KTH SOLID MECHANICS SEMINAR; Thursday, November 8th, 15.15; KTH Solid Mechanics Seminar room

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“Modelling of interfacial damage and mixed mode crack growth under creep conditions”

In many engineering applications, at elevated temperature, structural components exhibit significant time-dependent inelastic deformation which might lead to nucleation, growth and coalescence of voids. This cavitation occurs primarily on the grain boundaries, and their growth is controlled by grain-boundary and surface diffusion and/or power-law creep. In the context of fracture mechanics, a crack may advance along an interface or interconnected grain-boundaries as a result of intensive void growth and coalescence. Therefore, an accurate prediction of creep failure is required to design structures with high integrity and safety. The present talk focuses on studying failure of polycrystalline materials under creep conditions. In a series of investigations, we have challenged two aspects of this problem. Firstly, we have attempted to devise constitutive descriptions of the localized damage process (in micro and macro-scales) and crack propagation. Secondly, we have developed analytical models for creep crack growth under steady-state conditions. To model this localized cavitation process and crack propagation, we have used interface models (i.e. a class of cohesive type models) in which the damage development is described by a traction/separation-rate law. In particular, we have examined two different types of models: an empirical Kachanov type damage mechanics model; and a micromechanical model based on the grain-boundary cavitation model of Cocks and Ashby. In creep crack growth problems, if damage development is confined to a small region ahead of the growing crack, a deformation based parameters such as the creep *J*-integral, i.e. C^*, can be used to describe both the development of cavitation and the rate of propagation of the macroscopic crack. Hence, we have considered crack growth under mixed mode loading and identify the conditions under which C^* can be used. Consequently, we have developed analytical models for steady-state crack growth, which can be calibrated against detailed finite element models and used to provide an assessment of the effect of different material parameters and damage development processes on the crack growth behaviour. These models have then been used to study some practical problems. More specifically, we have studied failure in nuclear power plants where components suffer from in-service failures at the dissimilar interface, i.e. life is much reduced compared to similar metal weld counterparts at the same operating stress and temperature.

Elsiddig Elmukashfi is a lecturer at St Anne’s College and postdoctoral researcher in the Department of Engineering Science, University of Oxford, UK. He received a PhD in Solid KTH Royal Institute of Technology, Sweden. During his PhD, he developed theoretical models and experimental techniques for studying crack propagation and damage in rubber. Since 2016, he has been working in different research problems including creep crack growth and damage development in polycrystalline solids, failure in aero-engines under thermal loading and modeling of Hydrogen embrittlement in metals. His research interests lie primarily in the area of fracture and damage mechanics.

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