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Experimental Investigation of the Effects of Adding MWCNTs or/and Fiber Pre-stressing on the Fatigue Life of Composite

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Abstract

Fatigue failure is the most reason for materials failure due to stresses under the strength limits of materials. The fatigue properties of composite materials can be improved by using high properties reinforcements such as carbon, Kevlar, and glass fibers. Several procedures can be used to increase the stiffness, strength, fatigue strength, and fatigue life composite materials. These procedures such as applying pre-stress to the fibers during curing process, and/or adding Nanoparticles like Multi-wall Carbon Nanotubes (MWCNTs) to the resin of the composite. This research studied experimentally the effect of adding MWCNTs that had high mechanical properties with different percentage ratios (0.5, 1 and 2wt.%) to the epoxy and composite (epoxy + carbon fiber with volume fraction of 30%). The pre-stress of (2.5, 5, 7.5, and 10MPa) applying to the carbon fibers during the curing process of hand layout of composite to produce residual stresses inside the resin of composite that may give extra stiffness to the fibers. The fatigue test results of fully reversed bending stress with ($R = -1$) showed maximum increasing ratio in fatigue life for the epoxy reached 350% when adding 1wt.% MWCNTs, while the improvement ratio for hybrid composite reaches 2850% when adding 1wt.% MWCNTs with fiber pre-stressing value of 10MPa. The adding MWCNTs to the resin with ratio of 2wt% will decrease the fatigue life of the composite due to the agglomerate of Nanomaterials inside the resin that make it been as weakness points and can't transfer the load between MWCNTs, and that reduces the positive effect of adding MWCNTs.

Keywords: Composite, Carbon Fiber, MWCNTs, Fiber Pre-Stressing, Fatigue Life