On the identifiability of sheet metal constitutive parameters using the Arcan test

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***Abstract* —** In modern industry, modelling and simulation are crucial phases of product development. Sheet metal forming processes typically involve large deformations and complex phenomena. As a result, modelling the behaviour of the materials during forming requires complex constitutive models and high accuracy in their calibration to produce a realistic simulation of the forming processes. During the last decades, a huge effort was made by the scientific community to develop precise constitutive model formulations in elastoplasticity, including complex yield functions [1], and isotropic and kinematic hardening models [2]. However, due to the increased flexibility of the mathematical formulation and the consequent increase in the number of constitutive parameters that must be calibrated, the identification of the parameters of such models involves a complex calibration procedure. Classically, the calibration was done using standard homogeneous tests, where each test represents a single stress/strain state. As a result, an extensive experimental campaign is usually required to fully characterise the material behaviour. Nowadays, with the use of heterogeneous test configurations and full-field measurements, it is possible to measure a combination of multiple stress/strain states. This rich kinematic data can be used in inverse identification techniques, such as the virtual fields method [3], to identify multiple parameters from a single test with reduced cost and time [4]. Moreover, the richness of the measured kinematic data is highly dependent on the test configuration used, and while the Arcan test has been used in sheet metal plasticity by some authors, it is rarely used in heterogeneous test design for plastic constitutive model calibration. Nonetheless, the Arcan test is an interesting test configuration since it allows the loading direction to be varied in a standard uniaxial tensile testing machine.

This study presents a numerical evaluation of the Arcan mechanical test to identify plasticity constitutive parameters of a dual-phase steel (DP600). The numerical model used considers the anisotropy and hardening of the material. Several Arcan test configurations are simulated and further evaluated regarding their mechanical state heterogeneity using a set of indicators. This approach presents a methodology for selecting the most suitable configuration.

Keywords— Sheet metal forming; Inverse calibration; Anisotropic plasticity; Arcan test; Heterogeneous test evaluation.

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TOPIC

1) a.:Sustainable Manufacturing Solutions -Manufacturing Processes & Simulation

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