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Abstract

This paper describes fatigue tests performed on 6061-T651 and 5083-H321 aluminum friction stir welded joints with dimensions and loading conditions typical for structural applications. Butt and lap joint details with various defects intentionally introduced were tested under tension-only constant and variable amplitude loading conditions. In this paper, the fatigue test results are presented along with supporting metallurgical and nonlinear fracture mechanics analyses. Based on this work, it is concluded that kissing bond defects on the order of 0.3-1.0 mm can result in a significant fatigue life reduction and a shift in the failure mode to the weld root. The investigated toe-flash defect had less of an effect on fatigue performance. The lap joint did not perform as well as the butt joint detail.

Keywords: Aluminum; Friction stir welds; Defects; Fracture mechanics; Variable amplitude loading

1. Introduction and Background

Friction stir welding (FSW) is a solid-state joining process. It involves rotating a cylindrical tool with a short protrusion or “pin”, which is plunged between two metal plates. High pressure and shear strain plastically deform and consolidate the work pieces by means of material extrusion from the front to the back of the tool [1]. The plates are clamped with a sturdy fixture to the backing plate with an anvil piece of hardened steel underneath the path of the FSW tool, counteracting the vertical and horizontal forces