

A flexible topfloor system with integrated heating and cooling for the Infra+ floorsystem



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ABSTRACT

Adaptability and flexibility are frequently used but not well defined terms in the building industry. Due to the complexity of the building process and the wide variety of people and interests, adaptability and flexibility have different meaning and value for the different participants in relation to comfort and financial aspects. Therefore we determined that the starting-point is that “flexibility must not be a option but has to be a standard feature of a building component at no or little additional cost”.

This has been the main goal of designing a top floor for the Infra+ floor.

The design has been divided in several stages:

- The SlimBouwen[®] philosophy was used to define a design strategy for building products
- The Infra+ floor system is one of the existing products that fits very well the SlimBouwen[®] philosophy but does not completely fulfill all criteria. This is mainly due to the fact that the existing top floors for Infra+ do not meet the expected adaptability and flexibility standards, especially when heating and cooling need to be integrated.
- The defined design strategy led to a completely new design of a top floor which integrated heating and cooling.

The new top floor is based on the SlimBouwen[®] philosophy of prof. dr. ir. J.J.N. Lichtenberg from the University of Eindhoven. This philosophy states among others that the nowadays building industry is very conservative, inefficient with space and materials, produces lots of waste and that innovations are mainly based on “Innovation by Addition”. Designing a top floor system for the Infra+ floor according to this theory proves that a highly flexible and adaptable system is possible and, not necessarily an option but can be a standard feature of the product at competitive cost.

SlimBouwen[®]

Slimbouwen[®] is not a building system, but “an integral view on building and possibly a system of agreements and guidelines at strategic level” [Lichtenberg, 2005]. SlimBouwen[®] aims particularly at the following aspects:

- Flexibility and comfort (People);

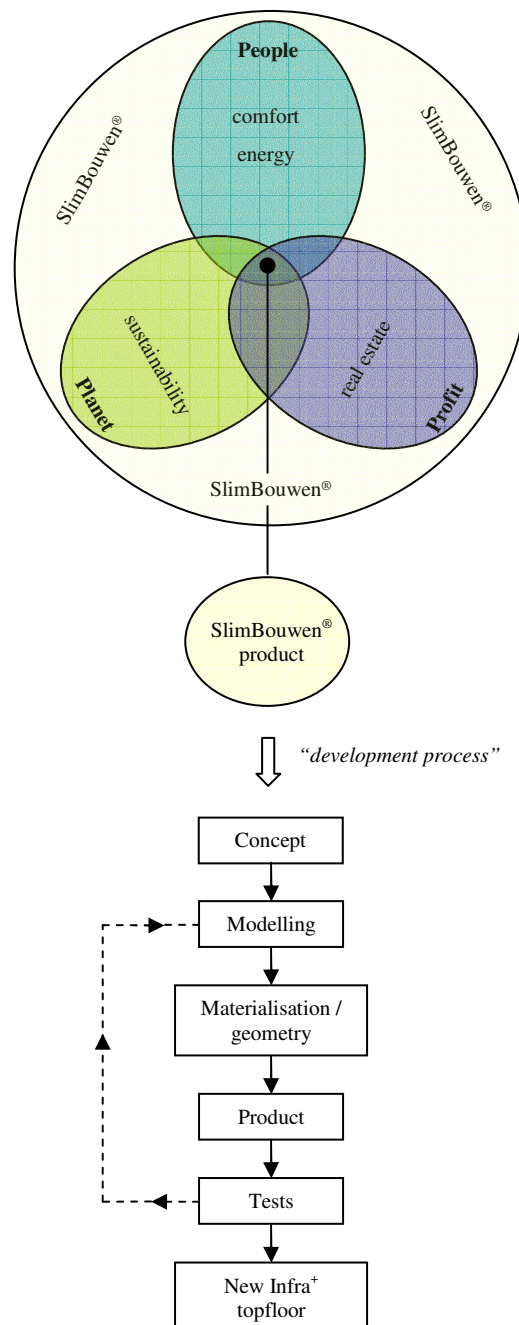
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- Reduction of waste, energy saving and emission of CO₂ (Planet);
- Efficiency (reduction of failure costs, weight saving, reduction of volume, gain of construction time by reorganisation of the construction process)(Profit)

Moreover it is important that adaptability and flexibility are embedded into the design, so that when user requirements are changing, the building can anticipate to it, both on the level of ‘support’ and ‘infill’.

Instead of Innovation by Addition, the following approach was used:

SlimBouwen[®] is a philosophy which can be used as a guideline for designing building products that, have standard features like flexibility and comfort and, which were designed from an *integral* point of view. For example not only the user or constructor are regarded as main users but also the building process and the end users comfort and flexibility are taken into account.



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Background on the design method for product development in the building industry according to SlimBouwen Strategy

In the last decades the tendency has arisen in the Netherlands to deal more carefully with the available land/space. In this context the Dutch government has taken measures to use land optimally by means of multiple and intensive space usage (MIR). Primarily MIR has been meant as an instrument for building and investing in urban area with as objective optimum use of available ground.

This means explicit that on the available ground housing space is created, which is not function-tied. I.e. the space is suitable for numerous application and possibilities without high investments when the function changes.

This requires naturally creative solutions of architects and builders, but also of investors.

Investors have one goal and that is maximum output on own capital.

The output on a property investment is a combination of direct output arising from direct net turnovers and indirect output which is the change in value of the property investment. Both, direct and indirect output are influenced by the mechanism of supply and demand. Space, for which no tenant has interest, remains without rental incomes and therefore without positively direct output. The same applies to real estate, which is not let or can be let. This has a lower value then real estate that is long-term let.

However, it must be taken into account that the location of the present real estate has a substantial influence on the value appraisal; a building due for demolition on own ground in the center of Amsterdam has a significant higher value then a similar object on the country side.

Investors have been therefore interested in real estate, which is readily marketable and is well located.

The foundation is in fact laid for a number of investment risk to overcome; vacancy and value development.

The Dutch society is continuously developing; the population increase continues to persevere, the need for living space per person increases steadily and the demographic composition of the population modifies, etc...

This development has unmistakably its repercussion on the Dutch real estate market. Looking at the current Dutch office market, one deduce, that there are approximately 200,000 employees necessary to fill the current vacancy in the offices. To this subject several studies have been dedicated, which do reflect unmistakably that this problem cannot be solved on short term.

Unfortunately a large number of office buildings have been build for a fixed function. This leads to restrictions with respect to function conversion, on account of the applying land-use plans and the tight Dutch laws and legislation. Due to this, owners of office premises are faced with structural vacancy and a lot of insuperable considered problems like investment results.

Aforementioned developments ask for another approach and interpretation of the real estate market. From numerous sectors we know the phenomenon, in which production resources are deployed as a company means and are as such also managed. Anticipating on the market requires coordination of the production resources and the interpretation of this market needs. Financial modifications and/or developments in the market are taken into account from the start.

Eversince, the real estate market has used traditional building methods to interpret and meet the current market needs without anticipating on future changes in the market needs. Housing constructions are still made from poured concrete structures or stacked constructions, offices are mainly realized by means of concrete elements - columns, beams and floors - and curtain walls. All these construction methods lead to buildings without considerable flexibility to provisions.

The choice for new innovative construction methods, which create flexibility and quality in buildings, united with ingenious financing methods, offer investors for the future less score risk and a more positive value development of their well portfolio. Investors, however, have to be prepared to leave the conventional out-of-date manner of building. Only in this way the space arises for new construction concepts, which simply can anticipate on future market developments.

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In times of high dynamics in the use of spaces (housing/offices), it appears that function-tied buildings can anticipate on the requirements and demands of the user/investor. The requirement for flexible construction systems originates from non function-tied building and the resulting requirements and demands. Flexible construction systems have the advantage that modifications in the design, implementation, and use stage modifications can be processed until a late stage.

Within these flexible construction systems floors have a distinguished role. This is due to the large quantity piping which is present in the floors. Choices which are made, in whatever stage of the construction process or use phase has thus, generally have large consequences for existing piping and therefore for the floors.

A solution for the piping problems in the floor can be found in constructive flexible piping floors. These floors ensure a separation of the constructive function and the piping installation. The constructive flexible floors have been designed in such a way that the piping at each stage of the process (design, implementation and use) can remain accessible. A good example of a constructive flexible control floor is the Infra+ floor (supplier: Prefab Limburg).

With the development of such constructive flexible control floors one problem has been solved, but leads ensures directly to a new problem. All constructive flexible control floors which are available on the market, are not the result of an integral approach. This has led to semi-finished products, which still must be provided with a top floor. The current generation of top floors do not meet all boundary conditions and requirements of the underlying semi finished product (constructive flexible floor). As a result of that, the advantages of the constructive flexible floors cannot be used.

The new top floor is based on the SlimBouwen[®] philosophy of prof dr ir J.J.N. Lichtenberg from the University of Eindhoven. This philosophy states among others that nowadays the building industry is very conservative, inefficient with space and materials, produces lots of waste and that innovations are mainly based on "Innovation by Addition". Designing a top floor system for the Infra+ floor according to this theory proves that a highly flexible and adaptable system is possible and, not necessarily an option but can be a standard feature of the product at competitive cost.

With the newly developed top floor, installations are easy accessible in the constructive floor. Necessary changes in the installation structure due to function changes of the building are easy to achieve. The accessibility and pattern of the installations is no longer connected to the function of the building.

The newly developed top floor is a result of the optimum flexibility in combination with low temperature floor heating/refrigeration.

The flexibility of the top floor ensures a longer life span of the building. Changes in relation to the control course can be achieved easily. By the detaching the accessibility of piping from the building function an important cost factor is controlled.

In other words, function free buildings with integrated heating and cooling are made possible by this top floor (in combination with constructive flexible floors).

The presence of low temperature floor heating and high temperature cooling, has big advantages, like for example healthier indoor climate. Furthermore, the advantage of the building users is the lower usage costs for such a system in comparison with a traditional system (radiators).

The substantial extra value for the investor and user by the application of the new developed top floor, is therefore gained by combining low-energy heating/cooling with optimum flexibility. Because of this, shifts in the market which lead to function changes in buildings can be caught by the flexibility of the top floor with conservation of low temperature heating/refrigeration. This can be realized without many incremental costs for the investor or user.

The constructive Infra+ floor system

The Infra+ floor system (see figure 1) was one of the first products that resulted from SlimBouwen[®] philosophy.

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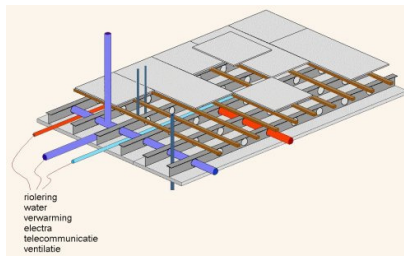


Figure 1. A schematic overview of the Infra+ floor system, which is standard to facilitate installations at a high flexibility and adaptability level

Method

In the current Infra+ floor system, its flexibility can be limited due to the currently used top floor systems. Especially if floor heating is desired, the top floor is mostly constructed as an anhydrite top floor, which is heavy and not flexible. A flexible top floor system with integrated heating and cooling was not available for the Infra+ floor up till now. Therefore, de SlimBouwen[®] approach has been used to define a design strategy for building products and as result a new top floor was developed.

The development stages are:

- idea to concept
- from concept to laboratory product
- from laboratory product to industrial product.

The following topics were regarded while developing a concept and a product:

- flexibility (fully)
- low temperature heating ($T_{\text{water}} 35 \text{ }^{\circ}\text{C}$) and high temperature cooling ($T_{\text{water}} 18 \text{ }^{\circ}\text{C}$)
- thermal comfort aspects for the user (no radiation asymmetry)
- thermal comfort in relation to the heat demand of the building (less air movement)
- costs of production and installation (cost comparable with traditional equipment without flexibility)
- construction strength, weight and height (according to legalization)
- fire resistance (depending on building function)
- labor legislation (< 20 kg. per tile)
- installation requirements (accessibility)
- acoustics (according to legalization, extra: SlimBouwen[®] demand on low noise radiation)

Results

The evaluation of these topics have led to a concept which, could be materialized into a laboratory beta product by choosing appropriate materials. In the concept stage, no choice of material was made or required. By calculations and research several appropriate materials have been chosen and adequate material dimensions have been calculated. This has led to the newly designed top floor which meets most of the requirements of the SlimBouwen[®] philosophy and the People/Planet/Profit requirements.

A detailed picture of the newly developed floor cannot be shown due to the patent procedure. Figure 1 is an impression of the existing infra+ floor with the newly developed top floor.

The use of the SlimBouwen[®] philosophy as a design method for product development in the building industry has proven to be highly effective and resulted in the newly developed top floor.

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