A Finite Element Approach to the Integrated Modelling of the Incremental Forming of Friction Stir Welded Sheets

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Abstract. Industry of thin sheet components has an increasing need to produce parts having advanced mechanical and superficial properties and which, at the same time, meet aesthetical requirements of the customers. The main industrial processes in productions of this kind of components regard jointing, plastic forming and cutting. Modeling the impact on the produced part of different operative conditions in several successive processes requires an integrated approach.

The focus of the present work is the development of an integrated numerical model able to simulate the forming, by means of Single Point Incremental Forming (SPIF), of thin laminate aluminum alloys (series 6000) foils jointed by Friction Stir Welding (FSW) process. In concept, the approach is based on the link between two submodels simulating the two consecutive processes. The first submodel, taking in input the geometry and the mechanical properties of the anisotropic laminate aluminum foil, was built to simulate in ABAQUS computational environment, the joining by FSW, requiring in input its operative parameters (trajectory of the joint, rotation velocity, advancing speed and geometry of the pin). FSW sub-models provides in output the mechanical properties of the welded sheet and the geometry of nugget zone, thermo-mechanically affected zone and heat affected zone. These output feeds the SPIF sub-model, which, requiring also the operative parameters (trajectory and speed of the indenter), evaluate the formability of the FS welded material.

The aim of this work is to build an integrated FSW-SPIF model, in order to investigate the impact of the operative parameters' variations of the two processes on the formability of the friction stir welded sheets and on the mechanical properties of the final formed part.