Linear Analysis Result: beam1

unit: [N], [mm]

Member Information:

EID	i	j	E [MPa]	I [mm^4]	A [mm^2]	L [mm]	θ
1	1	2	2.10e+05	2.50e+08	None	4000.0	0
2	2	3	2.10e+05	2.50e+08	None	4000.0	0

EID	c	s	cs	c^2	s^2	AE/L	12EI/L^3	6EI/L^2	4EI/L	2EI/L
1	None	None	None	None	None	None	9843.75	1.97e+07	5.25e+10	2.62e+10
2	None	None	None	None	None	None	9843.75	1.97e+07	5.25e+10	2.62e+10

Member Local Stiffness:

$$[K1] = \begin{bmatrix} 9.84e+03 & 1.97e+07 & -9.84e+03 & 1.97e+07 \\ 1.97e+07 & 5.25e+10 & -1.97e+07 & 2.62e+10 \\ -9.84e+03 & -1.97e+07 & 9.84e+03 & -1.97e+07 \\ 1.97e+07 & 2.62e+10 & -1.97e+07 & 5.25e+10 \end{bmatrix}$$

$$[K2] = \begin{bmatrix} 9.84e+03 & 1.97e+07 & -9.84e+03 & 1.97e+07 \\ 1.97e+07 & 5.25e+10 & -1.97e+07 & 2.62e+10 \\ -9.84e+03 & -1.97e+07 & 9.84e+03 & -1.97e+07 \\ 1.97e+07 & 2.62e+10 & -1.97e+07 & 5.25e+10 \end{bmatrix}$$

Structure Global Stiffness:

$$[K] = \begin{bmatrix} 9.84e+03 & 1.97e+07 & -9.84e+03 & 1.97e+07 & 0.00e+00 & 0.00e+00 \\ 1.97e+07 & 5.25e+10 & -1.97e+07 & 2.62e+10 & 0.00e+00 & 0.00e+00 \\ -9.84e+03 & -1.97e+07 & 1.97e+04 & 0.00e+00 & -9.84e+03 & 1.97e+07 \\ 1.97e+07 & 2.62e+10 & 0.00e+00 & 1.05e+11 & -1.97e+07 & 2.62e+10 \\ 0.00e+00 & 0.00e+00 & -9.84e+03 & -1.97e+07 & 9.84e+03 & -1.97e+07 \\ 0.00e+00 & 0.00e+00 & 1.97e+07 & 2.62e+10 & -1.97e+07 & 5.25e+10 \end{bmatrix}$$

Nodal Displacement & Nodal Load:

$$\{r\} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \theta 2 \\ 0 \\ \theta 3 \end{bmatrix} \qquad \{R\} = \begin{bmatrix} Fy,1 \\ M1 \\ Fy,2 \\ 12000000.0 \\ Fy,3 \\ 0 \end{bmatrix}$$

Member Local P:

$$\{P1\} = \begin{bmatrix} 3.00e+03 \\ 3.00e+06 \\ 3.00e+03 \\ -3.00e+06 \end{bmatrix} \qquad \{P2\} = \begin{bmatrix} 1.50e+03 \\ 1.50e+06 \\ 1.50e+03 \\ -1.50e+06 \end{bmatrix}$$

Structure Global P:

$$\{P\} = \begin{bmatrix} 3.00e+03 \\ 3.00e+06 \\ 4.50e+03 \\ -1.50e+06 \\ 1.50e+03 \\ -1.50e+06 \end{bmatrix}$$

Nodal Displacement {rf}:

$$\{Rf\} = [Kff]\{rf\} + \{Pf\}$$

$$\{rf\} = [Kff]^{(-1)} \times (\{Rf\} - \{Pf\})$$

$$[Kff] = \begin{vmatrix} 1.05e+11 & 2.62e+10 \\ 2.62e+10 & 5.25e+10 \end{vmatrix}$$

$$\{Rf\} = \begin{vmatrix} 1.20e+07 \\ 0.00e+00 \end{vmatrix}$$

$$\{Pf\} = \begin{vmatrix} -1.50e+06 \\ -1.50e+06 \end{vmatrix}$$

$$\Longrightarrow \{rf\} = \begin{vmatrix} \theta 2 \\ \theta 3 \end{vmatrix} = \begin{vmatrix} 1.39e-04 \\ -4.08e-05 \end{vmatrix}$$

Reaction Force {Rs}:

$\{Rs\} = [Ksf]\{rf\} + \{Ps\}$

$$[Ksf] = \begin{vmatrix} 1.97e+07 & 0.00e+00 \\ 2.62e+10 & 0.00e+00 \\ 0.00e+00 & 1.97e+07 \\ -1.97e+07 & -1.97e+07 \end{vmatrix}$$

$$\{Ps\} = \begin{vmatrix} 3.00e+03 \\ 3.00e+06 \\ 4.50e+03 \\ 1.50e+03 \end{vmatrix}$$

$$\Longrightarrow \{Rs\} = \begin{vmatrix} Fy,1 \\ M1 \\ Fy,2 \\ Fy,3 \end{vmatrix} = \begin{vmatrix} 5.73e+03 \\ 6.64e+06 \\ 3.70e+03 \\ -4.29e+02 \end{vmatrix}$$

Member Force:

Beam: member1

$$\{F'1\} = [K1]\{r1\} + \{P1\} = \begin{vmatrix} 5.73e+03 \\ 6.64e+06 \\ 2.68e+02 \\ 4.29e+06 \end{vmatrix}$$

Beam: member2

$$\{F'2\} = [K2]\{r2\} + \{P2\} = \begin{vmatrix} 3.43e+03 \\ 7.71e+06 \\ -4.29e+02 \\ 4.66e-10 \end{vmatrix}$$