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Effect of constitutive laws using cohesive elements on cracks patterns in concrete at the meso-scale

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Concrete can be described at several levels. At the macro-scale all material properties are averaged and the attention is paid to cracking. More detailed simulations take the internal structure of concrete into account. When describing concrete at the meso-level: aggregates, cement matrix, macro-voids and interfacial transition zones (ITZs) may be distinguished. All phases have different elastic and strength properties that influence the overall behaviour of concrete specimens.

The mesoscopic approach presented here uses interface cohesive elements to simulate cracks at the mesoscale [1, 2]. The material internal structure was taken into account by considering four different phases, namely aggregate, cement matrix, ITZs and macro-voids. The shapes and positions of aggregates were obtained with the aid of X-ray micro-computed tomography images of concrete specimens [3]. Cracks could be created inside the cement matrix and in ITZs but no cracks were allowed inside aggregates. Different elastic properties were assumed for bulk finite elements covering aggregate grains, cement matrix and homogeneous region. Different fracture properties (critical traction and fracture energy) were taken for aggregate-cement matrix and cement matrix-cement matrix interfaces.

In the paper the influence of constitutive laws describing fracture on crack patterns was investigated. Different damaged-based isotropic formulations relating tractions and relative displacements on the crack's surface were assumed. In addition a discrete form of the Mohr-Coulomb law was also tested. Numerical simulations of the three-point bending test were performed. The obtained results were compared with the experimental outcomes.

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