MECHANICAL BEHAVIOUR OF FRICTION STIR OVERLAP WELDS FOR AERONAUTICAL APPLICATIONS

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Abstract

The application of friction stir welding (FSW) in an overlap configuration could be an attractive replacement to the riveting process for assembly of fuselage primary structures due to the similarity in tolerance management, which makes its implementation easier in comparison to other joint geometries such as butt welds.

In order to quantify the static and fatigue strength of this joint geometry, an experimental investigation on AA2024 sheets was performed. Several configurations of lap joints were performed using single and multiple passage FSW. Their mechanical behavior was assessed through static and fatigue tests.

Cross-sectional analysis and mechanical tests of the different welding configurations indicated that using standard FSW tools, the reduction of the strength area is unavoidable due to the vertical material flux during the process. The material flow is responsible for a hook shaped unwelded defect at the interface of the plates near the nugget. This defect is highly detrimental to the fatigue properties, reducing the fatigue life significantly.

Currently, the low mechanical characteristics of FSW overlap joints limit their potential application in primary aircraft structures, where high fatigue resistance is imperative. Furthermore, a corrosion protection concept needs to be developed and assessed before its application, in order to ensure the structural integrity under all loading and environmental conditions.

Keywords Friction stir welding, primary welded structures, overlap joints, static strength, fatigue strength.

1. Introduction

Friction stir welding (FSW) is a welding process with high reliability and efficiency for light metals such as aluminium alloys. It has been developed since 20 years and can be found in numerous applications in aerospace and aeronautical structures (Lohwasser and Chen, 2010). In the case of primary aeronautical structures, the major joining process continues to be the riveting process. However this process has many non-added value parts and operations, which could be improved using advanced joining processes if all requirements of aeronautical structures are fulfilled. The application of welding processes can improve primary structures with significant cost, weight and lead times reductions, since it does not require fasteners, sealants and the associated application tasks, as demonstrated by Tempus (2001). In the case of FSW technology, its application to the assembly of fuselage stiffened panels can be performed according to different geometric configurations as butt-joints, overlap joints and T-joints (where the skin panels can be joined together with a stiffener even if it is a different material). A straightforward replacement of the riveted joints could be the overlap welded joint configuration since the