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Effect of SWCNTs and Graphene on the fatigue behavior of antisymmetric GFRP laminate

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Abstract

In this relatively unique study, the impact of adding nanoparticles (NPs) on the fatigue properties of antisymmetric glass fiber reinforced polymer (GFRP) laminate has been investigated. Antisymmetric GFRP laminates ($+45/0_2/90_2/0_2/-45$) were prepared and reinforced once with 0.1 wt.% of single walled carbon nanotubes (SWCNTs) and then with 0.1 wt.% of Graphene nanoplatelets (GNPs). The NPs reinforced GFRP laminates are termed here GFNRP nanocomposites. Ultrasonication method was used to disperse the NPs using carefully chosen process parameters. Fatigue tests were analyzed based on S-N curves, stiffness degradation and hysteresis loops. The results showed that the use of 0.1 wt.% of SWCNTs led to an increase in the fatigue strength coefficient (FSC) and the fatigue strength exponent (FSE) of GFNRP nanocomposite specimens by 51% and 24%, respectively, while the use of similar wt.% of GNPs enhanced the FSC and FSE by 33% and 25%, respectively. Consequently, fatigue life of GFNRP nanocomposites are surprisingly enhanced by about three and twelve times when GNPs and SWCNTs are used, respectively. The findings would give designers much more confidence in using antisymmetric composite laminates in specific elastic tailoring structures.

Key words: GFRP, CNTs, graphene, antisymmetric laminate, fatigue properties

1. Introduction

FRP composites are widely used in many industries in different applications due to their outstanding mechanical properties and low density. Specifically, GFRP composites have a wide range of applications due to their high specific modulus, strength, light weight and low cost [1–5]. Consequently, GFRP composites are usually subjected to fatigue loads during their service life. For this reason, fatigue behavior is very important for safe operation [6–8]. Although most applications make use of symmetric GFRP composite laminates, there are others where