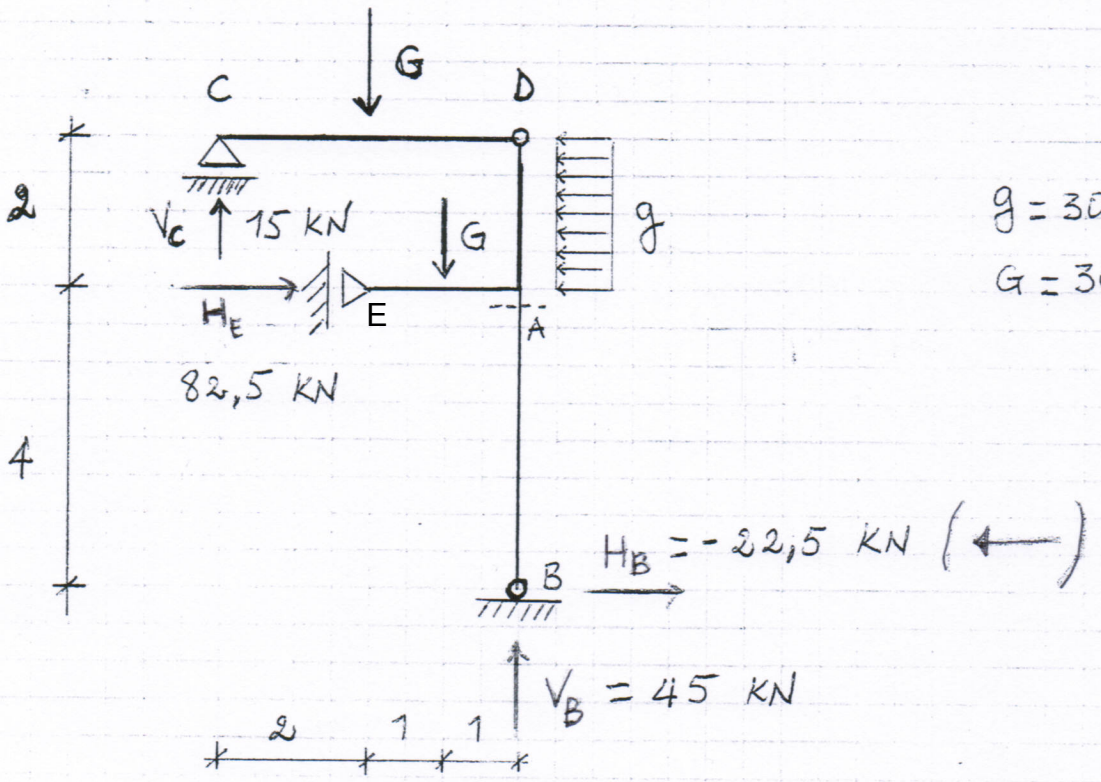
PROVA SCRITTA DI TECNICA DELLE COSTRUZIONI

31/08/2017 TEMA B



$g = 30$ kN/m

$G = 30$ kN

$H_B = -22{,}5$ kN (←)

i) Determinare i diagrammi e i valore significativi dei parametri di sollecitazione (M, N, T)

Equazioni di equilibrio:

$V_C + V_B - G - G = 0$

$H_E + H_B - 2 \cdot g = 0$

$-V_C \cdot 4 + G \cdot 2 = 0$ (Polo D) tronco CD

$-V_C \cdot 2 - G \cdot 1 + g \cdot 2 \cdot 1 + V_B \cdot 2 + H_B \cdot 4 = 0$ (Polo E) Equilibrio Globale

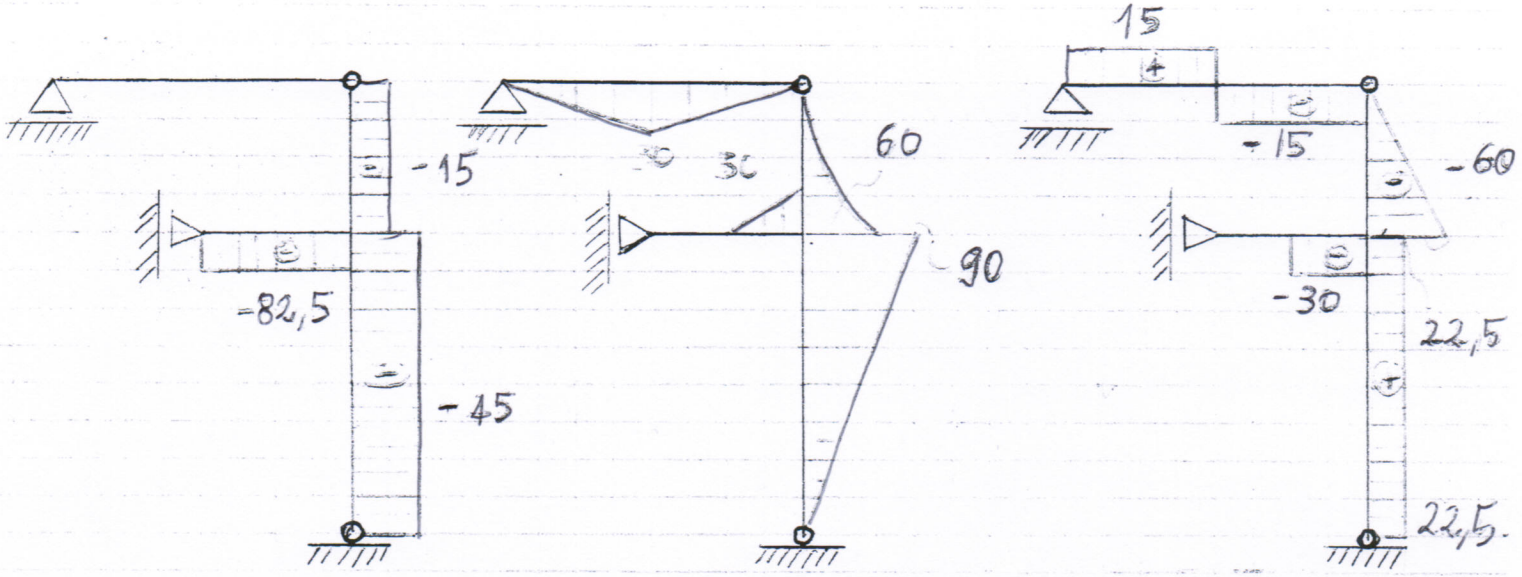
$V_C = 2 \cdot G - V_B = 15$ kN

$V_B = 2 \cdot G - V_C = 45$ kN

$V_C = G \cdot 2/4 = 15$ kN

$H_E = 2 \cdot g - H_B = 82{,}5$ kN

$H_B = (V_C \cdot 2 + G \cdot 1 - g \cdot 2 \cdot 1 - V_B \cdot 2)/4 = 22{,}5$ kN (←)



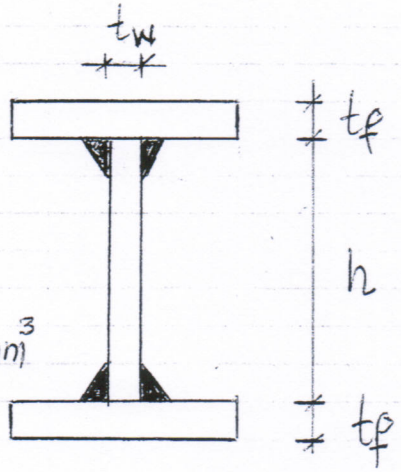
N [kN] M [kNm] T [kN]

(ii)

SEZIONE A

$M_{ED} = 90$ kNm

$V_{ED} = 22,5$ kN



$f_{yk} = 275$ MPa

$$W_{El,MN} = \frac{M_{ED} \cdot \gamma_{M0}}{f_{yk}} = 343\,636,36\ mm^3$$

IPOTIZZO $\begin{cases} h = 230\ mm \\ t_f = 10\ mm \end{cases}$ $t_w = 0,8 \cdot t_f = 8\ mm$

$$J = \frac{1}{12} b \cdot (h + 2\,t_f)^3 - \frac{1}{12} (b - t_w) \cdot h^3 \quad (*)$$

$$W_{el} = \frac{b \cdot (h + 2 \cdot t_f)^3 - (b - t_w) \cdot h^3}{12} \cdot \frac{2}{(h + 2 t_f)} \quad (**)$$

$$= \frac{1}{6} b \cdot (h + 2 \cdot t_f)^2 - \frac{1}{6} \cdot \frac{(b - t_w) \cdot h^3}{h + 2 t_f}$$

Per trovare b $\begin{cases} b \gg t_w \\ h \gg 2 \cdot t_f \end{cases}$

$$W_{el,} = \frac{(b \cdot (h + 2 \cdot t_f)^2}{6} - \frac{b \cdot h^3}{6 \cdot (h + 2 t_f)} + \frac{t_w \cdot h^3}{6 \cdot (h + 2 t_f)}$$

$$W_{el} \cong \frac{b\cdot[(h+2t_f)^2 - h^2]}{6} + \frac{t_w \cdot h^2}{6}$$

N.B. Uso questa equazione solo per trovare b !!!

$$\Rightarrow b \cong \frac{6\cdot W_{el} - t_w \cdot h^2}{(h+2\cdot t_f)^2 - h^2} \cong 170{,}68 \text{ mm} \quad (h \text{ scelto va bene})$$

Pongo $b = 200$ mm

$$W_{el} = \frac{1}{6} b\cdot(h+2\cdot t_f)^2 - \frac{1}{6}\frac{(b-t_w)\cdot h^3}{h+2\cdot t_f}$$

$$W_{el} = 525\,957{,}33 \text{ mm}^3$$

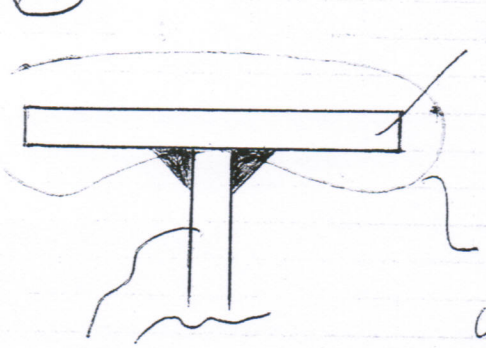
VERIFICA A FLESSIONE

$$M_{ED} < M_{RD} = \frac{W_{el}\cdot f_{YK}}{\gamma_{M0}} = \frac{525\,957{,}33 \cdot 275}{1{,}05} = 137{,}8 \text{ KN}\cdot\text{m}$$

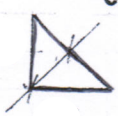
VERIFICA A TAGLIO

$$V_{ED} < V_{RD} = \frac{A_V \cdot f_{YK}}{\sqrt{3}\cdot\gamma_{M0}} = \frac{(h\cdot t_w)\cdot f_{YK}}{\sqrt{3}\cdot\gamma_{M0}} = 278{,}23 \text{ KN}$$

(iii)



$a = 4$ mm



dimensione del cordone d'angolo

circuitazione per ottenere la tensione in corrispondenza dell'attacco ala-anima

ANIMA

$$\tau_{ATTACCO} = \frac{V_{ED}\cdot S_{ALA}}{J_{Profilo}\cdot 2a}$$

Se ipotizzo che $2\cdot a = t_f$ è come se avessi una sezione compatta e la saldatura è "implicitamente" verificata

$$S_{ALA} = (t_f \cdot b) \cdot \left(\frac{h}{2} + \frac{t_f}{2}\right) = 240\,000\ mm^3$$

$$J_{PROFILO} = \frac{1}{12} \cdot b \cdot (h + 2 \cdot t_f)^3 - \frac{1}{12} \cdot (b - t_w) \cdot h^3 = 65 \cdot 744 \cdot 666{,}67\ mm^4$$

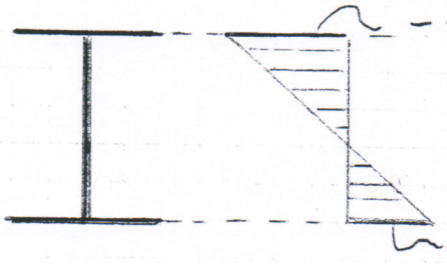
$$V_{ED} = 22\,500\ N$$

$$\tau_{II} = 10{,}26\ MPa \leq \beta_1 \cdot f_{yk} \ (= 0{,}85 \cdot 275 = 233{,}75\ MPa)$$

(iv)

$$N_{ED} = -45\ kN \qquad M_{ED} = 90\ kN \cdot m \qquad V_{ED} = 22{,}50\ kN$$

diagramme delle tensioni normali



$$\sigma_{SUP} = \frac{N_{ED}}{A} - \frac{M_{ED}}{W} = \frac{-45\,000}{5840} - \frac{90\,000\,00}{525\,957{,}33}$$

$$= -178{,}82\ MPa$$

$$\sigma_{INF} = \frac{N_{ED}}{A} + \frac{M_{ED}}{W} = -\frac{45\,000}{5840} + \frac{90\,000\,000}{525\,927{,}33}$$

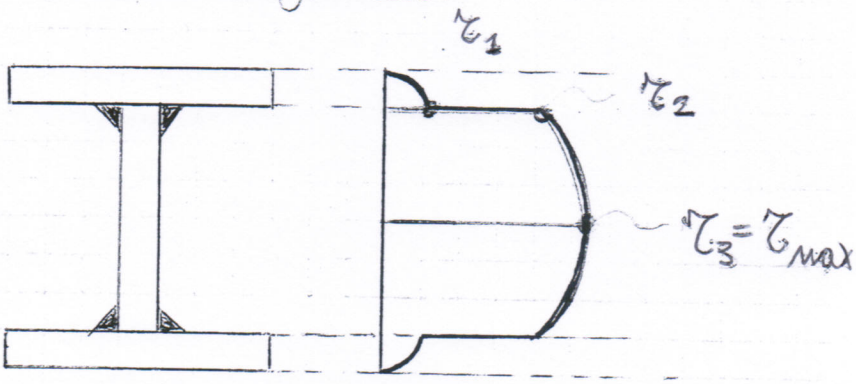
$$= +163{,}42\ MPa$$

Diagramma delle tensioni tangenziali

$$\tau_1 = \frac{V_{ED} \cdot S_{ALA}}{J_{PROFILO} \cdot b} = 0{,}41\ MPa$$

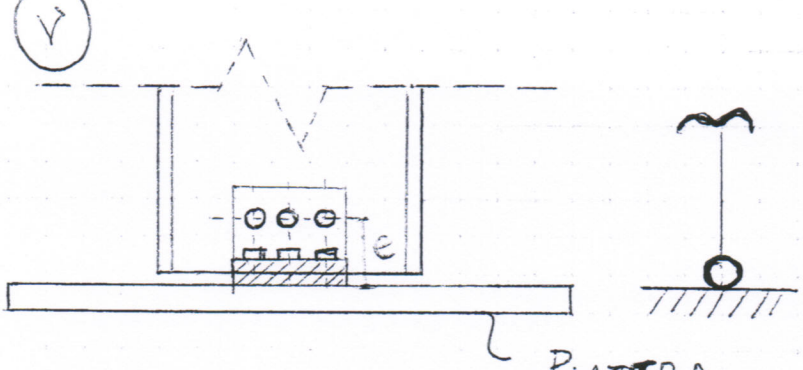
$$\tau_2 = \frac{V_{ED} \cdot S_{ALA}}{J_{PROFILO} \cdot 2a} = 10{,}26\ MPa$$

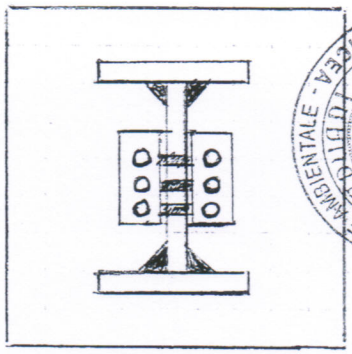
$$\tau_3 = \frac{V_{ED} \cdot S_{1/2}}{J_{PROFILO} \cdot t_w} = 12{,}53\ MPa$$



$$S_{1/2} = S_{ALA} + \left(\frac{h}{2} \cdot t_w\right) \cdot \frac{h}{4} = 292 \cdot 900\ mm^3$$

(V)



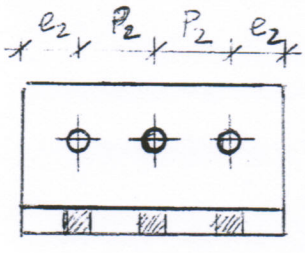


la colonna non appoggia direttamente sulla piastra di base quindi N_{ED} viene trasferito alla piastra di base tramite i bulloni

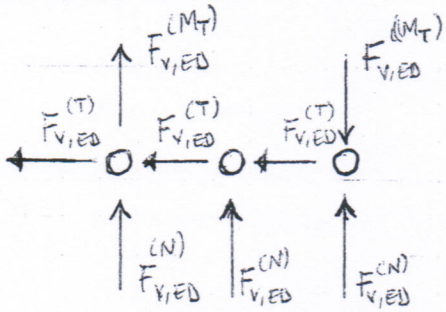
$V_{ED} = 22,5$ kN

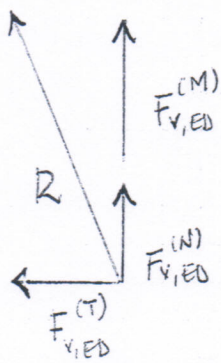
$N_{ED} = -45$ kN

M16 CL 8.8



eccentricità taglio





$e_1 = 60$ mm $\quad P_2 = 60$ mm

$e_2 = 50$ mm $\quad e = 70$ mm

$M_T = T \cdot e = 22,5 \cdot 0,07 = 1,575$ kN·m

$$F_{V,ED}^{(N)} = \frac{N_{ED}}{n \cdot n_f} = \frac{45}{3 \cdot 2} = 7,500 \text{ kN}$$

$$F_{V,ED}^{(T)} = \frac{V_{ED}}{n \cdot n_f} = \frac{22,5}{3 \cdot 2} = 3,750 \text{ kN}$$

$$F_{V,ED}^{(M_T)} = \frac{M_T}{h} \cdot \frac{1}{n_f} = \frac{1,575}{0,12} \cdot \frac{1}{2} = 6,56 \text{ kN}$$

$$R = \sqrt{\left(F_{V,ED}^{(M_T)} + F_{V,ED}^{(N)}\right)^2 + F_{V,ED}^{(T)^2}}$$

$$= \sqrt{(6,56 + 7,5)^2 + 3,75^2}$$

$$= 14,55 \text{ kN}$$

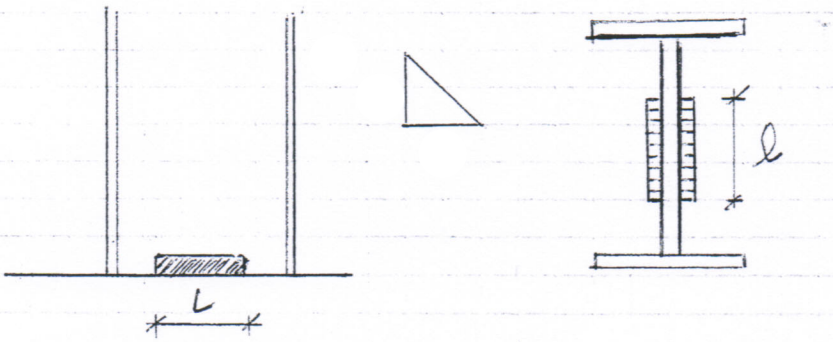
$$= F_{V,ED}$$

$$F_{V,RD} = \frac{0,6 \cdot f_{ub} \cdot A_{res.}}{\gamma_{M_2}} = \frac{0,6 \cdot 800 \cdot 157}{1,25} = 60,29 > F_{V,ED}$$

(vi) (SALDATURA S235)

$N_{ED} = -45$ kN

$V_{ED} = 22{,}5$ kN



$a = 5$ mm

$l = 190$ mm

$$\tau_{\perp} = \frac{V_{ED}}{2 \cdot a \cdot l} = \frac{22500}{2 \cdot 5 \cdot 190} = 11{,}84 \text{ MPa}$$

$$\sigma_{\perp} = \frac{N_{ED}}{2 \cdot a \cdot l} = \frac{45000}{2 \cdot 5 \cdot 190} = 23{,}68 \text{ MPa}$$

(*) $\sqrt{\sigma_{\perp}^2 + \tau_{\perp}^2 + \tau_{\parallel}^2} \leq \beta_1 \cdot f_{yk}$

(**) $|\sigma_{\perp}| + |\tau_{\perp}| \leq \beta_2 \cdot f_{yk}$

$f_{yk} = 235$ MPa

$\beta_1 = 0{,}85$ $\beta_2 = 1$

(*) $26{,}47 \leq 0{,}85 \cdot 235$

(**) $23{,}68 \leq 1 \cdot 235$