Karlsruhe Institute of Technology

IMB KARLSRUHE

Institute of Reinforced Concrete and Building Materials
Department Reinforced Concrete

Adaptive Modularized Constructions Made in Flux: Precise and Rapid Building (DFG SPP 2187)

Intelligent Modularization for Scalable Concrete Construction by Adaptation of the Methods for Modular Construction Development

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1. Motivation and Objectives

Modular construction methods make it possible to standardize products and processes in component production. Furthermore, this construction method additionally forms an important basis for exploiting economies of scale with differing building sizes and types. Ultra-high performance concretes with carbon and textile reinforcement make it possible to construct buildings that are more durable and additionally represent an economical and ecological alternative to regular reinforced concrete. The aim of the joint research project is the transfer of the methodical concept of construction kits and basic development from the field of mechanical engineering to civil engineering as well as the investigation of the ultra-high performance concrete components of the kit and the zero tolerance dry joints between them. Standardized modules can be produced efficiently and subsequently mounted on the construction site in a time and cost-effective manner [1].

2. Approach

The segmentation process considers skeleton construction (Fig. 1), which delineates a high flexibility in plan and elevation as well as an ideal construction type for the implementation of construction kit structure. The focus of the research project on part of the Department of Reinforced Concrete, Institute of Reinforced Concrete and Building Materials (IMB) is the development of a basic concept for the construction of rigid frames by using construction kit modules and series. The prefabricated elements are braced by implemented tendons, which form an entire support structure.

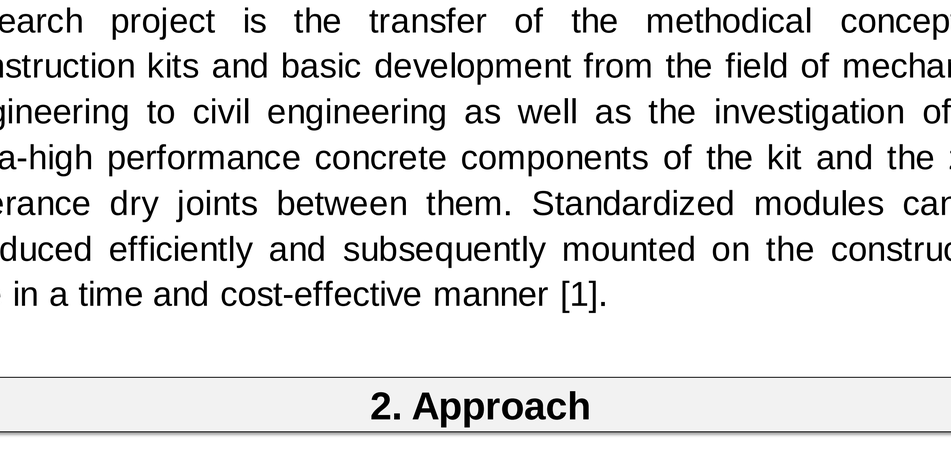

Figure 1: Skeleton construction (left), modules and variants (right)

Hereby the questions arise, how to ensure the static requirements for the force transfer in the zero tolerance dry joints, the standardized design of the interfaces between tendon and component, the correct implementation of the textile reinforcement within the component and the segment dimensioning of the high-performance components.

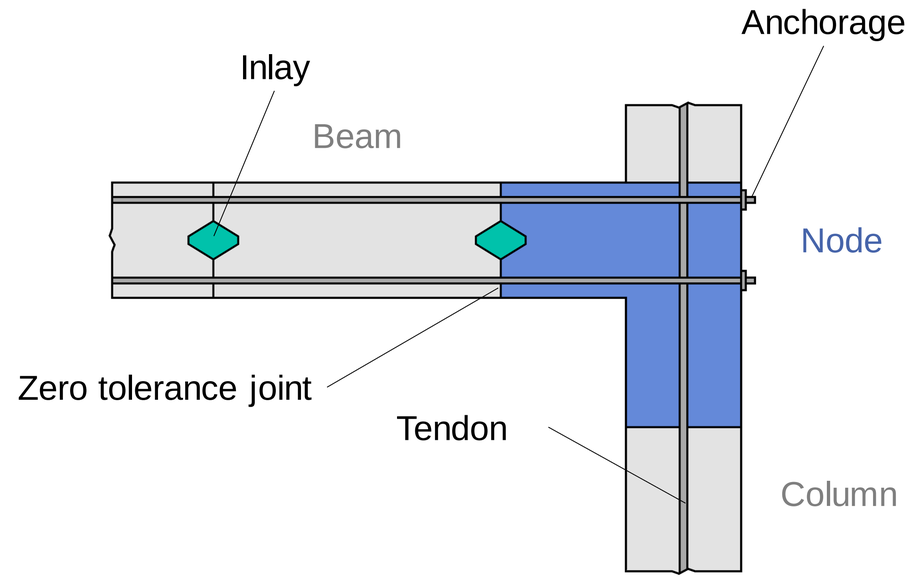

Figure 2: Schematic illustration of a frame node

The focus of the research project on part of the IPEK – Institute of Product Engineering is the construction kit development and its construction series development in the civil engineering context to make the efficiency and effectiveness advantages of this method available to civil engineering. Additionally the optimization of the construction kit architecture by an evolutionary algorithm, to gain a minimal inside diversity by getting a maximal outside diversity, is part of the aim. In particular, the selection of the construction kit's architecture, the determination of necessary modules and the definition of specific dimensions will be investigated. The fulfilment of the defined aims in the joint research project facilitates the usage of the developed construction kit material, construction time and construction cost savings. The interdisciplinary work of both institutes facilitates the optimal knowledge exchange and transfer between the fields of civil engineering and mechanical engineering [1].

[1] Albers, A.; Stempniewski, L.; Kempf, C.; Manny, A.; Renz, R.; Spadinger, M.: *Intelligente Modularisierung für den skalierbaren Betonbau durch Adaption der Methoden zur Baukastenentwicklung.* In: BetonWerk International Nr. 3, 2020, S. 27

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