Prediction of the onset of fracture of DP980 steel 1.2t under typical loading conditions based on associated and non-associated flow rules

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This paper is concerned with prediction of the onset of fracture of DP980 steel 1.2t under typical loading conditions based on associated and non-associated flow rules to consider the influence of histories in stress path and strain path on the damage accumulation. In general, metallic sheets exhibit a considerable anisotropy due to their crystallographic texture and it significantly affects their deformation behavior when subjected to certain loading conditions. In order to consider the mechanical anisotropic characteristics of the sheet metal during the simulation, the Hill's 48 quadratic plastic potential was utilized and its material parameters were determined on the basis of the initial Lankford coefficients and/or yield stresses along the orthotropic and diagonal axes of the sheet metals. The Lou−Huh ductile fracture criterion was employed to evaluate the damage accumulated during the deformation. The coefficients of the Lou−Huh ductile fracture criterion for DP980 were obtained by evaluating the equivalent plastic strain to the fracture from tensile tests of various shape of specimens which induce typical loading conditions such as pure shear, plane strain tension, and uniaxial tension at the material point where the fracture initiates. Strain measurement were performed by the two-dimensional digital image correlation (2D-DIC) method. In order to perform the fracture simulation based on associated and non-associated flow rules, a vectorized user-defined material subroutine (VUMAT) was developed for commercial finite element code ABAQUS/Explicit.

Keywords: Damage accumulation, Associated flow rule, Non-associated flow rule