EFFECTS OF BOND THICKNESS ON THE COHESIVE ZONE MODEL PARAMETERS IN MODE I OF A HIGH TOUGHNESS STRUCTURAL ADHESIVE

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Abstract: The automotive industry is currently increasing its use of structural adhesives to reduce vehicle weight and improve crash resistance. Interfacial delamination is a critical issue for the design and application of laminated composites and bonded structures. A recent approach consists in the use of Cohesive Zone Models (CZM), which accurately simulate fracture behavior of bonded joints. A CZM requires the definition of cohesive laws which depends on essentially three parameters of the adhesive: stiffness, cohesive traction and critical fracture toughness in the respective mode of loading. The purpose of this work was to evaluate the effect of bond line thickness on the cohesive law parameters in mode I. The adhesive tested, Betamate 1496s, is a one component, heat curing, high toughness structural epoxy adhesive, commonly employed on the bonding of vehicles body structure. Double Cantilever Beam (DCB) tests were conducted on four bond thickness: 0.30, 0.56, 0.81 and 1.57 mm. The Compliance Based Beam Method (CBBM) was used to obtain the critical fracture toughness. The DCB tests were numerically simulated by the commercial code ABAQUS®, using Finite Element Method (FEM) to estimate the remaining cohesive law parameters by fitting the numerical force-displacement (P-δ) curves to the experimental P-δ curves. The results revealed a linearly increasing dependency of the critical fracture toughness with bond thickness, however the cohesive traction and stiffness appear almost unaffected by variations on bond thickness. A sensitivity analysis revealed that the P-δ curves can be calibrated with either a triangular or a trapezoidal cohesive law. Moreover, although parameters could be estimated to fit the P-δ loading phase with good accuracy, it isn't possible to simultaneously fit the delamination phase, regardless of the chosen cohesive parameters. Further work is needed to address this particular problem in the employed model.

Keywords: bond thickness, structural adhesive, Cohesive Zone Model, Double Cantilever Beam, fracture toughness