

$q = 3000 \text{ N/m}$

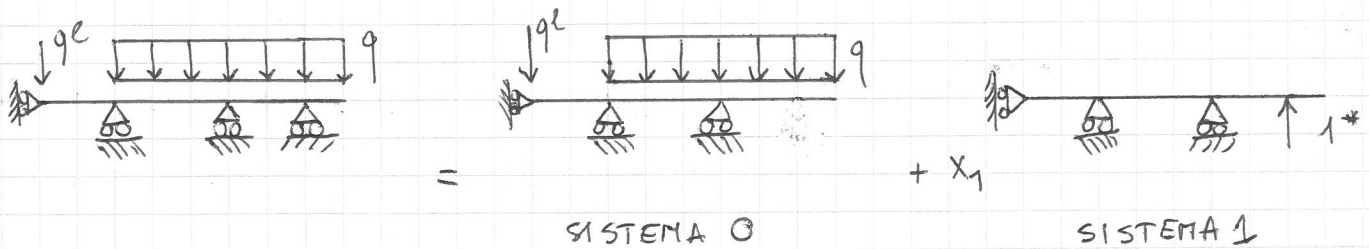
$l = 3 \text{ m}$

$l_1 = 2 \text{ m} = \frac{2}{3}l$

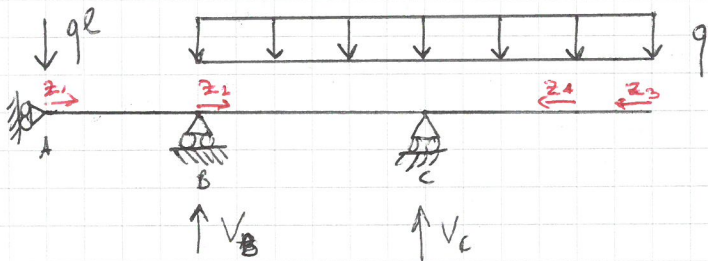
$l_2 = 1 \text{ m} = \frac{1}{3}l$

1 volta iperstatica

1) $k \rightarrow \infty$



SISTEMA 0



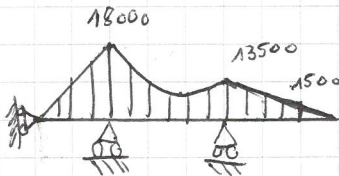
$\rightarrow) H_A = 0$

$\uparrow) V_B + V_C = 3ql$

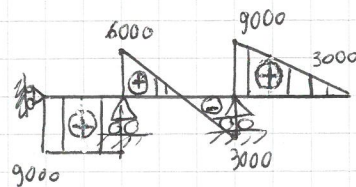
$\hookrightarrow) V_B l = ql(\frac{2}{3}l + l)$

$V_B = \frac{5}{3}ql = 15000 \text{ N}$

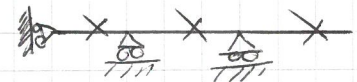
$V_C = 3ql - \frac{5}{3}ql = \frac{4}{3}ql = 12000 \text{ N}$



(M)



(T)



(N)

$z_1: M(z_1) = -qlz$

$T(z_1) = -ql$

$N(z_1) = 0$

$z_2: M(z_2) = -\frac{2}{3}ql^2 + \frac{2}{3}qlz - \frac{qz^2}{2}$

$T(z_2) = \frac{2}{3}ql - qz$

$N(z_2) = 0$

$z_3: M(z_3) = -\frac{qz^2}{2}$

$T(z_3) = +qz$

$N(z_3) = 0$

$z_4: M(z_4) = -\frac{1}{18}ql^2 - \frac{1}{3}qlz - \frac{qz^2}{2}$

$T(z_4) = +\frac{1}{3}ql + qz$

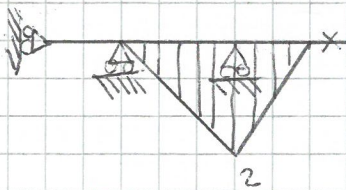
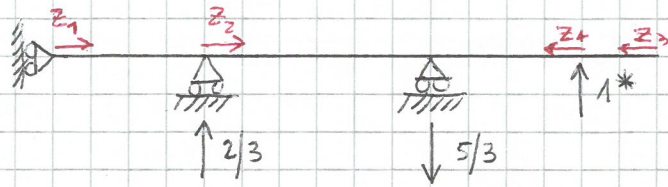
$N(z_4) = 0$

SISTEMA 1

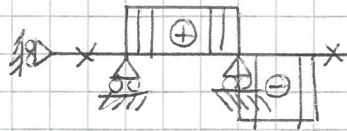
→) $H_A = 0$

d) $V_{el} = 1 \cdot l_1 = V_B = \frac{l_1}{l} = \frac{2}{3}$

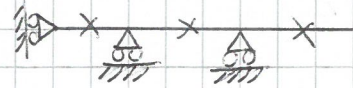
↑) $V_c = 1 + \frac{2}{3} = \frac{5}{3}$



(M)



(T)



(N)

$z_1: M(z_1) = 0$

$T(z_1) = 0$

$N(z_1) = 0$

$z_2: M(z_2) = \frac{2}{3}z$

$T(z_2) = \frac{2}{3}$

$N(z_2) = 0$

$z_3: M(z_3) = 0$

$T(z_3) = 0$

$N(z_3) = 0$

$z_4: M(z_4) = 1z$

$T(z_4) = -1$

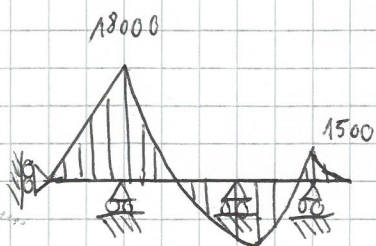
$N(z_4) = 0$

$-\frac{58250}{EJ}$

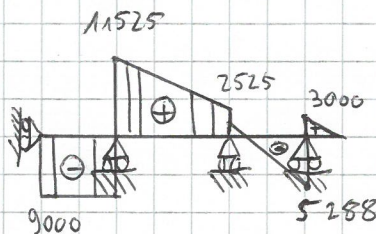
$$\eta_{10} = \frac{1}{EJ} \left[\int_0^l \left(-\frac{2}{3}ql^2 + \frac{2}{3}qlz - \frac{qz^2}{2} \right) \left(\frac{2}{3}z \right) dz + \int_0^{2/3l} \left(-\frac{1}{18}ql^2 - \frac{1}{3}qlz - \frac{qz^2}{2} \right) (z) dz \right]$$

$$\eta_{11} = \frac{1}{EJ} \left[\int_0^l \left(\frac{2}{3}z \right)^2 dz + \int_0^{2/3l} (z^2) dz \right] = \frac{1}{EJ} \left[4 + \frac{8}{3} \right] = \frac{20}{3EJ}$$

$\eta_{11} X_1 = -\eta_{10} \rightarrow X_1 = 8288 N$



(M)



(T)



(N)

2) Progetto e verifica

$$M_{max} = 18000 \text{ Nm} \quad \sigma_{am} = 190 \text{ MPa}$$

$$W_{min} = \frac{M_{max}}{\sigma_{am}} = \frac{18000 \cdot 1000}{190} = 94 \text{ cm}^3$$

Accesto IPE 160 $W_x = 108.7 \text{ cm}^3$ $A = 20.99 \text{ cm}^2$

$$J_x = 869.3 \text{ cm}^4$$

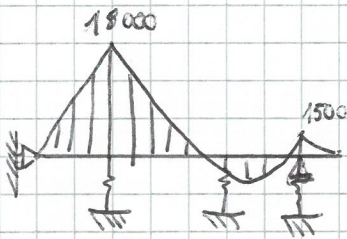
$$\sigma_{max} = \frac{M_{max}}{W_x} = \frac{18000}{869.3} = 165 \text{ MPa} < 190 \text{ MPa}$$

3) $k = 80 \text{ kN/m}$

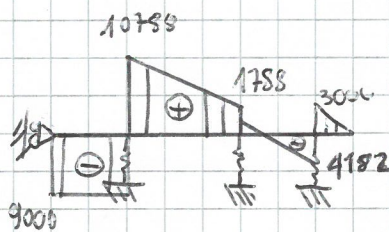
$$L_{v2} = 0 = L_{vi} = \eta_{11} X_1 + \eta_{10} + \frac{1}{K} (V_B' \cdot V_B + V_C' \cdot V_C + V_D' \cdot V_D)$$

$$\text{dove } V_i = V_i^0 + X_1 V_i^1, \quad i = B, C, D$$

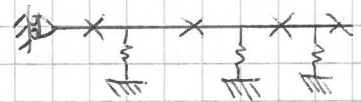
$$X_1 = 7182 \text{ N}$$



(M)



(T)



(N)