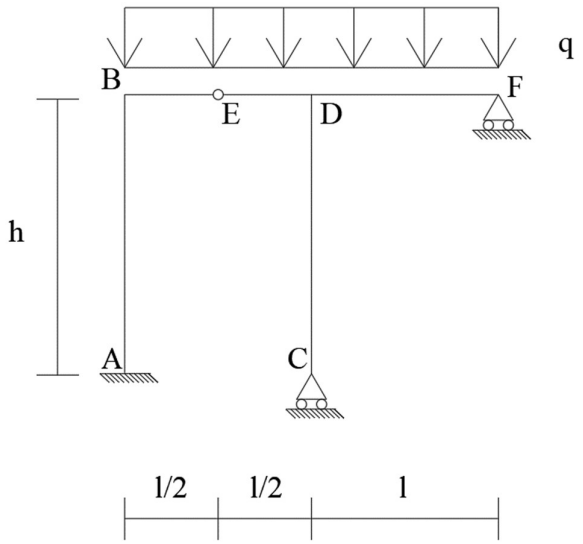
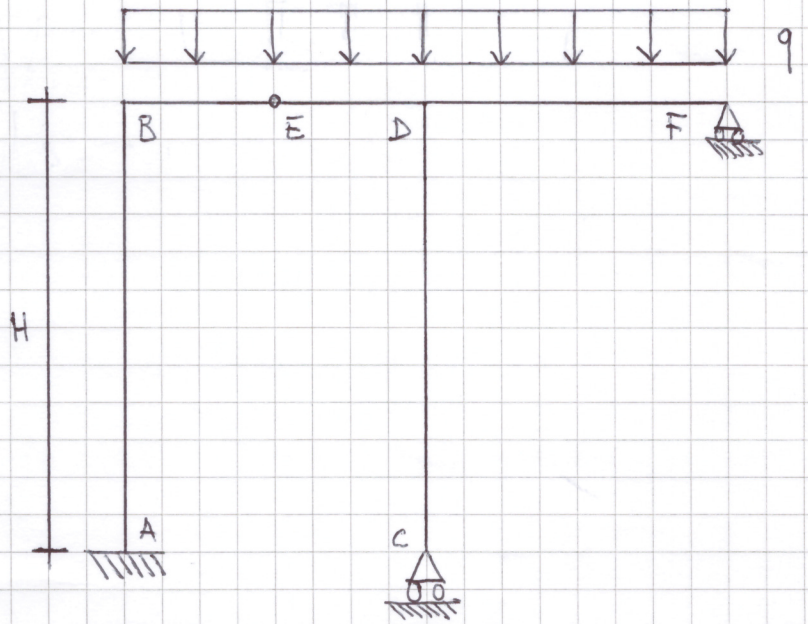
# Totale SdC 21/06/2021




1) Determinare i diagrammi quotati MNT della struttura in figura con q = 4000 N/m, l = 2 m, h = 3 m. In questa fase, si trascuri la deformabilità assiale delle aste. Si dimensioni poi a flessione il telaio con la formula M/W usando profili IPE. Per tutti gli elementi si assuma un acciaio Fe 430 con tensione ammissibile di 190 MPa e modulo di Young pari a 210000 MPa.
2) Determinare i diagrammi quotati MNT della struttura considerando il difetto dell'asta CD di 1 cm più lunga e la deformazione assiale.

# SOLUZIONE COMPITO 21/06/2021




**DATI:**

$l = 2\ m$

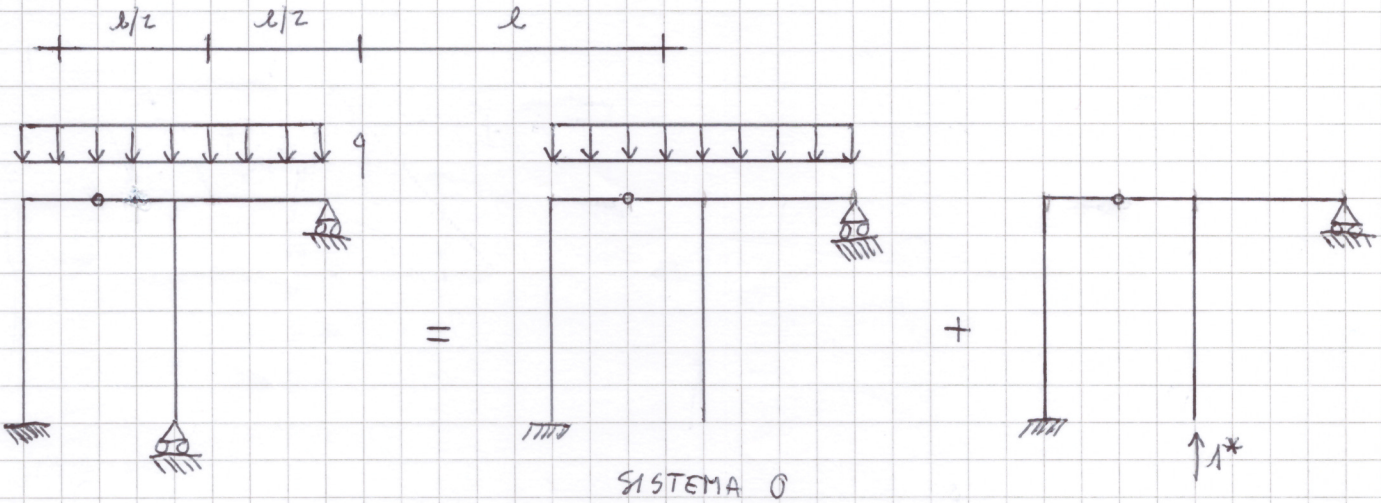
$H = 3\ m$

$q = 4000\ N/m$

$E = 210000\ MPa$

$\sigma_{am} = 190\ MPa$

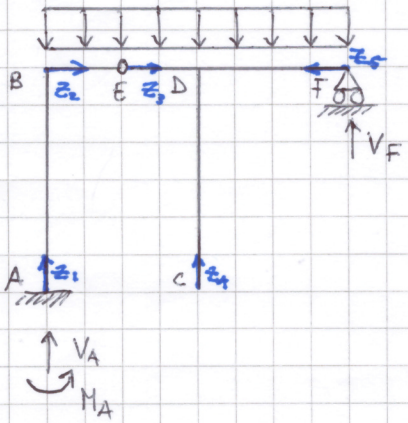
$\Delta H = 1\ cm$




SISTEMA 0

SISTEMA 1

1) Si trascuri la deformabilità assiale




**SISTEMA 0**

$\rightarrow)\ H_A = 0$

$E\ \curvearrowright_{Dx}\ V_F\left(l+\frac{l}{2}\right) - q\left(l+\frac{l}{2}\right)\left(\frac{3}{4}l\right) = 0 \longrightarrow V_F = \frac{3}{4}ql = 6000\ N$

$\uparrow)\ V_A + V_F = 2ql \longrightarrow V_A = \frac{5}{4}ql = 10000\ N$

$E\ \curvearrowright_{Sx}\ -V_A\frac{l}{2} + q\frac{l}{2}\frac{l}{4} + M_A = 0 \longrightarrow M_A = \frac{ql^2}{2} = 8000\ Nm$

**Tratto AB**

$N(z_1) = -\frac{5}{4}ql = -10000\ N \qquad T(z_1) = 0 \qquad M(z_1) = -\frac{ql^2}{2} = -8000\ Nm$

**Tratto BE**

$N(z_2) = 0 \qquad T(z_2) = \frac{5}{4}ql - qz \qquad M(z_2) = -\frac{ql^2}{2} + \frac{5}{4}qlz - q\frac{z^2}{2}$

Tratto ED

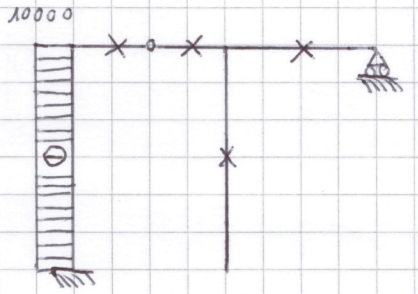
$N(z_3) = 0$ $\quad T(z_3) = \frac{3}{4}ql - qz$ $\quad M(z_3) = \frac{3}{4}qlz - q\frac{z^2}{2}$

Tratto CD

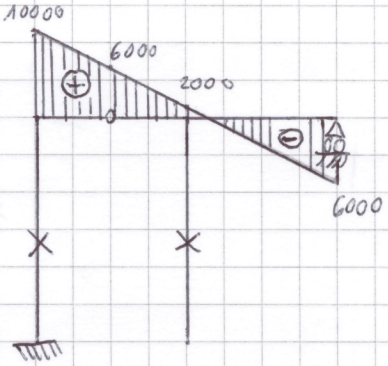
$N(z_4) = 0$ $\quad T(z_4) = 0$ $\quad M(z_4) = 0$

Tratto FD

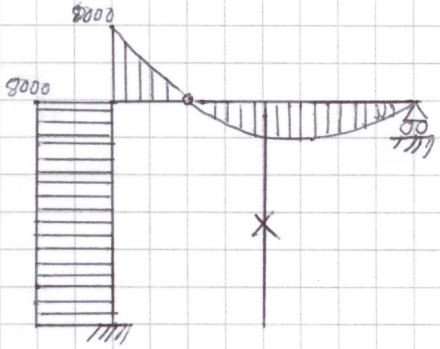
$N(z_5) = 0$ $\quad T(z_5) = -\frac{3}{4}ql + qz$ $\quad M(z_5) = \frac{3}{4}qlz - q\frac{z^2}{2}$




N[N]

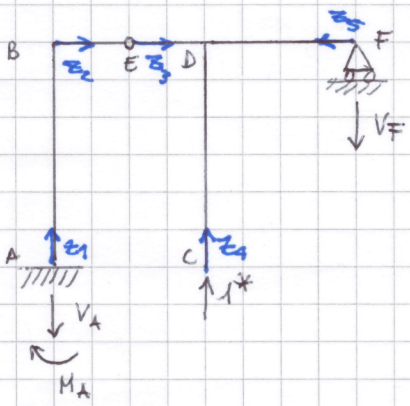



T[N]




M[N·m]

SISTEMA 1




$\rightarrow) \quad H_A = 0$

$E\uparrow_{Dx} \quad -V_F\left(\frac{l}{2}+l\right) + 1^*\frac{l}{2} = 0 \longrightarrow V_F = \frac{1}{3}$

$\uparrow) \quad 1^* - V_F - V_A = 0 \longrightarrow V_A = 1 - \frac{1}{3} = \frac{2}{3}$

$E\uparrow_{Sx} \quad -M_A + V_A\frac{l}{2} = 0 \longrightarrow M_A = \frac{1}{3}l = \frac{2}{3}$

Tratto AB

$N(z_1) = \frac{2}{3}$ $\quad T(z_1) = 0$ $\quad M(z_1) = \frac{2}{3}$

Tratto BE

$N(z_2) = 0$ $\quad T(z_2) = -\frac{2}{3}$ $\quad M(z_2) = \frac{2}{3} - \frac{2}{3}z$

Tratto ED

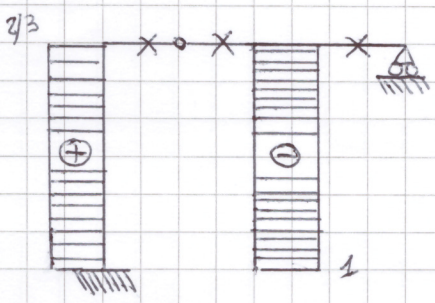
$N(z_3) = 0$ $\quad T(z_3) = -\frac{2}{3}$ $\quad M(z_3) = -\frac{2}{3}z$

Tratto CD

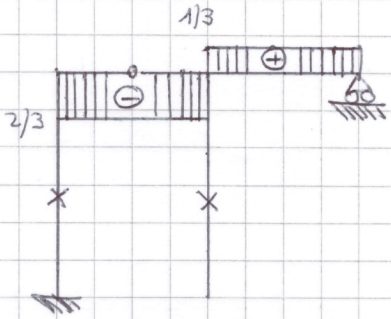
$N(z_4) = -1$ $\quad T(z_4) = 0$ $\quad M(z_4) = 0$

Tratto FD

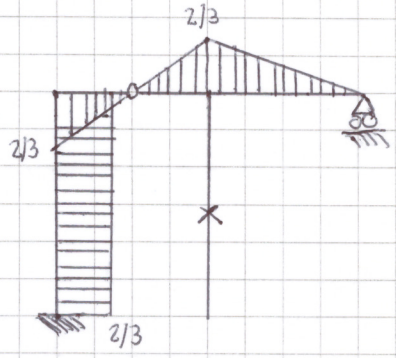
$N(z_5) = 0$ $\quad T(z_5) = 1/3$ $\quad M(z_5) = -\frac{1}{3}z$




N[N]




T[N]



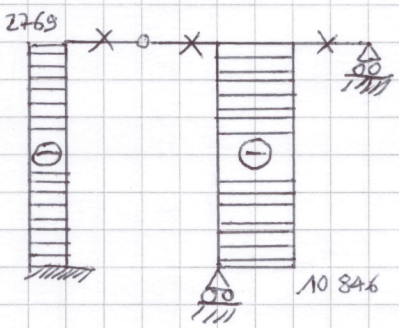

M[N·m]

$$\eta_{10} = \frac{1}{EJ}\left[\int_0^H \left(\frac{z}{3}\right)\left(-q\frac{l^2}{2}\right)dz + \int_0^{l/2}\left(\frac{z}{3} - \frac{z}{3}z\right)\cdot\left(-q\frac{l^2}{2} + \frac{5}{4}qlz - q\frac{z^2}{2}\right)dz + \int_0^{l/2}\left(\frac{3}{4}qlz - q\frac{z^2}{2}\right)\cdot\left(-\frac{1}{3}z\right)dz + \right.$$

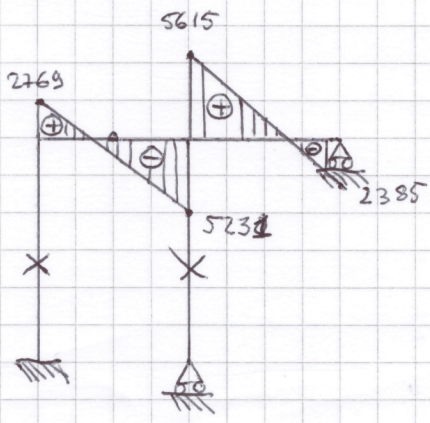
$$\left. + \int_0^l \left(-\frac{1}{3}z\right)\left(\frac{3}{4}qlz - q\frac{z^2}{2}\right)dz\right] = -\frac{188000}{9EJ}$$

$$\eta_{11} = \frac{1}{EJ}\left[\int_0^H \left(\frac{z}{3}\right)^2 dz + 2\int_0^{l/2}\left(-\frac{z}{3}z\right)^2 dz + \int_0^l \left(-\frac{1}{3}z\right)^2 dz\right] = \frac{52}{27EJ}$$

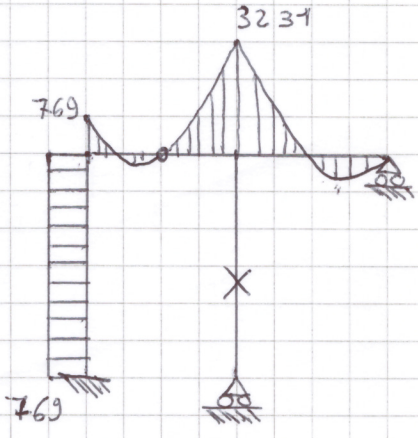
$$X_1 = -\frac{\eta_{10}}{\eta_{11}} = 10\,846\ N$$




N[N]




T[N]




M[Nm]

Progetto e verifica a flessione

$M_{max} = 3231\ Nm$

$$\frac{M_{max}}{W} < \sigma_{amm} \longrightarrow W_{min} = \frac{M_{max}}{\sigma_{amm}} = 17.00\ cm^3$$

Adotto profilo IPE 80 ($A = 7.64\ cm^2$ $I_x = 80.1$ $W_x = 20.0\ cm^3$)

$$\sigma_{mm,max} = \pm \frac{M}{W_x} \begin{cases} \sigma_{max} = 162 < 190 \quad \checkmark \\ \sigma_{mm} = -162 < 190 \quad \checkmark \end{cases}$$

2) Considero sfilo asta CD di 1 cm più lunga e deformata la tavola

$$\eta_{10} = \frac{1}{EJ}\left[\int_0^{H_{new}} \left(\frac{z}{3}\right)\left(-q\frac{l^2}{2}\right)dz + \int_0^{l/2}\left(\frac{z}{3}-\frac{l}{3}z\right)\left(-q\frac{l^2}{2}+\frac{5}{4}qlz-q\frac{z^2}{2}\right)dz + \right.$$

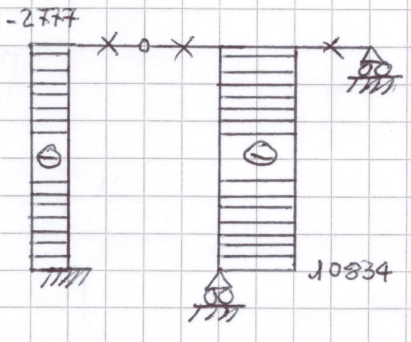
$$\left. + \int_0^{l/2}\left(-\frac{l}{3}z\right)\left(\frac{3}{4}qlz - q\frac{z^2}{2} + \int_0^{l}\left(-\frac{1}{3}z\right)\left(\frac{3}{4}qlz - q\frac{l^2}{2}\right)dz\right] = -\frac{188480}{9EJ}\right.$$

$$\eta_{11} = \frac{1}{EJ}\left[\int_0^{H_{new}}\left(\frac{z}{3}\right)^2 dz + 2\int_0^{l/2}\left(-\frac{2}{3}z\right)^2 dz + \int_0^{l}\left(-\frac{1}{3}z\right)^2 dz = \frac{1303}{675EJ}\right.$$

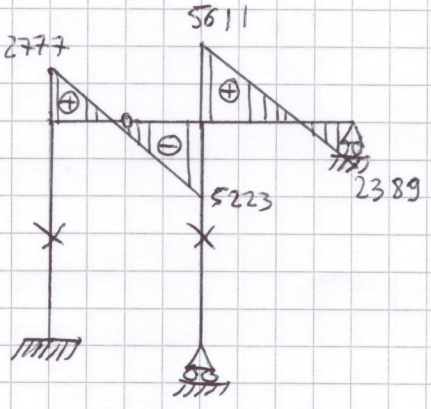
$$\eta_{10}^{a} = \frac{1}{EA}\int_0^{H_{new}}\left(\frac{z}{3}\right)\left(-\frac{5}{4}ql\right)dz = -\frac{60200}{3EA}$$

$$\eta_{11}^{a} = \frac{1}{EA}\left[\int_0^{H_{new}}\left(\frac{z}{3}\right)^2 dz + \int_0^{H_{new}}(-1)^2 dz = \frac{3913}{900EA}\right.$$

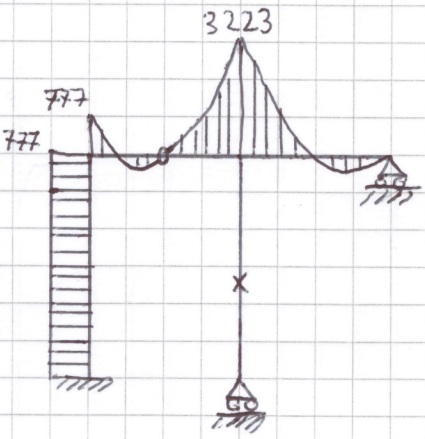
$$X_1 = -\frac{\eta_{10} + \eta_{10}^{a}}{\eta_{11} + \eta_{11}^{a}} = 10834\ N$$




N [N]




T [N]




M [Nm]