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# Modelling of strain localization in ductile materials

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The physical mechanisms governing ductile fracture of metals and alloys are nucleation, growth and coalescence of voids, as demonstrated by the dimpled fracture surfaces. However, ductile fracture is often preceded by strain localization into narrow bands. A recent study by *Tekoğlu* et al. [1], employing unit cell simulations, has shown that macroscopic strain localization occurs simultaneously or prior to void coalescence depending on the stress triaxiality. Thus, the strain localization phenomenon can be considered to be a severe warning against ductile failure. This warning can be viewed as a lower bound to ductile failure. In many instances, the localization process is very abrupt and the localization criterion is observed to be very close to complete failure, justifying its use as a ductile failure criterion.

In this study, the imperfection band approach of strain localization theory, which was proposed by Rice [2], is used to predict initiation of ductile fracture in metals. A planar imperfection band is assumed in an otherwise homogeneous and homogeneously deformed material element and the conditions for localization inside the band are sought for within a wide range of band orientations and stress states. The material inside the imperfection band is modelled with porous plasticity, whereas metal plasticity (or porous plasticity) is used for the bulk material. The imperfection is taken as either an initial porosity or a volume fraction of void nucleating particles.

The strain localization analyses are compared with unit cell computations [3] and existing experimental data for steel and aluminium alloys. Based on these studies, it is concluded that the imperfection band version of the strain localization theory, when carefully calibrated, gives reliable estimates of the onset of ductile fracture for a wide range of loading conditions. Lastly, a case study is presented in which strain localization theory is used within a multi-scale modelling framework to establish computational damage models for large-scale simulations of structural components with reduced experimental calibration.

*References*

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