

Failure of AA6022-T4 Sheets in Hole-Expansion after Uniaxial Prestrain

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Abstract. To replicate the behavior of anisotropic sheets during multi-step forming, as in stamping in a progressive die, the hole-expansion (HE) of uniaxially-prestrained AA6022-T4 sheets is studied. The prestrain experiments involve wide dogbone specimens. During these experiments, Digital Image Correlation (DIC) is used to assess the uniformity of the strain fields. It is found that while the strain fields are not as homogeneous as for the conventional dogbone specimens, the strains around the hole position are relatively uniform. The prestrain experiments are terminated when approx. 60% of the uniform elongation in tension develops at the central region of the specimen. Subsequently, HE specimens are created from the wide prestrain specimens by end-milling a 35 mm dia. hole. The HE experiments use a flat-headed punch of 100 mm dia. and are performed in a fully-instrumented hydraulic press, where measurements of the punch force and displacement, as well as DIC are available. Due to the orthotropy of the material, this otherwise axisymmetric problem develops a very clear variation of the thickness around the circumference, which is captured by DIC. Subsequently, finite element (FE) simulations of the HE experiments are performed. For material modeling, the initial yield surface of this AA6022-T4 alloy is represented by the Yld2000-2D yield criterion very accurately. The yield surface is assumed to evolve by distortional hardening, replicated here by the Homogeneous Anisotropic Hardening (HAH) model. This model is calibrated by performing cyclic tension-compression and two-step tension tests, where subsize tensile specimens are extracted from a prestrained wide dogbone specimen in 30°, 60° and 90° to the prestrain direction. The parameters of the HAH model are calibrated by matching the tension-compression first and then the two-step tension experiments. The results of the FE simulations of the prestrained HE tests are then compared to the DIC measurements.