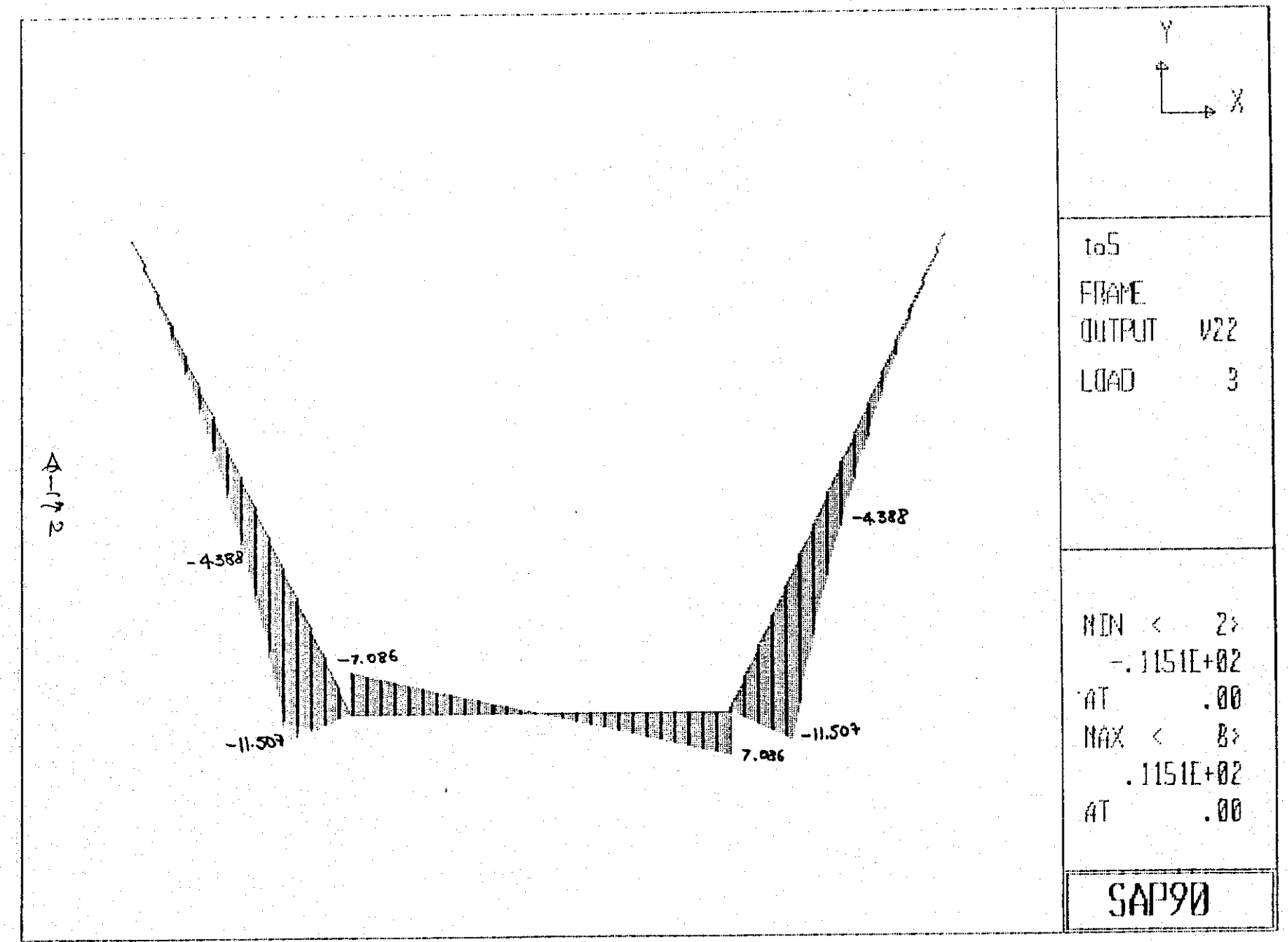
Y
X
1 of 5
FRAME
OUTPUT V22
LOAD 3
MIN < 2>
-.1151E+02
AT .00
MAX < 8>
.1151E+02
AT .00
SAP90
-4.388
-7.086
-11.507
7.086
-11.507
-4.388

DESIGN OF THE TRANSITION

— DATA FOR CALCULATION OF REINFORCEMENT

$f'_c = 210\ kg/cm^2$

$f_y = 4200\ kg/cm^2$

$b = 100\ cm$

$d = 43\ cm$

$r = 7.0\ cm$

$M_U = 20.744\ ton\text{-}mt.$

$$A_S = \frac{20.744 \times 10^5}{0.9 \times 4200\,(43 - 2)} = 13.38\ cm^2 \qquad 1\varnothing 16\ @15.5$$

$$a = \frac{13.38 \times 4200}{0.85 \times 210 \times 100} = 3.15\ cm$$

$$\rho = \frac{13.38}{100 \times 43} = 0.003112 < \rho_{min} = 0.0033$$

$A_{S\,min} = 0.0033 \times 100 \times 43 = 14.33\ cm^2 \Rightarrow 7\varnothing 16 \Rightarrow 1\varnothing 16\ @15.5$

— SHEAR STRESS CHECK.

$V_U = 14.18\ ton.$

$V_c = 0.85 \times 0.53 \sqrt{210} \times 100 \times 43 = 28.071\ kg.$

$V_c > V_c$ "OK"

NO REQUIERE ESTRIBOS.

— REINFORCEMENT FOR SHRINKAGE AND TEMPERATURE

$A_S = 0.002 \times 100 \times 43 = 8.6\ cm^2$ $\quad 1\varnothing 14\ @20$

$A_S = 0.002 \times 100 \times 33 = 6.6\ cm^2$ $\quad 1\varnothing 12\ @20$

$A_S = 0.002 \times 100 \times 22 = 4.06\ cm^2$ $\quad 1\varnothing 12\ @25.$

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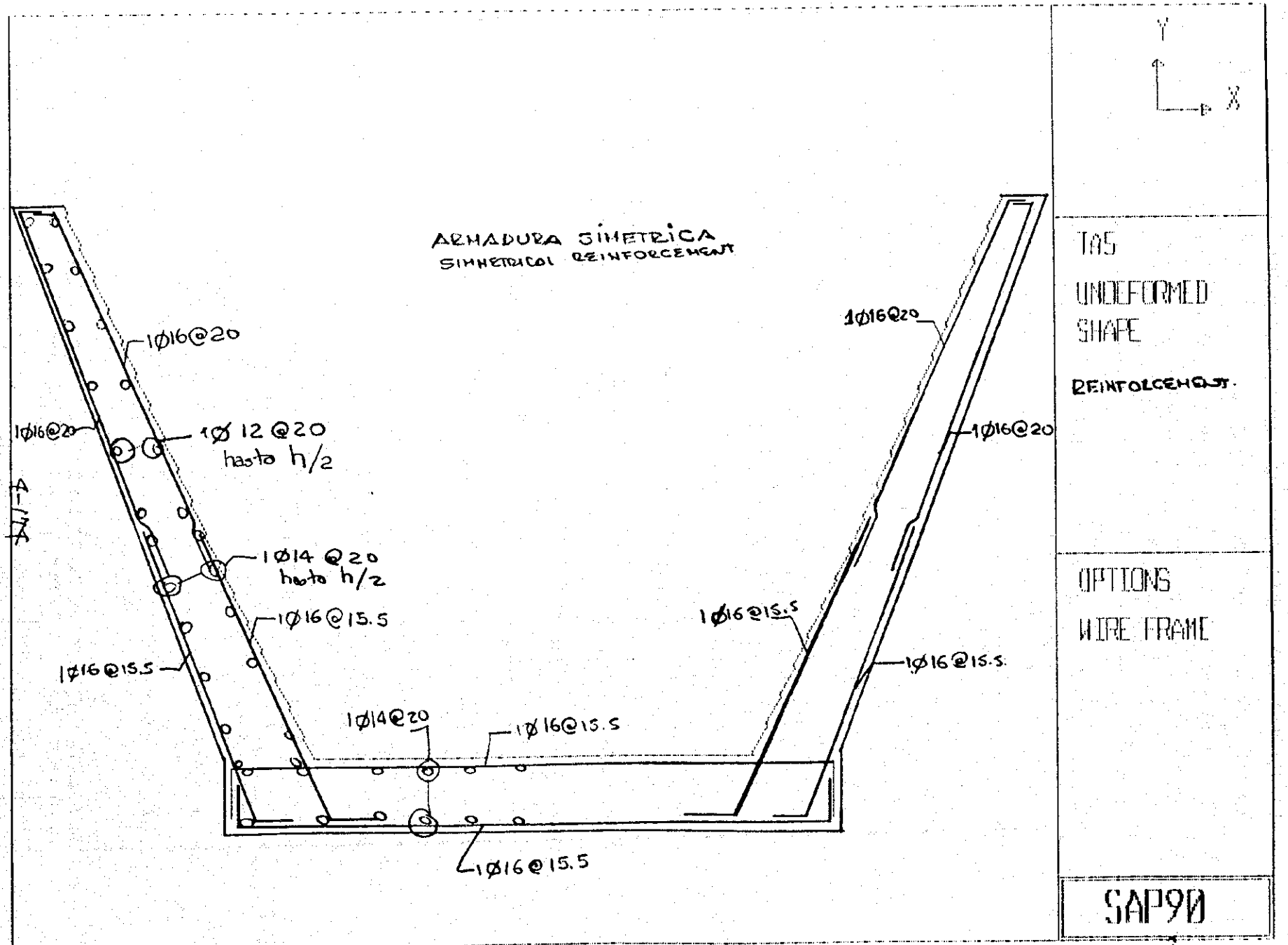

ARMADURA SIMETRICA
SIMMETRICAL REINFORCEMENT
1Ø16@20
1Ø16@20
1Ø 12 @20
hasta h/2
1Ø14 @20
hasta h/2
1Ø16@15.5
1Ø16@15.5
1Ø14@20
1Ø16@15.5
1Ø16@15.5
1Ø16@20
1Ø16@20
1Ø16@15.5
1Ø16@15.5
A-A
Y
X
TAS
UNDEFORMED
SHAPE
REINFORCEMENT.
OPTIONS
WIRE FRAME
SAP90

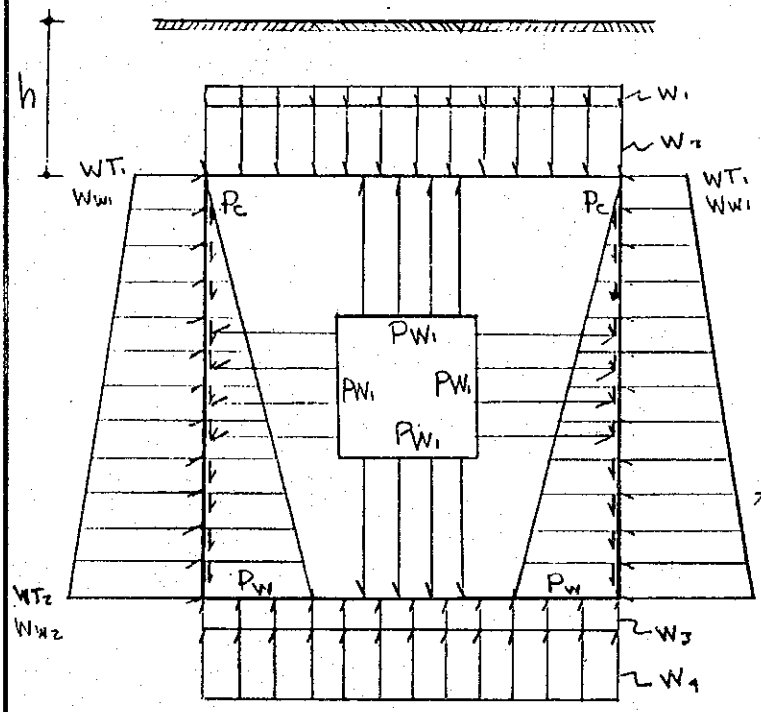
THE LOAD FOR ANALYSIS AND DESIGN OF SIPHONS 2.9 x 2.9 x 0.5

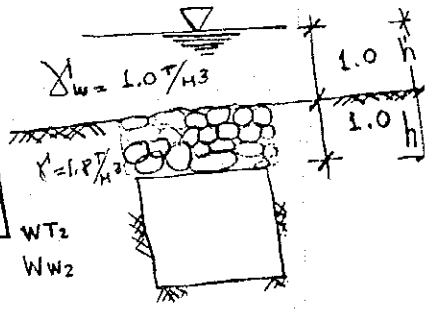
- THE LOADS APPLIED IN THE DESIGN OF SQU ARE AS FOLLOWS :

W1 : LIVE LOAD OF HS-20-44 TRAILER
W2 : VERTICAL LOAD OF EARTH WEIGHT AND SELF WEIGHT OF TOP SLAB
W3 : SURCHARGE OF THE UPLIFT ACT ON BOTTOM SLAB.
W4 : REACTION LOAD ACT ON BOITOM SLAB
WT : LATERAL EARTH PRESSURE
PW : LATERAL WATER PRESURE
Pc : LOAD OF CONCRETE
WW : PRESSURE OF WATER

DATA

$\gamma_{soil} = 1.80\ T/M^3$ UNIT WEIGHT
$\phi = 20°$ ANGLE OF INTERNAL FRICTION
$\gamma_{concrete} = 2.4\ T/M^3$ UNIT WEIGHT
$Ka = 0.50$ COEFFICIENT OF EARTH PRESSURE
$f'c = 180\ Kg/cm^2$ STRENGTH OF CONCRETE
$Fy = 4200\ Kg/cm^2$ YIELD STRENGHT OF REFORCING BAR
$E_{CONCRETE} = 2.1 \times 10^5$ MODULUS OF ELASTICITY (Kg/cm^2)
$E_{STEEL} = 2.1 \times 10^6$





CARGA / SECCION	W1	W2	W3	W4	WT1 / WW1	WT2 / WW2	Pc	PW	PW1	h	h'
2.9x2.9 0.5		10.65 1.2		10.65 3.6	4.725	7.785	4.08	3.4		5	
2.9x2.9 0.5		1.8 1.2	5.4	7.2 3.6	2.4	7.16	4.08	3.4		1	1

Revision	Checked by / Revisado por	Date (Fecha)	Approved by: / Aprobado por:	Date (Fecha)	Revision	Checked by: / Revisado por	Date (fecha)	Approbed by: / Aprobado por:	Date (Fecha) / Aprobado por:

THE LOADS APPLIED IN THE DESIGN OF SIPHON, SQUARE SECTION

$P_c = 0.5 \times 3.4 \times 2.4 = 4.08$ ton.

$P_c = t \times H \times \gamma_{concrete}$

$W_2 = 0.5 \times 2.4 + 5.25 \times 1.8 = 10.65$ t/m²

$W_2 = t \times \gamma_{concrete} + \left(h + \frac{t}{2}\right)\gamma_{soil}$

$W_4 = 10.65 + \frac{2 \times 4.08}{3.4} = 13.05$ t/m²

$W_4 = W_2 + \frac{2P_c}{\left(B_1 + \frac{t}{2}\right)}$

$W_{T1} = 0.5 \times 1.8 \times 5.25 = 4.725$ t/m²

$W_{T1} = \left(\frac{t}{2} + h\right) \times \gamma_{soil} \times Ka$

$W_{T2} = 0.5 \times 1.8 \times 8.65 = 7.785$ t/m²

$W_{T2} = \left(h + t_2\right)H + t) \times \gamma_{soil} \cdot Ka$

$P_w = 3.4 \times 1.0 = 3.4$ t/m²

$P_w = (t+H) \times \gamma_{water}$

$P_{W1} =$ height of pressure of water $\times$ 1.0

$W_2 = \overset{t,t_1,t_2}{0.5} \times \overset{\gamma_c}{2.4} + \overset{h}{1.0} \times \overset{(\gamma_s - \gamma_w)}{0.8} + \overset{h'}{1.0} \times \overset{\gamma_w}{1.0} = 3.0$ T/m²

$W_3 = 1 \times 5.4 = 5.4$ T/m²

$W_3 = \left(h' + h + (H+t)\right)\gamma_{water}$

$W_4 = 3.0 + \frac{2 \times 4.08}{3.4} + 5.4 = 10.8$ T/m²

$W_4 = W_2 + \frac{2 \times P_c}{\left(B_1 + \frac{t}{2}\right)} + W_3$

$W_{T1} = 1 \times 0.8 \times 0.5 + \overset{W_{W1}}{1 \times 2.} = 2.4$ T/m²

$W_{T1} = h_1(\gamma_s - \gamma_w)Ka + \gamma_w\left(h' + h + (H+t)\right)$

$W_{T2} = 4.4 \times 0.8 \times 0.5 + \overset{W_{W2}}{1 \times 5.4} = 7.16$ T/m²

$W_{W1} = \overset{h}{2.0} \times \overset{\gamma'}{1.0} = 1.0$

$W_{W2} = 5.4 \times 1.0 = 5.4$

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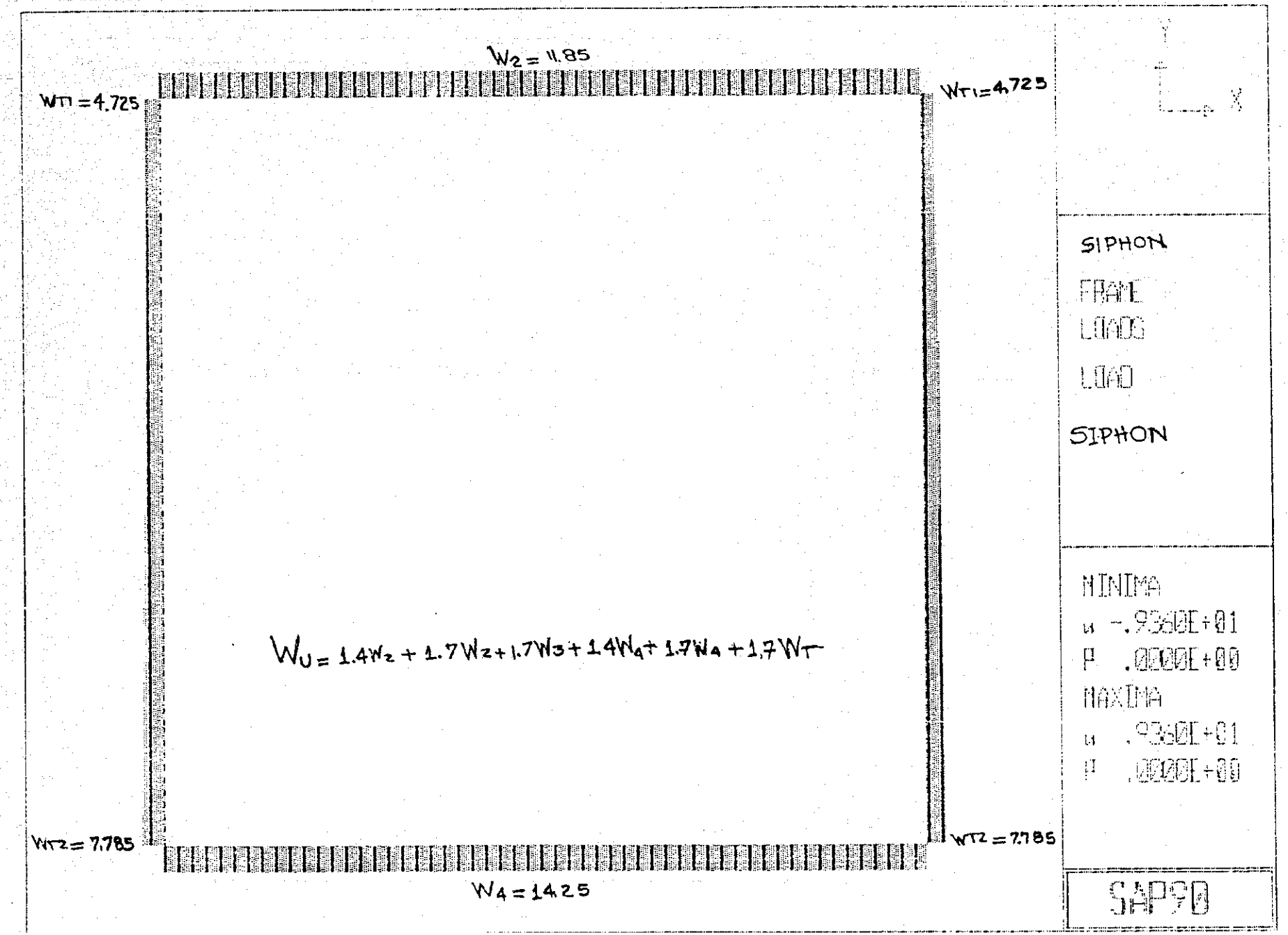
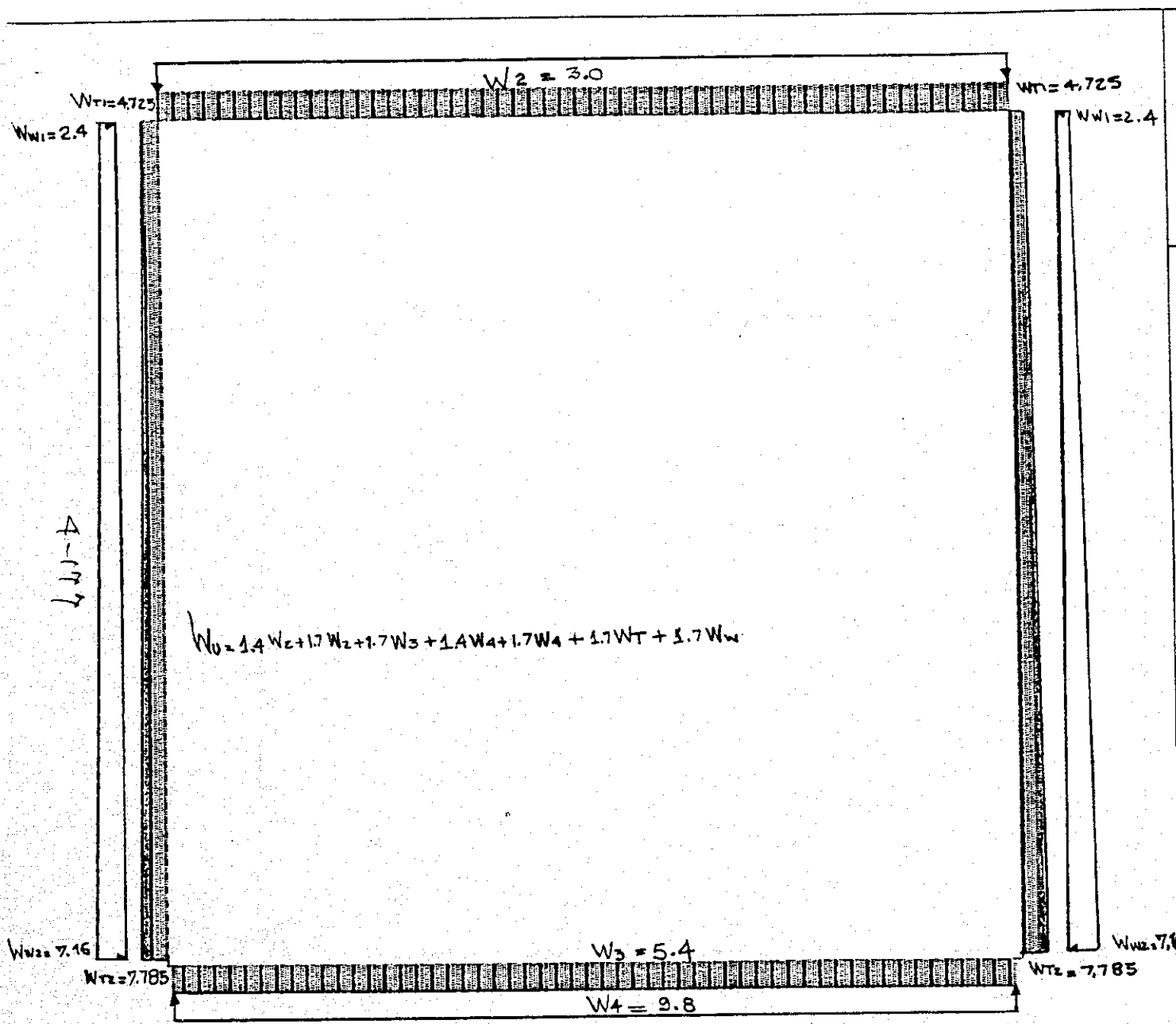

W2 = 11.85
WT1 = 4.725
WT1 = 4.725
WU = 1.4W2 + 1.7W2 + 1.7W3 + 1.4W4 + 1.7W4 + 1.7WT
WT2 = 7.785
WT2 = 7.785
W4 = 14.25
Y
X
SIPHON
FRAME
LOADS
LOAD
SIPHON
MINIMA
U -.9360E+01
P .0000E+00
MAXIMA
U .9360E+01
P .0000E+00
SAP90



Y

X

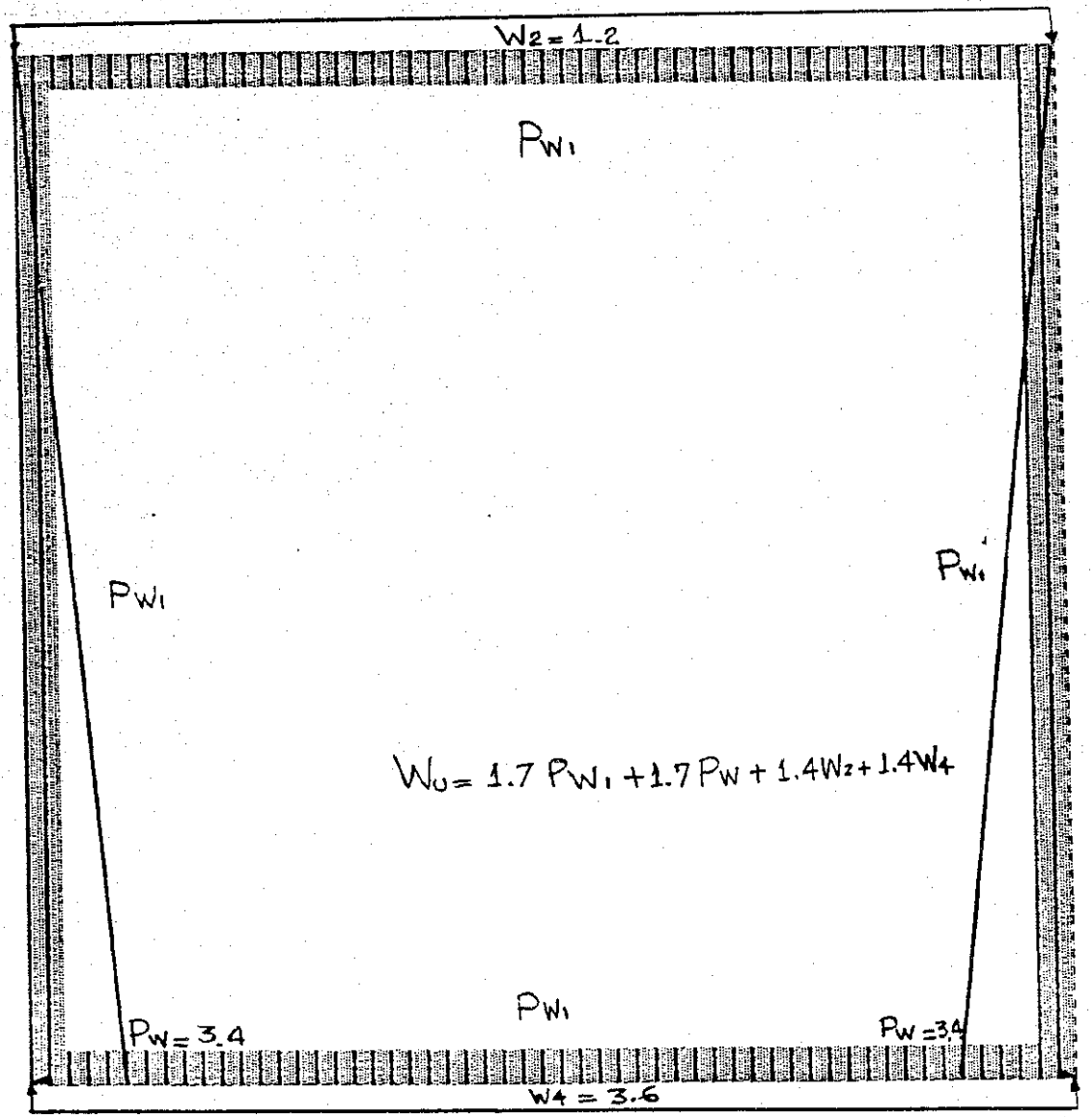
qL

FRAME
LOADS

LOAD
ton/mt

MINIMA
U -.9270E+01
P .0000E+00
MAXIMA
U .9270E+01
P .0000E+00

SAP90



SIPHON

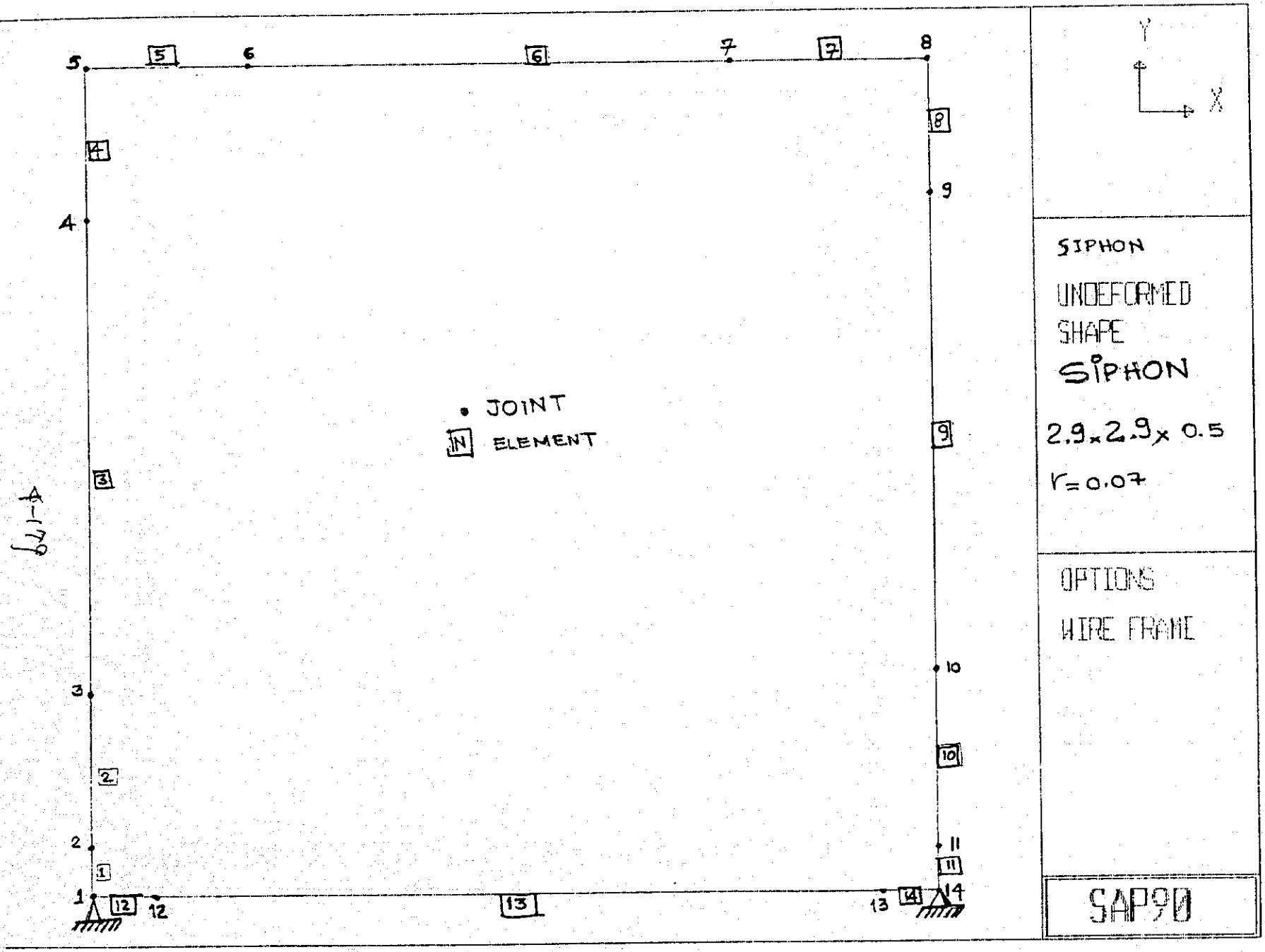
FRAME
LOADS

LOAD

SIPHON

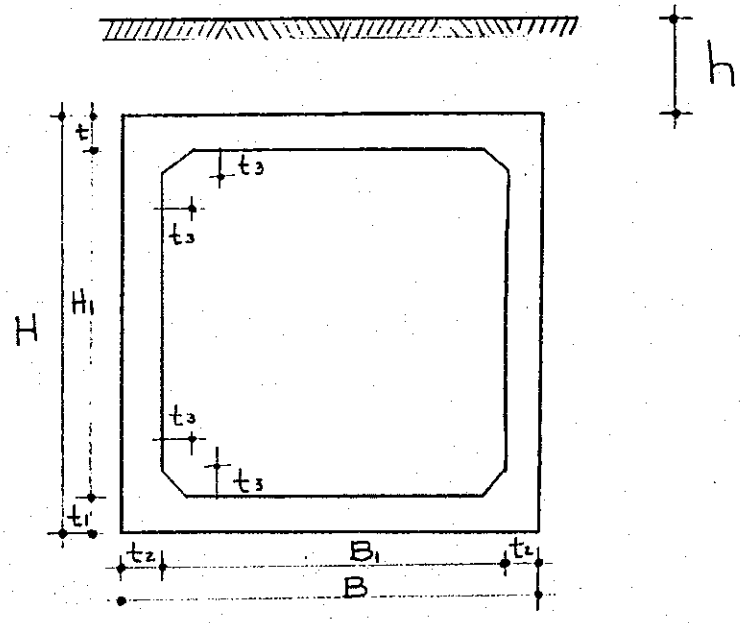
MINIMA
u -.1000E+01
P .0000E+00
MAXIMA
u .1000E+01
P .3000E+00

SAP90

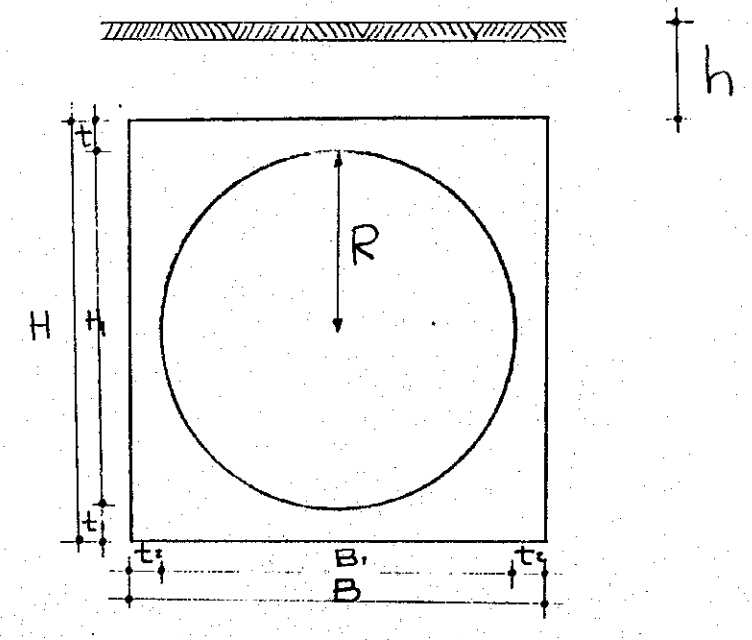

Y
X
SIPHON
UNDEFORMED
SHAPE
SIPHON
2.9x2.9x 0.5
r=0.07
OPTIONS
WIRE FRAME
SAP90
JOINT
ELEMENT
A-17

DIMENSIONS

SIPHON A



SIPHON B



TIPO / DIM	A	B	
H	3,9	4,2	
H_1	2,9	3,2	
B	3,9	4,2	
B_1	2,9	3,2	
t	0,5	0,5	
t_1	0,5	0,5	
t_2	0,5	0,5	
t_3	0,3	0,3	
R		3,2	

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4-180

```
:FON h=5.0   si1
:STEM
:5

)INTS
   X=0    Y=0     Z=0
          Y=0.01
          Y=0.55
          Y=2.85
   X=0.0 Y=3.40
   X=0.55 Y=3.40
   X=2.85 Y=3.40
   X=3.4  Y=3.40
   X=3.4  Y=2.85
)  X=3.4  Y=.55
   X=3.4  Y=0.01
2  X=0.01 Y=0.
3  X=3.39 Y=0.
   X=3.4  Y=0.

:STRAINTS
 14 1  R=0,0,1,1,1,0
 14 13 R=1,1,1,1,1,0

?AME
1=2 NL=19
 SH=R T=.70,1    E=2100000.
 SH=R T=.50,1
 WL=0,-10.65      :w2
 WL=0,-1.20       :w2
 WL=0             :w3
 WL=0,10.65       :w4
 WL=0,3.60        :w4
 WL=0,1.00        :pw1
 TRAP=0,-7.785,0,0.54,-7.290    :wt
 TRAP=0,-7.290,0,2.30,-5.220    :wt
 TRAP=0,-5.220,0,0.55,-4.725    :wt
) TRAP=0,-4.725,0,0.55,-5.220   :wt
1 TRAP=0,-5.220,0,2.30,-7.290   :wt
2 TRAP=0,-7.290,0,0.54,-7.785   :wt
3 wl=0,-1.0       :pw1
4 TRAP=0,3.400,0,0.54,2.850   :pw
5 TRAP=0,2.850,0,2.30,0.550   :pw
6 TRAP=0,0.550,0,0.55          :pw
7 TRAP=0,0.000,0,0.55,0.550    :pw
8 TRAP=0,0.550,0,2.30,2.850   :pw
9 TRAP=0,2.850,0,0.54,3.400   :pw
 1 2  M=1,1,1 nsl=0        LP=1,0
 2 3  m=1,2,1 NSL=7,0,0,6,14
 3 4  m=2,2,1 nsl=8,0,0,6,15
 4 5  m=2,1,1 nsl=9,0,0,6,16
 5 6  m=1,2,1 NSL=1,2,0,6
 6 7  M=2,2,1 nsl=1,2,0,6
 7 8  m=2,1,1 nsl=1,2,0,6
 8 9  m=1,2,1 NSL=10,0,0,6,17
 9 10 m=2,2,1 nsl=11,0,0,6,18
) 10 11 M=2,1,1 nsl=12,0,0,6,19
1 11 14 m=1,1,1 NSL=0
2 1  12 m=1,2,1 nsl=4,5,3,13
3 12 13 m=2,2,1 nsl=4,5,3,13
4 13 14 m=2,1,1 nsl=4,5,3,13

)mbo
 c=1.7,1.4
```

4-181

```
c=0,1.4,0,1.7,1.7

FON h=1.0 ; h'=1      si2
STEM
5

INTS
   X=0    Y=0     Z=0
          Y=0.01
          Y=0.55
          Y=2.85
   X=0.0  Y=3.40
   X=0.55 Y=3.40
   X=2.85 Y=3.40
   X=3.4  Y=3.40
   X=3.4  Y=2.85
   X=3.4  Y=.55
   X=3.4  Y=0.01
   X=.01  Y=0
   X=3.39 Y=0
   X=3.4  Y=0

STRAINTS
 14 1  R=0,0,1,1,1,0
 14 13 R=1,1,1,1,1,0

AME
=2 NL=19
 SH=R T=.70,1    E=2100000.
 SH=R T=.50,1
 WL=0,-1.8         :w2
 WL=0,-1.2         :w2
 WL=0,5.4          :w3
 WL=0,7.2          :w4
 WL=0,3.60         :w4
 WL=0,1.00         :pw1
 TRAP=0,-7.160,0,0.54,-6.390    :wt
 TRAP=0,-6.390,0,2.30,-3.170    :wt
 TRAP=0,-3.170,0,0.55,-2.400    :wt
 TRAP=0,-2.400,0,0.55,-3.170    :wt
 TRAP=0,-3.170,0,2.30,-6.390    :wt
 TRAP=0,-6.390,0,0.54,-7.160    :wt
 wl=0,-1.0         :pw1
 TRAP=0,3.400,0,0.54,2.850    :pw
 TRAP=0,2.850,0,2.30,0.550    :pw
 TRAP=0,0.550,0,0.55           :pw
 TRAP=0,0.000,0,0.55,0.550    :pw
 TRAP=0,0.550,0,2.30,2.850    :pw
 TRAP=0,2.850,0,0.54,3.400    :pw
 1 2   M=1,1,1 nsl=0        LP=1,0
 2 3   m=1,2,1 NSL=7,0,0,6,14
 3 4   m=2,2,1 nsl=8,0,0,6,15
 4 5   m=2,1,1 nsl=9,0,0,6,16
 5 6   m=1,2,1 NSL=1,2,0,6
 6 7   M=2,2,1 nsl=1,2,0,6
 7 8   m=2,1,1 nsl=1,2,0,6
 8 9   m=1,2,1 NSL=10,0,0,6,17
 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 14 m=1,1,1 NSL=0
 1  12 m=1,2,1 nsl=4,5,3,13
 12 13 m=2,2,1 nsl=4,5,3,13
 13 14 m=2,1,1 nsl=4,5,3,13

mbo
 c=1.7,1.4,1.7
```

4-182

: c=0,1.4,0,1.7,1.7

- DATA FOR CALCULATION OF THE REINFORCEMENT

$f'_c = 210\ kg/cm^2$

$f_y = 4200\ Kg/cm^2$

$b = 100\ cm$

$d = 43\ cm$

$r = 7\ cm$

$M_U = 20.658\ ton\text{-}mt$

$$A_s = \frac{20.658 \times 10^5}{0.9 \times 4200 \times 43} = 12.709\ cm^2$$

$$a = \frac{12.709}{0.85 \times 210 \times 100} = 7.12 \times 10^{-4}\ cm$$

$$\rho = \frac{12.709}{100 \times 43} = 0.002956 < \rho_{min}$$

$A_{s\,min} = 0.0033 \times 100 \times 43 = 14.33 = 6\varnothing 18 \Rightarrow 1\varnothing 18@20$

$A_{s\ SHRINKAGE} = 0.002 \times 100 \times 50 = 10.0\ cm^2$ S/face $\quad 1\varnothing 12 @ 25$ IN EACH FACE

- SHEAR STRESS CHECK

$V_c = 0.85 \times 0.53\sqrt{210} \times 100 \times 43 = 28.071.9\ Kg$

$V_U = 20.988 < V_c$ $\quad h = 5\ mt$, pressure of water $= 5.0\ T/M^2$

$V_U = 34.190 > V_c$ $\quad h = 10\ mt$, pressure of water $= 10.0\ T/M^2$

$V_s = 28.071 - 34.199 = 6.127.03$

$$A_V = \frac{6.127.03}{0.85 \times 4.200 \times \sin 45} = 2.4271\ cm^2$$

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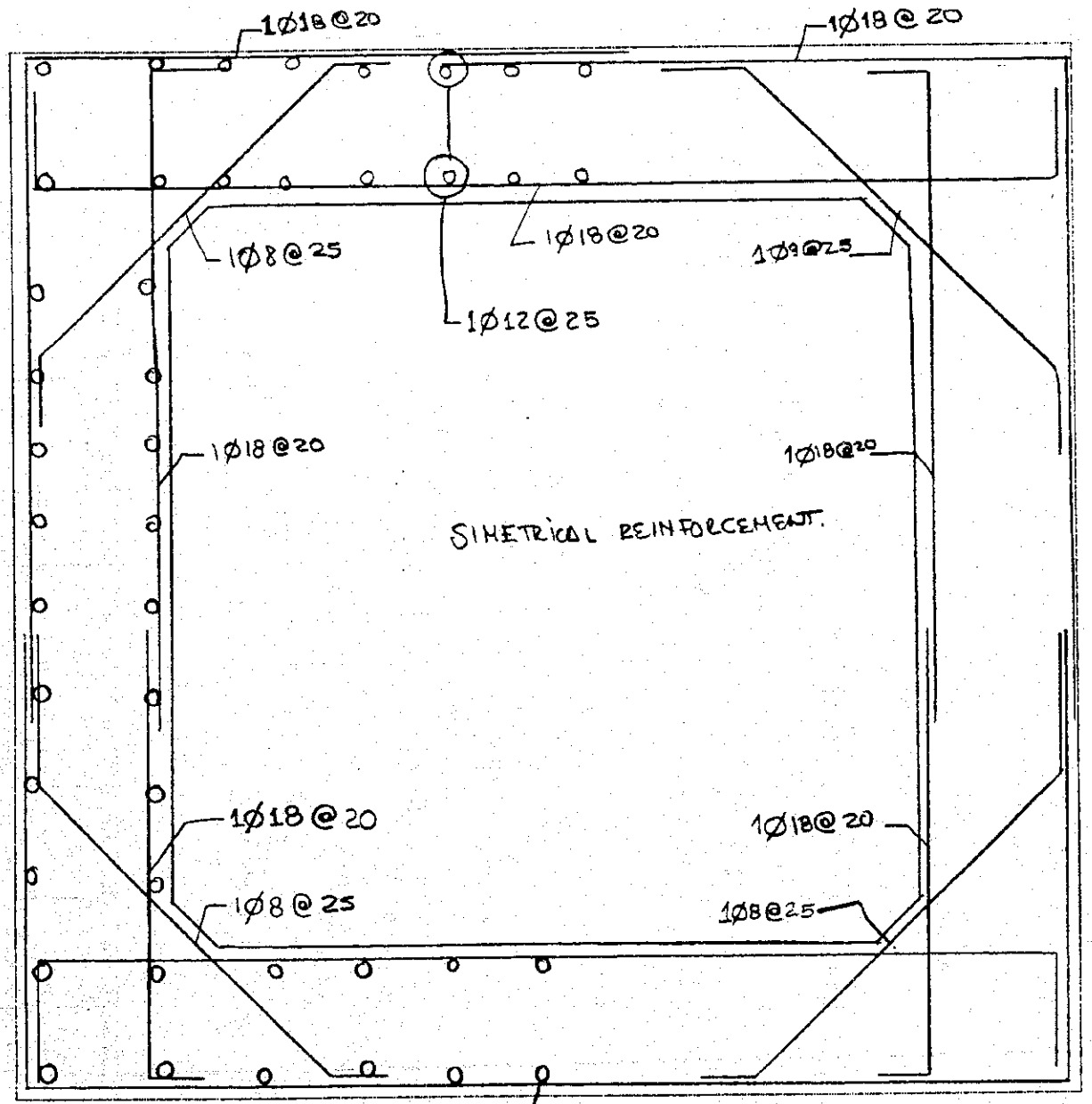


A-20

Y
X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

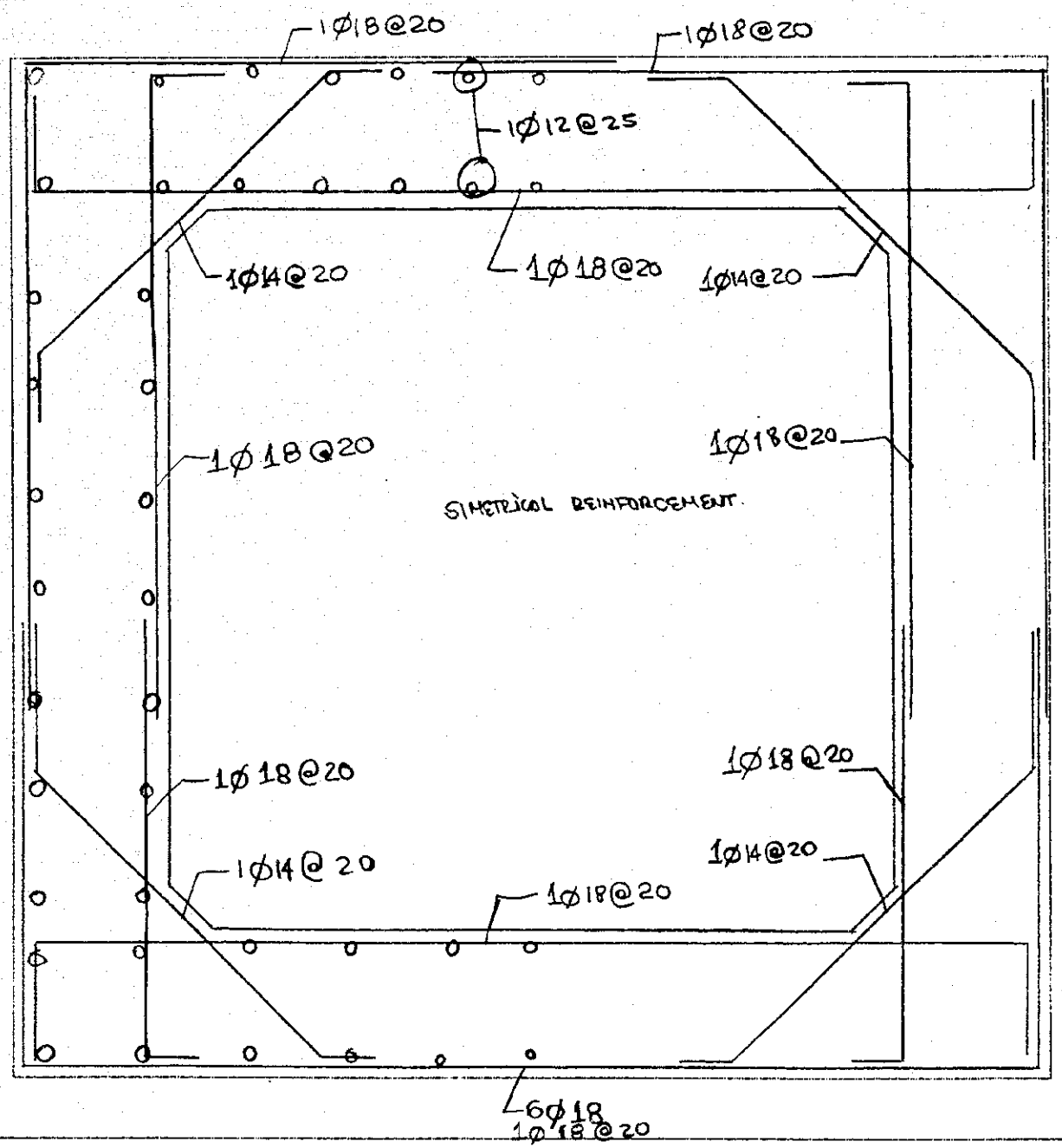
h=1 ; h'= 1

pressure of water = 5T/m²
= 10T/H²

OPTIONS

WIRE FRAME

SAP90



SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

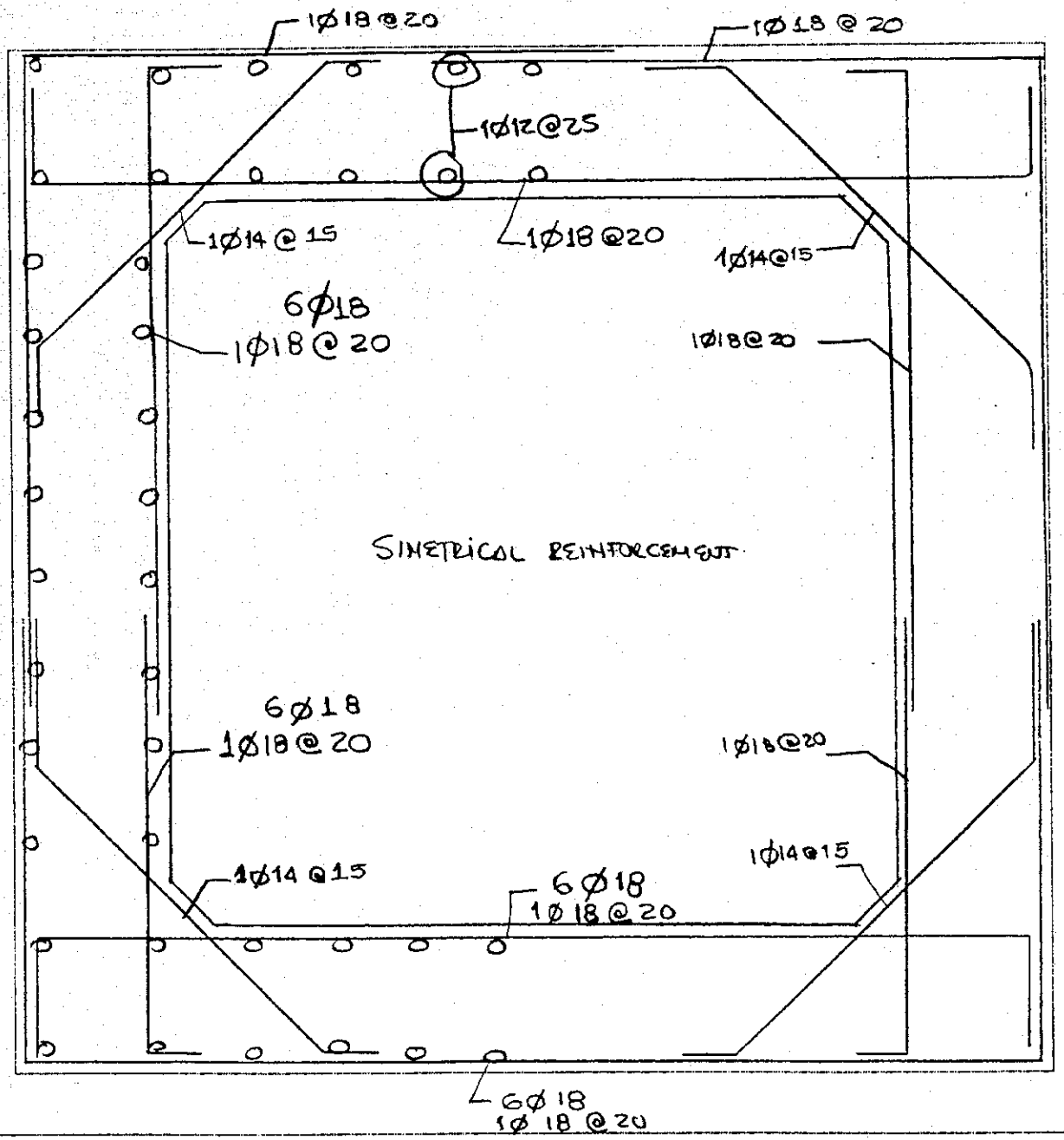
$h = 1$; $h' = 1$

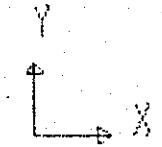
pressure of water = 15 T/m²

OPTIONS

WIRE FRAME

SAP90





SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

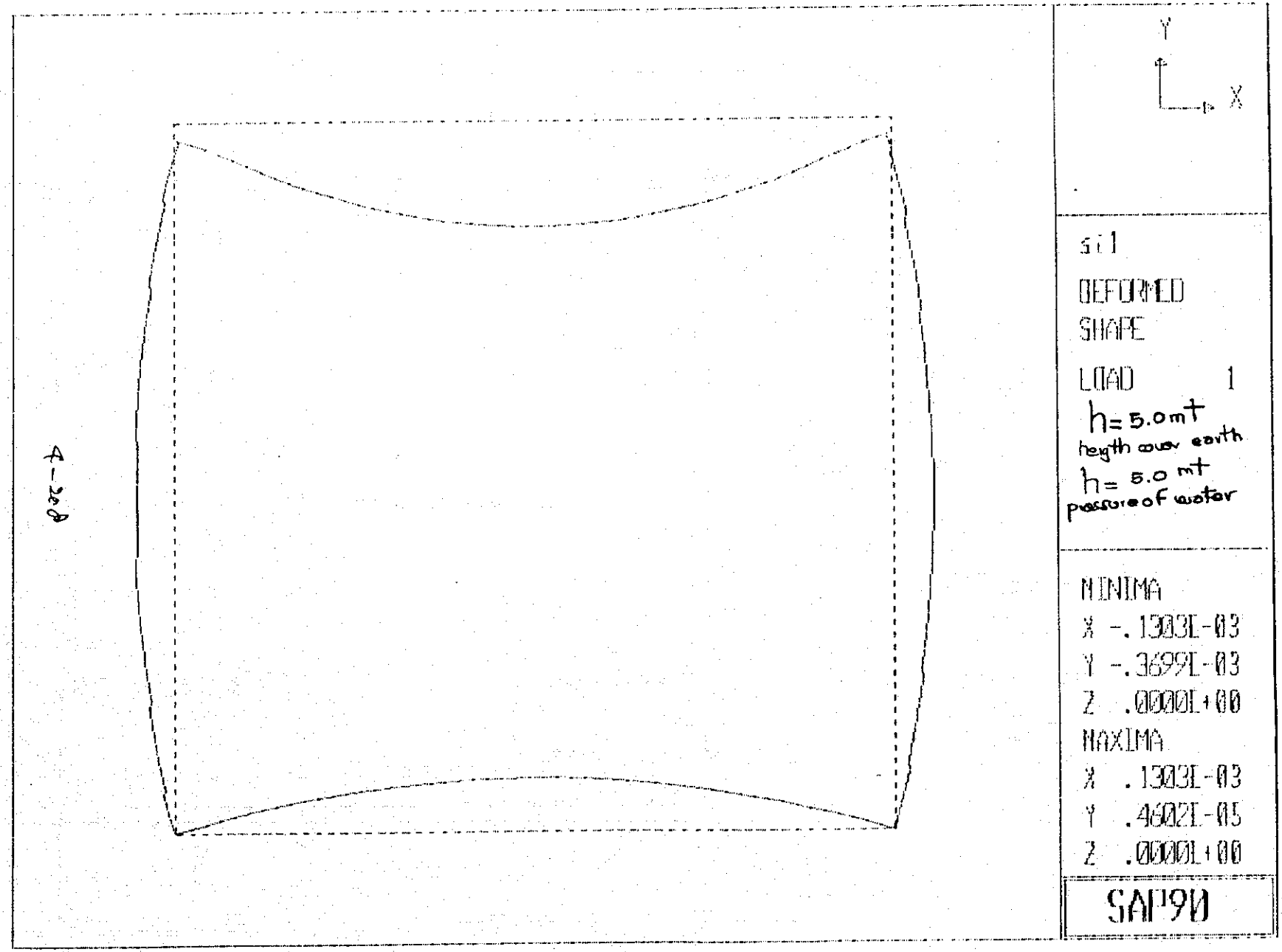
$h = 1$; $h' = 1$

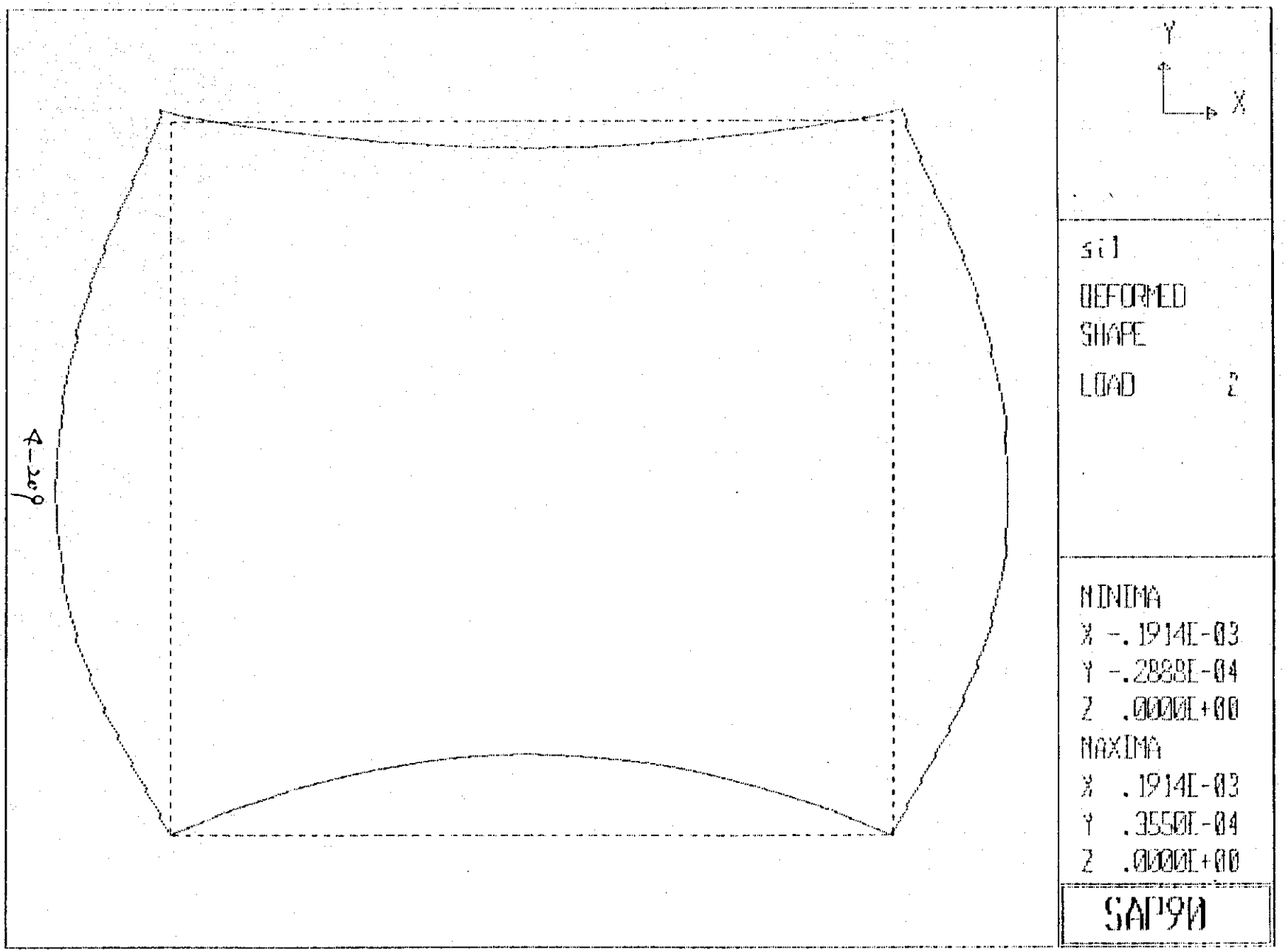
pressure of water = 18 T/m²

OPTIONS

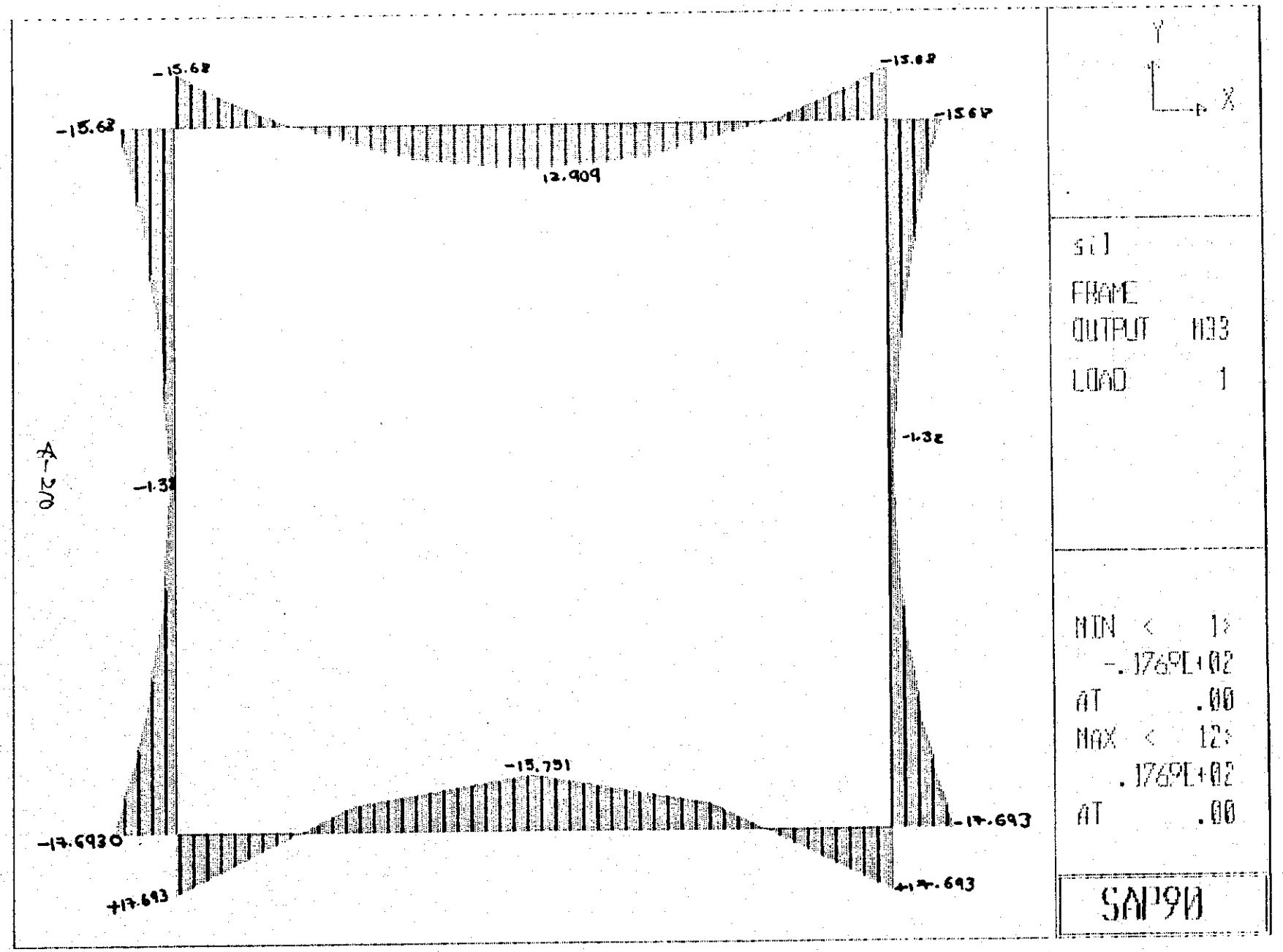
WIRE FRAME

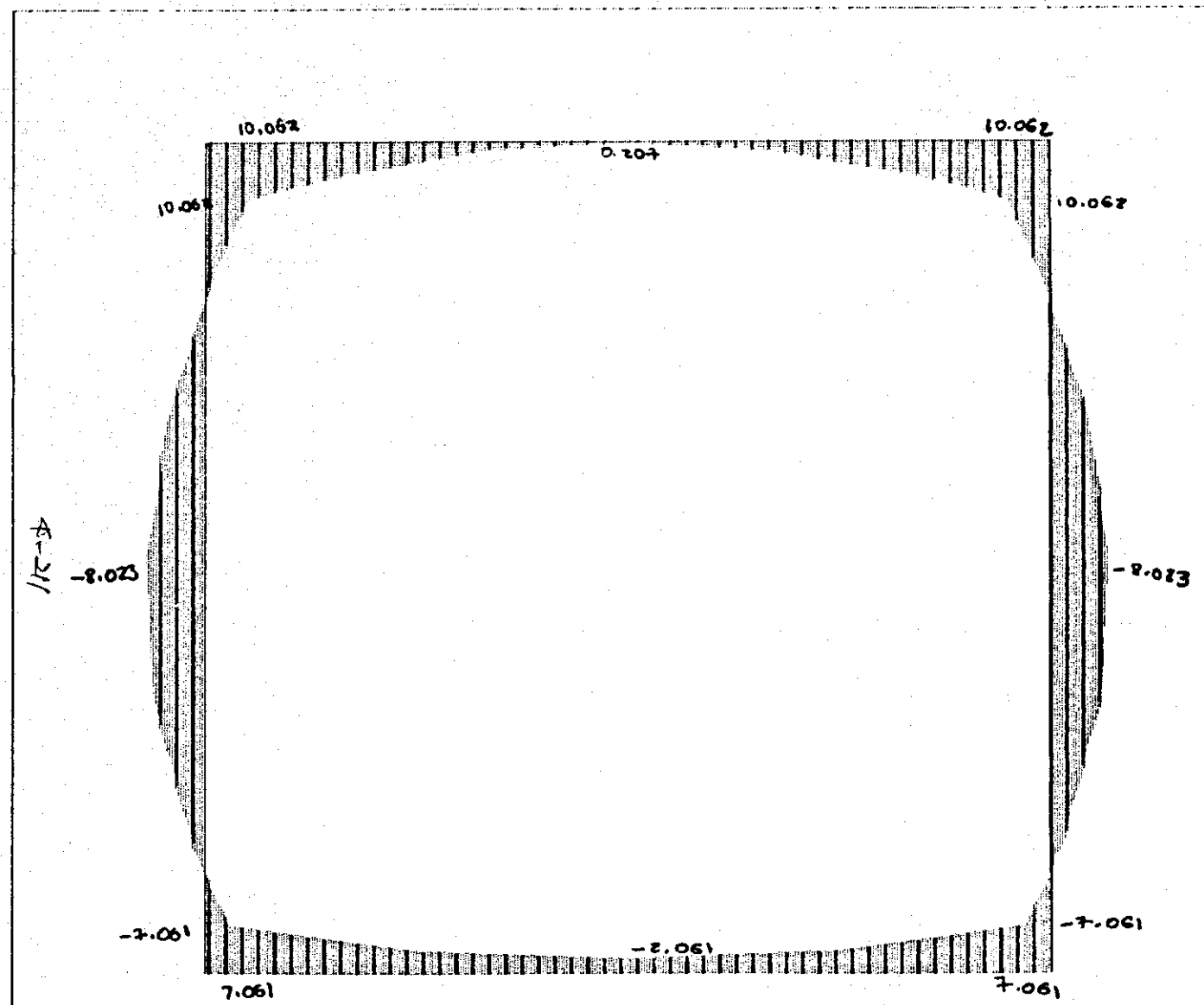
SAP90


Y
X
4-20
1:1
DEFORMED
SHAPE
LOAD 1
h=5.0mt
height over earth
h= 5.0 mt
pressure of water
MINIMA
X -.1303E-03
Y -.3699E-03
Z .0000E+00
MAXIMA
X .1303E-03
Y .4602E-05
Z .0000E+00
SAP90


Y
X
SET
DEFORMED
SHAPE
LOAD 2
MINIMA
X -.1914E-03
Y -.2888E-04
Z .0000E+00
MAXIMA
X .1914E-03
Y .3550E-04
Z .0000E+00
SAP90

4-209


-15.62
-15.62
12.909
-15.62
-15.67
-1.38
-1.38
-15.791
-17.693O
-17.693
+17.693
-17.693
+17.693
Y
X
ST]
FRAME
OUTPUT H33
LOAD 1
MIN < 1>
-.176PE+02
AT .00
MAX < 12>
.176PE+02
AT .00
SAP90

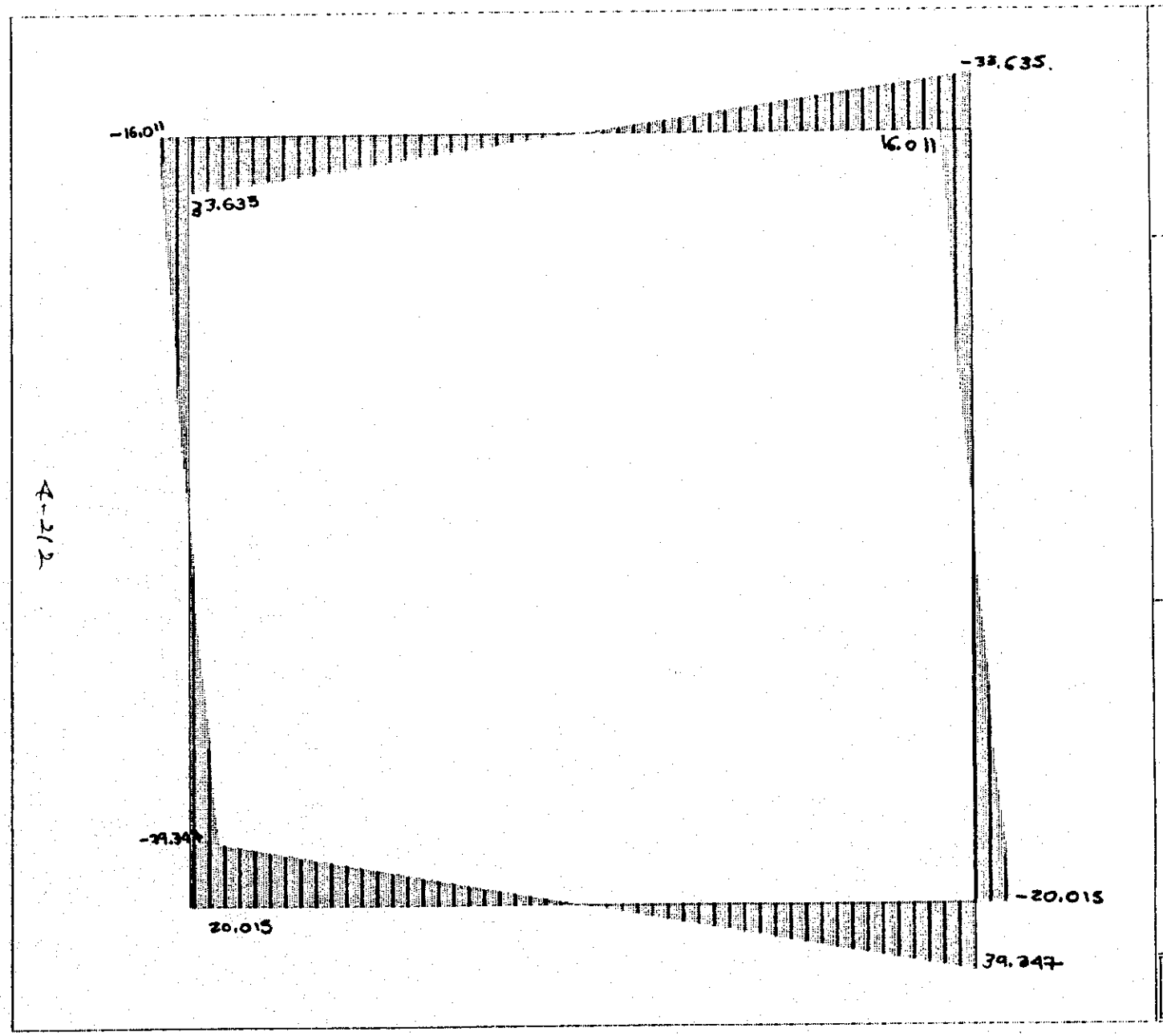


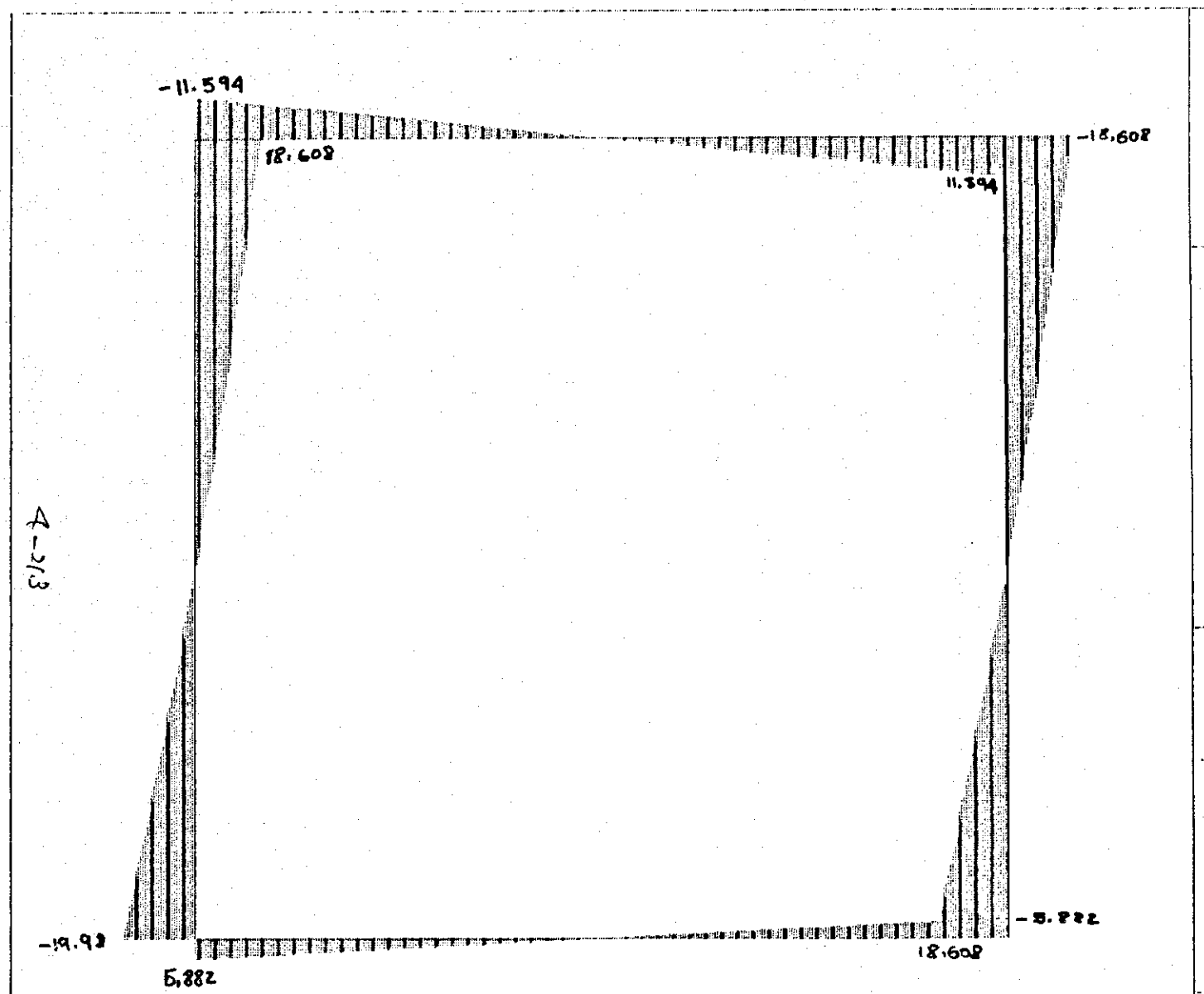
Y
X

Sc 1
FRAME
OUTPUT 133
LOAD 3

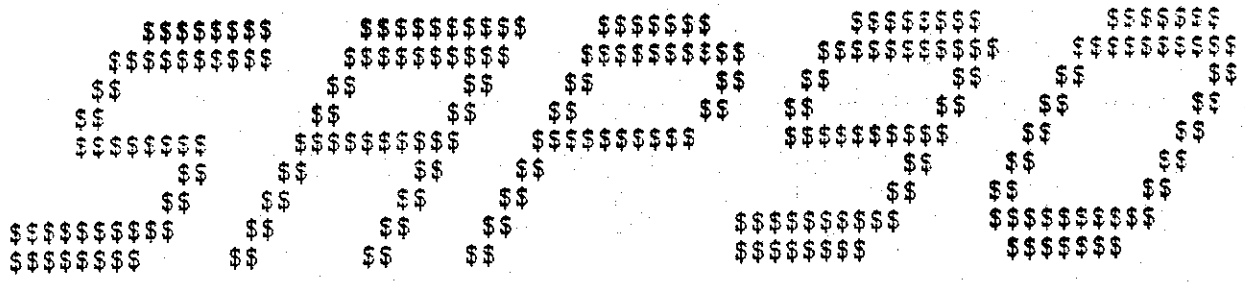
MIN < 3>
-.7897E+01
AT 1.15
MAX < 4>
.1006E+02
AT .55

SAP90


-33.635
-16.011
16.011
33.635
-39.347
-20.015
20.015
39.347
Y
X
Gil
FRAME
OUTPUT V22
LOAD 1
MIN < 12>
-.3935E+02
AT .00
MAX < 14>
.3935E+02
AT .01
SAP90


-11.594
18.608
-18.608
11.594
-19.93
5.882
18.608
-5.882
Y
X
st 1
FRAME
OUTPUT 022
LOAD 3
MIN < 1>
-.1998E+02
AT .00
MAX < 10>
.1998E+02
AT .54
SAP90

A-23



STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

SIFON h=5.0 si1 h = 5.0 pressure of water

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
1								
	1	.000			-33.634			
		.000	20.015	-17.693				
		.010	20.015	-17.493				
		.010			-33.634			
	2	.000			11.594			
		.000	-19.980	7.061				
		.010	-19.980	6.861				
		.010			11.594			
2								
	1	.000			-33.634			
		.000	20.015	-17.493				
		.540	13.095	-8.574				
		.540			-33.634			
	2	.000			11.594			
		.000	-19.980	6.861				
		.540	-12.521	-1.891				
		.540			11.594			
3								
	1	.000			-33.634			
		.000	13.095	-8.574				
		1.136	.000	-1.320				
		2.300	-11.362	-8.131				
		2.300			-33.634			
	2	.000			11.594			
		.000	-12.521	-1.891				
		1.002	.000	-8.023				
		2.300	13.676	1.160				
		2.300			11.594			
4								
	1	.000			-33.634			
		.000	-11.362	-8.131				

	2	.000			11.594			
		.000	13.676	1.160				
		.550	18.608	10.062				
		.550			11.594			
5								
	1	.000			-16.011			
		.000	33.635	-15.680				
		.550	22.753	-.173				

SIFON h=5.0 si1

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIA TOR
		.550			-16.011			
	2	.000			18.608			
		.000	-11.594	10.062				
		.550	-7.843	4.717				
		.550			18.608			
6								
	1	.000			-16.011			
		.000	22.753	-.173				
		1.150	.000	12.909				
		2.300	-22.753	-.173				
		2.300			-16.011			
	2	.000			18.608			
		.000	-7.843	4.717				
		1.150	.000	.207				
		2.300	7.843	4.717				
		2.300			18.608			
7								
	1	.000			-16.011			
		.000	-22.753	-.173				
		.550	-33.635	-15.680				
		.550			-16.011			
	2	.000			18.608			
		.000	7.843	4.717				
		.550	11.594	10.062				
		.550			18.608			
8								
	1	.000			-33.634			
		.000	16.011	-15.680				
		.550	11.362	-8.131				
		.550			-33.634			
	2	.000			11.594			
		.000	-18.608	10.062				
		.550	-13.676	1.160				
		.550			11.594			
9								
	1	.000			-33.634			
		.000	11.362	-8.131				
		1.164	.000	-1.320				
		2.300	-13.095	-8.574				
		2.300			-33.634			
	2	.000			11.594			
		.000	-13.676	1.160				

SIFON h=5.0 si1

F R A M E E L E M E N T F O R C E S

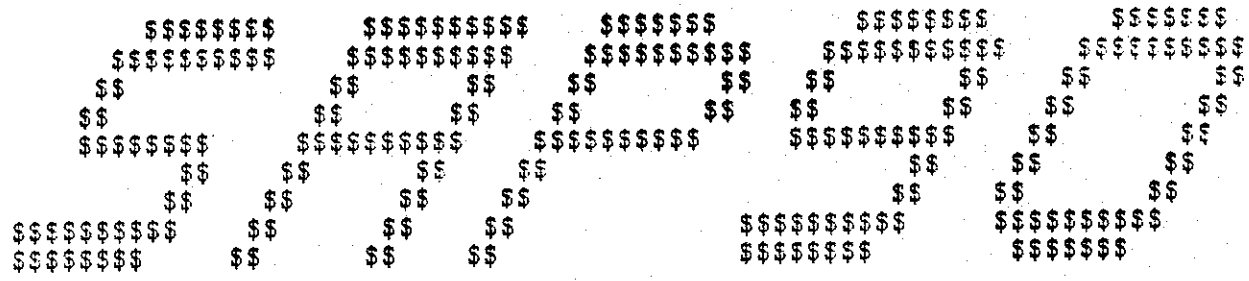
ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		1.298	.000	-8.023				
		2.300	12.521	-1.891				
		2.300			11.594			
10								
	1	.000			-33.634			
		.000	-13.095	-8.574				
		.540	-20.015	-17.493				
		.540			-33.634			
	2	.000			11.594			
		.000	12.521	-1.891				
		.540	19.980	6.861				
		.540			11.594			
11								
	1	.000			-33.634			
		.000	-20.015	-17.493				
		.010	-20.015	-17.693				
		.010			-33.634			
	2	.000			11.594			
		.000	19.980	6.861				
		.010	19.980	7.061				
		.010			11.594			
12								
	1	.000			.000			
		.000	-39.347	17.693				
		.010	-39.115	17.301				
		.010			.000			
	2	.000			.000			
		.000	5.882	-7.061				
		.010	5.847	-7.002				
		.010			.000			
13								
	1	.000			.000			
		.000	-39.115	17.301				
		1.690	.000	-15.751				
		3.380	39.115	17.301				
		3.380			.000			
	2	.000			.000			
		.000	5.847	-7.002				
		1.690	.000	-2.061				
		3.380	-5.847	-7.002				
		3.380			.000			

SIFON h=5.0 si1

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
14								
	1	.000			.000			
		.000	39.115	17.301				
		.010	39.347	17.693				
		.010			.000			

.000	-5.647	-7.002	
.010	-5.882	-7.061	
.010			.000



STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

SIFON h=10.0 si1

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
1								
	1	.000			-33.634			
		.000	20.015	-17.693				
		.010	20.015	-17.493				
		.010			-33.634			
	2	.000			26.044			
		.000	-34.190	15.616				
		.010	-34.190	15.274				
		.010			26.044			
2								
	1	.000			-33.634			
		.000	20.015	-17.493				
		.540	13.095	-8.574				
		.540			-33.634			
	2	.000			26.044			
		.000	-34.190	15.274				
		.540	-22.141	.088				
		.540			26.044			
3								
	1	.000			-33.634			
		.000	13.095	-8.574				
		1.136	.000	-1.320				
		2.300	-11.362	-8.131				
		2.300			-33.634			
	2	.000			26.044			
		.000	-22.141	.088				
		1.057	.000	-11.446				
		2.300	23.606	3.497				
		2.300			26.044			
4								
	1	.000			-33.634			
		.000	-11.362	-8.131				

	2	.000			26.044			
		.000	23.606	3.497				
		.550	33.213	19.146				
		.550			26.044			
5								
	1	.000			-16.011			
		.000	33.635	-15.680				
		.550	22.753	-.173				

SIFON h=5.0 si1

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXI. TO
		.550			-16.011			
	2	.000			33.213			
		.000	-26.044	19.146				
		.550	-17.618	7.139				
		.550			33.213			
6								
	1	.000			-16.011			
		.000	22.753	-.173				
		1.150	.000	12.909				
		2.300	-22.753	-.173				
		2.300			-16.011			
	2	.000			33.213			
		.000	-17.618	7.139				
		1.150	.000	-2.992				
		2.300	17.618	7.139				
		2.300			33.213			
7								
	1	.000			-16.011			
		.000	-22.753	-.173				
		.550	-33.635	-15.680				
		.550			-16.011			
	2	.000			33.213			
		.000	17.618	7.139				
		.550	26.044	19.146				
		.550			33.213			
8								
	1	.000			-33.634			
		.000	16.011	-15.680				
		.550	11.362	-8.131				
		.550			-33.634			
	2	.000			26.044			
		.000	-33.213	19.146				
		.550	-23.606	3.497				
		.550			26.044			
9								
	1	.000			-33.634			
		.000	11.362	-8.131				
		1.164	.000	-1.320				
		2.300	-13.095	-8.574				
		2.300			-33.634			
	2	.000			26.044			
		.000	-23.606	3.497				

F R A M E E L E M E N T F O R C E S

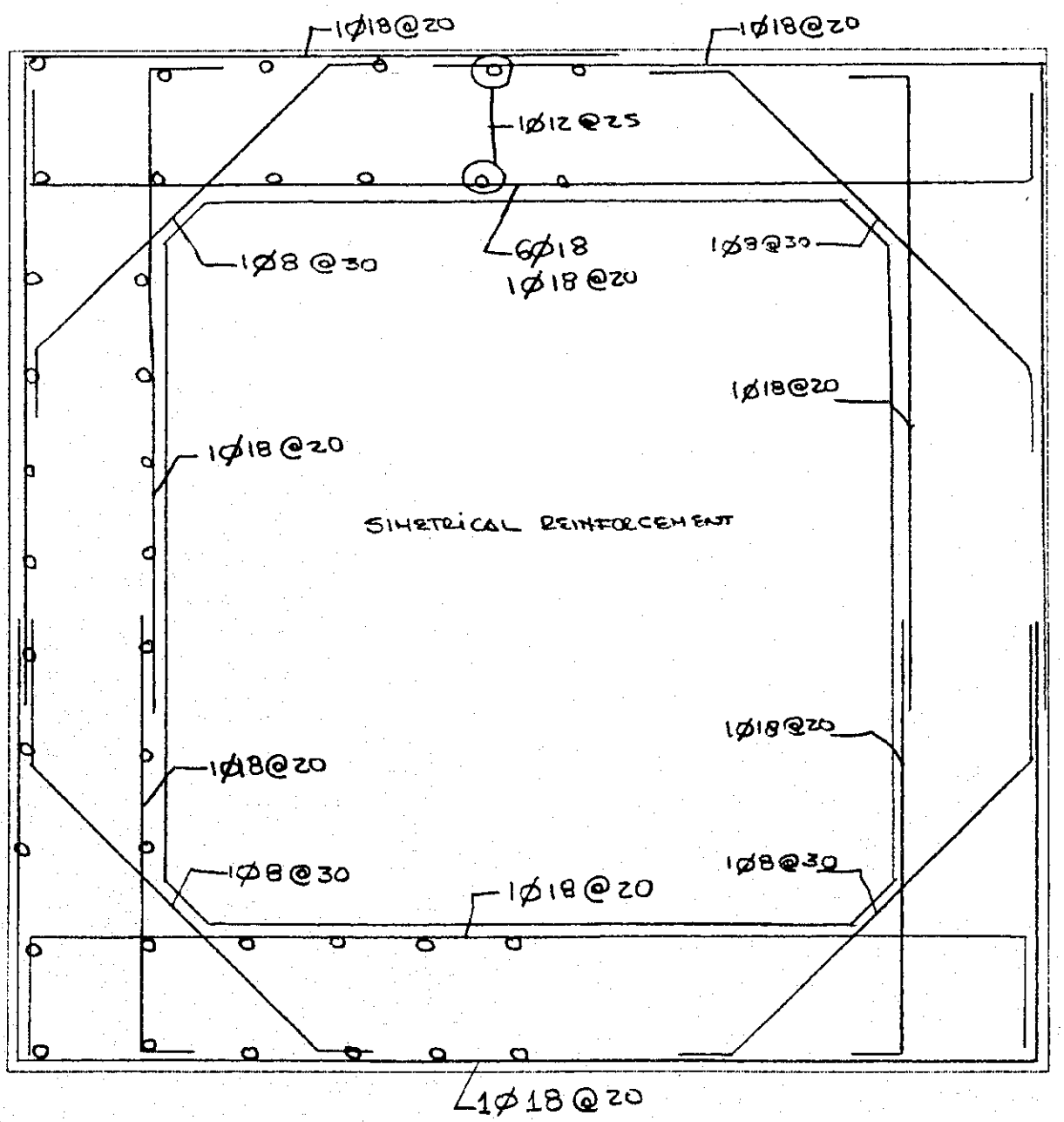
ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		1.243	.000	-11.446				
		2.300	22.141	.088				
		2.300			26.044			
10								
	1	.000			-33.634			
		.000	-13.095	-8.574				
		.540	-20.015	-17.493				
		.540			-33.634			
	2	.000			26.044			
		.000	22.141	.088				
		.540	34.190	15.274				
		.540			26.044			
11								
	1	.000			-33.634			
		.000	-20.015	-17.493				
		.010	-20.015	-17.693				
		.010			-33.634			
	2	.000			26.044			
		.000	34.190	15.274				
		.010	34.190	15.616				
		.010			26.044			
12								
	1	.000			.000			
		.000	-39.347	17.693				
		.010	-39.115	17.301				
		.010			.000			
	2	.000			.000			
		.000	20.332	-15.616				
		.010	20.212	-15.414				
		.010			.000			
13								
	1	.000			.000			
		.000	-39.115	17.301				
		1.690	.000	-15.751				
		3.380	39.115	17.301				
		3.380			.000			
	2	.000			.000			
		.000	20.212	-15.414				
		1.690	.000	1.666				
		3.380	-20.212	-15.414				
		3.380			.000			

SIFON h=5.0 si1

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
14								
	1	.000			.000			
		.000	39.115	17.301				
		.010	39.347	17.693				
		.010			.000			

.000	-20.212	-15.414	
.010	-20.332	-15.616	
.010			.000



SIPHON

UNDEFORMED SHAPE

REINFORCEMENT FOR $h = 5.0$ mt

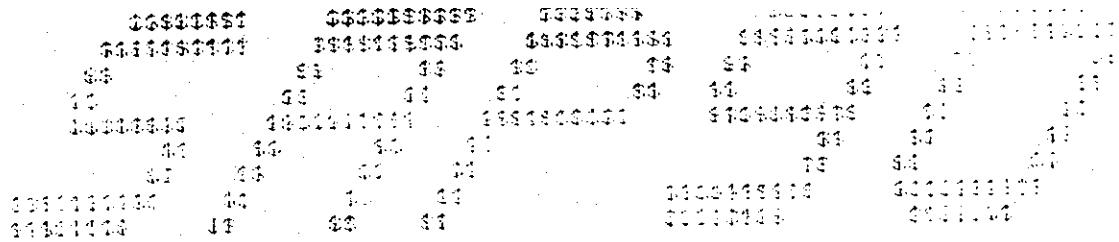
pressure of water = 5.0 T/m²
= 10. T/m²

OPTIONS

WIRE FRAME

SAP90

4-232



STRUCTURAL ANALYSIS PROGRAM

VERSION 7.41

INPUT FILE: h15.0

F R A M E E L E M E N T F O R C E S

ELEMENT	JOINT	LOAD	IN PLANE SHEAR	IN PLANE MOMENT	AXIAL FORCE	OUT OF PLANE SHEAR	OUT OF PLANE MOMENT	AXIAL TORQUE
1	I	1			-32.654			
		2		-17.693				
		3	20.113	-47.473				
	J				-55.674			
		1			40.494			
		2	-41.211	24.172				
		3	-41.789	85.686				
					40.494			
2	I	1			-55.654			
		2	21.113	-17.693				
		3	37.687	-1.574				
	J				-55.654			
		1			37.074			
		2	-21.211	22.419				
		3	-3.789	2.412				
					41.494			
3	I	1			-55.654			
		2	21.211	-17.693				
		3	3.789	-2.412				
	J				-55.654			
		1			40.494			
		2	-21.211	3.067				
		3	-37.687	-24.944				
					40.494			
4	I	1			-32.654			
		2	-21.211	-3.151				
	J							

ACTIC

SIFON N=1.0 sil

F R A M E E L E M E N T F O R C E S

EL	LOAD	STAT	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
	ID	END	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ
		.550			-16.011			
		.000			47.819			
		.000	-40.494	28.230				
		.550	-27.393	9.561				
		.550			47.819			
4								
	1	.000			-16.011			
		.000	22.733	-.173				
		1.100	.000	12.907				
		1.100	-21.733	-.173				
		1.100			-16.011			
	2	.000			47.819			
		.000	-27.393	9.561				
		1.100	.000	-6.190				
		1.100	27.393	9.561				
		1.100			47.819			
5								
	1	.000			-16.011			
		.000	-21.733	-.173				
		.550	-33.636	-15.680				
		.550			-16.011			
	2	.000			47.819			
		.000	27.393	9.561				
		.550	40.494	28.230				
		.550			47.819			
6								
	1	.000			-33.634			
		.000	16.911	-15.680				
		.550	11.363	-8.131				
		.550			-33.634			
	2	.000			40.494			
		.000	-47.819	28.230				
		.550	-33.636	9.808				
		.550			40.494			
7								
	1	.000			-33.634			
		.000	11.363	-8.131				
		1.100	.000	-1.330				
		1.100	-13.095	-8.574				
		1.100			-33.634			
	2	.000			40.494			
		.000	-33.636	9.808				

SIFON H=5.0 sil

F R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	SECT ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXI TO
	1.000			40.494			
	1.000	.000	-14.894				
	2.000	21.761	2.067				
	2.300			40.494			
10							
1	.000			-33.634			
	.000	-18.095	-8.574				
	.540	-20.015	-17.493				
	.540			-33.634			
1	.000			40.494			
	.000	21.761	2.067				
	.540	48.399	25.606				
	.540			40.494			
11							
1	.000			-33.634			
	.000	-20.015	-17.493				
	.010	-20.015	-17.693				
	.020			-33.634			
1	.000			40.494			
	.000	48.399	25.606				
	.020	48.399	24.172				
	.020			40.494			
12							
1	.000			.000			
	.000	-22.347	17.693				
	.010	-22.115	17.501				
	.010			.000			
2	.000			.000			
	.000	22.782	-24.172				
	.010	22.777	-23.825				
	.010			.000			
13							
1	.000			.000			
	.000	-22.115	17.501				
	1.000	.000	-11.511				
	1.000	22.115	11.511				
	2.010			.000			
2	.000			.000			
	.000	-22.777	23.825				
	1.000	.000	-5.078				
	1.010	22.777	-22.223				
	2.010			.000			

NOTE

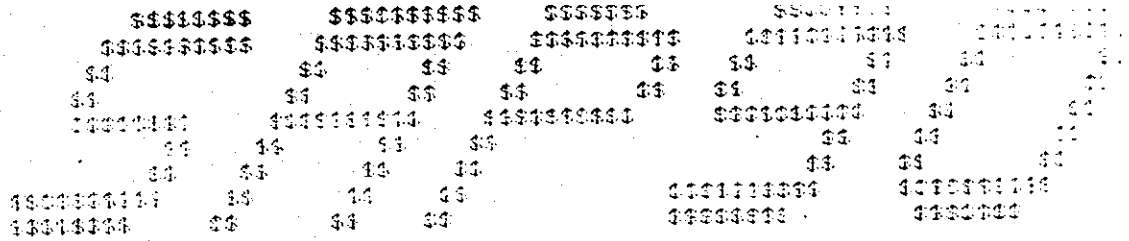
PAGE
PROGRAM:SAP90/FILE:sil.I

STP INFLOW sil

F R A M E E L E M E N T F O R C E S

ELT LOAD ID COMB	SECT ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXI TO
10							
1	.000			.000			
	.000	17.457	17.693				
	.540	20.015	17.493				
	.540			.000			

.000	-34.577	-25.825
.010	-34.782	-24.172
.010		.000



STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

NOTES

TITLE h=18.0

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST END	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TOR
1								
	1	.000			-33.634			
		.000	20.015	-17.493				
		.010	20.015	-17.493				
		.010			-33.634			
	2	.000			49.164			
		.000	-56.925	29.305				
		.010	-56.925	29.736				
		.010			49.164			
2								
	1	.000			-33.634			
		.000	20.015	-17.493				
		.540	12.007	-6.574				
		.540			-33.634			
	2	.000			49.164			
		.000	-56.925	29.736				
		.540	-37.552	3.255				
		.540			49.164			
3								
	1	.000			-33.634			
		.000	12.008	-6.574				
		1.136	.000	-1.320				
		2.300	-11.362	-8.131				
		2.300			-33.634			
	2	.000			49.164			
		.000	-37.552	3.255				
		1.067	.000	-10.966				
		2.300	39.493	7.233				
		2.300			49.164			
4								
	1	.000			-33.634			
		.000	-11.362	-8.131				

SIGN N=5.0 S11

F R A M E E L E M E N T F O R C E S

ELT	LOAD ID	COMB	DIST END	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
			.550			-16.011			
	2		.000			56.582			
			.000	-49.164	33.680				
			.550	-33.258	11.014				
			.550			56.582			
6									
	1		.000			-16.011			
			.000	22.753	-.173				
			1.150	.000	12.909				
			2.300	-22.753	-.173				
			2.300			-16.011			
	2		.000			56.582			
			.000	-33.258	11.014				
			1.150	.000	-8.110				
			2.300	33.258	11.014				
			2.300			56.582			
7									
	1		.000			-16.011			
			.000	-22.753	-.173				
			.550	-33.631	-15.680				
			.550			-16.011			
	2		.000			56.582			
			.000	33.258	11.014				
			.750	49.164	33.680				
			.550			56.582			
8									
	1		.000			-33.634			
			.000	16.011	-15.680				
			.550	11.362	-8.131				
			.550			-33.634			
	2		.000			49.164			
			.000	-56.582	33.680				
			.550	-39.495	7.235				
			.550			49.164			
9									
	1		.000			-33.634			
			.000	11.362	-8.131				
			1.164	.000	-1.320				
			2.300	-13.095	-9.574				
			2.300			-33.634			
	2		.000			49.164			
			.000	-39.495	7.235				

SIFON N=5.0 sil

FRAME ELEMENT FORCES

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		F
ID	TYPE	END	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	
		1.213	.000	-10.[illegible]				
		2.300	37.332	0.000				
		2.300			[illegible]			
10								
	-	[illegible]			-33.[illegible]			
		.000	-18.095	-8.574				
		.540	-29.815	-17.493				
		.540			-33.634			
	2	0.0			49.164			
		.000	37.332	0.000				
		.540	30.929	25.750				
		.540			49.164			
1								
	1	.000			-33.634			
		.000	-29.815	-17.493				
		.540	-30.615	-17.693				
		.540			-33.634			
	2	.000			49.164			
		.000	30.721	25.750				
		.010	30.725	25.305				
		.010			49.164			
2								
	-	.000			.000			
		.000	-29.347	17.693				
		.010	-29.115	17.301				
		.010			.000			
	2	.000			.000			
		.000	43.452	-29.305				
		.010	43.106	-29.879				
		.010			.000			
3								
	1	.000			.000			
		.000	-29.115	17.301				
		.010	[illegible]	-17.[illegible]				
		.010	[illegible]	17.301				
		.010			.000			
	2	.000			.000			
		.000	43.106	-29.879				
		.010	[illegible]	0.000				
		.010	-43.[illegible]	21.670				
		.010			.000			

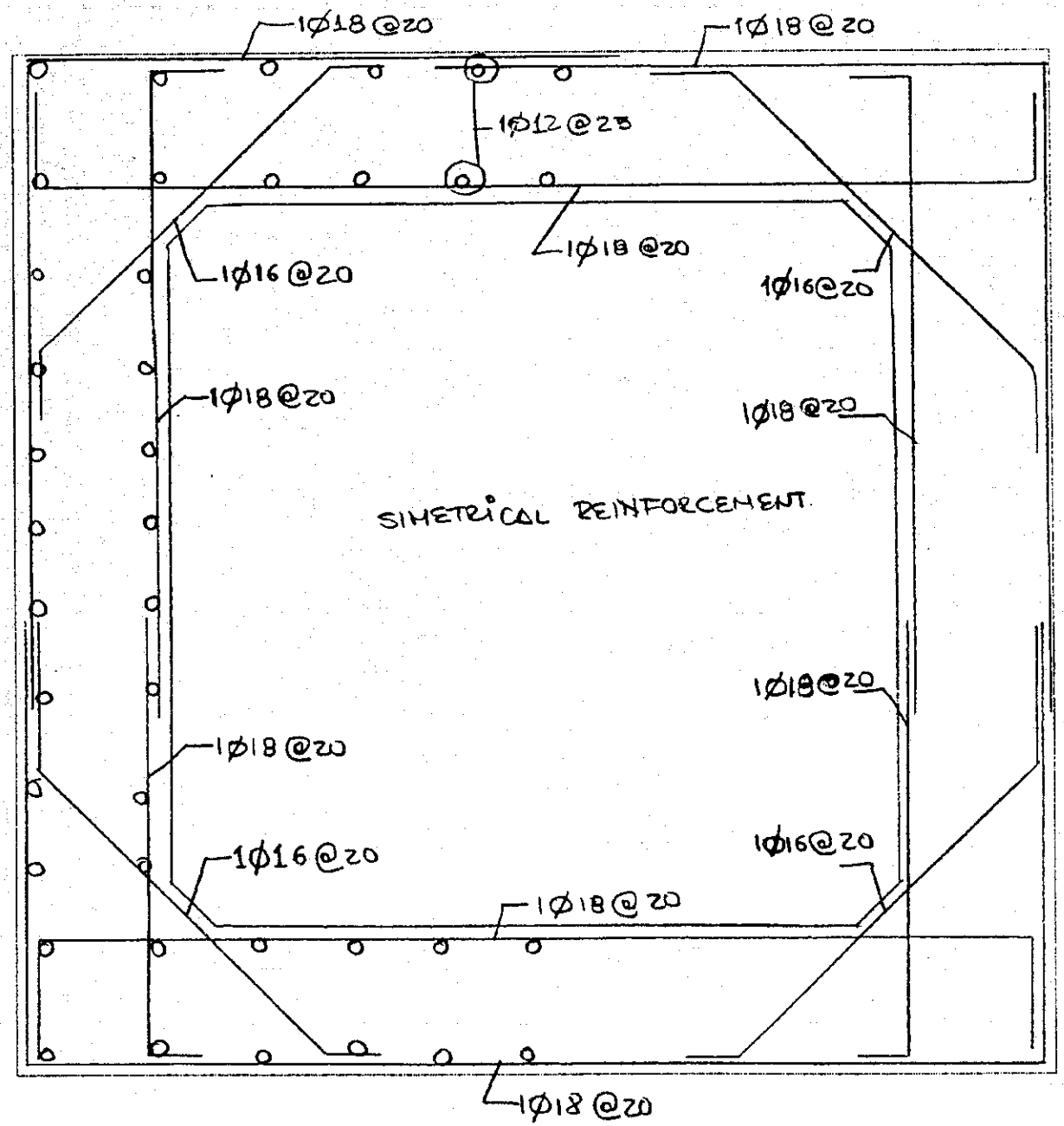
NOTE:

SIFON N=5.0 sil

FRAME ELEMENT FORCES

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXI
ID	CASE	END	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TO
10								
	-	[illegible]			.000			
		0.00	33.[illegible]	17.300				
		.00	[illegible]	17.693				
		.00			.000			

.000	-43.196	-28.872	
.010	-43.452	-29.305	
.010			.000



4-23/

Y
X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT FOR h= 5

pressure of water = 15T/M²
18T/M²

OPTIONS

WIRE FRAME

SAP90

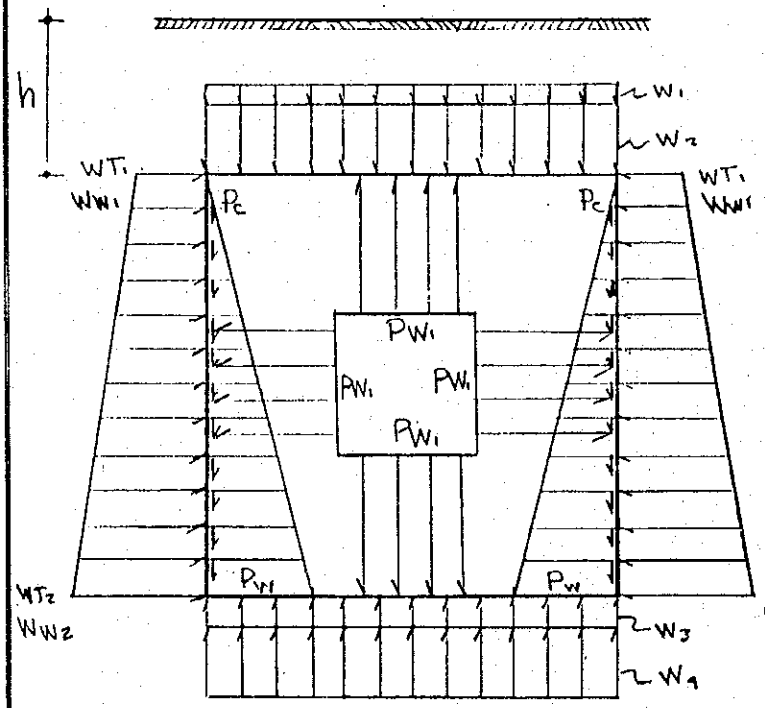
THE LOAD APPLIED FOR ANALYSIS AND DESIGN OF CIRCULAR SIPHON R = 3.2

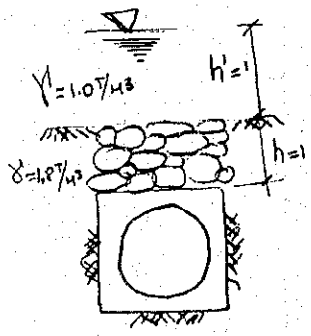
- THE LOADS APPLIED IN THE DESIGN OF CIRCULAR SIPHON ARE AS FOLLOWS :

W1 : LIVE LOAD OF HS-20-44 TRAILER
W12 : VERTICAL LOAD OF EARTH WEIGHT AND SELF WEIGHT OF TOP SLAB
W3 : SURCHARGE OF THE UPLIFT ACT ON BOTTOM SLAB.
W4 : REACTION LOAD ACT ON BOTTOM SLAB
WT : LATERAL EARTH PRESSURE
PW : LATERAL WATER PRESURE
Pc : LOAD OF CONCRETE
WW : PRESSURE OF WATER

DATA

$\gamma_{soil} = 1.80\ T/M^3$ UNIT WEIGHT
$\phi = 20°$ ANGLE OF INTERNAL FRICTION
$\gamma_{concrete} = 2.4\ T/M^3$ UNIT WEIGHT
$Ka = 0.50$ COEFFICIENT OF EARTH PRESSURE
$f'c = 180\ Kg/cm^2$ STRENGTH OF CONCRETE
$Fy = 4200\ Kg/cm^2$ YIELD STRENGHT OF REFORCING BAR
$E_{CONCRETE} = 2.1 \times 10^5$ MODULUS OF ELASTICITY (Kg/cm^2)
$E_{STEEL} = 2.1 \times 10^6$





CARGA / SECCION	W1	W2	W3	W4	WT1	WT2	Pc	PW	PW1	h	h'
R=3.2 0.5		11.25 1.2		11.25 4.709	5.625	8.955	6.492	3.7		6	
R=3.2 0.5		1.8 1.2	5.7	7.50 4.709	2.4	7.58	6.492	3.7		1	1

Revision	Checked by Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approbed by: Aprobado por:	Date (Fecha) Aprobado por:

THE LOADS APPLIED IN THE DESIGN OF SIPHON, CIRCULAR SECTION INSIDE

$P_c = 0.5 \times 3.7 \times 2.4 + \frac{0.9 \times 0.9}{2} \times 2.4 + 0.9 \times 0.5 \times 2.4 = 6.492$ t

$W_2 = 0.5 \times 2.4 + 6.25 \times 1.8 = 12.45$ t/m²

$W_4 = 12.45 + \frac{2 \times 6.492}{3.7} = 15.959$ t/m²

$W_{T1} = 0.5 \times 1.8 \times 6.25 = 5.625$ t/m²

$W_{T2} = 0.5 \times 1.8 \times 9.95 = 8.955$ t/m²

$P_W = 3.7 \times 1.0 = 3.7$ t/m²

P_{W1} = height of pressure of water × 1.0

$W_2 = 0.5 \times 2.4 + 1 \times 0.8 + 1.0 \times 1.0 = 3.0$ T/m²

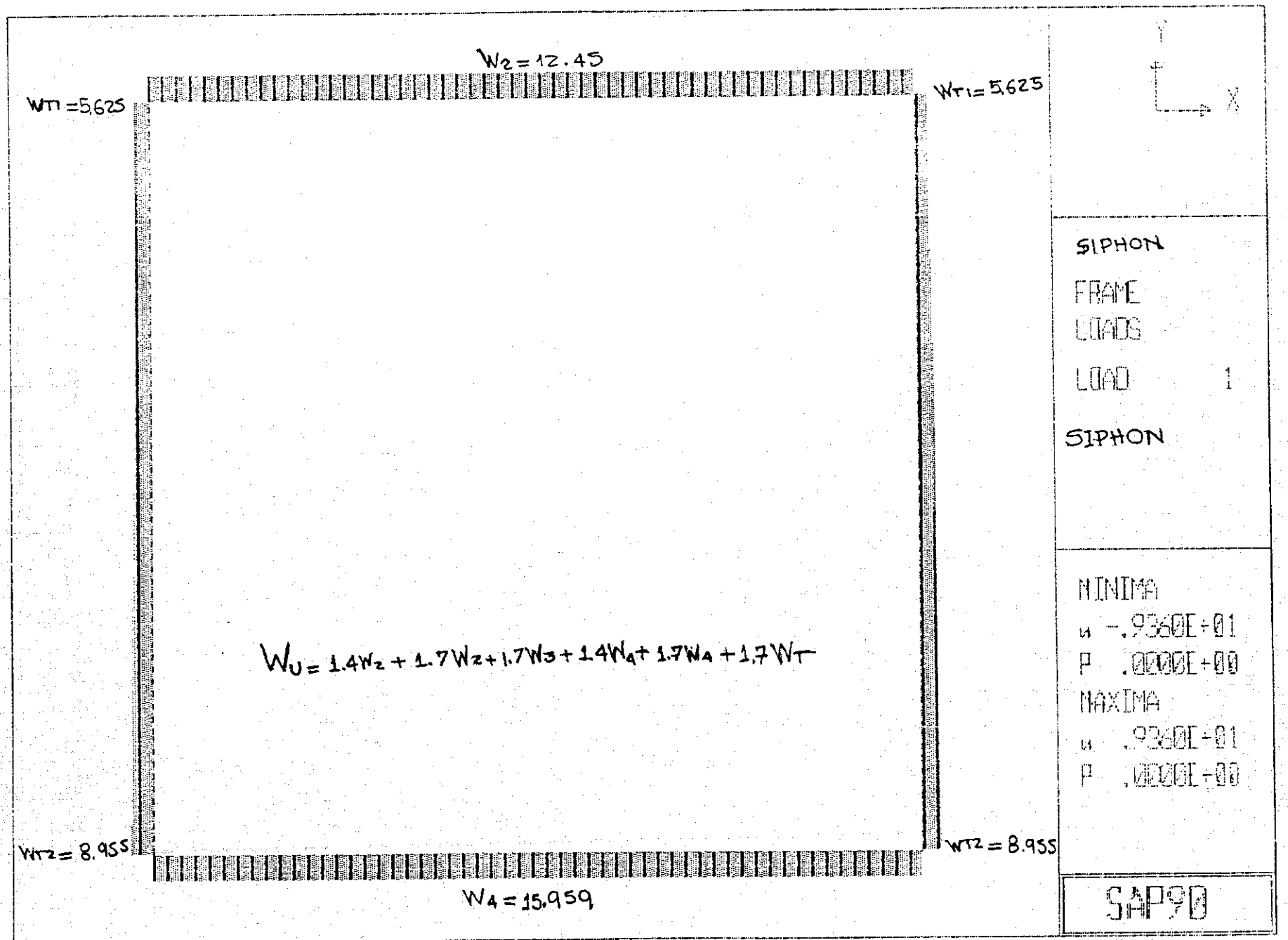
$W_3 = 1 \times 5.7 = 5.7$ t/m²

$W_4 = 3.0 + \frac{2 \times 6.492}{3.7} + 5.7 = 12.209$

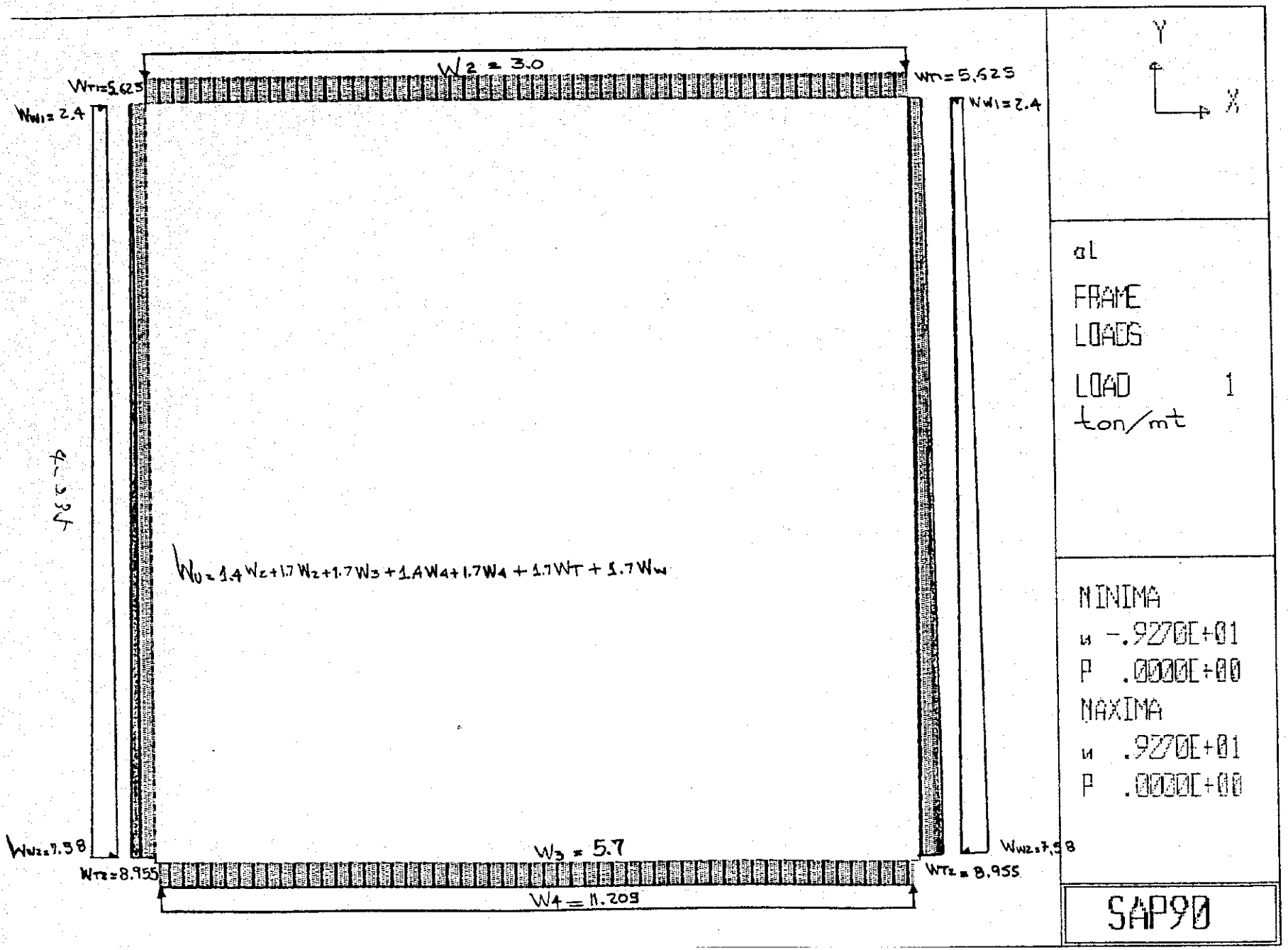
$W_{T1} = 1 \times 0.8 \times 0.5 + 1 \times 2 = 2.4$

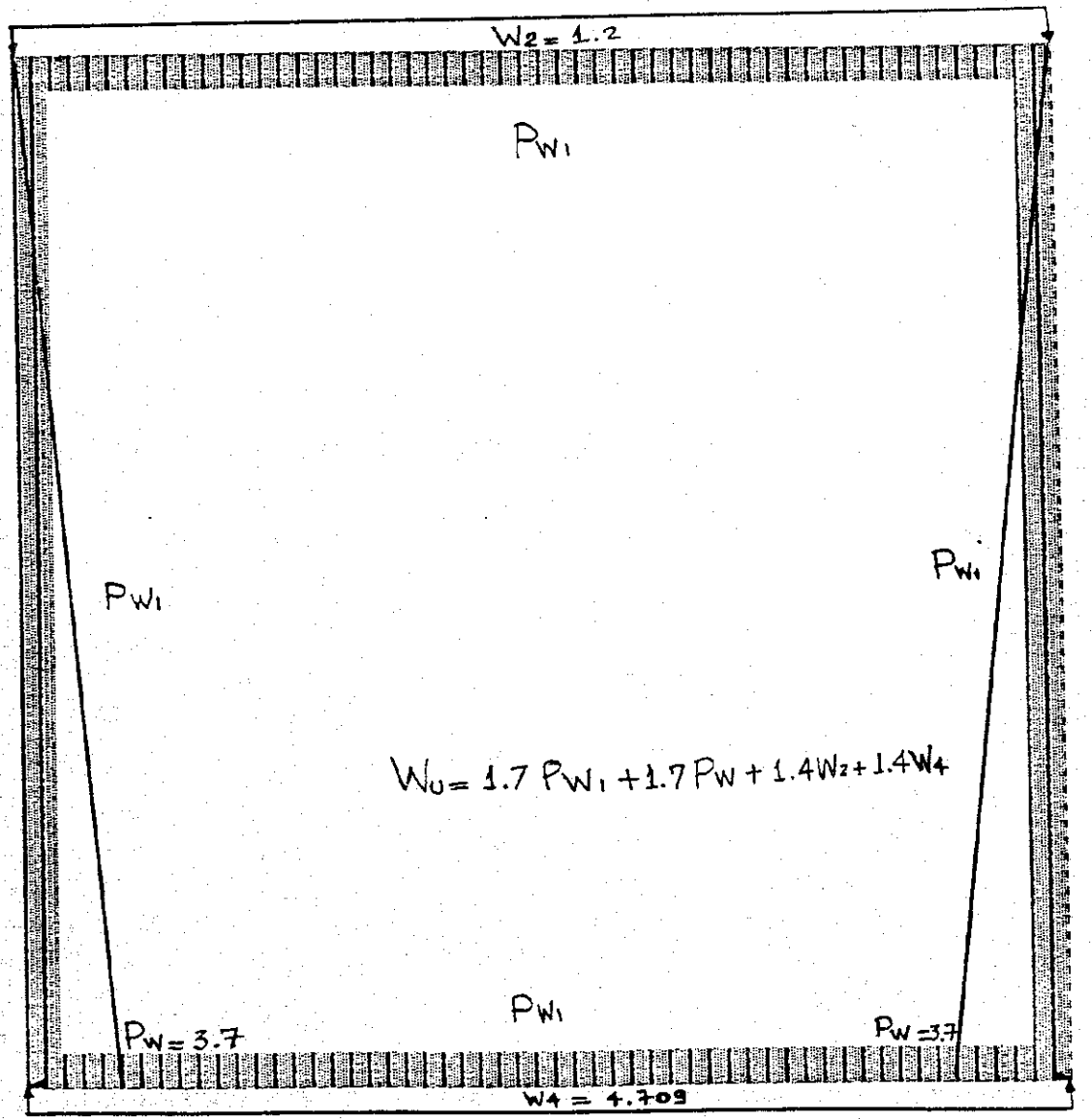
$W_{T2} = 4.7 \times 0.8 \times 0.5 + 1 \times 5.7 = 7.58$

Revision	Checked by Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approbed by: Aprobado por:	Date (Fecha) Aprobado por:


W2 = 12.45
WT1 = 5.625
WT1 = 5.625
$W_U = 1.4W_2 + 1.7W_2 + 1.7W_3 + 1.4W_4 + 1.7W_4 + 1.7W_T$
WT2 = 8.955
WT2 = 8.955
W4 = 15.959
Y
X
SIPHON
FRAME
LOADS
LOAD 1
SIPHON
MINIMA
U -.9360E+01
P .0000E+00
MAXIMA
U .9360E+01
P .0000E+00
SAP90

A-23C


W2 = 3.0
Wt=5.625
Wm=5,625
Ww1=2.4
Ww1=2.4
4~3.24
Wu = 1.4 Wz+1.7 Wz+1.7 W3 + 1.4 W4+1.7 W4 + 1.7 Wt + 1.7 Ww
W3 = 5.7
Ww2=7.58
Ww2=7.58
Wtz=8.955
Wtz = 8.955
W4 = 11.209
Y
X
gL
FRAME
LOADS
LOAD 1
ton/mt
MINIMA
M -.9270E+01
P .0000E+00
MAXIMA
M .9270E+01
P .0000E+00
SAP90



Y
X

SIPHON

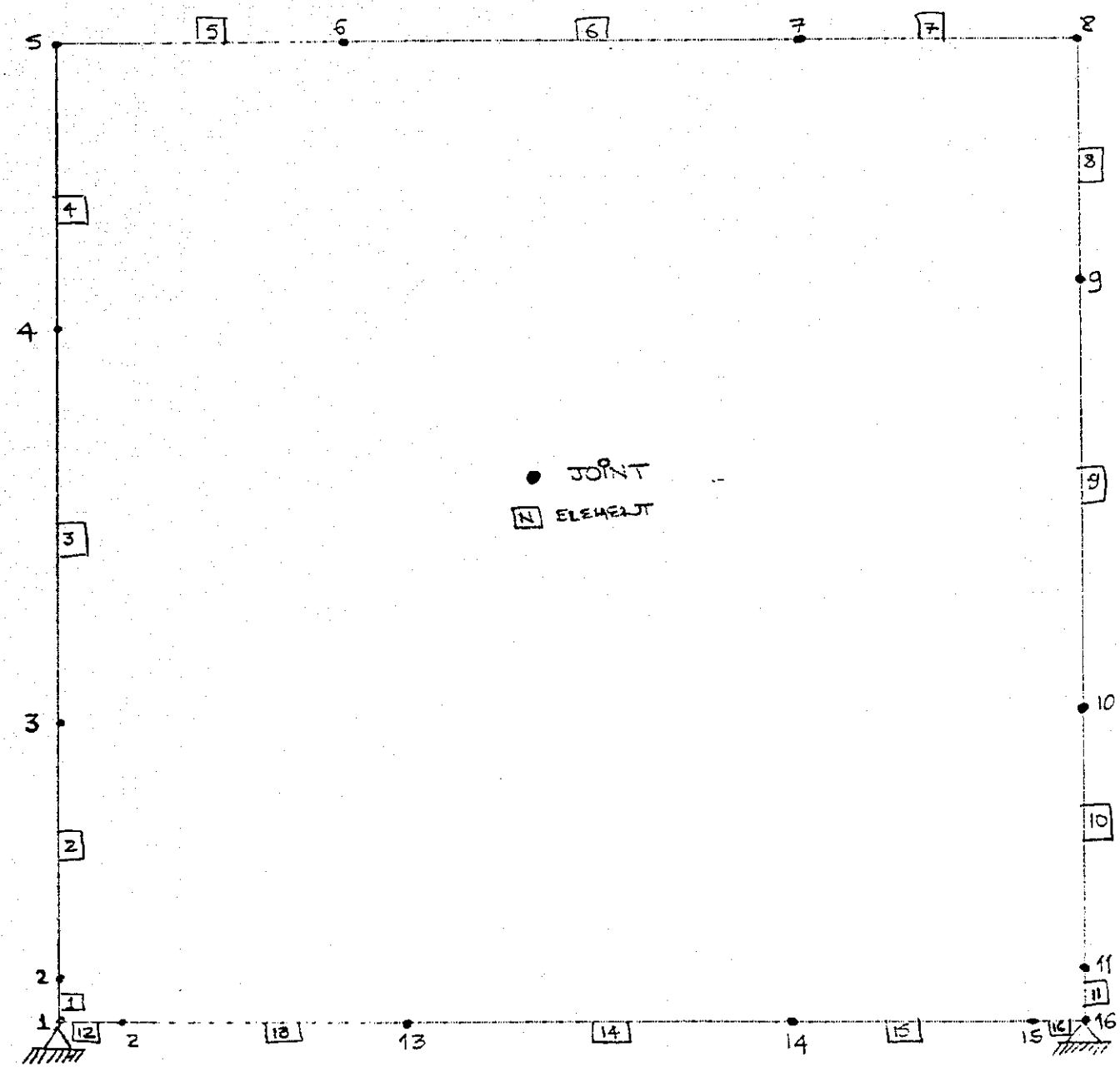
FRAME
LOADS

LOAD

SIPHON

MINIMA
U -.1000E+01
P .0000E+00
MAXIMA
U .1000E+01
P .0000E+00

SAP90



Y
X

MODEL SHAPE

UNDEFORMED SHAPE

CIRCULAR SIPHON

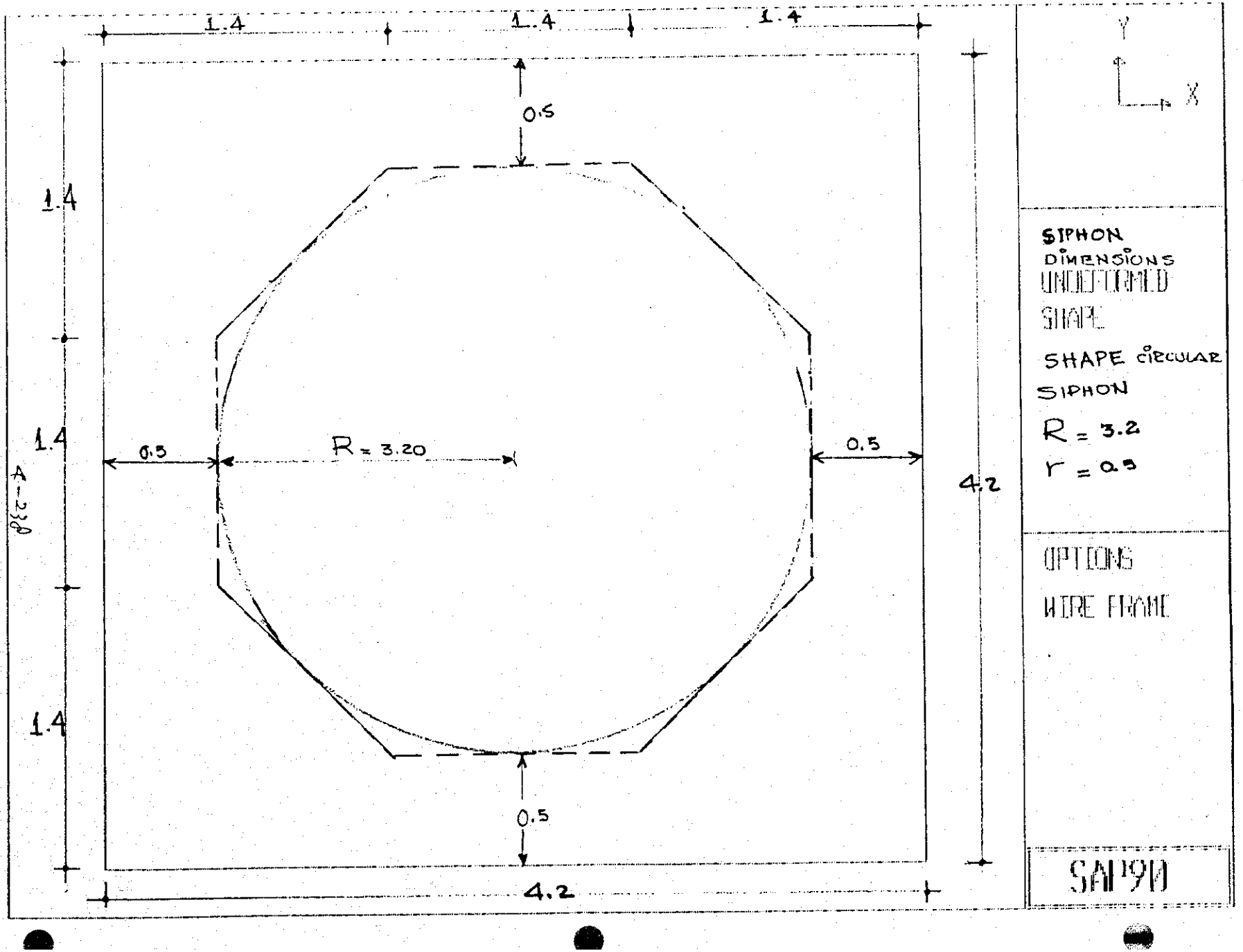
R=3.2×0.5

r=0.07

OPTIONS

WIRE FRAME

SAP90

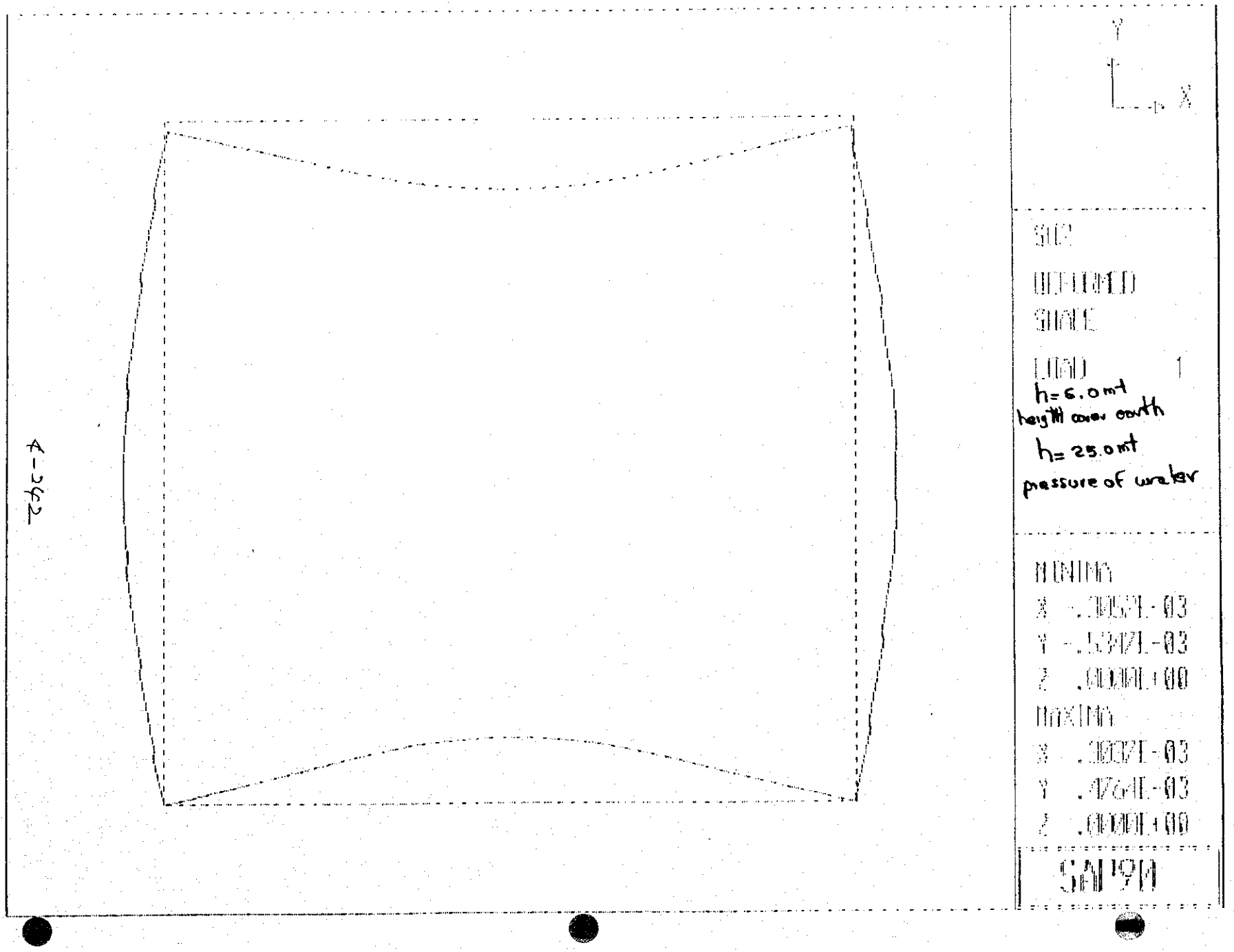

1.4
1.4
1.4
0.5
1.4
1.4
0.5
R = 3.20
0.5
4.2
0.5
4.2
4-230
Y
X
SIPHON
DIMENSIONS
UNDEFINED
SHAPE
SHAPE CIRCULAR
SIPHON
R = 3.2
r = 0.5
OPTIONS
WIRE FRAME
SAP90

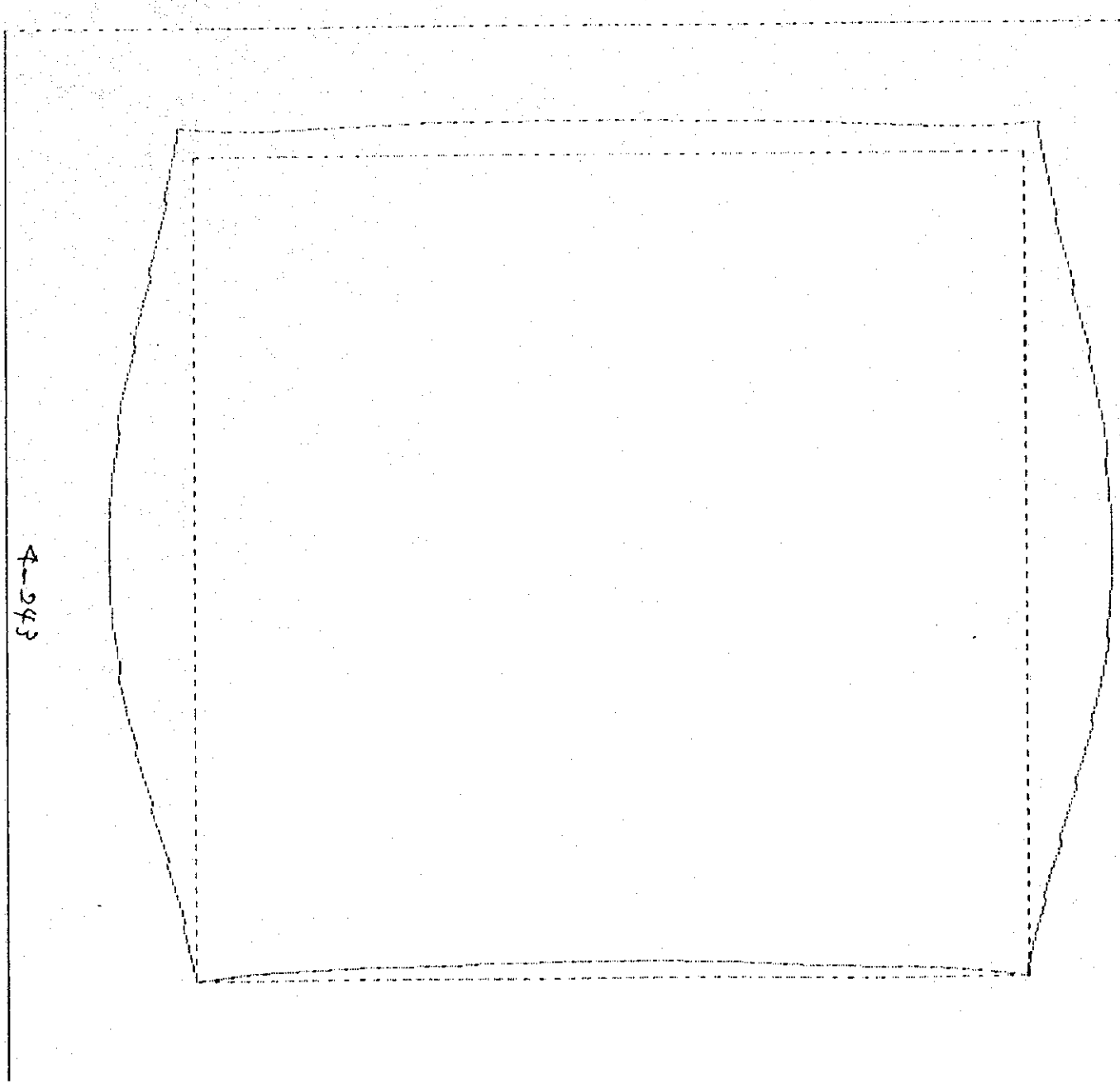
```
SIFON CIRCULAR H=1 , B =1
SYSTEM
L=5

JOINTS
1    X=0    Y=0     Z=0
2    X=0    Y=0.01  Z=0
3           Y=1.20
4           Y=2.50
5           Y=3.70
6    X=1.2  Y=3.70
7    X=2.5  Y=3.70
8    X=3.7  Y=3.70
9    X=3.7  Y=2.50
10   X=3.7  Y=1.20
11   x=3.7  Y=.01
12   X=.01   Y=0.
13   X=1.20 Y=0.
14   X=2.50 Y=0.
15   X=3.69 Y=0.
16   X=3.7   Y=0.

RESTRAINTS
1 16 1   R=0,0,1,1,1,0
1 16 15  R=1,1,1,1,1,0

FRAME
NM=2 NL=19
1 SH=R T=1.4,1     E=2100000.
2 SH=R T=.50,1
1 WL=0,-1.8        :w2
2 WL=0,-1.2        :w2
3 WL=0,5.7         :w3
4 WL=0,7.5         :w4
5 WL=0,4.709       :w4
6 WL=0,48.0        :pw1
7 TRAP=0,-7.580,0,1.19,-5.900
8 TRAP=0,-5.900,0,1.30,-4.080
9 TRAP=0,-4.080,0,1.20,-2.400
10 TRAP=0,-2.400,0,1.20,-4.080
11 TRAP=0,-4.080,0,1.30,-5.900
12 TRAP=0,-5.900,0,1.19,-7.580
13 wl=0,-48.       :pw1
14 TRAP=0,3.700,0,1.19,2.500
15 TRAP=0,2.500,0,1.30,1.200
16 TRAP=0,1.200,0,1.20
17 TRAP=0,0,0,1.20,1.200
18 TRAP=0,1.200,0,1.30,2.500
19 TRAP=0,2.500,0,1.19,3.700
1 1 2   M=1,1,1                LP=1,0
2 2 3   m=1,2,1 NSL=7,0,0,6,14
3 3 4   m=2,2,1 nsl=8,0,0,6,15
4 4 5   m=2,1,1 nsl=9,0,0,6,16
5 5 6   m=1,2,1 NSL=1,2,0,6
6 6 7   M=2,2,1 nsl=1,2,0,6
7 7 8   m=2,1,1 nsl=1,2,0,6
8 8 9   m=1,2,1 NSL=10,0,0,6,17
9 9 10  m=2,2,1 nsl=11,0,0,6,18
10 10 11  M=2,1,1 nsl=12,0,0,6,19
11 11 16 m=1,1,1
12 1  12 m=1,1,1
13 12 13 m=1,2,1 nsl=4,5,3,13
14 13 14 m=2,2,1 nsl=4,5,3,13
15 14 15 m=2,1,1 nsl=4,5,3,13
16 15 16 m=1,1,1
```

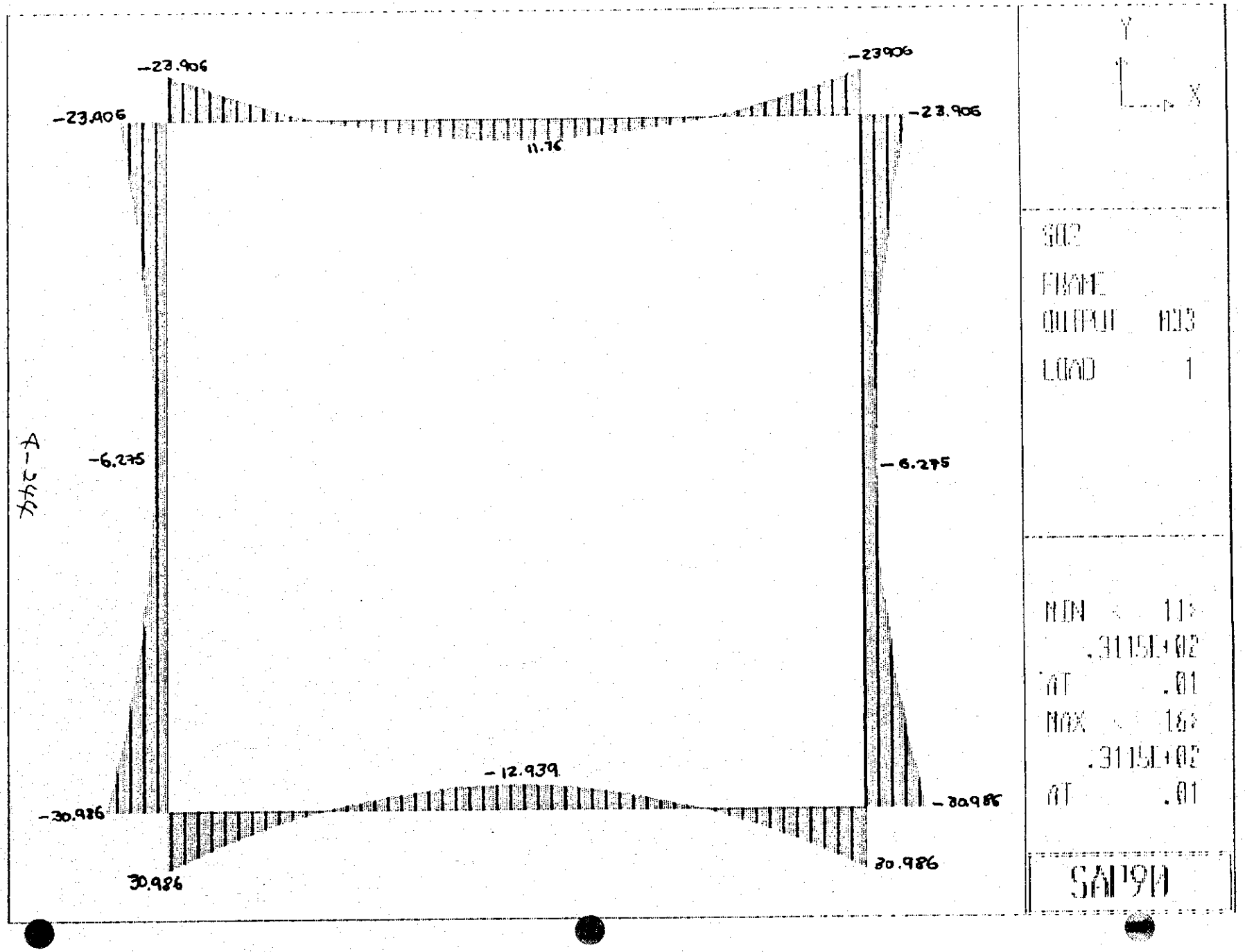
```
combo
1 c=1.7,1.4,1.7
2 c=0,1.4,0,1.7,1.7


SIFON CIRCULAR h=6
SYSTEM
L=5

JOINTS
1    X=0    Y=0     Z=0
2    X=0    Y=0.01  Z=0
3           Y=1.20
4           Y=2.50
5           Y=3.70
6    X=1.2  Y=3.70
7    X=2.5  Y=3.70
8    X=3.7  Y=3.70
9    X=3.7  Y=2.50
10   X=3.7  Y=1.20
11   x=3.7  Y=.01
12   X=.01   Y=0.
13   X=1.20 Y=0.
14   X=2.50 Y=0.
15   X=3.69 Y=0.
16   X=3.7   Y=0.

RESTRAINTS
1 16 1  R=0,0,1,1,1,0
1 16 15 R=1,1,1,1,1,0

FRAME
NM=2 NL=19
1 SH=R T=1.4,1     E=2100000.
2 SH=R T=.50,1
1 WL=0,-11.25      :w2
2 WL=0,-1.20       :w2
3 WL=0             :w3
4 WL=0,11.25       :w4
5 WL=0,4.709       :w4
6 WL=0,30.         :pw1
7 TRAP=0,-8.955,0,1.19,-7.875
8 TRAP=0,-7.875,0,1.30,-6.705
9 TRAP=0,-6.705,0,1.20,-5.625
10 TRAP=0,-5.625,0,1.20,-6.705
11 TRAP=0,-6.705,0,1.30,-7.875
12 TRAP=0,-7.875,0,1.19,-8.955
13 wl=0,-30.       :pw1
14 TRAP=0,3.700,0,1.19,2.500
15 TRAP=0,2.500,0,1.30,1.200
16 TRAP=0,1.200,0,1.20
17 TRAP=0,0,0,1.20,1.200
18 TRAP=0,1.200,0,1.30,2.500
19 TRAP=0,2.500,0,1.19,3.700
1 1 2  M=1,1,1                LP=1,0
2 2 3  m=1,2,1 NSL=7,0,0,6,14
3 3 4  m=2,2,1 nsl=8,0,0,6,15
4 4 5  m=2,1,1 nsl=9,0,0,6,16
5 5 6  m=1,2,1 NSL=1,2,0,6
6 6 7  M=2,2,1 nsl=1,2,0,6
7 7 8  m=2,1,1 nsl=1,2,0,6
8 8 9  m=1,2,1 NSL=10,0,0,6,17
9 9 10 m=2,2,1 nsl=11,0,0,6,18
10 10 11  M=2.1.1 nsl=12.0.0.6.19
```

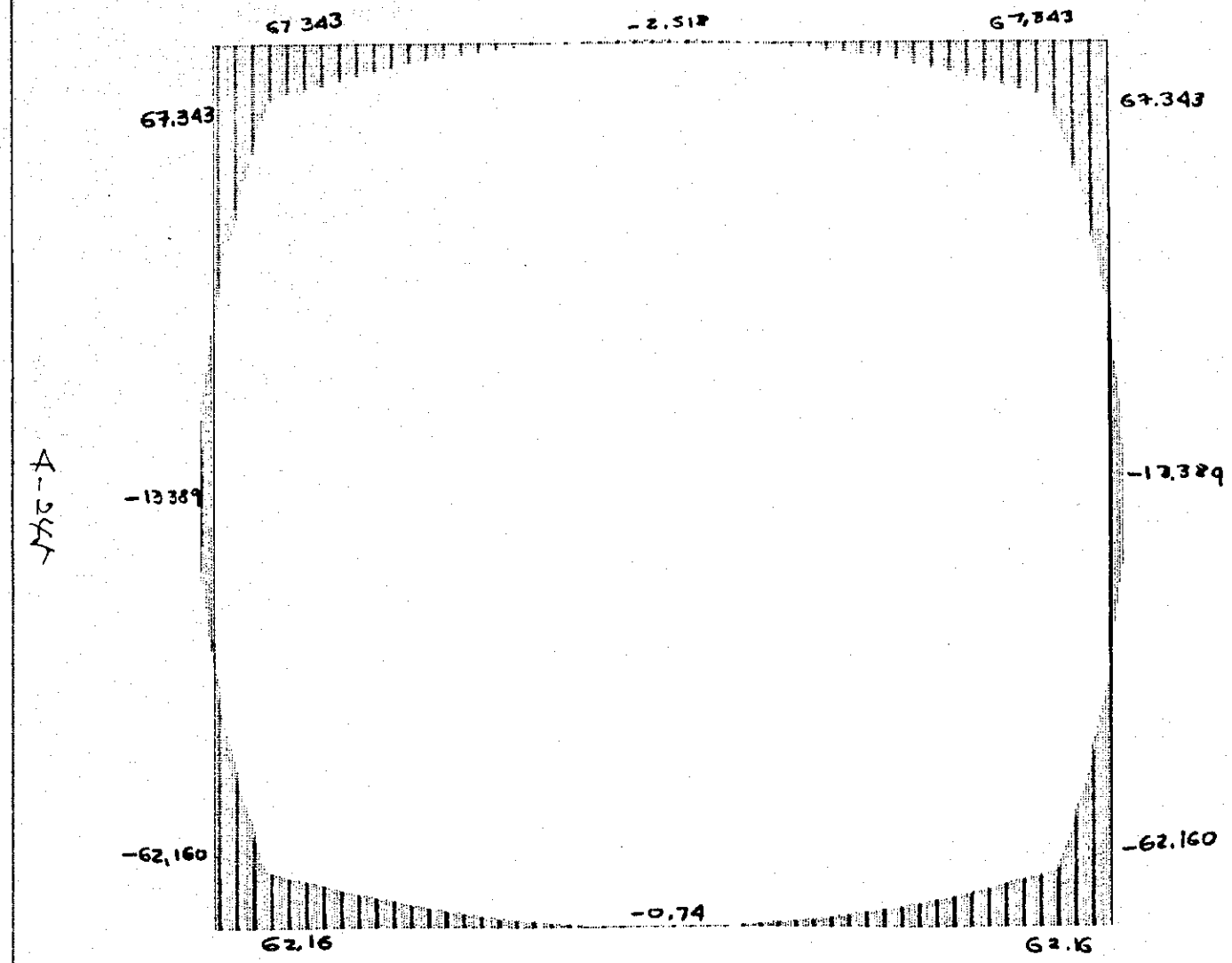
4-240

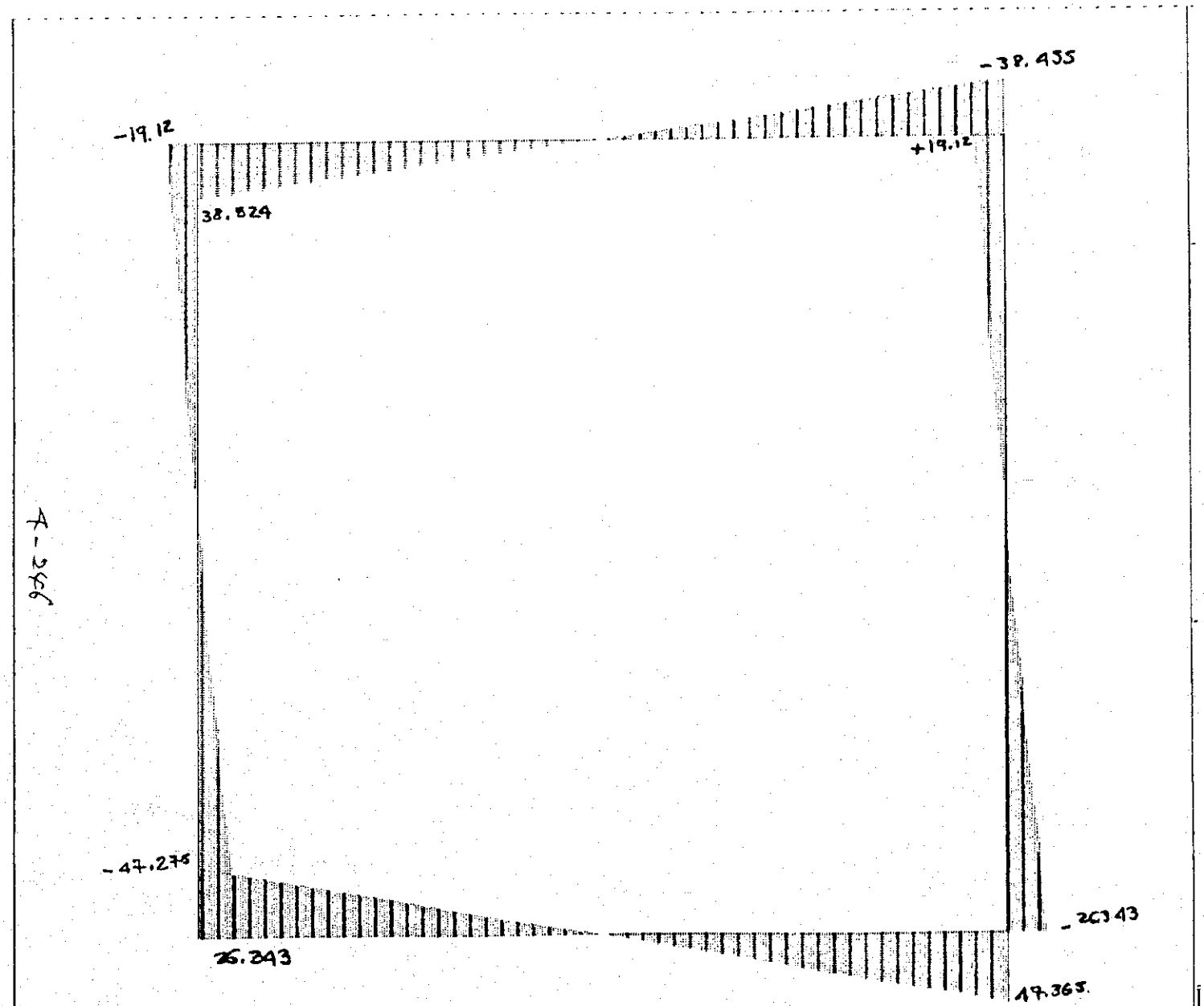
```
12 1  12 m=1,1,1
13 12 13 m=1,2,1 nsl=4,5,3,13
14 13 14 m=2,2,1 nsl=4,5,3,13
15 14 15 m=2,1,1 nsl=4,5,3,13
16 15 16 m=1,1,1

combo
1 c=1.7,1.4
2 c=0,1.4,0,1.7,1.7
```


Y
X
SOIL
DEFORMED
SHAPE
LOAD 1
h=6.0mt
height cover earth
h=25.0mt
pressure of water
MINIMA
X -.3053E-03
Y -.1497E-03
Z .0000E+00
MAXIMA
X .3003E-03
Y .1764E-03
Z .0000E+00
SAP90
A-262

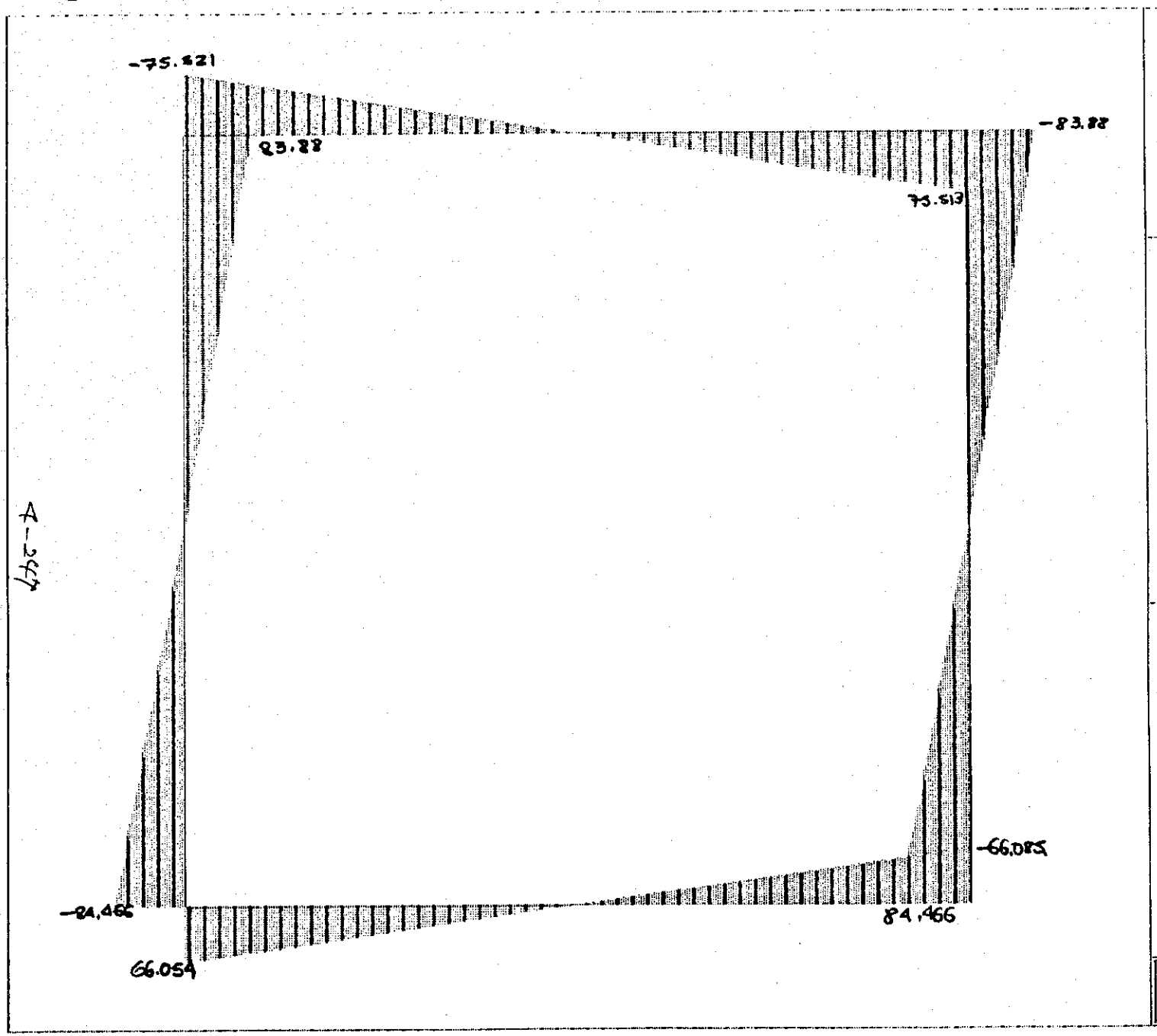

Y
X
SH2
DEFORMED
SHAPE
LOAD 2
MINIMA
X -.5399E-03
Y .0000E+00
Z .0000E+00
MAXIMA
X .5407E-03
Y .2515E-03
Z .0000E+00
SAP90


-23.906
-23.906
-23.906
-23.906
11.76
-6.275
-6.275
-12.939
-30.986
-30.986
30.986
Y
X
SEC
FRAME
OUTPUT
LOAD
1
MIN
MAX
SAP90


67.343
-2.518
67.343
67.343
-13.389
-13.389
-62.160
-62.160
-0.74
62.16
62.16
Y
X
SIDE
FRAME
OUTPUT
LOAD
MIN
AT
MAX
AT
1.20
SAP90


-38.435
-19.12
+19.12
38.529
-47.275
-26.343
-26.343
17.365
Y
X
SEC
FRAME
OUTPUT
LOAD 1
MIN
AT .00
MAX
AT 1.19
SAP90

A-36


-75.521
83.88
-83.88
75.513
-66.055
-84.466
66.054
84.466
Y
X
SD2
FRAME
OUTPUT V23
LOAD 2
MIN < 1>
-.1002E+03
AT .00
MAX < 10>
.1002E+03
AT 1.19
SAP90

A-247

SAP90

STRUCTURAL ANALYSIS PROGRAMS

VERSION [illegible]

[illegible] PROGRAM:SAP90/FILE:[illegible]

[illegible] h= 25 mt pressure of water

[illegible] E L E M E N T   F O R C E S

[illegible]	DIST	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
1	[illegible]			[illegible]			
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]			[illegible].524			
2	[illegible]			75.[illegible]			
	[illegible]	-54.[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]			[illegible]			
[illegible]	[illegible]			[illegible]			
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]			[illegible]			
[illegible]	[illegible]			[illegible]			
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]			[illegible]			
1	[illegible]			[illegible]			
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]			[illegible]			
2	[illegible]			[illegible]			
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]				
	[illegible]			[illegible]			

	1.190	-19.120	-23.715	
	1.200	-19.120	-23.906	
	1.200			-38.524
2	.000			73.581
	.000	[illegible]	-0.171	
	.190	+3.438	6.534	
	1.200	+3.600	6.343	
	1.200			76.581

NOTES

[illegible]

FRAME ELEMENT FORCES

ELT LOAD ID CASE	POINT FUNC	SHEAR	MOMENT	AXIAL FORCE	J-D FLANGE SHEAR	MOMENT	TOTAL TORQ
1	.000			-19.120			
	.000	38.524	-23.906				
	.200	19.536	7.343				
	1.200			-19.120			
2	.000			80.800			
	.000	-73.581	67.343				
	1.200	-34.057	6.106				
	1.200			83.880			
3	.000			-19.120			
	.000	19.536	7.343				
	.532	.000	11.760				
	1.200	-19.469	7.388				
	1.200			-19.120			
4	.000			83.880			
	.000	-26.577	6.106				
	.650	.000	-1.510				
	1.200	26.529	6.102				
	1.200			83.880			
1	.000			-19.120			
	.000	-19.469	7.388				
	1.190	-38.455	-23.779				
	1.200			-19.120			
2	.000			83.880			
	.000	26.529	6.102				
	1.200	79.513	-67.327				
	1.200			83.880			
3	.000			-38.455			
	.000	19.120	-23.779				
	1.190	6.648	-8.230				
	1.200	.140	-0.144				
	1.200			-38.455			
4	.000			73.517			
	.000	-83.600	67.327				
	1.190	-32.091	-1.917				
	1.200	-31.666	-2.036				
	1.200			76.583			
1	.000			-38.455			

F R A M E E L E M E N T F O R C E S

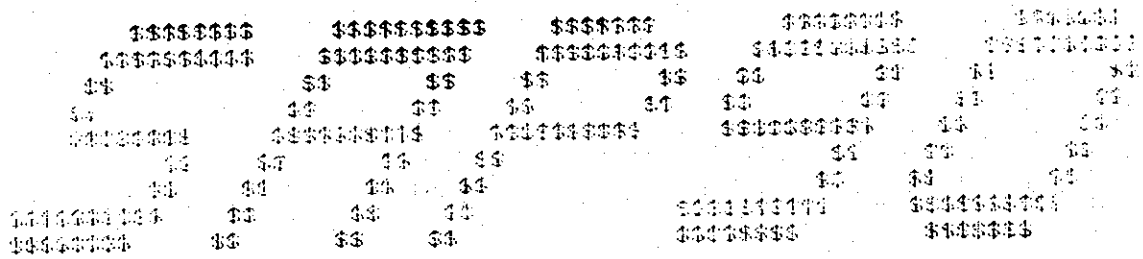
ELT ID	LOAD COMB	DIST END I	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		.000	6.648	-8.164				
		.362	.000	-6.273				
		1.300	-9.463	-9.713				
		1.300			-38.455			
	2	.000			75.513			
		.000	-31.666	-2.236				
		.702	.000	-13.393				
		1.300	27.672	-5.143				
		1.300			75.513			
10								
	1	.000			-38.455			
		.000	-9.463	-9.713				
		1.180	-26.343	-30.626				
		1.190	-26.343	-30.689				
		1.190			-38.455			
	2	.000			75.513			
		.000	27.672	-5.143				
		1.180	84.041	60.531				
		1.190	84.466	61.374				
		1.190			75.513			
11								
	1	.000			-38.455			
		.000	-26.343	-30.689				
		.010	-26.343	-31.153				
		.010			-38.455			
	2	.000			75.513			
		.000	84.466	61.374				
		.010	84.466	62.218				
		.010			75.513			
12								
	1	.000			.000			
		.000	-47.275	30.786				
		.010	-47.275	30.513				
		.010			.000			
	2	.000			.000			
		.000	66.054	-62.160				
		.010	66.054	-61.499				
		.010			.000			
13								
	1	.000			.000			
		.000	-47.275	30.513				
		1.190	-18.671	-7.535				
		1.190			.000			

?1FON CIRCULAR N=6

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST END I	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	2	.000			.000			
		.000	66.054	-61.499				
		1.190	23.324	-8.319				

	1	.000		.000
		.000	-16.671	-7.535
		.645	.000	-12.939
		1.336	16.761	-7.477
		1.300		.000
	2	.000		.000
		.000	23.274	-9.719
		.650	.000	-1.744
		1.300	-23.336	-8.340
		1.300		.000
15				
	1	.000		.000
		.000	16.761	-7.477
		1.190	47.362	31.679
		1.190		.000
	2	.000		.000
		.000	-23.336	-8.340
		1.190	-46.671	-11.357
		1.190		.000
30				
	1	.000		.000
		.000	-47.362	30.679
		1.190	47.362	31.153
		1.190		.000
	2	.000		.000
		.000	-46.671	-61.557
		1.190	-46.671	-62.218
		1.190		.000



STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

ADINA

PROGRAM:SAP90/TITLE:3D22.TDF

[illegible] h = 30.0 mt pressure of water

F R A M E E L E M E N T F O R C E S

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
ID	COND	SHOT	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ
1								
	1	.000			-91.524			
		.000	24.343	-30.986				
		.600	36.343	-30.723				
		.600			-38.524			
	2	.000			91.246			
		.600	-100.174	75.392				
		.600	-100.174	74.390				
		.600			91.246			
2								
	1	.000			-38.524			
		.000	36.343	-30.723				
		1.350	9.403	-9.817				
		1.190	9.403	-9.715				
		1.190			-38.524			
	2	.000			91.246			
		.600	-100.174	74.390				
		1.190	-73.775	-4.403				
		1.190	-55.165	-4.738				
		1.190			91.246			
3								
	1	.000			-38.524			
		.000	9.403	-9.715				
		.738	.000	-6.275				
		1.300	-6.646	-8.164				
		1.300			-38.524			
	2	.000			91.246			
		.000	-55.265	-4.738				
		.600	.000	-14.815				
		1.300	37.134	-1.919				
		1.300			91.246			

		.000	-6.648	-8.188	
		1.190	-19.120	-23.715	
		1.200	-19.120	-23.906	
		1.200			-38.524
	2	.000			91.245
		.000	27.226	-1.913	
		1.190	23.422	22.372	
		1.200	23.537	22.511	
		1.200			91.240

SIPON CIRCULAR ARC

F R A M E E L E M E N T F O R C E S

EL ID	LOAD COND	DIST END-I	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	M-T TO
1								
	1	.000			-19.120			
		.000	19.124	-23.906				
		1.200	19.539	7.343				
		1.200			-19.120			
	2	.000			99.537			
		.000	-91.246	90.325				
		1.190	-77.063	6.540				
		1.200			99.537			
6								
	1	.000			-19.120			
		.000	19.539	7.343				
		.652	.000	11.760				
		1.200	-19.459	7.386				
		1.200			-19.120			
	2	.000			99.537			
		.000	-91.246	6.340				
		.652	.000	-4.052				
		1.200	91.054	6.334				
		1.200			99.537			
7								
	1	.000			-19.120			
		.000	-19.459	7.386				
		1.200	-38.198	-23.779				
		1.200			-19.120			
	2	.000			99.537			
		.000	92.054	6.334				
		1.200	91.254	-50.309				
		1.200			99.537			
8								
	1	.000			-38.455			
		.000	19.12[illegible]	-23.779				
		1.190	6.648	-8.250				
		1.200	6.648	-8.164				
		1.200			-38.455			
	2	.000			91.238			
		.000	-99.137	80.309				
		1.190	-77.063	-1.549				
		1.200	-77.126	-1.422				
		1.200			91.238			
9								
	1	.000			-38.455			

SIFON CIRCULAR h=6

F R A M E E L E M E N T F O R C E S

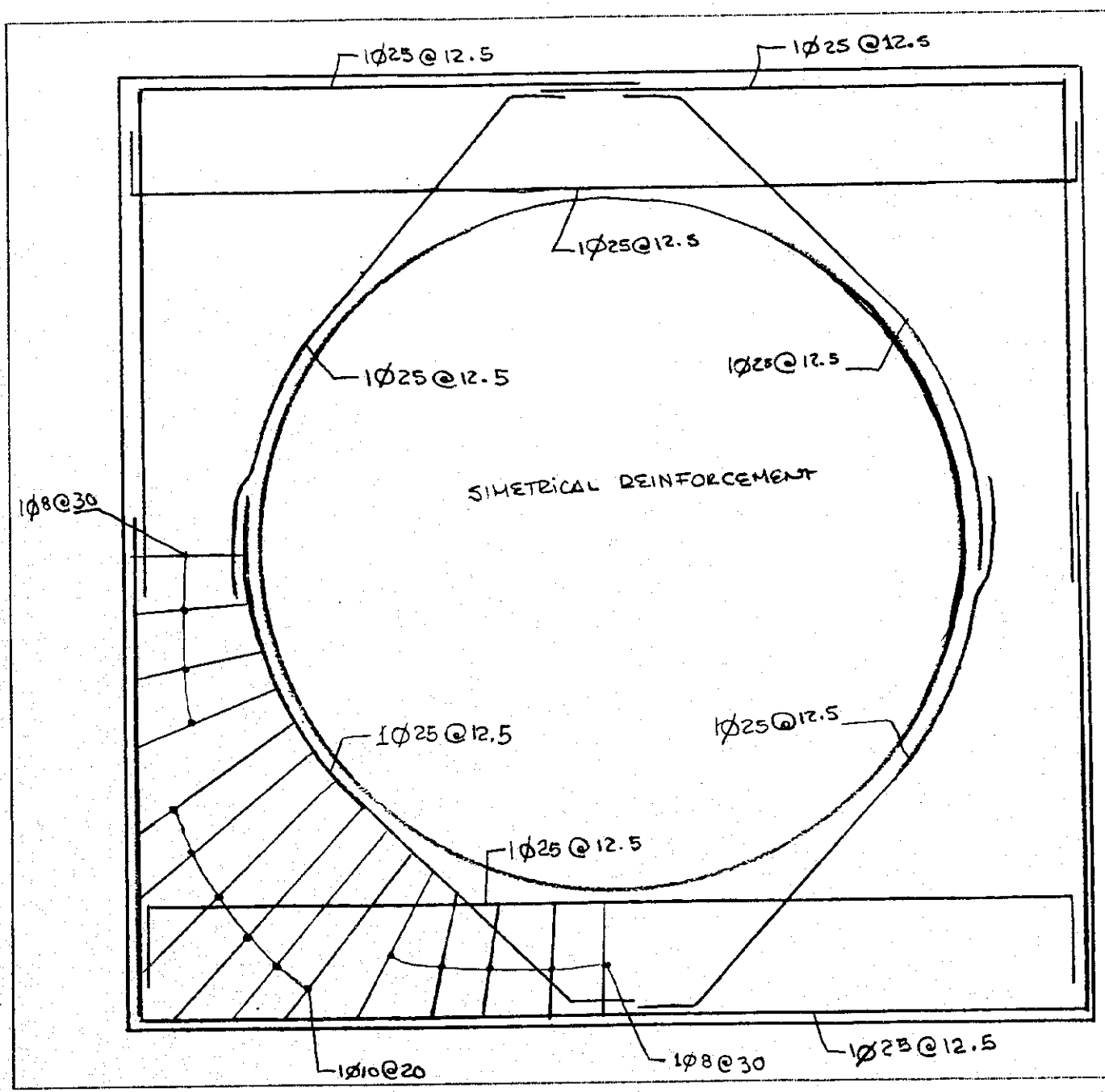
ELT ID	LOAD COMB	DIST END I	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		.000	6.648	-8.164				
		.562	.000	-6.273				
		1.300	-9.463	-9.713				
		1.300			-77.455			
	2	.000			91.238			
		.000	-37.124	-1.922				
		.692	.000	-14.019				
		1.300	55.262	-4.742				
		1.300			91.238			
10								
	1	.000			-38.455			
		.000	-9.463	-9.713				
		1.190	-20.742	-30.626				
		1.190	-20.742	-30.839				
		1.190			-38.455			
	2	.000			91.238			
		.000	37.261	-4.742				
		1.190	99.684	73.450				
		1.190	100.174	74.449				
		1.190			91.238			
11								
	1	.000			-38.455			
		.000	-16.747	-31.938				
		.010	-20.547	-31.137				
		.010			-38.455			
	2	.000			91.238			
		.000	100.174	74.449				
		.010	100.174	75.450				
		.010			91.238			
12								
	1	.000			.000			
		.000	-47.275	30.956				
		.010	-47.275	30.508				
		.010			.000			
	2	.000			.000			
		.000	81.674	-75.371				
		.010	81.674	-74.375				
		.010			.000			
13								
	1	.000			.000			
		.000	-47.275	30.513				
		1.190	-16.071	-7.555				
		1.190			.000			

SIFON CIRCULAR h=6

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST END I	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		.000			.000			

	1.190	28.549	-8.602	
	1.190			.000
14				
	.000			.000
	.000	-16.671	-7.555	
	.445	.000	-12.559	
	1.340	16.701	-7.477	
	1.340			.000
	.000			.000
	.000	28.549	-8.602	
	.450	-1.000	.369	
	1.300	-28.381	-8.622	
	1.300			.000
15				
	.000			.000
	.000	16.701	-7.477	
	1.190	47.365	31.679	
	1.190			.000
	.000			.000
	.000	-1.000	-8.622	
	1.190	-51.711	-74.630	
	1.190			.000
16				
	.000			.000
	.000	47.365	31.679	
	.000	47.365	31.153	
	.000			.000
	.000			.000
	.000	-51.711	-74.630	
	.000	-51.711	-75.430	
	.000			.000



Y

X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

pressure of water = 25 T/M²
30 T/M²

heigh of pressure = 25 mt
30 mt

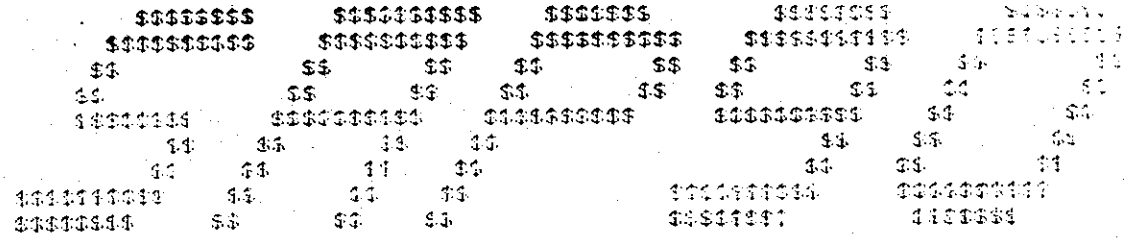
R = 3.2×0.5

r = 0.07

OPTIONS

WIRE FRAME

SAP90



STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

/

DIFOW CIRCULAR R=47 pressure of water.

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COND	DIST END	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
1								
	1	.000			-38.524			
		.000	26.343	-30.986				
		.010	26.343	-30.723				
		.010			-38.524			
	2	.000			144.711			
		.000	-118.510	120.381				
		.010	-118.510	118.845				
		.010			144.711			
2								
	1	.000			-38.524			
		.000	26.343	-30.713				
		1.160	9.463	-9.810				
		1.160	9.463	-9.715				
		1.190			-38.524			
	2	.000			144.711			
		.000	-118.510	118.845				
		1.190	-53.079	-2.847				
		1.190	-53.183	-3.374				
		1.190			144.711			
3								
	1	.000			-38.524			
		.000	9.463	-9.715				
		.738	.000	-6.275				
		1.300	-6.648	-8.166				
		1.300			-38.524			
	2	.000			144.711			
		.000	-53.280	-3.374				
		.625	.000	-19.653				
		1.300	55.678	-.934				
		1.300			144.711			
4								

```
          1.190      -19.120      -23.715
          1.200      -19.120      -23.906
          1.200                                -38.524

     1     .000                                144.711
           .0[illegible]   55.[illegible]     -.654
          1.1[illegible]   151.773     122.940
          1.[illegible]    151.772     124.463
          1.200                                144.711
```


[illegible] CIRCULAR BAR

F R A M E   E L E M E N T   F O R C E S

```
 [illegible]  [illegible]  DIST       1-2 PLANE              AXIAL      1-3 PLANE         AXIAL
 [illegible]  [illegible]  [illegible]  SHEAR       MOMENT     FORCE      SHEAR    MOMENT   TORQ
 ------------------------------------------------------------------
              .000                                -19.120
              [illegible]  [illegible]  -23.906
              1.1[illegible]  1[illegible]   7.343
              1.2[illegible]                      -19.120

     1        .000                                152.772
              .0[illegible]  -[illegible].711   124.463
              [illegible]    -[illegible].047   7.120
              [illegible]                         152.772
 ------------------------------------------------------------------
              [illegible]                         -19.120
              [illegible]    13.[illegible]     7.343
              [illegible]    [illegible]        11.760
              1.300          -[illegible]       7.368
              1.[illegible]                       -19.120

     1        .000                                152.772
              .[illegible]   -10.[illegible]    7.126
              [illegible]    [illegible]        -9.[illegible]
              1.[illegible]  [illegible]        7.120
              [illegible]                         152.772
 ------------------------------------------------------------------
     1        .000                                -19.120
              [illegible]    -11.4[illegible]   [illegible]
              1.[illegible]  -11.4[illegible]   [illegible]
              1.[illegible]                       -19.120

     1        .000                                151.772
              [illegible]    [illegible]        7.122
              1.[illegible]  [illegible]        124.447
              1.[illegible]                       151.772
 ------------------------------------------------------------------
              [illegible]                         -[illegible]
              [illegible]    [illegible]        [illegible]
              1.2[illegible] [illegible]        -[illegible].250
              1.[illegible]  [illegible]        -[illegible].164
              1.2[illegible]                      -38.4[illegible]

     1        .000                                144.701
              [illegible]    -[illegible]       124.447
              1.[illegible]  -16.4[illegible]   -.[illegible]
              1.[illegible]  -[illegible]       .[illegible]
              1.[illegible]                       144.703
 ------------------------------------------------------------------
     1        [illegible]                         -[illegible]
```

F R A M E E L E M E N T F O R C E S

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		TORQ
ID	COMB	ENDS	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	
		.000	6.646	-8.104				
		.342	.000	-6.273				
		1.200	-9.463	-9.713				
					-38.453			
		.000			144.703			
		.000	-55.178	-.038				
		.077	.000	-19.606				
		1.200	55.178	-3.377				
					144.703			
10								
	1	.000			-38.453			
		.000	-9.463	-9.713				
		1.200	-20.343	-30.626				
		1.200	20.343	-30.689				
		1.200			-30.453			
		.000			144.703			
		.077	22.284	-3.377				
		1.200	133.703	117.372				
		1.200	133.703	115.904				
		1.200			144.703			
11								
	1	.000			-38.453			
		.000	-20.343	-30.689				
		.120	-22.343	-32.153				
		.120			-38.453			
	2	.000			144.703			
		.000	-57.910	115.904				
		.120	-57.910	226.440				
		.120			144.703			
12								
	1	.000			.000			
		.000	-47.611	56.784				
		.120	-47.611	40.718				
		.120			.000			
	2	.000			.000			
		.000	47.611	-56.784				
		.120	47.611	-40.718				
		.120			.000			
13								
	1	.000			.000			
		.000	-47.077	40.547				
		1.190	-1.671	-.755				
		1.190			.000			

F R A M E E L E M E N T F O R C E S

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
ID	COMB	ENDS	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	TORQ

		[illegible]	[illegible]	
	1.190	47.634	-10.443	
	1.190			.000
14				
	1 .000			.000
	.000	-16.[illegible]	-7.5[illegible]	
	.[illegible]	.000	-12.[illegible]	
	1.[illegible]	16.701	-7.[illegible]	
	1.[illegible]			.000
	2 .000			.000
	.000	47.634	-10.443	
	.[illegible]	-.000	5.[illegible]	
	1.[illegible]	-47.666	-10.463	
	1.[illegible]			.000
15				
	1 .000			.000
	.000	16.701	-7.477	
	1.[illegible]	47.365	30.679	
	1.190			.000
	2 .000			.000
	.000	-47.666	-10.463	
	1.[illegible]	-134.901	-119.091	
	1.190			.000
16				
	1 .000			.000
	.000	47.365	30.679	
	.000	47.365	31.153	
	.000			.000
	2 .000			.000
	.000	-134.901	-119.091	
	.000	-134.901	-120.440	
	.000			.000

- DATA FOR CALCULATION OF THE REINFORCEMENT

$f'_c = 210\ Kg/cm^2$

$f_y = 4200\ Kg/cm^2$

$b = 100\ cm$

$d = 43\ cm$

$r = 7\ cm$

$M_U = 88.62\ ton\text{-}mt$

$$A_s = \frac{88.62 \times 10^5}{0.9 \times 4200 \times 138} = 17.63\ cm^2$$

$$a = \frac{17.63}{0.85 \times 210 \times 100} = 9.88 \times 10^{-4}\ cm$$

$$\rho = \frac{17.63}{100 \times 133} = 0.001326 < \rho_{min}$$

$A_s = 0.0033 \times 100 \times 133 = 44.33\ cm^2 \Rightarrow 9\varnothing 25 \Rightarrow 1\varnothing 25 @ 12.5$

$A_{s\,temp} = 0.0020 \times 100 \times 140 = 28\ cm^2/2\ face \Rightarrow 1\varnothing 16 @ 15.5$

- SHEAR STRESS CHECK

$V_U = 115,881\ ton$

$V_C = 0.85 \times 0.53 \sqrt{210} \times 100 \times 133 = 86\,827.25$

$V_S = 115\,881 - 86\,827.25 = 29.053.742$

$$A_V = \frac{29.053.742}{0.85\ 4.200 \times \sin 45} = 11.51\ cm^2 \Rightarrow 1\varnothing 16 @ 20$$

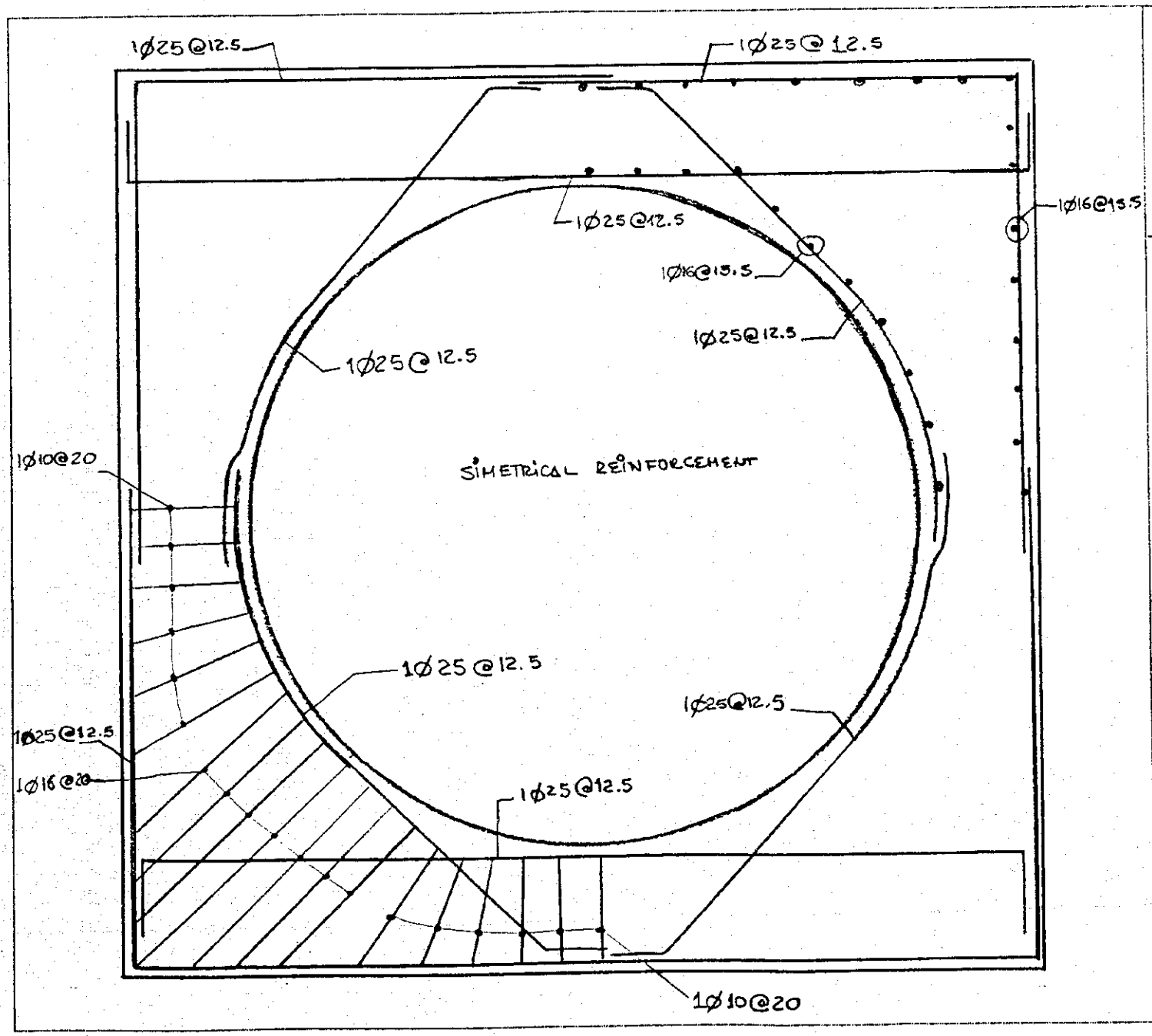
$V_C = 0.85 \times 0.53 \sqrt{210} \times 100 \times 43 = 28.071,97$

$V_U = 39.453\ kg.$

$V_S = 39.453 - 28.071\ 97 = 11.381.02$

$$A_V = \frac{11.381.02}{0.85 \times 4200 \times \sin 45} = 4.51 \Rightarrow 6\varnothing 10$$

Revision	Checked by: Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approved by: Aprobado por:	Date (Fecha) Aprobado por:



Y
X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

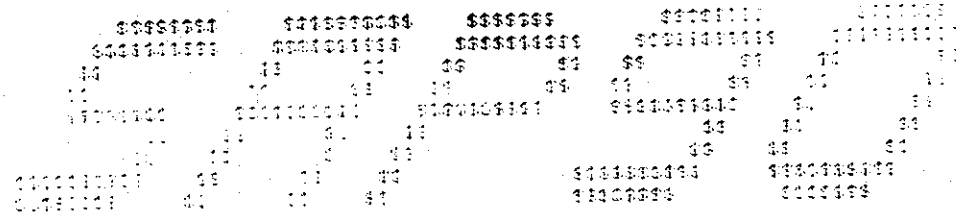
pressure of water = 35 T/m²
height of pressure = 35 mt

R = 3.2 x 0.5
r = 0.07 cm

OPTIONS

WIRE FRAME

SAP90



STRUCTURAL ANALYSIS PROGRAM

VERSION 5.41

NOTE

h=40 presence of water.

F I N A L E L E M E N T F O R C E S

LOAD	ELEM	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TOR
				-30.504			
			-30.955				
			-30.725				
				-30.504			
				122.696			
			101.656				
			20F.340				
				122.696			
				-30.504			
			-30.723				
			-0.810				
			-0.716				
				-31.504			
				122.696			
			101.545				
			-1.415				
			-5.010				
				101.696			
				-30.504			
			-9.715				
			-6.275				
			-8.166				
				-30.504			
				122.696			
			-5.655				
			-17.654				
			-1.292				
				101.696			

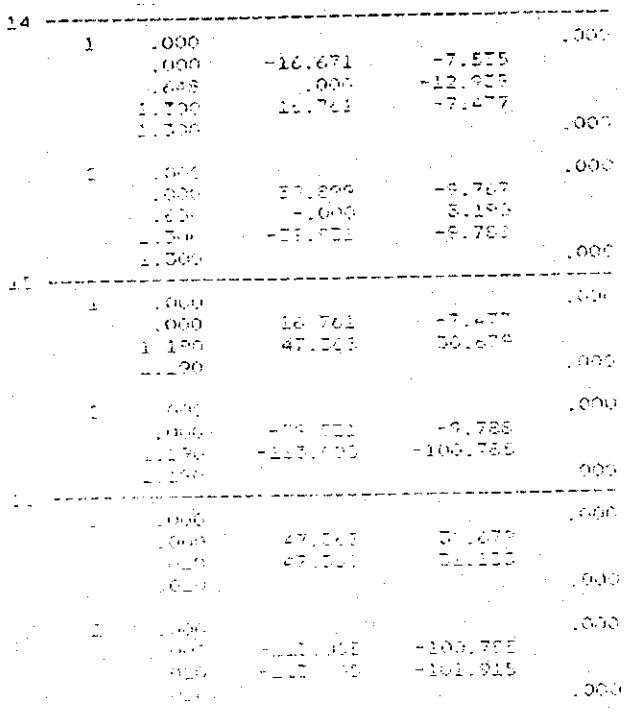
	1.190	-19.120	-23.715	
	1.200	-19.120	-23.906	
	1.200			-39.524
				122.47
				100.696

SITE2D

SIFOR2 CIRCULAR RAFT

F O O T I N G E L E M E N T F O R C E S

JOINT NUMBER	LOAD CASE NUMBER	SHEAR FORCE	MOMENT	AXIAL FORCE	SHEAR FORCE	MOMENT	AXIAL FORCE
5							
	2			-19.120			
		0.000	-23.906				
		0.000	7.340				
				-19.120			
	3			120.696			
		-122.670	120.696				
		-45.122	8.340				
				13.394			
7							
	4			-19.120			
		-17.950	7.340				
		.000	-.760				
		-10.470	7.340				
				-17.120			
	5			17.394			
		-47.122	8.340				
		.000	-.760				
		-17.470	7.340				
				23.191			
9							
	6			-39.524			
		-35.177	7.340				
		-17.470	-23.906				
				-41.120			
	7			122.696			
		-47.122	8.340				
		-10.470	-23.906				
				100.696			
11							
	8			-41.120			
		-35.177	7.340				
		.000	-.760				
		-17.950	7.340				
				-39.408			
	9			100.696			
		-47.122	8.340				
		.000	-.760				
		-17.950	7.340				
				100.696			
13							
	10			-17.120			



h = 5 height cover earth ; h = 40 mt pressure of water

- DATA FOR CALCULATION OF THE REINFORCEMENT

$f'_c = 210\ kg/cm^2$

$f_y = 4200\ kg/cm^2$

$b = 100\ cm$

$d = 43\ cm$

$r = 7.0\ cm$

$M_u = 30.986$

$A_{s\,min} = 0.0033 \times 100 \times 43 = 44.33\ cm^2 \Rightarrow 9\varnothing 25 \Rightarrow 1\varnothing 25 @ 12.5$

$M_u = 101,856\ ton\text{-}mt$

$A_s = \dfrac{101,856 \times 10^5}{0.9 \times 4200 \times 133} = 20.26\ cm^2$

$\rho = \dfrac{20.26}{100 \times 133} = 0.001523 < \rho_{min}$

$A_{s\,min} = 0.0033 \times 100 \times 133 = 44.89\ cm^2 \Rightarrow 9\varnothing 25 \Rightarrow 1\varnothing 25 @ 12.5$

$A_{s\,temp} = 0.002 \times 100 \times 140 = 28\ cm^2/2\ FACE \Rightarrow 1\varnothing 16 @ 15.5$

SHRINKAGE

- SHEAR STRESS CHECK

$V_u = 131.589\ kg$

$V_c = 86.827.25\ kg < V_u$

$V_s = 113589 - 86.827.25 = 44762.25\ kg$

$A_v = \dfrac{44762.25}{0.85 \times 4200 \times \sin 45^\circ} = 17.73\ cm^2 \Rightarrow 7\ 7\varnothing 18 \Rightarrow 1\varnothing 18 @ 16.5$

$V_c = 0.85 \times 0.53\sqrt{210} \times 100 \times 43 = 28.071.97$

$V_s = 45.130 - 28.071.97 = 17.058.03$

$A_v = \dfrac{17,058.03}{0.85 \times 4200 \times \sin 45^\circ} = 6.75\ cm^2 \Rightarrow 1\varnothing 12 @ 20$

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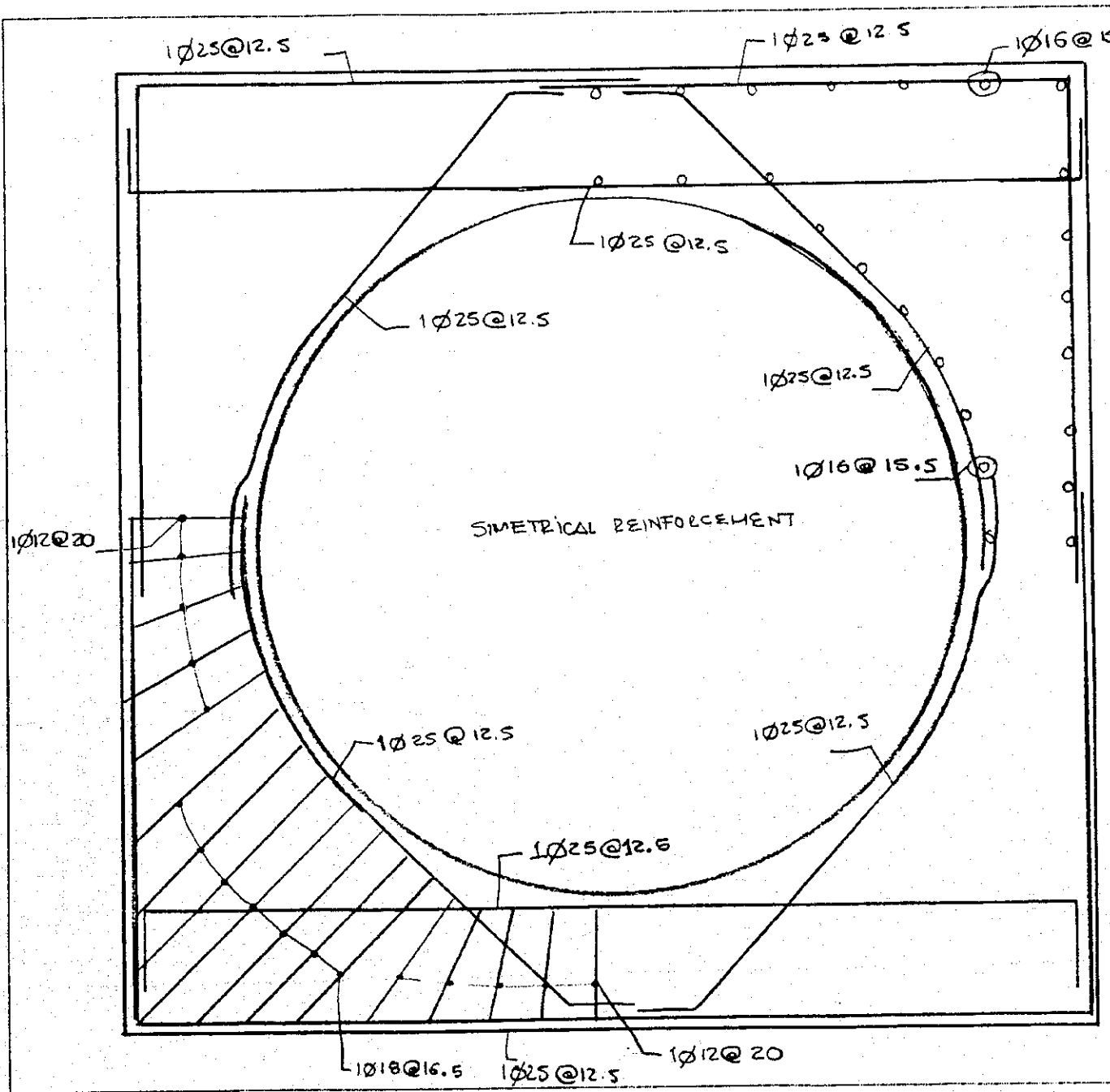


Y

X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

pressure of water = 40 T/M²

height of pressure = 40 mt.

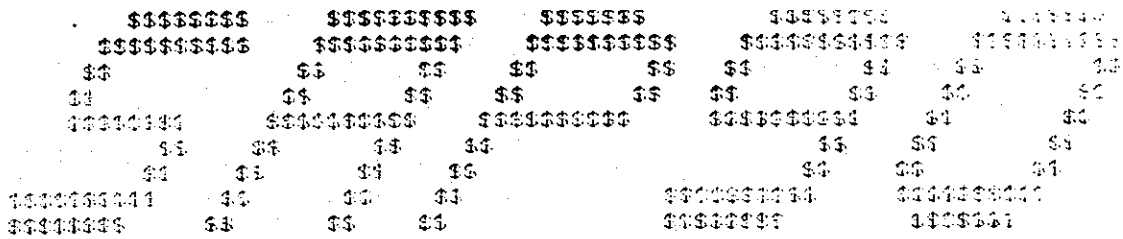
R = 3.2 ± 0.5

r = 0.07 cm

OPTIONS

WIRE FRAME

SAP90



STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

SIFON CIRCULAR n=47 pressure of water.

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COND	DIST (ND)	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
1								
	1	.000			-38.524			
		.000	26.343	-30.066				
		.010	26.343	-30.728				
		.010			-38.524			
	2	.000			144.711			
		.000	-153.580	120.381				
		.010	-153.580	118.845				
		.010			144.711			
2								
	1	.000			-38.524			
		.000	26.343	-30.723				
		1.160	9.463	-9.510				
		1.170	9.463	-9.715				
		1.170			-38.524			
	2	.000			144.711			
		.000	-153.580	118.845				
		1.160	-53.079	-2.847				
		1.170	-52.250	-3.374				
		1.170			144.711			
3								
	1	.000			-38.524			
		.000	9.463	-9.715				
		.738	.000	-6.275				
		1.300	-6.648	-8.166				
		1.300			-38.524			
	2	.000			144.711			
		.000	-52.250	-3.374				
		.625	.000	-19.683				
		1.300	51.678	-.054				
		1.300			144.711			
4								

	1.190	-19.120	-23.715	
	1.200	-19.120	-23.906	
	1.200			-38.524
2	.000			144.711
	.010	15.079	-.854	
	1.190	15.577	121.540	
	1.200	152.772	124.463	
	1.200			144.711

AUTED

SITE DIAGRAM NO.

F R A M E E L E M E N T F O R C E S

ELT	LOAD	DIST	1-2 PLANE		AXIAL	1-3 PLANE		AXIAL
NO	COND	RATIO	SHEAR	MOMENT	FORCE	SHEAR	MOMENT	FORCE
3								
	1	.000			-19.120			
		.010	20.324	-23.906				
		1.010	19.553	7.343				
		1.020			-19.120			
	2	.000			152.772			
		.010	-144.711	124.463				
		1.010	-20.047	7.128				
		1.020			152.772			
4								
	1	.000			-19.120			
		.010	19.553	7.343				
		.010	.000	11.760				
		1.010	-20.469	7.308				
		1.020			-19.120			
	2	.000			152.772			
		.010	-20.047	7.128				
		.010	.000	-9.599				
		1.010	20.071	7.128				
		1.020			152.772			
1								
	1	.000			-19.120			
		.010	-15.407	7.308				
		1.000	-20.469	-23.779				
		1.010			-19.120			
	2	.000			152.772			
		.010	20.324	7.148				
		1.000	144.197	124.447				
		1.010			152.771			
2								
	1	.000			-38.455			
		.010	19.553	-23.779				
		1.190	6.640	-8.230				
		1.200	6.047	-8.164				
		1.200			-38.455			
	2	.000			144.703			
		.010	-152.772	124.447				
		1.190	-26.477	-.297				
		1.200	-27.077	-.368				
		1.200			144.703			
3								
	1	.000			-38.455			

SIFON CIRCULAR h=6

F R A M E E L E M E N T F O R C E S

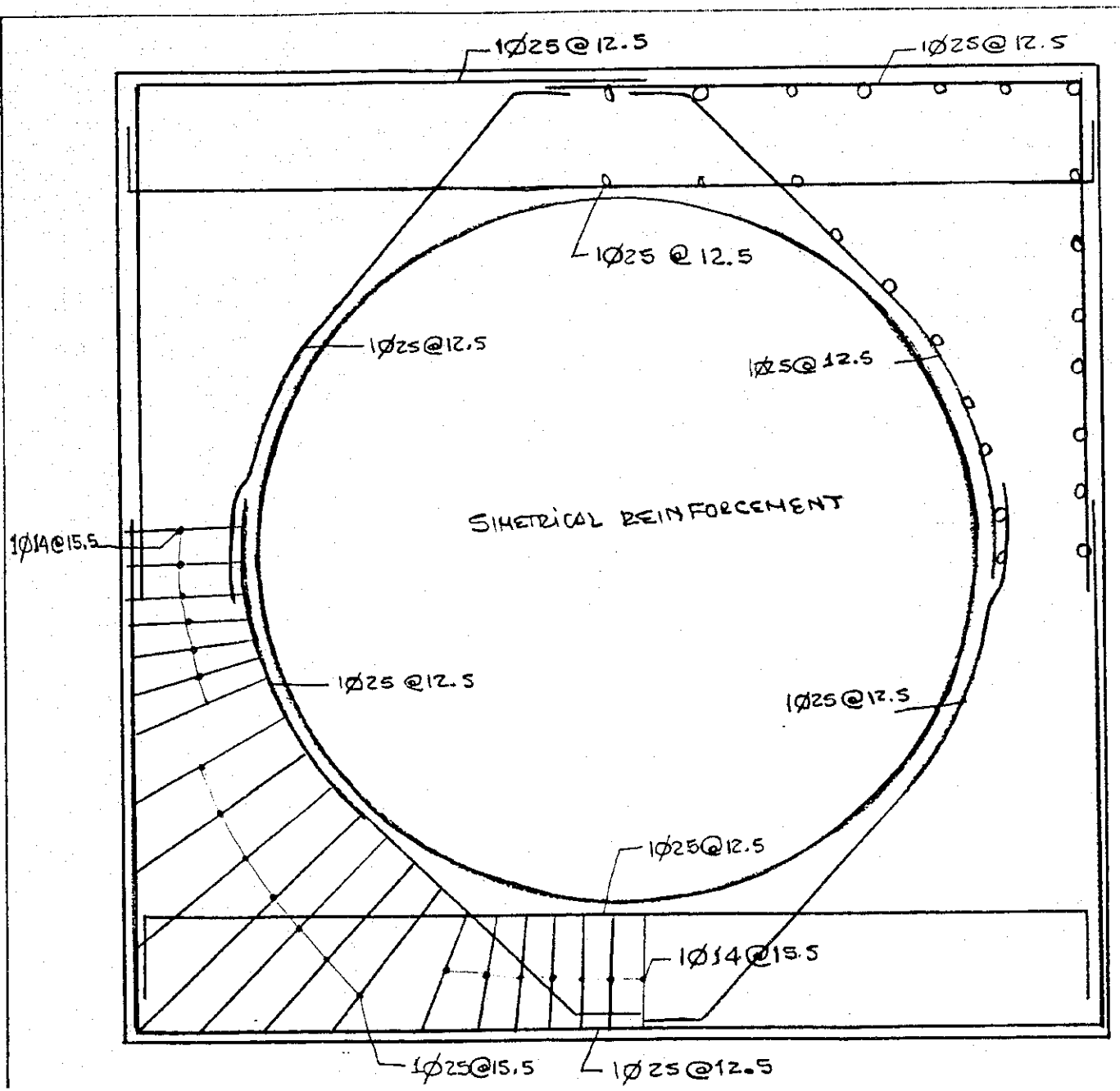
ELT ID	LOAD COMP	DIST END	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		.000	6.648	-8.164				
		.562	.000	-6.273				
		1.500	-9.463	-9.713				
		1.300			-39.455			
	2	.000			144.703			
		.000	-53.676	-.858				
		.675	.000	-19.686				
		1.500	52.280	-3.377				
		1.300			144.703			
10	----------							
	1	.000			-38.455			
		.000	-9.463	-9.713				
		1.190	-26.343	-30.626				
		1.190	-26.343	-30.889				
		1.190			-38.455			
	2	.000			144.703			
		.000	52.280	-3.377				
		1.190	152.761	117.372				
		1.190	153.580	118.904				
		1.190			144.703			
11	----------							
	1	.000			-38.455			
		.000	-26.343	-30.889				
		.010	-26.343	-31.153				
		.010			-38.455			
	2	.000			144.703			
		.000	153.560	118.904				
		.010	153.580	120.440				
		.010			144.703			
12	----------							
	1	.000			.000			
		.000	-47.277	30.013				
		.281	-47.277	5.313				
		.000			.000			
	2	.000			.000			
		.000	126.574	-100.351				
		.010	126.574	-119.602				
		.010			.000			
13	----------							
	1	.000			.000			
		.000	-47.277	30.013				
		1.190	-26.671	-7.535				
		1.190			.000			

SIFON CIRCULAR h=6

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMP	DIST END	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ

		[illegible]	[illegible]	
	1.190	47.634	-10.443	
	1.190			.000
14				
				.000
4	.000			
	.000	-16.671	-7.535	
	.145	.000	-12.959	
	1.300	16.701	-7.477	
	1.300			.000
				.000
3	.000			
	.000	47.634	-10.443	
	.650	-.000	5.033	
	1.300	-47.666	-10.463	
	1.300			.000
15				
				.000
1	.000			
	.000	16.701	-7.477	
	1.190	47.365	30.679	
	1.190			.000
				.000
2	.000			
	.000	-47.666	-10.463	
	1.190	-134.901	-119.091	
	1.190			.000
16				
				.000
1	.000			
	.000	47.365	30.679	
	.010	47.365	31.153	
	.010			.000
				.000
2	.000			
	.000	-134.901	-119.091	
	.010	-134.901	-120.440	
	.010			.000



Y

X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT

pressure of water = 47.0 T/m²

heyth of pressure = 47.0 m

R = 3.2 ± 0.5

r = 0.07 cm

OPTIONS

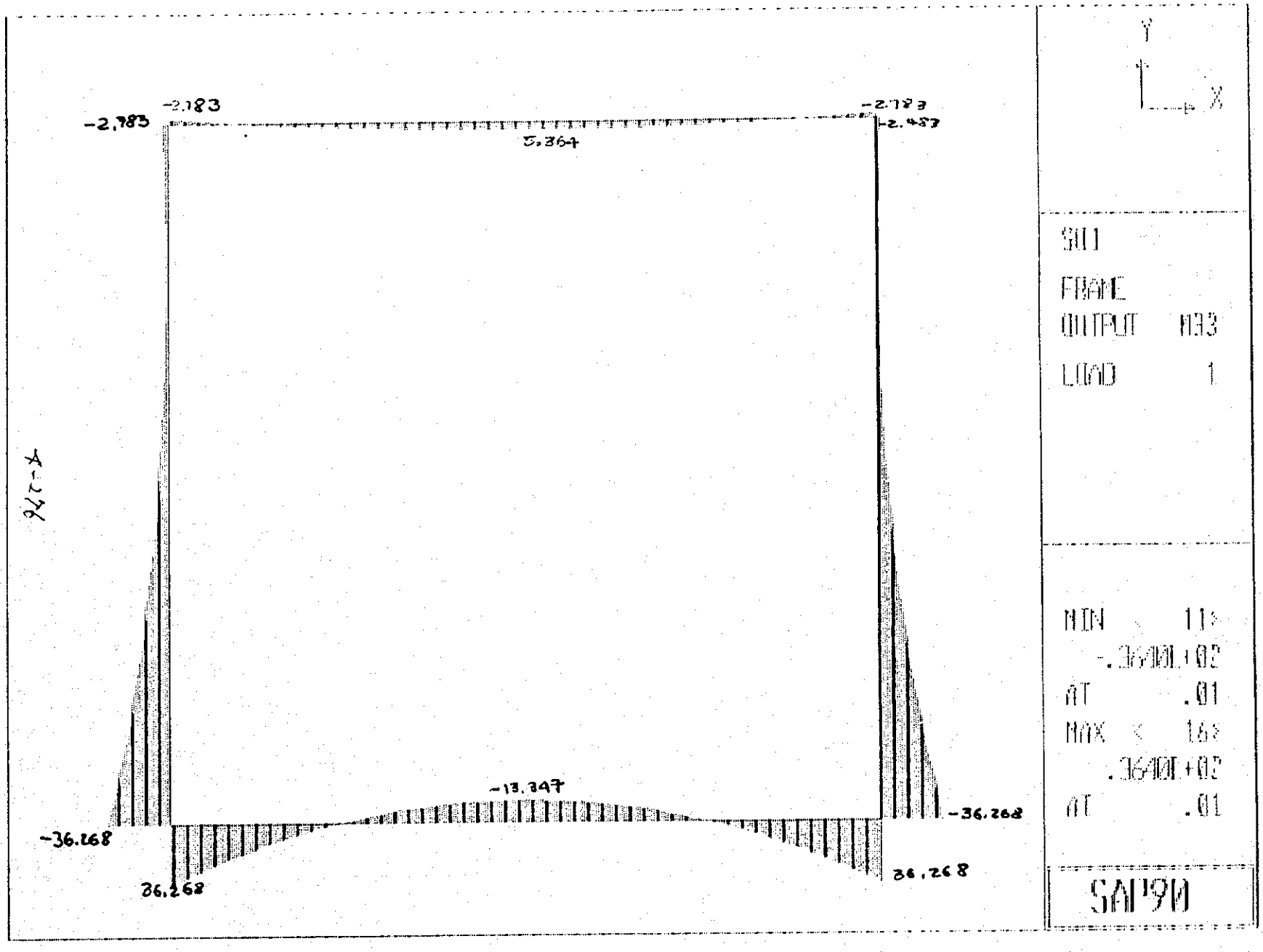
WIRE FRAME

SAP90

Y
X
SOIL
DEFORMED
SHAPE
LOAD 1
CIRCULAR INCIDE
SIPHON h'=1 ; h'=1
h= 48 mt
pressure of water
MINIMA
X -.2822E-03
Y -.2264E-03
Z .1000E+00
MAXIMA
X .2810E-03
Y .9400E-03
Z .1000E+00
SAP90

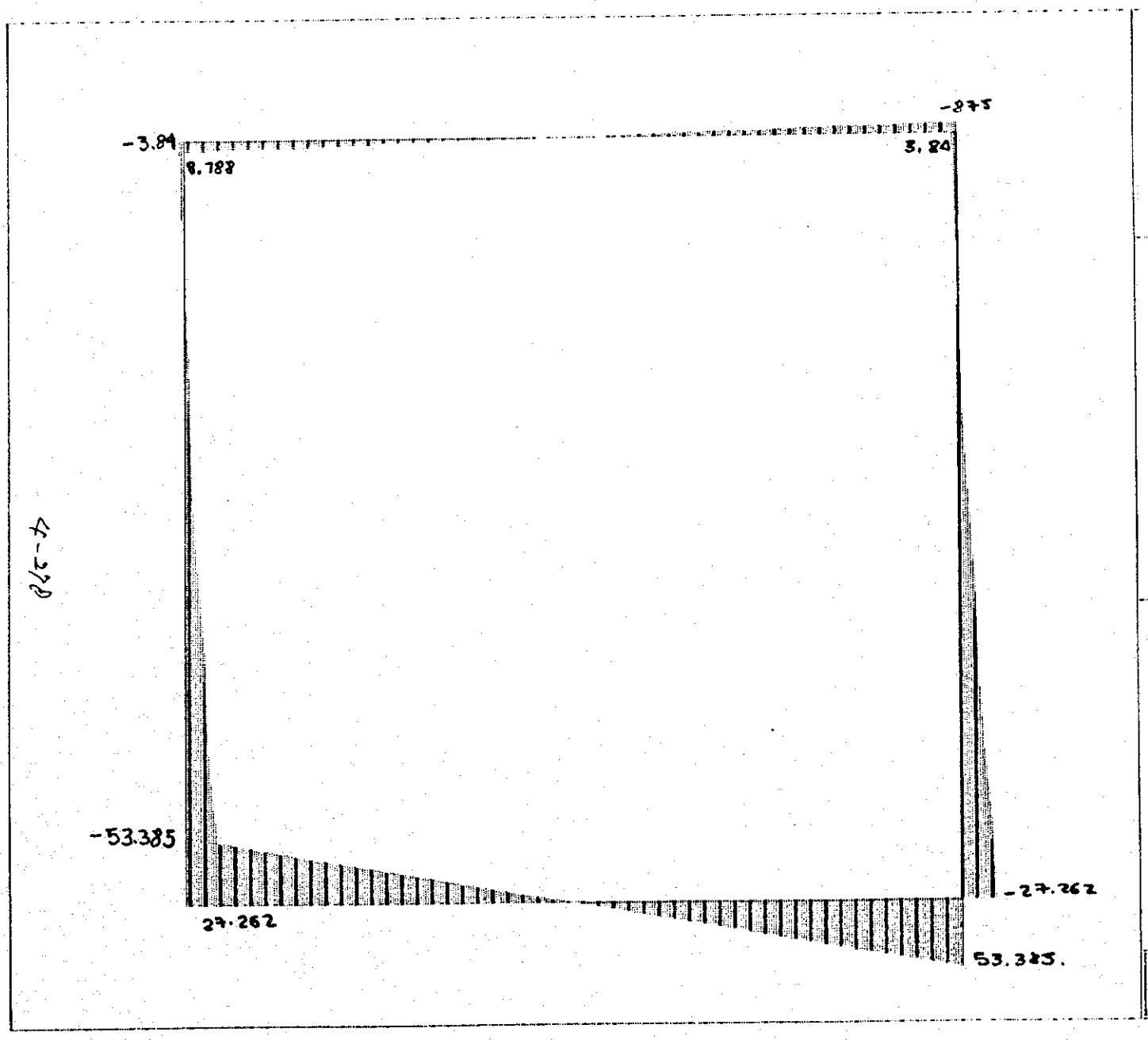
Y
X
SOIL
OUTDOOR
SHAPE
LOAD
MORPHO
X -.7191-02
Y -.5411-05
Z .0000+00
MAXIMA
X .7191-02
Y .1227-02
Z .0000+00

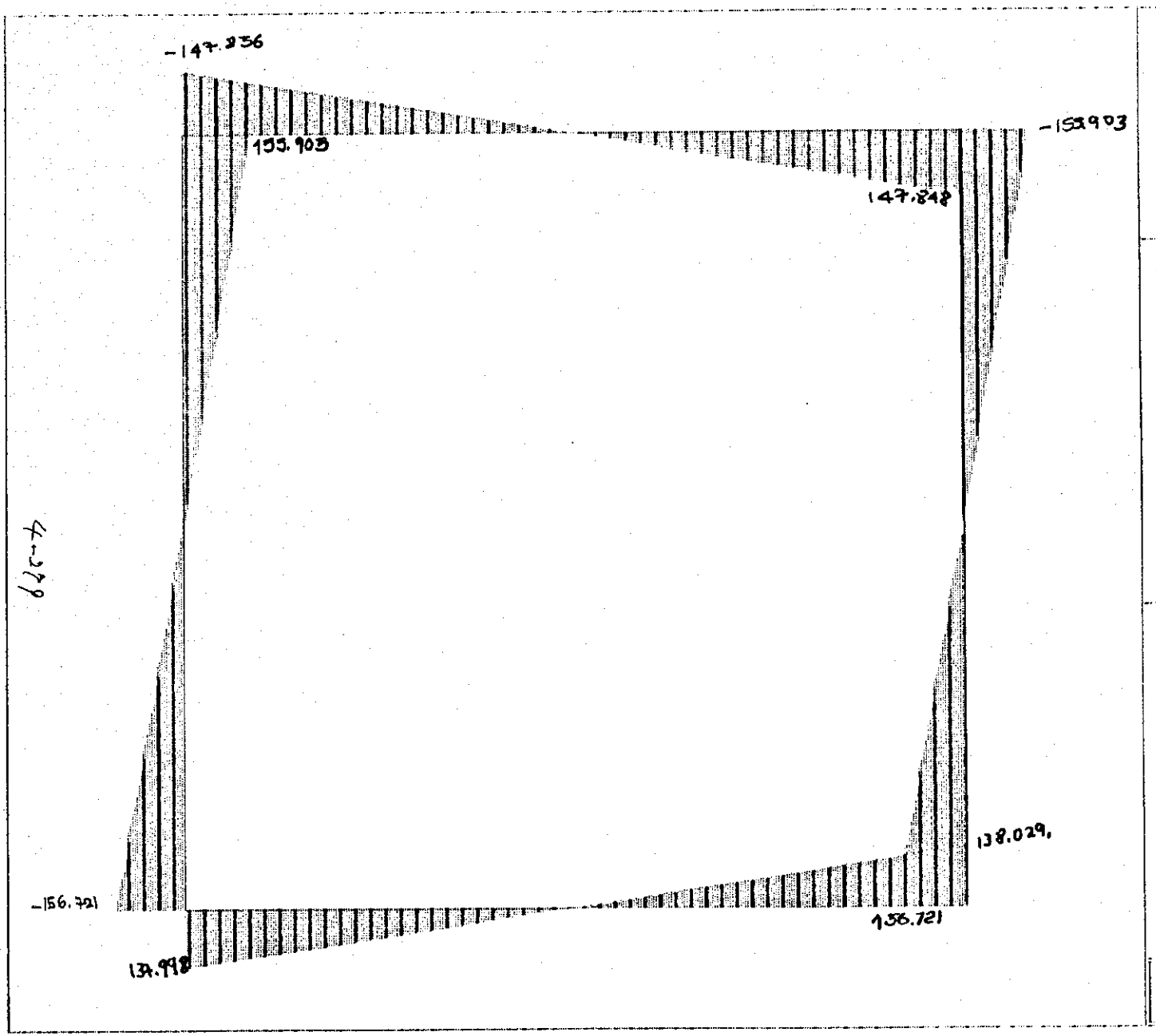
4-27


-2.183
-2.183
-2.183
-2.487
5.364
-13.397
-36.268
-36.268
36.268
36.268
Y
X
SOIL
FRAME
OUTPUT M33
LOAD 1
MIN < 11>
-.3640E+02
AT .01
MAX < 16>
.3640E+02
AT .01
SAP90

SAMPLE
MIN 16
.1331+02
AT .01
MAX 9
.1771+02
AT 1.20
SEL
FRAME
OUTPUT REG
LOAD 2
124.059
-123.028
124.059
127.028
6.296
123.059
122.022
122.059
-19.969
-123.028

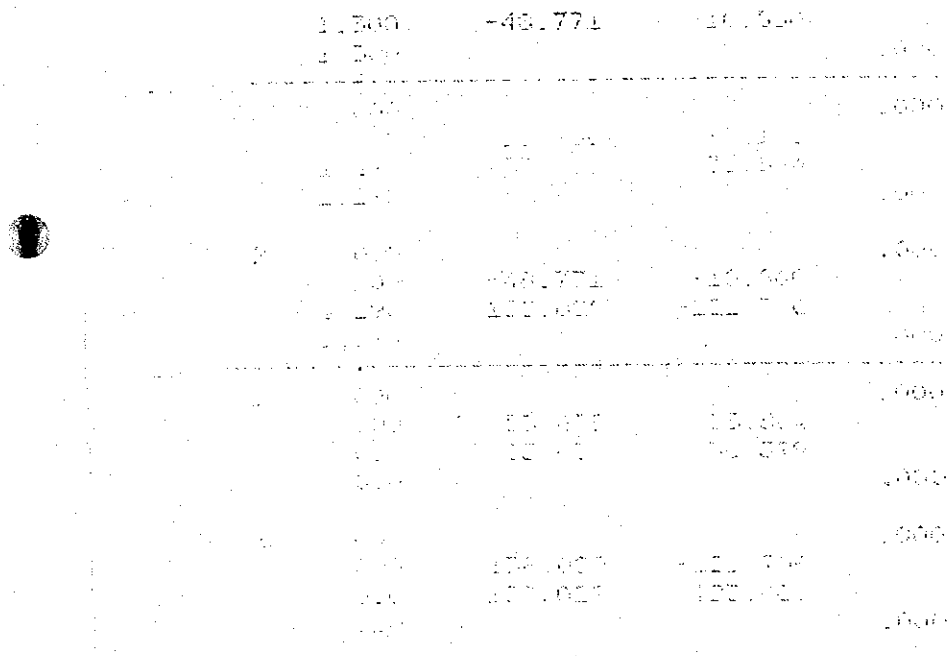
4-277


-3.84
8.788
-875
3.84
-53.385
27.262
-27.262
53.385.
Y
X
SOL
FRAME
OUTPUT 023
LOAD 1
MIN < 12>
-.5338E+02
AT .00
MAX < 15>
.5346E+02
AT 1.19
SAP90


-147.936
155.905
147.848
-153903
138.029
-156.721
136.721
137.998
Y
X
SOL
FRAME
OUTPUT V23
LOAD 2
MIN < 1:
-.1567L+03
AT .00
MAX < 10:
.1567L+03
AT 1.19
SAP90

$h = 48$ pieture of water

AXIAL TORQ	MOMENT



$h=1$; $h'=1$; pressure of water $48\ T/M^2$

- DATA FOR CALCULATION OF THE REINFORCEMENT.

$f'_c = 210\ kg/cm^2$

$f_y = 4200\ kg/cm^2$

$b = 100\ cm$

$d = 133\ cm$

$r = 7\ cm$

$M_u = 123{,}028\ ton$

$$A_s = \frac{123{,}028 \times 10^5}{0.9 \times 4200 \times 133} = 24.47\ cm^2$$

$A_{s\,min} = 0.0033 \times 100 \times 133 = 43.89\ cm^2 = 9\varnothing 25 \Rightarrow 1\varnothing 25 @ 12.5$

$A_{s\,temp}$ SHRINKAGE $= 0.002 \times 100 \times 140 = 28\ cm^2/2$ FACE $\Rightarrow 1\varnothing 16 @ 15.5$

- SHEAR STRESS CHEK.

$V_u = 156{,}721\ ton$

$V_c = 86{,}827\ ton < V_u$

$V_s = 156.721 - 86.827 = 69{,}894\ ton$

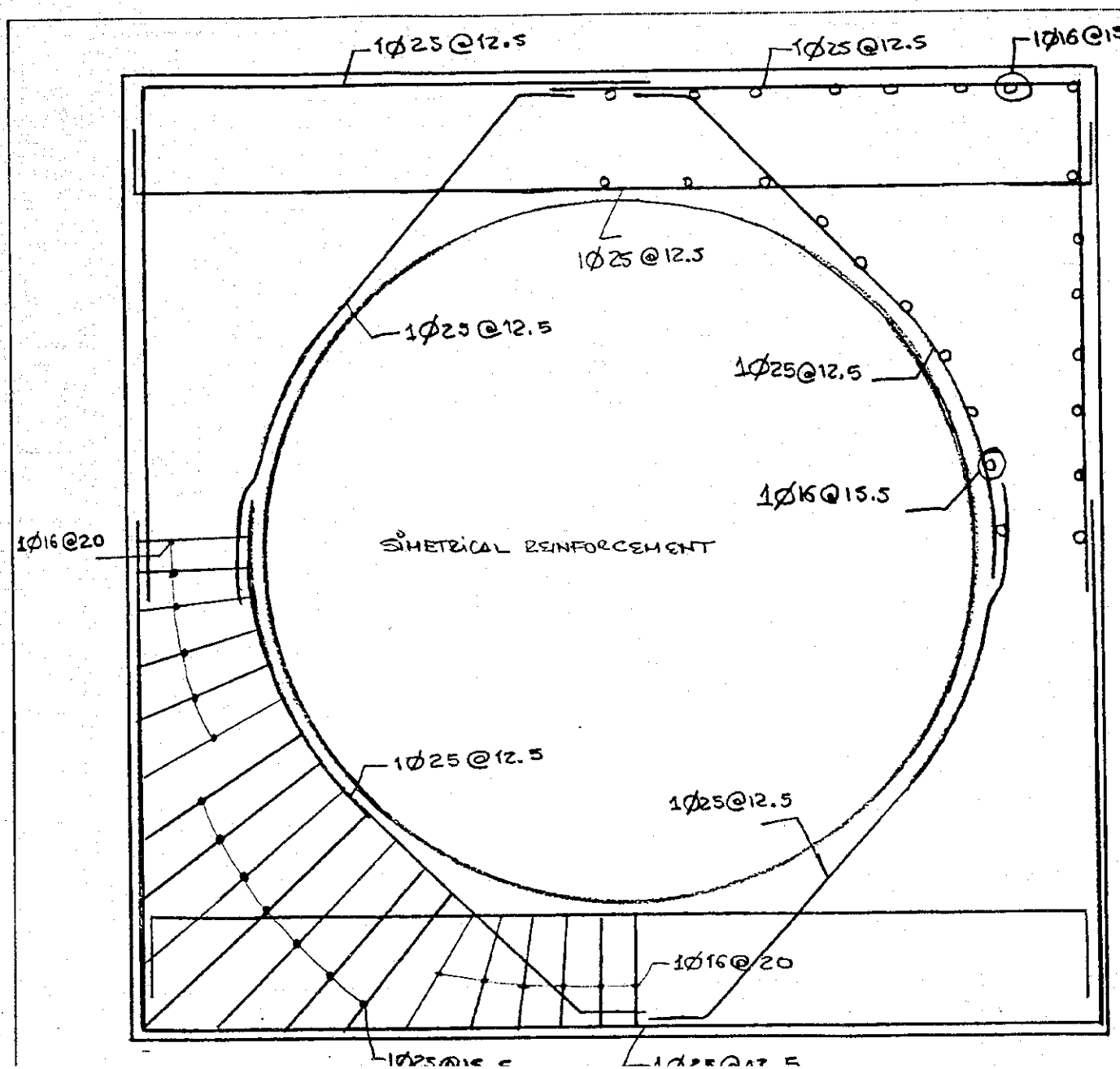
$$A_v = \frac{69894.00}{0.85 \times 4200 \times \sin 45} = 27.69\ cm^2 \Rightarrow 1\varnothing 25 @ 15.5$$

$V_u = 56.77\ ton$

$V_s = 56{,}77 - 28{,}071 = 28.70$

$$A_v = \frac{28.70 \times 10^3}{0.85 \times 4200 \times \sin 45} = 11.37\ cm^2 \Rightarrow 1\varnothing 16 @ 20$$

Revision	Checked by Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approved by: Aprobado por:	Date (Fecha) Aprobado por:



Y
X

SIPHON

UNDEFORMED SHAPE

REINFORCEMENT
h= 1 ; h' = 1

pressure of water = 4.8 T/m²

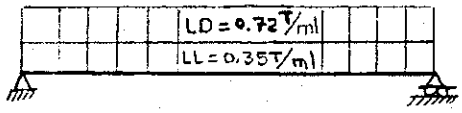
R = 3.2×0.5
r = 0.07 cm

OPTIONS

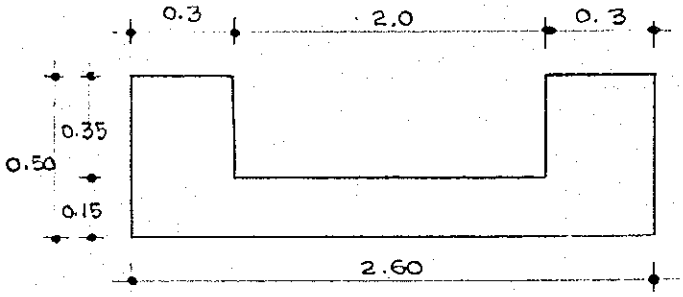
WIRE FRAME

SAP90

PEDESTRIAN BRIDGE DESIGN



- SHAPE AND DIMENSIONS



DATA

$f'_c = 210\ kg/cm^2$

$f_y = 4200\ kg/cm^2$

$b = 30\ cm$

$d = 46\ cm$

$r = 4\ cm$

b h $\gamma_{concrete}$ h slab x b x $\gamma_{concrete}$

$LD = 0.3 \times 0.5 \times 2.4 + 0.15 \times 1 \times 2.4 = 0.72\ T/m^2$

$LL = 0.35\ T/m^2$

$W_U = 1.4 \times 0.72 + 1.7 \times 0.35 = 1.603\ T/ml$

$M_U = \frac{1.603 \times 10.0^2}{8} = 20.04\ ton\text{-}mt$ $\quad M_U = \frac{W_U L^2}{8}$

$V_U = \frac{1.603 \times 10}{2} = 8.02\ ton$ $\quad V_U = \frac{W_U \times L}{2}$

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

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

$A_S = \frac{20.04 \times 10^5}{0.9 \times 4200\ (46 - \frac{9}{2})} = 12.77\ cm^2 = 5\ \emptyset\ 18$

$A_{S\,min} = 0.0033 \times 30 \times 46 = 4.55\ cm^2 = 3\ \emptyset\ 14$

Revision	Checked by: Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approbed by: Aprobado por:	Date (Fecha) Aprobado por:

Flat plate

DATA

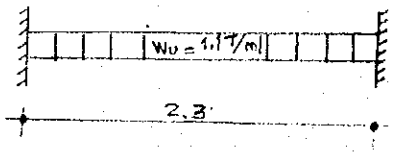
$f'_c = 210\ kg/cm^2$

$f_y = 4200\ kg/cm^2$

$b = 100$

$d = 2.5$

$r = 2.5$



$L = 2.3\ m$

$LD = 0.15 \times 2.4 \times 1 = 0.36\ T/m^2$

$LL = 0.35\ T/m^2$

$W_U = 1.4 \times 0.36 + 1.7 \times 0.35 = 1.10\ T/m^2$

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

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

$A_s = \frac{0.48 \times 10^5}{0.9 \times 4200 \left(12.5 - \frac{2.5}{2}\right)} = 1.13\ cm^2$

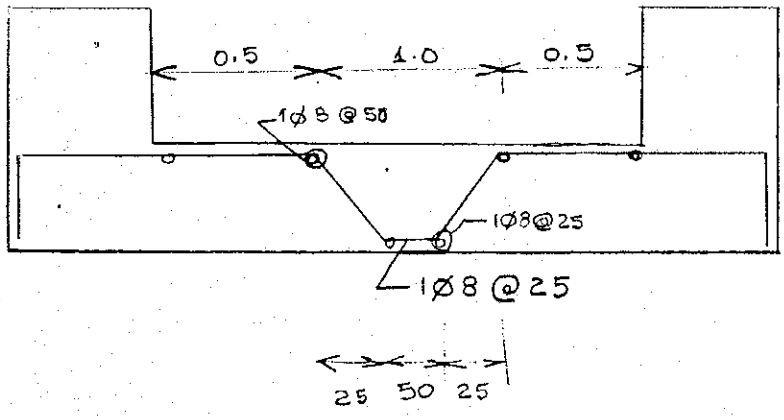
$\rho = \frac{1.13}{100 \times 12.5} = 0.0009 < \rho_{min}$

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

$\rho = \frac{0.57}{100 \times 12.5} = 0.0004 < \rho_{min}$

$\rho_{min} = 0.002$

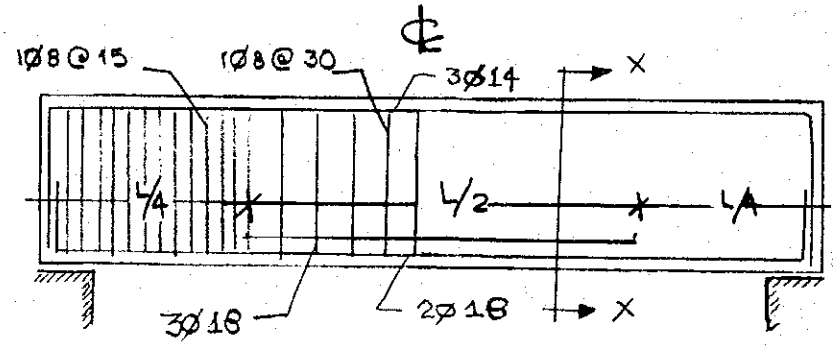
$A_s = 0.002 \times 100 \times 15.0 = 3.0\ cm^2/FACE \Rightarrow 4\phi 8 \Rightarrow 1\phi 8 @ 50$

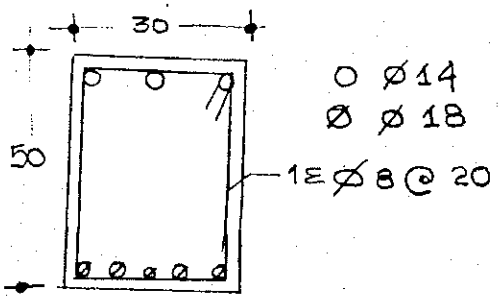


Revision	Checked by Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approbed by: Aprobado por:	Date (Fecha) Aprobado por:

4-207

DETAIL OF REINFORCEMENT FOR BEAM





O Ø 14
Ø Ø 18

SECTION X-X

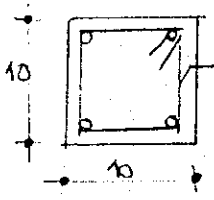
STRESS SHEAR CHECK

$V_U = 8.02$ ton

$V_c = 0.85 \times 0.53 \sqrt{210} \times 30 \times 46 = 9.009{,}14$ kg.

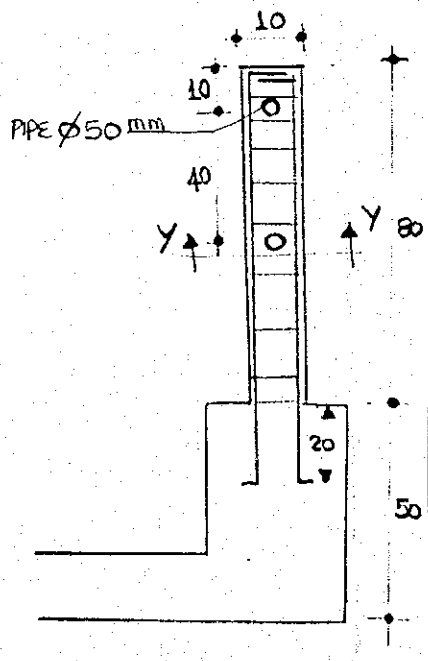
$V_c > V_U$ NO REQUIRED STIRRUPS

1Ø8 TO $\frac{d}{2}$ NORMATIVE



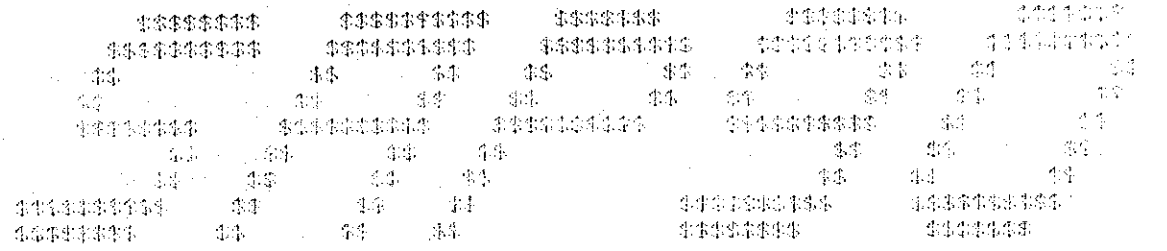
O 4Ø8
1EØ8 @ 15
r = 2,5 cm = cover

SECTION Y-Y



Revision	Checked by Revisado por	Date (Fecha)	Approved by: Aprobado por:	Date (Fecha)	Revision	Checked by: Revisado por	Date (fecha)	Approved by: Aprobado por:	Date (Fecha) Aprobado por:

4-208



STRUCTURAL ANALYSIS PROGRAM

VERSION 5.41

ASTEC

PAGE

PROGRAM:SAP90/FILE:SAP22.T1

STION CIRCULAR h=40 pressure of water.

F R A M E E L E M E N T F O R C E S

ELT ID	LOAD COMB	DIST END	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TOR
1								
	1	.000			-38.524			
		.040	26.343	-30.966				
		.010	26.343	-30.723				
		.010			-38.524			
	2	.000			122.696			
		.000	-131.509	101.656				
		.010	-131.509	100.540				
		.010			122.696			
2								
	1	.000			-38.524			
		.000	26.343	-30.723				
		1.180	9.463	-9.631				
		1.190	9.463	-9.715				
		1.190			-38.524			
	2	.000			122.696			
		.000	-131.509	100.540				
		1.180	-45.130	-3.400				
		1.190	-44.450	-3.935				
		1.190			122.696			
3								
	1	.000			-38.524			
		.000	9.463	-9.715				
		.738	.060	-6.275				
		1.300	-6.649	-8.166				
		1.300			-38.524			
	2	.000			122.696			
		.000	-44.450	-3.935				
		.620	.060	-17.076				
		1.300	40.635	-1.292				
		1.300			122.696			
4								

5. Tunel

5. Tunel

5.1 Cálculo de Diseño Hidráulico

(1) Generalidades

Las rutas de los túneles de derivación se determinaron considerando la distancia más corta entre la entrada y salida de los mismos. Se determinaron algunas curvas en las rutas para obtener suficiente cobertura del suelo desde la superficie. Para cada túnel se determinó un diámetro a partir de los resultados de los análisis técnicos y económicos

Una sección de herradura estandar fué adoptada para los túneles para conseguir un flujo uniforme del agua a través de los mismos. El máximo caudal se obtiene por medio de un flujo libre abierto y la altura de agua en el interior del túnel equivale al 80% del diámetro del túnel. Esto se determinó mediante el estudio de las curvas hidráulicas características para el túnel. La pendiente de la rasante de cada túnel fué escogida para obtener una condición de flujo libre abierto.

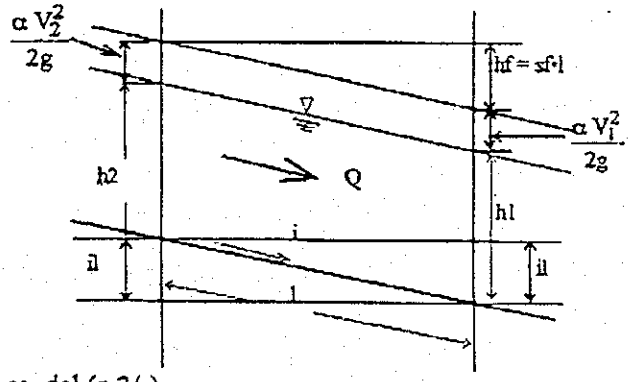
(2) Túnel de Derivación Daule-Peripa - La Esperanza

El túnel de derivación Daule Peripa - La Esperanza es un túnel no presurizado de 8,3 km de longitud con un diámetro de 3,7 m y una sección en forma de herradura, y su pendiente es de 1:1.500. El caudal máximo requerido es de 18,0 m^3/s.

El nivel de agua para un caudal variable en el foso de entrada (entre el pozo de la válvula y la entrada del túnel) se obtiene aplicando el método de cálculo de flujo no uniforme en el túnel bajo la condición de que el nivel de agua a la salida del túnel sea de 63,5 m.s.n.m. (nivel óptimo del agua). El cálculo de flujo no uniforme utiliza la siguiente ecuación:

$$\phi = h_1 - i \cdot l + \frac{\alpha \cdot Q^2}{2 \cdot g \cdot A_1^2} + \frac{n^2 \cdot l \cdot Q^2}{2 \cdot R_1^{4/3} \cdot A_1^2}$$

$$\psi = h_2 + \frac{\alpha \cdot Q^2}{2 \cdot g \cdot A_2^2} - \frac{n^2 \cdot l \cdot Q^2}{2 \cdot R_2^{4/3} \cdot A_2^2}$$



donde, Q : caudal (m3/s)
i : gradiente de la rasante del túnel
α : 1,1

n : coeficiente de rugosidad (0,015)
g : aceleración de la gravedad (9,8 m/s^2)

Los resultados de los cálculos se muestran en la tabla y figura que se anexan.

(3) Túnel de Derivación La Esperanza - Poza Honda

El túnel de derivación La Esperanza - Poza Honda es un túnel no presurizado de 11,4 km de longitud con un diámetro de 3,5 m y una sección en forma de herradura y su gradiente es de 1:1.500. El caudal máximo requerido es de 16,0 m^3/s.

El nivel para el caudal máximo en el punto de transición con el canal abierto se obtiene mediante el método de cálculo de flujo no uniforme aplicado al túnel y estructura de entrada bajo la condición de que el nivel de agua a la salida del túnel sea de 102,5 m.s.n.m. (nivel óptimo del agua). El cálculo de flujo no uniforme utiliza la ecuación mencionada previamente:

Los resultados del cálculo se muestran en la tabla que se anexa.

(4) Túnel de Derivación Poza Honda - Mancha Grande

El túnel de derivación Poza Honda - Mancha Grande es también un túnel no presurizado de 4,1 km de longitud con un diámetro de 2,5 m y una sección en forma de herradura y su gradiente es de 1:3.900. El caudal máximo requerido es de 4,0 m^3/s.

El nivel de agua para un caudal variable en el foso de entrada (entre el pozo de la válvula y la entrada del túnel) se obtiene aplicando el método de cálculo de flujo uniforme en el túnel más el cálculo de las pérdidas por entrada. El cálculo se efectúa mediante la siguiente fórmula de Manning:

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

donde, V : velocidad del flujo (m^3/s)
n : coeficiente de rugosidad (0,015)
R : radio hidráulico (m)
I : gradiente de la solera del túnel

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

donde, WL : nivel de agua en el pozo de entrada (m)
TIL : nivel de la solera a la entrada del túnel (m)
D : profundidad del flujo a la entrada del túnel (m)
fe : coeficiente de pérdidas por entrada (0,2)
V : velocidad media del flujo en la parte de la transición del túnel (m/s)
g : aceleración de la gravedad (9,8 m/s^2)

Los resultados del cálculo se muestran en la tabla y figura que se anexan.

Cálculo del Flujo No Uniforme del Túnel de Derivación Danle-Peripa - La Esperanza

(Q = 18 m³/s)

Estación No.	Distancia (m)	Distancia acumulada desde la salida (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0	0	60,500	3,000	15,600	1,154	63,500
E.P del túnel	0	0	60,500	3,013	10,845	1,660	63,513
+10,0m	10	10	60,507	2,981	9,886	1,821	63,488
1	990	1000	61,167	2,950	9,792	1,838	64,117
2	1000	2000	61,833	2,929	9,731	1,850	64,762
3	1000	3000	62,500	2,917	9,693	1,857	65,417
4	1000	4000	63,167	2,909	9,670	1,862	66,076
5	1000	5000	63,833	2,904	9,655	1,864	66,737
6	1000	6000	64,500	2,901	9,647	1,866	67,401
7	1000	7000	65,167	2,900	9,642	1,867	68,067
8	1000	8000	65,833	2,899	9,638	1,868	68,732
8+285,83m	285,83	8285,83	66,024	2,898	9,638	1,868	68,922
8+295,83m	10	8295,83	66,031	2,940	10,877	1,655	68,971
Entrada	0	8295,83	66,031	2,972		0,000	69,002

(Q = 14 m³/s)

Estación No.	Distancia (m)	Distancia acumulada desde la salida (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0	0	60,500	3,000	15,600	0,897	63,500
E.P del túnel	0	0	60,500	3,008	10,830	1,293	63,508
+10,0m	10	10	60,507	2,987	9,901	1,414	63,494
1	990	1000	61,167	2,721	9,076	1,543	63,888
2	1000	2000	61,833	2,537	8,459	1,655	64,370
3	1000	3000	62,500	2,432	8,096	1,729	64,932
4	1000	4000	63,167	2,381	7,913	1,769	65,548
5	1000	5000	63,833	2,359	7,836	1,787	66,192
6	1000	6000	64,500	2,350	7,805	1,794	66,850
7	1000	7000	65,167	2,347	7,794	1,796	67,514
8	1000	8000	65,833	2,346	7,790	1,797	68,179
8+285,83m	285,83	8285,83	66,024	2,346	7,789	1,797	68,370
8+295,83m	10	8295,83	66,031	2,385	8,824	1,587	68,416
Entrada	0	8295,83	66,031	2,414		0,000	68,445

(Q = 10 m³/s)

Estación No.	Distancia (m)	Distancia acumulada desde la salida (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0	0	60,500	3,000	15,600	0,641	63,500
E.P del túnel	0	0	60,500	3,004	10,819	0,924	63,504
+10,0m	10	10	60,507	2,990	9,911	1,009	63,497
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	64,475
4	1000	4000	63,167	1,888	6,117	1,634	65,055
5	1000	5000	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	8000	65,833	1,857	6,004	1,666	67,690
8+285,83m	285,83	8285,83	66,024	1,857	6,004	1,666	67,881
8+295,83m	10	8295,83	66,031	1,898	7,023	1,424	67,929
Entrada	0	8295,83	66,031	1,922		0,000	67,953

V-3

690

(Q = 7,5 m³/s)

Estación No.	Distancia (m)	Distancia acumulada desde la salida (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0	0	60,500	3,000	15,600	0,481	63,500
E.P del tùnel	0	0	60,500	3,002	10,814	0,694	63,502
+10,0m	10	10	60,507	2,992	9,916	0,756	63,499
1	990	1000	61,167	2,451	8,161	0,919	63,618
2	1000	2000	61,833	1,994	6,509	1,152	63,827
3	1000	3000	62,500	1,693	5,397	1,390	64,193
4	1000	4000	63,167	1,570	4,942	1,518	64,737
5	1000	5000	63,833	1,547	4,853	1,545	65,380
6	1000	6000	64,500	1,544	4,845	1,548	66,044
7	1000	7000	65,167	1,544	4,845	1,548	66,711
8	1000	8000	65,833	1,544	4,845	1,548	67,377
8+285,83m	285,83	8285,83	66,024	1,544	4,845	1,548	67,568
8+295,83m	10	8295,83	66,031	1,586	5,868	1,278	67,617
Entrada	0	8295,83	66,031	1,606		0,000	67,637

(Q = 5,0 m³/s)

Estación No.	Distancia (m)	Distancia acumulada desde la salida (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0	0	60,500	3,000	15,600	0,321	63,500
E.P del tùnel	0	0	60,500	3,001	10,810	0,463	63,501
+10,0m	10	10	60,507	2,993	9,918	0,504	63,500
1	990	1000	61,167	2,386	7,934	0,630	63,553
2	1000	2000	61,833	1,824	5,881	0,850	63,657
3	1000	3000	62,500	1,404	4,322	1,157	63,904
4	1000	4000	63,167	1,237	3,699	1,352	64,404
5	1000	5000	63,833	1,212	3,607	1,386	65,045
6	1000	6000	64,500	1,215	3,615	1,383	65,715
7	1000	7000	65,167	1,214	3,614	1,384	66,381
8	1000	8000	65,833	1,214	3,614	1,384	67,047
8+285,83m	285,83	8285,83	66,024	1,214	3,614	1,384	67,238
8+295,83m	10	8295,83	66,031	1,255	4,645	1,076	67,286
Entrada	0	8295,83	66,031	1,270		0,000	67,301

(Q = 2,5 m³/s)

Estación No.	Distancia (m)	Distancia acumulada desde la salida (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0	0	60,500	3,000	15,600	0,160	63,500
E.P del tùnel	0	0	60,500	3,000	10,808	0,231	63,500
+10,0m	10	10	60,507	2,993	9,920	0,252	63,500
1	990	1000	61,167	2,347	7,793	0,321	63,514
2	1000	2000	61,833	1,709	5,455	0,458	63,542
3	1000	3000	62,500	1,139	3,329	0,751	63,639
4	1000	4000	63,167	0,860	2,269	1,102	64,027
5	1000	5000	63,833	0,848	2,224	1,124	64,681
6	1000	6000	64,500	0,852	2,240	1,116	65,352
7	1000	7000	65,167	0,851	2,234	1,119	66,018
8	1000	8000	65,833	0,851	2,236	1,118	66,684
8+285,83m	285,83	8285,83	66,024	0,851	2,236	1,118	66,875
8+295,83m	10	8295,83	66,031	0,887	3,281	0,762	66,918
Entrada	0	8295,83	66,031	0,896		0,000	66,927

Cálculo del Flujo No Uniforme del Túnel de Derivación La Esperanza - Poza Honda

(Q = 16 m³/s)

Estación No.	Distancia (m)	Distancia acumulada (m)	Cota del fondo (m)	Altura de agua h(m)	Area de flujo (m²)	Velocidad de flujo (m/s)	Nivel de agua (m)
Canal de salida	0,00	0,00	99,700	2,800	13,720	1,166	102,500
E.P del tunel	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	8,844	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
Alc. de entr.16	9,00	11.426,05	107,317	2,871	10,047	1,593	110,188
Alc. de entr.17	31,00	11.457,05	107,338	2,865	10,028	1,595	110,203
BP de alc. de entr.	38,00	11.495,05	107,363	2,859	10,006	1,599	110,222
Canal abierto	12,00	11.507,05	107,762	2,500	11,501	1,391	110,262

Cálculo Hidráulico del Túnel de Derivación Poza Honda - Mancha Grande

(Q = 4 m³/s)

	Distancia desde EP (1/3900)	Cota de la solera (m)	Altura de agua (m)	Area de flujo (m²)	Caudal (m³/s)	Nivel de agua (m)
Fin de transición	4082,930	90,047	1,997	4,484	0,892	92,044
B.P de transición	4092,930	90,049	2,006	5,015	0,798	92,056
Entrada	4092,930	90,050	2,013			92,063

(Q = 3 m³/s)

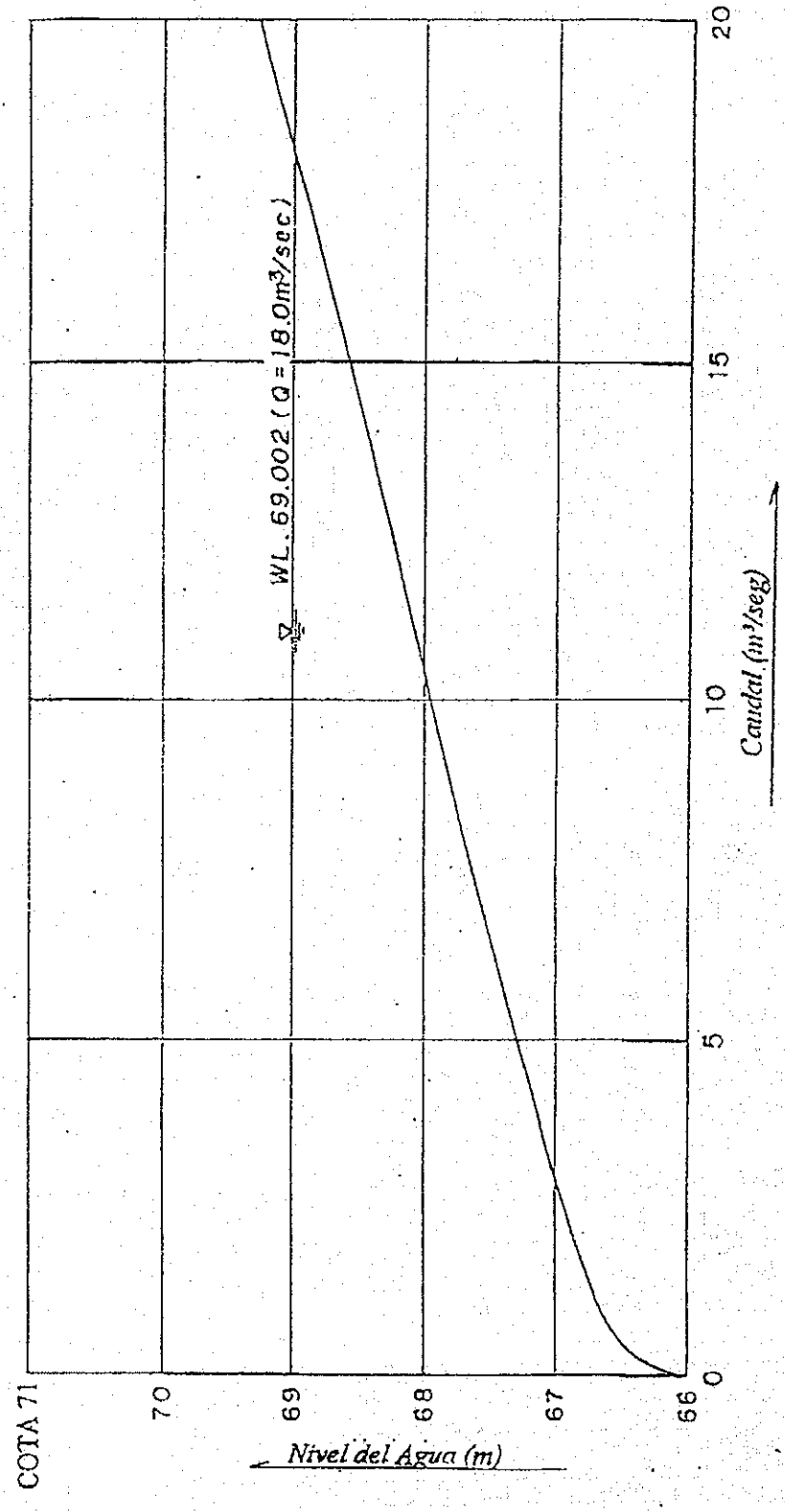
	Distancia desde EP (1/3900)	Cota de la solera (m)	Altura de agua (m)	Area de flujo (m²)	Caudal (m³/s)	Nivel de agua (m)
Fin de transición	4082,930	90,047	1,564	3,507	0,856	91,611
B.P de transición	4092,930	90,049	1,573	3,931	0,763	91,622
Entrada	4092,930	90,050	1,579			91,629

(Q = 2 m³/s)

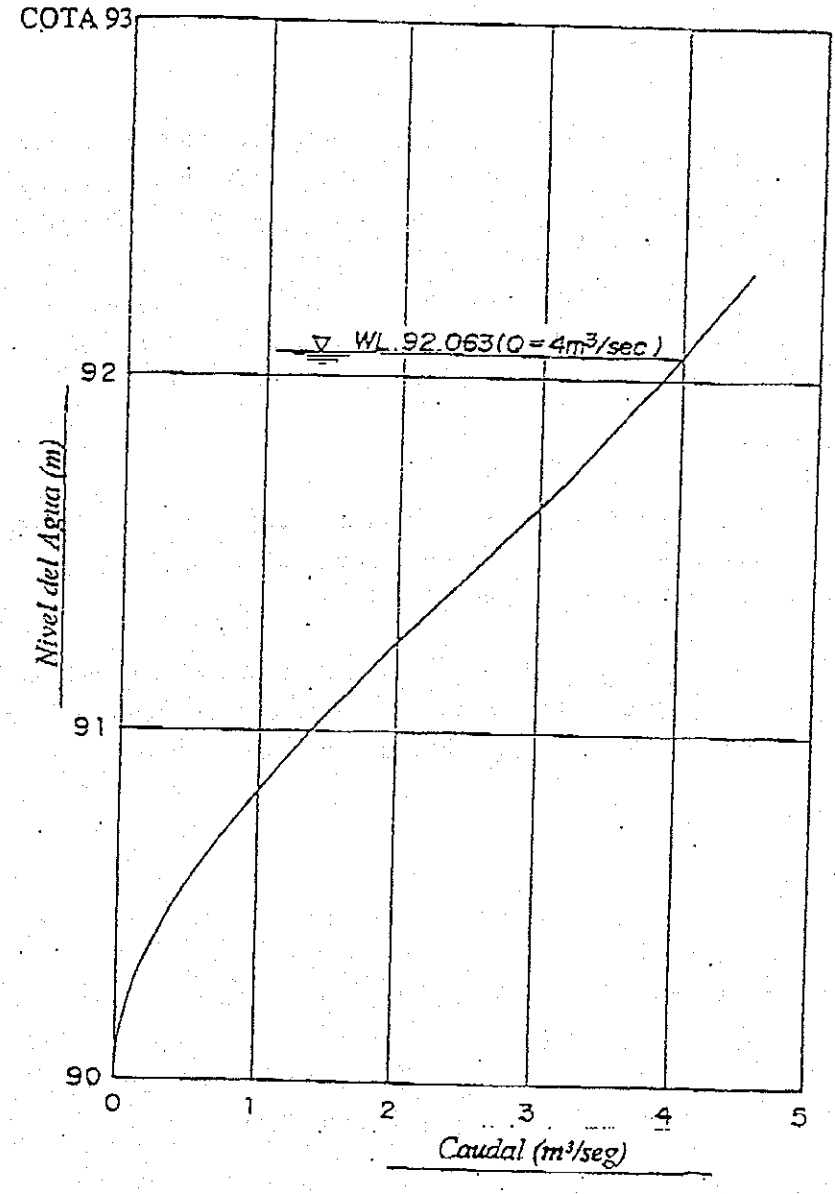
	Distancia desde EP (1/3900)	Cota de la solera (m)	Altura de agua (m)	Area de flujo (m²)	Caudal (m³/s)	Nivel de agua (m)
Fin de transición	4082,930	90,047	1,186	2,569	0,779	91,233
B.P de transición	4092,930	90,049	1,194	2,986	0,670	91,244
Entrada	4092,930	90,050	1,200			91,250

(Q = 1 m³/s)

	Distancia desde EP (1/3900)	Cota de la solera (m)	Altura de agua (m)	Area de flujo (m²)	Caudal (m³/s)	Nivel de agua (m)
Fin de transición	4082,930	90,047	0,772	1,526	0,655	90,819
B.P de transición	4092,930	90,049	0,781	1,952	0,512	90,830
Entrada	4092,930	90,050	0,784			90,834



Curva de Descarga en la Entrada Conguillo



Curva de Descarga en la Entrada Poza Honda