

Prefeitura Municipal de Pôrto Alegre

PROTOCOLO GERAL

PROCESSO N.º 19207 2

Vide processo nº
14033/48

INTERESSADO: FRANCISCO M. MEDAGLIA

ASSUNTO: MODIFICAÇÃO DE PAVIMENTO TERREO

LOCAL: L Ed. L.
RUA C. COLOMBO 256, 260, 264

DISTRIBUIÇÃO	Classificação	ANEXOS :		
		DOCUMENTOS	PLANTAS	CHAVES
OV.	-52		4	

OBS.:

anexo ap 109107-64
Const 14.033/48
SEM EFETIVO
194 9

Nenhum processo poderá ser encaminhado EM MÃOS,
nos seus diferentes trâmites pela Prefeitura, a não
ser quando assim determine o Prefeito.

18

Ilmo. Snr. Prefeito Municipal

19207

Leq

R

M-52

4 plants

Francisco M. Medaglia, proprietário
do terreno à rua Cristovão Colombo; Modificação do pavimento terreo
junto ao prédio n.º 256 desejando construir, conforme plantas anexas
vem pedir a V. S.ª a respectiva licença.

O requerente reside à Rua C. Calcinha n.º 438

Nestes termos

P. deferimento.

Pôrto Alegre, 20 de junho de 1949

DIRETORIA GERAL DE
SERVIÇOS INDUSTRIAES
(Departamento Central)

5 JUL 1949

PROTOCOLLO

De Francisco Medaglia

Seu assento:

F. L. de A. B. S.
Eng. civil

D.G.O.V. CR\$ 320

Formulário: CONSTRUÇÃO

D. DE OBRAS

1ª SECCAO

N.º 29

15492-36

24-6-49

Aguirre

D.G.O.V. PROTOCOLO
Recor. plantas
Em 4 de 8 1949
Rodrigues

Directoria Geral Viacao
PRO
Directoria de Instalações
Domiciliares
Agua e Exgotto
PROTOCOLLO

15 JUL 1949

Fls. 190

Nos. 27

BRASIL
PREFEITURA
DE
PORTO ALEGRE
TAXA DE EFFICIENTE
*0320
CR\$ 1 CENTAVOS

PREFEITURA MUNICIPAL
CIVIL
PORTO ALEGRE

6186

S. G. URBANISMO
Nada temos a opôr.

24/6/49

Subst. o Sub-Diretor

Recomendamos a
inscrição a S. G. U. de
Industriais.

Em 4-3-49

Solicitamos a
D. G. S. L.

5-7-49

M. J. Queiroz

à D. I. P.

em 18-7-49

D. J. J. J.

A planta de esgoto
fica na D. I. P.

7-7-1949

J. J. J.

J. J. J.

8/7/49

J. J. J.

D. I. P. O. V.

8.7.49

J. J. J.

Recomendamos a
inscrição a S. G. U. de
Industriais.

Em 19-7-49

J. J. J.

Visto
20-7-49

M. J. Queiroz

Nada mais te-
mos a opôr.

Em 27-7-49

J. J. J.

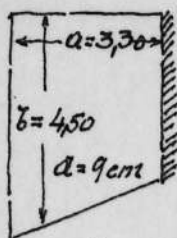
De acordo
2-8-49

M. J. Queiroz

CALCULO DA ESTRUTURA DE CONCRETO ARMADO PARA O EDIFICIO DE PROPRIEDADE DO SNR.^o FRANCISCO MAINERI MEDAGLIA, A SER CONSTRUIDO A' RUA CRIS. COLOMBO, ONDE EXISTEM OS PREDIOS N^{os} 258 E 260.

A) CALCULO DAS LAGES.

LAGE 1



$$a=3,30; b=4,50; \frac{b}{a} = \frac{4,5}{3,3} = 1,39; m_a = 20,1; m_b = 50,8; h_a = 0,904$$

$$M_a = \frac{450 \times 10,89}{20,1} = 243 \text{ mkg}; \sigma_c = 36; s_{fa} = 2,37; \underline{5 \phi \frac{5}{16} \text{ p.m.}}$$

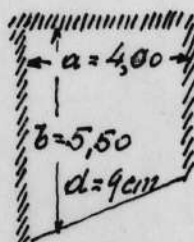
$$M_b = \frac{450 \times 10,89}{50,8} = 96 \text{ mkg}; \sigma_c = 21; s_{fb} = 0,91; \underline{6 \phi \frac{3}{16} \text{ p.m.}}$$

$$d = 9 \text{ cm. } q_a = 0,904 \times 450 = 405; q_b = 450 - 405 = 45$$

$$-M_a = -\frac{1}{10} \times 405 \times 10,89 = -440 \text{ mkg}; \text{Calc. } -\frac{440 + 632}{2} = -536 \text{ mkg.}$$

$$\sigma_c = 59; s_{fa} = 5,45; \underline{11 \phi \frac{5}{16} \text{ p.m.}}$$

LAGE 2



$$a=4,00; b=5,50; \frac{b}{a} = \frac{5,5}{4,0} = 1,38; m_a = 31,3; m_b = 69,3; h_a = 0,879$$

$$M_a = \frac{450 \times 16}{31,3} = 230 \text{ mkg}; \sigma_c = 35; s_{fa} = 2,25; \underline{5 \phi \frac{5}{16} \text{ p.m.}}$$

$$M_b = \frac{450 \times 16}{69,3} = 104 \text{ mkg}; \sigma_c = 22; s_{fb} = 0,99; \underline{6 \phi \frac{3}{16} \text{ p.m.}}$$

$$d = 9 \text{ cm. } q_a = 0,879 \times 450 = 395; q_b = 450 - 395 = 55$$

$$-M_a = -\frac{1}{10} \times 395 \times 16 = -632 \text{ mkg. Calc. } -536 \text{ mkg.}$$

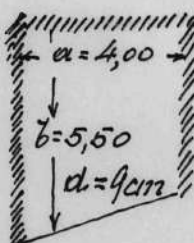
$$\sigma_c = 29; s_{fa} = 5,45; \underline{11 \phi \frac{5}{16} \text{ p.m.}}$$

$$-M_b = -\frac{1}{10} \times 55 \times 30,35 = -165 \text{ mkg. Calc. } -\frac{(166 + 605)}{2} = -386 \text{ mkg.}$$

$$\sigma_c = 48; s_{fb} = 3,87; \underline{8 \phi \frac{5}{16} \text{ p.m.}}$$

$$-M_{ad} = -\frac{1}{12} \times 16 \times 395 = -526 \text{ mkg}; \sigma_c = 58; s_{fa} = 5,32; \underline{11 \phi \frac{5}{16} \text{ p.m.}}$$

LAGE 3



Identica a Lage 2

$$M_a = 230; s_{fa} = 2,25; \underline{5 \phi \frac{5}{16} \text{ p.m.}}$$

$$M_b = 104; s_{fb} = 0,99; \underline{6 \phi \frac{3}{16} \text{ p.m.}}$$

$$d = 9 \text{ cm. } q_a = 395; q_b = 55$$

$$-M_a = -526 \text{ mkg.}$$

$$s_{fa} = 5,32; \underline{11 \phi \frac{5}{16} \text{ p.m.}}$$

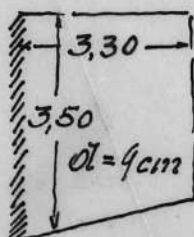
$$-M_{ad} = -632 \text{ mkg. Calc. } -\frac{632 + 370}{2} = -501 \text{ mkg.}$$

$$\sigma_c = 57; s_{fb} = 5,15; \underline{11 \phi \frac{5}{16} \text{ p.m.}}$$

$$-M_b = -166 \text{ mkg. Calc. } -\frac{166 + 635}{2} = -400 \text{ mkg.}$$

$$\sigma_c = 44; s_{fb} = 4,00; \underline{6 \phi \frac{3}{8} \text{ p.m.}}$$

LAGE 4



$$a=3,30; b=3,50; \frac{b}{a} = \frac{3,5}{3,3} = 1,06; m_a = 27,5; m_b = 38,2; h_a = 0,756$$

$$M_a = \frac{450 \times 10,89}{27,5} = 178 \text{ mkg}; \sigma_c = 30; s_{fa} = 1,73; \underline{6 \phi \frac{1}{4} \text{ p.m.}}$$

$$M_b = \frac{450 \times 10,89}{38,2} = 128 \text{ mkg}; \sigma_c = 25; s_{fb} = 1,23; \underline{7 \phi \frac{3}{16} \text{ p.m.}}$$

$$d = 9 \text{ cm}; \quad q_a = 0,756 \times 450 = 340; \quad q_b = 450 - 340 = 100$$

$$-M_a = -\frac{1}{10} \times 10,84 \times 340 = -370 \text{ mkg}; \quad \text{Calc.} = -501 \quad s_{fa} = 5,15; \quad 11 \phi \frac{5}{16} \text{ p.m.}$$

LAGE 5.

$$v_{a0} = 2,10; \quad M = \frac{450 \times 4,41}{10} = 198 \text{ mkg}; \quad d = 8 \text{ cm}; \quad \sigma_c = 38; \quad s_f = 2,25; \quad 7 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 6.

$$v_{a0} = 1,00; \quad M = \frac{450 \times 1,21}{8} = 68 \text{ mkg}; \quad d = 7 \text{ cm}; \quad \sigma_c = 25; \quad s_f = 0,90; \quad 6 \phi \frac{3}{16} \text{ p.m.}$$

Identica a Lage 6.

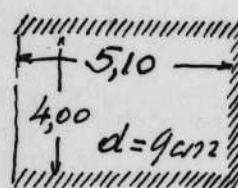
LAGE 7.

$$M = 68 \text{ mkg}; \quad d = 7 \text{ cm}; \quad \sigma_c = 25; \quad s_f = 0,90; \quad 6 \phi \frac{3}{16} \text{ p.m.}$$

LAGE 8.

$$v_{a0} = 2,20; \quad M = \frac{450 \times 4,84}{10} = 218 \text{ mkg}; \quad d = 8 \text{ cm}; \quad \sigma_c = 40; \quad s_f = 2,48; \quad 8 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 9.



$$a = 4,00; \quad b = 5,10; \quad \frac{b}{a} = \frac{5,1}{4,0} = 1,27; \quad m_a = 33,5; \quad m_b = 62,5; \quad h_a = 0,837$$

$$M_a = \frac{450 \times 16}{33,5} = 215 \text{ mkg}; \quad \sigma_c = 34; \quad s_f = 2,13; \quad 7 \phi \frac{1}{4} \text{ p.m.}$$

$$M_b = \frac{450 \times 16}{62,5} = 115 \text{ mkg}; \quad \sigma_c = 24; \quad s_f = 1,13; \quad 7 \phi \frac{3}{16} \text{ p.m.}$$

$$d = 9 \text{ cm}$$

$$q_a = 450 \times 0,837 = 375;$$

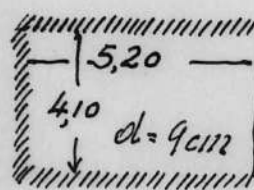
$$q_b = 450 - 375 = 75$$

$$-M_{a_e} = -\frac{1}{10} \times 16 \times 375 = -605 \text{ mkg}; \quad \text{Calc.} = -386 \text{ mkg}; \quad \sigma_c = 48; \quad s_{fa_e} = 3,87; \quad 8 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_{a_d} = -\frac{1}{12} \times 16 \times 375 = -504 \text{ "}; \quad \text{"} = -440 \text{ "}; \quad \sigma_c = 52; \quad s_{fa_d} = 4,45; \quad 9 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{1}{8} \times 26,01 \times 75 = -245 \text{ "}; \quad \text{"} = -250 \text{ "}; \quad \sigma_c = 37; \quad s_{fb} = 2,47; \quad 5 \phi \frac{5}{16} \text{ p.m.}$$

LAGE 10.



$$a = 4,10; \quad b = 5,20; \quad \frac{b}{a} = \frac{5,2}{4,1} = 1,27; \quad m_a = 33,5; \quad m_b = 62,5; \quad h_a = 0,832$$

$$M_a = \frac{450 \times 16,81}{33,5} = 227 \text{ mkg}; \quad \sigma_c = 35; \quad s_{fa} = 2,24; \quad 5 \phi \frac{5}{16} \text{ p.m.}$$

$$M_b = \frac{450 \times 16,81}{62,5} = 122 \text{ mkg}; \quad \sigma_c = 24; \quad s_{fb} = 1,16; \quad 7 \phi \frac{3}{16} \text{ p.m.}$$

$$d = 9 \text{ cm}$$

$$q_a = 0,837 \times 450 = 375$$

$$q_b = 450 - 375 = 75$$

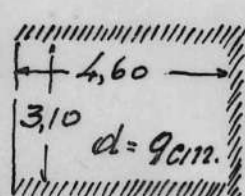
$$-M_{a_e} = -\frac{375 \times 16,81}{10} = -635 \text{ mkg}; \quad \text{Calc.} = -400 \text{ mkg}; \quad \sigma_c = 54; \quad s_{fa_e} = 4,00; \quad 6 \phi \frac{3}{8} \text{ p.m.}$$

$$-M_{a_d} = -\frac{375 \times 16,81}{12} = -530 \text{ "}; \quad \text{"} = -435 \text{ "}; \quad \sigma_c = 52; \quad s_{fa_d} = 4,40; \quad 9 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{2704 \times 75}{8} = -254 \text{ "}$$

$$s_{fb} = 2,47; \quad 5 \phi \frac{3}{8} \text{ p.m.}$$

LAGE 11.



$$a = 3,10; \quad b = 4,60; \quad \frac{b}{a} = \frac{4,6}{3,1} = 1,48; \quad m_a = 30; \quad m_b = 76,2; \quad h_a = 0,905$$

$$M_a = \frac{450 \times 9,61}{30} = 145 \text{ mkg}; \quad \sigma_c = 27; \quad s_{fa} = 1,42; \quad 3 \phi \frac{3}{16} \text{ p.m.}$$

$$M_b = \frac{450 \times 9,61}{76,2} = 57 \text{ "}; \quad \sigma_c = 16; \quad s_{fb} = 0,54; \quad 5 \phi \frac{3}{16} \text{ p.m.}$$

$$d = 9 \text{ cm}$$

$$q_a = 450 \times 0,905 = 405$$

$$q_b = 450 - 405 = 45.$$

$$-M_{a_e} = -\frac{1}{12} \times 9,61 \times 405 = -376; \text{ Calc. } -440$$

$$S_{f_{a_e}} = 4,45$$

$$9 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_{a_d} = -\frac{1}{10} \times 9,61 \times 405 = -390; \text{ calc. } -295$$

$$\bar{\sigma}_e = 41; S_{f_{a_d}} = 2,94$$

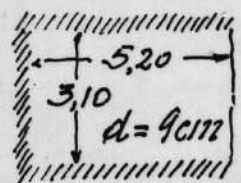
$$6 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{1}{8} \times 21,16 \times 45 = -120; \text{ Calc. } -103$$

$$\bar{\sigma}_e = 32; S_{f_b} = 0,98$$

$$6 \phi \frac{3}{16} \text{ p.m.}$$

LAGE 12.



$$\alpha = 3,10; b = 5,20; \frac{b}{\alpha} = \frac{5,2}{3,1} = 1,68; m_a = 28,1; m_b = 42,5; k_a = 0,940$$

$$M_a = \frac{450 \times 9,61}{28,1} = 154 \text{ mkg}$$

$$\bar{\sigma}_e = 28; S_{f_a} = 1,50$$

$$5 \phi \frac{1}{4} \text{ p.m.}$$

$$M_b = \frac{450 \times 9,61}{42,5} = 47 \text{ mkg}$$

$$\bar{\sigma}_e = 14; S_{f_b} = 0,43$$

$$5 \phi \frac{3}{16} \text{ p.m.}$$

$$d = 9 \text{ cm}$$

$$Q_a = 450 \times 0,945 = 425$$

$$Q_b = 450 - 425 = 25.$$

$$-M_{a_e} = -\frac{1}{12} \times 9,61 \times 425 = -340$$

$$S_{f_{a_e}} = 4,40; 9 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_{a_d} = -\frac{1}{10} \times 9,61 \times 425 = -410$$

$$\text{Calc. } -303; \bar{\sigma}_e = 41; S_{f_{a_d}} = 2,90$$

$$6 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{1}{8} \times 27,04 \times 25 = -85$$

$$S_{f_b} = 0,98; 6 \phi \frac{3}{16} \text{ p.m.}$$

LAGE 13.

$$v_{ao} = 2,10; M = \frac{450 \times 4,41}{10} = 200 \text{ mkg}; d = 9 \text{ cm}; \bar{\sigma}_e = 32; S_f = 1,94; 7 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 14.

$$M = \frac{450 \times 4,41}{10} = 200 \text{ mkg}; d = 9 \text{ cm}; \bar{\sigma}_e = 32; S_f = 1,94; 7 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 15.

$$M = \frac{450 \times 1,44}{8} = 81 \text{ mkg}; d = 7 \text{ cm}; \bar{\sigma}_e = 27; S_f = 1,05; 6 \phi \frac{3}{16} \text{ p.m.}$$

LAGE 16.

$$v_{ao} = 1,30; M_q = \frac{450 \times 1,64}{2} = 382 \text{ mkg}; M_p = 720 \times 1,3 = 935$$

$$M_T = 1317 \text{ mkg}; d_o = 13 \text{ cm};$$

$$\bar{\sigma}_e = 61; S_f = 8,9; 7 \phi \frac{1}{2} \text{ p.m.}$$

LAGE 17

$$M_q = \frac{450 \times 2,25}{2} = 506 \text{ mkg}; M_p = 360 \times 1,5 = 540$$

$$M_T = 1046 \text{ mkg};$$

$$d = 12 \text{ cm};$$

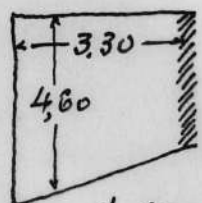
$$\bar{\sigma}_e = 12;$$

$$\bar{\sigma}_e = 59;$$

$$S_f = 7,65$$

$$6 \phi \frac{1}{2} \text{ p.m.}$$

LAGE 18.



$$d = 9 \text{ cm}$$

Identicas a Laje 1.

$$d = 9 \text{ cm.}$$

$$M_a = 243$$

$$S_f = 2,37$$

$$5 \phi \frac{5}{16} \text{ p.m.}$$

$$M_b = 96$$

$$S_f = 0,91$$

$$6 \phi \frac{3}{16} \text{ p.m.}$$

$$Q_a = 405$$

$$Q_b = 45$$

$$-M_a = -440 \text{ mkg. Calc. } -439$$

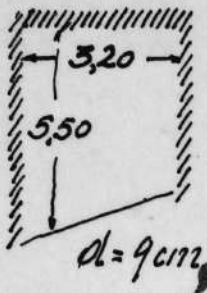
$$\bar{\sigma}_e = 52; S_{f_a} = 4,45$$

$$9 \phi \frac{5}{16} \text{ p.m.}$$

107

LAGE 19.

F 4



$$a = 3.20; b = 5.50; \frac{b}{a} = \frac{5.5}{3.2} = 1.72; m_a = 27.9; m_b = 46.3; \mu_a = 0.945.$$

$$M_a = \frac{450 \times 10.24}{27.9} = 165 \text{ mkg};$$

$$\sigma_c = 29; s_{fa} = 1.61; \underline{6 \phi \frac{1}{4} \text{ p.m.}}$$

$$M_b = \frac{450 \times 10.24}{46.3} = 48 \text{ mkg};$$

$$\sigma_c = 14; s_{fb} = 0.44; \underline{5 \phi \frac{3}{16} \text{ p.m.}}$$

$$q_a = 0.945 \times 450 = 425 \text{ kg};$$

$$q_b = 450 - 425 = 25 \text{ kg}.$$

$$-M_{ae} = -\frac{10.34 \times 425}{10} = -438 \text{ mkg};$$

$$s_{fae} = 4.46; \underline{9 \phi \frac{5}{16} \text{ p.m.}}$$

$$-M_{ad} = -\frac{10.24 \times 425}{12} = -364 \text{ "};$$

$$\text{Calc.} = -240; \sigma_c = 36; s_{fad} = 2.36; \underline{5 \phi \frac{5}{16} \text{ p.m.}}$$

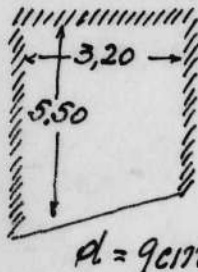
$$-M_b = -\frac{3925 \times 25}{10} = -76 \text{ "};$$

$$\text{"} = -303; \sigma_c = 41; s_{fb} = 2.90; \underline{6 \phi \frac{5}{16} \text{ p.m.}}$$

LAGE 20.

$$v_{80} = 1.60; \eta = \frac{450 \times 2.56}{10} = 115 \text{ mkg}; d = 9 \text{ cm}; \sigma_c = 24; s_f = 1.16; \underline{7 \phi \frac{3}{16} \text{ p.m.}}$$

LAGE 21.



Idéntica a Lage 19.

$$M_a = 165 \text{ mkg};$$

$$s_{fa} = 1.61$$

$$\underline{6 \phi \frac{1}{4} \text{ p.m.}}$$

$$M_b = 48 \text{ "}$$

$$s_{fb} = 0.44$$

$$\underline{5 \phi \frac{3}{16} \text{ p.m.}}$$

$$-M_{ae} = -364 \text{ "}$$

$$s_{fae} = 2.36$$

$$\underline{5 \phi \frac{5}{16} \text{ p.m.}}$$

$$-M_{ad} = -438 \text{ " Calc.} = -404$$

$$\sigma_c = 44$$

$$s_{fad} = 4.05$$

$$\underline{6 \phi \frac{3}{8} \text{ p.m.}}$$

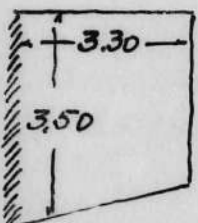
$$-M_b = 76 \text{ " " } = -316$$

$$\sigma_c = 42$$

$$s_{fb} = 3.12$$

$$\underline{7 \phi \frac{5}{16} \text{ p.m.}}$$

LAGE 22.



Idéntica a Lage 4.

$$M_a = 178 \text{ mkg};$$

$$s_{fa} = 1.73$$

$$\underline{6 \phi \frac{1}{4} \text{ p.m.}}$$

$$M_b = 128 \text{ "}$$

$$s_{fb} = 1.23$$

$$\underline{7 \phi \frac{3}{16} \text{ p.m.}}$$

$$d = 9 \text{ cm}$$

$$q_a = 340 \text{ kg}.$$

$$q_b = 110 \text{ kg}.$$

$$-M_{ad} = -370 \text{ mkg}.$$

$$s_{fa} = 4.05$$

$$\underline{6 \phi \frac{3}{8} \text{ p.m.}}$$

LAGE 23.

Idéntica a Lage 5; $d = 8 \text{ cm};$

$$s_{fa} =$$

$$\underline{7 \phi \frac{1}{4} \text{ p.m.}}$$

LAGE 24.

$$M_a = 68 \text{ mkg. } d = 7 \text{ cm.}$$

$$s_f = 0.98$$

$$\underline{6 \phi \frac{3}{16} \text{ p.m.}}$$

LAGE 25.

Idéntica. $M_a = 68 \text{ mkg } d = 7 \text{ cm.}$

$$s_f = 0.98$$

$$\underline{6 \phi \frac{3}{16} \text{ p.m.}}$$

LAGE 26.

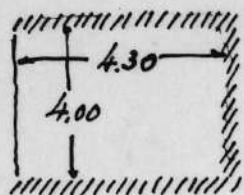
Idéntica a Lage 8. $d = 8 \text{ cm}$

$$s_f =$$

$$\underline{8 \phi \frac{1}{4} \text{ p.m.}}$$

117

LAGE 27.


 $d = 9 \text{ cm.}$

$$a = 4.00; b = 4.30; \frac{b}{a} = \frac{4.3}{4.0} = 1.07; m_a = 40.3; m_b = 53; k_a = 0.732$$

$$M_a = \frac{450 \times 16}{40.3} = 178 \text{ mkg.}$$

$$S_{f_a} = 1.73$$

$$6 \phi \frac{1}{4} \text{ p.m.}$$

$$M_b = \frac{450 \times 16}{53} = 136 "$$

$$\sigma_c = 26; S_{f_b} = 1.33$$

$$8 \phi \frac{3}{16} \text{ p.m.}$$

$$q_a = 450 \times 0.732 = 330 \text{ kg.} \quad q_b = 450 - 330 = 120 \text{ kg.}$$

$$-M_{a_e} = -\frac{16 \times 330}{10} = -530 \text{ mkg.}$$

$$S_{f_{a_e}} = 2.90$$

$$6 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_{a_d} = -\frac{16 \times 330}{12} = -442 " ; \text{Calc.} = -375.$$

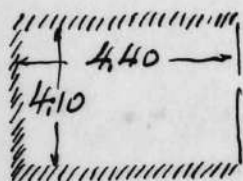
$$\sigma_c = 47; S_{f_{a_d}} = 3.75$$

$$8 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{16.49 \times 120}{10} = -222 " ; \text{Calc.} = -169$$

$$\sigma_c = 29; S_{f_b} = 1.63$$

LAGE 28.


 $d = 9 \text{ cm.}$

$$a = 4.10; b = 4.40; \frac{b}{a} = \frac{4.4}{4.1} = 1.07; m_a = 40.3; m_b = 53; k_a = 0.732$$

$$M_a = \frac{450 \times 16.81}{40.3} = 186 \text{ mkg.}$$

$$\sigma_c = 31; S_{f_a} = 1.82$$

$$6 \phi \frac{1}{4} \text{ p.m.}$$

$$M_b = \frac{450 \times 16.81}{53} = 143 "$$

$$\sigma_c = 27; S_{f_b} = 1.40$$

$$8 \phi \frac{3}{16} \text{ p.m.}$$

$$q_a = 450 \times 0.732 = 330 \text{ kg.} \quad q_b = 450 - 330 = 120 \text{ kg.}$$

$$-M_{a_e} = -\frac{16.81 \times 330}{10} = -556 \text{ mkg.}; \text{Calc.} =$$

$$S_{f_{a_e}} = 3.12$$

$$7 \phi \frac{5}{16} \text{ p.m.}$$

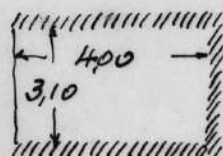
$$-M_{a_d} = -\frac{16.81 \times 330}{12} = -464 " ; " = -394 \text{ mkg.}; \sigma_c = 48; S_{f_{a_d}} = 3.92$$

$$8 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{16.81 \times 120}{10} = -233 " ; " = -174 " \quad \sigma_c = 30; S_{f_b} = 1.70$$

$$6 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 29.


 $d = 9 \text{ cm.}$

$$a = 3.10; b = 4.00; \frac{b}{a} = \frac{4.0}{3.1} = 1.26; m_a = 33.8; m_b = 61.9; k_a = 0.833$$

$$M_a = \frac{450 \times 9.61}{33.8} = 128 \text{ mkg.}$$

$$S_{f_a} = 1.23$$

$$7 \phi \frac{3}{16} \text{ p.m.}$$

$$M_b = \frac{450 \times 9.61}{61.9} = 71 "$$

$$S_{f_b} = 0.68$$

$$5 \phi \frac{3}{16} \text{ p.m.}$$

$$q_a = 450 \times 0.833 = 385 \text{ kg.}$$

$$q_b = 450 - 385 = 65 \text{ kg.}$$

$$-M_{a_e} = -\frac{9.61 \times 385}{12} = -308 \text{ mkg.}$$

$$S_{f_{a_e}} = 3.75$$

$$8 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_{a_d} = -\frac{9.61 \times 385}{10} = -370 " \quad \text{Calc.} = -285 \text{ mkg.} \quad \sigma_c = 40$$

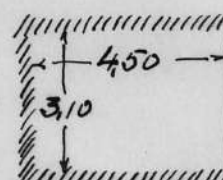
$$S_{f_{a_d}} = 2.82$$

$$6 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{16 \times 65}{10} = -104 " \quad " = -110 " \quad \sigma_c = 23 \quad S_{f_b} = 1.06$$

$$6 \phi \frac{3}{16} \text{ p.m.}$$

LAGE 30.


 $d = 9 \text{ cm.}$

$$a = 3.10; b = 4.50; \frac{b}{a} = \frac{4.5}{3.1} = 1.45; m_a = 30.4; m_b = 74; k_a = 0.897$$

$$M_a = \frac{450 \times 9.61}{30.4} = 143 \text{ mkg.}$$

$$\sigma_c = 27$$

$$S_{f_a} = 1.41$$

$$8 \phi \frac{3}{16} \text{ p.m.}$$

$$M_b = \frac{450 \times 9.61}{74} = 59 "$$

$$\sigma_c = 16$$

$$S_{f_b} = 0.55$$

$$5 \phi \frac{3}{16} \text{ p.m.}$$

$$q_a = 450 \times 0.897 = 405 \text{ kg.}$$

$$q_b = 450 - 405 = 45 \text{ kg.}$$

$$-M_{a_e} = -\frac{9.61 \times 405}{12} = -324 \text{ mkg.}$$

$$S_{f_{a_e}} = 3.92$$

$$8 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_{a_d} = -\frac{9.61 \times 405}{10} = -388 " \quad \text{Calc.} = -294 \text{ mkg.} \quad \sigma_c = 41$$

$$S_{f_{a_d}} = 2.94$$

$$6 \phi \frac{5}{16} \text{ p.m.}$$

$$-M_b = -\frac{20,25 \times 45}{10} = -92 \text{ mkg.}$$

LAGE 31.

$$Sf_b = 1,06;$$

$$6 \phi \frac{3}{16} \text{ p.m.}$$

$$M = 200 \text{ mkg.}$$

$$d = 9 \text{ cm.}$$

$$Sf = 1,94$$

$$7 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 32.

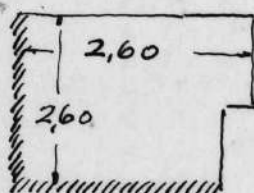
$$M = 200 \text{ mkg.}$$

$$d = 9 \text{ cm}$$

$$Sf = 1,94$$

$$7 \phi \frac{1}{4} \text{ p.m.}$$

LAGE 33.



$$a = 2,60; b = 2,60; \frac{b}{a} = 1,00 \quad m_a = 36,5; m_b = 37,2 \quad h_a = 9,509.$$

$$M_a = \frac{450 \times 6,76}{36,5} = 84 \text{ mkg.}$$

$$C_e = 28; Sf_a = 1,12$$

$$7 \phi \frac{3}{16} \text{ p.m.}$$

$$M_b = \frac{450 \times 6,76}{37,2} = 82 \text{ "}$$

$$d = 7 \text{ cm;}$$

$$Sf_b = 1,12$$

$$7 \phi \frac{3}{16} \text{ p.m.}$$

$$Q_a = 450 \times 9,509 = 230 \text{ kg.}$$

$$Q_b = 450 - 230 = 220 \text{ kg.}$$

$$-M_a = -M_b = -\frac{6,76 \times 230}{8} = -195 \text{ mkg.}$$

$$C_e = 46$$

$$Sf_a = 2,66$$

$$9 \phi \frac{1}{4} \text{ p.m.}$$

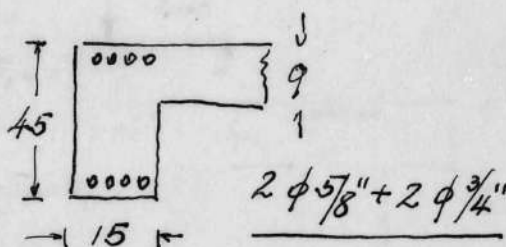
B) CALCULO DAS VIGAS

VIGA 1.

Carga:

Peso proprio	$0,15 \times 0,40 \times 2400$	$= 144 \text{ kg.}$
Telhado	150×4	$= 600 \text{ "}$
Parede e 3º Andar	400×3	$= 1200 \text{ "}$
Lage 1 3º Pav.	$4,5 \times 2,30$	$= 103 \text{ "}$
Parede 2º Pav.	$400 \times 2,5$	$= 1000 \text{ "}$
Lage 1 2º Pav.		$= 103 \text{ "}$
Parede 1º Pav.		$= 1000 \text{ "}$
Lage 1º 1º Pav.		$= 103 \text{ "}$
		$= 4253 \text{ kg.}$

$$v_{50} = 3,30$$



$$M = \frac{1}{10} \cdot 4253 \times 10,89 = 4650 \text{ mkg.} \quad b = 4,5 \times 9 + 15 = 4,5 \times 45 = 55 \sim 52$$

$$C_e = 37; d_0 = 45; Sf = 7,80;$$

$$b_0 = 15; d_0 = 40; 2 \phi \frac{5}{8} + 2 \phi \frac{3}{4}$$

$$R_A = R_B = 4260 \times 1,65 = 7.060 \text{ kg.}$$

VIGA 2.

Peso proprio.	$= 144 \text{ kg.}$
Telhado	$= 600 \text{ "}$
Parede 3º Andar.	$= 1200 \text{ "}$
Lg 1. 3º Pav.	$405 \times 1,65 = 670 \text{ "}$
Parede 2º Andar	$= 1000 \text{ "}$
L. 1. 2º Pav.	$405 \times 1,65 = 670 \text{ "}$
Parede 1º Andar	$= 1000 \text{ "}$
L. 18. 1º Pav.	$405 \times 1,65 = 670 \text{ "}$
	$= 5954 \text{ kg.}$

Q₁

$$Q_1 = 5960 \text{ kg.}$$

P proprio	$= 144 \text{ kg.}$
Telhado	$= 600 \text{ "}$
Parede 3º Andar	$= 1200 \text{ "}$
L. 5. 400 x 9	$= 400 \text{ "}$
Parede 2º A.	$= 1000 \text{ "}$
L. 5. 400 x 1	$= 400 \text{ "}$
Parede 1º Pav.	$= 1000 \text{ "}$
L. 23. 400 x 1	$= 400 \text{ "}$
	$= 5144 \text{ kg.}$

Q₂

$$Q_2 = 5150 \text{ kg.}$$

$$-M_{ap} = -\frac{1}{8} \cdot \frac{5960 \times 5^3 + 5150 \times 2,6^3}{5 + 2,6} = -13742 \text{ mkg.}$$

$$R_1 = \frac{5960 \times 5}{2} - \frac{13742}{5} = 12160 \text{ mkg.}$$

$$d_1 = \frac{12160}{5960} = 2,04 = 2,04$$

$$M_{ivão} = 12160 \times 1,02 = 12403 \text{ mkg.}$$

$$R_3 = \frac{5150}{2} - \frac{13742}{2,5} = 1384 \text{ kg.}$$

$$d_2 = \frac{1384}{5150} = 0,27$$

m

$$M_{2v\tilde{a}o} = 1380 \times 0,13 = 180 \text{ kg.}$$

No apoio - Armadura dupla

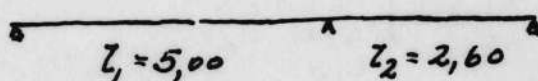
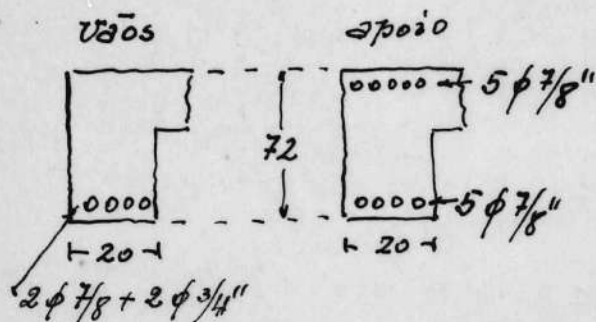
$5\phi 7/8"$

$$\sqrt{\frac{1374200}{20}} = 263; h' = 0,263 \times 263 = 69; d = 72 \text{ cm} \quad Sf = \frac{1376 - 20169}{100} = 19,00$$

$$N^o 1^o v\tilde{a}o \quad b_0 = 4,5 \times 7 + 20 = 51,00 \quad \bar{\sigma}_c = 39,0 \quad Sf = 12,50; \quad 2\phi 7/8" + 2\phi 3/4"$$

$$b_0 = 20; d = 72 \quad \text{No apoio} - 5\phi 7/8"$$

$$\text{No v\tilde{a}o} - 2\phi 7/8" + 2\phi 3/4"$$

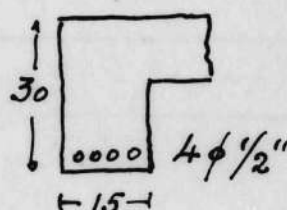


VIGA 3.

Carga:

P próprio	$0,15 \times 0,4 \times 2400$	$= 144 \text{ kg}$
Telhado		$= 600 "$
Placote	3º andar	$= 1200 "$
Parede	2º "	$= 1000 "$
Parede	1º "	$= 1000 "$
		<u>4000</u>

vão 2,10



$b_0 = 15$

$$M = \frac{1}{10} \cdot 4000 \times 4,41 = 1764 \text{ mkg.} \quad b_0 = 4,5 \cdot 7 + 15 = \sim 45$$

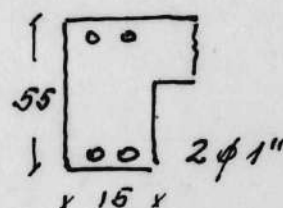
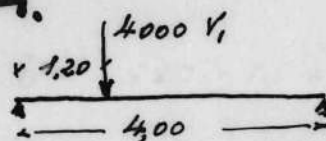
$$\bar{\sigma}_c = 39; d_0 = 30; Sf = 4,62; 4\phi 1/2" \quad R_1 = R_2 = 4000 \times 1,00 = 4000 \text{ kg.}$$

$$b_0 = 15 \quad d_0 = 30 \quad Sf = 4\phi 1/2"$$

VIGA 4.

Carga:

P.p.		$= 144 \text{ kg.}$
Tel.		$= 750 "$
Par.	3º Andar	$= 3000 "$
L 9	3º Pav. $2,60 \times 75$	$= 195 "$
L 9	2º "	$= 195 "$
L 27	$120 \times 2,15$	$= 258 "$
		<u>4542 kg.</u>



$$M_g = \frac{1}{10} \times 4550 \times 16 = 7300 \text{ mkg.}$$

$$M_p = \frac{4000 \times 2,8 \times 1,2}{4,00} = 3360 \text{ mkg.}$$

$$M_T = 7300 + 3360 = 10660 \text{ mkg.} \quad b_0 = 4,5 \times 9 + 15 = \sim 55$$

$$d_0 = 55 \quad Sf = 15 \text{ cm} \quad \bar{\sigma}_c = 48; \quad 2\phi 1"$$

$$R_A = 4550 \times 2 + 2800 = 11300 \text{ kg}; \quad R_B = 4550 \times 2 + 1200 = 10300 \text{ kg.}$$

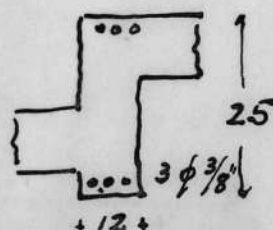
$$b_0 = 15 \quad d_0 = 55 \quad Sf = 2\phi 1"$$

VIGA 4A.

Carga:

P.p.		$= 144 \text{ kg.}$
3 Par. 15		$= 1200 "$
L 5	$300 \times 1,1$	$= 330 "$
L 5	" "	$= 330 "$
L 23	" "	$= 330 "$
L 6	$450 \times 0,6$	$= 270 "$
L 6	" "	$= 270 "$
L 24 e 21		$= 270 "$
		<u>3144 kg ~ q = 3150 kg.</u>

vão 1,40



MD

$$M = \frac{1}{10} \times 3150 \times 1,96 = 615 \text{ mkg.} \quad \delta_0 = 4,5 \times 7 + 12 = \sim 40$$

$$d_0 = 25 \quad \sigma_c = 29 \quad S_f = 1,97 \quad 3 \phi \frac{3}{8}"$$

$$R_A = R_B = 3150 \cdot 0,70 = 2205 \text{ kg.}$$

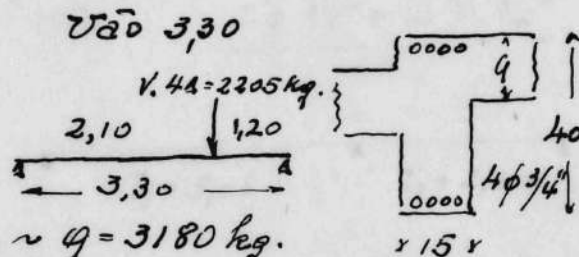
$$\delta_0 = 12 \quad d_0 = 25 \quad S_f = 3 \phi \frac{3}{8}"$$

VIGA 5.

Carga:

P.p.			144 kg
Par.	15	240 x 3	= 2160 "
L.1	3°	45 x 2,3	= 103 "
L.1	2°	"	= 103 "
L.18	1°	"	= 103 "
L.5	3°	150 x 1,25	= 188 "
L.5	2°	"	= 188 "
L.23	1°	"	= 188 "

$$3177 \text{ kg.} \sim q = 3180 \text{ kg.}$$



$$M_q = \frac{1}{10} \cdot 3180 \times 10,89 = 3480 \text{ mkg.} \quad M_p = \frac{2205 \times 1,2 \times 2,1}{3,30} = 1700 \text{ mkg.}$$

$$M_T = 3480 + 1700 = 5180 \text{ mkg.} \quad \delta_0 = 15 \quad \delta = 4,5 \times 9 + 15 = \sim 55$$

$$d_0 = 40 \quad \sigma_c = 46 \quad S_f = 10,20 \quad 4 \phi \frac{3}{4}"$$

$$R_A = 3180 \times 1,55 + \frac{2205 \times 1,2}{3,30} = 6050 \text{ kg.} \quad R_B = 5250 + 1405 = 6655 \text{ kg.}$$

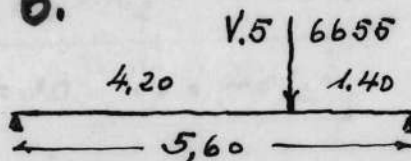
$$\delta_0 = 15 \quad d_0 = 40 \quad S_f = 4 \phi \frac{3}{4}"$$

VIGA 6.

Carga:

P.p.		0,15 x 0,5 x 2400	= 180 kg.
Par.	15		= 2160 "
L.1	3°	405 x 1,65	= 670 "
L.1	2°	"	= 670 "
L.18	1°	"	= 670 "
L.2	3°	345 x 2	= 790 "
L.2	2°	"	= 790 "
L.14	1°	425 x 1,8	= 680 "

$$6610 \text{ kg.}$$



$$M_q = \frac{6610 \times 31,36}{10} = 20800 \text{ mkg.} \quad M_p = \frac{6655 \times 1,4 \times 4,20}{5,60} = 6950 \text{ mkg.}$$

$$M_T = 20800 + 6950 = 27750 \text{ mkg.} \quad \delta_0 = 12 \times 9 + 15 = \sim 120$$

$$d_0 = 60 \quad \sigma_c = 48 \quad S_f = 36 \quad 5 \phi 1 \frac{1}{4}"$$

$$R_A = 6610 \times 2,8 + \frac{6655 \times 1,4}{5,60} = 20250 \text{ kg.} \quad R_B = 18600 + 5005 = 23605 \text{ kg.}$$

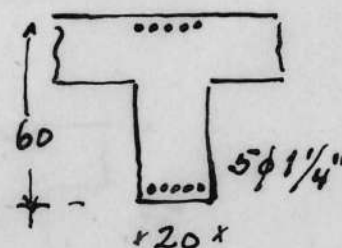
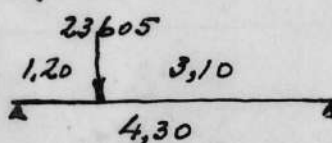
$$\delta_0 = 15 \quad d_0 = 60 \quad S_f = 5 \phi 1 \frac{1}{4}"$$

VIGA 7

Carga:

P.p.		0,9 x 2400	= 216 kg.
Par.	15		= 2160 "
L.2	3°	55 x 2,75	= 152 "
L.2	2°	"	= 152 "
L.14	1°	"	= 152 "
L.4	3°	375 x 2	= 750 "
L.4	2°	"	= 750 "
L.27		330 x 2	= 660 "

$$4992 \text{ kg.} \sim q = 5000 \text{ kg.}$$



$$M_q = \frac{5000 \times 18,60}{10} = 9250 \text{ mkg.} \quad M_p = \frac{23605 \times 3,10 \times 1,2}{4,30} = 20400 \text{ mkg.}$$

$$M_T = 20400 + 9250 = 29650 \text{ mkg.} \quad \delta = 12 \times 9 + 20 = \sim 125$$

F.q.

$$d_0 = 60 \quad \sigma_c = 49 \quad S_f = 38,70 \quad 5 \phi 1\frac{1}{4}"$$

$$R_A = 5000 \times 2,15 + \frac{23605 \times 3,10}{4,30} = 27350 \text{ kg.} \quad R_B = 10750 + 6405 = 17155 \text{ kg.}$$

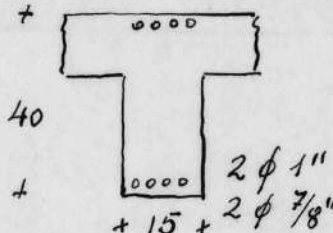
$$\bar{b}_0 = 20 \quad d_0 = 60 \quad S_f = 5 \phi 1\frac{1}{4}"$$

VIGA 8.

CARGA:

P.p.			= 144 kg.
PAR. 15			= 2160 "
L 11	3°	405 x 1,55	= 630 "
L 11	2°	" "	= 630 "
L 24	1°	385 x "	= 630 "
L 13	3°	450 x 1	= 450 "
L 13	2°	" "	= 450 "
L 31	1°	" "	= 450 "

$$Q \sim 5550 \text{ kg.}$$



$$M = \frac{5550 \times 15,21}{10} = 8460 \text{ mkg.} \quad \bar{b}_0 = 15 \quad \bar{b} = 12 \times 9 + 15 = \sim 120$$

$$d_0 = 40 \quad \sigma_c = 34 \quad S_f = 16,4 \quad 2 \phi 1" + 2 \phi 7/8"$$

$$R_A = R_B = 5550 \times 2 = 11.100 \text{ kg.}$$

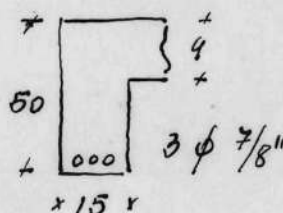
$$\bar{b}_0 = 15 \quad d_0 = 40 \quad S_f = 2 \phi 1" + 2 \phi 7/8"$$

VIGA 9.

CARGA:

P.p.			= 180 kg.
PAR. 30	3		= 3600 "
L 11	3°	45 x 2,80	= 105 "
L 11	2°	" "	= 105 "
L 24	1°	65 x 2,00	= 130 "
L 16		3 x 450 x 1,10	= 1485 "
PAR. 15		3 x 240 x 3	= 2160 "

$$Q \approx 7770 \text{ kg.}$$



$$M = \frac{1}{10} \times 7770 \times 9,61 = 7500 \text{ mkg.} \quad \bar{b}_0 = 15 \quad \bar{b} = 45 \times 7 + 15 = \sim 55$$

$$d_0 = 50 \quad \sigma_c = 44 \quad S_f = 11,70 \quad 3 \phi 7/8"$$

$$R_A = R_B = 7770 \times 1,55 = 12100 \text{ kg.}$$

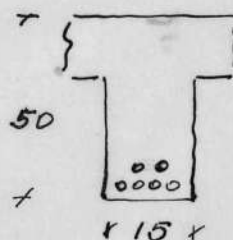
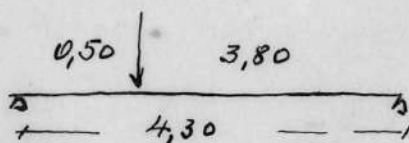
$$\bar{b}_0 = 15 \quad d_0 = 50 \quad S_f = 3 \phi 7/8"$$

VIGA 10.

CARGA:

P.p.		= 216
PAR. 15		= 2160
L 4	3°	= 750
L 4	2°	= 750
L 27	1°	= 660
L 11	3°	= 630
L 11	2°	= 630
L 24	1°	= 630

$$Q \sim 6430 \text{ kg.}$$



$$M_q = \frac{6430 \times 18,50}{10} = 12000 \text{ mkg.} \quad M_p = \frac{12.000 \times 3,8 \times 0,5}{4,3} = 5350 \text{ mkg.}$$

$$M_T = 17350 \quad \bar{b}_0 = 15 \quad \bar{b} = 12 \times 9 + 15 = \sim 120$$

$$d_0 = 50 \quad \sigma_c = 46 \quad S_f = 27,50 \quad 4 \phi 1" + 2 \phi 7/8"$$

$$R_A = 6430 \times 2,15 + \frac{12100 \times 3,8}{4,3} = 24.400 \text{ mkg.}$$

$$R_B = 13700 + 1400 = 15100 \text{ kg.}$$

$$\bar{b}_0 = 15 \quad d_0 = 50 \quad S_f = 4 \phi 1" + 2 \phi 7/8"$$

VIGA 11.

F10.

CARGA:

$$\begin{aligned} P.p. & 0,15 \times 0,2 \times 2400 = 108 \text{ kg.} \\ L 33 & 2,30 \times 1,30 = 300 \text{ "} \\ ESCADA & 500 \times 1,70 = 850 \text{ "} \end{aligned}$$

$$V_{\bar{a}o} = 260$$

$$q \approx 1260 \text{ kg.} \quad M = \frac{1}{10} \times 1260 \times 6,76 = 865 \text{ mkg.}$$

$$b_o = 12 \quad b = 4,5 \times 7 + 12 = \sim 40. \quad d_o = 25 \quad c_c = 35 \quad sf = 2,76 \quad 4 \phi 3/8"$$

$$R_A = R_B = 1260 \times 1,3 = 1640 \text{ kg.}$$

$$\boxed{b_o = 12 \quad d_o = 25 \quad sf = 4 \phi 3/8"} \quad \text{}$$

VIGA 12.

CARGA:

$$\begin{aligned} P.p. & = 144 \text{ kg.} \\ PAREDE 25 & = 3800 \text{ "} \\ 3 L. 33 & 3 \times 230 \times 1,3 = 860 \text{ "} \end{aligned}$$

$$V_{\bar{a}o} = 2,60$$

$$M = \frac{1}{10} \times 4610 \times 6,76 = 3120 \text{ mkg.}$$

$$q \approx 4610 \text{ kg.}$$

$$b_o = 15; \quad b = 4,5 \times 7 + 15 = \sim 45; \quad d_o = 40; \quad c_c = 39; \quad sf = 6,15 \quad 2 \phi 5/8" + 1 \phi 3/4"$$

$$R_A = R_B = 4610 \times 1,30 = 6000 \text{ kg.}$$

$$\boxed{b_o = 15 \quad d_o = 40 \quad sf = 2 \phi 5/8" + 1 \phi 3/4"} \quad \text{}$$

VIGA 14.

CARGA:

$$\begin{aligned} P.p. & 0,15 \times 0,60 \times 2400 = 216 \text{ kg.} \\ PAR. & 3^\circ \quad 240 \times 3 = 720 \text{ "} \\ L 3 & 3^\circ \quad 3/5 \times 2 = 790 \text{ "} \\ L 2 & 3^\circ = 790 \text{ "} \\ PAR. & 15^\circ \quad 2^\circ = 720 \text{ "} \\ L 3 & 2^\circ = 1580 \text{ "} \\ PAR. & 15^\circ \quad 1^\circ = 720 \text{ "} \\ L & 1^\circ \quad 450 \times 1,5 = 675 \text{ "} \end{aligned}$$

$$\begin{array}{ccccccc} A & & A & & A & & A \\ x & 4,70 & x & 5,30 & x & 4,00 & x \end{array}$$

$$\begin{aligned} PAR. 15 & = 2160 \text{ kg.} \\ P.p. & = 216 \text{ "} \\ q_2 & \approx 2380 \text{ kg.} \end{aligned}$$

$$q_1 \approx 6200 \text{ kg.}$$

$$-M_{ap} = -0,100 \times 6200 \times 28,09 = -17500 \text{ mkg.} \quad M_2 = 0,08 \times 6200 \times 28,09 = -14000 \text{ mkg.}$$

$$M_2 = 0,025 \times 6200 \times 28,09 = 4300 \text{ mkg.}$$

$$G = 260 \quad Q = 6200 \times 5,3 = 32860$$

$$M_1 = 32860 \times 5,3 \times \frac{1}{10} = 17400 \text{ mkg.} = M_3$$

$$M_2 = 32860 \times 5,3 \times \frac{1}{14} = 12400 \text{ mkg.} \quad X_1 = 32860 \times 5,3 \times \frac{1}{8,6} = 20100 \text{ mkg.} = X_2$$

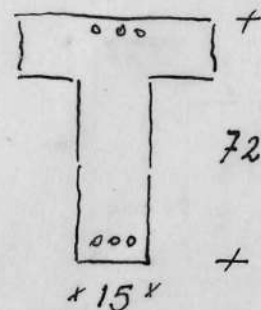
$$\text{No Apoio} \quad X = 20100 \text{ mkg.} \quad b = 15 \quad h = 70 \quad d_o = 72$$

$$\frac{6h^2}{135} = 545$$

$$\Delta M = 2010 - 545 = 1465$$

$$F_e = \frac{15 \times 70}{180} + \frac{1465}{1,5 \times 68} = 19,90 \text{ cm}^2 \quad 4 \phi 1"$$

$$F_e' = \frac{1465}{0,685 \times 68} = 31,60 \text{ cm}^2 \quad 6 \phi 1"$$



NO 10 VAO.

$$\Delta M = 1750 - 545 = 1205$$

$$F_e = \frac{15 \times 70}{180} + \frac{1205}{1,5 \times 68} = 17,32 \text{ cm}^2 \quad 3 \phi 1" + 1 \phi 3/4"$$

$$F_e' = \frac{1205}{0,686 \times 68} = 26,00 \text{ cm}^2 \quad 5 \phi 1"$$

NO 2º VAO

$$M_L = 1240$$

$$\Delta M = 1240 - 545 = 695$$

mm

$$F_e = \frac{15 \times 70}{180} + \frac{695}{1,5 \times 68} = 12,35 \text{ cm}^2$$

$$F_e' = \frac{695}{0,685 \times 0,68} = 15,00 \text{ cm}^2$$

$$2 \phi 1" + 1 \phi \frac{3}{4}"$$

$$3 \phi 1"$$

REAÇÕES: $R_1 = R_4 = 0,4 \times 32860 = 13144 \text{ kg}$. $R_2 = R_3 = 1,1 \times 32860 = 36140 \text{ kg}$.

Sf = Apoio	4 $\phi 1"$	$b_0 = 15$	$d_0 = 72$
1º vao	6 $\phi 1"$		
	3 $\phi 1" + 1 \phi \frac{3}{4}"$		
2º vao	5 $\phi 1"$		
	2 $\phi 1" + 1 \phi \frac{3}{4}"$		
	3 $\phi 1"$		

VIGA 15.

CARGA:

P.p. $0,15 \times 0,60 \times 2400 = 216 \text{ kg}$.

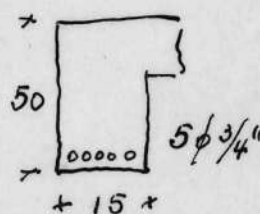
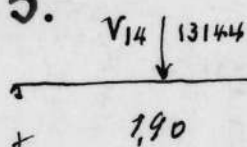
PAR. $12,5 \times 400 = 5000 "$

L 2 $3^\circ 2,75 \times 55 = 155 "$

L 2 $2^\circ " = 155 "$

TEL. $= 450 "$

$$q = \sim 5980 \text{ kg}$$



$$M = \frac{1}{10} \times 5980 \times 3,61 = 2160 \text{ mkg}$$

$$M_p = \frac{13150 \times 1,9}{4} = 6250 \text{ mkg}$$

$$M_T = 2160 + 6250 = 8410 \text{ mkg}$$

$$b_0 = 15; d_0 = 4,5 \times 9 + 15 = \sim 55$$

$$d_0 = 50 \quad \sigma_c = 47 \quad Sf = 13,10 \text{ cm}^2 \quad 5 \phi \frac{3}{4}"$$

$$R_A = R_B = 5980 + 6572 = 12552 \text{ kg}$$

$$b_0 = 15 \quad d_0 = 50 \quad Sf = 5 \phi \frac{3}{4}"$$

VIGA 16

CARGA:

P.p. $= 216 \text{ kg}$

PAR. 30 $4 \times 400 = 3600 "$

TEL. $= 450 "$

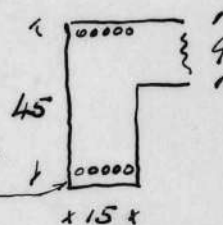
L 2 $3^\circ 55 \times 2,75 = 155 "$

L 2 $2^\circ " = 155 "$

L 14 $1^\circ 25 \times " = 70 "$

$$q = \sim 4650 \text{ kg}$$

$$v_{ao} = 3,30$$



$$2 \phi \frac{3}{4}" + 2 \phi \frac{5}{8}"$$

$$M = \frac{4650 \times 10,89}{10} = 5100 \text{ mkg}$$

$$b_0 = 55 \quad d_0 = 45 \quad \sigma_c = 40 \quad Sf = 8,85 - 2 \phi \frac{3}{4}" + 2 \phi \frac{5}{8}"$$

$$R_A = R_B = 4650 \times 1,65 = 7660 \text{ kg}$$

$$b_0 = 15 \quad d_0 = 45 \quad Sf = 2 \phi \frac{3}{4}" + 2 \phi \frac{5}{8}"$$

VIGA 17.

CARGA:

P.p. $0,15 \times 0,6 \times 2400 = 216 \text{ kg}$

TEL. $= 450 "$

PAR. 25 $4 \times 400 = 3500 "$

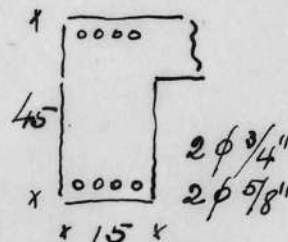
L 3 $3^\circ 55 \times 2,75 = 155 "$

L 3 $2^\circ " = 155 "$

L 21 $1^\circ 25 \times " = 75 "$

$$q = \sim 4650$$

$$v_{ao} = 3,30$$



Identicas Viga 16

$$b_0 = 15 \quad d_0 = 45 \quad Sf = 2 \phi \frac{3}{4}" + 2 \phi \frac{5}{8}"$$

$$R_A = R_B = 7660$$

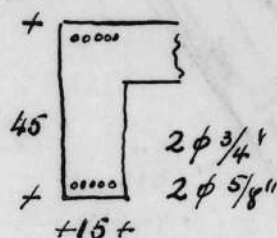
m

VIGA 18.

F.12.

CARGA:

P.p.	=	216 kg.	v̄ ₀	3,30
TEL.	=	450 "		
PAR.	=	3600 "		
L 4 3°	110 x 1,75 =	193 "		
L 4 2°	=	193 "		
L 22 1°	=	193 "		
	q =	~4850 kg.		



$$M = \frac{4850 \times 10,89}{10} = 5350 \text{ mkg. } b_0 = 15; d_0 = 45; \bar{v}_c = 41; S_f = 9,25 \text{ cm}^2$$

$$R_A = R_B = 4850 \times 1,65 = 8000 \text{ kg.}$$

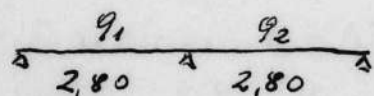
$$b_0 = 15 \quad d_0 = 45 \quad S_f = 2\phi 3/4 + 2\phi 5/8$$

VIGA 19.

CARGA:

P.p.	=	216 kg.
PAR. 25	=	3600 "
LOG 4 3°	240 x 1,65 =	560 "
L 4 2°	=	560 "
L 22 1°	=	560 "
TEL.	=	450 "
	q ₁ =	~5450 kg.

P.p.	=	216 kg.
TEL.	=	450 "
PAR.	=	3650 "
L 8 45° x 1	=	450 "
L 8	=	450 "
L 26	=	450 "
	q ₂ =	~5620 kg.



$$M_{ap.} = -0,125 \times 5450 \times 7,84 = -5800 \text{ mkg.}$$

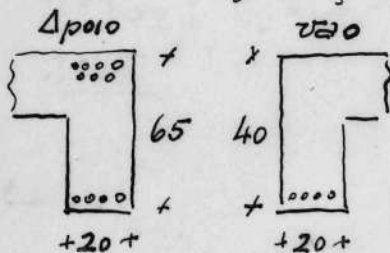
$$M_1 = M_2 = 907 \times 5450 \times 7,84 = 3260 \text{ mkg. } b_0 = 20$$

$$\text{No Apoio: } \bar{v}_c = 50; d_0 = 65; S_f = 22,60$$

$$4\phi 5/8 + 3\phi 1"$$

$$\text{No v̄}_0: b_0 = 20; b = 45 \times 7 + 20 = \sim 50$$

$$d_0 = 40; \bar{v}_c = 37; S_f = 6,25 \quad 4\phi 5/8$$



$$\text{No Apoio } b_0 = 20; d_0 = 65; S_f = 4\phi 5/8 + 3\phi 1"$$

$$\text{No v̄}_0 \quad b_0 = 20; d_0 = 40; S_f = 4\phi 5/8$$

$$R_1 = R_3 = 0,375 \times 5450 \times 2,80 = 6250 \text{ kg.}$$

$$R_2 = 1,250 \times 5450 \times 2,80 = 20080 \text{ kg.}$$

VIGA 20.

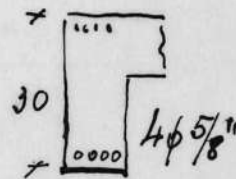
CARGA:

P.p.	=	144 kg
TEL.	=	650 "
PAR.	=	3600 "

$$q = \sim 4400 \text{ kg.}$$

$$M = \frac{4400 \times 5,76}{10} = 2540 \text{ mkg. } b_0 = 15$$

$$b_0 = 15; b = 45; \bar{v}_c = 43; d_0 = 30;$$



$$R_A = R_B = 4400 \times 1,20 = 5300 \text{ kg.}$$

$$b_0 = 15; d_0 = 30; S_f = 4\phi 5/8$$

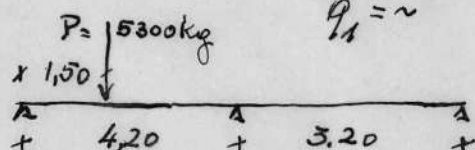
VIGA 21.

CARGA:

P.p.	$0,15 \times 0,6 \times 2400$	=	216	kg	
PAR.	25	=	3000	"	
TEL.		=	650	"	
L 10	3°	$375 \times 2,60$	=	195	"
L 10	2°	" "	=	195	"
L 28		$120 \times 2,30$	=	268	"
	$0 = \sim$		=	4520	"

P.p.	=	216 kg.
PAR. 25	=	3000 "
L 12 3°	25 x 2,60 =	65 "
L 12 2°	" " =	65 "
L 30 1°	45 x 2,25 =	102 "
L 16	=	1485 "
PAR.	=	2160 "

$$q_2 = \sim 7100 \text{ kg.}$$



$$M_{AP} = -\frac{1}{8} \frac{4520 \times 4,2^3 + 7100 \times 3,2^3}{4,2 + 3,2} = -9625 \text{ mkg.}$$

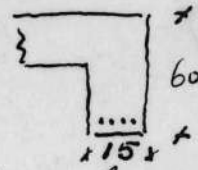
$$R_1 = \frac{4520 \times 4,2}{2} - \frac{9625}{4,2} = 7200 \text{ kg. } \alpha_1 = \frac{7200}{4520} = 1,59$$

MD

F. 13.

$$M_1 = 7200 \times \frac{1,6}{2} = 5760 \text{ mkg.}; \quad R_3 = \frac{7100 \times 3,2}{2} - \frac{9625}{3,2} = 8350 \text{ kg.}$$

$$\alpha_2 = \frac{8350}{7100} = 1,18 \quad M_2 = 8350 \times \frac{1,18}{2} = 4930 \text{ mkg.}$$



CARGA CONCENTRADA.

$$2 M_{p.p.} (4,2 + 3,2) = - \frac{1}{4,2} (5300 \times 1,50 \times 2,7 \times 5,7); \quad M_{ap} = -1960 \text{ mkg.}$$

$$R_{1p} = \frac{5300 \times 2,7}{4,2} - \frac{1960}{4,2} = 2935 \text{ kg.}$$

$$R_{2p} = 2980 \text{ kg.}$$

$$M_{1p} = 2935 \times 1,50 = 4400 \text{ mkg.};$$

$$R_{3p} = - \frac{1960}{3,2} = -615 \text{ kg.}$$

$$M_{2p} = -615 \times 1,6 = -985 \text{ mkg.};$$

$$\text{MOMENTOS APOIOS: } -9625 - 1960 = -11586 \text{ mkg.} \quad \text{REAÇÕES } R_1 = 7200 + 2935 = 10135 \text{ kg.}$$

$$1^\circ \text{vão: } M_1 = 5760 + 4400 = 10160 "$$

$$R_2 = 26150 + 2980 = 29130 "$$

$$2^\circ \text{vão: } M_2 = 4930 - 985 = 3945 "$$

$$R_3 = 8350 - 615 = 7735 "$$

$$\text{SECCÃO NO APOIO: } b_0 = 15; d_0 = 60; l = 58. \quad \Delta M = 1160 - \frac{15 \times 58^2}{135} = 784 \text{ mkg.}$$

$$T_e = \frac{15 \times 58}{180} + \frac{784}{15 \times 56} = 14,20 \text{ cm}^2 \quad 5 \phi 3/4" \quad T_e' = \frac{784}{0,865 \times 56} = 20,30; \quad 6 \phi 3/4" + 1 \phi 7/8"$$

SECCÃO NO VÃO:

$$1^\circ \text{vão: } b_0 = 4,5 \times 9 + 15 = 55 \quad d_0 = 60 \quad \bar{\sigma}_c = 42; \quad S_f = 13,30 \quad 5 \phi 3/4"$$

$$2^\circ \text{vão: } \bar{\sigma}_c = 24; \quad S_f = 4,45 \quad 2 \phi 3/4"$$

VIGA 22.

CARGA:

P.p.			144 kg.
3 PAR. 15	200 x 2 =	1200 "	
L 8	450 x 110 =	495 "	
L 8	" " =	495 "	
L 26	" " =	495 "	
L 7	450 x 96 =	270 "	
L 7	" " =	270 "	
L 25	" " =	270 "	
		<u>q = ~3640 kg.</u>	

$$\text{vão } M = \frac{1}{10} \times 3640 \times 1,44 = 5250 \text{ mkg.}$$

$$R_A = R_B = 3640 \times 0,6 = 2184 \text{ kg.}$$

$$b_0 = 12 \quad d_0 = 25 \quad S_f = 3 \phi 3/8"$$

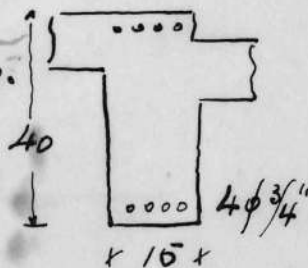
VIGA 23.

CARGA:

P.p.			= 144 kg.
PAR. 15			= 2160 "
L 4 3°	110 x 1,70 =	187 "	
L 4 2°	" " =	187 "	
L 22 1°	" " =	187 "	
		<u>q = ~2870 kg.</u>	

$$M_q = \frac{2870 \times 11,60}{10} = 3320 \text{ mkg.}$$

$$M_p = \frac{2140 \times 2,2 \times 1,2}{3,4} = 1700 \text{ mkg.}$$



$$M_T = 3320 + 1700 = 5020 \text{ mkg.} \quad b_0 = 15 \quad l = 4,5 \times 9 + 15 = 55$$

$$d_0 = 40; \quad \bar{\sigma}_c = 46; \quad S_f = 10,00; \quad 4 \phi 3/4"$$

$$b_0 = 15; d_0 = 40; S_f = 4 \phi 3/4"$$

$$R_A = 2870 \times 1,70 + \frac{2140 \times 2,20}{3,40} = 6320 \text{ kg.}$$

$$R_B = 4900 + 770 = 5670 \text{ kg.}$$

CARGA:

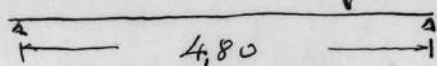
P.p.	0,15 x 0,6 x 2400	= 216 Kg.
PAR.	15	= 2160 "
L 4	3° 340 x 1,65	= 560 "
L 4	2° "	= 560 "
L 22	1° "	= 560 "
L 3	3° 345 x 2	= 790 "
L 3	2° "	= 790 "
L 21	1° 425 x 1,6	= 680 "

$$q = \sim 6320 \text{ Kg.}$$

VIGA 24.

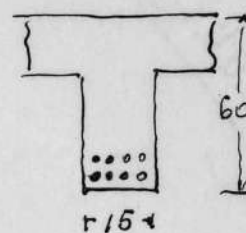
F.14.

$$P = 6320 \text{ Kg.}$$



$$M_g = \frac{6320 \times 2.40}{10} = 14500 \text{ mkg.}$$

$$M_p = \frac{6320 \times 1.2 \times 3.6}{4.8} = 5720 \text{ mkg.}$$



$$M_T = 14500 + 5720 = 20220 \text{ mkg.} \quad b_0 = 15; \quad b = 12 \times 9 + 15 \approx 120$$

$$d_0 = 60; \quad \sigma_c = 40; \quad S_f = 26.20$$

$$4\phi 7/8" + 4\phi 3/4"$$

$$b_0 = 15; \quad d_0 = 60; \quad S_f = 4\phi 7/8" + 4\phi 3/4"$$

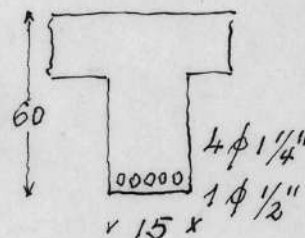
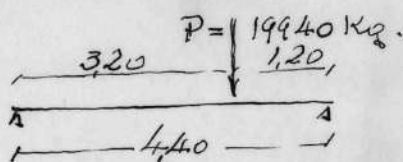
$$R_A = 6320 \times 2.40 + \frac{6320 \times 1.2}{4.8} = 16780 \text{ Kg.} \quad R_B = 15200 + 4740 = 19940 \text{ Kg.}$$

VIGA 25.

CARGA:

P.p.		= 216 Kg.
PARADE	15	= 2160 "
L 3	3° 50 x 2.75	= 152 "
L 3	2° "	= 152 "
L 21	1° 25 x "	= 70 "
L 10	3° 375 x 2.05	= 755 "
L 10	2° "	= 755 "
L 28	380 x "	= 635 "

$$q = \sim 4900 \text{ Kg.}$$



$$M_g = \frac{1}{10} \cdot 4900 \times 19.36 = 9500 \text{ mkg.}; \quad M_p = \frac{19940 \times 1.2 \times 3.2}{4.4} = 15250 \text{ mkg.}$$

$$M_T = 9500 + 15250 = 24750 \text{ mkg.}; \quad b_0 = 15; \quad b = 12 \times 9 + 15 \approx \sim 120; \quad \sigma_c = 45$$

$$S_f = 32.20 \text{ cm}^2 \quad 4\phi 1 1/4" + 1\phi 1/2"$$

$$b_0 = 15 \quad d_0 = 60 \quad S_f = 4\phi 1 1/4" + 1\phi 1/2"$$

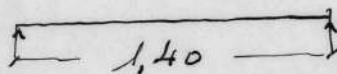
$$R_A = 4900 \times 2.2 + \frac{19940 \times 1.2}{4.40} = 16250 \text{ Kg.}; \quad R_B = 10800 + 14500 = 25300 \text{ Kg.}$$

VIGA 26.

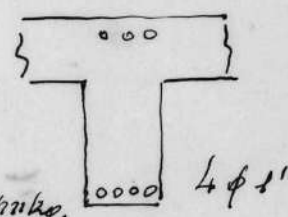
CARGA:

P.p.		= 216 Kg.
PAR.	15	= 2160 "
L 10	3°	= 755 "
L 10	2°	= 755 "
L 28	1°	= 635 "
L 12	3° 425 x 1,65	= 700 "
L 12	2° "	= 700 "
L 30	1° 405 x "	= 670 "

$$q = \sim 6600 \text{ Kg.}$$



$$M = \frac{6600 \times 19.36}{10} = 12800 \text{ mkg.}$$



$$b_0 = 15; \quad b = 120 \quad d_0 = 50 \quad \sigma_c = 38 \quad S_f = 19.80 \quad 4\phi 1"$$

$$R_A = R_B = 6600 \times 2.2 = 14500 \text{ Kg.}$$

$$b_0 = 15 \quad d_0 = 50 \quad 4\phi 1"$$

VIGA 27.

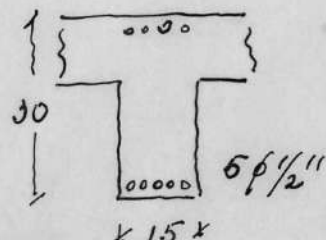
CARGA:

TEL		= 450 Kg.
P.p.		= 180 Kg.
PAR	30	= 2160 "
L 17	3°	= 675 "
L 17	2°	= 675 "
L 17	1°	= 675 "

$$q = \sim 4820 \text{ Kg.}$$

$$v_{\text{ad}} = 2.20$$

$$M = \frac{4820 \times 484}{10} = 2340 \text{ mkg.}$$



$$b_0 = 15; \quad b = 45 \times 9 + 15 \approx \sim 55 \quad d_0 = 30; \quad \sigma_c = 41; \quad S_f = 6.15; \quad 5\phi 1/2"$$

$$R_A = R_B = 4370 \times 1.10 = 4840 \text{ Kg.}$$

$$b_0 = 15 \quad d_0 = 30 \quad S_f = 5\phi 1/2"$$

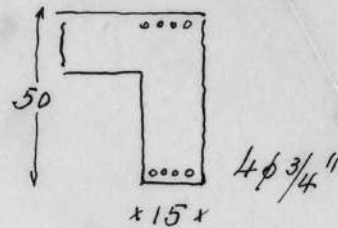
VIGA 28.

F.15.

CARGA

P.p.	=	144 Kg.
TEL.	=	450 "
PAR. 25	=	3600 "
L 14 3°	450 x 1,1	= 495 "
L 14 2°	"	= 495 "
L 32 1°	"	= 495 "
$q \approx 5680 \text{ Kg.}$		

$$v_{20} = 3,50$$



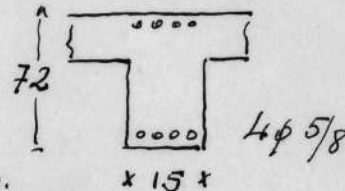
$$M_g = \frac{5680 \times 12,25}{10} = 6950 \text{ mkg}; \quad b_0 = 15; \quad b = 55; \quad d_0 = 50; \quad b_c = 42; \quad s_f = 10,82 \quad 4\phi 3/4"$$

$$R_A = R_B = 5680 \times 1,75 = 10.000 \text{ Kg.} \quad \boxed{b_0 = 15 \quad d_0 = 50 \quad s_f = 4\phi 3/4"}$$

VIGA 29.

CARGA:

P.p.	0,15 x 0,6 x 2400	=	216 Kg.
L 33	3 x 230 x 1,30	=	900 "
$q \approx 1120 \text{ Kg.}$			



$$M_g = \frac{1120 \times 4,41}{10} = 500 \text{ mkg}; \quad M_p = \frac{13150 \times 1,3 \times 0,8}{2,10} = 6500 \text{ mkg.}$$

$$M_T = 7000 \text{ mkg}; \quad d_0 = 72; \quad b_0 = 12 \times 7 + 15 \approx 95; \quad b_c = 20; \quad s_f = 7,20 \quad 4\phi 5/8"$$

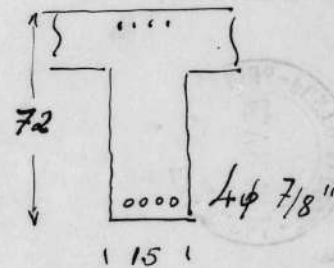
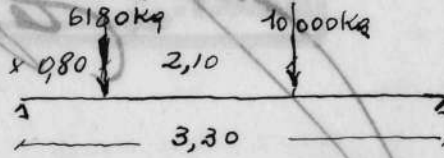
$$R_A = 1120 \times 1,05 + \frac{13150 \times 1,3}{2,10} = 9830 \text{ Kg.} \quad \boxed{b_0 = 15 \quad d_0 = 72 \quad s_f = 4\phi 5/8"}$$

$$R_B = 1180 + 5000 = 6180 \text{ Kg.}$$

VIGA 30.

CARGA

P.p.	=	252 Kg.
PAR. 25	=	3600 "
L 33	=	900 "
$q \approx 4760 \text{ Kg.}$		



$$M_g = \frac{4760 \times 10,89}{10} = 5200 \text{ mkg.} \quad M_p = 9400 \text{ mkg.}$$

$$M_T = 14600 \text{ mkg.} \quad d_0 = 72; \quad b = 95; \quad b_c = 31; \quad s_f = 15,75 \quad 4\phi 7/8"$$

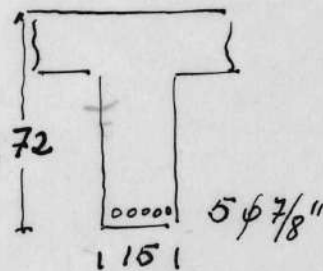
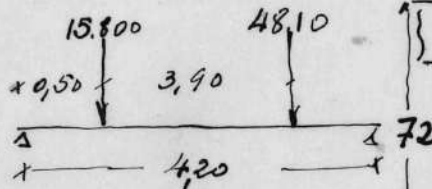
$$R_A = 4760 \times 1,65 + 8300 = 16200 \text{ Kg.} \quad \boxed{b_0 = 15 \quad d_0 = 72 \quad s_f = 4\phi 7/8"}$$

$$R_B = 7900 + 7900 = 15800 \text{ Kg.}$$

VIGA 31.

CARGA:

P.p.			=	250 Kg.
PAR.	15.	3×720	=	2160 "
L 14	$3^{\circ} 20'$		=	900 "
L 32			=	450 "
L 12	3°	$425 \times 1,55$	=	660 "
L 12	2°	" "	=	660 "
L 30	1°	405 "	=	630 "
				$q \approx 5710 \text{ Kg.}$



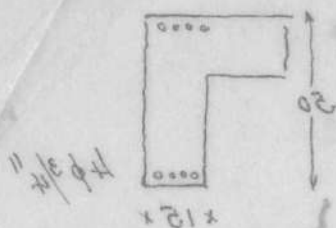
$$M_g = \frac{5710 \times 17,54}{10} = 10100 \text{ mkg.}; \quad M_p = 7200 \text{ mkg.}; \quad M_T = 17300 \text{ mkg.}$$

$$b = 12 \times 9 + 15 \approx 120; \quad d_0 = 72; \quad b_c = 30; \quad s_f = 18,70 \quad 5\phi 7/8"$$

$$R_A = 5710 \times 2,10 + 13910 = 25910 \text{ Kg.} \quad \boxed{b_0 = 15 \quad d_0 = 72 \quad s_f = 5\phi 7/8"}$$

$$R_B = 5710 \times 2,10 + 6700 = 18700 \text{ Kg.}$$

mf



$$0.05 = 0.05$$

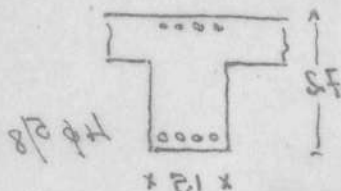
[illegible]

$\phi_0 = 10; \phi = 20; \phi' = 30; \phi'' = 40; \phi''' = 50; \phi^{(4)} = 60; \phi^{(5)} = 70; \phi^{(6)} = 80; \phi^{(7)} = 90; \phi^{(8)} = 100$

$$R_A = R_B = 2080 \times 1.72 = 10,000 \text{ kg}$$

$$|P_0 = 12 \quad q_0 = 20 \quad z_f = 1.4 \phi^{3/4}|$$

5P. 241V



$1.13 \times 1.30 \times 1.30 = 1.92$
 $0.12 \times 0.54 \times 0 = 0$
 $51.5 = 51.5$

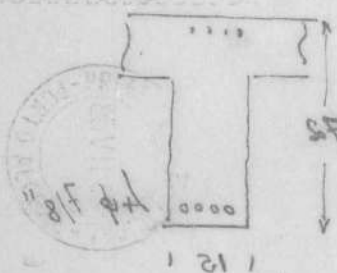
$$M_p = \frac{11.50 \times 4.41}{10} = 500 \text{ mm}^2; \quad M_p = \frac{13.12 \times 13.08}{5.10} = 3200 \text{ mm}^2$$

$$M_T = 7000 \text{ mm}^2; q_0 = 6; ; f_x = 15 \times f + 12 = p_0; ; f_y = 20; ; f_z = 20; ; f_{xy} = 70$$

$$P_B = 1180 + 2000 = 3180 \text{ m}^2$$

$$P_A = 1150 \times 102 + \frac{13120 \times 1.3}{2 \times 10} = 1830 \text{ m}^2$$

$$\left[\begin{array}{l} P_0 = 12 \\ q_0 = 75 \\ z_f = 450/8 \end{array} \right]$$



$\frac{1}{2} = 0.5$
 $\frac{1}{3} = 0.33$
 $\frac{1}{4} = 0.25$
 $\frac{1}{5} = 0.2$
 $\frac{1}{6} = 0.166$
 $\frac{1}{7} = 0.142$
 $\frac{1}{8} = 0.125$
 $\frac{1}{9} = 0.111$
 $\frac{1}{10} = 0.1$
 $\frac{1}{11} = 0.0909$
 $\frac{1}{12} = 0.0833$
 $\frac{1}{13} = 0.0769$
 $\frac{1}{14} = 0.0714$
 $\frac{1}{15} = 0.0667$
 $\frac{1}{16} = 0.0625$
 $\frac{1}{17} = 0.0588$
 $\frac{1}{18} = 0.0556$
 $\frac{1}{19} = 0.0526$
 $\frac{1}{20} = 0.05$
 $\frac{1}{21} = 0.0476$
 $\frac{1}{22} = 0.0455$
 $\frac{1}{23} = 0.0435$
 $\frac{1}{24} = 0.0417$
 $\frac{1}{25} = 0.04$
 $\frac{1}{26} = 0.0385$
 $\frac{1}{27} = 0.037$
 $\frac{1}{28} = 0.0357$
 $\frac{1}{29} = 0.0345$
 $\frac{1}{30} = 0.0333$
 $\frac{1}{31} = 0.0323$
 $\frac{1}{32} = 0.0312$
 $\frac{1}{33} = 0.0303$
 $\frac{1}{34} = 0.0294$
 $\frac{1}{35} = 0.0286$
 $\frac{1}{36} = 0.0278$
 $\frac{1}{37} = 0.0270$
 $\frac{1}{38} = 0.0263$
 $\frac{1}{39} = 0.0256$
 $\frac{1}{40} = 0.025$
 $\frac{1}{41} = 0.0244$
 $\frac{1}{42} = 0.0238$
 $\frac{1}{43} = 0.0233$
 $\frac{1}{44} = 0.0227$
 $\frac{1}{45} = 0.0222$
 $\frac{1}{46} = 0.0217$
 $\frac{1}{47} = 0.0213$
 $\frac{1}{48} = 0.0208$
 $\frac{1}{49} = 0.0204$
 $\frac{1}{50} = 0.02$

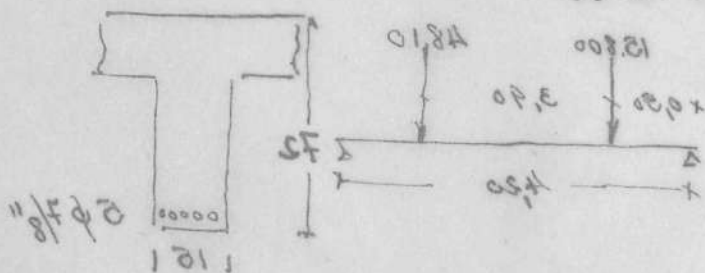
$$M_2 = \frac{1750 \times 10^8}{10} = 2500 \text{ mkg.}$$

$$M_3 = 2100 \text{ mkg.}$$

[illegible]

$$\begin{aligned} \psi_0 &= \psi_{00} + \psi_{01} = 12800 \text{ Hz} \\ \psi_1 &= \psi_{00} + \psi_{01} + \psi_{02} + \psi_{03} = 19500 \text{ Hz} \end{aligned}$$

1. ΕΛΛΗΝ



Year	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

$$M = \frac{2510 \times 17.24}{10} = 4310 \text{ mkg} \quad ; \quad M = 7500 \text{ mkg} \quad ; \quad M = 15300 \text{ mkg}$$

$$p = 15 \times 1 + 12 = 27 \text{ ; } q = 15 \times 1 + 12 = 27 \text{ ; } r = 15 \times 1 + 12 = 27 \text{ ; } s = 15 \times 1 + 12 = 27$$

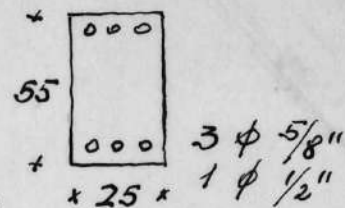
$$P^0 = 10 \quad q^0 = f_0 \quad z = 0.048$$

VIGA 32.

F.16.

CARGA:

P.p. = 300 Kg.
 RESERV. 400 x 1,70 = 680 "
 PAR. 30 = 3600 "
 ESC. 3 x 450 x 1,70 = 2290 "
 $q \approx 6870 \text{ Kg.}$



$M = \frac{6870 \times 6,76}{10} = 4660 \text{ mKg.}$; $b_0 = 25$; $d_0 = 55$; $\sigma_c = 47$;

$S_f = 6,60 \quad 3 \phi 5/8" + 1 \phi 1/2"$

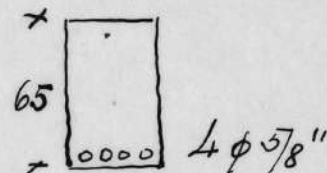
$R_A = R_B = 6870 \times 1,30 = 8950 \text{ Kg.}$

$b_0 = 25 \quad d_0 = 55 \quad S_f = 3 \phi 5/8" + 1 \phi 1/2"$

VIGA 33.

CARGA:

P.p. = 300 Kg.
 RESERV. 1400 x 1,25 = 1750 "
 PAR. 25 = 3600 "
 $q \approx 5650 \text{ Kg.}$



$M = \frac{5650 \times 11,56}{10} = 6550 \text{ mKg.}$; $b_0 = 25$; $d_0 = 65$; $\sigma_c = 47$;

$S_f = 7,80 - 4 \phi 5/8"$

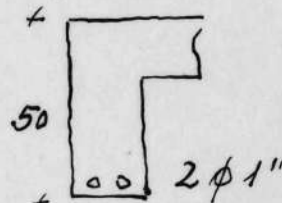
$R_A = R_B = 5650 \times 1,70 = 9600 \text{ Kg.}$

$b_0 = 25 \quad d_0 = 65 \quad S_f = 4 \phi 5/8"$

VIGA 34.

CARGA:

P.p. = 300 Kg.
 RES. = 1750 "
 PAR. 15 = 2160 "
 L 13 30 x 20 = 900 "
 L 31 = 450 "
 $q \approx 5560 \text{ Kg.}$



$M = \frac{5560 \times 11,56}{10} = 6450 \text{ mKg.}$; $b_0 = 15$; $b = 45 \times 9 + 15 = 55$; $d_0 = 50$; $\sigma_c = 40$

$S_f = 10,00 - 2 \phi 1"$

$R_A = R_B = 5560 \times 1,7 = 9500 \text{ Kg.}$

$b_0 = 15 \quad d_0 = 50 \quad S_f = 2 \phi 1"$

VIGA 35.

CARGA:

P.p. = $0,15 \times 0,6 \times 2400 = 216 \text{ Kg.}$

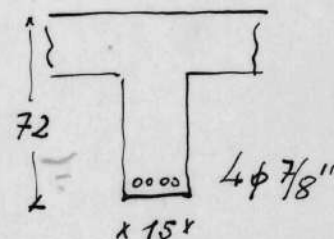
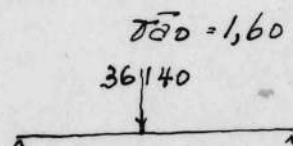
$M_g = \frac{300 \times 2,56}{10} = 76,80 \text{ mKg.}$

$M_p = \frac{36140 \times 1,6}{4} = 14456 \text{ mKg.}$

$M_T = 14456 + 77 = 14533 \text{ mKg.}$ $b_0 = 12 \times 9 + 15 \approx 123$

$d_0 = 72$; $\sigma_c = 27$; $S_f = 15,50 - 4 \phi 7/8"$

$R_A = R_B = 300 \times 0,8 + 18070 = 18310 \text{ Kg.}$



$b_0 = 15 \quad d_0 = 72 \quad S_f = 4 \phi 7/8"$

VIGA 36.

IDENTICA A VIGA 35

$b_0 = 15 \quad d_0 = 72 \quad S_f = 4 \phi 7/8"$

mf

CARGA:

VIGA 37.

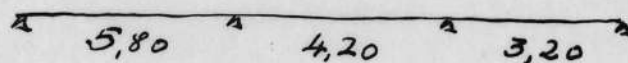
F 17.

$$\begin{array}{lll}
 \text{P.p.} & = 216 \text{ Kg} & \text{P.p.} & = 216 \text{ Kg} & \text{P.p.} & = 216 \text{ Kg} \\
 \text{L} & 21.425 \times 1,6 = 680'' & \text{L} & 28.330 \times 2,2 = 725'' & \text{L} & 30.405 \times 2,2 = 890'' \\
 & = 180'' & & = 180'' & & = 180'' \\
 & q_1 \approx 1080 \text{ Kg} & & q_2 \approx 1130 \text{ Kg} & & q_3 \approx 1290 \text{ Kg}
 \end{array}$$

$$L_1 = R_1 = \frac{1}{4} q_1 l = \frac{1080 \times 5,80^2}{4} = 9120$$

$$L_2 = R_2 = \frac{1130 \times 4,20^2}{4} = 5000$$

$$L_3 = R_3 = \frac{1190 \times 3,20^2}{4} = 3300$$



$$X_1 = -0,25 \times 9180 - 0,2667 \times 5000 + 0,0667 \times 5000 + 0,0625 \times 3300 = -3170 \text{ mKg}$$

$$X_2 = +0,0625 \times 9120 + 0,0667 \times 5000 - 0,2667 \times 5000 - 0,25 \times 3300 = -1405 \text{ mKg}$$

$$R_1 = 1080 \times 2,9 - \frac{3170}{5,80} = 2600 \text{ Kg}$$

$$\begin{aligned}
 R_2 &= \begin{cases} 1080 \times 2,9 + 540 = 3680 \\ 1130 \times 2,1 - \frac{-3170 + 1405}{4,2} = 2800 \end{cases} = 6480 \text{ Kg}; \\
 R_3 &= \begin{cases} 2380 - 420 = 1960 \\ 1290 \times 1,6 - 440 = 2510 \end{cases} = 4470 \text{ Kg}
 \end{aligned}$$

$$R_4 = 2070 - 440 = 1630 \text{ Kg}$$

$$M_{12} = \frac{2600^2}{2 \times 1080} = 3140 \text{ mKg}$$

$$M_{23} = \frac{2800^2}{2 \times 1130} - 3170 = 280 \text{ mKg}$$

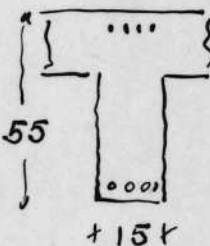
$$M_{34} = \frac{1630^2}{2 \times 1290} = 950 \text{ mKg}$$

No Apoio 2 $b_0 = 15$; $d_0 = 55$; $\bar{c} = 50$; $s_f = 4,50 - 4 \phi 1/2''$

No Apoio 3 $\bar{c} = 31,5$; $s_f = 1,97 - 2 \phi 1/2''$

No 1º vao $\bar{c} = 17$; $s_f = 4,25 - 4 \phi 1/2''$

No 2º e 3º vao $s_f = 4,00 - 2 \phi 1/2''$



$$b_0 = 15 \quad d_0 = 55$$

VIGA 38.

CARGAS:

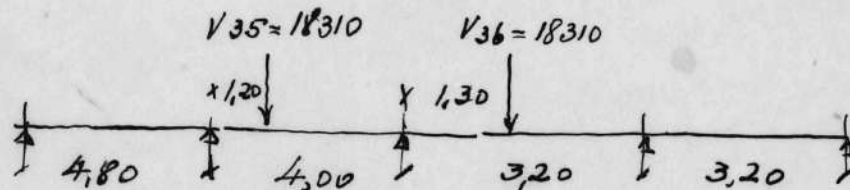
$$\begin{array}{lll}
 \text{P.p.} & = 216 \text{ Kg} & \text{P.p.} & = 216 \text{ Kg} & \text{P.p.} & = 216 \text{ Kg} & \text{P.p.} & = 216 \text{ Kg} \\
 \text{L} & 19 & = 680'' & \text{L} & 27 & = 725'' & \text{L} & 29 & = 770'' & \text{L} & & = 180'' \\
 & = 180'' & & & = 180'' & & & = 180'' & & & = 180'' \\
 & q_1 \approx 1080 \text{ Kg} & & q_2 \approx 1130 \text{ Kg} & & q_3 \approx 1170 \text{ Kg} & & q_4 \approx 400 \text{ Kg}
 \end{array}$$

$$L_1 = R_1 = \frac{1}{4} \times 1080 \times 4,8^2 = 5760$$

$$L_2 = R_2 = \frac{1}{4} \times 1130 \times 4,0^2 = 4520$$

$$L_3 = R_3 = \frac{1}{4} \times 1170 \times 3,2^2 = 3000$$

$$L_4 = R_4 = \frac{1}{4} \times 400 \times 2,2^2 = 484$$



$$X_1 = -0,25 \times 5760 - 0,2667 \times 4520 + 0,0667 \times 4520 + 0,0667 \times 3000 - 0,0167 \times 3000 - 0,0156 \times 484 =$$

$$X_1 = -1440 - 1205 + 320 + 200 - 50 - 7 = -2182 \text{ mKg}$$

m

$$X_2 = 0,0625 \times 5760 + 0,0667 \times 4520 - 0,2667 \times 4520 - 0,2667 \times 3000 + 0,0667 \times 3000 + 0,0625 \times 484 =$$

$$X_2 = 360 + 320 - 1210 - 830 + 200 + 30 = \underline{-1100 \text{ mkg.}}$$

$$X_3 = -0,0156 \times 5760 - 0,0167 \times 4580 + 0,0667 \times 4520 + 0,0667 \times 3000 - 0,2667 \times 3000 - 0,25 \times 484 =$$

$$X_3 = -89 - 76 + 320 + 200 - 800 - 120 = \underline{-565 \text{ mkg}}$$

$$L_1 = R_1 = 0$$

$$L_2 = \frac{18310 \times 1,20 \times 280}{16} (4 \times 2,80) = 26200 ; R_2 = \frac{18310 \times 1,2 \times 3,8}{16} (4 \times 1,20) = 20.000$$

$$L_3 = \frac{18310 \times 1,30 \times 1,90}{10,24} (3,2 \times 1,9) = 22500 ; R_3 = \frac{18310 \times 1,3 \times 1,9}{10,24} (3,2 \times 1,3) = 20250$$

$$L_4 = R_4 = 0.$$

$$X_{1p} = -0,2667 \times 26200 + 0,0667 \times 20.000 + 0,0667 \times 22500 - 0,0167 \times 20.250 = \underline{-7520 \text{ mkg}}$$

$$X_{2p} = 0,0667 \times 26200 - 0,2667 \times 20000 - 0,2667 \times 22500 + 0,0667 \times 20250 = \underline{-8250 \text{ mkg}}$$

$$X_{3p} = -0,0167 \times 26200 + 0,0667 \times 20.000 + 0,0667 \times 22500 - 0,2667 \times 20250 = \underline{-3000 \text{ mkg.}}$$

$$X'_T = -2182 - 7520 = \underline{-9702 \text{ mkg}} ; X''_T = -1100 - 8250 = \underline{-9350 \text{ mkg.}} ; X'''_T = 570 - 3000 = \underline{-2430 \text{ mkg}}$$

$$R'_{1g} = 1080 \times 2,4 - \frac{2182}{4,80} = 2130 \text{ Kg.} ; R''_{2g} = \frac{1080 \times 2,4 + \frac{2182}{4,80}}{1130 \times 2 - \frac{-2182 + 1100}{4}} = 3050 \text{ } \left. \vphantom{\frac{1080 \times 2,4 + \frac{2182}{4,80}}{1130 \times 2 - \frac{-2182 + 1100}{4}}} \right\} = 5580 \text{ Kg.}$$

$$R'_{3g} = \frac{1130 \times 2 + \frac{1100}{4}}{1170 \times 1,6 - \frac{-1100 + 565}{3,2}} = 2540 \text{ } \left. \vphantom{\frac{1130 \times 2 + \frac{1100}{4}}{1170 \times 1,6 - \frac{-1100 + 565}{3,2}}} \right\} = 4587 \text{ Kg.}$$

$$R'_{4g} = \frac{1880 - 167}{400 \times 1,1 + \frac{565}{2,2}} = 1720 \text{ } \left. \vphantom{\frac{1880 - 167}{400 \times 1,1 + \frac{565}{2,2}}} \right\} = 2470 \text{ Kg.} ; R'_{5g} = 400 \times 1,1 - 250 = 190 \text{ Kg.}$$

REAÇÕES CARGAS CONCENTRADAS :

$$R_{1p} = -\frac{7520}{4} = -1880 \text{ Kg.} ; R_{2p} = \frac{+1880}{18310 \times 280} - \frac{-7580 + 3250}{4} = 12670 \text{ } \left. \vphantom{\frac{+1880}{18310 \times 280} - \frac{-7580 + 3250}{4}} \right\} = 14550 \text{ Kg.}$$

$$R_{3p} = \frac{5460 + 182}{18310 \times 1,9} - \frac{-8250 + 3000}{3,2} = 12640 \text{ } \left. \vphantom{\frac{5460 + 182}{18310 \times 1,9} - \frac{-8250 + 3000}{3,2}} \right\} = 18.332 \text{ Kg.} ; R_{4p} = \frac{7460 - 1840}{1360 \times 1,10 - 2000} = 6980 \text{ Kg.}$$

$$R_{5p} = -\frac{3000}{2,2} = -1360 \text{ Kg.}$$

$$R_{1T} = 2130 - 1880 = 350 \text{ Kg.} ; R_{2T} = 5580 + 14550 = 20130 \text{ Kg.} ; R_{3T} = 1170 \text{ Kg.}$$

$$R_{4T} = 4590 + 18240 = 22930 \text{ Kg.} ; R_{5T} = 2440 + 6980 - 9390 \text{ Kg.}$$

Mto nos vao - CARGA CONCENTRADA.:

$$M_{1p} = -1880 \times 2,40 = -4510 \text{ mkg.} ; M_{2p} = 12670 \times 1,20 - 7520 = 7700 \text{ mkg.}$$

$$M_{3p} = +12640 \times 1,30 - 8250 = 8250 \text{ mkg.} ; M_{4p} = 1360 \times 1,10 - 2000 = -1510 \text{ mkg.}$$

107

M.to. VÃO CARGAS DISTRIBUIDAS.

$$M_{1q} = \frac{2130^2}{2 \times 1080} = 2120 \text{ mkg}; \quad M_{2q} = \frac{2530^2}{2 \times 1130} = 2182 = 658 \text{ mkg}.$$

$$M_{3q} = \frac{2047^2}{2 \times 1170} - 1100 = 700 \text{ mkg}; \quad M_{4q} = \frac{690^2}{2 \times 400} = 565 = 30 \text{ mkg}.$$

$$M_{1T} = -4510 + 2120 = -2390 \text{ mkg}; \quad M_{2T} = 7700 + 660 = 8360 \text{ mkg}.$$

$$M_{3T} = 8250 + 700 = 8950 \text{ mkg}; \quad M_{4T} = -1510 + 30 = -1480 \text{ mkg}.$$

CALCULO DAS SECCOES:

$$b_0 = 15 \quad d_0 = 72 \quad \frac{b_0^2}{135} = 545$$

No Apoio 2. $X' = -970 \text{ mkg}; \quad \Delta M = 970 - 545 = 425$

$$F_e = \frac{15 \times 70}{180} + \frac{425}{1,5 \times 68} = 9,52 \text{ cm}^2 \quad 5 \phi 5/8"$$

$$F_e' = \frac{425}{0,682 \times 0,68} = 9,15 \text{ cm}^2 \quad 5 \phi 5/8"$$

No Apoio 3: $X' = 935 \quad \Delta M = 935 - 545 = 390$

$$F_e = 5,5 + \frac{390}{1,5 \times 68} = 9,52 \text{ cm}^2 \quad 5 \phi 5/8"; \quad F_e' = \frac{390}{0,682 \times 0,68} = 8,40 \text{ cm}^2 \quad 5 \phi 5/8"$$

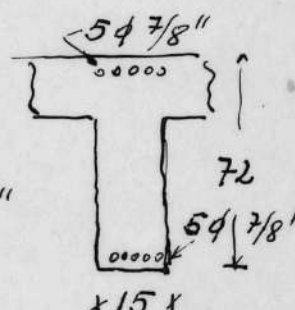
No Apoio 4: $\sigma_c = 39; \quad S_f = 3,80 \text{ cm}^2 - 2 \phi 5/8"$

No 1º vão: $\sigma_c = 31; \quad S_f = 2,56 \text{ cm}^2 \text{ (Negativo)} \quad 2 \phi 5/8"$

No 2º vão: $\sigma_c = 12 \times 7 + 15 = 95; \quad \sigma_c = 22; \quad S_f = 8,70 - 5 \phi 5/8"$

No 3º vão: $\sigma_c = 23; \quad S_f = 9,35 - 5 \phi 5/8"$

No 4º vão: $\sigma_c = 23,5; \quad S_f = 1,60 \text{ (Negativo)} - 1 \phi 5/8"$

**VIGA 39.**CARGA:

P.p.	0,15 x 0,7 x 2400	= 250 kg.	vão = 1,80
L 2	3º 55 x 2,80	= 155 "	
L 8	2º " "	= 155 "	
PAR.	25 " x 400	= 4400 "	
TEL.		= 450 "	

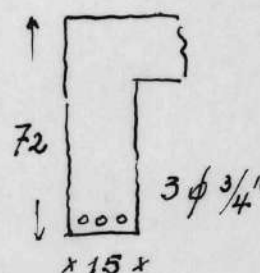
$$q = \sim 5410 \text{ kg}.$$

$$M_q = \frac{1}{10} \times 5410 \times 3,24 = 1760 \text{ mkg}.$$

$$M_p = \frac{13150 \times 1,8}{4} = 5920 \text{ mkg}. \quad M_T = 7680 \text{ mkg}.$$

$$b_0 = 15; \quad b = 4,5 \times 7 + 15 = 46; \quad d_0 = 72; \quad \sigma_c = 32; \quad S_f = 8,00 \text{ cm}^2.$$

$$R_A = R_B = 5410 \times 0,9 + 6575 = 11444 \text{ kg}. \quad \boxed{b_0 = 15 \quad d_0 = 72 \quad S_f = 3 \phi 3/4"}$$

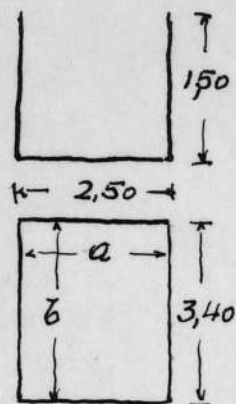
**ESCALADA.**

$$M = \frac{500 \times 10,89}{10} = 550 \text{ mkg}.$$

$$d_0 = 11; \quad \sigma_c = 45; \quad S_f = 4,40 \text{ cm}^2 - 9 \phi 5/16" \text{ p.m.}$$

RESERVATORIO.

F.20.



CARGA: $q = 1800 \text{ Kg.}$

$a = 2,50$; $b = 3,40$; $\frac{b}{a} = 1,36$; $m_a = 16$; $m_b = 29,5$; $k_a = 0,773$

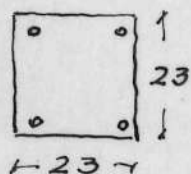
$M_a = \frac{1800 \times 6,25}{16} = 700 \text{ mkg.}$ $\sigma_c = 43$; $s_f = 4,75$ - $10 \phi \frac{5}{16}$ p.m

$M_b = \frac{1800 \times 6,25}{29,5} = 380$ " $\sigma_c = 30$; $s_f = 2,52$ - $8 \phi \frac{1}{4}$ p.m

$q_a = 1800 \times 0,773 = 1400 \text{ Kg.}$ $q_b = 1800 - 1400 = 400 \text{ Kg.}$

C- CALCULO DOS PILARES.

PILAR 1.



$P_1 = V_1 + V_2 = 7050 + 12160 = 19210 \text{ Kg.}$; $\lambda = \frac{h}{d} = \frac{4,00}{0,2} = 20,00$

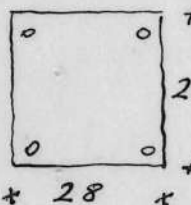
$w = 1,25$; $P_1 w = 1,25 \times 19210 = 24.000 = 24 \text{ Ton.}$

$F_b = \frac{24}{0,046} = 520$; $\sigma_c = 9,04 + 0,01 \times 0,5 = 0,046$

$F_e' = 9,01 \times 520 = 5,20 \text{ cm}^2$; $a = \sqrt{520} = 23 \text{ cm.}$ - $4 \phi \frac{1}{2}$ "

Dist. entre estribos: $12 \times 1,27 = 15 \text{ cm}$

PILAR 2.



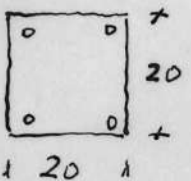
$P_2 = V_2 + V_5 = 29650 + 6050 = 35700 \text{ Kg.}$ $\lambda = \frac{4,00}{2,5} = 16,00$

$w = 1,05$; $P_2 w = 1,05 \times 35700 = 37,5 \text{ Ton.}$

$F_b = \frac{37,5}{0,046} = 815$; $a = 28$; $s_f = 8,15$ - $4 \phi \frac{5}{8}$ "

Dist. entre estribos $d = 12 \times 1,58 = 19 \text{ cm.}$

PILAR 3.

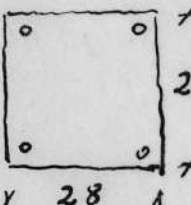


$P_3 = V_2 + V_3 = 1384 + 4000 = 5400 \text{ Kg.}$ $\lambda = \frac{4,00}{2,0} = 2,0$

$w = 1,25$; $P_3 w = 1,25 \times 5400 = 6,8 \text{ Ton}$

$F_b = \frac{6,8}{0,046} = 147$; $a = 20$; $d = 15$ $s_f = 4 \phi \frac{1}{2}$ "

PILAR 4.

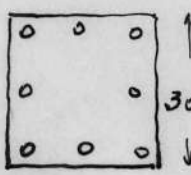


$P_4 = V_1 + V_{16} + V_6 = 7050 + 7660 + 20250 = 34960 \text{ Kg.}$ $\lambda = \frac{4,00}{2,8} = 1,4$

$P_3 w = 35$

$F_b = \frac{35}{0,046} = 756$; $a = 28$; $d = 19$; $s_f = 4 \phi \frac{5}{8}$ "

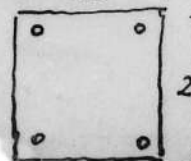
PILAR 5.



$P_5 = V_{41} + V_4 + V_7 = 10900 + 2205 + 27350 = 41455 \text{ Kg.}$

$F_b = \frac{41,5}{0,046} = 900$; $a = 30$; $d = 15$; $s_f = 8 \phi \frac{1}{2}$ "

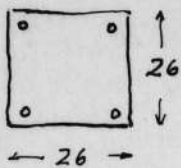
PILAR 6.



$P_6 = V_4 + V_{10} = 10300 + 24400 = 35700 \text{ Kg.}$

$F_b = \frac{35,7}{0,046} = 775$; $a = 28$; $d = 19$; $s_f = 4 \phi \frac{5}{8}$ "

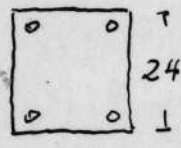
MD

PILAR 7.

$$P_7 = V_{27A} + V_8 + V_9 = 4810 + 11100 + 12100 = 28000 \text{ Kg.}; \lambda = 16$$

$$W = 1,05; P_7 W = 29,4$$

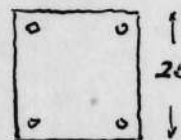
$$\bar{F}_b = \frac{29,4}{0,046} = 640; a = 26; d = 19; S_f = \underline{4 \phi 5/8''}$$

PILAR 8.

$$P_8 = V_{27A} + V_{34} + V_{32} = 4810 + 9500 + 8950 = 23260 \text{ Kg.}$$

$$W = 1,05; P_8 W = 1,05 \times 23,26 = 24,5 \text{ Ton.}$$

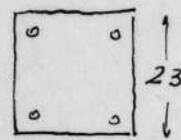
$$\bar{F}_b = \frac{24,5}{0,046} = 535; a = 25; d = 19; S_f = \underline{4 \phi 1/2''}$$



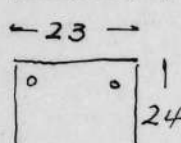
$$P_8' = 23260 + 2600 + 560 = 26420 \text{ Kg.}$$

$$W = 1,05; P_8' W = 1,05 \times 26,5 = 27,8 \text{ Ton.}$$

$$\bar{F}_b = \frac{27,8}{0,046} = 605; a = 25; d = 19; S_f = \underline{4 \phi 5/8''}$$

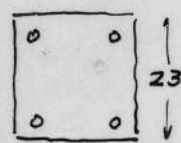
PILAR 9.

$$P_9 = V_{32} + V_{33} = 8950 + 9600 = 18550 \text{ Kg.}; d = 23. S_f = \underline{4 \phi 1/2''}$$



$$P_9' = 18550 + 2600 + 560 = 21710 \text{ Kg.}$$

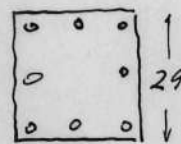
$$a = 24; d = 15; S_f = \underline{4 \phi 1/2''}$$

PILAR 10.

$$P_{10} = V_{16} + V_{34} + V_{38} = 7660 + 11450 + 350 = 19460 \text{ Kg.}$$

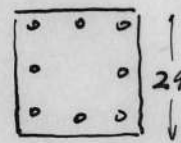
$$W = 1,15; P_{10} W = 19,5 \times 1,15 = 22,4 \text{ Ton.}$$

$$a = 25; d = 15; S_f = \underline{4 \phi 1/2''}$$

PILAR 11.

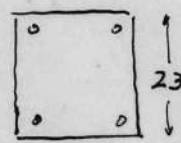
$$P_{11} = V_7 + V_{38} = 17155 + 20130 = 37285 \text{ Kg.}$$

$$\bar{F}_b = \frac{37,3}{0,046} = 810; a = 29; d = 15; S_f = \underline{8 \phi 1/2''}$$

PILAR 12.

$$P_{12} = V_{10} + V_{38} = 15100 + 22930 = 38030 \text{ Kg.}$$

$$a = 29; d = 15; S_f = \underline{8 \phi 1/2''}$$

PILAR 13.

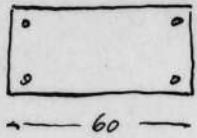
$$P_{13} = V_8 + V_{38} = 11100 + 9390 = 20490 \text{ Kg.}$$

$$W = 1,15; P_{13} W = 1,15 \times 20,5 = 23,6 \text{ Ton.}$$

$$\bar{F}_b = \frac{23,6}{0,046} = 515; a = 23; d = 15; S_f = \underline{4 \phi 1/2''}$$

PILAR 14.

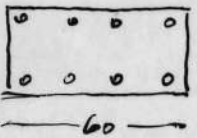
F. 22.



$$P_{14} = V_{34} + V_{29} + V_{15} + V_{38} = -1170 + 4920 + 9330 + 9500 = 27000 \text{ Kg.}$$

$$W = 1.25; P_{14}W = 27000 \times 1.25 = 33800$$

$$\bar{F}_b = \frac{33800}{9046} = 3730; a = 20; b = \frac{230}{20} = 37 \text{ cm}; d = 19; 5f = \underline{4 \phi 5/8''}$$

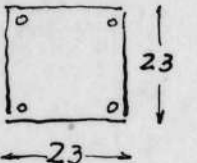


$$P_{14A} = 27000 + 1000 + 1640 = 29640$$

$$W = 1.25; P_{14A}W = 1.25 \times 29640 = 37,20 \text{ ton.}$$

$$\bar{F}_b = \frac{37,20}{9046} = 810; a = 20; b = \frac{810}{2} = 42 \text{ cm}; d = 15; 5f = \underline{8 \phi 1/2''}$$

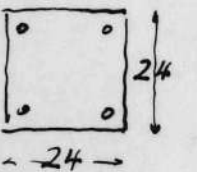
PILAR 15.



$$P_{15} = V_{11} + V_{12} + V_{33} = 4920 + 9600 + 6000 = 20520 \text{ Kg.}$$

$$a = 23; d = 15;$$

$$5f = \underline{4 \phi 1/2''}$$

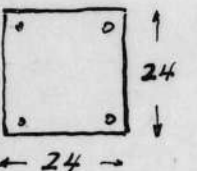


$$P_{15A} = 20500 + 510 + 1200 + 1640 = 23850 \text{ Kg.}$$

$$a = 24; d = 15;$$

$$5f = \underline{4 \phi 1/2''}$$

PILAR 16.



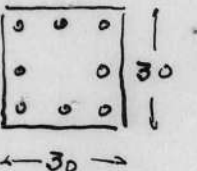
$$P_{16} = V_{17} + V_{39} + V_{37} = 7660 + 11450 + 2600 = 21710 \text{ Kg.}; \lambda = \frac{400}{22} = 19$$

$$W = 1.20; P_{16}W = 21,71 \times 1.20 = 26,10 \text{ ton.}$$

$$\bar{F}_b = \frac{26,10}{9046} = 567; a = 24; d = 15;$$

$$5f = \underline{4 \phi 1/2''}$$

PILAR 17.

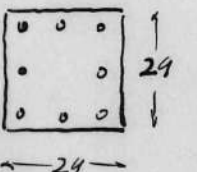


$$P_{17} = V_{25} + V_{35} + V_{37} = 6480 + 18310 + 16250 = 41040 \text{ Kg.}$$

$$a = 30; d = 15;$$

$$5f = \underline{8 \phi 1/2''}$$

PILAR 18.

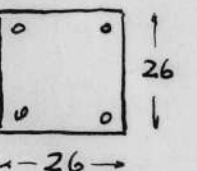


$$P_{18} = V_{26} + V_{36} + V_{37} = 14500 + 18310 + 4470 = 37280 \text{ Kg.}$$

$$a = 29; d = 15;$$

$$5f = \underline{8 \phi 1/2''}$$

PILAR 19.

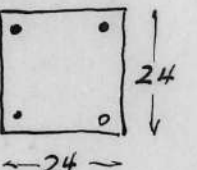


$$P_{19} = V_{31} + V_{37} = 25910 + 1630 = 27540$$

$$a = 26; d = 19;$$

$$5f = \underline{4 \phi 5/8''}$$

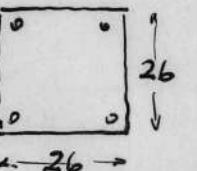
PILAR 20.



$$P_{20} = V_{12} + V_{30} = 6000 + 15,800 = 21800 \text{ Kg.}$$

$$a = 24; d = 15;$$

$$5f = \underline{4 \phi 1/2''}$$

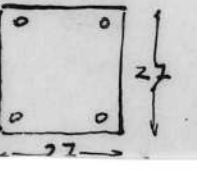


$$P'_{20} = 21800 + 600 + 5000 = 27400$$

$$a = 26; d = 19;$$

$$5f = \underline{4 \phi 5/8''}$$

PILAR 21.



$$P_{21} = V_{17} + V_{18} + V_{24} = 7660 + 8000 + 16780 = 32440 \text{ Kg.}$$

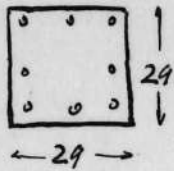
$$\bar{F}_b = \frac{32,44}{9046} = 705; a = 27; d = 19;$$

$$5f = \underline{4 \phi 5/8''}$$

m

PILAR 22.

F 23.

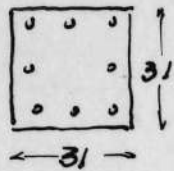


$$P_{22} = V_{21} + V_{22} + V_{25} = 10135 + 2185 + 25300 = 37620 \text{ Kg.}$$

$$a = 29; \quad d = 15;$$

$$S_f = \underline{8 \phi 1/2''}$$

PILAR 23.

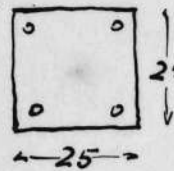


$$P_{23} = V_{21} + V_{26} = 29130 + 14500 = 43630 \text{ Kg.}$$

$$F_b = \frac{43630}{0,064} = 950; \quad a = 31; \quad d = 15;$$

$$S_f = \underline{8 \phi 1/2''}$$

PILAR 24.



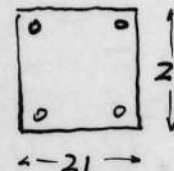
$$P_{24} = V_{21} + V_{31} = 18700 + 7735 = 26435 \text{ Kg.}$$

$$w = 1,05; \quad P_{24} w = 26435 \times 1,05 = 27,8 \text{ ton.}$$

$$F_b = \frac{27,8}{0,046} = 615; \quad a = 25; \quad d = 19;$$

$$S_f = \underline{4 \phi 5/8''}$$

PILAR 25.



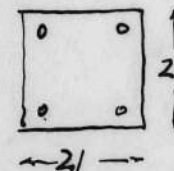
$$P_{25} = V_{27} + V_{28} = 10.000 + 4810 = 14810 \text{ Kg.}$$

$$w = 1,25; \quad P_{25} w = 14810 \times 1,25 = 18,6 \text{ Ton.}$$

$$F_b = \frac{18,6}{0,046} = 405; \quad a = 21; \quad d = 15;$$

$$S_f = \underline{4 \phi 1/2''}$$

PILAR 26.

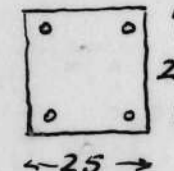


$$P_{26} = V_{18} + V_{19} = 8000 + 6250 = 14250 \text{ Kg.}$$

$$a = 21; \quad d = 15;$$

$$S_f = \underline{4 \phi 1/2''}$$

PILAR 27

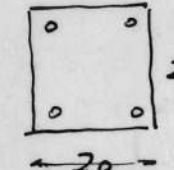


$$P_{27} = V_{19} + V_{23} = 20080 + 5670 = 25750 \text{ Kg.}$$

$$a = 25; \quad d = 19;$$

$$S_f = \underline{4 \phi 5/8''}$$

PILAR 28.



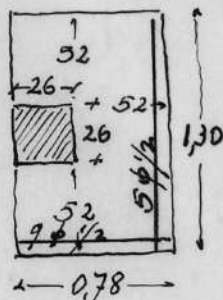
$$P_{28} = V_{19} + V_{20} = 5300 + 6250 = 11550 \text{ Kg.}$$

$$a = 20; \quad d = 15$$

$$S_f = \underline{4 \phi 1/2''}$$

D) CALCULO DAS SAPATAS DE FUNDAÇÃO

SAPATA 1.



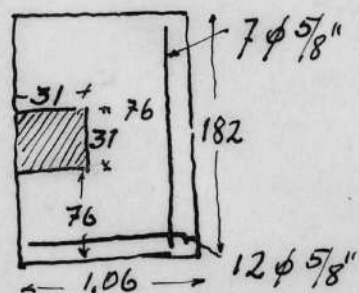
$$P = 20000; \quad S = \frac{20000}{2} = 10000; \quad \Omega = 1,30 \times 0,78$$

$$M = 2704 \quad d_o = 25 \quad \sigma_c = 40$$

$$S_{fa} = 10,40 \quad - \quad 9 \phi 1/2''$$

$$S_{fb} = 6,10 \quad - \quad 5 \phi 1/2''$$

SAPATA 2.



$$S = \frac{38.000}{2} = 19000 \quad \Omega = 1,06 \times 1,82$$

$$M = 5776 \quad d_o = 35 \quad \sigma_c = 41$$

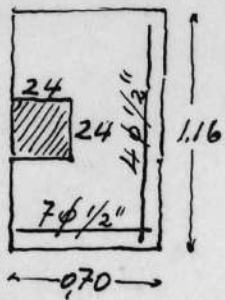
$$S_{fa} = 23,8 \quad - \quad 12 \phi 5/8''$$

$$S_{fb} = 13,8 \quad - \quad 7 \phi 1/8''$$

m)

ΣΑΡΑΤΑ 3.

F.24.



$$P = 7000$$

$$\Omega = 0,70 \times 1,16$$

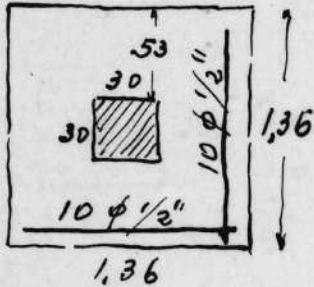
$$\sigma_c =$$

$$\alpha_0 = 25$$

$$S_f = \frac{7 \phi 1/2''}{4 \phi 1/2''}$$

$$S_f = \frac{7 \phi 1/2''}{4 \phi 1/2''}$$

ΣΑΡΑΤΑ 4.

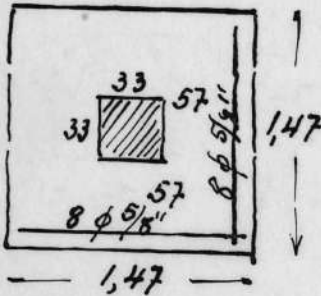


$$P_k = 37000 \quad S = \frac{37000}{2} = 18500; \quad \Omega = 1,36 \times 1,36$$

$$M = \frac{2 \times 53 \times 100 \times 0,53}{2} = 2809 \quad \alpha_0 = 25; \quad \sigma_c = 41$$

$$S_f = 12,4 - \frac{10 \phi 1/2''}{10 \phi 1/2''}$$

ΣΑΡΑΤΑ 5.



$$P = 43000; \quad S = \frac{43000}{2} = 21500; \quad \Omega = 1,47 \times 1,47$$

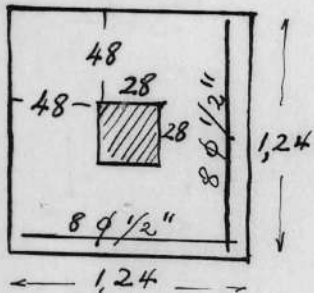
$$M = \frac{2 \times 57 \times 100 \times 0,57}{2} = 3250 \quad \alpha_0 = 25; \quad \sigma_c = 45$$

$$S_f = 15,6 - \frac{8 \phi 5/8''}{8 \phi 5/8''}$$

ΣΑΡΑΤΑ 6.

IDENTICA A. ΣΑΡΑΤΑ 4. $P = 37.000.$

ΣΑΡΑΤΑ 7.

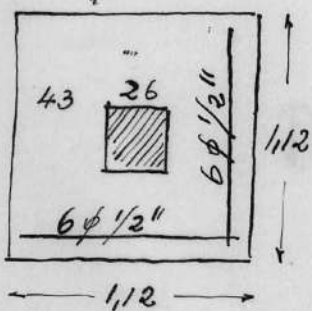


$$S = \frac{30.000}{2} = 15000 \quad \Omega = 1,24 \times 1,24$$

$$M = \frac{2000 \times 0,48^2}{2} = 2304 \quad \alpha_0 = 25. \quad \sigma_c = 36.$$

$$S_f = 9,15 - \frac{8 \phi 1/2''}{8 \phi 1/2''}$$

ΣΑΡΑΤΑ 8.

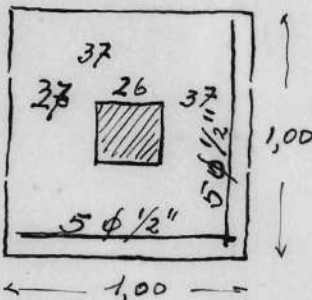


$$S = \frac{25000}{2} = 12500; \quad \Omega = 1,12 \times 1,12$$

$$M = \frac{2000 \times 0,43^2}{2} = 1849 \quad \alpha_0 = 25 \quad \sigma_c = 32.$$

$$S_f = 6,6 - \frac{6 \phi 1/2''}{6 \phi 1/2''}$$

ΣΑΡΑΤΑ 9.

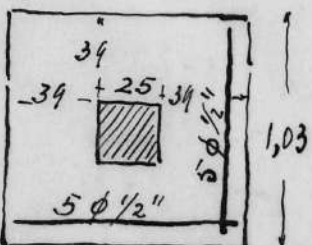


$$S = \frac{20000}{2} = 10000 \quad \Omega = 1,00 \times 1,00$$

$$M = \frac{2000 \times 0,37^2}{2} = 1369 \quad \alpha_0 = 20 \quad \sigma_c = 36$$

$$S_f = 5,7 - \frac{5 \phi 1/2''}{5 \phi 1/2''} \quad \alpha_0 = 20$$

ΣΑΡΑΤΑ 10.



$$S = \frac{21.000}{2} = 10500 \quad \Omega = 1,03 \times 1,03;$$

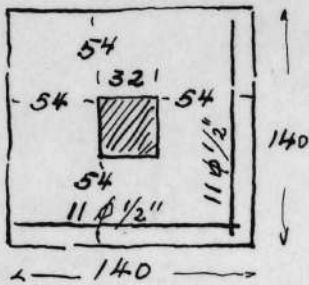
$$M = \frac{2000 \times 0,39^2}{2} = 1521; \quad \alpha_0 = 20 \quad \sigma_c = 38$$

$$S_f = 6,25 - \frac{5 \phi 1/2''}{5 \phi 1/2''}$$

100

ΣΑΡΑΤΑ 11.

Τ.25.

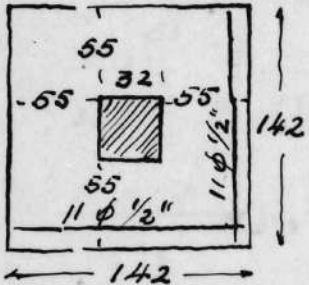


$$S = \frac{39000}{2} = 19500; \quad \Omega = 140 \times 140;$$

$$M = 2916 \quad \bar{\sigma}_c = 42 \quad d_o = 25$$

$$S_f = 13,3 \quad - \quad \underline{11 \phi \frac{1}{2}''}$$

ΣΑΡΑΤΑ 12.

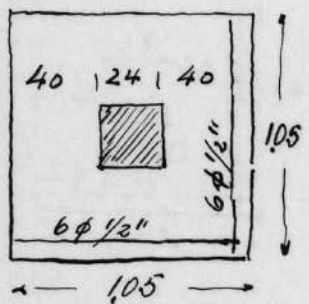


$$S = \frac{40000}{2} = 20000; \quad \Omega = 1,42 \times 1,42;$$

$$M = 3025 \quad \bar{\sigma}_c = 43 \quad d_o = 25$$

$$S_f = 14,00 \quad - \quad \underline{11 \phi \frac{1}{2}''}$$

ΣΑΡΑΤΑ 13.

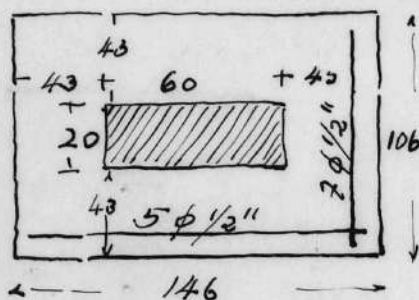


$$S = \frac{22000}{2} = 11000; \quad \Omega = 1,05 \times 1,05$$

$$M = 1600 \quad \bar{\sigma}_c = 39 \quad d_o = 20$$

$$S_f = 6,85 \quad - \quad \underline{6 \phi \frac{1}{2}''}$$

ΣΑΡΑΤΑ 14.



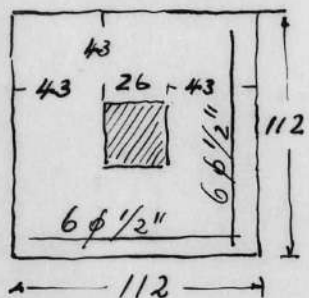
$$S = \frac{31000}{2} = 15500 \quad \Omega = 146 \times 106$$

$$M = 1849; \quad \bar{\sigma}_c = 32; \quad d_o = 25;$$

$$S_{fa} = 6,25 \quad - \quad \underline{5 \phi \frac{1}{2}''}$$

$$S_{fb} = 8,60 \quad - \quad \underline{7 \phi \frac{1}{2}''}$$

ΣΑΡΑΤΑ 15.



$$S = \frac{25000}{2} = 12500; \quad \Omega = 1,12 \times 1,12$$

$$d_o = 25$$

$$S_f = \quad - \quad \underline{6 \phi \frac{1}{2}''}$$

ΣΑΡΑΤΑ 16.

ΙΔΕΝΤΙΚΑ Α ΣΑΡΑΤΑ 15

ΣΑΡΑΤΑ 17.

ΙΔΕΝΤΙΚΑ Α ΣΑΡΑΤΑ 5.

$$S = \frac{43000}{2} = 21500$$

$$\Omega = 1,47 \times 1,47$$

$$d_o = 25 \quad S_f = \quad \underline{8 \phi \frac{5}{8}''}$$

ΣΑΡΑΤΑ 18.

ΙΔΕΝΤΙΚΑ Α ΣΑΡΑΤΑ 11.

$$S = \frac{39.000}{2} = 19.500;$$

$$\Omega = 1,40 \times 1,40$$

$$d_o = 25 \quad S_f = \quad \underline{11 \phi \frac{1}{2}''}$$

W

SAPATA 19.

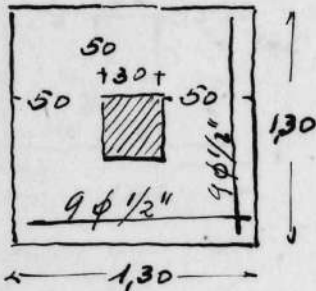
F.26.

IDENTICA A SAPATA 7. $S = \frac{30000}{2} = 15000$ $\Omega = 1,24 \times 1,24$
 $d_o = 25$ $S_f =$ $8 \phi 1/2"$

SAPATA 20.

IDENTICA A SAPATA 7. $S = 15.000$; $\Omega = 1,24 \times 1,24$; $d_o = 25$; $S_f =$ $8 \phi 1/2"$

SAPATA 21.

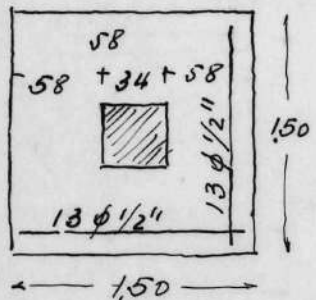


$S = \frac{34000}{2} = 17000$. $\Omega = 1,30 \times 1,30$
 $M = 2500$ $d_o = 25$ $\sigma_c = 38$
 $S_f = 10,40$ $9 \phi 1/2"$

SAPATA 22.

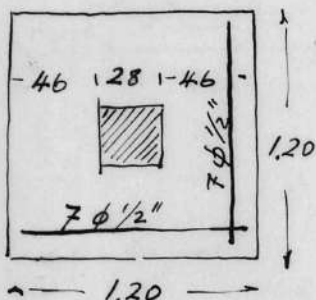
IDENTICA A SAPATA 11. $S = 19500$; $\Omega = 1,40 \times 1,40$; $d_o = 25$; $S_f =$ $11 \phi 1/2"$

SAPATA 23.



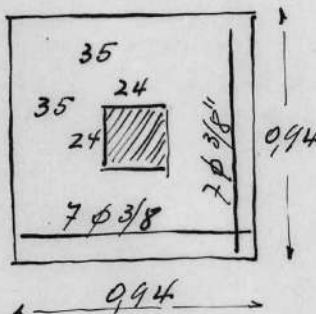
$S = \frac{45000}{2} = 22500$. $\Omega = 1,50 \times 1,50$
 $M = 3364$; $d_o = 25$ $\sigma_c = 46$;
 $S_f = 16,5$ $13 \phi 1/2"$

SAPATA 24.



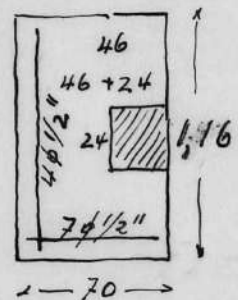
$S = \frac{28000}{2} = 14000$ $\Omega = 1,20 \times 1,20$
 $M = 2116$ $d_o = 25$ $\sigma_c = 35$
 $S_f = 8,20$ $7 \phi 1/2"$

SAPATA 25.



$S = \frac{17000}{2} = 8500$ $\Omega = 0,94 \times 0,94$
 $M = 1225$ $d_o = 20$ $\sigma_c = 34$
 $S_f = 4,80$ $7 \phi 3/8"$

SAPATA 26.

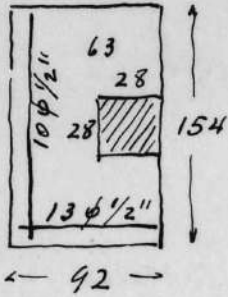


$P = 16.000$; $S = \frac{16000}{2} = 8000$; $\Omega = 1,16 \times 0,70$
 $M = 2116$ $d_o = 25$ $\sigma_c = 34$
 $S_{fa} = 7,75$ $7 \phi 1/2"$
 $S_{fb} = 4,80$ $4 \phi 1/2"$

W7

SAPATA 27.

F.27



$$P = 28000 \quad S = \frac{28000}{2} = 14000 \quad \Omega = 1,54 \times 0,92$$

$$M = 3969 \quad d_o = 30 \quad \sigma_c = 40$$

$$Sf_a = 16,4 \quad - \quad 13 \phi 1/2"$$

$$Sf_b = 9,55 \quad - \quad 10 \phi 1/2"$$

SAPATA 28.

IDENTICA A SAPATA 26.

$$\Omega = 1,16 \times 0,70 ; d_o = 25 ; \quad Sf_a = 7,75 - 7 \phi 1/2"$$

$$Sf_b = 4,80 - 4 \phi 1/2"$$

— x — x —

L. L. Silva
 Eng. Civil.

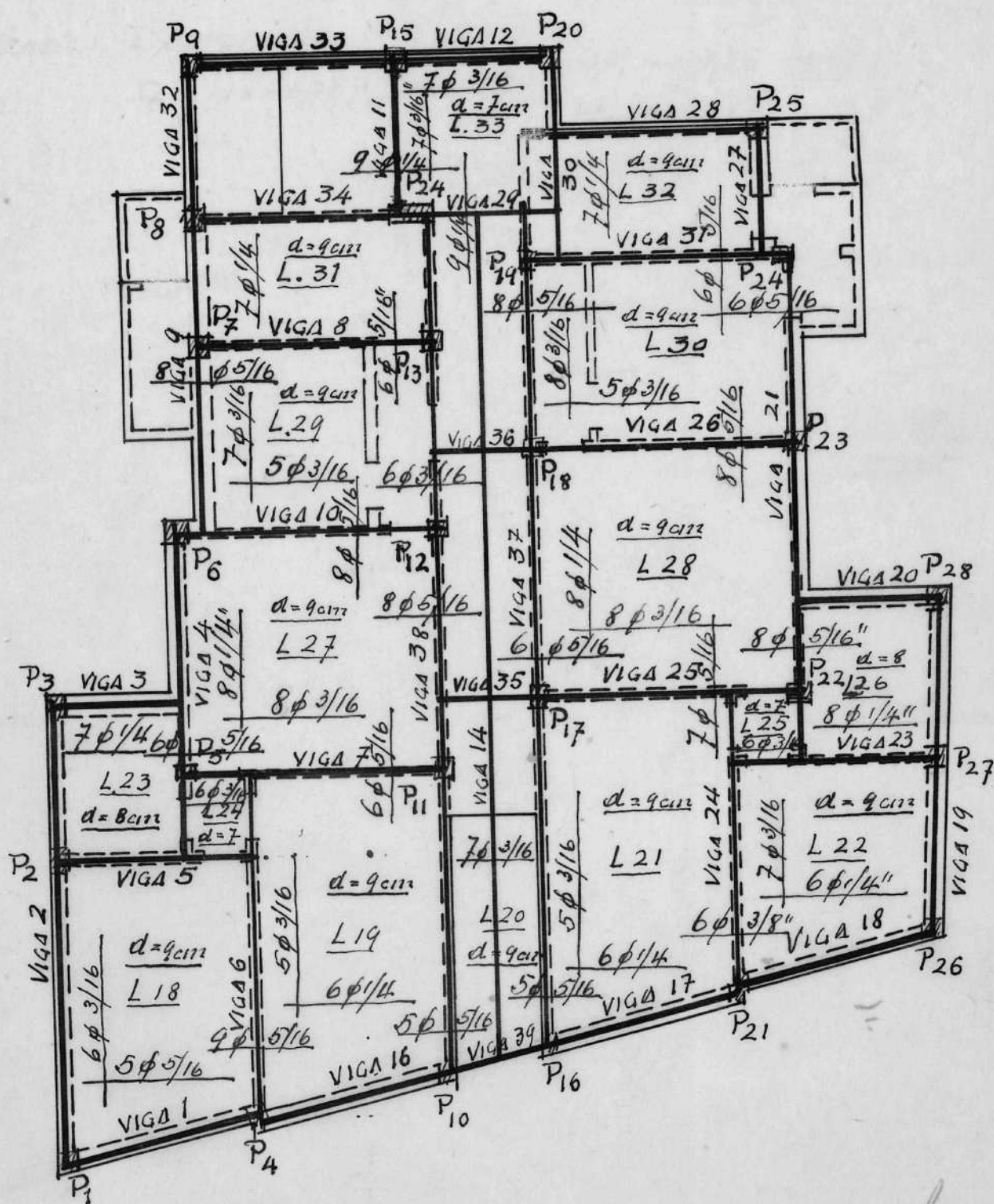
C.R.E.A n° 120

28/01/98.

PLANTA DO 1º PISO. (1º PAV.).

F. 28.

Esc 1:100

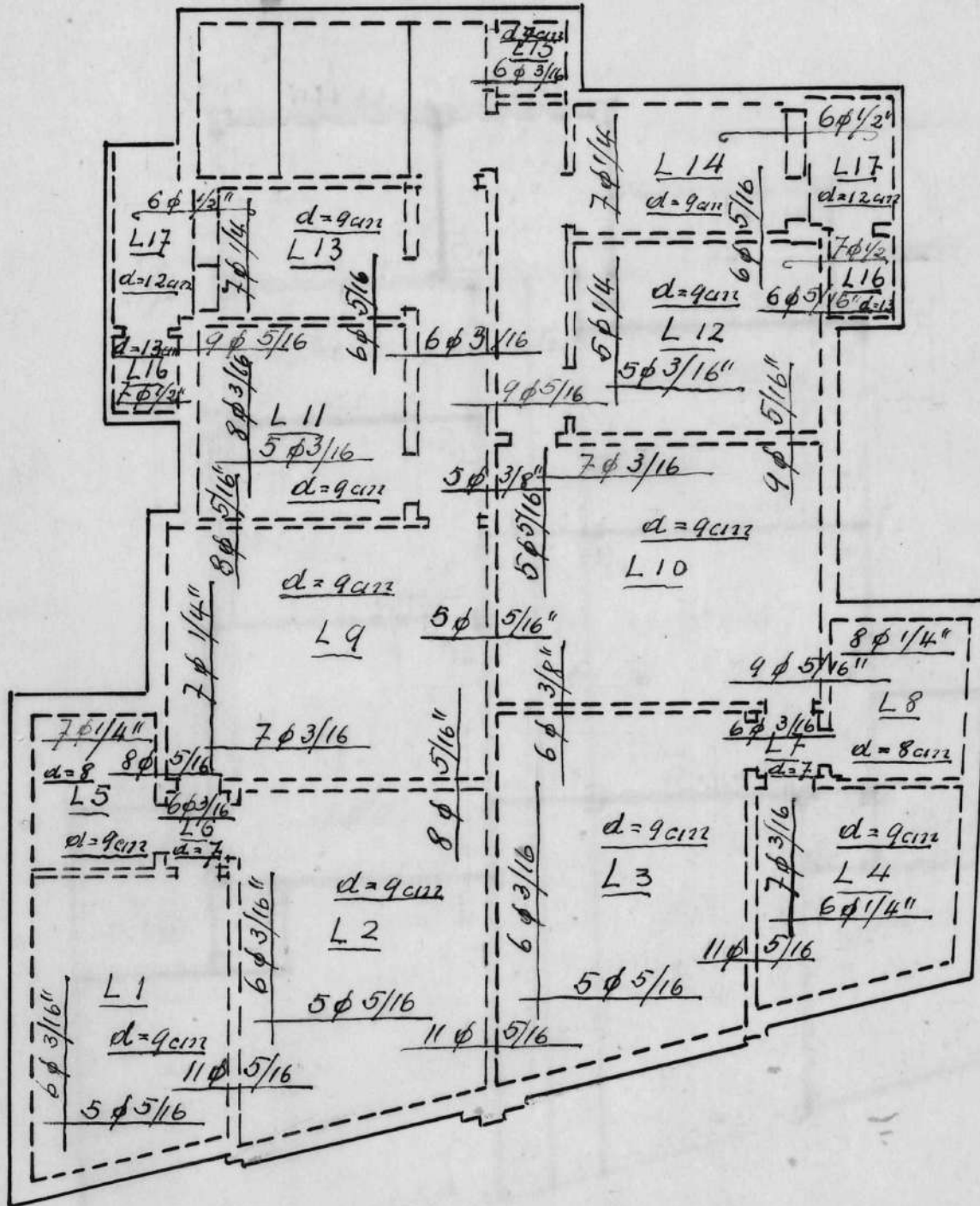


L. L. Silva
Eng Civil
CREA 120

F.29.

PLANTA DO 2º E 3º PAVIMENTO.

Esc. 1:100

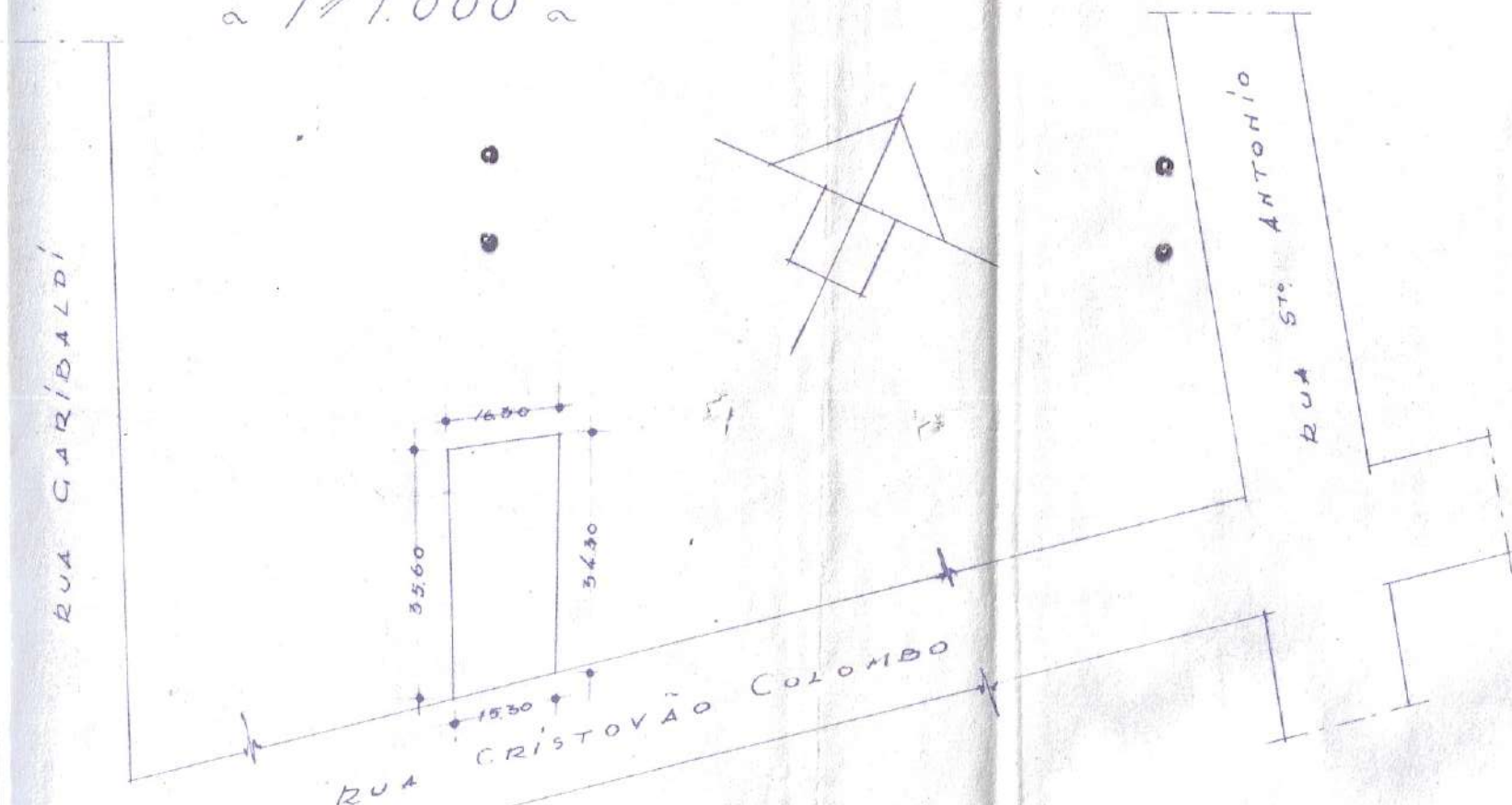


L. L. L. L.
 Eng. Civil
 CREA. 120

PLANTA PARA MODIFICAÇÃO DO PAVIMENTO
TERREO DO EDIFÍCIO CONSTRUÍDO À RUA
CRISTOVÃO COLOMBO, PROPRIEDADE DO SR.
~ FRANCISCO M. MIDAGLIA ~

SITUAÇÃO

~ 1/1.000 ~

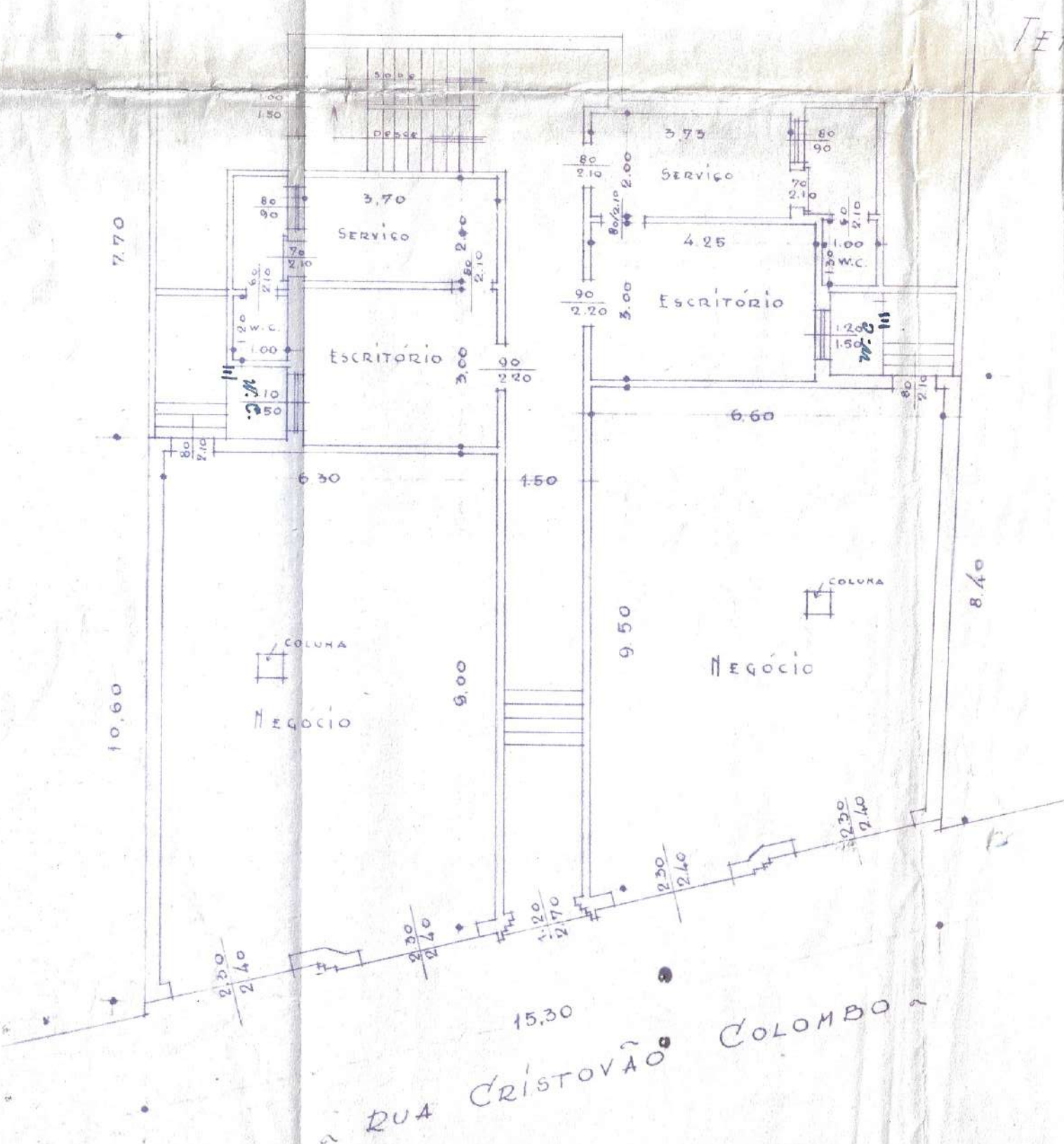


ATENÇÃO!
Nenhuma alteração poderá
ser feita na situação do prédio
sem a planta habida sem pré-
aviso à
DIRETORIA DE CADASTRO.

TERREO

~ 1/500 ~

porão



~ FACHADA ~

PROPRIETÁRIO

Francisco Manoel Mida glia

CONSTRUTOR

J. L. Silva

DIRETORIA DE OBRAS
2ª SEÇÃO
ZONA II LIVRO DE OBRAS Nº 76

ÁREA
VISTO

Data: 19-12-1937

RECEITA MUNICIPAL
DE PORTA-PAIS
1703199



ANDAMENTO

DIRETORIA	ENTRADA	SAÍDA	OBSERVAÇÕES
OBRAS E VIACAO	21 JUN 1949		

Do Diretor Geral de O. e V.:

Do Diretor Geral dos Serviços Indústrias:

Do Diretor Geral do Expediente:

Do Prefeito:

DESPACHOS