Accepted Manuscript

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PII: S0997-7538(16)30302-3

DOI: 10.1016/j.euromechsol.2016.09.014

Reference: EJMSOL 3358

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 27 June 2016

Revised Date: 23 September 2016

Accepted Date: 29 September 2016

Please cite this article as: Gruben, G., Morin, D., Langseth, M., Hopperstad, O.S., Strain localization and ductile fracture in advanced high-strength steel sheets, *European Journal of Mechanics / A Solids* (2016), doi: 10.1016/j.euromechsol.2016.09.014.

Strain localization and ductile fracture in advanced high-strength steel sheets

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Abstract

An experimental-numerical approach is applied to determine the strain localization and ductile fracture of high-strength dual-phase and martensitic steel sheet materials. To this end, four different quasi-static material tests were performed for each material, introducing stress states ranging from simple shear to equi-biaxial tension. The tests were analysed numerically with the nonlinear finite element method to estimate the failure strain as a function of stress state. The effect of spatial discretization on the estimated failure strain was investigated. While the global response is hardly affected by the spatial discretization, the effect on the failure strain is large for tests experiencing necking instability. The result is that the estimated failure strain in the different tests scales differently with spatial discretization. Localization analysis was performed using the imperfection band approach, and applied to estimate onset of failure of the two steel sheet materials under tensile loading. The results indicate that a conservative failure criterion for ductile materials may be established from localization analysis, provided strain localization occurs prior to ductile fracture.

Keywords: Ductile fracture; Stress triaxiality; Lode parameter; Finite element method, Strain localization

1 Introduction

The physical mechanism leading to ductile fracture in polycrystalline materials is nucleation and growth of microvoids [1, 2]. When the microvoids reach a certain volume fraction, they

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