Title

TENSILE FATIGUE BEHAVIOR OF STITCHED CARBON/EPOXY COMPOSITES

Abstract text

An investigation of the effect of stitch density (number of stitch per unit area, SD) on the fatigue behavior of carbon/epoxy (aerospace grade, T800/XNRH6813) under tension-tension load is presented. Stitch density is of moderate (SD = 0.028/mm2) and high density (SD = 0.111/mm2). A relatively new stitch thread material called Vectran® is used as a stitching thread. Vectran exhibits excellent tensile properties, which are similar to Kevlar®, yet its moisture absorption is extremmely low that makes it suitable for wet environment. Fatigue test is carried out with load ratio R of 0.1, and frequency of 5 Hz. Maximum stress (Smax) applied is between 50% and 80% of tensile strength of unstitched composites (Su = 654 MPa). Three important fatigue characteristics, namely fatigue life, stiffness degradation and fatigue damage growth, of stitched and unstitched composites are presented in this study. At low Smax, the fatigue test is carried out for more than 5 million cycles. Fig. 1 show that stitched composites with SD = 0.111/mm2 exhibits better fatigue life as compared to unstitched and moderately stitched composites (SD = 0.028/mm2). Stitch density does not significantly alter the stiffness degradation trend of carbon/epoxy. As exemplified in Fig. 2, under Smax = 472 MPa, normalized stiffness (E/E0) of three types of composite drops from 1.0 to around 0.85 in the early life (n/Nf < 0.1). Thereafter, the stiffness would degrade in a modest rate up to around 0.78 until the later stage of composite life (n/Nf = 0.9). Finally, the stiffness immediately drops to around 0.68 when the specimens fail catastrophically. Damage investigation shows that the stitched composites, both moderately and densely stitched ones, exhibit higher density of cracks (transverse and oblique cracks) as compared to unstitched composites. In densely stitched composites, the delamination can be effectively suppressed, and number of fiber splitting in 0° plies is minimized. Such damage behaviour (in densely stitched composites) translate into better fatigue life.

Keywords

STITCHED COMPOSITE, FATIGUE, STIFFNESS DEGRADATION, DAMAGE GROWTH

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