Editorial

Computational Methods for Fracture

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The numerical study of fracture has far-reaching applications throughout engineering and science. Its importance is becoming even more significant that engineers and materials scientists are thriving to devise new lighter and stronger materials from the bottom up.

Simulating fracture requires devising suitable models, discretizing the resulting partial differential equations, and solving them numerically. Each of those three steps poses its own difficulties which have been tackled in various ways, both academically and for practical applications.

This special issue deals with a range of such models: discretization and solution methods applied to a number of problems ranging from rock mechanics to surgical simulation requiring tackling various loading spectra, ranging from fast dynamics to quasistatic loading, and leading to a number of different failure modes, from brittle to ductile fracture.

The topics of this issue can be decomposed into five groups:

Models have been developed with special emphasis on rock mechanics and multi-field problems in fracture [1, 2] with applications, for example to coupled thermohydro-mechanical model of jointed hard rock for compressed air energy storage, and to rock failure [3].

Discretization methods have been heavily investigated, to address the difficulties faced by the standard finite element method [4], in particular, associated with remeshing as the cracks evolve. The issue discusses recent developments in meshless methods, including a posteriori error estimation and adaptive methods.

Dynamic fracture is in itself a wide field of study. Papers in this issue focus on explicit dynamics and tackle, in particular, the issue of energy dissipation during crack growth and the simulation of fracture in thin shells due to dynamic and impulsive or explosive loading.

Model reduction methods have recently been developed for fracture simulations. Algebraic model reduction such as the proper orthogonal decomposition (POD) is not inherently well-suited to such problems [5–8]. This issue discusses one possibility relying on the combination of POD with meshfree methods.

Parameter identification in fracture mechanics is a topic of special interest in practical applications and a necessary step to provide convincing and predictive modeling and simulation tools. Two methods are discussed in this issue, both for crack parameter identification and multifield problems in fracture.

Through these five topics, we believe the issue gives a fair reflection of the current state of the art, with a heavy focus on modeling and simulation methods, although covering the whole spectrum of applications and methodologies would require a much more substantial volume.

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