ISTITUTO AUTONOMO CASE POPOLARI - BRINDISI -

LEGGE 5-8-1978 n°457 : COSTRUZIONE DI n. 60 ALLOGGI POPOLARI IN FRANCAVILLA FONTANA - PIANO DI ZONA 167.

- CALCOLI STATICI -

ANALISI DEI CARICHI:

- SOLAIO ULTIMO PIANO - $s=(20+5)$ cm

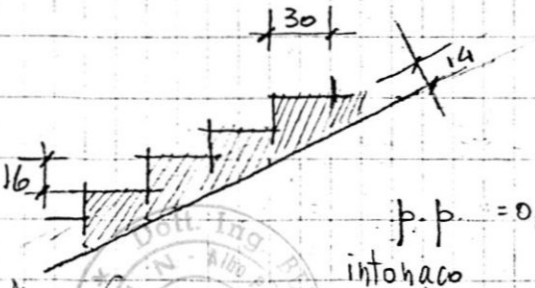
p.p	=	295,00 kg/mq
intonaco (cm 1,5)	=	30,00 "
impermeabilizzazione	=	75,00 "
sovraccarico	=	150,00 "
totale		550,00 kg/mq

- SOLAIO PIANO RIALZATO + PIANO TIPO $s=(20+5)$ cm

p.p	=	295,00 kg/mq
intonaco (cm 1,5)	=	30,00 "
pavimentazione	=	75,00 "
tramezzi	=	100,00 "
sovraccarico	=	250,00 "
totale		750,00 kg/mq

- BALCONI $s=(20+5)$ cm

p.p	=	295,00 kg/mq
pavimentazione	=	60,00 "
intonaco	=	45,00 "
sovraccarico	=	400,00 "
totale		800,00 kg/mq.



- SCALA

p.p. $= 0,22 \times 1,00 \times 1,00 \times 2500$	=	550,00 kg/mq
intonaco	=	40,00 "
rivestimento	=	80,00 "
sovraccarico	=	400,00 "
totale		1070,00 kg/mq

UFFICIO DEL CONTO CIVICO - BRINDISI
Si attesta che copia del presente atto risulta depositato presso questo Ufficio ai sensi della legge ... 9 GEN. 1985 ... D'UFFICIO Ing. Francesco Santostasi
Dott. Ing. BERNARDO COSTANTINO N. 1906 Albo Prov. Ingegneri di Brindisi

- MURATURA ($s = 40\,cm$; $h = 2{,}75\,m$) $\simeq 1000{,}00\ Kg/ml$ -

- PARAPETTO ($s = 20\,cm$) $\simeq 200{,}00\ Kg/ml$

- MATERIALI -

a) CALCESTRUZZO : CLASSE 250

$$\bar{\sigma}_c = 60 + \frac{R_{bk} - 150}{4} = 85\ Kg/cmq \quad \text{- travi -}$$

$$\bar{\sigma}_c = 0{,}7\left[60 + \frac{R_{bk} - 150}{4}\right] = 59{,}5\ Kg/cmq \quad \text{- pilastri -}$$

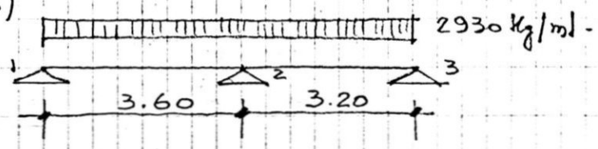
$$\bar{\tau}_{co} = 4 + \frac{R_{bk} - 150}{75} = 5{,}33\ Kg/cmq \quad \text{- tensione amm. nel conglomerato}$$

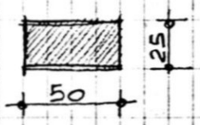
senza richiesta di verifica al taglio o alla torsione -

b) ACCIAIO : Fe B 38 k $\quad k_f = 2200{,}00\ Kg/cmq$ -

PIANO TIPO

TRAVI (1-2-3) - (4-5-6)





p.p. $= 0{,}50 \times 0{,}25 \times 1{,}00 \times 2500 \simeq 315{,}00\ Kg/ml$ -

muratura $= \simeq 1000{,}00$ "

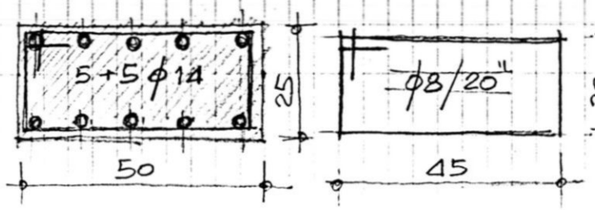
solaio $750 \times \overline{4{,}30}/2 \simeq 1615{,}00$ "

totale $2930{,}00\ Kg/ml$ -

$$M = \frac{q l^2}{11} = 2930 \times \frac{\overline{3{,}60}^2}{11} = 3450\ Kgm$$

$$\sqrt{M/b} = \sqrt{\frac{3450}{0{,}50}} = 83{,}09\ ; \quad c_n = \frac{22}{83{,}09} = 0{,}265 \quad \xrightarrow[A_f = A'_f]{k_f = 2200} \sigma_c \simeq 65\ Kg/cmq$$

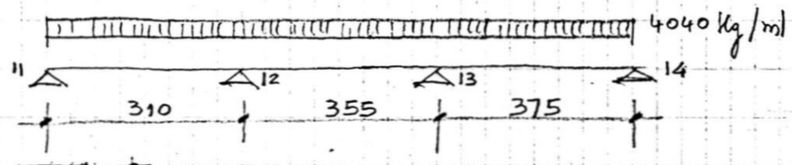
$A_f = A'_f = 0{,}00189 \times 83{,}09 \times 50 = 7{,}85\ cm^2$; $\boxed{5+5\,\phi 14} = 7{,}70\ cm^2$; staffe $\phi 8$ a 2br/20" -

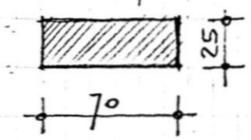


$$R_{1/2} = R_{2/1} = 2930 \times \frac{\overline{3{,}60}}{2} = 5275\ Kg$$

$$R_{2/3} = R_{3/2} = 2930 \times \frac{\overline{3{,}20}}{2} = 4690\ Kg$$

TRAVI (11-12-13-14) - (15-16-17-18)





p.p. $= 0{,}70 \times 0{,}25 \times 1{,}00 \times 2500 = 440{,}00\ Kg/ml$

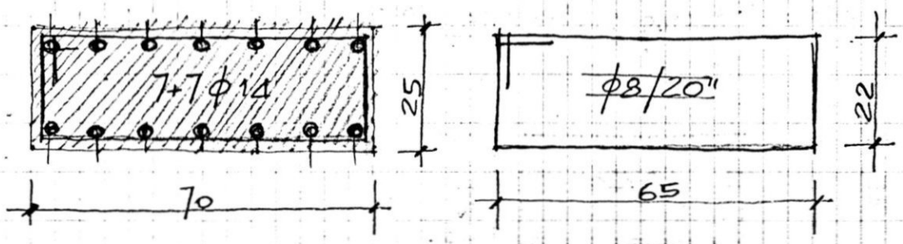
solaio $= 750 \times \frac{4{,}30 + 5{,}30}{2} = 3600{,}00$ "

totale $4040{,}00\ Kg/ml$

$$M = \frac{q l^2}{11} = 4040 \times \frac{\overline{3{,}75}^2}{11} = 5164\ Kgm$$

$$\sqrt{\frac{M}{b}} = \sqrt{\frac{5164}{0{,}70}} = 85{,}89\ ; \quad c_n = \frac{22}{85{,}89} = 0{,}256 \quad \xrightarrow[A_f = A'_f]{k_f = 2200} \sigma_c \simeq 67\ Kg/cmq$$

$A_f = A'_f = 0{,}00194 \times 85{,}89 \times 70 = 11{,}66\ cm^2$; $\boxed{7+7\,\phi 14} = 10{,}78\ cm^2$; staffe $\phi 8$ a 2br/20" -

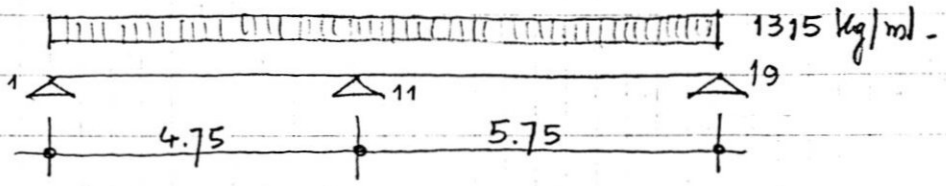


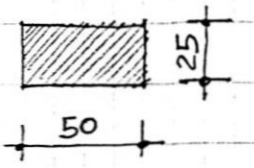
$$R_{11/12} = R_{12/11} = 4040 \times \frac{\overline{3{,}10}}{2} = 6260\ Kg$$

$$R_{12/13} = R_{13/12} = 4040 \times \frac{\overline{3{,}55}}{2} = 7170\ Kg$$

$$R_{13/14} = R_{14/13} = 4040 \times \frac{\overline{3{,}75}}{2} = 7575\ Kg$$

TRAVI (1-11-19) - (6-18-26)





p.p muratura $= 0{,}50 \times 0{,}25 \times 1{,}00 \times 2500 = 315{,}00$ kg/ml

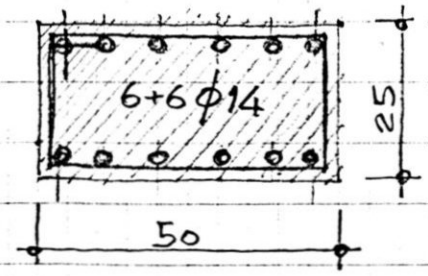
$= 1000{,}00$ "

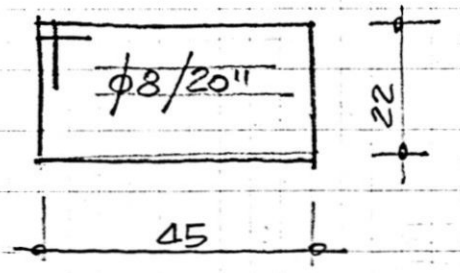
totale $1315{,}00$ kg/ml

$$M = \frac{ql^2}{11} = 1315 \times \frac{\overline{5.75}^2}{11} = 3959 \text{ kgm}$$

$$\sqrt{\frac{M}{b}} = \sqrt{\frac{3959}{0{,}50}} = 88.90 \; ; \; c_h = \frac{22}{88.90} = 0{,}247 \xrightarrow[A_f = A'_f]{k_f = 2200} \sigma_c \cong 68 \text{ kg/cmq}$$

$A_f = A'_f = 0{,}00201 \times 88{,}90 \times 50 = 8{,}93$ cmq ; $\boxed{6+6\,\phi 14} = 9{,}24$ cm^2 ; staffe $\phi 8$ a 2br/20" -

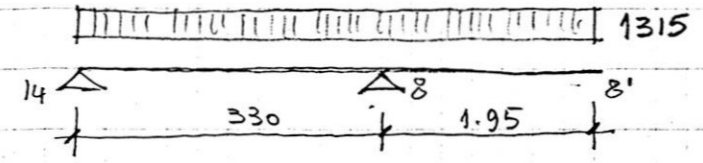


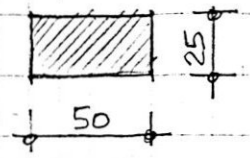


$$R_{1/11} = R_{11/1} = 1315 \times \frac{\overline{4.75}}{2} = 3125 \text{ kg}$$

$$R_{11/19} = R_{19/11} = 1315 \times \frac{\overline{5.75}}{2} = 3780 \text{ kg}$$

TRAVI (14-8-8') - (15-9-9')





p.p. = 0,50 × 0,25 × 1,00 × 2500 = 315,00 kg/ml

muratura = 1000,00 "

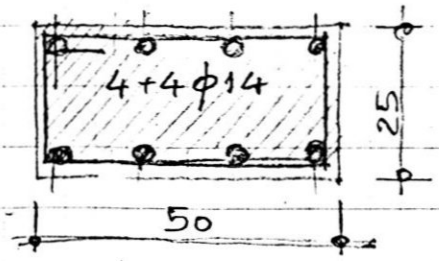
totale 1315,00 kg/ml

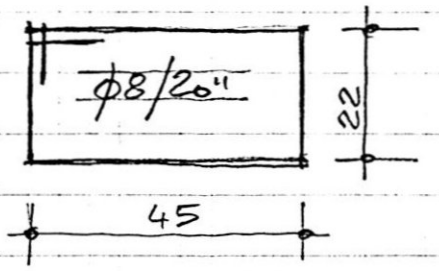
$$M_{max} = 1315 \times \frac{1,95^2}{2} = 2500 \text{ kgm}$$

$$\sqrt{\frac{M}{b}} = \sqrt{\frac{2500}{0,50}} = 70,71 \; ; \; c_h = \frac{22}{70,71} = 0,311 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c \simeq 55 \text{ kg/cmq}$$

$$A_f = A'_f = 0,00156 \times 70,71 \times 50 = 5,51 \text{ cmq} \; ; \; \boxed{4+4\phi14} = 6,16 \text{ cmq}$$

In 8': $f = \frac{1}{8} \frac{pl^4}{EJ} = 1,7$ mm

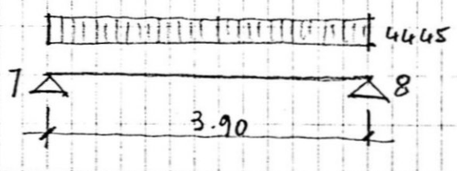


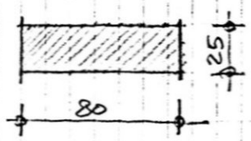


$R_{14/8} = R_{8/14} = 1315 \times 3,30/2 = 2170$ kg

$R_{8/8'} = 1315 \times 1,95 = 2565$ kg

TRAVI (7-8) – (9-10)



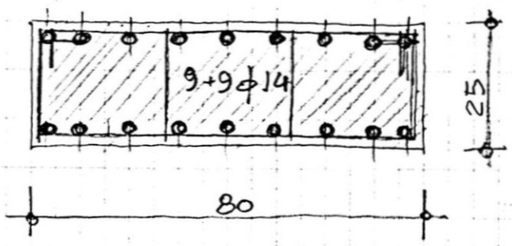


p.p. = 0,80 × 0,25 × 1,00 × 2500 = 500 Kg/ml
muratura = 1000 "
balcone 800 × 2,10 + 200 = 1880 "
solaio 750 × 2,85/2 = 1065 "
totale 4445 Kg/ml

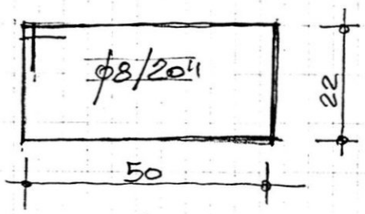
$M = \frac{q l^2}{11} = 4445 \times \frac{3{,}90^2}{11} = 6146$ Kgm

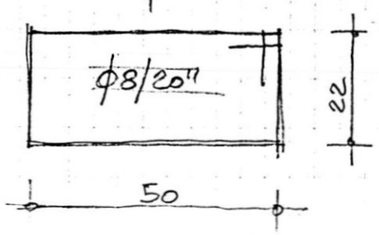
$\sqrt{\frac{M}{b}} = \sqrt{\frac{6146}{0.80}} = 87{,}65$; $c_h = \frac{22}{87.65} = 0{,}251$ $\xrightarrow[A_f = A'_f]{K_f = 2200}$ $\sigma_c = 67{,}5$ Kg/cmq

$A_f = A'_f = 0{,}00198 \times 87.65 \times 80 = 13{,}88$ cmq ; $\boxed{9+9\,\phi 14} = 13{,}85$ cmq

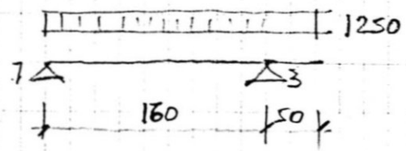


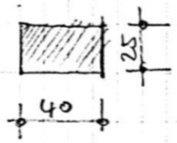
$R_{7/8} = R_{8/7} = 4445 \times \frac{3{,}90}{2} = 8670$ Kg.



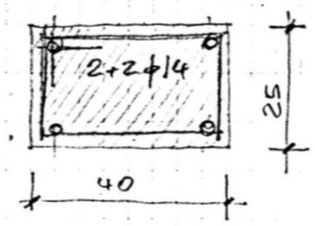


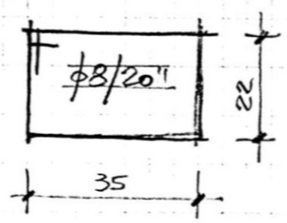
TRAVI (3-7) – (4-10)





p.p = 0,40 × 0,25 × 1,00 × 2500 = 250,00 Kg/ml
muratura = 1000.00 "
totale 1250.00 Kg/ml.

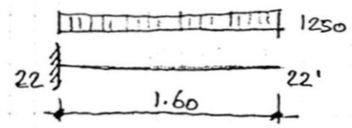


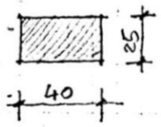


$R_{7/3} = 1250 \times 1{,}60/2 = 1000$ Kg

$R_{3/7} = 1250\left(\frac{1{,}60}{2} + 0{,}50\right) = 1625$ Kg

TRAVI (22-22') – (23-23')



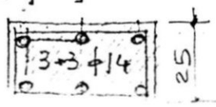


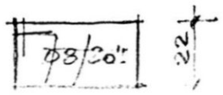
p.p. = 0,40 × 0,25 × 1,00 × 2500 = 250 Kg/ml
muratura = 1000 "
totale 1250 Kg/ml

$M = \frac{q l^2}{2} = 1250 \times \frac{1{,}60^2}{2} = 1600$ Kgm

$\sqrt{\frac{M}{b}} = \sqrt{\frac{1600}{0{,}40}} = 63{,}25$; $c_h = \frac{22}{63{,}25} = 0{,}347$ $\xrightarrow[A_f = A'_f]{K_f = 2200}$ $\sigma_c \cong 50$ Kg/cmq

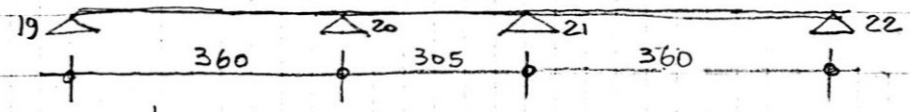
$A_f = A'_f = 0{,}00140 \times 63{,}25 \times 40 = 3{,}54\ cm^2$; $\boxed{3+3\,\phi 14} = 4{,}62$ cmq

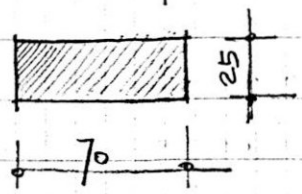




$R_{22/22'} = 1250 \times 1{,}60 = 2000$ Kg.

TRAVI (19-20-21-22) - (23-24-25-26)



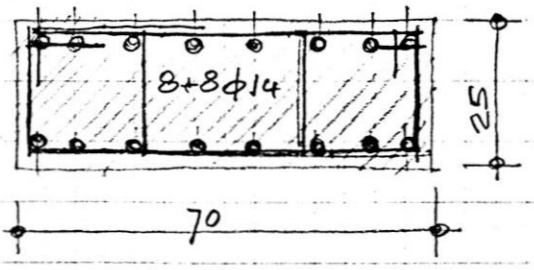


p.p.	$= 0{,}70 \times 0{,}25 \times 1{,}00 \times 2500$	$= 440{,}00$ kg/ml
muratura		$= 1000{,}00$ "
solaio	$= 750 \times \overline{4{,}50}/2$	$= 1690{,}00$ "
balcone	$= 800 \times 2{,}00$	$= 1600{,}00$ "
totale		$4730{,}00$ kg/ml

$$M = \frac{ql^2}{11} = 4730 \times \frac{\overline{3{,}60}^2}{11} = 5572 \text{ kgm}$$

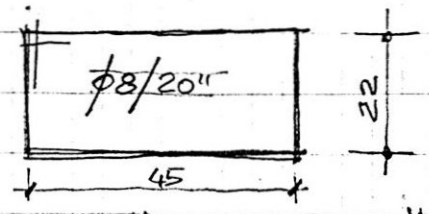
$$\sqrt{\frac{M}{b}} = \sqrt{\frac{5572}{0{,}70}} = 89{,}22 \; ; \; c_h = \frac{22}{89{,}22} = 0{,}246 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 69 \text{ kg/cmq}$$

$$A_f = A'_f = 0{,}00204 \times 89{,}22 \times 70 = 12{,}74 \text{ cmq} \; ; \; \boxed{8+8\phi14} = 12{,}32 \text{ cmq}$$



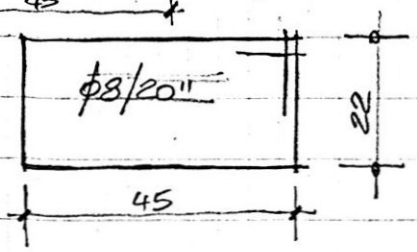
$$R_{19/20} = 4730 \times \frac{\overline{3{,}60}}{2} = 8515 \text{ kg}$$

$$R_{20/19} = \qquad = 8515 \text{ kg}$$



$$R_{20/21} = 4730 \times \frac{\overline{3{,}05}}{2} = 7215 \text{ kg}$$

$$R_{21/20} = \qquad = 7215 \text{ kg}$$

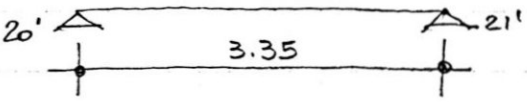


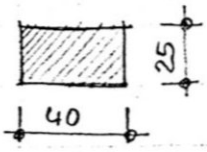
$$R_{21/22} = 4730 \times \frac{\overline{3{,}60}}{2} = 8515 \text{ kg}$$

$$R_{22/21} = \qquad = 8515 \text{ kg}$$

PIANO TIPO

- TRAVI (20'-21') - (24'-25')



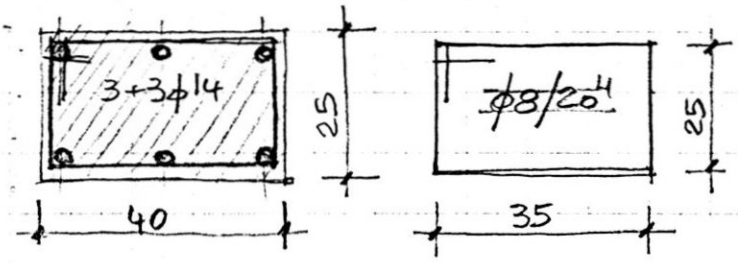


p.p. = 0,40×0,25×1,00×2500 = 250,00 kg/ml
muratura = 1000,00 "
totale 1250,00 kg/ml

$M = \frac{q l^2}{8} = 1250 \times \frac{\overline{3,35}^2}{8} = 1753$ kgm

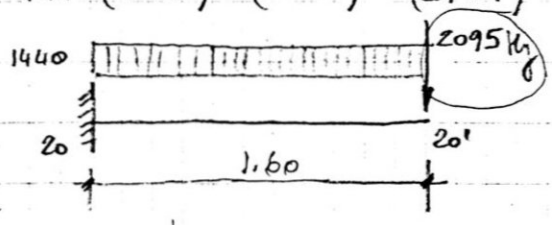
$\sqrt{\frac{M}{b}} = \sqrt{\frac{1753}{0,40}} = 66,21$; $c_h = \frac{22}{66,21} = 0,332 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 52$ kg/cmq

$A_f = A'_f = 0,00150 \times 66,21 \times 40 = 3,97$ cmq ; $\boxed{3+3\phi14} = 4,62$ cmq

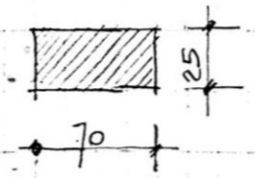


$R_{20'/21'} = R_{21'/20} = 1250 \times \frac{3,35}{2} = 2095$ kg.

- TRAVI (20-20') - (21-21') - (24-24') - (25-25')



$R_{20/20'} = 1440 \times 1,60 + 2095 = 2304 + 2095 = 4400$ kg.

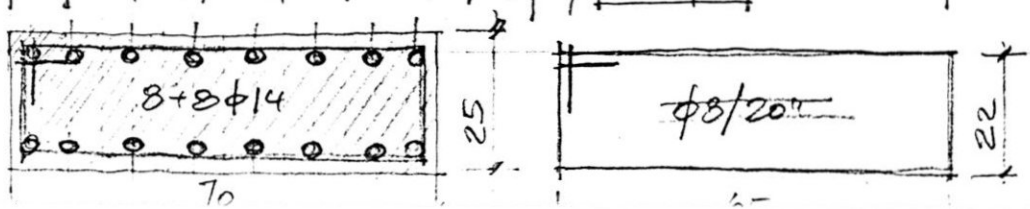


p.p. = 0,70×0,25×1,00×2500 = 440,00 kg/ml.
muratura = 1000,00 "
totale 1440,00 kg/ml

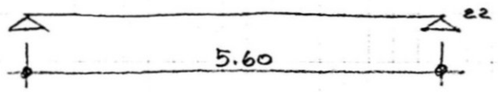
$M = 1440 \times \frac{\overline{1,60}^2}{2} + 2095 \times 1,60 = 1845 + 3350 = 5195$ kgm

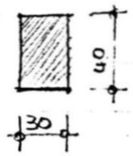
$\sqrt{\frac{M}{b}} = \sqrt{\frac{5195}{0,70}} = 86,14$; $c_h = \frac{22}{86,14} = 0,255 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 67$ kg/cmq

$A_f = A'_f = 0,00197 \times 86,14 \times 70 = 11,87$ cmq ; $\boxed{8+8\phi14} = 12,32$ cmq



TRAVI (14-22) - (15-23)





p.p = 0,30 x 0,40 x 1,00 x 2500 = 300,00 kg/ml

muratura = 1000,00 "

totale 1300,00 kg/ml

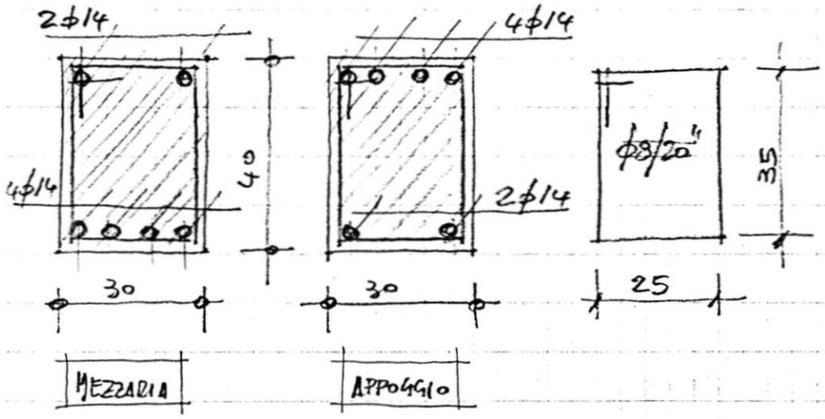
$M = \frac{q l^2}{11} = 1300 \times \frac{\overline{5,60}^2}{11} = 3706$ kgm

$\sqrt{\frac{M}{b}} = \sqrt{\frac{3706}{0,30}} = 111,14$; $c_h = \frac{37}{111,14} = 0,332$ $\xrightarrow[A'_f = 0,50 A_f]{k_f = 2200}$ $\sigma_c = 58$ kg/cmq.

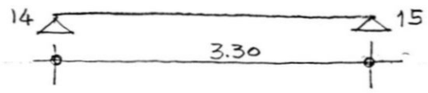
$A_f = 0,00151 \times 111,14 \times 30 = 5,03$ cmq. ; $\boxed{4\phi14} = 6,16$ cmq ; $\boxed{A'_f = 2\phi14}$

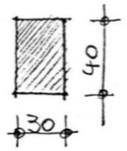
$R_{14/22} = R_{22/14} = 1300 \times \frac{5,60}{2} = 3640$ kg

$\tau_{max} = \frac{T_{max}}{bh_0} = \frac{3640}{30 \times 0,9 \times 37} = 3,64$ kg/cmq $< 5,33$ kg/cmq.



TRAVI (14-15) - (22-23)





p.p = 0,30 x 0,40 x 1,00 x 2500 = 300,00 kg/ml

muratura = 1000,00 "

Scala = 1070 x $\overline{5,30}/2$ = 2835,00 "

totale 4135,00 kg/ml

$M = \frac{q l^2}{11} = 4135 \times \frac{\overline{3,30}^2}{11} = 4093$ kgm

$\sqrt{\frac{M}{b}} = \sqrt{\frac{4093}{0,30}} = 116,81$; $c_h = \frac{37}{116,81} = 0,316$ $\xrightarrow[A'_f = 0,50 A_f]{k_f = 2200}$ $\sigma_c \cong 62$ kg/cmq

$A_f = 0,00160 \times 116,81 \times 30 = 5,60$ cmq ; $\boxed{4\phi14} = 6,16$ cmq ; $\boxed{A'_f = 2\phi14}$

$R_{14/15} = R_{15/14} = 4135 \times \frac{3,30}{2} = 6822$ kg.

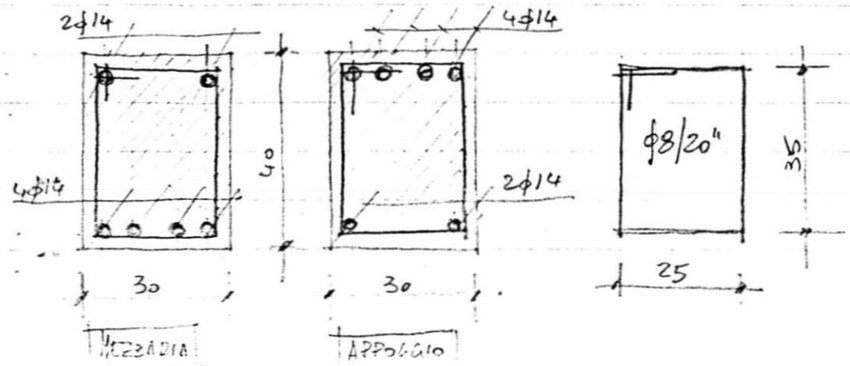
$\tau_{max} = \frac{T}{bh_0} = \frac{6822}{30 \times 0,9 \times 37} = 6,82$ kg/cmq $> 5,33$ kg/cmq.

SCORRIMENTO PER METÀ TRAVE:

$S_T = \frac{T}{h_0} \cdot \frac{l}{4} = \frac{6822 \times 330}{0,9 \times 37 \times 4} = 16900$ kg

Piego 2ϕ14 ; $S_p = \sqrt{2} \cdot f_p \cdot k_f = \sqrt{2} \times 3,08 \times 2200 = 9580$ kg.

$S_s = S_T - S_p = 16.900 - 9580 = 7320$ kg. $\xrightarrow[A_s = 1,01 cm^2]{\phi8 \text{ a } 2br}$ $s = \frac{S_s}{k_f A_s} = \frac{7320}{2200 \times 1,01} \cong 3$



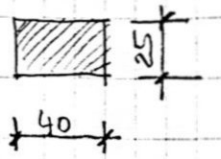
RIEPILOGO CARICHI SUI PILASTRI

PIANO TIPO

PILASTRI				
1-6	$R_{1/2} + R_{1/11}$	= 5275 + 3125	= 8400	kg
2-5	$R_{2/1} + R_{2/3}$	= 5275 + 4690	= 9965	"
3-4	$R_{3/2} + R_{3/7}$	= 4690 + 1625	= 6315	"
7-10	$R_{7/3} + R_{7/8}$	= 1000 + 8670	= 9670	"
8-9	$R_{8/7} + R_{8/8'} + R_{8/14}$	= 8670 + 2565 + 2170	= 13.405	"
11-18	$R_{11/1} + R_{11/12} + R_{11/19}$	= 3125 + 6260 + 3780	= 13.165	"
12-17	$R_{12/11} + R_{12/13}$	= 6260 + 7170	= 13.430	"
13-16	$R_{13/12} + R_{13/14}$	= 7170 + 7575	= 14.745	"
14-15	$R_{14/13} + R_{14/8} + R_{14/15} + R_{14/22}$	= 7575 + 2170 + 6820 + 3640	= 20.205	"
19-26	$R_{19/11} + R_{19/20}$	= 3780 + 8515	= 12.295	"
20-25	$R_{20/19} + R_{20/20'} + R_{20/21}$	= 8515 + 2095 + 7215	= 17825	"
21-24	$R_{21/20} + R_{21/21'} + R_{21/22}$	= 7215 + 2095 + 8515	= 17.825	"
22-23	$R_{22/21} + R_{22/22'} + R_{22/23} + R_{22/14}$	= 8515 + 2000 + 6820 + 3640	= 20.975	"

- PIANO COPERTURA -

Trav (1-2-3) - (4-5-6)

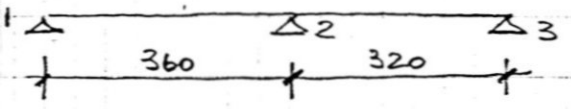


p.p = 0,25 × 0,40 × 1,00 × 2500	=	250,00 kg/ml
muratura	=	200,00 "
solaio 550 × 4,30/2	=	1180,00 "
		1630,00 kg/ml

$M = \frac{ql^2}{11} = 1630 \times \frac{\overline{3,60}^2}{11} = 1920$ kgm ;

$\sqrt{\frac{M}{b}} = \sqrt{\frac{1920}{0,40}} = 69,29$; $c_h = \frac{22}{69,29} = 0,317 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 55$ kg/cmq

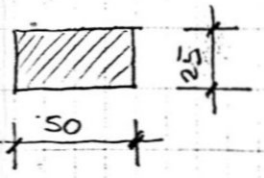
$A_f = A'_f = 0,00156 \times 69,29 \times 40 = 4,32$ cmq $\rightarrow$ $\boxed{4+4\,\phi 12} = 4,52$ cmq - - staffe $\phi 8$ a 2br/20"



$R_{1/2} = R_{2/1} = 1630 \times \overline{3,60}/2 = 2935$ kg

$R_{2/3} = R_{3/2} = 1630 \times \overline{3,20}/2 = 2610$ kg -

TRAVI (11-12-13-14) - (15-16-17-18)



p.p. = 0,25 × 0,50 × 1,00 × 2500	=	312,00 kg/ml
solaio = 550 × (4,30 + 5,30)/2	=	2640,00 "
		2952,00 kg/ml

$M = \frac{ql^2}{11} = 2952 \times \frac{\overline{3,75}^2}{11} = 3773$ kgm ; $\sqrt{\frac{M}{b}} = \sqrt{\frac{3773}{0,50}} = 86,87$

$c_h = \frac{22}{86,87} = 0,253 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 67,5$ kg/cm² ; $A_f = A'_f = 0,00198 \times 86,87 \times 50 = 8,60$ cm²

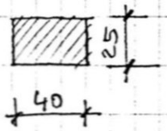
$\boxed{5+5\,\phi 16} = 10,05$ cm² - staffe $\phi 8$ a 2br/20"

$R_{11/12} = R_{12/11} = 2952 \times \overline{3,10}/2 = 4575$ Kg

$R_{12/13} = R_{13/12} = 2952 \times \overline{3,55}/2 = 5240$ Kg

$R_{13/14} = R_{14/13} = 2952 \times \overline{3,75}/2 = 5535$ Kg

TRAVI (1-11-19) - (6-18-26)



p.p = 0,40 x 0,25 x 1,00 x 2500 = 250,00 Kg/ml
parametro = 200.00 "
450,00 Kg/ml

$M = \frac{q l^2}{11} = 450 \times \frac{\overline{5,75}^2}{11} = 1352$ Kgm ; $\sqrt{\frac{M}{b}} = \sqrt{\frac{1352}{0,40}} = 58,15$

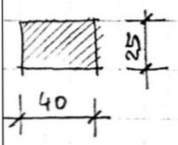
$c_h = \frac{22}{58,15} = 0,378 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 48$ Kg/cmq

$A_f = A'_f = 0,00132 \times 58,15 \times 40 = 3,07\ cm^2$; $\boxed{4+4\ \phi 12} = 4,52\ cm^2$ - staffe $\phi 8$ a 26v/20" -

$R_{1/11} = R_{11/1} = 450 \times \overline{4,75}/2 = 1070$ Kg

$R_{11/19} = R_{19/11} = 450 \times \overline{5,75}/2 = 1295$ Kg

TRAVI (8-14) - (9-15)



p.p = 0,40 x 0,25 x 1,00 x 2500 = 250,00 Kg/ml
muratura = 1000,00 "
1250,00 Kg/ml

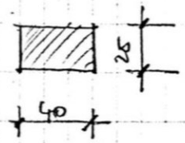
$M = \frac{q l^2}{11} = 1250 \times \frac{\overline{3,30}^2}{11} = 1237$ Kgm

$\sqrt{M/b} = \sqrt{\frac{1237}{0,40}} = 55,62$; $c_h = \frac{22}{55,62} = 0,395 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 45$ Kg/cmq

$A_f = A'_f = 0,00124 \times 55,62 \times 40 = 2,75\ cm^2$; $\boxed{4+4\ \phi 12} = 4,52\ cm^2$ - staffe $\phi 8$ a 26v/20" -

$R_{8-14} = R_{14/8} = 1250 \times \overline{3,30}/2 = 2065$ Kg

TRAVE (8-9)



p.p = 0,40 x 0,25 x 1,00 x 2500 = 250,00 Kg/ml
muratura = 1000,00 "
solaio = 650 x 2,85/2 = 925,00 "
2175,00 Kg/ml

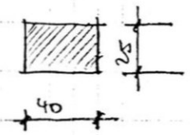
$M = \frac{q l^2}{11} = 2175 \times \frac{\overline{3,10}^2}{11} = 1900$ Kgm ; $\sqrt{M/b} = \sqrt{\frac{1900}{0,40}} = 68.92$

$c_h = \frac{22}{68,92} = 0,319 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 55$ Kg/cmq

$A_f = A'_f = 0,00156 \times 68,92 \times 40 = 4,30\ cm^2$; $4+4\ \phi 12 = 4,52\ cm^2$; staffe $\phi 8$ a 26v/20" -

$R_{8/9} = R_{9/8} = 2175,00 \times \overline{3,10}/2 = 3370$ Kg.

TRAVI (7-8) - (9-10)



p.p = 0,40 x 0,25 x 1,00 x 2500 = 250,00 Kg/ml
solaio = 550 x $\overline{4,30}$/2 = 1180,00 "
muratura = 200,00 "
1630,00 Kg/ml

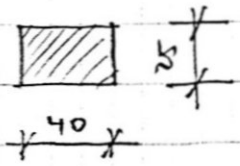
$M = \frac{q l^2}{11} = 1630 \times \frac{\overline{3,75}^2}{11} = 2083$ Kgm ; $\sqrt{\frac{M}{b}} = \sqrt{\frac{2083}{0,40}} = 72,17$

$c_h = \frac{22}{72,17} = 0,304 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 57,5$ Kg/cm²

$A_f = A'_f = 0,00164 \times 72,17 \times 40 = 4,73\ cm^2 \rightarrow \boxed{4+4\ \phi 12} = 4,52\ cm^2$ - staffe $\phi 8$ a 26v/20"

$R_{8/7} = R_{7/8} = 1630 \times \overline{3,75}/2 = 3056$ Kg.

TRAVI (4-10) - (3-7)

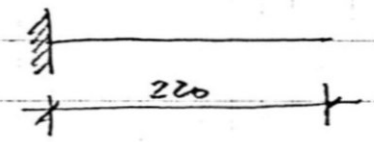


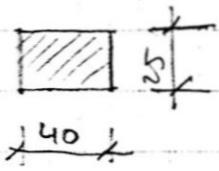
p.p = 250 Kg/ml
muratura = 200 "
450 Kg/ml

$\boxed{4+4\phi12}$ - staffe $\phi8$ a 2bracci/20"

$R_{4/10} = R_{10/4} = 450 \times \overline{2,10}/2 = 470$ Kg -

TRAVI (8-8') - (9-9')





p.p. = 250,00 Kg/ml
muratura = 200,00 "
450,00 Kg/ml

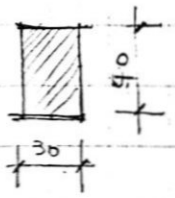
$M = \frac{p l^2}{2} = 450 \times \frac{\overline{2,20}^2}{2} = 1089$ Kgm -

$\sqrt{\frac{M}{b}} = \sqrt{1089/0,40} = 52,17$; $C_h = \frac{22}{52,17} = 0,421$; $\xrightarrow[A_f = A'_f]{k_f = 2200} \sigma_c = 42,5$ Kg/cm²

$A_f = A'_f = 0,00117 \times 52,17 \times 40 = 2,44$ cm² ; $\boxed{4+4\phi12}$ - staffe $\phi8$ a 2br/20" -

$R_{8/8'} = 450 \times \overline{2,20}/2 = 495$ Kg -

TRAVE 14-15 -



p.p = 300,00 Kg/ml
muratura = 1000,00 "
Scala $1070 \times \overline{5,30}/2$ = 2835,00 "
solaio $650 \times \frac{2,85}{2}$ = 925,00 "
5060,00 Kg/ml

$M = \frac{pl^2}{11} = 5060 \times \frac{3{,}30^2}{11} = 5009\ Kgm$; $\sqrt{\frac{M}{b}} = \sqrt{\frac{5009}{0{,}30}} = 129{,}22$

$c_h = \frac{37}{129{,}22} = 0{,}286 \xrightarrow[A'_f = 0{,}5 A_f]{k_f = 2200} = \sigma_c = 65 \div 70\ Kg/cm^2$

$A_f = 0{,}00173 \times 129{,}22 \times 30 = 6{,}70\ cm^2 \rightarrow \boxed{6\ \phi 12} = 6{,}79\ cm^2$

$A'_f = \boxed{3\phi 12}$

Scorrimento per metà trave -

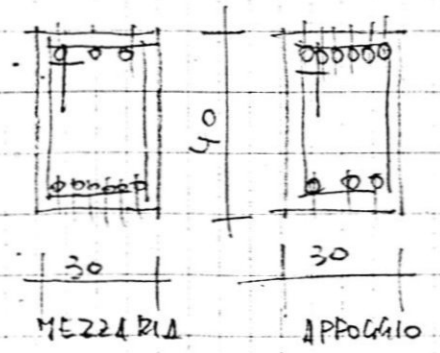
$R_{14/15} = R_{15/14} = 5060 \times 3{,}30/2 = 8350\ Kg$ - $S_T = \frac{T}{h_0} \cdot \frac{l}{4} = \frac{8350}{0{,}9 \times 37} \times \frac{3{,}30}{4} = 20686\ Kg$

$\tau_{max} = \frac{T_{max}}{b z_0} = \frac{8350}{30 \times 0{,}9 \times 37} = 8{,}36\ Kg/cm^2 > 5{,}33\ Kg/cm^2$

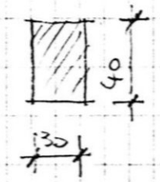
piegh. $3\phi 12 \rightarrow (f_p = 3{,}39\ cm^2) \rightarrow S_p = \sqrt{2} \times f_p \times k_f = \sqrt{2} \times 3{,}39 \times 2200 = 10515\ Kg$

$S_s = S_T - S_p = 20686 - 10515 = 10171\ Kg$

Uso staffe $\phi 8$ a 2br ($A_s = 1{,}01\ cm^2$) $\rightarrow s = \frac{S_s}{k_f} = \frac{10171}{2200} \cong 5$ (uso staffe $\phi 8$ a 2br/20") -



TRAVI (14-22) - (15-23)



p.p. = 300,00 Kg/ml -

muratura = 1000,00 "

solaio = 550 x 2,70/2 = 750,00 "

2050,00 Kg/ml -

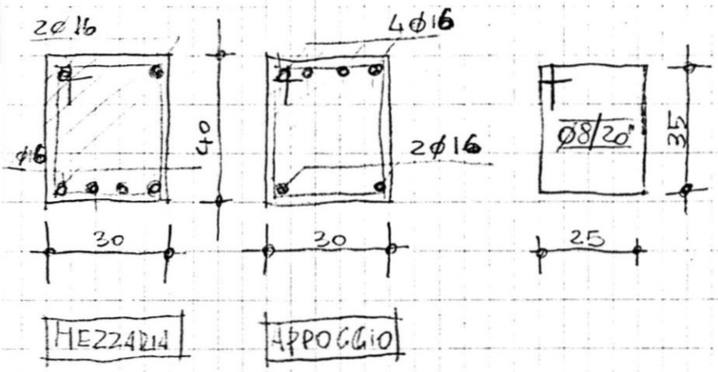
$M = \frac{pl^2}{11} = \frac{2050 \times 5{,}60^2}{11} = 5844$ Kgm -

$\sqrt{\frac{M}{b}} = \sqrt{\frac{5844}{0{,}30}} = 139{,}57$; $c_h = \frac{37}{139{,}57} = 0{,}265$ $\xrightarrow[A'_f = 0{,}5A_f]{K_f = 2200}$ $\sigma_c \cong 75$ Kg/cmq ;

$A_f = 0{,}00193 \times 139{,}57 \times 30 = 8{,}08$ cm² ; $\boxed{14\phi16} = 8{,}04$ cm² ; $A'_f = 2\phi16$

$R_{14/22} = R_{22/14} = 2050 \times 5{,}60/2 = 5740$ Kg

$\tau_{max} = \frac{T_{max}}{bh_0} = \frac{5740}{30 \times 0{,}37} = 5{,}75$ Kg/cmq > 5.33 Kg/cmq.



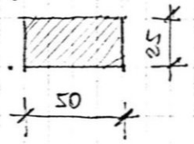
SCORRIMENTO TOTALE / METÀ TRAVE $S_T = \frac{T}{h_0} \cdot \frac{l}{4} = \frac{5740}{0{,}9 \times 37} \times \frac{560}{4} = 24132$ Kg

Pieg. 2ø16 ($\phi_p = 4{,}02$ cm²) ; $S_p = \sqrt{2} \times \phi_p \times K_f = \sqrt{2} \times 4{,}02 \times 2200 = 12470$ Kg

$S_s = S_T - S_p = 24132 - 12470 = 11.662$ Kg

Uso staffe ø8 a 2br ($A_s = 1{,}01$ cm²) → $s = \frac{S_s}{K_f} = \frac{11.662}{2200} \cong 6$ (staffe ø8 a 2br/20") -

TRAVI (19-20-21-22) - (23-24-25-26)



p.p = 0,50 x 0,25 x 1,00 x 2500 = 312,00 Kg/ml -

solaio = 550 x (5,30/2 + 1,30) = 2172,00 "

muratura = 200,00 "

2685,00 Kg/ml

$M = \frac{pl^2}{11} = \frac{2685 \times 3{,}60^2}{11} = 3163$ Kgm ; $\sqrt{M/b} = \sqrt{\frac{3163}{0{,}50}} = 79{,}54$

$c_h = \frac{22}{79{,}54} = 0{,}276$ $\xrightarrow[A_f = A'_f]{K_f = 2200}$ $\sigma_c = 63$ Kg/cmq

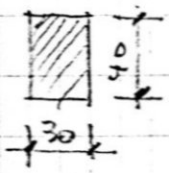
$A_f = A'_f = 0{,}00120 \times 79{,}54 \times 50 = 7{,}15$ cm² → $\boxed{4+4\phi16} = 8{,}04$ cm²

$R_{19/20} = R_{20/19} = 2685 \times 3{,}60/2 = 4835$ Kg

$R_{20/21} = R_{21/20} = 2685 \times 3{,}05/2 = 4093$ Kg

$R_{21/22} = R_{22/21} = 2685 \times 3{,}60/2 = 4835$ Kg

TRAVE 22-23



p.p = 300,00 Kg/ml -
muratura = 1000,00 "
1300,00 Kg/ml -

$M = \frac{pl^2}{11} = \frac{1300 \times 3{,}30^2}{11} = 1287$ Kgm ; $\sqrt{M/b} = 65{,}49$

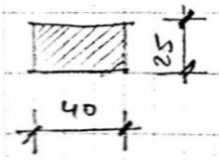
$c_h = \frac{37}{65{,}49} = 0{,}565 \xrightarrow[A'_f = 0{,}5A_f]{K_f = 2200} \sigma_c < 40$ Kg/cm² -

$A_f = 0{,}00103 \times 65{,}49 \times 30 = 2{,}02$; Uso $A_f = 4\phi12$ (staffe $\phi 3a\ 26x/20''$) -
$A'_f = 2\phi12$

$R_{22/23} = R_{23/22} = 1300 \times 3{,}30/2 = 2145$ Kg -

— COPERTURA SALA MACCHINE —

TRAVI (8-9) - (14-15) - (8-14) - (9-15)



pp = 250,00 Kg/ml
solaio = 550 × 2,70/2 = 745,00 "
muratura = 200,00 "
1195,00 Kg/ml

$M = \frac{pl^2}{11} = 1195 \times \frac{3{,}45^2}{11} = 1295$ Kgm - $\sqrt{M/b} = \sqrt{\frac{1295}{0{,}40}} = 56{,}90$

$c_h = \frac{22}{56{,}90} = 0{,}386 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c = 46$ Kg/cm²

$A_f = A'_f = 0{,}00130 \times 56{,}90 \times 40 = 2{,}95$ cm² → $\boxed{3+3\phi12} = 3{,}39$ cm² - (staffe $\phi 3a\ 26x/20''$)

$R_{8/9} = R_{9/8} = R_{14/15} = R_{15/14} = R_{8/14} = R_{14/8} = R_{9/15} = R_{15/9} = 1195 \times 3{,}45/2 = 2060$ Kg -

CALCOLO PILASTRI

	QUOTA -4-			QUOTA -4-			QUOTA -3-			QUOTA -3-		
PILASTRO	P (Kg)	Aci (cm²)	Afi	AR	AfR	STAFFE	P	Aci	Afi	AR	AfR	STAFFE
1-6	4605	77	[illegible]	30x30	4ϕ12	ϕ6/18"	13605	228	1,37	30x30	4ϕ12	ϕ6/18"
2-5	6145	103	[illegible]	30x30	4ϕ12	ϕ6/18"	16710	280	1,68	30x30	4ϕ12	"
3-4	3680	61	[illegible]	30x30	4ϕ12	ϕ6/18"	10595	178	1,06	30x30	4ϕ12	"
7-10	4126	69	[illegible]	30x30	"	"	14396	242	1,45	30x30	4ϕ12	"
8-9	13706	230	[illegible]	30x30	"	"	27711	465	2,79	"	4ϕ12	"
11-18	7540	127	[illegible]	"	"	"	21305	358	2,15	"	4ϕ12	"
12-17	10415	175	[illegible]	"	"	"	24445	411	2,46	"	4ϕ12	"
13-16	11375	191	[illegible]	"	"	"	26720	449	2,69	"	4ϕ12	"
14-15	26410	444	[illegible]	"	"	"	47215	793	4,76	"	4ϕ12	ϕ6/18"
19-26	6730	113	[illegible]	"	"	"	19625	329	1,97	"	4ϕ12	ϕ6/18"
20-25	9530	160	[illegible]	"	"	"	27955	470	2,82	"	4ϕ12	ϕ6/21"
21-24	9530	160	[illegible]	"	"	"	27955	470	2,82	"	4ϕ12	"
22-23	13320	223	[illegible]	"	"	"	34895	[illegible]	[illegible]	"	4ϕ12	"

	QUOTA -2-			QUOTA -2-			QUOTA -1-			QUOTA -1-			O
PILASTRO	P	Aci	Afi	AR	AfR	STAFFE	P	Aci	Afi	AR	AfR	STAFFE	
1-6	22605	380	2,28	30x30	4ϕ12	ϕ6/18"	31605	531	3,19	30x30	4ϕ12	ϕ6/18"	40605
2-5	27.275	458	2,75	30x30	4ϕ12	"	37840	636	3,81	30x30	"	"	48405
3-4	17.510	294	1,76	30x30	4ϕ12	"	24.425	410	2,46	30x30	"	"	31340
7-10	24666	414	2,48	30x30	4ϕ12	"	34936	587	3,52	30x30	"	"	45206
8-9	41716	701	4,20	30x30	4ϕ12	"	55721	936	5,61	30x40	4ϕ14	ϕ6/21"	69726
11-18	35070	589	3,54	30x30	"	"	48835	820	4,92	30x30	4ϕ14	"	62600
12-17	38475	646	3,88	30x30	"	"	52505	882	5,29	30x30	4ϕ14	"	66535
13-16	42065	707	4,24	30x40	"	"	57410	964	5,78	30x40	4ϕ14	"	72755
14-15	68020	1143	6,86	30x40	6ϕ12	"	88825	1492	8,95	30x40	6ϕ14	ϕ6/21"	109630
19-26	32520	546	3,28	30x30	4ϕ12	"	45415	763	4,58	30x30	4ϕ12	ϕ6/18	58310
20-25	46380	779	4,67	30x40	4ϕ12	"	64805	1089	6,53	30x40	6ϕ12	"	83230
21-24	46380	779	4,67	30x40	4ϕ12	"	64805	1089	6,53	30x40	6ϕ12	"	83230
22-23	56470	949	5,69	30x40	6ϕ12	"	78045	1311	7,87	30x40	6ϕ14	ϕ6/21"	99620

	QUOTA -O-			QUOTA -O-		
PILASTRO	P	Aci	Afi	AR	AfR	STAFFE
1-6	40605	682	4,09	30x30	4ϕ12	ϕ6/18"
2-5	48405	813	4,88	30x30	4ϕ14	ϕ6/21"
3-4	31349	527	3,16	30x30	4ϕ12	ϕ6/18"
7-10	45206	759	4,55	30x30	4ϕ12	"
8-9	69726	1172	7,03	30x40	4ϕ16	ϕ6/24"
* 11-18	62600	1052	6,31	30x40	4ϕ16	"
* 12-17	66535	1118	6,71	30x40	4ϕ16	"
13-16	72755	1223	7,33	30x40	4ϕ16	"
* 14-15	109630	1842	11,05	30x60	6ϕ16	"
* 19-26	58310	980	5,88	30x40	4ϕ14	ϕ6/21"
20-25	83230	1399	8,39	30x50	4ϕ16	ϕ6/24"
21-24	83230	1399	8,39	30x50	4ϕ16	"
22-23	99620	1674	10,04	30x60	6ϕ16	"

	QUOTA F					
	P	Aci	Afi	AR	AfR	STAFFE
	49605	833	5,00	30x30	4ϕ14	ϕ6/21"
	58970	991	5,94	30x40	4ϕ14	"
	38264	643	3,86	30x30	4ϕ12	ϕ6/18"
	55476	932	5,59	30x40	4ϕ14	ϕ6/21"
*	83731	1407	8,44	30x50	6ϕ16	ϕ6/24"
	76365	1283	7,70	30x50	6ϕ16	"
	80565	1354	8,12	30x50	6ϕ16	"
	88100	1480	8,88	30x50	6ϕ16	"
*	130435	2192	13,15	30x70	8ϕ16	"
	71205	1197	7,18	30x40	4ϕ16	"
	101655	1708	10,25	30x60	6ϕ16	"
	101655	1708	10,25	30x60	6ϕ16	"
*	121195	2037	12,22	30x70	6ϕ16	"

1.057.220 x 2 = 2.114.440 kg

- FONDAZIONI - FRANCAVILLA -

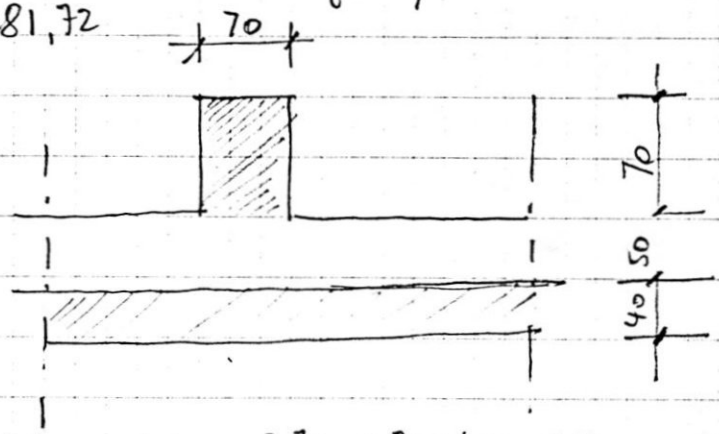
Si prende una platea con nervature:

$\Sigma P = 2.114.440$ Kg

$A = (12,70 \times 23,10) - (7,70 \times 1,45) =$ mq. 281,72

Considero una distribuzione uniforme sul terreno dei carichi trasmessi dai pilastri:

$$\frac{\Sigma P}{A} = \frac{2.114.440}{281,72} = 7505 \text{ Kg/mq.}$$



batolo : 0,40 x 1,00 x 1,00 x 2500 = 1000 Kg/mq

platea : 0,50 x 1,00 x 1,00 x 2500 = 1250 "

nervature $= \frac{1225 \times 153}{281,72} = 665$ "

terreno = 1225 "

4140 Kg/mq

Nervatura: p.p. = 0,70 x 0,70 x 1,00 x 2500 = 1225 Kg/ml.

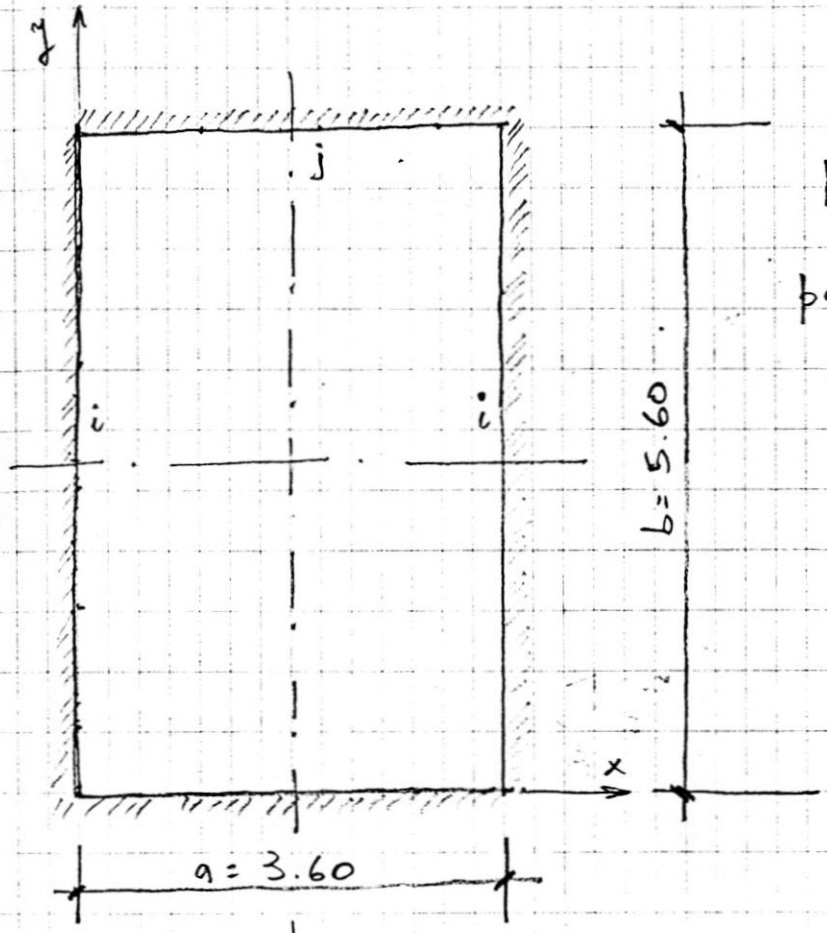
6 x 12,70 =	= ml.	76,20
2 x (12,70 - 1,45) =	= "	22,50
2 x [23,10 - 8 x 0,70)	= "	35,00
2 x [7,70 - 3 x 0,70)	= "	11,20
1 x [2 x 0,90 + 7,70 - 2 x 0,70]	= "	8,10
	ml	153,00

$153,00 \times 0,70 = 107,10$ mq.

Sovraccarico terreno: $0,50 \times 1,00 \times 1,00 \times 1600 + 0,70 \times 1600 \times \frac{107,10}{281,72} = 800 + 425 = 1225$ Kg/mq

In totale: 7505 + 4140 = 11645 Kg/mq. ($\simeq 1,16$ Kg/cmq).

CALCOLO LASTRA INCASTRATA LUNGO LE NERVATURE:



$p = 11645 - 2250 = 9395 \ Kg/mq$

$pa^2 = 9395 \times 3{,}60^2 = 121.759 \ Kgm/m$

$\frac{b}{a} = \frac{5{,}60}{3{,}60} = 1{,}55$

$c_1 = 0{,}0348$

$c_2 = 0{,}0095$

$c_i = 0{,}0768$

$c_j = 0{,}0570$

Momento flettente massimo: $m_{ix} = -c_i \, pa^2 = -0{,}0768 \times 121759 = 9351 \ Kgm/m$

$\sqrt{m_{ix}} = \sqrt{9351} = 96{,}70$; $c_h = \frac{45}{96{,}70} = 0{,}465 \xrightarrow[A_f = A'_f]{K_f = 2200} \sigma_c \simeq 40 \ Kg/cm^2$

$A_f = A'_f = 0{,}00109 \times 96{,}70 \times 100 = 10{,}54 \ cm^2 \rightarrow 5 + 5\phi 16 = 10{,}05 \ cm^2$

– CALCOLO NERVATURE –

Considero il pilastro più sollecitato (14)

$P_{14} = 130.435$ Kg. $\quad L = \frac{2{,}90 + 2{,}30 + 4{,}90 + 2{,}45}{2} = 6{,}27$ ml.

$P/ml = \frac{130.435}{6.27} = 20803$ Kg/ml.

1) $l = 4{,}90$ ml

$M = \frac{pl^2}{12} = 20800 \times \frac{\overline{4{,}90}^2}{12} = 41620$ Kgm

$\sqrt{\frac{M}{b}} = \sqrt{\frac{41620}{0{,}70}} = 243{,}83$; $c_h = \frac{115}{243{,}83} = 0{,}471 \xrightarrow[A'_f = 0{,}50\, A_f]{K_f = 2200} \sigma_c = 40$ Kg/cm q

$A_f = 0{,}00103 \times 243{,}83 \times 70 = 17{,}58$ cm² . $\quad 9\phi16 = 18{,}10$ cm²

$A'_f \quad = \quad 5\phi16 = 10{,}05$ cm²

$T_{max} = 20800 \times \overline{4{,}90}/2 = 50960$ Kg ; $\tau_{max} = \frac{T_{max}}{b h_0} = \frac{50960}{70 \times 0{,}9 \times 115} = 7{,}03$ Kg/cm²

Per metà trave:

$S_T = \frac{T_{max}}{h_0} \cdot \frac{l}{4} = \frac{50960}{0{,}9 \times 115} \times \frac{490}{4} = 60314$ Kg

Piego $4\phi16 \rightarrow (A_p = 8{,}04\,cm^2)$; $S_p = \sqrt{2} \times A_p \times K_f = \sqrt{2} \times 8{,}04 \times 2200 = 25.014$ Kg

$S_s = S_T - S_p = 60314 - 25014 = 35.300$ Kg

Uso staffe a 2br /25" → $s_s = 11$ → $A_s = \frac{S_s}{K_f s_s} = \frac{35300}{2200 \times 11} = 1{,}45$ cm²

Uso staffe $\phi10$ a 2br/25" –

2) $l = 3{,}90$; $p|_{ml} = 20.800\ kg/ml$

$$M = \frac{pl^2}{12} = 20800 \times \frac{\overline{3{,}90}^2}{12} = 26.364\ kgm.$$

$$\sqrt{\frac{M}{b}} = \sqrt{\frac{26364}{0{,}70}} = 194{,}06 \quad ; \quad c_h = \frac{115}{194{,}06} = 0{,}592 \xrightarrow{k_f = 2200} \sigma_c = 35\ kg/cmq$$

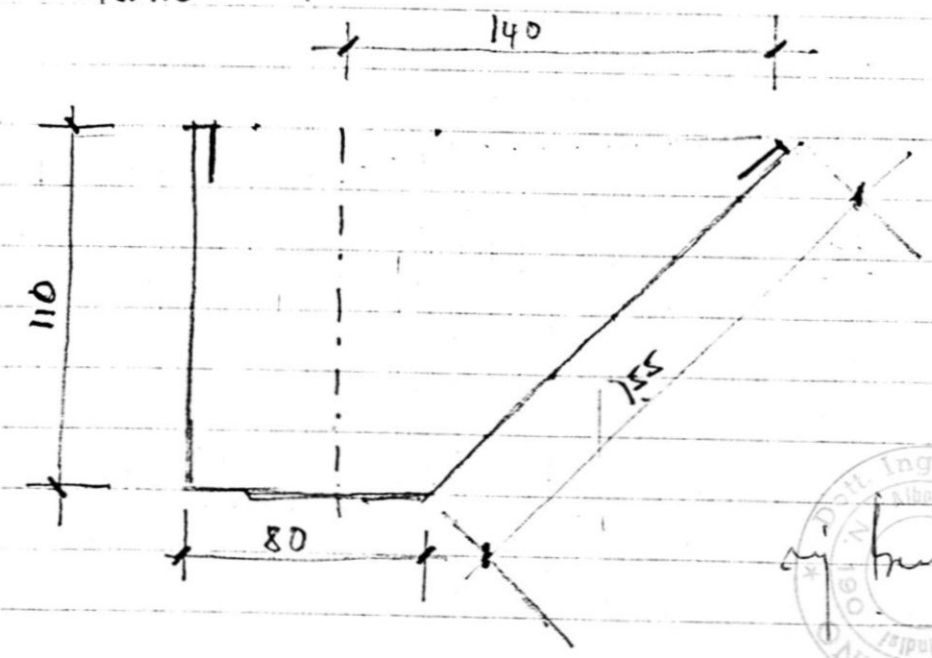
$$A_f = 0{,}000263 \times 194{,}06 \times 70 = 11{,}72\ cm^2 \rightarrow 6\phi16 = 12{,}06\ cm^2$$

$$T_{max} = 20.800 \times \overline{3{,}90}/2 = 40560\ kg.$$

$$\tau_{max} = \frac{T_{max}}{b h_0} = \frac{40560}{70 \times 0{,}9 \times 115} = 5{,}59\ kg/cmq.$$

Scorrimento / metà trave

$$S_t = \frac{T_{max}}{h_0} \times \frac{l}{4} = \frac{40560}{0{,}9 \times 115} \times \frac{3{,}90}{4} = 38200\ kg.$$



Dott. Ing. BERNARDO COSTANTINO