LIST OF ABBREVIATIONS

CLPT - Classical Laminated Plate Theory

CZM- Cohesive Zone Model

DOF- Degree of Freedom

ERR- Energy Release Rate

FE- Finite Element

FEA- Finite Element Analysis

FEM- Finite Element Method

FG- Functionally Graded

FGA- Functionally Graded Adhesive

FMGB- Functionally Modulus Graded Bondline

FRP- Fiber Reinforced Polymer

FSDT - First-order Shear Deformation Theory

HSDT - Higher-order Shear Deformation Theory

LEFM- Linear Elastic Fracture Mechanics

LSE- Least Square Estimation

MCCI- Modified Crack Closure Integral

MLM- Maximum Likelihood Method

NA- Neutral Axis

PMCE- Principle of Minimum Complementary Energy

SERR- Strain Energy Released Rate

VCCT- Virtual Crack Closure Technique

LIST OF SYMBOLS

a_{ii} - Diagonal elastic compliance

$a_{ij}(i \quad j)$ - Off-diagonal compliance

A - Crack surface created by the delamination opening

c_E - Specific heat capacity

C - Suffix for the notation of compression behaviour under bimodularity

C_{ijkl} - Elastic stiffness

D - Constant

E_C - Modulus of elasticity for compression

E_T - Modulus of elasticity for tension

EI - Flexural rigidity of the beam

$E_1(I)$ - Lower bound Young Modulus

$E_2(I)$ - Upper bound Young Modulus

$f(x)$ - Probability density function of Weibull distribution

f_i - Body force

F – Sum of axial forces

F_i - Force at delamination tip for the fracture mode i

G_I- First mode of SERR

G_{II}- Second mode of SERR

G_{III}- Third mode of SERR

G_T- Total strain energy release rate

G_c - Critical value of the energy release rate

G_M, G_{MT}, and G_{TH} - SERR components due to mechanical, superposition of individual effects thermo-mechanical loading and only thermal loading, respectively

Gr/E- Graphite/Epoxy

h_C - Height of the beam above neutral axis in compression region

h_T - Height of the beam below neutral axis in tension region

h – Total height of the beam

I - Hydrostatic stress

k_{ij} - Thermal conductivity coefficient

l - Length of the projection of the deformed beam on x-axis

L - Length of the beam without deformation

L_b - Length of bond

L_s - Length of substrate

m - Shape Parameter

$M(x)$ - Bending moment

ne - Total number of elements

N - Ratio of length of bond and substrate

N - Shape function for displacement

N - Shape function for temperature

P_f - Failure distribution of Weibull parameter

q_i - Heat flux

$\bar{Q}$ - Flux

R - Bimodular ratio

s - Distance measured along the bond length

t – Width of the beam

T - Temperature change

T - Suffix for the notation of tension behaviour under bimodularity

T_0 - Reference temperature

$\bar{T}_i$ - Surface traction

$u(x,z)$ - In-plane displacement

u_i - Opening displacement for the fracture mode i

$_C$ - Poisson's ratio for compression

$_T$ - Poisson's ratio for tension

w - Lateral deflection

W- Energy released by the propagation of a crack

x_0 - Scale parameter

x - Location parameter

z - Global coordinate

, and - Principal stress directions

$_{ij}$ - Thermal constant

- Fiber orientation

- Coefficient of thermal expansion

$_i$ - Temperature gradient

$_b(x)$ - Deflection of the beam due to bending stresses only

$_m$ - Maximum deflection of the beam due to bending stresses

$(x \quad a)$ - Crack opening displacement between the upper and lower delaminated surfaces

(x) - Stress at the crack front required to close the delaminated area

u_z, u_x, u_y - Relative opening, sliding and tearing displacements, respectively

- Strain

$_{xz}$ - Transverse shear strain

- Stress

$_{xx}$, $_{yy}$ and $_{zz}$ - Normal stresses components of any stress tensor

[$_{zz}$ $_{zx}$ $_{zy}$] - Interlaminar stress

- Mass density

- Entropy density