ΑΝΑΚΟΙΝΩΣΗ-ΠΡΟΣΚΛΗΣΗ
ΔΗΜΟΣΙΑ ΥΠΟΣΤΗΡΙΞΗ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ

Προσκαλούνται οι φοιτητές, τα μέλη Δ.Ε.Π., οι διδάσκοντες του Τμήματος και κάθε ενδιαφερόμενος, στη δημόσια υποστήριξη της Διδακτορικής Διατριβής:

"Porous Materials: Constitutive Modeling and Computational Issues"
του κ. Σωκράτη Ξένου,

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Abstract

This work is concerned with the development, calibration, and numerical implementation of a novel fully explicit isotropic, rate-independent, elasto-plastic model for porous metallic materials. The microstructure is assumed to consist of a random, with uniform probability, distribution of randomly oriented spheroidal voids of the same shape. The proposed model is based on earlier homogenization estimates that use a Linear Comparison Composite (LCC) theory. The resulting expressions exhibit the simplicity of the well-known Gurson model and, thus, their numerical implementation in a finite element code is straightforward. To assess the accuracy of the analytical model, we carry out detailed finite-strain, three-dimensional finite element (FE) simulations of representative volume elements (RVEs) with the corresponding microstructures. Proper parameter calibration of the model leads to fairly accurate agreement of the analytical predictions with the corresponding FE average stresses and porosity evolution. We show, both analytically and numerically, that the initial aspect ratio of the voids has a significant effect on the homogenized effective response of the porous material leading to extremely soft responses for flat oblate voids (e.g., aspect ratio less than 0.5) especially at high stress triaxialities.

Next, we examine the computational issues related to the numerical implementation of rate-independent constitutive models that lead to softening behavior. It is shown analytically that elastic-plastic models based on ``local'' continuum formulations that do not incorporate a characteristic length scale may lead to loss of ellipticity of the governing partial differential equations (PDEs) and mesh-dependent numerical solutions. To remedy the associated numerical problems, we propose an implicit non-local version of the porous model developed in this work which is based on the introduction of a non-local porosity variable determined from the solution of an additional PDE. We show both analytically and numerically that the regularized version of the model allows for preservation of the elliptic properties of the governing equations yielding mesh-independent, converged solutions in the post-bifurcation regime. The bifurcation point (i.e., strain-to-localization) is found to be highly dependent on the micro-void's shape, with very flat voids (e.g., aspect ratio less than 0.3) leading to lower localization strains. The material length introduced by the non-local formulation is found to have minimal effect on the predicted bifurcation point, only affecting the post-bifurcation gradient of the macroscopic stress-strain curve and the size of the highly strained zone in the structure.

In the last part of this study, both the local and the non-local versions of the model are efficiently implemented in a commercial finite element code (ABAQUS). The models are used for the numerical solution of boundary value problems (BVPs) related to forming and ductile fracture processes under both quasi-static and dynamic conditions. In particular, the industrially relevant problems of Hole expansion (HET) and Charpy impact (CVN) test, the cup-and-cone fracture phenomenon as well as ductile fracture of a specimen with complex geometry and comparison with corresponding experimental results are analyzed in detail. Numerical predictions in all cases indicate that ductility is an increasing function of the void shape parameter

and materials comprising flat oblate voids of low aspect ratio exhibit early macroscopic crack initiation and propagation compared to materials with spherical/almost spherical voids. Finally, the model's capability to reproduce experimental results with sufficient accuracy suggests that it can be utilized to provide predictions with only a small amount of parameters that may be calibrated from either micromechanics calculations or experimental data.

Η παρουσίαση θα πραγματοποιηθεί στο εργαστήριο Laboratoire de Méchanique des Solides του École Polytechnique στο Παρίσι την Παρασκευή 28 Ιουνίου 2024 και ώρα 15:00 με δυνατότητα παρακολούθησης μέσω τηλεδιάσκεψης στον παρακάτω σύνδεσμο:

(https://cnrs.zoom.us/j/92438517851?pwd=aCx9I7av3ybBirAXnaB2l2i83itksb.1)

ΣΥΝΤΟΜΟ ΒΙΟΓΡΑΦΙΚΟ

Ο Σωκράτης Ξένος γεννήθηκε το 1995 στην Καρδίτσα και αποφοίτησε από το 3ο Γενικό Λύκειο Βόλου. Ακολούθησε προπτυχιακές σπουδές στο ΠΘ, από όπου έλαβε δίπλωμα Μηχανολόγου Μηχανικού το 2018. Τον Δεκέμβριο του 2019 και τον Ιανουάριο του 2020 έγινε δεκτός ως υποψήφιος διδάκτορας από το τμήμα Μηχανολόγων Μηχανικών του ΠΘ και τη σχολή École Polytechnique του Institute Polytechnique de Paris αντίστοιχα, για την πραγματοποίηση διδακτορικών σπουδών στο πλαίσιο συνεπίβλεψης (co-tutelle). Έκτοτε συμμετείχε συχνά στην υποστήριξη εκπαιδευτικών δραστηριοτήτων. Ο κ. Ξένος έχει δημοσιεύσει δύο (2) εργασίες σε διεθνή περιοδικά υψηλού δείκτη απήχησης, και έχει παρουσιάσει την δραστηριότητά του σε ένα διεθνές συνέδριο.

Βόλος - Ιούνιος 2024,
Ν. Αράβας
Επιβλέπων Καθηγητής