Matrixes of DL-21

Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{E} = \begin{pmatrix} 17.2 & 7.5 & 8.5 & 0 & 0 & 0 \\ 7.5 & 17.2 & 8.5 & 0 & 0 & 0 \\ 8.5 & 8.5 & 17.4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4.6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4.8 \end{pmatrix}^{E} 10^{10}\, N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{D} = \begin{pmatrix} 17.5 & 7.8 & 8.6 & 0 & 0 & 0 \\ 7.8 & 17.5 & 8.6 & 0 & 0 & 0 \\ 8.6 & 8.6 & 20.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4.8 \end{pmatrix}^{D} 10^{10}\, N/m^2$$

Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{E} = \begin{pmatrix} 8.2 & -2.1 & -3.0 & 0 & 0 & 0 \\ -2.1 & 8.2 & -3.0 & 0 & 0 & 0 \\ -3.0 & -3.0 & 8.7 & 0 & 0 & 0 \\ 0 & 0 & 0 & 21.7 & 0 & 0 \\ 0 & 0 & 0 & 0 & 21.7 & 0 \\ 0 & 0 & 0 & 0 & 0 & 20.6 \end{pmatrix}^{E} 10^{-12}\, m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{D} = \begin{pmatrix} 7.9 & -2.4 & -2.3 & 0 & 0 & 0 \\ -2.4 & 7.9 & -2.3 & 0 & 0 & 0 \\ -2.3 & -2.3 & 6.8 & 0 & 0 & 0 \\ 0 & 0 & 0 & 16.7 & 0 & 0 \\ 0 & 0 & 0 & 0 & 16.7 & 0 \\ 0 & 0 & 0 & 0 & 0 & 20.6 \end{pmatrix}^{D} 10^{-12}\, m^2/N$$

Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{S} = \begin{pmatrix} 960 & 0 & 0 \\ 0 & 960 & 0 \\ 0 & 0 & 875 \end{pmatrix}^{S}$$

Matrix of Free Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{T} = \begin{pmatrix} 1250 & 0 & 0 \\ 0 & 1250 & 0 \\ 0 & 0 & 1150 \end{pmatrix}^{T}$$

Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 235 & 0 \\ 0 & 0 & 0 & 235 & 0 & 0 \\ -51 & -51 & 140 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 21.2 & 0 \\ 0 & 0 & 0 & 21.2 & 0 & 0 \\ -5.0 & -5.0 & 13.7 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 10.8 & 0 \\ 0 & 0 & 0 & 10.8 & 0 & 0 \\ -0.7 & -0.7 & 15.7 & 0 & 0 & 0 \end{pmatrix} C/m^{2}$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 12.7 & 0 \\ 0 & 0 & 0 & 12.7 & 0 & 0 \\ -0.9 & -0.9 & 19.5 & 0 & 0 & 0 \end{pmatrix} 10^{8} V/m$$