Punching shear behaviour of fibre reinforced concrete slabs in the area of internal support

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Started: **10/2017**

☒ **ongoing** ☐ **finished**

The design and construction of reinforced concrete flat slabs has become increasingly common due to the construction and architectural advantages in office buildings, residential buildings and parking structures. Because of the optimized construction height, in conjunction with the flat underside of the slab, this type of construction meets a variety of requirements for the owners and contractors. This type of construction fulfills the demands for high level of flexibility in the floor plan, the easy placement and installation of the building services, as well as the high standards for aesthetics and economic construction practice.

The ultimate strength of reinforced concrete flat slabs is usually governed by the punching shear capacity at its slab-column connections. The simultaneous effect of high shear forces and negative bending moments leads to a spatially highly stressed area, which causes a very brittle and sudden failure mode and can cause a progressive collapse of the entire structure. In the past, alternatives such as stirrups, bent-up bars, shear studs or post-installed shear reinforcement have been established to increase the punching shear capacity. However, all of these methods have disadvantages, which require special design rules and often lead to problems and deficiencies in the construction.

Since the introduction of the DAfStb Guideline “Steel Fibre Reinforced Concrete” in 2012 there is an increasing use of steel fibre reinforced concrete in construction practice. The addition of steel fibres to conventional concrete provides a significant improvement in the post-cracking tensile strength. Some studies [1] in the past showed an increase in the punching shear strength of fibre reinforced concrete slabs which will be examined in more detail in the context of this work.

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EXPERIMENTAL RESEARCH

A literature search of existing research on the punching shear capacity of steel fiber reinforced concrete flat slabs showed that most tests were performed with slab thicknesses not relevant to practice. For this reason several tests were carried out to investigate the influence of the following factors: practice relevant slab thickness, steel fibre ratio, type of steel fibre and concreting method.

The experimental work involved testing slab specimens subjected to concentrated loading up to failure. These slabs measured 2800 x 2800 mm with a thickness between 200 and 300 mm.

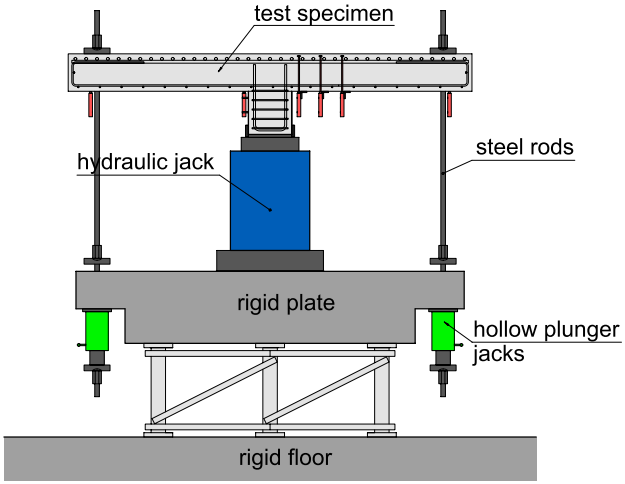

Fig. 1: schematic test setup

In addition to the experimental investigations and the punching shear database developed for of fibre reinforced concrete slabs, numerical investigations are being carried out in order to allow a systematic description of the load-bearing behaviour and the main bearing mechanisms. The experimental database can hereby be further refined and completely developed.

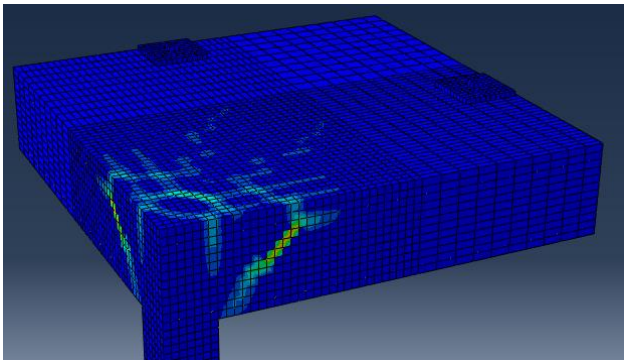

Fig. 2: punching shear failure in numerical simulation

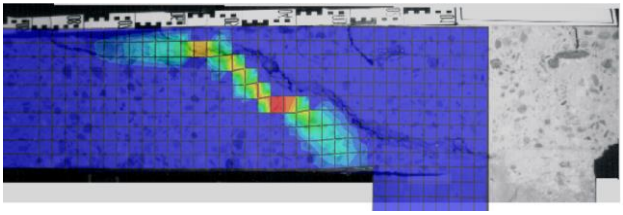

Fig. 3: comparison of failure mode of numerical and experimental investigation

Further scope of research

Further research efforts aim to provide appropriate and analytically based design approaches for the punching shear strength of steel fibre reinforced concrete slabs for use in practice. The potential applications and acceptance of the modern construction material “steel fibre reinforced concrete” will thereby be enhanced and extended.

References

[1] Swamy RN, Ali SAR: Punching shear behavior of reinforced slab-column connections made with steel fiber concrete, ACI Structural Journal, Vol. 79 (6), 1982.