HYBRID FE-DE SIMULATION OF NOTCHED BAR IMPACT TESTING

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Januar 2008, 20 Seiten

Dynamic rupture and fragmentation processes play a decisive role for technical applications and in nature. They can be observed on nearly all time and length scales. The understanding of such kind of processes poses a challenge to science, due to their complexity. In the extreme situation of fragmentation the material behavior is much more brittle as under the condition of quasi-static tension. Also, contrary to expectations the observed crack velocities are much lower than the maximal possible values given by the Rayleigh wave speed. The mechanisms behind these phenomena are not yet completely understood. Unfortunately, often the experimental studies of fragmentation processes are limited by technical reasons or, if we want to look inside a material, not possible. However, today computers enable researchers to simulate 3D systems with many thousands of particles and interaction forces. For the simulation of failure and fragmentation of brittle, disordered media, like concrete, the Discrete Element Method (DEM) can be successfully applied. One of the biggest advantages of the method is its full physical access to the dynamic fracture propagation throughout the whole fracture progress. However, one considerable disadvantage of the method is the large number of particles involved for discretizing a real structure. Therefore, DEM simulations are limited to relatively small domains. However only a small number of elements is located in the damage zone while the majority is used for the elastic foundation of the damage zone.

The thesis covers three main parts: The methodology, the Charpy test and the simulation scheme for the Charpy test, and the simulation results. The first part of the methodology introduces the concept of multiple-scale methods and describes the coupling between FE and DE domains. Then the second methodology describes the Charpy test and the related hybrid simulation model. The next part deals with the mechanical characteristics of the hybrid system, before finally questions of crack propagation velocities and dissipated energies are discussed.