Dynamic Ductile Fracture with a Directional Phase-Field Split

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ABSTRACT

Strain-hardening cement-based composites (SHCCs) denote a class of composite materials, which consist of a finely grained cementitious matrix and short, high-performance polymer micro fibres, which are randomly orientated within the material. The tensile behaviour of the material is linear-elastic up to the formation of the first crack, that is bridged by micro fibres. This results in a very limited opening of the crack and an increase in the load-bearing capacity for further tensile loading. The subsequent formation of multiple cracks is accompanied by a very high energy absorption capacity both for quasi-static and dynamic loading conditions. At ultimate load, the fibres are either ruptured or pulled out of the matrix, where frictional effects provide an additional mechanism to dissipate energy and preserve a certain amount of stability for the structure even for large deformations [1]. The experimental investigation of the rate dependent, tensile material characteristics is based on both, static and dynamic testing. A uniaxial tension test and a split-Hopkinson-bar spallation test setup are used to investigate the material for strain rates up to 150/s [2]. In terms of numerical material modelling, the SHCC characteristics under tensile loading can be represented by a set of 3 different features. At the beginning, the material is linear elastic. The evolution of multiple cracks, which are bridged by micro fibres, accompanied by an increase in the load-bearing capacity is typical for a state of plastic hardening and, finally, the pull-out and rupture of the fibres can be represented by a macroscopic fracture of the structure itself. The contribution at hand presents the extension of the directional phase-field model [3] to ductile fracture in order to simulate the complex material behaviour of SHCC under tensile loading at different rates of strain.

REFERENCES

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