The Critical Neck Spacing in Ductile Plates Subjected to Dynamic Biaxial Loading: On the Interplay between Loading Path and Inertia Effects

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ABSTRACT

In this work we have investigated the emergence of a critical wavelength which characterizes the localization pattern in ductile plates subjected to dynamic biaxial loading. For that task we have used a linear stability analysis and finite element calculations. The stability analysis includes specific features to account for inertia and stress triaxiality effects inside the necking. Two different finite element models are built: (1) a unitary cell model in which the localization is favored by a sinusoidal geometrical perturbation and (2) a plate with constant cross section which allows to assess the collective behaviour of multiple necks. A wide spectrum of loading paths which range from plane strain to biaxial stretching has been explored. We have demonstrated that, if inertia plays a dominant role in the loading process, the influence of geometrical perturbations in the necking inception is substantially reduced and the necking pattern shows a deterministic nature. The deterministic nature is directly connected to the emergence of a critical wavelength which characterizes the neck spacing at high strain rates. This critical wavelength increases (i.e. the neck spacing increases) and becomes less prevailing (i.e. the necking pattern becomes less uniform) as we move away from plane strain to biaxial stretching.