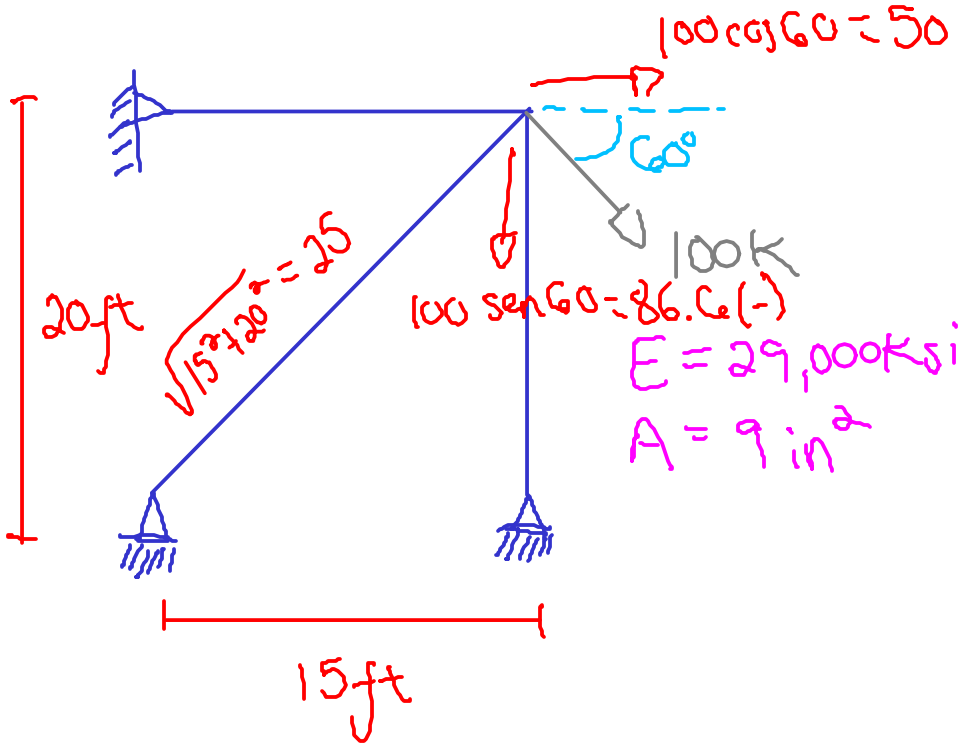
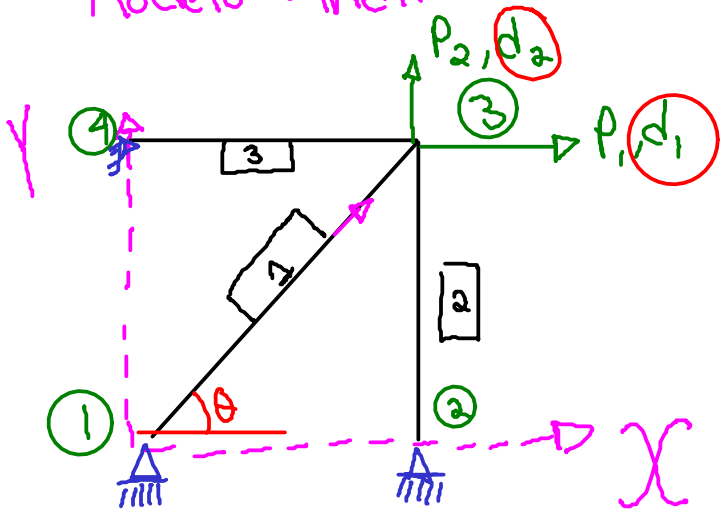


Resolver mediante el método de las RIGIDECES

$E = 29{,}000 ksi$

$A = 9\ in^2$

Modelo Analítico → ARMADURA ←



Matrices de Rigidez de la estructura

$$K_{Local} = \frac{EA}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$

$$\cos\theta = \frac{15}{25} = 0.6 \qquad \operatorname{sen}\theta = \frac{20}{25} = 0.8$$

$$K_{global} = \frac{EA}{L}\begin{bmatrix} \cos^2\theta & \cos\theta\operatorname{sen}\theta & -\cos^2\theta & -\cos\theta\operatorname{sen}\theta \\ \cos\theta\operatorname{sen}\theta & \operatorname{sen}^2\theta & -\cos\theta\operatorname{sen}\theta & -\operatorname{sen}^2\theta \\ -\cos^2\theta & -\cos\theta\operatorname{sen}\theta & \cos^2\theta & \cos\theta\operatorname{sen}\theta \\ -\cos\theta\operatorname{sen}\theta & -\operatorname{sen}^2\theta & \cos\theta\operatorname{sen}\theta & \operatorname{sen}^2\theta \end{bmatrix}$$

$$K_{1\,global} = \frac{(29{,}000)(9)}{(25)(12)} \begin{bmatrix} 0.36 & 0.48 & -0.36 & -0.48 \\ 0.48 & 0.64 & -0.48 & -0.64 \\ -0.36 & -0.48 & 0.36 & 0.48 \\ -0.48 & -0.64 & 0.48 & 0.64 \end{bmatrix}$$

$$K_1 = \begin{array}{c} \\ 0 \\ 0 \\ 1 \\ 2 \end{array} \begin{array}{c} \begin{array}{cccc} 0 & 0 & 1 & 2 \end{array} \\ \begin{bmatrix} 313.2 & 417.6 & -313.2 & -417.6 \\ 417.6 & 556.8 & -417.6 & -556.8 \\ -313.2 & -417.6 & 313.2 & 417.6 \\ -417.6 & -556.8 & 417.6 & 556.8 \end{bmatrix} \end{array}$$

vertical

$$K_2 = \begin{array}{c} \\ 0 \\ 0 \\ 1 \\ 2 \end{array} \begin{array}{c} \begin{array}{cccc} 0 & 0 & 1 & 2 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1087.5 & 0 & -1087.5 \\ 0 & 0 & 0 & 0 \\ 0 & -1087.5 & 0 & 1087.5 \end{bmatrix} \end{array}$$

$$\cos\theta = \frac{0}{20} = 0$$

$$\operatorname{sen}\theta = \frac{20-0}{20} = 1$$

$$K_2 = \frac{(29000)(9)}{20(12)} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \end{bmatrix}$$

$$K_3 \rightarrow \frac{(29000)(9)}{15(12)} \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$K_3 \rightarrow \begin{array}{c} \\ 0 \\ 0 \\ 1 \\ 2 \end{array} \begin{array}{c} \begin{array}{cccc} 0 & 0 & 1 & 2 \end{array} \\ \begin{bmatrix} 1450 & 0 & -1450 & 0 \\ 0 & 0 & 0 & 0 \\ -1450 & 0 & 1450 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

$$S = \begin{array}{c} \\ 1 \\ 2 \end{array} \begin{array}{c} \begin{array}{cc} 1 & 2 \end{array} \\ \begin{bmatrix} (313.2+0+1450) & (417.6+0+0) \\ (417.6+0+0) & (556.8+1087.5+0) \end{bmatrix} \end{array} = \begin{bmatrix} 1763.2 & 417.6 \\ 417.6 & 1644.3 \end{bmatrix}$$

$$P = S\,d$$

$$d = S^{-1} P$$

$$\hat{P} = \begin{bmatrix} 50 \\ -86.6 \end{bmatrix}$$ (calculadora)

$$d = \begin{bmatrix} 0.0434 \\ -0.063 \end{bmatrix} \text{ in Global}$$

Desplazamientos y fuerzas en los extremos del elemento

$$V_1 = \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0.0434 \\ -0.063 \end{bmatrix} \text{ in}$$

$$U = T\,v$$

$$T = \begin{bmatrix} \cos\theta & \text{sen}\theta & 0 & 0 \\ 0 & 0 & \cos\theta & \text{sen}\theta \end{bmatrix}$$

$\cos\theta = 0.6$

$\text{sen}\theta = 0.8$

$$U_1 = \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} 0.6 & 0.8 & 0 & 0 \\ 0 & 0 & 0.6 & 0.8 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0.0434 \\ -0.063 \end{bmatrix} = \begin{bmatrix} 0 \\ -0.0249 \end{bmatrix} \text{ in}$$

$$Q = KU$$

$$Q_1 = \begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} = \frac{EA}{L} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix}$$

$$= \frac{(29000)(9)}{(25)(12)} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -0.0249 \end{bmatrix} = \begin{bmatrix} 21.66 \\ -21.66 \end{bmatrix}$$ LOCAL

21.66 COMPR.

21.66

$$F = T^T Q$$

$$F = \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{bmatrix} = \begin{bmatrix} 0.6 & 0 \\ 0.8 & 0 \\ 0 & 0.6 \\ 0 & 0.8 \end{bmatrix} \begin{bmatrix} 21.66 \\ -21.66 \end{bmatrix} = \begin{bmatrix} 13 \\ 17.33 \\ -13 \\ -17.33 \end{bmatrix}$$ GLOBAL

Elemento 2

$$V_2 = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0.0434 \\ -0.063 \end{bmatrix}$$ desp. GLOBALES

$U = TV$

$\cos\theta = 0$

$\text{sen}\theta = 1$

desp. LOCALES

$$T = \begin{bmatrix} \cos\theta & \text{sen}\theta & 0 & 0 \\ 0 & 0 & \cos\theta & \text{sen}\theta \end{bmatrix}$$

$$U_2 = \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0.0434 \\ -0.063 \end{bmatrix} = \begin{bmatrix} 0 \\ -0.0637 \end{bmatrix} \text{ in}$$

$$Q_2 = \begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} = \frac{EA}{L} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -0.0637 \end{bmatrix} = \frac{(2900)(9)}{(20)(12)} \cdots$$

$$= 1087.5 \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -0.0637 \end{bmatrix} = \begin{bmatrix} 69.27 \\ -69.27 \end{bmatrix} \text{ COMPR.}$$

$$F = T^T Q$$

$$F = \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 69.27 \\ -69.27 \end{bmatrix} = \begin{bmatrix} 0 \\ 69.27 \\ 0 \\ -69.27 \end{bmatrix} K$$

Elemento 3

$$U_3 = \begin{bmatrix} U_1 \\ U_2 \\ U_3 \\ U_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0.0434 \\ -0.063 \end{bmatrix}$$

$$U_3 = TV = \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0.0434 \\ -0.063 \end{bmatrix} = \begin{bmatrix} 0 \\ 0.0434 \end{bmatrix} in$$

$\cos = 1$

$\sin = 0$

$$Q = KU$$

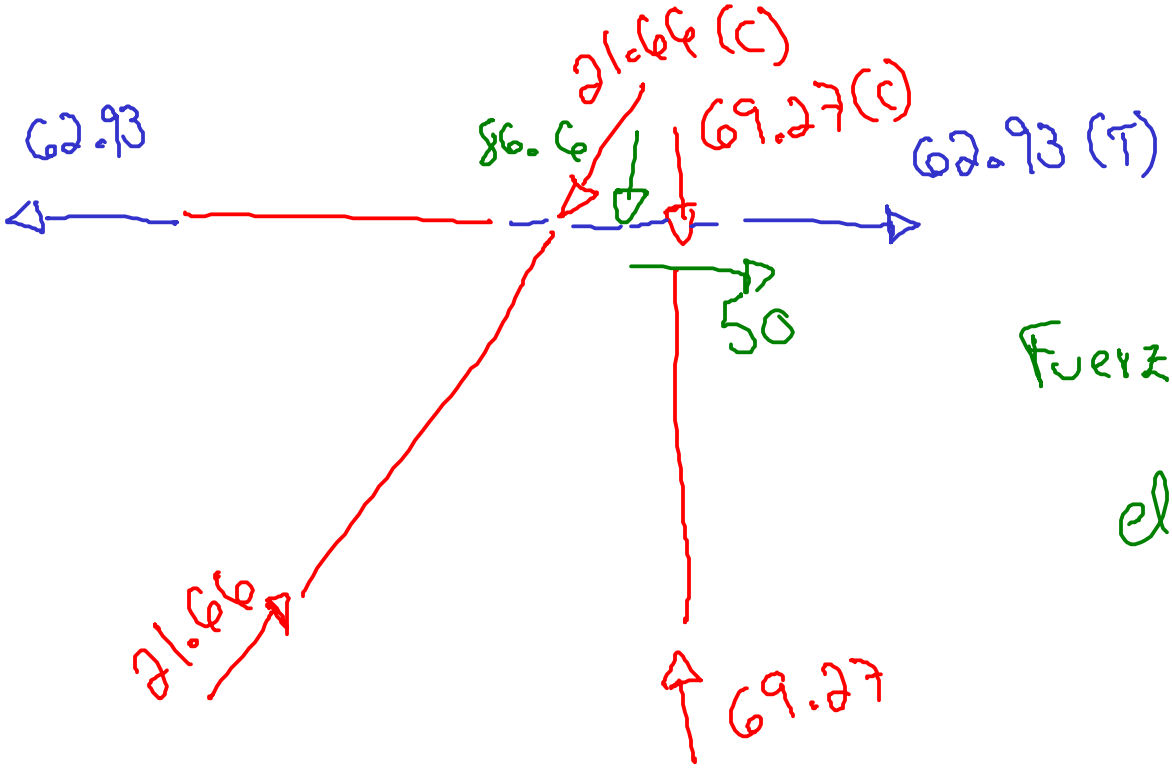
$$Q_3 = \frac{EA}{L} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = \frac{(29000)(9)}{(15)(12)} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0.0434 \end{bmatrix}$$

$$Q_3 = \begin{bmatrix} -62.93 \\ 62.93 \end{bmatrix} \Rightarrow \text{Tens.}$$

62.93 ⟵ ⟶ 62.93

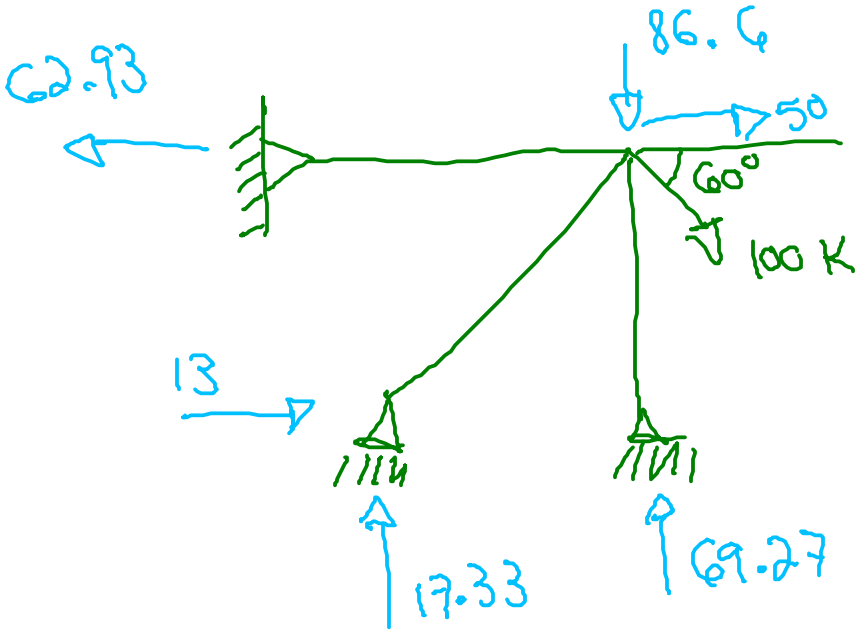
$$F = T^T Q$$

$$F_3 = \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} -62.93 \\ 62.93 \end{bmatrix} = \begin{bmatrix} -62.93 \\ 0 \\ 62.93 \\ 0 \end{bmatrix} K$$



Verde = F. ext.

Fuerzas Axiales en los elementos



$\Sigma F_x = 0 = -62.93 + 13 + 50 \approx 0$

$\Sigma F_y = 17.33 + 69.27 - 86.8 = 0$

$\circlearrowleft^{+} \Sigma M_{①} = 69.27(15) + 62.93(20) - 100\cos 60(20) - 100\,\text{sen}\,60(15)$

$= -1.39 \approx 0.$