Abstract

Adhesively bonded joints are widely used for aircraft structural joints. The durability and damage tolerance of laminated composites are critical design considerations for airframe composite structures. In this context, research is carried out to address the following;

1. Conduct a parametric study to identify factors affecting adhesive bonding and use Design of experiment (Taguchi approach) to optimise lap shear strength of Single Lap Joints (SLJ). This approach was helpful in optimizing bonding parameters.
2. The optimised bonding parameters arrived through statistical approach and used it to study the effect of interface ply on lap shear strength. It was found that impregnated peel-ply was able to give higher lap shear strength. Overlap length of 12.5mm identified by Taguchi approach meeting ASTM 1002-05 specifications.
3. Damage tolerances of laminated composite structures were studied experimentally through various thickness reinforcement techniques (TTR) like Stitching, Z-pinning and tufting. Z-pinning is recommended for prepregs and Tufting for dry preforms.
4. Dispersion of Multi Wall Carbon Nano Tubes (MWNT) to epoxy adhesives to enhance lap shear strength of SLJ. On less viscous resins (Araldite 501 A/B), at an optimum level of 0.3 percentage MWNT dispersion, the lap shear strength enhanced by 28 percentages.
5. Evaluate damage tolerance of various composite structural joints by fracture toughness estimation. The Fracture toughness is measured by Double Cantilever Beam (DCB) tests and validated by Finite Element Analysis.
6. Fracture toughness of an room temperature curable epoxy adhesive, Araldite AV138/HV998 was measured and found that, it is two times higher than the another epoxy adhesive, Araldite 501A/B.
7. Delamination resistance of tufted composites experimentally determined and found that 12 times higher than untufted specimens.
8. Development of special bonding fixtures for SLJ, scarf joints and composite machining tools. The indigenously designed SLJ fixture is recommended for characterizing adhesives.
9. Indigenously developed composite machining tools like scarf tool, step lap tool performed well and increased the load carrying capacity of the scarf joint, thereby making it as a damage tolerant joint.

The damage tolerant composite structural joints can be made through various ways Viz. Dispersion of MWNT on epoxy adhesives, tufting on pre-forms and introduction of cover plies.

Keywords: Composites, Scarf joints, Step lap joints, Adhesive bonding fixtures, Interface ply, MWNT, Dispersion, Tufting, Z-pinning, delamination resistance.