Geotechnik im Bauwesen
Geotechnical Engineering
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Short report

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Research topic: **"**Experimental and theoretical investigations to the punching behaviour of RC footings"

Lemma: "Punching behaviour of RC footings"

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Summary:

Due to the concentrated load introduction high moments and shear forces occur in the area of the alignment between foundation and column. This can cause a bending- or a local shear force failure, which is also known as punching. In terms of punching structural behaviour foundations are handled like point-supported panels. Experiments prove that the shear span ratio has a large impact on the punching structural behaviour; however this impact is not covered in the existing models. A database was used to analyze selected normative regulations and mechanical models and evaluate those by means of probabilistic methods [1].

For an experimental test of the structural behaviour 17 punching experiments were conducted on a foundation. Five foundations were bedded on sand under realistic conditions. In addition to that on 12 samples a consistent ground pressure was simulated by hydraulic presses. The results were clearly affected by the shear span ratio. The inclination of the cracks varied between 45° on compacted and 35° on slim foundations, further the absorbable lateral force fell by a rise of the shear span ratio. Rearrangements in soil pressure distribution were distinguished for the compacted foundations under higher loads than for the slim foundations. A punching reinforcement was more efficient on the slim foundation than on the impacted foundations. The foundations bedded in sand achieved an insignificant higher breaking load in comparison to the steady loaded samples. This observation can be explained by the accumulation of the soil pressure in the area of the column. The closer the ultimate strength gets to the base failure load the higher the concentration of the soil pressure.

The impact of several parameters on the punching resistance of foundations without reinforcement was analyzed in non linear numeric simulations. Two different failure mechanisms could be observed. The structural behaviour of compacted foundations can be described as a band of pressure cone bowls. The punching cone in ultimate state originates in the first place via splitting of the pressure cone bowls. Slimmer foundations fail whenever the pressure zone on the column section reaches the load bearing capacity as a consequence of the tangential bending pressure and the vertical shear force. The approach for a realistic arrangement of the ground pressure can lead to economic advantages, especially for slim, less inflexible foundations.

Based on experimental and theoretical researches an existing mechanical model was expanded in a way that it could be applied on calculations for foundations without punching reinforcement. For the National Appendix of Eurocode 2 (Germany) adjusted, an empirical equation was developed for foundations without punching reinforcement and semi probabilistically evaluated. Moreover a half empirical design approach was deduced for foundations with punching reinforcement. For eccentric loaded foundations with and without punching reinforcement the design approaches were combined with a sector model.

References:

[1]: RICKER, M.: Zur Zuverlässigkeit der Bemessung gegen Durchstanzen bei Einzelfundamenten. Aachen: Lehrstuhl und Institut für Massivbau, RWTH Aachen, 2009 (Schriftenreihe des Lehrstuhls und Instituts für Massivbau (IMB) Heft 28). – Diss.