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NOVEL MULTISCALE DEFORMATION AND FAILURE PROBLEMS IN PRACTICAL ENGINEERING APPLICATIONS

J. P. ROUSE*

C. J. HYDE**

C. J. BENNETT***

* University of Nottingham
Nottingham, NG7 2RD, UK
James.Rouse@nottingham.ac.uk

** University of Nottingham
Nottingham, NG7 2RD, UK
Christopher.Hyde@nottingham.ac.uk

*** University of Nottingham
Nottingham, NG7 2RD, UK
Chris.Bennett@nottingham.ac.uk

ABSTRACT

A particular set of challenges are encountered by industrial engineers when tackling practical stress analysis problems. Structural deformation and failure problems are often multiscale in nature; design geometries and materials can be described on a wide range of length scales and design evaluations may well require the evaluation of multiple quantities of interest at several of them. At the largest, macro, length scale, engineers may wish to evaluate global stiffness to answer fundamental deflection and interference questions. At smaller meso and micro length scales an engineer may well be concerned with gradient dependent quantities that indicate the potential for premature failure and fracture. Boundary conditions are not typically known at the small length scales and must be extracted from larger analyses. In addition, evolution of the material or structure at the micro and meso length can result in local stiffness variations, thereby influencing the macro solution. Multiscale analyses are therefor motivated, however pragmatic implementation in large engineering problems demands efficient and intelligent use of data in order to make analyses tractable. Many regions of interest may exist in a particular problem and restrictions on discretisation refinement may limit the fidelity of solutions on which others rely. This session will explore how multiscale analysis methods can be used in realistic analysis problems involving (but not limited to) fatigue, fracture, and damage. Contributions that make use of novel numerical schemes, model order reduction approaches, and artificial intelligence/machine learning are particularly welcome.