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Characterization of the Austenitic Stainless Steel: design, simulation and experimental testing of cupping tool for the deep drawing process.

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ABSTRACT

Simulation of a sheet metal forming process involves complex material behavior and tool-material interaction analysis. Metastable austenitic stainless steels, such as AISI 301 steel, are used in the production of a variety of formed and drawn parts for architectural, automotive, and electrical appliances. The ability of such steels to undergo severe forming operations is governed by their plastic behavior; the stress developed in response to imposed forming strains. This work presents an experimental characterization of the mechanical behaviour of the austenitic stainless steel (AISI 301) of 0,4 mm of thickness.

Specifically, this paper presents the modeling and experimental validation of the different formability tests: uniaxial tensile, Erichsen and cylindrical cup (varying the Limiting Drawing Ratio LDR). Additionally, the friction coefficient for the lubrication conditions used in the formability test has been measured by means of Inland testing equipment (using suitably designed and fabricated tools). In order to produce the Forming Limit Diagram (FLD), the square grid pattern has been marked onto the surface of the blank sheet using a Nd:YAG Laser System. The FLD has proved useful for characterizing the formability of the sheet metal and provides information for press-shop operations.

The deformation process has been captured with the Forming Measurement Tool Innovations (FMTI) grid analysis system, using a square grid analysis (SGA) and a grid analyzer diagnostics device (Check Camera). The deformation measurements are based

on the computer vision technique, which utilizes the image of a grid pattern placed onto the work piece.

After the characterization of the material, the Finite Elements Method (FEM) analysis has been applied, to simulate sheet metal forming process for industrial application. The forming analysis has been performed with AUTOFORM finite element software. This application illustrates the advantages of the FEM current techniques in stamping parts for electrical appliances, considering that the geometry and the strain distribution of the test parts, as optimization variables, are decisive acceptance criteria in the design phase. A deep drawing rig has been designed and built as a result of the simulation process. The results of the forming process have been consistent with the experiments and finite element results. This research contributes to simplify and accelerate the analysis and resolution of real cases in industry.

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