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Yield criterion and finite strain behavior of random porous isotropic materials. (English)

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Summary: The mechanical response of isotropic elastoplastic materials containing random distributions of initially spherical voids is investigated computationally based on Fast Fourier Transform simulations. Numerical limit-analysis simulations at constant stress triaxiality allow to determine the yield surfaces, leading in particular to the determination of a Representative Volume Element size for the onset of coalescence/inhomogeneous yielding. Moreover, two different coalescence regimes are observed that differ by the presence of shearing. The yield surfaces are found to be consistent with the combination of two models proposed in the literature, a GTN-type model calibrated for homogeneous yielding of random porous materials and an inhomogeneous yielding model accounting for both coalescence with or without shear. Finite strain simulations performed for different hardening moduli and stress triaxialities under axisymmetric loading conditions confirm the existence of a RVE up to the onset of inhomogeneous yielding. Coalescence strains are found to be significantly smaller for random porous materials than for periodic distribution of voids. A homogenized model is finally proposed that reproduces quantitatively the behavior of isotropic elastoplastic materials containing random distributions of voids under finite strains.

MSC:

74F10 Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)
74C15 Large-strain, rate-independent theories of plasticity (including nonlinear plasticity)
74E35 Random structure in solid mechanics

Keywords:

finite strain elastoplasticity; porous material; random void distribution; representative volume element; inhomogeneous yielding

Software:

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