A Study On the Correlation Between Construction Technologies to shorten the Project Duration and Environmental Impediment Factors in High-Rise Buildings

Dong Woo Kim¹, Jiho Park², Kyung Rai Kim³

¹ Dept of Architecture, Ajou University, Suwon, Korea, 443-749
² Dept of Architecture, Ajou University, Suwon, Korea, 443-749
³ Dept of Architecture, Ajou University, Suwon, Korea, 443-749

¹ ioluhk@hotmail.com, ² adonija@paran.com, ³ kyungrai@hotmail.com

ABSTRACT

The recent trend for more technologically complicated high-rise buildings causes unprecedented environmental damages to the neighbouring properties and public streets. Moreover, the air quality in South Korea, which is already worse than those in the other developed countries, are being affected negatively from the increase of CO₂, noise, air pollution and wastes from the elongated project time shortening. Subsequently, the public agencies have been experiencing the continuously increasing amount of the environment-related complaints from general public. In lieu of this recent trend, this study aimed to analyze the time shortening elemental technologies associated to the structural construction and final finishing construction from various foreign and domestic case studies. This study product intends to match these elemental technologies to the possible environmental hazards to probe further the potential outcomes out of these combinations to be utilized as a basis for environmental-friendly elemental technology development.

KEYWORDS:  Time shortening, Project Duration, High-rise Building, Elemental Technology, Environmental impediment Factors

1. INTRODUCTION

1.1. Background and the purposes of this study

Recently, the combination of rapid urbanization and increase of land value has led denser development patterns in Korean cities. To respond the challenges from the lack of development in the urban core and to attract more efficient use of the urban land, high-rise buildings became quickly popular. The momentum for skyscrapers appeared in the United States in 1930s first, and now is widespread all over the world, including Asia and Middle East after 1990s. Korea has not been an exception from this trend; the high-rise buildings are quickly increasing in the areas like mixed-use development buildings. However, the surge of public complaints have increased from these high-rise construction work sites, mainly due to the lack of work space, noise, vibration, dust and traffic congestion. (Korea National Housing Corporation, 1997) Urban areas tend to be more negatively affected from these pollutions, and it is believed that Korea’s global competitiveness might be impeded out of the adverse impacts from the public opposition, elongated project time shortening and increased construction costs.

Given the contemporary trends for construction time shortening, this study project has aimed to produce an outcome which includes the foreign and domestic case studies with construction technologies for project-time shortening in high-rise building projects. Also, the potential
environmental impacts from these construction technologies were another main theme of this study project.

1.2 The scope and methodologies of the study

This research project analyzed multiple foreign and domestic high-rise projects, which could reduce the project time shortening than the comparison cases. These cases included commercial-residential mixed use condominiums, office-residential mixed use condominiums, and residential condominiums. The reduction of the project time shortening was measured in terms of the frame construction and final finishing construction by actual job site data. The correlation between the introduced time shortening construction technologies and environmentally impediments were further analyzed.

2. ASSESSMENT OF CURRENT TRENDS OF HIGH-RISE BUILDINGS

2.1 High-rise buildings within and outside of South Korea.

An analysis for the high-rise buildings with at least 40 floors indicated that there are 2,056 high-rise buildings are either completed, under construction or in planning phase. In particular, there are five Asian countries in Table 1, which is the top 10 list with the most high-rise buildings in the world as of now. (Chang Yong Jeong et al. 2005)

To stand alongside with this current trend, the demands for such high-rise buildings continue to expand. In specific, these high-rise buildings should be one of the most attractive alternatives to South Korea, a country with a desperate necessity to maximize the efficient use of land. In addition to all of these, high-rise buildings are considered as environmentally friendly because it prohibits the cities...
from being sprawled, and they are quickly becoming more available for the hollowness in the inner cities. (Hae-Seong Je, 2006)

2.2. The needs for the project time shortening for high-rise buildings.
In spite of the recent changes around construction industry, the same 10 to 15 days project time shortenings are still effective for the frame construction works to complete a floor in Korea. Unlike to Korean examples, project time shortening per floor in the developed countries typically take no more than two to four days. Also, the number of complaints out of the elongated project duration tends to increase as more days are required to complete the job. The reduction on the project time shortening can bring many advantages not only economically but also environmentally. These are the necessities to create innovative alternatives to the construction period shorter than they are now. (Korea Concrete Institute, 2000)

3. ANALYSIS ON THE PROJECT TIME SHORTENING AND THE ENVIRONMENTALLY IMPEDIMENT CASE STUDIES FROM DOMESTIC HIGH-RISE BUILDING PROJECTS.

This section has assessed the case studies of the project time shortening from the high-rise buildings and has analyzed the construction technologies behind the time shortening and the correlation between those technologies and the environmentally impediment factors.

3.1 Case study

Five different high-rise building sites have been selected for case study purposes in terms of the project time shortening. These five cases include both Korean and foreign projects; four of them were SRC, while the remaining one is RC. Analysis on the construction technologies for the project time shortening has been made on the basis of the actual data from the corresponding sites.
Table 2. Summary of Case study

<table>
<thead>
<tr>
<th>Category</th>
<th>Type</th>
<th>Construction Technologies to reduce the project time shortening</th>
<th>Frame work cycle</th>
</tr>
</thead>
</table>
| T Site         | Apartment and stores  | · PFP (Pre Fabrication Piping) technology  
· N-technology  
· Materials available by unit and system  
· Half PC  
· Construction process (Pre-built, Pre-Fabrication)  
· RCP technology  
· High-strength concrete, Super-flexible concrete  
· Introduce TACT project management process technique  
· Introduce the mixer car control system  
· Lift-Up technology  
· Logistics systems with the internet and bar code.  
· Core wall framework system form (ACS Form and Slip Form) | 3 day-cycle |
| I Site         | Apartment House       | · CPB (Concrete Placing Boom)  
· Sky-Deck  
· ACS (Auto Climbing System) form  
· Al. curtain wall  
· Pre-fab, coupler  
· High-strength concrete  
· TFT (Task Force Team) | 4 day-cycle |
| B Site         | Apartment and stores  | · Core wall framework system form (ACS Form)  
· Preassembling  
· Hi-strength concrete  
· Lift-up method  
· GPS measuring system  
· Shuttle Hoist Car  
· High-speed, mass storage crane  
· Run parallel with direct pumping and re-pumping | 3 day-cycle |
| S site         | Office                | · Lean construction  
· Early dismantle lift car  
· Early start of curtain wall  
· TACT  
· Early start of Interior  
· Early start of elevator | 6 day-cycle |
| W Site         | Office                | · Semi Top-Down method  
· Preassembling  
· PFP (Pre Fabrication Piping) technology  
· Unit Floor construction plan  
· Non Supporting Top Down technology  
· Unitized system | 4 day-cycle |

From these five case studies, high-rise building technology used in reducing project time shortening can be summarized as: using of high-strength concrete; pre-assembling of reinforcing bars; systemized cast; equipment planning; planning on electricity, mechanics, and elevators. In terms of environmentally impedimental factors, waste and noise level that were generated from construction procedure were studied based on policies relevant to environment-friendly construction. Then the impact of construction technologies to shorten the project duration on waste, noise level, and air pollution were analysed.
4. CONCLUSIONS

This study analysed five cases of high-rise building project time shortening, focused on structural and finishing construction, and drew conclusion on construction technologies necessary in reducing project time shortening. In addition, environmentally impending factors were derived from laws and policies related to environment-friendly concept. Following is the summary of construction technologies that can be used in project time shortening as well as each of their impact on environment.

(1) Using high-strength concrete- High-strength concrete was used in all five high-rise construction sites. This is the crucial and essential technology that should be incorporated in constructing buildings with 100 or more floors. High-strength concrete reduces surface areas of columns and walls as its strength increases, and shortens project duration by reducing cure period. Moreover, from environment perspective, it creates powerful effect in reducing the amount of waste by curtail the usage of waste materials including concrete, metal, oil and wood. Concrete casting technologies like CPB and high-pumping enduring plumbing are recommended for the concrete casting process for the high-rise buildings to reduce the project duration.

(2) Using System form – Core walls in high-rise structures use ACS form and Slip form so that their convenience in assembling, disassembling, and transportation will reduce the project duration. In addition, this technology increase diverse use and recycling of materials, which will reduce scattered dust, noise, vibration, and waste materials including wood, metal and oil.
(3) **Hoisting plan** – Finishing project duration was shortened by an early dismantling of heavy lifting equipment, such as a crane, along with early outset on finishing construction of exterior wall, curtain wall for example. Curtailing the usage frequency and early dismantling of heavy equipment had positive impacts on reducing noise and scattered dust.

(4) **Pre-Assembling of Reinforcing Bars** – Reinforcing bars for retaining wall or columns can be assembled on the ground, lifted up with T/C, and installed at once. This process shortens the project duration while increasing the level of details in construction. Compared to the traditional method, pre-assembling method decreases the frequency of the use of lifts and results in less noise and dust during construction.

(5) **Electricity, mechanics, and elevator construction** – After completing structural construction, final finishing construction begins as quickly as possible. Early operation of elevator led to early dismantling of exterior piping so that exterior finishing construction can be completed as quickly as possible. In terms of facility, overhead plumbing was unitised by utilizing PFP technology, produced in a mass from factory, installed in a short time, and therefore resolving lack of working and storage space which is a common issue arising in urban construction site. This unitised plumbing system also decreased welding frequency as well as the material storage space and resulted in reduced negative environmental impact.

As described above, time shortening construction technologies are effective not only in shortening the project duration but also reducing environmental impact such as waste, noise, and vibration. Although some elemental technologies mentioned in this study might possibly be beyond the reality of current situation, the importance lies on more of incessant effort for reform and innovation than other advanced countries.

This study presents a problem of limited sources, which include only five cases of building site. Further study on the subject requires in-depth research on project time shortening construction technologies with environmental concerns based on more abundant case studies.

**KNOWLEDGE**

This work was supported by Sustainable Building Research Center of Hanyang University which was supported the SRC/ERC program of MOST( grant R11-2005-056-03005-0)

**REFERENCES**


Seon-Ok Im,2005 “Sk telecom euljiro building construction place” p49-52

Han-Soo Kim,2006."The Process of Planning and Developing Enviroment -Friendly Projects-I.PARK Samseong-dong Case” p87-90


Jin-Soo Kim, “Present Domestic Condition of High-rise Mixed-Use Buildings”, Samsung Engineering & Construction” Architecture & Urban Research Information Center p34-38-

Samsung Corporation Construction Department, 2002 “Report on the Task to Reduce the Construction Duration by 30% -- Samsung Life Soo-Song Dong Residence Site” p9-25