Influences of Yield Criteria on Stress Based Forming Limit Diagram of DP980 Steel

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ABSTRACT

In this study, experimental and numerical analyses for forming limit stress diagram (FLSD) of an advanced high strength (AHS) steel grade 980 were carried out. Forming limit curve of the steel was first experimentally determined by means of the Nakazima stretch–forming test. Then, analytical calculations of the FLSD were performed based on the Marciniak–Kuczynski (M–K) model. The FLSD was also directly computed by using the experimentally obtained FLD data. Different yield criteria, namely, Hill'48 (*r*–value and stress–based), Yld89 (*r*–value and stress–based) and Barlat2000 (Yld2000–2d) were examined, in which predicted plastic flow behaviors of the AHS steel were evaluated. Hereby, the strain hardening was described according to the Swift law. To identify material parameters of each model, uniaxial tension, balanced bi–axial bulge test and in–plane biaxial tension test were performed. Influences of the constitutive yield models on numerically predicted FLSDs were investigated and compared to that resulted from the experimental FLD data. Additionally, predicted plastic flow stresses and plastic anisotropies of the AHS steel in different directions were evaluated. Effects of the applied anisotropic yield functions, strain rate sensitivities, imperfection values and work hardening coefficient on the calculated FLSDs were discussed. It was found that the stress based forming limits were strongly affected by the yield criterion. The FLSD based on the Yld2000–2d yield model acceptably agreed with the FLSD based on the experimental FLD data. Accuracy of the FLSD predictions using the M–K theory, especially in the biaxial state of stress, significantly relied on the used yield criterion, for which yield stresses and *r*–values from different loading directions were required.

Keywords: Forming limit stress diagram, Marciniak–Kuczinsky model, Yield criteria, High strength steel.