

A short course on

Equilibrium

This video:

Forces on a Rigid Body

Terje's Toolbox is freely available at terje.civil.ubc.ca

It is created and maintained by Professor Terje Haukaas, Ph.D., P.Eng.,
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Equilibrium Equations

Linear equilibrium

$$\sum F_x = 0$$



Point forces

Linear equilibrium

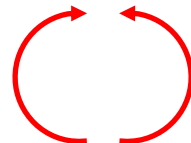
$$\sum F_y = 0$$



Point forces

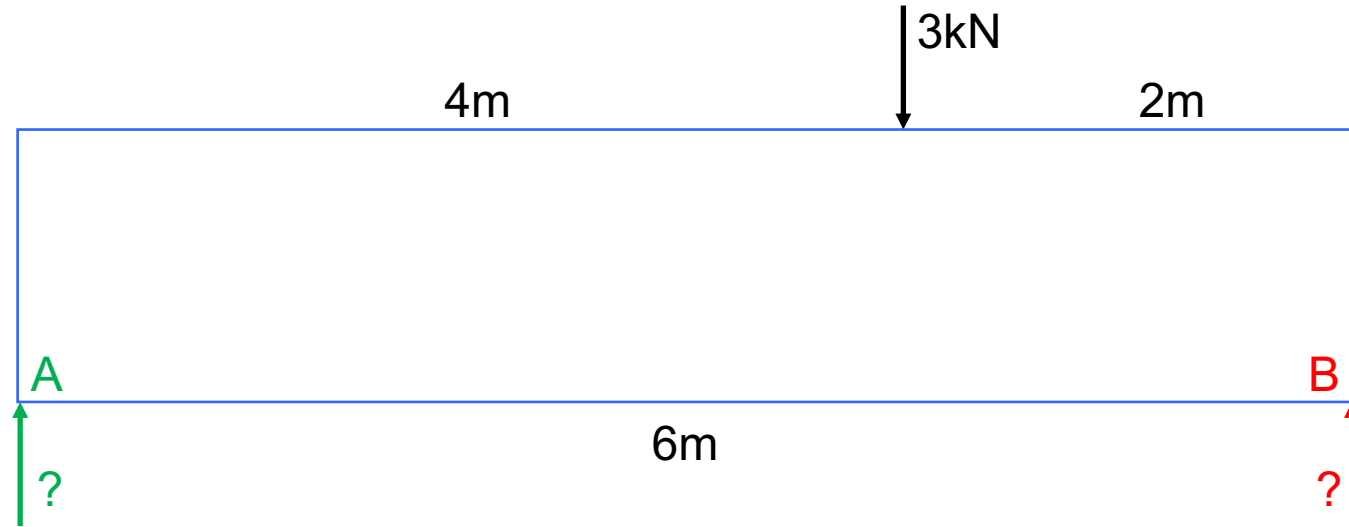
Angular equilibrium

$$\sum M = 0$$



Moments about a selected point

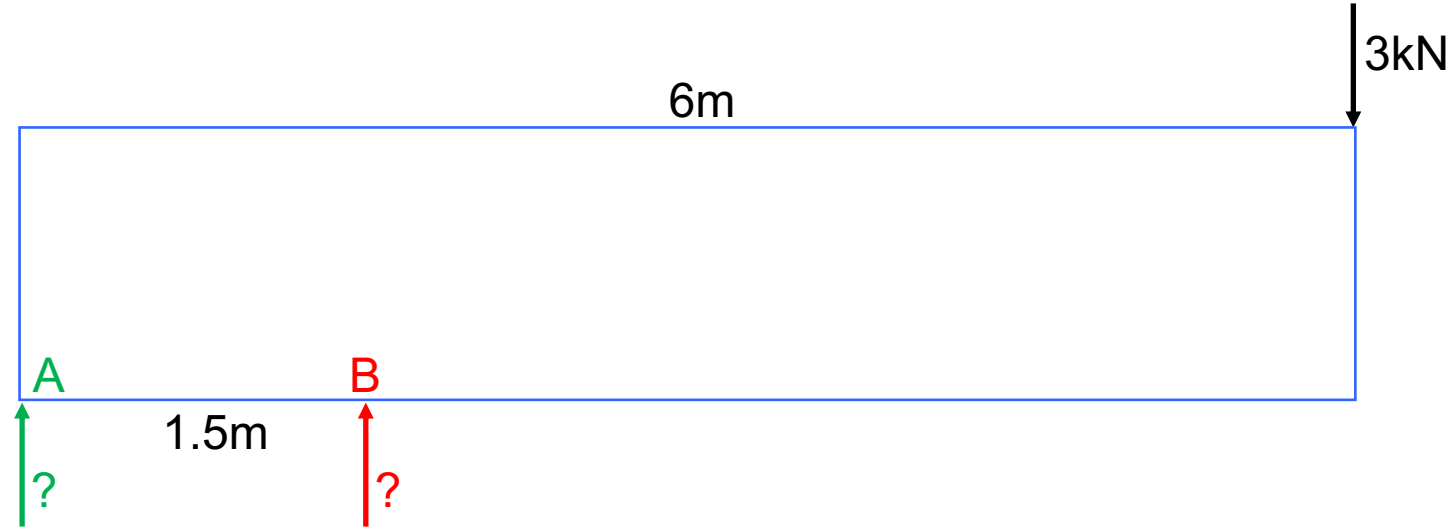
Example



$$\sum M_A = (3\text{kN})(4\text{m}) - (R_B)(6\text{m}) = 0 \rightarrow R_B = 2\text{kN}$$

$$\sum F_y = 3\text{kN} - R_B - R_A = 0 \rightarrow R_B = 1\text{kN}$$

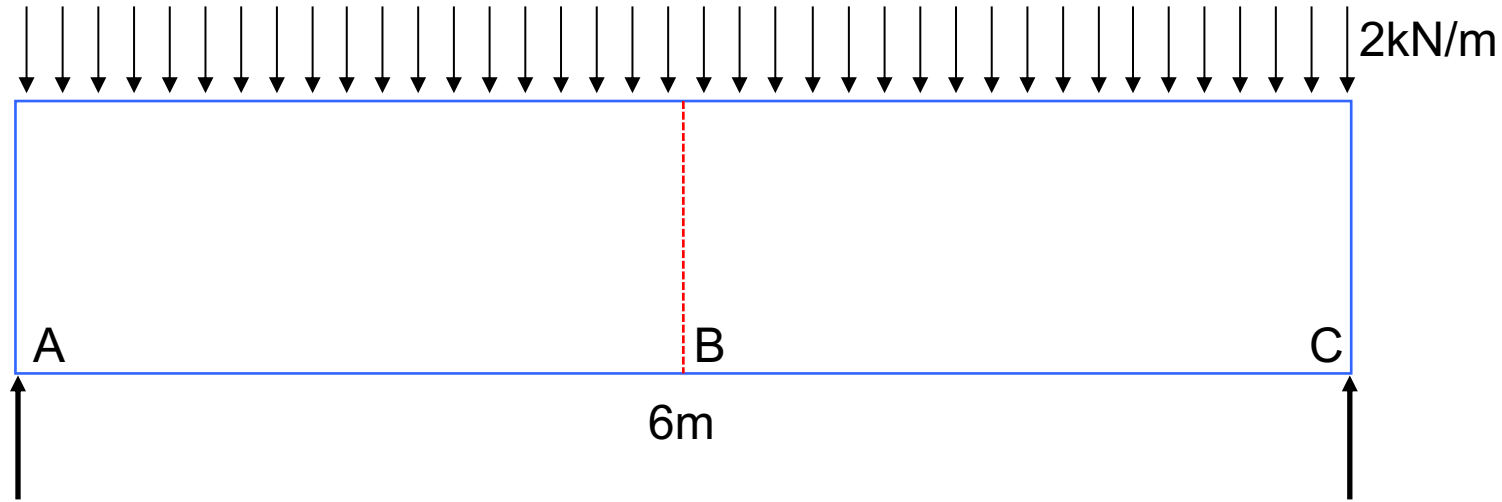
Example



$$\sum M_A = (3\text{kN})(6\text{m}) - (R_B)(1.5\text{m}) = 0 \rightarrow R_B = 12\text{kN}$$

$$\sum F_y = 3\text{kN} - 12\text{kN} - R_A = 0 \rightarrow R_B = -9\text{kN}$$

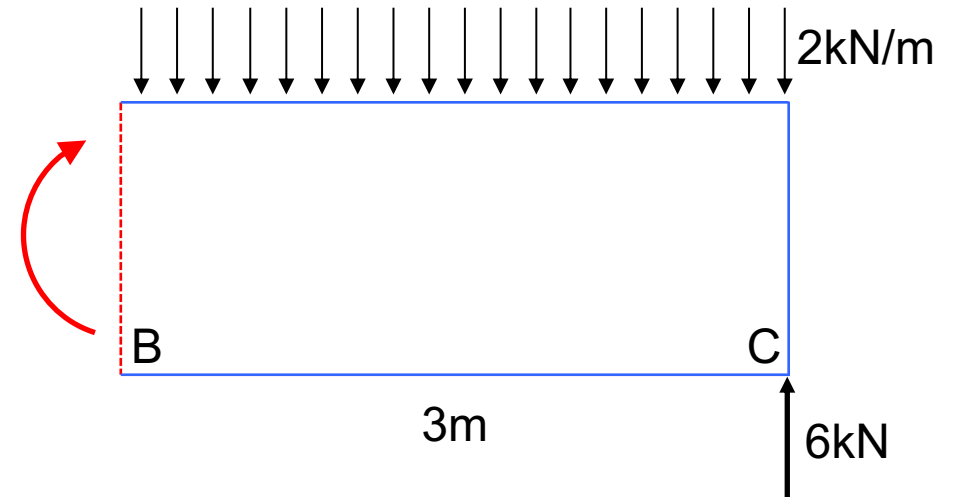
Example



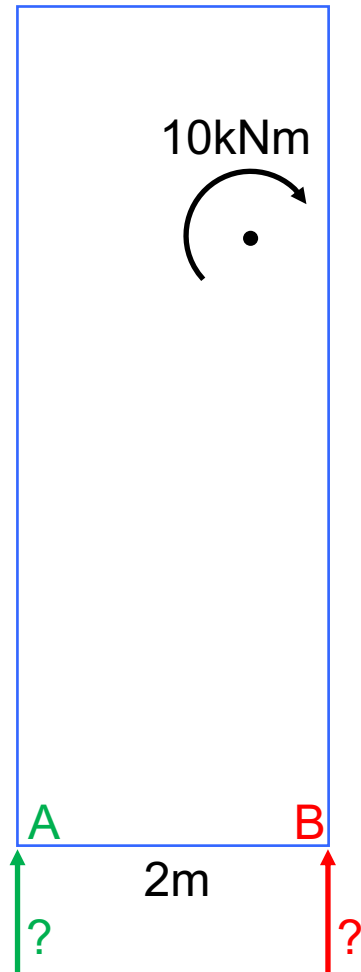
$$\sum M_A = \left(\frac{2\text{kN}}{\text{m}}\right)(6\text{m})(3\text{m}) - (R_C)(6\text{m}) = 0 \rightarrow R_C = 6\text{kN}$$

$$\sum F_y = \left(\frac{2\text{kN}}{\text{m}}\right)(6\text{m}) - 6\text{kN} - R_A = 0 \rightarrow R_A = 6\text{kN}$$

$$\sum M_B = M + \left(\frac{2\text{kN}}{\text{m}}\right)(3\text{m})\left(\frac{3\text{m}}{2}\right) - (6\text{kN})(3\text{m}) = 0 \rightarrow M = 9\text{kNm}$$



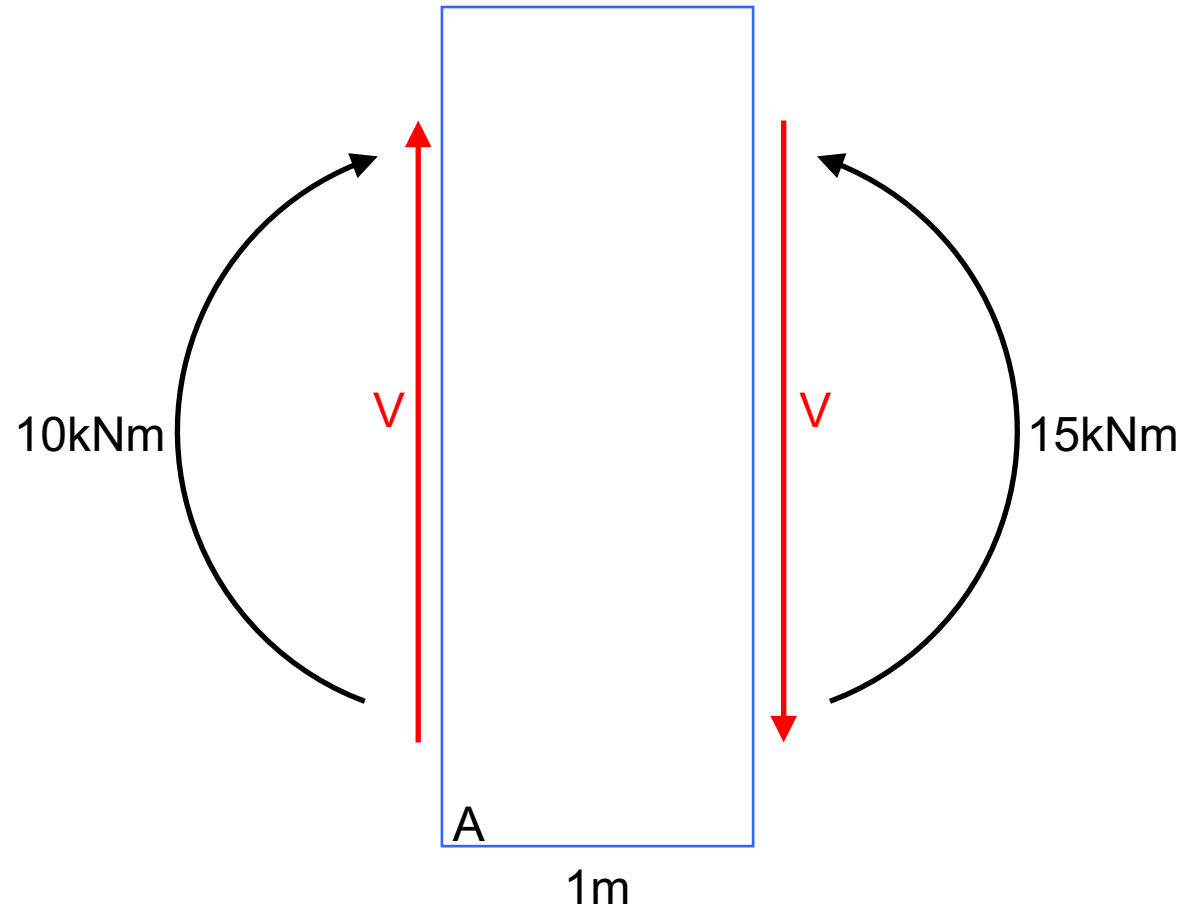
Example



$$\sum M_A = 10\text{kNm} - (R_B)(2\text{m}) = 0 \rightarrow R_B = 5\text{kN}$$

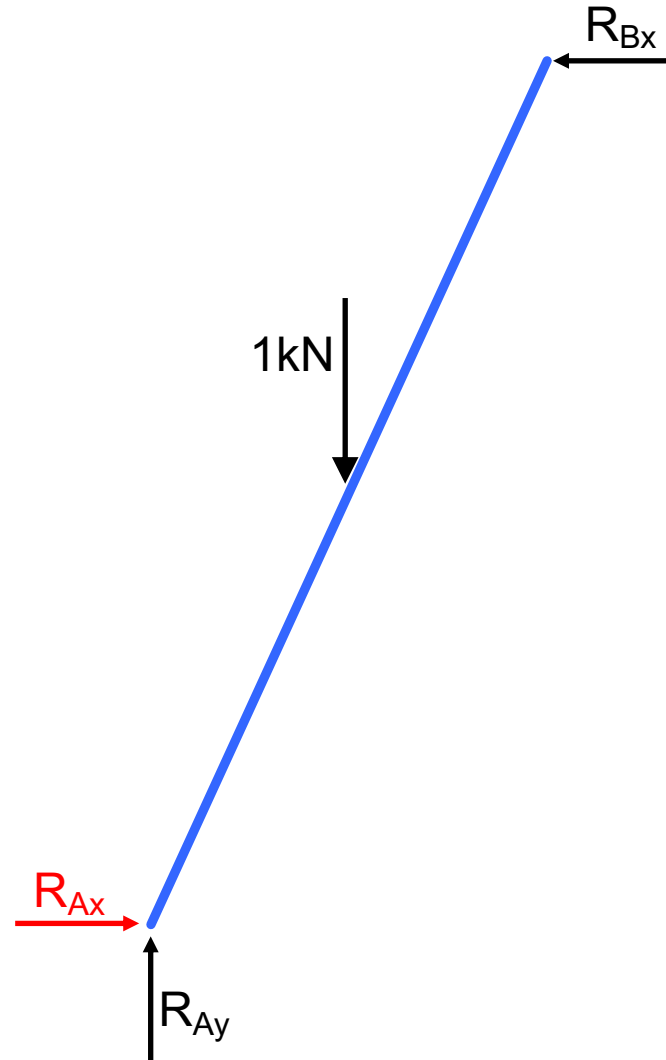
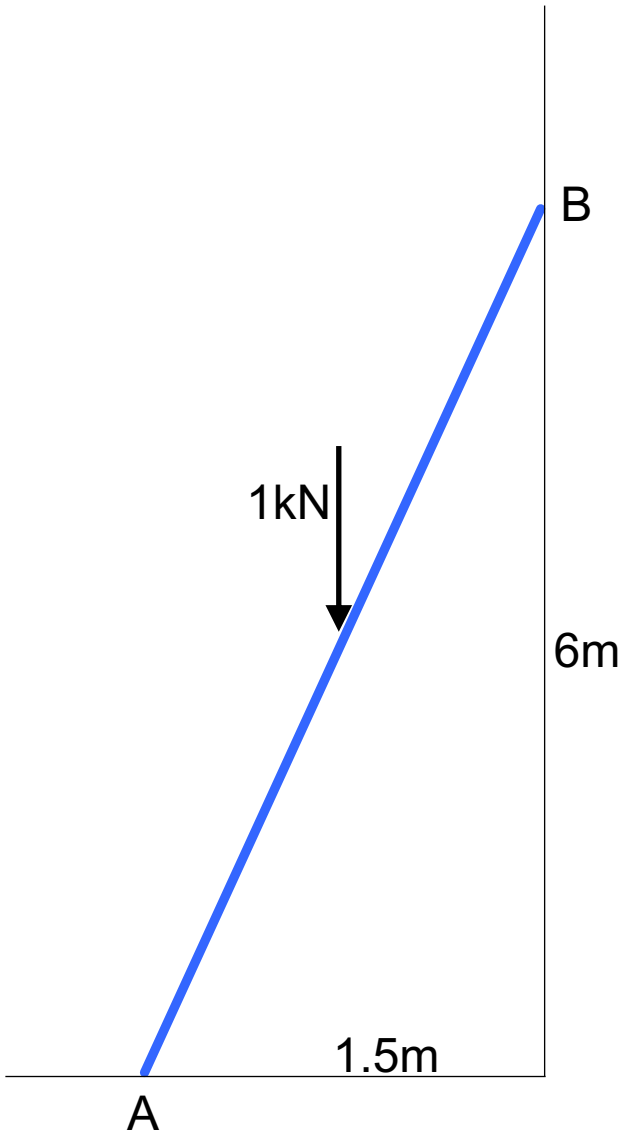
$$\sum F_y = 5\text{kN} + R_A = 0 \rightarrow R_A = -5\text{kN} \quad (\text{tension})$$

Example



$$\sum M_A = 10\text{kNm} - 15\text{kNm} + V \cdot 1\text{m} = 0 \rightarrow V = 5\text{kN}$$

Example

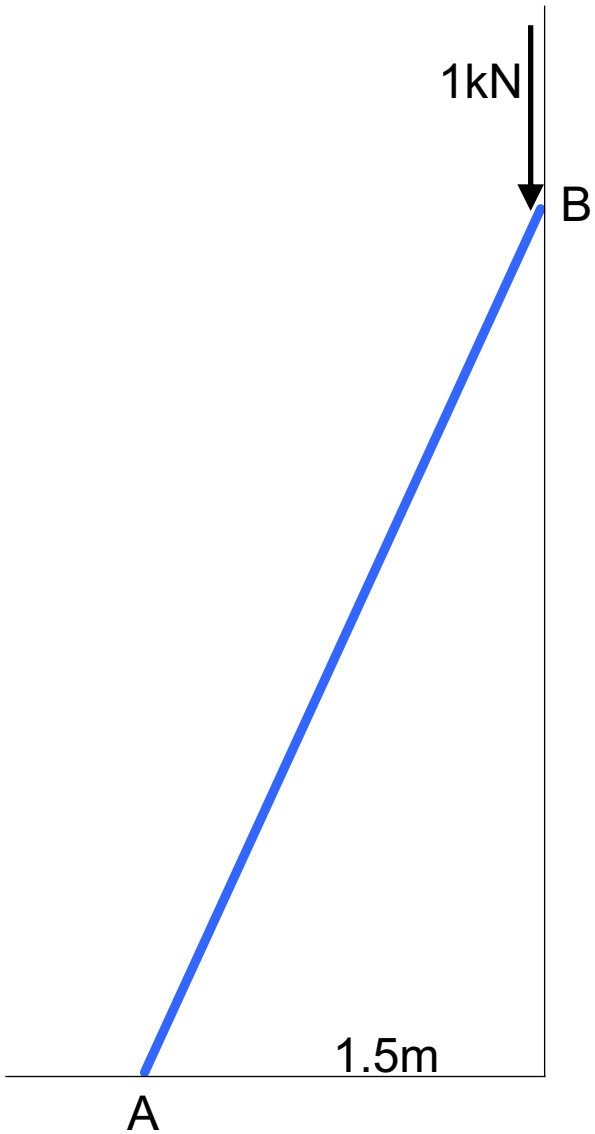


$$\sum F_y = 1\text{kN} - R_{Ay} = 0 \rightarrow R_{Ay} = 1\text{kN}$$

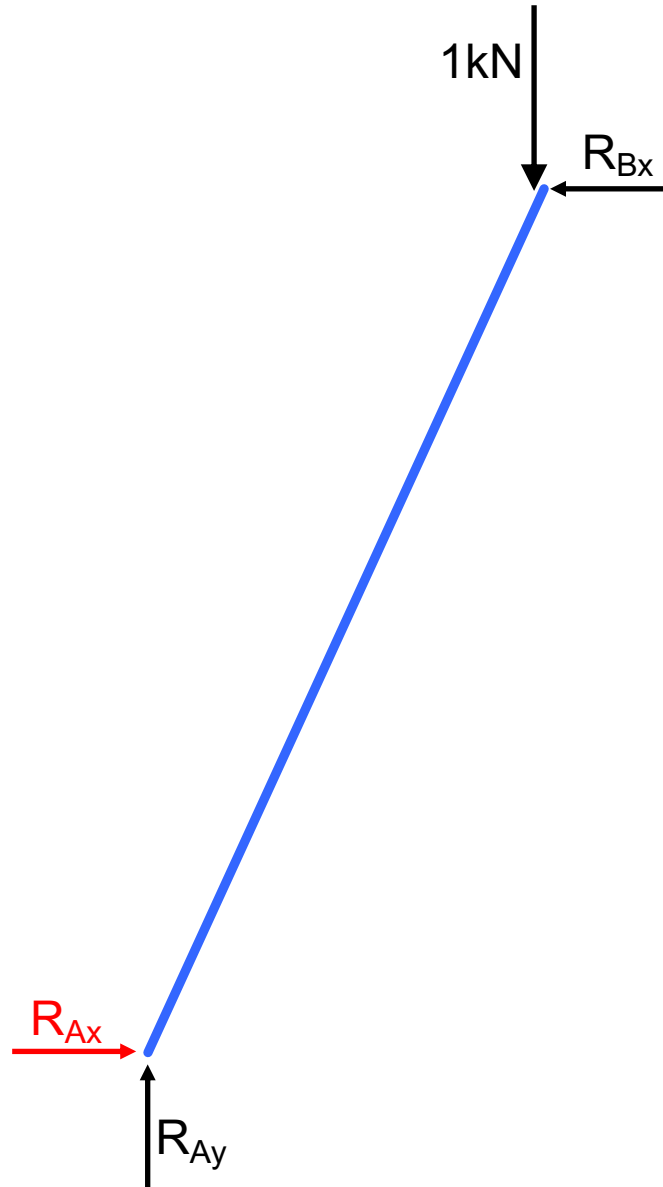
$$\sum M_A = (1\text{kN})(0.75\text{m}) - (R_{Bx})(6\text{m}) = 0$$
$$\rightarrow R_{Bx} = 0.125\text{kN}$$

$$\sum F_x = R_{Ax} - R_{Bx} = 0 \rightarrow R_{Ax} = 0.125\text{kN}$$

Example



6m



$$\sum F_y = 1\text{kN} - R_{Ay} = 0 \rightarrow R_{Ay} = 1\text{kN}$$

$$\sum M_A = (1\text{kN})(1.5\text{m}) - (R_{Bx})(6\text{m}) = 0$$
$$\rightarrow R_{Bx} = 0.25\text{kN}$$

$$\sum F_x = R_{Ax} - R_{Bx} = 0 \rightarrow R_{Ax} = 0.25\text{kN}$$

More lectures:

Terje's Toolbox:

terje.civil.ubc.ca