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**AUTOR:**

SECRETARIA DOS RECURSOS HÍDRICOS – SRH; GEONORTE

**TÍTULO:**

PROJETO EXECUTIVO DA BARRAGEM MARCO

**SUBTÍTULO:**

VOLUME 8 CÁLCULO ESTRUTURAL

FOLHA DE DADOS - GED/SRH

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Tipo de Empreendimento:

<input checked="" type="checkbox"/> Barragem	<input type="checkbox"/> Açude	<input type="checkbox"/> Adutora	<input type="checkbox"/> Canal / Eixo de Transp.	<input type="checkbox"/> Outro
Rio / Riacho Barrado: <u>Riacho do Corrego</u>		Fonte Hídrica: _____		

Bacia: Acarauí  
 Sub-bacia: \_\_\_\_\_  
 Municípios: Marco  
 Distrito: \_\_\_\_\_  
 Microregião: bitoral de Lamocim e Acarauí  
 Estado: Ceará

Lote: 00033 - Prep () Scan ( ) Index ( )  
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Geonorte



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**PROJETO EXECUTIVO DA BARRAGEM MARCO,  
EM MARCO, CEARA.  
VOLUME 8: CALCULO ESTRUTURAL**

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## 1. INTRODUÇÃO

Estamos apresentando o cálculo estrutural da Tomada d'Água (torre de comando a montante, boca de montante, galeria e boca de jusante) da Barragem Marco, em Marco, Ceará, apresentado no Anexo A (Memória de Cálculo) e no Anexo B (Desenhos).

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**ANEXO A:**

**Memória de Cálculo**

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## MEMORIA DE CALCULO

### 1. INTRODUÇÃO:

1.1 - A presente MEMORIA DE CALCULO refere-se ao projeto e cálculo estrutural da torre, boca de montante, galeria e boca de jusante da Tomada d'água da Barragem MARCO, no Município de MARCO, Estado do Ceará.

### 1.2 - Cargas:

#### 1.2.1 - Peso próprio da estrutura:

concr.armado :  $\gamma_c = 2,5 \text{ t/m}^3$   
concr.ciclópico:  $\gamma_c = 2,2 \text{ t/m}^3$

1.2.2 - Vento: Foram consideradas as prescrições da NB-599.

#### 1.2.3 - Coeficientes de segurança - Tensões de cálculo:

Foram observadas as prescrições da NB-1/78.

### 1.4 - Materiais Empregados:

Concreto armado -  $f_{ck} = 15 \text{ MPa}$

Aço CA-50 -  $f_{yk} = 500 \text{ MPa}$

Aço CA-60 -  $f_{yk} = 600 \text{ MPa}$

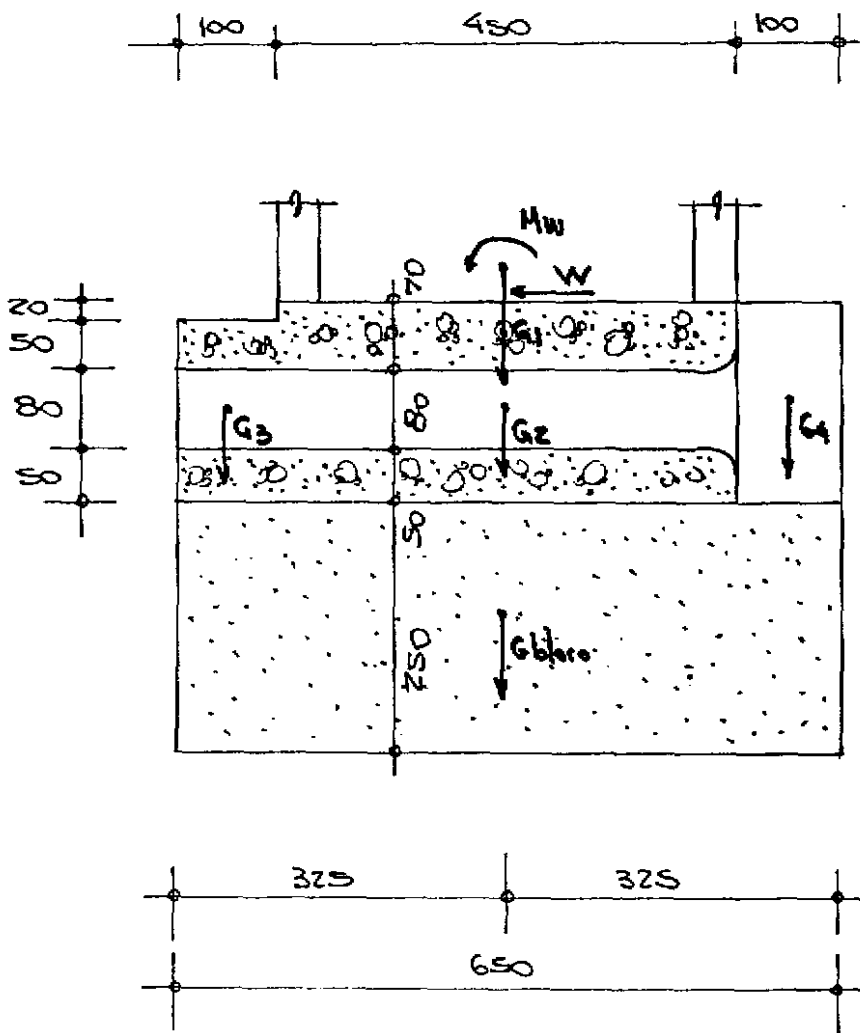
### 2. TORRE:

#### 2.1 - Verificação da estabilidade do conjunto:

##### 2.1.1 - Direção X:



2.1.1.1 - Redução do sistema de forças ao centro de gravidade da base:



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a) Cargas Verticais e Momentos:

N	X	M = N.X
G1 = 100,0	. 0,00	= 0,00
G2 = 115,8	. 0,00	= 0,00
G3 = 7,3	. 2,75	= 20,08 (+)
G4 = 2,0	. 2,75	= 5,50 (-)
$\Sigma G = 225,10$ t		$\Sigma GX = 14,58$ t.m

b) Ações do Vento:

Momentos no nível "0":

$$M_w = \frac{16,5 \times 0,377^2}{2} = 51,32 \text{ t.m}$$

Momento no topo do bloco de concreto ciclópico:

$$M_w = 51,32 + 6,22 \times 2,0 = 63,76 \text{ t.m}$$

2.1.1.2 - Tensões no Concreto Ciclópico:

$$N_1 = 225,10 \text{ t}$$

$$M_1 = 14,58 + 63,76 = 78,34 \text{ t.m}$$

$$e = 0,35 \text{ m} < b/3 = 2,17 \text{ m}$$

$$c = b/2 - e = 2,9 \text{ m}$$

$$\sigma_{\max} = \frac{2 \times 225,10}{3 \times 2,90 \times 5,40} = 9,58 \text{ t/m}^2 \quad (\text{OK!})$$

2.1.1.3 - Tensões na Rocha de Fundação:

Admitindo o bloco de concreto ciclópico com 2,50 m de altura, obtém-se:

$$N2 = 225,10 + 6,50 \times 7,40 \times 2,50 \times 2,2 = 489,65 \text{ t}$$

$$M2 = 14,58 + 51,32 + 6,22 \times 4,50 = 93,89 \text{ t.m}$$

$$\sigma_{1,2} = \frac{489,65}{6,50 \times 7,4} \pm \frac{93,89 \times 6}{7,40 \times 6,50^2} = \begin{cases} \sigma_1 = 11,98 \text{ t/m}^2 \\ \sigma_2 = 8,38 \text{ t/m}^2 \end{cases}$$

2.1.2 - Direção Y:

2.1.2.1 - Como todas as cargas coincidem com o centro de gravidade da base, não há excentricidade devido ao carregamento vertical.

Ação do Vento:

Momento no nível "0":

$$M_w = \frac{16,5 \times 0,331^2}{2} = 45,06 \text{ t.m}$$

Momento no topo do bloco de concreto ciclópico:

$$M_w = 45,06 + 5,46 \times 2,0 = 56,0 \text{ t.m}$$

2.1.2.2 - Tensões no Concreto Ciclópico:

$$N1 = 225,10 \text{ t}$$

$$M1 = 56,0 \text{ t.m}$$

$$e = 0,25 \text{ м} < a/3 = 2,5 \text{ м}$$

$$c = a/2 - e = 3,45 \text{ м}$$



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$$\sigma_{\max} = \frac{2 \times 225,10}{3 \times 2,70 \times 4,5} = 12,4 \text{ t/m}^2$$

### 2.1.2.3 - Tensões na Rocha de Fundação:

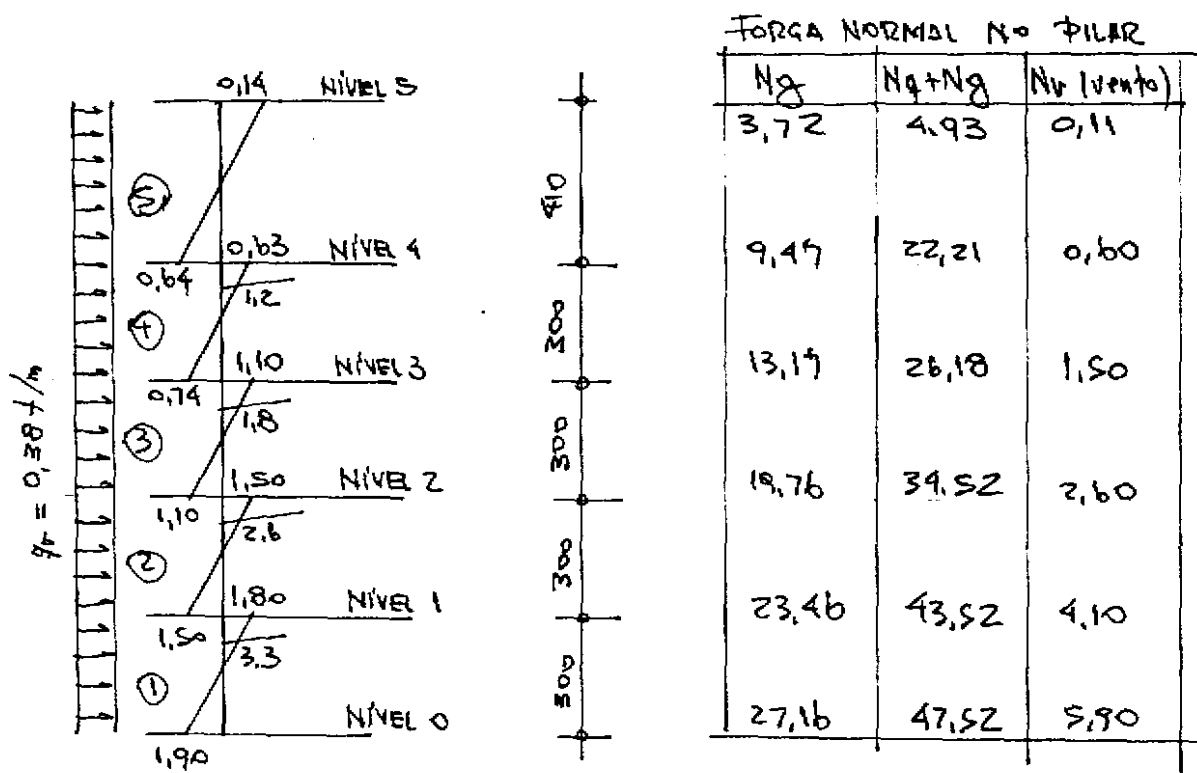
$$N_2 = 489,65 \text{ t}$$

$$M_2 = 45,06 + 5,46 \times 4,50 = 69,63 \text{ t.m}$$

$$\sigma_{1,2} = \frac{489,65}{6,50 \times 7,40} \pm \frac{69,63 \times 6}{6,50 \times 7,4^2} = \begin{cases} \sigma_1 = 11,35 \text{ t/m}^2 \\ \sigma_2 = 9,01 \text{ t/m}^2 \end{cases}$$

### 2.2 - Resolução do Pórtico e Dimensionamento dos Pilares:

#### a) Momentos Fletores (tf.m):



- Determinação do comprimento de flambagem:

I) Trecho corrente: pilares 40 X 50

$$L_e = 2,25 \times 1,15 = 2,6m - \lambda = 22,5$$

II) Trecho superior: pilares 20 X 20

$$L_e = 1,15 \times 4,10 = 4,70 - \lambda = 81,31$$

b) Dimensionamento dos Pilares: a hipótese mais desfavorável corresponde à ação de  $N_g + N_q + N_v$  (ação do vento):

Barra 1: 40 X 50

$$N_k = 71,92 \text{ ton}$$

$$M_k = 3,10 \text{ t.m} - e = 0,04 \text{ m}$$

$$1 - A_{sx} = A_{sy} = 6,84 \text{ cm}^2$$

$$2 - A_{sx} = A_{sy} = 6,84 \text{ cm}^2$$

Barras 2, 3, 4: 40 X 50

$$N_k = 47,62 \text{ ton}$$

$$M_k = 1,50 \text{ t.m} - e = 0,03 \text{ m}$$

$$1 - A_{sx} = A_{sy} = 4,46 \text{ cm}^2$$

$$- A_{s,\text{min total}} = 10,0 \text{ cm}^2$$

Barra 5: 20 X 20

$$N_k = 5,04 \text{ ton}$$

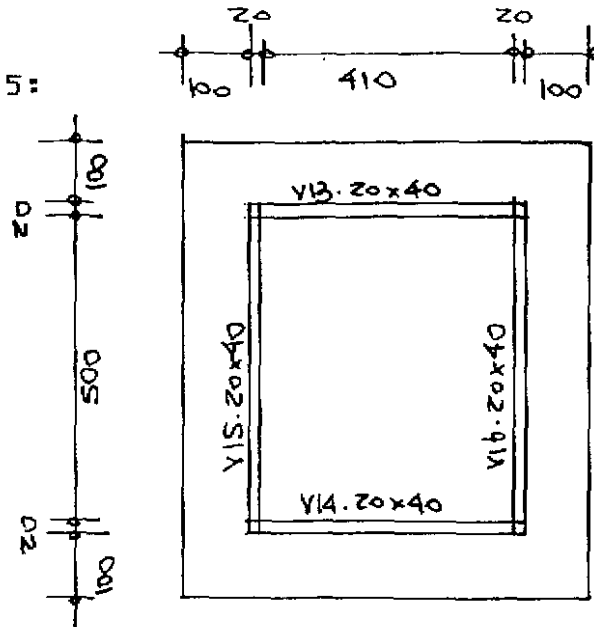
$$M_k = 0,64 \text{ t.m} - e = 0,13 \text{ m}$$

$$1 - A_{s,\text{min}} = 2,0 \text{ cm}^2$$

2.3 - Dimensionamento das Lajes e Vigas:

Foram dimensionadas segundo os critérios da NB-1/78.

NIVEL 5:



$$pp - 0,10 \times 2,5 = 0,25 \text{ t/m}^2$$

$$sob. = 0,10 \text{ t/m}^2$$

---


$$0,35 \text{ t/m}^2$$

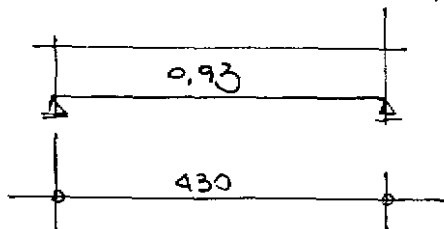
Momento dos balanços:

$$X = \frac{0,35 \times 1,1^2}{2} = 0,21 \text{ t.m/m}$$

$$Q = 0,35 \times 1,0 = 0,35 \text{ t/m}$$

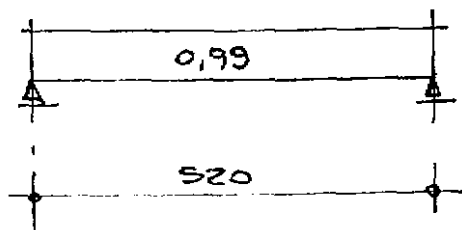
$$V13 = V14 - 20 \times 40$$

pp - 0,20  
L - 0,38  
M - 0,35

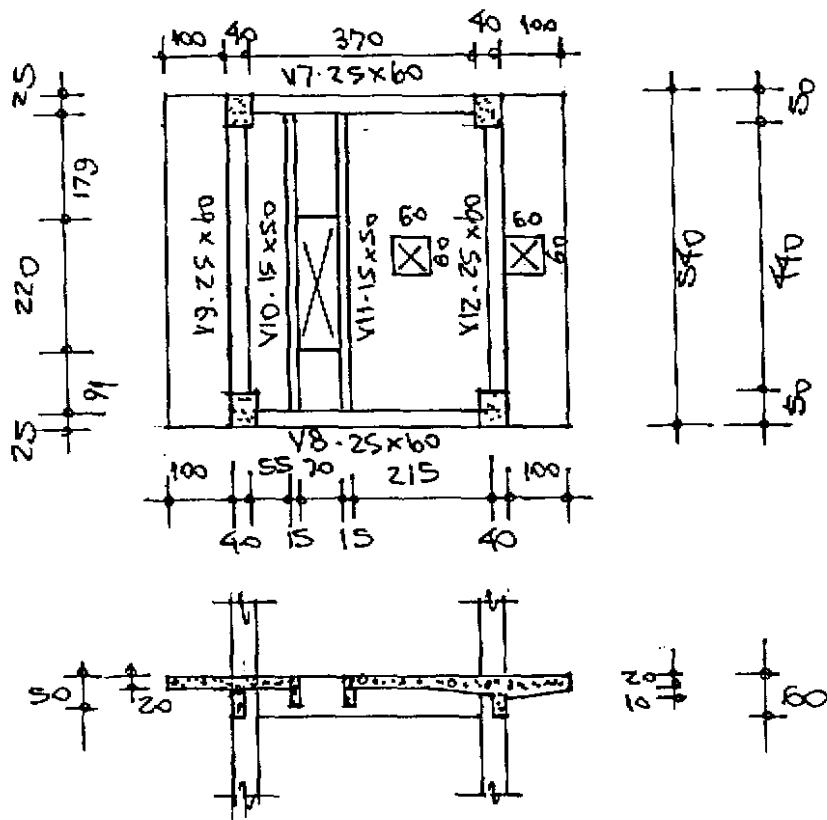


V15 = V16 - 20 X 40

pp - 0,20  
 L - 0,44  
 M - 0,37



NIVEL 4 - Operação:



pp - 0,20 x 2,5 = 0,50 t/m<sup>2</sup>

sob. = 1,00 t/m<sup>2</sup>

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$$q = 1,50 \text{ t/m}^2$$

Marquise variável:

$$pp - 0,25 \times 2,5 = 0,63 \text{ t/m}^2$$

$$\text{sob.} = 1,00 \text{ t/m}^2$$

---


$$= 1,63 \text{ t/m}^2$$

Esforços na marquise variável:

$$X = \frac{1,63 \times 1,125^2}{2} = 1,03 \text{ t.m/m}$$

$$Q = 1,63 \times 1,125 = 1,83 \text{ t/m}$$

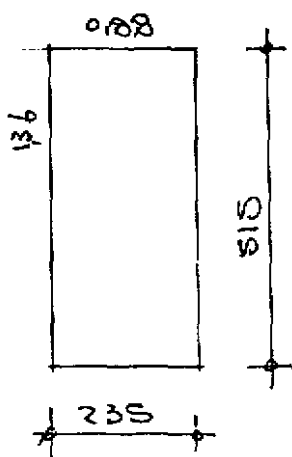
Esforços na marquise constante:

$$X = \frac{1,50 \times 1,125^2}{2} = 0,95 \text{ t.m/m}$$

$$Q = 1,50 \times 1,125 = 1,70 \text{ t/m}$$

Lajes centrais:

L1 :



$$p = 1,5 \text{ t/m}^2$$

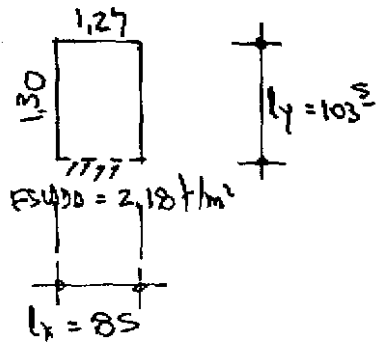
$$M_x = 0,89 \rightarrow \text{4.bc.12}$$

$$M_y = 0,35 \rightarrow \text{4.bc.16}$$

A handwritten signature or set of initials, possibly 'M', written in dark ink.



L2 :



$$\lambda = 1,20$$

$$p = 1,5 \text{ t/m}^2$$

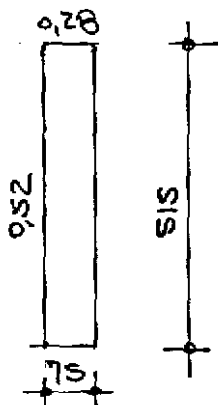
$$M_R = \frac{1,32}{10,7} + \frac{1,85}{4,10} = 0,57$$

$$M_X = \frac{1,32}{14,10} + \frac{1,85}{13,1} = 0,23$$

$$M_Y = \frac{1,32}{80} - \frac{1,85}{29,2} = -0,04$$

$$M_{XY} = \frac{1,32}{17,9} + \frac{1,85}{32,4} = 0,113$$

L3 :

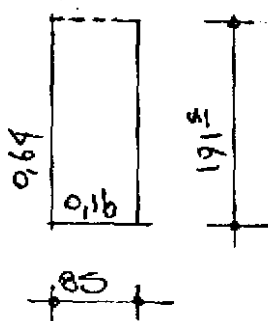


$$p = 1,5 \text{ t/m}^2$$

$$A_{s_x} = 3,9 \text{ c.17}$$

$$A_{s_y} = 3,9 \text{ c.17}$$

L4 :



$$\lambda = 2,25$$

$$p = 1,5 \text{ t/m}^2$$

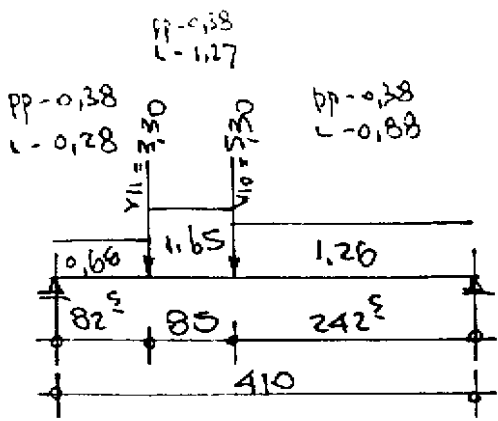
$$M = \frac{1,5 \times 0,18^2}{8} = 0,119 \text{ t/m/m}$$

$$R_x = \frac{1,5 \times 0,185}{2} = 0,164 \text{ t/m}$$

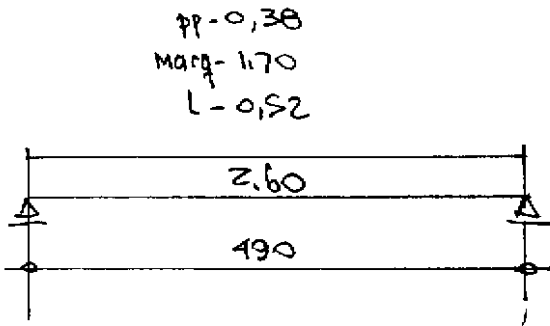
$$R_y = 0,125 \times 0,185 \times 1,50 = 0,116 \text{ t/m}$$

VIGAS:

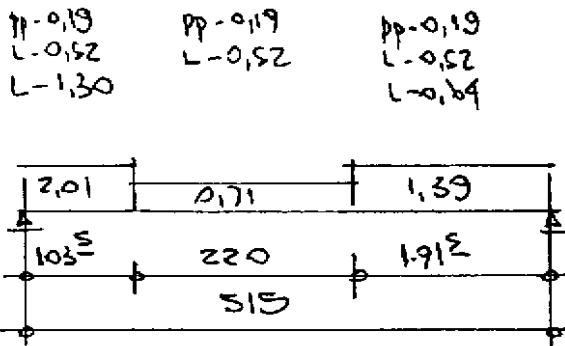
$$V7 = V8 - 25 \times 60$$



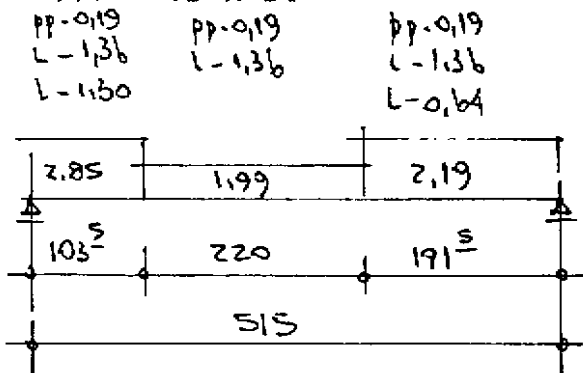
V9 - 25 X 60



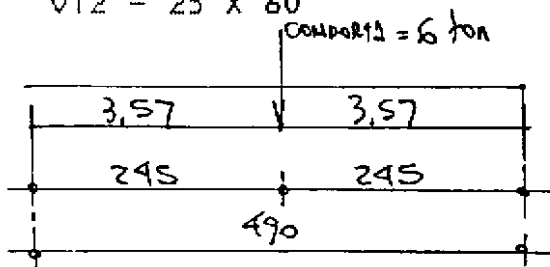
V10 - 15 X 50



V11 - 15 X 50



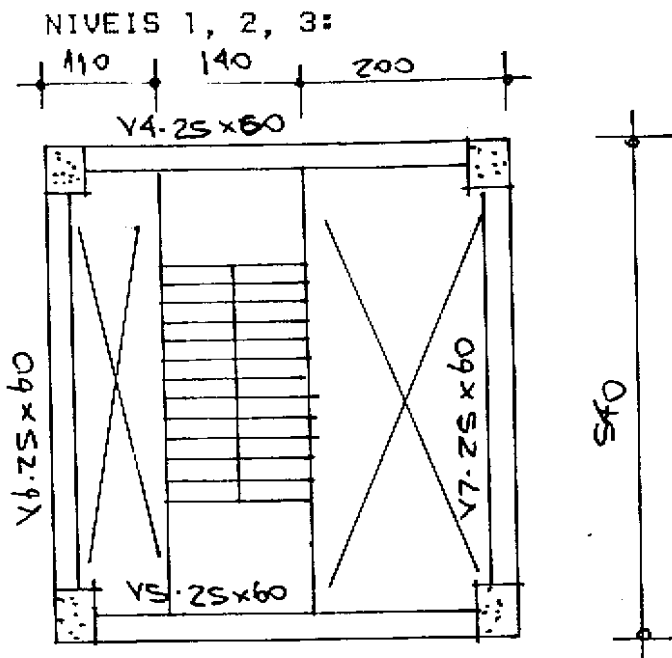
V12 - 25 X 60



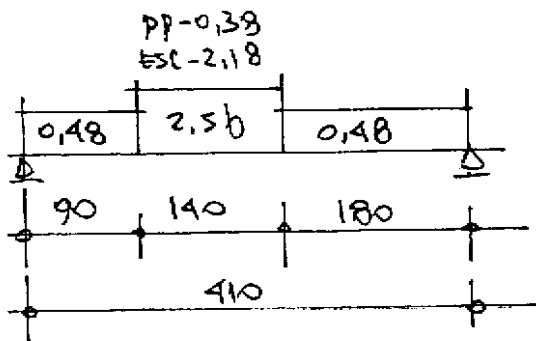
$pp-0,38$   
 $margin-1,83$   
 $L-1,36$



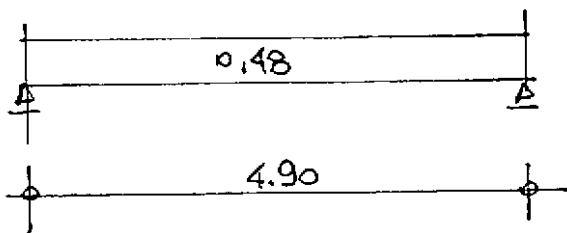
000017



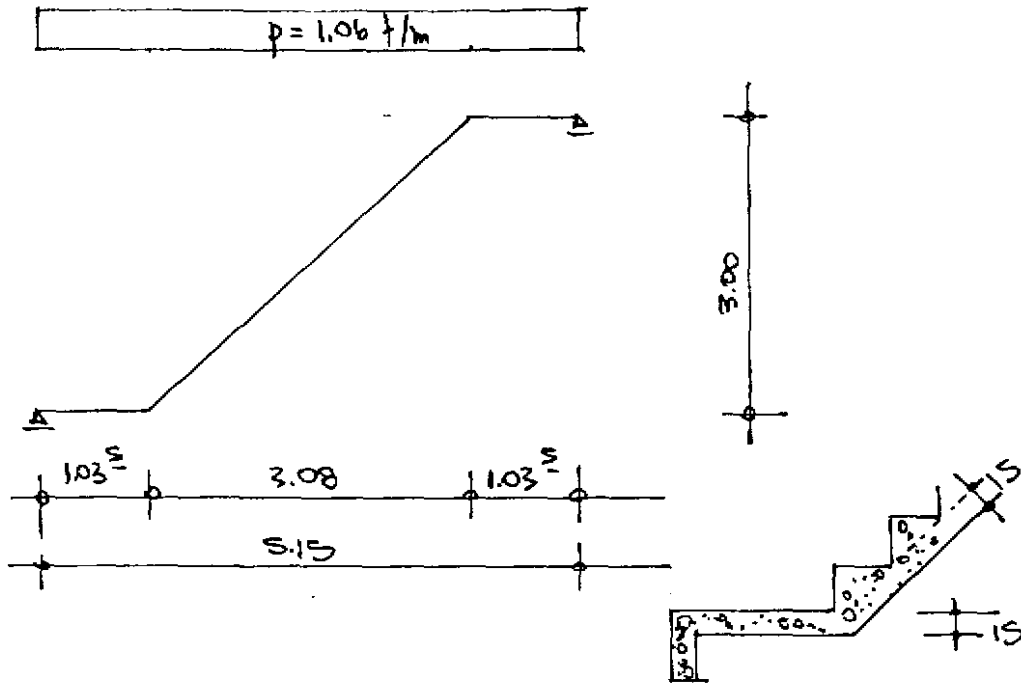
$$V1 = V2 = V4 = V5 - 25 \times 60$$



$$V3 = V6 = V7 - 25 \times 60$$



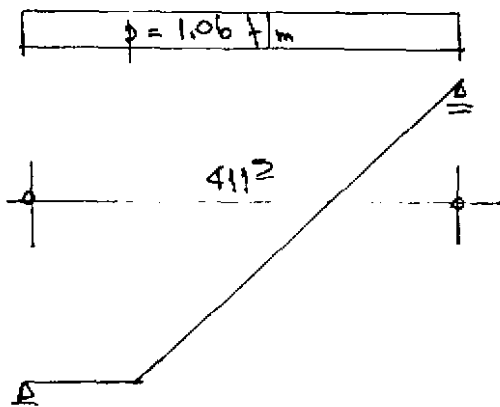
CALCULO DA ESCADA:



$$\begin{array}{rcl}
 pp - 0,15 \times 2,5 = 0,38 & pp - 0,3027 \times 2,5 = 0,76 \\
 \text{sob.} & = 0,30 & \text{sob.} & = 0,20 \\
 & \underline{\hspace{1cm}} & & \underline{\hspace{1cm}} \\
 & 0,68 & & 1,06
 \end{array}$$

$$M = \frac{1,06 \times 5,15^2}{8} = 3,51 \text{ t.m} \quad - \quad A_s = 11,81 \text{ cm}^2 \quad (\# 12.5 \text{ c. } 10)$$

$$Q = \frac{1,06 \times 5,15}{2} = 2,73 \text{ t}$$



$$M = \frac{1,06 \times 4,115^2}{8} = 2,25 \text{ t.m} \quad - \quad A_s = 6,46 \text{ cm}^2$$

(\\$10c.11)

$$Q = \frac{1,06 \times 4,115}{2} = 2,18 \text{ t}$$

### 3. BOCA DE MONTANTE:

Levando em conta que os esforços solicitantes são relativamente pequenos com relação às dimensões das peças estruturais, dimensionaram-se as mesmas pelas condições de armaduras mínimas.

- Peças solicitadas predominantemente à flexão:

$$A_s = 0,15\% b_w.d$$

- Peças solicitadas predominantemente à compressão:

$$A_s = 0,5\% A_c$$

### 4. GALERIAS:

A galeria foi analisada como uma estrutura em quadro fechado, considerando-se duas situações:

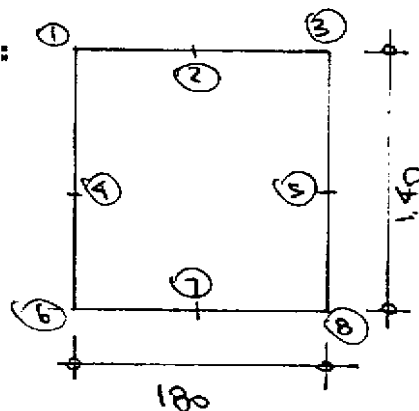
#### 4.2.1 - Ação do carregamento vertical:

$$g_1 = 2,1 \times 22,0 = 46,20 \text{ t/m}$$

$$g_2 = 0,5 \times 2,5 = 1,25 \text{ t/m}$$

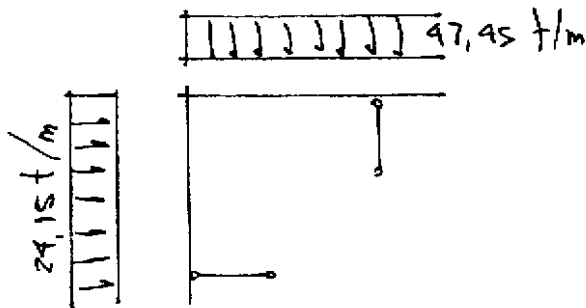
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$$47,45 \text{ t/m}$$



#### 4.2.2 - Ação do empuxo de terra:

$$P = k \cdot \gamma \cdot h = 0,5 \times 2,1 \times 23 = 24,15 \text{ t/m}$$



$$S1 = \frac{47,45 \times 1,40^2}{4} \times \frac{1,40}{1,80} + \frac{24,15 \times 1,80^2}{8,56} = 27,225$$

$$S2 = \frac{47,45 \times 1,40^2}{4} \times \frac{1,40}{1,80} + \frac{24,15 \times 1,80^2}{7,50} = 28,516$$

$$m1 = m2 = 4,333$$

$$X1 = - \frac{27,225 \times 4,333 - 28,516}{17,775} = -5,03 \text{ t.m} - A_s = 6,75 \text{ (}\Phi 10 \text{ c.11)}$$

$$X2 = - \frac{28,516 \times 4,333 - 27,225}{17,775} = -5,42 \text{ t.m} - A_s = 6,75 \text{ (}\Phi 10 \text{ c.11)}$$

$$M2 = 14,19 \text{ t.m/m} - A_s = 10,77 \text{ cm}^2/\text{m} \text{ (}\Phi 12,5 \text{ c.11)}$$

$$M4 = 0,90 \text{ t.m/m} - A_s = 6,75 \text{ cm}^2/\text{m} \text{ (}\Phi 10 \text{ c.11)}$$

## 5. BOCA DE JUSANTE:

5.1 - Tensões no solo de fundação: Redução do sistema de forças ao centro de gravidade da base:

*[Handwritten signature]*

N	X	NX
G1 = 13,12	3,40	44,61
G2 = 3,81	2,00	7,62
G3 = 1,41	0,65	0,92
G4 = 3,45	1,60	5,52
G5 = 21,02	1,05	22,07
G6 = 10,44	0,70	7,31
G7 = 2,52	2,60	6,55
G8 = 9,97	1,35	13,46
G9 = 5,25	2,55	13,39
G10 = 1,87	0,90	1,68
<hr/>		<hr/>
$\Sigma N = 72,86 \text{ t}$		$\Sigma NX = 24,49 \text{ t.m}$

### 5.1.1 - Tensões no Concreto Ciclópico:

$$N1 = 72,86 \text{ t}$$

$$M1 = 24,49 \text{ t.m}$$

$$e = \frac{24,49}{72,86} = 0,34 \text{ m} < \frac{7,10}{3} = 2,4 \text{ m (OK)}$$

$$c = \frac{b}{2} - e = 3,21 \text{ m}$$

$$\sigma_{\max} = \frac{2 \times 72,86}{3 \times 3,21 \times 3,50} = 4,32 \text{ tf/m}^2 \quad (\text{OK})$$

### 5.1.2 - Tensões na Rocha de Fundação:

Considerando o bloco de concreto ciclópico com 1,50 m de altura:

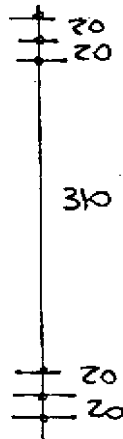
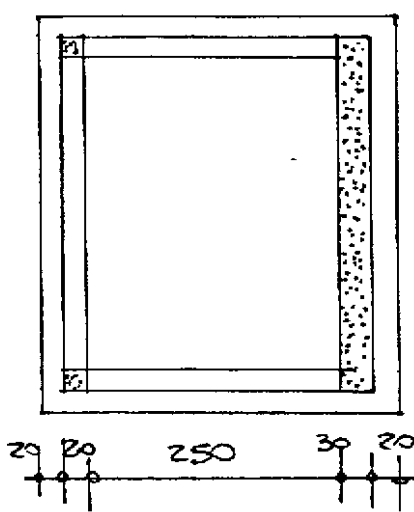
$$N_2 = 72,86 + 7,10 \times 3,50 \times 2,2 = 127,53 \text{ t}$$

$$\sigma_{1,2} = \frac{127,53}{7 \times 3,50} \pm \frac{24,49 \times 6}{3,50 \times 7,10^2} = \begin{cases} \sigma_1 = 6,0 \text{ t/m}^2 \\ \sigma_2 = 4,3 \text{ t/m}^2 \end{cases}$$

## 5.2 - Dimensionamento das Lajes, Vigas e Cortinas:

a) Lajes e Vigas:

Laje de Forro: (L1)



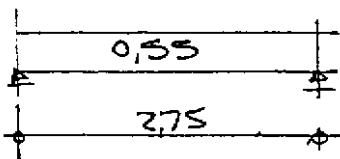
$$\begin{aligned} h &= 10 \text{ cm} \\ pp &= 0,25 \\ r &= 0,05 \\ sob &= 0,10 \\ \hline &0,40 \text{ t/m}^2 \end{aligned}$$

$$V_1 = V_2 - 20 \times 30$$

$$\begin{aligned} pp &= 0,15 \\ M &= 0,12 \\ L &= 0,28 \end{aligned}$$

$$M = 0,52 \text{ t.m} - A_s = 1,01 \text{ cm}^2$$

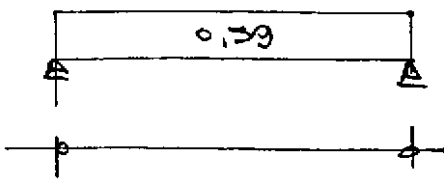
$$Q = 0,76 \text{ t} - \text{estr. } 3.4 \text{ c. } 15$$



$$V_3 - 20 \times 30$$

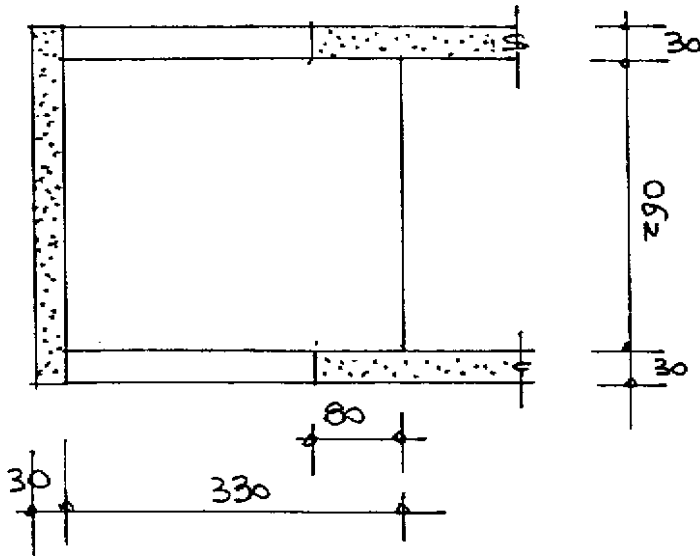


$pp = 0,15$   
 $M = 0,12$   
 $L = 0,32$



$M = 0,80 \text{ t.m} - A_s = 1,01 \text{ cm}^2$   
 $Q = 0,97 \text{ t} - \text{estr. } 3.4 \text{ c.13}$

L2 (PISO)

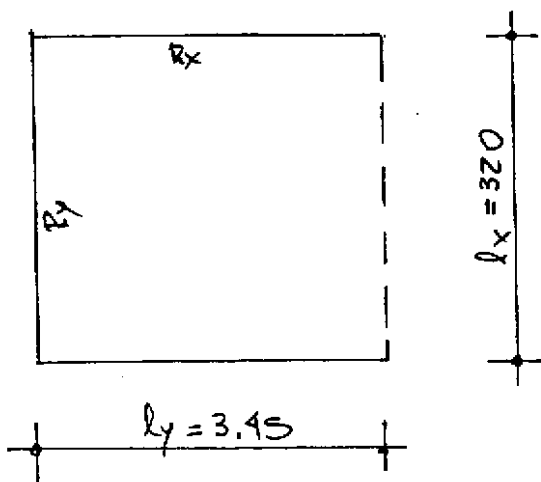


$h = 15 \text{ cm}$

$pp = 0,38$   
 $mr = 0,05$   
 $so = 0,30$   


---

 $0,73 \text{ t/m}^2$



$\lambda = \frac{3,45}{3,20} = 1,10$

$M_r = 8,06/10,2 = 0,79 \text{ tm/m} - A_s = 2,08 \text{ cm}^2$

$M_x = 8,06/13,8 = 0,98 \text{ tm/m} - A_s = 1,55 \text{ cm}^2$

$M_y = 8,06/45,9 = 0,18 \text{ tm/m} - A_s = 1,55 \text{ cm}^2$



$$M_{xy} = 8,06/16,7 = 0,48 \text{ tm/m} - A_s = 1,55 \text{ cm}^2$$

$$R_x = 0,42 \times 0,73 \times 3,20 = 0,98 \text{ t/m}$$

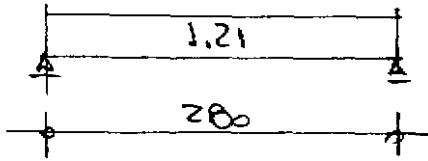
$$R_y = 0,36 \times 0,73 \times 3,45 = 0,91 \text{ t/m}$$



$$V4 = V5 - 30 \times 30$$

$$p_f = 0,23$$

$$L = 0,98$$

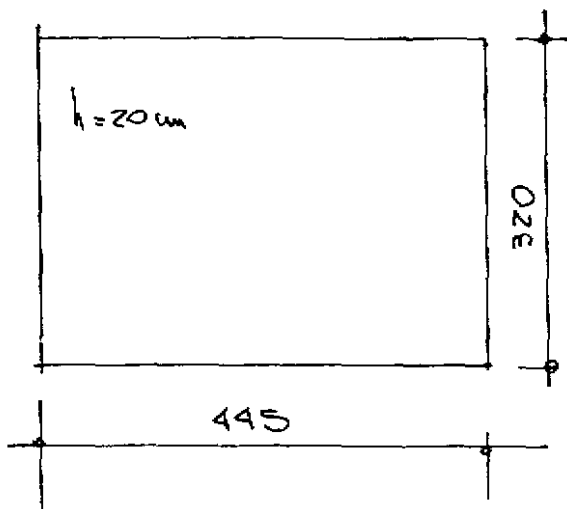


L3 (FUNDO)

$$M = 1,19 \text{ t.m} - A_s = 1,51 \text{ cm}^2$$

$$Q = 1,69 \text{ t} - \text{estr. } 4.6 \text{ c.14}$$

$$\frac{57,64 + 3,46 + 1,75}{24,85} = 2,50 \text{ t/m}^2$$



$$\left. \begin{array}{l} M_x = 1,77 \\ M_y = 1,09 \end{array} \right\} A_s = \text{6.3 c.11}$$

$$R_x = 2,00$$

$$R_y = 2,56$$

$$\lambda = \frac{2,50}{3,20} \approx 0,8$$

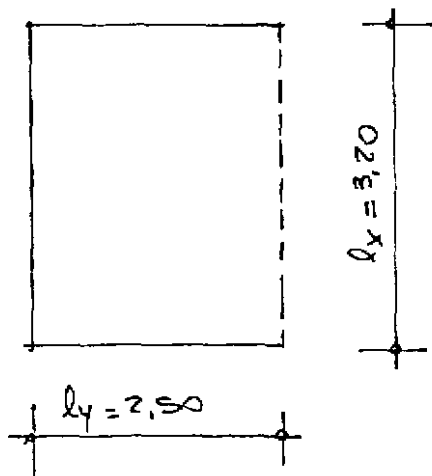
$$M_r = 20/9,1 = 2,20 \text{ t.m/m}$$

$$M_x = 20/13,8 = 1,45$$

$$M_y = 20/33,2 = 0,60$$

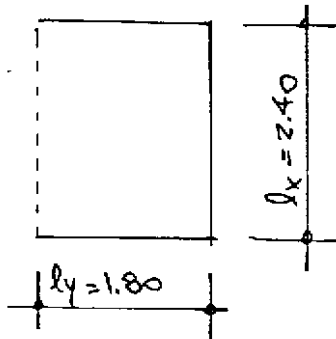
$$M_{xy} = 20/12,9 = 1,55$$

$$- A_s = \text{6.3 c.11}$$



b) CORTINAS:

C1 -



$$\lambda = \frac{1.80}{2.40} \cong 0,8$$

$$M_r = 10,9/9,1 = 1,2 \text{ t.m/m}$$

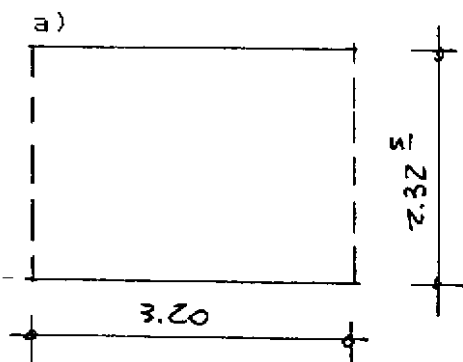
$$M_x = 10,9/13,8 = 0,29$$

$$M_y = 10,9/33,2 = 0,33$$

$$M_{xy} = 10,9/12,9 = 0,34 \quad - \text{F6.3 c.11}$$

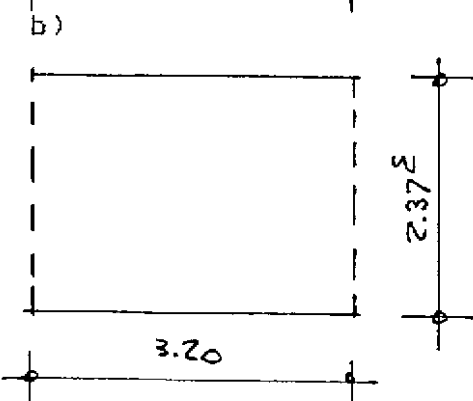
$$q = K \cdot \gamma \cdot h = 0,5 \cdot 2,1 \cdot 2,40 = 2,52$$

C2 -



$$q = 0,5 \times 2,1 \times 2,325 = 2,44$$

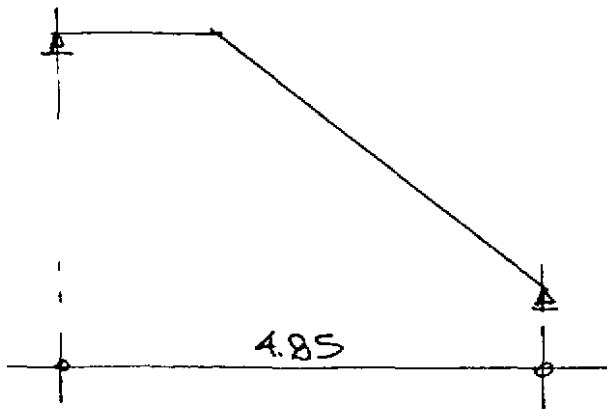
$$M = 1,65 \text{ t.m/m} - \text{As } \text{F6.3 c.11}$$



$$q = 0,5 \times 2,1 \times 4,6 = 4,63$$

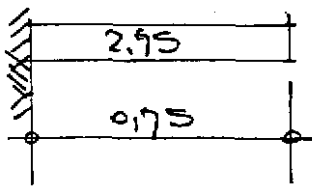
$$M = 3,41 \text{ t.m/m} - \text{As } \text{F8.0 c.10}$$

ESCALA:



pp	-	0,70	M = 3,09 t.m - As = 9,25 cm <sup>2</sup>
rev	-	0,05	( $\nabla$ 12.5 c.14)
sob	-	0,30	Q = 2,55 t
		<hr/>	
		1,05 t/m <sup>2</sup>	

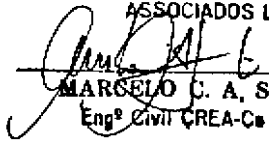
Consolos : 20 X 40



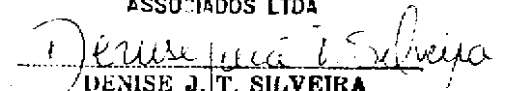
pp	-	0,20	
Q	-	2,55	
		<hr/>	
		2,75 t/m	

X = 0,77 t.m - As = 1,28 cm<sup>2</sup>  
 ( 2 $\nabla$ 10.0)  
 Q = 2,06 t -  $\nabla$ 4.6 c.16

MARCELO C. A. SILVEIRA ENGENHEIROS  
ASSOCIADOS LTDA

  
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MARCELO C. A. SILVEIRA ENGENHEIROS  
ASSOCIADOS LTDA

  
DENISE J. T. SILVEIRA  
Eng.º CIVIL CREA-Cb 7256/D



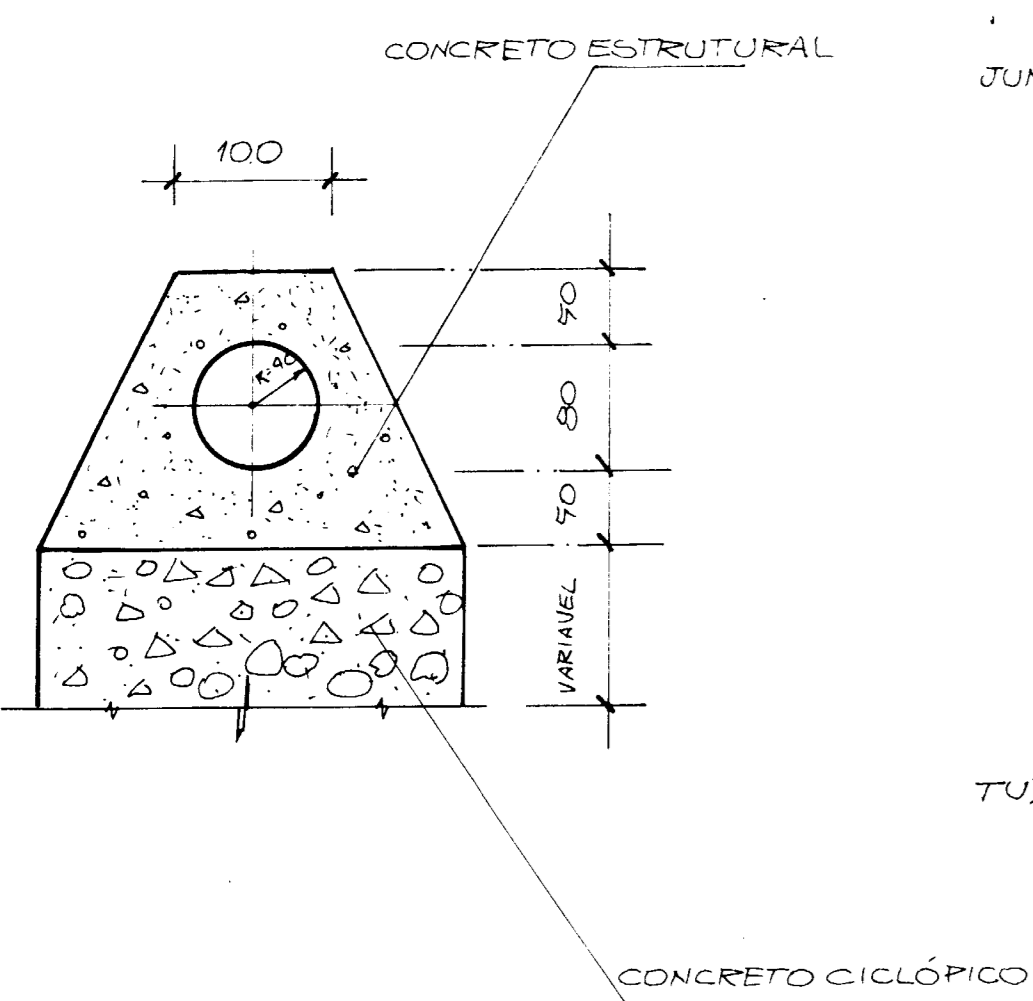
Geonorte

**ANEXO B:**

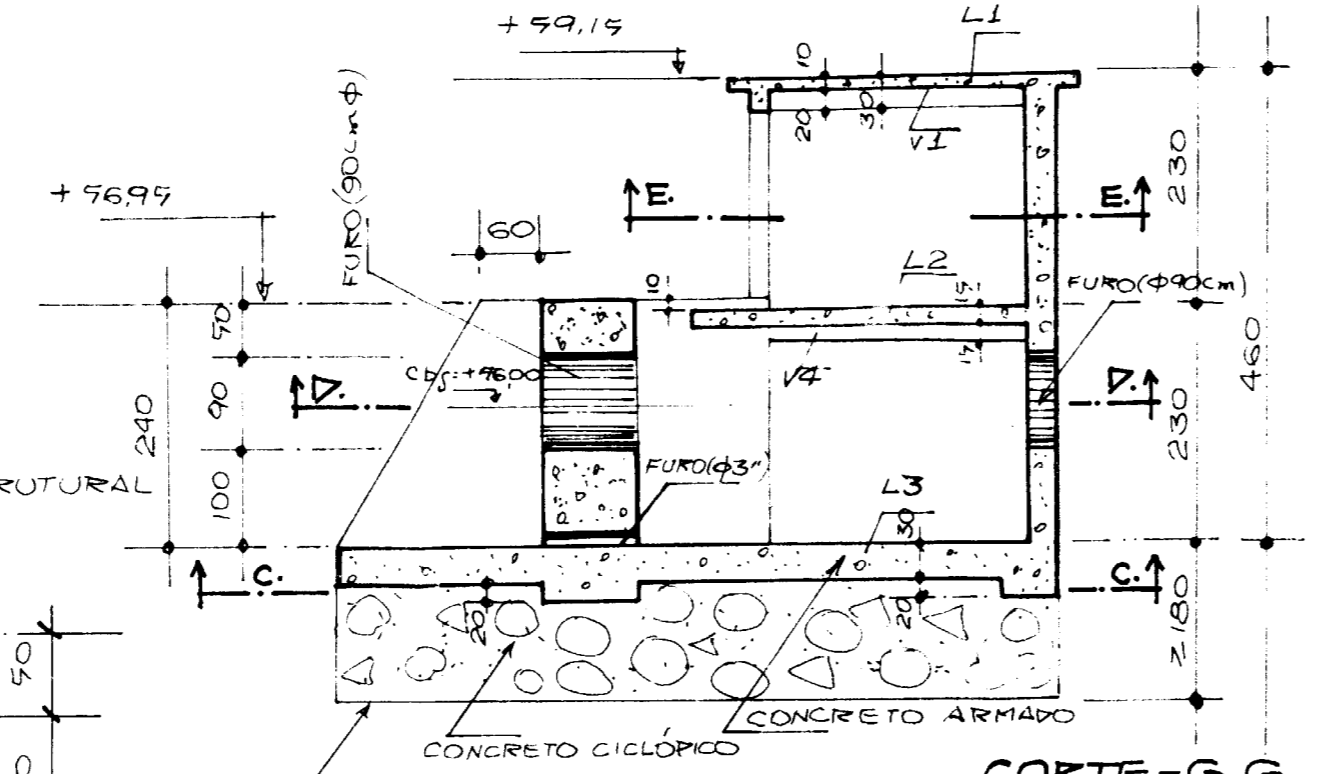
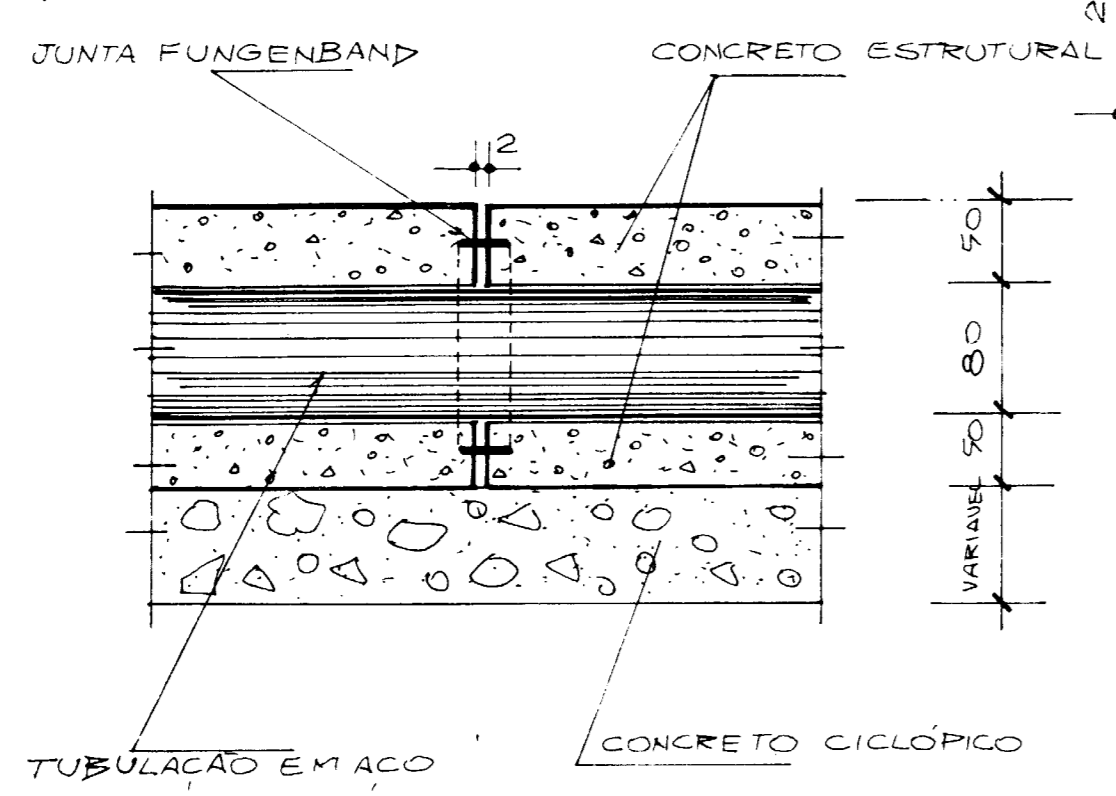
**Desenhos**

000030

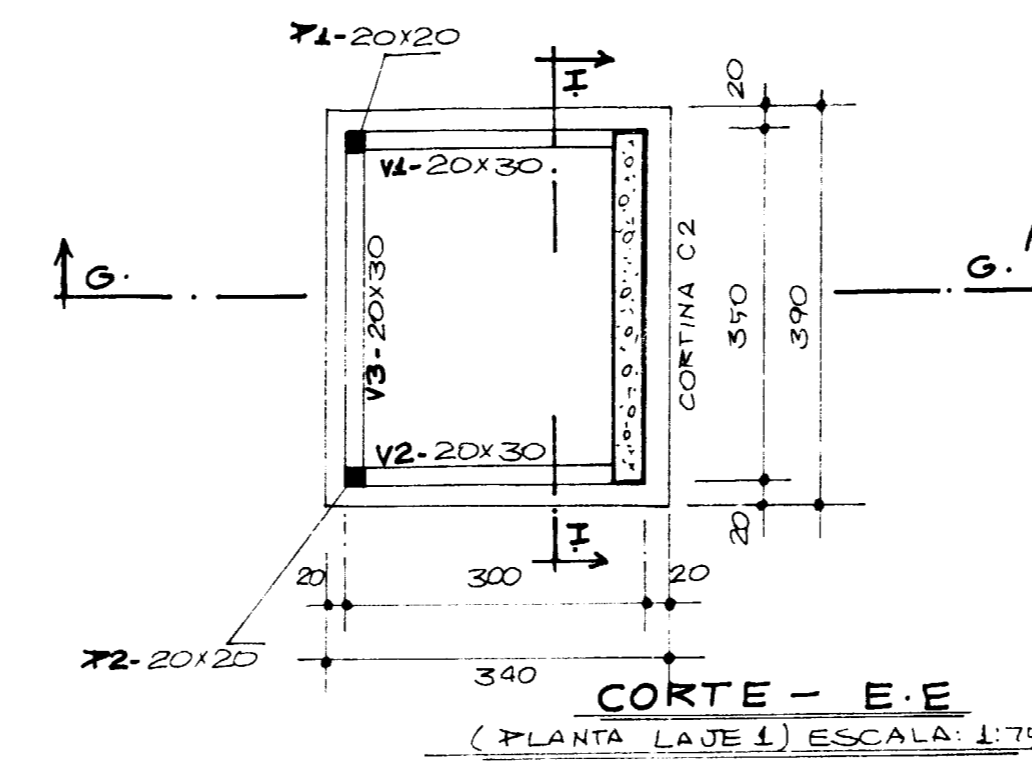
**CORTE - A.A.**  
ESCALA: 1:50



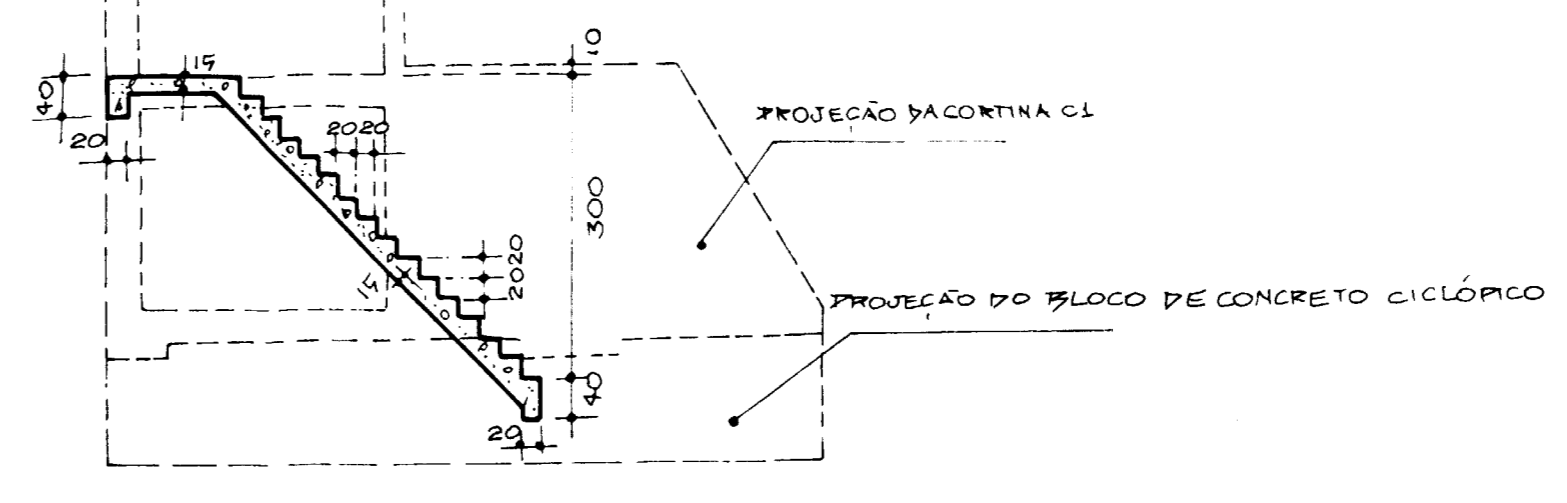
**DETALHE - A**  
ESCALA: 1:90



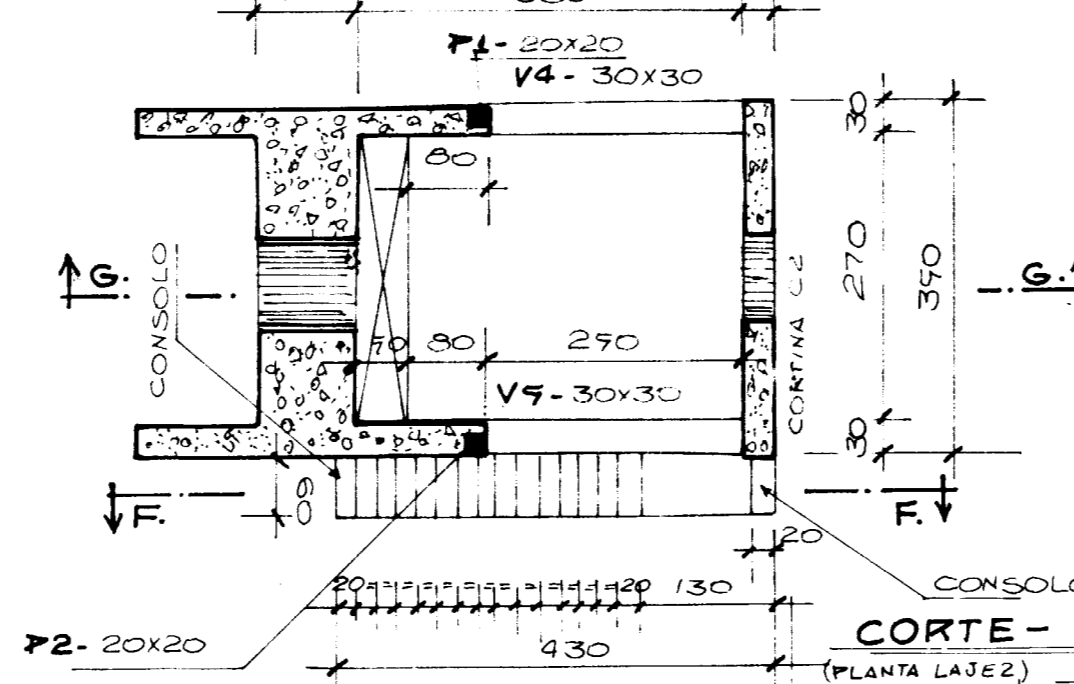
**CORTE - G.G.**  
ESCALA: 1:75



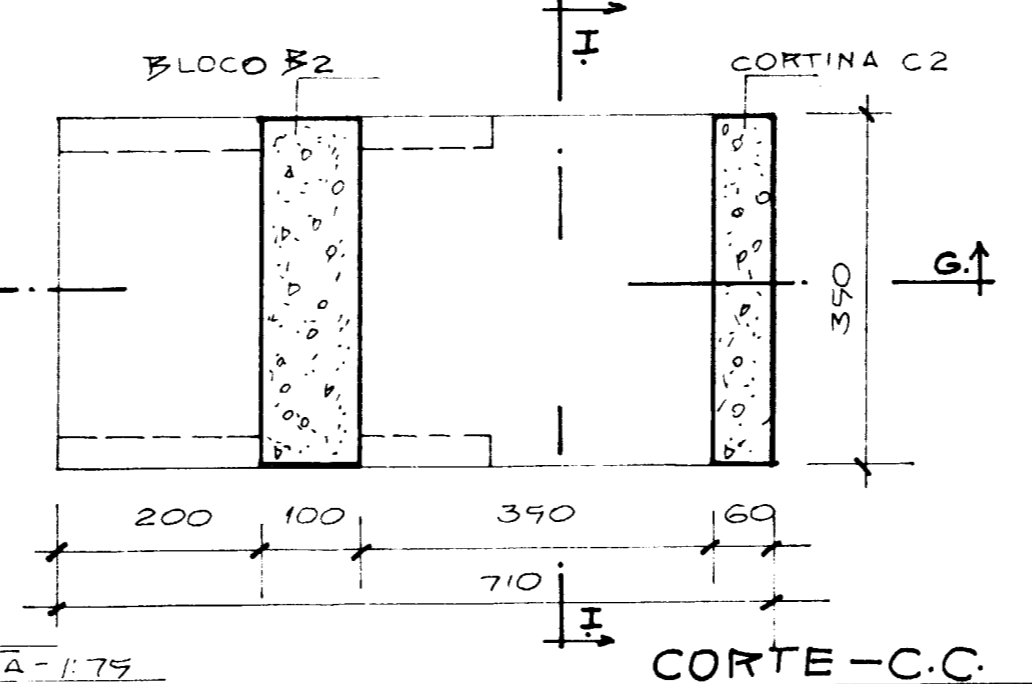
**CORTE - E.E.**  
(PLANTA LAJE 1) ESCALA: 1:75



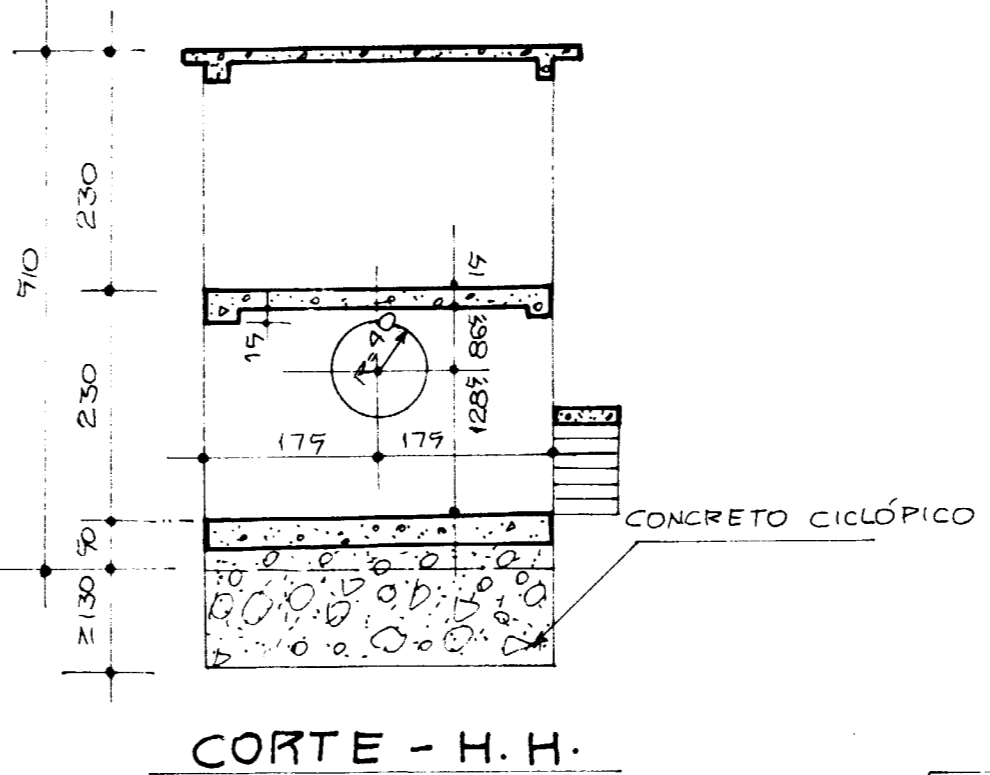
**CORTE - F.F.**  
(ESCALA) ESCALA: 1:75



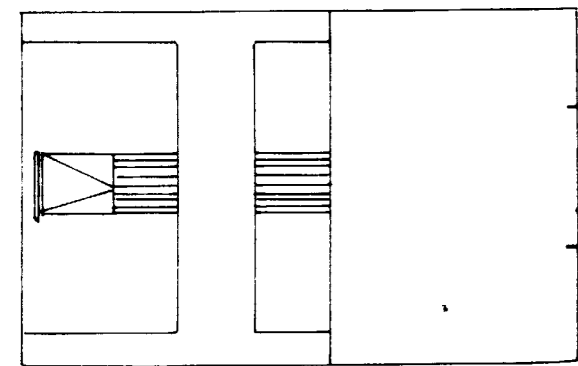
**CORTE - D.D.**  
(PLANTA LAJE 2) ESCALA: 1:75



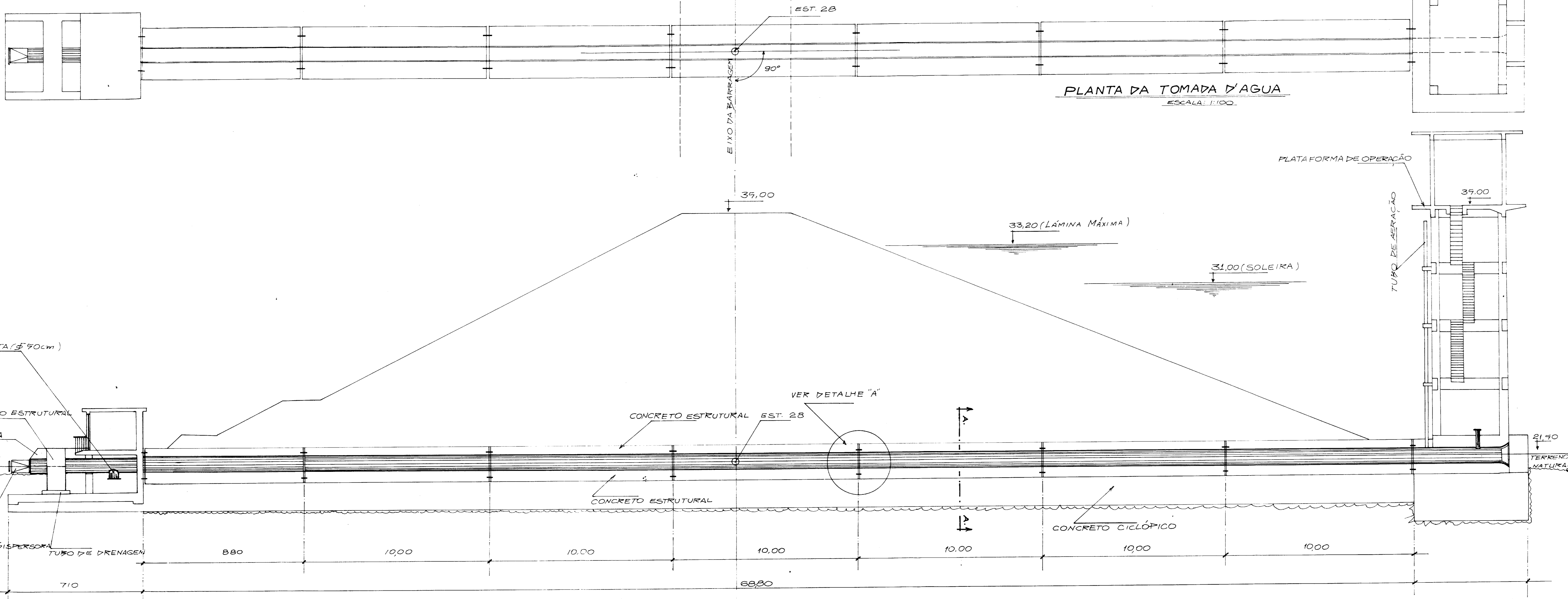
**CORTE - C.C.**  
(PLANTA LAJE 3) ESCALA: 1:75



**CORTE - H.H.**  
ESCALA: 1:75

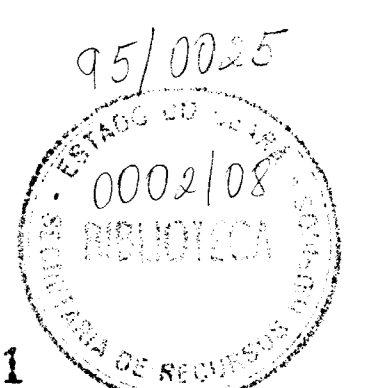


**PLANTA DA TOMADA D'AGUA**  
ESCALA: 1:100



**TOMADA D'AGUA** ESCALA: 1:100  
(PERFIL LONGITUDINAL) - ESTACA 28

1:150 (1:100)



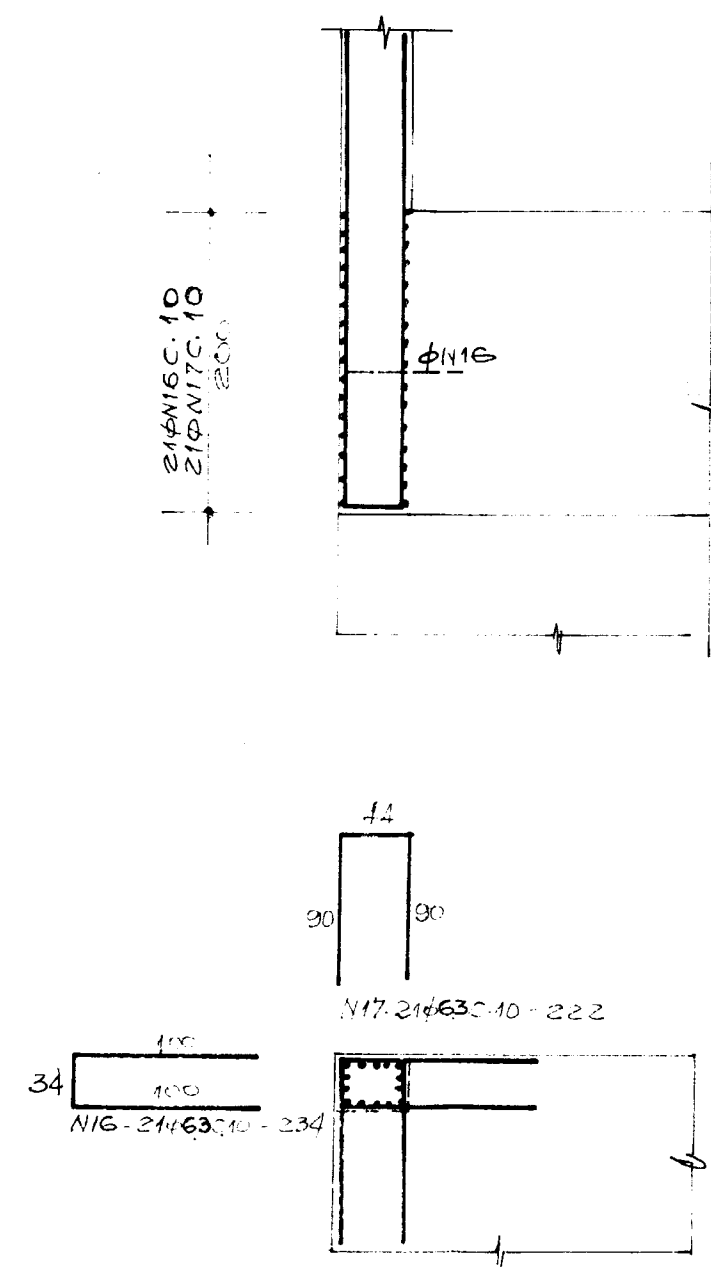
000031

PRONI PROGRAMA NACIONAL DE IRRIGAÇÃO		DESENHO	
DNOCS - DEPARTAMENTO NACIONAL DE OBRAS CONTRA AS SECAS		JOÃO	
BARRAGEM MARCO		DATA	
MUNICÍPIO DE MARCO - CEARÁ		JUNHO / 88	
FORMAS DA GALERIA		ESCALA	
E BOCA DE JUSANTE		INDICADAS	

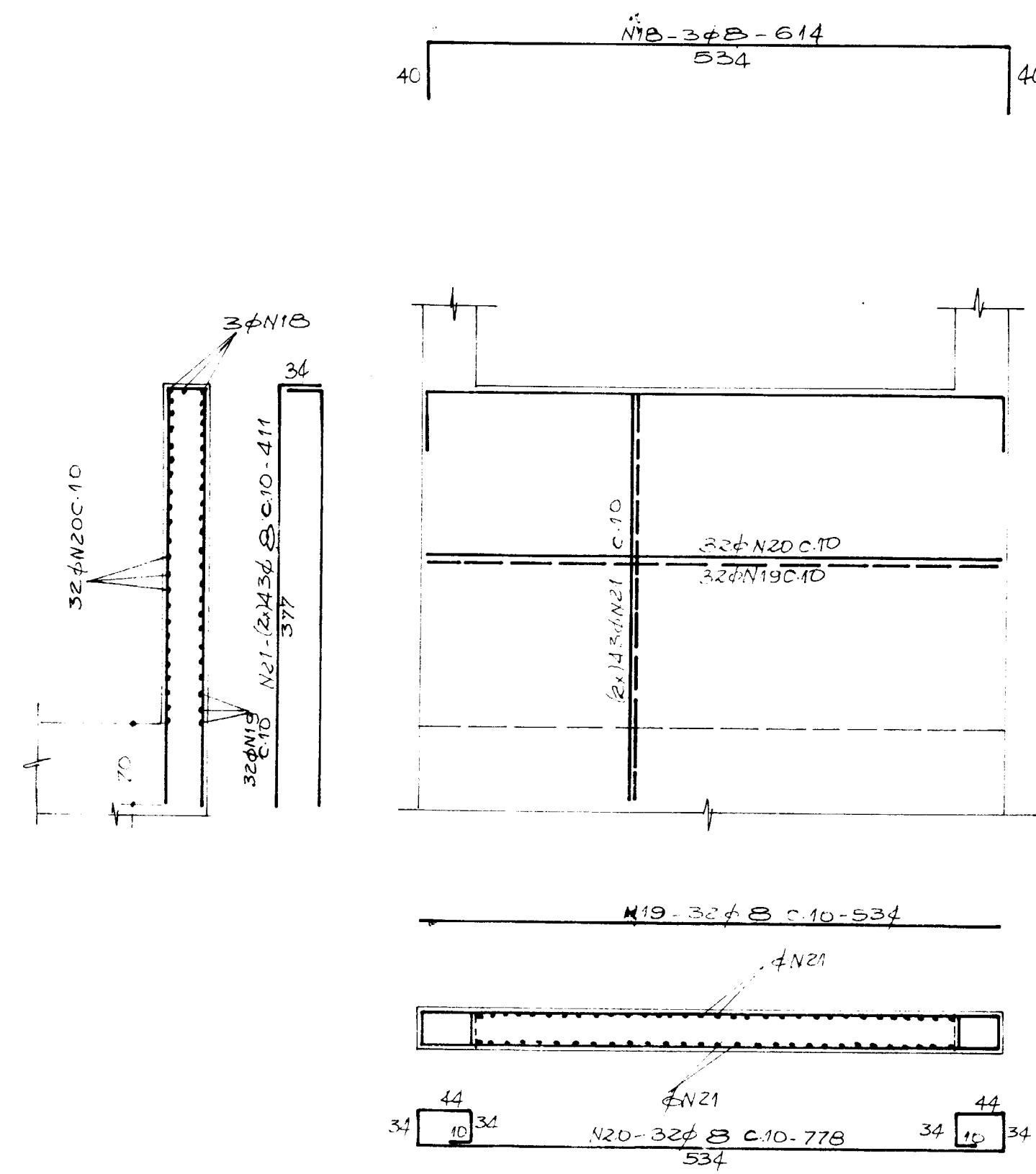




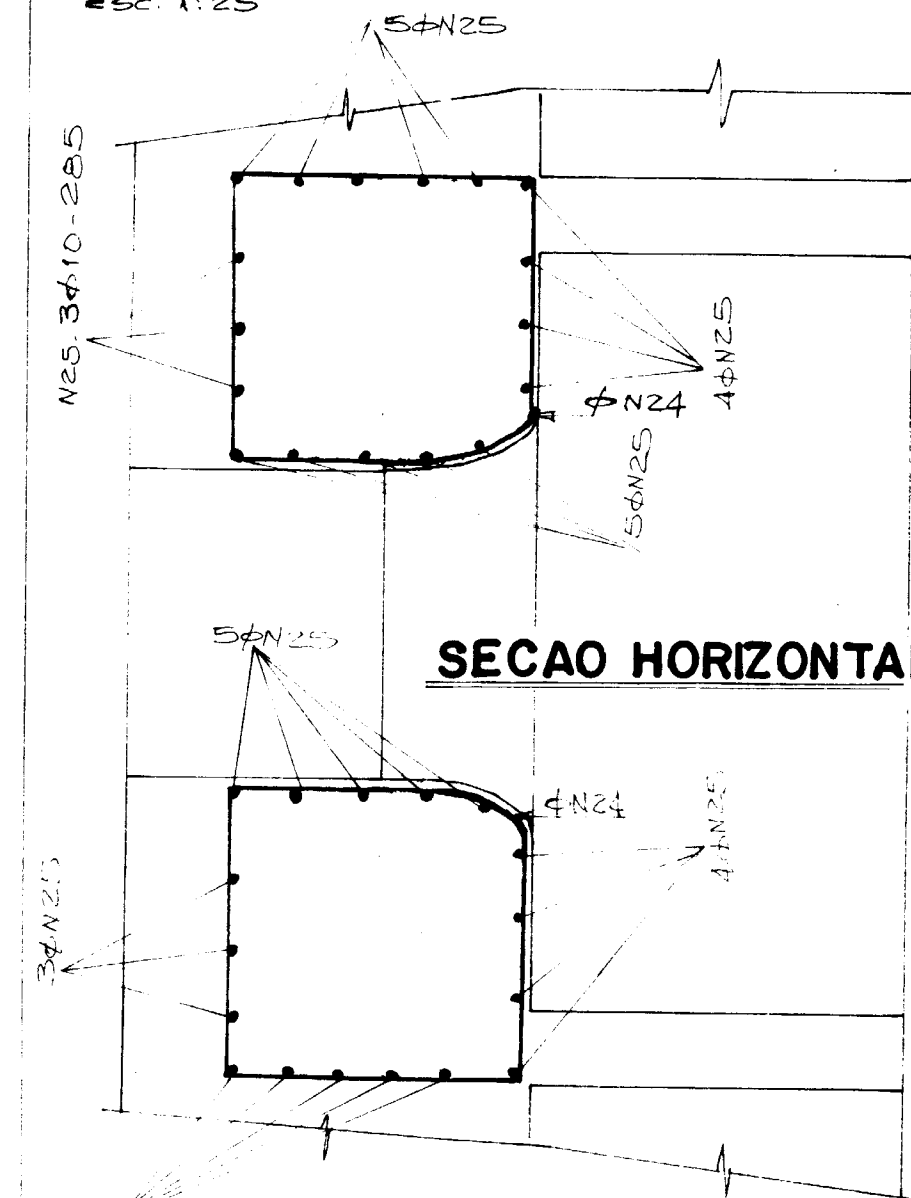
**DETALHE DOS PILARES (NO TÊCHO DO BLOCO) (4x)**  
Esc. 1:50



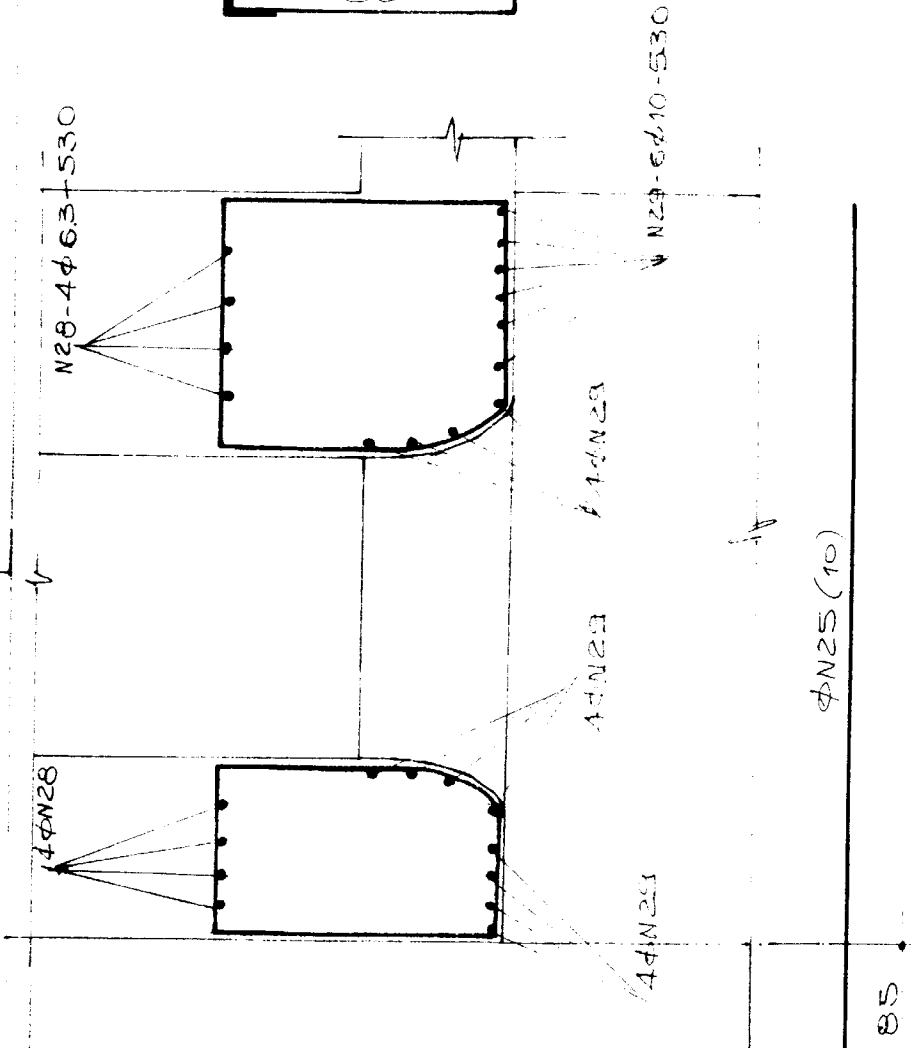
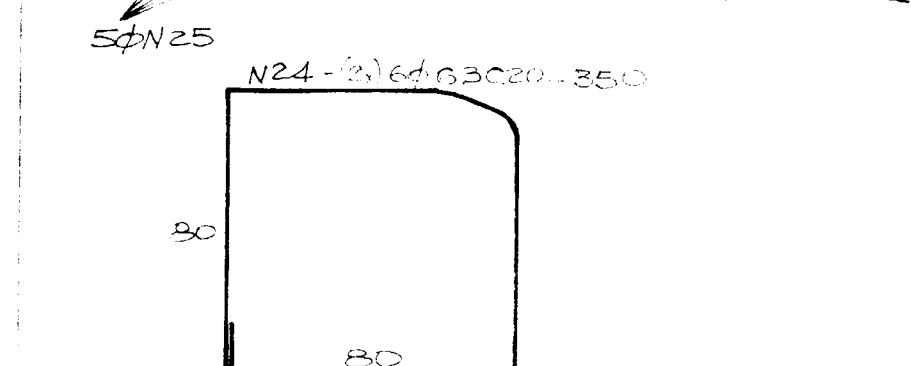
**PAREDE SOBRE O BLOCO**  
Esc. 1:50



**BOCA DE MONTANTE**  
Esc. 1:25

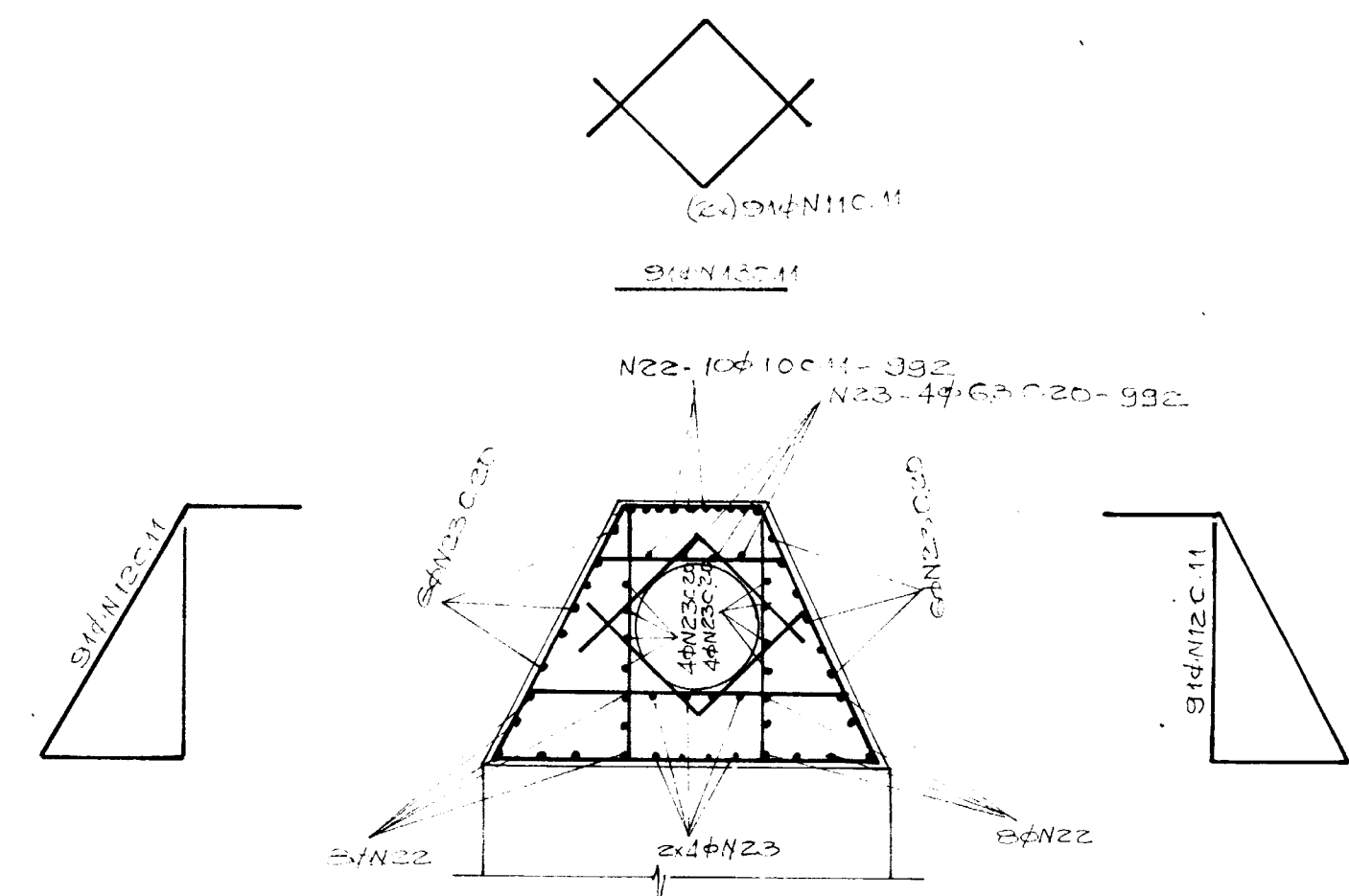


**SEÇÃO HORIZONTAL**

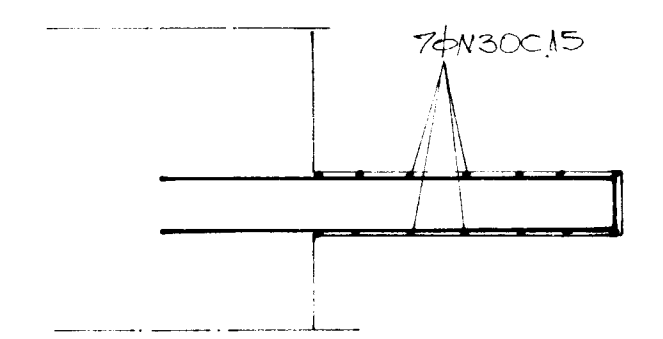


**SEÇÃO VERTICAL**

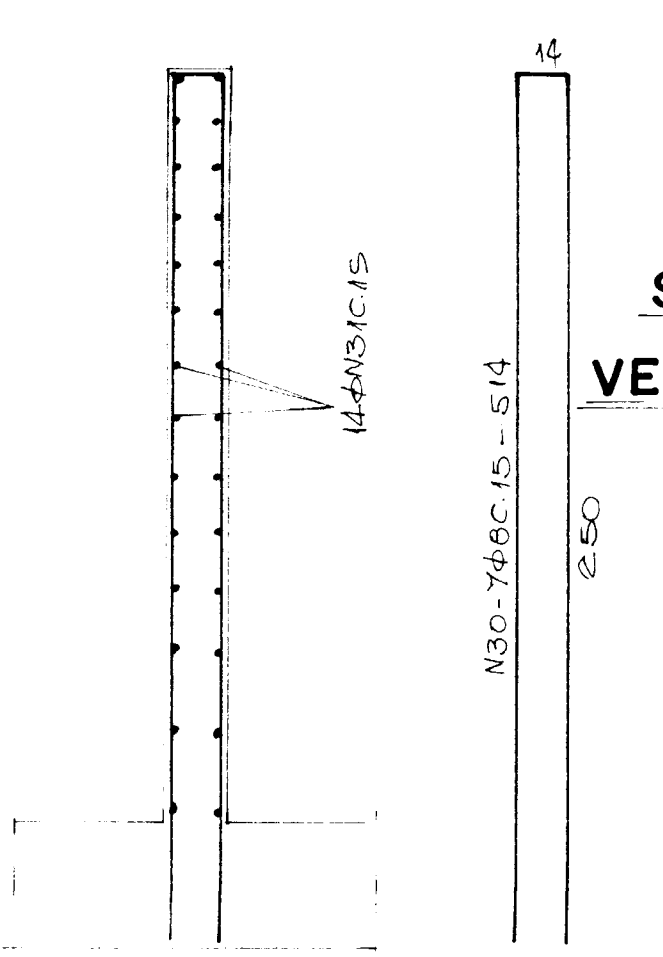
**GALERIA**  
Esc. 1:50



**MUROS LATERAIS**  
Esc. 1:25



**SEÇÃO HORIZONTAL**



**SEÇÃO VERTICAL**

COMPONENTES				
QUANT.	RECURSOS	UNID.	VALOR UNIT.	VALOR TOTAL
1	26	Ø	514	13364
2	52	Ø	464	21008
3	26	10	150	3900
4	32	65	150	4800
5	18	6	444	7992
6	76	10	570	43320
7	36	"	534	18690
8	76	"	240	18240
9	38	"	784	29792
10	82	"	190	15580
11	1294	125	240	310560
12	1294	10	545	705230
13	647	125	144	93168
14	647	"	344	222568
15	328	10	274	89912
16	84	63	234	19566
17	84	"	222	18648
18	3	8	64	192
19	32	"	534	17088
20	32	"	778	24896
21	66	"	411	27126
22	182	10	992	180544
23	224	63	992	222208
24	12	"	350	4200
25	34	10	285	9690
26	6	63	310	1860
27	6	"	270	1620
28	6	"	530	3180
29	18	10	530	9540
30	14	8	514	7196
31	28	"	313	8764

RESUMO DE MATERIAIS			
ESPECIFICAÇÃO	QUANTIDADE	VALOR UNIT.	VALOR TOTAL
63	298240	820	24455680
80	116428	913	106216764
10	119442	7731	922300006
125	626226	6890	4314896340
<b>PESOS TOTAL</b>			<b>15954 Kg</b>

1:150 1/10m<sup>2</sup> 95/0025  
 0009/08  
 BIBLIOTECA

000033

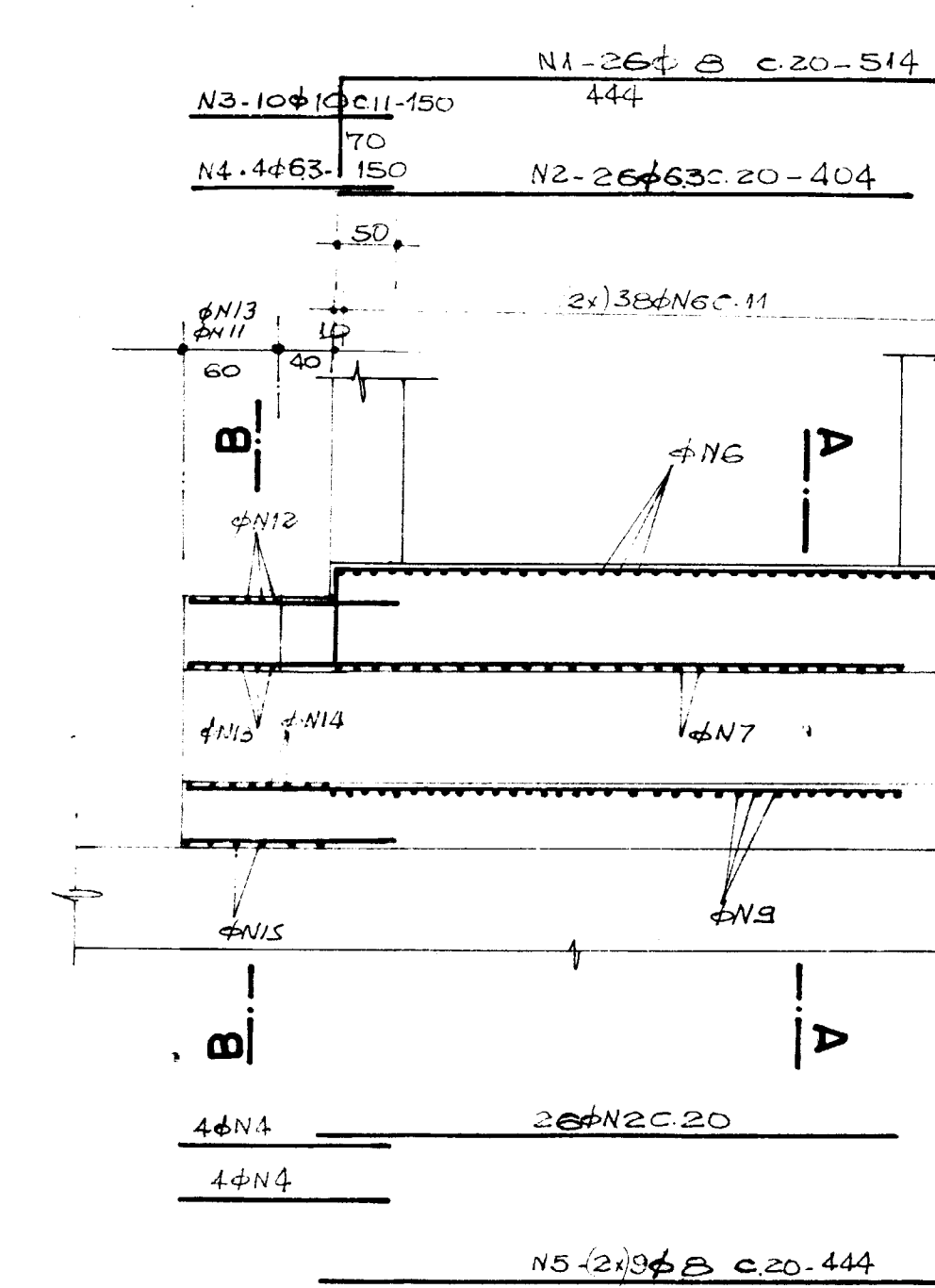
**PRONI-PROGRAMA NACIONAL DE IRRIGAÇÃO**  
**DNOCs- DEPARTAMENTO NACIONAL DE OBRAS CONTRA AS SECAS**

**BARRAGEM MARCO**  
 MUNICÍPIO DE MARCO - CEARÁ

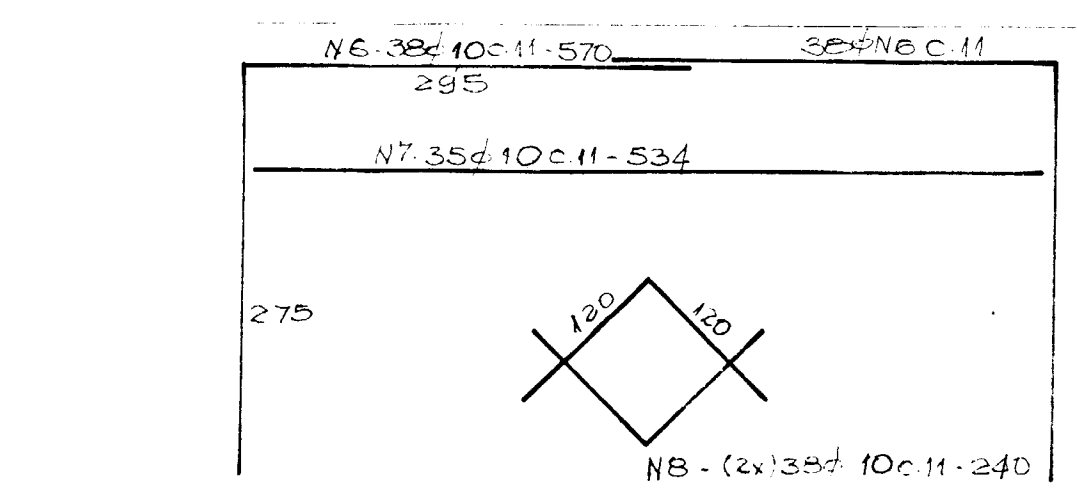
ARMADURAS DA BOCA DE MONTANTE E GALERIA

DESENHO  
 JOAO  
 DATA  
 JUNHO / 88  
 ESCALA  
 INDICADAS

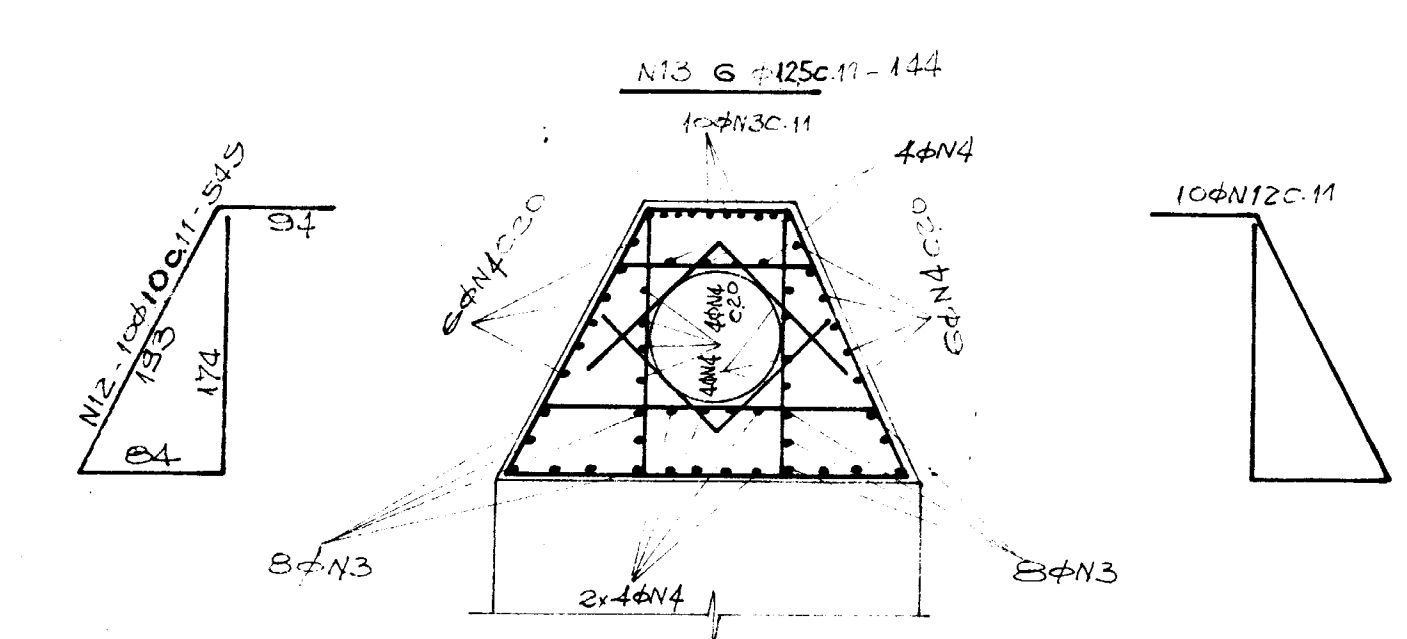
Geonorte



**BLOCO**  
Esc. 1:50



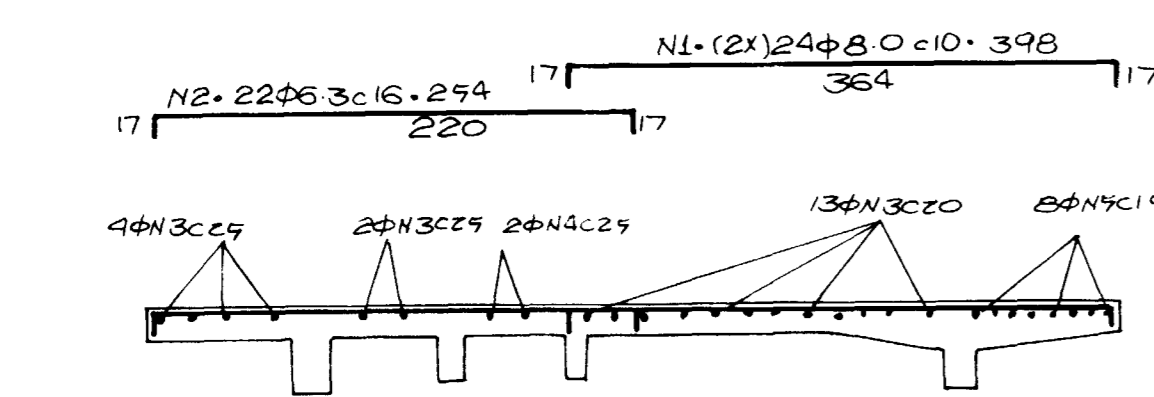
**CORTE A-A**  
Esc. 1:50



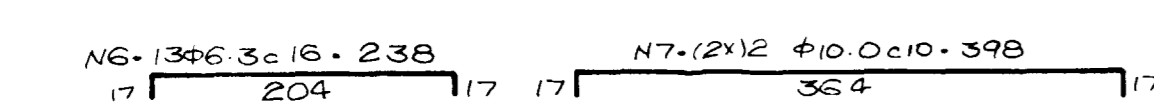
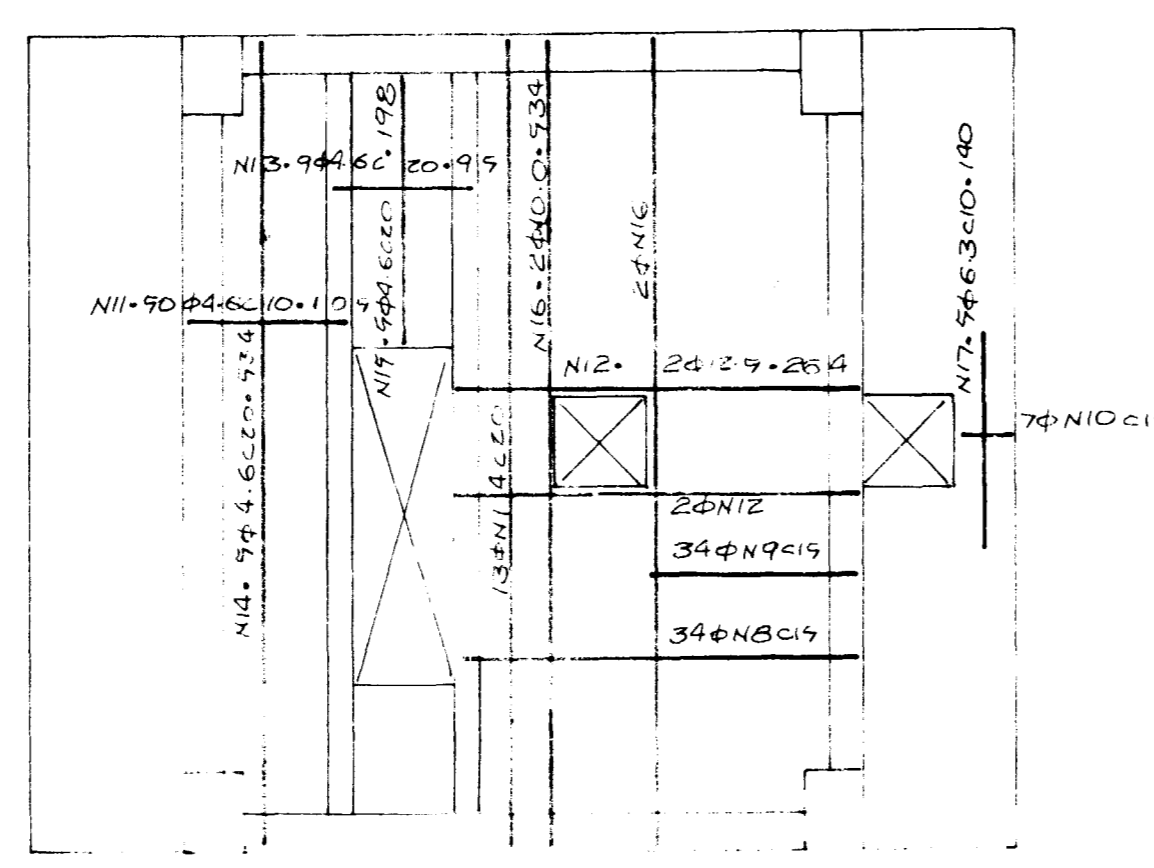
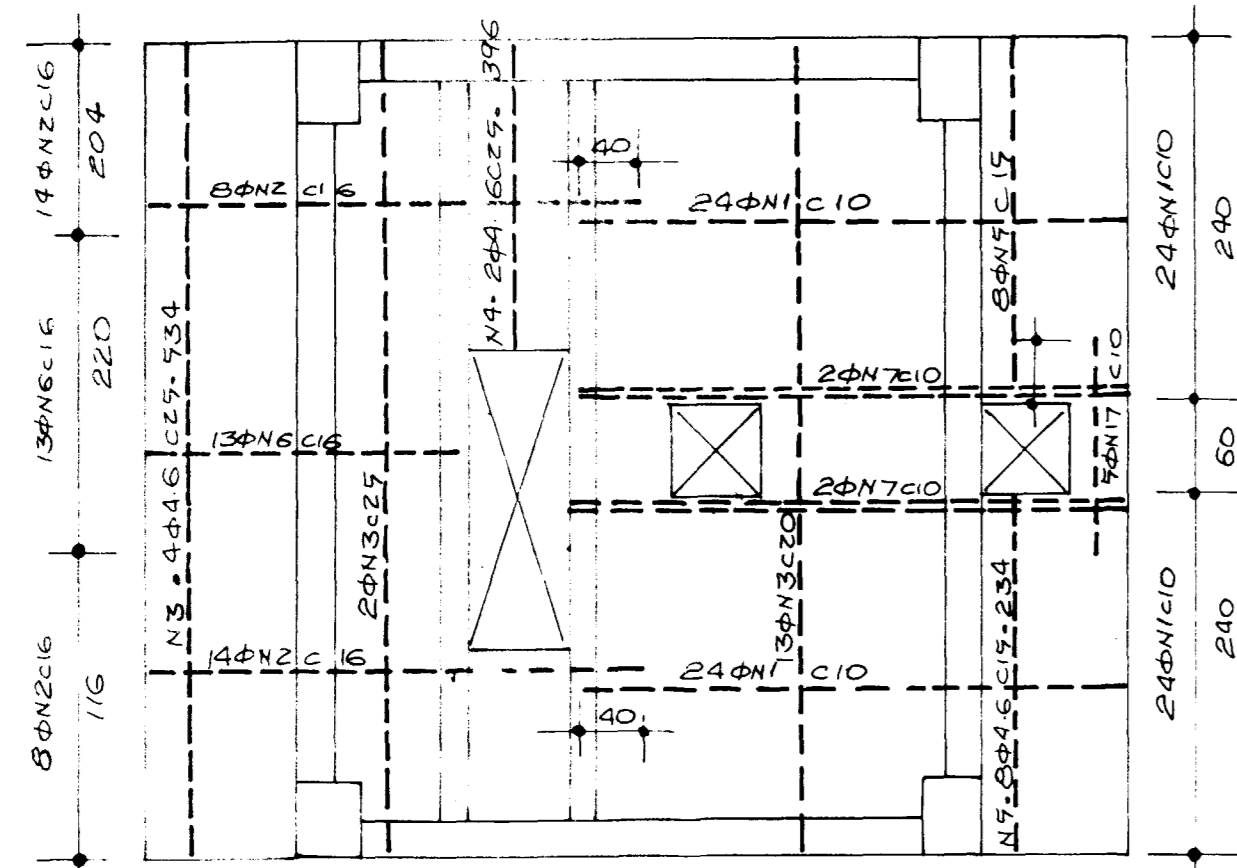
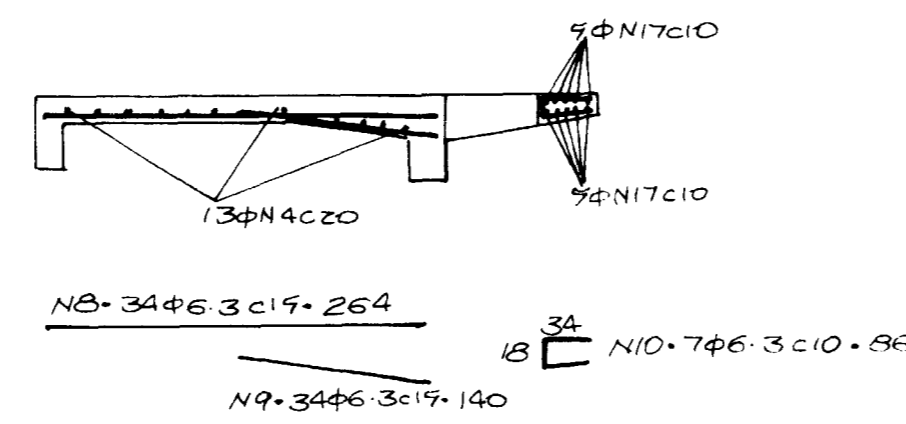
**CORTE B-B**  
Esc. 1:50

**NIVEL 4**  
ESCALA 1:90

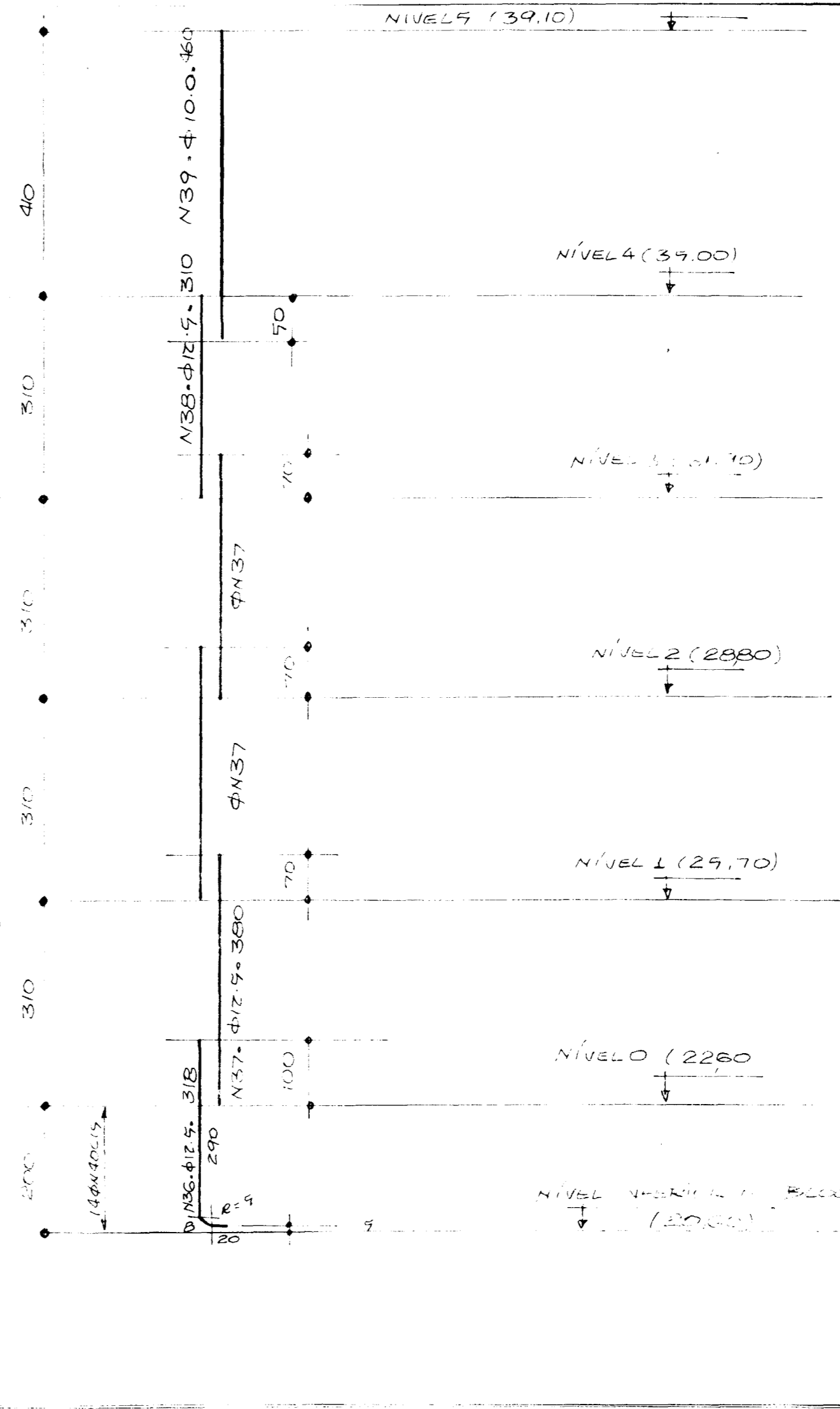
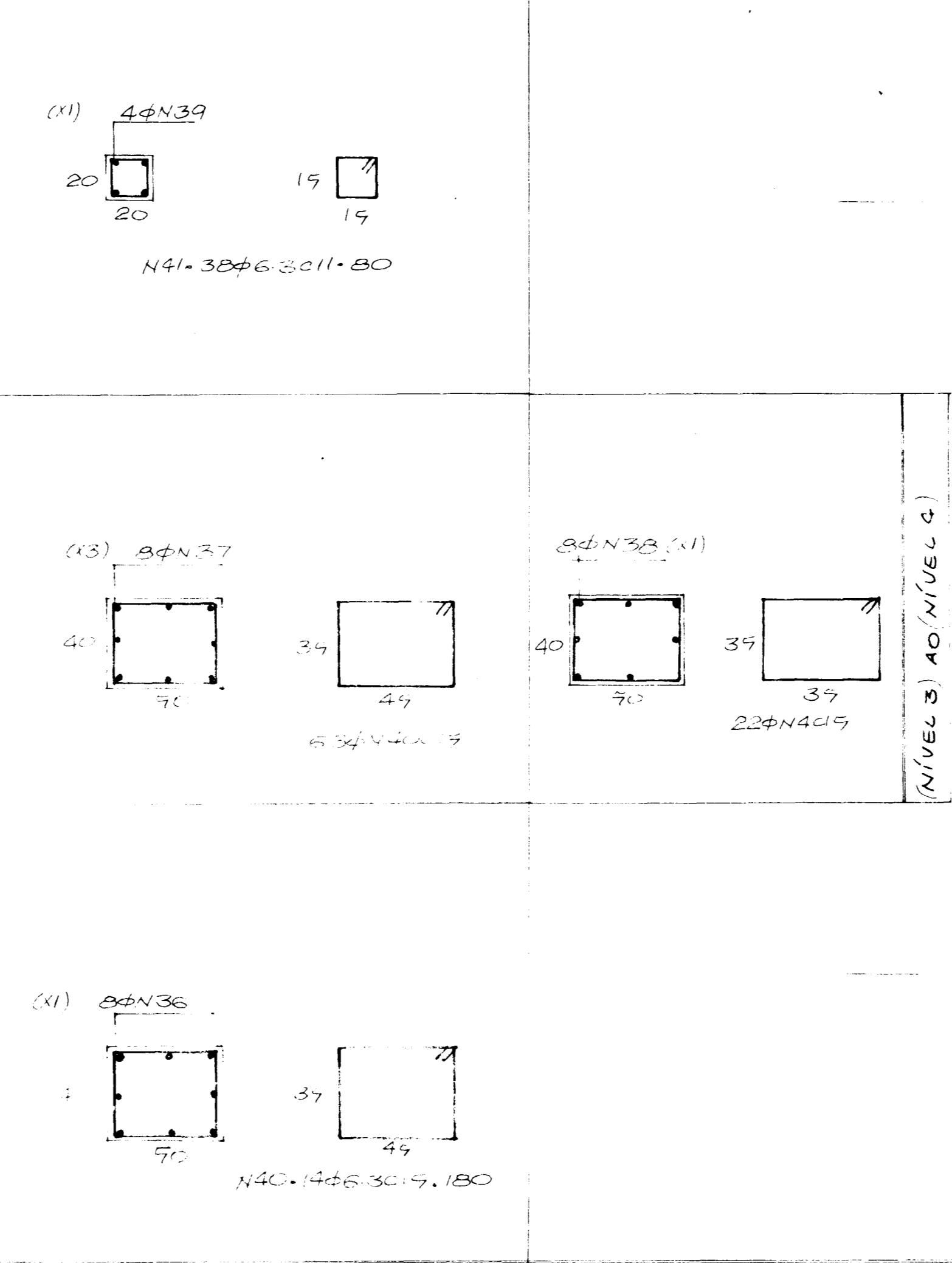
**ARMADURA NEGATIVA DA LAJE**



**ARMADURA POSITIVA DA LAJE**



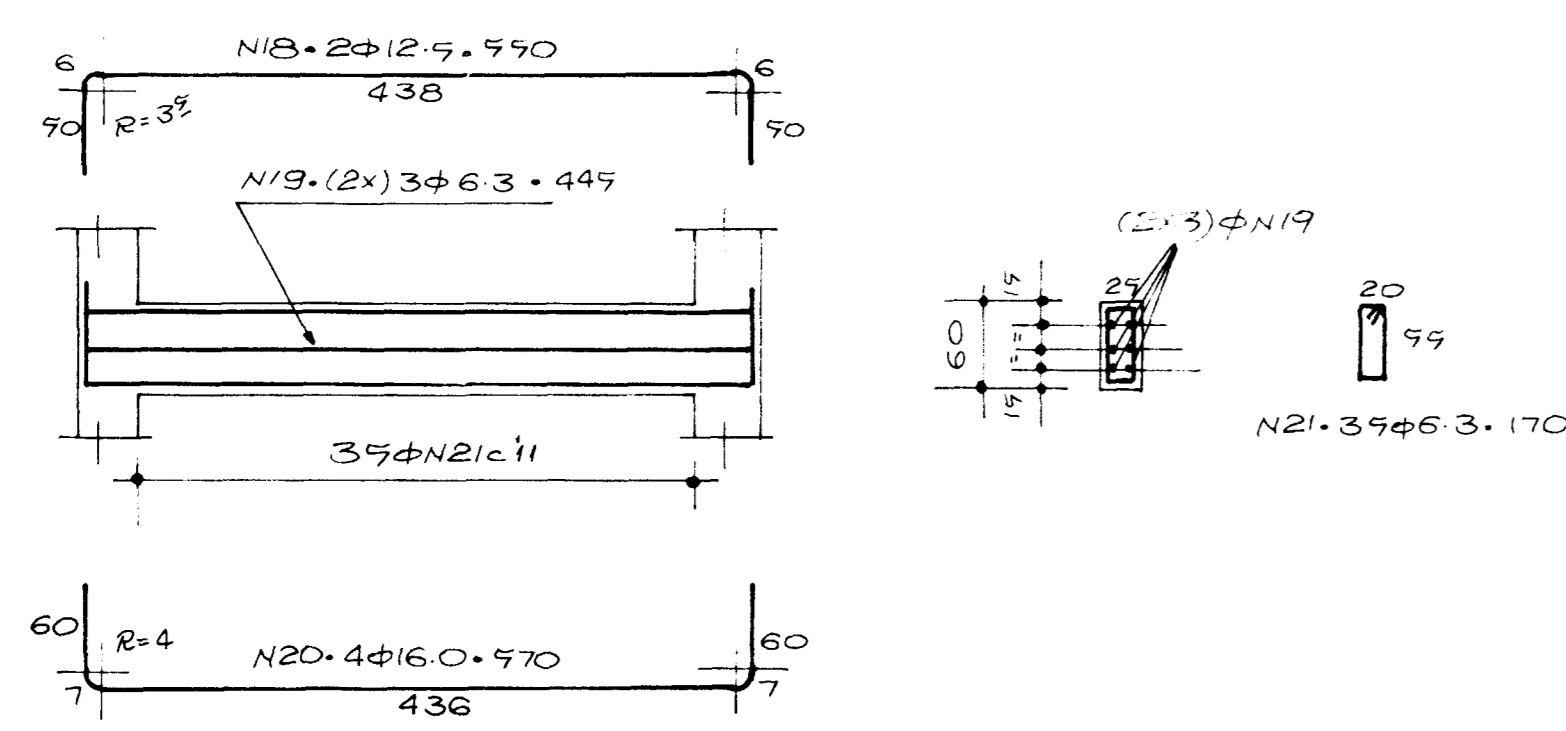
**PILARES DA TORRE (14)**  
ESCALA 1:20



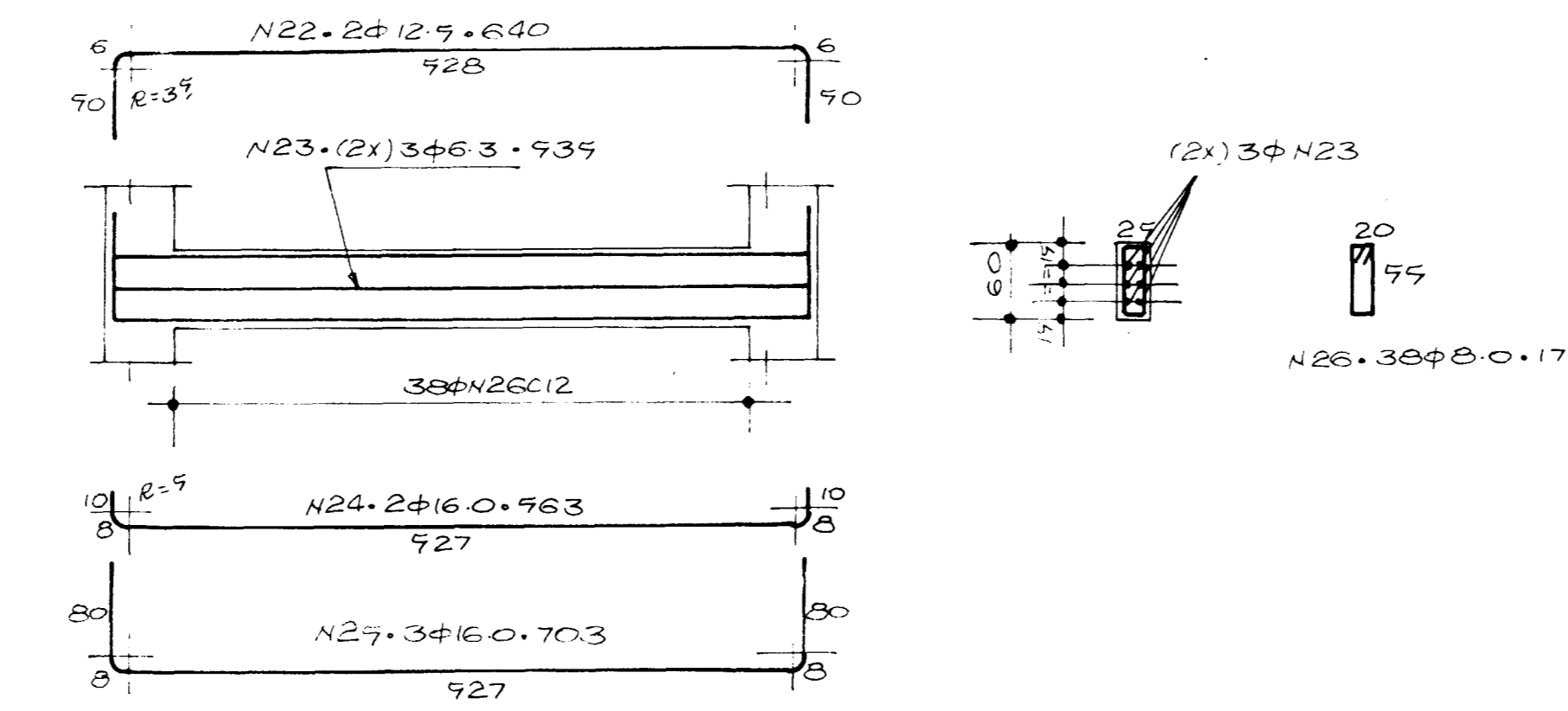
ESQUEMA VERTICAL

Item	Qtd	Dim	Vol (m³)	Peso (kg)	Item	Qtd	Dim	Vol (m³)	Peso (kg)
1	48	8.0	3.98	19104	22	2	12.9	640	1280
2	20	6.3	2.44	4080	23	8	6.3	939	3210
3	19	4.6	1.34	10146	24	2	16.0	563	1126
4	2	"	1.93	396	25	2	"	703	1406
5	16	"	3.4	3744	26	38	8.0	170	6460
6	13	6.3	2.38	3094	27	2	6.3	979	1190
7	4	10.0	3.98	1992	28	1	12.9	960	960
8	34	6.3	264	8976	29	3	"	620	1860
9	34	"	140	4760	30	35	6.3	130	4680
10	7	"	86	602	31	2	"	979	1190
11	90	4.6	109	9290	32	2	12.9	620	1240
12	4	12.9	264	1096	33	42	4.6	130	9460
13	9	4.6	99	899	34	6	12.9	640	3840
14	18	"	134	9612	35	6	6.3	939	3210
15	9	"	198	990	36	8	12.9	318	2944
16	4	10.0	934	2136	37	24	"	380	912
17	10	6.3	140	1400	38	8	"	310	2480
18	4	12.9	99	2200	39	4	"	460	1840
19	12	6.3	449	5340	40	99	6.3	180	17820
20	8	16.0	970	4960	41	38	"	80	3040
21	100	6.3	170	17000	42	"	"	"	"

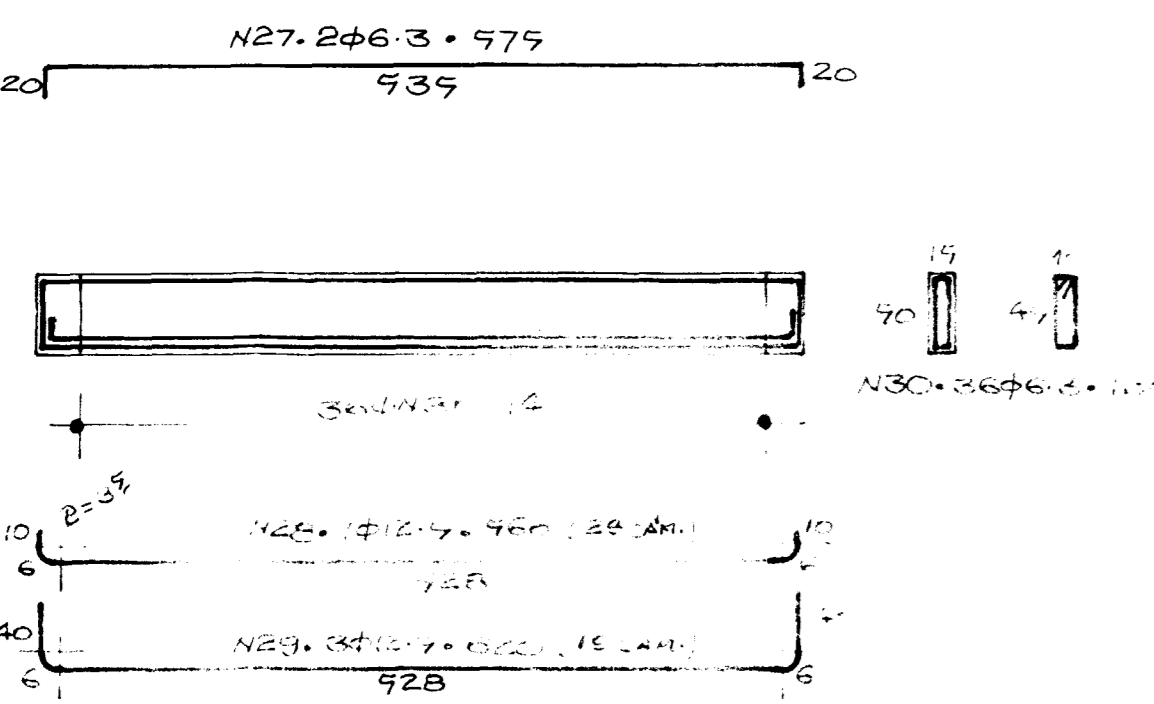
**V8-V9-27x60 (NIVEL 4) (X2)**



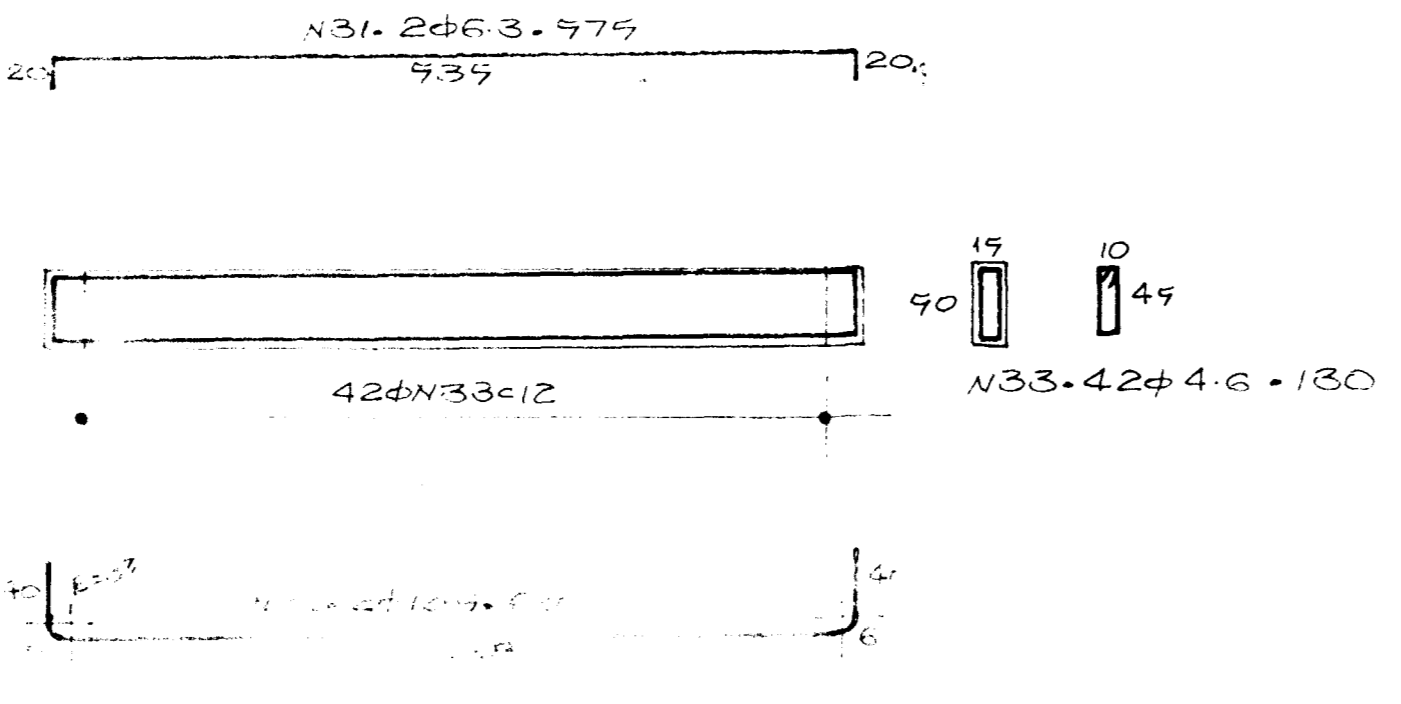
**V13-27x60 (NIVEL 4) (X1)**



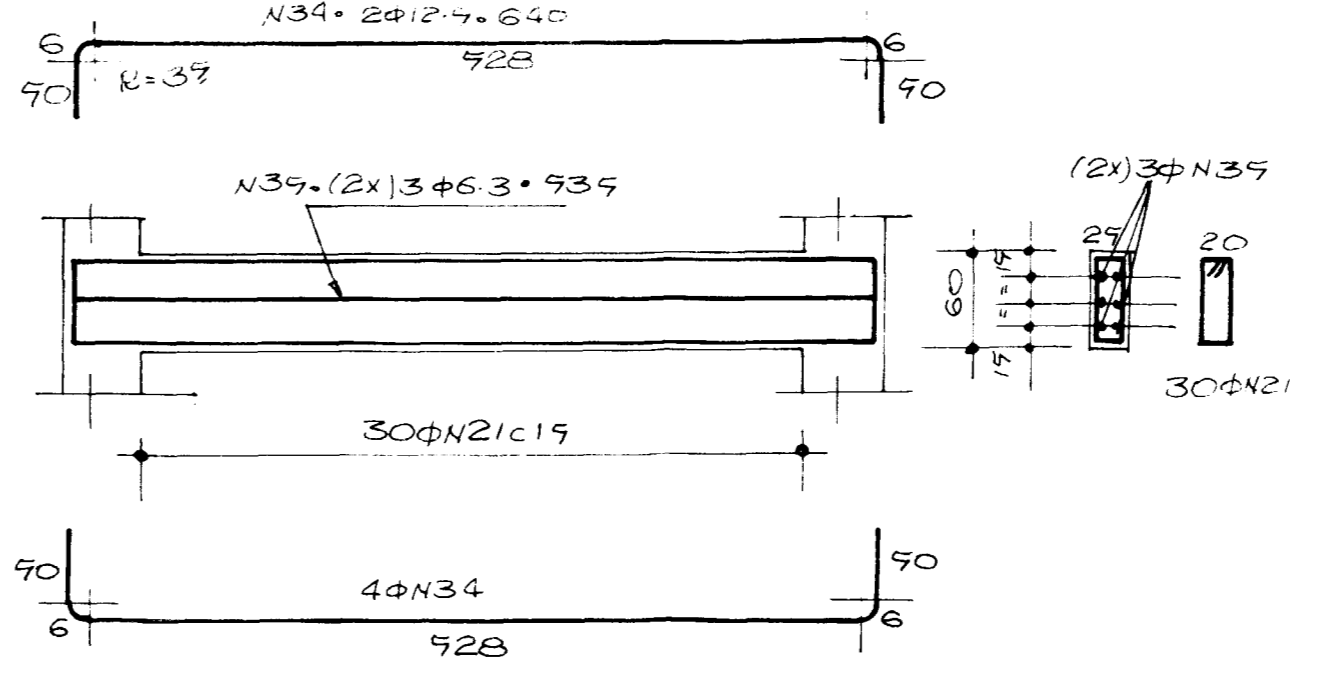
**V12-19x90 (NIVEL 4) (X1)**



**V11-19x90 (NIVEL 4) (X1)**



**V10-29x60 (NIVEL 4) (X1)**



Resumo de Armaduras

Dim	Qtd	Vol (m³)	Peso (kg)
4.6	364.73	53	64.60
6.3	809.12	222	64.90
8.0	299.64	113	"
10.0	37.28	26	"
12.9	198.12	218	"
16.0	70.92	129	"
<b>PESO TOTAL</b>			<b>797Kg</b>

150x200mm 95/0025  
000034

**PRONI- PROGRAMA NACIONAL DE IRRIGAÇÃO**  
**DNOCS- DEPARTAMENTO NACIONAL DE OBRAS CONTRA ASSECAS**

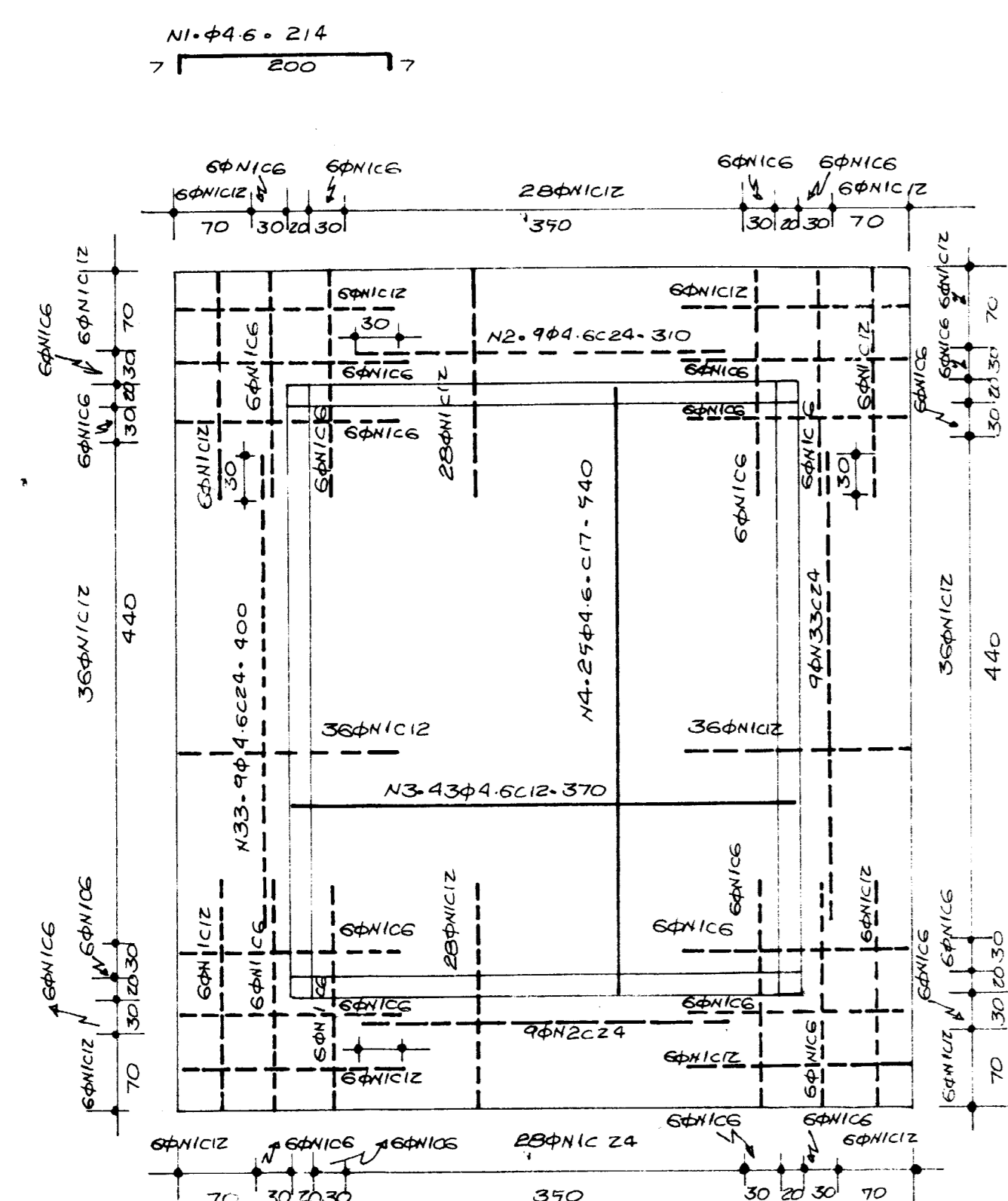
**BARRAGEM MARCO**  
MUNICÍPIO DE MARCO - CEARÁ

TORRE DE COMANDO  
ARMADURAS DAS LAJES DO NIVEL 4  
ARMADURA DAS VIGAS - NIVEIS 1 A 4  
PILARES

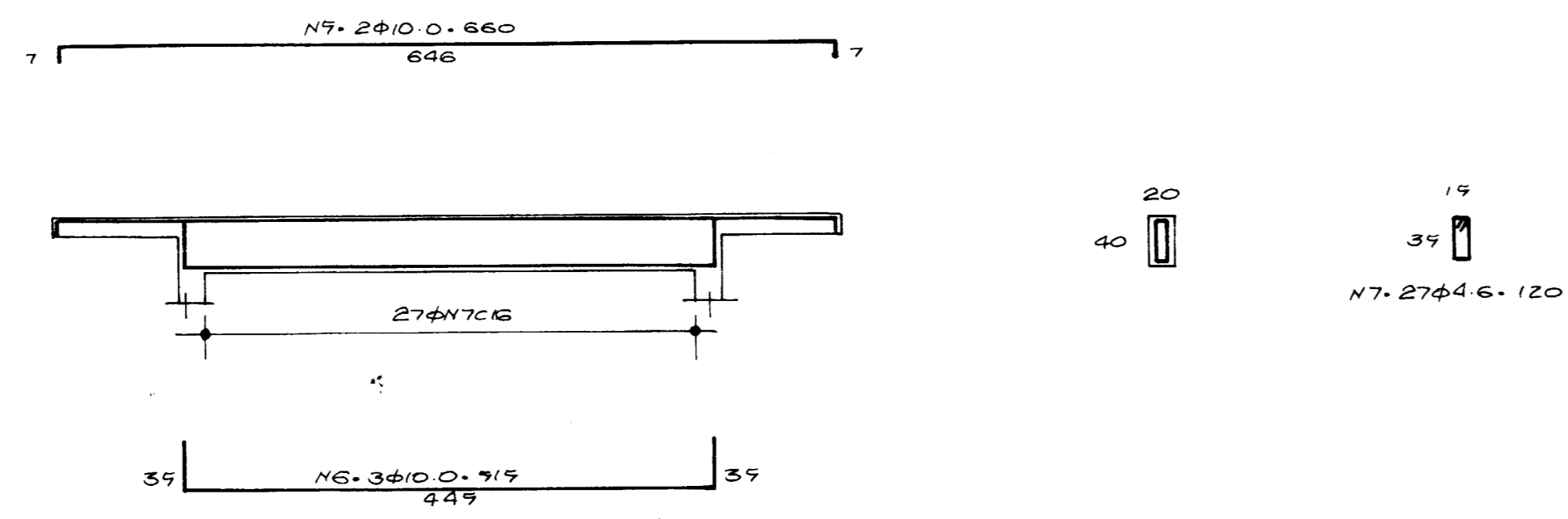
DESENHO: JOÃO  
DATA: JUNHO/88  
ESCALA: INDICADAS

Geonorte

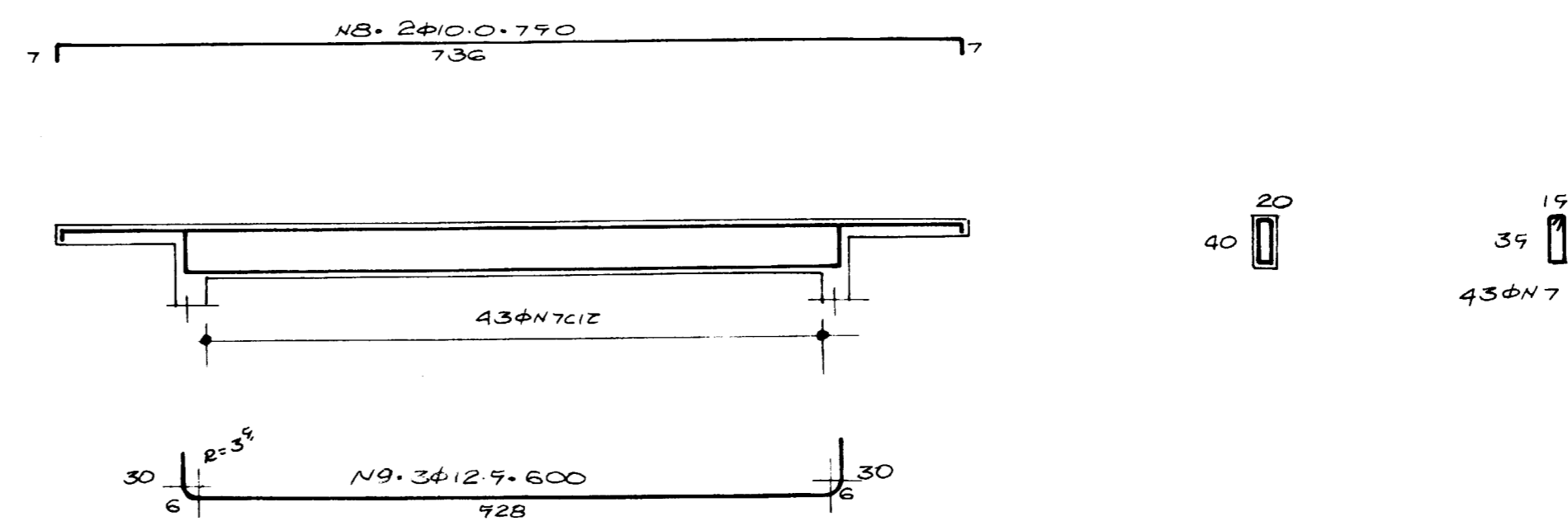
**NÍVEL - 5**  
(ARMADURA DA LAJE) ESC: 1/90



**V14 = V15 - 20x40 (NÍVEL 5) (X2)**

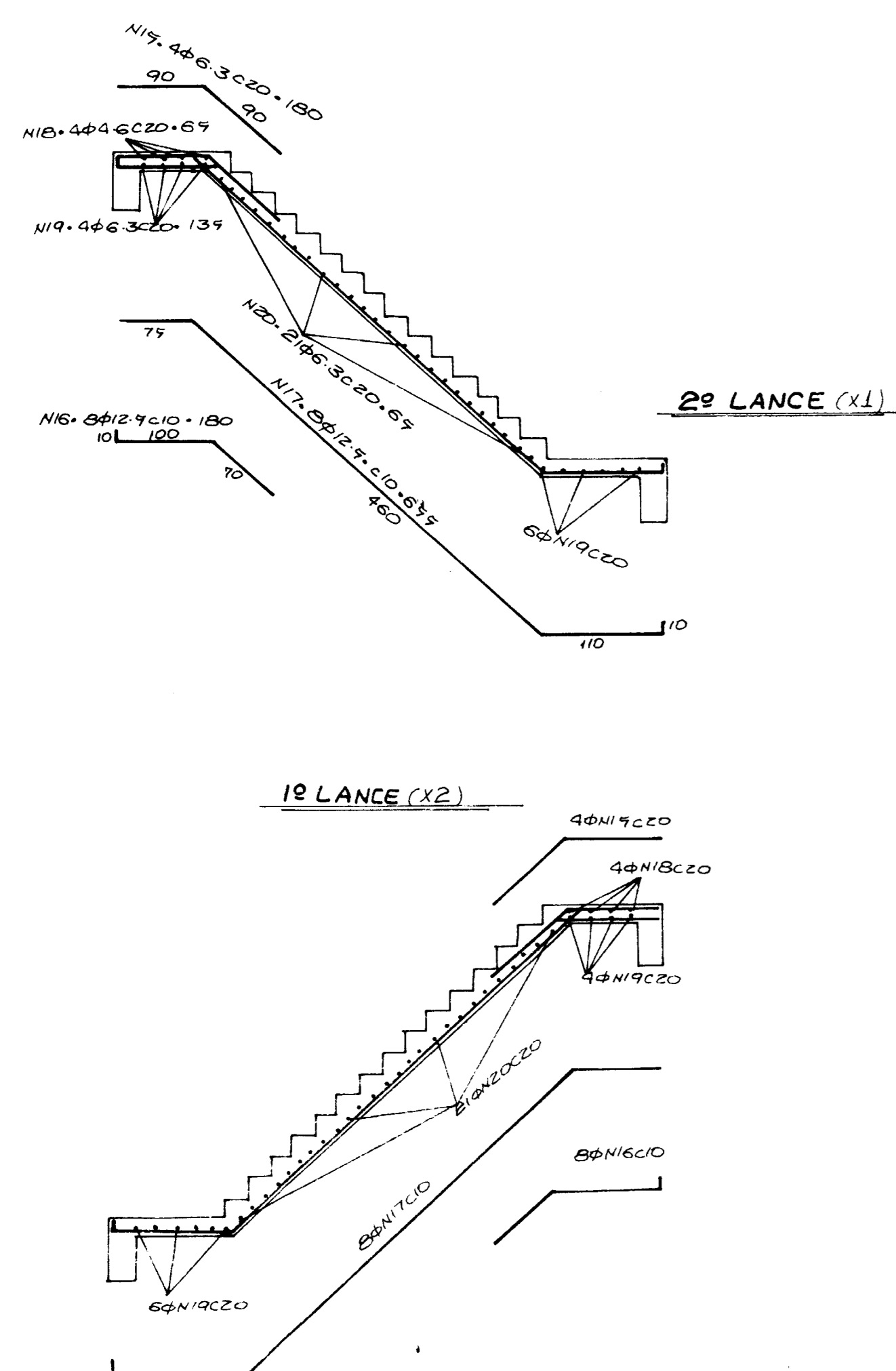


**V16 = V17 - 20x40 (NÍVEL 5) (X2)**

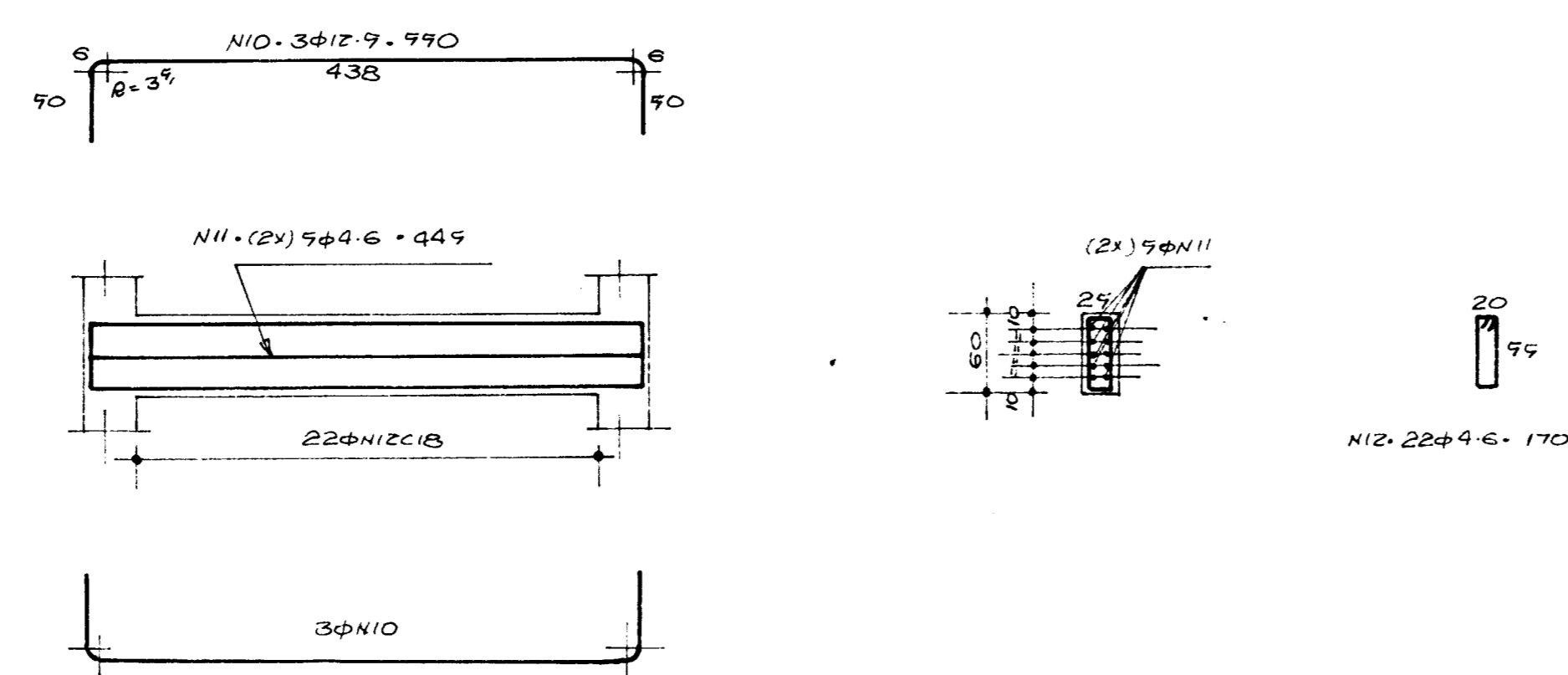


QUANT.	DIAM.	COMPRIMENTO	VOLUME
1	272	46	214
2	18	"	310
3	43	"	370
4	29	"	440
5	4	10,0	660
6	6	"	915
7	14,0	4,6	120
8	4	10,0	790
9	6	12,9	600
10	3,6	"	970
11	6,0	4,6	445
12	27,0	"	170
13	3,6	12,9	640
14	6,0	4,6	535
15	2,4	6,3	180
16	4,0	12,9	180
17	2,4	"	695
18	1,2	4,6	65
19	1,2	6,3	135
20	6,3	"	65

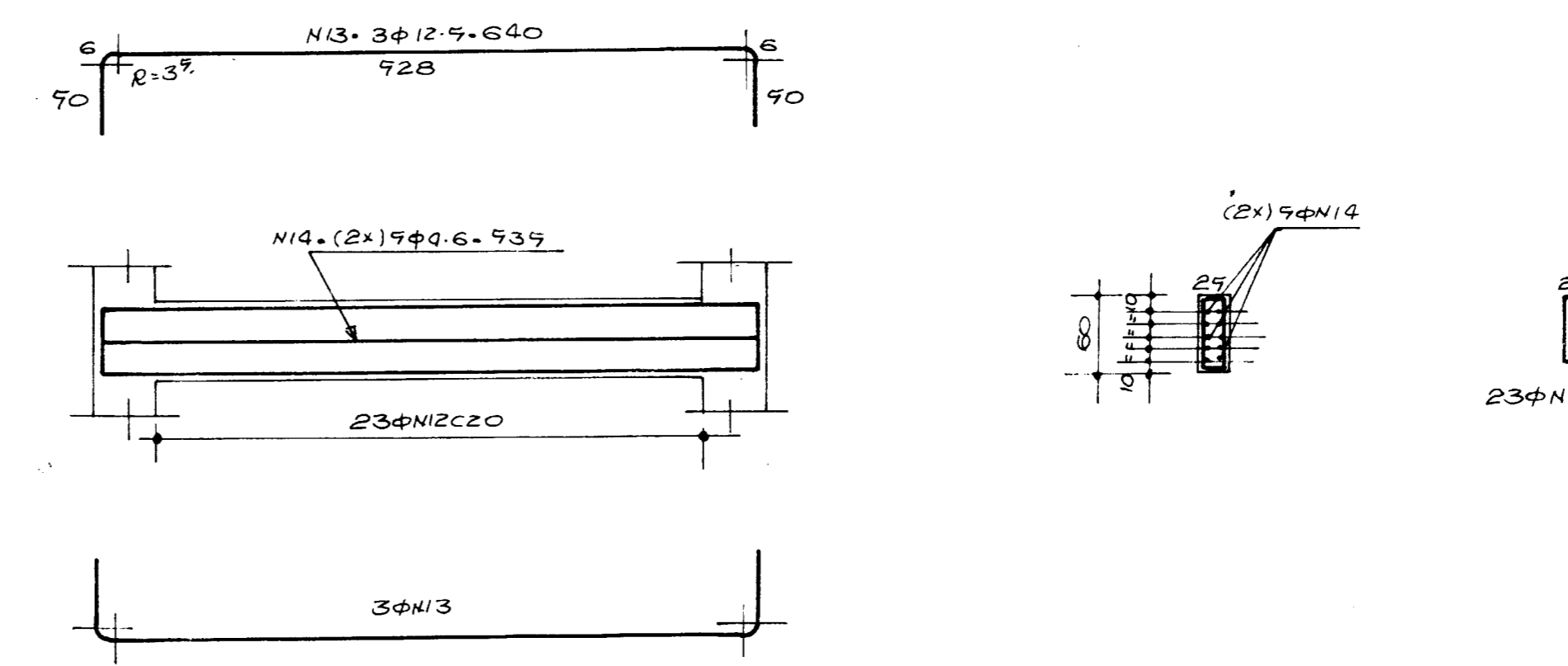
**ARMADURA DA ESCADA**  
ESC: 1/90



**V1 = V2 - (NÍVEL 1) = V4 = V7 - (NÍVEL 2+3) = 25x60 (X6)**



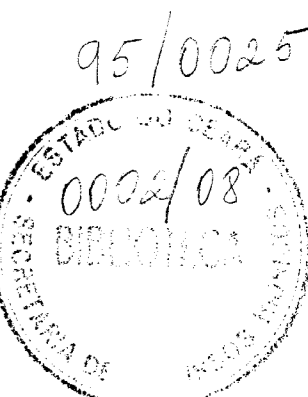
**V3 (NÍVEL 1) = V6 = V7 (NÍVEL 2+3) = 25x60 (X6)**



Resumo das Armaduras

DIAM.	QUANT.	COMPRIMENTO	VOLUME
4.6	2696,98	380	CA-60
6.3	100,35	28	CA-90
10.0	87,30	61	" "
12.9	708,00	779	" "
PESO TOTAL			1248Kg

fc = 150 kg/cm²



000035

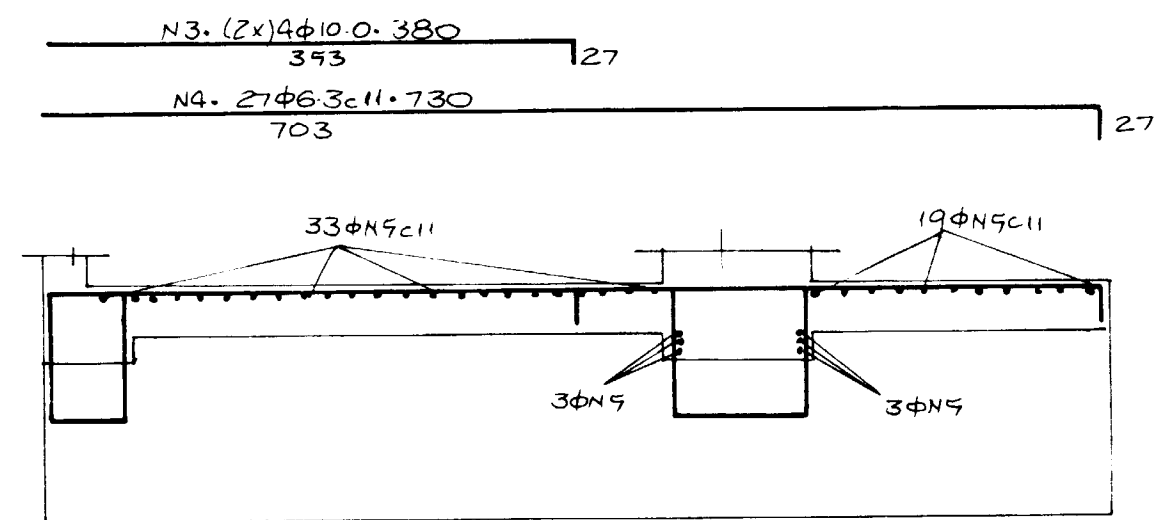
**PRON I - PROGRAMA NACIONAL DE IRRIGAÇÃO**  
**DNOC S - DEPARTAMENTO NACIONAL DE OBRAS CONTRA AS SECAS**

**BARRAGEM MARCO**  
MUNICÍPIO DE MARCO - CEÁRA

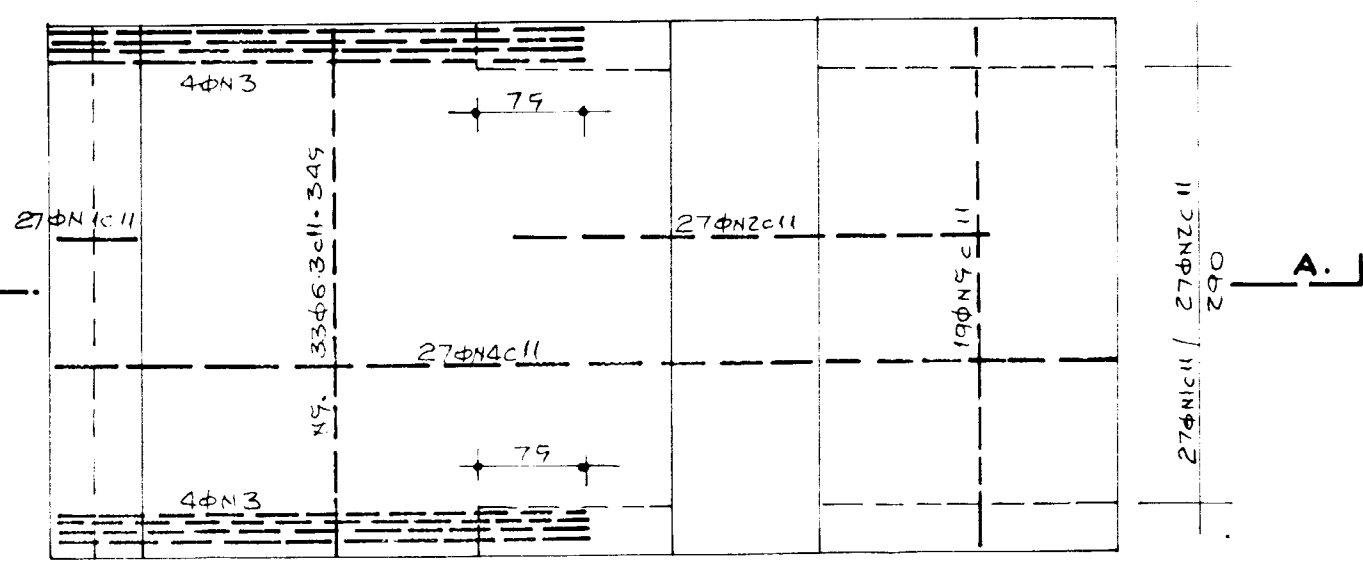
TORRE DE COMANDO  
ARMADURAS DAS LAJES E VIGAS DO NÍVEL 5  
ESCADA

DESENHO: JOÃO  
DATA: JUNHO/88  
ESCALAS: INDICADAS

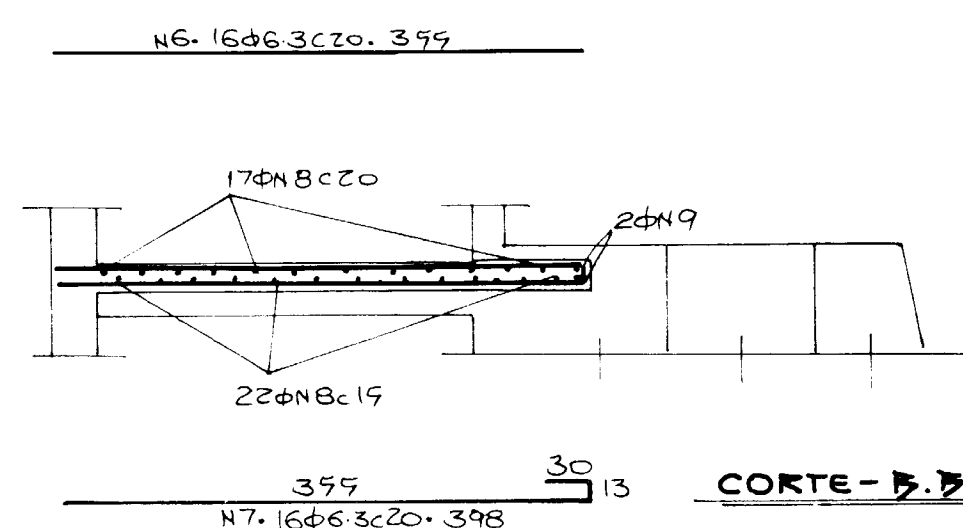
Geonorte



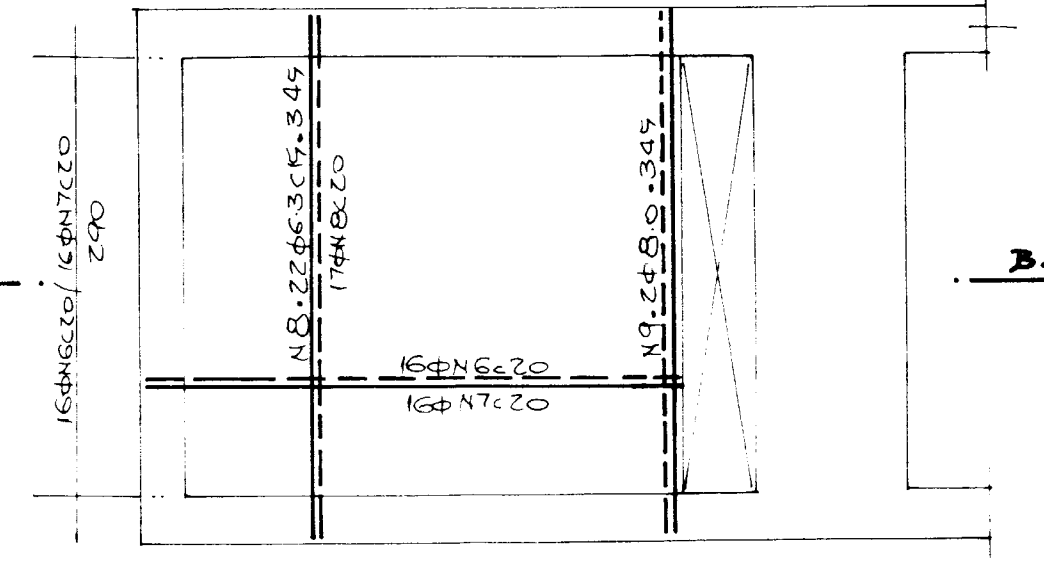
CORTE - A-A



ARMADURA DA LAJE L3  
BOCA DE JUSANTE

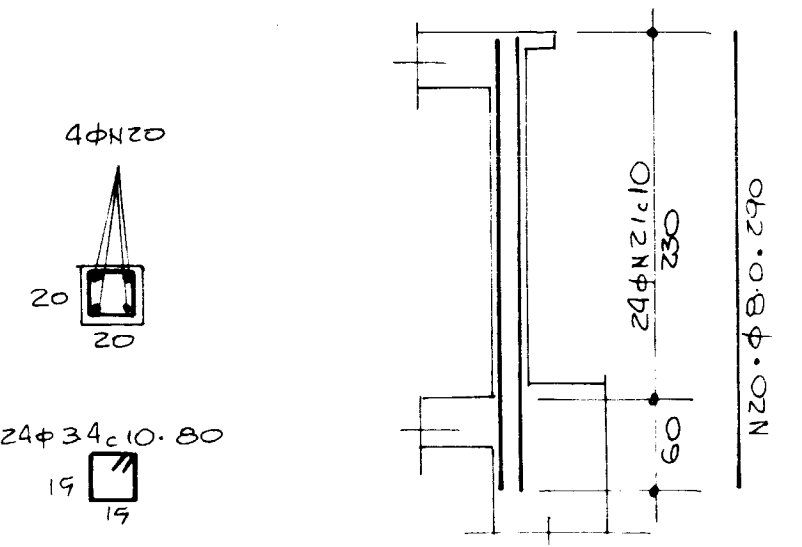


CORTE - B-B



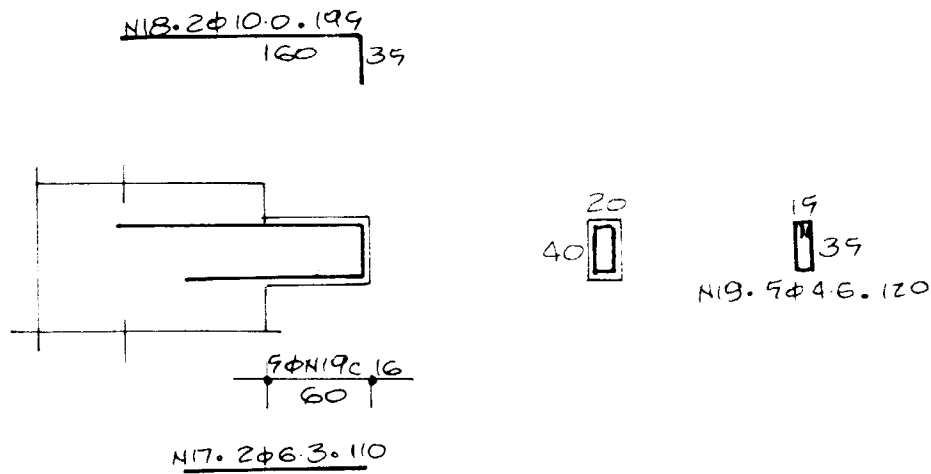
ARMADURA DA LAJE L2  
BOCA DE JUSANTE

P1 = P2 - 20x20  
BOCA DE JUSANTE

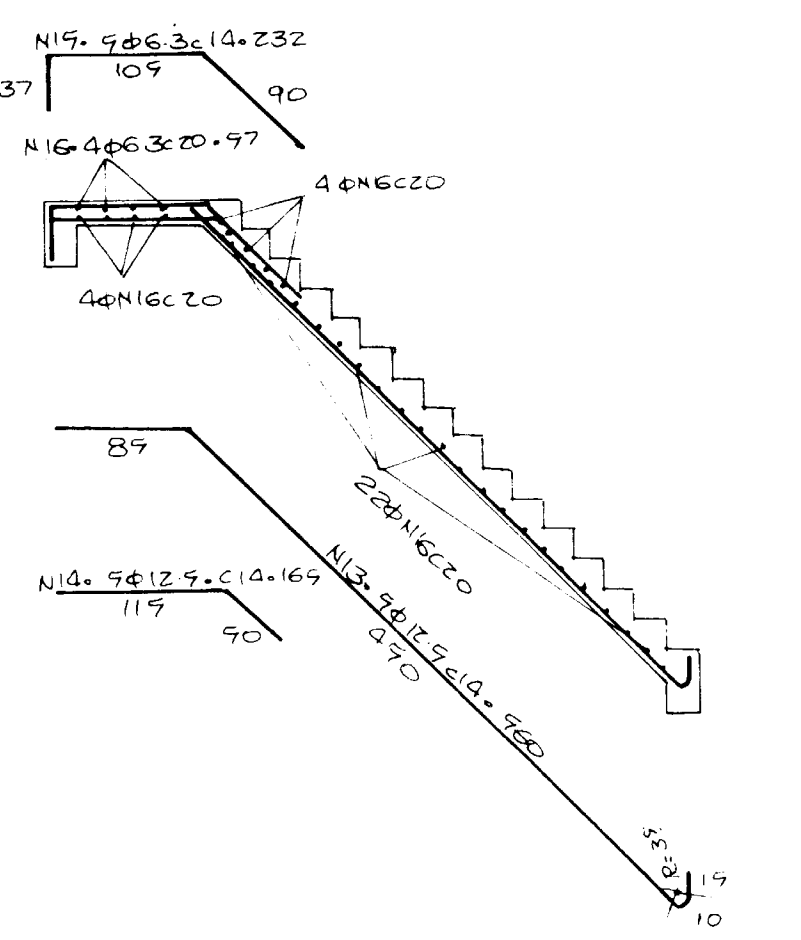


ARMADURA DA LAJE L1  
BOCA DE JUSANTE

CONSOLO - 20x20 (12)  
BOCA DE JUSANTE

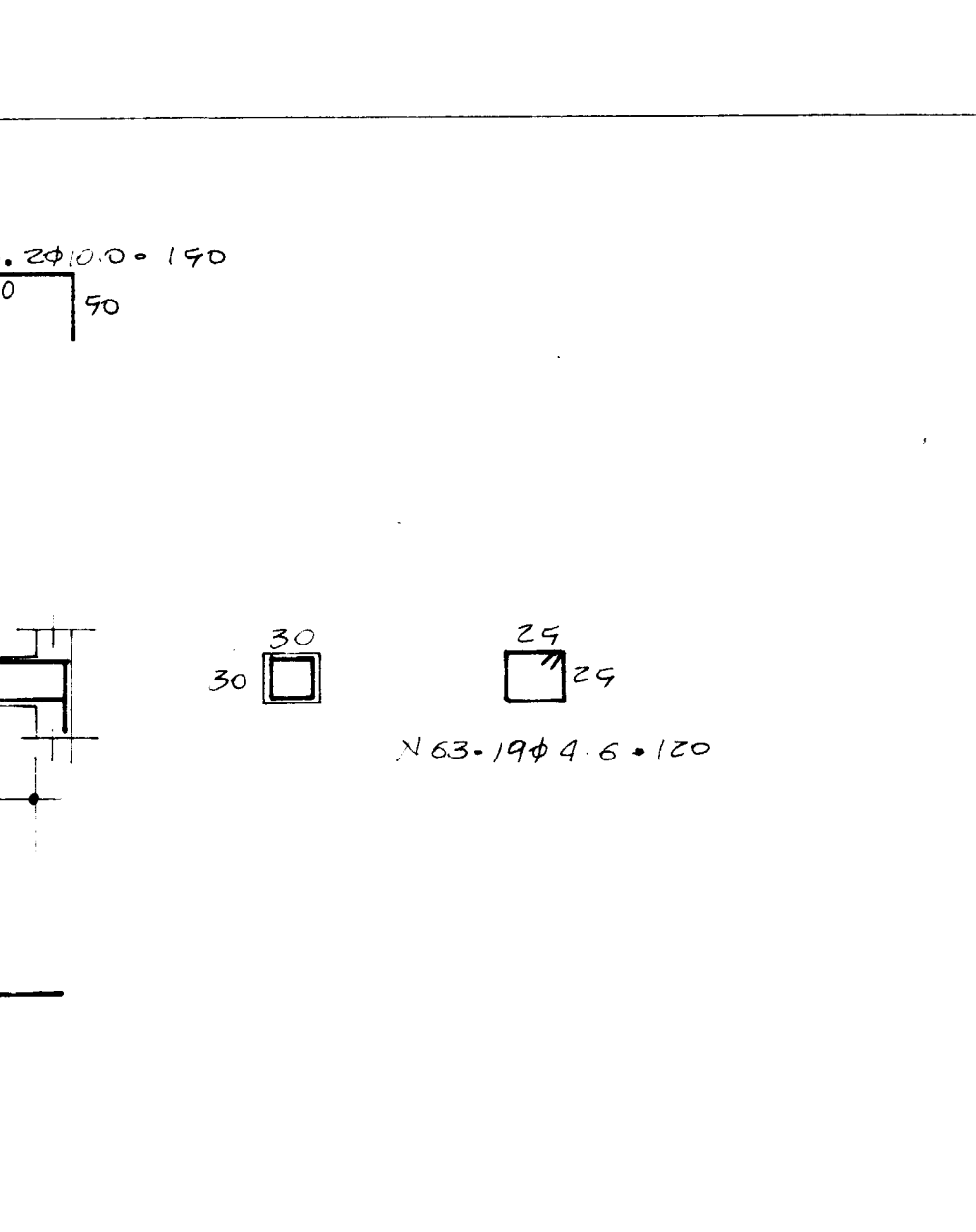
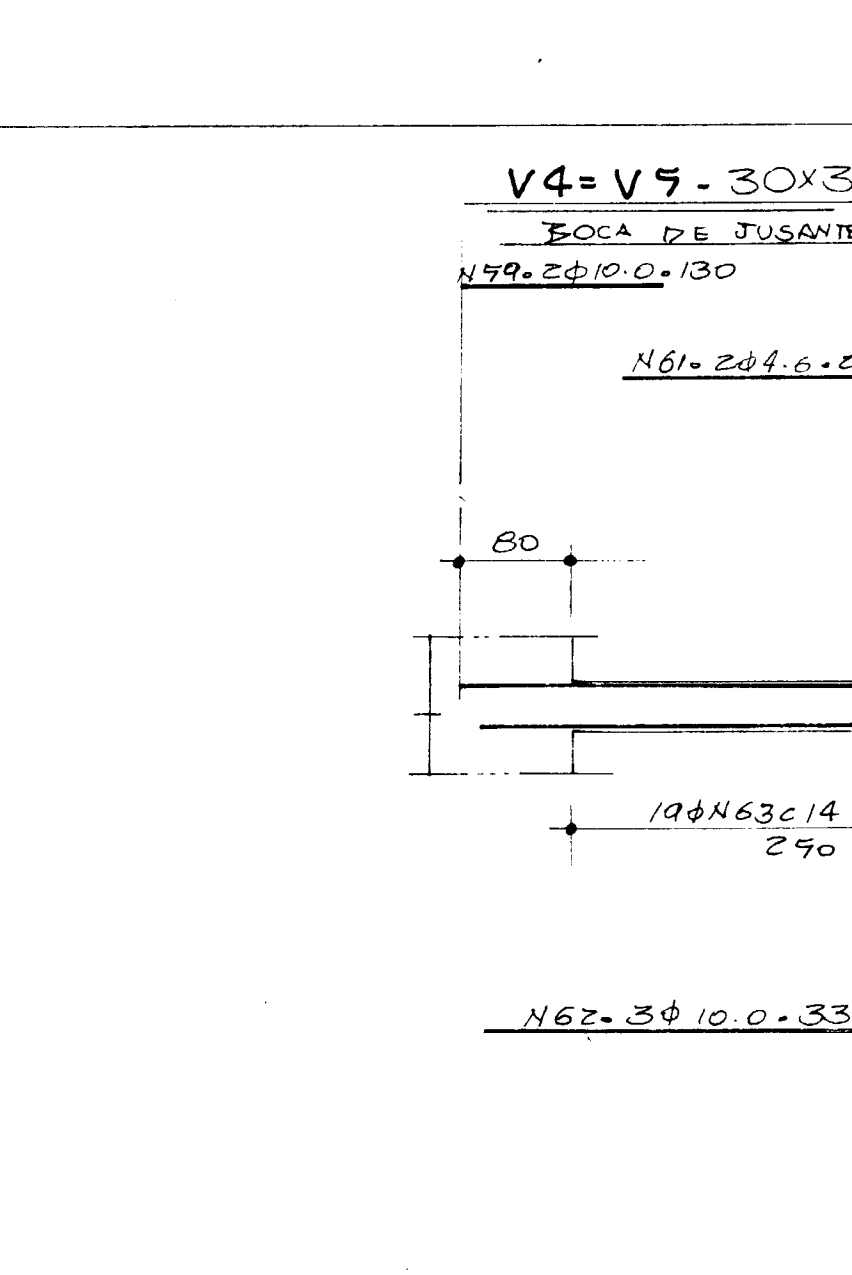
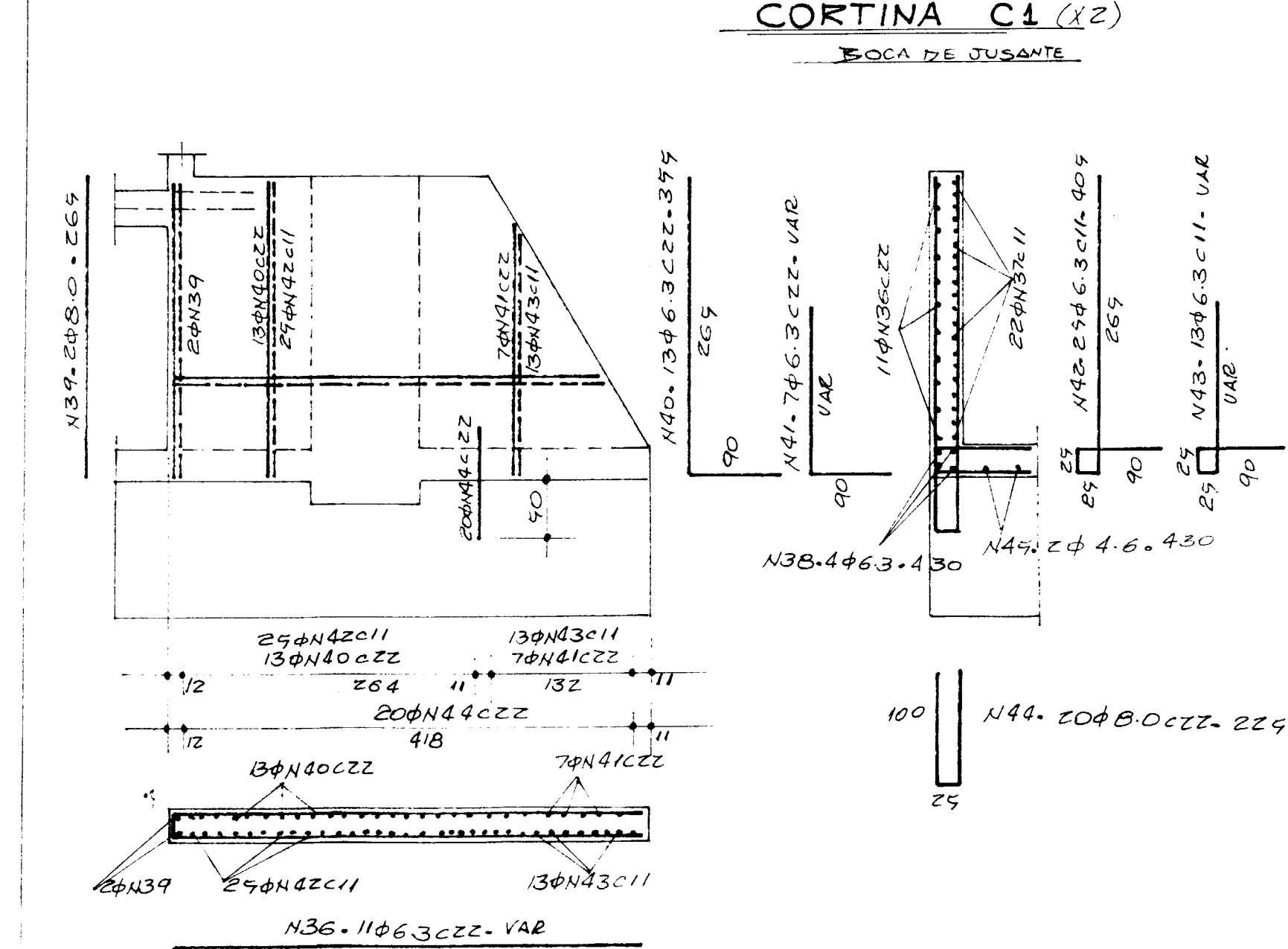
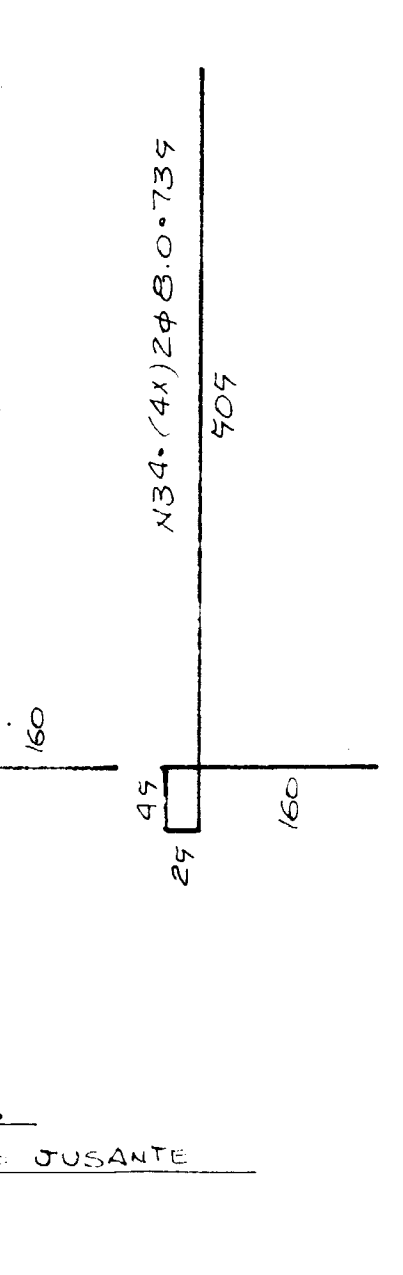
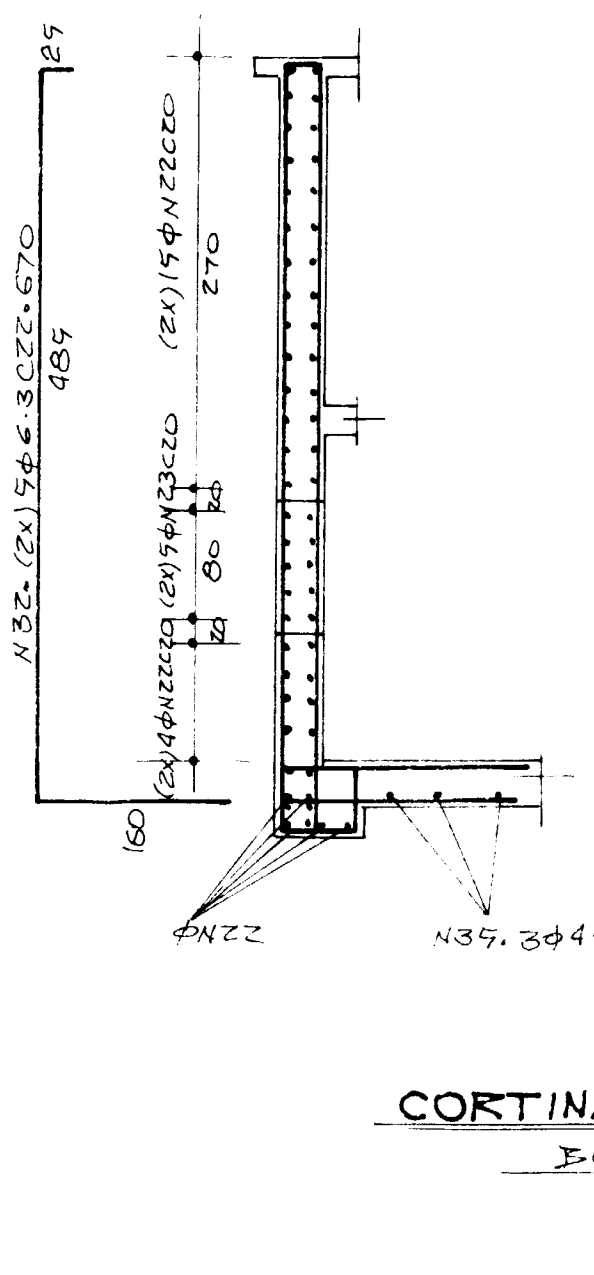
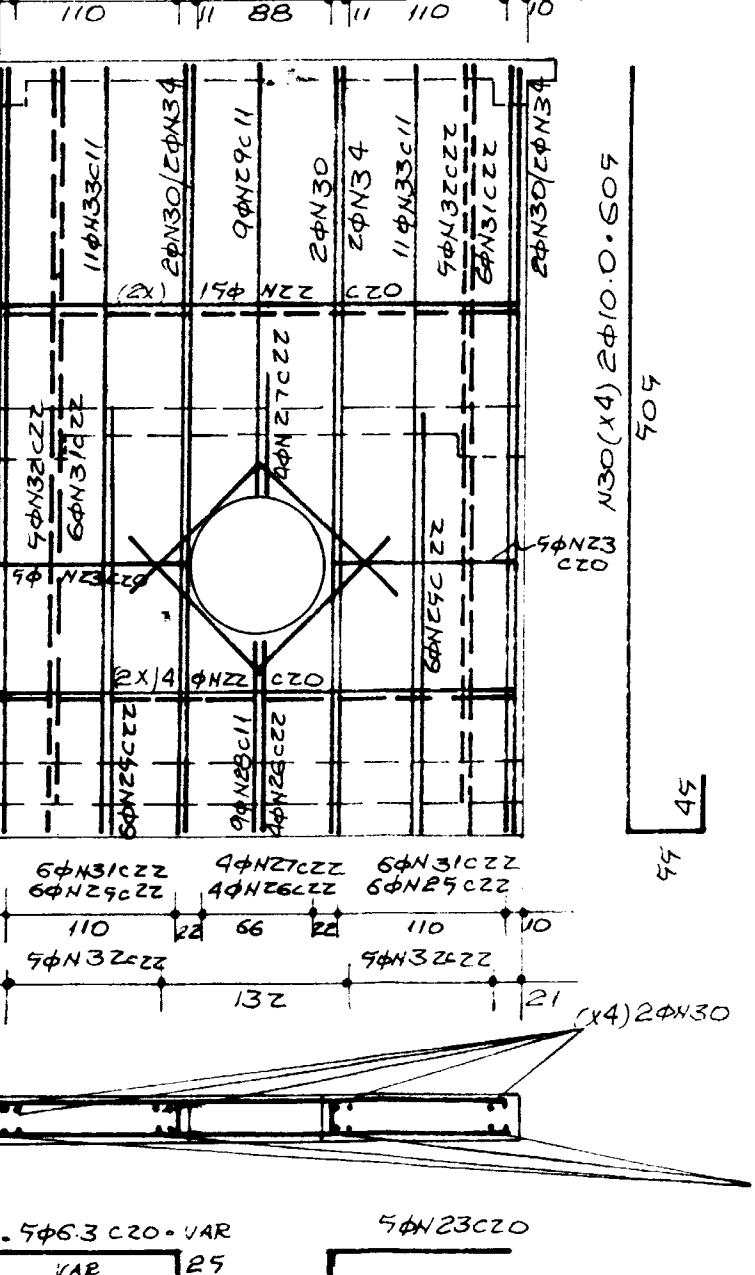
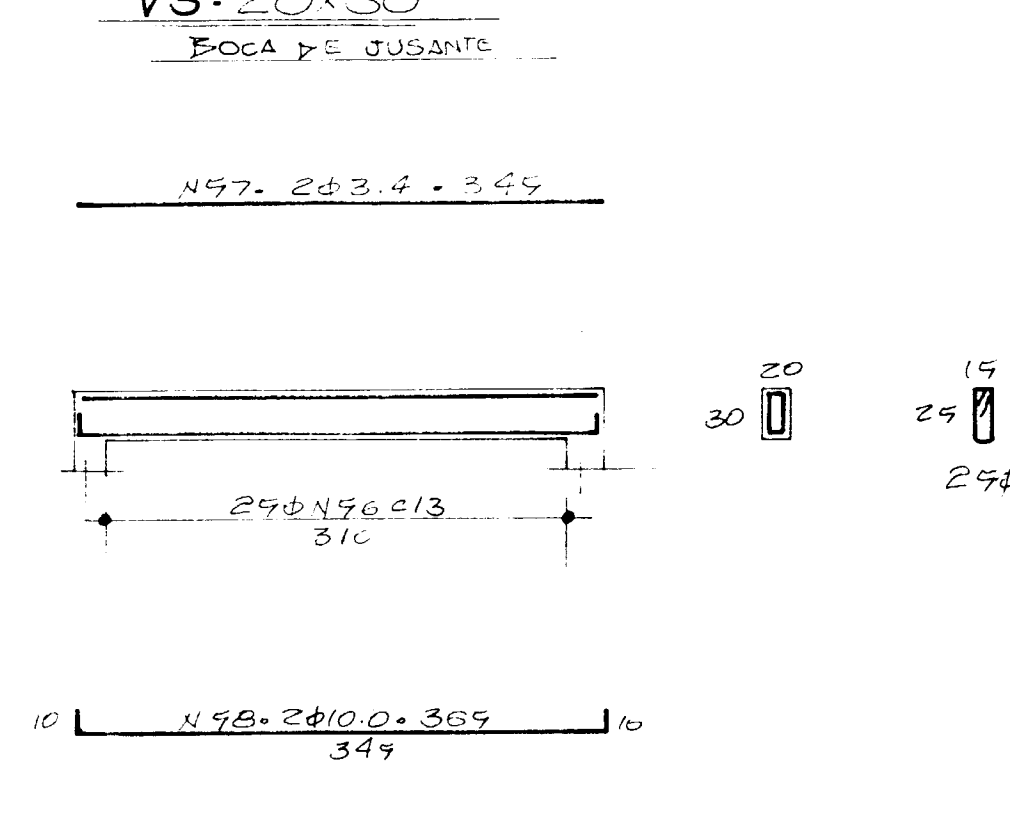
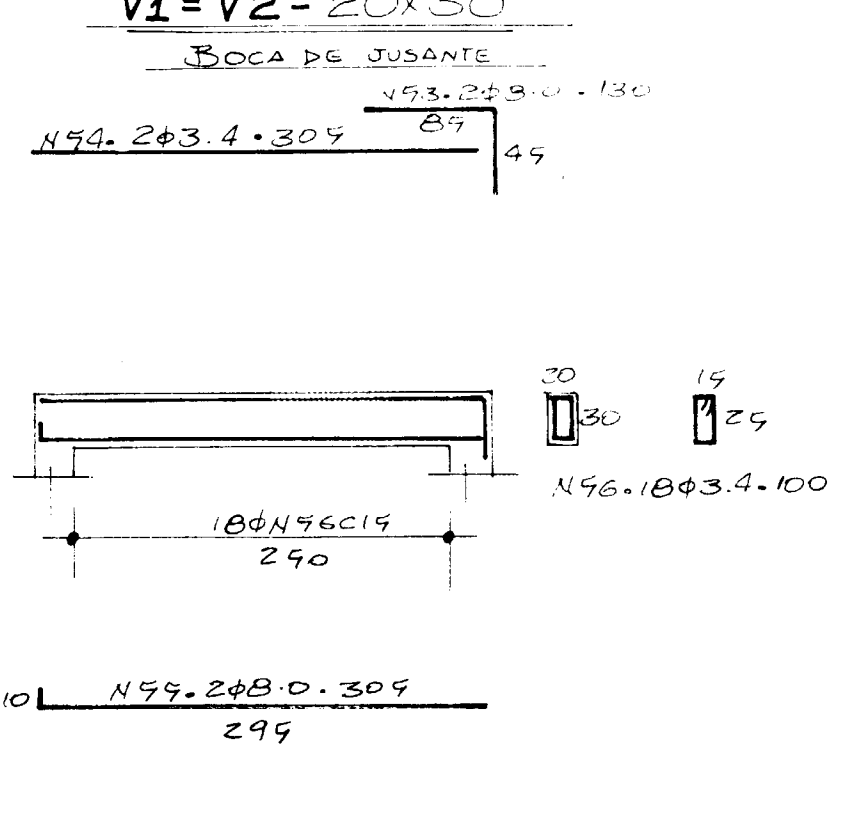
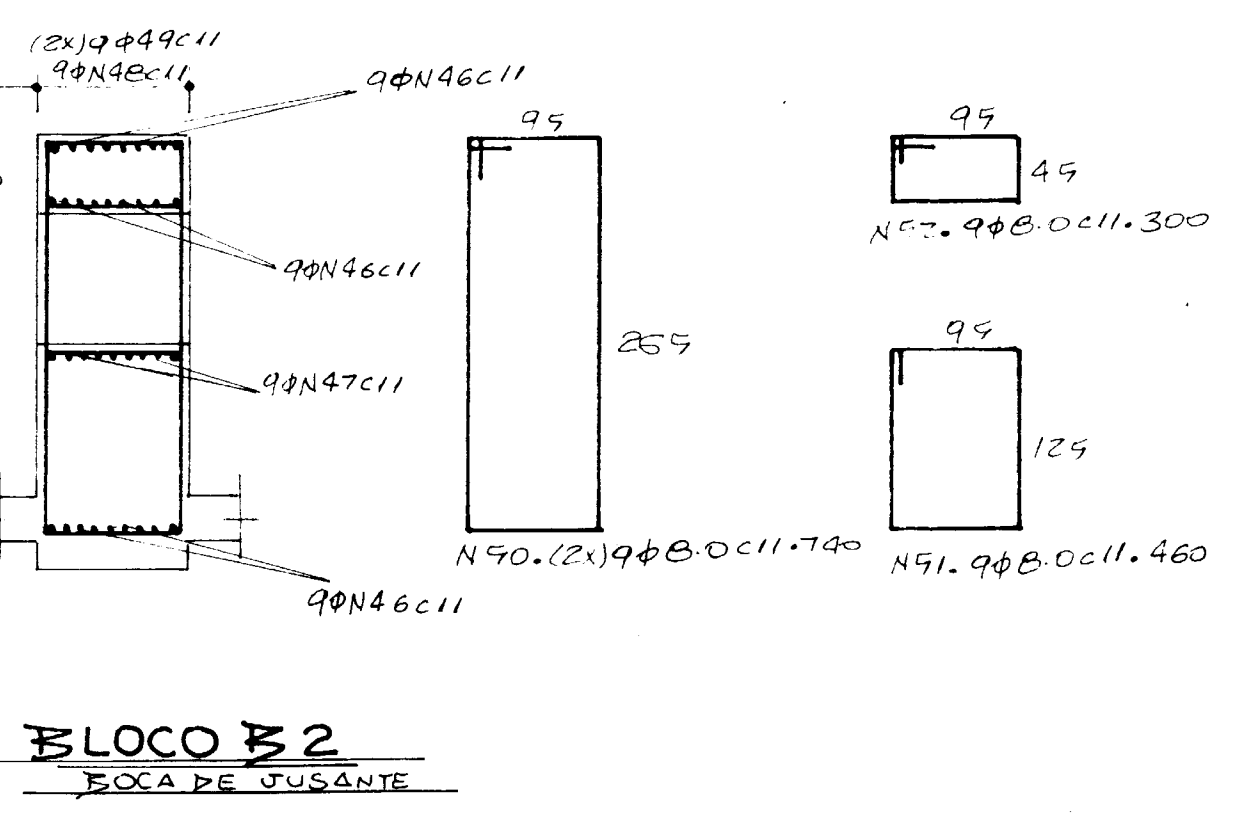
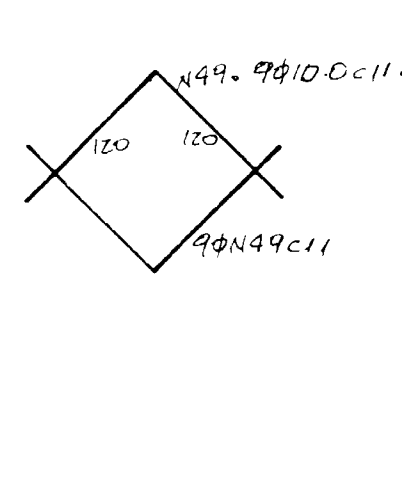
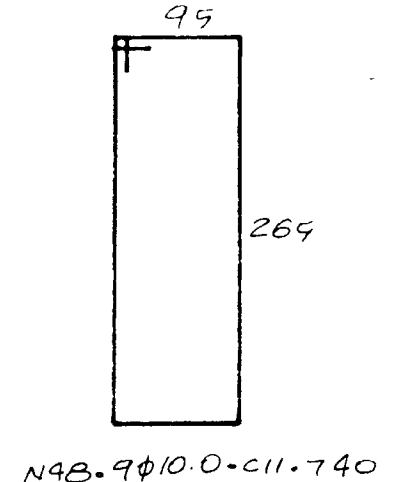
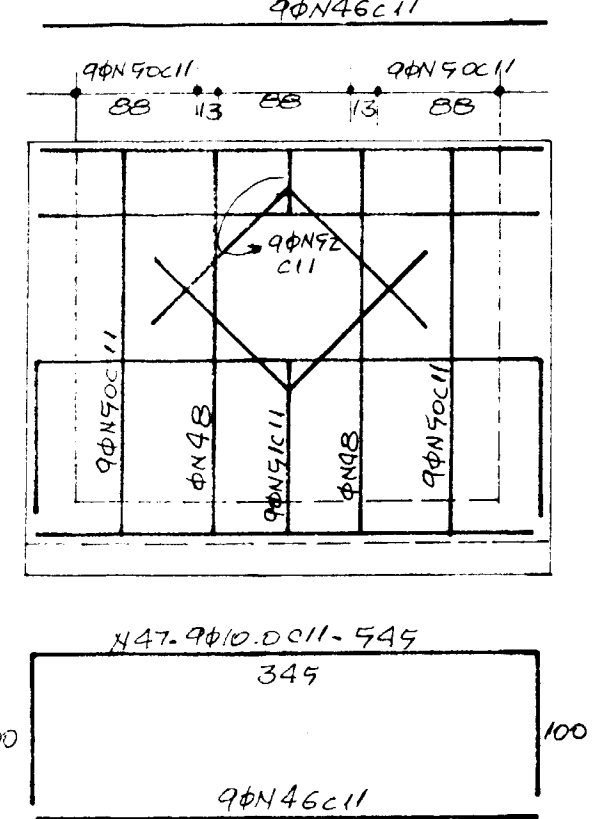
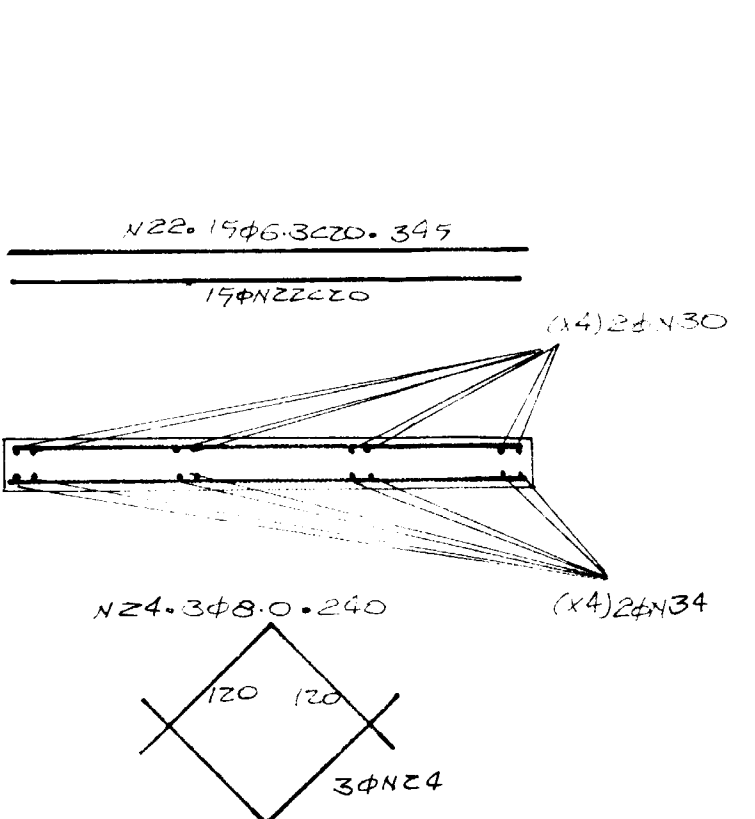


ESCAPA  
BOCA DE JUSANTE



1	27	10,0	290	7830	33	22	6,3	760	16720
2	27	"	654	17698	34	8	8,0	739	9880
3	8	"	340	3040	35	3	4,6	349	1039
4	27	6,3	730	19710	36	22	6,3	VARIÁVEL	8000
5	98	"	345	20010	37	44	"	VARIÁVEL	16000
6	16	"	359	9690	38	8	"	430	3440
7	16	"	349	6368	39	4	8,0	269	1060
8	39	"	349	13449	40	26	6,3	359	9230
9	2	8,0	345	690	41	14	"	VARIÁVEL	3300
10	22	3,4	300	6600	42	90	"	409	20270
11	16	"	350	9600	43	26	"	VARIÁVEL	6800
12	78	"	74	5774	44	40	8,0	229	9000
13	5	12,9	460	2800	45	4	4,6	430	1720
14	5	"	169	829	46	27	10,0	349	9319
15	9	6,3	232	1160	47	9	"	445	4909
16	34	"	97	1938	48	9	"	740	6660
17	4	"	110	440	49	18	"	240	4320
18	4	10,0	195	780	50	19	8,0	740	13320
19	10	4,6	170	1200	51	9	"	460	4140
20	8	8,0	290	2320	52	9	"	300	2700
21	48	3,4	80	3840	53	2	"	130	920
22	46	6,3	349	15870	54	4	3,4	309	1220
23	10	"	VARIÁVEL	3300	55	4	8,0	309	1220
24	6	8,0	240	1440	56	61	3,4	100	6100
25	12	"	260	3360	57	2	"	345	690
26	3	"	VARIÁVEL	600	58	2	10,0	369	730
27	4	"	VARIÁVEL	390	59	2	"	130	920
28	9	6,3	VARIÁVEL	2800	60	4	"	190	600
29	9	"	VARIÁVEL	9000	61	4	4,6	200	800
30	8	10,0	609	4870	62	6	10,0	330	1980
31	12	6,3	930	6360	63	38	4,6	150	4760
32	10	"	670	6700	64	"	"	"	"

3,4	291,34	23	CA-60
4,6	93,19	14	"
6,3	1933,31	932	CA-90
8,0	466,00	206	"
10,0	631,78	438	"
12,9	36,25	40	"
PESO TOTAL		1253 kg	



PRON I - PROGRAMA NACIONAL DE IRRIGAÇÃO  
DNOCS - DEPARTAMENTO NACIONAL DE OBRAS CONTRA AS SECAS

**BARRAGEM MARCO**  
MUNICÍPIO DE MARCO - CEARÁ

ARMADURAS DA BOCA DE JUSANTE

DESENHO: JOÃO  
DATA: JUNHO/88  
ESCALAS: INDICADAS

000036

Geonorte