Cracking behaviour of cementitious mortar accounting for its heterogeneous nature

Akanksha Mishra*, Pietro Carrara, Roland Kruse and Laura De Lorenzis

Institute of Applied Mechanics
Technische Universität Braunschweig
Pockelstr. 3, 38106 Braunschweig, Germany
e-mail: {akanksha.mishra, p.carrara, r.kruse, l.delorenzis}@tu-braunschweig.de,
web page: https://www.tu-braunschweig.de/iam

ABSTRACT

Mortar, a blend of binding material, water and fine aggregates (i.e. sand), is one of the most widely used structural materials all over the world. In particular, it constitutes the matrix that binds together the coarse aggregates in concrete. Since these aggregates are usually much more resistant than mortar, the crack responsible for material failure is assumed to nucleate and propagate within the mortar. Thus, it becomes important to study the cracking behavior of the mortar, which is non-trivial due to its intrinsic heterogeneous nature. The heterogeneities, i.e. the air voids and the sand aggregates, act as imperfections, influencing the crack nucleation and propagation. Therefore, accurate numerical models are needed, which can simulate the cracking behaviour of the mortar accounting for its heterogeneous nature.

The phase field method for fracture [1–4] is a recent and attractive method that elegantly simulates complicated fracture processes including crack initiation, propagation, branching and merging. Here, a continuous crack field parameter varying smoothly between damaged and virgin material approximates the sharp crack.

The main contribution of this work is to simulate the cracking phenomena in cementitious mortar taking into account its heterogeneous nature within the phase field framework. The heterogeneous nature of the mortar is accounted as spatial variation of its elastic and fracture properties based on a suitable statistical distribution obtained through an experimental campaign. In particular, three-point bending and compression tests are performed to obtain the statistical distribution of the elastic and fracture properties. The validity of the proposed approach is demonstrated through the simulation of available experimental tests and the comparison of the results with the experimental evidence in terms of crack pattern and load-displacement curve.

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