**NOTATIONS**

\( E_1 \)  
longitudinal Young’s modulus of lamina

\( \nu_{12} \)  
major Poisson’s ratio of lamina

\( E_2 \)  
transverse modulus

\( G_{12} \)  
Shear modulus

\( Q_{11}, Q_{22}, Q_{12} \text{ and } Q_{66} \)  
reduced on-axis stiffnesses

\( S_{11}, S_{22}, S_{12} \text{ and } S_{66} \)  
reduced on-axis compliances

\( \sigma_1, \sigma_2 \text{ and } \tau_6 \)  
in-plane stress components

\( \varepsilon_1, \varepsilon_2 \text{ and } \varepsilon_6 \)  
in-plane strain components

\([T]\)  
transformation matrix

\( m, n \)  
direction cosines

\([Q]_{1,2}\)  
principal stiffnesses matrix

\([Q]_{x,y}\)  
transformed stiffnesses matrix

\( u_o, v_o \)  
reference plane displacements in x- and y-directions

\( w \)  
out-of-plane displacement in the z-direction

\( \alpha_x, \alpha_y \)  
Rotations of the x- and y-axes

\( h \)  
Total laminate thickness
$z_b$ Co-ordinate of a point B in $z$-direction

$u, v$ Displacements of a general point in $x$- and $y$-directions

$z$ Through-the-thickness coordinate of a general point

$\varepsilon_x, \varepsilon_y$ and $\gamma_{xy}$ General strain components

$\varepsilon_x^o, \varepsilon_y^o$ and $\gamma_{xy}^o$ General strain components on the reference plane

$\kappa_x, \kappa_y$ and $\kappa_{xy}$ Curvatures of the laminate

$[Q]_{x,y}^k$ Transformed stiffness matrix of the $k^{th}$ lamina

$[\varepsilon^o]_{x,y}$ Column matrix consisting of reference plane strains

$[k]_{x,y}$ Curvature matrix

$[\sigma]^k_{x,y}$ Matrix containing the stress components of $k^{th}$ lamina

$t$ Layer thickness

$N_x^k, N_y^k$ normal forces per unit length

$N_s^k$ shear force per unit length

$M_x^k, M_y^k$ bending moments per unit length

$M_s^k$ twisting moment per unit length

$z_k$ and $z_{k-1}$ $z$ coordinates of the upper and lower surfaces of layer $k$.

$A_{ij}$ extensional stiffnesses, or in-plane laminate moduli, relating in-plane loads to in-plane strains
coupling stiffnesses, or in-plane /flexure coupling laminate moduli, relating in-plane loads to curvatures and moments to in-plane strains.

$B_{ij}$

bending or flexural laminate stiffness relating moments to curvatures

$D_{ij}$

Residual strains along material co-ordinates

$e_1, e_2 \text{ and } e_6$

Residual strains along general co-ordinates

$e_x, e_y \text{ and } e_{xy}$

Residual strains along material co-ordinates

$[N^{HT}]_{x,y}$

Residual force resultant

$[M^{HT}]_{x,y}$

Residual moment resultant

$[N] and [M]$ total force and moment resultants equal to the respective sums of their mechanical and residual components.

$F_{1t}$ Longitudinal composite tensile strength

$F_{2t}$ Transverse composite tensile strength

$F_6$ In-plane shear strength

$F_{1c}$ Longitudinal composite compressive strength

$F_{2c}$ Transverse composite compressive strength

FML Fiber Metal Laminate

ARALL Aramid Reinforced ALuminium Laminates

GLARE GLAss REinforced aluminium laminate

CARE CArbon REinforced aluminium laminate

HTCL Hybrid Titanium Composite Laminate (NASA)
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TiGr</td>
<td>Titanium Graphite Hybrid Laminate (The Boeing Company)</td>
</tr>
<tr>
<td>CF/PEEK</td>
<td>carbon fiber-reinforced poly-ether-ether-ketone</td>
</tr>
<tr>
<td>GF/PEI</td>
<td>glass fiber-reinforced poly-ether-imide</td>
</tr>
<tr>
<td>CLT</td>
<td>Classical Lamination Theory</td>
</tr>
<tr>
<td>FPF</td>
<td>First Ply Failure</td>
</tr>
<tr>
<td>MPDM</td>
<td>Material Property/stiffness Degradation Methods</td>
</tr>
<tr>
<td>CDM</td>
<td>Continuum Damage Mechanics</td>
</tr>
<tr>
<td>WWFE</td>
<td>World Wide Failure Exercise</td>
</tr>
</tbody>
</table>