

Zukunft Bau

SUMMARY REPORT of research project

Date 17/06/2016

Title

Infra-Lightweight Concrete in Multi-Story Residential Buildings (INBIG)

Motive/ Background

The project „Infra-Lightweight Concrete in Multi-Story Residential Buildings” (INBIG) was initiated to investigate the architectural and structural potential of Infra-Lightweight Concrete for its application in multi-story residential buildings. The aim was to support the implementation of this insulating and load-bearing high performance lightweight aggregate concrete in today's construction market.

Contents of the research project

The project includes five work packages over a period of 24 months.

Work package 1: Background and literature research (2 months)

The background research and review of relevant literature was carried out to collect and review existing information, to transfer knowledge and to investigate existing and planned reference buildings. The results were summarized in a separate report.

Work package 2: Designs of characteristic building types (6 months)

Six characteristic designs for real sites in the central city area of Berlin were developed taking into account the specific properties of ILC. Four typical multi-story residential buildings were considered: point block, linear block (Zeilenbau), perimeter block and vacant lot. The task was to develop one or two designs for each type. The close cooperation between architects and civil engineers was especially important to incorporate the specific requirements resulting from the material's properties during the different stages of the design process. Based on selected lots in Berlin, the following six designs were developed:

- 2x vacant lot: Kantstraße 126, Kantstraße 128, Berlin ([Figure 1](#))
- 2x linear block: Alte Jakobstraße, Kracauer Platz, Berlin
- 1x point block: multi-story reference building as basis for setting up a parameter matrix (no lot)
- 1x point block: high-rise tower in Berlin-Mitte
- 1x point block: city mansion, Stavanger Straße, Berlin

Due to its specific properties, such as the dry density below 800 kg/m^3 , Infra-Lightweight Concrete is not regulated by the Eurocode 2. Hence, some modifications of the design regulations and special considerations of topics such as durability, fire protection, sound insulation, or long-term deformation are necessary. As a basis for the characteristic designs, the

existing knowledge about various properties of ILC was summarized and illustrated and procedures how to handle these properties during the design process were proposed.

Work package 3: Structural detailing (6 months)

In this phase, structural details which require special consideration when built in ILC, such as window details, connections of balconies or slab/wall connections, were identified and developed. Some specifically representative details were selected for the production as prototypes (Figure 2 and Figure 3) during the next phase. In addition, thermal simulations and thermal break analyses were conducted to evaluate and optimize the developed structural details.

Work package 4: Construction and testing of prototypes (6 months)

At this stage the selected prototypes were planned in detail and built at a 1:1 scale. During the process, different concretes mixes (Figure 4), formwork panels, reinforcement materials and construction methods were used. Some prototypes were subsequently tested regarding their load-bearing capacity (Figure 5) and moisture absorption. Additionally, experiments were carried out using small scale samples to determine further properties such as water vapor diffusion, water penetration depth, freeze-thaw resistance and shrinkage. Also, practical aspects like the most appropriate formwork panel material, limits of free fall height during concreting or time limits for stripping were investigated.

Work package 5: Summary and conclusion (4 months)

The results were summarized and areas described where further research is needed.

Conclusion

The project was successfully completed in the planned time frame. The results showed that multi-story buildings using monolithic walls of Infra-Lightweight Concrete can be realized within the framework of today's energy regulations in Germany. Due to its inherent freeform potential with respect to surface treatment, shape and structural capacity the architectural potential of this material is much higher than that of the common thermal insulation composite systems with multiple layers. With ILC, simpler technical solutions concerning joints can be put into practice and thus the building's complexity can be reduced, while durability, sustainability and robustness of buildings are increased.

It is planned to publish the gained knowledge about the possible application range of ILC as a handbook to support clients, architects, engineers and construction companies when using ILC in practice.

Facts

Short title:	INBIG
Research staff:	Dipl.-Ing. Dipl.-Wirt. Ing. Claudia Lösch, Dipl.-Ing. Architekt Philip Rieseberg
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PICTURES:



Figure 1: characteristic design Kantstraße



Figure 2: prototype 1, facade element



Figure 3: prototype 3, ILC balcony



Figure 4: prototype 2, window element, ILC with a dry density of 800kg/m^3 (left) and 600kg/m^3 (right)

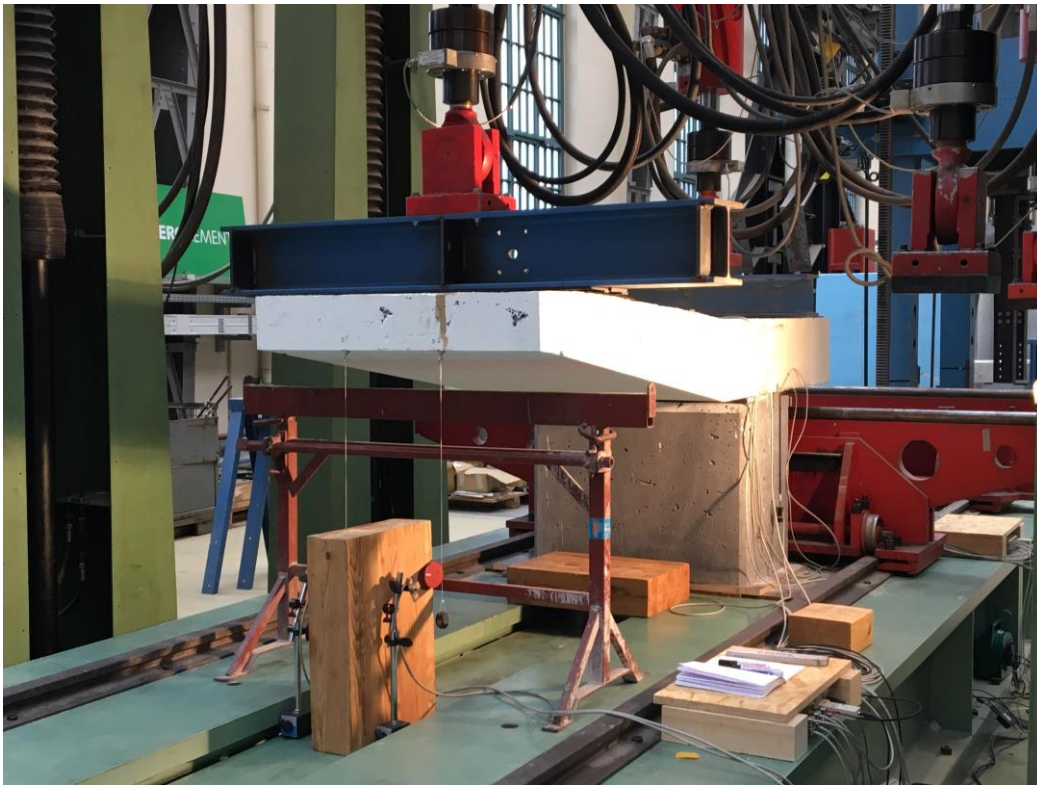


Figure 5: testing of prototype 3 with respect to load-bearing behaviour under bending