MODELLING THE BOND BEHAVIOUR OF NATURALLY CORRODED REINFORCED CONCRETE

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ABSTRACT

Corrosion of reinforcement causes cracking, spalling, and affects the bond. Most of the work done on this topic concerns experimental data with artificial corrosion. Lack of natural corrosion experimental data has resulted in that numerical models are mostly calibrated with artificially corroded experiments. Earlier research concerning the effect of corrosion rate has indicated that the results may not be representative for actual field conditions. For this reason, the anchorage capacity of naturally corroded reinforcement was investigated experimentally. Several specimens with varying extent of corrosion damages were successfully tested in a suspended four-point bending test set-up leading to anchorage failure. In this work, these specimens were modelled, with the aim to evaluate the behaviour of different bond models to assess the structural behaviour.

A comparison of two approaches to model the anchorage behaviour was done: (a) Finite Element (FE) analyses were performed using 3D solid elements for concrete, and beam elements for reinforcement, where the interaction was explicitly described using a bond-slip constitutive model, and (b) FE analysis with 3D solid elements for both concrete and reinforcement, where a frictional model described the concrete/rebar interaction, and the effect of corrosion was taken into account by introducing the swelling action and the flow of rust through cracks. In both types of FE analyses, non-linear fracture mechanics, with a rotating crack model based on total strain, was used to describe cracking of concrete. The bond models used were developed in previous works.

The results show some differences between the two approaches. Using the bond-slip constitutive model in model (a) was useful to obtain a good approximation to the real behaviour. However, it was shown that this modelling technique has shortcomings, mainly because the splitting action is not included. The more complicated modelling, including the frictional model and corrosion, described the involved phenomena in a more fundamental way, and yielded more realistic results compared with the experiments.