

## Matrixes of DL-45HD

### Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^E = \begin{pmatrix} 18.3 & 12.6 & 11.5 & 0 & 0 & 0 \\ 12.6 & 18.3 & 11.5 & 0 & 0 & 0 \\ 11.5 & 11.5 & 13.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2.6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.9 \end{pmatrix}^E 10^{10} N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^D = \begin{pmatrix} 18.5 & 12.7 & 10.5 & 0 & 0 & 0 \\ 12.7 & 18.5 & 10.5 & 0 & 0 & 0 \\ 10.5 & 10.5 & 16.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 5.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 5.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.9 \end{pmatrix}^D 10^{10} N/m^2$$

### Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^E = \begin{pmatrix} 13.1 & -4.2 & -7.6 & 0 & 0 & 0 \\ -4.2 & 13.1 & -7.6 & 0 & 0 & 0 \\ -7.6 & -7.6 & 20.4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 38.4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 38.4 & 0 \\ 0 & 0 & 0 & 0 & 0 & 34.6 \end{pmatrix}^E 10^{-12} m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^D = \begin{pmatrix} 11.5 & -5.8 & -3.7 & 0 & 0 & 0 \\ -5.8 & 11.5 & -3.7 & 0 & 0 & 0 \\ -3.7 & -3.7 & 11.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 20.1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 20.1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 34.6 \end{pmatrix}^D 10^{-12} m^2/N$$

Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \epsilon_{11} & 0 & 0 \\ 0 & \epsilon_{11} & 0 \\ 0 & 0 & \epsilon_{33} \end{pmatrix}^s = \begin{pmatrix} 875 & 0 & 0 \\ 0 & 875 & 0 \\ 0 & 0 & 740 \end{pmatrix}^s$$

Matrix of Free Dielectric Constant

$$\begin{pmatrix} \epsilon_{11} & 0 & 0 \\ 0 & \epsilon_{11} & 0 \\ 0 & 0 & \epsilon_{33} \end{pmatrix}^t = \begin{pmatrix} 1670 & 0 & 0 \\ 0 & 1670 & 0 \\ 0 & 0 & 1550 \end{pmatrix}^t$$

Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 520 & 0 \\ 0 & 0 & 0 & 520 & 0 & 0 \\ -150 & -150 & 360 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 35.0 & 0 \\ 0 & 0 & 0 & 35.0 & 0 & 0 \\ -11.0 & -11.0 & 26.0 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 13.5 & 0 \\ 0 & 0 & 0 & 13.5 & 0 & 0 \\ -4.9 & -4.9 & 14.1 & 0 & 0 & 0 \end{pmatrix} C/m^2$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 17.5 & 0 \\ 0 & 0 & 0 & 17.5 & 0 & 0 \\ -7.0 & -7.0 & 18.8 & 0 & 0 & 0 \end{pmatrix} 10^8 V/m$$