On the identifiability of sheet metal anisotropic plasticity constitutive parameters using the Arcan test and full-field measurements

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Abstract The development of sheet metal parts is increasingly aided by numerical simulation, where the results are heavily influenced by the constitutive parameters of the material. Accurate results depend on the calibration of the constitutive models, which determine the behaviour of the material during the forming process, including anisotropy. To fully characterise the mechanical behaviour of the material, mechanical testing is essential. However, classical mechanical tests may not provide sufficient kinematic data. However, modern technology now enables the measurement of diverse strain states using heterogeneous test setups and full-field measurements. In addition, new heterogeneous test configurations have emerged, where full-field measurements can be coupled with inverse identification techniques, such as the virtual fields method (VFM), to fully characterise the material behaviour with a reduced number of experimental tests. However, the accuracy of this methodology is influenced by a variety of factors, including the test configuration, the constitutive model and the selection of a suitable identification strategy. The Arcan test is a unique testing setup that enables the variation in the loading direction in a standard uniaxial tensile testing machine. While this test has been used in sheet metal plasticity, it is not commonly used for calibrating plastic constitutive models in heterogeneous test design. However, the Arcan test offers the potential for interesting heterogeneous test configurations. This work aims at evaluating various Arcan test configurations through simulation and measuring their mechanical state heterogeneity using a set of indicators. The simulation results are then used to generate deformed speckle pattern images that are analysed using digital image correlation (DIC) to obtain kinematic data. The results are then used to calibrate the sheet metal constitutive parameters using the VFM through an inverse identification approach.

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