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Modeling of ductile behavior of metals with a semi-empirical approach: application to the stamping and uniaxial tests

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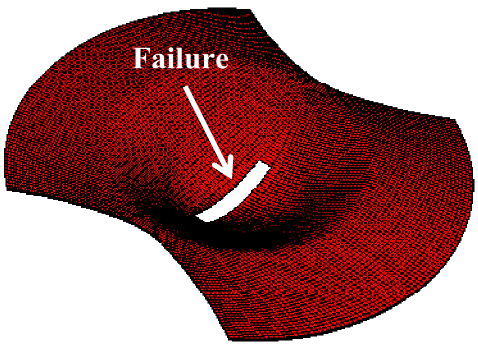
ABSTRACT

For a large number of metal forming processes the loading conditions are severe. Therefore, it is necessary to develop robust tools to predict structural response of theses materials under these loading conditions. In this paper, we propose a semi-empirical elastic-viscoplastic material model combined with a non-linear isotropic damage evolution law. The effect of strain hardening, strain-rate hardening, pressure and thermal softening are incorporated in this modeling for a wide range of loading rates. Like in the mechanical threshold stress model, the flow stress is decomposed as the sum of an effective stress and a thermally-activated component. The proposed model is a semi-empirical description of the plastic deformation behaviour of ductile metals where some of the physical aspects are taken into account via the mechanical threshold stress and an Arrhenius type expression relating strain rate to activation energy and temperature. The damage evolution law is based on the theory of continuum damage mechanics by assuming the existence of new ductile damage dissipation potential. The models have been implemented in the form of a user material subroutine (VUMAT) in the commercial finite element code ABAQUS/Explicit. We simulated the uniaxial loading tests of copper, stamping process and Nakazima test of HY100. Results from our model are in a good agreement with the existing experimental results.
We realised a combination between the FEM results and the "Virtual Reality" techniques.



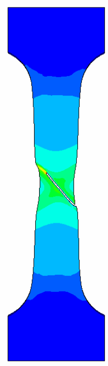


Figure 1: Deformed mesh obtained during Nakazima test and uniaxial loading test.

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