**STRESS ANALYSIS OF A GRMs REINFORCED CFRP LAMINATE WITH AN OPEN HOLE.**

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**ABSTRACT**

Over the past few decades carbon fibre reinforced polymers (CFRPs) have been the subject of extensive research due to their exceptional specific properties and the inherent ability to modify them according to design requirements. Thus, they have been associated with high performances and significant weight savings in a broad range applications. Despite their superiority over homogeneous materials, the susceptibility1 of CFRP composites to damage has proved to be a critical factor. Specifically, design defects such as open holes, typically incorporated for joining and attachement purposes, can give rise to regions of high stress concentration that can significantly impair their structural integrity. Therefore, the stress distribution at such regions2 must be determined to ensure the integrity of the structure.

More recently, graphene and related materials (GRMs) have emerged as ideal candidates for the development of more advanced and multifunctional composites. Due to their nanometric size and 2D shape, GRMs possess exceptionally high specific area and low defects, along with high stiffness and strength. Graphene nanoplatelets (GNPs) and reduced graphen oxide (RGO) are forms of GRMs that have demonstrated the potential to enhance the properties of the polymeric matrix, as well as, the interfacial connections of the layers. Thus, CFRPs integrated with GRMs, such as GNPs, could potentially be enhanced not only in terms of their mechanical properties but also mediate the distribution of stresses in geometric discontinuities, such as open holes.

This study investigated the effect of GNPs in the stress concentration around a circular hole3 of a CFRP laminate. The stress concentration was quantified by using the stress concentration factor *K*, utilizing theoretical2 and numerical methods, for both neat CFRP and hybrid CFRP. A good agreement between analytical and numerical data was observed for the decay of the stress concentration, which was expressed as a function of the distance from the edge of the notch. In accordance to the latter models, the highest stress concentration factor *K* was predicted for the neat CFRP. The analytical models for the 0.2% w/w and 1% w/w GNPs reinforced CFRPs demonstrated a decrease of 10% and 22%, respectively, while the numerical models a respective reduction of 6% and 13.5%. Thus, it is evident that by adding GNPs in notched CFRPs, the stress concentration can be effectively reduced, leading to an increase of the remaining life of the composite.

**KEYWORDS:** Composites, stress concentration, notch, GRMs, GNPs reinforced CFRPs

**REFERENCES**

[1] Vishwas Mahesh, Sharnappa Joladarashi, Satyabodh M. Kulkarni. (2020). *A comprehensive review on material selection for polymer matrix* composites subjected to impact load.

[2] Arjyal BP, Katerelos DG, Filiou C, Galiotis C. (2000). *Measurement and Modeling of Stress Concentration around a Circular Notch*. Vol 40

[3] Tan SC.(1978). *Finite-Width Correction Factors for Anisotropic Plate Containing a Central Opening:* *I. Approximate Stress Analysis and Fracture Models.* Vol 21