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Join the Conversation. What you have to say matters.
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\textsuperscript{a}Department of Naval Architecture and Ocean Engineering, United States Naval Academy, Annapolis, MD
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Experimental and Numerical Study of Hybrid Steel-to-Fiber Reinforced Polymer Joints Under Tensile Loading

Abstract

Hybrid metal-to-fiber reinforced polymer (FRP) joints are being used more commonly for load bearing applications. However, these hybrid joints usually entail geometry and material discontinuities which can induce stiffness mismatch and cause local stress concentrations. The shock impedance mismatch caused by the different wave propagation characteristics can also be crucial to the structural response of the hybrid joints under impulsive loads due to sources such as an air blast or underwater explosion (UNDEX). Recent research at Imperial College London (ICL) and the U.S. Naval Academy (USNA) has focused on characterizing the behaviour and ultimate load capacity of metal-to-composite hybrid joints with different configurations under various loading conditions. This paper presents results from tensile strength testing of steel-to-vinyl ester GRP double lap joints, comparing pseudo-static strength with dynamic strength and comparing joints that exploit perforated steel plates with those manufactured with non-perforated steel plates. An intentional manufacturing flaw also was incorporated into half of the joints, both perforated and non-perforated joints, in order to assess the effect of this flaw type on joint strength. These experimental results are compared to Finite Element Analysis (FEA) results for both perforated and non-perforated joints.

T. Löbel, D. Holzhüter, C. Hühne
German Aerospace Center (DLR), Braunschweig, Germany

Disbond-Stopping Concepts for Bonded Composite Joints

Abstract

Bonded composite joints have many advantages in comparison to conventional fasteners. However, adhesive bonding of primary aircraft structures is still a certification issue. One promising way to achieve airworthiness for bonded composite joints in accordance with the authority requirements is the establishment of disbond-constraining design features. Consequently, two novel design features are developed. On the one hand, the hybrid bondline is introduced as a combination of adhesive bonding and local thermoplastic welding. On the other hand, an array of small diameter pin elements is used as out of plane reinforcements. Enhanced manufacturing concepts are developed for both features. Their mechanical performance is evaluated by means of static and fatigue tests. Both principles are proven successful since crack growth is fully stopped for both technologies in fatigue crack lap shear (CLS) tests under relevant loading conditions. Thus, it can be concluded that these technologies are a promising step towards certification of bonded composite joints.
Quality Controlled Induction Welding by Adapted Process Parameters

Abstract

In this paper the continuous induction welding of carbon textile reinforced thermoplastics is introduced and investigated regarding optimized process parameters and quality control. The resulting overall bonding quality of welded joints shows the capability to replace other mechanical joining methods like bolts. Therefore, the process has a high potential for the aerospace as well as the automotive industry. During induction welding, the heating of the material is generated by induced eddy currents and joule losses. Due to their electrical conductivity, carbon fiber reinforced thermoplastic composites can be inherently heated. To prevent delamination (void growth) of the laminate, the part surface is cooled by an air jet. To implement a quality controlled, automated welding process the surface temperature is monitored and a thermal simulation is used to calculate the temperature in the joining area. The thermal simulation model is explained and process diagrams are calculated. These process diagrams can easily be changed by a user interface. For different welding speeds, optimum coil settings are found to gain bonding strength at autoclave quality with high welding speed and reproducibility. Overlap specimens were produced and tested to verify the simulated optimum parameters and to show the capability of the quality control concept.

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