

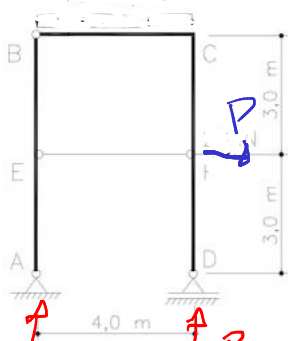
7) Calcular o deslocamento horizontal do ponto F.

Dados: trechos AB, BCD: $E.A=16 \times 10^5 \text{ kN}$;

$E.I=2 \times 10^8 \text{ kN.cm}^2$.

trecho EF: $E.A=10^5 \text{ kN}$;

$E.I=4 \times 10^4 \text{ kN.cm}^2$.



R_{Ax}
to

R_{Ay}

R_{Dy}

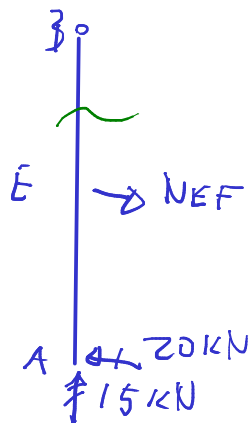
$$M_{BC} = 15 \cdot x - \frac{15 \cdot x^2}{2} \quad \frac{15 \cdot 4^2}{2}$$

60 kN.m

60 kN.m

60 kN.m

M



$$M_B = 0$$

A-B

$$-20 \cdot 6 + 3 N_{EF} = 0$$

$$N_{EF} = 40 \text{ kN}$$

$$M_B = 20 \cdot 6 - 40 \cdot 3 = 0$$

1º) Reações:

$$\sum M_A = 0:$$

$$R_{Dy} = \frac{20 \cdot 3 + 120}{4} = 45 \text{ kN}$$

$$\sum F_y = 0:$$

$$-60 + 45 + R_{Ay} = 0$$

$$R_{Ay} = 15 \text{ kN}$$

$$\sum F_x = 0$$

$$R_{Ax} = -20 \text{ kN}$$

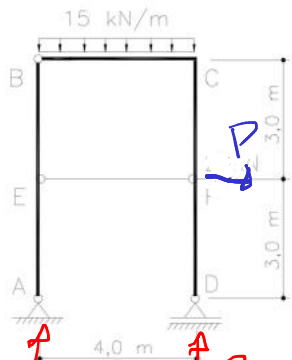
7) Calcular o deslocamento horizontal do ponto F.

Dados: trechos **AB, BCD**: $E.A=16 \times 10^5 \text{ kN}$;

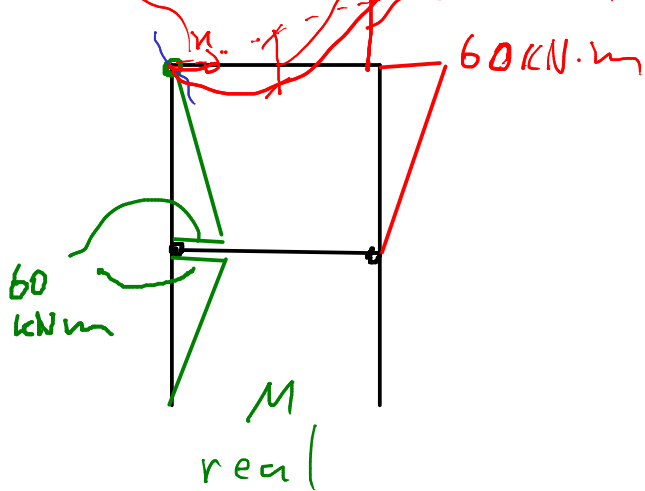
$E.I = 2 \times 10^8 \text{ kN.cm}^2$.

trecho **EF**: $E.A=10^5 \text{ kN}$;

$E.I = 4 \times 10^4 \text{ kN.cm}^2$.



$R_{Ax} = 0$
 $R_{Ay} = \frac{15 \cdot 4}{2} = 30 \text{ kN}$
 $R_{Dy} = \frac{15 \cdot 4}{2} = 30 \text{ kN}$
 $R_{Dx} = P$



$$\sum M_A = 0:$$

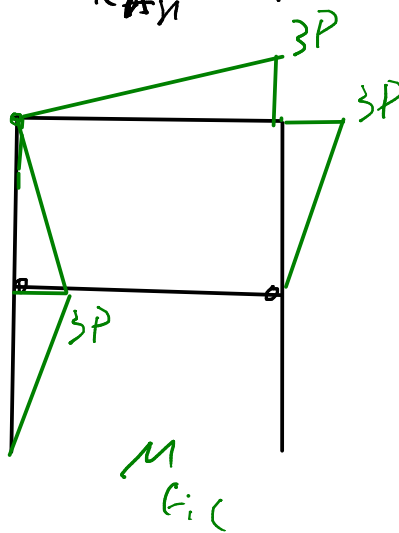
$$R_{Dy} = \frac{3P}{4}$$

$$\sum F_y = 0:$$

$$R_{Ay} = -\frac{3}{4}P$$

$$\sum F_x = 0$$

$$R_{Ax} = -P$$



$$M_B = 0 \Rightarrow 6P - 3N_{EF} = 0$$

$$N_{EF}$$

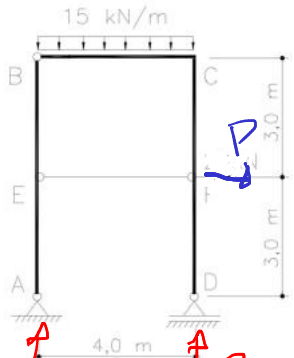
$$N_{EF} = 2P$$

$$P$$

$$E.I = 2 \times 10^8 \text{ kN.cm}^2.$$

$$\text{trecho EF: } E.A = 10^5 \text{ kN};$$

$$E.I = 4 \times 10^4 \text{ kN.cm}^2.$$



$$R_{Ax} = 0$$

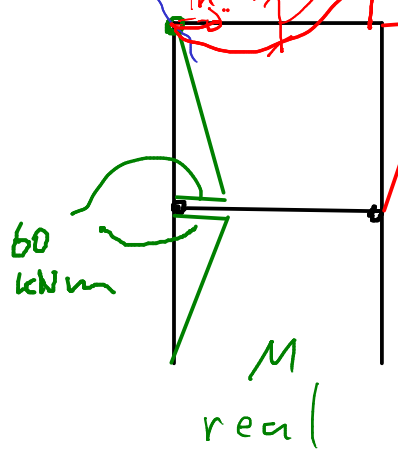
$$R_{Ay}$$

$$R_{Dy}$$

$$B_C = 15 \cdot u - \frac{15 \cdot u^2}{2}$$

$$60 \text{ kN.m}$$

$$60 \text{ kN.m}$$



M

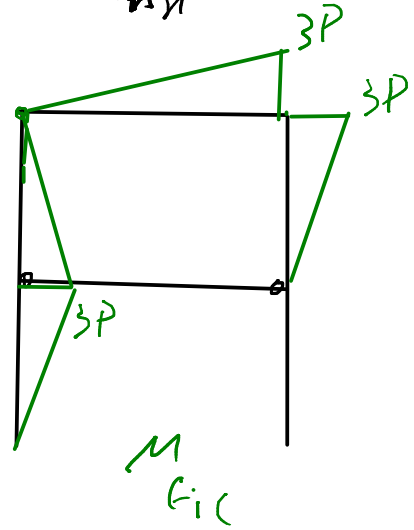
$$R_{Dy} = \frac{3P}{4}$$

$$\sum F_y = 0 :$$

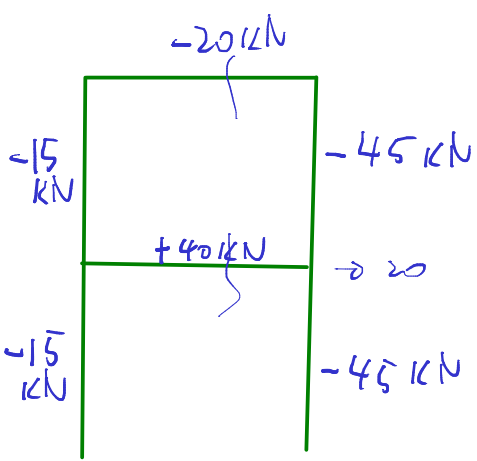
$$R_{Ay} = -\frac{3}{4} P$$

$$\sum F_x = 0$$

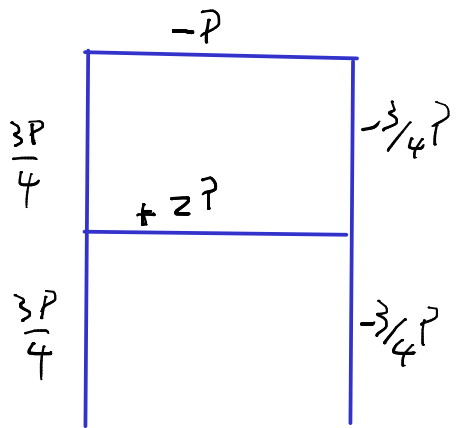
$$R_{Ax} = -P$$



M fict



N

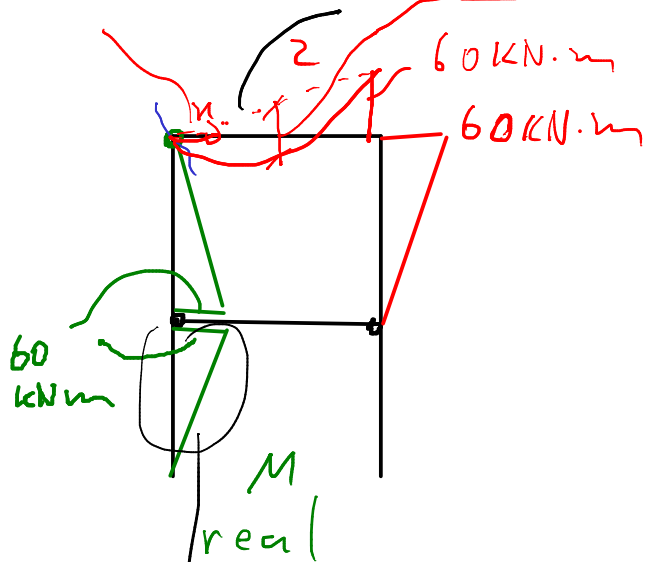
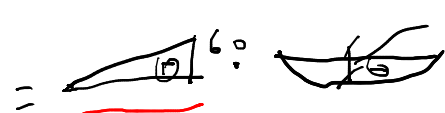


Castigliano:

$$\Delta = \frac{\partial U_e}{\partial P} = \frac{\partial}{\partial P} \left(\sum_{i=1}^n \int_0^{L_i} \frac{(M+M_F)^2}{2EI} dx + \sum_{i=1}^n \frac{(N+N_F)^2 \cdot L_i}{2EA} \right)$$

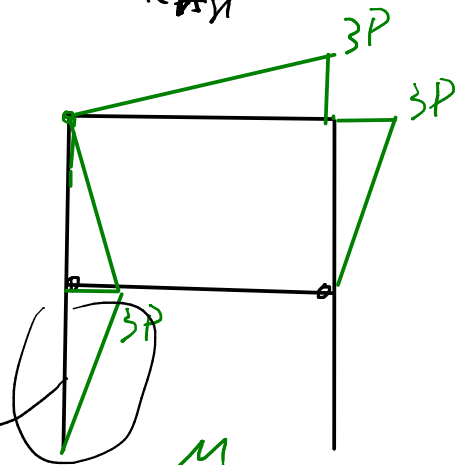
$$\sum_{i=1}^n \int_0^{L_i} \frac{(M+M_F) \cdot \frac{\partial(M+M_F)}{\partial P}}{EI} dx + \sum \frac{(N+N_F)}{EA} \frac{\partial(N+N_F)}{\partial P} \cdot L_i$$

$$\frac{15 \cdot 4^2}{8} = 30 \text{ kN}\cdot\text{m}$$



$$\sum \uparrow n = 0$$

$$R_{Ay} = -P$$



$$\Delta = \frac{1}{EI} \int_0^4 \left(\frac{60}{4} + \frac{3P}{4} \right) \cdot \frac{3}{4} dx + \frac{1}{EI} \int_0^3 \left(\frac{60}{60} + \frac{3P}{3P} \right) \cdot \frac{3P}{3P} dx$$

$$+ \frac{1}{EI} \int_0^4 \left(\frac{60}{4} - \frac{30}{4} + \frac{3P}{4} \right) dx$$

$$\left(\begin{array}{c} \text{---} \\ \diagdown \\ \text{---} \end{array} \right)^3 dx$$

$$+ \frac{1}{EI} \int_0^3 \left(\begin{array}{c} 60 \\ \diagdown \\ \text{---} \end{array} \quad \begin{array}{c} 3x \\ \diagdown \\ \text{---} \end{array} \right) \cdot \begin{array}{c} 3 \\ \diagdown \\ \text{---} \end{array} dx$$

$$+ \left(-\frac{15.3}{4} \cdot \frac{6}{EA} \right) + \frac{80.4}{EA} + \frac{20.4}{EA} + \frac{45.3}{4EA} \cdot 3$$