ABSTRACT

Recent experiments have highlighted the efficacy of post-installed reinforcement in enhancing the capacity of groups of bonded anchors undergoing concrete breakout failure mode. This technique is particularly useful to enhance the performance of anchorages installed in members of limited dimensions such as beams and columns. This thesis presents the results of corresponding numerical investigations on bonded anchor groups in concrete strengthened with post-installed supplementary reinforcement subjected to tension loads. The study is conducted using the 3D Finite Element (FE) approach. The constitutive law of concrete is the microplane model with relaxed kinematic constraint. The interface between anchor or reinforcement and concrete is modeled with two-node bar elements, which are assigned with corresponding bond-stress slip characteristics. The proposed FE approach is validated against experimental results available in the literature by comparing load-displacement behavior and failure mode.

The validation incorporates anchor groups with different configurations of post-installed supplementary reinforcing steel bars. The numerical investigations provide a deeper insight into the detailed behavior of anchor groups with post-installed reinforcement through the visualization of crack patterns, stress flows, and strain development. The results show that the post-installed rebars can lead to a significant increase in the performance of post-installed anchorages, and the load increase depends on the number and arrangement of rebars and the failure mode of the system.

Lastly, the thesis presents a parametric study on strengthened anchor groups with post-installed rebars in narrow reinforced concrete (RC) members under various configurations. These simulations mimic anchorages used for seismic retrofitting beam-column joints in RC structures using a fully fastened haunch retrofit solution. Due to the limited width and depth of beams and columns, the capacity of the anchorages is often the weakest link in such retrofitting methods. The results from the FE study indicate that the post-installed supplementary reinforcement can be an efficient solution for upgrading the performance of post-installed anchorages in such retrofitting techniques.