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Using XFEM technique to predict the damage of unidirectional CFRP composite notched under tensile load

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Abstract. The composite materials are widely used in aircraft structures. Their relative rigidity/weight gives them an important advantage over the metal structures. The objective of this work is to analyze by the finite element method the mechanical behavior of composite plate type notched with various forms under tensile load. Two basic parameters were taken into consideration. The first, the form of the notch in order to see its effect on the stress and the failure load. The second, we studied the influence of the locale orientation of fiber around the plate's notch. These parameters are studied in order to see their effects on the distribution stress and failure load of the plate. The calculation of the failure load is determined numerically with the numerical code ABAQUS using the XFEM (extended Finite Element Modeling) based on the fracture mechanics. The result shows clearly that it is important to optimize the effect of fiber orientation around the notch.

Keywords: CFRP (reinforced carbon fiber polymers); XFEM (extended finite element modeling)

1. Introduction

Several mechanism of damage can occur in composite structures, such as delamination of the fiber-matrix interface, delamination of the interlayer's in the case of the laminates and or else breakage of the fibers. These mechanisms can occur simultaneously due to the effect of several parameters such as the type of loading and the boundary conditions. The necessary presence of some form of the notch in the structures causes an imbalance of resistance near the notch. Several researchers have been interested in this research axis in order to characterize this phenomenon. (Kirsh *et al*. 1898) was the first to study the phenomenon of stress concentration and distribution around a hole. Subsequently, Analytical solutions have been gradually found by various

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considering uncertain fracture properties and effect of fiber bridging", Ph.D. Dissertation, University of British Columbia, Canada.

Nagashima, T. and Suemasu, H. (2006), "Stress analyses of composite laminate with delamination using XFEM", *J. Comput. Meth.*, **3**(4), 521.

Neuber, H. (1961), "Theory of stress concentration for shear strained prismatic bodies with nonlinear stress-strain law", *J. Appl. Mech.*, **28**(4), 544-550.

Pilkey, W. and Peterson's, D. (1997), *Stress Concentration Factors*, Wiley, New York, U.S.A.

Qian, Z.D. and Jing, H. (2012), "Fracture properties of epoxy asphalt mixture based on extended finite element method", *J. Centr. South Univ.*, **19**(11), 3335.

Seyhan, A.T. Tanoglu, M. and Schulte, K. (2008), "Mode I and mode II fracture toughness of e-glass non-crimp fabric/carbon nanotube (CNT) modified polymer based composites", *Eng. Fract. Mech.*, **75**, 5151-5162.

Tan, J.L.Y., Deshpande, V.S. and Fleck, N.A. *Prediction of Failure in Notched CFRP Laminates Under Multi-Axial Loading*, Cambridge University Engineering Dept., Trumpington St., Cambridge, CB2 1PZ, U.K.

Tseng, C.H., Wang, C.C. and Chen, C.Y. (2007), "Functionalizing carbon nanotubes by plasma modification for the preparation of covalent-integrated epoxy composites", *Chem. Mater.*, **19**, 308-315.

Victor, M., Marianne, P., Marie-Laetitia, P., Helene, W., Arthur, C. and Moussa, K. (2015), "Determination of the elastic properties in CFRP composites: Comparison of different approaches based on tensile tests and ultrasonic characterization", *Adv. Aircr. Spacecr. Sci.*, **2**(3), 249.

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