Numerical coupling between damage and gas permeability for concrete applied on a 3D splitting test

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ABSTRACT

During their service life, due to external loading (mechanical and/or environmental), concrete structures may undergo damage in a diffuse manner (microcracking) at the material scale and/or localised (macrocracking) at the structural level. The estimation of the evolution of transfer properties in such a cracked material is a key issue for structural durability analysis. The aim of this contribution is to validate two numerical modelling of leakage rate through a concrete specimen in a splitting test against experimental results. The mechanical state of the material is described by means of a newly enhanced non-local damage model which takes into account the stress state and provides a very realistic damage field representing micro cracking and macro cracking at failure [1].

To study the coupling between the mechanical state of the material and the permeability, two approaches will be investigated:

- A semi-discrete one based on the global tracking algorithm [2], allowing to find the crack path, is proposed. Once the crack path is found, the Crack Opening Displacement (COD) can be computed along the discretized crack surface by equivalence with strong discontinuity approach [3]. The final step is to prescribe Poiseuille's law along the crack surface to estimate the leakage rate while imposing a pressure gradient.

- A continuous one based on a permeability-damage law, which allows to predict a leakage rate without need to calculate the CODs [4]. In this case, the permeability is obtained at each integration point and is used to compute the leakage rate point wise in the volume rather than along a surface as in the first method.

For the purpose of validation, a physical experiment has been performed on a mortar specimen subjected to splitting test; the gas permeability of the specimen is measured during the test at different load levels. The validation of both numerical approaches against experimental results is performed on the leakage rate perpendicular to the disk for different load stages.

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