Matrixes of DL-31

Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{E} = \begin{pmatrix} 6.1 & 1.9 & 2.0 & 0 & 0 & 0 \\ 1.9 & 6.1 & 2.0 & 0 & 0 & 0 \\ 2.0 & 2.0 & 5.3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6.5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6.5 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.1 \end{pmatrix}^{E} 10^{10} N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{D} = \begin{pmatrix} 6.1 & 2.0 & 2.2 & 0 & 0 & 0 \\ 2.0 & 6.1 & 2.2 & 0 & 0 & 0 \\ 2.2 & 2.2 & 6.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6.8 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6.8 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.1 \end{pmatrix}^{D} 10^{10} N/m^2$$

Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{E} = \begin{pmatrix} 19.7 & -4.3 & -5.9 & 0 & 0 & 0 \\ -4.3 & 19.7 & -5.9 & 0 & 0 & 0 \\ -5.9 & -5.9 & 23.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 15.4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 15.4 & 0 \\ 0 & 0 & 0 & 0 & 0 & 48.0 \end{pmatrix}^{E} 10^{-12} m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{D} = \begin{pmatrix} 19.6 & -4.3 & -5.5 & 0 & 0 & 0 \\ -4.3 & 19.6 & -5.5 & 0 & 0 & 0 \\ -5.5 & -5.5 & 20.4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 14.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 14.6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 47.8 \end{pmatrix}^{D} 10^{-12} m^2/N$$

Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{S} = \begin{pmatrix} 305 & 0 & 0 \\ 0 & 305 & 0 \\ 0 & 0 & 265 \end{pmatrix}^{S}$$

Matrix of Free Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{T} = \begin{pmatrix} 320 & 0 & 0 \\ 0 & 320 & 0 \\ 0 & 0 & 300 \end{pmatrix}^{T}$$

Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 48 & 0 \\ 0 & 0 & 0 & 48 & 0 & 0 \\ -11.4 & -11.4 & 90 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 16.9 & 0 \\ 0 & 0 & 0 & 16.9 & 0 & 0 \\ -4.3 & -4.3 & 33.9 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 3.1 & 0 \\ 0 & 0 & 0 & 3.1 & 0 & 0 \\ -0.9 & -0.9 & 4.3 & 0 & 0 & 0 \end{pmatrix} C/m^{2}$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 11.5 & 0 \\ 0 & 0 & 0 & 11.5 & 0 & 0 \\ -4.0 & -4.0 & 18.8 & 0 & 0 & 0 \end{pmatrix} 10^{8} V/m$$