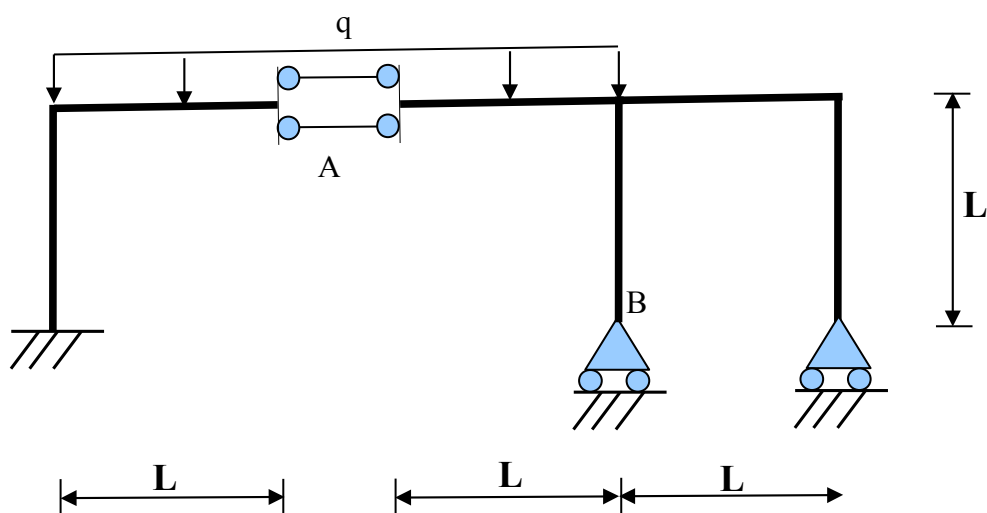
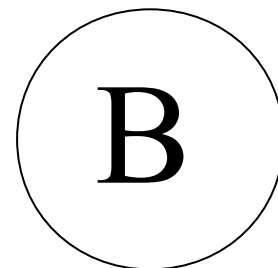


$$L = 1 \text{ m}, q = 20 \text{ kN/m},$$
$$E = 210 \text{ GPa}, \sigma_{\text{amm}} = 240 \text{ MPa},$$

La travatura in figura deve essere realizzata con profilati IPE.

- Disegnare i diagrammi quotati delle caratteristiche della sollecitazione in presenza del carico distribuito q .
- Dimensionare la travatura.
- Calcolare lo spostamento verticale del punto A (doppio pendolo).
- Disegnare nuovamente i diagrammi quotati considerando, in aggiunta al carico q , anche un abbassamento (cedimento) del vincolo in B pari a 2cm.

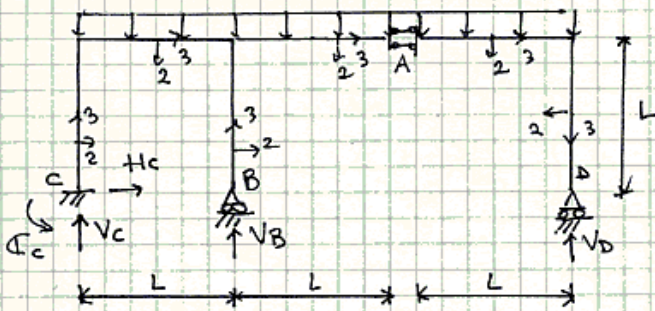


$$L = 2 \text{ m}, q = 10 \text{ kN/m},$$
$$E = 210 \text{ GPa}, \sigma_{\text{amm}} = 240 \text{ MPa},$$

La travatura in figura deve essere realizzata con profilati IPE.

- Disegnare i diagrammi quotati delle caratteristiche della sollecitazione in presenza del carico distribuito q .
- Dimensionare la travatura.
- Calcolare lo spostamento verticale del punto A (doppio pendolo).
- Disegnare nuovamente i diagrammi quotati considerando, in aggiunta al carico q , anche un abbassamento (cedimento) del vincolo in B pari a 2cm.

A)



$$H_c = 0$$

$$V_d = qL$$

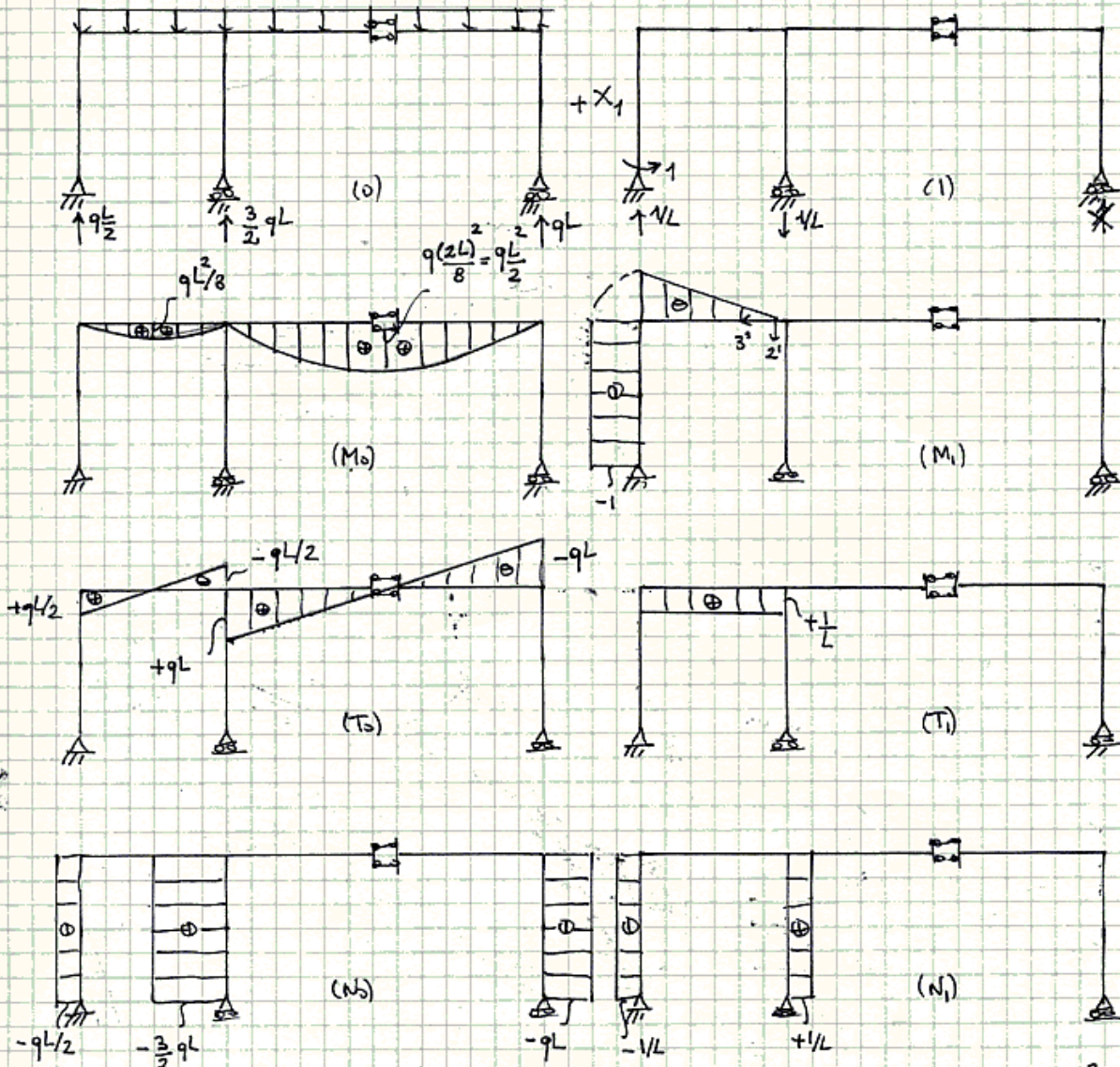
$$V_c + V_B = 2qL$$

$$C_c + V_B L = \frac{9}{2} qL^2 - 3qL^2$$

Tre incognite (V_c , V_B e C_c) e due eq.m.

La travatura è una volta iperstatica.

Incognita iperstatica $X_1 = C_c$.

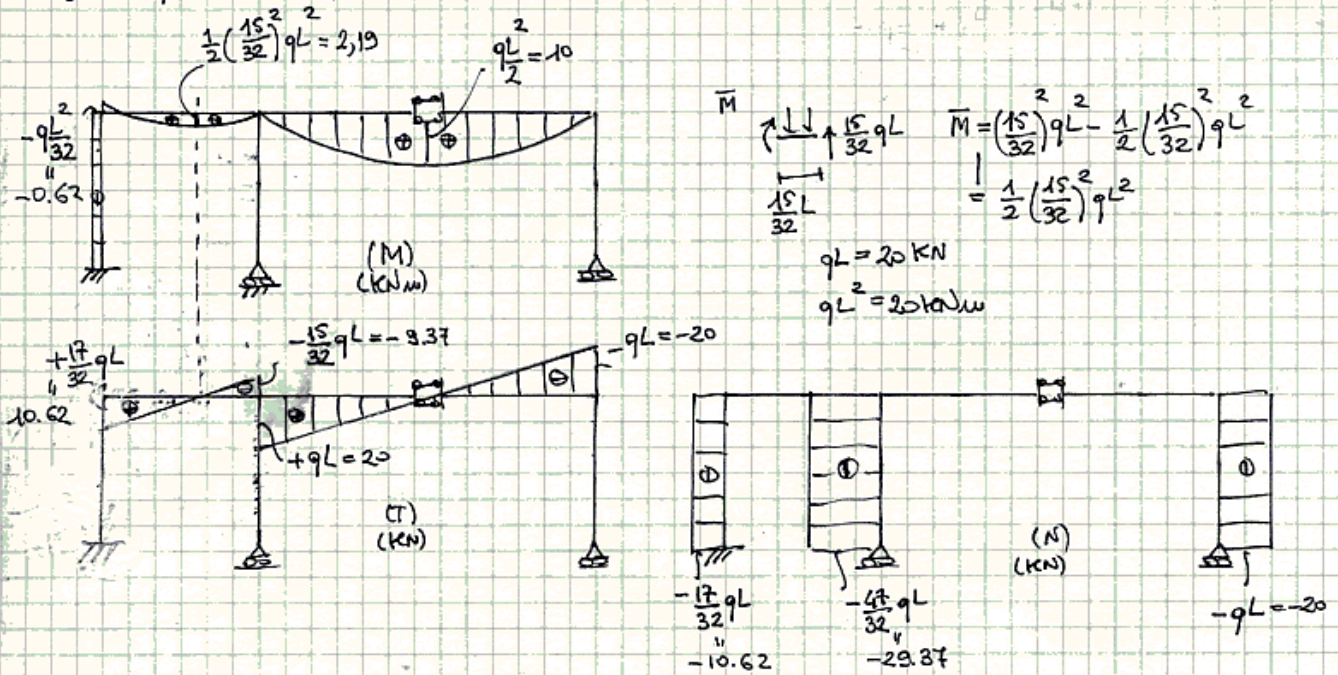


$$EI_1 M_{10} = \int_0^L \left(-\frac{x_3^2}{L}\right) \left(-q \frac{x_3^2}{2} + q \frac{L}{2} x_3\right) dx_3 = \frac{q}{2L} \int_0^L \left(x_3^3 - L x_3^2\right) dx_3 = \frac{q}{2L} \left(\frac{L^4}{4} - \frac{L^4}{3}\right) = -\frac{qL^3}{24}$$

$$EI_1 M_{11} = L + \frac{L}{3} = \frac{4L}{3}$$

$$X_1 = -\frac{M_{10}}{M_{11}} = + \frac{qL^3}{24} \cdot \frac{3}{4L} = + \frac{qL^2}{32}$$

Diagrammi quotati (risolto):



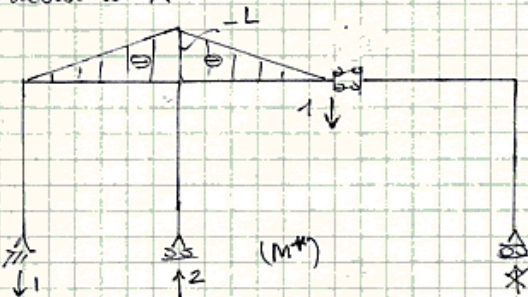
Dimensionamento:

$$W_1 \geq \frac{qL^2}{2,6 \text{ ANM}} = \frac{10 \cdot 10 \cdot 10^3}{2,6 \cdot 10^2} = 41,67 \text{ cm}^3$$

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$$\begin{cases} I_1 = 317,8 \text{ cm}^4 \\ A = 13,21 \text{ cm}^2 \end{cases}$$

Deformazione in A:



Condimento in B:

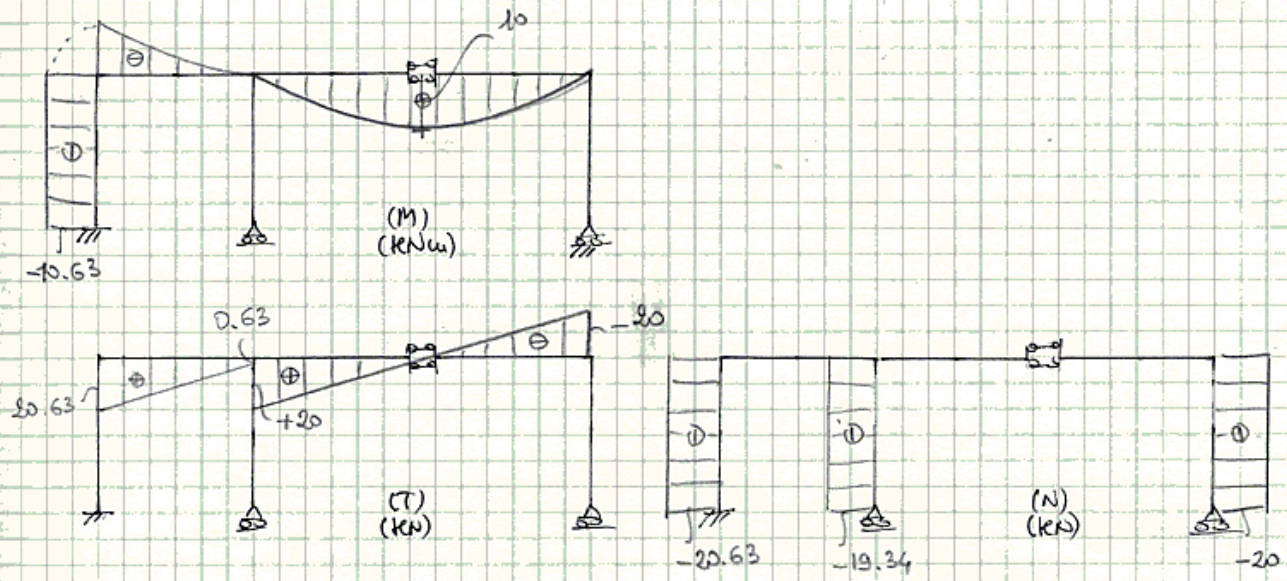
$$M_{10} + M_{11} X_1 = M_1$$

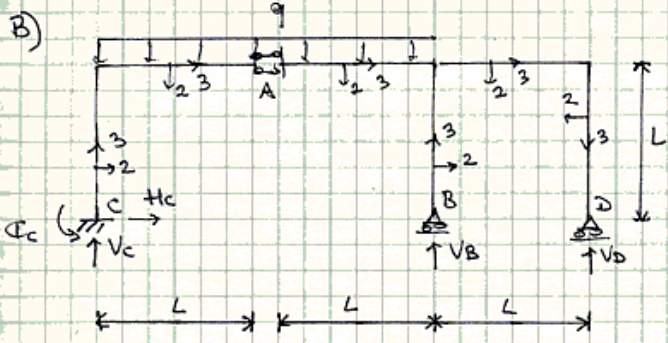
$$M_1 = \delta \cdot \frac{1}{L}, \quad \delta = 2 \text{ cm}$$

$$X_1 = -\frac{M_{10}}{M_{11}} + \frac{M_1}{M_{11}} = \frac{qL^2}{32} + \frac{\delta}{L} \frac{3EI_1}{4L} = \left(0,625 + \frac{3 \cdot 2 \cdot 1 \cdot 10^3 \cdot 317,8 \cdot 10^{-8} \cdot 2 \cdot 10^{-2}}{4 \cdot 10} \right) \text{ KNm}$$

$$= (0,625 + 10,01) \text{ KNm} = 10,63 \text{ KNm}$$

Diagrammi quotati compresi nel cedimento e di q:



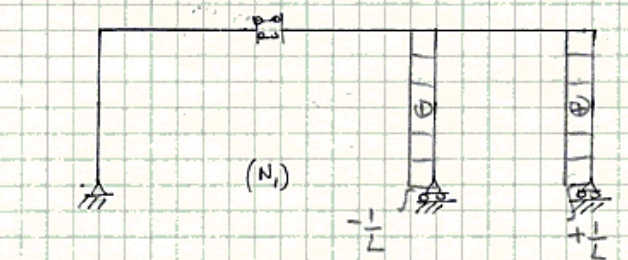
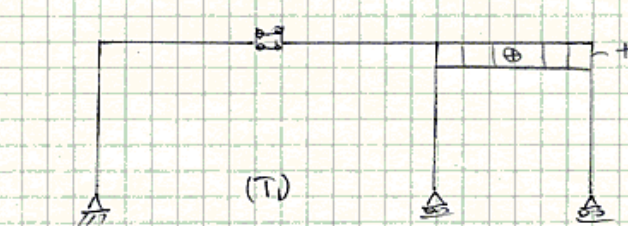
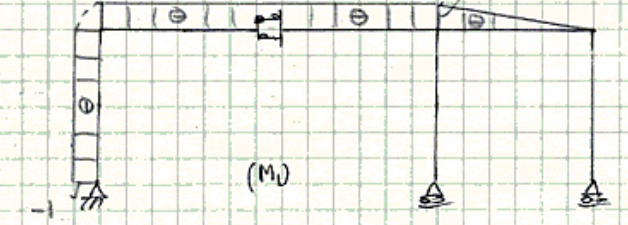
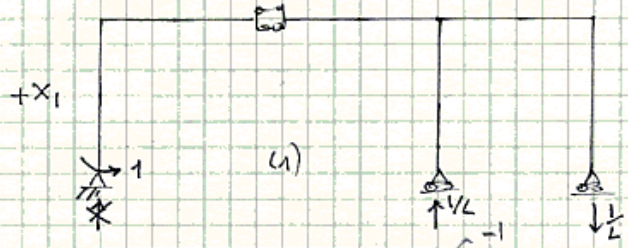
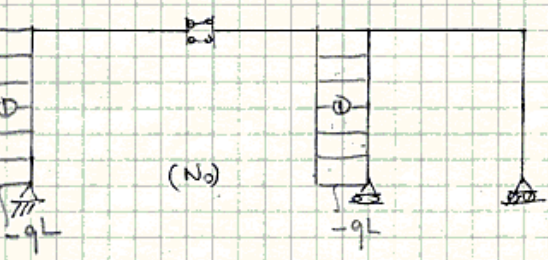
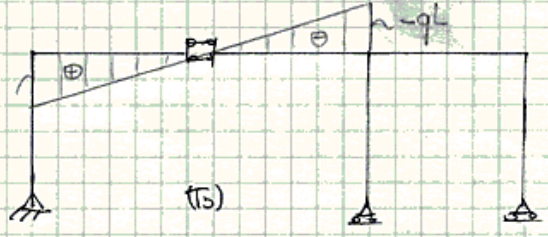
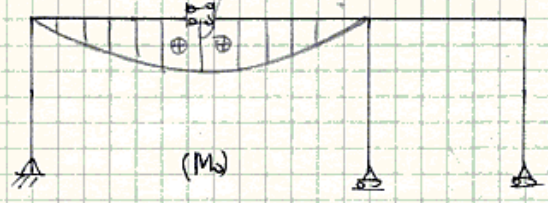
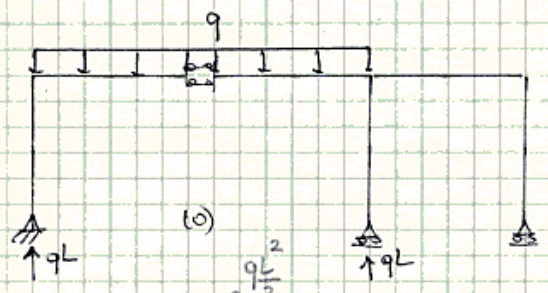


$$V_c = qL$$

$$H_c = 0$$

$$\begin{cases} V_B + V_D = qL \\ V_B 2L + V_D 3L + C_c = 2qL^2 \end{cases}$$

La struttura è una vettura iperstatica.
 Macognita iperstatica: $X_1 = C_c$.

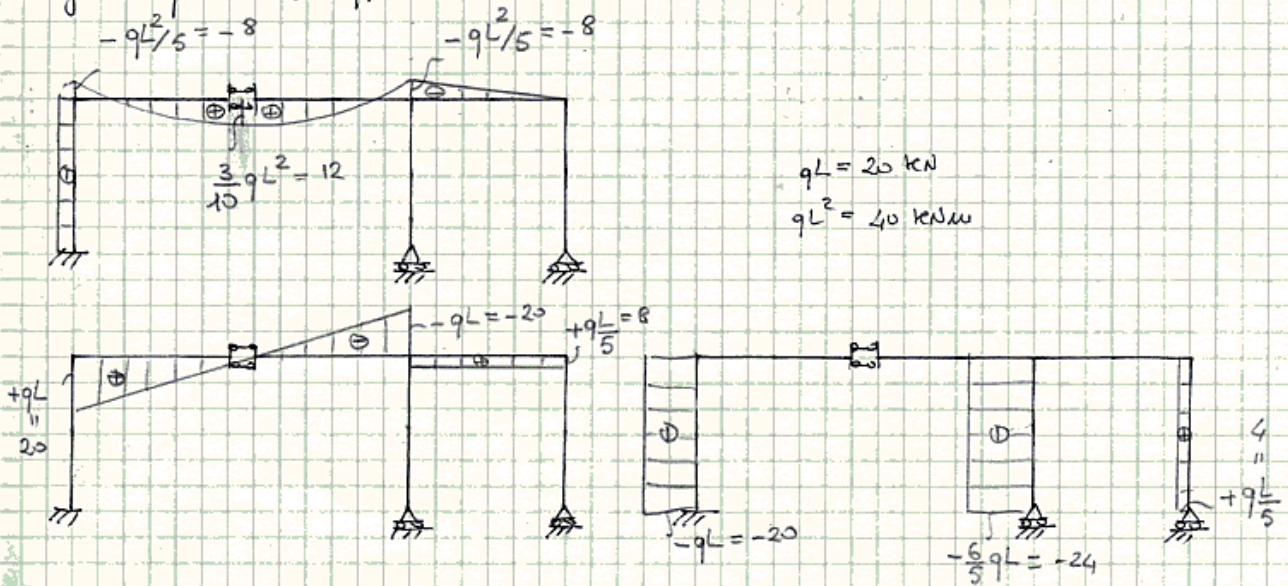


$$EI_1 M_{10} = (-1) \left[2L \frac{qL^2}{8} - \frac{1}{3} L \frac{qL^2}{2} \right] = -\frac{2}{3} qL^3$$

$$EI_1 M_{11} = L + 2L + \frac{1}{3} = 3L + \frac{1}{3} = \frac{10}{3} L$$

$$X_1 = -\frac{M_{10}}{M_{11}} = \frac{2}{8} qL \frac{3}{10L} = \frac{qL^2}{5}$$

Diagrammi quotati (solo q):

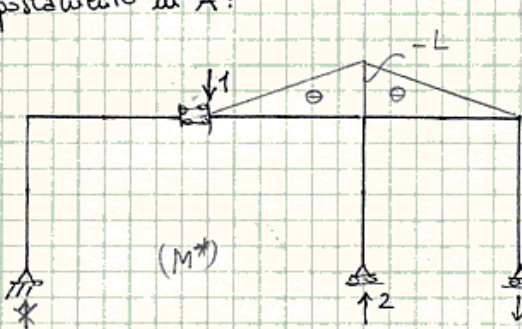


Dimensionamento:

$$W_1 \geq \frac{3qL^2}{56\Delta M} = \frac{8 \cdot 40 \cdot 10^3}{10 \cdot 240 \cdot 10^6} \cdot 10^8 \text{ cm}^3 = 50 \text{ cm}^3$$

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Spostamento in A':



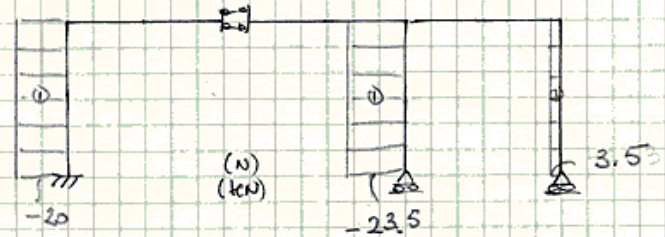
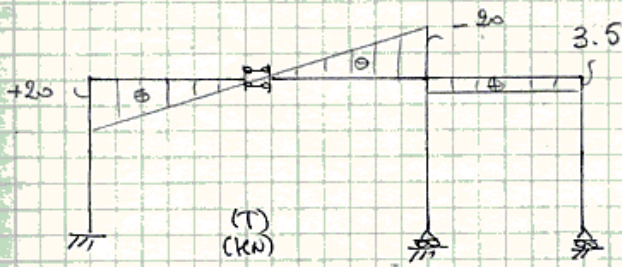
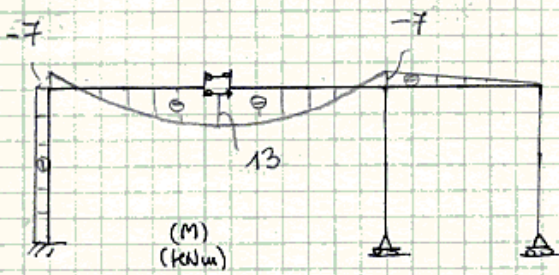
$$\begin{aligned}
 1 \cdot \delta_{A'} &= \frac{1}{EI_1} \int_0^L (-x_2) \left(-q \frac{x_2^2}{2} + \frac{3}{10} qL^2 \right) dx_2 + \\
 &+ \frac{1}{EI_1} \frac{1}{3} L (-L) \left(-\frac{qL^2}{5} \right) \\
 &= \frac{1}{EI_1} \left[-\frac{qL^4}{40} + \frac{qL^4}{15} \right] = \frac{qL^4}{24EI_1}
 \end{aligned}$$

Cedimento:

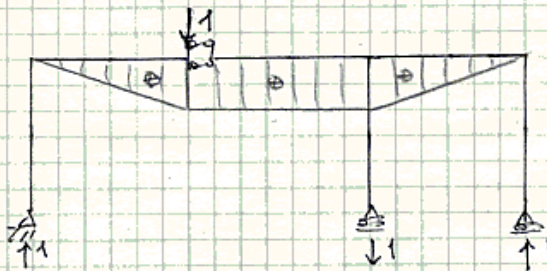
$$\eta_0 + \eta_{II} X_1 = \eta_1, \quad \eta_1 = -\frac{\delta}{L}, \quad \delta = 2 \text{ cm}$$

$$\begin{aligned}
 \rightarrow X_1 &= \frac{qL}{5} - \frac{\delta}{L} \frac{3EI_1}{10L} = \left(8 - \frac{3 \cdot 2 \cdot 1 \cdot 10^4 \cdot 317,8 \cdot 10^8 \cdot 2 \cdot 10^{-2}}{4 \cdot 10 \cdot 10^6} \right) \text{ kNm} \\
 &= (8 - 1) \text{ kNm} = 7 \text{ kNm}
 \end{aligned}$$

Diagrammi quotati (compresi di q e d):



NB: Spostamento in A:



$$EI_1 \delta_A = -\frac{1}{3} L \cdot L \cdot \frac{qL^2}{5} + \int_0^L L \left(-q \frac{x_3^2}{2} + \frac{3}{10} qL^2 \right) dx_3 + \int_0^L x_3 \left(-q \frac{L^2}{5} + qLx_3 - q \frac{x_3^2}{2} \right) dx_3$$

$$= -\frac{qL^4}{15} + \frac{2}{15} qL^4 + \frac{13}{120} qL^4 = \frac{7}{40} qL^4$$