CONSTRUCTION OF A PROTOTYPE OF AN INDUSTRIAL, FLEXIBLE AND DEMOUNTABLE (IFD) APARTMENT BUILDING SYSTEM

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Abstract
In the framework of the Sustainable Construction Program the Dutch government wishes to support the development and use of IFD Building Technology, which is considered to be a potentially successful integral construction concept. In the context of this program two industrial partners, a large building owner and the Eindhoven University of Technology are developing an IFD system-concept for the construction of multi-storey apartment buildings. The project has been awarded with a substantial subsidy of the Dutch government. Prototype testing is carried out in the ‘DUBO-park’ (Sustainable Building Park), a special testsite on the premises of the Eindhoven University of Technology.
The paper describes the principles of IFD Building Technology, the research-program of the IFD Apartment Housing Project, the objectives of prototype testing and experiences during construction of the prototype.

Key words: Industrial, flexible, demountable, IFD, Building Technology, sustainable Construction, integrated Design, prototype construction

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Introduction

For quite a long time the objective of the Dutch government was to stimulate energy conservation. The result of this was that in the Netherlands the energy saving no longer should have the highest priority. In the framework of sustainable construction the most important judgement tool is life cycle assessment (LCA). In respect the following environmental criteria are used:

- emissions (aquatic and airborne);
- waste;
- energy consumption.

Specifically looking to "waste" we may observe that life cycle assessment is a bit awkwardly expression. After all, with building materials only very seldomly there is a closed cycle. In the present building practice from an environmental point of view waste is a much bigger problem than energy consumption. Usually this is related to the construction phase of the building. During the construction phase the amount of waste still is about 10% of all the used (and paid) building materials. Also during the course of life of the building, materials are "produced" in a relatively short period. This is a problem that does not allow for the waste problem, on the other way around, to be solved. Therefore, we would find a substantial solution for the waste problem, if we would have a substantial solution for the energy consumption. A good contribution to this solution is "Industrial, Flexible and Demountable (IFD) Building Technology."

IFD technology.

Important aspects of IFD technology are:

- flexibility in the design phase means for example that the developer of the building can wait until the last moment with final decisions about the lay-out of floors;
- demountable also means that reuse or at least recycling is possible;
- perhaps IFD technology can mean: less construction (in general).

Design criteria.

For the design on changeability the following criteria could be used [Hendriks 99]:

- Integration and independence of disciplines;
- supporting structure;
- building envelope;
- interior finishing.
board and installation
closed-formed and open profiles. The element is on both sides covered with a system of EPS foam.
The other example is given in Figure 2. This is a full steel framework consisting of so-called
system is covered with dry casting on elastic supports to obtain good acoustic quality.
The underside of the elements consists of concrete strips connected to steel I-beams. This

![Diagram of INFRA+ Floor System]

Figure 1 INFRA+ Floor System

Figure 1 shows the principle of the INFRA+ Floor System [Zanden 98], developed from the
The examples are limited to two housing concepts, because of the limited length of the paper:
the need for IFD solutions already has resulted in a host of new developments.

Some examples of IFD technology:

- Interior finishing (highly finishable and modular)
- Building envelopes (insulated and modular)
- Insulation (precast concrete)
- Supportive structure (structured)
- Changeability on all aspects:
  - Assembly instructions
  - Quality system design
  - Demountability
  - Functionality
  - Maintainability
- Prototyping, designing and
  - Core attention to design work
- Perfect modular means

- No in situ prefabrication
  - No asbestos
  - No plaster
  - No screed floors
  - No mortar joints
  - No in-situ concrete
- Completely dry construction method, which means:
Figure 2. SADFE floor system.

The SADFE floor system is designed to support the weight of the building and provides a stable platform for the floors above. It comprises precast concrete elements that are easily installed and can be adjusted to fit the specific needs of the building. This system is particularly useful in high-rise buildings where traditional construction methods may be less efficient or costly.

The SADFE system is also adaptable to various architectural designs, allowing for creative and innovative floor layouts. It can be easily integrated with other building components, such as walls and roofing systems, to create a cohesive and functional structure.

Overall, the SADFE floor system offers a cost-effective and efficient solution for modern construction projects, providing a durable and reliable foundation for the development of new buildings.
shown in Figures 4 and 5. The project is to develop two different basic prototypes for the housing concept: These are shown in Figures 4 and 5. This is also investigated by prototype testing, which will also be used for further research and evaluation. After evaluation of the research prototypes a real prototype will be built for amounts in prototype testing. The requirements on real transfer, manageable connection of thermal bridges and the requirements on real transfer, manageable connection of thermal bridges and building physical aspects. The requirements on real transfer, manageable connection of thermal bridges and building physical aspects. The requirements on real transfer, manageable connection of thermal bridges and building physical aspects. The requirements on real transfer, manageable connection of thermal bridges and building physical aspects.

The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing. The University of Liège's Centre for the Development of Structural Research (CERS) has a long experience with building prototypes, especially in the design of innovative and experimental research with the use of simulation and structural testing.
Pictures show the construction process. By building the test module, industrial building aspects are applied on real site, some

3. Independent subsystems.
2. Flexible production systems.
1. Clean driven production and marketing.

Today's industrial building means:

5. Application information technology
4. Collaboration independent of one project
3. Mass production
2. The production is mechanized.
1. The production takes place in the factory.

Industrial building traditional means:

Construction of the prototype

- Demountability
- Technical performance
- Amount of waste, target (zero)
- Sound insulation properties
- Adaptation characteristics of the housing concepts
- Mountability

The first test phase will be concentrated on the following aspects:
For the degrees four different wall concepts are selected.

Figure 6: The test module situated on the DUBO-Park.

The concepts are tested in the DUBO-Park (Sustainable Building Park), a special testing

Figure 4: Van Damm roof system with one cold formed profile.
Table 1: The assembly of the test module in Eindhoven.
Conclusions

Information to be applied on a real-life pilot project.

The IPE TOP research program for apartment buildings will provide for detailed
environmental criteria concerning straw bale and timber facades. Simultaneously, there is a positive effect on the
production of building components and the actual construction, thus also during the course of
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References

Bouwadviesron, June 1996, in Dutch.

Zandberd, C. van den: „Flexibel bouwen met constructieloos gesysteem”, De


Heinrikans, N. en G.P. Jacobs „Industriëel Flexibel en Demontabele Bouwen

Bouwtechniek, 1996, in Dutch.

Jacobs, G.P. „Het ontwerpen van een verstaande bouwboek op een

Landoon, 1996, in Dutch.