



IBRACON



PONTE PRESIDENTE COSTA E SILVA

MÉTODOS EXECUTIVOS

Bruno Contarini

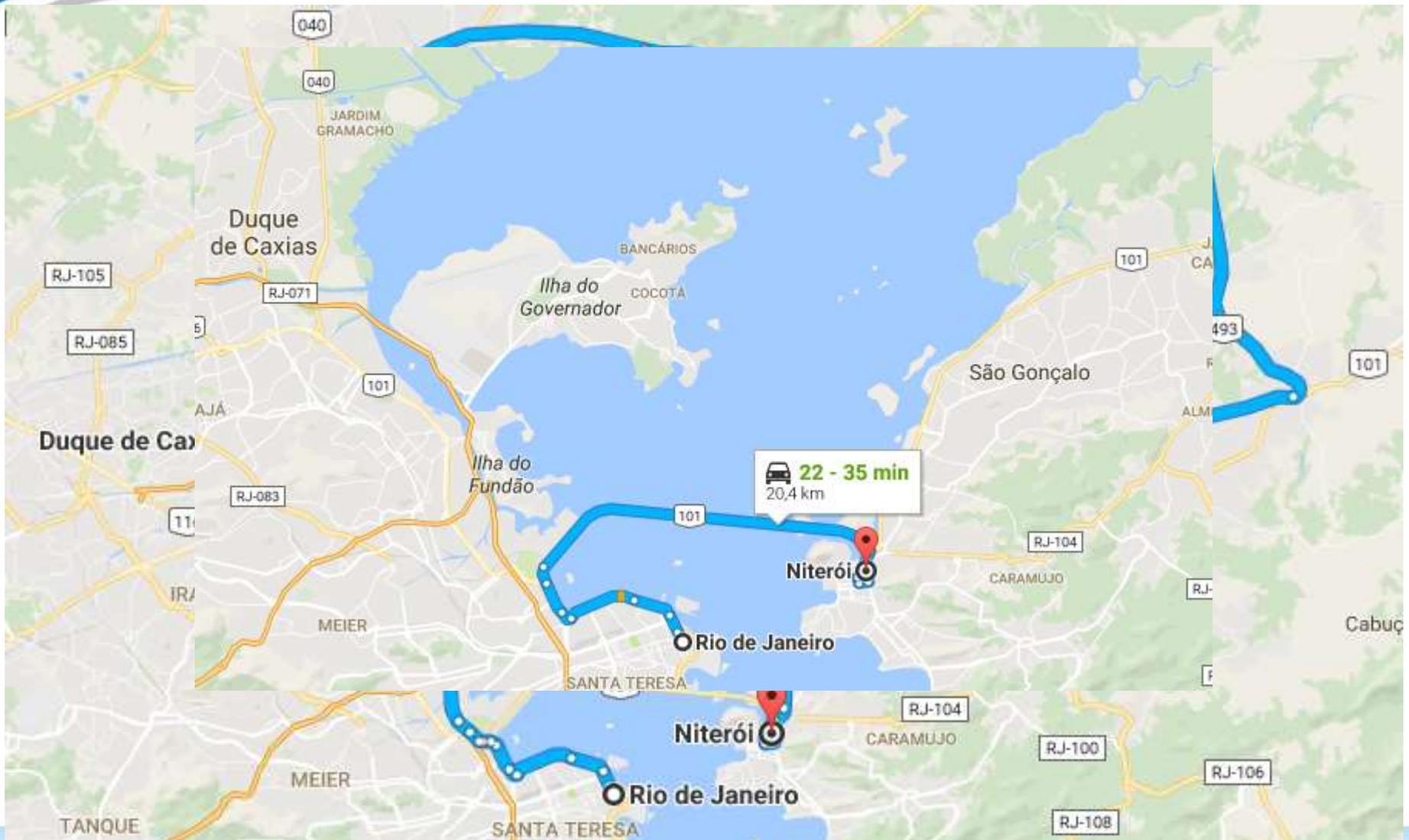
Engenheiro Civil – Diretor Técnico BC Engenharia

bceng@veloxmail.com.br





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- Obras em Terra
 - Fundação – Blocos e Pilares

- Obras em Mar
 - Mario Vila Verde e Benjamin Ernani Diaz



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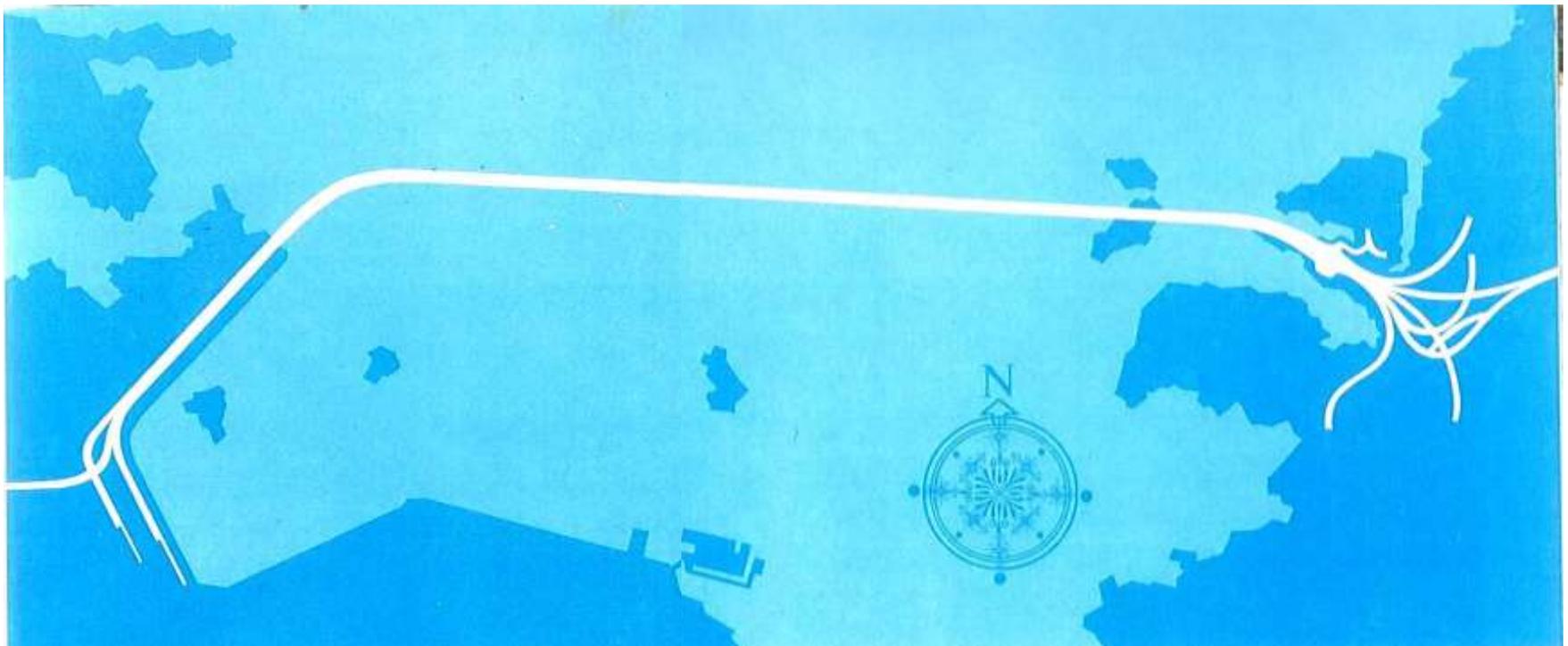
Ponte Rio - Niterói

- 72 m de altura
- 13.290 m de extensão no mar
- 300 m de vão central metálico



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Traçado





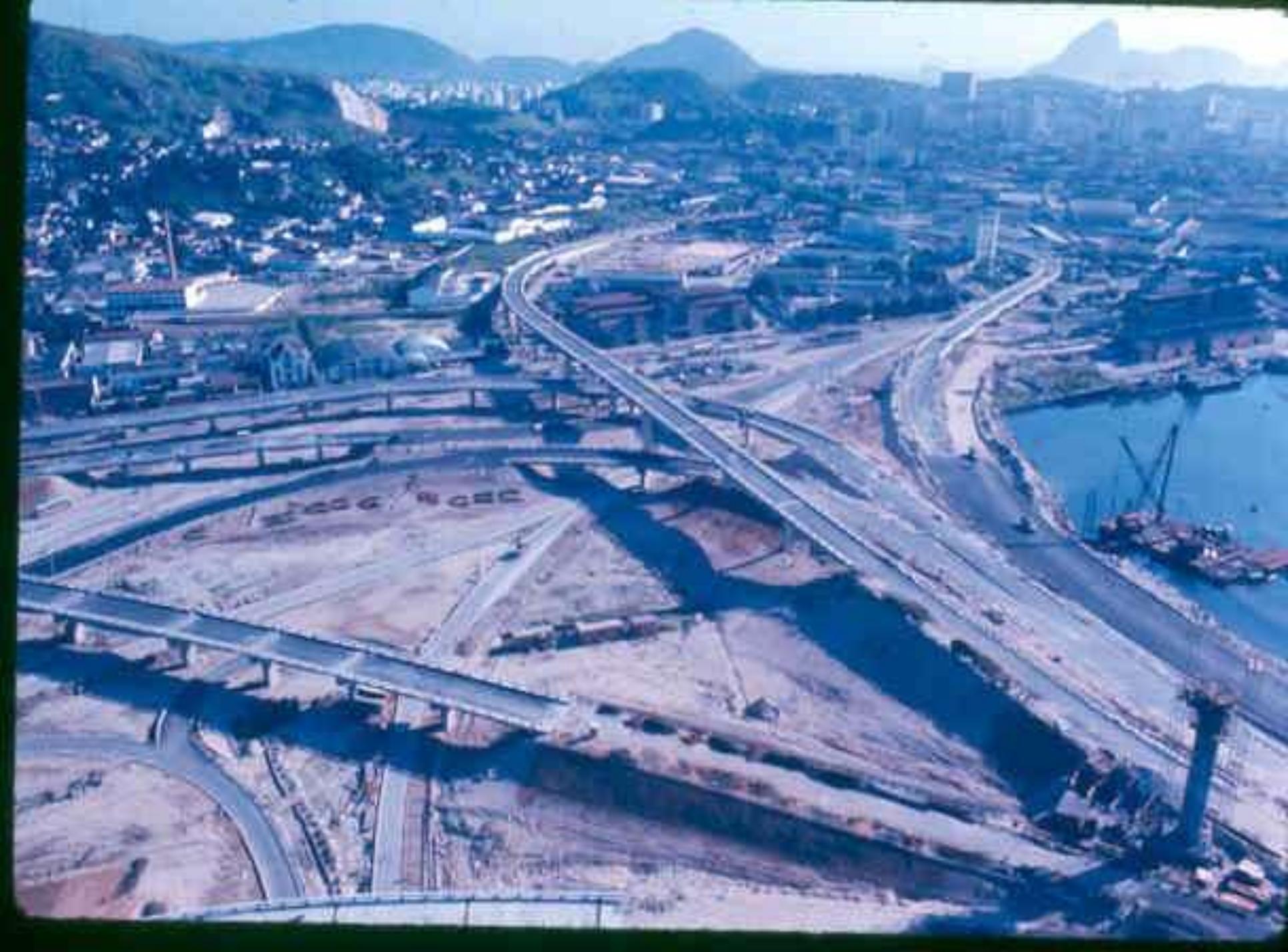


GUANABARA

ACESSO NITERÓI

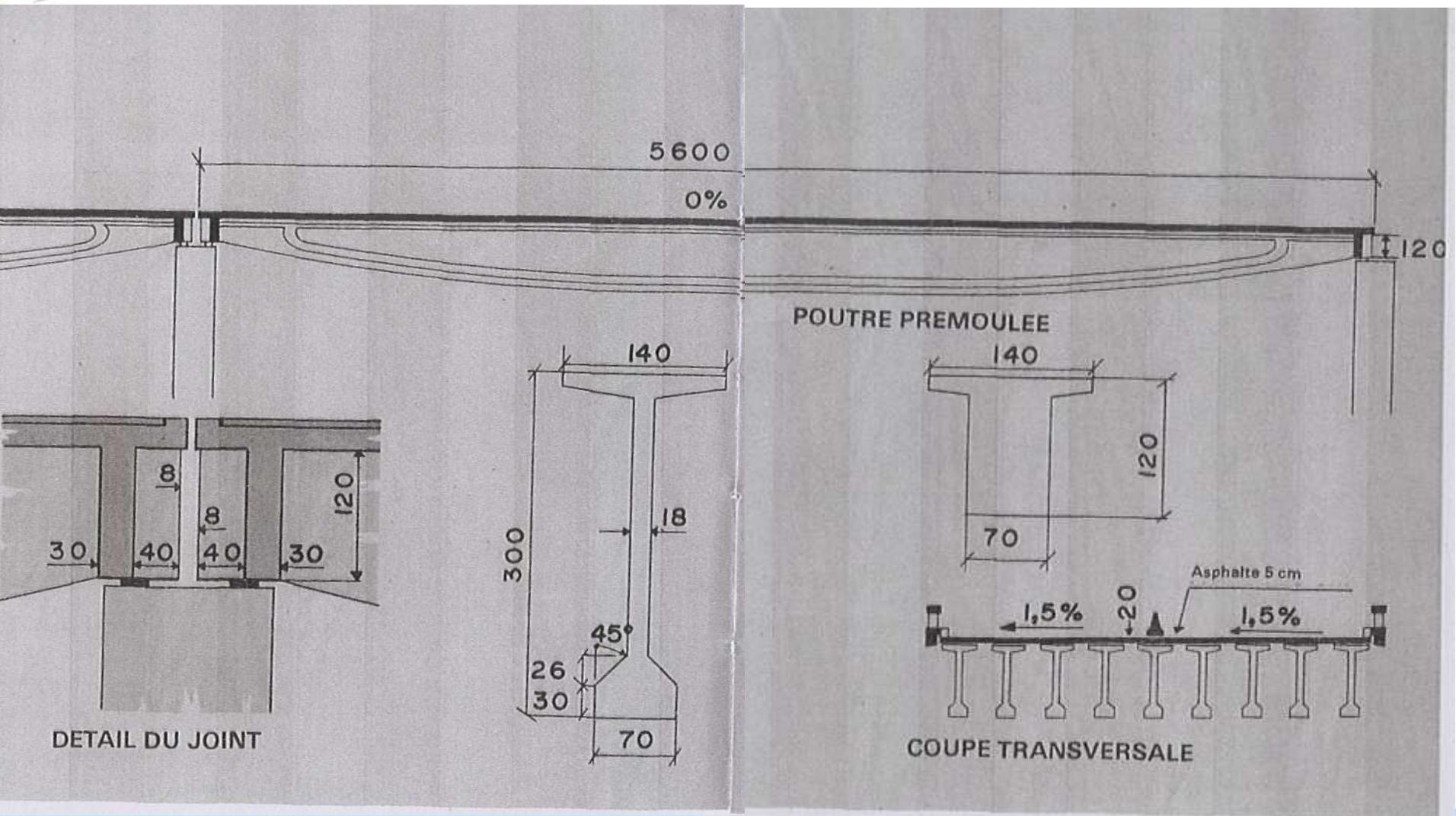
mapa@dovio
Plano Aldeia do Castelo
Cartógrafo Responsável





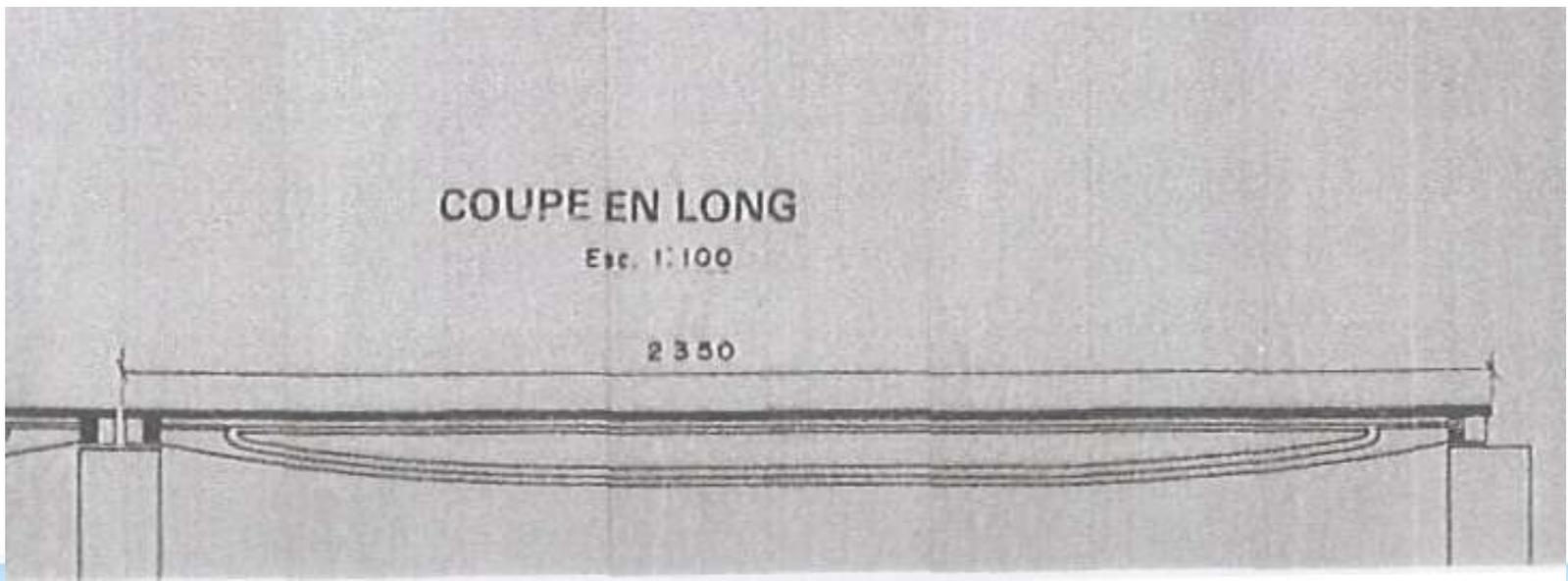
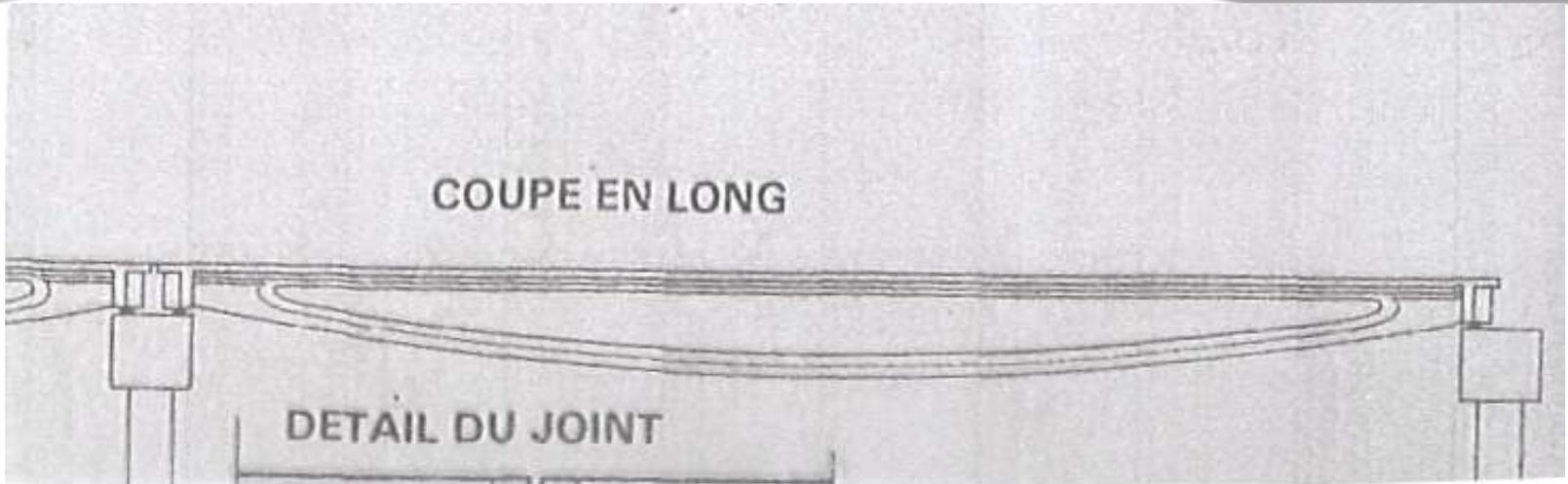


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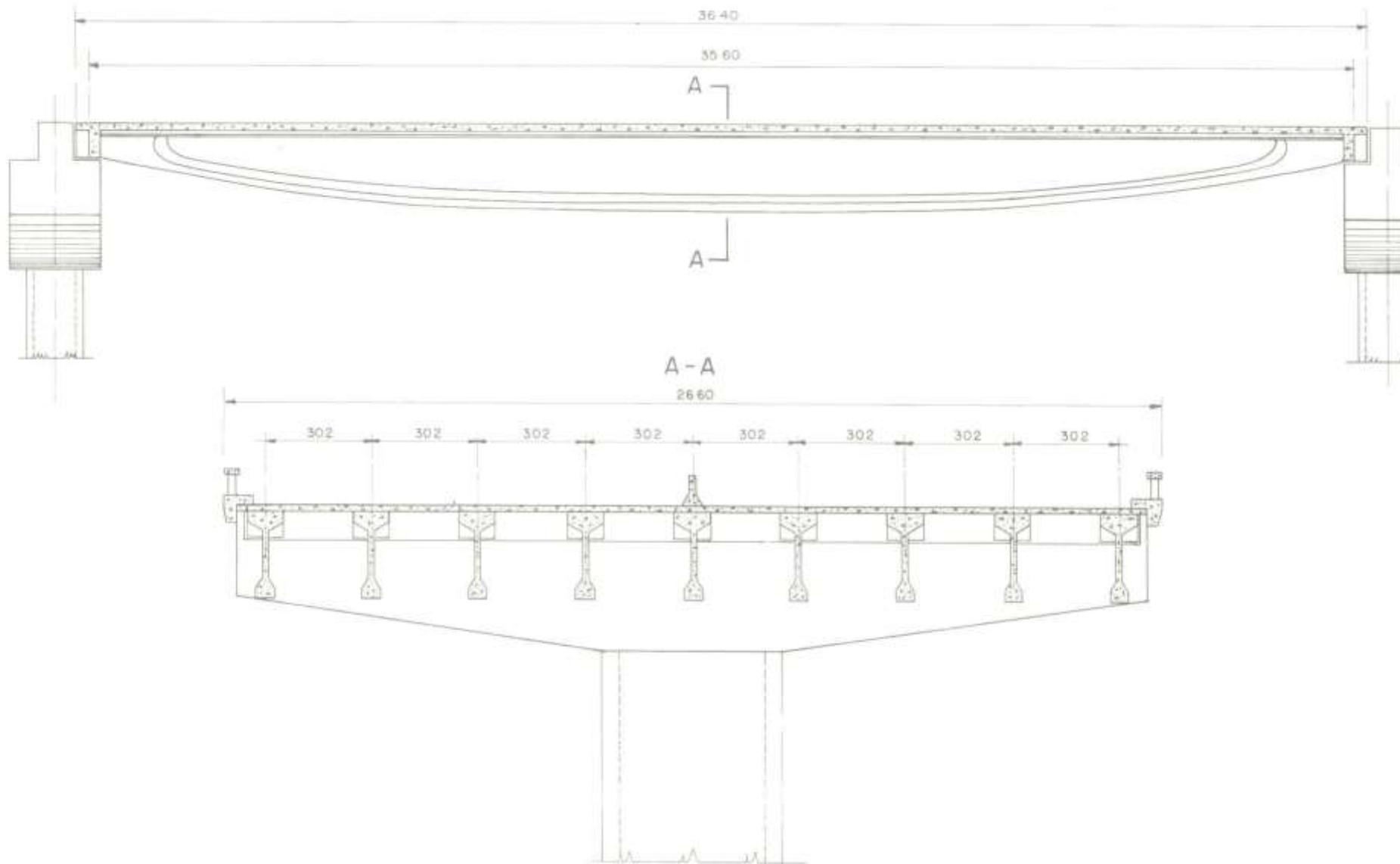


Fig. 7.2. Viadutos dos acessos em terra. Vão típico com longarinas pré-moldadas.

CHANTIER DE POUTRES AVEC DIAGRAMME DE FLUX

PREMOULES DES ARMATURES

APPROVISIONNEMENT

BUREAUX

ARMATURES

PREMOULES DES PLAQUES DE TETE

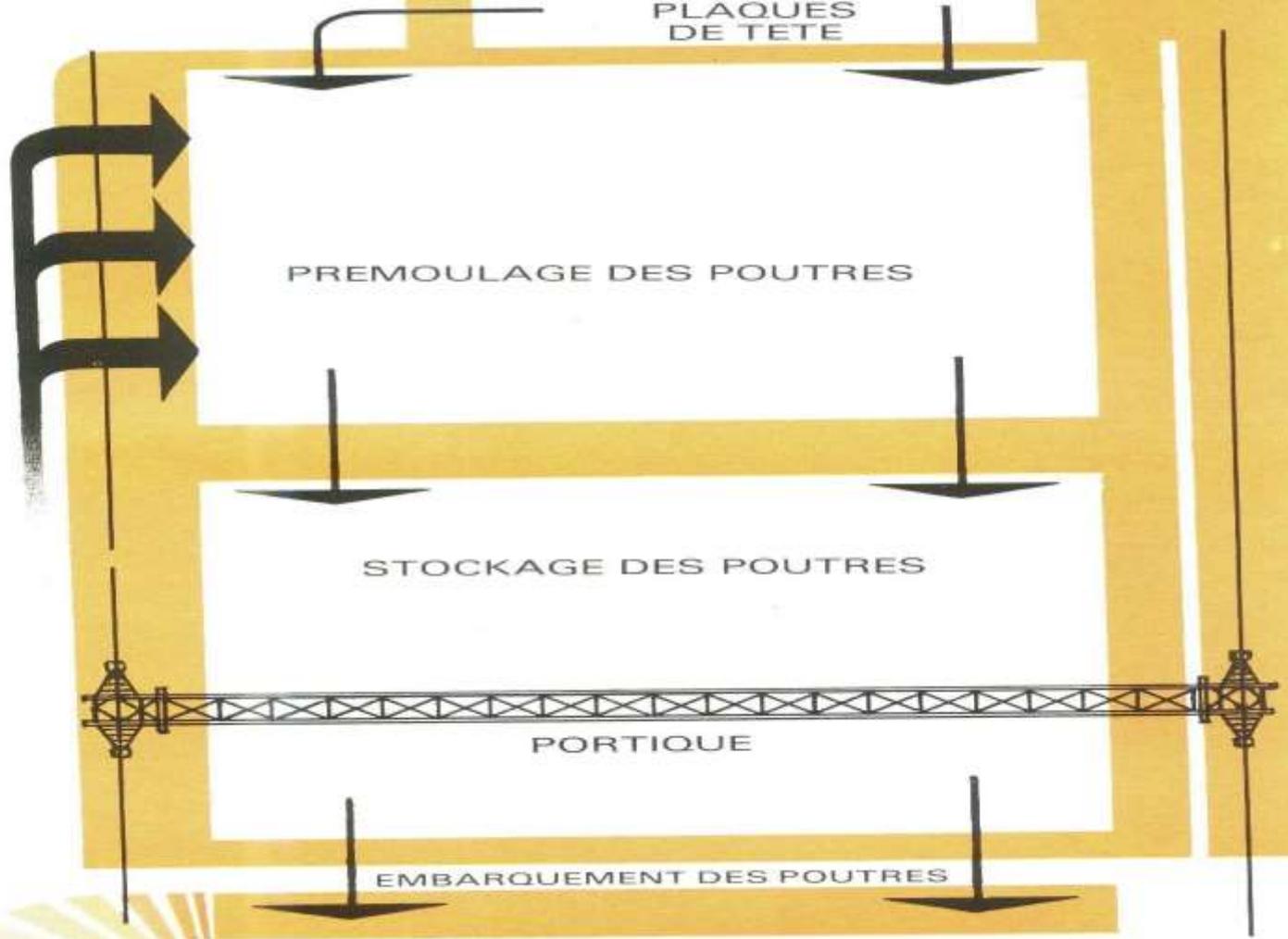
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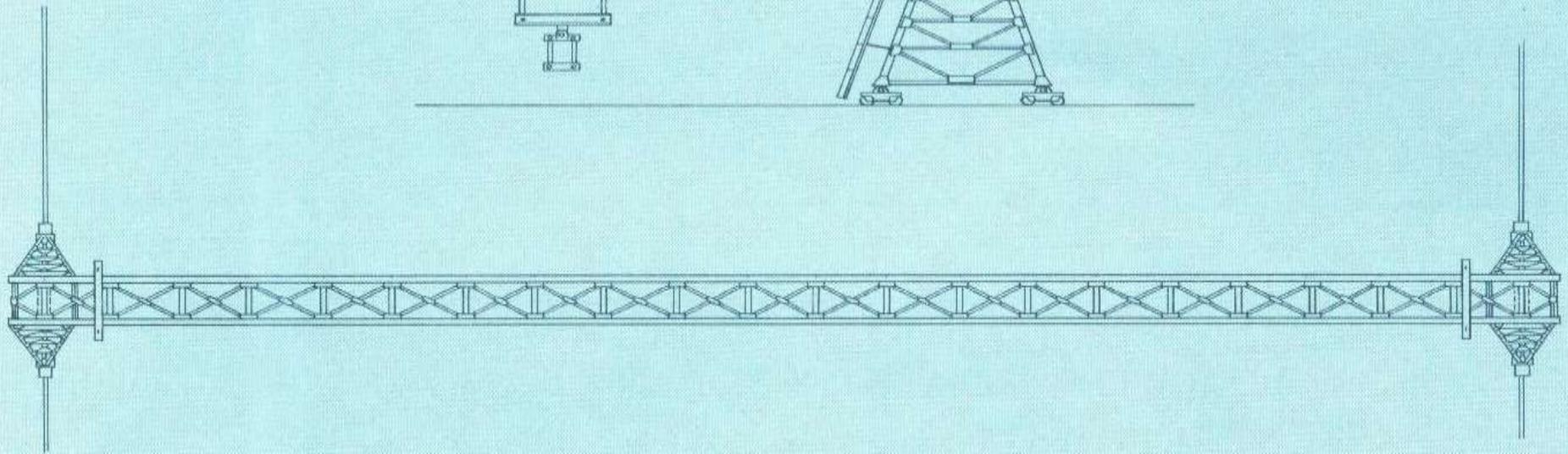
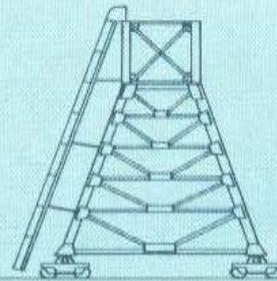
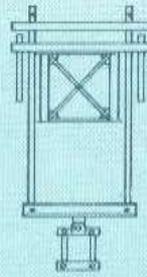
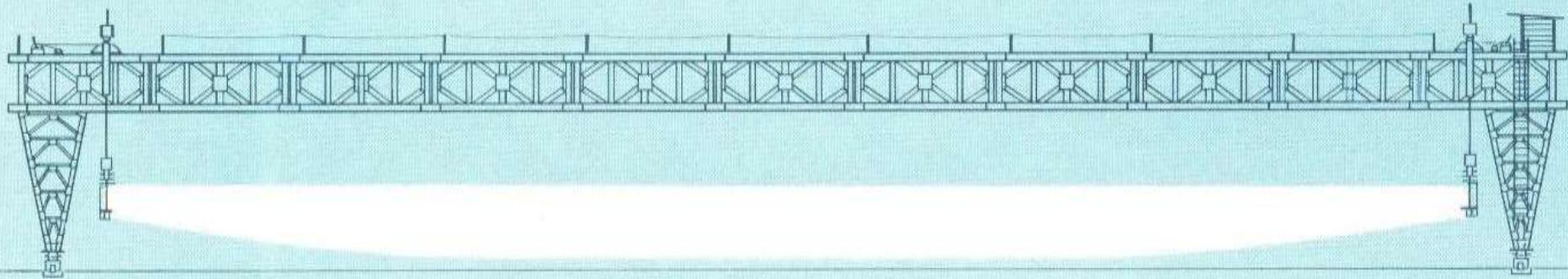
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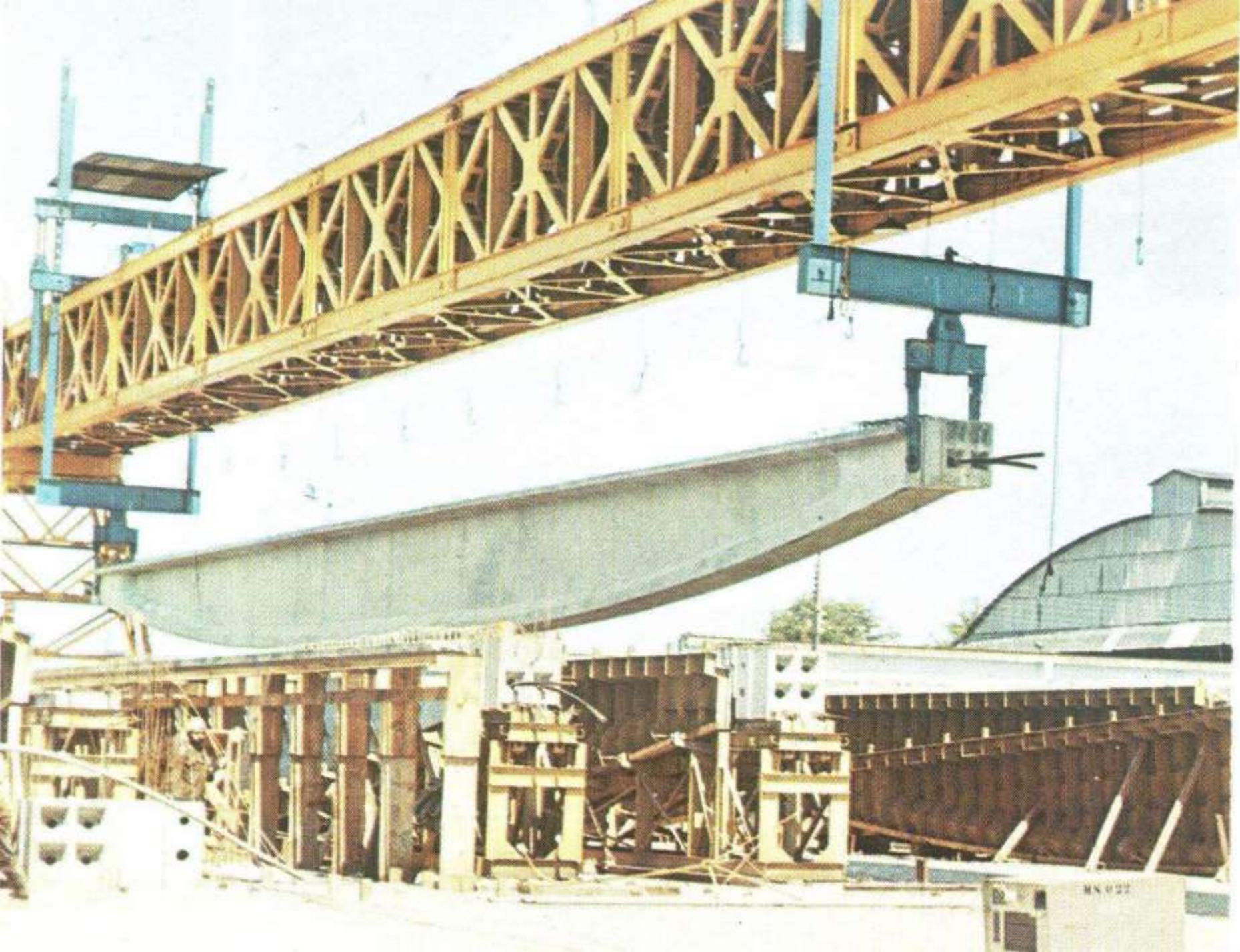
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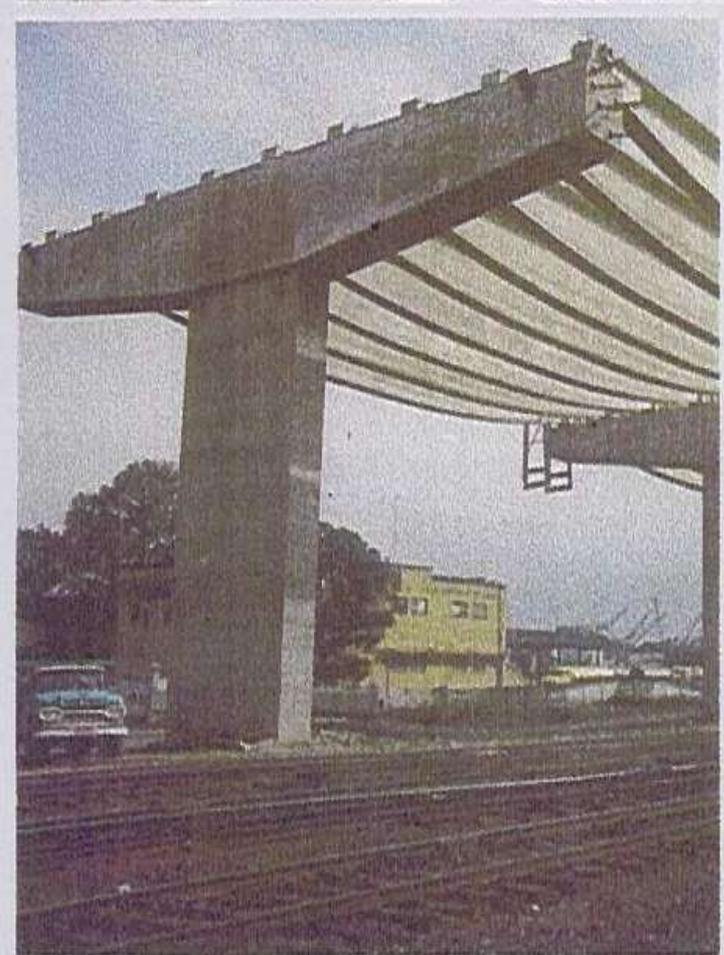
PORTIQUE

EMBARQUEMENT DES POUTRES

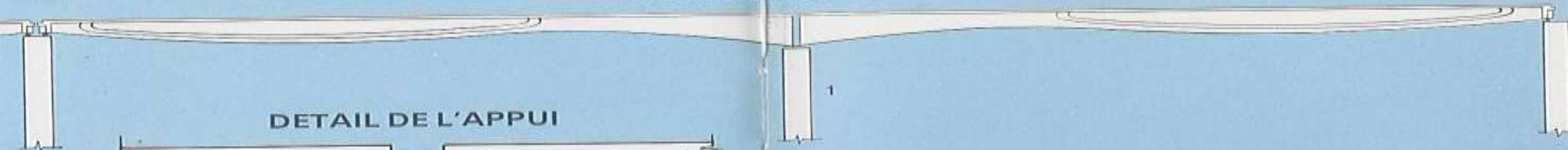




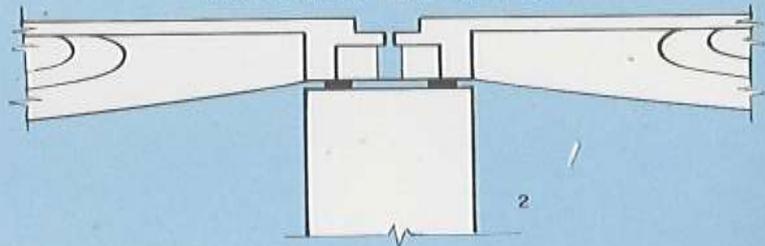




COUPE EN LONG



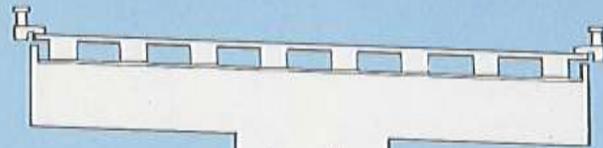
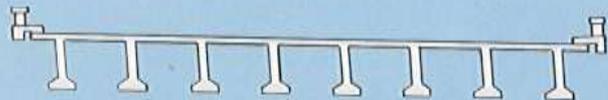
DETAIL DE L'APPUI



PLAN

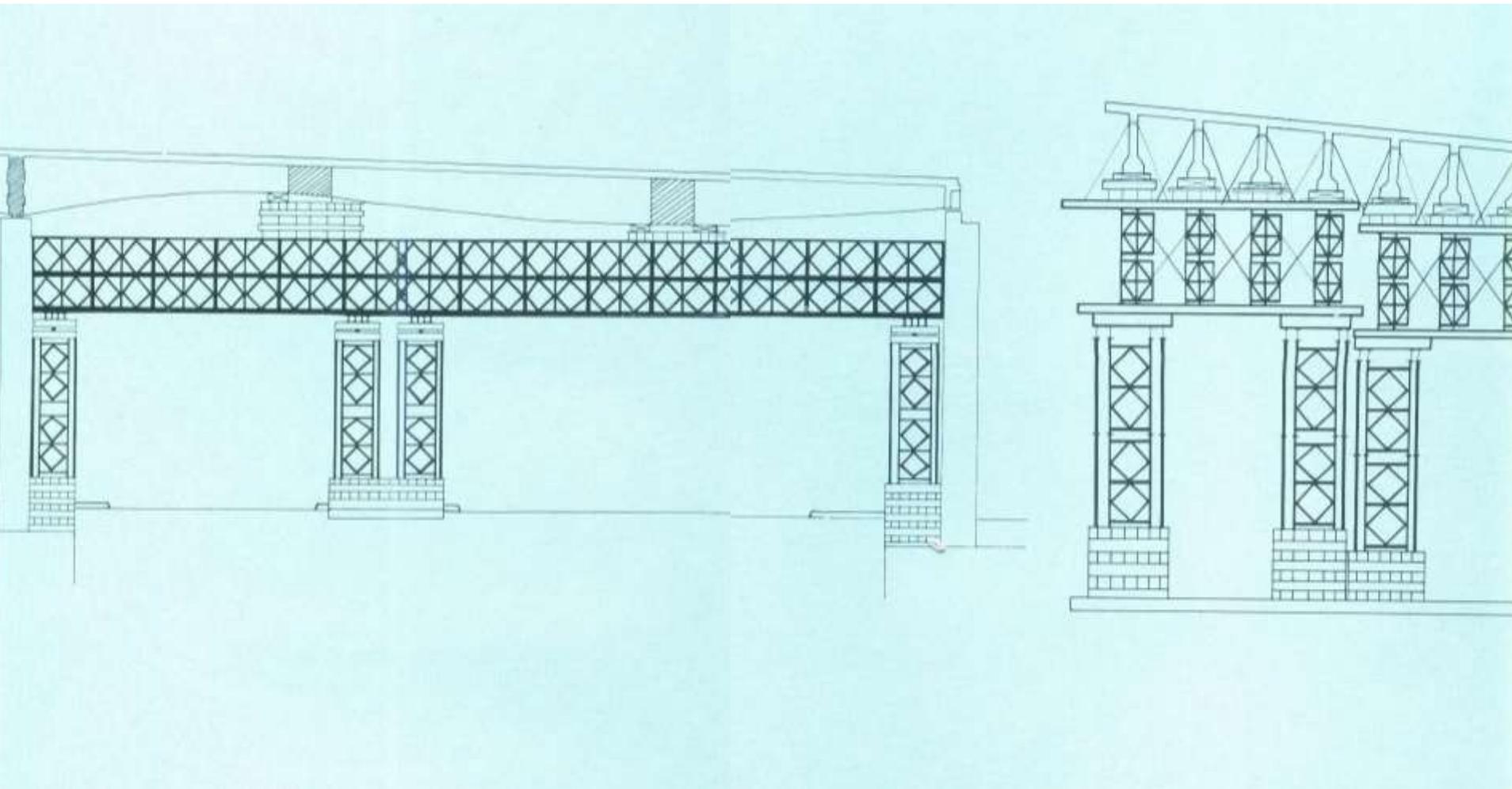


DISTRIBUTION DES LONGERONS





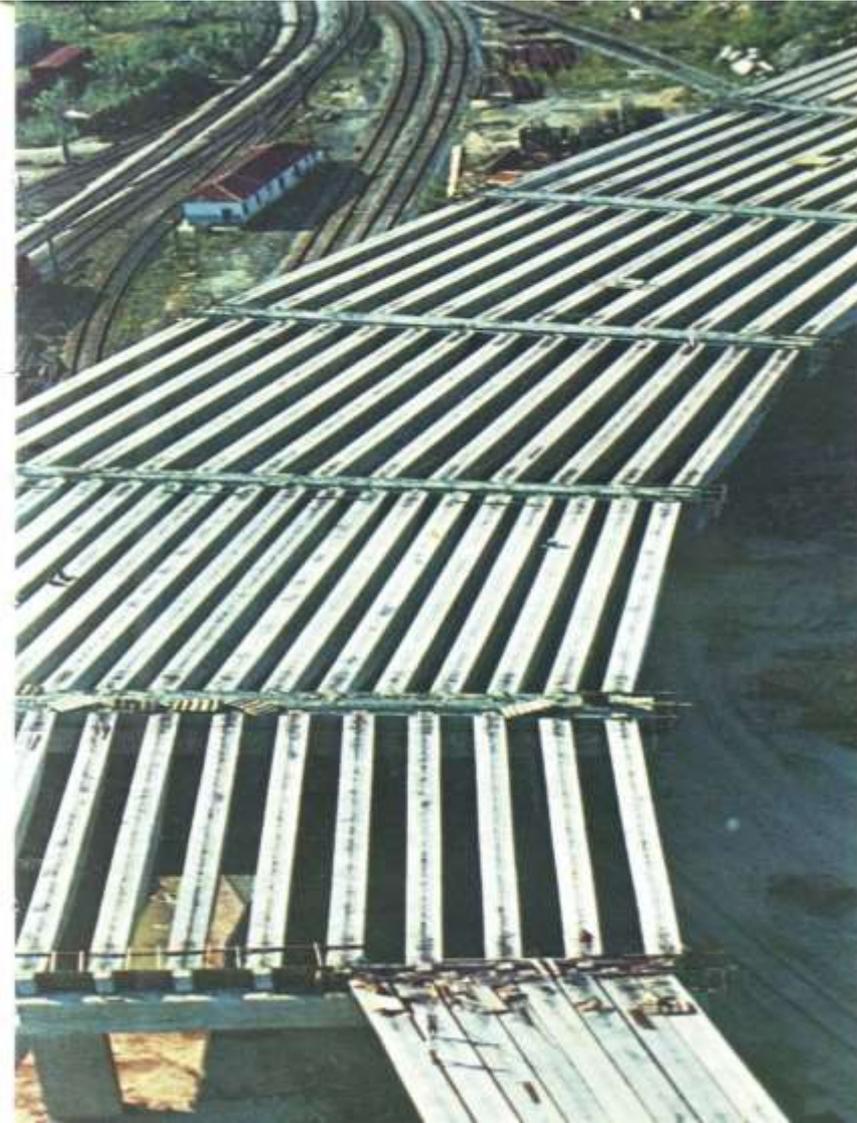
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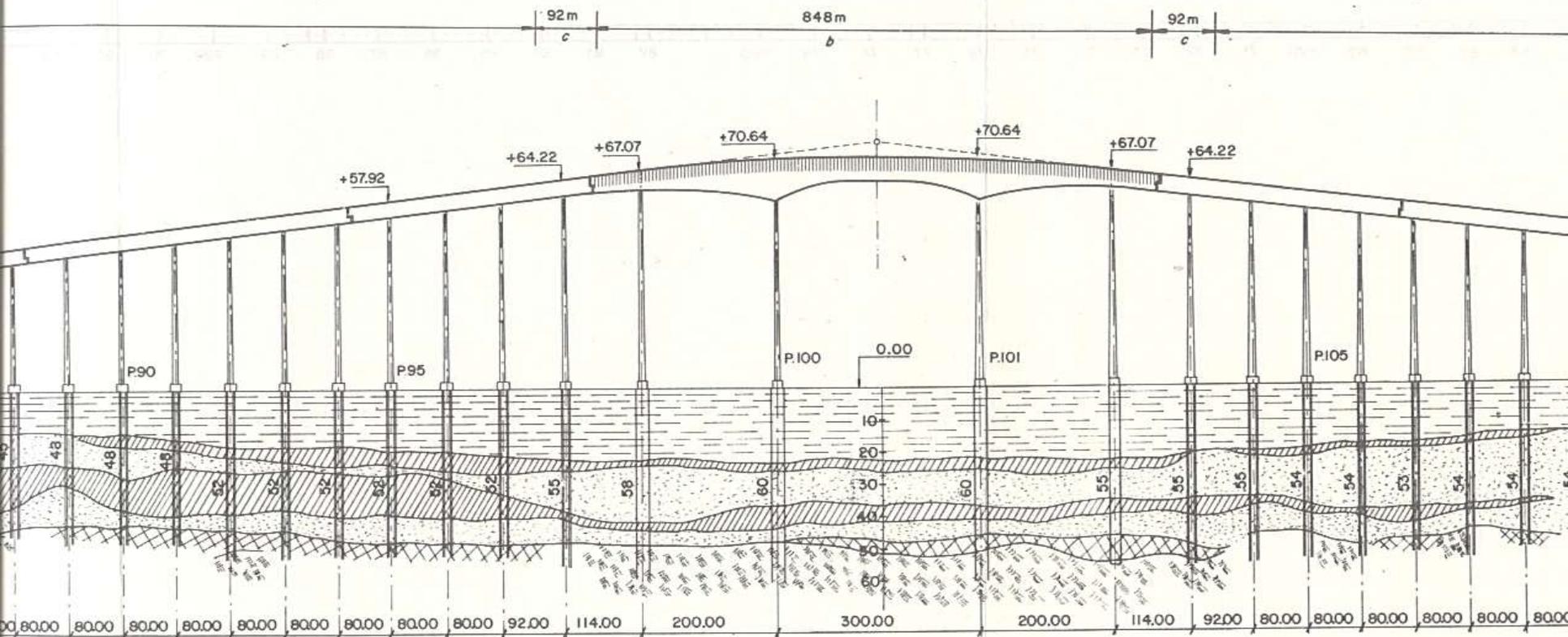
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- Fundações
- Blocos e pilares
- Vãos com vigas pré-fabricadas
- Vão sobre a Av. Brasil

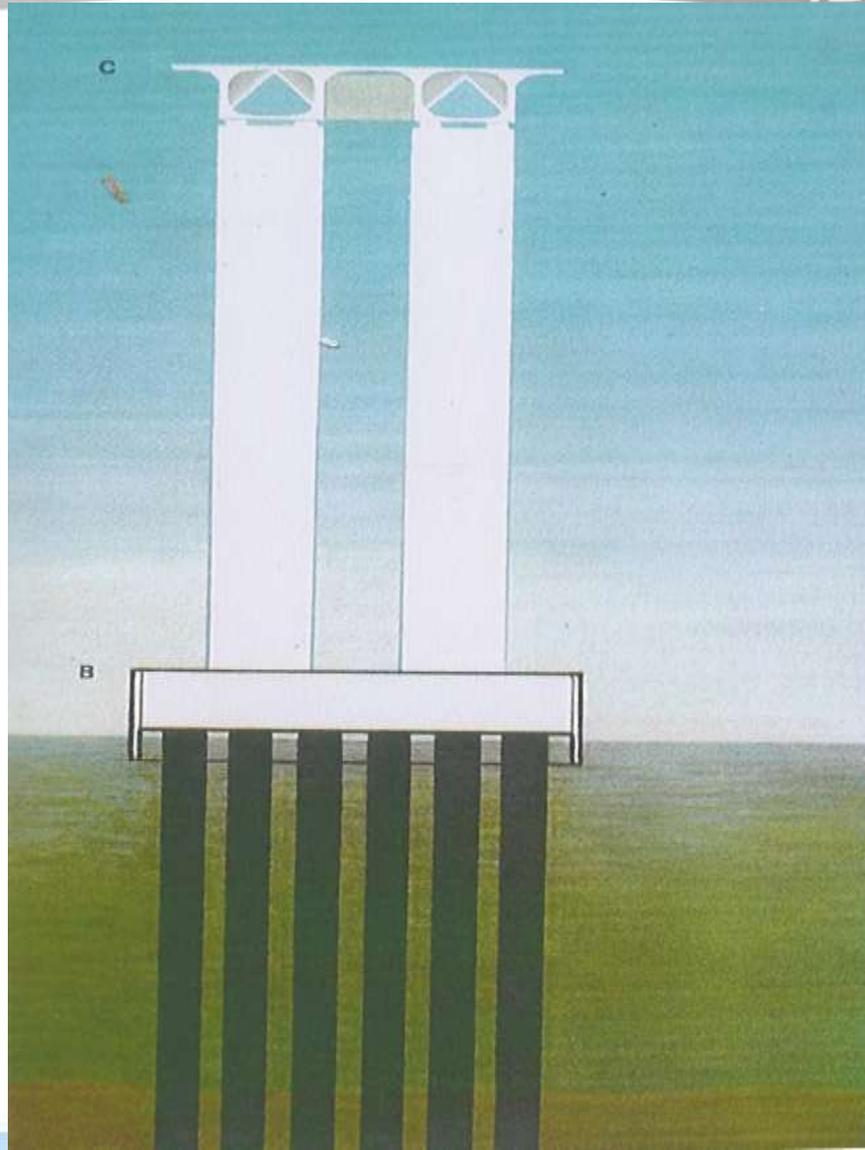


9.231.49m





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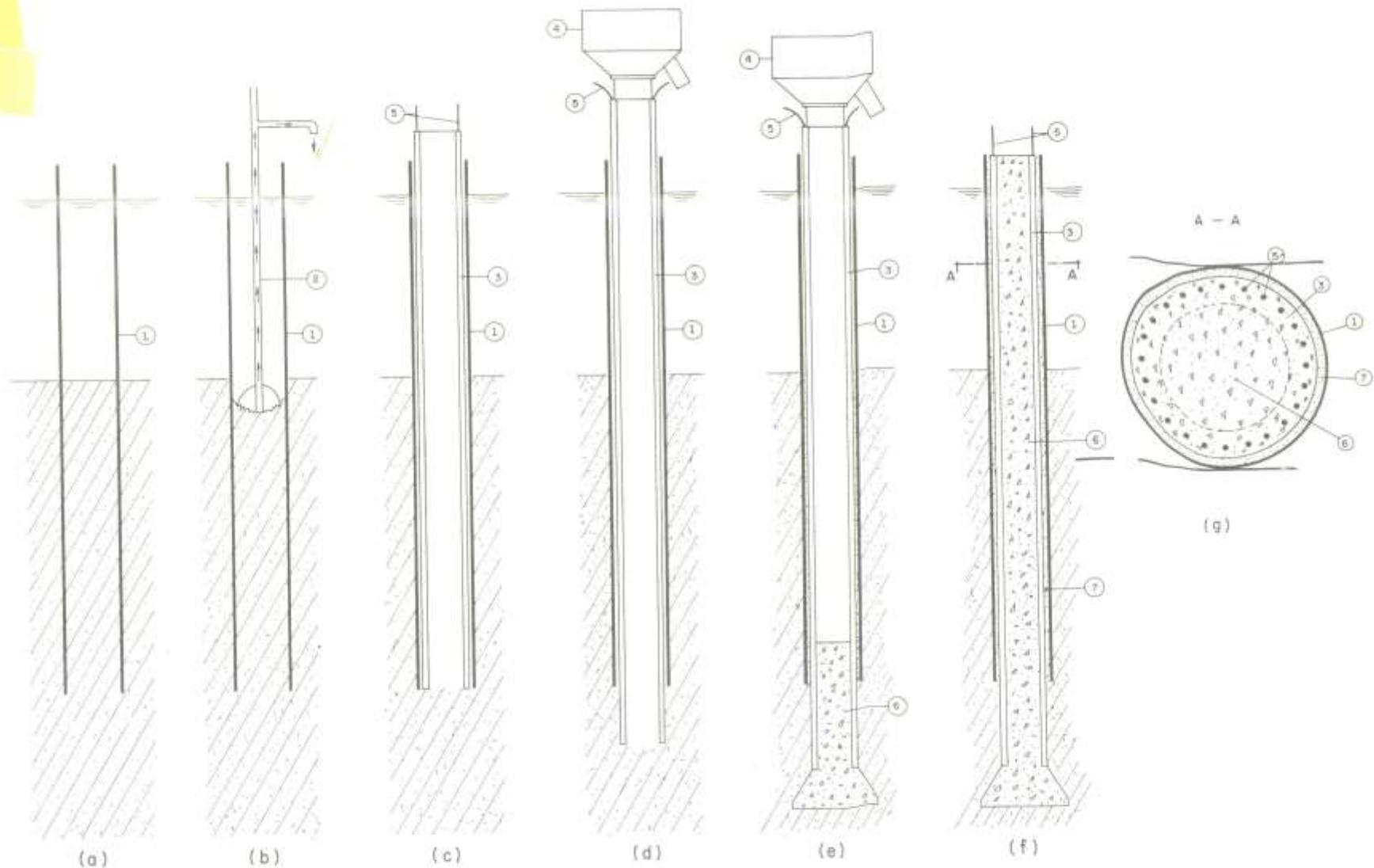


Fig. 3.4. Tubulão a ar comprimido com escavação tubada prévia: a) camisa metálica (1) cravada no solo; b) escavação no interior da camisa com equipamento provido de air-lift; c) tubulão de concreto armado parcialmente pré-moldado (3), com armação (5), colocado no interior da camisa metálica (1); d) escavação a ar comprimido no interior do tubulão de concreto, com auxílio de campânula (4); e) concretagem da base alargada e parte do fuste (6) sob ar comprimido; f) conclusão da concretagem a céu aberto (6), enchimento de areia (7) entre o tubulão e a camisa.

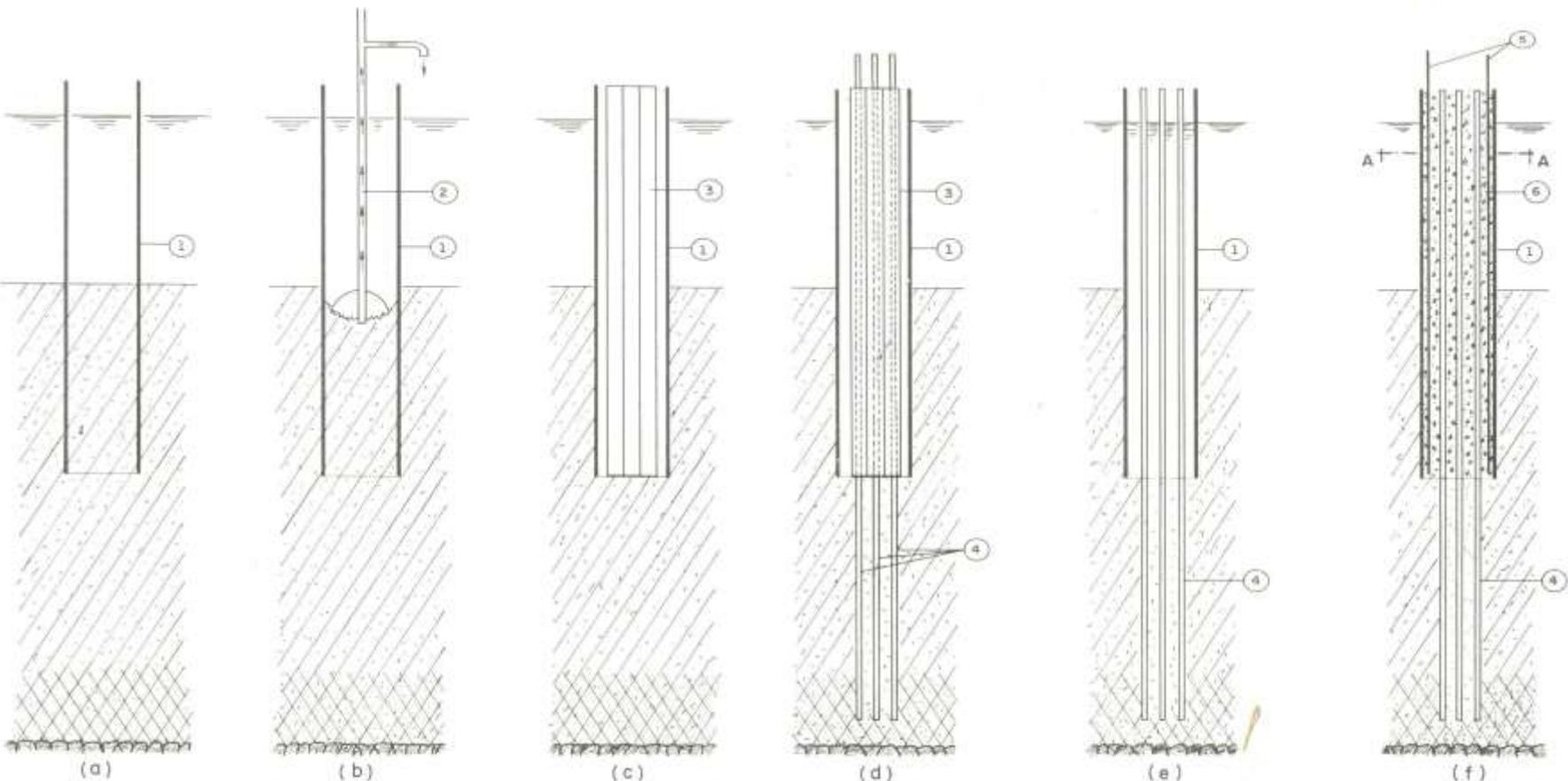
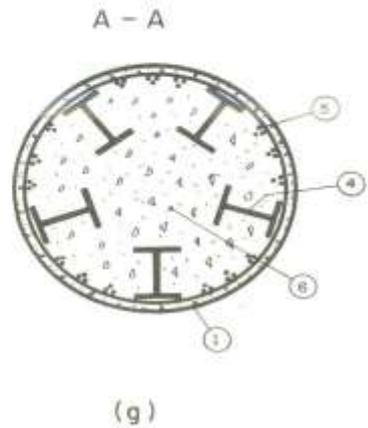
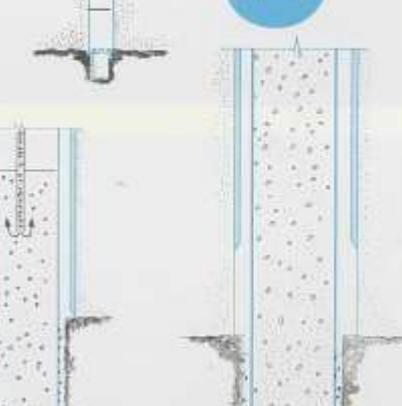
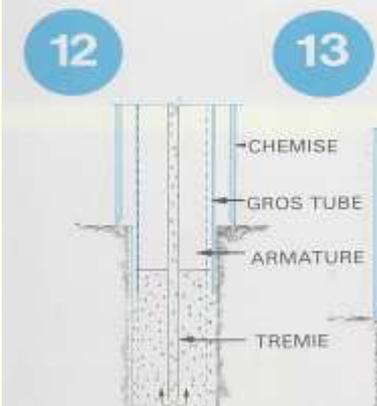
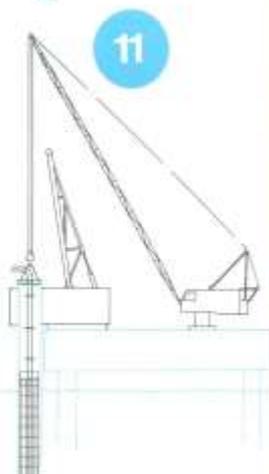
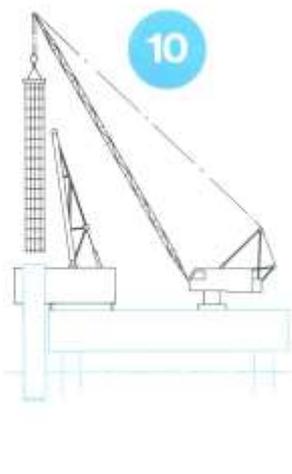
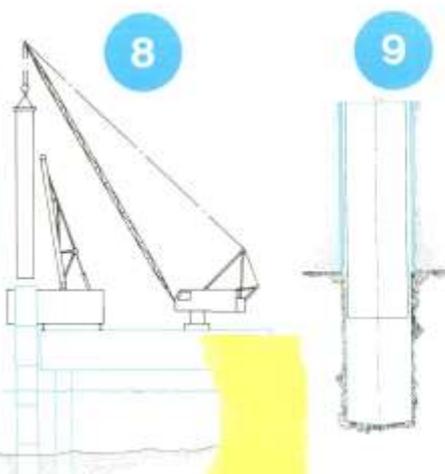
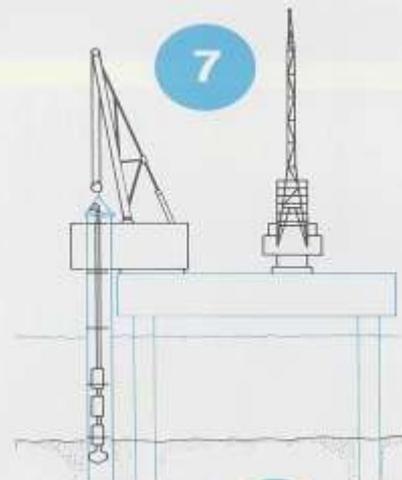
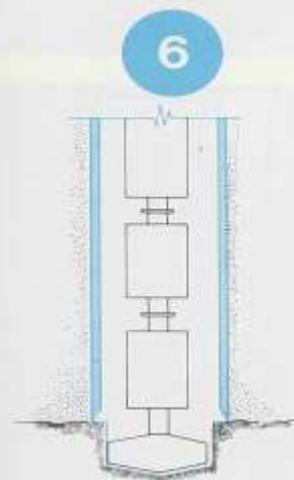
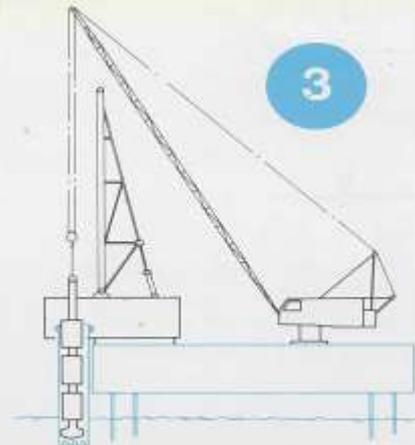
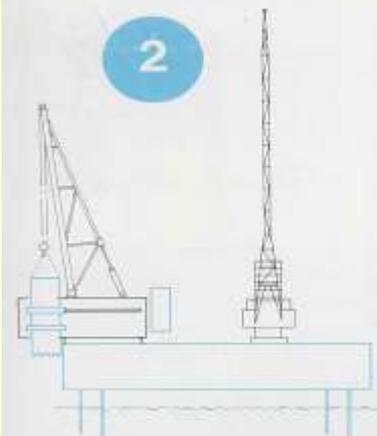
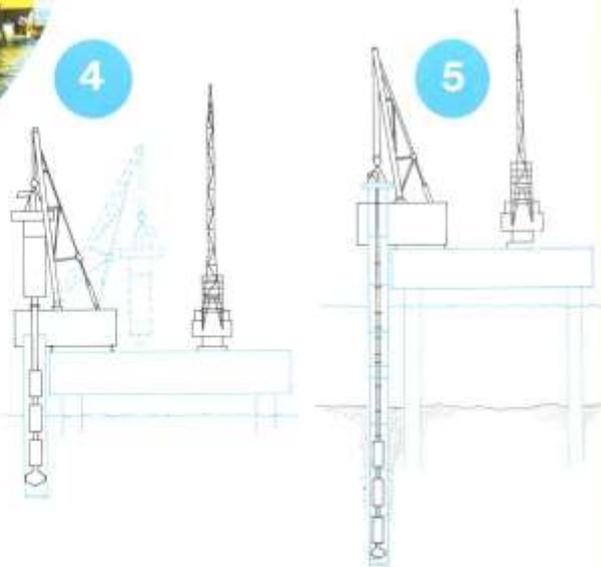
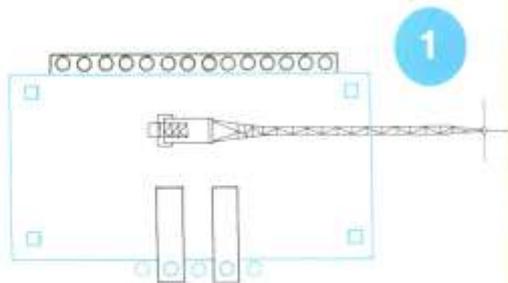


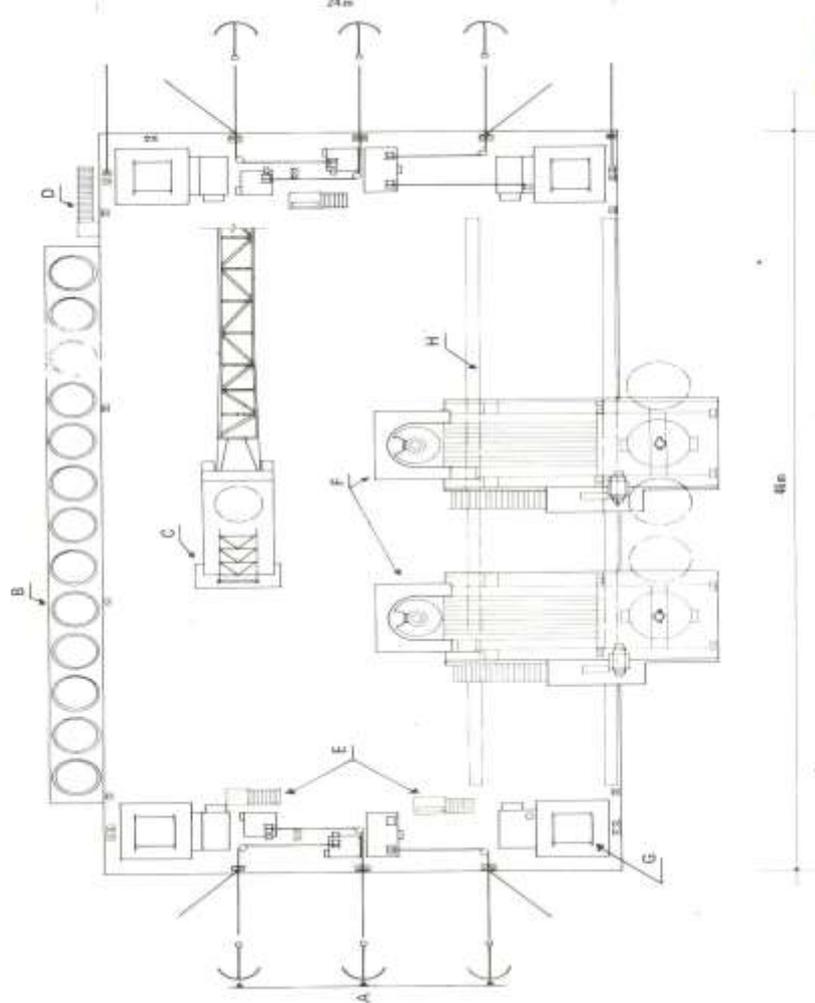
Fig. 3.5. Tubulão misto com estacas metálicas: a) camisa metálica cravada (1); b) escavação do interior da camisa, com equipamento (2) provido de air-lift; c) colocação de gabarito enrijecedor (3) no interior da camisa; d) estacas metálicas (4) cravadas através do gabarito enrijecedor (3); e) retirada do gabarito; f) colocação de armação (5); enchimento com concreto submerso (6).

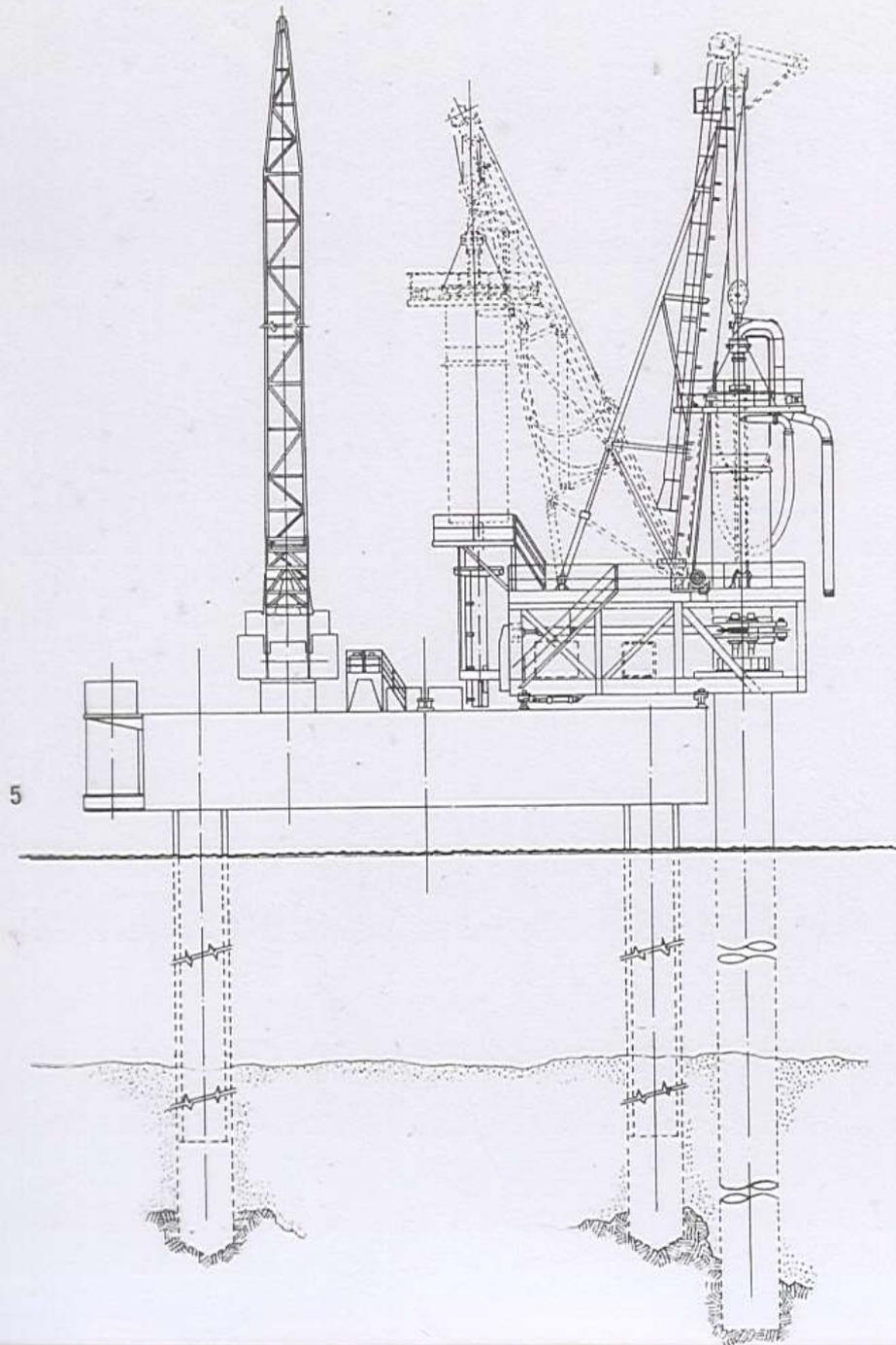




— Equipement pour forçages
 — Plate-forme circulaire L.H.C.
 — Hélicoptère équipé avec
 équipement de tubage BADE,
 perforance WPCU et
 spire AMERICAN



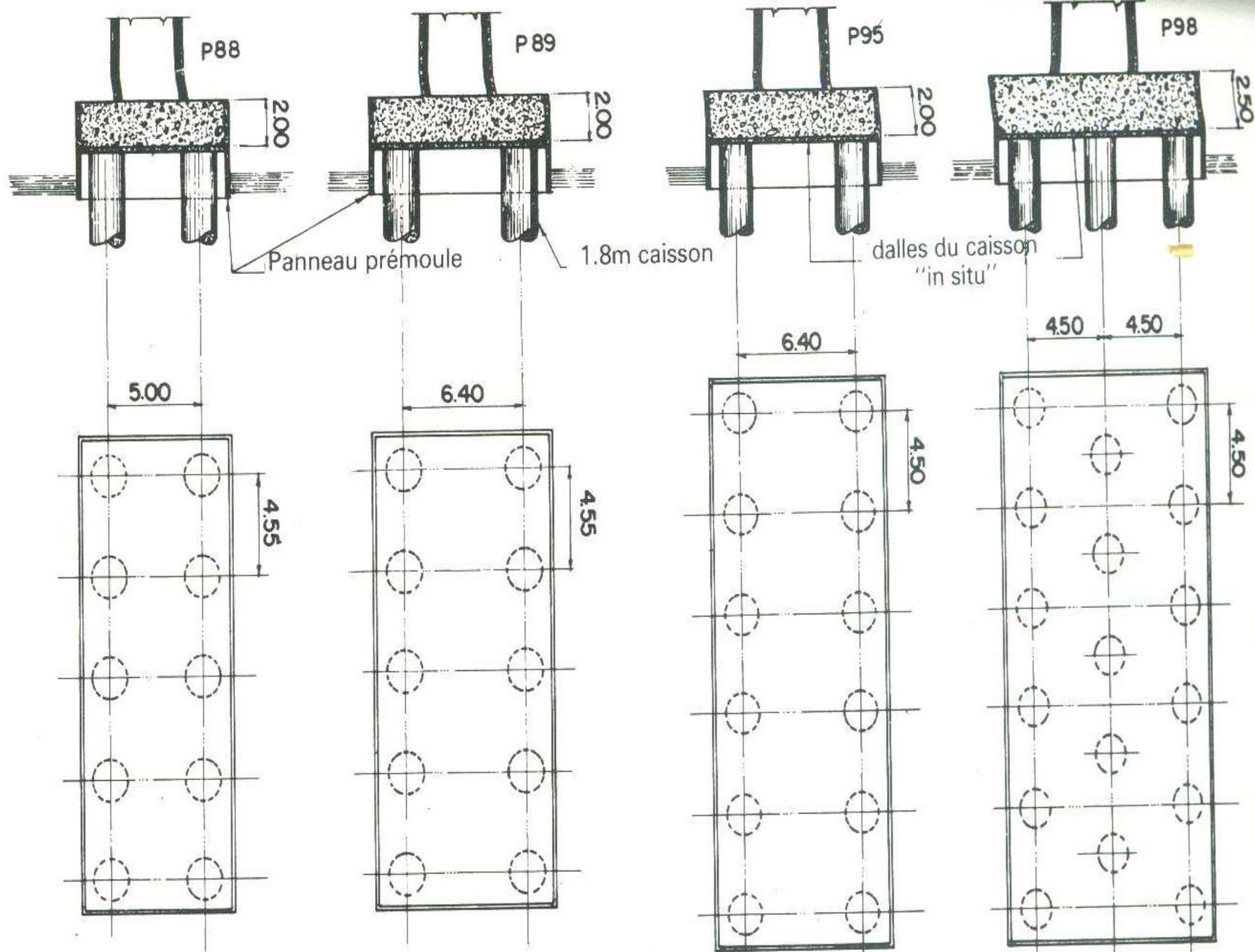


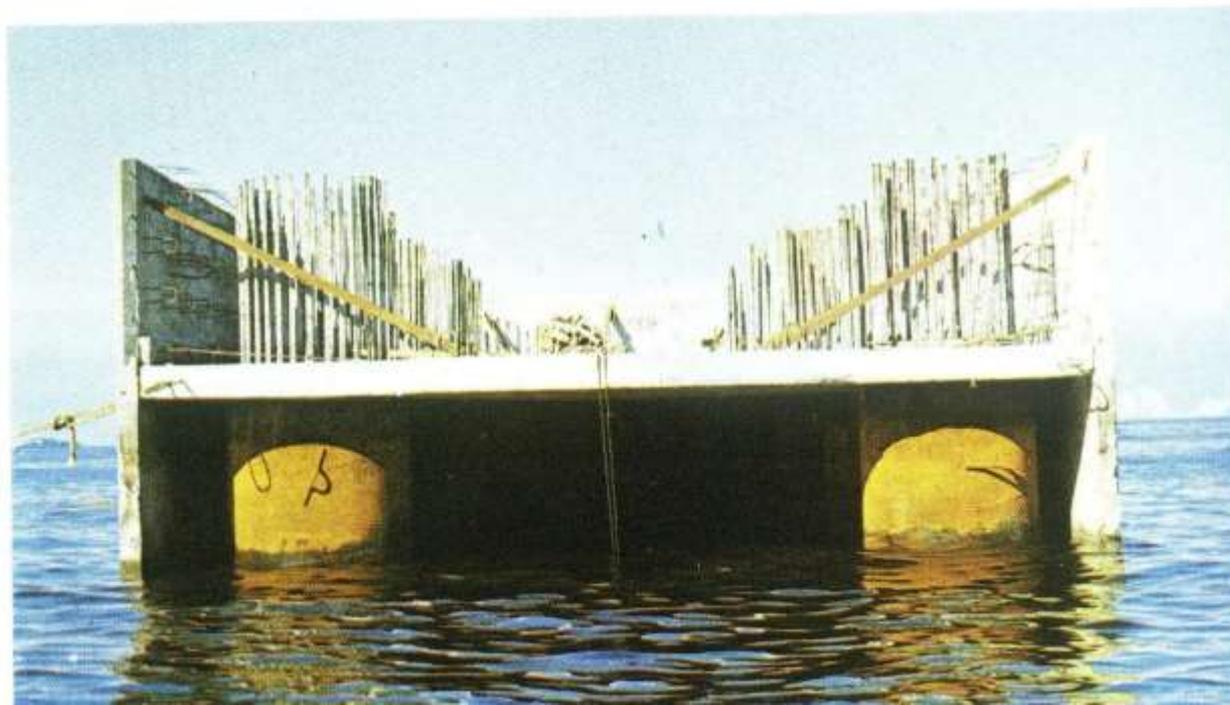


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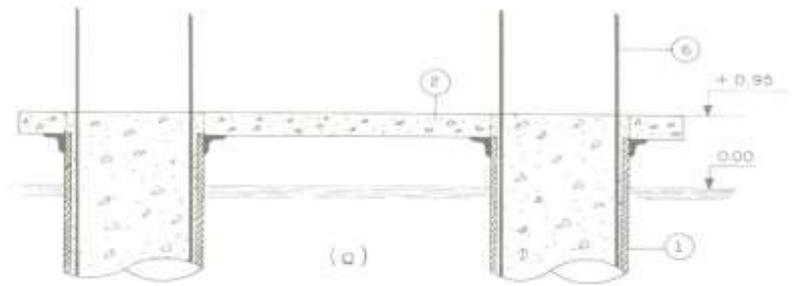




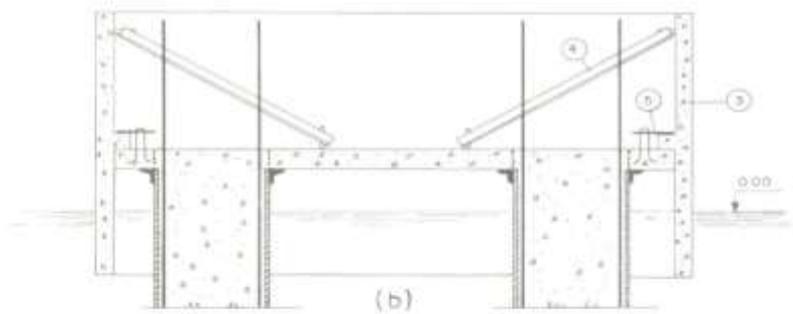




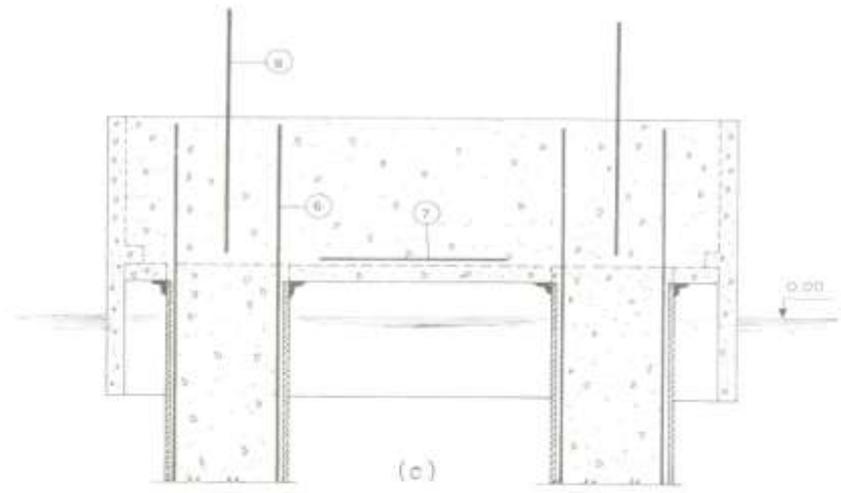
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(a)



(b)



(c)

Fig. 5.3. Blocos dos acessos sobre o mar. Seqüência construtiva: a) tubulões (1) com laje de fundo (2) e armação (6); b) colocação das saias-formas (3) pré-moldadas, apoiadas em dentes e presas com grampos (5) e tonneiras (4); c) colocação da armação do bloco (7) e de saída do pilar (8). Concretagem do bloco.

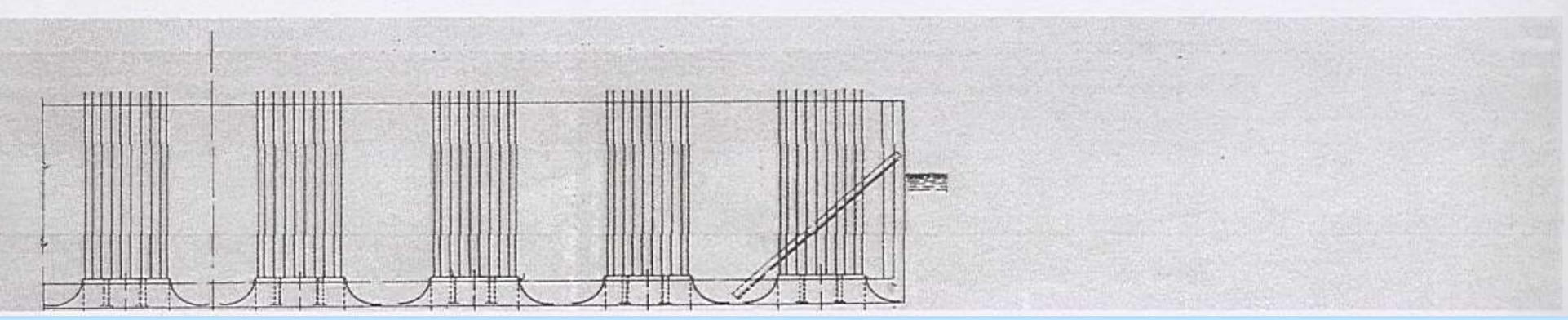
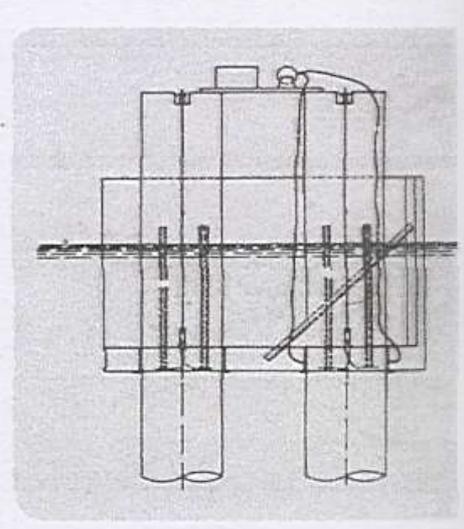
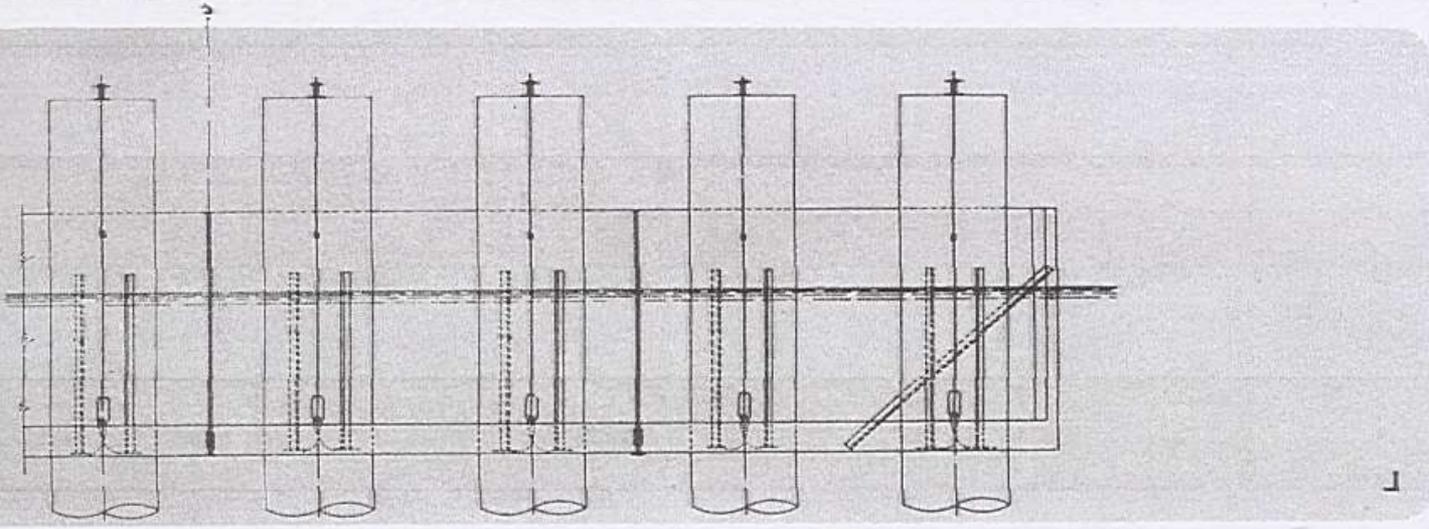
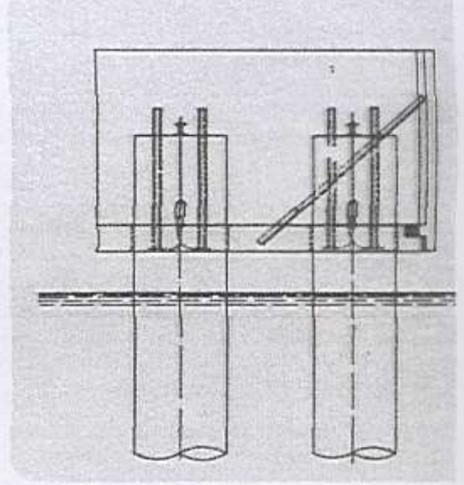
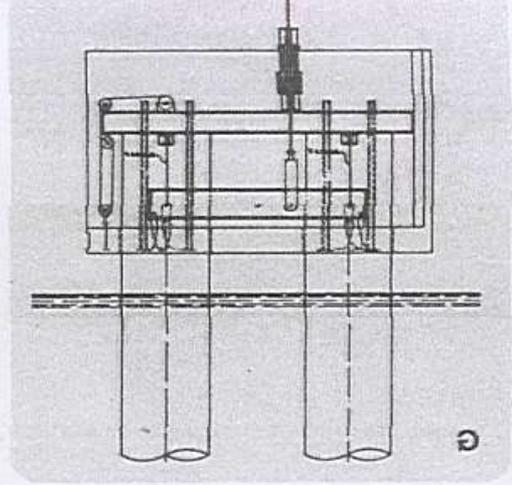
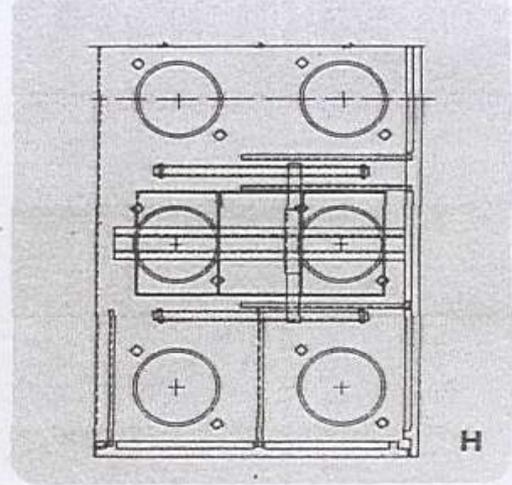
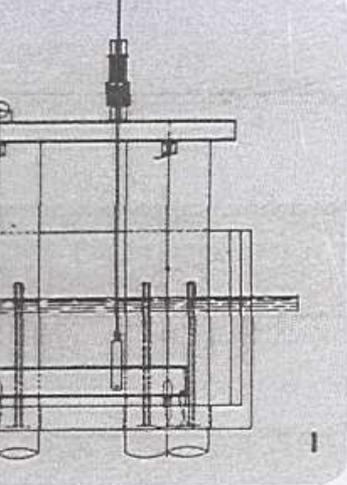
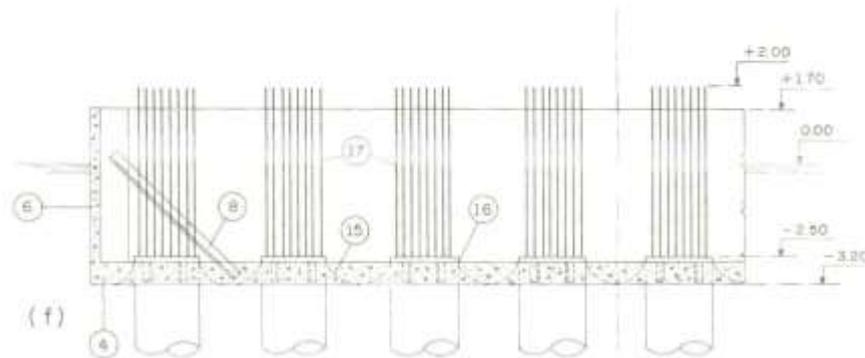
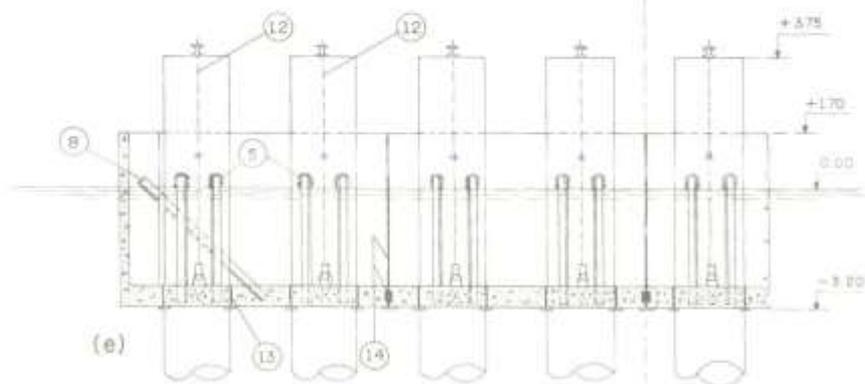
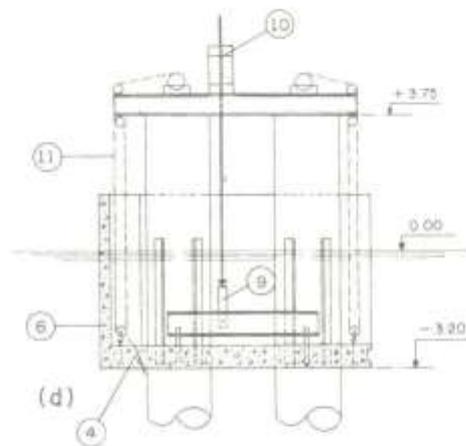
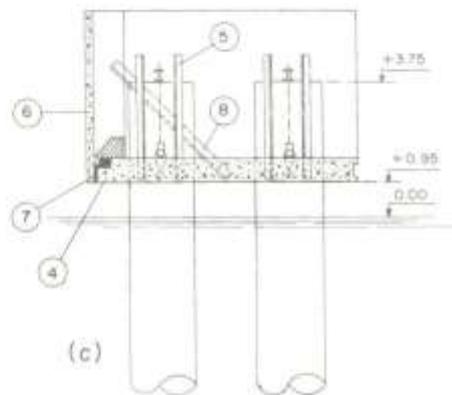
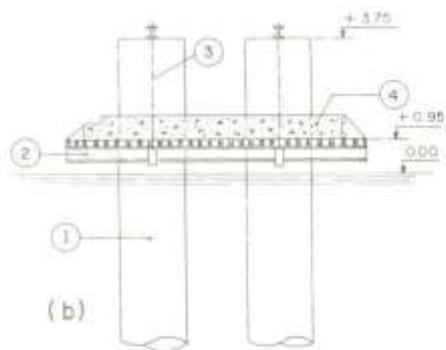
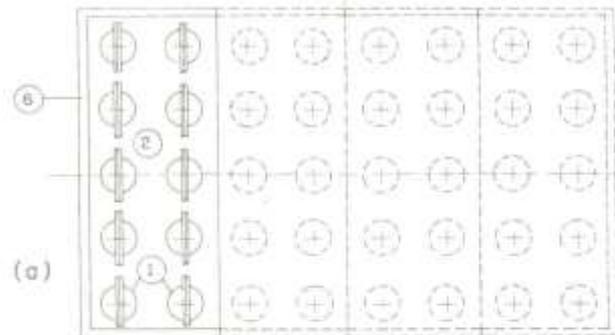
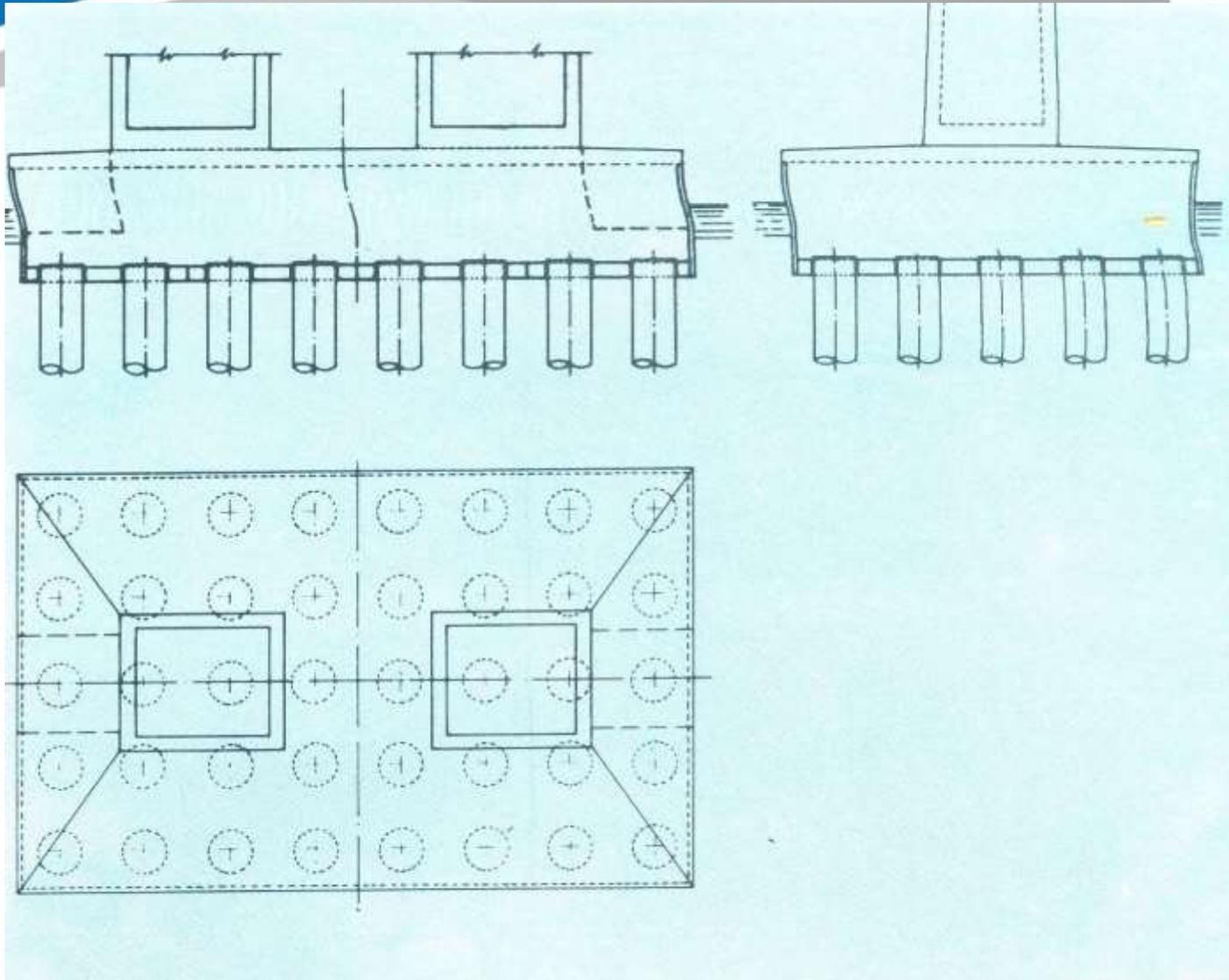


Fig. 5.4. Blocos dos pilares principais P100, P101. Seqüência construtiva: a) vista superior da laje de fundo (2) dividida em setores, apoiada nos tubulões Bade-Wirth (1); b) setor de lajes de fundo (4), concretado sobre escoramento (2) suspenso ao tubulão (1) por pendurais (3); c) colocação de forma lateral pré-moldada (6), fixação das cantoneiras de apoio (8); concretagem da junta (7); d) descida de um setor com pendurais (9) ligados ao sistema hidráulico (10); nota-se o dispositivo de equilíbrio (11); e) setores da laje de fundo rebaixados para cota de projeto, suspensos em pendurais (12); cantoneiras de subpressão (5) soldadas nas camisas; injeção submersa dos espaços entre a lajinha e as camisas (13) e dos espaços entre setores da laje de fundo e formas laterais (14); f) caixa esgotada; vergalhões (15) ancorados na laje de fundo, soldados nas camisas dos tubulões (16); transferência do esforço de subpressão para os vergalhões (15); arrazamento do concreto dos tubulões para a cota -2,50; armação e concretagem do bloco.



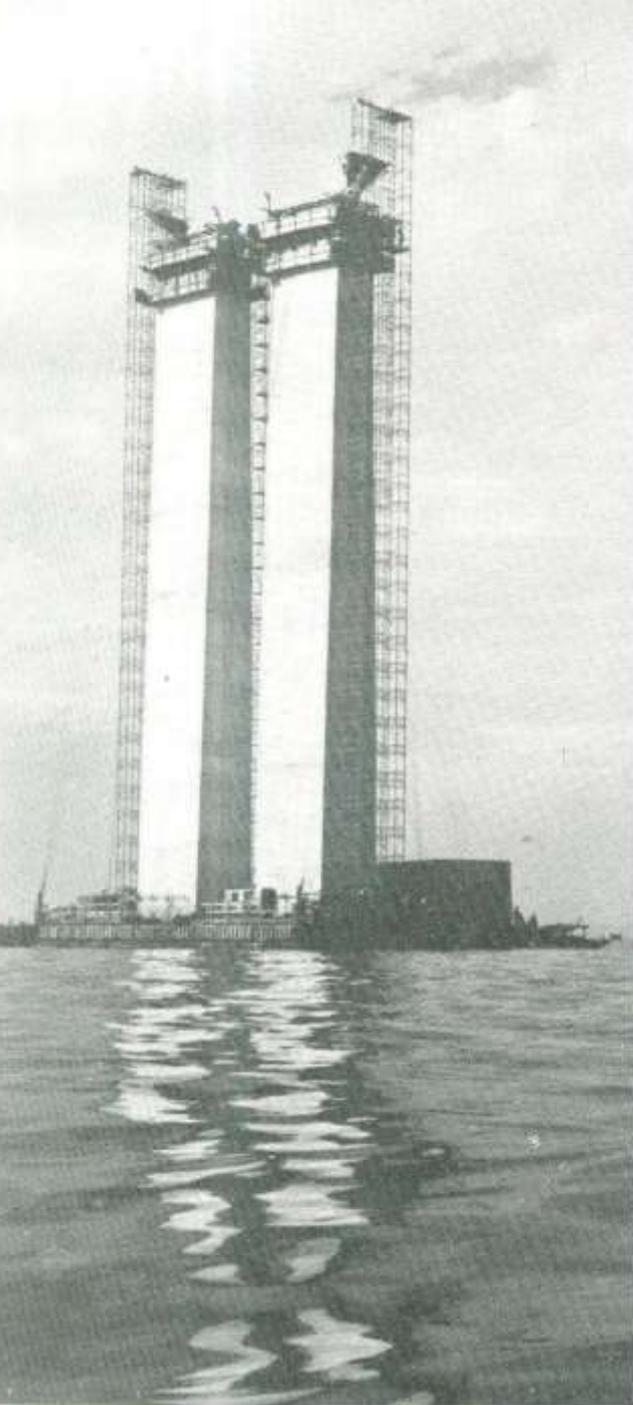




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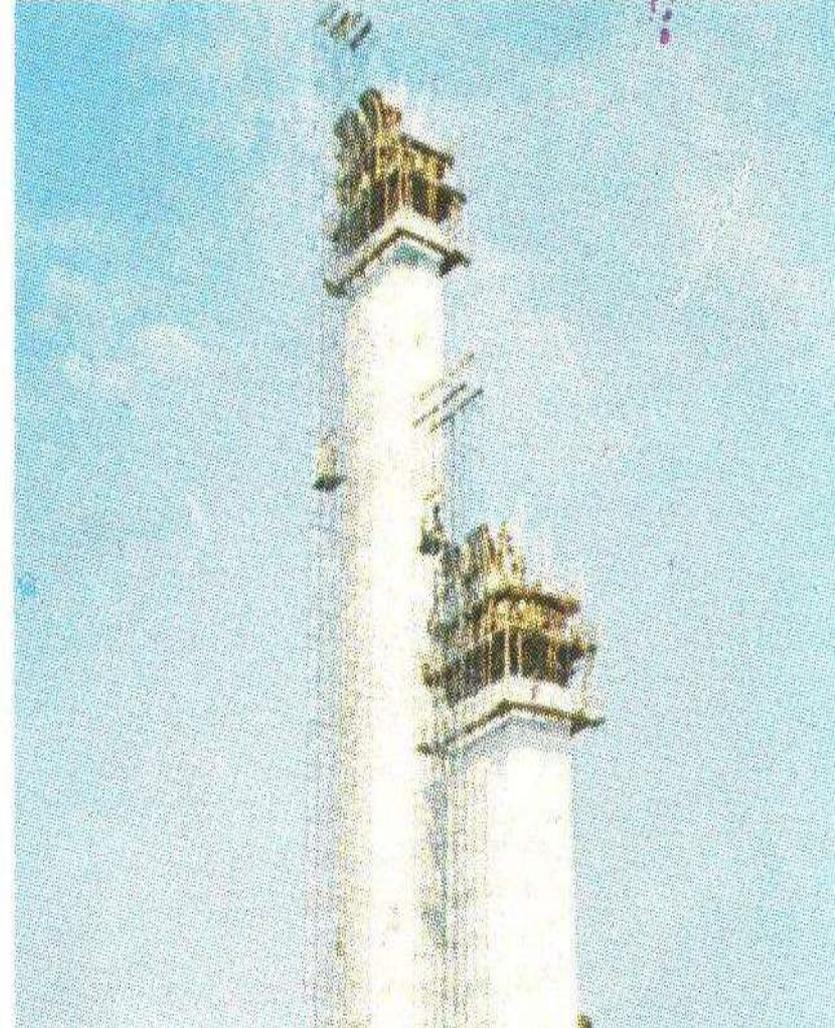
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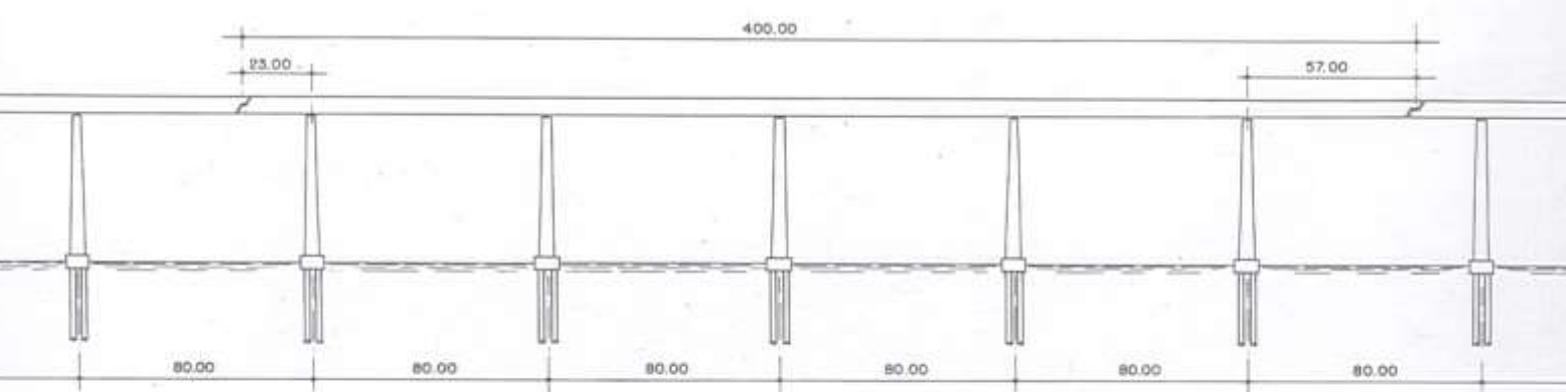


Fig. 8.1. Estruturas de acesso sobre o mar. Viga contínua protendida, comprimento 400 metros entre rótulas.

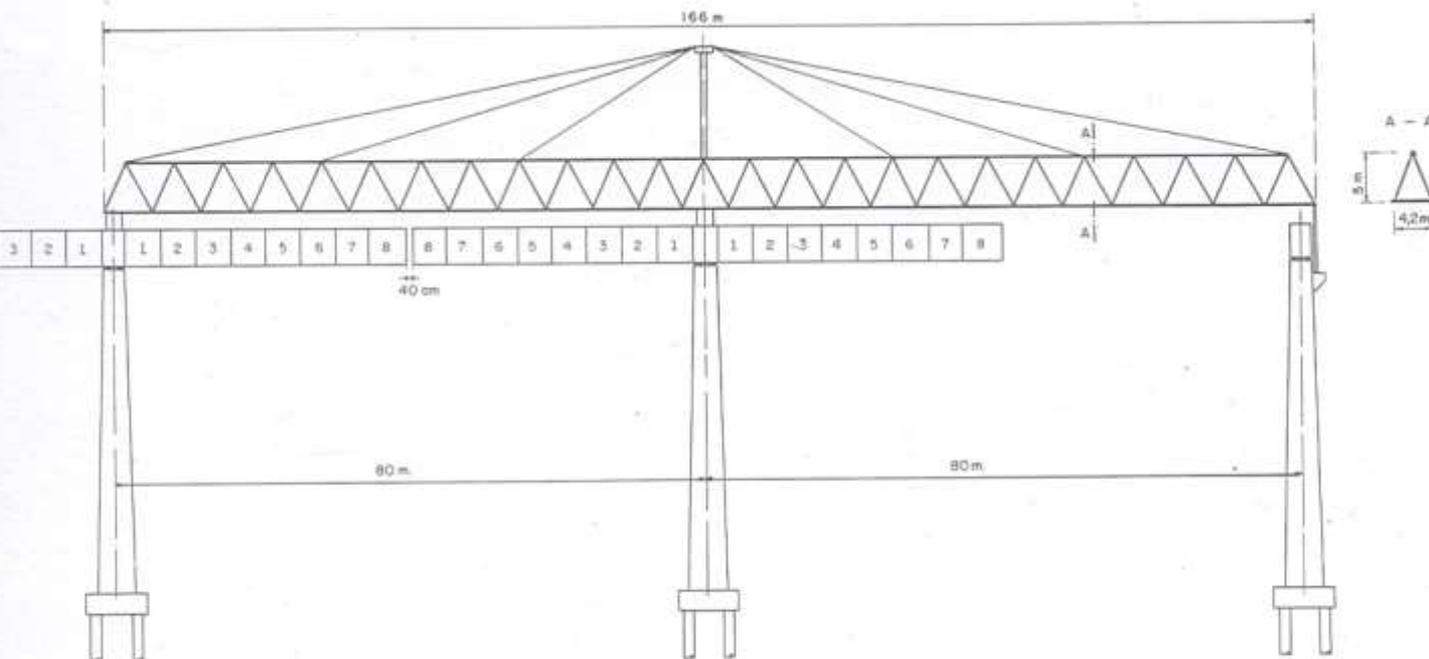
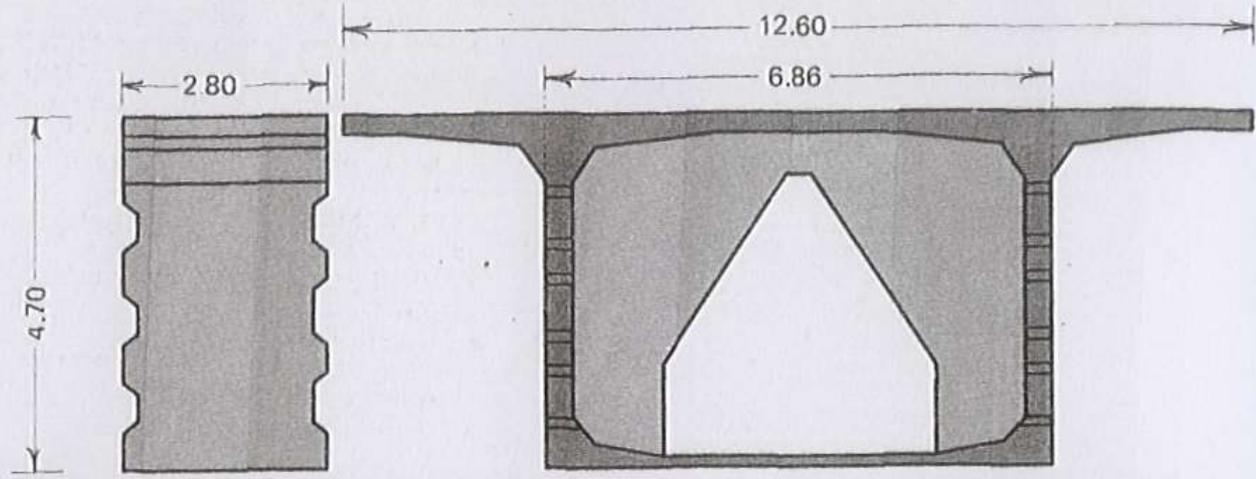
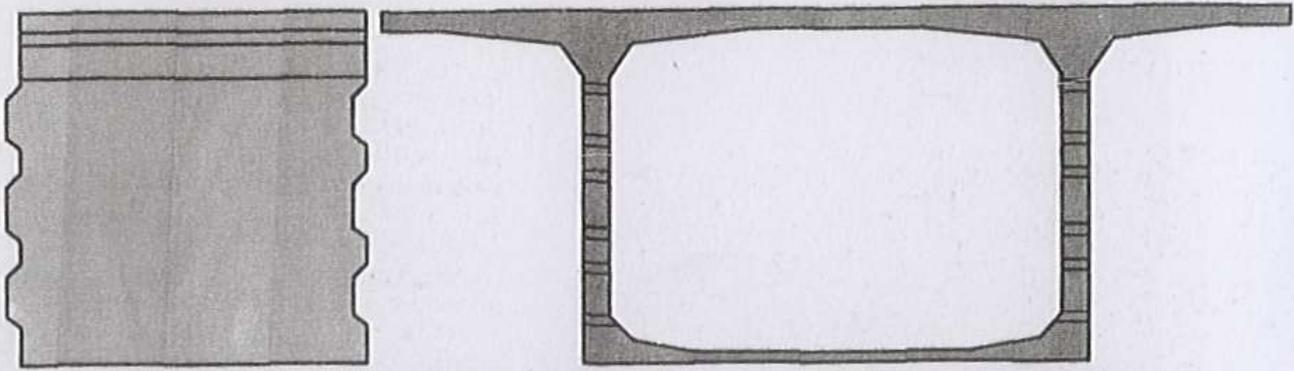


Fig. 8.2. Estruturas de acessos sobre o mar. Montagem de aduelas pré-moldadas, com auxílio de treliça autolanzável.

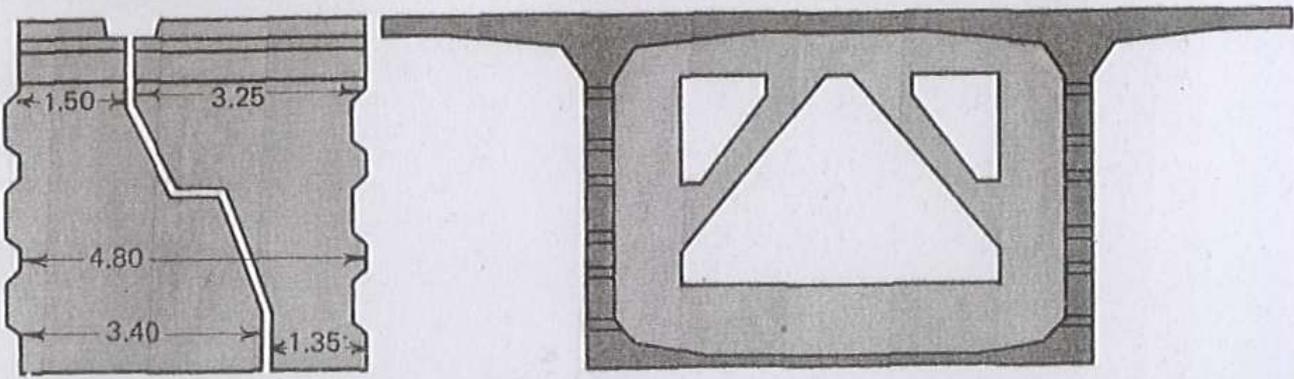
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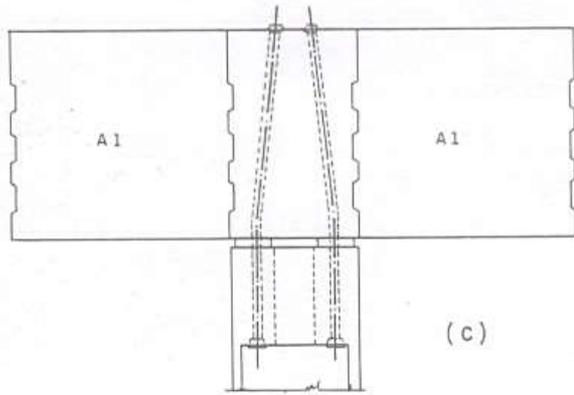
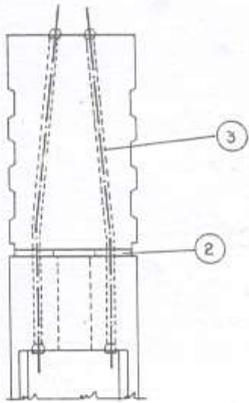
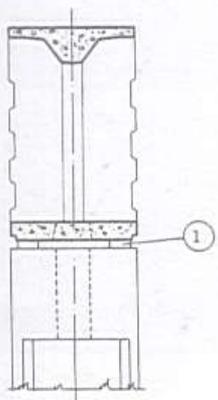


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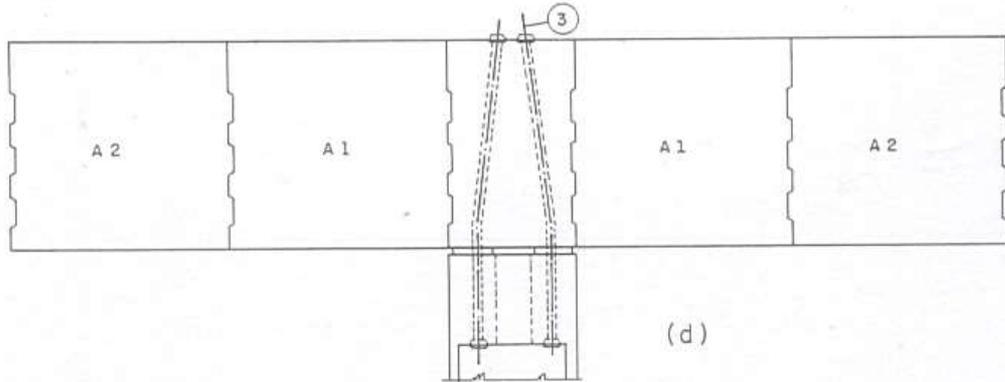
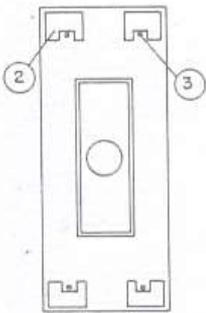
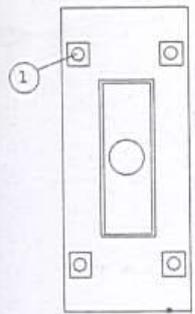


NGE ADUELA





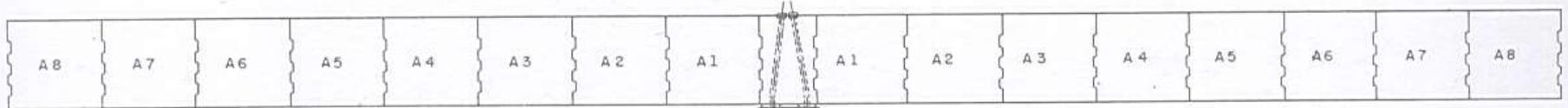
(c)



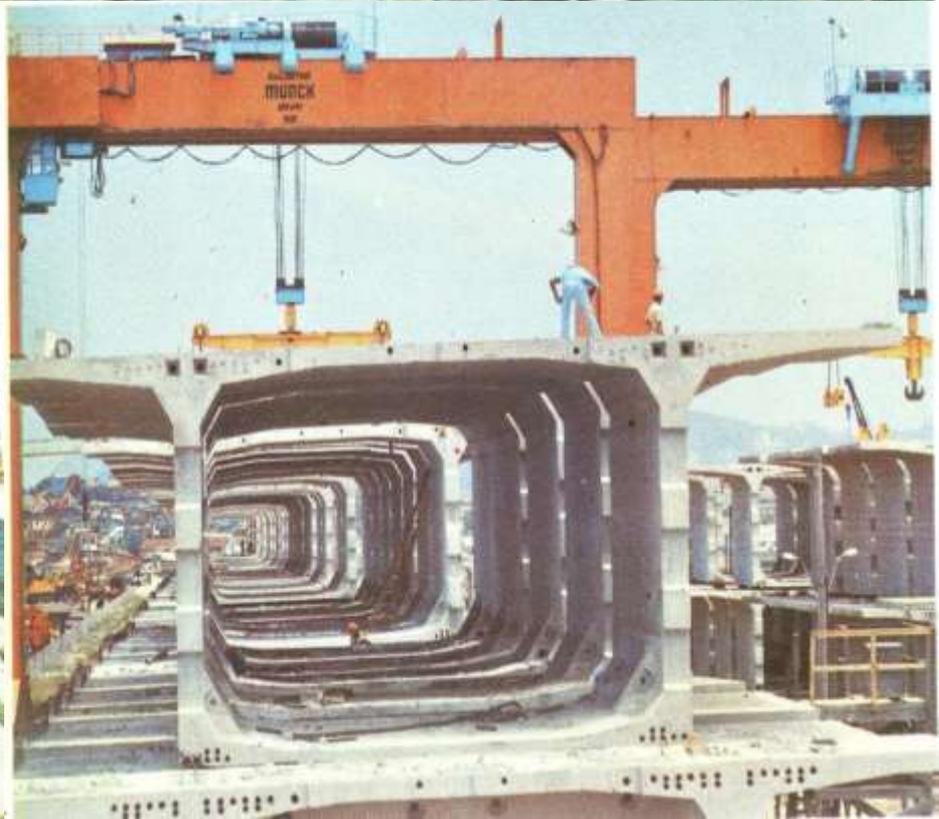
(d)

(a)

(b)



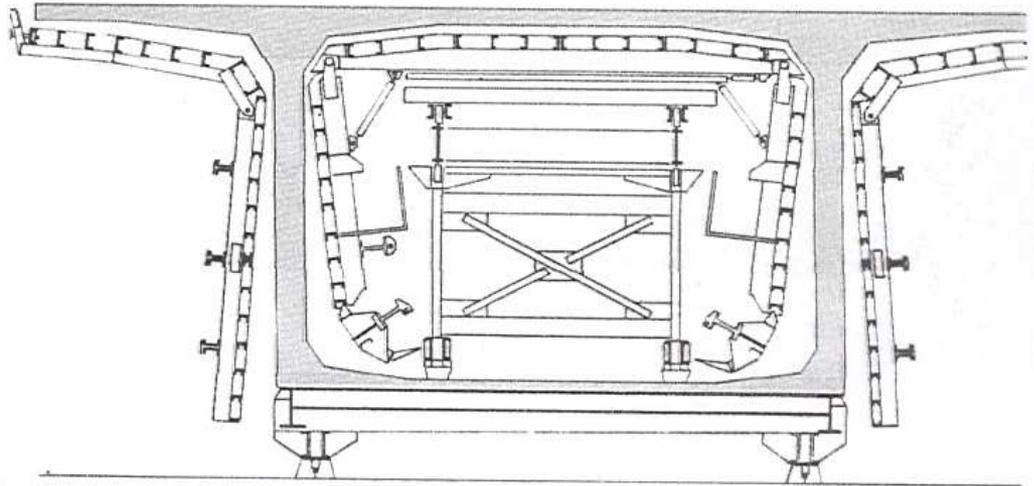
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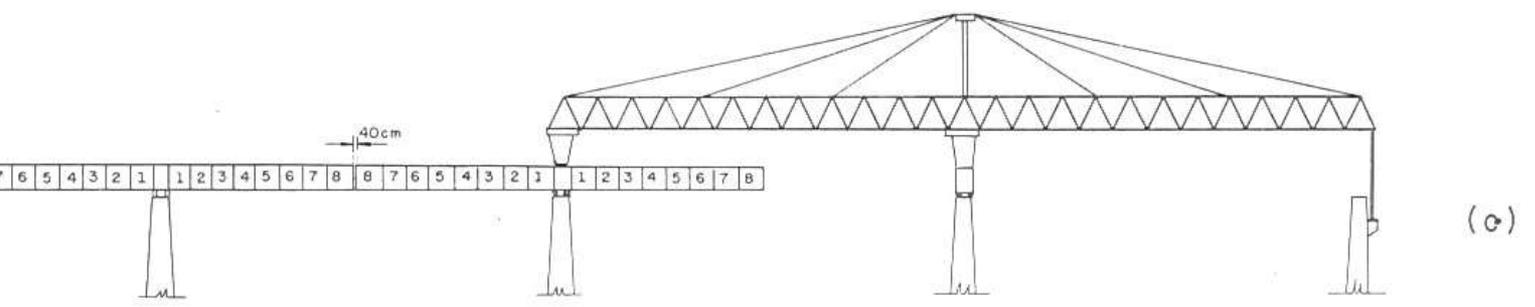
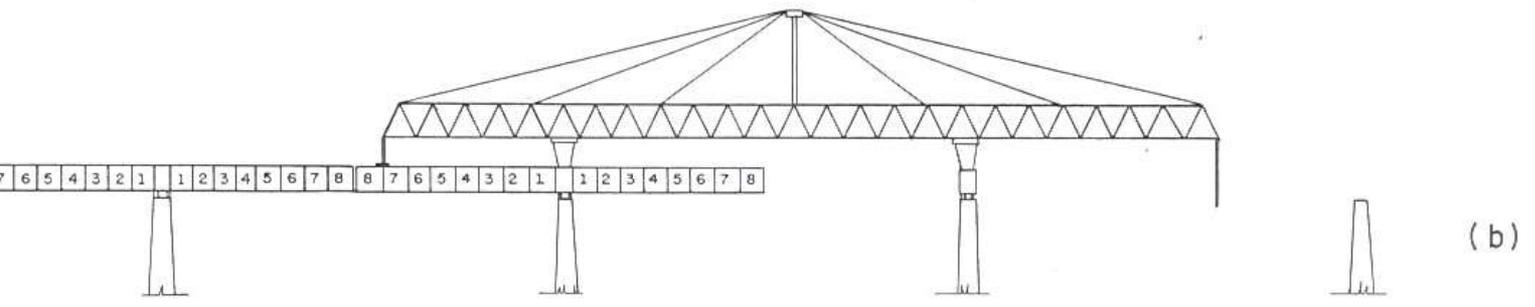
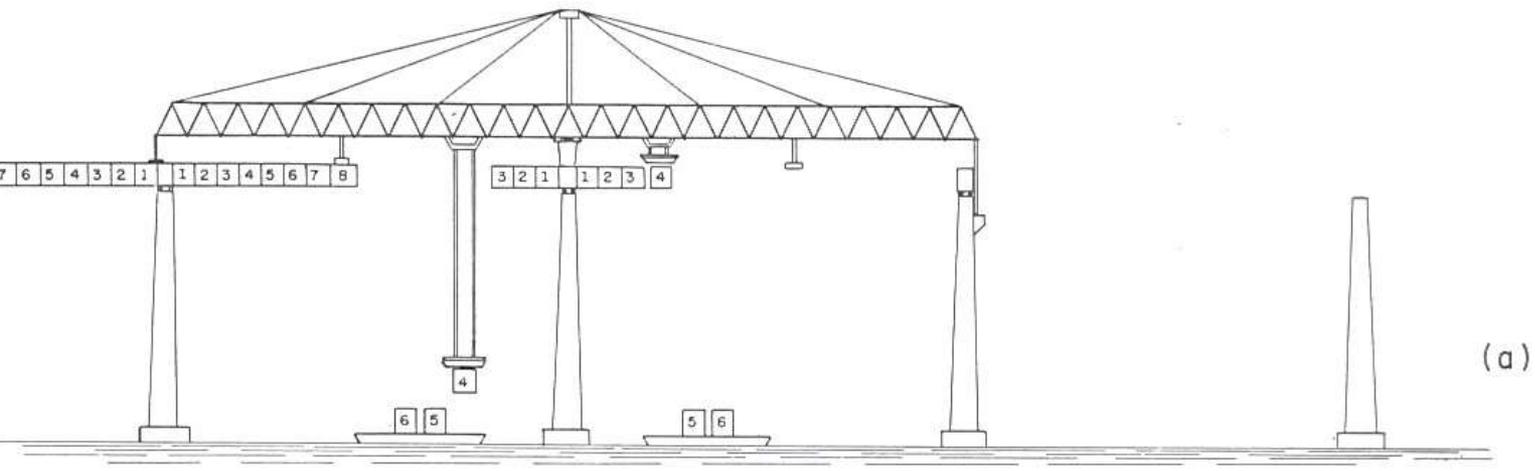




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Item 1 - Este SE complementa o SE-106 onde é explicada a montagem da aduela de apoio. Aqui será considerada como montada esta aduela e com a treliça em posição de montar as outras, ou seja, com o apoio central sobre o pilar em que elas serão montadas.

Item 2 - A sequencia de operações aqui descritas deverá ser rigorosamente obedecida.

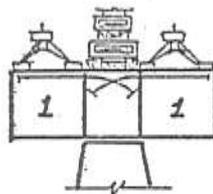
Não é permitida, sem prévia autorização da Diretoria Técnica, qualquer alteração desta sequencia.

Entender-se-á como lado dianteiro da treliça ao correspondente à direção do vão central e, consequentemente, o lado traseiro será o que está em direção aos Acessos.

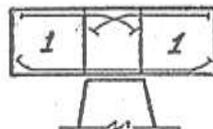
MONTAGEM DAS ADUELAS 1, 2, 3, 4

Item 3 - A sequencia de operações de montagem para os pares de aduelas de nºs 1, 2, 3 e 4 é idêntica à descrita no SE-107/1, itens 3 a 28. Esquemáticamente, a situação no final da montagem do par de aduelas 4 é a mostrada no desenho das páginas 10, 11, 12 e 13.

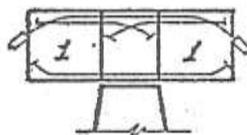
ADUELAS Nº 1



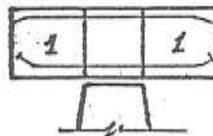
Aduelas em posição de montagem.
Colocação e protensão dos cabos de brelagem superiores com força de 60 t/cabo.



Liberação das aduelas da treliça.
Colocação e protensão dos cabos provisórios inferiores C38 com 165 toneladas.

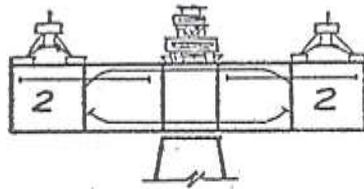


Colocação e protensão dos cabos definitivos superiores
C43 e C44 com 165 toneladas
C41 e C42 com 165 toneladas.

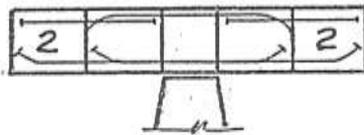


Retirada dos cabos de brelagem superiores.
Conjunto pronto para receber aduelas de nº 2.

ADUELAS Nº 2

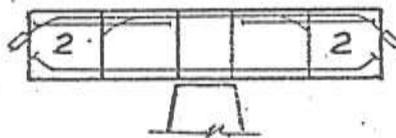


Aduelas em posição de montagem. Colocação e protensão dos cabos de brelagem superiores com 60 toneladas.

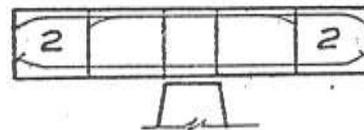


Liberação das aduelas da treliça.

Colocação e protensão dos cabos provisórios inferiores C39 com 165 toneladas.

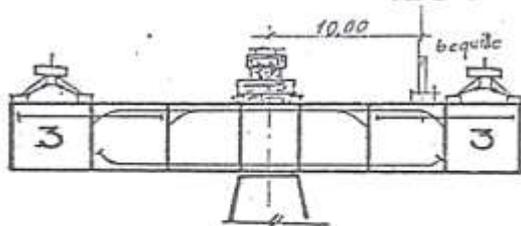


Retirada dos cabos provisórios que ligavam as aduelas 1 (C38). Colocação e protensão dos cabos definitivos superiores
C47 e C48 com 165 toneladas
C45 e C46 com 165 toneladas

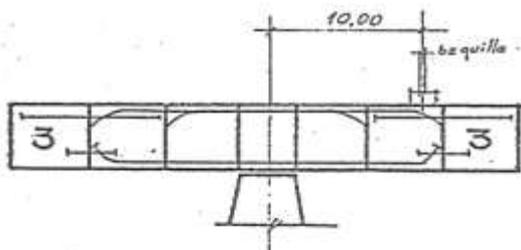


Retirada dos cabos de brelagem superiores.
Conjunto pronto para receber aduelas de nº 3.

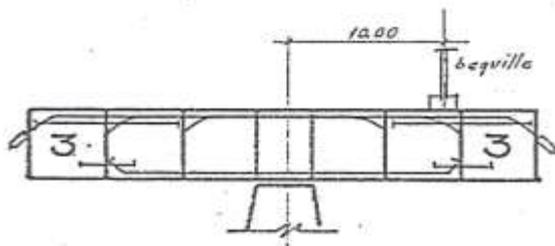
ADUELAS Nº 3



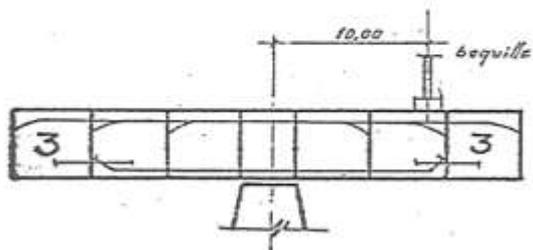
Aduelas em posição de montagem.
Colocação e protensão dos cabos de brelagem superiores com 60 t/cabo.



Liberação das aduelas da treliça.
Colocação e protensão dos cabos de brelagem inferiores com 55 t/cabo.



Colocação e protensão dos cabos definitivos superiores
C49 e C50 com 165 toneladas
C51 com 165 toneladas.



Retirada dos cabos de brelagem superiores.
Conjunto pronto para receber as aduelas de nº 4.

h) Fechar os registros da linha.

6. Soltar as cunhas do pê traseiro:

a) Soltar as barras Macalloy e passar estropos na travessa de apoio do pê traseiro, a fim de deslocá-la com a viga.

7. Tensionar os cabos H-80 a 272 kg/cm^2 (250 ton):

a) Seguir com as porcas de segurança.

b) Controlar a pressão de 10 em 10 kg/cm^2 .

c) Cuidado com a dissemetria.

d) Terminada a operação fechar os registros e levar as porcas ao contato.

8. Levantar a viga no pilar central de 200 mm:

a) Subir de 5 em 5 mm.

b) Cuidado com a dissemetria.

c) Colocar calços de segurança logo que possível.

d) Levantar a viga uns 20 mm, reapertar os parafusos basculantes e de fixação dos carros.

e) Terminada a operação verificar o nivelamento e fechar os registros.

9. Levantar a viga no pilar dianteiro até o mesmo nível do pilar central:

a) Subir de 5 em 5 mm.

b) Cuidado com a dissemetria.

c) Colocar calços logo que possível.

d) Terminada a operação verificar o nivelamento da viga no sentido transversal e longitudinal e fechar os registros.

g) Terminada a operação encostar as porcas e fechar os registros.

28. Tensionar os cabos H-20 até 155 kg/cm^2 (140 ton):

- a) Subir a pressão de 10 em 10 kg/cm^2 .
- b) Acompanhar com as porcas.
- c) Cuidado com a dissemetria.
- d) Terminada a operação encostar as porcas e fechar os registros.

29. Tensionar os cabos H-44 até 200 kg/cm^2 (180 ton):

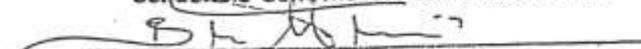
- a) Subir a pressão da linha até 110 kg/cm^2 .
- b) Abrir os registros dos macacos.
- c) Subir a pressão de 10 em 10 kg/cm^2 .
- d) Cuidado com a dissemetria.
- e) Terminada a operação encostar as porcas e fechar os registros.

30. Liberar o carro C-2:

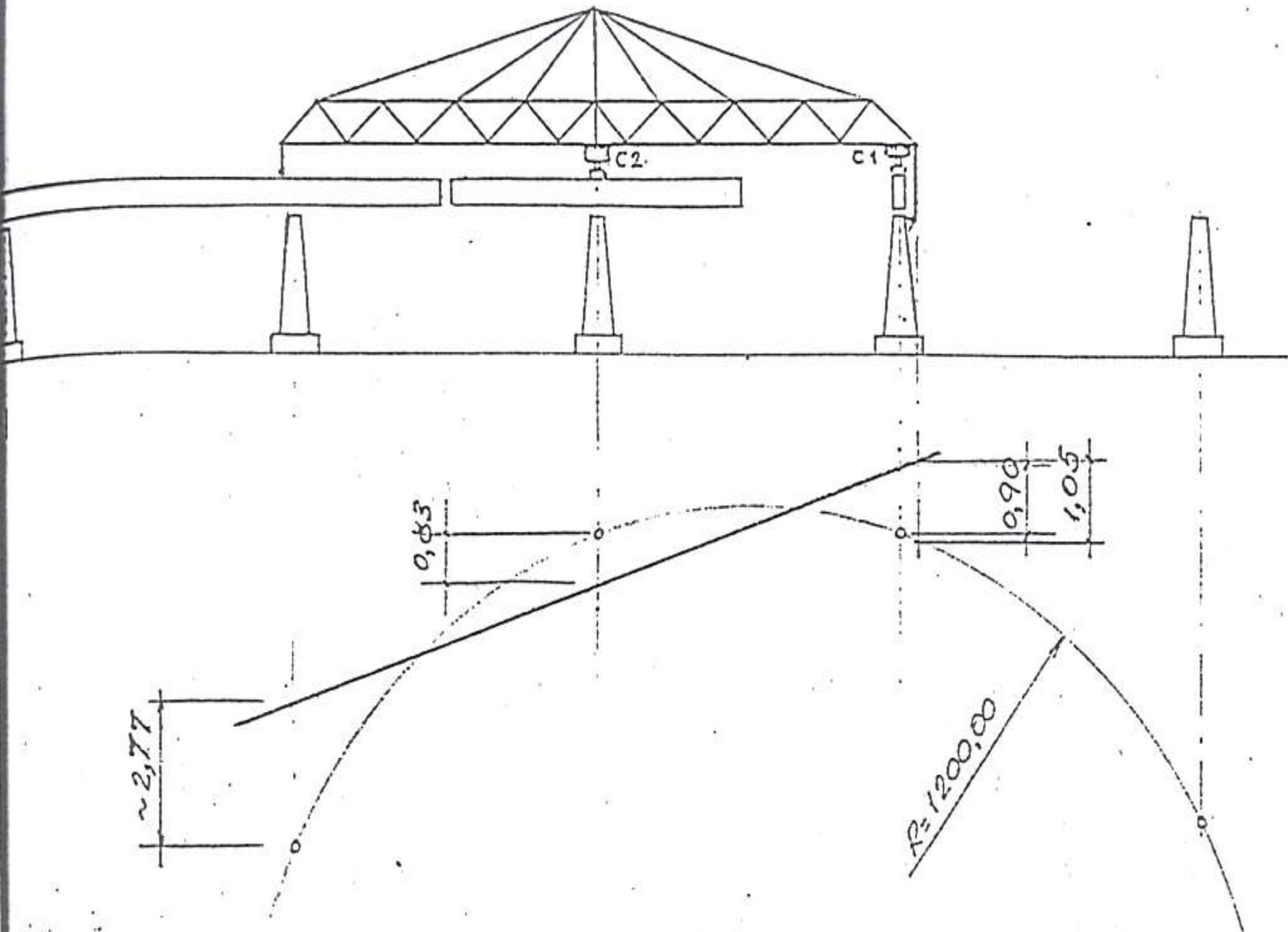
- a) Soltar parafusos de trava.
- b) Abaixar os macacos de suspensão.

31. A viga está liberada para montagem de aduelas.

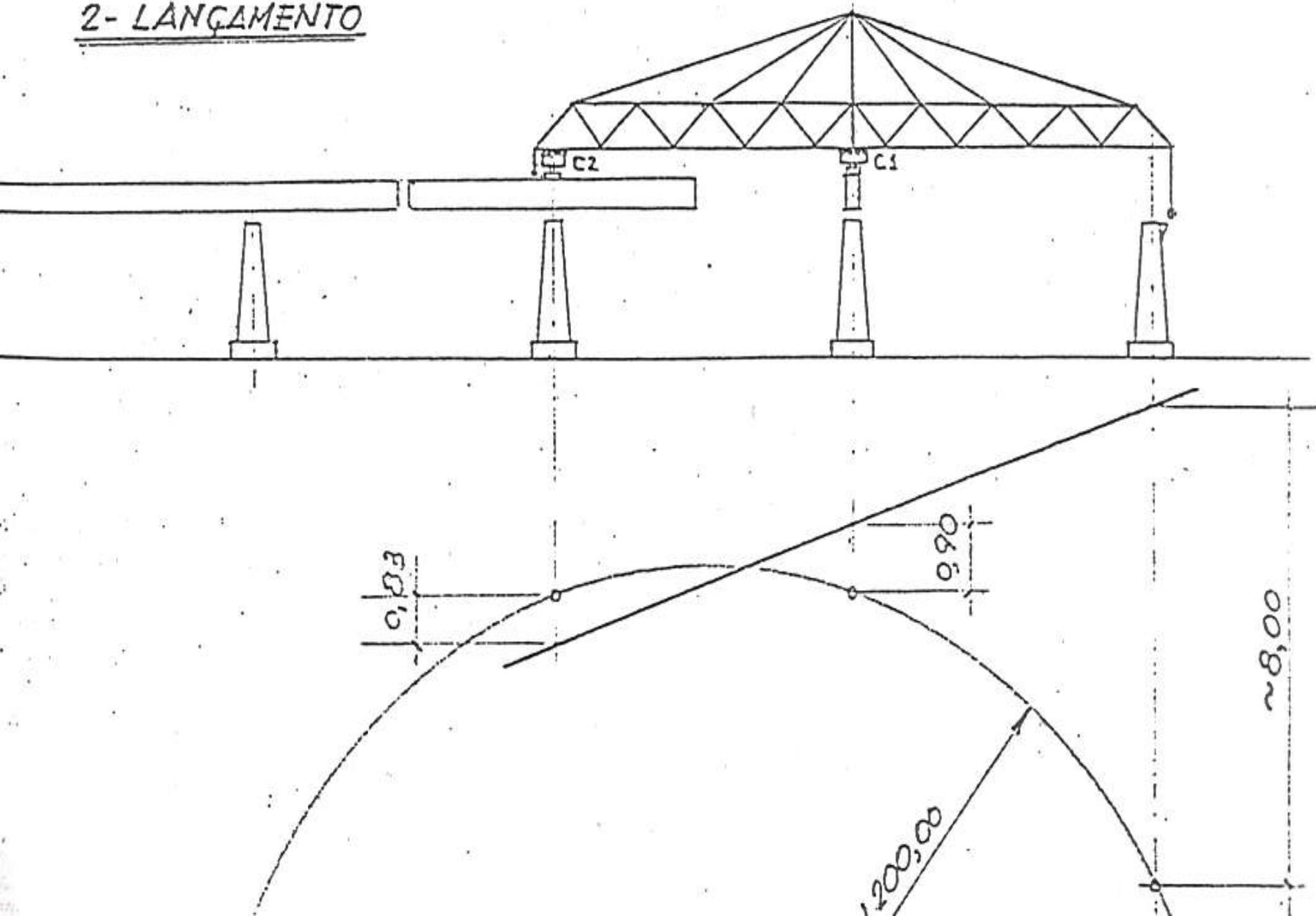
CONSORCIO CONSTRUTOR GUANADARA LTDA.


Eng.º Bruno Cesarini
Líder Técnico

1-VIGA PRONTA PARA O LANÇAMENTO



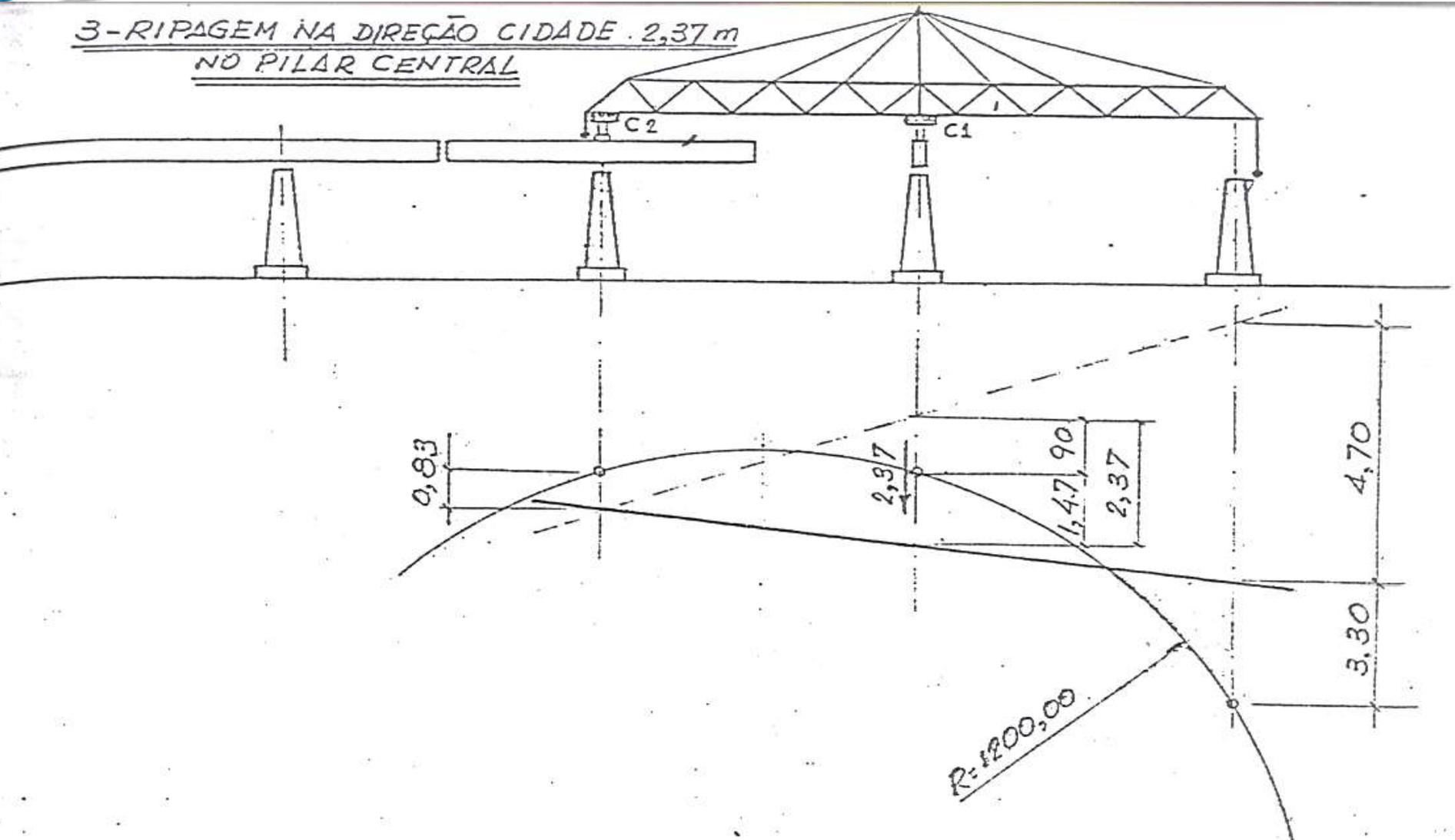
2- LANGAMENTO





IBRACON

3-RIPAGEM NA DIREÇÃO CIDADE . 2,37 m
NO PILAR CENTRAL

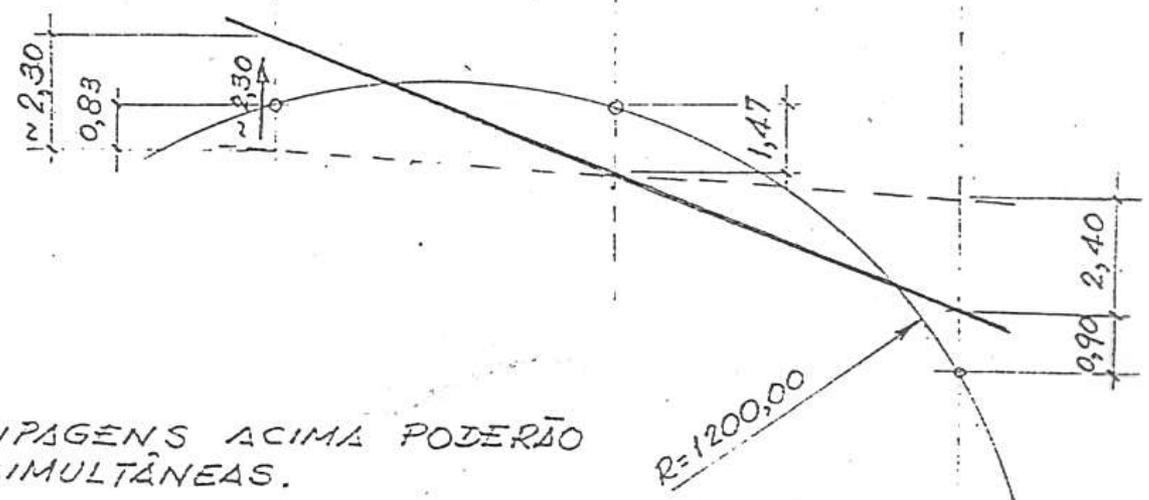
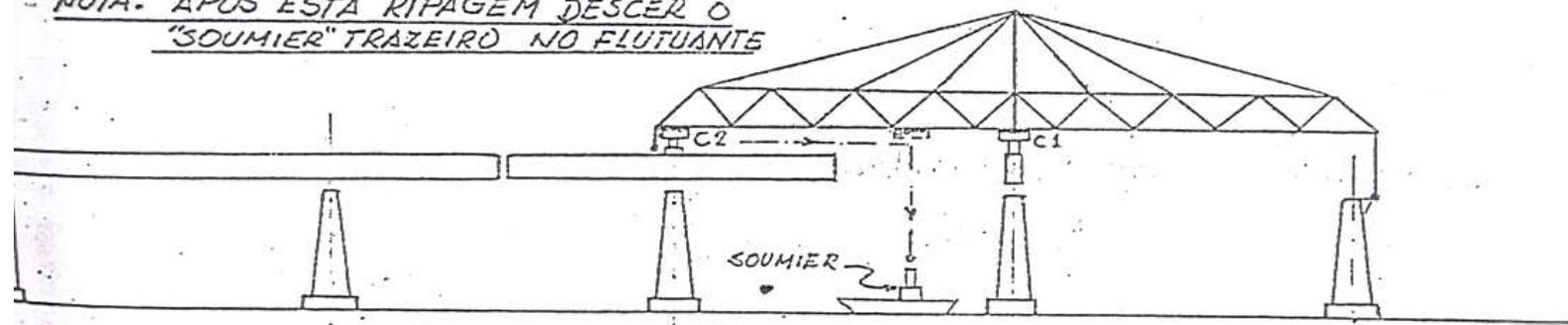




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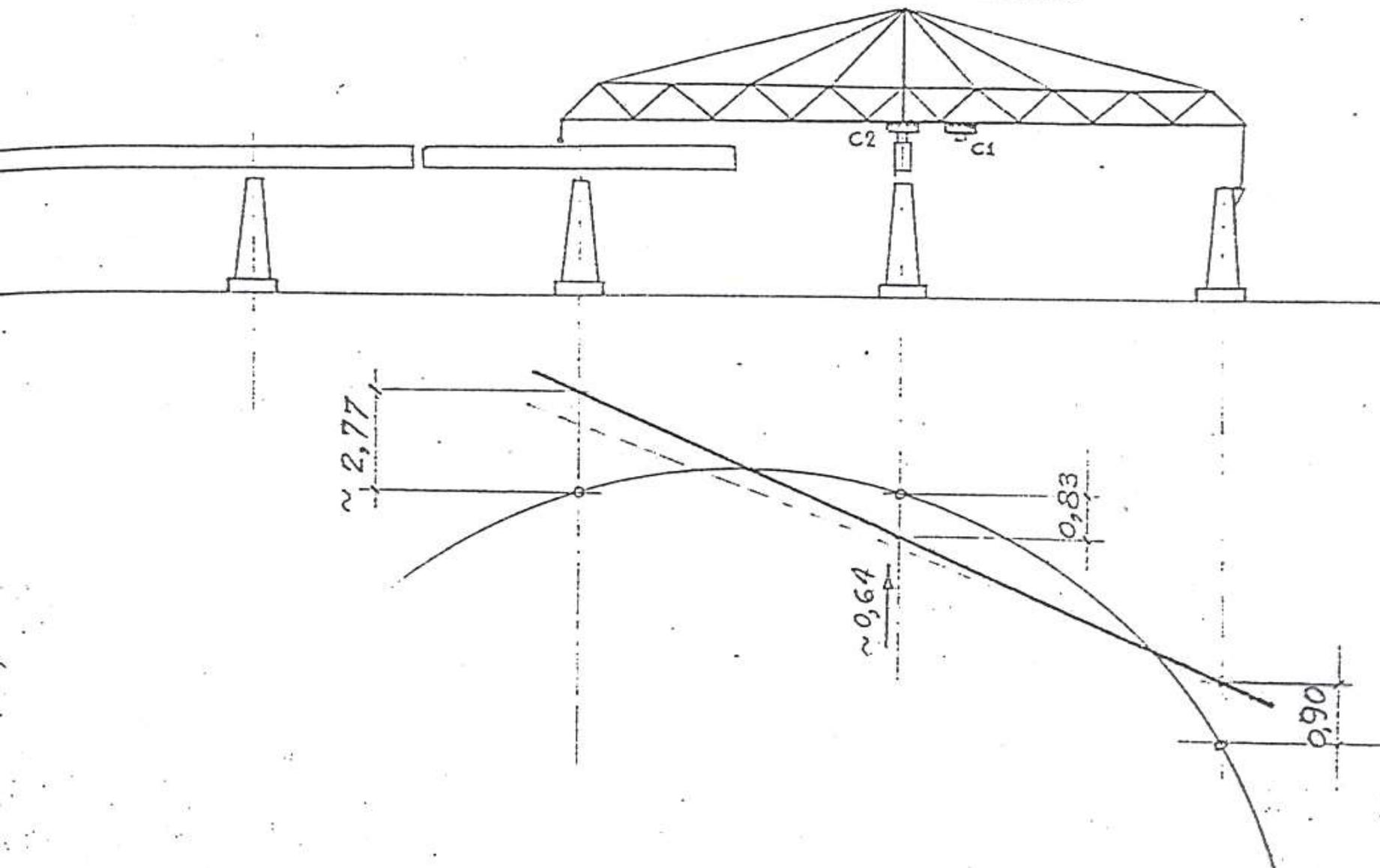
4- RIPAGEM NA DIREÇÃO PAQUETA' ~2,30m
NO PILAR TRAZEIRO

NOTA: APÓS ESTA RIPAGEM DESCER O
"SOMIER" TRAZEIRO NO FLUTUANTE



NOTA: AS RIPAGENS ACIMA PODERÃO
SER SIMULTÂNEAS.

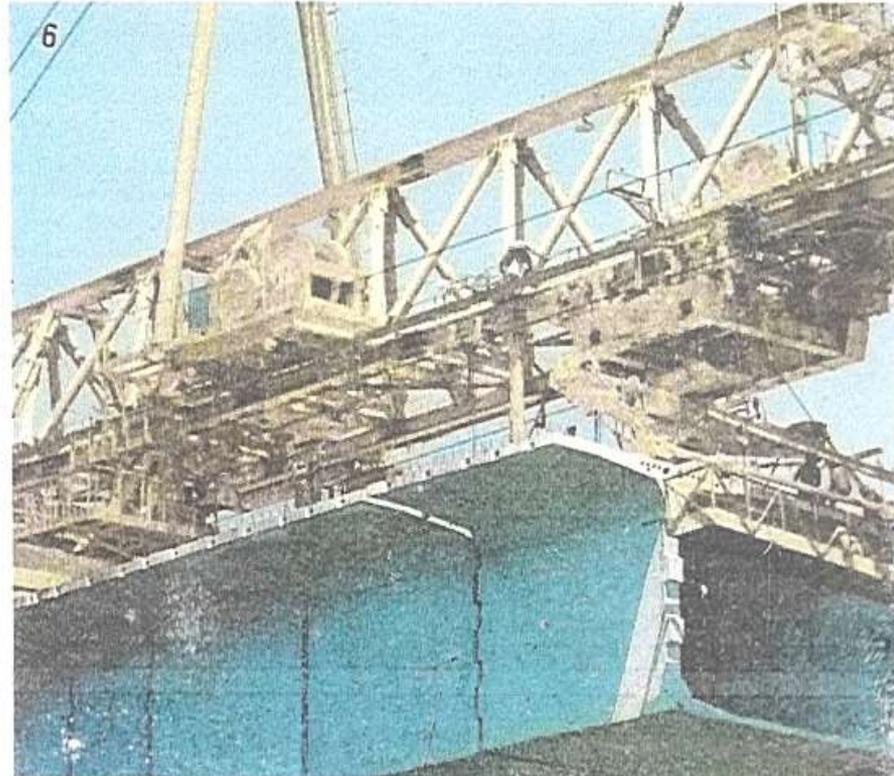
5- RIPAGEM NA DIREÇÃO PAQUETA DE $\sim 0,64m$
A VIGA FICARÁ A $0,83m$ DO CENTRO DO PILAR

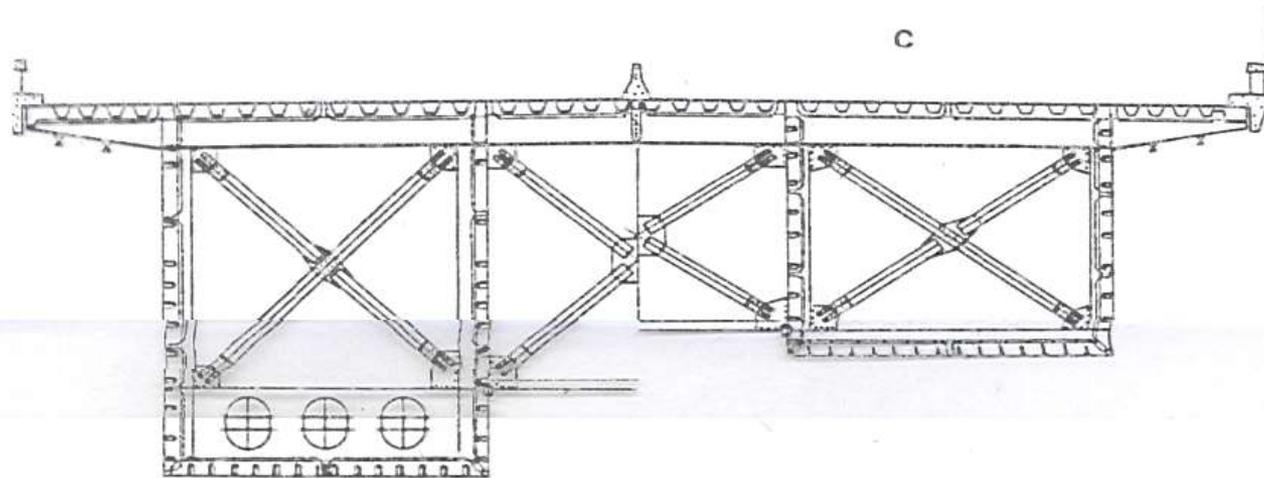
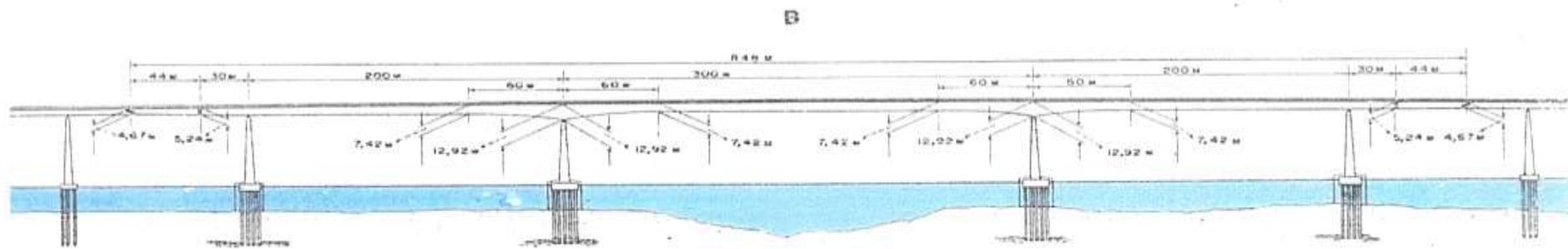
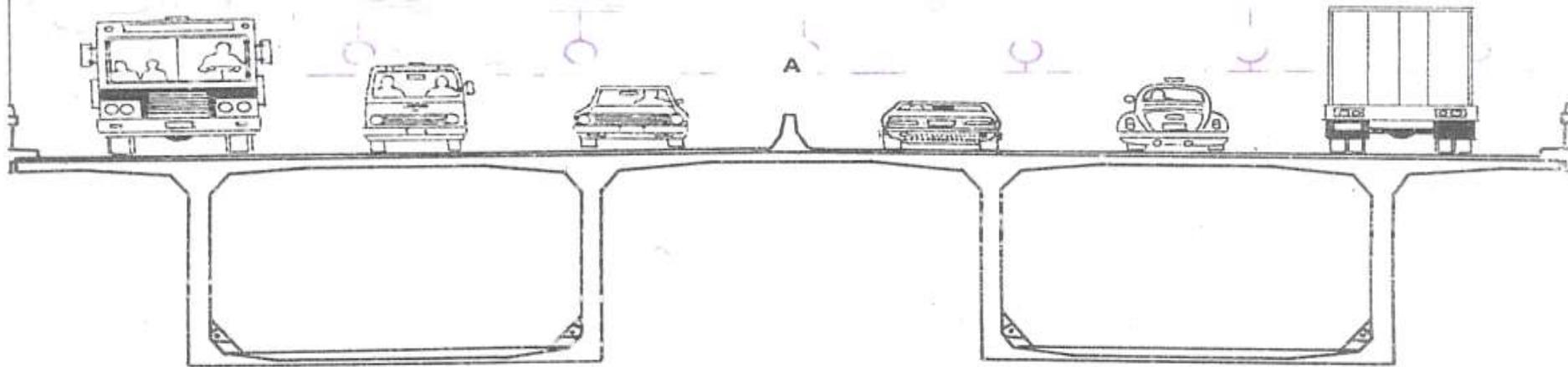


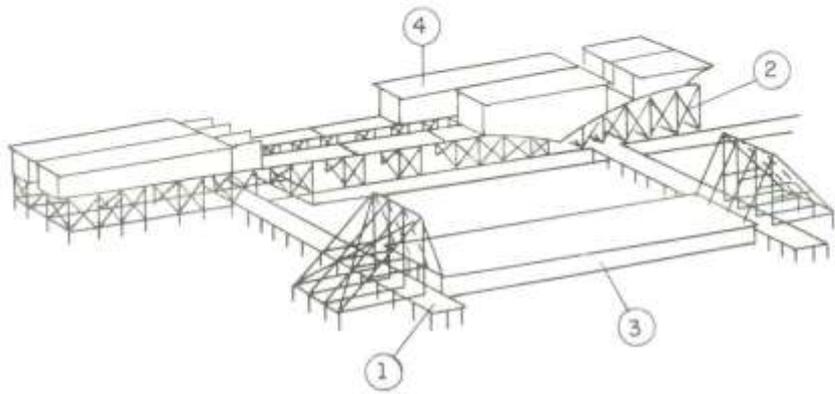




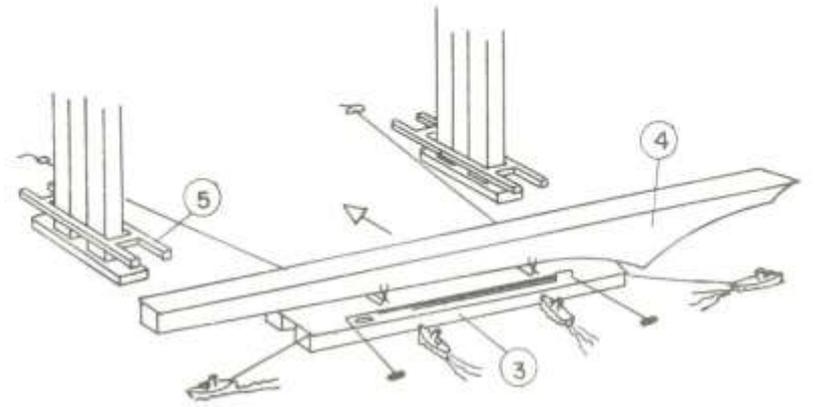
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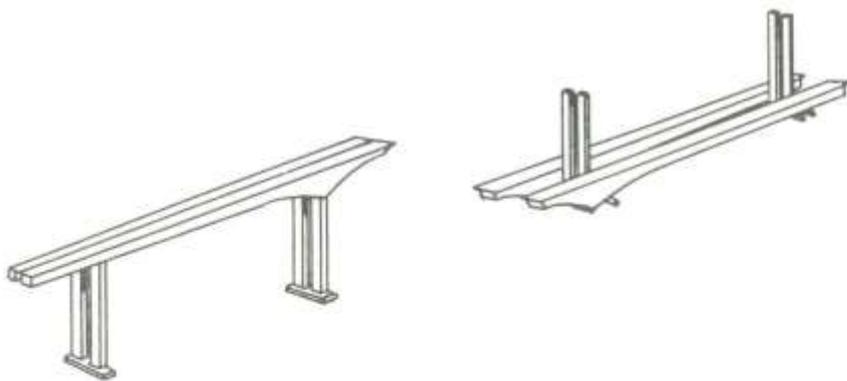




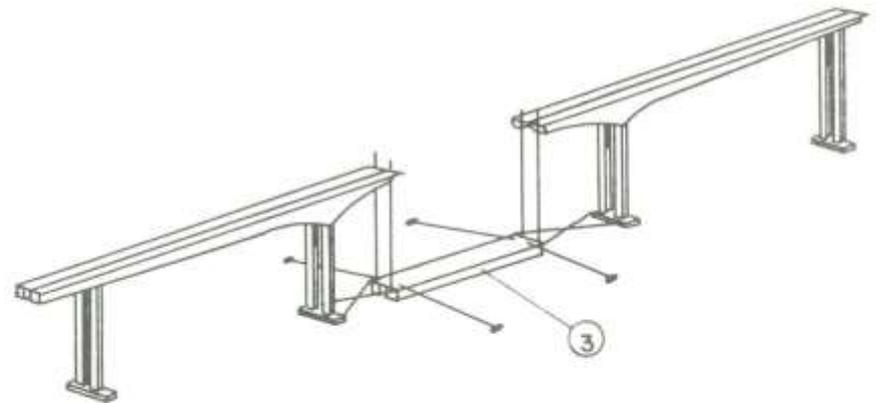
(a)



(b)



(c)



(d)

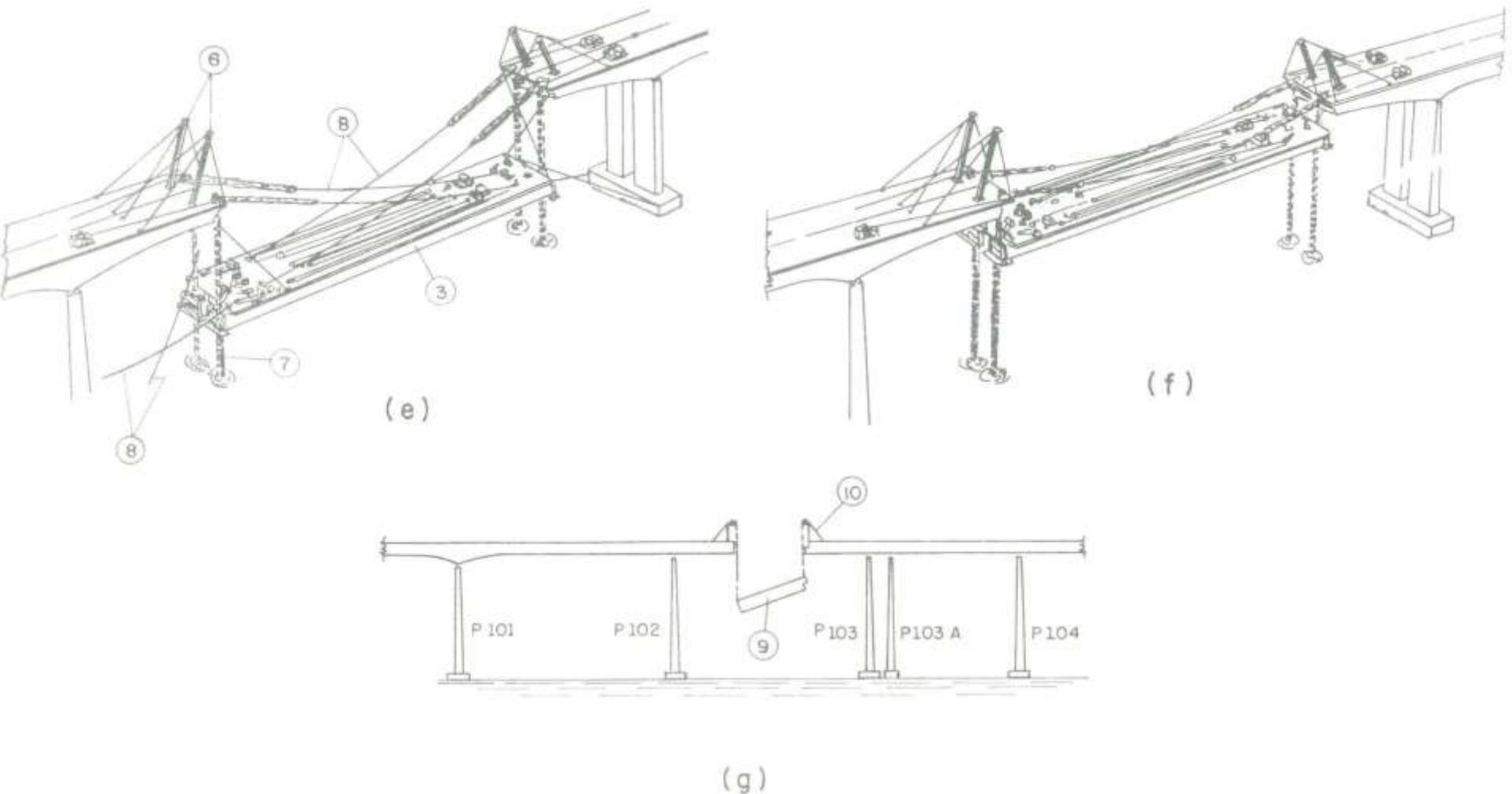


Fig. 9.6. Sequência de montagem dos elementos metálicos pré-fabricados: a) segmento central (3) lançado ao mar após ser deslizado sobre o pier (1). Segmentos laterais (4) fabricados sobre escoramento (2); b) segmento lateral (4) apoiado no segmento central flutuante (3) se dirige para o anel de içamento (5); c) içamento dos segmentos laterais; d) início de içamento do segmento central (3); e) o segmento central (3) apoiado nas colunas de içamento (7), as quais foram montadas pela torre (6). Notam-se os cabos de amarração reguláveis (8); f) segmento central na fase final de içamento; g) montagem dos vãos laterais de 44 m (9) com auxílio de torres triangulares (10).

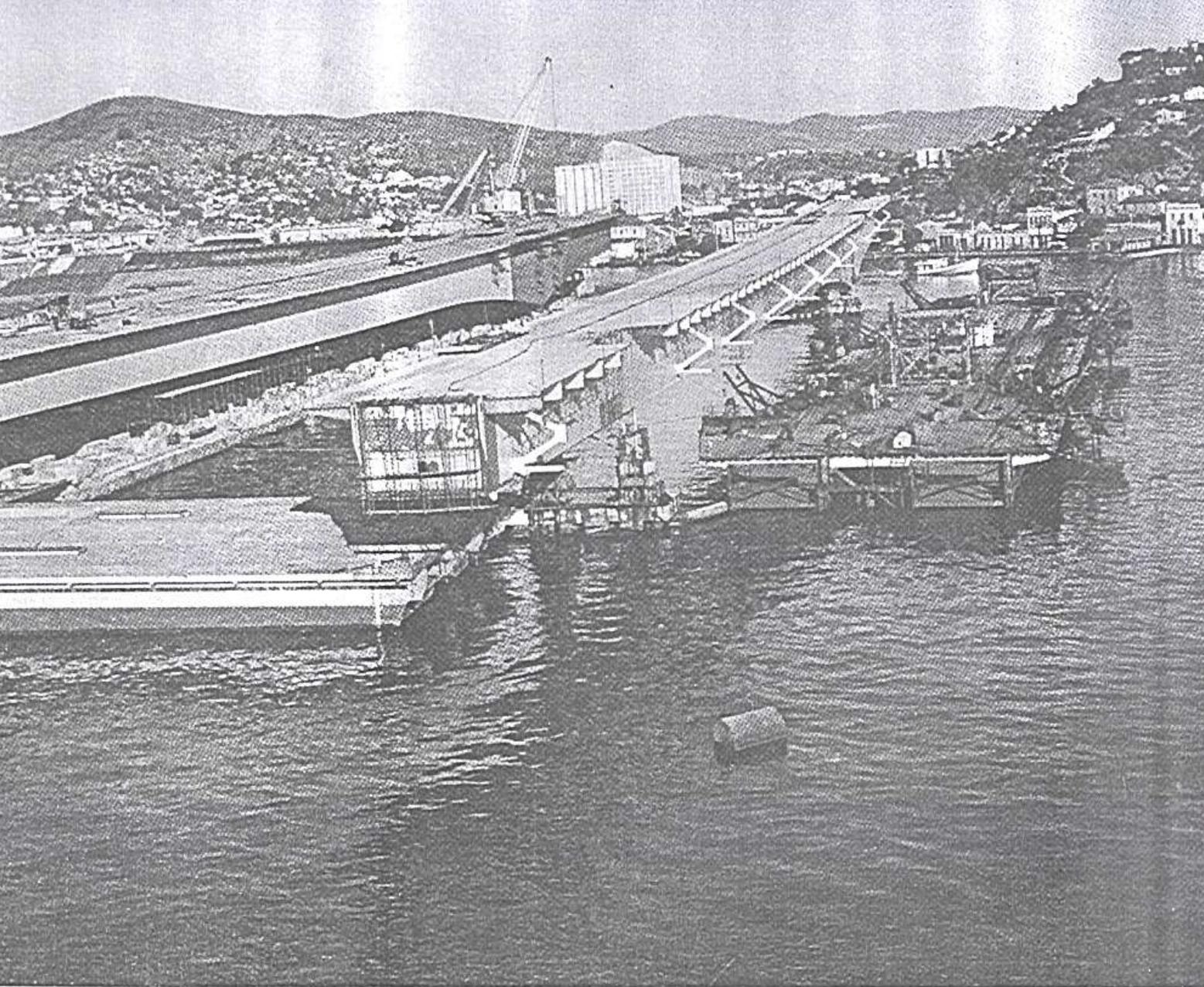


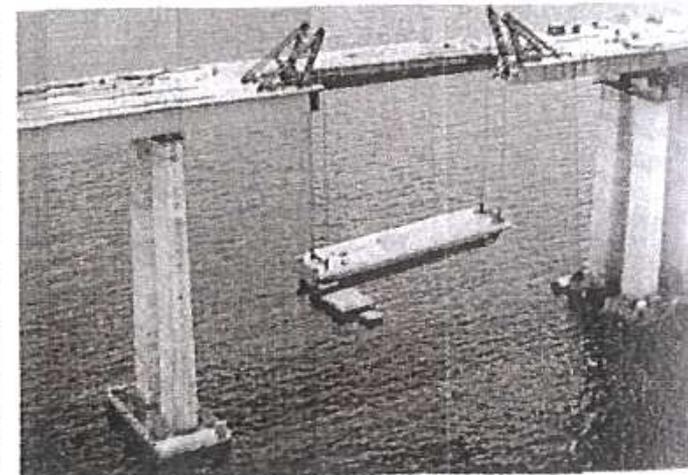
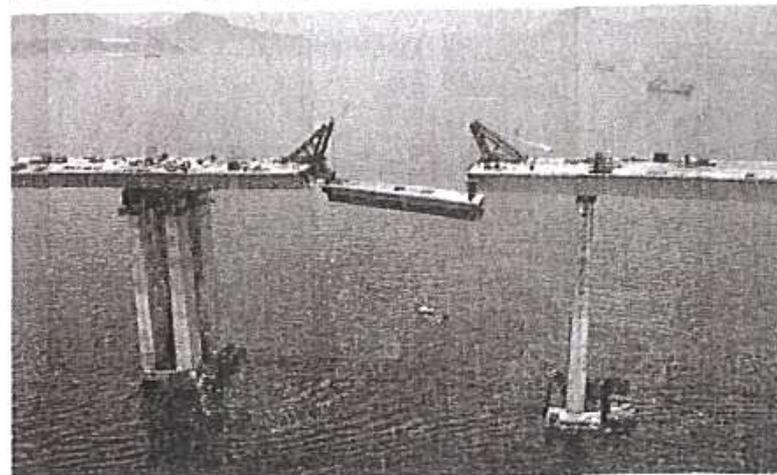
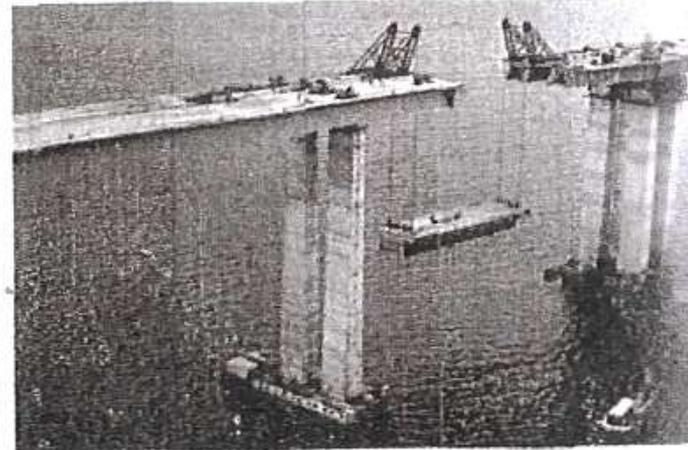
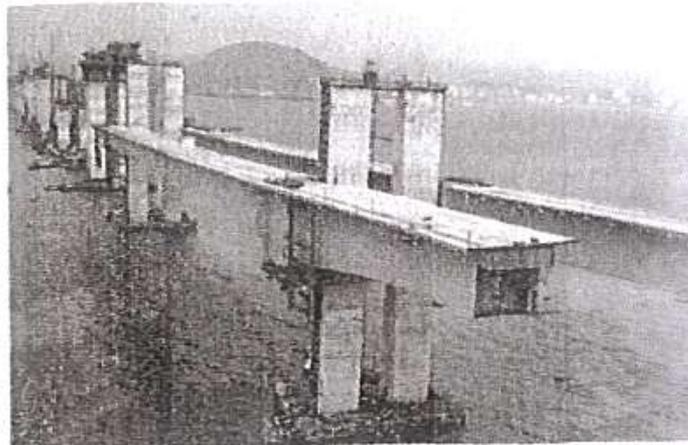
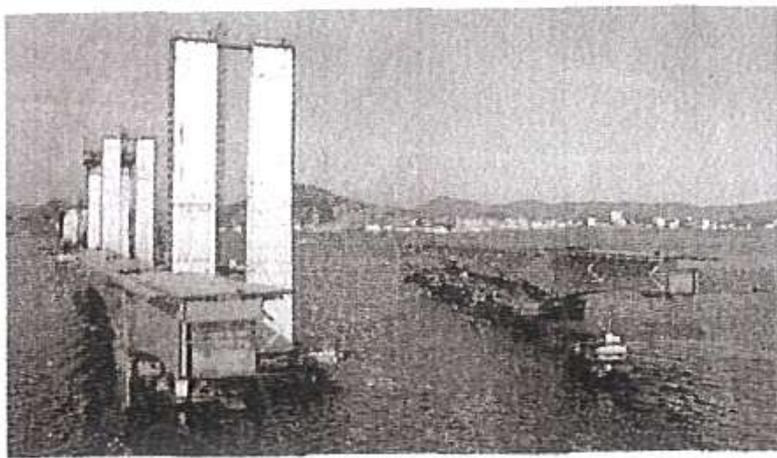
Foto 9.4.3. A mesma fase da foto anterior. À direita, vê-se o flutuante formado pelo segmento central de 176 m. Em primeiro plano, à esquerda, vêem-se um vão de 44 m ancorado junto ao pier.



















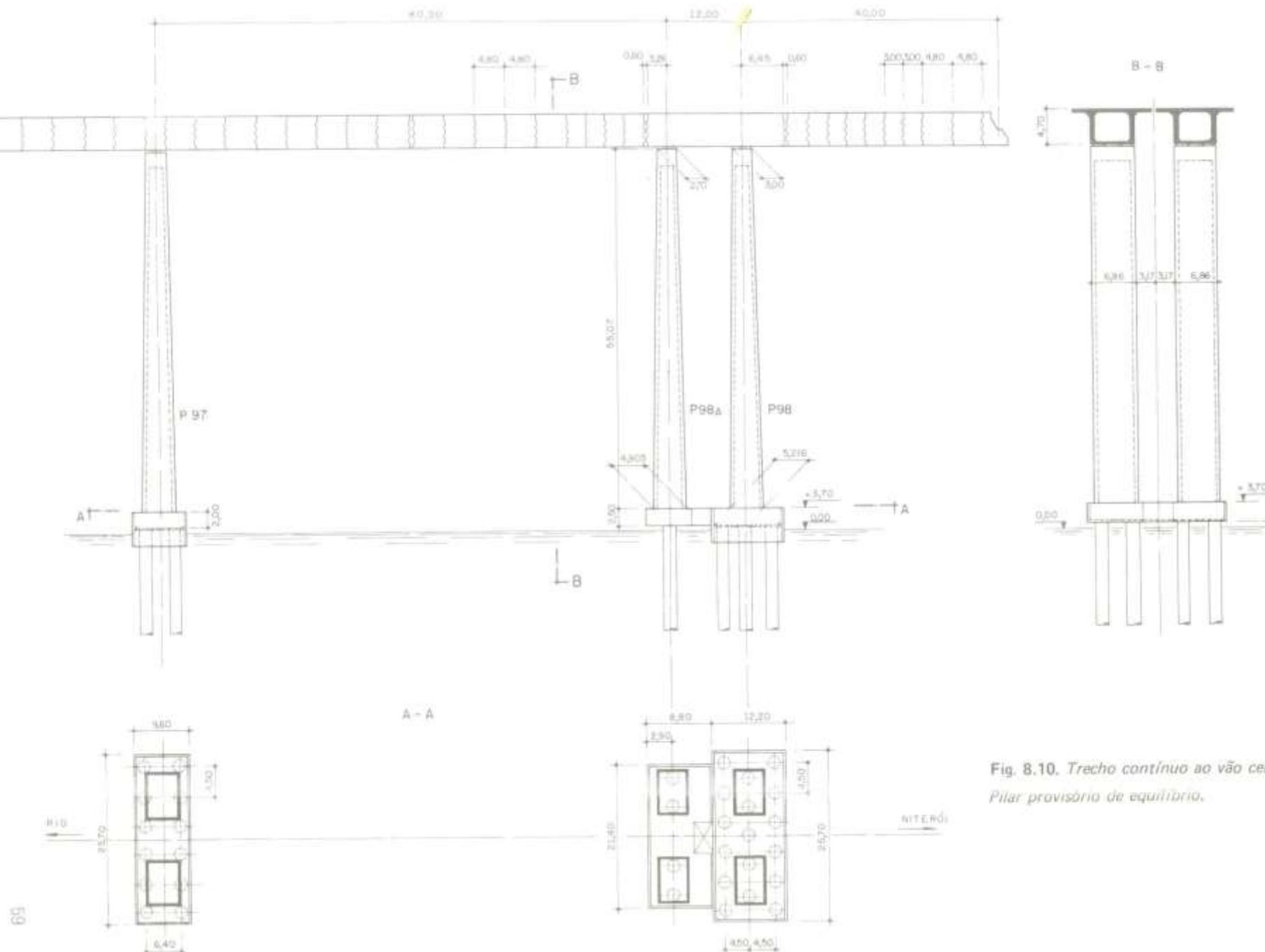


Fig. 8.10. Trecho contínuo ao vão central. Pilar provisório de equilíbrio.

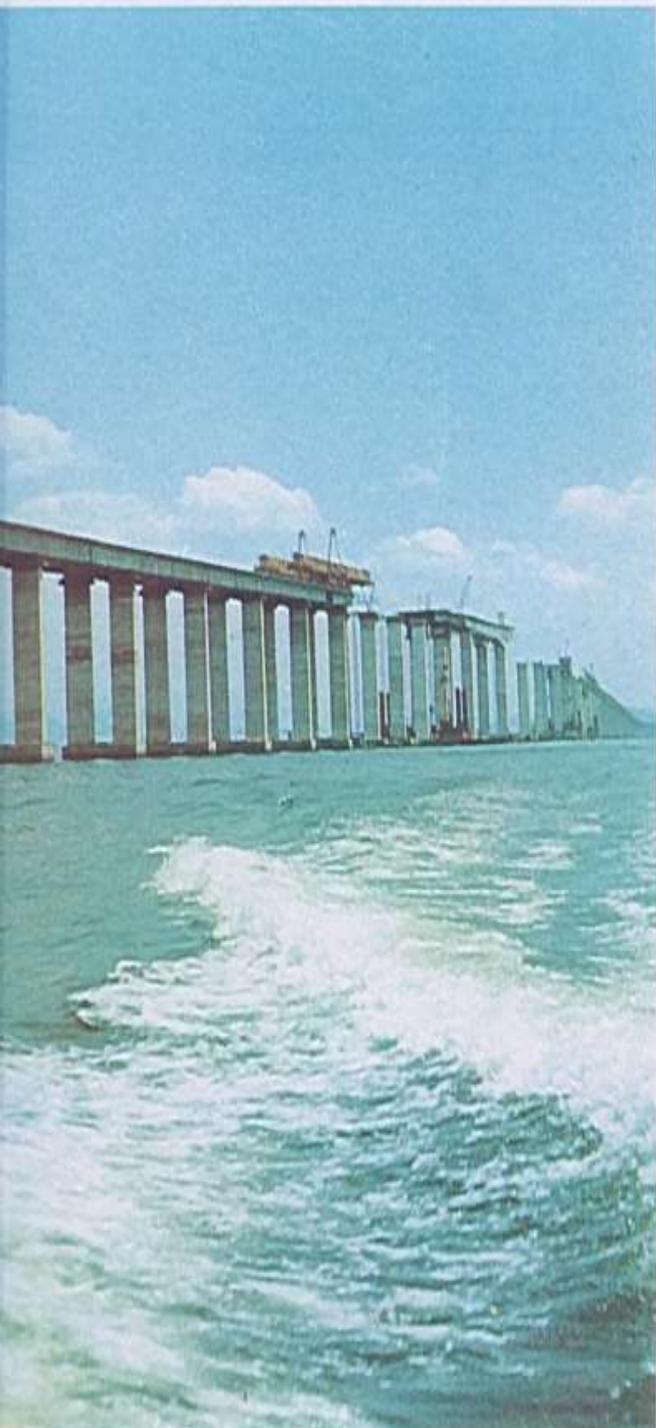






Foto 8.5.5. Vista frontal do escoramento de montagem, no pilar 103 lado Paquetá.



Foto 8.5.6. A treliça ancorada levanta a aduela n.º 3 do lado Rio.



IBRACON



Foto 8.5.7. Pormenor da estrutura de içamento das aduelas.



IBRACON

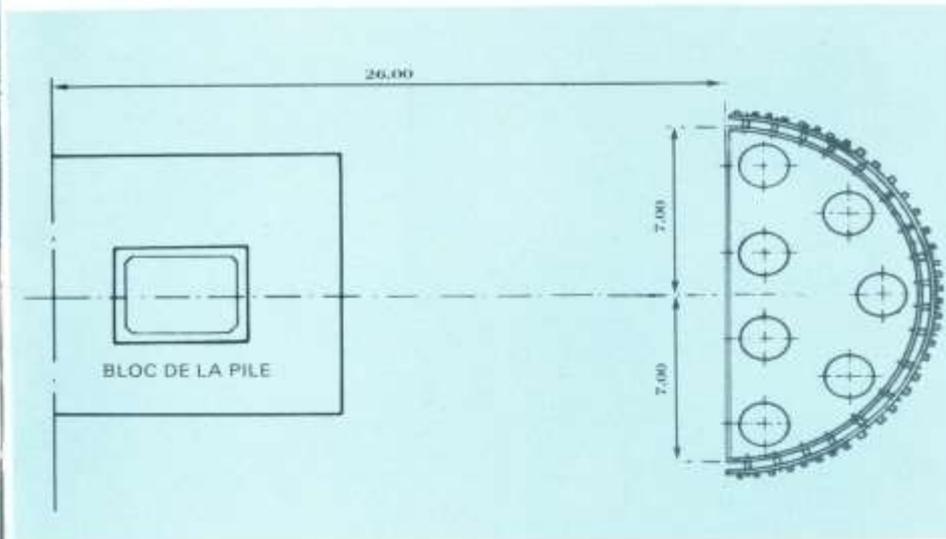
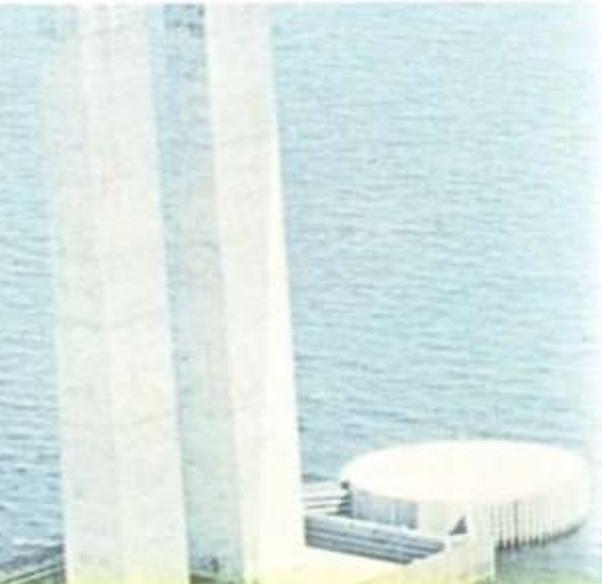
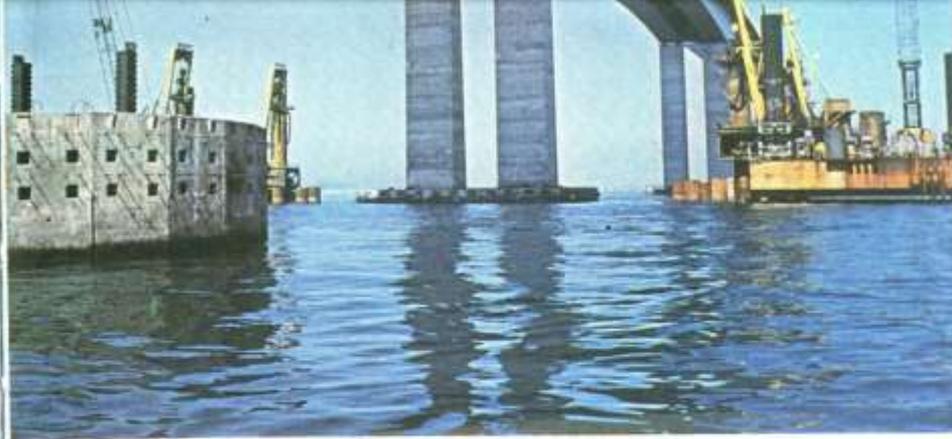
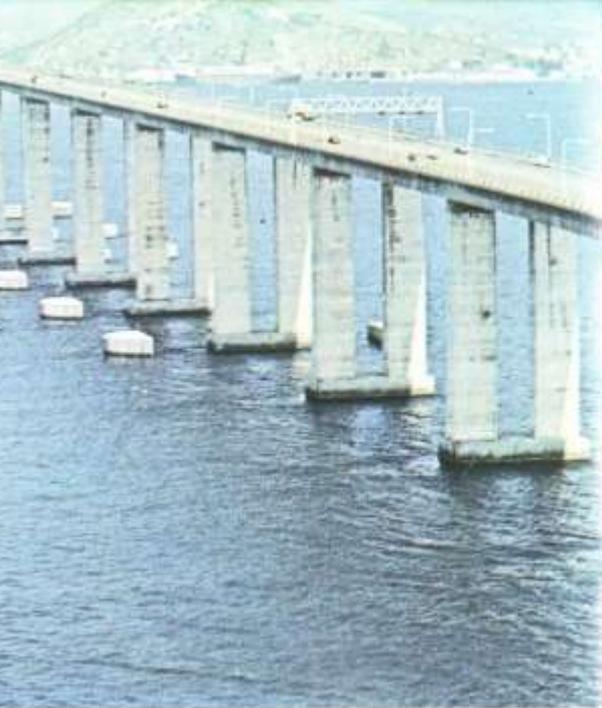
58 CONGRESSO
BRASILEIRO DO
CONCRETO

BELO HORIZONTE, MG, 11/10 a 14/10, 2016



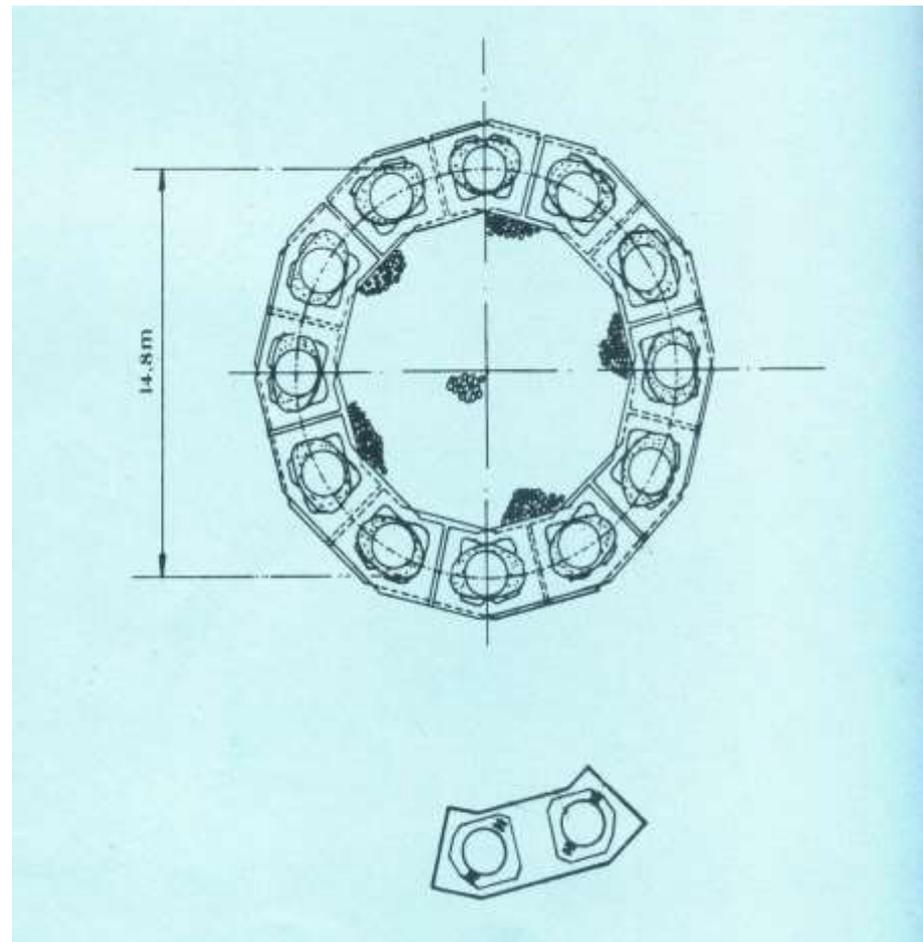
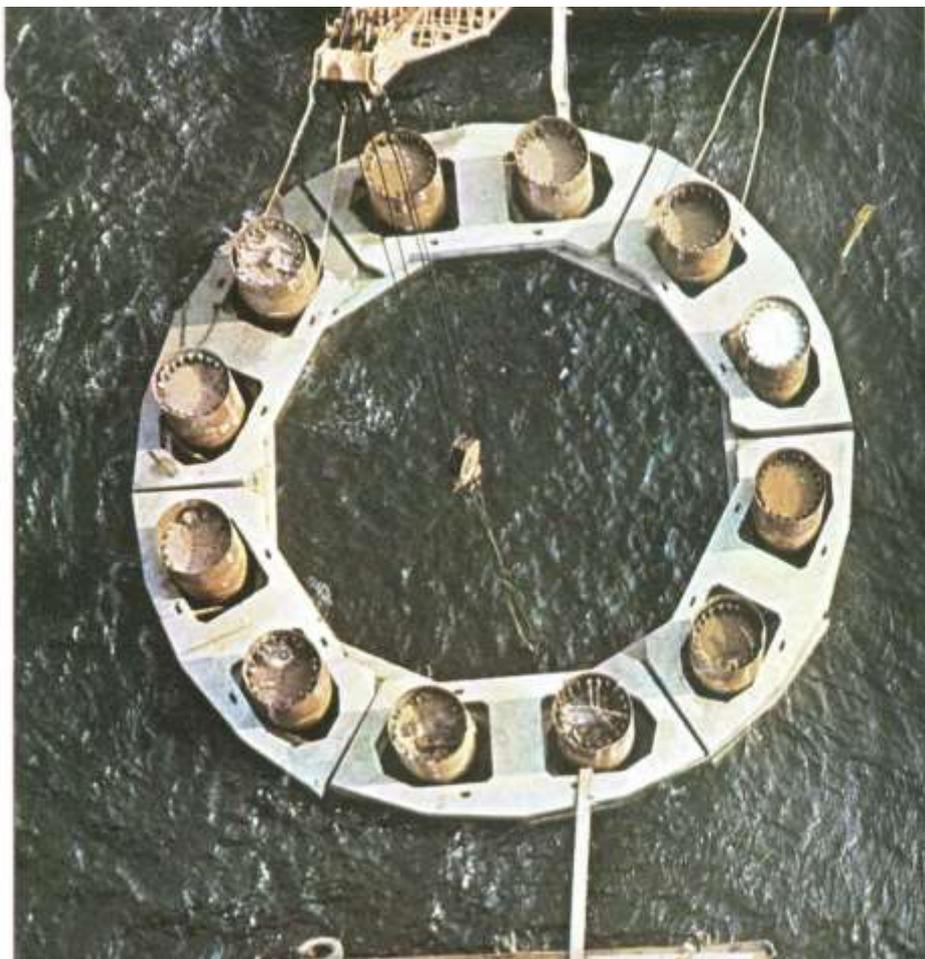




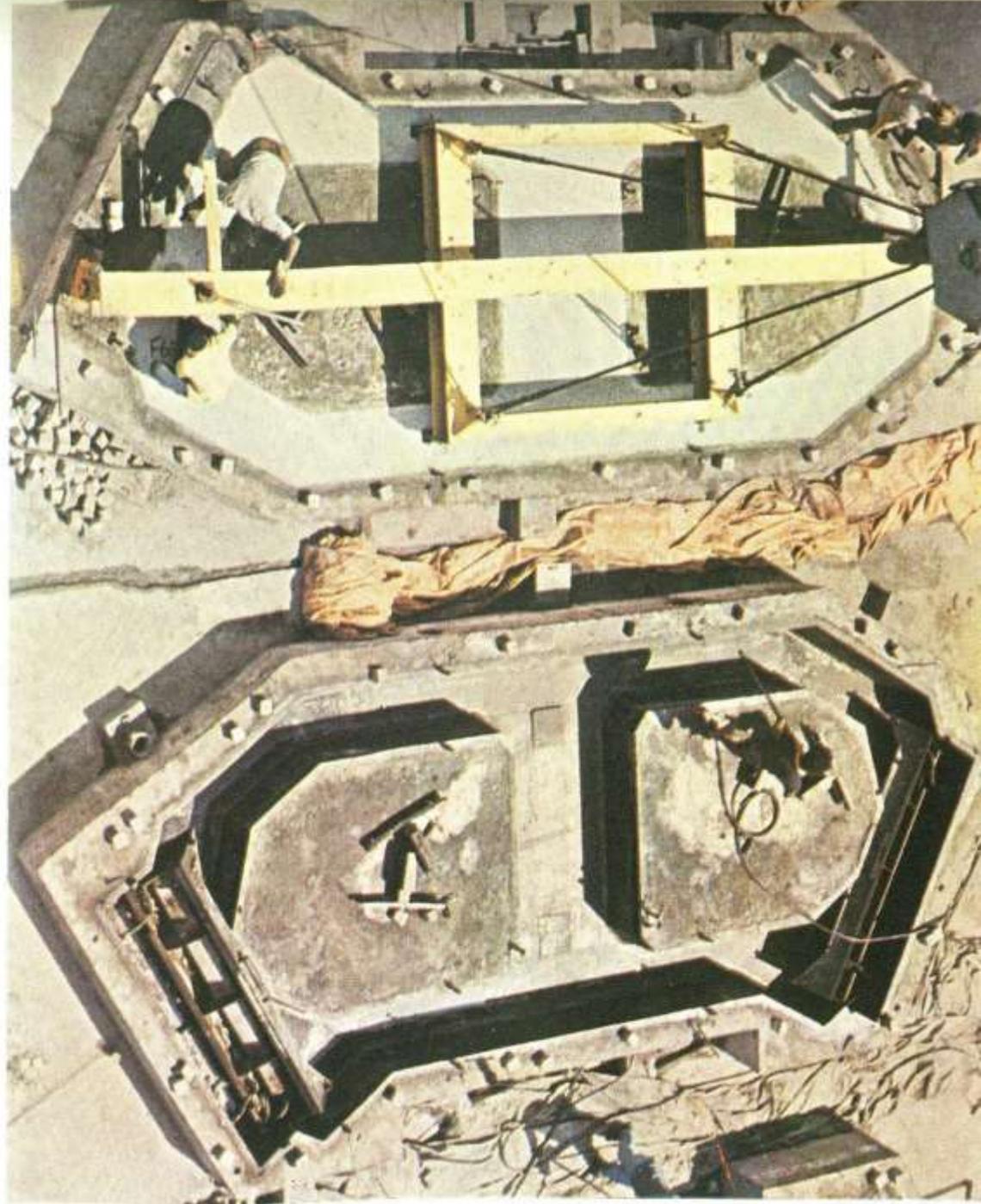
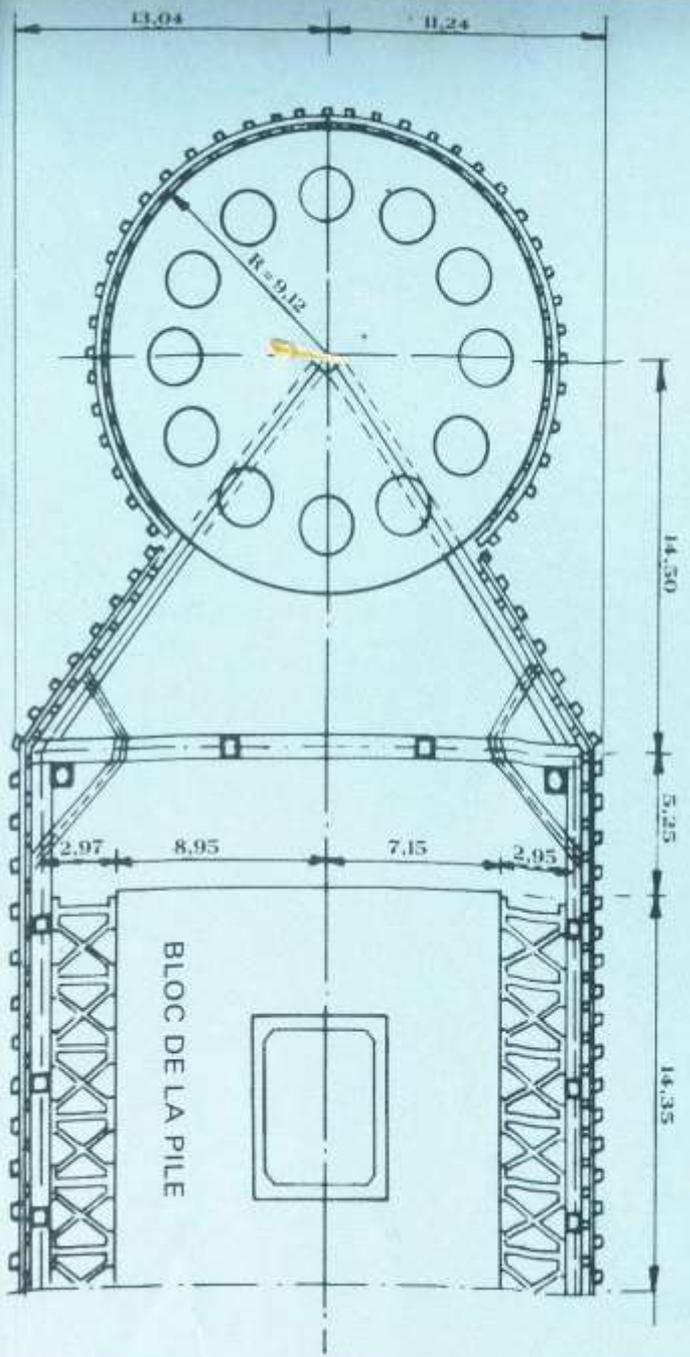




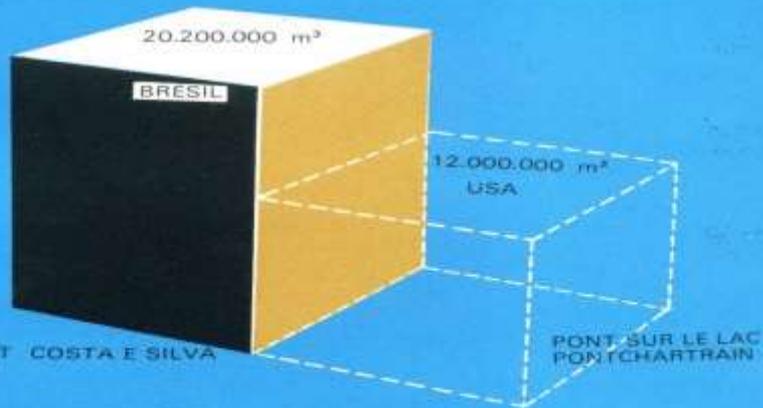
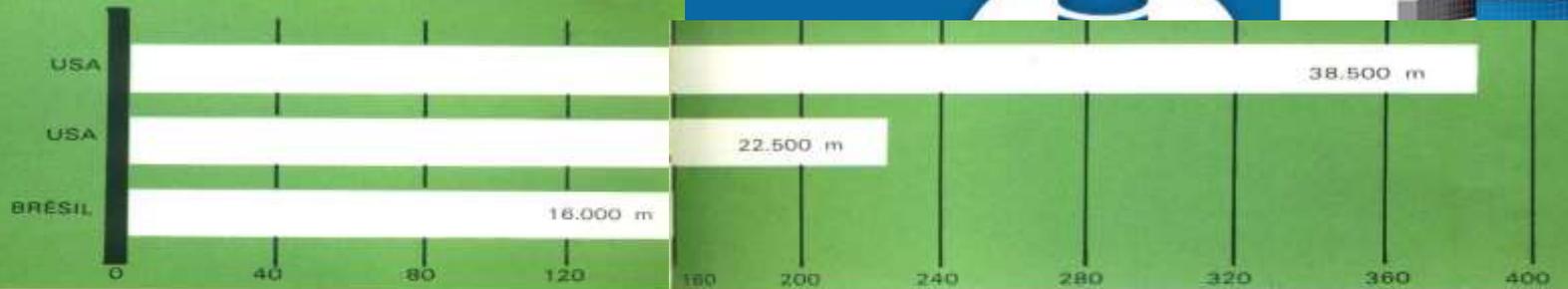
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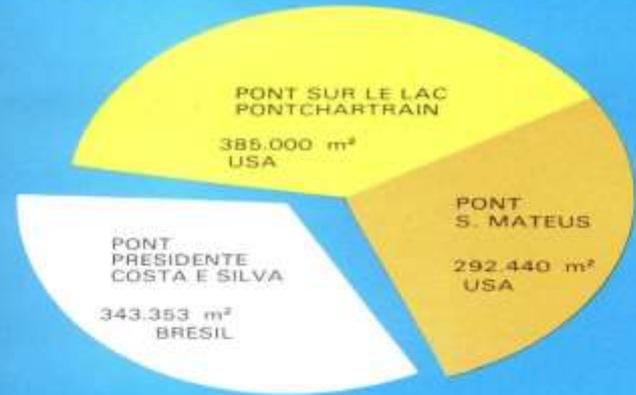




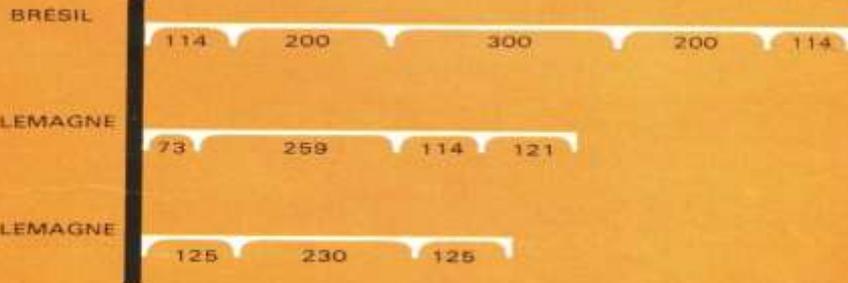
EN LONGUEUR



EN ESPACE-STRUCTURE



EN SURFACE-STRUCTURE



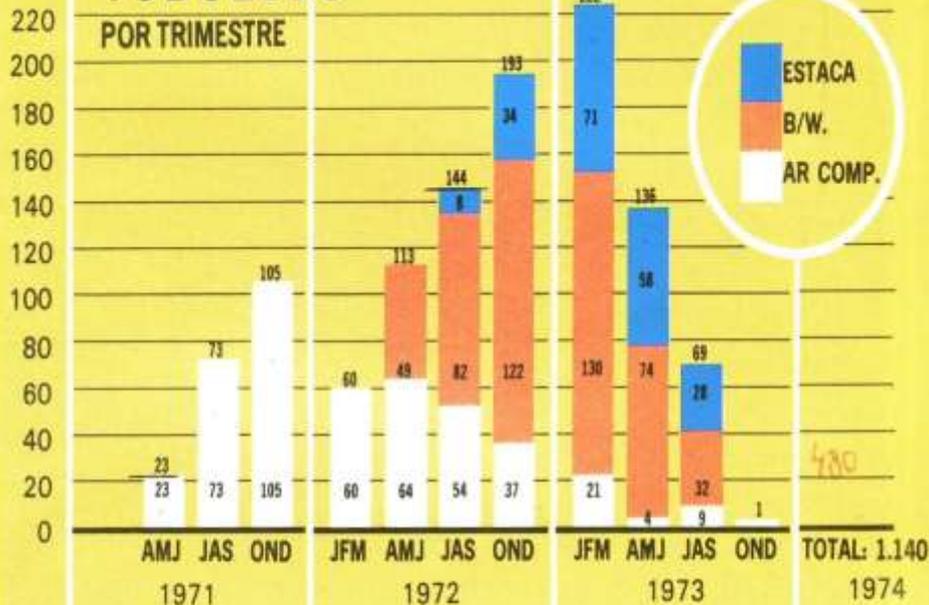
EN PORTÉES AVEC POUTRES MÉTALLIQUES



EN STRUCTURES AVEC VOUSOIRS PRÉ-MOULÉS

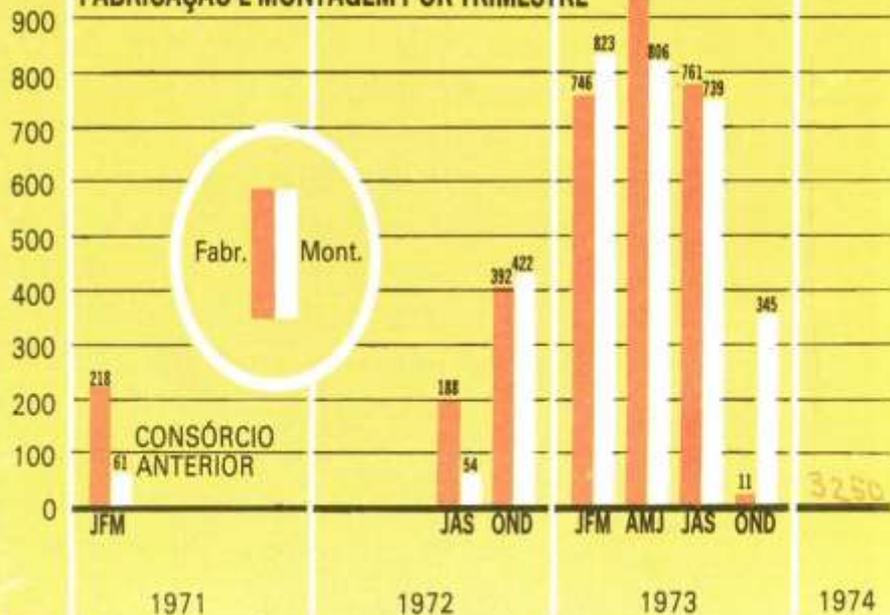
TUBULÕES

POR TRIMESTRE



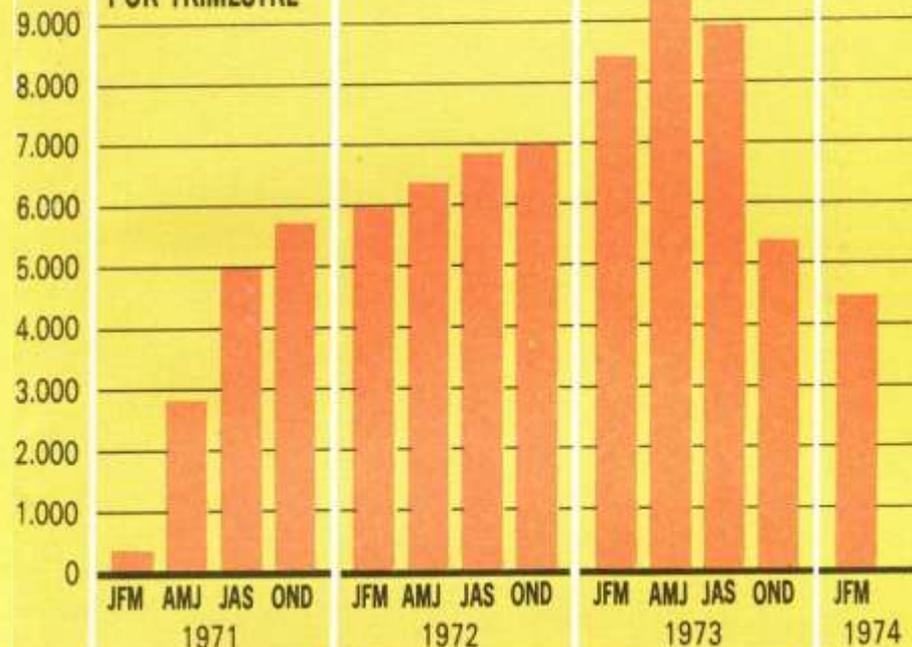
ADUELAS

FABRICAÇÃO E MONTAGEM POR TRIMESTRE



MÃO-DE-OBRA

POR TRIMESTRE



RESULTADOS DOS ENSAIOS

BLOCO	RESISTÊNCIA À COMPRESSÃO - Mpa				MÓDULO DE ELASTICIDADE - Gpa			
	1ª INSP.	2ª INSP.	3ª INSP.	Média	1ª INSP.	2ª INSP.	3ª INSP.	Média
BLOCOS DO VÃO CENTRAL								
99	49,50	31,10	36,10	38,90	27,60	27,98	18,21	24,63
100	43,90	43,70	40,80	42,80	26,56	28,01	23,21	25,93
101	39,70	31,80	36,90	36,13	30,21	28,98	18,94	26,04
102	40,20	34,10	36,10	36,80	28,88	27,45	18,17	24,83
BLOCOS REPETIDOS								
78	44,00	33,40	38,30	38,57	31,07	28,03	20,41	26,50
117	31,19	41,30	30,80	34,43	35,15	29,00	18,20	25,78
BLOCOS VARIADOS								
43	30,55				31,07			
45	41,63				32,48			
46	32,84				33,65			
47		36,90				27,45		
58		33,10				28,54		
66		33,70				28,01		
107			29,90				12,48	
126			40,70				23,07	
135			42,00				24,53	
MÉDIA	35,01	34,57	37,53	38,70	32,30	28,00	20,03	26,61

01/11 MON. 03

09:22:06

UC - Pista 2

16-10-97



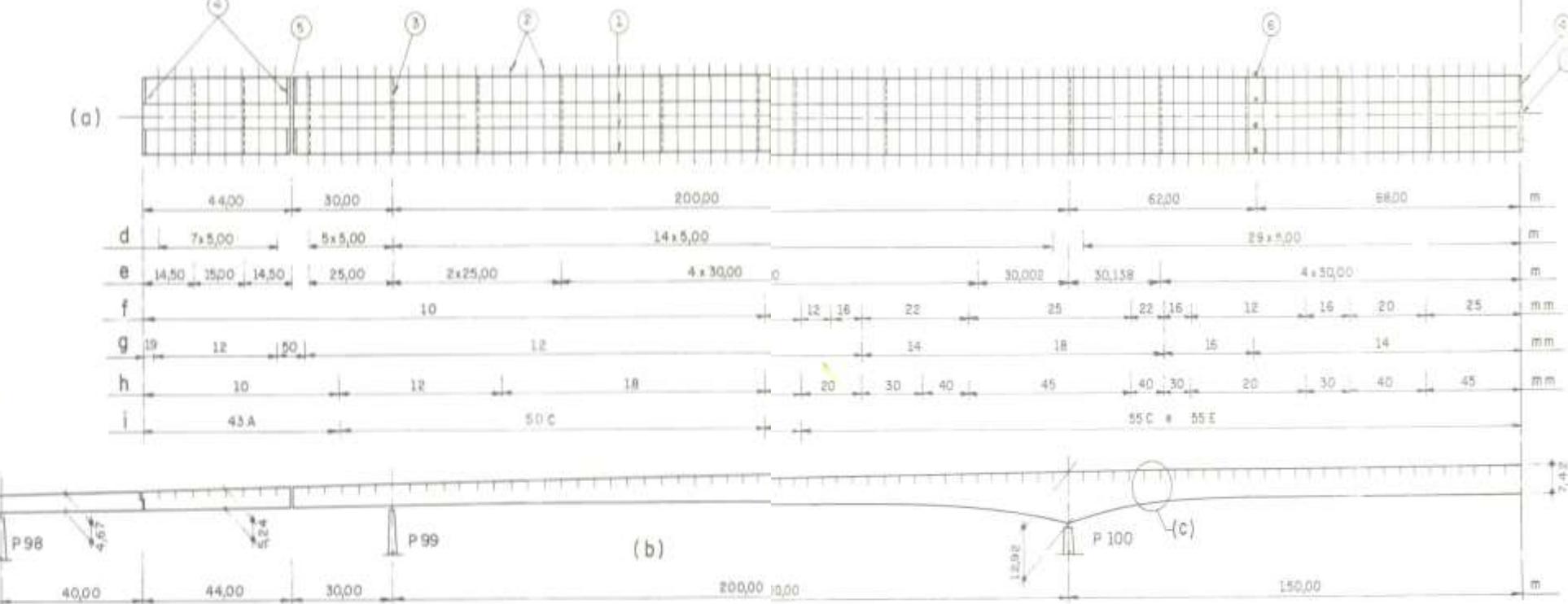


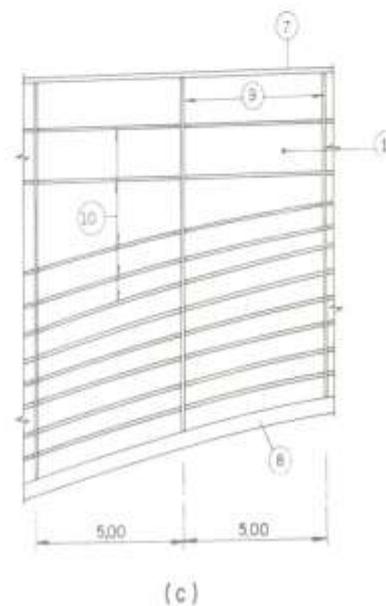
Fig. 9.2. Particulars das estruturas metálicas: a) planta dos vigamentos, mostrando:

- | | |
|-------------------------------|---|
| 1. almas das vigas principais | 4. diafragmas de alma cheia |
| 2. transversinas | 5. junta de dilatação |
| 3. quadros transversais em X | 6. emenda de campo do vigamento (planta principal, com parafusos de alta resistência) |

b) elevação; c) pormenor dos enrijecedores, mostrando:

- | | |
|-------------------|---------------------------------|
| 7. chapa superior | 9. enrijecedores transversais |
| 8. chapa inferior | 10. enrijecedores longitudinais |

d) espaçamentos entre transversinas e enrijecedores verticais (metros); e) espaçamento entre quadros transversais em X (metros); f) espessuras da placa superior (7), em mm; g) espessuras da chapa de alma (1), em mm; h) espessuras da placa inferior (8), em mm; i) tipos de apoios utilizados, segundo a norma inglesa inglesa BS 4360.



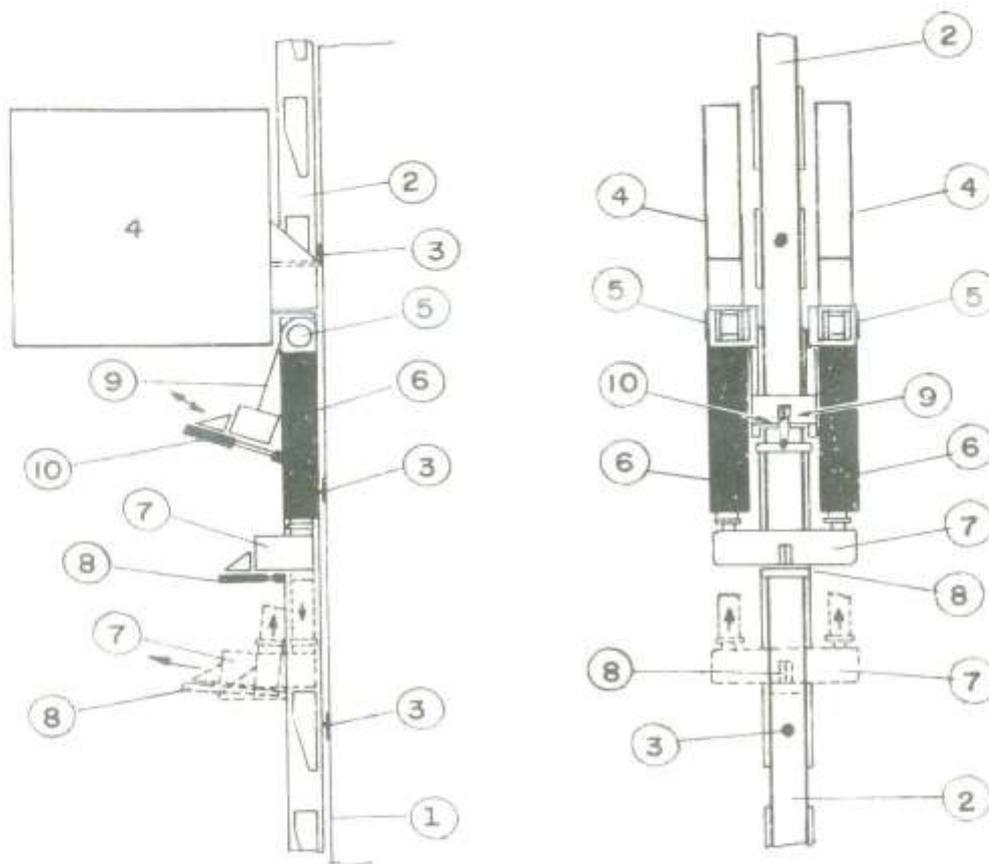


Fig. 9.7. Dispositivo hidráulico de elevação das estruturas metálicas:

1. Face do pilar.

2. Coluna de içamento.

3. Parafusos de fixação da coluna de içamento do pilar.

4. Viga do quadro de içamento.

5. Pino de apoio do quadro de içamento.

6. Macacos de içamento (capacidade 450 t por macaco).

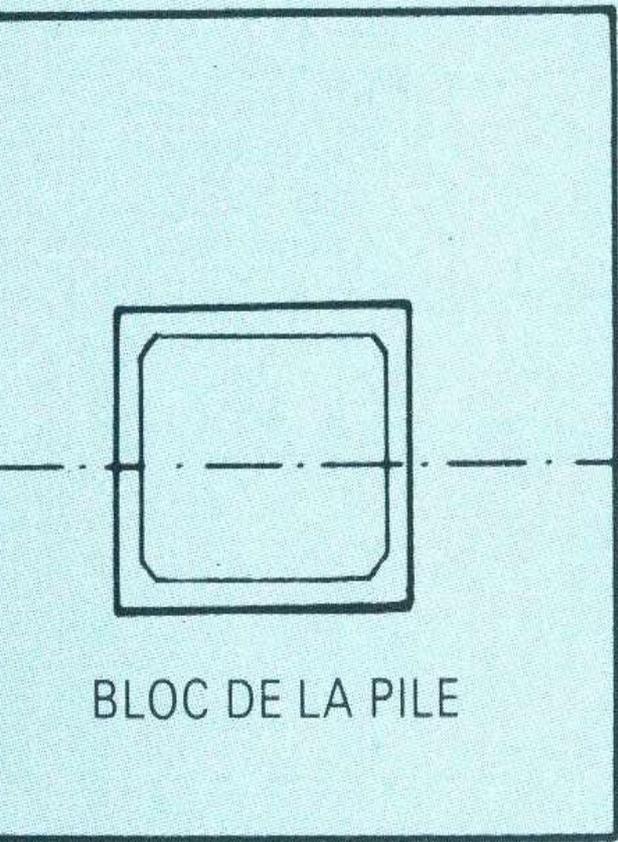
7. Viga de apoio dos macacos.

8. Macaco para retirar a viga (7) do dente.

9. Viga de trava.

10. Macaco para retirar a viga (9) do dente.

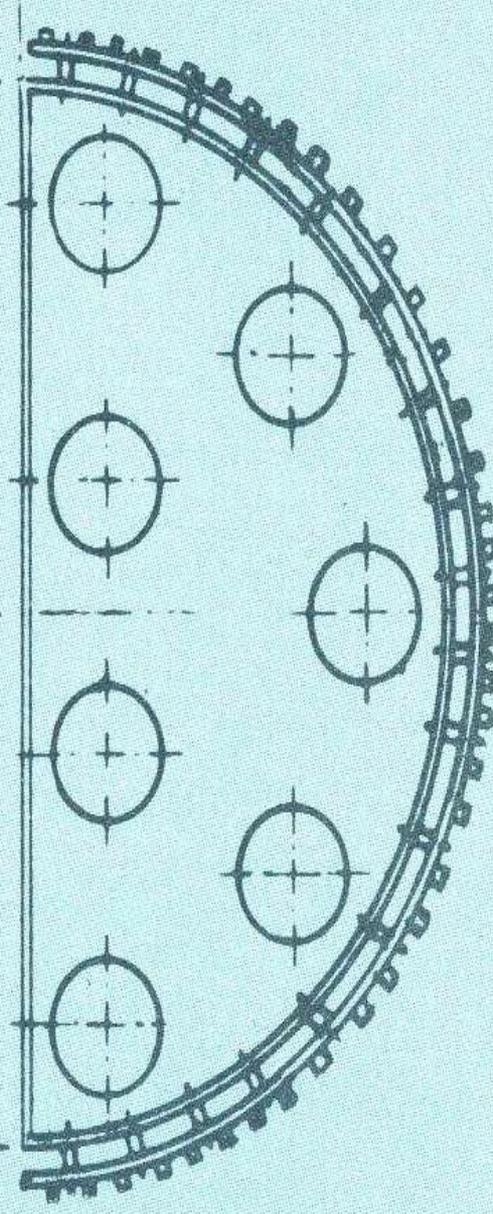
26,00



BLOC DE LA PILE

7,00

7,00



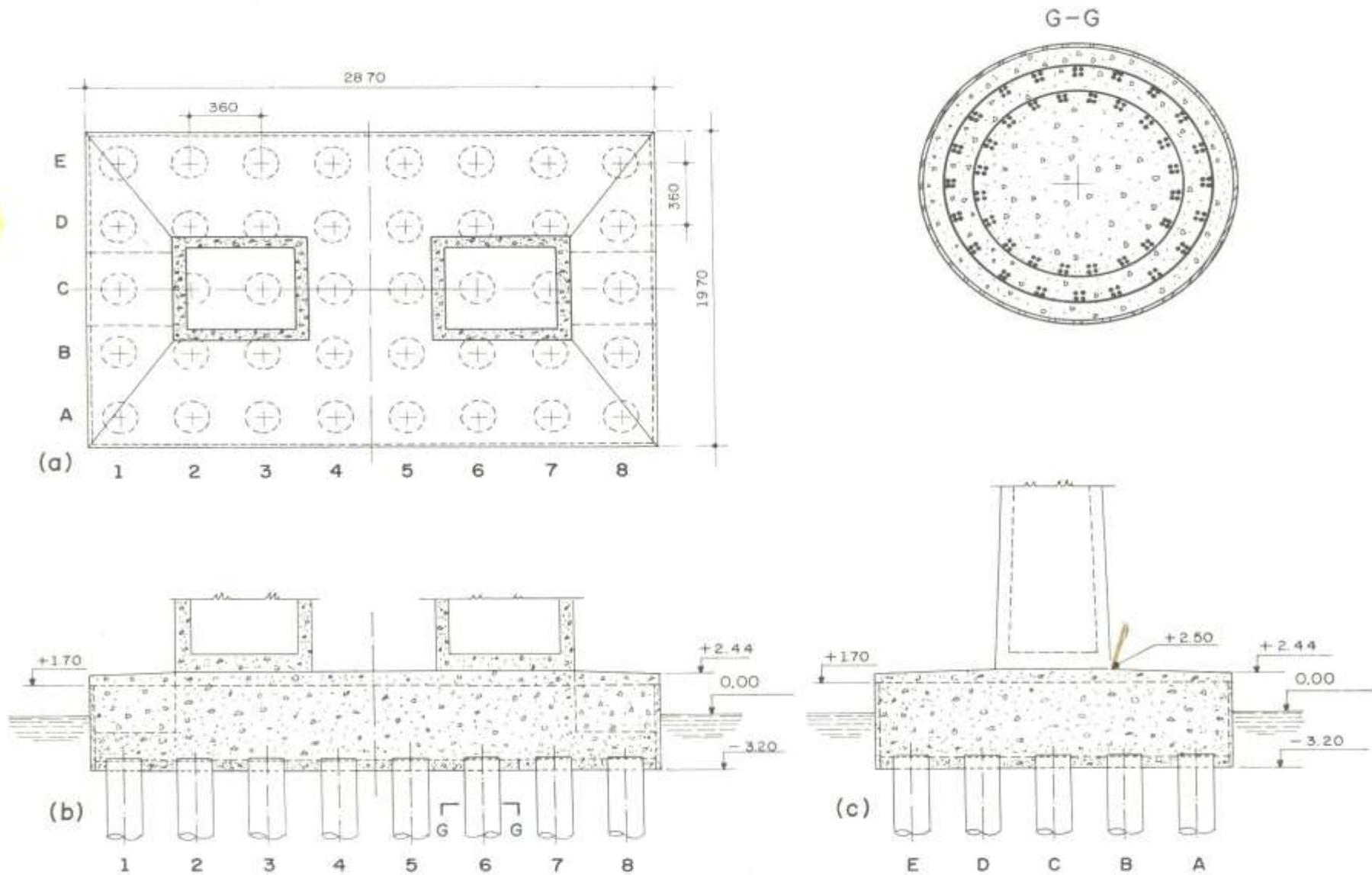
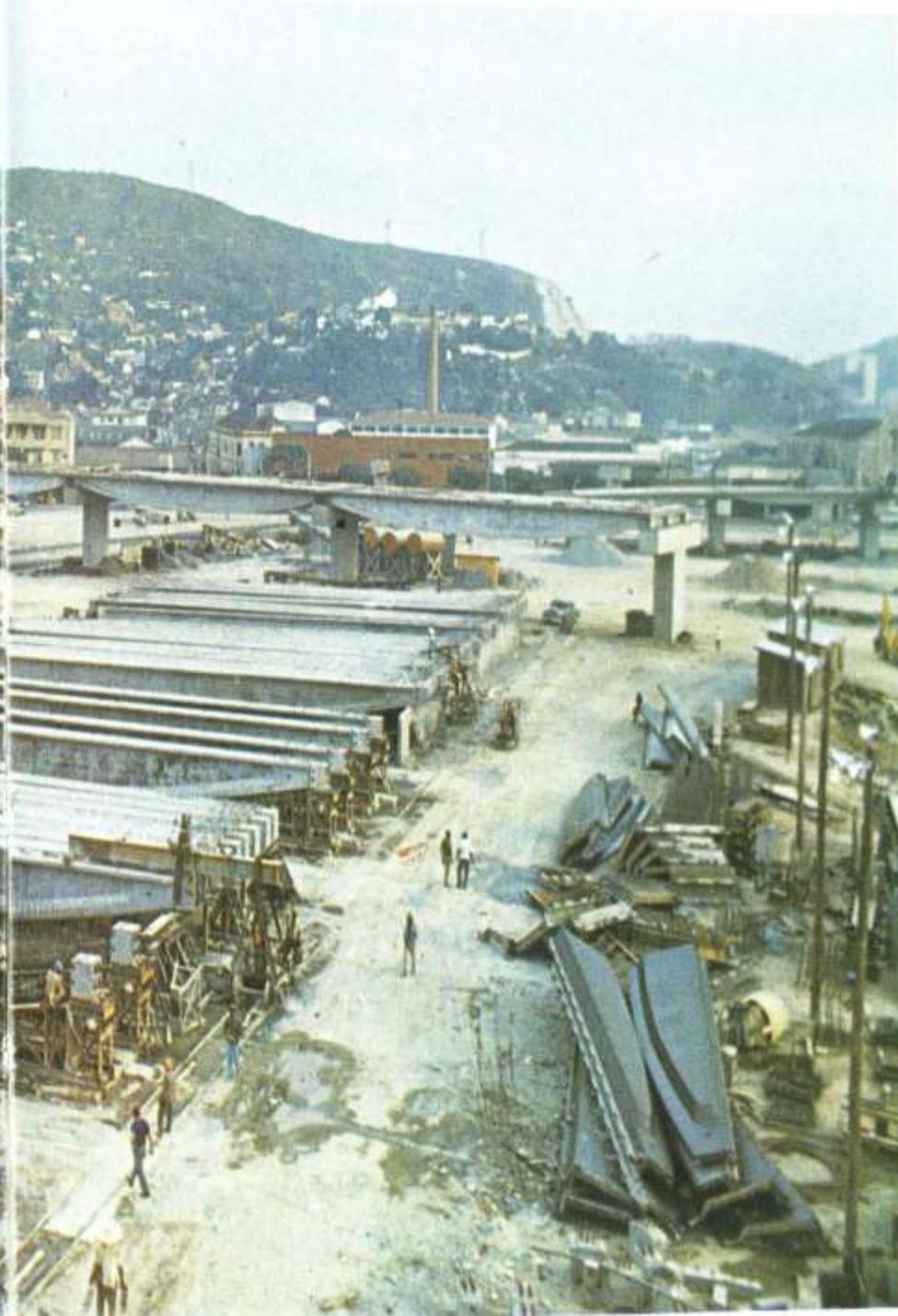


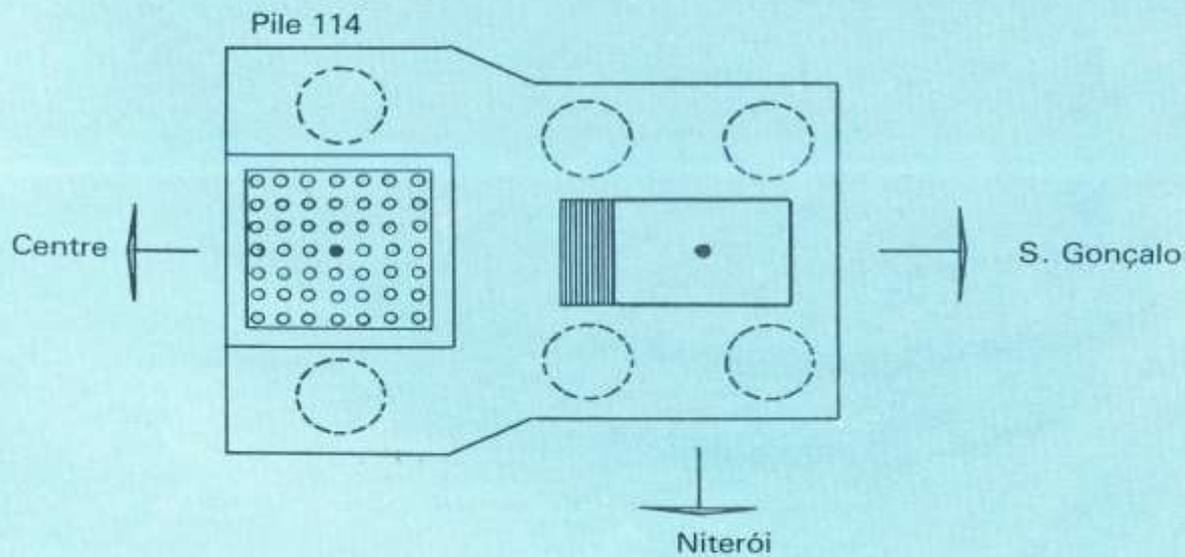
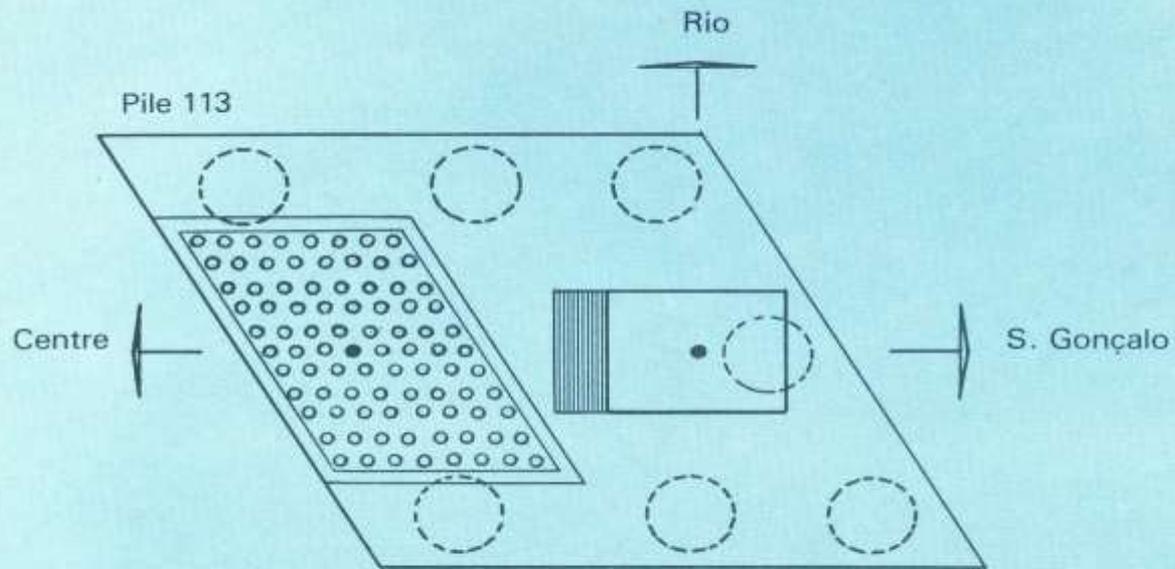
Fig. 4.3. Fundação dos pilares centrais P100, P101. Projeto definitivo em tubulões Bade-Wirth.

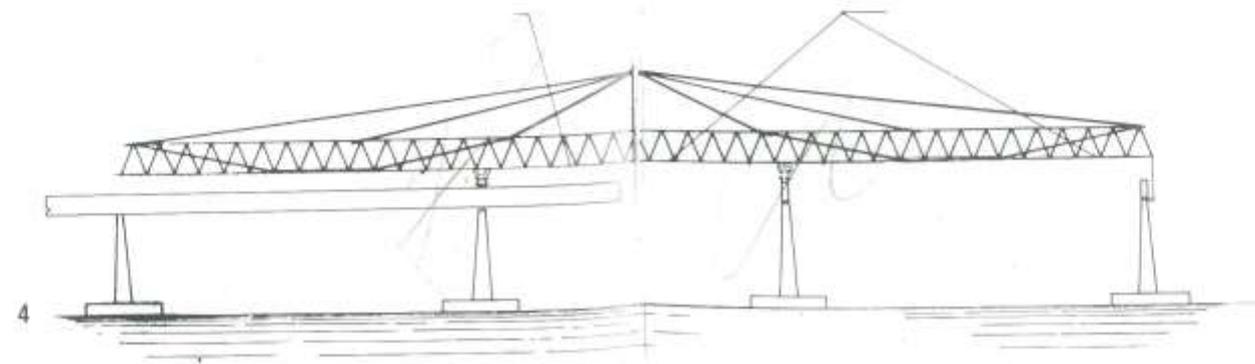
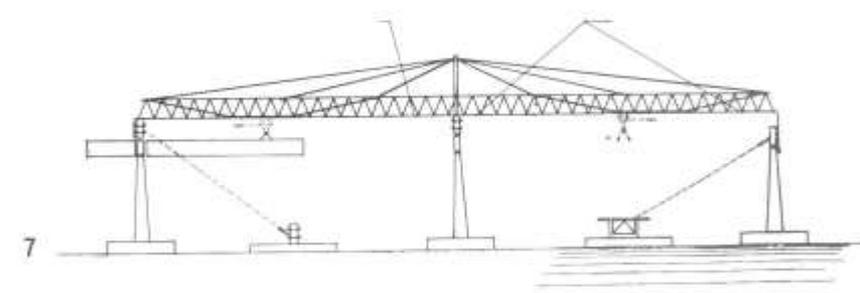
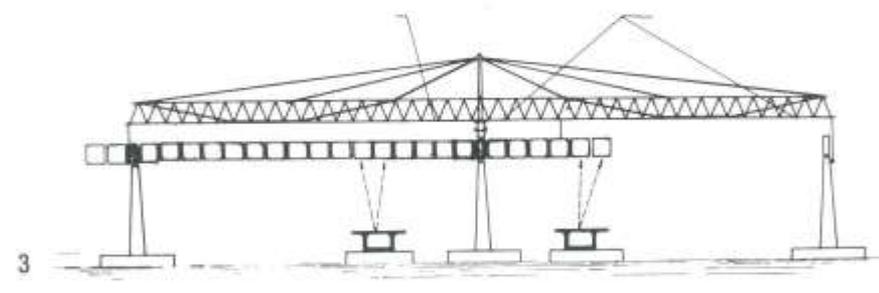
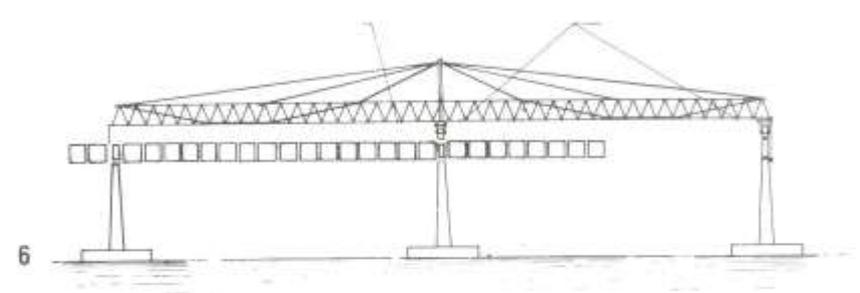
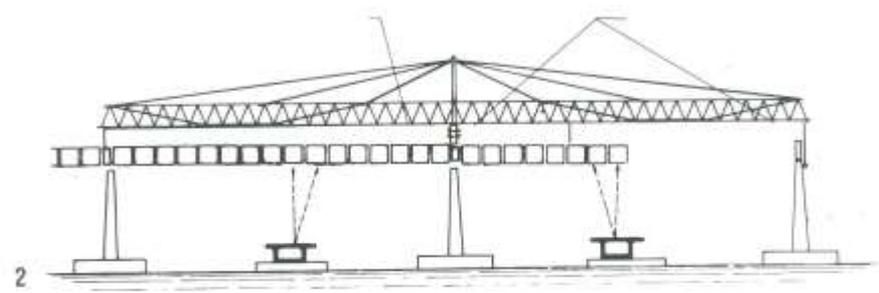
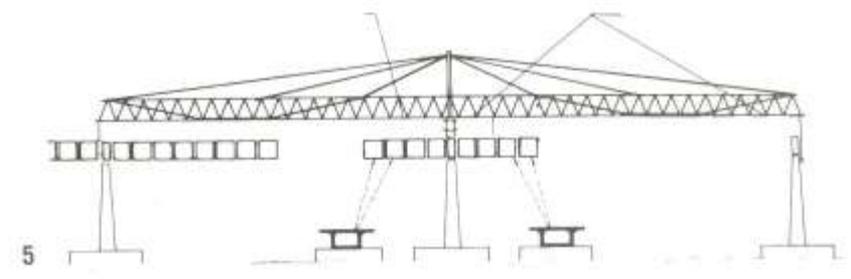
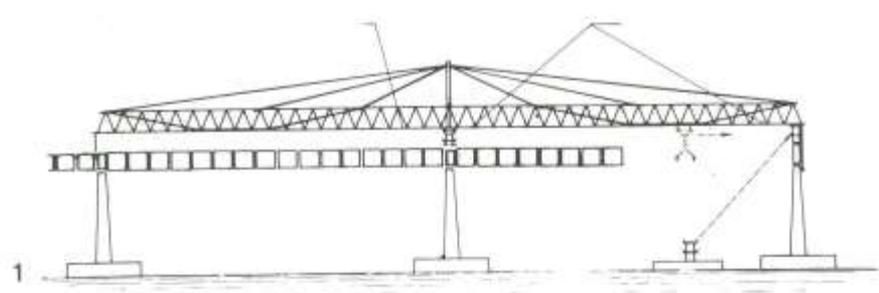




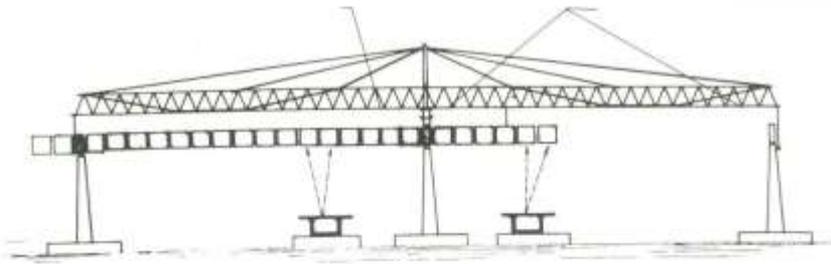




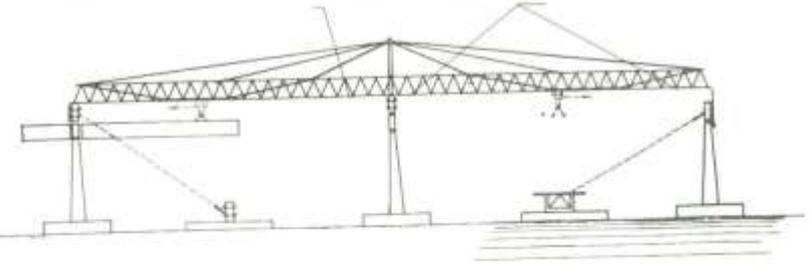




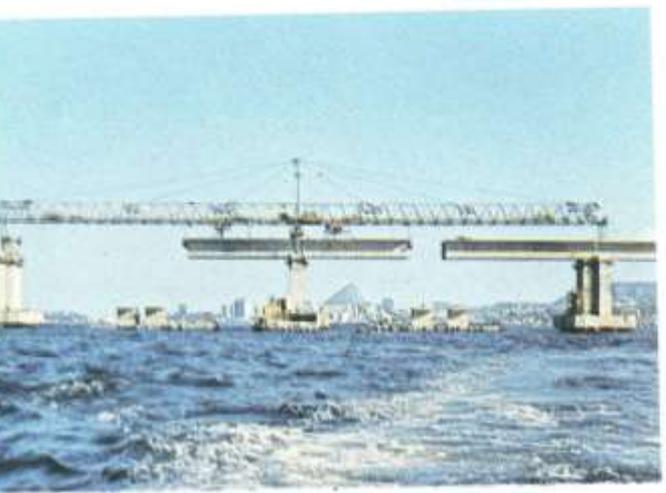
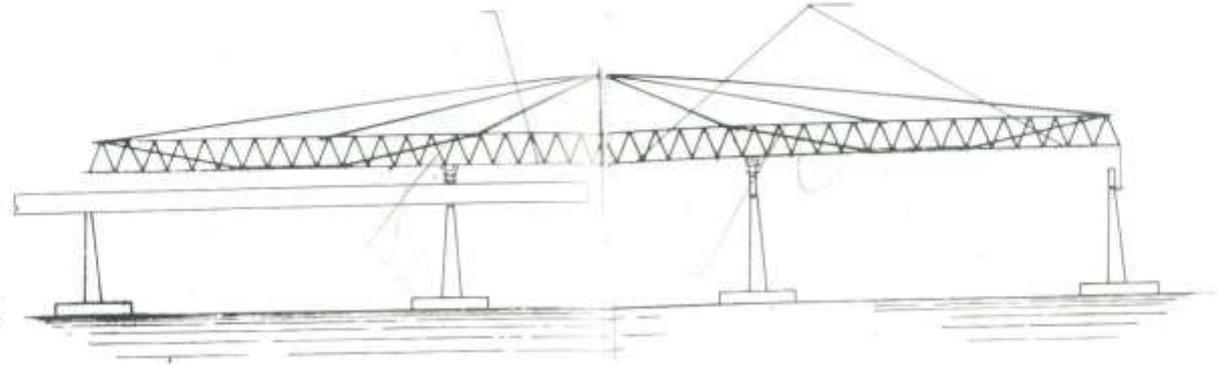
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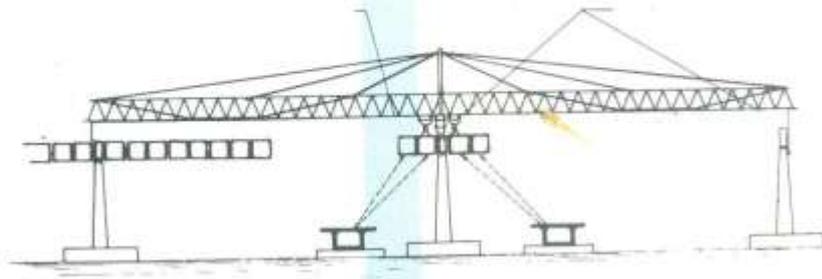


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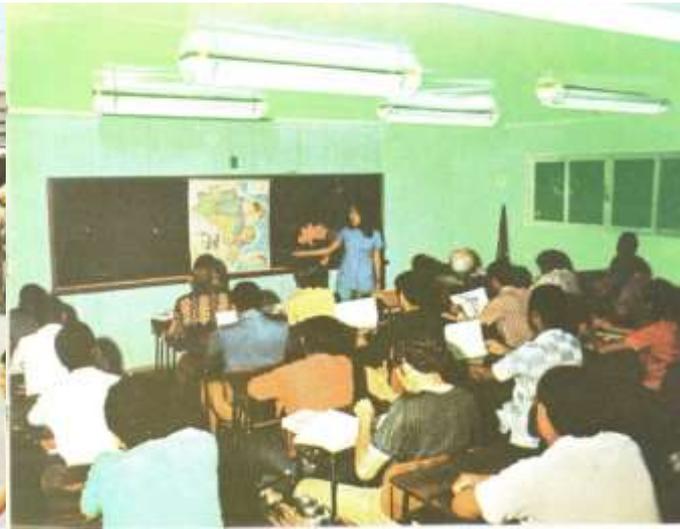
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58 CONGRESSO
BRASILEIRO DO
CONCRETO
BELO HORIZONTE, MG, 11/10 a 14/10, 2016

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