

Measurement of Crack Opening Displacement in Damaged Composite Aerospace Laminates Using ESPI

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During the service life composite laminates undergo complex combinations of thermal and mechanical loading leading to microdamage accumulation in the plies. The most common damage mode is intralaminar cracking in layers. The crack opening displacement (COD) and the crack sliding displacement (CSD) during loading reduce the average stress in the damaged layer, thus reducing the laminate stiffness. In other words, the elastic modulus in the loading direction and the corresponding Poisson's ratio decrease.

Previously these parameters have been calculated using finite element method (FEM) assuming linear elastic material with idealized geometry of cracks [1]. The only correct way to validate these assumptions is through experiments.

In this paper these parameters are measured experimentally providing laminate stiffness reduction models with valuable information for validation of used assumptions and for defining limits of their application. In particular, the displacement field on the edges of a [0/ +70₄/ -70₄]_s glass fiber/epoxy laminate specimens with multiple intralaminar cracks is studied and the COD and CSD dependence on the applied mechanical load is measured. The specimen full-field displacement measurement is carried out using ESPI (Electronic Speckle Pattern Interferometry) [2]. By studying the displacement discontinuities, the crack face displacements were measured. A comparison between the COD and the CSD (for the same crack) is performed.

1.Lundmark P. and Varna J., Constitutive Relationships for Laminates with Ply Cracks in In-plane Loading, *International Journal of Damage Mechanics*, 2005, Vol. 14, No.3, pp. 235-261.

2.Farge, L., Varna, J. and Ayadi. Z., Damage characterization of a cross-ply carbon fiber/epoxy laminate by an optical measurement of the displacement field, *Composites Science and Technology*, 2010, Vol. 70, pp. 94-101.