The University Of Sheffield.

Department of Mechanical Engineering

Mechanical Engineering Departmental Seminar

Thursday 21st February 2008

1.00 pm – 2.00 pm, St Georges Lecture Theatre 15
Sir Frederick Mappin Building

"Study of crack tip plasticity under cyclic mixed-mode loads"

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Abstract

The fatigue life of structural components depends significantly on the plasticity in the crack tip region. For example, plasticity-induced crack closure is known to decelerate the crack growth. Moreover residual stresses developed as a consequence of the plasticity being constrained around the crack tip, have a significant role on the direction of crack propagation. Finite element (FE) methods are commonly employed in order to model plasticity. However, if millions of cycles need to be modelled to predict the fatigue behaviour of a component, the method becomes computationally too expensive.

By employing a multi-scale approach, very precise analyses computed by FE can be brought to a global scale. The data generated using the FE method enables us to identify a global cyclic elastic-plastic model for the crack tip region. Once this model is identified, it can be employed directly, with no need of additional FE computations, resulting in fast computations. This is done by partitioning local displacement fields computed by FE into intensity factors (global data) and spatial fields. A Karhunen-Loeve algorithm developed for image processing was employed for this purpose.

In addition, the partitioning is done such as to distinguish between the elastic and plastic components. Each of them is further divided into opening mode and shear mode parts. The plastic flow direction was determined with the above approach on a centre cracked panel subjected to a wide range of mixed-mode loading conditions. It was found to agree well with the maximum tangential stress criterion, provided that the loading direction is corrected for residual stresses. In this approach, residual stresses are measured at the global scale through internal intensity factors.