Title:
Characterization of interface damage of fiber-reinforced polymer composite laminates under mode i loading

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Abstract:
In this study, the unidirectional carbon fiber-reinforced polymer (CFRP) composite laminates under the Mode I loading are characterized using Cohesive Zone Model (CZM). A bilinear traction-displacement softening law is assumed for the interface behavior. The required interlaminar properties and CZM model parameters are characterized through an experimental-finite element (FE) approach. These parameters are the critical Mode I energy released rate, GIC, tensile strength, T and tensile penalty stiffness, kn. For this purpose, a unidirectional, 32-ply ([0]32) double-cantilever beam specimen is tested to fracture. The global load-displacement response of the specimen to the interface crack extension is recorded. The result establishes the Mode I critical energy release rate, GIC = 0.31 N/mm. The validated finite element (FE) simulation of the test is then employed to extract the CZM model parameters corresponding to the observed interlaminar damage initiation event. The FE-calculated maximum normal stress at the interface crack front is taken to represent the tensile strength of the interface, T=62.5 MPa. The corresponding slope of the stress-relative opening displacement of this critical material point indicates the penalty stiffness of the interface, kn = 0.98×106 N/mm3. With the established interfacial properties, the CZM could then be employed in simulating the deformation and damage process of the interfaces in FRP composite laminates under Mode I loading.