MATRIX CRACKING AND ITS EFFECT ON THE MECHANICAL PROPERTIES OF FRP ANGLE-PLY LAMINATES

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Abstract

Fiber Reinforced Plastics (FRP) are used in many industries, such as aeronautical, automotive, construction, etc. FRP have properties, which are highly dependent on the ply fiber orientations and which can be designed for optimum laminate performance. Many damage modes can be observed in laminates, such as transverse cracking, delamination, fiber fracture, longitudinal splitting, etc. Usually during tensile loading, cross-ply and angle-ply laminates would initially demonstrate formation of matrix intralaminar cracks in the most off-axis plies, which normally originate from the free edges, and propagated in the width direction of the coupon. The purpose of this study is to investigate effect of matrix cracking on the mechanical properties of angle-ply FRP laminates. Carbon and glass fiber reinforced polymer laminates (CFRP and GFRP) are tested. The laminates with layups $[\theta_m^{(2)}/\theta_n^{(1)}]_s$ cured by using autoclave method are loaded monotonically and cyclically to obtain their mechanical properties and the effect of matrix cracks on the properties. Some of the effects include reduction of laminates' stiffness and residual strains after unloading. In compare to cross-ply laminates, cracks are hardly formed on angle-ply laminate due to its higher stiffness properties. In order to obtain higher crack densities in specimens, artificial cracks method was introduced in this study, where notches were made at the edges of some specimens before tested in tension. The measured stiffness reduction as a function of the crack density is compared to an analytical prediction for cracked angle-ply laminates based on a variational stress analysis. The experimental results for stiffness reduction agree well with the analytical results. Understanding the behavior of damaged cross-ply and simple angle-ply laminates is of high importance for prediction of damage effects on laminates with more complex configuration, e.g. with quasi-isotropic layups.

Keywords

Laminate, Stiffness reduction, Artificial cracks, Crack density, Damage behavior

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