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Computational modeling of material deterioration at various length scales

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In the past decade, a dominant theme in computational fracture mechanics has been to obtain a more fundamental understanding of material deterioration process, rather than relying on phenomenological or empirical approaches to make predictions. This is driven by a growing need to make predictions of the failure behavior of materials across length scales starting from first principles and going up to the continuum scale. In order to predict such material response, the development of rigorous computational models for modeling material deterioration process at various time and length scales has been of importance to the computational mechanics community. Several interesting approaches have thus been proposed to increase our understanding of the inter-related materials deterioration processes at disparate length scales. While experimental fracture mechanics is important for identifying the physical phenomena and formulation and validation of fracture theories and methods, computational techniques become extremely important for predication and design of a range of engineering applications.

This special issue deals with a range of innovative computational models for predicting material deterioration processes across various length scales. The manuscripts in this special issue on computational failure analysis methods can be categorized as discrete and continuous approaches to fracture. In the discrete category, methods such as the meshfree, peridynamics, and hybrid meshfree-finite element methods have been developed. In the continuous approaches, standard and extended finite element methods as well as boundary element and scaled boundary methods have been developed. Both discrete and continuous methods have been applied to different types of materials accounting for brittle and ductile failure. For instance, the coupled meshfree-finite element method has been proposed for large deformation analysis taking advantage of meshfree methods which are suited for large deformations. Similar approach has also been applied to ductile fracture. Other approaches such as the scaled boundary element method have been employed to model fracture in concrete. There are also contributions to continuous crack methods which kinematically enrich the constitutive model. Moreover, this special issue presents interesting applications of these state-of-the-art methods to gain better understanding of fundamental issues including how materials fail under dynamic loading

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conditions. Within this context, a variety of different materials were also studied including geo- and structural materials such as rock, soil and concrete.

We would like to thank all authors who submitted papers to this special issue on computational modeling of material deterioration at various length scales. This special issue turned out to be an excellent representative source for current computational methods in fracture mechanics, thanks to the outstanding contribution of the participating authors.