Matrixes of DL-48

Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{E} = \begin{pmatrix} 15.5 & 8.5 & 8.4 & 0 & 0 & 0 \\ 8.5 & 15.5 & 8.4 & 0 & 0 & 0 \\ 8.4 & 8.4 & 13.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4.3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4.3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 3.5 \end{pmatrix}^{E} 10^{10}\, N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^{D} = \begin{pmatrix} 16.1 & 9.1 & 7.8 & 0 & 0 & 0 \\ 9.1 & 16.1 & 7.8 & 0 & 0 & 0 \\ 7.8 & 7.8 & 17.2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 7.7 & 0 & 0 \\ 0 & 0 & 0 & 0 & 7.7 & 0 \\ 0 & 0 & 0 & 0 & 0 & 3.5 \end{pmatrix}^{D} 10^{10}\, N/m^2$$

Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{E} = \begin{pmatrix} 10.9 & -3.4 & -4.8 & 0 & 0 & 0 \\ -3.4 & 10.9 & -4.8 & 0 & 0 & 0 \\ -4.8 & -4.8 & 13.8 & 0 & 0 & 0 \\ 0 & 0 & 0 & 23.1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 23.1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 28.6 \end{pmatrix}^{E} 10^{-12}\, m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^{D} = \begin{pmatrix} 9.9 & -4.4 & -2.5 & 0 & 0 & 0 \\ -4.4 & 9.9 & -2.5 & 0 & 0 & 0 \\ -2.5 & -2.5 & 8.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 13.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 13.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 28.6 \end{pmatrix}^{D} 10^{-12}\, m^2/N$$

Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{S} = \begin{pmatrix} 1430 & 0 & 0 \\ 0 & 1430 & 0 \\ 0 & 0 & 1550 \end{pmatrix}^{S}$$

Matrix of Free Dielectric Constant

$$\begin{pmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{pmatrix}^{T} = \begin{pmatrix} 2530 & 0 & 0 \\ 0 & 2530 & 0 \\ 0 & 0 & 2650 \end{pmatrix}^{T}$$

Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 475 & 0 \\ 0 & 0 & 0 & 475 & 0 & 0 \\ -150 & -150 & 365 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 21.2 & 0 \\ 0 & 0 & 0 & 21.2 & 0 & 0 \\ -6.4 & -6.4 & 15.6 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 20.4 & 0 \\ 0 & 0 & 0 & 20.4 & 0 & 0 \\ -5.3 & -5.3 & 22.6 & 0 & 0 & 0 \end{pmatrix} C/m^{2}$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 16.3 & 0 \\ 0 & 0 & 0 & 16.3 & 0 & 0 \\ -4.0 & -4.0 & 16.8 & 0 & 0 & 0 \end{pmatrix} 10^{8} V/m$$