Thermo-Viscoplastic Behavior of AA6061 under Dynamic Biaxial Loadings

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Abstract. Sheet metal forming processes are widely adopted in industry to produce thin-wall parts. With increasing demands for safety, lower weight or decreased fabrication costs, new materials and innovative forming processes emerge. The numerical simulation tool, mainly based on the finite element modelling, is intensively used to analyse the performances of these materials and to optimize these new processes. The improvement of prediction models requires characterizations of the material behaviour for conditions close to the ones encountered in practice during the forming stage or in use.

In this study, the calibration of a thermo-visco-plastic model of an aluminium alloy (AA6061) under biaxial tensile loadings is proposed. The temperature dependency of the hardening behaviour of this metallic alloy is studied from ambient temperature up to 200°C in the intermediate strain rate range. The parameter identification process is based on a unique biaxial tensile test performed on a dedicated cross specimen. The cruciform specimen shape used in this work has been previously proposed by authors [1] to characterize the strain-rate dependent behaviour of DP600 steel at room temperature. An experimental biaxial flow stress curve up to 30% of equivalent plastic strain can be determined by means of this cross specimen with a constant thickness central zone.

The identification strategy is based on the FE model of the in-plane biaxial tensile test and both experimental local principal strains at the central point of the specimen and global force measurements along the two arms of the specimen. An insulated box supplied by a hot air generator allows to ensure that a constant temperature field in the specimen at the beginning of the test.

Experiments presented in this study validate the capabilities of the servo-hydraulic device to investigate the thermoplastic behavior of strain rate dependent materials under biaxial loadings for an intermediate strain rate range.

[1] W. Liu, D. Guines, L. Léotoing, E. Ragneau, Identification of strain rate-dependent mechanical behaviour of DP600 under in-plane biaxial loadings. Materials Science & Engineering A676 (2016) 366–376.