

Accepted Manuscript

Loss of ellipticity in elasticity with energy limiters

K.Y. Volokh

PII: S0997-7538(16)30104-8

DOI: [10.1016/j.euromechsol.2016.10.003](https://doi.org/10.1016/j.euromechsol.2016.10.003)

Reference: EJMSOL 3363

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

Received Date: 12 July 2016

Revised Date: 8 October 2016

Accepted Date: 10 October 2016



Please cite this article as: Volokh, K.Y., Loss of ellipticity in elasticity with energy limiters, *European Journal of Mechanics / A Solids* (2016), doi: 10.1016/j.euromechsol.2016.10.003.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Loss of ellipticity in elasticity with energy limiters

K.Y. Volokh*

Faculty of Civil and Environmental Engineering, Technion – I.I.T., Israel

October 14, 2016

Abstract

Traditional hyperelastic models usually obey requirement of material stability in various forms: Baker-Ericksen inequalities, strong ellipticity, polyconvexity etc. It is reasonable, of course, to require stability for the intact behavior of materials. However, all materials fail and a description of failure should be incorporated in the constitutive law. A simple version of hyperelasticity with failure can be formulated based on the introduction of the limiter in the strain energy density. The limited strain energy bounds maximum achievable stress automatically. Evidently, the elasticity with the energy limiter should exhibit material instability.

This note addresses two practically interesting calculations concerning the onset of material instability via the loss of ellipticity. First, we consider simple shear of natural rubber. We find the direction of failure localization, which is in perfect *qualitative* correspondence with fracture observations in rubber bearings after earthquakes. Interestingly, the direction of failure localization is different from the one predicted by the criterion of maximum tension stress or stretch. Second, we consider equibiaxial tension of a sheet of aneurysm material. We find that the isotropic aneurysm material exhibits infinitely many possible directions of failure localization in equibiaxial tension. The latter means that the random direction of cracks in equibiaxial tension experiment, e.g. membrane inflation, can be an indicator of material isotropy. Accordingly, a preferable direction of the crack alignment can be interpreted as an indicator of the aneurysm anisotropy.

1 Introduction

Materials fail. This physical observation was a bit ignored during the development of the theory of elasticity. Indeed, various requirements (Baker-Ericksen inequalities, strong ellipticity, polyconvexity etc.) are often imposed on the constitutive models to prevent from the appearance of

*E-mail: cvolokh@technion.ac.il

Download English Version:

<https://daneshyari.com/en/article/5014392>

Download Persian Version:

<https://daneshyari.com/article/5014392>

[Daneshyari.com](https://daneshyari.com)