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MICRO-MECHANICAL NUMERICAL ANALYSIS OF DUCTILE DAMAGE UNDER DYNAMIC LOADING CONDITIONS

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This contribution deals with the influence of the stress-state on plastic deformations and damage processes of ductile materials subjected to high strain rates. The material behavior is described by a continuum damage model which takes into account the dependence on the stress-state within the corresponding constitutive equations. To study the damage processes in more detail, micro-mechanical studies of elastic-plastic media containing pores have been performed and analyzed in detail.

The continuum damage model is based on the introduction of damaged and fictitious undamaged configurations [3] which relate to each other by damage tensors. On the undamaged configurations an elastic-plastic material law is evolved taking into account a generalized hydrostatic-stress-dependent yield condition and a non-associated flow rule. In a similar way a damage condition and a corresponding damage rule are introduced on the damaged configurations while both strongly depend on stress state. In addition the rate and temperature dependence of the material is reflected by a multiplicative decomposition of the plastic hardening and damage softening functions [4, 5].

The damage behavior of ductile metals under static loading conditions is frequently studied by micro-mechanical analysis of void containing micro cells, see e.g. [7, 6], while analysis under dynamic loading conditions are not commonly realized [2]. In this context experimental observations on spall damage [1] strongly suggest that void growth is an important mechanism which leads to final fracture of the material. Consequently three-dimensional numerical studies of unit cells containing different distributions of spherical voids are analyzed. In this connection special focus is given to the size and distribution of the voids, the influence of the boundary conditions and to the plastic hardening behavior of the matrix material. These micro-mechanical studies provide valuable references with respect to the damage processes of ductile metals under dynamic loading which can be used to validate the damage criterion and damage law of the proposed continuum damage model.

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