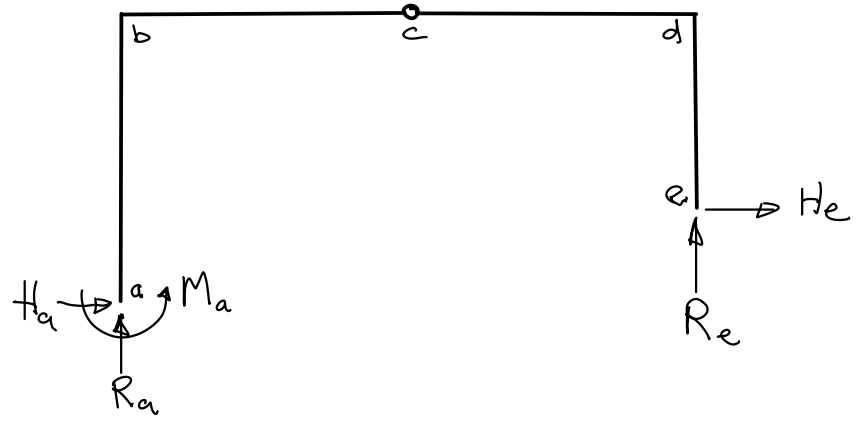
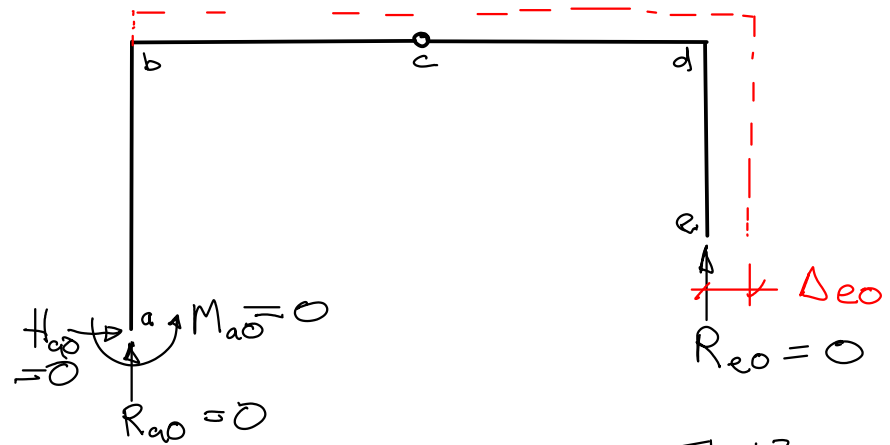


Real

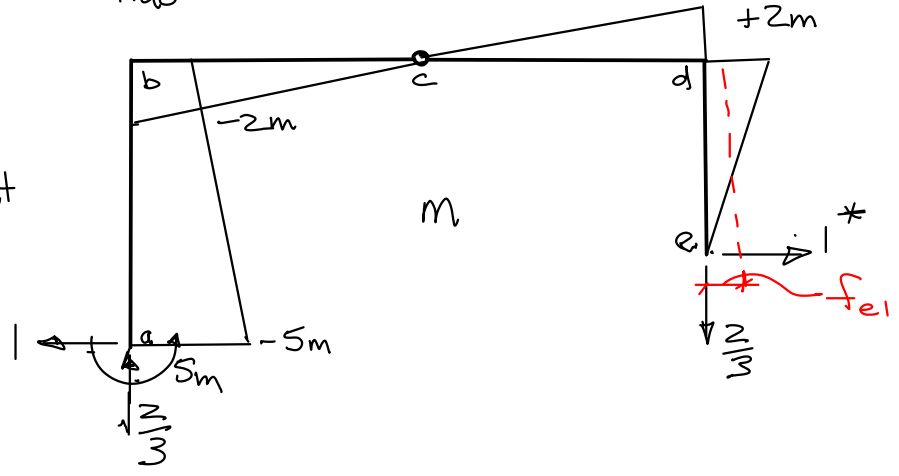


1° S.I.  
Choose  $H_e$   
as redundant

Primary



Unit Redundant



Free body diagram for the unit redundant force showing a unit horizontal force  $I$  and a unit vertical force  $I/N$  at point e. The equilibrium equation is:

$$\sum M_c = 0$$

$$f_{eI} = \frac{1 \times 2}{3} = \frac{2}{3}$$

Displacement in primary

- due to change in length of members  
due to temp. change

$$\begin{aligned}\Delta_{eo} &= \sum u dL \quad (\text{tension +ive}) \\ &= -\frac{2}{3} \times +50^\circ \times 12 \times 10^{-6} \frac{\text{m}}{\text{m}^\circ\text{C}} \times 3\text{m} \quad (\text{seg. ab}) \\ &\quad + 1 \times 50^\circ \times 12 \times 10^{-6} \text{m/m}^\circ\text{C} \times 6\text{m} \quad (\text{seg bcd}) \\ &\quad + \frac{2}{3} \times 50^\circ \times 12 \times 10^{-6} \text{m/m}^\circ\text{C} \times 2\text{m} \quad (\text{seg de}) \\ \Delta_{eo} &= 3200 \times 10^{-6} \text{m} \quad (= 3.2 \text{ mm}) \quad (\text{; } \rightarrow)\end{aligned}$$

Flexibility Coeff (displ due to unit redundant)  
due to flexure (axial effects assumed  
not significant, as usual)

Need EI - assume EI constant

$$\begin{aligned}f_{e1} &= \int \frac{m m}{EI} \\ &= \frac{1}{EI} \left[ \int \left( \begin{array}{c} 3 \\ -5 \quad -2 \end{array} \right)^2 + \int \left( \begin{array}{c} 2.5 \\ -2 \end{array} \right)^2 + \int \left( \begin{array}{c} 1 \\ 2.5 \end{array} \right)^2 + \int \left( \begin{array}{c} +2 \\ 2 \end{array} \right)^2 \right] \\ &= \frac{1}{EI} \left[ \frac{3}{6} (-5(2 \times -5 + -2) + -2(-5 + 2 \times -2)) \right. \\ &\quad \left. + 2 \times \frac{2.5}{3} \times 2 \times 2 + \frac{2}{3} \times 2 \times 2 \right] \\ &= \frac{87.33 \text{ m}^3}{EI}\end{aligned}$$

Compatibility

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

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

Solve

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

To obtain numeric values

assume  $W360 \times 122$   $I = 365 \times 10^6 \text{ mm}^4$   
 $E = 200\,000 \frac{\text{N}}{\text{mm}^2}$

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

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

$H_e = -2.67 \text{ kN} \quad (\therefore \leftarrow)$

Stiffer members would lead to higher forces.

Superposition

$H_a = H_{a0} - 1 \times -2.67 = 2.67 \quad (\therefore \rightarrow)$

$R_a = R_{a0} + \frac{2}{3} \times -2.67 = -1.78 \quad (\therefore \downarrow)$

$M_a = M_{a0} + 5 \times -2.67 = -13.35 \quad (\therefore \curvearrowright)$

$R_e = R_{e0} - \frac{2}{3} \times -2.67 = 1.78 \quad (\therefore \uparrow)$

FBD

