MM 42: Topical Session: Fundamentals of Fracture - Continuous Models

Time: Wednesday 16:30–17:45 Location: H4

Topical Talk MM 42.1 Wed 16:30 H4

Configurational Mechanics: A Continuum Approach to Model Fracture and Defects — •Paul Steinmann — Chair of Applied Mechanics, University Erlangen-Nuremberg, Germany

Configurational mechanics is a branch of continuum modelling that allows to model fracture and defects (such as single and distributed dislocations, interfaces, vacancies, etc) based on concepts from continuum field theories. The key notion is hereby the configurational force that is dual (in terms of the dissipation power) to the motion of these kind of defects relative to the ambient material. This is clearly opposite to the common notion of forces that may be considered as being energetically dual to the motion of material relative to the ambient space. The talk will highlight especially the roots of concepts from fracture mechanics in continuum modelling. Configurational mechanics then allows to include straightforwardly various modelling options such as coupled problems or lenght scale dependent models. Especially at the micro and nano scale the material response in general and the fracture behavior in particular become decisively dependent on the ratio of lengths characterizing the dimension of a specimen and the dimension of the materials micro structure. These effects may be captured by gradient and/or surface enhanced continuum models, both having direct consequences within configurational mechanics.

MM 42.2 Wed 17:00 H4

Modeling of planar cracks in 3D elastic media considering the effects of surface elasticity by using FEM - SGBEM coupling — •Binh Thai Nguyen[1], Jaroon Rungamornrat[1], Teerapong Senjuntichai[1], and Anil C. Wijeyewickrema[2] — [1]Department of Civil Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand — [2]Department of Civil and Environmental Engineering, Tokyo Institute of Technology, Tokyo 152-8552, Japan

A computationally efficient and accurate numerical technique having the ability to model isolated planar cracks in three-dimensional linear elastic media considering the effects of surface elasticity is presented. The governing equations are formulated based on the classical theory of linear elasticity for the bulk and Gurtin-Murdoch surface elasticity model for the crack surfaces. The resulting system of equations is then solved numerically by using the FEM-SGBEM coupling procedure. Application of the technique to the stress analysis of nano-crack problems are also presented for some selected cases to study the nanoscale influence and size-dependency behavior.

MM 42.3 Wed 17:15 H4

On the Propagation of two en passent cracks upon mutual interaction: A phase field study — •Martin Lautenschläger, Michael Fleck, Denis Pilipenko, and Heike Emmerich — Materials and Process Simulation, University of Bayreuth, Germany

A phase field model for the simulation of crack propagation in brittle materials is applied to the problem of two mutually interacting "en passent" cracks. Thereby, crack growth is described as a first order phase transformation process, where the solid parent phase transforms into an infinitely weak "broken" phase, driven by elastic energy dissipation. We discuss the problem of "en passent" cracks in a two dimensional plain strain geometry, subjected to a constant uniaxial pulling velocity of mode I type. Our model reproduces a number of basic features that are also observed in corresponding experimental setups: Initially, when the two cracks propagate independently, they approach each other along straight paths. Then, during the early stage of the mutual interaction and for certain geometrical circumstances the principle of local symmetry may even force the cracks to turn slightly away from each other. When the line connecting the two crack tips alines with the pulling direction, the two cracks curve towards each other upon mutual tip-tip interaction until each crack tip reaches the other's crack tail, finally releasing a lenticular fragment. Here, we investigate the crack propagation dynamics as well as the chosen crack paths as a function of all relevant physical dependences, such as the pulling velocity, the materials Poisson ratio and so forth.

MM 42.4 Wed 17:30 H4

Simulation of damage accumulation in slip bands and their influence on the resonant behavior in the very high cycle fatigue (VHCF) regime — •Philipp-Malte Hilgendorff[1], Andrei Grigorescu[2], Martina Zimmermann[3], Claus-Peter Fritzen[1], and Hans-Jürgen Christ[2] — [1]Institut für Mechanik und Regelungstechnik - Mechatronik, Universität Siegen, Germany — [2]Institut für Werkstofftechnik, Universität Siegen, Germany — [3]Institut für Werkstoffwissenschaft, Technische Universität Dresden, Germany

The service life of structural components under very high cycle fatigue loading is mainly determined by the period of fatigue crack initiation and thus the localization of plastic deformation. By means of a new approach the characterization of the damage accumulation in the VHCF regime is based on the resonant behavior of the specimen. The resonant behavior of a metastable austenitic stainless steel (AISI304) is studied experimentally in the VHCF regime and shows a distinct transient characteristic. To obtain a physically-based understanding of this characteristic, a microstructural simulation model is proposed which accounts for the damage mechanisms of slip bands. The implementation of the simulation model into a numerical method allows the investigation of the damage accumulation in a simulated microstructure. The numerical method used in this study is the two-dimensional (2-D) boundary element method which is based on two integral equations. Results show that simulation of slip bands is in good agreement to microscopic observations and that plastic deformation in slip bands influences the transient characteristic of the resonant behavior.