Matrixes of DL-53

Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{E} = \begin{pmatrix} 15.3 & 10.7 & 10.2 & 0 & 0 & 0 \\ 10.7 & 15.3 & 10.2 & 0 & 0 & 0 \\ 10.2 & 10.2 & 12.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2.6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.3 \end{pmatrix}^{E} 10^{10}\, N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{D} = \begin{pmatrix} 16.7 & 12.1 & 9.7 & 0 & 0 & 0 \\ 12.1 & 16.7 & 9.7 & 0 & 0 & 0 \\ 9.7 & 9.7 & 15.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 5.9 & 0 & 0 \\ 0 & 0 & 0 & 0 & 5.9 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.3 \end{pmatrix}^{D} 10^{10}\, N/m^2$$

Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{E} = \begin{pmatrix} 16.4 & -5.1 & -9.5 & 0 & 0 & 0 \\ -5.1 & 16.4 & -9.5 & 0 & 0 & 0 \\ -9.5 & -9.5 & 24.2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 37.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 37.6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 43.0 \end{pmatrix}^{E} 10^{-12}\, m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{D} = \begin{pmatrix} 13.8 & -7.7 & -3.9 & 0 & 0 & 0 \\ -7.7 & 13.8 & -3.9 & 0 & 0 & 0 \\ -3.9 & -3.9 & 11.6 & 0 & 0 & 0 \\ 0 & 0 & 0 & 17.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 17.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 43.0 \end{pmatrix}^{D} 10^{-12}\, m^2/N$$

Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{S} = \begin{pmatrix} 1435 & 0 & 0 \\ 0 & 1435 & 0 \\ 0 & 0 & 1360 \end{pmatrix}^{S}$$

Matrix of Free Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{T} = \begin{pmatrix} 3170 & 0 & 0 \\ 0 & 3170 & 0 \\ 0 & 0 & 3350 \end{pmatrix}^{T}$$

Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 760 & 0 \\ 0 & 0 & 0 & 760 & 0 & 0 \\ -275 & -275 & 610 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 27.0 & 0 \\ 0 & 0 & 0 & 27.0 & 0 & 0 \\ -9.3 & -9.3 & 20.6 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 19.8 & 0 \\ 0 & 0 & 0 & 19.8 & 0 & 0 \\ -9.3 & -9.3 & 17.7 & 0 & 0 & 0 \end{pmatrix} C/m^{2}$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 15.9 & 0 \\ 0 & 0 & 0 & 15.9 & 0 & 0 \\ -6.8 & -6.8 & 13.1 & 0 & 0 & 0 \end{pmatrix} 10^{8} V/m$$