MODELLING OF BOND BEHAVIOUR OF NATURALLY CORRODED REINFORCEMENT IN CONCRETE STRUCTURAL MEMBERS

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ABSTRACT

Corrosion of reinforcement is one of the common causes of deterioration in concrete structures. Cracking and spalling of the concrete are two physical signs of such damage which affect the bond mechanism; if this takes place in anchorage zones, load carrying capacity is also decreased. These effects have been studied by several researchers and numerical models have been developed to describe the phenomenon.

Lack of natural corrosion experimental data resulted in numerical models that are mostly calibrated with a set of artificially corroded experiments. Earlier research concerning the effect of corrosion rate has indicated that these results may not be representative of the actual field conditions. For this reason, the anchorage capacity of naturally corroded reinforcement was investigated experimentally. The experiment consisted of several specimens with varying extent of corrosion damages which were successfully tested in a four point bending test set-up supported by suspension hangers. The anchorage behaviour was monitored through measurements of the applied load, free-end slip and mid-span deflection.

Nonlinear finite element analysis was used to evaluate different test set-ups and further design the most promising one. Later the model was applied to study the structural behaviour of the tested specimens. The analyses were performed on a two-dimensional model with plane stress elements for the concrete and truss elements for the reinforcement. Non-linear fracture mechanics was used for the concrete, with a smeared rotating crack model. The interaction between the concrete and rebars was provided using interface elements. The bond-slip behaviour was described by the bond stress-slip relations according to CEB-FIB Model Code 2010. Analyses were initially run with a bond slip curve assuming uncorroded reinforcement. Later on, the corrosion level was described by altering the maximum bond stress based on indicative reduction values in the residual bond strength given in CEB-FIB Model Code 2010. In these analyses, both bond and material parameters were adjusted to capture the actual behavior of tested specimens. By the use of this modelling, the anchorage of the corroded reinforcement could be studied more in detail. The results from the non-linear 2D finite element analysis showed good correlation with the experimental results in terms of the maximum failure loads and deflections but could not sufficiently describe the free end slip behavior of the main tensile reinforcements.