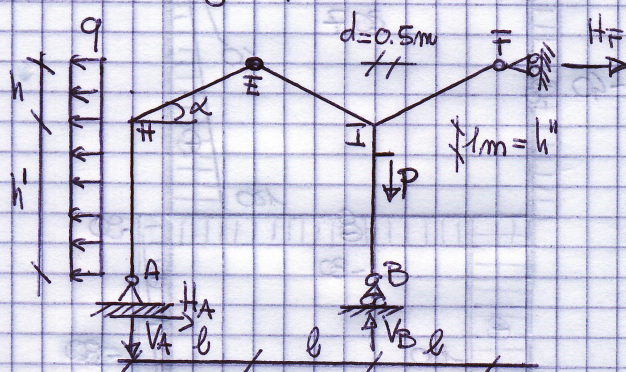


Esercizio 1

La struttura, i vincoli e il carico sono simmetrici, perciò studierò solo metà struttura con gli opportuni vincoli.



$$q = 10 \text{ kN/m}$$

$$h = 2 \text{ m}$$

$$h' = 5 \text{ m}$$

$$l = 4 \text{ m}$$

$$P = 50 \text{ kN}$$

$$\alpha = \arctan(h'/l) = 26.6^\circ$$

$$\sum \uparrow V_B l = P(l+d) \Rightarrow V_B = \frac{P(l+d)}{l} = 56.25 \text{ kN}$$

$$\uparrow V_A = V_B - P = 6.25 \text{ kN}$$

$$\sum \circlearrowleft V_A l - q \frac{(h'+h)^2}{2} + H_A (h+h') = 0 \Rightarrow H_A = \left(\frac{q(h'+h)}{2} - V_A \right) \cdot \frac{1}{(h+h')} = 31.42 \text{ kN}$$

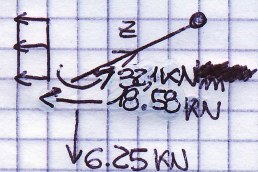
$$\rightarrow H_F = q(h+h') - H_A = 38.58 \text{ kN}$$

Verifica

$$\sum \circlearrowleft -H_F (h+h') + q \frac{(h+h')^2}{2} - P(2l+d) + V_B 2l = \dots = 0 \quad \text{ok!!!}$$

Analizzo i tratti individuati

• Tratto HE con $z \in [0, 4.47]$

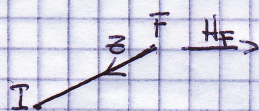


$$N(z) = 6.25 \sin \alpha + 18.58 \cos \alpha + q z \sin \alpha \cos \alpha$$

$$T(z) = -6.25 \cos \alpha + 18.58 \sin \alpha + q z \sin^2 \alpha$$

$$M(z) = -32.1 - 6.25 z \cos \alpha + 18.58 z \sin \alpha + q \frac{(z \sin \alpha)^2}{2}$$

• Tratto FI con $z \in [0, 4.47]$

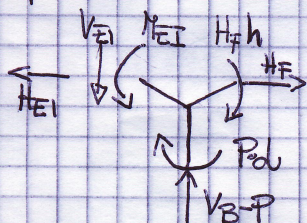


$$N(z) = H_F \cos \alpha = 34.5 \text{ kN}$$

$$T(z) = H_F \sin \alpha = 17.27 \text{ kN}$$

$$M(z) = -H_F z \sin \alpha$$

• Equilibrio nodo I

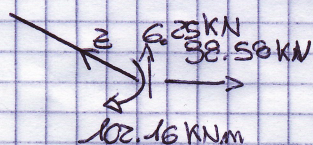


$$H_{EI} = H_F = 38.58 \text{ kN}$$

$$V_{EI} = V_B - P = 6.25 \text{ kN}$$

$$M_{EI} = P l + H_F h = 102.16 \text{ kN m}$$

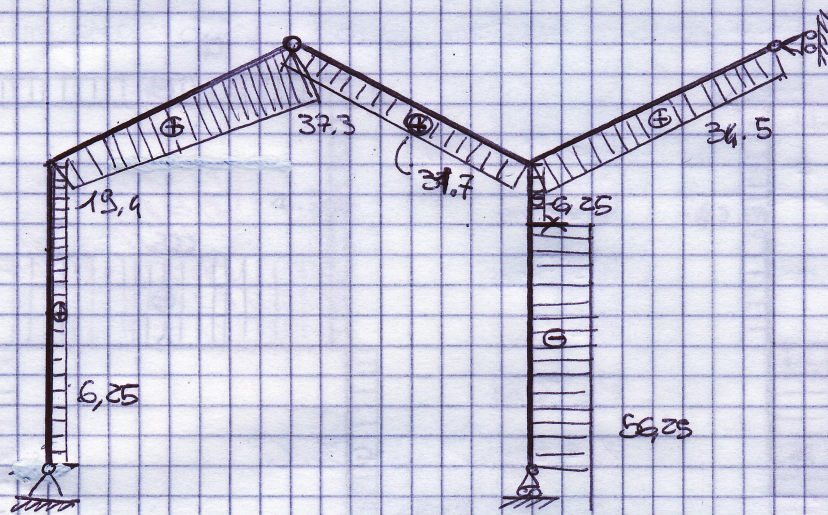
• Tratto EI con $z \in [0, 4.47]$



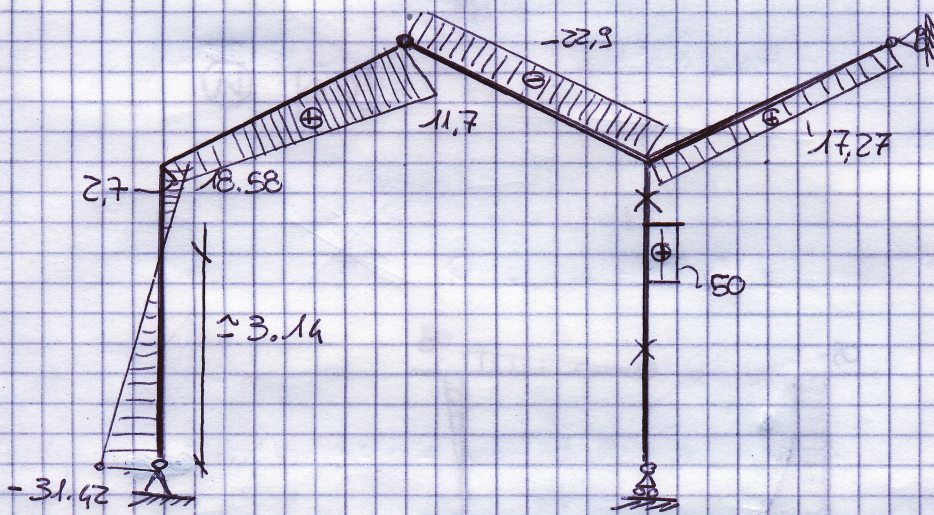
$$N(z) = 38.58 \cos \alpha - 6.25 \sin \alpha = 31.7 \text{ kN}$$

$$T(z) = -38.58 \sin \alpha - 6.25 \cos \alpha = -22.9 \text{ kN}$$

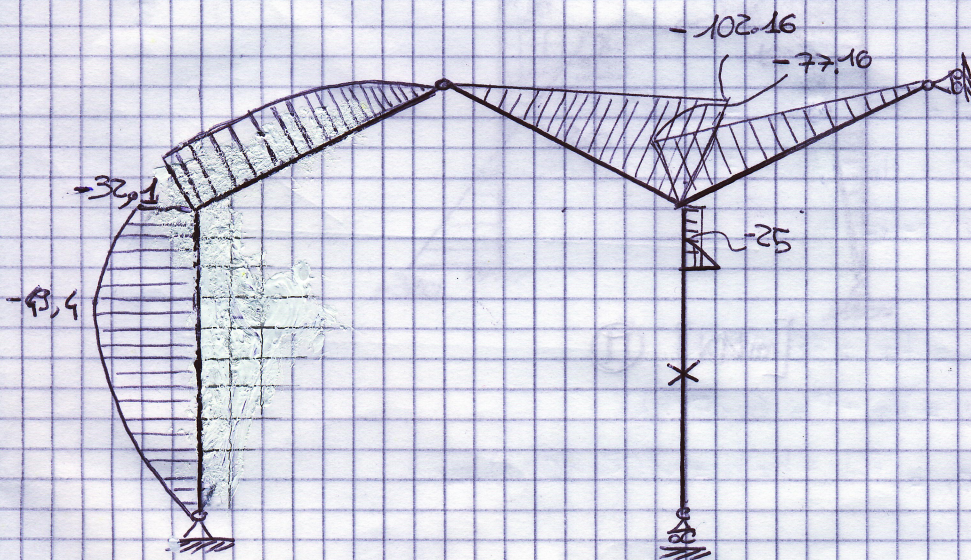
$$M(z) = -102.16 + 38.58 z \sin \alpha + 6.25 z \cos \alpha$$



Ⓝ [kN]

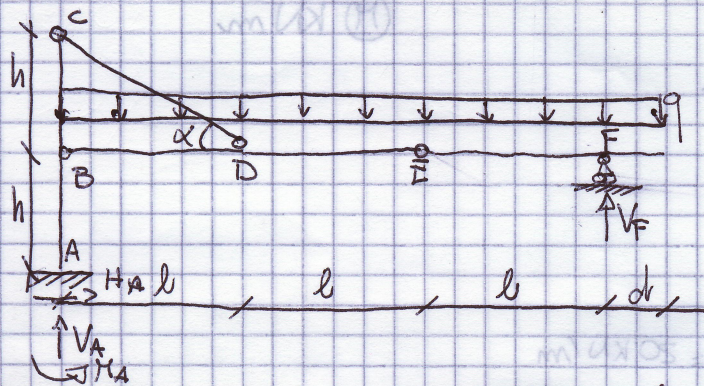


Ⓣ [kN]



Ⓜ [kNm]

ESERCIZIO 2:



$$q = 50 \text{ kN/m}$$

$$h = 4 \text{ m}$$

$$l = 6 \text{ m}$$

$$d = 2 \text{ m} = l/3$$

$$\alpha = \arctan\left(\frac{h}{l}\right) \approx 33.7^\circ$$

$$B) V_F l = q \frac{(l+d)^2}{2} = q \frac{(l + l/3)^2}{2} = q \frac{(4/3 l)^2}{2} = q \cdot \frac{16 l^2}{9} \cdot \frac{1}{2} = q l^2 \frac{8}{9} \Rightarrow V_F = \frac{8}{9} q l = 266.7 \text{ kN}$$

$$\uparrow V_A + V_F = q (3l + l/3) = q \cdot 10l = 1000 \text{ kN}$$

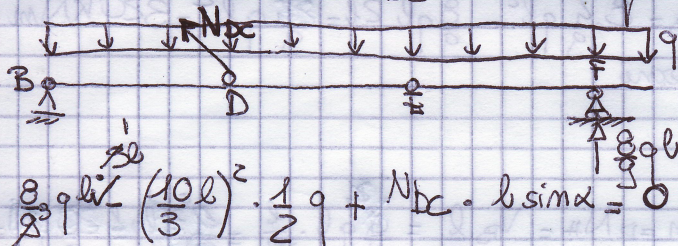
$$V_A = \frac{10}{3} q l - \frac{8}{9} q l = \frac{22}{9} q l = 733.3 \text{ kN}$$

$$\rightarrow H_A = 0$$

$$A) V_F 3l + H_A - q \frac{(3l+d)^2}{2} = 0$$

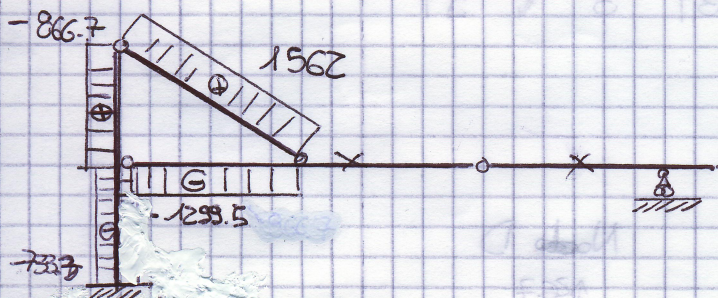
$$H_A = -3l \cdot \frac{8}{9} q l + q \frac{(10l)^2}{2} \cdot \frac{1}{2} = \left(-\frac{8}{3} + \frac{50}{9}\right) q l^2 = \frac{26}{9} q l^2 = 5200 \text{ kNm}$$

Ricavo la azione in N_{DC} tramite equ. alla rotazione della parte BF attorno a B

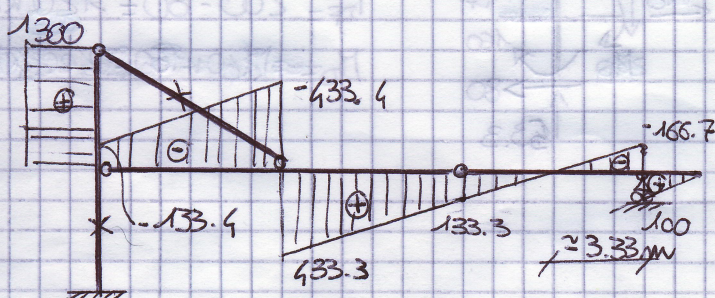


$$\frac{8}{9} q l^2 - \frac{(10l)^2}{2} \cdot \frac{1}{2} q + N_{DC} \cdot l \sin \alpha = 0$$

$$N_{DC} \sin \alpha = \left(-\frac{8}{3} + \frac{50}{9}\right) q l = \frac{26}{9} q l = 866.7 \text{ kN} \Rightarrow N_{DC} \approx 1562 \text{ kN}$$

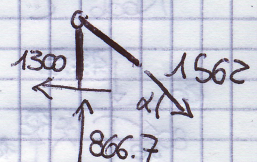


② [kN]

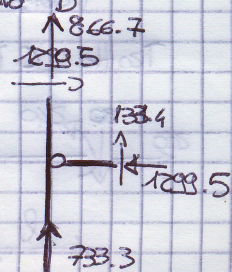


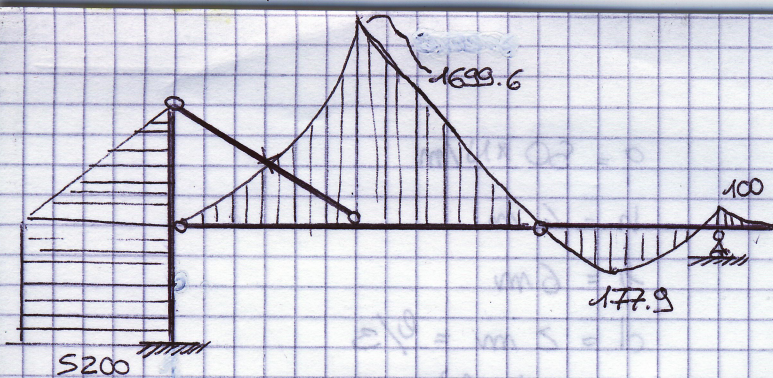
① [kNm]

Nodo C



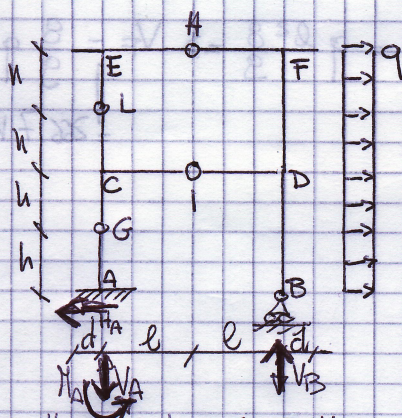
Nodo B





(M) KNm

Esercizio 3



$$q = 20 \text{ kN/m}$$

$$h = 2 \text{ m} = \frac{2}{3}l$$

$$l = 3 \text{ m}$$

$$d = 1 \text{ m}$$

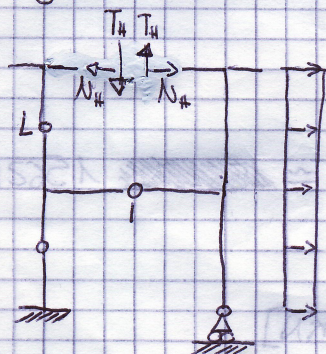
$$\rightarrow H_A = 4qh = 160 \text{ kN}$$

$$\textcircled{E} V_B 2l = 4qh^2 \Rightarrow V_B = 2qh = \frac{8}{3}ql = 53.3 = V_A \quad \textcircled{G} M_A = H_A h = 4qh^2 = 320 \text{ kNm}$$

Verifica di M_A

$$\textcircled{A} M_A - 4qh \cdot 2h + V_B 2l = 0 \Rightarrow M_A = 8qh^2 - 2lV_B = 8 \cdot \frac{4}{3}ql^2 - \frac{8}{3}ql \cdot 2l = \frac{16}{3}ql^2 = 320 \text{ kNm} \Rightarrow \text{OK!}$$

Aperto la maglia in H per ricavare gli sforzi interni

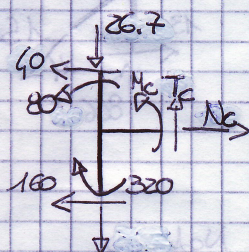


$$\textcircled{L} N_H h = T_H l$$

$$\textcircled{I} V_B l = N_H 2h \Rightarrow N_H = V_B \frac{l}{2h} = \frac{8}{3}ql \cdot \frac{l}{2h} = \frac{4}{3}ql = 40 \text{ kN}$$

$$T_H = N_H \cdot \frac{h}{l} = \frac{4}{3}ql \cdot \frac{2}{3} \cdot \frac{1}{3} = \frac{8}{9}ql = 26.7 \text{ kN}$$

Nodo C

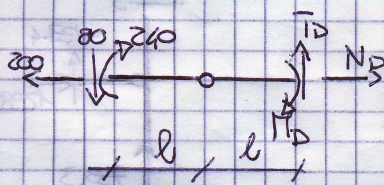


$$T_C = 26.7 + 53.3 = 80 \text{ kN}$$

$$N_C = 160 + 40 = 200 \text{ kN}$$

$$M_C = 320 - 80 = 240 \text{ kNm}$$

Tratto C D

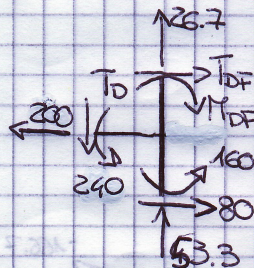


$$T_D = 80 \text{ kN}$$

$$N_D = 200 \text{ kN}$$

$$M_D = T_D \cdot l = 240 \text{ kNm}$$

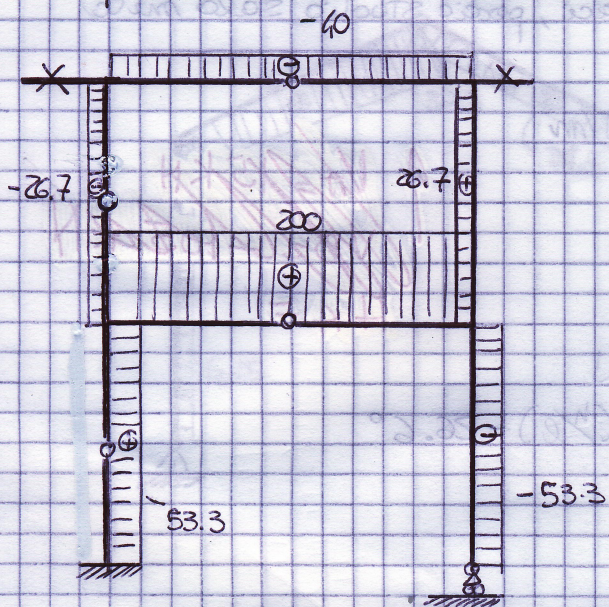
Nodo D



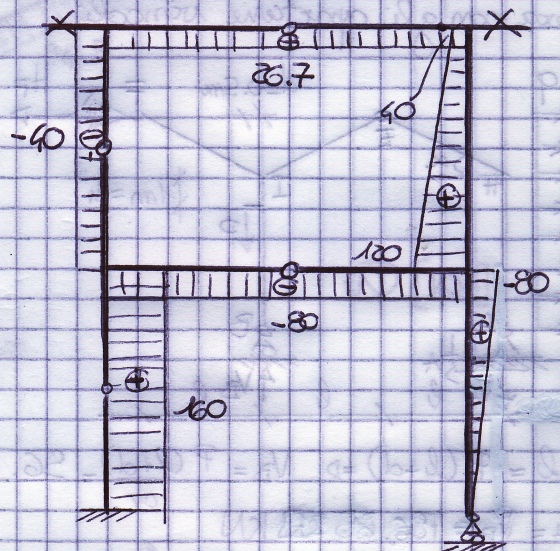
$$T_D = 26.7 + 53.3 = 80 \text{ kN}$$

$$T_{DF} = 200 - 80 = 120 \text{ kN}$$

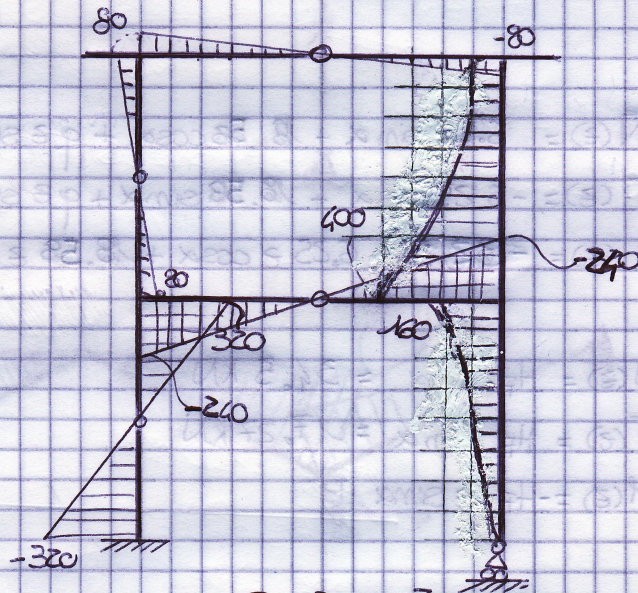
$$M_{DF} = 240 + 180 = 420 \text{ kNm}$$



(N) [kN]



(T) [kN]



(M) [kNm]