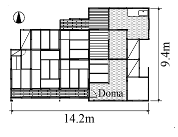
	Conventional Timber Frame Construction					
	A	B	C	D	E	F
Exterior						
1F Plan (Y, X)						
Location	Tokyo (Shinagawa)	Tokyo (Suginami)	Tokyo (Kanda)			
Construction Year	1961 (reinforced in 2006)	1966 (reinforced in 2005)	1930 (reinforced in 2003)	1930	1960	1965
House Type	Conventional Two-storied House		Urban Two-storied House (only F, Three-storied House)			
Wall	mud wall and plaster board	plywood and plaster board	plywood and plaster board, mortar plastering			
Roof	clay tiles					
1F Area (m^2)	99.8	83.64	23.89	35.26	68.12	23.89
Total Weight (kN)	583	377	92.3	164	303	113

Table 2 The Characteristics of Investigated Houses (By Traditional Timber Construction)

	Traditional Timber Detached Houses				
	a	b	c	d	e
Exterior					
1F Plan Y X					
Location	Gifu Pref. (Takayama)			Tokyo (Oume)	Yamaguchi Pref.
Construction Year	the 17^{th}-18^{th} century	the 17^{th} century	the end of 18^{th} century	the 19^{th}-20^{th} century	the 19^{th} century
House Type	farmhouse		house with a steep rafter roof	folk house	farmhouse
Wall	timber	timber and mud	timber	mud	mud
Roof	thatched roof	wooden singles	thatched roof		thatched roof (covering tin)
1F Area (m^2)	149	146	210	98.7 (only search area)	113
Total Weight (kN)	129	367	646		255

※The direction of X is the ridge direction and the direction of Y is the span direction in the 1F Plan row.
※The number described in brackets in the Construction Year row is the year in which reinforcement or rebuilding was performed.
※Total weight of conventional houses is the value estimated in seismic diagnosis and measurement investigation.

4) **House *d*** : This house is located in Oume City in western Tokyo. Oume city is a suburban form village in Tokyo. The construction type is traditional timber. This house is a post and beam structure with mud hanging walls. The roof is thatched with reed. The year of construction is between 19^{th} to 20^{th} century. The authors categorize this house as a Folk house. Investigation of this house was performed in the search for a 1F plan.

5) **House *e*** : This house is located in Yamaguchi Prefecture. Yamaguchi prefecture is located in southwestern Japan. The construction type is traditional timber. This house is a post and beam structure with mud hanging walls. The roof is thatched with reed covered with tin. The year of construction is sometime in the 19^{th} century. The authors categorize this house as a Farm house. Lateral loading tests were performed on this house in 2004.

2.3 Experimental Methods

Six velocimeters were used in the tests. Typical examples of the measurement program are shown in Fig.1. Each experiment was performed on two kinds of sets. Fig. 1-b is the set to determine the vibration mode of vertical motion. Fig.1-a, 1-c are the sets to determine the torsional mode. First, the microtremor measurement was conducted to identify the natural frequency in the first mode. Second, the forced vibration test in the first mode was performed by human power (e.g., some persons push column). The sampling frequency was 200Hz, which was measured by displacement. The recording time was 300 seconds for the microtremor measurement and 60 seconds for the forced vibration test.

2.4 Results of the Experiments

The natural frequency was determined by the predominant frequency of the transfer function and vibration modes. The transfer function was taken from the Fourier spectrum calculated by FFT analysis of the response wave of displacement. The vibration mode was determined from the phase difference and amplitude of the transfer function. The damping factor was calculated from the logarithmic decrement of the free vibration waveform and curve fitting of the transfer function by the formula of the amplification ratio. All results of the analysis are shown in Table 3. Each result is discussed below.

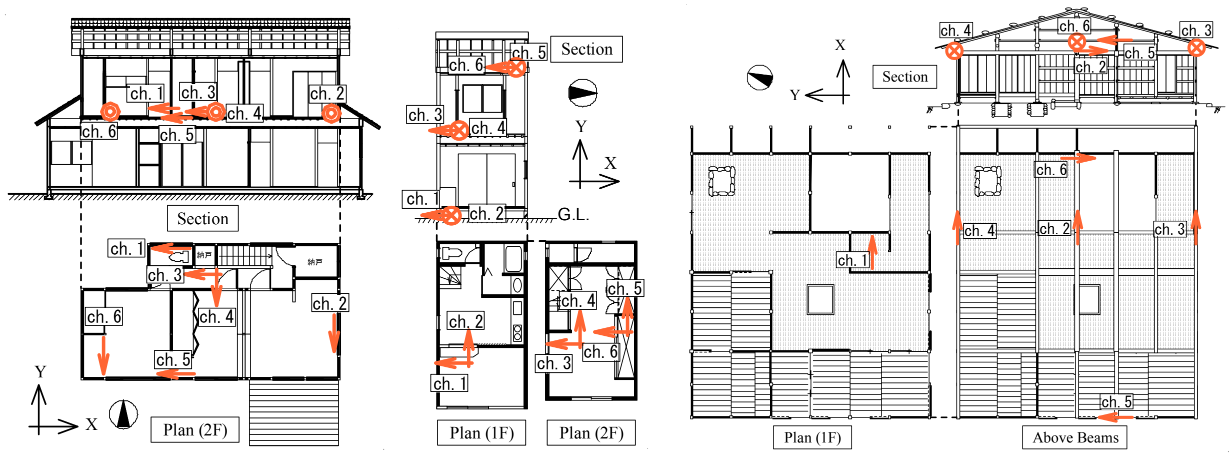


Fig.1-a) Conventional House (e.g. House A)

Fig.1-b) Urban House (e.g. House C)

Fig.1-c) Traditional House (e.g. House b)

Fig.1 Measurement Program

1) Natural Frequency of Vibration

The typical transfer functions of the investigated houses are shown in Fig. 2. Only house *d* is shown in the Fourier spectrum, because a good result was not determined. Urban houses have a common configuration of slenderness. Therefore, the predominant points in their transfer function are different in the ridge direction (X) and the span direction (Y). House *F* is an isolated example, because this figuration is almost square. In the comparison of the natural frequency of vibration in the first mode, the frequency is 3.4～4.7 Hz for conventional houses, 2.8～7.4 Hz for urban houses, 2.0～5.66 Hz for farm houses and folk houses.

Table 3 The Results of the Microtremor Measurement

Type	House		Plan (m)	Weight (kN)	Max. Disp. (mm)	Natural Freq. (Hz)	Damping Factor (%) Log	Damping Factor (%) Curve	Keq (kN/mm)	Keq ratio X/Y	Length ratio X/Y
Suburban	A	(X)	13	583	0.022	4.66	2.9	-	51	1.3	1.4
		(Y)	9.1		0.035	4.13	2.4	-	40		
	B	(X)	14	377	0.008	4.54	3.5	-	31	1.8	1.9
		(Y)	7.3		0.001	3.37	4.8	-	17		
Urban	C	(X)	3.6	92.3	0.027	5.08	1.2	-	10	0.5	0.5
		(Y)	6.7		0.020	7.42	1.0	-	20		
	D	(X)	4.6	164	0.036	2.83	2.2	-	5	0.2	0.6
		(Y)	7.5		0.020	6.93	1.3	-	32		
	E	(X)	12	303	0.054	5.37	2.8	-	35	2.2	2.2
		(Y)	5.7		0.011	3.60	0.8	-	16		
	F	(X)	4.0	113	0.010	5.57	-	-	14	1.0	0.7
		(Y)	5.9		0.013	5.47	-	-	14		
Farm	a	(X)	14	367	0.001	2.88	-	1.5	12	1.2	1.3
		(Y)	11		0.001	2.66	-	1.4	10		
	b	(X)	13	129	0.001	4.30	-	1.3	10	0.6	1.2
		(Y)	11		0.001	5.66	-	0.8	17		
	c	(X)	18	646	0.003	2.71	-	1.9	19	1.8	1.0
		(Y)	17		0.006	2.00	-	1.7	10		
	e	(X)	14	255	0.015	3.91	2.9	-	16	1.2	1.5
		(Y)	9.4		0.030	3.52	2.6	-	13		
Folk	d	(X)	14	283	0.002	3.13	2.0	2.2	11	1.0	1.5
		(Y)	8.9		0.004	3.13	2.6	3.2	11		

※X is ridge direction and Y is span direction in the House row.

※In the damping factor column, “Log” is a calculation from the logarithmic decrement of the free vibration waveform, “Curve” is a calculation from curve fitting of the transfer function by the formula of the amplification ratio.

※Keq is the equivalent stiffness calculated from the relation of the weight and the natural frequency of vibration in the first mode, using the following calculation.

$$K_{eq} = (2\pi f)^2 \times m / 1000$$

(K_{eq} (kN/mm): equivalent stiffness, f (Hz): first natural frequency, m (t): the weight of house estimated in seismic diagnosis)

※The natural frequency of vibration in first mode of A, B and C are the value investigated after reinforcement.

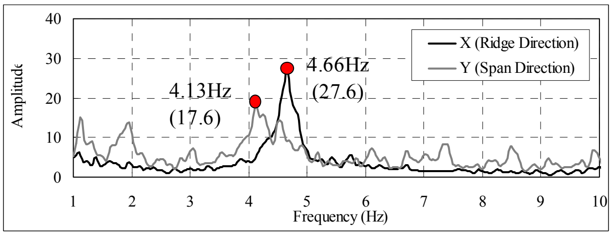


Fig.2-a) House A (after reinforcement)

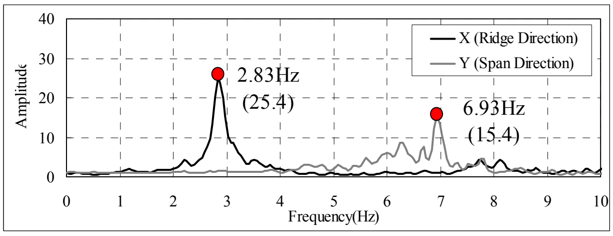


Fig.2-b) House D

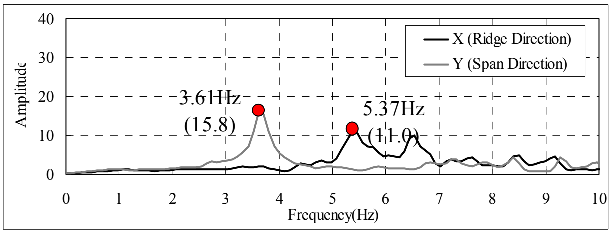


Fig.2-c) House E

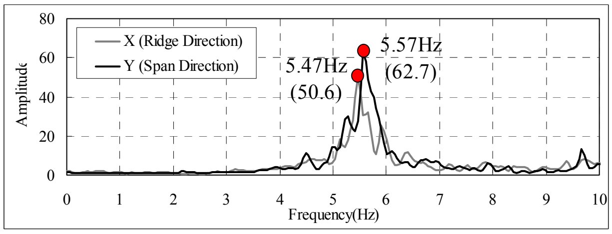


Fig.2-d) House F

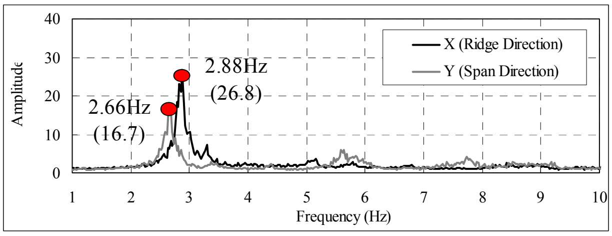


Fig.2-e) House a

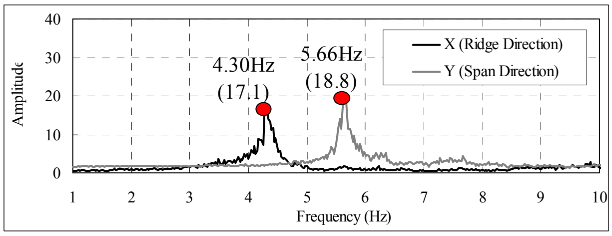


Fig.2-f) House b

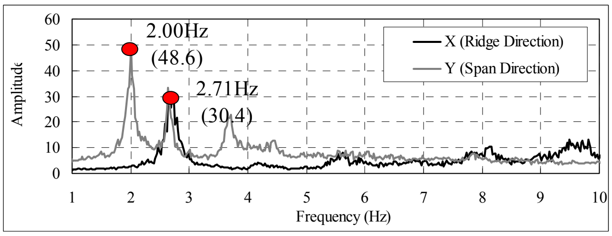


Fig.2-g) House c

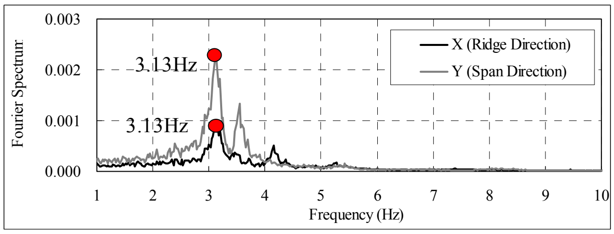


Fig.2-h) House d

Fig.2 The Transfer Functions of Investigated Houses

2) Equivalent Stiffness

The equivalent stiffness is calculated from the relation of the first natural frequency and the total weight of the house. The equivalent stiffness of the conventional houses is relatively high. Urban houses are affected by the slenderness ratio, so the ratio of the equivalent stiffness of the ridge direction and span direction is about 2:1. From the comparison of the ratio of the equivalent stiffness and the ratio of the length of the ridge direction and span direction, there seems to be a good relation between the length of the walls and the first natural frequency in the case of conventional timber frame houses.

3) Damping Factor

The damping factor of houses, as obtained by the authors, range from 0.8% to 4.8%. The damping factor is 2.4%～4.8% for conventional houses, 0.8%～2.8% for urban houses, 0.8%～3.2% for farm houses and folk houses. The damping factor tends to have a large vibration. The results of the experiments at this time could not be related to a specific physical quantity with the damping factor.

3. Comparison with Previous Research

The fundamental vibration characteristics of timber houses by microtremor measurement have been accumulated from previous research[5)-48)]. In this section, the results of survey documents are compared with the results of microtremor measurement performed by the authors and presented in this paper.

The relation of the first natural frequency and year of construction is shown in Fig. 3. The frequency values in Fig. 3 are averages of the ridge direction and span direction. The year of construction in Fig. 3 are estimated if the precise year of construction is unknown.

In case of conventional houses, the frequency tends to rise as the year of construction rises (i.e., approaches the present age). It has been suggested that this tendency is related to the progress of construction methods of conventional timber houses. The first natural frequency of conventional houses is about 2.0～10 Hz. The results from the experiments conducted by the authors have the same tendency as those shown in the previous research. In the case of urban houses, folk, and farm houses, the relation of natural frequency with the year of construction isn't determined to be precisely proportional. In Fig.3, the results of temples and shrines are shown in Fig.3 for reference. In the case of temples and shrines, minute rising of the natural frequency is determined as the year of construction approaches the present age. The first natural frequency is about 2.0～6.0 Hz for urban houses, about 2.0～5.0 Hz for farm houses and folk houses. Furthermore, temples and shrines is 1.0～4.0 Hz.

From the comparison with previous research, the results by the authors show the same tendency as those in the previous research. The distribution of natural frequency of vibration in the first mode by construction type is clarified. It is thought of as this tendency is available for a nondestructive inspection method.

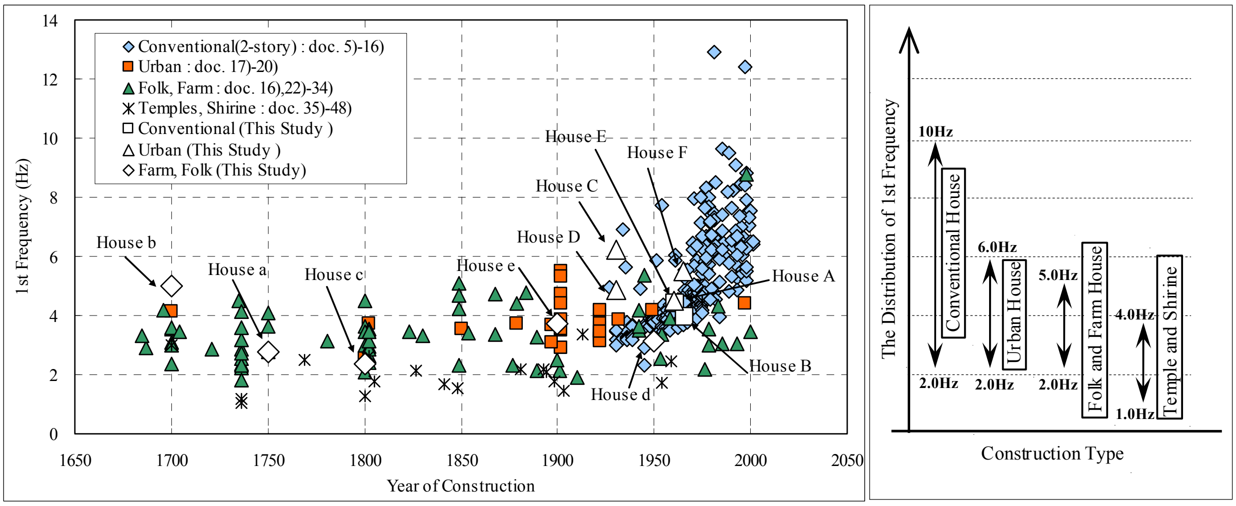


Fig.3 The Relation of the First Natural Frequency and Year of Construction

4. Conclusions

1. The results of microtremor measurements of eleven houses are accumulated for the categories of conventional house, urban house, farm house and folk house.
2. The results of microtremor measurements performed by the authors determine the natural frequency of vibration in the first mode is 3.4～4.7 Hz for conventional houses,2.8～7.4 Hz for urban houses, 2.0～5.66 Hz for farm houses and folk houses.
3. From previous research, the first natural frequency is 2.0～10 Hz for conventional houses, 2.0～6.0 Hz for urban houses, 2.0～5.0 Hz for farm houses and folk houses, 1.0～4.0 Hz for temples and shrines.
4. The results of experiments clarify that the damping factor is 2.4%～4.8% for conventional houses, 0.8%～2.8% for urban houses, 0.8%～3.2% for farm houses and folk houses.
5. A good relation of the length of walls and the first natural frequency is suggested in the comparison of the equivalent stiffness and slenderness ratio in conventional timber frame houses.

6. In the case of conventional houses, the frequency tends to rise as the year of construction approaches the present age.

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References

1) Fujita, K., et. al, Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo Part 1-2 ,Building Stock Activation, 2007
2) Sato, H., et. al, Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo Part 4 ,Building Stock Activation, 2007
3) Sato, H., et. al, Study on the Dynamic Characteristics of Traditional Timber Farmhouses in Mountainous Districts of Japan –Microtremor Measurement in the Hida Region-, 6th International Symposium on Architectural Interchanges in Asia, 2005
4) Sato, H., et. al, Study on the Structural Performance of Traditional Timber House Based On-Site Loading Test -Lateral loading test of a farmhouse in Yamaguchi prefecture, Annual Proceeding of the Architectural Institute of Japan, No.602, pp187-194, Apr., 2006
5) Yamabe, K. et. al, Measurement of Natural Periods of Timber Two-storied Houses in Kawasaki city, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.219-220, Oct., 1977
6) Onozuka, K., et. al, Study of Dynamic Characteristics of Wood-framed House Subjected to Microtremor Part.1-3, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.219-220, Sept., 1998, C-1, pp.129-131, Sept., 1999
7) Irie, Y., Dynamic Soil-Structure Interaction of Two Storied Timber Houses and a Five Storied RC Structure Based on Earthquake Observations Study of input motion to timber houses Part 1, Annual Proceeding of the Architectural Institute of Japan, No.536, pp109-114, Oct., 2000
8) Kandori, K., et. al, Micro-tremor properties of wooden framed structure, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.241-242, Aug., 2004
9) Yazawa, K., et. al, Natural Period of the Conventional Timber House of Aomori, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.423-424, Aug., 2002
10) Tahara, K., Suda, T., et. al, Development of Structural Design Method on Conventional post and Beam Structures Part. 8-9, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.193-196, Sept., 1998
11) Suzuki, Y., et. al, Dynamic Characteristics of Wood Houses from Microtremor Observation, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.221-222, Sept., 1998
12) Kagami, H., et. al, Method for Loss Estimation of Wooden Houses in Snowy Cold Region : Measurement of Natural Period by use of Microtremors, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, B-2, pp.23-24, Sept., 1998
13) Iwai, T., Nakaji H., et. al, Vibration Measurement and Horizontally Loading Tests of Full scale Conventional Wood Houses Part.1-2, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.115-118, Sept., 1996
14) Onai, T., et. al, Study on Natural Period and Wall Disposition Damaged Houses at Hyougo-Ken Nanbu Earthquake, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.11-12, Sept., 1995
15) Suzuki, Y., et. al, Dynamic Characteristics by Microtremor Measurements for Wood Houses in Ashiya, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.9-10, Sept., 1995
16) Kawaguti, Y., et. al, et. al, Experimental Study on the Structural Performance of a Wooden House Part.5-6, Journal of the Architectural Institute of Japan, Chugoku Branch, vol.25, pp.137-144, Mar., 2003
17) Nii, A., et al, Vibrational Characteristics of Machiya in Kyoto Based on Ambient Vibration Tests, Annual Proceeding of the Architectural Institute of Japan, No.613, pp43-50, Mar., 2007
18) Suda, T., et al, Vibration Characteristics of a Typical Traditional Wooden House, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.469-470, Sept., 2005
19) Suda, T., et. al, Investigation on Structural Characteristics of Traditional Wood Houses with Regional Distinctive Features : Regions of Higashiyama and Kazue-mati in Ishikawa Prefecture, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.407-408, Sept., 2002
20) Takeda, N., et. al, Investigation on Stractural Characteristics of Traditional Wood Houses With Regional Distinctive Features - The Region of Hino-dho in Tottori Prefecture, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.405-406, Sept., 2002

21) Oonishi, K., et. al, Investigation on Stractural Characteristics of Traditional Wood Houses With Regional Distinctive Features - The Region of Hgasihiroshima City and Kurose-cho in Hiroshima Prefecture, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.403-404, Sept., 2002
22) Tabuchi, A., et. al, Seismic Performance of Traditional Wooden Structure : Microtremor Measurements of The Noya House in Tuyama City, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.133-134, Sept., 2000
23) Sakamoto, I., et. al, Static and Dynamic Experiment on a Traditional Wooden house Part 1, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C, pp.1227-1228, Sept., 1985
24) Fukumoto, K., et. al, Dynamic characteristics of conventional thatched wood houses obtained from microtremor measurements, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.209-210, Sept., 2000
25) Itou, S., et. al, Horizontal Loading Tests on Traditional Timber House in Tohoku District Part.1 Outline of Test House and Tremor Measurement, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.267-268, Sept., 2002
26) Saitou, T., et. al, Dynamic Characteristics of Traditional Wooden House from Microtremor Measurement, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.447-448, Sept., 2003
27) Yamaguchi, A., et. al, Dynamic Characteristics of The Hirai House, an Important Cultural Property, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.445-446, Sept., 2003
28) Uemori, S., et. al, Study on Structural Characteristics of Traditional Wooden Houses by Measures in Sites, a Thatched-Ruuf House in Kouka Town, shiga Pref. Part.4, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.435-436, Sept., 2003
29) Shinoki, H., et. al, Frame of Miscanthus Reed Roofing House in Minehama Village of Akita Prefecture Part.4 Structural Characteristics by Vibration Test, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.45-46, Aug., 2004
30) Maekawa, H., Microtremore Measurement on Wooden Buildings, Which are Important Cultural Properties, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.223-224, Sept., 1997
31) Kawai, N., Maekawa, H., Uchida, A., Dynamic characteristics of traditional wooden house Part.4, 6-8, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C, pp.1029-1030, Sept., 1993 : C, pp.111-112, Sept., 1994 : C-1, pp.53-54, Aug., 1995 : C-1, pp.445-446, Sept., 2003
32) Inoue, Y., et. al, Dynamic characteristics of traditional wooden house Part5, Journal of the Architectural Institute of Japan, Kanto Branch, pp.25-28, 1993
33) Maekawa H., et. al, Dynamic Characteristic of Traditional Wooden Buildings : Part9 : Estimation of Load-displacement Relationship and Natural Frequencies on Houses, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.145-146, Sept., 2000
34) Noguchi, H., et. al, The Results of Lateral Loading Tests of a Farmhouse Built in Edo age, Annual Proceeding of the Architectural Institute of Japan, No.360, pp.23-30, Feb., 1986
35) Irie, Y., et. al, Estimation of Stiffness and Damping Constants on Analytical Models of Four Temples Standing at Shizuoka Prefecture Based on Microtremor Measurement, Annual Proceeding of the Architectural Institute of Japan, No.608, pp.85-92, Oct., 2006
36) Miyamoto, S., et. al, Case Study of Seismic Diagnosis and Retrofit for Japanese Old Temple, Annual Proceeding of the Architectural Institute of Japan, No.593, pp.87-94, July, 2005
37) Sakamoto, I., et. al, Study on Structural Evaluation Test of Traditional Wooden Buildings Part 1-6, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.185-196, Sept., 1996
38) Tooyama, K., et. al, Vibration Test of a Wooden Shrine, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C, pp.929-930, Aug., 1995
39) Ogata, T., et. al, Study on Seismic Performance of Wooden Temple Buildings Part.1-2, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.443-446, Sept., 2006
40) Fujii, T., et. al, Study of Dynamic Characteristic of Temples to Improve Seismic Performance of Cultural Properties, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.465-466, Sept., 2006
41) Yokochi, S., et. al, Study on Seismic Evaluation and Retrofit of Dainippon Ho-tokusya Dai-kodo Part.1-3, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.31-36, Aug., 2004
42) Oota, T., et. al, Seismic Performance Evakuation and Improvement of Buddhis Buildings Part.1 Vibration Characteristics Evakuation of an Actual Buddhist Building, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.41-42, Aug., 2004
43) Mastuo, K., et. al, Seismic Capacity of Traditional Wooden Structure : Seismic Test of The Saionji Temple in Sakaide City Part 1-3, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.161-166, Sept., 1999
44) Nagase, T., et. al, Microtremor Observation at Toshoda-iji Kondo, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.131-132, Sept., 2000
45) Ishimaru, S., et. al, Retrofit of a Traditional Wooden Structure by the Wall Damper System named as *Kame-Kabe* Part.1, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, B-2, pp.421-422, Sept., 2001
46) Kawai, N., Maekawa, H., Uchida, A., Dynamic Characteristics of Traditional Wooden building Part 1, 3-4, 6, 7, 8, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.55-56, Aug., 1995, C-1, pp.173-174, Sept., 1996, C-1, pp.221-222, Sept., 1997, C-1, pp.259-260, Sept., 1998, C-1, pp.157-158, Sept., 1999,
47) Ogata, T., et. al, Study on Seismic Performance of Temple Buildings, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.445-446, Sept., 2005
48) Kanno, T., et. al, Experiments on Seismic Safety of Traditional Timber Temples Part 1-2, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, pp.439-442, Sept., 2005

Conversion of office buildings;

A cross-case analysis based on 14 conversions of vacant office buildings

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Keywords: building activation, adaptation, risks, chances, case-study

Abstract

Building conversion is a way of activating and reusing vacant office buildings. Former research (Barlow and Gann, 1993, Brand, 1994, Douglas, 2006, Geraedts and Van der Voordt, 2003, 2007) has shown possibilities for conversion through theory and practise, and has delivered instruments for determining the conversion possibility of vacant buildings. Still, building conversion is not taking place on a large scale. There may be several reasons; lack of knowledge about building conversion, uncertainty about financial feasibility, and little knowledge about the chances and risks of building conversions. This paper aims at answering the following questions: What are the risks and chances of building conversions? Can these be revealed at an early stage, increasing the feasibility of the project? These questions will be answered based on a cross-case analysis of 14 buildings in the Netherlands which were converted from offices to housing. We will discuss legal, financial, technical, functional and architectonic issues, both theoretically and empirically, by presenting findings from the 14 cases, revealing the risks and chances of building conversions to support decision making on dealing with vacant office buildings.

Introduction

Building conversion is a well known phenomenon; inner city buildings loose their function, and adapt to new use. In the Netherlands though, the scale on which since 2001 office buildings have lost their function is so far unprecedented; at the end of 2006 about 6 million square metres, equalling 14% percent of the office space in the Netherlands, was vacant. Building conversion is a way of coping with vacant office buildings. The alternatives are consolidation, renovation or upgrading, or demolition - eventually with new construction on the site. Most owners of vacant office buildings choose consolidation; to do nothing, but to wait for better times. This choice is often not based on rational reasoning. The value of office buildings is based on rent value, not on the value of the building itself. Hence, the sale of a vacant building brings less than the sale of an occupied building. The building will not be sold in accordance with its book value, which means facial loss for the seller. For housing market investors and real estate developers, high asking prices is a reason for not converting vacant office buildings into housing. The different real estate markets are separated; office market actors have little knowledge about the housing market, and vice versa. Among the stakeholders on the real estate market there is a general lack of knowledge about conversion processes (Remøy, 2007). Still, several vacant office buildings have been converted into housing. Which building- and location-characteristics influenced the project positively or negatively? Can risks and chances of conversion projects be revealed and controlled, increasing the financial feasibility of the project?

Method

This paper is based upon a cross-case analysis of 14 cases. The cases were selected for the book "Transformation of office buildings" that was published in January 2007 (Van der Voordt et al., 2007). The cases were chosen to make it possible to generalise the findings within a specific group of conversion projects (Flyvbjerg, 2004): They are all examples of conversion from offices into housing, they are of significant size (the smallest counted 18 apartments) and the cases chosen were carried out during the last ten years, since the juridical framework stayed more or less the same during this period. Table 1 gives an overview of the 14 cases that were studied. The studies were performed after the conversion. Case study evidence includes material from several sources; the situation before conversion was studied through documents; text, photos and drawings, and the situation after conversion was studied through documents and visits to the building. Interviews with stakeholders were held to gain insight in the process and to gain additional information of the situation before conversion. In any building project, several actors are involved, the client, the developer, the architect, the structural engineer, the installation engineer and finally the assigned builder. We intended to perform two interviews for each project, one with the architect and one with the developer. In some cases though, there was no architect involved, while in two cases we also interviewed the client. The interviews were semi-structured, based on an interview protocol (Yin, 1989, Mason, 1996), evolving during the six months period in which they were held.

Table 1: conversion cases

	Delivery	Delivery converted	Amount of units	Type of dwelling	Interviews
De Stadhouder	1974	2005	70	Starters buy	1
Lodewijk Estate	1954	1999	24	Seniors, buy / rent	1
De Enk	1956	2006	69	Starters, buy	2
Schuttersveld	1915-1923	2003	104	Luxurious, buy	2
Westplantsoen	1970-1980	1999	45	Students, rent	1
Billiton	1938	2004	28	Luxurious, buy	2
Hof ter Hage	1935-1967	1998	*97	Mixed, buy	2
Wilhelmina Estate	1969	2007	*43	Mixed, buy	2
Granida	1958	2005	*30	Luxurious, rent	3
Residence De Deel	1959	1999	18	Seniors, buy	1
Twentec Building	1960-1965	2002	*87	Luxurious, rent	2
Eendrachtkade	1980	2004	83	Students, rent	1
The Churchill towers	1970	1999	120	Mixed, rent	2
Puntegale	1940-1946	1999	*210	Starters, rent	2

*Other functional programs were added, such as shops, health care and commercial space.

Interviews

In the interviews, we questioned project specificities. The first issue was the project initiative. Mostly, the project was initiated by the developer, but sometimes also by the local municipality or the owner of the vacant building. The second issue was the spatial program, the appointed user and feasibility. We questioned the relation with the local municipality and their role in the project. The third issue was the design phase. Mostly, the architect had the most information about this part of the project, but due to the project character, other stakeholders played more important roles than they would have done in a typical new construction project. The director of the project was sometimes the architect, sometimes the developer. The fourth issue was the construction phase and eventual problems surfacing at this stage of the project. The final issue was about delivery, use and building management; process evaluation, financial feasibility and user satisfaction.

Additional data, the project documents

We visited the buildings and photographed the new situation. In some cases, we spoke to the inhabitants. Furthermore, for extra information, we used photos of the existing situation and the architectural drawings of the building before and after conversion. In many cases, these drawings gave a good overview of the existing structure, stairways, elevators and exterior and structural walls, while the interior walls were less credible. The interiors of office buildings are often adapted without updating or making new drawings. The written documents consisted of magazine- and newspaper- articles. These were especially useful for projects that were converted several years ago and where the interviewees were forgetting details.

Data analysis

We had 24 interviews about 14 projects. For each project, we wrote project and process descriptions, distilled from the interviews and the written documents. The drawings and photos were used to explain the situation. The stories we wrote based on the interviews were sent to the interviewees for feedback and accordance. When the interviewees did not agree on the story we had a second round of feedback. The stories written up from only one interview were validated by another stakeholder of the same project. The projects and data were filled in a matrix and analysed for patterns (Yin, 1989). As a result, the projects could be divided in three categories; buildings from before 1950 (or designed before 1950), buildings from 1950 to 1965 and buildings from 1965 to 1980. The 5 buildings from before 1950 share several characteristics; they are monumental in their appearance, 3 are classified as monuments. The buildings have structural, solid outer walls and considerable size. Four were built to accommodate specific governmental services. 4 buildings were built between 1950 and 1965 (though Lodewijk Estate was built in 1954, it was built from an earlier design). During the fifties, new construction methods entered the market. The buildings of the Akzo headquarters [De Enk] in Arnhem and the GGD Building [Granida] in Eindhoven have a construction of columns in the facade with additional columns in the centre of the building, while the Estate De Deel and the Twentec Building are early examples of constructions with columns and free floors. Of the 5 buildings newer than 1965, one of them has a structural facade in the form of facade columns, four have a construction of columns and free floors. Of these four, in two of them the columns are put directly behind the facade, while in the other two the facade is kept completely free from the construction.

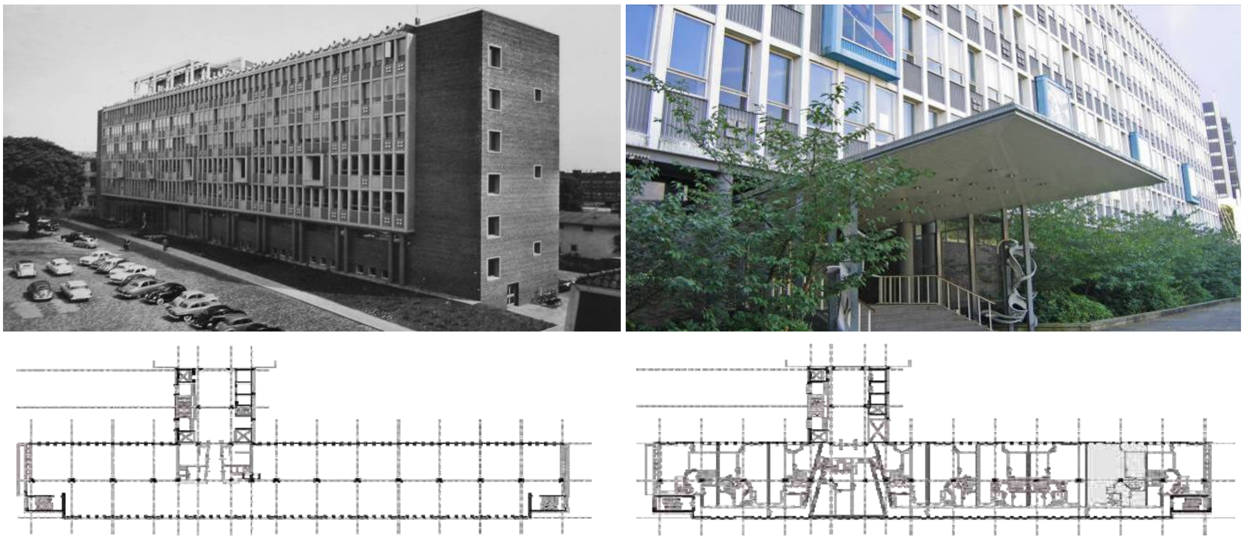

Figure 1: De Enk. Left: the building before conversion, to the right the building after conversion.

Figure 2: Twentec building. Left the building before conversion, to the right the building after conversion.

Risks

Former research (De Vrij, 2004, Geraedts and Van der Voordt, 2007) developed instruments to decide office buildings potential for conversion, and also developed checklists to determine development risks (Table 2).

Table 2: Checklist of potential risks, translated from de Vrij (2004)

Location and Market	**Aspect**
1. Legal	
	1. Zoning law
	2. Land ownership
	3. Soil pollution
2. Financial	
	1. Purchasing costs of vacant office buildings
	2. Housing (rental) and commercial space market
3. Technical	
	1. Stench pollution
	2. Noise pollution
4. Functional / Architectonic	
	1. Bad reputation, unsafe area
	2. Amount of parking places
	3. Amount of facilities in the area
	4. Accessibility by public transport
	5. Routing of the area
Building	**Aspect**
1. Legal	
	1. Presence of asbestos
	2. Monumental status
	3. Dutch building decree, including fire regulation
	4. Municipal building act
2. Financial	
	1. Acquirement / purchasing costs
	2. Initial phase investments
	3. Financial feasibility
	4. Vacancy of the new function
3. Technical	
	1. Incorrect technical assessment
	2. Inadequate pipes, ducts, electricity system and water supply
	3. Inadequate acoustic insulation of the floors
	4. Inadequate thermal insulation of facade, openings and roof
	5. Damp / condensation in structure
	6. Joints of brick walls in poor condition
	7. Daylight < 10% of the appointed living-space
	8. Sunlight; building is poorly situated
	9. Inadequate / poor state of main structure or foundation
4. Functional / Architectonic	
	1. Incorrect assessment of functional possibilities
	2. Low recognisability of the building and its entrance
	3. Building too slender or too deep
	4. Too loose fit, too high floors
	5. No basement
	6. Windows not operable
	7. Few or poor quality of interior walls, few points for attaching interior walls to the facade
	8. No balconies or roof terraces
	9. Not enough elevators and staircases

We performed the cross-case analysis of the 14 cases focusing on the risks and unforeseen problems that surfaced during the building phase of the project. The four risk-categories (legal, financial, technical, and functional/architectonic) of de Vrij were used.

Legal

The projects were all completed, which implies that the requirements made in the zoning law and in the building law were met satisfactorily. Asbestos was found in seven of the fourteen projects. The removal of asbestos follows strict rules and therefore carries high expenses. In all the projects though, removal of eventual asbestos was taken into account in the sales contract of the existing building. What was stated as a risk in previous research is taken into account by developers of conversion projects, and has gone from being a risk to being a cost that can be calculated.

Financial

Apartments in the projects studied were let or sold without problems, except in a few cases; in one case luxurious apartments without a private outdoor space and with incidentally low ceilings (not according to the building rules) were sold only after lowering the price. In another case, some apartments with daylight from the north only, were not sold for the initial asking price. Anyhow, the risk of not being able to sell the apartments in conversion projects is equal to other projects. In some cases, model apartments were furnished to boost the sale, occasionally even before initiating the conversion. Any developer, assisted by an architect, needs to be aware of the users' wishes. Even in a stressed housing market, quality and willingness to pay correspond, especially in the upper part of the housing market.

Technical

3 out of 5 buildings from before 1950 were not constructed according to the construction drawing, or the construction differed and had different measurement from floor to floor. In one of the five projects, the differences were anticipated upon from the start, the floors were radically different. Two of the four buildings from 1950 to1965 were not built according to drawings and the construction materials and measurements were different per floor. The buildings constructed after 1965 showed no such differences. The risk of inconclusive drawings and differing construction is strong in buildings dating from before 1965. Building methods and measuring methods were not as precise. In the first years after the Second World War housing, and not utility buildings, were prioritised in the Netherlands. It was difficult to get building materials, and in many cases entrepreneurs used the materials they could find without changing the drawings.

The main construction was found in unsatisfactorily state only in one of the 14 projects [Granida]. The concrete of the external columns was rotting and was renovated and reinforced. The repair itself forced extra costs onto the project, but additionally, as a result of the repairs the columns got wider, and the design needed modification. In another project [Billiton], concrete rot was found in part of the facade but took a minor investment to repair. Rotting wood or concrete, or oxidising steel can raise the price of a conversion, but in most cases, these problems can be seen in the preliminary phase and will not be a risk. Adding weight to the construction was problematic in one single case only. Office buildings are constructed to carry more weight than housing, hence in most cases, an additional floor can be carried by the existing construction.

Apartments are normally smaller than office units and more shafts are needed for electricity, water and plumbing. In the buildings from before 1965, floors were penetrated and shafts were placed without problems. After 1965, reinforced concrete was commonly used, making larger span without columns possible. The problem of reinforced concrete though, is that it loses strength when the reinforcing steel cables are cut. In three of the five buildings built after 1965, reinforced concrete was used. Nowadays, reinforced concrete is the most common material to use in buildings. When renovating or converting a building newer than 1965, the construction method should be taken into account. Designing apartments with a minimum of shafts is a challenge for the architect. The problem can be solved; the accurate place of the steel trusses can be located with accurate metal detectors [Eendracht].

Reinforced concrete was not used in building constructions before 1965. The measurements of the structural grid were smaller. The small spans came with thin, light floors. These floors are strong; they are constructed to allow for the weight of office equipment, which before 1965 was heavier than it is now. The problem of converting these constructions into housing is the acoustic insulation of the floors. It is reasonable to say, that floors from before 1965 will need to be acoustically improved to meet the requirements of modern building standards. This can be done, as seen in the cases, by adding a floating floor and a lowered ceiling.

The Dutch building decree requires a higher level of thermal and acoustic insulation of the facade for housing than for offices. The facades in 6 of the buildings were removed and new facades were added. In 7 projects, the thermal and acoustic insulation of the facades was improved, for 5 of the projects there was no other possibility because these were monumental. The facade of only one project was not altered.

Functional

In the initial phase of a conversion project, before deciding to buy the property, the developer, alone or with the architect and other experts, made quick scans of the possibilities for conversion. Sketches were made, when possible based on the original drawings, to make an estimation of the possibilities to fill in apartments or other functions. The quality of the first sketches and estimations are seen as a risk, though not experienced in any of the cases studied.

Additional risks

Additional to the pre-signalled risks, some new risks appeared in this study. The municipality not allowing exceptions from the zoning plan is a risk. But based on these cases, we recognised the risk of the municipality slowing the process where a change or an exception of the zoning plan was needed. One of the chances of conversion projects is the short time span from first sketch till delivering the apartments. Long lasting procedures may slow the process and delay income, spoiling the financial feasibility of the project.

When a first scan is made of the building to convert, the height of the floors needs attention. In most cases, office buildings have higher floors than requested for apartments, but when both a floating floor and a suspended ceiling are needed, excess height is required. To be sure to obtain a free height of 2,60 meters inside the apartments, the height from floor to floor should be 3 meters, allowing for mechanical ventilation above the suspended ceiling and a minimum height of 10 centimetres for the floating floor.

Not really an additional risk, but a result of other risks is the financial feasibility. A lowered ceiling and floating floor can be placed; constructions can be repaired and reinforced, shafts can be made through reinforced concrete floors and municipalities will allow changes or exceptions to the zoning plan. But the conversion costs will rise as a result.

Risk list based on the cross case analysis

Several of the risks recognised by De Vrij could easily be assessed in the initial phase of the conversion and are not seen as risks. After analysing the 14 cases, the risk-list could be shortened.

Table 3: Risks defined by the cross-case study of the 14 cases

Market, location and building	Aspect
1. Legal	
	1. Zoning law: Impossible to meet requirements (function, form, size)
	2. Dutch building decree: Impossible to meet requirements from the (VROM, 2003), including noise-level prescriptions and fire-precautions
	3. Municipal building act: The municipality is unwilling to cooperate
2. Financial	
	1. Development costs: Slow handling of procedures (loss of income)
	2. Vacancy: Failing incomes from exploitation or sale of the property
3. Technical	
	1. Incorrect or incomplete building structure assessment
	2. Inadequate / poor state of the main structure or foundation (rotten concrete or wood, corroded steel)
	3. Insufficient shafts available; Construction allows no extra penetrations or shafts being made
	4. Inadequate acoustic insulation of the floors / Thin floors
	5. Insufficient thermal and acoustic insulation in the facades
	6. Insufficient daylight for housing
4. Functional / Architectonic	
	1. Incorrect assessment of functional possibilities: Preliminary sketches prove worthless; "unusable" space

Chances

The short development time-span from the first sketch till delivery of the apartments is a chance for conversion projects. The project Stadhouder was developed in two years only, from the first sketch till the delivery. While still working on the design, the facade was removed and the building stripped down to construction, stairs and elevator. Not only was time saved because the main structure was already there, but also because of this, there were less unworkable days because of bad weather.

The “WYSIWYG-factor” is another chance for conversion projects: What You See Is What You Get. Model apartments can be furnished already before demolition starts. Most people cannot interpret architectural drawings, while this communication form may better inform potential buyers and boost the apartment sales.

From the project De Stadhouder we learnt that the economical feasibility of conversion projects can be influenced positively by exploiting the existing fiscal rules: Increasing the financial feasibility of conversion projects is the possibility to pay only 6% of conveyance duty on the land and existing building, instead of the VAT of 19%. The property is bought with 6% conveyance duty and is then split in apartment shares and sold to the buyers. If the apartments are sold within six months, the conveyance duty only has to be paid over the second sale and is then paid by the buyers. The VAT of 19% is then only paid over the building activities.

Conversion of vacant offices is a possibility for development in an already organised context, in central urban areas. The conversion of an already existing building normally attracts less negative meddling from neighbours or neighbouring users than the demolishment of an existing building and new construction. Adding up, the redevelopment of one building in an area of vacancy, obsolescence and dilapidation can give a possible boost to that area and increase the value of the land within reasonable investment time-perspectives. This gives developers and investors a chance to increase the financial feasibility of a project, for both social housing corporations and corporations active in the liberal housing market.

Finally, conversion of vacant offices is a sustainable alternative to demolish and rebuild. Converting vacant office buildings into housing saves building materials and building materials transportation, and produces less waste than demolition and rebuilding. An often heard argument for demolition is that the thermal insulation in older buildings is not adequate. Demolition is in this case used as a sustainability argument. However, the case studies show that the performance of existing office buildings can be adapted to the level of the Dutch building legislation law as well as to the level of comfort expected by the appointed user group.

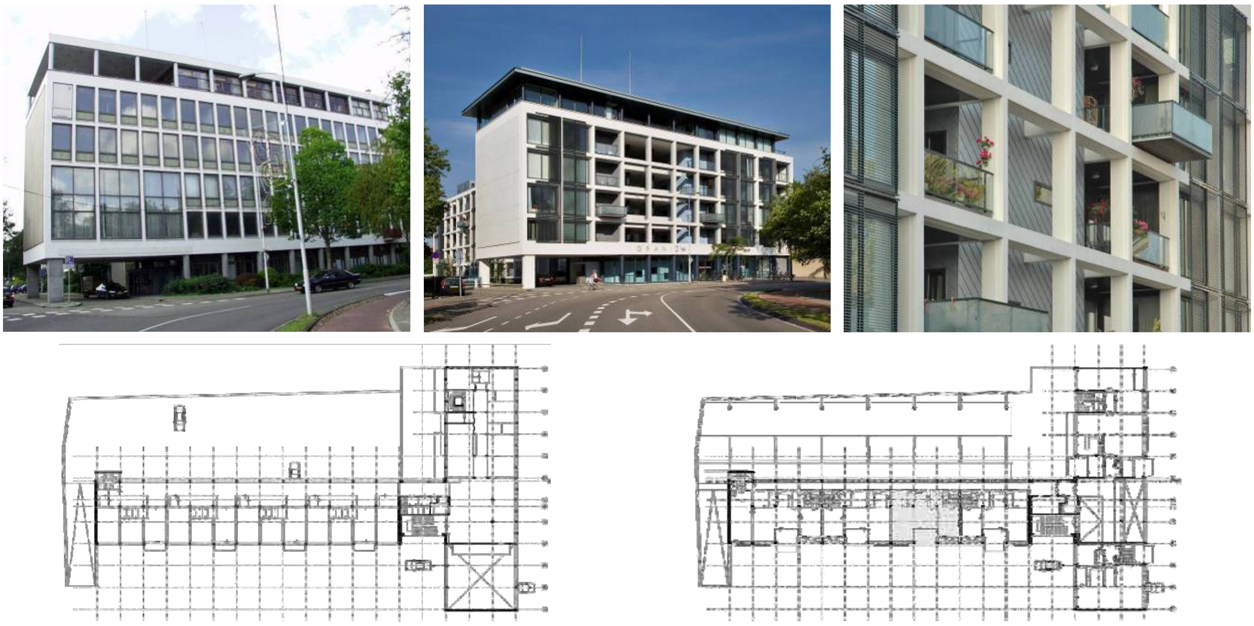

Figure 3: Granida. Left the building before conversion, to the right the building after conversion.

Conclusion

Most of the risks that were recognised in the cross-case analysis were found in the technical category. The risks within this category turned out to depend on the construction year of the existing building, which have common building characteristics. Fewer technical risks were experienced in the conversion of the 5 buildings that were originally built between 1965 and 1980. The construction drawings of these buildings were correct and the state of the construction was good. The floors in the buildings from the later part of this period, De Stadhouder, Westplantsoen and Eendrachtskade, had sufficient acoustic insulation for housing. The Eendrachtskade had double glazing, and the thermal insulation of the facade was sufficient for housing, but the acoustic insulation was not. In this case, the municipality made an exception from the building decree since students are considered to tolerate noise well. If the appointed user groups had been seniors, probably the acoustic insulation of the facade would have had to be improved. In the financial category few risks are recognised. However, all technical, legal and functional risks influence the financial feasibility of the project. Hence, it may be concluded that most risks can also be seen as financial risks.

The projects included in this study are completed conversion projects. One of the legal risks was the municipalities' cooperation on zoning plan changes and building decree exceptions. However, the parties involved in all 14 conversions were satisfied with the municipalities' cooperation. One of the questions remaining unanswered is whether the projects would have failed without municipal cooperation. Would lack of cooperation have delayed and threatened the projects' financial feasibility, or would the projects not have been completed at all? A possible next step of this research is to study projects that were considered for conversion, but did not pass the go-no-go.

In the analyses of the 14 cases, we aimed at revealing the factors that influence the projects financial feasibility. The developers we interviewed stated that the earnings on conversion projects are too low compared to new constructions. Also, other actors in the conversion processes complained about overrun budgets and too many hours spent to develop specific solutions to problems that occurred during the building- process. Of the 14 cases, only one developer was willing to share financial information regarding the project. In one case, the developer informed us that the financial goal was not achieved, because of failing exploitation. In the other 13 cases, the developers claimed that there were no financial losses, despite the fact that the budgets were overrun. In future studies we hope to be able to make complete analyses, but then we will need insight in the financial information of the projects.

Acknowledgement
The 14 case studies were executed for the book *Transformatie van kantoorgebouwen / Transformation of office buildings* (Van der Voordt et al., 2007). The data collection and case descriptions for the book were performed by Hilde Remøy, Collin Oudijk and Theo van der Voordt.

Sources
Barlow, J. & D. Gann. 1993. *Offices into flats.* York: Joseph Rowntree Foundation.
Brand, S. 1994. *How buildings learn; what happens after they're built.* New York: Viking.
De Vrij, N. 2004. Meten is weten. *Real Estate & Housing.* Delft: Delft University of Technology.
Douglas, J. 2006. *Building adaptation.* Oxford: Butterworth-Heinemann.
Flyvbjerg, B. 2004. Five misunderstandings about case-study research. In Seale, C., G. Gobo, J. F. Gubrium & D. Silverman (Eds.). *Qualitative Research Practice.* London: Sage.
Geraedts, R. P. & D. J. M. Van Der Voordt. 2003. Offices for living in: An instrument for measuring the potential for transforming offices into homes. *Open House International* 28: 80-90.
Geraedts, R. P. & D. J. M. Van Der Voordt. 2007. A Tool to measure opportunities and risks of converting empty offices into dwellings. In 2007, E. (Ed.) *ENHR; Sustainable Urban Areas.* Rotterdam.
Mason, J. 1996. *Qualitative researching.* London: Sage.
Remøy, H. 2007. De markt voor transformatie van kantoren tot woningen / The market for conversion from offices into housing. In Van Der Voordt, T., R. Geraedts, H. Remøy & C. Oudijk (Eds.). *Transformatie van kantoorgebouwen thema's, actoren, instrumenten en projecten.* Rotterdam: Uitgeverij 010.
Van Der Voordt, D. J. M., R. P. Geraedts, H. Remøy & C. Oudijk (Eds.). 2007. *Transformatie van kantoorgebouwen thema's, actoren, instrumenten en projecten. Rotterdam*: Uitgeverij 010.
Vrom. 2003. Bouwbesluit. VROM: www.vrom.nl
Yin, R. K. 1989. *Case study research; design and methods.* London: Sage.

Study on Parts and Components for Renovation of Multi-family Dwellings

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Abstract

Observations in Japan, Australia and the Netherlands suggest that refurbishment of multi-storey buildings includes a lot of demolition and some damage to the remaining base building, resulting in waste in terms of material as well as process. A challenge as the world inevitably moves towards more sustainable construction practices is how can waste reduced while refurbishing buildings? This paper describes a work in progress and builds on collected data in the three countries mentioned.

The paper draws on the following previously published findings:

1. A comparative analysis of materials and building parts used in newly constructed and refurbished buildings;
2. Potential problems identified from the data mentioned;
3. A classification of materials and parts with regard to newly built and refurbishments.

Recommendations are made with regard to process and product.

It is presumed that refurbishment can gain efficiency if:

1. The differences between new construction and refurbishment are minimised, by focussing on the similarities as production processes rather than the differences in materials used;
2. Replacing outdated techniques and materials to fit the existing buildings by using the latest materials and parts. This needs rethinking of the interfaces between materials and probably a decoupling of interface and appearance.
3. Information about applied building parts should be retrievable in the future, it is therefore necessary that building parts be identified by some form of tag and that the attached information can be interrogated.

1. INTRODUCTION

It is common practice that obsolescence of dwellings, entire buildings or even larger sections of the built environment is solved by demolition and construction of new buildings. The latest innovations in construction technology can be used, such as a large degree of off site (pre-) production. New designs can result in a better fit to new demands that could not have been foreseen in the past. However, sustainability concerns both in relation to resource depletion and waste generation have put into question the overall effectiveness of demolition and rebuild. Rather than optimizing only on construction costs (demolition and rebuild usually is less expensive) it makes sense to optimize on long term use of the built environment, reducing the waste of building material that still have value, reducing traffic as a result of demolition and reconstruction, reducing the loss on interest during the construction of newly built buildings. (If planned well refurbishment can be done in stages, thus keeping the building partly operational). This needs a rethink of the refurbishment process.

How can we minimize inconveniences such as noise, dust, traffic and pollution of refurbishment, by its own nature taking place in or close to built-up and used environments? All activities, from removing parts, to cleaning up surfaces to rebuild on, to adding new materials and parts need to be measured against these criteria. The international survey has made clear that if the existing structure of the building to be refurbished is not readable, and if the original drawings are not available or do not match the actual construction, destructive research is the only option left to document the starting point of refurbishment after having stripped the building.

If we see the construction process as a chain of events that involves the connection of new parts to the larger whole, we can focus on materials and parts connected by interfaces. This in turns allows us to precisely describe building materials in terms of dimension, quality and capacity (such as shape, texture, weight, colour, fire-resistance, embedded energy, carbon footprint or what else is or will become relevant). Position is important as well, however this is not an entity of the material or part being described rather than the consequence of the building design. Describing the interface (dimension, quality and position) gives clues as to how to refurbish in the future. Although the overall drawings of a building remain very important (how else could we tell a hospital from a residential building?) they should not have to contain much more information than the distribution of space for rooms and space for material, in other words, space plan and material plan complementing each other in the same drawing. The material plan in turn only should contain information about material boxes: space allocated to a certain building part, with certain specifications. The data of the building parts now can be connected to the building part rather than to the traditionally documented building. With this mind set, data on the building parts of twelve projects in three countries were collected and compared and quantified in data sheets for further analysis (Cuperus et al, 2007).

2. METHOD FOR INVESTIGATION

Data were collected in three ways:

1. Site visits to twelve projects in Japan, Australia and the Netherlands, in order to document parts used;
2. Process analysis using questionnaires for designers, builders and institutional clients such as housing corporations;
3. Project analysis using questionnaires, drawings and product information.

2.1 Site visits

The initial intention was to document four apartment buildings in each country, two being refurbishment projects and two newly built projects. This plan was later changed. It was hard to find relevant and representative refurbishment projects in Sydney Australia. In the Netherlands interesting large-scale refurbishments were found that possibly contribute better to this study, these refurbishments included a substantial modification of the base building, change of use and innovations in plumbing and electrical serviced positioned in hollow floors. The site visits took place between August 2004 to August 2006.

The study projects were documented on two data sheets each. On the first sheet some project data were collected, such as the name and address of the building, ownership / rental details, type of construction (refurbishment, newly built) , architect, contractor and numeric details such as site, building and floor area, number of floors and units. On the second sheet construction data as presented, organized in building part groups, such as external wall, roof, balcony, stairs, mechanical electrical and plumbing installations, inner partitions and finishings. The major constitutive elements and materials are itemised and characterized as project dependent or independent (custom made or standard parts), and also categorised in terms of whether they are used for renovation only or for new construction as well. Finally they are classified in terms of complexity, are they simple elements (single material) or are they units made up of a combination of many parts and materials (composite elements)?

		
Kouyoudai Nagoya	Park City Torimi, Nagoya	Hikarigaoka Hights, Nagoya
		
Syouwa-park2, Nagoya	Lumiere, Sydney	Victoria Garden, Sydney
		
Keyenburg, Rotterdam	La Fenetre, The Hague	Florijn Noord, Amsterdam

Fig.1 Nine out of twelve investigated projects.

This study has its origins in Japan and the first projects selected were renovation projects in Nagoya. They are three renovation projects in residential areas: Condominium Kouyoudai, Park City Torimi, Hikarigaoka Hights and one newly constructed project in an industrial area: Uhouse Syouwa-park2. This selection was used as an example to find comparable projects in Australia and the Netherlands. In contrast to Japan and the Netherlands, the building cycle in Sydney during the time frame of this study was such that there were no comparable refurbishment projects (five years earlier this would have been very different), consequently two new projects were selected: Lumiere in the city of Sydney and Victoria Garden in Chatswood. Two Netherlands projects fit the Japanese examples very closely: Complex 50 and Florijn Noord, in Amsterdam, both representatives of mass housing from the sixties. Keyenburg, Rotterdam was added, since this is one of the icons for Open Building, equipped with facilities for easy future transformation. It was built in 1984 containing 152 small dwellings, and has recently been refitted as 93 dwellings for double handicapped persons. The fourth Dutch project is the recently completed la Fenetre in The Hague and is interesting because of its innovative floor system that accommodates space for plumbing and cabling.

2.2 Collected data

The projects documented in the study differed, some were newly built, others were straight refurbishments and yet others combined refurbishment with newly built extensions, either adjacent to or on top of the existing buildings. They were labelled as 'n' (new), 'r' (renovation) and 'r-n' (table 1-1,2).

The projects were first of all characterised in terms of the elements used, these were classified in terms of the primary functions performed, such as exterior wall, roof, balcony, stairway, plumbing and cabling and interior finishes. The materials were characterized as 'c' (custom made parts) and 's' (standard parts), In other words, made to order (MTO) and made to stock (MTS) (Ballard et al. 2007). MTS parts usually are of a generic character, and serve as many different situations as possible while still keeping a limited range of stock. Large production runs justify serious product development and a lot of embedded quality. In order to increase their applicability special attention needs to be given to keeping the interfaces simple. MTO products are project dependent, with small productions runs and the possibility to tailor them to the project (table 1-1).

In addition the materials and parts examined were identified as 'u' (unit) or complex parts and 's' (simple), mono-material parts (table 1-2).

Not all materials and parts surveyed have the same degree of complexity. It may not come as a surprise that in all projects

common use space

region of building		**custom**[custom-made parts]:*c* or **standard**[standard parts]:*s*								
		the Netherlamds			Janan				Australia	
	N: New construction R: Renovation	N: La Fenetre	R: Florijn Noord	R: Keyenburg	N: Syouwa	R: Torimi	R: Kouyoudai	R: Hikarigaoka	N: Lumiere	R: Victoria
exterior wall	exterior wall				c	s	s		c*	c*
	autoclaved light weight concrete				s	s			s*	
	sash and backbend				c	s				
	exterior wall base				s	s			c	c
	vetilation pipe and around it				s	s			s*	c
	others									
	beams covering									
	verge of a flowerbed									
	plansier									
	outside stairs									
	handrail post									
	concrete grid with balconies									
	timber frame with double glass and closed panels	c	c							
	inner cavity wall timber frame			c						
	outer cavity wall concrete brickwork			s						
	auminium window frames			s						
	Loovers									c*
	Aluminium Sliding Doors / Windows									c*
	Door Panels									s
rooftop	roof	s	s	s	s	s			c	c*
	top rail	s	s	s	s	s	s		c	c*
	penthouse prefab timber frame		s		s	s	s		c	c*
	entrance		s		s	s	s		c	
	waterproofing	s	s	s	s	-	s		c	
	handrail		s		s	-	c		c	
	others									
	bicycle parking									
	fence/gate						c			
	metal clotheshorse						c			
	Concrete balustrade								c	
	Color Bond Metal Sheeting									c*
	Insulation									s
	Gyprock Ceiling									c
balcony	floor	s	s	s	s	s	s			c
	balcony partition	s	s	c	s	s				c*
	handrail	s	c	c	s	-	s			s*
	handrail wall	s			c	s	s			c
	others									
	side ditch						s			
stairway	exterior (stairway)	s	s	s	s	s			c	c
	leader	s	s		s	s			c	c
	floor	s	s	s	s	s			c	c
	wall	s	s	s	s	s			c	c
	ceiling	s	s	s	s	s			c	c
	handrail	s	s	s	s	s			c*	c*
	others									
facilities	tremch for dewatering	s	s	s		s			c	c
	water supply pipe	s	s	s		s			s*	s*
	drain	s	s	s		s	s		c	s*
	elevator door	s	s	s		s			c*	c*
	air conditioner					s			s	s
	others									
	exposed piping									
	leader for dewatering							s		
	Sauna									c
	Swimming Pool									c
	Flower Planter									c*
indoor	steel fittings	s	s	s	s	s			s*	s*
	wooden fittings	s	s	s	c	s			c*	c*
	floor	s	s	s	s			s	c	c
	wall	s	s	s	s			s	s*	c
	ceiling	s	s	s	s	s	c		c	c
	others									
	dust outlet				c		s			
	Vanity unit								s	s
	Shower Screen								c*	c*
	Kitchen cabinets								c*	c*

c* Meaning the item is actually custom designed first, then, manufactured into bulk quantities

s* Meaning the item comes in off-shelf sizes, then, being manipulated into on-site requirments.

Table 1-1 Usage conditions of parts(1)

region of building		renovation[renovation only]:***r*** or **both**[for both renovation and new construction]:***rn***						**unit**[unit construction system]:***u*** or **simple**[simple parts]:***s***								
		the Netherlamds		Japan			Aust-ralia	the Netherlamds			Japan				Australia	
	N: New construction R: Renovation	R: Florijn Noord	R: Keyenburg	R: Torimi	R: Kouyoudai	R: Hikarigaoka	R: Victoria	N: La Fenetre	R: Florijn Noord	R: Keyenburg	N: Syouwa	R: Torimi	R: Kouyoudai	R: Hikarigaoka	N: Lumiere	R: Victoria
exterior wall	exterior wall			*r*	*r*		*n*				*s*	*s*	*s*		*u*	*u*
	autoclaved light weight concrete			*r*							*s*	*s*			*s*	
	sash and backbend			*r*							*s*	*s*				
	exterior wall base			*r*			*rn*				*s*	*s*			*s*	*s*
	vetilation pipe and around it			*r*			*n*				*s*	*s*			*s*	*s*
	others															
	beams covering															
	verge of a flowerbed															
	plansier															
	outside stairs															
	handrail post															
	concrete grid with balconies															
	timber frame with double glass and closed panels	*r*						*s*	*u*							
	inner cavity wall timber frame															
	outer cavity wall concrete brickwork															
	auminium window frames		*r*							*s*						
	Loovers						*n*									*u*
	Aluminium Sliding Doors / Windows						*n*									*u*
	Door Panels						*n*									*u*
rooftop	roof	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	top rail	*r*	*r*	*r*	*r*		*rn*	*s*	*s*	*s*	*s*	*s*	*s*		*s*	*s*
	penthouse prefab timber frame	*r*		*r*	*r*		*n*		*s*		*s*	*s*	*s*		*s*	*s*
	entrance	*r*		*r*	*r*				*s*		*s*	*s*	*s*		*s*	
	waterproofing	*r*	*r*		*r*			*s*	*s*	*s*	*s*	-	*s*		*s*	
	handrail	*r*			*rn*				*s*		*s*	-	*s*		*s*	
	others															
	bicycle parking															
	fence/gate				*rn*								*u*			
	metal clotheshorse				*rn*								*u*			
	Concrete balustrade														*s*	
	Color Bond Metal Sheeting						*n*									*u*
	Insulation						*n*									*s*
	Gyprock Ceiling						*n*									*s*
balcony	floor	*r*	*r*	*r*	*r*		*n*	*s*	*s*	*s*	*s*	*s*	*s*			*s*
	balcony partition	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*				*s*
	handrail	*r*	*r*	-			*n*	*s*	*s*	*s*	*s*	-	*u*			*s*
	handrail wall			*r*	*r*		*n*	*s*			*s*	*s*	*s*			*s*
	others				*r*											
	side ditch												*s*			
stairway	exterior (stairway)	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	leader	*r*	*r*	*r*			*n*	*s*	*s*		*s*	*s*			*s*	*s*
	floor	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	wall	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	ceiling	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*				*s*	*s*
	handrail	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*				*s*	*s*
	others															
facilities	tremch for dewatering	*r*	*r*	*rn*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	water supply pipe	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	drain	*r*	*r*	*r*	*r*		*n*	*s*	*s*	*s*	*s*	*s*	*s*		*s*	*s*
	elevator door	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	air conditioner			*r*			*n*				*s*	*u*			*u*	*u*
	others															
	exposed piping															
	leader for dewatering					*r*								*s*		
	Sauna						*n*									*u*
	Swimming Pool						*n*									*u*
	Flower Planter						*n*									*s*
indoor	steel fittings	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	wooden fittings	*r*	*r*	*r*			*n*	*s*	*s*	*s*	*s*	*s*			*s*	*s*
	floor	*r*	*r*			*r*	*n*	*s*	*s*	*s*	*s*	-		*s*	*s*	*s*
	wall	*r*	*r*			*r*	*n*	*s*	*s*	*s*	*s*	-		*s*	*s*	*s*
	ceiling	*r*	*r*	*r*	*rn*		*n*	*s*	*s*	*s*	*s*	*s*	*u*		*s*	*s*
	others															
	dust outlet															
	Vanity unit						*n*								*u*	*u*
	Shower Screen						*n*								*s*	*s*
	Kitchen cabinets						*n*								*s*	*u*

Table 1-2 Usage conditions of parts(2)

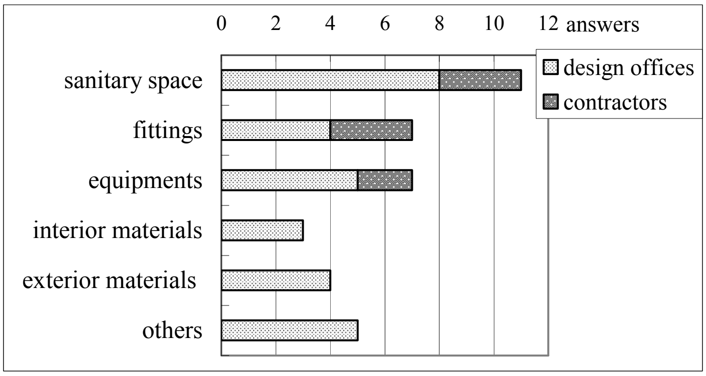
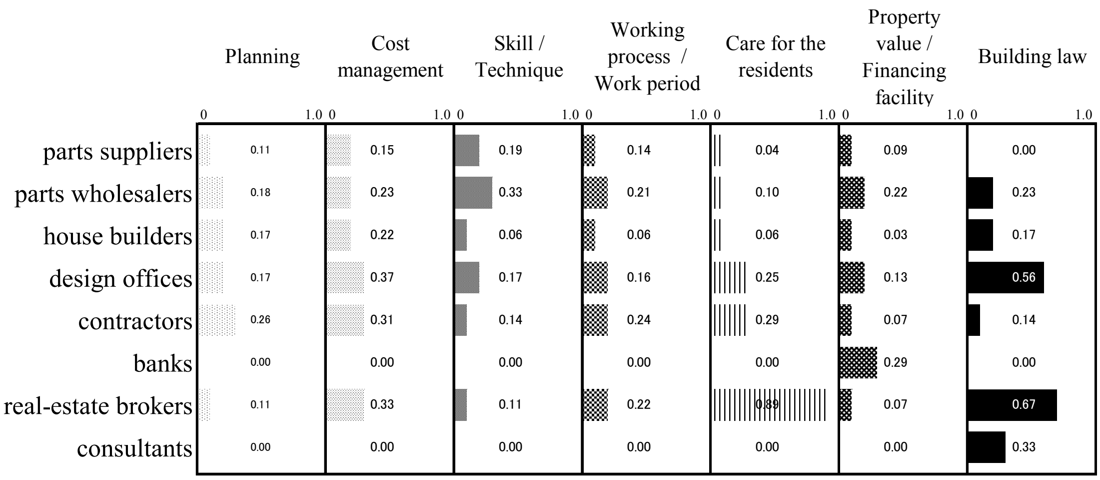


Fig. 2 Difficult spaces of renovation

the bathroom was by far the most complex area, followed by fittings and equipment. This complies with findings of extensive research from the time the buildings to be refurbished were built (van Randen et al).In order to better understand the parties' need for specific information during the complete construction process, a survey was done in the Nagoya region. Besides the obvious (banks are interested in the financial aspects and real estate agents in legal aspects and in communicating with the clients) it was found that some aspects, such as time planning, financial and legal issues are relevant to many of the parties. (fig 3).



	Planning	Architects' role is uncertain.
		Investigation /diagnosis methods are not constructed.
		To build residents' consensus is difficult.
	Cost management	Poor profits
		Pay doesn't correspond to the workload of each type of work.
		Expecting cost before it starts construction is difficult.
	Skill / Technique	Construction system is limited.
		Advanced technique is necessary.
		Workers' skill is various.
	Working process / Work period	Managing progress of work is difficult.
		Workable hours is limited.
		Work period is short.
	Care for the residents	Considering noises and vibrations for neighboring is hard.
		Securing residents' temporary dwellings is difficult.
		It is difficult for the workers to construct it with the residents live.
	Property value / Fnancing facility	Market is uncertain.
		Asset value of used dwellings is vague.
		Financing for renovation is incomplete.
		Money advantage by doing the renovation construction is few.
		Budget for the product development is insufficient.
	Building law	Performance in the buildings don't fill a present standard.

Fig. 3 problems of renovation (rate of a company)

3 ANALYSIS

Construction is a rather low-tech industry, processing simple materials and parts or simply connecting complex units, however with a high degree of complexity when it comes to customer satisfaction, organization and quality control. Refurbishment projects have the added complexity that the work has to be built onto existing base building infrastructure rather than on a green-field building site.

3.1 Notes on the process

Many trades in the construction industry are low tech, however this work can only be done by skilled workers. Bricklaying is a skill and installing electrical works, plumbing and mechanical components influence the long-term safety in use of a building.

Building construction is a sequence of low-tech activities with many trades and shared or not well-defined responsibilities. Two recent accidents arising from building failures that caused fatalities in the Netherlands (Kleinman, 2007) were caused by modifications not being communicated upstream, resulting in foundations that did not fit the buildings.

This survey found that information on the building to be refurbished is hard to find, the original drawings often cannot be retrieved or do not represent the actual building. Lack of essential information combined with a complex communication process form the bottleneck in the process. Although this is not typical for refurbishment projects (they are production processes like any production process), the information bottleneck surfaces earlier, since the lack of information on the existing building is clear as a major constraint from the outset.

Since this problem is created by the innate complication of working with insufficient information, it makes sense to look for the solution by simplification rather than installing even more information intensive control mechanisms. Information that is needed should be easy to find, for example by making the building easy to interrogate on matters that are important.

Examples of such strategies include embossed markings in concrete showing where not to drill, non-removable bar code stickers or electronic tags. Embedded computer chips are already ubiquitous, they are used to register pets and cattle, it makes sense to use such electronic coding techniques to identify buildings parts where it is important that other users, downstream of from manufacture, need to know important operational and maintenance details. This helps to manage risks for the life of a facility.

Another way of decreasing the information problem is to reduce the number of parties involved, by subcontracting larger chunks of work, and limiting the practice of pyramid sub contracting. Move to having one multi-skilled team do a larger package of work such as a complete bathroom or kitchen, or even the complete fit-out of a dwelling. They would have better control of quality, fewer chances for ambiguity of responsibility and better assurance of customer satisfaction.

3.2 Notes on materials and products

Based on the above observations it can be said that the complexity of managing the low-tech construction process is related to the simplicity of many activities by many different trades, such as cutting materials to size and connecting them to a larger whole. In order to better understand these processes, we need to look into the nature of connecting materials and parts. Some materials (M) are delivered in bulk, are shapeless and get their final shape after they have been applied, for example paint, glue, mortar and concrete, before curing. Another category of materials (S) has a fixed shape, but needs to be cut to size. Think of timber, sheet materials, bricks. A third category (P) contains parts ready to be installed, made off site, however cannot be modified without damage, such as pre-cast concrete and a window frame. Two category P elements (for example a window frame in a pre-cast concrete panel) only fit if the information of these parts has been communicated well. A P element surrounded by S elements (for example a window frame in a brick wall) requires low tech, however skilled activities to be fitted. The looser dependency between the two parts is compensated by the skill of the trade. Using an S material (for example a joint filling silicone kit) minimizes the dependencies of the parts mentioned and lowers the required skill level. These examples demonstrate the importance of dependencies between parts, related to their nature (M, S or P) and the available skills to connect parts, in other words the skills to build.

Multi-skilled teams work better if the requisite skills are easier to master, such as using foolproof positive connectors for making electrical and plumbing connections. There is a significant opportunity for product designers to develop complex building parts with a high degree of embedded complexity and quality. For instance, imagine a completely prefabricated wall for bathroom or kitchen. Once it is in place and connected to the mains, the only thing left is to connect the customer chosen appliances.

4 CONCLUSIONS

This paper built on an international survey of twelve refurbishment projects in Japan, Australia and the Netherlands. The study focussed on materials, parts and components used in the documented projects. Although refurbishment of existing buildings is more sustainable than demolish and build, refurbishing buildings can still be a rather wasteful process. In order to explore ways to improve this process, references were made to the building node studies from the early nineties, providing this paper historical bedding and the latest insights in construction management by referring to aspects of Lean Construction, such as creating value, banishing waste and definitions with regard to off-site production.

In the final analysis it can be concluded that:

Refurbishment should be seen as an ordinary production process, rather than a special construction process. This allows us to see the peculiarities of the process (low tech resulting in complex management structure).

Simplifying the information exchange with regard to the remaining parts of the base building as well as the newly added parts contributes to a more transparent and less wasteful process.

In order to make the information retrievable in the future it should be connected to the building parts rather than to a database of drawings that loose their value if they are not constantly updated.

A pyramid of sub contractors should be avoided. Instead multi-skilled team who can handle complex jobs decoupled from other trades and teams, such as doing the complete fit out of a bathroom or kitchen.

These approached demand the use of simple interfaces between the different domains of trade. Many foolproof connectors for wiring and plumbing already exist. At the same time this is a source for new product development.

The next step in this research could be a pilot project in which these recommendations are tested and evaluated and compared with traditional projects.

References

BALLARD, G., MATTHEWS, O. & CUPERUS, Y. (2007) *Prefabrication, assembly and open building*, http://www.iglc.net/themes/prefab/

CUPERUS, Y. (2001) *An Introduction to Open Building*. IGLC9, the Ninth Conference of the International Group for Lean Construction. Singapore, National University of Singapore.

CUPERUS, Y., KAWANO, N., LIN, K., MAROSSZEKY, M. & MURAKAMI, S. (2007) *Refurbishing Residential Housing, an International Comparative Study*. IN HAUPT, T. C. & MILFORD, R. (Eds.) CIB World Building Congress, 2007. Cape Town, CIB.

KAPTEIJNS, J. (1993) *Het Informatiseren van het Ontwerpen van Bouwknopen,* Delft, OBOM.

KLEINMAN, C. S. (2007) *Rd book for Building Projects.* Cement, 2004/4, 28-31.

VREEDENBURGH, E. (1990) *Leidingsystematiek in relatie tot flexibiliteit*, Delft, Publicatiebureau Bouwkunde.

Strategies for Modification of Space in Building Stock

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Keywords: Building stock, Function, Space, Modification, Functional capacity

Abstract
Rapid social-economic development causes rapid functional upgrading and transformation in architecture. A mismatch between space and new functions emerges in some buildings with resultant accumulation of building stock. Activating this building stock necessitates relevant modification of space. General strategies for modification of space should be tailored to the specific modification practices.

This essay elaborates on case studies of four spatial modification processes in building stock and evaluates their functional capacities before and after modifications. From the results of the studies the article summarizes three general strategies for modification of space in building stock.

1. Introduction:
"Buildings - and the neighborhoods they occupy - are not static artifacts even during the most stable times, and during times of social and technical upheaval need adjustment in some measure to remain attractive, safe and useful"(OB Mexico 2002). The rapid rise in living-standards brings about rapid functional upgrading in response. People prefer new buildings with better quality and service. As a result, those buildings which fail to catch up with functional upgrading, may fall vacant and be reduced to building stock. In addition, rapid urban development and expansion results in relocation of certain enterprises. A functional transformation of those buildings is necessary if they are expected to remain valuable. Buildings unsuitable for functional transformation are likely to become building stock.

In view of economics, sustainability and historical value, to demolish building stock is not always the best choice. Instead of being demolished, stock can be activated by various measures, such as spatial modification and aesthetic and technological renovation. This essay intends to approach the issue of building stock activation from the perspective of space modification with the aim of arriving at relevant general strategies.

2. Case study
Building stock covers various types of buildings. These include residential, factory, office, educational facilities, etc. The variety of building types and uses means that their functional upgrading and transformation must be in conjunction with their different requirements and backgrounds. Four selected cases in this paper include both functional upgrading and transformation. Three of them are residential, ranging from concrete-frame structures to brick structures; the other is a multi-storey factory.

The modifications in four cases are described using four spatial facets: size, shape, quality (service), and linkage. Functional capacity, an Open Building concept which refers to a range of variations in floor plan and use within the constraints of a given base building, is also mentioned.

Case 1 Enping Street Residence, Shenzhen
Enping Street Residence, built in the 1980's, is located in Overseas Chinese Town (OCT). It was built to accommodate the senior staff of an OCT developer. Today, staff members have bought their own residences in other places. In response to new regional planning, the OCT developer wants to convert the residence into a youth hostel through simple and inexpensive modification.

Fig. 1 Original Southern Façade

Fig. 2 Current Southern and Northern Façades

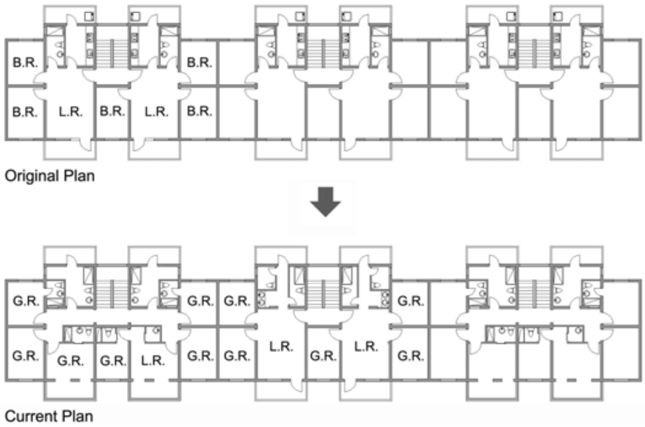


Fig. 3 Typical Plan Before and After Renovation

The original five-storey slab building was composed of three stair cores and thirty units. Each unit had a living room, 2-3 bedrooms, a kitchen, a bathroom, and two balconies.

In the functional transformation of the building the administration, service and public space needed to be placed on the ground floor. The small rooms in the original brick structure were insufficient to contain functions which need large spaces. Therefore, a horizontal extension was built to provide large spaces for a lobby, conference room, café, and dining area. The extension also connects three detached stair cores on the ground floor.

The upper floors are used as guest rooms. The location of doors, windows and walls could not be changed arbitrarily therefore the inflexible brick structure did not have as much functional capacity as a concrete structure. One third of the overall units were converted into suite rooms with little modification. The other units were divided into small guest rooms through rearrangement of the linkages between rooms. Original kitchens were replaced by bathrooms. The living rooms were converted into corridors and small guest rooms by the addition of bathrooms and partitions. The facade renovation consisted mainly of the modification of balconies and windows. All the balconies were renovated and space for air conditioners was well arranged.

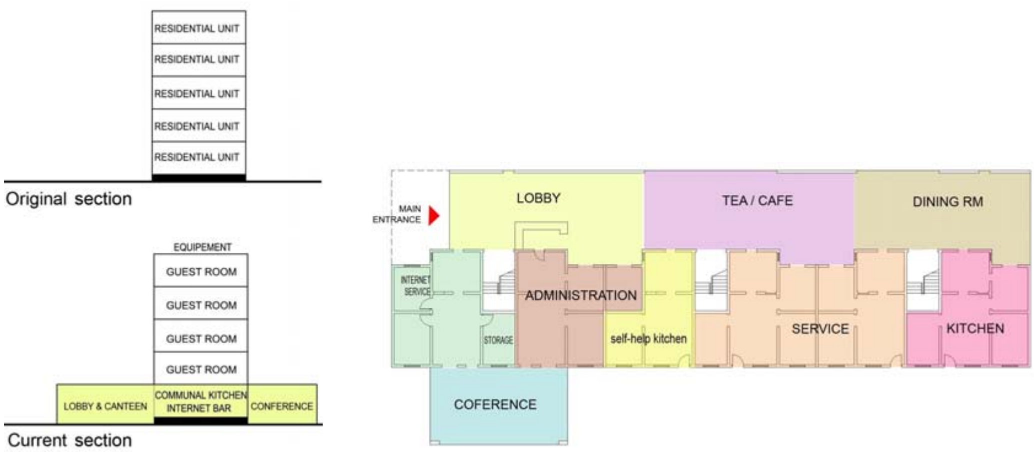


Fig. 4 Ground Floor Extension

Fig. 5 Photographs of Outside and Inside after Renovation

Table 1 Spatial changes in Enping Street Residence

Variables	Modifications
Size	Almost unchanged in typical floor, except the sub-division of living rooms. A large lobby and other public spaces were added on ground floor.
Shape	Almost unchanged
Quality	Sanitary system and lobby were added; balconies and windows were renovated. Parking space was sited near the building.
Linkage (typical floor)	

Case 2 Multi-storey residence for staff, Chongqing

The brick-structure residence built in the 1980's for staff and their families, enjoyed a convenient location in the city and was surrounded by nearby woods. It consisted of two joint six-storey buildings, each of which had six units and a staircase on each floor. Every unit, equipped with a kitchen and a bathroom, had a gross floor area of 40 or 50 sq. meters. The bigger units consisted of one living room, two bed rooms, a dining room and two balconies. Neither of the balconies was service use.

About ten years later, the original living and dining rooms were obviously smaller than those of newly-built residences. Families in the residence expected an enlargement of interior space, however demolition and rebuilding was economically unfeasible. By utilizing the yards beside the residence, larger living-dining rooms were added to all bigger units. After this enlargement, each unit had a bigger living room, and the original living room served as another bedroom. Although the kitchens and bathrooms could not be enlarged in the original brick structure, this modification enabled the residence to keep up with the average housing standard of the 1990's.

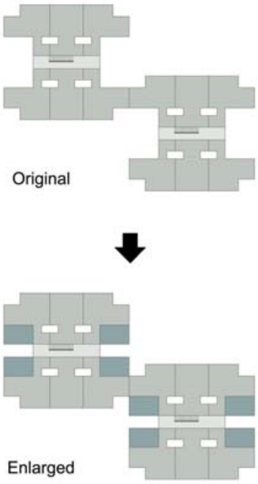
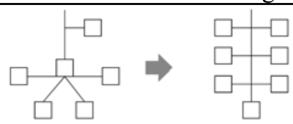


Fig. 6 Enlargement of the Residence

Fig. 7 Enlargement of end units

As a result of the limited functional capacity of this residence, it was difficult to be constantly upgrading in order to keep abreast with the increasingly higher living standards. Although the extended living-dining rooms could be built within a flexible concrete-frame structure, the functional capacity of whole building was limited by its original structure. Thus, for the sake of more efficient land-use this building was torn down in 2004. A new high-rise residence was built on the site to accommodate more people against the backdrop of current higher living standards.

Table 2 Spatial changes in a Multi-storey Residence for Staff

Variables	Modifications
Size	The living space was enlarged by about 10 square meters.
Shape	Almost unchanged
Quality	More bed rooms and storage spaces, larger living and dining spaces
Linkage	

Case 3 High-rise residence, Chongqing

This concrete-frame project was built around 2000. It had twelve stories, equipped with elevators and sufficient parking spaces. The developer had expected that their units could be both household and office oriented. The layout of some units was more suitable for small offices, and was not appropriate for dwellings. These units did not have a service balcony for daily laundry. Their bathrooms did not have natural ventilation and lighting, aspects frequently required by local customers. The materials on their façades looked stained. These units had large living rooms of 5.7 meters width (45 square meters), which were not in harmony with the other qualities of the units.

The demand for a higher standard in both residential and commercial accommodation frequently results in buildings being out of date. In this case small companies were dissatisfied with the quality of the units and gradually moved out. The remaining units were not suitable to serve as good residential apartments. It is currently being found difficult to market the remaining properties.

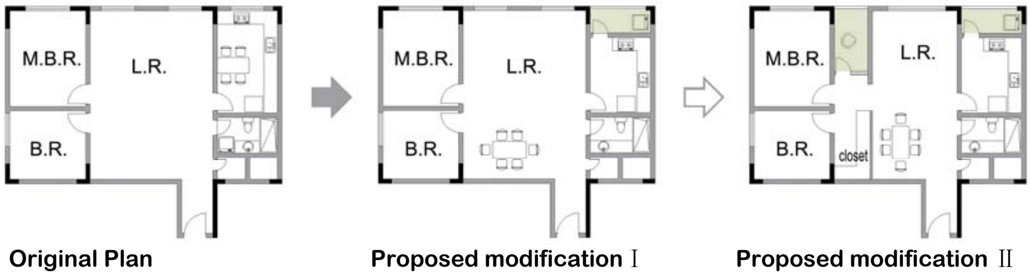


Fig. 8 Modification of the Unit

In order to improve the residential quality of these units, some modifications are proposed. The concrete-frame structure provides a certain degree of flexibility in space re-division. For instance, a service balcony for daily laundry could be obtained by the removal of the outer wall of kitchen. Likewise, light-weight partitions or furniture could be used to re-divide the original living room to meet the need for more storage space and a leisure balcony. These measures could give the building interior a level of quality comparable to recently built residential developments.

Table 3 Spatial changes in the high-rise residence

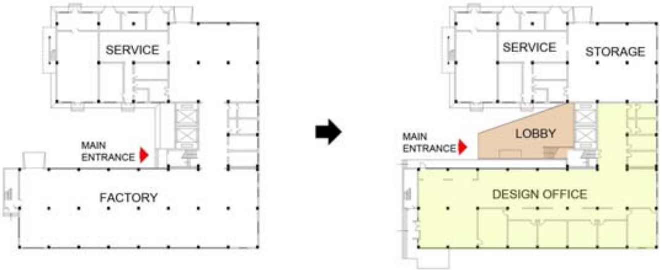
Variables	Modifications
Size	The living space was reduced to about 16 square meters.
Shape	Almost unchanged
quality	Sky garden, service balcony, storage space
Linkage	

Case 4 Multi-storey factory in OCT, Shenzhen

Many multi-storey factories were built in the 1980's in the eastern industrial area of OCT. However, since 2000 some occupiers moved away. The developer wanted to reuse these abandoned buildings employing simple and low-cost modifications. As one of the early modified projects, an abandoned six-storey factory was transformed into an office complex to accommodate culture and art related companies.

The concrete-frame structure, with sanitary systems and elevators in the center of each level, provided relatively high functional capacity. The original design with its three staircases met the requirements of the national design code for fire protection. The developer gave the companies freedom to subdivide the indoor spaces, and to make minor changes to the façade, including air conditioner locations and window styles. The company on the ground floor was permitted to arrange its main entrance freely. The developer hired architects to design an extension with a two-storey high lobby for the building and to renovate the stairs. This improved its quality as a modern office building. However, out of concern for reducing investment cost, the developer did not renovate the building to an optimized standard, despite the potential for improvement rendered possible by the flexibility of the original building structure.

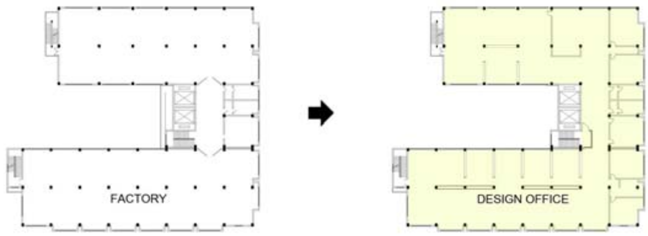
The new company occupying the second floor used furniture to subdivide the original large space. In this way, the structure and the partition levels were totally independent of each other. The subdivision did not reduce the functional capacity of the original construction and provided flexibility for further adjustment.



Original Current

Fig. 9 Modification of Ground Floor

Fig. 10 New Lobby

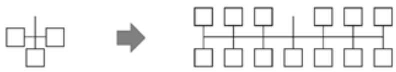


Original Current

Fig. 11 Subdivision of Typical Floor

Fig. 12 Modified Facade

Table 4 Spatial changes in a Multi-floor Factory in OCT

Variables	Modifications
Size	Through subdivision, the spatial size was suitably reduced for office use.
Shape	New lobby has a polygon shape, adding interest.
Quality	Lobby and other equipment were added. Parking spaces were located nearby.
Linkage (typical floor)	

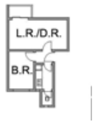
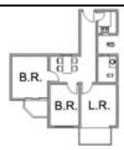
3. Strategies for modification of space

3.1. 'Muddling through'

Before the 1980's, historic buildings were the main category of buildings considered worthy of renovation. Their historic significance protected them from being demolished. However, since the 1980's, the trend to renovate reached a wider range of buildings, many of which did not have historic value. From that time a potential choice between renovation and demolition emerged. Many factors, such as economics, legislation, and urban planning, combined to have a remarkable influence on the choice. The issue of activation of building stock is further complicated by these undetermined factors which challenge the cost and sustainability of the building renovation. To ensure efficient use land, some low-rise building might need to be replaced by high rise buildings in the future (e.g. Case 2). Therefore, in some instances, the short-term value should be given paramount importance in the modification.

On the other hand, the limitation of functional capacity in some building stock makes it impossible to avoid demolition in the long term. Building stock is different from Open Building. "Open Building are designed with change in mind" (Kendall, 2000 p.56), while some building stock has very limited functional capacity. Although it is possible for some building stock to assume new functions through modification of space, most of them can not economically justify endless functional upgrading. In Case 2, for example, the units were brought up to the residential standard of the 1990s through functional upgrading by the addition of larger living-dining rooms, but, could they be modified to have larger kitchens with service balconies to meet the common residential standard in the 2000's? Could the building manage to include a sky garden by practical modification? Although the functional capacity may be enhanced by modification or flexible extension, some building stock still has the limitation of functional capacity as a hindrance predetermined by their individual features (especially their structure). Thus, the short-term value of modification is of greater importance.

Table 5 Development of Chinese residential design in different decades

Year	1970's	1980's	1990's	2002	2007
Feature of residence	Basic	More rooms	Floor area enlarged	Quality improved	Sentiment-oriented design
Example of the Ordinary Residential Unit					

'Muddling Through' was proposed by Charles E. Lindblom in 1959 in a journal *Public Administration Review*. It was introduced later into urban planning. 'Muddling Through' referred to using a policy which could achieve goals partially and it emphasized short-run objectives to solve current complex problems in uncertain circumstances. This strategy can be introduced into building stock activation. Since the matter of 'demolish or not' is determined by many uncertain factors and the functional capacity of building stock, the modification of space in some cases should emphasize short-term value. The aims of modification can be interpreted, in some instances, as being an improvement in the usefulness of the building during the period before it is finally determined to demolish it.

3.2. Utilizing flexibility of original buildings

Building stock always has a certain degree of flexibility. Modification should make use of this existing flexibility.

Concrete-frame structures always have higher flexibility and functional capacity. The most common method of modification for a concrete-frame structure is to re-divide its spaces by adjusting their partitioning (e.g. Case 4). Also, concrete-frame structures provide a potential freedom to modify the façade. Users have the choice of moving the position of the outer walls and windows to cater for the new functional requirements. In Case 3, the proposed layout entailed flexible adjustment on the façade. If a developer allows the occupants some freedom on façade control, residential units may serve the users better.

When considering the modification of inflexible brick structures, the original and future functions should have similar spatial requirements in size, shape and quality (e.g. Case 2 and the upper floors of Case 1). The star or tree structure spatial linkage also brings certain convenience in the re-organization of the space in original buildings (e.g. Cases 1 and 2). In addition, the yards and outside buildings can provide space for extra extensions (e.g. Case 1 and 2).

3.3. Maximizing functional capacity of the whole building

The functional capacity of modified buildings should be considered, especially when it will not cause a great increase in construction cost. In this way, the building can assume a variety of layouts to meet various or unpredictable function requirements, and may be kept in service longer.

"Design of the Support ideally incorporates capacity according to three principles. First, each dwelling in a Support must allow a variety of layouts. Second, it must be possible to alter the floor area by changing the boundaries of units within the base building or expanding it. Third, the Support or its parts must be adaptable to varying functions, some of which have been non-residential in character" (Kendall, 2000 p.39). To maximize functional capacity of the whole building, some Open Building design strategies can be implemented in the modification. They are listed as follows:

- Disentangled levels
- Proper arrangement of service systems
- Polyvalent spatial design (proper door location, neutral shape, etc)

Modifications in Cases 3 and 4 (the second floor of Case 4) have used the method of “disentangled levels”. They take advantage of the use of furniture as partition walls to sub-divide a large space. The partition level is total disentangled from the structural level. This means of modification does not reduce the functional capacity of the original large space.

Table 6 Strategies implement in four cases

Cases	Strategies		
	‘Muddling through’	**Utilizing flexibility**	**Maximize functional capacity**
Enping Street Residence	●	●	○
Multi-floor Residence for Staff	●	●	
High-rise Residence	●	●	●
Multi-storey Factory in OCT	●	●	●

4. Conclusion

An increasing number of buildings which fall short in functional upgrading or transformation are confronted with renovation and activation problems. Modification of space inside building stock contributes to lengthening the lifespan of these buildings. The three strategies illustrated above are proposed in order to generate more insightful understanding of the proper orientation of modifications, to inspire individualized methods of modification, and to gear the modification activities towards a more economic and sustainable end.

References

Kendall, S., and J. Teicher. 2000 *Residential Open Building*, London: E&FN spon.

Kendall, S. 2005 An Open Building Strategy for Converting Obsolete Office Buildings to Housing. *AIA Report on University Research*

Lindblom, C. The Science of “Muddling Through”. *Public Administration Review*, Washington D C: 1959, vol.19: 79-88.

Sustainable Redevelopment of Settlements: The Role of Tenants' Preferences and Participation

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Keywords: participation, redevelopment processes, user preferences, creativity.

Abstract

The redevelopment processes in residential estates cover high potential for more sustainable qualities. This holds especially for the housing stock from the post war era in Germany, which still represents one third of the existing multifamily housing units. Sixty years after they were built they face new challenges regarding new preferences of tenants and new regulations. Concerning the necessities of sustainable development, ecologic improvements have to be taken into account as well as social, economic and cultural aspects.

Within the process of redevelopment, housing companies can take advantage from the change by stimulating neighbourly social interaction. The "Green Folder" - a new participation method can help not only assessing the demands of people living in a settlement and gathering their ideas but also initiating contact and communication among neighbours and between neighbours and planners. Thus the often neglected social aspect of sustainability is integrated into the redevelopment process. While tenants' identification with their settlement may rise, housing companies follow their objectives to bind tenants. This again serves various different sustainability aspects.

1. Introduction

Many residential estates in Germany, especially from the post war era, are now facing redevelopment processes[1]. Due to changes in the preferences of tenants and due to new regulations and subsidies, more and more housing companies began to redevelop their housing stock. Within this redevelopment process high potential for more sustainable urban development can be ascertained. As the concept of sustainability is holistic and covers at least an ecological, an economical and a social pillar, we have to consider the relevant consequences which redevelopment processes will have on these dimensions. As the relevance of reduction of energy consumption for the ecologic dimension of the sustainability concept is beyond dispute, the paper will not concentrate on this. Beyond question is also that housing companies will make their decision based on economic considerations. As subsidies give incentives for redevelopment, but will not cover more than 20 % of the reconstruction costs, we may also assume that redevelopment decisions follow more or less the economic sustainability requirements. Hence, the paper will concentrate on the social aspects by considering effects that participation in the redevelopment process may have on residents.

Participation of residents can focus on aspects of design or configuration concerning the buildings, the

[1] The findings and practical experience underlying this paper derive from a transdisciplinary research project that concentrates on redevelopment processes in residential estates, built in the post war period (www.zeilen-umbruch.de). The project was financed by the Federal Ministry of Education and Research. The author was leader of the project.

apartments or the landscape. The paper presents a participation method, the "Green Folder", which was created to conduct redevelopment processes together with residents. The method had been applied twice for the planning of residential green spaces and public spaces. Besides assessing the demands of residents, the major objective of the method is to initiate contact and communication between neighbours.

2. The Current State and Potentials of Settlements

In Germany, as much as one third of the existing dwellings in multifamily houses were built in the post war era. Due to the destruction of World War II they were built quickly and with the restricted resources of this time. Because of the enormous share in the housing markets and because of its huge energy consumption these settlements play an important role within the process of sustainable urban development, which is intensified because of the discussion about carbon dioxide.

Furthermore the settlements also face new challenges because tenants preferences changed in the last half century and also demographic alterations have to be taken into account (Wendorf 2005, p. 272 f.). Especially the building services engineering is not up to date, e.g., dwellings have no central heating, windows are not air-tight and sometimes single glazed and the insulation of walls and roofs is bad. Elderly residents ask for barrier-free housing and accessibility products for bathrooms etc. Consequently, the housing estates urgently need alteration and adoption to modern preferences and energetic requirements now.

Because of their simplicity, the post war settlements were often criticized not only nowadays. There are even voices calling for pulling them down. For instance, Mitscherlich (1965) described the post-war housing programmes as "totally neglecting peoples' psycho-social demands". Looking at these estates nowadays, other factors than dilapidation and desperation, as expected according to Mitscherlich, can be found. Today these settlements are also characterized by well-functioning social structures and networks, contentment and a strong sense of belonging among residents. On this basis relationships may even be strengthened by involving neighbours in the process of planning. Common planning and common use of the residential environment may improve the interaction between neighbours.

Photo 1

Photo 2

The typical spacious greenery in settlements of the post war era (photo 1) thereby serves as a resource for a variety of leisure activities, including gardening, sports and relaxation. But even if space is rare (photo 2), interaction and activities may be generated by participation.

3. The Role of Participation in Sustainable Urban Development

Participation is one of the main elements of sustainable urban development. Since the United Nations Conference on Environment and Development 1992 in Rio, participation is encouraged through Agenda 21. Still the implementation of Agenda 21 is not yet finished everywhere. Moreover, participation can be applied not only for official urban planning but also on the level of redevelopment of housing estates. The latter usually belongs to the responsibility of housing companies. They are responsible for planning of

reconstruction and renovation and may involve their tenants in the process. Thereby participation may not only be regarded as a measurement to create suitable planning results. Just as well, it may intensify social interaction within the neighbourhood which is important for building and bridging so called “social capital”. Social capital in the sense of social relations based on commitment and trust (Coleman 1987, 1990) as well as social control among neighbours in functioning living quarters (Jacobs 1961, 1966) can be more or less incorporated in neighbourhood structures. This kind of a city´s irreplaceable (social) capital is receiving more and more attention in the discussion of sustainable urban redevelopment.
Considering post war era settlements, we can find good premises concerning social interacting. The well-functioning social structures are based on socials aspects related to the historical situation as well as to some physical frameworks.

3.1 Conditions for Social Networks

One major impact derives from the fact that still many of the residents of these estates are first time movers. They know each other for a long time and share common experiences. Moreover, some of them are in a similar situation like their neighbours: They get old and their radius of activities is decreasing. For this reasons they seem to have similar needs concerning the greenery and the infrastructure within a settlement. Furthermore having contact to their neighbours may play a more important role in their social relationships. This also holds for some of the persons moving into these settlements today. They are often single person households as the average size of a flat is very small in these buildings (many flats have less than 50 square metres). Without having children, it is usually more difficult to get into contact to neighbours.
Considering the physical framework of post war era settlements, we find good conditions to build and support social networks. The houses usually have 2, 3 or 4 stories, with two or three flats every story. This results in a total number of about 10 households sharing one staircase. Under these conditions, neighbours get into contact easily and know each other quite well. They know about their jobs, their children and many other details of their private life. At the same time, they know about peculiarities and oddities of neighbours and they have learned to handle them. Not incorporating this knowledge within the neighbourhood into the planning process will be missing a chance.
Regardless the time of living in a settlement, the individual situation of the household and the physical framework of a settlement, participation can facilitate the process of getting into contact to neighbours. It can also be a measure to evoke or intensify individual identification with the neighbourhood and the housing company and improve the reputation of a residential estate. Thus, it is an example of a win-win situation that reflects aims of the social and the economic pillar of sustainability at the same time.
But how is it possible to implement or “awaken” that kind of social capital within the redevelopment process in a settlement? Following this objective, a participation method, named the “Green Folder”, was developed.

3.2 The “Green Folder” method

The "Green Folder" method was developed as an instrument to carry out participation processes in residential estates. It combines different methods of participation in successive steps and tries to encourage neighbours to express themselves, to bring forward new ideas and, at the same time, to get into dialog with each other. It was developed and applied twice for the planning of residential outdoor spaces and the implementation of institutional arrangements for their sustainable use. Until now it is rather uncommon to involve residents as experts for their specific residential environments in planning and moreover, in care-taking activities. But handing over responsibilities to the residents could help solving problems

connected with commonly used green spaces and it could bring neighbours into contact.
In both applications the "Green Folder" method has proved appropriate to integrate the ideas and preferences of residents and to anticipate potential rivalries integrating the knowledge and creativity of neighbours as experts.
To be appealing for all residents and to address all kinds of creative potential, the „Green Folder" method combines adequate components from existing participation methods, complemented by newly designed components for those who are not familiar with filling in questionnaires (prepared stickers to be placed on a map, sheets for drawings and collages…). The whole participation process consists of two folders (photo 3), an exhibition and a final event with tenants.

Photo 3

It starts with a first folder specifically adjusted to the current situation of the settlement in question. The folder is designed according to the work-book method[2] that was successfully applied mainly in Scandinavian countries. To achieve a high rate of participation, the first folder was handed out personally to every household by members of the executive team. Residents were informed in advance about their possibilities to participate and could get assistance with filling in the folder. Besides the challenge to involve a wide range of neighbours with different interests and abilities in the process, the material was also created to address not only potentials but also difficulties in planning and using residential environments. The folders also intended to initialise a discussion about existing or potential conflicts, and they were used as a mediation attempt.
A new and very successful component of the first folder was e.g. the part "Write us a postcard!" Here, the residents could choose from a set of picture-postcards from their settlement. They were invited to briefly tell whatever they think, planners, housing companies and other stakeholders should know about their settlement. In effect, residents wrote about the current situation, if they feel comfortable or not. They also took the chance to express their worries about future developments and stated what should be done and what should strictly be avoided within their neighbourhood. These qualitative statements were evaluated, and they were a good basis for the planning process. Other components were stickers, to be placed on a map from the area in question, as well as the creative sheets for designing, e.g., a 'water basin without water'[3] that turned out to be broadly accepted by the participants. The results can be portrayed by collecting the ideas and carefully integrating them on maps or posters (Photo 4).

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[2] As so called *Arbeidsbokmetoden* this method was mainly developed by two researchers, Johs Oraug and Einar Rutledal Oraug, at the NIBR (Norwegian Research Institute for Town and Regional Planning) from the end of the 1970s (see Oraug 1979).

[3] The ‚water basin without water' combines the idea of having water in the residential area with the fact that running costs of a real water basin would be to expensive for most of the residents.

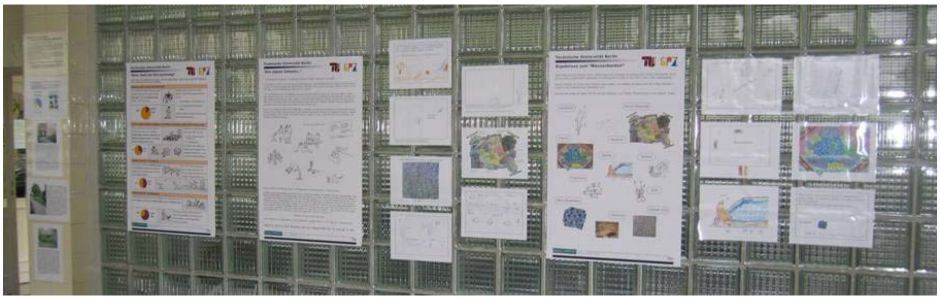

Photo 4

The second module of the method is a second folder, presenting first results from “Green Folder I” and offering the chance to give comments on the presented results and to discuss topics of interest in depth. Additionally an exhibition on site serves to present and discuss the results of the first folder in an appealing way. Persons from the executive team should attend the exhibition so that they could be addressed by and talk to the visitors and, of course, neighbours have another possibility to talk to each other (photo 4 and 5).

Photo 5

Photo 6

Photo 7

The last module is an event together with tenants. In one application of the method the final event offered working groups on topics like “godfathers for meeting places” (photo 6) or “playing and relaxing” (photo 7). This completed the proceedings and was meant to initiate long-term arrangements within the neighbourhood. The whole process was designed to give residents the possibility to step into the process at any time starting with the first or the second folder, with visiting the exhibition or just with participating in the final event.

The method had been carried out in a post-war settlement in Berlin with a total number of 560 households, where the green residential environments and their use had to be planned. It was embedded in a wider context of redevelopment of the building stock, where the housing design and the building services engineering was modernized completely, including insulation and solar-energy-facilities. The second application took place in a city in Brandenburg, south of Berlin, where a semi-public green space - left after demolition of a tower block - had to be planned for a future design and use. Here 700 households were addressed with the "Green Folder" method. In this second application 100 households participated. In the first application about 200 households filled in the first folder, 150 of them answered the second folder, many neighbours visited the exhibition and discussed the results and about 100 persons attended the final event.

To conclude, the method proved to be adequate for participating residents of different age and social and migrant backgrounds in planning processes. It is very important that the method entails low thresholds to participate. The method also proved to generate creative ideas as well as solutions for major problems in the neighbourhood.

First evaluations of expectations and experiences with the process have been carried out. Residents were asked within the second folder and planners, housing companies, and janitors were interviewed after the whole method was carried out. Residents were very satisfied about getting the possibility of participating this way. Most of the interviewees stated a positive impact concerning the acceptance of the newly planned residential environment as well as for the neighbourly relationships. For some experts from housing companies the method offered the first opportunity to get into direct contact with the residents. At the same time housing companies got useful hints on issues that are important for their specific neighbourhood not only for the actual planning task.

As the outcomes of the first application of the method are already implemented, it is also possible to observe first reactions to the realisation of the planning. Tenants as well as planners and the personnel from the housing company are proud of the process as well as of the results of the process. The following photo (8) illustrates a part of the outcome. It shows a "Place of Water" for relaxation and a chessboard for tenants.

Photo 8

4. Conclusion

Participation can play an important role towards more sustainable development. The "Green Folder" method has turned out to be able to create a realistic and creative basis for planning processes on the one hand side, and furthermore, it showed its potential for initiating contact between neighbours. Results of the participation method have recently been implemented. First evaluations show that residents appreciated very much that they have been involved in the planning process and it also turned out that they were very satisfied about the implementation of their ideas. These results plead for integrating tenants' preferences in the redevelopment process, not only because sustainable development of settlements is more than respecting the ecologic dimension of the sustainability concept. Various different psychological and social aspects serve the social dimension of sustainability. Last, not least, tenants' satisfaction also counts for housing companies.

5. References

Coleman, James. 1987. "Norms as Social Capital", in Gerard Radnitzky and Peter Bernholz (eds.) *Economic Imperialism: The Economic Method Applied Outside the Field of Economics* New York: Paragon House Publishers.

Coleman, James. 1990. *Foundations of Social Theory*. Cambridge, MA: Harvard University Press.

Jacobs, Jane. 1961. *The Life and Death of Great American Cities.* New York: Random House.

Jacobs, Jane. 1966. *Tod und Leben großer amerikanischer Städte*. Frankfurt: Ullstein.

Oraug, Johs. 1979. *Beboermedvirkning ved utbedring av eldre strøk – Arbeidsbokmetoden.* (Participation of residents in the reconstruction of older settlements). NIBR-arbeidsrapport.nr. 17/79. Oslo: NIBR.

Wendorf, Gabriele. 2005. *Wohnsiedlungen im Umbruch*. In: vhw Forum Wohneigentum. Zeitschrift für Wohneigentum in der Stadtentwicklung und Immobilienwirtschaft. Heft 5, S. 271-275.

Apartment Housing in Dhaka City: Past, Present and Characteristic Outlook

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Keywords: Apartment, Dhaka, Informal Housing, Private Developer, Residential Transformation

Abstract
This paper contributes to the view that apartment housing in most cities in developing countries are different in nature and extent than that operative in developed countries. It addresses the emergence of multi-storied apartments through transformation in residential areas in Dhaka, one of the most populous cities in the world and largest metropolitan region in Bangladesh, with a particular reference to a study conducted at Dhanmondi Residential Area. It identifies the key forces and processes underlying Dhaka's residential transformation and the advent of multi-storied apartments. Fragmentation of functions and the uses of building stocks in relation to the socio-economic aspects with local conditions were sought in the empirical survey. The increasing housing demand is being fulfilled essentially by multi-storied apartments. Thus multi-storied apartments are steadily transforming the landscape and lifestyle of huge urban dwellers in Dhaka. It reveals from the study that apartment living gain much popularity and dominance of informal apartments over formal apartments are more evident. Apartment living is now well established among the people of Dhaka and Dhanmondi is the best example of the transition of single family dwelling houses to multi-storied apartments within a span of two and half decades.

1. Introduction
1.1 Background and Objective of the Study
Dhaka is the nucleus city of Bangladesh and has come to be known as one of the mega cities of the world. The city in 2001 had over 12 million people for the larger conurbation and 6 million people within the central city area (Islam, 2005). The quick growth of population of Dhaka has been caused by high rate of in-migration, territorial expansion and natural growth. As housing cannot keep pace with the population increase, the city has experienced tremendous housing lack since 1970s. Phenomenal growth of the city population is dominantly contributing to the dynamic changes in residential areas. It is a deplorable fact that residential areas have lost much of their residential character in order to cope with rapid urbanization. The traditional urban housing form in Dhaka has undergone many radical transformations over the past few decades. The traditional fabric of the city has either been damaged, remodeled or has disappeared entirely. Architecturally significant buildings that are fifty to hundred years old, representing their time, and located in the older part of the city, have now become obsolete primarily because of economics (Ahmed, 2004). Thus the increasing housing demands are being fulfilled essentially by multi-storied apartments. The dwelling culture has also changed gradually over a short span of time. The traditional dwelling custom has changed in different orders from the native origin. The concept of living in multi-storied apartments is something that is ordinarily not ingrained in the cultural experience of most Bangladeshi's. It is a new experience for many people to live in apartments and maintain their life style, thus changing the urban and social fabric from the classic single storied independent house, to sharing smaller units of space side by side with numerous other families.

Based on this background, the objective of this paper is to make an interim report on an ongoing study to identify the state of transformation in residential areas, the key forces to develop multi-storied apartments, a popular dwelling structure at present, and the adaptive alterations made by the developers in providing housing. This is the broad concren of the paper. In particular, the study examines how, why and when apartments, a western housing model, came to take place to the city of Dhaka, replacing the earlier house forms during the last two and half decade and remain a popular housing form at present. This will not only fill in a missing gap in the housing history of Dhaka, of which there is a shortage of research, but also provide an opportunity to make a new visual approach to the state of city's dominant housing types and reflect on the residential culture.

1.2 Research Methodology

The characteristic of the residential areas in the city has undergone dynamic changes mainly due to commercialization. Thus, urban lifestyle and house form experiences a series of alteration and adjustment in its planning, organization and hierarchy of space, and façade treatment, that correspond to the changing habits and activities as opposed to traditional behavior. By considering the present situation of Dhanmondi Residential Area (DRA) in the city of Dhaka, the study considers the extent to which residential structures has transformed into apartments including physical characteristics, fragmentation of pattern of usage, informal development, among other factors. The approach was to search the factors that contribute significantly to the emergence of apartment through residential transformation and how it becomes well suited in the local housing market. The time period dealt with in this study ranges from 1980s when the apartments first introduced in the housing history of the city and advanced in the subsequent years. The study was based on the field survey conducted in 2006 in DRA. To conduct the study, a total of 256 multi-storied buildings are considered in the study area. The field survey covers the statistics of present building stocks, height and pattern of use of multi-storied apartments. Published reports, bulletin, journals and newspapers were the sources of secondary data relevant to household income, expenditure, housing cost and affordability. A combination of quantitative and qualitative data analysis was used to grasp a better understanding of the real picture that exists in the study area.

2. The Study Area

Dhanmondi is located 5 km away from the city center (Fig. 1). The administrative boundary of Dhanmondi area is commonly referred as Dhanmondi thana, consists of 3 wards and has an area of about 10 sq. km (BBS, 2001). Dhanmondi thana is bounded by Tejgoan and Mohammadpur thanas on the north, Lalbag thana on the south, Ramna thana on the east, Hazaribagh and Mohammadpur thanas on the west.

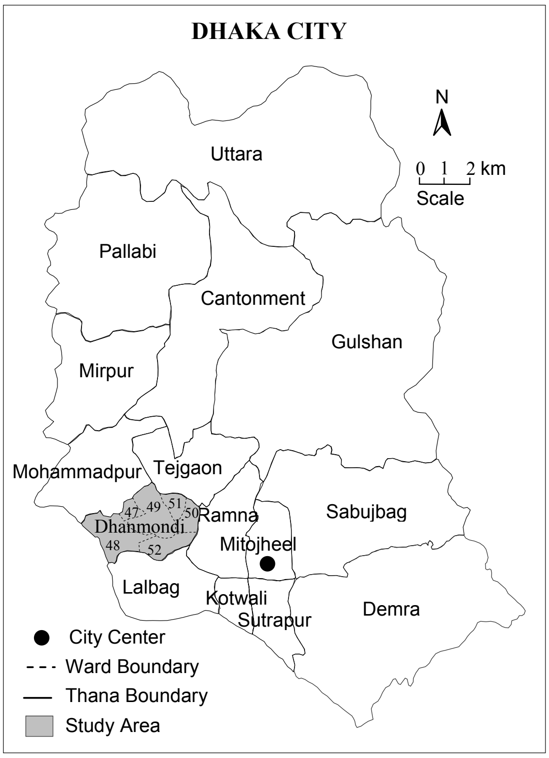

Fig. 1 Dhanmondi Area in Dhaka City

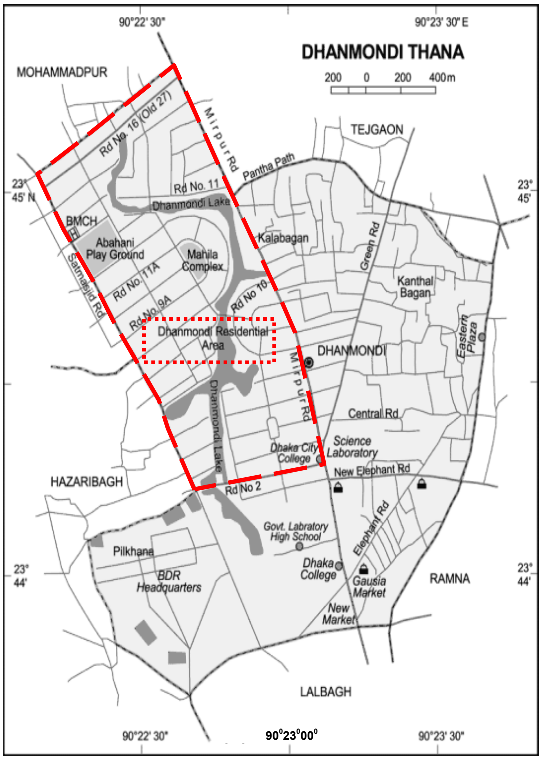

Fig. 2 DRA in Dhanmondi Thana

The population size in Dhanmondi was 202,000 in 1991 and increased to 264,000 in 2001 with different income groups which eventually shape a gross density of 26,400 persons per sq. km (BBS, 2001). Thus, Dhanmondi is now set to become one of the most densely populated up-market residential areas in Dhaka city. The study continues to DRA which belongs to ward number 49 and initially it was designed as a low-density residential area for high and higher-middle income groups at early 1950s. By the next decade it had become the prime and typical residential area in the capital. DRA was one of the first planned residential communities in Dhaka with an area of 1.92 sq. km. Figure 2 shows the extent of DRA with 50 and 51 no. wards in Dhanmondi thana.

Dhanmondi is basically laid out on a gridiron pattern and consists of rectangular plots (Fig. 3). Predominant house form was individual private homes with a front lawn and /or a back garden. It has about 1000 highly serviced plots. Most buildings at that period were owner ocuupied. Few tenants lived in Dhanmondi at that time which is a complete different phenomena comparing the present one. There was only one school and one mosque within Dhanmondi. Even in the early 80s, Dhanmondi was a picture of perfect residential area with independent homes, lakes and only a few corner shops (Hafiz, 2004). But as Dhaka started expanding rapidly, Dhanmondi had to accommodate the pressures of substantial urbanization. Within the last few years its status is changed to a semi-commercial area. Already the plots around the Mirpur Road, Road no: 27, Satmasjid Road and Road no: 2 (Fig. 2) have been converted into commercial ones. Consequently, residential structures also undergo adaptive alteration. Schools, clinics, fast food shops, banks and other commercial establishments began to crop up all over the place. Urbanization and high demand for housing in elegant locations has made Dhanmondi attractive to the affluent residents of Dhaka. But problems relating to indiscriminate development of high and medium rises are evident in Dhanmondi. The intense development of a low-density, low-rise residential area has given rise to a dense development and proliferation of built structures.

3. The State of Transformation

Dhanmondi was a planned formal residential area with all urban facilities. Gradual invasion of non-residential uses has drastically affected the quality and changed the character of Dhanmondi. It presents a unique case that is in transition having been under many development pressures and internal destruction forces as revealed from the comparison between Fig. 3 and Fig. 4. Such unplanned development has not only destroyed residential character, but has also resulted in unprecedented environmental degradation.

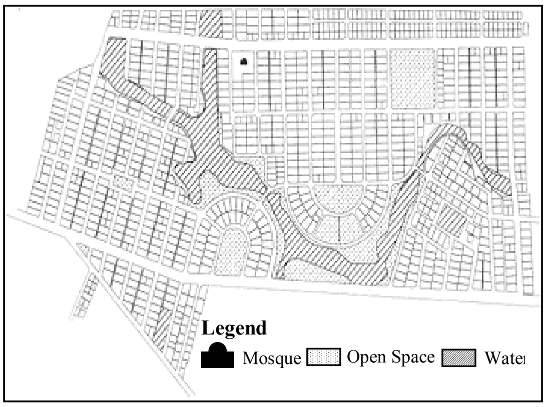

Fig. 3 Original Map of Dhanmondi (1960)

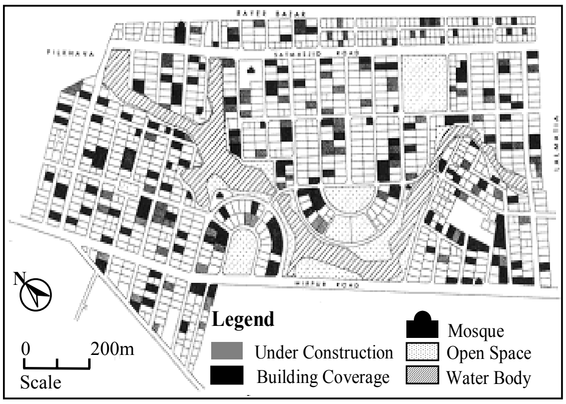

Fig. 4 Dhanmondi Residential Area in 2001

3.1 Building Stock, Changes in Plot Coverage and Height

Besides the commercialization of residential plots, the whole of Dhanmondi area has been virtually surrounded by shopping malls, hospitals, clinics, restaurants and offices. Huge number of non residential building infrastructures is noticeable at Dhanmondi and also presented in Table 1. Most houses built on these plots in early 80s, were low-rise 3 to 4 story's with maximum utilization of floor spaces. Plot sizes at Dhanmondi vary from 350 to 1400m². It was common that most houses are occupied 50% of land keeping rest spaces free for open space like green or garden and also separate garage. But now land coverage varies from 70% to 80% even more in practice. In Dhanmondi, flats were mostly used for rental accommodation as a source of income generation, multiple dwelling and limited floor space with two or three rooms with other facilities like toilet, kitchen with few provision of parking. Due to lack of concern of authorities, building height restrictions are not honored. Out of the 256 studied buildings, 37 buildings within the area have found constructed in violation of the law which restricts more than six storey (Table 2). High rates of transformation in the building stock are occurring as extensions, modifications, alterations and high-rise (6 to 20 storey) construction are taking place by formal and informal private developers.

Table 1 Building Stocks at Dhanmondi

Structure Type	**Number**
School	50
NGO Office	100
College & Private University	40
Medical College, Hospital & Clinic	27
Fast food & Chinese Restaurant	17
Shopping Mall	52
Community Center	14

Table 2 Height of the Building Structures

Building Height	**Number**	**Percentage (%)**
5 Storey	88	34.38
6 Storey	131	51.17
7 Storey	21	8.20
8 Storey	08	3.13
9 Storey	03	1.17
10 Storey +	05	1.95
Total	256	100

3.2 Factors of Recent Changes

Despite the residential importance of Dhanmondi, recent development pressures have caused many of its transformation process. Lack of proper maintenance has resulted in the deterioration of local building stock and its eventual replacement by new apartments. The lack of flexibility in addressing modern urban needs is also evident. The change in cultural values has resulted in a different perception. Modern functional requirements manifested in the changing needs and new uses have created new forms of spaces, buildings and structures. Social factors such as changes in local lifestyles and household composition have stimulated the transformation process. The most important factor is the absence of responsive workable criteria and plans to guide the growth and developments in the residential area.

3.3 Fragmentation of Functions and Uses

Recent functional changes tend to result in commercial developments. The functions of many buildings along the major streets are changing from residential to commercial, institutional and manufacturing activities. Quaint independent houses have been turned to high rise apartments. Multi-storied apartments are presently used in different functions. Following Table 3 give an outlook of the pattern of use of these multi-storied apartments. Out of the 256 buildings, 30 were found to be used non-residential purpose. Different commercial uses of the buildings are common in the study area and represented in Table 4.

Table 3 Usage of Apartments

Use Types	**Number**
Residential	216
Commercial	30
Residential cum Commercial	6
Commercial cum Residential	4
Total	256

Table 4 Non Residential Usage

Modes of Use	**Number**
Education Institution	8
Hospital & Diagnostic Center	13
Shopping center	7
Restaurant	2
Other Commercial	10

3.4 Densification, Intensification and Replacement

Densification takes the form of extensions, additions and alterations to the existing buildings. This attitude varies in its scale, between the addition of a small element to a vertical extension and mainly by the individual property holder or the informal sector (Fig. 5). This has severe physical consequences, as the existing fabric is being progressively destroyed and new problems are created. The active process of demolishing and rebuilding is causing the disappearance of the earlier building stock (Fig. 6). This process is responding to new functional and technical needs (replacement by new apartments with new functions) and morphological requirement aspects. The new high-rise developments by the formal developers represent the major part of this replacement process (Fig. 7). A new skyline of high-rise apartments is rapidly appearing along the main streets, destroying the streetscape. House construction is predominantly a self-help activity in

Dhaka. Thus individual landlords from informal sector to large private developers' contribute to different phases of transformation as a whole.

Fig. 5 Densification by Individual Property Holder

Fig. 6 Demolishing & Rebuilding by Informal Sector

Fig. 7 High-Rise Construction by Formal Private Developer

4. Multi-Storied Apartments

Three decades back the city dwellers were reluctant to live in apartment while ten years back some one would have thought twice before buying an apartment. But in the last couple of years people have shown an increased interest living in apartments either by owning or renting. In recent years it becomes the most popular housing form in Dhaka. Multi-storied apartments seems to be a feasible solution to housing need of an increased pressure of population provided that good housing and urban design are factors to be taken into account.

4.1 Introduction of Apartments in Dhaka

With a rising population and increasing housing demand, apartment culture has grown up in Dhaka sharply. The horizontal expansion of the city is very limited as Dhaka is hemmed by a network of rivers that makes outward expanding difficult and only vertical expansion is possible to accommodate the growing numbers of residents. Apartments were first introduced by the formal private developers in early 80s to the housing history of Dhaka. It first appeared in Dhaka near Eastern Plaza and subsequently Dhaka experienced a boom in apartment development in all residential areas including Paribagh, Maghbazar, Siddeshwari, Shantinagar, Dhanmondi, Mirpur, Banani, Old DOHS, new DOHS, Gulshan and Baridhara, to name just a few. Soon after, small scale developers, individual home owners choose apartments to construct on their own properties demolishing the earlier house form due to high demand of housing as a result of rapid urbanization and population growth. Later building apartments become well accepted to this informal housing provider and spread out all over the city.

Twenty years ago there were fewer than five companies in Bangladesh engaged in developing apartments while today there are more than 250 developers. But there are many other companies/individuals engaged in such development in smaller scale or in informal sector. In most of the cases an individual or real estate company constructs one or more buildings comprising of several apartments, which are later sold to individual purchasers. This has prompted many individual entrepreneurs to develop apartment buildings resulting in an increased number of real estate companies in the city.

4.2 Types of Apartments

Apartment housing in Dhaka has become increasingly popular in recent days and is likely to continue. It may be worthwhile to describe here the types of apartments, which are now being built in Dhaka. Broadly speaking two types of apartment development can be noticed. Firstly, up to G + 5 story walk up apartments, which are usually RCC frame structure. The second types of development are those apartments in high-rise buildings of more than six stories. But the present trend in Dhaka City is 12-20 stories. Besides, there are other apartments provided by the informal private sector mostly for rental use.

4.3 Factors to the Emergence of Apartments

Due to the growth of huge population over a short span of time, the pressure on land for residential use has been very high. As a result, land price as well as construction cost increased significanty. Apartments are found well suited in Dhaka due to scarsity of land resources. Dhaka has experienced an unprecedented increase in land value since the early seventies. The value of land in Dhaka city, mainly in the central area, has increased at a rate much higher than the increase in cost of living in Dhaka. The price of typical residential land has increased 40 times (approx.) during the period 1975-2006. In the absence of any proper land value records it is very difficult to compare the land value over the past decades. But Table 5 will provide some idea regarding the increase in land value between 1975 and 2006.

Table 5 Land Price in Dhaka (US$/sq.m)

Area	1975	2000	2006
Motijheel	72	900	1,650
Dhanmondi	36	567	1,430
Mohammadpur	36	309	362
Mirpur	14.5	180	385
Goran	6	155	242

Source: Islam (2005) and P. Alo (2006)

There are also other reasons such as reluctance of individuals to spend time and energy in house construction, increased awareness of apartment living and western influence. This is how apartment living is becoming increasingly popular. Moreover the absentee i.e. the wage earners in Middle East and other countries are also a major contributing factor towards the increasing demand for apartments. As a result of increased demand, many apartment builders have appeared in the market in recent years. Some of the other factors that have contributed to development of apartments includes, desire to live within the city, increasing commercial market for apartments, profitability for both owners of land and developers, availability of loans from financial institutions, existence of flexible rules for development and number of reliable developers in real estate. Furthermore fragmentation of ownership of land due to inheritance laws has led primarily the well off families to seek developers to build apartments on their lands that bring not only ownership of a few apartments to co-owners but also ready cash. Personal security has also been a big factor for many residents moving from residential houses to apartments.

5. Informal Development

5.1 Definition and Estimates

According to the definition of UN Habitat (2003), informal housing are the one which begins informally, without a title deed or services, and which the members of the household design, finance and often build with their own hands. Such housing usually belongs to the poor and gradually improves over time. In case of Dhaka, most apartments are built in their own land but construct building violating the development rule. In some cases informal apartments in Dhaka are also both legal and illegal service deficient settlements. For example, informal developers are constructing apartments without honoring the height limit of residential areas and covering 70-80% of the plot which eventually treated as an informal apartment.

In the absence of well-established formal land and housing markets, informal sector has been playing the major role to cater the housing needs of a vast majority of urban population. Small-scale builders and developers, (self-help) owner-builders, slum landlords and their intermediaries, operating in the informal private sector, are the largest suppliers of land and shelters in Dhaka. The dominant role of the informal sector is revealed as it has the 95% share of the total owned properties. In Dhaka, the rental sub-market in informal apartment is the single largest supplier of housing. Informal rental apartments in Dhaka have been estimated to vary between 50% to 55% of the total housing stock in Dhaka. With regard to the types of new housing produced, formal private developers generally serve only the upper and upper middle income groups. The dominance of the informal delivery systems over the formal system is highlighted by a breakdown of the housing stock into sub-categories. The informal sector is estimated to have produced 85 percent of the 1.0 million housing units in the Dhaka city area (Table 6). Among them private informal sector (apartments) accounts for half of the total stock and formal sector represent the only 15 percent of it.

Table 6 Relative Importance of Informal Housing Delivery Sub-Sectors in Dhaka

Housing Sub-sector		**Units**	**Percentage (%)**
Formal Sector	Public housing	100,000	10
	Private Housing	48,000	4.8
	Cooperative	2,000	2
	Total Formal Sector	**150,000**	**15**
Informal Sector	Private Housing	500,000	50
	Slums	200,000	20
	Squatter Settlements	150,000	15
	Total Informal Sector	**850,000**	**85**
Total		1,000,000	100

Source: Estimates from Islam, 2004

5.2 Housing Cost and Affordability

Existing housing supply has been characterized by 'a critical imbalance' between housing cost to household income ratio that has been known to affect homeownership as well as rental housing. According to a survey conducted by the Consumers Association of Bangladesh (CAB), in 2007 house rent in the Dhaka city increased by 250 percent in last 17 years despite presence of rent control laws and courts. Still this sector remains within the range of the urban majority as the rents in formal sector apartments are much higher than the informal sector. Thus the informal rental apartments are affordable source of shelter to the city dwellers and gain its popularity as a new dwelling style.

Residential land values in prime locations of Dhaka range between US$ 350 and $1430 per square meter which is too high compared to other cities in developed countries. For example, areas in the US where land prices exceed $60 per square foot are rare (Hoek-Smit, 1998). These prices make it impossible for the limited income people to purchase land in the open market within the city area. Besides housing remain an additional cost which the upper middle class can barely afford. An average median income household needs nearly 20 years of income to own an apartment unit at current market price.

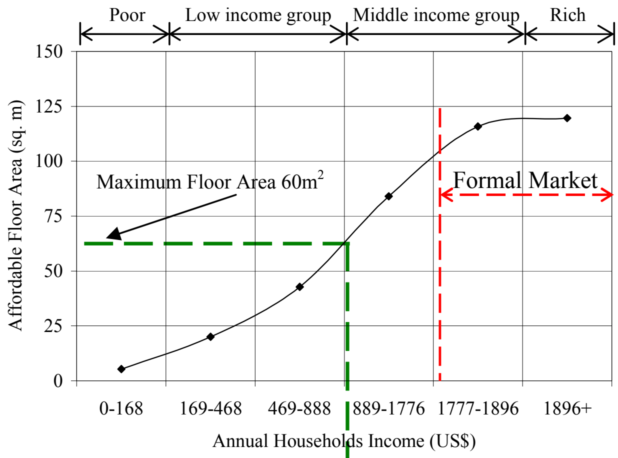

Fig. 8 Households Income and Affordable Floor Area

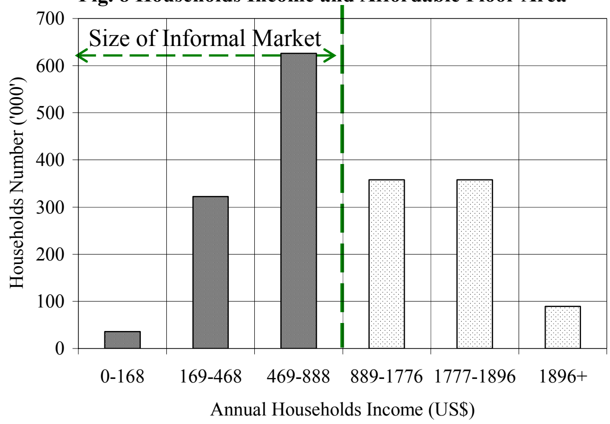

Fig. 9 Households Income Distribution

Fig. 8 and 9 illustrate the extent of housing cost (in terms of floor area) in the formal and informal market in contrast with the household income distribution of the city dwellers of Dhaka. In Fig. 9, the annual income distribution to each income group is shown with household number of individual group. Highest number of households is belongs to lower middle and low income group. Similarly, Fig. 8 represents the floor area (sq. m) that can be affordable to each income group. The projection of Fig. 9 to Fig. 8 exposes the amount of floor area that a particular group of households can afford. At current market price, a floor area of $60m^2$ is not affordable to the majority of the city dwellers in the formal housing market. Thus the vast majority of the city dwellers depend on informal housing that is affordable to their income range. Purchasing an apartment unit is too difficult to this section of city dwellers due to the poor affordability. Hence informal rental apartment provide them an affordable shelter to abode and thus it remain popular dwelling form in Dhaka. In the formal sector, most of the apartments are built for owner user. As a result, these apartment units are large in size and stylish. Average minimum size of these apartments is $100m^2$. A minute part of the city dwellers can have access to these formal sector apartments.

5.3 Housing Quality

Although the informal apartments are playing an important role in Dhaka, there exists a wide range of differences in the quality of housing provided by the informal sector in comparison with the formal one. Characteristics and the difference in the housing quality by both the providers are figure out in Table 7.

Table 7 Differences in Formal and Informal Apartments

Factors	Formal Private Apartments	Informal Private Apartments
Finance	Housing projects are usually backed by strong financial support i.e. banks, housing financing institutions and mortgage bodies which eventually provides quality housing.	Weak, poor and informal finance like loan from individuals, relatives, selling other assets in rural origin are most common. Thus finance remains the main barrier to provide quality housing.
Construction	Industrialized and costly construction method are practiced generally	Self help activity and low cost construction are common
Material	High quality	Average
Structure	Mid to high rise	low to mid rise, walk up apartment
Dwelling Unit size	Units are over 100 sq. m size is typical	Unit are between 50-70 sq. m
Planning	Fairly good (Planned as owner user)	Poor (Planned as rental use)
Utility and service	Adequate	Inadequate and lack of infrastructure
Environment	Good	Poor neighborhood

6. Discussion & Conclusion

Residential areas in Dhaka have undergone commercial onslaught and their residential character are fading. The rapid deterioration of DRA in Dhaka city, due to huge population growth and rapid urbanization is likely to result in a huge housing lack that needs urgent attention, exacerbating the already critical housing situation. The process DRA developed is a demand driven phenomena. Multi-storied apartments provided by the formal and informal developer are found to be well suited in Dhaka and contributing well to the problem. Formal sector apartments are pricing much due to the high land price and construction cost and it serve the high and higher-middle income groups. More distinctly, informal apartments developed by the small scale developers and individual households provide affordable shelter to the highest segment of city dwellers of middle and lower-middle income groups though they are service deficient. Enabling, facilitating and channeling the potential of the informal sector might be an answer to the problem.

Reference:

Ahmed, N. & Khan, N. 2004. Evolution of House form in Dhaka City, *Global Built Environmental Review (GBER)* Vol. 3 (3): 38-48.
BBS, 2001. *Bangladesh Population Census 2001: Analytical Report*. Bureau of Statistics, Dhaka.
Hafiz, R. 2004. Comfort and Quality of Indoor and Outdoor Spaces of Dhaka: An Analysis of Urban Planning and Design. *Global Built Environmental Review (GBER)* Vol. 4 (2): 61-70.
Hoek-Smit, M. 1998. Housing Finance in Bangladesh – Improving Access to Housing Finance by Middle and Lower Income Groups *Report Prepared for the Government of Bangladesh, Ministry of Local Government, Rural Development and Co-operatives, GOB/ UNDP/ UNCHS (Habitat).*
Islam, N. 2004. The Poor's Access to Land and Housing in Dhaka *Paper written for the World Bank* Dhaka Urban Poverty Study.
Islam, N. 2005. Dhaka Now: Contemporary Urban Development. *Bangladesh Geographic Society,* Dhaka.
The Daily Prothom Alo, July 24, 2006. at: (http://www.prothom-alo.net/v1/newhtmlnews1/index.php)
UN Habitat 2003. Rental Housing: An essential Option for the Urban Poor in Developing Countries, Nairobi.

Guidelines for the Activation of Collective Housing Based on Vernacular Values: Project for the Rehabilitation of Trung-Tu District in Hanoi, Vietnam

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Abstract

The authors have carried out an academic project for the rehabilitation of collective housing in Trung-Tu District, with collaboration with Hanoi Architectural University since March 2004. We have already conducted several field surveys on the living environment and historical change in dwelling units, the actual traffic situation and parking of motorcycles, and various activities in outdoor spaces, commercial activities in particular. Here we discuss the change in the resident families, the satisfaction ratings concerning current living conditions, the actual situation of refurbishment and addition in dwelling units, the actual usage of common corridors, and the actual condition concerning the utilization of outdoor spaces from the viewpoint of commercial activities.

1. Introduction

Since the 1960s, the government of Vietnam has constructed various types of collective housing estates in Hanoi, some of which were supported by the technical know-how of the former Soviet Union and North Korea, for example, construction using precast concrete panels. However, in the subtropical climate, these buildings have been deteriorating functionally, structurally, and aesthetically. All types of changes have taken place in many of these apartments, which have been influenced by rapid economic and social changes.

In March 2004, we initiated a project for the rehabilitation of collective housing in Trung-Tu District; the construction took place between 1974 and 1978, and involved collaboration with a research group from Hanoi Architectural University. This academic project aims to reveal the vernacular styles and values fostered among inhabitants across a span of thirty years and over, as Hanoi changed to a megalopolis; it also aims to provide a framework of a scheme for rehabilitating the housing estates by adding new contemporary functions and values that meet various current needs.

This paper refers to some findings and observations from the surveys and studies we have conducted so far.

2. Outline of Our Previous Surveys

Based on an agreement with Hanoi Architectural University in March 2004, we carried out the following field surveys in the housing estate of Trung-Tu District, after the University conducted negotiations and talks with administrative bodies.

2.1 Surveys in March and August 2004

Surveys of the living environment and historical change in dwelling units: We developed a questionnaire survey for dwelling units in two districts (four units in Kim-Lien District and eleven units in Trung-Tu District); we obtained a drawing of the actual living conditions in the units and took photographs of the interior of each room. The questionnaires used for the interviews with residents considered various factors such as the residents' occupancy period, the structure of the resident family, his/her relationship with the neighborhood, his/her satisfaction rating concerning the location of the housing estate and the arrangement of the rooms, and his/her usage of rooms corresponding to daily life, and the history of extension of space or repair.

Collection of previous studies: The working team of Hanoi Architectural University has collected fifteen documents (written in Vietnamese) on housing estates and housing policy in Vietnam.

2.2 Surveys in August and December 2005

Surveys of the actual traffic situation and parking of motorcycles: At two intersections of the main streets in Trung-Tu District, we counted the number of cars, motorcycles, and bicycles three times a day (at 8:30 am, 11:30 am, and 4:30 pm) six times in order to determine the daily traffic volume in this estate. We also counted the number of motorcycles parked in various open spaces in the estate twice a day (at 7:00 am and 2:00 pm), and obtained an idea of the bike parking situation.

Survey of various activities in outdoor spaces: On the plot plan, we traced the whereabouts of umbrageous trees and temporary awnings (blue plastic sheets or parasols) installed over shops and expanded areas of buildings. Considering this, we observed various daily activities in outdoor areas such as spaces between two apartment buildings, pocket parks and open spaces, parking lots, sidewalks, etc., early in the morning and in the afternoon.

Hearings or interviews: We conducted hearings on the history and current situation with two nursery schools, a kindergarten, an elementary school, and a high school located in Trung-Tu District. We also conducted an interview with the former engineer who was directly involved in constructing this housing estate.

Surveys in dwelling units: The teams from Hanoi Architectural University developed a questionnaire survey for thirty-six dwelling units of Trung-Tu District, based on the format of the 2004 survey.

2.3 Surveys in July and August 2006

Hearings regarding maintenance and management: We conducted an interview with a person—from the administrative section of the People' Committee of Trung-Tu District—responsible for the management of this housing estate—and collected information on the rules and regulations. We also met with some people who were playing a leading role in each apartment house in order to find out about the actual daily management practices and some agreements among the residents related to environmental sustainability.

Supplemental surveys in dwelling units: We visited twenty-five units of eight apartment houses that were selected from the thirty-six dwelling units surveyed by the teams from Hanoi Architectural University in 2005, and obtained a picture of the actual using condition of the extended parts and common corridors of the apartments. Additionally, the teams from Hanoi Architectural University collected additional data from eight dwelling units. Thus, until this point, in all, we were able to obtain the data of fifty-five dwelling units.

Measurement of indoor environmental fluctuation: The fluctuation of temperature and humidity was traced every five minutes for three or six days in six dwelling units, which were in different locations and whose situations were different.

Survey of various activities in outdoor spaces: We constantly surveyed commercial activities at thirteen places between two apartment houses. We observed active outdoor stalls, being interested in how they established their territories, in particular. We also surveyed three other outdoor spaces between apartment houses, where we hardly observed commercial activities, and four small public parks located in this estate.

Based on these surveys, the following critical issues arise.

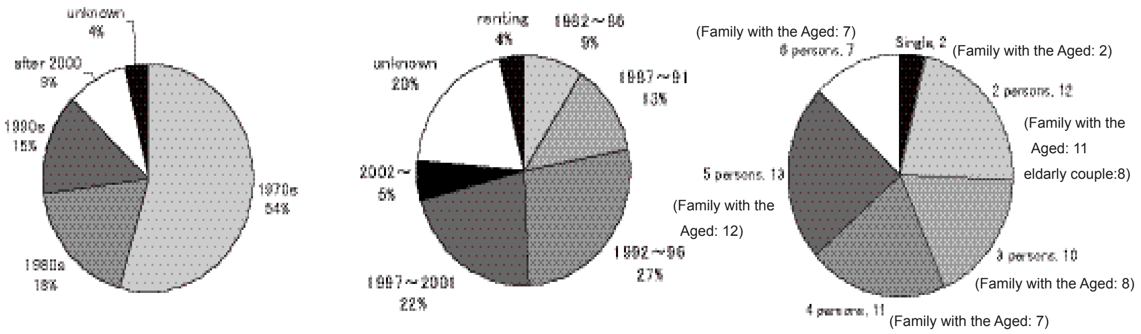
3. Changes in the Resident Families and Satisfaction Ratings Concerning Current Living Conditions

3.1 Family Structure

Most heads of households in Trung-Tu District were retired public officials, civil servants, or workers for government offices, schools, the army, etc. With regard to the period during which the residents settled into the housing estate, among the fifty-five surveyed units, those who had been living there since the 1970s numbered thirty (fifty-four percent). The families who had been living in this housing estate from its foundation still formed a majority in this community.

Since the late 1980s, the dwelling units have been transferred from being State property to being privately owned by the residents. The results of the survey indicated that the peaks of the transfer appeared at around 1995–96 and 2000–01. Only two from among the fifty-five surveyed units remained rented, and it is conceivable that most of the dwelling units in Trung-Tu District have already been privatized. However, it is interesting to note that some residents (eleven units) are not completely certain about their ownership status.

At the time of moving into the apartment, most households comprised four to six members. From among these households, there was also a seven-member family living in a dwelling unit of only fourteen square meters. Gradually, especially in the 1980s, many children got married and moved out of their parents' homes; currently, the small households comprising less than three members constitute almost half the surveyed units (twenty-four units, i.e., 44%). We note the fact that the households with elderly persons (over sixty years of age) make up eighty-five percent (forty-seven out of fifty-five units), and that eight among the twelve households comprise only elderly couples. Two single-person households comprise elderly persons. Recently, we observed substantial social changes among the residents, such as an increase in small families and the aged. These problems are expected to become even more serious.



Date of Settlement **Date of Privatization** **Member of the Resident Family**

Total Number of Surveyed Dwelling Units :55

Fig.1 Resident Families in Trung-Tu District

3.2 Satisfaction Ratings Concerning Living Conditions

The results of the questionnaire survey revealed that most people are satisfied with the relationship with the neighborhood (satisfied: eighty-two percent), and the location of this housing estate (satisfied: seventy-five percent, dissatisfied: five percent). In the earlier days, during the 1950s and 60s, before the estate was constructed, this place was just a suburban area in the verdant countryside; however, now, Hanoi, the capital, has developed remarkably, and most people recognize that Trung-Tu District is one of the most attractive places in the heart of the city. Further, half of the surveyed households are moderately satisfied with their surrounding environments (satisfied: fifty-four percent, dissatisfied: twenty-seven percent). Although some feel positively about the leafy district near the water in the midst of the great city, others complain about the increasing traffic congestion and ambient noise, and some local residents are worried about their apartments' stagnating economic value caused by the deterioration of the buildings.

The opinions of the residents are divided on the issues of room size and room arrangement. Half of those surveyed are expressed dissatisfaction with regard to both the issues (dissatisfaction with room size: forty-two percent, dissatisfaction with the room arrangement: forty-six percent). Since around 2000, some of the dwelling units have increased their floor space of approximately 30 square meters by the government-backed scheme. However, in some of these expanded units, there was an unoccupied room, because the number of people in the household had decreased. Meanwhile, as expected, those who have not yet extended their apartments are complaining about the size of the rooms, and are strongly requesting the government-backed extension. Regardless of the size of the rooms, a considerable number of residents are unhappy with the arrangement of the rooms. At the same time, it appears that some people are reasonably pleased with their living conditions, probably because they independently recently made certain remodeling changes and extended their floor space.

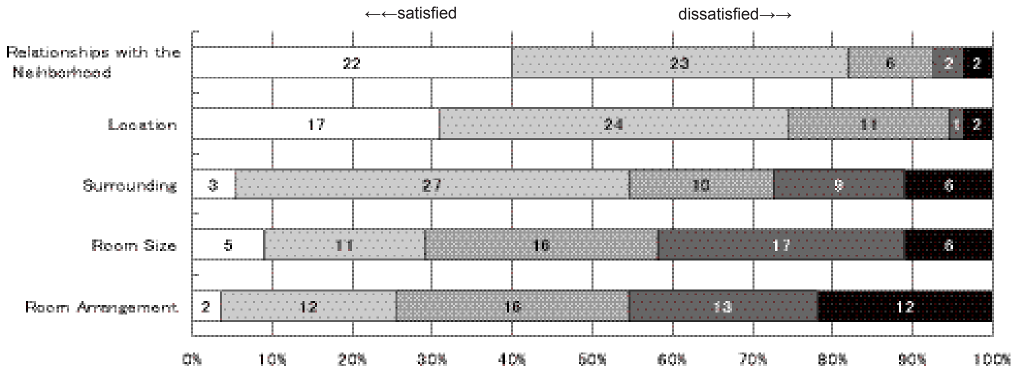


Fig.2 Satisfaction Ratings Concerning Living Conditions

4. Actual Situation of Refurbishment and Addition

4.1 Refurbishment and Addition in the Dwelling Units

As mentioned earlier, the extension work, which results in almost doubling the original floor space, has been conducted under the government support in some apartment houses in Trung-Tu District. However, as already described earlier, this extension work is performed so uniformly that in some cases, it does not correspond to the change in family structure and demands of the residents. These extended dwelling units became more elongated in shape, after a floor space of around 6.5 meters was added to the window-balcony side of the original dwelling units that were around 7.7 meters in depth and 4.4 meters in width. Thus, the units included a windowless room directly facing the open air. Furthermore, ventilation, which is essential for comfort, is impaired, because the unique-shaped openings of the partition wall are often blocked.

We also found some kind of refurbishments or repairs in each dwelling unit, and the results of the survey revealed that particularly during the 1980s and 90s, after the shift of economic policy, a number of additions and enhancements have been made. These spontaneous extensions that the residents got done on their own have been actively made, particularly in the ground floor units, because they are rather free from structural and mechanical constraints. Further, additions on the upper floor often require the lower units to be extended. We found some example wherein the extension works had been completed up to the third floor through mutual collaboration and adjustment among the residents. Some adventurous works such as extending the floor out a few meters from the former balcony, which are obviously highly dangerous in terms of structure, are found throughout Trung-Tu District. Further, the extension of the space is rather detrimental to the residential amenities, because the walls of these works are usually made of cheap materials that are inferior in terms of insulation efficiency. Their appearance, however, is varied, rather dynamic, and even attractive, which has created a peculiar appearance.

4.2 Actual Usage of Common Corridors

The results of the survey on the actual condition of eighteen common corridors reveal that the refurbishing works are related to the recent government-backed additions. In the apartment houses in which the government-backed additions have not yet been executed, we found various types of refurbishing in the spaces of the common corridors. For example, on the second floor of Bock A1, two dwelling units had constructed rooms beyond the common corridor through the expansion of the lower units; the flooring of both the units was made of the same tiles. Presumably, both households were closely connected with each other. On the other hand, on the third floor of Bock D1, wherein the residents are dissatisfied with the cramped space of the room, there are few major refurbishing works; however, there were many simple arrangements such as iron grills and the use of the corridor to put kitchen accessories and household groceries as well as to hang the laundry.

In the cases where the government-backed additions had been implemented, the residents are tolerably satisfied with the size of the rooms; however, they felt that the residential environment had worsened, particularly that in the middle room. On the second floor of Block C3, although the space had been increased beyond the common corridor upon the extension of the lower units, as described above, the residents did not use the rooms for living, but instead, used them as a rooftop garden, decorating the area with potted plants.

In terms of the residents' awareness of common corridors, in general, most residents assume that the part of the corridor in front of their own door belongs to them. This would be part of the reason that common corridors are completely separated from staircases by steel-barred doors at places where the corridor is regarded as the private space of the two or four dwelling units facing the corridor.

5. Various Activities in Outdoor Spaces

5.1 Actual Conditions Concerning the Utilization of Outdoor Spaces from the Viewpoint of Commercial Activities

We were able to observe various people's activities in outdoor spaces in a wide range of physical settings such as spaces between two apartment buildings, pocket parks, parking lots, and sidewalks. These spaces are largely utilized for a range of commercial activities.

All kinds of commercial activities are carried out in Trung-Tu District, such as the running of stands or stalls for snacks, light food or refreshments, perishable foods, and articles such as household goods in addition to the running of barber shops and the selling of lottery tickets. Viewing the commercial activities with respect to the behaviors of consumers or users, the activities can be roughly classified into two types. The first type comprises activities wherein the customers or users stay at the same place for some time, for example, small restaurants with temporary awnings (blue plastic sheets or parasols) and tables and chairs, and barber shops under shady trees. The second type comprises activities wherein the customers do not stay at the shop for very long, for example, street stalls selling fresh fruit, vegetables, and flowers, where the customers are just passers-by. Of particular interest is how the people use an alley facing the main streets. This alley is almost empty in the afternoon, and is crowded only in the early morning, when people come to buy various fresh foods. The breadth of the alley makes it advantageous for stalls selling fresh foods under the shade of blue plastic sheets installed between the wall of an apartment house and the brick fence of a kindergarten. Passers-by can enjoy shopping safely because no motorcycles pass through the alley. This alley is a busy food market that resembles the souq-s or bazaar-s in the Middle East. It should be noted that this temporary space is used for bustling commercial activities on a daily basis.

5.2 Territory and Composition of Stalls between Two Apartment Houses

The most characteristic sight in the outdoor spaces are the roadside stands or stalls—each having its own unique character—which have been set up in the spaces at each place. In the survey on commercial activities at thirteen places between two apartment houses, we conducted interviews with ten stall owners. Most of the owners had begun their businesses in the late 1980s, and they usually shared a certain relationship with the neighboring shops or dwelling units. The majority of them were women living in the housing estate, who were earning pocket money in their spare time.

We could observe how they formed their territory, organizing information with regard to aspects such as the flow of passers-by or customers, the position and relationship between shopkeepers and guests, the manner in which goods were displayed, and the motorcycle parking situation. Parasols and awnings play a role in visually marking the territory of the stalls as well as in providing shade. The border of each sphere of business is defined by where the guests' motorcycles are parked.

6. Conclusion: Evaluation of Vernacular Values in Collective Housing Estates in Hanoi

The apartment houses in Trung-Tu District have dramatically changed in terms of both their appearances and interiors. Various types of refurbishments and additions in each dwelling unit have been implemented, while large-scale expansion has been executed by government supports. These spontaneous extensions do not guarantee the fact that the quality of the materials used for the construction is good, since usually, adequate attention is not given to safety and comfort. Even in their present appearance and shape, which at first glance, may be assumed to be irregular or spatially disordered, we found characteristic forms and ways of the use of spaces by residents, who since the foundation of this housing estate, have repeatedly retouched and modified their dwellings as per the demands of the occasion. By observing the actual condition and usage in common corridors in particular, we observed that next-door neighbors understood each other's rights and were considerate of each other's needs; we also detected the fact that the residents' daily maintenance of the corridors was good and they kept the corridors in good shape. Unquestioning support for this is provided by the data from the questionnaire survey conducted with the residents. The residents' awareness with regard to a sound pattern of community life has brewed gradually for a long time, which has resulted in a well-balanced adjustment and consensus in daily living.

Meanwhile, looking at the actual situation of the outdoor spaces, various types of commercial activities are actively conducted all over in the housing estate. Commercial activities pertaining to food or eating are at the center of most business practices, and people enjoy buying seasonal foodstuffs and eating out in the shade. All this implies that the outdoor spaces in the estate can serve not only as open-air places to relax for people who live in and visit the area but also as a means to conserve and improve the residential environment. It is rather unique that the territory of the stalls is formed by a simple awning or a parasol. Apparatuses that can keep out too much sunlight are essential; the residents' manipulate temporary items such as parasols and blue plastic sheets, combining leaves projecting from buildings and big trees. The usage of open spaces depends on the time zone, and simple and common materials are used as awnings or furniture for commercial activities, which prominently show that outdoor spaces in the estate are used flexibly. Further, commercial activities in the estate contribute not only to the enhancement of a sense of community but also to the empowerment of people's activities. These vigorous commercial activities closely related to residents living in the estate probably stem from the indigenous Vietnamese lifestyle. The primary issue is how to evaluate and understand the value of the vernacular characteristics observed in the way of life in the housing estate as a potential feature that should be preserved.

References:

Clement, P. and Lancret, N. 2003. *HaNoi Chu Ky Cua Nhung Doi Thay; Hinh Thai Kien Truc Va Do Thi.* Hanoi: NXB Khoa hoc va ky thuat (in Vietnamese)

Schenk, H. and Trinh, D. L.,ed. 1999-2001. *Housing and Land in Hanoi*, vol.1-3, Hanoi: Cultural Publishing House

Shinozaki, M., Tomoda, H., et al. 1999-2003. *Urban Housing in Hanoi, Vietnam.* no.4-15, Summaries of Technical Papers of Annual Meeting, A.I.J., E-2, (in Japanese)

Yamada, Y., Tran, T. Q. H, et al. 2005-207. *Studies on the Rehabilitating Method of Collective Housing Estates in Hanoi, Vietnam*. no.1-8, Summaries of Technical Papers of Annual Meeting, A.I.J., E-2, (in Japanese)

Design Methods and Tendencies of Architectural Conversions in Various Countries of Different Cultures I, Works in the U.S.A. and Italy

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Abstract

This research, consisting of three serial articles, attempts to understand the current tendencies of the architectural conversion in several countries of different cultures and to examine design approach and method in conversion from international view points. Converted works were collected through the magazine issued in each country and field surveys in those countries were executed from 2004 to 2007.

This first article focuses the architectural conversion in the U.S.A. and Italy and analyzes the outline of distinctive tendencies and characteristic design, classifying converted works into three categories; conversion from office and residential facilities, from industrial facilities, and from public facilities.

In both countries, from the table which shows comparison arrangement of the use before conversion and after conversion regarding converted works, it can be understood that conversions of various building-types have been performed and that the design manners of conversion are also various. Especially conversions of high-rise buildings or large-scale industrial facilities which characterize some examples in the U.S.A are successful both in the light of adaptive reuse of existing building stocks and urban activation. In Italian examples, the charm of conversion design, fusion of the old and the new, and unexpected architectural expression which newly constructed architecture could not display, can be found.

Introduction

Recently, concern over architectural conversion has been increasing in Japan from the viewpoints of the effective reuse of existing building stock and urban activation. However, the possibility for the conversion design along with its attractiveness has hardly been discussed until date, though such possibilities from both a technical and a business perspective are pursued. On the other hand, if we look elsewhere in the world, various conversions have been practiced for more than 10 years in many countries. Although these conversions have been discussed in several books, systematic and synthesized research into architectural conversion does not yet exist. Therefore, our research attempts to understand tendencies of the architectural conversion in cosmopolitan cities and to examine the applicability of the design approaches and methods employed in conversion works. Concrete examples of conversion works in the United States, Italy, France, Germany, Finland, and Australia were identified through the magazines published in each country, and field surveys were conducted between 2004 and 2007 in approximately 20 cities of those countries in order to understand the tendencies and design methods within architectural conversion from an international viewpoint.

This research presentation consists of three articles, of which this is the first, focusing on the architectural conversion in the United States and Italy.

I. Architectural conversion in the U.S.A.

I-1 Recent tendencies

The research objects in the United States were selected mainly from articles in architectural magazines such as Architectural Record, Architecture, and Progressive Architecture (discontinued in 1995) published between January 1990 and July 2006, of these 47 works were chosen as field survey objects. Architectural conversion was not what was started in recent years, as is seen in loft buildings in the Soho area of New York and Ghirardelli Square in San Francisco; the number and kind of such architectural conversions were limited in those days. However, if we refer to Table I, which compares the arrangement of the uses of the 47 examples before and after conversion, it is evident that conversions of different kinds of buildings have taken place. It can also be understood that there are many conversions from office buildings to hotels in particular, and that positive reuse of industrial facilities has been executed. As a result, recent trends within architectural conversion in the United States are entering a new stage. Moreover, when these examples are surveyed in detail, it can further be understood that there are many cases of large-scale conversion and that the design techniques of architectural conversion are extremely varied. Hereinafter, an outline of the distinct trends and characteristic designs is described concerning works converted from office and residential facilities, industrial facilities, and public facilities.

Table I. The Matrix of the Works in the U.S.A. Showing Changes of Uses Before Conversion and After Conversion

			Use After Conversion											
			Office	Residential Facilities		Public Facilities							Commercial Facilities	Total
			Low and Medium Rise Office Building	Hotel	Appartment	Museum	Educational Facilities	Assemby Facilities	Library	Community Center	Government Offices	Theatre	Stores	
Use Before Conversion	Office	High Rise Office Buildings		4										4
		Low and Medium Rise Office Buildings				1	1				1	1		4
	Residential Facilities	Loding Facilities		2										2
		Private				1	1			1		1		3
	Industriel Facilities	Factory	3			1	1						2	7
		Warehouse	3			1	1						1	6
		The Others					1							1
	Public Facilities	Station		1		1		2	1					5
		Government Offices		1		1							2	4
		Library				1								1
		Gymnasium								1				1
		Educational Facilities				1								1
	Commercial Facilities	Stores			1				1				1	3
	Wharf Facilities	Warehouse	2										1	3
		Transport	1										1	2
	Total		9	8	1	8	5	2	2	2	1	2	8	47


Fig.1 Hotel Barnham


Fig.3 Hard Rock Hotel


Fig.4 Hard Rock Hotel


Fig.2 Plan of Reliance Building(left), Plan of Hotel Barnham(right)


Fig.5 Lowes Hotel

I-2. Works converted from office and residential facilities (Table II)

Within the cases shown in Table II, the trend for the famous high-rise office buildings of the Chicago school, art deco and early international style to be converted into high-class hotels is prominent, thereby changing their historical value into commercial value. These examples include the Reliance Building, one of the most important high-rise works of the Chicago school (No. 2 in Table II, Figs 1 and 2, originally designed by Daniel Burnham and completed in 1895, presently the Hotel Burnham), Chicago's excellent art deco high-rise Carbite & Carbon Building (No. 4, Fig. 3 and 4, designed by the Burnham Brothers and completed in 1925, presently the Hard Rock Hotel), and the P.S.F.S. Building, the first international style high-rise building (No. 3, Fig. 5, originally designed by Howe & Lescaze and completed in 1932, presently the Lowes Hotel). In these examples, planning and design techniques for converting offices to hotels are skillfully executed, preserving the exterior design and the main design elements of the interior.


Fig.6 Hudson


Fig.9 The Gateway School


Fig.7 Thaw Conservation Center, Morgan Library


Fig.8 Atelier of Thaw Conservation Center, Morgan Library


Fig.10 The Gateway School

Table II. The Works of Architectural Conversion in U.S.A.: Offices and Residential Facilities

Offices and Residential Facilities						
No.	use before conversion	use after conversion	title of work	published year	location	architect
1	High-Rise Office Building	Hotel	Trump International Hotel & Tower	1998	New York NY	Philip Johnson
2	High-Rise Office Building	Hotel	Hotel Burnham	1999	Chicago IL	McClier / Antunovich Associates
3	High-Rise Office Building	Hotel	Lowes Hotel	2000	Philadelphia PA	BLT Architects
4	High-Rise Office Building	Hotel	Hard Rock Hotel	2004	Chicago IL	Lucien Lagrange
5	Low and Medium-Rise Office Building	Community Center, Church	Seamen's Church Institute	1991	New York NY	James Stewart Polshek& Partners
6	Low and Medium-Rise Office Building	Theater	Philadelphia Arts Bank	1994	Philadelphia PA	Mitchell Kurtz Architect
7	Low and Medium-Rise Office Building	School of Arts	Otis Collage of Art and Design	1997	Los Angeles CA	Bobrow/Thomas and Associates
8	Low and Medium-Rise Office Building	City Hall	West Hollywood City Hall	1999	W. Hollywood CA	Ellerbe Becket Architect
9	Lodging facilities	Hotel	Hudson	2000	New York NY	Philippe Starck
10	Lodging facilities	Hotel	The Marinetime Hotel	2004	New York NY	S.Macpherson, E.Goode
11	House	Elementary School	The Gateway School of New York	2002	New York NY	ABA Studio /Andrew Bartle Architects
12	House	Conservation Center in Museum	Thaw Conservation Center, Morgan Library	2002	New York NY	Samuel Anderson Architect
13	House	Community Center	Lesbian Gay Bisxual Transgender Center	2002	San Francisco CA	Cee/Pfau Collaborative

On the other hand, when the existing building does not have historical value, a new element is introduced into a part of the exterior appearance, and the design technique of carrying out an image reform both inside and outside is adopted. An example is the present Hudson (No. 9, Fig. 6, conversion design by Philippe Starck, originally the American Women's Association and completed in 1928). This is an example, which succeeded in completely changing the entire exterior image just by adding a simple facade associated with Le Corbusier's early 1920s residence to the low parts of the existing featureless building. Leaving the brick-finish structure also inside, a contrasting design element is introduced and a peculiar hotel space is created. Overall, it can be presented within the conversion as a case showing excellent design technique.

Among some of the works converted from residential facilities to public facilities, the Thaw Conservation Center, Morgan Library (No. 12, Figs 7 and 8) is a case where the top floor of the old Morgan mansion was converted into a conservation center. The extension, designed by Renzo Piano, was constructed between the library and the Morgan mansion by McKim, Mead & White, and this conversion was performed along with it. This is an excellent example, which presents the technique of proliferating public facilities via the extension and combination of the conversion and preservation of a traditional masonry townhouse.

The gateway school (No. 11, Figs 9 and 10) is a case where a row house of 7 m width in New York was converted to an elementary school. Natural lighting and internal spatial continuity were improved by introducing a new stairway and a vertical void space, and unfavorable conditions for a school have been overcome.

I-3. Works converted from industrial facilities (Table III)

In the case of industrial facilities such as factories and warehouses, it is usual that the former are converted to shops and the latter to offices; however, in some cases, they are converted into academic facilities and museums, making the best use of an original huge space characteristic of industrial facilities. One famous example of a recent conversion from a factory to commercial facilities is the Chelsea Market (No. 1, Figs 11 and 12) in New York. Although this area once prospered as an industrial area, it became a ruinous environment following factory relocation and economic depression. Recently, the large Nabisco factory built in 1890 was converted into a fashionable complex of shops and offices, which is now also called the Chelsea Market. The special feature of this conversion design is to leave the industrial ruin-like atmosphere untouched, and to expose the old iron framework, pipes, and deteriorating brick walls. This conversion started the trend of converting other


Fig.11 Chelsea Market


Fig.12 Chelsea Market


Fig.13 Vitra Showroom


Fig.14 Art Center College South Campus


Fig.15 Art Center College South Campus

Table III. The Works of Architectural Conversion in U.S.A.: Industrial Facilities

Industrial Facilities						
No.	use before conversion	use after conversion	title of work	published year	location	architect
1	Factory (Snack)	Shopping Moll	Chelsea Market	1990	New York NY	Vandeberg
2	Factory (tire)	Shopping Moll, Office, Hotel	Citadel	1990	Los Angeles CA	Nadel Partnership & Sussman/ Prejza
3	Fanctory (car)	Studio for Photography	Industria Superstudio	1992	New York NY	Deborah Berke & Carey Mc Whorter
4	Fanctory (Repair Shop of Bus)	University	California College of Arts & Crafts, Montogomery Campus	1996	San Francisco CA	Tanner Leddy, Maytum Stacy
5	Fanctory (Repair Shop of Car)	Showroom	Comme des Garcons	1999	New York NY	川久保玲
6	Fanctory (Printing Office)	Museum	Dia:Beacon	2004	Beacon	Openoffice Arts
7	Fanctory, Warehouse	Office, Studio	Culver City	1997	Los Angeles CA	Eric Owen Moss
8	Warehouse	Museum	Boston Childrens Museum	1979	Boston	Kennedy & Violich
9	Warehouse	Office	9350 Civic Center Drive	1999	Los Angeles CA	Barton Myers
10	Warehouse	University	Southern California, Institute of Architecture	1999	Los Angeles CA	Gary Paige
11	Warehouse	Showroom and Office	Vitra in New York	2001	New York NY	Lindy Roy
12	Warehouse	Office	TBWA/Chiat/Day	2002	San Francisco CA	Marmol Radziner
13	Warehouse	Office	American Meteorological Society	2002	Boston	Anmahian Winton
14	Facility of a Wind Tunnel Test	Art School	Art Center College of Design South Campus	2000	Los Angeles CA	Daly Genik

small factories and warehouses one after another. The Vitra Showroom (No. 11, Fig. 13) features among such conversions. As a result, the neighboring area has become one of the most fashionable districts as a whole. This is a good example that shows the influence and usefulness of the conversion upon urban activation and renewal. One of the examples of a conversion to a university taking advantage of the huge space of an industrial facility is the Art Center College South Campus (No. 14, Figs 14 and 15), where classrooms are arranged around the huge space of the former wind tunnel laboratory. As part of the exterior design, a unique volume on the rooftop dedicated to controlling the level of daylight successfully produces a contrasting harmony between the old and the new.

Table IV. The Works of Architectural Conversion in U.S.A.: Public Facilities

Public Facilities						
No.	use before conversion	use after conversion	title of work	published year	location	architect
1	Post Office	Shopping Moll	The Pavilion	1982	Washington DC	-
2	Station Building	Shopping Moll	St.Louis Union Station	1985	St.Louis MO	Mackey Mitchell Associates
3	Station Building	Convention Center	Prime F. Osborn III Convention Center	1986	Jacksonville FL	-
4	Bureau of the Mint	Museum	National Building Museum	1989	Washington DC	-
5	Station Building	Museum	Cincinnati Museum Center	1990	Cincinnati OH	E.Vernr Johnson & Associates
6	Gymnasium	Community Center	Hamilton Fish Park	1993	New York NY	Jhon Ciardullo Associates
7	Station of Street Car and Office	Library of University	Library, Baruch College	1995	New York NY	Davis,brody & Associates
8	Elementary School	Museum	P.S.1 Institute for Contemporary Art	1997	Long Island NY	Frederick Fisher & Partners
9	Station Building	Convention Center	Pennsylvania Convention Center	2000	Philadelphia PA	Thompson, Ventulett, Stainback & Associates
10	Customs	Hotel	Monaco Hotel	2001	Washington DC	MacCraclen Architects
11	Post Office	Store	Apple Store	2002	New York NY	Bohlin Cywinski Jackson
12	Library	Museum	Asian Art Museum	2003	San Francisco CA	Gae Aulenti, HOK, LDA, RWA


Fig.16 Brauch College's Library


Fig.17 Baruch College's Library

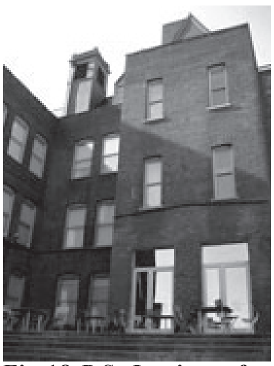
Fig.18 P.S. Institute for Contemporary Art

I-4. Works converted from public facilities (Table IV)

In these cases, there are various types of original buildings such as stations, government and municipal offices, elementary schools, libraries, etc. Since they are historical landmarks in most cases, the conversion design tends to perform a conservative repair of the exterior appearance and to make the best use of the characteristics of the internal spaces. One of the successful examples is Baruch College Library (No. 7, Figs 16 and 17), where the former tram operating station was converted into the university library by changing the

former marshaling yard into a roofed atrium and by adding floors as necessary. Here, the new interior spaces were wholly created, while the exterior design was conserved as much as possible.
P.S. 1 Institute for Contemporary Art (No. 8, Fig. 18), a conversion from an elementary school to a museum, is an example of successfully creating a museum with a unique atmosphere different from that usual in modern art museums by preserving the plan composition of the corridor access-type classrooms of the pre-existing elementary school.

II. Architectural conversion in Italy

II-1. Recent tendencies

Italy has a long history of reusing buildings via renovation and conversion. The research objects were selected mainly from articles in the architectural magazines Abitare, Casabella, and Domus, published between January 1990 and February 2004. In the first survey, 97 conversion works were found, of which 27 were chosen for field survey (Tables VI, VII and VIII). Table V which carries out comparison arrangement of the use before conversion and after conversion of 97 examples shows that conversions of various building-types have been performed as in the U.S.A. However, compared with works in the U.S.A., it can be seen that there is a greater number of conversions from residential facilities; conversions from office facilities are extremely rare, but conversely there are many examples of conversions to office facilities. The differences in such trends emerge from the fact that differences in building type that existed in the central parts of the city: Italy has many residential facilities, and the United States has many office facilities in central urban areas. Moreover, Italy has more traditional buildings than the United States, so it is more important a design task to achieve relationship and harmony between the existing traditional parts and the new parts produced by conversion. Hereinafter, an outline of the distinctive tendencies and characteristic designs is described concerning works converted from office and residential facilities, from industrial facilities, and from public facilities.

Table V. The Matrix of the Works in Italy Showing Changes of Uses Before Conversion and After Conversion

			Use After Conversion							
			Offices	Commercial Facilities	Residencial Facilities	Restaurant	Hall	Exhibition Facilities	Public Facilities	Total
Use Before Conversion	Industrial Facilities	Factory	11	3	1		2	7	4	28
		Warehouse	5	1	2	2		3	1	14
	Residential Facilities	Palazzo	2	3	1	1		8	1	16
		Monastery			2			2	2	6
		Castle	1		2			1		4
		Appartment	4	4		1		1	1	11
		Farmhouse	1							1
	Public Facilities	Church						3	2	5
		Hospital						1	2	3
		Complex							4	4
		Cinema					2			2
		The Others						1	2	3
	Total		24	11	8	4	4	27	19	97

Table VI. The Works of Architectural Conversion in Italy: Offices and Residential Facilities

Offices and Residencial Facilities						
No.	use before conversion	use after conversion	title of work	published year	location	architect
1	Palazzo	Showroom	Marino alla Scala in Milano	1997	Milano	Pierluigi Cerri
2	Palazzo	Super Market	Peck in Milano	1997	Milano	Gianmaria e Roberto Beretta
3	Palazzo	Office	Massimiliano Fuksas's Office	1998	Roma	Massimilliano Fuksas
4	Palazzo	Showroom	Against the Fashion Grain	1999	Roma	C. Lazzarini+ C. Pickering
5	Palazzo	Showroom	Showroom Degli Effetti	2001	Rome	Massimiliano Fuksas
6	Monastery	Hotel	Four Season's Hotel	2002	Milano	-
7	Castle	Museum	Castle Rivoli	1999	Torino	Andrea Bruno
8	Appartment	Showroom	Staff, Showroom	1998	Milano	Toni Cordero
9	Appartment	Restaurant	Gastronomic Academy in Roma	1999	Roma	Roberto Liorni
10	Appartment	Showroom	Financial Information	2000	Mlano	-

II-2. Works converted from office and residential facilities (Table VI)

It is a prominent fact that there are many conversions from palazzos. Mario alla Scala in Milan (No. 1, Figs 19 and 20) is a shop converted from a palazzo, which was built in 1876 and later converted to a hotel in 1905. One feature of its design was to remove a part of the floor slab in order to make a vertical void space in the entrance lobby. The 400-mm-diameter pillars are newly set to support an interior balcony and the installed computerized lighting equipments that change with time, thereby uniting a traditional building with a modern expression. In the Delli Effetti (No. 5, Figs 21 and 22), the entry hall of the Renaissance period palazzo was converted into a showroom. Here, because 15th-century stonework was discovered during the renovation work, this wall has been exposed. A part of the stonework was covered with special glass on which the projected image is collaged. Although this showroom is a small-scale example, it is characteristic


Fig.19 Mario alla Scala


Fig.22 The Delli Effetti


Fig.25 Castle Rivoli

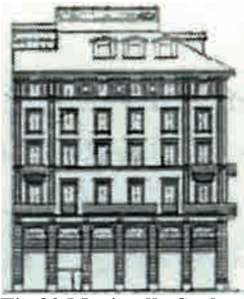
Fig.20 Mario alla Scala


Fig.23 Court of Four Season's Hotel Milano


Fig.26 Castle Rivoli


Fig.21 The Showroom, the Delli Effetti


Fig.24 Four Season's Hotel Milano

of synthesizing contemporary interior design and preserving restoration.

As one of the examples converted from residential facilities than other palazzos, the Four Seasons Milano (No. 6, Figs 23 and 24) was converted from a monastery of the courtyard plan type in 1993. This was later extended by the conversion of a neighboring neoclassical palazzo in the middle of the 18th century. Within this extension, a glazed restaurant facing the courtyard and an underground space were constructed. During this work, columns, the decoration of their capitals, vault ceilings, and a fresco painting of the Renaissance period were discovered and restored as much as possible. As a result, this example became a fusion of modern space, such as a glazed courtyard passage, the Renaissance monastery, and the neoclassical facade.

Castle Rivoli in a suburb of Turin (No. 7, Figs 25 and 26) carried out a conversion of its section (140 m in length and 7 m in width) into a contemporary art gallery. A new roof and the glass on the edge sides were designed in the contemporary manner, thereby producing an architectural expression unifying the traditional and the new.

II-3. Works converted from industrial facilities (Table VII)

Although conversion from industrial facilities have various uses, factories and warehouses are in many cases converted to studios and offices. There are also many examples of conversions from factories to buildings such as art museums and exhibition halls, schools, and theaters, etc. that requires a large space. On the other hand, warehouses are ideal for small-scale exhibition spaces, residences, restaurants, etc. In the conversion of industrial facilities, the space characteristic of the existing buildings is utilized in various ways.

Lissoni (No. 4, Figs 27 and 28) is an example where a part of a two-storey factory built in the early 20th century was converted into an office design. All of its floors, walls, ceilings, air-conditioning systems, sashes, furniture, and exposed piping were painted white, thereby producing well-controlled unity in combination with the spatial characteristics of the original design.

The Rome Municipal Contemporary Art Museum (No. 7, Figs 29 and 30) is an example of a conversion of a

Fig.27 Atelier of Lissoni's Design Office

Fig.28 Lissoni's Design Office

Fig.29 Courtyard of the Rome Municipal Contemporary Art Museum

Fig.30 The Rome Municipal Contemporary Art Museum

Fig.31 Dante O. Benini's Design Office

Fig.32 Ateliers of Dante O. Benini's Design Office

Fig.33 The Gianfranco Ferre's Design Office

Table VII. The Works of Architectural Conversion in Italy: Industrial Facilities

Industrial Facilities						
No.	use before conversion	use after conversion	title of work	published year	location	architect
1	Factory	Studio	Studio Mendini	1990	Milano	Alessandro Mendini
2	Factory	Studio, Gallary Office, Residnces	San Lorenzo District	1990	Roma	-
3	Factory(Car)	Museum, Stores, Offices	Lingotto Factory	1996	Torino	Renzo Piano
4	Factory	Studio for Architects	Lissoni Associati	1998	Milano	Piero Lissoni
5	Factory	Fitness Club	Industrial Memory	2000	Milano	Balossi Restelli
6	Factory	Studio for Architects	Studio Puppa	2000	Milano	Daniela Puppa
7	Factory	Museum	Galleria Comunale Arte Moderna e Contemporanea Roma	2001	Roma	Odile Decq, Benoit Cornette
8	Warehouse	Museum	Tuscolano Museum	2000	Frascati	Massimiliano Fuksas
9	Warehouse	Studio for Architects	Working Amid History	2001	Mantova	Giampaolo Benedini
10	Warehouse	Showroom, Office	Gianfranco Ferre Building	2002	Milano	Marco Zanuso
11	Warehouse, House	Studio for Architects	Dante O. Benini & Partners Architects	2003	Milano	Dante O. Benini
12	Power Plant	Museum	Montemartini Power Plant /Musei Capitolini	2000	Milano	-

Fig.34 Showroom of the Gianfranco Ferre's Design Office

Fig.35 The Capitolini Museum

Fig.36 The Capitolini Museum

beer brewery of the courtyard type to an art museum. The iron and glass roof was installed over the courtyard to turn it into the entrance and exhibition hall. The contrasting fusion of the contemporary roof and the traditional existing building is characteristic.

Dante O. Benini (No. 10, Figs 31 and 32) is a case where the whole of a warehouse and two adjoining houses were converted into an architect's office. Since the existing warehouse had a high ceiling, new floors were installed so that different floor levels may be connected. In addition, excavation work involving the installation of a garage was newly performed. As for the facade, this was covered with translucent glass supported by DPG, and only the glass above the existing arch opening is transparent in order to preserve the memory of the existing facade.

Gianfranco Ferré's design office (No. 11, Figs 33 and 34) was converted from a carriage company's headquarters constructed in 1902. While the art nouveau-influenced Liberty-style facade was restored along the street, a comparative glass facade was newly extended to the plaza side. Moreover, a large-scale renovation involving the extension of the floor and construction of the interior balcony in the former large trading room was undertaken. This was finished in a high-quality design using the marble, the terrazzo, and the metal etc. for the interior.

The Capitolini museum (No. 12, Figs 35 and 36) is an interesting example where the historic Montemartini power plant built in the early 20th century was converted into a museum. It is noteworthy that the exhibition space for classical sculptures is located in front of industrial inheritances such as the dynamo.

II-4. Works converted from public facilities (Table VIII)

Since public facilities have various characteristics both on the exterior and in the interior spaces, it is important to preserve and make the best use of spatial and historical characteristics.

The Turin State Archive (No. 3, Figs 37 and 38) was converted from a nightingale-type hospital built in the early 19th century, which was characterized by big windows to allow sufficient natural light and high ceilings. Materials were stored in orderly rows of a high density in long wards that diverge from the inspection part previously used as a station for nurses. It differs from a usual archive in which rationality has been valued over recent years, whereas this example has a spatial charm.

The Diocletian Bathhouse (No. 6, Figs 39 and 40) has a long history of extension and conversion. Its central hall was converted by Michelangelo in the 1560s to the Santa Maria Delli Angeli church, and soon altered again thereafter. The extension of the abbey of this church was completed at the end of the 17th century, and recently a part of the original bathhouse was converted and reused as a part of the National Museum, forming a historic complex. It differs from some National Museums in that the preservation and restoration of a portion of it prevents the original form of the bathroom from being carried out now. In particular, the Octagon Hall creates a harmonized contrast between the old and the new, inserting a metal-meshed dome and a glass-floored inspection bridge into a remarkable ancient space.


Fig.37 The Turin State Archive


Fig.39 Diocletian Bathhouse


Fig.38 Storehouses of The Turin State Archive

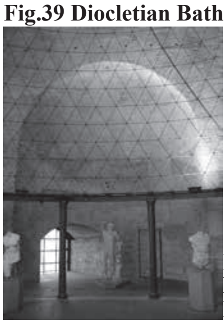
Fig.40 Octagon Hall of Diocletian Bathhouse

Table VIII. The Works of Architectural Conversion in Italy: Public Facilities

Public Facilities						
No.	use before conversion	use after conversion	title of work	published year	location	architect
1	Church, Library	Library, Gallary	Ambrosian Library and Art Gallery	1998	Milano	Griffini e Montagni
2	Church	Library	Library Church	2000	Roma	-
3	Hospital	Archive	Torino State Archive	1993	Torino	Giorgio Raineri
4	Hospital	Concert Hall	Concert Hall of Giuseppe Verdi Synphony Orchestra	2000	Milano	-
5	Astronomic Observatory Dome	Center for Astronomic Observatory	Astronomical Observatory of Brera	1996	Milano	Adalberto Caccia Dominioni
6	Public Bathhouse	Museum	Baths of Diocletian	1998	Roma	Giobanni Bulian

Conclusion

Conversions of high-rise buildings or large-scale industrial facilities, such as those in the U.S.A, are considered successful both in the light of adaptive reuse of existing large-scale building stocks and urban activation, despite the strong tendency to preserve the exterior design. Among the conversion examples within Italy, the charm of the conversion design, namely harmony of the old and the new, or unexpected architectural expression which newly constructed architecture could not display, can be found.

Acknowledgement

We would like to thank the Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis, the 21st COE Program of Tokyo Metropolitan University.

Design Methods and Tendencies of Architectural Conversions in Various Countries of Different Cultures II
Works in France, Germany and Finland

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Abstract

The purpose of our study is to clarify the design methods and tendencies in works of architectural conversion in various countries of different cultures. This article focuses on works of architectural conversion in 10 cities of France, Germany, and Finland. The following are made clear, as a result of our study: 1. In France, almost all works investigated are located in the center of the city, and already have a court or a large space like a courtyard in the center. Thus, on conversion, the architectural intervention was conducted against these spaces. 2. In Germany, not only are the original architectural elements such as structure, facade, and scheme conserved, but also contemporary elements of architecture are installed in the existing buildings in a positive way. 3. In Finland, although the façades of existing industrial facilities are conserved, interior space is changed into various types of public facilities in order to meet the modern demand for new architectural functions, so that they possess a new aspect that newly constructed buildings do not have.

Introduction

This article follows the previous one titled "Design Methods and Tendencies of Architectural Conversions in Various Countries of Different Cultures I - Works in the U.S.A. and Italy" presented by Dr. Katsuhiro KOBAYASHI. The purpose of our study is to clarify the design methods and tendencies within works of architectural conversion in various countries of different cultures. This second article focuses on works of architectural conversion in France, Germany, and Finland. The article is the fruit of our investigations in 10 cities: Paris, Berlin, Duisburg, Leipzig, Essen, Oberhausen, Hamburg, Witten, Helsinki, and Turku. In order to clarify the tendencies or background, the works are classified into three categories according to the original function of the existing buildings: "offices and residential facilities like offices, hotels, apartments etc.," "industrial facilities like factories, warehouses etc," and "Public Facilities like museums, department stores, universities etc."

The works in France were identified from articles that appeared in the principal architectural magazines namely *L'Architecture d'Aujourd'hui*, *Techniques & Architecture*, and *Le Moniteur Architecture* between January 1990 and January 2004. The works in Germany were identified from articles that appeared in the principal architectural magazine *DB: Deutsche Bauzeitung* between January 1990 and December 2006. The works in Finland were identified from articles that appeared in the main architectural magazine *Arkkitehti* between January 1990 and December 2006.

I. Architectural conversion in France

I-1.Recent tendencies

Forty-five works of architectural conversion were identified, which are included 22 investigated in France (Table I.). The works identified in our studies are classified into four categories based on the original function of the existing buildings (Table II.). There are various kinds of building types within the original facilities: departmental stores, theaters, play rooms, museums, assembly halls, railway bridges etc. Many buildings have been rehabilitated and converted in France. Almost all works were located in the center of the city, and many residential and industrial facilities have been converted into offices because of increasing architectural conversion into new company premises such as internet and financial agencies[1]. Various kinds of buildings are converted into different types of facilities in order to meet the modern demand for building functions.

I-2. Works converted from offices and residential facilities.

The Maison de l'Asie, Ecole français d'extrème-orient (No.1 in Table I) is an educational facility comprising a research center and library, and these two buildings are connected via a patio. An hotel constructed in 1886 was converted into the research center, and a building constructed in the 1920s was converted into the library(Fig.1)[2]. The patio, which was converted from the backyard between the two buildings, connects them(Fig.2). It plays an important role in supplying fresh air and natural light inside the two buildings.The Office Wilmotte(No.5 in Table I)has been rehabilitated effectively with a meeting space converted from a small courtyard[3]. Since its entire circumference is enclosed by the Office Wilmotte building and the adjacent one, the small courtyard was changed into a comfortable and well-lit meeting space covered with glass(Fig.3). The newly constructed staircase in the courtyard, which connects several office floors, is a functional and an architectural necessity[4].

The Galerie Colbert(No.3 in Table I)was built in the two courtyards of the Hôtel Bautru de Serrant designed by Louis le Vau in 1637[5]. According to its plan, the framework of the site is a block with two common courtyards. In the 18th century, the ground floor and the two courtyards had been converted into stables[6].

Table I. The Works of Architectural Conversion in France

No.	use before conversion	use after conversion	title of work	published year	location	architect
Offices and Residential Facilities						
1	Palais, Building	Facility for University	Maison de l'asie, Ecole français d'extréme-orient	1994	Paris	Albert-Gilles Cohen, Louis Guedj, Denis Lengart
2	Palais	Office	Headquarter of AXA in Paris	2000	Paris	Ricardo Bofill
3	Palais	Facility for University	Gallary Colbert	1990/ 2004	Paris	Dominique Pinon
4	Immeuble	Facility for University	University Reception Center	1991	Paris	Jean-Loup Pivin, Bruno
5	Immeuble	Office	Office Wilmotte	1991	Paris	Jean-Michel Wilmotte
6	Appartment	Office	Post Office	1993	Paris	Fabrice Dusapin
7	Hotel (Entrance Hall)	Cafe	Small Yellow Cafe	1998	Paris	Christian Biecher
Industrial Facilities						
8	Factory	Atelier and house	Sous-Plexe	2001	Paris	Carl-Fredrik Svenstedt
9	Factroy and Workshop	Atelier	Atelier 16-forge	2002	Paris	Philippe Prost
10	Warehouse	Showroom, Office	Showroom Vitra	1990	Paris	Antonio Citterio
11	Warehouse	Facility of Medical	Center for Patients of Drug Addiction	1994	Paris	Jade et Sami Tabet
12	Warehouse Office	Office	The Agency for Cultural Affairs of France	2004	Paris	Francis Soler, Frédéric Druot
13	Greenhouse	Museum	Orangerie Museum	2006	Paris	Agence Brochet-Lajus-Pueyo
Public Facilities						
14	Facility for University	Lodging Facilities	Maison Suger	1990	Paris	Antoine Grumback
15	Playroom	Museum	Gallary Jeu de Paume	1991	Paris	Antoine Stinco
16	Department Store	General Merchandising Store	Fnac Etoile	1991	Paris	Architral
17	Pavilion	Movie theater	MK2 Quai de Seine	1996	Paris	Frédéric Namur
18	Theater (Concert	Office	Spray	2000	Paris	Carl-Fredrik Svenstedt
19	Museum	Gallary	Pavilion Arsnal	2001	Paris	Finn Geipel, Giulia Andi
20	Assembly Hall	Office, Studio	Headquarter of Jean-Paul Gaultier	2004	Paris	Alain Moatti, Henri Rivière
21	Pavilion	Museum	Petit Palais	2006	Paris	Atelier d'Architecture Chaix - Morel
Civil Engeeing Facilities						
22	Bridge for Railway	Store and Showroom	Viaduc of Arts	1995	Paris	Patrick Berger,

Table II. The Matrix of the Works in France Showing Changes of Uses Before Conversion and After Conversion

Use Before Conversion		Use After Conversion: Offices	Commercial Facilities	Exhibition Facilities	Educational Facilities	Medical Facilities	Lodging Facilities	Total
Office and Residential Facilities	Palais, Hôtel	3		2	2			7
	Immeuble, Apartment	7	3		1			11
Industrial Facilities	Factory	7						7
	Warehouse	4		1		1		6
Public Facilities	Department Store	1	1					2
	Pavillon		1	1				2
	The Others	4		2	1		1	8
Civil Engieering Facilities			2					2
Total		26	7	6	4	1	1	45

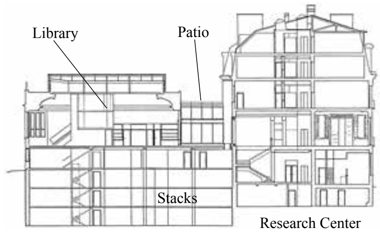


Fig.1 Section Maison de l'Asie


Fig.2 Court of Maison de l'Asie

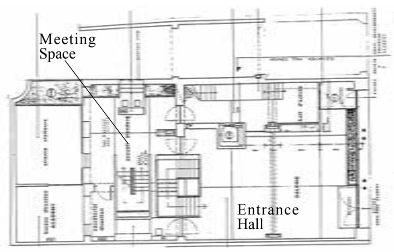


Fig.3 Ground Floor Plan, Office Wilmotte

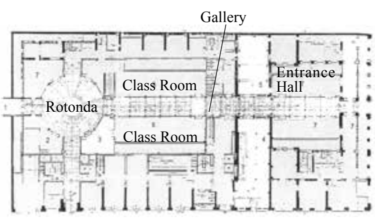


Fig.4 Court of Galerie Colbert

In 1826, the gallery was constructed in the two courtyards enclosed by the hotel by extending the new part of the building and demolishing the old part. Stores were located on the ground floor and residences were located on the second, third and forth floor. In 2006, the devastated gallery was reconstructed, and the hotel and the gallery were converted into a university and an academic institution(Fig.4). Upon conversion, new courtyards were constructed at the second floor(Fig.5).

In the case of many works converted from residential facilities, the courtyard in the existing buildings was utilized effectively resulting in an increase in total floor space, and was beneficial to the center space. These architectural interventions add value to the existing buildings upon conversion.

I-3. Works converted from industrial facilities

The Center for Patients with Drug Addiction(No.11 in Table I)is a work converted from a warehouse constructed of steel construction(Fig.6). A common-use space on the ground floor and a small private room on the first floor were installed in the warehouse and covered with a large roof. These are arranged in a U-shape, and the small courtyard is located in the center of the U(Fig.7). The center must be secluded from the outside due to issues of social safety and vocational rehabilitation[7]. However, it is only necessary to have at least a limited point of contact with the outside so that the small courtyard, where face-to-face interaction with patients can be conducted, allows sunlight, light winds, and various sounds into the center from outside.

The Vitra showroom(No.10 in Table I)is located in a former courtyard surrounded by neighboring buildings. The courtyard was converted into a storage area for audio equipment components[8]. In 1990, this storage area was converted into a comfortable furniture showroom by covering it with a glass roof, installing a stairwell in the center of the storage area, locating the staircase at the side of the main façade, painting the walls only with white, and removing the unnecessary columns from the showroom(Fig.8).

In 1933, the storage area of the department store constructed in 1919 by Vaudoyer was converted into a government office building[9]. In 2004, the French Agency for Cultural Affairs(No.10 in Table I)was installed in the building and in the newer building constructed in 1960 by Olivier Lahalle(Fig.9). The work displays two important points: One is the cancellous mesh of metal screen across the entire facade to combine almost the whole facade of the two buildings, and the other is the attempt at a new composition of the courtyard, which was enclosed as the buildings were newly constructed and was composed of a metal and glass facade(Fig.10).

In the case of industrial facilities, the rehabilitation of the courtyard is the main architectural intervention, and the center spaces of the buildings were changed based on the new functions of the converted buildings

Fig.5 The Courtyard of Galerie Colbert

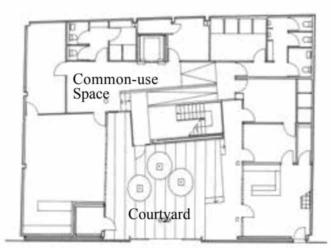


Fig.7 Ground Floor Plan The Court of the Center for Patients Drug Addiction

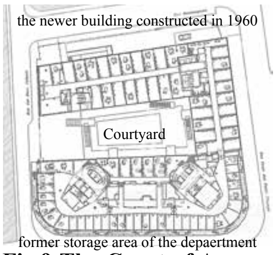


Fig.9 The Court of Agency for Cultural Affairs of France

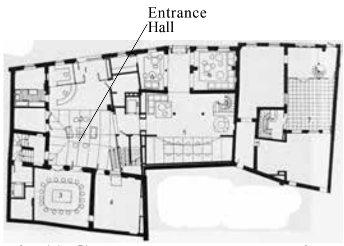


Fig.11 Ground Floor Plan Maison Suger

Fig.6 The Center for Patients Drug Addiction

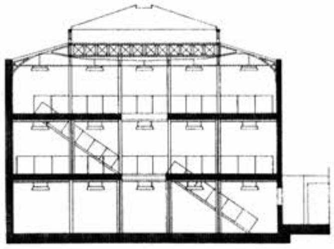


Fig.8 Section The Showroom Vitra

Fig.10 The Court of Agency for Cultural Affairs of France

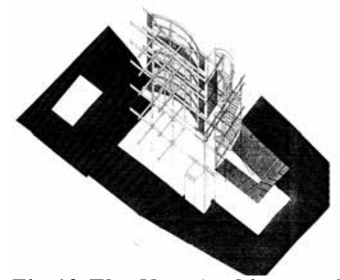
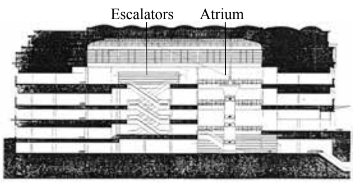


Fig.12 The New Architectural Elements of Maison Suger



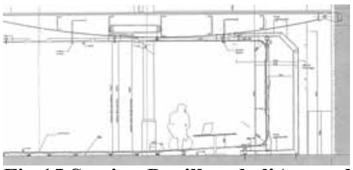


Fig.13 The Atrium of Fnac Etoile **Fig.14 Section Fnac Etoile** **Fig.15 Section Pavillon de l'Arsenal** **Fig.16 Pavillon de l'Arsenal**

and the activation of the whole set of buildings.

I-4. Works converted from public facilities

The Maison Suger(No.14 in Table I)is a lodging facility with 33 rooms for foreign researchers. It was converted from three local educational offices of Paris University(Fig.11)[10]. The new architectural elements comprising roofs, stairs, corridors, and windows were installed in the three existing buildings in order to connect them, and were reconstituted as lodging facilities(Fig.12). Among these elements, a former courtyard within the buildings was changed into an entrance hall. The Fnac Etoile(No.16 in Table I)is a general merchandise store converted from a departmental store constructed in 1912. The subjects of conversion are architectural conservation and building modernization[11]. Not only were the two façades on the two avenues conserved, since the problems associated with the construction did not have to be resolved, but also the stained glass windows covering the large atrium which were designed by Jacques Gruber were restored(Fig.13). However, 17 new escalators were built at the center of the building, in order to improve the interior circulation in the store(Fig.14).

The museum constructed by Clément in 1878 had been converted into other facilities on several occasions and was also converted into an exhibition facility called the Pavillon de l'Arsenal in 1988. The main façade constructed of stone and the steel-frame hall were conserved. However, the new architectural intervention undertaken in 2001 involved wrapping the interior walls, the floor, and the ceiling of the ground floor with pieces of steel plate(Fig.15)[12]. This contrasts the tight space of the ground floor with the large space of the central atrium(Fig.16).

In the case of the industrial facilities, the architectural intervention to reconstitute the central space equivalent to the courtyard leads to the activation of the whole building.

II. Architectural conversion in Germany

II-1. Background

In Germany, several industrial facilities were converted into urban facilities like office buildings, hotels, museums etc. in the center of the city and in the neighboring areas because the demand for urban facilities increased after East and West Germany were reunified[13]. In northwest Germany, former heavy industrial facilities such as coal mines, and former storage facilities such as granaries, were no longer necessary because of the transition of industrial development and international industrial adjustment[14]. Therefore, many industrial facilities were converted into public facilities such as museums, theaters, or exhibition spaces, and a national policy was formulated for the activation of the devastated areas and for tourism resource development[15].

Since industrial facilities generally cover extremely large spaces, they are not converted into a single facility such as a museum, a school, or a theater, but rather into a complex of offices, public, and commercial facilities. Therefore, entire industrial areas are going to be gradually converted into cultural areas for tourism.

II-2. Works converted from offices and residential facilities

A fortified manor constructed 500 years ago was converted into the Culture Center House Witten(No.2 in Table II)[16]. The manor was seriously damaged during World War II. Therefore, although it was constructed of stone, new architectural elements composed of steel and glass were added(Fig.17)[17]. A concert hall was installed in the large space and many small rooms were changed into rehearsal rooms for music, offices, and exhibition space(Fig.18).

II-3. Works converted from industrial facilities: factories.

The industrial facilities of a telephone exchange and substation constructed by H.H. Müller in the center of Berlin in the 1920s were converted into the Ewerk complex(No.10 in Table II)comprising offices, exhibition, and event spaces by combining them with new buildings[18]. The telephone exchange which was located in the overhanging volume was not converted, and mechanical equipment such as cranes were conserved in the substation so that various events could be organized not only in the large space of the former substation but also in the unique space of the former telephone exchange(Fig.19,20). The Zollverein Coal Mine Industrial Complex in Essen was designed by Fritz Schupp and Martin Kremmer. It was established in 1932 and closed down in 1990[19]. The boiler house was converted into the Red Dot Design Center(No.6 in Table II)by Norman Foster. Its facade and plan were composed symmetrically, and architectural volumes comprising elevators, offices, and exhibition space were newly constructed in the boiler house by following the symmetrical arrangement of the boilers(Fig.21). These are connected by the bridges located around them. Car, cleaner, and bathtub works were exhibited in the architectural volumes, on the boilers(Fig.22).

Fig.17 Culture Center of Witten

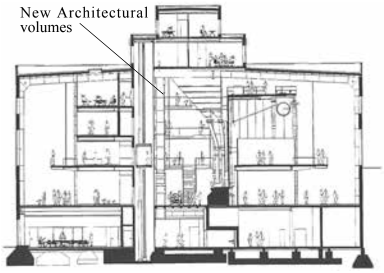


Fig.21 Section Red Dot Design Center

Table II. The Works of Architectural Conversion in Germany

No.	use before conversion	use after conversion	title of work	published year	location	architect
Offices and Residential Facilities						
1	Villa	Gallery	Gallery for Contemporary Art in Leipzig	1990's	Leipzig	Peter Kulka
2	Fortified Manor House	Cultural Centre	Cultural Center House, Witten	2004	Witten	Von Busse ,Klapp
Industial Facilities: Factories						
3	Factory (electricity, Motor, Assemby of Machine)	Laboratry Complex	AEG am Humboldthain	Since 1980's	Berlin	-
4	Factory (Spinning)	Art Hall	Leipziger Cotton Spinning Mill	1992	Leipzig	Kahlfeldt, Kahlfeldt
5	Factory	Office	Grunder and Trade Center	1996	Leipzig	Architekturbüro Eckhard Frodermann
6	Boiler of Mining	Museum	Design Center	1997	Essen	Norman Foster
7	Flour Mill	Museum	Centre for Modern and Contemporary Art in Duisburg	1999	Duisburg	Herzog & de Meuron
8	Transformation	Office	Metahaus	2000	Berlin	Kahlfeldt, Kahlfeldt
9	Brewery	Office	Advertising Agency Office	2001	Berlin	Mateja Mikulandra Mackat
10	Substation	Office, Housing, and Event Spaces	Ewerk	2005	Berlin	Hoyer, Schindele, Hirschmüller
11	Electric Power Company	Office	Transformer station crowd refuge	2006	Berlin	Kahlfeldt, Architekten
12	Dairy Factory	Hotel	Hotel Spreebogen Berlin		Berlin	
13	Brewery	Centre for Culture and Art	Pefferberg		Berlin	-
Industial Facilities: Storages						
14	Gas Tank	Exhibition Hall	Gasometer in Oberhausen	1994	Oberhausen	Feuer und Flamme
15	Station	Museum	Hamburg Station Museum for the	1996	Berlin	Josef Paul Kleihues
16	Warehouse of Coalmine	Choreographic Center	Choreographic Center North Rhine Westphalia	2004	Essen	Christoph Mackler
17	Bunker	Gallery	Reichsbahn-Bunker	2007	Berlin	-
Public Facilities						
18	Market	Exhibition Hall	Art Association in Hamburg	1994-05	Hamburg	Oswald Matthias Ungers
19	Church	Museum	MACHmit! Museum for Children Berlin	2003	Berlin	Klaus Block
20	Town Center	Shopping Mall	Hanse Viertel	2003-04	Hamburg	-
21	Exhibition	Museum	Industrial Safety Museum		Berlin	

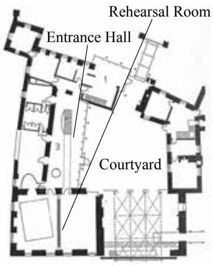


Fig.18 Ground Floor Plan Culture Center of Witten

Fig.22 Red Dot Design Center

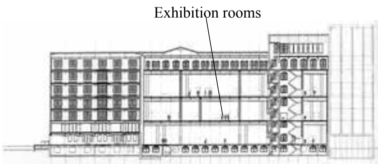


Fig.23 Center for Modern and Contemporary Art in Duisburg

Fig.19 Ewerk

Fig.24 Center for Modern and Contemporary Art in Duisburg

Fig.20 Event Hall of Ewerk

Fig.25 Center for Modern and Contemporary Art in Duisburg

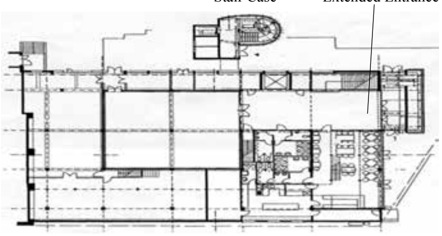


Fig.26 Ground Floor Plan Center for Modern and Contemporary Art in Duisburg

The Centre for Modern and Contemporary Art in Duisburg(No.7 in Table II), which Herzog & de Meuron converted from a flour mill building in 1999, is based on the master plan of the approximately 89-hectare inner harbor designed by Norman Foster[20]. The industrial facilities were converted into cultural and commercial facilities by adding the new constructions like residential facilities and office buildings. Some slabs in the center were demolished, the height and width of the exhibition rooms were extended, and all the inner walls were painted white in order to exhibit very large paintings(Fig.23). Therefore, the interior is wholly like a museum, but the exterior is not; it is more like an industrial facility(Fig.24).

II-4. Works converted from public facilities

In 1995, Oswald Matthias Ungers converted one of the market buildings gradually constructed near the Hamburg terminal from 1917 to 1951 into the Art Association in Hamburg(No.18 in Table II)[21]. The entrance was extended to the south using a steel frame and glass and a new main facade was erected on the same side(Fig.25). The steel structures were exposed in the museum on the ground and first floors. The staircase was extended outside in order to directly access the art school on the third floor, and one large room was divided into small classrooms(Fig.26). Not only was the original structure of the existing market building effectively activated, but contemporary architectural elements were also extended.

III. Architectural conversion in Finland

III-1. Background

There are two reasons why many leading works of architectural conversion occurred in Helsinki. One is the policy regarding architectural conservation and the control of rebuilding operated by the government from the 1970s to the 1980s[22]. The 1992 Helsinki Master Plan took a bold step, in terms of land use[23]. This increased architectural rehabilitation and many works of architectural conversion were initiated at the same time. The other reason is the scale of the city. Helsinki is so small and compact that the distance from the main terminal to the waterfront is very short. Therefore, Helsinki has the geometrical advantage of converting industrial facilities into public facilities, easily and functionally. Most works were converted from industrial facilities, as was the case in Germany, because the former industrial area at the waterfront was converted into cultural

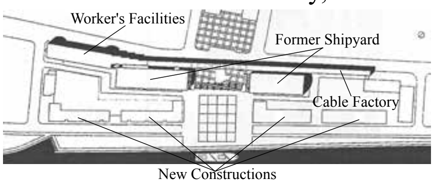


Fig.27 Site Plan Turku Art Academy

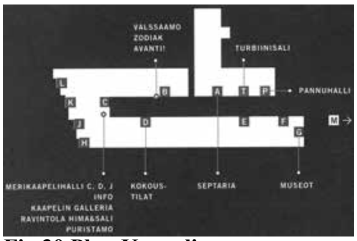


Fig.30 Plan Kaapeli


Fig.28 Turku Art Academy


Fig.31 Åbo Akademi University


Fig.29 Kaapeli


Fig.32 Ground Floor Plan Åbo Akademi University

Table III. The Works of Architectural Conversion in Finland

No.	use before conversion	use after conversion	title of work	published year	location	architect
Offices and Residential Facilities						
1	Office and Dwelling	Museum	Amos Anderson Art Museum	1999	Helsinki	Kari Hyvarinen-Jaakko Suihkonen
2	Appartment	Office, Showroom	Ruggedly Beautiful Concrete	2000	Helsinki	Jouni Kaipia
Industial Facilities: Factories						
3	Factory (Cable)	Exhibition Hall	Cable Factory KAAPELI	1991	Helsinki	Openoffice Arts + Architecture
4	Factory (Glass)	Academy	Helsinki Pop & Jazz Conservatory	1995	Helsinki	Mauri Tommila, Yajana Vuojala
5	Ship Building	Academy	Turku Art Academy	1997	Turku	Laiho-Pulkkinen-Raunio
6	Brewery	Office	Headquarter of Sampo-Life Insurance Company	1999	Helsinki	SARC
7	Factory (Glass)	Gallery	Arabia Factory in Helsinki	1999	Helsinki	Tommila
8	Factory	Academy	Helsinki Polytechnic	1998	Helsinki	Kai Wartiainen
9	Factory	Academy	Media Center Lume	2000	Helsinki	Heikkinen-Komonen
10	Factory (Bread)	Academy & Studio	Art Bakery	2004	Helsinki	Brunow & Maunura
11	Ironwork	Academy	Arts of Abo Academy University	2004	Turku	Pekka Maki
Industial Facilities: Storages						
12	Equipment Store for the Navy	Information Center	Inventory Chamber C 74	1998?	Helsinki	Laiho-Pulkkinen-Raunio
13	Granary	Museum	Maritime Museum	2000	Turku	LPR-Architect
14	Vegetable and Grain Storage	Office	Stakes and Senate Office Building, Helsinki	2002	Helsinki	Heikkinen-Komonen
15	Industrial Warehouse	Courthouse	Helsinki Courthouse	2004	Helsinki	Tuomo Siitonen
Public Facilities						
16	Tennis Court	Museum & Cinema	Helsinki City Art Museum, Tennis Palace	-	Helsinki	-


Fig.33 Helsinki Courthouse

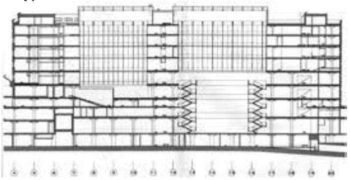


Fig.34 Section Helsinki Courthouse


Fig.35 Stakes and Senate Office Building

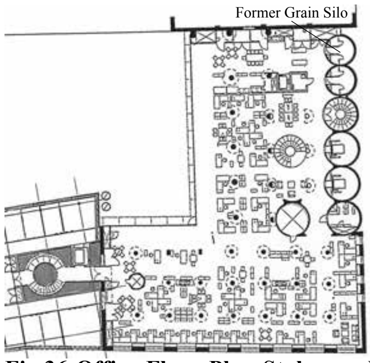


Fig.36 Office Floor Plan Stakes and Senate Office Building

and public areas. The third largest city, Turku, also has the same advantage.

III-2. Works converted from industrial facilities: factories etc.

The shipyard, the cable factory, and the workers' facilities were situated where Turku Art Academy(No.18 in Table III)is now located, in the large riverside area comprising educational facilities, a museum, and offices(Fig.27)[24]. The large mechanical equipment was conserved inside the former shipyard, but the new theater and rehearsal room were installed in the center of this(Fig.28). The other facilities were each converted into educational facilities but by conserving the original structures and adding contemporary elements of architecture. This work has architectural benefits which include not only the conversion of one building but the activation of a former industrial area with adding new constructions.

Kaapeli(No.18 in Table III), which was converted from a NOKIA cable factory, is one of the largest arts centers at the Helsinki waterfront(Fig.29)[25]. The former factory has various spaces, both large and small scale, so that a variety of facilities can be housed together, including museums, exhibition spaces, galleries, libraries, culture centers of foreign countries, ateliers, stores, conference rooms, restaurants etc. All of these facilities have been constituted using the original structures, staircases, elevators, and windows, with the addition of partitions, air conditioning, electronic equipment etc(Fig.30). Kaapeli is the main facility of the cultural area for social education and tourism.

The ironworks, which had been constructed by G. T. Chiewitz near the historic area of Turku in 1856, ceased operating in 1952. The architectural competition for its activation was held in 1997[26]. The construction by Åbo Akademi University(No.11 in Table III)was based on the ideas presented by the first prize-winner to construct art facilities in the area of the former ironworks(Fig.31)[27]. Since the old buildings were different in construction, style, and material, and were isolated from each other, all buildings were connected to one another by adding three new buildings in order to enable them to function as a university. The courtyards were established among the old buildings, by adding the new corridors, and the new bridges(Fig.32).

III-3. Works converted from industrial facilities: warehouses etc.

The medium-rise buildings of the headquarters and the brewery were constructed on the Helsinki waterfront in 1940. These were converted into the Helsinki Courthouse(No.15 in Table III)by the end of 1990(Fig.33)[28]. The medium-rise building is a former brewery, so the large space which was supported by the mushroom-shaped columns of the lower floors was converted into courts of justice and public areas, and the upper floors were converted into comfortable offices by removing the slabs from the center of the building(Fig.34). Since the main entrance was located at the former carry-in entrance, the existing glass facade softens the sense of pressure which a newly built courthouse normally possesses[29]. The facades of the headquarters and the factory were conserved so that the exterior is different from the interior. This architectural aspect, which a newly built courthouse would never possess, was borne from the architectural conversion.

The grain silo, which was constructed on the east side of Helsinki in 1934, was converted into the Stakes and Senate office building(No.14 in Table III)by Mikko Heikkinen and Markku Komenen in 2002[30]. Since it is a landmark in this area, the facade of the silo was conserved(Fig.35). However, effective windows are needed in office spaces, so the symbolic facade of the north side was preserved and a full-height glazing with blinds was built at the south side, in order to make the interior of the former silo bright and comfortable(Fig.36). Almost all the works have facades different from the function of the buildings, and it was made clear that these are a new type of architecture in Finland.

Conclusion

Many buildings have been rehabilitated and converted in France. The existing buildings were located in the center of the city so that they possess large spaces such as courtyards or atrium in their centers. Therefore, architectural intervention was necessary for this space in order to activate the architectural conversion.

On the other hand, many works converted from large industrial facilities exist in Germany and Finland. Thus, the industrial areas comprise a number of buildings converted into new urban blocks with cultural and public facilities. In Germany, not only were the original architectural elements such as the structure, facade, and scheme conserved, but also contemporary elements of architecture were installed in the former residential and public facilities in a positive way. In Finland, although the facades of former large industrial facilities were conserved, interior spaces were changed into various public facilities in order to meet the modern demand for new architectural functions so that they possess a new aspect that new buildings do not have.

Acknowledgement

We would like to thank the Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis, the 21st COE Program of Tokyo Metropolitan University.

Notes

1. According to an interview with the architects at the atelier of architect Philippe Prost.
2.C. S.-P., “Interieurs, Paris 16e bois, verre et lumière pour la Maison de l’Asie,” *Le Moniteur Architecture-AMC*, no.62–63, juin-juillet 1995, pp.50–51.
3. B.F., “Wilmotte à la Bastille,” *L’Architecture d’aujourd’hui*, no.276, septembre 1991, p.143.
4. C.P., “Interieurs, Agence Wilmotte,” *Le Moniteur Architecture-AMC*, no.24, septembre 1991, pp.51–52.
5. THOMINE (Alice), “La Galerie Colbert Paris,” Paris, 2005.
6. JIMENO (Frédéric), et al, *Le Cheval à Paris*, Paris: Action artistique de la Ville de Paris, 2006, p.98.
7. C. S. -P., “Fins de Chantier, Paris 18e centre d’hébergement et de soins pour toxicomanes,” *Le Moniteur Architecture-AMC*, no.61, mai 1995, p.20.
8. Anonyme, “Showroom Vitra, Paris,” *L’Architecture d’aujourd’hui*, no.269, juin 1990, p.222.
9. A.S., “Actualité, Nouvelle grille au Palais-Royal, Ministère de la Culture, Pais,” *Techniques & Architecure*, no.476, pp.102–103.
10. EDELMANN (Frédéric), “Réalisation, Grumback rue suger,” *L’Architecture d’aujourd’hui*, no.270, septembre 1990, pp.90–94.
11. C.P., “Interieurs, Fnac Etoile, Paris,” *Le Moniteur Architecture-AMC*, no.28, février 1991, pp.62–63.
12. C. S. -P., “Le Pavillon de l’Arsenal fait peau neuve,” *Le Moniteur Architecture-AMC*, no.140, février 2004, p.70.
13. According to an interview with the architect Zorana Konopek.
14. Brochure “Ein Erlebnis / An Experience.”
15. STIFTUNG (Wüstenrot), *Umnutzungen im Bestand, Neue Zwecke für alte Gebäude*, Stuttgart, Zürich: Karl Krämer Verlag, 2000.
16. Brochure “Haus Witten.”
17. ZAHLTEN (Norbert), “Culture Centre,” *DB: Deutsche Bauzeitung*, 1998, p.66.
18. According to an interview with the architect Zorana Konopek.
19. GEDANKE (Gebauter), Die Zeche Zollverein Schacht XII in Essen, (KunstOrt Ruhrgebeit), Essen: Klartext Verlag, 2004.
20. Brochure “Der Innenhafen-Seine Geschichte und industrielle Entwichlung-,” (Innenhafen Duisburg, Entwicklungsgesellschaft mbH).
21. MEYHOFER (Dirk), “Asyl für die Kunst,” *DB: Deutsche Bauzeitung*, March 1995, p.78.
22. According to an interview with Dr. Eng. Riitta Salastie at Helsinki City Planning Department.
23. ヘルシンキ都市計画局著、日本フィンランド都市セミナー実行委員会編「都市の開発ヴィジョン」『ヘルシンキ／森と生きる都市』市ヶ谷出版社、1997、p.157.
24.FRIGO (Jean-Pierre), “Rescapés du passé, Conservatoire de musique, Turku, Finlande,” *Techniques & Architecture*, no.432, Paris, juillet 1997, pp.82–84.
25. Brochure “KAAPELI, the best venue in town.”
26. JONASSON (Maren), ÖSTMAN (Ann-Catrin), *Allt af jern, texter kring en järnmanufakturs och ett industrikvarters metamorfoser,* Utgiven av Humanistiska fakulteten, 2004.
27. MÄKI (Pekka), “Tiedettä rautatehtaalla,” *Arkkitehti*, may 2004, pp.42-44.
28. Brochure “Helsinki Court House (renovation of the old alcohol factory).”
29. SIITONEN (Tuomo), “Concrete Structure of the year 2004: Helsinki Court House,” *Betoni*, Helsinki, January 2005, p.15.
30. HEIKKINEN (Mikko), KOMONEN (Markku), “Rough concrete, green canyon,” *Arkkitehti*, Helsinki, juin 2002, pp.28–29.

Design Methods and Tendencies of Architectural Conversions in Various Countries of Different Cultures III -Works of TZG in Sydney -

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Keywords: Conversion, NSW Heritage Act, Sydney, Tonkin Zulaikha Greer Architects

Abstract
The purpose of the article is to clarify the design method and tendencies of the works of architectural conversion in Sydney by Australian architects Tonkin Zulaikha Greer (TZG). Since The Heritage Council of NSW, an advisory body that includes members of the community, the government, the conservation profession and representatives of organizations such as the National Trust of Australia (NSW), was established under the NSW Heritage Act of 1977, the Council has actively promoted the history and heritage of Sydney over the past years. The History Program has recently been expanded to include a historian research. In these movements in Sydney, many TZG designs were adopted to the historically important building refurbishments. They respectfully relate with the existing buildings by refurbishing and enhancing them with their design additions, in the process, converting the prosaic into the poetic and neo-future. TZG design techniques and their insight for conversion synchronize with Australian Heritage movement and mark a philosophical shift in Australia. In this paper, through four works - Hyde Park Barracks Museum, The Rock Square, Sydney Customs House and Portico - of their heritage project, TZG design method for architectural conversion is investigated.

1. Introduction
Sydney is the biggest capital in NSW state in Australia. The history of the city begins from the immigration and settlement from Europe in 1788. Sydney, the city that the first colony government established develops as a center of economy, trade and industry. Although there is a great landscape of soaring skyscrapers in the city, a lot of old and historical building are saved and preserved by Heritage legislation of NSW. Sixty-three percent of heritage in the state list are concentrated in Sydney and the outskirts, and they are utilized and activated in the modern city with using conversion design. In this paper,

the architectural conversion technique of Tonkin Zulaikha Greer (TZG) is investigated through the above mentioned four works under our field work in Sydney.

2. Heritage Act of NSW

Heritage consists of the places and objects that the Australian community has inherited from the past and wants to hand on to future generations (RTA 2004, Miyazawa, O. 2003). Heritage is defined as the character of the Australian history, society and identification, and one of the important conditions is social nature. In addition, unlike Japan, Australian Heritage is regarded as not "art and culture" but "urban planning, urban design" and a law for heritage and a city planning system support an Australian Heritage Act system. The heritages can be accepted by three different levels of government structure in Australia; federal government, state government and a self-governing body. From a global movement of historic building protection, NSW made the Heritage Act of 1977 (Fig. 1) in a comparatively earlier stage than any other area in Australia. NSW heritage is diverse and includes buildings, objects, monuments, aboriginal places, gardens, bridges, landscapes, archaeological sites, shipwrecks, relics, bridges, streets, industrial structures and conservation precincts. The Heritage Council of NSW is established under the NSW Heritage Act of 1977 and is an advisory body that includes members of the community, the government, the conservation profession and representatives of organizations such as the National Trust of Australia (NSW). Although the Heritage Council makes decisions about the care and protection of heritage places and items that have been identified as being significant to the people of NSW, the range of the Act is from temporal bailout for a permanent preservation order. The contents of the revised act in 1987 changed for more active keep and preservation of Heritage from adopting the system to list Heritage for prevention of the destructions. The register of NSW Heritage is managed by the Heritage Council. The Heritage Council consists of fifteen members, whom are to be appointed by the Minister, the National Trust of Australia (New South Wales), the Royal Australian Historical Society, the Council of the Royal Australian Institute of Architects (New South Wales Chapter), the Planning Institute of Australia (New South Wales Division). The committee discusses with the owner and self-governing body in monthly meetings and the decision is announced by public source such as newspapers. After receipt and digesting citizen opinions, the registration is determined by the Council. Also, heritage management procedures are implemented by the Heritage Office and Department of Urban Affairs and Planning. The Unit consists of four staff, which possesses suitable qualifications, knowledge and skills relating to architecture, the building, development and property industries, archeology and so on. The work of the Heritage Office is to (1) work with communities to help them identify their important places and objects (2) provide guidance on how to look after heritage items (3) support community heritage projects through funding and advice (4) maintain the NSW Heritage Database, an online list of all statutory heritage items in NSW (5) give advise to Central Sydney Planning Committee (CSPC).

NSW Heritage Act, 1977 (Amended 1999)
· Establishes Interim Heritage Orders.
· Establishes the State Heritage Register.
· Requires minimum standards of maintenance for items on the State Heritage Register.
· Protects non-Aboriginal archaeological relics.
· Requires Heritage Registers for Government Departments under S170.
· Requires annual reporting on items included in Section 170 Heritage Registers.

Fig. 1 Summary of NSW Heritage Legislation[1)]

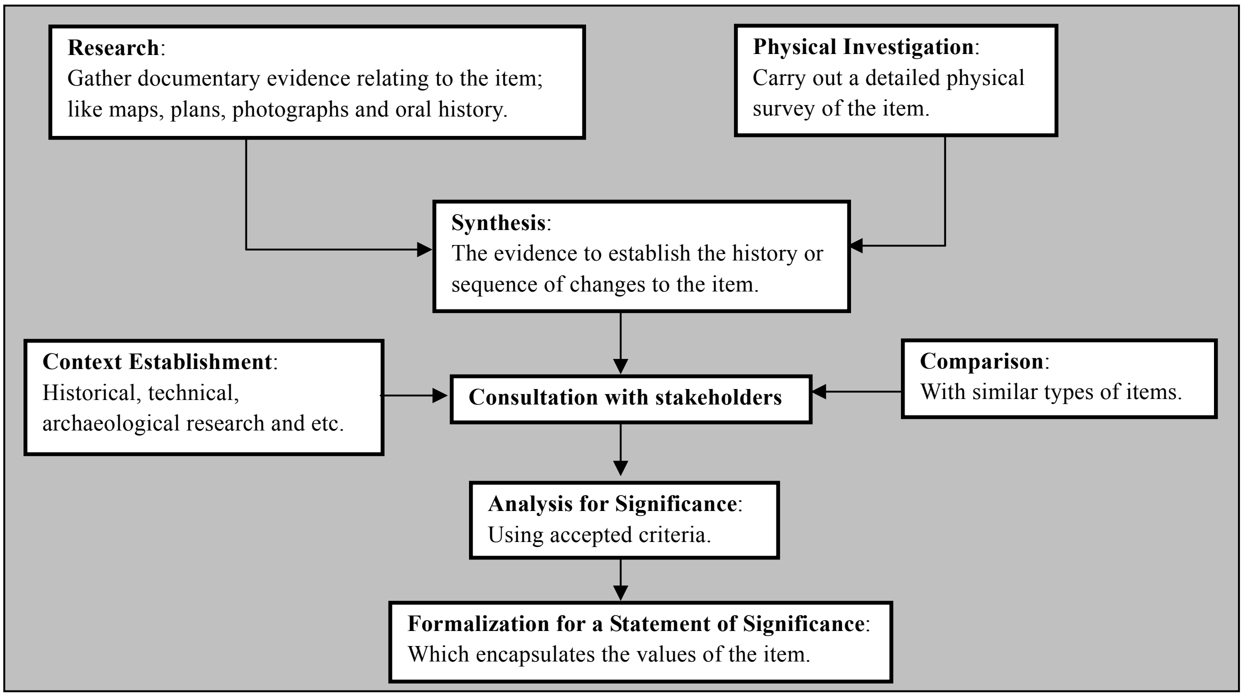

Fig. 2 Determining Heritage Significance[1)]

3. Tonkin Zulaikha Greer (TZG) Architects

TZG is famous architects on behalf of Australia. Their works are created in not only architectural buildings but also art or monumental projects such as the Australian Pavilion in WORLD EXPO 2000 SYDNEY (Fig. 3), the National Memorial to the Australian Vietnam Forces (Fig. 4) and The Australian War Memorial in London (Fig. 5) which honor the soldiers engaged in Vietnam War and WW2 (Patrick B. 2005). Furthermore, TZG deals with a lot of conversion architecture projects and shows the high quality design which shows high respect for the history and leads the Australian heritage movement for preservation to success. In this paper, TZG design method for architectural conversion in terms of material, history, design and construction is investigated through analysis of four works of their heritage project studied during our field work in Sydney city.

Fig. 3 Australian Pavilion[2)]

Fig. 4 the National Memorial[2)]

Fig. 5 The Australian War Memorial [2)]

3.1 Sydney Customs House

Sydney Customs House is located on its prominent site at Circular Quay Fleet on Sydney Cove, a very reputed spot in Sydney[5)]. The building has undergone five major refurbishments[5)] over the long life. This building is classified as a significant heritage building by the National Trust and on the register of the National Estate[7]. In 1844 Customs House has been transformed since it commenced as a two storey Georgian-style building (Fig. 6), rebuilt in 1885 as a three storey Italianate classical plazzo with a central pediment and ground floor Doric colonnade[4]. Two more floors addition gave a French Neoclassical style to the building in 1903[4]. The present six level building (Fig. 7) houses a variety of cultural facilities including office facilities (Fig. 8), a city planning model, galleries, a museum, a number of bars and cafes and a restaurant[2]. The Customs House itself represents a kind of model of the larger process of Sydney city-building. The sixth major refit of the Customs House was completed by the City of Sydney in 1998 when it was re-activated by TZG for re-use as a cultural facility. Although the significant 19^{th} century sandstone fabric was extensively conserved, the most interior spaces were restored drastically by 6-year-refurbishment[2)7)]. TZG rearrangement of the building created a light-filled atrium topped with a glazed roof (Fig. 9) and computer controlled louvers and achieved environmental sustainability and a high level energy-efficient design[2)7)]. Although the present management of Customs House was at stake in a three-way deal between the Federal government, the City of Sydney and the developers of East Circular Quay, the major condition is the Commonwealth's 60-year lease to the City that the vast majority of the building be retained for public use[5]. Two restaurants and cafés in Customs House are run on the lease from the City of Sydney[7]. In terms of structure, the building is a composite load-bearing and framed structure. The external masonry walls range from 680mm to 750mm thick with internal walls about 200mm[8]. The internal beams vary in fabric from wood to steel. The load-bearing masonry on the perimeter of the building and the steel-framed structure in the core are fairly readily separable in the upper reaches of the building, though the edges of concrete floors do bear on the earlier masonry at the perimeter of the framed structure of the core.

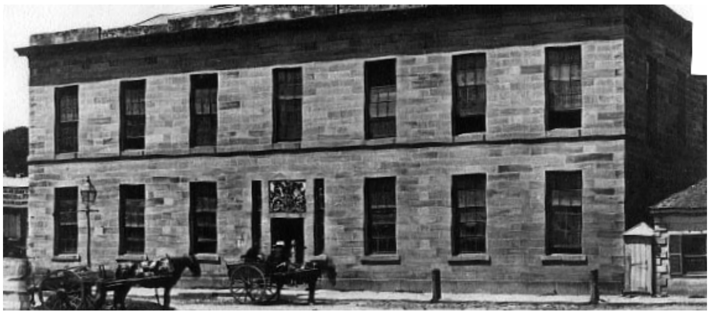

Fig. 6 Appearance in 1844[9]

Fig. 7 Present appearance

Fig. 8 Library

Fig. 9 Atrium

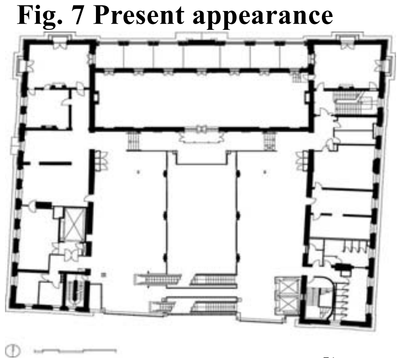

Fig. 10 Plan drawing[2]

3.2 The Rocks Square

The Rocks Area is the groundbreaking settlement site where the first immigrants the Governor Phillip led in 1788 began to inhabit. In 1971, the movement by inhabitants, citizen and National trust experts to find significance of the history value in the rocks against "The Rocks Re-Development Plan", the preservation of assets by NSW government management was examined and administrated by Sydney coastal line association[7). The Rocks Square is a public space (Fig. 12), adjoined by a glass-roofed Portico, leading tourist and heritage precinct to sixty specialty shops[2)3)]. The Square unites three underused buildings as two levels[2)]. Small enclosed public squares are surprisingly rare in Sydney. The cladding brick was preserved, it was established glass-roof and a pergola in a roof part newly by TZG. The square has been repaved in sandstone, with careful attention to access for the disabled[2)]. Materials inside have been selected to match the stone, brick and appearance of neighboring Victorian residential and warehouse buildings[2)]. The face brick matches the color of the convict-made sand stock bricks; sandstone is used as paving and walls to the public spaces; the interior is marked by expressive hardwood using[2)3)] (Fig. 14, 15, 16). New facades, deeply modeled and carefully-articulated, envelop the 1970s building relating to adjoining large-scale Colonial and Victorian warehouses[2)]. Both levels have multiple entrances in to the surrounding streets and lanes[2)]. In addition, old hardwood materials are reinforced with metal material. The reinforcement is characteristic to accept bending moment by beam string structure. Old materials and fusion with new material are planned well here.

Fig. 11 Present Appearance

Fig. 12 Public square

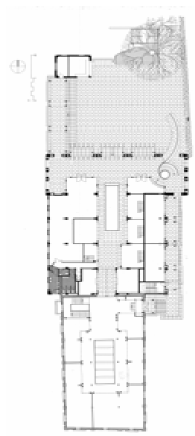

Fig. 13 Plan Drawing[2)]

Fig. 14 Entrance

Fig. 15 Souvenir shop

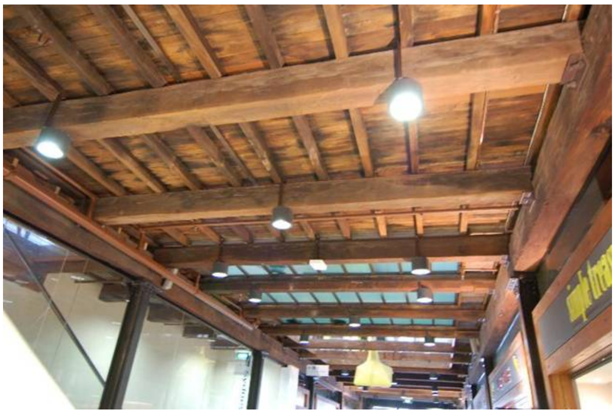

Fig. 16 Hardwood beams

3.3 Hyde Park Barracks

There are many 19th to 20th century historical buildings along Macquarie Street at the center of Sydney city. One of those Sydney's earliest examples of refined architecture, Hyde Park Barracks exists to house transported convicts in a self-contained walled compound in order to solve night-time crime[3)]. Constructed by convict labor, the Barracks is one of the finest works of the accomplished colonial architect Francis Greenway[3)9)]. It has had many occupants and was an Immigration Depot for single female immigrants seeking work as domestic servants and awaiting family reunion from 1848 to 1886 and also a female asylum from 1862 to 1886[9)]. From 1887 to 1979 law courts and government offices were based at the Barracks[9)]. Hyde Park Barracks was carefully restored, conserved and converted into a museum (Fig. 18) in the early 1990s as a project of the Historic Houses Trust of New South Wales[7)]. The building was a masonry structure. TZG preserves the outer stone union before, the inside is reinforced with the iron frame and the roof is a feature on the outlook in making the best use of a king post truss structure[3)]. In present conversion project, the old displays were removed, modern services were realigned and extensive conservation works were undertaken based on a critical focus on the place, the diverse histories of the occupants and the cultural significance for Australia. The three-storey main building is the centerpiece of the walled compound[3)]. Each floor has four large rooms divided by staircases[3)]. The most interior spaces were restored drastically. Modern materials such as glass and steel are used in ways which clearly distinguish the new work from the original fabric[3)]. The internal beams vary in fabric from wood to steel (Fig. 19, 20).

Fig. 17 Present appearance[(2)]

Fig. 18 Exhibition

Fig. 19 Corridor

Fig. 20 Ceiling

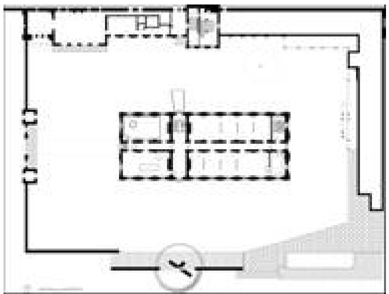

Fig. 21 Ground plan drawing[2)]

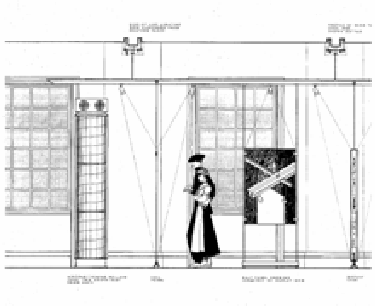

Fig. 22 Section drawing[2)]

3.4 The Scots Church (Portico)

The Scots Church was built in 1930s. Although Sydney city tried to build the maximum height permitted of 150 feet church with a steel-framed commercial tower as a monumental expression of “the universal character and inherent nobility of Presbyterianism and the material consummation of the church’s pioneer efforts in this new world of Australia” [7)], only the first five floors and the assembly hall had been completed (Fig. 23) when construction work was deferred and abandoned following the economic crash of the Great Depression 1929 and substantially incomplete[2)3)]. The original external stonework was attached to the steel frame with concealed fixings, making this a very early use of dry-jointed cladding[3)]. In 2001, redevelopment programs of the disused, heritage-listed 1920s Scots Church got approval of Sydney City and remodeling construction began[7)]. Won, furthermore, as a result of a limited ‘design excellence’ competition conducted as part of the City of Sydney's Design Excellence program, Tonkin Zulaikha Greer's recent addition was designed[7)]. The project gives high rise 20 storey apartment-church building from more sixth floor enlargement (Fig. 24). The structure of an original lower storey building part is preserved in stone massing appearance and the steel frame system is adopted with overused modern glass facades in the residence apartment[2)]. In the residence department, maisonette style is adopted and employed. To achieve a maximum number of high-quality apartments, a system of two-level units was developed with corridors and lift access at every second floor, the building elevation created by the sequence of double-storey apartment boxes continues the proportions of the Perpendicular Gothic façade below emphasizing the verticality and creating a dynamic shape. Integrating natural ventilation system is set by open-able sliding doors and shading elements and a passive solar system to allow daylight to penetrate deep into the apartments. The new development utilizes original support structure and references the Neo-Gothic massing of the original design. The new towers use sandstone colors to connect to the restored stone base, as well as expanses of seamed zinc and brilliant glazing[2)]. The interplay of solid and light, zinc and glazing combined with the irregular rhythm of colored glazing panels, blinds and shutters, creates an elevation that reflects the refinement of the urban location and chaotic mixture with the past and the present[2)]. It is a characteristic example that reinforcement for the foundation is made structurally for enlargement load of TZG addiction is excessive.

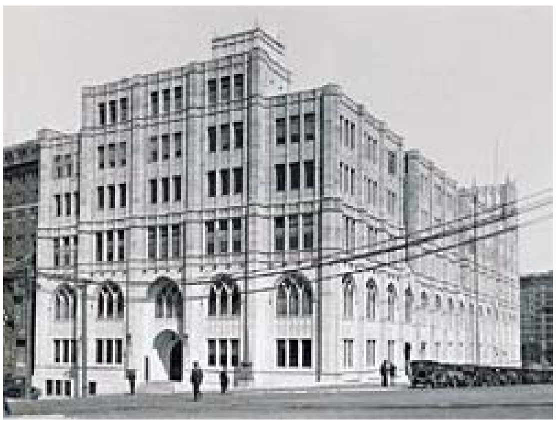

Fig. 23 Appearance in 1931[8)]

Fig. 24 Present appearance

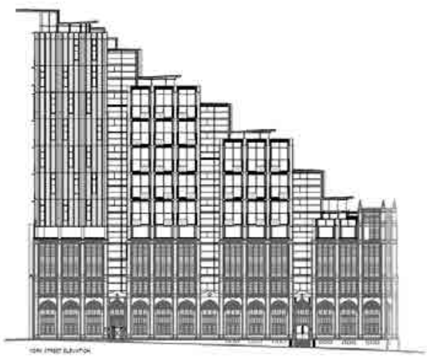

Fig. 25 West elevation drawing[2)]

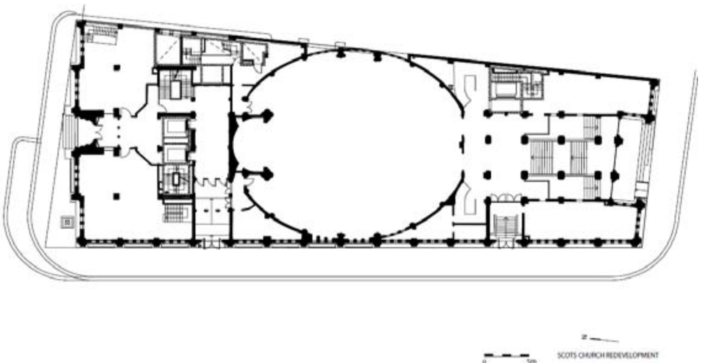

Fig. 26 Ground plan drawing[2)]

4. Summary

NSW heritage is diverse and includes buildings, objects, monuments, Aboriginal places, gardens, bridges, landscapes, archaeological sites, shipwrecks, relics, bridges, streets, industrial structures and conservation precincts are valued socially, architecturally, naturally, archeologically, culturally, scientifically and historically[1)7)]. Every heritage item has a past, a present and a future[1)7)]. It is important to research and understand an item's past in order to assess the significance and in turn pass on those significant aspects to future generations. NSW state government promoted the campaign for an active conversion of historical building and regarded reuse of Heritage as "high energy efficient development" with establishment of the Heritage Act underlying a policy of "a living city". Architects TZG take a role as a pioneer in Australia. As the characteristics of TZG technique for conversion, (1) TZG preserves old outer material bricks and stone appearance by adopting the same color modern material such as glass or steel to façade making the past and present contrast. Furthermore TZG uses a high level energy-efficient design for environmental sustainability and enhances the level of Sydney Heritage campaign. (2) In the terms of the structures, many works reinforced original mason structures with a steel framework inside, keeping the outer brick and masonry appearances. Almost all Heritage buildings TZG takes are masonry structures, and the roof makes the best use of a king post truss structure from early time. Because there are not many earthquakes in Australia, not so much severe limit regulation for structure design is possible. Although hardwood used for beams is mainly reinforced by a metal device plate in the joint, it is characteristic to bear bending moment by structure of beam string structure with terms of both a functional and an apparent insight by these apparatus combinations. These TZG design techniques and their insight for conversion synchronize with Australian Heritage movement. The situation of joint creation makes co-existence of Historic buildings and modern architecture. These forward movements leads Sydney to be "the town which is the third most comfortable town in the world to live in"[7)].

5. Acknowledgements

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Note and Reference

1) Roads and Traffic Authority, New South Wales. 2004. *Roads and Traffic Authority Heritage Guidelines Version 2*. RTA NSW Press.

2) Patrick B. 2005. *Tonkin Zulaikha GreerArchitects.* Pesaro Publishing: 36-155.

3) Graham J. 1997. *A Guide to Sydney Architecture*. The Watermark Press: 21-201.

4) The Institution of Engineers, Australia. 1999. *Sydney's Engineering Heritage*: 12-60.

5) Naomi S., 2007. *MONUMENT 76*. Pacific Magazines Pty Ltd Sydney: 64-76.

6) Owen M. 2005. *HOW THE ROCKS WAS WON –PLANS vs POLITICS-*. Engineers Media.

7) Miyazawa, O., Council of Local Authorities for International Relations (CLAIR) Online. 2003. *A Report for a preservation and activation of historical heritage buildings in Australia* (in Japanese). Tokyo. CLAIR Report Press 239: 1-67. http://www.clair.or.jp/j/forum/c_report/

8) Laura H. 2006. *Portico*. Architecture Australia. Media Pty Ltd.
http://www.archmedia.com.au/aa/aaissue.php?issueid=200607&article=11&typeon=2

9) Customs House Online. *Customs House Heritage Interpretative panels*. The Customs House management team, the City of Sydney Press. http://www.cityofsydney.nsw.gov.au/customshouse/heritage/

10) Historic Houses Trust of NSW Online. *HISTORIC HOUSES TRUST*. http://www.hht.net.au/home

From Conversion to Adaptive Reuse

– Progress of Reuse-Revitalization Program in North/South Americas and Recent Trend –

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Abstract

In U.S.A., reuse of existing building stock has undergone three stages. The first Historic Conversion up to 1980s aimed mainly to sustain buildings of cultural and historic importance by introducing retail activities. In the second phase in 1990s, such history-based restraint was shunned and replaced by more general terms, flexible enough to cover expanding types of target edifice along with broadening scope of design/planning. Adaptive Reuse was widely applied. Community Revitalization was preferred, too, where a reuse project aroused the rejuvenation of the declining community. In the present decade, reuse tends to emphasize public-private partnership, a catalytic role for neighborhood revitalization, and proposal of novel designs and innovative technology.

Introduction

Reuse of existing buildings has been a common practice, especially in the case of masonry structure due to its inherent durability of the material. In the U.S.A. such conversion shifted from the plain elongation of the building life to a new stage in 1980s as of positive strategy for reviving commercial values in the form of shopping mall. Toward the end of the twentieth century the next stage of conversion emerged responding to broadening aim and scope both in architectural design and urban planning.

The present paper describes, firstly, a brief history of this transition. Secondly, it reports the findings from the current results in U.S.A. along with a few related projects in South America. The data was obtained through on-site surveys conducted in 2003-2006.

1. First Stage of Conversion as in "Historic Conversion" in late 1970s to 1980s

Renewal project of discarded building stocks was initiated in 1970s with such shopping mall creation as Ghirardelli Square (San Francisco, chocolate factory of 1893/ 1964) and Quincy Market (Boston, hall 1742, and market 1826/ 1978), and they remained no more than tourist attraction. Amendment of Historic Preservation Act of 1980 then introduced a new judgment in evaluating historic property as of cultural heritage, beyond the prior standard upon aesthetics. This guideline led reassessment of the governmental facilities and required a certain amount of each departmental asset to be regenerated.

1.1 Historic Preservation

The Old Post Office of 1899 in Washington, D.C. was one of those and the most succeeded conversion trials. Revived in 1982 as the Pavilion, the preserved Romanesque exterior and iron-caged roof encased an early version of a food court at the atrium level and offices in the upper levels (Fig. 1). Calling back officials working nearby as well as tourists, this first conversion of a governmental facility contributed to revive Federal Triangle, long impoverished quarter of the Capitol city. Receiving influence from this success, the private sector also set about the similar projects of commercial survival as in the case of the Bourse (Fig. 2; Philadelphia, 1895 merchandise exchange/1982). Those target buildings been of historic importance for the development of each city and often designated as cultural property, their renewal projects turned to be known generally as historic conversion.

1.2 Residential Conversion by Private Firm

Regarding to less-historic stock, restoration of old warehouses into studios and designer's offices foreran such as in the Soho district, New York City, and the professionals specializing in this matter were occasionally entitled remedial architects. Soon in the early 1980s followed residential renewal, now in the form of business enterprise and stimulating enough to create a new housing market in midtown. Historic Landscapes for Living, Philadelphia-based venture group, pioneered this course by combining a process of assessment of an antiquated building, purchase upon its market value, preservation of the exterior characteristics and the original interior details while introducing modern equipments. Sales and later maintenance, all were integrated under the management of a single company. This fresh business model along with the harmony between old and new within high ceiling, stout rafters and brick walls (Fig. 3) could cultivate a clientele among a surfing generation of young professionals, so-called DINKS. Their great success led a nation-wide boom of residential conversion.

Fig. 1 The Pavilion, Washington, D.C.

Fig. 2 The Bourse, Philadelphia

Fig. 3 Bank Street Court, Philadelphia

2. Second Stage of Conversion as in "Adaptive Reuse" in 1990s

2.1 Expansion of Scope and Building Types

In the next decade, conversion began to spread over wider type of building stocks, and gradually get recognized as neither mere a retrospection nor elongation of building life but a practical enhancer of architectural and market

Fig. 4 Le Rivage, New York

Fig. 5 Trump International Hotel and Tower, New York

values of each target. Furthermore, it could an effective planning tool for revitalizing the neighboring area. Some examples of such extended scope are as follows.

2.2 Commercial-to-High-rise Residential Reuse

Rose Associates, Inc., New York realtor, purchased a commercial bank, once flourished in the Lower Manhattan since 1931, and remodeled this 34-story office building into a high-rise apartment tower. Le Rivage (Fig. 4) carries space to lease of as many as 64 types and each unit offers high ceiling and good overview. Art Deco motifs on its façade and in the lobby well bequeath the heyday of the local prosperity.

Residential use had been restricted in the south end district of Manhattan, but the affluence of office floor inspired practical use of surplus space toward the end of 1980s. Timely introduction of tax privilege induced financial incentive, and made the cost to reuse the existing buildings relatively feasible compared to new construction. Escalating demand for the loft-style residence, and, most of all, access to the financial center materialized this first project in the city to succeed. In the vicinity, the similar residential conversion is expected to follow among mid to high-rise offices of the same class and history.

In Uptown, rather new skyscraper only of 28-year-old transformed from a headquarter of oil company to a complex of hotel and apartment in 1997 (Fig. 5). Its whole height of 176 m with 44 stories was stripped down to the core steel frame, and then retouched to contain 168 hotel suits plus 158 condominiums. A set of building and corner plaza of this Trump International Hotel and Tower provided the southwest block of the Park District with a focus around which a redevelopment of the inactive surrounding area is under way.

2.3 Institutional-to-Cultural Reuse

P.S.1 Institute for Contemporary Art (Fig. 6) opened in 1997 in a deserted Romanesque Revival public school building of 1900 in Long Island City. An institution of P.S. -the initials stand for “public school”- had since the mid-1970s campaigned for abandoned city-owned buildings as venues for art and workspaces for artists. Under the aim of presenting respect for the building and a concern to express its history, later accretions were removed and stripped down to its original form. History revealed, usable space maximized, and outdoor gallery extended, the reborn became a home for art as well as year-round gathering.

Fig. 6 P.S.1 Institute for Contemporary Art, New York

2.4 Recycle of Ubiquitous Buildings

Conversion in the second stage extended its reach over various types and ranks of building owing to the combined incentives of finance, tax system and housing market, as mentioned in 2.2. The benefits passed on to non-conspicuous or ordinary buildings. Encouraged architects sought inspirations for the design from the building history itself along with the local context and harmonized those inherent properties with their own expression. To quote only a few from the works in San Francisco, Oriental Warehouse, two-level masonry structure built in 1868 by a steamship company, turned into 66 rental lofts in 1966, and the other four-story storage of 88-year-old revived as a new office of ad firm, TBWA/ CHIAT/ DAY (Fig. 7). Nautical references introduced within, a wooden ship's outer hull and the like, recalls its Gold Rush heyday.

Fig. 7 TBWA/ CHIAT/ DAY, San Francisco

3. Recent Trends in 2000s

3.1 Boutique Hotels

Run by an independent owner, guest rooms of less than 200 and located close to the downtown entertainment area- such genre of hotel is recently called boutique hotel. The renowned skyscraper forerunner and a decidedly masterpiece of the Chicago School design, Reliance Building led its way. Built in 1894, a speculative mix-use building of 14 stories had degraded over the years accompanied by the decline of Chicago downtown office market and let go to the hand of the city. Owing to preservation action through public/private partnership, it received restoration and adaptive use project reproduced it into an intown hotel of 122 rooms in 1999. The reborn Burnham Hotel (Fig. 8) is appraised not only for refurbished beauty of craftsmanship but also by triggering the rejuvenation of the declining downtown district.

Fig. 8 Burnham Hotel, Chicago

Fig. 9 Lowes Hotel, Philadelphia

Fig. 10 Hard Rock Hotel, Chicago

Hotel Monaco, opened in 2002, derived from a governmental office, former post office in the early nineteenth century and later the Tariff Commission. A hotel reuse idea made the best possible use for its highly compartmentalized floor plan. Behind the Neoclassical façade of three stories, its public spaces and private rooms were all enlivened by newly brought Art Deco furnishings.

The following projects in this boutique hotel series are known for the role of catalyst for neighborhood revitalization.

3.2 Reuse of Skyscrapers

PSFS (Philadelphia Saving Fund Society) or the pioneer of the international style skyscraper of 1932 also turned into a city hotel in 2000, Lowes Hotel (Fig. 9). It preserves original Art Deco embellishment in stainless steel grills, fixtures and everywhere that presents the best offer to guests and visitors. Another office tower in Chicago, Carbide and Carbon Building of 1929 or the most beautiful skyscraper along her main avenue, survived as a hotel, too. Hard Rock Hotel (Fig. 10), reborn in 2003, carries a typical Art Deco in massing and detail while integrates in interior designs with the reminder of the Rolling 60s, and thus stands out now as the most popular hot spot in the city.

Skyscrapers have lately been facing the threat of destruction. The above-referred projects are so challenging as to present a model for sustaining the most common building type through adaptive reuse.

3.3 Cultural Revitalization of Industrial and Transport Facilities

Railroad terminals used to be the front door in the cityscape. Their advantages in proximity to the center city and huge volume initially encouraged its expanse of space to be filled with facilities and performances, such as a museum in Musée d’Orsay (Paris, 1987) or a reception stage set with exhibit trains in Pennsylvania Convention Center (Philadelphia, 2000). Centro Cultural Estacion Mapocho (Santiago, 2004, Fig. 11) took an opposite direction by presenting the utmost element unique to this type of architecture. New addition was limited to a memorial exhibit hall installed underneath the concourse, and the rest, platform and railway, was paved flat and left open. Under a forest of steel arched trusses, reuse plan beckons visitors to take full pleasure in spazio, or literally put unobstructed expanse of space, immersed in repose amid the noisiest quarter of the city.

Fig. 11 Centro Cultural Estacion Mapocho, Santiago

Fig. 12 California College of Arts & Crafts, San Francisco

Fig. 13 Dia: Beacon, Beacon, New York

California College of Arts & Crafts (San Francisco, 2003, Fig. 12) is a rebirth of a bus repair garage. The cavernous concrete and curtain-wall structure of 1951 contained an unobstructed space, where two floors were inserted on both sides for studios and labs, and the center left untouched to the full length of 120 m for a passage and multiple uses. Such self-suspended treatment of floors just fits a monument from the technological heyday of the postwar era.

Dia: Beacon (Beacon, NY, 2004, Fig. 13) is the other application of huge space to the exhibit purpose. In transforming a former package-printing plant, architecture was conceived as a frame for the work. Fixtures and ductwork were taken away to reveal the power of the vast structure. Two vast galleries and smaller ones in the back take light entirely from above by skylights and clerestories. Bathed in daylight of almost clinical evenness, the set of free-moving space and light presents a protest against the conventional lobby-type and fully controlled museum system.

3.4 Waterfront Recreation by Reuse

Long forgotten piers along San Francisco's Embarcadero, or embankment, happened to reappear when the 1991 earthquake demolished the double-decked freeway running in front. An opportunity to reunite the city with the waterfront given, a series of adaptive reuse projects was proposed by citizen groups and carried under the direction of the city's Port Commission and private developers. Renovation of the Ferry Building (2003, Fig. 14) led the way. After a four-year restoration, a Beaux Arts monument now houses a locally oriented, public market on the ground floor along the Nave, a 200 m long, sky lit, two-story concourse. The second and third floors contain offices, one public and the rest to lease. Then extended the rehabilitation to the northern piers, 1-1 1/2-3-5 (fig. 15). Pier 3, just opened in the fall of 2006, is so well attended that its rental space in the head office and warehouse was all sold out to various design, financial and legal firms by the opening day, due to proximity

Fig. 14 The Ferry Building, San Francisco

Fig. 15 Pier 1, San Francisco

Fig. 16 Pier 1 - 1•1/2 - 3, San Francisco

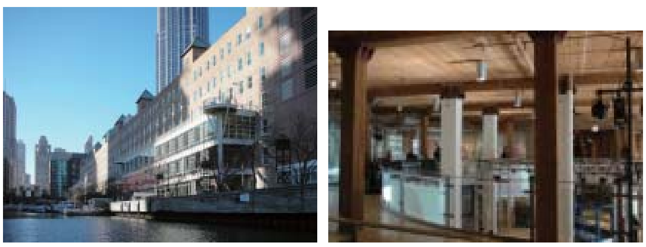


Fig. 17 River East Art Center, Chicago

to downtown, ocean view through each window and the latest form of geothermal air-conditioning system combined. The periphery is kept open for public, recreational use where the ocean-side promenade connects piers to the length of 4 km, and to be extended further as the scheme progresses (Fig. 16). The projects created the completely new waterfront that is respectful of the buildings' transportation history while encourages new uses as well as maritime, open spaces and public access.

The same was true with the case of North Pier in Chicago, or presently River East Art Center (Fig. 17). A warehouse on a decaying pier brought an ignition to her redeveloping lakefront. In converting the 85-year-old merchandise exhibition and distribution facility into a commercial complex, three floors housed specialty retail and four floors above offices. New elements in glass and metal such as projected gallerias on the rear, canal side and various metal fixtures express a contrast with existing heavy timber structure. The main atrium, oval and three-story high, and curved space to both wings led shoppers to easy stroll. The retail floors were once again in 2006 transformed into an art center and the new cultural activities are reviving a maritime quality of the area that attains this project to a true representative of community revitalization.

3.5 Other Type

Edificio J. M. Carrera in Santiago (2005. Fig. 18) is a rare, reverse case from commercial to governmental reuse. While the exterior of a former hotel of 1940 in modern Rationalism style stayed untouched except necessary repairs, the interior received a bold reformation for a new use of the ministry of foreign affairs. Lower floors of halls stood as they were for ceremonial receptions, typical floors up to 14th level were redesigned for office work on free-flow planning, and the top three floors for the minister's private office and conference. What enabled this project was simply the beneficial offer at the initial estimation, the cost of reuse fell far short of that of scrap-and-build.

Fig. 18 Edificio Carrera, Santiago

Chart 1. Chronologocal Review of the Terms and Background

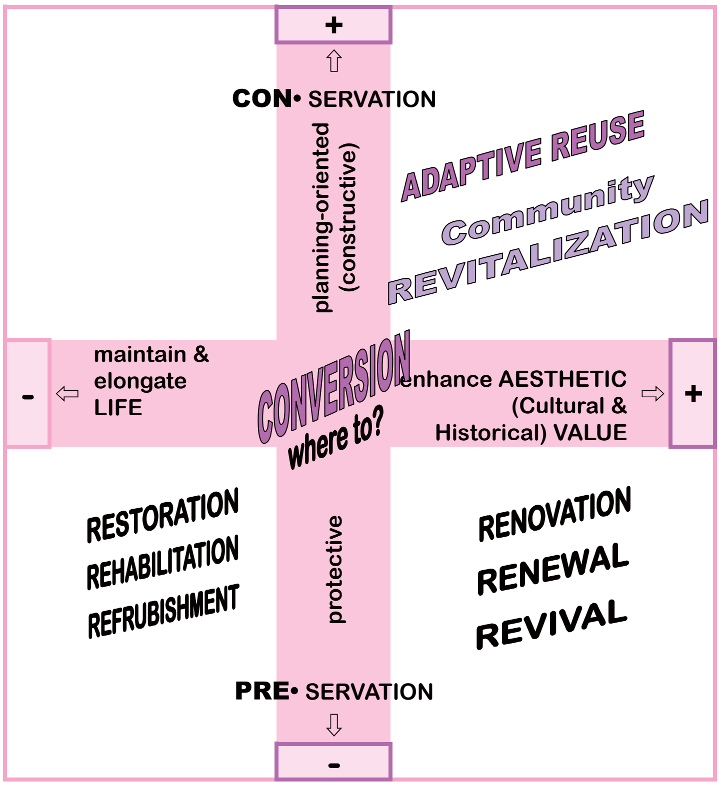
Period	Trend	Background	Advocated terms
1970s		Sluggish housing market	**"Historic" Conversion**
1980s	Boom in Recycling Historic buildings		
		U-turn to the center city linked to active housing market	
		Residential inroad onto midtown commercial district	
1990s	Expanding demand for recycling wider building types and pursuing business target		Conversion receding/ to be replaced by **"Adaptive Reuse"** **"Revitalization"** **"Community Revitalization"**
		Demand for Loft-type residence	
		Tax incentive for midtown development	
		Financial support for home acquisition	
		Relative reduction in improvement cost of existing buildings to new construction	
	Promotion of residential reuse from the office buildings		
2000s	Resurrection of urban/local community through reuse project		Collective term yet in hunt
	The term Conversion currently is used narrowly in the housing market in two ways; transfer of its service from commercial to residential, and of ownership type from rental to condominium		

Those recent achievements in the present decade suggest, on one hand, the importance of public-private partnership in reuse programs. Such projects undertaken as mutual collaboration make substantial private capital investments, creating commercial attraction and public access and space improvements that enable the related communities to find and enjoy their familiar but restricted assets. The other lesson is about an essential stand in seeking a reuse solution. Discovery of the original and inherent attraction in existing building, translation of those findings into unique design proposals and creation of a new market model are the prerequisites to success.

4. Conclusion - Search for New Terms

As Chart 1 summarizes, reuse of building stocks as cultural asset has undergone three stages in U.S.A. The prior terminology "Conversion," generally coupled with a preposition of "Historic," could not cover ever- widening of building type and broadening scope of projects by 1990s. It also reminded the people concerned of troublesome prerequisite formalities in the past decades, required by authorities and related societies and caused a delay in numbers of conversion program. The background been so compelling, new phrases were to be sought. The term "Reuse" seemed to be applicable. Combining an adjective, "Adaptive Reuse" is accepted in many cases until today. This "adaptive" evokes an image of increase or creation of values as a result of the conduct of reuse. Conversion, in contrast, refers simply to change of use in its original meaning as of alteration and modification, according to English dictionaries. In case that Adaptive Reuse arouses further reviving activities in the neighborhood community, the term "Revitalization" is applied, too. Such influential movement is often entitled "Community Revitalization." As shown in Chart 2, any generic term is not yet held in common, though [1].

Chrat 2. Search for New Terminology



Notes

1) The term Conversion currently is used narrowly in the housing market in two ways; transfer of its service from commercial to residential, and of ownership type from rental to condominium.

Regarding to the shift of terms, the author owed information to interviews with Ms. Jo A. Gause, Urban Land Institute; Mr. Michael P. Di Rienzo, National Trust; and Mr. Robert A. Scaglio, Rose Associates, Inc.

In case of Chile, Mr. De La Cruz, Architect-in-chief for the work of Edificio Carrera, prefers the word of Recycle as it implies a development capability on a new use. Official bulletins and guidebooks there occasionally carry Remodelación, too. But the author has experienced no mention of Conversion so far.

Reassessment of Historic Building Conservation through Conversion in Britain from the Viewpoint of Adapting it to the Japanese Context

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Keywords: Building Conservation, Listed Building System, Architectural Value, Conversion, Checking System, Britain

Abstract

The concept of building conservation has recently undergone significant changes in Japan. It was assumed that building conservation was a part of the government's policy for protecting national cultural properties; however, current thought recommends that historic buildings should be used in the same way as new buildings. People in various fields have shown an interest in them. With this background, the conversion of historic buildings was highlighted, and this movement was initiated in Britain. The British government employed this idea in times of recession and recommended conversion as a solution for the conservation of listed buildings. Such an approach may also be useful in Japan. In particular, this approach could assist town planning by enabling the use of regional heritages. However, Britain and Japan greatly differ with respect to their backgrounds, and it would be impossible to adopt British systems in Japan without changing them. In this essay, I have examined the system of British building conservation through conversion. Moreover, I have discussed the strengths and limitations of Japan adopting the British technique by comparing the circumstances of both countries with regard to building conservation.

1. Introduction

In recent times, the effective utilization of historic buildings through 'conversion' has come to be recognized as a useful method for building conservation. From the historical point of view, changing the usage of old buildings is not a special consideration; however, there have been some recent cases of historic buildings being converted for commercial purposes. Numerous successful examples of the renovation of historic buildings in foreign places by means of conversion have been introduced to Japan. Following this, some historic buildings in Japan have also been restored using this new and previously untested method.

However, the background underlying the conservation of historic buildings is different for each country, and a host of problems is likely to arise if a foreign method is introduced into a country without suitable modifications. For example, the legislation system differences between the two countries could cause impediments. In Japan, the Law for the Protection of Cultural Properties and the Building Act are both legislations for historic building conservation. However, such laws vary from country to country. Therefore, it is necessary to take into account the entire system of legislation in foreign countries. In addition to this, each country has some unwritten rules in accordance with customary practice, which may not be clearly provided in its legislation. Hence, when employing a foreign system, it is impossible to arrive at an appropriate restoration method without considering the background of the country in question. Moreover, it is necessary to solve any particular problem that may result from the different systems of the two countries.

Britain was the first to undertake historic building conservation through conversion as a government policy, and this method has yielded positive results. Based on Britain's gainful implementation of this technique, it can be concluded that remodelling historic buildings through conversion has not only achieved success from the viewpoint of economics but also advanced the scheme of historic building conservation. However, the situation is gradually changing due to the redevelopment boom caused by unprecedented economic prosperity in Britain. In this essay, I have examined the historical process and features of British building conservation by means of conversion from a systematic viewpoint. In addition, I have discussed the potential strengths and limitations regarding Japan's implementation of this British method by comparing the circumstances of both countries with respect to building conservation.

2. Background of Adopting Conversion as the Method of Building Conservation in Britain

Regarding the practice of building conservation in Britain, it is assumed that it was necessary to convert the usage of historic buildings in such a way as to enable them to function as independent buildings to be used for commercial purposes as per current requirements. The British government has clearly mentioned this policy in its Planning Policy Guidance Note 15, 'Planning and the Historic Environment' (issued in September 1994). The note implies that the government recommends conversion as a solution for historic building conservation.

This concept dates back to the government policy during the Thatcher era. At that time, the conservation of historic buildings in a central town was an extremely serious urban issue that arose in the midst of a recession. A large number of Victorian buildings, which had been the mainstay of prosperity at one time, lost their purpose in contemporary society and became superfluous. However, most of them were already specified as listed buildings and required substantial conservation by the Town and Country Planning Act 1968. Many of them did not find tenants and were in an unmanageable state. In this context, the Department of the Environment issued a circular titled 'Historic Buildings and Conservation Areas: Policy and Procedures' (Circular 8/87) in order to include the new scheme of building conservation in the government's economic activation policy. In this state paper, conversion was recommended as a solution for conserving listed buildings. This concept originated from the idea that the conservation of historic buildings should be economically effective, without requiring administrational assistance. Further, the conservation should act like a value addition for the old buildings. Since Britain was in a terrible recession at that time, such an idea was welcomed. This idea is influential even now.

Developers were the first to enter the scene, considering it a business opportunity. There were plenty of vacant Victorian office buildings in the town in question. If these vacant buildings could be converted into housing, it would be possible to convert the town centre from a slum area to a newly developed housing area; therefore, many Victorian office buildings were converted into housing. Many people like to live in such centrally located converted buildings. Consequently, building conversion has become a flourishing business. In this way, Thatcher's goal was achieved. At present, this method of building conservation is widely accepted, with few people opposing it.

Such a method might greatly benefit building conservation in Japan, where there have been redevelopment attempts for some important local buildings in each town. However, the central and local governments have provided limited support for building conservation, and therefore, it is important to add value and make the buildings more attractive through their conversion.

In such a situation, it is crucial to understand the different backgrounds of historic building conversion in Japan and Britain. The British legal system and administrative procedures were formed over a vast period of time. Because the systems in Japan are comparatively new and lack the corresponding amount of experience, adopting such a conversion method could cause a number of problems, which should be considered at the outset.

First, the number of legally protected buildings differs for both countries. In Japan, 4,404 buildings (2,519 sites) are protected as national treasures and important cultural properties, while 6,064 buildings are protected as listed buildings by the Law for the Protection of Cultural Properties (mentioned above; these figures are as of 1st June 2007). In Britain, however, there are approximately 500,000 listed buildings. The Planning (Listed Buildings and Conservation Areas) Act 1990 restricts any change of the current condition for listed buildings. If someone wishes to change the condition of a listed building, that person is required to obtain the permission of the authorities; this is called a 'listed building consent'. Since the majority of historic buildings are listed, their current conditions cannot be changed without legal permission. Listed building consents are issued by the Department of Culture, Media and Sport for Grade I and II* listed buildings and by the local planning authority for Grade II listed buildings. However, these permissions are not issued without a specialist's advice. English Heritage plays an important role in such considerations, and special commission is organized in some cases. In short, professional opinions are referred to whenever the current state of a historic building is to be altered. Due to this system, the architectural or historical value of historic buildings can be retained even after their conversion.

3. Development of the British Conservation System

The British economy was reactivated during Blair's regime. It is thought that the various deregulations adopted since Thatcher's time as political measures to encourage Britain's economy were responsible for this economic improvement. Allowing the conversion of historic buildings as a building conservation technique was one such deregulation aimed at achieving economic independence. However, even though the British authorities allowed conversion, they continued to protect the historical and architectural value of the converted buildings. It is reported that the British building conservation system functions extremely well. In addition, the British have been able to consider each individual case carefully and select the best method, partly due to the slow process of conversion during the continuous recession. This is because rapid development occasionally opposes conservation.

The Ancient Monuments Protection Act 1882 was the first act pertaining to historic building conservation in Britain. While this was the beginning of legal protection of monuments, the 1900 amendment expanded the scope of monuments to be protected to include even constructed monuments. Thereafter, some nationally important historical buildings were protected by the Ancient Monument Consolidation and Amendment Act 1913.

Further, the conservation of historic buildings was applied to town planning. The 'Building Preservation Order', which protects certain buildings from being demolished under the guise of development, was introduced by the Town and Country Planning Act 1932. After World War II, this system was revised to refer to the current condition. The authorities began to compile a list, called the 'Statutory List of Buildings of Special Architectural or Historic Interest', in order to decide beforehand which building is to be included in the 'Building Preservation Order', if threatened with demolition. It leads to the so called 'Listed Building'. The listed building system was introduced by the Town and Country Planning Act 1968, and this system continues to be in effect even now.

To summarize, the conservation of historic buildings was initiated for the purpose of protecting national cultural properties. Following this, The Town and Country Planning Act was enacted to enforce a system to combat the development rush which occurred after World War I. Thereafter, a more sophisticated system was established during the recession, which occurred long after World War II. For the first time since the initial years of development, Britain had to confront problems related to fast-paced development. Therefore, the new development gave rise to some new problems that the British had never experienced thus far.

4. Recent Movements in Britain

At this point, let us examine the Oxford Castle Regeneration Project as a recent example. This project involves redeveloping the redundant historic castle yard dating back from the Middle Ages into a new sightseeing spot in the old town of Oxford. This project has received as much attention as another example of conversion—this time from a prison into an excellent hotel.

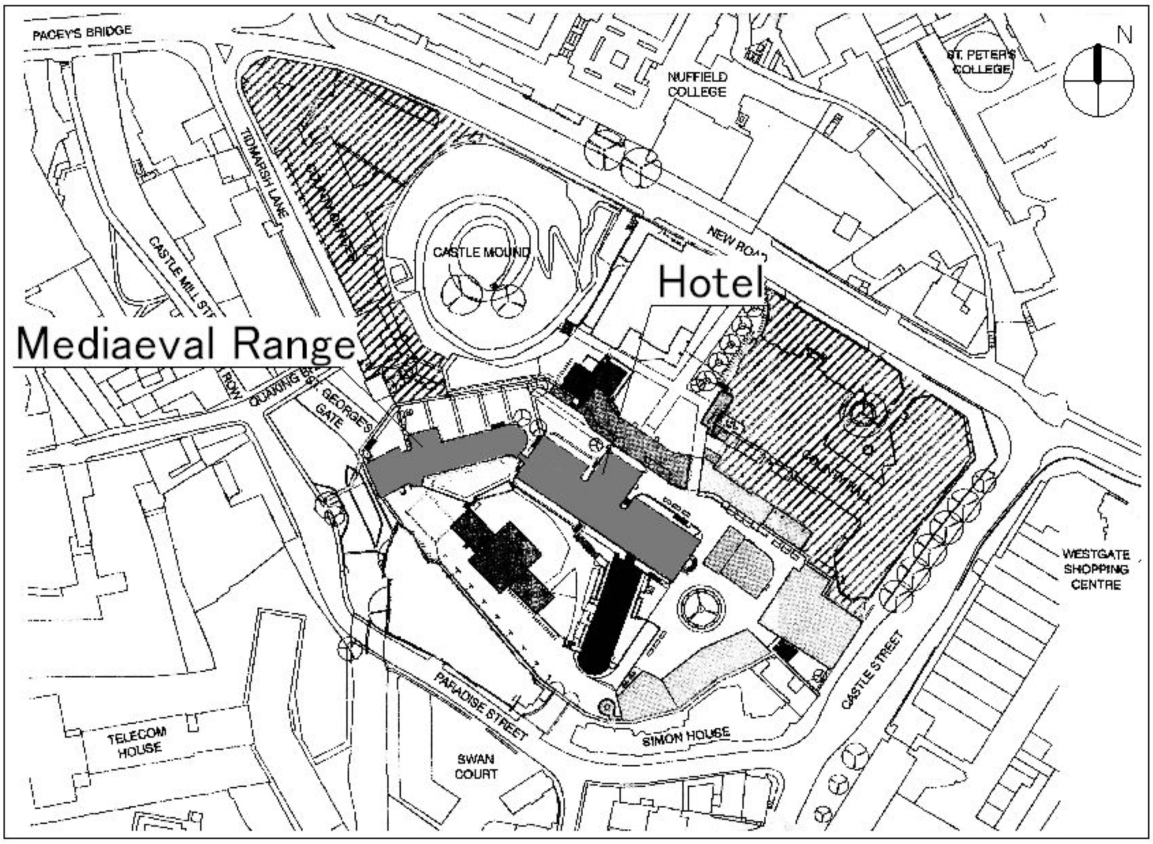

fig.1 Site Plan of the Oxford Castle

When this prison was shut down in 1996, its surroundings included numerous historic constructions, including the Castle Mound, which was registered as a scheduled monument of the Ancient Monuments and Archaeological Areas Act 1979. Some of the historic buildings on this site were from mediaeval times, and others were constructed a little later. The site had a long history of repeated extension and rebuilding, and almost all the buildings were listed buildings under the Act. The mediaeval castle buildings were classified as Grade I, other important buildings were ascribed Grade II*, and the Victorian prison buildings were given Grade II.

Based on the development policy, this development was divided into two phases—the first involved finding a successful method of building conservation, while the second emphasized incorporating modern amenities in the buildings in order to make them suitable for contemporary usage. The Grade I and II* buildings were restored by the Oxford Preservation Trust and are currently fitted with facilities for education and exhibition, with hardly any changes made to their existing state. Meanwhile, a group of Grade II Victorian buildings were largely remodelled and rebuilt for an entirely new purpose by the Trevor Osborne Property Group of developers. In this process, new facilities were fitted into the old buildings, and the prison buildings were converted into a hotel and commercial establishments. Therefore, from a commercial viewpoint, this project was concluded successfully. At present, the hotel prospers, and it is difficult to get reservations in it.

In this project, the planner ranked the buildings depending on their hierarchy of importance and customized the manner of reconstruction based on the architectural value of the buildings. If all historic buildings are conserved following the concept of 'authenticity' provided in the Venice Charter, it might result in limitations regarding usage. Therefore, developers were permitted to remodel historic buildings that did not have a high architectural value and given comparatively more freedom as regards their reuse. For instance, despite the fact that the prison buildings were listed as Grade II listed buildings, many new windows were inserted into the original walls in order to ensure proper lighting. This was done wherever prison cells were converted into hotel guestrooms. Usually, such destructive changes are not permitted because they cause considerable damage to the original buildings.

fig.2 The Castle Mound

fig.3 Mediaeval Range

fig.4 South Side of the Hotel

fig.5. Entrance of the Hotel

fig.6 Interior of the Hotel

fig.7 New Windows

When I questioned the person in charge of the project (I interviewed Ms. Debbie Dance of the Oxford Preservation Trust on 9th February 2007 at Oxford) about this, she informed me that this had been a much-discussed problem. In the end, they had concluded that modern functionality should be given priority. Moreover, they decided to convert the site into a commercial complex comprising a hotel and made changes accordingly. However, the reconstruction was implemented based on the premise that it would be possible to return the buildings to their former state after academic architectural investigation, even if their original condition was ruined by remodelling. In this project, the developer desired a bold remodelling, which the conservationist considerably opposed. The conservationist's opinion served to contain the developer's bold ideas, and the issue ended with a conscientious decision. Similarly, the conservation of historic buildings tends to be disregarded during the rush for development. However, in the project under consideration, we can assume that we have sufficiently examined the necessary measures to ensure that the value of the original buildings is preserved. This is a laudable aspect of this redevelopment project from the viewpoint of the conservation of historic buildings. On the other hand, for the developer, this redevelopment requires more procedures than usual and also a lot of time. In the above case, the Osborne Group accepted this condition. They recognized the importance of the historic buildings and heeded the conservationist's opinion. In this way, the redevelopment projected progressed in conjunction with the conservation of historic buildings. Similar conditions prevail in other redevelopment sites at various places in Britain.

In short, historic buildings were not demolished even during the redevelopment boom, because of the smooth functioning of the historic building conservation system that was formed after much deliberation at the time of the recession. Moreover, after the long experience in historical redevelopment projects, developers have realized the importance of historic buildings, which has resulted in a virtuous cycle with regard to their conservation.

5. Adapting the British Method to a Japanese Context

The conservation of historic buildings through conversion is likely to be very useful in the future for Japan. In particular, it will aid town planning by making regional heritage buildings usable. Many local societies in Japan have begun to design characteristic townscapes including a conserved local historic building which may not necessarily be precious from the perspective of architectural history but would be important for each local society. For making such historic buildings reusable, conversion must be very effective. Therefore, conversion appears to have become one of the most practical techniques for historic building conservation in Japan. However, it is necessary to address a number of concerns before introducing the British system in Japan. These concerns originate from the differences between the respective building conservation backgrounds in Britain and Japan and are described in Chapter 2.

The first problem that is already mentioned is that in Japan, there are too few historic buildings whose conversion is legally restricted. In Britain, approximately 500,000 buildings were specified as listed buildings, and the process of construction was examined and controlled by the local government before developers were allowed to change the current condition. However, even if a similar restriction is imposed on cultural properties in Japan, it will be ineffective because a number of historic buildings in Japan are not under legal protection; moreover, few such buildings are considered to be cultural properties. Therefore, even though it is necessary to improve and convert undesignated historic buildings for reuse, it is impossible to legally prevent the developer from carrying out any destructive work. On the contrary, these buildings are more likely to be demolished, as a matter of fact. Therefore, it is necessary to list more historic buildings and impose legal restrictions on the number of changes that can be made to their current conditions as soon as possible. For this, it would be desirable to increase the powers of authorities by enforcing the Law for the Protection of Cultural Properties. For instance, the number of listed buildings could be increased under this law. In addition, we should also consider introducing new methods based on other regulatory systems like the Building Act, the Landscape Act, and so on.

Further, it is important to increase the governmental control on the process of construction work during conversion. In Britain, almost all historic buildings have been converted only after the local government's approval, called a listed building consent, because the law specifies almost all these historic buildings as listed buildings and no construction work can be carried out or change made in their current condition without permission from the government. In this process, developers of all projects, including those for historic buildings, have to obtain a specialist's opinion on whether or not their plan is likely to damage the building's architectural value. In other words, the opinions of specialists such as architectural historians are reflected in all the construction work undertaken in Britain. However, in

Japan, there is no system to check such development, except for buildings that are specified as cultural properties. Even though conversion appears to be an effective method, we cannot check whether the architectural value of many of these buildings would be ruined due to construction work carried out to make them reusable. Even in Britain, where the checking system was apparently perfect, numerous historic buildings fell prey to the crisis of demolition during the development rush. Needless to say, we hope that more thought will be given to the establishment of such a system in Japan.

It is also important to consider the reusability of historic buildings from the viewpoint of safety. Historic buildings often do not conform to the present safety standards. Moreover, enforcing these standards while remodelling a historic building occasionally ruins the building's architectural value. In addition, from the legal standpoint, the safety standards do not apply as long as 'building operation' is not undertaken in historic buildings, because the Building Act in Japan allows for some 'exceptional measures for existing buildings'. Due to this act, some owners do not change the current building conditions, because if they carry out building operations, it would not be possible to retain those conditions, as mandated by law. However, as compared to modern buildings, historic buildings require the implementation of more safety measures before they can be reused. Therefore, we should examine individual cases to ensure that the developers have implemented safety measures in historic buildings without ruining their architectural value. Further, it is necessary to formulate a building conversion system that accounts for such concerns. Many foreign countries positively encourage research on this aspect of development. For instance, English Heritage, a government agency, has initiated research on fire prevention and remodelling of historic buildings in order to make them suitable for use by physically handicapped persons. In Japan, too, we need a corresponding research.

6. Conclusion

Conversion can increase the value of historic buildings, in addition to making them suitable for use. We can conclude that in Britain, this method has proved gainful from the viewpoints of commerce as well as conservation of British historic buildings. In the future, this technique could be effective in any country. However, for this, it is crucial to establish a system to ensure that conversion does not ruin a building's architectural value; this system should evaluate each case from the viewpoint of architectural history and present an appropriate judgement. We should not forget that Britain has a checking system in place to protect the architectural value of its buildings, and this system practically prevents developers from carrying out redevelopment recklessly. It is necessary to not only promote conversion for commercial purposes but at the same time prevent the loss of architectural value with respect to building conservation.

Britain currently has an effective system wherein the developer is required to heed a specialist's opinion. The conservation of the historic buildings is practised even during large-scale redevelopment, where a booming economy exerts strong pressure to destroy historic buildings for immediate profit. Developers usually make bold changes to the present conditions of historic buildings during such a development boom. Therefore, in such times, there is an even greater need for a system that will control reckless development and protect the architectural value of buildings.

Reference

Cherry, Gordon E. 1996. *Town Planning in Britain since 1900.* London: Blackwell.

Cullingworth, Barry and Nadin, Vincent. 2002. *Town and Country Planning in the UK.* London and New York: Routledge.

Delafons, John. 1997. *Politics and Preservation.* London: E & FN Spon.

Harvey, John. 1972. *Conservation of Building.* Toronto and Buffalo: University of Toronto Press.

Mynors, Charles. 1999. *Listed Buildings, Conservation Areas and Monuments.* London: Sweet & Maxwell.
Ohashi, Ryuta. 2006. On the Re-development of Oxford Castleyard. Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan 2006, F-2: 165–166.
Ohashi, Ryuta. 2007. *Building Conservation and Town Regeneration in Britain.* Tokyo: Kashima Institute Publishing.
Ross, Michael. 1996. *Planning and the Heritage: Policy and Procedures.* London: E & FN Spon.
Suddards, Roger W. and Hargreaves, June M. 1996. *Listed Buildings.* London: Sweet & Maxwell.

A Study on Model Method of Japanese School Buildings Renewal and Conversion through The Actual Proposal Projects

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Keywords: school building, decrease in the number of children, renovation, conversion, earthquake retrofit

Abstract

Post-war Japan witnessed the construction of many school buildings with standard designs; however, today, these school buildings pose certain serious problems. First, school buildings made of reinforced concrete have become decrepit, and they require reinforcement to withstand earthquakes. Second, there has been an increase in the number of vacant classrooms and closed school buildings because of the declining birthrate.

Through this study, we describe certain school-building renovation and conversion models that have been comprehensively examined from the perspectives of architectural planning, structural engineering, building production, and architectural environment. We believe that these renovation and conversion models that have been comprehensively examined will be useful and effective against the stock management society.

We have proposed several models for school renovations and conversions. In this report, I will propose some of these models based on the following two patterns: (A) renovations of old, traditional school buildings to change them into contemporary and functional schools and (B) a complete conversion of vacant school buildings to other public facilities for the local community.

Through these project models, we show that the renovations and conversions of school buildings based on comprehensive consideration are effective with regard to cost, energy, and provision of amenities.

1. Introduction

1.1 Background

In post-war Japan, construction of many reinforced concrete school buildings with standard designs rapidly spread. Among elementary and secondary schools alone, the number of such public school buildings amounts to 55,000. Moreover, it is regarded that school buildings over 20-years-old constitute more than 70% of all public elementary and secondary school buildings. In addition, it is an established fact that a large proportion of this 70% of school buildings was built before 1981 when the new quake-resistance standards were set. Currently, in Japan, earthquake retrofit is being progressively performed on such school buildings as part of a national project. The completion of this project had been targeted by the end of 2006; however, the poor financial state of the national and local governments has delayed the process. In addition, most of the school buildings are not only decrepit but also suffer from a functional shortage that incapacitates them to meet the requirements of the present education system with its curriculums and learning activities. On the other hand, a declining birthrate in Japan has resulted in an increasing number of vacant classrooms and closed schools. The effective utilization of these spaces is an important issue faced by every school and local government. It is difficult to sell these public school buildings and renovate them to suit other uses because national funds have been invested in the maintenance of these buildings by local governments. The easing of existing regulations has allowed the conversion of public school buildings to other public facilities; however, encumbered by the difficulties of maintaining relationships with different jurisdictions and by the complication of project finance distribution, many local governments are still unable to find a feasible solution to the problem of effective utilization of school buildings.

Therefore, renovation and conversion projects of many school buildings have not been comprehensively considered. There are few model projects that have been renovated or converted comprehensively, for example, Kohoku elementary school (Yokohama City) and Kyuhaku elementary school (Ohta City). However, these model projects are nothing more than "the model"; most projects are still being worked in each independent purpose.

1.2 Purpose of this project

The aims of our project were as follows:

1) To comprehensively propose more realistic renovation or conversion models for closed school buildings and vacant classrooms based on several aspects: architectural planning, structural engineering, building production, and architectural environment

2) To frame realistic models that consider each "object" school building's background and characteristics by observing certain specific target school buildings

3) To formulate a general and versatile renovation and conversion method that proposes plans with the consideration of each school's surroundings and background

4) To arrive at a finding that ensures the future utilization of school buildings and to indicate its effectiveness with respect to cost, energy, and provision of amenities through a comprehensive consideration of the planning models.

2 Brief of this project

Our projects were implemented under the local governments of two cities: Y City and T City. These cities were faced with different situations. Y City is one of the biggest cities in Japan and has more than 500 public schools. While the number of students was decreasing in some districts, in others, it was increasing. Y City also had many old, traditional school buildings that needed to be repaired, reformed, and reinforced. On the other hand, T City is located in a big residential district, which was developed as a new town in the 1970s. Just prior to the implementation of our project, T City had been facing a serious population problem in that an increase in the number of elderly people had been concomitant with a rapid decrease in the number of children. Therefore, the city had six vacant school buildings that were temporarily being used as public facilities without any reform or repair.

We had proposed some models for the renovation and conversion of existing schools in these two cities. In this report, I propose four models categorized under two patterns. These patterns are as follows: 1) renovation of old, traditional school buildings to contemporary and functional schools and 2) complete conversion of vacant school buildings to other facilities for the local community.

3 Renovation of old school buildings to contemporary and functional schools

3.1 KAM Project

This project aimed to remodel a secondary school building into a school with a new curriculum, which provided education primary through early secondary levels. Our remodel target school was

N secondary school located in the KAM area in the southern tip of Y City. N secondary school had several vacant classrooms because of a decrease in the number of students in this area. Moreover, in K elementary school that is situated adjacent to N secondary school, the number of pupils was also decreasing. Consequently, teachers of these two schools had tried to introduce informal and flexible learning by providing adequate staff and utilizing spaces in these schools. In addition, they had introduced a departmentalized classroom system and a new curriculum for students across nine academic grades from elementary to early secondary school. We proposed to convert N secondary school into a new nine-grade school through the implementation of a new concept [Fig.1].

The objectives of our plan were as follows:

1) To design a small nine-grade school by putting to use the intimate and calm atmosphere of these schools
2) To find a new method of schooling that sets the foundation for future schooling styles across Y City
3) To propose a new curriculum with renovation models
4) To divide the nine-grade school to lower school, middle school, and upper school
5) To change the existing school library, computer room, and audiovisual room to well-developed learning centers and set them in the center of the school
6) To change the barrier-free design
7) To take advantage of the structure by removing a part of the floor slab or by constructing rooms on some part

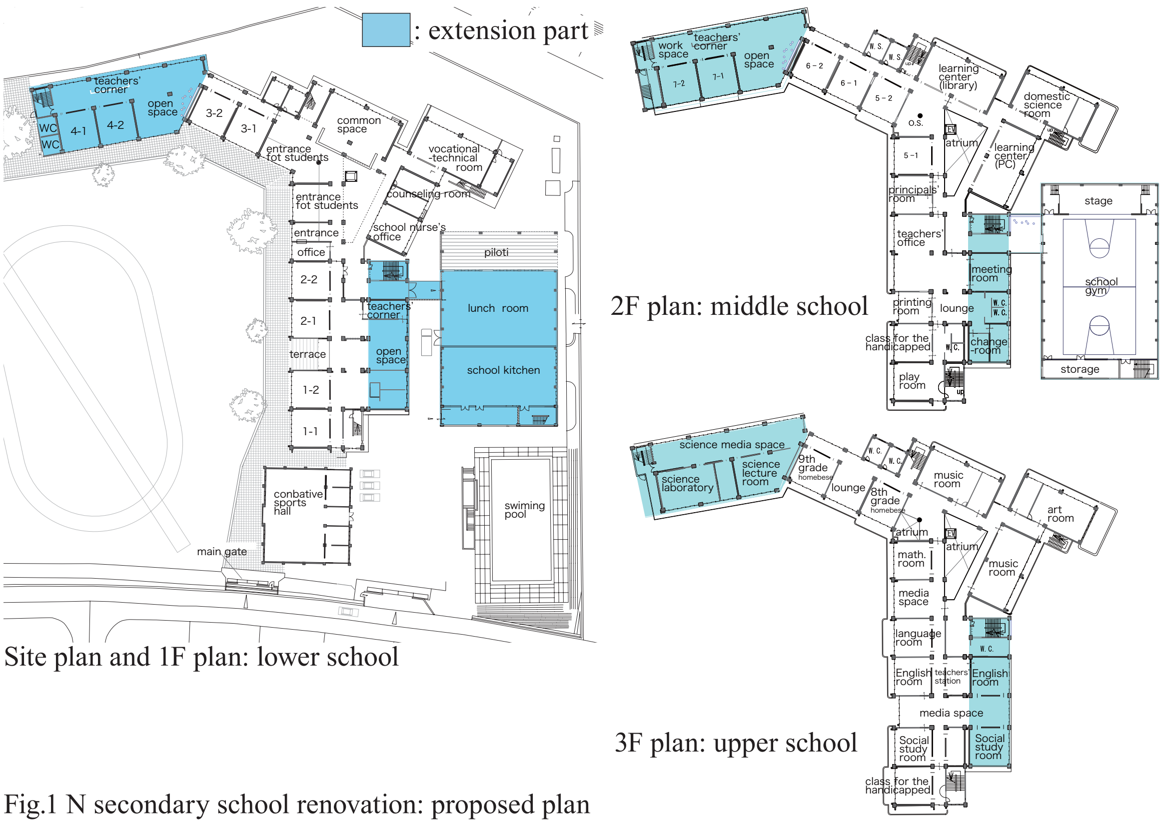


Fig.1 N secondary school renovation: proposed plan

3.2 SAK Project

S school, the target school in this project, consisted of an old school building that was constructed in a traditional style [Fig.2]. It is located near the center of Y City. The building of S school has been extended on four occasisons and the oldest part had been constructed in 1959. The school building was decrepit, and it needed not only a seismic retrofit but also reform or repair. Although the school had been successfully experimenting with a small-group teaching system, it encountered problems the preceding year due to a shortage in classrooms that was brought about by an increase in the number of students. We aimed to perform the following tasks in order to comprehensively renovate the school, while considering economy and effectiveness [Fig.3].

1) Change it to a high-speck school building by effectively appending structures to the school building—to transform spacial composition to suit an informal learning environment and to implement a barrier-free design style for normalization as a community facility

2) Create a comfortable learning and living environment—to introduce energy-saving designs and ensure psychological comfort

3) Improve school safety—to protect students from intruders and reinforce and repair the building by incorporating functional changes

Finally, the performance of the abovementioned tasks would produce an effective renovation model in an ecological and economical way.

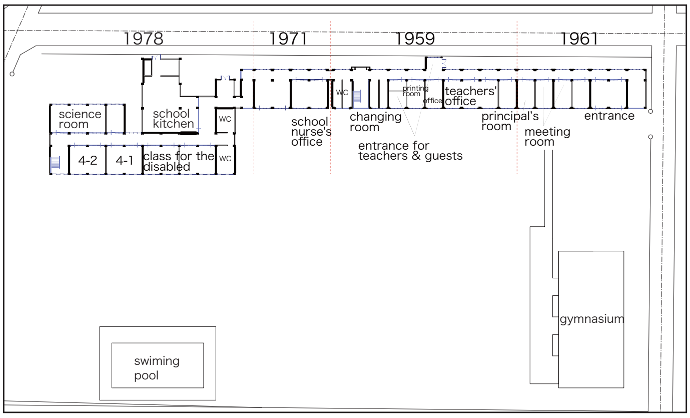


Fig.2 existing SAK elementary school:siteplan

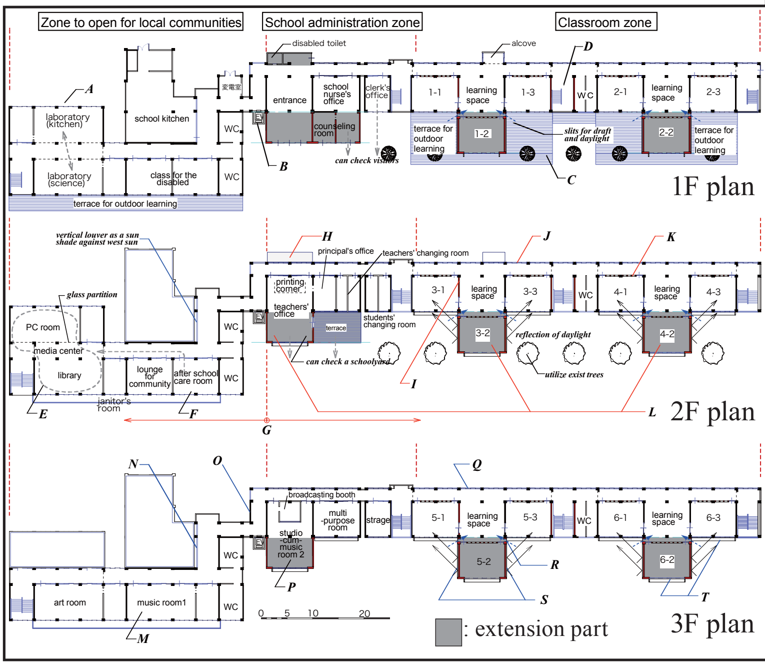


Fig.3 SAK elementary school renovation: proposed plan

detail design point

A) Practical learning area that can be used as a one room

B) Put an elevator near the class for the disabled children and community zone

C) Outdoor learning space—wood deck and grass lighten up heat accumulation of ground

D) Adding new stairs for ensuring escape route and ensuring learning unit of each grade

E) Connecting library and PC room as a media center

F) After school care children can use the media center

G) In newer building part, to change room uses and adding environment improvement without exist construction change.

In older part, adding some spaces and reinforce exist construction with these added spaces

H) minimum extension because of school premise narrowness

I) Adding aseismic capacity to exist wall

J) Adding aseismic capacity to north side wall if it don't have enough strength

K) Adding airtightness, sound absorbency and aseismic capacity to classroom partition of corridor side

L) Adding aseismic capacity to exist building with extension

M) Music room for instrument

N) Setting a vertical louver against west sun

O) Covering all building with exterior thermal insulation

P) Music room for chorus and dancing

Q) Adding new window sash for improvement insulation efficiency

R) Slit for draft and daylight

S) To paint the wall bright color, it lighten up classroom by reflecting daylight

T) To put appentice to south windows for direct light mitigation

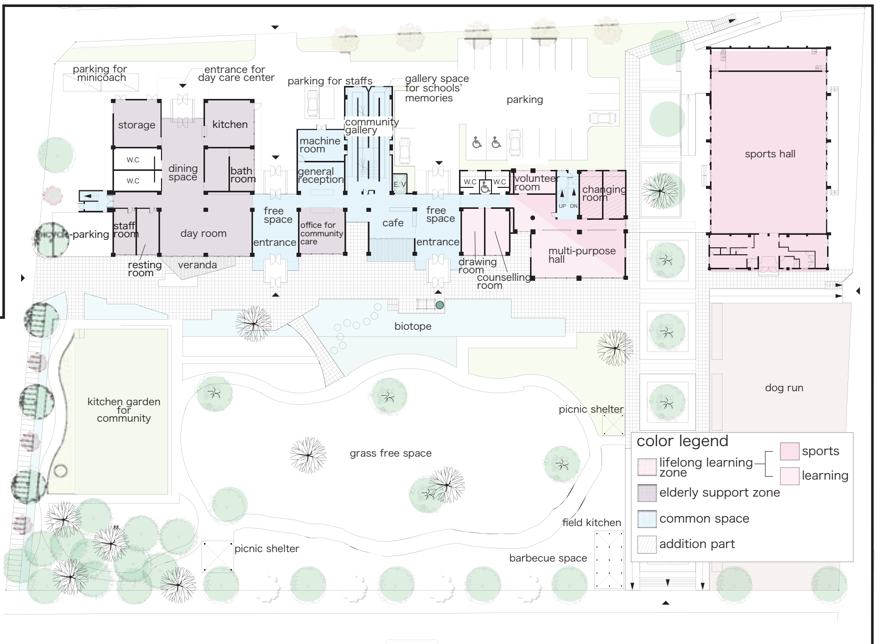
4 Full conversions of vacant school buildings to other public facilities

4.1 KIR project

The KIR area, situated in the northwest part of Y City, is a residential area that is not well connected. This led to an annual decrease in the number of young families residing in this area; consequently, the number of students also decreased in the three elementary schools in this area. Subsequently, the local government put the students of the three elementary schools into one of the schools, while another school building was converted into a public facility for the community. The government was undecided on the how to use the third building, which was the oldest one. We surveyed the conditions in the three buildings, the public facilities and service network in this area, and the need of the local people for public service. We then proposed a plan on how to utilize these school buildings and also demonstrated through a conversion model how one of these buildings could be changed into a lifelong learning facility for the local people belonging to different generations [Fig.4]. We designed the conversion model as follows:

1. By changing to a more functional design, we promoted effective communication among users belonging to different generations.
2. By removing some floor slabs or parts of the building, we strengthened the base of the building, and maximized the utilization of its large capacity.
3. By removing some floor slabs or parts of the building, we constructed an atrium using glass to allow natural light, and we built a rooftop garden to serve an ecological purpose.
4. By developing the schoolyard, we converted it into a multipurpose park for people living nearby.

On the presentation of this conversion model, the local and city governments directed that the different functions (day-care center, recreation and relaxation center for the aged, child support center, and community center functions) needed to be separated according to the jurisdictions of the local government.



Site and 1F plan →
Changing groung to community park. Setting day care center to the first floor.

2F plan ↓
Setting communication area to the west side and sports area to the east side.

3F plan ↘
Setting learning area and cutting out some part of this building for weight saving of existing construction.

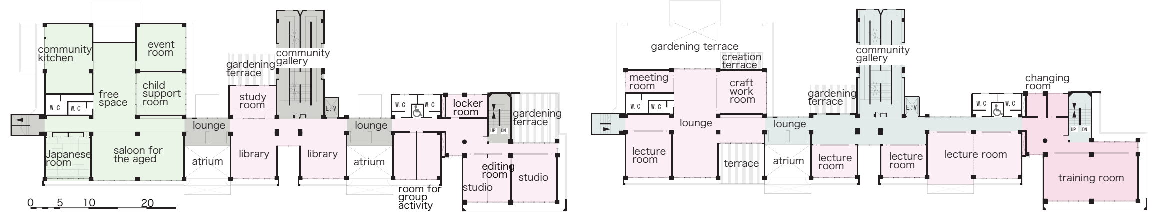


Fig.4 KIR project conversion of vacant school to a lifelong learning facility for the local people

4.2 HGN Project

HGN elementary school had closed down in 1995, and its building was being used as a provisional public facility [Fig.5]. This school building was located next to the main pedestrian street and also near a railway station. As a result, local people visited this public space on a daily basis. However, the building had not been repaired or remodeled for public use, and it stood as a typical, traditional school building. We believed that a conversion model based on this building could act as a general model for many traditionally designed school buildings in Japan.

Subsequently, our team proposed two conversion models (pattern A and pattern B).

Pattern A: We suggested changing the school building into a complex facility that included a community center and office spaces for lease. The neighboring area did not house a community center, notwithstanding the systematic improvement in community facilities in T City. We also surveyed the actual state of the existing community centers in T City. Therefore, we converted the HGN school building into a community facility for different generations, i.e., a day-care center for the elderly, an after-school care center for children, and a lifelong learning center for the local people. In addition, since the location of the building was convenient for business, we converted the upper floors into a welfare office and an office space for Soho [Fig.6].

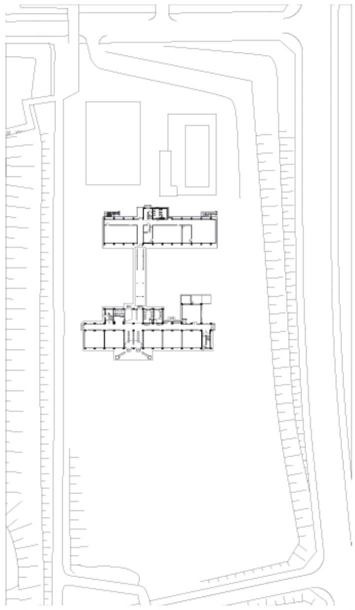


Fig.5 HGN elementary school existing site plan (1:3000)

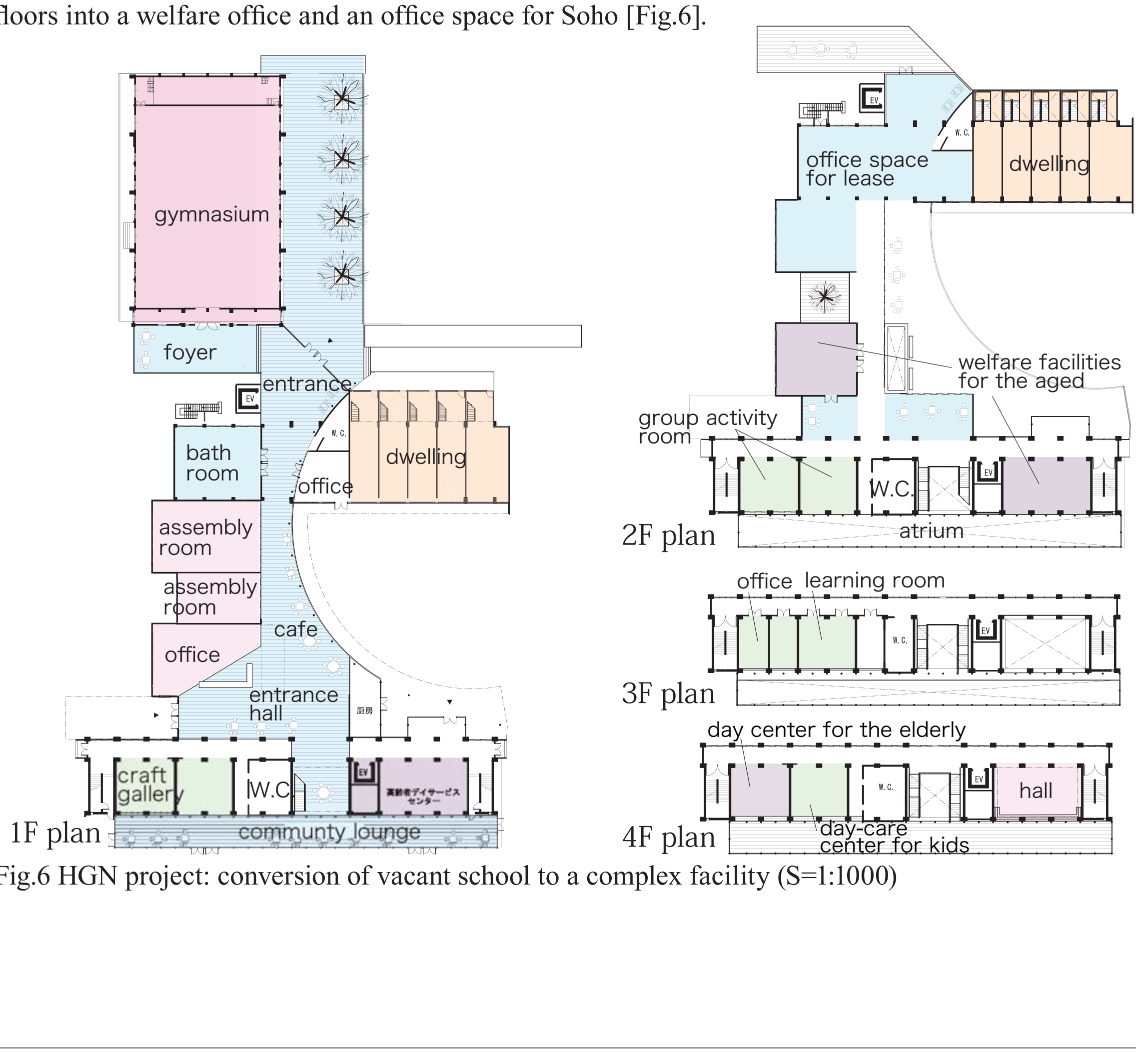
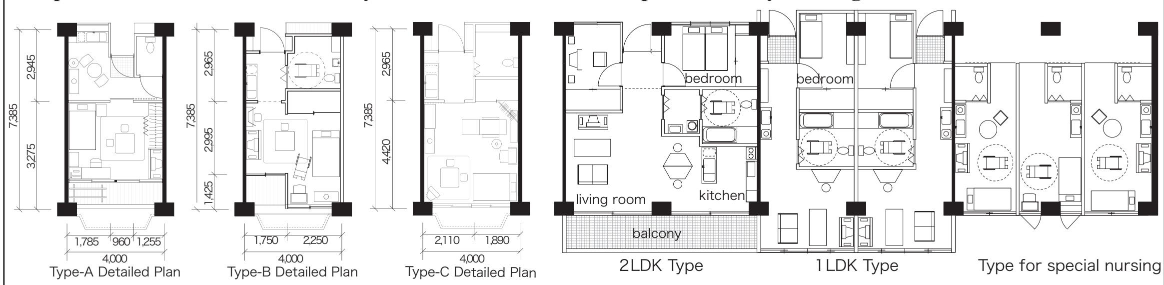


Fig.6 HGN project: conversion of vacant school to a complex facility (S=1:1000)

Pattern B: We attempted the entire conversion of the traditional school building into a dwelling facility for the aged. In Japan, traditional school buildings have approximately the same span, module, and floor height. A classroom could be changed into a traditional Japanese dwelling space (2 rooms, comprising the dining room and kitchen). In addition, half the space of a classroom could be changed into a bed-sitting-room for singles. We proposed care houses for the aged who required nursing care and housings for healthy aged people [Fig7,8,9].

Unit plan : Care house for the elderly | **Unit plan : Elderly housing**



Type A
- A plan for comparatively active and healthy elderly people
- Each room has a space for visiter, and a bedroom to be private space
- Each room has a wide balcony, dweller can get natural light and outside atmosphere

Type B
- A wheelchair-accessible plan
- This plan is suited for wheelchair user because it designed effective width to be wide
- This plan has a balcony and enough bedroom space

Type C
- A plan for the elderly with mild disabilities
- Bathroom has enough space, so dweller can change it to be suited for his handicap
- Priority in this plan is to keep wide bedroom

2LDK Type:
- This plan is for elderly couple
- This room has a balcony by extension with cantilever
- This plan is suited for wheelchair user

1LDK Type:
- This plan is for single
- This room keep a enough space by extension with cantilever
- This plan is suited for wheelchair user

Type for special nursing:
- In this plan, we divide one classroom into three parts. This size is matching to space standard of the new special elderly nursing home
- Each room has bathroom
- This plan is suited for wheelchair user

Fig.7 HGN project detail plan: changing classroom unit to dwelling unit

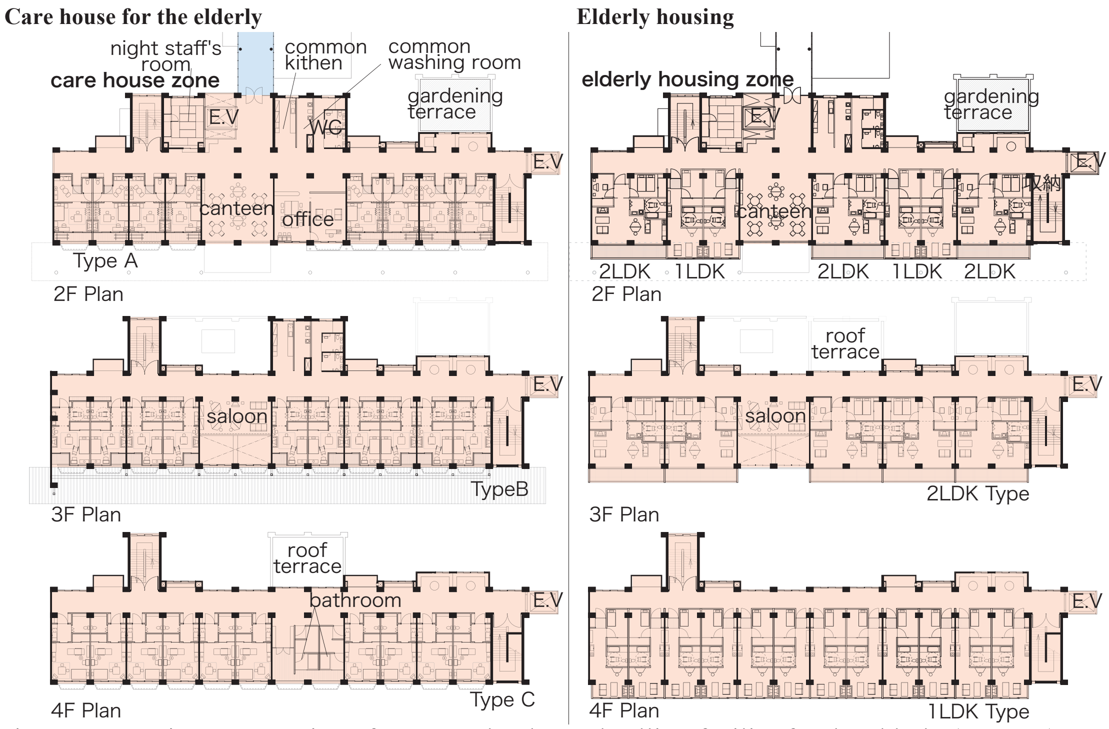
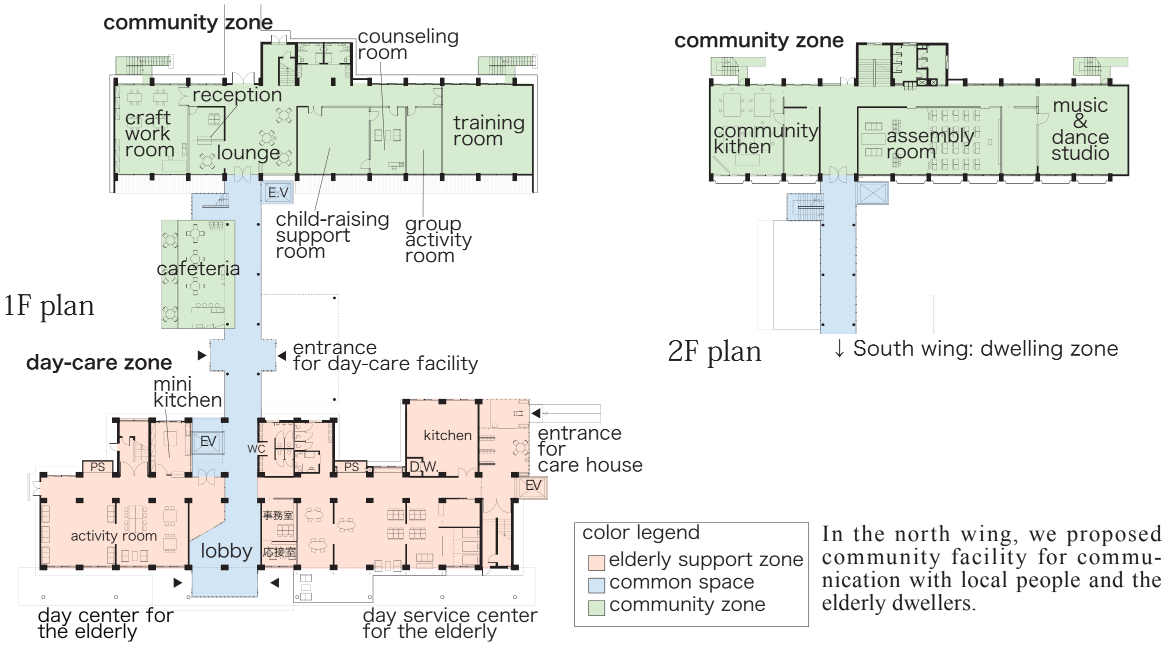


Fig.8 HGN project: conversion of vacant school to a dwelling facility for the elderly (S=1:800)



In the north wing, we proposed community facility for communication with local people and the elderly dwellers.

Fig.9 HGN project pattern B: first and second floor plan

5 Conclusion and future tasks

In this report, I explain the main concepts and functional proposals pertaining to each project; however, as each plan indicates, these proposed models are based on comprehensive consideration. From the viewpoint of facility or cost management, it is certainly disadvantageous to continue using school buildings by carrying out repeated renovations that are funded in a segmentalized manner, similar to the process many local governments adopt. Thus, with the implementation of this project, the following will be brought into effect: (1) it will be required to adaptable change in software in public works, and it should be planned comprehensively from united or city government level. (2) an adaptable and effective financial system in place of a rigid system, and (3) a review of the compartmentalized public administration system.

On the subject of the conversion and renovation of school buildings, it is important to ask the following questions with regard to long-term planning.

1. For how many years will this building be used?
2. Which is the most important point involved in this task (renovation or conversion)?
3. How high spec do we need in each renovation or conversion task?
4. Is there a need for convert or renovate this building based on people's future needs?

A consideration of all the abovementioned aspects is required to provide effective cost management on every conversion and renovation work that is undertaken. Moreover, we will try to do a trial calculation on each proposal model plan that we designed, and try to indicate relationship between these proposal models and cost-benefit.

Acknowledgements

I greatly appreciate the staffs all of the target schools and those of the city governments of Y and T cities for their suggestions, support, and cooperation in bringing our survey to fruition. In addition, our proposed models were formulated through collaborative work with a team of graduate students. Further, I would also like to thank our team members.

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A study on the emergence of the concept of architectural conservation through conversion in Japan

Activation project of the Shimbashi station to a railway museum by Hoshin KURODA in beginning of the Taisho era

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Keywords:
architectural conservation, Hoshin KURODA, Shimbashi station
urban design, city beautiful movement, medievalism.

Abstract:

It is Hoshin KURODA, the first architecture critic in Japan, that insisted for the first time the conversion to conserve occidental traditional style architecture in this country. He pretended as a realist and not as a conservation fundamentalist, the activation of the Shimbashi station, the first railway station in Japan, to a museum, soon after the decision to deprive it of the use as a passengers' station and its name. It is also to remark that it is in the *Tokyo Asahi Shimbun*, one of the biggest national daily papers of the period and not in the erudite medias, that his opinion was published.

Kuroda's thesis was furthermore excellent by taking into account its previous use and its geographic particularities and by seeking a method to make coexist the old architecture with the new building. Moreover he proposed not only the architectural activation but also an urban design of its surroundings under the influence of the city beautiful movement and the medievalism funded on John Ruskin, William Morris or Viollet-le-Duc then introduced in Japan.

This is very the root of the method of architectural conservation through conversion in Japan which is easily used today.

0. Problematics:

Building activation is undoubtedly as old as the birth of architecture. However, until when can we go up to find the beginning of «intentional conversion»? There are probably two origins for that. One is born in the concept of sustainable development which is enough recent; it is what our COE aims to deepen. The other is born to transmit architecture to future generation through conversion. This last concept later will lead into a legislative system whose reasoning is not any more sentimental but scientific. Our study is focused on the concept of architectural conservation through conversion in Japan because this type of reuse, being based on popular feeling, facilitates dialogue with owners to conceal and because the success of this type of conservation enlightens people, which will push additionally the sustainable development type architectural conversion.

Moreover, our study limits the object: occidental traditional style architecture in Japan. In the history of historic building protection in our country, only Shinto shrines and Buddhist temples, in other words, religious architecture, have been legislatively protected since the Meiji era. But not only their form or function are largely different from the civil architecture of which our COE considers the conversion, but also the religious architecture is for the majority made of wood. It means that the historic building conservation does not give us idea to activate contemporary ordinary and civil buildings made normally of the other materials. This is why we limit the research field.

A intensive review on the existing researches shows us that it is only my study[i] which answers directly to this question so that, relying on it, this paper analyses the activation project of the Shimbashi station [Figure 1] to a railway museum by Hoshin KURODA.

Figure 1: The Shimbashi station
(From *Meiji Taisho showcase*:
http://showcase.meijitaisho.net/)

1. Problems of the inconvenient emplacement to be a central station:

When the Restoration Government made a project to construct a railway between Tokyo and Yokohama in the beginning of the Meiji era, Tokyo was already a monster city counting almost one million of population. The railway had to be drawn, just like in European cities, along the city edge and the station had to be placed on the most nearest point to the city centre. Constructed within these conditions, the Shimbashi station was very far from the Nishon-bashi (the Japan Bridge), central point of the whole road network in Japan[ii]. It is fact that the Tokyo railway carriage was created in 1882 to connect the Shimbashi station to the city centre but naturally a locomotive mass transit system with its own railway was required to reach there without road congestion. Furthermore, the Ueno station was created as a first private locomotive railway terminal in Japan for the Nihon Railway on July 28th 1883 but it was also on the edge of the old city centre so that the rail extension was also required.

The crucial point for the Shimbashi station is *Tokyo shiku kaisei* (*Tokyo urban restructure project*) which decides to connect the Tokaido line to the Tohoku line:

«The railway between the Shimbashi and Ueno stations must be connected with a new station in the Kajiya bridge area and in the north of the Mansei bridge.»[iii]

The Government thus decided to construct a central station, future Tokyo Station, and it was this decision that made Shimbashi station out of use. The construction work for the railway penetrating the city being engaged on September 17th 1890, it was only on 14 December 1914 that the Tokyo station was opened and it was very at this moment that the Shimbashi station was out of use at the end of forty three years function. We can find an article on the opening day of the Tokyo Station in the *Tokyo Asahi Shimbun* (Tokyo Asahi Newspaper) on 21st December 1914 reporting «The first day visit to the Tokyo Station / 300 staffs seemed glad / Passengers were surprised of its splendour». Aside this report, we also find an article whose titre is «The last day of the Shimbashi station». It begins with the following sentence:

«The Shimbashi station! How nostalgic its name sounds! Oh, it became a seed of memory from today. »

2. The first thesis to prevent the demolishment:

The conservation proposal through conversion of the Shimbashi station is not for a building that will be destroyed but for an architecture which is left without function. This is a big conceptual progress for the occidental traditional style architecture conservation in Japan, because it makes recognize the architectural value before its demolishment and it may thus conduct to a realistic activation program.

So let us examine the thesis of Kuroda published in the *Tokyo Asahi Shimbun* on 8-9th August 1914 with a titre of «Activate the Shimbashi station as a Railway museum»[iv].

We have to remark that this is the first thesis written to prevent the demolishment of the occidental traditional style architecture in Japan. Almost all the thesis for the architectural conservation had been presented too late for their preservation; they were anything but an essay funded on nostalgic memory. But in the problematic of the Shimbashi station in 1914, a «preventive conservation thesis» was published for the first time in the history of the occidental traditional style architecture conservation in Japan.

Furthermore, we have to note two particularities: the first is that Kuroda is not an architect but an art critic and the second is that it was in a newspaper that the thesis was published. These mean that his opinion might generally enlighten the readers and that the architectural conservation gained a popularity getting out of the academic circle to the popular field.

3. The Shimbashi station or the Shiodome Station:

The reason why the Shimbashi station is disused is the necessity to connect the Tokaido line to the Tohoku line with constructing a central station. Because his form as a terminal did not permit the passage, another station had to be built between the Tokyo station and the Shinagawa station. For that, the railway was branched off in the west of the Shimbashi station to construct the Karasunomori station which had been already constructed on December 1910 and newly designed by Atelier Tatsuno-Kasai by Renaissance style in March 1914.

The Karasunomori station becoming a passengers' station, the Shimabashi station was obligated to be a specialized freight depot at the same moment of the opening of the Tokyo station on 20th December 1914.

This function change caused a problematic of its name conservation. Just before the opening of the Tokyo station, the Karasunomori station deprived the Shimbashi station of its name as a passengers' station and the old Shimbashi station, being a freight depot, was renamed Karasunomori station. And it was not anyone but Kuroda that was opposed to it. «Activate the Shimbashi station as a Railway museum» was developed to protest to this conceptual change which conducted him to conceive an architectural conservation through activation. Kuroda accuses with the following sentence:

«Taking a dead man's name to name someone can commemorate this alive person but if we take a living man's name, it is stupid.»

«The Shimbashi station has worked without break for forty three years since his naissance. It is fact that now a great one (i.e. Tokyo station) is born but it is very heartless to kill him and deprive him of his name to give it to a new one (i.e. Karasunomori station).»

Is the personification is a Kuroda's strategy? This thesis being published in a popular newspaper, it was perhaps convincing to employ this method.

This naming problem interested not only Kuroda but also, for exemple, Hanjirou FURUKAWA, vice minister of the National Railway Agency. He emitted the following comment in the *Tokyo Asahi Shimbun* on July 15th 1914:

«Now the name of Shimbashi connotes Tokyo and the name of Tokyo connotes Shimbashi. It is a habit. […] Even if the present Shimbashi station is conserved in the present site (and even if it is removed somewhere) and used as a freight depot, it is reasonable to continue to call it Shimbashi station for our future memory.»

This article tells us that even among the executives of the National Railway Agency, there was a protestant for the name change. It shows also that Shimbashi meant whole Tokyo in this period because of the strong image of «civilisation development (*bunmei kaika*)» of the Shimbashi station. In this context, this opinion was similar to that of Kuroda.

But both were neglected. The *Tokyo Asahi Shimbun* reports on 3rd September 1914 the decision to give the name of Shimbashi to the Karasunomori station. According to this article, this change was a result of requests advanced from the people and the same journal reports on 4th the change of the name of Shimbashi station to Shodome station.

4. Spiritual conversion for conservation:

Now let us enter in the analysis of Kuroda's conservation thesis; what was his concept and what was his logic?

First of all, he points out the earliness of the Shimbashi station:

«Not only this building is the first railway station but also the first architecture built with occidental material, structure and style in our country. It is said that a small brick building had been constructed in Tatsunokuchi before it, toward 1869, but after its demolishment, the Shimbashi station is the oldest occidental style architecture.»

As Kuroda insists that «the art of an era is a representation of the spirit of the age and the art of a country is a representation of its national characters»[v] in another thesis published in the same period, he gives importance to the reflex of the spirit of the age or the national characters on the architecture and the art. We can understand his conservation thesis in this context.

But he can not advance beyond the remark on the earliness and can not ask its quality for example its aesthetic value. In this point, this thesis did not go beyond those published to conserve some primitive occidental traditional style architectures in Japan in previous periods. The following sentence is one of the proves for that:

«Of course the Shimbashi station was designed by a civil engineer and we can not appreciate it. The aesthetic value may be almost zero. But anybody can not deny the fact that it is the oldest and it is because of this point that we can not neglect its historic value.»

This undecided expression was a limit of Kuroda. He published an essay titled «Tokyo by architecture» from January to March 1912 in the *Yomiuri Shimbun* and we can find a paragraph titled «Impression around Shimbashi» which critics violently the Shimbashi station as a main entrance of the capital:

«First of all, though the Shimbashi station is built of stone to be dignified, it is too unrefined. Such appearance makes us to take it for a warehouse. It is fact that its oldness gives nuance but it does not go well with today's Tokyo. An architecture of two or three hundreds years old wears a positive antiquity in London and an architecture of the Tokugawa era is interesting in Tokyo, but I can not appreciate this product of the Meiji era.»[vi]

This negative article was published only two years before «Activate the Shimbashi station as a Railway museum». It means that it was a big spiritual conversion for Kuroda to take this architecture in the positive context and we can say that he invented the concept of earliness for that.

5. Activation as a new method for conservation:

Not only today but also in the past, the architectural conservation is impossible only with ideals thesis. Until the Taisho era, there were a certain number of conservation thesis for the occidental traditional style architecture in Japan but they did not propose concrete method so that, without some exceptions of partial preservation, all were demolished.

Recognizing this weak point, Kuroda proposes a concrete method which enables the conservation. It was, as we can see it in the title of «Activate the Shimbashi station as a Railway museum», an activation thesis:

His thought on architecture of this period is shown in «Kenchiku hihyou no hyoujun (Standards for the critic on architecture)»[vii] and among the standards, he points out «beauty of contents». To deal with it, he defined a classification to each use. Indeed, in *Toshi no bisou* (*Embellishment of the city*)[viii] of the beginning of the Showa era, he insists that an architecture must be designed according to its use.

The Shimbashi station will be deprived of its use as a passengers' station by the Karasunomori station. For Kuroda, thus, the lack of the use must be filled to save it as an architecture. For that, Kuroda proposes the activation as a railway museum.

It is fact that, until then, there were several conversion examples of the occidental traditional style architecture but the thesis of Kuroda is the first that proposes the conversion for conservation. This conversion is not a simple change of use but an activation to add a new value in order to save a disused architecture. The method to which we easily resort today for the architectural conservation was born like this in the beginning of the Taisho era.

Now let us analyze the contents of the thesis. It might be sure that the former use of the architecture inspired Kuroda to propose its activation as a railway museum:

«If the building is converted to a museum and several objects concerning the railway are exposed in it, the relation between the museum and its properties will be very interesting. This point surprises other museums which are really boring.»

Furthermore, Kuroda takes into account its geographic situation which is rarely considered even today:

«Because the railway museum belongs either to the transport museum or to the post museum, it is worth while making it independent. Particularly it is convenient that the ministry of the post is situated nearby.»

Kuroda does not propose anything but, with taking into account the previous use and the geographic situation, a very «railway» museum. In particular, we have to remark the consideration on the geographic situation; it will be analyzed below in detail.

It is also to remark that Kuroda is not a conservation fundamentalist but a realist. He does not propose a rigid conservation without activation but accepts the use change and the plan modification caused by it. He shows its cohabitation with the new use as a freight depot and try to make a compromise:

«To make a museum, we have to convert only the current ticket gate, various class' waiting room and some parts of the first floor. To be served for the freight depot, the platform and the others may be destroyed or converted. Perhaps the National Railway Agency is not too poor to conserve them as they are.»

This proposition is really by a specialist who knows well architecture.

Thus, this activation thesis by Kuroda is not only the first proposition of the occidental traditional style architecture conservation through conversion but also a high quality proposal with taking into account the previous use and the geographic situation and considering the cohabitation with the new use.

6. Toward the city beauty:

Kuroda goes further. He proposes not only the architectural conservation but also an embellishment of its neighbourhood. It is a naissance of conservation thesis founded on the city beautiful movement:

«It is extremely suitable to plant trees in that place to make a square and to erect statues of meritorious persons for the railway.»

The end of the Meiji era and the beginning of the Taisho era are the debut of the age of cities. It is exactly in this period that a concept to design architecture in its urban context was born. For an early example, we can cite an article of Hideo MAMIZU criticizing that the Imperial museum of Kyoto designed by Tokuma KATAYAMA in 1895 does not take into account the urban context of Kyoto[ix]. The construction of Marunouchi called *Iccho London* (Londoners' block) being almost achieved, the concept of city beauty was more and more deepened; in fact, it is from this period that urban architectures begin to be designed with a rotunda.

According to Masami TANIGAWA, Kuroda is the first critic who payed attention to the city in such turning period:

«His critic is funded on his own thesis on cities. For him, it is not the architectural beauty or ugliness but it must be the effect or the influence given by the architectural beauty or ugliness that that determine its value. Such thesis, being yet very strange for the epoch, seems very primitive but has to be highly evaluated.»[x]

Furthermore, we are interested in the fact that Kuroda is not an architect but an art critic, even the first architecture critic in Japan[xi] and that he points out the park as one of the seven conditions that determines the city beauty[xii].

These facts mean that Kuroda was able to consider the conservation of the Shimbashi station not only on the architectural scale but also on the urban scale and that the critic could imagine the city beauty achieved by the installation of a small square around it. In this point, his ability was eminent.

7. Interest in the medievalism:

«Activate the Shimbashi station as a Railway museum» being the first thesis that was documented to conserve previously an architecture, it gives us a very romantic impression which we can not feel from the conservation thesis proposed at the same period to save Buddhist temples or Shinto shrines.

We can find some common points, like an honest expression of structure and material and an accent on functionality, with the rationalism insisted by some medievalists like William Morris or Eugène Viollet-le-Duc in the second half of 19^{th} century.

As *Ruskin sho* (*Abstract of Ruskin*) by translation of Torajirou SAWAMURA would be published as 8^{th} volume of *Shumi sousho* (*Pastime series*) edited by Kuroda in 1915, we can say that the critic had been interested in the medievalism[xiii].

According to Akira HASEGAWA, *Ruskin genkou roku* (*Ruskin's sayings*) had been already published in 1908, *Shakai kairyou ka to shiteno Ruskin* (*Ruskin as a social reformer*) and *John Ruskin no kenchiku ron hoi* (*Complement for John Ruskin's architectural thesis*) in 1909[xiv]. Also the bachelor thesis of Masao TAKAMATSU titled «Kenchikuka no shuyou (Moral of architects)» influenced deeply by Ruskin had been serialized in *Kenchiku zassi* (*Architectural review*) from September to November; being the same age as him, Kuroda seemed also influenced by the medievalism.

It is fact that we do not have any proof to show that Kuroda was touched by Ruskin with a conscience for conservation, but, according to Hiroyuki SUZUKI, Ruskin's conservation concept was founded on the «sentiment for the epoch»[xv]; this is very similar to Kuroda's concept of «spirit of the age». Kuroda had been very critic to the Shimbashi station but to face of its conservation, the medievalists' conservation thesis seemed occur to him. Also «Activate the Shimbashi station as a Railway museum» is the first conservation thesis in which we can observe the influence of foreign architectural thoughts.

8. Proposition to remove and reassemble the Shimbashi station:

After all, Kuroda's proposition being not realized, another was published in 1917. What was proposed was to remove and reassemble the Shimbashi station and the proposed use was also a railway museum. But its concept was completely different form that of Kuroda:

«Built to open the first railway in our country for the Keihin section, this edifice was inaugurated by His Majesty Meiji with a big ceremony in September 12th 1872. Almost every year for forty three years since then, His Majesty Meiji went to all over Japan. The station having such a deep relation avec His Majesty, there is a proposition to remove and reassemble it in the Meiji Jingu Park in order to conserve it eternally.»[xvi]

What we can observe here is the imperialism and nothing like Kuroda's appreciation for the sprit of the age in the beginning of the Meiji era, his attachment to the station's name or his proposition with taking into account its previous use and geographic particularity. Because the imperialism was not fully strong in this epoch, the proposition did not have ill will. After all, this proposition was not realized.

Figure 2: Reproduced Shimbashi station in the valley of skyscrapers

9. Conclusion:

Before the connection project between Ueno and Yokohama, Kuroda's point view on the Shimbashi station had been very negative. But facing on the danger that its name might be deprived, he changed his opinion with finding in it the sprit of the age in the beginning of the Meiji era.

Furthermore, his thesis was characterized by its realism; in fact, he proposed its activation with taking into account its previous use and its geographic particularity. We can also conclude that it developped excellently the architectural conservation to the urban design under the influence of city beautiful movement and the medievalism of the epoch.

But, finally, this proposition not being realized, the Shimbashi station was burned out at the moment of the terrible earthquake of Kanto on 1st September 1923. We have to say that «Activate the Shimbashi station as a Railway museum» could not influence the mass popularity.

Almost ninety years after Kuroda's proposition and eighty yeas after the demolishment, the Shimabshi station is reproduced in the valley of skyscrapers in Shiodome and a railway history exposition room is installed in it [Figure 2]. We doubt ourselves what Kuroda, instigator of the city beautiful movement, says about the extreme and ugly change of the urban context[xvii].

Notes:

[i] TORIUMI Motoki, *Wagakuni senzen ni okeru kindai kenchiku hozon gainen no houga ni kansuru kisoteki kenkyu* (*A basic study on the emergence of the concept of conservation of the occidental traditional style architecture before the World War II in Japan*), master thesis in the department of urban engineering, University of Tokyo, March 1994.

[ii] However we have to remark that this site choice was partially due to its proximity to the Tsukiji foreign settlement. Because the authority wanted to avoid quarrels with foreign people, Shimbashi was one of the best sites which did not enter in the existing city centre and was not so far from Tsukiji.

[iii] «Shiku kaisei ikensho (Opinion for the Tokyo restructure project) », in *Tokyo shi shikou shigai hen* (*Tokyo city historic archives – Urban development section*), vol.70, pp.98-99.

[iv] We can find its abstract in *Kenchiku sekai* (*Architectural world*), Vol.8-9, 1914, pp.104-105.

[v] KURODA Hoshin, *Nihon bijutsu-shi kouwa* (*Essay on the history of Japanese art*), First volume, Shumisosho Hakkoujo, 1914, pp.10-11.

[vi] KURODA Hoshin, *Toshi bi to kenchiku* (*City beauty and Architecture*), volume 8 of the *Hoshin selection*, Shumi-fukyu-kai, 1954, pp.35-37.

[vii] KURODA Hoshin, «Kenchiku hihyou no hyoujun (Standards on the architecture critic)», in *Kenchiku zasshi* (*Architectural review*), vol.25-no.293, May 1911, pp.283-288.

[viii] KURODA Hoshin, *Toshi no bisou* (*Embellishment of the city*), Yuzankaku, 1928.

[ix] MAMIZU Hideo, «Teikoku Kyoto Hakubutsukan (Imperial Museum of Kyoto)», in *Kenchiku zasshi* (*Architectural review*), Vol.12-No.134, February 1898, pp.49-51.

[x] TANIGAWA Masami, «*Shumi sousho* ni mirareru toshi-bi kan ni tsuite (The point of view on the city beauty seen in *Pastime series*)», in *Kenchiku gakkai Touhoku shibu kenkyu houkokushu* (*Proceedings for the AIJTouhoku section research meeting*), Vol.8, March 1968.

[xi] FUJIOKA Hiroyasu and KUROIWA Suguru, «Kindai nihon saisho no «kenchiku hyouronka» KURODA Hoshin no kenchiku kan (The point of view on the architecture of Hoshin KURODA, the first «architecture critic» in the modern Japan)», in *Nihon kenchiku gakkai keikaku kei ronbun houkoku shu* (*AIJ Journal of Architecture – Planning*), No.409, March 1990, pp.161-168.

[xii] The seven conditions are (1) situation of the ensemble (2) disposition of streets, rivers and parks (3) architecture (4) street (5) park (6) signboard and announcement (7) communication and transport sysytem.

[xiii] FUJIOKA and KUROIWA, reference cited above.

[xiv] HASEGAWA Akira, «TAKAMATSU Masao no Ruskin (Masao TAKAMATSU's Ruskin)», in *Toshi kairo* (*Urban gallery*), Tokyo, Chuko edition, 1985, pp.42-49.

[xv] SUZUKI Hiroyuki, «Victorian gothic makki no kenchiku hozon ron sono2: John Ruskin no kenchiku hozon gainen (Conservation thesis of the end of the Victorian gothic part 2: John Ruskin's onservation concept», in *Nihon kenchiku gakkai keikaku kei ronbun houkoku shu* (*AIJ Journal of Architecture – Planning*), No.255, May 1977, pp.103-107.

[xvi] «Kyu Shimbashi eki ga Meiji Jingu Gaien ni utsusaru (The old Shimbashi station will be removed to the Meiji Jingu Park», in *Kenchiku sekai* (*Architectural world*), Vol.11-10, October 1917.

[xvii] We have to express one more question. The Yokohama station had been built by the same architect, with a same design, at the same time of the Shimbashi station. It was also obligated to change its name from Yokohama station to Sakuragichou station in 1915. But we can find nothing from Kuroda about it.

Sustaining the Living Environment

Evaluation of the Tourist-led Conservation Project in Old Saida

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Old Saida, conservation practices, tourist path, living environment, local Agenda21

Abstract
Why the local living environment in old Saida failed to improve with a going on conservation and a tourist-led development project? Au contrary it got worse. And how much reviving the historic city center and monumental heritage participate in reviving the local living environment within the historic cities? These questions are clearly addressed in the context of the local Agenda 21 and in the 3rd international seminar of small coastal historic cities held in Saida. Within the context of sustainable development, this research aims to evaluate the conservation experience and the tourist-led development project and their role in relation with the local living environment, it relies on a comparative analysis of collected data threw questionnaires conducted in the years 1996, 2000 and 2007 to detect the livelihood and living environment in old Saida. It concluded that the going conservation and tourism activities are simply tourist-led conservation project that didn't reach or affect the locals or their living environment and for sustainable development their involvement in the conservation and benefitting from the tourists activities is essential.

1. Introduction

The urban conservation practice in Old Saida introduced several successful individual projects for the main historic buildings and the historic city center. On the western façade, cafes, small restaurants and souvenir shops invaded the touristic area. Despite the renovation of the infra structure, the tourist-led conservation project and the efforts of the city municipality to revive the city center, the condition of the locals and their living environment didn't improve. In fact it got worse, but why? And how much the conservation practice and the related tourism industry can participate in a proper and sustainable development for the local living environment? Such issues were clearly addressed in the context *Rio declaration* (the local Agenda 21) and in the 3rd international seminar of small coastal historic cities held in Saida. This research relies on a comparative analysis of collected data in 2007 with others collected in 1996 and 2000 by Hariri foundation as indictors to the changes in the livelihood and living environment in old Saida. Within the context of sustainable development, we aim to evaluate the conservation experience and the tourist-led development project and their role in relation with the local living environment. Old Saida is a small typical Arabic Mediterranean city with great heritage that the world recognized and the locals look at with pride. The challenges facing the live and successful conservation and tourism experiences in Saida are great. Hopefully this research will not only contribute in sharing this experience but also as an indicator of the values of the local living environment to any sustainable development project in the historic cities.

2. Methodology

The living environment is the physical space where locals live and practice their social live. This environment has a complex fabric, clusters of court houses particular to Islamic and Arabic historic cities. In this research, we discuss the historical values of individual monuments, historic city center and the living spaces within historic cities. Those values justify and compensate the costs of conservation. We also discuss the relationship between conservation practices and sustainability and the relationship between tourism as a natural option for conservation projects and sustainability. The sustainability is a wide word and papers aren't enough to describe, but in this research we discuss the aspects of local citizens' rights and the necessity of their participation in any development project within their local living environment, furthermore, the role of local authorities as provider and protector of this right, all in the contexts of Local Agenda 21 as a reference. To detect the locals' participation, benefits, changes in their livelihood and their living spaces, we conducted a questionnaire. The questions asked are similar to previous questionnaires conducted by the Hariri Foundation in the year 1996 and 2000 and considered as a database to be used for the western façade design competition organized by the Lebanese ministry of public work. For us this comparison will be use as indicator for the changes in the locals living environment which reflects for sure whether the development is reaching locals and their environment or not. With the relationship with the context of the Local Agenda 21 it will be easy to determine whether the development could be considered sustainable or not. This research consists of the following steps:

a) Evaluating conservation practices in old Saida. We distinguished two groups. We also highlighted the Saida International Seminar and its results. All by answering the questions; why, When, how and who?

b) We describe the current situation of the living environment by using the results of the questionnaire.

c) We discussed the aspects of sustainability in the conservation projects.

d) We discussed tourism industry and how tourism can participate in the sustainable development.

e) We highlighted the role of local authorities and some useful recommendations from the Local Agenda 21and the Saida international Seminar.

f) And finally we could conclude that involving locals' and their living environment in the conservation practices and getting returns out of the tourism industry is one of the essentials for sustainable development within a proper guidance from the local authorities.

3. Conservation and Rehabilitation of Architectural and Urban Heritage.

3.1 Conservation and restoration practices.

We can divide the conservation and restoration projects in Old Saida into two groups. The first group consists of buildings with historic and religious values. The owner is the government or a religious organization while the sponsorship and execution management are by an NGO (mainly the *Hariri* foundation). The second group consists of building with some historical values, but more personal for a certain family. In this case the owner is the sponsor and the execution manager. The restoration approach is more flexible than the one followed by the first group, and the objective is to introduce a new function to the restored structure. Examples for those two groups:

a) Al'omari Mosque. It is a structure located on a high hill of the old city facing the Mediterranean on the west coast (Fig.1, no 11). Built by the crusades as a church to serve the knights *Saint Jean L'hospitalier* in the mid 13th century*,* then transformed into a mosque during the *Mamlouk period* in the late 13th century and named *Al'omary mosque*. Currently few elements of the old structure remained; the supports of the southern wall and some of the praying hall cross vaults. It was in the 18th century that the mosque was named by the *Grand mosque*. The earthquake in 1837 followed by the bombardment of the *Anglo - Austrian* navy in 1840 damaged the mosque .During the restoration between 1848 and1849, new elements were added to the south elevation , some modifications in the windows and the cross vaults and some stylistics elements were added to the Minaret. After its destruction by the *Israeli* bombardment in 1982 the late prime minister *Mr. Rafic Hariri* (a native of Saida with great wealth), decided to build a new mosque for the city, but the municipality and local citizens expressed their desires to see the Grand mosque rebuilt. With the support of the *Waqf* office in Saida the preparation for the reconstruction was handled to professor *Saleh Lamei* (the director of the Islamic architectural heritage center in Cairo). The reconstruction project started in Feb 1983 and finished in Jan 1986. It consisted of 4 steps: 1) Topographical and graphical scan and photography. 2) The reinforcement of fragile roofs and walls. 3) Analysis of the different materials and mortars originally used. 4) The proper restoration. The project earned the *Agha-khan prize* in 1986.

b) Khan El Frenj. This structure composed of two stories and was constructed using the baring walls on continuous footings and built with sandstone (Fig.1 no1). It has a rectangular shape but the caravanserai itself is a square (58*58m), and contains a court (48*48). In the ground floor there is a stable of (12.5*22.5m). Voyagers of 17the century wrote about; built by The prince *Fakhereddine II* late 16th century to become the center of commerce with France(Residence and trading place for *French merchants*).By the impulsion of *Ahmad Basha al Jazzar* it was empty from all the French merchants in 1791. Few years later in 1798 it becomes a military base during the campaign of *Napoleon* on *Egypt*. In 1809 the counselor of France made the east wing his residence and made critical renovation for its western façade. In 1860 *Ernest Renan* use it in the frame of his Mission to Phoenicia as storage for his archeological excavation goods in Saida and its surroundings. In the late 19th century the *Franciscans* convent, the *Pharmacy of the Sisters of Saint Joseph* and a school for orphans occupied the northeast part. Later during the Lebanese war, refugees occupied the khan. In 1992, *Hariri foundation* made an agreement with the French government the owners of the khan allowed the foundation to use and manage the building (time period is unknown) for return of complete restoration and maintenance. The local municipality facilitated some legal and logistic complications of such large project in it critical place. The team that accomplished the Al'omari mosque and other projects executed and managed the project using

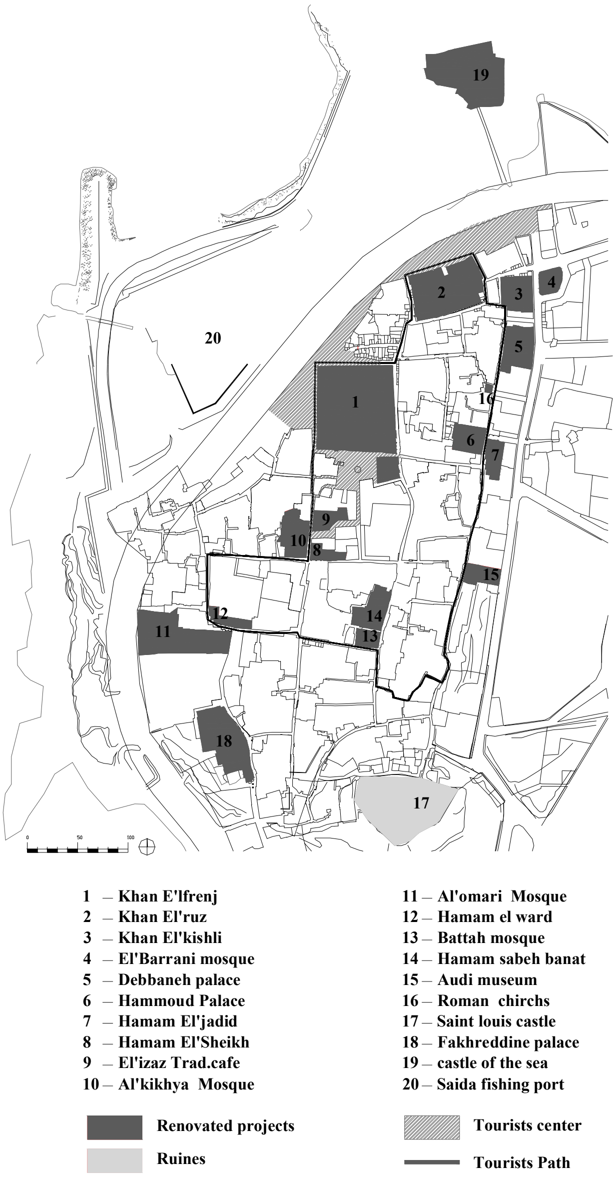


Fig.1 The old city of Saida

similar approach and techniques. Finished in 1997, currently the khan is used for cultural events sponsored by *Hariri* Foundation.

c) Debbaneh family museum and Audi Soap museum. Within the private projects which considered a source of encouragement of ancient buildings are those of *Debbaneh* and *Audi* families (Fig.1 no15 and 5). .The house of *Debbaneh* is a beautiful example of the domestic architecture. It is a part of the *Hammoud* family buildings. It was built in the early 18th century and became the *Debbaneh* family property by the mid 18th century. It has a beautiful Syrian style, with wood ceilings and marble flooring with geometric ornaments a reminder of the great palaces in Damascus. Located on the 2nd floor over the passing street, the entrance is threw a narrow stairs. In the early 20th century *Raphael Debbaneh* constructed two additional floors with the help of Italian architects. He covered the court with a brick roof creating a central covered patio. Unfortunately the events of the civil war driven the rich family to leave and armed groups occupied the house. It was the reason that structural and decorative elements start to deteriorate. In 1999 the descendants of *Raphael Debbaneh* created a foundation with an objective to restore the historic value of such magnificent house and to turn it into a museum to display the family collection of art and photos. To deal with such project and hope this family foundation provided all the technical and the financial support. But such experience was not unique a short distance away another family, the *Audi* family took personally to restore the old family savonery (soap factory) in the heart of the historic district. The objective of the rehabilitation was to bring back some of the traditional artisana to live again. A group of labors with architects and interior decorators started to uncover the old structure of the vaults and treating them with traditional material exposing the sandstone texture and adding contemporary decorative wood, glass and stainless steel paths and decorative items. A technique found to be popular and copied later by many shops.

3.2 The 3rd international seminar of small coastal historic cities

This seminar was launched by *UNESCO* under the request of Saida Municipality and was co-organized between the national comity of Saida municipality, the *Hariri* Foundation and with the Beirut *UNESCO* office. After Essouira in 1997 and El'mehdia in 1999, Saida was selected to be the subject of the Third *UNESCO* Seminar concerning the urban development of small coastal historic cities. With a scientific and cultural platform, this seminar can offer for different cities the opportunity to participate and debate the experts' inter-disciplinary points of view and evaluate previous experiences. At the seminar the municipality of Saida and the *Hariri* Foundation introduced the wining project of the Costal Façade Design Competition held in Saida in the year 2000 by Mr. *Rasem Badran*, (a leading urban planner in Jordan). The project holds within a general urban plan for the city of Saida as a whole and considers that developing the Old Saida is essential for the development of the larger city. Concerning Old Saida the project organizes the coastal elevation and introduces additional tourist structures on the seafront with a look influenced by the local architectural vocabulary. '*It is possible to develop and organize the coastal façade of Saida, and by this it can revive the city with its urban and architectural nature, which is absent. And it could bring back the lost identity. Such development can connect the old city with some activities and can be essential in the general development of the city',* says *Mr. Badran* in his presentation the seminar. Concerning the old city center he added: '*Developing the city center and its engine where some leading projects can create possibilities for locals to participate and get benefits of this development, in addition to creating chances for participants to gain by providing additional services. The concentration of conservation projects for the main monuments and the infrastructure can low the bill of conservation for the city in general, which will be renovated later threw the local participation when the level of investment is acceptable'*. The municipality of Saida adopted *Mr. Badran* general plan and furthermore, it was supported by many in the seminar. Afterword, the municipality of Saida started to widen the coastal boulevard by renovating randomly added parts of the city's western facade. In 2002 the *World Bank* funded a renovation project for all the paths within Old Saida. The plan included walls cleaning and treatment, tiling and the basic infrastructure under the supervision of the Comity of Development and Reconstruction (CDR, Lebanese government). In 2004 the coastal boulevard was almost finished, the western façade from the *Castle the Sea* till *Khan El Frenj* was renovated, along with some essential paths within the old city. At that moment the municipality introduced the *Tourists Path* as a tourist-led development project, which is basically a plan of chosen renovated path that connects the main historic buildings for tourists to navigate. Small restaurants and souvenir shops invaded the tourist path; a small hotel and café-trotoire occupied some parts of the western elevation beside *Khan El'frenj*. Saida could host an average of 1500 daily visitor at nighttime (the municipality of Saida).

4. Investigating the Living Environment

4.1 The living Environment in Old Saida

Table .1 locals complains

Locals complains	
2000	2007
40% willing to relocate	57% willing to relocate
Humidity	Humidity
entertainment	solving legual problems
social values	social values
low income rate	low income rate
noise and pollution	noise and pollution
infra structure	house condition
size of living space	size of living space

The current situation of Old Saida as large clusters of deteriorated buildings does not reflect the history of the city. Since the city is located on the Mediterranean Sea, it has a special relationship with the sea threw a small port, while trading and fishing were the expertise of the people. The after mass of 1957 earthquake brought for the first time the idea of two cities, an old historic city and a new city. Old Saida hosts the poorest society, and some of the 50000 *Palestinian refugees* that fled their land in the 1967to Saida. It also plays an economical role in the larger city's economy as local traditional market. It attracts poor shoppers and holds the main fish market. The old city totally depends on the larger city for general and public services. In 1982 as mentioned before, the Israeli invasion destroyed large part of old Saida. '*It was a disaster almost 1000 families lost their homes, with the help of Hariri Foundation we conducted a fast and large restoration project with 500 labors, we didn't think much about proper conservation techniques, we focused on bringing people to their homes, as soon as possible'*, said *Mr. Ahmead Kalash* (the mayor of Saida at that time). During the civil war, maintenance of infrastructure stopped and many took opportunity to extend their homes chaotically without authorization. A survey taken in 1993 by Hariri foundation showed 38% of the homes have to be distorted, 30% need major restoration and 32% need some. The basic infrastructure was useless. Now almost 2500 families live in old Saida, with a population of 13000.

4.2 Questionnaire of the Residents with Comparison to previous Surveys

To give an exact image to the current living conditions, a questionnaire was conducted in Jun 2007, with the help of 5th year Architectural Engineering students in Beirut Arab University. We interviewed 100 randomly selected homes in old Saida which represents almost 4%and involving 557 people. This questionnaire is similar to the context of other questionnaires conducted by Hariri Foundation in 1996 and 2000. I have to note that the rate of answering for each question is an 80%. The aim is to detect whether the conservation projects or the newly introduced tourism development affected the living environment or not, in addition to the level of satisfaction among locals. The results of the questionnaire and the comparison are:

a) Residents' backgrounds

- In 1996: 60.28% Lebanese, 36.92 Palestinians, 2.80% others.
- In 2000: 59.00%Lebanese, 37.20% Palestinians, 3.80% others.
- In 2007: 58.00% Lebanese, 37.00% Palestinians, 5.00% others

Others represent daily labors from Arabic and African countries living in groups of men. (Table.3)
We discovered also that 42.00% are owners, 4.00% live with no charge and 54.00% rent.

b) Unemployment rate

- In 2000: unemployment rate: 10.3%
- In 2007: unemployment rate: 8.2 % (age 20-40)

c) Educational level

- In 2000: 72.1 % 10 years school, 16% less, 11.9% more
- In 2007: 65% 10 years school, 8% less, 27% more

d) Problems

In 2000: 40% of the residents are willing to relocate for the following reasons(Table 1):

- High humidity and lack of sunshine.
- Lack of activity places especially for the youngsters.
- Low-income rate for those who work within the city, 35% live and work in the old city.
- Noise and pollution.
- Lack of infrastructure.
- Size of the living space.
- The lost of social connection especially with new comers.

In 2007: 57% of the residents are willing to relocate for the following reasons:

- Noise and pollution.

- Physical condition of the living space.
- Size of the living space.
- Legality problems among ownership partners.
- Security.
- High humidity and lack of sunshine.
- Low-income rate for those who work within the city, 33% live and work in the old city.
- The lost of social connection especially with new comers.

e) Buildings physical conditions

- In 2000: 76.6 % acceptable, 20.8% fare, 2.6% bad
- In 2007: 74.00 % acceptable, 25.00% fare, 1% bad

When asked about restoration activities

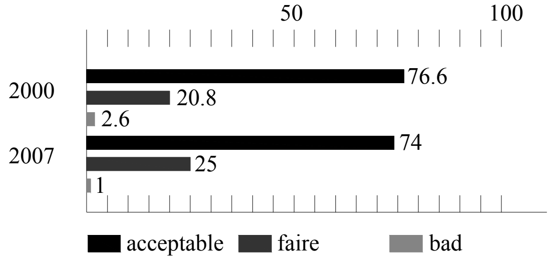
- 62% can afford basic restoration, 30% find it difficult and 8% are not willing.

Note: the building condition evaluation is based on the residents' opinion not on scientific and technical method, besides many of the badly damaged homes are vacant and were not part of the survey. (Table .2)

f) Reaction to the going on renovation and tourist activities (Table.4)

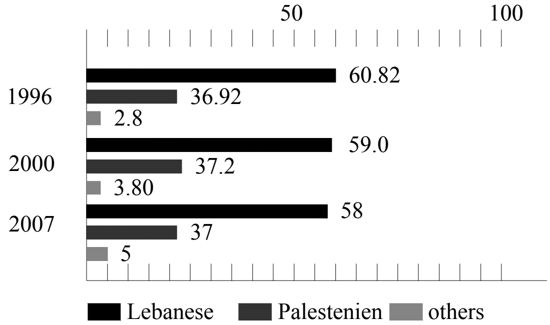
- 3% have work within the shops and cafes.
- 83% are satisfied with the infrastructure.
- 87% are glad for the tourist activities.
- 81% have nothing to win or lose by the tourist activities.

Table .2 condition of living spaces



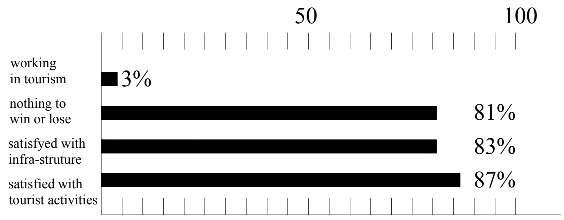
Residencescondition, survey based on residents oppenion not on scientifical methods

Table .3 residents' background



Residents background (old saida)

Table .4 levels of satisfaction and involvement



2007 survey is based on residents oppenion

5. Saida Conservation and Tourism Projects in the context of Sustainable Development

5.1 Sustainable Aspects of the Conservation Practice

Form many scholars, any approach or activities in the field of conservation are sustainable. But it is a conflicting matter between different schools of restoration and it is more conflicting among locals when such act is considered socially unequal or economically unjustified. However, historic cities such as Saida are an urban environment with architectural heritage expressed by a particular urban fabric and historic monuments inside of which a community lives and practice its cultural and social habits. On another hand, historic city centers and the monumental heritage within historic cities play a medial role by the identity that they reflect and the services that they provide. The degradation of historic city centers and monumental heritage means the loss of the medial function of urban spaces and loss of instrument of sociality. For that, conservation of historic city centers and monumental heritage is justified and can compensate the cost of conservation. This conservation approach was followed successfully in Saida and could be accepted as sustainable by the meaning that the old city center and the monument can sustain itself in the dynamic role that they play. If we follow the same philosophy, the role that old Saida plays to the larger Saida is the same as the role of the historic center to old Saida, which are the center and the monumental heritage in the same time. From this sense, the degradation of old Saida is disastrous and the conservation old Saida as a whole especially the living spaces is necessary and should compensate the cost of its restoration. Furthermore, the principles 1 and 8 of the *Local Agenda 21* (UNGA, Rio declaration on environment and development June 1992) concerning crucial questions of urban sustainable development are the fight against poverty and social exclusion to guarantee a more equal level of quality of life. Based on our research and the collected data from the questionnaire we discovered that: a) the going on conservation project doesn't include restoration for private homes. b) 74 % of the locals find their homes condition is acceptable while professional evaluation estimates 47 % of the homes need major restoration, which reflects that locals cannot evaluate properly their properties. c) Approximately 62% of the locals doesn't have the financial and the technical capacity for the restoration of their living space. d) The renovation of the street network sponsored by the *World Bank* didn't penetrate the walls to reach inside the homes which raised inequality feelings among locals. e) The number of the people willing to relocate rose from 40% in 2000 to 57% in 2007.

5.2 Tourism and sustainable development

Tourism is one of the largest industries in the world. Like any other global industry, tourist business activities can have a considerable impact on local development trends. Fundamentally it involves the transportation and hosting of the tourism consumer in a local community. Historic cities and architectural heritage monument often serve as tourist destination. Moreover, tourism can support to maintain monuments and encourages investors in the field of renovation and refurbishment. But can also degrade the social and the natural wealth of a community. The intrusion of uninformed large numbers of foreigners into a local society can undermine pre-existing social relationship and values. Can tourism contribute to local sustainable development or not? As any development it is possible if it can lead to greater and more equitably distributed local wealth and enhance the integrity of local environment, as addressed in the *Agenda 21* and the *UN Conference on environment and development*. In the case of Old Saida, the Tourists Path and reviving the Old city center could attract in fact an average of 1500 visitors at night time, and furthermore, it could connect the old city with the larger Saida with memories and by attracting citizens to visit dear places. Like other cities, cafes small restaurants and souvenir shops invaded the western façade and the tourist path. Many spaces for locals to socialize and for fishermen to clean their nets and many local crafts were replaced. Among 76 shops only 5% of the owners live in the old city while 3% of the locals work in this business (Saida municipality). Furthermore, although 87% are glad for the going on activities but in term of involvement 81% feel that they have nothing to do with it, which is true because a taxation system is not in place. Finally when it comes to the area coverage, the area involved in tourist activities is too small comparing to the total area.

6. Managing the old city Facts and Recommendations

6.1 The Local Authorities

As providers of social services, builders of economic infrastructure, regulators of economic activities and managers of natural environment local authorizes' role is of an initiator and a facilitator among the diverse interests seeking to influence the direction of local development *(UN Conference on environment and development*). Also it is their responsibility to steer increasingly internal and external, global forces on local development so that development achieves the shared vision of the local population (local Agenda 21). This research detected many facts concerning the Municipality of Saida and its partners the local NGOs especially the Hariri Foundation concerning the development of Old Saida. a) They could support and serve the city in the most difficult times such as a civil war. b) The municipality participated in the conservation and the renovation projects as a facilitator and a promoter while the NGOs provided sponsorship and management. c) The city is globally recognized by the international seminar. d) They could provide the basic infrastructure with the help of the World Bank. e) Over 80% of the locals are satisfied with the restoration and tourism activities. f) The city hosts 1500 visitors at night time. But another fact also floated to the surface. The old city represents 10% of the larger city and the lack of personals and finance are limiting the municipality's capability to provide basic services, solve legal conflicts among locals and to conduct large scale renovation project.

6.2. Recommendations

The UN commission of Sustainable development has recognize *Local Agenda 21* as an effective mechanism threw number of principles necessary for the sustainable development planning ,the World Heritage Association provided many guidelines for managing historic sites and Saida Conference added more specific recommendations for the case of Saida .It is a long list but I shall present some :

- Participation and transparency that involves local residents, representing all major groups of society.
- Partnerships that build collective responsibility for planning, decision making, problem solving, project implementation and evaluation.
- Systematic approach that addresses the underlining causes of social, economic and ecological problems.
- Equity and justice, which are secured locally through the provision of equal opportunities and human rights.

- Concern for the future, that require long term planning and action that addresses both immediate needs and long term trends.
- Evaluate and improve efforts to address sensitive tourism development issues such as inequitable distribution of tourism revenues and displacement of pre-existing settlements by tourism.
- Tourism Taxes and local profit-sharing arrangements.
- Active participation of the tourism industry in the conservation of a site by long-term monitoring and technical assistance.
- Training and preparing locals to participate in site conservation efforts.
- Creating a special comity as part of the local authority municipality that can manage the conservation activities and address the needs of the locals.

7. Conclusion

The old city of Saida represents a living heritage that can be considered one of the main resources that the city possesses, the municipality of Saida and their partners mainly the Hariri foundation possess the necessary knowledge and organization and succeeded in presenting successful examples for restoration and conservation, also succeeded in presenting the city to the world but they lack of personals and finance. Livability is related to the living environment. Saida is a poor city in a poor country and .It inherited political, economical and warfare problems threw the last 150 years and now struggling to develop itself. The going on conservation and tourism is actually a tourist-led conservation project; it did help reviving some parts of the old city but didn't reach the living environment or the locals. This lack of involvement and other required elements can lead to more demographical change which will break the social fabric. It will also lead to worsen the physical condition of the living environment especially when locals cannot evaluate and properly repair their property damages. This will break the urban fabric. In addition to loosing the urban and social fabric, the feeling of inequality will raise the violence and crime rate which will damage the tourism industry. It is clear that the level of locals' involvement in the conservation projects and benefiting from of the tourism industry is essential not to mention the role of the local authority. If the municipality of Saida could organize a special comity for old Saida with the following objectives: a) creating a plan to reviving the living environment. b) Providing the necessary services and technical guidance. c) Collaborating with local and international NGOs, local families and volunteers to conduct and sponsor individual projects. d) Training the unemployed to work in conservation and tourism industry. e) Creating taxation and monitoring the impact of tourist on the local environment. Only at that time we can consider that the going on conservation and tourism development projects is major step toward sustainability.

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References

ICLEI, 1999. *Sustainable tourism: a local authority perspective*. New York: UN, DESA.

Badran, Rasem 2000. *Western Façade design competition*. Lebanon: UNESCO, 3rd Int. Seminar.

Majzoub .T. 1989. The social history of Saida. Beirut Al asrya library press

Taboroff, J.2000*Conserving The Historic Built environment in the Mediterranian coast*: UNESCO, 3rd Int. Seminar.

Majzoub .T. 2000. *The local crafts conservation* . Lebanon: UNESCO, 3rd Int. Seminar.

Grimaldi, M. 2000. Tourism Development Potentials connected to heritage and environmental resources. UNESCO, 3rd Int. Seminar.

De Marco, M.2007 Refurbishment and conservation in sustainable renewal of architectural and urban heritage. Italy. Politecnico Di Bari

Hariri Foundation 2001. *The city of Saida, a living memory*. Beirut .

Distr. General . 1992. Report of the United nations conference on environment and development. Rio Di Janeiro, UN

Saleh Lamei Mostafa, 1997 *La methologie scientifique de restauration des monuments*:Madina numero 3.

Bernard Fonquerine, 1997. *Reahabilitation et mise en valeur du centre ancien de Saida*: Madima mumero 3.

Said Zulficar, 1997.*La grande mosquee Al-Omari prix agha khan 1989*: Madina Numero 3.

Transformation and typology;

Vacancy, characteristics and conversion-capacity

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Keywords: adaptation, building-type, characteristics, cases, office building activation

Abstract

Successful conversion of structurally vacant office buildings into housing depends on several market-, location-, and building- characteristics. In this contribution we look into specific office building characteristics. By structural vacancy, we mean buildings that have been vacant for three or more years, without perspective of future tenancy. Office buildings can be described typologically by their architecture, use and structure, which again can be recognised by physical building characteristics. If a group of buildings share the same building characteristics, we speak of a building type. It is useful to recognise several types, since these comprise specific characteristics that influence the buildings capacity to be converted. In the development of office buildings, there has been an apparent move towards standardisation (Kohn & Katz, 2002). In this paper, we will consider the historical development of office buildings and how the development of specific building characteristics is related to user demands.

Can structurally vacant office buildings be described typologically? Which characteristics influence the capacity for conversion into housing? Physical building characteristics that describe a type are: Structure and floor span, facade characteristics, floor lay-out and the length and depth of the building, and the number and situation of stairs and elevators. These characteristics also influence the buildings conversion capacity (Remøy and Van der Voordt, 2007). We define building types through a literature study on the development of specific building characteristics. This contribution discusses office building vacancy and the conversion of vacant office buildings into housing from a typological point of view. The research is embedded in the Dutch situation and focuses on Dutch building types, but makes comparisons to office building types worldwide.

Introduction

To accommodate conversion of structurally vacant offices into housing, the characteristics of the building and the location as well as the market should allow conversion and both the building and the location should be suitable for living. After conversion the housing should be suitable for the intended user groups. The potential return on investment should be positive, which means that if the intended users are starters, the conversion costs would need to be lower than for a building that is converted into luxurious housing. Market, location and building together decide the possible structural and architectural degree of adaptation. Office buildings can be described by their architecture, use, and structure. In this paper, we discuss which functional demands have led to the most common office building characteristics. If more buildings share the same characteristics, we speak of a building type. Can vacant office buildings be described typologically by their characteristics? Can these types be connected to specific building periods? Which typological characteristics influence the capacity for conversion into housing?

Typologies and type are much discussed in architecture. About the relationship between type and form, Aldo Rossi says: The concept of type is permanent and complex, a logical principal that is prior to form and that constitutes it (Rossi and Eisenman, 1985). Eugene Kohn relates office building types to the forces of finance, plan, program and design (Kohn and Katz, 2002), while Gunst and De Jong focus on the emergence of the office building as a type (Gunst and Jong, 1989). Interestingly, in his more or less standard work on building types, Pevsner (1976) does not recognise the office building as a type, but speaks of it as a subtype to other types, such as government buildings, banks and warehouses. In this study, we are interested in the characteristics that describe the building type and that also possibly influence the specific type's conversion capacity. Building characteristics that describe a type are: Structure and floor span, facade characteristics, floor lay-out and the length and depth of the building, and the number and situation of stairs and elevators. Through case-studies the influence of these characteristics on the buildings capacity for conversion are revealed.

The typology of office buildings in a historical perspective

The history of office work and office buildings is described by Van Meel (2000) and Duffy (1997). Though banks, stock-exchanges and governmental buildings existed already in the middle ages, specialised office buildings were not invented until the industrial revolution, when clustering of work outside the home and development of mass production techniques led to the need for coordination and administration of these activities. Office buildings were needed for this administrative revolution. The first specialised office buildings were based on the older types, used by bankers, dealers and notaries. The Uffizi (Giorgio Vasari, 1650) in Florence is a famous example. The work was performed in huge halls at long tables. This office type was used until the twentieth century's writing rooms.

At the beginning of the twentieth century office work changed dramatically. Based on the routine work in the factories, Frederick Taylor developed a vision on administrative work that would be followed worldwide. Hierarchy, rationality, work division, precision and supervision were central themes. Offices were grand halls with factory-like lines of small desks, the 'white collar factories'. Steel (first cast iron) structures were introduced to the construction industry, making it possible to develop larger structural spans. By using this relatively light and compact material, less space was needed for the structure and more floors could be stacked on top of each other. At the same time, technical developments, such as the development of the safety elevator, took place. High-rise without elevators would be impossible. The development of high-rises in New York and Chicago signified the office building development in the early 20th century. From then on, developments in office buildings followed the economical growth cycles (Kohn and Katz, 2002).

After the Second World War strong economic growth led to the expansion of the service sector and the arising of the service economy. In the US, artificial lighting and mechanical ventilation led to the development of deeper office buildings. The US was leading within the area of office architecture. Europe was influenced by the developments in the US but the scale of the buildings was not applied here. The deep open floors did not answer to the European office culture. European architects were not really interested in the lay-out of offices, but the formal language of American modernism had much influence on the exterior appearance of office buildings. The facade structure was given much attention. Studies were carried out on the grid of the facade structure and the possibility for flexible interior divisions of floor plans in spaces of different size. The curtain wall had its break through and Le Corbusiers Domino plan was applied.

The ideological ideas of the sixties also influenced architecture; architects started concerning more about work processes and the interior of the workspace instead of just designing the facade, the envelope. The rejection of hierarchical mindsets and the focus on communication and human relations led to the development of the office landscape. In the Netherlands, architects experimented with new lay-outs and variants of the office landscape, of which Herman Hertzbergers building for Centraal Beheer is the most significant. Office buildings were detected as interesting investments, and the rental office and shared offices were introduced. The commercial and financial services business was growing. Office organisations wanted to be flexible and have the opportunity to grow and move. Since then, the trend only has become stronger and renting office space is now the most common form of office accommodation.

In the seventies, the increase of rental offices led to standardisation of the structure and the interior of office buildings. The energy crisis in 1973 brought up more interest for climatic control. Insulated facades and double glazing were introduced, combined with not operable windows. The Dutch building decree was altered and required more daylight access in office buildings. The office landscapes lost popularity. Employees complained about the internal climate, lack of privacy and outside view. Office landscapes clashed with the European office culture. Especially in Northern Europe office buildings were narrow because of the preferred office lay-out: cellular offices along a corridor.

From 1985 onwards most employees worked with a computer. More computers and other technical apparatus required new cabling, cooling and more attention to the indoor climate. The buildings were narrow. All workplaces were near the facade and computers were served by a cable stalk in the facade. The ideas about office work have changed. With mobile phones, laptops, internet and e-mail the employee has become less dependant of the office building. Shared or flexible workspace has become normal. At the same time, more people work at home or at different places during the week (Vos et al., 1999). Office buildings are standardised according to a main structural grid of 7,2m and a facade grid of 1,8m. Multiple floor types are used and experiments on integrating installations in the floors are conducted. Employees are more assertive and do not want to work in a shed on a business park, but in dynamic, urban surroundings, i.e. in or near the urban centres (Florida, 2003). Work, living and leisure are becoming more intertwined than they used to be. Because of the shortage of qualified employees, employers see pleasant working surroundings as a tool in attracting the skilled employees.

Albeit the office building type originated in administrative buildings from the middle age, during its development its characteristics developed and became specific, and the office building type can be recognised as a separate building type. Until the industrial revolution, offices had much in common with housing, and the use of buildings could easily be adapted. From the industrial revolution onwards, the specificities of the office building type started to develop. Mass production of building materials made construction cheaper and led to modular building systems, prefabrication and standardisation. Another force to the increasing standardisation was the economical growth and the changing role of the office user; office users went from owning their own office buildings to being tenants. Office buildings are developed and standardised to accommodate office organisations. With a surplus of office buildings on the market, some buildings become structurally vacant, redundant and obsolescent.

Characteristics and vacancy

A mismatch of demand and supply of office space has led to a replacement market. It is caused by an increasing stock and high supply of office buildings, which is not following the demand of office space. Organisations move to high quality buildings and affordable space. The buildings left behind remain vacant. Buildings from 1950 to 1990 have the main share in the structural vacancy; while office buildings from after 1990 are more popular. These findings correspond with the obsolescence of the supply from this period (Remøy, 2007). The vacancy concentrates in the buildings from 1970 to 1990; while in buildings from 1950 to 1970 it is less significant. Probably the bad buildings are already taken off the market. In the remainder of this paper we will therefore concentrate on the office buildings developed between 1970 and 1990. The standard office building from the seventies and eighties has a simple shape. Two types are the most dominant (Kamerling et al., 1997, Reuser et al., 2005). First, the tall buildings constructed as floors and columns and stabilised by means of a central core of stairs and elevators shafts, eventually with extra stabilisation elements in the facade. The second archetype is the low-rise, oblong building, also built up of floors with columns and stabilising walls in one or two directions, depending on the floor type. A central core with the stairways and the elevator shaft is normally located in the centre of the building. At the head of the building, we normally find the escape routes.

Structure and floors

In the beginning of the seventies two types of structures were popular: A flat-slab beamless floor on columns and a header beam along the facade, and a flat-slab beamless floor on columns and a cantilevered facade, Both can be recognised by their square structure (Spierings et al., 2004). The result is flexible, slack floors that can only support load bearing walls placed on the structural gridlines. Penetrations in the floors cannot be big, since the floors span in two directions. By the end of the seventies and beginning of the eighties the linear structures became more common; mostly load bearing perpendicular to the long facade. More prefab constructions were used. The most common structures were cassette floors (span 9-15m) on columns, a structure with facade beam and parallel beams on columns with precast concrete panels (span up to 12m) and a linear spanned floor with hidden beams and a rib floor (span 9-15m) on columns. Standardisation was pursued. The structural grid was more and more a manifold of 1,8m. The concrete floors were pre- or post-stressed, which made it possible to create even bigger spans without increasing the own weight of the floors.

Floor lay-out, building length and depth

Until the mid-sixties offices in the Netherlands were built for the owner-users who had much influence on the design of office buildings. This tradition also influenced the design of rental offices. The Dutch employee is assertive. Company profiles are democratic and not hierarchic. In combination with the Dutch building decree on daylight access, these factors determine the depth of office buildings. Dutch and other Northern European office buildings are narrow compared to buildings in other countries. A depth of 14,4m is common. The required daylight access is expressed in the building decree as the equivalent daylight surface: square metres of daylight that enters through windows or other glass building-parts. The required daylight access in office buildings equals a vertical glass surface of minimum 5% of the square metres usable floor space. For housing, daylight access equalling 10% of the usable floor space is required.

Facade

The energy crisis in 1973 left its mark on architecture. Insulation of the facade was until then not normal, but in the seventies it became a standard part of the facade. Prefab elements were used more often, especially insulated prefab sandwich elements. Insulating and sun-reflecting glazing was developed and the climate-facade and the climate-window were introduced. Window frames and curtain walls were mostly manufactured from aluminium while up till then steel had normally been used. The completely glazed curtain wall was clearly expressing the curtain wall principle (Kamerling et al., 1997). Often, the windows in buildings from these years can not be opened. During the eighties thought was given to the well-being of office employees. Attention was drawn to the '*Sick Building Syndrome*'. This term points to the fact that office employees became sick from their work surroundings. Some of the problems were caused by facades without operable windows, and the operable windows were re-introduced to the office building, together with individually adjustable heating, ventilation and sunscreens. In the eighties, next to the completely glazed curtain walls or strip-window facades, load bearing facades and floor - to - floor prefab elements were used. By standardising the facade measurements, the exterior form of office buildings became more similar.

Stairs and elevators

The location of stairways in office buildings varies. Since the seventies the central stability core with an elevator and eventually staircases and facilities has become standard in high-rise and centrally oriented buildings. Depending on the structure the core is stabilising in one or two directions. Low-rise office buildings have, depending on their length, one or more entrances and elevator-cores and escape routes on the head of the buildings.

Characteristics and conversion capacity

Structure and floors

The main structural grid is more and more often a multiple of 1,8m. Measurements of 5,4m and 7,2m are common. These measurements are also common in Dutch housing: 5,4m is a standard dimension. In buildings with flat-slab beamless floors from the seventies, the big number of columns may cause a partition problem. The linear structures from the eighties have larger spans perpendicular to the long walls and are more flexible towards adapting the buildings to new use. Beams under the floors may cause problems, because the free height of the floors is incidentally lowered. The floors in office buildings are normally constructed to carry more weight than in housing (In offices, 300kg/m^2 is required, in housing, that is 175kg/m^2), a positive characteristic for conversion of these buildings. Floors from this period though are often precast concrete floors. The limited possibility of penetrating these floors makes it difficult to add vertical shafts. The steel cables in the floors may be located, but are not always located on the same place in all floors. Floors of this kind may be of hindrance for conversion, but does not make it impossible.

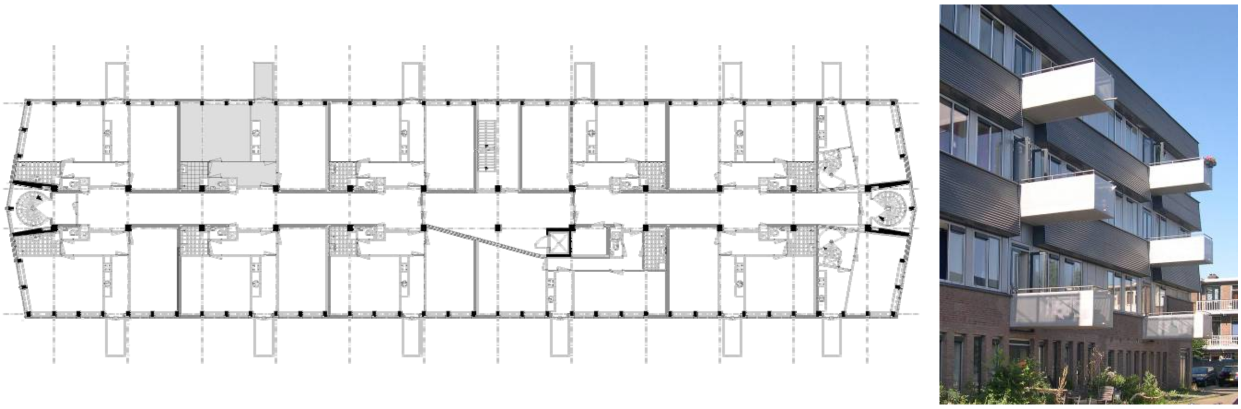

Figure 1: The 5,4m structural grid enhanced the conversion capacity. The existing facade was upgraded by placing new windows, insulation and balconies. An additional floor was added on top of the building.

The floor height of office buildings is mostly sufficient for realising housing; the Dutch building decree requires 2,6m free floor height in housing. The acoustic insulation of floors from the seventies and eighties is not sufficient for housing. To respond to the requirements of the building decree, acoustic insulation is mostly added according to the box-in-box principle, with a suspended ceiling and a floating floor. When lowering the floor height locally because of existing beams, exceptions from the requirements may be given.

Floor lay-out, building length and depth

An efficient lay-out of housing on an office floor may be negatively influenced by the office floor plan. The place of the central elevator and staircases may be inadequate for housing. Moving the elevator core and staircase is usually not possible, because the core also serves the stability of the structure. Placing a new elevator in many cases would only be possible outside the existing building, so that no extra shafts have to be made in the existing floor.

The depth of office buildings is mentioned as an obstacle for conversion into housing, but if we compare the normal depths of Dutch office buildings from the seventies to the normal depths of Dutch housing, the differences are rather small. In many cases the depth of office buildings is even a positive aspect when considering conversion. The building depth may be an obstacle for conversion of older types; buildings from before 1970 are generally deeper and with less day-light access.

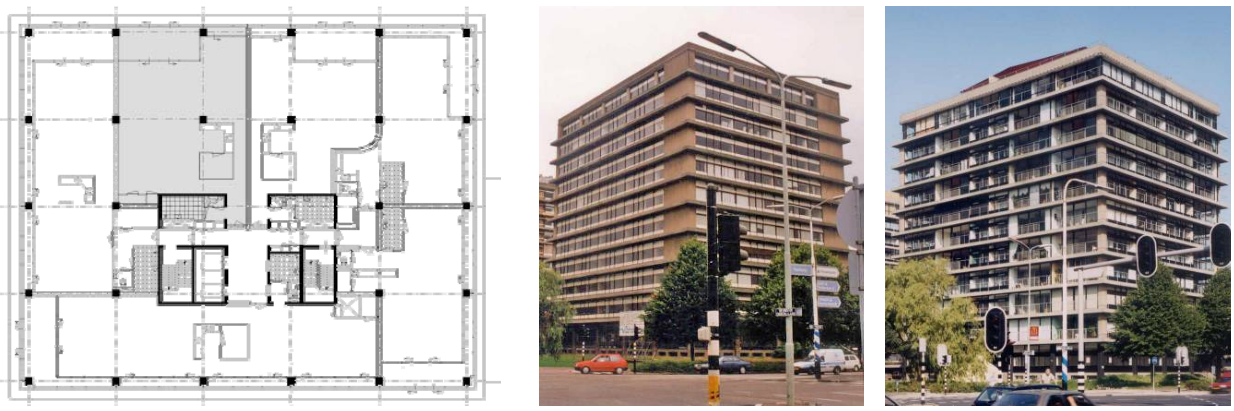

Figure 2: The building depth of the existing building provided open, spacious floor plans. 2 of the 4 elevators were not needed and were reused for shafts or included in the apartments.

Facade

Completely replacing the existing facade implies a big investment. In examples of conversion of office buildings into student housing the financial targets are met because the facade could be maintained. When office buildings are converted into more expensive housing though, more serious changes can be made, but interventions in the facade are critical factors for the financial feasibility of conversion projects.

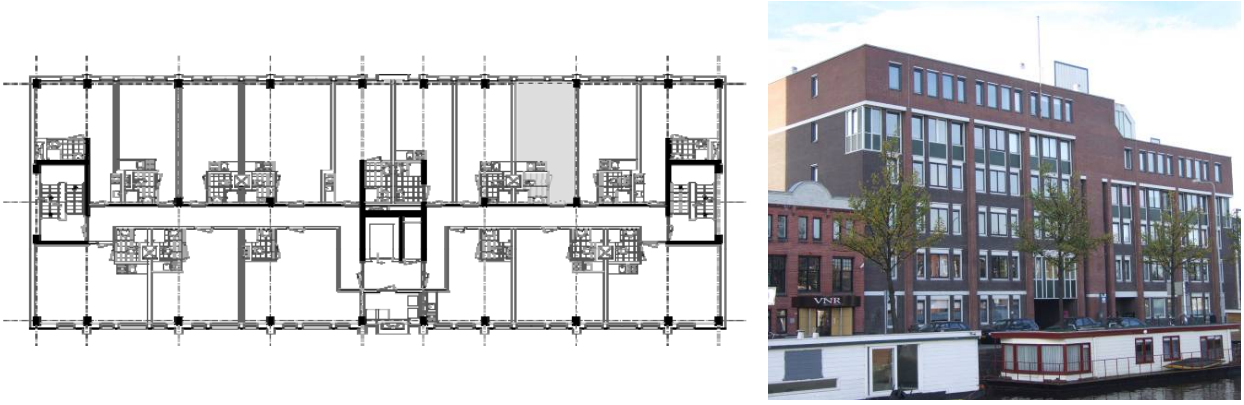

Figure 3: The building had operable windows in every bay and was converted from office building to student housing without altering the facade. The floor lay-out with a central elevator caused an awkward routing.

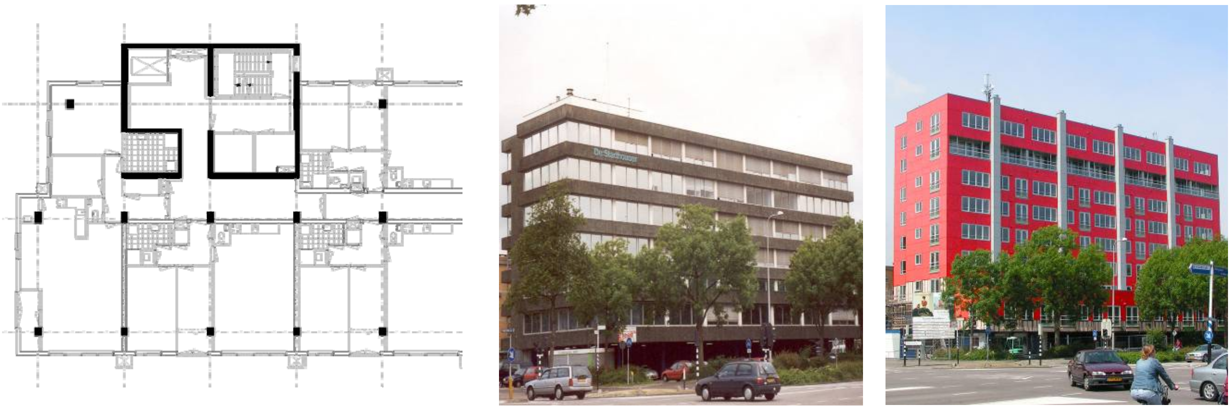

Figure 4: The prefab curtain wall could not be altered and was replaced. The cantilevering of the floors made it impossible to add balconies.

The Dutch building decree was recently altered. Until 2003, a balcony or other private outdoor space was mandatory. Even though the new building decree does not prescribe a private outdoor space, most people demand or desire dwellings to have a balcony or a terrace, especially in more expensive high-end apartments. Until the seventies modernism had a great influence on the design of floor plans. The Domino-principle by Le Corbusier was incorporated in its pure form with columns and floors, with cantilevering floors and a curtain wall facade. Such a structure though makes the addition of balconies difficult. Adding a loggia is an alternative; the floors need to be wrapped in insulation and an undesired height difference between inside and outside would be the result. French balconies or winter gardens are possible solutions.

Figure 5: Private outdoor space inside the facade envelope; a winter garden.

Stairs and elevators

Office buildings are designed for more people/m^2 and more traffic than apartment buildings. Therefore, the number of elevators available for the new function is a positive aspect for conversion. Elevator shafts that are not needed after the conversion into housing may be reused as shafts for ventilation, electricity, water supplies and sewer. Since the shafts are often used to provide for the stability of the structure, the possibility for alterations or making holes in the shaft walls may be restricted. The requirements to escape routes though are stricter for housing than for offices. The Dutch building decree requires two different exit routes for apartments on floors higher than 12,5m from the ground. Adding extra stairs may be necessary.

Table 1: Summarising the typological characteristics that influence the buildings conversion capacity.

	Positive	Negative
Structure and floors	• Structural grid 5,4m or 7,2mm: common in housing • Columns; free plans • Constructed for heavy carriage; 300kg/m^2 required, 175kg/m^2 required for housing	• Dense grids • Low ceilings under existing beams • Reinforced concrete: complicates floor penetration Thin floors: acoustic insulation insufficient
Facade	• Facade grid 1,8m and load bearing walls: possible to attach interior walls to facade	• Curtain walls:, inadequate technical state, no attachment-points for interior walls • Cantilevering floors: complicates adding balconies • Remove and rebuild facades
Floor lay-out, length and depth	• Depth of buildings normally enhances the conversion capacity	• Centrally placed elevators and staircases
Stairs and elevators	• Excess number of elevators	• Insufficient number of escape routes • Space occupied by stairs and elevators: Excessive

Reflection

The market situation and the building location may explain which buildings are left vacant and which are occupied (Remøy et al., 2007), and can also be a reason why a building cannot be converted into housing. There are few building characteristics that make conversion impossible: A building is more easily manipulated than its location. It is sound to say that the post-war urban development and its functional separation was an unsustainable urban development, hindering building conversion and obstructing urban redevelopment. Of the characteristics that describe the typology of an office building the characteristics of the structure and the floors are the most crucial for the conversion capacity. The scale of the structure must provide separation into usable space. In buildings from the seventies and eighties the structure normally provides enough free space. It is often a multiple of 1,8m, such as 5,4m or 7,2m. The floors of office buildings also normally provide enough strength for housing. Problems may occur though when manipulating the floors. A typical floor in an office building is made of pre- or post-stressed concrete. If the steel in the floors is cut, the floors loose strength. Apartment buildings have a higher density of vertical shafts than office buildings. Penetrating the floors to create shafts for water, electricity and sewer is one of the problems of converting offices into housing.

In this paper we asked the question ‘can structurally vacant office buildings be described typologically’? At this moment though, we are still collecting the empirical data needed to answer this question. What we have described in this paper are the characteristics that can typologically describe the standard office building from the seventies and eighties. We know that structural vacancy, redundancy and obsolescence are increasing in buildings from this period. However, we do not know whether the *structurally vacant buildings* from this period share the characteristics of the *typical buildings* from this period. Empirical study of the characteristics of vacant offices will reveal whether we can speak of a typology of vacancy. If, as we assume, one type of office building has a big part of the structurally vacant building stock, it will be interesting to discuss further the specificities of conversion of this type.

Literature

Duffy, F. & K. Powell. 1997. *The new office.* London: Conran Octopus.

Florida, R. 2003. Cities and the Creative Class. *City & Community* 2: 3-19.

Gunst, D. D. D. & T. D. Jong. 1989. *Typologie van gebouwen; planning en ontwerp van kantoorgebouwen.* Delft: DUP.

Kamerling, J. W., M. Bonebakker & R. Jellema. 1997. *Hogere bouwkunde Jellema. Dl. 9. Utiliteitsbouw; bouwmethoden.* Leiden: SMD/Waltman.
Kohn, A. E. & P. Katz. 2002. *Building type basics for office buildings.* New York: Wiley.
Pevsner, N. 1976. *A history of building types.* London: Thames and Hudson.
Remøy, H. 2007. De markt voor transformatie van kantoren tot woningen / The market for conversion from offices into housing. In Van Der Voordt, T., R. Geraedts, H. Remøy & C. Oudijk (Eds.). *Transformatie van kantoorgebouwen thema's, actoren, instrumenten en projecten.* Rotterdam: Uitgeverij 010.
Remøy, H., P. W. Koppels, C. Van Oel & H. De Jonge. 2007. Characteristics of vacant offices: A Delphi-approach. *ENHR Rotterdam 2007.* Rotterdam.
Remøy, H. & D. J. M. Van Der Voordt. 2007. Conversion of office buildings; a cross-case analysis based on 14 conversions of vacant office buildings. Delft University of Technology.
Reuser, B., E. V. Dongen, P. Gros, R. V. D. Varst, M. D. Zoete, T. Pulles & R. T. Areias. 2005. What's in a box. In Reuser, B. (Ed.) Delft: Delft University of Technology.
Rossi, A. & P. Eisenman. 1985. *The architecture of the city.* Cambridge, Mass.: MIT Press.
Spierings, T. G. M., R. P. V. Amerongen & H. Millekamp. 2004. *Jellema hogere bouwkunde. Dl. 3. Bouwtechniek, draagstructuur.* Utrecht: ThiemeMeulenhoff.
Van Meel, J. J. 2000. *The European office; office design and national context.* Rotterdam: 010 Publishers.
Vos, P., J. V. Meel & A. Dijcks. 1999. *The office, the whole office and nothing but the office a framework of workplace concepts, version 1.2.* Delft: Delft University of Technology.

A Study on the Architectural Conversion from Office to Residential Facilities - Through Three Case Studies in Tokyo -

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Keywords: Architectural Conversion, Office Building, Residential Facilities, Case Study, Tokyo

Abstract

In recent years, building conversions from office buildings to residences have proliferated within Japanese metropolitan areas, due to the unstable condition of building stocks. With this in mind, we have been involved in certain building conversion projects from 2004, one of which was not realized, another, which was already completed, and the final one, which is currently at the design stage for execution.

Upon completion of these designs, we organized and compared the basic data of these cases, for example, locations, building sizes, uses and certain features of the base buildings. From these analyses, the background of conversion was then clarified from both macroscopic and microscopic perspectives around the buildings. Next, we compared the plans, sections and uses, before and after conversion, and obtained certain methods specified for conversion for each of the cases. We also analyzed the processes from before to after conversion, especially from the perspective of design and the legal standpoint of building use. Finally we could reveal certain regenerating methods and problematic points concerning the utilization of existing building stocks.

1. Introduction

The climate surrounding building stocks in central Tokyo has become very fluid in recent years. As an example, around the time of 2003, there was a surplus of newly constructed office buildings, and the issue of an increase in the rate of vacancies within existing stock arose. Since that time, many methods have emerged to regenerate stocks, involving the conversion of vacant office buildings into residences. Currently, although the market is predominantly occupied with recovering the balance, the supply quantity of new buildings remains redundant. In fact, reconstruction of existing stocks is proceeding in combination with an economic boom, meaning the total amount of stock remains constant. Under such circumstances, however, methods of regenerating and utilizing stock can be deemed effective from the environmental and city regeneration perspectives, and those will also continue increasing in future.

This research aims to clarify the methods used to regenerate existing building stocks and problematic points for the realization of the same, by examining the methods based on the cases of conversion in which we are involved, and from various perspectives, covering office buildings to residences.

2. Actual circumstances of the building market in central Tokyo

In Japan, despite the stagnancy affecting the construction of office buildings following the bubble economy, which lasted from the late 80s to the early 90s, the building supply has since rocketed. Subsequently, the supply quantity has experienced smooth recovery, in line with Japanese economic trends, with 2003 recording an excess in building construction. Consequently, office buildings were overstocked, raising the issue of an increase in the rate of existing stock vacancies. Subsequently, rents of compact office buildings dropped to the level of housing rent or below, and ever since, the conversion of vacant office buildings to residences has become a visible phenomenon.

At present, while the supply quantity of new office buildings is still redundant, conversely, the office building market is recovering the balance, due to an increased ratio of the reconstruction of existing stock. In addition, the active situation of the housing market remains ongoing, while the quantity of vacant housing stock has plummeted. The aforementioned data thus indicates that the demand for offices matches the newly constructed major office buildings, and that likewise, the demand for housing matches the major new housing construction. Moreover, in the near future, the ratio of vacant office stocks will climb as the baby boomers start retiring in 2010 and the market competition intensifies. Since this will represent a challenge facing conversions of small office buildings to residences from a quantity-based perspective, there will be a need to clarify target tenants and redesign buildings utilizing their special features in the conversion.

3. Outline of three case studies

We are involved in three conversion projects; with terms ranging from 2004 to 2006. Although one remains unrealized (Y building), another has already been completed (M building), while the final one currently remains at the design stage for execution (G building). Firstly, we briefly outline three projects in this chapter.

3-1. Y Building

This building is located in Kanda, a downtown area in central east Tokyo, and accessible from the station within 10 minutes on foot, at the corner of a narrow back street. This building, which has been used for offices, has 6 stories and 1 basement, a footprint of 225 square meters, and total floor area of 1360 square meters. Construction was completed in 1990, about 14 years previously to the project in which we were involved in 2004.

Fig. 1 Y Building before Conversion and its Surroundings

In Kanda, although there are some big developments along major streets, city blocks tend to be full of small buildings called “pencil buildings”. Although Y building is in relatively good condition based on the aspect of floor size, despite deterioration of the building equipment and finishing, it still has some vacant floors, which is presumably attributable to its location. With this in mind, we proposed a more effective design and renovation program for attracting tenants.

We proposed a floor divided into small rooms, which would be usable by small businesses consisting of one or two person/s, and a working style incorporating many shared areas, usable as meeting spaces, factories, and cafes, as well as small private rooms. As the floors advance upwards, we clarify their articulation, expand their size, and gradually highlight the residential function. Finally, the upper level of the building is occupied by rooms which function intermediately between an office and a residence.

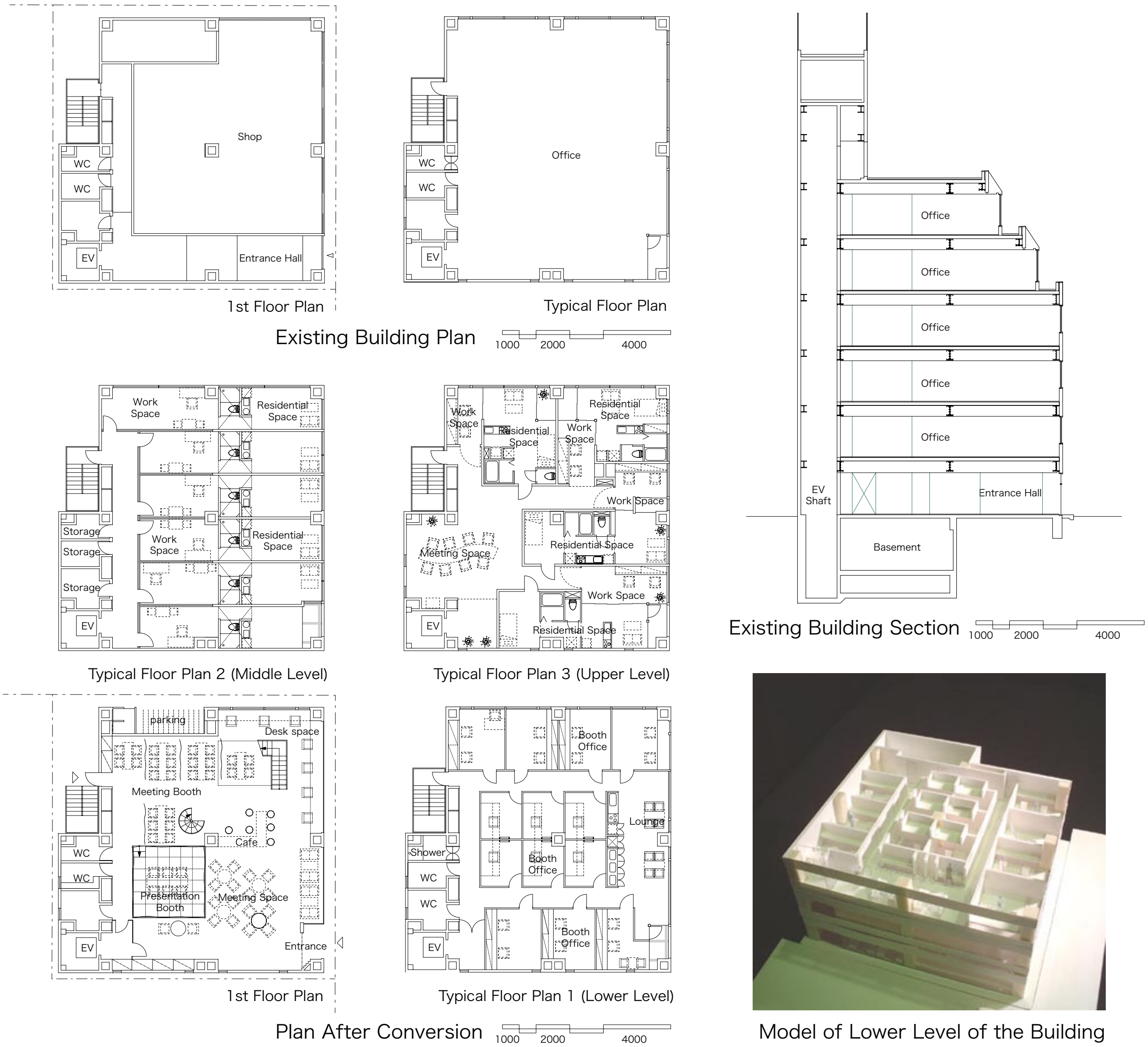


Fig. 2 Proposal for Y Building

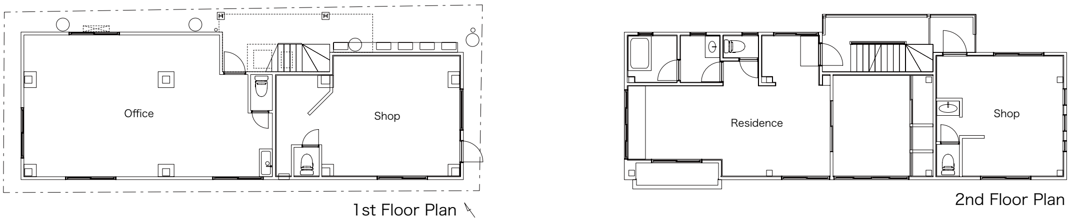
In this project, our proposal was based on the idea of mismatches that occur between buildings and companies, especially from the aspect of size. We designed the entire building interior based on a recommendation for small companies to connect to the urban community as an extension of mutual company communication within the building, reflecting the nature of Kanda as a very traditional, characteristic city.

3-2. M Building

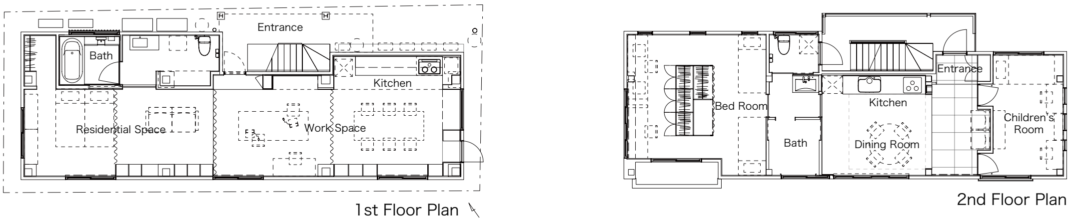
This building is located along a cozy little shopping street near a small station, located about 30 minutes from central Tokyo by train. As a typical structure within a time-honored shopping street, it has a narrow frontage and a considerable depth, as well as complicated usage. The first floor was used as an office and shop, the second floor as a residence, and the third floor for an atelier. The building size is 3 stories, with a footprint of

Fig. 3 M Building before Conversion

67.4 square meters, and total floor area of 178.5 square meters. 26 years had passed since the completion of construction when we got involved in its renovation in 2005.
This shopping street is declining, as the managers of small shops retire, with major retailers moving into the adjacent big station, and its appearance is being drastically transformed. We regenerated this building for two households, into residences and a home office.
The existing building had an external stair, with floors that are independent of each other, so we took over its composition, and added a different character to each floor. On the first floor, the existing partition walls were removed to leave a single long space, softly articulated into a few areas and characterized by structural rhythm. In the second floor, based on functional requests, we insert many walls into the long building



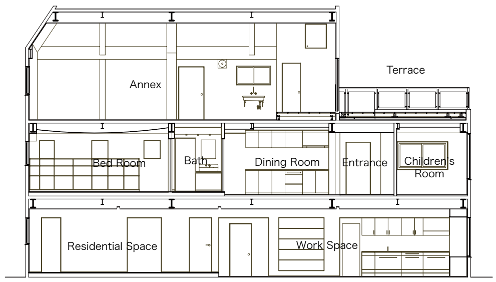
Existing Building Plan 500 1000 2000



Plan After Conversion 500 1000 2000

Night View of the Facade

Interior View of the 1st Floor



Section After Conversion 500 1000 2000

Fig. 4 Proposal for M Building

skeleton, and generate repeated rooms, each with different characters. Meanwhile, the third floor is settled as an annex, and its space is utilized without articulation.

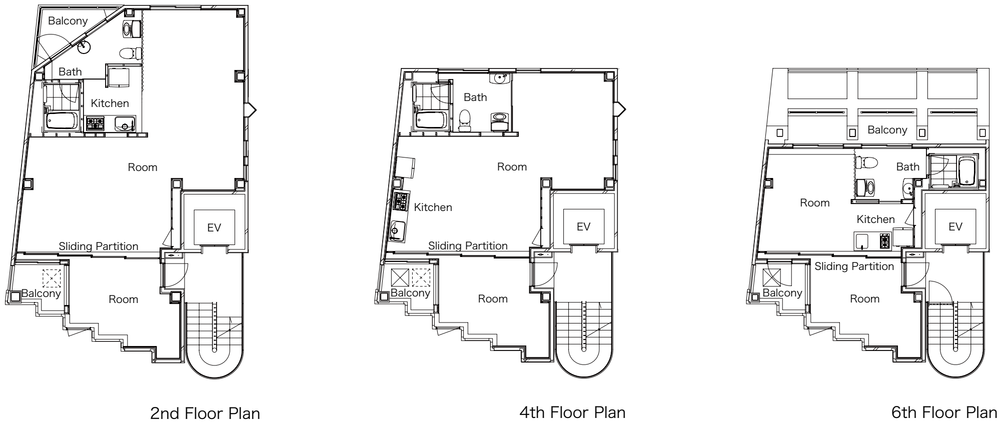
In this project, one of the important themes involves creating a new relationship between a building and a street. This is not an activation of the street as a shopping street, but rather a promotion to change its character as a human street, whereby shops and residences are mixed. On the first floor, we create a gradational layout of space that gets the public closer to the street, helping residents improve their relations with the outside, and vice versa.

3-3. G Building

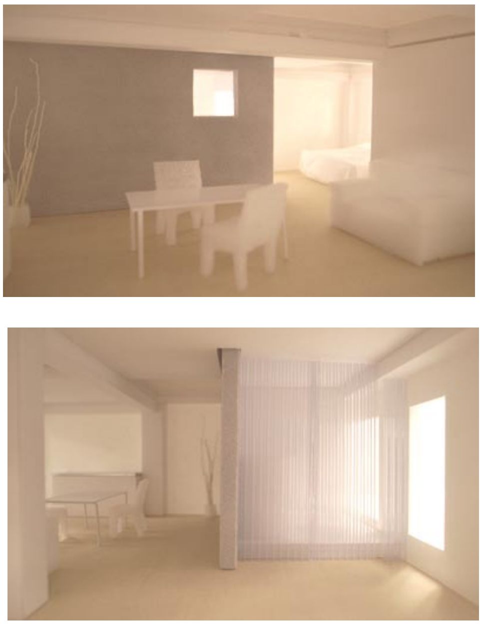
This building is located alongside a major busy urban ring road. There are many small factories in its vicinity, and it has an atmosphere like that of downtown. It takes 15 minutes from the nearest station to this building, and there are very few pedestrians along with ring road, with most coming by bicycle. This small but tall building had been used as an office, with 6 stories, an 83 square meter footprint, and total floor area of 360 square meters. A period of 16 years has elapsed since the completion of construction, making it relatively new, although many areas have deteriorated due to leakage caused by rain. Moreover, since there were no tenants when we became involved in this project, we decided to convert this building from an office to housing, with the surrounding market in mind.

Fig. 5 G Building before Conversion and its Surroundings

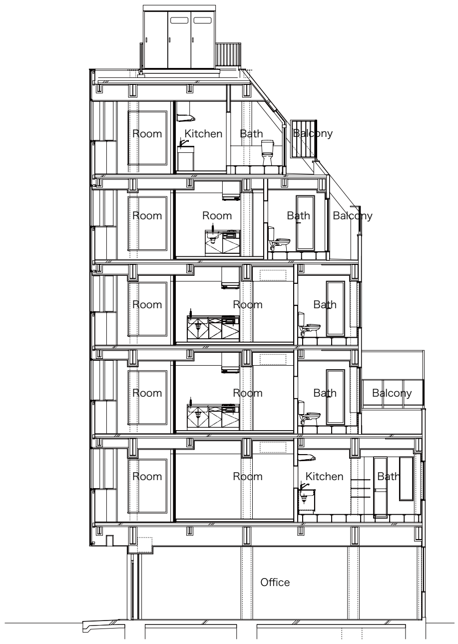
We proposed a single housing unit per floor from the second to the sixth floor, and a continuation of the office on the first floor, due to its environmental incompatibility. To resolve the problem of noise from the ring road, we established a space adjacent to the facade, with partitions separating the space from the room inside, in order to create a double-skinned facade. This space includes a dirt floor, and is expected to be used as a major entrance, a recreation area (for bicycles, gardening...), and an annex room, as if it were outside. The room



Plan After Conversion



Interior View of the 4th Floor (Model)



Section After Conversion

Fig. 6 Proposal for G Building

inside the partition, meanwhile, includes just a single big wall on the north side of the floor, with a space provided for utilities on the far side of the wall. This wall is set as a major correspondence to the undulation of the existing external wall, in order to generate soft articulation and depth into the vacant floor.

This building has an irregular configuration, tapered as it rises due to the building code, meaning the floors become smaller as the height increases. We applied the same manipulation to each floor, but the diversity generated led to the characteristic configuration of the existing building.

4. Comparison and Analysis of three case studies

Once the designs for the three projects were completed, we organized and compared the data obtained from these projects. The three projects are independent; each with its own context. We analyzed the three projects from a physical perspective and aspects of change of usage of building.

4-1. Methods for renovation

We extracted some specific methods for renovation, independent of context, for each project.

One of the remarkable methods used in the Y building involves a vertically gradational building composition that clarifies the room articulation as the floors get higher. This is a method used to organize the whole building. As for other methods used, those standing out include the creation of many booths with partitions, and lofts, for example. In the M building, the most interesting method involves applying quite different operations for each floor, and layering them. These are delicate and soft, while also clear and powerful on the other hand. As another remarkable method, on the first floor, there is a horizontally gradational composition concerning the usage of space, whether private or public, and involving both proposals for the interior and exterior faced surroundings. The G building incorporates a simple system, but various floors and although the same operation is applied to all floors, diversity still occurs based on the irregular configuration of the building. In the interior, the position of the walls is determined by the undulation of the building skeleton. These factors are dependent on the existing building, but also represent a skillful diversion of the building character. Another remarkable method is the setting of partitions in order to create a double-skinned facade.

The common terms in the three projects are the existence of a method for articulation, and one for organization that can also be called a method for syntagm. On the other hand, the specific methods used for each project are: sectional operations in the Y building, the application of many operations relating to articulation in the M building, and operations involving the new relationships established with surroundings in the M and G buildings. These methods are either site- or building-specific, and directly connected to the essence of the proposal. From the viewpoint of the relationship between each of the methods and the context, it is clear that there are both methods responding to one parameter, and methods responding to many parameters. Moreover, the fact that the methods used are inter-linked is also clear. These aspects would strengthen the proposal and clarify its direction.

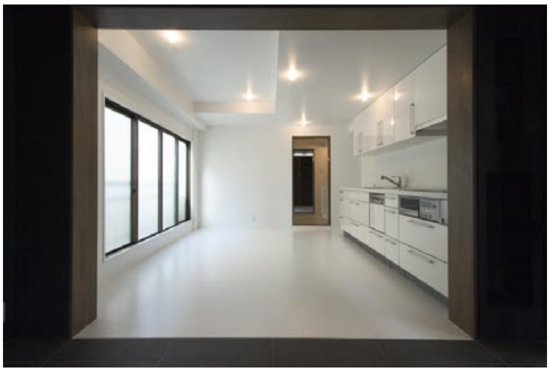


Fig. 7 Interior View of M Building (Left) and G Building (Right, Photo Collage) after Conversion

4-2. Processes of conversion

The three projects all relate to residential facilities and include the replacement of office buildings with residential facilities, to one degree or another. Along the way, the legal problem concerning conversion of building use arises. We compared and analyzed the methods used to insert the residential facilities, and the change in the legal position of the buildings, both before and after conversion.

In the Y building, from its mid or upper level, we inserted the residential functions on a gradual basis with advancing height, and in this case, residential facilities were set in the form of collateral facilities added to the office. Consequently, rooms in the upper level of the building incorporate intermediate functions between offices and residences and we resolve the project with no change of facilities from a legal perspective. As with the Y building, the M building also sees an unchanged legal position. On the first floor, we inserted residential functions using a method equivalent to that for the Y building, while on the second floor upwards, we reinforced the existing residential functions. The three projects all involved specific cases, since the owner of the building had bought it with a clear vision concerning its future utilization. The G building is the only project in which we converted the building facilities from a legal perspective, exclusively incorporating housing alone between the second and sixth floors. However, a further critical problem of the lack of procedure for legal permission arose at the time of construction, meaning the ongoing project faced many restrictions.

Based on the aforementioned analysis, it is clear that there are many methods available to “residentialize” the building, as far as manipulation is concerned. In reality, advancing information technology means the line between business and dwelling is blurred, raising the possibility of adjusting the building facilities while maintained an unchanged legal status as far as possible. On the other hand, it is definitely effective to convert building facilities with unchallenged legal permission, although numerous buildings can be presumed to have irrelevant aspects from a legal perspective, just like G building, in Japan, meaning it might be preferable to clarify the means of correcting the legal position of those buildings in future, and obviously ensuring legal permission.

5. Conclusion

Since the three projects in which we are involved are comparatively small, with costs strictly limited in each case, we did not manipulate the relevant factors to such a drastic extent. Moreover, generally speaking and in terms of dwellings, the first thing to highlight is the unlimited possible solutions. Based on such assumption, we were able to reveal certain key points concerning the conversion from office to residential facilities; namely that articulation within a floor is an important factor for creating a specific proposal, and that in addition, organization, such as the method used to layer floors, is also a remarkable factor. These solutions are based on reflection of the microscopic environment (building), and macroscopic environment (surroundings). Moreover, when dealing with complicated conditions, it is effective to apply a method whereby many requirements are resolved at the same time, or linking some methods functionally.

During conversion from office to residential facilities, especially buildings with hard conditions, there is the potential to use methods partly involving far-fetched solutions to requirements, which also lead to reflections of its context. There are innumerable such cases in cities and many variations are currently devised for the manner of utilization. Basically, the regeneration of stock involves success and failure being questioned by the economic aspect of business. However, there is also a need to inspect the effect, not only from temporary, local viewpoints but also longitudinal, urban viewpoints, so that more effective utilization can be perpetuated.

Acknowledgments

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A Study on the Conversion Design of School Building affected by the Existing Building Specifications

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Keywords: School Building, Idle Classroom, Conversion, Stock Management, Design Method, Existing Building

Abstract

Currently in Japan, as a result of the diminishing number of children, vacancy and closing of elementary schools has increased. For the increasing number of surplus facilities occurring by declining number of children, it is extremely important that elementary schools are utilized for non-school facilities. Conversion which is the one of building transformation techniques were restricted by the design of existing building. This study aimed to clarify the influence of existing building stock upon the conversion design through a brief understanding of the partial conversions carried out on public elementary and junior high schools in the 23 Wards, Tokyo. First, the spatial dimensions of existing school buildings such as structural frame, story and ceiling height, were investigated. Second, the spatial capacities of existing building from compare with before and after the conversion were found out. Third, the zones of conversion design restricted by structural frame, ceiling, opening and floor level were carried out. The standard line for conversion design that we derived was effective the space arrangement of new functions, and these can also be referred to in other countries where elementary schools are constructed under standardized plannings similar to those in Japan.

1. Introduction

1.1 Background and Purpose

In Japan, demolition and new construction based on declining in the durability and increased availability of buildings continues to be practiced. This practice is unfavorable from the viewpoint of utilization of the existing building stock. In addition, in the case of pubic buildings, there are few good policies to overcome demolition and new construction because financial conditions are tight. The conversion of existing public buildings can be quickly and flexibly support of demand of local residents. Therefore, to convert to new facility is an extremely effective technique leading preservation and improvement of the public property and also providing regional service further than the present conditions.

Currently in Japan, as a result of the diminishing number of children, vacancy and closing of elementary schools has increased. For the increasing number of surplus facilities occurring by declining number of children, it is extremely important that elementary schools are utilized for non-school facilities, such as elderly welfare facilities, community centers, child welfare institutions, etc. Various conversion cases are performed on Ministry of Education, Culture, Sports, Science and Technology in Japan.

Conversion which is the one of building transformation techniques were restricted by the design of existing building. So when we convert to new function building, we need to add design requirement of building stock. This study aimed to clarify the influence of existing building stock upon the conversion design.

1.2 Study Object, Method

This study's object is the partial conversion under the tight conditions both in space and finance. These are 23 objects among public elementary and junior high schools in the 23 Wards comprising central Tokyo, that the partial conversions have been done into social educational facilities, elderly welfare facilities, and child welfare facilities. With 1 exception, all these conversion cases were on the ground floors.

Analyzing conversion design plans of these study objects, the existing school buildings specifications and the spatial changes occurred by conversion were grasped. And from these, how the conversion designs have been affected were found out.

2. Existing Building Specifications and Spatial Changes

2.1 Existing Building Specifications

School buildings are constructed under 6 standard planning methods shown as Table 1, regarding both the layout and the span of pillars. Regarding the arrangement of corridor and classroom, there are 3 patterns shown as Table 1. Regarding the span of pillars, there are 2 types —8~9m span and 4~5m span. The differences in the beam arrangements and depth are recognized in accordance with the difference in the span (Fig 1).

Table 1 Layout and Span of Pillars

		Span	
		8~9m	4~5m
Layout	Corridor /Classroom	Corridor Classroom 3 cases	4 cases
Layout	Sub Calssroom /Corridor /Classroom	6 cases	4 cases
Layout	Calssroom /Corridor /Classroom	1 cases	5 cases

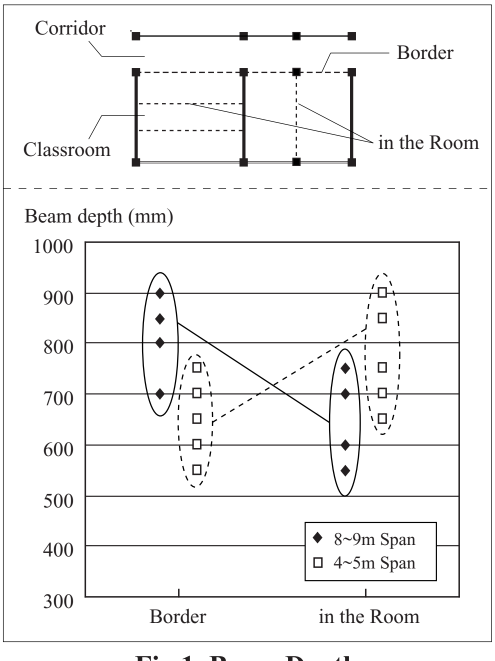
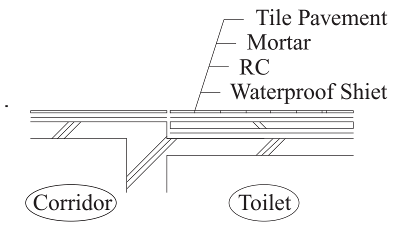
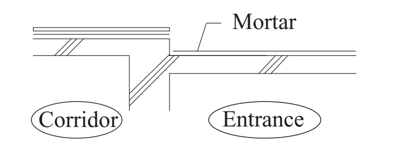
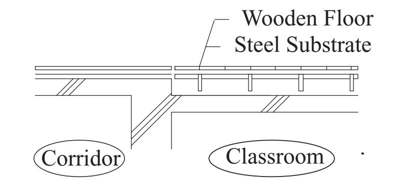


Fig 1 Beam Depth

Regarding the floors, the difference in concrete slab level between the borderline of toilet room / entrance / classroom and corridor can be recognized. But there is no difference in floor level between toilet room / classroom and corridor because of waterproof and substrate. Toilet room is utilized as ever after conversion, with the small work for making flat level. But entrance, when it is transformed into living room, needs bigger work for flat level.

Table 2 Differences in Concrete Slab Levels

Toilet (9 cases)	Entrance (10 cases)	Classroom (2 cases)
		

Most of openings are as high up as to the bottom line of beam in accordance with the lighting regulation law. And some have sliding doors for in and out access.
As neither air conditionings nor insulators in interior work are furnished, it can be mentioned that the rooms in the school building can not be kept in comfortable temperature.
You see, from Fig 2, 3 types of ceiling height —more than 3000mm, 2600~3000mm, lower than 2600mm. Average story height is 3500mm. As Fig 3, the beam depth are 500~900mm, that is, the ceiling height of corridor and entrance is up to the bottom of beam.

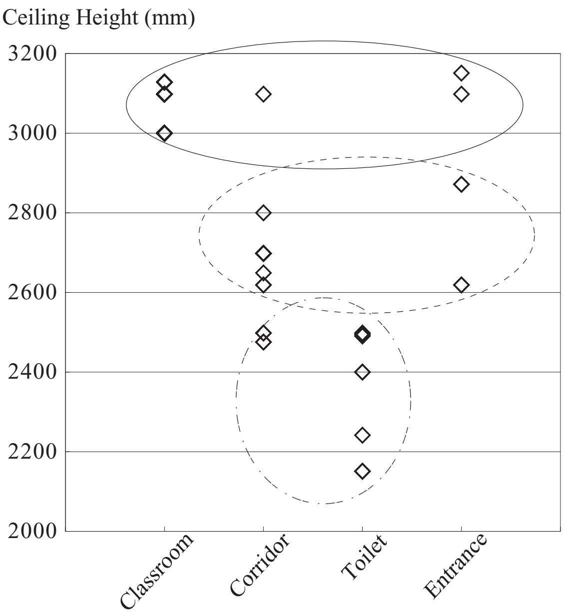


Fig 2 Ceiling Height of the Existing Building

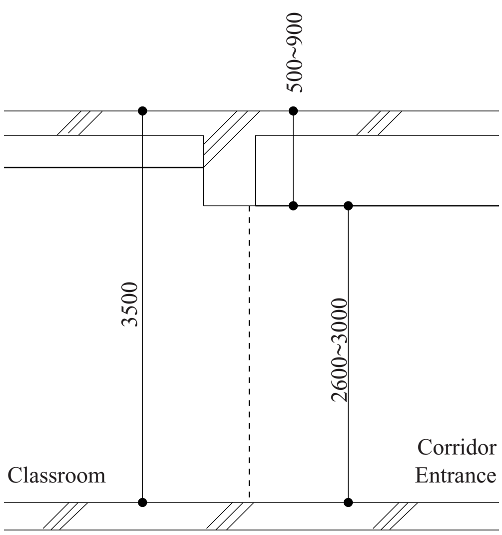


Fig 3 Ceiling Layout of the Existing Building

2.2 Spatial Changes occurred by Conversion

The ceiling height is necessarily reduced in accordance with the increasing floor finishing for making all floor flat, or the falling ceiling line for installation of air conditioner. Each room's ceiling height after conversion are illustrated in the Fig 4. Classrooms are converted into various kinds of rooms and the original ceiling height (3000mm) is enough. So the ceiling heights after conversion of classrooms can be various. On the contrary, toilet rooms being utilized as ever, the ceiling height have almost no change. Because of making floor level flat, the ceiling height of entrance shows a marked tendency to fall.

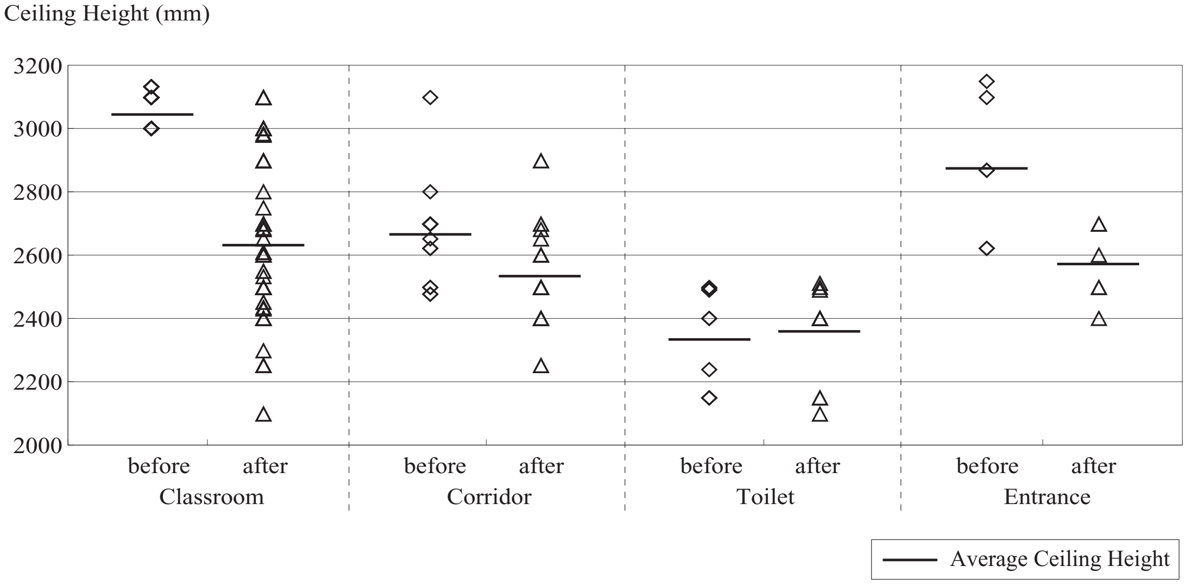


Fig 4 Ceiling Height before and after Conversion

The correlation between the increasing floor finishing and its method—mortar rendering or RC add / raised flooring system or timbering subfloor —is shown as Fig 6. That shows you the method difference—wet or dry— occurs around 100mm.

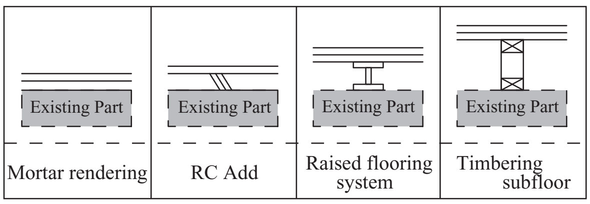


Fig 5 Method of the Increasing Floor Finishing

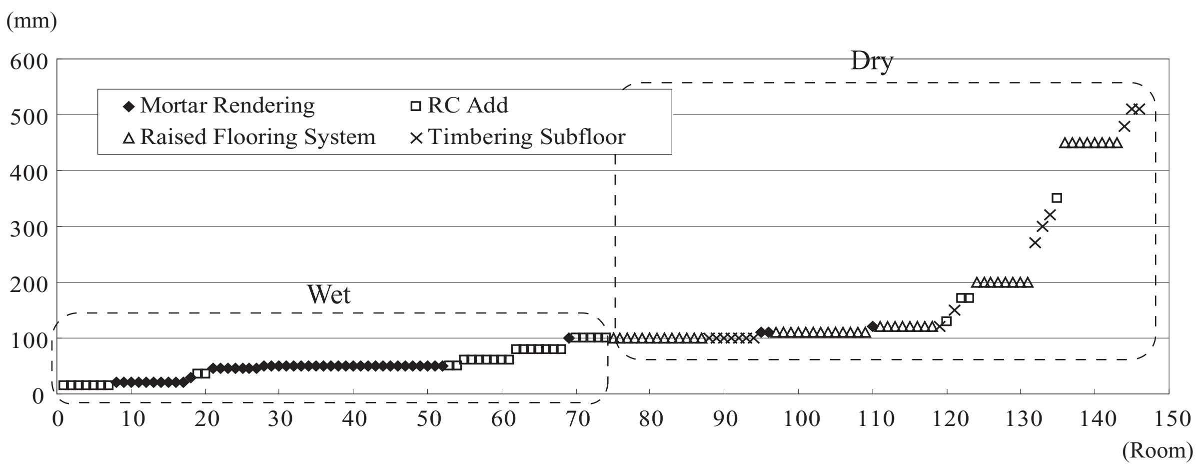


Fig 6 Correlation between the Increasing Floor Finishing and Method

3. Relations between Existing Building Specifications and Spatial Changes occurred by Conversion

The Table 3 is the points to be paid attention when the conversion planning of existing buildings into other facilities.

Ceiling height —falls by furnishing air conditions and duct (A).

Floor —removal of concrete slab (B), increasing floor finishing (C), removal differences in level (D).

(B) When the rooms without pipe lying beneath the floor are converted to be a toilet room or bathroom, concrete slab should temporarily be removed for piping work.

Opening —ceiling folding upward (E), setting up the hanging wall and the reduction the window size (F), RC add (G).

(E) When the top edge of opening is lower than ceiling height, ceiling should be folded upward.

(F) In accordance with the lower ceiling height, the window should be reduced and the hanging wall should be set up.

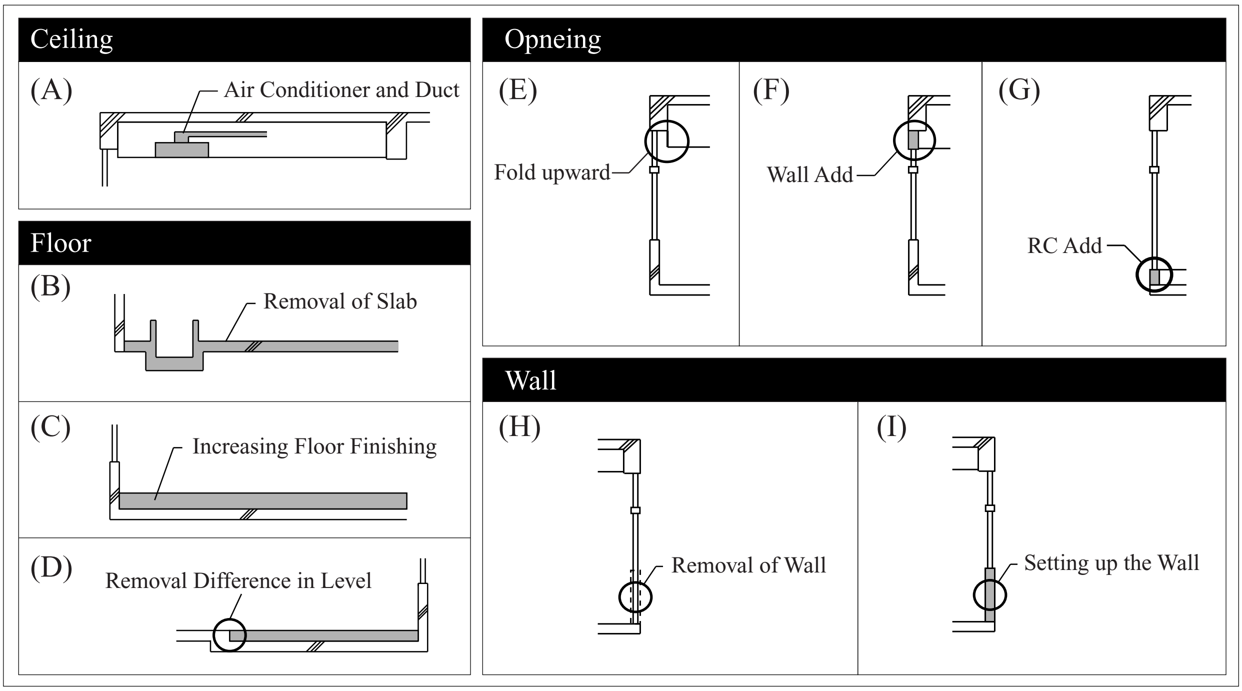
(G) In case of increasing floor finishing, sliding sash door should be reduced and RC should be add.

Wall —entrance / access change causes wall removal (H) or setting up (I).

(H) Removal of wall for setting up the entrance.

(I) Setting up the wall for removal of the entrance.

Table 3 Points of Conversion Design



Abstracting these above changes and their maximum dimensions of ceiling height fall and increasing floor finishing, the conversion planning on the existing building is shown as Fig 7. In this range, the spatial plan will be fixed. The basises for designing are drawn in dot lines.

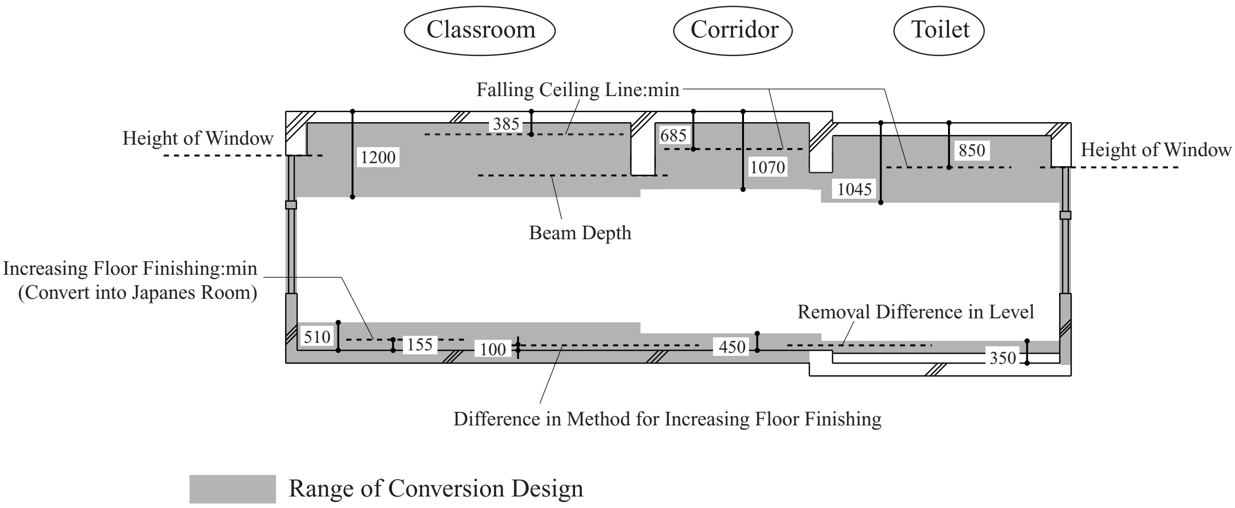


Fig 7 the Range of Conversion Design

4. Conclusion

This paper showed the school building specifications and the points to be paid attention during the conversion designing, and the range of conversion design on school building, especially aiming at the vertical sectional plan. School buildings originally have high ceiling and rather large internal space, but the lack of equipments and the difference in floor level often causes the reduction of the internal space.

The range and standard lines for conversion design that we derived was effective the space arrangement of new functions, and these can also be referred to in other countries where elementary schools are constructed under standardized planning methods similar to those in Japan.

Acknowledgments

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References

Okamura, T., M. Tsunoda. 2005. *Planning and design methods for partial conversion of public school in Tokyo 23wards*. Proceedings of the 2005 World Sustainable Building Conference in Tokyo. Paper No.10-017 pp.2892-2897

Omi, Y., S. Muralami, and M. Tsunoda. 2007. *Case Studies on Sustainable Elementary School Building Design by Partial Conversion*. Proceedings of the International Conference on Sustainable Building Asia 2007. Abstract No. PSBT07-0064

Saito, R., M. Tsunoda. 2004. *Refurbishment Works according to Conversion from Public Elementary School in Yokohama-city*. Proceedings of the 10th International Conference of CIB W104 Open Building Implementation. Paper No. 29 pp. 1-10

Design for Reuse- Case study of World Exposition 2005 Aichi Japan

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Keywords:
World Exposition, module, material conversion, bidding for reuse, Kaisho Forest Center, 3R

Abstract

In the 156 years history of World Expositions every EXPO has developed and exhibited new possibilities offered by the technology, architecture and urban design of the age the EXPO was held. In this way the World Expositions have furnished us with a glimpse of the future, a quality that has become a hallmark of the EXPO. Sometimes this glimpse has been of the immediate future, sometimes of a more distant one. Contemporary EXPOs are of a 6 months' duration, and therefore every facility at the site is basically conceived as temporary structure. The aim of this paper is to analyze the history of conversion of some

EXPOs of the past and to show which ones have been successful in this field. Secondly, we shall examine which facilities were reused and converted at the EXPO 2005 in Aichi. In this respect we shall focus on two examples of government and official participants' pavilions and see how successful planning can lead to a systematic reuse and recycling system. In this connection we shall also see, how an auctioning system can support the whole of the conversion process. Thirdly we will examine the challenges encountered during the actual conversion that took place at the "Aichi Prefecture Pavilion" converting this into the "Kaisho Forest Center".

At the same time, we shall examine how the materials that were used in the construction of this pavilion also were reused to build the "Shimoyama Elementary School". Lastly we suggest to the EXPO 2010 Shanghai, China how the system of reuse and conversion can be put into practice during both the planning and construction phases and then later during the deconstruction phase. These suggestions will be of use both for EXPO 2010 and other future EXPOs.

1. Introduction – Problematics, methodology and structure of the study:

EXPO 2005 Aichi was the first World Exposition of the 21st century. Therefore, it was important to address the pressing global problems of the environment as well as to reconsider the relation between humankind and nature. Sustainable development is not only sustainability of natural resources, but also of finding a means to do with what we already have and to use these resources to their utmost. Therefore actual conversion and the idea that conversion is a do-able practice in future EXPOs is of utmost importance.

One of the main themes of EXPO 2005 was to minimize building waste. The use of modules offered by the organizers, instead of constructing individual pavilions was to reduce impact on the environment by not having to use transportation costs for building materials sent from distant areas of the world. The 3R's system, (reduce, reuse and recycle) was considered in all the stages of planning, construction and operation. From 1994 when BIE (Bureau of International Exposition) recognized the main theme "Nature's Wisdom" to be the focal point for solution to global issues, the search to find a new paradigm for symbiosis of humankind and nature started. This was the main theme of EXPO 2005 Aichi.

One of EXPO 2005's greatest strengths was its' environmental friendliness. In order to implement this theme, a research committee for 3R's in Expo was organized in the BCJ (Building Center of Japan) in 2002. The chair was Prof. K. Kimura and other members were Prof. S. Fukao, J. Shiino, T. Nobe, S. Matsumura, M. Yamaha and H. Watanabe.

It was deemed important to conduct a self imposed environmental assessment. It was to eventually consist of some 217 items, including topics such as rare animals and plant-life, land quality and waste materials. The opinion of local citizens toward the environment was reflected through a variety of related organizations. The 3r's were also put into effect. For example, if a tree absolutely had to be removed, it was transplanted to another location or given to local citizens who planted it in their own yards.

To compensate for the loss of felled trees, many more were planted in other areas, such as Mongolia, the foot of Mt. Fuji, as well as nearby towns.

The EXPO site was separated into 2 areas. The largest was Nagakute and the smaller area was Seto. The 2.6km Global Loop in the Nagakute area was a symbolic structure in EXPO 2005 that stated "we will not tread on the terrain in order to protect life on earth". The Global Loop was a "floating" corridor that linked all the "Commons" of the EXPO at the same level. By traveling this "loop", visitors could literally, travel to all corners of the world, on foot or by using the electric trams and pedi cabs. It was barrier free for wheelchairs and baby buggies and it embodied the principles of universal design. A short portion of the Global Loop remains as a memorial of EXPO 2005. During the deconstruction of the loop, there were requests from the public to have it converted into a multi-purpose skating or skateboarding track as well as a bicycle or running track.

The Seto area was the point of origin for EXPO 2005 and was designated by the city of Seto and Aichi Prefecture to become a commemorative zone after the EXPO finished, therefore the Aichi Prefecture Pavilion was planned from the beginning with conversion in mind.

2. Building, site and infrastructure activation in past international expositions:

Before delving into the main analysis on the Aichi exposition, let us briefly examine how facilities built for international expositions were activated in the past. First of all, expositions facilities were built under the following concepts:

① Build for temporary use and demolish after exposition without reusing; this seems apart from our interest but the site exists even after the demolishment of the pavilions; it is thus the situation of this former site that we should examine from the point of view of activation.

② Build as urban stock for permanent use; this is seen in expositions of past in developing cities or countries; for example, the Paris expositions in the 1800's left not only future architectural heritages such as the Grand Palais and the Petit Palais used even today as an art museum, but also infrastructures, in the forms of the Lyon Station and the Alexandre III bridge[i].

③ Build under concept of sustainable development after making a reuse programme for a whole body or his parts; this is as we will show later in this paper, the concept proposed and practiced in the Aichi exposition. It is an indispensable concept for future expositions in any country.

We conducted a field study, from the point of view of ③, on expositions after the Rio's declaration on sustainable development in 1992 in the United Nations Conference on Environment and Development (UNCED)[ii]. Except for horticultural exhibitions and the Taejon exposition in Korea, we investigated four expositions: Seville, Genoa, Lisbon and Hannover. The Table 1 below summarizes the acquired results of this field work:

Table 1: Expositions' equipments activation in the four expositions after 1992

City Country	Year	Pavilion on the original site	Pavilion remove and reassemble	Pavilion 3R's	site	infrastructure
Seville Spain	1992	▪ Activation of 3 pavilions (ex: from the Italia Pavilion to an Incubation centre for young venture enterprises) ▪ Several pavilions left in ruins	×	×	Activation to the Cartuja 93 Parque Científico y Tecnológico (but problem of lack of public transport system except a poor bus network)	▪ Failure of activation of the rope way (now closed) ▪ Failure of activation of the park (now ruined)
Genoa Italy	1992	Activation to the Cotone Congressi Genova of the main pavilion converted for the exposition from a cotton warehouse by Renzo Piano	×	×	Activation to Porto Antico waterfront park by Renzo Piano (good visiting performance)	High quality urban design proposed by Renzo Piano (ex:reconnection of the exposition area to the old city centre by burying a current traffic road,)
Lisbon Portugal	1998	Activation of several pavilions into a theatre etc. (but problem of low function rate)	×	×	Rehabilitation of a polluted area along the River Tejo and its activation to a waterfront park (good visiting performance)	▪ Construction of an underground ▪ Construction of a new town ▪ Construction of a business district
Hannover Germany	2000	▪ Appropriation of many existing fair pavilions ▪ Activation of 4 pavilions (ex: from the EU pavilion to three Art schools and a multi-level parking structure)	Activation of 8 pavilions (ex: from the Vatican pavilion to the Kloster Volkenroda Monastery)	Paper recycle of the Japan pavilion	▪ Central area: Maintaining of the original fair site ▪ East area: activation of several pavilions to form a business district ▪ West area: demolishment of all the pavilions to form a lawn park	Construction of a tramway

Among these cases, we give high evaluation to the Genoa exposition and the Hannover exposition from the point of view of sustainable development.

The Genoa exposition seems to be a failure because of its low visiting performance, but thanks to Renzo Piano, being invited as a master architect of this event, a well considered master plan was elaborated by taking into account the sustainability of this city. Indeed, Piano met the challenge by planning with the following concept:

"The *Genovese* dislike waste. I interpret this temperament in my project so that I make works show a permanent value for Genoa with following its development plan whose perspective contains also the reuse after the session."[iii]

The exposition's heritage, constructed according to this philosophy, accommodates today 3.5 million visitors, produces 48.5 million euros of income, employs 900 employees, and raises 50 million euros of far-reaching economic effect per year.

Because the city of Hannover has had a long tradition of international trade fairs since 1946, the site program ordered a maximum use of the existing pavilions having 2 million m^2. Further more, our field study made clear the activations which are shown in Table 2, and Figure 1.

On the other hand, most of the pavilions left after the Seville exposition became ruined and the technology park built on the site is only accessible by car; it is not equipped with a sustainable public transport system except a poor bus network. Concerning the Lisbon exposition, we can appreciate the rehabilitation of a polluted area along the River Tejo and its activation to a waterfront park; but the function rate of the conserved pavilions seems poor and we saw several pavilions in ruin.

Table 2: Architectural activations after the Hannover expositions
(*Zero Emissions Research & Initiatives)

Pavilions	Activation [Conversion (C) or Remove and Reassembly (RR)]
EU	(C) 3 Art schools and a multi-level parking
Christ	(RR) Kloster Volkenroda [monastery] [Figure 1]
France	(C) Sports shop of French capital
Netherlands	(RR) RR in Netherlands (new occupation unknown)
Sweden	(C) Business centre of Swedish capital
Lithuania	(RR) RR in Lithuania as an exhibition centre
Latvia	(RR) RR in Latvia (new occupation unknown)
China	(C) Germany-China clinic
Norway	(RR) RR in Norway (new occupation unknown)
Vatican Pope	(RR) Community centre of Liepaja city in Latvia
Nepal	(RR) Nepal promotion centre in Germany
Singapore	(RR) Partial RR in Singapore (new occupation unknown)
Japan	(Recycle) Recycle of so-called Paper Pavilion
ZERI*	(RR) RR in Tokyo and Paris to be exhibited (not realized?)



Figure 1: Activation of the Christ pavilion to the Kloster Volkenroda by remove and reassembly in Freistaat Thülingen, Germany [Photo: Space Modulator, No.89、2003]

The detailed investigation on these expositions gave us the following conclusions:

① Draw a clear vision from the initial stages of facility planning and on stock activation after the conclusion of use of the facilities, the site and the infrastructure;

② Conduct a strict cost-benefit analysis if the equipment is to be conserved;

③ Prepare a transport program if the site is reused; from the point of sustainable development, the program must reduce car use and encourage the use of public transport system.

With these perspectives, now let us enter into the analysis on stock activation in the Aichi exposition.

3. Examples of material conversion in Aichi Expo 2005

Expo 2005 was a 6 month event and basically every facility was planned and built as temporary structure. In accordance to the main theme of the Expo, The 3R system, (reduce, reuse and recycle) was considered from the initial stages of the planning, construction and operation.

Examples of adopting the 3R's are as follow:

- Official participants' pavilion/module system, 18mx18mx9m (height);
- Japan government pavilion/internet auction for reuse of most of the materials;
- Gas pavilion/reuse of gas facilities;
- Kaleidoscope Tower/moved to another place in Aichi pref.;
- Expo-vision screen/moved to the Mizuo track field;
- Bench/reuse in parks in Aichi and Kanagawa pref.;
- AED/reuse in 26 cities and towns;
- Dry mist/reuse in Anjo city and Toyota city;
- Wind & solar generation/reuse in Toyota city and Anjo city;
- Global Tram/reuse in amusement facility;
- Bicycle taxi/reuse in Aichi, Gifu and Shiga pref.

Among the examples of reuse in Expo 2005 shown above, this paper will explain the following three cases in details.

Case 1: Government Pavilion of Japan in Nagakute area [Figure.2].

The pavilion was designed as temporary architecture and the reconstruction of whole building in another location was not considered. The pavilion was thought as an experimental model of new businesses of the concept of reuse and recycle of architecture in the near future. In general, the building is composed of thousands of elements, frame members, units, pieces and materials.

In the case of reuse of elements, the decision of the optimum unit or element is most important. And keeping the material value of the element and setting of the optimum price is also important.

The information system to match the supply and needs is required.

Figure 2:Japan Government Pavilion.

As the result of reuse of Nagakute pavilion, the following information is obtained:

(1) As the result of the first auction: average successful bid was 47.4%:

High percentage of what acquired successful bids was as follows:

- Elevator 100%;
- Exhibition material 63.9%;
- Environmental material 60.4% (these two materials seemed to get the premium value for memory of the Expo);
- Interior electrical wiring, air conditioning ducts and etc. 50.6%;
- The infrastructural materials were thought that the reduction in value was small.

Low percentage of obtaining successful bids was «doors and fixtures» 1.8%

(2) At the second auction, 100% of woods, kitchen facilities, equipment unit, and electric facilities were successfully auctioned.

Through the experience of bids for reuse, the following flow is required to be maintained:

① Data-base of reuse materials (kinds, quality, quantity, location);
② Obtain reuse materials (and keep and stock the materials);
③ Establish the optimum market system;
④ Establish the optimum management system.

<u>Case 2: Official participants' pavilion:</u>

In this Expo, every official participant's pavilion was designed using the module system. The basic module size was 18mx18mx9m (ceiling height) and five modules were provided at maximum. Exterior finishing and interior exhibition were completed by each country. The reason why the module system was applied was to reduce the waste of building materials after the Expo and to increase the possibility of reuse of the module. The following two examples are conversion of pavilions to factories:

Case 2-1: Qatar Pavilion was converted to the factory building of Nippon Denshi Kogyo Co., ltd. in Toyoake City [Figure.3].

Figure 3:
Left: Qatar pavilion after EXPO 2005
Right: Nippon Denshi Kogyo

Case 2-2: Austria pavilion was converted to the factory building of Jin-no Company Ltd., in Toyoake City. In this case the conventional 3 storied building was constructed connected to the reused building [Figure.4].

Figure.4:
Left: Austria pavilion after EXPO 2005
Right: Jin-no Company

4. The reuse program of timber at Aichi Kaisho Forest Center (Aichi Pavilion Seto at the Expo 2005 Aichi, Japan)

The Aichi Pavilion Seto, in the Seto area, is one of two pavilions that were constructed by the host prefecture Aichi. The 3,000m^2 pavilion used during the expo was scheduled to be reduced to half the size after the EXPO, and become the Satoyama Visitor Center, located in the 'Kaisho Forest' construction zone. It is possible to say 1,500m^2 of the permanent section, which included furniture, was reused. The other 1,500m^2 temporary sections, will now be discussed in some detail keeping in mind the concept of 3R's.

The temporary section of the exterior walls of the Aichi Pavilion Seto was constructed using pure, unrefined timber. Excluding the theatre part, the same timber was used for the interior walls and floorboard. Approximately 100m^3 of temporary housing materials were nearly 100% reused in the reconstruction work. This reuse initiative was planned in detail right through from the design phase. A search was conducted for a site that was still under construction when the exposition ended in order to identify and examine whether materials could be used from the Aichi Pavilion Seto. An elementary school based relatively close to the EXPO site in Shimoyama Village[iv] expressed a willingness to be involved in the reuse plan and therefore timber was used from this region.

Due to the timber being public property, this complicated ownership details and therefore a clearance valuation was required to complete the transfer of ownership. However, within the half year period of the EXPO, the depreciation on the materials was minimal and hence it was possible for these second hand materials could be purchased at price higher than their actual cost. To avoid this problem the following steps were taken. Firstly, Aichi Prefecture borrowed timber on lease and upon termination of the Expo, the materials were returned to the Shimoyama Forest Association. Secondly, the materials were bought by Shimoyama Village and supplied to the elementary school construction group [Figure. 5].

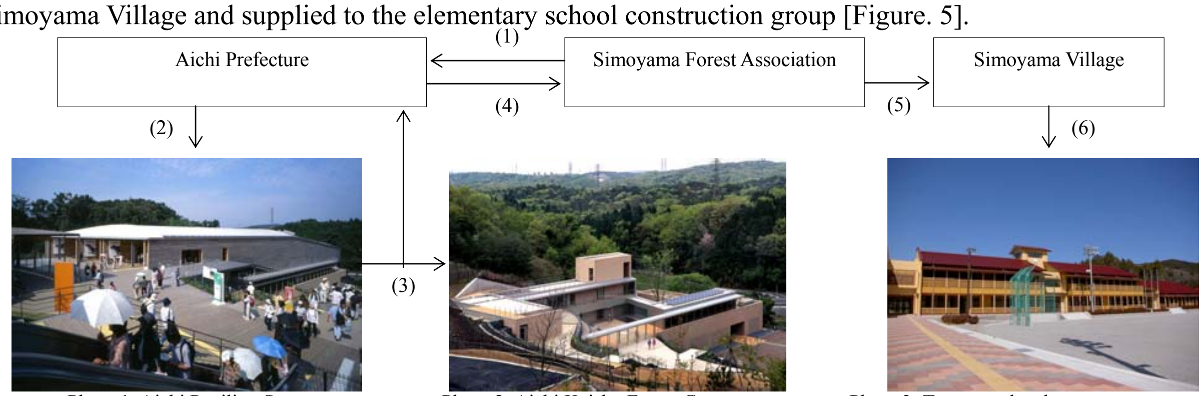

Photo 1: Aichi Pavilion Seto　Photo 2: Aichi Kaisho Forest Center　Photo 3: Tomoegaoka elementary school of Simoyama village

(1) A lease loan, (2) A construction period & an exhibition period, (3) Reconstruction, (4) A lease expiration return, (5) Sale, (6) Construction and the completion

Figure 5: The reuse flow

This above process also assisted with the handover of materials between Aichi Prefecture and contractor. Such building materials are often managed by the contractor through the construction phase and are handed over upon completion as usual. However, if the contractor were to sublet the contract it would infringe the law. Therefore, during construction, the materials were borrowed by Aichi prefecture, which bore the construction insurance cost for the material and the contractor bore the installation and processing costs. Thus, by using this arrangement it made the lease plan possible.

Some ideas were required for the design and construction of the sites, not only for the module and details but also as part of the reuse plan. Using the unit system could restrict both the buildings and incur losses, and would also have increased the costs at the same time. Therefore a refined process was adopted where the timber used for construction was assembled gradually piece by piece, thus minimizing the risk of over expenditure. Furthermore, to facilitate the drying process of the timber, gaps were left between the timber beams during the running of the Expo.

Photo 4:
The outside details of
Aichi Pavilion Seto

Photo 5:
The inside details of
Aichi Pavilion Seto

Photo 6:
The floorboard was made of hinoki (25mm × 110mm),
The outside and inside wall was made of cedar(25mm × 180mm)

Photo 1, 2, 4,5,6: by T.Ohashi
Photo 3: by Aichi prefecture

Figure.6 Details

Advantages:

① Aichi Prefecture and Shimoyama Village were able to reduce costs working together, by having the recycle plan in place.

② Positive forest management effects by using local materials along with reduction of CO2 (carbon footprints) by increasing efficiency of transportation.

③ Children and citizens of the area were enlightened by the fact that local timber was used at the Expo and reused at their local elementary school.

Future Points to Consider:

❶ In construction of the exhibition building and in reconstruction, it was necessary to forecast the rate of potential loss;

❷ The construction process did not go as smoothly as planned, due to extension of materials depot, resulting in lost production time.

In conclusion, Shimoyama Village, Shimoyama Forest Association, members from Aichi Prefecture Municipality, designers and contractors met and comprehensively reviewed the entire project, right back to the initial stages. In addition, there are currently similar lease projects in progress where the entire building is to be leased. The objective now is to promote the idea of public ownership, review legislative reform, and make construction methods with recycled materials more common place. Looking to the future the process of maintenance and recycling requires further examination into the durability of buildings and materials used in construction.

5. Conclusion and Advice for Shanghai Expo

The next registered World Exposition will take place in Shanghai in 2010. The theme is “Better Cities-Better Life”. The construction on the site has already started and the EXPO promises to become a very important milestone in the history of World Expositions, with a very large number of participating nations and probably of a record number of visitors. We understand that the Shanghai EXPO intends to use the concept of sustainability that was so successfully launched at the 2005 EXPO, a concept important to have present in almost all the areas of EXPO.

The question of waste will be one of the major challenges at this EXPO and will affect almost all areas of the event. Waste is not only material waste but also waste of resources, knowledge etc.

In order for this major event to get the best possible results in cost efficiency, learning from the recent EXPO in Aichi can prove to be crucial.

Therefore the 2010 EXPO in Shanghai can no doubt use the well-documented experience of EXPO 2005 Aichi to its own advantage and to the advantage in general of the EXPO movement. Building upon the experience of the past, is also a kind of "conversion" and "reuse", like when Shanghai EXPO plans to use old factory buildings in their "Best city practice zone", they actually adhere to the principle of conversion, this shows how sustainability and conversion are matters of the greatest importance to this EXPO - just as it was to EXPO 2005.

The experience of EXPO 2005 Aichi in reuse and conversion can be useful, relevant and of great benefit for the organizers of the next EXPO in Shanghai in 2010.

Basic references:

- HIRANO Shigeomi (in Japanese), *Encyclopaedia on the history of the international expositions*, Tokyo, Uchiyama-koubou, 1999
- TRIGUEIROS Luiz et al., *Lisbon Expo 98 – Projects*, Lisbon, Blau, 1996;
- *idem*, *Exposição mundial de Lisboa – Arquitectura*, Lisbon, Blau, 1998;
- WORNER Martin et al., Architeckturführer Hannover, Berlin, Dietrich Reimer Verlag, 2000;
- OTTO Hermann, Architektur der Expo-Stadt, Hannover, Verlag Artforum, 2000;
- PIANO Renzo et al., *Porto Antico di Genova 1995-2004*, Genoa, Porto Antico S.p.A., s.d.;
- LAGOMARSINO Luigi et al., *Cento anni di architetture a Genova*, Genoa, De Ferrari, 2004;
- MORICONI Mauro et ROSADINI Francesco, *Genova 900 – L'Architettura del movimento moderno*, Torino, Testo & Immagine, 2004;
- Case study "Aichi Expo Tree", edited by Aichi Prefecture, Ministry of Agriculture, Forestry and Fisheries, Forest Department, March 2006
- 3Rs in advanced eco-oriented project Bureau of International Exposition 2005 Aichi, Japan.

Basic websites:

- International expositions bureau: http://www.bie-paris.org/main/index.php?lang=2
- Parque Expo 98 S.A: http://www.parquedasnacoes.pt/inicio.asp?V=5&L=pt
- Museum der Expo 2000 Hannover: http://www.exposeeum.de/expo2000/index_e.htm
- Cartuja 93 Parque Científico y Tecnológico: http://www.cartuja93.es/
- Porto Antico di Genova S.p.A: http://www.portoantico.it/
- Renzo Piano Building Workshop: http://www.rpbw.com/
- AICHI Prefecture : http://www.pref.aichi.jp/rinmu/expo_kizukai.htm

Notes:

[i] It is interesting to remark that there are some cases in which a certain number of Expos equipments were left behind without previous program. For example, the Eiffel Tower was programmed to be demolished at the end of 20 years after the Expo of 1889 but she was conserved to be an important cultural urban stock today.

[ii] For the detail of this field study, refer to the following articles (in Japanese): TORIUMI Motoki and TSUNODA Mari Christine, « A basic fieldwork for the research on World Expositions heritage», in *Proceedings for the 2005 AIJ meeting F-1*, September 2005, pp.377-378; idem, « Building Stock Activation after Seville and Genoa Expositions - A basic fieldwork for the research on World Expositions heritage II», in *Proceedings for the 2007 AIJ meeting F-1*, September 2007,

[iii] ISHIDA Shunji (in Japanese), *Renzo Piano Navigation Journal*, Tokyo, TOTO publications, 1998, p.102.

[iv] This village is now a part of Toyota City by merger.

Open Construction for Living Façades of Residential Buildings in Taiwan

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Keywords: Open building, housing façade, building envelope, urban form, balcony

Abstract

The balconied façades of residential buildings in Taiwan are one of the most vigorous parts of urban streetscape. They are usually enclosed by metal grating soon after construction, and kept changing over time. Although these living facades reveal a great deal of functional complexity, constructional disorder and chaos in appearance, they have shaped a unique living culture and urban form in Taiwan.

Today building renovation in Taiwan is getting to play a more important role in construction industry; the conventional building industry for new housing has been very slow while fit-out business is growing prosperously due to the demand for higher living quality and more sophisticated functions. Since sustainable development has become an irresistible movement the building stock activation for living adaptation responding to its environmental, social and cultural concerns are particularly critical.

With a view to dealing with the chaotic building appearance and keeping active adaptation, this study proposes an incorporated solution for the balconied façade of residential building in Taiwan; technically adopting open construction methods with minimum environmental impact to meet the needs of living adaptation such as upgrading physical building quality, accommodating the increasing HVAC equipment even solar devices in a passive and healthy way, and culturally following the local thematic systems to incubate vernacular urban forms. A comparison with other cultures like those in Middle East is also discussed to broaden the view of this study.

1. Introduction

The contemporary high-density urban housing in Taiwan has revealed a fine-grained quality responsive to the needs of the individual inhabitant through its living facades, especially the balconied facades. But this fine-grained quality is mostly shown in a disorder or even chaotic way so that the streetscape is bad in appearance. The reason for this untidy phenomenon is lack of better technical solutions which beyond the control of building regulations. The ideal solutions should be in favor of adaptation and making changes in a way following the consensus or the vernacular culture. In terms of open building, they should be based on capacity design, open construction and thematic systems.

Façade itself has played two roles in the built environment; morphologically and culturally it is a basic element of streetscape to brew the urban form. Physically it is the main part of building envelope or building skin to protect from weather, noise and human intrusion for shelter, safety, public health, and to obtain natural resources for comfort. When a balcony attached, it provides more vigorous living functions.

The well-known Next 21 project in Japan demonstrated ideas of providing variety for unit layout and capacity for later change, including relocating façade panels. Which suggested a new model of future housing as part of urban form with fine-grained quality in horizontal and vertical distribution. Although the relocation of its façade panels came out in difficulty due to the restriction of connecting methods, the trial was still a valuable experience.

The purpose of this study is, by following the trend of return to fine-grained urban fabric, to develop a better model of housing façade in Taiwan. Therefore, under the control of morphological, territorial and cultural orders, the capacity for change through positioning, zoning with shared values, and constructional interface with open system are pursued.

2. Methods

Based on the theory of open building three steps are taken; firstly, change behaviors on the balconied facades are widely observed and surveyed. Secondly, through the measurement of selected cases, capacity for change is analyzed by observed functions, dimensional regulations and construction methods. Thirdly, a thematic system is developed to synthesize the capacity design with sustainable construction.

3. Results

3.1 Patterns of Change on Facade

The façades of residential buildings in Taiwan are typically composed of exterior walls and balconies, which are enclosed by metal grating usually soon after the completion of construction, and then keeping changed over time. And it is obvious that the balconied façade is the most frequently changed part of the building envelope of housing in Taiwan. The changes on these balconied façades, by recent observation, could be categorized to six patterns, in terms of the degree of popularity, as follows.

3.1.1 Attaching shelters

With a view to protecting openings from the rain, the sun and the intruder, overhangs and metal grating are attached align with the wall or protrude beyond the wall. Thus the openings are still open or semi-open to the public.

3.1.2 Attaching or relocating facilities

Due to the innovation of air conditioning system in the hot and humid climate in Taiwan, the size and the amount of AC units are beyond the capacity of the existing space. Thus attaching to the facades becomes the easiest solution meanwhile the running pipes are exposed at will.

3.1.3 Extending space

By enclosing balconies or terraces, the spaces could get better protection and privacy. Thus interior spaces can be enlarged, even extra rooms are created.

3.1.4 Planting or decorating

Plants are put on the floors, decks or hung on the walls. Occasionally garden-style fence and seating are decorated for leisure amusement.

3.1.5 Replacing materials or windows

When renovation is taken, finishing materials are often replaced for waterproofing, and windows are often replaced for functional upgrade.

For the above-mentioned changes small contractors construct most of the cases. Except for renovation the materials used are semi-finished products such as metal studs, glass panels or acrylic-plastic sheets, which are connected by screws, bolts and silicon.

3.2 Capacity Analysis and Suggestions

The changes on the balconied facades — no matter the old fashion long balcony or the new style short shallow balcony— have shown their complexity of functions which beyond the expectations of the designers. In other word, the balconied facades are lack of capacity for change. Therefore, this disorderly and crowded streetscape becomes the basic element of urban form in Taiwan (Figure 1-2).

Fig. 1 Complicated Functions on Balconies

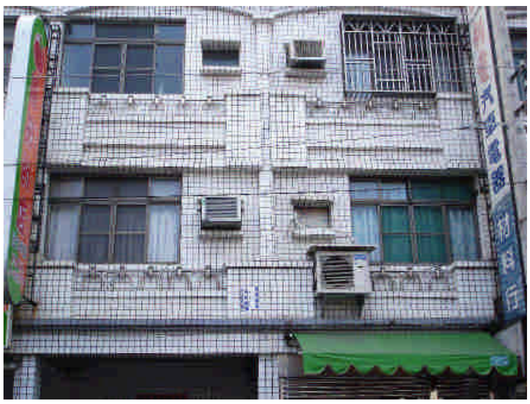

Fig. 2 Disorder on Facades

With a view to improving the capacity for change on the balconied façade, its functions and roles must be clarified, its dimension and module must be coordinated, and its construction methods must be easy for de-composition, re-composition and incorporation of M&E systems. Through a wide survey in this study, ten typical cases are selected and measured. The followed analysis, reorganization and suggestions are described as below.

3.2.1 Roles and functions

As a role of elementary unit of urban form, the balconied façade function as:

(1) Interface of levels; between building level and infill level

(2) Interface of territories; private territory but Semi-public space

(3) Shared value of building form; balcony as cultural thematic variation

As a role of building envelope, which is composed of the exterior wall and a balcony, the balconied façade function for:

(1) Protecting from weather; shading, rain and wind sheltering, heat insulation

(2) Protecting from noise (as sound barrier) and dust

(3) Protecting from intrusion of human or insects

(4) Protecting children from falling down

(5) Catching daylight and decreasing the glare of sunshine

(6) Exchanging air and energy for ventilation, air conditioning and discharging exhaust air from kitchen or toilet

(7) Utilizing sun and fresh air for clothes sun baking and gas burning in water heater

(8) Providing space for clothes washing, drying and hanging, water heater and AC unit installation, tools and garbage storing, and planting, etc.

(9) Escaping from fire or disaster; hanging 'Emergency Exit & Escape Sling'

3.2.2 Dimension and module

In a typical unit of a residential building, dimensional regulations on elevation and section of the balconied façade are observed as the following. On horizontal dimension, two or three sectors could be classified following the same required functions as mentioned above (Table 1). While on vertical dimension, three zones could be classified referring to the above-mentioned functions of the building envelope (Table 2).

Table 1 Horizontal Distribution of Functions

Sector / Function	Side Sector	Middle Sector	Side Sector
(1) Protecting from weather	sun, wind, rain, heat	sun, wind, rain, heat	sun, wind, rain, heat
(2) Protecting from noise and dust	noise, dust	noise, dust	noise, dust
(3) Protecting from intrusion	human, insects	human, insects	human, insects
(4) Protecting from falling	children	children	children
(5) Controlling sunlight		daylight, glare	
(6) Exchanging air and energy	exhaust air, waste heat	fresh air, sun energy	exhaust air, waste heat
(7) Utilizing sun and fresh air	heater	clothes	
(8) Providing space	fan or AC washer, sink	hanger plants	fan or AC dryer, cabinets
(9) Escaping for safety		cable hanger exit door	

Table 2 Vertical Distribution of Functions

Function / Zone	(1) Protecting from weather	(2) Protecting from noise and dust	(3) Protecting from intrusion	(4) Protecting from falling	(5) Controlling sunlight	(6) Exchanging air and energy	(7) Utilizing sun and fresh air	(8) Providing space	(9) Escaping for safety
Upper Zone	sun, wind rain, heat	noise dust	human insects	–	daylight glare	exhaust air waste heat	–	fan or AC hanger	cable hanger
Middle Zone	wind heat	noise dust	human insects	children	daylight glare	fresh air sun energy	clothes heater	plants dryer	exit door
Lower Zone	wind heat	noise dust	human insects	children	–	fresh air sun energy	–	washer sink cabinets plants	–

And when the two dimensions are put together, the reasonable distribution of functions on a unit façade could be positioned (Figure 3). Beside the prevention from noise, dust, insect and human intrusion should be in all surface area, other functions could be classified to the specific dimensional range as zones and sectors. A missing function for day lighting is suggested as showed on the oblique lines. For those housing units with less flooring area or having two balconies in the front and in the back, smaller façades of two sectors are applied. For those housing units with more flooring area or having only one balcony, larger façades of three sectors are the cases.

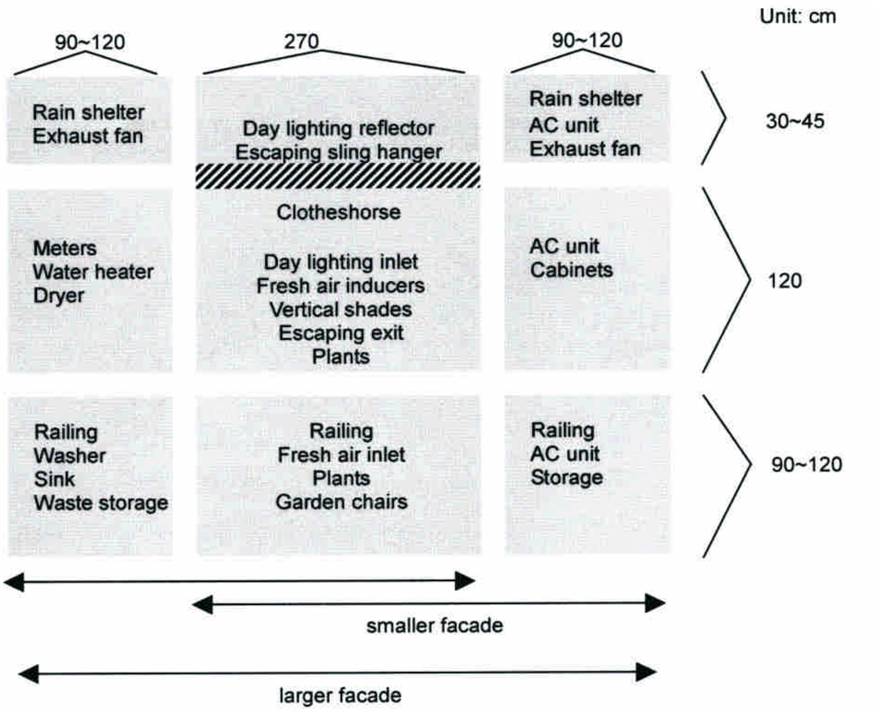

Fig. 3: Elevation of Balconied Facade

On its section the depth of balcony in most cases is between 90 cm and 150cm. With a view to carrying AC units, installing cantilevered security metal grating, hooking the Escaping sling hanger or keeping clearance for vertical shades, an extra depth of 30cm is needed to extend outwards (Figure 4). Due to the poor shading and daylighting design of housing in general, a proposed overhang could be placed between the upper zone and the middle zone, in the middle sector, so as to shade the opening meanwhile to help reflect daylight into the deeper room. This also could be the support for the escaping sling hanger and the clotheshorse. Besides, the partial setback or protrusion of the façade is suggested (Figure 5), which keeps the exhaust air outlet away from the fresh air inlet, may help insure the air quality and cleanness between stories in terms of hygiene. Further study of its aerodynamic behaviors in micro-scale is needed.

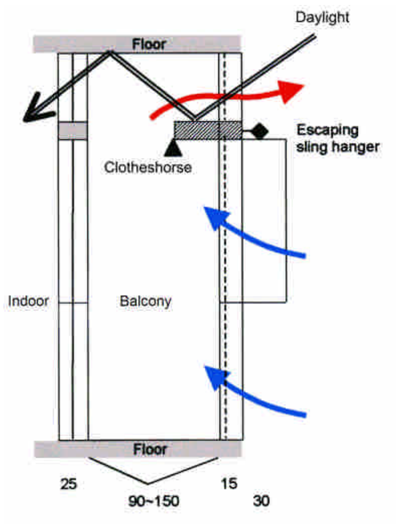

Fig. 4 Section

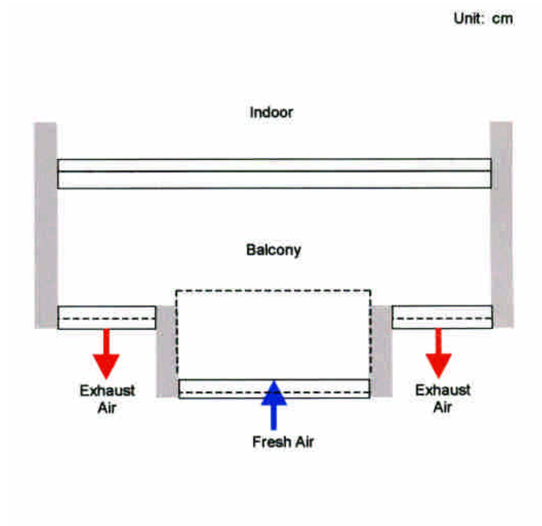

Fig. 5 Plan

3.2.3 Constructional interface

The basic infill elements of a typical balconied façade in Taiwan including concrete walls, aluminum windows and doors, sliding glass doors, short concrete wall, steel rails, etc. are mostly connected to the structure in a chemical way such as by mortar. When being occupied the attached elements, including PS canopy, steel grids, aluminum windows, AC units, etc., are usually connected to the existing façade in a mechanical way such as by expansion bolts. Therefore, the first constructed infill elements are difficult to be changed or renewed while the later attached elements are relatively easier to do so.

3.3 Proposition and Discussion

With a view to providing “capacity for change” on the balconied façade and controlling the change in a thematic way, a better approach is suggested by steps as follows.

Step 1: to separate the construction of the infill with the shell. That is to separate the façade with the building structure.

Step 2: to connect all the elements and components in a detachable and reusable way while the elements and components themselves are replaceable and exchangeable in size and shape.

Step 3: to package all the infill elements by zones and sectors. The package may involve the two layers of the double skin or just the outer layer depending on the individual situation of each case.

3.3.1 Thematic proposal

Since the major feature of housing façade in Taiwan is the iron or steel grid-like railing which covers the opening of balcony and window. It looks ugly and cage-like but there is no way to stop its construction except controlled by compulsory prohibition. In this case, it has to be taken for granted as part of the living culture. And shifting attitude from prohibition to adoption is necessary so as to find a positive solution.

An interesting finding from observation is that those iron or steel grid-like railings, which usually covered by canopies, are not for preventing from human intrusion by thieves or robbers anymore as we thought. They were for that purpose in the beginning but no longer effective today. Other consideration are possible, such as increasing the sense of safety, improving privacy to a certain extent, protecting clothes for drying, and enhancing the rain leakage proof due to the poor construction quality in average (Figure 6-7).

Fig. 6 Grid Variation

Fig. 7 Railing not for Protection

Through the synthesis of roles, functions, change patterns and dimensional regulations a unit model of thematic design is proposed as below (Figure 8). Thematic variations are shown as well. The unit model is consisted of a metal framing and panels or equipment. The framing of three zones and two or three sectors is anchored to the building structure, and panels or equipment are filled into the framing at will.

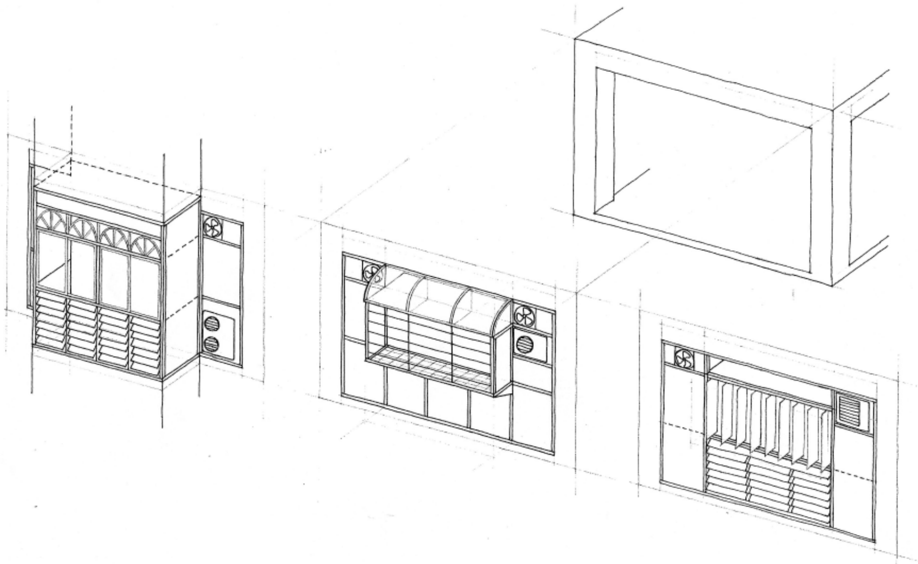

Fig. 8 Thematic Variations on Balconied Facades

3.3.2 Potential development

The model proposed here looks simple and easy in practice, but it still needs follow-up. Different viewpoints are discussed to broaden and deepen the meanings it implies; Technically the balcony offers a chance to create double-skin façade; when the balcony is covered and enclosed, double skin is created on the façade and its functions may work like a "box window" (Figure 9). When AC units are installed within, comparing with the traditional windows in Middle East (Figure 10), it seems play the same game.

Fig. 9 Box Window

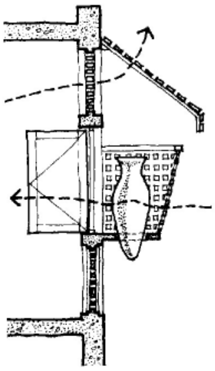

Fig. 10 Window Fixture()

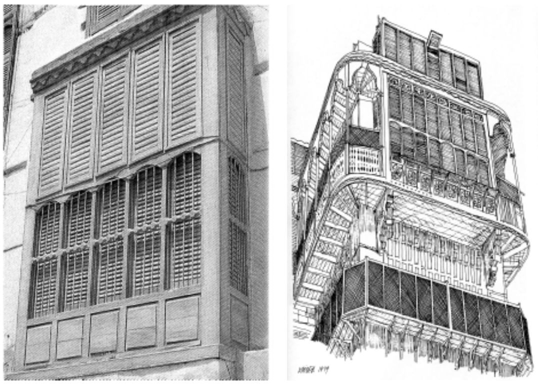

Fig. 11 Wooden Screen Windows(Talib, 1984)

Culturally the model offers an interesting comparison with the traditional housing facades in hot and arid areas; the unique building features with cantilevered or screened windows and balconies in India, Middle East and North Africa (Figure 11) have the similar flavor. Refinement of the model is needed to incubate cultural beauty.

5. Conclusion

In this study an effort to synthesize interdisciplinary knowledge and concerns is made so as to explore new possibilities of problem solving to the existing living environment in Taiwan. As a result a thematic design of balconied façade is proposed to response to the common life in Taiwan as well as to shape the basic urban form practically. Thematic variations are expected to present a collective aesthetic values and cultural appreciation in a sense. While the packaged construction method may introduce trade reorganization for mass customization and help further development of infill products in Taiwan.

6. References

Habraken, N.J. 2003. 'Making Urban Fabric Fine Grained', Proceedings of Dense Living Urban Structures, International conference on open building, vol.1, pp. 27-32. Hong Kong: Faculty of Architecture, The University of Hong Kong.

Kobets-Singh, Elena & Kendall, Stephen. 2001. 'Living Facades', *Agile Architecture Proceedings*, pp. 133-145, Delft, The Netherlands: OBOM, DelftUT.

Liu, Peng. 2001. 'Living Facades', *Agile Architecture Proceedings*, pp. 169-182, Delft, The Netherlands: OBOM, DelftUT.

Talib, Kaizer. 1984. *Shelter in Saudi Arabia*, London: Academy Editions.

A Comparative Analysis of Building Envelopment Technologies

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Key words: Sustainable construction, economic sustainability, anthropogenic heat load.

Abstract

This paper describes the use of a new wall panel system that can be retro fitted to exiting building stock. It describes the inherent insulation improvements, ease of retro fitting and its low anthropogenic heat absorption ability, particularly useful for built up cities concerned with the Heat Island affect.

The paper further describes the outcome of a wall systems evaluation study for the Sydney market as of 2003, which concluded that Autoclaved Aerated Concrete (AAC) panel systems had the potential to give both builders and developers savings in time, cost and ease of construction on commercial, residential and other projects when compared to other envelopment systems.

Findings from the case studies showed that for a project of about one hundred units, valued at around twenty million dollars, the main savings were as follows:
Between 10% and 30% savings on wall costs depending on the building's design and performance criteria..
Between 10% and 17% saving on size and cost of the structure by reducing the overall mass through lighter weight walls.
Between 4% and 8% saving on time over a concrete framed traditional masonry alternative, based on a construction program of about a year, and over 40% saving on time of construction for a concrete framed AAC solution compared to a load bearing block work alternative.

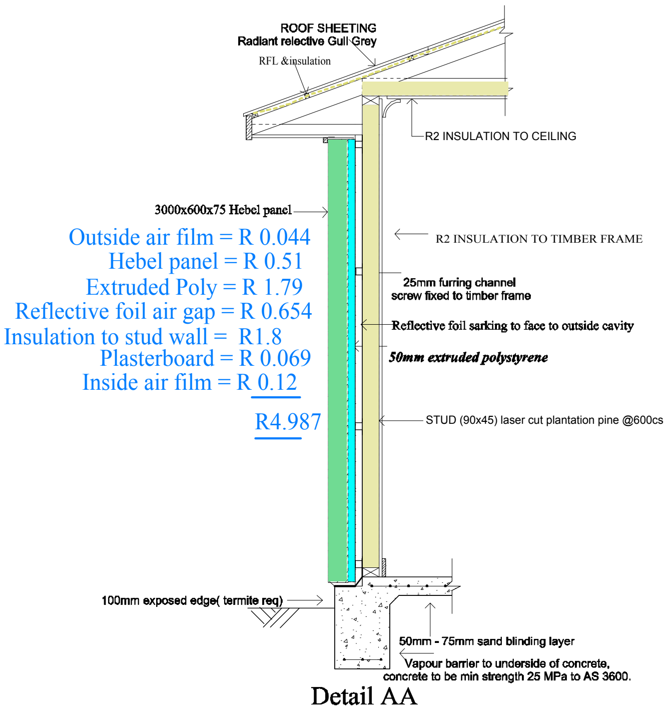
Further considerations of applying the triple bottom line to social and ecological values are also discussed in the paper.

Introduction

The need to incorporate economics and buildability into lean / community (low funds available) projects created a desire for the author to design a wall panel that could be built quickly, operate efficiently, be easily be disassembled, recycled and offer retro fit ability to existing structures.

The author's desire to produce a high efficiency wall cladding both thermally and with mainstream buildability culminated in the design of the Supatherm R 5 wall panel, which has been developed with assistance from CSR Hebel Pty Ltd and Aerodynamic Developments Pty Ltd. The panel has twice the insulation value of standard brick veneer construction, 4.5 times less weight than brick veneer and is estimated to be 30% faster to build with similar embodied energy.

Alternative to standard construction



Alternative is faster to build, 4.5 times less weight.
And has twice the insulation value

Figure No 1. Supatherm R5 wall panel

The external cladding system was then derived as the focus for a more refined research study and several proposed systems have been extensively evaluated (West 2006) refer to figure 2.

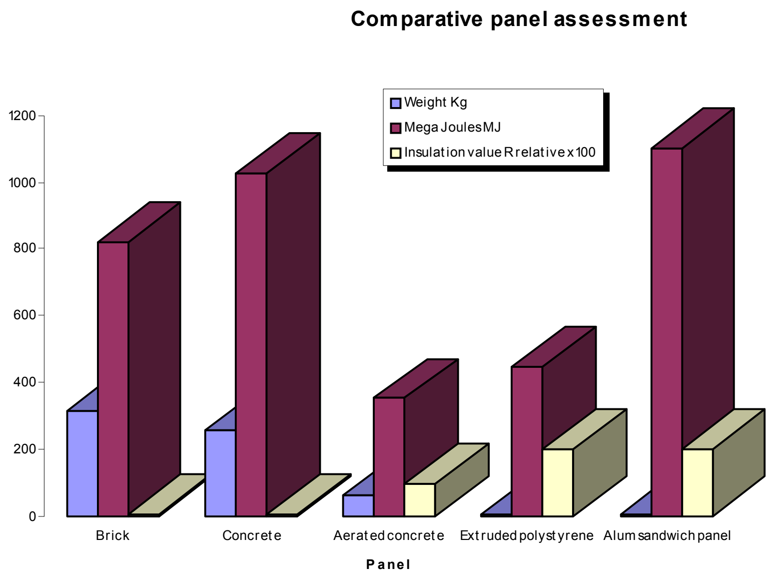


Figure No 2. Comparative analysis of suitable wall panels, comparing weight, embodied energy and insulation properties

The buildability, methodology and the first trial application of the technology were first employed on a small project building in Strathfield, Sydney Australia (refer to figure No. 3), which proved to be very successful. The wall system utilised a timber structural frame, which is common in traditional Japanese architecture. The timber frame was assessed as being preferable as a renewable / sustainable plantation source and timber has the outstanding features of not only being a renewable resource and easily worked, it has the added ability to lock in carbon and produce oxygen during its growth.

Figure No 3. Supatherm system applied to a timber structural frame

Further to this successful implementation where the walls were erected in a day a further series of experiments were organised for 3 test buildings to be built on the University of Technology, Sydney's property at Yarrawood, western Sydney region.

The Yarrawood experiments were initiated at UTS under the initial guidance of the author to assess and analyse actual buildings internal temperatures and subsequent energy required to maintain comfort levels with heating and cooling values compared to various building envelopes.

The experimental project initially funded by CSR Pty Ltd at the Yarrawood site of the University of Technology, Sydney simultaneously measured internal temperatures of three identically shaped and configured buildings (except walling materials), allowing a thermal comparison of test buildings with approximately 40m^3 internal airspace each. The experiments included the Supatherm, lightweight insulated (Hebel) aerated concrete panel devised by the author for its buildability, low anthropogenic heat value while maintaining high insulation, offered twice the thermal insulation value over the alternate wall systems, which were a standard brick veneer cladding and a mud brick building, refer to figure No 4 below.

Figure No 4. Low anthropogenic heat, high insulation wall panel.
(Photo courtesy CSR Pty Ltd , Moor and Heathcote, UTS)

The results of these experiments has only limited data but a review of results by Heathcote (2006), revealed a 1.4^0 Celsius lower average for maximum temperatures for the insulated Hebel building. This is a significant measure for reducing anthropogenic heat island uptake, when considering sensible heat and thermal mass gain. For a 40m^3 internal airspace based on a 21^0 C and 50% RH setting, a 0.2 kWhr energy input requirement is needed to reduce the high thermal mass airspace by 1.4^{0}C to match the insulated airspace temperature.

The real energy savings achieved by low anthropogenic heat uptake walls are much greater when the insulation properties of the walls are further considered for cooling and heating of internal airspaces by on going energy savings achieved in maintaining temperatures to an insulated airspaces and these insulation considerations have a marked effect on energy consumption and health as sleeping and productivity have been shown to be affected when night time temperatures are above 25^0 C, refer to Murakami (2006) “Tropical nights”, data has shown that the number of nights above 25^0 C has increased from 10to 50 nights in fifty years in Tokyo.

The issue of heat island effect, continuing temperature rise and the ongoing negative affect on summer peak power loads is a concern for all major cities with populations above 2 million. Tokyo, by way of example (population exceeding 12 million), has had a rise of 3^0 C in annual mean temperature in the last 80 years. Murakami (2006) applying data supplied by the Tokyo Electric Power Company, calculated that the impact of a one degree temperature rise on peak power supply (Exasperated by high thermal mass city environments) for the hottest day in the Tokyo area was equivalent to 1.8GW of electricity - an enormous 3% increase in power supply. The estimated supply by nuclear power generation was calculated as equivalent to 2 medium-sized nuclear reactors at a cost of $2.5 billion (US).

Comparison of Autoclaved Aerated Concrete (AAC) panel system versus traditional concrete block

A number of residential projects within the Sydney area were analysed in 2004 in order to review the performance of AAC in terms of time, cost and buildability in real terms. As a comparison, a non-load bearing AAC (Case study 1) and a load-bearing concrete block masonry project (case study 2) were reviewed in order to reveal the issues that are relevant when using these wall systems. A summary sets out the similarities and differences of each project and each wall system considered.

The Bauhaus Apartments (figure No.5) is a complex of 134 units completed by Multiplex Pty Ltd in January 2002. It is a concrete framed structure, using non load-bearing walls to separate individual units and common areas on each floor.

Figure No 5 Bauhaus Apartments in Pyrmont (2001-2002)

Overview Case study 1

Wall type choice
AAC panels were used at this project for inter-tenancy walls. These walls were basically in straight lines with minimal set-out required as they were placed between columns, making it an ideal AAC project. The wall type is a 75mm panel, combined with a 64mm steel stud, Tontine insulation and lined on both sides with 13mm plasterboard, achieving an STC rating of 50 in the field.

Architects Krikis Tayler detailed the CSR Hebel wall panel as a lightweight, fast and acoustically high performance wall panel that would be ideal on this project where plasterboard was used as the surface for all walls.

Cost
The use of AAC represented significant savings to the builder over a block work solution as originally detailed. The following table Table No1 sets out savings made over the whole project in terms of supply and installation costs.

Table No 1 Savings in supply and installation

Component	Wall Height	Wall Length	Total Area	Cost / m2	Total Cost	Comment
AAC Panel	2.54	147	373.38	$ 65.00	$24,269.70	Panels 2.54m height x 600mm width.
64mm Stud	2.54	147	373.38	$ 10.00	$3,733.80	
Insulation	2.54	147	373.38	$ 5.00	$1,866.90	50mm thickness Tontine TSB 4
Sundries	2.54	147	373.38	$ 5.00	$1,866.90	Includes fixings backing rod, AAC adhesives, etc.
				Total =	$31,737.30	
Block work	2.54	147	373.38	$ 80.00	$29,870.40	Block work rate based on single height work. No additional scaffolding required.
Furring Channels	2.54	147	373.38	$ 20.00	$7,467.60	Furring channels on both sides of walls.
Acoustic Mounts	2.54	147	373.38	$ 7.60	$2,837.69	Fixed to block work at 600mm centres.
Insulation	2.54	147	373.38	$ 10.00	$3,733.80	2 x 25mm thickness Tontine TSB 2
Sundries	2.54	147	373.38	$ 5.00	$1,866.90	Includes fixings, fire rated mastic, brick ties, etc.
				Total =	$45,776.39	
Total Saving per floor for using AAC system instead of block work =						$14,039.09
Total Saving per floor multiplied by 12 floors =						$168,469.06

Note: Wall length is total of all inter-tenancy walls per floor.

Assume supply and installation of plasterboard and setting is same for both systems.

Table No1

Further to the direct savings as shown above, additional indirect savings were made from reduced site accommodation and reduced waste. The actual cost of AAC related site accommodation and rubbish removal, together with an estimated cost for the same for block work wall systems, highlighted a further $40,000 saving in this area of the project.

Time

The use of AAC panels on the project provided a significant time saving on the fit-out cycle. This initial saving can be taken even further when considering that AAC panels are much cleaner to install than conventional brick or block work, thus eliminating the need to scrape floors prior to laying carpet.

As can be seen, a saving of 10 days was made for the cycle of a typical floor, allowing finishing trades to access a cleaner area, much earlier, in order to complete their works. It should be noted that this 10 day saving can only be made once, as each trade must stay in sequence, thus the total contract saving would be about two weeks, and not 10 days multiplied by twelve floors as may be interpreted on first appraisal of the program.

Buildability

Being an inner city project, the Bauhaus was subjected to a fairly large amount of union activity during its construction. Two issues relating to wall construction that were driven by industrial means were the noise created by the brick saw when cutting blocks and the dust generated from cutting AAC panels.

The brick saw generated a high-pitch scream when operating that made it impossible for anyone to work within 10 metres of it. It was not only the subject of numerous complaints from workers on site but was also the cause of several visits from council rangers following complaints from local residents. This continued until a cutting booth was constructed from foam filled aluminium refrigeration panels, costing approximately $3000. This booth was dismantled and then re-erected on each new floor as the bricklayers progressed up the building, taking two men a day to dismantle and a further day to re-erect the enclosure each time.

It should also be noted that the Multiplex first-aid shed recorded no injuries on site during the entire AAC installation process.

Overview Case study 2

The 'Sur Mer' Multiplex (refer to figure 6 below) re-development of the 'North Cronulla Hotel' site in North Cronulla involved the construction of 160 units and a large bar. The building has a concrete framed structure and rendered block work to internal and external walls.

Figure 6 Sur Mer Apartments in Cronulla (1999-2001)

Wall Type choice:
The project brief called up concrete block work to all walls with cement rendered finish as is typical in the local area.

The architect, Rice Daubney detailed hollow core 140mm wide concrete blocks, with a 10mm thickness of render on both sides that achieved an acoustic rating of 45 STC. Internal walls within each unit were 90mm block and cement render in order to maintain a uniform finish throughout.

Cost
As all of the walls were single height, a 75mm panel system could have been used. The cost saving of the completed wall would have been $20/m2. Table No 2 below shows the effect of this cost saving on a project basis.

Table No 2. Cost saving analysis if AAC adopted.
Table No 2

ACC to Masonry wall cost comparison

AAC System	Total Area	Rate per m2	Cost ($)
Inter-tenancy Walls – 2 x AAC Panels	4500	200	900,000
Corridor – 1 x AAC + 64 stud.	3000	140	420,000
Façade – 125mm AAC + 64 Stud	6300	200	1,260,000
Plasterboard Internal Walls	3840	85	326,400
			$2,906,400
Blockwork	Total Area	Rate per m2	Cost ($)
Solid Blockwork Walls	11340	140	1,587,600
Cavity Brickwork (Façade)	6300	180	1,134,000
Cement Render (External)	28980	25	724,500
Cement Render (Internal)	6300	28	176,400
			$ 3,622,500

Total Saving by Changing to AAC Wall System = $716,100
Percentage Cost Saving = 20%

. Note on Pricing
The rates quoted in the cost tables have been supplied as indicative only at the time of the project. These prices should not be relied upon but their comparative differences (AAC to block work) is accurate

Table No 2

From an on-cost aspect, additional site accommodation for 12 more men than would be required for AAC installation amounts to a cost of $55 per week or $1100 for the entire block-laying contract.

Additionally, the waste produced by the block-laying process resulted in an additional 15m^3 bin per floor being used, at a cost of $600 per bin or $7200 for the project.

Time
Once formwork was stripped and access was made available to floors, teams of 12 block layers and 3 labourers were completing all of the internal walls in about 10 days. As an exercise, a program has been produced in retrospect to try to establish what the time saving could have been, had an AAC wall panel system been used.

Although the typical floor cycle saving of two weeks cannot be multiplied by the number of floors, it shows that the project can be completed at least two weeks earlier, giving the builder a possibility of earning bonuses and saving at least two weeks of preliminaries.

Buildability
Joe Pirrello, the Multiplex Site Manager at Sur Mer, commented that the project progressed at a steady pace in comparison to other similar projects but missed opportunities of improving on performance and on-cost savings by not choosing an AAC internal wall system. The project was also exposed to OH & S issues from having up to 70 block-layers on site at any one time.

Structurally the building had to be strengthened to handle the construction loads placed on it during the block-laying process. This had a direct cost effect from increased stressing and reinforcement, and this also required some co-ordination on site to ensue that the block pallets were positioned correctly on each floor adjacent to columns so as to not overload individual areas.

Through the use of two 75mm AAC wall panels, with 10mm plaster board lining on both sides, an improved acoustic rating by up to 15% could have been achieved, for a similar wall thickness and negligible loss of strata areas. The internal walls could also have been made of 75mm panel, clad with 10mm plasterboard on both sides, thus maintaining a solid masonry feel, and further adding to strata areas through the use of slightly narrower walls.

At Sur Mer, due to an absence of wall cavity in the inter-tenancy wall system, 45 STC was the highest rating achievable. This may present a problem with new developments as sound ratings required by the BCA and council have increased since this development application was approved. A possible alternative may be to build two 90mm walls with a cavity in between but this reduces strata areas of individual units and significantly adds to the project costs, from the actual costs of the walls to the increase in strength (and cost) of the structure required to support the additional weight.

Another acoustic issue that arose was the need to saw cut the tops of walls where the 10mm gap between the top of the wall and the slab above had been bridged. This is a typical detail normally sealed with fire rated mastic to provide acoustic isolation floor to floor but one that did not take into account the unexpected movement associated with post tensioned structures. This whole exercise cost the block laying contractor 1 man 3 days per floor, or $14,400 for the project, based on a $50/hour charge-out rate.

From an OH & S perspective the site averaged about 3 cases per week where various back strains were recorded in the first-aid logbook. These incidents not only put added pressure on the site's resources but also exposed both the builder and the sub-contractor to the possibility of lawsuits over worker's compensation claims.

A potential on-going maintenance problem at Sur-Mer, or any other rendered high rise project is the continual need to repair cracking render that typically occurs as the building settles. Recently developers have been moving to direct fixing plasterboard to whatever wall system they choose in an effort to avoid this ongoing issue over the building's warranty period.

Conclusion

There is an urgent need to widen the scope of materials deemed to be green and include total lifecycle energy evaluation to include such issues as associated reduction of anthropogenic loading of the built environment, buildability and safety. The detailed evaluation of the wall panel energy study lead to the appraisal of the Supatherm insulated autoclaved aerated concrete AAC panel system and its subsequent trial as a new building system.

The use of the AAC panel system in comparative building studies resulted in significant savings in cost, some savings in time and significant benefits in buildability when comparing AAC implementation to other wall systems evaluated.
From the projects that actually used AAC, and the mock-up costing table for the Sur Mer project if it had changed to AAC, estimated savings of between 10 and 20 percent could be achieved by simply changing to an AAC wall system.

None of the projects in the case study fully realised the benefit in reducing the weight of the structure as a result of the lower dead loads associated with AAC compared to block work, or other alternative wall systems.

Cost savings between 10 and 20 percent for various components of structure, from reduced footings, to thinner slabs to reduced reinforcement required in edge beams and transfer slabs have been estimated by lighter design options This saving can end up being quite considerable when structures for typical 100 unit residential developments cost around 5 million dollars, thus presenting an opportunity for $50,000 to $100,000 savings.

A typical floor cycle on an average sized concrete framed residential project could be reduced by approximately 2 weeks through the use of AAC wall systems. As was stated in the individual case studies, this saving can only be taken once due to the sequential nature of building and the need to complete one section of the works before the next phase can begin.

The following time related benefits occur automatically as a result of using an AAC system:

- Reduced team sizes means less time required to establish on site, induct staff, relocate from one work face to another, and clean-up on completion of works.
- Smaller team and cleaner system means that other trades can work in same area while panels are being installed, thus further compressing the construction program.
- Less mess created means less time wasted cleaning up during and on completion of works.
- No time lost erecting scaffold for higher sections of walls.

On a buildability basis, all the projects looked at benefited from the reduced congestion, higher production rate and cleaner nature of AAC.
Other benefits that occurred on more than one project included:

- Savings in waste and site accommodation costs.
- Less injuries on site through properly designed, ergonomic installation systems and a lighter weight product.
- Less industrial activity due to a smaller work force and a cleaner system.
- Less materials handling issues through lighter crane lifts and more completed wall area per crane lift (less total crane lifts required), as well as less material deliveries per m^2 of wall system.
- The system is easily retro fitted to structures and building stock can be easily disassembled and recycled.

Further to this and exceedingly important, end users benefit from a product that has higher acoustic performance, greater energy efficiency and lower anthropogenic heat up take, leading to improved comfort within their apartments and lower on-going costs through reduced electricity bills, reduced CO_2 and reducing the impact of the urban heat island effect.

References

Heathcote, K 2006 “Comparative Analysis of the Thermal Performance of Three Test Buildings” AUBEA, Sydney UTS (PowerPoint presentation)

McArdle R 2004 Undergraduate Thesis, University of Technology, Sydney.

Murakami, S 2006 “Technology and Policy Instruments for Mitigating the Heat Island Effect” International Workshop on Countermeasures to Heat Islands, Tokyo, Japan pp1-13.

West S.T.K 2006 “Difficulties in Defining Product Sustainability” Clients Driving Innovation: Moving Ideas into Practice, CRC for Construction Innovation March 2006, Gold Coast, Australia. CD Rom pp 67-79

Exterior Refurbishment Techniques in Various Thermal Environments

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Keywords: Cityscape, Conversion, Environment, Façade, Local, Material

Abstract
This paper analyzes the way the periphery of a building should be from multiple viewpoints of equipment, materials, design, and planning to summarize the key points of peripheral design. Ten buildings in five cities located in three regions, specifically, a cold region, warm region, and region with high temperature and high humidity, were selected as subjects of research. Three among the ten were refurbished, whereas the other seven were newly constructed buildings involving peripheral technology applicable to repair. Both nonresidential buildings (offices) and residential buildings (apartment houses, hotels, medical/welfare facilities, etc.) were selected in each region. Based on the investigation into individual buildings, four points of peripheral design were summarized as follows: (1) the periphery of a building should be recaptured as a zone with a depth of the exterior wall ± 2.0 to 3.0 m instead of discussing it as a line on the exterior walls; (2) peripheral design should be considered carefully in consideration of localized environmental conditions, such as the direction and altitude, as well as the site location, such as urbanity, and the use of the building; (3) despite the germination of various possibilities of peripheral deign perceived in various thermal environments, materials are found to be used improperly regardless of the environment, resulting in uniform appearances of all cities. Local materials and global technology should therefore be combined; and (4) design techniques suitable for the environment should be proposed based on the rating of the exterior of an individual building not only as an appearance of a single building but also as part of a cityscape.

1. Introduction

In Japan, a land that stretches long from north to south, thermal environments widely vary from one region to another. It is therefore expected that various forms of exterior retrofitting techniques are required to adapt to varying environments when compared with techniques of seismic retrofitting. In this study, buildings located in various thermal environments were surveyed, with their peripheral features being analyzed from multiple aspects of equipment, materials, design, and planning, to extract the points of optimum techniques for exterior repair.

Ten buildings in five cities were selected from three regions for surveying. These are located in Amami-oshima, Kagoshima Prefecture, representing regions with high temperature and high humidity, Sapporo, Hokkaido, and Matsumoto, Nagano Prefecture, representing cold regions, and Kakegawa, Shizuoka Prefecture, and Tokyo representing warm regions. Three of the ten buildings were refurbished, whereas the other seven were newly constructed with exterior techniques applicable to repair. Both non-residential (office) and residential buildings (apartments, hotels, medical and welfare institutions, etc.) were selected from each city.

1. Exteriors in regions with high temperature and high humidity – sunlight control, airiness, and rainwater treatment

Amami Hospital, a mental hospital having 350 beds located in an urban area of a port city in Amami-oshima, is characterized by its plan configuration. In a standard floor, three blocks each of standard care units, each accommodating about 20 patients, are placed in clusters on the east and west sides across a central patio. This building therefore has a great amount of exterior walls compared with its floor area. Each cluster contains three wards facing the south, north, and east or west.

One of the subjects of peripheral design in regions with high solar altitudes is the control of direct sunlight. In Amami Hospital, sunlight is controlled by deep eaves and semi-exterior spaces called “wind terraces” made of open masonry. However, the same shapes of these factors irrespective of the directions cause disparity in the interior environments, such as the darkness of the rooms facing north. It should be noted that trees planted around the building are an effective factor for controlling the solar irradiation onto the exterior walls.

Another important subject is airiness. Though the wind terraces are expected to provide airiness, they are not fully utilized, as the other windows are configured so as not to open wider than 10 cm for the sake of safety of the patients and little consideration is given to ventilation through the doors of patients’ rooms. It is necessary to consider openings dedicated to ventilation through exterior walls and partitions, including doors, separately from windows for views and natural lighting. Also, the odd spatial scale of the wind terraces and absence of attracting facilities, such as water service, naturally make the spaces unused, with the windows to the interior being mostly closed. Appropriate setup of such spaces is a key to successful design.

Finally, no marked deterioration was observed on the exterior walls, being protected from the rainy climate by a combination of inward inclination and drainage devices from the head board to the independent beams.

Fig.1 Exterior

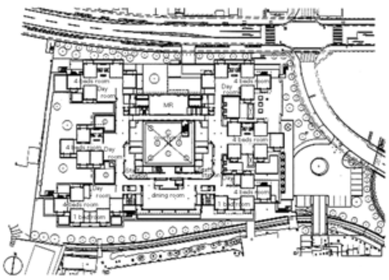

Fig.2 Plan

Fig.3 Terrace of wind

1. Exteriors in cold regions -- External insulation, flat facade, low opening ratio, natural ventilation during intermediate seasons

Four buildings were examined in Sapporo, Hokkaido: two refurbished buildings (an office building and a hotel) and two newly constructed buildings (a skyscraper office building and a middle-rise office building).

(1) The tile exterior walls of the Sapporo Chamber of Commerce and Industry building, a reinforced concrete internally insulated building, were repaired. The existing tiles were fixed by the pin net method, on which expanded polyurethane was applied for external insulation, and stoneware tiles were then applied for finishing by the dry method to prevent joint deterioration due to freezing and thawing action. The horizontally continuous windows were replaced with insulation sashes as they were to be flush with the new wall surfaces. In cold climate, where measures are necessary to prevent snow accretion, icing, and dropping of ice and snow, flat and smooth facades are generally required. Since this causes doors and windows to be placed in the front, the sizes and colors of members composing doors and windows produce a strong effect on the entire facade. The insulation was sufficient, as external insulation was applied with the existing

internal insulation remaining as it was. However, risk potentials during demolition should be investigated, as various materials are embedded in the walls, and it is advisable to secure an agreement among parties concerned in regard to the identified risks.

Fig.4 Exterior (before)

Fig.5 Exterior (after)

(2) Hotel Elm is also an example of refurbishment of a reinforced concrete building. Since the existing building was scarcely covered with walls, externally insulated metal facades and resin sashes were applied to the concrete framing in the form of curtain walls. The formation of a dry facade, on which no sealing is exposed, requires a sufficient depth. It also requires the solving of several other issues including clearance to the boundaries of the premises and extra floor areas (as the effective floor area ratio to the building volume is reduced in terms of budget). This hotel also reduces the perimeter loads by significantly reducing the opening ratio in consideration of the fact that it is a transient hotel in an urban area with poor views.

Fig.6 Exterior

Fig.7 Exterior

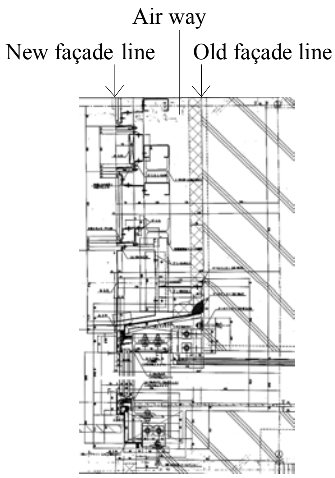

Fig.8 Detail

(3) Sapporo Japan Life Insurance Building is a newly constructed office skyscraper with completely flat facades to prevent snow accretion. Each of the areas east and west of the center core is provided with utility voids for both outdoor air and exhaust air called "air wells" for air conditioning. Elements causing accretion and dropping of ice and snow, such as louvers, are therefore eliminated from the external surfaces. The cap pieces on the roof are also made of stainless steel and inclined 58 inward as another measure against snow accretion, while ensuring an effective snow receiving surface (horizontal projected area).

Fig.9 Exterior

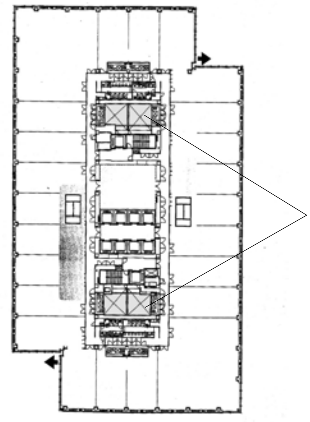

Fig.10 Plan

(4) Taisei Sapporo Building is a reinforced concrete office building made using stay-in-place prestressed concrete forms with preset external insulation for architectural concrete finish. The stripe structure of the formwork characterizes the building appearance as it is. The reduction of the opening ratio to 19% enabled the panel heating/cooling of floors and ceilings utilizing the framing (so-called "northland air conditioning"). Instead of the reduced peripheral openings, atriums called "eco-voids" are placed in the office zone to provide supplementary lighting and temperature differential ventilation during intermediate seasons by the coupled motion of peripheral openings and top lights. The peripheral openings are made of panels flush with the glass surfaces, being consistent with the flat and smooth surfaces of the facades to prevent snow accretion.

Fig.11 Exterior

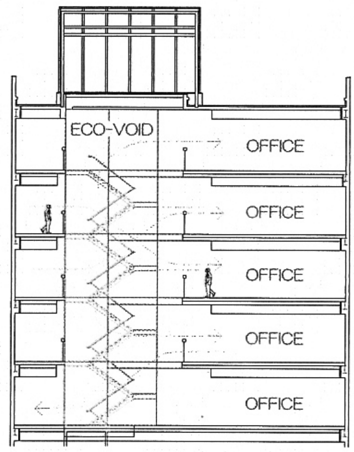

Fig.12 Section

2. Exteriors in warm regions – renewal/addition of functions and peripheral zones

The Sumitomo Corporation Mitoshiro Building (Chiyoda Ward, Tokyo) is a 40-year-old office building. Its precast concrete curtain walls were replaced with aluminum curtain walls to reduce the weight for seismic resistance and renew and add functions for improving the work environment. The window area was increased to reduce the artificial lighting in combination with a light control system. Box-shaped eaves combining horizontal louvers on the south side and vertical panels on the east and west sides reduced the solar loads to 2/3. The added functions include air-conditioning technology for individual air conditioners and smoke vent panels in the transom windows. While the deterioration loads on glass surfaces by rainfall and ultraviolet are alleviated by louvers, etc., the complicated shapes of curtain walls to contain new functions suggest difficulty of maintenance.

Fig.13 Exterior (before)

Fig.14 Exterior (after)

Fig.15 Detail

The Kakegawa City Hall in Shizuoka Prefecture is an office building having a step-shaped atrium in the center. It is a narrow building along the east-west axis comprising office zones on the east and west sides across the central atrium. The two office zones are connected with north and south peripheral corridors, which serve as buffering zones for the huge atrium and both office zones to control the environment. This building provides a new viewpoint of exterior refurbishment that involves planning by regarding the peripheral zone as not only the exterior walls but also the area including peripheral corridors. Though the difference between the north and south corridors is currently limited to the glass type, it is worthwhile to investigate the scale and uses of the corridors and addition of external elements, such as eaves.

Fig.16 Interior

Fig.17 Exterior

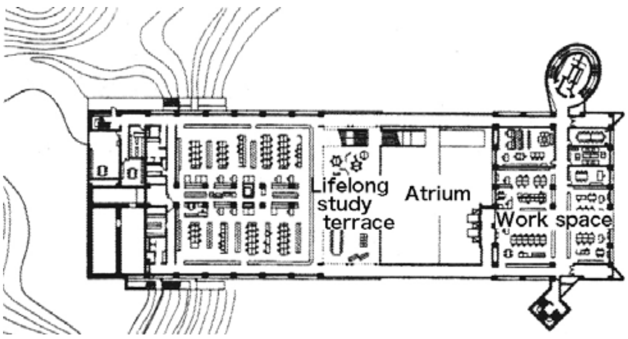

Fig.18 Plan

3. Exteriors of residential facilities – peripheral waterlines

Consideration of residential facilities was complemented with an eye for conversion from offices to residential houses.

Sanbo-en in Matsumoto, Nagano Prefecture, and My Way Yotsuya in Shinjuku, Tokyo, are both all-single-occupancy nursing-care facilities for extended stay. Plans for 30 to 60 beds are configured for both facilities depending on the site conditions based on units for 8 to 10 people. Waterlines for water closets, etc., for each room, which are normally placed on the corridor side, are placed on the exterior wall side to realize cleanness for these functions utilizing natural lighting and ventilation. Only a humidifier and floor heating are provided for each room, while warm/cool air is introduced from the common space using the air fans along the waterline on the exterior wall side. The constant negative pressure on the room side confines the air in each room, preventing air in the rooms of bacteria carriers from coming out into the common spaces, thereby being effective in preventing in-facility infection. The incidence ratios of influenza in both facilities are therefore kept marginal.

Fig.19 Interior (Sanbo-en)

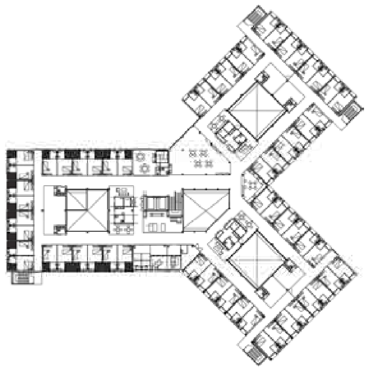

Fig.20 Plan (Sanbo-en)

Fig.21 Interior (My Way Yotsuya)

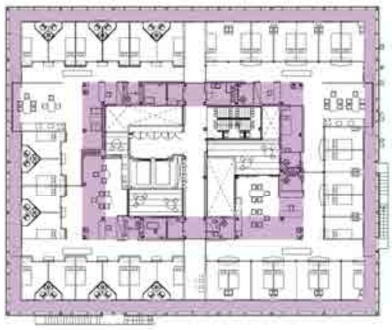

Fig.22 Plan (My Way Yotsuya)

Smart Minami-Aoyama is a barrier-free apartment house built 10 years ago in Minato Ward, Tokyo. All waterlines, utility items, and piping are placed on the peripheral zones where natural lighting and ventilation are ensured. Such utility items serve as a buffer zone for the inside space environment. When converting office buildings to apartment houses, the locations of water-related equipment generally restrict the conversion design. This building shows a possibility of arranging all utility lines on the exterior wall side. However, since the temperature of the buffer zone combining small spaces and large windows could widely change, it will become necessary to choose between two courses including planning: a short-term variable space like a sunroom as an internal space placed on the outside and a stable space with controlled opening as an external space placed on the inside.

Fig.23 Interior

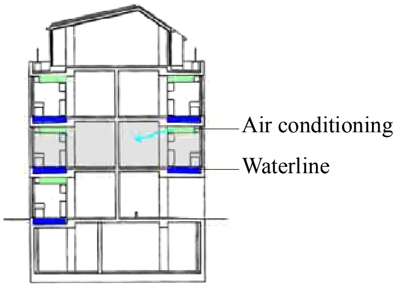

Fig.24 Section

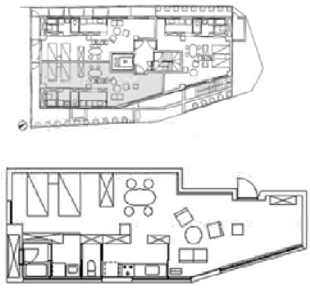

Fig.25 plan

4. Conclusion

(1) From line to band
Instead of limiting the periphery of a building to the exterior wall, it is necessary to recapture it as a zone having a depth of the exterior wall ± 2.0 to 3.0 m. This band can widely vary, depending on the thermal environment and building uses, from one formed as a semi-external space on the outside of the exterior wall to one regarded as an internal space within the exterior wall having various functions. In any event, its design is required to clarify the role of the peripheral zone including planning and provide an appropriate scale and facility suitable for the role. This peripheral zone viewpoint does not conflict with the flat skin design, which is one of the trends of modern architecture, but introduces a new aspect of the relationship between the flat skin and the internal space.

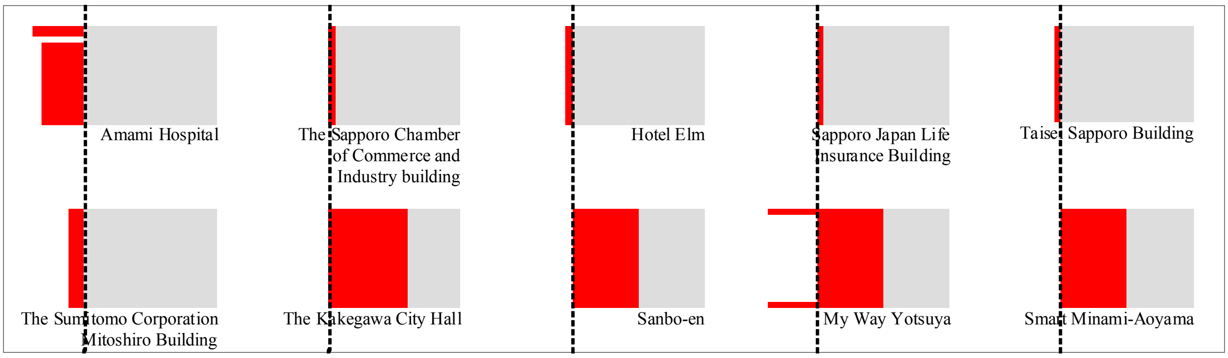

Fig.26 Perimeter diagram

(2) Direction and altitude
Few of the buildings under study devise peripheral features in regard to direction. However, site survey and consultations with residents have revealed the differences between interior environments in different directions. It is therefore necessary to investigate techniques to improve peripheral features in consideration of local conditions including room directions and wind directions. However, the viewpoint of room direction and wind direction of buildings in crowded urban areas may differ from that of non-urban buildings standing far apart from one another, as the solar and wind loads on exterior walls can differ. Such differences should also be taken into consideration.

The problem of altitude is not sufficiently exemplified in the present survey. However, it should also be included in the investigation in view of the fact that heat pump air conditioners available in mass merchandise stores are installed everywhere, such as on balconies and external corridors, of skyscrapers, which have recently begun to appear in many cities in Japan, in the same manner as those for detached houses.

(3) Depletion of local materials

During the cross-sectional survey of the various temperature environments, we scarcely found local characteristic materials. We do not mean to deny the globalization of materials due to the development of information and material flow and the sophistication of construction technology, but materials unrelated to individual environments were found to be improperly used, while germination of peripheral design to adapt to various thermal environments was observed. It is necessary to explore methods to combine local materials and global technology.

(4) From individual buildings to cityscape

When walking along the streets of Sapporo, many buildings are found to have flat facades in the local environment requiring measures to prevent accretion and dropping of ice and snow. The size and colors of members composing the openings of such buildings are as they are an important component of the cityscape. It is therefore necessary when repairing the exteriors of buildings in various environments to grasp the appearance of the resulting exterior both as a single building and a part of the collective cityscape and to propose a form of repair suitable for both.

Fig.27 Flat façade in Sapporo

5. Future development

- Surveying of examples in localized environments, such as typhoon-prone areas and chloride-attack areas.
- Surveying of skyscraper residential facilities.
- Study on foreign examples.
- Typification of exterior repair techniques including the above examples.
- Comprehensive case study covering individual buildings and cities.

6. Acknowledgements

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A document offer

Nikken Sekkei Ltd. (fig.2, 4, 10, 18)
Taisei Corporation (fig.12)

A Study on the Facade Design for Activating Renewal of Buildings Addressing Various Thermal Environments

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Keywords: Facade Design , Renewal , Thermal Environments , Questionnaire

Abstract
Detailed documentation of environment control techniques for building periphery can be valuable data for renewal and reconstruction of buildings, which are expected to continue to increase, but there has been limited accumulation of research examples. The authors carried out literature searching of the facade design of the examples of buildings called "environmental buildings," particularly regarding segments related to thermal loads. From the searching result, multiple glass is used for the largest number of buildings and is widely distributed throughout all regions and the solar transmittance tends to decrease as the window area ratio increases. Questionnaire survey was also conducted in regard to examples in standard warm climates to investigate and grasp how warm/cool the users of the building feel and the demand for repair. A standard questionnaire technique for improving the thermal environment of buildings to be renewed is also discussed. As advantages of the building, the interior multi-story space and the south and north glass facades strongly affect the impression on the residents. On the other hand, the glass facades prone to the effect of the external environment presumably led to complaints on hotness expressed in the answers. These answers appear to be derived from dissatisfaction regarding the air-conditioning system and window opening/closing system.

1. Introduction
Global environment issues have been addressed in recent years. In the field of architecture, the control of heat loss through exterior walls and windows of buildings has been recognized as effective measures for energy conservation and items of the first priority at the time of repair. For this reason, detailed

documentation of environment control techniques for building periphery can be valuable data for renewal and reconstruction of buildings, which are expected to continue to increase, but there has been limited accumulation of research examples. Also, in Japan, where the thermal environments widely vary, the establishment of environment control techniques suitable for regional characteristics is vital for the standardization of activating renewal for buildings in the future.

The authors therefore carried out literature searching of the facade design of the examples of buildings called "environmental buildings," particularly regarding segments related to thermal loads, in each environmental region. Questionnaire survey was also conducted in regard to examples in standard warm climates to investigate and grasp how warm/cool the users of the building feel and the demand for repair. A standard questionnaire technique for improving the thermal environment of buildings to be renewed is also discussed.

2. Literature Searching

2.1 Overview

Literature searching was carried out on 66 environmental buildings selected from relatively ecological projects undertaken by major architectural design offices and those that won prizes including the environmental and energy-saving building prize. Table 1 gives the searching items including the specifications for exterior walls, glass, and shielding, which are related to facades. The perimeter annual load (PAL) values, an index to energy efficiency expressing the thermal loss through exterior walls and windows of buildings, were examined in regard to 14 examples based on the PAL statements in comparison to standard PAL values. The window area ratios and solar transmittance for each aspect were also calculated.

Table 1 Searching Items

Building Data	Name , Location , Completion Year , Building Use , Designer Total Floor Area , Structure , Number of Stories
Exterior Wall	Exterior Wall Specification / Coefficient of Heat Transmission
Glass	Glass of Energy Conservation / Window System / Thickness Window Area Ratio
Shielding	Eave Form , Blind Setting Position

2.2 Results

Figure 1 shows the building scales, uses and regions of searched examples. Large percentages of buildings under study are located in the Kanto, Tokyo and Kansai areas. Large percentages of building uses are offices.

Figure 2 shows the number of buildings involving glass and shielding specifications with energy saving techniques. In the glass specifications, multiple glass is used for the largest number of buildings and is widely distributed throughout all regions. Low-e glass with high insulating performance is used primarily in the Kanto region and farther north. As for window systems, double skin window systems are used in 6 buildings, among which they are used on the south side of 4 buildings. Air flow window systems are used for 5 buildings, in which these are all facing offices in office buildings, presumably to lighten the rooms and provide a view. The number of buildings involving shielding specifications reveals that inside blinds and overhung eaves are commonly used. Overhung eaves are found throughout all regions and installed in all aspects of buildings. On the other hand, outside blinds and side fin-type eaves are installed in much fewer buildings.

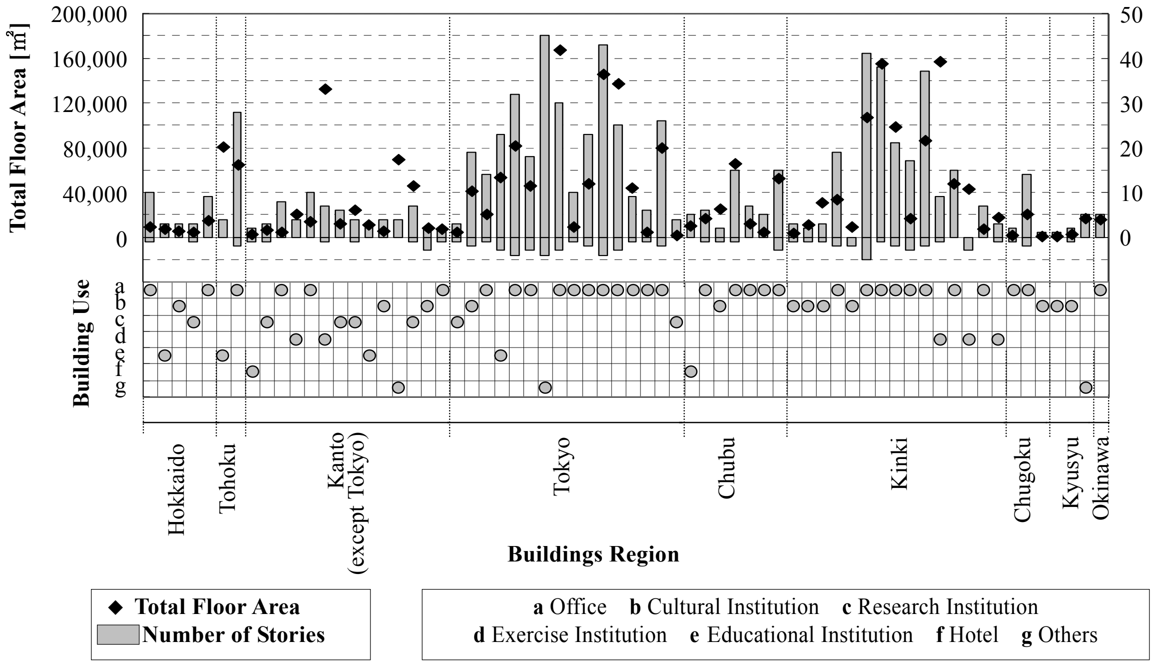

Figure 1 Building Scales, Uses and Regions

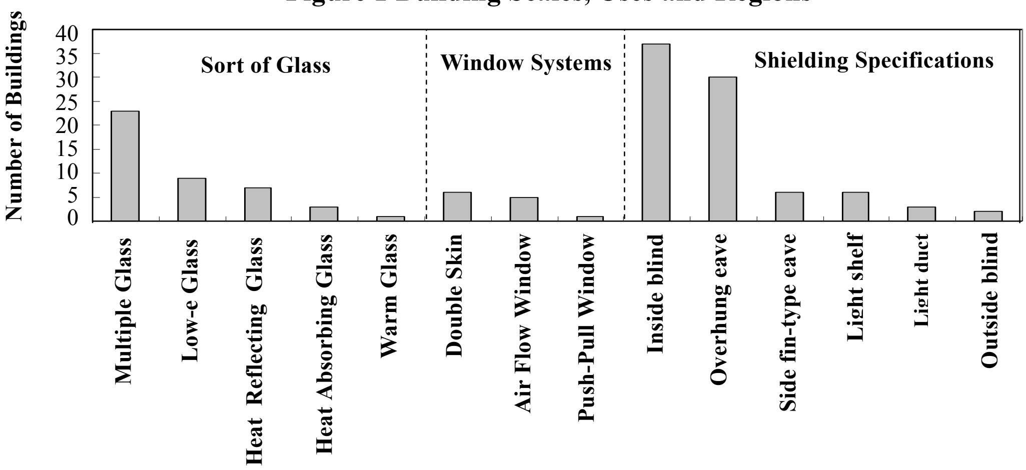

Figure 2 Number of Buildings Involving Glass and Shielding Specifications with Energy Saving Techniques

Figure 3 shows the ratio of PAL values in each aspect based on the PAL statements to the standard PAL values. The sums of the PAL values in all aspects of all buildings meet the requirements, being less than 1.0. When examined separately, however, the PAL values of some of the aspects of some buildings exceed the standard values. The surfaces with high PAL values may face such spaces as cores, which do not give priority to the thermal load decrease. Also, the small exterior wall areas in such aspects do not significantly affect the overall PAL values.

Figure 4 shows the correlation between the solar transmittance ratio and the window area ratio. The solar transmittance tends to decrease as the window area ratio increases. It is therefore found that the sunlight shielding performance of windows tends to be high in buildings with high percentages of glass. No marked difference is observed between aspects.

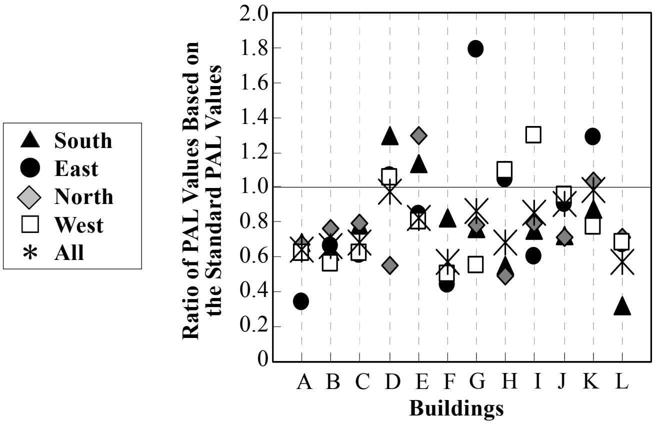

Figure 3 Ratio of PAL Values Based on the Standard PAL Values

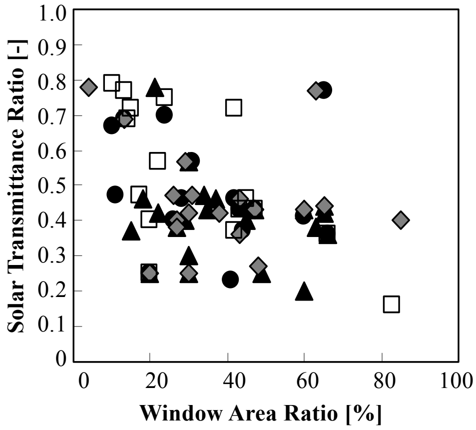

Figure 4 Correlation between the Solar Transmittance Ratio and the Window Area Ratio

3. Questionnaire Survey

3.1 Overview

The city hall of K city was selected as an ecological building located in a standard warm climate in Japan, and a questionnaire survey was conducted in this building. Table 2 gives an outline of this building. The K city hall is located in Chubu. The solar transmittance of this building is 0.77 (0.38 for the south aspect). The window area ratio exceeds 60% excepting the west facade facing a hill. This building is therefore particularly light-transmitting through the north and south facades. Inside roll screens are installed only for windows on the south facade. The photograph of the inside building is shown in Fig. 5. There is an atrium in the center of the building, and the corridor is set up in the surroundings.

A questionnaire survey was conducted on 125 workers of the building in December 2006, and 100 answered. Table 3 gives the points of the questionnaire, which included the following to obtain meaningful data for future environmental improvement of the building. This questionnaire is characterized by planning from the standpoint of not only design engineers as in conventional renewal but also residents of the building, while collecting data in consideration of the regional characteristics.

Table 2 Outline of the K City Hall

Location	Glass Specifications	Solar Transmittance Ratio	Window Area Ratio	Shielding Specifications
Chubu	Sheet Glass 15mm Heat Absorbing Glass 15mm (South)	0.77 (0.38 for the south aspect)	South 63% East 65% North 63% West 13%	Inside Roll Screans (South)

Table 3 Points of the Questionnaire

1. Current Environmental Features of the Building
2. Analysis of Answers by Individuals, Work Floors, and Work Environments
3. Seasonal Differences
4. Aesthetic Appearance and Design Factors
5. Demand for Improvement

Figure 5 Photograph of the Inside Building

3.2 Results

Advantages of the building: Figure 6 shows the most favorable point of the building selected in the answers. More than 70% respondents selected “light and open spaces.” Specifically, “spacious and open interior spaces (47%)” and “light and open because of natural lighting from the south and north facades (41%)” accounted for the most part (Fig. 7), suggesting that the interior multi-story space and the south and north glass facades strongly affect the impression on the residents. Note that the residents on upper floors tend to feel the interior space greater, and those on the south side tend to feel the space lighter by natural illumination (Fig. 8).

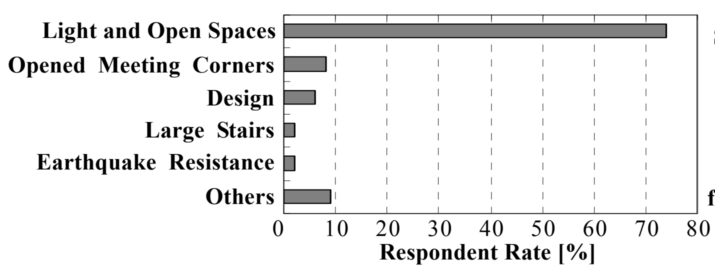

Figure 6 Most Favorable Point of the Building

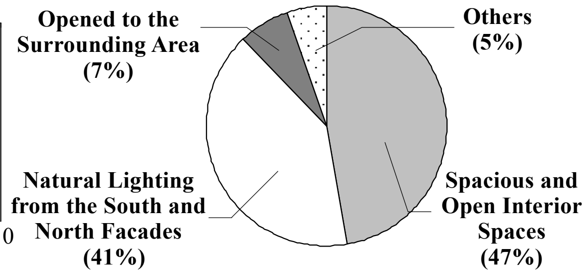

Figure 7 Breakdown of the Light and Open Spaces (74 answers)

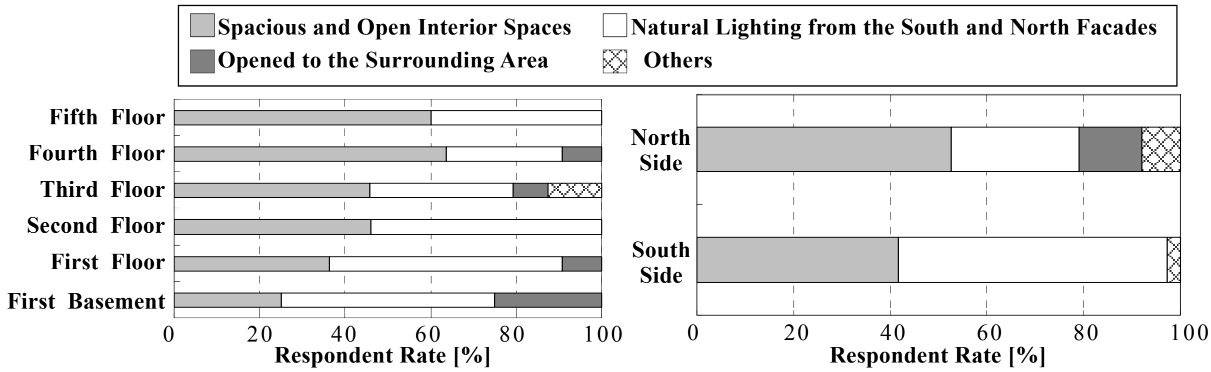

Figure 8 Answers of Each Floors and Sides

Sense of warmth in summer and winter: Figure 9 shows the rating of the sense of warmth at midsummer by selecting from seven levels. Those who selected "(d) appropriate" accounted for 22% of the total respondents, while the answer on the "hot" side accounted for 65%. When examined floor by floor (Fig. 10), the percentages of "(d) appropriate" are high on the fifth floor and first basement, where the office space consists of separate rooms with individual air-conditioning. The percentage of answers complaining hotness was high on the floors connected to the multi-story space, presumably due to the difficulty in air-conditioning large spaces and the high sunlight gains through the glass facades. Figure 11 shows rating of the sense of warmth at midwinter by selecting from the same seven levels. Those who selected "(d) appropriate" accounted for 40%, being higher than the answers for midsummer. When examined floor by floor (Fig. 12), the percentages of (d) are high on the fifth floor and first basement similarly to midsummer, again suggesting the difficulty in air-conditioning in floors connected to the multi-story space. The preset temperatures of this building are cooling to 28°C and heating to 20°C in line with the state measures. Such minimum air-conditioning and the glass facades prone to the effect of the external environment presumably led to complaints on hotness expressed in the answers.

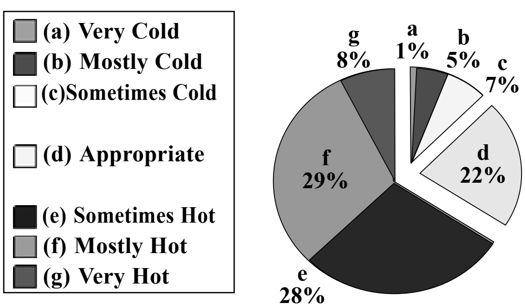

Figure 9 Rating of the Sense of Warmth at Midsummer

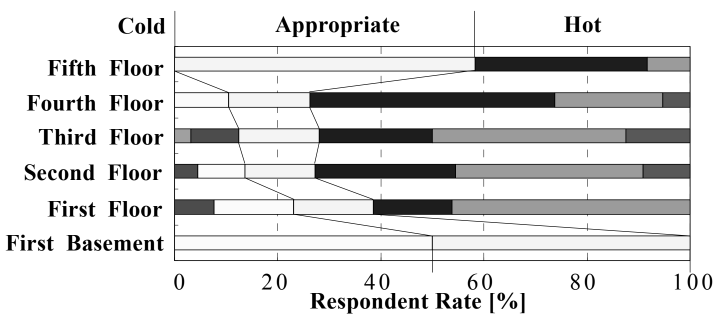

Figure 10 Rating of the Sense of Warmth at Midsummer According to Floor

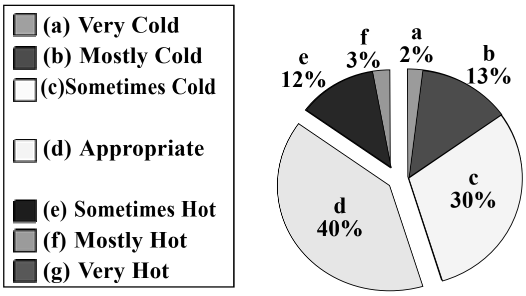

Figure 11 Rating of the Sense of Warmth at Midwinter

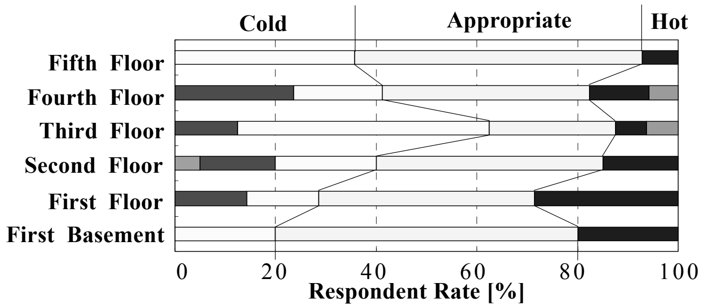

Figure 12 Rating of the Sense of Warmth at Midwinter According to Floor

Demand for repair: Figure 13 shows the points of dissatisfaction and points requiring improvement about the building. 40, 31, and 22% of the total respondents selected traffic lines, environment, and space expansion, respectively, as the points requiring improvement. As shown in Fig. 14, many wish for measures against hotness in summer and improvement in the air flow. These answers appear to be derived from dissatisfaction regarding the air-conditioning system and window opening/closing system. Since this building is prone to the effect of the external environment, it is inferred that an easier way for residents to operate the air conditioning system is demanded.

As stated above, the questionnaire survey carried out in this study has provided useful data for future environmental renewal.

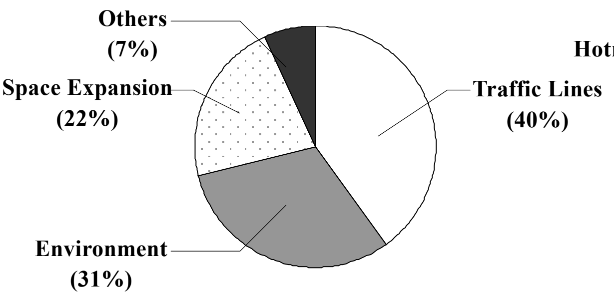

Figure 13 Points Requiring Improvement

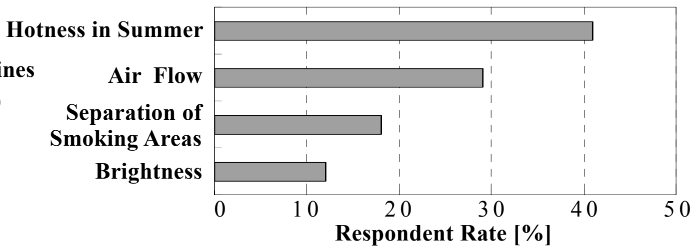

Figure 14 Points Requiring Environmental Improvement (31 answers)

4. Summary

There are the widely varying thermal environments in Japan. Literature searching was carried out for examples of so-called environmental buildings to grasp the energy conservation techniques involving glass and shielding specifications. Investigation into PAL statements revealed the negative correlation between the window area ratio and the solar transmittance. These results are useful for discussing the relationship between the solar illumination conditions and the renewal design of openings of each region.

The authors also proposed a questionnaire technique for improving the thermal environments of buildings during building renewal and carried out a questionnaire survey at the K City Hall in a standard warm region. This building with a relatively high window area ratio and solar transmittance in a warm climate caused a lot of complaints by residents about hotness in summer. The survey has provided data for reference for renewal design in various thermal environments. The authors intend to continue investigation into the relationship between the peripheral specifications and energy including comparison between the energy consumptions before and after actual refurbishment.

5. References

Institute For Building Environment and Energy Conservation. 1986-2004. *IBEC* No35-142.

Institute For Building Environment and Energy Conservation. 2006. *Energy Conservation Standard of Building and Guidance of Calculation.*

Office Refurbishment by means of Façades with Integrated Building Services

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Keywords: Integration of Installation into Facades; Re-activation of buildings; Future façade-technology; Refurbishment; case study

Abstract
With growing consciousness for the relation between facades and energy-consumption and the rising sensibility for sustainability and lifetime behaviour of buildings in the beginning of the 21st century double facades, hybrid facades and decentralized mechanical services have been developed. In a market with rising demands on quality and ecologic/economic sustainability, such as Europe, these principles will increasingly have to be applied for the refurbishment of the enormous number of existing buildings. One of the biggest advantages of service integrated envelopes for renovation lies in the possibility to upgrade quality and efficiency with minimal interference with the interior.
The author's research led to different efficient strategies that deal with the complex influencing factors. It aims to develop systemized solutions for varied circumstances to be found in an international market, for which a service integrated façade is a promising approach. In one example the application of such a system is presented. An additional façade layer with integrated HVAC is being applied to an office-high rise built in 1970. Simulations have shown that an energy saving of 75% is possible.

1. Introduction – The Way to services integrated facades
Façade construction has been a fast developing technology in the building market. In early 20th century the search for structural slenderness and greater transparency led to the product "curtain wall" (Herzog) (Brooks). Mass customization and possibilities of prefabrication made the construction of pre-cast concrete-slabs possible in the 1960s and 70s. Current façades are based either on post-and-rail systems, related to building technology oriented on craftsmen's work, or on element systems, which bear more possibilities of industrialized production (Krewinkel).
With growing consciousness for the relation between facades and energy-consumption in the beginning of the 21st century, research aimed on integration of climate-technology into the façade. This resulted in the development of double facades (Pottgiesser) in the 1990s. The actual development shows the tendency towards total integration of mechanical services into the façade (Oesterle et al.). Climate units with minimized dimensions built either into a façade element or attached at floor level provide all necessary heating and cooling means. Ventilation is achieved by direct connection to the outside. This makes air ducts and installation space within the building obsolete. Two actual examples for service-integrated facades are shown in Figure 1.

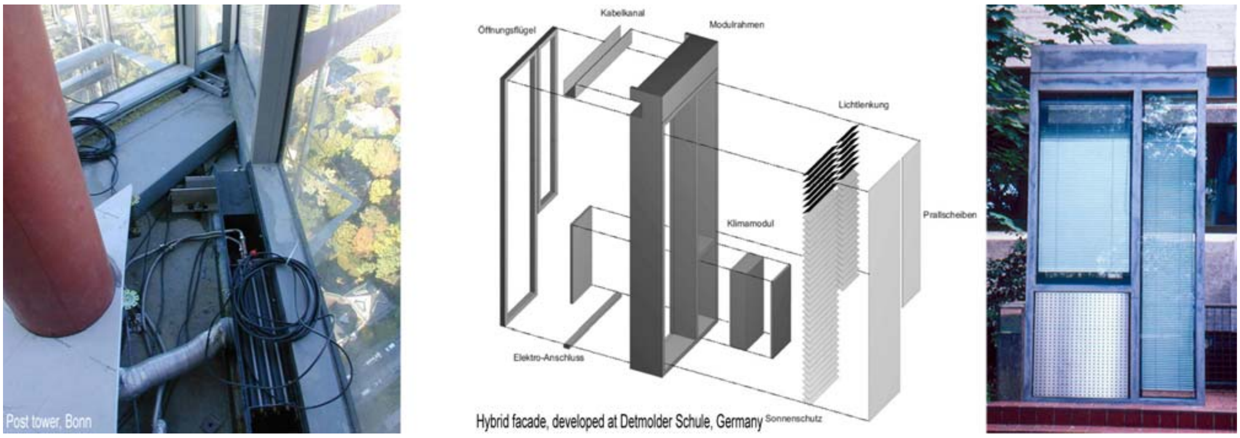

Figure 1: Service integrated façades today

2. Facade Refurbishment – Research project at TU Delft

The aim of this research project is to find systematic solutions for the refurbishment of facades for office buildings. The façade serves as an integral part in the building climate concept and thus can not be considered separately. Upgrading the building envelope contributes to more efficiency with limited interference with structure and running work. The main research question is: How is it possible to combine sustainable refurbishment with economic feasibility? It is desired to create an overview of aspects to be kept in mind and present suggestions for systemized façade-refurbishment for real estate dated from 1960 to 1990. The development of systemized solutions suitable for different building types and problems and their verification in case studies form the practical base of this work.

3. Aspects of refurbishment

3.1 The market for refurbishment

The greatest number of office real estate in Europe is dated from the 1960s to 1980s. A study of IFO-institute shows that between 65% of non-housing real estate in Western Europe (agricultural buildings excluded) was built before1978 (Russig). Market-analysis states that in a decreasing market like Western Europe only "grade A"-buildings are lettable. Besides the factors space and location, a modern and economical HVAC is part of this.

3.2 Energy-consumption

The mentioned buildings mostly provide a low insulation level and outdated installations. This causes high energy consumption. Round 75% of end energy consumed in buildings of the tertiary sector is used for heating and cooling (Schlomann et al.). Improvements in this aspect can thus lead to big savings both on financial as on ecologic level. The EU directive 2002/91/EC on energy performance of buildings (EU) aimed to raise concern in energy consumption by introducing "Energy Passports" in January 2006. These will be compulsory from mid 2007 and make the running costs of buildings comparable (Poeggeler).

3.3 Building construction possibilities

The refurbishment-planning has to deal with existing structure and detailing. The existing substructure, material and connections have just as much influence as fire protection rules, sound protection and energetic demands.

3.4 Building services

The big chance in façade refurbishment lies in the possibility to install new building services. Decentralized units mounted in one go with the façade refurbishment require less vertical installations which can be installed relatively easy. Heating, ventilation, cooling and IT-installations can be upgraded without interfering with the interior. This keeps cost short for relocation of staff and renovation of the finishes. Old installations can stay in place disused and can be removed, when it is financially feasible, e. g. on renovation of the interior, demolition or when commodity prices pay back labour cost.

3.5 Comfort

The comfort of working staff is an often underestimated factor in productivity. The building skin has to provide the necessary thermal protection in winter as well as in summer, glare-protection, lighting and contact to the outside. Giving people the opportunity to regulate their work environment has proven to contribute enormously to their comfort and productivity [4]. Modern HVAC installations provide the chance for individual exerting of influence. If part of an entire climate-concept they help saving energy and thus money.

3.6 Aesthetics

Renovation projects always have to deal with architectural design aspects. Referring to “office grade A” the design and identification with the building are important rental matters. The user demands a representative, individually designed building. Monumental protection rules sometimes also apply to the project and thus impose guidelines to the design.

3.7 Finance

In addition to the aspects mentioned above, the financial plan has to contain various other matters. For example there may be the possibility to produce energy with the new building skin. Governments in Europe support renovation-projects by means of grants and favourable tax legislation. The renovation-proposal has to prove on one hand to be more profitable than demolishing and rebuilding, on the other hand it has to provide an economic surplus value in comparison to leaving everything like it is. Only when the refurbishment is feasible there will be the chance to realize a sustainable, energy- and material-conscious building upgrade.

4. Development of systems

During the research project a market survey has been realized in the Dutch and German building market. Working together with important real estate owners a broad overview of refurbished and to-be-refurbished buildings has been created. Realized refurbishment projects tend to be isolated solutions for single projects, and thus relatively expensive. The main aim of the research is to identify refurbishment-strategies to develop systemized solutions and products. Those shall be applicable and adjustable for different situations.

Renovation principles for office facades can be sorted into three main categories: Single skin solutions; double skin facades fitted from inside and double skin facades installed from outside. Figure 2 gives an overview of structural principles and properties, such as the qualitative influence on the energy saving potential, comfort and the aesthetic effect. The applicability of different levels of installations and the potentials of combination with decentralized integrated service units and are evaluated as well.

Overview of systems for facade refurbishment TU Delft, Th. Ebbert, March 2007		Single Skin solutions		Double skin solutions (inside)		Double skin solutions (outside)			
		S1 Replacement of curtain wall	S2 Upgrade by replacement of windows, extra insulation	Di1 Adding of inner exhaust facade	Di2 Adding of inner insulated facade	Do1 Adding of multi storey facade	Do2 corridor facade	Do3 Adding of box-type facade	Do4 HVAC-integrated facade
									
Market / Finance	suitable for	curtain wall with low standards	window-facades	listed buildings with relatively good standards, existing central ventilation	listed buildings, low standards	low and medium height, capable construction	capable construction, intended new HVAC	capable construction, intended new HVAC	medium - high buildings, new HVAC
	Financial aspects	big interference with interior and running work	often the cheapest solution	big interference with interior and running work	big interference with interior and running work	creates a new appearance to the building; little interference with interior	big savings on running cost, little interference with interior	big savings on running cost, little interference with interior	big savings on running cost, little interference with interior, complicated planning, often expensive construction
Construction	Impact on structure	new connections and extra loads	very low	very low	low	Extra load to be suspended (often from roof)	Extra loads brought into floor slaps	Extra loads brought into floor slaps	Extra loads either in roof or floor slaps
	Sound-insulation	depending on glass and components, generally improved	depending on glass and components, generally improved	good	very good	from outside: good; from inside rather bad (cavity)	from outside: good; horizontal noise transport	depending on windows, generally improved	depending on windows, generally improved
	Fire-protection	no changes to existing situation	no changes to existing situation	cavity and ventilation requires special concern	closed cavity requires special concern	danger of rising hot gas in cavity, special means necessary	closed cavity requires special concern	closed cavity requires special concern	danger of rising hot gas in shaft, special means necessary for box-windows
	Impact on interior	very high	very low	low - high	very high	very low	low	low - medium	low - high
Energy		higher insulation, saving of heating and cooling energy, optimal up-to date standards	higher insulation, saving of heating and cooling energy, special concern: cold-bridges	medium improvement, depending on existing systems; additional insulation necessary in balustrades	high insulation level possible, special concern on cold bridges	relatively high insulation, danger of high temperature in summer	combination of natural ventilation and heat exchangers possible, high saving potential	combination of natural ventilation and heat exchangers common; high saving potential	combination of natural ventilation and heat exchangers possible, draft in shaft supports ventilation, high saving potential
	Sun screen	every system possible	outside recommends, wind loads	blinds in cavity are protected from wind, absorbed heat is ventilated off	in cavity	in cavity	in cavity	in cavity	in cavity
Aesthetics		retrofitting within original grid, possibility for complete new appearance	good relation inside-outside, few changes in building design possible	very little changes	very little changes	completely new appearance, openings not clearly visible	often horizontal emphasis due to ventilation units	different materials and designs possible	combination of box-window and multi-storey-facade; very big impact
Comfort	indoor climate	installation of new HVAC possible; up to date comfort	depends on existing building services and detailing of facade, improvement of thermal comfort	depends on existing building services and detailing of facade, improvement of thermal comfort	good insulation and high thermal comfort	good insulation in winter, in summer risk of excess-heat	very good insulation, sun-screens necessary, risk of over-heating	very good insulation, sun-screens necessary	good insulation in winter, in summer risk of excess-heat
	natural ventilation	depends on climate concept, often operable windows	possible to integrate, not very common	not possible	possible; demands "intelligent user"	high air velocity in cavity	individual possibility of ventilation, heat exchangers	individual possibility of ventilation, heat exchangers	Individually controlled mechanical with heat recovery
	operable windows	common	rare, depends on HVAC concept	not possible	possible; demands "intelligent user", risk of condensation	condensation-risk on outer skin, fire protection, sound transport from other floors; possible	sound transport to other room	common, condensation risk	possible
	influence of user	depends on installed/ renewed HVAC	HVAC not changed	rare	possible	individual controls common	individual controls common	individual controls common	individual controls common
Building services		possible to integrate installations	integration rarely realized, ventilation units possible	central ventilation required, different heating / cooling means possible	existing systems may be re-used, individual systems possible	installations possible if existing facade and system permit	heat exchangers common, heating and cooling possible	heat exchangers common, heating and cooling possible	heating and cooling possible, fresh air through cavity, exhaust via shaft
Combination with installations	central HVAC	O	O	++	+	++	+	O	O
	radiator + climate ceiling +	+	++	O	+	O	O	+	O
	low temperature system	O	+	-	-	O	O	O	O
	Decentralised HVAC	+	++	+	+	O	+	++	++

Figure 2: Overview of façade-principles for refurbishment

S1: The replacement of existing curtain-walls or pre-fabricated facades with a similar façade construction provides the widest range of possibilities. The main focus of detailing lies in the connection to the main bearing structure. Climate- and architectural design can be solved according to actual standards. This way of refurbishment is particularly feasible, when a total renovation is due and the building is emptied. It then still is more sustainable than demolishing the entire structure.

S2: Replacement of existing windows and extra thermal insulation of walls proves to be the most common way of dealing with façade renovation. It is cost effective and sustainable in terms of material consumption. It does usually not take advantage of the possibility to upgrade building services and is mainly applicable for window-facades.

Di: Application of an additional façade layer from the inside is predominantly interesting for listed buildings. Dependant on the quality of the existing façade it can be realized as exhaust façade (Di1) or box window (Di2). Special tasks in this case lie in the insulation of cold bridges and the integration of existing HVAC.

Do: The addition of a second layer to the existing skin prevents interference with the interior. The application of a multi-storey-façade (Do1) is a relatively cheap solution providing good extra insulation. Any double façade bears the typical risks of overheating in summer and fire-protection difficulties. Operable windows support sound transfer in the cavity and the risk of condensation on the outer glass. Corridor facades (Do2) and Box-type facades (Do3) provide different levels of horizontal and vertical separation of the cavity which keeps the façade controllable. The integration of all building services into the façade (Do4) realized in form of decentralized units, presents maximum flexibility. Existing installations can be kept in place, though set out of use. All new services are provided from the outside. Decentralized units give users the maximum possibilities to adjust indoor climate individually. Difficulties lie in the detailing of connections to and penetration of the existing structure.

5. Case Study - Refurbishment without interference with interior

One example of an additional façade with decentralized building service installation was developed in 1999 in co-operation with Delft Technical University. Within the research project the author has been given the opportunity to develop the system further and apply it to a case study.
The case study building was constructed in 1972 and is composed of a 3 storey base which serves as conference centre and a 10-storey office-tower on top of this base which is the focus of the research (Figure 4). The façade is characterized by various building physical problems such as rain-water entering the construction and lacking wind-tightness. All office-spaces are fully air-conditioned by means of decentralized units. The system is controlled centrally and not adjustable by the user (Figure 5). Actually the building consumes over 1.2 million kWh/a (315 kWh/m²a) of energy, of which round 80% are used for heating and cooling. (Evers et al.).

Figure 3: Situation before renovation

Currently the building is used by the owner himself but it is intended to rent out office space in small units in the near future. Keeping this in mind the owner wishes to reduce running costs and give the building a new and modern appearance. A special task in this project lies in the fact that the interior has recently been refurbished. Therefore it is neither affordable nor desired to interfere with finishes.

5.1 Application of the system

Based on the given circumstances the application of an extra façade on the outside appeared to be the optimal solution. During the design process, in co-operation with a climate engineer three different designs were developed.
In a "minimal constructional impact solution" (version 1) most of the façade stayed in place. Existing windows and climate-units were replaced and extra insulation added. In the feasibility study this led to extra costs for relocation of staff and renovation of the interior while the maximum positive effect on energy saving could not be reached in simulations. A second option aimed on maximizing the energy savings (version 3). In this design a climate skin was installed; solar-chimneys contributed to the support of natural ventilation. This solution prove to be too expensive in comparison with the achievable payback on energy saving and added property value. Furthermore it led to structural complications.

5.2 Architecture and construction

The preferred solution (version 2) aims to combine advantages of both others and be in favour of the architecture: A second skin is placed only in front of the existing glazing. Vertical profiles, suspended from a steel-framework which rests on the main bearing structure, give a structure to the building. This creates a vertical emphasis and transparent appearance for the office tower. (Figure 4) The existing facade will not be changed. Besides avoiding disturbance with the interior this also contributes to fire protection. Sprinkler installation in both the cavity and near the façade inside office-space avoids the need for horizontal separation of the cavity. All sprinkler-tubing is installed within the additional façade.

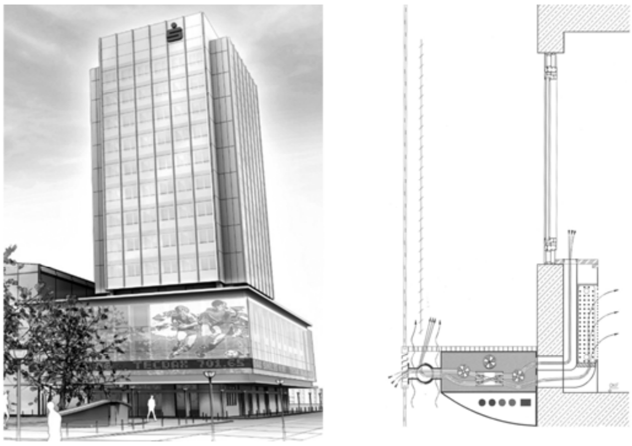

Figure 4: Design for refurbishment

5.3 Climate-Design

To prevent interference with the interior the covers of the existing climate units are re-used. Modern de-central climate units are installed therein. These units provide individual mechanical ventilation with heat recovery and combine this with convector units for both heating and cooling. In wintertime the preconditioned air from the cavity is used, while exhaust air is let out to the outside. In summertime fresh air is drawn in from outside, while the solar chimney effect in the cavity supports exhaust ventilation. Every room is equipped with controls for individual regulation of ventilation and heating/cooling.

5.3 Results

The biggest economic and ecologic gain lies in the improvement of the building performance. Simulations have proven that the proposed solution (version 2) provides an energy saving potential of 75%. The actual 315 kWh/m²a primary energy demand will be reduced to 81 kWh/m²a in the future (Evers et al.). This is mainly based on better insulation and an accurately adjustable HVAC system. Figure 5 also shows that cooling-energy is almost not required; this is due to sufficient sun-screens and ventilation (Evers et al.).

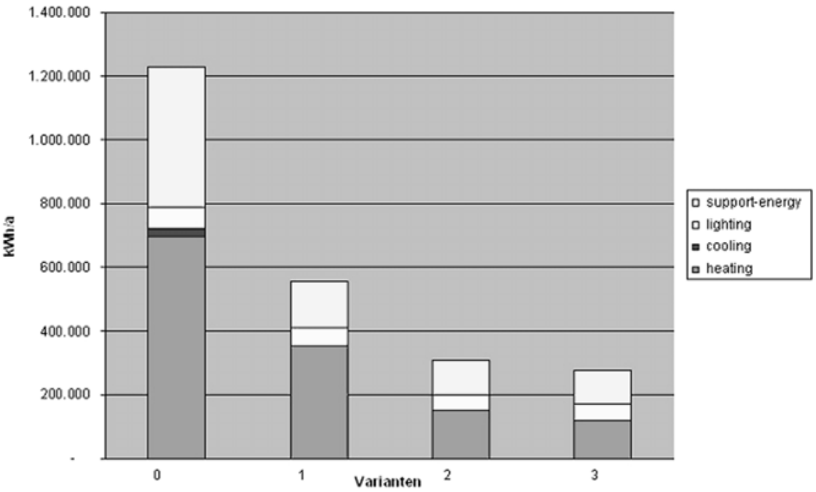

Figure 5: Total final energy consumption (Balck + Partner)

The feasibility study showed that only on energy savings the break even point for the installed building services will be reached within 11 years. This is due to the facts that energy costs will rise and that the "old" HVAC-system will require significantly more maintenance. Taking the entire refurbishment-project into account, the investment will pay back only on energy saving within 18 years (figure 6), which is well within the technical lifespan of all its components. (Evers et al. 2006)

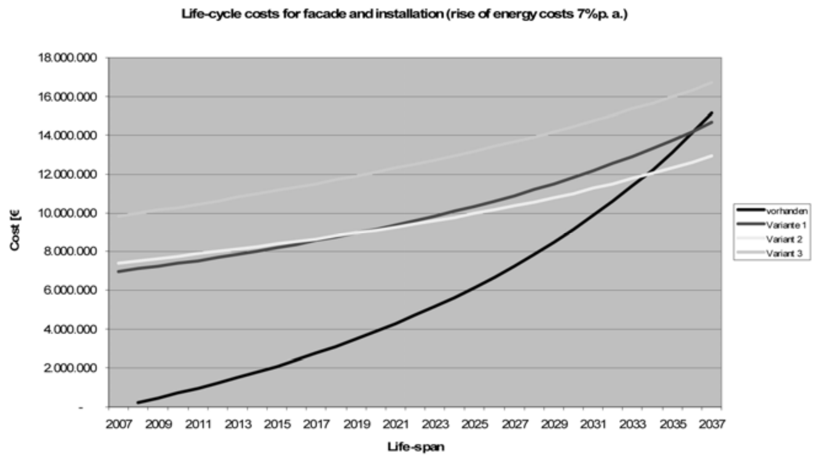

Figure 6: Life Cycle costs project (Balck + Partner)

The feasibility study has not taken into account further added value like better lettability and higher rental rates that can be achieved. One example shall represent these factors: New, smaller, air-conditioning units are placed in the existing. When the interior will be renovated, the big covers will be replaced by smaller ones. This will lead to a gain of 14 m² or 4% of rentable area per floor.

6. Conclusion

Facades are one of the most important and complex parts in building. The integration of new materials and climate installation into the building envelope is state of the art and will be one of the major tasks for the future. Façade renovation has to be considered together with climate design. It provides the chance to save material and energy and thus improve sustainability of buildings. The real estate market offers a great number of projects for refurbishment. The author's research shows that integrated envelopes are applicable in refurbishment projects.

Double skin facades provide a number of disadvantages such as overheating in summer and condensation in winter, high costs and a bigger consumption of resources and grey energy. Nevertheless, for the task of renovation they may be particularly useful, as they provide installation space and the big opportunity to build without interference with on-going work and the interior.

Taking all aspects of renovation into account system-based solutions can be developed for the market. The integration of services into the building envelope provides many advantages particularly in renovation. The big task for planners is to prove to the market, that such solutions are economically feasible and individually adaptable. For this it needs more case studies which show that intelligent renovation in Europe not only supports sustainability but also is profitable investment.

7. References

EU directive 2002/91/EC on energy performance of buildings

Herzog, et al. 2004. *Facade manual*. Basel: Birkhaeuser

Brookes, A. 1998. *Cladding of Buildings*. London: Spon

Krewinkel, H. 1998. *Glass buildings*. Basel: Birkhaeuser

Oesterle, et al. 1999. *Doppelschalige Fassaden*. Munich: Callwey

Pottgiesser, U. 2004. *Fassadenschichtungen Glas*. Berlin: Bauwerk

Hausladen, G. 2005. *Clima Design*. Munich: Callwey

Russig, V. 1999. *Gebäudebestand in Westeuropa*. Munich: IFO Schnelldienst

Schlomann, B. et al. 2004. Energieverbrauch der privaten Haushalte und des Sektors GHD. *Technology Report No. 17/02*

Poeggeler, B. 2005. *Warum brauchen die Häuser in Europa einen Pass?* www.europa-digital.de

Evers, Balck und Partner, TU Delft. 2006. *Feasibility study Sparkasse Ludwigshafen*

A multidisciplinary challenge for technological adaptation

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1. Abstract

This research concentrates on Bam, a desert city in southeast Iran, which experienced a devastating earthquake in December 2003. Because of the huge number of people suffering from the human and economical outcome of the earthquake phenomenon, sustainable technological improvement and qualification for the rebuilding of the city are very important. To find a proper solution to get the housing stock up to a suitable level, and progressing in an evolutionary structure, the interdisciplinary collaboration of form, construction and materials have to be studied. In order to achieve more sustainability, an environmentally friendly way of materialization in the structure has to be considered, too. To have a successful reconstruction of the city it is important that the design of the building be according to the wishes and ideas of the future inhabitants. Therefore, before the actual rebuilding of the city, these demands have to be studied. In the study presented here, first, 25 people with different backgrounds were interviewed for their ideas of the rebuilding of the city and housing. After two years, the interview was repeated. Furthermore, prior to designing, the old situation was analyzed and concepts for rebuilding were made. The last stage was the analysis and evaluation of the feasibility of the concept.

2. Introduction

2.1. Material minimization

Many places across the glob are affected by frequent earthquakes. From 1990 through 1996, there have been more than 150 big earthquakes (USGS, 2006). In figure 1, the global frequency of the largest earthquakes during 20th century is shown. Bam, a desert city in southeast Iran, was destroyed, in December 2003, by one of those earthquake disasters with a magnitude of 6.5 (Zare et al. 2004).

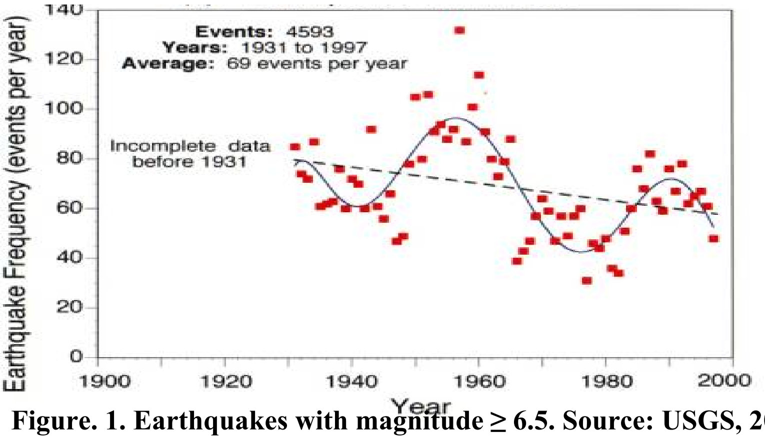


Figure. 1. Earthquakes with magnitude ≥ 6.5. Source: USGS, 2006

Although minimization of material use has always been a goal for the building industry, recently this aim was extended into the design and performance of buildings. Material minimization has big economical advantages, while it has also been identified as a very useful way to decrease the environmental impact (Dickson et al., 1999). To develop a sustainable construction eco-costs should be taken into consideration (De Jonge, 2005). The direct and indirect environmental impact costs generated by the use of resources are called eco-costs (Hendriks et al., 2002). The ecological impact of each step in the product chain is based on technical measures to prevent pollution and resource depletion to a level, which is sufficient to make the human society sustainable. Hendriks et al. (2002) divided the eco-costs into five components (3 direct and 2 indirect). In relation to the material minimization, two are relevant:

- *Virtual pollution prevention costs, being the costs required to reduce the emissions of the Production processes to a sustainable level (Vogtlander et al., 2001).*
- *Materials depletion costs, being (costs of raw materials) (1-α), where α is the recycled fraction*

In fact, the building product (i.e. structural element) should be produced in an eco-efficient system. In which the costs and impacts are not separated from each other. This relationship is stated in an equation by Hur et al. (2006) as:

$$\text{Eco efficiency} = \frac{\text{Product or service value}}{\text{Environmental influences}}$$

The Canadian society for Civil Engineering stated that all activities related to this engineering should aim at minimizing the environmental burden under five global consequences:

- Human health,
- Climate change,
- Resource depletion,
- Biodiversity,
- Energy depletion (Perks et al., 2007).

In the field of sustainable construction according to the eco-costs recycling and reuse together with other related criteria are also important issues, as the CSCE said that “best practices for eco-efficiency efficiency such as increased energy/water efficiency the minimization of waste and resource consumption, the employment of clean technology should be employed.” (Perks et al., 2007). Although this study is not focused on the eco-cost, the issue of material minimization is relevant to the aim (finding a suitable structure for Bam).

2.2. Reconstructing Bam

For the reconstruction after an earthquake, due to the scale of the destruction, in some cases such as Bam a huge amount of materials is being used (UNPD, 2005). Therefore, to achieve more sustainability in such cases

the minimization has extra effects both on environmental and economic aspects. On the other hand, in rebuilding, after a severe earthquake structural strengthening needs extra consideration. Strength is the ability of a structure to withstand maximum loads that may occur within the service life without excessive deformation or collapse (Merritt et al., 1990).
The reconstruction in Bam, in addition to many aspects and factors, is also highly depended on the results of investigation about the probability of re-occurrence of the phenomenon in the future. When the repetition of the phenomenon has been proved (such as in Bam), declining the vulnerability of the inhabitants in terms of collapsing construction in the future, needs the most consideration. This, normally results in durable materials and structural enhancement (Taranath, 2005). So, in design for a situation such as Bam, durability (Yu et al., 2006), structural integrity (Merritt, 1990) and materials minimization (Dickson et al., 1999) are always important factors. To obtain efficiency in these important factors, many items are involved, but form finding always plays a major role. Therefore, a stable form in which material used in the construction is optimized (resulting in an optimum structure) is the aim of this study.

2.3. Form finding

Penelis and Kappos (2005) believe that in order to avoid collapsing of a structure we should enable it to absorb and dissipate the kinetic energy imparted in it during the seismic excitation. This again involves not only the materials but also the structural form and organization, which are related to the stability of the structure. Stability means the structure is unable to move freely and permit damages to property or injury of the occupant. This is possible by proper arrangement and interconnection of structural components that have adequate strength and rigidity (Merritt et al., 1990)
Material studies led to the decision that concrete is the best material for this case (Shahnoori et al., 2007). The principles for developing a stable construction combined with form analyses and the vernacular architecture resulted in an investigation in dome constructions (figure.3.).

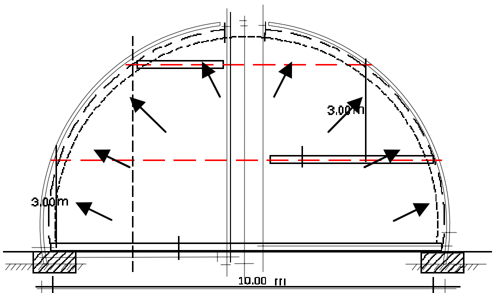


Figure. 2. The dome structure for the re-housing in Bam

Dome based forms have been used in the houses in the region for a long time (Pirnia, 2005). It was a structural solution for the desert conditions and a passive solution (Lute, 1992). Wood was not easily available and the harsh climate required intensive sun protection (Pope, 1965). Therefore, the dome constructions materialized with different types of concrete have been studied. Similarly Belmouden et al. (2007) studied the dome structure under the same conditions (e.g. seismic desert condition, concrete material, etc). By modeling the structure, they proved that this is a good option for such a situation. Besides, Eekhout (2004) believed that using modern techniques and qualities/possibilities of free form design, called 'BLOB' would help to solve the old problems of constructions. Combining these findings with the traditional buildings shows that the dome construction is technically a good option to be used as a house form in the reconstruction of Bam.

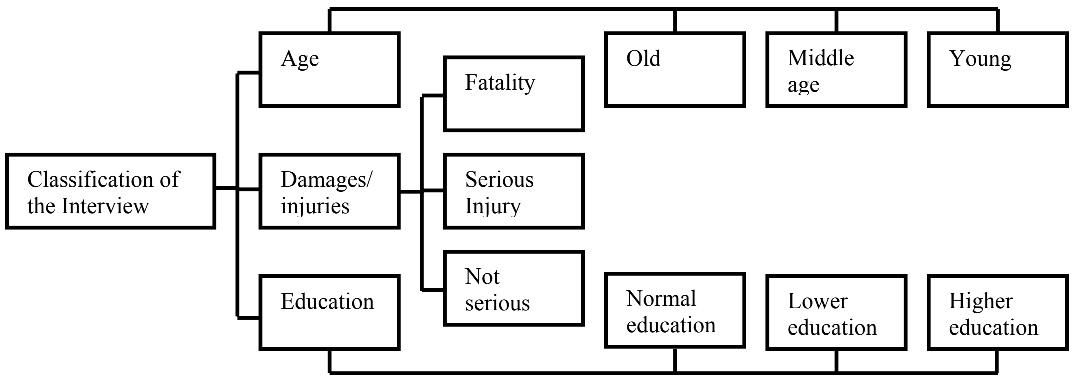
However, because severe earthquakes always have a big impact on human society, there are not only economic consequences to be dealt with, but also social influences. Earthquakes and the reconstruction period after that highly affect the inhabitants and their way of life. This may even result in an extreme that causes the native people to leave their lands. Changes to the main function of the area or unbalanced populations of regions are possible social effects of earthquakes. This has happened in Tokyo after the Kanto earthquake in 1923 (EC, 1999), and in Booin Zahra after the earthquake of 1962 (UN, 1968).

It could be stated that keeping the social integrity of the area is even more important than being prepared for possible earthquakes re-occurrence. Rebuilding damaged cities in an attractive way is a major issue. It is essential that the original inhabitants and landowners stay on their lands, as they know how to work the land and city in the most effective way. This has even more priority in a desert city such as Bam, as desertification (Pachauri et al, 1997) is a constant threat. Therefore, this study focuses on establishing the valuation that people give for living in a dome construction. Although the geography and history can cause extreme differences in both people and building over very small distances (Atkinson, 1967), dealing with common conditions can also create similarities in various regions. Therefore, the aim for this paper is to find out whether a dome structure that technically seems suitable is also socially acceptable for rebuilding in Bam.

3. Approach and materials

The main approach in this study was a combination of research and design that circularly completed each other in different phases. In the research section interview played a key role. Two rounds of interviews were held. As the focus of the study was to confirm the feasibility of the BLOB dome to be a home for the local application, a questionnaire has been defined that contained questions about this matter. The researchers personally submitted them to each interviewee in the first round. The interview included also some questions about other purposes as well, which are not included in this paper. Two groups of 25 people have been interviewed in two different occasions. The first group was at that time still living in the emergency house. The second round of the interview was done two years later. The questions were repeated, but in a different distribution and in a questionnaire. Three people from the first group were chosen to answer again, to qualify the questions for the reproducibility. Furthermore 22 new families have been asked (The questionnaire has also been sent to Japan, but few, answers were received).
All people interviewed were divided in groups based on education, age, damage to their house and the degree of personal damage that they suffered in the last earthquake. Figure 3, shows the classification of the interviewees.

Figure. 3. Classification of the two local interview and questionnaire



Questions in the interview and the questionnaire were focused on the experiences of the people in within the sheltering and the social demands for the reconstruction of a house. It was for instance including:
- Name, age, affiliation, age, and education…
- Where did you live (after the earthquake) in first:
  A. days
  B. two weeks
  C. two months
  D. six months
  E. one year
  F. two years
  G. three years
  H. now
- What do you think about the new techniques of using clay as the main material for your house?

- What material do you prefer for your future home?
- Do you like a house in the form of a dome?
- What feeling do you have about a dome house? Do you like to live in such a construction? Why?
- What form do you prefer for your own home? Why...

These sort of questions conducted people to think about the answers just in the direction of the construction of their houses.

Results of different classifications have been analyzed, and with the literature study, the final evaluation of the design led to the conclusion.

4. Results

In the first interview and questionnaire, 25 forms were submitted to the people who were interviewed and 25 answers received. However, in the second questionnaire from 25 submitted forms only 21answers were obtained. Results of both questionnaires are still classified based on three different divisions of age, education, and damage. However, these classifications appeared to be dividable into more branches for each, after the answers were collected. Therefore, divisions were branched as it is shown in the tables 1, 2, and 3.

Table. 1. Sub-classification and results of the two local interview and questionnaire, divided by the age (In the second interview 4 of the people didn't respond)

	Number	Answers on a dome shaped house				
Age		negative	positive	neutral	No answer	
20-25	6 & 1	4 & 1	2 & 0	0& 0	0 & 0	
25-35	7 & 5	5 & 5	0 & 0	1& 0	1 & 0	
35-45	8 & 11	5 & 9	1& 1	2& 1	0 & 0	
45-50	3 & 4	1 & 4	0& 0	1& 0	1 & 0	
50+	1 & 0	0 & 0	0& 0	1& 0	0 & 0	
total	25&25/21	60%&76%	12%&4%	20%&4%	8%&16%	

Table. 2. Sub-classification and results of the two local interview and questionnaire, divided by education (In the second interview 4 of the people didn't respond)

	Number	Answers				
Education		negative	positive	neutral	No answer	
Master	0 & 2	0& 2	0& 0	0& 0	0 & 0	
Bachelor	2& 4	2& 4	0&0	0& 0	0& 0	
Technician	1& 3	0& 2	1& 1	0& 0	0 & 0	
Diploma	16&10	12& 9	2& 0	1& 1	1 & 0	
< Diploma	6& 2	1& 2	0& 0	4& 0	1 & 0	
total	25&25/21	60%&78%	12%&-4%	20%&4%	8%&16%	

Table. 3. Sub-classification of the two local interview and questionnaire, divided by the suffered damage (In the second interview 4 of the people didn't respond and ***relates to the people that did not suffer serious injury or damage)

	Number	Answers				
Damage		negative	positive	neutral	No answer	
Fatality	16 & 10	9& 9	1 & 0	4 & 1	2 & 0	
Severe injury	11& 12	7 & 11	1 & 1	2 & 0	1 & 0	
Destroyed home	13 & 13	7& 12	1 & 1	3 & 0	2 & 0	
Damaged home	5& 3	2& 2	0 & 1	1 & 0	1 & 0	
***Not affected	7& 5	5& 4	1 &0	1& 1	0 & 0	
total	25&25/21	60%& 78%	12% & 4%	20% & 4%	8% & 16%	

From the first interview, we found that16 houses were destroyed, 4 houses severely damaged, and 5 were without considerable damages. Most of the interviewed people in the first session suffered severe injury or had a death toll in the family. In the second round, more people were not affected by the earthquake. This society in the second interview 13 houses were destroyed, 3 severely damaged and 5 without considerable damages. In which 10 families lost their family members, 12 serious injuries, and 5 without considerable injury and the rest injured.
From the first interview, 25 people generally replied the questionnaire, but in details, some questions remained without answers, which were 21 from the 25 in the second round of the investigation. The answers about the question of living in a dome shaped house are demonstrated in the table number 4.

Table. 4. The answers of people in Bam to the question of "whether they want to live in a dome house

Total	Negative	Positive	Neutral	No response
100%/100% (25 & 21)	60% & 78%	12%& 4%	20%& 4%	8 % & 16%

Table number 1 shows the answers for the different age groups on the question about the wished form of their future home. There was a positive relation between age and the liking of a dome form for a home. Younger people liked the dome form more compared to the elderly. The age group (15-25) liked the dome shape the most. Education did have a significant effect on the liking of the dome form. Highly educated people liked the dome form less compared to uneducated people. The damage to the home of people was not/most certainly relevant to their feeling for the dome form home. The higher the damage the more they had negative feelings about the dome shaped house. The personal damage was also relevant to the opinion of people about a dome for a house.
The answer to the question about their future house and idea about the form of the house are presented in table 4. The table shows that from the first 25 responses only 3 people did not mind to live in a dome/copula form house. From the second interview with 21 received answers, only 1 person was interested in living in such a house. These people were mostly focused on normal, orthogonal houses.

5. Discussion

Because of the social (and environmental) impact from the changes and incidents in the rebuilding of Tokyo after the Kanto earthquake in 1923 (EC, 1999), and in Booin Zahra after the earthquake of 1962 (UN, 1968) the initiative was taken to study the social attitude towards rebuilding Bam with dome shaped houses. It could be argued that dome shaped houses relate to the old vernacular buildings in the area and that this relation would satisfy the local inhabitants (Pirnia, 2005). However, the huge demand for change that is occurring across the globe (Leupen, 2005) covers many places including desert areas due to the internet connection and satellite receivers (Kries, 2004). Besides, after an earthquake, housing is even more sensitive (Mileti, 1974) and as a home is different from a house, rebuilding a home needs extra consideration in such a situation (Kronenburg, 2002). Therefore, there are two possible views on the matter. Technically a dome has interesting features that lead to the idea that rebuilding Bam with dome houses would be a good idea (similar to Belmouden et al. 2007), but this study shows that that would be a social miscalculation.

This is a usual finding, as history shows that dome houses were never a success to be used as homes. The implementation is the depended issue, as it was for instance in the Drop City (Voyd, 1969). The Drop City (figure 4.), in Colorado (US), was called "*a Model Hippie commune"* by CLUI (1996), began in 1965 (Vassar, 2007), with the idea to be an environmental sculpture (Voyd, 1969).

Even in this case which was to be a place for artists (Oliver, 1969), it needed such a process. Although Voyd (1969) believed "*all the actions involved with construction were to be the easiest, most efficient, with least cost"*, and although it won the Dymaxion award in the US, Sadler (2006) called *it" a worrisome, structural soundness, uncomfortable, at times unhealthy and by most measure socially dysfunctional*"(Sadler, 2006). This city was inhabited only until 1973.

Figure. 4. Drop City, Colorado. Courtesy, Sadler

Soleri, for instance, built dome constructions as very suitable places in Arizona desert (e.g. Arcosanti) as a passive system (Soleri, 1987). Rebuilding a permanent home after an earthquake disaster makes the result much different. An example for such a case is the reconstruction after the earthquake of Qir (1972), a rural area in one of the southern parts of Iran (Berberian et al., 1976). The reconstruction happened after local investigation, ending up with a roundhouse with a curved roof (Rashidi, 1986). Although the houses were climatically compatible and structurally effective in the hot climate, they were not used as a permanent home (Rashidi, 1986).

Before the research was performed, some hypotheses were drawn up. The division of people in different groups was partly based on those hypotheses. It was expected that the younger people would like to live in extravagant dome shaped houses more than middle-aged people. Additionally it was expected that the attitude of old people towards such a form of house might be more positive compared to the middle age people because it reminds them of old days when the vernacular architecture was much more present. The research shows that these assumptions were partly right and partly wrong. Although young people were relatively more positive, old people were not interested in the dome house.
Because people that suffered severe personal damage or had fatalities to morn about were expected to be much more involved in the safety aspect and less in the visual appearance of their future homes, it was expected that the results would show that they were more often in the Neutral box that other people. The results show that this assumption is not right, because most of the people in the negative box experienced lost of relatives, destroyed house or severe injury.

Based on the findings presented in this paper and the conclusions from the paper of Belmouden et al. (2007) and the ideas of Eekhout (2004) it will be essential to combine the positive technical effects of the dome with the wishes of the current inhabitants of Bam that would like to live in orthogonal houses. This will be the aim for the rest of the PhD project, to combine those to a structurally optimal house for the rebuilding of Bam.

6. Conclusion

Material minimization is necessary in such a large amount of rebuilding (mass production for reconstruction) in which the structural quality and form play a major role. Therefore, the implementation of modern techniques in order to ensure the sustainability should be locally adaptable.
The dome form in a seismic city is a good alternative, however, for a city with the principles similar to Bam is not a good option to be a home for indigenous. Therefore, the quality of such kind of structures should be transferred in a new definition to enable the design to use the advantages.

7. Acknowledgment

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References:

Belmouden et al., 2007. *A modular Shell system for housing*, Vol. 48 (2007) No. 1, Journal of IASS, ISSN: 0304-3622
Berberian et al., 1976. *The 1962, earthquake and earlier deformations along the Ipak earthquake fault*, Geological Survey, Iran, Rep. 39, 419-427.
De Jonge, T. 2005. *Cost effectiveness of sustainable housing investments*, Delft, DUP Science ISBN: 90-407-2578-0
EC, 1999. Earthquake Center, 1999 (1999, October 11, 2006). "The 1923 Tokyo Earthquake" Sant Louis University, Department of Earth& Atmospheric science, Saint Louis, USA.
Hendriks et al., 2002. *Durable and sustainable construction materials and the building cycle*, Best, Aeneas, ISBN 90-75365-49-7
Hur et al., 2006. *A Study on The Eco-efficiencies for Recycling Methods of Plastics Wastes,* Dept. of Material Chemistry & Engineering, Konkuk University, Seoul, Korea
Kibert, C. J. 2005. *Sustainable Construction: Green Building Design and Delivery*, John Wiley & Sons Inc, ISBN-10: 0471661139
Kries et al. 2004. *Living Under the Crescent Moon.* Vitra Design Mus, ISBN: 978-3931936419.
Kronenburg R., 2002. *Houses in Motion: the genesis, history and development of the portable building*, Chichester, Wiley-Academy.
Leupen, B. 2005. *Time based architecture*, Uiteverijg 010 Rotterdam. ISBN: 978 90 6450 536 2
Leupen, B. 2006. *Frame and generic space*, Rotterdam, 010 publishers ISBN: 90-6450-598-5
Lute, P. J. 1949. *The use of predictions in temperature control in buildings a passive climate system application, Delft,* S.l., s.n*, ISBN:* 90-370-0075-4
Merritt et al., 1990. *Building engineering and system design*, New York, Van Nostrand Reinhold, ISBN: 0-442-20668-2
Mileti, D. S. 1974. *STRAIN-GAGE ACCURACY*, Society for Experimental Stress Analysis. Technical Committee on Strain Gages, Westport, Boston.
Oliver, P. 1969, *"Shelter and Society*", London, ISBN 214.66796.
Pachauri et al, 1997, Deforestation *and desertification in developing countries***,** *Environment, energy, and economy: Strategies for sustainability*, Edited by Yoichi Kaya and Keiichi Yokobori
Penelis et al., 2005. *Earthquake Resistant Concrete Structure*, Abingdon, Taylor & Fransis, ISBN: 0419187200
Perks et al., 2007. *"Infrastructure Capacity Building*", CSCE National Lecture, Toronto
Yu et al., 2006. *Durability of materials and structures in building and civil engineering,* Boca Raton, CRC Press, ISBN: 9-781870-32558-5
Pirnia, M. K. 2005. *Iranian architecture,* (Study of styles in architecture), ISBN: 964-96113-2-0,
Pope, A. O. 1965. *Persian Architecture*, Arthur Opham Pope &George Braziller, New York, 1965.
Sadler, S. 2006. *Drop City Revisited, Journal of* Architectural Education, vol. 58, No. 1 pp. 5-14.
Soleri, P. 1987. *Arcosanti: An Urban Laboratory*. Vti press, USA, ISBN: 978-0932238443.
Taranath, B. S. 2005. *Wind and earthquake resistant buildings*, New York, Dekker, ISBN: 0-8247-5934-6
USGS, 2006. *World's Major Earthquake hazards,* Unite States Geological Survey Earthquake Hazards Program, 2006
Vogtlander et al., 2001. *The model of the eco-costs/value ratio: a new LCA based decision support tool, S.l.*, S.n., *ISBN:* 90-5155-012-X
Voyd, B. 1969. *Shelter and society*, by Paul Oliver, London, Barrie & Jenkins, ISBN: 214.66796.0

Adaptable Architecture

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Abstract
In this paper a framework is created for categorizing adaptable architecture. The term adaptable architecture describes an architecture from which specific components can be changed in response to external stimuli, for example the users or environment. This change could be executed by the building system itself, transformed manually or could be any other ability to transform by an external force. Different levels of adaptation are determined to pinpoint the relations between the different connotations of adaptable. Realized adaptable projects are studied to define the relation of innovation and realization. To generalize the outcome of the analyses the different components of the building are categorized.

1. Introduction
Adaptation and flexibility have played an important role in experimental architectural projects in the last decades. Visionary projects and ideas were developed to link the architectural buildings with new technologies and possibilities. Inline with innovations of that time, a clear connection is found with experimental architectural projects and ideas. During the Industrial era, machine and technology played a very important role in the experimental projects of the Avant-garde. The comparison of architecture with a machine is typically for this period (Corbusier, 1924). With the era that followed, Futurism and Situationists developed imaginary ideas based on multi media techniques and the free state of mind. Realization of the projects wasn't the main goal (Archigram, 1972). With mobility and mobile parts, a step further was taken in the relation with machine. Today's period can be seen as the electronic era, an information society; individualization, commercialization, globalization and personification are characteristics of today. Next to the pace of the development of advanced electronic devices, and the growing commercialization on this field, the customization of these products plays a very important role. Individualism and the adaptation of the building on the personal wishes of the users and environment is, in relation to technological developments, a current subject of research.
This paper is part of a PhD research, in which the realization of an adaptable architecture with the use of dynamic materials is the main subject. The aim of this paper is to come to an extrapolation of the technology based on realized projects. In this research it is important to clarify the definitions of adaptable architecture to pinpoint the position in which the thesis research is found.

Various definitions of adaptable architecture are used in literature, but coherence between these is lacking. Different connotations are given, which are related to different levels of adaptation. Dekker (2006) stated that interactivity is specially used as an indicator of change in an installation or environment that a person can enforce, taking into account the mechanical, physical and psychological implications. According to Edler (2006) dynamic architecture or structures adapt to the varying needs of the users, to changing environmental circumstances or to the designers desires and imaginations. In the literature of Kroner (1997) intelligent architecture refers to built forms whose integrated systems are capable of anticipating and responding phenomena, whether internal or external, that affects the performance of the building and its occupants. Intelligent architecture responds to its occupants and the local and global environment in a sensitive, supportive and dignifying matter. Another connotation is given by Kronenburg (2002), in which the ultimate flexible interior may be one that is completely amorphous and transitional, changing shape, color, lighting levels, acoustic, temperature, as the inhabitants moves through it-abandoning flat horizontal surfaces and demarcations between hard and soft, warm and cold, wet and dry. It seems that there are several technicalities involved when defining aspects of adaptation.

2. Method

Various realized adaptable projects were analyzed to determine the stage of adaptation of the current building stock. Only projects that have the special ability of a relatively simple adaptation on the level of time and effort were analyzed. The focus in this research lies on projects that have the special ability of adaptation on re-appearing scale.

To categorize the different methods and levels of adaptation in the analyzed projects, a general overview of the building components was set. This overview gives an idea on what level in the building system adaptation is found. Various categories of the building are used in past research (Brand, 1994). In this research the categorization is based on adaptable components in architecture.

Next to the categorization of the building system the different levels of adaptation are given. According to developments in technology, science and application, adaptable architecture has the ability to get more sophisticated. The different levels of sophistication are concluded in a scheme. The case studies will be analyzed according to the levels of adaptation and concluded in a table. The table gives the overview of the method of adaptation of the different projects. On the hand of the method of adaptation the level and component of adaptation are concluded.

The outcome of the table was analyzed according to the general development of technologies. Therefore, it will give an insight into the realization of adaptable architecture with the use of new technologies in relation with its time. With this overview of the adaptable projects it will be possible to set the framework for the research of the PhD subject.

2.1 Categorizing building system elements

In this paper the categories of the building are important guidelines for the analysis of the projects. The categories can be divided in subcategories, which are the elements of the building. These elements can be divided in parts and the parts in pieces. To illustrate the different categories, examples of elements are given. These elements do not take part in the research and are only used to explain the different categories.

The fist category of the building system is the structural part, the construction of the building, which establishes the shape of the building and maintains its stiffness. The next category is the infill of the building. The infill includes all finishing components of the interior of the building; examples of elements of this group are walls, floors and ceilings etc. This group includes also non-bearing walls. The interior parts were excluded from the infill. The term interior in this research means the added components which are used to decorate and inhabit the building. Elements of this category are products like chairs, desks, closets etc. Finishes like paint and carpet are included in this group, as these aspects belong to the decoration of a house which can be renewed rather easy. In the fourth category the technical aspects of the building are assigned, this group consists of the technical installations of a building. As an example, central heating, air control and wiring and piping, could be given. The last category of the inside of the building is the ambient aspects. This category is not commonly used in the category of building systems. The ambient component of the building is focused on the emotional experience of the building spaces on a sensorial level. The intensity and color of lighting which will be related to the atmosphere of a room is a specific example. The skin of the building is included in the outfit category. This group includes the façade element, the roofing and elements like balconies. The overview of the categorization is presented in figure 1.

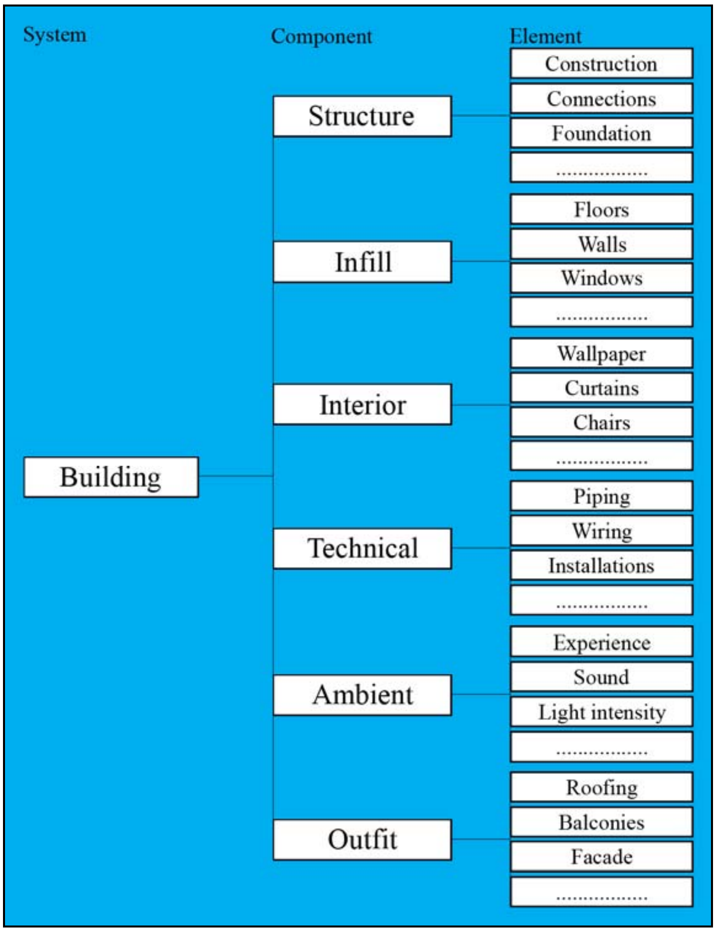

Figure 1 Overview of building system, category (components) and subcategory (elements)

2.1 Adaptation level

In this research the term adaptable architecture is used as a general definition of an architecture from which specific components can be changed in response to external stimuli (the user and/or the environment). Figure 2 presents the levels of adaptation based on the level of sophistication, which increases from left to right. The definition of the different terms of adaptation is explained below.

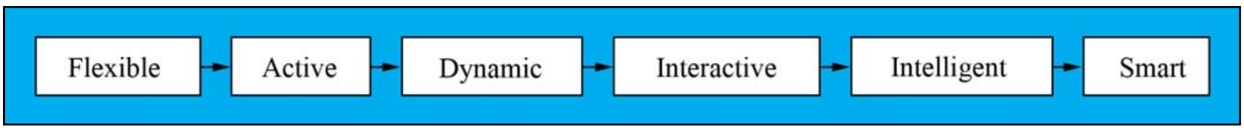

Figure 2 Levels of adaptation in order of sophistication

Flexible The first step in adaptable architecture is flexibility. With flexible architecture the possibility of adjustments on specific components of the building is aimed. This action is in direct control of the user, which means that the component doesn't have the ability to change itself. The components of the building are changeable, with an external force. The different possibilities of change are limited. As an example the Delfts Blauw apartment building in Delft from architect firm "de Architecten Cie." could be given, in which the façade could be changed by the user with sliding shutters. Flexible adaptation requires mechanical techniques such as bearings, which were developed in the middle ages.

Active An active building component will give a set reaction on a specific change; the action must be undertaken by the user or environment. An example of active components is a light switch. The building component responds on an action of the environment/ users with a specific reaction. Active adaptation requires electricity as basic technique, what is available for housing since around 1900.

Dynamic Dynamic architecture has the possibility to give different output on a certain input. The action-reaction relation is not a closed relation. More possibilities and settings are possible within one system. These possibilities are bordered and set in advanced. For dynamic adaptation computer technology is essential, this technology was ready for use in housing since around 1980.

Interactive A step further is taken with interactive architecture in which the building component has to ability to have a two way conversation with the users and/or its environment. A dialogue is set up between the user and system. An integrated system is needed for interactive relations. An example could be found in the saltwaterpavilion by ONL (www.oosterhuis.nl), in which the relation between virtual and real-time are visualized with projections. The projection reacts on external data input. The behavior and reactions are set by the programmer; this will mean that interaction will take place within a specific framework. Interactive adaptation needs digital sensoring what is available since around 1995.

Intelligent Intelligent according to Collier and Thelen (2003); "Users experience a system as intelligent not only if it accepts natural language input rather than just specific commands, but also if it allows the user to take initiative. If the system adapt itself to the users' interests and interaction preferences and works cooperatively with the user to accomplish specific goals with the use of additional sources of knowledge to meet the needs of the user, a system is considered intelligent".
With intelligent architecture the adjustment or transformation of the building component is selected by the system as a reaction on the external stimuli. The building can take its own conclusions for certain situation. Reactions on re-appearing situations will not logically lead to the same change or adaptation. The system has the ability to learn from its environment or users preferences. As an example the Chess computers Hydra (www.hydrachess.com) and Deep Blue (www.wikipedia.org) could be given. The Chess Computers have the ability to calculate indefinite possibilities of positions. This means that it can calculate faster as the human brain, and could therefore play chess with master chess players on a very high level, and actually win. Due to the fact that the machine is "thinking" during the turn of its opponent, the computer can react faster. According to master chess players the computer plays chess on a level which is nearly human, and also makes human mistakes. The only task the chess computer has is chess playing; therefore this computer can not be smart, according to this research. Intelligent adaptation requires more sophisticated computers with advanced software. Future developments based on the Law of Moore (1965), gives promising visions.

Smart Smart architectural components have the ability of self-initiative. The smart system is completely integrated in the life and behavior of the users and environment. The system is self-learning. As Vincent (2001) describes it precisely;" the ultimate smart structure would design itself". Smart systems are pervasive systems with knowledge. Ambient Intelligence has the ambition of a smart system. In Ambient Intelligence a full integration of technology and knowledge should lead to systems which fully collaborate but have also the possibility to take over task when other systems drop out. Ambient Intelligence should anticipate on the users' desires or environment without conscious meditation (Collier et al., 2003). Ambient Intelligence should be an open tool, could be customized by the user, and could learn itself. Smart architecture will mean that ubiquitous computing will lead to digital relationships. These relationships should be parallel to human interaction, based on emotion and intuitive. To create smart adaptability new techniques need to evolve that are not yet available. Promising developments on this field lie in quantum mechanics and DNA computers.

The subsequent stages of adaptable architecture in figure 2 include the lower stages. This will mean that the different stages of control will be part of the higher steps in technology of the adaptable architecture. In for example intelligent architecture the users have also the possibility to set new changes by hand, and tune preferences to their own ideas.

2. Results and analysis

Table 1 Overview of aspects of existing housing projects

	Architect/designer	Name Project	Place	Year	Component	Method of adaptation	Level
A	Rietveld, Gerrit	Rietveld-Schröder House	Utrecht	1924	Infill	Manually reconfigurable sliding walls.	Flexible
B	Corbusier, Le	Villa Savoye	Poissy-sur-Seine, France	1929	Infill	Free floor plan for flexible furnishing.	Flexible
C	Rohe, Mies van der	Tugendhat house	Brno, Czech Republic	1930	Infill	Draperies on ceiling tracks.	Flexible
D	Smithson, Alison and Peter	House of the Future	Prototype	1956	Infill	Manually reconfigurable folding walls.	Flexible
E	Becket, Welton	Mc Cullough House	Palm Springs, USA	1956	Infill/ Interior	Electronic driven elements, like doors, drawers.	Active
F	D'Angelo, Floyd	Aluminum House	Snow Creek, USA	1962	Structure	House structure on motorized rotating pole.	Active
G	Prouve, Jean	Villa Seynage (Maison Alba)	Prototype	1962	Structure	Changeable modular structure.	Flexible
H	Nouvel, Jean	Institute du Monde Arabe	Paris, France	1987	Outfit	Motor controlled apertures in facade.	Dynamic
I	Holl, Steven	Fukuoka apartment building	Fukuoka, Japan	1992	Infill	Manually pivoting elements.	Flexible

J	Ban, Shigeru	Curtain Wall House	Tokyo, Japan	1995	Outfit	Curtain wall.	Flexible
K	Ban, Shigeru	Nine Square Grid House	Kanagawa, Japan	1997	Infill	Manually changed walls.	Flexible
L	De Architecten Cie.	Delfts Blauw	Delft, Netherlands	1998	Outfit	Manually configurable sliding shutters and windows.	Flexible
M	Atelier Brüchner	CycleBowl	Hanover, Germany	2000	Outfit /Structure	With pneumatic pressure the facade and the roof could be changed.	Active
M	Ban, Shigeru	Naked House	Tokyo, Japan	2000	Infill/ Interior	Manually movable units.	Flexible
O	Colani	Rotorhouse	Germany	2000	Infill/ Interior	Electrical rotation room.	Active
P	Peter Marino Associates	Chanel Ginza	Tokyo, Japan	2004	Outfit	Adjustable translucency and image of façade. Possibility of motion pictures on the facade.	Dynamic
Q	UNStudio	Galleria Department Store	Seoul, South Korea	2004	Outfit	Image on façade can be changed. Also movies.	Dynamic
R	Herzog & de Meuron	Allianz Arena	Munich, Germany	2005	Outfit/ Infill/ Ambient	Pressure of façade can be adjusted to weather circumstances. Suspended ceiling. Adjustable color of façade.	Dynamic

The projects presented in table 1 are all characterized by the year the project was realized and the technology used to create adaptability. In figure 3 a graph is presented that combines the information in figure 2 and table 1. Figure 3 also shows when the different stages of flexibility were technically possible. From this graph it can be seen that most of the studied projects used aged technology and that the trend to use "old" technology has increased in the past years. Based on the currently available technology it should be possible to develop interactive adaptability. For intelligent and smart adaptability new technology needs to be developed.

Both figure 3 and table 1 show that none of the studied projects concerns interactive adaptability, even though this should be feasible with current technology.

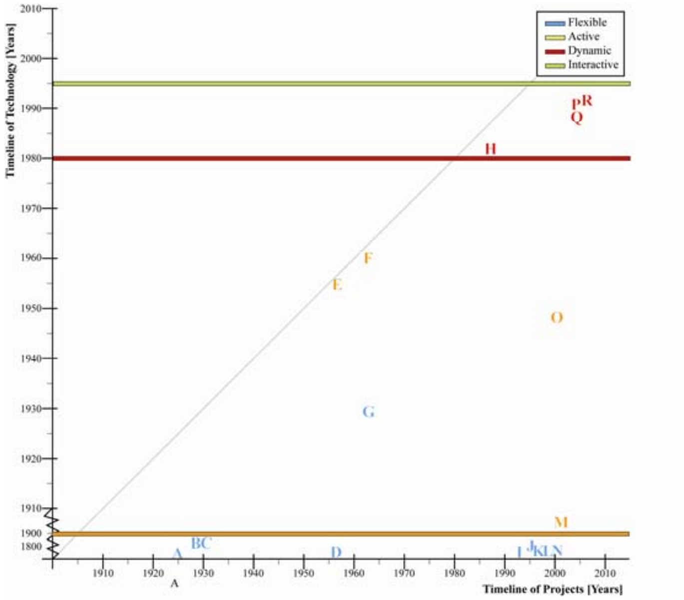

Figure 3 Year of realization of studied housing projects compared to the year of availability of technology used and the level of adaptability

3. Discussion and conclusion

Even though the projects are only a small selection of the realized adaptable buildings it could be concluded that most realized project are found on the level of flexible and active adaptation of buildings. This outcome is logically inline with technological developments. The integration of new technologies with old elements of the building is interesting. The electro optic windows of the Chanel Ginza building are an interesting example of material innovation (www.privalite.com). With the use of integrated material technology regular glass will get more possibilities.

What can be seen in realized adaptable projects is that elements of the building are integrated with existing technologies to get to the level of adaptation. Hardly any new elements are introduced. Adaptation is realized on a one-dimensional level. Different elements of adaptation react individually. A good example is the Allianz Arena, in this project all three aspects have their own change of input, and react independently. Most of the adaptable aspects concern the transformation of a room. This is an interesting outcome as space saving is a logical fact in city houses, in which space is limited. In relation with the traditional Japanese Washitsu rooms this level of adaptation has a very interesting history.

The Open Building theory is not specifically mentioned in this paper, as in the opinion of the writers Open Building is a subject of Flexible architecture, and not a specific level of adaptable architecture. Next to the fact that Open Building has its basics in building processes and systems, flexibility and variation are a common result of the involvement of the user in the building process (Kendall et al., 2000). The systems have the possibility to be renewed more easily compared to conventional houses, but this takes considerable effort.

Even though the scheme in figure 1 differs from the scheme used by Brand (1994) it has a lot of resemblance. The most impressive difference lies in the word Ambiance. Brand uses the word Environment, to refer to the outside area of the building. Because the research presented in this paper has no relation with the outside area in terms of adaptation, this term was changed to Ambiance which is much more relevant in the context.

It could be argued that the definitions and the related level of adaptability are not fully based on existing schemes. In some aspects the definitions presented differ from those used by for instance Holland (1992) and Negroponte (1970), for a general framework of levels of adaptation these definitions were refined to fulfill its purpose.

For the decision on the level of adaptability only the body of the building was considered. Interior aspects and technical as well as ambient aspects were not considered, as subject of research on its own. This was an attempt to narrow the subject of analysis.

The division of the timeline of the technical possibility to achieve a specific level of adaptability depends on the specific definitions presented in this paper. If the definition would be different this would possibly influence the division in level of adaptability. Furthermore the assumption that the named techniques are mainly responsible for the possibility to create a certain level of adaptability could be discussed. However, it is expected that the time connected to those techniques will not change significantly if further research proves that other techniques where in fact more decisive.

Based on the results presented here it was concluded that it is feasible to make an interactive adaptable design with use of dynamic materials (materials which have the ability to change their physical appearance and characteristics, with the change of an external output, for example temperature and electronic current). Then it would meet the requirement of new techniques and a new level of adaptability as can be concluded from this paper. Dynamic materials offer the possibilities of an integrated system. The first goal of the Ph.D. research is to take the next step of adaptable architecture on the level of interactive adaptability, with the use of dynamic materials.

8. References

Brand, S. 1994. *How Buildings Learn: What Happens After They're Built*. New York: Viking.

Collier, R. and E. Thelen, 2003. User-System Interaction Based on Spoken Dialogue. *The New Everyday*: 78-83. Rotterdam: 010 Publishers.

Cook, P., 1972. *Archigram*, London: Studio Vista.

Corbusier, Le 1923. Vers une Architecture. Paris: Crès.

Dekker, A. 2006. The New Art of Gaming, or What Gaming can Learn from Installation Art. *Game Set and Match II: on Computer Games, Advanced Geometries and Digital Technologies*: 116-125. Rotterdam: Episode Publishers

Edler, J. and T. Edler. 2006. Message vs. Architecture? Dynamic Media as a Continuation of Architecture. *Game Set and Match II: on Computer Games, Advanced Geometries and Digital Technologies:* 181-189. Rotterdam: Episode Publishers

Holland. J.E. 1992. *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence*. Cambridge, Mass.: MIT Press.

Kendall, S. and J.Teiger. 2000. *Residental Open Building*. London and New York: E & FN Spon.

Kronenburg, R. 2002. *Houses in Motion: The Genesis, History and Development of the Portable Building*. Chichester: Wiley- Academy

Kroner, W.M. 1997. An Intelligent and Responsive Architecture. *Automation in Construction* 6: 381-393.

Moore, G.E. 1965. Cramming more components onto integrated circuits. *Electronics Magazine 38.*

Negroponte, N.1970. *The Architecture Machine.* Cambridge, Mass.: MIT Press.

Vincent, J. 2001. Smart by Nature. *Lightness: The Inevitable Renaissance of Minimum Energy Structures*: 42-47. Rotterdam: 010 Publishers.

www.hydrachess.com

www.oosterhuis.nl

www.privalite.com

www.wikipedia.org

End-User Involvement in Building Activation Projects: Co-producing Space and Value

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Key words: co-production, end-user involvement, user composition, product functions

Abstract

With an awareness of the environmental impacts of construction activities, we are forced to consider how we can revitalise old building stock rather than demolish, which is traditionally practised. Utilisation of this building stock requires consideration to meet end-users requirements and to ensure that various features of renewed buildings are met so that value can be added on the users' terms. Technological and engineering innovations will encourage the effective renewal of old buildings, however it is also crucial for construction professionals to identify what users expect of such rehabilitated buildings. Literature claims that end-user involvement in the product development and design process provides a sense of ownership and leads to success in businesses. However, it is not easy to identify potential users and their complex and diverse requirements in construction. With this in mind, the paper initially puts forward product design concepts of 'user composition', 'product functions' and 'product structure' to clarify the way in which end-user product function requirements affect the product design. This will assist construction professionals in developing a more focused product that meets varying user requirements. Next, it introduces the concept of co-production, which emphasises end-users' active participation in product development. Finally, the paper discusses the ways in which end-users can be involved in construction projects and design processes, with an example of end-user participation in a building renewal project.

1. Introduction

In this current era with a heightened awareness of environmental impacts of construction activities, we are forced to think of ways old building stock can be revitalised, not simply demolished as has been traditionally practiced. In order to add value to the old building stock, it is important that this process meets the requirements of the end-user by incorporating various features of the buildings. Technological and engineering innovations will assist the effective renewal of old buildings, but it is crucial for construction professionals and practitioners to identify what the users expect of such rehabilitated buildings. Literature claims that end-user involvement in the process of design and product development provides end-users with a sense of ownership and thus makes them satisfied. This, in turn, leads to a success in businesses. However, it is not easy to identify potential users and their complex and diverse requirements in construction, particularly in buildings which will accommodate numerous and different users.

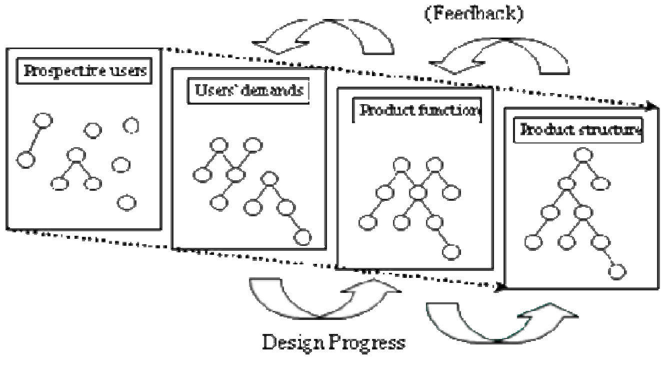
With this in mind, the paper initially proposes product design concepts of 'user composition', 'product functions' and 'product structure' to show the way in which end-users' feedback can have an effect on product design. Then, the paper introduces the concept of co-production, which emphasises end-users' active participation in the process of product development. This concept highlights the importance of developing a focused product which considers and meets the users' diverse requirements. The paper then discusses the ways in which end-users can be involved in construction projects and design processes, providing an example of end-user participation in a project which revitalised and reused an old factory building.

2. Design process and user feedback

There are certain features of the construction industry that make it potentially difficult to identify who 'the customer' is. Unlike other sectors with clearly defined end-users (e.g. banking) whose customer requirements are easily taken into account, there is a tendency for end-users of the construction industry to not be regarded as customers by firms who are inclined to think only of their immediate clients. For example, in the social housing sector, the customers of a construction company are usually local authorities, and end-users who will actually occupy the houses are often not taken into consideration during the product development process.

Nonetheless, the requirements of 'ultimate customers' cannot be neglected. Feedback and information from end-users must be incorporated into the product development and design process. Specific requirements of end-users have to be captured in order to achieve a maximum level of customer satisfaction, which ultimately will contribute to the success of the business. Therefore, we need to know who the end-users are, what their requirements are and how they can be involved in the product development and design process. To clarify the way end-user requirements affect the design of the products, we use some product design concepts: 'user composition', 'product functions' and 'product structure'. In order to discuss how to achieve user participation in product development, and how to incorporate customer requirements in product design, we will highlight the mechanisms of the design process and show the characteristics of these mechanisms. Figure 1 shows that the four phases in the design process influence each other with feedback constantly being provided. It is also clear that users and their requirements form the basis of the design process.

Figure 1. Four aspects of the design process



(1) Prospective users
There are many types of prospective users for each product. The prospective users have different characteristics and may also have structural relationships amongst themselves (user structure). For example, while some products are used only by individual customers, other products are meant for a large number or the general public.

(2) User demands
The totality of user requirements is closely linked to user structure. It is quite straightforward to understand the requirements of single users, but it becomes increasingly complex when a product has many different users. The level of difficulty becomes significantly greater when the users of a product cannot be identified. User requirements can vary greatly but remain unidentified. Furthermore, requirements of users can include abstract things such as wishes, hopes and feelings, which cannot be clearly expressed and therefore, occasionally come into conflict with each other.

(3) Product functions
A product is developed based on the composition of various product functions (Fujimoto 2002). It is therefore essential to make product functions correct in order to make the product right. However, it is possible that different users can require different functions from the same product. The heterogeneity nature of users and their requirements suggests an importance in understanding the characteristics of users and corresponding product function requirements.

Furthermore, every product has a specific composition of prospective users. We identify three types of users: single users, private/specific groups of people and unspecific groups of people. The difference between the three user types has significant impacts on product design. In the case of a product of complex features, such as a public building, not only can users be quite diverse within one product class, but the functions required can also be diverse ('multiple-users' and 'multiple-functions'; Figure 2). For example, the living room of a house will have multiple users that are a private group of people (e.g. household members), and the entrance hall and conference rooms of a city hall would have multiple users of unspecific groups of people (e.g. the general public). In both cases, users often have specific requirements, and design professionals need to meet their expectations with regard to the main functions (which characterise the product) and sub-functions (the requirements which will be varied according to users and therefore will have to be prioritised) of the product. While it is relatively easy to obtain opinions about the living room from family members of a house, it is much harder to obtain all the differing opinions on the entrance hall of a city hall from its potential users. Clearly, the user structure (e.g. specific customers vs. a large number of the unspecific general public) has a significant effect on product functions, and consequently on product structure.

Figure 2. User composition and product functions

User Type	Single Function	Multiple Functions
single users	software application	cell phone, PC
a large number of a private group of people	private car	house
a large number of the general public	tram	*city hall*

(4) Product structure
The product structure is constructed based on product functions (Ulrich et al. 1995). At this stage, the developer or producer of a product could have strong input into the product design based on their experience

and knowledge. This could result in an end product showing the design firm's usual design characteristics (Fujimoto et al. 2001), which may not necessary reflect users' ideas.

The complex relationships between potential users, user requirements, required product functions and product structure show the significance of involving end-users of the product. In cases with products having multiple features, such as a public building, users can be quite diverse within one product class. By categorising multiple users according to their use of the building, their wide-range and distinct function requirements can also be categorised. In turn, this helps the producers and architects to work more effectively on the design of each product function. User composition can help firms to segment their customers, which facilitates a more user-oriented production.

3. Co-production

There are difficulties in meeting user demands, especially when there are so many users with diversified and sometimes conflicting requirements. A company can offer each individual user the chance of contributing to product design by drawing the user into the product development process. This method allows the business to adapt to the requirements of the users and tailor the product specifically for them (McKenna 1991). The literature of 'user innovation' claims that users' feel satisfied with innovative companies and innovative products and services which materialise their requirements and desires (Ellis and Curtis 1995). Feedback from them, as well as an accurate understanding of their contexts, is crucial to desired outcomes (Herstatt and von Hippel 1992; Leonard-Barton, 1984).

Indeed, users' participation in product design has become widespread. Some companies place emphasis on pro-active user relationships by anticipating what users like and learn from them in order to provide customer-focused products. In particular, when a product has many unspecified users with highly heterogeneous requirements, a product that reflects the average user requirements will leave many of the users dissatisfied. One way of responding to this problem is to enable users to modify products to create a better fit to match their own requirements. This approach has become common in the development of software applications (Franke and von Hippel 2003; Lakhani and von Hippel 2003). Skilled users can create customised and superior versions by integrating their knowledge into product design (Leonard-Barton 1984; von Hippel 1988), and the experiences of those 'lead users' present solutions to problems (Slaughter 1993). This leads to a high level of customer satisfaction. Lead users like working on the problem, improving the product and enjoy the reputation gained from making high-quality contributions to its development (von Hippel 2005).

Similarly, the literature on 'co-production' emphasises users' active involvement in product development. Udwadia and Kumar (1991) for example, talk of 'co-construction' of new products, which takes into account user requirements through information technology. This process can include user experimentation and subsequent design modifications leading to a close collaborative relationship between producers and consumers/users, and subsequently a shared ownership of the final product. In such co-production, users can play an active role in the production of goods and services on their own terms (Ostrom 1996). Positive attitudes towards bringing users' ideas into the product development process of design, delivery and after-care can change the whole situation. Innovative approaches such as these can lead to new and more user-friendly forms of products and services which reflect the requirements of end-users.

However, construction is different from, for example, software applications. Therefore, one important question in construction projects is how to incorporate user requirements in the actual physical form of buildings. End-users cannot modify the product on their own and create an improved or customised version like they may do with software. So, how can users' heterogeneous needs and requirements be incorporated into product design? In order to produce a building on users' terms, the product must have a certain degree of flexibility to meet individual aptitudes and interests. This, for example, can be achieved by increasing customer choices in design and increasing user involvement in the decision-making process. In the house building business in Europe, customers' design participation has become widespread. As an example, flexible plan forms (i.e. the possibility of changing the internal layout of developments after they have been built) in France and the communal covered open space in Denmark result from user design participation (Woolley

1994). Such participatory housing may look fairly conventional, but on closer inspection, one can see the influence of users in many different ways, such as internal layouts, as well as choices of house types available to users. These examples suggest that user participation can bring about innovation in house building. Innovative approaches such as this can lead to new and more user-friendly forms of housing design, reflecting users' interests and ideas (ibid.). This way, value can be added to the building. It will be a perceived value by users, rather than an intended value that producers expect to add to the building (see Rindova and Petkova 2007). Therefore, architects and designers need to obtain feedback on 'in-use performance' of the products. What they need is a voice from people who actually and potentially may use the product, even though their experience and knowledge cannot be integrated in the same manner as computer software design. In this light, the following sections discuss ways of co-producing and co-renovating buildings.

4. Involving users into design process

So, how can users, especially end-users be involved in the design process and express their opinions; and how do they take part in product development?

In recent years, the scale of large construction projects has increased. Large projects inevitably have many stakeholders. For example, a project to build a city hall has a number of stakeholders including the mayor of the city (i.e. client), architects, construction engineers and other engineers, researchers and citizens (i.e. end-users). Furthermore, such a large project is likely to have many users – both specific and unspecific – and therefore the number of functions required by different users and issues to be solved are significantly greater than, and different from, those involved in a project building a residential house, which is used only by its household members. Therefore, even when the users of the building are unspecified it is crucial to engage with potential users, such as those who may come to the city hall for a concert/meeting or for administrative purposes, and categorise them according to their use of the building.

In a large building project, whilst construction engineers deal with issues and agendas that are physical, architects ensure that the design is generated from not only the pure design perspective, but also from the historical, social and psychological viewpoints. This requires the architects to consult with people who are aware of both the historical and psycho-social contexts. This is an example again where end-users become part of the design process. End-users' opinions about the project can be collected and discussed in a number of ways. The larger the project, the more information is required. Typically in a large building project, formal interviews with representatives of the public and/or a questionnaire surveys involving the wider public are conducted. But consultation exercises can also be held. These have more elements of active user participation than interviews and questionnaire surveys alone. Such public consultations, i.e. meetings that involve both designers and users include international environmentalist groups to discuss ecological matters.

There are different degrees to involvement in the design process by the end-users. We identify three levels: (1) input and feedback, (2) controlling and (3) accomplishment. 'Input and feedback' is the least pro-active form, in which end-users put forward their demands and see how their demands are treated. At the 'controlling' level, end-users are involved in the actual design process and get to observe how the project is being conducted, but they are not involved in the technical aspects of it. Lastly, end-users get involved in all levels of activities ('accomplishments'). In this case, they develop abilities to technically intervene in the project. In reality, the first two levels are more feasible and should be achieved in building projects, but end-users' technical intervention can be difficult to achieve.

There is an advantage to such active end-user participation. Alexander (1964) points out that user participation makes a strong sense of solidarity amongst participants. Such solidarity helps them explicitly express their requirements, which otherwise may remain unsaid, and thus make them strongly motivated as participants. With the experience of participation in product development, the end-users' sense of responsibility will be raised; and their newly acquired sense of responsibility concerns not only the project context itself; but also many other issues including the environment and culture.

By looking at the ways in which users can be involved in (public) building projects, we identify four implications of end-user participation in general:

1. The expansion of the boundary of the meaning of "customers",
2. Customers (end-users) taking part in many aspects of a project (design, product development),
3. Customers developing their sense of ownership and responsibility through the experience of the participation, and
4. Participation helping the concepts (social meaning) of the product (e.g. a city hall foyer as 'a place of comfort' for the general public) to penetrate into society.

5. Cable Factory, Helsinki

The following case is taken from a successful renovation project of a former Nokia Cable Factory building in Helsinki, Finland. An interview account with one of the architects on the renovation team (and his published article), as well as a published account (by Högström, published on the Cable Factory website), are used to draw information.

The Cable Factory (Nokia Kaapeli) is an example which shows a certain respect for the industrial past. A balance between existing older structures and new interventions was achieved by both contrasting and blending the two (Verwijnen, 1996). With the expansion of business and shortage of space in the 1950s and new town planning which moved industrial buildings farther from the city centre in the 1960s, Nokia Kaapeli decided to relocate. During the last few years of ownership, Nokia Kaapeli invested very little in the maintenance of the building. As the industry was moving from the area, Nokia Kaapeli started renting the premises at very affordable rates, and many artists and small businesses moved to the Cable Factory, due to the fact that they were able to secure peaceful working spaces. There were also spaces suitable for performances and exhibitions. The potential of the factory and its ideological philosophical starting point was proved to be effective in practice before any official decisions were made. The administrative decision-making took four years. In 1987, the city of Helsinki and Nokia agreed on the procedures for the transitional period and formed a delegation to plan the future use of the factory in the ownership of the city. Plans were made to build schools, hotels, museums and even a car park to the former factory. The concerned tenants of the Cable Factory founded an association, Pro Kaapeli. Architects who had worked at the Factory also created a parallel plan to save the building and the activities that were prevalent at the post-industrial Cable Factory. They considered what kind of space was available in the building and the ways internal spaces could be used by different users (artists and visitors). Pro Kaapeli pointed out deficiencies in the planning of the area and even got the media involved. Pro Kaapeli was featured in the leading national newspapers and national TV and managed to dissolve deeply rooted prejudices against house squatters and artists who were often considered as 'shady'. Along the lines with Pro Kaapeli, a commissioned report described the identity of the Cable Factory and was used as a guideline for the future development, so that the unique atmosphere would not be destroyed and the building would act as a cultural symbol. 'For Helsinki the value of the Cable Factory likes on an emotional level' (Verwjinen 1996: 126). Those who were involved in this renovation project felt that the building and its newly found artistic community were too unique and valuable to be wiped away. A new agreement was made with Nokia, the city council decided to protect the Cable Factory and its milieu and an estate company was founded. Almost all tenants were allowed to stay. Now, the new Cable Factory hosts theatres, museums, art schools and many small businesses and art workshops, and is regarded as a renowned art establishment in Europe. The usable surface area is 53,348 square meters, of which 40,000 have been rented, and 99 per cent of the work spaces are in use. More than 200,000 people annually attend the events taking place in the halls, museums and dance theatres. The Cable Factory finances its own operations; the turnover surpassed 3.5 million Euros in 2005. The new Cable Factory was - albeit initially born accidentally - was realised with tenants' pro-active involvement, mainly Pro Kaapeli.

This is a case where end-users took a pro-active role in the renovation of an old building. Since the end-user group included architects who had previously occupied space in the building, they had technical knowledge, as well as clear product function requirements, in terms of the use and identity of the building. In light of the implications of end-user participation presented above, this case shows the following:

- The customer includes not only Helsinki City, who came to possess the factory building after the company moved, but also sitting tenants and potential users.

- End-users (not intermediary customers like the city council) intervened to a large extent and changed the initial plan of renovation.
- End-users saved the old building from being turned into hotels and kept their cultural tradition. This gives them a great amount of pride.
- The identity of the building was created through user participation.

6. Conclusion

As the concept of co-production suggests, users' active involvement in the design process can lead to a successful renovation. In order to add value to the renovated buildings on the (end-) users' terms, designers need to analyse both existing and potential users of the building and their function requirements in order to meet their expectations and ultimately to make their projects successful.

However, product users are complex. Firstly, the term encompasses many different types of customers; including end-users who actually use the product and are often overlooked in both the product development and design processes. In the case of the Cable Factory, Helsinki City Council was the visible and immediate customer/user, and the sitting tenants were end-users who actually used the building. Secondly, there can be different kinds of end-users for one product and this implies they have different product function requirements. The Cable Factory building required space for diverse activities for a wide range of end-users, such as space for working (painting, practicing, etc.); exhibiting and performing; eating and drinking; conducting administrative work; etc. In light of customer satisfaction and a success in the renovation project, it is crucial for any firm to identify who the end-users will be, to analyse what they require and to incorporate their requirements in the end product.

The key to the success of the case presented above relies not only on the use of the space, but also that the identity and meaning of the building were generated amongst user groups (which included professional architects who had technical knowledge). This is particularly important in the case of reusing old building stock which carry history and meaning to many people. This approach can be quite useful when potential users cannot be identified. At least, cultural meaning attached to the building can be saved by consulting current owners of buildings and local people. This helps designers to develop their renovation projects in line with local tradition without overlooking the industrial connotations of the building and the meaning created from subsequent cultural occupation prior to renovation, as in the case of the Cable Factory.

This paper has discussed the significance of, and approaches to involve users in the process of product development and implications of their participation. The case study of renovating an old factory building has offered insights that raise our awareness of the importance of listening to end-users and reflecting their ideas in the design process. Despite the complexity and difficulty, design practitioners should maximise end-user involvement. This paper outlines this concept, however it does not involve any empirical studies. The next step therefore would be to investigate a real building activation project and analyse the way in which end-users participate in the project and make recommendations to the actual practice.

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References

Alexander, C. 1964. *Notes on the Synthesis of Form*. Cambridge, MA.: Harvard University Press.
Ellis, L. W. and Curtis, C. C. 1995. Measuring customer satisfaction. *Research Technology Management* 38(5): 45-48.
Franke, N. and von Hippel, E. 2003. Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. *Research Policy*, 32(7): 1199-1215.
Fujimoto, T., Aoshima, Y. and Takeishi, A. 2001. *Business Architecture*. Tokyo: Yuhikaku.

Fujimoto, T. 2002. Architecture, capability, and competitiveness of firma and industries. Discussion Paper CIRJE-F-182, Centre for International Research on the Japanese Economy, Faculty of Economics, University of Tokyo.

Herstatt, C. and von Hippel, E. 1992. From experience. Developing new product concepts via the lead user method: a case study in a "low-tech" field. *Journal of Product Innovation Management* 9: 213-221.

Högström, H. Finnish Cable Factory. http://www.kaapelitehdas.fi/.

Lakhani, K. R. and von Hippel, E. 2003. How open source software works: "free" user-to-user assistance. *Research Policy* 32(6): 923-943.

Leonard-Barton, D. 1984. Diffusing innovation: when the users are not the choosers. *Knowledge: Creation, Diffusion*, *Utilization* 6(1): 89-111.

McKenna, R. 1991. *Relationship Marketing: Successful Strategies for the Age of the Customer*. Reading, MA.: Addison-Wesley.

Ostrom, E. 1996. Crossing the great divide: coproduction, synergy and development. *World Development* 24(6): 1073-1087.

Rindova, V. P. and Petkova, A. P. 2007. When is a new thing a good thing? Technological change, product form design, and perceptions of value for product innovations. *Organization Science* 18(2): 217-232.

Slaughter, S. 1993. Innovation and learning during implementation: a comparison of user and manufacturer innovations. *Research Policy* 22: 81-95.

Udwadia, F. E. and Kumar, E. R. 1991. Impact of consumer co-construction in product/service markets. *Technological Forecasting and Social Change* 40(3): 261-272.

Ulrich, K. 1995. The role of product architecture in the manufacturing firm. *Research Policy* 24: 419-440.

Verwijnen, J. 1996. The Cable Factory: A story of another kind of interior renovation. In I. Helkama (ed.) *Helsinki Interiors*. Helsinki: Rakennustieto.

Von Hippel, E. 1988. *The Source of Innovation*. Oxford: Oxford University Press.

Von Hippel, E. 2005. Democratizing Innovation. Cambridge, MA.: MIT Press.

Woolley, T. 1994. Innovative Housing in the UK and Europe. In R. Gilroy and R. Woods (eds.) *Housing Women*. London: Routledge.

Factors Affecting Open Building Implementation in High Density Mass Housing Design in Hong Kong

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Abstract
The vast majority of buildings being constructed in Hong Kong today are massive 40+-storey high-rise residential building towers housing hundreds of families. Immense resources – land, material, time, labour, money, energy – have been invested in their realization. However, almost all of these buildings, including those currently under construction and on the drawing boards, are not designed with adaptability and flexibility as a design intention and will cause major problems in the future: their lack of capacity for re-activation means that their only fate is demolition, thereby consuming even more resources, producing more waste, and causing more disruption to the environment. Unless we change our mind-set in mass housing design, today's designs will inevitably become tomorrow's problems. This paper studies the scenario design requirements and critical dimensions of use-territories in public mass housing in Hong Kong in view of extracting useful patterns for use in future designs. Case studies of popular residential layouts currently used in Hong Kong will be used to illustrate the kind of problems the majority of the existing residential building stock will face when the need for renewal and upgrade arises.

"Tomorrow is today." - Martin Luther King Jr.

1. Introduction
In modern cities and countries, mass housing emerges as a more and more vital issue to the well being of the community. In places like Japan, Singapore and Hong Kong, a lack of developable land in urban areas makes multi-unit housing the mode of living for the vast majority of the people. In Hong Kong, such residential buildings typically extend over forty storeys to fully utilize the scarce land supply. At present, Hong Kong is the home to 24 of the 50 tallest residential building in the world[1]. All of these residential towers are over 60 floors in height with the tallest, Sorrento Tower 1, topping 75 floors at 256m (Fig. 1). The Hong Kong SAR Government provides and builds the majority of such high-rise residential buildings for both rental and sale, accounting for around 60% of all housing units currently occupied. At present, slightly over 50% of Hong Kong's population live in some kind of public housing.

However, the room layouts variations of the present typical high-rise residential designs in Hong Kong are severely limited and cannot satisfy the highly variable spatial needs of the many users. Users have to make alterations to their units before moving in. Many even change the spatial layout of the units by knocking down brick walls and building new ones to form rooms that suite their requirements. Understandably, certain aspects of a building may become obsolete over time as the needs of the users also change. In this case, however, valuable resources - material, energy, time, money, manpower - are rendered obsolete before they are even put into use. Such *immediate obsolescence* is unacceptable in the light of the international direction towards a sustainable community. Flexible housing design can be a solution to this problem because with flexibility in layout configurations there is a better chance for the users to find a unit that can fulfil their respective spatial requirements.

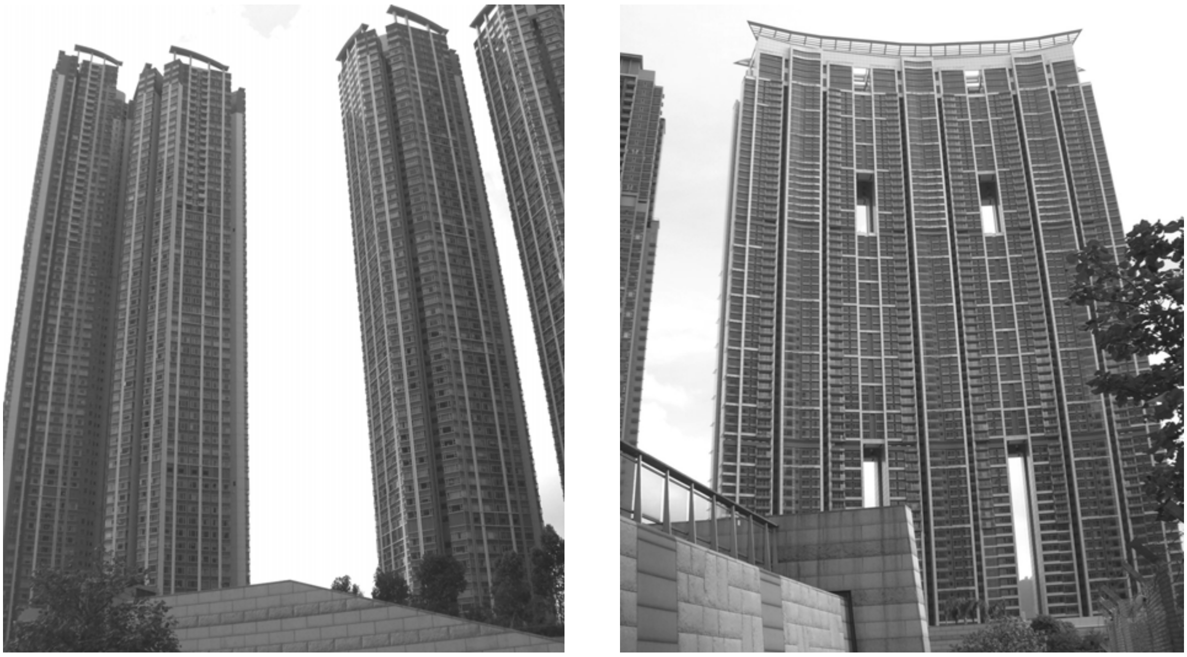

Fig. 1: Super-highrise residential developments in the Kowloon Station development

One of the major objections to flexible designs is that flexibility entails complex construction and hence higher costs – the economy of scale through repetition is the main reason inadequate standardized designs are being used in the first place. This can be overcome by using a modular "kit-of-parts" to create the spatial configurations required for various spatial needs of the users. Although the room layouts inside a unit may vary, they are nonetheless composed of the same building elements from the modular "kit-of-parts". Being modular, pre-fabrication technology can be utilized to further assure quality and save on costs. The Hong Kong Housing Department has itself identified prefabrication and flexible building designs as two key approaches to waste management in public housing production (Gabriel, 2000).

2. The Open Building System

The flexible or "open building" approach to mass housing design is actually not new. N. J. Habraken had proposed a similar approach to mass housing design in the 60's and 70's by organizing the built environment into a number of levels (Fig. 2). Within this hierarchy of levels, any given or fixed elements can be termed "support" and any element the user/designer is free to add in or change "infill" (Boekholt, Dinjens, Habraken, and Thijssen, 1976). Thus on the building lot level, the support is the government-controlled setting out of building lot boundaries (same level elements) and the infill is the buildings (elements of the next lower level) the lot owner would design and construct. The given support elements define the immutable framework around which one asserts control and is free to add and arrange any infill elements.

This approach to design allows decision on each level be made separately and systemizes the apparent unsystematic design process. As the designer moves from the higher levels (site, building, etc.) onto the lower ones (unit, room, furniture, etc.), what is put in as infill elements at a higher level becomes the support elements for the next lower level. The design of a building can therefore be simplified into selection of options from a solution set from each of the levels the design involves. A detailed description of this concept of designing residential buildings based on support/infill can be first found in Habraken's book, "*Supports: An Alternative to Mass Housing*" (Habraken, 1972) and later further elaborated in "Variations: The Systematic Design of Supports", which was co -written in 1976 by Habraken and three other then members of the Design Methods

Group of the Department of Architecture at the University of Eindhoven. This approach to housing design, which is also known by the name of "open building", has been applied with varied success up to present. However, this concept has very seldom been applied in scales similar to mass housing in Hong Kong where towers typically reach 40 floors in height with 8 to 10 units per floors.

Fig. 2: The basic support from the book "Variations: The Systematic Design of Supports" and three layout options of infill arrangements

This remainder of this paper is divided into two main sections. The following section summarises the results of a study on the existing use territory conditions of public housing units in Hong Kong, which is a research funded by the Division Research Grant of the Division of Building Science and Technology of the City University of Hong Kong. The final section then applies some of the findings of the said study on ten different private mass housing developments to test their potential for flexibility on the room level.

3. Use Territory Study on Public Housing Units

To design a modular system that can satisfy the various spatial needs of mass housing users, one must first have a clear understanding of how they actually use space inside their units. Although there are many studies on the spatial characteristics of housing units and their layouts, none concentrated on *use-territories* and their implications towards flexible designs. Use territory is the area that is required for a human activity to take place. For example, each piece of furniture (e.g. a wardrobe) not only occupies space inside the room but also dictates an area around it in order for the function it serves to take place (e.g. the area immediately above the wardrobe must be kept clear for the user to open its doors to get to the clothes inside). Hence, the use "clothes storage" defines inside the architectural space we call "bedroom" a use-territory comprising two parts: the physical space occupied by the wardrobe, which has a definite boundary, and the space required to operate it, which has no tangible boundary.

The purpose of the investigation was divided into two parts. The first part is to study and survey the disposition of furniture and the space around them inside public housing units. The second part is to examine the results of the first part to identify patterns of use-territorial relationships. This investigation aims to provide information that is crucial to the development of a prefabricated modular system for housing design in future investigations and strategic research, which can provide sufficient flexibility for designers and economies of scale for manufacturers. The following are key issues to be addressed in this investigation:

1. What are the most common types of use-territories?
2. Are there recurring patterns of how use-territories are organized?
3. How are use-territories organized in the current standardized housing layouts?
4. What are the users' actual desired use-territory configurations?

The survey consists of visits to public and private housing estates for measurement, interviews, photo-taking, sketching, etc. The furniture layouts within each subject unit will be recorded, analyzed and presented in diagrams. The furniture layouts and the space around them represent the use-territory for each associated user activity (e.g. dining table + chairs = dining, sofa set + TV cabinet = living, computer desk + chair = work/study, etc.). The following information was recorded: the layout of the furniture in a use-territory, the dimensions of the furniture, the dimensions of the space around the furniture, the dimensions of the use-territory, and the position of the use-territory in the room.

The subject of study was the latest Home Ownership Scheme (public housing for sale) housing block design by the Hong Kong Housing Authority that is repeated all over Hong Kong in public housing estates in towers reaching 40 floors in height is the Concord Block. This design is based on the common "cruciform" tower with four wings, which holds a pair of units each. This configuration forms an eight-unit typical plan with two unit-type variations – a 62 m^2 net area 3-bedroom unit and a 45 m^2 net area 2-bedroom unit. Looking at the internal layout of the Concord Block design reveals that the spatial configuration not only lacks variety but also the capacity to provide options for post-occupancy alterations resulting in different room layouts. Due to various reasons, one of which ironically is the adaptation of prefabricated building components and mechanized formwork, the main facade wall of the units is not straight. For example, in the 3-bedroom unit, the two bedrooms protrude about 400mm from the face of the living room and 1475mm from the face of the en suite bedroom. This makes altering the internal layout of the unit difficult.

Fig. 3: Use-territory configuration variations in the 3-bedroom units.

After interviewing 80 households – 40 in 3-bedroom units and 40 in 2-bedroom units – recording the furniture layouts in each of the units, the data collected was tabulated and analysed. The findings can be divided into two main topics: the tenants' current use-territory configurations and their preferences for future re-configuration at the room level. The recorded use-territory configurations as reflected in the furniture layout in individual units show a wide range of different configurations within the relatively confined spaces in both types of units (Fig. 3). Despite the small sizes of the rooms, the tenants demonstrated that a high number of use-territory configuration variations remain possible. Some of the more popular configurations are tabulated in Fig. 4. From these "preferred" configurations, we can determine three important minimum dimensions regarding the width of rooms: 2500mm for living spaces, 1500mm for dining spaces, and 2100mm for bedrooms.

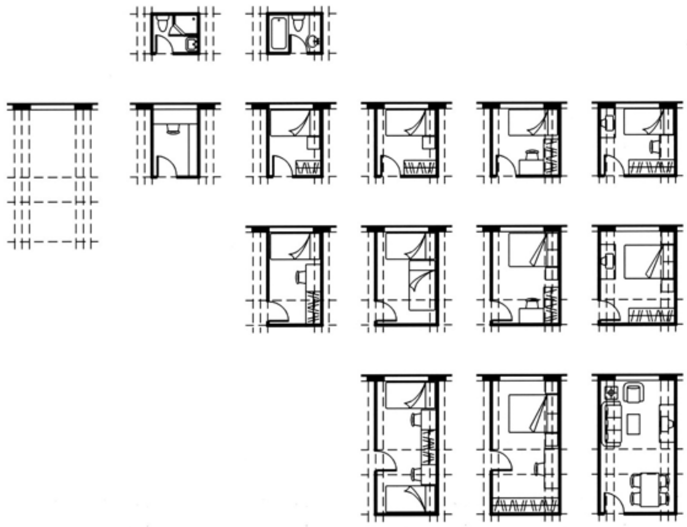

Fig. 4: Room-level flexibility: matrix of use-territory configurations

There are two ways to change the arrangements of the room-level elements in a residential unit: changing the size(s) of one or more room-level elements, and changing the number of room-level elements. It is therefore critical to take the potential desired changes into consideration when designing the initial layout of the unit and allow for the capacity to accommodate these future changes. This way, prospective tenants can determine the possibility for re-configuring the layouts before they purchase the flat and can therefore decide whether or not the unit type can meet their present and any future foreseeable needs and changes in needs. This is known as *scenario design* (Fig. 5). The survey discovered that the most common future re-configuration needs of the room-level elements of the units relating to their sizes and numbers are as follows: 1) increase the size of the living room, 2) increase the size of the master bedroom, 3) providing an additional room (as study or small bedroom), and 4) merging two rooms form a larger room (mostly to achieve the purposes of 1 and 2 when the number of rooms can be reduced). These scenario design requirements and the above critical dimensions will be applied in the next section to test the potential for future activation in terms of room layout flexibility in existing mass housing designs in Hong Kong.

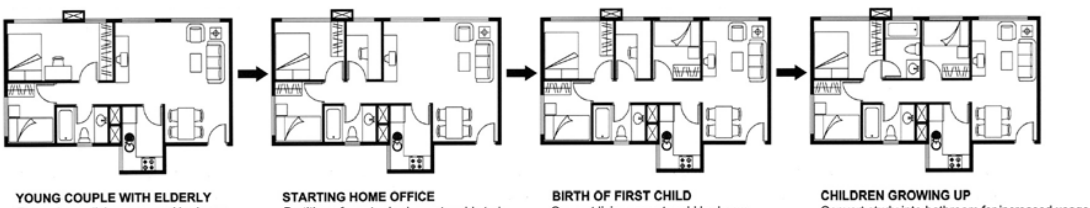

Fig. 5: Demonstration of scenario design in flexible housing unit prototype

4. Future Activation of Current Building Stock

Following the study on existing use territorial patterns and preferred reconfiguration needs, ten unit layout designs of plan types commonly adopted in Hong Kong (Fig. 6) are analysed by applying the resulting scenario design and dimensional requirements. The plans selected are of 3-bedroom units from existing residential buildings in Hong Kong completed in the past five to ten years, ranging from $75m^2$ to $88m^2$ in gross floor area.

The selected plans are representative of the majority of the more popular typical room-level arrangements in mass housing blocks in Hong Kong.

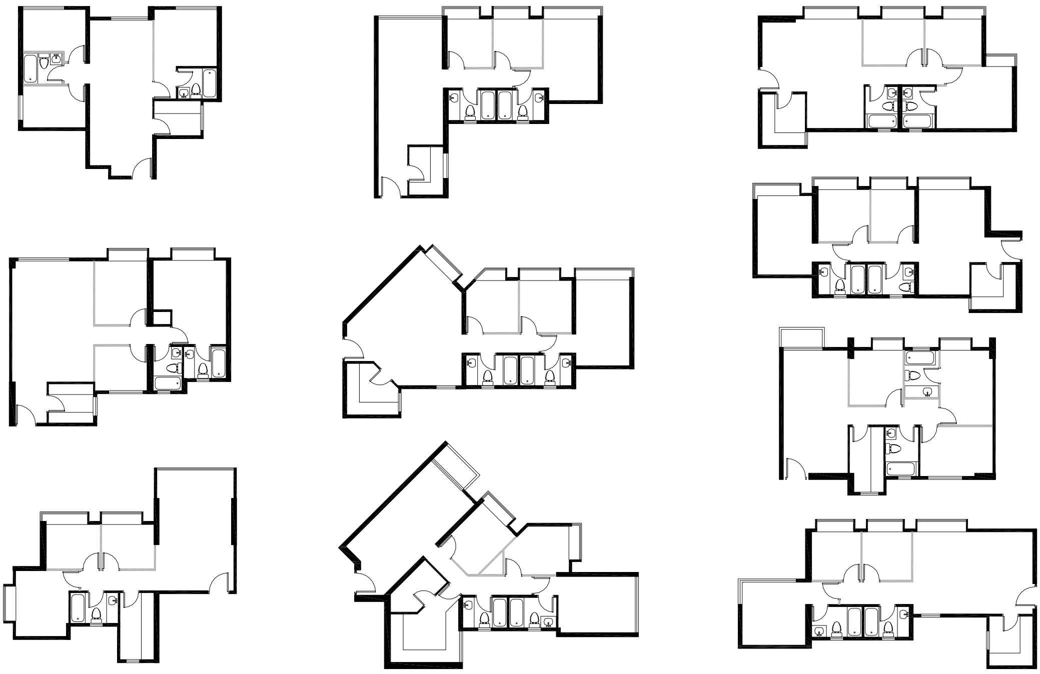

Fig. 6: The ten unit layout designs analysed in the study

In the above figure, the light-grey-hatched walls represent the non-structural wall that can be treated as removable infill elements. The solid walls mark either the structural shear walls or envelope walls that cannot be altered, and are therefore support elements in these layouts. It is obvious that in most of the above layouts, the shear walls occupy not only the external envelope but also the internal walls. Their location in the interior of the units severely limits the flexibility in terms of the arrangement of room-level elements. Almost all of the high-rise residential developments in Hong Kong adopts a concrete core and shear wall structural system. Unfortunately, with the high wind loads experienced by buildings in Hong Kong and their ever increasing heights, it becomes inevitable that one or more of the interior walls will be structural shear walls to resist the heavy lateral wind forces.

In applying the scenario design and dimensional requirements resulting from the use-territory study to the selected layout plans, it is apparent that the capacity for future room-level elements reconfiguration was not one of the main design considerations. There is no evidence of references to critical dimensions for the re-configuration of use-territories and room-level elements in the designs of the units. As a result, most of the units can only support very minimal room-level element re-configurations (Fig. 7) in relation to those stipulated in the previous section:

1. *Increase the size of the living room:* This is only achievable in four of the designs without reducing the number of rooms. However, the increase in size is limited to a maximum of 200mm to 400mm because any further increase would reduce the width of the adjacent bedroom to less than the preferred dimension of 2100mm.

2. *Increase the size of the master bedroom:* Again, this is only achievable in four of the designs without reducing the number of rooms. The increase in size is further limited to a maximum of 100mm to 300mm and in two cases a master bedroom with an irregular shape would be created.

3. *Providing an additional room (as study or small bedroom):* None of the designs in the sample can support the common scenario design need of forming an additional room, unless a room without an external opening is considered acceptable.

4. *Merging two rooms form a larger room:* This is achievable in all the designs. However, in most cases this leaves the undesirable result of a secondary room larger than the master bedroom.

Fig. 7: Scenario design analysis of some of the typical layouts

The analysis points to a number of factors that are indicative of the flexibility of the room-level elements. These factors must be taken into consideration in conjunction with the scenario design requirements and critical use-territory dimensions when designing a mass housing unit to ensure that it can be re-configured to serve future use patterns. In practice, all of these factors must be considered concurrently as there are inter-related:

4.1 Location of Openings

In all but one of the layout designs, bay windows dominate the front façade of the unit to maximise views and natural light. As a partition wall can only be located at the solid wall between bay windows, the expense of the bay windows severely limited the options for re-configuring the room layout for these units. In most cases, the wall space measures only 500mm, which is the minimum separation allowed between bay windows.

4.2 Location of Structural Shear Walls

As explained above, structural shear walls are always present in high-rise residential units in Hong Kong. As an irremovable element, the arrangement of the shear walls in the layout imposes a significant effect on how spaces can be configured within the unit. Hence, the structural frame design should not be only aiming at structural efficiency but also maximisation of flexibility of room-level elements.

4.3 Form of Unit-level Shell

In general, the more complicated/irregular the form of the unit-level shell the more difficult it is to configure the space into regularly shaped rooms in different ways. From a morphological point of view, a simpler form facilitates flexibility in internal layout options, especially at the front façade where most of the rooms align against.

5. Conclusion

With increasingly rapid transformation of the life-style of residents, user preferences out-grow the capacity of buildings faster than ever before. In residential buildings, especially mass housing buildings that are not custom-designed to individual resident needs, this mismatch occurs across different levels: use territory requirements at the furniture level, spatial organization at the room level, flat sizes and distribution at the unit level, envelope configuration at the building level, and so on. Mass housing buildings that are designed to satisfy immediate needs only will eventually become obsolete when they can no longer serve the users' changing needs. Unfortunately, the short-sighted approach driven by economic concerns and time constraints dominates the current market. Unless we review our design priorities and take a more long-term view of the impact of our designs, we are inevitably creating problems for the future generations.

References

Boekholt, J.T., Dinjens, P.J.M., Habraken, N.J. and Thijssen, A.P. 1976. *Variations: The Systematic Design of Supports.* Cambridge: The MIT Press.

Gabriel, C. 2000. "Management of Construction and Demolition Waste" *HKIA Journal* Issue No. 26 4th Quarter 2000.

Galfetti, G.G. 1997. *Model Apartments: Experimental Domestic Cells.* Barcelona: Editorial Gustavo Gili.

Kendall, S. and Teicher, J. 2000. *Residential Open Building.* London: E & FN Spon.

Habraken, N.J. 1972. *Supports: An Alternative to Mass Housing*. London: The Architectural Press.

Habraken, N.J. 1998. *The Structure of the Ordinary.* Cambridge: The MIT Press.

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[1] According to the records of the Emporis website (www.emporis.com) as of July 2007.

Transforming to variety: lessons from self-built neighborhoods in Dhaka

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Abstract
People, either owners or tenants, defy frequent move from houses they live, as well as from neighborhoods. However, housing consumptions change in time. Owners need to transform their houses, and tenants search for better options. Formal housings around the world, no matter how big the supplies are, and whatever effective their efforts are to reach all income groups, have frequently been suspect to cope with people's ever-changing housing consumptions. Owners have often been handicapped with no choice to transform accordingly and tenants do not have many options around either. These eventually lead people to move out from their neighborhoods. Lower income people, the biggest economic sub-group, and usually the left-outs from the formal housing supply mechanism, are more engaged in informal self-building primarily because it is cheaper. However, more interestingly, their houses transform continuously to offer various housing solutions that are dynamic, flexible and fit to various needs. They not only offer solutions to the owners, but also offer various options for the tenants. Tenants, who usually outnumber owners, often need to move out since they cannot transform the houses they live. Considering the variety collectively offered within these neighborhoods of self-built houses, there are many choices for existing tenants as well as newcomers which eventually keep neighborhoods alive.

1. Introduction
Residential built forms comprise the bulk of our urban built environment. Depending on the supply mechanism, there are two kinds of housings. One is formal and the other is informal. Formal housings can be delivered either by public authorities or by private developers. They mostly target two extreme income-groups i.e. the poor and the rich respectively, with some differences in their qualities around the globe. The main reason is that poor people are unable to build by their own due to lack of capital, while rich people consider housing as a commodity in the market, thus reluctant to invest the labor and time required if they have to build by themselves. However, inarguably the biggest housing supply comes from the informal sector, which is entirely privately developed. Other than a small sub-group inside, where rich individuals engage contractors or developers to build, the informal housings are built by middle-income and mainly the lower-middle-income people, who together constitute around 70% of population (wikipedia 2007), but are left-out from the formal housing supply mechanism. Interestingly, not enough study was done on the housing needs for this major group.

However, several countries like Japan, Hong Kong, have set examples to reach out for this group with the help of substantial government resources. Nevertheless, whatever the size of the supply is, one major point was persistently ignored that built form is a human and social act, and both human and social needs change continuously along the period of inhabitation (Franklin 2006). It is more evident in residential built forms as human basic needs are developed and changed through a near infinite number of reasons and more importantly, within shorter time intervals. Whatever aesthetic or engineering skills are manifested, those built forms need to go through transformation, small or big, if they are to cope with the needs of the inhabitants. Seek (1983) stated that the reasons create 'housing stress' and argued that people always crave to overcome this stress and to reach a stage of equilibrium. They tend to adjust and re-adjust their level of tolerance but eventually reach a critical point at which they have either to improve or to move (Carmon 1987). Habraken (1998) added that people's search to establish control over the territory of his abode also ignites to transform their built form frequently. However, in formal housings, there is not much freedom to exercise transformation even the public authority is generous enough to deliver housing to all groups.

Added to this fact, most of the individual housing units in formal public housings as well as in informal housings (referred to as self-built neighborhoods), are rental units. The tenants there have little or no authority to make housing adjustments resulting from their housing stress. To be precise, they can only adjust their furniture, but cannot change the partition walls or any part of the building. If tenants reach critical point but fail to transform, obviously the only other remedy is to move out. In many places around the world, there are instances where public housings offer much interest at the beginning by attracting a target group of tenants with homogeneous housing needs, but along time needs became heterogeneous and the houses do not offer the freedom to transform accordingly. When moving out is the only choice, they have to leave the neighborhood because of lack of variety. With sharp contrast, the self-built neighborhoods can firstly offer a continuous supply of housing units through transformation without extending the city, and then they also offer a wide range of variety regarding two major architectural qualities i.e. layout and size (Tipple 2000). Thus they can keep tenant's interests sustained inside the same neighborhood even though they need to move from their current abode. Each house there starts with its own unique initial built form depending on the plot sizes, shapes and the individual requirements of the owners, and then achieves its own unique momentum to grow and transform along time. Previous studies showed how transformation can offer variety, but concentrated only on owner-oriented situations and on houses with homogeneous start point (Tipple 1999). This study further exemplifies what more transformation can offer in owner-tenant situations and in situations with heterogeneous start point. We do not negate the achievements of public housings, but suggest that lessons can be learnt from self-built neighborhoods in order to design or regenerate large scale public housings around the world which involves huge resources but can lose their attractions along time.

2. The Context: Self-built neighborhoods Dhaka

Self-built neighborhoods (*SBN)*, as the term suggests, represent neighborhoods which contains houses built by owners themselves, and in most case even without formal engagement of contractors or developers. Owners usually spend their leisure time for the management of the whole construction and they do it in phases so that they do not burden their limited resources (Carmon 2002). Invariably the owners in *SBN* represent the lower income group in the society. In *SBN*, public authority usually plans the street networks, and publish building regulations with the buildings are being inspected after construction. There is not much role of public authority on partition walls i.e. on internal layouts, except for few parts of the world. However, in Dhaka, as in many other places in the world, there is also another type of *SBN*, where street networks also generate informally i.e. resulting from land ownership legacy. The special characteristics of these *SBN* include heterogeneous sets of plot sizes and shapes, very complicated, organic web-like pattern of street networks, and limited car access at the deepest ends of the webs. Though this study represents a particular vernacular *SBN*, our findings can fit any *SBN*, as our results concentrate on layouts of individual houses in an abstract way.

3 Spontaneous Transformation

Spontaneous transformation (*ST*) in houses is defined as the alterations of either any or both the external and partition walls occurred during house improvement. For the convenience of the study, *ST* refers to only actions involving construction works such as constructing or demolishing walls, constructing floors, making door openings etc. From literature, we selected layouts and sizes of housing units as determinants of variety inside neighborhoods. Dominant reasons behind *ST* were analyzed in order to concentrate on particular transformed units. Qualitative data reduction methods were applied to categorize those units. We used theoretical sampling in order to get 'useful' samples. Our 61 house-owners were at post-family stage (no children less than 18 years old), and have been expected to experience all significant reasons of *ST*.

3.1 Reasons of transformation

In owner-oriented houses, *ST* usually result from demographic issues such as increase in number of children, growing up of children, increase in household members, changing demands of family members etc. (Seek 1983). However, in tenant-oriented houses, economic issues also govern *ST* decisions as many economic activities revolve around a house. Table 1 shows the major reasons behind *ST*. We have accumulated different reasons from studies on *ST* all around the world (Seek 1983, Tipple 2000, Davis 1999, Carmon 2002), and used only those which are found in our context.

Table 1 Reasons of transformation

Stress	Issues	Σf	Reasons	f	%
Internal (153)	**Demographic**	46	More people joining the household	1	1%
			Children getting older, so need for newer spaces	15	9%
			Improving design solutions for owner	30	18%
	Economic	96	To get more rental income through tenancy	88	53%
			To start a business	5	3%
			To rent out shop	3	2%
	Miscellaneous consumptions	11	To accommodate car	6	4%
			For storage	5	3%
External (14)	**Qualitative issues**	3	Search for identity	0	0%
			Need for improved status	0	0%
			To follow neighbor's trend	3	2%
	Others	10	To respond to changes in bylaws	4	2%
			To enjoy recently available building services	0	0%
			To overcome cramped condition	0	0%
			To exploit alteration in access roads or plot sizes	6	4%
	Change of ownership	1		1	1%
	Total	167			

We have found that increase in rental income through tenancy is the major reason behind *ST*. 88 of 167 cases (53%) of *ST* occurred in order to increase income through tenancy (Table 1). This is achieved by increasing the number of rental units. So, our study refers to only rental units which evolved through *ST*.

3.2 Categories of transformation

The major two categories of transformation in our study are building level (*BL*) and partition level (*PL*) transformations. The former involves alteration works which affect the overall shadow area of the built form, and the latter involves internal alteration works with the overall built form unaffected. In our context, the significant instances of *ST* at *BL* mainly resulted addition of vertical floors, while *ST* at *PL* resulted reorganization of internal spaces. The following figure is a schematic diagram to explain these two types:

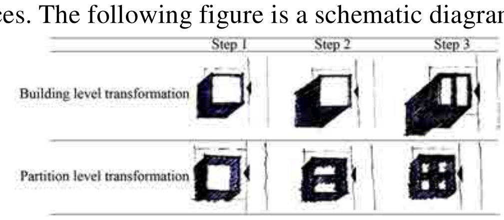
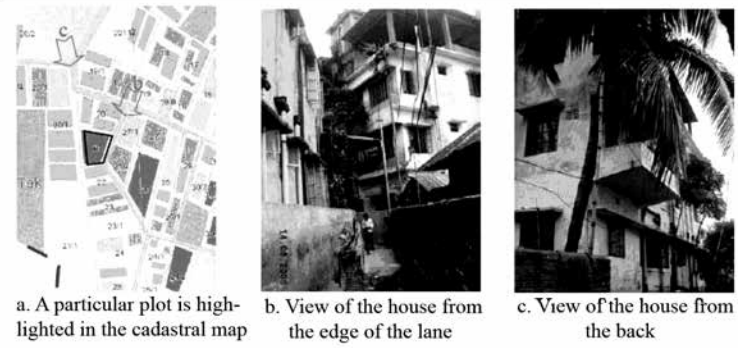


Fig. 1 Conceptual sketches of building and partition level transformation

4. General characteristics of houses before and after *ST*:

Statistical methods such as medians and quartile values are used to find different representative values because they are not influenced by outliers. Remarks were based on those values. Results of the survey show an average median value of 195 m^2 area of individual plots, the first and third quartile values (Q1, Q3) suggest that most of the plot sizes range from 167 – 223 m^2 area. Site coverage is usually 2/3rd of land area (fig 2e), thus around 130 m^2. Individual plots are generally quadrangular, if not exactly rectangular, with two bigger arms and two smaller arms. In fig 2, a particular plot (no.21) deep inside one of these *SBN* is highlighted in order to illustrate this characteristic.



Area (m^2)	%
100-150	3
150-200	48
200-250	30
250-300	15
300-350	5
Total	100%

d. Distribution of plot sizes

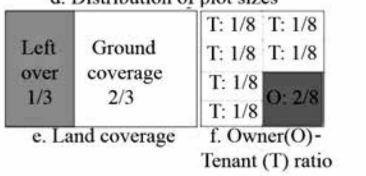


Fig. 2 Characteristics of built area usage and a typical plot inside self-built neighborhoods in Dhaka

Usually one of the smaller arms abuts the street in order to give frontage to a greater number of plots. Efforts are made to achieve twin units with the stair at the center of one of the bigger arms (Fig 3a), though geometrically they are rarely precise. Since the entry should lead to the staircase, an obscured passage is common in order to access the staircase, which is by the way, the main entrance of the building. However, ground floors often have different entry points and different solutions than typical floors.

Exceptions happen especially on smaller and bigger than average plots. Smaller plots cannot have more than one unit at each floor, so stair can be at front (fig 3b); and bigger plots can enjoy the privilege of having the staircase at the middle of the front façade (fig 3c). Anyway, there are plenty of exceptional cases depending on the individual complexity of the location, frontage, and orientation of the plots.

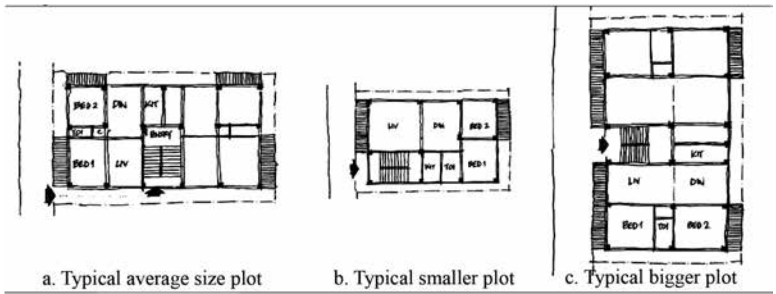


Fig 3 Typical conceptual floor layouts in plots

We have seen from table 1 that the main reason behind transformation is to get as many rental units as possible in order to increase rental income. The houses are mostly occupied by tenants. From table 2a, we find that a median average of 25% (1/4th) of the total built area is occupied by owners, and the rest 75% (3/4th) is occupied by tenants after all transformations. (Q1, Q3) values suggest that owners tend to occupy 20% - 33% of the total built area of the house.

Table 2 Characteristics of houses after transformation

a. Owner occupied area

% of Area	%
10%-20%	23
20%-30%	41
30%-40%	23
40%-50%	3
50%-60%	8
> 60%	1
Total	100%

b. Number of flats in a house

Number	%
2-4	3
4-6	34
6-8	26
8-10	21
10-12	7
12-14	7
> 14	2
Total	100%

c. Increase in the number of rooms

Number	%
0	13
0-10	26
10-20	11
20-30	10
> 30	1
Total	100%

The average number of flats after all transformations in a house is 7 (total distribution in table 2b), out of which one is usually occupied by the owner, or other members of the family (married children in most cases). Considering the owner occupying one-fourth ($1/4^{th}$) of the total area, and the rest of the 6 rental units sharing the rest three-fourth ($3/4^{th}$) with each getting around one-eighth ($1/8^{th}$) of the total area, the owner's flats are twice in size than the tenants' flats (Fig 3f).

Since transformations lead to the increase in the number of rental flats, smaller areas suggest appearance of smaller rental units after transformations. The average increase of number of rooms after transformations is 7 (total distribution shown in Table 3c), with (Q1, Q3) as (4, 14). Considering 6 rental units evolved through *ST*, the ultimate smallest independent rental unit consists of approximately 1 or 2 rooms (Bed or Liv+Bed), with is no hint of individual rooms being subdivided (Explained more in 5.2.2)

5. Spontaneous Transformation create variety in layouts

There are different methods to increase the number of rental units through *ST*. When *ST* is at *BL*, i.e. when new floors are added, we can see two methods: new improved layout, and appearance of smaller units. We exclude the ones where existing layout is repeated. In *ST* at *PL* we find two methods: to subdivide existing unit, and to rent individual rooms to different tenants with toilets and kitchens being shared.

5.1 Building level transformation

ST at *BL* consists of 77% (68 out of 88) of the total incidents responsible for increasing number of rental units. The rest 23% (20 out of 88) are by *ST* at *PL.* The two methods of *ST* at *BL* are discussed below.

5.1.1 New layout

'*New layout*' is defined as newer solution of layouts in floors built in later phases of the house with replicating the boundaries of previously defined units in other previous floor(s) (Fig 4).

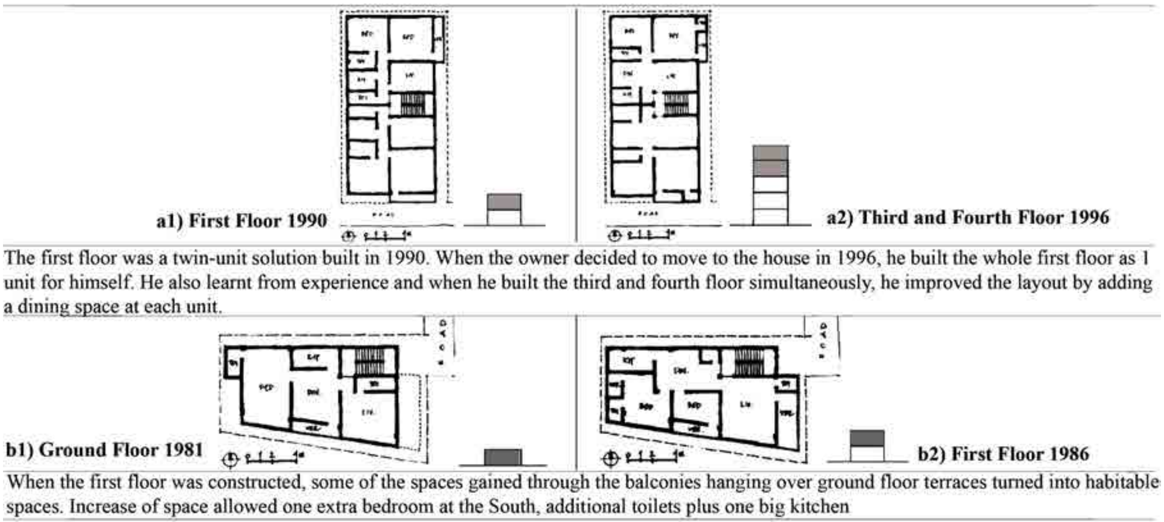


Fig 4 Example of 'New layout'

5.1.2 Smaller units

'*Smaller unit*' is defined as appearance of smaller sized rental units in newer floors built in later phases, which may or may not be same or mirror to each other (Fig 5).

The popularity of '*new layout*' (69% among *ST* at *BL*) suggests that owners learn from the experience with the previous layouts and try to introduce improved solutions very often when any new vertical floors are added later on. The houses experience transformation for a quite long period of 8 -16 years, it is not unusual to go through that kind of learning process.

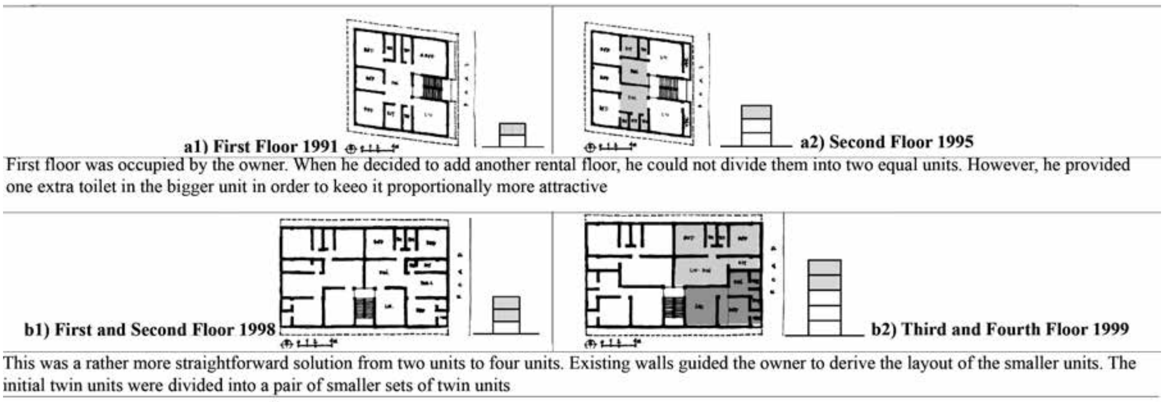


Fig 5 Example of 'Smaller unit'

We also see that '*smaller units*' (12%) appear mainly at newly added 4th of 5th floors rather than in lower floors. It suggests that owners learn that walking up 4 or 5 floors does not bring popularity to bigger units at that level so they cannot fetch higher rental income. This is supplemented by the fact that if necessary the number of units at lower levels can be increased through other methods, i.e. *ST* at *PL* discussed below.

5.2 Partition level transformation

5.2.1 Sharing

'*Sharing*' is defined as the redistribution of usage of spaces by renting out separate rooms in a current big unit to separate families, only by closing/ opening some doors, or by mutual co-habitation (with the help of shared toilet and kitchen),with no partition wall constructed or demolished.

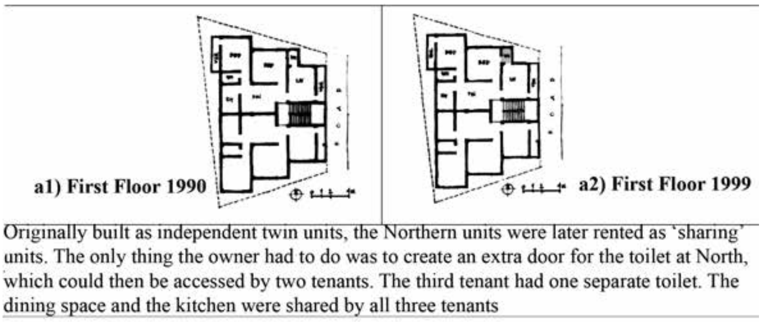


Fig 6 Example of 'Sharing'

5.2.2 Subdivision

'*Subdivision*' is defined when a certain unit is divided into two or more number of units involving construction works in partition wall(s). Here, the existing layout goes through some sort of 'surgery'. Generally, new units emerge in the simplest of ways, for example, dividing along a longitudinal or transverse axis (transverse in fig 7b) around the middle of a unit, where the existing configuration of maximum number of rooms can be retained (only two walls shown in dotted lines). Comparing figure 7c, 7d, and 7e, we can find that the branches remain untouched as much as possible. Only an introduction to a new kitchen is necessary in lower right 1/4th unit (fig 7d). Usually the level of depth is increased due to transformation (in this case from 5 to 6 shown in fig 7d). Apparent decrease of levels in fig 7e is actually deceiving since there is an increase of one level at the leftmost branch where a toilet is introduced through transformation of verandahs (see also the lower right 1/4th unit in fig 7b). Actually, transformations in verandahs are very common even without any subdivision as we can find it in the left 1/2nd unit of fig 7b.

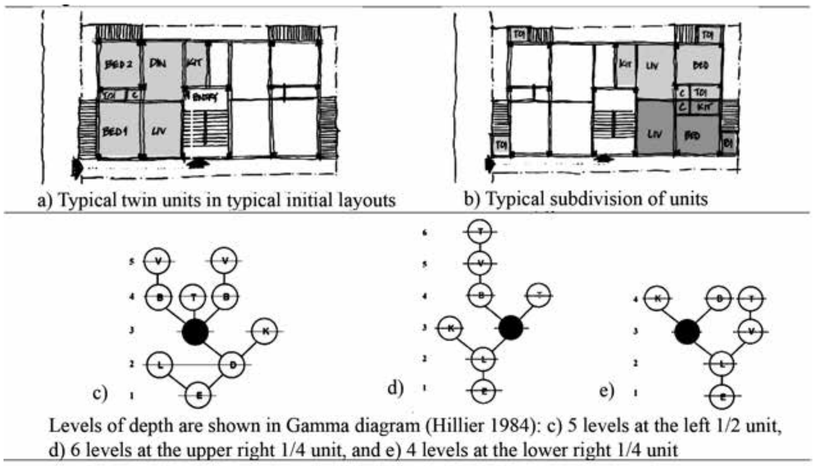


Fig. 7 Conceptual methods and characteristics of 'Subdivision'

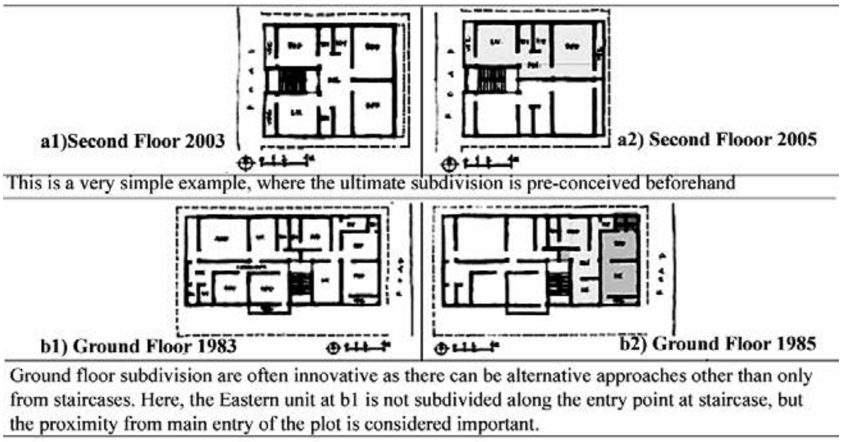


Fig 8 Example of 'Subdivision'

These two methods usually happen after houses already experience the *BL* transformations. For example, a '*new layout*' can be effective for several years after when, the owner may want to subdivide it into smaller units because the cumulative income of smaller units is usually more than a bigger unit could offer. Moreover, the 'attractiveness' of the plot , a term best explained by its proportionate distance from main street and its easy accessibility to vehicles, is important to make the decision whether to keep bigger units or not. Therefore, if a plot is not attractive, it is more likely that *ST* at *PL* would appear sooner.

It is also interesting to find a bigger number of '*sharing*' incidents (70% of *ST* at *BL)* than '*subdivision*' incidents (30%). Most of our '*sharing*' cases actually occurred to sites which are not 'attractive'; while '*subdivision*' occurred in more plots that are attractive. *Subdivision* is a more sophisticated method, and is only practiced if the payback though rent is expected to be profitable. For unattractive plots there is no reason to invest money on construction when that does not guarantee effective payback.

6 Spontaneous Transformation can create variety in sizes of rooms

Other than variety in layouts, *ST* can also create variety in sizes of rooms. From our study we find a wide variety in the size of the rooms. We divided the rooms into two categories. The first category is the habitable rooms (living and bedroom). The second category is the service rooms (toilets and kitchens).

6.1 Habitable rooms

The average median value of the area of both living and bedroom remains at (12.0 – 15.0) m^2 range. But a lower (Q1, Q3) values of (11.25, 16.25) in bedrooms suggests that sizes of bedrooms vary less than that of living rooms (11.25, 18.75). In fact the higher value of Q3 for living rooms shows that living rooms are usually bigger than bed rooms. However, the statements show a higher range of sizes in habitable rooms.

Table 5: Areas of rooms

a) Area of living rooms

Area (m^2)	%
7.5 – 10.0	3
10.0 – 12.5	28
12.5 – 15.0	20
15.0 – 17.5	15
17.5 – 20.0	16
20.0 – 22.5	16
22.5 – 25.0	2
Total	100%

b) Area of bedrooms

Area (m^2)	%
10.0 – 12.5	28
12.5 – 15.0	34
15.0 – 17.5	28
17.5 – 20.0	7
20.0 – 22.5	3
Total	100%

c) Area of toilets

Area (m^2)	%
< 2.0	12
2.0 - 2.5	19
2.5 – 3.0	25
3.0 – 3.5	24
3.5 – 4.0	14
4.0 – 4.5	2
4.5 – 5.0	2
> 5.0	1
Total	100%

d) Area of kitchens

Area (m^2)	%
< 2.0	3
2.0 – 3.0	4
3.0 – 4.0	47
4.0 – 5.0	31
5.0 – 6.0	12
6.0 – 7.0	3
7.0 – 8.0	1
> 8.0	0
Total	100%

6.2 Service rooms

In case of service rooms, toilets with an average area of 2.75 m^2 with (Q1, Q3) as (2.25, 3.25) suggest that values concentrate around the average. However, several consequent subgroups are simultaneously significant leaving all of them dominantly present in the population. Thus a wider range of 2.0 - 4.0 m^2 is common for toilets (see Table 5c for the total frequency distribution). The average size of kitchen has a median value of 3.5 m^2 with (Q1, Q3) at (3.5, 4.5) suggesting that a range of 3.0 – 5.0 m^2 is common for kitchens (see Table 5d for the total frequency distribution). Both these statements show that various sizes of toilets and kitchen exist in the neighborhoods.

7. Conclusion

This study clearly shows that transformations in self-built neighborhoods can generate a wide range of varieties in both arrangement of spaces and in their sizes. Even at same sizes, transformation provides variety in layouts. More importantly, different houses remain at different phases of transformation offering a continuous heterogeneity in the housing stocks inside the neighborhoods. This study can be complemented by a social survey which gives the picture of the heterogeneity in family structures inside these neighborhoods, a criterion which might be the basis of keeping a place alive. A combination of these two studies can enlighten architects and planners how to offer heterogeneity in layouts of housing units in large-scale formal housings in order to sustain their overall liveliness.

8. Acknowledgements

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9. References

Carmon, N. 1987. Improving housing by conventional versus self-help methods: evidence form Israel. *Urban Studies* 24:324-332.

Carmon, N. 2002. User-controlled Housing: Desirability and Feasibility. *European Planning studies* 10(3):285-303.

Davis, H. 1999. *The culture of building*. New York ; Oxford: Oxford University.

Franklin, B. 2006. *Housing transformations : shaping the space of twenty-first century living*. London ; New York: Routledge.

Habraken, N. J. 1998. *The structure of the ordinary: form and control in the built environment*. Cambridge, Mass.: MIT Press.

Hillier, B., and J. Hanson. 1984. *The social logic of space.* Cambridge: Cambridge University Press.

Seek, N. H. 1983. Adjusting Housing Consumption: Improve or move. *Urban Studies* 20:455-469.

Tipple, A. G. 2000. *Extending themselves : user-initiated transformations of government-built housing in developing countries*. Liverpool: Liverpool University Press.

Tipple, A. G., and A. Salim. 1999. User-initiated extensions as housing supply: A study of government-built low-cost housing estates in Malayasia. *TWPR* 21(2):119-154.

Wikipedia. 2007. "http://en.wikipedia.org/wiki/Lower_middle_class."

Examination of Adaptable Building
By "Self-Standing and Self-Build" Infill Space Unit

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Keywords: Adaptable Building, Open Building, Infill, Prefabrication

Abstract
From a viewpoint of supply separation of INFILL elements from SKELETON in open building processes, "Self-Standing and Self-Build (SS/SB)" infill unit that composes a space in itself is proposed in this paper. Since Self-Standing means there is very few joints between SKELETON and INFILL, this method has the possibility of liberating INFILL production from individual building production and so applying not only to new buildings but also existing buildings. And Self-Build has the possibility of making operation of INFILL easier and more familiar than current state for every user of buildings.
Concretely, this paper reports 1) a development of a prototype of self-standing prefabricated space unit framed by light gauge steel and 2) an experiment of self-build (DIY) construction of that, and examined effectiveness and possibility of the proposing method for realization of adaptable buildings.

1. Introduction
From 1990's in Japan, it has been advocated under the name of "SI method" that SKELETON intending building structure with long-life and INFILL intending interior (sometimes partially exterior) building elements for room arrangement and equipment with middle/short-life should be clearly separated in order to give flexibility and durability to the buildings. And now it is considered that "SI method" is one of the most effective ways to realize adaptable buildings.
However, in each existing SI building, not only SKELETON but also INFILL were designed and produced as a closed system proper for the building. It is a fact that there is no way except to develop original INFILL in each project because there is no ready-made INFILL on the market. Therefore it is difficult to escape from the vicious circle that the operation of INFILL (addition, exchange, etc.) is very limited, and the effectiveness of SI method cannot be demonstrated enough. On the contrary, if INFILL production is independent from each SKELETON and "Ecosystem of INFILL products" supplied by third parties is constructed, it is expected that adaptable buildings using SI method will widely spread.

2. "Self-Standing and Self-Build (SS/SE)" infill space unit
2.1 What is SS/SB concept?
From this perspective, "Self-Standing and Self-Build (SS/SE)" concept is proposed in this paper.
Self-Standing means there is very few joints between SKELETON and INFILL. This method has the possibility of liberating INFILL production from individual building production. Self-Build means operation of INFILL is easy and familiar even for every user of buildings. This method has the possibility of promoting changeable space by INFILL operation.
This concept is, so to speak, box-in-box approach and can apply not only to new buildings but also existing ones for renovation, conversion, temporary use, etc. Practically, it may suit the latter rather than

the former because the construction process of the unit is independent from others. Of course, it requires ceiling height and there are not so many buildings adoptable to the concept, especially in existing Japanese house buildings. Office buildings or school buildings, for example, may be more suitable for those enough ceiling height (See Fig.1). It is also necessary to refer surplus cost for the redundancy of box-in-box structure, but if these elements are standardized and can be reused several times, life-cycle cost might be not too high for the effectiveness.

Fig. 1 An image of interior using SS/SB units in high ceiling room

2.2 How to set up SS/SB unit?

SS/SB infill space unit is carried in pieces from outside of building to existing room or new one, and set up on site only with human power because heavy machinery cannot be used indoors.

It consists of not only main structure but also other subsystems like floor, wall, ceiling/roof, and etc. But those subsystems connect only to the main structure, and need not have the interface with the room where the unit is set up. Accordingly, it is enough to examine only the main structure of the unit first.

2.3 How to choose the material of the main structure of SS/SB unit?

To compare with other kinds of structure, steel framed one jointed with bolts (especially low tensile bolts) is easy to both build and dismantle and therefore excels in rebuilding many times. Zinced LGS (Light Gauge Steel) is considered to fit for material of a main structure of SS/SB space unit because of its total performance such as strength, lightness, durability and cost-efficiency, though it is heavier than aluminum. Of course, it was necessary to suppress the weight of each element so as to carry by human power. From an investigation result of a Japanese conventional timber house, which can be constructed by human power, about 90% of timber elements are below 20kg (See Fig.2).

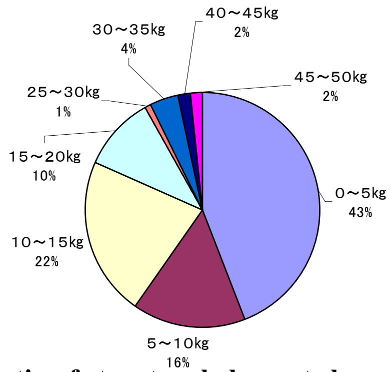

Fig. 2 Composition ratio of structural elements by weight in a timber house

3. Prototype design of SS/SB unit

3.1 Design condition of the main structure of SS/SB unit

To examine the effectiveness of the concept, a prototype of the main structure of SS/SB unit was designed. The design condition was as follows,

- Prefabricated post and beam construction made of zinced LGS is adopted as a structural system of the unit. Diagonal braces are added if necessary.

- Every element and joint has to be standardized and reduced in type as much as possible to be constructed easily. End-plate joint is adopted so as to simplify the connection between elements.
- Every element of the main structure of SS/SB unit is aimed at below 20kg to be carried by one person or below 40kg by two persons.

3.2 Composition of the prototype

Composition of the prototype is shown in Fig.3. Simple wall panels that are made of sub frames and louvers are added to the main structure. So do the floor panels and the ceiling/roof ones. Fig. 4 shows the drawings of the prototype.

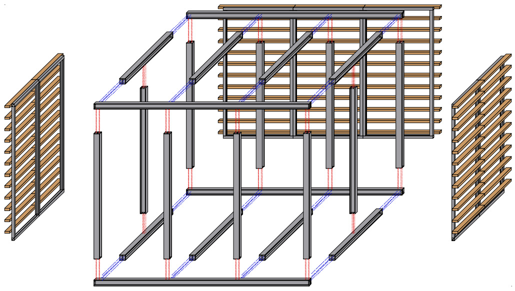

Fig. 3 Composition of the prototype

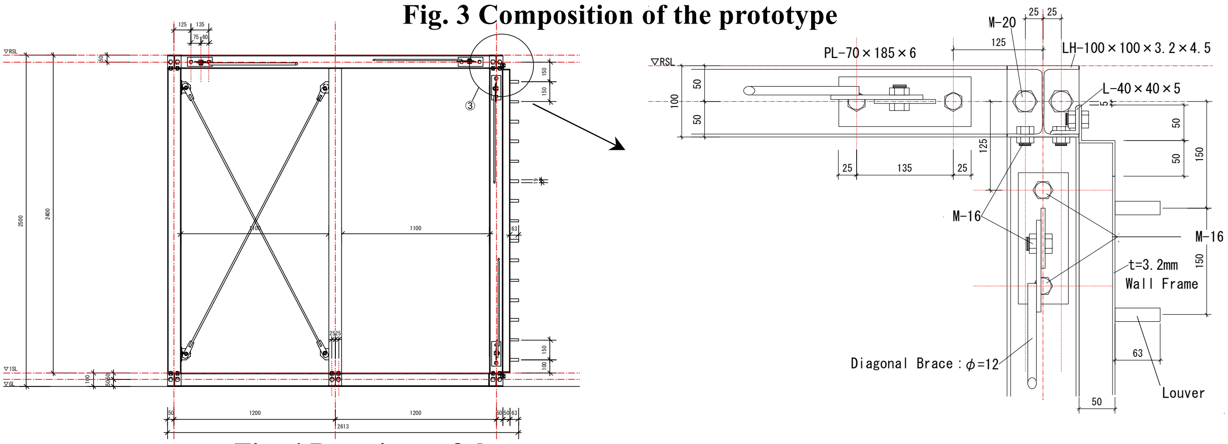

Fig. 4 Drawings of the prototype (Left: Section, Right: Detail of joint)

4. Construction experiment of the prototype

4.1 Prefabrication of the elements

All elements of the main structure, that consist of one kind of column, two kinds of roof beams and three kinds of floor beams, and sub frames were prefabricated in a factory. Finishing of the subsystems (floor, wall and ceiling/roof) made of plywood or wood louver was processed on the site. Table 1 shows basic specification and Fig. 5 shows elements of the prototype.

The weights of the elements were roughly controlled within the range of assumption; the shorter floor/roof beam (2.3m) was 21kg and longer one (3.7m) was 35.5kg.

Table 1 Basic specification

Structural system (main structure)		Post & Beam Construction (low tensile bolt joint)
Elements	Post/Beam	H. Beam (Zinc Plated Light Gauge Steel)
	Floor	Sub Frame +Floor Joist (2"x4" Dimension Lumber) or Floor Joist only(2"x6") + Plywood
	Wall	Sub Frame + Wooden louver (1"x3" Dimension Lumber)
	Roof/Ceiling	Steel Sub Frame + Wooden louver (1"x3" Dimension Lumber)
Externals size of the unit (Nominal-size)		2400mm×3600mm×2400mm (W ×L ×H)
Basic Dimension Module		1200mm (Horizontal/Vertical)
Weights		Total: about 500kg *The weight of the heaviest part(3.7m beam) : 35.5kg

Fig. 5 Elements of the unit

(#1: columns/beams, #2: wall/roof sub frame, #3: floor sub frame, #4: diagonal braces, #5: floor adjust bolts)

4.2 Construction experiment

Then, DIY construction experiment by the prefabricated SS/SB unit was executed (See Fig. 6).

At the first time, we made up the structure of the unit by 6 amateur persons in 8 hours. But at the second time, 4 persons in 5 hours (only the upper part from the columns) (See Fig.7). Between the two times' construction, it was necessary for 4 person and 3 hours to dismantle the unit.

Fig. 6 DIY construction experiment

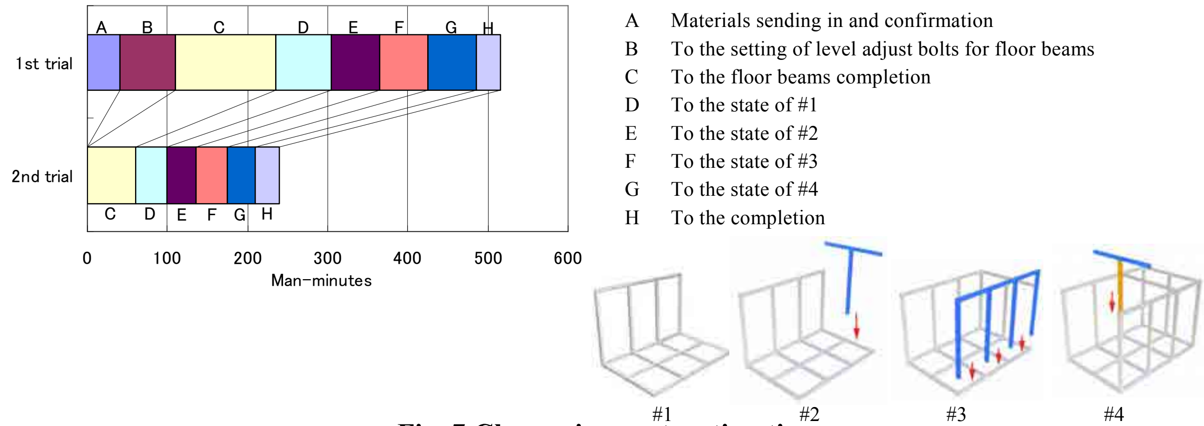

Fig. 7 Change in construction time

5. Conclusion

To separate INFILL supply/production from SKELETON in open building processes for adaptable buildings, this paper proposed SS/SB Infill space unit, developed the prototype and executed construction experiment. The feature of the concept that is easy to construction/dismantlement and thus suitable to change of dwelling was proved by the experiment.

Acknowledgement

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Facility Evaluation of Administrative Cost and Availability of Public Facilities
－ A Case Study of Tama City－

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Keywords:
Facility Management, Public Facility, Administration Cost, Resident Needs, Products Portfolio Management

Abstract

In Japan, for public facilities to correspond to the change in population size, in age demographics and in demand of users, it is necessary to keep up the construction activities including the maintenance preservation. For constructing a sustainable society, there is a pressing need to propose a new stock management method for existing public facilities. Under such a circumstance, it is important to promote the efficient use of existing institution. The characteristics of this research are as follows. First, the administration cost of existing public facilities is clarified. Second, using PPM（Products Portfolio Management）, the usage of facilities are examined in 4 levels taking the administration condition and users' usage condition into account. Therefore, each level of facility can take the administration, required performance, usage rate, residents' needs, etc., as the evaluation under uncertainty as well as decision making issue. The advantages of facility are income and efficiency; the disadvantages are outcome and loss. Furthermore, these factors can be placed as facility management. As a result, the appropriate preservation of existing public facility and the stock management technique which is suitable for the long-term cost reduction with a consideration on life-cycle assessment is presented. At last, we expect the results above to be useful tools for facility management.

1. Introduction

For public facilities to correspond to the change in population size, age demographics and demand of users, it is necessary to keep up the construction activities including the maintenance preservation. The large quantities of building stocks constructed by the policy of past time are now becoming old. The correspondence by conventional scrap and build is no longer an effective solution due to the various factors such as financial difficulties and growing concern towards environments in recent years. Therefore, for constructing a sustainable society, there is a pressing need to propose a new stock management method for existing public facilities which takes the actual condition of existing public facility stocks as well as the need of local residents into account.

Based on the viewpoint mentioned above, the purpose of this paper is to prove the actual condition of administration and usage rate of public facilities through their administration record and to search a method which can contribute to the decision making of a local government on the reduction in facility expenses and the facility rearrangement in the future.

Table 1 Facility Outlines

Type	No.	Establishment	Area(m2)	Facility Style	Service Outline
Public Hall	E	1999	4787	Complex	Rentable Room,Open Space,Enterprise Sponsorship,etc.
	N	1996	3686	Complex	Rentable Room,Open Space,Enterprise Sponsorship,etc.
Community Center	H	1995	1882	Complex	Rentable Room,Elderly Salon,Community Enterprise Plan
	M	1992	1505	Complex	Rentable Room,Elderly Salon,Community Enterprise Plan
	C	1994	1295	Single	Rentable Room,Community Enterprise Plan
	A	2000	1215	Complex	Rentable Room,Elderly Salon,Community Enterprise Plan
	S	1990	1181	Complex	Rentable Room,Elderly Salon,Community Enterprise Plan
	K	1987	794	Complex	Rentable Room,Elderly Salon,Community Enterprise Plan
	T	1990	592	Single	Rentable Room,Community Enterprise Plan
Elderly Welfare Center	W	1979	381	Complex	Rentable Room（Elderly）,Assisted Bathing,Enterprise Sponsorship,Night Opening（Citizen Group）
	Y	1978	350	Complex	Rentable Room（Elderly）,Assisted Bathing,Enterprise Sponsorship,Night Opening（Citizen Group）
	G	1980	342	Complex	Rentable Room（Elderly）,Assisted Bathing,Enterprise Sponsorship,Night Opening（Citizen Group）
	L	1977	227	Complex	Rentable Room（Elderly）,Assisted Bathing,Enterprise Sponsorship,Night Opening（Citizen Group）

2. Methods

In this paper, among all the public facilities in Tama-city, Tokyo, the ones with open space to the citizens and the available administrative/maintenance record are selected as the survey target. The numbers of target facilities are 2 public halls, 7 community centers and 4 elderly welfare centers and shown in Table 1. The data for the maintenance cost of buildings, the project or administration expenses and the number of facility users are of year 2004 and shown in Figure 1. In addition, the usage rate of rental rooms within the facilities is of year 2005.

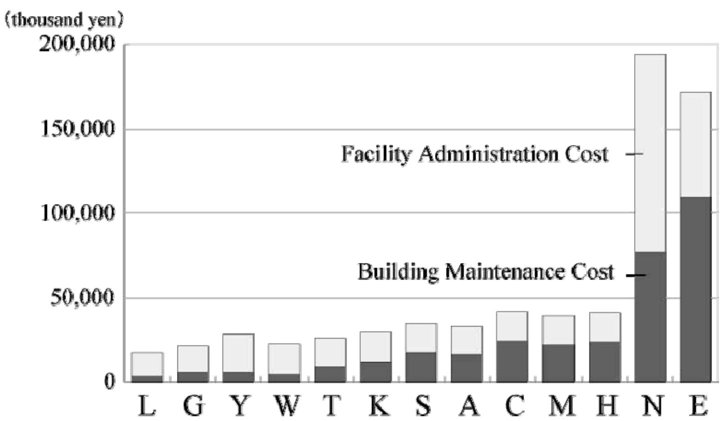

Figure 1 The Maintenance Cost for Each Facility

3. A Study on the Actual Condition of Public Facilities

3.1 The Actual Condition of Facility Users

Figure 2 shows the distribution of average number of facility users per day and the area of facility (in case of complex facilities, only the area occupied by the target facility is included). The number of open days throughout a year depends on the type of facility; the elderly welfare centers are opened 280 days, the public halls and community centers are opened about 330 days. The elderly welfare centers have the least average number of users per day and there is no correlation between the number of users and the size of facility. For community centers, there is a tendency that the facilities with larger area have less average number of users per day. For public halls, the number of users is in proportion to the size of facility. Therefore, the number of users in facilities such as elderly welfare center or community center is affected by other factors including the location of facility and the function of available space.

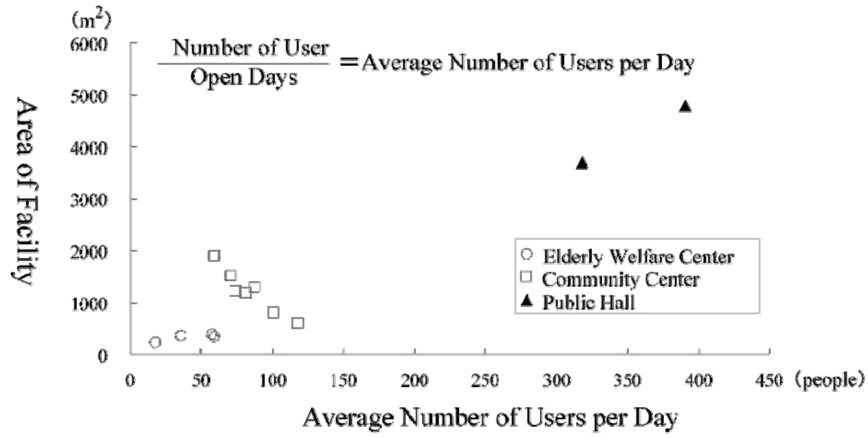

Figure 2 The Average Number of Users per Day and Area of Facility

3.2 Facility Maintenance Cost

Table 2 indicates the maintenance cost of each facility which is classified into the building maintenance cost and the facility administration cost. When making a comparison between the facilities, the public halls show much larger amount than others. The community centers and elderly welfare centers show almost equal amount regardless of their year of construction, however, each facility has own tendency in its breakdown. This fact is probably related to the size of facilities and the service provided by facilities.

Table 2 The Breakdown of Facility Maintenance Cost

Maintenance Cost	Building Maintenance Cost	Direct Expense	Fuel cost
			Rework cost
			Agent Service Cost
			Common Service Cost
			Construction Cost
			Repair Cost
			Incidental Cost
		Employment Cost	Personnel Expenses
			Incidental Cost
	Facility Administration Cost	Subcontracting Fee	
		Incidental Cost	
		Employment Cost	Personnel Expenses
			Incidental Cost

3.2-1 The Average Facility Maintenance Cost per Day per m^2

In order to show the productivity and efficiency of facility administration quantitatively and also to make a comparison of maintenance cost between each facility with a certain standard, the average facility maintenance cost per day per m^2(annual facility maintenance cost/365days/facility area) is shown in Figure 3. Although the elderly welfare centers show the highest cost, the breakdown by facility's building maintenance costs did not show a large difference between facilities.

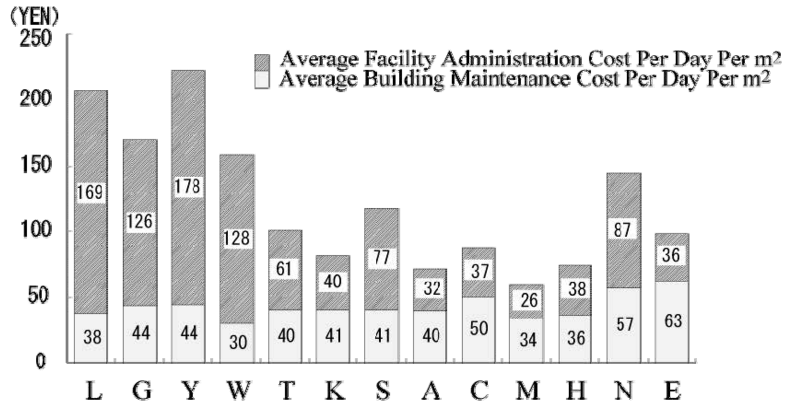

Figure 3 The Average Facility Maintenance Cost per 1 ㎡ per Day

3.2-2 The Administration Expenses

Figure 4 indicates the facility administration per user. The total expenses for the elderly welfare centers are much larger than other facilities. This is considered to be due to the special services provided to elderly by the facilities. There are inconsistencies in the expenses for community centers which are about 1/3 of the elderly welfare centers. The subcontracting fee per person is 90% of the administration expense for community centers. In addition, the personnel expenses for public halls and elderly welfare centers are occupying 80％ to 90％ of the administration expenses. Considering the majority of subcontracting fee is personnel expenses, there are no large differences between the breakdowns of total cost.

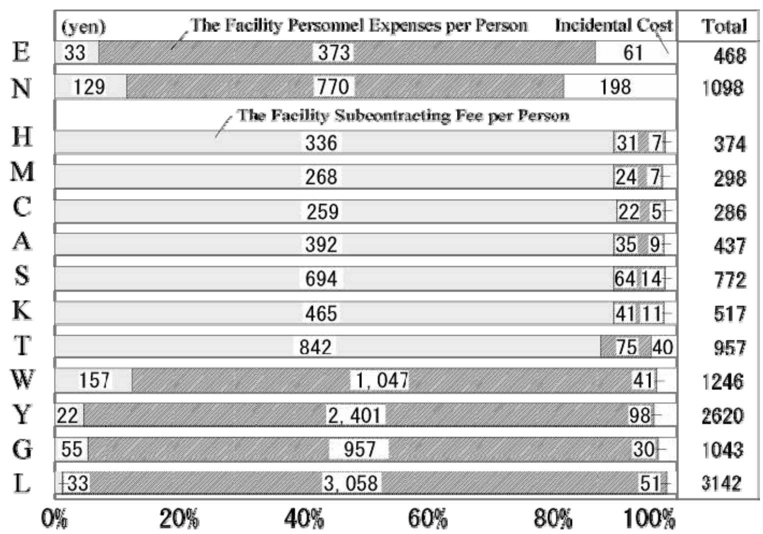

Figure 4 The Facility Administration Expenses per Person

3.3 The Usage Rate of Facilities

3.3-1 The Usage Rate of Rental Rooms

The usage rate is in percentage of annual usage service level divided by available service level which indicates the demand in rental rooms and facilities. In this section, the target of survey is the facilities with collectable data. Based on the year 2005's data, for 7 community centers and 2 public halls, the distribution of usage rate of rental rooms by each room type is shown in Figure 5.

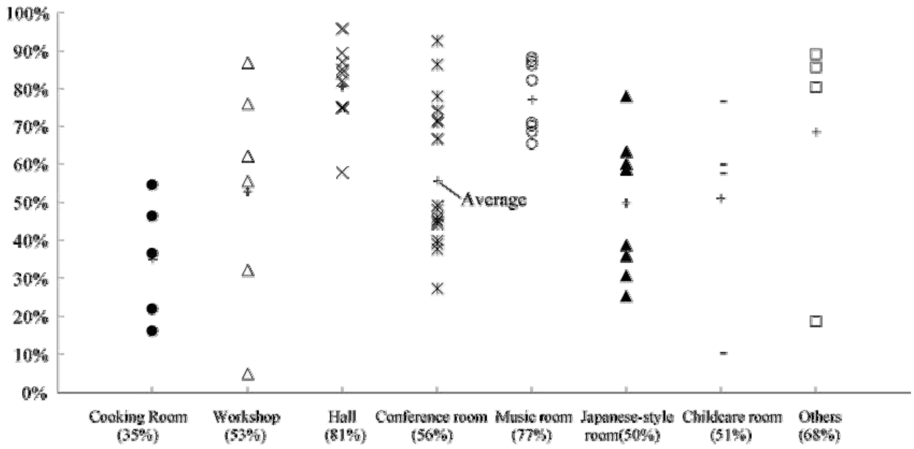

Figure 5 The Usage Rate of Each Rental Room

The average usage rate of entire rental rooms is 60%. In each type of rental room, the halls and music rooms show the highest usage rate and are the most consistent. This fact indicates that the users are satisfied with the usage purpose of each rental room or the physical performance of space. Secondly, the average usage rate of meeting rooms, craft rooms, nursery rooms and the Japanese rooms are about the same ratio, however, the distribution for each room type show a large difference. The cooking room has the lowest average usage rate because of the specialized features in the space design which limit the usage purpose. The rental rooms, except the halls and music rooms, show a large difference in the usage rate even though they are under the same name.

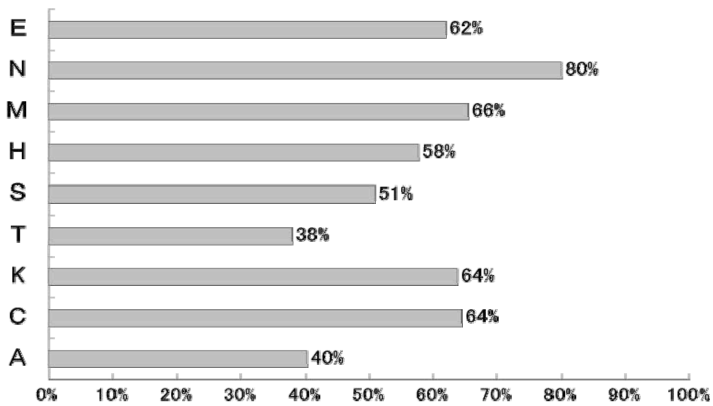

Figure 6 The Usage Rate of Each Facility

3.3-2 The Usage Rate of Facilities (Figure 6)

The usage rate of facilities is defined as percentage of annual usage service level divided by available service level. The average usage rate of entire facilities is 58%. The highest usage rate is the 80% of Public Hall N. The Community Center T and A are below 50%. Other facilities show the usage rate of around 60%.

4. A Study on the Evaluation Method of Facility Administration

4.1 An Assumption on the Purpose of Evaluation and Evaluation Items

In order to utilize the existing facilities continuously, it is necessary to be strongly aware of the concept on cost performance which is a balance between the demand for facility usage and facility maintenance cost. Therefore, this section pays close attention to the usage rate and facilities/rental rooms maintenance cost. By using the PPM analysis method and plotting the solutions of facility utilization level and administration features on 4 quadrant matrix, the portfolio of entire survey target is grasped and an attempt to propose a strategic decision making plan is made accordingly.

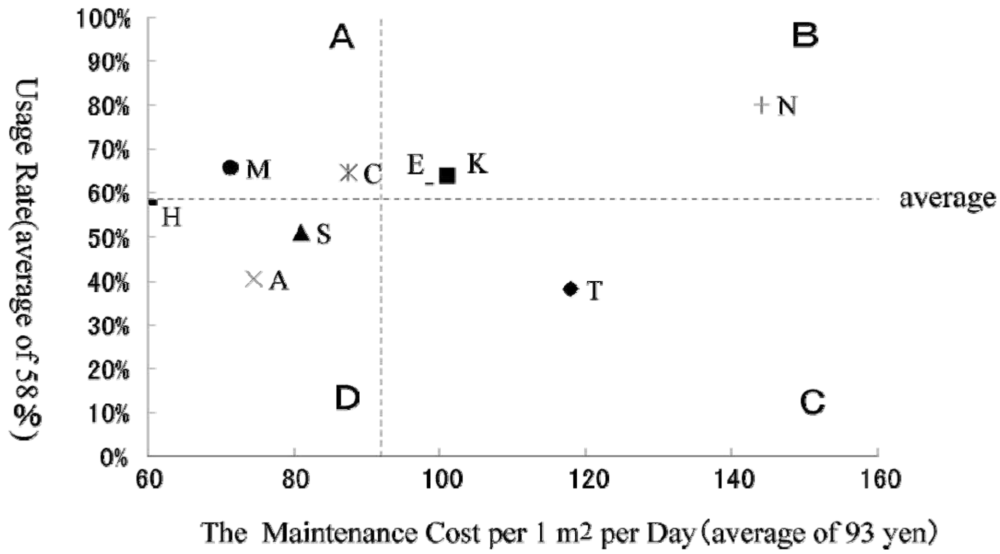

Figure 7 The Usage Rate and Maintenance Cost of Facilities

4.2 Study 1: The Analysis on the Usage Rate and Maintenance Cost of Facilities per Unit Area

In Figure 7, from the viewpoint on efficient utilization and reducing maintenance cost of existing facilities, the average maintenance cost(average of 93 yen) per 1 m^2 per day is set as a standard. Based on this standard, the facilities are classified into 5 groups in order to obtain an efficient FM method. Group A: Satisfactory Facility (continue its usage while maintaining the facility), Group B: Improvement on Facility Maintenance is Required (control of maintenance cost and revise the usage fee), Group C: Evaluation on Consolidation of Facility is Required (change the usage purpose or disable the building), Group D: Improvement on Facility Usage Rate is Required (deregulate the facility placement purpose and improve the current facility performance). The usage rate of Facility N is higher than the average; however, since the maintenance cost is 1.6 times larger than the average, the reevaluation of facility administration cost is necessary. For Facility T, since the facility maintenance cost is 1.3 times larger than the average with a low usage rate, the total facility management needs to be reviewed.

4.3 Study 2: The Analysis on the Usage Rate of Rental Rooms and Daily Administration Maintenance Cost

Through this paper, it became evident that some rental rooms in the facilities with low usage rate show higher usage rate than others. Therefore, it is necessary to make more efficient and economical proposal by analyzing individual facility in details. In Figure 8, based on the usage rate (average 60%) of entire rental rooms (63 rooms) and average daily maintenance cost (average of 5759 yen) as its standard, the rental rooms are classified into 4 groups and the possible improvement on rental rooms is investigated. Group A: Satisfactory Rental Room, Group B: Improvement on Rental Room Maintenance Cost is Required, Group C; Change in Rental Room Usage Purposes is Required, Group D: Improvement on Rental Room Usage Rate and Deregulation of Usage Purposes is Required. All of the halls (8 halls) are distributed in Group B except 1 facility. Although its usage rate is high, the maintenance cost is considered to be high due to the large room area. The meeting rooms (18 rooms) which have the most rooms are distributed in A-1, B-6, C-1 and D-10. The Japanese rooms (10 rooms) are distributed in A-4, B-1 and D-5.

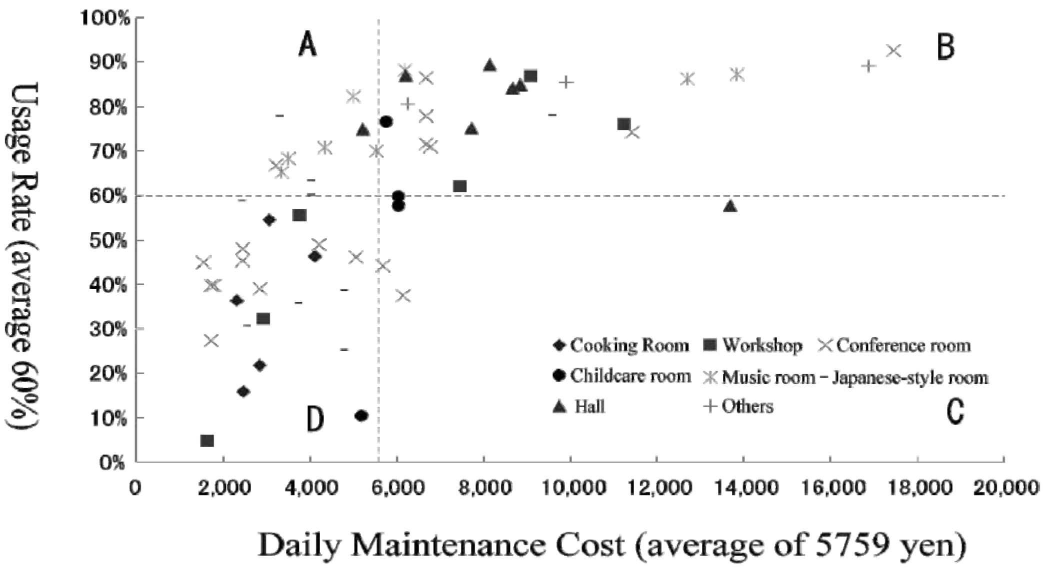

Figure 8 The Usage Rate and Administration Cost of Rental Rooms

5. Conclusion

In this paper, the administration cost per 1 m^2, facility maintenance cost, building maintenance cost and administration cost per person, as well as the facility usage rate of each rental room were obtained. As a result, the quantification of actual condition of administration in public facilities became possible. In addition, from the viewpoint on cost performance of public facilities, both usage rate and administration maintenance cost were taken into total consideration thus the actual condition of each facility and rental room was discovered. These results will provide more realistic proposals for improving the administration of existing public facilities in the future. The remaining issues of this study are to review the target value of each usage rate. It is also necessary to investigate the users' level of satisfaction towards the facilities and their usage purposes while taking the space design of facilities into consideration.

6. Acknowledgements

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7. References

1. Ping-Chuan HSIEH and Makoto TSUNODA: A Study on Transformation of Spatial Reorganization for Regeneration of Public Facilities - A Case Study in Tama-City -, The 6th International Symposium on Architectural Interchanges in Asia, Vol.2, pp.1397-1402, 2006.10

2. Tohru YOSIKAWA, Miki ARIMOTO, Kenji TAKEMIYA, Makoto TSUNODA: A method of rearrangement planning of community facilities utilizing exiting public buildings in matured suburban residential areas: A case study in Tama City, The 2005 World Sustainable Building Conference, p.3664-3671, 2005.9

3. Tama Comprehensive Plan, from First to Fourth

Mechanical and Chemical Properties of the Concrete Used in the Structures Built in Old Days

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Keywords: Old structure, Concrete, Long term-durability, Mechanical property, Chemical analysis, Electron probe microanalyzer

Abstract
Performance of a concrete is changed gradually with the age by chemical and/or physical actions. Deterioration of a concrete progressed to high level may cause serious damages on the structure. Whereas there are many concrete structures durable for long term. In this research, concrete samples taken from the two structures built in 1938 and 1940 were evaluated by mechanical tests and chemical analyses. Information on the raw materials, design, and technique of construction in those days obtained by these evaluations must be valuable for considering the long term-durability.

1.Introduction
Hardened concrete has toughness, but it is not permanent. Deterioration by chemical and/or physical actions may progress in severe circumstances, and it may cause serious damages on the construction. Cement and concrete consume a lot of natural earth resources and fuels for their production such as a limestone, sand, gravel, coal, petroleum, and so on. Considering the global requirements for saving the resource and energy, long life cycle is generally needed for industrial materials, and cement and concrete are not the exceptions. In Japan, there are many structures built in over fifty or one hundred years ago keeping their soundness. Actual information obtained by evaluating these old concrete structures must be useful for considering the long-term durability. However, there were not always many researches into the old structures which evaluated their materials scientifically (Yokozeki et al. 1998) (Mori et al. 2003)

(Tamai, Y et al. 2006) (Hoshino et al. 2006). In this paper, concrete samples taken from two structures built in 1938 and 1940 were evaluated by mechanical tests and chemical analyses. Necessary factors for long-term durability of concrete were considered based on the experimental information on the raw materials, design and construction about seventy years ago.

2.Experiment

2.1 Structures from Which the Samples were Taken

Two concrete structures built in Japan about seventy years ago were selected. Appearances of them are shown in **Fig.1**.

Structure (a) is a shed for watching the enemies built by the Japanese navy in Yokosuka-city (Kanagawa prefecture). It was completed in 1938. Samples for evaluation were taken from the wall facing the west side. **Fig.1** shows the appearance from the east side.

Structure (b) is an oil storage tank built in Kure-city (Hiroshima prefecture) in 1940 (Sawaki et al. 2007). Inner volume of it was about fifty thousands kiloliter. It was located on a coast at a distance of about 100 meters from the seashore. As shown in **Fig.2**, the diameter and the height of the tank was 88 meters and 10 meters, respectively. Inner side of the tank was made with cylindrical concrete of the thickness of about 30 centimeters. Cross section of the inner concrete is shown in **Fig.2**. Samples for evaluation were taken from this concrete. The height of the sampling point was about 6.5 meters from the bottom of the tank.

Structure (a) Structure (b)

Fig.1 Appearances of the structures from which the samples were taken

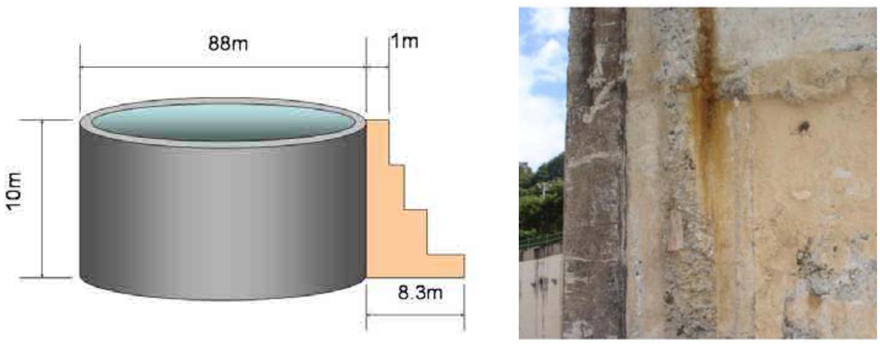


Fig.2 Inner side of the tank of the structure (b) made with cylindrical concrete

2.2 Samples Taken from the Structures

Cylindrical concrete samples were taken from each structure. Appearances of them are shown in **Fig.3**. The diameter and the length of the sample taken from the structure (a) (sample (a)) were 45mm and 300mm, and which of the sample taken from the structure (b) (sample (b)) were 150mm and 250mm, respectively.

Sample taken from the structure (a)

Sample taken from the structure (b)

Fig.3 Appearances of the samples

2.3 Observation on the Deterioration in Macro Area

The cylindrical concrete samples were divided into two parts along the central line for the long direction.

2.3.1 Observation by naked eyes

Cross section of the concrete was observed by naked eyes to check the state of the cement paste, aggregate, and the interface of cement paste and aggregate.

2.3.2 Depth of neutralization

A solution of phenolphthalein in methanol was sprayed on the cross section of the concrete, and the depth of the part which was not colored red was measured.

2.3.3 Distribution of element

Square sample with dimensions of 40mm by 40mm by 10mm was taken from the sample (b). The polished and carbon-deposited surface (40mm by 40mm) was subjected to elemental mapping analysis of calcium, chlorine and sulfur by electron probe microanalyzer (EPMA). The condition of measurement was as follows.

Accelerating voltage : 15kV, Current : 5×10^{-8}A, Time of measurement for each pixel : 40msec, Diameter of the probe : 100 μ m, Size of each pixel : 200 μ m, Number of pixels for measurement: 160,000 (400 by 400)

2.4 Estimation of Mix Proportion

Estimation was carried out in accordance with Japan Cement Association's method.

2.5 Measurement of Mechanical Properties

Compressive strength, Young's modulus and Poisson's ratio were measured in accordance with JIS A 1107.

2.6 Measurement of Pore Size Distribution

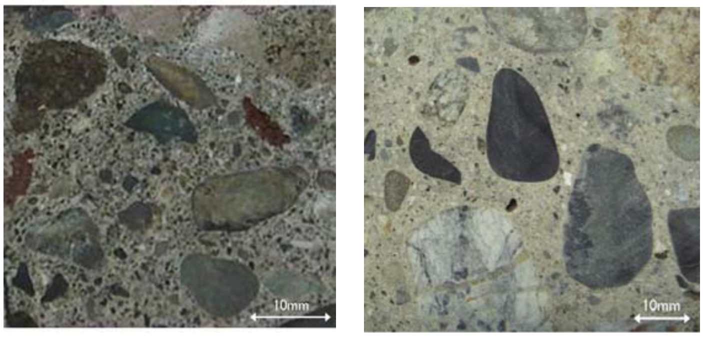
Small pieces of the concrete of about several millimeters after dehydration by immersed in acetone and drying by kept in vacuum chamber for one week was subjected to mercury intrusion porosimetry (MIP). Range of pressurizing of MIP was from 0.5 to 60,000psia.

3.Results and Discussions

3.1 Deterioration in Macro Area

3.1.1 Observation by naked eyes

Appearance of the cross sections of the concrete sample (a) and (b) are shown in **Fig.4**. In the both samples, coarse aggregates had round shape, so they were considered to be river gravel. Aggregates contacted with the cement well, and defects in the interface between cement paste and aggregate were not observed. Defects in the cement paste probably because of poor compacting of concrete were also not observed. They were considered to be dense concretes well compacted. Silica gel formed by alkali-silica-reaction was not observed.



Sample (a) Sample (b)

Fig.4 Appearance of the cross section of the samples

3.1.2 Depth of neutralization

Results are shown in **Table 1**. Mean values measured on the inner side of the sample (a), outer side of the sample (a), and on the inner surface of the sample (b) were 6.9mm, 6.4mm and 4.8mm, respectively. The structure (a) is located on a hill which is about 100 meters above sea level, so it has usually been exposed to the wind. The structure (b) had not been filled with oil at all time, so the upper part of its concrete had been exposed to the air when the oil level had been low. Considering the age and the conditions to be exposed, neutralization of these structures are considered to be little compared to the other structures built in the same age, for example the concrete arch bridge in Miyanoharu line (Tamai, T et al. 2006).

Table 1 Depth of neutralization of the samples

Sample (a) : Inner side of the wall

No.	1	2	3	4	5	6	7	8
Depth(mm)	6.0	10.0	5.5	15.0	4.0	4.0	4.0	7.0

Ave. : 6.9mm (σ =3.59)

Sample (a) : Outer side of the wall

No.	1	2	3	4	5	6	7	8
Depth(mm)	9.0	11.0	11.0	2.0	1.0	5.5	7.0	5.0

Ave. : 6.4mm (σ =3.55)

Sample (b)

No.	1	2	3	4	5	6	7	8	9	10
Depth(mm)	4.6	4.2	5.5	4.1	4.6	4.7	6.7	4.5	4.2	6.6
No.	11	12	13	14	15	16	17	18	19	20
Depth(mm)	4.7	3.5	3.5	4.7	5.9	4.0	2.9	3.8	5.4	8.3

Ave. : 4.8mm (σ =1.25)

3.1.3 Distribution of element

Result of the mapping analysis of the sample (b) is shown in **Fig.5**. In the area of about several millimeters depth from the surface, the concentrations of calcium, chlorine and sulfur were lower than those in the inner area. This is considered to be due to the neutralization caused by carbonation and/or dissolution of cement paste. Its depth, about several millimeters was close to the value measured by spraying of phenolphthalein.

It is well known that sulfur and chlorine transfer to the non-neutralized area due to the incline of their concentrations caused by the decomposition of sulfur or chlorine-containing hydrates in the carbonated area (Kobayashi et al. 1990). Such phenomenon could be observed in sulfur's result, but the extent of it was not large, so it suggested that the carbonation did not progress much.

The concentration of chlorine in the non-neutralized area declined gradually toward the inner area. It suggests that the chloride from the ocean intrudes into the concrete. However, the concrete was not a steel-reinforced one, so the deterioration due to the chlorine was not observed.

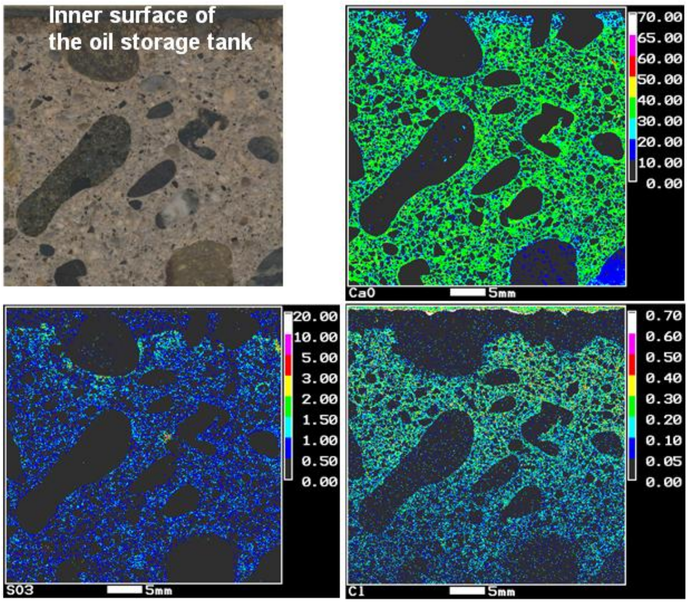


Fig.5 Distribution of Ca, S and Cl in the sample (b)
(Area for analysis : 40mm by 40mm)

3.2 Mix Proportion

Observation with scanning electron microscope showed that the sample (a) and the sample (b) didn't contain blending components such as blast furnace slag, therefore the kind of cement used in them was supposed to be ordinary Portland cement (OPC). Estimation was carried out under the premise that the cement was OPC. When the content of cement in the concrete was calculated, the values of ignition loss (ig.loss) and content of CaO of cement were fixed for 0.6% and 65%, respectively, they were close to the standard values of OPC in 1940 (Nakao 1968). At the calculation of content of aggregate in the concrete, the values of insoluble matter (insol.), ig.loss and content of CaO of aggregate were fixed for 95.2%, 1.2% and 0.4%, respectively, they were mean values of natural aggregates (river sand and gravel) mined in Japan. The result is shown in **Table 2**.

Estimated unit weights of cement, water and aggregate of the sample (a) were 397kg/m^3, 263kg/m^3 and 1595kg/m^3, respectively. Ratio of water to cement (W/C), and that of aggregate to cement (A/C) were calculated as 0.66 and 4.02. W/C was relatively large, and A/C is small, so it was supposed that a concrete with good fluidity was used in the structure (a) in order to fill up them fully around the steel for reinforcement.

Estimated unit weights of cement, water and aggregate of the sample (b) were 236kg/m^3, 139kg/m^3 and 2013kg/m^3, respectively. W/C and A/C were calculated as 0.59 and 8.52, they were lower and higher compared to those of the sample (a). It is known that unit weight of water is needed to be 147 kg/m^3 on average to prepare a concrete with 4cm slump using river sand and river gravel. Unit weight of water of the sample (b) was approximate to this value. So, the sample (b) is supposed to be prepared as a relatively hard concrete. Whereas, it was confirmed that the sample (b) had almost no defects. From these results, sample (b) is supposed to be filled up fully by careful compacting.

Table 2 Estimated mix proportion of the samples

	Unit weight of concrete (kg/m^3)		Unit weight (kg/m^3)			Water cement ratio
	Absolute dry condition	Surface dry condition	Cement	Water	Aggregate	
Sample(a)	2069	2255	397	263	1595	0.66
Sample(b)	2264	2388	236	139	2013	0.59

3.4 Mechanical Properties

Results of compressive strength, Young's modulus and Poisson's ratio are shown in **Table 3**. The mean value of compressive strength of two test piece of the sample (a) was 41.6N/mm^2. That of the sample (b) was 40.6N/mm^2. These values are considered to be sufficiently high as the concrete prepared about seventy years ago. As shown in **Fig.6**, which illustrates the relationship between the ratio of cement to water (C/W) and the compressive strength of the several long-aged concretes, the strength of the sample (a) and (b) are not inferior to those of the concrete having a similar C/W, and it suggests that the mechanical properties of these structures have not been deteriorated seriously.

Table 3 Results of compressive strength, Young's modulus and Poisson's ratio

		Sample (a)			Sample (b)		
Items		No.1	No.2	Ave.	No.1	No.2	Ave.
Diameter (mm)		45.0	45.0	—	152.1	152.2	—
Height (mm)		89	89	—	163	153	—
Ratio (Height/Diameter)		1.98	1.98	—	1.07	1.01	—
Correction Factor		1.00	1.00	—	0.887	0.870	—
Maximum Load (kN)		60.6	71.6	—	777.5	900.0	—
Compressive Strength (N/mm^2)	Before Correction	38.1	45	41.6	42.8	49.5	—
	After Correction				38.0	43.1	40.6
Young's Modulus (kN/mm^2)		29.9	26.3	28.1	28.8	25.3	27.1
Poisson's Ratio		0.27	0.29	0.28	0.197	0.159	0.178
Mass of Specimen (g)		313.6	316.9	—	6994.3	6536.7	—
Unit Weight of Concrete (kg/m^3)		2220	2240	2230	2360	2359	2360

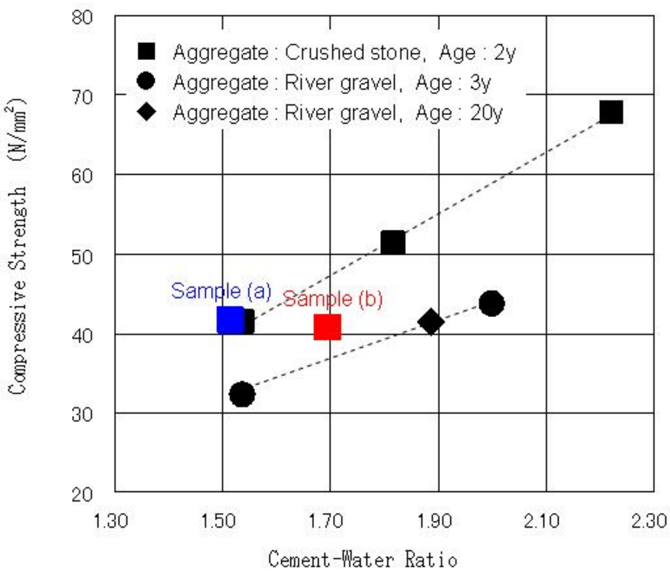


Fig.6 Relationship between the ratio of cement to water and the compressive strength

3.5 Pore Size Distribution

Pore size distribution of the sample (a) and the sample (b) are shown in **Fig.7**. For the comparison, result of a concrete passed about twenty years since it was prepared is also shown in **Fig.7**. Pores which have the diameter from 1 to 10μm in the sample (a) and (b) were more than that in the comparative concrete. But the pores smaller than 0.1μm, which are so-called capillary pore and relate closer to the mechanical properties and durability of the concrete, in the sample (a) and (b) are less than those in comparative concrete. Pores smaller than 0.01μm are mainly gel pore, which are the inner space of calcium silicate hydrate. Gel pore in the concrete increases as the hydration of the cement proceeds. Gel pore in the sample (a) and (b) were more than that in comparative concrete.

From these results, it is supposed that the sample (a) and (b) have dense texture and the hydration of their cement proceed to high extent.

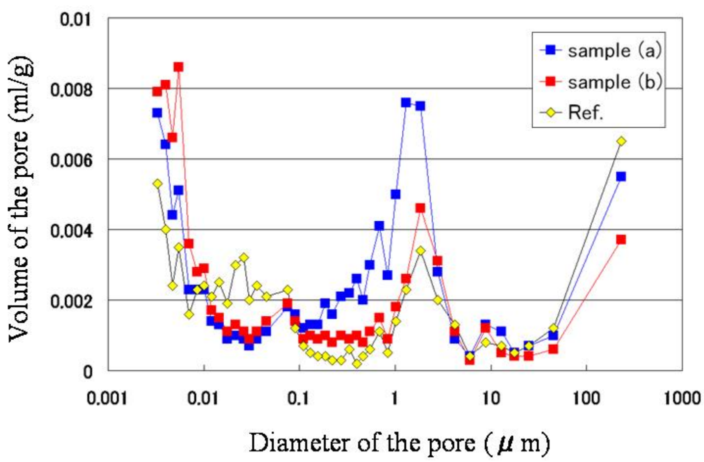


Fig.7 Pore size distribution of the samples

4.Conclusion

Concrete samples were taken from two structures built in 1938 and 1940, and their mechanical and chemical properties were evaluated. In both concretes, serious deterioration with the age was not observed. Mechanical properties were good, and macro and micro texture suggested that careful construction was carried out on these structures. These results certify that the structures built with good construction can keep a long-term durability.

References

Hoshino, T., M. Tsuji, S. Takahashi, K. Asaga, Y. Nakata, and K. Uomoto.K. 2006. Analytical research on dockyard concrete built over one hundred years ago. *Midterm report of committee on assessment and repair of historical structures*, 67-74.

Kobayashi, K., R. Shiraki, and K. Kawai. 1990. Migration and concentration of chlorides, sulfides and alkali compounds caused by carbonation. Concrete Research and Technology. Vol.1. No.2. 69-82.

Mori, Y., Y. Uno, and K. Kobayashi. 2003. Research on freight ship "TAKECHI-MARU" built with steel-reinforced concrete. *Proceedings of the Japan Concrete Institute*. Vol.25. No.2. 1939-1944.

Nakao, T. 1968. Quality of Japanese cement. *CEMENT &CONCRETE*. No.253. 27-40.

Sawaki, D., S. Tanaka, I. Kuroda, and A. Yonekura. 2007. Mechanical and chemical properties of concrete taken from an oil storage tank built in the early year of Showa Period. Submitted to *Cement Science and Concrete Technology*. No.61.

Tamai, T., I. Kobayashi, H. Watanabe, and H. Kasami. 2006. Investigation of concrete arch bridges in existence in Miyanoharu line. *Proceedings of the Committee on Historical Studies in Civil Engineering held by Japan Society of Civil Engineers*. 26. 1-9.

Tamai, Y., T. Sasaki, T. Morikawa, S. Yoshida, H. Nishizawa, and Y. Tanigawa,Y. 2006. Analytical research on underground concrete pillar and foundation built ninety years ago, *Midterm report of committee on assessment and repair of historical structures*, 61-66.

Yokozeki, Y., J. Nakasone, K. Kakizaki, and K. Watanabe. 1998. Durability of underground concrete structure built over one hundred years ago. *Proceedings of the Japan Concrete Institute*. Vol.20. No.1. 251-256.

Analysis of Process in Building Activation Projects in Japan

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Keywords: Buildings Activation, Process of projects, Collaboration between participants

Abstract

We interviewed those who were involved in the associate project of the 21st Century COE Program at Tokyo Metropolitan University's "Development of Technologies for the Activation and Renewal of Building Stocks in the Megalopolis", according to the time series of the project. Throughout this renovation project, we interviewed them to ask about their problems and opinions at each stage of the project according to the time series, and summarized them into a flow chart, which clarified the actual situation of the collaboration of the people involved.

This survey research of the experimental project was conducted based on the idea that, in order to develop students who could collaborate smoothly with other fields, it was necessary for universities and research institutes to provide the students with training opportunities and help them learn and deepen the methodology of inter-discipline collaboration.

1. Introduction

Modern architecture around us is constructed with a variety of materials and methods against a diverse and complex social background. Wholesome, continuous utilization of these buildings can no longer be achieved by limited specialized knowledge or a small group's technology alone, but requires the cooperation of technical expert teams with different advanced, specialized capabilities. Technical expert teams consist of specialists in many fields, who are expected to have not only advanced specialized knowledge, but also a broad perspective and practical workability. In other words, personnel that have "deep expertise" in the vertical direction as well as "comprehensive interdisciplinary capacity" in the horizontal direction, i.e. specialists who have such T-shaped specialized capability are now necessary. It is also extremely important for the teams to collaborate closely with other associate experts and to always grasp the entire picture of a project.

Against this background, the present study conducted process analysis of several projects that were actually conducted as part of the 21st Century COE Program at Tokyo Metropolitan University's "Development of Technologies for the Activation and Renewal of Building Stocks in a Megalopolis" with the aim of providing opportunities for experiencing new working styles. Faculty staff and students in different specialized fields participated in the projects, holding discussions and being involved in the entire process from design to construction. We made proposals for future smooth cooperative works by analyzing the temporal development of rehabilitation works that were conducted for the activation and renewal of existing buildings, identifying key issues and problems at each process step, and clarifying how participants collaborate with each other and what was the reason for their failure in collaboration. The aim of the present study is to determine how participants with different specialized knowledge collaborate with each other for a renewal project and how each developed himself/herself.

2. Overview of the project

From several projects we here focus on the project in which Ph. D. students of three different fields participated and explain it in some detail. The students were provided with the opportunities to experience collaboration with other fields by taking advantage of the knowledge that they learned in their specialized course.

Table 1 Project data

Project name	Experimental building for stairs-integrated elevator installation system
Work content	As a perfect barrier-free renovation method for staircase type apartments, the existing stairs were removed and a new floor and an elevator integrated with stairs were experimentally installed into the residential building
Location	Kimitsu-shi, Chiba Prefecture
Design period	July to November 2005
Construction period	December 2005 to February 2006
Main use	Apartment-type housing complex (Not changed)
Structure	Extension part: Steel construction, 4 stories above the ground Existing part: Reinforced concrete structure, 4 stories above the ground

Fig. 1 Building before renovation

Fig. 2 Building after renovation (left) / Fig. 3 Entrance of apartment (right)

Fig. 4 New added elevator system (left) / Fig. 5 Facade of the building (right)

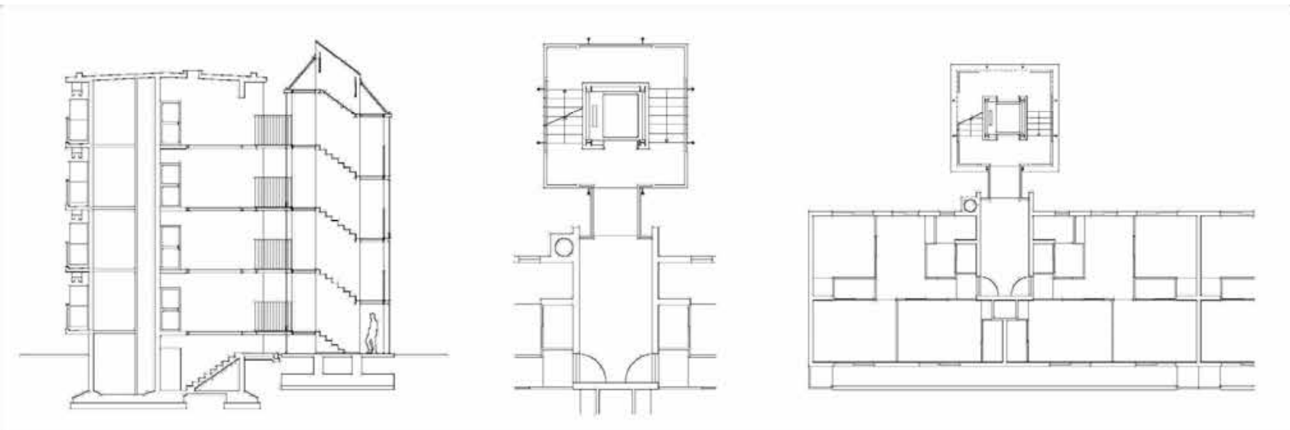

Fig. 6 Section and plans of the building with the new elevator system

3. Involved people's impression at each stage of the project

We interviewed the people involved to ask their opinions and impressions about the problems or the collaboration at each stage of the project. The result of the interview was summarized in the following flow chart according to the rough time series throughout the project.

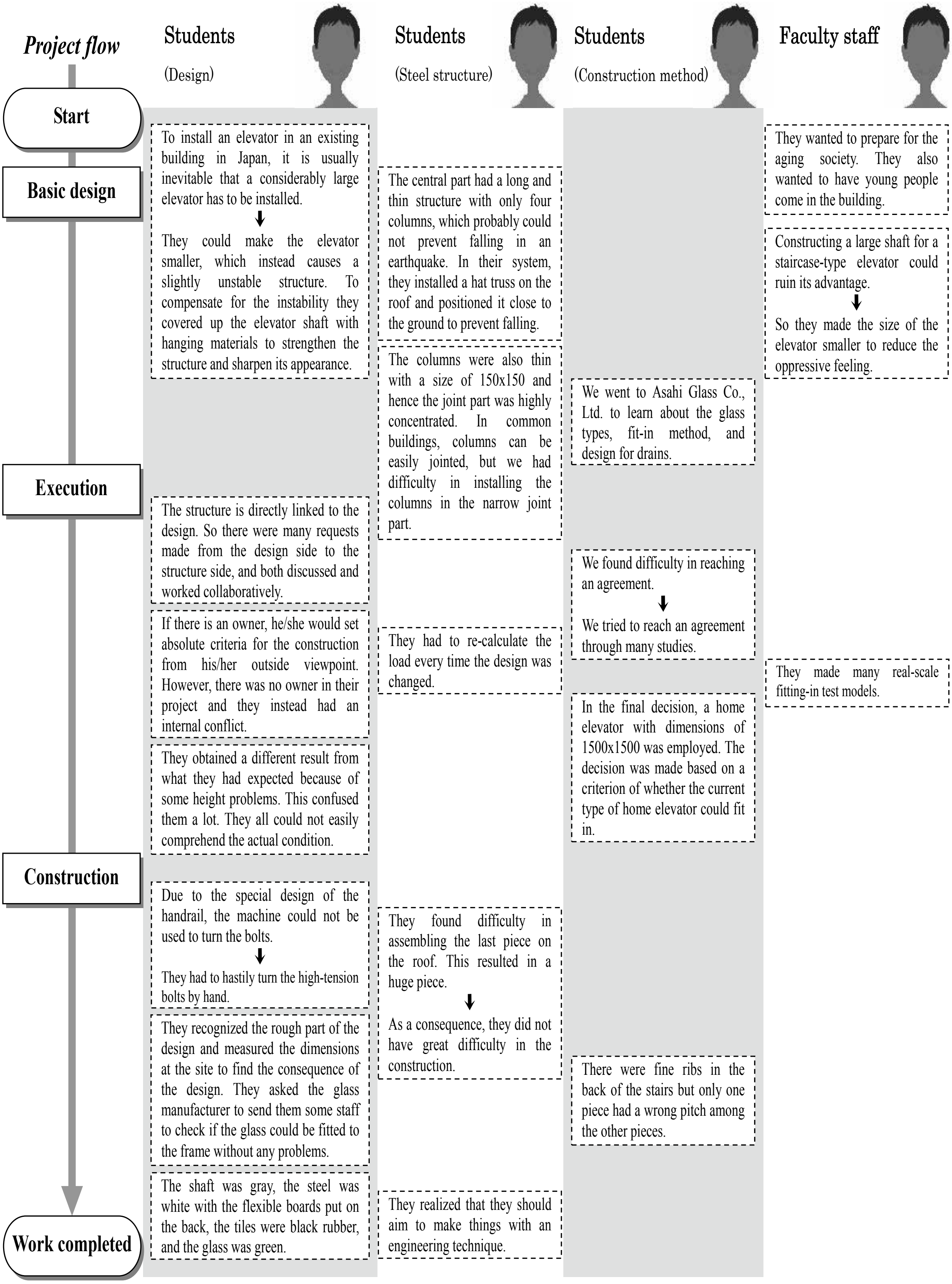

Fig. 7 Opinions and problems at each stage

In the beginning of the project, it was necessary to establish a common view as the members did not know each other well and their specialized fields were so different. They felt at first that they sometimes could not comprehend what others said, but through the course of the studies they began to understand each other. The following outlines the achievements and difficulties that the student participants had through their experience in this project:

Students who study design;

・The stairs-integrated elevator installed this time was itself a structure and so it was directly linked to the design. Therefore, various requests were made from the design side to the structure side and they learned the structure viewpoints through the discussion.

・At the core stage of the execution design, they, the specialists of design, often found difficulty in the discussion and hesitated to make claims. So they learned through the experience that they have to have a clear intention of standing firm.

・They could make an agreeable design in the collaborative work. They were in charge of site supervision after the construction began and they had to make various decisions at the site. They felt pressure but also enjoyed it.

Students who study structure;

・It was their first experience to design a steel structure. Also, since the structural problems were directly linked to the design, they had to answer many questions asked by the design specialists and they needed to modify the structure calculation every time the design specialists re-examined and changed the design. So they learned a lot from the work.

・They made the columns thinner to meet the design requirement. This made the joint more concentrated and they went through difficult work.

・The graduate students who major in structure usually struggle with calculations and graphs without touching real buildings. But through the experience in the actual project and the discussion with people of various fields, they recognized again that the actual work was the basis of our study and the recognition had an influence on our attitude toward the study. They often focus on the academic or scientific beauty but they realized that they should never forget the essential aim of “making something”.

Students who study building construction;

・Various aspects of the resulting design could not be achieved if they hadn’t worked with the structure specialists.

・Although they went through some difficulty to reach an agreement with the builder who pointed out a cost issue, they received various design ideas from the workers at the site and learned many things such as pride in making things.

4. Summary

The student participants received the following educational effects:

1. They could deepen their knowledge of their own specialized field to make it a more practical form by participating in the actual renovation work.
2. They could learn the viewpoints from the positions of other fields through the collaborative work with the students of fields different from theirs.
3. They learned through actual experiences the method of developing a project in collaboration with the specialists of fields different from theirs.

Each student is now working on a thesis or next designs by taking advantage of the achievements that they made in the project, demonstrating his/her advance.

Acknowledgement

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References

Ogawa, H., S. Fukao, S. Yamazaki, K. Kobayashi, K. Kadowaki, and S. Minami. Eindhoven the Netherlands 03-05 July 2006. Development of a New Elevator System for Aged Residential Buildings. *Adaptable 2006, TU/e, International Conference on Adaptable Building Structures*.

Ogawa, H., K. Tahara, H. Yaginuma, H. Suzuki, N. Kato, K. Kadowaki. Personal interviews. 2006.

A Study on the Water Supply System in Consideration of Apartment Housing Renovation

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Keywords: apartment housing, water supply system, receiving tank, water quality

Abstract
In recent years, with efforts to realize a sustainable society, longer lasting and higher quality architectural stock is desired in the architecture field. In current times, utilization of apartment housing stock is a valid method for realizing a sustainable society. In actual implementation, it is necessary to review this overall from various angles, including the architectural plan, design, structure, environment and facilities. Over the last few years we reviewed sustainability centered on the “water-supplied-area” i.e. bathroom, kitchen, lavatory, washroom etc. and the water supply system. However we think that in utilizing apartment housing stock, the advances in technology and changes in lifestyle have a big influence. In this research, we verified the influence of these changes, from existing data and measurement analysis of the water supply system in existing apartment housings. Then we offer our review of the water supply system in consideration of apartment housing renovation. As a solution for pressure shortage, we examined the plumbing system through which the effectiveness of loop piping became clear. Moreover, we proposed a system as a solution for water quality deterioration, and pressure shortage, by zoning system.

1. Introduction
In the domain of architecture, the effective utilization of architectural stocks is sought for the realization of a sustainable society. This study is intended to identify a water supply system capable of keeping up with the changes in lifestyles and equipment and facilities, as well as building up renovation programs and renovation technologies aimed at the effective utilization of apartment housing stocks.

This article summarizes the existing data for apartment housing stocks in Japan and provides potential problems at this point in time through a fact-finding survey on water use in existing apartment housings. In addition, the article proposes a plumbing system in individual dwelling units as a water supply system for better apartment housing stocks and a zoning system by water quality level as well.

2. Survey on the Present Conditions of Housing Stocks in Japan

2.1 Changes in Housing Stock

In order to identify the actual conditions of housing in Japan, data on housing stocks from the Housing and Land Survey by the Statistics Bureau of the Ministry of Internal Affairs and Communications was reviewed. Figure 1 presents the changes in the number of dwelling units, the number of vacant dwellings, and the number of households across the country, and Figure 2 provides a breakdown of the existing housing stocks by year of construction. From Figure 1, the rate of vacant dwellings is found to be consistently increasing, while the number of household members is found to be decreasing. In addition, the number of housing stocks surveyed in 2003 was found to be largest in the period of construction between 1981 and 1990, accounting for 25.8% of the total. This has revealed the fact that the housing stocks constructed within 15 to 25 years and thus considered in need of equipment replacements account for the greatest number among existing housing in Japan.

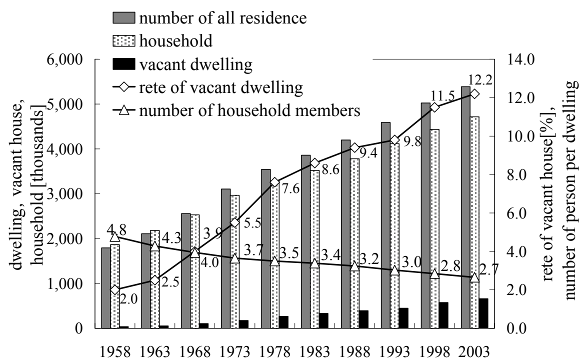

Fig. 1 Changes in Number of Dwelling Unit, Vacant Dwellings, Households

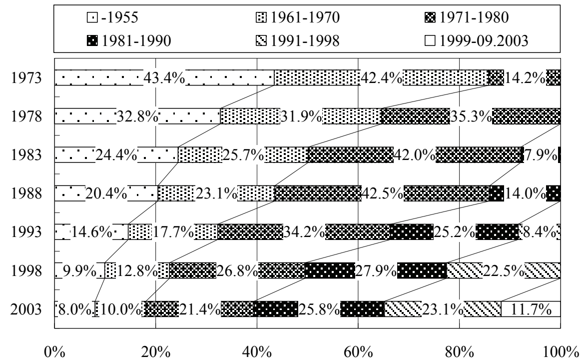

Fig. 2 Construction Time of Architectural Stocks

2.2 Unit Requirements for the Design of Plumbing Systems

In order to identify the changes in factors relating to water supply systems and analyze the present conditions, a review was made of the existing data which would be required for the design of plumbing systems from 1955 onwards. It was based on hearings, published reports, and literature, as well as various related documents on the design guidelines and design practices specified by public organizations. As one of the results obtained from the review, Figure 3 presents the changes in unit requirements for design water supply quantity and design population supplied per dwelling unit (2DK). As can be seen from the figure, in the last 50 years or so, per capita water consumption has nearly doubled, whereas the number of household members has been reduced by half.

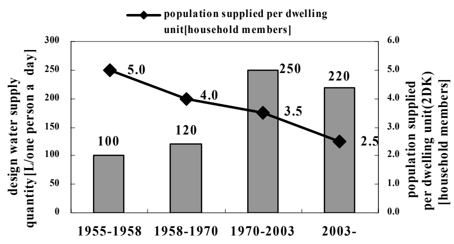

Fig. 3 Changes of Water Consumption, Population Supplied

2.3 Case Study on the Capacity of Receiving Tanks

In order to identify possible effects of changing unit requirements with changing design guidelines, a case study was made on the design water supply quantity, design population supplied, and the number of times water is changed in receiving tanks. For the case study, 5 apartment housing stocks each were selected from the Tokyo Metropolitan area and Kanagawa Prefecture, which varied from one another in the year of their construction to represent different unit requirements. Table 1 provides a summary of the housing stocks targeted to the case study, and Table 2 lists the calculated results of the number of times the water was changed in the receiving tanks. For the number of times the water was changed in receiving tanks, 1.67 to 2.5 times per day is specified under the current guidelines. Among the buildings designed in 1983 and later, some were found to incorporate receiving tanks that do not meet the specifications.

Table 1 Analysis Cases

case	number of dwelling unit	completed year of building	design water supply quantity	population supplied per a dwelling unit[2DK]	volume of receiving tank[rate of per a day]	rate of vacant house
Tokyo-1	41	1957	100L	5.0	30-50%	11.2%
Kanagawa-1	18	1957	100L	5.0	30-50%	10.3%
Tokyo-2	40	1960	120L	4.0	30-50%	11.2%
Kanagawa-2	21	1959	120L	4.0	30-50%	9.7%
Tokyo-3	53	1967	120L	4.0	30-50%	11.2%
Kanagawa-3	31	1964	120L	4.0	30-50%	9.7%
Tokyo-4	134	1971	250L	3.5	30-50%	11.2%
Kanagawa-4	87	1976	250L	3.5	30-50%	9.7%
Tokyo-5	64	2002	220L	2.5	40-60%	11.2%
Kanagawa-5	121	1996-	220L	2.5	40-60%	9.7%

Table 2 Water Change Time in the Receiving Tank

case	estimate[frequency	with vacant
Tokyo-1	3.45	3.06
Kanagawa-1	3.00	2.69
Tokyo-2	3.16	2.81
Kanagawa-2	2.63	2.37
Tokyo-3	1.37～2.28	1.21～2.02
Kanagawa-3	1.92～3.19	1.70～2.83
Tokyo-4	1.29～2.14	1.14～1.90
Kanagawa-4	1.29～2.14	1.16～1.93
Tokyo-5	0.98～1.47	0.87～1.30
Kanagawa-5	1.13～1.69	1.02～1.53

3. Fact-Finding Survey on Apartment Housing

3.1 Description of Survey

In order to summarize the existing data and examine the results obtained from the case study, actual measurements were conducted on the building outlined in Table 3. Measurements included the water supply quantity, supply water temperature, electric current for pump running, concentration of residual chlorine, and water pressure. The measuring points are shown in Figure 4. Measurements were conducted at intervals of 1 second for all of the items, and the output signals from the individual measurement instruments and thermocouple were transmitted through a data logger to a personal computer for recording.

The concentration of residual chlorine was determined with a portable residual chlorine concentration meter. In addition, in the neighborhoods of the measuring site, the outdoor temperature, humidity, and amount of solar radiation were also measured. The measurement took about 2 months from August 3, 2006 to September 29, 2006. Because of missing measured data, the analysis focused on the data measured in the approximately one month from August 6 through September 9.

Table 3 Outline of Measured Apartment Housing

the location	kashiwa city, tiba-ken, japan
completion of building	1988
number of floor	1st basement, 5th floor
number of dwelling unit	all:40 2LDK:10vacant houses for all 30 3LDK:2vacant houses for all 10
scale capacity	building areas :801.097m^2, floor areas :3168.223m^2
water service installation	water supply system:booster pump hot water supply system:innstantaneous heater water resource:city water, bore 40mm
measurement period	from August 3,2006 to september 29,2006

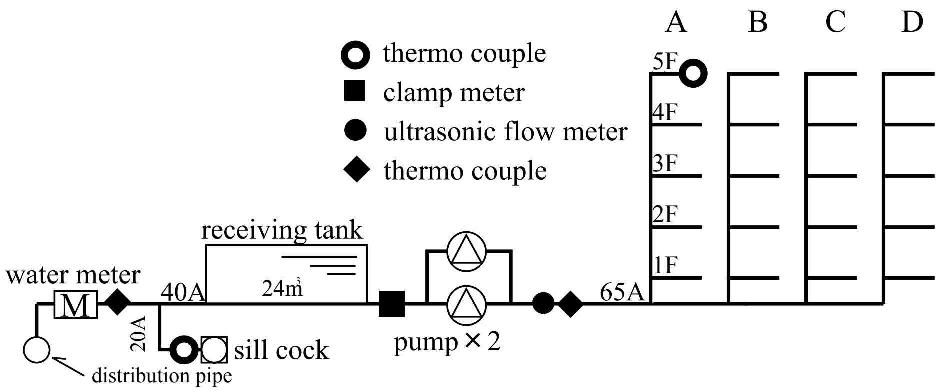

Fig. 4 Measuring Point

3.2 Discussion on Water Supply Demand

A typical change in water supply quantity over time is shown in Figure 5 for individual days of the week. The water consumption exhibits a pattern having two peaks, which represents a peak occurring both in the morning and afternoon similarly as reported in the existing surveys. In order to compare the actual conditions with the current design methods and standard values in effect, the peak rate and instantaneously volume of water supply were determined for validation. The peak rate was found to be lower compared to the existing results of a similar survey on a building located in central Tokyo, though it is nearly consistent with the currently effective design standards. The instantaneously volume of water supply determined based on the methods proposed by individual institutions and the average value of the measured results. Based on the comparison with actually measured results, it was found that theinstantaneoously volume of water supply can be excessively large when determined in accordance with the currently effective standards, even if it is calculated in consideration of the presence of vacant dwellings. Figure 6 shows the number of times the water was changed in the receiving tanks. As a result of a similar case study as discussed in the previous section 2 based on the design guidelines with consideration given to the rate of vacant dwellings at the time of actual measurement, the number of times the water was changed in the receiving tanks was found to be 0.88. However, the actual measurements resulted in 0.60 on average, showing that the water was changed approximately every 2 days. This represents a smaller number of times the water was changed in receiving tanks by a factor of 4 compared to the currently specified standards. In addition, it was also revealed that, relative to the design water supply quantity assumed at the completion of the building, the water consumption at the time of the actual measurements corresponded to approximately 30, showing significantly lower water consumption.

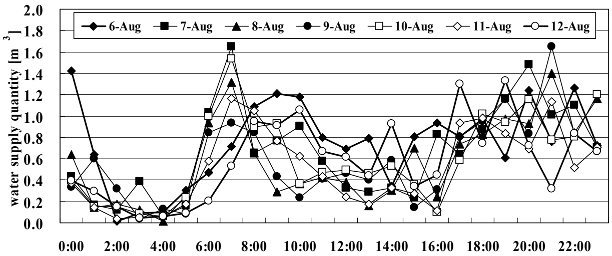

Fig. 5 Changes of Water Consumption

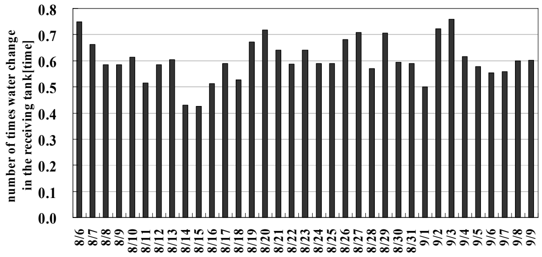

Fig. 6 Number of Times Water Change in the Receiving Tank

3.3 Discussion on Water Supply Pressure

Changes in water supply pressure from the water main over time are presented in Figure 7. The supply pressure was found to be approximately 0.25 MPa on average, though it is not constant but fluctuates within a range of 0.1 MPa. Variations in water supply pressure at the terminal faucets and water consumption are plotted in Figure 8. The water supply pressure at the terminal faucets was found to be 0.30 MPa on average, and the variation in water supply pressure was found to be affected by water consumption.

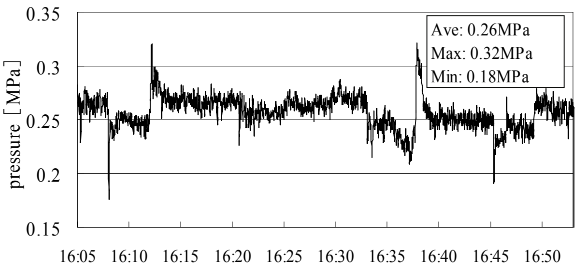

Fig. 7 Pressure Fluctuation of City Water Service Pipe

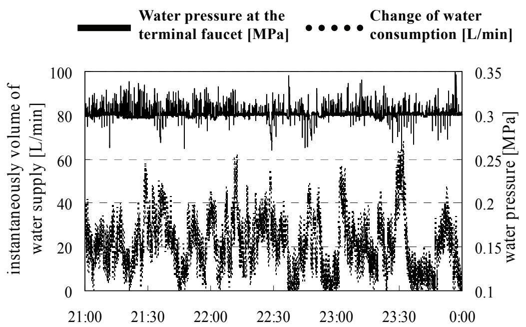

Fig. 8 Changes of Water Consumption, Pressure at the Terminal Faucet

3.4 Discussion on Supply Water Quality

Based on the actually measured results on water supply demand, it was found that water consumption has decreased significantly compared to the design water supply quality at the completion of the building. Then, in order to identify the effects of the decreasing water consumption on the water quality, water sampling and analysis were carried out with the concentration of residual chlorine defined as an indicator. The inflow to and outflow from the receiving tanks and the terminal faucets were selected as measuring points. The measured results of the difference in the concentration of residual chlorine between the inflow to and outflow from the receiving tanks are plotted in Figure 9. In our survey, the difference in the concentration of residual chlorine is found to reach its largest value of 0.34 mg/L in the summer season in which the water temperature is high. Based on the measurements at the terminal faucets in dwelling units, no residual chlorine was observed at the faucets in some time zones. To identify possible factors causing the water temperature increase in the receiving tanks, Figure 10 provides the typical daily variations in individual items considered to be possible factors. From the figure, it is found to be likely that the water temperature increases due to the outdoor temperature and intensity of solar radiation. However, fluctuations in water consumption affects the retention time in receiving tanks, and thus it can greatly govern water temperature increases.

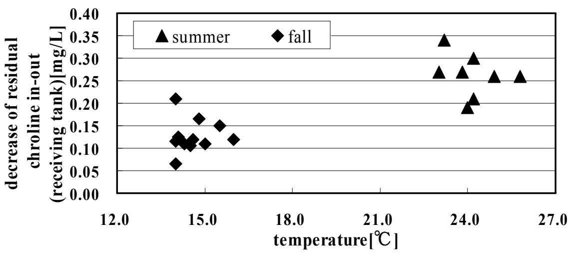

Fig. 9 Decrease of Residual Chlorine for Receiving Tank

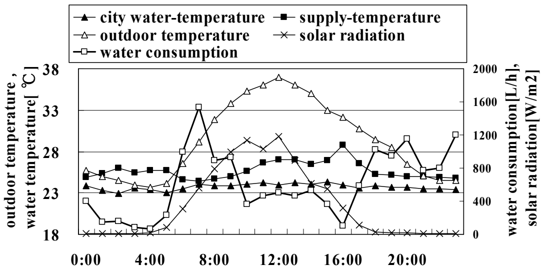

Fig.10 Change Outdoor Temperature, Water Temperature and Water Consumption

4. Proposal of Water Supply System Renovation Planning

The literature reviews and actual measurements discussed as of Section 3 have revealed a possible problem involved in the utilization of housing stocks that the mixed factors causing the increasing and decreasing water consumptions could provide fluctuating water supply quantities to individual dwelling units. This is likely to cause a deterioration of the water quality in the receiving tank systems popularly adopted in many stocks and insufficient minimum required water pressures. This section proposes a solution to these problems.

4.1 Plumbing System in Individual Dwelling Units

The water supply pipelines in the apartment housing subjected to the actual measurements in Section 3 are shown in Figure 11. The apartment housing adopts a branch piping system. For the effective utilization of the apartment housing stock, renovation of the water-supplied areas is indispensable in consideration of the needs of residents. The renovation would involve the issue of increasing the minimum required water pressure. Then a plumbing system in individual dwelling units was examined as an approach to compensate for possible insufficient pressure. As the plumbing system, a branch piping system, a header

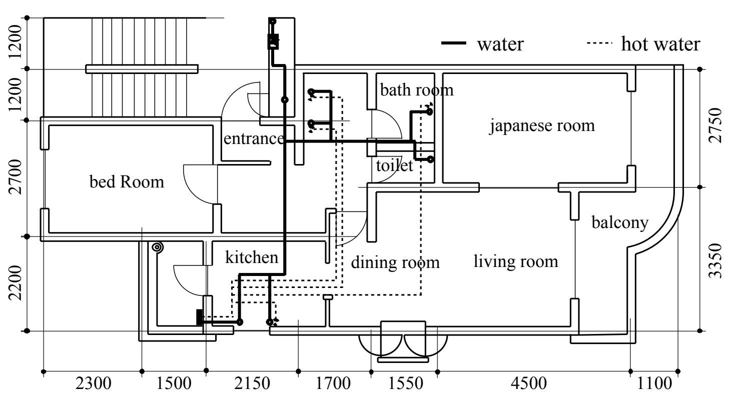

Fig. 11 Branch Piping System

Table 4 Simulation of Minimum Required of Water Pressure

piping system	pressure loss[MPa]			required pressure[MPa]		
	both	shower	toilet	both	shower	toilet
branch	0.109	0.049	0.060	0.341	0.181	0.160
header	0.088	0.061	0.059	0.320	0.193	0.159
loop	0.086	0.050	0.041	0.318	0.182	0.141

piping system, and a loop piping system were selected, and a case study was conducted on the pressure loss due to the use of equipment. The loop piping system was analyzed based on the Hardy-Cross method. The results obtained are summarized in Table 4. As a result, it was found that the header piping system and loop piping system provide smaller pressure losses and more stabilized flow rates in the event of concurrent use of equipment compared to the branch piping system.

4.2 Zoning System by Water Quality Level

It was found that apartment housing stocks offer a problem of significantly decreasing the concentration of residual chlorine in the receiving tanks due to the decreasing water consumption. Then an examination was made on a zoning system for water supply by summarizing the water supply systems and giving consideration to the effective utilization of stocks and the required water quality. Zoning plans during new construction and renovation of water supply systems are shown in Figure 12. Plan 1 is free from zoning by water quality, though it allows for water supply without through any receiving tank. Plan 2 and Plan 3 refer to the application of the zoning system in the potable water supply system and low quality water supply system. These plans are often adopted in office buildings, though less often observed in apartment housing. The zoning system by water quality provides the advantages listed below.

(1) Allows for independent determination of the water quality level for individual required water qualities

(2)Eliminates insufficiency in supply water pressure and available consistent water supply due to decreased number of concurrently used water supplied areas by adoption of the zoning system

(3)Easier to adopt the utilization of rainwater or recycled use of wastewater for new construction or renovation, thus contributing to the effective utilization of water

(4)Allows for the construction of an independent water circulation system for individual buildings, leading to disaster-resistant urban planning

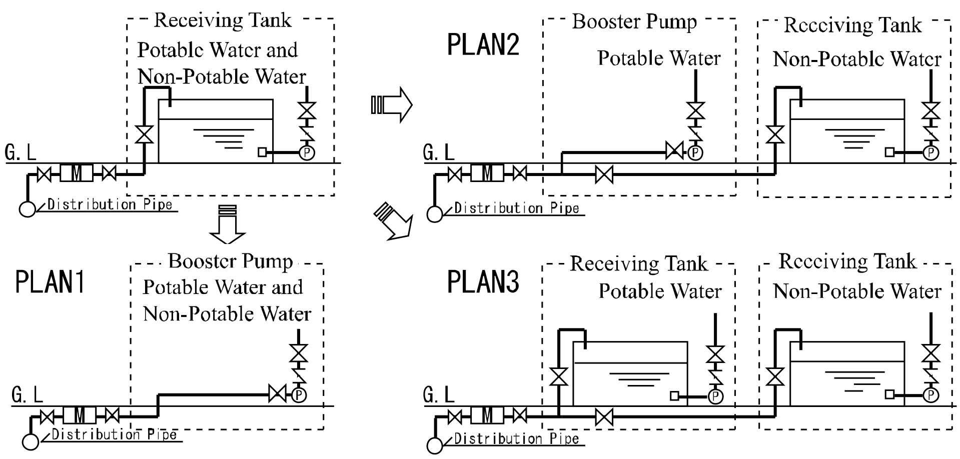

Fig. 12 Plan of Zoning System by Water Quality Provide

5. Conclusion

The findings obtained in this study are summarized below.

(1) For housing stocks, those constructed within 15 to 25 years account for the largest percentage at 25.8%. Vacant dwelling units are increasing, accounting for 12.2%. For the unit requirements, the per capita daily design water supply quantity has nearly doubled in the last 50 years, and the number of household members has reduced by half.

(2) The water consumption was found to be approximately 30% of the assumed design water supply quantity, and the capacity of the receiving tanks exceeds the currently specified standards by approximately 70%.

(3) The actual measurements showed 0.34 mg/L of the largest difference in concentration of residual chlorine between the inlet and outlet of the receiving tank.

(4) As a result of a review of the plumbing system, the loop piping system and header piping system were found to be more effective for their capabilities of decreasing possible pressure losses.

(5) The zoning system for water supply helps assure proper water quality and consistent water supply, while also facilitating the effective utilization of water as well.

Acknowledgements

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A large amount of cooperation and advice was pro-vided by the members of the above research and promotion projects. We would here like to express our cordial thanks to them all.

References

T.Akibayashi :*Changes in a Residence*, Journal of the SHASE, Japan.Vol.78,No.8,2004.

N.Ichikawa,et al. :*Investigation of Water Consumption in the Metropolitan Apartment Houses*, Transaction of SHASE, Japan, pp.53-67, 1993.

S.Okada,et al. :*Influence of Water Supply System Piping on Concentration of Residual Chroline*, Summaries of Technical Papers of Annual Meeting, SHASE, Japan, pp.1801-1804, 2002.

T.Mizutani, et al. :*Study on Renewal Plan and Renewal Technology for Water Supply System in Apartment Houses Part1 Case study of existing apartment houses*, Summaries of Technical Papers of Annual Meeting, AIJ, D-1,pp.413-414, 2006.

Health Facility Water System and Management Strategies for Sustainable Building Rehabilitation: A Case Study

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Keywords: Water Management, Assessment Method, Health Facility, Sustainability

Abstract
The research was undertaken into water management at a NSW rural base health facility in order to develop a suitable assessment method of a water system and its management for sustainable building rehabilitation strategies. The current rapidly evolving social and technical dynamics have often resulted in a mismatch between the existing stock and contemporary user/building requirements with new technical systems which are given top priority for rehabilitation requirements. As a result, basic building systems such as water system have become less popular subject although water is one of the key components in terms of sustainability. Especially this is an indispensable building service area with regard to building type such as health facility, because water quality, supply and security are crucial to the provision of adequate public health services. However, this is a complex facility management task, if the facilities are aged building stock. Growing sensitivity to water supply, usage and waste management requires a greater understanding of health facility management issues and decisions.
This study aimed to design efficient water management strategies for health facilities for maintaining the provision of essential services and for future and alternative water supply systems in terms of sustainable building rehabilitation. The research consists of 2 phases: 1)analysing the water management decisions of an existing NSW rural base hospital in an area which is experiencing a 'crisis' of insufficient water supply and 2) identifying criteria for sustainable building rehabilitation strategies based on the perception of staff involving the water management decisions which were analysed in phase 1. The outcome was interpreted in combination with other sources of data such as rainfall, water storage and water usage. This paper reports the results of phase 1.

1. Introduction
With growing awareness of the problem of global climatic change, holistic water management plays a crucial role of providing basic social requirements; especially for the provision of minimal and critical health care services.
During the 1970s and 1980s, widespread droughts in Africa raised the growing awareness of potential of water harvesting in order to improve crop production (Evanari et al, 1971). However, recent droughts as a result of climate change have highlighted the risks not only to crops and livestock, but also to human beings. Reduced water supply would have an initial impact on human health, and cause serious problems to health facilities such as hospitals (Carthey and Chandra, 2007). Sustainable water management for future and alternative water supply systems and the building rehabilitation strategies for health facilities

are urgently needed to maintain provision of basic health services (WHO, 2007). In order to formulate sustainable rehabilitation strategies, it is necessary to identify building assessment criteria for the existing building stock (Lundie et al, 2006). However, this assessment method has to be implemented together with our future requirements.

One of key requirements is alternative water sources which we do not currently take advantage of.

There are generally used two options: harvesting and recycling water sources, which involve the rainwater catchments system and the recycling system. However, there is limited information of water catchments design in terms of health facilities. This indicates that water harvesting techniques for health facilities is not commonly used. Moreover since waste water from health facilities is currently considered as unsuitable for recycling purposes, this water source for recycling is ruled out as a possible option.

2. Aim and Methods

This study reviews the existing water management strategies of an Australian rural base hospital located in an area which is experiencing water problems in order to develop additional methods suitable for investigating health care facility water management and usage problems.

The study aims to establish:

- Perceptions of the staff regarding impact of water quality and usage on the daily operations of the health care facility.
- Availability of information regarding this topic.
- Options considered. (Best practice indicators)
- Current water mitigation strategies in place. (What's possible – decision processes)
- Evaluation/monitoring of different strategies.

This study was designed to identify the perceptions of staff regarding the current water management in place, management decision process, alternative water sources and impact of water quality and usage, which portray key components for future facility usage and its management. Therefore the most important part of the study to be carried out is the interview which was based on the grounded theory (Minichiello et al, 1999 and Jeon, 2004). Main discussion topics for the interview session were selected to identify assessment criteria derived from consideration for healthcare facilities (Hirota, 2007). The outcomes need to be interpreted in combination with other sources of data such as rainfall, water storage and water usage by using (Strauss and Corbin, 2005).

2.1 Study Sample

The research was carried out on a rural base hospital which serves a population of approximately 35,000 people. The site was chosen due to its location within an area which is experiencing special water supply problems. Part of the site selection criteria was the likelihood that staff at this hospital had considered water supply, quality and conservation issues and therefore were likely to engage actively with the interviews which were required by this research. The health facility was also sufficiently large to have a wide range of higher level services and usage and was accessible for the researchers.

2.2 Interview

Based on the project proposal which was approved by and which complied with the policies and procedures of the UNSW, Faculty of the Built Environment Research Ethics Panel, the interviews were then conducted using a set of standard open ended trigger questions. The interviews were transcribed and analysed for themes and content.

Management, environmental health, clinical, hotel and facility staffs were selected as the interview participants. All participation was voluntary and respondents were assured of their anonymity.

2.3 Rainfall Analysis

Data for rainfall and dam water catchment from the year 2000 to date were obtained from the local town council. The local metrological station provided meteorological data for the last 11 years from the 1996.

The results of the data analysis were categorized into monthly water production, water storage volume, the effects of water restriction and the relationship between rainfall and water storage volume. Also this data was used for the water harvesting calculation. The formula which is based on 60% run-off coefficients was used in this calculation (University of Arizona, 2004).

2.4 Water Usage Analysis

The hospital water consumption data together with consumption figures for the town from 2000 to date was provided by the Area Health Service**.** In addition, the town council made available to the researchers their water consumption data which are provided to the public on a weekly basis.

The results of the data analysis were categorized into daily water consumption, monthly waste water generation and the effects of water restriction on water consumption.

3. Results and Discussion

3.1 Interview

The interviewed participants perceived that the council had generally done a good job in managing the water supply issue and that the standard of water quality remained satisfactory, except for the taste and the inherent property of water ‘hardness’. The council education program proved to be the public source of information and there was a positive reaction on the part of the respondents to the council’s activities. One participant actually commended the council for implementing water restrictions early and said that the town had been saved due to this early action and the manner in dealing with this difficult situation. To this end, the council education program was successful in engaging everyone to feel included and willing to comply with the water management strategies implemented at the local hospital.

The highest priority was given in every case for to the desired health outcomes for patients. Water saving strategies did not require additional capital expenditure on especially targeted key high usage areas such as the dishwashing even as the crisis worsened. At the peak of the crisis, water conservation was viewed as a higher priority concern than ecological sustainability and other conservation issues. This caused some concern amongst the staff but the overall water management decision was respected and executed.

Internal communication systems (staff meetings, notifications for repairs etc) were efficient and valued by all the respondents. The main staff frustrations expressed during the interviews was with the application for external grants, difficult deadlines or when ad hoc design decisions were made off site and introduced without prior or a ‘sufficient’ period of consultation. This is not necessarily water management related but highlighted the need to include staff in communications especially on high priority issues. The communication amongst the staff was interesting in that the respondents often recalled different rationales for the identical decisions; in some cases economic (eg budget allocation), and in some cases feasibility (e.g. unacceptable water quality) but in all cases, the final decision was executed. This indicates that the entire staffs were unified in their commitment to achieving the aim of concerning water.

Water harvesting was seen as the next logical step for the hospital to consider and current efforts were being encouraged as there was such familiarity and acceptance as a result of the staff's personal experiences. Water recycling, seen in a more critical frame, is expressed as a realistic possibility.

3.2 Rainfall Characteristics

The total annual rainfall is shown in Fig. 1 below. The average total rainfall over the past 11 years (1996-2006), is 577mm/year. Irregular rainfall patterns through the years have been recorded. From Fig 1, it is clear that although the total annual rainfall per year (1996-2006) has not changed dramatically, it is difficult to pin point the rainy season within each year. In addition, there are occasions of heavy downpours recorded annually between 1996 and 2006.

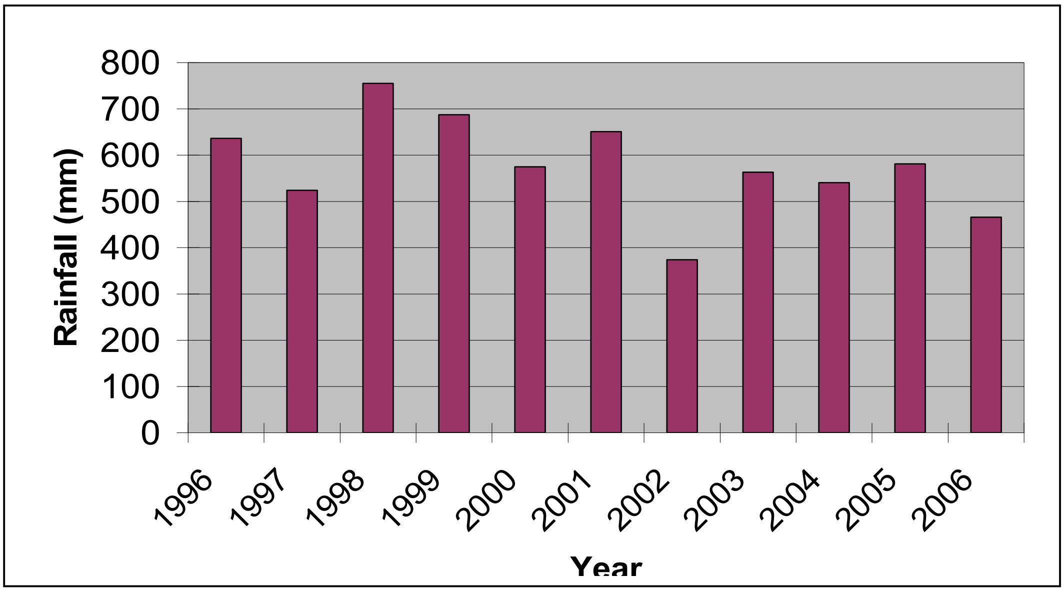

Fig. 1 Total Annual Rainfall

3.3 Water Storage

There are 3 water storage locations within the city. The water storage capacities are 9000, 6250 and 330 ML. In the past water restriction was applied several times from the year 1999 to 2006. The relationship between water storage volume and the restriction is shown below in Fig. 2.

Based on the hospital site area of 3.875 ha and the average annual rainfall of 0.45m (a conservative estimate), water harvest calculation for the site has been calculated. It is approximately 10,400 m^3 or 10.4 ML. Since the roof plan area on the study site is 0.7266 ha with an average annual rainfall of 0.45m (conservative estimate), a run-off coefficient of the roof of 90% and the accessibility of the roof area of 50% (University of Arizona, 2004), the water harvest from the roofs would be about 1.5ML. As

0.7266 ha of the site would collect 1.96 ML, the estimated water harvesting is 10ML.

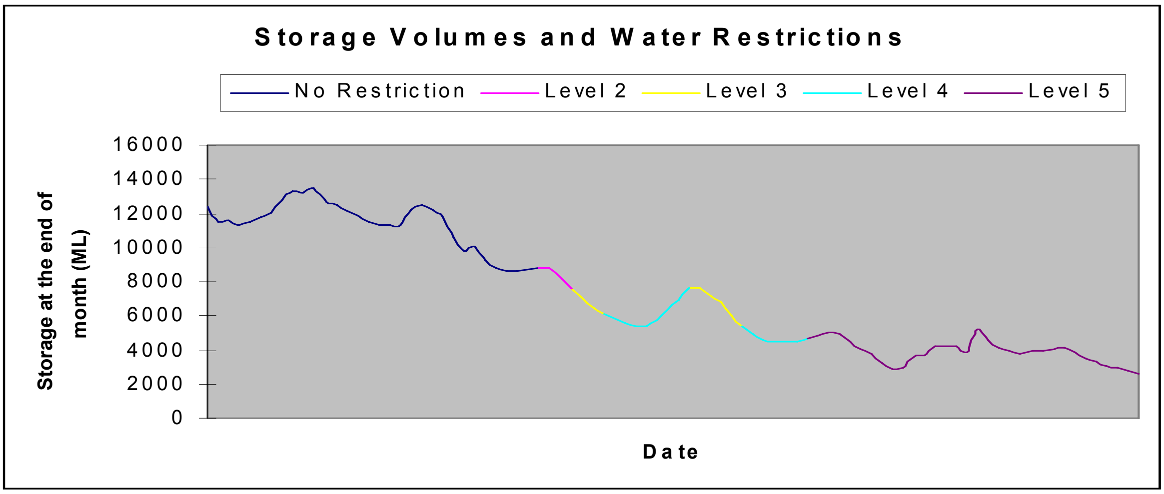

Fig. 2 Water Daily Consumption between 1999 and 2006

3.4 Water Consumption

The daily water consumption through the years 2000 to 2007 is shown below in Fig. 3. The diagram indicates that the water consumption has been falling throughout this period. Every time the restriction level rose, a significant level of reduction in water consumption was recorded.

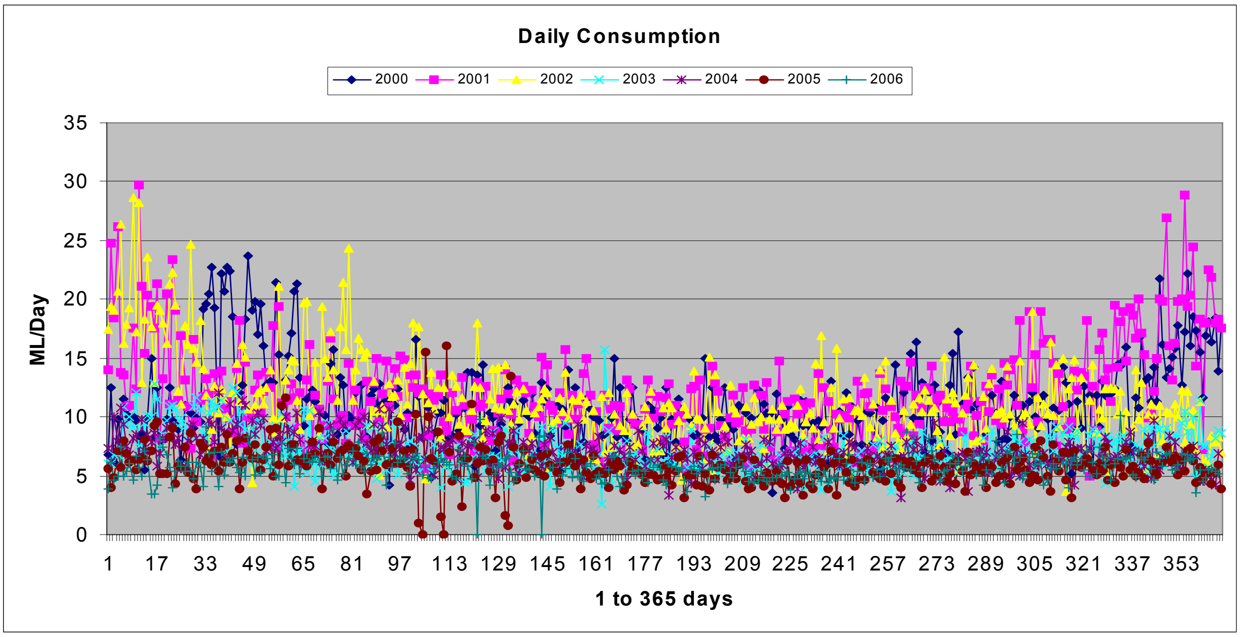

Fig. 3 Water Daily Consumption between 2000 and 2007

4. Conclusion

The participants indicated that the council had generally done a good job in managing the water supply problem. The council education program played the main role in distributing the information and there was a positive public reaction to it. Each of the water management groups had organized their own internal communication systems. These worked effectively and were valued by all the respondents. Since an irregular rainfall pattern occurred throughout the years from 1996 to date, it became hard to rely on conventional water supply systems. Moreover because there is good potential for collecting rain water on the site, water harvesting seems to be the next logical step for the health care facility to consider and current efforts were being encouraged as there was such familiarity and acceptance of this as a result of the staff's personal experiences. Water recycling was viewed in a negative manner by all the participants. However, it would be a realistic option as this city is located in a high risk area of climatic variability.

5 Acknowledgements

We would like to thank the local council, the area health service and the rural base hospital for providing the data. In addition, we wish to express our appreciation to the interviewees for their participation and contributions to this study.

6. References

Carthey, J. and Chandra, V. 2007. *The Impact of Climate Change on Healthcare Facility Infrastructure: A Preliminary Investigation of Mitigation and Adaptation Strategies.* CHAA Conference 2007.

Critchley, W. and Siegert, K. 1991. *Water Harvesting,* Rome: FAO.

Evanari, M., Shanan, L. and Tadmor, N.H. 1971. *The Negev, the Challenge of a Desert*. Cambridge, Massachusetts : Harvard University Press.

Hirota, K. 2007. *A Study of Post Occupancy Evaluation Questionnaires for Indoor Air Quality and Infection Control at Healthcare Facility*. Roomvent 2007.

Jeon, Y. 2004. *The Application of Grounded Theory and Symbolic Interactionism.* Scandinavian Journal of Caring Science, 18:249-256.

Lundie et al. 2006. *Sustainability Framework for the Australian Water Industry.* Journal of the Australian Water Association, pp. 54- 59.

Minichiello et al. 1999. *Handbook for Research Methods in Health Science.* Sydney: Addison-Wesley.

Strauss, A.L. and Corbin, J. 2005. *The basics of qualitative analysis.* Thousand Oaks, CA: Sage.

University of Arizona. 2004. *Geotechnical, Rock and Water Resources Library*, (Updated 2004), < http://www.grow.arizona.edu/Grow--GrowResources.php?ResourceId=174>

WHO. 2007. C*orrespondence to the Philippine office regarding to water management issue dated on 5th of July 2007.*

A study of the urban tissue design for reorganizing urban environments
– A case study of the Shimbashi areas of Tokyo

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Keywords: Urban tissue, Design method, Urban environment, Existing building stock, Public spaces

Abstract

The author studied the areas along the city planning road “Ring Route 2”, also known as MacArthur Road, in the Shimbashi - Toranomon district of Minato-ku, Tokyo, in an effort to draft a district plan and design guidelines that embody aesthetic urban planning and environmental design. The aim was to establish a design method for reorganizing an existing urban environment by unifying the architecture, city planning, civil engineering and landscape design. Design guidelines for the area were drafted and their effectiveness was tested by using them in a schematic design. It is hoped that the results of this study will be utilized in local city planning and district design guidelines in the near future.

1. Purpose of the study

The economic growth that occurred in Japan after the end of World War II has led to the emergence of cityscapes dominated by huge high-rise buildings, but often without beautiful scenery and community spaces. This is because architecture, city planning, civil engineering and landscape design have become too specialized and there has been no integrated, holistic approach to the design of urban environments. The author studied the areas along the city planning road “Ring Route 2”, also known as the MacArthur Road, in the Shimbashi - Toranomon district of Minato-ku, Tokyo, in an effort to draft a district plan and design guidelines that embody aesthetic urban planning and environmental design (Fig.1).

Fig. 1 Map of the MacArthur Road in The Shimbashi -Toranomon area today

It has been common for the areas adjacent to a new city planning road to be developed haphazardly without any coordination between architectural design and civil engineering design, with the inevitable result of inferior public spaces and greenery. By reflecting on conventional environmental design, the author aimed to establish a design method for reorganizing an existing urban environment by unifying the architecture, city planning, civil engineering and landscape design.

2. Methodology

The geographical and historical characteristics of the area were studied using old maps and aerial photographs, and the development process, changes in the industrial structure and demographics of the area were analyzed. The present situation of building stock was investigated using account books and fieldwork and a database was made which suggests buildings that may be suitable for reuse.

The Shimbashi - Toranomon district, which is located between the Kasumigaseki governmental district and the Shiodome business district in Tokyo, is expected to become a new business zone after the completion of a new city planning road. The future potential of this area for business and residential functions was analyzed based on three-dimensional perspective views and models of the blocks that were created to study various alternatives for future city spaces. During the course of this study, interviews were conducted with local government representatives, university researchers and people who live and work in this area to obtain a variety of opinions.

3. Analysis of the study area

3.1 The analysis of the characteristics of the study area

Studies were made of the geographical characteristics, historic development process, changes in the industrial structure, and characteristics of the residential areas of the Shimbashi - Toranomon district. The historical development process of the city was analyzed using old maps and aerial photographs. Residents, workers and visitors to the district were interviewed to get an understanding of the everyday life of the local people.

1) Area characteristics observed in the field work

A. The charm of the district：Lively atmosphere of bars and cafes.

B. Problems in the district: Because there are relatively few stores, everyday life is inconvenient. The educational environment for children is bad, and the local community has not been active recently.

C. Expectations for and uneasiness about the construction of Ring Route 2： Because of the lack of information from government authorities and developers, it is hard for the local community to have an image about the future of the town. The community is afraid that the new road may divide their town into north and south parts. The road plan has little relevance to most of the senior citizens for them to have an interest in the development.

2) Historical changes

The historic transformation of the blocks of Shimbashi district was investigated based on old maps (Fig.2). A study was made of the history of the traditional furniture industry in this area and the development process of the local industries was analyzed. Before the Great Kanto Earthquake of 1923, the furniture industry prospered in the Shimbashi district along Red Brick Street and Hibiya Avenue. This was because many foreign embassies located in Minato-ku in the Meiji Era and lifestyles became increasingly westernized, so the demand for western furniture rose and lasted for three generations. However, many furniture stores were forced to close during the post-war high economic growth period when the local rents increased dramatically. Today, there are not even any furniture stores in the area.

The local industry of Shimbashi has shifted from furniture making to the information industry. Shimbashi is a downtown area where people rarely establish roots because of the rapid changes that have occurred there since the postwar high economic growth period.

Problems in this area were identified by analyzing the population dynamics, the night to day population ratio, the present situation of office space and the local city plans. The following is a list of some of the problems that this district is currently facing

A. The population of Minato-ku has been increasing, but the population of the Shimbashi district continues to decrease.

B. The young generation continues to move out and the population is aging.

C. The hollowing out of the district is indicated by the unbalance between the day and night time populations and the empty office spaces.

D. There is a lack of central space and organization which can become the focus of the town.

E. The rapid changes in the industrial structure have made it difficult for new businesses to take root.

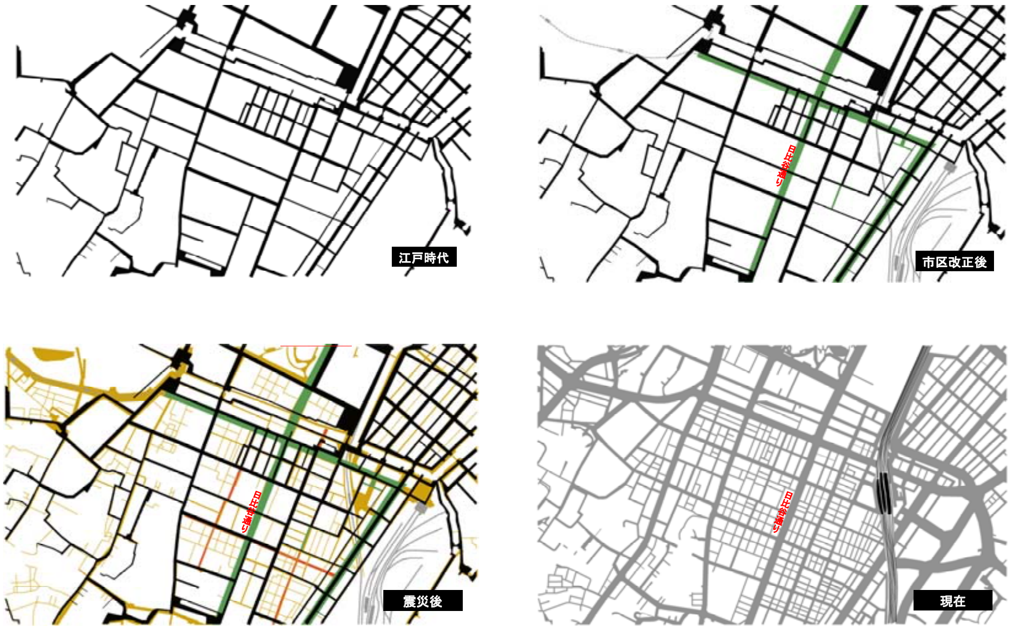

Fig. 2 The historical transformation of the subdivision of the blocks in Shimbashi
Upper left: Edo era, Upper right: around 1912
Lower left: after the Kanto Earthquake in 1923, Lower right: Present

3.2 Investigation of the buildings and open spaces existing in the area

The locations and characteristics of the buildings which are suitable for reuse and conversion in the future were investigated by surveying account books and conducting fieldwork (Fig.3). A database was compiled of the field work, which included studies about open spaces such as roads, public spaces and green tracts of land

3.3 Examination of the development possibility of the area

In the Shimbashi - Toranomon district which is located next to the Kasumigaseki and Shiodome central business districts, rapid development is expected in the near future after the completion of a new city planning road. The possibility was investigated of developing office and residential space

Fig. 3 Location of the vacant offices

in this district. Based on interviews with local residents, the author proposed that this area could become more attractive through mixed use development including housing. Facilities which could enhance the attractiveness of the area include the following:

A. A nursing facility and a day center for the elderly which are necessary for a district like Shimbashi where the population is aging.

B. Dormitories for the medical and social welfare students of Jikei University.

C. A library which is open throughout the week.

D. An information and event space where people can gather freely.

E. An NPO center where any group moving into the Shimbashi area can start up their offices easily.

F. Work spaces that businessmen or software creators can use while they are working in Shimbashi..

G. A hotel or condominium that can provide long-term accommodation for visitors.

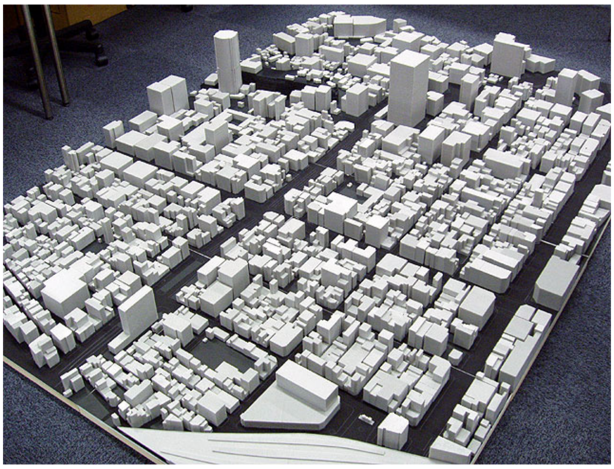

Fig. 4 Model of the present area

4. An urban environment to aim for

The author made a detailed model of the district level (Fig.4) and three-dimensional CG to study the city space. As a result of the study, it was determined that the 600% floor area ratio established in the current regulations would be high enough even after MacArthur Road is completed. The road will become the main axis of the district of Shimbashi and most of the existing buildings along the road are expected to be rebuilt in the near future. Therefore, it is necessary to establish city planning regulations as soon as possible to prevent the construction of unharmonious buildings following the completion of MacArthur Road.

Special attention was paid to vacant lands, parking lots which can be changed into public spaces and green tracts of land. The author envisions continuous green spaces which will become attractive pedestrian walkways that will make it enjoyable for people to walk in the inner part of the district. Figure 5 shows a situation in which an alley and vacant land that is not used can become a community garden. The author also proposes attracting pedestrians into the vacant areas of Shimbashi by linking open and green spaces into a contiguous network.

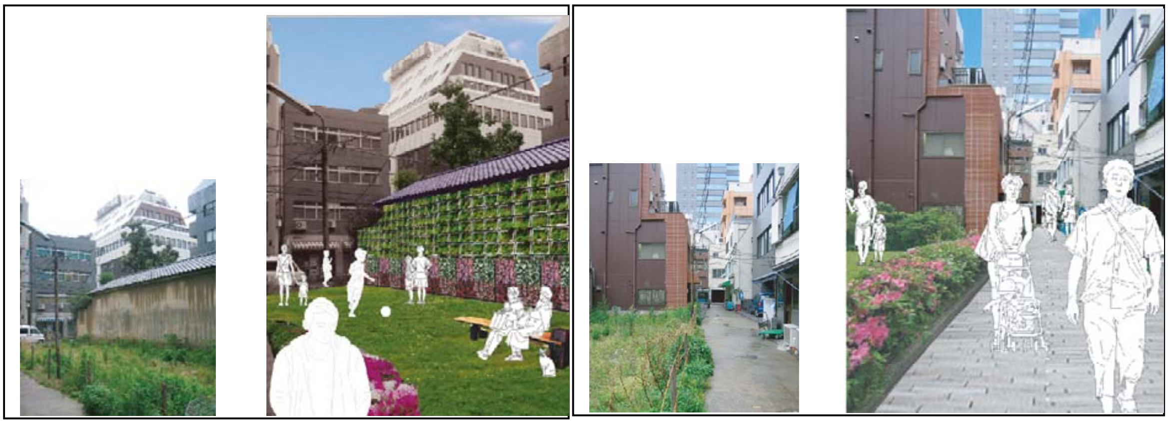

Fig. 5 Network of open and green spaces made from the unused urban spaces

5. Proposal for the design guidelines

The author made a draft for the city planning guidelines to create the desired urban space. The rules that should be set for the city planning guidelines are as follows:

1) Rules for buildings

A. Rules for external wall easements

Along MacArthur Road: Walls may be no more than 6.0m high and must be set at least 1.0m away from the roadside, or at least 3.0m away when the ground level is used as a pedestrian arcade.

B. Maximum building height: The maximum height of buildings should be no more than 30m to maintain harmony with existing neighboring buildings.

C. Building use: Commercial uses are recommended for the lower floors of buildings facing MacArthur Road and offices and/or residential uses for the middle and upper floors.

D. Position of doorways of buildings: The doorways of houses should be located away from the main street to secure privacy and security.

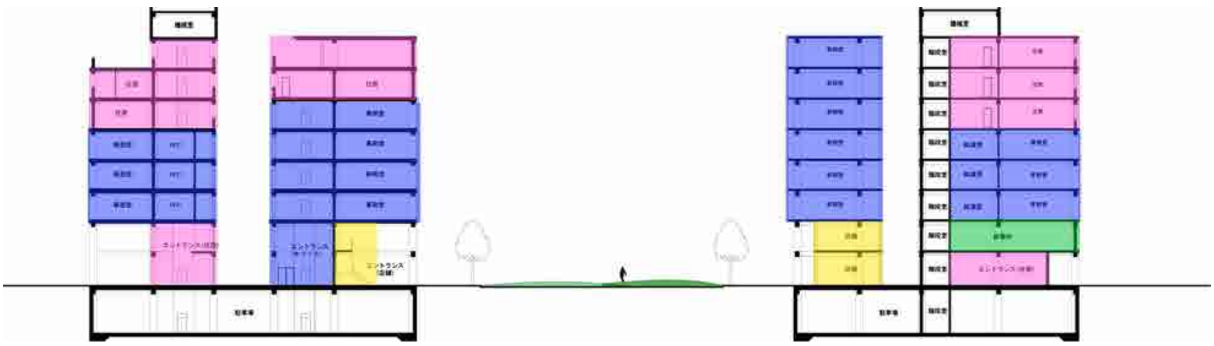

Fig. 6 Commercial use（Yellow）for the lower floors and office (Blue) and/or residential use (Red) for the middle and upper floors

2) Rules for the street space

A. Create an active margin: The spaces of the lower part of buildings along the pedestrian walkway will be used for creating turnout. Ex. Open air cafés.

B. Create a vibrant atmosphere for the pedestrian walkway

C. Plants and street furniture: Arrange continuous plants within 5m from the roadside at each site. Install street furniture along the street.

3）Other Rules

A. Underground parking network: Connect the underground parking areas in this area in order to facilitate the auto traffic on the ground level and control on-street parking.

B. Restrictions on signboards: Neither roof signboards nor overhanging signboards should be installed along MacArthur Road.

C. Walls, fences, gates and signboards which may obstruct traffic and block out the cityscape should be restricted.

6. Conclusions

The author studied the geographical and historical characteristics of the areas, using old maps and aerial photographs, and analyzed the historical development process, the changes in the industrial structure and the demographics of the area. The author also investigated the present situation of building stocks through account books and fieldwork and made a database which suggests buildings that may be suitable for reuse and conversion.

The Shimbashi - Toranomon district, which is located between the Kasumigaseki governmental district and the Shiodome business district in Tokyo, is expected to become a new business and residential zone after the completion of a new city planning road. The author analyzed the potential of areas for future business and residential functions and made three-dimensional perspective views and models of the blocks to study various alternatives for future city spaces. Design guidelines for the area were drafted and their effectiveness was tested by using them in a schematic design.

This study has revealed that it is very important to pay attention to the existing resources in the area, some of which are not fully used currently but have high potential. The author proposes that vacant spaces and parking lots in the area be converted into continuous green spaces which will encourage people to walk into the inner part of the district where many vacant office spaces currently exist. If more people visit, new shops and new offices will open accordingly. It is also important to establish city planning regulations and design guidelines as soon as possible, especially for the area along "Ring Route 2" (MacArthur Road), because new redevelopments are expected to follow immediately after the construction of the road. It is hoped that the results of this study will be utilized in local city planning and district design guidelines in the near future.

7. Acknowledgements

The author would like to thank my students, especially Ms. Nishii, Mr. Fukuda and Ms. Ohi who assisted with this study and made the drawings for this paper.

8. References

The Architectural Institute of Japan, 2006-2007. *The development and control of city architecture* Vol.1-3. Tokyo: The Architectural Institute of Japan.

City Planning Area Reorganization and New Framework of Land Use Control due to Merger of Municipalities

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KEYWORDS: Merger of Municipalities, City Planning Area Reorganization, Differences of Land Use Control

ABSTRACT

It is important to restrict an unnecessary expansion of the urban area to urge effective use of an architectural stock since we are facing the phase of depopulation today. The merger of municipalities brought many of the unions to have more than one city planning area inside, and City Planning Area (hereafter CPA) is being reviewed in each prefecture.

Then, this study aims to show the status of examining CPA reorganization and the idea of the framework for land use control in each prefecture through the questionnaire survey to the prefectures. The method of introducing Area Division into Non-Area Divided CPA and its problems are also viewed in this study.

Consequently the followings are found, many prefectures recognize the problems in designation form of present CPA; additionally, many prefectures consider that the differences of land use control between Urbanization Control Area (hereafter UCA) and the surrounding area are the issues; to overcome these problems, each prefecture is devising not only the unification of Area Divided and Non-Area Divided CPAs, but also the methods, such as, the deregulation by Ordinance 3483 in UCA, the designation of Specific Usage Limitation Area in Non-Area Divided CPA, and so on.

1. Introduction

An appropriate urban area is to be discussed when we examine effective use of architectural stock. In Japan, the urban area has been extended along with a continuous population growth since World War II. The population is starting to decrease today, and then it is important to restrict an unnecessary expansion of urban area to urge effective use of architectural stock. In Japanese city planning system, the urban area is considered to be an Urbanization Promotion Area (hereafter UPA) in the Area Divided CPA. And, the urban area in Non-Area Divided CPA is a zoning area. However, even if the UPA is strictly set, the urban area can sprawl out to the area loosely regulated and adjacent to urban area, such as, the Non-Area Divided CPA or the outside of CPA. Such problems of the development caused by the differences of the regulation are demonstrated in the former studies. The merger of municipalities called "Large merger at the Heisei Era", in the meantime, has been urged on a nationwide in Japan. And it brought many municipalities more than one CPA inside. Therefore, CPA is being reviewed in each prefecture. This review aims at adjusting the difference between the administration area of municipality and CPA, and the review is expected to urge the expansion of CPA and the adjustment of Area Divided CPA and Non-Area Divided one.

Then, in this study the questionnaire survey to the prefectures which are the decision makers of designation for CPA and Area Division is conducted. In the questionnaire, the questions about the following items are asked; 1) issues of the present CPA zone and its countermeasures; 2) status of examining present CPA reorganization; 3) issues on land use depending on presence of Area Division; 4) idea of Specific Usage Limitation Area (hereafter SULA) and Semi-CPA as land use control method for the Non-Area Divided CPA or the outside of CPA. This study aims to show the status of examining CPA reorganization and the idea of the framework for land use control in each prefecture. Moreover, the method of introducing Area Division into Non-Area Divided CPA and its problems are viewed in the cases of Shizuoka City and Hamamatsu City which integrated the Area Divided CPA and Non-Area Divided ones.

2. Reorganization of CPA by merger of municipalities

2.1 Recognition to CPAs zone

There are 39 prefectures recognizing that they need to cope with the situation to have more than one CPA in a municipality (Fig.1). Additionally, 13 prefectures recognize that it is necessary to review CPA zone from wider regional aspect, regardless of the range of local authorities. According to the answers, we found that local prefectures have more awareness of issues of present CPA expansion than the metropolitan regions. As a problem with this current state, many prefectures point out that the numerous regulations coexist in a municipality and the residents feel unfair towards the differences of city planning tax (Table.1). In addition, some prefectures consider it to be a problem that the wave of the developments is transferred to the loosely regulated area from UCA, though their point of view is minor.

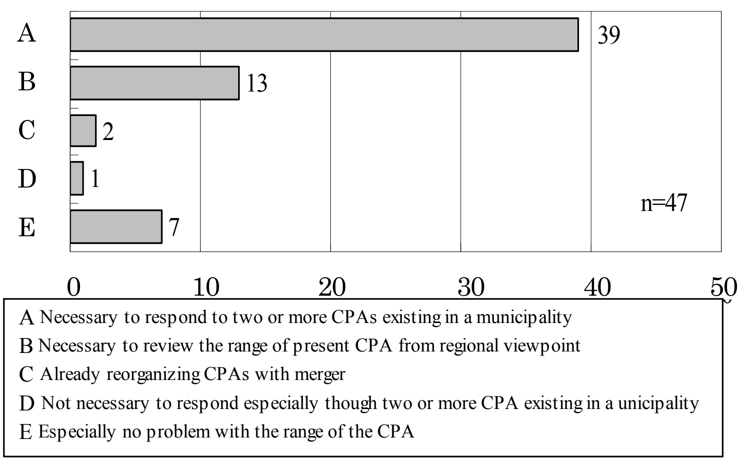

Fig.1 Recognition to the Range in CPA

2.2 Countermeasures to the problem of CPAs

Based on the above-mentioned problems, the prefectures are asked to list all imaginable counter measures to the problems (Table. 2). It is natural that many prefectures should point out the reorganization and the integration of the CPAs as countermeasures. There are 12 prefectures considering

Table 1 Problem on the Range of CPA

item	Number
Existence of different land use control or building form control by coexistence of more than one CPA in a municipality	20
Resident's unfair feeling by presence of city planning tax or difference of regulation	12
Inconformity between the jurisdiction area and the range of CPA of merged municipality	9
Obstacle to united, comprehensive city planning administration of merged municipality	5
Progress of development to the loose regulated area of Non-Area Divided CPA or the area outside of CPA	5
Existence of two or more master plans in the merged municipality	2

newly designating the outside area as CPA. And, 4 prefectures newly consider the introduction of Area Divided CPA; 5 prefectures aim at applying the institution such as Specific Usage Limitation Area for Non-Area Divided CPA; some prefectures point out the designation of Semi-CPA.

Table 2 Countermeasures to the Problem of CPA

item	Number
Reorganization and/or integration of CPAs	23
New designation and/or expansion of CPA	12
Introduction of Area Division CPA	4
Using institution in UCA - District Plan, Ordinance 3483 and so on	1
Using institution in the loose area of Non-Area Divided CPA - Specific Usage Limitation Area, District Plan and so on	5
Designation of Semi-City Planning Area	3
Reexamination of master plan and/or policy to land use	2
Under discussion	2
Others	4

2.3 Status of examining CPA reorganization

The followings show status of examining CPA reorganization in each prefecture in the present stage (Fig.2). Saitama, Shizuoka and Kagawa Prefectures answered that CPAs in their prefectures have already been reorganized. Among them, the status of Shizuoka Prefecture will be stated in the next chapter. And, 4 prefectures have already presented the policy of reorganization, and 10 prefectures have constituted the advisory committees for discussion. These prefectures are advancing the movement of CPA reorganization. Some have not started a concrete examination yet, though they recognize the necessity of CPA reorganization, since the city planning policy of municipality after merger has not yet been made or that the basic survey of city planning should be done first.

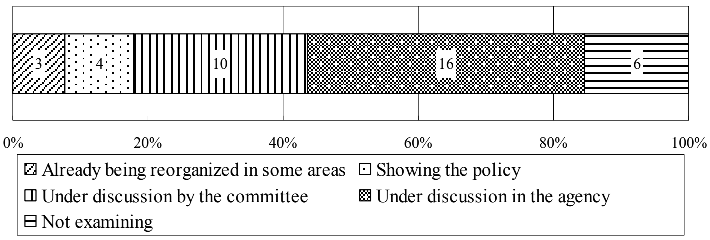

Fig.2 Examination Situation of CPA Reorganization

3. Cases of integrating Area Divided CPA and Non-Area Divided one

We choose Shizuoka City and Hamamatsu City in Shizuoka Prefecture as CPA reorganization cases. Both cities came to have to designate Area Division in the whole CPA, because Sizuoka City became the government ordinance designated city in April 2005, and Hamamatsu City in April 2007. The case of both cities will be a finding when a prefecture will start to integrate the city planning areas by the Area Division.

3.1 Shizuoka City

Shizuoka City has already been a government ordinance city when it merged with Kambara Town. Therefore, Shizuoka City had to designate Area Division in the part of former Kambara Town, in mergering on March 31, 2006.

In Shizuoka City, originally the UPA has comparatively been populated, and Ordinance 3483 is not applied to the UCA. In former Kambara Town, there has been densely inhabited district (DID). Though a zoning area has not bee designated, the UPA was newly set in the area. The population of former Kambara Town has also compactly increased, and the population dependence on the UPA is 98% against the population in the CPA. We think that Area Division was

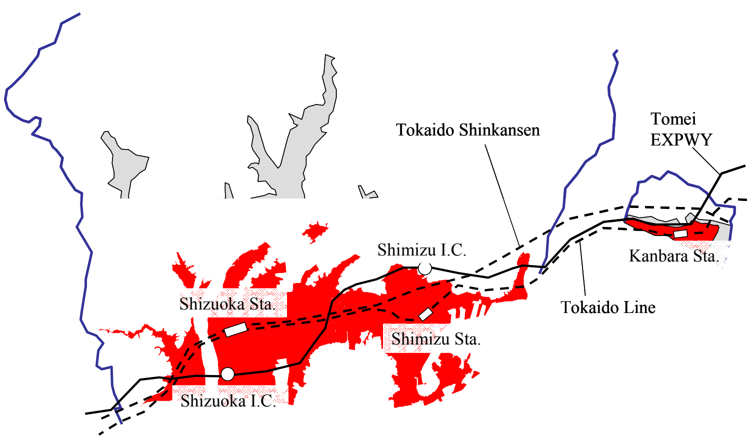

Fig.3 Shizuoka City Planning Area

newly to be applied to Shizuoka City because it succeeded in designating the UPA of accommodating the majority of the population. However, it seems difficult for many local cities to designate the UPA of accommodating the majority of the population like Shizuoka City, considering the requirements of population density and accumulation.

3.2 Hamamatsu City

Hamamatsu City merged with 12 local authorities in July, 2005 to become the government ordinance city. There are 4 CPAs in Hamamatsu City: Seien Regional and Okuhamana Regional CPAs are the Area Divided CPAs; Tenryu and Mikkabi CPAs are the Non-Area Divided ones. 4 CPAs are integrated into Hamamatsu CPA and the Area Division is applied to the whole area, at the same time, Hamamatsu City becomes the government ordinance city on April 1, 2007. In the Non-Area Divided CPAs at Tenryu and Mikkabi, the existing zoning areas become the UPAs, and Ordinance 3483 and Ordinance 3484 operated in Hamamatsu City will be applied to other UCAs. However, Hamamatsu City limits the designated area by an original city planning ordinance as the requirement for the area designation of Ordinance 3483 and there is also the requirement for the continuity in the ordinance. We will watch whether Ordinance 3483 will become the deregulation measure for the UCA where the Area Division is newly applied.

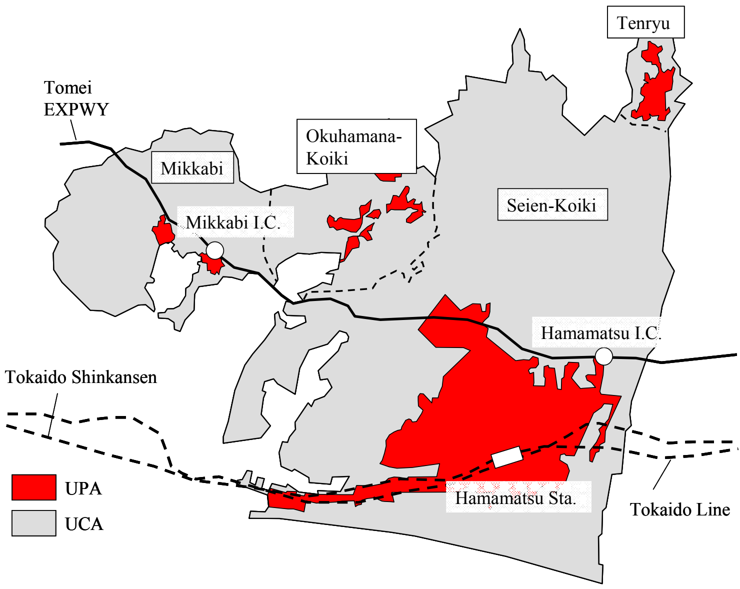

Fig.4 Hamamatsu City Planning Area

4. Problem due to disunion of land use control and its countermeasures

4.1 Recognition concerning the difference between UCA and surrounding area

Here, we will show how each prefecture considers the problem caused by the limited designation of Area Divided CPA. Categorizing the problems listed by 32 prefectures, we found that the majorities pointed out the progress of sprawl development in the outside of CPA and the non-Area Divided CPA as a problem (Table.3). About the countermeasure, for instance, Yamanashi Prefecture, which answered "The population flows out to non-Area Divided CPA beyond the UCA." as a problem, attempts to solve the problem mainly by the deregulation in the Area Divided CPA through the expansion of the UPA and the Ordinance 3483. On the other hand, Ehime Prefecture, which has both the Area Divided and Non-Area Divided CPAs in Imabari City, is examining the integration of them as the Area Divided CPA after the deregulation of the UCA by Ordinance 3483 to release resident's feeling of unfairness. Similarly, Ibaraki Prefecture, which pointed out resident's dissatisfaction at the boundary of Area Division and Non-Area Division CPAs as a problem,

Table 3 Problem due to Difference of Regulation

item	Number
Progress of sprawl to the outside of CPA	14
Progress of sprawl to Non-Area Divided CPA	12
Unfair feeling by the difference of regulation for the development and building	4
Difficulty of unifying the land use when the Area Divided CPAs are adjacent to Non-Area Divided CPAs	3
Complication of the building confirmation administration by adjacent of UPA and the area outside of CPA	1
Insufficient infrastructure improvement by small-scale development at the area outside of CPA	1

thinks that they should correct the difference of land use control by designating the SULA in the loosely regulated area of Non-Area Divided CPA, and by designating district plans and so on in the UCA. Thus, as for the land use control of the Area Divided CPA and the surrounding area, it is necessary not only simply to unify the presence of Area Division but also to apply the institution according to the situation in the area. However, it is necessary to verify the validity and effect of the application firmly.

4.2 Idea to Specific Usage Limitation Area

Twelve cities and towns in 5 prefectures designate the SULA at the time of the questionnaire. Among these, 3 cities and 3 towns of Kagawa Prefecture, 2 cities of Ehime Prefecture and a city of Kumamoto Prefecture use SULA as the alternative measures of the land use control of the former UPA due to the Area Division abolition. Besides, Ube City in Yamaguchi Prefecture designates the area to restrict the location of a large-scale store of 1500 m^2 or more. Minokamo City and Tomika Town in Gifu Prefecture designate the area to maintain the living environment around highway IC. More than half of the opinions are affirmative; the institution is effective as means to settle disunion of regulation; it should be described in the CPA master plan and it should be supported by proper information so that the local authorities positively use it (Table 4). On the other hand, there are opinions that the institution can not settle the disunion of the regulation. Especially, there are opinions that to settle the disunion of the regulation, the SULA decided by local authorities is unsuitable, while the whole prefecture approach is necessary.

At present, the SULA has not been positively used except for its use as the alternative solution of the Area Division. However, we clarify the fact that the prefectures recognize its effectiveness to some extent. In the future, a positive role of the prefecture including the whole prefecture approach is expected so that the local authorities may effectively use it.

4.3 Idea to Semi-City Planning Area

At the time of the questionnaire, there are only 4 cases with the designation of Semi-CPA; they are Aomori City in Aomori Prefecture, Maebashi City in Gunma Prefecture, Makinohara City in Shizuoka Prefecture, and Gyokuto Town in Kumamoto Prefecture. By the City Planning Act Amendment in 2006, the decision makers changed from the local authorities to the prefectures, and the area can be widely designated including the Area of the Land for Agricultural Use. Then, it is expected to apply to the institution. As an idea of each prefecture to Semi-CPA, 13 prefectures show the policy of positive use. 12 prefectures are under discussion. A concrete use method of the institution is being examined after amendment of the Act (Table 5). Semi-CPA will be generally applied as a preventive measure to the area where the development pressure will be expected. However, Fukuoka Prefecture plans to designate Semi-CPAs to all the area outside of CPA except the solitary islands and the conservation forests. On the other hand, there are many negative opinions to the designation, such as, "Judging carefully" and "Not examining it". The followings are shown as the reasons; the group regulation of the Building Standards Act is applied; there is no merit of the designation because the district plan cannot be used and the city planning project is not enforceable. Moreover, there are opinions that it is more effective to designate Non-Area Divided CPA than to designate Semi-CPA. A further argument of the

Table 4 Idea to Specific Usage Limitation Area

item	Number
Effective as the means to cancel the discontinuity of the regulation	17
Support the positive use of municipality	10
Esteeming the judgment of municipality	8
Not considering as a means to cancel the discontinuity of the regulation	5
No opinions	2
No Non-Area Divided CPA or Answer refusal	5

Table 5 Idea to Semi-City Planning Area

item	Number
Using positively as land use control for the area outside of CPA	13
Under discussion / Scheduled to examine	12
Examining it in consideration of the opinion of related local authorities	3
Judging carefully because there is a demerit in the designation	8
Not Considering the designation	11

possibility of use of Semi-CPA is necessary as the increase of the designation cases expected in the future.

5. Conclusion

Consequently, it was shown that many prefectures recognize that issues lie in a designation form of a present CPA, and that they examine CPA reorganization based on the recognition. Additionally, many prefectures consider that the differences of land use control between UCA, where regulation is strict, and the surrounding area, where regulation is easy, are problems. We found that as measures to correct the differences, each prefecture is devising not only the integration of Area Divided and Non-Area Divided CPA but also the methods, such as, the deregulation by use of 3483 Ordinances in UCA, the designation of Specific Usage Limitation Area in non-zoning area of Non-Area Divided CPA, and the regulation strengthened by expansion of CPA outside CPA and the designation of Semi-CPA.

Moreover, we clarify the followings from the cases of CPA reorganization that introduced the Area Division system into Non-Area Divided CPA; due to dense habitants UPA was comparatively easy to set in Shizuoka City; similarly, in Hamamatsu City, due to the application of Ordinance 3483, deregulation is possible even in the area becoming UCA by Area Division. However, when such a method is applied to a similar case, we point out the followings; new UPA seems to be difficult to set; Ordinance 3483 can not restrict the urban area depending on the way of application.

Reference

M.Kohno, T.Matsukawa and B.Nakade. 2002. Study on Land Use Control and Development Trend in Fringe Area of Area Designated City Planning Area *Journal of City Planning Institute of Japan* No37:691-702

T.Akashi. 2005. A Study about Unconformity Between the Development Project and the Administration Body on Land Use Control System in View of regional Scale – By Analysis of the Regional Shopping Center Development Project in the Suburbs of Local Cities - *Journal of City Planning Institute of Japan* No40-3:421-426

Y.Iwamoto, T.Matsukawa and B.Nakade. 2006. Study on the Problem and Ideal Way for Achievement of United Land Use Control in City Region – Through the Development Condition in the Matsumoto City Region and the Approach of Each Local Authority – *Journal of City Planning Institute of Japan* No41-3:595-600

Proposal for the Urban Restructuring Method from a Perspective on Child-Care Support - Case Study: Tama New Town, Tokyo -

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Keywords: child-care, urban restructuring, working guardian, nursery services

Abstract

The purpose of this study is to examine a child-care supportive environment for working guardian from the unified improvement of urban structure, working style and nursery for children.

One of the reasons for the rapidly declining birthrate in Japan during recent years is the hardship of child-care faced by working guardian. This hardship is caused by the following various factors combined or alone; an urban structure such as distance structure between the workplace and home which concerns commuting time, types of occupation and working hours, a level of freedom within the working environment, a quality of nursery services and their distribution situation, and a level of support from family members. In European nations, especially in the Scandinavian countries, they have brought a child-care support into effect in their society. On the other hand, as it is prominent in the birthrate, Japan is not providing an adequate supportive environment for working guardian to raise children.

Therefore, this study takes the differences that may be caused by the types of occupation, generation, community circumstances into consideration, and examines the current urban structure and the employment situation in the context of child-care environment for working guardian. By defining the specific causes of difficulties in child-care faced by working guardian, this study aims to obtain further insights for creating a supportive child-care environment.

1. Introduction

1.1 Background

One of the reasons for the rapidly declining birthrate in Japan during recent years is the hardship of child-care faced by working guardian. This hardship is caused by the following various factors combined or alone; an urban structure such as work place-home distance which is related to commuting time, occupation, working hours, working condition including the flexibility in working hours and time, level of nursery services as well as their placement situation and availability of family members' support.

In Japan, through the old and new Angel Plan established in 1994 and 1999, the policies to improve the various nursery services including the child-care leave benefit, placement of nursery service inside companies and enlarged number of nursery services have been introduced. However, since this "policy with the lead on fulfilling nursery services" was not effective enough to prevent the declining birthrate, the Shiomi*1 and Komiyama*2, pointed out the relationship between the urban structure, working patterns and birthrate and suggested the significance of environmental arrangement which includes the improvement on working style, Miyazawa*3, pointed out that the working style or work place are limited by the area of residence through analysis on time distance between home, office, and nursery service. Ono & Ohmura*4*5, analyze and point out the significance of working hours for wives in determining the household's location of residence. Their study also suggests that the maintenance condition of nursery services is related to restraining wives from giving a birth or keeping their jobs. As pointed out by the existing studies above, there is a connection between work pattern and urban structure, as well as the decline in birthrate and working style. In European nations such as Scandinavian countries, the social support such as child-care leave and child-care expense support in addition to the child-care support service including the maintenance on nurseries and babysitters is taking its action in the society. Such a child-care supportive environment which takes working patterns, urban structure and the child-care service entirely into consideration is desirable for the future of Japan.

1.2 Purpose

This research examines the current urban structure and working situation as a child-care environment for working guardian by paying attention to the differences caused by occupations, generations and characteristics of area. The purpose of this paper is to gain an insight on an ideal child-care supportive environment and policies by proving the detailed causes of difficulties in child-care.

This paper takes Tama New Town region as a case model. By analyzing the relationship between operation hours of nursery [1)], the commuting time between work place and nursery (home) and possible working hours, the ways to support working guardian with their child-care are examined. The final purpose of this paper

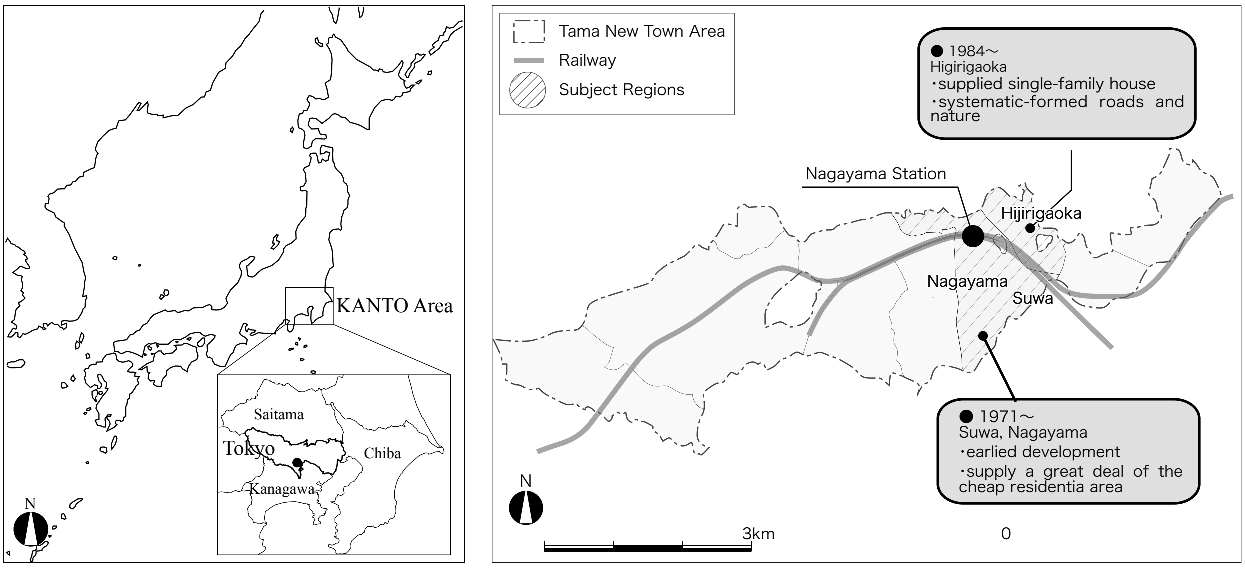


Figure 1 Subject Regions

is to gain an insight on urban restructuring method which can improve the potential of existing society by analyzing the urban structure from a viewpoint on child-care.

2. Subject Regions

The subject region of this paper is Tama City, Tokyo (Fig.1).

Within Tama City, there is the oldest area of Tama New Town region which were completed in the very beginning of the development when the massive residential complex supply took place in Japan during 1960' s. Due to the drastic change in population, in declining birthrate/aging society and in life style in recent years, the consolidation of public facility stock which were once provided massively and providing support for elderly have been notable issues, therefore the urban space in Tama City is facing a turning point for restructuring. This paper focuses on and analyze Suwa/Nagayama district in Tama City shown in Figure 1.

3. The Research Method

3.1 The Commuting Time: Nursery Office

First of all, the commuting time to work place is examined for analysis. Considering the circumstance of working guardian in child-care, it is more important to pay attention to the location of nursery and work place (transportation time), the operation hours of nursery, the starting/finishing time of work and working hours than the distance between home and nursery in determining the possibilities of keeping the current working patterns (working hours, work place). Therefore, a traffic line of dropping a child off at the nursery on the way to work and picking a child up during the operation hours at the nursery on the way back from work is taken into account while mainly focusing on the travel time from the nursery to work [2). The analysis method is as following.

(1) Based on the data from PT(Person Trip Survey) [3) conducted in 1998, the location of office and way of commuting for workers in the subject regions is obtained.

(2) The travel time to work place by major way of commuting is obtained.

(3) The travel time between nursery and station using GIS(Geographic Information System) is examined.

(4) By summarizing each obtained time above, the travel time between nursery and work place is calculated.

3.2 The Working Pattern of Parents in Child-Care

Second, (5) the operation hours of nursery obtained from the survey, (6) the working hours which are classified into several stages in accordance with full-time employee, part-time employee and other types of employment. (7) the total time (round-trip travel time) of nursery work place nursery is calculated. Assuming that only one of the parents is in charge of drop-off/pick-up, (6) working hours and (7) round-trip travel time need to be included in (5) the operation hours of nursery. Through these factors, the relationship between commuting time(nursery work place) and working hours can be calculated when setting the subject regions as the base for child-care [4).

4. The Result of Analysis

Based on the analysis method, the analysis results are indicated in the following procedure.

4.1 The Adequacy in Number of the PT Sample

First, the adequacy in the number of PT used for this paper is examined. The population and number of PT sample for Tama City at the time of survey is shown in Table 1. In Japan, the established productive age in general is from 15-years old through 65-years old. In contrast with this established population of 109,233 people, the number of PT sample is 53,266 people in Tama City and 14,695 people in the subject regions. This number of sample is valid enough from the statistics perspective.

composition of population at Tama city(2000)				Number of samples of PT Survey		
total	age:0〜14	age:15〜64	age: 65〜	total number of commuting trips	total number of trips at subject regions	total number of commuting trips by train
143,314	20,965	109,233	13,116	53,266	14,695	29,695

Table 1 Compositon of Population at Tama City and Number of commuting trips in the subject regions

4.2 The Commuting Style of Workers in the Subject regions

Based on the results obtained from PT, the number of commuting trips in the subject regions is depicted by each time zone (Fig. 2). Also, in order to understand the means of transportation used for commuting, the Figure 2 shows the number of trips obtained as following; the total number of trips by each transportation for different time zones is multiplied by the number of commuting trip ratio which is the number of commuting trips in Figure 2 divided by the total number of trips.

The number of trips for commuting to work is concentrated between 5am to 10am. In addition, the most frequent number of trips for commuting to work is in order of train, cars and on foot. This paper precedes the analysis based on the above data; the most frequent commuting time zone is between 5am to 10am and the major means of transportation is train.

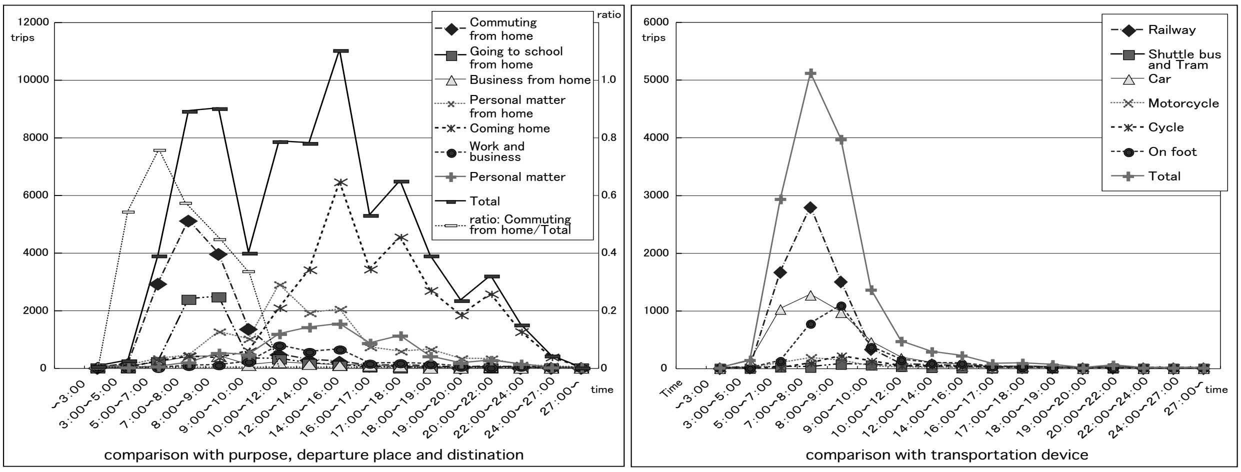


Figure 2 Variation with Periods of Time of Number of Trips

4.3 The Work Location and Commuting Hours of Workers in the Subject regions

The Figure 3 shows the total result of commuting destination from the subject regions. The Figure shows the commuting destination of trip between 5-7am, 7-8am, 8-9am and 9-10am. The time is the departure time from subject regions. Also, the Table 2 shows the top 10 municipals with the highest number of commuting trips in each time period. The figures indicated in parenthesis are number of trips.

There was no major difference between work locations during commuting hours. It is evident that the departure time of worker is not affected by the location of their work place. In Japan, considering the encouragement on staggered commuting hours and flextime to reduce the rush hour congestion in recent years, it is assumed that choice of commuting time is largely affected by the starting time of working.

4.4 Commuting Time by Train and Work Location

In Figure 4, the required commuting time from Nagayama Station, Keio/Odakyu line, which is the only railway station in the subject regions, to work place (closest station) by train among the PT in the subject

rank order	1	2	3	4	5	6	7	8	9	10
5-7am	Setagaya(273)	Minato(269)	Shibuya(169)	Chofu(119)	Chuo(98)	Hachioji(79)	Ota(76)	Sagamihara(66)	Shinjuku(65)	Fuchu(64)
7-8am	Chiyoda(571)	Shinjuku(565)	Shibuya(293)	Fuchu(266)	Chuo(227)	Setagaya(167)	Bunkyo(162)	Hachioji(154)	Chofu(120)	Tachikawa(112)
8-9am	Shibuya(445)	Minato(362)	Chofu(305)	Chiyoda(227)	Shinjuku(198)	Fuchu(132)	Suginami(126)	Hachioji(106)	Tama(73)	Machida(61)
9-10am	Chofu(83)	Chiyoda(78)	Setagaya(65)	Shinjuku(64)	Asao(51)	Oume(49)	Minato(34)	Koto(28)	Tama(22)	Hachioji(21)

Table 2 The Top 10 Municipals with the Highest Number of Commuting Trips in Each Time Period

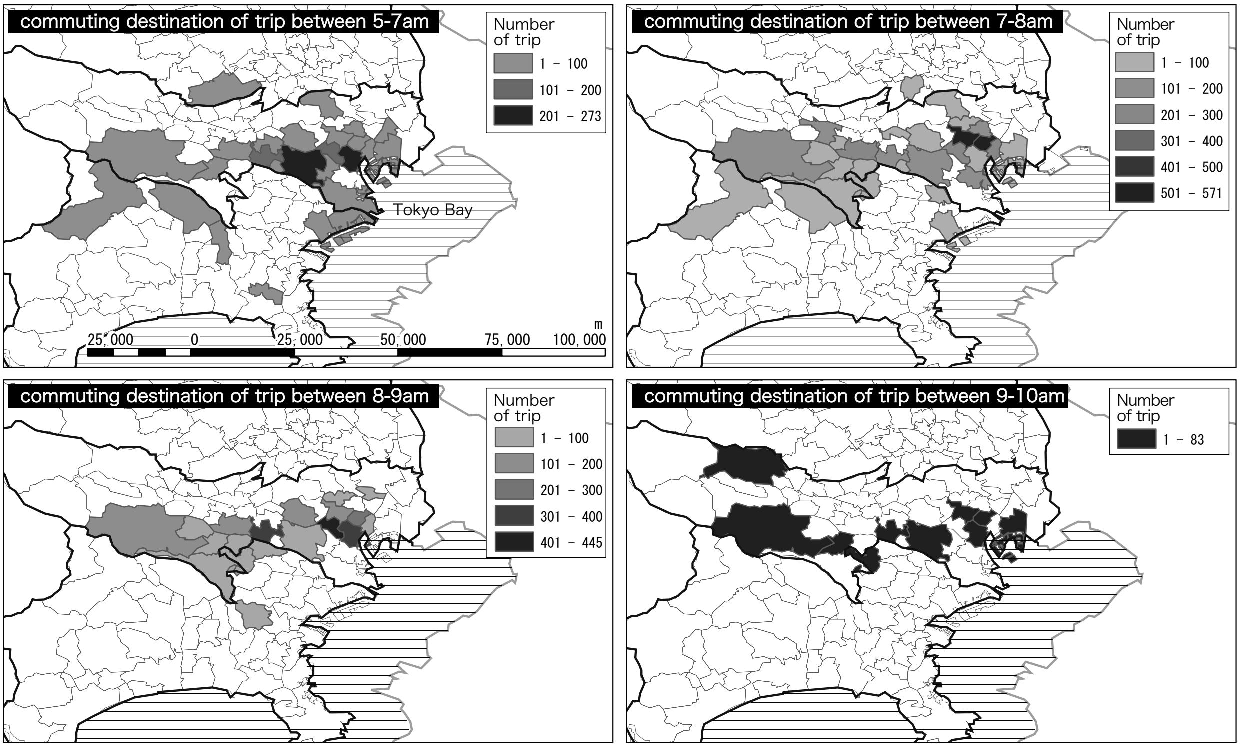


Figure 3 Variation with Periods of Time of Commuting Destination from the Subject Regions

rank order	1	2	3	4	5	6	7	8	9	10
Commuting Destination (number of trip)	Shibuya (992)	Shinjuku (939)	Chiyoda (925)	Minato (780)	Chofu (686)	Setagaya (556)	Fichu (497)	Chuo (361)	Hachioji (323)	Bunkyo (216)
Required Time by Train	60min	60min	75min	75min	30min	45min	30min	75min	45min	75min

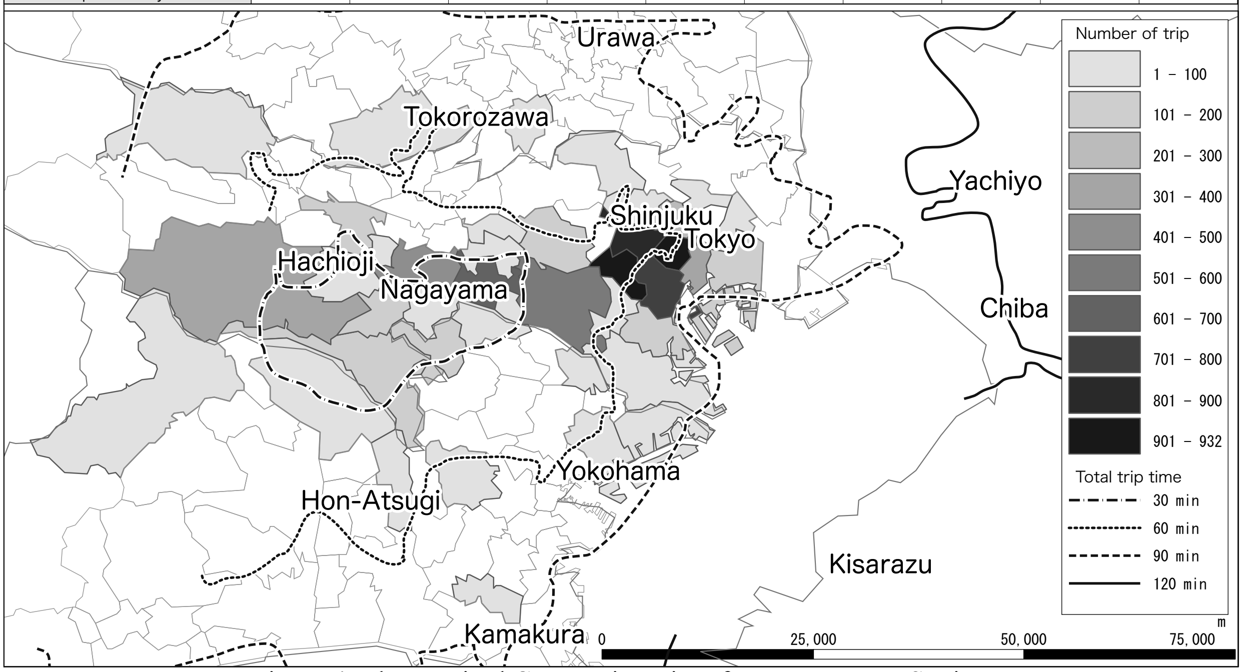


Figure 4 The required Commuting Time from Nagayama Station and Total Commuting Trips from Subject Regions by Train

regions is shown. For calculating the time required, the Time Schedule Survey which gives the information on arrival/departure tracks in stations for looking up the transferring train was used. In addition, the number of train during commuting hours was taken into consideration, thus the departure time from Nagayama. The work locations in 23 wards of Tokyo are about within 75 minutes range by train from Nagayama station. The major business district such as Chofu City and Fuchu City are about within 30 minutes range by train. The work locations of all residents in the subject regions are within 90 minutes range from Nagayama Station.

5 Using Nursery Service and Working Hours

5.1 The Travel Time Between Nursery/Station and Operating Hours

Next, the travel distance and time required between nursery and station is calculated from the actual location of nurseries in the subject regions. Table 3 shows the travel distance and time from the nurseries to the station. As it is evitable in the travel time from the nurseries to the station, the nurseries are classified into 2 types by their distance from the station; the ones within 10 minutes distance from the station and the ones within 20 minutes from the station. The nurseries that are further away from the station have a better access to public transportation such as buses. Therefore, the travel time from the nursery to the base train station (Nagayama Station) is about 15 minutes and added to the travel time from Nagayama Statio to work place. Also, the current operation hours of nursery service is about 10 to 13 hours which is adapted in the next chapter.

name of nursery	Ka	Kog	Kob	Sa	Na	Ha	Yu
travel distance to station	198m	537m	1583m	607m	100m	642m	1155m
required time to station from nursery on foot (min)	2	7	20	8	1	8	14
open time of nursery	7:00～19:00	7:00～19:00	7:00～19:00	8:00～18:00	7:15～20:15	7:30～19:00	7:00～19:00

Table 3 The Travel Distance and Required Time from the Nurseries to the Station.

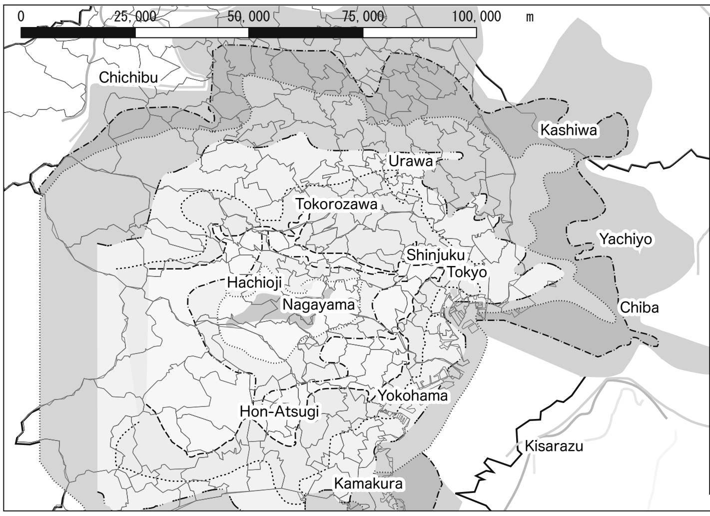
5.2 The Relationship between Commuting Time and Possible Working Hours

As mentioned above, the traveling condition from subject regions to work place, the location of nursery within the subject regions as well as their operation hours is obtained. Based on these facts, the working pattern using the nursery service is examined. Figure 5 shows the collected data of the nursery service operation hours, commuting time and possible working hours.

According to 4.4, most work locations of residents in the subject regions are within Tokyo 23 ward, thus this area applies to within 75 minutes range of time required by train. The possible working hours in this area is less than 7 hours when the operation hours of nursery is 10 hours, and less than 9 hours when the operation hours of nursery service is 12 hours. The legally regulated maximum working hours are 40-hour week which is an average of 8-hour day. According to the Statistics Department of Management and Coordination Agency, the regular employees [5)] work average of 7.6-hour day. However, in reality, it has already become normal for full-time employees to excess the legally regulated maximum working hours. The relationship of situation between working pattern, location of home (nursery) and work place confirms the difficulties for working guardian in child-care.

6 An Assessment on Working Patterns, Urban Structure and Location of Nursery from a Viewpoint on Child-Care

The residential area in suburbs which requires a long-hour commute to central city is called “bed town”. Such area was constructed for the life style during the high economic growth period; fathers work long hours



	Open time of Nursery	Nursery to Station (min)	Duration of Train (min)	Total trip time (min)	Maximum workable time
	10h	15	15	60	9h
	12h	15	15	60	11h
	10h	15	30	90	8.5h
	12h	15	30	90	10.5h
	10h	15	45	120	8h
	12h	15	45	120	10h
	10h	15	60	150	7.5h
	12h	15	60	150	9.5h
	10h	15	75	180	7h
	12h	15	75	180	9h
	10h	15	90	210	6.5h
	12h	15	90	210	8.5h
	10h	15	105	240	6h
	12h	15	105	240	8h
	10h	15	120	270	5.5h
	12h	15	120	270	7.5h
	10h	15	135	300	5h
	12h	15	135	300	7h

Figure 5 The Relations between the Nursery Service Operation Hours
and total time of commuting time and possible working hours

in the city and mothers take care of children at home or work part-time near home. This life style is no longer typical due to the arrival of Gender-Equal Society in recent years. It has become extremely difficult for both parents to work and raise their children in the suburban new town. It is especially difficult to maintain the same work pattern and be engaged in child-care when only one of the parents is in charge of drop-off/pick-up at the nursery. From the viewpoint on nursery service, working patterns, location of home and work, the relationship between child-care support for working guardian and urban structure is suggested as following.

1) Nursery Service: the extension on operation hours or placement near work place can be considered. However, this will burden children to commute and take time away from parents-child, therefore actively adapting these ideas remain doubtful.

2) Working Patterns: Sequencing the working hours is one of the child-care support policies which can guarantee the handling of both work and child-care without changing current work place, residence and nursery hours. In addition, by utilizing the flextime which liberalizes the start/end of work time, couples can share drop-off/pick-up duty which will also enable them to handle both work and child-care without changing other urban structures.

3) Location of Home: By moving residence near work place, the nursery and work place relationship can be improved without burdening a child to commute. In this case, a relocation by crossing different municipalities occurs, therefore, providing a support beyond municipalities is necessary which will be against the recent trend in decentralization of government power in child-care support (the country is transferring the child-care support task and fund to municipalities) in Japan.

Acknowledgements
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Note:
1) The nursery for children in Japan is provided for parents who are not able to take care of their children due to work, school, elderly care or family care and mainly act as a work support facility for parents.
2) This paper sets work location as the closest station from work. Therefore, compare to the actual situation, the evaluation for a travel distance between nursery and work becomes smaller while the possible working hours become bigger.
3) Person Trip indicates "a movement (trip) of a person", the investigation conducted by Tokyo Metropolitan Transportation Planning Organization which studied "who", "when", "why", "from where", "to where" and "how" of traveling people to grasp all their activity patterns during a weekday. The unit of this survey is "a unit in which a person with a purpose travels from one place to another" set as a "trip" and the main mean of transportation is counted as 1 trip no matter how many times a person transfer while traveling.
4) This is based on the assumption that nursery service is located within the subject regions. Therefore, the assumption on a travel line is made as following; dropping off a child at nursery, traveling to the station which is a departure point of subject regions and then commuting to work. Commuting with a child or nursery services located in work place were not included in the analysis of study this time.
5) Regular Employee: a person who is under the following conditions; 1) A person who was employed for uncertain period of time or over 1 month, 2) Temporary or day laborer who was employed 2 months previously to the date of survey and worked for more than 18 days during the 2 months.

Reference
*1: T. SHIOMI, 2004, *Father and child care*, Gakushikai Magazine, No.846. P.81
*2: K. KOMIYAMA, 2005, *Feature of nursery, nursery school and unification of nursery school*, Child Book co.
*3: H. MIYAZAWA, 1998, *Investigating Time-space Constraints on Accessibility to Day Nursery Facilities in Nakano Ward, Tokyo*, Geographical review of Japan. Ser.A, Vol.71, No.12, pp.859-886
*4: H. ONO and K. OMURA, 2000, *The Trends of DIWKS in Tokyo Metropolitan Areas and the Relation with Nursery Supply*, City Planning Institute of Japan, Journal of the City Planning Institute of Japan, No.35, pp. 271-276
*5: H. ONO and K. OMURA, 1999, *Basic Study on Development from the View Points of Housing Choice of Two-income Families with Children*, City Planning Institute of Japan, Journal of the City Planning Institute of Japan, No.34, pp.289-294
*6: Statisticd Bureau, Director-General for Policy Planning & Statistical Research and Training Institute, *http://www.stat.go.jp/data/nihon/16.htm*

Urban Simulation in Terms of Comparison between the Housing Stock and Household Composition in the Tokyo Metropolis

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Keywords: housing stock, household composition, number of dwellings newly built, simulation

Abstract
The purpose of this study is to predict the prospective relationship between the number of households and the Tokyo Metropolis housing stock from the year 2005 to 2020. Firstly, the study area was divided into nine zones according to the major zones of the Tokyo Metropolitan Area Person Trip Survey conducted in 1998, and the housing demand in each zone and municipality was respectively estimated. Secondly, this study estimated the number of dwellings in each zone and municipality respectively. To this end, three cases were assumed concerning the numbers of dwellings newly built of the following two kinds of buildings, namely detached houses and apartment houses. Finally, the numbers of households and dwellings were compared and the following results were obtained. In the first case, where houses are built at a rate equivalent to the present figure, the number of large-scale dwellings will become excessive, especially in the central ward area, while the stock of small-scale dwellings will be insufficient. In the second and third cases, where the numbers of dwellings newly built will be coordinated to meet demand, detached houses will get older, mainly in the ward area, while apartment houses will age in the central ward area.

1. Introduction
The Japanese population declined in 2006 for the first time since World War II, and is predicted to decrease in 2050 to 75% of the figure in 2005 and still further in future (National Institute of Population and Social Security Research of Japan, 2006). Although the population of larger cities, such as Tokyo, has been increasing, their population is also predicted to decline in the near future, as well as the number of households. In this situation, the question of how to scale down the extended urban area and form compact cities has become an important issue in Japanese urban planning. This planning will involve management of urban building stock, and thus the need to predict the future distribution of stock and to compare it with future demand for the same. Among the building stock, housing stock is particularly abundant, meaning that prediction of the distribution of housing stock while comparing with the population projection is indispensable to planning compact cities. The purpose of this article is to conduct this comparison in the Tokyo Metropolis, the core of the largest urban area in Japan, via computer simulation.
The following are preceding studies of this article. Although Kashiwadani and Asakura (1994) developed a population prediction method by incorporating the cohort method with future housing stock, they did not develop the projection method of future housing stock. Yoshida et al (2002) developed a population prediction method considering the moving behavior of residents, but they did not consider the distribution

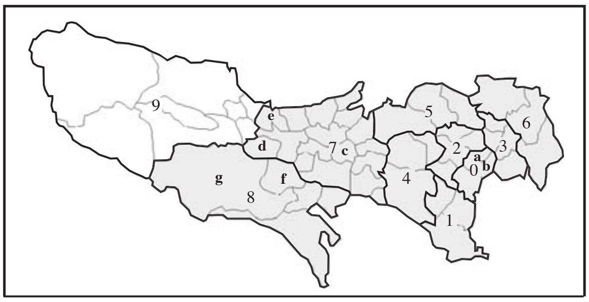
of housing stock. Aiming to fill this research gap, this article proposes a simulation method and presents the result of the simulation by revising a technical report by Kondo and Yoshikawa (2006).

This article consists of three sections. Firstly, the study method, including the simulation system developed in this study, is illustrated. Secondly, by using the simulation results, the distribution of housing stock and that of households are compared, before, finally, conclusions and remaining issues are stated.

2. Study Method

2.1 Target Area

The Tokyo Metropolis has many municipalities with various construction activity and change in population. With this in mind, this study classified the municipalities into nine zones, according to the major zones of the Tokyo Urban Area Person Trip Survey, as shown in Figure 1. Simulation was initially conducted in these zones, and based on the result, a detailed simulation was conducted in the municipalities. Zone 9, however, at the western end of the Tokyo Metropolis, was excluded from the simulation because certain municipalities in the zone lacked the necessary data and due to the relatively small population contained within. The grey area in Figure 1 is the target area.



Area	Zone ID	Municiparities
ward area	0	**a.** Chiyoda ward **b.** Chuo ward Minato ward
	1	Meguro ward Shinagawa ward Ota ward
	2	Shinjuku ward Bunkyo ward Shibuya ward Toshima ward
	3	Taito ward Sumida ward Koto ward Arakawa ward
	4	Setagaya ward Nakano ward Suginami ward
	5	Kita ward Nerima ward Itabashi ward
	6	Adachi ward Katsushika ward Edogawa ward
Tama area	7	Chofu city Komae city Mitaka city Musashino city Nishi-tokyo city Kiyose city Higashi-kurume city Fushu city Kunitachi city **c.** Koganei city Kokubunji city Kodaira city Higashi-murayama city Tashikawa city **d.** Akishima city Higashi-yamato city **e.** Musashi-murayama city
	8	Machida city Tama city Inagi city **f.** Hino city **g.** Hachioji city
	9	Mizuho town Fussa city Hamura city Akiruno city Hinohara village Hinode town Ome city Okutama town

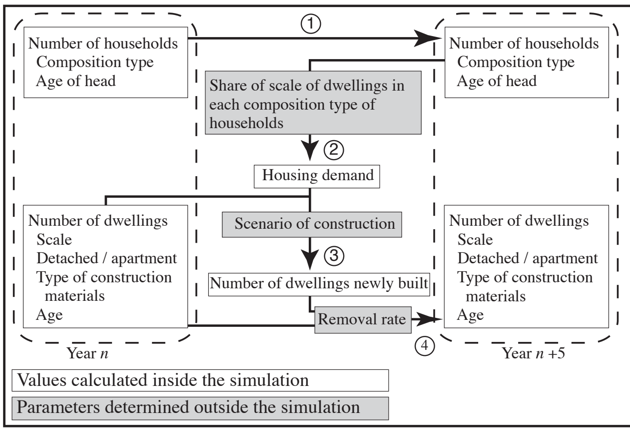
Fig. 1 Large Zones of the Tokyo Urban Area Person Trip Survey and Municipalities in Tokyo

2.2 Target Year, Target Period, Procedure of Simulation and Data

The target year of prediction was set to 2020. Because some of the data in 2005 was unavailable, they were projected using pre-2005 data. The target period, from 2000 to 2020 was divided into four terms of five years and the situations at the ends of the terms, in 2005, 2010, 2015 and 2020 respectively, were obtained. Figure 2 shows the simulation procedure and the data used in this simulation were summarized in Table 1.

2.3 Scale of Dwellings and Household Composition

The scale of dwellings is closely related to the household composition and this article analyzed the relation by using the Housing and Land Survey of Japan in 2003. The dwellings were divided into the following



① Calculation of the number of households in each composition type of households (single-person households of age under 65, single-person households of age 65 and over, multiple-person households); based on the projected number of households in year *n* +5

② Calculation of the housing demand for each scale (small or large) of dwellings in year *n* +5 by multiplying the number of households in each composition type in year *n* +5 and the share of the scale of dwellings of the composition type

③ Prediction of the number of dwellings newly built considering the relation between the housing demand and the number of existing dwellings in year *n*, according to the scenario of construction

④ Calculation of the number of dwellings in year *n* +5 by multiplying the numbers of existing dwellings in year *n* and that of dwellings newly built and the survival rate obtained by subtracting the removal rate from 1

Fig. 2 Procedure of the Simulation

Table 1 Calculation Methods and Sources of Data

Values	Calculation method
Number of households	In order to adjust the counting date of data-1 (October 1st) to that of data-4 (January 1st), the rate of change from October 1st to January 1st, obtained from data-2, was applied to data-1.
Number of dwellings in 2005	The number of dwellings built before the year 2000 was determined by subtracting the number of dwellings removed before December 31st of 2005, projected using the removal rate shown below, from the number of dwellings built before 2000 and surviving on October 1st of 2003; extracted from Table 4 in Data-3. The number of dwellings built after 2001 was determined by subtracting the number of dwellings removed before December 31st of 2005, projected using the removal rate shown below, from the number of dwellings built after 2001 extracted from data-4.
Number of dwellings newly built	The number was extracted from data-4. The share of detached or apartment houses and the share of each construction material in the number of newly built dwellings was assumed to be the same as the share in data-4.
Removal rate	The removal rate is defined as the probability that a dwelling of age n at a certain year will be removed within the following x year period. It was given by subtracting the survival rate from 1. The survival rate, meanwhile, is defined as the proportion of the survival rate function at age $n + x$ to that at age n and the survival rate function was given by substituting the age into the function proposed in data-5.
Share of scale of dwellings in each composition type of households	The share was determined using Table 6 of data-3; as described later.

Data	Source and explanation
data-1	Household Projections for Tokyo: 2005-2020 by the Tokyo Metropolitan Government. The projections contain the number of households on October 1st of 2000, 2005, 2010, 2015 and 2020 and were given by revising the former projection calculated based on Census of 2000 using Census of 2005.
data-2	Households and Population on the Basic Resident Register by the Tokyo Metropolitan Government. This study used the values on January 1st and October 1st every year from 2001 till 2006 of the result.
data-3	Housing and Land Survey in 2003 by the Statistical Bureau of Japan. This study used Tables 4 and 6 of the survey.
data-4	Housing Construction Survey by the Construction Research Institute. This study used the total volume of housing construction in each year of the period 2001 till 2005.
data-5	Komatsu et al. (1992) . They estimated the survival rate of houses in each age, based on the type and construction material and using a method called Interval Survival Rate Estimation Method, focusing on the number of existing and removed buildings within fixed asset register data. They estimated a survival rate function from the survival rates via a parametric approach.

two types by scale: less than 30 m^2, categorized as small-scale dwellings, and equal to or more than 30 m^2, categorized as large-scale dwellings. The households were further classified by age and size into the following three categories: single-person households of age under 65, single-person households of age 65 and over, and multiple-person households. The share of each scale and tenure type of dwellings in each household category in each zone is illustrated in figure 3. The figure shows that the share of small-scale dwellings varies across the zones, especially in the case of single-person households of age under 65. Detailed analysis of the Housing and Land Survey data suggested that this variation does not derive from the income of the household or the age of the head of the household. Accordingly, this study adopted the same share throughout the prediction term instead of changing the share by building a projection model.

2.4 Scenarios of Construction Amount of Dwellings

It is difficult to predict the number of dwellings newly built because this is affected by policy or economic circumstances. Thus this study assumed the following three scenarios and compared the results:

1) The first scenario, called Case-A, assumed the numbers of dwellings newly built in the second, third and fourth terms to remain the same as that in the first term, 2001-2005.
2) The second scenario, called Case-B, assumes the numbers of dwellings built in each of the second, third and fourth terms to be determined such as to balance the number of dwellings and the demand for the same. If the number of dwellings exceeds demand, no construction takes place.
3) The third scenario, called Case-C, assumes that the number of dwellings meets the demand at the end of the simulation. The number of dwellings newly built in each term is constant and determined by one third of the difference between the demand and the number of dwellings in 2020.

The number of dwellings built each term is determined separately for each type of scale, while the shares of the two types of building, namely detached houses and apartment houses, are assumed to be the same as those in the first term, 2001-2005. A similar rule is assumed to apply to the share of each type of building materials.

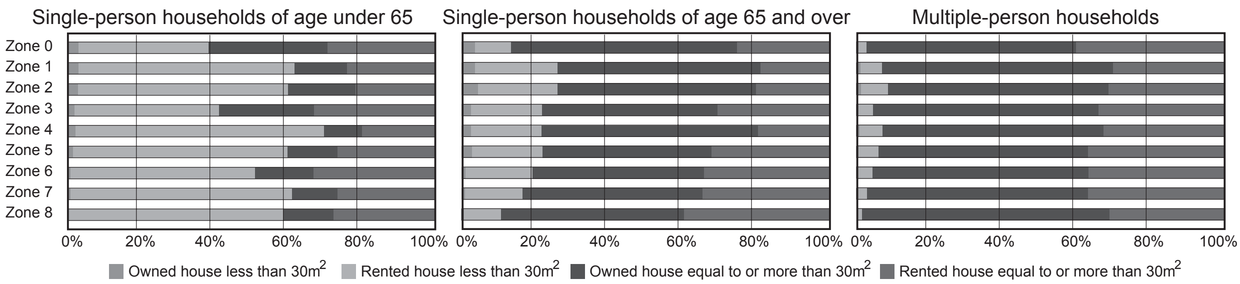


Fig. 3 Share of Each Scale and Tenure Type of Dwellings in Each Household Category in Each Zone

3. The Result of the Simulation

3.1 The Simulation in the Zones

The projected numbers of households are shown in figure 4. The numbers of dwellings built in each term in the three cases are shown in figure 5 and the results of simulation are shown in figures 6, 7 and 8. These figures illustrate the following two indexes: the ratios of the number of households to the number of dwellings and the average age of dwellings. The former index, called housing demand/stock, shows the balance between housing demand and stock. If the value is larger than one, dwellings run short, and vice versa. Note that the figure of housing demand/stock in Case-B was omitted because the case tries to balance the housing stock with demand and the latter index shows the aging of dwellings. If the value is large, the dwellings in the zone may be decrepit if appropriate maintenance is not applied.

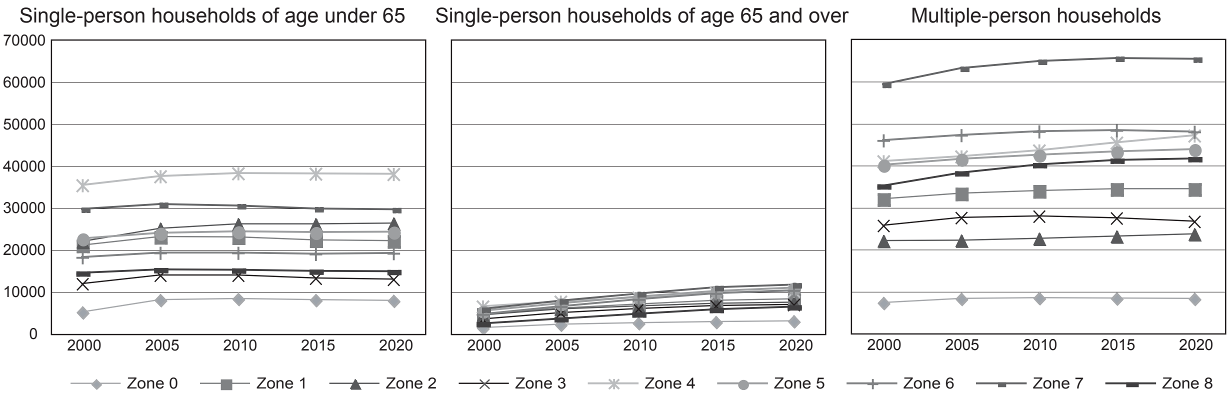


Fig. 4 The Projected Number of Households in Each Composition Type in Each Zone

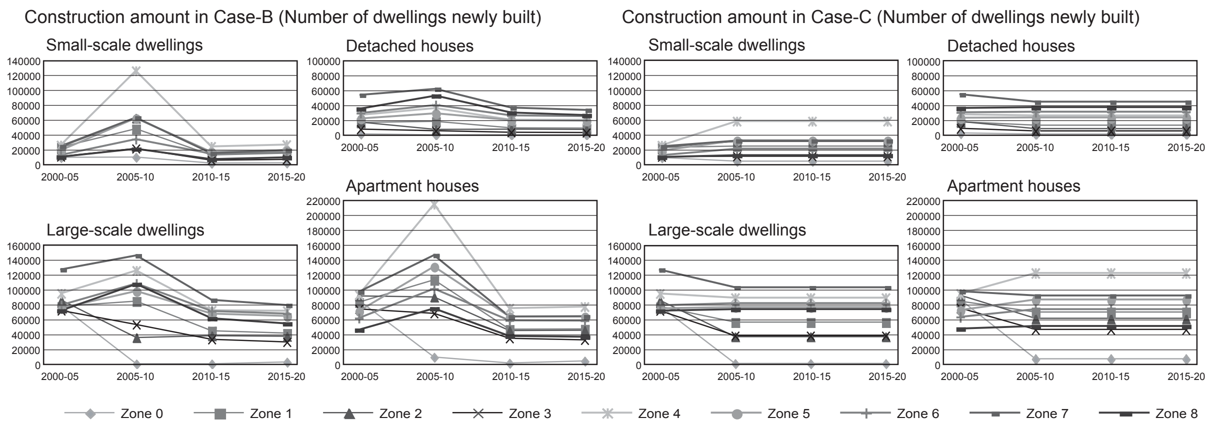


Fig. 5 The Construction Amount in Cases-B and -C

Let us review the situation at the start of the simulation in 2005, which is shown on the extreme left in figures 6, 7 and 8. Small-scale dwellings are running short in general, especially in the western part of the ward area shown in Figure 1, while large-scale dwellings are running short in zone 8 and in the southern part of the ward area, and there is a surplus in zone 0. The average age of small-scale dwellings is small in zone 0 and in those outside the ward area, namely the Tama area shown in Figure 1, especially zone 8, while that of large-scale dwellings is small in zone 0. The average age of detached houses is large in the zones of the central and northeastern ward areas, whereas that of apartment houses is smallest in zone 0, largest in zone 5, and intermediate in the other zones. This is because many apartment houses have been built in zone 0, due to the recent drift of population toward the inner city.

3.1.1 Case-A

The balance of housing demand and stock is similar to that in 2005, but the shortage in dwellings is gradually solved and a surplus is generated, especially in zone 0. This is because the growth in the number of households slows down and is overcome by the continuing increase in dwellings. Especially, the demand for large-scale dwellings is generally satisfied. Meanwhile, the shortage in small-scale dwellings is untied in some of the zones but persists in the western part of the ward area, especially zone 4.

The average age of dwellings increases in the fringe of the ward area at the beginning of the simulation and later in the Tama area zones. In particular, large-scale dwellings in zone 5 grow old fast. Detached houses initially grow old in the central ward area, followed by the eastern ward area and finally the western ward area. The aging of apartment houses proceeds initially in the northern ward area and zone 8, followed by the surrounding zones, while in zone 0, aging does not proceed because of significant construction.

3.1.2 Case-B

The average age of small-scale dwellings drastically decreases in most zones in 2010, because many new dwellings are built in the second term, 2006-2010, as shown in figure 5, to cover the shortage in 2005. From 2015 onwards, the aging of dwellings proceeds, especially in the central ward area and zone 8. The average age of large-scale dwellings increases in order of proximity to the central ward area except for zone 4, where aging is slow. The tendency of aging in detached houses is similar to that in Case-A, though the aging is faster, while the average age of apartment houses decreases in 2010, and then swiftly increases. The aging proceeds, especially in zone 0 and its surroundings, due to the fact that the number of existing dwellings exceeds demand in 2005 and due to the small number of dwellings newly built after 2005.

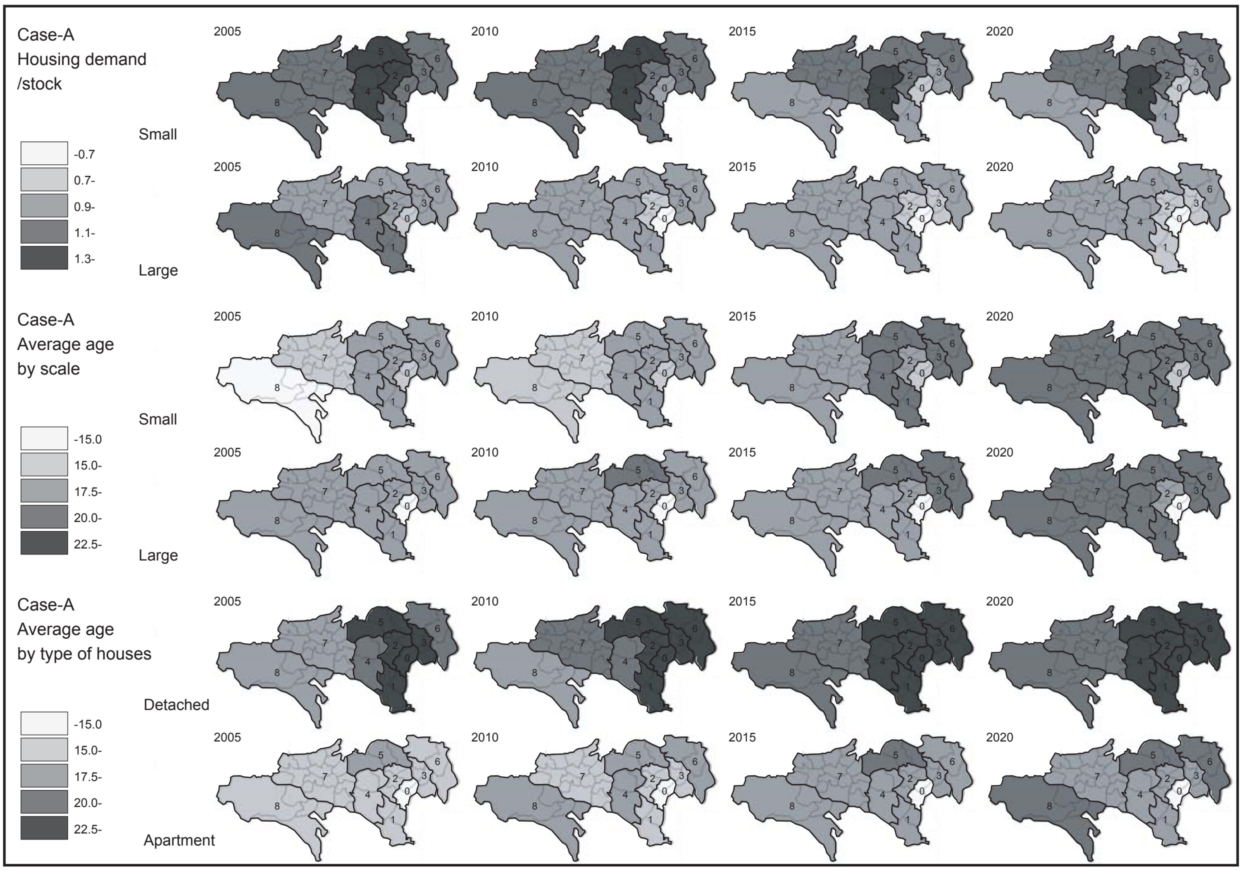


Fig. 6 Results of Simulation: Case-A

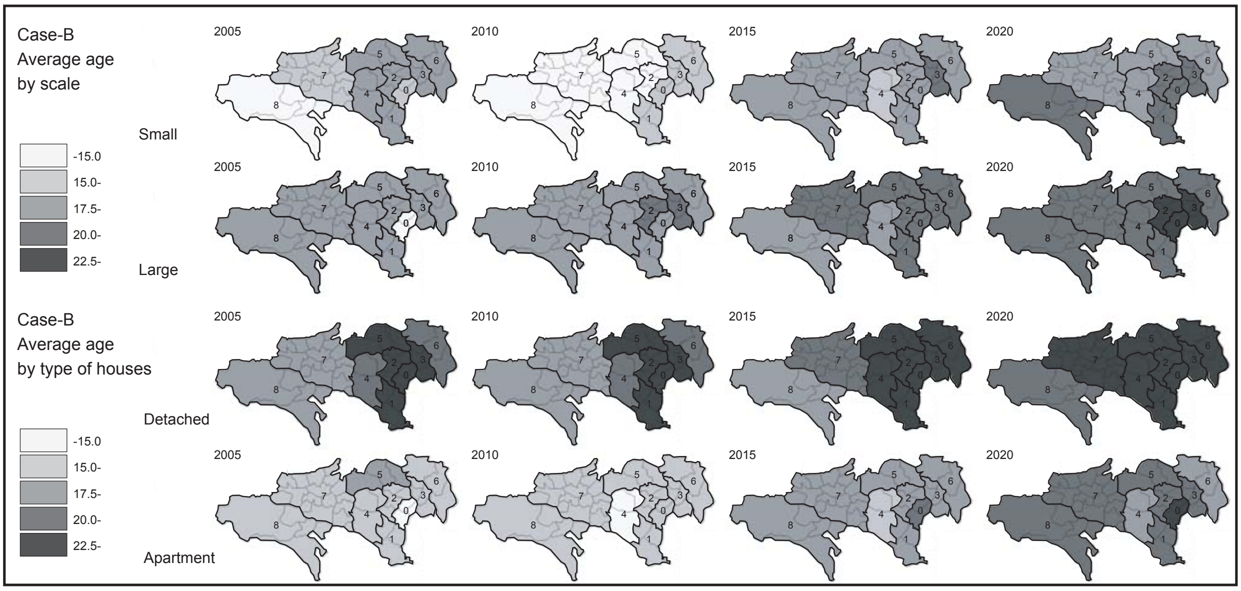


Fig. 7 Results of Simulation: Case-B

3.1.3 Case-C

A shortage is evident in small-scale dwelling in Zone 4 in 2015, implying the existence of considerable demand for small-scale dwellings. Large-scale dwellings, on the other hand, show a surplus in zone 0 in 2010, but are balanced in the other zones and in other terms in terms of demand and stock.

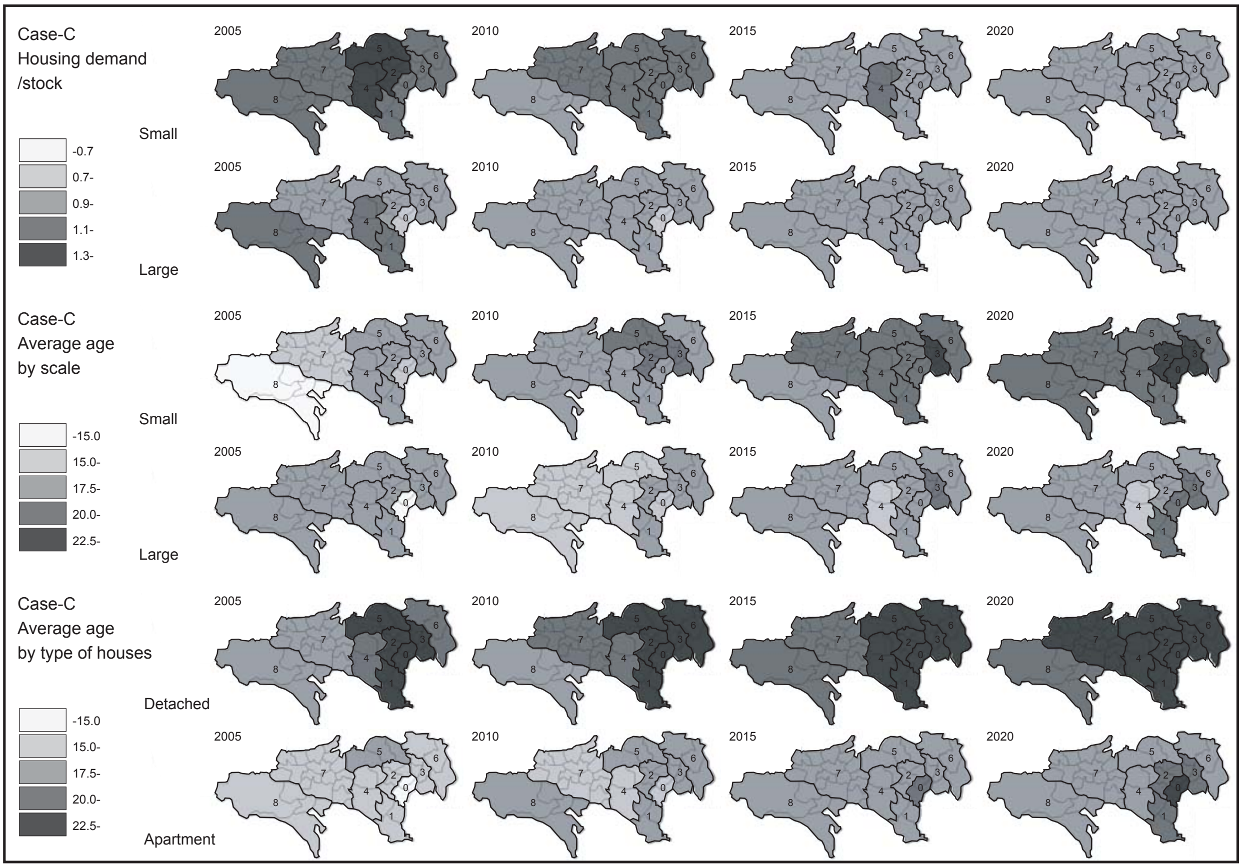


Fig. 8 Results of Simulation: Case-C

The average age of small-scale dwellings increases first in zones 2, 3 and 5, particularly zone 3, followed by the other zones. The aging is faster than in Case-B, because the number of small-scale dwellings built newly in Case-C is smaller than that in Case-B. The aging of large-scale dwellings proceeds more slowly than in Case-B, because the number of dwellings built newly in Case-C is greater than that in Case-B, in contrast to small-scale dwellings. Again, the average age is high in zone 3, while in contrast, the average age in zone 4 is low, as in Case-B. The tendency toward aging in detached houses is similar to that in Case-B, while the tendency toward aging in apartment houses in the central ward area is similar to that in Case-B, but slower in the other zones.

3.2 Simulation in municipalities: Case-D

In order to analyze detailed difference within each zone, this study conducts a simulation in municipalities. The results of the preceding section suggest that the scenario of Case-C is appropriate because the stock and demand are balanced but the number of newly built dwellings does not fluctuate violently. However, the number of dwellings newly built in the simulation by municipality unit differs from that in the zonal unit. One reason for this is the fact that the number of newly built dwellings becomes larger than by the zone unit, because the imbalance in housing demand and stock across municipalities is equalized in the zonal simulation. Another reason for this is the fact that the calculated value of demand changes due to the effect of accumulating area size. For this reason, the simulation in municipalities is called Case-D as opposed to Case-C.

The result of the simulation is shown in figure 9 and the balance between demand and stock of small-scale dwellings differs among some adjacent municipalities, for example, Chiyoda and Chuo wards or Hino and Hachioji cities shown in Figure 1. The shortage continues until 2015 in the western ward area and eastern Tama area, showing the persistent demand existing in this area. The large-scale dwellings, meanwhile,

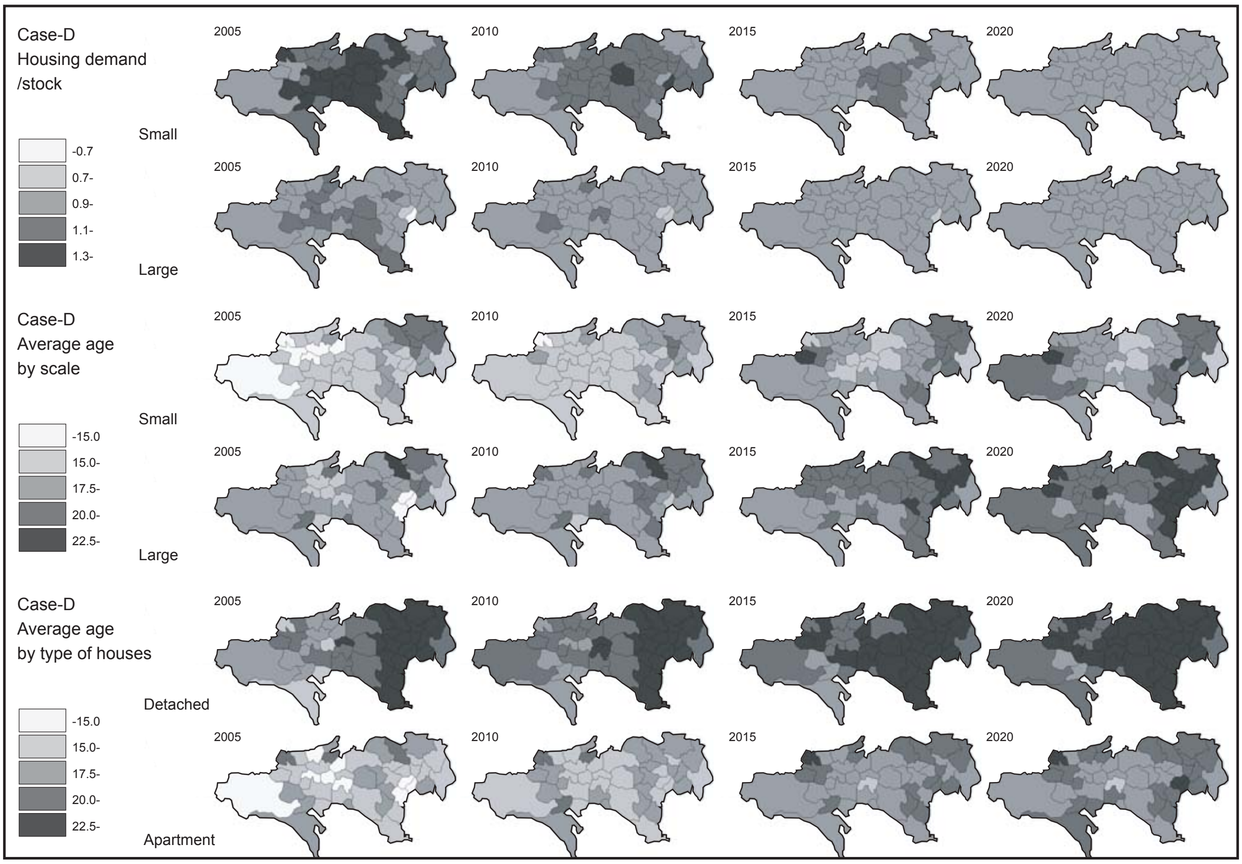


Fig. 9 Results of Simulation: Case-D

showed evidence of a shortage in the southwestern ward area, around the Chuo railway in the Tama area in 2005. In contrast, Chuo ward has a surplus even in 2015, which implies that the construction in recent years exceeds demand in this area.

The average age of small-scale dwellings increases locally in Chiyoda ward and Akishima city. However, on the whole, it is smaller than that in Case-C, while that of large-scale dwellings is greater than that in Case-C, especially in the central and northern ward areas, as well as Koganei, Akishima and Musashi-murayama cities. The average age of detached houses is similar to that in Case-C, while that of apartment houses increases in the central ward area and certain municipalities in the northern and southern parts of the Tokyo Metropolis.

4. Conclusion

The result of the simulation is summarized as follows:

1) In 2005, small-scale dwellings are running short in the Tokyo Metropolis and there is a surplus of large-scale dwellings in the central ward area. If the construction trend in 2001-2005 continues, as is assumed in Case-A, this situation will likewise persist.

2) If the numbers of newly built dwellings are determined as meeting the demand in each term, as assumed in Case-B, the construction will peak in 2006-2010, and then decrease rapidly.

3) If the numbers of newly built dwellings are determined to be constant and to meet the demand at the end of the simulation period, as assumed in Case-C, the average age of small-scale houses is larger than that in Case-B, while the average age of large-scale houses is smaller that in Case-B.

4) If the numbers of newly built dwellings are determined as constant and meeting demand at the end of the simulation period in each municipality, as is assumed in Case-D, local differences in the average age of houses are observed.

The following summarizes the remaining issues of this study. The effect of the behavior of moving houses was included in this simulation model via the population projection. However, this latter does not take any future shortage or excess in houses into account, meaning the development of a simulation system taking this factor into account remains work to be done and further, developing a detailed model of the relation between the size of households and the scale of dwellings is another outstanding issue.

References

Kashiawadani, M. and Y. Asakura. 1994. A Population Projection Model by Zone and Age Class Using Cohort Analysis and Housing Data Regression. *Papers on City Planning* 29: 535-540.

Komatsu, Y., Y. Kato, T. Yoshida and T. Yashiro. 1992. Report of an Investigation of the Life Time Distribution of Japanese Houses At 1987: Estimation Based on the Ledgers of Buildings for Fixed Property Taxes. *AIJ Journal of Architecture, Planning and Environmental Engineering* 439: 101-110.

Kondo, S. and T. Yoshikawa. 2006. Urban Simulation in Terms of House Stock and Household Composition - Tokyo Metropolitan Case, *Reports of the City Planning Institute of Japan*, 5-4: 127-131.

National Institute of Population and Social Security Research of Japan. 2006. *Population Projection for Japan*. http://www.ipss.go.jp/pp-newest/j/newest03/newest03point.pdf

Yoshida, A., K. Miyamoto and K. Kitazume. 2002. Analysis on Household Transitions and Relocation Behavior for Forecasting Population Distribution by Age in Residential Districts. *Papers on City Planning* 37: 379-384.

An information system for the decision-making in urban planning

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Keywords: Computing, Decision Making, Construction, Communication

Abstract

All the actors of urban planning and building produce information: the customer's owners, designers, sector of the realization and the companies of the branch of industry, which propose products for the building. All wish today to develop a better communication of this piece of information. Far from a simple "mechanization" of the traditional methods, this situation transforms the maintenance of the real estate property and modifies several aspects particularly in the engineering:

- quantitative and qualitative increase of the piece of information,
- interconnection of the information systems of each of the actors,
- development of simulation's tools and assistance in all the sectors,
- description of the building(ship) throughout its cycle of life.

In front of this problem, it is necessary to elaborate a model facilitating the division and the consultation of all the information bound to the real estate property. This model constitutes a decision-making tool to the various actors of this sector. It is thus in the particular fields of the technical maintenance of the real estate property and its management that the application of this model intends to position. The database management systems and their exploitation via the Internet network allow to envisage answers to the questions bound to the structuralization of the descriptive information of the building, the management of a process of preservation, the division of information distributed between distant partners, traceability of the decisions for the maintenance of the building.

The article presented here thus proposes a decision-making tool in the service of the urban planning. This tool is interested in the questions bound specifically to the production and to the use of projected plans of management of the real estate property. It is thus to the methodology of elaboration and manners of this tool that turns this research, in a spirit of generalization and diversification the grounds of experiment because these will include at the same moment the urban tissue but also from the building particular as of the urban network.

The elaboration of this decision-making tool dedicated to the maintenance of the real estate property passes by the necessity of informing the building, concerning its shape and its manners. Indeed, a relevant modelling of the studied architectural object allows sticking to its morphology a set of data and of information. The objective being to end in a system of information referenced spatially on the scale of the architecture, in which the representation of the building can serve as interface privileged by navigation. The model has to answer a certain number of requirements. He has to allow:

- the visualization on Web, without real investment, of various scenes ;
- the visualization of these scenes on every operating system ;
- the reaction of the user on the shown scene either by moving there, or by interrogating it, or by modifying it ;

that the scene serves as interface with a Database management system.

1. Introduction

Urban actors are producers of information: the owner building customers, the companies of the sector of realization and the companies of industrial sector who offer products for the building. All wish today to develop a better communication of this information. With these problems, it is necessary to work for a model facilitating the division and the consultation of the whole of information related to the real inheritance. This model constitutes a tool of decision-making aid with the various actors of this sector.

It is thus in the particular fields of urban planning of the real inheritance and its management that intends to position the application of this model. The systems of DAO, the management' systems of data bases and their exploitation via Internet network make it possible to consider answers for the questions related to the structuring of descriptive information of the territory, the management of a process of conservation, the division of information distributed between distant partners, the traceability of the decisions for the management of the territory.

The article presented here proposes a tool of decision-making aid with the service of the reasoning of the management in urban planning.

2. The information system or "SIG"

In first, it is necessary to agree on some terms, acceptances and precise details on the system, the information system and in particular the role of the SIG in information technologies.

By system, we want to say the whole of elements in dynamic interaction, organized according to a finality. A system is a whole of elements which interact between them by exchanging internal and external information with support of transportation. For Jean-Louis Moigne (1990) an information system is the whole of methods and means collecting, controlling, memorizing and distributing information necessary to the exercise of the activity of any point of an organization. It has the role to ensure the coupling between the system of operation and the system control : it's function is to produce and memorize information, representations of the activity of the physical system then to place them at the disposal of the system control.

The functional diagram on figure 1 explains the positioning of the Information system within the organization, being used as means of connection and exchange between the physical elements of the organization (men, machines, produced...) and the system control and management (place of management, planning, prospection).

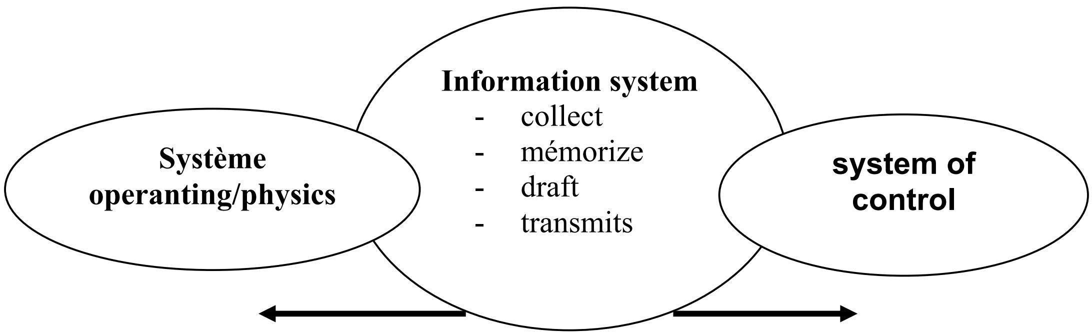

Figure 1 : Positioning of the information system

Compared to the many definitions and existing descriptions, let us retain this one :

a SIG can be defined like a system of management of data bases conceived to seize, store, handle, analyze and post data with space reference in order to solve complex problems of management and planning.

The SIG integrate primarily two modules : a Data base management system DBMS and a module allowing to treat the space character of information.

Like any data base management system, a SIG is equipped with relative functions (figure 2) :

- the acquisition of the data
- storage,
- the handling and analyzes data,
- the posting and the generation of the interfaces,
- an interface with the user.

What can be expressed by the five "to acquire, file, reach, analyze and post". The SIG resting on a DBMS makes it possible to the user to act in entry and exit of the system.

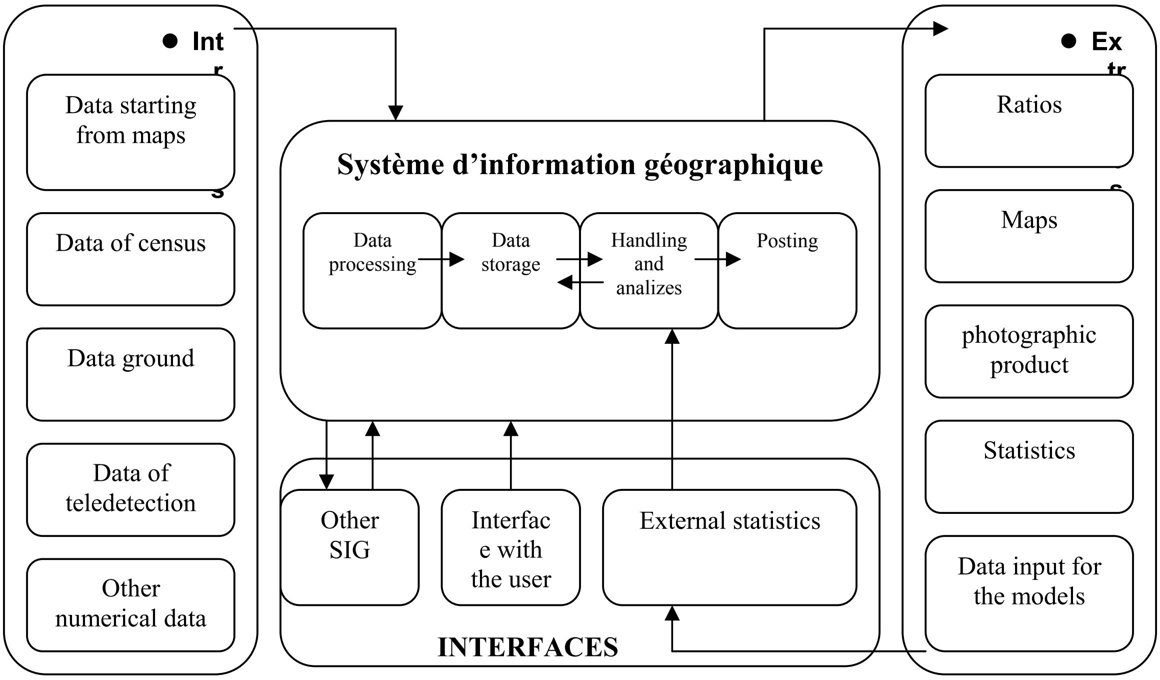

Figure 2 : Components of a SIG [FIS-93] in [LAA 00]

Within the framework of this work, it is important to identify the contributions of the SIG to the management of the real inheritance.

The questions concerned with the co-education of the urban functions, the durable development and the occupation of the ground, are overlapping and maintain relations of the causal type. The decisions are numerous and they are blocked by their increasing complexity that the actors of the urban development have to solve. The design of a Geographical Information system must answer above all with management, the control of this increasing complexity to accompany the practices by urban refitting, the control of operations of town planning and the installation of the new documents of city planning.

The SIG are tools which make it possible to satisfy the need for information and communication. The problems of urban planning management that the actors of installation have to solve are complex because they are largely overlapping. The management of the urban project, local installation have need for objective information answering this complexity.

The need for communicating information from the various actors requires an instrument making it possible to assist the collaboration of administrative and technical competences for a global and synthetic solution of the problems of installation.

3. SIG: a tool of assistance for urban planning

The SIG can not be regarded as tool of decision-making aid because it does not integrate a clean decision-making process. However, it makes it possible to have, several years in advance, a detailed image from what will occur on the ground. Moreover, much of treatments sets of themes (built inheritance and not built, demography, health, employment...) can be carried out and thus allow to treat the future data of census to support the decisions of the actors on a whole of knowledge multi-sets of themes and organized.
The SIG makes it possible to show the induced effects of the policies of development, by providing a quantitative characterization of the medium, according to scenarios of development. It is what makes of it a tool of decision-making aid within the framework of the urban development.
But it misses methods however making it possible to carry out choices among the various possible solutions relative to a decisional problem given to become genuine tools of decision-making aids.

Although the SIG provide to the decision maker a whole of powerful tools for handling, the management and the analysis of the data with space reference, they miss a whole of mechanisms making it possible to integrate the preferences of the decision maker and to carry out a choice in a context of evaluation of objectives and criteria conflict.

It is this report which returns many researchers to couple the SIG and the methods of multicriterion analysis; because the SIG alone does not offer the means of making of the decision-making aid strategic or of the multicriterion evaluation of an urban planning.

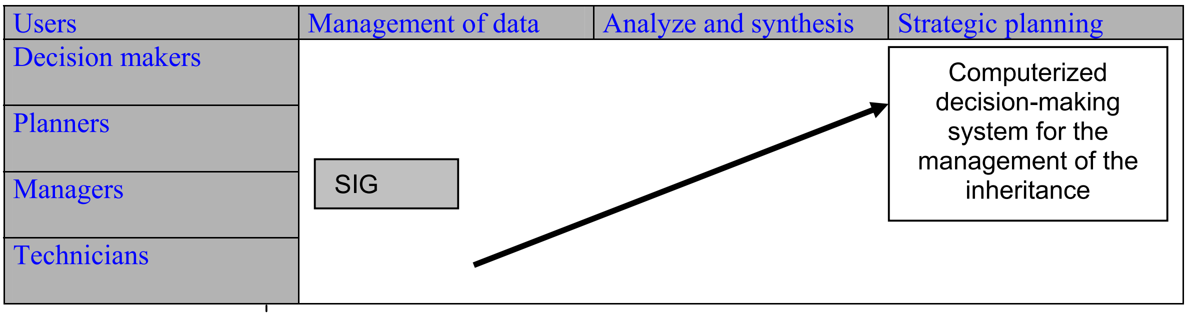

Figure 3 : Position of the SIG with respect to the users and the activities.

Because of their role of collecting, storage and data processing, Clarke (1990) notes that the SIG provide more decision-making aid at the operational level than at the technical and strategic levels.

4. Proposal for an information system geographic and logistic "SIGL"

Far from a simple "mechanization" of the traditional methods, SIGL is a system which transforms the field of the maintenance of the real inheritance and modifies of them several aspects particularly in the field quantitative and qualitative increase in

- of the information management:
- interconnection of the information systems of each actor,
- information, will to have a description.

It is thus towards a methodology of development and uses of this tool that this research is directed, in a spirit of generalization and diversification of the grounds of experimentation since those will include at the same time urban fabric but also from the point of view of the particular building like urban screen.

Making of this tool of decision-making aid dedicated to urban planning passes by the need for documenting the building, concerning its form and its uses. Indeed, a relevant modelling of the studied architectural object makes it possible to attach to its morphology a whole of data and information. The objective being to lead to an information system referred spatially on the scale of the architecture, in which the representation of the building can be used as privileged interface of navigation.

The model must answer a certain number of visualization on the Web, without material–requirements. It must allow:

- the visualization of these scenes on each
- investment, of various scenes;
- reaction of the user on the scene visualized either while
- operating system;
- That the scene serf of–moving there, or by questioning it, or by modifying it ; interface with a System of Management of Data bases.

Lastly, the management of information relating to urban planning, is of course the basic problem which this study tackles. In addition, the project aims at benefiting from the development of a whole of techniques data-processing (approach object, technologies of the Web, etc...) to try providing the foundations of an information system localised.

5. Protocol of application

For the management and its planning Valenciennes needs, on her territory, of exhaustive geographical knowledge and an information management increasingly finer.

The SIGL constitutes a response to these daily problems: it enables them to easily integrate the geographical component in management, to optimize it and improve knowledge of the territory. It does not act more than one simple tool of census of geographical information but of a true Information system federator, interoperable with all the components which are attached to it and all the trades applications which result from this. The data is centralized and shared with the users of the SIG, or the improvement the knowledge of the–users of other applications.

SIGL allows one:

- **improvement of knowledge of the territory,**

It is possible to reach the land register and information which is attached to it. One can visualize microfiches and the data relating to the pieces (name of the building, of the occupant, surfaces...), while profiting from a cartographic representation.

Many management tools trades can be developed by our services around tool SIGL: management of the networks, follow-up of permit building, management of the roads, installation of the parks... As many applications which make it possible to enrich knowledge by the university territory, and to improve the exploitation

- **Cartography and management of the–of it in an intuitive and interactive way networks**

The exploitation of the various networks requires their geographical representation. That constitutes a stage impossible to circumvent. This achieved operation, one can then visualize them and update them from the station office or directly on the ground thanks to the mobile solutions. Very simply, with the solutions trades developed one is able to analyze and anticipate the incidents

- **Planning of the interventions**

Once the isolated failures, the management tools of networks, cleansing helps us to decide actions and means to implement for repairing and maintain them

– **Optimization of the management of the inheritance not built**

Beyond its capacities of representation, SIGL makes it possible to manage and chart the inheritance. Using the solutions trades integrated into the application, one can decide and optimize the equipment installation of and organize in an optimal way the interventions of maintenance on the inheritance...

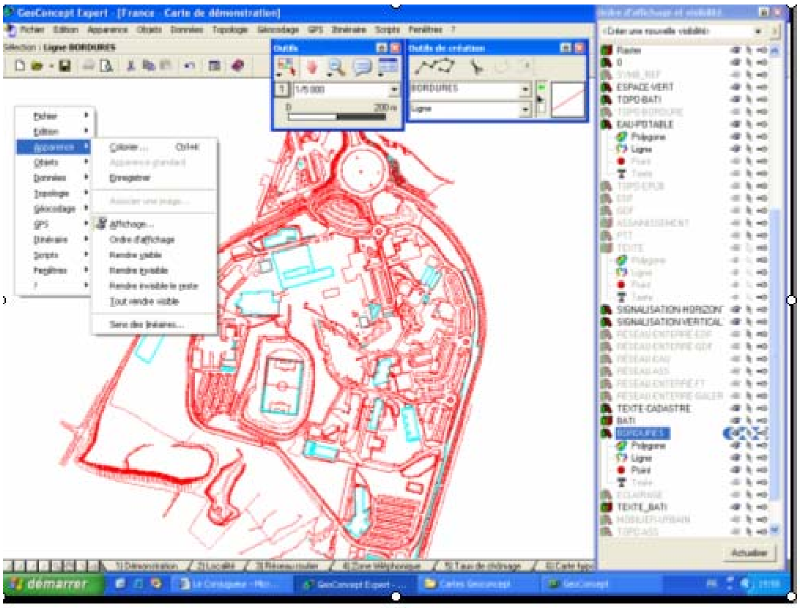

Figure 4 : Geolocalisaion of university site Mont Houy

5.1. SIGL : tool of assistance for decision and communication in urban planning

SIGL is a genuine tool of decision-making aid. It in particular contributes to identify the stakes of the site of Valenciennes. It makes it possible to organize all the stages preliminary to the choices of a future establishment bus it takes part to carry out analyses sets of themes on statistical and geographical data. It facilitates the analysis of the territory and brings a synthetic vision of information.

It makes it possible in particular to the various actors of the inheritance to visualize the evolution of fabric in space and time. SIGL becomes a genuine tool of communication and assistance to convince the decision makers and the users of the inheritance. So initially, the SIGL contributes to better managing geographical data and to integrate all information relating to the territory, the real advantage lies in its capacity to disseminate and share relevant information with a certain number of actors for fast decision-makings. The data are stored on a waiter of data and are shared by all the users. According to rights' which are allotted to them, they reach information in reading mode or writing. Information is accessible to all and is integrated into a reference frame supporting collaboratif work thus.

5.2. SIGL : tool for diagnosis, tools for evaluation

Knowledge, thanks to the acquisition of information on behalf of a manager of the inheritance, enables him to carry out choices, because it has a global vision of the problem and possible solutions and their consequences, while bringing a satisfactory technical solution and best accepted.

But before the decision maker can choose, it is necessary to design a panel of choices possible to propose to him, objective of a tool of decision-making aid. This panel corresponds to a series of possible actions, even with scénarii. By scenario one understands at the same time the whole of the essential elements structured in space (or groundwork) and the course envisaged of the action (for example intervention of work) which takes into account the elements considered. The scenario of a management of the real inheritance thus constitutes the tool which supports the process of its development: each expression of the scenario corresponds to a determined phase, thus adapting to the successive needs for an evolutionary process. Michel Godet defines a scenario as a coherent unit, having a temporal dimension, "formed by the description of a future situation and advance of the events which make it possible to pass from the situation origin to the future situation"[1]. The true difficulty is the formalization of the scénarii. It is thus interesting to consider the methods of development of the scénarii, at the same time as a concrete translation of the mental representation that is made the manager (like the actor of the intervention); and as elements of representation of the concretization of waiting of the users of the buildings.
The recourse to the tools of decision-making aid can intervene constantly of the process of exploitation and throughout cycle of life of the frame. In an approach quality, it is desirable that it is committed very upstream of the decision, as of the preliminary studies. Moreover one could distinguish various types of tools of decision-making aid, according to the tools–moment when they intervene, and thus according to also the objectives:

- Tools for diagnosis; they intervene upstream, and they are used to estimate the state and thus the degree of quality of an element of the existing frame, in a concern of defining the failing elements, weak points, who can transform themselves into strong points and thus constitute the elements necessary in order to build the tools for evaluation;
- those–tool of decision-making aid for the intervention; intervene a posteriori, to evaluate the results and the consequences of the decisions taken and installations. The retrospective analysis of the decisions taken can be regarded as a factor of quality assurance, in the optics of a step of control permanent of the quality of the interventions carried out.

6. Conclusion

Any organization (community, CCI,...) having problems of territorial information and management of inheritance, needs on its territory exhaustive geographical knowledge and an information management increasingly finer. Thanks to the SIGL, it is from now on possible to easily integrate the geographical component in the management urban planning of Valenciennes, to optimize it and improve knowledge of its territory.
Our objective is not to create a documentation base which would be adjusted with the need with our project to enable us to validate our starting assumption, but to confront well this assumption and the step of project which accompanies it with concrete cases. This is why we will use several documentation data bases already implemented within the framework of the grounds of experimentation described further, and which concern problems of documentation of the territory or the site.

[1] Godet, M. (2004) « La boîte à outils de prospective stratégique : problèmes et méthodes », Cahiers du LIPSOR, n°5, page 20.

8. References

DaulL, B. 1993. *Editorial* Génie Urbain n° 397, CDU, pp.3

Didier M. 1991. *Utilité et valeur de l'information géographique* , CDU 22694 ; IGN 58924, Paris, Economica, 255 p.

Eurovista, 1995. *Les SIG dans les collectivités territoriales*. Paris, Nouvelles Editions Européennes.

Fournillier J.-M., 1989. *Problématique des villes françaises en matière de banques de données urbaines*. in Actes du séminaire CNIG/AFI3G, Paris. CDU 27123

Godet, M. 2004. *La boîte à outils de prospective stratégique: problèmes et méthodes*, Cahiers du LIPSOR, n°5, page 20.

Lemoigne J.L. 2003. *Le constructivisme. Modéliser pour comprendre*, L'Harmattan.

Demand Structure of Public Facilities Based on the Zonal Interchange of Residents: Evidence From a Questionnaire Survey

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Keywords: demand structure, public facilities, questionnaire survey,

Abstract

This paper aims to obtain the demand structure of public facilities within Tama City via a questionnaire survey. With a focus on public facilities that comprise rooms rented for recreational activities, this paper determines the relation between the demand structure of the facilities and the zonal interchange of residents. First, we provide details of the questionnaire survey and basic data related to each facility. Second, we consider the basic ability of facilities to attract users with reference to a comparison of the characteristics of users based on the questionnaire survey and statistical data on potential users. Finally, based on the relation between the two most frequently used facilities, we estimate the demand structure of public facilities based on the zonal interchange of residents.

1. Introduction

In Japan, in addition to many other countries, depopulation and associated changes in the demographic structure of society are becoming increasingly urgent problems. In addition, revitalization projects within central Tokyo will accelerate the concentration of population in this area, leading to accelerated population outflow from the surrounding suburbs. Therefore, changes in the demographic structure of Tokyo and the depopulation of suburban areas will become increasingly serious issues. Under these circumstances, it will also become increasingly important to study the sustainability of suburban areas.

For example, population forecasting for Tama City, located in suburban Tokyo, suggests that the population of the city will fall by about 30% from 2005 to 2025. Over the same period, the number of children is predicted to decline and the number of elderly to increase. Tama City includes part of Tama New Town, one of the largest housing developments in Japan; consequently, many public facilities have been constructed in response to the development. The situation concerning public facilities will change drastically in the near future due to the effects of depopulation and population outflow.

In such suburbs, it will become important to review the public facilities that were constructed in great numbers during periods of population growth. To adequately review public services, it is necessary to obtain the prospective demand structure of existing public services. Focusing on public facilities that comprise rental rooms for which the management has been reviewed by the City Office, this paper obtains the demand structure of the facilities based on the zonal interchange of residents. This is undertaken in order to estimate the spatial relations among public facilities in Tama City.

2. Research method

We first review previous studies related to the current paper. Yoshikawa et al. (2005) examined Tama City in terms of developing a method of planning the rearrangement of community facilities by utilizing existing public buildings. Hsieh et al. (2006) investigated in detail part of the public building stock of Tama City and developed a method to estimate the feasibility of their conversion from the viewpoint of facility management; however, we are yet to see an approach that investigates a restructuring method that considers the effect of competing facilities and the zonal interchange of residents. Yanagisawa et al. (2007) provided a basic estimation model of the demand structure of existing public facilities in Tama City by considering the unavailability of the nearest facility due to a shortage in capacity; however, the relation between the relative locations of facilities and usage frequency remains an unsolved question. In addition, no previous study has considered the trip distribution pattern of users relative to regional characteristics. To fill this gap in existing research, the present paper obtains the demand structure of public facilities within Tama City via a questionnaire survey.

This paper uses the results of the questionnaire conducted by Kurakazu et al. (2007). The questionnaire survey aimed to estimate the relationship between the specifications of rooms and their demand structure and the relationship between the obtained user characteristics and their needs for rental rooms within each public facility. The present paper focuses (based on the questionnaire results) on the potential of each facility location and analyzes the relation between the demand structure of each facility and the zonal interchange of residents. Figure 1 shows the locations of the facilities considered in the questionnaire survey. These 18 facilities, denoted by the letters A to R in Figure 1, provide rental rooms whereby users can rent the rooms for their own use. The rental rooms in these facilities are used for recreational activities such as music practice, craft workshops, and meetings.

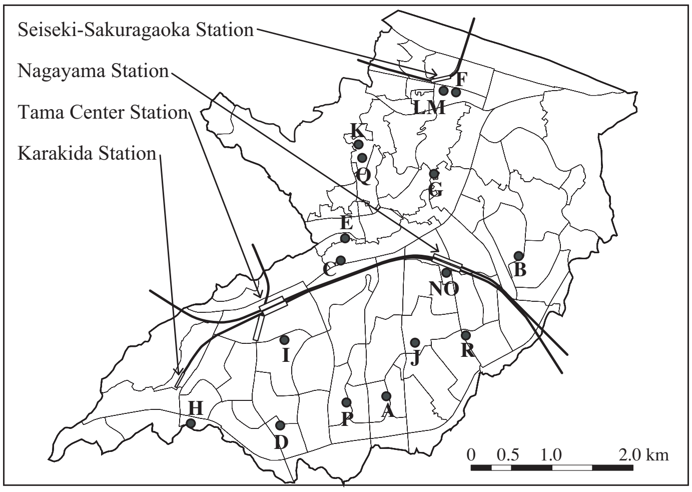

Figure 1 Location of the analyzed facilities

Figure 2 shows the main questionnaire items; the consultation period for the survey extended from 20 April 2006 to 20 May 2006, with the deadline being 31 May 2006. Respondents to the questionnaire were leaders of community groups that used one of the studied facilities during the consultation period. The staff at each facility provided respondents with a questionnaire form, a list of the analyzed facilities, and a list of the rooms available for rent. Completed questionnaires were collected by mail or via a collection box located at each facility. Table 1 lists the number of returned questionnaires classified in terms of the most frequently used facility. The number of observed cases represents the total number of community groups that used a given facility during the consultation period. The number of observed cases for Facilities D and J could not be obtained. Table 1 also shows that the number of rooms available for rent at the considered facilities varies widely, as does the response rate to the questionnaire. This paper focuses on a comparison among Facilities A - G, LM, and NO, because for these facilities the number of observed cases per month and the number of answers to the questionnaire are relatively large.

Question 1)
Representative age, occupation and means of transportation of participants in your community group

Question 2-1)
Which facility does your community group use most frequently?
Question 2-2)
Which rooms in the most frequently used facility do your community group use?

Question 3-1)
Which facility does your community group use second-most frequently?
Question 3-2)
Which rooms in the second-most frequently used do your community group use?

Figure 2 Questionnaire items

Table 1 Basic data regarding to the questionnaire survey and the analyzed facilities

	A	B	C	D	E	F	G	H	I	J	K	LM	NO	P	Q	R
Number of rooms for rent	7	7	3	6	10	3	7	11	15	5	3	12	14	2	2	2
Number of returned questionnaires	48	35	15	34	55	36	51	4	39	7	2	69	105	9	4	16
Number of distributed questionnaires	80	120	50	140	80	90	90	150	400	20	50	430	750	30	30	90
Number of observed cases per month	138	121	44	-	81	64	72	56	218	-	26	207	375	27	31	33

3. Basic ability of certain facilities to attract users

In terms of the characteristics of users, as determined based on the questionnaire survey, this paper focuses on the users' transport modes and their age based on the answers provided at the most frequently used facilities. Figure 3 shows the transport modes taken in traveling to each facility. About 40% of the users of Facilities A - G traveled by foot. This finding reflects the fact that Facilities A - E and G are located far from rail stations, unlike Facilities LM and NO. Facility F is located very close to a station; however, the number of users of this facility is small, partly because the capacity of Facility F itself is small (Table 1). The transport modes taken to Facilities LM and NO are dominated by car, bus, and train. The factors of location and the large number of available rental rooms results in a relatively large utility area for Facilities LM and NO, resulting in turn in a large number of observed cases (Table 1).We analyzed the difference in the number of observed cases between Facilities LM and NO based on the average daily number of passengers passing through stations within Tama City. Seiseki-Sakuragaoka Station on the Keio Line is the nearest station to Facility LM, while Nagayama Station on the Keio and Odakyu Lines is closest to Facility NO. Table 2 shows that

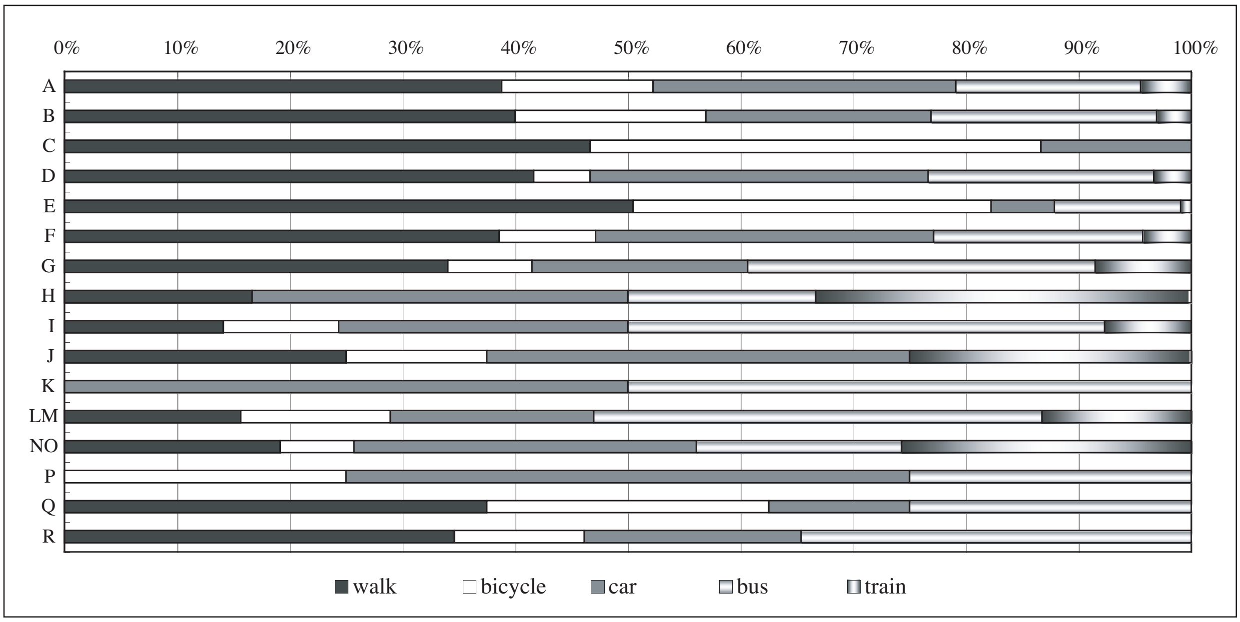

Figure 3 Means of transportation to each facility, as based on the results of the questionnaire survey

similar numbers of passengers pass through these stations; accordingly, the difference in the number of observed cases for the two facilities must be associated with a factor other than passenger numbers.

The characteristics and distribution of users may explain the differences between Facilities LM and NO. Figure 4 indicates that a high percentage of the users of these facilities are aged between 50 and 79. In addition, Figure 5 indicates that a high percentage of the total respondents to the questionnaire listed their occupation as housewife.

We also assessed the relation between the population distribution and the distribution of users, based on the questionnaire results. Figure 6, based on the 2005 Population Census of Japan, suggests that the percentage of female residents aged between 50 and 79 varies widely in different areas of Tama City, with high percentages recorded in central and southern areas. This finding explains the large number of observed cases at Facility NO.

Thus, considering that the facilities of interest are used by community groups consisting of more than one participant, the question of whether or not a facility is used frequently is strongly related to whether the participants enjoy good access to the facility. From the perspective of the location-allocation problem, Ohsawa et al. (1987) reported that the optimum location of multi-person facilities tends to move toward the central part of a target area as the number of participants grows within the community group. This theoretical explanation also supports the basic ability of the given facilities to attract users.

Table 2 Number of passengers getting on and off trains at various stations within Tama City

	Getting on		Getting off	
	with commuter pass	without commuter pass	with commuter pass	without commuter pass
Seiseki-Sakuragaoka Station on the Keio Line	18118	15113	18118	15250
Nagayama Staiton on the Keio and Odakyu Lines	18638	13938	18638	13775
Tama Center Staiton on the Keio and Odakyu Line and the Tama Toshi Monorail Line	46378	26311	46378	26398
Karakida Staiton on the Odakyu Line	24506	8662	24506	8372

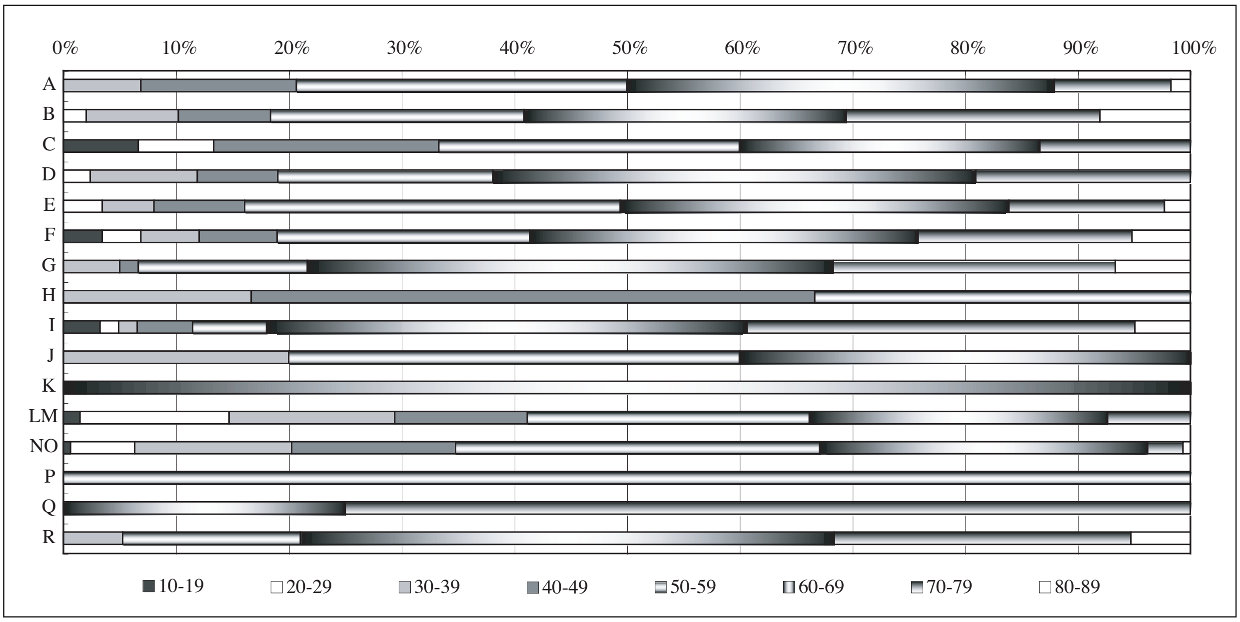

Figure 4 Age distribution of the user group for each facility, as based on the results of the questionnaire survey

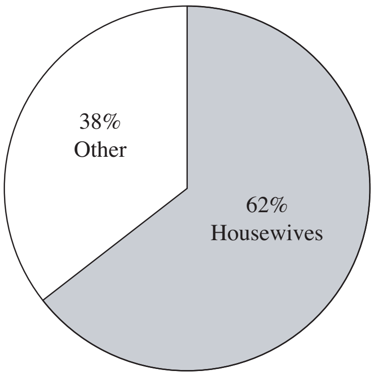

Figure 5 Percentage of respondents who reported their occupation as that of housewife

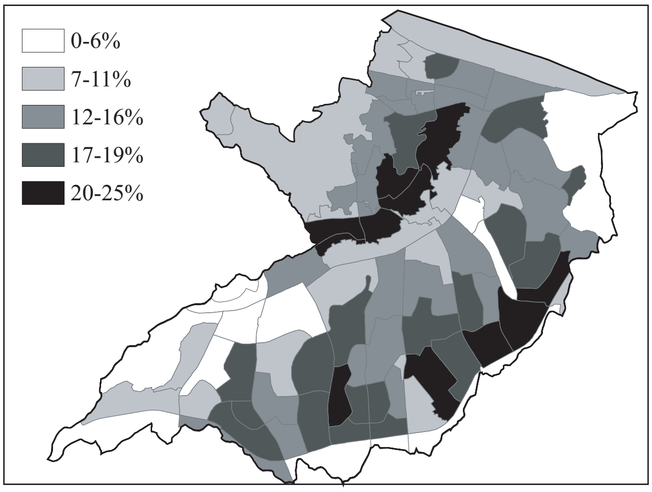

Figure 6 Percentage of the population of Tama City made up of women aged 50-79

4. Relation between the two most frequently used facilities

In terms of the basic ability of certain facilities to attract users (as discussed above), we did not consider the effects of the unavailability of the most frequently used facilities. If the most frequently used room in a facility is unavailable, the user will then search for the second-most frequently used facility and arrive at the following choices: (X) to use a different room in the most frequently used facility; or (Y) use a room in another facility.

From the viewpoint of facility location, choice X corresponds to the situation in which the most frequently used facility is the same as the second-most used facility, whereas choice Y implies that the two facilities differ. In the questionnaire survey, 243 out of 529 community groups answered the question regarding which room in a facility is the second-most frequently used facility. The relations between the two most frequently used facilities are shown in Table 3; the values of this table indicates the number of trip from most frequently used facilities to second-most frequently used facility. Table 3 shows that the number of answers corresponding to case X is slightly higher than those corresponding to case Y. This is because almost all users are eager to use the same facility all of the time.

Table 3
Relations between the two most frequently used facilities

Most frequently used facility \ Second-most frequently used facility	A	B	C	D	E	F	G	H	I	J	K	LM	NO	P	Q	R
A	8				2	1	2					1	2	1		
B	1	8					1					1	4			
C	1		3			1				1			1	1		
D	1	1		11			1						1			2
E	3				13				3				2			
F		1			1	4			1			1				
G				1			10		1		1	10	1			
H		1										2				
I					3	1	1	1	9			1	2	1		
J										1			1			
K											1					
LM		3				2	4		1			11	5	1		
NO	5	2		1	1	1	1			3		14	41	2		1
P	1			1												
Q	1														1	
R	3											1		1		

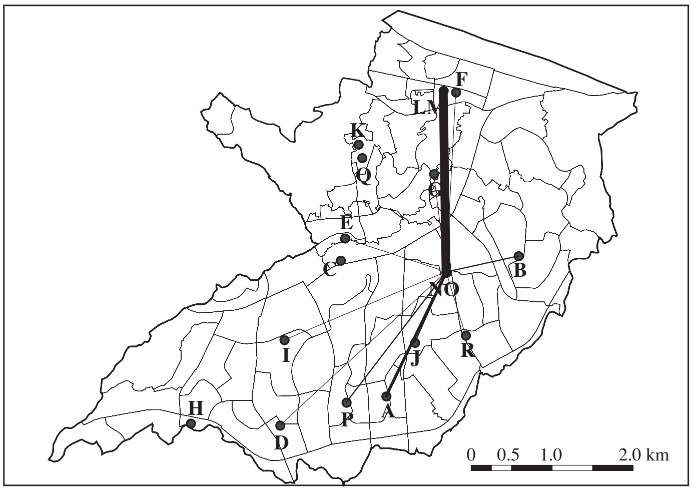

Figure 7 Destinations of trips made from Facility NO
(line width is proportional to the number of trips)

In the situation whereby the two most frequently used facilities differ, the strongest relations are found between facilities with a large number of rental rooms and that are located near stations, and facilities with a relatively small number of rental rooms and that are located away from stations, such as trips from Facility B to Facility NO and trips from Facility G to Facility LM. In considering the relation between Facilities LM and NO, a large number of trips are made from Facility NO to LM (Figure 7). Therefore, the choice of an alternative facility is not simply based on the distance between the most frequently used facility and the second-most frequently used facility.

Finally, we consider the number of observed cases and the questionnaire results in terms of the capacity of each facility. In Figure 8, the number of observed cases, the number of most frequently used facilities, and the number of second-most frequently used facilities are divided by the number of rental rooms in each facility. Despite the differences apparent in the different locations, the results presented in Figure 8 suggest that the utilization ratios of Facilities A and B exceed that of Facility LM. In addition, the utilization ratio of Facility F exceeds that of Facility LM, despite the fact that the two facilities share the same location-related conditions. This finding is related to the distribution of population shown in Figure 6. Unfortunately, the questionnaire results are inadequate in terms of revealing the full relation between the demand structure and the zonal interchange of residents.

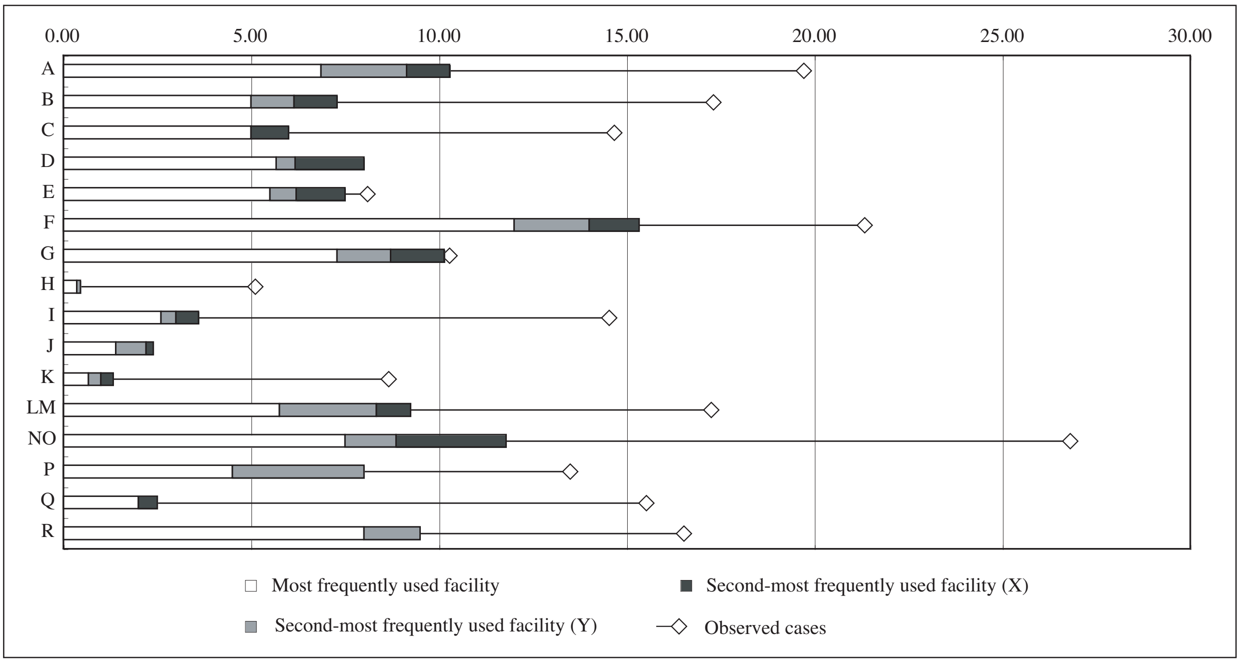

Figure 8 Number of observed cases (see Table 1), most frequently used facility, second-most frequently used facility (Y), and second-most frequently used facility (X) relative to the number of rental rooms available in each facility

5. Concluding remarks

This paper analyzed the demand structure of public facilities within Tama City via a questionnaire survey. With a focus on public facilities that provide rental rooms for recreational use, the aim of the study was to determine the relation between the demand structure of the facilities and the zonal interchange of residents.

The results show that women residents aged between 50 and 79 are the main users of rental rooms in public facilities. In addition, the demand structure of these facilities varies considerably with capacity and location. It should be noted that the potential utility of public building stock is affected by the relation between the ability of the facility to attract users (based on location-related conditions) and the zonal interchange of residents. Therefore, in developing an approach to restructuring public facilities that offer rental rooms, it is important to evaluate the network of existing public facilities based on a combined analysis of trip distributions, usage frequency, and the unavailability of the most frequently used facilities.

The following issues remain to be addressed in light of this study:

(1) to determine whether users will assign a priority to the facility location or room specification in choosing a facility;

(2) to develop a theoretical model to estimate the demand structure of public facilities in terms of accessibility, based on location; and

(3) to develop a model for restructuring public facilities based on the zonal interchange of residents.

Acknowledgements

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Reference

Hsieh P. C. and Tsunoda M., 2006, "A Study on Transformation of Spatial Reorganization for Regeneration of Public Facilities - A Case Study in Tama-City -", Proceedings vol.2 of the 6th International Symposium on Architectural Interchanges in Asia, pp.1397-1402

Kurakazu R., Yoshikawa T., Tsunoda M. and Takemiya K., 2007, "A study of community facilities utilization from users view point", Summaries of Technical papers of annual meeting (Architectural Institute of Japan)

Ohsawa Y. and Suzuki A., 1987, "Location-allocation problem of multi-person facility", Journal of the operations research society of Japan, Vol.30, No.3, pp.368-395

Yanagisawa K. and Yoshikawa T., 2007, "Estimation of the Demand Strucure in the Public Regional Facility - Case Study in Tama City, Tokyo", Summaries of Technical papers of annual meeting (Architectural Institute of Japan)

Yoshikawa T., Arimoto M., Takemiya K. and Tsunoda M., 2005, "A Method of Rearrangement Planning of Community Facilities Utilizing Existing Public Buildings in Matured Suburban Residential Areas A Case Study in Tama City", The 2005 World Sustainable Building Conference, pp. 3664-3671

The Value of Niigata Machi-ya Activation
- Estimation Using CVM and Questionnaire Survey -

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Keywords: Contingent Valuation Method (CVM), willingness to pay (WTP), Non-used value, Niigata, Machi-ya

Abstract
This study estimates the value of the Activation of Machi-ya buildings in Niigata by using the contingent valuation method. Machi-ya is the Japanese traditional style house for merchants and craftsmen. Niigata has about a thousand Niigata-Machi-ya around Furu-machi, the commercial center, of which over ten percent of them are currently vacant and are set to be lost. Although it is difficult to obtain a direct profit from these Machi-ya buildings, they nevertheless represent the traditional characteristics of the city. The value of the existence of such traditional buildings is a non-use value, which needs a certain method to be estimated by. We estimated the value of Niigata Machi-ya activation by the Contingent Valuation Method, using the data gained from interviews conducted around typical Machi-ya buildings. The interview contains two parts, the attributes of respondents and the willingness to pay (WTP) for the fund to the contingent projects of Machi-ya activation. We gave two types of activation projects, namely preserving and remodeling projects. Over half were unaware of Niigata Machi-ya. The remodeling project was chosen by about half the respondents, and preserving the project by about quarter of the total. WTP was lower among the residents of Furu-machi, higher in respondents from the outside. The residents nearby Machi-ya have low recognition of the value of Machi-ya buildings. These results show the importance of informing the preciousness of Machi-ya, especially to owners and residents in the vicinity.

1. Introduction
Machi-ya is the Japanese traditional style house for merchants and craftsmen. In typical cases, shop or work spaces face the street, with dining spaces and kitchen linked behind them. Kyo-Machi-ya in Kyoto is the most famous Machi-ya style building. Although many Japanese cities have their own typical Machi-ya style buildings to suit their specific climatic condition, few cities have succeeded in stimulating such areas. There are about a thousand Niigata-Machi-ya buildings around Furu-machi, the commercial center of Niigata city. The Niigata-machiya are characterized by *Choh-ji dukuri* and *Haridashi mado*. *Choh-ji dukuri* is named after the T-shaped ridge of the roof. Niigata machi-ya features roofs with ridges vertical to the front streets, while the shape of the roof ridge was changed to a T-shape with fire prevention purpose. The front ridge is parallel to the front street, and the back ridge is vertical to the street. *Haridashi mado* is the name for the over hanging windows of the second floor, which have been used like balconies for

watching festivals. Over ten percent of Niigata-machiya buildings are now vacant. It is difficult to gain profit directly from these Machi-ya buildings, but they still represent the traditional characteristics of the city and possess a typical building style, based on the regional climatic characteristics. They need to be stimulated.

The purpose of this paper is to estimate the value of Niigata Machi-ya activation.

There are several papers which estimate the value of the control law for preserving traditional cities, such as Aoyama *et al.* (2000). However, we are unable to find research which estimates the value of machi-ya building activation. The value of the activation of such traditional buildings is a non-use value, which requires a certain method for estimation. The Contingent Valuation Method (CVM) is frequently used for estimating values which comprise both used- and non-used value.There are several economic methods used to estimate such values. The Travel Cost Method is used to estimate the used-value by surveying a person's touring behavior (Ono *et al.*, 1996), although it cannot estimate the non-used value. The Hednic price method, meanwhile, estimates the value reflected in the land price (Jiang *et al*., 2005). CVM is the best method for estimating the value of Niigata Machi-ya activation. Activation of these traditional buildings will be promoted by showing the value of preserving them.

2. Theory of CVM

CVM is the method used for the estimation of the benefit of non-market goods. Benefit is estimated by asking the Willingness to pay (WTP) for the contingent project, by showing the present and after project conditions respectively. WTP is the amount that the respondent will pay for the fund or tax for the project.

In this study, we made the assumption that Niigata Machi-ya will be as things stand and we presumed the existence of a contingent activation project. The extent of the willingness to pay for funding or tax of respondents is questioned.

Estimation of the benefit is as follows. The aggregation of the acceptance rate from the result of the survey represents the distribution of WTP. Using the proposed amount of fund T and the attributes of respondents Z, the difference of the utility of before and after the project, ΔV, is expressed as $\Delta V = \alpha + \beta \ln T + \gamma Z$. Using ΔV, the probability of acceptance $P(T)$ is expressed as follows.

$$P(T) = \frac{1}{1 + \exp(-\Delta V)}. \qquad (1)$$

This represents the WTP curve. By calculating parameters α, β, γ, the WTP curve is estimated and then the median of WTP, which is T of $p(T) = 0.5$, is gained as the WTP per respondent (household or individual).

WTP, multiplied by the number of persons or households gaining benefit from the project, equates to the total project benefit.

3. Survey Method

3.1 Outline of the survey

We performed a survey by questionnaire for 5 days (September 20-22, and 30, October 1; three weekdays and two weekend days) on the street around the "old Ozawa's house", which is one of the typical Machi-ya buildings and well preserved. The survey was performed from 11:00 to 17:00 on weekdays and 12:00 to 16:00 during weekends. We showed a questionnaire sheet to respondents, and asked about each question orally. We filled in questionnaire sheets reflecting the choices and free answers given by respondents. The answer time for survey per respondent took about 7-8 minutes and we gained 87 answers in three weekdays and 187 answers in two weekend days. Because the survey was held on the street, quite a few people refused to answer, but a total of 204 persons did respond to our survey.

The questionnaire form contains two parts, a survey on the attributes of respondents and a survey on the CVM willingness to pay (WTP) for the fund to the contingent projects of Machi-ya activation.

3.2 Survey on the attributes of respondents

We gave several questions for survey on the attributes of respondents as follows.

How they recognize machiya: recognition levels of Kyo-Machi-ya (Machi-ya in Kyoto) and Niigata Machi-ya, reason for recognizing Niigata Machi-ya.

Attributes of respondents: their age, sex, occupation, and home address.

3.3 Survey for CVM

We gave the following two cases of contingent projects of activation in the questionnaire for CVM.

Case 1: Preserving the present condition to the historical center (preserving project)

Case 2: Remodeling for commercial use (shop or restaurant) with Machi-ya characteristics (remodeling project)

In case 1, we requested the WTP (willingness to pay) for one set of funding for repair and reinforcement to the historical center, and the WTP for each year's fund for management. In case 2, we requested the WTP for one set of funding for remodeling for a shop or restaurant. We presumed that the management cost would be paid from the profit of the shop, so three WTP were asked to the respondents in the questionnaire survey. Each question was composed using the payment card method, and the alternatives were ¥0-, ¥500-, ¥1000-, ¥2000-, ¥5000-, ¥10000-.

Before the question, we call the respondent's attention to the condition whereby payment to the fund or tax will result in a reduction of the household budget for other goods or services.

4. Results

4.1 Results of attribute of respondents

The age structure of respondents and of Niigata city are shown in Fig. 1. Young respondents (under 20 years old), middle aged respondents (30-40 years old) are about 30% and elderly respondents (over 50 years old) are about 40%. Although the ratio of old respondents is slightly more than that of Niigata city, the age structure of respondents is still similar to that of the latter.

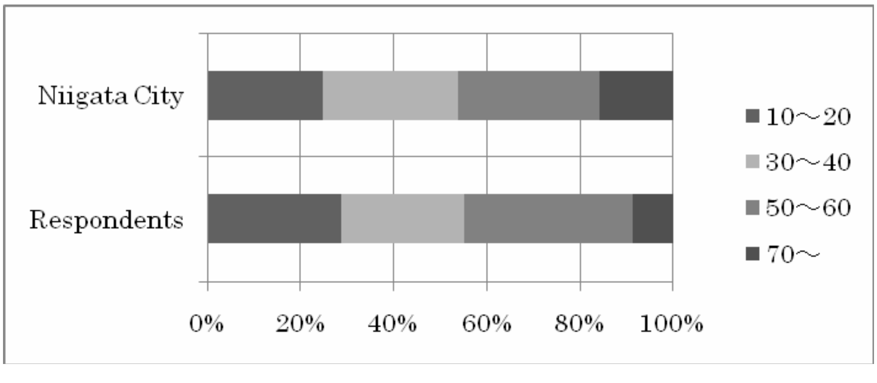


Fig. 1 Age structure of respondentsand Niigata city

The residential sites of the respondents are shown in Fig. 2. About 10% of respondents live in Furu-machi (the town in which we conducted the survey), about 70% in Niigata city, and the other respondents were from outside Niigata city. This means that over 80% of respondents to the area around Niigata Machi-ya were residents of Niigata city. The recognition level of Machi-ya is shown in Fig. 3. Although 95% of respondents knew about Kyo-machi-ya, only 38 % of respondents were aware of Niigata Machi-ya near their homes.

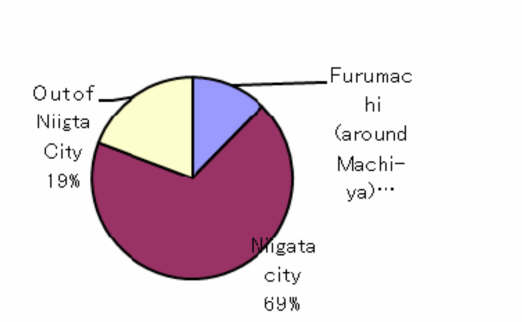


Fig. 2 Residential sites of respondents

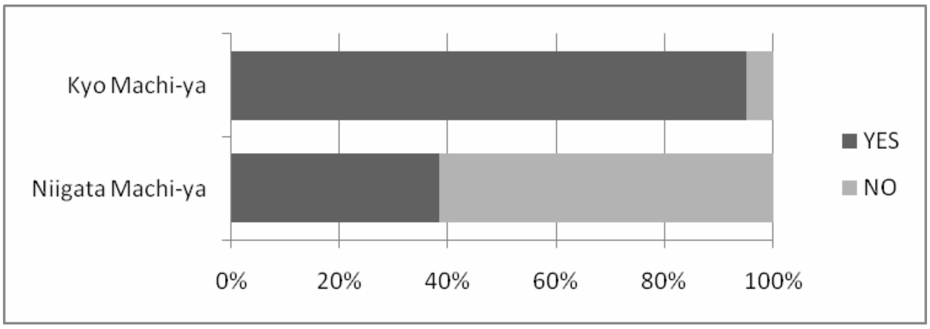
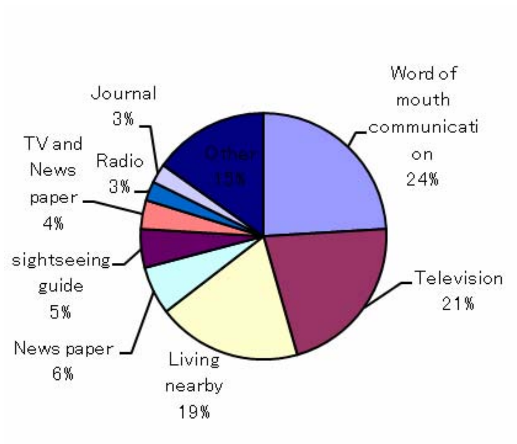


Fig. 3 Recognition level of Machi-ya

We asked the reason why they know Niigata Machi-ya, to the 38 % respondents who answered affirmatively to this question. Half the answers were "information from TV" or "word-of-mouth communication" (Fig. 4). The percentage of those answering "living nearby Machi-ya" was only 19%. As the half respondents actually lived in Machi-ya neighborhoods, this indicates that the vicinity of a dwelling does not necessarily equate to sufficient recognition of Machi-ya.

We asked the respondents which case of activation they preferred, and the result is shown in Fig. 5. Over half the respondents chose the remodeling project.



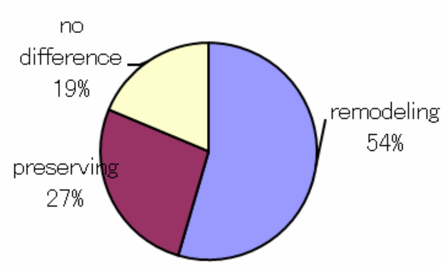


Fig. 4 Reason for recognizing Niigata Machi-ya

Fig.5 Preferrence of activation case

4.2 Results of the CVM survey and Estimation of Willingness to Pay

The result of collected answers of the CVM survey is shown in Table 1.

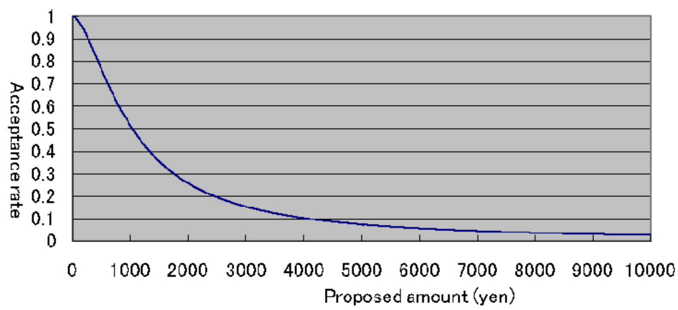
The accumulative acceptance rate for the amount of subscription to the fund for the projects are shown in the table.

Table 1 Accumulative acceptance rate

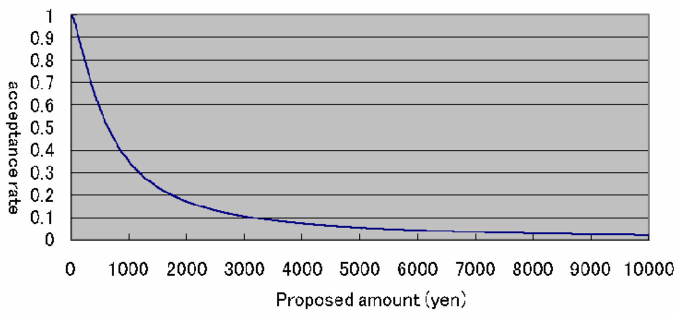
proposed amount of fund(yen)	0	500	1000	2000	5000	10000
Repair (preserving)	1.00	0.80	0.50	0.19	0.09	0.03
Management (preserving)	1.00	0.66	0.33	0.11	0.06	0.03
Repair (remodeling)	1.00	0.63	0.37	0.10	0.05	0.03

(%)

Based on those results, parameters α, β in equation (1) of each 3 types are calculated and the WTP curves are estimated. Figs. 6. A-C show the estimated WTP curves. The medians of 3 WTPs, which correspond to the half ratio of acceptance, are shown in table 2.

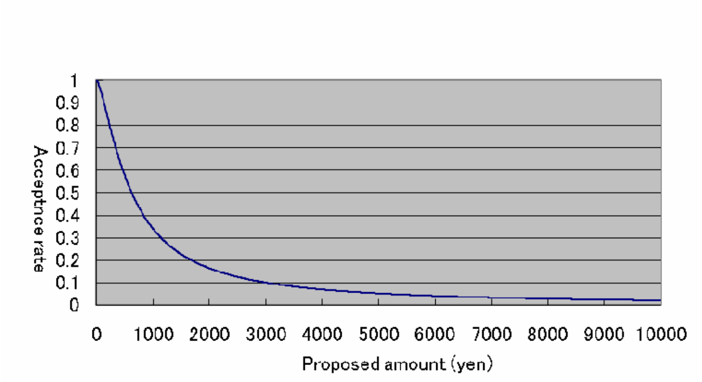


A: **Repair (preserving)**



B: **Management (preserving)**

Fig. 6 WTP curves



C: **Repair (remodeling)**

Fig. 6 WTP curves (continued)

Table 2 Median of WTP

	WTP [yen/**household**/time]	**WTP** [**yen**/household/year]	**WTP** [yen/**household**/time]
Median	**Repair (preserving)**	**Management (preserving)**	**Repair (remodeling)**
	1,026	**572**	**621**

The total benefit of each case is calculated as follows:

The WTP for repair and reinforcement (in Case 1) is 1026 yen, and the total benefit of the project is about 98 million yen.

WTP for maintenance and management (in Case 1) is 572 yen, and the total benefit is about 34.6 million yen.

WTP for remodeling (in Case 2) is 621 yen, and the total benefit of the project is about 47.7million yen.

These amounts of benefit were calculated based on the number of households visiting Niigata Machi-ya and the ratio of Niigata citizens in respondents, as well as the acceptance rate of the projects.

4.4 WTP belong to the individual factors of the respondents

WTP belonging to the generation of respondents are shown in table 3. The younger generation recognize the high value of the remodeling project, while the older generation recognize the high value in preserving the project. The 30-40 year old generation have a low WTP in every type.

WTP based on the sexuality of respondents are shown in table 4, with little significant difference obvious between female and male WTP.

WTP belonging to the home address of respondents are shown in table 5 and the WTP of the remodeling model is higher in the evaluation from near residents and lower in that from distant residents. As we performed the survey on the street nearby Machi-ya, most respondents from outside Niigata city seemed to recognize the value of Niigata Machi-ya already before the research, and the near residents seem to evaluate the use value higher than the non-used value, such as the tradition of the region.

Table 3 WTPs belong to the generation

generation	Repair (preserving)	Management (preserving)	Repair (remodeling)
10～20	1,004	735	801
30～40	885	471	572
50～	1,109	683	583

（Yen）

Table 4 WTPs belong to sexuality

sexuality	Repair (preserving)	Management (preserving)	Repair (remodeling)
male	1,155	603	664
female	888	650	602

(yen)

Table 5 WTPs belong to the Residential site

Residential site	Repair (preserving)	Management (preserving)	Repair (remodeling)
Furumachi	645	168	830
In Niigata city	1,012	656	632
Outside Niigata city	1,278	853	512

Table 6 WTPs belong to the preference of activation projects

Preferred Project case	Repair (preserving)	Management (preserving)	Repair (remodeling)
Preserving	1,228	773	555
Remodeling	1,007	567	706
No difference	873	649	551

(yen)

5. Consideration

We estimated the value of Activation of Niigata Machi-ya buildings in two contingent cases.

In the preserving project, the estimated total benefit of repair and reinforcement is about 98 million yen, and the estimated total benefit of the maintenance and management per year is about 34.6 million yen. In the remodeling project, the estimated total benefit of repair and remodeling is about 47.7 million yen.

Let us suppose we have a real project, and access to the funds discussed above. There is one famous case of Niigata Machi-ya activation, *"E-ya"* (meaning 'picture shop' in English), which is now used as a gallery of pictures drawn by artists who have links to Niigata.

The cost of repair and reinforcement of the Machi-ya "Old Ozawa house", which we showed to the respondents to help them imagine the WTP , was estimated based on the cost of those of *"E-ya"*. The cost of repair and reinforcement for a single Machi-ya, of size almost equivalent to the Ozawa house, is estimated at 21 million yen.

The cost of maintenance and management was estimated using the same procedure above and these costs are estimated at 30 million yen for a year.
These costs are both lower than the estimated benefits and this result shows us that it is important to implement both cases of activation.
There is one point to focus on. We explained the details of Niigata Mach-ya sufficiently before asking WTPs, to the respondents who answered that they didn't know about Niigata Machi-ya in the first question. As shown in Fig. 3, less than 40% of respondents recognized appropriately about Niigata Machi-ya in the first question, which seems to represent the present conditions around Niigata machi-ya.
For those unfamiliar with Niigata Machiya, the value of activation will not be recognized appropriately. As over half of residents living in the vicinity of Machiya don't recognize the value of activation, it is highly probable that the Niigata Machi-ya will be lost.
These results show the importance of broadcasting the value of Machi-ya which represent the traditional characteristics of the city and which have a typical building style, based on the regional climatic features.

6. Conclusion

We estimated the value of Activation of Machi-ya buildings in Niigata Using contingent valuation method. Niigata Machi-ya activation was evaluated by CVM (Contingent Valuation Method) using the data gained from the questionnaire survey. The questionnaire contains two parts, the attributes of tourists and the willingness to pay (WTP) for the fund to the contingent projects of Machi-ya activation. We specified two types of activation projects, maintaining the present condition to the historical center (preserving project) and remodeling to shop with Machi-ya characteristics (remodeling project), and requested the WTP by payment cards method.
The results were as follows. Over half the respondents were citizens of Niigata city and over half were unfamiliar with the Niigata Machi-ya. The remodeling project was chosen by about half the respondents, and the preserving project by about a quarter. Both respondents responded with a higher WTP for the chosen project than for others, while WTP was lower in residents of Furu-machi, and higher in respondents from the outside. Residents living in the vicinity of Machi-ya had a low recognition of the value of Machi-ya buildings, while younger and older respondents responded with a higher WTP than the middle aged.
These results show the importance of broadcasting the value of Machi-ya activation especially to owners and residents nearby.

References

Aoyama, Y., D. Nakagawa, R. Matsuyama and T. Oba. 2000, The economic evaluation of the Ancient Capitals Preservation Law based on the consciousness of Kyoto, Papers on City Planning, No. 35, pp. 169-174.
Ohno, E., S. Tanae and A. Takagi, 1996, Benefit Evaluation of Park Improvement by using the New Travel Cost Method, Papers on Civil engineering, No. 13, pp. 401-408.
Jiang, E., D. Nakagawa, Y. Karatani and Y. Aoyama, 2005, Calculation of Benefits brought about by Transportation Penetration in Suburban residential area., Papers on City planning, No. 40-3, pp. 343-348.

The Formation of Vernacular House in South Kalimantan Province, Indonesia : Environmental Impact of River Network Evolution

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Keywords: Vernacular architecture, formation, Environmental impact, conservation.

Abstract

Kampung (urban village) of South Kalimantan province have ten types vernacular houses and one traditional house, which are shaped by the topographic condition, river living style and local material. The formation of these characteristics structure consists of construction a set of hierarchy enclosure and their corresponding zone communities with the objective of systemizing the inner zone movement of kampungs while the existence of vernacular house has been disappeared now. This paper presents to estimate the formation of vernacular house for environmental impact of river network evolution. It provides a quantitative basis to describe the pattern of vernacular substances in case of building activation in South Kalimantan (Borneo Island) for conservation and preservation area.

1. Introduction

1.1. Background

Formation, evaluated as a result of accumulation of the environmental impact, play an important role in vernacular architecture of Kalimantan. Impact categories are mainly based on their nature as a diffusion of settlement pattern. The most important reason for the existence of a third Malay settlement area, namely the island of Borneo is that traditionally the process of Malay settlement grew considering to the land of the Dayak customary in which they exist. (Hikajat Bandjar.JJ.Ras.1977). But, the `Coastal Malays`, living not only on the coasts but also far inland, have so far received little attention. In the sultan period from 16th century, the vernacular house became one of the popular styles in Barito Basin. These records provide evidence for river level change and its influence on the Banjarese communities and the environment succession. The present work studied the conservation of floating market and vernacular house in three cities called "Rumah Bubungan Tinggi" in the South Kalimantan. These cities are the most oldest example type of the "Rumah Banjar". Obviously, the aquatic environments are focused on the quantitative basis of formation pattern. Within this context, this research deals with a specific aspect, the formation of field works of mosaics in relation to river network evolution based on a seventy inhabitant correspondences.

Vernacular building in Indonesia are the reproduction of folk architecture that emerged as an image of each ethnic group and environment through culture of rationalization process, and as a result of a distinctive style of traditional housing called Rumah adat. Vernacular buildings are the product with a thousand senses based on climate, space and culture.

Kalimantan heritage resources are a threat as an approach of conservation planning in case of building activation today. In Indonesia, several studies have been carried out in the field of vernacular architecture of Indonesia. This study is generated in the context of the available data obtained from a certain traditional historic site with the powerful vernacular houses in South Kalimantan, Indonesia. Undeniably one of the most mysterious islands in the world the Kalimantan is visually adventuring not only due to its enclosure river and swampy. Some of small town, kampungs and villages in Banjarmasin, Martapura, Marabahan and Amuntai are the oldest cities which high prestige historic.
In this study, in order to determine a primitive profile of vernacular house, its formation mechanism and the relationship between an environmental impact and river network are investigated.

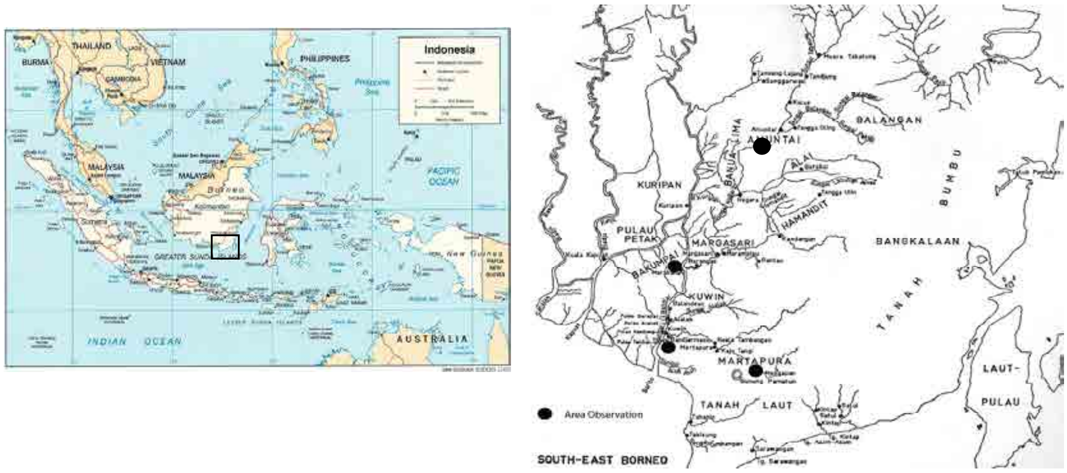

Fig.1 Area Observation

1.2. Object of Study

1.3. Objectives

Our objectives in this study are to clarify the sense of traditional and vernacular buildings based on using open building method which critical problem from the past and nowadays pointing of recently condition. It shows different type of houses based on region and historic background. Finally, patterns are decided.
This research provides formation of vernacular house approach in a case study of Martapura, Marabahan, Banjarmasin and Amuntai city. Some environmental impact results of vernacular architecture scenarios are presented in the paper. While four cities in the eleven type of traditional houses scenarios for conservation assessment purposes considered of harmonization process that are creating the opportunity to building stock activation icon more effective values for sustainable urban regeneration.(Fig.1)
This framework is then used to analyse the processes and outcomes of formation of vernacular house in South Kalimantan in the 1800s and1945s, pointing of view of traditional houses until contemporary.

2. Methodology

This study employed Open Building Theory (OB theory) as a method of analysis by mapping the contents of environmental impact into formation icon, to clarify the relation of between approaches. The result was placed into a primary pattern according to categories of house to understand how environmental impact related to the housing development. For this study, categories content two levels are derived from a diagram of the principle of environmental levels, two distinguishing phases of a built environmental level: tissue level and house allocation level. Tissue level deals with identifying and describing a building assignment lot base on lot occupant in which the urban environment determines all of the impact features and specifies all the requirements that a successful pattern solution must have. House allocation level deals with dwelling occupant.

Based on the foregoing discussion, another methodology has been supported to combine process-level models. First, Bossel`s framework, the six fundamental environmental properties are environmental stae, resource scarcity, variety, variable, change and other actor systems. (Bossel, 1999). Those fundamental include basic indicator correspond to human, support and natural system. Second, the methodology of gradation that combine the exterior and interior evaluation. Third, AquaBAMM`s framework, built as a hierarchical approach with four level data analysis.

In order to evaluate environmental impact of river network evolution on formation of vernacular house, the rural households and eco tropical sustainability, riverside household were surveyed using a pre-designed questionnaire in 2006-2007. To uncover possible misinterpretations of questions or ambiguities in the questions response categories, the questionnaire was in June 2006 on a sample of 4 households in Banjarmasin,7 households in Martapura, 2 households in Marabahan. In May 2007, 70 households from 1 village were sampled in Amuntai.

3. Results and Discussion

3.1. Tissue Level Response

Formulation of vernacular house and aquatic environment

South Kalimantan province is one of four Indonesian provinces in Indonesia (West Kalimantan, East Kalimantan and middle Kalimantan) that constitute with 11 regencies and 5 ethnics which lies through the Barito river tributaries (Kuin, Martapura, Sigaling, Pangeran). An evolution composite to the reconstruction of river network has showed during 1530 until 1899s from Banjarmasin city. The river tributary were transported into 2007s in the desa of Sapala which very primitive people and pattern of riverside settlement. The mosaic presented from central pattern changed to linear influenced by road construction today (Fig.2).

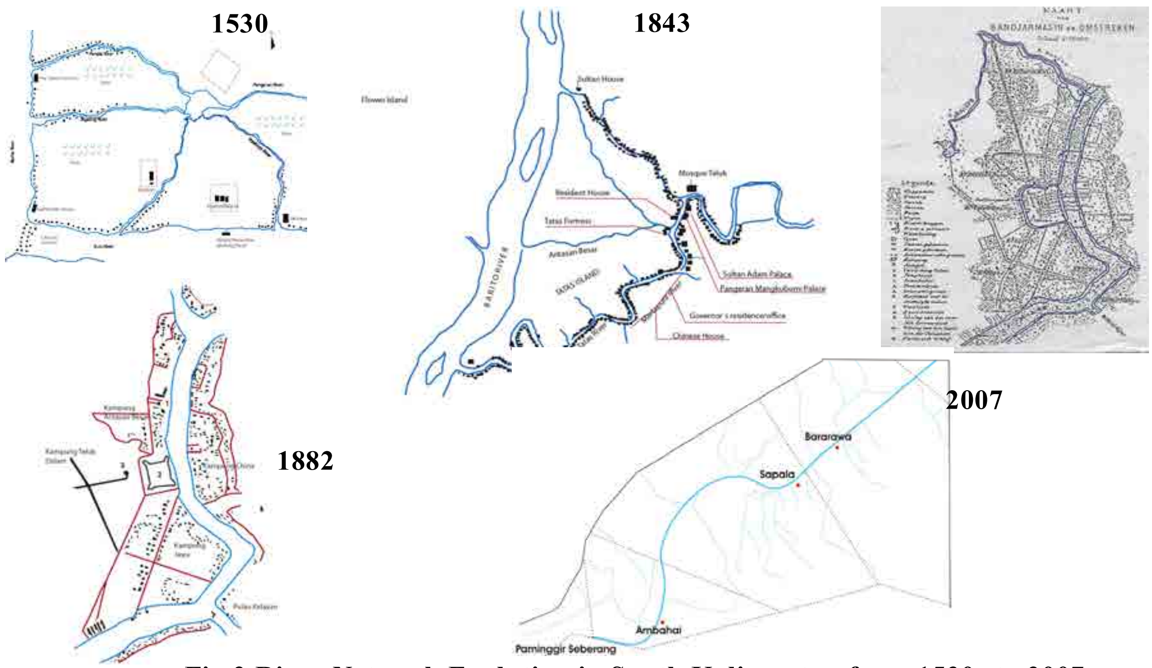

Fig.2 River Network Evolution in South Kalimantan from 1530s to 2007

The South Kalimantan province can be considered based on The Encyclopedia of Vernacular Architecture of the World (EVAW) edited by Paul Oliver in term of social and economic assessment while the aquatic environment indicated as habitat symbolism. The evaluation of environmental impact of the vernacular house in 4 cities indicated:

Table 1. The Distinguishing between Three City

City	Note
Martapura (MTP)	A zone around 0-200 m from central of BJM and at the foot of the Meratus range, very famous as diamond kampung,(survey July 06) some people not only settled on raft in the river but also rest on high poles on the marshy bank river and on the land,(Hikajat Bandjar by J.J.Ras) 49 km2, 12 kampungs,(Statistic 02-03, Depart. Of Public Office, City Development Section) Islamic dominant characteristic life style.
Banjarmasin (BJM)	A city with a thousand river, also the same with MTP city, where the first of Bandjar kingdom settled all constructed on bamboo and iron wood, (survey July 06)BJM near the confluence of the MTP and Barito River, lie in an extensive swampy area which is regularly inundated at high tide and thus not very suitable for cultivation, the low lying area to the west of this belt that is, all the land west of Barito is inhabited by Ngadju Dajak tribes(Hikajat Bandjar by J.J.Ras), a coastal district and the biggest port in Kalimantan (Borneo) on the 13th century(survey July 06), 72 km2, the smallest town with high density population in Kalimantan 5 % growing average almost landuse dominated for settlement 3.343 Ha(Statistic 02-03), 11 kampungs in the north BJM (Depart.of Public Office, City Development Section)
Marabahan (MBH)	The originally narrow settlement area gradually expanded westward and southward, following the course of the Nagara River and that of the Barito below present day MRB, the port and trading centre of the Nagara Daha realm was located at MRB on the conluence of the Nagara River with the Barito some 40 km upstream of BJM(Hikajat Bandjar by J.J.Ras), 20 Ha, 1.6% growing average/year(Statistic 02-03), there are Bandjar tribe, bakumpai, java, bali and sunda.
Amuntai (AMT)	The low river-banks passed the desa of Danau Pangang, especially desa of Sapala, where found many water-buffoloes and vast stretches of rice fields. A large and beautiful kampung that it containt 1,480 houses,(Hkajat Bandjar by J.J.Ras) built on both side of the river, are all constructed of bamboo and iron-wood.

A. Socio Economic Assessment

Table 2 presents some parameters that have real influence the overall assessment value of the seven orientors `impact grades, the ratings for the identified social and cultural parameters from 0.01 to 3.82. The highest indicator value content of the indication at the time of sampling was in the rate 3.84 for support and natural. Most of the indicators are above the low level. This indicates that the consideration of environment impact must take a strong focus attention for improving inhabitant quality in Sapala Village part area. The values for orientors such as coexistence and psychological need rate from 1 to 3, content a mean value of danger and good.

The present river in the Sapala Village carry formation from sources more than 20 km, on the contrary, in the raining season, this village become a large lake, such long transport distances are know to lead to effective resetting of natural resource evolution.

B. Aquatic Cultural Heritage Value

In the framework of conservation intervention, the aquatic cultural heritage value can be translated by terms such as induced from traditional to contemporary dwellings. In the aquatic environment, a detailed aquatic cultural assessment involving a comprehensive field survey has determined of how individual elements influenced the overall AquaBAMM conservation value. The result of the overall South Kalimantan river catchment focus only on the levels of the criterion rating and AquaScore that close to half of the catchment area was rated a medium value (22%) with 71.4% being high, 22.2%low and 100% each for very high and very low (table). All spatial units had better than 30% dependability in their scores and most had reliabilites of more than 40% with an overall mean dependability of 50%. The means AquaScore dependability rated between 44%(low) and 90%(very high). The spatial variation of the AquaScore values within the river in South Kalimantan is presented in Table 3.

Table.2 Indicator of Social Sustainable Assessment in South Kalimantan

Orientors	Subsystem	Indicator Performance	Assessment Result
exitence	human	Health food	0.13
	support	-	0.00
	natural	-	0.00
effectiveness	human	Distribution of personal income	0.14
	support	Residential water consumption	0.00
	natural	Solid waste system	0.00
freedom of action	human	Housing affordability ratio	
	support	Voter participation	0.00
	natural	Rivers	3.82
security	human	Crime-SARA	0.00
	support	Emergency room use for non ER purposes	0.00
	natural	Soil pollution	0.01
adaptability	human	Youth involvement in community service	0.02
	support	Better community space	3.84
	natural	Wetland	3.84
coexistence	human	Ethnic diversity of teachers	0.26
	support	Water quality	0.01
	natural	fish population	2.47
psychological needs	human	Neighbourliness	3.80
	support	Pedestrian-titian friendly street and bridges	0.15
	natural	Open space in kampung (urban villages) and village	1.00
overall			19.49

Table.3 Aqua Conservation Value

Location		Natural Aquatic			Natural Catchment			Diversity and Richness			Threatened Species and Ecosystem			Priority species and Ecosystem			Special Features			Connectivity			Representativeness		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Banjarmasin City																									
Kampung:																									
Kuin Utara I	2	●			●				●			●		●			●	●		●			●		
Aqua Score		67%H/22%M			57.1H%/42.9%M			37.5%H/62.5%M			16.7%H/66.7%M/16.7%L			100%H			50%H/50%M			66.7%M/33.3%L			100%H		
Sungai Jingah	1		●			●			●		●			●			●				●		●		
Aqua Score		22.2%H/44.4%M33.3%L			42.9%H/57.1%M			37.5%H/50%M/12.5%L			83.3%H/16.7%M			100%H			80%H/20%M			33.3%H/66.7%M			100%H		
Surgi Mufthi	22		●			●			●		●			●				●			●		●	●	
Aqua Score		22.2%H/44.4%M33.3%L			42.9%H/57.1%M			12.5%H/62.5%M/25%L			50%H/33.3%M/16.7%L			100%L			30%H/50%M/20%L			33.3%H/66.7%M			50%H/50%M		
Martapura City																									
Kampung :																									
(Urban village)																									
Melayu	1			●	●				●	●		●						●			●			●	
Aqua Score		11.1%H/33.3%M/55.6%L			71.4%M/28.6%L			25%H/37.5%M/37.5%L			16.7%H/50%M/33.3%L			100%L			10%H/60%M/30%L			33.3%H/66.7%M			100%M		
Keraton	1		●		●					●	●			●					●		●				●
Aqua Score		22.2%H/44.4%M/33.3%L			71.4%M/28.6%L			12.5%H/12.5%M/75%L			50%H/33.3%M/16.7%L			100%L			10%H/40%M/50%L			33.3%H/66.7%M			100%L		
Karang Intan	1		●			●	●		●				●	●				●	●			●	●		
Aqua Score		44.4%H/55.6%M			4.3%H/42.9%M/42.9%			12.5%H/62.5%M/25%L			33.3%H/16.7%M/50%L			100%L			20%H/40%M/40%L			100%L			50%H/50%M		
Gedang	1		●		●					●		●		●					●			●			●
Aqua Score		22.2%H/44.4%M/33.3%L			57.1%M/42.9%L			25%H/37.5%M/50%L			16.7%H/50%M/33.3%L			100%L			10%H/40%M/50%L			100%L			100%L		
Keramat	1		●		●				●		●			●				●		●			●		
Aqua Score		66.7%H/33.3%M			100%M			37.5%H/50%M/25%L			50%H/33.3%M/16.7%L			100%L			10%H/60%M/30%L			66.7%M/33.3%L			100%M		
Desa:																									
(Village)																									
Teluk Selong	1			●		●			●		●	●	●	●			●					●	●		
Aqua Score		22.2%H/33.3%M/44.4%L			4.3%H/57.1%M/28.6%			25%H/50%M/37.5%L			33.3%H/33.3%M/33.3%L			100%H			50%H/40%M/10%L			33.3%M/66.7%L			100%M		
Amuntai City																									
Desa:																									
Sapala	70			●	●		●	●			●			●			●			●			●		
Aqua Score		77.8%H/22.2%L			42.9%H/14.3%M/42.9L			100%H			50%H/16.7%M/33.3%L			100%L			90%H/10%M			90%H/10%M			100%H		

3.2. House Allocation Level

A. Formulation of kampung-desa and aquatic environment

The basic idea of this level that we can distinguish different levels of intervention such as: cities, housing, and inside house fit-out elements like partitioning, kitchen, bathroom equipment, and finally furniture. Each level has its own pace of change. The higher level is most stable and changes very slowly, the lower level can change much faster. The distinction of levels makes it possible for a neighborhood to exist for a long time while renewing itself piece by piece in response to the need of the people living there.

This capacity for partial change in response to daily life by means of partial interventions was always present in historic vernacular urban environment from precedents to OB as well.

We found some topological character of pattern for RBT groups. The implication of the basic model of the RBT, movement and distortion base on time line analyses result eight primary pattern. Primary pattern described as a comparative tool and decision level for many providers to explore each component of the building. One of those patterns are community configuration patterns, the exploration might combine to both urban structure and urban space as implication for starting the possibility of intervention. This means that the principles can bond functionalities to environment, such as community space and parking area (public space), without their configuration being customized. There are 13 sub patterns include formal and community configuration. (See Fig.3)

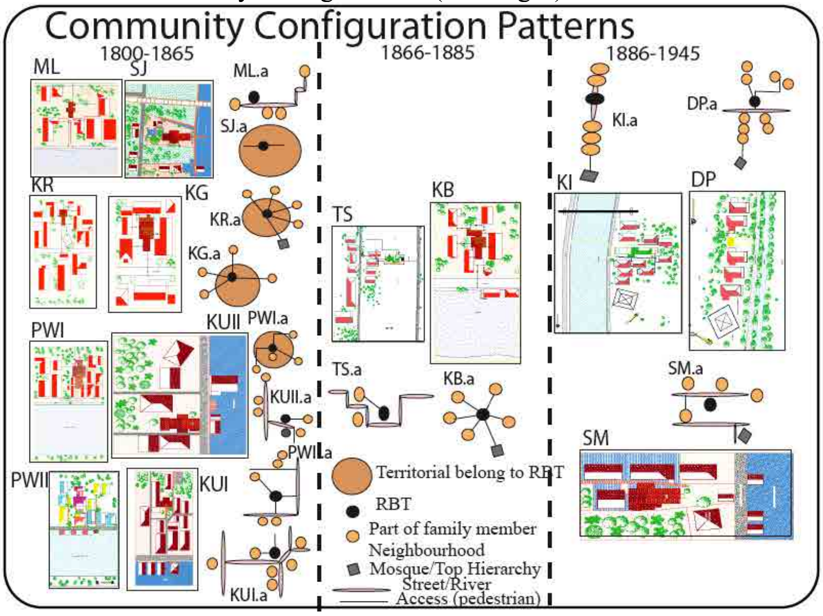

Fig.3 Community Configuration Patterns

B. Overall formation and environment impact

The traditional Kalimantan house styles on the BJM are consistently related to the mozaic of river network and their old development pattern. Modern house styles on the BJM are related to the pattern of road colonies and their new development patterns. Finally, the result that modern house and house on land were use to contemporary life which found new colonies in road facing houses more than in water facing houses to some extent.

Bilateral and rotational symmetry is indicated the most dominate in those formations. Three-folds rotational symmetry without any reflection symmetry (called: triskelion) composed three heavy chains on top level. The similar symmetry has a significance affinity with that of `golden section`. It means that divine proportion, golden ratio and PHI investigated to vernacular houses. (See Fig. 4)

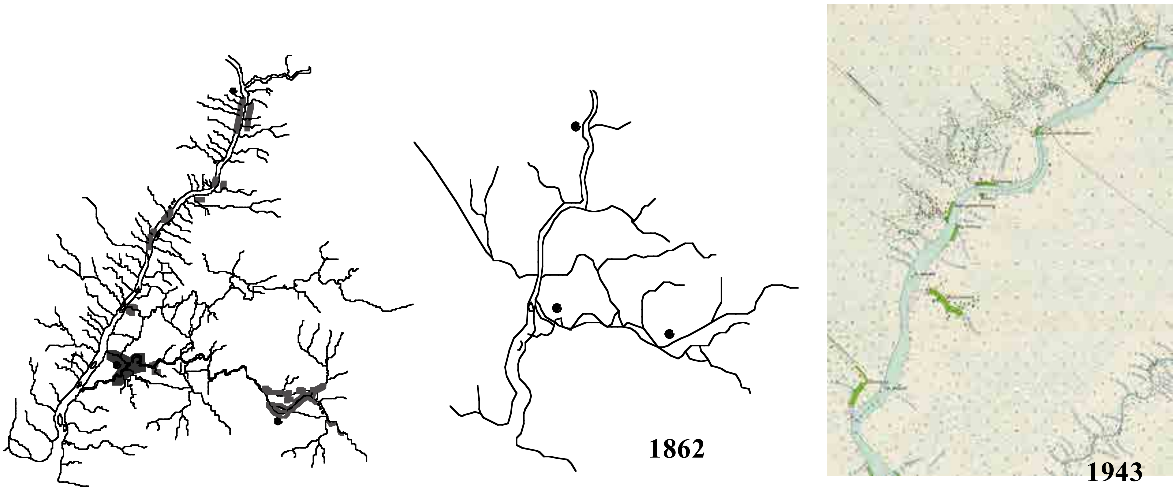

Fig.4 River Network Evolution
During The Beginning of 19th until 20th century

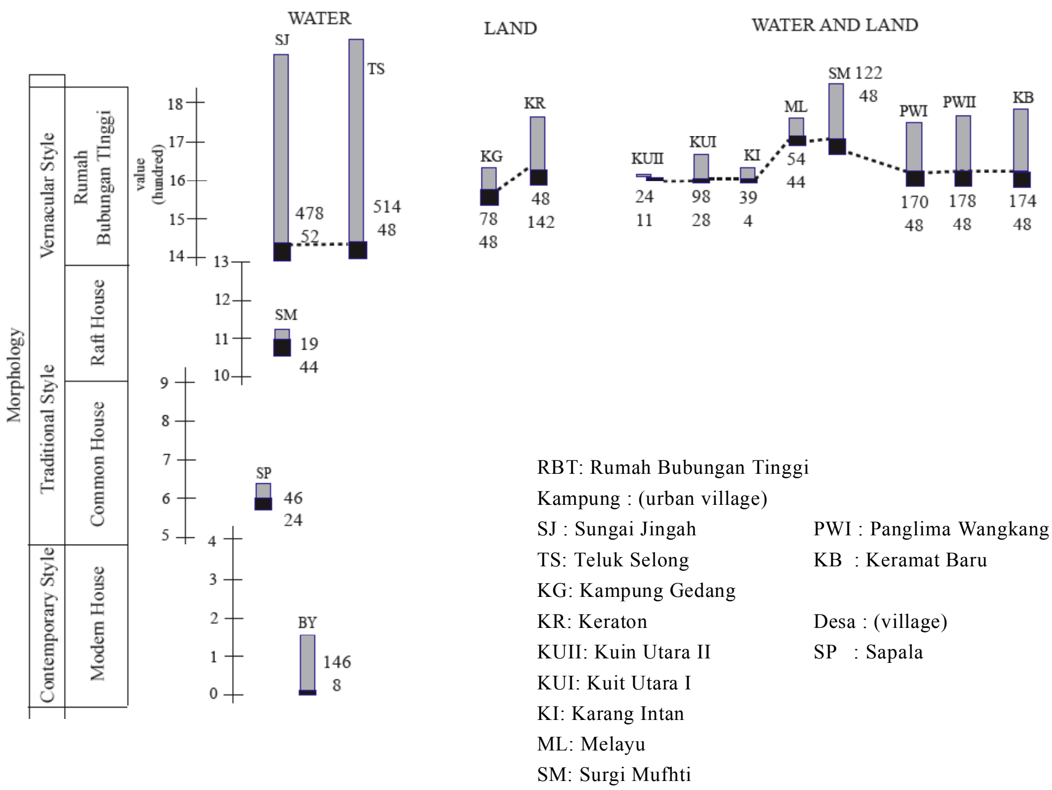

Table.4 The Formation from Traditional to Contemporary House:
Integration System Expression Based on River Network Evolution

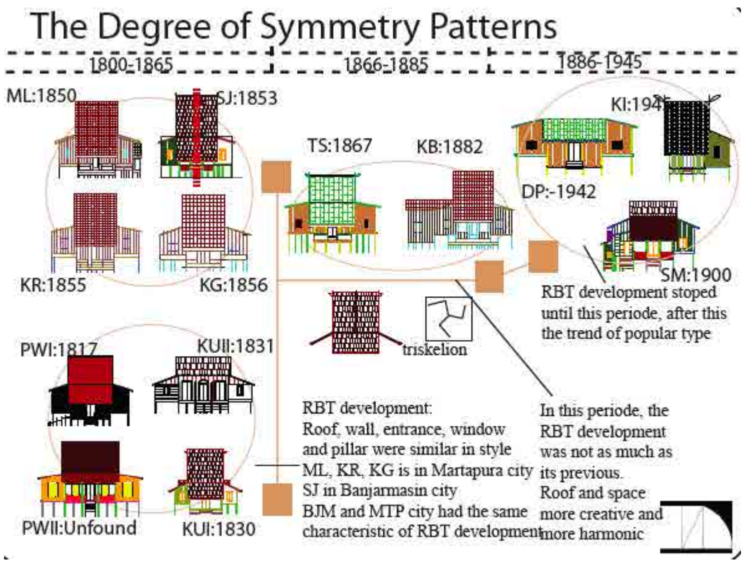

Fig.5 The Degree of Symmetric

4. Conclusion

Thirteen vernacular houses varying in size and plan built in wooden style. Others built in rafting and land based construction. The fact that although the form of vernacular houses (RBT) in BJM distinct from MTP and MBH, the most basic principle among the settlements are similar. RBT in MTP and BJM are the generation and variation from MBH. Consistently, RBT in the period 1880-1865 was a repeatedly relates façade and roof element and a few parts in the same way. The configuration incorporates a rule of selection and a rule of distribution found in the TS and SJ.

However, the desa of Sapala in Amuntai City are one of the case samples for primitive architecture that have to be improved. These data suggest that the old rivers and modern rivers have to increase the special zone for built environment to be better.

A combination of basic indicator and aqua score evaluation data has provided a useful tool in the formation and reconstruction of river network evolution. The principle of OB theory not only for traditional style but also vernacular and contemporary style, in which compatibility can be included, can provide a framework of option for building activation today. In fact, the validity of those principles may vary with the context in which one will have to decide.

5. Acknowledgements

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References

Benson.J.F. 2003. *What is the alternative? Impact Assessment tools and Sustainable Planning,* Beech Tree Publishing

Habraken, N. J. 2001. *The Structure of The Ordinary, Form and Control in The Built Environment*, MIT Press.

Habraken, N. J. and MIT Students. 1981. *The Grunsfeld Variations*, MIT

Ipekoglu, Basak.2006. *An Architectural Evaluation Method for Conservation of Traditional Dwellings,* Building and Environment 41

Koos Bosna, HMV. 2000. *John Habraken and The SAR (1960-2000),* NAI publisher

Kendal, Stephen and Teicher, Jonathan. 2000. *Residential Open Building,* E & FN Spon

Activation of the Historic and Cultural Resources on Urban Renewal Area in Korea

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Keywords : History, Culture, Conservation, Utilizing, Urban Renewal

Abstract

Recently, there are various redevelopments such as "Housing Redevelopment", "New Town Project", "Residential Environment Improvement", and "Housing Rebuilding" owing to the building obsolescence, local urban decline, and poor urban surrounding in Korea. Most of the projects have pursued the demolition method instead of rehabilitation or infill redevelopment. Consequently, many developers have implemented redevelopment projects without their local identity and placeness, destroying many historic and cultural resources(hereafter called "HCR").

Therefore, the finding and revitalizing HCR in redevelopment area is necessary. The purpose of this paper is 1) making the concept of HCR from urban renewal perspective, 2) analysis and study of case in which HCR were utilized into urban design factors, and 3) classifying utilizing methods of HCR.

The scope of cases in this paper deal with 4 types of urban renewal : land redevelopment for housing complex, residential environmental improvement, urban environmental renewal, and housing redevelopment with traditional housing.

In this paper, we established the revised concept of HCR from too broad sense for urban renewal. From urban renewal perspective, the concept of HCR should include the essential factors of past, generality, utilizability. Through this concept, the types of HCR could be classified into cultural heritage, natural environment, townscape, traditional housing, old building, public street, folk tale, old name of place, residents' memories and consciousness.

About method of using factors of HCR, we could suggest 3 types of methods : mere preservation, using a townscape factor, and utilizing a public place.

1. Introduction

Since the 1990s, urban renewal in Korean city had begun to act dynamically owing to the building obsolescence, poor urban surrounding, and economical benefits. The active urban renewal spreaded from old urban area to new land near city. In case of projects in new land, burial cultural heritage discovered during excavating before building construction. Then, many developer used to regard burial cultural heritage as a obstacle of the development. Such as it, the development and conservation always have conflicted.

However, we should see it as positive factors to utilize not obstacles because that was our identity as well as our history, past. Though conservative experts related with it by now, it is time that progressive developers are interested in historic and cultural resources. The way of conservation of historical heritage have changed from preservation of protected individual one to conservation concern with groups of historic one. Also, the scope of historic and cultural heritage is expanded to near past such as time originating memory of present residents.

2. What is the New Concept of Historic and Cultural Resource ?

In case of Korea, the concept of historic and cultural resource is related with the cultural heritage originated before Chosun epoch(~1900), which were conserved by law. However, in recent years, the concept of historic and cultural resource began to change more broadly. Specially in field of urban renewal, the scope of it includes various factors of some resources originated after 1900's

Therefore, we should find the correct scope of historic and cultural resources, dividing words of HCR to each essential word. The 3 words are history, culture, and resource. The history means the events of past, so the essential point of history is 'past'. The culture means activities such as arts and philosophy for the development of civilization and people's mind, so the essential point of culture is 'generality'. The resource means some materials that they can use in order to function properly, so the essential point of resource is utilizability.

The scope of past in HCR is very broad on time axis. In case of urban renewal, we need reestablishment of the scope of it. From legal perspective, the scope of period of HCR is the time before 1900. However, from urban renewal perspective, the scope of it includes memories of present citizen. This memories mostly originated after 1900 before 1950. For example, now 80 years-old people was born in 1927. His childhood days are between 1927 and 1950.

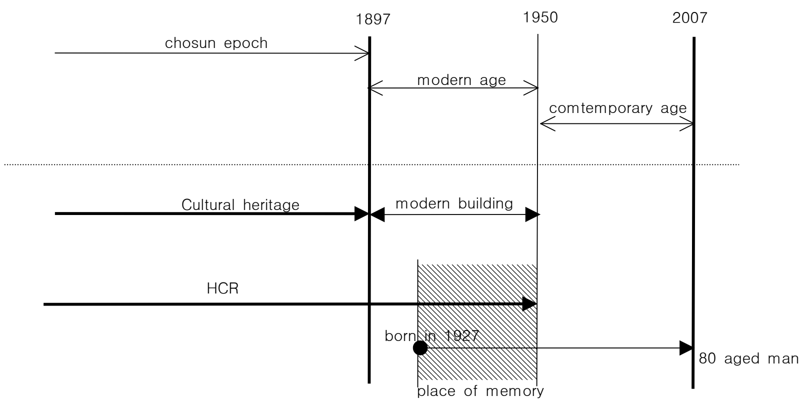

Fig. 1 Time Scope of HCR

The culture is a kind of acts or events made by not an individual but some groups. In case of urban renewal, in other words, minimum unit of some group in urban renewal is residents in same neighborhood unit. Therefore, the scope of generality in HCR are limited by residents lived in urban renewal area.
The resources of HCR is related with utilizability in the future for the public people. Therefore, the scope of utilization in HCR includes just conservation, use of image, place for the public.
Therefore, the HCR is conceptualized as something originated before 1950s, familar to many people in same area, and utilizable to make a place or facilities for descendents at present or in the future
While the concept of HCR includes 3 items, past, generality, and utilizability, the types of HCR could be divided into hardware and software from physical perspective. Also they could be divided into isolated preservation of cultural heritage and practical use for making or renewing village from useful perspective. Therefore, types of HCR are as below table.

Table 1 Types of HCR

	Hardware	Software
Preservation ↕ Practical use	cultural heritage natural environment townscape traditional/old housing old street and pattern	folk tale old name of place residents' memories consciousness

3. Case Study ; HCR applied to Urban Renewal Area

There are no many cases of housing complex development applying the historic and cultural resources in Korea. The reason of it is the fact that there are many projects of land development for housing complex. These projects of it mostly adopt the way of whole removal and development. After 1999, the Cultural Heritage Administration began to be interested in caring excavated cultural heritage under land on which housing construction projects are accomplishing. Thus, the related legal act was revised. The law of cultural heritage conservation became including obligation item of researching heritage on land surface in project site. According to this act, the project case applying HCR came out, especially with excavated cultural heritage.
Types of case applying HCR are various, including the case using excavated cultural heritage. In recent years, cases of utilizing HCR are summarized as follows ; making a park with excavated cultural heritage, making a public place with nature environment such as very old tree, renewing a favorite and memorial street as dynamic and imageable street, and making village with regenerating traditional housing, 'Hanok'.
First cases about the making a park with excavated cultural heritage are three projects constructed by KNHC(Korean National Housing Corporation). One is Galsan project in Ichun city, the other is Baran project in Hwasung city, last is Okhyun project in Ulsan city. Every case are projects with discovered cultural heritage excavated. The method of utilizing it have two ways, restoration on site

and moving restoration on site discovered. Galsan project is a case with the restoration on site, making a neighbor park in housing district. This project was identified as the field of relic burying underground resulted from the excavation investigation of cultural assets before the construction. Consequently, this is a case creating park on the field of relic burying underground by modifying the original design.

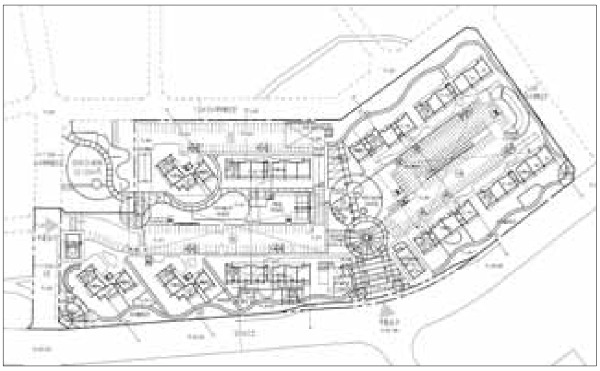

Fig. 2 The first plan of Galsan project

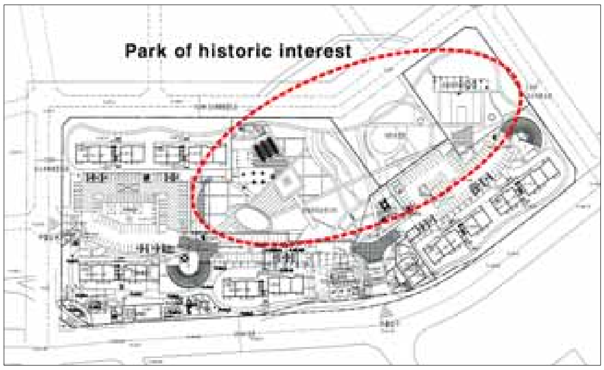

Fig. 3 The final plan of Galsan project

Both of Baran and Okhyun project are cases which have a moving restoration on site. These cases have had an good effect on the children education and the regional identity promotion constructed by making the relic park and the exhibition complex within region.

Fig. 4 Park of historic relics, Baran

Second case is related with utilizing nature environment such as a old tree. The Cases related with it have two cases. One is Bongsan project in Deajeon city, the other is Jangyou project in Kimhae city. There are a 2000-year-old tree on the redevelopment site in Bongsan area. It has been planned the open space around the housing location with consideration of this old tree from phase of the site design. In the case of Jangyu, the old tree located on the redevelopment region was moved to the open space within the site providing the common space for residential communication. These cases are represented as converting the existing symbolic and residential communicating area to the newly residential memorial place when operating redevelopment.

Fig. 5 Old tree, Bongsan

Fig. 6 Old tree, Jangyou

Third case is related with the revitalization of old street and its pattern. There are many cases such as the whole preservation and utilization for the street built on the historic buildings. Taean Project in Hwasung city is the case that utilized the historical meanings by constructing the neighborhood and street parks for preserving the pattern of old street connecting the historically meaningful two places ; the Royal mausoleum of SADOSEJA and Yougju Temple.

Fig. 7 Plan of Teaan Project

Fig. 8 Old street, Teaan

Forth case is related with densely build-up area of traditional housing, 'Hanok' in Korean word. In Korea, many traditional housing area remain around all of the whole country. However, owing to weak point and uncomfortable of Hanok, many people leave and move to more modern-styled housing. In recent years, Caring and interesting of Hanok densely area have came out among experts group and local residents. The Chunju Hanok village is a good case as a making renewal village of densely Hanok area.

Fig. 9 Hanok village, Chunju City

4. Method of utilizing factors of HCR

As several cases we look around above, types of utilizing HCR are various. While the types of HCR used in housing development or renewal area are summarized as excavated cultural heritage, natural environment, old street and its pattern, and densely traditional building area. The types of utilizing method of HCR could make 3 types from residents' perspective.

First type of utilizing method of HCR is just preservation. In case of it, their value of preservation is raised as old as possible, which sample are excavated cultural heritage, traces of historic housing base. Most of its might let developer for profit regard as a obstacle of projects.

Second type of utilizing method of HCR is a use of imageable HCR factor. For example, traditional village entrance, Hanok's roof style, elevation of old building, and stone walls are good samples for imageable HCR.

Last, third type of it is a making place with public function such as education for child and residents' rest. For example, the erecting of a museum, exhibition hall with cultural heritage are good sample as reviewing above. Particularly, the neighbor park utilizing HCR is major sample of utilizing method.

5. Conclusion

According as the projects of urban renewal, including land development for housing, became increasing in recently years, related planner and urban designer begin to be interested in local identity. Simultaneously, they tried to find how to deal with cultural heritage discovered during early phase of development project.

This paper started from above thoughts. Namely, the way of solution about both local identity and cultural heritage in urban renewal and housing development area might be found out at once through the conceptualizing of historic and historic resource, classification of HCR types, and grouping of utilizing method.

Therefore, the concept of HCR maintain essences of past, generality, and utilizability. The types of HCR could be classified into hardware and software or preservation factor and appliable factor. The groups of utilizing HCR could be defined as isolated conservation, using as image and townscape, and utilizing a urban public place.

Everything have own past and history. When they exist in succession with present, there would be their own identity. In the same manner, it of place and district on urban renewal and housing development could be created and maintained all the time.

References

Korean National Housing Corporation. 2006. *Plan for Town-History Plaza with the concept of placeness.* Seoul: KNHC

Dosam, R. Sungman, B. 2006. *Research of the Effect of Cultural Environment on Regional Value.* Seoul: Seoul Development Institute

Steven Tiesdell, Taner Oc, Tim Heath. 1996. *Revitalizing Historic Urban Quarters*. London: The Architectural Press

Urban Environmental Planning Methods towards Sustainable Development Case Study in Thai Nguyen

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Methodology of Urban Environmental was researched in order to integrate the environment in to master plan for sustainable development. The research concentrate on integration of environmental considerations, public communication and community participation, sector coordination and inter-level cooperation, private sector participation in urban planning and management.

To test the practical and application of the methodology of urban environmental planning, Pilot planning exercises (PPE) will be carried out in Thai Nguyen city.

The steps of Pilot planning exercises in Thai Nguyen city:

1. Planning requirements

This initial step of proposed urban environmental plan preparation process represents the decision to start the planning. This decision is given out by Thai Nguyen CPC.

The planning is established by Thai Nguyen CPC, which is derived from the local demand. In order to reduce time for planning establishment and approval, the planning is proposed to be brief and include those items:

a. Responsibility for setting up the planning requirement
b. Content of planning requirement: Determining characteristics of the urban area; Determining urban population scope; Determining development orientation of urban space, technical infrastructure, social infrastructure for each period of 5 years, 10 years and forecasting urban development direction for the period of 20 years.
c. Time for implementing planning

2. Data collection

Data collection is an important step in assessing the existing urban environmental condition of the planning area. In order to have precise existing urban environmental condition, numbers of methods are employed to collect data.

Data on existing urban environmental conditions will become the baseline of establishing the planning, forecasting urban development and become the base for building an environmental improvement and protection strategy.

The CBUEPM project proposes that Data Collection should be contributed to by all sectors, and all related departments should have responsibilities to provide data. Furthermore, communities should be encouraged to contribute to gathering data for establishing the baseline, including providing their own data.

This step is proposed to also include the collection of environmental baseline data, i.e. background material on the environment, natural resources and environmental problems.

Data should be added

Environmental data base is a content the will describe the existing local environment such as ground water, surface water, air, noise environment. In order to have all information, survey questionnaire, field trip, collect environmental report and measure at the environmental hot spot. These are steps to be done:

- Define existing pollution sources
- Assessment of environmental quality
- Zoning environmental pollution area
- Collect comment from community on existing urban development through survey questionnaire

3. Data analysis

It is one of the most important steps to formulate plan. The analysis step includes all related aspects from natural condition, socio-economic to comprehensive existing situation, etc.

The analysis used the comparison between practical situation and design standard which is the basis to give recommendations and requirements for plan preparation.

To fulfill this step, the coordination among all sectors regarding on data collecting must be considered carefully especially data on existing environment.

The analysis must consider the balance between socio-economic development needs and the impact to environment. Besides, the participation from public & private sector is the necessary consideration for effect investment and the reality of plan.

Some analysis methods could be used such as:

- SWOT analysis method (strength, weakness, opportunity, threat)
- LGM analysis method (lack, gap, mismatch)
- GIS application (geographic informatics system)

4. Setting priorities

Scope of setting priorities part are as follows:

- To consider on keeping balance between natural resource protection, living environment & health improvement and socio-economic development needs.
- To propose realistic plan

However, it is necessary to coordinate sectors at provincial as well as city level in collecting data to fulfill tasks of setting priorities such as:

- Advices from related sectors
- Advices form public & private sectors
- Community participation

Based on analysis and assessment, Province/City people committee will give the final decision.

This step is the foundation for next phase of plan preparation. Steps of setting priorities part are as follows:

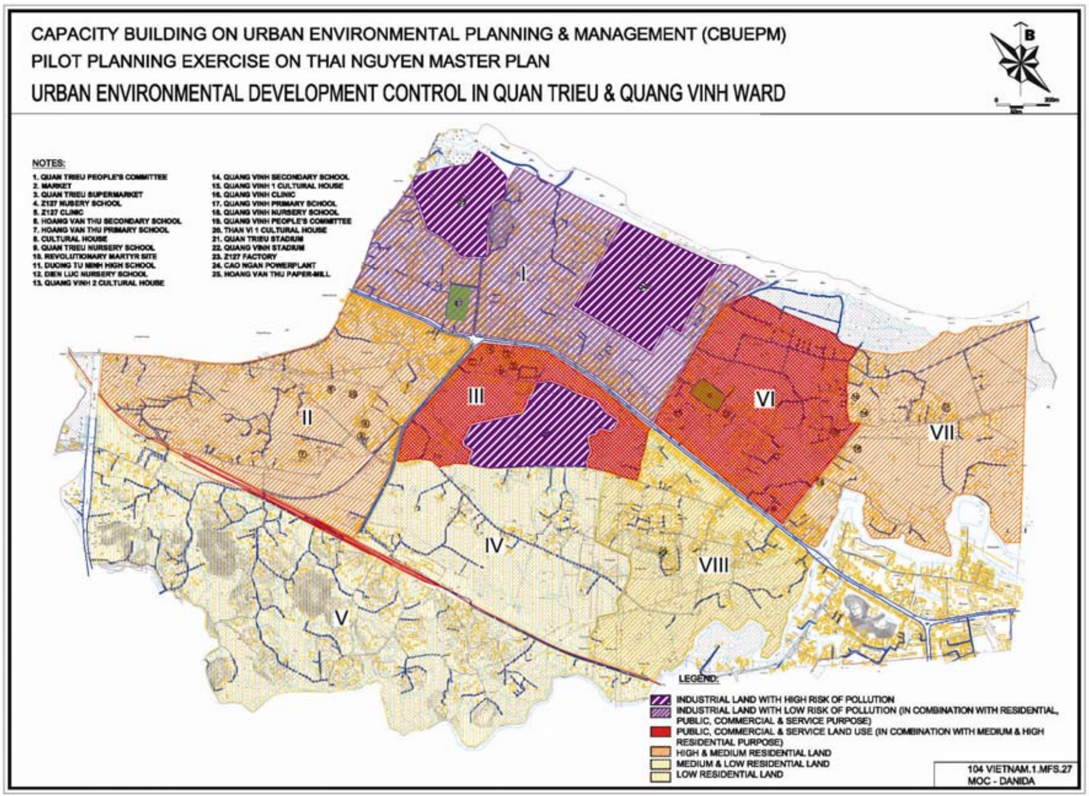
a) Criteria to define priorities:
b) The integration of environmental consideration in setting priorities part
c) Advices from related sectors
d) Advices from public & private sectors
e) Advices from public & private sectors
f) General summary, analysis

Setting priorities in Quan Trieu & Quang Vinh ward

a) Quan Trieu ward

Area I: The northern of Duong Tu Minh road

- To limit development around risk polluted areas including Hoang Van Thu paper-mill factory, Cao Ngan power plant & coal conveyor.
- To preserve existing industrial land use in the North, to limit industrial development as proposed in the approved Thai Nguyen master plan because of difficulties in compensation and site clearance the high residential density.
- To encourage commercial & service development along Duong Tu Minh road.



Area II:

- To strengthen green buffer zone along the coal conveyor to minimize dust & noise pollution possibility.
- Recommended functions: residential, public, commercial & service purposes.

Area III:

- To plan ward's public administration offices, cultural & sport centers.
- To control development around Z127 factory in order to prevent pollution impact around this area.

- To control development and water pollution possibility around Quang Vinh lake.

Area IV:
- To focus on investment on green buffer zone to minimize dust & noise pollution possibility along railway.

Area V:
- Land elevation is high, advantage for construction.
- Focus on investment on green buffer zone along railway.

b) Quang Vinh ward
Area VI:
- To focus on socio-infrastructure developments including public building, cultural & sport centers, etc.

Area VII:
- To continue agricultural development.
- To utilize advantage land for construction for reserved residential land use in the future.

Areau VIII:
- To give priority for agricultural development in short-term period and convert into residential land in long-term plan.

5. Plan preparation
The results of data analysis, proposals on development control and setting priorities are foundations for plan proposals. In this research, the "plan proposal" considered and compared the approved Thai Nguyen master plan in the view of methodology on urban environmental planning.
Proposals or recommendations mentioned in the area of Quan Trieu & Quang Vinh ward did not represent as the typical role of master plan, it only illustrated or demonstrated some examples that could be applied in the whole city or in the master plan of Thai Nguyen city.
Proposals on development control, development encouragement or investment priorities based on urban environmental planning methodology in Quan Trieu & Quang Vinh ward will be compared with the contents of the approved Thai Nguyen master plan, from that, proposals on revising or readjustment will be given.

Proposals on revising and readjustment on approved Thai Nguyen master plan - Demonstrated in Quan Trieu & Quang Vinh ward
The proposals on revising and readjustment are based on data analysis's results, proposals on development control and setting priorities.

Quan Trieu ward:
- Area I: The northern of Duong Tu Minh road
This area is the highest residential density in Quan Trieu ward. Besides, there have cultural & sport centers, Quan Trieu stadium, nursery schools, etc.

The approved Thai Nguyen master plan has proposed main function of this area is industrial zone No.2 with an area of 60ha. However, it did not mention plan for compensation and site clearance; the plan proposals were still political ideals rather than realistic.
The area around polluted sources such as: Hoang Van Thu paper-mill factory, Cao Ngan power plant & coal conveyor need to have green buffer zone in order to minimize dust & noise pollution. With residential land which is adjacent to industrial area, it is possible to insert tree in residential area.
The infrastructure including electrical supply, water supply, sewage system, etc. has been mentioned in the approved master plan. However, it is necessary to get agreements from factories or enterprises that the discharging quality must obey to standard.
In the short-term period, temporary solutions in conformity with plan could be implemented such as: to upgrade drainage & sewage system, to plan tree in polluted impact areas, etc.
Environmental solutions:
+ The 54m green buffer zone width can reduce noise pollution from 70dB down to 60 dB (living standard).
+ To isolate and minimize dust & noise pollution from Cao Ngan power plant by using 54m width green buffer zone, especially to pay attention to chimney height and wind direction.
+ To diminish noise caused by transportation system by adding garden, public space dispersal.

Proposals: to readjust main function from concentrated industrial zone to be industrial zone in combination with upgrading existing residential area, and commercial & service purposes along Duong Tu Minh road.
- Area II:
The residential density in this area is medium. As mentioned in the approved Thai Nguyen master plan, Quan Trieu located in the urban residential area No.1 in which target population is 119,000 persons in compare with 20,919 persons in 2006.
The area II includes 6 household clusters (No. 17 to No. 22) with an area of 51ha and 1,500 persons. The planed population is 4,700 persons, BCR is 30%, average floor is 3 floors.
There has lots of vacant land in this area with high elevation; it is possible to convert into urban residential land in long-term plan. There also has a coal conveyor connecting with Cao Ngan power plant, it is necessary to pay attention to green buffer zone when implementing urban land expansion.
As result from multi-criteria land assessment, this area is advantage for construction, and primary function could be medium & high density residential land, in combination with public & service purposes.
The infrastructure must be planed in obey to design standard, especially water supply, sewage system, green zones, solid waste collection, etc.

Proposals: agree with functions in approved Thai Nguyen master plan
- Area III:
Area III includes 4 household clusters (No.12-15) with an area of 47ha and 1,400 persons. This area is now the public administration center including ward people's committee office, market, post office, etc.
As planed in the approved Thai Nguyen master plan, the existing functions is kept and oriented for up gradation; BCR is planed to be 30-35%, average floor is 4 floors.
This area belongs to the advantage area for construction; however Z127 factory is located here which need to be paid attention on environmental pollution possibility. The old coal mine which has now become Quang Vinh lake need to be improved and upgraded.

The infrastructure plan must obey to design standard, especially the green buffer zone around polluted sources such as: roads, Z127 factory, etc.

Proposal: Agree with approved primary function as public land, however it should readjust to be public land in combination with improving existing residential land use.

- Area IV:

Area IV includes household cluster No. 16 with an area of 37ha and 315 persons; most of land stock is now using for agriculture. In the approved Thai Nguyen master plan, it is planed to be new residential land with the capacity of 1,700 persons, BCR is 35-45% and average floor is 3-5 floors.

In this area, about 66% of land area belongs to disadvantage area for construction which is costly for leveling expense in serving for urban development. Besides, green buffer zone along railway to minimize dust & noise pollution must be paid attention.

Proposals: agree with primary function as residential land, however the average floor should be readjusted down to 2-4 floors.

- Area V:

Area V includes 3 household clusters (No.23-25) with an area of 73ha and 1,300 persons. In the approved master plan, it is planed to be new residential land, target population is 9,800 persons, BCR is 35-45% and average floor is 3-5 floors.

In general, this are has high elevation, advantage for construction, especially residential purpose.

There has San Diu minority ethnic living in this area; most of them have low income. As planed, this area will have development potential as locating between new national road No.3 and Viet Bac road (next to railway), however with the existing situation, the location is not convenient in compare with other areas.

To carry out the plan as approved, it will require much time and capital for infrastructure implementation. Besides, the target population is 9,800 persons in compare with the current number of 1,300 persons is not so realistic in short-term development period.

Proposals: agree with primary function as residential land, however the average floor should be readjusted down to 2-4 floors.

Quang Vinh ward

- Area VI:

Area VI includes 7 household clusters (Rang oi 1, Rang oi 2, Dien Luc 1, Dien Luc 2, Quang vinh 1, Quang vinh 2 & Mo bach 1) with an area of 60ha and 2,000 persons. The existing function of this area is public administration center, cultural & sport center, etc. including: ward people committee office, Quang Vinh stadium, Duong Tu Minh high school, etc.

In the approved master plan, this area is divided into 3 different functions: public land, residential land and education & vocational schools.

The proposed location of approved vocational schools is the high density residential area with more than 700 existed houses, this plan must be reconsidered for its realistic in compensation and site clearance.

The proposed residential land is located in Quang Vinh 2 household cluster, which is planed to increase population from 320 persons up to 2,520 persons; BCR is 25-35%, average floor is 2-4 floors.

Most of area VI locates in the low elevation area, disadvantage for construction and costly for leveling expense.

Proposals: In general, agree with primary functions as mentioned in the approved Thai Nguyen master plan, however, the location and scale of vocational schools must be reconsidered for its realistic.

- Area VII:

Area VII includes 5 household clusters (Rung Vau, Soi Dau, Cua Ngoi, Quang Vinh 2 & Mo Bach 1) with an area of 25ha and 1,200 persons.

In the approved master plan, it is divided into 3 areas with residential function, BCR is 25-35%, average floor is 2-4 floors and target population is 3,450 persons.

More than 50% of land stock locate in low elevation area, disadvantage for construction and costly for leveling.

Proposals: In general, agree with proposed functions in the approved Thai Nguyen master plan.

- Area VIII:

Area VIII includes 4 household clusters (Than Vi 1, Than Vi 2, Tan Thanh, Mo Bach 2) with an area of 72ha and 900 persons.

In the approved master plan, it is planed to be residential land with target population is 5,200 persons, BCR is 25-35% and average floor is 2-4 floors.

Most of area belongs to disadvantage area for construction, especially that the southern part has threat of flooding possibility higher than 1m.

Proposals: In general, agree with proposed function as residential land, however, the southern part should be readjusted to be reserved residential land.

6. Assessment and appraisal

Scope

This step aims at assessing the projects by comparing the plans with the initial requirements. The assessment should cover all aspects:

- The conformity with the national or regional socio-economic plans;
- The environmental considerations;
- The flexibility of the plans & capability of investments.
- The assessment must be implemented by all related organizations.

Methodology

- To compare plan’s proposals with initial requirements.
- To have participation from community representatives to receive comments and get agreements and to increase community’s awareness.
- To organize workshops & seminars to receive comments from related sectors and to propose plan’s proposal to DOC for appraisal.
- To submit plan’s proposal to PPC, CPC for approval.

Conducted assessment in Quan Trieu & Quang Vinh ward

- Plan's proposal is shown in community workshops.
- Community's representatives are invited to participate in workshop for giving comments & advices.
- Public workshops are held to increase community's awareness on plan's proposal.
- In workshops, only representatives living in PPE area could give comments and advices for readjustment; others could only give comments in general, advices on readjustment are forbidden.
- If comments & advices from community are suitable, DOC must summarize and supplement into final plan's proposal.
- Final proposal will be submitted to PPC for approval.

7. Implementation and management

- This step is actually not part of the plan preparation process itself, because at this step, the preparations process is completed. However, this is important for the next phase of the plans.
- Plan implementation and management is very important to bring plans into reality.
- As regulated in construction law, PPC has responsibility on both plan's preparation and plan's implementation and management.
- In Vietnam, all urban master plans are adjusted after a period of 5 years, so the experiences and lessons learnt from implementation and management steps will help to develop situations in the future.
- The implementation of PPE will be carried out by Thai Nguyen DOC's experts with supports from VCCP company and PMU.
- The urban environmental initiatives will be implemented by consultants & technicians signed contract with Thai Nguyen DOC.

Conclusions

Environmental issues have been considered in current planning process but need to be improved more. The improvement on environmental consideration integration for sustainable planning is necessary. The pilot planning exercise has considered environmental factors such as: soil, air, water, cemetery, solid waste, etc. and applied into Thai Nguyen master plan; the achieved results have proven its effectiveness and feasibility.

Public communication and community participation is one proposal of urban environmental planning methodology in order to improve the current planning process. By adding the community participation in to planning process, the community's stakeholders such as: ward's officers, leaders of household clusters, households' representatives, etc. have opportunities in taking part into plan's preparation and increasing their awareness. Lessons learnt from PPE in master plan scale is that main stakeholders participating in planning process should be ward's officers such as: chairman, vice-chairman, planning officers, etc.)

Sector coordination and inter-level cooperation is necessary to be considered in all sectors. The lack of institutional has caused the ineffectiveness on sector coordination and inter-level cooperation. Though PPE has proposed some solutions but not yet achieved as expected. To deal with this problem, it should has the cooperation among consultants, experts, specialists at all sectors & levels to work on the coordination institutional.

Private sector participation is one of factors affected to the realities of planning implementation. The lack of private sector participation in the existing planning process has resulted as "hanging plan". The PPE has called for the participation from private sector but the result is not as good as expectation.

Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo
Part1 Overview and Proposal of Opening Reinforcement

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Keywords: Structural Experiment, Seismic Retrofit, Timber Frame Construction.

Abstract
This paper describes the outline of the structural performance evaluation of existing timber houses in Tokyo, conducted by the Tokyo Metropolitan University timber engineering laboratory since 2003. On-site investigation, questionnaire to the residents, microtremor measurement, and seismic diagnosis was conducted on thirteen detached conventional timber houses and three timber apartment houses. Out of the sixteen houses investigated structural strengthening repair work was conducted on two detached houses and three apartment houses, and the results are described and discussed in detail in Parts 2 and 3. Part 1 describes the background, overall methodology and significance of the research, results of static loading tests on walls and new opening reinforcements proposed and developed by the authors.

1. Introduction
Structures in Japan are often devastated by severe natural hazards such as earthquakes and typhoons, and to secure the structural safety of dwelling houses against natural disaster is essential. Approximately 40% of the existing housing stock in Tokyo is of timber frame construction. The devastating damage from past natural hazards reveals that the structural safety of these existing timber houses are in need of due consideration. This research clarifies the structural performance of existing timber houses in Tokyo through four years of investigation by the Tokyo Metropolitan University timber engineering laboratory in collaboration with the architectural design laboratory.

2. Background of Research
2.1 Structural Safety Standards of Timber Houses in Japan
The structural safety of timber houses in Japan against a horizontal load can be determined by four different structural calculation methods. For timber houses with one or two stories, no larger than $500m^2$, no taller than 13m, and with an eave height no higher than 9m, the 'wall amount method' is applied to confirm the structural safety against horizontal load. This is a simplified structural calculation method

against seismic load and wind load, described in the following section. For timber houses higher and/or larger than 13m and/or $500m^2$ either the ‘allowable stress design method’, the ‘horizontal load carrying capacity method’, or the ‘limit stress design method’ can be used to verify the structural safety of the structure against earthquakes and typhoons. In this paper the structural performance of existing conventional timber frame detached and apartment houses, which are one or two stories, no larger than $500m^2$, no taller than 13m, and with an eave height no higher than 9m is discussed.

2.2 Wall Amount Method

The wall amount method was first developed based on an investigation of the disaster of the 1948 Fukui Earthquake. The calculation method was implemented in the Building Standard Law at its enforcement in 1950. The wall amount method is widely used in Japan for its simplicity and efficiency. The method has undergone many revisions throughout our history of earthquake hazard and disaster investigations. The most influential revision was that of the Building Standard Law in 1981, when the required horizontal resisting load (wall amount ratio) was increased. Therefore structures designed and built before 1981 may not have the required horizontal load resistance of the building code today. These structures built before 1981 are called non-conformed buildings, and are known to suffer greater damage from earthquakes. The principle of the wall amount method can be described as follows.

1) The shear wall carries out two-thirds of the horizontal load applied to the structure.
2) Non-structural members carry out the remaining one-third of the horizontal load.
3) The amount of the shear wall is described in the form of its length [L(m)]. The height of the shear wall and each story is assumed constant.
4) The horizontal load carrying capacity of different types of shear walls is defined as “Wall Ratio [a]”. The wall ratio is the normalized allowable shear strength of the shear wall determined from the equation shown below.
5) The effective wall length [Le(m)] is compared with the required wall length [Lr(m)].
6) The required wall length [Lr(m)] is determined by multiplying the required wall amount ratio with the floor area, for seismic load and projected area for wind load.
7) The wall amount ratio is defined in the Building Standard Law by the weight, soil, and story of the target structure.

$$L_e \geq L_r$$

$$L_e = L \times a \ , \quad a = \frac{P_0}{1.96} \ , \quad D_s = \frac{1}{\sqrt{2\mu - 1}}$$

$$P_0 = Min\begin{Bmatrix} P_u \dfrac{0.2}{D_s} \\ P_y \\ \dfrac{2}{3} P_{max} \\ P_{1/120} \end{Bmatrix}$$

where,

Le [m]: Effective wall length

Lr [m]: Required wall length [m]

a: Wall ratio

P_0 [kN/m]: Short term allowable shear stress

1.96 [kN]: Normal shear stress per wall length [1m]
P_u [kN]: Ultimate shear stress
D_s: Structural characteristic factor
μ: Ductility factor
P_y [kN]: Yeild stress
P_{max} [kN]: Maximum stress
$P_{1/120}$ [kN]: Shear stress at 1/120rad. story drift.

2.3 Seismic Diagnosis of Timber Houses

The seismic diagnosis method for timber houses in Japan was first published in 1979. The principle of the structural calculation method is based on the wall amount method, with due consideration for deterioration. The seismic diagnosis method has also undergone several revisions as well as the wall amount method. The Seismic Repair Promotion Law was enforced in 1995, reflecting the devastating damage by the 1995 Hyogoken Nanbu Earthquake. The importance and necessity of seismic diagnosis was strongly emphasized.

Although the national government as well as the local government is promoting the need for seismic diagnosis and structural repair work, existing buildings in need of structural repair are still at large. This is especially serious for timber houses. The existing housing stock is estimated to be approximately 47 million units in Japan, 5.4 million units exist in Tokyo. The existing non-conformed timber housing stock is presumed to be approximately 13 million units in Japan, 0.84 million units in Tokyo, as of 2003.

3. Outline of Research

3.1 Objective

The objective of this paper is to reveal problems and practical solutions for the structural strengthening repair work of conventional timber houses in Japan. The case studies of different types of timber houses as well as their structural performance determined by on-site experiments and analyses performed by the authors are described in the following Part2-Part5. The results of the four years of research operated by the timber engineering laboratory of Tokyo Metropolitan University as part of the 21st Century COE Research is described.

3.2 Method

The authors performed seismic diagnosis, structural analysis, micro tremor measurement and structural reinforcement repair work on several detached timber houses and timber apartment houses in Tokyo. In this paper (Part1) the background and outline of the research is described as well as the method and results of the opening reinforcements (such as doors and windows) proposed and developed by the authors. In Parts 2 and 3 case studies of seismic diagnosis and structural strengthening repair works on timber detached houses (Part2) and timber apartment houses (Part3) are introduced. In (Part4) analysis of urban houses in the downtown district of Tokyo (*Kanda)* is described and in (Part5) the investigated vibration characteristics of the timber houses is discussed together with the validity of the application of microtremor measurement.

4. Opening Reinforcement

4.1 Investigation of the Utilization of Openings

The structural deficit of existing conventional timber houses is known to be their large openings, lack of shear walls, small dimensions of columns, and joints lacking adequate fasteners. Many types of methods and devices for the reinforcement of existing timber houses are being proposed, but the enforcement of structural strengthening has not prevailed much. This lack of enforcement is due mainly to the fact that the structural strengthening of existing timber houses is not merely a technical issue, but also a conflict between design requirements against financial restrictions. In order to design an effective structural strengthening device it is essential to make the device simple, easy to install, non-disturb and affordable.

The authors conducted an investigation on the utilization of houses accompanied by a hearing investigation with the residents and selected large openings as the target of reinforcement. The authors investigated thirteen conventional timber detached houses (see Part2 for detail) and three low-rise timber apartment houses (see Part 3 for detail), built before 1970 in Tokyo. All of the investigated timber houses are non-conformed structures. An example of an investigated conventional timber detached house is shown in Fig.1.

Fig.1 Example of investigated conventional timber detached house

From the investigated results of thirteen detached timber houses and three low-rise apartment houses, 482 sets of openings existed. Out of the 482 sets of openings 228 sets were doors and the other 254 sets were windows as shown in Fig.2. The types and percentage of the 228 sets of doors are shown in Fig.3. The percentage shows that the sliding door, typical Japanese style, shares 46% (104 sets) of the total amount of doors. The authors conducted a hearing investigation on the utilization of each door and window. The result of the utilization of the 104 sets of sliding doors is shown in Fig.4. The utilization of the doors are divided into five types according to the way the opening is used based on the results of the hearing investigation. The results show that although the sliding door is designed to allow passage from both sides of the door, only 2% of the investigated doors were used in this original style. 67% of the sliding doors were used by passage on only one side allowing light in, but shut on the other side. By including 24% of the openings, which allow passage on one side and are closed on the other side, 91% of the sliding doors were used only on one side.

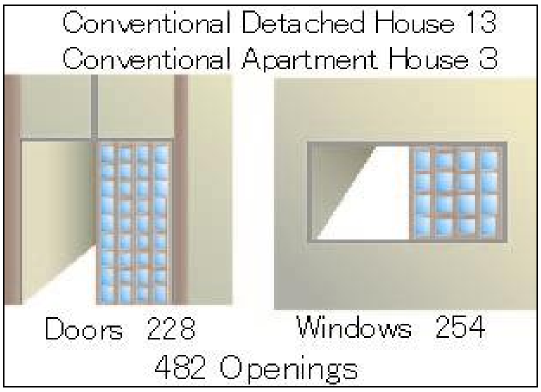


Fig.2 Number of Investigated Doors and Windows

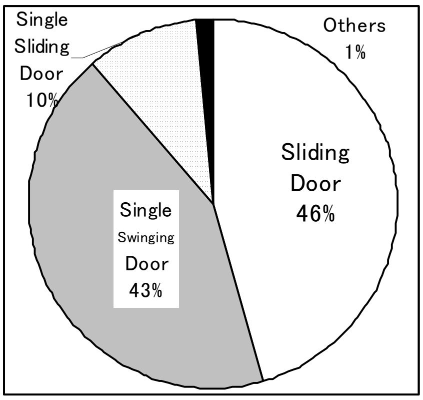


Fig.3 Types and percentage of Doors (228 sets)

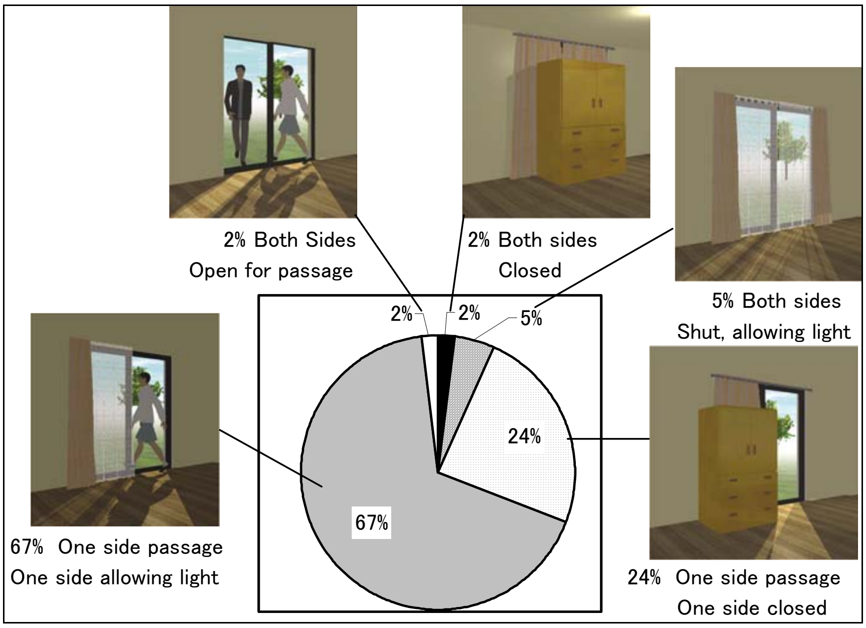


Fig.4 The utility and percentage of Sliding Doors (104 sets in total)

4.2 Structural Strengthening Method and Device

The structural deficit of conventional Japanese timber houses is known to be their lack of shear walls, large openings, and small dimension of columns. Therefore, the most efficient structural strengthening method is to install new shear walls at the openings. As the installations of new walls affect the planning as well as the design of the house, it is not always favored. Based on the investigated results of the utility of the sliding doors, the authors proposed a new type of reinforcement wall, which is installed on one side of the sliding door and allows light through. The basic idea of the opening reinforcement is shown in Figs.5 and 6. For sliding doors, which are closed and unused (Type A), a simple method such as a plywood wall can be applied. For sliding doors which are used on one side (Type C or D), or doors which are closed for passage, but allow light through (Type B), new types of reinforcement as shown in Fig.6 are proposed by the authors. The authors proposed a timber lattice, which is often used in traditional Japanese houses for openings, with acrylic nailed on to one side. The acrylic is used for its transparency as well as tensile force, whereas the timber lattice works as a buckling restraint element. An expand-metal wall is also proposed for openings which open on one side, and allow light in on the other side. The expand metal allows light and air to penetrate through the opening and is useful for interior walls. The materials acrylic and expand metal were selected because they are non-expensive available materials on the market today.

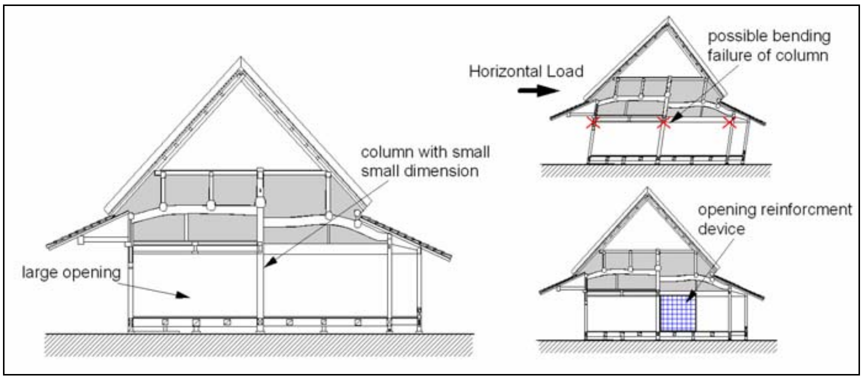


Fig.5 Basic mechanism of opening reinforcement

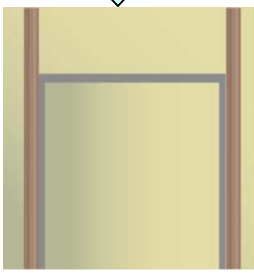
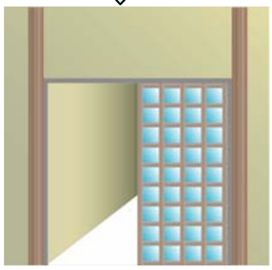
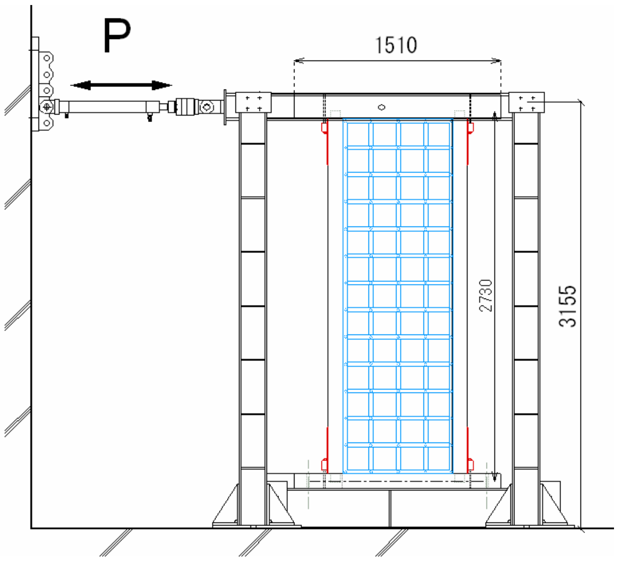
Utility Types of Sliding Doors	 A	 B	 C	 D
Reinforcement	 Plywood shear wall	 Timber lattice and acrylic wall	 Expand metal wall	 Timber lattice and acrylic door type wall

Fig.6 Types of Utilization for sliding doors and proposed reinforcement

4.3 Structural Experiments on Opening Reinforcement

Static lateral loading tests on the newly proposed opening reinforcement were performed at Tokyo Metropolitan University. A full scale specimen of the timber lattice wall, expand-metal wall, and door type timber lattice and acrylic wall was constructed. The loading apparatus, specimens, measured load displacement relationship and determined wall ratios are shown in Fig7 to Fig.9, and Table1 respectively.



(unit mm)

Fig.7 Loading apparatus of static loading test

		
Timber lattice and acrylic	Expand-metal	Timber lattice and acrylic door type

Fig.8Full scale models of opening reinforcement subjected to static lateral loading experiment

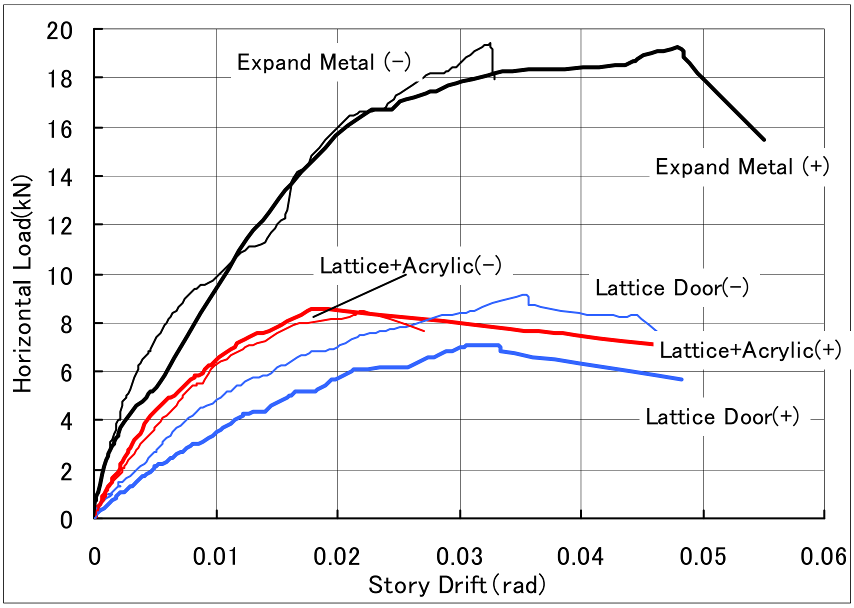


Fig.9 Load displacement relationship of the experimented wall

Table1 Experimental results and determined wall ratio

Type of Wall		Pu*(0.2/Ds) [kN]	Py [kN]	2/3 Pmax [kN]	P(1/120) [kN]	Po [kN]	Wall Ratio
Timber lattice and acrylic	−	**3.72**	5.42	6.19	6.00	3.72	2.2
	+	5.51	**4.96**	6.28	6.76	4.96	
Expand-metal	−	**7.69**	10.78	14.24	10.34	7.69	4.0
	+	8.12	13.29	14.13	**8.00**	8.00	
Lattice and acrylic door type	−	**3.99**	5.47	6.68	4.79	3.99	1.8
	+	3.26	4.63	5.21	**3.22**	3.22	

From the results of the experiment, the determined wall ratios are 1.8 to 4.0. The wall ratio is a normalized factor of the short-term allowable shear stress of the wall. The wall ratio is a normalized value so that 1.0 is equal to the allowable shear stress of 4.5 by a 19 mm timber brace. The validity of the opening reinforcement walls were proven. In the following Parts 2 and 3, a trial for the application of opening reinforcement to existing conventional timber detached houses and low-rise apartment houses is introduced. The problems and solutions encountered during the course of actual construction are discussed.

5. Conclusion

The outline of the structural performance evaluation of existing timber houses in Tokyo, conducted by the Tokyo Metropolitan University timber engineering laboratory since 2003 was introduced. Based on the on-site investigation and hearing from the residents on thirteen existing conventional timber detached houses and three apartment houses in Tokyo, 91% of the surveyed sliding doors were found to be used only on one side. A new opening reinforcement device using timber lattice, acrylic and expand-metal was developed by the authors. The structural performance of the device was determined by static lateral loading tests on full-scale models of reinforcement. The wall ratio was determined based on the results of the static loading tests and the validity of the reinforcement device was proven. The application of the devices are discussed in the following Parts2 and 3.

6. References

Fujita, K. et.al., 2004, Journal of Asian Architecture and Building Construction, On-Site Lateral Loading Test of Traditional Japanese Timber House.

Takahashi, S. and Fujita, K., 2006, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, A study on the Reinforcement of Opening in Existing Wood House with consideration of Permeability Part2 (in Japanese)

Takahashi, S. and Fujita, K., 2005, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, A study on the Reinforcement of Opening in Existing Wood House with consideration of Permeability Part1 (in Japanese)

Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo
Part2 Case Study on Detached Houses

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Keywords: Microtremor Measurement, Timber Frame Construction, Seismic Retrofit

Abstract
This paper presents a case study of seismic diagnosis and structural reinforcement repair work conducted on two conventional detached timber houses in Tokyo. The investigated timber houses are of conventional timber frame construction, built in the middle of the 20th century. This paper describes the results of an on-site investigation, seismic diagnosis, microtremor measurement, and structural reinforcement repair work conducted on two existing conventional detached timber frame construction houses. The results of the seismic diagnosis showed that the horizontal load carrying capacity of the investigated houses were far below the required values in the Building Standard Law. Detailed investigation on how the openings and doors are used in each house was conducted by interviewing the residents. From these results, the subject of strengthening walls and openings was selected. The authors selected types of strengthening work according to the utility and requirements of each opening. The structural reinforcement work on openings, proposed by the authors, as described in Part 1, was applied.

1. Introduction
1.1 Objective

This paper reveals the structural performance of standard existing detached timber houses in Tokyo, through on-site investigations, micro tremor measurement, seismic diagnosis, and seismic strengthening repair work. The problems and validity of seismic diagnosis and reinforcement repair work is revealed.

1.2 Method of research

The research was operated by the timber engineering laboratory of Tokyo Metropolitan University. Seismic reinforcement repair work was done on two existing detached timber houses in Tokyo, both of which were constructed during the 1960s to the 70s. The repair work was based on detailed investigation and interview to the residents. In this paper result of one of the two houses is discussed in detail.

2. Description of the investigated timber house (House F)

The house investigated was built in 1961, a two story house with 12.7m by 9.1m first floor plan. The house is of conventional post and beam construction. Conventional clay tile roofing (‘*Sangawara*’ in Japanese), mud walls with a bamboo substrate for the interior wall, gypsum board (12mm) with mortar finishing for the exterior wall, and unreinforced concrete foundation were used. The floor areas were 1st floor 99.8m^2 and 2nd floor 55.2m^2. The subject of investigation is located in the residential district of Tokyo (Shinagawa ward).

The view of the house is shown in Fig.1, section and plans are shown in Figs.2 to 4. The planning and construction style is of standard level for a house built in the 1960’s. The horizontal load-resisting element is the mud wall. The columns are 105 by 105 mm in dimension, the mud wall thickness was 50 – 60 mm. The living room had undergone refurbishment twice and the walls were covered with gypsum board.

Fig.1 View of House F

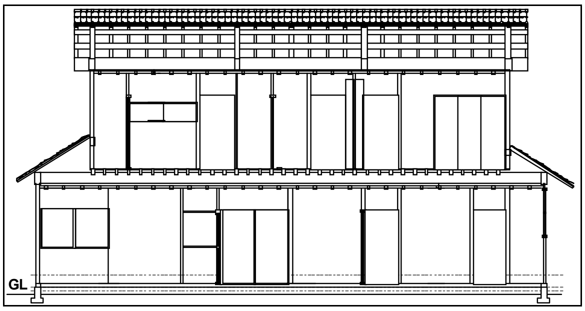


Fig.2 EW Section

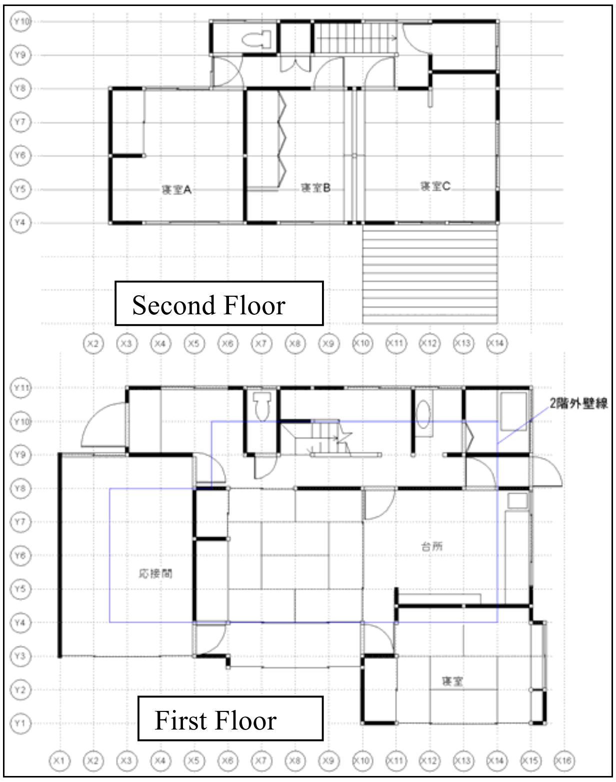


Fig.3 Plan

3. Seismic Diagnosis

The seismic diagnosis for timber houses [The Japan Building Disaster Prevention Association, 2004] was applied to the investigated house. The seismic diagnosis for timber houses is divided into three different methods according to the level of information and the professional knowledge of the investigator. The simplest method of seismic diagnosis of the three is the “Anti-Seismic Home for Everyone”, a check list for the residents. The second and third levels of seismic diagnosis are mainly for professionals; architects and engineers to operate. The “General Diagnosis Method” is based on the results of a non-destructive investigation, whereas the “Detailed Diagnosis Method” presumes the information of the joints and detailed specifications as known. In this research both the general and detailed diagnosis were done on the target house, during each phase of the investigation and structural reinforcement work. The calculated horizontal load resistance of the structure is modified by the eccentricity in plan and deterioration of the structure and the horizontal load carrying capacity is determined. By dividing the horizontal load carrying capacity by the required horizontal load of the structure, the sufficiency is determined, which is represented as the "seismic index". The required level of the seismic diagnosis for timber houses is for the structure not to collapse during large earthquakes. The seismic index and its corresponding seismic diagnosis are shown in Table.1.

The result of the "General Diagnosis" and "Detailed Diagnosis" performed on the house investigated is shown in Table 2. The results show that the target house has a high possibility of collapse for each direction on each floor. The determined results of the diagnosis are based on a non-destructive investigation method; consequently, the details of the joints and specification of the structural members are revised after the structural strengthening repair work starts and an investigation accompanied by partial destruction is done. The structural strengthening repair is planned based primarily on the results shown in Tables 2 and 3, and is afterward revised based on the modified results of the seismic diagnosis. The project was planned and operated with the house continuously inhabited by the residents throughout the whole repair work process.

Table 1. Seismic Index and Diagnosis

Seismic Index	Seismic Diagnosis
1.5 or Over	Safe
1.0 to 1.5	Low Possibility of Collapse
0.7 to 1.0	Possibility of Collapse
Under 0.7	High Possibility of Collapse

Table 2. Result of General Diagnosis based on Non-destructive Investigation

Floor	Direction	Horizontal Load (kN)	Eccentricity Factor	Deterioration Factor	Horizontal Load Carrying Capacity (kN)	Required Strength (kN)	Seismic Index
Second	X (EW)	24.45	0.75	0.70	12.84	30.67	0.41
	Y (NS)	22.89	0.75	0.70	12.02	30.67	0.39
First	X (EW)	63.05	1.00	0.70	44.14	77.28	0.57
	Y (NS)	60.63	0.75	0.70	31.83	77.28	0.41

Table 3. Results of Detailed Diagnosis (Building Standard Law Enforcement Ordinance method)

Floor	Direction	Horizontal Load (kN)	Stiffness Factor [Fs]	Eccentricity Factor [Fep]	Floor Factor [Fef]	Horizontal Load Carrying Capacity (kN)	Required Strength (kN)	Seismic Index
Second	X (EW)	26.80	1.0	1.0	1.0	26.80	43.24	0.61
	Y (NS)	18.33	1.0	1.0	1.0	18.33	43.24	0.42
First	X (EW)	51.15	1.0	0.74	1.0	37.76	82.60	0.45
	Y (NS)	48.74	1.0	0.79	1.0	38.45	82.60	0.46

*Eccentricity 0.15 or over: decrease of horizontal load of the structure is required.

4. Structural strengthening repair work

4.1 Method of structural strengthening

The structural strengthening method was planned based on the results of the seismic diagnosis, interviews with the residents on the use of their house, and financial aspects. After several revisions the structural reinforcement plan was decided on and performed as shown in Fig.5. The main methods applied to the structure are as follows.

(1) The shear wall of plywood (thickness 7.5mm), fastener nail N50 (length 50mm, 2.75mm in diameter, 150mm spacing) is installed over the existing mud wall. A-3, 4, 5, 6, 7, 8 Wall ratio 2.5.

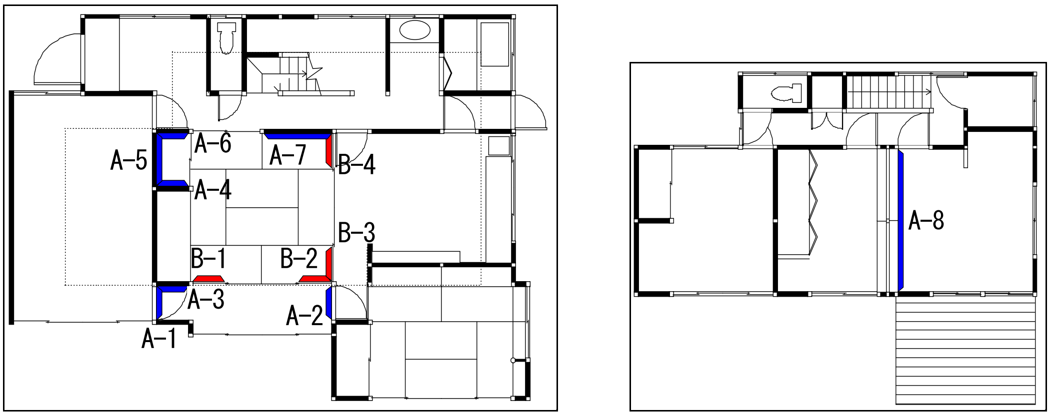
(2) The shear wall of plywood (same as in (1)) is installed at existing unused doors. A-1, 2.

(3) The shear wall of timber lattice and acrylic (timber lattice 30 by 40mm, thickness of acrylic 3mm, fastener nail ZN90 spacing 200mm), proposed by the authors described in Part 1, is installed at the unused parts of sliding doors. B-1, 2, 3, 4 Wall ratio 2.2.

(4) A reinforced concrete foundation is newly installed at the location of the newly installed shear walls.

(5) Metal fasteners are installed at the column beam connections.

The following pictures show the structural strengthening repair work, view of the original, and finished interior.



First Floor Second Floor

Fig.5 Structural Reinforcement Plan (colored lines indicate the reinforcement work).

Existing unreinforced concrete foundation New foundation Plywood over existing door

Fig.6 Reinforcement Repair Work

Original sliding door　　Installation of timber lattice wall　　Finished interior (A-6,7)

Fig.7 Reinforcement with Timber Lattice and Acrylic

4.2 Revised results of seismic diagnosis

The seismic diagnosis was revised according to the results of the partial destructive investigation, which was operated during the course of the structural reinforcement repair work. The calculated results are shown in Tables 4 and 5. The calculated effect of the seismic reinforcement work is also shown in the tables. The structural reinforcement repair was planned to by step-by-step method and for this phase, the target seismic index was 0.7.

Table 4 Revised Results of Seismic Diagnosis

Before strengthening							
Floor	Direction	Horizontal Load (kN)	Eccentricity Factor	Deterioration Factor	Horizontal Load Carrying Capacity (kN)	Required Strength (kN)	Seismic Index
Second	X (EW)	~~24.45~~ 24.72	0.75	0.70	~~12.84~~ 12.98	30.67	~~0.41~~ 0.42
	Y (NS)	~~22.89~~ 23.13	0.75	0.70	~~12.02~~ 12.14	30.67	0.39
First	X (EW)	~~63.05~~ 61.16	~~1.00~~ 0.75	0.70	~~44.14~~ 32.11	77.28	~~0.57~~ 0.41
	Y (NS)	~~60.63~~ 6082	0.75	0.70	~~31.83~~ 31.93	77.28	0.41

Table 5. Revised results of the detailed diagnosis, before and after strengthening

Before strengthening								
Floor	Direction	Horizontal Load (kN)	Stiffness Factor [Fs]	Eccentricity Factor [Fep]	Floor Factor [Fef]	Horizontal Load Carrying Capacity (kN)	Required Strength (kN)	Seismic Index
Second	X (EW)	26.80	1.0	1.0	1.0	26.80	43.24	0.61
	Y (NS)	18.33	1.0	1.0	1.0	18.33	43.24	~~0.42~~ 0.41
First	X (EW)	51.15	1.0	0.74	1.0	37.76	82.60	0.45
	Y (NS)	48.74	1.0	0.79	1.0	38.45	82.60	~~0.46~~ 0.41
After Strengthening								
Floor	Direction	Horizontal Load (kN)	Stiffness Factor [Fs]	Eccentricity Factor [Fep]	Floor Factor [Fef]	Horizontal Load Carrying Capacity (kN)	Required Strength (kN)	Seismic Index
Second	X (EW)	26.80	1.0	1.0	1.0	26.80	43.24	0.61
	Y (NS)	33.43	1.0	1.0	1.0	33.43	43.24	0.77
First	X (EW)	73.91	1.0	0.94	1.0	69.63	82.60	0.84
	Y (NS)	64.75	1.0	0.90	1.0	58.02	82.60	0.70

5. Micro tremor measurement

5.1 Method of experiment

Micro tremor measurement and free vibration tests were operated before and after the structural reinforcement repair work. The measurement clarifies the basic vibration characteristic of the structure as well as the effect of the structural reinforcement repair work in a small displacement range. The devices and the units used for the measurement are shown in Table 6. The locations of the measurement devices are shown in Fig.8.

Table 6 Measurement specification

Measurement Device	Tokyo Sokushin SPC-35, VSE-15D×6
Unit of Data	Displacement (mm)
Sample Frequency	200 (Hz)
Duration	Micro Tremor: 5min (60,000 data), Free Vibration: 1min (12,000 data)
Maximum Range	Micro Tremor: 0.1mm, Free Vibration: 10mm
Filter	High Pass Filter 0.1Hz

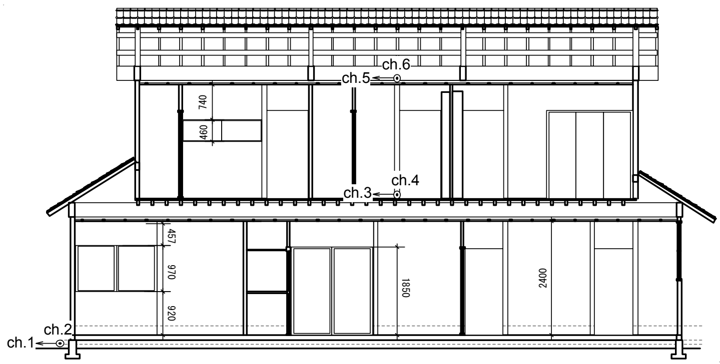


Fig. 8. Location of the measurement device

5.2 Results of measurement

The transfer function determined from the Fourier spectrum is shown in Fig.9. The natural frequency of vibration in the first mode determined from the transfer function is shown in Table 7, for before and after the structural reinforcement work. The natural frequency of vibration has increased 8% to 19% after the structural reinforcement work. This value corresponds to the increase in stiffness resulting from the positive effect of the structural reinforcement repair work. By assuming that the increase in the mass of the structure can be ignored, the calculated increase in the stiffness is approximately 17% to 40%. The damping factor determined by the logarithmic decrement of the free vibration wave profile was approximately 2.3-2.9%, and the correlation to the effect of structural reinforcement is not apparent. The vibration modes of the structure are illustrated in Fig10.

The natural frequency of vibration in the first mode of the house investigated is illustrated in comparison with the preceding research on the two-story timber frame house in Japan (Fig.11). The illustrated results reveal that the natural frequency of vibration determined by this experiment shows good agreement with the results of preceding research. This fact suggests that (1) the vibration characteristic of the investigated detached timber house is of standard level based on preceding research, (2) although the effect of reinforcement is evident from measured natural frequency, the influence of the year of construction is predominant. Therefore in order to evaluate the seismic performance of detached timber houses by micro tremor measurement, further detailed study is necessary.

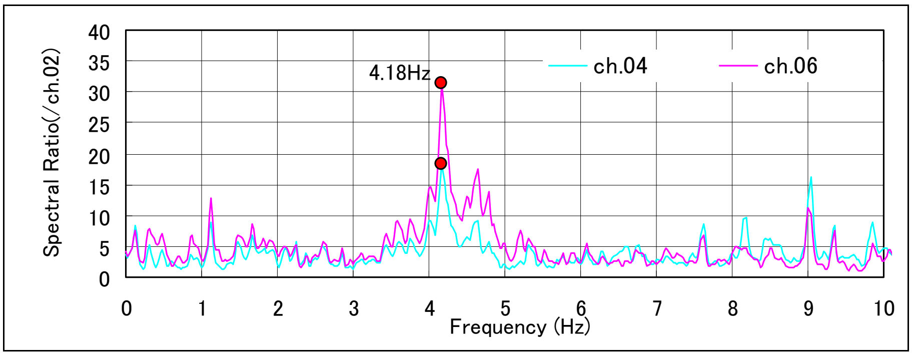


Fig. 9 Transfer function before reinforcement (Y (NS) direction)

Table 7 Vibration Characteristic before and after reinforcement

Direction		Original			After Reinforcement		
		Max. Amplitude (mm)	Natural Frequency (Hz)	Damping Factor (%)	Max. Amplitude (mm)	Natural Frequency (Hz)	Damping Factor (%)
X	Micro Tremor	0.0081	4.25	–	0.0218	4.61	–
EW	Free Vibration	0.0348	4.10	2.32	0.0348	4.69	2.89
Y	Micro Tremor	0.0183	3.81	–	0.0525	4.18	–
NS	Free Vibration	0.0555	3.71	2.63	0.0610	4.40	2.37

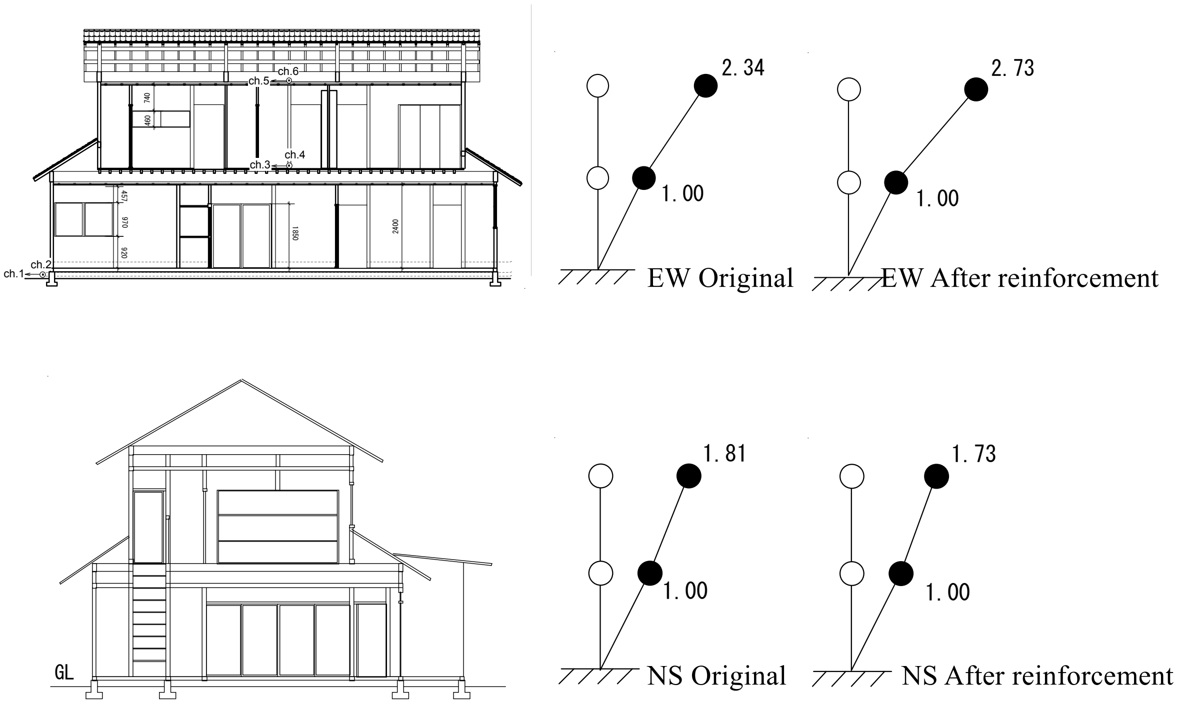


Fig.10 Vibration mode of the structure

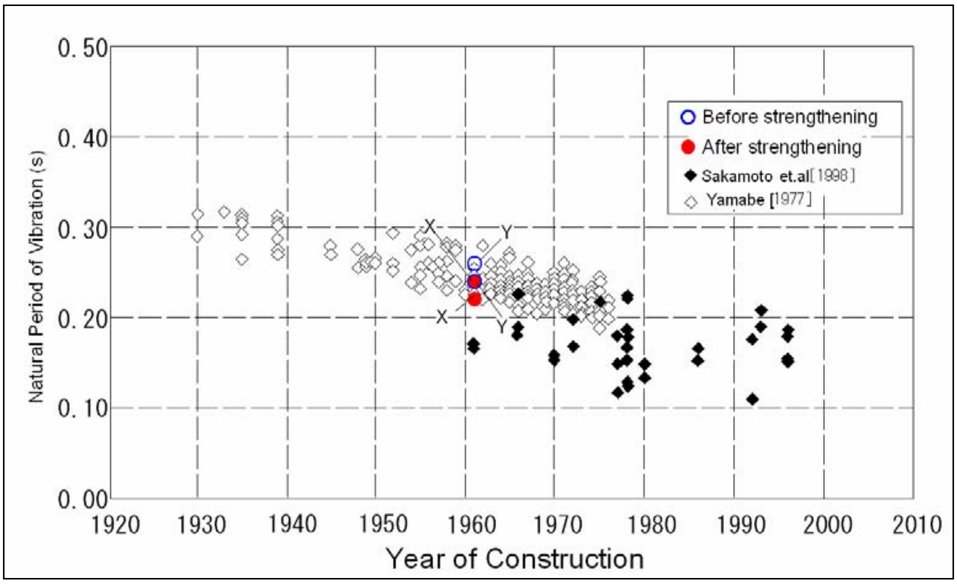


Fig.11 Correlation of the year of construction and natural period of vibration in the first mode by micro tremor measurements on two-storied conventional detached timber houses

6. Conclusion

The case study of the results of on-site investigation, seismic diagnosis, microtremor measurement and structural reinforcement repair work conducted on an existing conventional detached timber frame construction house was reported. The results of the seismic diagnosis showed that the horizontal load carrying capacity of the houses investigated were far below the required values in the Building Standard Law. The timber house investigated is of standard plan and construction compared to other houses of the same era, which suggest the vulnerability and voluminous stock of the potentially hazardous existing timber housing. Based on a detailed interview with the residents, structural reinforcement work using timber lattice and acrylic applied to unused sliding doors was proposed by the authors and the validity of the reinforcement method was proven.

Acknowledgement

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References

Japan Building Disaster Prevention Association 2004, Seismic Diagnosis and Reinforcement of Timber Houses (in Japanese)

Sakamoto, I. et.al., 1998, Study of dynamic characteristics of wood-framed house subjected to microtremor, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, 219-220 (in Japanese)

Takahashi, S., Fujita, K., 2006, A Study on the Reinforcement of Opening in Existing Wood House with consideration of Permeability Part2, C-1 (in Japanese)

Yamabe, K., et.al, 1977, Measurement of the Natural Period of Two-storied Timber Houses in Kawasaki-City, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, 501-502 (in Japanese)

Design Strategies for Activating Public Housing Stock
Learned through the Development of an Elevator Addition System

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Keywords: Mass-housing, Aged Residential Building, Barrier Free, Elevator Addition

Abstract
Various government authorities and public corporations built a huge number of dwellings for rent to accommodate the high concentrations of population in urban areas in the mass-housing era between 1955 and 1973 in Japan. These are four- or five-story reinforced concrete buildings; however, they only have stairway access. Housing estates that have a large number of elderly people urgently require the addition of elevators to make access more convenient. This paper presents the development of a new elevator addition system for such deteriorating aged residential buildings with the added advantages of greater flexibility and functionality.

1. Background and Objectives
In Japan, there is a huge volume of public residential buildings for rent built in the mass-housing era between 1955 and 1973. They were built on a massive scale in the same estate in a short period, to supply the dwellings more efficiently to reconstruct war-damaged cities and to accommodate the high concentrations of population in urban areas. Today, 30 years or more have passed since they were built, and some problems are now arising in such old housing estates.
One of the most serious problems is the rapid increase in the numbers of elderly people. However, most of the aged public residential buildings only have stairway access though they are four or five stories high. The objective of this paper is to develop a new technology to add elevators to aged residential buildings to facilitate access. Furthermore, we consider some design strategies to bear in mind when activating the aged housing stock obtained through this development.


Fig. 1 Housing Estate Built in the Mass-housing Era


Fig. 2 Residential Building with Added Elevator Towers


Fig. 3 Residential Building with Added Access Corridors

2. Review of Existing Elevator Addition Technologies and Set Goal of Development

Some technologies for adding elevators to aged residential buildings built in the mass-housing era (Kadowaki et al. 2005) already exist. One solution is the addition of an elevator tower to each staircase of the building. This method requires no repair to the existing building. However, it does not achieve barrier free access to the dwelling because the elevator car has to stop at the landings of stairways, so that the residents have to go up or down half the story height on foot.

A recent alternative is to add access corridors and an elevator tower to the building to achieve barrier free access. This method requires changing the position of the entry to the dwelling unit, followed by drastic change to the existing structural frame and interior layout, so that the residents have to move during the renovation work. It constitutes an obstacle to renovating the residential buildings, which are located in a small housing estate or in a housing estate in urban areas, by reason of the difficulties to secure substitute addresses. The higher cost of renovation and the longer term required for the residents' consensus caused by the entire building renovation are also obstacles.

Based on such review of the existing methods, we set the goals for the development method as follows:

1) To achieve barrier free access to the dwelling.
2) To make it possible to renovate each staircase (not the entire building) to facilitate obtaining the residents' consensus.
3) To reduce the renovation cost.
4) To make the additional part as a self-standing structure that will not incur structural loads on the existing building.
5) To facilitate renovation work that does not compel residents to move.

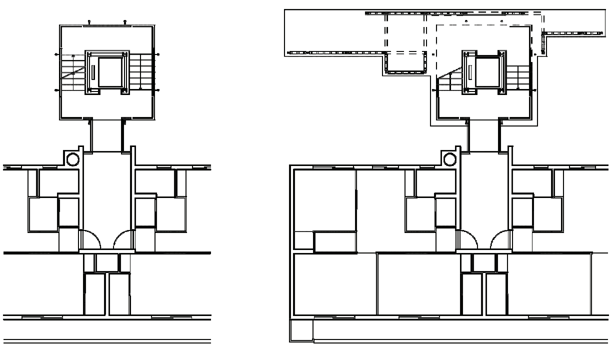
Fig. 4 Typical Floor Plan and Ground Floor Plan of the Experimental Elevator Addition System

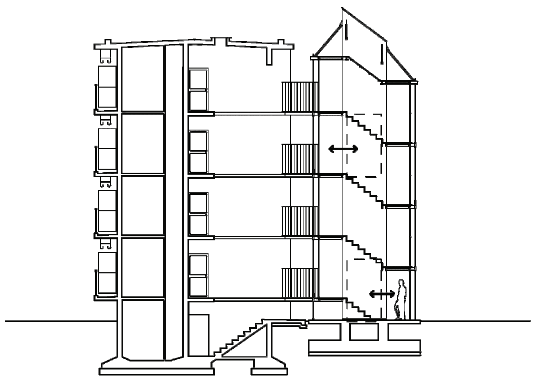
Fig. 5 Cross-section of the Experimental Elevator Addition System

3. Developed Elevator Addition System

3.1 Setup of the System

We developed a new elevator addition system which achieves the set five goals. Furthermore, we designed the system in detail and constructed it experimentally to verify its feasibility. Partial floor plans and a cross-section of the experimental elevator addition system are shown in Fig. 4 and 5.

The developed system consists of three main parts: elevator/stair tower unit, connection unit, and approach lobby unit. The elevator addition process is as follows: firstly, the elevator/stair tower unit, consisting of an elevator shaft and stairs installed in a spiral design encircling the shaft, is installed on the outside of the existing staircase. Next, the existing stairs are removed and the elevator/stair tower unit and the existing building are connected via the connection unit, which consists of new floors installed in the vacant stairwell and bridges. As the occasion demands, the approach lobby unit is built at the same time as constructing the unit. Let us now look at each unit in detail.

3.2. Elevator/Stair Tower Unit

The elevator/stair tower unit, which is the main part of this system, is designed to be compatible with a compact elevator to reduce the renovation cost in consideration of the limited number of the serving dwelling units and infrequency of use.

We determined the smallest elevator car size as being within the limit of accommodating one wheel chair user and one aide, and adopted the elevator with front and rear opening to facilitate a wheel chair user's access without installing a long ramp in place of the ground floor steps. Miniaturizing the elevator with front and rear opening is also effective because it does not compel the wheel chair user to turn around when getting in and out.

On the other hand, miniaturizing of the elevator causes structural instability of the narrow elevator shaft in an earthquake. We solved this problem with the use of slender tension rods around the elevator shaft which tie the trussed cantilevers from the top of the shaft and the foundation as shown in Fig. 7 in order to bear horizontal load.

The stairs and landings encircling the shaft are hung from the rods without supports to avoid an oppressive view from the dwelling and to give a lighter impression of the elevator shaft.

It should also be added as a device of the elevator/stair tower unit that we reduce the use of steel in quantity to reduce cost, for example, by using the stringers both as braces of the elevator shaft.

3.3 Connection Unit

The connection unit consists of the new floor slabs installed in place of the removed concrete stairs of the existing building, and the bridges between the elevator/shaft unit and the existing building. The

Fig. 6 Experimental Elevator Addition System

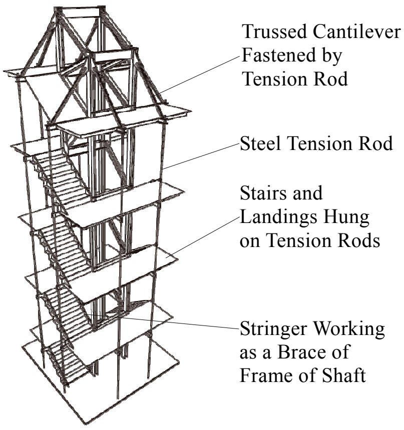

Fig. 7 Structural System of Elevator/Stair Tower Unit

Fig. 8 New Floor Installed in Vacant Stairwell

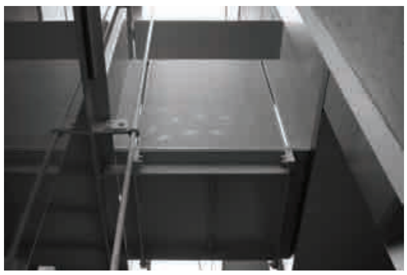

Fig. 9 Connecting Bridge

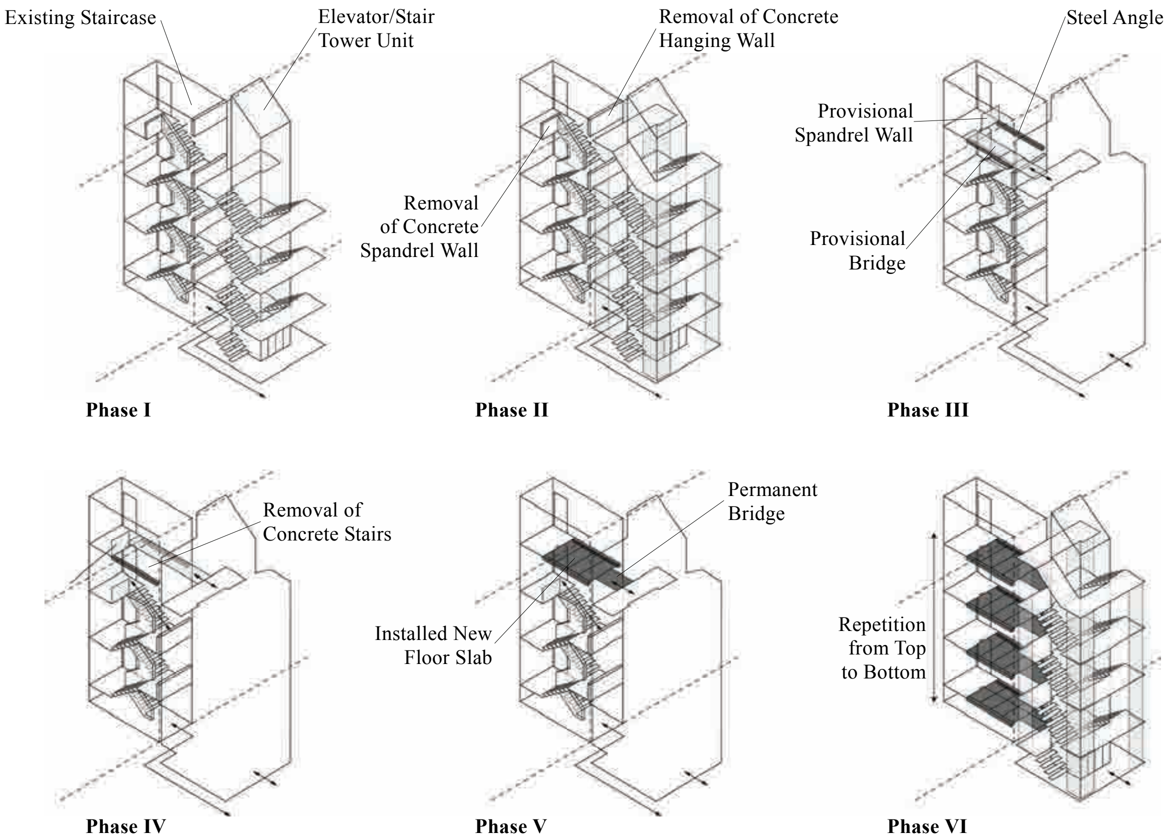

Fig. 10 Renovation Process

new floor is built from the pre-stressed concrete panels supported by steel angles attached to the concrete walls of the vacant stairwell. The bridge is built from the steel plate with ribs. The bridge works as an expansion joint between the elevator/stair tower unit and the new floor in an earthquake because the elevator/stair tower unit and the existing building are different in their shaking motions.

We designed this connection unit to be compatible with facilitating renovation work that does not compel residents to move. The renovation process is shown in Fig. 10.

Firstly, the elevator/stair tower unit is installed on the outside of the existing staircase at intervals of about 1500mm as a passage to allow the residents to use the existing stairs. The connecting work begins from the top floor. The spandrel wall on the top floor of the staircase is removed, and a provisional bridge connects the existing building and the elevator/stair tower unit after attaching steel angles. The provisional bridge allows the residents of the top floor to use the elevator/stair tower unit to access the dwelling, while the residents of the lower floors can use the existing stairs. Then, it becomes possible to remove the existing stairs between the top floor and the right lower floor. After the removal, the new floor slab is installed; the permanent bridge connects it to the elevator/stair tower unit instead of the provisional bridge. When installing the new floor, the residents

Fig. 11 Approach Lobby Unit

Fig. 12 Interior View of Approach Lobby Unit

of the said floor cannot access the dwelling; however, the installation work per floor is finished within two days. The connecting work is completed by repeating this process from the top floor to the ground floor.

3.4 Approach Lobby Unit

We designed this system to be able to add an approach lobby unit to add greater value than achieving barrier free access to the dwelling. The approach unit lobby is able to be designed relatively freely; in the case of the experimental construction, we designed it as a steel structure in the same way as other units. The approach unit allows the equipping of an automatically lockable lobby to increase security.

4. Design Strategies in Activating Aged Housing Stock

In the preceding chapter, we saw the details of the developed system. In this chapter, we will refer to some important points which are required when activating aged housing stock.

1) To Increase the Various Values of a Dwelling

We designed the system not only to increase accessibility to the dwelling, but also to increase various values accompanied by elevator addition.

What we must refer to at first is that we intended to enrich the communal area, for example, new entrance porches for each dwelling generated on the additional floors in the stairwell. This space is well-lighted because of the miniaturized elevator shaft, and it will make the residents' use more active. The approach lobby unit is also designed based on the same concept.

The second point we intended is to increase security. Not only the automatically lockable lobby, but also the lighting equipped with the new stairs, which makes the elevator/stair tower unit look like an illumination tower at night, are considerations for security for the sidewalks in the housing estate which are liable to be in poor light.

The third point is consideration for the scenery of the housing estate developed in the mass-housing era, which were planned with extensive greenery with wide open spaces. The slender elevator/stair tower unit, which provides a lighter impression, is designed not to spoil the beauty.

2) To Give Flexibility to the System Design

We completed this elevator addition method as a "system" to cope with the largeness in quantity of the residential buildings built in the mass-housing era; however, we also regarded it as important to leave some non-systematized parts, or in other words "the parts that added flexibility in designing", to address various problems under a variety of circumstances surrounding housing estates. For example, the exterior facing around the elevator/stair tower unit is placed as a non-systematized part because of the influence of the exterior looking onto the scenery of the housing estate.

In the experimental construction, we used glass panels for exterior facing; use of glass panels is undesirable from the structural viewpoint because of their heaviness, however, a structure, which can stand the weight, secures the use of other materials.

The approach lobby unit is also placed as a non-systematized part. Moreover, the elevator/stair tower unit should be provided for flexibility in extending the elevator shaft according to certain modules to accommodate a larger elevator car.

3) To Increase Diversity in the Housing Estate

Most problems arising in a housing estate constructed in the mass-housing era are caused by the uniform and monotonous design of dwellings. Housing supply on a massive scale in the same estate in a short period brought homogenization of the family type and the strata of residents, and it is bringing a rapid increase in the number of aged residents and stagnation of community. When activating such building stock, it is important to increase diversity in the housing estate.

The developed elevator addition system, which is able to be applied to each staircase, is favorable to accommodate various types of residents to increase diversity. From this viewpoint, it is also desirable to add the elevators around the housing estate though they are usually clustered from the point of view of construction efficiency.

5. Conclusion

In this paper, we presented a new elevator addition system for aged residential buildings constructed in the mass housing era, and have discussed some viewpoints regarded as important when renovating deteriorating housing estates. As we mentioned, the circumstances surrounding the housing estate are various; it is also desirable that the activation methods are many and diverse, that is, accumulation of such development is important to realize sustainability in these housing estates.

Part of this work has already been presented in Ogawa et al. 2005 and Ogawa et al. 2006.

Acknowledgement

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This research was conducted as part of the 21st Century COE Program of Tokyo Metropolitan University “Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis” subsidized by Ministry of Education, Culture, Sports, Science and Technology of Japan.

References

Kadowaki, K., S. Fukao, and T. Arahira. 2005. Regeneration of Public Residential Buildings for Rent in Japan. *Open House International* 30, no. 2: 49-58

Ogawa, H., S. Fukao, and K. Kadowaki. 2005. Actual Conditions of Elevator Addition to the Aged Public Housing in Japan and a Proposal of an Alternative Method. Paper Presented at the 2005 World Sustainable Building Conference, September 27-29, in Tokyo, Japan.

Ogawa, H., S. Fukao, S. Yamazaki, K. Kobayashi, K. Kadowaki, and S. Minami. 2006. Development of a New Elevator System for Aged Residential Buildings. Paper Presented at the Joint CIB, Tensinet, IASS International Conference on Adaptability in Design and Construction, July 3-5, in Eindhoven, The Netherlands

Proposal of heavy insulation for the renovation of apartment housing complex in Tama New Town for energy conservation and more comfortable living environment

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Keywords: Global environment, Heat insulation, Repair, Thermal environment, Energy conservation.

Abstract

The residents of an apartment complex in Tama New Town were surveyed for their views on the environmental conditions in the complex, especially the temperature, humidity, ventilation and occurrence of dew condensation. The reinforced concrete complex was about 20 years old. The authors then conducted workshops with the residents to explain the results of the survey, and together with the residents, formed a consensus to select a method for adding exterior or heat insulation to the buildings. A simulation was conducted, specific procedures were selected and construction costs were estimated

1. Introduction

Let us begin with a brief description of the Japanese approach to the global environmental situation. This year marks the tenth anniversary of the Third Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, which met in Kyoto in December 1997. In March 2007, the European Union agreed to revise its goal of reductions of greenhouse gases relative to the 1990 emissions from 8% to 20% by the year 2020. Japan set a goal of reducing its emissions from the 1990 level by 6% during the timeframe 2008-2012, but its emissions were actually 8.1% higher in 2005, casting doubt about its ability to meet its goal. As shown in (Fig. 1） , the Energy Conservation Center, Japan(ECCJ) has compared the domestic energy consumption by individuals and in houses and multiple-dwelling buildings with industrial and transportation energy consumption. If the amount of energy in 1973 is normalized to 100, in 2004, it was 247, nearly two and a half times as great. Our lifestyle has become much richer and more comfortable, but at a steep price to the global environment.

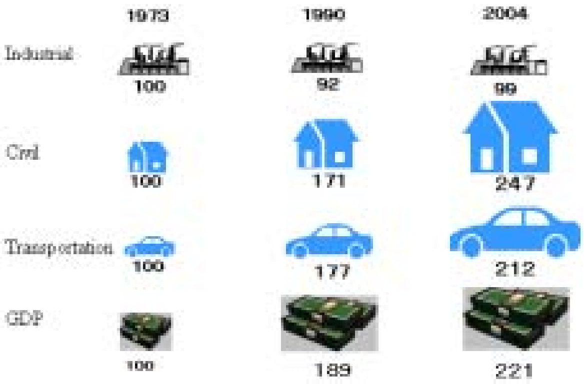

Fig. 1 The total energy consumption

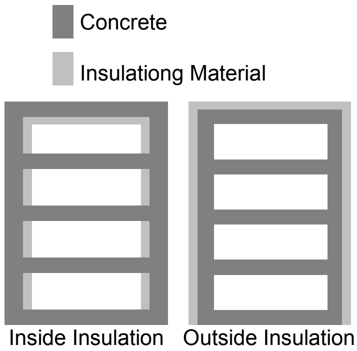

Fig. 2 The model of inside insulation and outside insulation

2.Proposal

Tama New Town is 30 km west of Tokyo. Currently, it has a population of about 140,000 in 60,000 households. Due to the simultaneous drop in the percentage of the population in a productive age group and the aging of structures, it is facing a steady deterioration of the living environment. Fortunately, there are realistic ways to counteract the aging of structures and the decline in the living environment.

This paper proposes that one of the effective countermeasures against structural aging and the decline of the living environment is to refurbish the structures with heavy outside heat insulation (Fig. 2). It is well established that repeated condensation of dew is the fundamental cause of the deterioration of concrete, but it is also believed that this can be reversed by putting a complete stop to condensation, and the lives of buildings that have been damaged by dew can actually be considerably lengthened.

Living spaces that have been restored using exterior insulation are “re-born” from spaces with low energy efficiencies to spaces that can be air-conditioned to comfortable levels with much lower energy expenditure. Allergens are also suppressed, leaving the spaces healthier for the inhabitants

3. Performance of insulation in Tama New Town (Minami-osawa district) buildings

3.1 Case study of a dwelling that was uninsulated until 1973 (Fig. 3)

The roof was asphalt for waterproofing with bricks along the eaves.

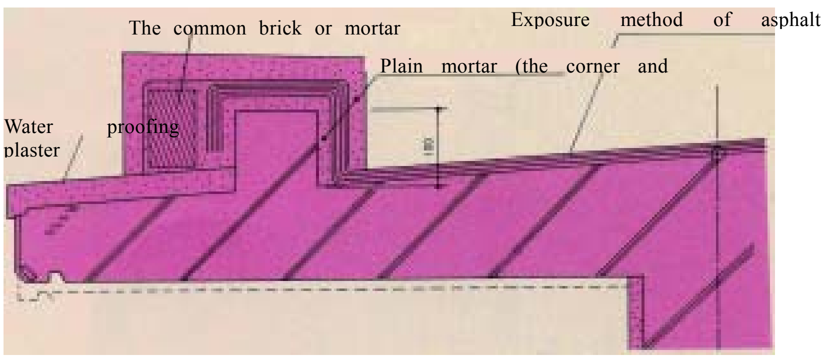

Fig. 3 Detail of no permission thermal residence

3.2 Asphalt waterproofing as heat insulation, 1974 – 1976 (Fig. 4)

This building was initially uninsulated and only a layer of insulation was added, but it was quite beneficial, and the building is maintained in good condition at this time.

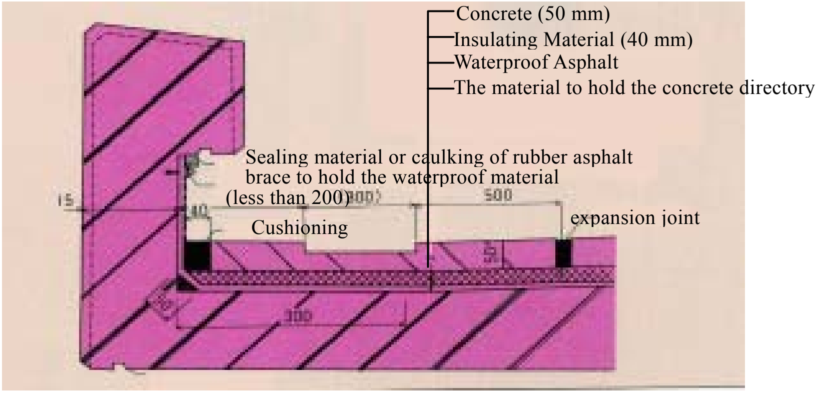

Fig. 4 Detail of asphalt proof

3.3 Since 1977

Fig. 5 shows an example, which was completed in 1982. The roof includes parapets. The waterproofing methods have been revised since the building was constructed.

Fig. 5 Asphalt proof of outside insulation

4. Resident attitude survey

4.1 Objectives and topics of survey

In Minami-osawa district, the residents of a building that had been refurbished with exterior insulation were surveyed to learn their views about the discomfort from heat, cold, dew condensation and mold in the buildings, and to examine the effectiveness of the refurbishing.The topics of survey are shown in Table 1.

4.2 Poll topics (Table1)

The questionnaires were distributed to 146 households, and 105 questionnaires (71.9 %) were recalled.

Environmental condition	Environmental control	Life correspondence
Cold of winter and Heat of summer	Air-conditioning	Use frequency
Ventilation of winter and summer	Ventilation method	Number of Ventilation
Dew condensation	Dew condensation measure	Correspondence to dew condensation
Mold	Mold measure	Occurrence frequency of mold

Table 1 Topics of survey

4.3 Poll results

Summer heat and winter cold

Figs.6 shows the results of the subjective sensations of heat during the summer as reported by the residents of the top and the lowest floors. The dwellings on the top floors were hotter than those on the lowest floors.

Figs.7 provides the respondents' answers about cold during the winter. Those in Bedroom 1, which is on the south side of the building, reported being fairly comfortable, while those in Bedrooms 2 and 3, on the north side, tended to feel colder.

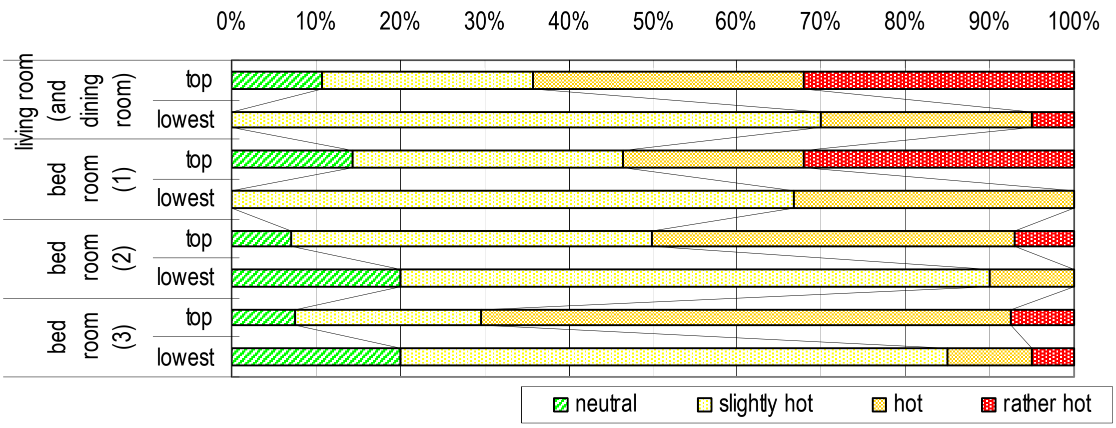

Fig. 6 The vote of the hotness of the objective rooms (summer)

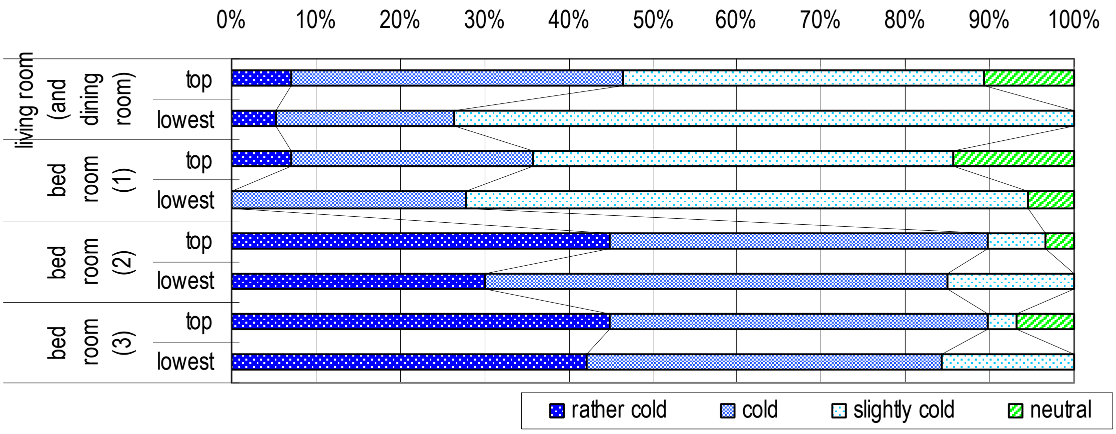

Fig. 7 The vote of the cold of the objective rooms (winter)

Ventilation in summer and winter (Figs.8 and 9)

The baths, changing rooms and toilets in the buildings covered by the survey are provided with mechanical ventilation when they do not have windows opening to the outside. Of course, they do not have ventilation systems that operate 24 hours/day, and their mechanical ventilation systems are all Class 3. The kitchens are equipped with range hood exhausts and inlets with coupled shutters, but the other fans do not have their own exhaust outlets. Thus, the residents use screen doors or open their windows in order to get adequate ventilation and cooling.

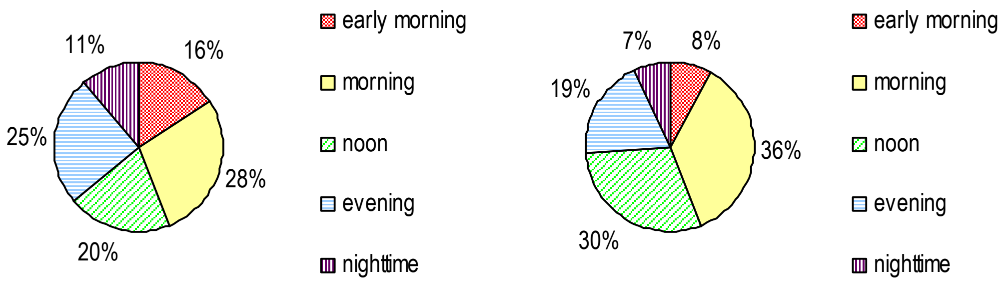

Fig. 8 The time zone of ventilation in summer(left) and winter(right)

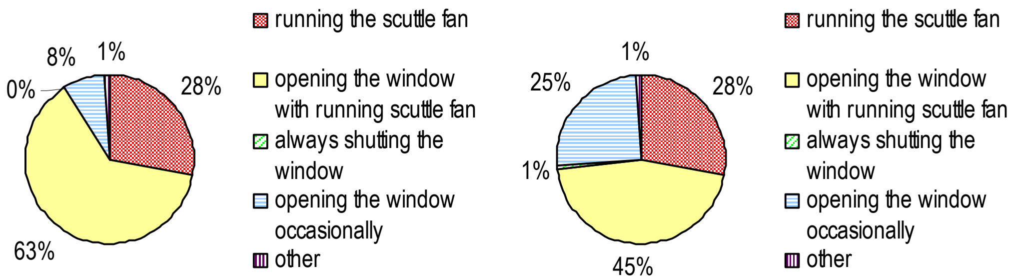

Fig. 9 method to use to ventilate the indoor air of summer(left) and winter(right)

Occurrence (Fig. 10) and management(Fig. 11) of dew condensation

Nearly all the residents reported condensation during the winter; 20% reported that it also occurs during the rainy season.

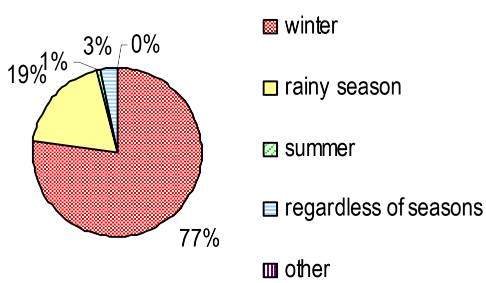

Fig. 10 season to find the dew condensation

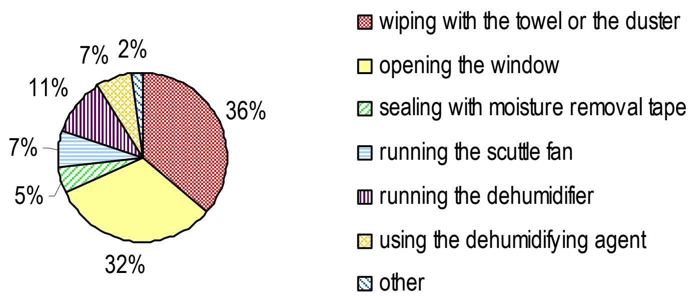

Fig. 11 method to remove the dew condensation

Measure against mold

The survey results showed 30% of the households reported that mold appears constantly, while 50% said it appears "sometimes." Thus, mold is an everyday concern for nearly all the households.

Fig. 12 and 13 indicate that mold outbreaks are most prevalent in the winter and rainy season; these two seasons account for 3/4 of all outbreaks.

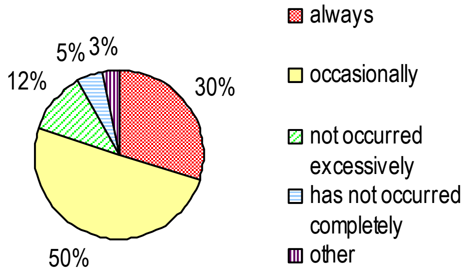

Fig. 12　frequency to find the mold

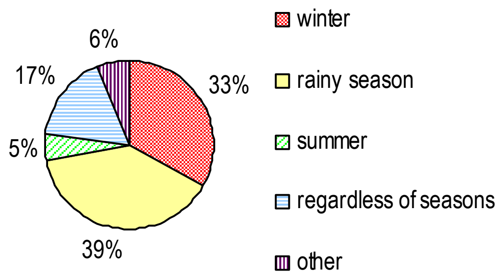

Fig. 13 season to find the mold

5. Proposal for a procedure to refurbish outside insulation, based on experience in the Minami-osawa apartment complex.（Table2）

This proposal assumes only enough funding to insulate the walls, so no costs are included for insulating openings or the roof. The work consisted of the following tasks: a high-pressure wash of the exterior wall; application of expanded polystyrene (EPS) insulation; coverage of outer corners and openings; installation of sleeves over equipment; installation of shock-resistant reinforcing mesh; coverage of the building foundation; protection of the existing structure and furnishings; and recycling of EPS insulation. The cost given below for these tasks is only an estimate. **(Table3)**

Table 2 Specification of apartment house

Object building	Apartment building
Constructive year	1985 construction
Constructive subject	Urban Renaissance Agency(UR)
Structural	RC wall type structure (5 floors)
The number of houses	20 doors

Table 3 Proposition contents repair for outside insulation system

	Existing (the inside insulation)	Level 1 Outside insulation	Level 2 Outside insulation	Level 3 Outside insulation
Roof	PV seat waterproof +extruded polystyrene foamt 50 ㎜ concrete (t50 ㎜)+ extruded polystyrene foamt 30 ㎜ rubber asphalt waterproof layer +RC 150 ㎜		PV seat waterproof + phenol foam t50 ㎜ PV seat waterproof +extruded polystyrene foam t50 ㎜ concrete (t50 ㎜) + extruded polystyrene foam t30 ㎜ rubber asphalt waterproof layer +RC 150 ㎜	
U-value of Roof	1.19 W/m^{2}K	1.19 W/m^{2}K	0.47 W/m^{2}K	0.47 W/m^{2}K
External wall	RC 150 ㎜	Outside insulation construction (EPS40 ㎜) RC 150 ㎜	Outside insulation construction (EPS100 ㎜) RC 150 ㎜	Outside insulation construction (EPS150 ㎜) RC 150 ㎜
U- value of Wall	4.1 W/m^{2}K	0.81 W/m^{2}K	0.38 W/m^{2}K	0.26 W/m^{2}K
Window	Single aluminum sash	Multi layer aluminum sash	Low-E resin sash	Low-E resin sash
U-value of Window	5.7 W/m^{2}K	3.28 W/m^{2}K	1.69 W/m^{2}K	1.69 W/m^{2}K
Cost		25,000,000 yen (1,250,000 yen per an apartment)	27,000,000 yen (1,350,000 yen per an apartment)	30,000,000 yen (1,500,000 yen per an apartment)

6. Popularizing this method

6.1 Agreements with the apartment complex

The installation of heavy insulation performed in the model housing complex was time-consuming, and the project was overseen by a special committee, effectively, a “refurbishing committee,” who reported to the facility management union. The organization included qualified construction contractors and others knowledgeable in fields concerned with protecting the appearance of the buildings, such as building maintenance and management, grounds-keeping, and exterior upkeep. In contrast with the management union, which is convened for a single fiscal year, the period of the committee was left un-determined, and it operated autonomously.

For several years, the committee had been viewing presentations by representatives from outside insulation manufacturers and holding conferences about outside insulation. Subsequently, it decided to apply heavy insulation at the same time as new waterproofing to the roof. It planned to add outside insulation to the walls next, as part of regular refurbishing. The present survey indicates that the residents are increasingly interested in such improvements and hope that that project would lead to a more expanded effort in insulation. Such an extensive project needs three essential elements: people, materials and money. The community has yet to agree on a particular project as providing sufficient value for cost, however, and will need to build up a reserve fund for the next step of re-insulation.

6.2 Role of workshops

The authors found that a strong consensus is essential if the management is to carry through with re-insulation of a building under The comparted Ownership Law, but it is not easy to create the motivation to get the project started. It is impossible, in practical terms, in a condominium where the management union is apathetic to building management. In view of national concerns such as global warming and the desirability of using building stock for as long as possible, management unions need to change their attitudes toward these matters.

6.3 Support by experts

The national authorities have an essential role to play in promoting the re-insulation of buildings to high insulation values throughout Japan. Individual specialists will also be an integral part of this process, if it is to be carried out throughout the country. Local authorities will need to enact their own campaigns to raise the consciousness of the citizens in order for the public to reach a consensus supporting such a plan. A consensus was reached among the residents of Minami- osawa apartment complex, due to the efforts of the organization within the complex and local NPO and specialist advisors, who also helped to convince the residents to support their re-insulation project.

7. Summary

The purpose of this project was to apply heavy insulation to existing multiple-dwelling structures in order to study the potential benefits in terms of answering the need of this era to reduce the human load on the global environment, making better use of existing building stock, and renovating apartment complexes. An apartment complex was chosen in Tama New Town, a typical example of a large-scale planned satellite town, for a special installation of heat insulation. The residents were surveyed for their impressions of the heat environment in this apartment complex. A new method of insulating buildings against heat extremes was proposed.

The authors hope that the results of this research will contribute to improvements in the living environments of apartment complexes throughout Japan.

Acknowledgements

The authors extend their deepest thanks to the residents of Minami-osawa apartment complex, who were far more generous than we had expected in their responsiveness to the survey, and who gave full cooperation during the authors' observations of the thermal environment. The authors also express their gratitude to the members of the Apartment Complex Management Union, whose great cooperation and assistance was of great benefit to this project.

References

Tanaka T. and Yumoto L. 2007. *Future housing with external insulation*.

ECCJ: The Energy Conservation Center, Japan www.eccj.or.jp/

Phenol foam:www.neoma.jp

Extruded Polystyrene foam:www.dowkakoh.co.jp

Kobayashi,K.et. al. *Insulated method of UR rental house and the history.*
Urban Renaissance Agency(Japan Housing Corporation)

Bio-Inspired Ventilating System for Building Envelopes

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Keywords: Bionic, adaptable, integration, deformations, transformation, ventilation.

Abstract
A breathing skin for buildings based on principles and methods abstracted from nature is presented. Installing and integrating services in the envelope for building renewal, result in less interference with the interior spaces. And by moving the old services from the interior, an extra space is provided.
The developed skin reacts to changing conditions and influences the air pressure on the surface to perform a process of inhaling and exhaling. The system is created by a specific arrangement of a basic component, to utilize the space and the materials in an efficient way. The orientation and the geometry of the components allow deformations. These deformations are important for creating gradient pressure on the surface of the building skin, in order to allow sucking and expelling the air, which results in regulating the interior microclimates. Piezoelectric wires are used to generate the deformations. The rate of air-exchange is affected by the velocity of the component changing shape (deformation velocity). By developing this system we are not dealing with a separate ventilation system, but with an integral part of the building envelope, which functions as a protective layer too. In this way we save material and energy and thus improve the sustainability of buildings.

1. Introduction
The envelope of the building is mostly responsible for building's energy consumption. In the last decades, systems for buildings that respond to environmental changes have made rapid advances. New building systems and products, software and procedures are being developed. The consciousness for the relation between façade and energy-consumption resulted in making research on integration of climate-technology into façades (Ebbert et al. 2006).
After the world-war-II a huge number of people were left without housing. As a result, a big mass of buildings were constructed, where the quantity was more important than the quality. This existing housing stock needs to be upgraded with today's and future's needs of the users (Kendall 1999).
Façade development is increasingly concerned with ongoing changes within the existing building stock. Industrialized production is possible due to the current façade stock which is based on post-and-rail systems or on element systems (Krewinkel 1998; Oesterle et al. 1999).
In building renewal, installation and integration of services in the façade structure is one of our major tasks. In our research we develop envelopes, as adaptive systems to changing environmental conditions and integrate them into structures. Our aim is to combine new façade technologies with research going on new materials, where we improve the performance of the façade.
The envelope of the building is responsible for a major part in controlling the climate and energy consumption. By upgrading the envelope of the building, the performance of the building (the organism) is

improved, thus contributing to a more efficient building.
For developing services and systems for facades, we use the nature as a source of methods and principles. For millions of years have nature been revolting and creating structures that tend to perfection in terms of energy consumption, environmental adjustment and survival. In “On Growth and Form”, D’Arcy Thompson (1961) suggested that living things adapt their shapes to physical forces applied on them. When a new structure is “born”, a number of elements of the same environment participate for a certain period of time in its creation, either directly or indirectly. This environment can be influenced from other environments. Hence, every new structure (that survives) is born after a long and complicated procedure where many elements have contributed each in its own way and magnitude to build the features, characteristics and mechanism of the structure.

2. Biomimetics

Biomimetics is not about nature imitation, but the observation at their properties and principles, and the transformation and the development of these principles into sophisticated technological solutions. These solutions can result in new means by which buildings can respond, adapt and interact to regulate their interior environment for the satisfactory of their users.
Nature has always inspired technology, and led to effective algorithms, methods, materials, processes, structures, tools, mechanisms, and systems (Bar-Cohen 2006).
Constructing structures with cells is a method used in the majority of plants and animals. This method provides the ability to grow with fault-tolerance and self-repair (healing). Honeycomb has been a model for construction, for its perfect cellular shape (hexagonal) that result in an optimal packing shape. Maximum stability with minimum amount of material is the aim of the bees while creating their structure. For that reason it is an ideal solution in aircraft, where they need light weight structures.

3. Methods and Principles in Nature

The main aim of the research is to develop adaptive systems for buildings based on principles and methods in nature abstracted and transformed into technical solutions. These adaptive systems regulate the interior environment, by responding to changing environmental conditions. In developing these systems we take advantages from ongoing research in the material field. Some advanced materials can be applied to systems in structures and buildings to adapt their properties and hence optimize their performance. In this paper we, specifically, address the piezoelectric material to be integrated in the envelope as will be further discussed later on.
Nature presents an *infinite* source for research and knowledge that has been used by many researchers from different fields for different aims. Living organisms have unique integration geometries and techniques that allow them to adapt to different environments. They can sense and react to local changes causing a global behavior. Their development through evolution can take decades and centuries to give structural solutions (such as ventilating systems). One of the challenges is the development of effective and efficient envelopes that uses the natural dynamics in the neighborhood of structures instead of counteracting with them.
Investigating and analyzing natural systems can result in models for dynamic and adapting materials. And we are able to analogously apply solutions abstracted from nature in the desired system. Size and proportion is important in such systems and should be considered prior to abstracting principles. In this paper, we present some breathing organisms and circulation systems (air exchange), which can be found in many living creatures for different tasks. The main methods and principles are abstracted and transformed to develop the presented envelope.

The following cases from nature are brought to show different methods for ventilation and integration patterns:

(1) *Ascoinoide sponge*: It has an interesting geometric regularity that provides a unique circulation of water through and around its walls. The sponge consists of membranes on the envelope which sucks the food through them, and expels the water out through an atrium in the middle. The outer layer consists of thin cells which are tightly packed together. The inner layer consists of internal chambers, which are surrounded by a membrane that makes beat movements to create an active pumping process of water throughout the sponge walls and to absorb nutrients.

(2) *Respiration systems*: many living organisms have a mechanism in their body for exchanging air (inhaling and exhaling). There are four main respiration systems; (a) integument – where the exchange of gas occurs in the water directly through their integument; (b) gills – external tissues with many enfolding that increases the surface area for gas exchange. Organisms which live in water have this type of system for gas exchange; (c) lungs – the system is located inside the body connected to the outside by a pathway. By moving the muscles of the chest the air is sucked inside through the pathway to fill the lung. The lung has a great surface area of gas exchange due to its tiny protrusions inside; and (d) tracheae – the system is divided into a lot of small tubes that are in contact with muscles and organs. This kind of system functions in bodies less than 5 cm in length. Body movements increase the diffusion of gases inside.

(3) *The skeleton of a sea sponge*: the fibers of the skeleton are overlapped or overlaid in a regular or crisscross pattern, with diagonal fibers to reinforce the skeleton. When increasing the diameter of the sponge skeleton a spiral pattern is emerged to be stronger. According to Reichmanis (2005) the sponges are formed in a perfect way with the exact amount of material for optimizing the design. Understanding how their structures evolve could help in design processes.

(4) *The surface of a sea sponge*: sponges have an extraordinary surface features. They don't have organs, muscles or nervous system. They only have specialized cells for different purposes. The sponge can increase its volume and by that it increases the inner and outer surface area. It generates a water flow by a nonstop beat and movements of flagella (a long slender projection from the cell body) which is part of the choanocytes (collar cells in the sponge). The water flows into the shafts through the pores in the body wall. The sponge also consist of oscules (outgoing of the channel system permeating the sponge) that close and open.

3.1 Principles Abstraction

Table 1 a summary of Keywords Abstracted from the Natural Systems above

System	Keywords
Ascoinoide sponge	Circulation, membranes, sucking, expelling, atrium, cells, chambers, pumping, absorption.
Respiration systems	Gas exchange, tissues, enfolding, surface area, pathway, muscles, sucking, protrusions, division, tubes, movements, diffusion, expansion, contraction.
The skeleton of a sea sponge	Helix like structure, overlapping, overlaying, crisscross pattern, diagonal, fibers, skeleton, increasing/decreasing, optimization.
The surface of a sea sponge	Differentiation, nonstop beating, movements, shafts, pores, close/open, channel system, permeable.

From studying and analyzing natural systems that perform ventilation or circulation processes, we had abstracted the principles and methods that these systems are based on. And we summarized the main keywords in a table (Table 1) as a reference for our work.

Different methods for ventilation (gas exchange) are used in the living organism. In the living organism we can see that the gas exchange is performed through a series of actions which is related mainly to parts movements influencing the air pressure to create a flow against the exchange tissues. The surface area of the exchange is greatly expanded in such natural systems, by dividing the system into many small parts, chambers or sub-branches. The gas exchange process is happening continuously, and it depends on the pressure changes. Integration patterns are based on simple basic geometry to create more complex functionality of the system.

3.2 Principles Transformation

Based on the principles and methods abstracted from the natural systems, a breathing skin for buildings was designed (Fig. 1). In our work we will refer to the following methods:

1. Generating gradient pressure by parts movements.
2. Increasing and decreasing the volume to result in sucking and expelling.
3. Dividing the system based on hierarchy.
4. Controlling the air-exchange by designing the surface pattern (sea sponge).

These methods provide the base-line for our development, where during the transformation we keep and follow these methods in order to create the new system based on natural principles.

By this transformation we consider the envelope of the building as a ventilation system that improves the functionality of the building skin.

3.3 Transformation Results

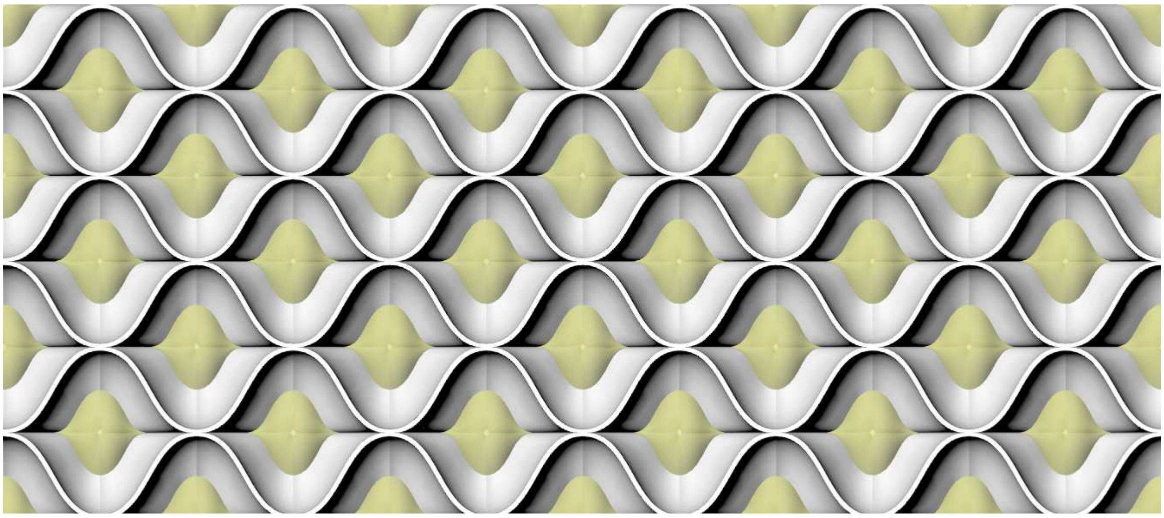

Fig. 1 a Computer generated view at the Skin 1:1

We developed a skin that reacts to changing conditions and influences the air pressure on the surface to perform a process of inhaling and exhaling. It provides an extended surface area for air exchange created by a lot of small active units (a basic component). Increasing the exchange surface of the skin improves the ventilation through it.

The designed skin is a system where local changes occur to create global behavior. The system is created by a specific arrangement of a basic component, to utilize the space and the materials in an efficient way. The orientation and the geometry of the components allow deformations in order to perform the inhaling and exhaling process which results in regulating the interior microclimates.

3.3.1 Basic Component

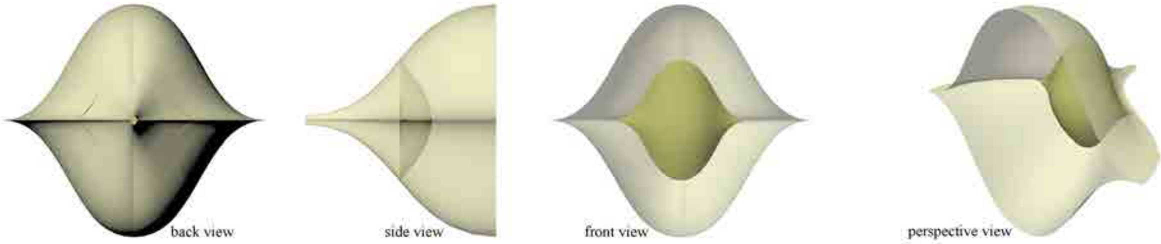

Fig. 2 the Active Basic Component

The component presented in Fig. 2 is produced from elastic membrane that allows it to be flexible. The component cross section consists of three hierarchical parts: opened, semi permeable chamber, and a closed part. This hierarchy is important to create three chambers with different air pressure. The changes in the geometrical state of the components allow the air to flow in and out. The rate of air-exchange depends on the velocity rate of the component changing shape (deformation). Sensors are attached to the inner side of the skin, which give signals (through a control system) to the component to increase or decrease the deformation velocity. The middle chamber allows the air to flow in one direction. Hence it functions as a lung allowing air to flow in both directions (in and out). A more detailed explanation of this lung like chamber is discussed later in the paper.

3.3.2 Basic Component Deformation and Integration

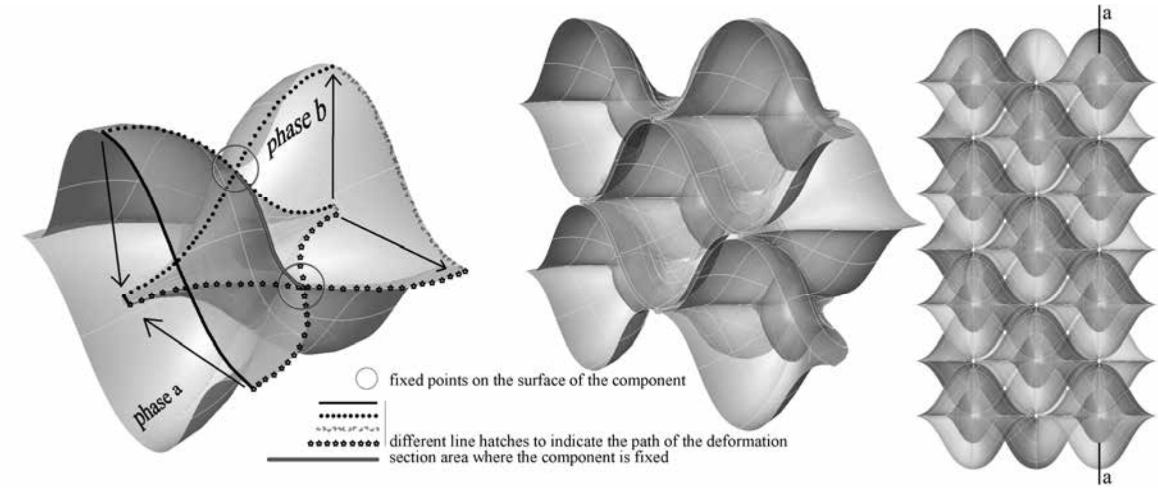

Fig. 3 Component Deformation

The deformation of the basic component is continuous. It deforms from phase a. to phase b. and vice versa (as shown in Fig. 3, left). At phase a. the component is opened to the outside and closed to the inside, but this state is changing all the time at different velocities depending on the conditions of the interior space. The system is an integral part of the building envelope. The active ventilating components with their arrangement and geometrical integration create the protective envelope for the building, not just a protective layer but also an adaptive system based on bionic principles. The arrangement of the components creates an envelope that has the ability to perform dynamic continuous changes. Dynamics are produced due to geometry and material hierarchies. These dynamics generate gradient air pressure which in turn creates process of inhaling and exhaling, performed at the same time. While some components are performing inhaling other components are performing exhaling.

The components are made from membrane materials that are able to receive signals from sensors and respond by changing their geometry, this change will enable the air to permeate the lung-like-chamber from one side and expel it from the other side during the geometry change of the component.

3.3.3 Lung-like-Chambers Arrangement in the System

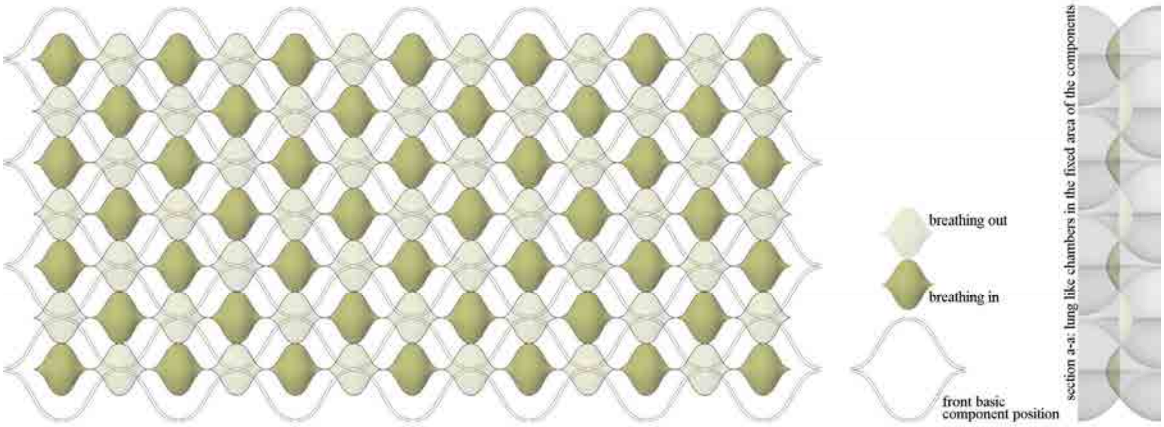

Fig. 4 the Pattern of the Lung-like-Chambers Net

The position of the lung-like-chambers is fixed in the basic component. As mentioned earlier in Fig. 3, there are fixed points in the basic component during their continuous changing. The chambers are based in the middle of the basic component cross-section, where the basic component is fixed and no movements occur. They are arranged in a diagonal crisscross pattern (as presented in Fig. 4) to optimize the stability of the system. This net is the basic support of the dynamic system, where the basic component is attached to this net too. The two different color scales of lungs in Fig. 4 imply the direction of air flow through the system. The air flows from outside to inside or from inside to outside through the lung and it doesn't flow in reverse direction through the same lung-like-chamber.

3.3.4 Piezoelectric Material Application

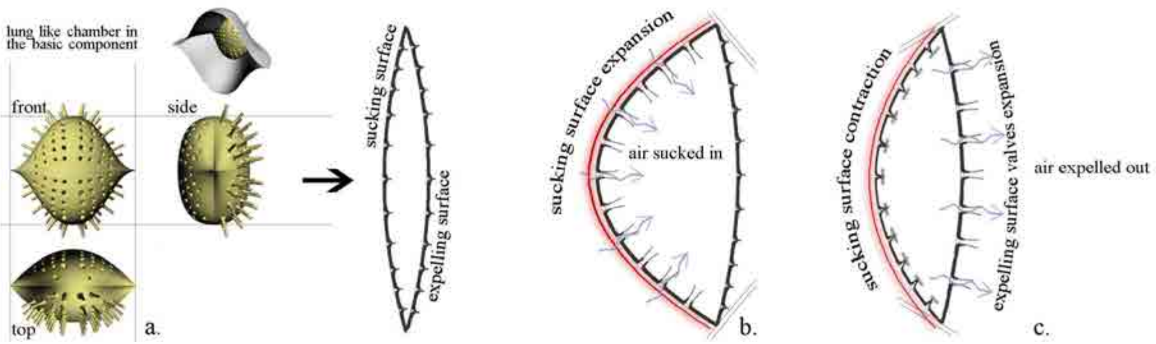

Fig. 5 the Expansion of the Lung-like-Chamber

The lung like chamber is designed on base of principles and methods abstracted from respiration systems, surface of the sea sponge and the asconoid sponge, which were presented earlier.

The lung like chamber consists of two surfaces attached to each other at their edges creating a specific volume in the basic component (as presented in Fig. 5a). Piezoelectric wires are attached on the sucking surface of the lung like chamber. The sucking surface is controlled separately (Fig. 5b & 5c). When a voltage is applied to the piezoelectric wires on the sucking surface, the lung expands and increases its volume and by that it increases the inner and outer surface area. A low pressure is created in the lung which results in sucking the air inside the lung (Fig. 5b). The air flows into the lung through shafts on the surface of the lung. The shafts are designed in a way that allows the air to flow in one direction; valves are attached to the inner surface of the shafts, when the air pushes on the inner surface towards out, the valves are contracted and closed. Stopping the voltage from the surface results in contraction and creating over pressure (Fig. 5c), which results in expelling the air out of the lung like chamber through the other side, where the air pushes on the inner side of the expelling surface and results in opening the valves. By this action the air flow is controlled to flow through the lung in one direction.

3.3.5 Lung Expansion and Contraction combined with Basic Component Deformation

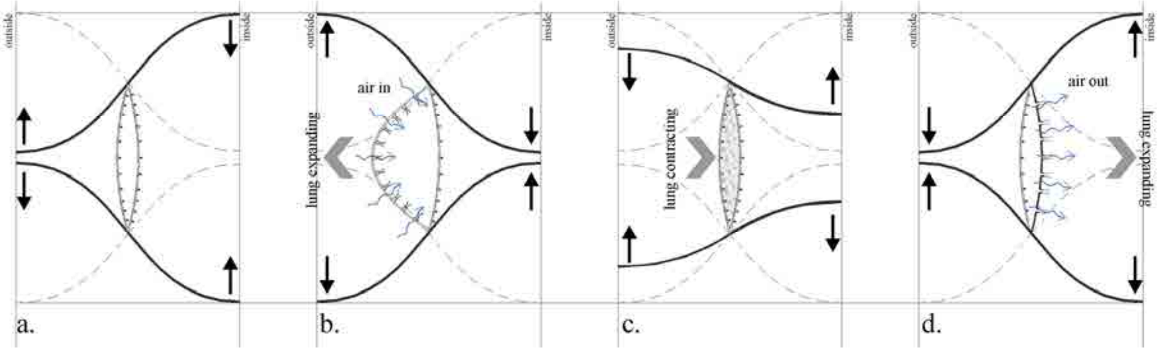

Fig. 6 the Process of Air-Exchange that occurs in the New Skin

In natural respiration systems air circulation is generated by a nonstop beat or movements of the muscles or different parts of the system. These movements create over/low pressure where the air is sucked or expelled, as already explained and summarized before.

Based on sections 3.1 and 3.2, the expansion and contraction of the lung-like-chamber is combined with the movements of the basic component (Fig.6 a-d). When a voltage is applied to piezoelectric wires on the lung, results in the expansion of the lung, and at the same time the basic component deforms and opens to create a bigger volume on that side where the lung had expanded (Fig.6 b). Creating a bigger volume increases the low pressure and increases the air sucking from the surrounding environment. Stopping the voltage will result in contracting the lung and creating over pressure inside (Fig.6 c), at the same time; the basic component is deforming and closing the side where the air was sucked inside the lung, and opening the other side (Fig.6 d). Creating the bigger volume in the basic component creates low pressure which will result in improving the air expelling from the lung to the other side, And so on. In this way the skin sucks air from one side and expels it to the other side. The skin consists of lung-like-chambers that take air from outside to inside, and lung-like-chambers that take air from inside to outside. In this way the air is exchanged continuously.

4. Conclusions

We had developed a skin that performs a gas exchange process which can be integrated into structures with the property of adaptation, based on principles abstracted from natural organisms.

With installing and integrating services in the envelope for building renewal, we result in less interference with the interior spaces. And by moving the old services from the interior, an extra space is provided. By developing the presented breathing system we are not dealing with a separate ventilation system, but with a system that is an integral part of the building envelope which functions as a protective layer too. In this way we save material and energy and thus improve the sustainability of buildings.

The developed skin has a unique geometry and integrity, which allows it to react to the environmental changes. The elastic material used for the skin is important to make it possible to react and change continuously. Utilizing advanced materials in the design, which are not common in the building industry, opens new opportunities for better solutions for building envelopes.

Currently we are running simulation tests to investigate the behavior of the ventilating system for structures with different requirements in order to optimize their functionality. We also intend to test a prototype of the developed system based on the required improvements (from the simulations). Our vision includes a new class of building envelopes which are self-adapting systems that can behave “intelligently”. This class is a result of ideas transformed from nature, with the property of adaptation to changing environmental conditions. And can be the solution for the major problems in integrating new services for the existing stock of buildings.

5. References

Addington, M. and Schodk, D. 2005. *Smart Materials and Technologies*. Oxford: Elsevier-Architectural Press.

Bar-Cohen, Y. 2006. Biomimetics: Biologically inspired Technologies. Boca Raton: Taylor & Francis.

Ebbert, E. and Knaack, U. 2006. *The Integral Envelope Applied for Sustainable Office Refurbishment*. Proceedings of 2nd CIB International Conference: Smart and Sustainable Built Environment, SASBE2006, Shanghai, China.

IL 6, 1973. *BIOLOGY AND BUILDING 3*. Institute for Lightweight Structures, Stuttgart.

Kendall, S. 1999. Open Building: An Approach to Sustainable Architecture. *Journal of Urban Technology*, vol. 6, no. 3: 1-16.

Krewinkel, H. 1998. *Glass Buildings: Material, Structure and Detail*. Switzerland: Birkhauser.

Oesterle, E., Lutz, M. and Lieb, R. 1999. *Doppelschalige Fassaden*. Munich: Callwey.

Purves, W. and Orians, G. 1983. *LIFE: The Science of Biology*. Boston: Willard Grant press.

Reichmanis, E. 2005. *Research on Deep-Sea Sponge Yields Substanial Mechanical Engineering Insights*.

Teuffel, P. 2006. Utilization of Advances in Material and Computer Science for Building Structures, *Game Set and Match II*: 264-270.

Thompson, D'Arcy Wentworth 1961. *On Growth and Form*. Cambridge University Press, Cambridge.

Tsui, E. 1999. *Evolutionary Architecture: Nature as a Basis for Design*. Toronto: John Wiley & Sons.

An Adaptable Façade Concept for Sustainable Office Refurbishment

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Keywords: Integration of Installation into Facades; Re-activation of buildings; Future façade-technology; Refurbishment; demands in office renovation

Abstract
A large percentage of offices in Europe is outdated on technical and design aspects. Different promising facade and climate concepts exist for new construction. The presented research aims to derive from these systems a high potential flexible and upgradeable façade concept suitable for renovation of office buildings. For a case study a concept has been developed which provides connections and installation space. Different levels and means of installations are just as possible as an easy change of cladding material or building physical standards. As such system can supply the necessary installations appropriate to every individual room it prevents the production and mounting of excessive components. Being upgradeable it combines the interests of sustainability and an economics to extend the life cycle of building stock.

1. Introduction
Two thirds of the office buildings in Europe are outdated. This means that façade and installations are older than 30 years (Russig). The average renovation interval for the interior is seven years. Design fashion changes rapidly. The supporting structure on the contrary can last very much longer. Dealing with a decreasing market for office real estate and thus falling rental rates, while user demands enlarge, building owners face the question of how to treat their office stock.
Demolition of technically good buildings leads to unnecessary waste, emission of CO2, energy consumption both in construction, as well as in form of grey energy bound in the material and processes. It also is a question of destruction of capital and on the social level a loss of architectonic identity in successively grown city centres. The research project “Systems in Façade refurbishment” aims to analyze common problems and to proof that renovation of offices can be a feasible solution helping to extend the life cycle of buildings.

2. Demands for façades
To be able to deal with current and future demands for a building envelope one has to take many different aspects into account during the design process. Those aspects can be sorted into the categories: Architectural design, building construction, installation and financial aspects (Figure 01). The importance of economic aspects in the planning and design process is often underestimated, as ultimately, every concept has to prove it’s feasibility to be realized.

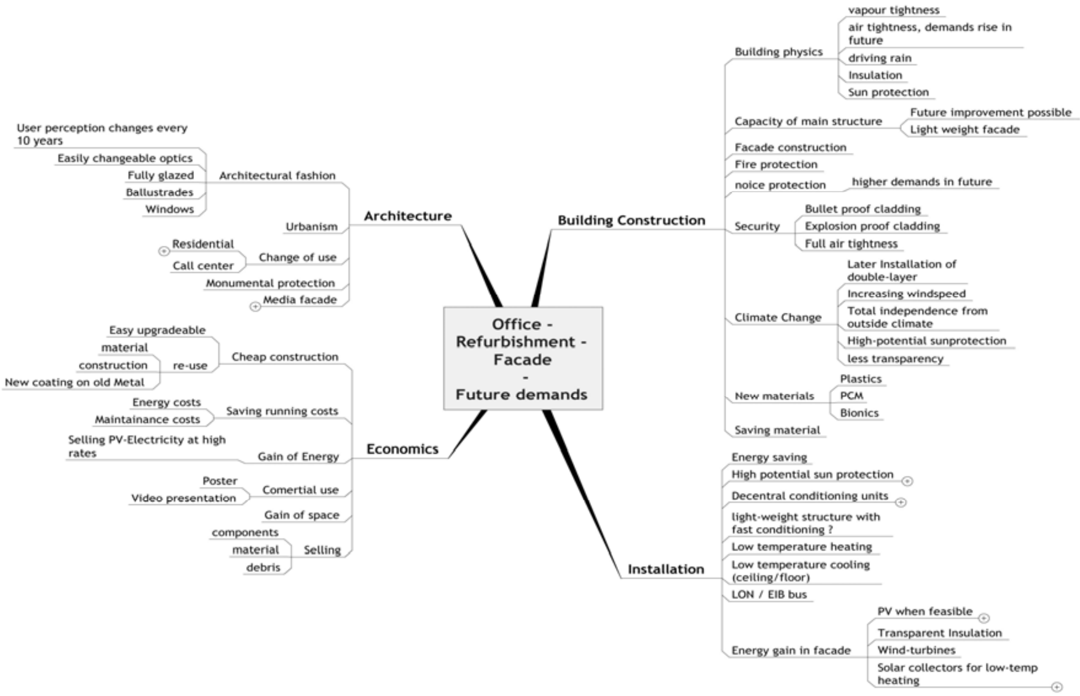

Figure 01: Overview of future demands for office facades

2.1 Architectural design:

The architectural fashion is subject to constant change. To maintain a building, the outer appearance should be possible to be changed easily. New materials will provide properties and functions not yet known. Media installations may become a more important feature.

On the contrary to constant change, more and more buildings are subject to monumental protection. In such case an upgrade may only take place without changing the outer appearance and will thus interfere with the interior.

The use of the building may change. The tendency to work from home and not in a physical office, for example, already leads to an oversupply of office space. This situation will probably get worse in the future. To deal with it, the option to change the use of the building, e. g. to residential use, must be considered.

2.2 Building construction

The supporting structure of a building limits the possibilities in façade renovation. Particularly steel structures are often not capable of extra loads. In such case the use of light weight materials can be considered.

Fire protection has shown to be one of the biggest issues and motivations for renovation.

While upgrading the façade all aspects of building physics, such as insulation, and vapour impermeability have to be brought to actual standards. A further future update should be kept possible.

Global climate change will most likely generate a demand for future upgrade. While today's standards meet current needs, in the future higher temperatures, greater wind loads and stronger rainstorms are expected. (Stock)

2.3 Installations

Climate, electric and IT-installations are subject to constant development, thus a chance for upgrade must be provided to easily maintain or replace components. Furthermore the complete HVAC concept may be altered, e.g. to low temperature heating and cooling.

The gain of energy within the façade is another topic of interest. Large surfaces of buildings can be equipped with PV or other means to produce energy which can be used or sold.

Sun protection is most important in office buildings. Buildings with more than 55% of glassed surface tend to overheat (Hausladen) et al. Modern sun blinds installed outside prevent excessive heat input while allowing indirect natural lighting.

Decentralized installations provide a large potential especially in renovation, as every need for ventilation and air condoning is met in the façade without the demand for ventilation ducts inside the building.

The recent development in BUS systems makes control and maintenance of many data-points possible. Modern climate concepts demand a facility management system that allows for both individual and central control.

The users' demands on their work environment change often. In northern Europe, for example people ask for individual climate control and operable windows for direct connection to the outside, while in other countries office staff relies more on central air conditioning.

2.4 Economic aspects

The expense of the building process and construction is only one part of the financial plan: Re-use and re-cycling of material saves costs, selling of used material, especially metal is an option, too.

Very important for the users of a building are running and maintenance costs. With the introduction of the European Energy passport (EU) a tool is introduced which makes these costs more transparent to tenants and thus influences their decision for a property. Energy gained in the building envelope can be used or sold, often to very good conditions, depending on political guidelines.

By renewing the façade and installation concept extra space can be gained due to smaller components or by transferring installation space into rental space by replacement of central air conditioning systems with decentralized façade-bound components.

3. Latest Developments in façade Concepts - Service integrated façade systems

Various façade system producers and architects have recently developed service integrated facades. These are composed of parts with fixed glazing, operable windows and decentralized HVAC service installations. In the development process facility managers, climate designers and the manufacturers of HVAC components are integrated. Such systems are designed as element facades which can be installed in floor-high components. Decentralized heating-, cooling and ventilation units provide all necessary installations with minimized dimensions. They include mechanical ventilation with heat recovery and a heat exchanger for air conditioning. Air is taken in and brought out directly through the façade in every element. Thus no central mechanical ventilation and air ducts need to be installed.

Due to these short distances, such units provide a high efficiency in air conditioning and heat recovery. As every façade element is equipped with HVAC installations, it is easy to provide individual comfort control for every office space. Disadvantages of such systems lie in the lack of compatibility with operable windows and mainly in a large number of maintenance points like filters. A well administered facility management system is essential for this façade type. BUS installations with many data-points help solve the mentioned disadvantages. Two examples for modern, integrated façade systems are shown in Figure 2 (TEMotion) and Figure 3 (Capricorn):

Figure 02: Facade system TEMotion

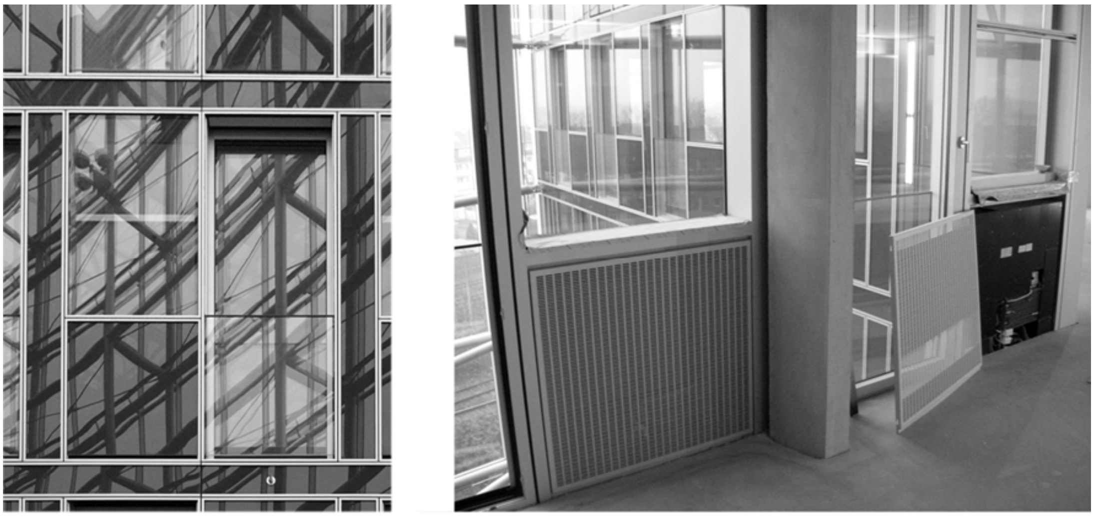

Figure 03: Facade system Capricorn building, Düsseldorf, Germany

4. The refurbishment envelope that changes with the use

All the service integrated façade systems on the market have been designed for new construction and thus plan to be equipped with complete installation units in minimized dimensions. For the task of refurbishment special matters have to be taken into account. During a case study analysis within the research program "Façade systems for refurbishment" at Delft Technical University a renovation façade has been developed which is suitable for renovation of different building types. This design has been developed to concept level and is currently undergoing further development.

Within a case study it has been designed for a building with concrete balustrades. This is reasonable, as fire regulations in Germany, where the case study building is located, demand a vertical barrier of one meter for high rise buildings.

The façade is composed of five components: A non transparent balustrade, a fixed glazing, an operable window, vertical connection elements and integrated space for installation units. For the case study the façade has been constructed as a ventilated façade, which can be cladded with different materials such as metal, glass, natural stone or wood panels. Further advantages of the ventilated façade lie in the flexibility

for exchange of elements and insulation as well as in the good heat protection in summer due to the shading effect. The complete façade structure is mounted from the outside, which causes little interference with the interior. While connection details stay the same, the façade grid is adjustable both horizontally and vertically to different office grids.
Operable windows contribute to energy saving in spring and autumn. They provide the user with a desired connection to the outside and serve for maintenance and cleaning as the dimension of the fixed glazing permits to be reached from the window openings.
Horizontal adjustable sun blinds are installed outside the façade. These provide an efficient sun protection combined with relatively low costs and individual control. Depending on wind loads the installation of an additional glass pane for protection of the blinds can be considered.
Vertical connections between the floors of the building provide the option to install new tubing, electric cabling and IT installations within the façade. This prevents interference with the interior of the building, as no installations need to be installed in rooms or hallways. Existing installations can either continue to be used or set out of service depending on the climate concept. Old tubing can later be removed, when the next renovation of the interior is due. Horizontal distribution of media is realized within the balustrade space of the façade system. The installations are brought into the building either through the balustrade or at the connection points to vertical elements. Installation space is generously dimensioned to allow adding or replacing of ducts in the future.

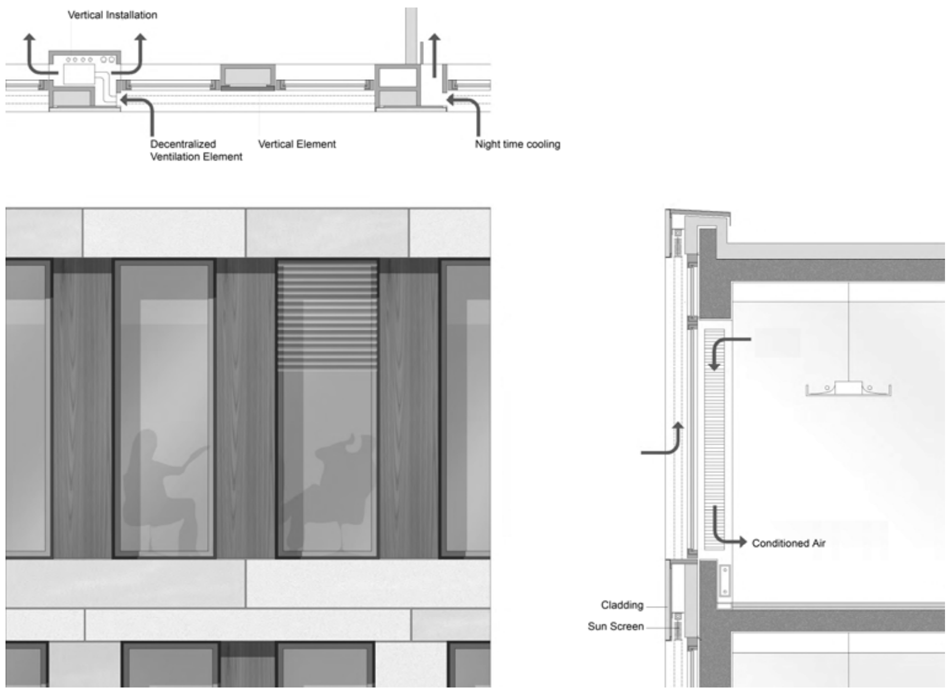

Figure 04: Concept for upgradeable refurbishment façade

The installation units, integrated into the façade, can be placed horizontally at balustrade level, where fire protection demands and given circumstances allow. Alternatively they can be installed vertically, in addition to or as a substitute for the connection elements.
The climate concept is based on the idea of de-centralized installations and full flexibility for upgrade and change. Following this, the installation “box” can be filled with different components or left empty. During the life cycle of the building different demands occur for different rooms (north- or south side; many

electric appliances; high air exchange rates; etc.). With a flexible system rooms can individually and successively be up- or downgraded depending on the use. The following installation concepts are imaginable:

4.1 A minimal solution

The building is equipped with high insulation and a ventilated façade. Thus it does not need any cooling and only minimal heating. Existing radiators (often installed in northern European office buildings) will be kept in use. Operable windows supply ventilation.

Such concepts demand "smart users" able and willing to adjust their own office climate. Window contacts, thermostats and a central override control for heating and windows would allow saving energy or open designated windows for natural night time cooling.

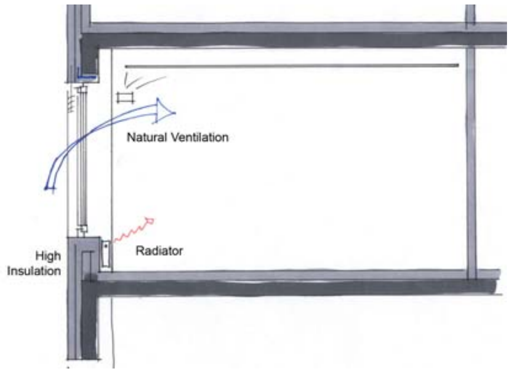

Figure 05: Minimal solution

4.2 Improved energy performance through heat exchangers

As natural ventilation may lead to higher energy demands in extreme weather conditions (summer, winter, climate change) due to the direct exchange of air of different temperature levels, mechanical ventilation with heat recovery is a common option. Small individual ventilation units can be installed in the climate-boxes and thus provide fresh air without the loss of thermal energy. Such small decentralized fans with heat exchanger provide a high efficiency, as no ducts are needed to transport conditioned air.

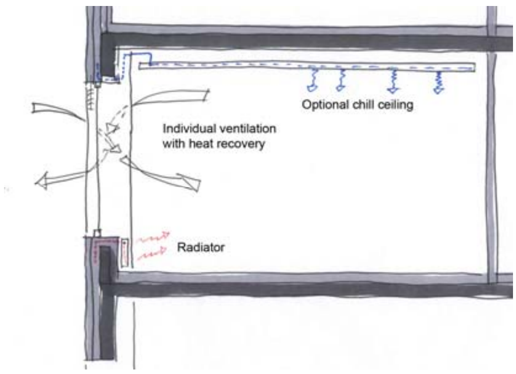

Figure 06: Improvement by heat exchanger

4.3 The all-in-one solution

Climate installation devices which provide ventilation with heat recovery and air conditioning by heat exchangers can be placed into the installation space provided. These are connected to hot water and cooling liquid circuits, are controlled individually and provide full climate conditioning with a high efficiency. This is due to direct air supply through the façade and small, energy efficient fans.

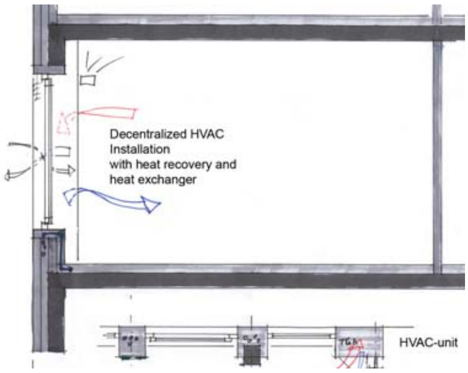

Figure 07: Decentralized HVAC units

4.4 Low temperature heating/cooling

Alternatively to active air conditioning, the installation of low temperature systems can be considered. A chill ceiling provides comfortable cooling in summer by transporting water of a temperature slightly below room temperature through small tubes within a suspended ceiling. In a highly insulated office building heating is only rarely necessary, thus the ceiling can also be used for heating in winter. For a surface heating the temperature of the water only needs to be around 25 °C instead of the 70°C hot water needed for radiator heating. The changing of the climate installations to such a low temperature system makes the old machinery redundant and opens the field for sustainable solutions. The desired temperature level can e.g. be reached by geo thermal energy and heat pumps.

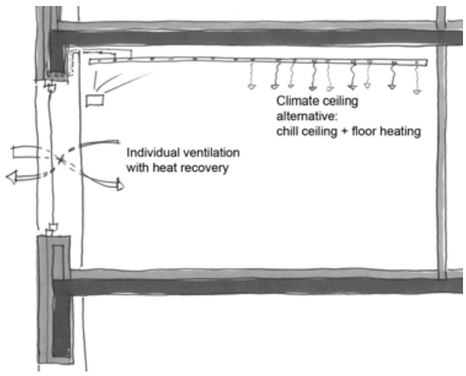

Figure 08: Low temperature heating and cooling

As long as installation space is provided and easily accessible, changing of installations can be done with minimal interference with running work. An important task not yet solved lies in the easy possibility to combine and connect components. While electric and IT installations are equipped with common connectors, the topic of easy (de-) connection of water-, heating and cooling liquid tubing is new in the building process and demand further development.

4.5 Envelope for rent
For future buildings it is imagined to be an interesting marketing concept to offer “Facades for rent”. Users rent façade components or installation parts according to their need. When they are not needed any more, the supplier takes them back into stock to rent them out to other clients. This does not only extend the life cycle of the building, but also the one of every single component and it prevents an overproduction.

5. Summary and conclusion
There is a big market for refurbishment of office buildings. Many interesting façade systems and components are already available for new construction. To transfer those for the task of renovation, various special aspects have to be taken into account. New developments particularly have to deal with the demands of the user and a big flexibility in construction, installation and design. To achieve flexibility and upgradeability of the building envelope a standard is needed for dimension and connection of various installation components. New business-concepts may turn up in which a tenant of a building can rent installation components to be installed into his façade system according to his needs and return them for re-use. New materials and technical innovations will contribute to more sustainable and material saving constructions.
Finally it can be concluded, that refurbishment of office buildings by means of smart façade and installation concepts extends the life span of buildings significantly and thus supports both feasibility and sustainability.

7. References
EU directive 2002/91/EC on energy performance of buildings
Hausladen, G. et al. 2006. *Clima Skin.* Munich: Callwey
Stock, M. (Ed.). 2005). PIK Report No.99: **KLARA - Klimawandel - Auswirkungen, Risiken, Anpassung**. Potsdam: PIK

Measurement Analysis on Thermal Environment of Crowded Wooden-housing Area for Improvement Proposal

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Keywords: Crowded wooden-housing area, Outdoor thermal environment in summer, Summer measurement, D/H ratio, Heat-island phenomenon

Abstract
This research involved two types of field surveys undertaken in mid-summer 2005, targeting the crowded wooden-housing area that mainly lies within Machiya district, Arakawa-Ku. First, we undertook a long-term survey in which the temperature and humidity of seven areas in Tokyo, including the Machiya district, were measured and compared. Second, we undertook a short-term survey (in greater detail than the long-term survey) in which we measured the outdoor air temperature, road surface temperature, and wind velocity in the Machiya, Kanda, and Koganei districts. The surface temperatures in these areas were measured using an infrared camera. We then used these measurement data to examine the elements that influence the thermal environments of alleys.
The results of the long-term survey revealed a heat-island phenomenon in Tokyo and a difference in the thermal environments of urban and suburban areas. The results of the short-term survey revealed that the thermal environment is affected by a number of factors, including road surface temperature, wind velocity, road width to building height ratio (D/H ratio), road surface material, plantings, and occasional watering of the road. Based on the above results, a design proposal was introduced to improve the thermal environment of the crowded wooden-housing area.

1. Introduction
In areas of central Tokyo dominated by overcrowded wooden housing, deterioration of the thermal environment has become increasingly serious with increasing intensification of the recently developed heat-island phenomenon. In terms of improving the crowded wooden-housing area, the comfort of the living environment is one of the most important factors. In addition, approaches that utilize natural energy as much as possible are necessary to ensure a sustainable lifestyle. It is also necessary to link proposed improvements to the thermal environment with disaster prevention and urban planning to achieve a safe, comfortable living environment.
The present research involved two types of field surveys undertaken in mid-summer 2005, mainly in the Machiya district, to gather fundamental data on outdoor thermal conditions. Based on these data, we examined the elements that influence the outdoor thermal environment.

2. Long-Term Measurement of Outdoor Temperature and Humidity in Seven Areas of Tokyo

2.1 Measurement Details

The temperature and humidity in seven areas of Tokyo were measured to determine the thermal environment in crowded wooden-housing areas. Table 1 shows the measurement details, while Fig. 1 shows the seven measurement points in Tokyo, Fig. 2 shows the measurement point in Kanda, and Fig. 3 shows the equipment used in undertaking measurements.

Table 1 Measurement Details (Long-Term Measurement)

Measured Area	Area Characteristics	Measurement Equipment	Measuring Term
Kanda	Center City	Thermo-Recorder RTR-53	2005/7/29-2005/9/12
Machiya	Center Residential	Thermo-Recorder RS-10	2005/7/29-2005/9/12
Nakano	Center Residential	Thermo-Recorder RS-10	2005/7/29-2005/9/12
Suginami	Center Residential	Thermo-Recorder RS-10	2005/7/29-2005/9/12
Koganei	Suburb Residential	Thermo-Recorder TR-72S	2005/7/29-2005/9/12
Hachioji	Suburb Residential	Thermo-Recorder RS-10	2005/7/29-2005/9/12
Takao	Suburb Residential	Thermo-Recorder RS-10	2005/7/29-2005/9/12

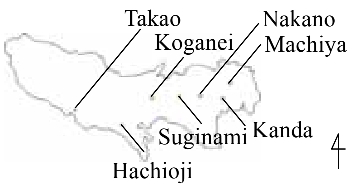

Fig.1 Measurement Point (Tokyo Area)

Fig.2 Measurement Point (Kanda)

Fig.3 Thermo-Recorder

2.2 Measurement Results

Figure 4 shows temporal variations in outdoor temperature over a period of 1 week. For all measurement points, the daytime temperature exceeded 35 [°C], which is as high as the temperatures recorded in tropical areas. The heat-island phenomenon is apparent from Fig. 4, which shows that the temperature increases toward the center of the city. In comparing temperatures at 5 a.m., when minimum temperatures are recorded for all measurement points, there is always a difference of about 2–3 [°C] between Kanda and Takao. On August 5, 2005—the hottest day of the year—the temperatures at every point were about 27 [°C]; the next morning at 7a.m., the temperature reached 29 [°C] at Kanda and Machiya.

Figure 5 shows temporal variations in outdoor relative humidity during the same week as that considered in Fig. 4. The relative humidity clearly decreases toward the city center, and the diurnal range in relative humidity is greater in suburban areas; therefore, the outdoor thermal environment shows significant variation, even within a given metropolitan area.

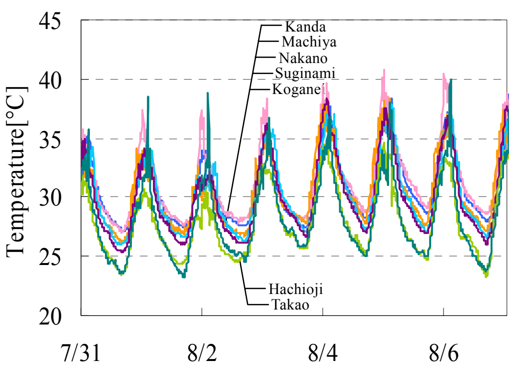

Fig.4 Variation of Air Temperature (2005/7/31-2005/8/7)

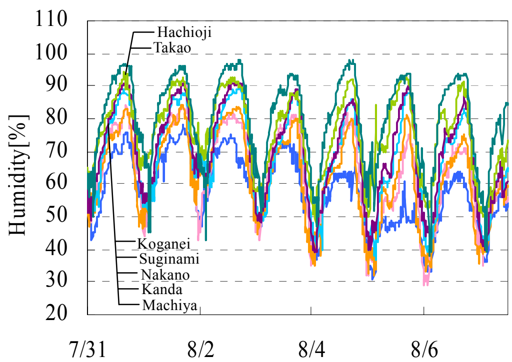

Fig.5 Variation of Relative Humidity (2005/7/31-2005/8/7)

3. Short-Term Detailed Measurements within Crowded Wooden-Housing Areas

3.1 Measurement Details

Short-term measurements were undertaken at Machiya district in Arakawa-Ku, which has been deemed a Priority Improvement District by the Tokyo Metropolitan Government. This area has variable road widths and road orientations, as well as several planted areas and areas of bare ground. For comparison, we also took measurements within the Kanda district at Chiyoda-Ku and Koganei-Shi.

Figures 6–8 shows the locations of measurement points in the Machiya, Kanda, and Koganei districts, respectively, while Table 2 lists the measurement details. Measurements were carried out from August 3 to 6, 2005, while fundamental weather data were measured from July 29 to August 15, 2005 at a site located on the roof of the Arakawa campus of the Tokyo Metropolitan University, located close to Machiya. Measurements of temperature, ground temperature, wind velocity, and wind direction were performed every three hours from 5 a.m. until 8 p.m. The surface temperatures of surrounding objects were also recorded using an infrared camera. Ten thermocouples were attached to a 3-meter-high pole at various heights; the pole was placed upon a trolley equipped with an anemometer to enable movement around the study area.

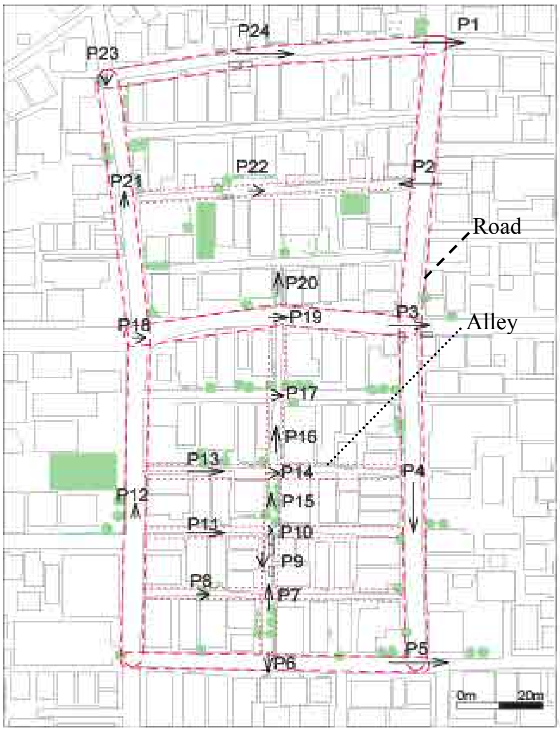

Fig.6 Measurement Point (Machiya)

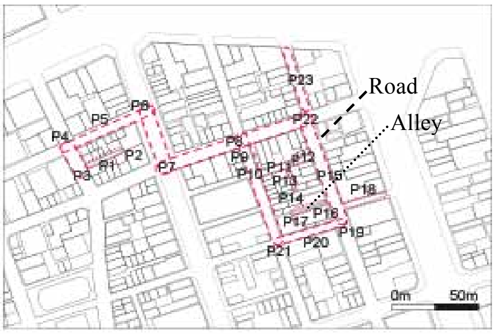

Fig.7 Measurement Point (Kanda)

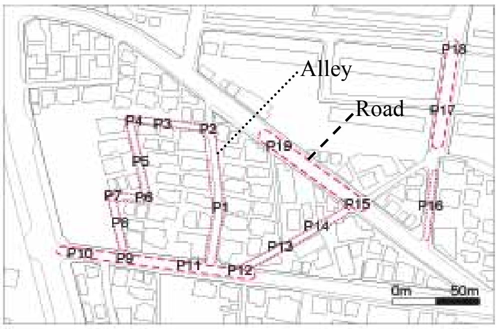

Fig.8 Measurement Point (Koganei)

Table 2 Measurement Details (Short-Term Measurement)

Measured Area	Measuring Term	Measurement Elements	Measurement Equipment
Machiya	2005/8/3	Air / Ground Temperature	Thermo Couple 0.1mm Φ
	2005/8/4	(H=0,50,100,200,300,600,1200,1800,2400,3000[mm])	
Kanda	2005/8/5	Wind Velocity / Direction	Anemometer
Koganei	2005/8/6	Surface Temperature	Infrared Camera
[Weather Data] Arakawa Campus	2005/7/29-2005/8/15	Air Temperature Air Humidity Radiation Wind Velocity / Direction Precipitation	Weather Station [Cabled Vantage Pro2, Davis Instrument]

3.2 Measurement Results

3.2.1 Analysis of Ground Surface Temperature

Figures 9–11 shows temporal variations in road surface temperatures (roadways wider than 4[m]) in the Machiya, Kanda, and Koganei districts, while Figs. 12–14 show temporal variations in alley surface temperatures (roadways narrower than 4[m]) in the same districts. The daytime temperature in Kanda does not increase to the same degree as that in the Machiya and Koganei districts. This finding reflects the fact that Kanda has many tall buildings that prevent direct sunlight from reaching the ground. Comparing Figs. 13 and 15, the road/alley temperature is lower in Machiya than in Koganei. Although both districts have similar building characteristics, Machiya does not receive as much direct sunlight as Koganei because it is more crowded.

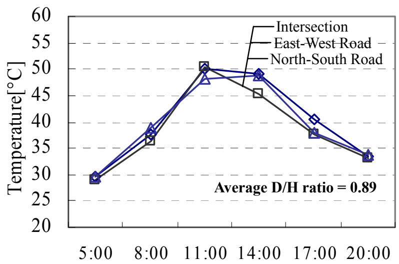

Fig.9 Road Surface Temp (Machiya 8/4)

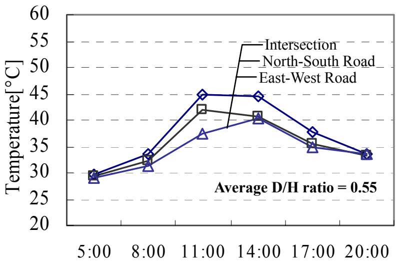

Fig.10 Road Surface Temp (Kanda 8/5)

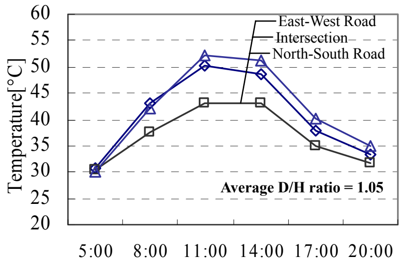

Fig.11 Road Surface Temp (Koganei 8/6)

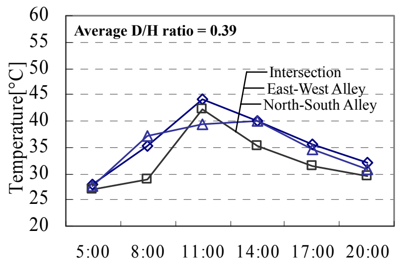

Fig.12 Alley Surface Temp (Machiya 8/4)

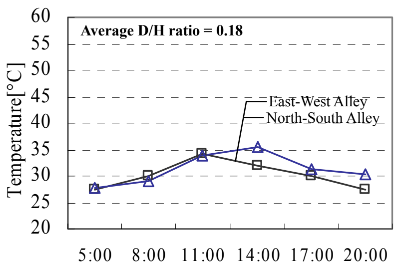

Fig.13 Alley Surface Temp (Kanda 8/5)

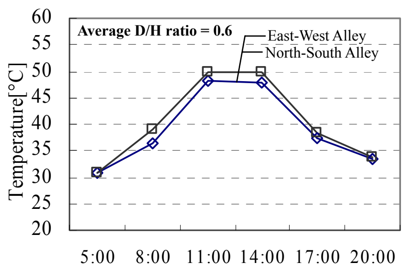

Fig.14 Alley Surface Temp (Koganei 8/6)

Figure 15 shows the ground temperature plotted against D/H for the Machiya, Kanda, and Koganei districts. D/H represents the ratio of road width to average building height at each measurement point. It appears from Figure 15 that the ground surface temperature increases for higher D/H values. Figure 16 shows the ground temperature plotted against insolation for different values of D/H. Ground temperature clearly increases with increasing insolation. Note that Fig. 16 does not include data for the period subsequent to peak insolation.

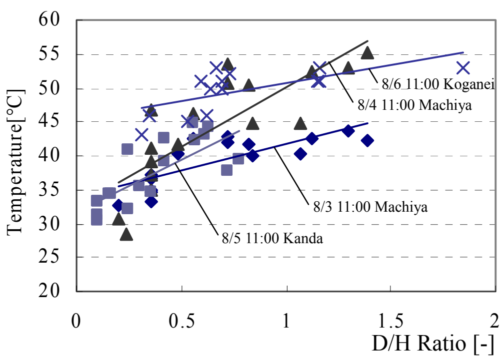

Fig.15 Ground Surface Temp to D/H Ratio

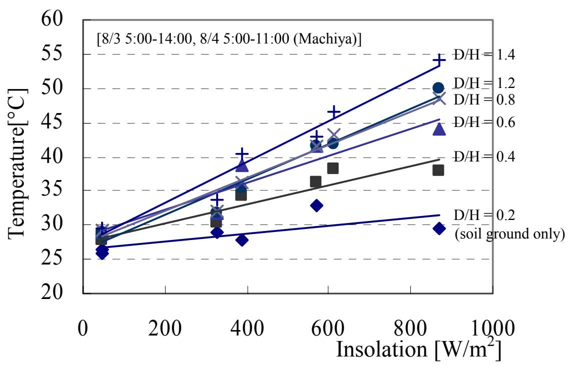

Fig.16 Ground Surface Temp to Insolation

3.2.2 Analysis of Wind Condition

The arrows in Figure 6 indicate the wind velocity and wind direction in the Machiya district at 11 a.m. on August 4. The figure shows that the wind in this area blows along roads and is weaker for narrower road widths. Figures 17–19 show the frequency distribution of wind velocity along roads in the Machiya, Kanda, and Koganei districts, while Figs. 20–22 show the equivalent data for alleys. Along roads, the wind velocity is 0–4 [m/s], whereas along alleys it is generally less than 1 [m/s]. It appears that for smaller D/H values, indicating crowded areas, wind velocity is reduced.

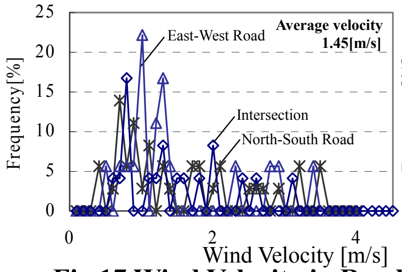

Fig.17 Wind Velocity in Road (Machiya 8/4)

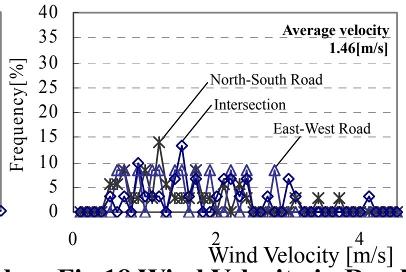

Fig.18 Wind Velocity in Road (Kanda 8/5)

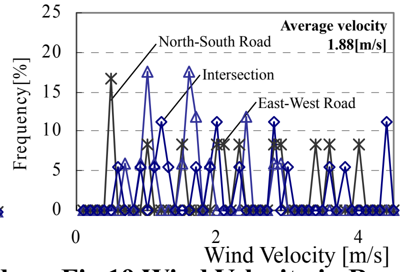

Fig.19 Wind Velocity in Road (Koganei 8/6)

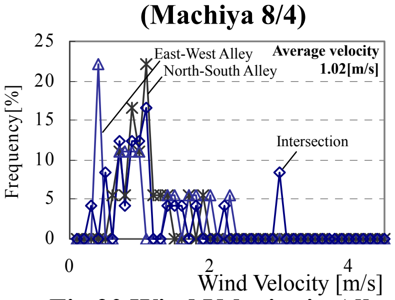

Fig.20 Wind Velocity in Alley (Machiya 8/4)

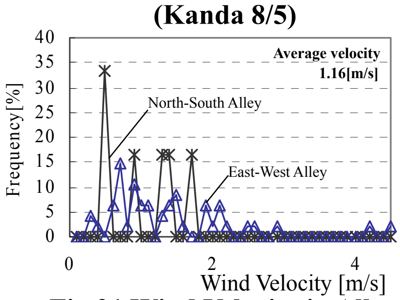

Fig.21 Wind Velocity in Alley (Kanda 8/5)

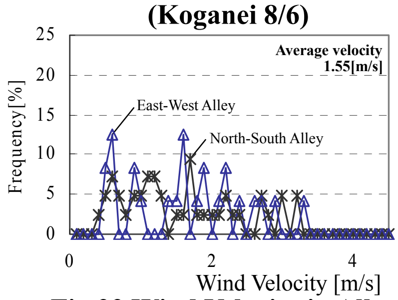

Fig.22 Wind Velocity in Alley (Koganei 8/6)

3.2.3 Effects of Ground Surface Material, Plantings, and Occasional Watering of the Road

Figure 23 shows an infrared image of a road in Machiya at 2 p.m. on August 4, while Fig. 24 shows temporal variations in the road surface temperature and air temperature (H = 1200 mm) at the same measurement point. The temperature of the asphalt-paved road rose to over 50 [°C], as did roofs and walls exposed to direct sunlight. In contrast, the temperature of the walls sheltered by plants was around 40 [°C], 10 [°C] lower than that of exposed surfaces. Figure 25 shows the range in air temperature for different road surface materials, as measured at 2 p.m. on August 4. Measurement points 15 and 16 in the alley are covered by soil. Compared with the asphalt-paved surface at measurement point 9, the surface temperatures of points 15 and 16 are nearly 10 [°C] lower; the air temperature from the surface to a height of 1800 [mm] is also lower. Figure 27 shows the range of air temperature before and after watering of the road was done at 8 p.m. on August 3. Following watering, the air temperature at a height of 1200 [mm] fell by about 1 [°C]; the cooling effect is greatest at this height.

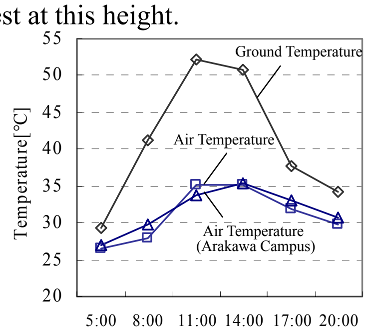

Fig.23 Variation of Air Temperature and Ground Temperature (Machiya 8/4 14:00)

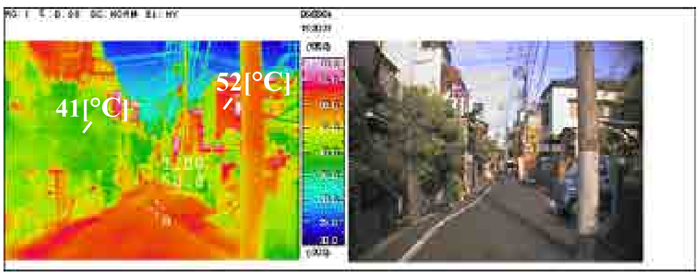

Fig.24 Photo by Infrared Camera at Fig.23 Measurement Point

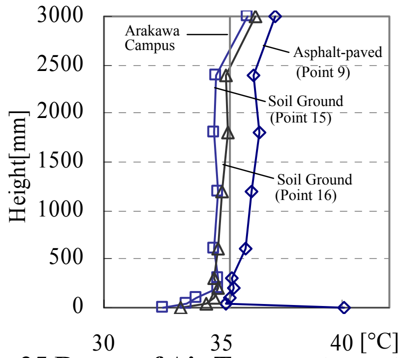

Fig.25 Range of Air Temperature at Vertical Points with Different Ground Material (Machiya 8/4 14:00)

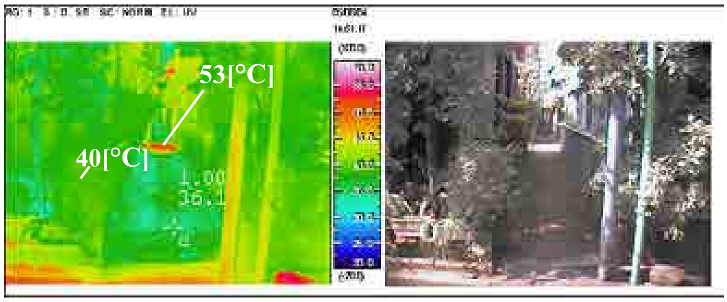

Fig.26 Photo by Infrared Camera at Fig.25 Measurement Point

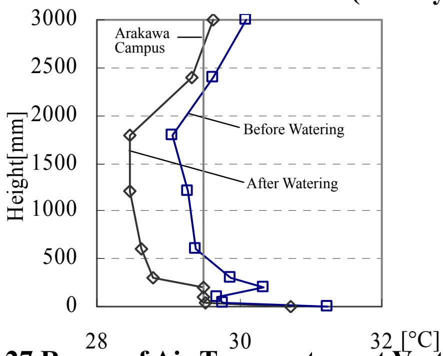

Fig.27 Range of Air Temperature at Vertical Points after Watering the Alley (Machiya 8/3 8:00)

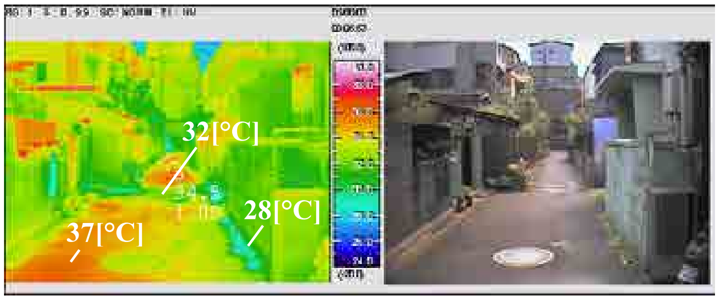

Fig.28 Photo by Infrared Camera at Fig.27 Measurement Point

4. Conclusion

In examining several factors that affect the outdoor thermal environment in Tokyo, we obtained the following results: 1) we confirmed the presence of the heat island effect in Tokyo, as the temperature in central Tokyo is as high as that recorded in the tropics, and we recorded large diurnal variations in the thermal environment within individual metropolitan areas; 2) the daily increase in road surface temperature is greatly influenced by direct sunlight; in addition, higher D/H values are associated with higher road surface temperatures; 3) the wind velocity tends to be weaker for areas with lower values of D/H; 4) the daily increase in road surface temperature is effectively suppressed in the cases that the road surface material is soil, is shaded by plants, or is watered. Watering of the road is especially effective, resulting in a reduction in air temperature by 1–2 [°C]. A design proposal, based on the above results, was introduced to improve the thermal environment of areas of crowded wooden housing. The proposal seeks to overcome the disadvantage of the weakening of wind velocity in areas with small D/H values, although such areas have the advantage of shading from direct sunlight. The solution detailed in this proposal involved the convergence of non-utilized space to a single site, ensuring a continuous connection among different spaces to ensure adequate wind flow throughout the area without changing the D/H ratio.

References

Sunaga, N., T. Fukazawa, and S. Matsumoto. 2006. Improvement Proposal for Densely Crowded Wooden-housing Area Viewing from the Point of Thermal Environment. 2005 Reports of Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis: 62-63,206-209

Matsumoto, S., N. Sunaga, and T. Fukazawa. 2006. Field Survey on Thermal Environment in the Densely Crowded Wooden-Housing Area in Summer. Summaries of Technical Papers of Annual Meeting. Architectural Institute of Japan: 919-920

Matsumoto, S., N. Sunaga, and T. Fukazawa. 2006. Field Survey on Summer Thermal Environment within the Crowded Wooden-Housing Area in Tokyo. Summaries of Technical Papers of the First National Conference. Heat Island Institute International: 24-25

Research on the Regional Difference of Exterior Wall Refurbishment

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Keywords: Detached house, Exterior wall, Refurbishment

Abstract

In Tokyo, there are many congested areas of wooden houses, and the risk of such buildings collapsing or large-scale fire occurring following a huge earthquake is very high. Many such aged buildings exist in such regions, and many are not suited for present anti-earthquake regulations. With this in mind, the aseismic capacity and fire-resistance performance of individual buildings must be improved by updating or refurbishment. To promote the disaster prevention plan, there is a need to understand the tendency to the refurbishment act of individual buildings, and to comprehend urban characteristics as the accumulation of each building.

No major difference emerged in each region, although the distribution at distance between the buildings was investigated in terms of the exterior wall refurbishment experience. When examining the relationship of the distance between buildings and the category of exterior wall, the difference between refurbishment experiences was seen. Moreover, when the relationship of the construction age and the category of the exterior wall were similarly analyzed based on the refurbishment experience, a similar characteristic was seen in each region.

1. INTRODUCTION

In Tokyo, there are many congested areas of wooden houses, and the risk of such buildings collapsing or large-scale fire occurring following a huge earthquake is very high. Many such aged buildings exist in such regions, and many are not suited for present anti-earthquake regulations. With this in mind, the aseismic capacity and fire-resistance performance of individual buildings must be improved by updating or refurbishment. To promote the disaster prevention plan, there is a need to understand the tendency to the refurbishment act of individual buildings, and to comprehend urban characteristics as the accumulation of each building. Based on such opinion, the author analyzed the exterior wall refurbishment cycle using a questionnaire survey and visual investigation. Consequently, it was confirmed that the refurbishment cycle of exterior walls differed in each urban area, and this was presumed to be due to the various attributes of the buildings in each urban area.

As mentioned above, the purpose of this research is to derive the factors which influence the exterior wall, and clarify the realities of exterior wall refurbishment.

2. THE OVERVIEW OF THE RESEARCH

2.1. Overview of Investigation

2.1.1 Examination Method

The target areas of investigation are N area, which is located in a wooden built-up area, and M area, which is located in a suburban estate. This research is based on a questionnaire which was distributed in November, 2005, visual investigation which took place in October, 2005, and measurement investigation, which was conducted in January, 2007. Table 1 summarizes the investigation. The targets for the questionnaire were randomly selected from all the detached houses existing in the research area and completed by the individual owners of the detached houses. Visual investigation was performed on all the existing buildings, and measurement investigation was conducted on all the detached houses present within the research area.

Table 1 Outline of the Investigation

		N Area	M Area
Site		Hachioji, Tokyo	Suginami, Tokyo
Type of Exterior Wall		Lath-Mortar / Wood Siding / Ceramic Siding / ALC Panel / Other	
The number of the measured buildings		1209	542
The number to have distributed a questionnaire form		200	175
The number to have collected a questionnaire form		146	105
The number of the data valids	Refurbished	74	42
	Non-refurbished	45	33

2.1.2. Details of the Measurement Investigation

A laser range finder was used for the measurement of the building intervals. During the investigation, two investigators stood on the prolongation of the exterior-wall-surface and measured the interval of buildings from the road. Where housing shapes were uneven, they measured the minimum and maximum distance values respectively. In some cases, they also measured the distance from the exterior-wall-surface to the obstacle, in addition to that among the dwelling units, too. Fig. 1 shows how to investigate the interval of buildings. Obstacles refer to irremovable fences located on the property line, such as chain-link fence, stone wall, wood fence, hedge and so on. This is because although the object in question was not, strictly speaking, an interval of buildings, it may act as a hindrance to refurbishment work, so we added it to the investigation items. During this research, the minimum value of each individual result is used.

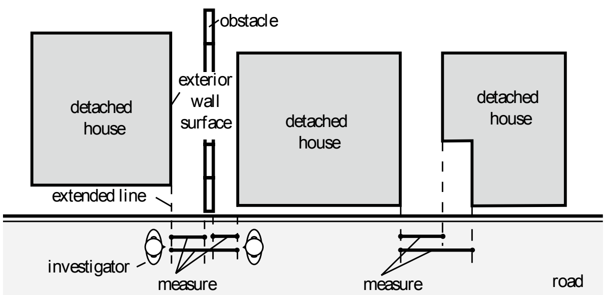

Fig. 1 Method of the Measurement Investigation

2.2. Overview of the Investigation Area

2.2.1. The Wooden Built-up Area

Tokyo contains many densely built-up areas of wooden houses, with a total of more than 300 such areas (over 22,000 ha) in the city. The historical details in such areas depend on each area, but are particularly linked to the haphazard development of built-up areas after the Great Kanto Earthquake in 1923 and World War II. All such areas feature a high density of wooden houses and complicated narrow streets. There are many fragile areas subject to seismic hazards and there is a need to ensure immediate protection against disasters. The M area, one of those under investigation, is such a wooden built-up area, where housing land development was progressional, mainly around the railroad station, after the Great Kanto Earthquake and was not burnt away by war damage. The area features a mixture of detached houses and low-rise apartments. In terms of the degree of district-based vulnerability assessment released by Tokyo city, the M area has a maximum fire-hazard-rating of 5, meaning immediate measures are needed.

2.2.2. The Suburban Estate

The suburban estate was developed during a period of high economic growth. Many such residential areas developed in the Tokyo suburbs from around the 1960s onwards, with backgrounds that differ from the wooden built-up areas, namely with planned roads and orderly blocks. Many suburban estates were also made by opening up mountainous regions. The N area was developed following the creation of a housing site in the 1970s, by several home builders. Streets are planned in a pin grid array format and sufficient width is also ensured. Virtually all buildings in the area are detached houses and there are no apartments.

Fig. 2 Photographs of Wooden Built-up area (left) and Suburban Estate (right)

2.3. The Exterior Wall Construction Method of Detached Houses in Japan

The exterior wall construction method, which is used for detached houses, can be roughly divided into wet and dry process construction methods respectively. The former is the method used to make exterior-wall-surface groundwork and finishing by using the plastering-material of the plaster and mortar and so on, while the dry process construction method is used for exterior wall finishing by using industrial goods, such as the ceramic siding and the ALC panel.

The wet process construction method has been widely used since pre-war times, especially the lath-mortar construction, which was adopted for many homes as promoting incombustibilization in the city after the Great Kanto Earthquake in 1923. Beforehand, wood siding walls, which are typical of the dry process construction method, were generally used as the exterior walls of detached houses. However, at present, such wood siding walls are less frequently used due to the controls imposed of the Building Standards Law. Instead, ceramic siding walls have become popular as the dry process construction method rather than wood siding walls. These former became especially popular as a general construction method when appearing in the 1970s and continuing into the 1980s, where there was subsequently a rough drop in consumption of lath-mortar, on a temporary basis.

According to market research on exterior walls, the sales volume in each year of lath-mortar have decreased, from a figure of 45% (1983) to 11% (2006). Conversely, the sales volume for each year of ceramic siding increased from 25% (1983) to 70% (2006). When viewing this result, it seems the lath-mortar will keep inexorably decreasing, but this is actually not the case. There are many inhabitants who prefer the seamless aspect of lath-mortar, while the range of expression is also getting wider.

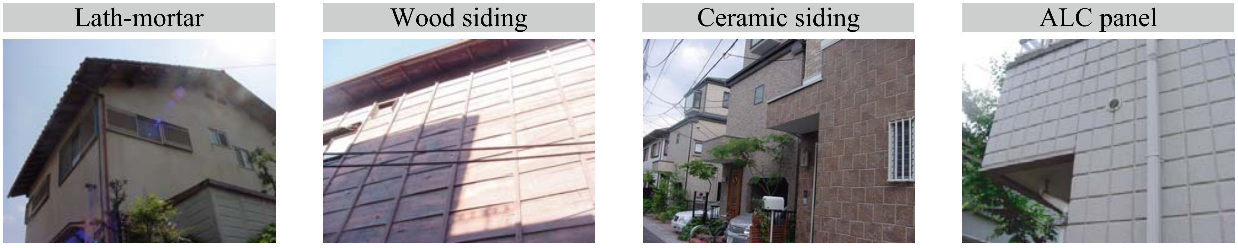

Fig. 3 Exterior wall photographs

3. THE EXTERIOR WALL REFURBISHMENT EXPERIENCE AND THE CHARACTERISTICS OF THE AREA

During this research, the types of exterior wall, the period of the construction of the building and the interval of the building were highlighted as candidates of factors having an influence on the exterior wall refurbishment. The purpose in this chapter is to judge whether or not these factors have an influence on exterior wall refurbishment. The types of exterior wall and the construction period are based on the result of a questionnaire, while the interval of buildings is the result of measurement investigation performed in January, 2007.

3.1. Distribution of the Interval of Buildings

The measuring result of the interval of buildings is shown in Fig. 4. Many buildings had obstacles in the N area, and as for the value used for analysis; the overall figure approximately represents the distance from the obstacle to the exterior-wall-surface. Because the separation of buildings from property lines by 1500 mm (becoming 1000 mm in the 1990s) was imposed in the district plan in the N area, the peak comes at approximately the same level, while in the M area, we can see the peak of building intervals comes at a point narrower than that of the N area. This result indicates that the M area has a greater density than the N area.

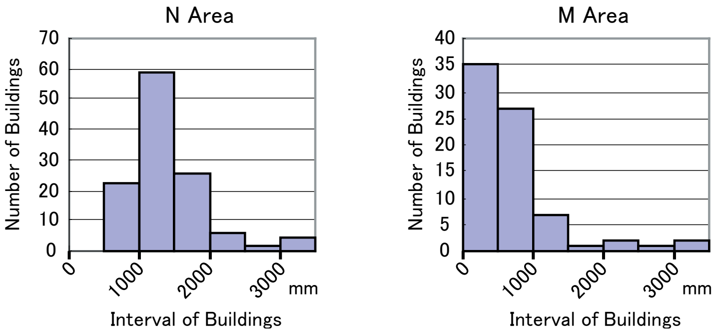

Fig. 4 Distribution of the Intervals of Buildings

3.2. Construction Year and the Types of Exterior Wall

Figs. 5 and 6 show the rate of relations between the construction year and the types of exterior wall for both refurbished and non-refurbished buildings. The distribution shapes also differ in both areas for both types of buildings. In both areas, about 70 percent of buildings are non-refurbished and constructed after the 1990s, while as for refurbished buildings, the rate of those constructed before the 1990s represents about 90 percent.

When examining the relationship among the types of exterior wall and the construction period, the rate which the construction period uses siding board and ALC from the 1990s onwards becomes high in both areas.

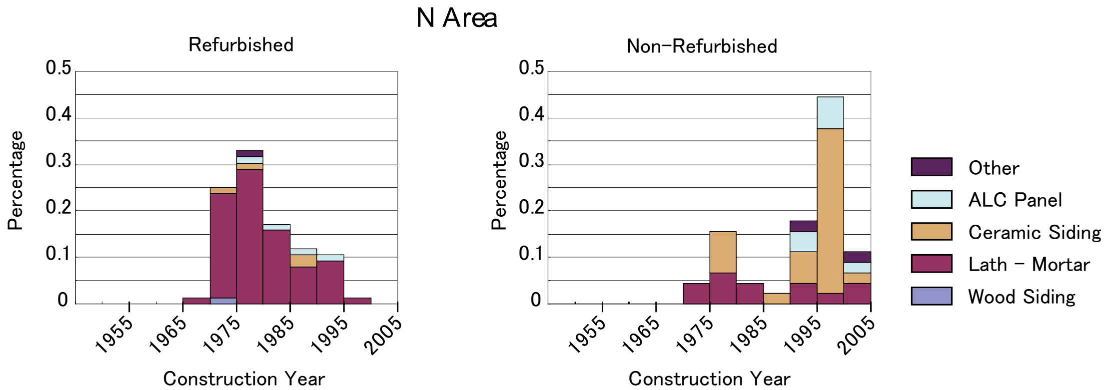

Fig. 5 Relation between the Construction Year and Exterior Wall by Refurbishment Experience in the N Area

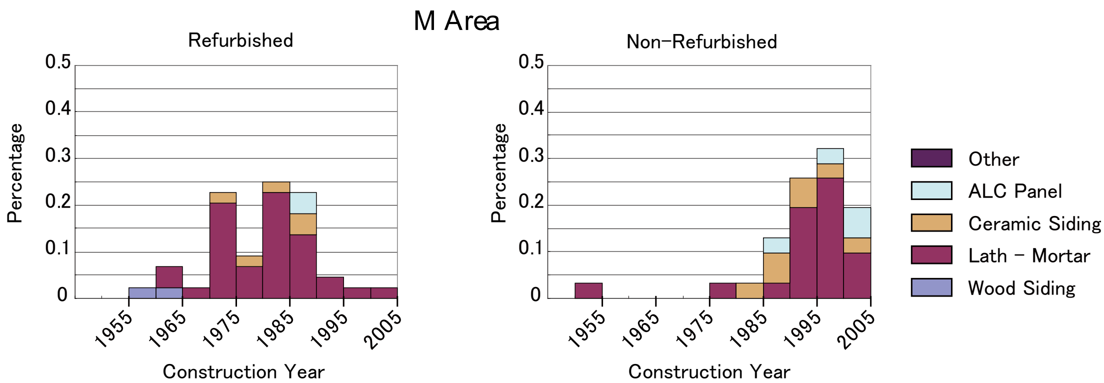

Fig. 6 Relation between the Construction Year and Exterior Wall by Refurbishment Experience in the M Area

3.3. The Interval of Buildings and the Types of exterior wall

In this section, we analyzes the intervals of buildings and the exterior wall refurbishment experience, based on the viewpoint of the types of exterior wall. Figs. 7 and 8 show the relations between the types of exterior wall and the interval of buildings for each exterior wall refurbishment experience.

In the M area, the rate of unfurbished homes soars when the building interval narrows. However, a high ratio is similarly apparent for houses where the exterior walls have been refurbished. In the N area, there are no differences whatsoever between the interval of buildings and the exterior wall refurbishment.

The variation in the exterior wall refurbishment, which is apparent at an interval level approximately equal to or less than 1000 mm for buildings in the M area, is dependent on houses where the exterior walls are siding-boards and ALC-panels. The siding-boards and ALC-panels, where the building interval is equal to or less than 1000 mm for buildings in the M area, is constructed via mini-development, while in the N area, most of the houses lacking refurbishment experience use siding-boards and ALC-panels for the exterior walls.

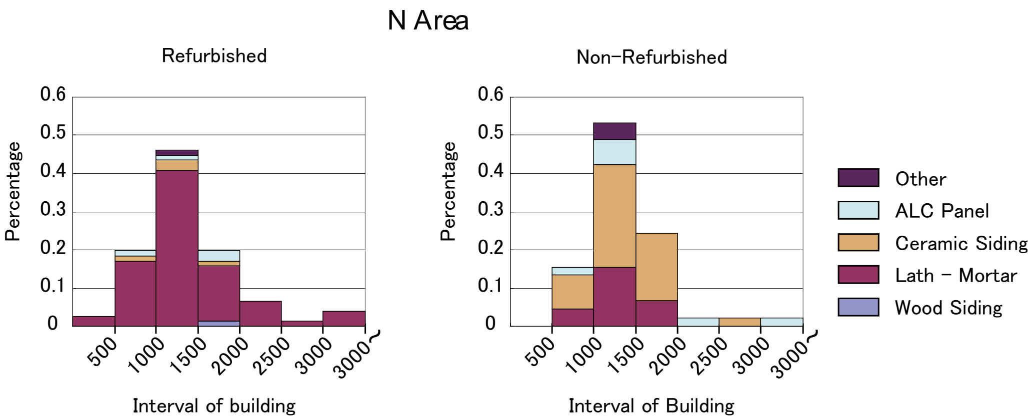

Fig. 7 Relation between the Interval of Buildings and Exterior Walls by Refurbishment Experience in the N Area

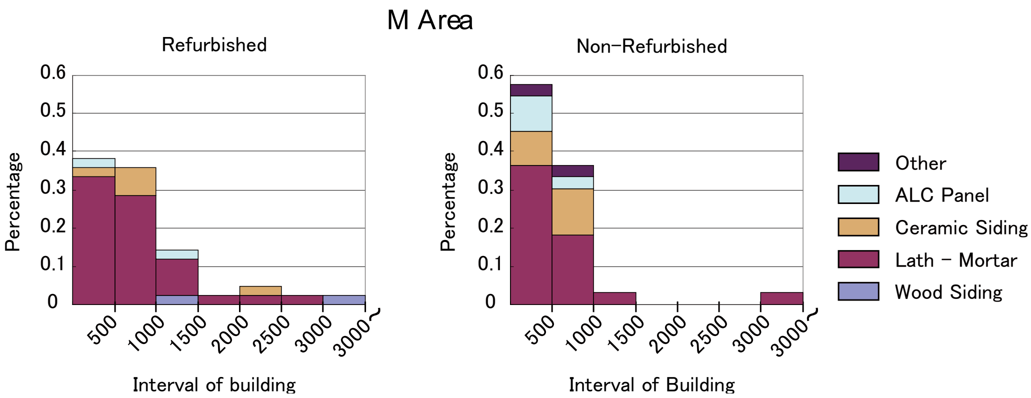

Fig. 8 Relation between the Interval of Buildings and Exterior Walls by Refurbishment Experience in the M Area

4. THE ANALYSIS OF THE REFURBISHMENT CYCLE OF THE EXTERIOR WALL

4.1. The Calculation of the Exterior Wall Refurbishment Cycle

The Kaplan-Mayer method (hereinafter, the "KM method") was used to adapt the survival time curve in both areas and lead the refurbishment cycle. The KM method is a technique for modeling the survival function and the accumulation hazard function, although it does not define a specific distribution function and handles the experience distribution itself which was observed. The data to use is limited to the refurbishment record and age of buildings when refurbishing each house.

Generally, a Kaplan-Meyer survival curve is shown by the following formula. Firstly, let the survival function be $S(t)$. Here, t shows the time which becomes $t_j < t \leq t_{j+1}$ when making a refurbishment occurrence as in time $0 < t_1 < t_2 < \cdots < t_j < \cdots$. $S(t)$ is shown by the following numerical formula when making the total of observation objects about the time j of the observation as n_j and the number of the refurbished buildings as d_j .

$$\hat{S}(t)=\left(1-\frac{d_1}{n_1}\right)\times\left(1-\frac{d_2}{n_2}\right)\times\cdots \quad = \prod_{t_j<t}\left(1-d_j/n_j\right) \qquad (1)$$

Here, $S(0)=1$. Refer to the reference therefore in the details of this method.

The result of leading a survival curve in each area is shown in Fig. 9. The refurbishment cycle is defined as the year in which the survival rate of external wall refurbishment exceeds 50%. Consequently, the refurbishment cycle of the N area becomes 10 years that of the M area becomes 15 years.

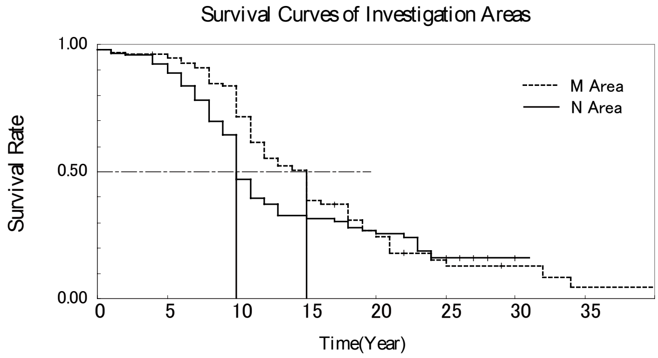

Fig. 9 Survival Curves of the Investigation Areas

4.2. Consideration of the Differences in the Exterior Wall Refurbishment Cycle

After seeking the refurbishment period of the exterior wall, the refurbishment cycle of the N area was found to be about 5 years shorter than that of the M area. This aspect was analyzed from the viewpoint of each of the types of exterior walls and the construction periods.

The relation between the age of the building and the types of exterior wall used when refurbishing an exterior wall is shown in Fig. 10. When comparing the age of buildings in refurbishment in both areas, the refurbishment frequency of 6-10 years is high in the N area, while that of 6-15 years is high in the M area respectively. Variation in this frequency is thus thought to be attributable to the difference in the refurbishment cycle. However, the data for the types of exterior wall except the lath-mortar is insufficient and the difference among the types of exterior walls cannot be compared. Although further refurbishment of the siding took place within the 6-10 year period in the M area, the number remains insufficient compared with the lath-mortar, meaning it is difficult to compare the tendency based on types of exterior wall.

Composition in the construction period of both areas is shown in figure 11. When observing distribution in the period of construction of the refurbished building, buildings which were constructed in the 1970s exceed 50% in the N area; a figure which approaches 70% when also including those houses constructed in the 1970s and 1990s. On the other hand, as for the M area, the rate of houses constructed in the 1980s is 40% or more, with only around 30% constructed in the 1970s.

The relation between the age of buildings in refurbishment and the construction period of the same is shown in figure 12. Many buildings which were constructed in the 1970s and in 1990s were refurbished 6-10 years after construction. Also, in the 1980s, a tendency to refurbish 6-15 years after construction is seen. The difference in the tendency by construction period seems to influence the refurbishment cycle in both areas.

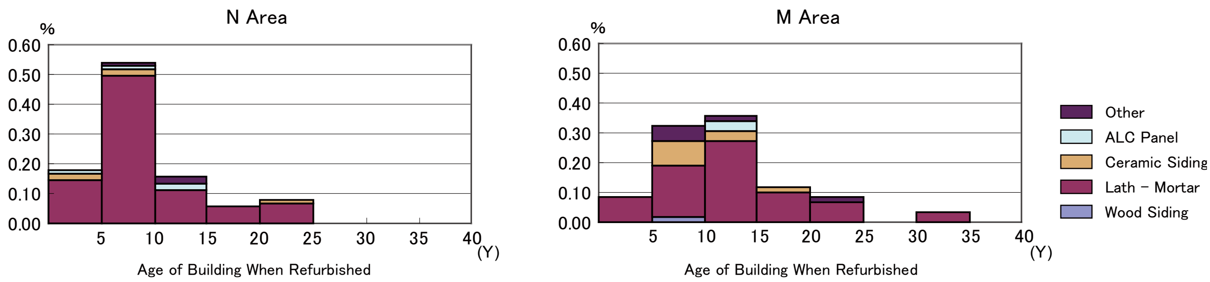

Fig. 10 Relation between the Refurbished Age of Buildings and the Types of Exterior Wall

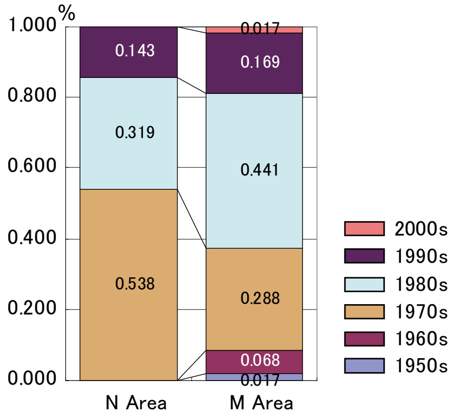

Fig. 11 Rate of Construction Period Which Have Refurbished

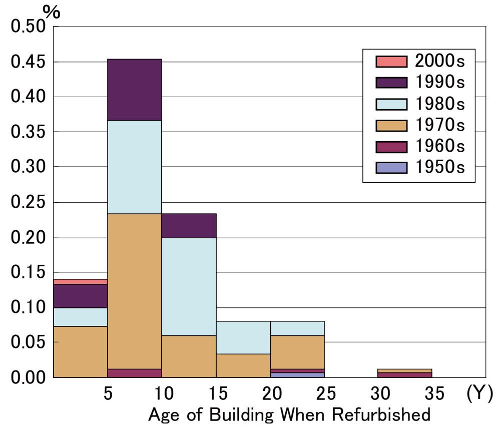

Fig. 12 Relation between the Refurbished age of Buildings and the Construction Period

5. CONCLUSION

The following knowledge was obtained from this research.

To begin with, as pointed out, the types of exterior wall, construction year and interval of buildings are the factors influencing the decision whether or not to refurbish exterior walls. Based on the distribution of building intervals by area, a difference was seen, although this difference was not revealed by the refurbishment experience. On the other hand, the rate at which ceramic sidings and ALC were used is high in non-refurbished building, while the rate of buildings constructed in later years is also high in non-refurbished buildings, meaning no difference among regions can be specifically revealed based on this tendency.

Subsequently, the exterior wall refurbishment cycle of each area was examined using the Kaplan-Mayer method. Consequently, the refurbishment cycle of the N area was revealed as 10 years, that of the M area as 15 years, and this inter-regional difference was subsequently analyzed. It was clarified that a difference in the tendency of refurbishment time based on the construction period emerges, which seems to have an influence on the refurbishment cycle of the exterior wall. When distribution in the construction period for refurbished buildings is viewed, a difference in both areas is clear. As for the M area, the rate of buildings constructed in the 1980s is high, and the time to refurbishment was long, while on the other hand, for buildings built in the N area, the rate of construction period was high in the 1970s and 1990s, while the refurbishment cycle was comparatively short. Therefore, as for the exterior wall refurbishment cycle, the construction period is presumed to become a factor and as for the types of exterior wall, the number of samples used for analysis must be increased in future.

References

Komatsu, Y., 1992. Some Theoretical Studies on Making a Life Table of Buildings, *AIJ Journal of Architecture and Environmental Engineering* 439: 91-99.

Ohashi, Y., and C. Hamada, 1995. *Analysis of Survival Data (Biostatistics Using SAS Software)*. Tokyo: University of Tokyo Press.

Saito, S., S. Fukao, and K. Kadowaki, 2007. Study on the Refurbishment Records of Detached Houses, *AIJ Journal of Architecture and Planning* 615:61-67

Tsunoda, M., 1995. *Joint Layout Design of Siding Board on Exterior Wall's Construction System in a Detached House*, Diss., Tokyo Metropolitan Univ.

The Past and Future of Industrial Heritage:
The case of the Former Onozuka Residence in Oyama, Tochigi Prefecture

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Keywords: Onozuka Residence, Soy Sauce Brewing, Remodeling Process, Timber-Framed Buildings, Building Conservation, Oyama city

Abstract
In accordance with the former Onozuka family head's will, the family's properties were donated to Oyama city in Tochigi prefecture in 2005. These include lands and a set of historical buildings. In this paper, we attempt to present the history of the site and discuss the characteristics of the changes in the buildings as a result of some remodeling processes.
The Onozuka family had been an owner of fertile land and were engaged in the fertilizer retail business. They had a residence along the Nikko-Kaido. In the beginning, they built a shop on the west side of the street. Later, they procured the site on the other side, and started soy sauce business. Some constructions related to the soy sauce brewery remain even today. The existing brewery constructions were built in the Taisho period, but during the course of their long history, they have been remodeled many times.
We conducted an architectural survey on this site and its buildings. As a result, we are able to clarify the history of the site and trace the remodeling process of these constructions. Through our findings, we will obtain not only a technical solution for remodeling but also knowledge about the usage of traditional Japanese constructions in the future. Therefore, this review is very important from the viewpoint of research on materials used to construct buildings.

1. Introduction
The Onozuka family, which was based in Oyama-shuku (the present town center of Oyama city, Tochigi prefecture) since the Edo Era (1603 －1868), had been an owner of fertile land. The family established residence and set up a company in central Oyama (present 1 chome, Tenjin-cho, Oyama city)which faced the former Nikko-Kaido (the old primary route). During the Meiji period (1868 － 1912), the family managed an oil and fertilizer business under the name of "Onozuka-Shoten." Afterward, they

fig. 1: Bird's –Eye View (photo by Yoshinobu Onozuka)

obtained the site located on the opposite side of the Nikko-Kaido (present 2 chome , Tenjin-cho) by around the middle of the Taisho period (1912－1926). In 1919, they laid on the foundations of brewing section, and began to produce and sell soy sauce. In this paper, we use the term “West Site (Old Residence)” to refer to the former site of the residence and the company, and the term “East Site (New Residence)” to refer to the site that the Onozukas obtained later and where they manufactured soy sauce (see figs.1～3).

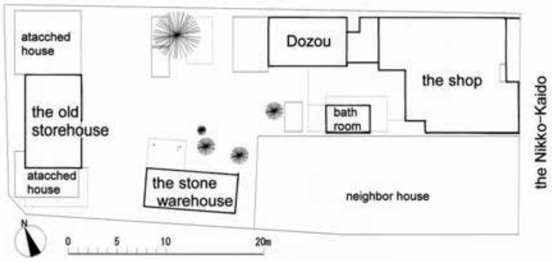

fig. 2 Site Plan of the West Site (Old Residence) (drawing by Kenichiro Nakamura)

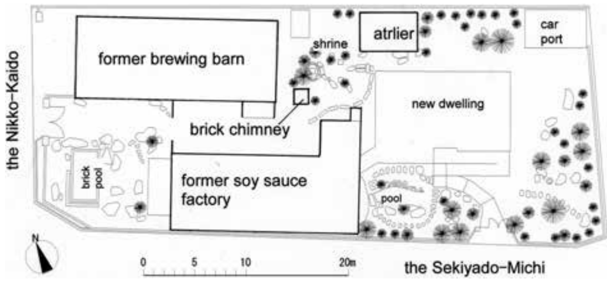

fig. 3 Site Plan of the East Site (New Residence) (drawing by Kenichiro Nakamura)

It was the family head, Kyuhei Onozuka (1874－1950), who started soy sauce brewing at the site. He is not only the founder of the soy sauce factory but also contributed to the local economy and politics of Oyama. He extended the business, while also playing important roles in the local community for forty years. For example, he filled posts such as Chairman of the Chamber of Commerce and Industry and that of the twelfth town Mayor of the Oyama town etc. Further, he was selected as a prefectural assembly member of Tochigi-prefecture.

Moreover, Yasushi Yamanaka (1899－1986), the nephew of Kyuhei, had also worked for the local community of Oyama for twenty-four years. He became the first city mayor of Oyama. He lived in the Old Residence, and studied hard. In addition, Kyutaro Onozuka (1898－1973), the eldest son of Kyuhei, succeeded the family business, －the soy sauce brewing business being the first one he succeeded－but latter became the first lawyer of Oyama, while remaining devoted to his hometown. In around 1948, Kyutaro discontinued the brewing of soy sauce, and at that time, began to convert the former soy sauce factory including his house into a lawyer’s office. In this process, many interesting techniques for the conversion of traditional Jpanese timber- buildings were used.

On the other hand, after World War II, The Onozuka barely dealt in the fertilizer business at the West Site. Moreover, the Old Residence first served as the dwelling of Kyuhei’s family, and after Kyuhei’s death, the buildings came to be leased separately to tenants.

In 2005, these properties were donated to Oyama city in accordance with the former family head’s will. The West Site has about 880 square meters, and the East Site has about 1,210 square meters.

In this paper, we would like to clarify the history of the sites and buildings and discuss the ways of remodeling historic buildings. Then, based on the field survey, we shall present the characteristics and raison d’etre of the historic buildings in these sites.

2. Historic Buildings at the West Site

The constructions of the old shop, the Dozou (the storehouse surrounded by a clay wall), the old storehouse, and the stone warehouse of the former Old Residence are still exstent at the West Site (see figs.1 and 2). These buildings originated during the time of “Onozuka-Shoten.” In the Taxation list description, it is recorded that these constructions were built in 1897. Unfortunately, we could not survey these buildings －except for the stone warehouse－ which we had to survey at the user’s convenience. However, based on interviews with member of the Onozuka family and the user of these buildings and our own inspection of the site, we estimate that these buildings were definitely constructed in around 1897.

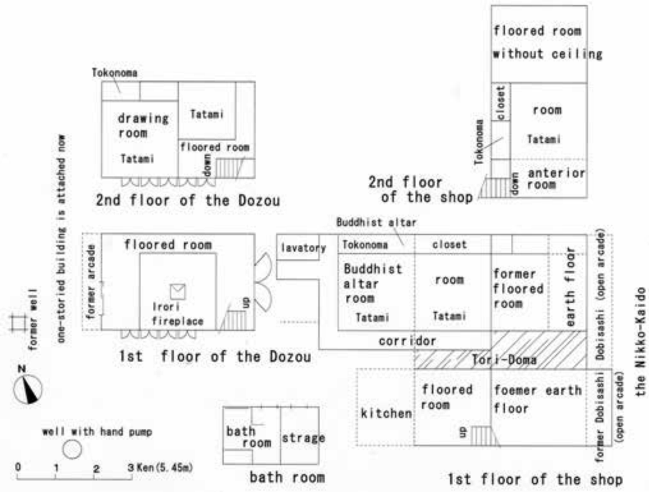

fig. 4 Conceptual Diagram of the Plan of the former Onozuka-Shoten Shop and Dozou

The old shop building was consisted of Onozuka-Shoten's former buisiness room, a room of strings commodities, the employees' room, family room, kitchen, a lavatory at the ground floor level, and attics at the second floor. This construction was built facing the Nikko-Kaido, and the front sides are two storied (see fig. 1 and fig. 4). In the front, there is a "Mae-Doma" (a work space in front with a beaten earth floor) and toward the back, a "Tori-Doma" (an indoor passage with a beaten earth floor) , to which every room is connected. At the back side, there is a bath room. This small construction is recorded in the taxation list as it was also built in 1897. At the beginning of the Showa period (1926－1989), a part of the room on the second floor was converted into the Zashiki (formal room). This room was used by the military during World War II. After the war, when the Onozuka-Shoten business was discontinued, this building was transformed into dwelling of the Onozuka family. However, when Kyuhei died in 1955, the entire building was leased, and it has been arriving now. The basic structure of the building is still characteristic of the remodeling style at the beginning of the Showa period, although the earth floor of the former business room and storage room for commodities was remodeled.

Dozou is a two－storied building and tiled to the roof. Originally, it was used to store furniture, house hold goods, and rice. Since a part of the wall collapsed during the Great Kanto Earthquake in September 1923, at the end of the same year, when he ran for the mayor election of the Oyama towm,

Kyuhei converted the storage room into the room on the ground floor and the drawing room on the second floor. At that time, casement windows were installed in the south walls of both the ground and second floor levels. Later, Kyuhei's family lived there, along with that, the second floor of the old shop building was offered to the military in World War II. After Kyuhei's death, it was leased, and the open arcade of the west wall was rebuilt as one-storied building. However, the basic structure of the construction in 1923 has been preserved until now.

The old storehouse building has a gabled tiled roof, and an eave is installed on the east side. After Kyuhei's death, it, too, was leased. In around 1978, it was extended to the north side, and in 1994, to the south side. However, the basic external appearance is the same as it was originally.

The stone warehouse is a two-storied building with an eave at the east gable end. It was originally a Dozou (clay wall) and was later rebuilt with stone. It is not unclear whether this structure was rebuilt in 1897 along with other buildings on the site. The ground floor of the warehouse was used to store furniture and household goods, and the second floor was used to store business documents like the Onozuka-Shoten account ledgers on the second floor.

As mentioned above, the principal buildings of the Onozuka-Shoten since the Meiji period still remain at the West Site. These constructions not only testify to the history of a certain affluent family but also to important political and economic events in Oyama. The old shop buildings and the Dozou, in particular, constitute an interesting architectural heritage to understand the turbulent ages of the Onozuka family and Oyama city from the end of the Taisho period to the beginning of the Showa period. In addition, the stone warehouse is very interesting from the viewpoint of architectural style.

3. Historic Buildings at the East Site

3-1. Site and Existing Buildings

At the East Site, three historic buildings related to soy sauce brewing remain : the former “Soy Sauce Factory,” the “Brewing Barn,” and the “Brick Chimney.” According to the Onozuka family documents such as the brewing record of 1919, entitled “Moromi Kumidasi cho,” and the product record of soy sauce in 1919, entitled “Syoyu Seisei cho,” it is clear that soy sauce was manufactured in 1919. Moreover, we estimate that the soy sauce factory and brewing barn were under construction until 1918 since the written estimate that was used at the time of purchasing the equipment for soy sauce brewing was found. Moreover, we can presume that the brick chimney was constructed in around 1923 since the purchase price of the bricks and transport fare have been recorded in the account book in 1923.

However, in around 1948, the Onozuka family discontinued soy sauce brewing because Kyutaro, who was the legitimate child of the family, switched to practicing law. He converted the building into a dwelling and attached a lawyer’s office adjacent to the east of the soy factory; thus the structure of the buildings began to change gradually (see figs. 1 , 3, and 14).

We will now describe the result of the reconstruction work on the former soy sauce factory, the brewing barn and brick chimney as representatives of constructions for the soy sauce industry.

3-2. Soy Sauce Factory

The former soy sauce factory building is a one-storied timber building with a gabled tiled roof. In one glance, it is difficult to tell that the factory was constructed from the building, because both the inside and outside walls of the building are covered with new materials and it has been converted into a housing unit (see figs. 5 and 6). However, as shown in the chart of the evidences(see fig. 7), most of the wooden pillars are the original pillars, and the roof truss is also intact. In view of the disintegration of the materials and the constructional techniques, for example, weathering, the type of the nails used, and the round wooden pegs used for the joint of the beams, it is surmised that the construction was built in Taisho period, when the soy sauce brewing business started. Moreover, based on the survey of the evidences of remodeling and the

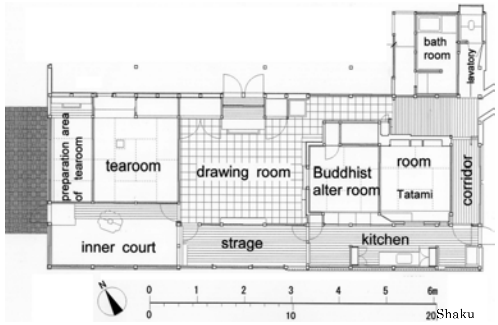

fig. 5 Plan of the Soy Sauce Factory (present)
(drawing by Hikaru Tamagawa)

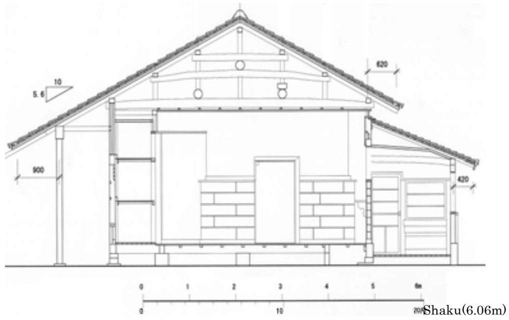

fig. 6 Cross Section of the Soy Sauce Factory (present)
(drawing by Ryosuke Yoshida)

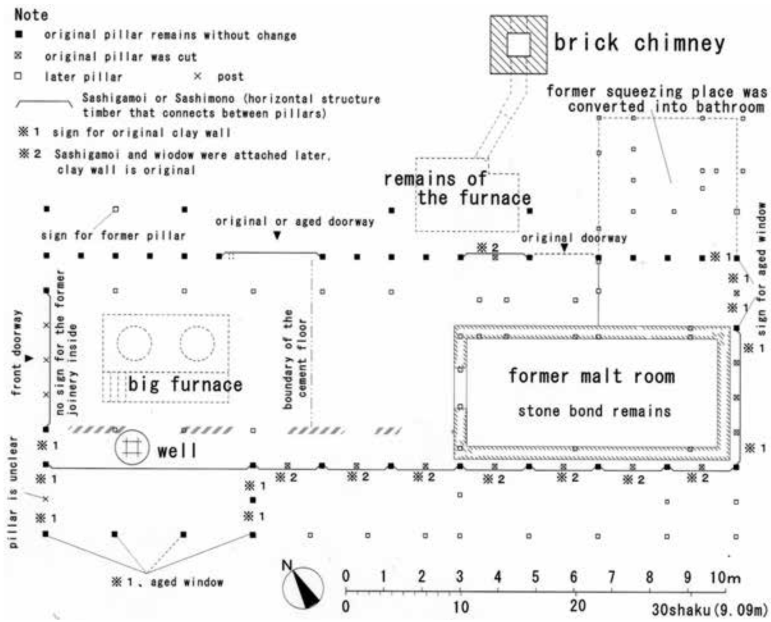

fig. 7 Chart of Evidence of remodeled the soy sauce factory

hearing investigation, it becomes clear that this building had remodeled at least thrice— once, as a factory and twice, as a house.

As shown in fig. 8, in around 1918, the interior of the factory consisted a wide beaten earth floor, a malt room, a washing place with a well inside, and a big furnace in a corner of the earth floor. It did not have a ceiling, and the beams were exposed in a vast space. The pillars of the outer wall were set in at an interval of half a "ken" (the historical Japanese module used for span; one ken is equal to approximately 1,800millmeters). This building was almost entirely enclosed by walls, except for the doors, one of which was located in the west wall, and two, in the north wall. Besides, a place of squeezing soy sauce was provided in the north-east corner of north eave of the factory.

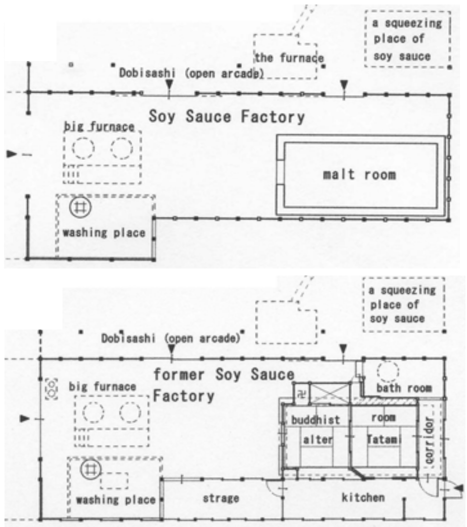

fig. 8.: Plan of the Soy Sauce Factory (upper:c.1919,lower:c.1957)

Later, before 1945, the eave was that was made for the lean-to roof had been extended to the south wall. At this time, the main pillars of the building were partly cut at the place where the eave was added, and this produced an interval of not half but one ken where a window was situated. The purpose of rebuilding may be considered to be the securing of storage space and the improvement of lighting inside.

Though the factory ceased operation in around 1948, the building was maintained as it was for about ten years afterward. Kyutaro set a cooking furnace beside the big furnace, and this space was utilized as his family kitchen. Then, in around 1957, the malt room was converted into a Buddhist altar room, a Japanese style living room and corridors, while the bathroom was rebuilt to the north of the former malt room. Moreover, a floor was built under the south eave, and it became the kitchen and storage room (see fig.8 below).

In addition, in around 1966, the leftover area with the earth floor was remodeled into a drawing room, a tearoom, and a room where preparations could be made before tea was actually served, while the washing area was converted into the inner court. Then, the place for squeezing soy sauce was demolished, and a bathroom and a lavatory were newly built, while the former bathroom was converted into the passage. At the same time, the exterior and the interior were restored to the current state.

3-3. Brewing Barn

The brewing barn building is a one-storied, timber building with a gabled tiled roof like that of the soy sauce factory. It was originally Dozou-zukuri (built with clay walls); however, in around 1969, it was rebuilt to its present state (see fig. 9 and fig. 10). At that time, the exterior and the interior were rebuilt with modern materials; a new floor and a stage were added, and new windows were fixed. Therefore, at first glance, it might not seem to be a historic building. However, this building possesses numerous historical signs, and it is a very valuable architectural heritage structure. Let us look the evidence chart of the remodeling of the brewing barn (fig. 11). Most of the pillars are the original ones, and the roof truss is

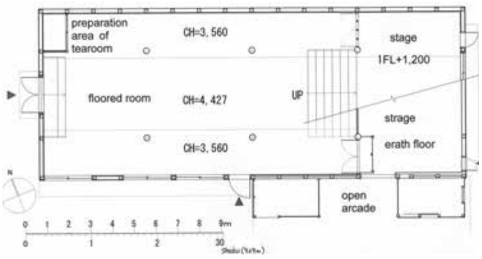

fig.9 Plan of the Brewing Barn (drawing by Mitsue Uto)

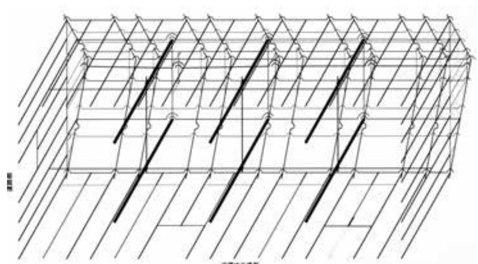
fig.10 Axonometric of the Main Construction of the Brewing Barn (drawing by Mitsue Uto)

still as it was. Judging from the materials used and the constructional techniques, we can deduce that this building was built in the Taisyo period, when the soy sauce brewing had just started. We can confirm this based on the fact the old picture is the same as what was observed during the field survey and hearing.

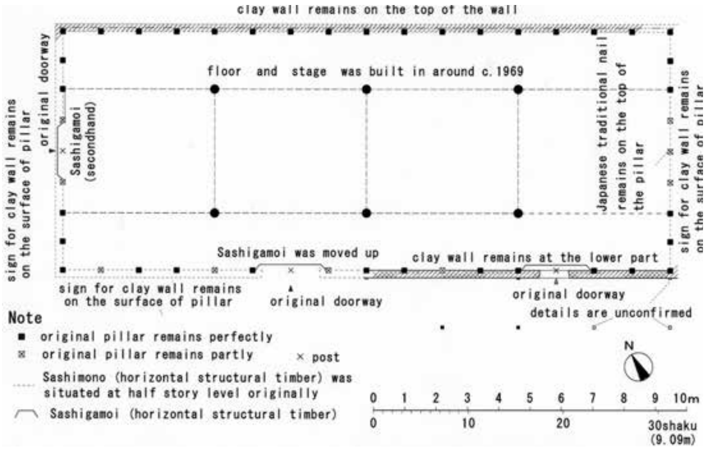

fig. 11 Chart of the Evidences of Remodeled of the Brewing Barn

That is, this building was first built as a soy sauce brewing warehouse. The date of construction might be around 1918 , when the family was preparing to venture into the business of producing soy sauce. At that time, the entire inside of the building consisted of an earth floor, and it had no partition. There was no ceiling, and there was no division between the nave and the aisle. This produced a vast interior space, similar to that of an aisled hall (basilica type) in Western countries. Two doorways were installed in the south wall, which faced the soy sauce factory, and one was added in the west gable end. A Dobisashi (open arcade) was situated at the south end, and the eave made from Oya stone was set attached to the west end (see fig. 12). Though it is uncertain whether the eave was part of the original structure, based on the hearing investigation, it existed at least in 1943, and it might have been part of the construction for soy sauce brewing.

After the soy sauce brewing had been discontinued, this building was kept intact for about twenty years, although it was sometimes leased as storage space. In around 1969, the clay of the walls was stripped off; a new floor and stage were built; extra windows were set up; and the exterior and the interior were remodeled. Coincidentally, the west half of the Dobisashi at the south wall and the eave at the west end, which was made from Oya stone were also removed. This remodeling was carried out because Kyutaro wished to convert the redundant storage space into meeting facilities, and a place where activities he enjoyed, such as dance parties, painting, and tea ceremonies, could be carried out. The original earth floor still remains under the stage, and the original wall construction can be seen in its doorway.

We discovered evidence suggesting that traditional Japanese nails (they were generally used before the Meiji-period) were used in some pillars in the brewing barn. On the other hand, we can find unnecessary cuts in the joints of the pillars and beams. Therefore, we can propose that this construction style had been employed in another place before it was used for the Onozuka-Shoten brewing barn.

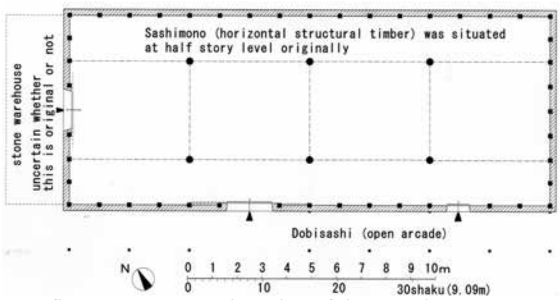

fig.12: Reconstruction Plan of the Brewing Barn

3-4. Brick Chimney

There is a chimney stack at the East Site. This chimney stack is familiar to the people of the region as a symbol of Oyama city. It is about 15 meters high, and it is made out of brick. Based on documents that survive among the Onozuka family, it became clear that this brick chimney was constructed in 1923. We excavated the surrounding area of the chimney runs from the furnace situated at under the north eave of the soy sauce factory (see fig. 13). This furnace had not yet been used and was buried under-ground.


fig.13 Duct of the Chimney and Remains of the Fire Place

However, after the hearing investigation, we found and excavated it, thereby confirming that it was the furnace for the Hiire (heating treatment), which is the last process for producing soy sauce.

4. Chronological Changes in the Soy Sauce Brewing Constructions (see fig.14)

According to the change in the occupants and living conditions, the transition of the principal buildings of the East Site in terms of what they were used for can be divided into five stages. Here, it is worth focusing on the soy sauce factory, brewing barn, brick chimney , and atelier, because they reveal how the Onozuka family and Oyama city were progressing with the passage of time.

4-1. First Stage: Early Phase of Soy Sauce Brewing(c.1918－c.1923)

There was a shop building on the west side and a place for squeezing soy sauce at the east edge of the north side of the soy sauce factory. The shop building also functioned as the worker's restroom and lodgings, besides a place to carry out product sales. although there is uncertainly regarding the structure and façade of the east edge of the site, in the register book, it was recorded that it had two big warehouses.

4-2. Second Stage: Last Phase of Soy Sauce Brewing(c.1924－c.1948)

Eaves had been extended to the south side of the soy sauce factory before 1945. Since it is confirmed that there was weathering on the south side of the pillar, the extension seems to have been built some years after the factory was first constructed, although the exact time is unclear.

On the other hand, Kyutaro built a dwelling and a lawyer's office adjacent to the east side of the soy sauce factory from the end of the Taisho period to the beginning of the Showa period. This was a small-scale one-storied house, consisting of an earth floor and three rooms. It should be noted, that this house

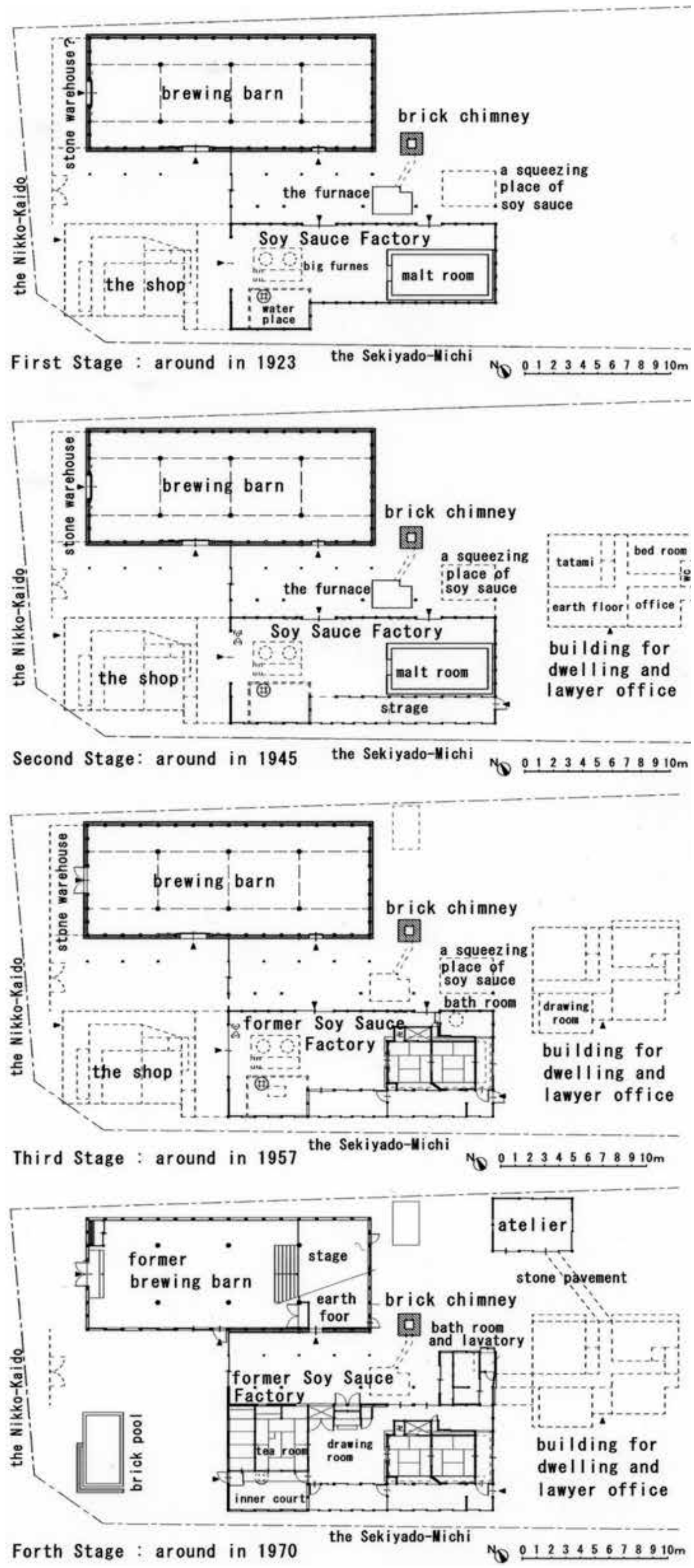

Fig.14 Chronological changes of the Soy Sauce Brewing Constructions

was built to perform the new function of a lawyer's office in the soy sauce brewery.

4-3. Third Stage: Changing Phase for Accommodation (c.1949－c.1957)

After discontinuing soy sauce brewing, Kyutaro used a part of the factory as a kitchen for his family. After this, in around 1957, he remodeled the malt room. Most of the thick Oya stone wall of the malt room was left, and was used to make a room inside. It was a very interesting style of redecoration, and the interior design, too, is attractive. On the other hand, in 1954, before the remodeling of the soy sauce factory, a drawing room and vestibule of the lawyer's office were built, and a pond garden was created in front of the entrance.

4-4. Forth Stage: Expanding Phase for Accommodation (c.1958－c.1970)

In around 1963, Kyutaro built a atelier to learn painting. Until about 1965, the shop building remained dismantled, and by about 1966, entire former soy sauce factory was converted into rooms for the family. Meanwhile, the place for squeezing soy sauce was rebuilt into a bathroom and a lavatory, and the exterior and interior walls were modified to their current condition. In addition, the brewing barn was remodeled by about 1964. Moreover, a garden was made at the former site of the shop building. Some of the brick used to pave the earth floor of the shop building still remains.

4-5. Fifth Stage: Last Phase for the Accommodation (c.1971－2005)

In 1998, the building with the residential quarters and lawyer's office was rebuilt. At that time, Kyutaro and his wife had already died, and his successor, Itsuko Onozuka, built a new house at this site. After Itsuko's death, all the properties of the Onozuka family were donated to Oyama city.
The sixth stage of soy sauce brewing constructions has recently begun.

5. The Future of the Historic Buildings of the Former Onozuka Residence

As mentioned thus far, the former Onozuka Residence has architectural and historical value. The remains of the buildings at the sites illustrate the history of the lifestyle of the Onozuka family and how Oyama was modernized. Therefore, these buildings are important from the viewpoints of cultural property and regional historical heritage. In other words, these are important not only for the Onozuka family but also for Oyama city, because these historic buildings are living witnesses of the history of both. Similarly, it is needless to mention that studying history is indispensable when thinking about the future; when we consider the future of Oyama, we have to conserve these buildings, because we can learn a lot from them. We hope to pass down this valuable heritage to the future using and maintaining these buildings adequately.

Moreover, since these buildings have been constructed from the Meiji to the Showa period, they are also an important part of the landscape of the Nikko-Kaido. It was hoped that the buildings of the Onozuka residence would be conserved even from the viewpoints of future town planning for Oyama city.

In this paper, we have concentrated on the process of remodeling of the historic buildings of the Onozuka residence, based on the change in lifestyle, and we demonstrated their importance in history. Moreover, we reviewed manner in which traditional Japanese timber buildings were converted from the perspective of the techniques used. Learning how remodeling was carried out in the past may prove very useful for the future. Learning from the experiences of the past is vital when considering the utilization of materials for buildings.

References

Onozuka Family and the Investigation Team for the Former Onozuka Residence. 2007. *Report on the Academic Investigation of the Historic Buildongs in the West and East Sites of the Former Onozuka Residence.* / Oyama-city. 1984. *History of Oyama-City, Modern 1.*

Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo

Part 3 Case Study on Low-Rise Apartment Houses

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Abstract

This paper presents the case study of seismic diagnosis and structural strengthening repair work conducted on low-rise timber apartment houses in the downtown district of Tokyo (*Sumida* Ward, *Kyojima*). The investigated timber apartment houses are one- to two-story low-rise timber apartment houses built in the middle of the 20th century. The investigated area is known for its densely populated small timber houses and is estimated to be one of the most vulnerable regions against earthquakes in Tokyo. The results of on-site investigations and a seismic diagnosis of three timber apartment houses revealed that the horizontal load carrying capacity of these houses was far below the required values in Japan's Building Standard Law. The authors conducted structural reinforcement repair work on two of the apartment houses in collaboration with the Center for Urban Development of *Kyojima*. The structural repair under financial and technological restrictions is discussed together with the need of preserving the cultural background of downtown Tokyo.

1. Introduction

Studies of the structural performance and structural reinforcement repair work of existing timber houses has been increasing slowly. Although the existing timber apartment houses suffered heavy damage by earthquakes, no study has yet been conducted. In a previous investigation, the evaluation of structural performance was a seismic diagnosis based on the result of investigations; however, it was difficult to determine the detailed specifications of the foundations and walls and to confirm the deterioration of a structure. Most of the existing timber apartment houses are old; therefore, their specifications are different from those of today and deterioration of hidden members probably exists.

There are numerous timber apartment houses in areas with densely packed wooden housing. The *Kyojima* area is one of these areas. The map of 3-chome, *Kyojima* is shown in Fig.1. There are low-rise timber apartment houses shown as Photo 1. Useful information is obtained through investigations and reinforcement repair work. By examining this information, the structural characteristics of existing timber apartment houses can then be estimated in other areas. This paper presents the results of the investigation and reinforcement work on the structural problems of three existing apartment houses, and discusses the financial and technological problems of the reinforcement work.

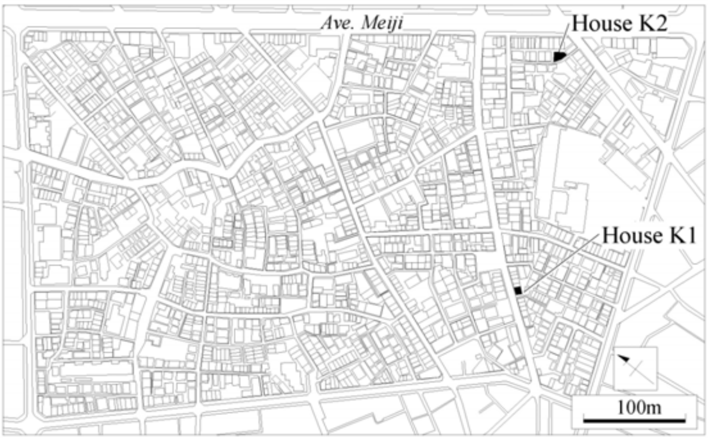


Fig.1. 3-Chome, *Kyojima*

Photo 1. The Existing Apartment Houses in *Kyojima*

2. Methods of Study

(1) On-site Investigation

To detect the materials and deterioration of the walls and roofs, a non-destructive investigation by measurement and observation was conducted. In addition, another investigation was conducted by interviews with the landlords and residents.

(2) Seismic Diagnosis

Based on the results of the investigations, a seismic diagnosis was conducted. House N was evaluated by a general diagnosis. Conversely, houses K1 and K2 were evaluated by a general diagnosis and a detailed diagnosis. The two diagnoses have different ways of calculating the horizontal load carrying capacity of the building. The two calculations for horizontal load carrying capacities $P_d(Q_d)$ are given in Eq. (1) and (2).

General diagnosis: $$P_d = P \cdot E \cdot D \quad (1)$$

where P is the strength, E is the reduction by the arrangement of structural elements, and D is the reduction by deterioration.

Detailed diagnosis: $$Q_d = (Q_{wn} + Q_{ww}) \times F_s \times F_e \quad (2)$$

where Q_{wn} is the strength of the walls, Q_{ww} is the strength of the walls with openings, F_s is the reduction by the stiffness ratio, F_e is the reduction by the eccentricity. In the detailed diagnosis, Q_{wn} and Q_{ww} include the reduction by deterioration.

(3) Reinforcement Repair Work

Reinforcement repair work was conducted on two of the apartment houses. Detailed investigations accompanied by partial destruction of the members were conducted.

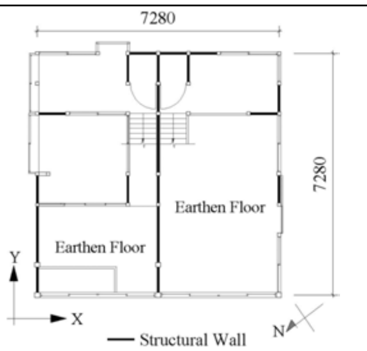
3. Results of Investigation and Seismic Diagnosis

Table 1 shows an outline of the apartment houses investigated. The north part of house K2 was not investigated because the resident was very old. House K1 is a popular two-story timber apartment house in *Kyojima*. House K2 is also a typical one-story timber apartment house in *Kyojima*. House N is not in the same area. However, the floor space and the specifications of the roof and walls are the same as those of house K1. In some places in *Kyojima*, tinplate roofing is used instead of tile. The specification of the walls is mainly mud in all three houses. Therefore, this structural element is mainly mud wall. The plans and results of the general diagnosis are shown in Fig. 2. Each result of the general diagnosis is described as follows.

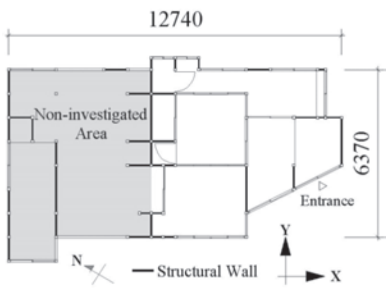
Table 1. Investigated Timber Apartment Houses in Tokyo

	House K1	House K2	House N
Location	Sumida, Tokyo	Sumida, Tokyo	Taito, Tokyo
Year of Construction	About 1926	About 1930	About 1923
Floor Space (m^2)	**1F** 52.9 **2F** 39.7	**1F** 75.9	**1F** 59.6 **2F** 56.3
Spec. of roof	Tile-roofing, partly tinplate	Tile-roofing	tinplate
Spec. of wall	outer wall Mud wall inner wall Mud wall, partly board wall	outer wall Mud wall inner wall Mud wall	outer wall Mud wall, partly tinplate inner wall Mud wall
photo			

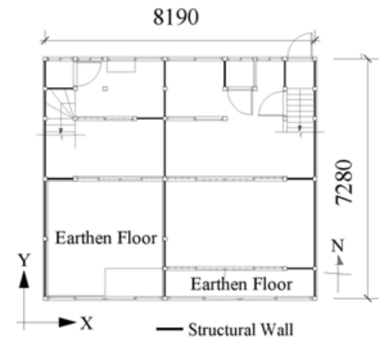
House K1



House K2



House N



	House K1			House K2			House N		
	Reduction of Eccentricity	Reduction of Deterioration	Evaluation	Reduction of Eccentricity	Reduction of Deterioration	Evaluation	Reduction of Eccentricity	Reduction of Deterioration	Evaluation
X	0.45	0.70	**0.13**	1.00	0.70	**0.55**	1.00	0.70	**0.32**
Y	0.80	0.70	**0.50**	1.00	0.70	**0.81**	1.00	0.70	**0.94**

Fig.2. Plans and Evaluations of Seismic Diagnosis (The General Diagnosis)

Table 2. The Judgment of Structural Performance

Evaluation	Judgment
1.5 ~	Safe
1.0 ~ 1.5	Low Possibility of Collapse
0.7 ~ 1.0	Possibility of Collapse
~ 0.7	High Possibility of Collapse

(1) House K1: The evaluation in both directions was under 0.7, and the judgment was “High Possibility of Collapse”. (Table 2) The evaluation was low because the shear walls were not adequate in both directions. Because the reduction of eccentricity was 0.45 in the X direction, the evaluation was 0.13. It is far below the other direction. There was an earthen floor along the road on the east side. The earthen floor did not have a wall in the X direction at all and all the facades along the road were openings. Therefore, the shear walls of the east side did not add enough support and the eccentricity occurred. Also, the strength of the walls had the reduction of connections because the connections had no metal fastener (Photo 2).

(2) **House K2:** The foundation is categorized into three classes according to the specifications. Table 3 shows the three classes of the foundation. The specification of the foundation of house K2 was not clear; therefore, a diagnosis was made by the specifications for Foundation 2 and Foundation 3. Figure 2 shows the evaluation for Foundation 3. The evaluation in the X direction was 0.55, and the judgment was "High Possibility of Collapse". The evaluation in the Y direction was 0.81, and the judgment was "Possibility of Collapse". The evaluation in the X direction was low because the shear walls were not adequate in the X direction. The Y direction has the reduction by eccentricity. The strength of the walls had the reduction of connections because the specification of the foundations was stone and the connections had no joint metal (Photo 3).

(3) **House N:** The evaluation in the X direction was 0.32, and the judgment was "High Possibility of Collapse". The evaluation was low because the shear walls in the X direction were not adequate. The evaluation in the Y direction was 0.94, and the judgment was "Possibility of Collapse". The evaluation was nearly 1.0 because the outer walls and the walls on the boundary of the dwelling unit were adequate. Because the rot of the column and the damage of the wall were found by on-site investigation, a reduction by deterioration occurred.

Table 3. Specification of Foundation

Foundation 1	Reinforcement Concrete or Mat Foundation
Foundation 2	Reinforcement Concrete with a Crack or Mat Foundation with a Crack. Concrete and Stone with Fix
Foundation 3	The Others

Photo 2. Column Base (K1)

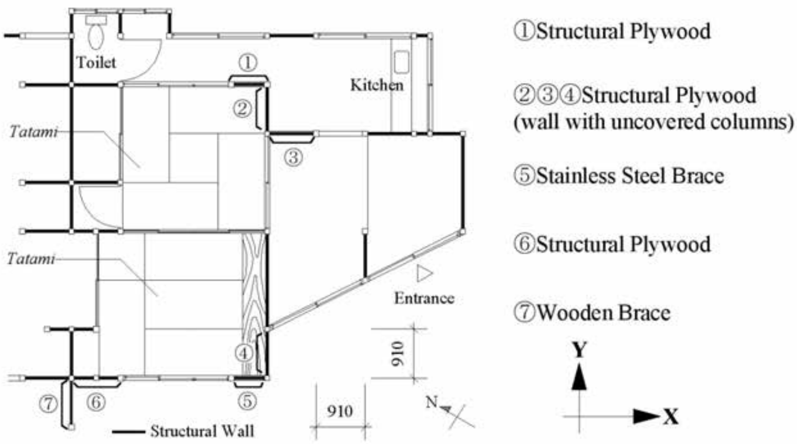
Photo 3. Column-Beam Connection (K2)

4. Results of Reinforcement Repair Works

We conducted two reinforcement repairs. This section reports the plan and a description of the work on house K2.

4.1 Plan

There is a resident in the dwelling unit on the north side. The dwelling unit on the south side is used as a nursing care center several times per month. We made a plan to conduct the repair work on only the unit on the south side as the first step of step-by-step repair work. The places of reinforcement were determined with attention to the following points: 1) the Japanese-style room in which a senior citizen resides was reinforced, 2) the places of reinforcement are arranged equally in a plane. Figure 3 shows the places of reinforcement. During the planning of the reinforcement repair work, the landlord hoped to leave the atmosphere as it was and avoid darkening the Japanese-style room. Therefore, No. 2 and No. 4 in Fig. 3 were reinforced by structural plywood with uncovered columns and No. 5 was reinforced by a brace of stainless steel. We conducted the reinforcement on the openings where the sliding door was not usually used (No. 1, No. 3, No. 5). After the reinforcement repair work, the existing foundation was not able to resist the pull-out force of the columns. Therefore, it was replaced with a new reinforced concrete foundation (Fig. 4).



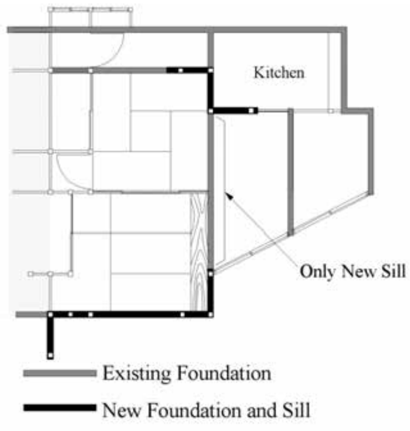


Fig.3. Plan of the Reinforcement in House K2 **Fig.4. Arrangement of Foundation**

4.2 Detailed investigation

We dismantled the floor of house K2 and investigated underneath prior to the reinforcement repair work. We found that the foundation was concrete. But, it was too old; therefore, it was removed and a new foundation was added. Also, the sill was decayed intensely; therefore, it was also replaced with a new one.

4.3 The enforcement of the reinforcement work

The main work projects are as follows.

(1) Foundation work: After the existing foundation and sill were removed, a foundation of reinforced concrete and sill, to which a disinfectant was applied, was added.

(2) Reinforcement by structural plywood: In No. 1 and No. 6, structural plywood was nailed on the columns and horizontal members. Whereas, in No. 2, No. 3 and No. 4, structural plywood was fixed on the columns and horizontal members through the member nailed them. A column would show on the surface of the wall by doing this. In addition, work was conducted to maintain *Nageshi,* horizontal pieces of timber in the frame of Japanese-style houses. For example, opening was replaced with structural plywood in No.1 and mud wall was replaced with structural plywood with uncovered column in No.2 (Fig. 5, Photo 4). Consequently, the atmospheres did not change.

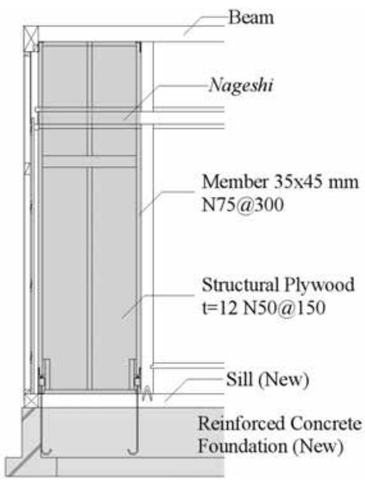


Fig.5. Structural Plywood With Uncovered Column (No.2)

Before Reinforcement **After Reinforcement**

Photo 4. Reinforcement on No.1 and No.2

(3) Openings of reinforcement by brace: In No. 5 the reinforcement was a brace ϕ 9 mm of stainless steel, which does not darken a room. After cutting only the reinforced part of the spandrel wall and locating the column, the brace was installed. The brace touched the existing sash; therefore, the sash was removed. It was fixed on the frame, which was nailed on the column from the outside again (Fig. 6). In addition, the paper sliding door, which became unnecessary by the reinforcement in No.1, was nailed from the inside (Photo 5).

(4) Reinforcement by wooden brace: In No. 7 the wooden brace was added (Photo 6). The finish of the outer wall was the wood siding using calcium silicate board.

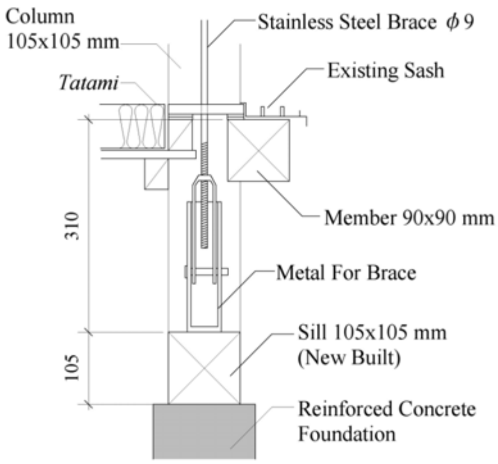


Fig.6. Detailed Section of Stainless Steel Brace

Photo 5. Paper Sliding Door (No.5)

Photo 6. Reinforcement by Wooden Brace (No.7)

4.4 The evaluation after the reinforcement work

Table 4 shows the evaluation of the detailed diagnosis after the reinforcement repair work. The evaluation did not change due to the result of the detailed investigation. However, by using structural plywood for the repair of the external wall on which there was intense damage, the evaluation in the Y direction rose.

Table 4. The Evaluation in Each Step

	Before Reinforcement	Plan	After Reinforcement
X	0.52	0.86	0.86
Y	0.70	0.98	1.13

5. Discussion

5.1 The characteristics of the building

Compared with the evaluations of the span direction (Y), the evaluations of the ridge direction (X) were low for all three apartment houses from the result of the seismic diagnosis of each building. The apartment houses have openings in the ridge direction and did not have partitions (Photos. 7 and 8). The evaluation of the span direction (Y) will change depending on whether there is an opening or not in the external wall. In other words, the ridge direction (X) needs to be reinforced in these apartment houses. However, because there are few existing walls, there will be many cases in which there are not enough strength if they are reinforced. Therefore, it is necessary that new structural elements are built in openings which have not been used and on the earthen floors.

Photo 7. The Openings in the Ridge Direction (N)

Photo 8. Continuous Room (K2)

5.2 Deterioration of the member

Detailed investigations by partial destruction of the members were conducted. The surface of the column bases visible on the outside had deteriorated. Most sections of some column bases had termite damage and decay (Photo 9). In addition, the sills decayed in houses K1 and K2 (Photo 10). The height of the beam for the foundation was low; therefore, the sills were decayed from ground moisture. In contrast, the column tops and the horizontal members were not decayed. In a building similar to these, the partial loss of sections by deterioration, which influences the structural performance, may occur in the hidden members. Therefore, the investigation by breaking part into a floor and a wall or using a fiberscope has to be conducted to evaluate their seismic performance correctly.

Photo 9. Decayed Column Base

Photo 10. Decayed Sill

5.3 The existing foundation

Table 5 shows the foundation of the investigated houses. In cases in which the surface of foundation deteriorated and is buried underground, it is difficult to investigate their material. The specification of the foundation is important to make the reinforcement plan. Therefore, it was investigated carefully.

Table 5. Foundation of Investigated Houses

	Specification of Foundation	Method of Investigation
House K1	Stone (*oyaishi*)	Observation and Partial destruction
House K2	Concrete	Observation and Partial destruction
House N	Concrete	Observation

5.4 The reinforcement repair work

To show the effect of the reinforcement on which there is no foundation means building a new foundation. However, the foundation work greatly influences the time and work cost. The reinforcement to the earthen floor for where there is no floor and no place needs to jack up the building was easy to carry out. Namely, it would reduce time and cost. Therefore, it is necessary to consider the simple reinforcement techniques. The frames were reinforced by structural plywood mainly. Most structural plywood touched the orthogonal walls and beams; therefore, it was nailed through the members or part of the plywood was cut. The horizontal strength of the reinforcement by structural plywood in this case should be evaluated in detail. In the reinforcement by structural plywood with uncovered columns where mud walls were removed, a large quantity of dust resulted. Therefore, it was necessary to devise how to do the work if a resident was living there. In the case that new structural elements were built, e.g., as reinforcement to the earthen floor in K1 (Photos 11 and 12) and reinforcement by brace to the opening in K2 (Photo 13), the designer should determine the place of reinforcement in consultation with the resident about directions for use. These reinforcements are effective for apartment houses that have a long frontage.

Photo 11. New Foundation on Earthen Floor (K1)

Photo 12. New Structural Element on Earthen Floor (K1)

Photo 13. Reinforcement by Stainless Steel Brace on Openings (K2)

6.Conclusion

We conducted investigations on three timber apartment houses. In addition, we conducted detailed investigations and structural reinforcement repair work on two of these houses. The seismic performance in the ridge direction of the existing timber apartment houses was generally below the required values in the Building Standard Law. The deterioration of structural members was found by detailed investigation. We needed to evaluate the seismic performance to evaluate the degree of deterioration. The foundation work was conducted with reinforcement of the frames. The reinforcement in the ridge direction was conducted by reinforcement of the openings and earthen floors. The financial and technological problems were understood. In the future, we need to quantify the deterioration found by our detailed investigations and verify the seismic performance and the reinforcement in the ridge direction in these cases.

Acknowledgement

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References

Bureau of Urban Development, Tokyo Metropolitan Government, The Fifth Result of Measurement of the Area Degree of Risk

Committee on Report on the Hanshin-Awaji Earthquake, AIJ, 1998, Report on the Hanshin-Awaji Earthquake Disaster Building Series, Volume 4, Wooden Structure Damage to Building Foundations

The Japan Building Disaster Prevention Association, 2004 revised edition, Detailed Seismic Evaluation and Retrofit of Wooden Houses

Sasaki, T., Fujita, K., 2006, Study on the Application of Seismic Diagnosis to Existing Wood Apartment Houses, Case Study of Timber Buildings Located in the Metropolitan District. Summaries of Technical Papers of Annual Meeting, Architectural Institute of Japan, C-1, 267-268

Seismic Diagnosis and Structural Performance Evaluation of Existing Timber Houses in Tokyo
Part 4 Analysis of Urban Houses in *Kanda*

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Keywords: pre-existing non-conformed structure, microtremor measurement, earthquake response analysis, exterior investigation

Abstract
The present paper describes research on the structural performance of urban houses in *Kanda*. The goal of this research is to evaluate of the seismic performance of these buildings and to verify the validity of the evaluation method of seismic performance of these houses. The targets of this research were timber structures located in the *Kanda* district of Tokyo prefecture. These structures are densely packed small to medium buildings. In order to clarify the seismic performance of timber houses, exterior investigation was performed on 244 timber structures and detailed investigation and microtremor measurement were performed on four timber small houses built in the 20th century. As a result, the fundamental vibration characteristics of these houses were observed. Moreover, earthquake response analysis was performed on the four investigated timber houses. The results of the analysis are discussed in comparison with the evaluation of these houses based on the seismic diagnosis.

1. Introduction
Japan has a long history of timber structures and earthquakes. Timber structures in Japan have suffered great damage caused by strong earthquakes. As a result, in the revision of the Building Standard Law in 1980, the load-carrying capacity method was introduced to examine the performance of structures against very severe earthquakes. However, there is a large number of pre-existing non-conformed structures, especially in the traditional residential districts of Tokyo. These houses have substandard structural performance. Therefore, it is important to accurately evaluate the structural performance of such houses and to improve their structural performance with respect to earthquakes.
In order to evaluate the seismic performance of timber houses, a large number of microtremor

measurements have been performed, including those by Yamabe et al. and Sakamoto et al.

Investigations were performed by the authors in order to clarify the seismic performance of small, detached timber houses such as residences with attached shops. In order to clarify the seismic performance of such structures and verify the evaluation method of seismic performance of timber houses in Japan, microtremor measurements and analysis were performed.

2. Research Area

The research area of the present study is the *Kanda* district of Japan, which is located in central Tokyo. The *Kanda* district contains a number of densely packed small low-rise timber houses and medium-sized medium-rise reinforced concrete construction and steel structures. As mentioned above, it is important to evaluate the seismic performance of these structures. The research area was decided the center part of the *Kanda* district, as shown in Fig. 1-a.

2.1 Previous Earthquake Disasters

Many large earthquakes having seismic intensity scale (JMA scale) approximately six are known to have occurred in the *Kanda* district. The most important examples are listed in Table 1 and are described in Fig. 1. For example, the 1923 Kanto Earthquake destroyed or seriously damaged 2,288 timber houses in the *Kanda* district. In addition, fires after the earthquake damaged or destroyed another 46,709 timber houses in the *Kanda* district.

In the *Kanda* district, three earthquakes having seismic intensity scale (JMA scale) five to seven have caused severe damage. However, the damage in the present research area was smaller than in other parts of the *Kanda* district because the research area is located near a diluvial deposit.

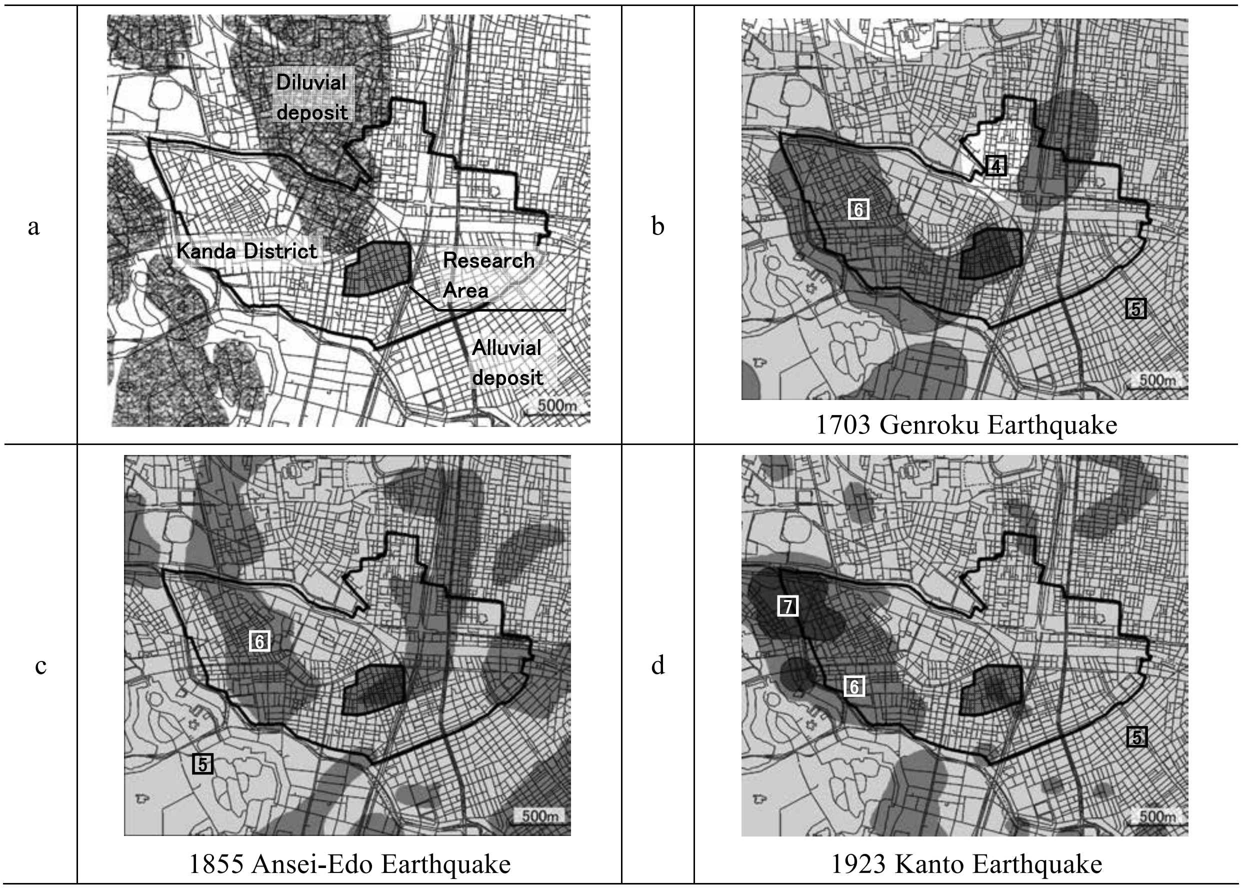


Fig. 1 Distribution of past earthquake disasters (a: geological map, b, c, and d: seismic intensity*)

* seismic intensity scale (JMA scale): 5 , 6 and 7

Photo. 1 Townscape

Table 1 History of earthquake disasters in *Kanda*

Earthquake	Year	Type of Earthquake	Epicenter	Magnitude	Seismic Intensity*1	Damage*2	Casualty*3
Genroku	1703	Subduction	Tokyo and the vicinity	7.9〜8.2	4〜6	28,000	6,700
Ansei-Edo	1855	Crustal	Tokyo and the vicinity	6.8〜7.0	5〜6	14,346	10,000
Kanto	1923	Subduction	South area of Kanto	7.9	5〜7	254,000	142,000

*1 recorded in the Kanda district, *2 number of houses damaged (collapsed, thrown and burnt down)
*3 number of persons killed

2.2 Typical Type of Timber House in the *Kanda* District

In order to clarify the typical type of timber house in the *Kanda* district, a survey was conducted over the entire research area, including all 244 timber structures. The evaluation in this survey was based on the exteriors of buildings. Residential dwellings, dwellings with shops and dwellings with offices account for approximately 75% of all buildings in the research area, as shown in Fig. 2. Moreover, the typical type of opening and frontage were as shown in Fig. 3. Dwellings with shops or offices accounted for over half of all buildings in the research area, and the ratio of structures having an entire frontage opening is high. The ratio of structures having narrow frontage side facing a road is also high. In the *Kanda* district, the number of dwellings with shops or offices that have wide openings and narrow frontages was great, and this type of dwellings was found to be typical in the *Kanda* district. Most of the dwellings of this type are problematic because they few shearing walls in the direction of the short side of the building.

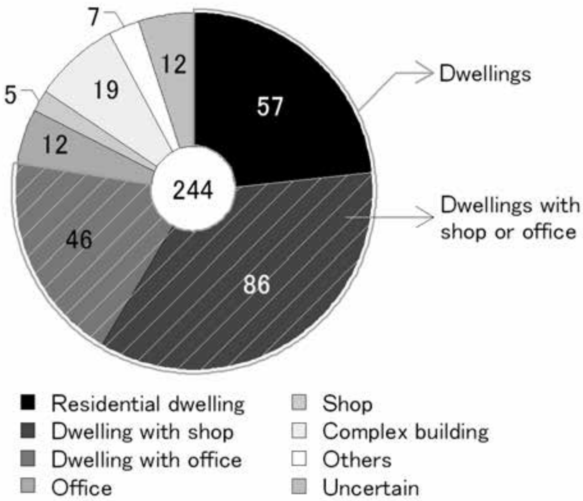
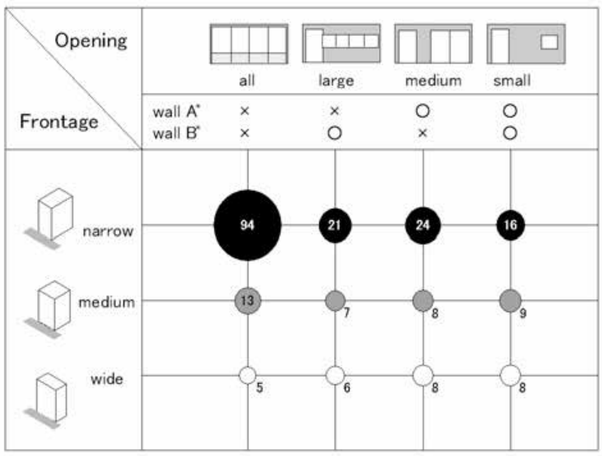


Fig. 2 Building Use



* wall A: structural wall, wall B: non-structural wall

Fig. 3 Typical Type of Opening and Frontage

3. Targets of Research

The targets of investigation of this research were four timber houses in the *Kanda* district as shown in Table 2. This paper presents the results for House B, shown in Fig. 4, in detail. The type of the opening and frontage of the target houses were those typical to the *Kanda* district.

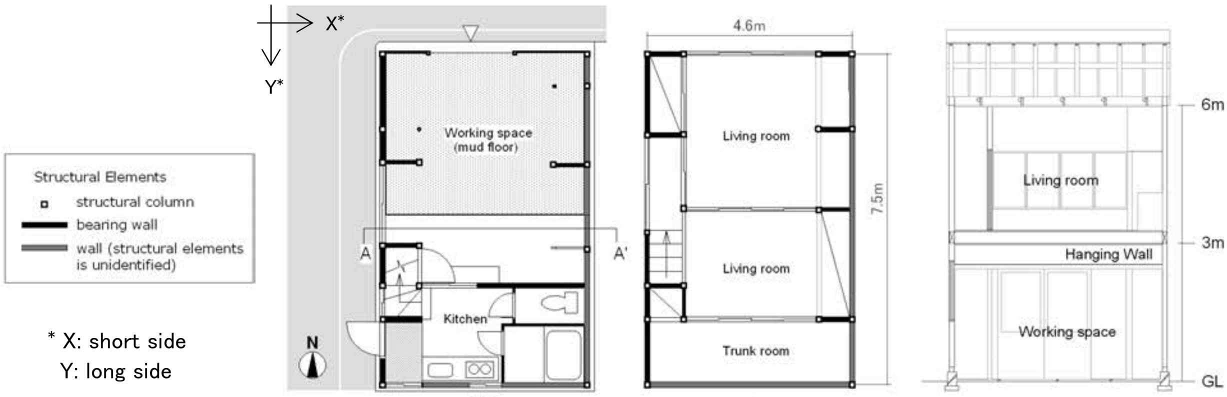
House B was built after the 1923 Kanto Earthquake in 1931. The residents of House B took up residence there in 1957. Although the kitchen was redesigned in 1996, the other parts of the house remain in their original condition. The first floor, except for the kitchen and bath, consists of a store and an office. The building is a post and beam structure with mortared walls, mud walls and construction blocks and the roof is thatched with tile. The frontage is narrow, and the opening is very large. This is the most typical type of small detached timber house in the *Kanda* district. This house is an existing non-conformed building.

Seismic diagnosis was performed on four timber houses based on the results of this investigation.
As a result, the seismic diagnosis of House B indicated a “possibility of collapse” and “high possibility of collapse” as a result of the insufficiency of the shear walls for the large opening in the workspace on the ground floor. The results of the seismic diagnosis of the four target houses ranged from 0.27 to 1.17 as shown in Table 2. Only House A posed no danger, because it was renovated in 2003.

Table 2 Research Targets

Name			A		B		C		D		
Photo											
Construction Year			1929 / 2003		1931		1961		1965		
Building Use			Dwelling with shop		Dwelling with shop		Dwelling with workshop		Residential dwelling		
Area(m^2)	Building Area		24		35		72		24		
	Total Floor Area		47		71		140		67		
Story			1	2	1	2	1	2	1	2	3
Result of Seismic Diagnosis*1		X*2	1.01	1.12	0.69	0.71	0.27	0.29	0.68	0.84	0.46
		Y*2	1.16	1.17	0.60	0.81	0.42	0.38	0.51	0.58	0.55

*1 Judgment of structural performance. 1.5～: Safe, 1.0～1.5: Low Possibility of Collapse, 0.7～1.0: Possibility of Collapse, ～0.7: High Possibility of Collapse
*2 X: Short side, Y: Long side



1F Plan 2F A-A’ Section

Fig. 4 Plan and Section of House B

4. Vibration Characteristics

In order to clarify and evaluate the fundamental vibration characteristics of the target houses, microtremor measurements (MT) and forced vibration tests (FV) were performed, as shown in Table 3. Six accelerograms were used in the tests, and they were set at the points indicated in Fig. 5. The natural frequency of vibration, the damping factor, and the vibration mode of the target houses were determined.

4.1 Fundamental Vibration Characteristics

The fundamental vibration characteristics of the house are as shown in Table 4 and the transfer functions are as shown in Fig. 6. The natural period of vibration of the first mode ranged from 0.13 to 0.35 second. The natural period in the X direction was twice as large as that in the Y direction. The natural frequency of the first vibration mode was distinguished, and the natural frequency of other modes was not found in the transfer function, as shown in Fig. 6.

The damping factor was calculated from the logarithmic decrement of the free vibration waveform. The damping factor ranged from 0.8% to 2.8%.

The vibration modes of these houses were determined from the phase difference and the amplitude of the transfer function from MT, as shown in Fig. 7. The first vibration mode was observed.

Table 3 Details of Measurement

	MT	FV
Unit of Data	Disp.	Disp.
Sampling Frequency	200Hz	200Hz
Duration	5min.	1min.
Points	60000	12000
Range	10mm	10mm
H.P.F.	0.1Hz	0.1Hz

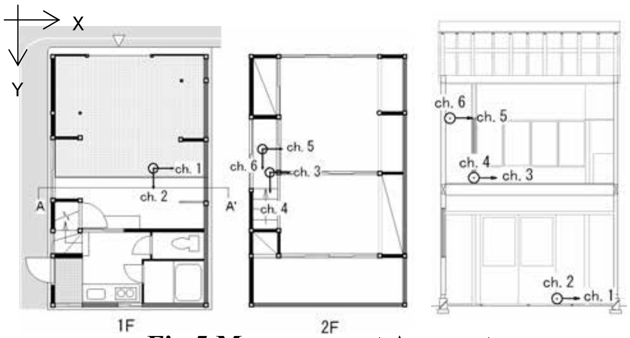


Fig.5 Measurement Apparatus

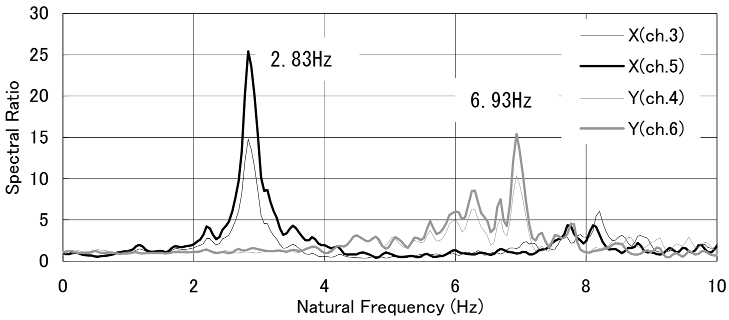


Fig. 6 Transfer Function of House B

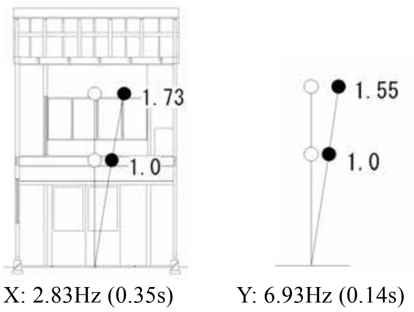


Fig. 7 Vibration Mode of House B

Table 4 Fundamental Vibration Characteristic

name	Direction	aspect ratio Y/X	Max Amplitude (mm)		Natural Period (s)		Damping Factor (%)
			MT	FV	MT	FV	
A	X	1.7	0.027	0.038	0.20	0.20	1.2
	Y		0.020	0.017	0.13	0.13	1.0
B	X	1.7	0.036	0.068	0.35	0.35	2.2
	Y		0.020	0.012	0.14	0.16	1.3
C	X	1.7	0.011	0.054	0.28	0.28	2.8
	Y		0.011	0.021	0.19	0.17	0.8
D	X	1.5	0.013	0.039	0.18	0.19	–
	Y		0.010	0.055	0.18	0.18	–

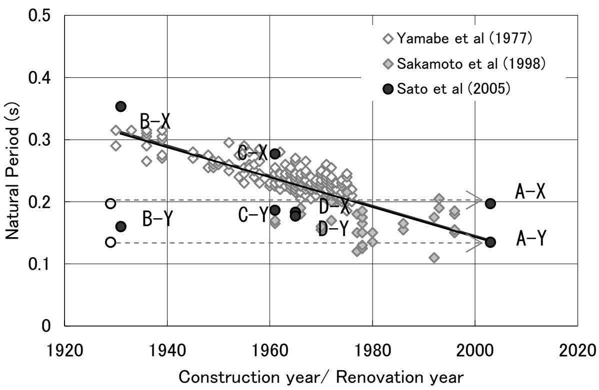


Fig. 8 Natural Period-Construction Year

4.2 Comparison with Previous Research

The target houses for microtremor measurement in previous studies were timber houses located in metropolitan areas, and the houses in the present study and those examined in previous studies are thought to be in similar situations. The results of the previous studies indicated that the natural period was inversely proportional to the construction year, as shown in Fig. 8. In the present study, the tendency of the natural period in the X direction was in fairly good agreement with that of previous research, if House A plotted at the year of renovation. However, in the present study, the natural period in the Y direction is approximately 0.15 seconds independent of the construction year. This difference is thought to be attributable to the aspect ratios of the houses.

5. Earthquake Response Analysis

5.1 Analytical Model

The target houses were modeled as one mass shearing model in the elastic region. These houses have two or three stories and were converted into a single-degree-of-freedom system, because only the first mode of the natural frequency was observed in these transfer functions. The conversion into a single-degree-of-freedom system performed based on the calculation method of response and limit strength. The parameters of the analytical model in the X direction are shown in Table 5. The effective mass (M_u) and the reference height (H_e) were determined from the results of the calculation method of response and strength at 1/120 rad. The equivalent stiffness (K_e) determined from the natural period of the first mode based on the microtremor measurement was found to be in good agreement with those of calculated stiffness of the sum of the stiffness of the shear walls.

5.2 Input Wave

The artificial earthquake wave was a simulated wave of engineering-bedrock motions for the 1923 Kanto Earthquake. This wave was used as the input wave as shown in Fig. 9 and was constructed based on the effect of the surface ground condition in the *Kanda* district. The duration time of this mode is 60 seconds. The maximum acceleration is 818 gal. The damping ratio is adopted as 5% as the proportional initial stiffness.

Table 5 X Direction Parameters

House	Weight*1 Mu (kN)	Height*1 He (m)	Stiffness*2 Ke (kN/mm)
A	84.7	4.44	8.80
B	154.2	5.03	4.97
C	287.3	5.13	15.08
D	167.5	4.78	20.20

*1 determined from the calculation method of response and limit strength
*2 determined from the result of microtremor measurement

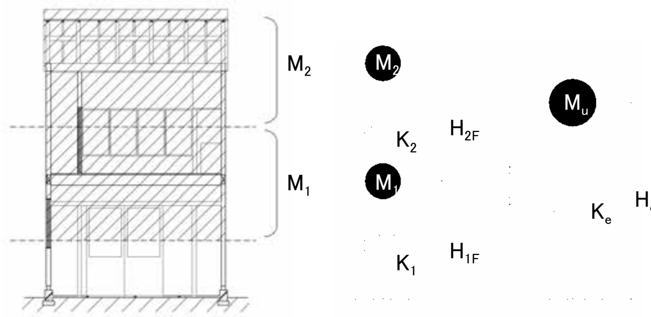


Fig.9 Model of Conversion

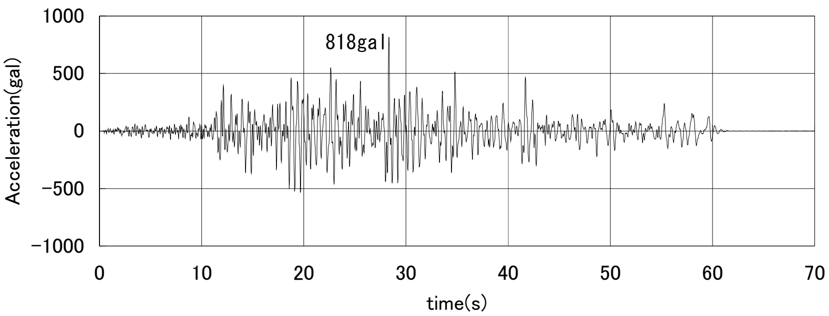


Fig.9 Input Wave for Analysis

5.3 Results of Earthquake Response Analysis

As a result of the earthquake response analysis, the maximum response displacement in the elastic region was obtained as shown in Fig. 10. The maximum response displacement ranged from 0.71 to 4.02 mm, as shown in Table 6. The displacement in the X direction ranged from two to five times that in the Y direction, except for House D. The reason for this is thought to be partially attributable to the fact that, except for House D, the aspect ratios of these houses were large. The simulated maximum displacement of House B in the X direction by this artificial wave was larger than those of the other three houses. The displacements in the Y direction of the four houses were similar.

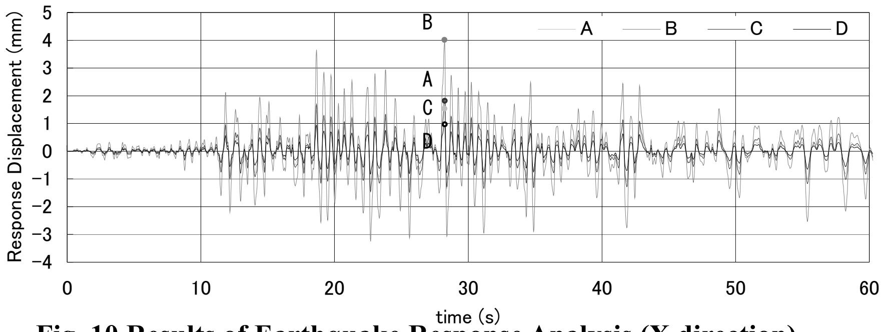


Fig. 10 Results of Earthquake Response Analysis (X direction)

Table 6 Max. Displacement of the Result of Analysis

House	Max. Disp.(mm)	
	X	Y
A	1.54	0.71
B	4.01	0.81
C	1.92	0.87
D	1.03	0.95

6. Discussion

6.1 Evaluation of Seismic Performance

In this research, seismic diagnosis, microtremor measurement and earthquake response analysis were performed. The results of the microtremor measurements and the earthquake response analysis indicate that the difference between the results for the X and Y directions is serious, as shown in Fig. 11. One side, in results of the seismic diagnosis, the difference between X direction and Y direction is small. Consequently, it was clarified the actual vibration characteristic (stiffness) of timber house is influenced by not only the structural walls but other non-structural elements.

Concerning the displacement in the X direction, House B was comparable to House A, which was constructed in the approximately same year as House B, the simulated maximum displacement of House B was larger than those of House A. With respect to seismic performance, House B was found to pose a danger, while House A posed minor danger. The reason for this was thought to be effect of renovation to House A in 2003.

6.2 Modeling for Analysis

With respect to an actual damage to a timber house caused by an earthquake, it is often observed that the destruction of a house was caused by large shear deformation of the first floor. In this research, the analytical models were converted to a single-degree-of-freedom system. The obtained results were thought to have fairly good agreement with the actual earthquake damage.

In the present study, the analysis examined small deflections in the elastic region. The equivalent stiffness was determined based on the results of microtremor measurements. However, the hysteresis characteristics of timber structure are nonlinear. The stiffness is dependent on the deformation. When examining the seismic performance of timber structures in the large deflection range, the nonlinearity should be taken into consideration.

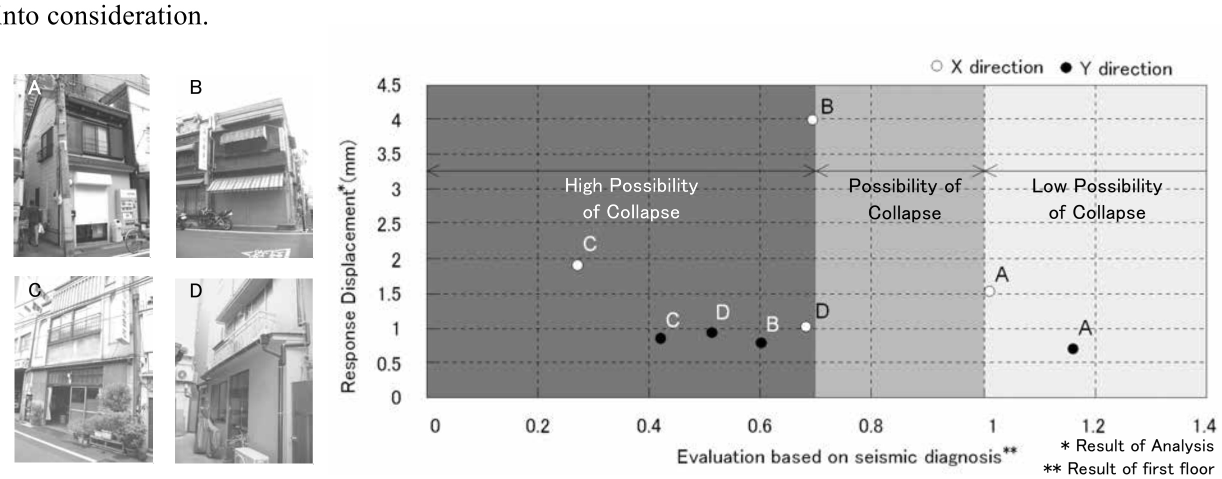


Fig. 11 Relationship between the evaluations based on seismic diagnosis and analysis

7. Conclusion

The seismic performances of urban houses were investigated in the *Kanda* district.

1. As a result of the earthquake response analysis, the response displacement of the subject houses ranged from 0.71 to 4.01 mm. The displacement in the X direction was scattered, and the displacement in the Y direction was approximately the same.
2. In the earthquake response analysis, the difference between the displacement in the X direction and that in the Y direction was found to be serious. However, in the seismic diagnosis, there was almost no difference between evaluation in the X and Y directions. Accordingly, the actual stiffness of timber houses is thought to be influenced by not only the structural walls but non-structural elements.
3. As a result of the analysis, with respect to the displacement in the X direction, comparison of House B and House A, which were constructed in approximately the same year, the simulated maximum displacement of House B was larger than that of House A. With respect to seismic diagnosis, House B was found to pose a danger whereas House A posed minor danger. The microtremor measurement evaluation of the two houses showed fairly good agreement with the result of evaluation by seismic diagnosis.

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References

Aiba, S. et al. 2006 Development of the methodologies to share the seismic risk information of building stock with community –The case study in central Tokyo where building stock is densely located -, Journal of Housing Research Foundation, No.32, 377-388

Baba, A. et al 2006 Study of seismic safety evaluation of existing wood houses in Kanda district, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, 263-264

Koshihara, M. and Sakamoto, I. 200) Seismic performance of wooden buildings in Japan, Japan-Taiwan International Workshop on Urban Regeneration 2005, 73-84

Manual of seismic design of timber structure using traditional timber building construction, 2004

Ohgaki, S. et al. 1988 Estimation of structural damage made by strong ground motion in the Odawara basin Part4. Microtremor measurements on shop, houses, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, Structure 1, 337-338

Sakamoto, I. et al. 1998 Study of dynamic characteristics of wood-framed house subjected to microtremor, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, 219-220

Takemura, M. 2003 the Great Kanto Earthquake of 1923

The book of the Building Standard Law, 2002

The Japan Building Disaster Prevention Association 2004 Seismic diagnosis and reinforcement of timber house

Suzuki, Y. et al. 1998 Dynamic characteristics of wood houses from microtremor observation, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, C-1, 221-222

Tsuji, Y. 2002 distributions of human loss, building damage, and seismic intensity in the central area of Edo (Tokyo) due to the Genroku Kanto Earthquake of December 31, 1703, Historic Earthquake, No.18 , 59

Usami, T. 1995 Distribution map of seismic coefficient in the Ansei-Edo Earthquake

Usami, T. 1996 Earthquake disaster in Japan

Yamabe, K. et al. 1977 Measurement of natural period of two-storied timber houses in Kawasaki-city, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, 501-502