Matrixes of DL-10

Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{E} = \begin{pmatrix} 11.3 & 2.5 & 2.2 & 0 & 0 & 0 \\ 2.5 & 11.3 & 2.2 & 0 & 0 & 0 \\ 2.2 & 2.2 & 14.2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 15.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 15.6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4.4 \end{pmatrix}^{E} 10^{10}\, N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{D} = \begin{pmatrix} 11.3 & 2.5 & 2.2 & 0 & 0 & 0 \\ 2.5 & 11.3 & 2.2 & 0 & 0 & 0 \\ 2.2 & 2.2 & 14.9 & 0 & 0 & 0 \\ 0 & 0 & 0 & 15.9 & 0 & 0 \\ 0 & 0 & 0 & 0 & 15.9 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4.4 \end{pmatrix}^{D} 10^{10}\, N/m^2$$

Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{E} = \begin{pmatrix} 9.5 & -1.9 & -1.2 & 0 & 0 & 0 \\ -1.9 & 9.5 & -1.2 & 0 & 0 & 0 \\ -1.2 & -1.2 & 7.4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6.4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6.4 & 0 \\ 0 & 0 & 0 & 0 & 0 & 22.8 \end{pmatrix}^{E} 10^{-12}\, m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{D} = \begin{pmatrix} 9.5 & -1.9 & -1.1 & 0 & 0 & 0 \\ -1.9 & 9.5 & -1.1 & 0 & 0 & 0 \\ -1.1 & -1.1 & 7.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6.3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6.3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 22.8 \end{pmatrix}^{D} 10^{-12}\, m^2/N$$

Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{S} = \begin{pmatrix} 138 & 0 & 0 \\ 0 & 138 & 0 \\ 0 & 0 & 121 \end{pmatrix}^{S}$$

Matrix of Free Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{T} = \begin{pmatrix} 140 & 0 & 0 \\ 0 & 140 & 0 \\ 0 & 0 & 128 \end{pmatrix}^{T}$$

Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 8 & 0 \\ 0 & 0 & 0 & 8 & 0 & 0 \\ -3 & -3 & 21 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 6.4 & 0 \\ 0 & 0 & 0 & 6.4 & 0 & 0 \\ -2.8 & -2.8 & 18.5 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 1.3 & 0 \\ 0 & 0 & 0 & 1.3 & 0 & 0 \\ -0.1 & -0.1 & 2.8 & 0 & 0 & 0 \end{pmatrix} C/m^{2}$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 10.2 & 0 \\ 0 & 0 & 0 & 10.2 & 0 & 0 \\ -0.2 & -0.2 & 26.4 & 0 & 0 & 0 \end{pmatrix} 10^{8} V/m$$