

## Matrixes of DL-41

### Stiffness Matrix

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^E = \begin{pmatrix} 16.9 & 9.3 & 9.0 & 0 & 0 & 0 \\ 9.3 & 16.9 & 9.0 & 0 & 0 & 0 \\ 9.0 & 9.0 & 13.3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 3.3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 3.3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 3.7 \end{pmatrix}^E 10^{10} N/m^2$$

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{11} & C_{13} & 0 & 0 & 0 \\ C_{13} & C_{13} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}^D = \begin{pmatrix} 16.9 & 9.4 & 8.2 & 0 & 0 & 0 \\ 9.4 & 16.9 & 8.2 & 0 & 0 & 0 \\ 8.2 & 8.2 & 18.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6.3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6.3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 3.8 \end{pmatrix}^D 10^{10} N/m^2$$

### Elastic Matrix

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^E = \begin{pmatrix} 10.2 & -3.1 & -4.8 & 0 & 0 & 0 \\ -3.1 & 10.2 & -4.8 & 0 & 0 & 0 \\ -4.8 & -4.8 & 14.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 30.4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 30.4 & 0 \\ 0 & 0 & 0 & 0 & 0 & 26.6 \end{pmatrix}^E 10^{-12} m^2/N$$

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{pmatrix}^D = \begin{pmatrix} 9.3 & -4.0 & -2.4 & 0 & 0 & 0 \\ -4.0 & 9.3 & -2.4 & 0 & 0 & 0 \\ -2.4 & -2.4 & 7.7 & 0 & 0 & 0 \\ 0 & 0 & 0 & 15.9 & 0 & 0 \\ 0 & 0 & 0 & 0 & 15.9 & 0 \\ 0 & 0 & 0 & 0 & 0 & 26.6 \end{pmatrix}^D 10^{-12} m^2/N$$

### Matrix of Clamp Dielectric Constant

$$\begin{pmatrix} \epsilon_{11} & 0 & 0 \\ 0 & \epsilon_{11} & 0 \\ 0 & 0 & \epsilon_{33} \end{pmatrix}^s = \begin{pmatrix} 390 & 0 & 0 \\ 0 & 390 & 0 \\ 0 & 0 & 300 \end{pmatrix}^s$$

### Matrix of Free Dielectric Constant

$$\begin{pmatrix} \epsilon_{11} & 0 & 0 \\ 0 & \epsilon_{11} & 0 \\ 0 & 0 & \epsilon_{33} \end{pmatrix}^T = \begin{pmatrix} 750 & 0 & 0 \\ 0 & 750 & 0 \\ 0 & 0 & 520 \end{pmatrix}^T$$

### Piezoelectric Constant Matrixes

$$\begin{pmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 310 & 0 \\ 0 & 0 & 0 & 310 & 0 & 0 \\ -65 & -65 & 170 & 0 & 0 & 0 \end{pmatrix} 10^{-12} C/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 46.5 & 0 \\ 0 & 0 & 0 & 46.5 & 0 & 0 \\ -14.0 & -14.0 & 37.0 & 0 & 0 & 0 \end{pmatrix} 10^{-3} Vm/N$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 10.2 & 0 \\ 0 & 0 & 0 & 10.2 & 0 & 0 \\ -1.7 & -1.7 & 10.9 & 0 & 0 & 0 \end{pmatrix} C/m^2$$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 & 29.3 & 0 \\ 0 & 0 & 0 & 29.3 & 0 & 0 \\ -6.5 & -6.5 & 43.6 & 0 & 0 & 0 \end{pmatrix} 10^8 V/m$$