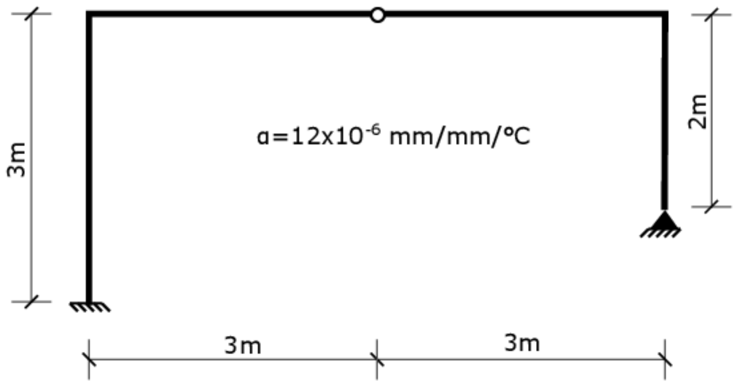
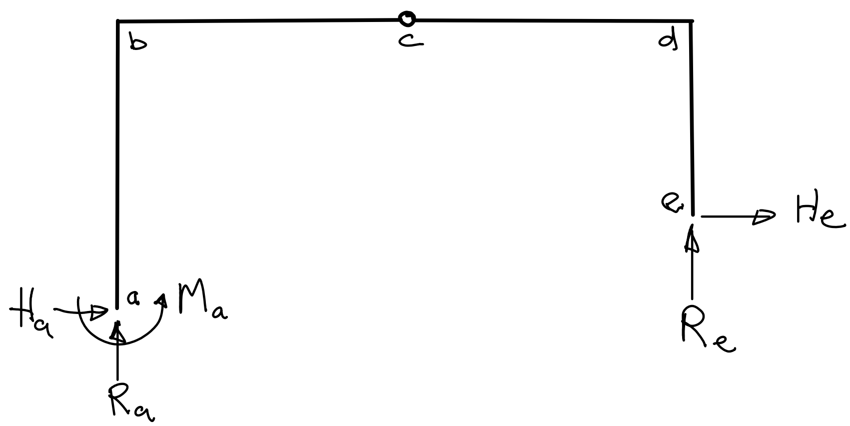
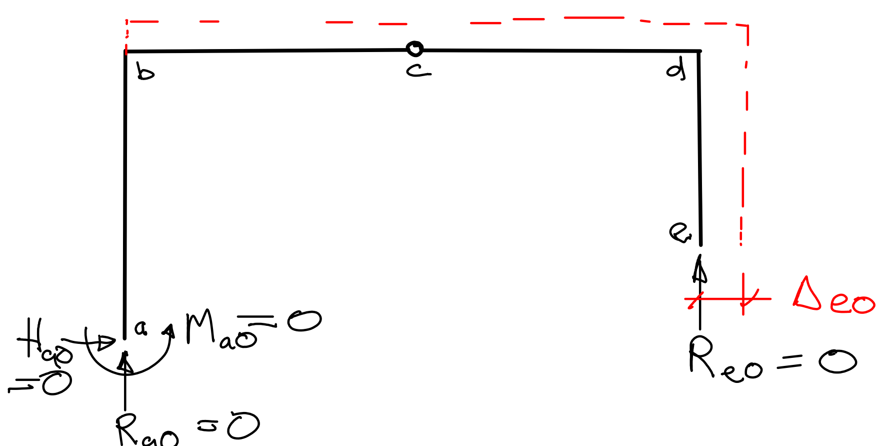


1° S.I.
Choose He as redundant

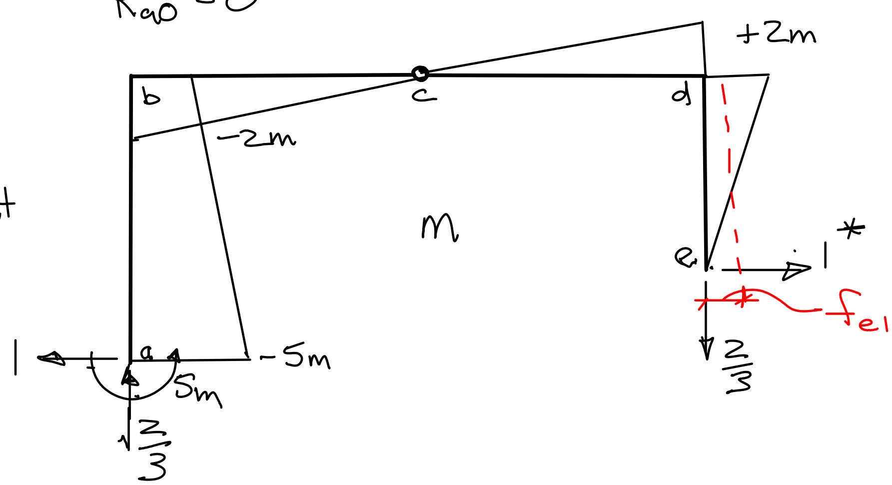
Real

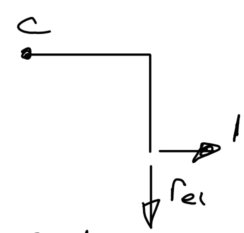


Primary



Unit Redundant





$\Sigma M_c = 0$

$r_{e1} = \frac{1 \times 2}{3} = \frac{2}{3}$

Displacement in primary
– due to change in length of members due to temp. change

$$\Delta_{eo} = \sum u\,dL \qquad \text{(tension +ive)}$$

$$= -\tfrac{2}{3} \times +50^\circ C \times 12 \times 10^{-6} \frac{m}{m/^\circ C} \times 3m \qquad \text{(seg. ab)}$$

$$+ 1 \times 50^\circ C \times 12 \times 10^{-6}\, m/m/^\circ C \times 6m \qquad \text{(seg bcd)}$$

$$+ \tfrac{2}{3} \times 50^\circ C \times 12 \times 10^{-6}\, m/m/^\circ C \times 2m \qquad \text{(seg de)}$$

$$\Delta_{eo} = 3200 \times 10^{-6}\, m \qquad (= 3.2\ mm)\ (\therefore \rightarrow)$$

Flexibility Coeff (displ due to unit redundant)

due to flexure (axial effects assumed not significant, as usual)

Need EI – assume EI constant

$$f_{e1} = \int \frac{mm}{EI}$$

$$= \frac{1}{EI}\left[\int\left(\ 3\ \ {-5}\ \ {-2}\ \right)^2 + \int\left(\ 2.5\ \ {-2}\ \right)^2 + \int\left(\ 2\ \ 2.5\ \right)^2 + \int\left(\ {+2}\ \ 2\ \right)^2\right]$$

$$= \frac{1}{EI}\left[\frac{3}{6}\left(-5(2\times-5+-2) + -2(-5+2\times-2)\right) + 2 \times \frac{2.5}{3} \times 2 \times 2 + \frac{2}{3} \times 2 \times 2\right]$$

$$= \frac{87.33\ m^3}{EI}$$

Compatibility

$$0 = \Delta_{eo} + H_e f_{e1}$$

$$H_e = -\frac{\Delta_{eo}}{f_{e1}}$$

Solve

$$H_e = \frac{-3200 \times 10^{-6}\, m}{\frac{87.33\ m^3}{EI}} = \frac{-36.64 \times 10^{-6}\ EI}{m^2}$$

To obtain numeric values

assume W360x122 $I = 365 \times 10^{6}\ mm^4$

$E = 200\,000\ \frac{N}{mm^2}$

$EI \approx 73000\ kN\text{-}m^2$

$$H_e = \frac{-36.64 \times 10^{-6} \times 73000\ kN\text{-}m^2}{m^2}$$

$H_e = -2.67\ kN$ (∴ ←)

Stiffer members would lead to higher forces.

<u>Superposition</u>

$H_a = H_{ao} - 1 \times -2.67 = 2.67$ (∴ →)

$R_a = R_{ao} + \frac{2}{3} \times -2.67 = -1.78$ (∴ ↓)

$M_a = M_{ao} + 5 \times -2.67 = -13.35$ (∴ ↺)

$R_e = R_{eo} - \frac{2}{3} \times -2.67 = 1.78$ (∴ ↑)

<u>FBD</u>