Zukunft Bau

Report

Title

Long Title: „Development of basalt-reinforced ceiling panels for residential buildings“

Motivation

Due to reinforcement corrosion damage are caused to reinforced concrete components, which leads to complex repair measures. By using non-corrosive basalt fiber reinforced polymer reinforcement, this common damage can be avoided. In order to be able to use this type of reinforcement in construction practice, precise knowledge of the structural behaviour in concrete members with this reinforcement type is required.

Scope of the research programm

Reinforcement made from fiber-reinforced polymers are not included in the current generation of standards in Eurocode 2 (DIN EN 1992-1-1). In Germany, therefore, a general technical approval (AbZ) is required for a non-regulated construction product. In international standards and guidelines (USA: ACI 440.1R-15), Canada: CSA-S806-12 and Japan: Japan Society of Civil Engineers, 1997) fiber-reinforced polymers (glass fiber, carbon fiber, aramid fiber) are already represented in design codes. The basalt fiber as reinforcement fiber in basalt fiber reinforced polymers (BFRP), however, is not taken into account in these international standards either. Since the basalt fiber has great potential for use in FRP materials regarding to ecological, economic reasons and due to its physical properties, this research project investigates its use in concrete ceiling components for residential buildings.

In order to investigate the new type of reinforcement material, research is first carried out on the material, bond and load-bearing behaviour of components with BFRP reinforcement material. In order to preserve the material properties of the BFRP reinforcement, which are important for the structural design, tests on the reinforcement itself as well as on small test specimens in concrete are initially carried out and evaluated as part of an experimental research program. The test results serve as the basis for dimensioning large-scale tests on slab strips with realistic spans in residential buildings. The maximum span is limited to 6.0 m, as this represents a length that is customary in practice for residential construction and within this limit the simplified verification procedure according to DIN EN 1996-3 / NA can be used for masonry residential buildings. This boundary condition should be adhered to, since a large number of residential buildings are built out of masonry. Furthermore, the shear load capacity without shear force reinforcement on concrete components with BFK reinforcement is investigated on beam cross-sections.

The large-scale tests should serve to understand the load-bearing, crack and deformation behavior of BFRP-reinforced concrete components. To evaluate the test results, component tests are carried out on steel reinforced concrete components with the same dimensions.

The obtained experimental results are evaluated and compared to analytical models of existing design codes regarding to their transferability to BFRP-reinforced concrete components. The knowledge gained from the experiments serve as a basis for deriving and adapting design approaches for BFRP-reinforced ceiling slabs without shear reinforcement.

Conclusion

In summary, it should be noted that ceiling panels for residential buildings with BFRP reinforcement can be designed. Due to the production method in a precast concrete plant, which is analogous to steel reinforced concrete construction, these ceiling components can be used in practice right now, provided that the legal requirements are met. However, due to the lower modulus of elasticity of the BFRP reinforcement, a higher degree of reinforcement can arise compared to a steel reinforced concrete component, since the component deflection has to be limited. However, great application potential is seen for these components.

Facts

Short title: Basalt-reinforced ceiling panels in residential buildings

Project Manager:	Univ.-Prof. Dr.-Ing. C.-A. Graubner, Dr.-Ing. Tilo Proske
Researcher:	Sebastian Hofmann, M.Sc.

Costs: 161.968,68 € €

Federal sponsoring: 112.664,80 €

Project duration: 24 months

Figures:

Figure 1: Basaltfaser auf Spule.jpg
Caption: Basalt fibre

Figure2: Straff umwickelte und besandete BFK-Bewehrung.jpg
Caption: Helically wrapped and sand coated BFRP reinforcement

Figure3: Versuchsaufbau zur Prüfung der Plattenstreifen mit 6,0 m Spannweite.jpg
Caption: Test setup of the 6,0 m span slab strips

Figure4: Versuchsaufbau zur Prüfung der Plattenstreifen unter Dauerbeanspruchung.jpg
Caption: Test setup of the slab strips under sustained loading

Figure5: Rissentwicklung während Prüfung am Plattenstreifen.jpg
Caption: Crack development in slab strips under static loading