APPENDIX 2

LOSS FACTOR MEASUREMENT

The loss factor $\eta$ is the specific damping capacity per radian of the damping cycle and is widely used in the case of viscous-elastic damping. The general relationship among various nomenclatures of damping measurement (valid for small values of damping) is given by Chandra et al. (2003).

$$\eta = \frac{\psi}{2\pi} = \frac{\delta}{\pi} = 2\xi = \frac{1}{q} = \frac{E''}{E'}$$  \hspace{1cm} (A.2.1)

The properties of carbon fibre, glass fibre and epoxy resin are presented in Table A.1.2.

Loss factor for carbon/epoxy ply ($\eta_C$),

$$\eta_1 = \frac{\eta_{E}E_fV_f + \eta_{m}E_mV_m}{E_fV_f + E_mV_m}$$  \hspace{1cm} (A.2.2)

$$\eta_2 = \frac{\eta_{E}E_mV_f + \eta_{m}E_fV_m}{E_mV_f + E_fV_m}$$  \hspace{1cm} (A.2.3)

$$\eta_{12} = \frac{\eta_{E}G_mV_f + \eta_{m}G_fV_m}{G_mV_f + G_fV_m}$$  \hspace{1cm} (A.2.4)

Applying all the stresses assumed for a cycle of operations in a system of forces,

The net material damping,
\[ \eta_c = \frac{\eta_1 + \eta_2 + \eta_{12}}{60} \]  
(A.2.5)

Loss factor for glass/epoxy ply \((\eta_G)\),

\[ \eta_1 = \frac{\etaGE_fV_f + \eta_{mE}E_mV_m}{E_fV_f + E_mV_m} \]  
(A.2.6)

\[ \eta_2 = \frac{\etaGE_mV_f + \eta_{mE}E_fV_m}{E_mV_f + E_fV_m} \]  
(A.2.7)

\[ \eta_{12} = \frac{\etaGE_mG_fV_f + \eta_{mG}G_fV_m}{G_mV_f + G_fV_m} \]  
(A.2.8)

Applying all the stresses assumed for a cycle of operations in a system of forces

The net material damping is, \( \eta_G = \frac{\eta_1 + \eta_2 + \eta_{12}}{60} \)  
(A.2.9)

The Carbon/epoxy weight is calculated as, \( W_{CE} = a b (\rho_{ce} \cdot t_{ce} \cdot N_{ce} ) \)  
(A.2.10)

The Glass/epoxy weight is calculated as,

\[ W_{GE} = a b (\rho_{ge} \cdot t_{ge} \cdot N_{ge} ) \]  
(A.2.11)

The laminate weight is calculated as, \( W_{C} = W_{GE} + W_{CE} \)  
(A.2.12)

\( W_{C} = 3.02\) kg

\[ \eta_{Hybrid} = \eta_c \frac{W_{GE}}{W_{C}} + \eta_G \frac{W_{CE}}{W_{C}} \]  
(A.2.13)

\[ \eta_{Hybrid} = 0.0012 \]