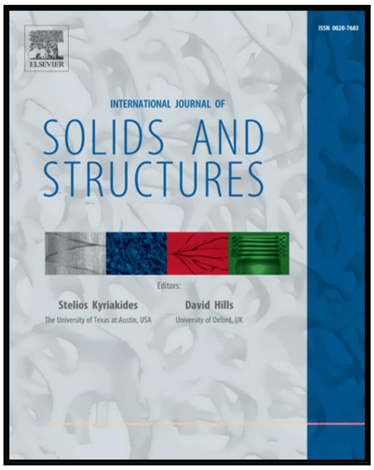
Accepted Manuscript



Multiple necking pattern in nonlinear elastic bars subjected to dynamic stretching: The role of defects and inertia

A. Vaz-Romero, J.A. Rodríguez-Martínez, S. Mercier, A. Molinari

PII: S0020-7683(17)30319-0
DOI: 10.1016/j.ijsolstr.2017.07.001
Reference: SAS 9647

To appear in: *International Journal of Solids and Structures*

Received date: 9 February 2017
Revised date: 12 June 2017
Accepted date: 1 July 2017

Please cite this article as: A. Vaz-Romero, J.A. Rodríguez-Martínez, S. Mercier, A. Molinari, Multiple necking pattern in nonlinear elastic bars subjected to dynamic stretching: The role of defects and inertia, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.07.001

Multiple necking pattern in nonlinear elastic bars subjected to dynamic stretching: The role of defects and inertia

A. Vaz-Romero[a], J. A. Rodríguez-Martínez[a,b], S. Mercier[b], A. Molinari[b,*]

[a]*Department of Continuum Mechanics and Structural Analysis. University Carlos III of Madrid. Avda. de la Universidad, 30. 28911 Leganés, Madrid, Spain*

[b]*Laboratoire d'Etudes des Microstructures et de Mécanique des Matériaux LEM3, UMR CNRS 7239, Université de Lorraine, Ile du Saulcy, 57045 Metz cedex 1, France*

Abstract

In this paper we explore the inception and development of multiple necks in incompressible nonlinear elastic bars subjected to dynamic stretching. The goal is to elucidate the role played by a spatial-localized defect of the strain rate field in the necking pattern that emerges in the bars at large strains. For that task, we have used two different approaches: (1) finite element simulations and (2) linear stability analyses. The finite element simulations have revealed that, while the defect of the strain rate field speeds up the development of the necking pattern in the late stages of the localization process, the characteristic (average) neck spacing is largely independent of the defect within a wide range of defect amplitudes. The numerical results have been rationalized with the linear stability analyses, which enabled to explain the average spacing characterizing the necking pattern at high strain rates. Moreover, the numerical calculations have also shown that, due to inertia effects, the core of the localization process occurs during the post-uniform deformation regime of the bar, at strains larger than the one based on the Considère criterion. This phenomenon of neck retardation is shown to have a meaningful influence on the necking pattern.

Keywords:
Dynamic necking, Nonlinear elasticity, Linear stability analysis, Numerical calculations, Inertia

1. Introduction

The problems of flow localization and fragmentation in ductile solids subjected to high loading rates have been intensively investigated over the last 70 years. This research field, which has been traditionally pushed forward by the aerospace and defence industries, is now especially active and

*Corresponding author. Tel. +33 387315369; Fax: +33 387315366. E-mail address: alain.molinari@univ-lorraine.fr