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MICROMECHANICAL MODELING OF DP600 AND DP800 STEELS PLASTIC BEHAVIOR BASED ON THE MORI-TANAKA HOMOGENIZATION SCHEME

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The properties of the dual-phase (DP) steels are attributed to the chemical composition, type, size, amount and spatial distribution of different phases that can be obtained during thermomechanical treatments. In this way, modeling of the mechanical behavior of the dual-phase steel microconstituents, namely, ferrite and martensite, is crucial to the numerical simulation of sheet metal forming processes of these steels. In this work, the microstructure of as-received DP600 and DP800 cold rolled steel sheets with 1.2 mm nominal thickness were firstly characterized by means of scanning electron microscopy (SEM) technique. The grain sizes and volume fractions of ferrite and martensite phases were obtained by means of digital image analysis. The Mori-Tanaka homogenization scheme was implemented in the finite element code ABAQUS using a User Material (UMAT) subroutine assuming linear isotropic elasticity and isotropic work-hardening behavior for both ferrite (matrix) and martensite (inclusion) phases. Simplified numerical models were defined using three-dimensional linear solid elements in order to reproduce the experimental results of uniaxial tensile and hydraulic bulge tests performed in DP600 and DP800 cold rolled steel sheets. The numerical predictions of the macroscopic true-stress versus true-strain equivalent measures are in good agreement with the corresponding experimental curves. The adopted micromechanical approach based on the Mori-Tanaka homogenization scheme also provided the local fields, namely, strains and stresses per phase. In particular, the residual stresses per phase which is very important to predict the undesired springback effects arising from the forming operations of advanced high strength steels.