6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

NUMERICAL INVESTIGATION OF ANCHORS UNDER SHEAR LOADING

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Key Words: *Discrete Element, Bonded Anchors, Concrete, Shear Loading, Aging*

The rapid advance of technology and innovations in the construction industry result (i.e. modular construction) in more demanding structures design, and require further improvements of building techniques. Therefore, the use of fasteners is of great importance, especially due to their wide applications (i.e. connecting or strengthening the structural members). Typically, fasteners are set in concrete, transferring the load to the structure through different working mechanisms. Depending on the load scenario, the fasteners can be loaded in tension, shear, or in a combination of the two. In this contribution, the focus is on anchors under shear loading located close to the edge of the concrete member. This type of load case results in concrete edge failure mode, forming a half-cone shaped breakout. Many researches were performed to derive an analytical model to predict the load capacity for such load, considering a spatially homogeneous material. From a mechanical point of view, concrete is a heterogeneous and aging material. The evolution of the concrete properties is not merely a function of time, but mainly a function of the cement hydration degree. Therefore, the concrete properties can differ with increasing edge distance, where the concrete close to the edge is more affected by the boundary conditions (i.e. temperature, humidity). For the anchors close to the edge, the presence of micro-cracks due to shrinkage can cause a reduction of load capacity. Also, close to the surface the overall concrete response is determined to a larger degree by the cement paste and less by the aggregate. This contribution shows calibration and validation of a bonded anchor model using a discrete element framework [1], which allows to model concrete at the meso-scale and to mimic quite well its heterogeneity. The experimentally obtained properties are used to calibrate the concrete material model. For the bond among the concrete and mortar, a stress-slip law is used. The law is calibrated on the experimental confined pull-out tests. In order to account for the changing of concrete properties and for the aging, a multiphysics approach is followed. In this, the chemical reactions that occur in concrete are simulated through a hygro-thermo-chemical model [2, 3]. Its results can be coupled to the mechanical model (one way coupling) in order to include the aging of the system, as well as additional effects, i.e. creep, shrinkage. The calibrated numerical model is used to investigate effect of the edge distance on the load capacity, depending on age, composition, and environmental boundary conditions.

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