Congress on Numerical Methods in Engineering
Lisboa, June 29 to July 02, 2015

RESUMO N° 334

DETERMINATION OF MACROSCOPIC YIELD SURFACES THROUGH HOMOGENIZATION-BASED MICROSCALE ANALYSES

Rodrigo Pinto Carvalho, em10063@fe.up.pt
Department of Mechanical Engineering, Faculty of Engineering, University of Porto, Portugal

Igor André Rodrigues Lopes, ilopes@fe.up.pt
Department of Mechanical Engineering, Faculty of Engineering, University of Porto, Portugal

Shenghua Wu, shwoo2001@gmail.com
Department of Mechanical Engineering, Faculty of Engineering, University of Porto, Portugal

Francisco Manuel Andrade Pires, fpires@fe.up.pt
Department of Mechanical Engineering, Faculty of Engineering, University of Porto, Portugal

Keywords: Micro-Mechanics, RVE, Homogenisation, Yield Surfaces

Over the past decade, the use of analytical and computational tools for the prediction of the constitutive behavior of materials at two or more physical scales has been the subject of increasing interest. In particular, the estimation of the effective parameters of a pre-defined macroscopic continuum constitutive model through the analysis of a microscopic representative volume element (RVE) and the development of new macroscopic constitutive models that result from the homogenisation of the response of a RVE has received considerable attention [1,2].

Our main purpose in the present contribution is to further investigate the second category of applications in order to determine macroscopic yield surfaces from the homogenized stress response Representative Volume Elements containing voids. To achieve this purpose, several confined finite element models of the microstructure containing voids with distinct shapes and sizes were developed to capture the response of porous materials. The prediction of macro scale yield surfaces was obtained from the solution of a boundary value problem of the RVE based on the knowledge of the macroscopic deformation tensors and internal variables. In the case of spherical voids, a comparison is made with Gurson´s yielding function [3]. Several matrix materials are considered, including both isotropic and anisotropic behavior. Whenever a pattern is found, analytical functions are developed to define yielding surfaces, and compared with other existing solutions.

[1] Danas, K., Aravas, N. (2012). Numerical modeling of elasto-plastic porous materials with void shape effects at finite deformations. Composites Part B, 43(6), 2544–2559

[2] Giusti, S., Blanco, P., Neto, E.S., Feijóo, R. (2009). An assessment of the Gurson yield criterion by a computational multi-scale approach. Eng. Computations, 26(3), 281–301

[3] Gurson, A. (1977). Continuum theory of ductile rupture by void nucleation and growth: Part I. J. Eng. Mat. and Tech., 99, 2–15