NOMENCLATURE

A       Cross sectional area of beam
a       Crack depth ratio
B       Width of the beam
D       Depth of the beam
D_{ij}  Bending stiffness
E_{f}   Elastic modulus for fiber
E_{m}   Elastic modulus for matrix
E_{1}   Longitudinal elastic modulus
E_{2}   Transverse elastic modulus
E'      Equals equivalent modulus of elasticity
F_{p}   Plasticity adjustment factor
f       Frequency (Hz)
\omega  Forcing frequency (Hz)
G_{f}   Shear modulus of fiber
G_{m}   Shear modulus of matrix
G_{12}  In plane shear modulus
I       Moment of inertia of the rectangular beam (mm^4)
[I]     Identity matrix
[K]     Stiffness of the matrix
K_{1}   Elastic stress intensity factor
[K_{c}] Stiffness matrix of the crack segment
L       Laminated beam length
L_{1}   Length of left segment
L_{2}   Length of right segment
L_{c}   Crack position from fixed end
M       Bending moment
[M]     Mass matrix
P  Applied axial force

$[K_1]$  Reduced stiffness matrix

$[\overline{K}_{II}]$  Transformed Reduced stiffness matrix

R  Frequency ratio

$R_p$  Modified axial crack depth ratio

$R_m$  Modified bending crack depth ratio

$R_{pm}$  Modified axial-bending crack depth ratio

$R_q$  Modified shear crack depth ratio

r  First estimation of plastic zone size

$r_p$  Crack tip plastic zone size

$[T]$  Transfer matrix

$[T_L]$  Transfer matrix of left segment

$[T_R]$  Transfer matrix of Right segment

$[T_c]$  Transfer matrix of the crack segment

$[T_{ce}]$  Transfer matrix of cracked beam element

V  Shear force

$V_f$  Volume fraction of fiber

$V_m$  Volume fraction of matrix

$W_f$  Weight of fiber

$W_m$  Weight of matrix

$Z_0$  Middle layer

$Z_1$  Direct distance from middle layer $Z_0$ axis to $Z_1$ axis

$Z_2$  Direct distance from middle layer $Z_0$ axis to $Z_2$ axis

$Z_3$  Direct distance from middle layer $Z_0$ axis to $Z_3$ axis

$Z_4$  Direct distance from middle layer $Z_0$ axis to $Z_4$ axis

$Z_5$  Direct distance from middle layer $Z_0$ axis to $Z_5$ axis

$\Delta C$  Compliance matrix of cracked element

$\Delta C_{pp}$  Axial compliance force

$\Delta C_{mm}$  Bending compliance force

$\Delta C_{pm}$  Axial-Bending compliance force

$\Delta C_{qq}$  Shear compliance force
\( \delta \)  Deflection of beam  
\( \theta \)  Ply angle  
\( \gamma_f \)  Poisson’s ratio of fiber  
\( \gamma_m \)  Poisson’s ratio of matrix  
\( \gamma_{12} \)  Major passion’s ratio  
\( \gamma_{21} \)  Minor passion’s ratio  
\( \rho_c \)  Density of FRC beam  
\( \rho_f \)  Density of fiber  
\( \rho_m \)  Density of matrix  
\( \sigma_p \)  Axial normal stress  
\( \sigma_m \)  Bending stress  
\( \tau \)  Shear stress  
\( \sigma_y \)  Near tip stress  
\( \sigma_{ys} \)  Yield strength of the material