

P-5B Electromechanical characteristics matrix

Stiffness coefficient matrix

$$\begin{bmatrix} C_{11}^E & C_{12}^E & C_{13}^E & 0 & 0 & 0 \\ C_{12}^E & C_{11}^E & C_{13}^E & 0 & 0 & 0 \\ C_{13}^E & C_{13}^E & C_{33}^E & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44}^E & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55}^E & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66}^E \end{bmatrix} = \begin{bmatrix} 17.6 & 12.7 & 11.5 & 0 & 0 & 0 \\ 12.7 & 17.6 & 11.5 & 0 & 0 & 0 \\ 11.5 & 11.5 & 13.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2.1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2.1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.4 \end{bmatrix}^E \cdot 10^{10} N/m^2$$

$$\begin{bmatrix} C_{11}^D & C_{12}^D & C_{13}^D & 0 & 0 & 0 \\ C_{12}^D & C_{11}^D & C_{13}^D & 0 & 0 & 0 \\ C_{13}^D & C_{13}^D & C_{33}^D & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44}^D & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55}^D & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66}^D \end{bmatrix} = \begin{bmatrix} 18.7 & 13.9 & 10 & 0 & 0 & 0 \\ 13.9 & 18.7 & 10 & 0 & 0 & 0 \\ 10 & 10 & 17.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4.3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4.3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2.4 \end{bmatrix}^D \cdot 10^{10} N/m^2$$

Elastic Flexibility Coefficient Matrix

$$\begin{bmatrix} S_{11}^E & S_{12}^E & S_{13}^E & 0 & 0 & 0 \\ S_{12}^E & S_{11}^E & S_{13}^E & 0 & 0 & 0 \\ S_{13}^E & S_{13}^E & S_{33}^E & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44}^E & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55}^E & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66}^E \end{bmatrix} = \begin{bmatrix} 15 & -5.6 & -8 & 0 & 0 & 0 \\ -5.6 & 15 & -8 & 0 & 0 & 0 \\ -8 & -8 & 21.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 47.2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 47.2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 41.4 \end{bmatrix}^E \cdot 10^{-12} m^2/N$$

$$\begin{bmatrix} S_{11}^D & S_{12}^D & S_{13}^D & 0 & 0 & 0 \\ S_{12}^D & S_{11}^D & S_{13}^D & 0 & 0 & 0 \\ S_{13}^D & S_{13}^D & S_{33}^D & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44}^D & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{55}^D & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66}^D \end{bmatrix} = \begin{bmatrix} 12.8 & -7.9 & -3.1 & 0 & 0 & 0 \\ -7.9 & 12.8 & -3.1 & 0 & 0 & 0 \\ -3.1 & -3.1 & 10.4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 23.2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 23.2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 41.4 \end{bmatrix}^D \cdot 10^{-12} m^2/N$$

Piezoelectric constant matrix

$$\begin{bmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{31} & d_{33} & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 610 & 0 \\ 0 & 0 & 0 & 610 & 0 & 0 \\ -200 & -200 & 430 & 0 & 0 & 0 \end{bmatrix} \quad 10^{12} \text{C/N}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & g_{15} & 0 \\ 0 & 0 & 0 & g_{24} & 0 & 0 \\ g_{31} & g_{31} & g_{33} & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 39 & 0 \\ 0 & 0 & 0 & 39 & 0 & 0 \\ -11 & -11 & 24.9 & 0 & 0 & 0 \end{bmatrix} \quad 10^{-3} \text{Vm/N}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & e_{15} & 0 \\ 0 & 0 & 0 & e_{24} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 13 & 0 \\ 0 & 0 & 0 & 13 & 0 & 0 \\ -9.9 & -9.9 & 12.9 & 0 & 0 & 0 \end{bmatrix} \quad \text{C/m}^2$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & h_{15} & 0 \\ 0 & 0 & 0 & h_{24} & 0 & 0 \\ h_{31} & h_{31} & h_{33} & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 16.8 & 0 \\ 0 & 0 & 0 & 16.8 & 0 & 0 \\ -12 & -12 & 15.1 & 0 & 0 & 0 \end{bmatrix} \quad 10^8 \text{V/m}$$

Clamped dielectric constant Matrix

$$\begin{bmatrix} \epsilon_{11}^S/\epsilon_0 & 0 & 0 \\ 0 & \epsilon_{11}^S/\epsilon_0 & 0 \\ 0 & 0 & \epsilon_{33}^S/\epsilon_0 \end{bmatrix} = \begin{bmatrix} 870 & 0 & 0 \\ 0 & 870 & 0 \\ 0 & 0 & 960 \end{bmatrix}^S$$

Free dielectric constant matrix

$$\begin{bmatrix} \epsilon_{11}^T/\epsilon_0 & 0 & 0 \\ 0 & \epsilon_{11}^T/\epsilon_0 & 0 \\ 0 & 0 & \epsilon_{33}^T/\epsilon_0 \end{bmatrix} = \begin{bmatrix} 1780 & 0 & 0 \\ 0 & 1780 & 0 \\ 0 & 0 & 1950 \end{bmatrix}^T$$

