Integrated Design in Welding and Incremental Forming: Mechanical Behavior of Friction Stir Welded Blanks

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Abstract. Sheet metal structures are used in a large number of industries, such as transportation, food, home appliance, among others. The manufacturing process, which is often a multi-stage process involving usually forming and assembly, is nowadays designed partly by numerical simulation, where each step can be individually considered. There is a huge interest to simulate the whole process, instead of focusing on some of the most important stages, in order to improve the reliability of the numerical predictions. However, such an integrated design of the whole manufacturing process is a complex route, and experimental validation is still necessary. The present study is part of a global project dealing with the forming of welded aluminium blanks. More specifically, blanks are initially welded by friction stir welding and the process parameters such as the rotational speed and the feed rate are changed to analyse and evaluate their influence on the mechanical properties of the blanks. Then, the welded blanks are formed into conical structures by single point incremental forming, in order to assess their formability. This paper deals with the mechanical characterization of the welded plates of similar materials, i.e. aluminium alloy of series 6000 (thickness of 2 mm). Three main areas can be distinguished in the welded blanks: the nugget zone at the center of the weld; the heat affected zone; and the base material. Tensile tests are carried out both on the base material and also on the material transversely to the weld using a digital image correlation device to capture the strain field (Fig. 1). Several tests are performed to evaluate the influence of the welding process parameters on the mechanical properties of the blank. The aim is to identify the material parameters to be used as input in the numerical simulation of the forming process.

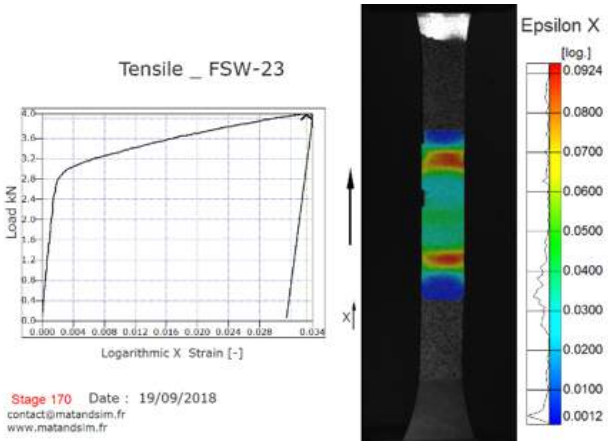

Figure 1 - Load-strain curve of a welded sample (left), and the strain distribution representation in the welded area (right).