Truss stiffness matrix in local coordinates

$$\bar{\mathbf{K}}^e = \frac{EA}{l}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}^e$$

Transformation matrix for truss element

$$\mathbf{T}^e = \begin{bmatrix} c & s & 0 & 0 \\ 0 & 0 & c & s \end{bmatrix}^e$$

Truss stiffness matrix in global coordinates

$$\mathbf{K}^e = \frac{EA}{l}\begin{bmatrix} c^2 & cs & -c^2 & -cs \\ cs & s^2 & -cs & -s^2 \\ -c^2 & -cs & c^2 & cs \\ -cs & -s^2 & cs & s^2 \end{bmatrix}^e \qquad \begin{array}{l} c = \cos(\alpha^e), \\ s = \sin(\alpha^e) \end{array}$$

Beam stiffness matrix

$$\mathbf{K}^e = \begin{bmatrix} \frac{12EI}{L^3} & \frac{6EI}{L^2} & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{4EI}{L} & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{2EI}{L} & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix}^e$$

Substitute nodal force vector for constant distributed load in a beam

$$\bar{\mathbf{z}}^e = \begin{bmatrix} \frac{qL}{2} & \frac{qL^2}{12} & \frac{qL}{2} & -\frac{qL^2}{12} \end{bmatrix}$$

Lagrange interpolation functions

$$\begin{aligned} N_1(x) &= 1 - \xi \\ N_2(x) &= \xi \\ \xi &= x/l^e \end{aligned}$$

Hermite interpolation functions

$$\begin{aligned} H_1(x) &= 1 - 3\xi^2 + 2\xi^3 \\ H_2(x) &= l^e(\xi - 2\xi^2 + \xi^3) \\ H_3(x) &= 3\xi^2 - 2\xi^3 \\ H_4(x) &= l^e(\xi^3 - \xi^2) \\ \xi &= x/l^e \end{aligned}$$