OPERATIVA EDILIZIA "LA CASA,.	FINANZIAMENTO GesCal (Legge 14-2-1963 n.60)	STAZIONE APPALTANTE Cooperativa "LA CASA,.			
PALAZZINA CON N° 6 ALLOGGI CONOMICI IN FASANO (Tipo B / Tipo D)		data: 21 NOV. 1966	ogg.		B
		ogg.	ogg.		
LAZIONE DI CALCOLO		Archivio			
Ing. GIOVANNI VALENTINI FASANO	PROGETTO	.		Approvazioni:	
Ing. AUGUSTO ROMITA BARI	CALCOLO STRUTTURA IN C.A.	● _firma_		C E C. 10 DIC. 1965	
Ing. GIOVANNI SABATINO CISTERNINO	IMPIANTI				
Ing. GIOVANNI VALENTINI FASANO	DIRETTORE DEI LAVORI	_firma_		Controllo disegni:	Visto:

RELAZIONE DI CALCOLO

per le strutture in C.C.A. di una palazzina

con n° 6 alloggi economici (Tipo B e C) in

FASANO

COOPERATIVA EDILIZIA "LA CASA"
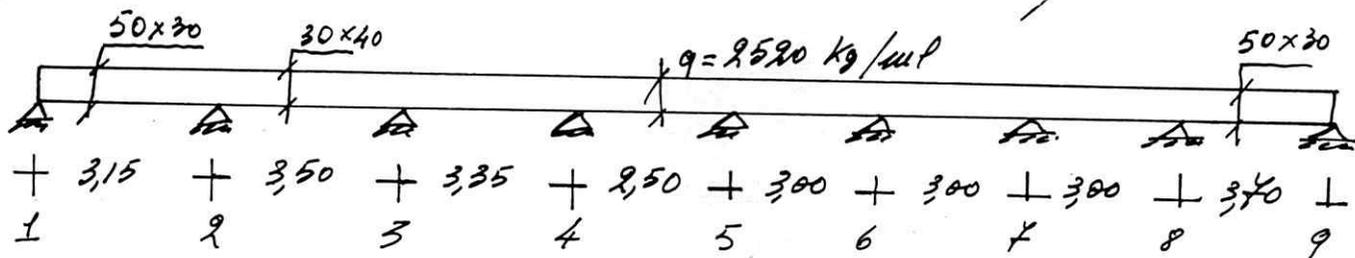

CALCOLI STATICI (parte seconda)

Dott.Ing.A ROMITA

Dott. Ing. Augusto Romita

Calcolo travi

Trave 1-2-3-4-5-6-7-8-9 di terzo piano

50×30   30×40 $q = 2520 \; kg/ml$ 50×30

$+3,15$ $+3,50$ $+3,35$ $+2,50$ $+3,00$ $+3,00$ $+3,00$ $+3,70$ $\perp$

1   2   3   4   5   6   7   8   9

$K_{2-1} = 0,37$; $K_{23} = 0,63$; $K_{3-2} = \dfrac{3,35}{6,85} = 0,489$; $K_{3-4} = 0,511$

$K_{4-3} = \dfrac{2,5}{5,85} = 0,428$; $K_{4-5} = 0,572$; $K_{5-4} = \dfrac{3,00}{5,5} = 0,545$; $K_{5,6} = 0,465$

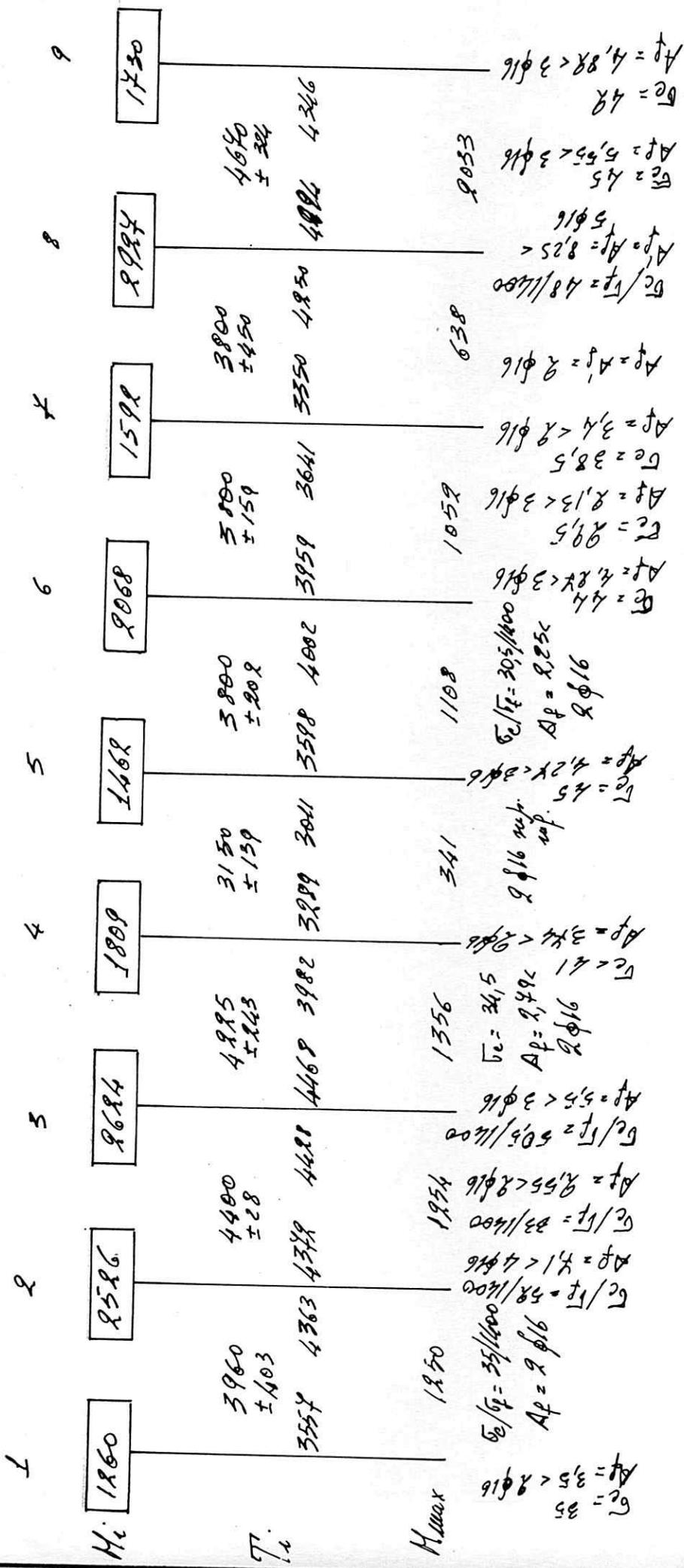$K_{6-5} = K_{6-7} = 0,50 = K_{7-6} = K_{7-8}$; $K_{8-7} = 0,705$

$\mu_1 = \dfrac{2520 \times 3,15^2}{20} = 1260 \; kgm$; $\mu_9 = \dfrac{2520 \times 3,7^2}{20} = 1730 \; kgm.$

$\mu_2 = \dfrac{2520 \times 3,15^2}{8} - 630 = 2500 \; kgm$; $\mu_8 = \dfrac{2520 \times 3,7^2}{8} - 865 = 3455 \; kgm.$

$\mu_{2-3} = 2580$; $\mu_{3-4} = 2365$; $\mu_{4-5} = 1310$; $\mu_{5-6} = 1890$; $\mu_{6-7} = \mu_{7-8} = 1890$

1	2 0,370 0,630	3 0,489 0,511	4 0,428 0,572	5 0,545 0,455	6 0,5 0,5	7 0,5 0,5	8 0,705 0,295	9
−1260	+2500 −2580	+2580 −2365	+2365 −1310	+1310 −1890	+1890 −1890	+1890 +189	+1890 −3455	+1730
+30	+50 +25	−122 −61	−570 −285	+343 +192	−96 −48	+24 +12	+486	
−2	−59 −118	−212 −424	+235 +440	−48 −96	+12 +24	−6 +1040		
+65	+129 −52	−103 +5	+10 +30	−134 +61	+535 −133	+4		
−4	+135	−137 +67	−68 +8	+61 +4	−267 −6	+99		
+5	−2 −14	−29 −38	−19 +40	−12 +20	−12 −6	−13		
−3	+10 −5	+14 −4	−7 +5	−12 +9	−17 +49	+9		
	+11	−10 +24	+4 +3	+9	−24 −25			
		+6 −14			+5			
		−2 +3						
kgm. 2526	2624	1809	1462	2068	1592		2927	

Cavallerizza coll. Travi 1÷9 di III piano
Soller. ed armatura

Per tutte le Travi:

$$T_{max} = 4994 \ kg \ ; \quad c_{max} = \frac{4994}{1865} = 4,21 \ kg/cmq \ ; \quad x_0 = \frac{4994}{2520} = 198 cm.$$

$$S = \frac{194 \cdot 4 \cdot 31.50}{2} = 21300 \ kg \ ; \quad \begin{cases} u_p = \frac{8000}{3960} = 2\,\phi16 \\ u_{st} = \frac{12000}{1400} = 8\,\phi8/20'' \end{cases}$$

Trani: 1-2-3-4-5-6-7-8-9 dei piano intermedio (II.I.p.t.)

$K_{2-1} = 0,820$; $K_{2-3} = 0,770$; $K_{3-9} = 0,489$; $K_{3-4} = 0,511$; $K_{4-3} = 0,674$; $K_{4-5} = 0,386$

$K_{5-4} = 0,302$; $K_{5-6} = 0,698$; $K_{6-5} = K_{6-7} = K_{7-8} = 0,50$; $K_{9-7} = 0,774$; $K_{8-9} = 0,226$

$M_1 = \dfrac{2625 \times 3,15^2}{18} = 1450 \ kgm$; $M_{2-3} = \dfrac{3666 \times 3,5^2}{12} = 3740 \ kgm$; $M_{3-4} = 3390 \ kgm$;

$M_{4-5} = 1680 \ kgm$; $M_{5-6} = 2480$; $M_{6-7} = M_{7-8} = 2380$; $M_{8-9} = \dfrac{2581 \times 3,7^2}{8} = 985 = 3445$

Caratterist. sollec. trasv. 1÷9 di piano irrigidimento.
Sollec. ed armatura.

	1	2	3	4	5	6	7	8	9
N_i	1450	2864	3953	2964	1852	2180	2048	3170	1940

T_i: 3688 4608 6122 6451 5505 4491 5009 4664 4544 4917 4993 5193 4477

| | 4150 ±452 | 6440 ±311 | 6080 ±355 | 4050 ±388 | 4800 ±109 | 4620 ±44 | 4620 ±343 | 4800 ±323 |

M_{max}: 1160 2273 1837 963 1708 1350 888 1890

$A_f = 3,08 < 2\,\phi16$
$c/q_t = 37,5/1100$

$A_f = 3,22 < 2\,\phi16$
$c/q_t = 33,5/1100$

$A_f' = A_f = 8,18 < 5\,\phi16$
$c/q_t = 4,4/1100$

$A_f = 3,99 < 2\,\phi16$
$c/q_t = 33/1100$

$A_f = 6,52 < 4\,\phi16$
$c_z = 49$

$A_f = 2,45 > 2\,\phi16$
$c_z = 30$

$A_f' = A_f > 4,48 < 4\,\phi16$
$c_z = 47$

$A_f' = A_f = 2\,\phi16$
$c_z < 25$

$A_f = 2,84 < 2\,\phi16$
$c_z = 44,5$

$A_f = 2,82 > 2\,\phi16$
$c_z = 30$

$A_f = 3,56 < 2\,\phi16$
$c_z = 35$

$A_f = 2,17 > 2\,\phi16$
$c_z = 26,5$

$A_f = 5,8 < 3\,\phi16$
$c_z = 46$

$A_f = 2,36 < 2\,\phi16$
$c_z = 28$

$A_f' = A_f = 8,8 < 5\,\phi16$
$c_z = 49$

$A_f = 5,08 < 3\,\phi16$
$c_z = 43$

$A_f = 5,47 > 3\,\phi16$
$c_z = 45$

Pa le travi: 1-2, 4-5, 8-9.
$T_{max} = 5193$ kg; $x_0 = \dfrac{5193}{2591} = 198$; $c = 440$ kg/cmq.

$S = \dfrac{4,40 \cdot 198 \cdot 50}{2} = 22\,780$ kg $\begin{cases} A_f = \dfrac{11\,100}{3960} = 3\,\phi16 \\ A_{st} = \dfrac{13\,780}{7200} = \phi\,8/20'' \end{cases}$

Pa le travi: 2-3-4; 5-6-7-8; $T_{max} = 6451$ kg; $x_0 = \dfrac{6451}{3666} = 184$ cm; $c = \dfrac{6451}{1395} = 5,21$ kg/cmq.

$S = \dfrac{5,21 \cdot 184 \cdot 50}{2} = 14\,400$ kg; $\begin{cases} A_f = \dfrac{7200}{3960} = 2\,\phi16 \\ A_{st} = \dfrac{8690}{7200} = \phi\,8/25'' \end{cases}$

Travi 10-11-12-13-14-15-16-17-18 di terzo piano

$q = 4995 \, kg/ml$ $q = 6855$ $q = 4995 \, kg/ml$

30×80   40×70   40×70

3,35 — 3,90 — 3,30 — 3,90 — 2,90 — 3,90 — 3,90 — 3,90

10 — 11 — 12 — 13 — 14 — 15 — 16 — 17 — 18
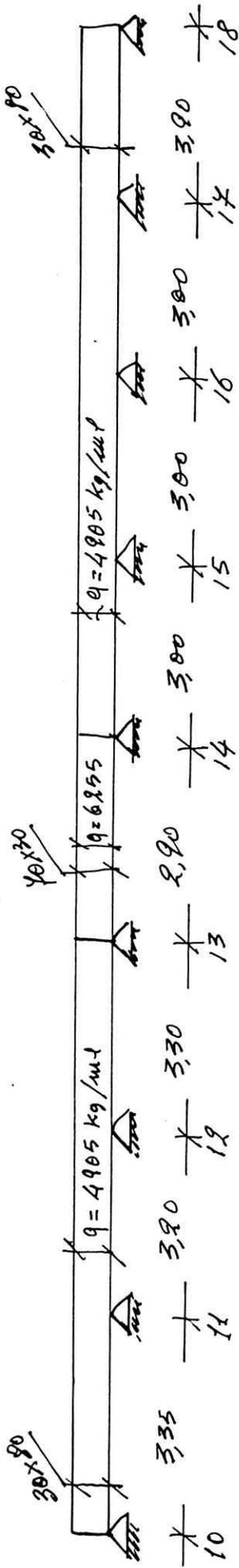
$K_{11-10} = \dfrac{0,895}{0,895 + 1,15} = 0,414 \; ; \quad K_{11-12} = 0,583 \; ; \quad K_{12-11} = 0,508 \; ; \quad K_{12-13} = 0,492 . \; K_{13-12} = 0,155 .$

$K_{13-14} = 0,845 \; ; \quad K_{14-13} = 0,803 \; ; \quad K_{14-15} = 0,197 \; ; \quad K_{15-14} = K_{15-16} = K_{16-15} = K_{16-17} = 0,50 \; ; \quad K_{14-16} = 0,633$

$K_{17-18} = 0,367 .$

$M_{10} = \dfrac{4995 \times 3,35^2}{24} = 2280 \, kgm \; ; \quad M_{18} = \dfrac{4995 \times 3,9^2}{24} = 3090 \, kgm \; ; \quad M_{11-10} = \dfrac{4995 \times 3,35^2}{8} = 5460$

$M_{14-18} = \dfrac{4995 \times 3,9^2}{8} \cdot 1540 = 7810 \, kgm \; ; \quad M_{11-12} = \dfrac{4995 \cdot 3,2^2}{12} = 4180 \; ; \quad M_{12-13} = 4465 \; ; \quad M_{13-14} = 4465 \; ; \quad M_{14-15} = 4380 \; ; \quad M_{14-15} = 3890$

$M_{15-16} = 3680 \; ; \quad M_{16-17} = 3680 \, kgm$

	0,414	0,583	0,508	0,492	0,155	0,845	0,803	0,197	0,50	0,50	0,50	0,50	0,633	0,367
	11		12		13		14		15		16		17	18
	-5460	+4180	-4465	+4465	-4380	+4380	-3680	+3680	-3680	+3680	-3680	+3680	-7810	+3090

Calcolo... di ... travi 10÷18 di III° ridho
Sollec. ed armatura.

	10	11	12	13	14	15	16	17	18
H_i	2280	5015	4068	4705	3740	3805	3083	6140	3720

8210 ±815   7840 ±296   8090 ±193   9180 ±332   7480 ±21   7480 ±240   7480 ±1030   9680 ±620

T_i 7395   9025 8166   8183 9432   8768 7379   7421   7160   8430 10820   8940

M_{max} 3320   1795   2999   4375   1810   9155   1050   4530

Per il nodo 10:
$c_2/c_1 = 37,5$
$A_f = 6,89 > 4\phi16$

Nodo 11:
$c_2 = 46,5$
$A_f = 9,95 > 5\phi16$
$c_2 = 49$
$A_f' = A_f = 14,35 > 8\phi16$

Nodo 12:
$c_2 = 39$
$A_f = 4,80 > 3\phi16$
$c_2 = 46$
$A_f' = A_f = 12,4 > 7\phi16$

Nodo 13:
$c_2 = 37$
$A_f = 6,10 < 3\phi16 + 2\phi10$
$c_2 = 50$
$A_f' = A_f = 11,55 > 6\phi16$

Nodo 14:
$c_2 = 34,5$
$A_f = 4,9 > 3\phi16$
$c_2 = 58,5$
$A_f = 10,5 < 6\phi16$

Nodo 15:
$c_2 = 33,5$
$A_f = 5,00 < 3\phi16$
$c_2 = 44$
$A_f' = A_f = 10,5 < 4\phi16 + 2\phi10$

Nodo 16:
$c_2 = 35$
$A_f = 4,40 < 4\phi16$
$c_2 = 44,5$
$A_f = 8,55 < 4\phi16 + 2\phi10$

Nodo 17:
$c_2 = 24$
$A_f = 3,62 > 2\phi16$
$c_2 = 54$
$A_f' = A_f = 18,9 > 10\phi16$

Nodo 18:
$c_2 = 47$
$A_f' = A_f = 17,8 < 8\phi16$
$c_2 = 44,5$
$A_f = 8,6 < 5\phi16$

Trave 13-14; $T_{max} = 9432$ kg. $t = \dfrac{9432}{0,9 \cdot 68,30} = \dfrac{9432}{6255} = 5,18$ kg/cmq ; $x_0 = \dfrac{9432}{6255} = 151$; $S = \dfrac{151 \cdot 20 \cdot 5,18}{2} = \dfrac{11450}{2} = 45 \cdot 9/25$

$w_b = 2610$

Per tutte le rimanenti travi; $T_{max} = 10820$ kg. $t = \dfrac{10820}{2020} = 5,1$ kg/cmq, $x_0 = \dfrac{10820}{4805} = 8,09$

$u_p = \dfrac{17100}{5060} = 4,816$

$S = \dfrac{209 \times 80 \times 5,1}{2} = 48780$ kg.
$u_{sf} = \dfrac{25600}{1600} = 68/12''$

Trave 10-11-12-13-14-15-16-17-18 di sbalzo interessato

$q = 4490\ Kg/ml$ $q = 6676\ kg/ml$ $q = 4490\ Kg/ml$

$J_{10-11-12-13} = J_{14-15-16-17-18} = 18 \cdot 10^4\ cm^4\ ;\quad J_{13-14} = 85,45 \cdot 10^4\ cm^4$

$\mu_{10} = \dfrac{4490 \times 3{,}45^2}{8} = 2680\ kgm\ ;\quad \mu_{14-10} = \dfrac{4490 \times 3{,}9^2}{8} = 3420\ ;\quad \mu_{14-18} = \dfrac{4490 \times 3{,}9^2}{8} = 8295$

$\mu_{11-12} = \dfrac{4490 \times 3{,}6^2}{12} = 3840\ ;\quad \mu_{14-10} = \dfrac{4490 \times 3{,}45^2}{12} \cdot 1340 = 5340\ ;\quad \mu_{1,8} = \dfrac{4490 \times 3{,}9^2}{8} = 3480\ ;\quad \mu_{14-15} = 4090\ ;\quad \mu_{15-16} = 4090\ ;\quad \mu_{16-17} = 8295$

$\mu_{12-13} = 4180\ ;\quad \mu_{13-14} = \dfrac{545}{545+3428} = 0{,}140\ ;\quad K_{14-14} = 0{,}860\ ;$

$K_{14-10} = \dfrac{0{,}84}{1{,}25+0{,}84} = 0{,}410\ ;\quad K_{11-12} = 0{,}590\ ;\quad K_{13-12} = \dfrac{545}{545+3428} \quad K_{12-11} = 0{,}491\ ;\quad K_{13-12} = \dfrac{33}{33+3{,}2} = 0{,}509\ ;\quad K_{12-13} = 0{,}491\ ;$

$K_{14-13} = K_{13-14}\ ;\quad K_{14-15} = K_{13-12}\ ;\quad K_{15-14} = \dfrac{2{,}65}{5{,}95} = 0{,}500\ ;\quad K_{16-15} = \dfrac{2{,}65}{5{,}95} = 0{,}445\ ;\quad K_{16-16} = \dfrac{1{,}51}{1{,}51+0{,}84} = 0{,}663\ ;\quad K_{14-18} = 0{,}337\ ;$

Kgm. 4641

Caratterist. di sollec. Travi 10÷18 di piano intermedio.
Sollec. ed armatura

	10	11	12	13	14	15	16	17	18

M_i: | 2680 | | 4641 | | 3758 | | 4177 | | 3903 | | 4654 | | 2712 | | 5137 | | 3430 |

| | 7980 ÷578 | 7980 ÷478 | 7450 ÷128 | 8350 ÷390 | 7480 ÷450 | 7480 ÷590 | 5960 ÷918 | 8800 ÷459 |

T_i: | 7211 | 8349 | 7478 | 6988 | 7388 | 7578 | 7960 | 8740 | 6950 | 7850 | 6880 | 7990 | 5042 | 6878 | 9939 | 4563 |

M_{max}^+ | 3120 | 1560 | 2948 | 563 | 2157 | 593 | 138 | 4363 |

$\frac{C_a/\tau_i = 41/1140}{A_f = 9,42 > 5\phi16+5\phi16}$

$\frac{C_a/\tau_i = 45/1160}{A_f = 8,7 < 5\phi16+2\phi10}$

$\frac{C_a = 48}{A_f^i = 13,4 < 7\phi16}$

$\frac{C_a = 30}{A_f = 4,23 > 3\phi16}$

$\frac{C_a = 50}{A_f = 10,5 < 5\phi16+2\phi10}$

$\frac{C_a = 37}{A_f = 6,15 < 3\phi16+2\phi10}$

$\frac{C_a = 46}{A_f^i = 11,8 > 6\phi16}$

$\frac{C_a = 85}{A_f^i = A_f = 8\phi16}$

$\frac{C_a = 46}{A_f = 9,05 < 4\phi16+2\phi10}$

$\frac{C_a = 36}{A_f = 5,9 < 3\phi16}$

$\frac{C_a = 48}{A_f^i = 13,5 < 6\phi16+2\phi10}$

$\frac{C_a = 25}{A_f^i = A_f = 8\phi16}$

$\frac{C_a = 41}{A_f = 9,4 < 5\phi16}$

$\frac{C_a = 85}{A_f^i = A_f = 8\phi16}$

$\frac{C_a = 50}{A_f^i = A_f = 14,4 < 7\phi16+2\phi10}$

$\frac{C_a = 45}{A_f^i = 18,8 < 6\phi16}$

$\frac{C_a = 44}{A_f = 11,8 < 5\phi16+2\phi10}$

Trave 13-14: $T_{max} = 7960$ kg ; $\ell = \frac{7960}{0,9 \cdot 30 \cdot 0,68} = \frac{7960}{6676} = 119$ cu ;

$S = \frac{119 \cdot 30 \cdot 4,33}{2} = \frac{7960}{2} = 7760$ kg

$U_p = 1946 \qquad U_{st} = 69/25''$

Per tutte le rimanenti travi: $T_{max} = 9939$ kg ; $d = \frac{9939}{2015} = \frac{9939}{4,58 \cdot 206 \cdot 80} = 4,58$ kg/cm² ; $x_0 = \frac{7960}{6676} = \frac{9939}{3140} = 206$ cm

$U_p = \frac{15050}{3140} = 4,816$ piegate

$S = \frac{4,58 \cdot 206 \cdot 80}{2} = 37.760$ kg .

$U_{st} = \frac{37680}{7400} = 68/12''$

Cross: Schema di calcolo telaio 18-90-21-22-93-94-85

Telaio 19·20·21·22·23·24·25
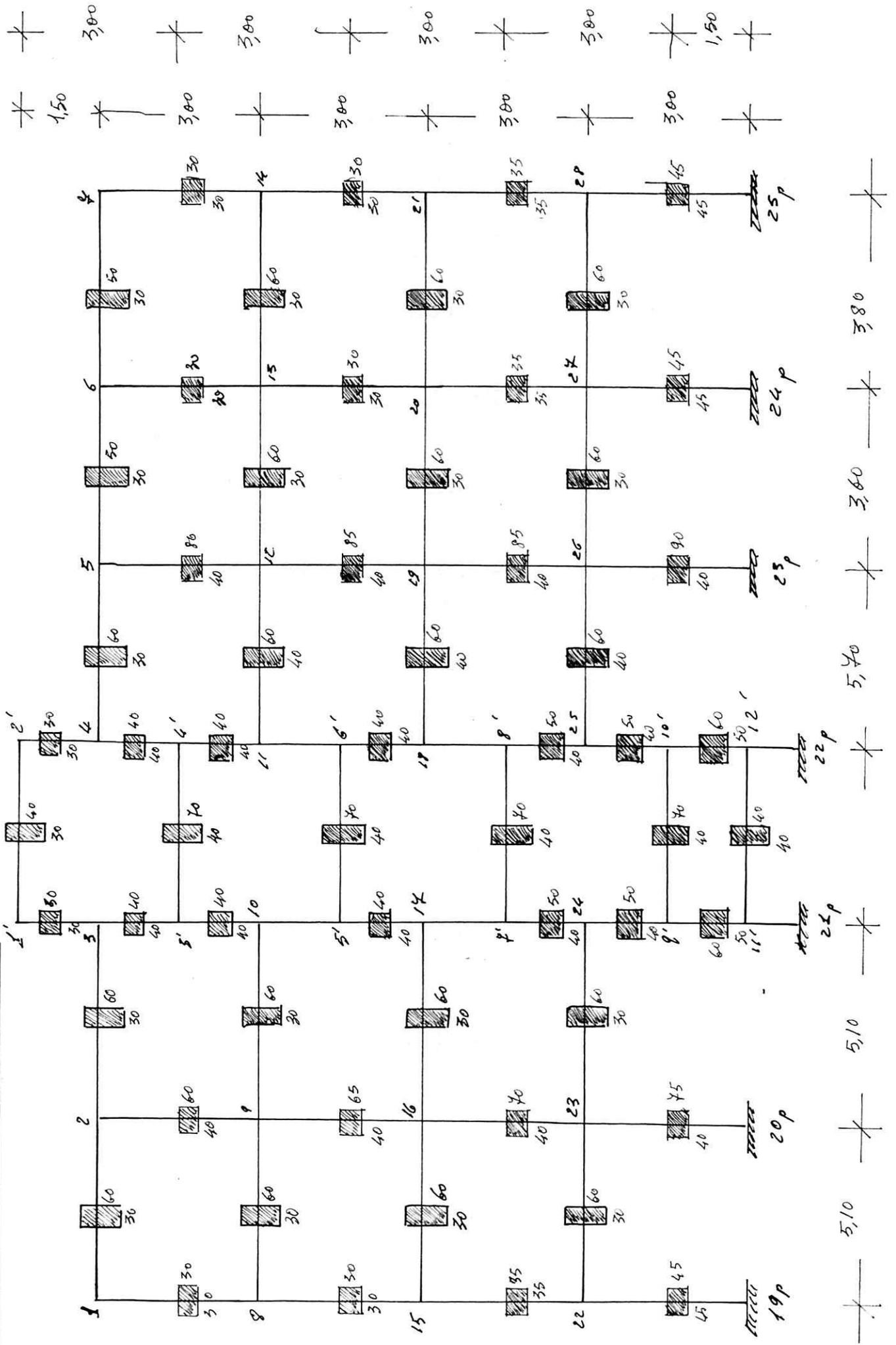
Momenti d'inerzia:

$$J_{1\text{-}2\text{-}3} \div J_{4\text{-}5} = J_{8\text{-}9\text{-}10} = J_{12\text{-}13\text{-}14} = J_{15\text{-}16\text{-}17} = J_{19\text{-}20\text{-}21} = J_{22\text{-}23\text{-}24} = J_{26\text{-}27\text{-}28} =$$

$$= \frac{30 \times 60^3}{12} = 540'000 \ cm^4.$$

$$J_{5\text{-}6\text{-}7} = \frac{30 \times 50^3}{12} = 312'500 \ cm^4;$$

$$J_{2\text{-}9} = J_{11\text{-}12} = J_{18\text{-}19} = J_{25\text{-}26} = \frac{40 \times 60^3}{12} = 720'000 \ cm^4$$

$$J_{1\text{-}8\text{-}15} = J_{6\text{-}13\text{-}20} = J_{7\text{-}14\text{-}21} = \frac{30 \times 30^3}{12} = 67'500 \ cm^4$$

$$J_{15\text{-}22} = J_{20\text{-}27} = J_{21\text{-}28} = \frac{35 \times 35^3}{12} = 124'500 \ cm^4$$

$$J_{22\text{-}19_p} = J_{27\text{-}24_p} = J_{28\text{-}25_p} = \frac{45 \times 45^3}{12} = 341'720 \ cm^4$$

$$J_{5\text{-}12} = \frac{80 \times 40^3}{12} = 426'667 \ cm^4; \quad J_{12\text{-}29\text{-}26} = \frac{85 \times 40^3}{12} = 453333 \ cm^4;$$

$$J_{26\text{-}27_p} = \frac{90 \times 40^3}{12} = 480'000 \ cm^4; \quad J_{9\text{-}16} = \frac{65 \times 40^3}{12} = 346'666 \ cm^4; \quad J_{16\text{-}23} = \frac{70 \times 40^3}{12} =$$

$$= 373'250 \ cm^4; \quad J_{23\text{-}20_p} = \frac{75 \times 40^3}{12} = 400'000 \ cm^4;$$

$$J_{3\text{-}10\text{-}17} = J_{4\text{-}11\text{-}18} = \frac{40 \times 40^3}{12} = 213'333 \ cm^4$$

$$J_{17\text{-}24\text{-}11'} = J_{18\text{-}25\text{-}12'} = \frac{50 \times 40^3}{12} = 266'666 \ cm^4; \quad J_{11'\text{-}21_p} = J_{12'\text{-}22_p} = \frac{60 \times 50^3}{12} = 625'000 \ cm^4$$

$$J_{5'\text{-}4'} = J_{5\text{-}6'} = J_{7'\text{-}8'} = J_{9'\text{-}10''} = \frac{40 \times 70^3}{12} = 800'000 \ cm^4$$

Momenti d'incastro perfetto:

$$\mu_{1\text{-}2}; \mu_{2\text{-}3} = 6920 \ kgm; \quad \mu_{4\text{-}5} = 8700 \ Kgm; \quad \mu_{5\text{-}6} = 3470; \quad \mu_{6\text{-}7} = 3870$$

$$\mu_{8\text{-}9} = \mu_{15\text{-}16} = \mu_{22\text{-}23} = 9720; \quad \mu_{9\text{-}10} = \mu_{16\text{-}17} = \mu_{23\text{-}24} = 10550 \ kgm;$$

$$\mu_{11\text{-}12}; \mu_{18\text{-}19} = \mu_{25\text{-}26} = 13225 \ kgm; \quad \mu_{12\text{-}13} = \mu_{19\text{-}20} = \mu_{26\text{-}27} = 4830 \ kgm;$$

$$\mu_{13\text{-}14} = \mu_{20\text{-}21} = \mu_{27\text{-}28} = 5870 \ kgm;$$

$$\mu_{5'\text{-}4'} = \mu_{5\text{-}6'} = \mu_{7'\text{-}8'} = \mu_{9'\text{-}10'} = 8500 \ kgm; \quad \mu_{11'\text{-}12'} = 2980 \ Kgm.$$

Coefficienti di ripartizione: $k = \dfrac{\frac{J_1}{l_1}}{\frac{J_1}{l_1} + \frac{J_2}{l_2} + \frac{J_3}{l_3}} =$

$$K_{1\text{-}2} = 0,830; \quad K_{1\text{-}3} = 0,17$$

$$K_{2\text{-}1} = \frac{1060}{1060 + 1060 + 412} = 0,337; \quad K_{2\text{-}3} = 0,327; \quad K_{2\text{-}17} = 0,336;$$

$$K_{3\text{-}2} = 0,272; \quad K_{3\text{-}1'} = K_{3\text{-}5'} = 0,364; \quad K_{4\text{-}5} = 0,272; \quad K_{4'\text{-}2'} = K_{4\text{-}4'} = 0,364;$$

$$K_{5\text{-}4} = 0,293; \quad K_{5\text{-}6} = 0,267; \quad K_{5\text{-}12} = 0,440;$$

$K_{6-5} = 0,453$; $K_{6-7} = 0,430$; $K_{6-13} = 0,117$

$K_{7-6} = 0,786$; $K_{9-14} = 0,214$;

$K_{8-1} = 0,145$; $K_{8-9} = 0,710$; $K_{9-15} = 0,145$

$K_{9-8} = 0,238$; $K_{9-10} = 0,238$; $K_{9-2} = 0,252$; $K_{9-16} = 0,272$ –

$K_{10-9} = 0,272$; $K_{10-5'} = 0,364$; $K_{5'-3} = K_{5'-10} = 0,213$; $K_{5'-4'} = 0,574$;

$K_{4'-5'} = 0,574$; $K_{4'-4} = K_{4'-11} = 0,213$; $K_{11-12} = 0,306$; $K_{11-4'} = K_{11-6'} = 0,347$

$K_{12-11} = 0,220$; $K_{12-13} = 0,364$; $K_{12-5} = 0,250$; $K_{12-19} = 0,266$;

$K_{13-18} = 0,445$; $K_{13-6} = 0,067$; $K_{13-14} = 0,421$; $K_{13-20} = 0,067$

$K_{14-7} = 0,120$; $K_{14-13} = 0,760$; $K_{14-21} = 0,120$

$K_{15-16} = 0,627$; $K_{15-8} = 0,128$; $K_{15-22} = 0,246$

$K_{16-15} = K_{16-17} = 0,233$; $K_{16-9} = 0,246$; $K_{16-23} = 0,298$

$K_{17-16} = 0,230$; $K_{17-5'} = K_{17-7'} = 0,385$; $K_{5'-10} = K_{5'-17} = 0,213$; $K_{5'-6'} = 0,574$

$K_{18-19} = 0,262$; $K_{18-6'} = K_{18-8'} = 0,369$; $K_{6'-5'} = 0,574$; $K_{6'-11'} = K_{6'-18} = 0,347$

$K_{19-18} = 0,218$; $K_{19-20} = 0,260$; $K_{19-12} = K_{19-26} = 0,261$

$K_{20-19} = 0,422$; $K_{20-21} = 0,398$; $K_{20-13} = 0,063$; $K_{20-27} = 0,117$

$K_{21-20} = 0,690$; $K_{21-14} = 0,109$; $K_{21-28} = 0,201$

$K_{22-15} = 0,159$; $K_{22-23} = 0,406$; $K_{22-19_p} = 0,435$

$K_{23-22} = 0,219$; $K_{23-16} = 0,272$; $K_{23-24} = 0,219$; $K_{23-20_p} = 0,292$;

$K_{24-23} = 0,230$; $K_{24-7'} = K_{24-9'} = 0,385$; $K_{7'-17} = K_{7'-24} = 0,240$; $K_{7'-8'} = 0,520$

$K_{25-26} = 0,262$; $K_{25-8'} = K_{25-10'} = 0,369$; $K_{8'-7'} = 0,520$

$K_{26-25} = 0,215$; $K_{26-19} = 0,258$; $K_{26-27} = 0,255$; $K_{26-23_p} = 0,272$;

$K_{27-26} = 0,335$; $K_{27-20} = 0,094$; $K_{27-28} = 0,317$; $K_{27-24_p} = 0,254$

$K_{28-27} = 0,478$; $K_{28-21} = 0,139$; $K_{28-25_p} = 0,383$;

$K_{9'-10'} = 0,327 = K_{10'-9'}$; $K_{9'-24} = K_{10'-25} = 0,141$; $K_{9'-11'} = K_{10'-12'} = 0,532$

$K_{11'-12'} = K_{12'-11'} = 0,070$; $K_{11'-21_p} = K_{12'-22_p} = 0,310$;

Travi: 19-20-21 (III piano)
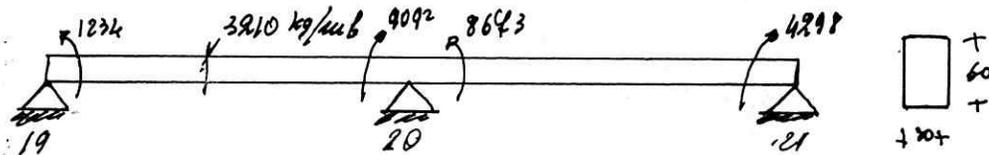
$M_{19}^- = 1234 \ kgm$; $z = \dfrac{58}{\sqrt{\dfrac{12340}{3}}} = \dfrac{58}{61} = 0,955 \quad < \begin{array}{l} \tau_c < 25 \\ 0,00101 \end{array}$

$$A_f = 2\phi 16$$

$M_{20}^- = 9092 \ kgm$; $z = \dfrac{58}{\sqrt{\dfrac{90980}{3}}} = \dfrac{58}{175} = 0,333 \quad < \begin{array}{l} 52 \\ 0,00230 \end{array}$

$$A_f' = A_g = 0,00230 \cdot 30 \cdot 175 = 12,1 < 6\phi 16 + 2\phi 10$$

$$T_{max}^{\pm} \ 9740 \ kg \ ; \quad \tau_{max} = \dfrac{9720}{1565} = 6,25 \ kg/cmq ;$$

$$\mu_p = 3\phi 16 \quad ; \quad \mu_{st} = \phi 8/25''$$

Momento di campata 19-20

$M_{max}^+ = \dfrac{9740^2}{6420} - 9092 = 7916 \ kgm$; $z = \dfrac{58}{\sqrt{\dfrac{79160}{3}}} = \dfrac{58}{162} = 0,368 \quad < \begin{array}{l} 52 \\ 0,00206 \end{array}$

$$A_f = 0,50 \ A_g = 0,00206 \cdot 30 \cdot 162 = 10,5 \ cmq < 5\phi 16 + 2\phi 10$$

$M_{21}^- = 4298 \ kgm$;

$z = \dfrac{58}{\sqrt{\dfrac{42980}{3}}} = \dfrac{58}{120} = 0,482 \quad < \begin{array}{l} 41,5 \\ 0,00161 \end{array}$

$$A_f = 0,00161 \times 30 \times 120 = 5,85 \ cmq < 3\phi 16$$

Momento di campata 20-21

$M_{max}^+ = \dfrac{9155^2}{6420} - 8643 = 4358 \ kgm .$ $\quad < \begin{array}{l} \tau_c = 4,5 \ kg/cmq \\ A_f = 5,85 < 3\phi 16 \end{array}$

$$\mu_p = 3\phi 16$$
$$\mu_{st} = \phi 8/25''$$

Trave 19-20-21 (II·I - piano terra)

Campata 19-20

$M_{19}^- = 6159 \ kgm$; $z = \dfrac{58}{\sqrt{\dfrac{61590}{3}}} = 0,404 \quad < \begin{array}{l} 50,5 \\ 0,00194. \end{array}$

$$A_f = 0,00194 \times 30 \times 143,5 = 8,38 \ cmq < 4\phi 16 + 2\phi 10$$

$M_{20}^- = 13444 \ kgm$; $z = \dfrac{58}{211} = 0,275 \quad < \begin{array}{l} 59 \\ 279 \end{array}$

$$A'_f = A_f = 0,00279 \cdot 30 \cdot 211 = 17,65 \approx 8\phi16 + 2\phi10$$

$$M^+_{19 \cdot 20} = \frac{13290^2}{8940} - 13444 = 6356 \; kgm;$$

$$z = \frac{58}{\sqrt{\frac{63560}{3}}} = \frac{58}{143,5} = 0,408 < \frac{52}{0,00194}$$

$$A_f = 0,00194 \cdot 30 \cdot 143,5 = 8,38 < 4\phi16 + 2\phi10$$

$$T_{max} = \frac{4470 \times 5,10}{2} + \frac{13444 - 3564}{5,1} = 13290 \; kg.$$

$$x_0 = \frac{13290}{4470} = 297 \, cm; \quad c_{max} = \frac{13290}{1565} = 8,5 \; kg/cmq$$

$$S = \frac{8,5 \cdot 297 \cdot 30}{2} = 37700 \; kg : \begin{cases} u_p = \frac{15100}{3960} = 4\phi16 \\ u_{st} = \frac{22700}{1400} = \phi 8/18'' \end{cases}$$

Campata 20·21

$$M^-_{21} = 7463 \; kgm; \quad z = \frac{58}{\sqrt{\frac{74630}{3}}} = \frac{58}{158} = 0,367 < \frac{52}{215}$$

$$A'_f = 0,50 \, A_f = 0,00215 \cdot 158 \cdot 30 = 10,2 \, cmq < 5\phi16 + 2\phi10$$

$$T_{max} = \frac{4880 \times 5,10}{2} + \frac{12373 - 6800}{5,10} = 13520 \; kg.$$

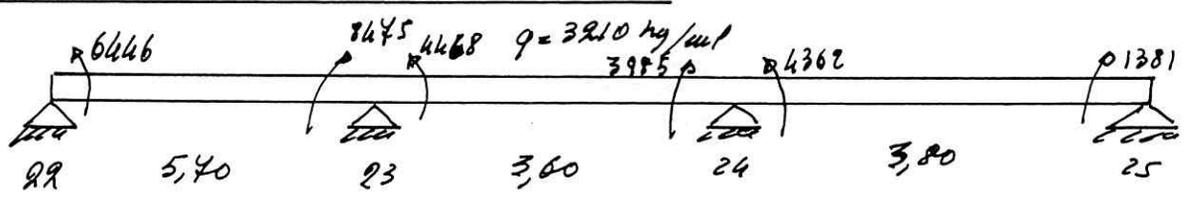$$x_0 = \frac{13520}{4880} = 277 \, cm; \quad c_{max} = \frac{13520}{1565} = 8,65 \; kg/cmq.$$

$$S = \frac{277 \cdot 8,65 \cdot 30}{2} = 36000 \; kg < \begin{cases} u_p = \frac{14400}{3960} = 4\phi16 \; piegati. \\ u_{st} = \frac{21700}{1400} = \phi 8/18'' \end{cases}$$

$$M^+_{max} = \frac{13520^2}{9760} - 11729 = 7071 \; kgm.$$

$$z = \frac{58}{\sqrt{\frac{70710}{3}}} = \frac{58}{154} = 0,377 < \frac{50}{0,00206}$$

$$A'_f = 0,50 \, A_f = 0,00206 \cdot 154 \cdot 30 = 9,55 < 5\phi16$$

Trave 22·23·24·25 (III piano)

Campata 22-23:

$$M_{22}^{-} = 6446 \ kgm; \qquad z = \frac{58}{\sqrt{\frac{64460}{3}}} = \frac{58}{146,5} = 0,395 < \frac{50}{0,00199}$$

$$A_f' = 0,25 \ A_f = 0,00199 \cdot 146,5 \cdot 30 = 8,75 < 4\phi16 + 2\phi10$$

$$M_{23}^{-} = 8475 \ kgm; \qquad z = \frac{58}{\sqrt{\frac{84750}{3}}} = \frac{58}{168} = 0,345 < \frac{50}{0,00285}$$

$$A_f' = A_f = 0,00285 \cdot 168 \cdot 30 = 11,35 \ cmq < 6\phi16$$

$$T_{max} = \frac{3210 \cdot 5,70}{2} + \frac{6446 - 8475}{5,70} = 8783 \ kg.$$

$$c_{max} = \frac{8783}{1560} = 5,64 \ kg/cmq; \qquad x_0 = \frac{8783}{3210} = 273 \ cm.$$

$$S = \frac{5,64 \cdot 273 \cdot 30}{2} = 23200 \ kg; \qquad \mu_p = \frac{9300}{3960} = 2\phi16; \qquad \mu_{st} = \frac{13700}{1400} = \phi8/25u$$

$$M_{max}^{+} = \frac{8783^2}{6420} - 6446 = 5554 \ kgm.$$

$$z = \frac{58}{\sqrt{\frac{55540}{3}}} = \frac{58}{136} = 0,427 < \frac{47,5}{0,00183}$$

$$A_f = 0,00183 \cdot 136 \cdot 30 = 7,5 \ cmq < 3\phi16 + 2\phi10$$

Campata 23-24

$$M_{24}^{-} = 4368 \ kgm; \qquad z = \frac{48}{\sqrt{\frac{43680}{3}}} = \frac{48}{121} = 0,397 < \frac{44}{190}$$

$$A_f' = A_f = 6,95 \ cmq < 3\phi16 + 2\phi10$$

$$T_{max} = 5942 \ kg; \qquad c = \frac{5942}{1290} = 4,61 \ kg/cmq; \qquad x_0 = \frac{5942}{3210} = 186 \ cm.$$

$$S = \frac{186 \cdot 4,61 \cdot 30}{2} = 12900 \ kg; \qquad \mu_p = \frac{5150}{3960} = 2\phi16; \qquad \mu_{st} = \frac{7740}{1400} = \phi8/25u$$
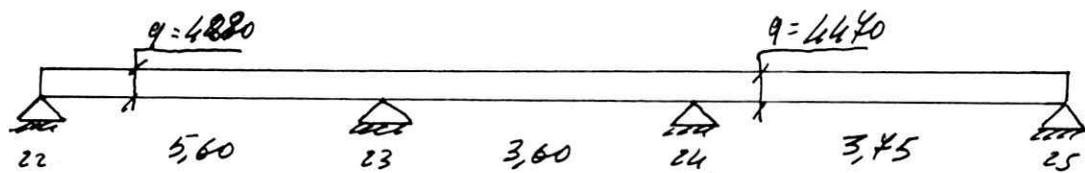
$$M_{max}^{+} = \frac{5942^2}{6420} - 4468 = 5520 - 4468 = 1082 \ kgm < \frac{\tau_e < 25}{A_f' = A_f = 2\phi16}$$

Campata 24-25:

$$M_{25}^{-} = 1381; \qquad z = \frac{48}{\sqrt{\frac{13810}{3}}} = \frac{48}{68} = 0,708 < \frac{84}{108} \qquad A_f = 2,2 \ cmq < 2\phi16$$

$$T = 6865 \ kg; \qquad c = 5,31 \ kg/cmq; \qquad \mu_p = 2\phi16; \qquad \mu_{st} = \phi8/25u$$

$$M_{max}^{+} = \frac{6865^2}{6420} - 4362 = 2988; \qquad z = \frac{48}{100} = 0,480 < \frac{41,5}{162}; \qquad A_f = 3\phi16 > 4,86 \ cmq$$

Trave 22·23·24·25 (II·I·piano terra)

$$q = 4880 \qquad\qquad q = 4470$$

22 —— 5,60 —— 23 —— 3,60 —— 24 —— 3,75 —— 25

Campata 22-23:

$M^-_{22} = 9654\ kgm;\qquad z = \dfrac{58}{\sqrt{\frac{96540}{4}}} = \dfrac{58}{155} = 0,374 <\ \genfrac{}{}{0pt}{}{50}{208}$

$A'_f = 0,50\ A_f = 0,00208 \cdot 40 \cdot 155 = 13\ cmq < 7\ \phi 16$

$M^-_{23} = 13765\ kgm;\quad z = \dfrac{58}{186} = 0,312 <\ \genfrac{}{}{0pt}{}{55}{252}\qquad A'_f = A_f = 18,8 < \genfrac{}{}{0pt}{}{9\phi16}{+2\phi10}$

$T = \dfrac{4880 \times 5,6}{2} + \dfrac{9654 - 13765}{5,60} = 12975\ kg\ ;\quad c = \dfrac{12975}{2080} = 6,22\ kg/cmq.$

$X_0 = \dfrac{12975}{4880} = 266\ cm;\qquad S = \dfrac{266 \cdot 40 \cdot 6,22}{2} = 33100\ <\ \genfrac{}{}{0pt}{}{u_p = 4\ \phi 16}{u_{st} = \phi 8/18"}$

$M^+_{max} = \dfrac{12975^2}{9760} - 9654 = 7546\ kgm.$

$\qquad\qquad z = \dfrac{58}{137,5} = 0,423 <\ \genfrac{}{}{0pt}{}{48}{185}\qquad A_f = 10,2\ cmq < \genfrac{}{}{0pt}{}{5\phi16 +}{2\phi10}$

Campata 23-24

$M^-_{24} = 5940\ kgm;\qquad z = \dfrac{58}{141} = 0,412 <\ \genfrac{}{}{0pt}{}{49.5}{190}$

$A_f = 0,00190 \cdot 141 \cdot 30 = 8,05\ cmq < 4\ \phi 16$

$T = \dfrac{4470 \cdot 3,6}{2} + \dfrac{1643}{3,6} = 8505\ ;\quad c = 5,42\ \frac{kg}{cmq};\quad X_0 = 190\ cm.$

$\qquad S = \dfrac{190 \cdot 30 \cdot 5,42}{2} = 15450\ ;\quad u_p = 2\phi 16;\quad u_{st} = \phi 8/25"$

$M^+_{max} = \dfrac{8505^2}{8940} - 6847 = 1238\ ;\quad z = \dfrac{58}{69} = \ <\ \genfrac{}{}{0pt}{}{<25}{A_f = 2\phi16}$

Campata 24-25:

$M^-_{25} = 3309\ kgm;\qquad z = \dfrac{58}{106,5} = 0,545 <\ \genfrac{}{}{0pt}{}{36}{0,00142.}$

$A_f = 0,00142 \cdot 106,5 \cdot 30 = 4,53\ cmq < 2\phi16 + 2\phi10$

$T_{max} = 9520\ kg\ ;\quad c_{max} = 6,08\ kg/cmq;\quad S = 18900\ kg;\quad \genfrac{}{}{0pt}{}{u_p = 2\phi16}{u_{st} = \phi 8/25"}$

$M^+_{max} = \dfrac{9520^2}{8940} - 5941 = 5041\ ;\quad z = \dfrac{58}{130} = 0,446 <\ \genfrac{}{}{0pt}{}{45}{174}$

$\qquad\qquad A_f = 6,85\ cmq < 3\phi16 + 2\phi10$

Travi $5'$-$6'$; $5'$-$4'$; $7'$-$8'$, -$9'$-$10''$: del pianerottolo di riposo.

$$M^-_{max} = 6469 \ kgm; \qquad r = \frac{68}{\sqrt{\frac{64690}{4}}} = \frac{68}{123} = 0,552 \underset{138}{\overset{35}{<}}$$

$$A_f = 0,00138 \cdot 40 \cdot 123 = 6,8 \ cmq < 3\phi16 + 2\phi10$$

$$T_{max} = \frac{7780 \cdot 3,30}{2} + \frac{6469 - 6127}{3,3} = 12800 + 104 = 12904 \ kg.$$

$$C_{max} = \frac{12904}{0,9 \cdot 40 \cdot 68} = \frac{12904}{2440} = 5,3 \ kg/cmq; \quad x_0 = \frac{12904}{7780} = 166 \ cm.$$

$$S = \frac{166 \cdot 5,3 \cdot 40}{2} = 17500 \ kg \begin{cases} u_p = \frac{8750}{3860} = 2\phi16 \\ u_{st} = \frac{10500}{1400} = \phi8/20'' \end{cases}$$

$$M^+_{max} = \frac{12904^2}{15560} - 6469 = 4291 \ kgm.$$

$$r = \frac{68}{\sqrt{\frac{42910}{4}}} = \frac{68}{104} = 0,652 \underset{116}{\overset{29}{<}}$$

$$A_f = 0,00116 \cdot 104 \cdot 40 = 4,83 \ cmq < 2\phi16 + 2\phi10$$

Armatura a torsione

$$M_t = 965 \ kgq/ml \quad ; \quad M_i = \frac{965 \cdot 33}{2} = 1514 \ kgm.$$

$$\frac{a}{b} = \frac{70}{40} = 1,75; \qquad \psi = 4,18$$

$$C_{tot} = 5,3 + \frac{4,18 \cdot 1540}{70 \cdot 1600} = 5,3 + 5,75 = 11,05 < 14 \ kg/cmq.$$
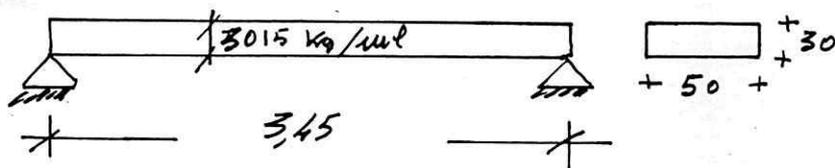
Realizzando l'armatura a torsione con ferri long. e staffe

$$A_{fl} = \frac{154'000 (65 + 35)}{65 \cdot 35 \cdot 1400} = 4,9 \ cmq < 3\phi16$$

$$\frac{st}{u} = \frac{2 \cdot 35 \cdot 85 \cdot 1400 \cdot 05}{154000} = 20,4 \ cm.$$

si useranno staffe $\phi8/20''$

Travi $1'-2'$; $8'-9'$ a spessore di II·I·p.t.

Momenti negativi:

$$M_1^- = M_2^- = \frac{3015 \cdot 3,45^2}{12} = 2900 \; kgm$$

$$r = \frac{28}{\sqrt{2900/5}} = \frac{28}{76} = 0,368 \begin{cases} 42,5 \\ 0,00210 \end{cases}$$

$$A_f' = A_f = 0,00210 \cdot 76 \cdot 50 = 8 \; cmq < 4\phi16$$

Momento di campata

$$M^+ = \frac{3015 \cdot 3,45^2}{8} = 4500 \; kgm$$

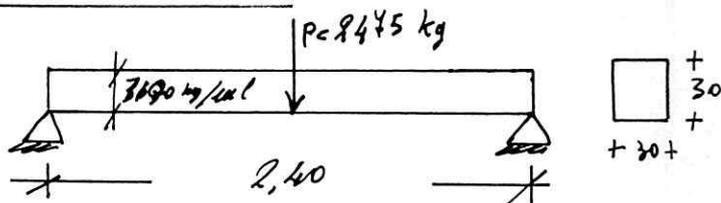$$r = \frac{28}{\sqrt{9000}} = \frac{28}{95} = 0,295 \begin{cases} \sigma_c = 57 \\ 0,00260 \end{cases}$$

$$A_f' = A_f = 0,00260 \cdot 95 \cdot 50 = 12,4 \; cmq < 7\phi16$$

$$T_{max} = \frac{3015 \cdot 3,45}{2} = 5230 \; kg \; ; \quad t = \frac{5230}{0,9 \cdot 50 \cdot 28} = 4,18 \; kg/cmq.$$

$$X_0 = \frac{5230}{3015} = 172,5 \; cm \; ; \quad S = \frac{4,18 \cdot 172,5 \cdot 50}{2} = 18100 \; kg.$$

$$u_p = \frac{7200}{3960} = 2\phi16 \; ; \quad u_{st} = \frac{10900}{1400} = \phi 8/20''$$

Trave $4'-5'$

$$M_4^- = M_5^- = M^+ = \frac{3180 \cdot 2,4^2}{12} + \frac{2475 \cdot 2,4}{8} = 1530 + 745 = 2275 \; kgm.$$

$$r = \frac{28}{\sqrt{\frac{22750}{3}}} = \frac{28}{87} = 0,322 \begin{cases} 52 \\ 0,00245 \end{cases}$$

$$A_f' = A_f = 0,00245 \cdot 87 \cdot 30 = 6,4 \; cmq < 3\phi16 + 2\phi10$$

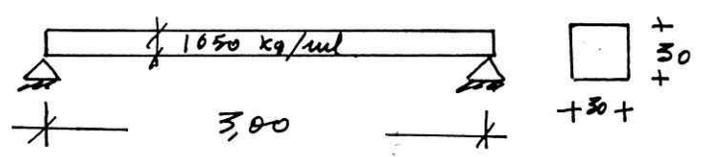$$T = \frac{3190 \cdot 2,40}{2} + 1237 = 3830 + 1235 = 5065 \text{ kg}.$$

$$c_1 = \frac{5065}{765} = 6,6 \text{ kg/cmq} \quad ; \quad c_2 = \frac{1237}{765} = 1,62.$$

$$S = \frac{6,6 + 1,62}{2} \cdot 120 \cdot 30 = 14.800 \text{ kg}.$$

$$M_p = \frac{5930}{3960} \approx 2\phi 16 \quad ; \quad M_{st} = \frac{8800}{1600} = \phi 8/20''$$
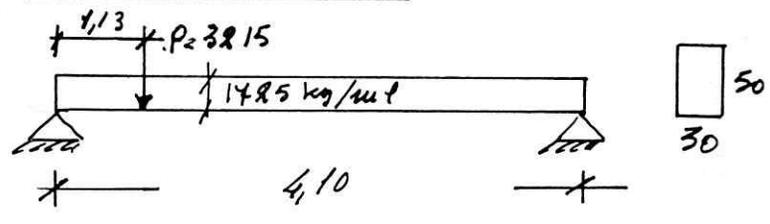
Travetto 4"-13'

$$M^+ = \frac{1650 \cdot 3^2}{8} = 1230 \text{ kgm} ; \quad z = \frac{28}{78,5} = 0,357 \underset{225}{\overset{50}{\diagdown}} \quad A'_f = A_f = 5,3 < 3\phi 16$$

$$c_{max} = \frac{2480}{765} = 3,24 \text{ kg/cmq} ; \Rightarrow st. \phi 8/20''$$

Trave 4-13 ; 5-14 :

$$M^-_{4-5} = \frac{1485 \cdot 4,10^2}{12} + \frac{3215 \cdot 1,13 \cdot 2,97^2}{4,1^2} = 4360 \text{ kgm}.$$

$$z = \frac{48}{\sqrt{\frac{43600}{3}}} = \frac{48}{121} = 0,397 \underset{0,00190}{\overset{43}{\diagdown}}$$

$$A'_f = A_f = 0,00190 \cdot 121 \cdot 30 = 6,9 < 3\phi 16 + 2\phi 10$$

$$M^-_{13-14} = 2420 + 740 = 3160 \text{ kgm} ; \quad z = 0,465 \underset{0,00167}{\overset{43}{\diagdown}} \quad A_f = 5,2 < 3\phi 16.$$

$$T_{max} = \frac{1485 \cdot 4,10}{2} + \frac{3215 \cdot 2,97}{4,1} = 5370 \text{ kgm} ; \quad c_{max} = \frac{5370}{1290} = 4,55.$$
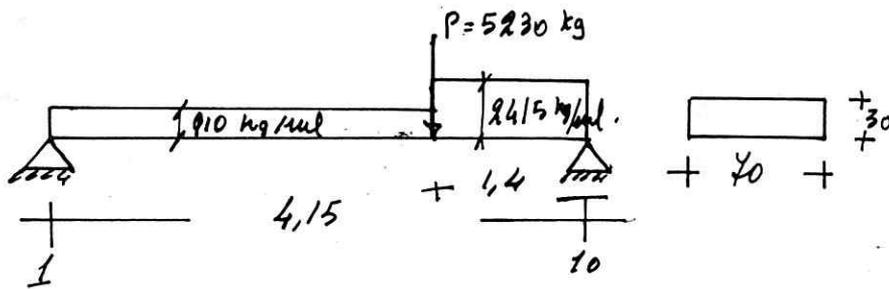
$$x_0 = \frac{5870}{1725} = 154$$

$$M^+ = 5870 \cdot 1,54 - \frac{1485 \cdot 1,54^2}{2} - 3215 \cdot 0,41 - 2180 = 4570 \text{ kgm}.$$

$$z = \frac{48}{\sqrt{\frac{45700}{3}}} = \frac{48}{123,5} = 0,387 \underset{0,00210}{\overset{52}{\diagdown}} \quad A'_f = 0,25 A_f = 1,9 \text{ cmq} < 4\phi 16$$

$$S = S_1 + S_2 \begin{cases} S_1 = \frac{2,74 \cdot 205 \cdot 30}{2} = 8500 \\ S_2 = 1,81 \cdot 113 \cdot 30 = 6150 \end{cases} \qquad M_p = 2\phi 16 \\ M_{st} = \phi 8/20''$$

Прол 1-10   (II - I · р.т)

$P = 5230$ kg

910 kg/ml.   2415 kg/ml.

+30

+ 70 +

4,15   + 1,4

1   10

$$M_1^- = \frac{910 \cdot 4,15^2}{12} + \frac{(2415-910) \cdot 3,45 \cdot 0,7^2}{4,15^2} + \frac{5230 \cdot 2,75 \cdot 1,4^2}{4,15^2} = 3108 \text{ кдм.}$$

$$M_{10}^- = 1330 + \frac{1505 \cdot 0,7 \cdot 3,45^2}{4,15^2} + 3250 = 5310 \text{ кдм.}$$

$$T_1' = \frac{910 \cdot 4,15}{2} + \frac{5230 \cdot 1,4}{4,15} + \frac{1505 \cdot 1,4^2}{2 \cdot 4,15} + \frac{M_1 - M_2}{\ell} = 3507 \text{ kg.}$$

$$T_{10} = 1890 + \frac{5230 \cdot 2,75}{4,15} + \frac{1505 \cdot 1,4 \cdot 3,45}{4,15} = 7618 \text{ kg}$$

$$X_0 = 2,75 ; \quad \tau_{max} = \frac{7618}{1765} = 4,32 \text{ kg/cmq.}$$

$$M^+ = 3507 \cdot 2,75 - \frac{910 \cdot 2,75^2}{2} - \frac{3108}{2} = 4656 \text{ кдм.}$$

$$S = S_1 + S_2 + S_3 - S_4 = 25710 \text{ kg}$$

$\begin{cases} S_1 = \frac{1,07 \cdot 70 \cdot 207,5}{2} = 7770 \\ S_2 = 1,02 \cdot 70 \cdot 275 = 19300 \\ S_3 = 0,207 \cdot 70 \cdot 275 = 3980 \\ S_4 = 0,287 \cdot 70 \cdot 275 = 5340 \end{cases}$

$$u_p = \frac{10300}{3260} = 3416$$

$$u_{st} = \frac{15450}{1400} = \phi 8/15''$$

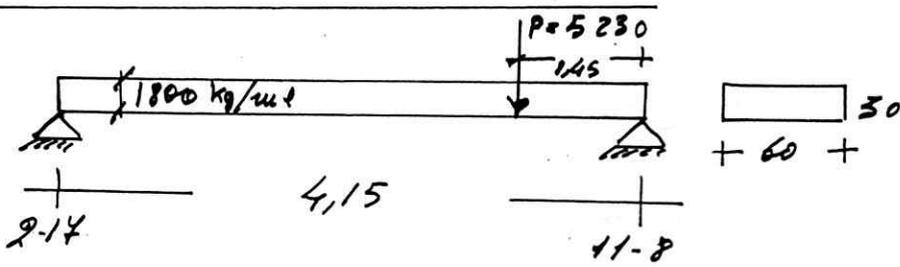$$M_1^- = 3108 ; \quad z = \frac{28}{\sqrt{\frac{31080}{7}}} = \frac{28}{66,8} = 0,422 \genfrac{}{}{0pt}{}{48}{185}$$

$$A_f = 0,00185 \cdot 66,5 \cdot 70 = 8,6 \text{ сmq} < 4\phi16 + 2\phi10$$

$$M_{10}^- = 5310 ; \quad z = \frac{28}{\sqrt{\frac{53100}{7}}} = \frac{28}{87} = 0,322 \genfrac{}{}{0pt}{}{53}{0,00245}$$

$$A_f' = A_f = 0,00245 \cdot 70 \cdot 87 = 14,9 \text{ сmq} < 7\phi16 + 2\phi10$$

$$M^+ = 4656 ; \quad z = \frac{28}{79,5} = 0,353 \genfrac{}{}{0pt}{}{48}{225}$$

$$A_f' = A_f = 12,5 \text{ сmq} < 6\phi16 + 2\phi10$$

Прог. 2-11; 8-17; (II; I; р.т)

$$M^-_{2-17} = \frac{1800 \cdot 4,15^2}{12} + \frac{5230 \cdot 2,70 \cdot 1,45^2}{4,15^2} = 2580 + 1730 = 4310 \text{ кгм.}$$

$$z = \frac{28}{\sqrt{\frac{43100}{6}}} = \frac{28}{84,7} = 0,331 < \frac{57}{235}$$

$$A'_f = A_f = 0,00235 \cdot 84,7 \cdot 60 = 10 \text{ сщ} < 5 \varnothing 16$$

$$M^-_{11-8} = 2580 + \frac{5230 \cdot 1,45 \cdot 2,7^2}{4,15^2} = 2580 + 3230 = 5810 \text{ кгм.}$$

$$z = \frac{28}{\sqrt{\frac{58100}{6}}} = \frac{28}{98,5} = 0,284 < \frac{57}{265}$$

$$A'_f = A_f = 0,00265 \cdot 98,5 \cdot 60 = 15,6 \text{ сщ} < 8 \varnothing 16$$

$$T^-_{2-17} = \frac{1800 \cdot 4,15}{2} + \frac{5230 \cdot 1,45}{4,15} = 3750 + 1830 - 347 = 5233 \text{ кгм.}$$

$$T^-_{11-8} = 3750 + 3420 + 347 = 7517 \text{ кг.}$$

$$\tau_{max} = \frac{7517}{1510} = 4,98 \text{ кг/сщ}$$

$$M^+_{max} = 7517 \cdot 1,45 - \frac{1800 \cdot 1,45^2}{2} - \frac{5810}{2} = 10900 - 1900 - 2905 = 6095 \text{ кгм.}$$

$$z = \frac{28}{\sqrt{\frac{60950}{6}}} = \frac{28}{100,5} \approx 0,280 < \frac{58}{275}$$

$$A'_f = A_f = 0,00275 \cdot 100,5 \cdot 60 = 16,5 \text{ сщ} < 8 \varnothing 16 + 2 \varnothing 10$$
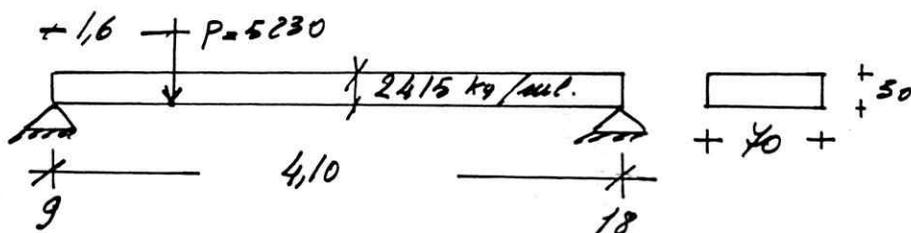
$$P = S_1 + S_2 + S_3 = 37400 \text{ кг} \qquad \begin{cases} S_1 = \frac{2,48 \cdot 208 \cdot 60}{2} = 15500 \text{ кг.} \\ S_2 = 2,27 \cdot 145 \cdot 60 = 19850 \text{ "} \\ S_3 = 0,829 \cdot 145 \cdot 60 = 2000 \text{ "} \end{cases}$$

$$U_p = \frac{15000}{3960} \approx 4 \varnothing 16$$

$$U_{st} = \frac{22600}{1400} = \varnothing 8/15''$$

Trave 9-18   (II ; I ; p.t)

$\leftarrow 1,6 \rightarrow \quad \downarrow P = 5230$

2415 kg/ml.

$\square \quad \begin{array}{c} \leftarrow 50 \\ \leftarrow 70 \rightarrow \end{array}$

4,10

9   18

$$M_9^- = \frac{2415 \cdot 4,10^2}{12} + \frac{5230 \cdot 1,6 \cdot 2,5^2}{4,1^2} = 3370 + 3000 = 6370 \text{ kgm.}$$

$$M_{18}^- = 3370 + \frac{5230 \cdot 2,5 \cdot 1,6^2}{4,1^2} = 5270 \text{ kgm.}$$

$$T_9 = \frac{2415 \cdot 4,1}{2} + \frac{5230 \cdot 2,50}{4,1} + \frac{6370 - 5270}{4,1} = 8418 \text{ kgm.}$$

$$T_{18} = 4950 + 2040 - 268 = 6722 \text{ kg.}$$

$$M_{max}^+ = 8418 \cdot 1,6 - \frac{2415 \cdot 1,6^2}{2} - \frac{6370}{2} = 7105 \text{ kgm.}$$

$$\tau_{max} = \frac{8418}{0,9 \cdot 70 \cdot 28} = 4,78 \text{ kg/cmq}$$

$$S = S_1 + S_2 + S_3 = 40'936 \text{ kg} ; \quad \begin{cases} S_1 = \frac{2,81 \cdot 205 \cdot 70}{2} = 20200 \text{ kg} \\ S_2 = 1,81 \cdot 160 \cdot 70 = 20300 \text{ "} \\ S_3 = 0,00152 \cdot 410 \cdot 70 = 436 \text{ "} \end{cases}$$

$$u_f = \frac{16400}{3960} = 4 \phi 16 ; \quad u_{st} = \phi 8/15"$$

$$M_9^- = 6370 ; \quad z = \frac{28}{\sqrt{\frac{63700}{7}}} = \frac{28}{95,5} = 0,293 < \frac{56}{260}$$

$$A_f' = A_f = 0,00260 \cdot 95,5 \cdot 70 = 17,4 \text{ cmq} < 8\phi 16 + 2\phi 10$$

$$M_{18}^- = 5270 ; \quad z = \frac{28}{\sqrt{\frac{52700}{7}}} = \frac{28}{75} = 0,373 < \frac{53}{240}$$

$$A_f' = A_f = 0,00240 \cdot 75 \cdot 70 = 14,6 < 7\phi 16 + 2\phi 10$$
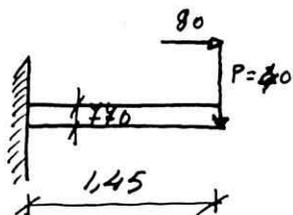
$$M^+ = 7105 ; \quad z = \frac{28}{\sqrt{\frac{71050}{7}}} = \frac{28}{100} = 0,280 < \frac{60}{279}$$

$$A_f' = A_f = 0,00279 \cdot 100 \cdot 70 = 19,8 < 10 \phi 16$$

Cordoli 10-19; 13-21; 14-22; 18-25

Armatura con 6 ∅16 superiori ed inferiori dei quali 2 sagomati;
staffe ∅8/25"

Verifica a torsione travi 3-4-5-6 (II·I·p.t.)

Luce max: trave 3-4; l= 335 cm; Sez.= 30×50 cmq.

$$M_t = \frac{770 \cdot 1{,}45^2}{2} + 40 \cdot 1{,}45 + 90 = 963 \ kgm/ml.$$

$$M_i = \frac{963 \cdot 3{,}35}{2} = 1610 \ kgm.$$

$$\frac{a}{b} = \frac{50}{30} = 1{,}67 \rightarrow \gamma = 4{,}25.$$

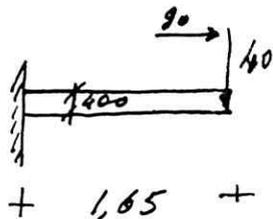$$\tau_{max} = \frac{161000 (25+45)}{25 \cdot 45 \cdot 1400} = 13{,}7 \ kg/cmq.$$

$$A_{fl} = \frac{161'000 (25+45)}{25 \cdot 45 \cdot 1400} = 7{,}95 \ cmq$$

$$A_2 = \frac{2 \cdot 25 \cdot 45 \cdot 1400 \cdot 0{,}79}{161'000} = 15{,}4 \ cm.$$

Si armerà a torsione con 4 ferri longitud. ∅16
e staffe ∅10/15"

Verifica a torsione travi 20-21; 22-23

Luce max: travi 20-21; l= 565 cm; Sez = 40×60 cmq.

$$M_t = \frac{400 \cdot 1{,}65^2}{2} + 40 \cdot 1{,}65 + 90 = 706 \ kgm/ml.$$

$$M_i = \frac{706 \cdot 5{,}65}{2} = 1980 \ kgm.$$

$$\tau_{max} = \frac{4,33 \cdot 198000}{60 \cdot 40^3} = 8,95 \ kg/cmq.$$
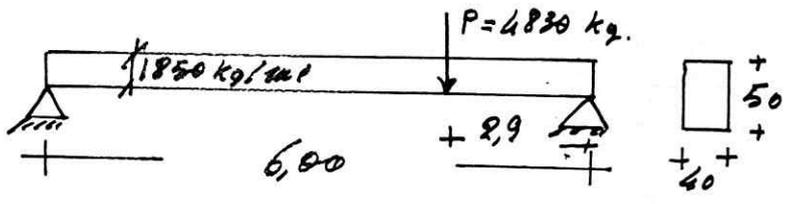
$$\frac{a}{b} = 1,5 \rightarrow \gamma = 4,33$$

$$A_{fl} = \frac{198000 (35+55)}{35 \cdot 55 \cdot 1400} = 6,62 \ cmq.$$

$$\Delta_2 = \frac{8 \cdot 35 \cdot 55 \cdot 1400 \cdot 0,79}{198000} = 21,4 \ cm.$$

Si armerà a torsione con 4 ferri longit. $\phi 16$ e staffe $\phi 10/20"$

Travi a spessore : Si disporranno in corrispondenza di ogni appoggio 4 $\phi 12$ perpendicolari alle travi -

Travi 13-21 ; 14-22 (seminterrato)

$$M_{max}^{-} = \frac{1850 \cdot 36}{12} + \frac{4820 \cdot 2,9 \cdot 3,1^2}{36} = 5550 + 3760 = 9310 \ kgm$$

$$t = \frac{48}{\sqrt{\frac{93100}{4}}} = \frac{48}{152} = 0,316 \quad < \begin{array}{l} 53 \\ 0,00240 \end{array}$$

$$A_f^{'} = A_f = 0,00240 \cdot 152 \cdot 40 = 14,6 \ cmq < 7\phi16 + 2\phi10$$

$$M_{max}^{+} = \frac{1850 \cdot 36}{20} + 2415 \cdot 3 - \frac{4830 \cdot 6}{8} = 5835 \ kgm.$$

$$t = \frac{48}{\sqrt{\frac{58350}{4}}} = \frac{48}{122} = 0,394 \quad < \begin{array}{l} 48 \\ 0,00200 \end{array}$$

$$A_f^{'} = 0,50 \ A_f = 0,00200 \cdot 122 \cdot 40 = 9,8 \ cmq < 5\phi16$$

$$T = 1850 \cdot 3,00 + 2415 = 5550 + 2415 = 7965 \ kg.$$

$$\tau_{max} = \frac{7965}{1720} = 4,62 \ kg/cmq \qquad u_p = \frac{11200}{3760} = 3\phi16 \ piegati.$$

$$u_{st} = \phi 8/25"$$

Travi 21-22 ; 13-14 (seminterrato)

$$M = 2980 \text{ kgm} ; \quad z = \frac{38}{\sqrt{\frac{29800}{4}}} = \frac{38}{86.5} = 0,440 < \begin{array}{c} 46 \\ 0,00178 \end{array}$$

$$A_f = 0,00178 \cdot 40 \cdot 86,5 = 6,15 \text{ cmq} < 3\phi16 + 2\phi16$$

$$M^+ = 1780 \text{ kgm} ; \quad z = \frac{38}{\sqrt{\frac{17800}{4}}} = \frac{38}{67} = 0,565 < \begin{array}{c} 34 \\ 0,00134 \end{array}$$
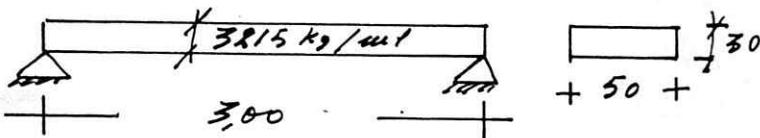
$$A_f = 0,00134 \cdot 40 \cdot 67 = 3,65 \text{ cmq} < 2\phi16.$$

$$T = \frac{3960 \cdot 3}{2} = 5950 \text{ kg} ; \quad c = \frac{5950}{1370} = 4,35 \text{ kg/cmq} ;$$

$$S = \frac{4,35 \cdot 40 \cdot 150}{2} = 13000 \text{ kg} ; \quad u_p = \frac{5200}{3960} = 2\phi16$$

$$u_{st} = \phi 8/20''$$

Trave 13'-14' (seminterrato)

$$M = \frac{3215 \cdot 9}{12} = 2480 \text{ kgm} ;$$

$$z = \frac{28}{\sqrt{\frac{24.800}{5}}} = \frac{28}{69,5} = 0,404 < \begin{array}{c} 45 \\ 0,00186 \end{array}$$

$$A_f' = 0,5 A_f = 0,00186 \cdot 69,5 \cdot 50 = 6,5 < 4\phi16$$

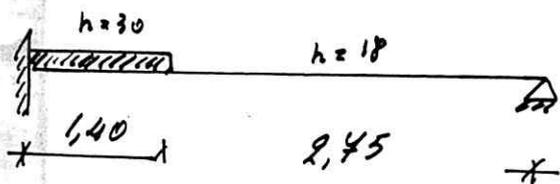$$T = 3215 \cdot 1,5 = 4830 \text{ kg} ; \quad x_0 = \frac{4830}{3215} = 150 ;$$

$$C_{max} = \frac{4830}{1260} = 3,83 \text{ kg/cmq} ; \quad 1 \phi16 \text{ piegato} ; \quad \phi 8/20''$$
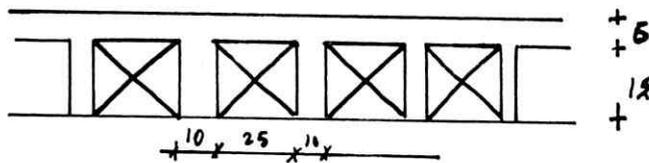
$$M^+ = \frac{3215 \cdot 9}{14} = 2070 \text{ kgm} ;$$

$$z = \frac{28}{\sqrt{\frac{20700}{5}}} = \frac{28}{64,5} = 0,434 < \begin{array}{c} 47 \\ 0,00181 \end{array}$$

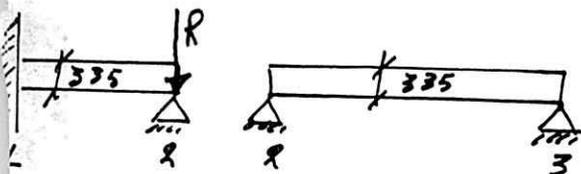$$A_f = 0,00181 \cdot 64,5 \cdot 50 = 5,85 \text{ cmq} < 3\phi16$$

Scala (rampa tipo)

h=30   h=18

1,40   2,75

Soletta rampante mista

+6 +12

10 25 10

Schema di calcolo

335   335

2 2 3

Analisi dei carichi:

p. proprio   250 kg/mq.
gradini rip.   200 "
pav. nitou.   100 "
Sormaccario   400 "
_____
                  950 kg/mq.

per travetto

$950 \times 0,35 = 335 \ kg/ml$

Calcolo della soletta rampante:

$M_q^- = M_8^- = M_{2-3}^+ = \frac{1}{12} 350 \cdot 2,75^2 = 222 \ kgm$

$t' = \frac{16}{\sqrt{2220}} = \frac{16}{47} = 0,341 < \frac{50,5}{0,00225}$

$A_f' = A_f = 0,00225 \cdot 47 \cdot 10 = 1,06 \ cmq < 1\phi14$

$R = \frac{335 \cdot 2,75}{2} = 460 \ kg$; $t_{max} = \frac{460}{0,9 \cdot 10 \cdot 16} = \frac{460}{144} = 3,18 \ kg/cmq.$

1 ϕ14 sagomato.

Calcolo del pianerottolo:

$M_1^- = \frac{335 \cdot 1,4^2}{2} + 460 \cdot 1,4 = 328 + 644 = 972 \ kgm.$

$t' = \frac{28}{\sqrt{9720}} = \frac{28}{98,5} = 0,284 < \frac{\sigma_c < 60}{t = 0,00279}$

$A_f' = A_f = 0,00279 \cdot 10 \cdot 98,5 = 2,76 \ cmq < 2\phi14$

Dott. Ing. Augusto Romita

$T = 335 \cdot 1,4 + 480 = 470 + 480 = 950 \ kg.$

$t = \frac{950}{0,9 \cdot 10 \cdot 28} = 3,83 \ kg/cmq$; 1 ϕ14 sagomato

Telaio n° 3 - Pilastri 19-20-21-22-23-24-25

19   20   21   22   23   24   25