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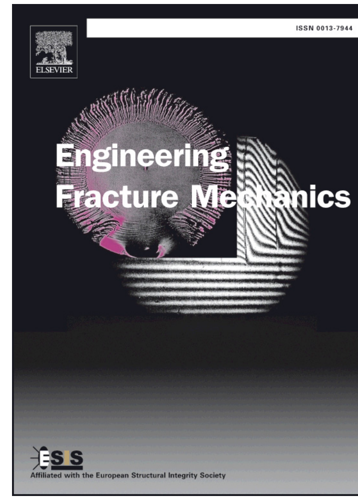

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Faizan Md. Rashid, Anuradha Banerjee

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Simulation of fracture in a low ductility aluminum alloy using a triaxiality dependent cohesive model

Faizan Md. Rashid, Anuradha Banerjee*

Department of Applied Mechanics
Indian Institute of Technology Madras, Chennai 600036, India.

Abstract

In the simulation of the ductile fracture process in a low ductility aluminum alloy, the limitations of the current implementation of a stress-state dependent cohesive model are identified. Ductile fracture data was generated at moderate triaxiality with experiments on a range of notched bars while at high triaxiality in growth of a pre-existing mode-I crack in compact test specimens. In the corresponding finite element analysis, cohesive elements obeying a stress-state dependent cohesive law were introduced in the plane where material separation was expected to occur. By recognizing that the effect of model parameters is decoupled in fracture at moderate triaxiality, a procedure is outlined to determine the unique combination of model parameters that is shown to reproduce the experimental data for the entire range of triaxility well. It is argued that the necessity of a plane strain core and its thickness is largely driven by the extent to which plastic deformation spreads during the growth of crack.

Key words: triaxiality, cohesive zone model, low ductility, mode - I, ductile fracture, elastic-plastic analysis, plane strain core, failure locus

1. Introduction

Failure mechanisms, while are diverse and dependent on the type of material system, such as, splitting of micro-cracks in brittle heterogeneous materials like concrete, crazing in polymers, or void nucleation around second phase particles, and their subsequent growth and coalescence in ductile metals, all show great sensitivity to the state of stress acting around the fracture process zone. In last few decades there has been, therefore, significant interest in development of fracture models that account for these effects.

One of the widely used models in simulation of ductile fracture, cohesive zone model, assumes the fracture processes to be localized in a narrow zone and the constitutive behaviour of this process zone is represented by a traction-separation law which has the work of separation or the cohesive energy per unit area, Γ_o, and the peak traction or the cohesive strength, $\sigma_{\max}$, as the primary model parameters. It is shown that

[1]Corresponding author: Tel: +91 +91 4422 574075, Fax: +91 4422 574052, Email: anuban@iitm.ac.in