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STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

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STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

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TEC

PAGE 1
PROGRAM: SAP90/FILE: si1.F3F

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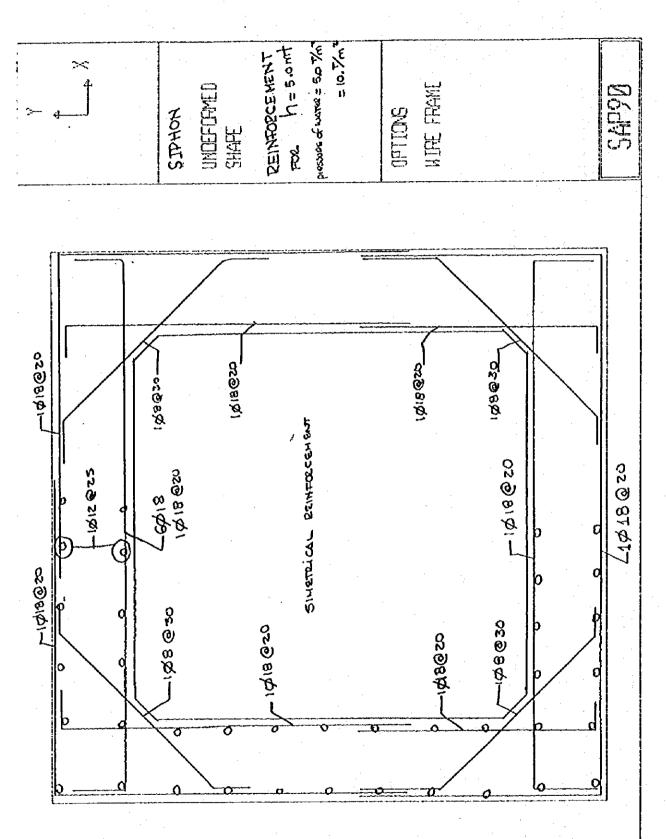
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STRUCTURAL ANALYSIS PROBESTAS

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TRAME ELEMENT FORCES

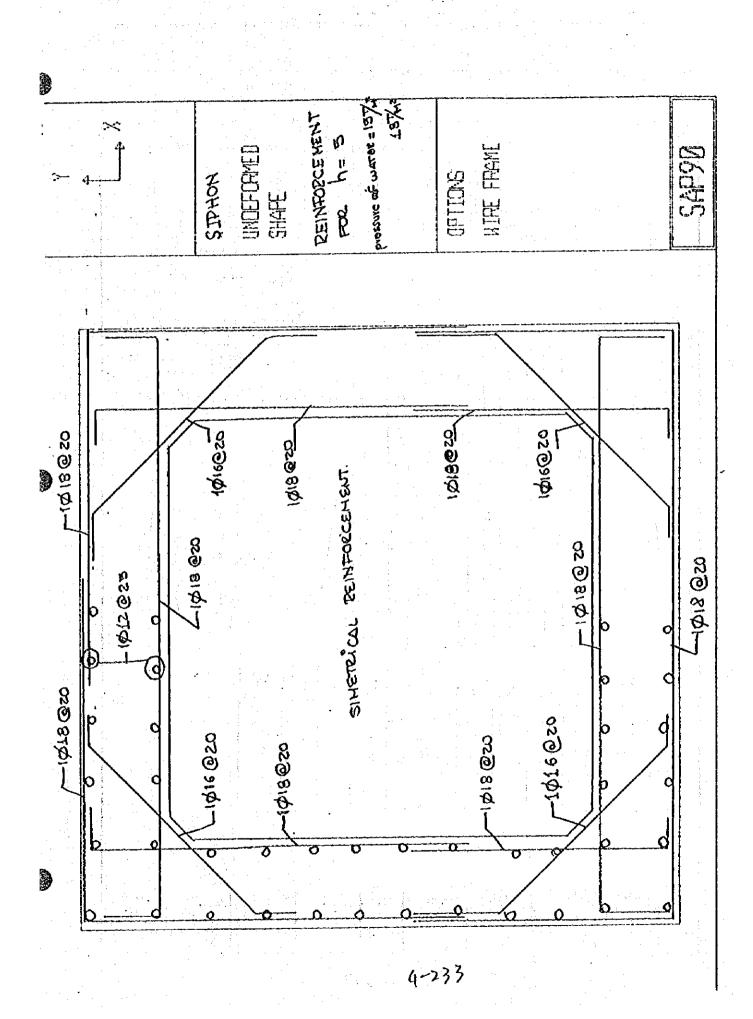
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			. 540 340	56.7725	20.736	49.164			
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			010. 010.	-26,633	~17.693	-33.634			
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			. 000 . 000	. 56.025	28,736	49.164			
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MEMBRILLO DUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO) THE LOAD APPLIED IN THE DESIGN OF CIRCULAR SIPHON WI: LIVE LOAD OF H5-20-44 TRAILER VI: VIERTICAL LOAD OF HARTH WEIGHT AND SALE WEIGHT OF TO! WI: JURICIAL LOAD OF THE UPLIET ACT ON ECITOH SLAB. WI: REACTION LOAD ACT ON ECITOH SLAB WT: LATERAL EARTH PRESURE PW: LATERAL WATER PRESURE P. 1000 DE COLURETE	Calculated by: CEDAR MEDINA S. Calculated por; Shed of Hoja do M R=3.2 ARR AS FOLLOWS:
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DAULE-PERIPA-LA ESPERANZA TRANSDASIN (TRASVASE DAULE PERIPA-LA ESPERANZA)	Calculated by:	-
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$$0.5 \times 3.7 \times 2.4 + 0.9 \times 0.9 \times 2.4 + 0.9 \times 0.5 \times 2.4 = 6.492 + 0.5 \times 2.4 + 6.25 \times 1.8 = 12.45 + 0.00 \times 2.4 + 6.25 \times 1.8 = 12.45 + 0.00 \times 2.4 + 6.25 \times 1.8 = 12.45 + 0.00 \times 2.4 + 0.00$$

 $W_{2} = 0.5 \times 2.4 + 1 \times 0.8 + 1.0 \times 1.0 = 3.0 \text{ T/m}^{2}$ $W_{3} = 1 \times 5.7 = 5.7 + 1/\text{m}^{2}$ $W_{4} = 3.0 + \frac{2 \times 6.492}{3.7} + 5.7 = 12.209$

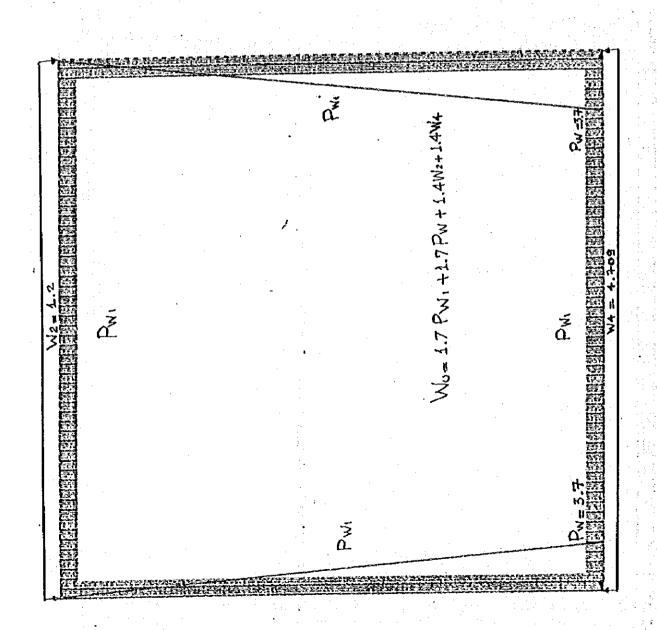
 $WT_{1} = 1 \times 0.8 \times 0.5 + 1 \times 2 = 2.4$ $WT_{2} = 4.7 \times 0.8 \times 0.5 + 1 \times 5.7 = 7.58$

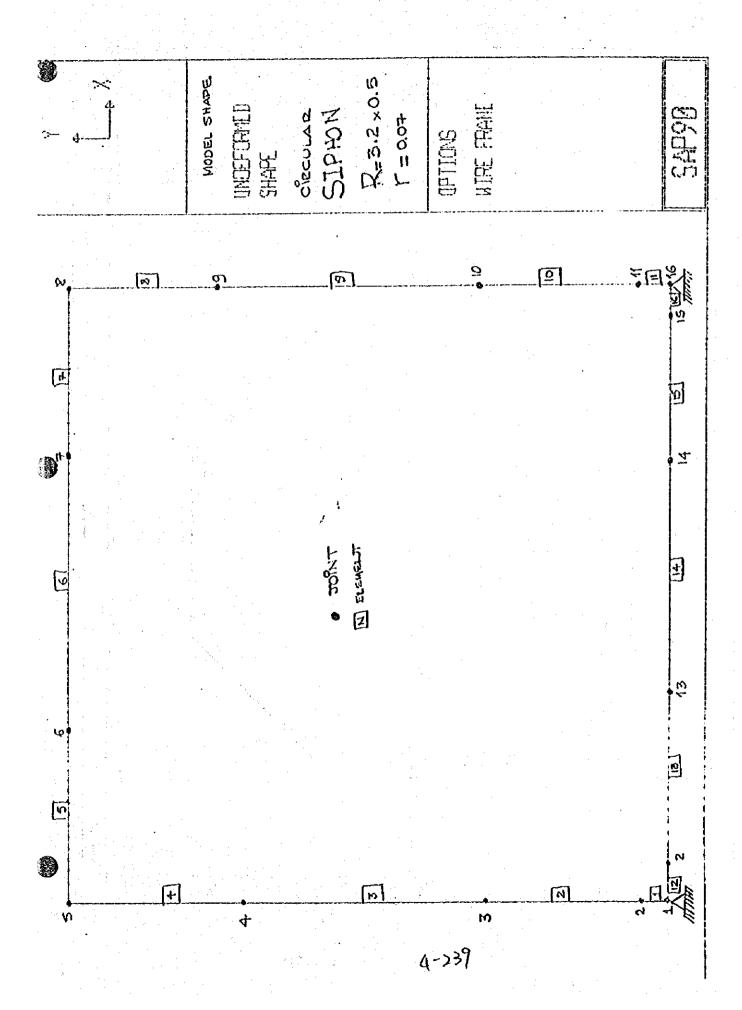
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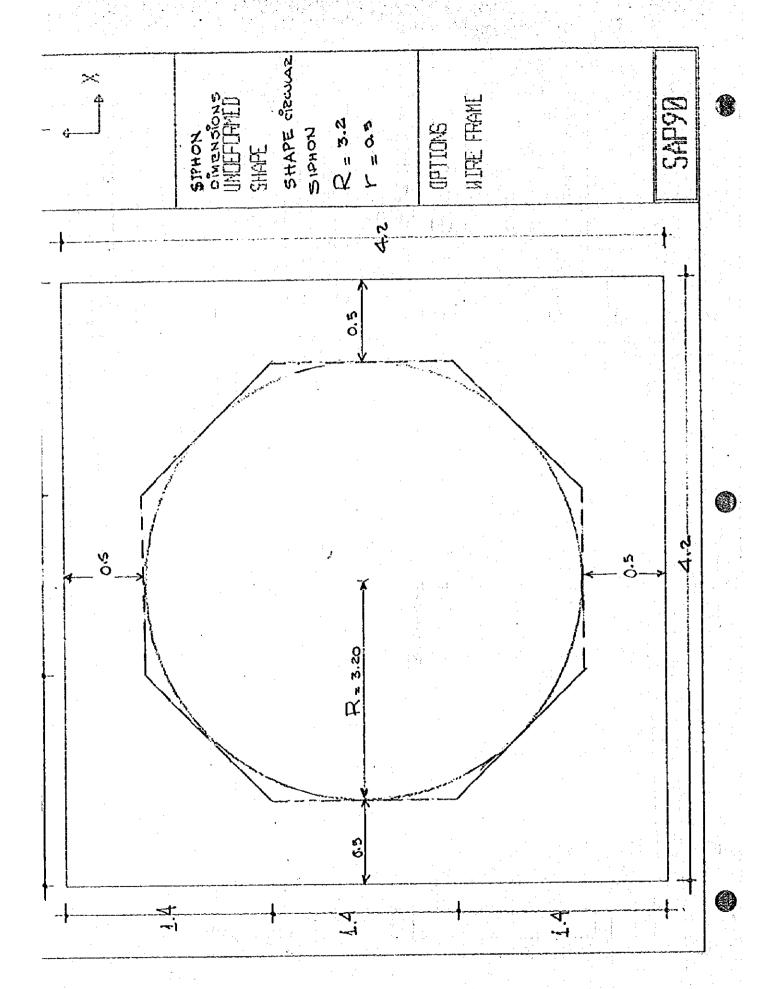
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INTS
                Z=0
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        Y=0.01 Z=0
  X=0
        Y = 1.20
        Y = 2.50
        Y = 3.70
  X=1.2 Y=3.70
  X=2.5 Y=3.70
  X=3.7 Y=3.70
  X=3.7 Y=2.50
  X=3.7 Y=1.20
  x=3.7 Y=.01
         Y=0.
  X=.01
  X=1.20 Y=0.
  X=2.50 Y=0.
  X=3.69 Y=0.
  X=3.7
        Y=0.
STRAINTS
16 1 R=0,0,1,1,1,0
16 15 R=1,1,1,1,1,0
AME
=2 NL=19
                 E=2100000.
SH=R T=1.4,1
SH=R T=.50,1
WL=0,-1.8
                  :w2
WL=0,-1.2

WL=0,5.7
                  :w2
                  :w3
WL=0,7.5
                  :W4
                  : W4
WL=0,4.709
WL=0,48.0
                  :pw1
TRAP=0,-7.580,0,1.19,-5.900
TRAP=0,-5.900,0,1.30,-4.080
TRAP=0,-4.080,0,1.20,-2.400
 TRAP=0, -2.400, 0, 1.20, -4.080
 TRAP=0,-4.080,0,1.30,-5.900
 TRAP=0,-5.900,0,1.19,-7.580
 w1=0,-48.
                 :pw1
 TRAP=0,3.700,0,1.19,2.500
 TRAP=0,2.500,0,1.30,1.200
 TRAP=0,1.200,0,1.20
 TRAP=0,0,0,1.20,1.200
 TRAP=0,1.200,0,1.30,2.500
 TRAP=0,2.500,0,1.19,3.700
                           LP=1,0
     M=1,1,1
     m=1,2,1 NSL=7,0,0,6,14
2 3
3 4
     m=2,2,1 nsl=8,0,0,6,15
4 5
     m=2,1,1 nsl=9,0,0,6,16
     m=1,2,1 NSL=1,2,0,6
5 6
6 7
     M=2,2,1 nsl=1,2,0,6
7
  8
     m=2,1,1 nsl=1,2,0,6
     m=1,2,1 NSL=10,0,0,6,17
8 9
9 10 m=2,2,1 nsl=11,0,0,6,18
 10 11 M=2,1,1 nsl=12,0,0,6,19
 11 16 m=1,1,1
    12 m=1,1,1
 12 13 m=1,2,1 nsl=4,5,3,13
13 14 m=2,2,1 nsl=4,5,3,13
 14 15 m=2,1,1 nsl=4,5,3,13
 15 16 m=1,1,1
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c=1.7,1.4,1.7
c=0,1.4,0,1.7,1.7
FON CIRCULAR h=6
STEM
5
INTS
                Z=0
  X=0
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        Y=0.01 Z=0
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        Y = 1.20
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  X=3.7 Y=3.70
  X=3.7 Y=2.50
  X=3.7 Y=1.20
  x=3.7 Y=.01
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STRAINTS
16 1 R=0,0,1,1,1,0
16 15 R=1,1,1,1,1,0
AME
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                 E=2100000.
SH=R T=1.4,1
SH=R T=.50,1
WL=0,-11.25
                  :w2
                  :w2
WL=0,-1.20
WL=0
                  :w3
                  W 4
WL=0,11.25
                  :w4
WL=0,4.709
WL=0,30.
                  :pw1
TRAP=0,-8.955,0,1.19,-7.875
TRAP=0,-7.875,0,1.30,-6.705
TRAP=0,-6.705,0,1.20,-5.625
 TRAP=0, -5.625, 0, 1.20, -6.705
 TRAP=0,-6.705,0,1.30,-7.875
 TRAP=0,-7.875,0,1.19,-8.955
                 :pw1
 w1=0,-30.
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 TRAP=0,2.500,0,1.30,1.200
 TRAP=0,1.200,0,1.20
 TRAP=0,0,0,1.20,1.200
 TRAP=0,1.200,0,1.30,2.500
 TRAP=0,2.500,0,1.19,3.700
                           LP=1,0
     M=1,1,1
      m=1,2,1 NSL=7,0,0,6,14
2 3
      m=2,2,1 nsl=8,0,0,6,15
3
     m=2,1,1 nsl=9,0,0,6,16
4 5
5 6
      m=1,2,1 NSL=1,2,0,6
  7
      M=2,2,1 nsl=1,2,0,6
6
      m=2,1,1 nsl=1,2,0,6
7
  8
8 9
      m=1,2,1 NSL=10,0,0,6,17
9 10 m=2,2,1 nsl=11,0,0,6,18
        M=2.1.1 nsl=12.0.0.6.19
 10 11
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mbo

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1 12 m=1,1,1

12 13 m=1,2,1 ns1=4,5,3,13

13 14 m=2,2,1 ns1=4,5,3,13

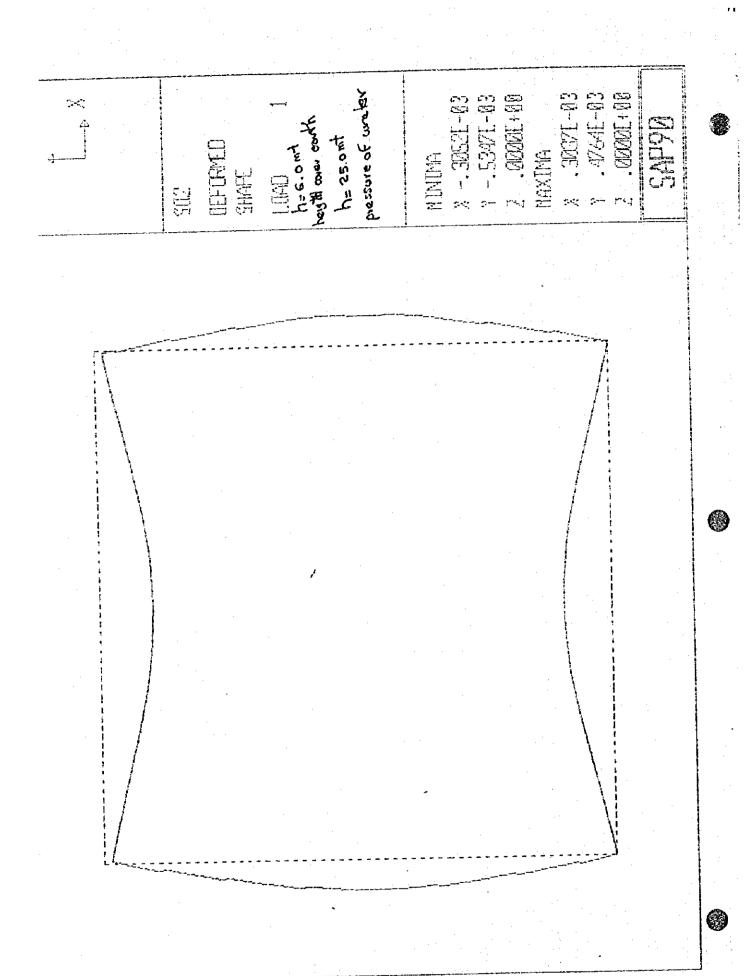
14 15 m=2,1,1 ns1=4,5,3,13

15 16 m=1,1,1

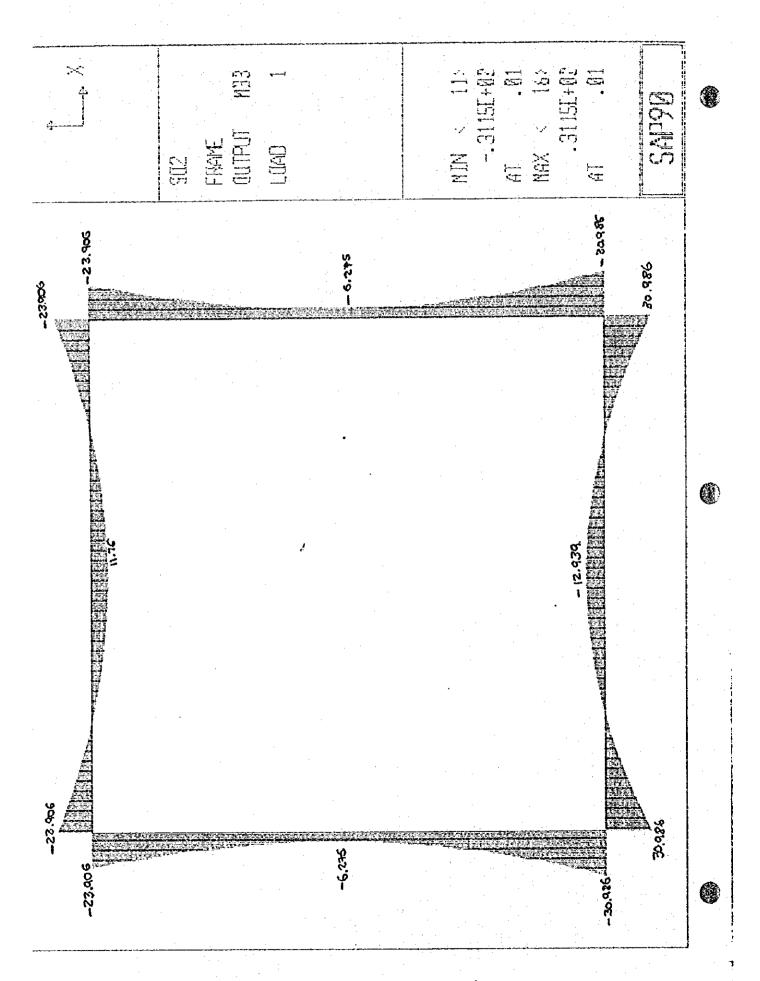
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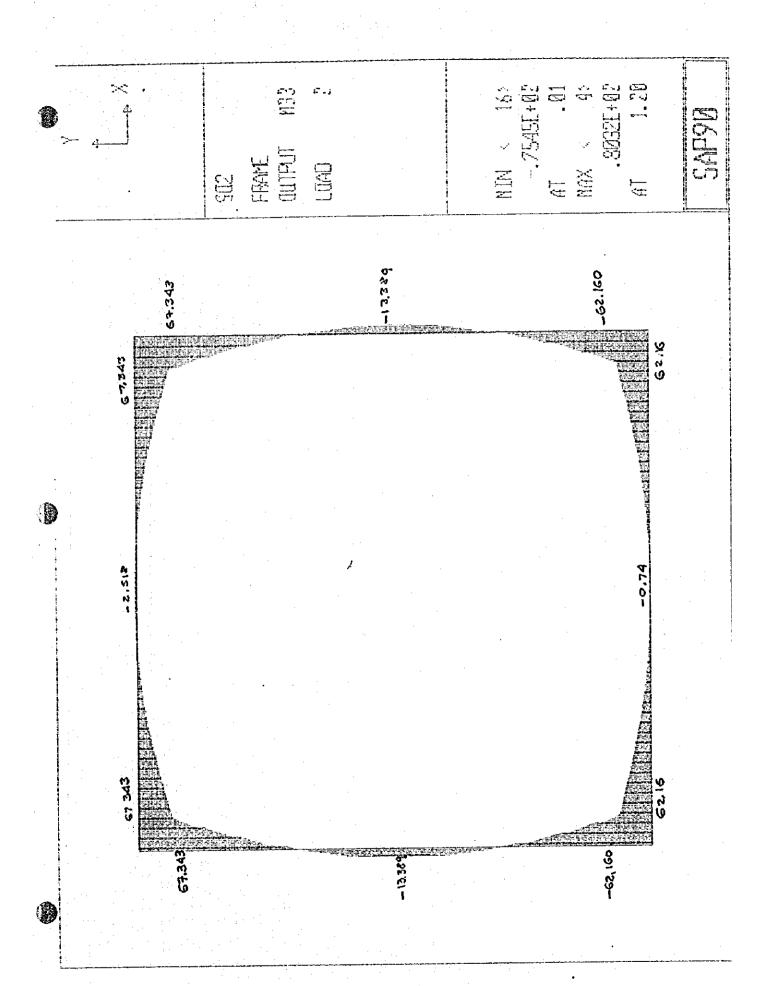
:=1.7,1.4

:=0,1.4,0,1.7,1.7
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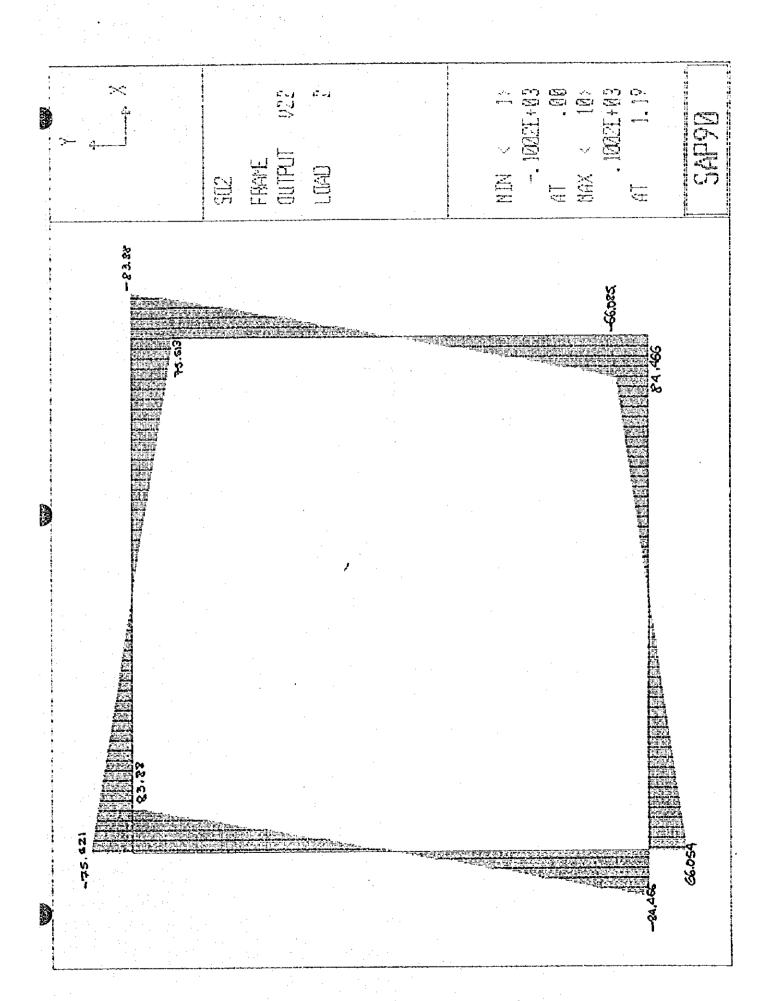


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STRUCTURAL ANALYSIS PROGRASIS

VERSION 5:41

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MOMENT

M= 25 mt pressure of water

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STRUCTURAL AMALYSTS FEGGRAMS

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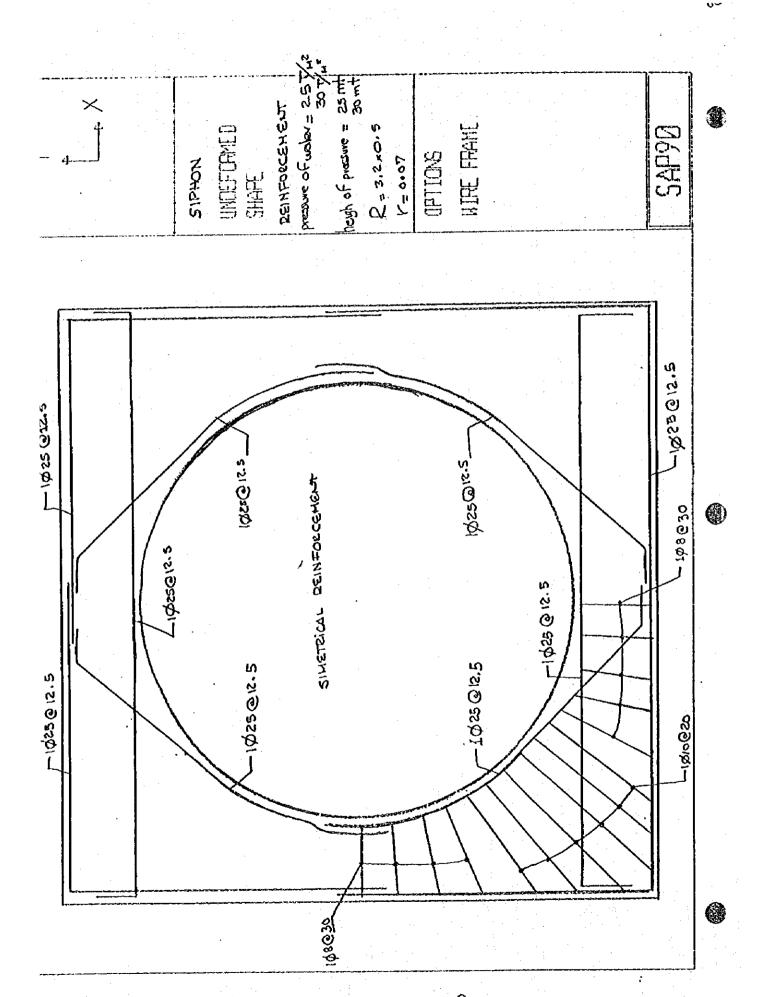
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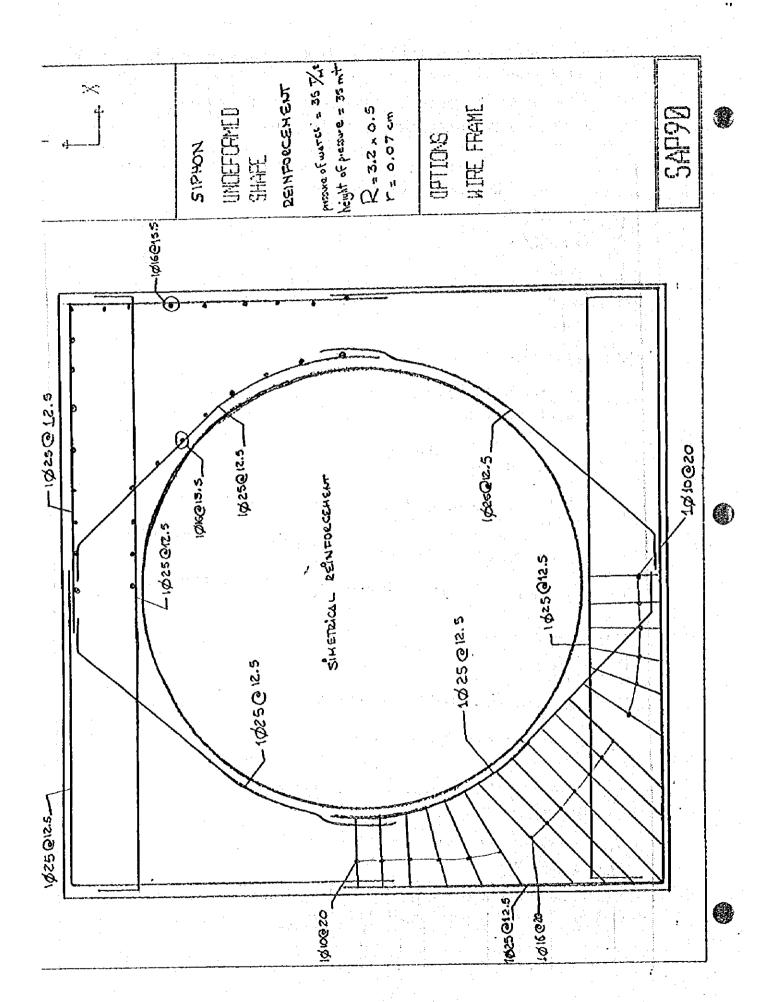
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STRUCTURES, ANALYSIS PROSESS

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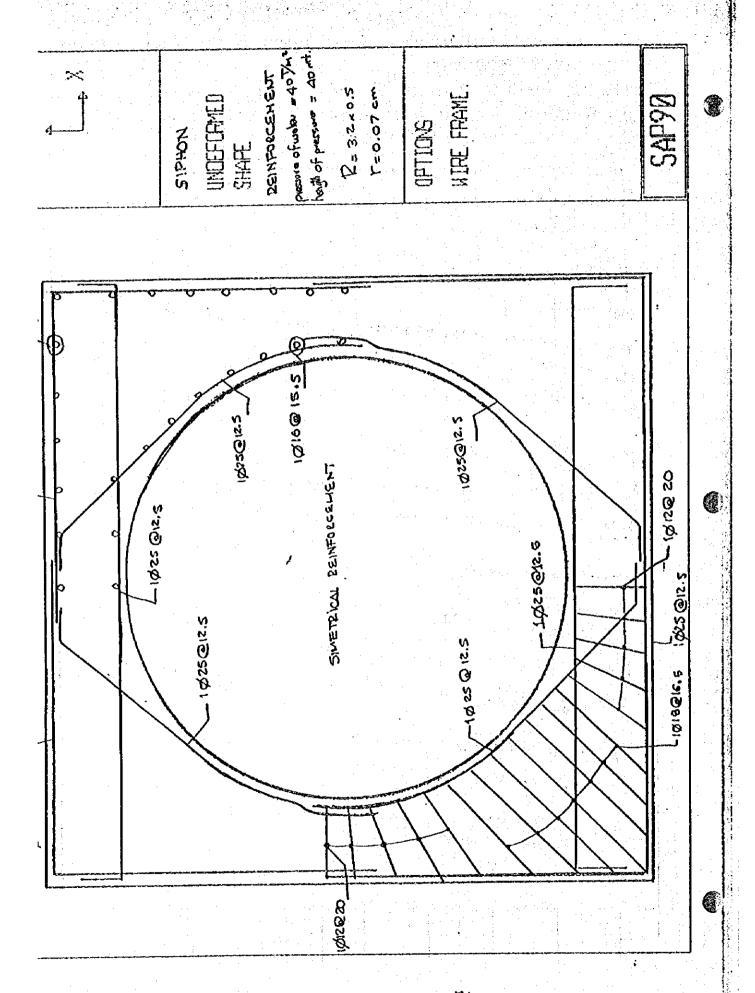
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JICA STUDY TEAM - GRUPO DE ESTUDIOS JICA DAULE-PERIPA-LA ESPERANZA TRANSUASIN (TRASVASE DAULE PERIPA-LA ESPERANZA) Calculated by: Calculado por: CCESS ROAD (CAMIN<mark>O DE ACCESO SA</mark> Sheet has houth ours earth; h=40ml pressure of water - DATA FOR CALCULATION OF THE BEINFORCEHENT 10= 50 Ka/cms fy = 4200 Kg/cm2 b = 100 cm d = 43 cm r = 7.0 cm Atmin = 0.0033x100x43 = 44.33 cm2 => 9026 => 1025@12.5 Mu= 30.986 Mu=101, 856 ton-mt As= 101,856×105 = 20.26 cm2 P= 20.26 = 0001523 < Pmin Ao min = 0.0033x100x133 = 44.89 cm2 => 9025 => 1025 @ 12.5 Astemp= 0.002 x 100 × 140 = 28 cm2/2 FACE => 1016 @15.5 Startor - shear smess check. Vu= 131.589 Kg Vc = 86.827.25 kg < Vu V5 = 113589 - 86.827.25 = 44 762.25 Kg. Av = 44.762.25 = 17.73 cm2 =7 7 Ø 18 => 1 Ø 18 @ 16.5 Vc= 0,85 x0,53 / 210 x 100 x 43 = 28.071,97 V5= 45.130-28.071.97= 17.058.03 Av= 17.058.03 = 6.75 cm2 => 1012@20 thecked by Revision Approtectly: Date (Fector) Approved by: Checked by. Unie (fecha) Doie (fecha) Dale (Feclu) Arrobalt me Antecado por:



CHARGOTORÁL ARALYSTO PROCNAM.

VERSION SLAX

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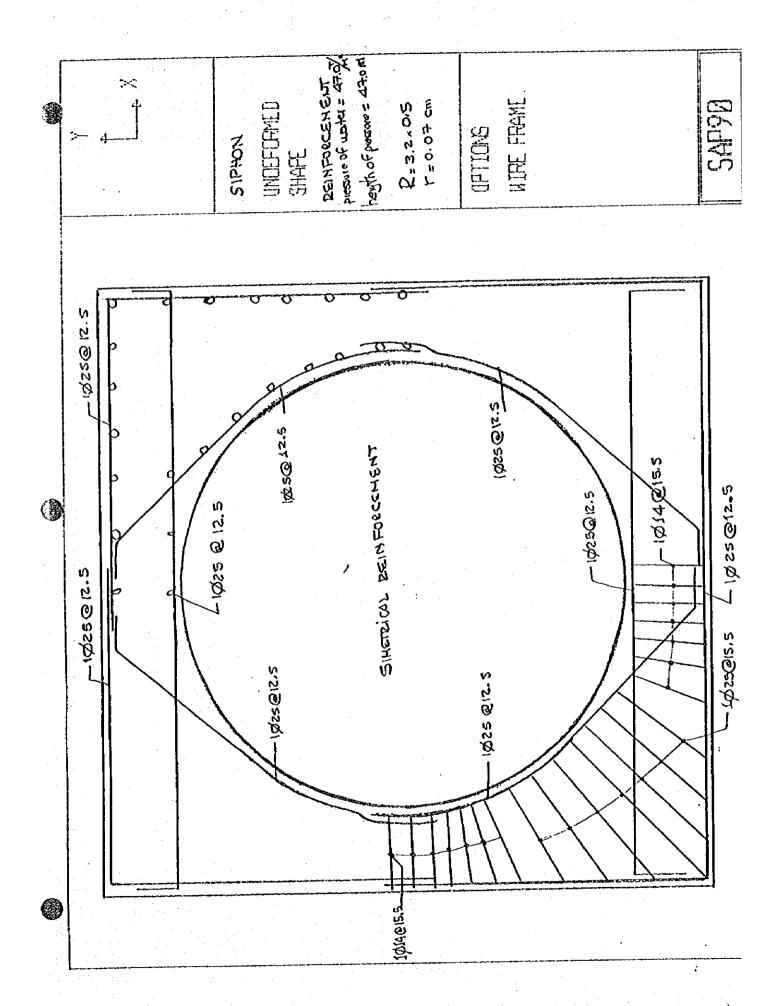
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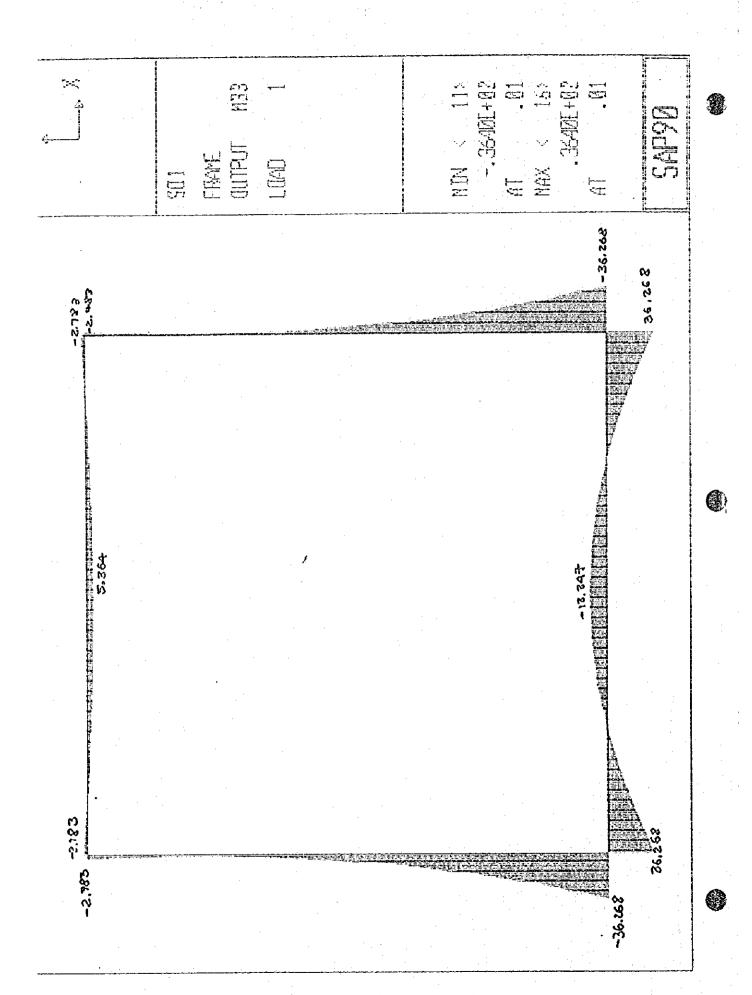
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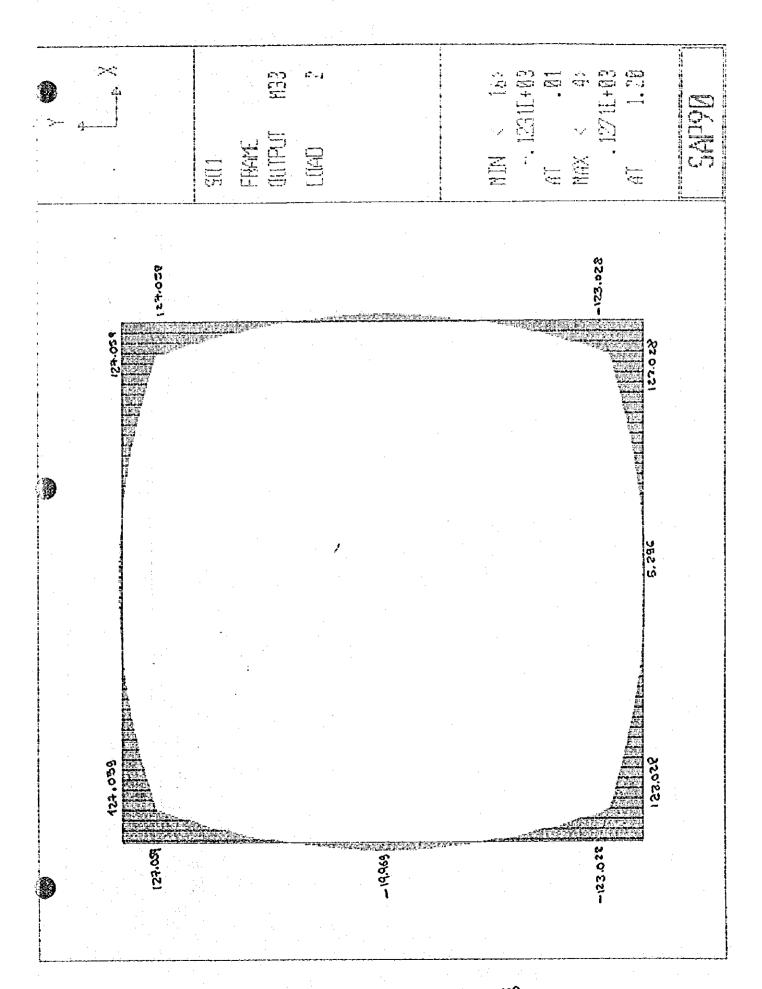
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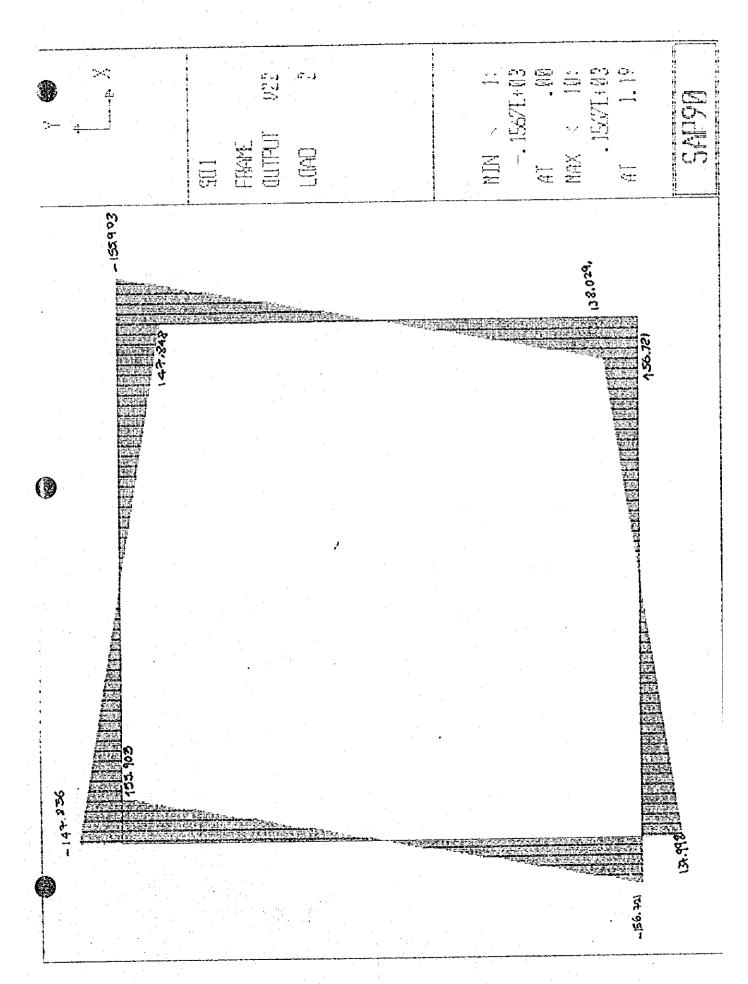
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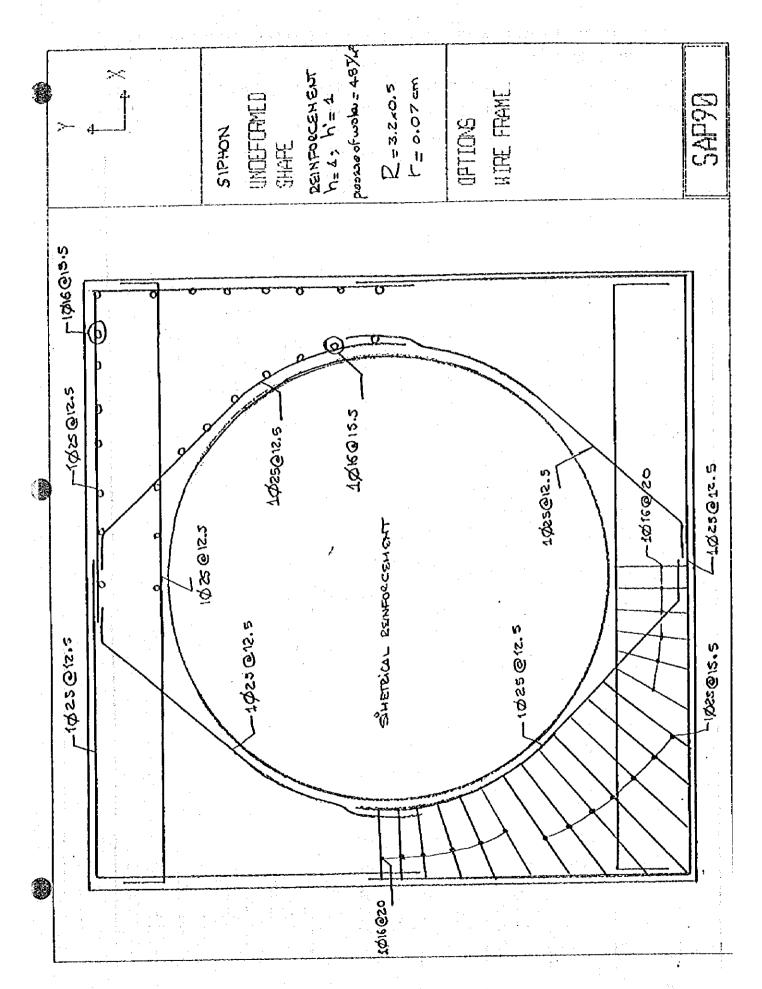
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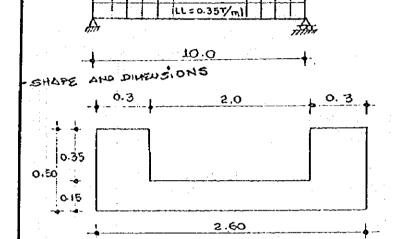
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DAULE-PERIPA-LA ESPERANZA TRANSDASIN (TRASVASE DAULE PERIPA-LA ESPERANZA)	Calculated by:		1.		
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f'c = 210 kg/cm2 fy = 4200 Kg/cm2 b = 30 cm

LD = 0.3 x 0.5 x 2.4 + 0.15 x 1 x 2.4 = 0.72 Tm2

LL = 0.35 7/m2

Wu= 1.4x 0.72+1.7x 0.35 = 1.603 7/m1

 $M_U = \frac{1.603 \times 10.0}{8} = 20.04 \text{ ton-mt}$

Mu= WL

 $V_0 = \frac{1.603 \times 10}{2} = 8.02 \text{ ton}$

Vu = WuxL

$$A_5 = \frac{20.04 \times 10^5}{0.9 \times 4200 \left(46 - \frac{4}{2}\right)} = 12.05 \text{ cm}^2$$

$$\vec{a} = \frac{12.05 \times 4200}{0.85 \times 210 \times 30} = 9.45 \text{ cm}$$

$$A_5 = \frac{20.04 \times 10^5}{0.9.4200 \left(46 - \frac{9}{2}\right)} = 12.77 \text{ cm}^2 = 50.18$$

Asmin = 0.0033 x 30 x 46 = 4.55 cm² = 30 14

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JAPAN INTERNATIONAL COOPERATION AGENCY - AGENCIA INTERNACIONAL DE COOPERACION DEL JAPON

MCA STUDY TEAM - GROTO DE ESTUDIOS RICA

DAULE-TERIFA-LA ESPERANZA TRANSUASIN (TRASVASE DAULE TERIPA-LA ESPERANZA)

MEMBRILLO OUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO)

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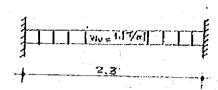
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DATA

$$F_{0}=210 \text{ Kg/cm}^{2}$$
 $F_{y}=4200 \text{ Kg/cm}^{2}$
 $b=100$
 $d=2.5$
 $r=2.5$

$$L = 2.3 \text{ m}^{\frac{1}{2}}$$

 $LD = 0.15 \times 2.4 \times 1 = 0.36 \text{ T/m}^{2}$
 $LI = 0.35 \text{ T/m}^{2}$

$$W_0 = 1.4 \times 0.36 + 1.7 \times 0.35 = 1.10 \text{ T/m}^2$$

$$M(-) = \frac{1.1 \times \overline{2.3}^2}{12} = 0.48 \text{ ton-mt}$$

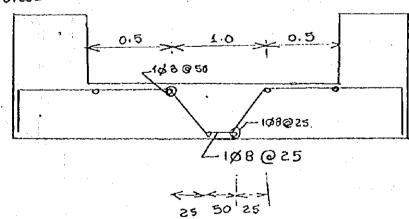
$$M(+) = \frac{1.1 \times \overline{2.3}^2}{24} = 0.24 \text{ km-mt}$$

$$A_0 = \frac{0.48 \cdot 10^5}{0.9.4200 \left(12.5 - \frac{2}{3}\right)} = 1.13 \text{ cm}^2$$

$$A_{5} = \frac{0.24 \times 10^{5}}{0.9 \times 4200 (12.5 - \frac{2.5}{2})} = 0.57 \text{ cm}^{2}$$

$$P = \frac{0.57}{100 \times 12.5} = 0.0004 \ \text{C Prin}$$

Prin = 0.002 As = 0.002 × 100 × 15.0 = 3.0 cm 2 face 408 => 108 @ 50



j	***	Checked by Revisado por	Approved by: Aprobada por:	Dale (Fesha)		Checked by: Revisado por	 	Date (Feelio) Applications:
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Feelsa; DAULE-PERIMA-LA ESPERANZA TRANSUASIN (TRASVASE DAULE PERIMA-LA ESPERANZA Calculated by: Calculado por: MEMBRILLO OUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO) Sheet Iloja FOR BEAH DETAIL OF BEINFORCEHELT 108@15 100 30 3014 2018 3018 0 Ø14 Ø ø 18 50 18 0 8 0 20 SECTION X-X STRESS SHEAR CHECK PPE \$50 mm Vu = 8.02 - pu 40 Vc = 0.85 x0.53 /210 × 30 × 46 = 9.009.14 kg. 00 NO REQUIRED STICKUPS BULLANCA 20 0408 50 SECTION Y-Y Approved by: Checked by: Checked by Dale (Fecha) Approved by: Date (Fecha) Revision Dale ((ccha) Unie (Fecha) Revisado por Αρκοδούο por Arrobakiran

JAPAN INTERNATIONAL COOPERATION AGENCY - AGENCIA INTERNACIONAL DE COOPERACION DEL JAPON

5. Tunnels

5. TUNNELS

5.1 Hydraulic Calculation of Diversion Tunnels

(1) Genaral

The route of the diversion tunnel was determined so as to be shortest length between the inlet and the outlet. Several curves were provided in the route to obtain sufficient covering depth from the ground surface. A diameter for each tunnel was determined from the results of technical and economical studies.

A standard horse-shoe section was adopted to the tunnels to make stable flow in the tunnels. The maximum discharge water flows in the tunnel under the conditions of an open flee flow and its flow depth is 80 % of the tunnel diameter. It was determined from the hydraulic characteristic curve in the tunnel. The invert gradient for each tunnel was designed so as to keep the open free flow condition.

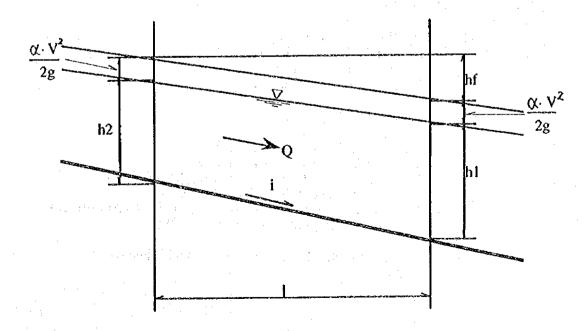
(2) Daule Peripa ~ La Esperanza Diversion Tunnel

The Daule Peripa ~ La Esperanza diversion tunnel is non pressure tunnel of 8.3 km long having a diameter of 3.7 m in horse-shoe shaped section and its gradient is 1:1,500. The maximum required discharge is 18.0 m³/sec.

Water level for the variable dischage in the inlet shaft (between valve pit and tunnel inlet) is obtained from the non-uniform flow calculation in the tunnel under the condition that water level at the tunnel outlet is El.63.5 (Target water level). The non uniform flow calculation is made according to the following equation.

$$\phi = h_i - i \cdot l + \frac{\alpha \cdot Q^2}{2 \cdot g \cdot A_i^2} + \frac{n^2 \cdot l \cdot Q^2}{2 \cdot R^{4/3} \cdot A_i^2}$$

$$\psi = h_z + \frac{\alpha \cdot Q^2}{2 \cdot g \cdot A_z^2} - \frac{n^2 \cdot l \cdot Q^2}{2 \cdot R^{4/3} \cdot A_z^2}$$



where, Q: discharge (m3/sec)

i : gradient of tunnel invert

 $\alpha:1.1$

n: roughness coefficient (0.015)

g: acceleration of gravity (9.8 n/sec2)

The calculation results are shown in the attached table and figure.

(3) La Esperanza ~ Poza Honda Diversion Tunnel

The La Esperanza ~ Poza Honda diversion tunnel is non pressure tunnel of 11.4 km long having a diameter of 3.5 m in horse-shoe shaped section and its gradient is 1:1,500. The maximum required discharge in the tunnel is 16 m³/sec.

Water level for the maximum discharge at the connection part with the open channel is obtained from the non-uniform flow calculation in the tunnel and inlet culvert under the condition that water level at the tunnel outlet is El.102.5 m (Target water level). The non uniform flow calculation is made using aforementioned equation.

The calculation result is shown in the attached table.

(4) Poza Honda ~ Mancha Grande Diversion Tunnel

The Poza Honda \sim Mancha Grande diversion tunnel is also non pressure tunnel of 4.1 km long having a diameter of 2.5 m in horse-shoe shaped section and its gradient is 1:3,900. The maximum required discharge is 4.0 m³/sec.

Water level for the variable dischage in the inlet shaft (between valve pit and tunnel inlet) is obtained from the uniform flow calculation in the tunnel and the calculation of the inlet loss of the tunnel. The calculation is made according to the following Manning's formula.

$$V = 1/n \cdot R^{2/3} \cdot I^{1/2}$$

where, V: flow velocity (m³/sec)

n: roughness coefficient (0.015)

R: hydraulic radius (m)

I : gradient of tunnel invert

 $WL = TIL + D + fe \cdot (V^2/2 \cdot g)$

where, WL : water level in the inlet shaft (m)

TIL: invert level at the tunnel inlet (m)

D: water flow depth in the tunnel inlet (m)

fe : coefficient of the entrance loss (0.2)

V : mean flow velocity in the tunnel transition part (m/sec)

g : acceleration of gravity (9.8 n/sec²)

The calculation results are shown in the attached table and figure.

Non-uniform Flow Calculation of Daule Peripa ~ La Esperanza Diversion Tunnel

(Q = 18 m3/s Station No.	Distance	Accum. dis.	Bottom El.	Water Depth	Flow area	Flow velocity	Water Level
	(m)	from outlet (m)	(m)	h (m)	(m2)	(m/sec)	(m) .
Outlet channel	0	0	60.500	3.000	15,600	1.154	
E.P. of tunnel	0	0	60.500	3.013	10.845	1.660	63.51
+10.0m	10	10	60.507	2,981	9.886	1.821	63.48
1	990	1000	61,167	2,950	9.792	1.838	64.11
2	1000	2000	61.833	2,929	9.731	1.850	64.76
3	1000		62.500	2,917	9.693	1.857	65.41
4	1000		63.167	2,909	9.670	1.862	66.07
5	1000		63.833	2.904	9.655	1.864	66.73
6	1000	1	64.500	2.901	9.617	1.866	67.40
7	1000		65.167	2.900	9.642	1.867	68.06
8	1000		65.833	2.899	9.638	1.868	
8+285.83m	285.83	8285.83	66.024	2.898	9.638	1.868	68.92
8+295.83m	10		66.031	2.940	10.877	1.655	68.97
Inlet	0			2.972		0.000	69.00

Station No.	Distance	Accum. dis.	Bottom El.	Water Depth	Flow area	Flow velocity	Water Level
	(m)	from outlet (m)	(m)	h (m)	(m2)	(m/sec)	(m)
Outlet channel	0	0	60.500	3.000	15.600	0.897	63.500
E.P. of tunnel	0	0	60.500	3.008	10.830	1.293	63.50
+10,0m	10	10	60.507	2.987	9.901	1.414	
1	990	1000	61.167	2.721	9.076	1.543	63.88
2	1000	2000	61.833	2.537	8.459	1.655	
3	1000	3000	62.500	2.432	8.096	1.729	64.93
4	1000	4000	63.167	2.381	7.913	1.769	
5	1000	5000	63.833	2,359	7.836	1.787	66.19
6	1000	6000	64.500	2.350	7.805	1,794	66.85
7	1000	7000	65.167	2.347	7,794	1.796	67.51
8	1000	8000	65.833	2.346	7.790	1.797	68.17
8+285.83m	285.83		66.024	2.346	7.789	1.797	68.37
8+295,83m	10			2,385	8.824	1.587	68.41
Inlet	0					0.000	68.44

Q = 10 m3/s		· · · · · · · · · · · · · · · · · · ·	Davan Di	Water Depth	Flow area	Flow velocity	Water Level
Station No.	Distance	Accum. dis.			· ·	,	
	(m)	from outlet (m)	(m)	h (m)	(m2)	(m/sec)	(m)
Outlet channel	0	0	60.500	3.000	15,600		63.500
E.P. of tunnel	0	0	60,500	3.004	10.819	0.924	63.504
+10.0m	10	10	60.507	2.990	9.911	1.009	
1	990	1000	61.167	2.538	8,465	1,181	63.705
2	1000	2000	61.833	2.185	7.209	1.387	64.018
3	1000	3000	62.500	1.975	6.439	1,553	
4	1000	4000	63,167	1.888	6.117	1.634	65.055
5	1000	+	63.833	1,865	6.033	1.658	65.698
6	1000	6000	64.500	1.859	6.011	1.664	66.359
7	1000	7000	65.167	1.858	6.005	1.665	67.025
8	1000		65.833	1.857	6.001	1.666	67.690
8+285.83m	285.83		66.024	1.857	6.004	1.666	67.881
8+295,83m	10	f	66.031	1.898	7.023	1.424	67.929
Inlet	0	1	66.031	1.922		0.000	67.953

$\frac{(Q = 7.5 \text{ m}3/}{\text{Station No.}}$	Distance	Accum, dis.	Bottom El.	Water Depth	Flow area		Water Level
	(m)	from outlet (m)	(m)	h (m)	(m2)	(m/sec)	(m)
Outlet channel	<u></u>	0	60,500	3.000			63.50
E.P. of tunnel	0	0	60.500	3.002			
+10.0m	10	10	60.507	2.992			
1	990	1000	61.167	2.451	8.161	0.919	
	1000	2000	61.833	1.994		~	
3	1000		62.500	1,693	5,397	1.390	
4	1000		63.167	1.570	4,942		
5	1000		63.833	1.547	4.853	1.545	65.38
	1000	 	64.500	1.544	4.845		
7	1000			1.544	4.845	1.548	
<u> </u>	1000			1.544	4.845	1.548	67.37
8+285.83m	285.83			1.544	4.845	1.548	67.56
8+295.83m	10				5.868	1.278	67.61
Inlet			1	1.606	,	0.000	67.63

met	l	0275.00		1.1			
(Q = 5.0 m3/	sec)	•					
Station No.	Distance	Accum. dis.	Bottom El.	Water Depth	Flow area	Flow velocity	Water Level
* · · · · · · · · · · · · · · · · · · ·	(m)	from outlet (m)	(m)	h (m)	(m2)	(m/sec)	(m)
Outlet channel	0	0	60.500	3.000			63.500
E.P. of tunnel	0	0	60.500	3.001			
+10.0m	10	10	60.507	2.993			
1	990	1000	61.167	2,386	7.934		
	1000	2000	61.833	1.824	5.881		
	1000	3000	62.500	1,404	4.322	1.157	
4	1000		63.167	1.237	3,699		
4	1000		63.833	1.212	3.607	1.386	
	1000	·	64.500	1.215	3.615	1.383	
	1000		65.167	1,214	3.614	1.384	
	1000			 	3.614	1.384	67.04
8+285.83m	285.83		66.024	1,214	3.614	1.384	67.23
8+295.83m	10			1.255	4.645	1.076	
Inlet	1	8295.83		·)	0.000	67.30
		, L					

Q = 2.5 m3/ Station No.	Distance	Accum, dis.	Bottom El.	Water Depth	Flow area	Flow velocity	Water Level
	(m)	from outlet (m)	(m)	h (m)	(m2)	(m/sec)	(m)
Outlet channel	0	0	60.500	3.000	15.600	0.160	
E.P. of tunnel	0	0	60.500	3,000	10.808	0.231	63.500
+10.0m	10	10	60.507	2.993	9.920		
1	990	1000	61.167	2.347	7.793	0.321	63.514
	1000	2000	61.833	1,709	5.455	0.458	
3	1000		62.500	1.139	3.329	0.751	63.639
4	1000	4000	63.167	0.860	2.269	1.102	64.027
	1000		63.833	0.848	2.224	1.124	64.681
	1000				2.240	1.116	65.352
<u>~</u>	1000				2.234	1.119	66.018
	1000		· · · · · · · · · · · · · · · · · · ·			1.118	66.684
8+285.83m	275.83					1.118	66.875
8+295.83m	10		·		3.281	0,762	66.918
Inlet	1 0					0.000	66.927

Non-uniform Flow Calculation of La Esperanza-Poza Honda Diversion Tunnel

(Q=16 m3/sec)

(Q=16 m3/se)	¢)				· · · · · · · · · · · · · · · · · · ·		
Sec. No.	Distance	Accum. dis.	Bottom El.	Water Depth	Flow area	Flow velocity	Water Level
	(m)	(m)	(m)	h (m)	(m2)	(m/sec)	(m)
Outlet channel	0.00	0.00	99.700	2.800	13.720	1.166	102.500
E.P. of tunnel	0.00	0.00	99.700	2.813	9,601	1.666	102.513
1	10.00	10.00	99.707	2.781	7.735	1.832	102.487
2	40.00	50.00	99,733	2.782	8.738	1.831	102.515
3	50.00	100.00	99.767	2.783	8.742	1.830	102.550
4	900.00	1,000.00	100.367	2,800	8.791	1.820	103.167
. 5	1,000.00	2,000.00	101.033	2.812	8.824	1.813	103.846
6	1,000.00	3,000.00	101.700	2.820	8.814	1,809	104.520
7.	1,000.00	4,000.00	102.367	2.824	8.857	1.807	105.191
8	1,000.00	5,000.00	103.033	2.827	8.864	1,805	105.860
9	1,000.00	6,000.00	103.700	2.829	8,869	1.804	106.529
10	1,000.00	7.000.00	104.367	2.830	8.872	1.803	107.196
11	1,000.00	8,000.00	105.033	2.830	8.874	1.803	107.864
12	1,000.00	9,000.00	105.700	2.831	8.875	1.803	108.531
13	1,000.00	10,000.00	106.367	2.831	8.876	1.803	109.198
14	1,000.00	11,000.00	107.033	2.831	8.876	1.803	109.865
15	417.05	11,417.05	107.311	2.831	8.876	1.803	110.143
Inlet Cul.16	9.00	11,426.05	107.317	2,871	10.047	1.593	110.188
Inlet Cul.17	31.00	11,457.05	107.338	2.865	10.028	1.595	110.203
BP of Inlet Cul		11,495.05	107.363	2.859	10,006	1.599	110.222
Open Channel	12.00		107.762	2.500	11.501	1.391	110.262

Hydraulic Calculation of Poza Honda~Mancha Grande Diversion Tunnel

(O = A m3/sec)

.]	Dis. from El Invert El.		Water Depth	Flow Area	Velocity	Water Level	
	(1/3900)	(m)	(m)	(m2)	(m3/sec)	(m)	
End of transito	4082.930	90.047	1.997	4,484	0,892	92.044	
BP of transition	4092.930	90.049	2.006	5.015	0.798	92.056	
Inlet	4092.930	90.050	2.013			92.063	

(Q = 3 m3/sec)

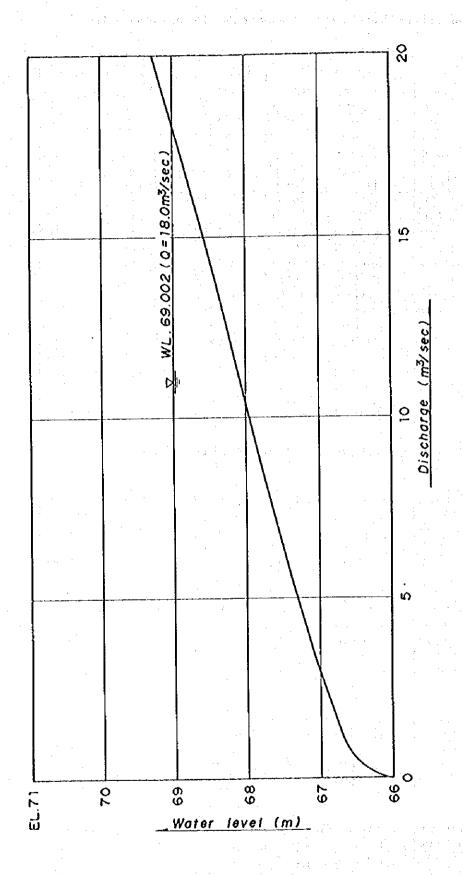
	Dis. from EF	Invert Et.	Water Depth	Flow Area	Velocity	Water Level
	(1/3900)	(m)	(m)	(m2)	(m3/sec)	(m)
End of transito	4082.930	90.047	1.564	3.507	0.856	91.611
BP of transition	4092.930	90.049	1.573	3.931	0.763	91.622
Injet	4092.930	90.050	1.579			91.629

(Q = 2 m3/sec)

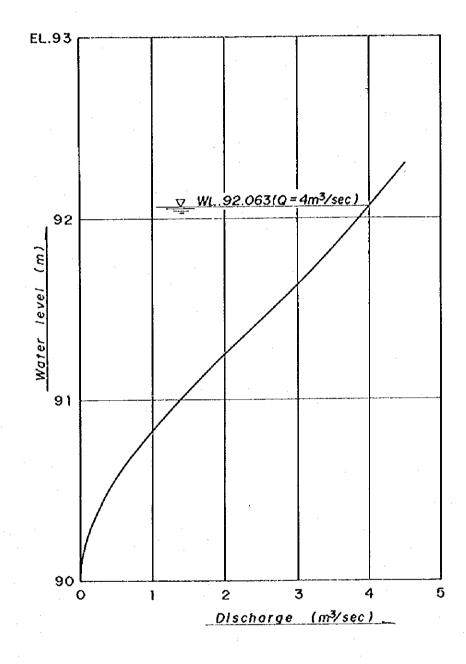
	Dis. from EF	Invert Et.	Water Depth	Flow Area	Velocity	Water Level
:	(1/3900)	(m)	(m)	(m2)	(m3/sec)	(m)
End of transito	4082.930	90.047	1.186	2,569	0.779	91.233
BP of transitio	4092.930	90.049	1.194	2.986	0.670	91.244
Inlet	4092.930	90.050	1.200			91.250

(Q = 1 m3/sec)

	Dis. from Ef	Invert El.	Water Depth	Flow Area	Velocity	Water Level
	(1/3900)	(m)	(m)	(m2)	(m3/sec)	(m)
End of transito	4082.930	90.047	0.772	1,526	0.655	90.819
BP of transition	4092.930	90.049	0.781	1.952	0.512	90.830
Inlet	4092.930	90.050	0.784			90.834



Discharge Curve at Congullo Inlet



Discharge Curve at Poza Honda Inlet

Tunnel Structural Analysis by FEM 5.2

Tunnel Structural Analysis for three tunnels, (1) Daule-Peripa ~ La Esperanza diversion tunnel, (2) La Esperanza ~ Poza Honda diversion tunnel and (3) Poza Honda Mancha Grande diversion tunnel was carried out by Finit Element Method (FEM).

Daule-Peripa ~ La Esperanza Diversion Tunnel **(1)**

(A) Procedure of Analysis

The first step is an analysis of bending The analysis is composed of 2 steps. moment, shearing and axial force to be acted on primary lining consisting of shotcrete and rock bolts. The second step is an analysis of maximum stress, minimum stress, maximum shear stress, etc., acting to lining concrete. Based on this analysis, thickness of shotcrete and arrangement of rock bolt as a primary lining and thickness of lining concrete and determined.

(B) Conditions of Analysis

Initial stress in the proposed tunneling route is estimated on the basis of overburden from ground surface to the tunneling elevation. The initial stress is classified into 3 cases i.e., Cases A-1, A-2 and A-3 as shown in Figure 5.2.1 and shown in Table 5.2.1.

Design values of foundation rock at the proposed route of Daule-Peripa ~ La Esperanza diversion tunnel are shown in Table 5.2.1 and design values of shotcrete, rock bolt and lining concrete are shown below.

Primary Lining (i)

- Shotcrete

 Design compressive strength: 210 kgf/cm² Shear strength : 42 kgf/cm²

 $: 2.40 \text{ t/m}^3$ Unit weight : 235,000 kgf/cm²(at age of 28 days)

: 10 cm or 15 cm • Thickness

- Rock bolt (SD35, D25)

· Elastic modules

: 17.6 t/m² • Tensile strength : 5.067 cm² · Cross sectional area

: 2,100,000 kg/cm² Elastic modules

: 2.0 m Length

(ii) Secondary Lining

- Lining concrete

• Design compressive strength: 210 kgf/cm²

• Unit weight : 2.40 t/m³

• Elastic modules : 235,000 kgf/cm²

• Poisson's ratio : 0.20 • Thickness : 30 cm

Typical cross section of the tunnel is shown in Figure 5.2.2.

(C) Structural Analysis

Tunnel structural analysis was carried out by FEM. Input data meshes were made for the analysis. They are shown in Figure 5.2.5. The base rock is considered as a visco-elastic material.

(D) Results of Analysis

The results of tunnel structural analysis are described hereunder.

(i) Case A-1: Overburden 60 m (700 m, 8 % of total tunnel length)

- Primary lining

Stress resultant in the shotcrete (thickness 10 cm) is less than 50 % of allowable one of the shotcrete at the elapsed time of 12 months after tunneling. Axial force acting on the rock bolt is less than 50 % of allowable tensile strength of the same (refer to Table 5.2.3).

Increment of compressive stress and tensile force acting on the shotcrete and rock bolt from immediately after tunneling to 12 months is shown in Figure 5.2.7.

Stress Resultant in the shotcrete (Case A-1) at the time of immediately after tunneling to 12 months is shown in Appendix, Table 5.2.5.

- Secondary lining

Maximum compressive stress, maximum tensile stress and maximum shear stress acting on the concrete are less than allowable stresses of the concrete (refer to Table 5.2.4).

(ii) Case A-2: Overburden 140 m (2,000 m, 24 % of total tunnel length)

- Primary lining

Stress resultant in the shotcrete of 10 cm thick is less than 60 % of allowable one of the shotcrete at the elapsed time of 12 months after tunneling.

Increment of compressive stress and tensile force acting on the shotcrete and rock bolt is shown in Figure 5.2.8.

- Secondary lining

Maximum compressive stress, maximum tensile stress and maximum shear stress acting on the lining concrete are 1.32 kgf/cm², 0.3 kgf/cm² and 6.4 kgf/cm², respectively. Those values show that the lining concrete is safety because concrete strength is much larger than those values.

Various stresses acting in the concrete are less than its allowable stresses (refer to Table 5.2.3).

(iii) Case A-3: Overburden 250 m (4,800 m, 58 % of total tunnel length)

- Primary lining

Compressive stress in the shotcrete is over its allowable stress at the time of 4 to 5 months after tunneling. On the other hand, tensile force acting in the rock bolt is around 95 % of its allowable one at the time of 12 months after tunneling (refer to Table 5.2.3).

Increment of compressive stress and tensile force acting in the shotcrete and rock bolt is shown in Figure 5.2.9.

Above results of the analysis suggest that secondary lining has to be done within 3 months after tunneling.

Since the tunnel length of the case A-3 is more than half of the total, construction schedule for this tunnel should be considered that concrete lining is started within 3 months after tunneling.

- Secondary lining

Maximum compressive stress is 19.6 kgf/cm², maximum tensile stress is 0.5 kgf/cm² and maximum shear stress is 9.5 kgf/cm² as shown in Table 5.2.4. Out of those stresses, maximum shear stress is over its allowable stress (8.5 kgf/cm²), but it is acted at the limited portion and average maximum shear stress is 8.4 kgf/cm². Thus,

basically, the lining concrete can be designed as non-reinforced concrete.

Detailed data obtained by FEM is shown in attached Data Book.

Tunnel type to be applied for Daule-Peripa ~ La Esperanza diversion tunnel is shown in Figure 5.2.13.

(2) La Esperanza ~ Poza Honda diversion tunnel

(A) Tunnel Structural Analysis

Tunnel structural analysis was carried out by FEM in the same manner as Daule-Peripa ~ La Esperanza Diversion Tunnel. Since the diameter of the tunnel is 3.50 m which is only 0.2 m smaller than Daule-Peripa ~ La Esperanza Diversion Tunnel. Thus, the structural analysis was made applying the same input data meshes as shown in Figure 5.2.5.

Procedure of the analysis is completely same as Daule-Peripa ~ La Esperanza Diversion Tunnel.

(B) Conditions of Analysis

Based on the topographical and geological conditions, the tunnel was classified into 4 cases for the analysis. They are as follows:

	Overburden	Tunnel Length			
$(q,r) = (r-r)^{\frac{1}{2}}$: 14 (m)			
Case A-1	60	400 (41 %)			
Case A-2	140	3,500 (31 %)			
Case A-3	250	1,300 (11 %)			
Case A-4	320	6,200 (54 %)			

(C) Structural Analysis

Tunnel structural analysis was carried out by FEM applying the same meshes as Daule-Peripa ~ La Esperanza diversion tunnel (refer to Figure 5.2.5).

(D) Design Values of Foundation Rock

Design values of base rock at the proposed route of La Esperanza ~ Poza Honda Diversion Tunnel are shown in Table 5.2.1. There are common with Daule-Peripa ~ La Esperanza Diversion Tunnel.

Design values of shotcrete concrete, rock bolt and lining concrete is the same as Daule-Peripa ~ La Esperanza Diversion Tunnel.

Typical cross section of the tunnel is shown in Figure 5.2.3.

(E) Results of Analysis

The results of tunnel structural analysis are described hereunder.

The case A-1, A-2 and A-3 are common to Daule-Peripa ~ La Esperanza Diversion Tunnel.

Case A-4: Overburden 320 m

- Primary lining

Since the stress resultant acting in the shotcrete of 10 cm thick is over allowable on e of the shotcrete, thickness of shotcrete was changed to 15 cm and the structural analysis was carried out.

Increment of compressive stress and tensile stress acting in the concrete and rock bolt is shown in Figure 5.2.10.

Stress result in the shotcrete of 15 cm thick is 97 % and 104 % of allowable ones of the shotcrete at the time of 2 months and 3 months after tunneling, respectively (refer to Table 5.2.3).

Thus, secondary lining with concrete has to be made within 2.5 months after tunneling.

Secondary lining

Maximum compressive stress, maximum tensile stress and maximum shear stress, acting in the concrete are less than allowable stress of the concrete (refer to Table 5.2.4).

Tunnel type to be applied for La Esperanza ~ Poza Honda diversion tunnel is shown in Figure 5.2.13.

(3) Poza Hodna ~ Mancha Grande Diversion Tunnel

(A) Tunnel Structural Analysis

Tunnel structure analysis was carried out by FEM in the same manner as before mentioned diversion tunnels.

(B) Conditions of Analysis

Initial stress in the proposed tunneling route is estimated on the basis of overburden from ground surface to the tunnel elevation. The initial stress is classified into 2 cases as shown in Figure 5.2.1, and overburden pressure is estimated as shown in Table 5.2.2.

Design values of bases rock at the proposed route of Poza Honda ~ Mancha Grande diversion tunnel are shown in Table 5.2.2.

Design values of shotcrete and rock bolt as primary lining and lining concrete as secondary lining are completely same as the other tunnels.

Typical cross section of the tunnel is shown in Figure 5.2.4.

(C) Structural Analysis

Tunnel structural analysis was carried out by FEM. Input data meshes were made for the analysis. They are shown in Figure 5.2.6.

(D) Results of Analysis

The results of tunnel structural analysis is described hereunder.

(i) Case B-1: Overburden 60 m (593 m, 14 % of total tunnel length)

- Primary lining

Compressive stress in the shotcrete of 10 cm thick is less than 36 % of allowable one of the shotcrete at the elapsed time of 12 months after tunneling. Tensile force acting in the rock bolt is less than 28 % of allowable one of the shotcrete.

Increment of compressive stress and tensile force acting in the shotcrete and rock bolt from immediately after tunneling to 12 months is shown in Figure 5.2.11.

- Secondary lining

Maximum compressive stress, maximum tensile stress and maximum shear stress acting in the concrete are less than allowable stresses of the concrete (refer to Table 5.2.4).

(ii) Case B-2: Overburden 300 m (3,500 m, 86 % of total tunnel length)

- Primary lining

Compressive stress in the shotcrete is over its allowable stress at the time of 3 months after tunneling. On the other hand, tensile force acting in the rock bolt is 96 % of its allowable tensile strength at time of 12 months after tunneling (refer to Table 5.2.3 and Figure 5.2.12).

Above results of the analysis suggests that secondary lining has to be done within 2 months after tunneling.

- Secondary lining

Maximum compressive stress and maximum tensile stress is within allowable ones of the concrete as shown Table 5.2.4. Maximum shear stress (9.6 kgf/cm²) is over the allowable one (8.5 kgf/cm²). However, it is occurred at the limited part, and average maximum shear stress in the lining concrete is 8.0 kgf/cm², less than allowable stress of the concrete as shown in the same Table.

Tunnel type to be applied for Poza Honda ~ Mancha Grande diversion tunnel is shown in figure 5.2.13.

Table 5.2.1 Design Values of Base Rock (Daule-Peripa~La Esperanza and La Esperanza~ Poza Honda Diversion Tunnels)

<u></u>		Case A-1	Case A-2	Case A-3	Case A-4
<u></u> 1	Overburden (m)	60	140	250	320
1.	Elastic Modulus E (kgf/cm²)	10,000	20,000	20,000	22,000
2.		2.5	5.0	5.0	5.0
3.	Cohesion C (kgf/cm²)	35	40	40	40
4.	Internal Friction Angle (degree)	1.7		1.8	1.8
5.	Unit Weight (t/m³)		0.2	0.2	0.2
6.	Poisson's Ratio	0.25	0.2	0.2	0.2
7.	Creep			0.5	0.5
	α	0.50	0.5		
	β (5 days loading)	0.016	0.033	0.033	0.036
8.	Initional Stress		•		Al enc
	a) Vertical σy (t/m²)	¹⁷ 102	² / 252	^{3/} 450	4/ 576
	b) Horizontal ox (t/m²)	¹⁴ 71	^{2/} 176	³⁷ 315	4/ 403

^{1/} $1.7 \text{ t/m}^3 \text{ x } 60 \text{ m} = 102 \text{ t/m}^2$ σy = $\lambda \cdot \sigma y = 0.7 \times 102 \text{ t/m}^2 = 71 \text{ t/m}^2$ 1/ σx = $1.8 \text{ t/m}^3 \times 140 \text{ m} = 252 \text{ t/m}^2$ 2/ **σ**y = $\lambda \cdot \sigma y = 0.7 \times 252 \text{ t/m}^2 = 176 \text{ t/m}^2$ 2/ σx = $1.8 \text{ t/m}^3 \text{ x } 250 \text{ m} = 450 \text{ t/m}^2$ 3/ $\sigma y =$ $\lambda \cdot \sigma y = 0.7 \times 450 \text{ t/m}^2 = 315 \text{ t/m}^2$ 3/ σx = $1.8 \text{ t/m}^3 \times 320 \text{ m} = 576 \text{ t/m}^2$ 4/ **σy** = $\lambda \cdot \sigma y = 0.7 \times 576 \text{ t/m}^2 = 403 \text{ t/m}^2$ σx =

Table 5.2.2 Design Values of Base Rock (Poza Honda ~ Mancha Grande Diversion Tunnel)

		Case B-1	Case B-2
1	Overburden (m)	60	300
2.	Elastic Modulus E (kgf/cm²)	10,000	20,000
3.	Cohesion C (kgf/cm²)	2.0	5.0
4.	Internal Friction Angle (degree)	30	40
s.	Unit Weight (t/m³)	1.8	2.0
6.	Poisson's Ratio	0.25	0.2
7.	Creep		
	α	0.50	. 0.5
	B (5 days loading)	0.016	0.033
8.	Initional Stress	•	
	a) Vertical oy (t/m²)	1/ 108	^{2/} 600
	b) Horizontal σx (t/m²)	^{1/} 76	420
		•	* •

 $1.8 \text{ t/m}^3 \text{ x } 60 \text{ m} = 108 \text{ t/m}^2$ 1/ $\sigma y =$

2/

 $\sigma_X = \lambda \cdot \sigma_Y = 0.7 \times 108 = 76 \text{ t/m}^2$ 2.0 t/m³ x 300 m = 600 t/m² $\sigma \dot{x} =$

σy =

 $\sigma x = \lambda \cdot \sigma y = 0.7 \times 600 \text{ t/m}^2 = 420 \text{ t/m}^2$ σx =

Summary of Structural Analysis Results on primary lining (1/2) Table 5.2.3

Elapsed time	T	Shotcrete			Rock Bolt	
from tunneling	N (ton)	M (tm)	s (kgf/cm²)	Judgment	Tensile Force (ton)	Judgment
Immediately after	33.9	0.030	35.7	satisfied	3.4	satisfied
1 month after	46.5	0.043	49.1	satisfied	4.3	satisfied
2 months after	57.5	0.054	60.8	satisfied	4.8	satisfied
3 months after	64.4	0.062	68.1	satisfied	5.2	satisfied
6 months after	72.8	0.071	77.0	satisfied	5.5	satisfied
12 month after	75.3	0.073	79.7	satisfied	5.6	satisfied

CASE $\Delta = 2(1 = 10 \text{ cm})$

Elapsed time	T	Shotcrete			Rock Bolt	
from tunneling	N (ton)	M (tm)	s (kgf/cm²)	Judgment	Tensile Force (ton)	Judgment
Immediately after	46.7	0.094	52.3	satisfied	4,9	satisfied
I month after	83.6	0.049	86.5	satisfied	7.6	satisfied
2 months after	103.4	0.061	107.1	satisfied	8.5	satisfied
3 months after	110.8	0.066	114.7	satisfied	8.8	satisfied
6 months after	114.9	0.069	119.0	satisfied	9.0	satisfied
12 month after	115.1	0.069	119.2	satisfied	9.0	satisfied

CASE A-3 (t = 10 cm)

Elapsed time		Shotcrete	Ì		Rock Bolt	
from tunneling	N (ton) M (tm) s (kgf/cm²)		Judgment	tensile Force (ton)	Judgment	
Immediately after	83.4	0.167	93.4	satisfied	8.8	satisfied
1 month after	149.2	0.088	154.5	satisfied	13.6	satisfied
2 months after	184.6	0.110	191.2	satisfied	15.2	satisfied
3 months after	197.8	0.118	204.9	satisfied	15.8	satisfied
	205.2	0.123	212.5	unsatisfied	16.1	satisfied
6 months after			212.9	unsatisfied	16,1	satisfied
12 month after	205.6	0.123	212.9	unsansneu		

Remark. N:

Axial force Bending moment Compressive stress M: s:

Allowable stress; sa = 210 kgf/cm² (shotcrete)

Tensile Strength = 17.6 ton (rock bolt)

Table 5.2.3 Summary of Structural Analysis Results on primary lining (2/2)

A = 4 (t = 15 cm)

Elapsed time	<u> </u>	Shotcrete			Rock Bolt	
from tunneling	N (ton) M (tm)		s (kgf/cm²)	Judgment	Tensile Force (ton)	Judgment
Immediately after	130.0	0.673	104.6	satisfied	9.9	satisfied
l month after	210.2	1,140	170.6	satisfied	15.4	satisfied
2 months after	293.1	0.373	205.4	satisfied	16.9	satisfied
3 months after	310.4	0.398	217.6	unsatisfied	17.5	satisfied
6 months after	318.9	0.411	223.6	unsatisfied	17.7	unsatisfied
12 month after	319.3	0.411	223.8	unsatisfied	17.7	unsatisfied

CASE B_{-1} (t = 10 cm)

Elapsed time	1	Shotcrete			Rock Belt	
from tunneling	N (ton) M (tm)		s (kgf/cm²)	Judgment	Tensile Force (ton)	Judgment
Immediately after	27.6	0.108	34.0	satisfied	3.0	satisfied
1 month after	42.8	0.069	46.9	satisfied	3.8	satisfied
2 months after	52.0	0.093	57.6	satisfied	4.2	satisfied
3 months after	50.1	0.239	64.5	satisfied	4.5	satisfied
6 months after	56.4	0.280	73.2	satisfied	4.8	satisfied
12 month after	58.3	0.292	75.8	satisfied	4.9	satisfied

CASE B-2 (t = 15 m)

Elapsed time	<u> </u>	Shotcrete			Rock Bolt	
from tunneling	N (ton) M (tm)		s (kgf/cm²)	Judgment	Tensile Force (ton)	Judgment
Immediately after	129.6	0.763	106.8	satisfied	9.7	satisfied
I month after	240.2	0.338	169.2	satisfied	14.6	satisfied
2 months after	288.2	0.470	204.7	satisfied	16.0	satisfied
3 months after	306.1	0.519	217.9	unsatisfied	16.6	satisfied
6 months after	316.1	0.546	225.3	unsatisfied	16.9	satisfied
12 month after	316.6	0.548	225.7	unsatisfied	16.9	satisfied

Remark. N:

Axial force

M:

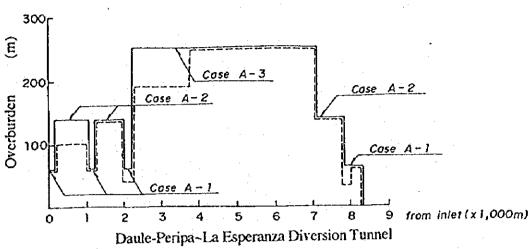
Bending moment Compressive stress

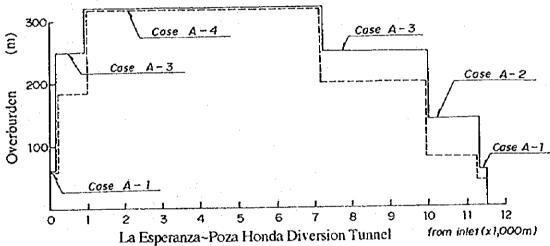
s: Allowable stress:

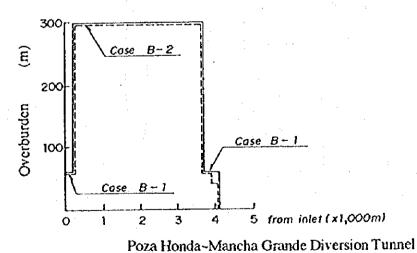
sa = 210 kgf/cm² (shotcrete)
Tensile strength = 17.6 ton (rock bolt)

Table 5.2.4 Maximum Compressive, Maximum Tensile and Maximum Shear Stress acting on the Lining Concrete.

Case of Compressi			Maximum Tensile		Maximum (kgf		
Analysis	ve Stress (kgf/cm²)	Judgment	Stress (kgf/cm²)	Judgment	Limited Part	Average in Section	Judgment
Case A-1	16.9	satisfied	0.8	satisfied	8.1	6.5	satisfied
Case A-2	13.2	satisfied	0.3	satisfied	6.4	5.3	satisfied
Case A-3	19.6	satisfied	0.5	satisfied	9.5	8.4	satisfied
Case A-4	19.5	satisfied	0.4	satisfied	9.4	8.4	satisfied
Case B-1	14.7	satisfied	1.2	satisfied	7.0	5.1	satisfied
Case B-2	20.1	satisfied	0.7	satisfied	9.6	8.0	satisfied







· Dotted line shows mean overburden

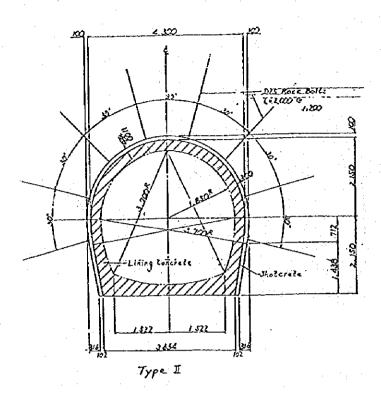
· Solid line shows applied overburden for tunnel structural analysis

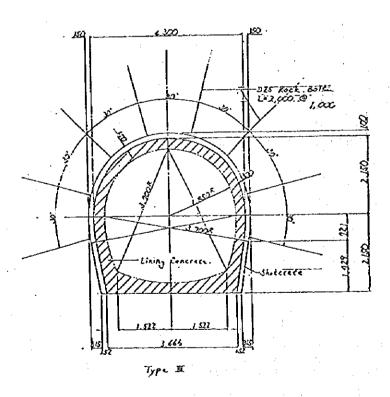
GOVERNMENT OF THE REPUBLIC OF ECUADOR CENTRO DE REHABILITACION DE MANABI (CRM) THE DETAILEO DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Cases of Tunnel Structural Analysis based on the Overburden, Geological Condition and Cross Section



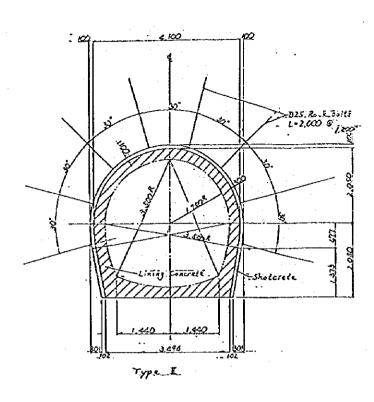


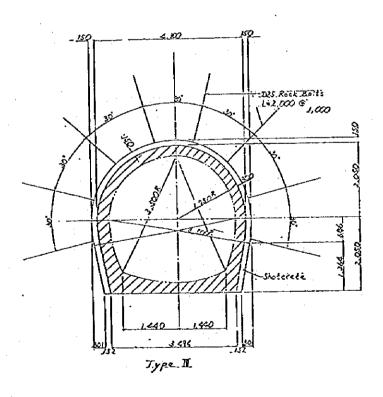
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JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Typical Cross Section, Types II and III (Daule-Peripa-La Esperanza Diversion Tunnel)



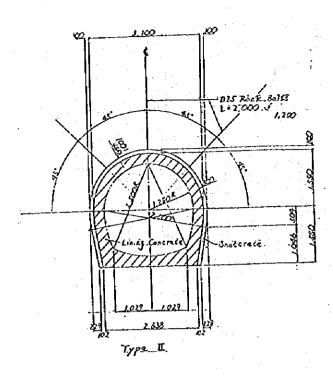


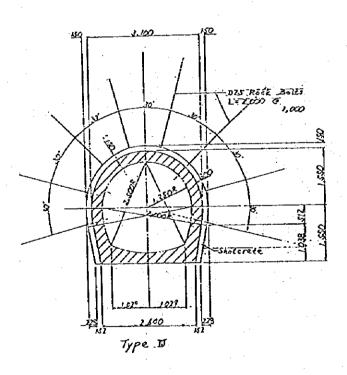
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JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Typical Cross Section, Types II and III (La Esperanza-Poza Honda Diversion Tunnel)



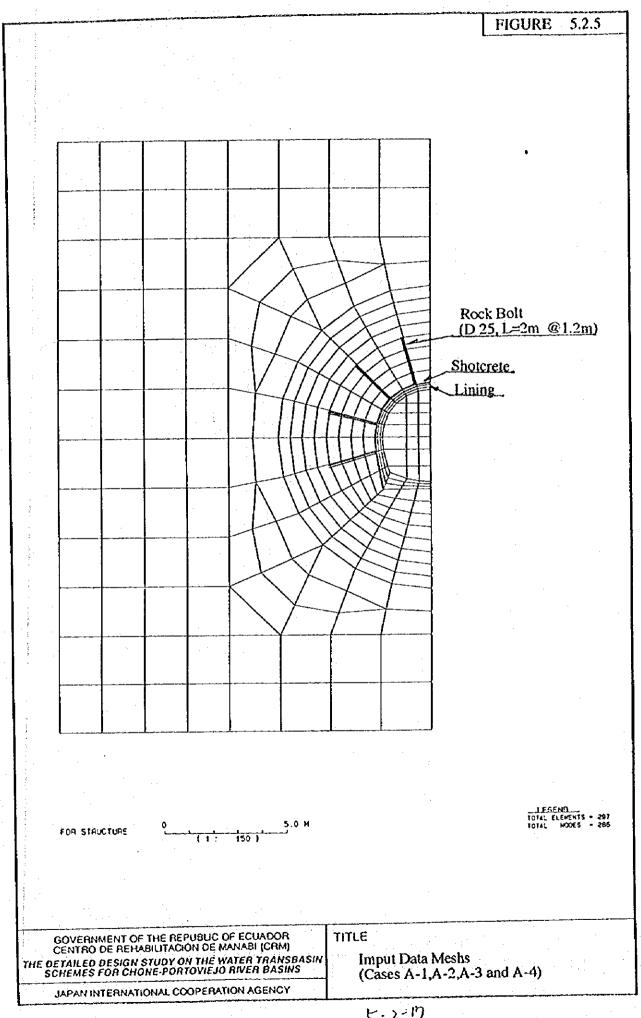


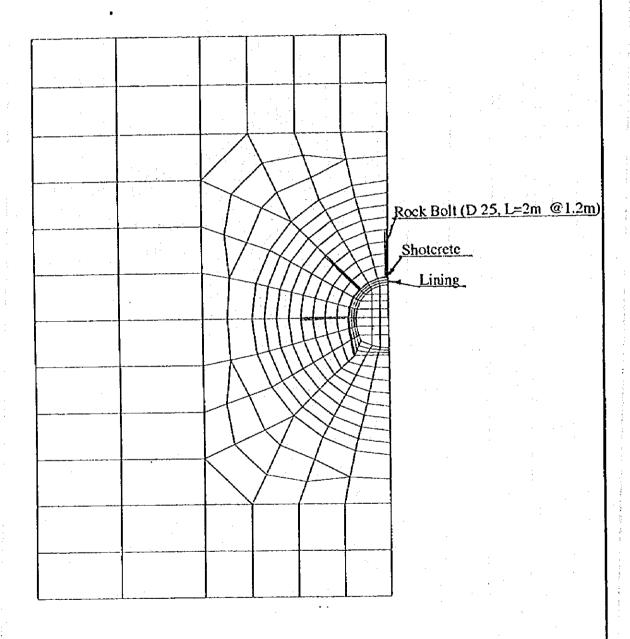
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THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

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TITLE

Typical Cross Section, Types II and III
(Poza Honda-Mancha Grande Diversion Tunnel)





FOR STRUCTURE

5.0 H

LEGENO OTAL ELEMENTS - 253 OTAL MODES - 260

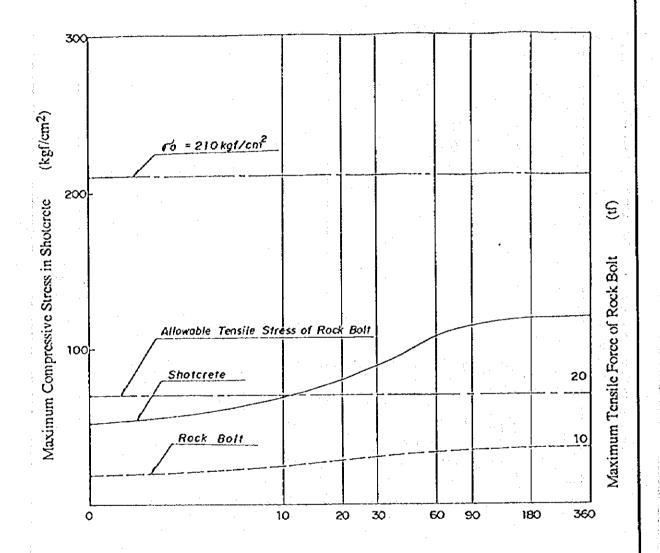
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Imput Data Meshs (Cases B-1 and B-2)

FIGURE 5.2.7 300 (kgf/cm²) $66 = 210 \, \text{kgt/cm}^2$ Maximum Compressive Stress in Shoterete 200 Ξ Maximum Tensile Force of Rock Bolt 100 Allowable Tensile Stress of Rock Bolt Shoterete 10 90 180 360 60 10 20 30 GOVERNMENT OF THE REPUBLIC OF ECUADOR CENTRO DE REHABILITACION DE MANABI (CRM) TITLE THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case A-1) JAPAN INTERNATIONAL COOPERATION AGENCY

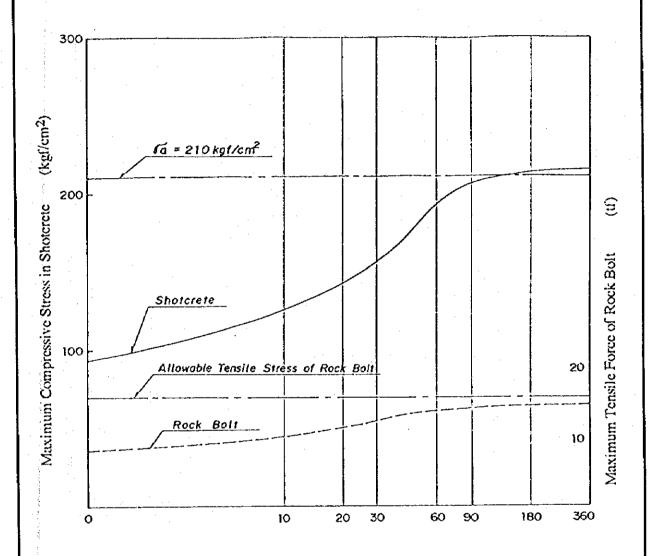


GOVERNMENT OF THE REPUBLIC OF ECUADOR CENTRO DE REPABILITACION DE MANABI (CRM) THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

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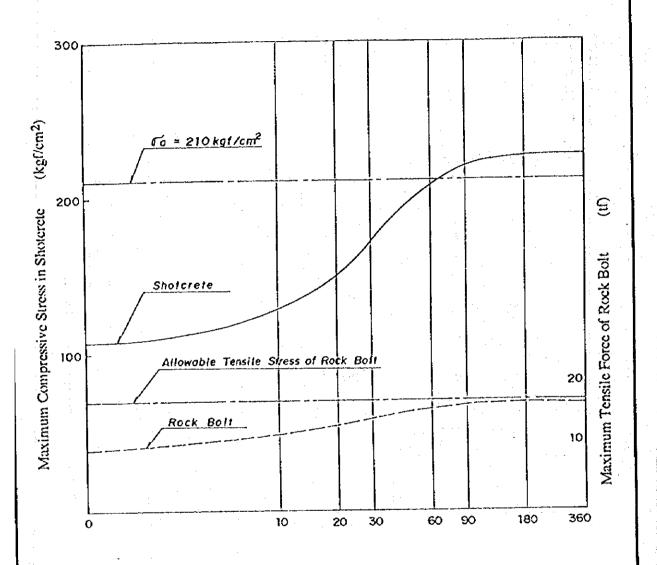
Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case A-2)



GOVERNMENT OF THE REPUBLIC OF ECUADOR CENTRO DE REHABILITACION DE MANABI (CRM)
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case A-3)

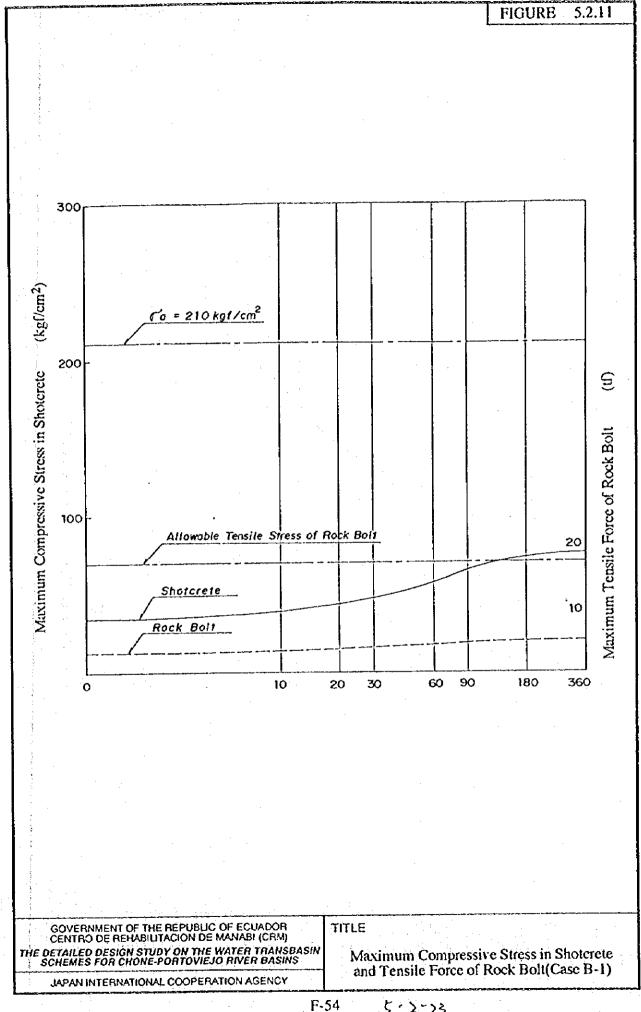


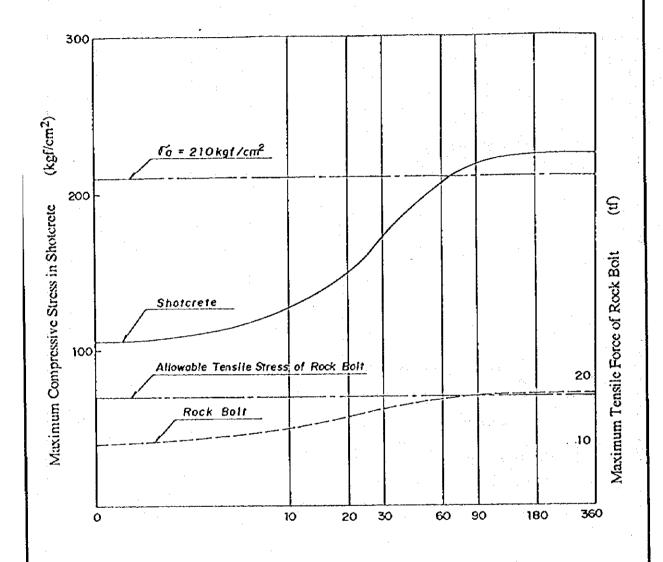
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TITLE

Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case A-4)



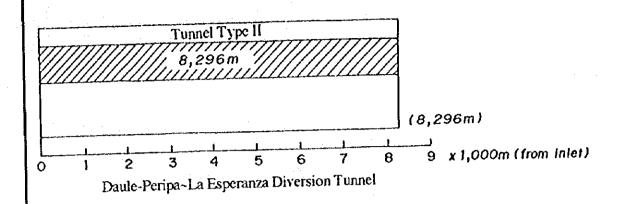


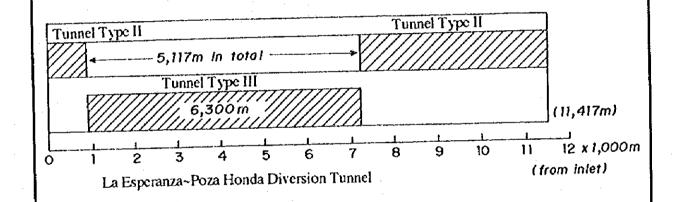
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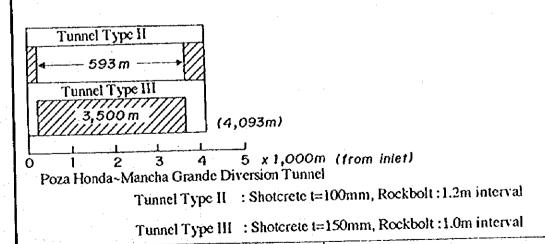
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TITLE

Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case B-2)







GOVERNMENT OF THE REPUBLIC OF ECUACOR CENTRO DE REHABILITACION DE MANABI (CRM) THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Determination of Tunnel Types based on the Tunnel Structural Analysis