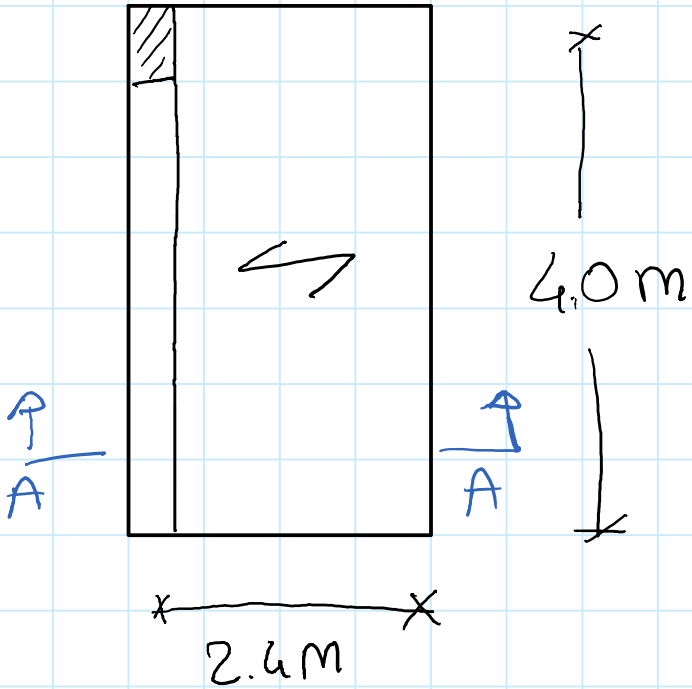
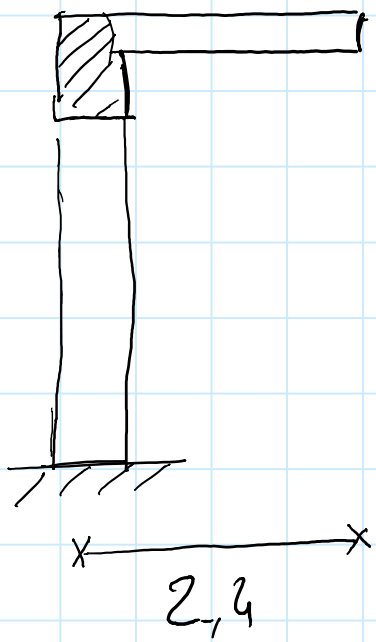
ESERCIZIO COMPITO

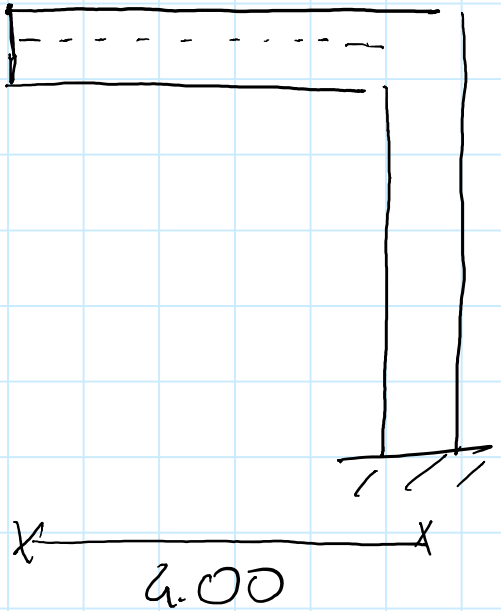


PIANTA

SEZ. A-A



PROSPETTO



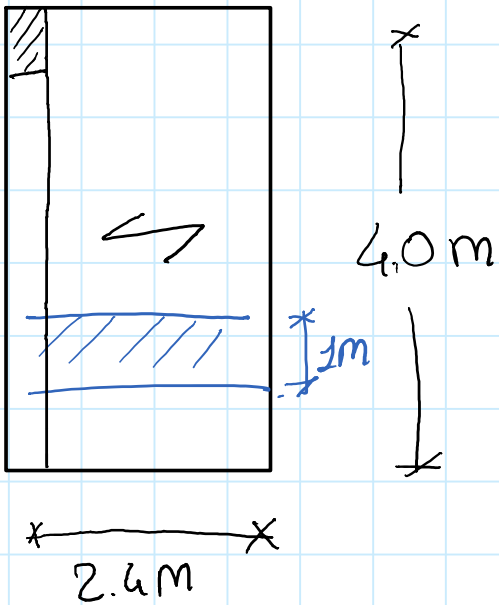
PROGETTARE
TRAVE E PILASTRO

$g_k = 3.6\ kN/m^2$

$q_k = 0,8\ kN/m^2$

C 30/37 , $c = 4\ cm$

CARICHI SULLA TRAVE

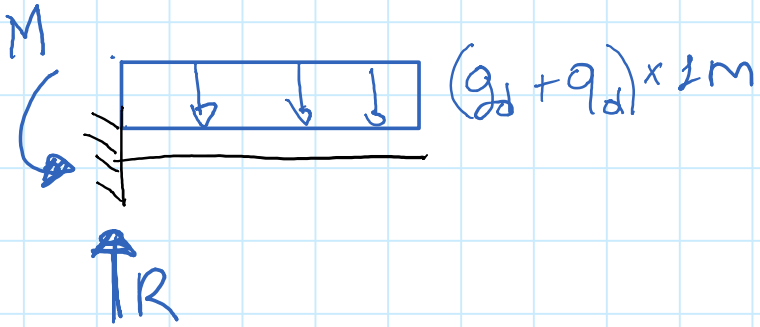


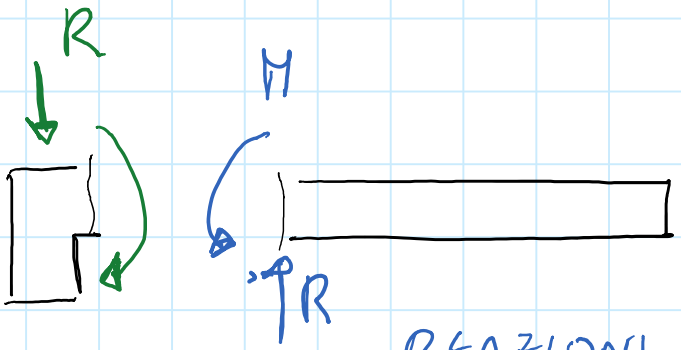
$$g_d = g_k \times 1.3$$

$$q_d = q_k \times 1.5$$

$$g_d = 3,6 \times 1,3 = 4,68 \ kN/m^2$$

$$q_d = 0,8 \times 1,5 = 1,2 \ kN/m^2$$





AZIONI SULLA TRAVE

REAZIONI SUL SOLAIO

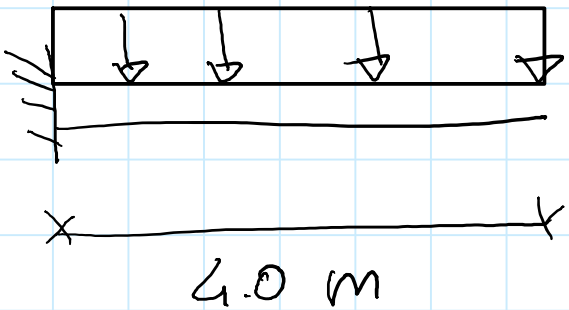
(RISULTANTE SU 1 m DI TRAVE)

$$R = (g_d + q_d) \times 1 \times 2,4 = 14,11 \ kN$$

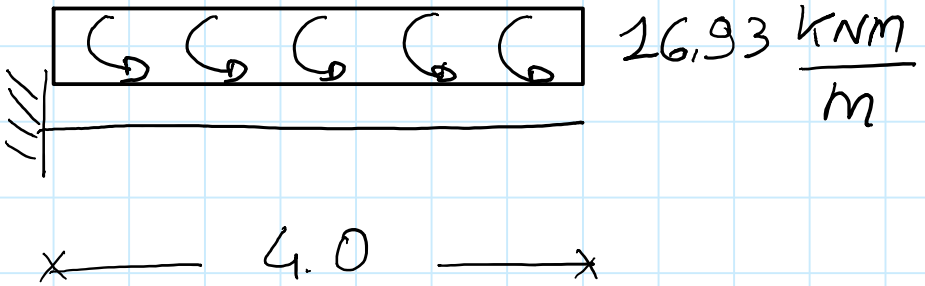
$$M = (g_d + q_d) \times 1 \times 2,4^2/2 = 16,93 \ kNm$$

CARATTERISTICHE SOLLECITAZIONE TRAVE

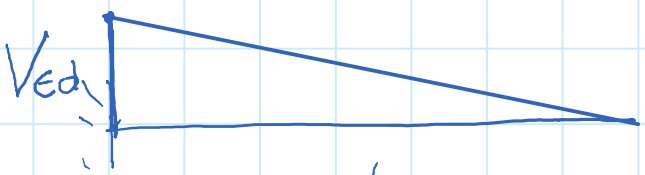
FLESSIONALI



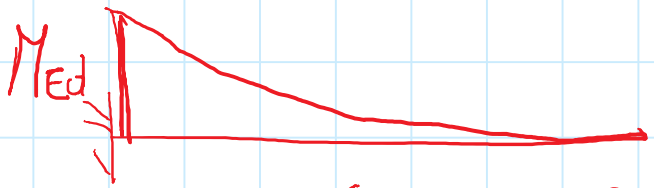
TORCENTI



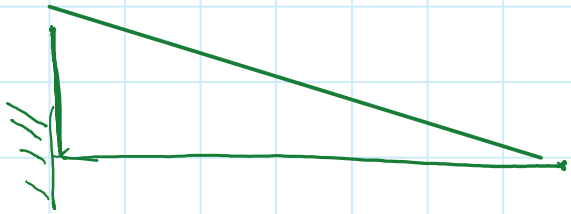
PESO PROPRIO $\simeq 0{,}3 \times 0{,}6\ m^2 \times 25\ kN/m^3 \times \underbrace{1.3}_{\gamma_G} = 5.85\ kN/m$



$V_{Ed} = (14{,}11 + 5{,}85) \times 4 = 79{,}84\ kN$



$M_{Ed} = (14{,}11 + 5{,}85) \times \frac{4^2}{2} \simeq 160\ kNm$



$T_{Ed} = 16{,}93 \times 4$

$= 67{,}72\ kNm$

(ANALOGIA TAGLIO)

PROGETTO TRAVE

DA FLESSIONE (NON CONDIZIONANTE) $\longrightarrow$ $M = \frac{bd^2}{\tau'^2}$

$$d = \tau' \sqrt{\frac{M}{b}} = 0.017 \sqrt{\frac{160}{0,30}} = 0,39\ m$$

$$d + c = 0,39 + 0,04 = 0,43\ m \Rightarrow 30 \times 50$$

DA TAGLIO E TORSIONE $\quad \frac{V_{Ed}}{V_{Rd,max}} + \frac{T_{Ed}}{T_{Rd\,max}} \leq 1$

V_{Ed} MOLTO BASSO $\Rightarrow$ SE $\frac{V_{Ed}}{V_{Rd\,max}} \simeq 0.2 \Rightarrow$

PROGETTO CONSIDERANDO $\frac{T_{Ed}}{T_{Rd,max}} \leq 1 - 0,2 \longrightarrow$

OPPURE $\frac{T_{Ed}}{T_{Rd,max}} \leq 1$ (ASSUMO $\cot\vartheta = 2,5$ E RIDUCO $\cot\vartheta$ QUANDO AGGIUNGO V_{Ed})

DIMENSIONAMENTO A TORSIONE

$$t = \max\left\{2c,\ \frac{A}{u}\right\} = 9.37\ cm$$

$$T_{Ed} = \nu f_{cd} \cdot t\, 2A_k \frac{\cot\vartheta}{1+\cot^2\vartheta}$$

$\cot\vartheta = 2.5$ (CAUTELATIVO)

$$A_k = \frac{67{,}72\ kNm}{0{,}5 \times 17\ \frac{N}{mm^2} \times 9{,}37\ cm \times 2} \cdot 10^3 \cdot \frac{1+2{,}5^2}{2{,}5} = 1233\ cm^2$$

SE $b = 30\ cm$ $\rightarrow$ $b_k = 30 - 9.37 = 20.63\ cm$

$$h_k = \frac{1233}{20{,}63} = 59{,}76\ cm$$

QUINDI $h = h_k + t = 59{,}76 + 9.37 = 69{,}13\ cm$

$\rightarrow$ 30×70

VERIFICA RIGOROSA

$$\frac{V_{Ed}}{\nu f_{cd} b z \frac{\cot\vartheta}{1+\cot^2\vartheta}} + \frac{T_{Ed}}{\nu f_{cd} t 2A_k \frac{\cot\vartheta}{1+\cot^2\vartheta}} = 1$$

$$t = \max\left\{2c; \frac{30\times 70}{2\times 100}\right\} = 10{,}5\ cm$$

$$b_k = 30 - 10{,}5 = 19{,}5\ cm$$

$$h_k = 70 - 10{,}5 = 59{,}5\ cm$$

$$A_k = b_k h_k = 19{,}5 \times 59{,}5 = 1160\ cm^2$$

$$u_k = 2\times(19{,}5+59{,}5) = 158\ cm$$

TORSIONE

$$T_{Rd\,max} = \underbrace{0{,}5}_{10^3} \times 17 \frac{N}{mm^2} \times 10{,}5\,cm \times 2 \times 1160\,cm^2 \times \frac{2{,}5}{1+2{,}5^2}$$

$$T_{Rd\,max} = 207{,}06 \cdot \frac{2{,}5}{1+2{,}5^2} = 71{,}6 \quad kNm$$

TAGLIO

$$V_{Rd,max} = \underbrace{0{,}5}_{10} \times 17 \frac{N}{mm^2} \times 30\,cm \times 0{,}9 \times \underbrace{66\,cm}_{h-c} \times \frac{2{,}5}{1+2{,}5^2}$$

$$= 2515 \times \frac{2{,}5}{1+2{,}5^2} = 522{,}3\ kN$$

COMBINATA

$$\frac{67{,}72}{71{,}6} + \frac{79{,}84}{522{,}3} = 1{,}08 \rightarrow$$

DEVO RIDURRE COEFF

CERCO $\cot\vartheta_{max}$ PER CUI LA SEZIONE È VERIFICATA

$$\frac{67,72}{207.06 \cdot \frac{\cot\vartheta}{1+\cot^2\vartheta}} + \frac{79,84}{1515 \times \frac{\cot\vartheta}{1+\cot^2\vartheta}} = 1$$

$$0,32 \cdot \frac{(1+\cot^2\vartheta)}{\cot\vartheta} + 0,053 \frac{(1+\cot^2\vartheta)}{\cot\vartheta} = 1$$

$$0,373 + 0.373 \cot^2\vartheta = \cot\vartheta$$

$$\cot^2\vartheta - \underbrace{2,68}_{\frac{1}{0,373}} \cot\vartheta + 1 = 0$$

$$\cot\vartheta = \frac{2,68}{2} \pm \sqrt{\left(\frac{2,68}{2}\right)^2 - 1} = 2,23$$

PROGETTO ARMATURE (INCASTRO)

CONVIENE PREDISPORRE TABELLA

	M	V	T	TOT
$A_{s,INF}$ (cm^2)				
$A_{s,SUP}$ (cm^2)				
$A_{s,p}$ (cm^2 PER LATO)				
A_{st} (cm^2/m)				

$\cot\vartheta = 2$

ARMATURA A FLESSIONE

$$A_{s,sup} = \frac{M_{Ed}}{0{,}9\, d\, f_{yd}} = \frac{160\ kNm}{0{,}9 \times 0{,}66\ m \times 391{,}3\ \frac{N}{mm^2}} \times 10$$

$$= 6.88\ cm^2$$

A_{INF}: VALUTO $M_{Rd,\ A'_s=0} = \frac{b \cdot d^2}{\chi^2} =$

$$= \frac{0{,}30 \times 0{,}66^2}{0{,}018^2} = 403\ kNm$$

$$M_{Ed} < M_{Rd,\ A'_s=0} \Longrightarrow A'_s = 0$$

ARMATURA A TAGLIO

$$V_{Rd,st} = n_b \frac{A_{st}}{s} f_{yd} z \cot\vartheta \qquad \cot\vartheta = 2$$

$V_{Rd,st} = V_{Ed}$

$s = 100$ (ARMATURA AL m)

$$A_{st} = \frac{79.84\,kN \cdot 100\,cm \times 10}{2 \cdot 391.3\,\frac{N}{mm^2} \times 0.9 \times 66\,cm \times 2}$$

n_b — $\cot\vartheta$

$$= 0.85\,cm^2/m$$

$$A_{sp} = \frac{V}{2} \frac{\cot\vartheta}{f_{yd}} = \frac{79.84\,kN \times 2}{2 \times 391.3\,\frac{N}{mm^2}} \times 10$$

$$= 2.04\,cm^2 \quad \text{TOTALI}$$

SUL SINGOLO LATO

$2.04/2 \rightarrow 1.02$

ARMATURA PER TORSIONE

STAFFE

$$T_{Rd,st} = \frac{A_{st}}{s} f_{yd} \cdot 2A_k \cot\vartheta$$

$T_{Rd,st} = T_{Ed}$

$s = 100\ cm \Longrightarrow$

$$A_{st} = \frac{67{,}72\ kNm \times 100\ cm \times 10^3}{391{,}3\ \frac{N}{mm^2} \times 2 \times 1160\ cm^2 \times 2}$$

$$= 3{,}73\ cm^2/m$$

LONGITUDINALE

$$T_{Rd,sl} = \frac{A_{sl}}{u_k} \cdot f_{yd} \cdot 2A_k \frac{1}{\cot\vartheta}$$

$T_{Rd,sl} = T_{Ed}$

$$A_{sl} = \frac{67{,}72\ kNm \times 158\ cm \times 2 \times 10^3}{391{,}3\ \frac{N}{mm^2} \times 2 \times 1160\ cm^2}$$

$$= 23{,}57\ cm^2$$

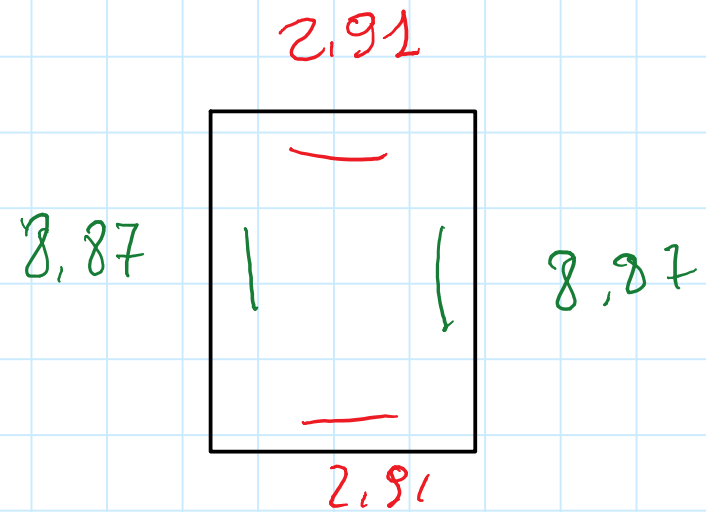
RIPARTIZIONE A_{se} SUL QUATTRO LATI

SUL LATO LUNGO

$$A_{s\,sup} = \frac{A_{se} \cdot h_k}{u_k} = \frac{23{,}57 \times 59{,}5\ cm}{158\ cm} = 8.87\ cm^2$$

SUL LATO CORTO

$$A_{s\,inf} = A_{s\,sup} = \frac{A_{se} \cdot b_k}{u_k} = \frac{23{,}57 \times 19.5}{158} = 2.91\ cm^2$$



ARMATURE NECESSARIE

	M	V	T	TOTALE
$A_{s,INF}$	0,0	//	2,91	2,91
$A_{s,sup}$	6,88 cm^2	//	2,91	9,79
$A_{s,p}$ (Pelo)	//	1,02	8,87	9,89
A_{st} $\frac{cm^2}{m}$	//	0,85	3,73	4,58 $\frac{cm^2}{m}$

STAFFE: SE USO $\phi 8 \Rightarrow A_{\phi 8} = 0,5\ cm^2$

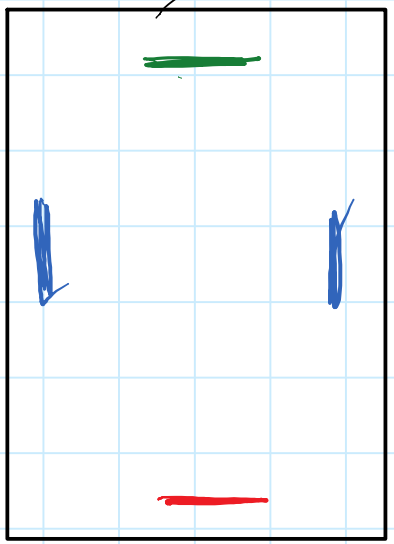
$$\frac{\text{NUMERO STAFFE}}{m} \times A_{\phi 8} = 4,58\ \frac{cm^2}{m}$$

$$\frac{\text{NUMERO STAFFE}}{m} = \frac{4,58}{0,5} = 9,13 \text{ STAFFE}$$

$\Rightarrow \phi 8/10$

DISPOSIZIONE ARMATURE

9,79 cm² → 4φ20



9,89 cm² → 4φ20

2,91 cm² → 1φ20

SE USO φ20

A = 3.14 cm² ⇒