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# EFFECTS OF YARN CRIMPING ON BRAIDED COMPOSITE DESIGN ALLOWABLES

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Braided composite materials are currently being evaluated for wing skin stiffeners on commercial aircraft. These carbon-fiber/epoxy materials allow for low-cost manufacturing while maintaining high strength-to-weight and stiffness-to-weight ratios. The proposed braid architecture consists of axial carbon fiber yarns and braider carbon fiber yarns making 60° to 70° angles with respect to the axial yarns. These 2-D triaxial braids are produced as long, continuous tubes, which are flattened, cut, and stacked to produce the desired part thickness and shape. When infiltrated with epoxy resin and cured under a compaction pressure, the fiber yarns become crimped, allowing for higher fiber packing. Although high fiber packing is desirable, yarn crimping (especially in the axial fiber yarns) is undesirable. Significant axial yarn crimp angles (greater than 10°) have been measured in braided composites. Comparable levels of crimping have been found to produce significant compressive strength reductions in laminated composites consisting of planar fiber sheets. Thus, axial yarn crimping is suspected of producing significant reductions in compressive strength allowables for braided composites.

The objective of this research is to *quantify* the reduction in compressive strength as a function of axial yarn crimp severity. Since crimp severity can be reduced by lowering the compaction pressure during curing, the resulting compressive strengths may be used to determine optimum processing conditions. A "cure-on-the-loom" manufacturing process was developed to produce braided composites with controlled levels of crimping. This method allowed for controlled levels of tension to be placed on the axial yarns and maintained during the curing process. With increasing tension, the crimp severity in the axial yarns was reduced. Thus, varying crimp severities were produced ranging from conventional levels (greater than 10°) to virtually straight axial yarns. Test results indicate that a 30% increase in compressive strength is obtainable by eliminating axial yarn crimping. Further compression testing is underway to quantify the relationship between crimp severity and compressive strength. Additional testing is planned to investigate the effect of crimping on the open-hole compressive strength, often considered a more significant design allowable.