ABSTRACT

Mixed-mode fracture characterization has been carried out considering the influence of bimodulus elasticity and functionally graded material behavior of laminated composites containing interface delamination. The formulation takes into account the thermoelastic anisotropy arising out of curing stresses developed during the manufacturing stages. The stress dependent elasticity problem has been solved numerically using iterative three dimensional finite element procedures with Strain Energy Release Rate (SERR) as the standard fracture parameter. Individual modes of SERR have been evaluated along the delamination front based on the concepts of Modified Crack Closure Integral (MCCI). The interface fracture behavior has been investigated for different numerical specimens depicting Tee Joints and Skin-stiffener models with tension compression bimodulus ratio R varying from 1 to 5 along the bond line with a linear functional profile for the respective functionally graded bimodular specimens. Functionally graded bimodular adhesively bonded tee joint reveals significant reduction in damage growth driving forces compared to that of unimodular adhesive. The relative influence of residual thermal stresses have been found to be more pronounced for bimodularity in comparison to functionally graded properties for assessing the delamination damage progression characteristics in functionally graded bimodular skin-stiffener specimens. The observations might assist the desirable intention of the skin stiffener designer to retard the interfacial failure propagation rate in order to intensify the structural integrity of the stiffened panel, so that the strength, lifetime and reliability of the panel structure can be significantly upgraded.

Keywords: Bimodularity, Functionally graded, Interface delamination, Stress dependent elasticity, Mixed-mode fracture, Strain energy release rate, Thermo-elastic anisotropy