Effects of Post-Welding Cooling Rate on Strength of TCW Joints: An Experimental and Numerical Investigation

Zhi Bin Tan, Liyong Tong

PII: S0143-7496(17)30245-2
DOI: https://doi.org/10.1016/j.ijadhadh.2017.12.018
Reference: JAAD2106

To appear in: *International Journal of Adhesion and Adhesives*

Received date: 16 September 2017
Accepted date: 15 December 2017

Cite this article as: Zhi Bin Tan and Liyong Tong, Effects of Post-Welding Cooling Rate on Strength of TCW Joints: An Experimental and Numerical Investigation, *International Journal of Adhesion and Adhesives,* https://doi.org/10.1016/j.ijadhadh.2017.12.018

Effects of Post-Welding Cooling Rate on Strength of TCW Joints: An Experimental and Numerical Investigation

Zhi Bin Tan and Liyong Tong *

School of Aerospace, Mechanical and Mechatronic Engineering, University of Sydney, Sydney, NSW 2006, Australia
(* corresponding author: liyong.tong@sydney.edu.au, Phone +61 2 9351 6949)

Abstract

In a thermoset composite welding (TCW) joint, a thermoplastic weld polymer is used to allow two carbon-epoxy components to be welded together, where thermal residual stresses can build up due to high mismatch in coefficient of thermal expansion. In this study, the effects of the cooling rate on joint strength were investigated experimentally and numerically for its effect on thermal residual stresses in the TCW joints. The experimental results showed that, by lowering the cooling rate, a higher joint strength can be obtained across different operating temperatures and different laminate configurations. It is believed that the material properties of the thermoplastic weld polymer had been altered by the use of different cooling rate and damage zone method was used in the numerical model to predict the material properties of the weld polymer. The numerical results confirm that the lower cooling rate produced weld polymer with higher strength and stiffness, which translated into a stronger TCW joint. The combination of experimental work and FEA model in this study allows the prediction of joint strength when the material properties are not widely available due to post-manufacturing treatment.

Keywords

Cooling rate, thermoset composite welding, shear strength, finite element

1 Introduction

Composite materials are being used in aerospace, automotive, wind turbine, ship building and infrastructure industries. In the aerospace industry, carbon fibre reinforced plastic (CFRP) material accounted for an increasing proportion of the frame structural weight of an aircraft. As a result of this, new joining methods have to be developed as the traditional way of joining metal are usually not suitable for composite materials. Adhesive bonding is used extensively in CFRP/CFRP and CFRP/metal connections and it has the distinct advantage of weight reduction, better environmental and fatigue