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Bulletin of the JSME

Vol.12, No.1, 2018

Journal of Advanced Mechanical Design, Systems, and Manufacturing

Experimental investigation of friction stir blind riveting process for similar and dissimilar alloy sheets

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Received: 14 December 2017; Revised: 1 February 2018; Accepted: 21 February 2018

Abstract

Friction stir blind riveting (FSBR) is a new joining method which eliminates the need to predrill a hole for rivet insertion. A new one-sided mechanical joining process, friction stir blind riveting (FSBR) was developed to form lap-shear joints for similar and dissimilar alloy sheets in different combinations. The similar and dissimilar joints are made from copper, Al 5052-H32, Al 6061-T6 metals. The process window was investigated of CNC machines using only three spindle speeds: 1110, 1750 and 2750 rpm. FSBR joints were observed and discussed during tensile testing. All the similar and dissimilar joints are well fabricated at 1750 rpm. Tensile testing results show that any material with copper combinations (copper used as a top plate) at 1750 rpm as riveting speed gives the appreciable ultimate tensile strength. Further study revealed micro structure of the joint interfaces, when compared with different combinations.

Keywords : Aluminum alloys, Copper, FSBR, Mechanical properties, Microstructure analysis

1. Introduction

Solid riveting is an important metal joining process in which a hole is made in the sheets and then the rivets are used to join the sheets. A self-piercing riveting was introduced to improve the process. Both these processes require the two sided access, which may be difficult and significantly slow down the joining process. A new metal joining process called as Friction stir blind riveting (FSBR) was developed by Wang and Stevenson, (2007). This process involves a combination of friction stir welding and blind riveting. FSBR process eliminates the need for the separate hole making operation required in the conventional blind riveting process while retaining the advantage of one-sided accessibility. The advantages of FSBR process are: (i) Most of the FSBR processes eliminate the need for a predrilled hole, thereby reducing the difficulties in laminating the multiple holes during joining. (ii) The methods are capable of joining both similar and dissimilar materials with a wide variety of material selections. (iii) They are highly suitable for batch production and automated feeding system. (iv) FSBR processes require a shorter span of process times including post processing and sample preparations as compared to other joining methods, e.g., adhesive bonding combined with welding. (v) FSBR joints have relatively high strengths and large displacements before fracture. (vi) FSBR processes allow the development of newer products and sophisticated design that were previously not possible with conventional joining processes. Gao et al., (2009) conducted experiments on 3 mm-thick AA 5052 sheets using FSBR joints and clearly found that the joints withstand a larger tensile load and possess a high fatigue resistance compared to electrical resistance spot welded joints. Changing et al., (2011) joined a dissimilar high strength steel DP600 (1mm) and magnesium alloys AZ31B (3 mm) sheets using FSBR process. Lathabai et al., (2011) made riveted joints in die cast and wrought Al alloys as well as Mg AZ31 sheet using FSBR process with several types of blind rivets. They concluded that rivets with a hollow mandrel head capture the work piece material displaced by the rivet within

Paper No.17-00679
[DOI: 10.1299/jamdsm.2018jamdsm0028]