Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

3D fracture analysis of concrete under uniaxial tension at the mesoscale

Yilmaz, Okan, okan.yilmaz@epfl.ch, EPFL; Molinari, Jean-François, EPFL, Switzerland

ABSTRACT

Modeling the structural behavior of concrete has always been an important engineering problem because of the importance and widespread usage of concrete in construction of various structures. Numerical simulations are often used to explore the mechanical behavior of concrete. In this study, the dynamic fracture response of concrete under uniaxial tension is investigated within a three-dimensional computational framework. Most of the efforts for the numerical analysis of concrete in the literature are limited to two-dimensional studies since three-dimensional numerical analyses are computationally expensive, which makes the use of parallel computing vital. Hence, a scalable parallel implementation for the finite-element analysis of concrete specimens is proposed. Concrete is modeled at the mesoscale allowing the representation of first level heterogeneities, namely the modeling of aggregates and mortar paste explicitly using linear elastic continuum finite elements. Crack initiation and propagation are modeled with dynamically inserted cohesive elements. The macroscopic tensile stress-strain response of the specimen is investigated at both prepeak and postpeak strength regions and the results obtained are compared with earlier simulations, which were conducted in two dimensions. Microcrack density and crack percolation in the mesostructure models of both two and three-dimensional setups are compared under different strain rates using cohesive crack maps and dissipated fracture energy.