

BARRAGEM DO RIO JAGUARI MIRIM

MUNICÍPIO DE SÃO JOÃO DA BOA VISTA

RIO JAGUARI MIRIM

**MEMÓRIA DE CÁLCULO ESTRUTURAL
ESTRUTURAS DE CONCRETO**

ADEQUAÇÃO DO PROJETO EXECUTIVO

5099-59-GL-430-MC-122-0B



Hidrostudio
engenharia

OUTUBRO/2016

INDICE

1	INTRODUÇÃO	1
2	REFERÊNCIAS.....	1
3	PONTE.....	2
3.1	GEOMETRIA DA ESTRUTURA	2
3.2	ROTEIRO DE CARREGAMENTO PARA AS LAJES DA PONTE.....	4
3.3	ROTEIRO DE CARREGAMENTO PARA AS VIGAS DA PONTE	5
3.4	DIMENSIONAMENTO E DETALHAMENTO	6
4	LAJE DE FUNDO E PILARES.....	54
4.1	LAJE DE FUNDO DO VERTEDOURO	54
4.2	PILARES.....	87
5	MUROS	94
5.1	MURO DIREITO MONTANTE	94
5.2	MURO DIREITO CENTRAL.....	100
5.3	MURO DIREITO JUSANTE TRECHO 1	109
5.4	MURO DIREITO JUSANTE TRECHO 2	122
5.5	MURO ESQUERDO CENTRAL	137
5.6	MURO ESQUERDO JUSANTE.....	151

1 INTRODUÇÃO

Esta Memória de Cálculo tem por objetivo a Adequação do Projeto Executivo da Barragem do rio Jaguari Mirim no Município de São João da Boa Vista, São Paulo.

2 REFERÊNCIAS

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR6118-2014**
Projeto de estruturas de concreto - Procedimento.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 06120 - 1980**
Cargas para o cálculo de estruturas.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 8681: ações e**
segurança nas estruturas: procedimento.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 07188 - 2013 -**
Carga móvel em ponte rodoviária e passarela de pedestre

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 07187 - 2003 -**
Projeto e execução de pontes de concreto armado e protendido.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 09062 - 2006 -**
Projeto e execução de estruturas de concreto pré-moldado

3.1 GEOMETRIA DA ESTRUTURA



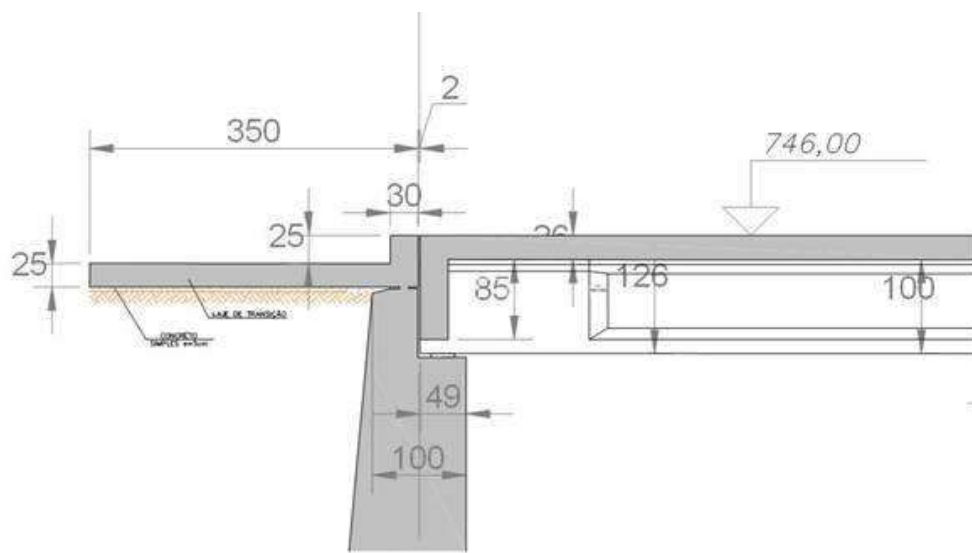


Figura 1: Geometria da Estrutura

3.2 ROTEIRO DE CARREGAMENTO PARA AS LAJES DA PONTE

3.2.1 Carga permanente

$$pp \text{ laje} = 0,26 \times 2,5 = 0,65 \text{ tf/m}^2$$

$$\text{pavimentação} = 0,10 \times 2,2 = 0,22 \text{ tf/m}^2$$

$$\text{gradil e guarda-rodas} = 0,015 + 0,18125 \times 2,5 = 0,47 \text{ tf/m}$$

3.2.2 Carga Móvel

Combinação de TB45 multiplicados por ϕ'

$$q = 0,50 \times \phi' \text{ tf/m}^2$$

3.2.3 Valor de ϕ'

$$\phi' = \text{CIV} \times \text{CIA}$$

$$\text{CIV} = 1 + 1,06 \times (20 / (\text{Liv} + 50)) = 1,34$$

com $\text{Liv} = 13,25\text{m}$

$$\text{CIA} = 1,25$$

$$\phi' = 1,67$$

3.3 ROTEIRO DE CARREGAMENTO PARA AS VIGAS DA PONTE

3.3.1 Primeira Fase

Só peso próprio das vigas longitudinais com resistência, peso das transversinas sem resistência, peso próprio das lajes sem resistência e sobrecarga de obra de 0,50 tf/m²;

3.3.2 Segunda Fase (I)

pavimentação, gradil e guarda rodas e distribuída de 0,50x ϕ' ;

3.3.3 Segunda Fase (II)

Combinação de TB45 multiplicados por ϕ' ;

3.3.4 Valor de ϕ'

$$\phi' = CIV \times CIA$$

$$CIV = 1 + 1,06 \times (20 / (Liv + 50)) = 1,34$$

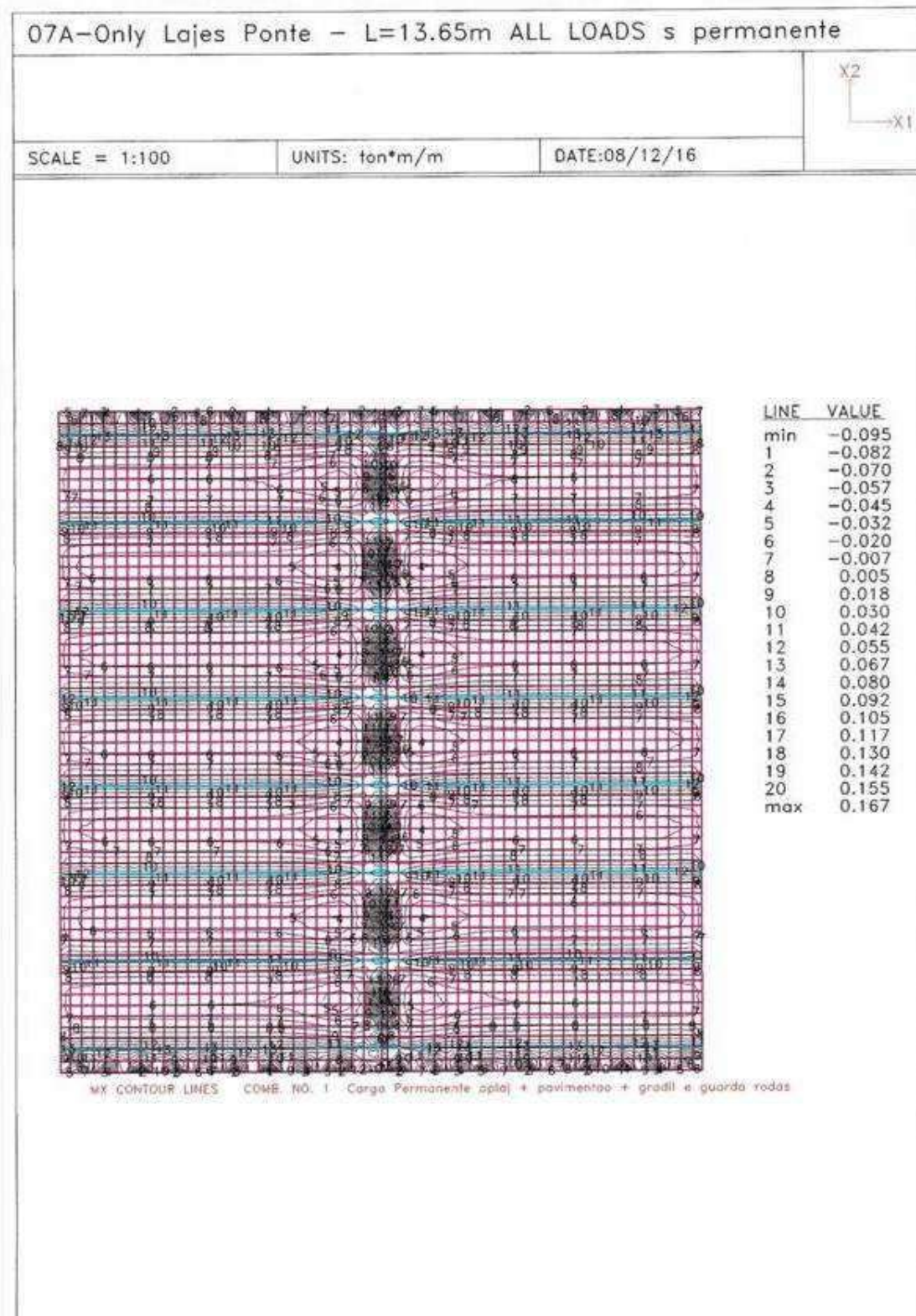
com Liv=13,25m

$$CIA = 1,25$$

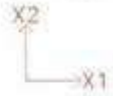
$$\phi' = 1,67$$

3.4 DIMENSIONAMENTO E DETALHAMENTO

3.4.1 Lajes da Ponte



07B-Only Lajes Ponte - L=13.65m ALL LOADS s sobrecarga



SCALE = 1:100

UNITS: ton*m/m

DATE:08/12/16

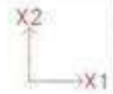


LINE	VALUE
min	-0.096
1	-0.077
2	-0.058
3	-0.039
4	-0.020
5	-0.001
6	0.018
7	0.037
8	0.056
9	0.075
10	0.094
11	0.113
12	0.132
13	0.151
14	0.170
15	0.189
16	0.208
17	0.227
18	0.246
19	0.265
20	0.284
max	0.303

MX CONTOUR LINES MAXIMUM COMB. ENVELOPE

$$X 1.67 \times 0.50 = 0.835 \text{ t/m}^2$$

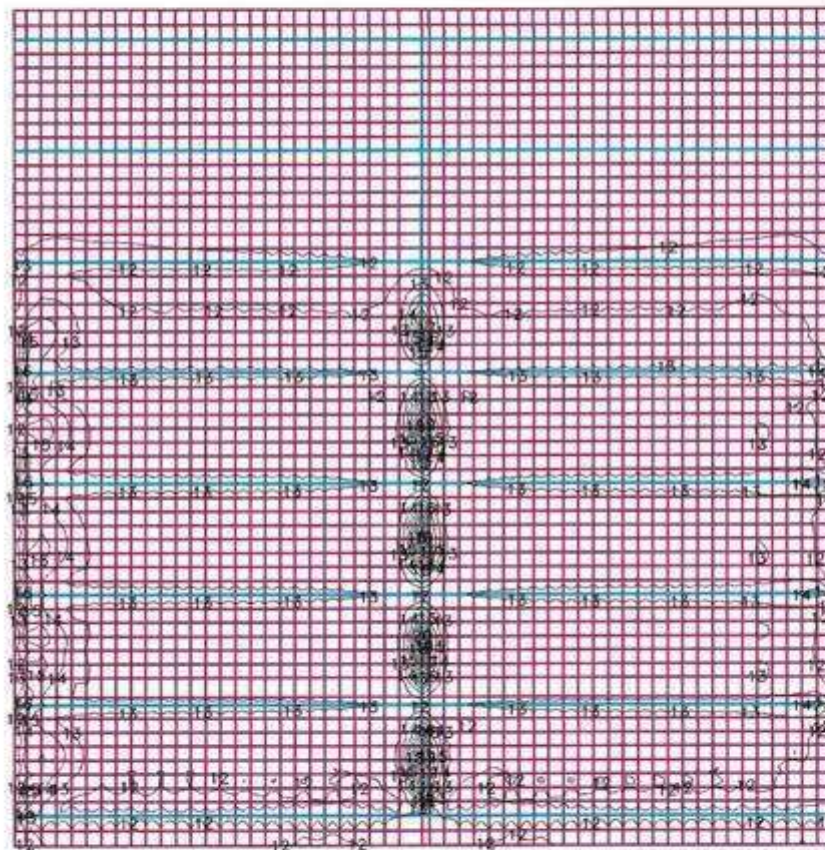
07C-Only Lajes Ponte - L=13.65m ALL LOADS s TB45



SCALE = 1:100

UNITS: ton*m/m

DATE:08/12/16



LINE	VALUE
min	-1.83
1	-1.67
2	-1.52
3	-1.36
4	-1.20
5	-1.04
6	-0.89
7	-0.73
8	-0.57
9	-0.41
10	-0.26
11	-0.10
12	0.06
13	0.22
14	0.37
15	0.53
16	0.69
17	0.85
18	1.01
19	1.16
20	1.32
max	1.48

MX CONTOUR LINES MAXIMUM LOADS ENVELOPE

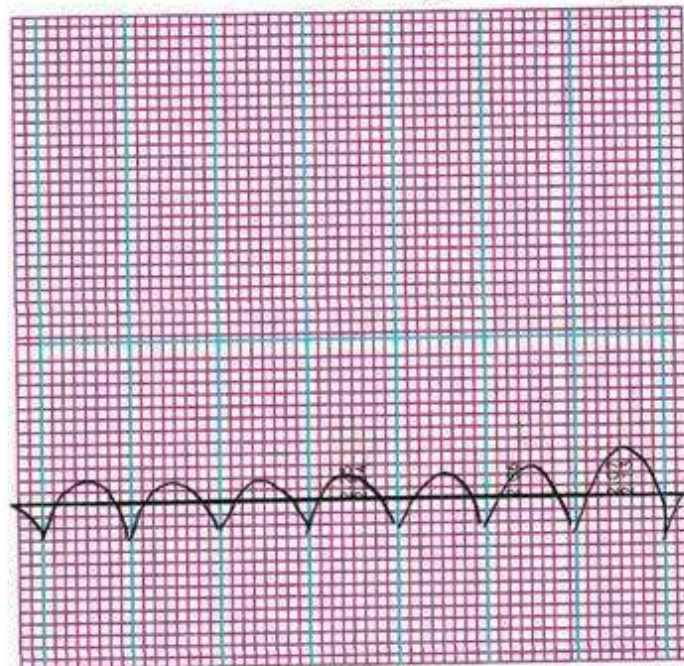
x1.67

07C-Only Lajes Ponte - L=13.65m ALL LOADS s TB45

SCALE = 1:125

UNITS: ton*m/m

DATE: 08/12/16



$$\begin{aligned}
 &= 1.62 \times 1.64 + 0.835 \times 0.381 + 0.247 \\
 &= 3.21 \text{ tfu/m} \\
 &= 1.62 \times 1.71 + 0.835 \times 0.327 + 0.254 \\
 &= 3.43 \text{ tfu/m} \\
 &= 1.62 \times 1.70 + 0.835 \times 0.348 + 0.231 \\
 &= 3.40 \\
 &= 1.62 \times 0.95 + 0.835 \times 0.161 + 0.326 \\
 &= 2.06 \text{ tfu/m}
 \end{aligned}$$

$$\begin{aligned}
 &0.130 + 0.835 \times 0.271 + 1.67 \times 2.25 = \\
 &= 4.11 \text{ tfu/m} \\
 &0.128 + 0.835 \times 0.274 + 1.67 \times 1.76 = \\
 &= 3.80 \text{ tfu/m} \\
 &0.137 + 0.835 \times 0.269 + 1.67 \times 2.06 = \\
 &= 3.80 \text{ tfu/m} \\
 &0.101 + 0.835 \times 0.307 + 1.67 \times 2.07 = \\
 &= 3.81 \text{ tfu/m}
 \end{aligned}$$

M_y

MOMENTS DIAGRAM MAXIMUM LOADS ENVELOPE

07A-Only Lajes Ponte - L=13.65m ALL LOADS s permanente

View: seo

SCALE = 1:125

UNITS: ton·m/m

DATE:08/12/16



COMB. NO. 1 Carga Permanente p/la + pavimento + gradil e guarda, rodas

MOMENTS DIAGRAM

(x1,0)

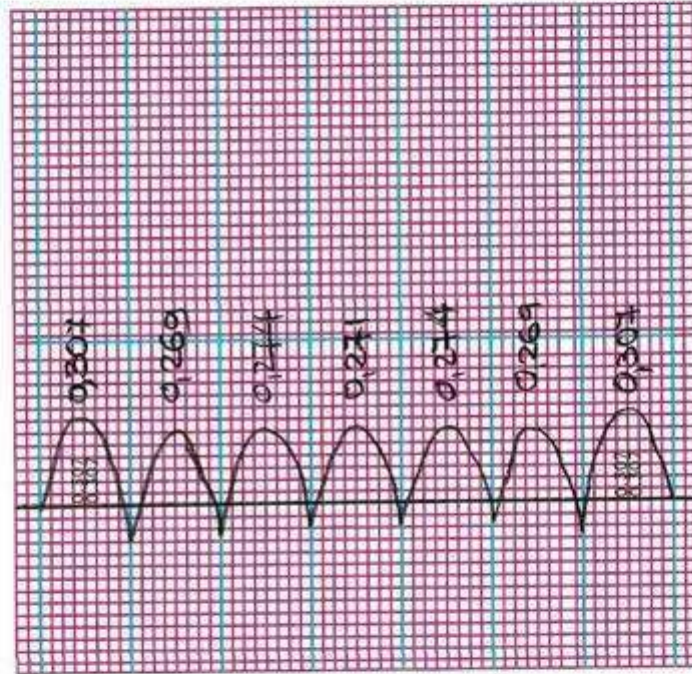
07B-Only Lajes Ponte - L=13.65m ALL LOADS s sobrecarga

View: sees

SCALE = 1:125

UNITS: ton*m/m

DATE:08/12/16



0,381
0,371
0,398
0,161

x 0,835
(x 1,67 x 0,50)

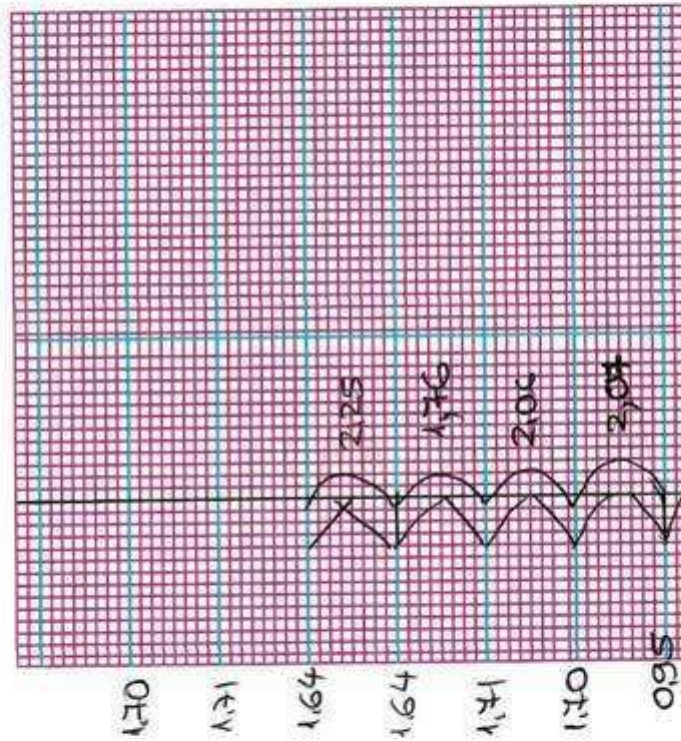
MOMENTS DIAGRAM MAXIMUM COMB. ENVELOPE

07C-Only Lajes Ponte - L=13.65m ALL LOADS s TB45

SCALE = 1:125

UNITS: ton*m/m

DATE:08/12/16



MOMENTS DIAGRAM MAXIMUM LOADS ENVELOPE

X 1.67

Processando-se com as vigas totalmente apoiadas temos:

a) Com $pp \text{ laje} = 0,26 \times 2,5 = 0,65 \text{ tf/m}^2$
 $Pavimentação = 0,1 \times 2,2 = 0,22 \text{ tf/m}^2$
 $Gradil + guarda rodas = 0,47 \text{ tf/m}$
 $M_x = 0,095 \text{ tf.m/m}$
 $X_x = 0,167 \text{ tf.m/m}$

b) Com sobrecarga = $\phi \times 0,50 = 1,67 \times 0,5 = 0,835 \text{ tf/m}^2$
 $M_x = 0,080 \text{ tf.m/m}$
 $X_x = 0,253 \text{ tf.m/m}$

c) TB45 $\Rightarrow P = \phi \times P = 1,67 \times 7,5 = 12,525 \text{ tf}$
 $M_x = 3,056 \text{ tf.m/m}$
 $X_x = 2,472 \text{ tf.m/m}$

d) Soma $M_x = 3,231 \text{ tf.m/m}$
 $X_x = 2,892 \text{ tf.m/m}$

e) Com $pp \text{ laje} = 0,26 \times 2,5 = 0,65 \text{ tf/m}^2$
 $\text{Pavimentação} = 0,1 \times 2,2 = 0,22 \text{ tf/m}^2$
 $\text{Gradil} + \text{guarda rodas} = 0,47 \text{ tf/m}$

$M_y =$	0,130	tf.m/m
$M_y =$	0,128	tf.m/m
$M_y =$	0,137	tf.m/m
$M_y =$	0,101	tf.m/m
$X_y =$	0,247	tf.m/m
$X_y =$	0,254	tf.m/m
$X_y =$	0,231	tf.m/m
$X_y =$	0,336	tf.m/m

f) Com sobrecarga = $\phi \times 0,50 = 1,67 \times 0,5 = 0,835 \text{ tf/m}^2$

$M_y =$	0,226	tf.m/m
$M_y =$	0,229	tf.m/m
$M_y =$	0,225	tf.m/m
$M_y =$	0,256	tf.m/m
$X_y =$	0,318	tf.m/m
$X_y =$	0,315	tf.m/m
$X_y =$	0,332	tf.m/m
$X_y =$	0,134	tf.m/m

g) TB45 $\Rightarrow P = \phi \times P = 1,67 \times 7,5 = 12,525 \text{ tf}$

$M_y =$	3,758	tf.m/m
$M_y =$	2,939	tf.m/m
$M_y =$	3,440	tf.m/m
$M_y =$	3,457	tf.m/m
$X_y =$	2,739	tf.m/m
$X_y =$	2,856	tf.m/m
$X_y =$	2,839	tf.m/m
$X_y =$	1,587	tf.m/m

h) Soma

$M_y =$	4,114	tf.m/m
$M_y =$	3,296	tf.m/m
$M_y =$	3,802	tf.m/m
$M_y =$	3,814	tf.m/m
$X_y =$	3,304	tf.m/m
$X_y =$	3,424	tf.m/m
$X_y =$	3,402	tf.m/m
$X_y =$	2,057	tf.m/m

Dimensionamento das lajes

$$h = 26 \text{ cm} \quad d = 7 \text{ cm} \quad f_{ck} = 30 \text{ MPa}$$

$$d = 19 \text{ cm} \quad (\text{pré-laje } f_{ck} = 25 \text{ MPa})$$

$$b = 100 \text{ cm}$$

$$A_{smin} = 0,15\% \cdot 100 \times 26 = 3,90 \text{ cm}^2/\text{m}$$

$$c/\phi 10 \text{ c}/20 = 4,0 \text{ cm}^2/\text{m} \quad M_k = 2,3 \text{ kNm/m}$$

$$c/\phi 12,5 \text{ c}/20 = 6,25 \text{ cm}^2/\text{m} \quad M_k = 3,54 \text{ kNm/m}$$

$$c/\phi 12,5 \text{ c}/17 = 7,35 \text{ cm}^2/\text{m} \quad M_k = 4,14 \text{ kNm/m}$$

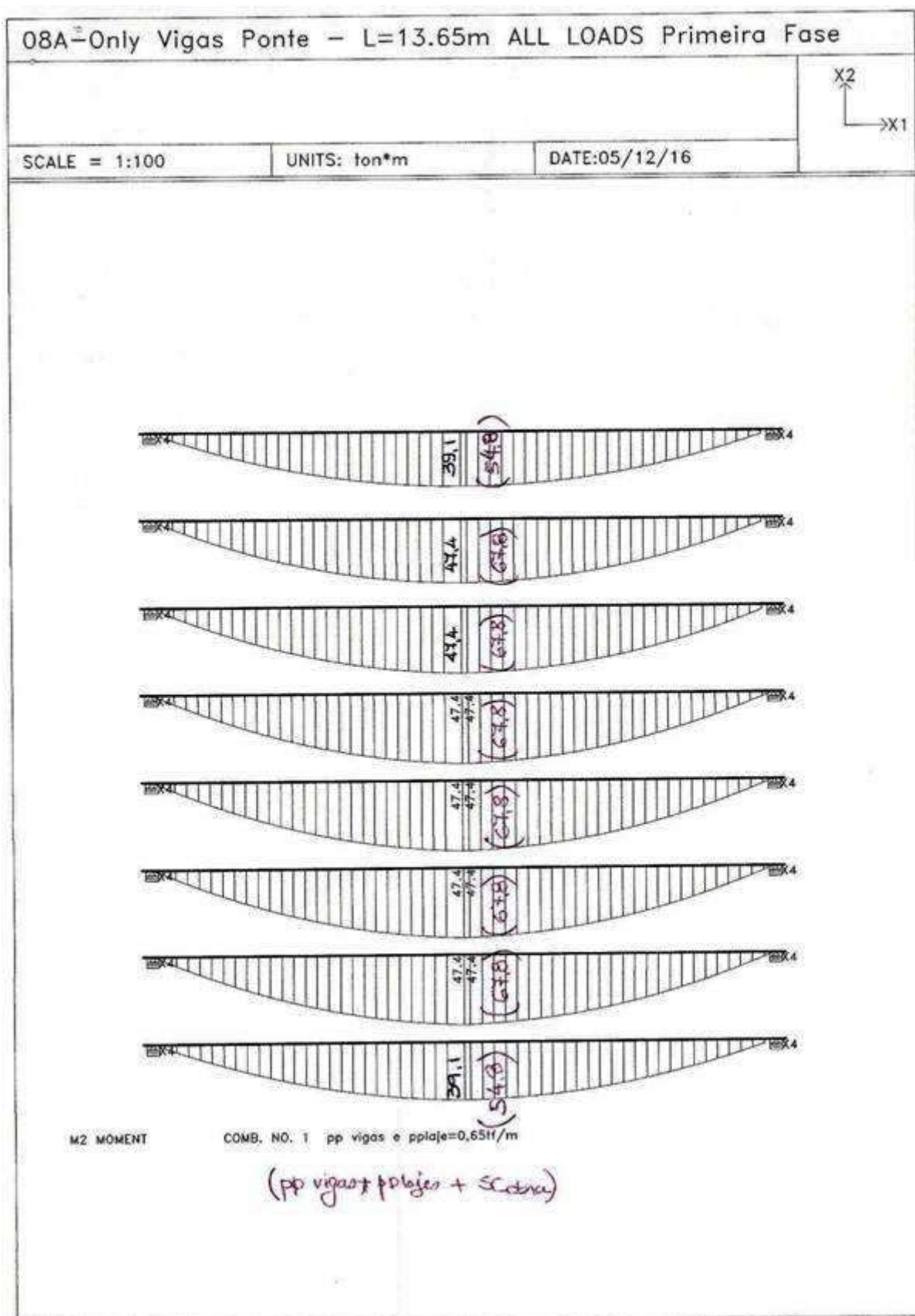
$$c/\phi 12,5 \text{ c}/15 = 8,33 \text{ cm}^2/\text{m} \quad M_k = 4,66 \text{ kNm/m}$$

$$\begin{array}{l} M_x = 3,231 \text{ kNm/m} \\ X_x = 2,892 \text{ kNm/m} \end{array} > \begin{array}{l} \text{adotamos } \phi 12,5 \text{ c}/20 \\ \text{sup e inf.} \end{array}$$

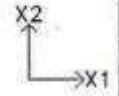
$$\begin{array}{l} M_y = 4,114 \text{ kNm/m} \\ X_y = 3,424 \text{ kNm/m} \end{array} \begin{array}{l} \text{adotamos } \phi 12,5 \text{ c}/15 \text{ (inf.)} \\ \text{adotamos } \phi 12,5 \text{ c}/20 \text{ (sup.)} \end{array}$$



3.4.2 Vigas da Ponte



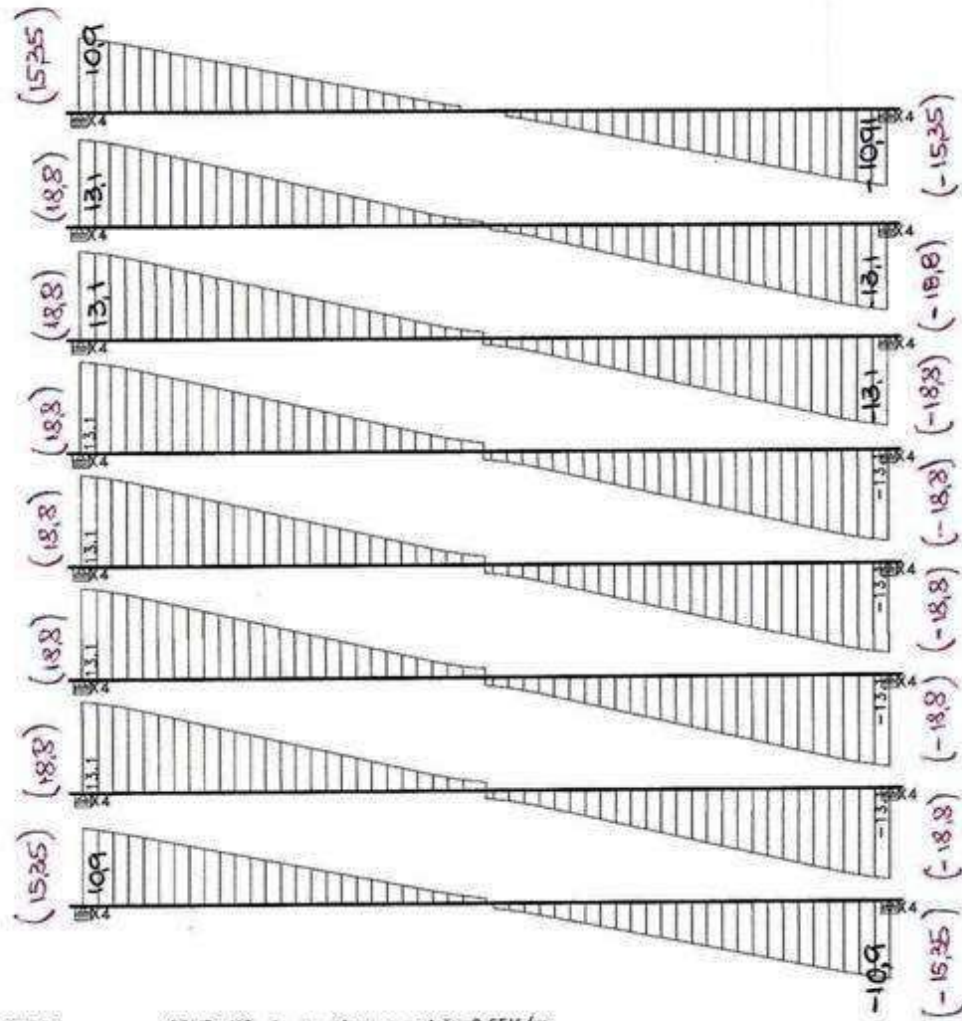
08A-Only Vigas Ponte - L=13.65m ALL LOADS Primeira Fase



SCALE = 1:100

UNITS: ton

DATE:05/12/16



V3 SHEAR

COMB. NO. 1 pp vigas e pptoje=0,65tf/m

(ppvigas + pptoje + sobra)

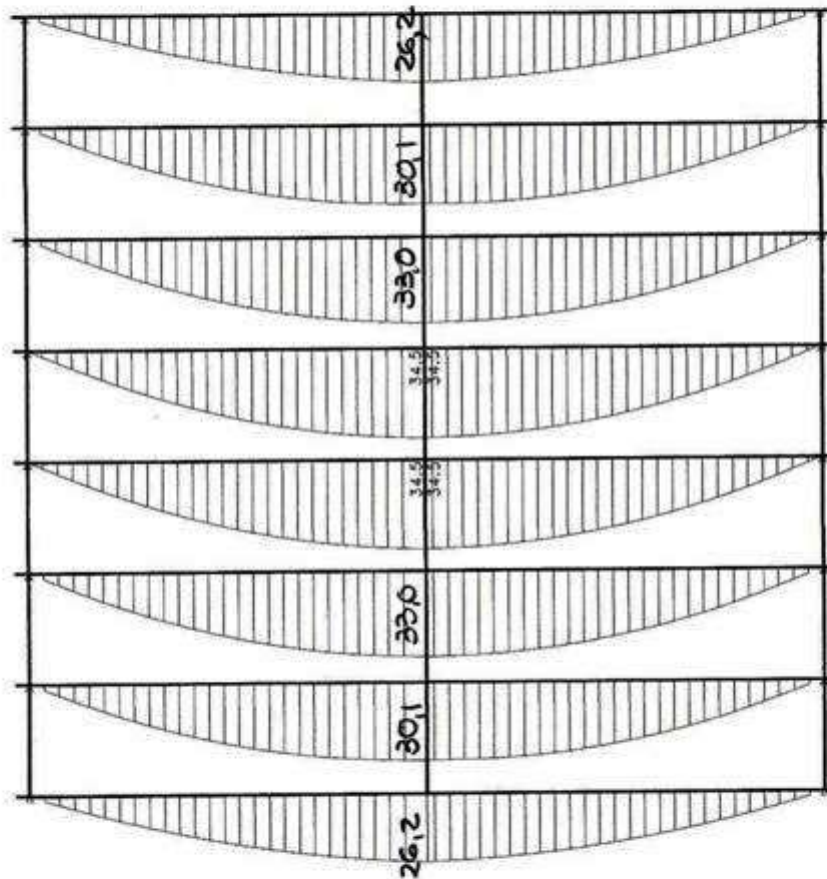
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC



SCALE = 1:100

UNITS: ton*m

DATE:07/12/16



M2 MOMENT

COMB. NO. 2 $1,67 \times 0,50 = 0,835$

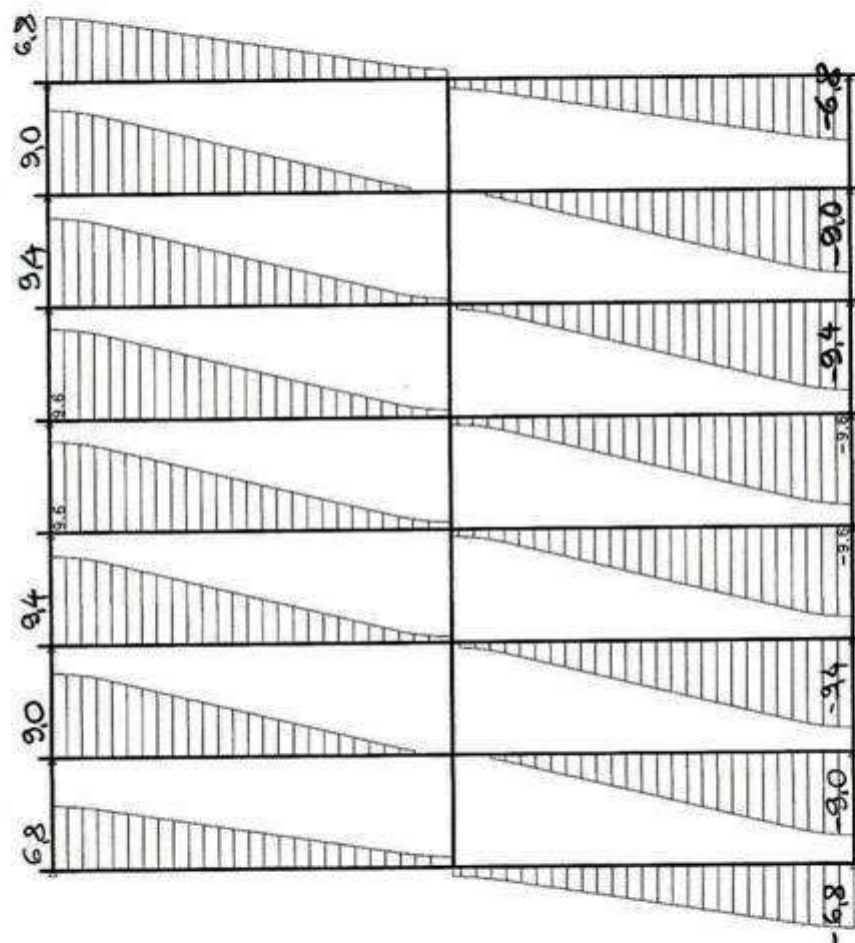
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC

X2
X1

SCALE = 1:100

UNITS: ton

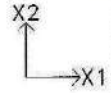
DATE:07/12/16



V3 SHEAR

COMB. NO. 2 $1.67 \times 0.50 = 0.835$

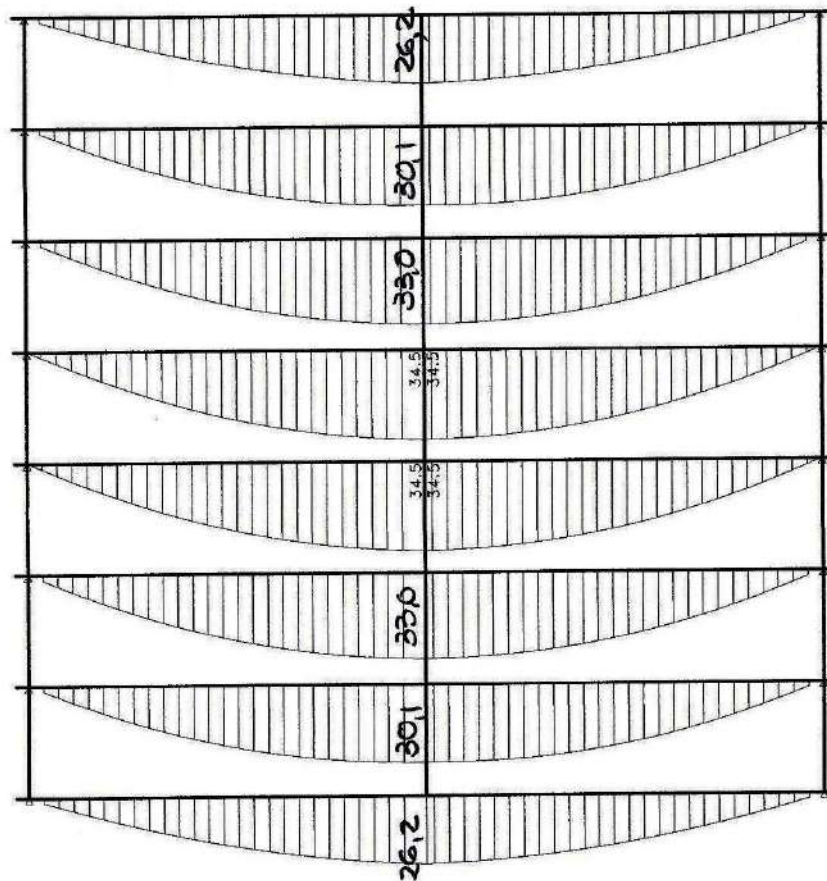
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC



SCALE = 1:100

UNITS: ton*m

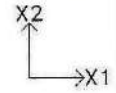
DATE:07/12/16



M2 MOMENT

COMB. NO. 2 $1,67 \times 0,50 = 0,835$

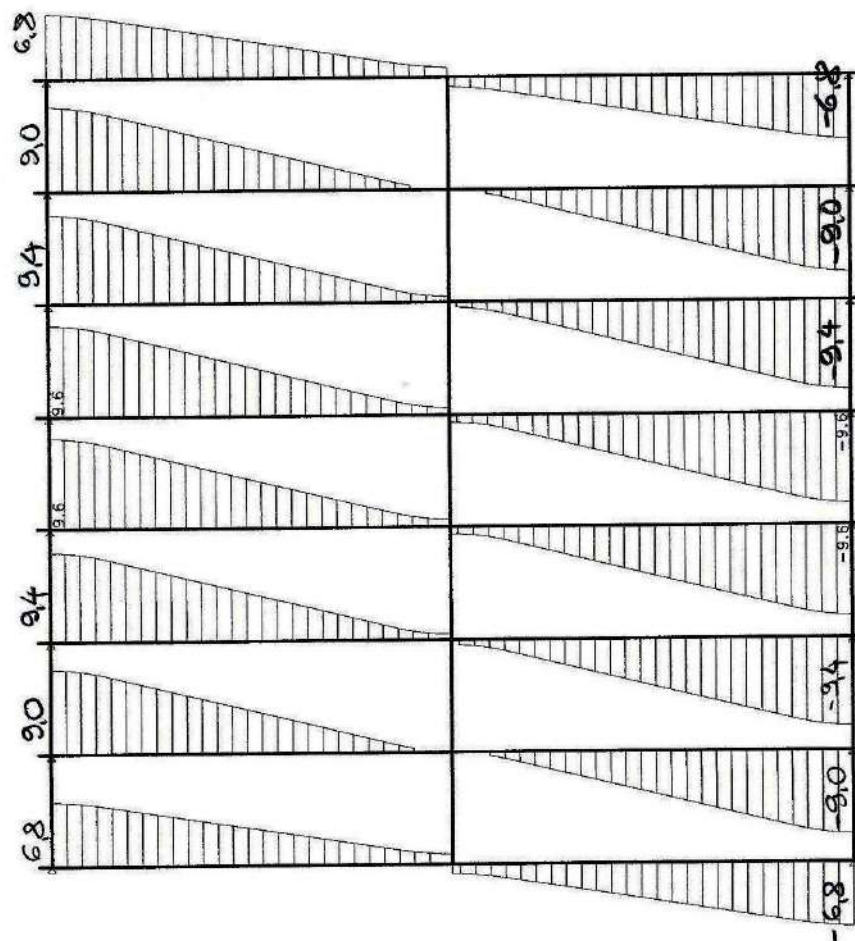
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC



SCALE = 1:100

UNITS: ton

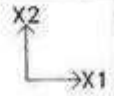
DATE:07/12/16



V3 SHEAR

COMB. NO. 2 $1.67 \times 0.50 = 0.835$

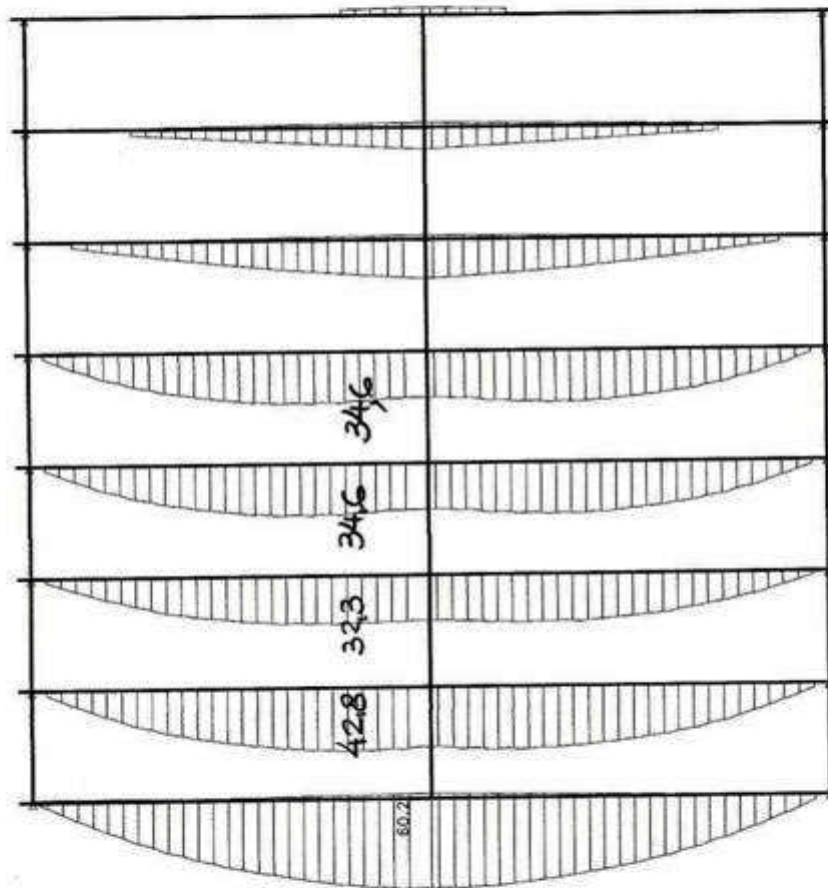
08C-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase s
TB45



SCALE = 1:100

UNITS: ton*m

DATE:05/12/16



M2 MOMENT

LOADS ENVELOPE

multiplicação por $\phi = 1.67$

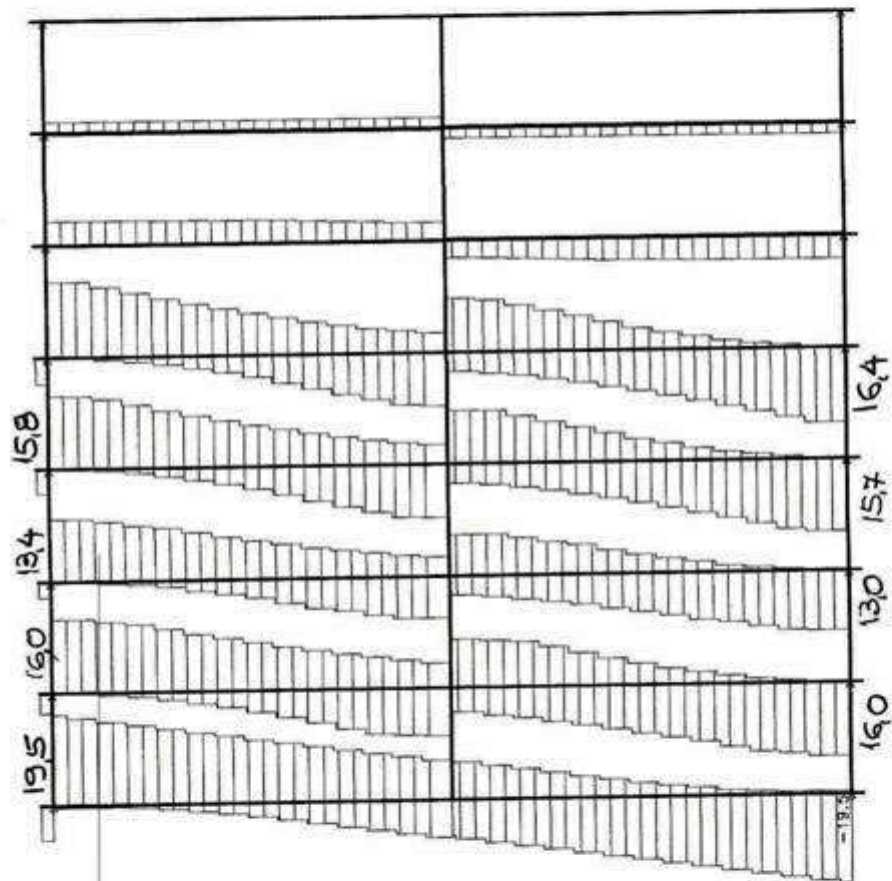
08C-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase s
T845

x2
x1

SCALE = 1:100

UNITS: ton

DATE:05/12/16

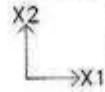


V3 SHEAR

LOADS ENVELOPE

Multiplican por $\phi' = 1,67$

08A-Only Vigas Ponte - L=13.65m ALL LOADS Primeira Fase pp
vigas, laje, sco



SCALE = 1:100

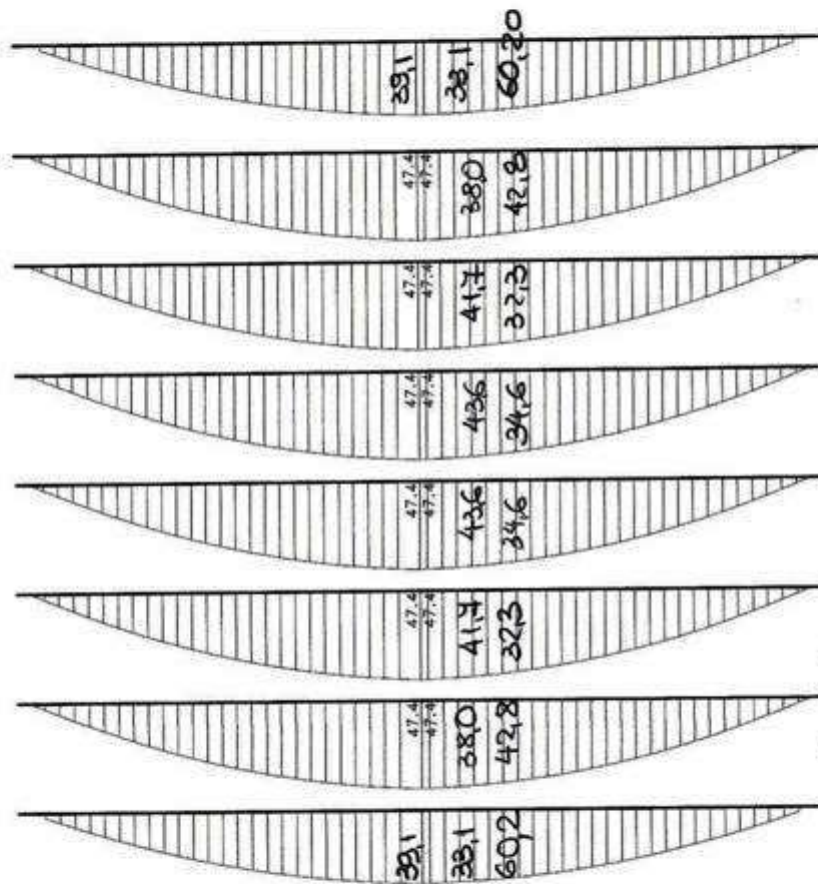
UNITS: ton*m

DATE:06/12/16

M2 MOMENT

COMB. NO. 1 pp vigas e plaje=0.65tf/m

(167x)



[67.8]

10 fase c/sc

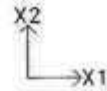
10 fase

25 fase

39.1	47.4	47.4	47.4	47.4	47.4	47.4	39.1
133.63	109.5	95.64	101.4	101.4	95.64	109.5	133.63
172.73	156.9	143.04	148.8	148.8	143.04	156.9	172.73

f/m

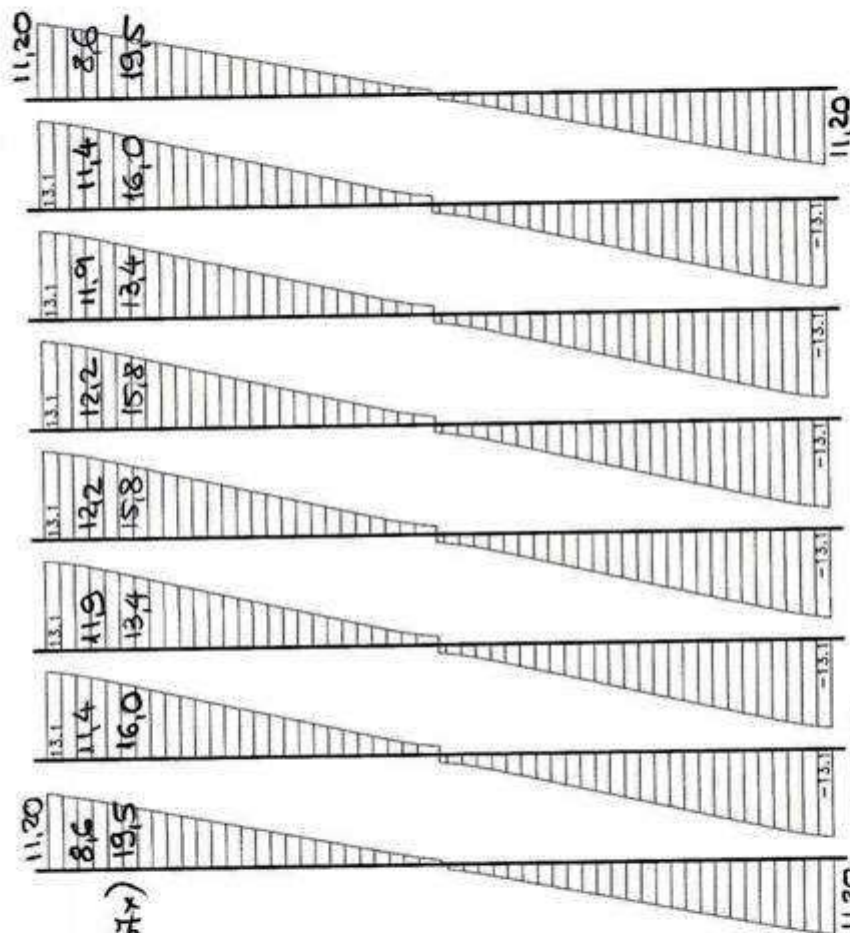
08A-Only Vigas Ponte - L=13.65m ALL LOADS Primeira Fase pp
vigas, laje, sco



SCALE = 1:100

UNITS: ton

DATE:06/12/16

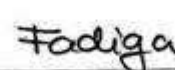


V3 SHEAR

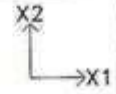
COMB. NO. 1 pp vigas e pptoje=0,65tf/m

15 face o/sc [18,8]
19 face 11,20
20 face 41,2
52,4
13,10 13,10 13,10 13,10 13,10 13,10 13,10
38,12 34,28 38,12 34,28 38,12 34,28 38,12
51,22 47,38 51,7 51,7 51,22 47,38 51,22
52,40 tf

SCALE = 1:100			UNITS: ton*m	DATE:07/12/16	
---------------	--	--	--------------	---------------	---



08A-Only Vigas Ponte - L=13.65m ALL LOADS Primeira Fase pp
-vigas, laje, sco

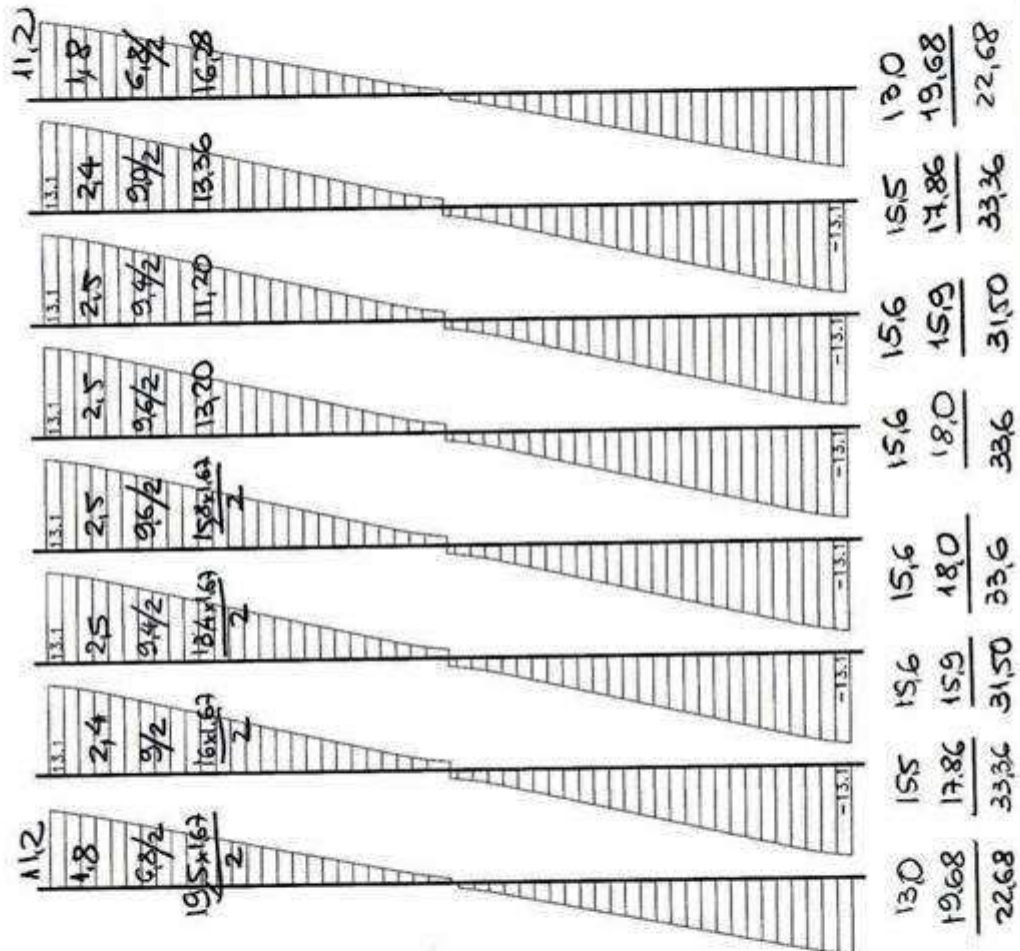


SCALE = 1:100

UNITS: ton

DATE:07/12/16

g_1 g_2 $q_1/2$ $q_2/2$

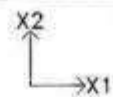


V3 SHEAR

COMB. NO: 1 pp vigas e p/laje=0,65tf/m

Padua

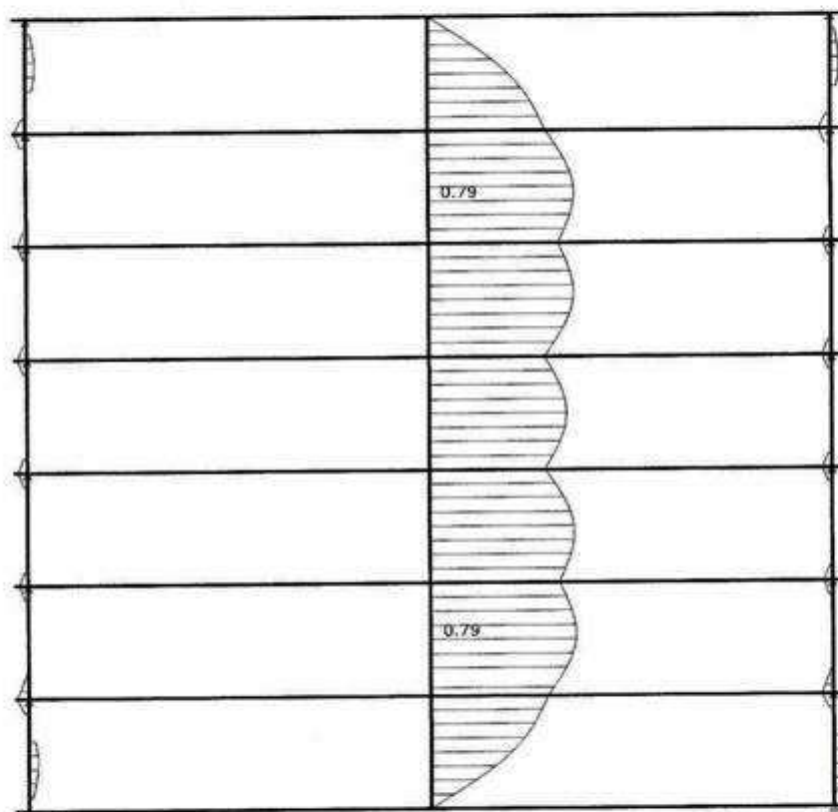
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC



SCALE = 1:100

UNITS: ton*m

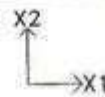
DATE:07/12/16



M2 MOMENT

COMB. NO. 3 Permanente 2 = Pavimento+ Gradil + Guarda Corpo

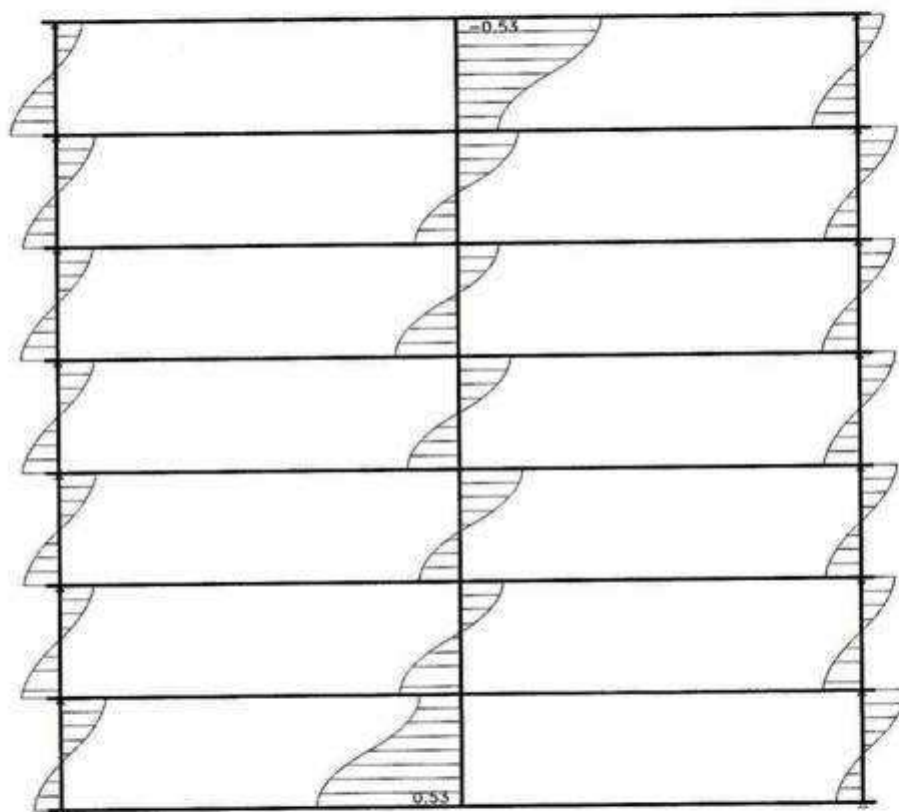
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC



SCALE = 1:100

UNITS: ton

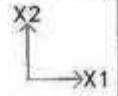
DATE:07/12/16



V3 SHEAR

COMB. NO. 3 Permanente 2 = Pavimento+ Gradil + Guarda Corpa

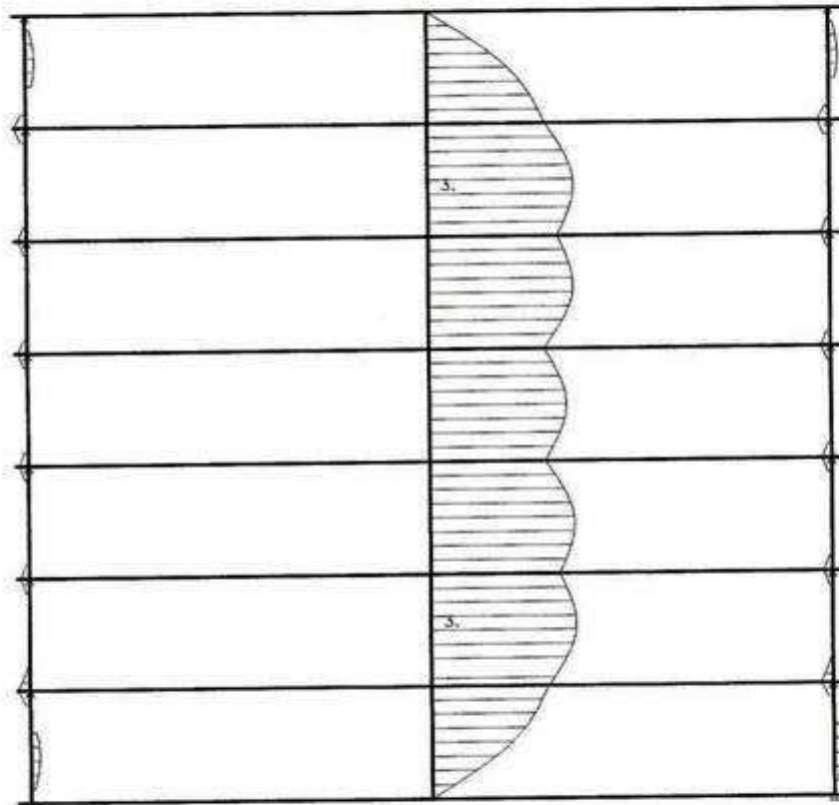
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav.
GC, SC



SCALE = 1:100

UNITS: ton*m

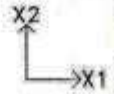
DATE:07/12/16



M2. MOMENT

COMB. NO. 2 1,67x0,50=0,835

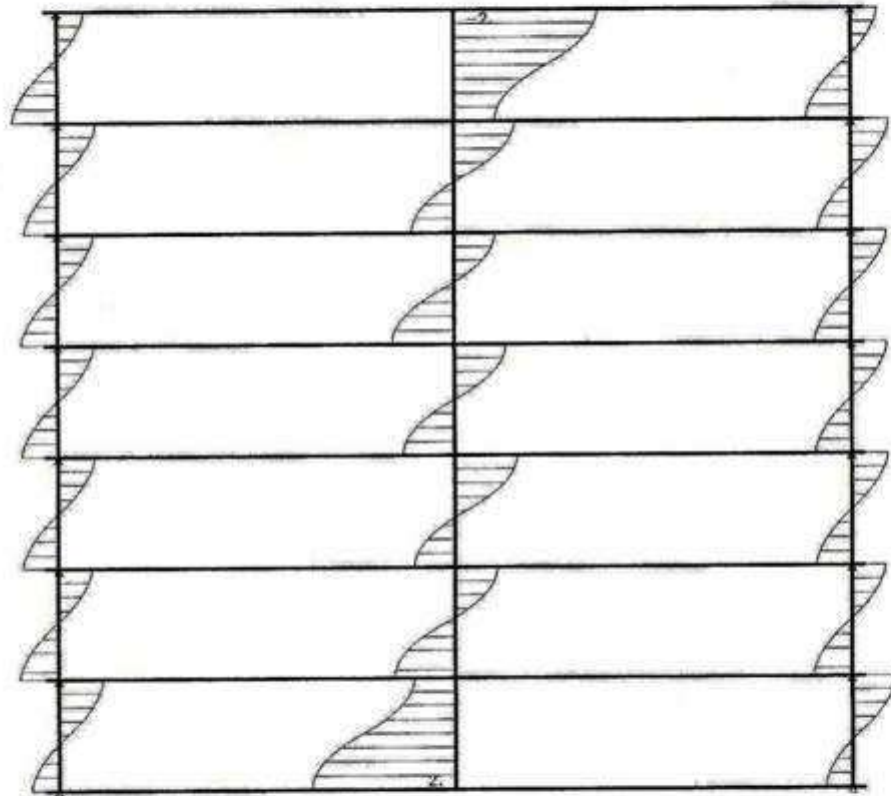
08B-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase Pav,
GC, SC



SCALE = 1:100

UNITS: ton

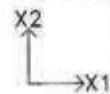
DATE:07/12/16



V3 SHEAR

COMB. NO. 2 $1.67 \times 0.50 = 0.835$

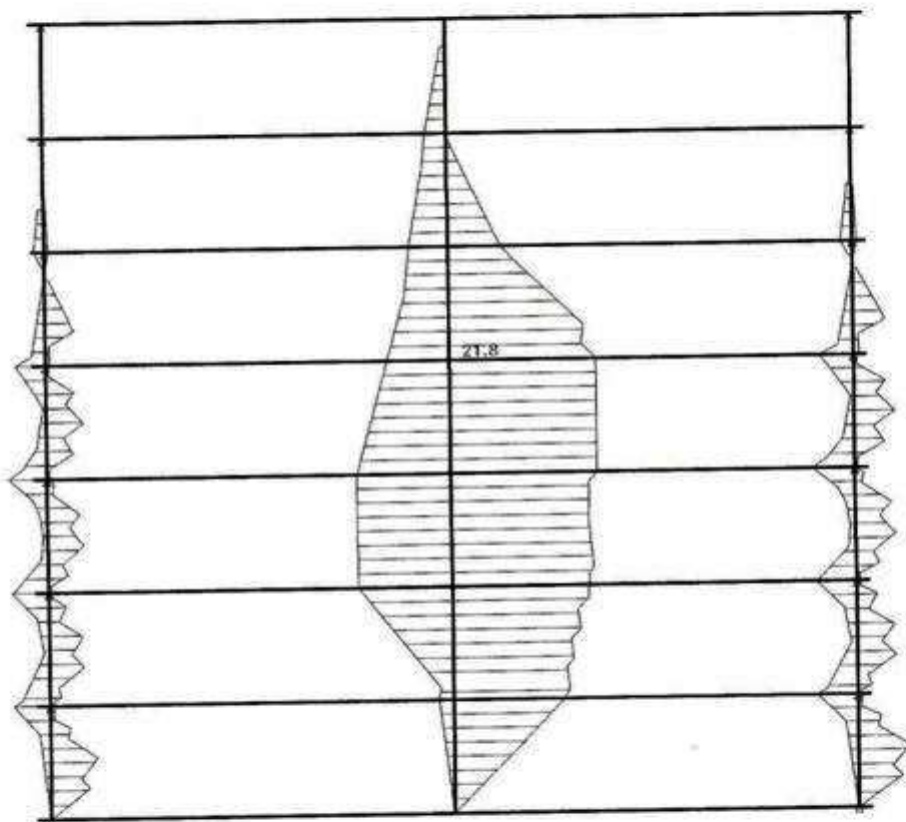
08C-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase s
TB45



SCALE = 1:100

UNITS: ton*m

DATE:05/12/16

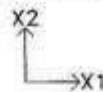


M2 MOMENT

LOADS ENVELOPE

Multiplicar por $\phi' = 1.67$

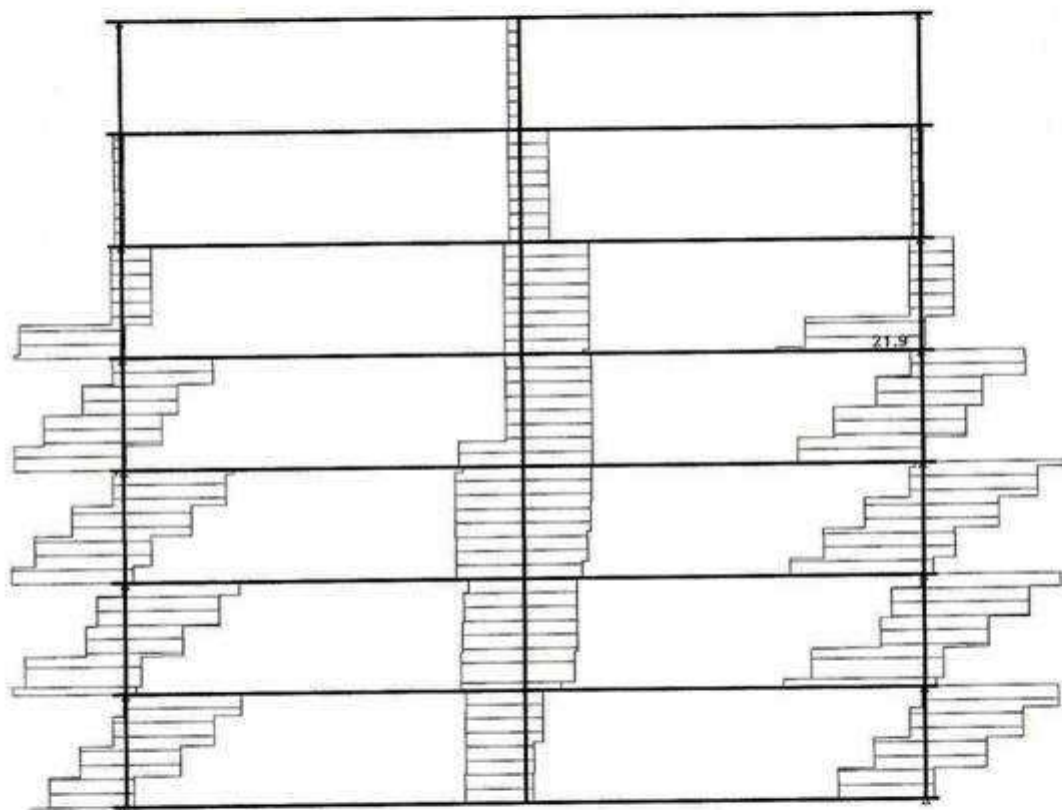
08C-Only Vigas Ponte - L=13.65m ALL LOADS Segunda Fase s
TB45



SCALE = 1:100

UNITS: ton

DATE:05/12/16



V3 SHEAR

LOADS ENVELOPE

Multiplicar por $\gamma' = 1.67$

Pré-Dimensionamento

a) Viga de borda

$$M_{kmax} = 172,73$$

$$f_{ck} = 30 \text{ MPa}$$

$$b_f = 143,5 \text{ cm}$$

$$b_w = 17 \text{ cm}$$

$$h = 126 \text{ cm} \quad d' = 12 \text{ cm}$$

$$d = 114 \text{ cm}$$

$$h_f = 26 \text{ cm}$$

$$\mu_{sd} = 0,061 \quad y = 8,5 \text{ cm} \quad A_{srec} = 50,66 \text{ cm}^2$$

$$c/ \quad 12,5 \phi 25 = 62,50 \text{ cm}^2 \quad \omega = 0,30$$

$$4 \phi 20 + 10 \phi 25 = 62,60 \text{ cm}^2$$

$$c/ \quad 13 \phi 25 = 650 \text{ cm}^2 \quad \omega = 0,28$$

$$\sigma_s = 2518 \text{ kgf/cm}^2 \quad \sigma_{II} = 25,42 \text{ cm}$$

b) Viga pré-moldada

$$M_{kmax} = 67,8 \text{ tfm}$$

$$f_{ck} = 30 \text{ MPa}$$

$$b_f = 100 \text{ cm}$$

$$b_w = 17 \text{ cm}$$

$$h = 100 \text{ cm} \quad d' = 12 \text{ cm} \quad d = 88 \text{ cm}$$

$$h_f = 5 \text{ cm}$$

$$\mu_{sd} = 0,057 \quad A_{srec} = 25,70 \text{ cm}^2$$

$$c/ \quad 13 \phi 25 = 650 \text{ cm}^2 \quad \omega = 0,08 \text{ mm}$$

c) Viga de borda

$$V_k = 52,4 \text{ tf}$$

$$b_w = 17 \text{ cm}$$

$$h = 126 \text{ cm}$$

$$d = 114 \text{ cm}$$

$$f_{ck} = 30 \text{ MPa}$$

Estribos $\phi 12,5$ c/14 cm (2R)

Estribos $\phi 10$ c/9 cm (2R)

d) Viga pré moldada

$$V_k = 18,80 \text{ tf}$$

$$b_w = 17 \text{ cm}$$

$$h = 100 \text{ cm}$$

$$d = 88 \text{ cm}$$

$$f_{ck} = 30 \text{ MPa}$$

Estribos ϕ

Estribos $\phi 10$ c/20 (2R)

Estribos $\phi 12,5$ c/32 (2R)

$$e) \quad M_g = 46,0 \text{ tfm}$$

$$V_g = 130 \text{ lf}$$

$$M_{g+q/2} = 109,4 \text{ tfm}$$

$$V_{g+q/2} = 22,69 \text{ lf}$$

$$b_f = 143,5 \text{ cm}$$

$$b_w = 17 \text{ cm}$$

$$h = 126 \text{ cm} \quad d = 114 \text{ cm}$$

$$h_f = 26 \text{ cm}$$

$$M_{g+q} = 109,4 \text{ tfm} \quad c/ 13 \phi 25 = 65,0 \text{ cm}^2$$

$$\sigma_{sI} = 1595 \text{ kg/cm}^2 = 159,5 \text{ MPa}$$

$$M_g = 46 \text{ tfm} \quad c/ 13 \phi 25 = 65,0 \text{ cm}^2$$

$$\sigma_{sII} = 671 \text{ kg/cm}^2 = 67,1 \text{ MPa}$$

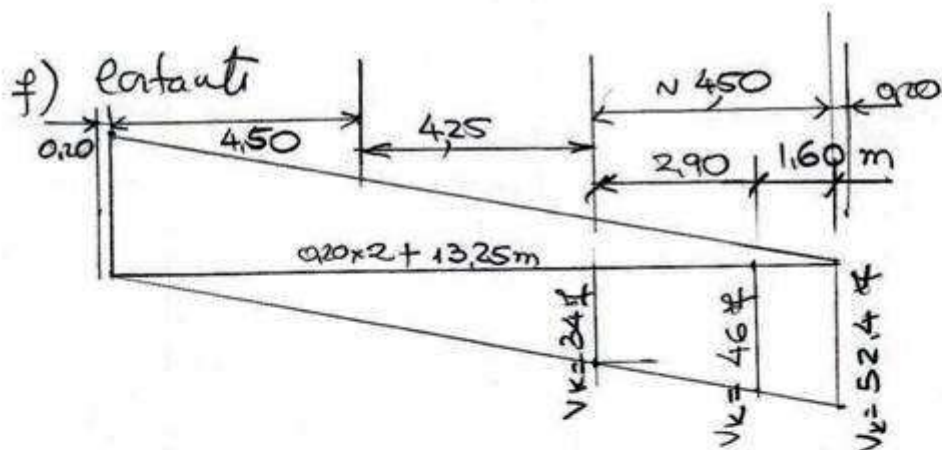
$$\Delta \sigma_{sII} = 92,4 \text{ MPa} < \Delta f_{sd} = 95 \text{ MPa} \quad \text{OK.}$$

$$V_g = 130 \text{ lf} \rightarrow A_{s1/5} = 2,91 \text{ cm}^2/\text{m} \quad \sigma_s = 769 \text{ kg/cm}^2$$

$$V_{g+q/2} = 22,69 \text{ lf} \rightarrow A_{s/5} = 5,88 \text{ cm}^2/\text{m} \quad \sigma_s = 1554 \text{ kg/cm}^2$$

$$(V_g + V_q) \cdot \gamma_f = \gamma_f \times 52,4 \quad A_{s/5} = 16,45 \text{ cm}^2/\text{m} \quad \sigma_s = 4348 \text{ kg/cm}^2$$

$$\Delta \sigma_s = 785 \text{ kg/cm}^2 = 78,5 \text{ MPa} < \Delta f_{sd} = 85 \text{ MPa}$$



$$V_k = 52.4 \text{ tf} \quad b_w = 40 \text{ cm} \quad f_{ck} = 30 \text{ MPa}$$

$$h = 126 \text{ cm} \quad d = 114 \text{ cm}$$

$$h_f = 26 \text{ cm}$$

$$A_{st/s} = 16.45 \text{ cm}^2/\text{m} \quad \phi 10 \text{ c/19} \quad 4 \text{ barras}$$

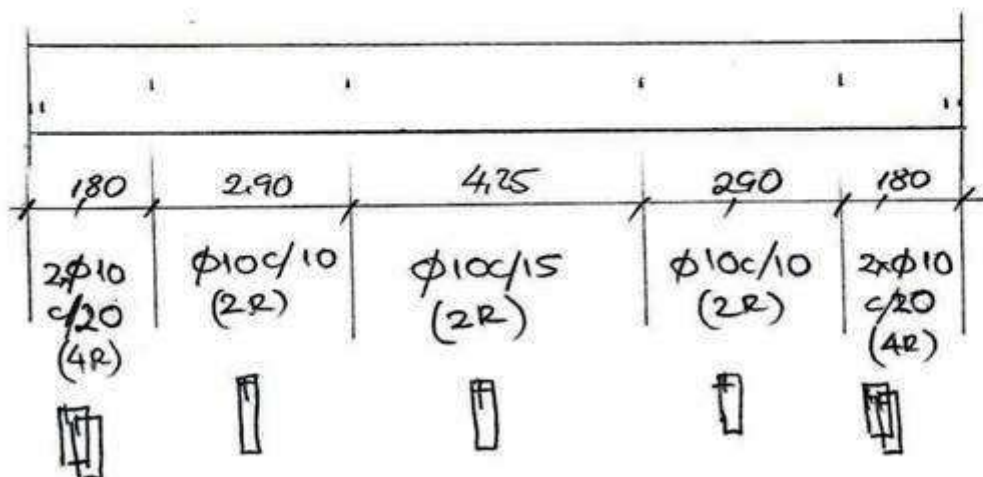
$$V_k = 46 \text{ tf} \quad b_w = 17 \quad f_{ck} = 30 \text{ MPa}$$

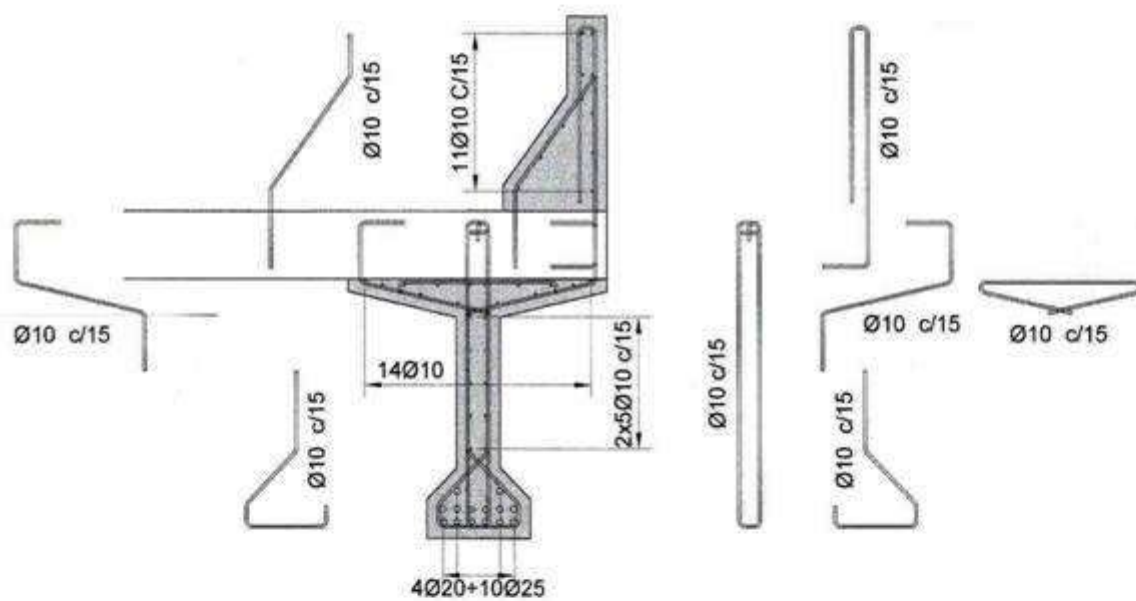
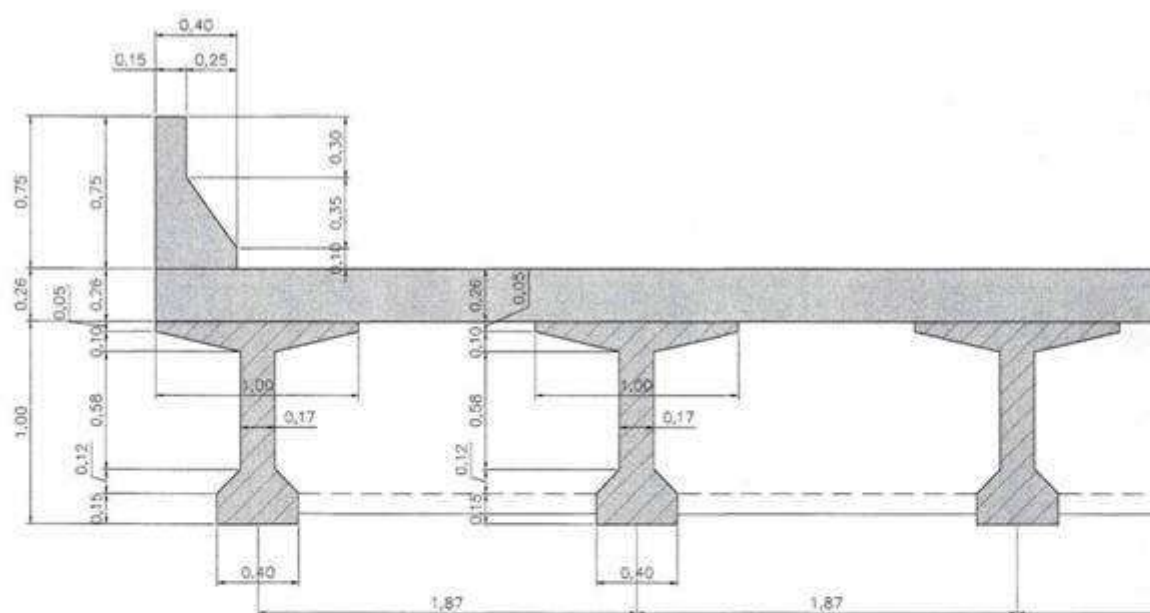
$$h = 126 \text{ cm} \quad d = 114 \text{ cm}$$

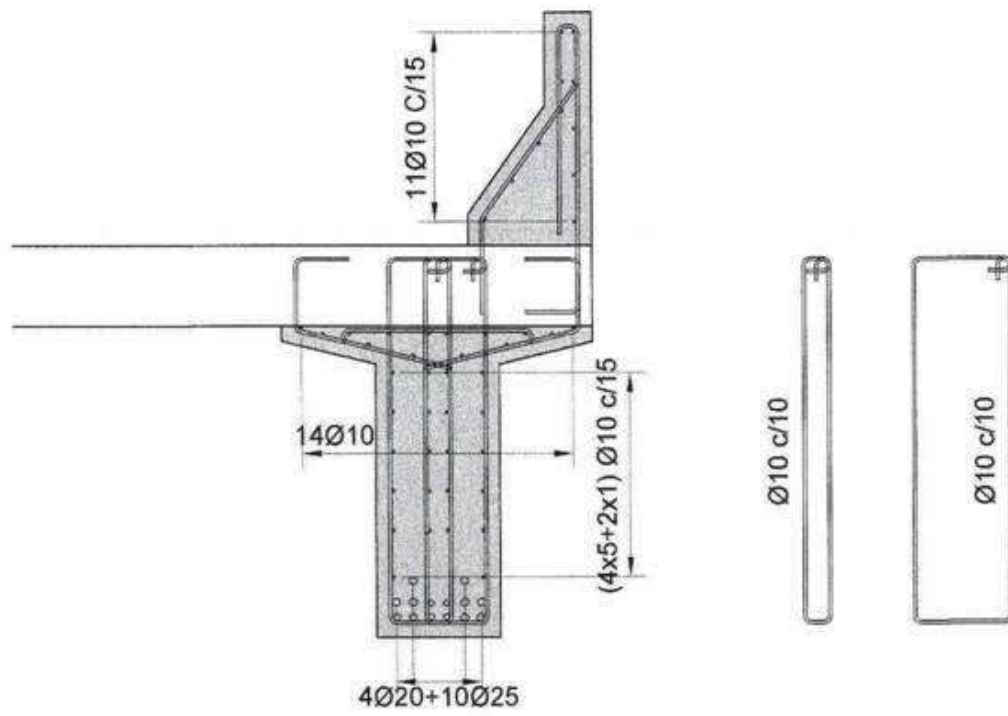
$$h_f = 26 \text{ cm}$$

$$A_{st/s} = 14.44 \text{ cm}^2/\text{m} \quad \phi 10 \text{ c/10 cm} (2R)$$

$$\text{para } \phi 10 \text{ c/15} (2R) = 10.67 \text{ cm}^2/\text{m} \Rightarrow V_k = 340 \text{ kN}$$







Transversal (30x122) (central)

$$M_k = 0,78 + 3,00 + 21,8 \times 1,67 = 40,20 \text{ tfm}$$

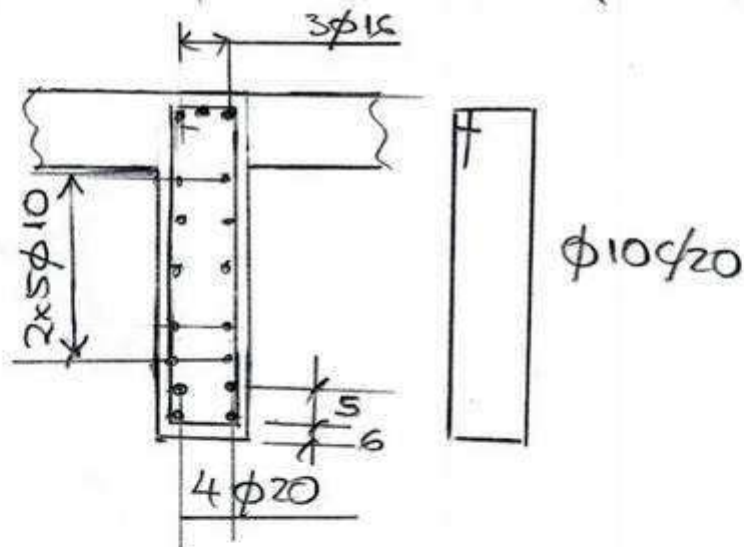
$$V_k = 0,53 + 2,00 + 21,9 \times 1,67 = 39,10 \text{ tf}$$

$$b = 30 \text{ cm}$$

$$h = 122 \text{ cm} \quad d' = 11 \text{ cm} \quad d = 111 \text{ cm} \quad f_{ck} = 30 \text{ MPa}$$

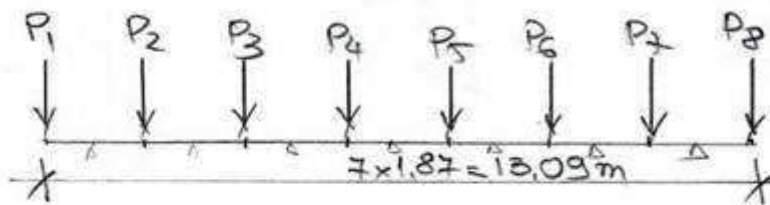
$$A_s = 12,3 \text{ cm}^2 \Rightarrow 4 \phi 20 = 12,60 \text{ cm}^2$$

$$V_k = 39,10 \text{ tf} \Rightarrow \phi 10 \text{ c/20 (2 rows)}$$



$$A_{sple} = 0,1\% \times 122 \times 30 = 3,66 \text{ cm}^2 / \text{face}$$

Transversaria (30x111) (borda)



$$P_1 = P_8 = 12.5 + 1.9 = 14.4 \text{ tf}$$

$$P_2 = P_7 = 15.4 + 2.7 = 18.1 \text{ tf}$$

$$P_3 = P_6 = 15.4 + 2.7 = 18.1 \text{ tf}$$

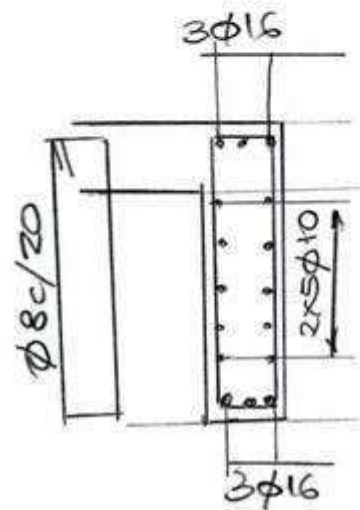
$$P_4 = P_5 = 15.4 + 2.8 = 18.2 \text{ tf}$$

$$R_{12} = R_{78} = 29.7 \text{ tf}$$

$$R_{23} = R_{67} = 10.1 \text{ tf}$$

$$R_{34} = R_{56} = 20.4 \text{ tf}$$

$$R_{45} = 17.1 \text{ tf}$$



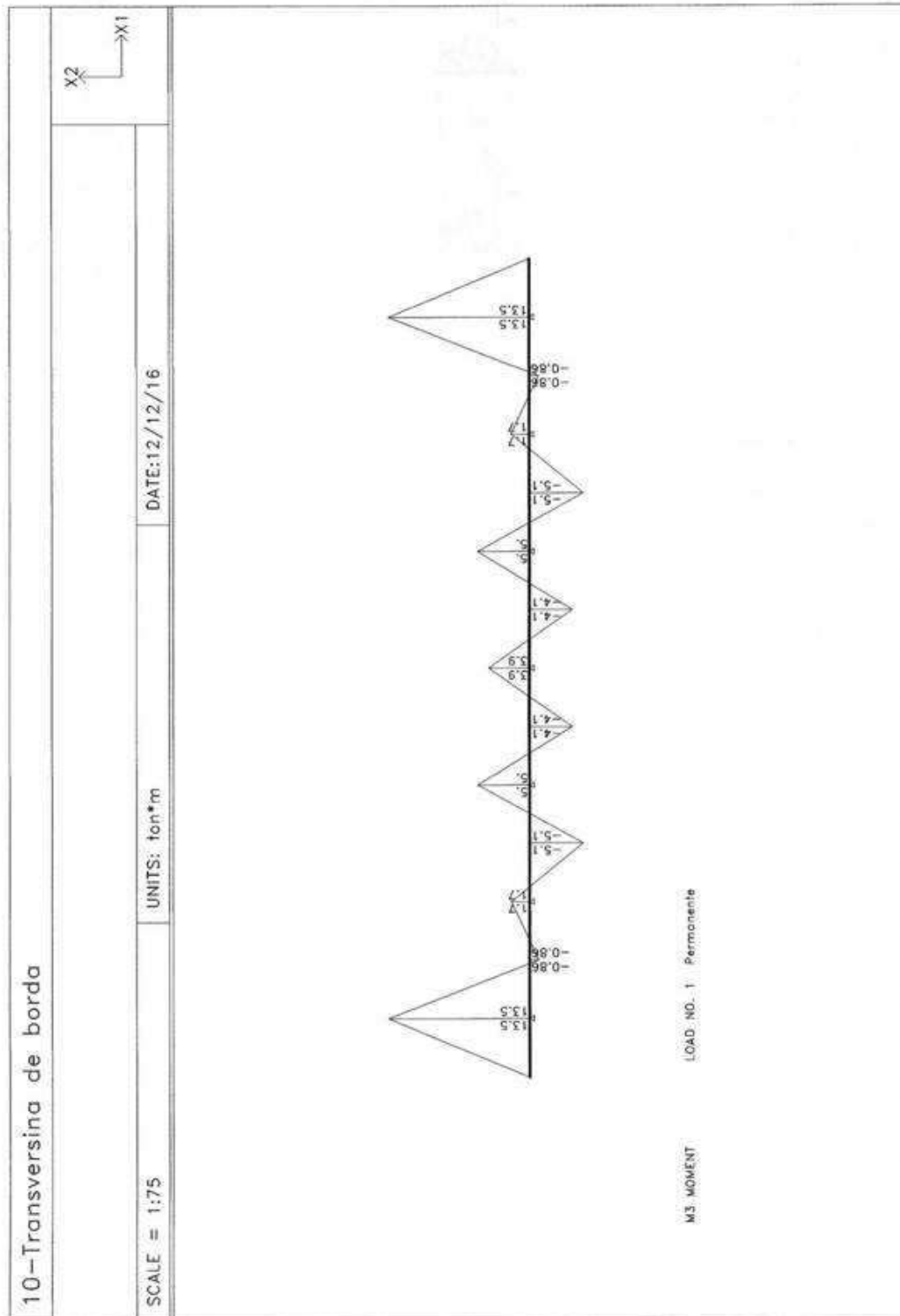
$$X = 13.5 \text{ tfm} \quad b = 30 \quad h = 111\text{cm} \quad d = 100\text{cm}$$

$$f_{ck} = 30\text{MPa}$$

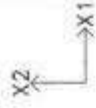
$$V = 15.3 \text{ tf} \quad A_s = 5.0\text{cm}^2 \quad 3\phi 16 = 5.94\text{cm}^2$$

$$A_{st/s} = 3.48\text{cm}^2/\text{m} \Rightarrow \phi 8 \text{ c/20cm}$$

Adota-se 3 $\phi 16$ superior e 3 $\phi 16$ inferior
estribos $\phi 8$ c/20cm



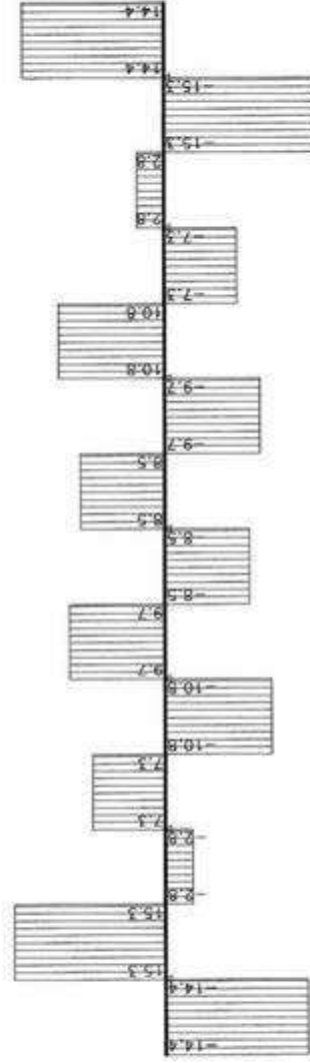
10-Transversina de borda



SCALE = 1:75

UNITS: ton

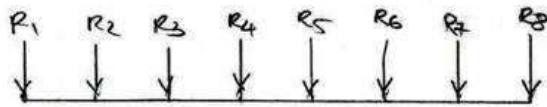
DATE: 13/12/16



V2 SHEAR

LOAD NO. 1 Permanente

3.4.3 Aparelhos de Apoio



max ~~max~~

$$R_1 = 12,5 + 9,2 + 22,1 \times 1,67 = 58,607 \text{ t} \quad \text{O}$$

$$R_2 = 15,4 + 12,9 + 25,8 \times 1,67 = 71,386 \text{ t} \quad *$$

$$R_3 = 15,4 + 13,2 + 24,4 \times 1,67 = 69,348 \text{ t} \quad \text{f}$$

$$R_4 = 12,5 + 13,5 + 24,4 \times 1,67 = 66,748 \text{ t} \quad \text{f}$$

$$\varphi_1 = 0,0019105 + 0,0005760 + 0,0006835 \times 1,67 = 3,62 \times 10^{-3} \quad \text{O}$$

$$\varphi_2 = 0,0022917 + 0,0006532 + 0,0006478 \times 1,67 = 4,03 \times 10^{-3} \quad *$$

$$\varphi_3 = 0,0022917 + 0,0007007 + 0,0004844 \times 1,67 = 3,80 \times 10^{-3}$$

$$\varphi_4 = 0,0022917 + 0,0007238 + 0,0005016 \times 1,67 = 3,85 \times 10^{-3}$$

min ~~max~~

$$R_1 = 12,5 + 1,9 = 14,4 \text{ t} \quad \text{O} \quad \Delta R = 44,207 \text{ t}$$

$$R_2 = 15,4 + 2,7 = 18,1 \text{ t} \quad * \quad \Delta R = 53,286$$

$$R_3 = 15,4 + 2,7 = 18,1 \text{ t}$$

$$R_4 = 15,4 + 2,8 = 18,2 \text{ t}$$

$$\varphi_1 = 0,0019105 + 0,0001201 = 2,03 \times 10^{-3} \quad \text{O}$$

$$\varphi_2 = 0,0022917 + 0,0001362 = 2,43 \times 10^{-3} \quad *$$

$$\varphi_3 = 0,0022917 + 0,0001461 = 2,44 \times 10^{-3}$$

$$\varphi_4 = 0,0022917 + 0,0001509 = 2,44 \times 10^{-3}$$

$$\text{O } \Delta \varphi = 1,59 \times 10^{-3}$$

$$* \Delta \varphi = 1,60 \times 10^{-3}$$

$$\sigma_{\text{mínima}} \text{ requerido} = 14.40 \text{ kgf}$$

$$\sigma_{\text{mín}} = 20 \text{ kgf/cm}^2 = \frac{14400}{A_{\text{mín}}}$$

$$A_{\text{mín}} = 720 \text{ cm}^2$$

$$\sigma_{\text{máxima}} \text{ requerido} = 71.386 \text{ kgf}$$

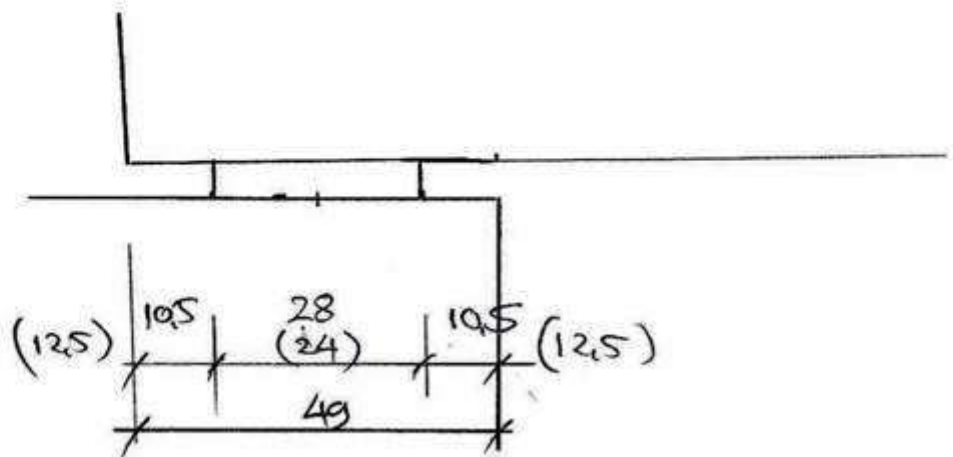
$$\sigma_{\text{máx}} = 100 \text{ kgf/cm}^2 = \frac{71386}{A_{\text{máx}}}$$

$$A_{\text{máx}} = 714 \text{ cm}^2$$

Nas vigas externas $A = 720 \text{ cm}^2$
 internas $A = 835 \text{ cm}^2$

$$\cdot \text{ c/ } 30 \times 28 = 840 \text{ cm}^2$$

$$\text{c/ } 30 \times 24 = 720 \text{ cm}^2$$



Máxima Reação

R ₁ =	12,5	+	9,2	+	1,67x	22,1	=	58,607	tf
R ₂ =	15,4	+	12,9	+	1,67x	25,8	=	71,386	tf
R ₃ =	15,4	+	13,2	+	1,67x	24,4	=	69,348	tf
R ₄ =	12,5	+	13,5	+	1,67x	24,4	=	66,748	tf

Distorção

φ ₁ =	1,91E-03	+	5,76E-04	+	1,67x	6,84E-04	=	3,62E-03	
φ ₂ =	2,29E-03	+	6,53E-04	+	1,67x	6,48E-04	=	4,03E-03	
φ ₃ =	2,29E-03	+	7,01E-04	+	1,67x	4,84E-04	=	3,80E-03	
φ ₄ =	2,29E-03	+	7,24E-04	+	1,67x	5,02E-04	=	3,85E-03	

Mínima Reação

R ₁ =	12,5	+	1,9	+	1,67x	0	=	14,4	tf
R ₂ =	15,4	+	2,7	+	1,67x	0	=	18,1	tf
R ₃ =	15,4	+	2,7	+	1,67x	0	=	18,1	tf
R ₄ =	15,4	+	2,8	+	1,67x	0	=	18,2	tf

Distorção

φ ₁ =	1,91E-03	+	1,20E-04	+	1,67x	0,00E+00	=	2,03E-03	
φ ₂ =	2,29E-03	+	1,36E-04	+	1,67x	0,00E+00	=	2,43E-03	
φ ₃ =	2,29E-03	+	1,46E-04	+	1,67x	0,00E+00	=	2,44E-03	
φ ₄ =	2,29E-03	+	1,51E-04	+	1,67x	0,00E+00	=	2,44E-03	

Carregamento Horizontal

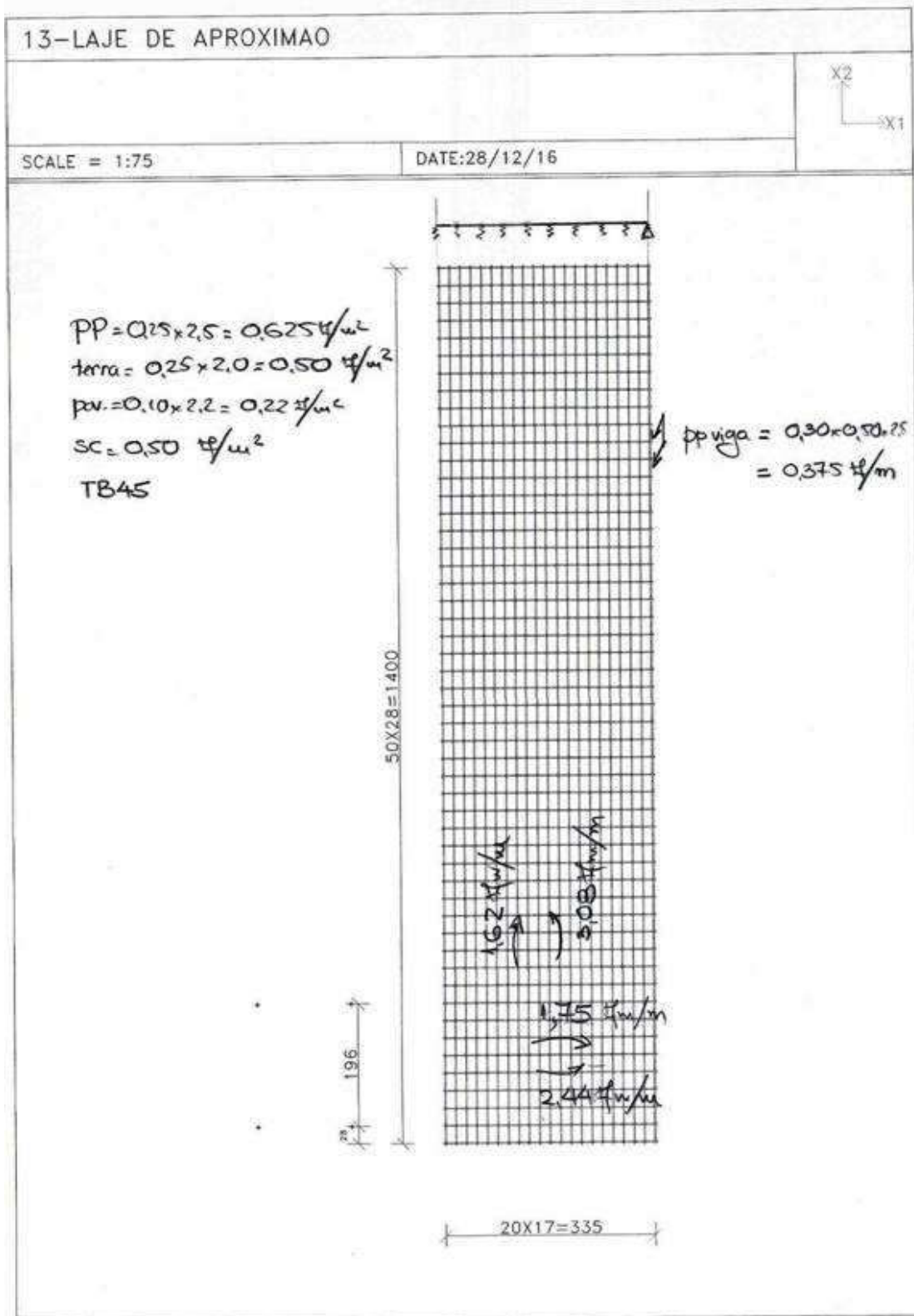
30% TB45	=	22,55	tf	H=	22,55	tf
5% da carga distribuida	=	7,48	tf	H/viga=	2,82	tf
B	=	13,29	m			
L	=	13,48	m			
número de vigas	=	8				

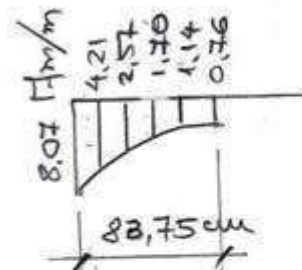
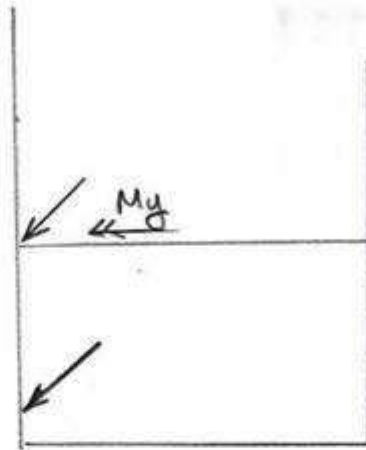
A>	732,5875	cm ²	A=	720	A<	720	cm ²	σ_{\max}	81,4	kgf/cm ²
A>	892,325	cm ²	A=	720	A<	905	cm ²	σ_{\max}	99,1	kgf/cm ²
A>	866,85	cm ²	A=	720	A<	905	cm ²	σ_{\max}	96,3	kgf/cm ²
A>	834,35	cm ²	A=	720	A<	910	cm ²	σ_{\max}	92,7	kgf/cm ²

A<	720	cm ²	σ_{\min}	20,0	kgf/cm ²
A<	905	cm ²	σ_{\min}	25,1	kgf/cm ²
A<	905	cm ²	σ_{\min}	25,1	kgf/cm ²
A<	910	cm ²	σ_{\min}	25,3	kgf/cm ²

Aparelhos de apoio de elastômero fretado					NEOPREX - EN 1337				
Cliente:	Hidrostudio				Vivan Engenharia				
Obra:	Ponte Sobre Rio Jaguari Mirim - Município de São João da Boa Vista								
Local:	Apoio das Vigas Internas								
Data:	13/12/2016				Versão Beta12				
	Carga permanente	15100	kgf	largura do aparelho / fl. eixo long. obra	24	cm	espessura da chapa externa	3	mm
	Carga acidental	53286	kgf	comprimento do aparelho	30	cm	espessura da chapa interna	3	mm
	Fator majoração cargas vivas	1		espessura camada de elastômero (t)	0,8	cm	cobrimto vertical	2,5	mm
	Rotação long. permanente	2,43E-03	rad	altura total elastômero = t.n.B	2,4	cm	cobrimto horizontal	4	mm
	Rotação long. acidental	1,60E-03	rad	0	16	kgf/cm2	nº de aparelhos para uso	4	unidades
	Horizontal long. permanente	0	kgf	fyk	2100	kgf/cm2	nº de aparelhos p/ ensaio	1	unidades
	Horizontal long. acidental	2820	kgf	atrito: concreto (t) ou demais (2)	6	fator			
	Deslocamento long. permanente	0	cm						
	Deslocamento long. acidental	0	cm						
	Deslocamento total permanente			0,00	cm		Fator de forma si	8,08	
	Deslocamento total acidental			0,57	cm		Fator de forma cobrimto	18,47	
	Tensão normal considerando área total do aparelho			99	kgf/cm2		H total	41,0	mm
	Tensão normal com área reduzida			106,0	kgf/cm2		σC25, σC30 e σC40 para a perfuração	125	kgf/cm2
	Tensão normal permanente com área reduzida			26,7	kgf/cm2	Erro 2	σC25, σC30 e σC40 para a perfuração	30	kgf/cm2
	Tmin - deslocamento - cargas permanentes			0,00	cm		Volume Unitário	2,952	dm3
	Tmin - deslocamento - cargas totais			0,74	cm		Volume Total para Compra	14,760	dm3
	Tmin - limitação deslocamento horizontal			0,81	cm				
	Tmax para estabilidade			11,57	cm		VERIFICAÇÃO PELO UIC-CODE		
	Soma das deflexões das camadas internas			0,2516	cm		Soma deflexões cam. internas	0,0791	cm
	Soma das deflexões das camadas de cobrimto			0,0057	cm		Soma deflexões cam. cobrim	0,0034	cm
	Deflexão total			0,2574	cm		Deflexão total	0,0825	cm
	Rotação admissível pela análise de estabilidade			3,33E-02	rad		Rot. adm. por estabilidade (K=1)	2,06E-02	rad
	Rotação admissível sem considerar camadas cobrimto			3,25E-02	rad		Idem, sem cam. cobrimto (K=1)	1,98E-02	rad
	Rotação adicional permanente pelo limite deformação 5			1,59E-02	rad		Rot. adm. permanente	5,29E-03	rad
	Deformação de cisalhamento por esforços normais			2,01					
	Deformação de cisalhamento por esforços horizontais			0,20					
	Deformação de cisalhamento devida às rotações			0,56					
	Deformações totais por cisalhamento no elastômero			2,77					
	Deformações totais por cisalhamento no cobrimto			2,14					
	Espessura mínima para a chapa interna de aço			1,07	mm				

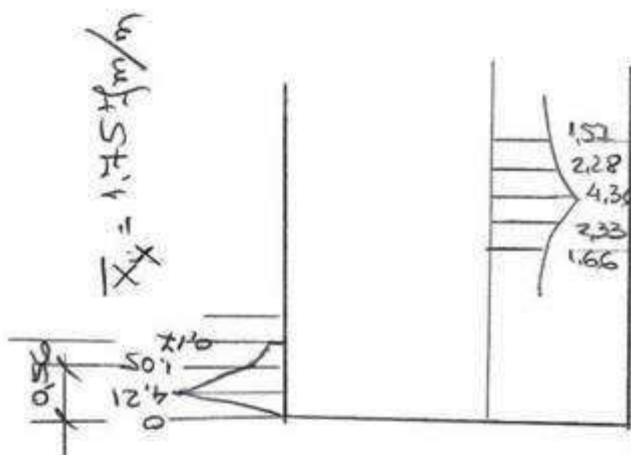
3.4.4 Laje de Aproximação





$$\bar{M}_y = 3,08 \text{ t/m/m}$$

$$X_y = 1,62 \text{ t/m/m}$$



$$\bar{X}_y = 1,45 \text{ t/m/m}$$

$$\bar{M}_x = 2,44 \text{ t/m/m}$$

$$b=100 \text{ cm} \quad h=25 \text{ cm} \quad d=18,6 \text{ cm} \quad f_{ek}=254 \text{ Pa}$$

$$M_y = 3,08 \text{ tfm/m} \quad \mu_{sd} = 0,070$$

$$A_{sue} = 5,57 \text{ cm}^2/\text{m}$$

$$c/\phi 12,5 \text{ c}/20 \text{ cm} = 6,25 \text{ cm}^2/\text{m} \quad \omega = 0,20$$

$$M_x = 2,44 \text{ tfm/m} \quad A_{sue} = 4,37 \text{ cm}^2/\text{m}$$

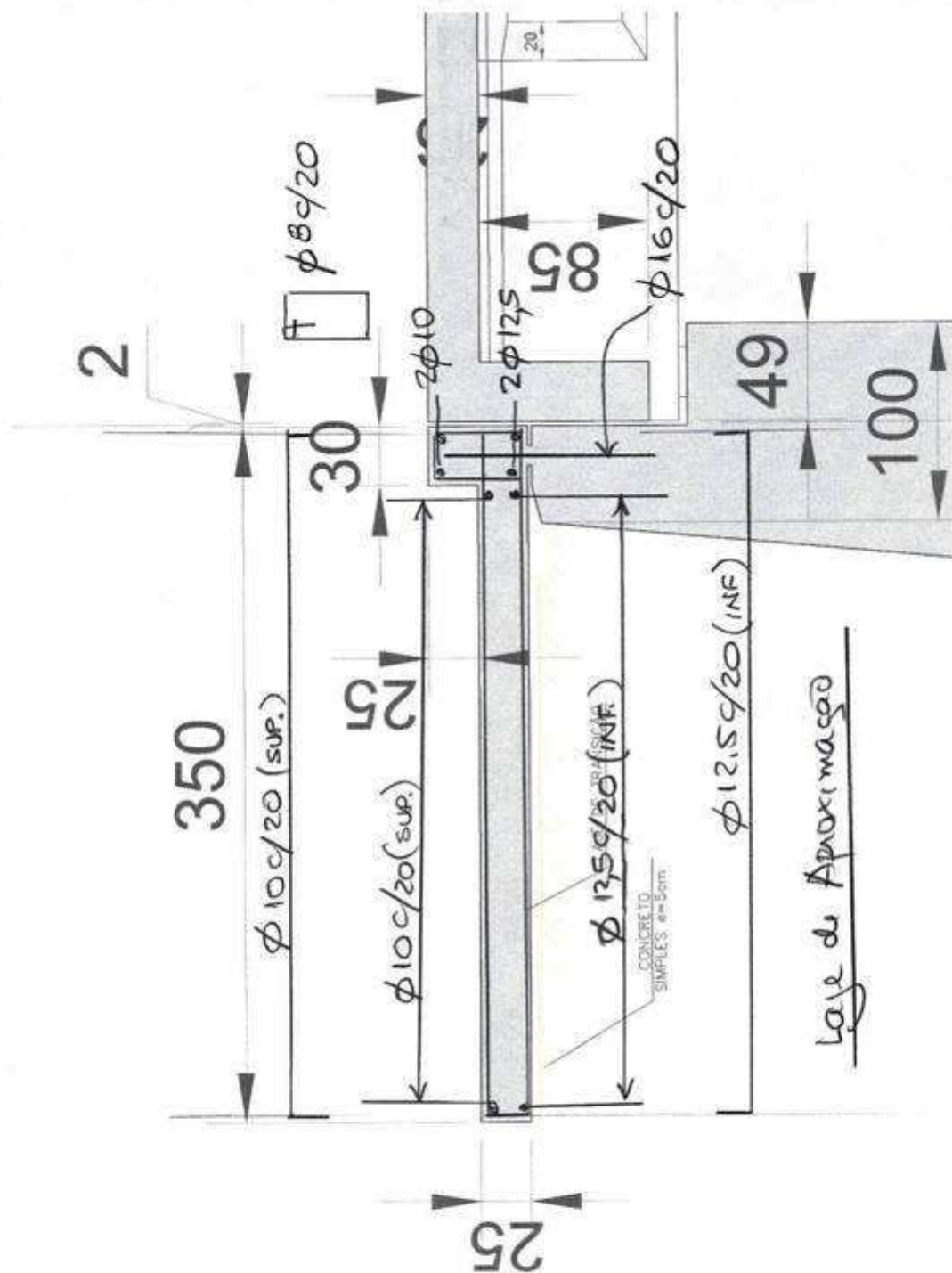
$$\text{Adotawues } \phi 12,5 \text{ c}/20 \text{ cm}$$

$$X_x = 1,75 \text{ tfm/m} \quad A_{sue} = 3,10 \text{ cm}^2/\text{m}$$

$$A_{sueu} = 3,75 \text{ cm}^2/\text{m}$$

$$c/\phi 10 \text{ c}/20 = 4,0 \text{ cm}^2/\text{m}$$

$$X_y = 1,62 \text{ tfm/m} \Rightarrow \text{Adotawues } \phi 10 \text{ c}/20 \text{ cm}$$

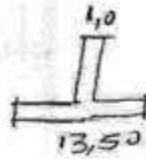


4 LAJE DE FUNDO E PILARES

4.1 Laje de Fundo do Vertedouro

<u>VERTEDOURO</u>				
1- PESO PRÓPRIO				
- PILAR				
$2 \times (1,0 + 2,0) / 2 \times 3,0 = 9,0$	2	AxZ	11,25	①
	1,25			
$1,13 \times 5,90 \times 0,85 = 5,67$	4,62		26,20	②
$(0,90 + 5,90) / 2 \times 2,37 = 8,06$	2,435		5,19	3'
$0,90 \times 2,37 = 2,13$	3,00		13,95	3"
$1,86 \times 5,0 / 2 = 4,65$	1,25		20,0	③
$8,0 \times 2,0 = 16,00$	-0,65		2,34	④
$0,90 \times 4,0 = 3,60$	-0,21		0,09	⑤
$0,50 \times 1,55 \times 0,5 = 0,43$	-1,55		2,50	⑥
$1,0 \times 2,50 = 2,50$				⑦
$\sum 46,26$				$\times 1,05 = 71,84$
$1,0 \times 2,0 = 2,00$	4,25		8,50	⑧
$1,0 \times 0,80 \times 0,5 = 0,40$	2,98		1,19	⑨
$2,36 \times 3,0 \times 0,5 = 3,54$	2,55		9,03	⑩
$6,50 \times 1,50 = 9,75$	-2,0		19,50	⑪
$0,70 \times 1,0 = 0,70$	-6,0		4,20	⑫
$0,50 \times 1,55 = 0,78$	0,475		0,37	⑬
$0,50 \times 1,55 \times 0,5 = 0,39$	0,73		0,29	⑭
$0,51 \times 3,0 = 1,53$	1,505		2,30	⑮
$\sum 19,09$				$\times 1,05 = 27,27$
				OU 20,10

Volume do concreto



$$V_c = 45,26 \times 1,0 + 19,09 \times 13,5 = \underline{302,98 \text{ m}^3}$$

$$\text{Peso} = 302,98 \times 2,40 = \underline{727,15 \text{ tf}}$$

Momento devido ao peso

$$M = (71,84 - 27,27) \times 2,4 = \underline{106,97 \text{ tfm}} \curvearrowright$$

- PONTE

$$M_{pp} = 179,33 \times 1,25 = 224,16 \curvearrowright$$

$$M_{sc} = 95,70 \times 1,25 = 119,63 \curvearrowright$$

$$M_{TIPO} = 45,0 \times 6,75 = 303,75 \curvearrowright$$

$$M_{sc}^{(1/2 \text{ ponte, C.A.R.R.})} = 47,85 \times 4,78 = 227,29 \curvearrowright * (P_{sc} = 47,85 \text{ tf})$$

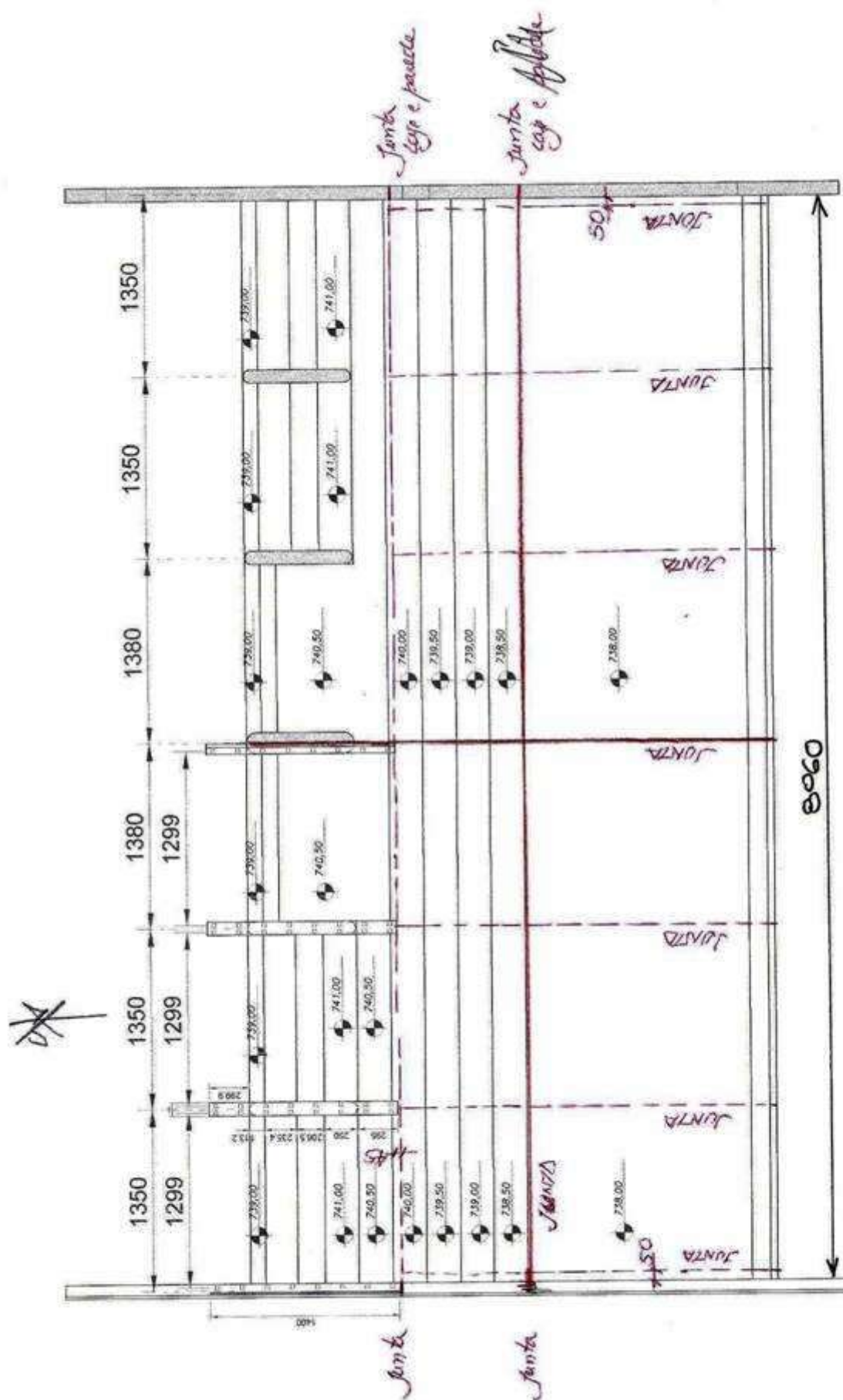
TENSÕES

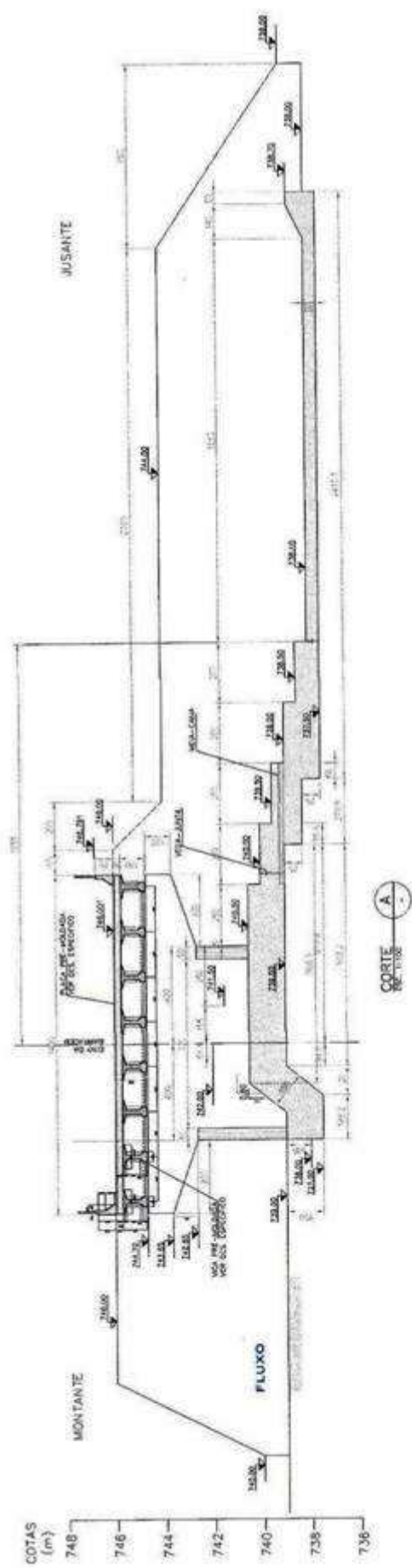
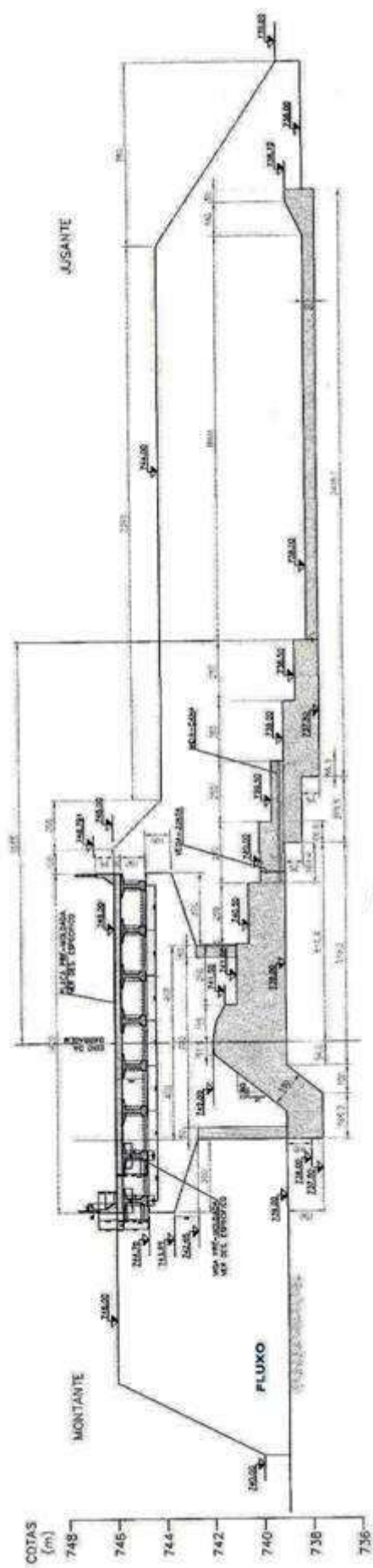
1- Jamente PP (parte descarregada)

$$P = 727,15 + 179,33 = 906,48 \text{ tf}$$

$$M = 106,97 + 224,16 = 331,13 \text{ tfm}$$

$$\sigma = \frac{-906,48}{13,50 \times 10,55} \pm \frac{331,13}{13,50 \times 10,55} \times 6 = -6,36 \pm 1,32 \left(\begin{matrix} -5,03 \text{ tf/m}^2 \\ -7,68 \text{ tf/m}^2 \end{matrix} \right)$$



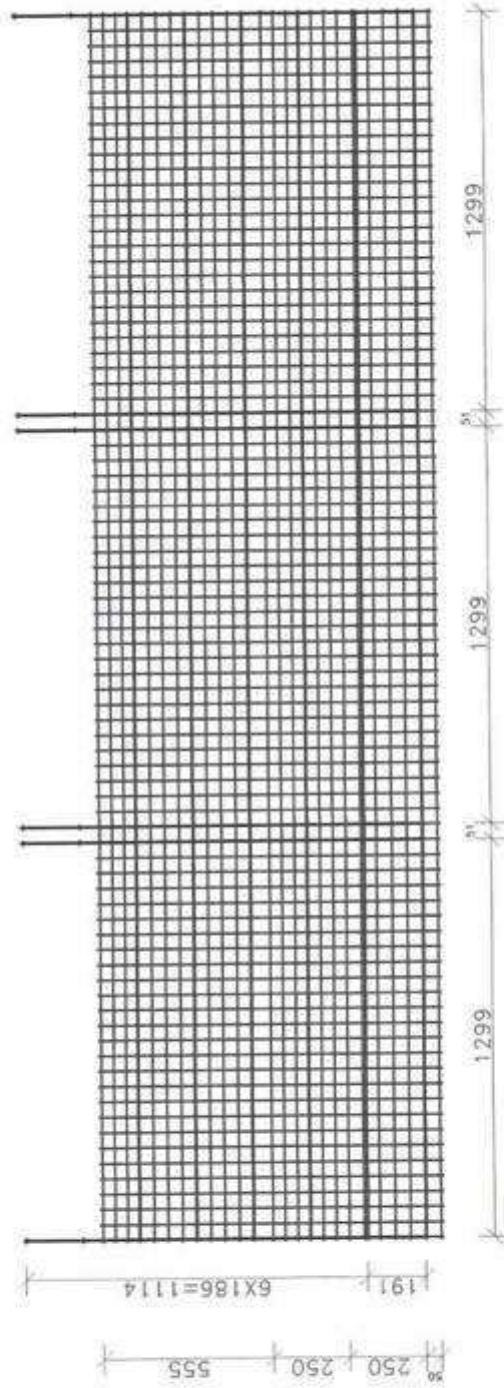


.11-Loje de Vertedouro 02



SCALE = 1:200

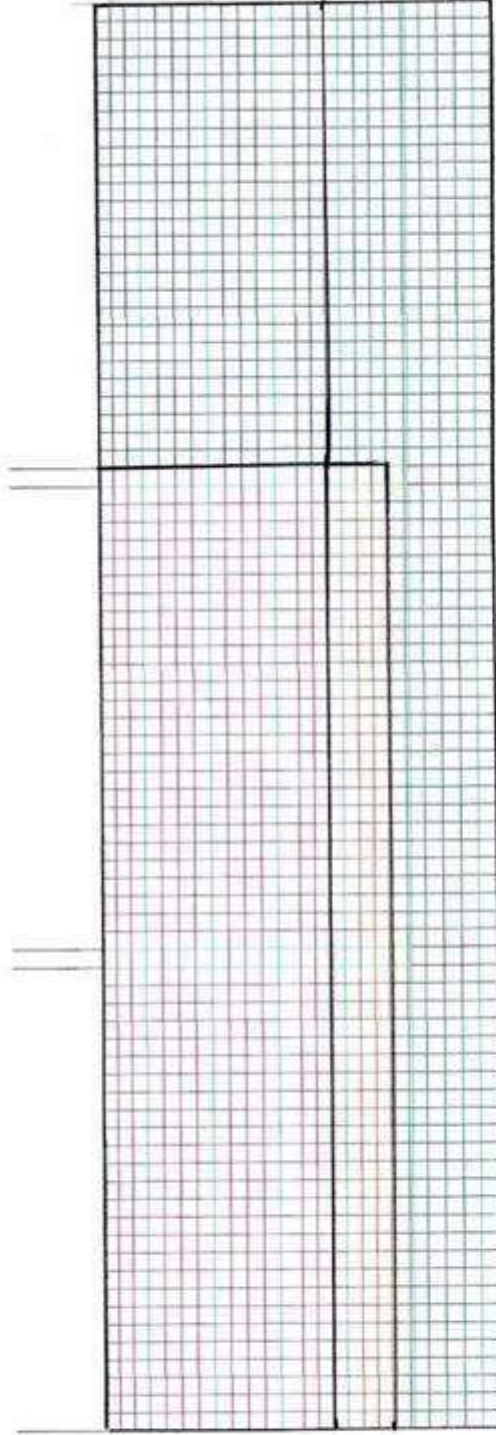
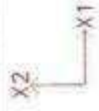
DATE:22/12/16



11-Laje de Vertedouro 02

SCALE = 1:170

DATE: 22/12/16

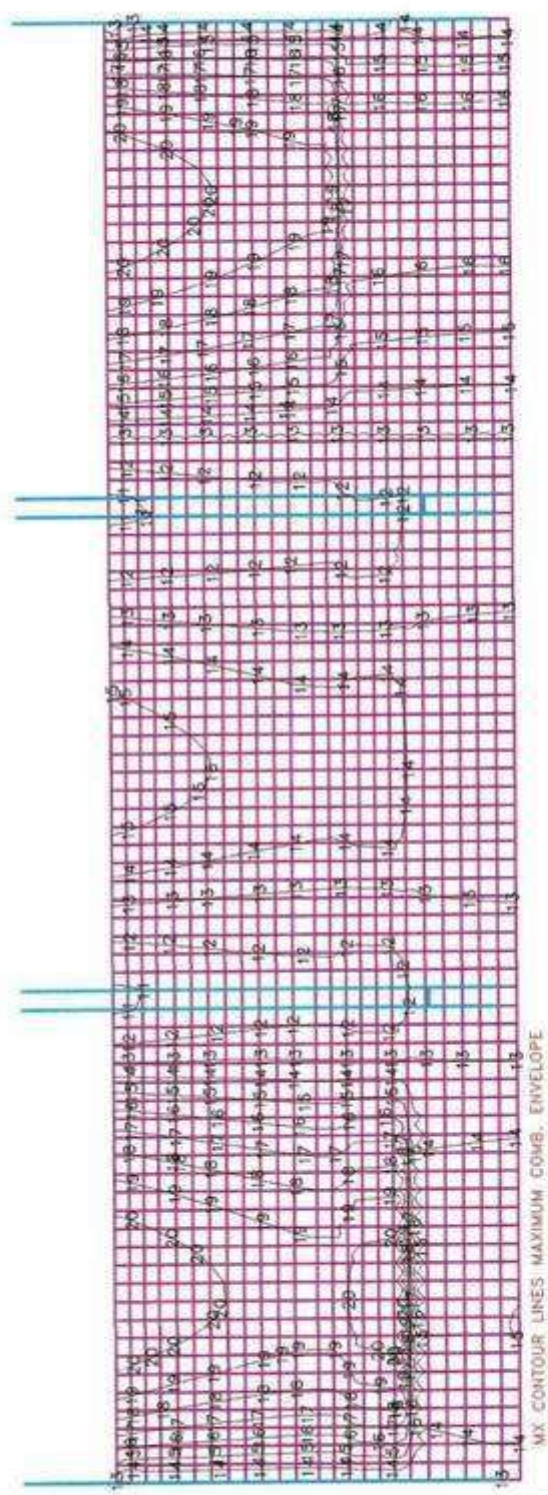


11-Laje de Vertedouro 02

SCALE = 1:170		UNITS: ton*m/m	DATE:22/12/16
---------------	--	----------------	---------------



LINE	VALUE
min	-134
1	-124
2	-114
3	-103
4	-93
5	-83
6	-72
7	-62
8	-51
9	-41
10	-31
11	-20
12	-10
13	0
14	10
15	20
16	30
17	41
18	51
19	62
20	72
max	82



11-Loje de Vertedouro 02

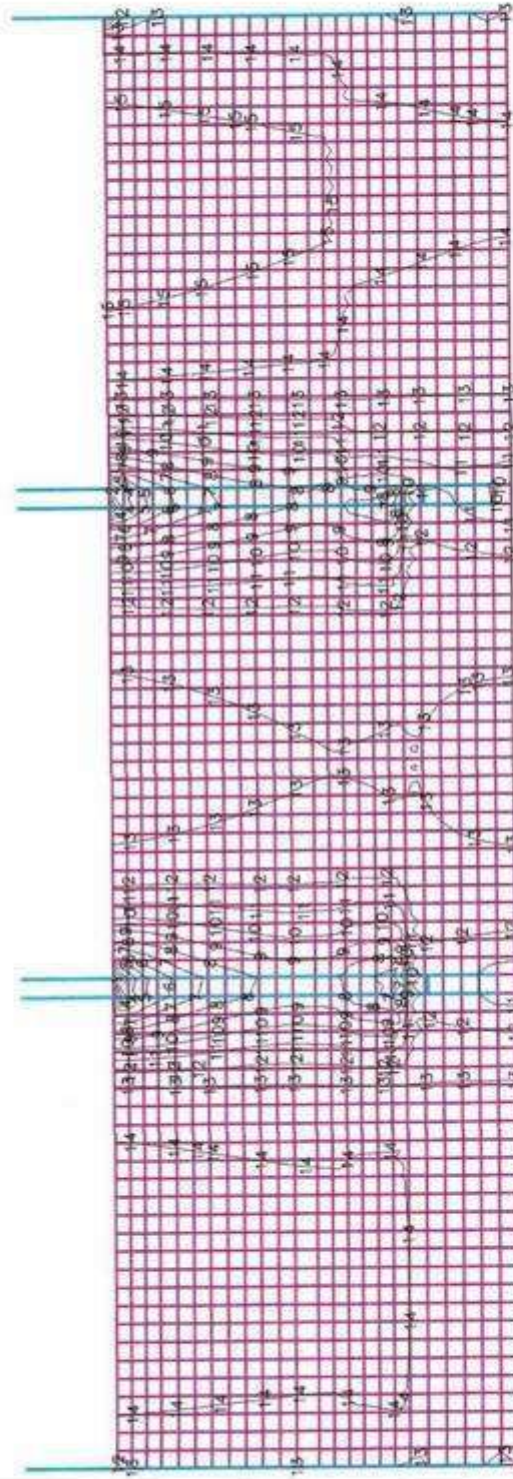


SCALE = 1:170

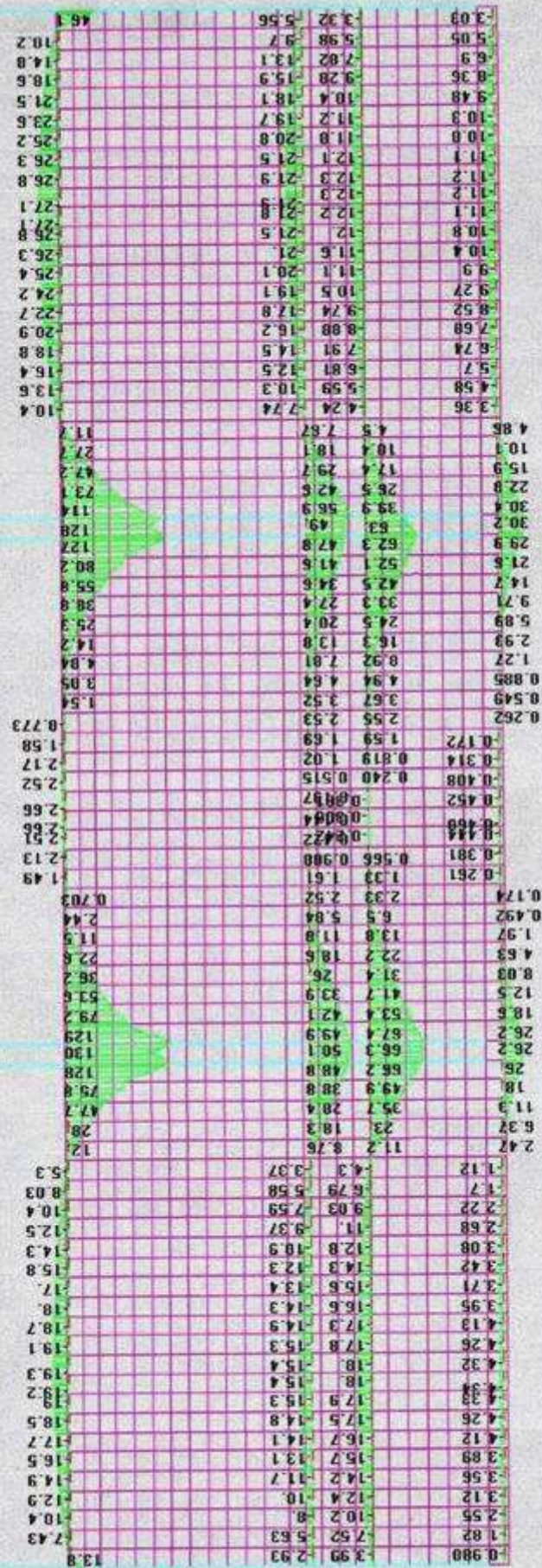
UNITS: ton*m/m

DATE:22/12/16

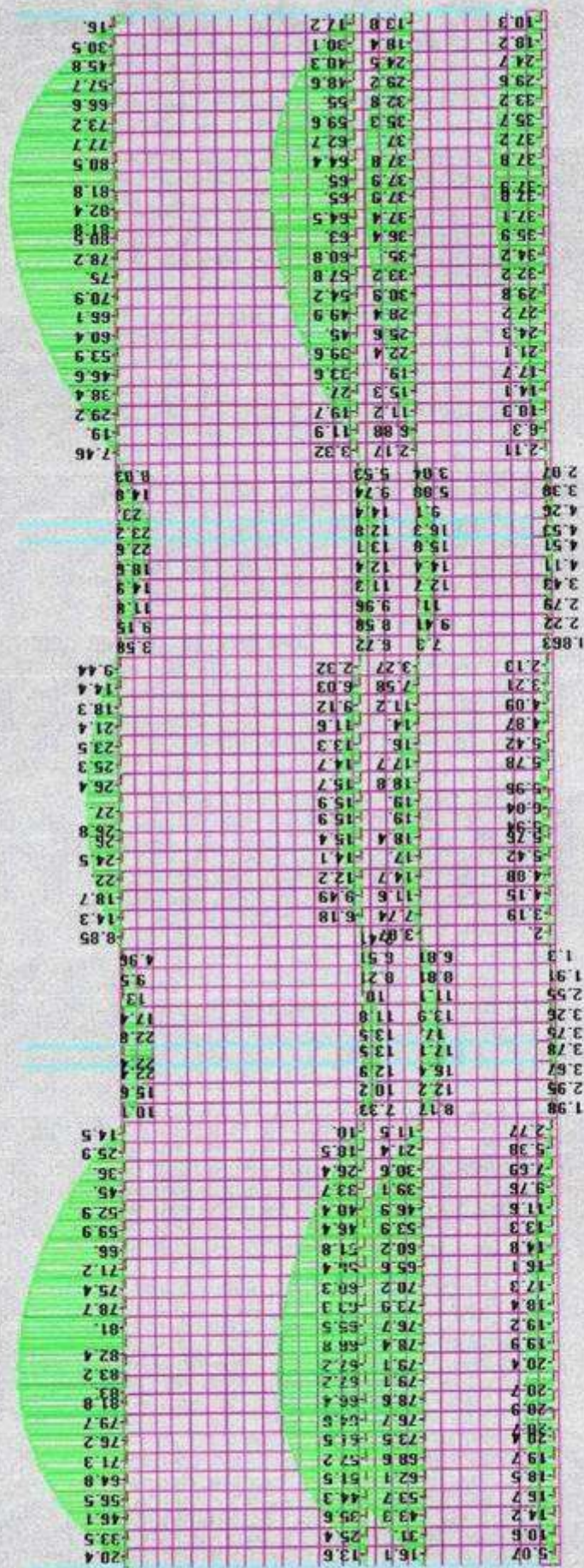
LINE	VALUE
min	-134
1	-124
2	-114
3	-103
4	-93
5	-83
6	-72
7	-62
8	-51
9	-41
10	-31
11	-20
12	-10
13	0
14	10
15	20
16	30
17	41
18	51
19	62
20	72
max	82



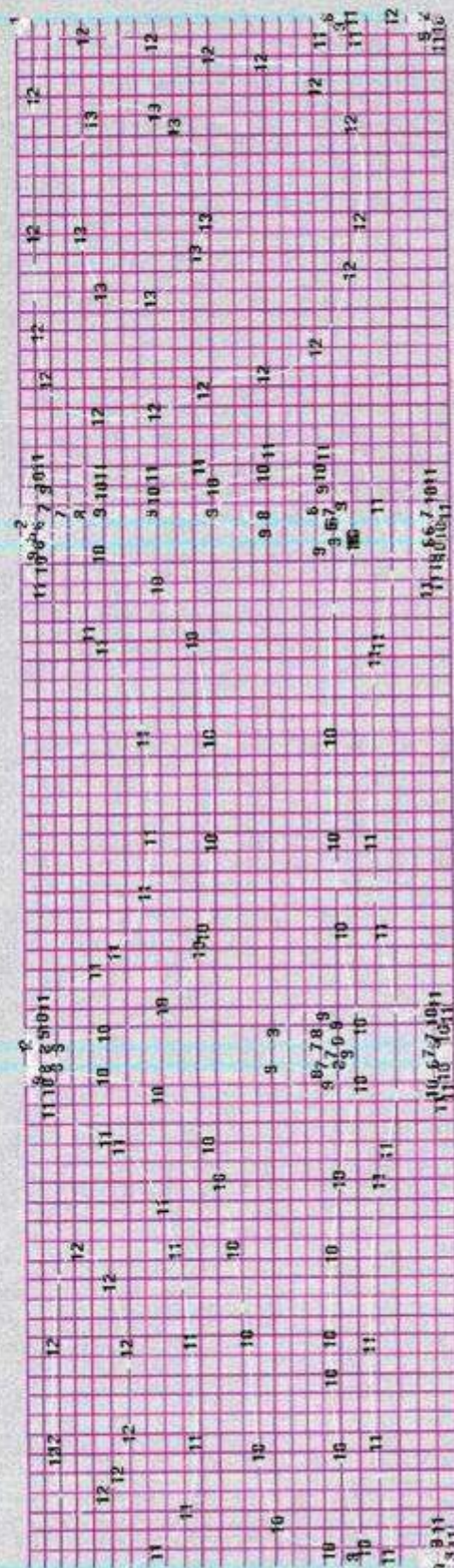
MX CONTOUR LINES MINIMUM COMB. ENVELOPE



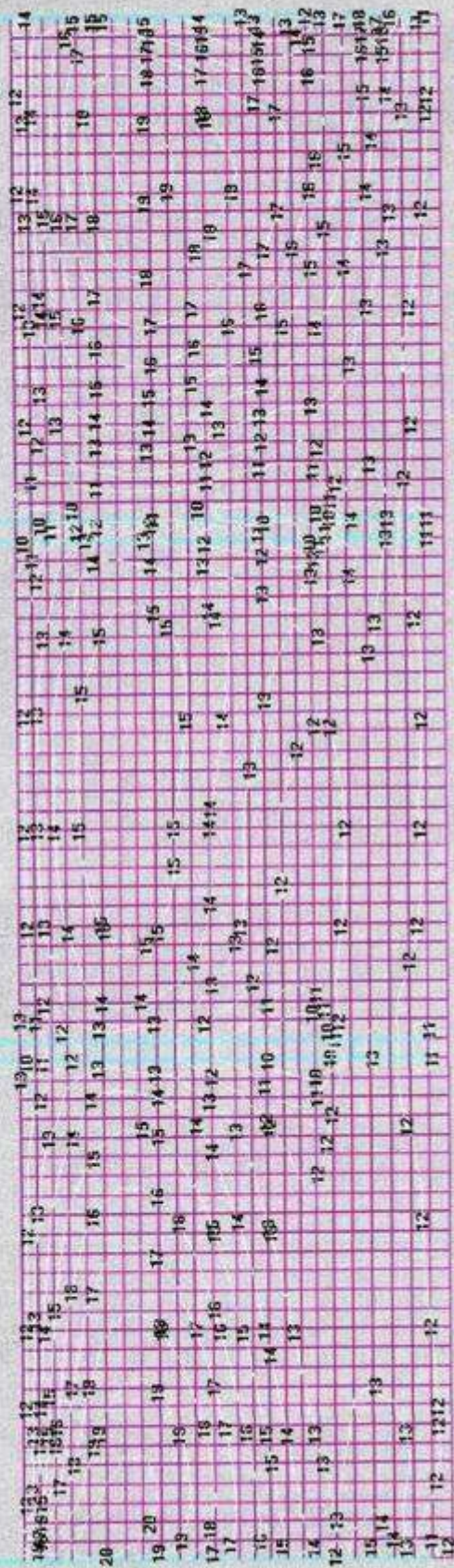
MOMENTS DIAGRAM (kNm/m) MAXIMUM COMB. ENVELOPE



LINE	VALUE
min	-19.5
1	-17.8
2	-16.1
3	-14.4
4	-12.7
5	-11.1
6	-9.4
7	-7.7
8	-6.0
9	-4.3
10	-2.6
11	-0.9
12	0.8
13	2.5
14	4.2
15	5.9
16	7.5
17	9.2
18	10.9
19	12.6
20	14.3
max	16.0



LINE	VALUE
min	-19.5
1	-17.8
2	-16.1
3	-14.4
4	-12.7
5	-11.1
6	-9.4
7	-7.7
8	-6.0
9	-4.3
10	-2.6
11	-0.9
12	0.8
13	2.5
14	4.2
15	5.9
16	7.5
17	9.2
18	10.9
19	12.6
20	14.3
max	16.0

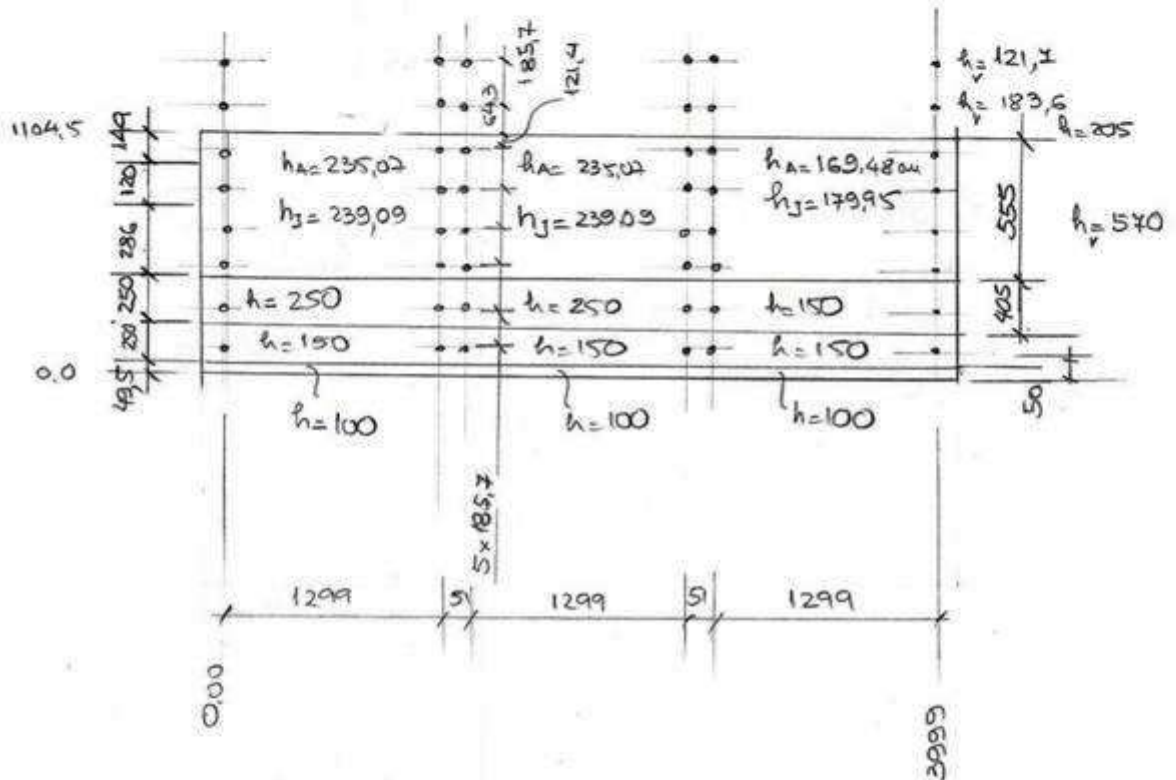
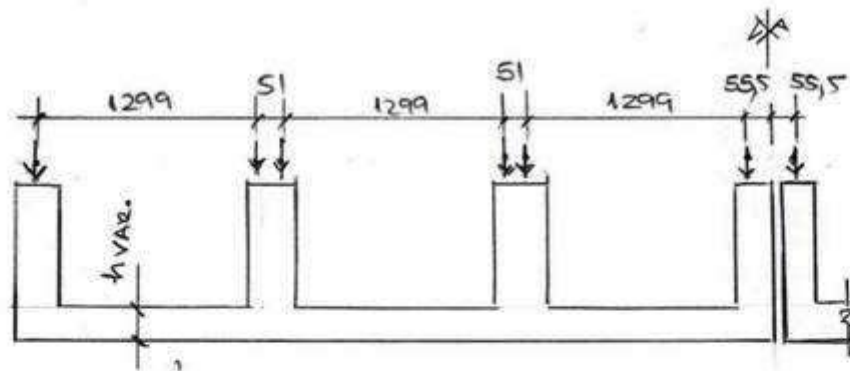


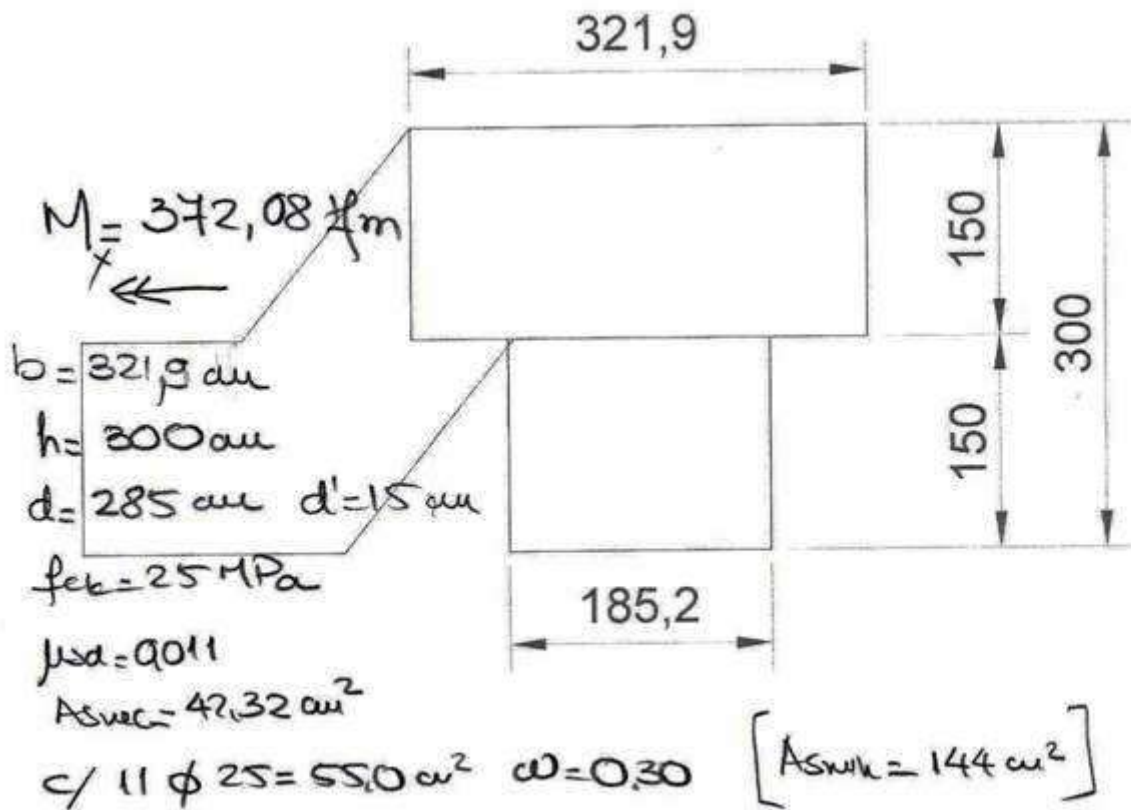
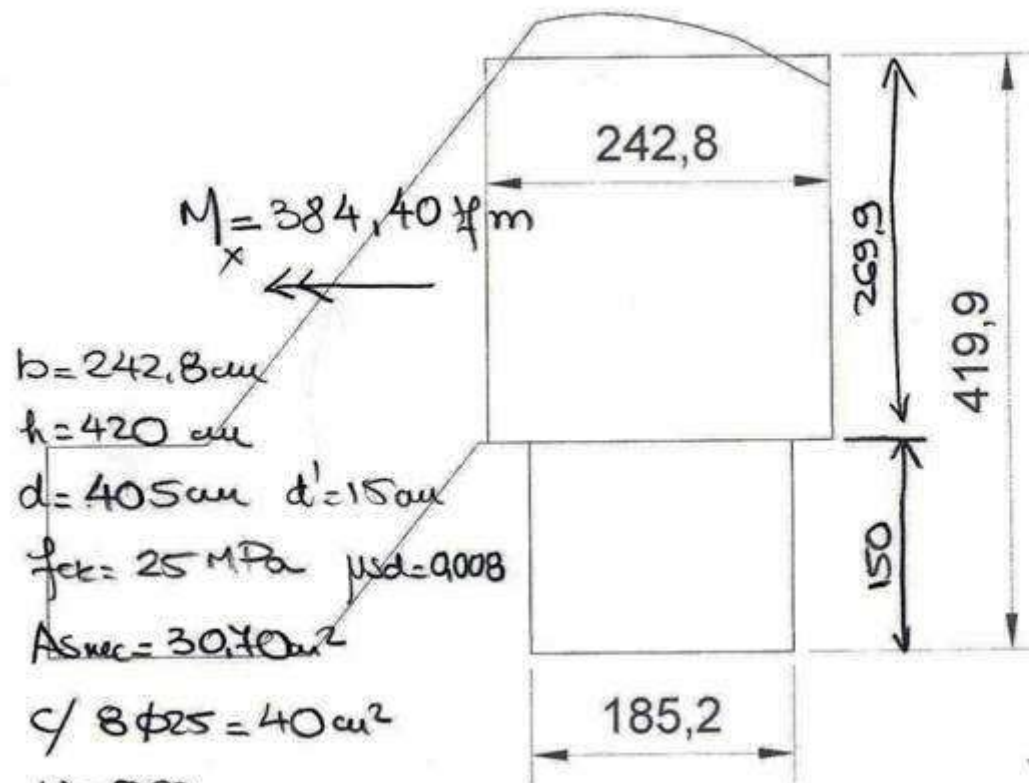
[illegible]

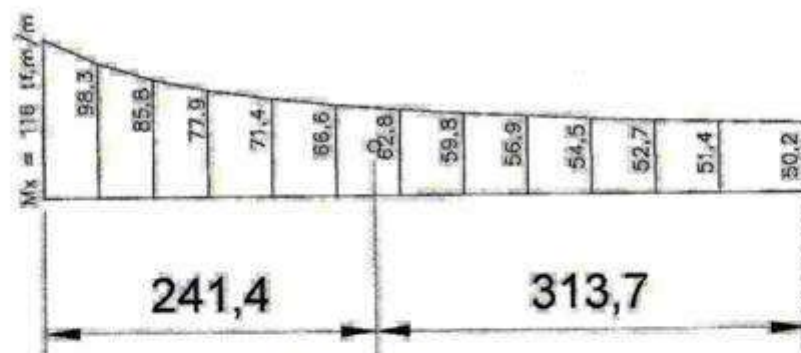
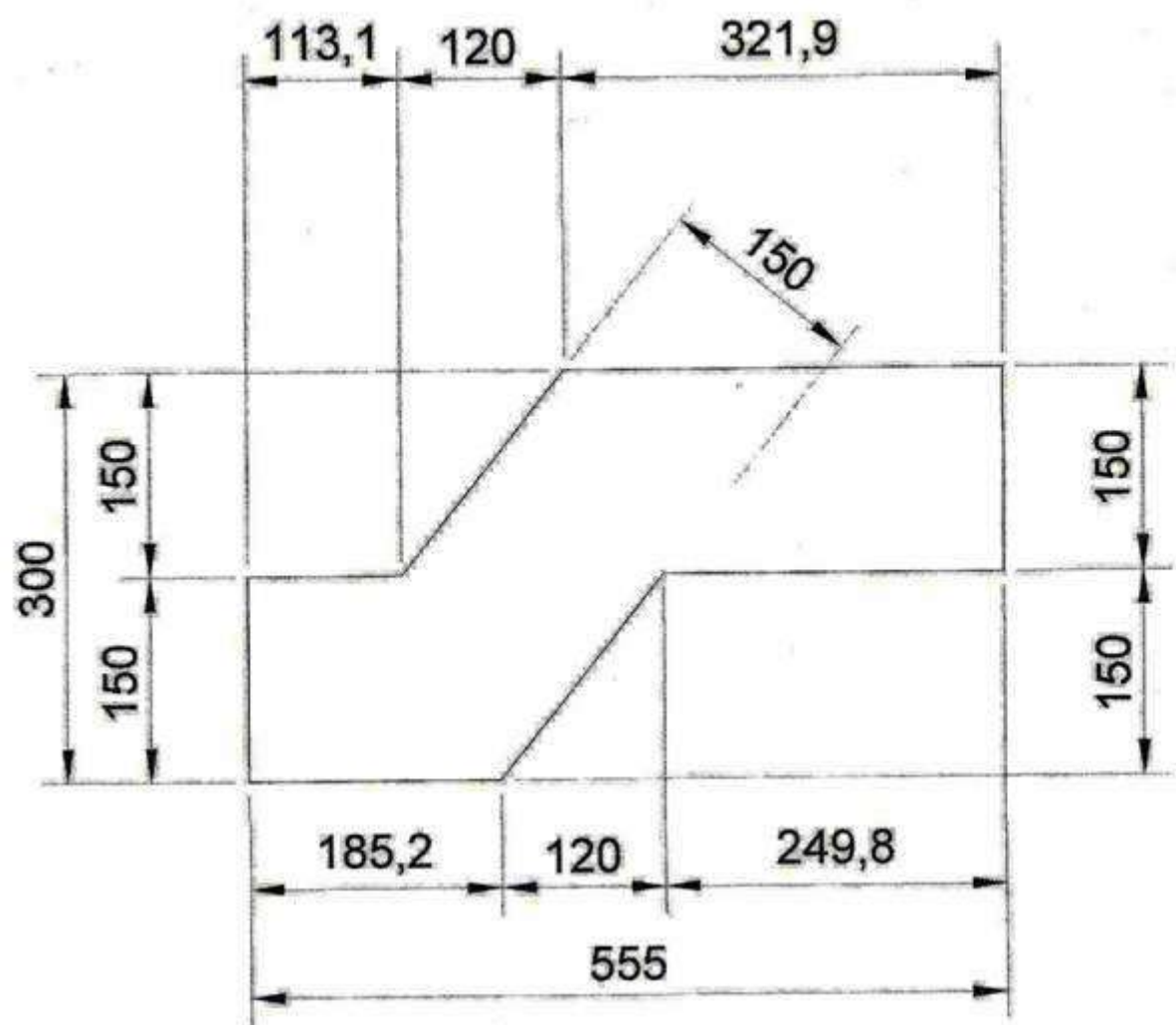
FILA D						FILA E						FILA F					
1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX	1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX	1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX
12,50	1,90	4,30	17,44	14,40	36,14	12,50	1,90	4,30	17,44	14,40	36,14	12,50	1,90	4,30	17,44	14,40	36,14
15,40	2,70	6,10	17,53	18,10	41,73	15,40	2,70	6,10	17,53	18,10	41,73	15,40	2,70	6,10	17,53	18,10	41,73
15,40	2,70	6,20	1,29	18,10	25,59	15,40	2,70	6,20	1,29	18,10	25,59	15,40	2,70	6,20	1,29	18,10	25,59
15,40	2,80	6,40	-0,32	18,20	24,28	15,40	2,80	6,40	-0,32	18,20	24,28	15,40	2,80	6,40	-0,32	18,20	24,28
15,40	2,80	6,40	0,10	18,20	24,70	15,40	2,80	6,40	0,10	18,20	24,70	15,40	2,80	6,40	0,10	18,20	24,70
15,40	2,70	6,20	0,01	18,10	24,31	15,40	2,70	6,20	0,01	18,10	24,31	15,40	2,70	6,20	0,01	18,10	24,31
15,40	2,70	6,10	0,01	18,10	24,21	15,40	2,70	6,10	0,01	18,10	24,21	15,40	2,70	6,10	0,01	18,10	24,21
12,50	1,90	4,30	-0,01	14,40	18,69	12,50	1,90	4,30	-0,01	14,40	18,69	12,50	1,90	4,30	-0,01	14,40	18,69
tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf

FILA A										FILA B						FILA C					
1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX	1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX	1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX				
1	12,50	1,90	4,30	17,44	14,40	36,14	12,50	1,90	4,30	17,44	18,70	36,14	12,50	1,90	4,30	17,44	14,40	36,14			
2	15,40	2,70	17,53	18,10	41,73	15,40	2,70	6,10	17,53	24,20	41,73	15,40	2,70	6,10	17,53	18,10	41,73				
3	15,40	2,70	1,29	18,10	25,59	15,40	2,70	6,20	1,29	24,30	25,59	15,40	2,70	6,20	1,29	18,10	25,59				
4	15,40	2,80	-0,32	18,20	24,28	15,40	2,80	6,40	-0,32	24,60	24,28	15,40	2,80	6,40	-0,32	18,20	24,28				
5	15,40	2,80	0,10	18,20	24,70	15,40	2,80	6,40	0,10	24,60	24,70	15,40	2,80	6,40	0,10	18,20	24,70				
6	15,40	2,70	0,01	18,10	24,31	15,40	2,70	6,20	0,01	24,30	24,31	15,40	2,70	6,20	0,01	18,10	24,31				
7	15,40	2,70	0,01	18,10	24,21	15,40	2,70	6,10	0,01	24,20	24,21	15,40	2,70	6,10	0,01	18,10	24,21				
8	12,50	1,90	4,30	-0,01	14,40	18,69	12,50	1,90	4,30	-0,01	18,70	18,69	12,50	1,90	4,30	-0,01	14,40	18,69			
	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf				

FILA D						FILA E						FILA F					
1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX	1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX	1ª FASE	2ª FASE	SC	TBMAX	MIN	MAX
12,50	1,90	4,30	17,44	14,40	36,14	12,50	1,90	4,30	17,44	14,40	36,14	12,50	1,90	4,30	17,44	14,40	36,14
15,40	2,70	6,10	17,53	18,10	41,73	15,40	2,70	6,10	17,53	18,10	41,73	15,40	2,70	6,10	17,53	18,10	41,73
15,40	2,70	6,20	1,29	18,10	25,59	15,40	2,70	6,20	1,29	18,10	25,59	15,40	2,70	6,20	1,29	18,10	25,59
15,40	2,80	6,40	-0,32	18,20	24,28	15,40	2,80	6,40	-0,32	18,20	24,28	15,40	2,80	6,40	-0,32	18,20	24,28
15,40	2,80	6,40	0,10	18,20	24,70	15,40	2,80	6,40	0,10	18,20	24,70	15,40	2,80	6,40	0,10	18,20	24,70
15,40	2,70	6,20	0,01	18,10	24,31	15,40	2,70	6,20	0,01	18,10	24,31	15,40	2,70	6,20	0,01	18,10	24,31
15,40	2,70	6,10	0,01	18,10	24,21	15,40	2,70	6,10	0,01	18,10	24,21	15,40	2,70	6,10	0,01	18,10	24,21
12,50	1,90	4,30	-0,01	14,40	18,69	12,50	1,90	4,30	-0,01	14,40	18,69	12,50	1,90	4,30	-0,01	14,40	18,69
tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf	tf

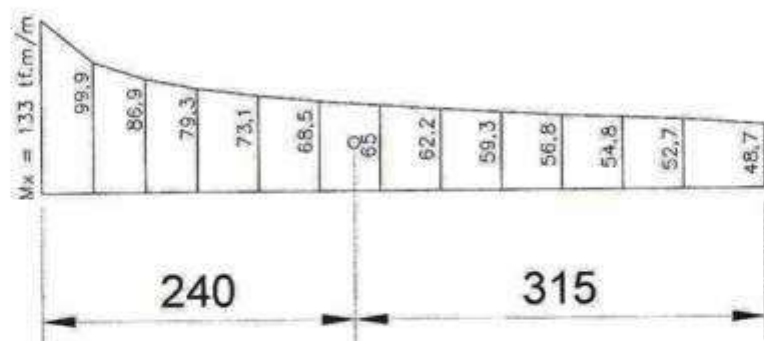
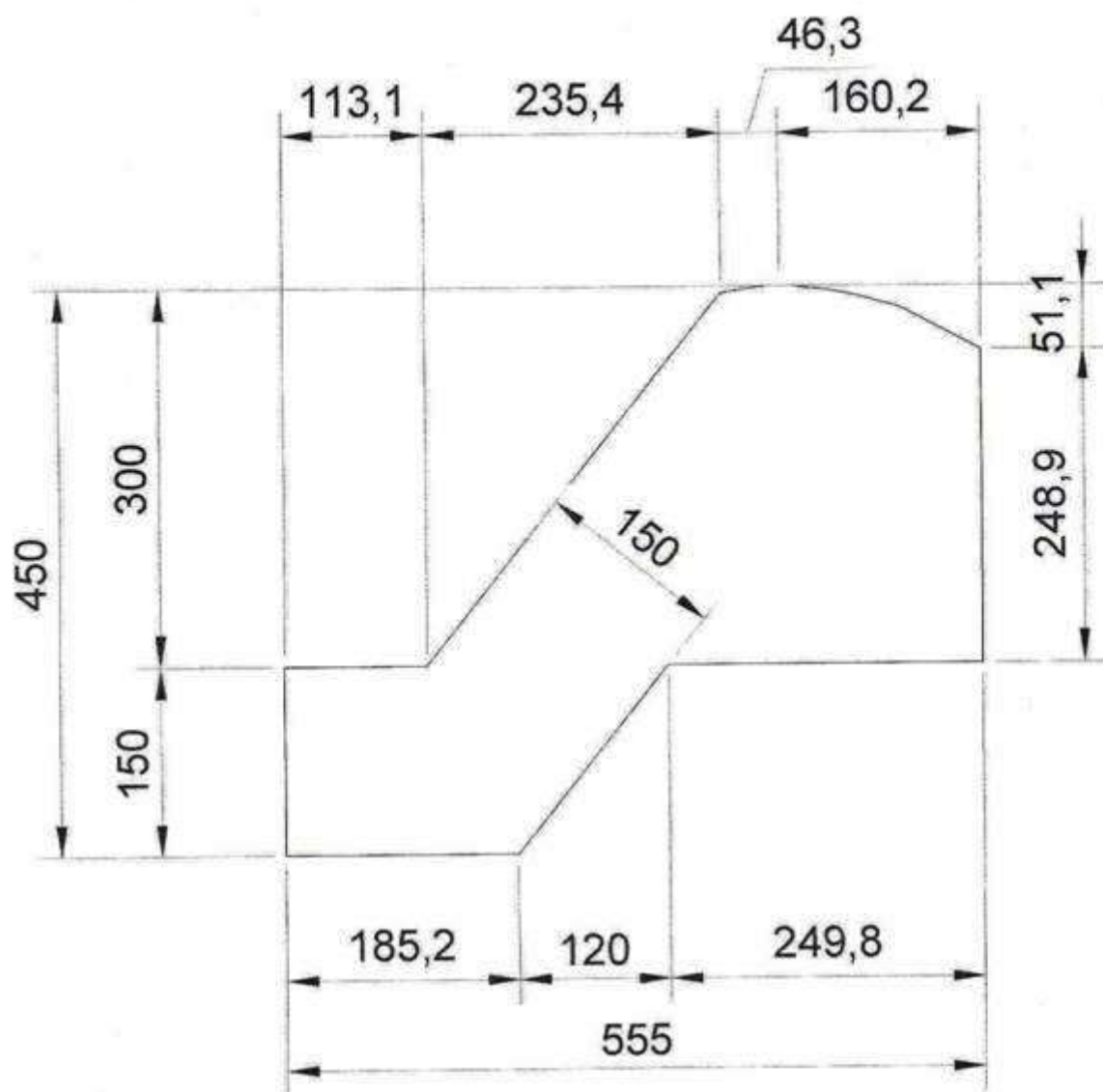






$$\bar{A}REA = 37.207,54 \text{ tf.m.cm/m}$$

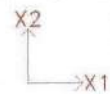
$$\bar{A}REA = 372,0754 \text{ tf.m}$$



$$\text{AREA} = 38.439,66 \text{ tf.m.cm/m}$$

$$\text{AREA} = 384,3966 \text{ tf.m}$$

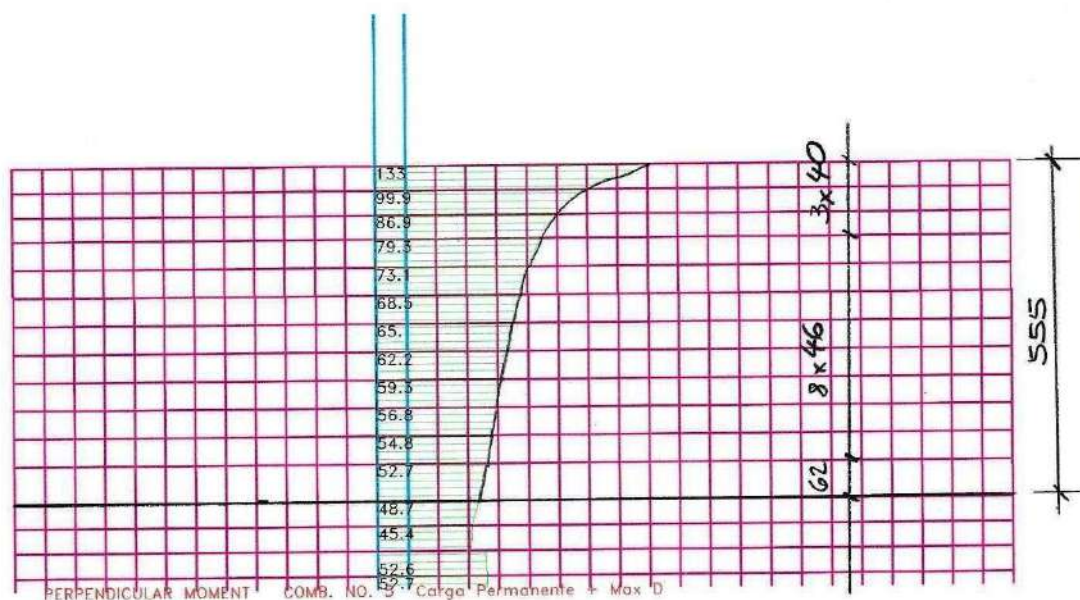
11-Laje de Vertedouro 02 k=5000 tf/m



SCALE = 1:100

UNITS: ton*m/m

DATE:23/12/16



$$Area = 38439,66 \frac{tf \cdot m}{m} \times cm$$

$$c/ M_x = 133 \text{ kgm/m}$$

$$b = 100 \text{ cm} \quad h = 150 \quad d = 135 \text{ cm} \quad f_{ek} = 25 \text{ MPa}$$

$$\mu_{sd} = 0,057 \quad A_{srec} = 32,87 \text{ cm}^2/\text{m} \quad A_{smin} = 22,5 \text{ cm}^2/\text{m}$$

$$c/ \phi 25 \text{ c} / 11,6 \text{ cm} \quad \omega = 0,30$$

$$c/ M_x = 133 \text{ kgm/m}$$

$$b = 100 \text{ cm} \quad h = 269,9 \quad d = 254,9 \quad f_{ek} = 25 \text{ MPa}$$

$$\mu_{sd} = 0,016 \quad A_{srec} = 16,9 \text{ cm}^2/\text{m}$$

$$A_{smin} = 22,5 \text{ cm}^2/\text{m}$$

$$c/ \phi 25 \text{ c} / 22,2 = 22,50 \text{ cm}^2/\text{m}$$

$$c/ M_x = 116 \text{ kgm/m}$$

$$b = 100 \text{ cm} \quad h = 150 \quad d = 135 \text{ cm} \quad f_{ek} = 25 \text{ MPa}$$

$$\mu_{sd} = 0,050 \quad A_{srec} = 28,53 \text{ cm}^2/\text{m}$$

$$c/ \phi 25 \text{ c} / 13,3 = 37,59 \text{ cm}^2/\text{m} \quad \omega = 0,30$$

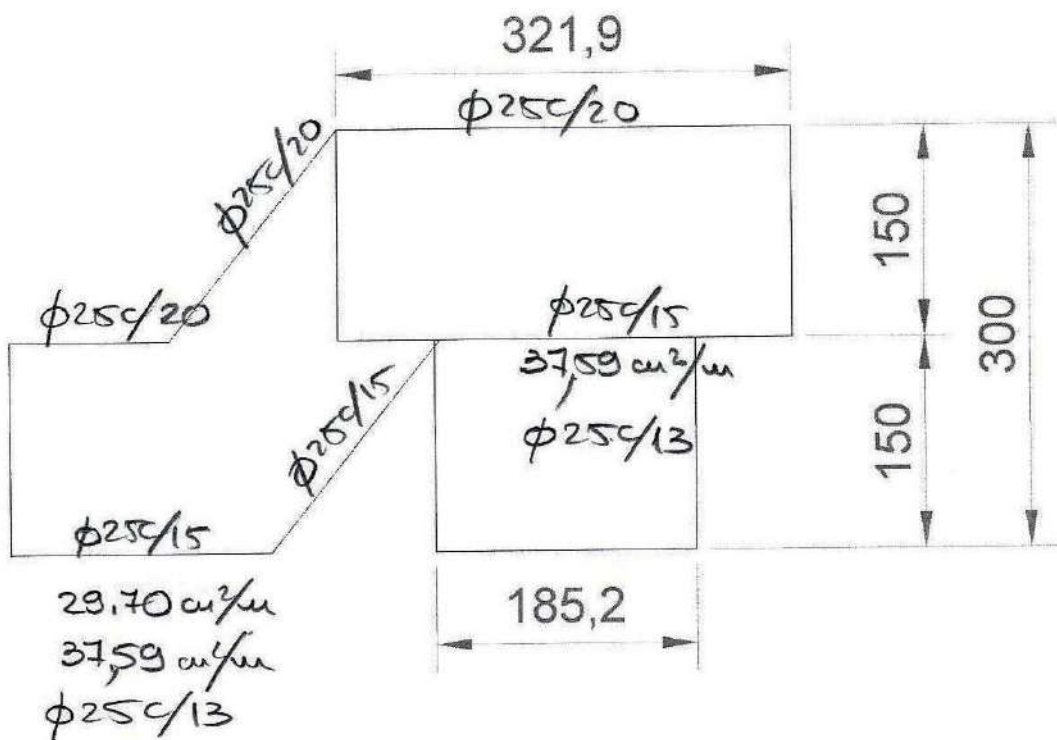
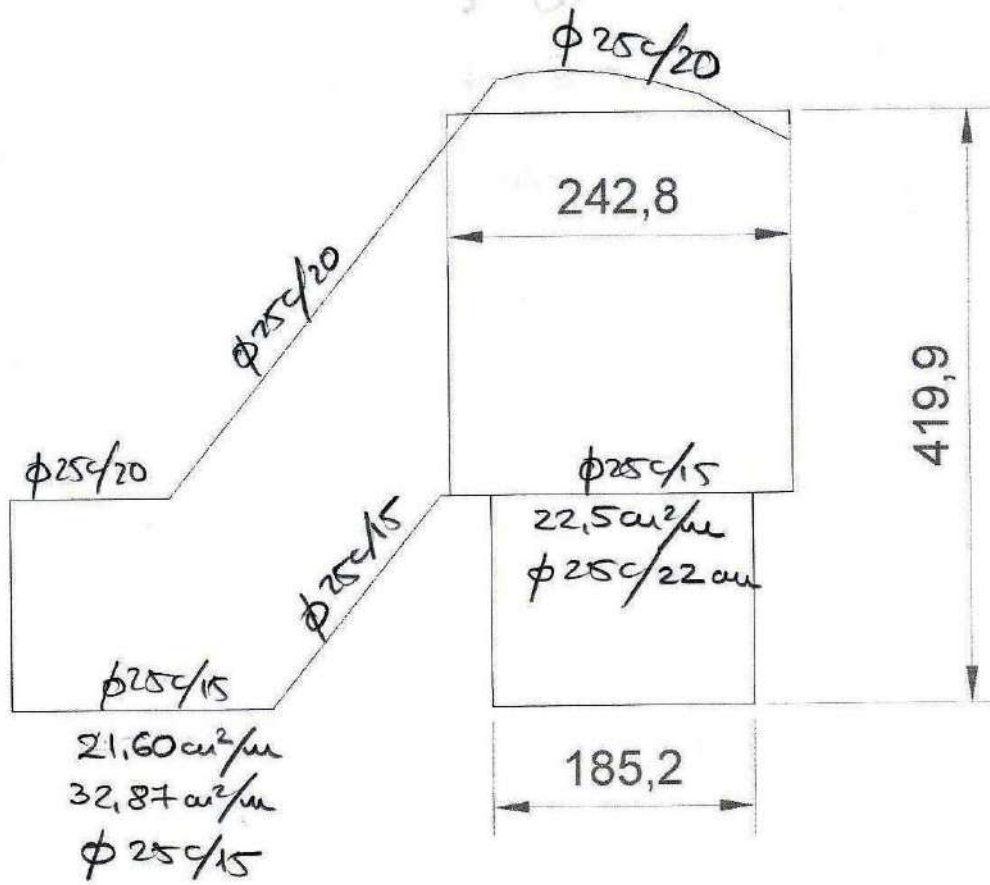
$$c/ M_x = 82 \text{ kgm/m} \quad (\text{traciona fibra superior})$$

$$b = 100 \text{ cm} \quad h = 150 \quad d = 135 \quad f_{ek} = 25 \text{ MPa}$$

$$\mu_{sd} = 0,035 \quad A_{srec} = 19,98 \text{ cm}^2/\text{m}$$

$$A_{smin} = 22,5 \text{ cm}^2/\text{m}$$

$$c/ \phi 25 \text{ c} / 19 \text{ cm} = 26,25 \text{ cm}^2/\text{m} \quad \phi 25 \text{ c} / 19 \text{ cm}$$



$$M_y = 20 \text{ kNm/m} \quad h = 150 \quad d = 135 \quad f_{ck} = 25 \text{ MPa}$$

$$\mu_{sd} = 0,009 \quad A_{s_{\text{req}}} = 4,79 \text{ cm}^2/\text{m}$$

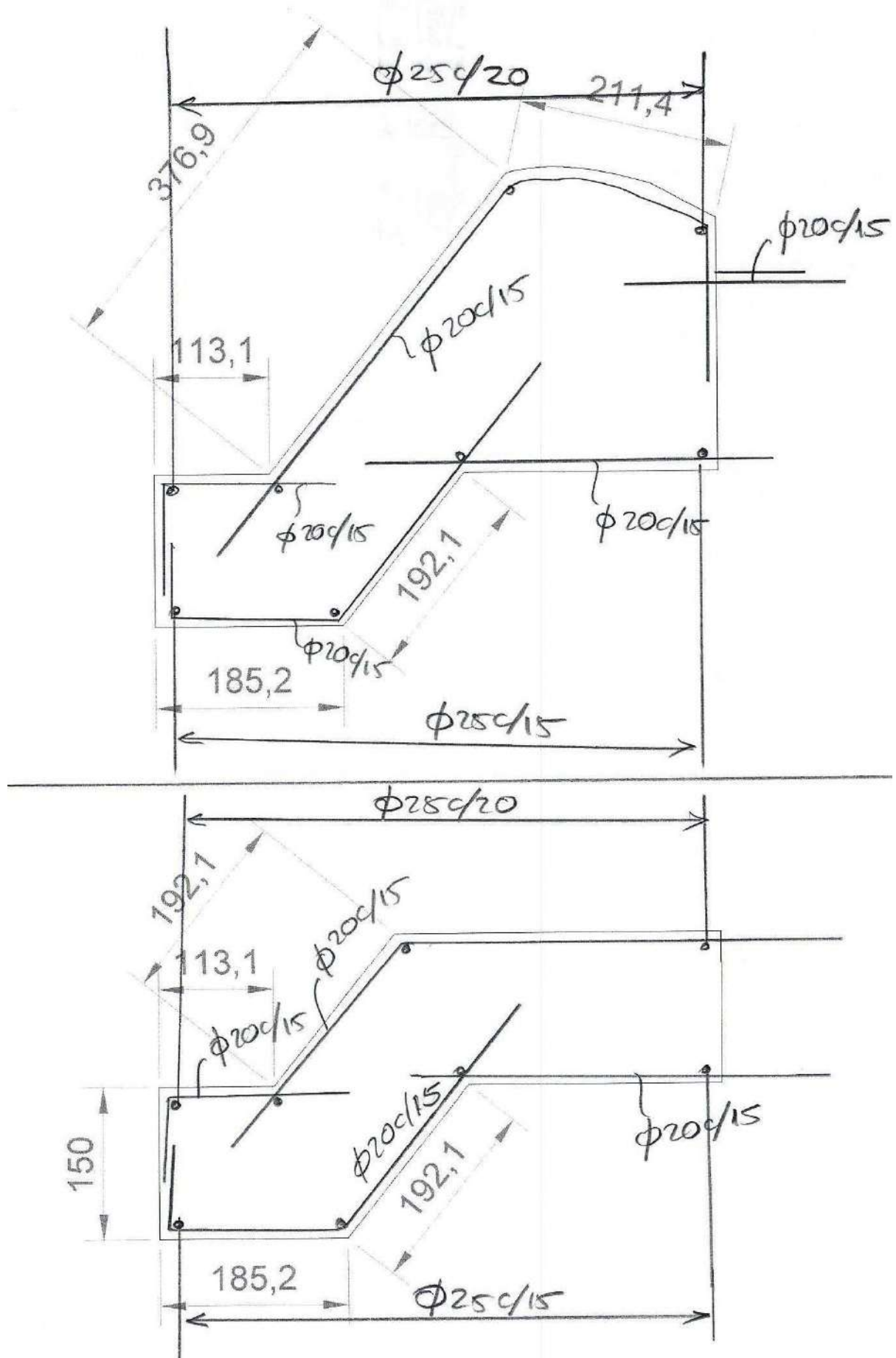
$$A_{s_{\text{min}}} = 0,15\% \cdot 100 \times 150 = 22,5 \text{ cm}^2/\text{m} \quad w = 0,02$$

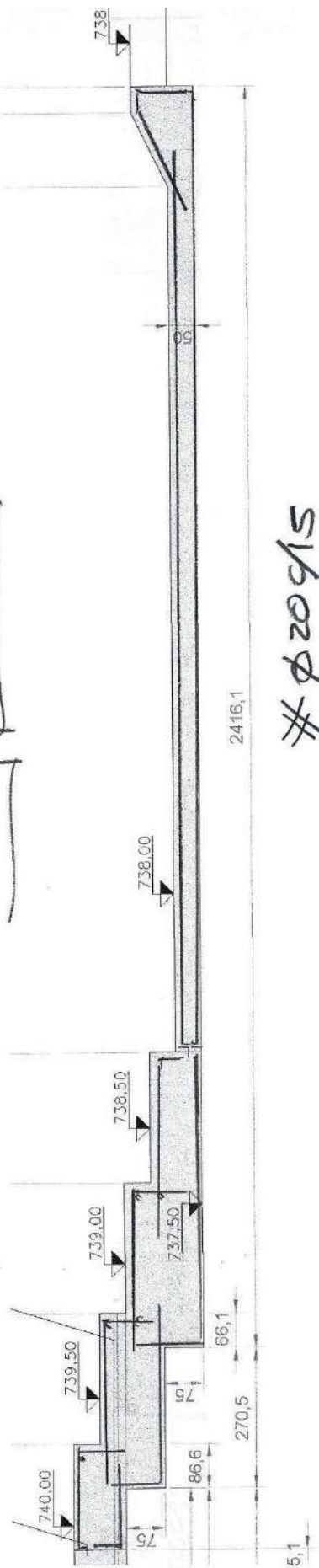
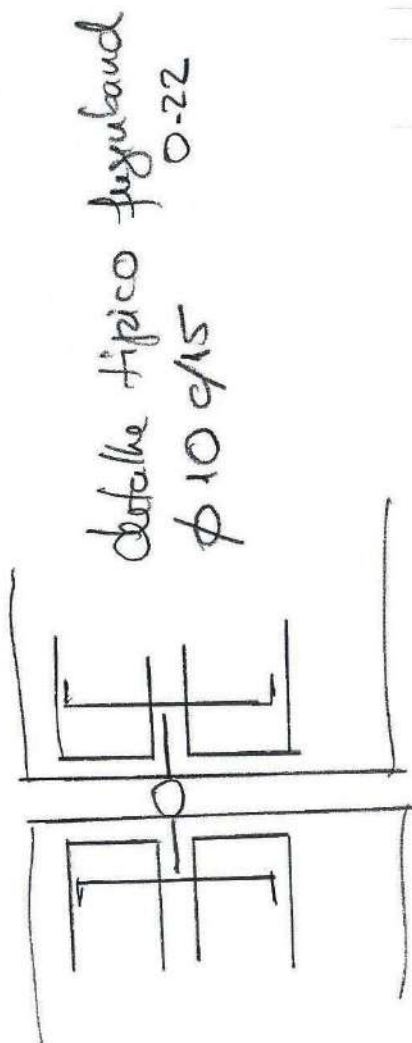
$$\phi 25 \text{ c}/22,5 \text{ cm}$$

$$\phi 20 \text{ c}/14 \text{ cm}$$

$$\text{procedimento thematic} \quad \phi 20 \text{ c}/15 \text{ cm}$$

$$\phi 25 \text{ c}/20 \text{ cm}$$





phi 20 c/15

4.2 Pilares

2 - ponte carregada

2.1 1/2 ponte o/ sobre carga 

$$P = 906,48 + 45 + 47,85 = 999,33 \text{ t}$$

$$M = 331,13 + 227,29 + 303,75 = 862,17 \text{ t/m}$$

TENSOES

$$\sigma = -\frac{999,33}{13,50 \times 10,55} \pm \frac{862,17 \times 6}{13,50 \times 10,55^2} = -7,02 \pm 3,64 \begin{cases} -3,37 \text{ t/m}^2 \\ -10,66 \text{ t/m}^2 \end{cases}$$

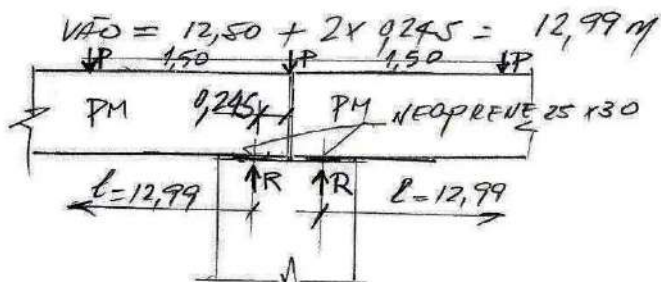
2.2 PONTE TOTALMENTE CARREGADA

$$P = 1047,18 \text{ t}$$

$$M = \overset{PP}{106,97} + \overset{SO}{119,63} + \overset{TT}{303,75} + \overset{RP ponte}{224,16} = 754,51 \text{ t/m}$$

$$\sigma = -\frac{1047,18}{13,50 \times 10,55} \pm \frac{754,51 \times 6}{13,50 \times 10,55^2} = -7,35 \pm 3,01 \begin{cases} -4,34 \\ -10,36 \end{cases}$$

REAÇÃO DO VEÍCULO



$$P = 6,04, \text{ pois é igual a } \frac{45,0 - 0,50 \times 3 \times 6}{6} \text{ , já que } \text{área do veículo}$$

CONSIDEROU-SE A CARGA DE MULTIDÃO ($0,504/m^2$) EM TODO TABULEIRO, INCLUSIVE NA PROJEÇÃO DO VEÍCULO.

$$R = \frac{60}{2} + 60 \times \frac{11,735}{12,99} = 8,42H$$

CONSIDERANDO-SE QUE SÃO 4R, POIS O VEÍCULO TEM 6 RODAS, E CONSIDERANDO-SE O COEFICIENTE ϕ' DE IMPACTO TEMOS:

REAÇÃO NO PILAR DEVIDO AO VEÍCULO É:

$$R_{TOT} = 4R \times \phi' = 4 \times 8,42 \times 1,67 = 56,25H$$

$$P = \frac{2 \times (2 \times 12,51 + 6 \times 15,40 + 2 \times 7,20 + 2 \times 10,20 + 2 \times 10,40 + 2 \times 10,70) + 56,25 + 23,25}{8,0}$$

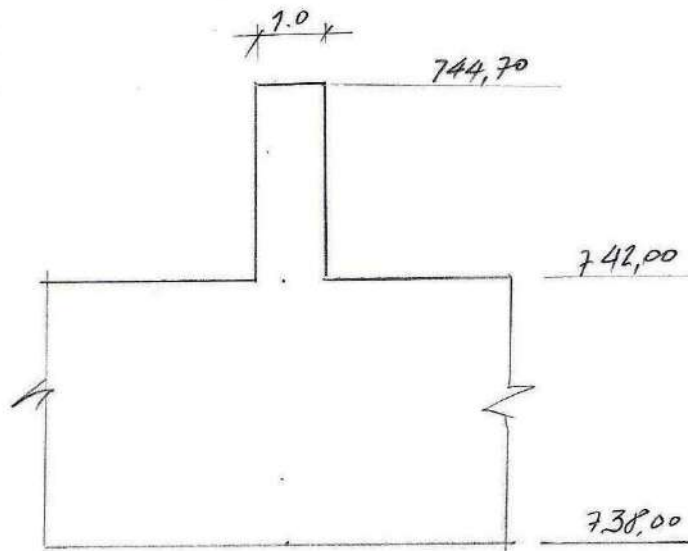
8,0
larg. do pilar

$$P = 58,54$$

CÁLCULO DO MOMENTO FLETOR NO Q DO PILAR

$$M_E = 2 \times (12,51 + 7,20) \times 6,51 - 2 \times (15,40 + 10,20) \times 4,65 - 2 \times (15,40 + 10,40) \times 2,79 - \\ - 2 \times (15,40 + 13,70) \times 0,93 - 28,13 \times 0,93 - (15,56 + 23,25 \times 4,0) \times \frac{4,0}{2}$$

$$M_E = -635,93 + 58,54 \times \frac{4,0^2}{2} = -167,61 \text{ kNm}$$



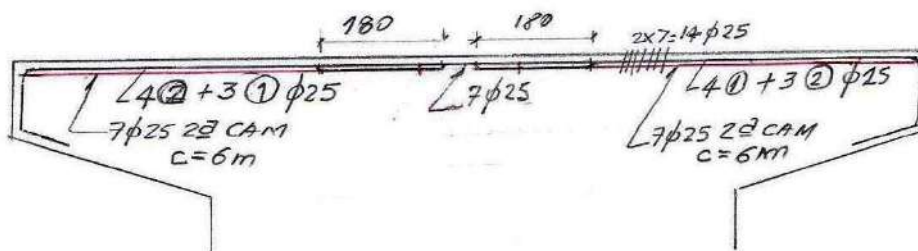
SEÇÃO TRANSV. AO FLUXO

TOMANDO-SE $d = 0,7 \times h = 0,7 \times 6,70 = 4,69 \text{ m}$

$$Z = \frac{167,61}{4,69} = 35,74 \text{ t} \quad \text{PI } \sigma_s = 2,0 \text{ t/cm}^2$$

$$A_s = \frac{35,74}{2,0} = 17,9 \text{ cm}^2$$

∴ MANTER 7φ25 AO LONGO DE TODA FACE SUPERIOR DO PILAR (DE BALANÇO A BALANÇO)



CISALHAMENTO

$$V = R_1 + R_2 + 1,05 \times 1,0 \times 2,5 \times 3,0 + 1,0 \times 1,0 \times 2,5 \times \frac{3,0}{2} =$$

$$V = 69,12 + 81,05 + 7,50 + 3,75 = 161,80 \text{ k}$$

CÁLCULO DA ARMADURA

- Redução $\frac{a}{2h}$

$$V = 69,12 + 81,05 \times \frac{0,64}{2 \times 1,84} + 6,81 = 90,03 \text{ k}$$

Adoto $\phi 16 \text{ c}/20$,
4 RAMOS ATE 1m

$\phi 12,5 \text{ c}/20$ 4R
no restante

$$V_{pp} = 1,05 \times 1,975 \times 1,0 \times 2,50 + 0,66 \times 1,975 \times 1,0 \times 2,5 \times 0,5 =$$

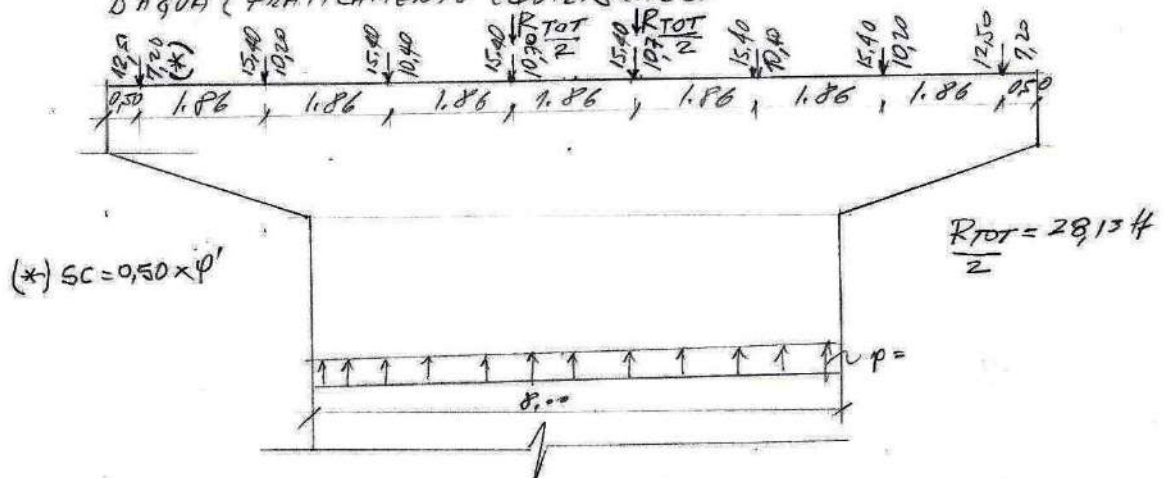
$$= 6,81 \text{ k}$$

PILAR CENTRAL

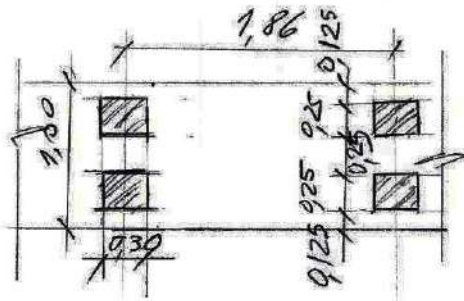
- AÇÕES :

PP; FREIAGEM; REAÇÕES DA; PONTE ROLOVIA; EMPUJO

D'ÁGUA (PRATICAMENTE EQUILIBRADO)



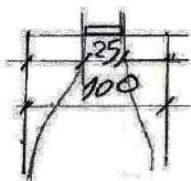
FRETAGEM NO PILAR



$$\sigma_{\max} = 100 \text{ kgf/cm}^2$$

$$N = 100 \times 25 \times 30 = 75000 \text{ kgf} = 75 \text{ tf}$$

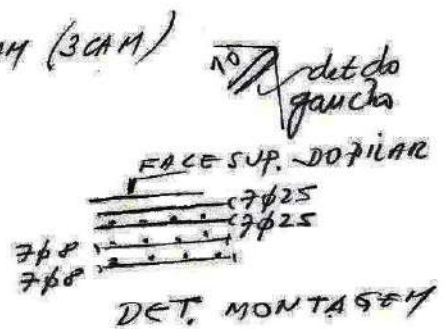
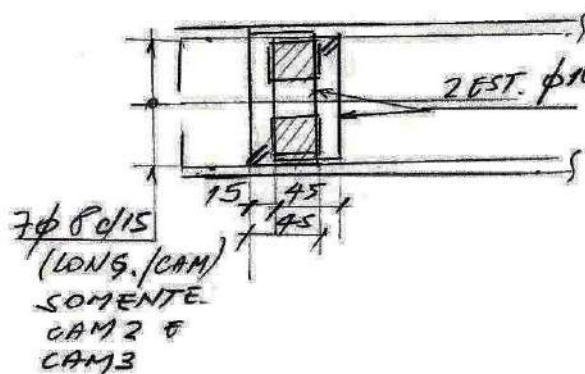
CONSIDERANDO 2N APLICADA NO EIXO DO PILAR
NA ÁREA DE 1 APARELHO 25X30

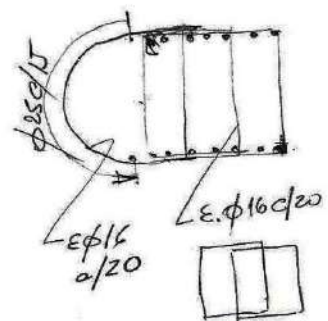
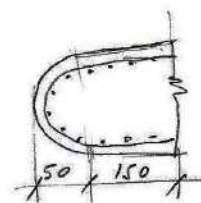
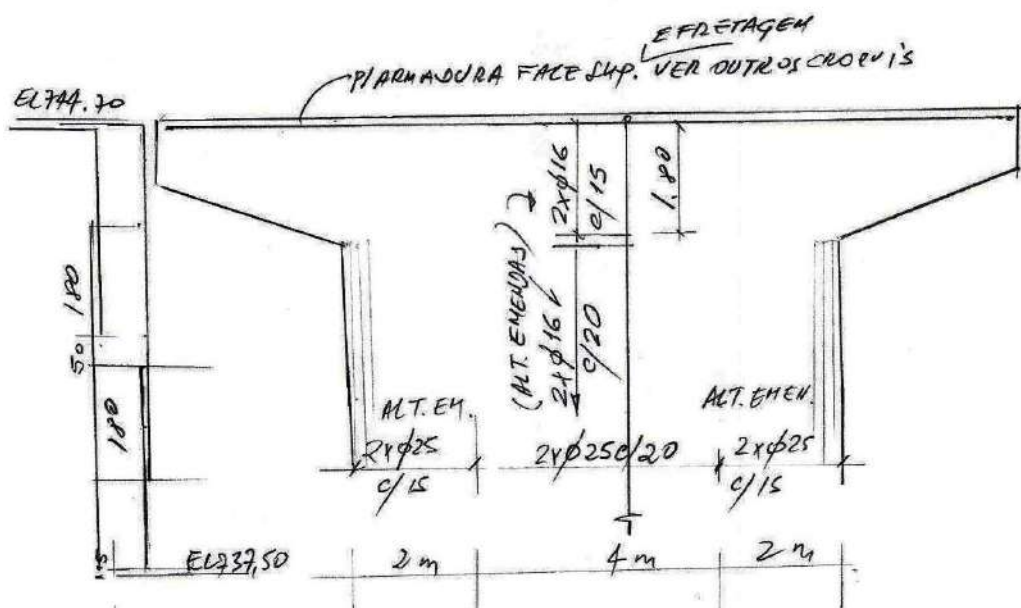


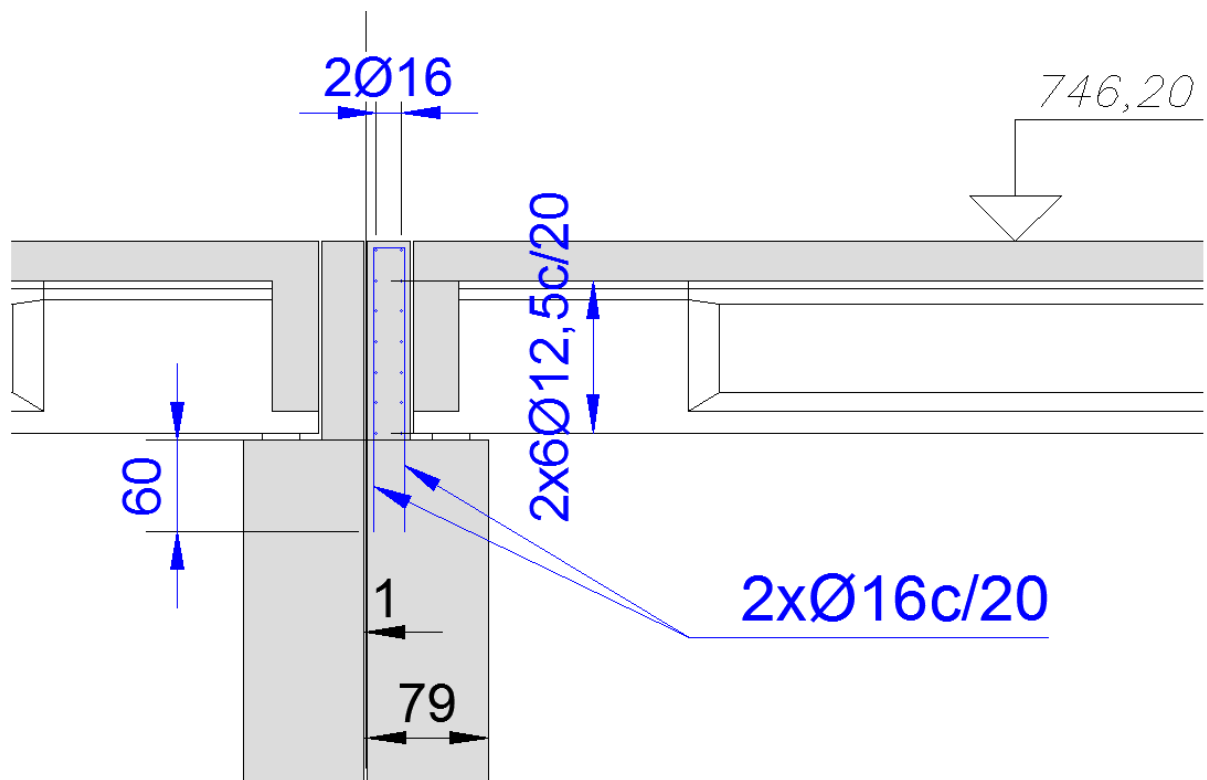
$$Z = 0,25 \times 2 \times 75 \left(1 - \frac{25}{100}\right) = 28,12 \text{ tf}$$

$$A_s = \frac{28,12}{30} = 9,4 \text{ cm}^2$$

ADOPTANDO-SE 3 CAM 3,1 cm²/CAM



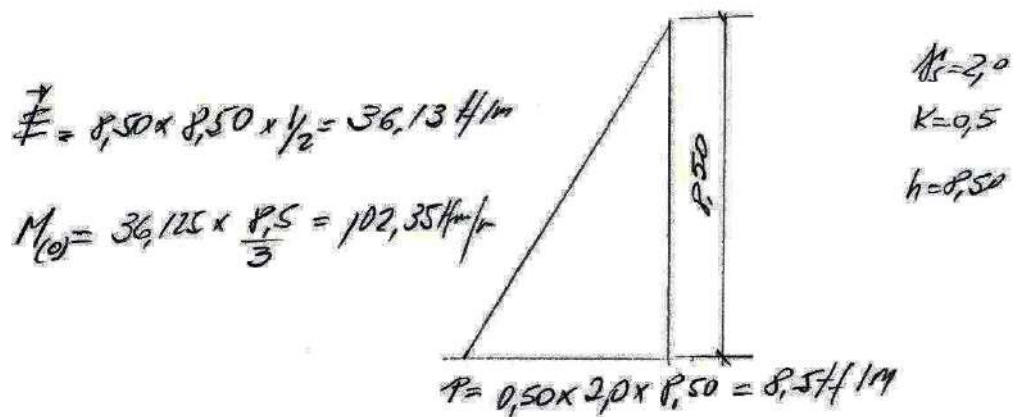




5 MUROS

5.1 Muro Direito Montante

EMPUXO DE SOLO



TENSOES

$$M_{(CS \text{ base})} = 135,17 + 192,78 - (47,73 + 42,0) \times 3,10 - 102,35 = -52,56 \text{ kNm}$$

$$\sigma = - \frac{-14,47}{1,0 \times 6,2} \pm \frac{52,56 \times 6}{1,0 \times 6,2^2} = \begin{cases} -6,3 \text{ kN/m}^2 \\ -22,67 \text{ kN/m}^2 \end{cases}$$

TOMBAMENTO (0)

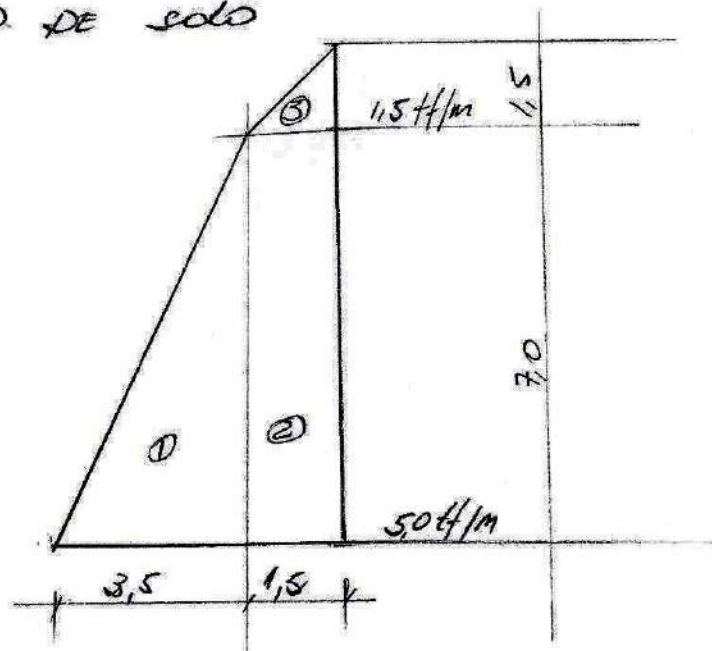
$$FST = \frac{135,17 + 192,78}{102,35} = 3,20 > 1,5 \text{ OK}$$

DESLOCAMENTO

$$FSD = \frac{(47,73 + 42,0)}{36,13} \times \frac{40}{1,5} = 1,34 > 1 \text{ OK}$$

$\phi_{\text{concreto (CCR)}} \times \text{concreto}$
 s/ considerar coesão

EMPUXO DE SOLO



$$\textcircled{1} \quad 3,5 \times 7,0 \times \frac{1}{2} = 12,25 \times \frac{7}{3} = 28,58$$

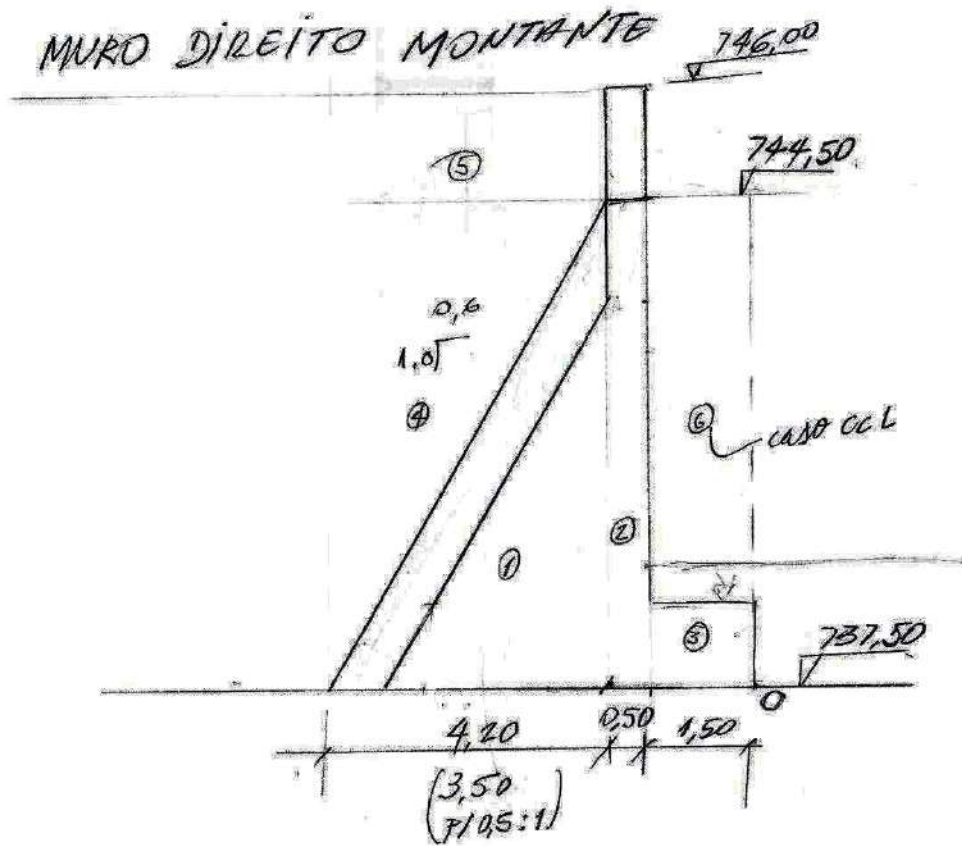
$$\textcircled{2} \quad 7 \times 1,5 = 10,50 \times \frac{7}{2} = 36,75$$

$$\textcircled{3} \quad 1,5 \times 1,5 \times \frac{1}{2} = 1,125 \times 7,5 = 8,44$$

28,58

73,77

*NOTA: EMPUXO DE ÁGUA OCORRE NAS 2 FACES DO MURO, ∴ = ZERO



ESTABILIDADE (S/A'GUA)

peso próprio

$$\begin{aligned}
 \textcircled{1} \quad & 4,2 \times 7,0 \times 0,50 = 14,70 \times 2,3 \times 3,4 = 114,95 \\
 \textcircled{2} \quad & 8,50 \times 0,50 = 4,25 \times 2,3 \times 1,70 = 17,11 \\
 \textcircled{3} \quad & 1,50 \times 1,20 = 1,80 \times 2,3 \times 0,75 = 3,10 \\
 & P = 47,73 \text{ t/m} \quad 135,17 \text{ t/m}
 \end{aligned}$$

peso solo (TALUDE)

$$\begin{aligned}
 \textcircled{1} \quad & 4,2 \times 7,0 \times 0,5 = 14,70 \times 2,0 = 29,40 \times 4,8 = 141,12 \\
 \textcircled{2} \quad & 4,2 \times 1,5 = 6,30 \times 2,0 = 12,60 \times 4,1 = 51,66 \\
 & P_s = 42,0 \text{ t/m} \quad 192,78 \text{ t/m}
 \end{aligned}$$

ALTERNATIVA 0,5:1

ESTABILIDADE (S/ ÁGUA)

peso próprio

$$\textcircled{1} = 3,5 \times 7,0 \times 0,50 = 12,25 \times 2,3 \times 3,167 = 89,23$$

$$\textcircled{2} =$$

$$\textcircled{3} =$$

$$\begin{array}{r} 17,11 \\ 3,10 \\ \hline P = 42,094 \quad 109,44 \end{array}$$

peso de coro

$$\textcircled{4} \quad 3,5 \times 7 \times 0,50 = 12,25 \times 2,0 = 24,50 \times 4,23 = 106,16$$

$$\textcircled{5} \quad 3,5 \times 1,5 = 5,25 \times 2 = 10,50 \times 2,75 = 38,38$$

$$25,0$$

$$145,54$$

TENSOES

$$\begin{aligned} M_{CG} &= 109,44 + 145,54 - (42,09 + 35,0) \times 2,75 = 102,35 \\ &= 59,37 \text{ t/m/m} \end{aligned}$$

$$\sigma = - \frac{77,09}{5,50} \pm \frac{59,37 \times 6}{1,1 \times 5,5^2} = \begin{pmatrix} -14,02 & \pm 11,78 \\ -25,80 & -2,24 \end{pmatrix}$$

$$FST = \frac{109,44 + 145,54}{102,35} = 2,49 > 1,5 \text{ OK}$$

$$FSD = \frac{(42,09 + 35,0) \times 1,40^0 / 1,1}{36,13} = 1,19 > 1,0 \text{ OK}$$

CASO LIMITE (CCL)

$$NANMA' = 744,50$$

PESO DE SOLO

④ Altera p_i $f_{s,sub} = 1,0$

$$12,25 \times 1,0 = 12,25 \times 4,33 = 53,04$$

$$\textcircled{5} \text{ permanece } \frac{10,50 \times 3,75}{22,75} = \frac{39,38}{92,42}$$

PESO D'ÁGUA

$$\text{IDEM, } \textcircled{4} \quad 12,25 \times 4,33 = 53,04$$

$$\textcircled{6} \quad 1,5 \times 5,80 \times 1,0 = 8,70 \times 0,75 = 6,52$$
$$\frac{20,95}{59,56}$$

SUPRESSÃO

$$S = 7,0 \times 5,50 \times 1,0 = \frac{38,50}{2} \times \frac{5,50}{2} = 105,88$$

TENJÕES

$$M(cg\text{ base}) = 109,44 + 92,42 + 59,56 - 105,88 - 73,77$$
$$- (42,09 + 22,75 + 20,95 - 38,50) \times 3,75 =$$
$$= -48,27 \text{ tfm/m}$$

$$V = -\frac{47,29}{5,50} \pm \frac{48,27 \times 6}{1,0 \times 5,5^2} \begin{cases} + 9,97 \text{ t/m}^2 \\ -8,60 + 9,57 \\ -8,60 - 9,57 \\ -18,17 \text{ t/m}^2 \end{cases}$$

$$e = \frac{48,27}{47,29} = 1,02$$

$$a = \left(\frac{5,5}{2} - 1,02 \right) \times 3 = 5,19 \quad \left(\begin{array}{l} 4,31 \text{ m de} \\ \text{trilha} \\ \text{OK} \end{array} \right)$$

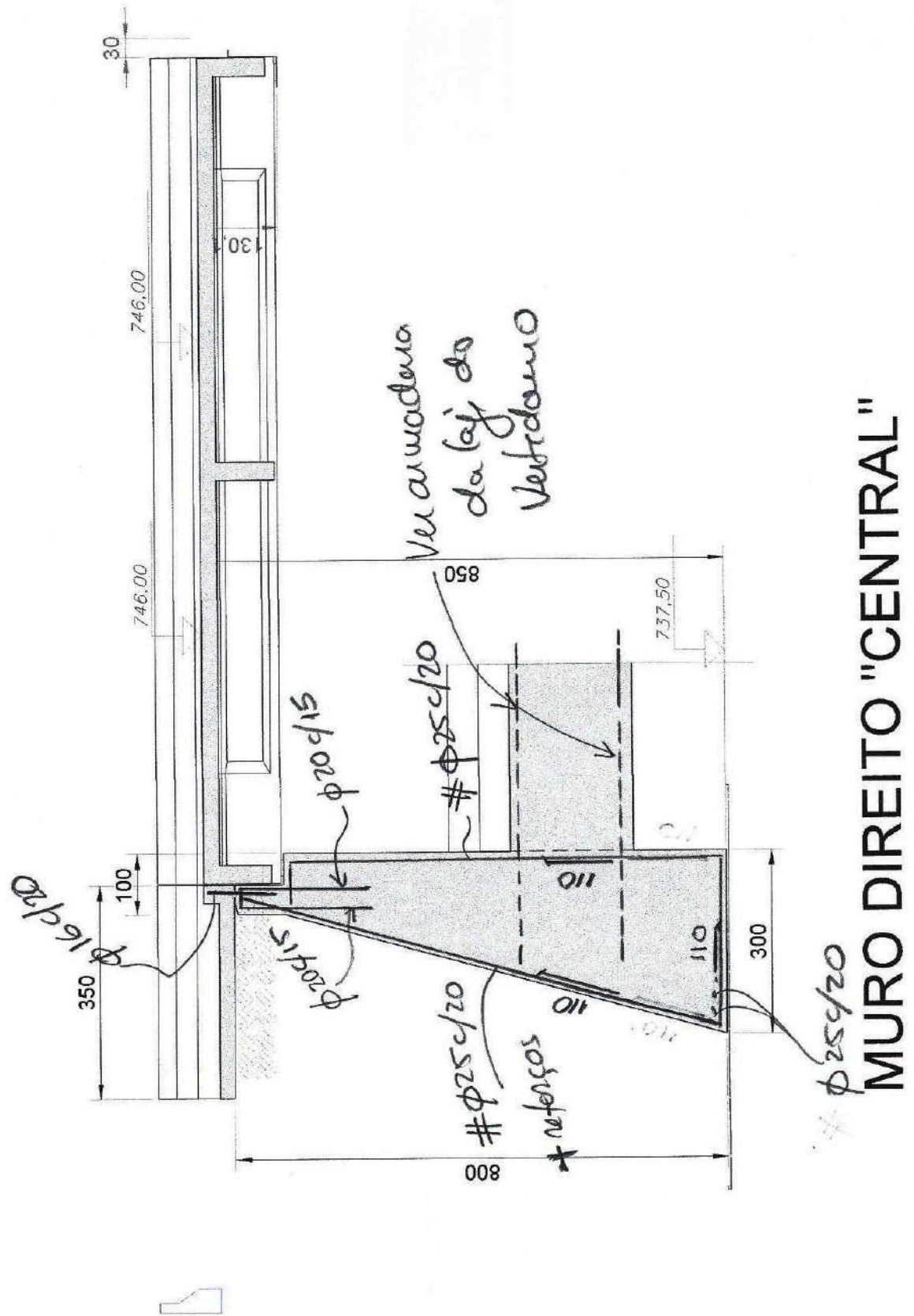
$$\sigma_{\max} = \frac{2N}{a} = \frac{2 \times 47,29}{5,19} = -18,22 \text{ t/m}^2 \quad \text{OK}$$

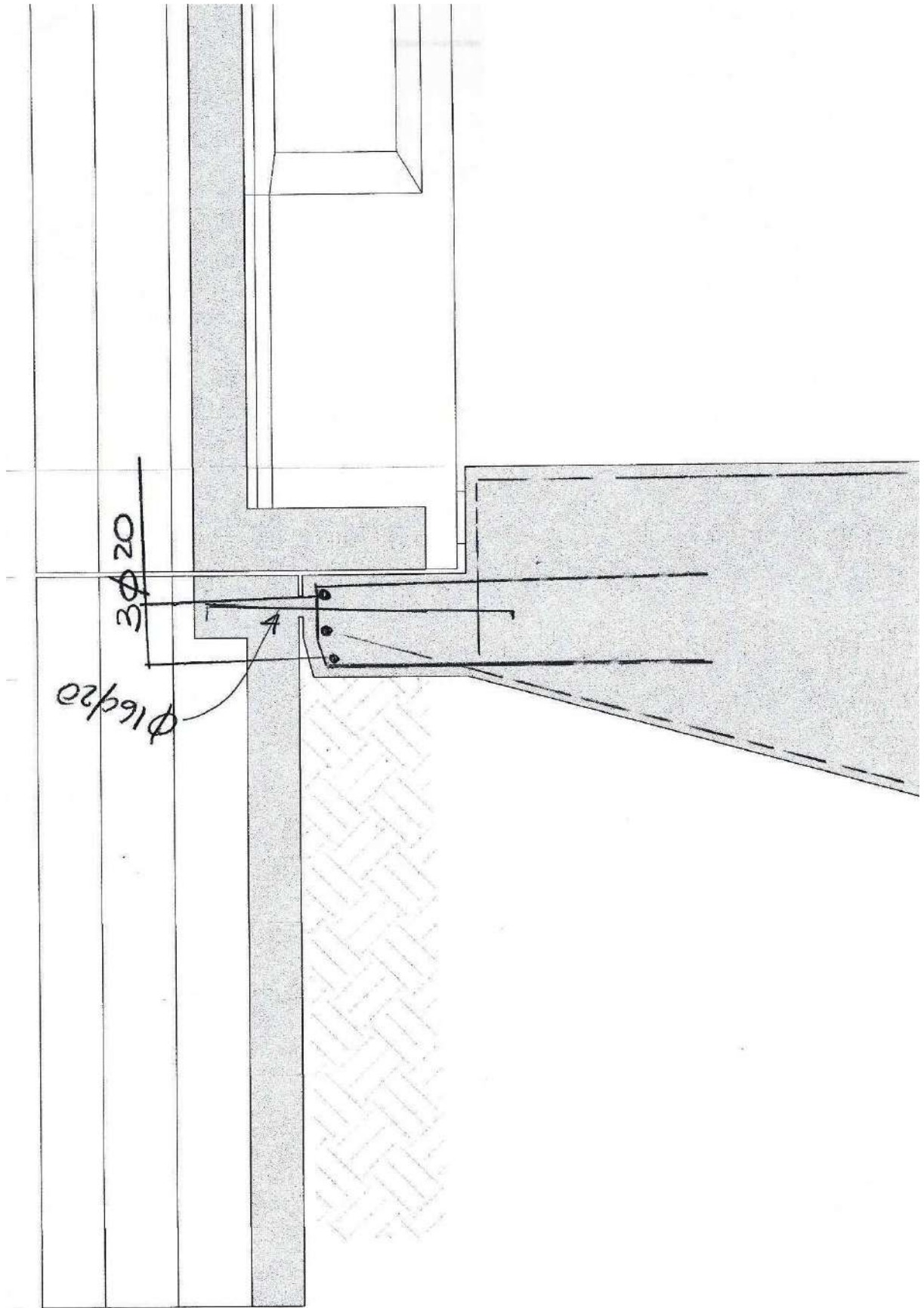
$$FST = \frac{109,44 + 92,42}{73,77 + 105,88 - 59,50} = 1,68 \quad \text{OK} > 1,2$$

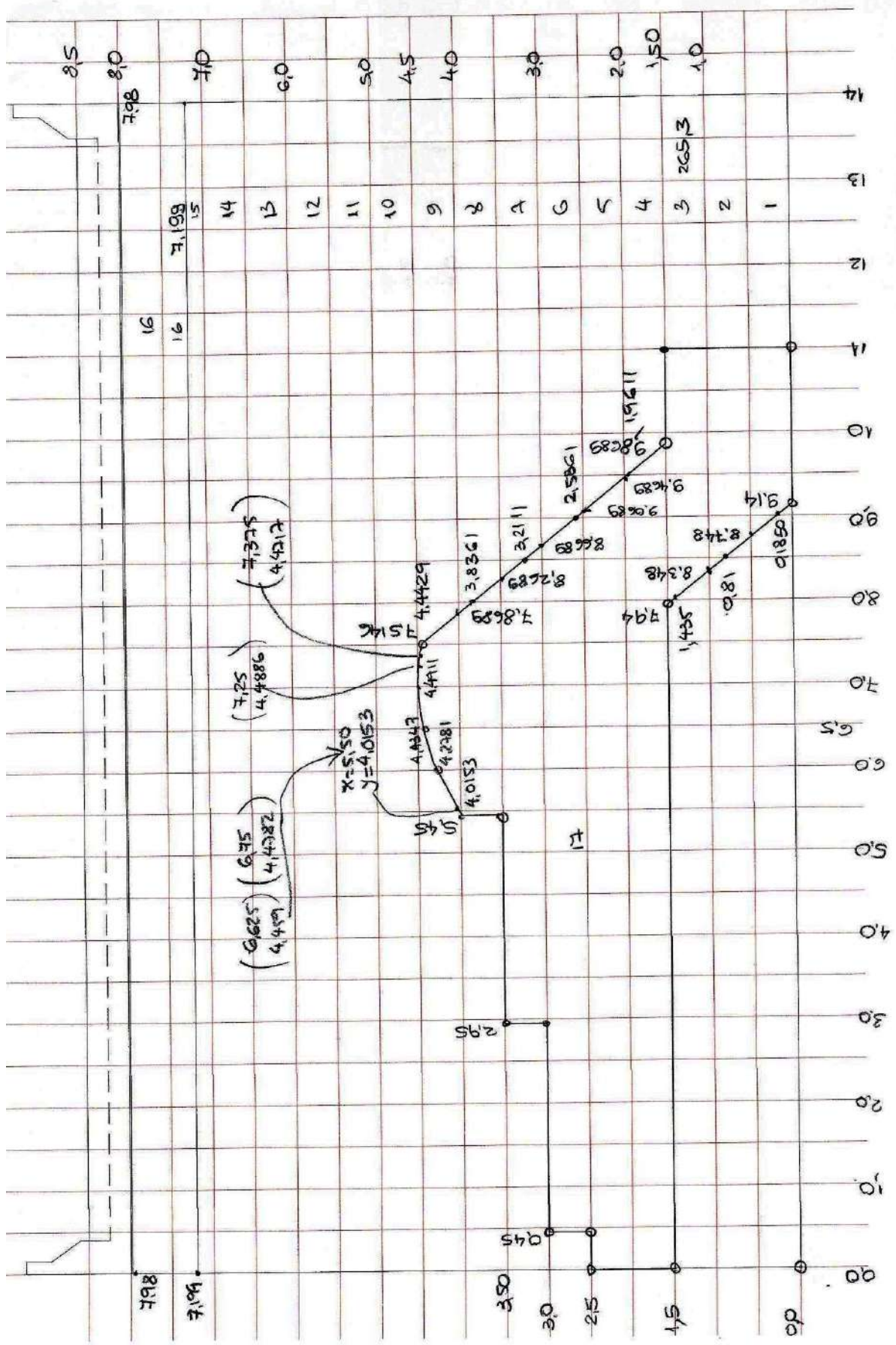
$$FSD = \frac{(42,09 + 22,75 + 20,95 - 38,50) \times 40 / 1,1}{23,88} = 2,74 > 1,0 \quad \text{OK}$$

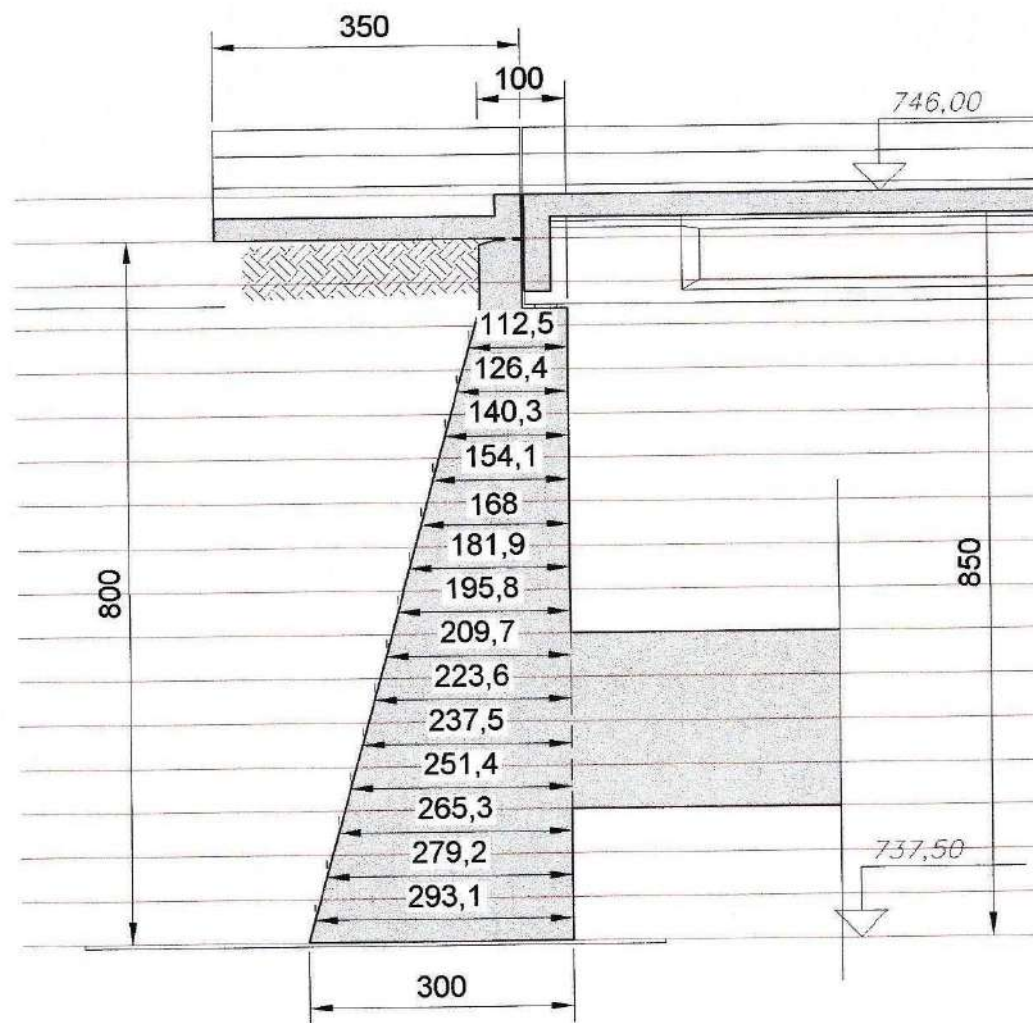
$$FSF = \frac{42,09 + 22,75}{38,50 - 20,95} = 3,69 \quad \text{OK} > 1,1$$

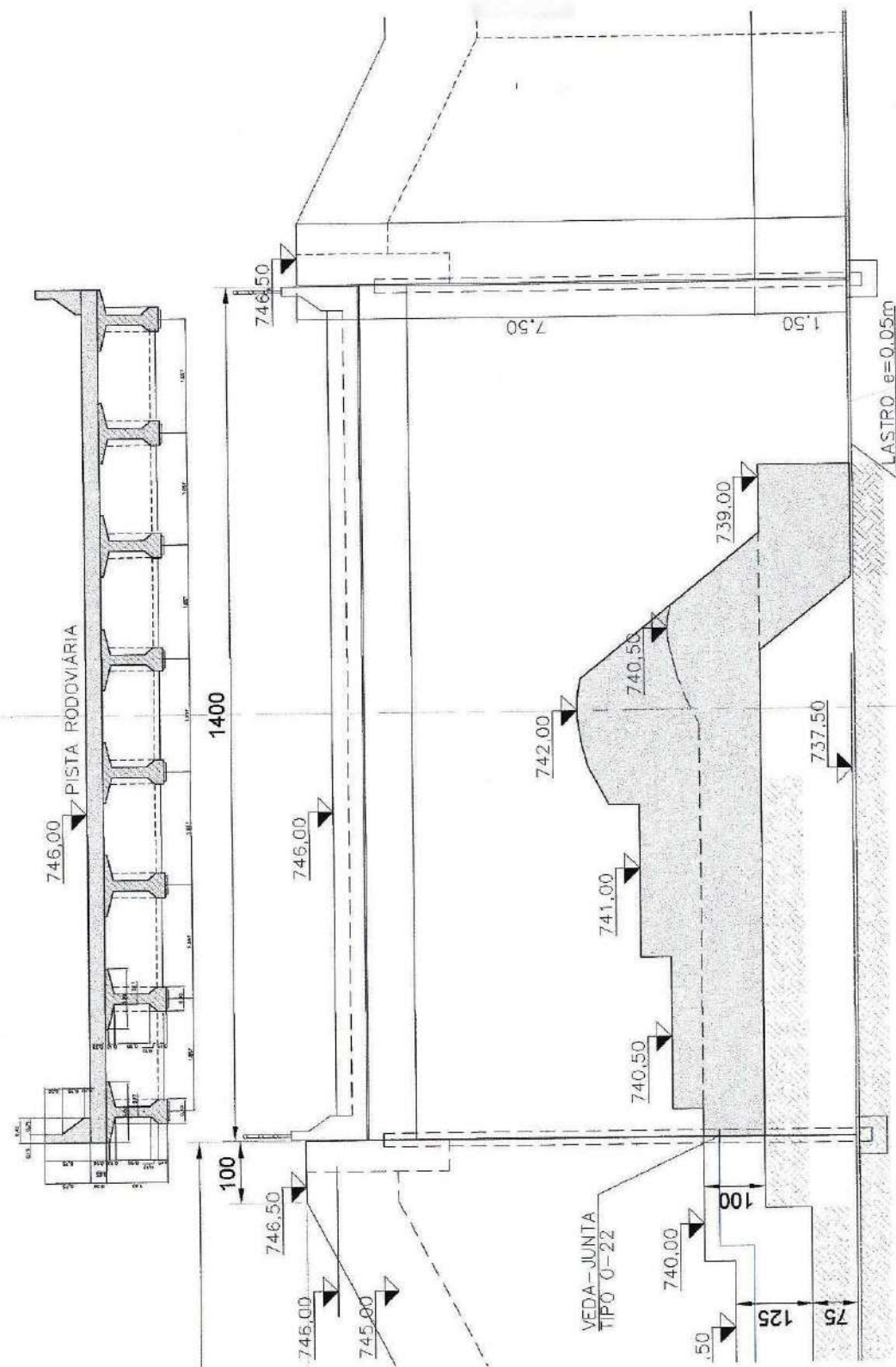
5.2 Muro Direito Central











VISTA FRONT
ESC. 1:50

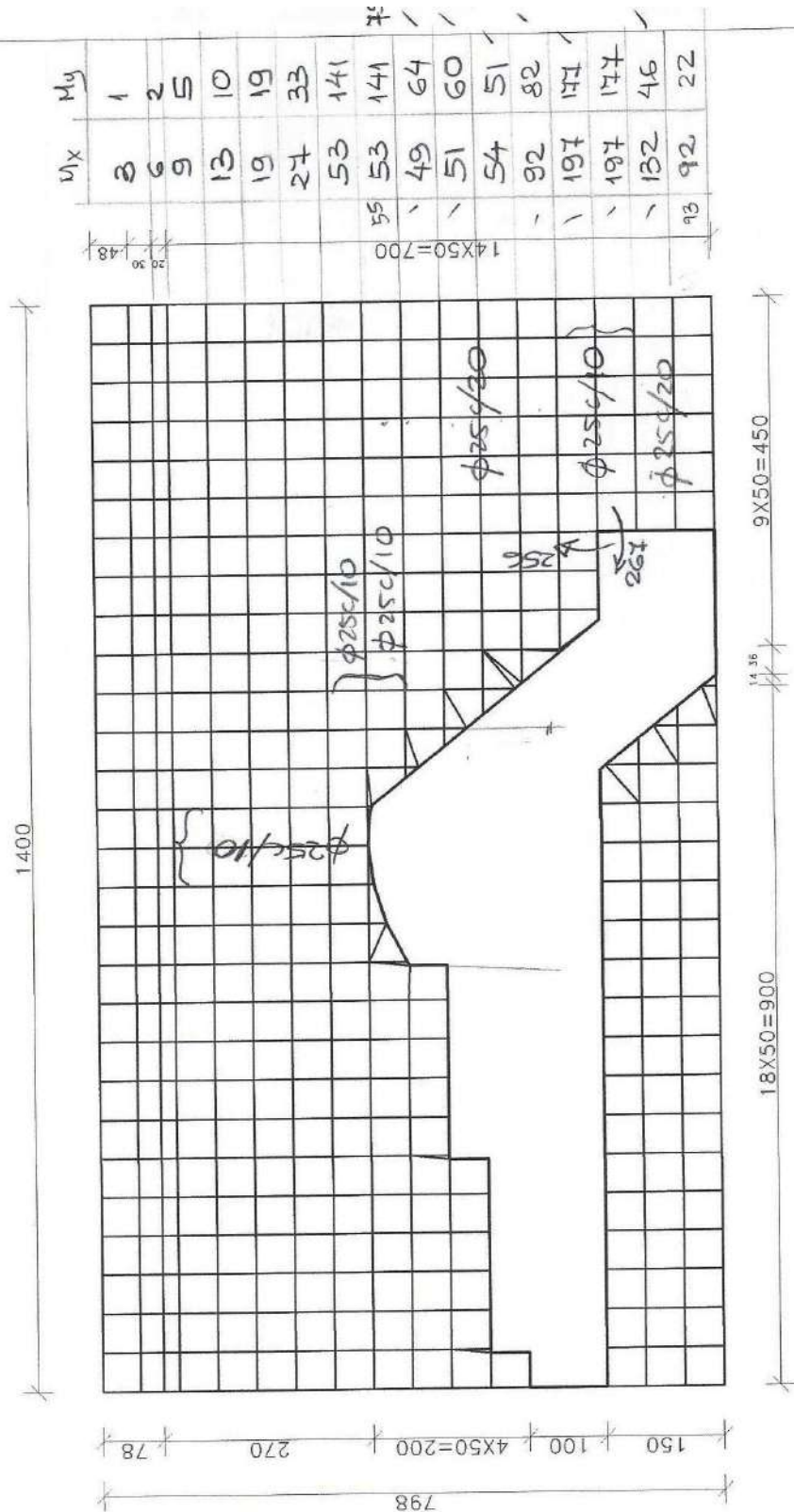
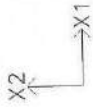
MURO DIREITO "CENTRAL"

21-Muro Direito Central - grid

View: geometria

SCALE = 1:75

DATE:08/03/17

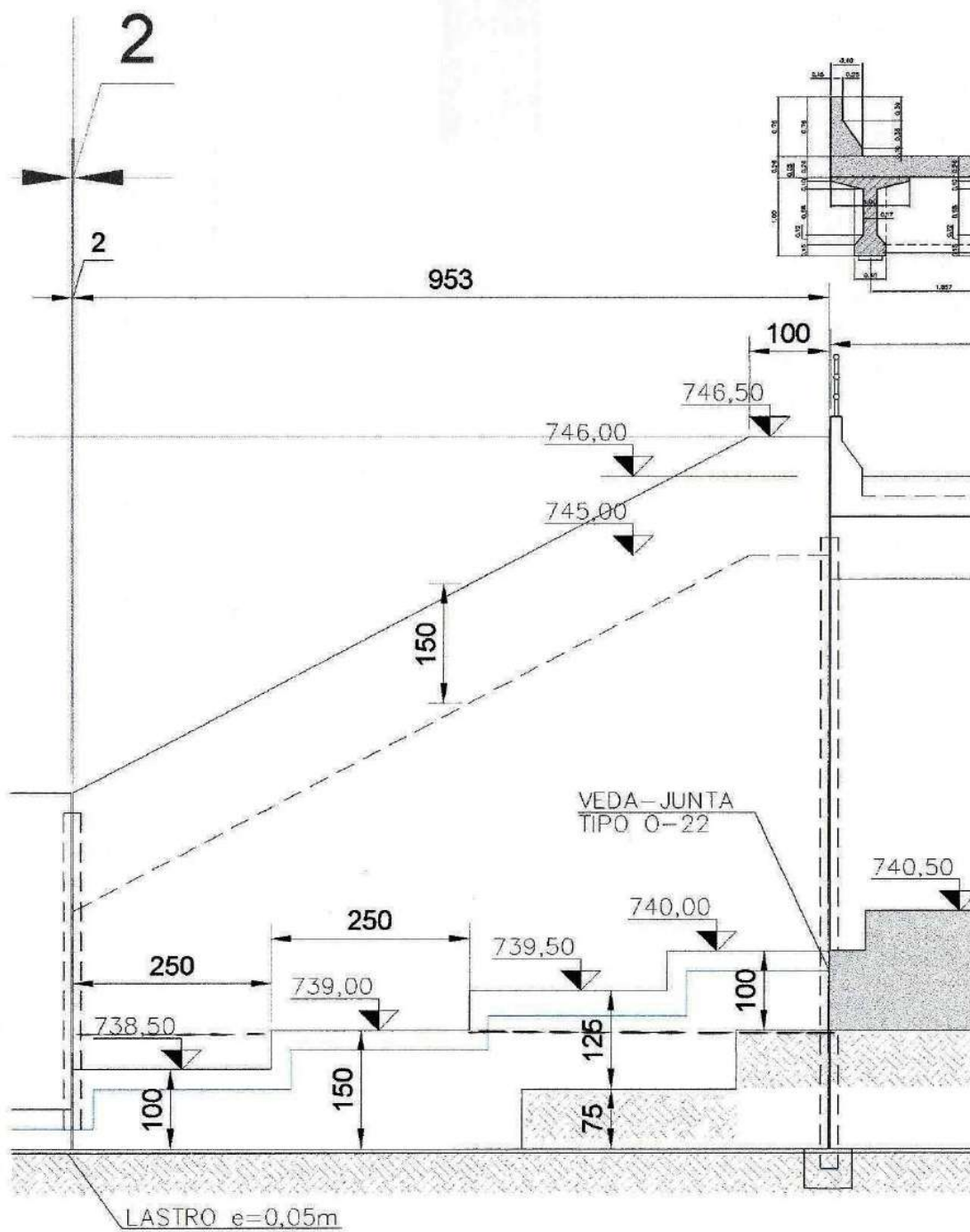


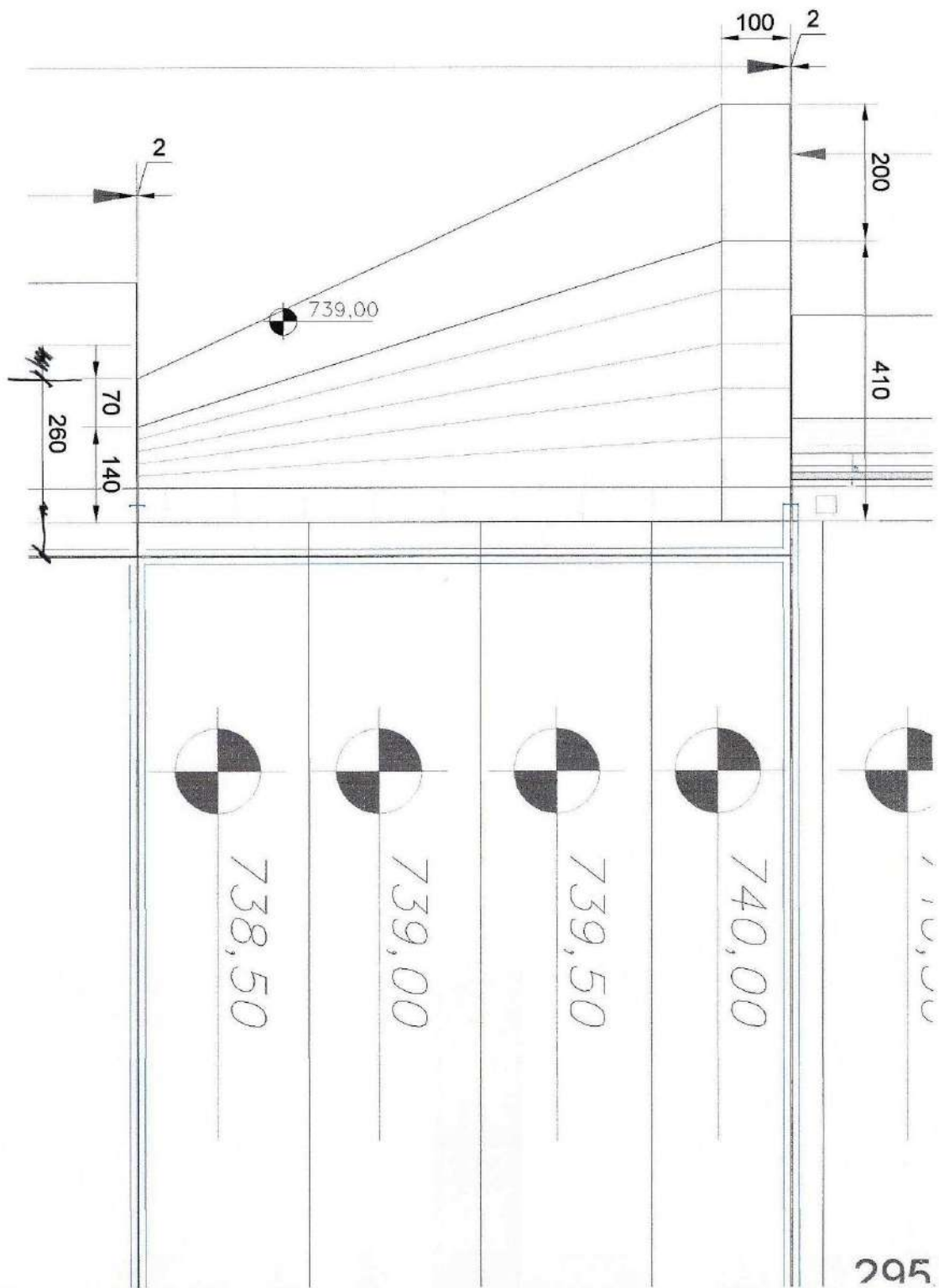
	Mx	My	M	2xM	h	d	b	As	0,15%Ac	Aswlc
16	3	1	3	6	51	41	100	4,81	7,65	M
15	6	2	6	12	100	90	100	4,33	15,00	2,38
14	9	5	9	18	112,5	102,5	100	5,71	16,88	2,16
13	13	10	13	26	126,4	116,4	100	7,27	18,96	2,84
12	19	19	19	38	140,3	130,3	100	9,52	21,05	3,62
11	27	33	33	66	154,1	144,1	100	15,03	23,12	4,73
10	53	141	141	282	168	158	100	61,80	25,20	7,44
9	53	141	141	282	181,9	171,9	100	56,10	27,29	29,74
8	49	64	64	128	195,8	185,8	100	22,68	29,37	27,18
7	51	60	60	120	209,7	199,7	100	19,70	31,46	11,21
6	54	51	54	108	223,6	213,6	100	16,51	33,54	9,76
5	92	82	92	184	237,5	227,5	100	26,60	35,63	8,20
4	197	177	197	394	251,4	241,4	100	54,78	37,71	13,16
3	197	177	197	394	265,3	255,3	100	51,56	39,80	26,81
2	132	46	132	264	279,2	269,2	100	32,27	41,88	25,30
1	92	22	92	184	293,1	283,1	100	21,21	43,97	15,96
										10,53

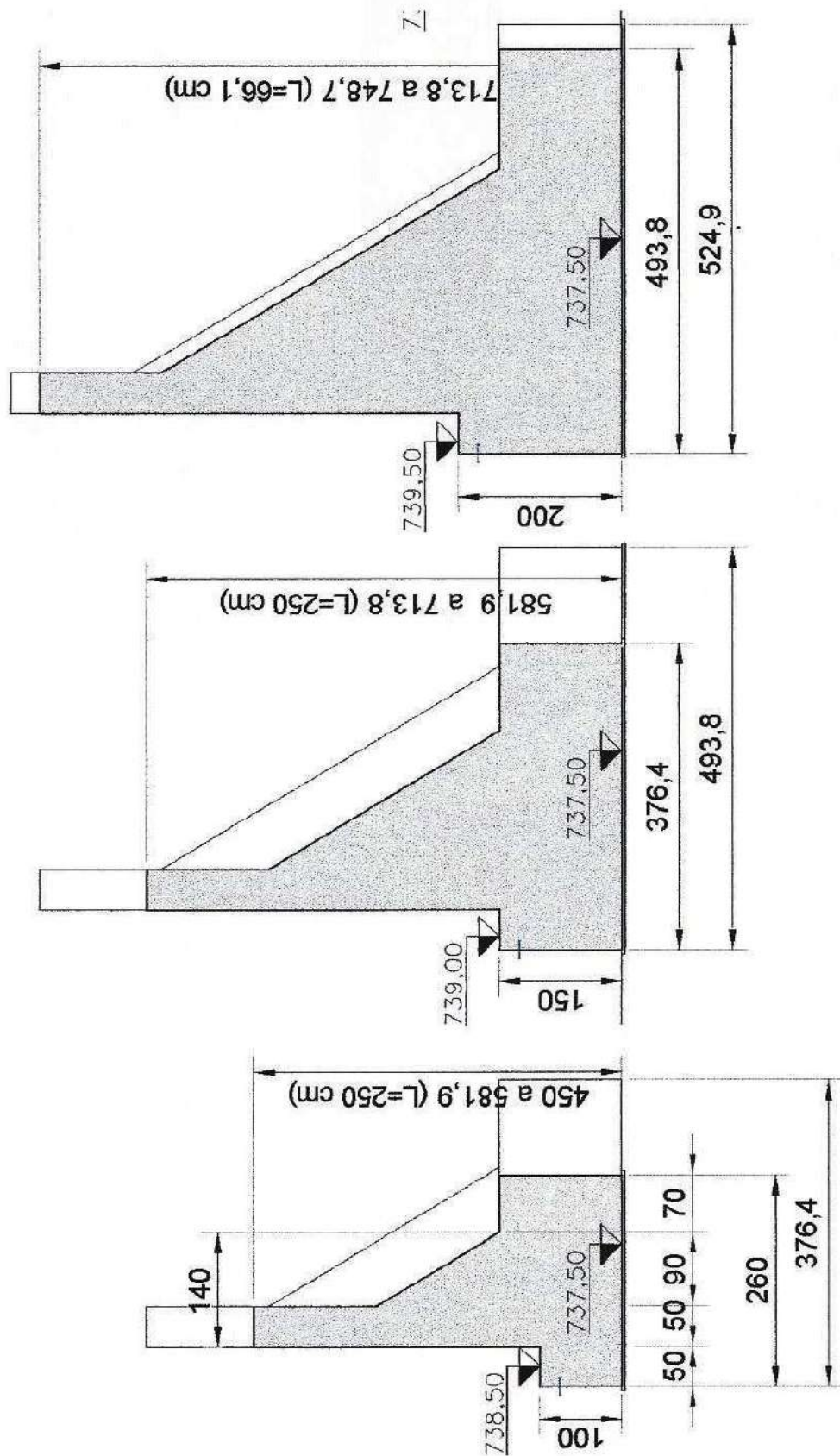
$\phi 20c/20 = 354$	$\phi 20c/15 = 21,0w^2/m$
$\phi 20c/35 = 940$	$\phi 25c/10$
$\phi 25c/11,9 = 4202$	
$\phi 25c/20 = 25,0w^2/m$	
$\phi 25c/27 = 18,52$	
$\phi 25c/13,2 = 57,88$	$\phi 25c/10$
$\phi 25c/22,3 = 22,42$	$\phi 25c/20$

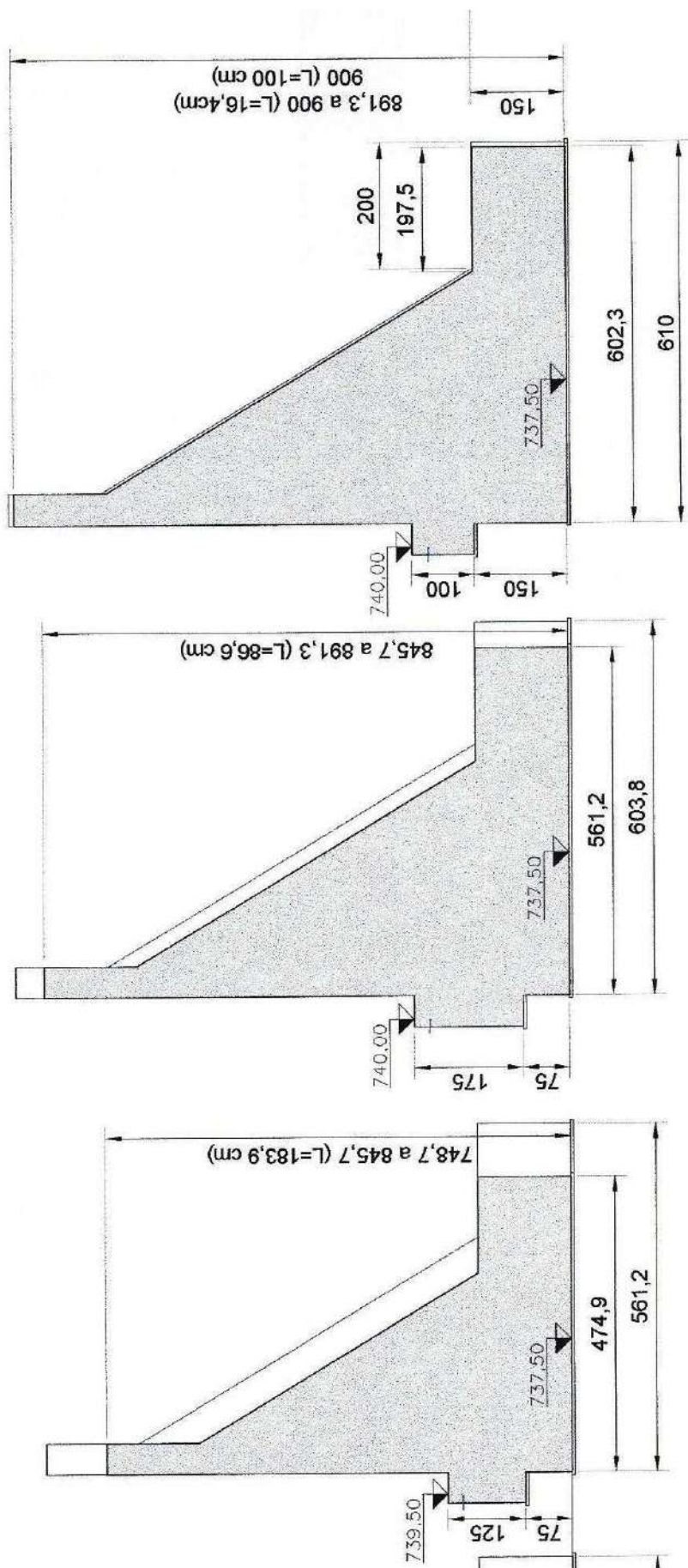
Technical drawing of a roof detail showing a sloped roof, a vertical wall, and a base. The drawing includes dimensions for heights, widths, and slopes. Key features include a sloped roof with a height of 150, a vertical wall with a height of 100, and a base with a width of 250. The drawing is labeled with "VEDA-JUNTA TIPO O-22" and "LASTRO $e=0,05m$ ".

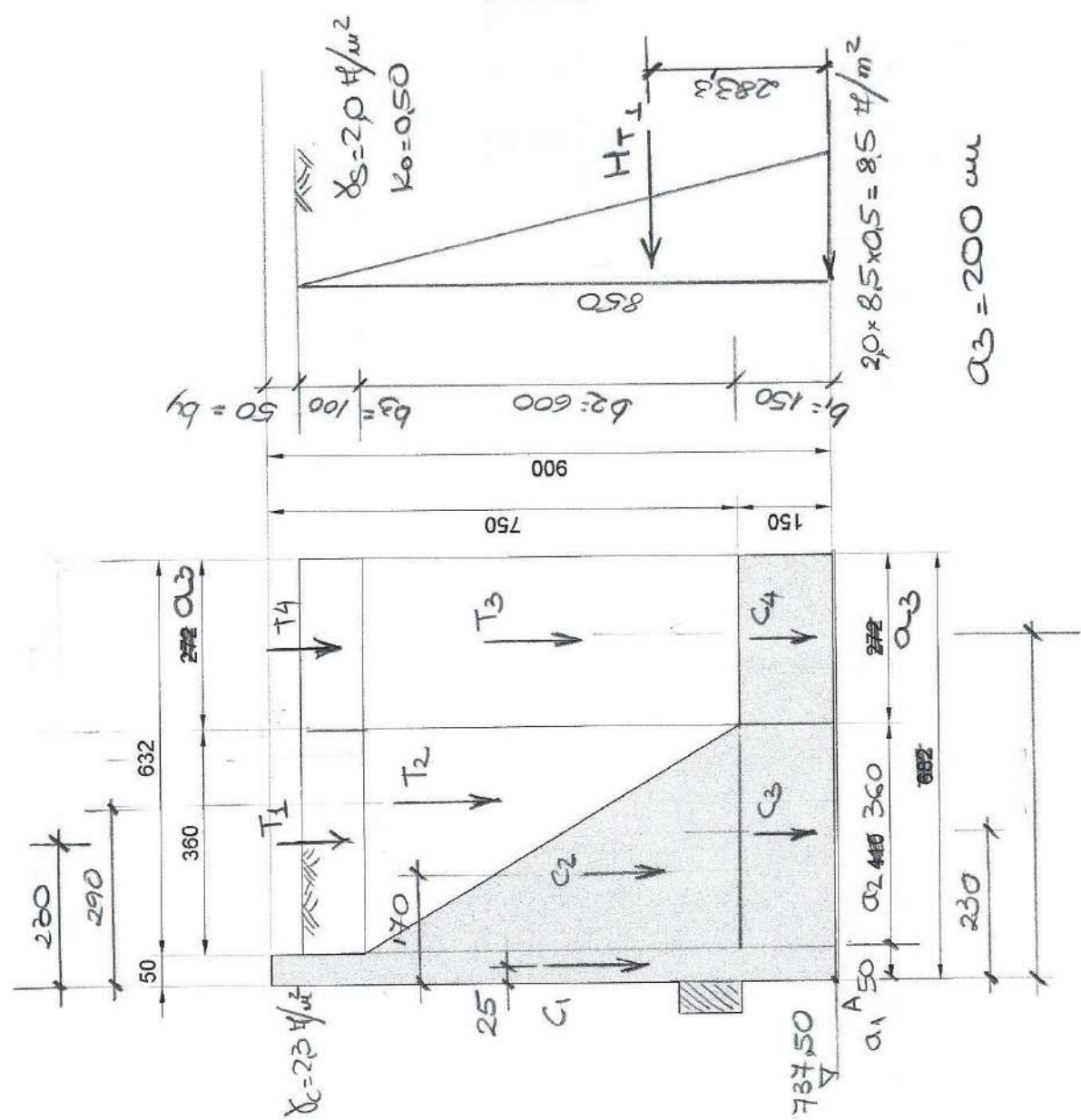
Memo diretto ai giovani (tratto 1)



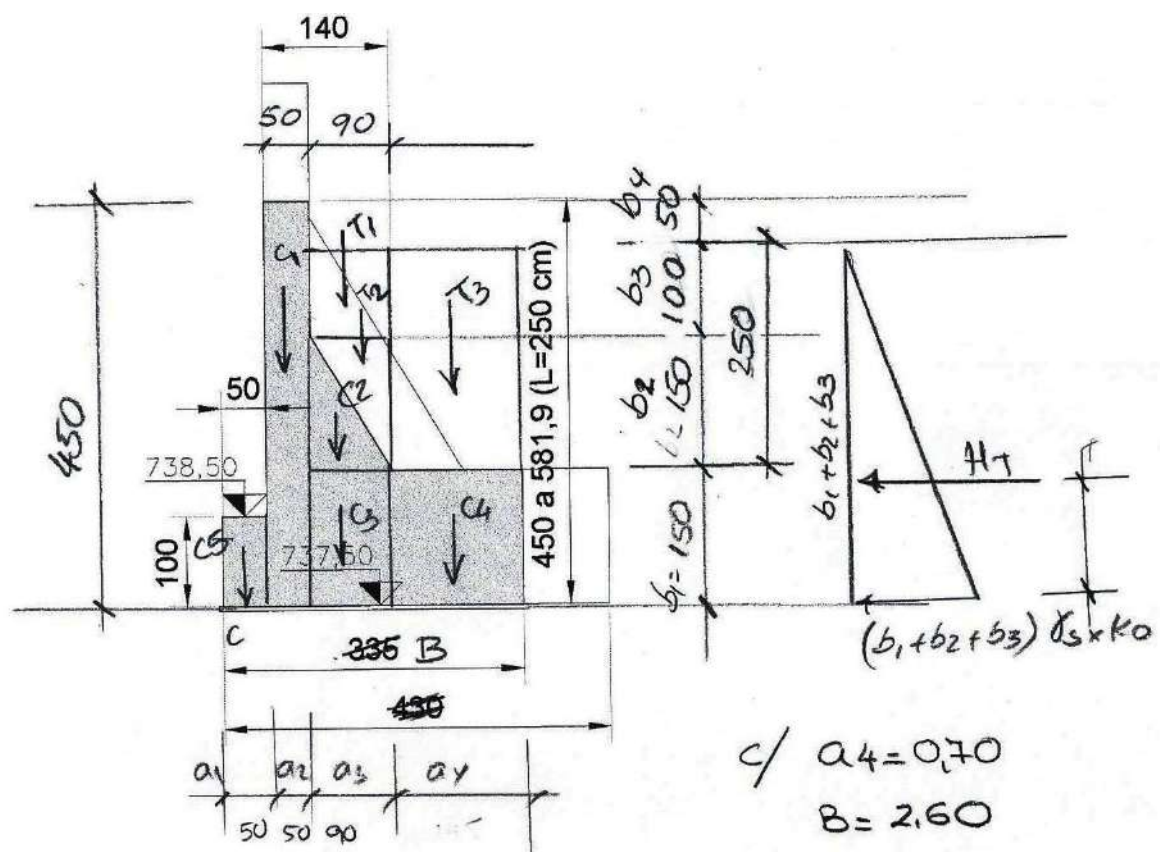


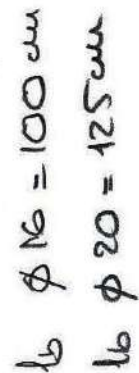






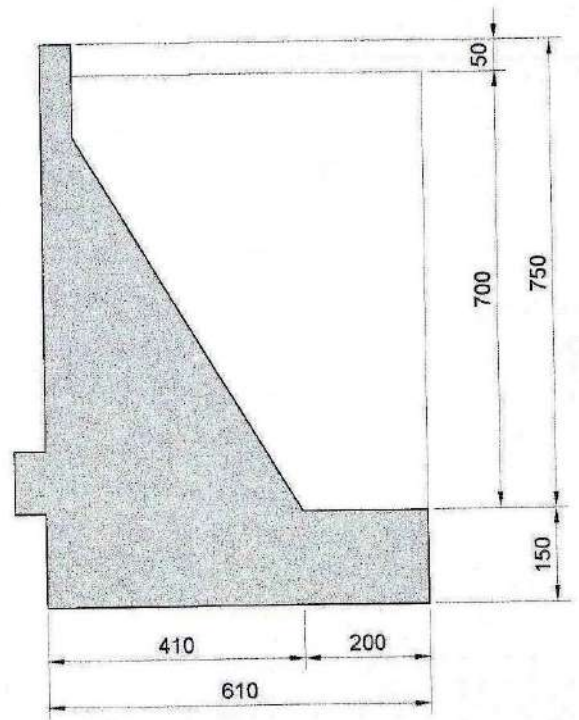
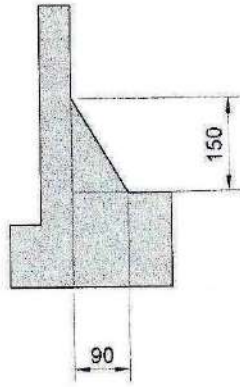
	Valores Mínimos para Fatores de Segurança		
	CCN	CCC	CCE
<i>FSF</i>	1,3	1,2	1,1
FST	1,5	1,3	1,2
<i>FSD ou FSD_φ</i>	1,5	1,3	1,1
FSD _C	3	2	1,3

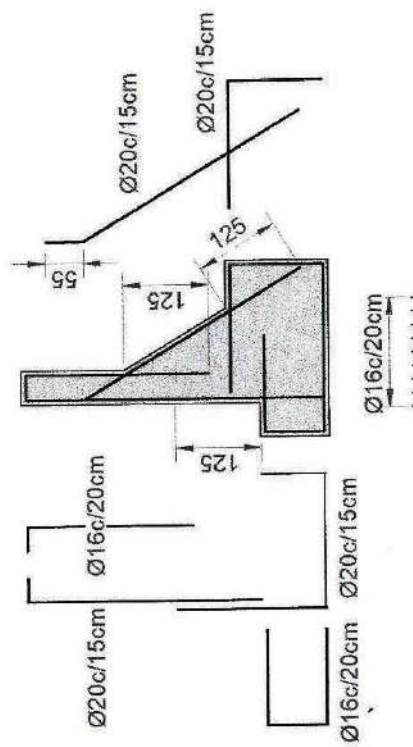
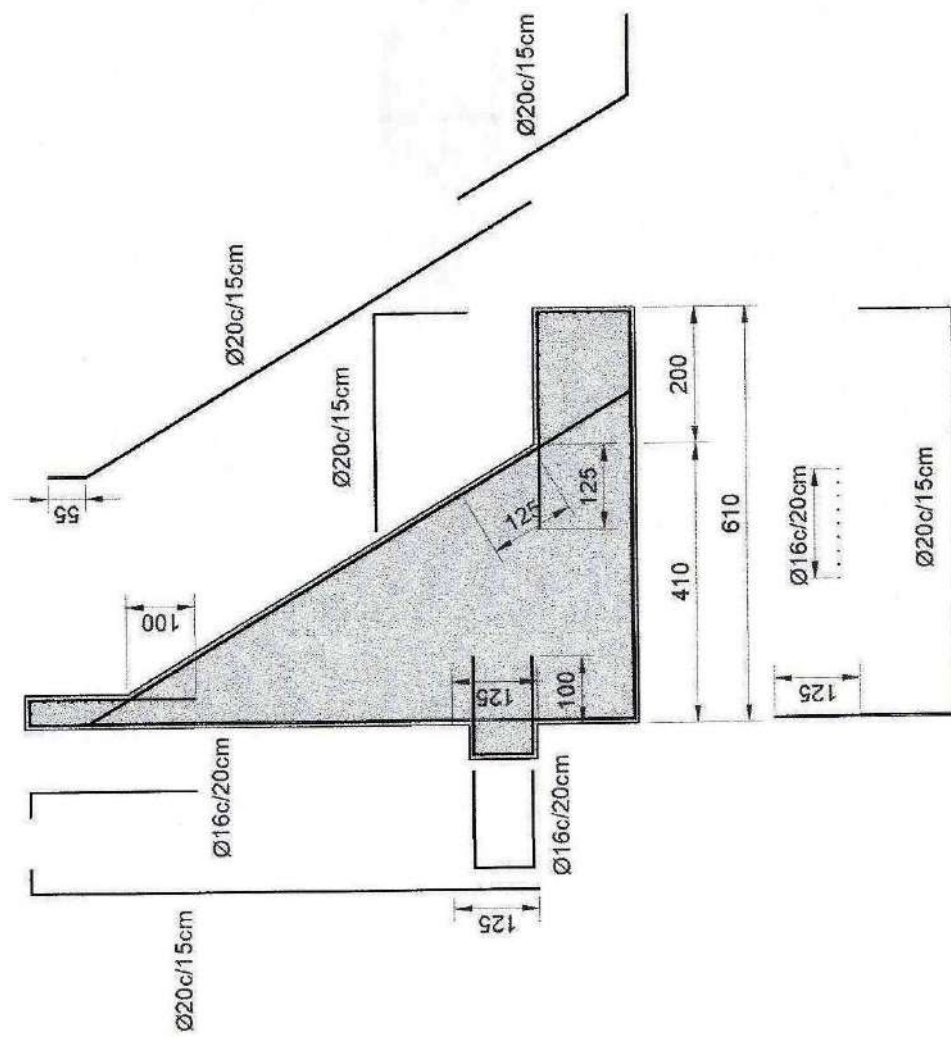


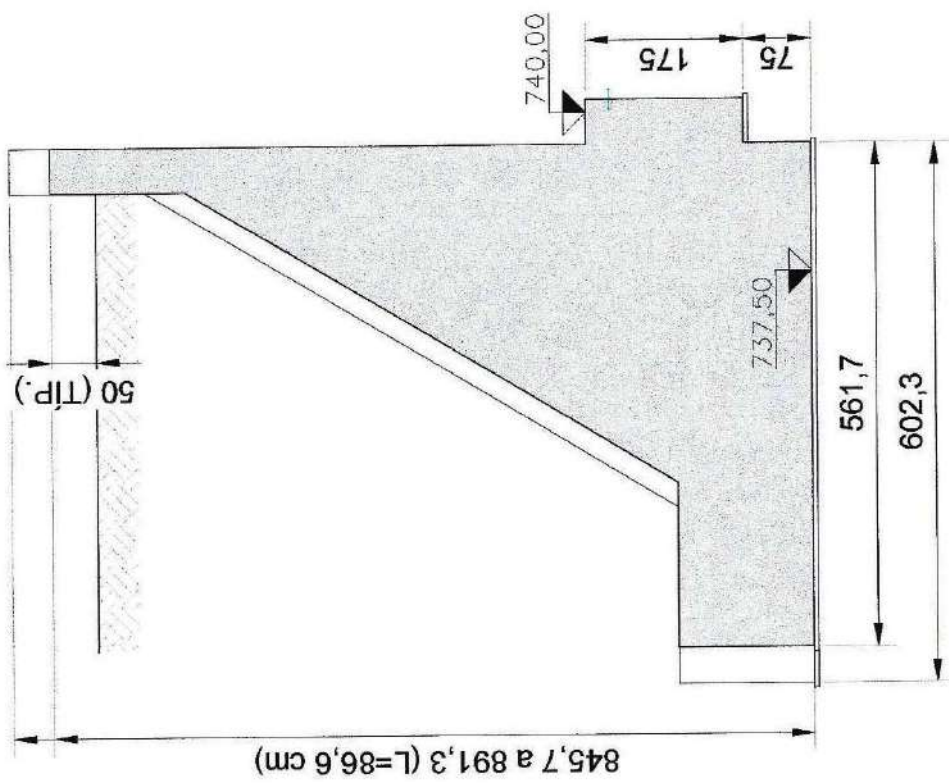
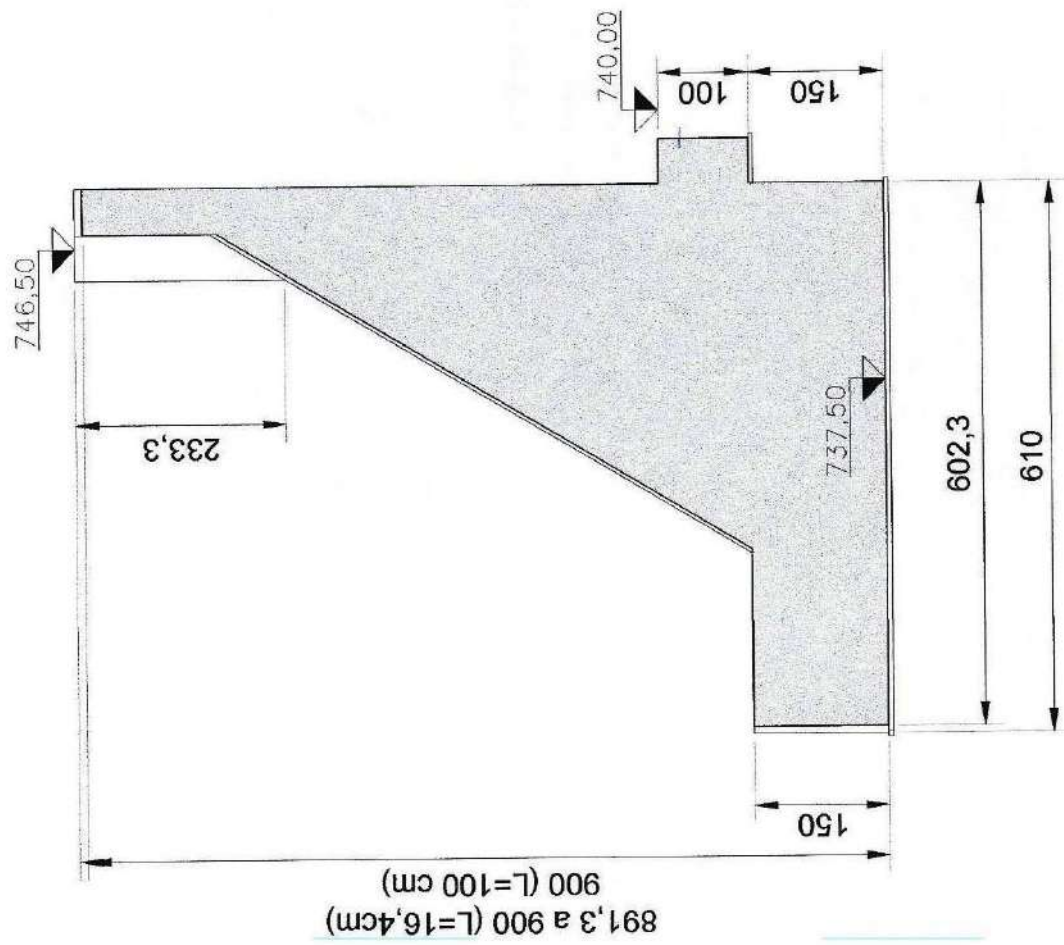


Adobaines $\phi 20 \times 17.5 \text{ cm}$
C/15 cm

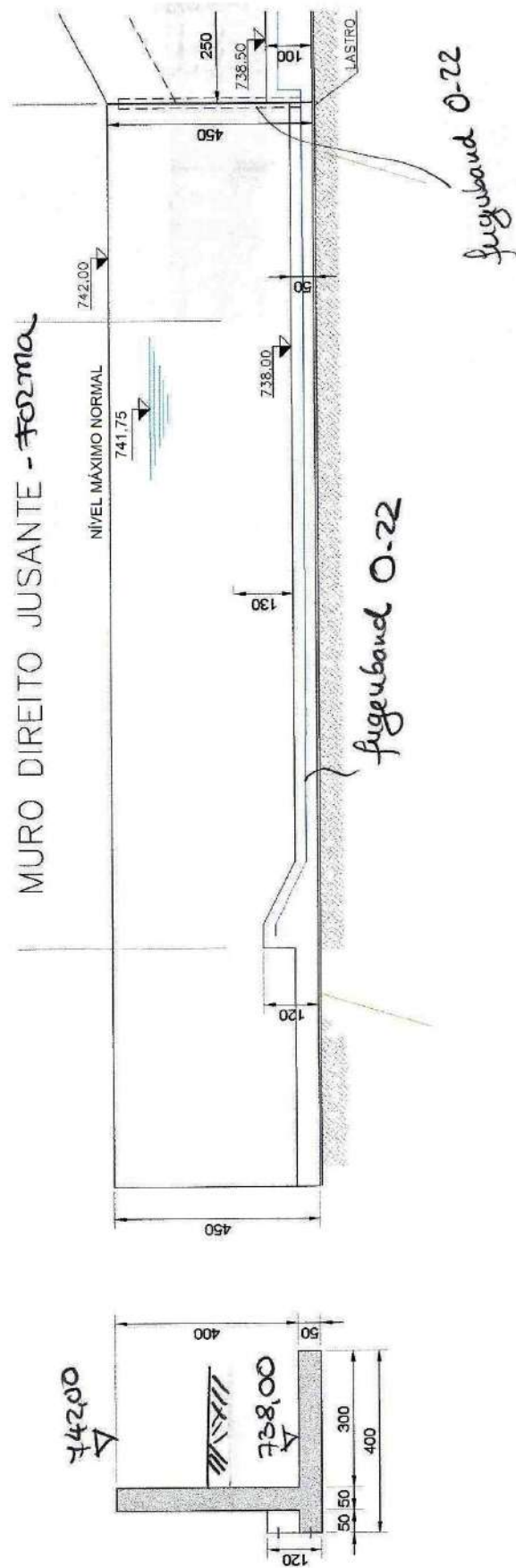
118





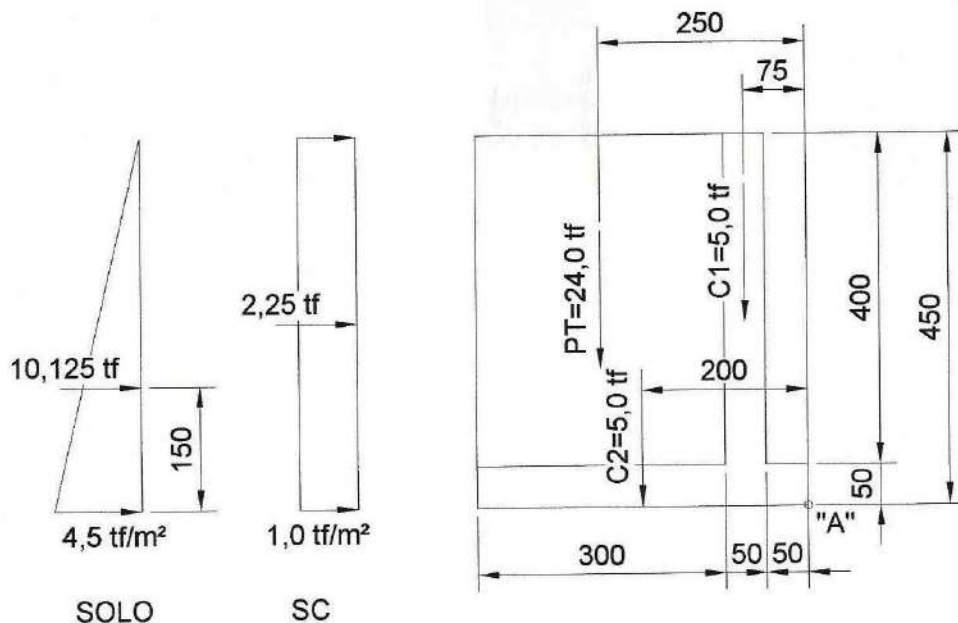


5.4 Muro Direito Jusante Trecho 2



Muro de arr. fixo - Verificação estabilidade

CCC
CONDIÇÃO DE CARREGAMENTO de CONSTRUÇÃO



FSF. (não há flutuação)

$$H = 10,125 + 2,25 = 12,375 \text{ tf}$$

$$V = 24,0 + 5,0 + 5,0 = 34,0 \text{ tf}$$

$$M_A(+) \Rightarrow \begin{aligned} 24,0 \times 2,5 &= 60,0 \\ 5,0 \times 0,75 &= 3,75 \\ 5,0 \times 2,0 &= 10,0 \\ \hline 73,75 \text{ tfm} \end{aligned}$$

$$M_A(-) \Rightarrow \begin{aligned} 10,125 \times 1,50 &= 15,1875 \\ 2,25 \times 2,25 &= 5,06 \\ \hline 20,25 \text{ tfm} \end{aligned}$$

$$M = 53,5 \text{ tfm}$$

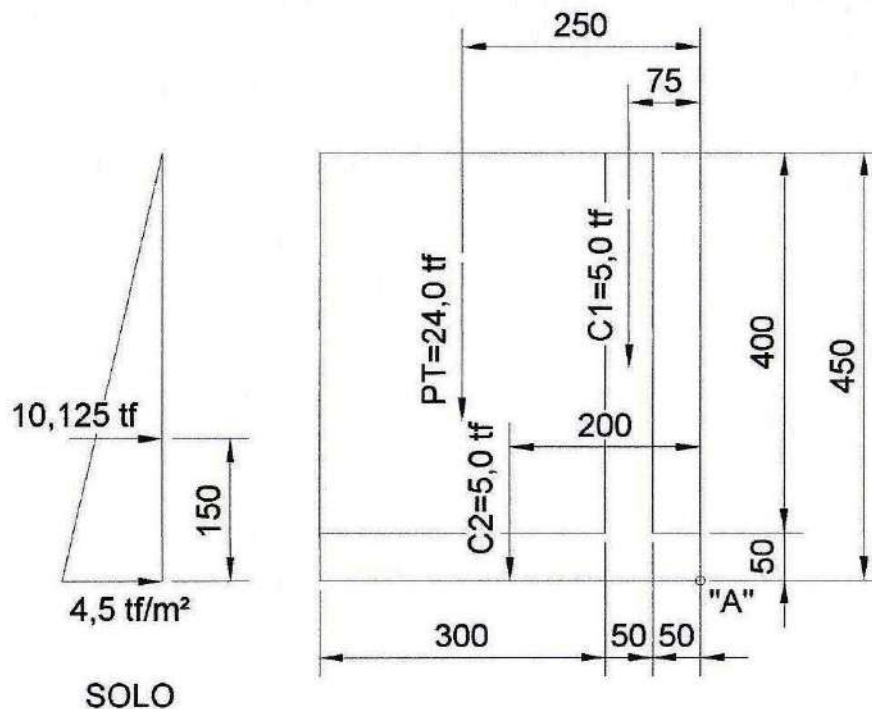
$$e = \frac{53,5}{34,0} = 1,57 \text{ m}$$

(totalmente comprimido)

$$FST = \frac{73,75}{20,25} = 3,64 > 1,30 \text{ OK}$$

$$FSD = \frac{\frac{34,0 \times 1,57}{1,3} + \frac{50 \times 40}{2}}{12,375} = 1,88 > 1,0 \text{ OK}$$

CCN
CONDIÇÃO DE CARREGAMENTO NORMAL



FST (Não há flutuação)

$$H = 10,125 \text{ tf}$$

$$V = 24,0 + 5,0 + 5,0 = 34,0 \text{ tf}$$

$$M_A(+) \Rightarrow 24,0 \times 2,5 = 60,0 \text{ tfm}$$

$$5,0 \times 0,75 = 3,75$$

$$5,0 \times 2,0 = 10,0$$

$$\underline{\underline{73,75 \text{ tfm}}}$$

$$M_A(-) \Rightarrow 10,125 \times 1,50 = 15,1875 \text{ tfm}$$

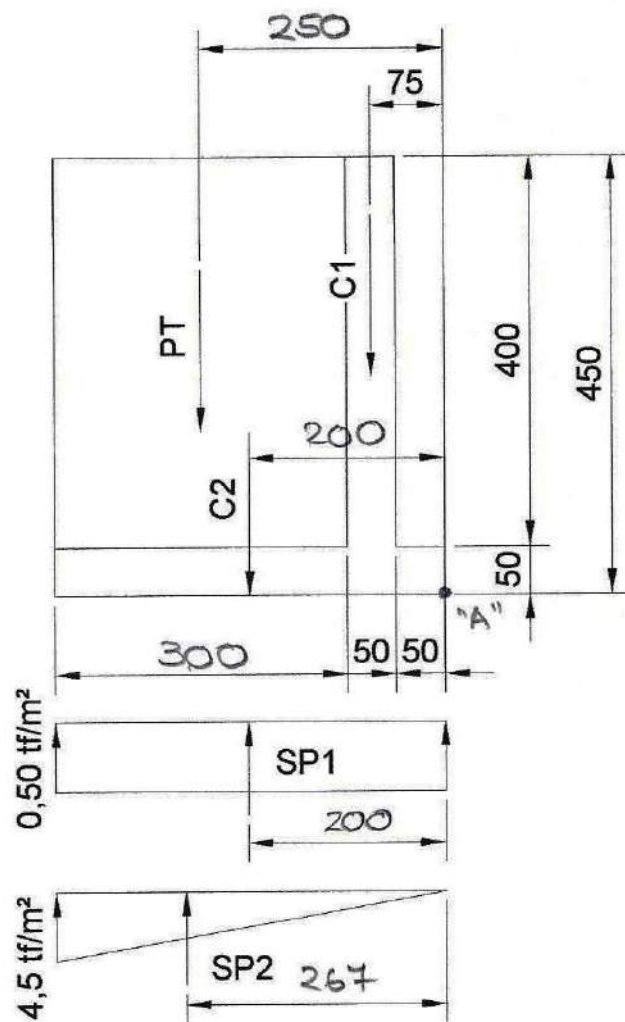
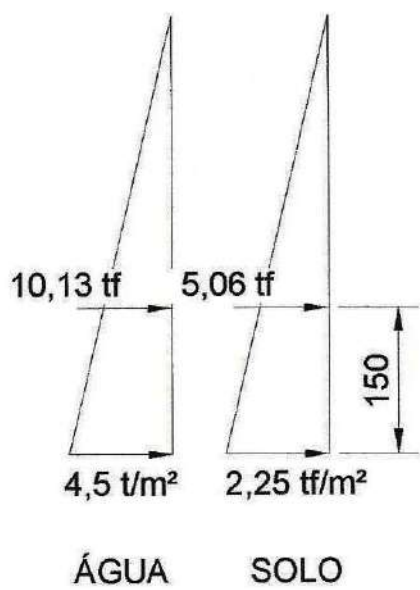
$$FST = \frac{73,75}{15,1875} = 4,86 > 1,5 \text{ OK}$$

$$M = 58,56 \text{ tfm} \quad e = \frac{58,56}{34,0} = 1,72 \text{ m} \quad e_{ca} = 0,28 \text{ m} \\ (\text{total/ comprimido})$$

$$FSD = \frac{\frac{34,0 \times \tan 27}{1,5} + \frac{5,0 \times 40}{3,0}}{10,125} = 1,80 > 1,0$$

	Valores Mínimos para os Fatores de Segurança		
	CCN	CCC	CCE
FST	1,5	1,3	1,2
FSF	1,3	1,2	1,1
FSD ou FSD_{ϕ}	1,5	1,3	1,1
FSD_C	3	2	1,3

CCE



$$H = 10.13 + 5.06 = 15.19 \text{ t}$$

$$P_T = 3.0 \times 4.0 \times 2.0 = 24 \text{ t}$$

$$C_1 = 0.50 \times 4.0 \times 2.5 = 5.0 \text{ t}$$

$$C_2 = 4.0 \times 0.5 \times 2.5 = 5.0 \text{ t}$$

$$SP_1 = 0.5 \times 4.0 = 2.0 \text{ t}$$

$$SP_2 = 4.0 \times \frac{4.5}{2} = 9.0 \text{ t}$$

} $V(+)$

} $V(-)$

$$V = 23.0 \text{ t}$$

$$FSF = \frac{24 + 5.0 + 5.0}{2.0 + 9.0} = 3.09 > 1.1 \text{ OK}$$

$$M_{A(+)} \Rightarrow 24.0 \times 2.5 = 60.0 \text{ t}\cdot\text{m}$$

$$5.0 \times 0.75 = 3.75$$

$$5.0 \times 2.0 = 10.0$$

$$\underline{73.75 \text{ t}\cdot\text{m}}$$

$$M_{A(-)} \Rightarrow (10.13 + 5.06) \times 1.50 = 22.79$$

$$2.0 \times 2.0 = 4.0$$

$$9.0 \times 2.67 = 24.03$$

$$\underline{50.82 \text{ t}\cdot\text{m}}$$

$$M = 22.93 \text{ t}\cdot\text{m}$$

$$FST = \frac{73.75}{50.82} = 1.45 > 1.20 \text{ OK}$$

$$e = \frac{M}{V} = \frac{22.93}{23.0} = 1.0 \text{ m} \quad 3e = 3.0 \text{ m}$$

$$\frac{3e}{B} = 0.75 = 75\% \text{ OK}$$

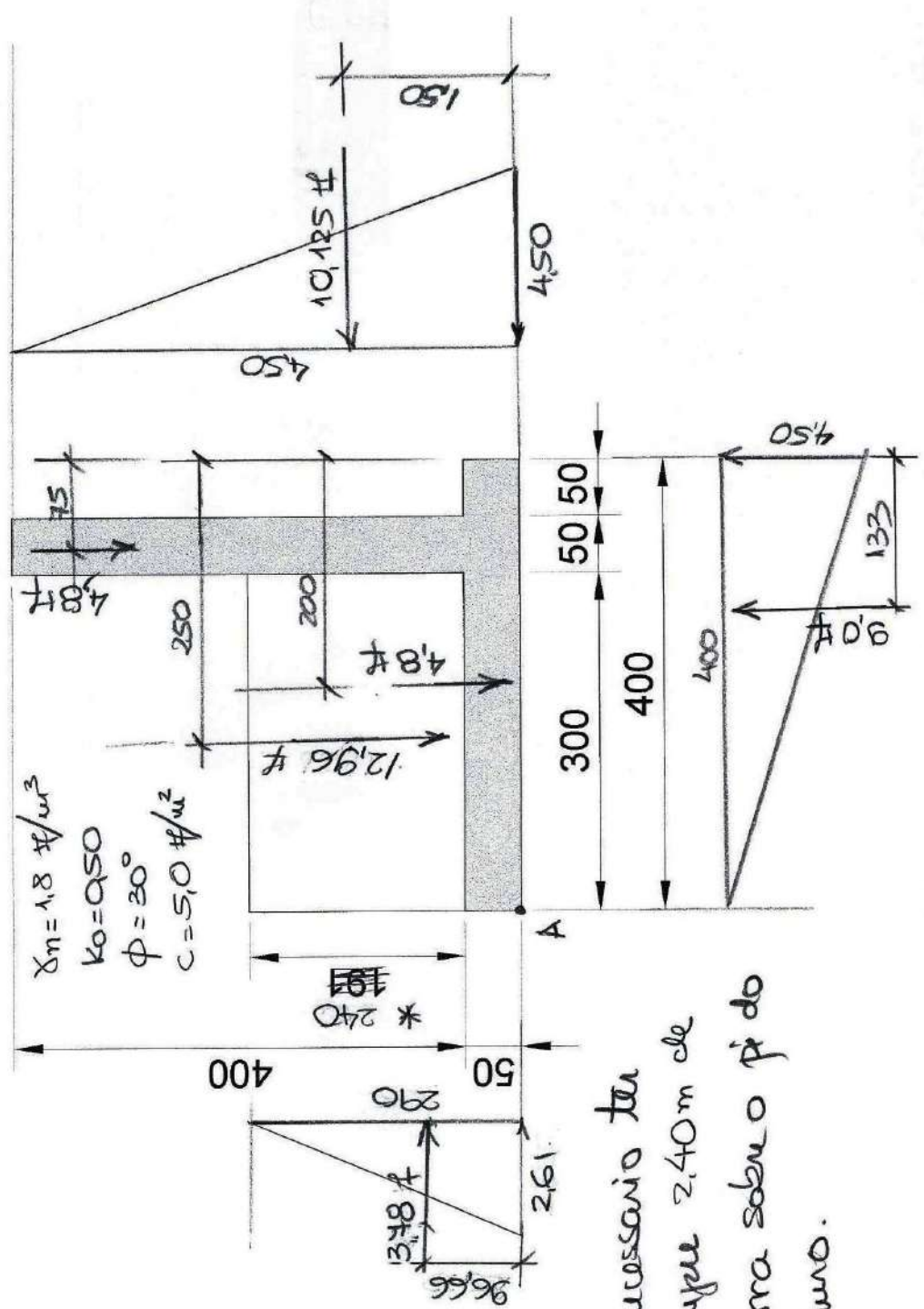
$$V_{max} \times \frac{3.0}{2} = 23.0 \quad G_{max} = 15.33 \text{ \$/m}^2 \quad \text{ok.}$$

$$FSD = \frac{\frac{23 \times 1.24}{1.1} + \frac{50 \times 3.0}{1.3}}{15.13} = 1.47 > 1.0$$

CCE

$$\gamma_{conc} = 2,4 \text{ \#}/\text{m}^3$$

$$\begin{aligned} \gamma_n &= 1,8 \text{ \#}/\text{m}^3 \\ k_0 &= 0,50 \\ \phi &= 30^\circ \\ c &= 5,0 \text{ \#}/\text{m}^2 \end{aligned}$$



É necessário ter sempre 2,40m de terra sobre o pé do muro.

$$\text{Empuxo de água } \frac{4,50^2}{2} = 10,125 \text{ tf}$$

$$\text{Peso do concreto } 0,50 \times 4,0 \times 2,4 = 4,8 \text{ tf/m}$$

$$0,50 \times 4,0 \times 2,4 = 4,8 \text{ tf/m}$$

$$\text{Peso de terra } 2,40 \times 3,0 \times 1,80 = 12,96 \text{ tf/m}$$

$$\text{Empuxo de terra } 2,90 \times 1,8 \times 0,5 = 2,61 \text{ tf/m}^2$$

$$\frac{2,61 \times 2,90}{2} = 3,78 \text{ tf/m}$$

$$\text{Subpressão } \frac{4,0 \times 4,50}{2} = 9,0 \text{ tf/m}$$

$$V(+) = 4,8 + 4,8 + 12,96 = 22,56 \text{ tf/m}$$

$$V(-) = 9,0 \text{ tf/m} \quad \text{FSF} = \frac{22,56}{9,0} = 2,51 > 1,10 \text{ OK}$$

$$V = 13,56 \text{ tf/m}$$

$$M_A(+) = 4,8 \times 3,25 + 4,8 \times 2,0 + 12,96 \times 1,50 =$$

$$= 44,64 \text{ tfm/m}$$

$$M_A(-) = 10,125 \times 1,50 + 9,0 \times \frac{4,0}{3} \times 2 - 3,78 \times 0,9666 =$$

$$= 35,53 \text{ tfm/m}$$

$$\text{FSF} = \frac{44,64}{35,53} = 1,26 > 1,20 \text{ OK}$$

$$M = 9,11 \text{ tfm} \quad e = \frac{9,11}{13,56} = 0,67 \text{ m} \quad 3e = 2,01 \text{ m}$$

$$\% \text{ comprimida} = \frac{2,015}{4,0} \times 100 = 50,39 \% > 50\%$$

$$\sigma_{max} \times \frac{2,015}{2} = 13,56 \quad \sigma_{max} = 13,46 \text{ #/m}^2$$

$$FSD = \frac{\frac{13,56 \times 27}{1,1} + \frac{2,015 \times 9,0}{1,3}}{10,125 - 3,78} = 2,21 > 1,0 \quad \text{OK.}$$

CASO ATUAL					
	CCN	CCC	CCE	CCE	FSF
FSF	1,30	1,20	1,10	1,10	FSF
FST	1,50	1,30	1,20	1,20	FST
FSD	1,50	1,30	1,10	1,10	FSD
FSD _C	3,00	2,00	1,30	1,30	FSD _C

	[tf]	[m]	[tf.m]	H+	H-	H
Água Interna						
0,00	10,13	e _A 1,50	M _A 15,19	3,78	10,13	-6,34

4,50
tf/m²

	[tf]	[m]	[tf.m]	V+	V-	V
Peso concreto						
2,40	4,80	e _A 3,25	M _A 15,60	22,56	9,00	13,56
	4,80	2,00	9,60			

OK

	[tf]	[m]	[tf.m]	M _A ⁺	M _A ⁻	M _A
Subpressão						
4,50	9,00	e _A 2,67	M _A 24,00	44,64	35,53	9,11
0,00						

OK

	[tf]	[m]	[tf.m]	φ	c
Peso de Terra					
1,80	12,96	e _A 1,50	M _A 19,44	27,00	5,00
3,00					

OK

	[tf]	[m]	[tf.m]
Empuxo de Terra			
2,61	3,78	e _A 0,97	M _A 3,66

σ_s H

	3e	B	%comprimida
	2,02	4,00	50,39

OK

$$M(+)= 4,25 \times 1,0 \times \frac{4,25}{2} + \frac{2,125 \times 4,25}{2} \times \frac{4,25}{3} + \\ + \frac{4,25 \times 4,25}{2} \times \frac{4,25}{3} = 28,23 \text{ tfm/m}$$

$$V(+)= 4,25 \times 1,0 + \frac{2,125 \times 4,25}{2} + \frac{4,25 \times 4,25}{2} = 17,80 \text{ tf/m}$$

$$M(-)= \frac{4,25 \times 4,25}{2} \times \frac{4,25}{3} = 12,80 \text{ tfm/m}$$

$$V(-)= \frac{4,25 \times 4,25}{2} = 9,03 \text{ tf/m}$$

$$M(+)= 28,23 \text{ tfm/m} \quad b=100 \text{ cm} \quad h=50 \text{ cm} \quad d=42 \text{ cm}$$

$$f_{ek}=20 \text{ MPa} \quad A_{srec}=24,12 \text{ cm}^2/\text{m}$$

$$A_{swu}=0,15\% \ 100 \times 50 = 7,5 \text{ cm}^2/\text{m}$$

$$c/\phi 25 \text{ c}/15 \text{ cm} = 33,33 \text{ cm}^2/\text{m} \quad \omega = 0,29$$

$$M(-)= 12,80 \text{ tfm/m} \quad A_{srec}=10,26 \text{ cm}^2/\text{m}$$

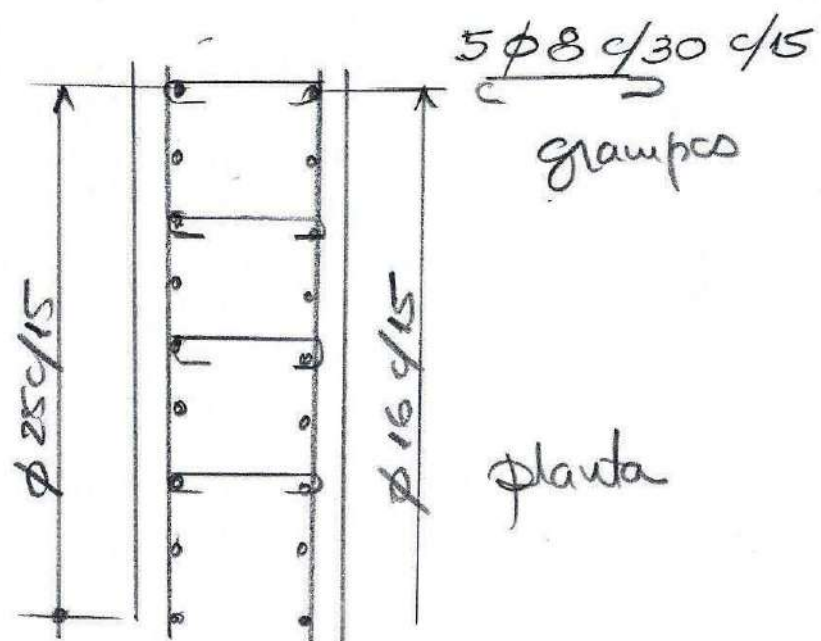
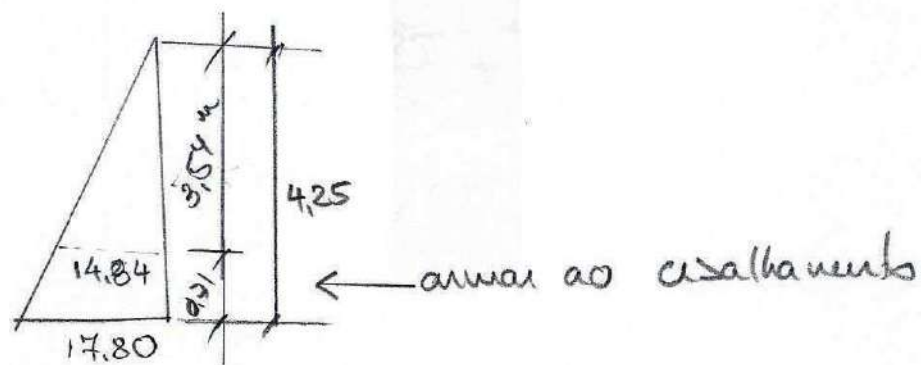
$$A_{swu}=7,5 \text{ cm}^2/\text{m}$$

$$c/\phi 16 \text{ c}/15 \text{ cm} = 13,20 \text{ cm}^2/\text{m} \quad \omega = 0,23$$

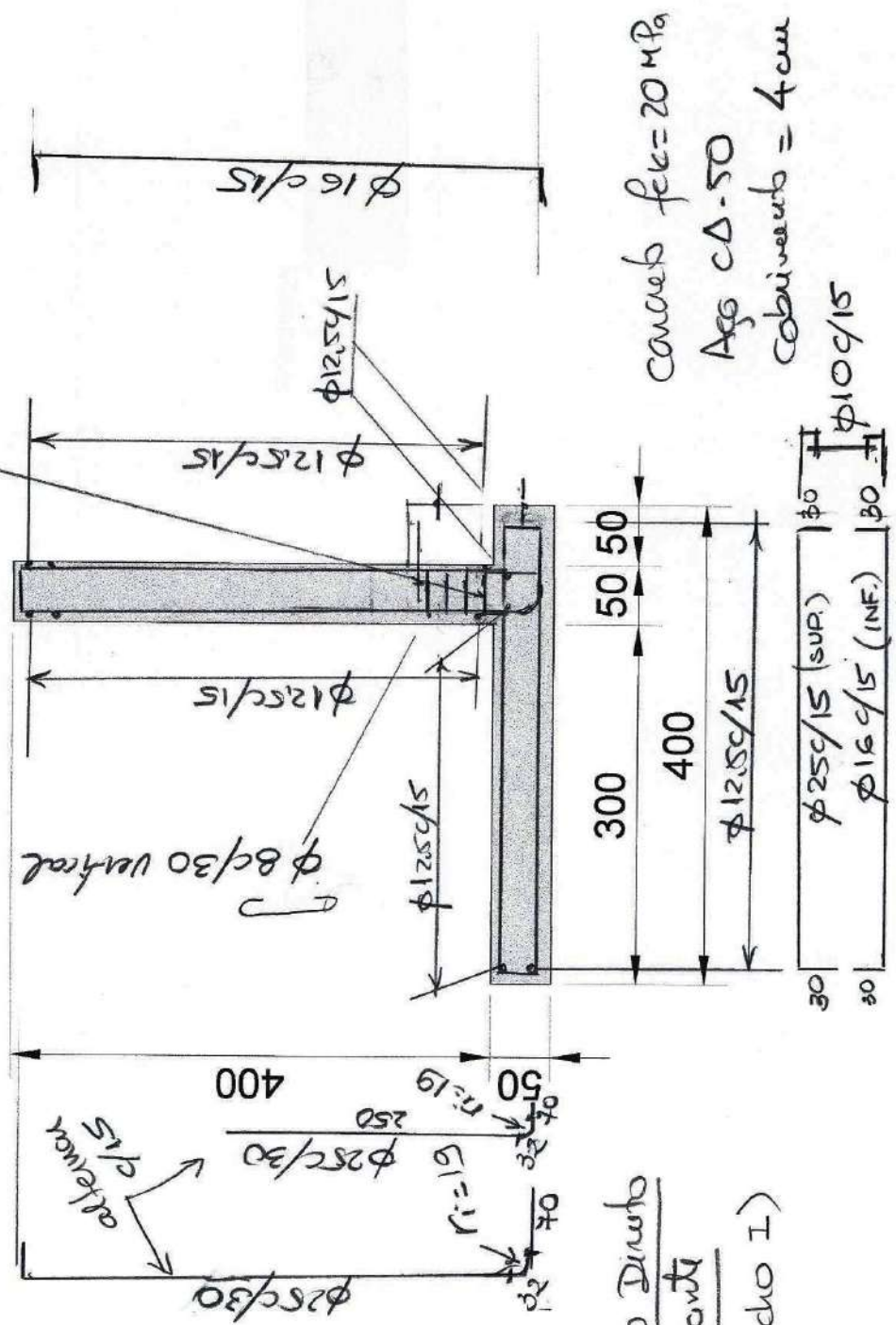
$$c/\phi 12,5 \text{ c}/15 = 8,33 \text{ cm}^2/\text{m}$$

$$V_{kmax}= 17,80 \text{ tf/m} > V_{Rk1}= 14,84 \text{ tf}$$

$$A_{sl/s}= n_{sl}= 8,84 \text{ cm}^2/\text{m} \Rightarrow \phi 8 \text{ c}/15 \text{ c}/30 = 11,11 \text{ cm}^2/\text{m}$$



gambas
 $\phi 8 \text{ c/15}$ vertical
 $\phi 16 \text{ c/30}$ horizontal

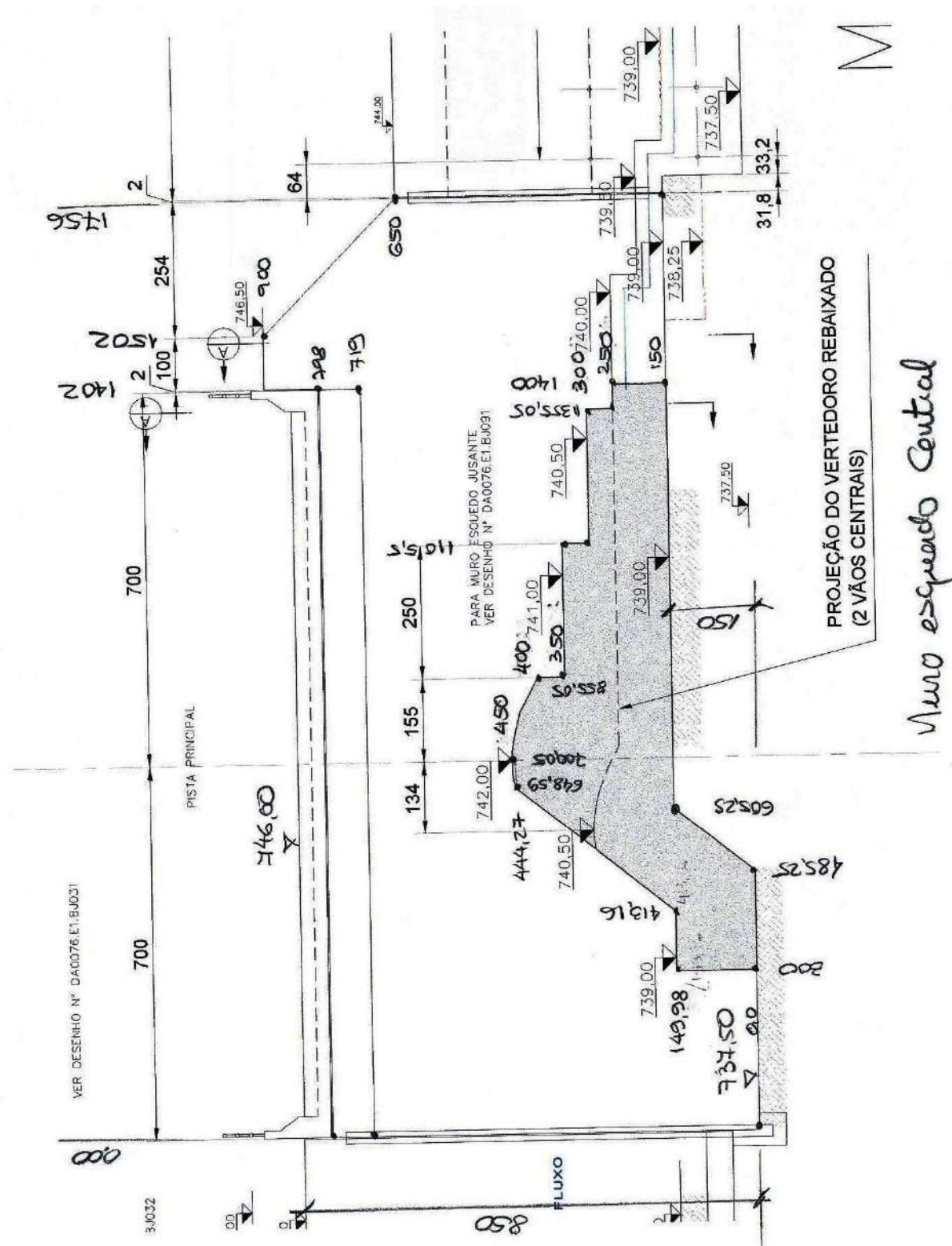


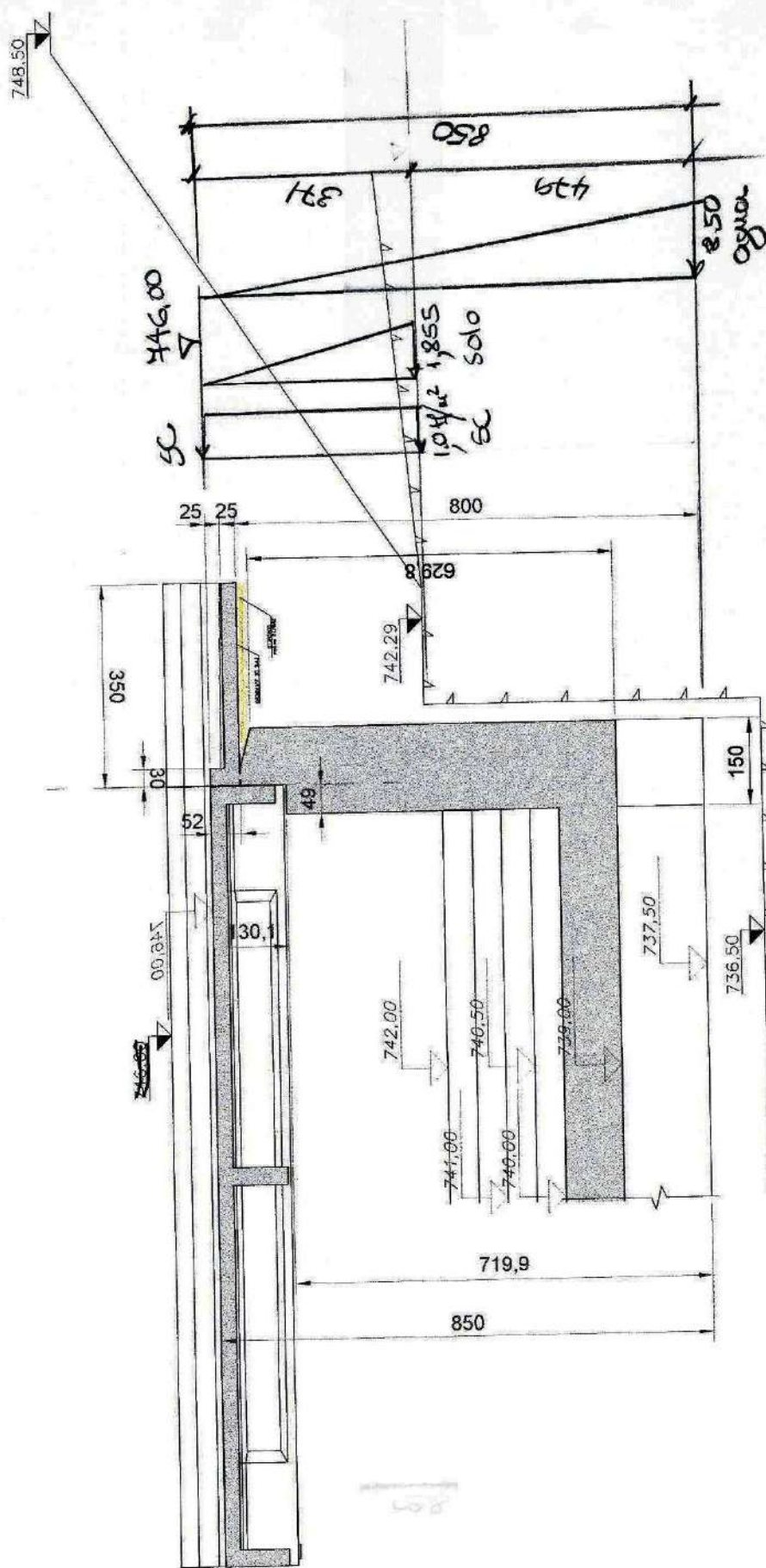
Muro Derecho
 fusante
 (Tramo I)

concreto $f_{ck} = 20 \text{ MPa}$
 Agg CD-50
 cobrimiento = 4 cm

30	$\phi 25 \text{ c/15}$ (SUP.)	30	$\phi 10 \text{ c/15}$
30	$\phi 16 \text{ c/15}$ (INF.)	30	

5.5 Muro Esquerdo Central



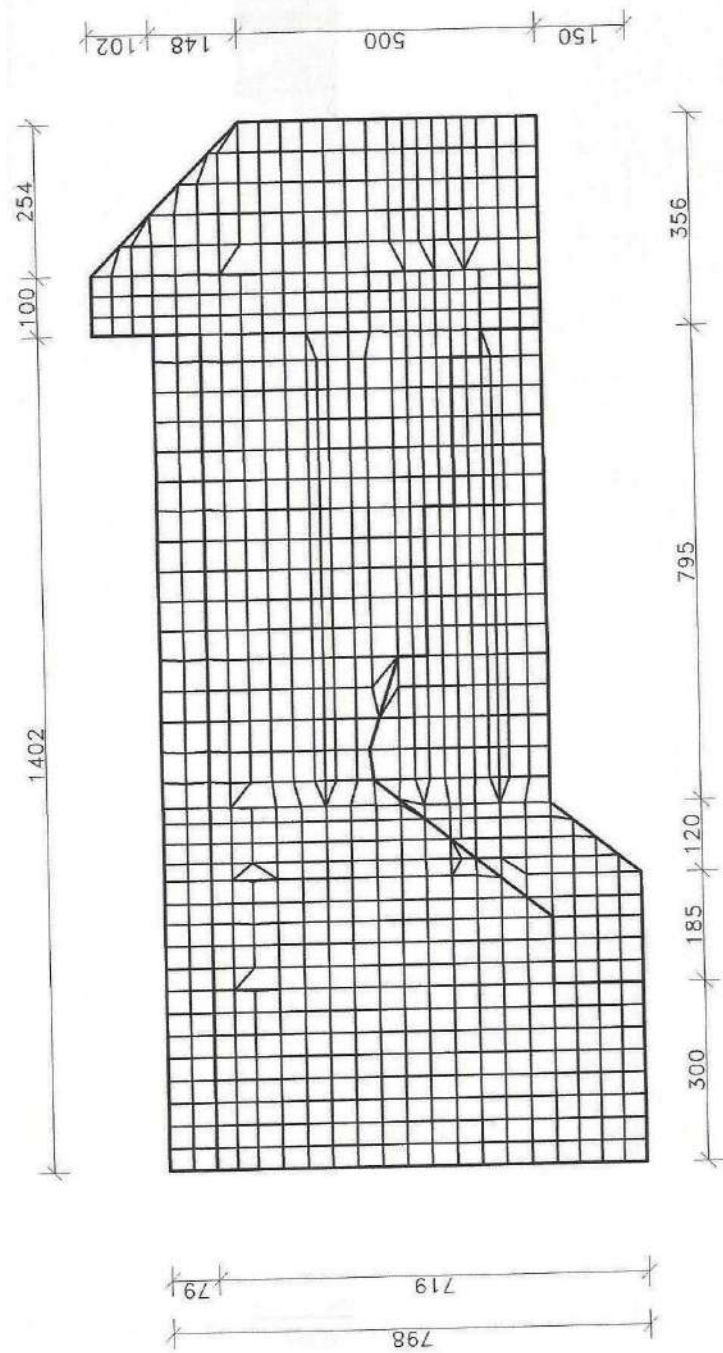
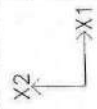


MURO ESQUERDO "CENTRAL"

20-Muro Esquermo Central

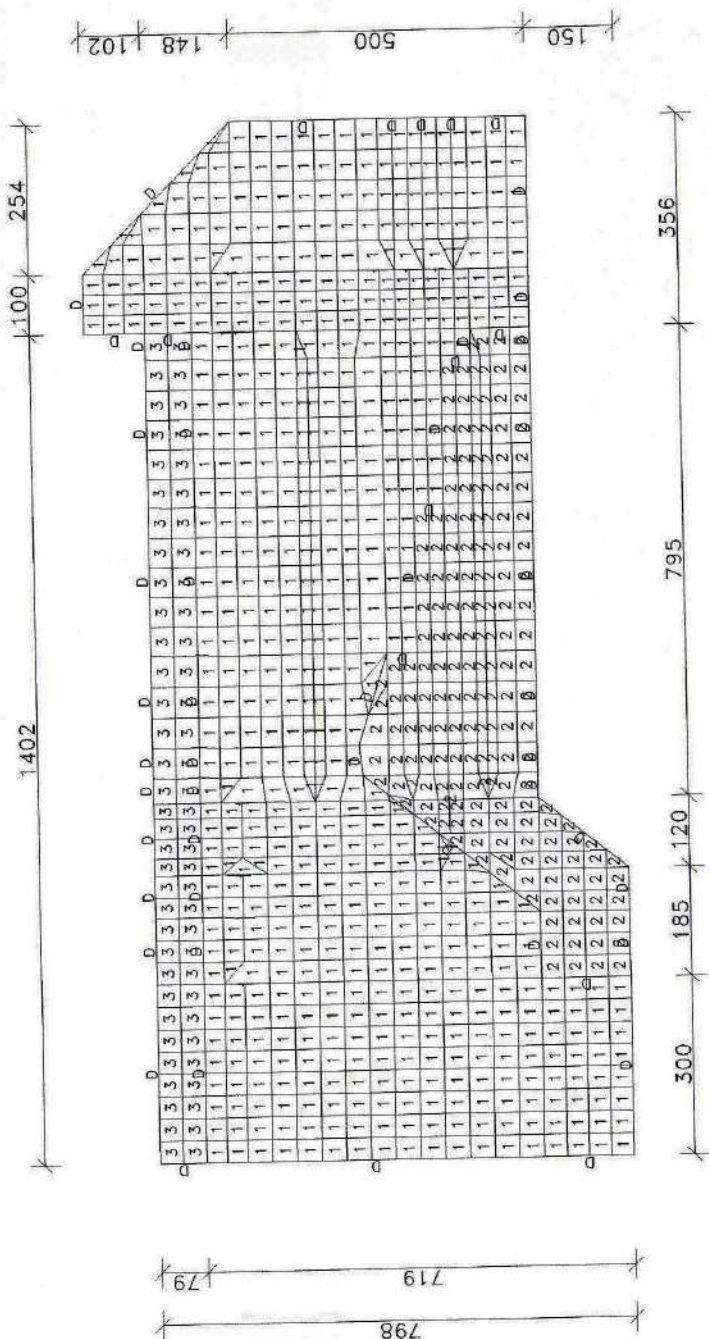
DATE: 21/02/17

SCALE = 1:100

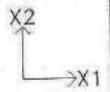


798
719
79

SCALE = 1:100



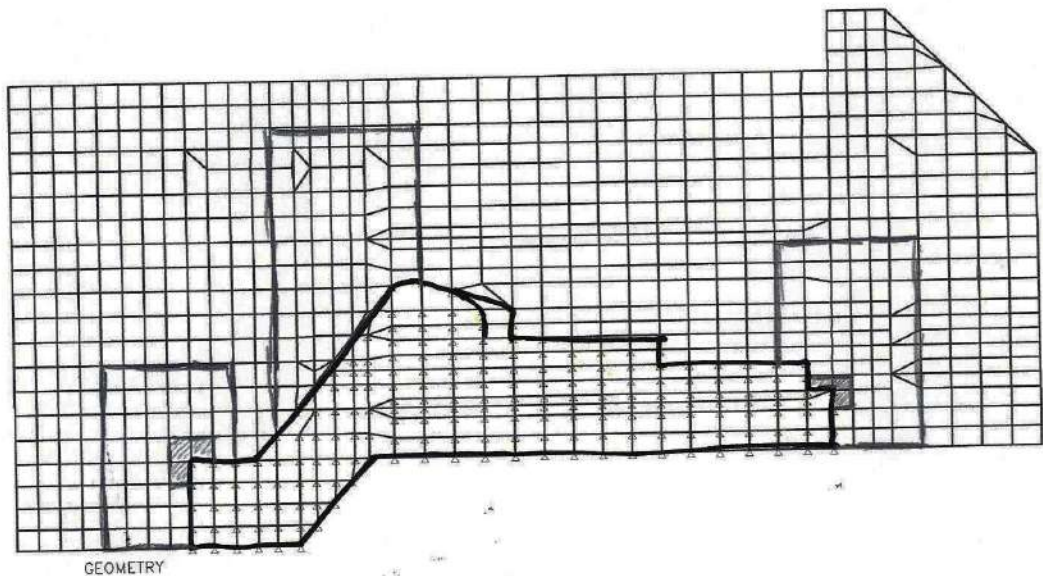
20-Muro Esquerdo Central



SCALE = 1:100

UNITS: ton m

DATE:22/02/17



GEOMETRY



$M_x = 140$



$M_y = 95$



$M_x = -52$

geral ϕ 25c/20

reforços c/ ϕ 25c/20

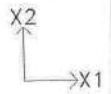
alternados com o

geral

M_x

20-Muro Esquerdo Central

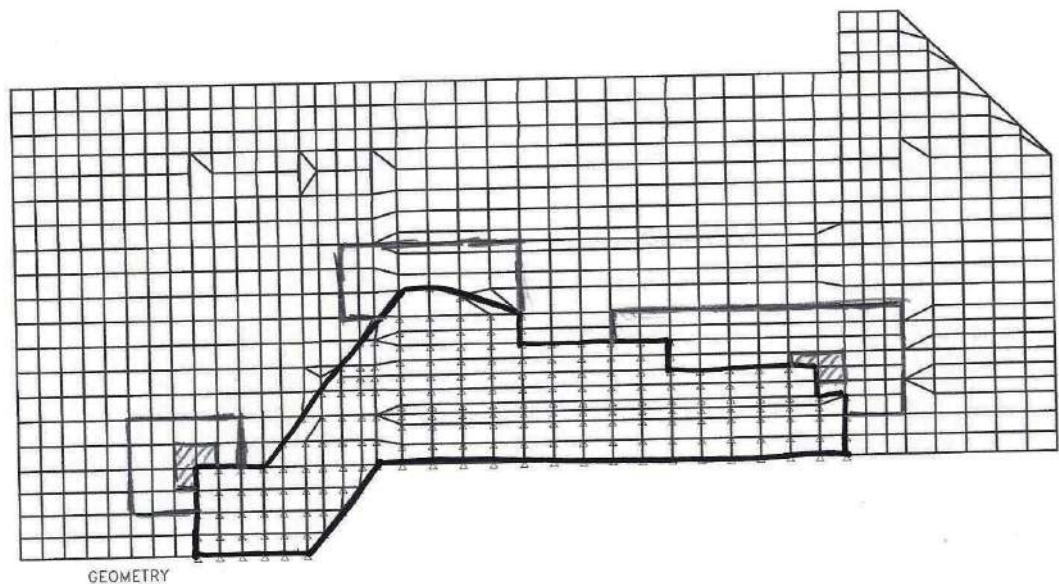
View: SECAO VERTICAL



SCALE = 1:100

UNITS: ton m

DATE:22/02/17



GEOMETRY

 158

 95

 33

geral ϕ 25c/20

refugo ϕ 25c/20 alternado
com o geral

My

$$b=100\text{ cm} \quad h=150\text{ cm} \quad d=140\text{ cm} \quad f_{ck}=20\text{ MPa}$$

$$A_{smin}=0,15\% \cdot 100 \times 150 = 22,50 \text{ cm}^2/\text{m}$$

$$c/\phi 25 \text{ c}/20\text{ cm} = 25,0 \text{ cm}/\text{m}$$

$$M = 75,0 \text{ kNm}/\text{m} \quad \omega = 0,30$$

$$c/\quad M = 95,0 \text{ kNm}/\text{m} \quad c/\phi 25 \quad A_s = 31,75 \text{ cm}^2/\text{m}$$

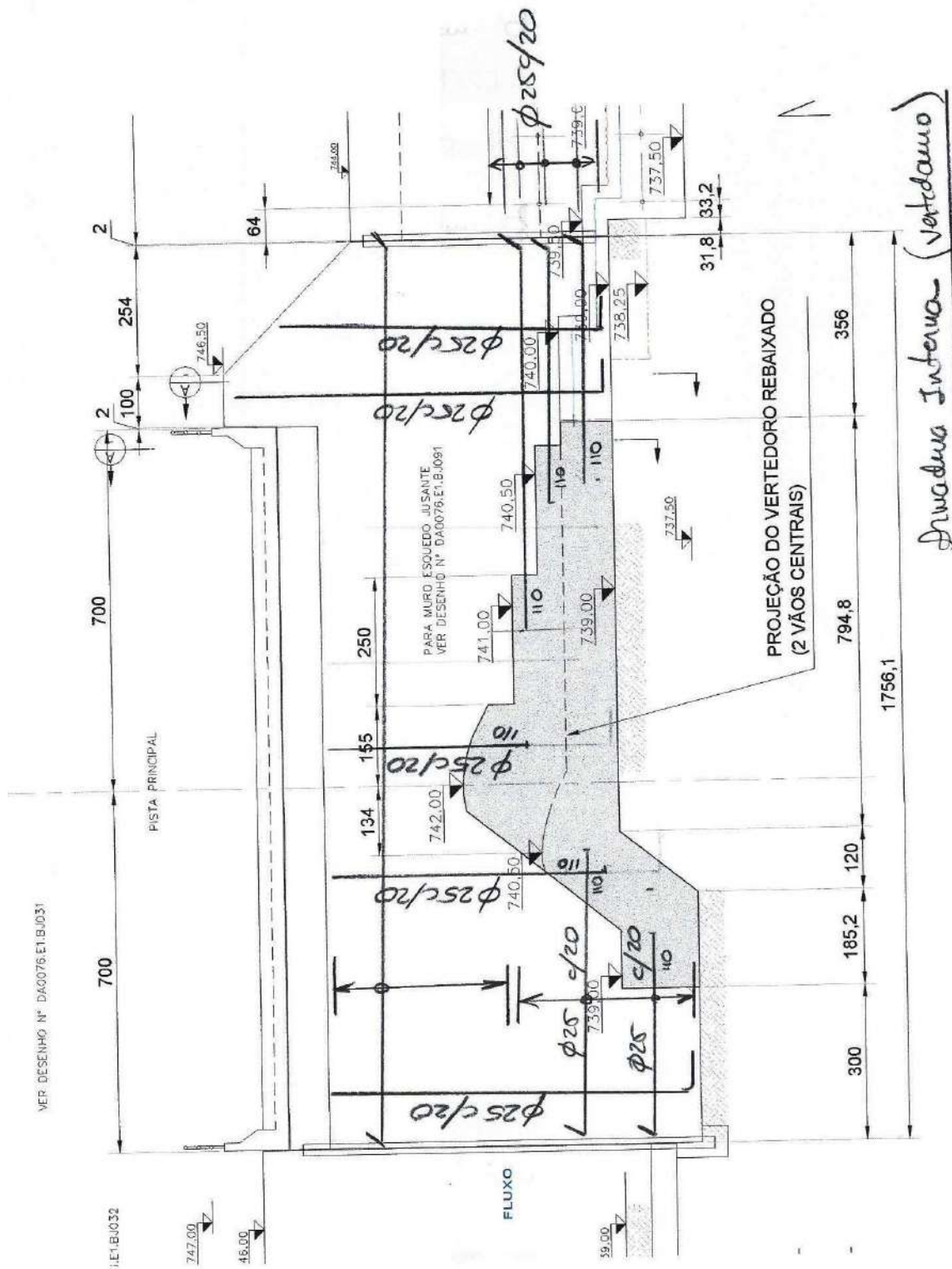
$$\phi 25 \text{ c}/15 = 33,33 \text{ cm}^2/\text{m}$$

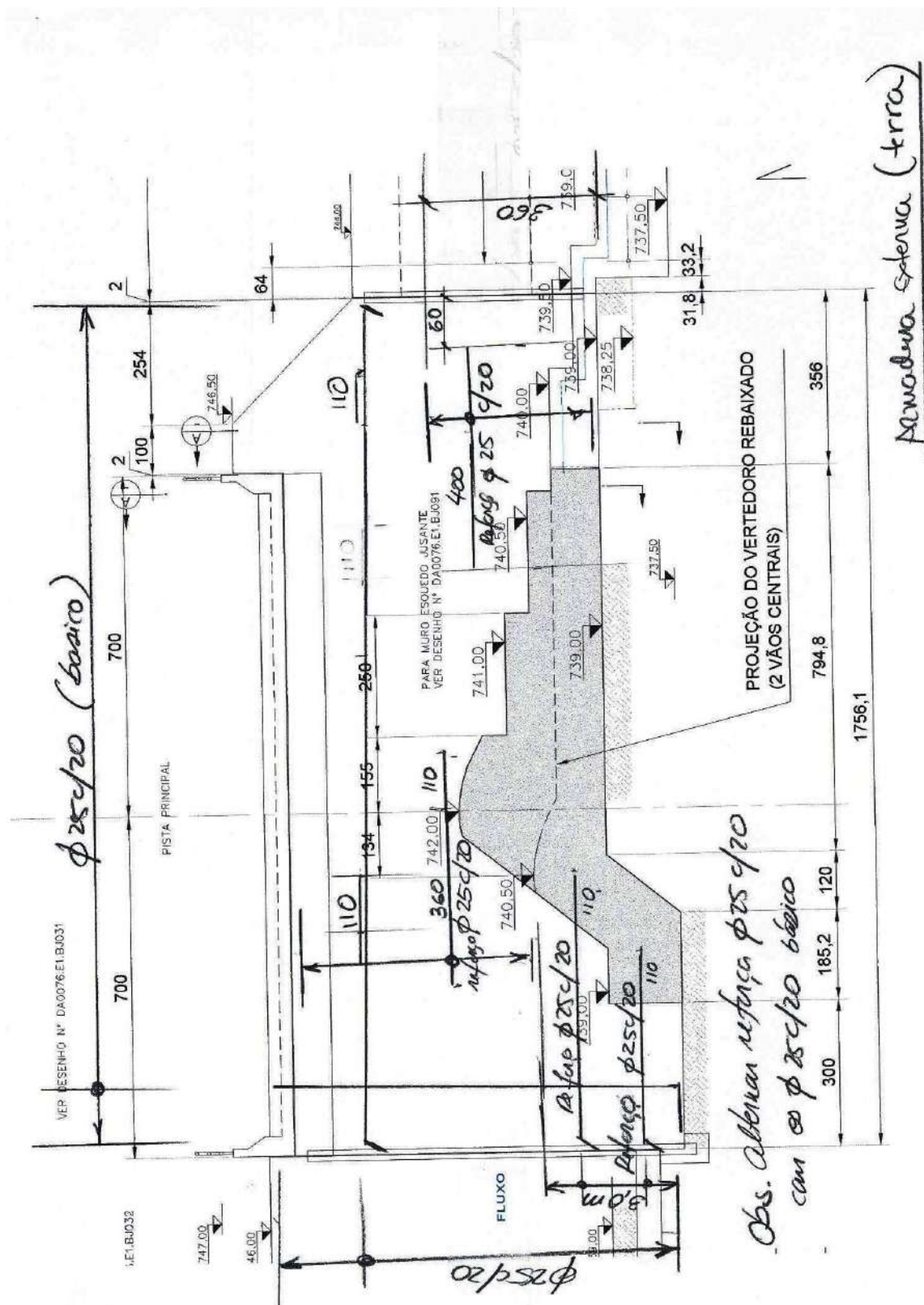
$$c/M = 158 \text{ kNm}/\text{m} \quad c/\phi 25 \quad A_s = 49,0 \text{ cm}^2/\text{m}$$

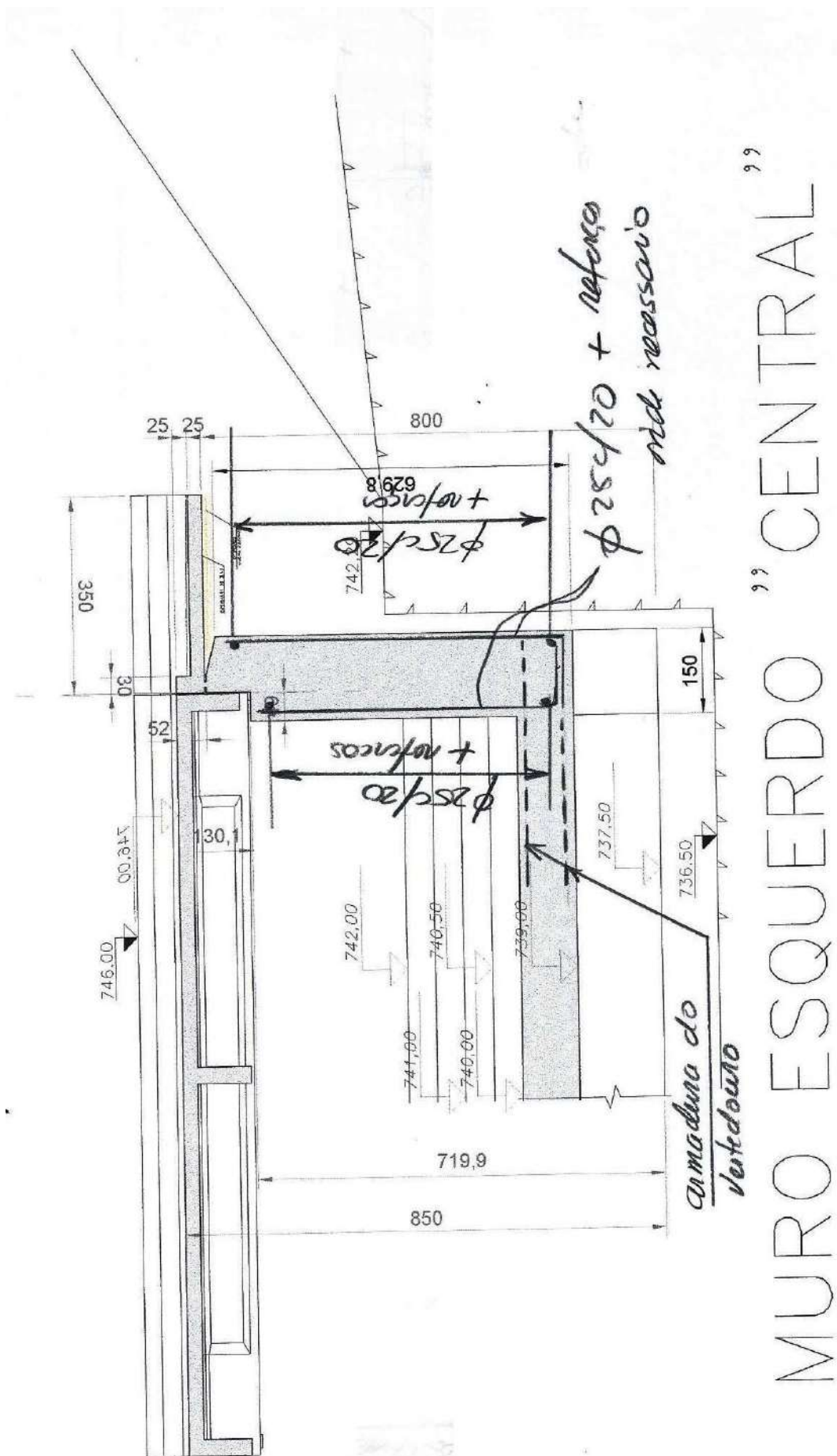
$$\phi 25 \text{ c}/10 = 50 \text{ cm}^2/\text{m}$$

$$c/\quad M = 170 \text{ kNm}/\text{m} \quad c/\phi 25 \quad A_s = 51 \text{ cm}^2/\text{m}$$

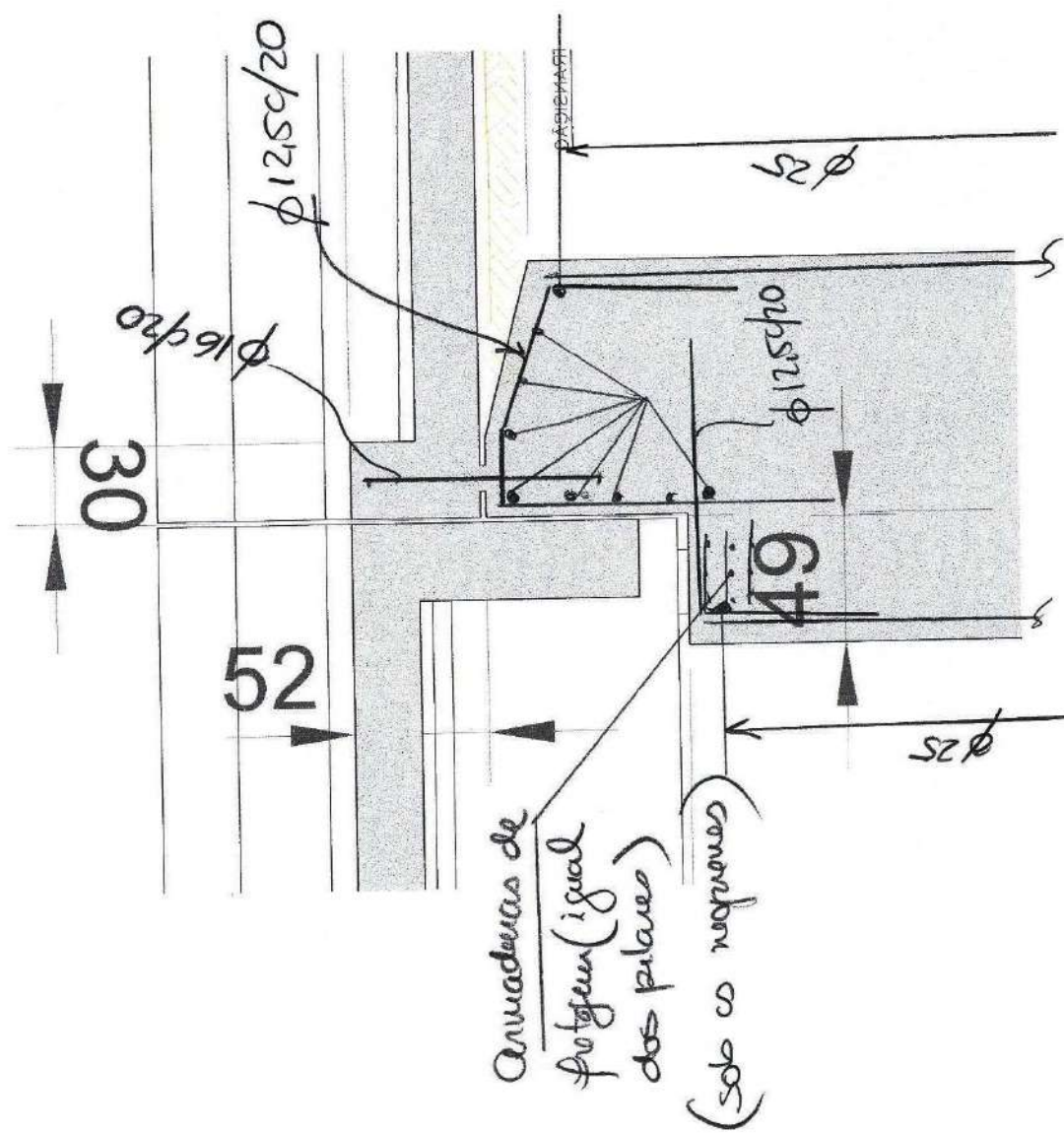
$$\sim \phi 25 \text{ c}/10$$

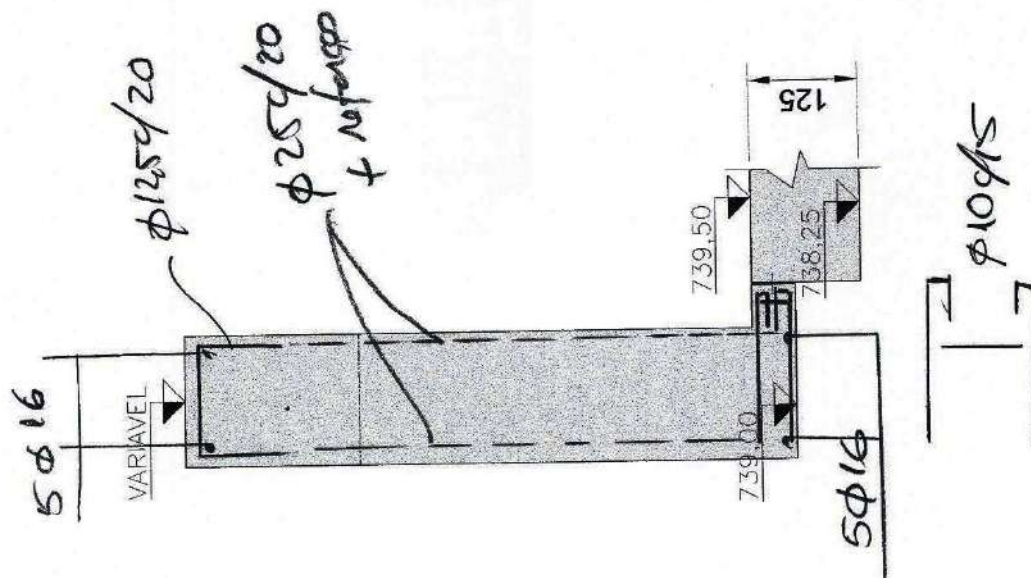
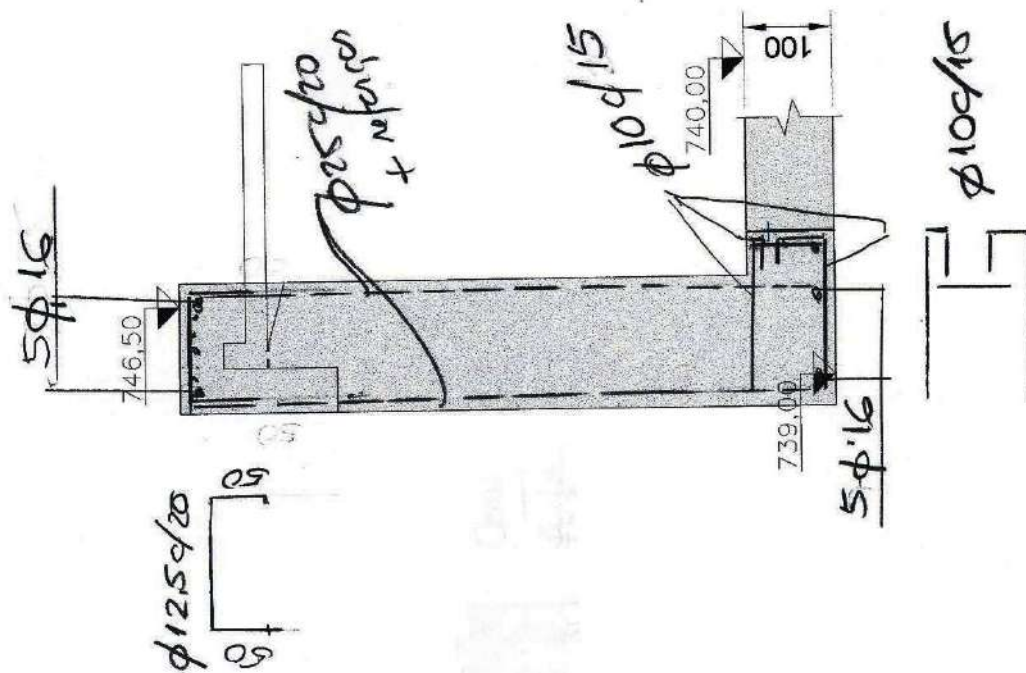






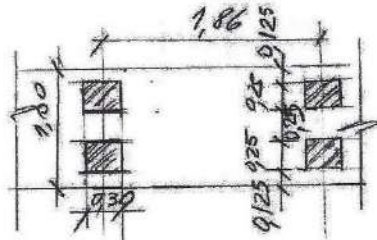
3/7





5/7

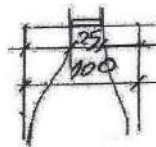
FRETAGEM NO PILAR



$$\gamma_{max} = 100 \text{ kgf/cm}^2$$

$$N = 100 \times 25 \times 30 = 75000 \text{ kgf} = 75 \text{ tf}$$

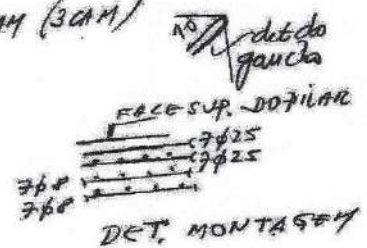
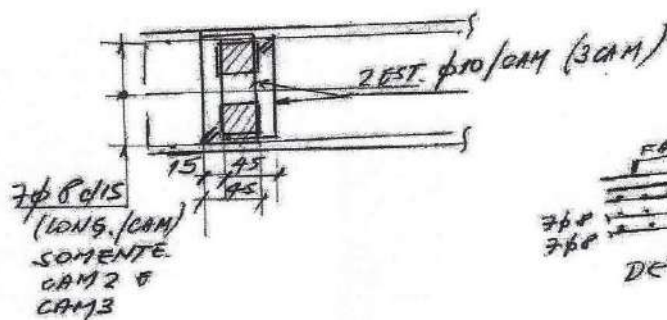
CONSIDERANDO 2N APLICADA NO EIXO DO PILAR
NA ÁREA DE 1 APADELHO 25X30



$$z = 0,25 \times 2 \times 75 \left(1 - \frac{25}{100}\right) = 28,12 \text{ tf}$$

$$A_s = \frac{28,12}{3,0} = 9,4 \text{ cm}^2$$

ADOPTANDO-SE 3 CAM 3,1 cm²/CAM



6/9

CCE
Rebaixamento não pido



		e_A	M_A
C_1	$0,5 \times 3,68 \times 2,3 = 4,23 \text{ tf}$	0,25	+ 1,06
C_4	$1,21 \times 2,18 \times 2,3/2 = 3,03 \text{ tf}$	0,903	+ 2,74
C_5	$2,49 \times 0,5 \times 2,3 = 2,86 \text{ tf}$	1,745	+ 4,99
T_1	$\frac{1,21 \times 2,18}{2} \times 2,0 = 2,64 \text{ tf}$	1,307	+ 3,45
T_2	$1,28 \times 2,18 \times 2,0 = 5,58 \text{ tf}$	2,35	+ 13,11
			+ 25,35
E_1	$1,88 \times 2,49 = 4,68 \text{ tf}$	1,745	- 8,17
E_2	$0,8 \times 0,80/2 = 0,32 \text{ tf}$	2,147	- 0,69
E_3	$0,8 \times 1,88 = 1,50 \text{ tf}$	0,94	- 1,41
E_4	$0,94 \times 1,88/2 = 0,88 \text{ tf}$	0,63	- 0,55
A_1	$1,88^2/2 = 1,77 \text{ tf}$	0,63	- 1,12
			- 11,94

$$FSF = \frac{4,23 + 3,03 + 2,86 + 2,64 + 5,58}{4,68} = \frac{18,34}{4,68} = 3,92 > 1,1$$

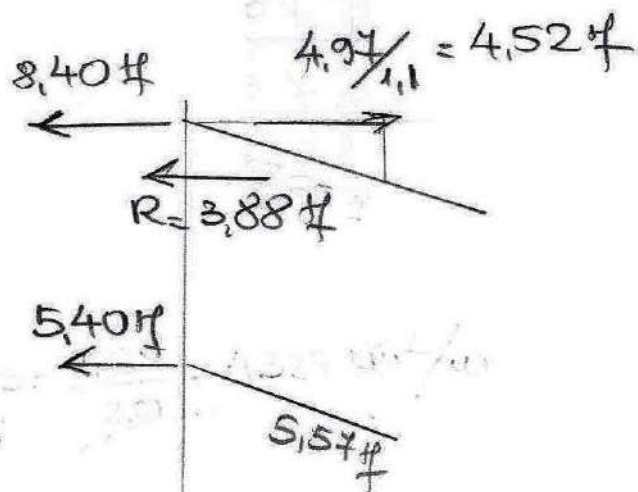
$$FST = \frac{25,35}{11,94} = 2,12 > 1,2$$

A parte superior é
atômica!

$$H = 0,32 + 1,50 + 0,88 + 1,77 = 4,47 \text{ tf}$$

$$V = 18,34 - 4,68 = 13,66 \text{ tf} \quad \phi = 20^\circ$$

$$V \text{ tg } \phi = 4,97 \text{ tf} \quad FSD = \frac{4,97/1,6}{4,47} = 1,01 > 1,0$$



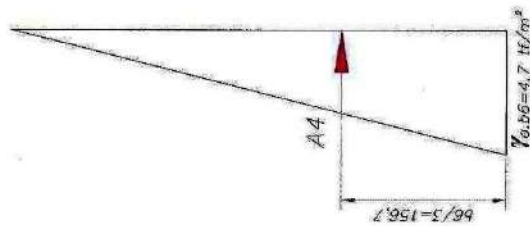
$$\bar{p}_g \approx 2.0 \text{ kN/m}^2$$

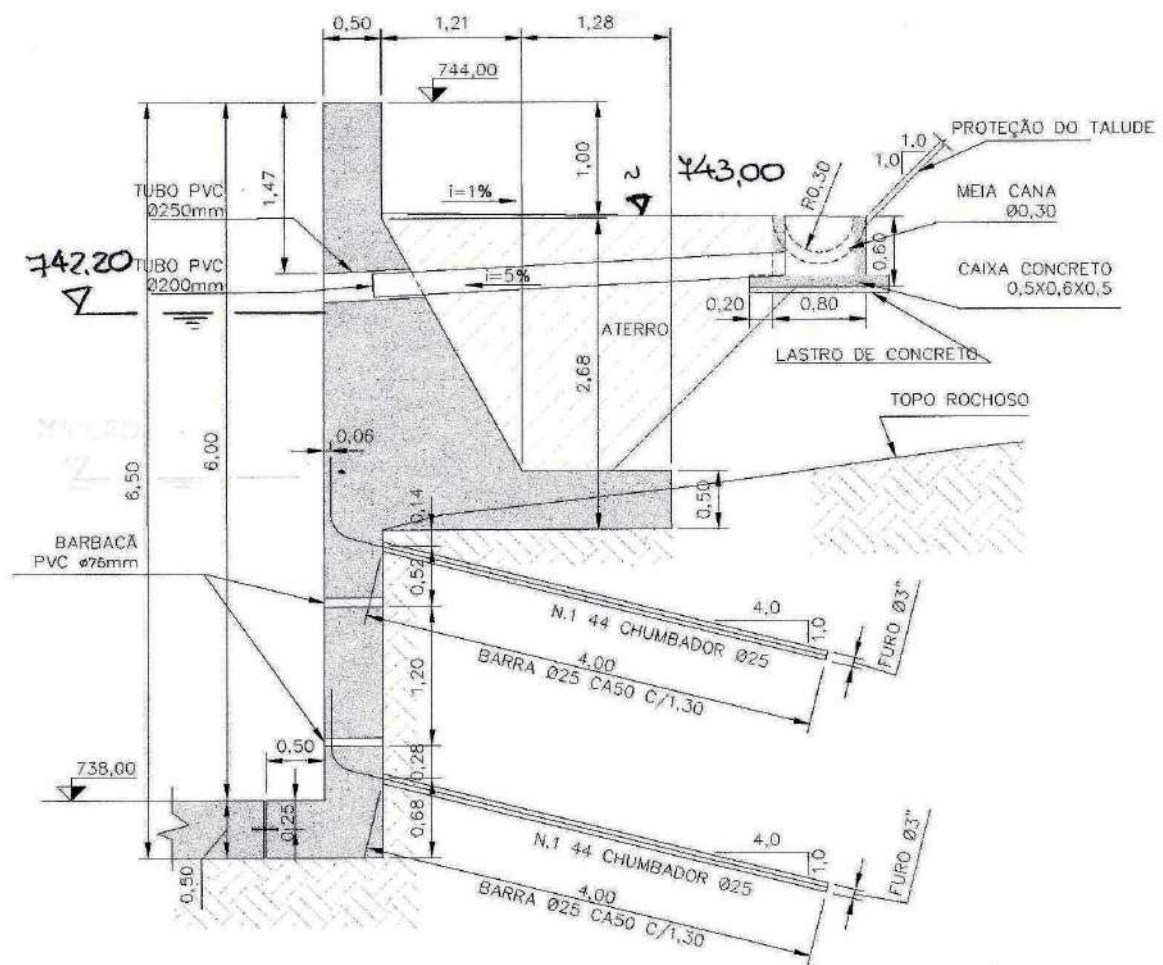
$$A_s = \frac{5.57}{2.0} = 2.79 \text{ m}^2/\text{m}$$

$$\phi_{25} = 0.8 \times 5.0 = 4.0 \text{ m}^2/\text{m} \text{ (80\% Area)}$$

$$e = \frac{4.0}{2.79} = 1.43 \text{ m} \text{ adota-se } e = 1.30 \text{ m}$$

dimensões ϕ_{25} e 1.30 m
adotado





CORTE
ESC. 1:50



Dimensionamento da Armadura:

$$f_{ck}=20\text{MPa}$$

$$b=100\text{cm}$$

$$h=50\text{cm}$$

$$d=50-6-1,6-1,6/2=41,6\text{ cm}$$

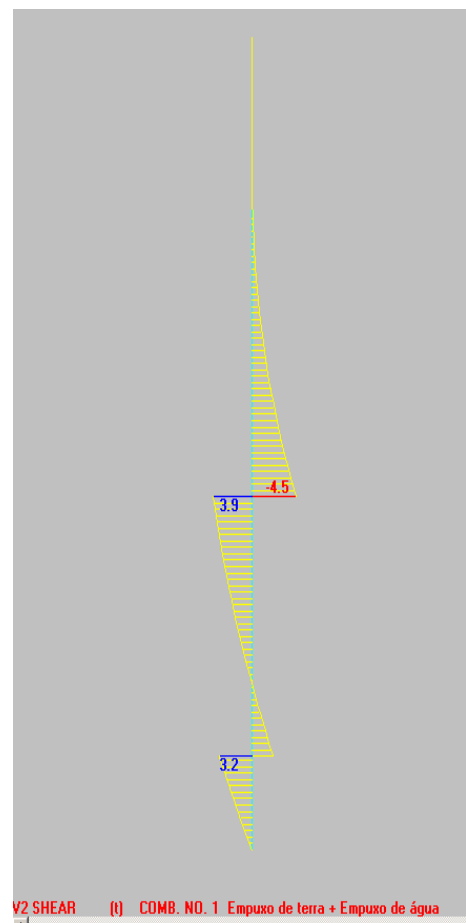
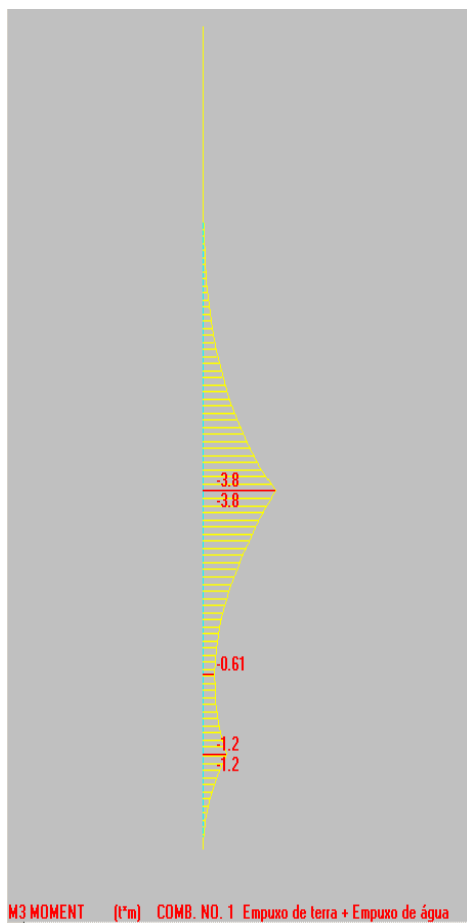
$$M_k=9,0\text{ tf.m/m}$$

$$A_{s_{nec}}=7,19\text{ cm}^2/\text{m}$$

$$c/\varnothing 16\text{mm } c/20\text{ cm} = 9,90\text{ cm}^2/\text{m temos } \omega=0,2\text{ mm}$$

$$VRk1=12.590\text{ kg/m}$$

Diagrama de Momentos Fletores e armadura adotada:



Adotaremos armadura # Ø16 mm c/20cm

