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Effect of Repair Procedures Applied to Composite Airframe Structures

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ABSTRACT

As composite materials are increasingly used in aircraft structural components, it is important to develop repair philosophies that will restore the structure to its original strength and design capability. Thus it is important to choose the proper repair methods/systems to restore the aircraft part structural integrity, and to understand the ultimate strength and durability of a given repair system under the specified design conditions and the most critical factors affecting the static strength and the long-term durability of the repair.

Bonded repairs have significant advantages over bolted repairs. Adhesively bonded repairs can restore a composite structure's original strength, are more fatigue resistant due to the absence of stress concentrations that occur at fastener holes, and are significantly lighter than bolted repairs due to the absence of fastener hardware. Adhesively bonded repairs have limitations due to the fact that a bonded joint is a single joint thus there is no redundancy in the load path.

A bonded joint with a good static strength will not necessarily yield good performance under dynamic loading, especially when subjected to the most aggressive environments. Adhesively bonded repairs are process-dependent, therefore repair technicians must have adequate training to successfully complete the bonding process and to ensure repeatability and structural integrity of the bond. Current NDI methods cannot provide absolute assurance of bond integrity. As a consequence, a substandard repair may not be detected until it actually disbonds, leading to a possible catastrophic failure of the repaired part.

Therefore, it is essential to substantiate environmental effects on the static strength and durability of bonded repairs, and the effects of surface preparation and the parent surface exposure to contamination prior to repair on the structural integrity of these bonded repairs. It is also necessary to understand the capabilities and limitations of the repair system utilized and the residual strength of a repaired part subjected to an anomalous process.

A summary of experimental results substantiating the static and residual strength of bonded repairs subjected to damage and process parameters will be presented. Data is shown for both sandwich and laminate substrates subjected to different repair variables including different materials, scarf rates, damage locations, contaminants, etc. Results of the investigation can be utilized to promote awareness of the critical issues related to bonded repairs, to draw attention to the need for appropriate training in the composite repair community, and to identify the degree of criticality of the different steps within a bonded repair, which will lead to more rigorous repair procedures.