EFFECT OF INTERFACIAL TRANSITIONAL ZONES ON CONCRETE BEHAVIOUR IN DEM ANALYSES

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Fracture greatly affects strength of quasi-brittle materials and therefore its understanding is vital for a reliable engineering design and construction of building infrastructure. Concrete may be described at the meso-level as a four phase material composed of aggregate, cement matrix, macro-voids and interfacial transitional zones (ITZs) between aggregates and cement matrix [1], [2]. ITZs are highly heterogeneous and porous regions. Their width varies between 0 µm and 50 µm, depending strongly upon the aggregate roughness. They play an important role in concrete since they are the weakest regions wherein micro-cracking always starts (because of their higher porosity). Thus, they become next attractors for macro-cracks.
In the paper, the effect of ITZs on the concrete behaviour (strength and fracture) at the meso-scale is theoretically studied in a notched concrete beam under quasi-static 3-point bending. The calculations were performed with the discrete element method (DEM) that takes advantage of the so-called soft-particle approach. A linear contact under compression was used [1]-[3]. The normal and tangential contact forces satisfied the cohesive-frictional Mohr-Coulomb condition. The method was very successful in describing fracture in concrete at both the macro- and meso-scale [1]-[3]. The meso-structure of concrete was directly taken from 3D x-ray images using the very advanced micro-tomography system SkyScan [1].
In order to simulate ITZs around aggregates using DEM, two different approaches were used. In the first approach, ITZs were simulated as contacts between aggregate and mortar grains [1]-[2]. Thus they had no a physical width. Different elastic, shear and tensile properties of ITZS were assumed but lower than these in the mortar. In the second approach they were simulated as porous mortar regions around aggregates with a different initial porosity but smaller than the mortar porosity Thus they had a physical width. In calculations, the different aggregate roughness was assumed. Attention was paid to the location of micro-cracks close to aggregates (in ITZs or between ITZs and the mortar). Numerical calculation outcomes at the global scale were directly compared with the corresponding experimental results [1].

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