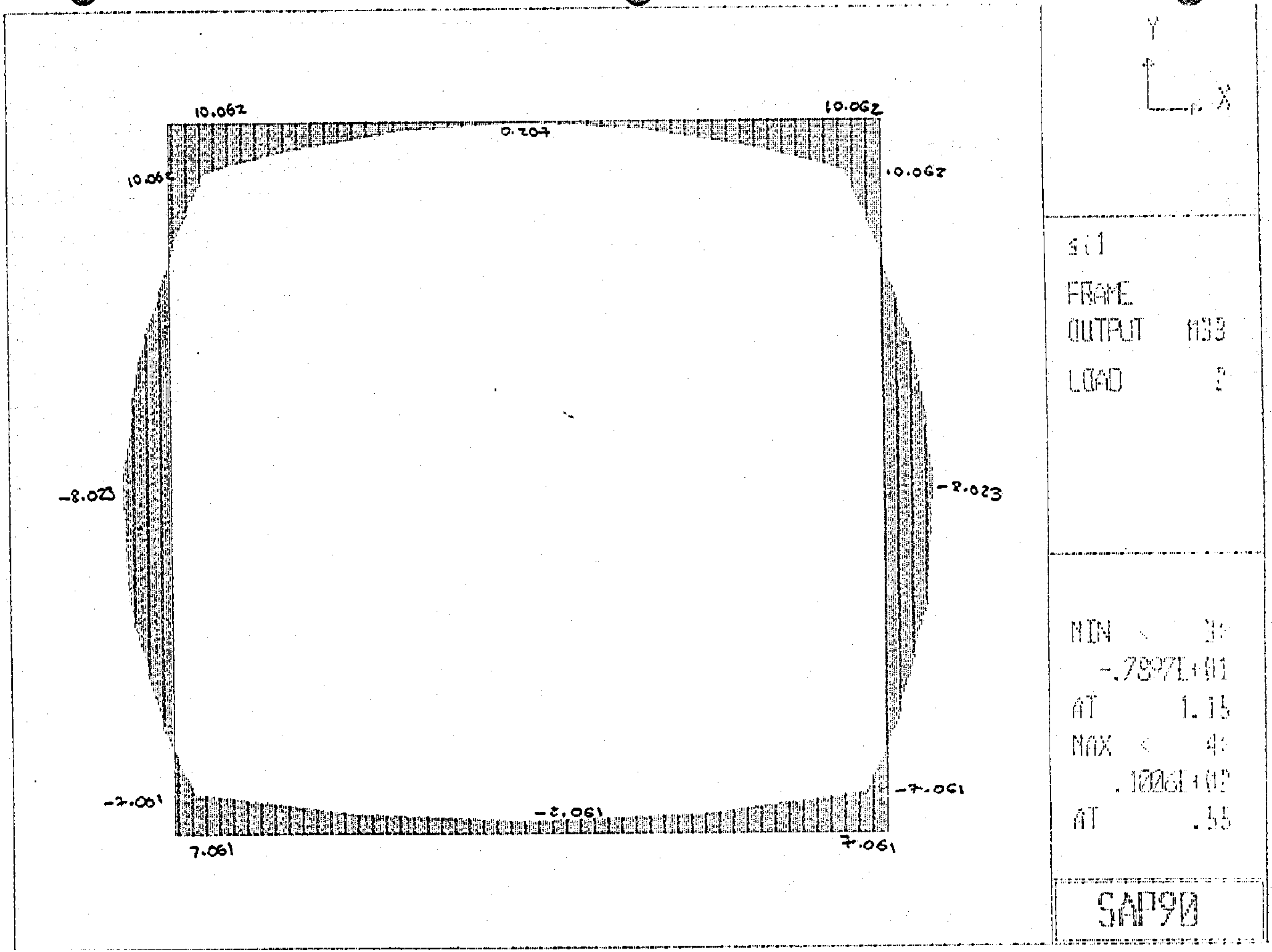
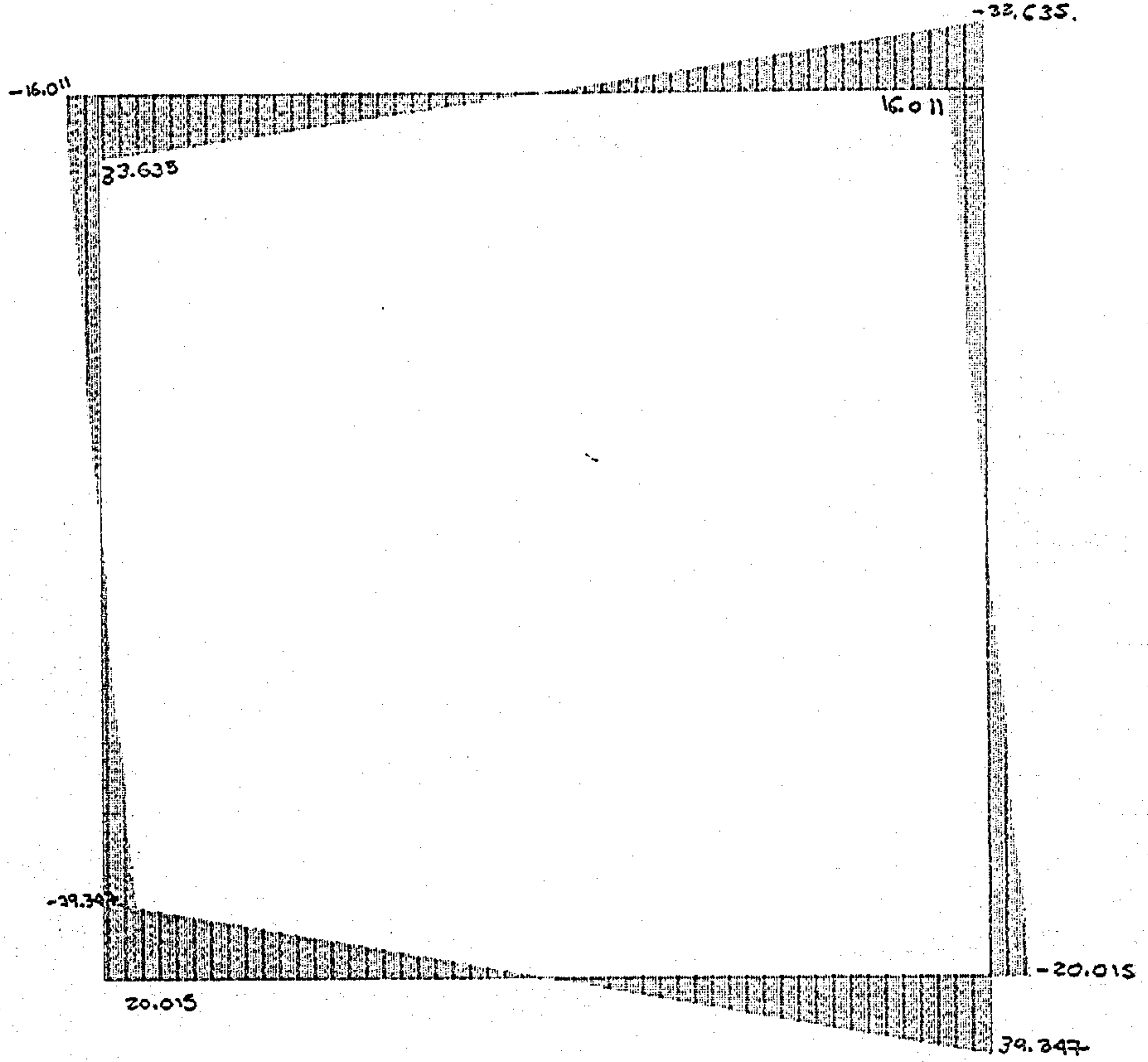


10.062
0.704
10.062
10.062
10.062
-8.023
-8.023
-7.061
-2.061
-7.061
7.061
7.061
Y
X
FRAME
OUTPUT M33
LOAD 2
MIN
-.7897E+01
AT 1.15
MAX
.1006E+02
AT .55
SAP90

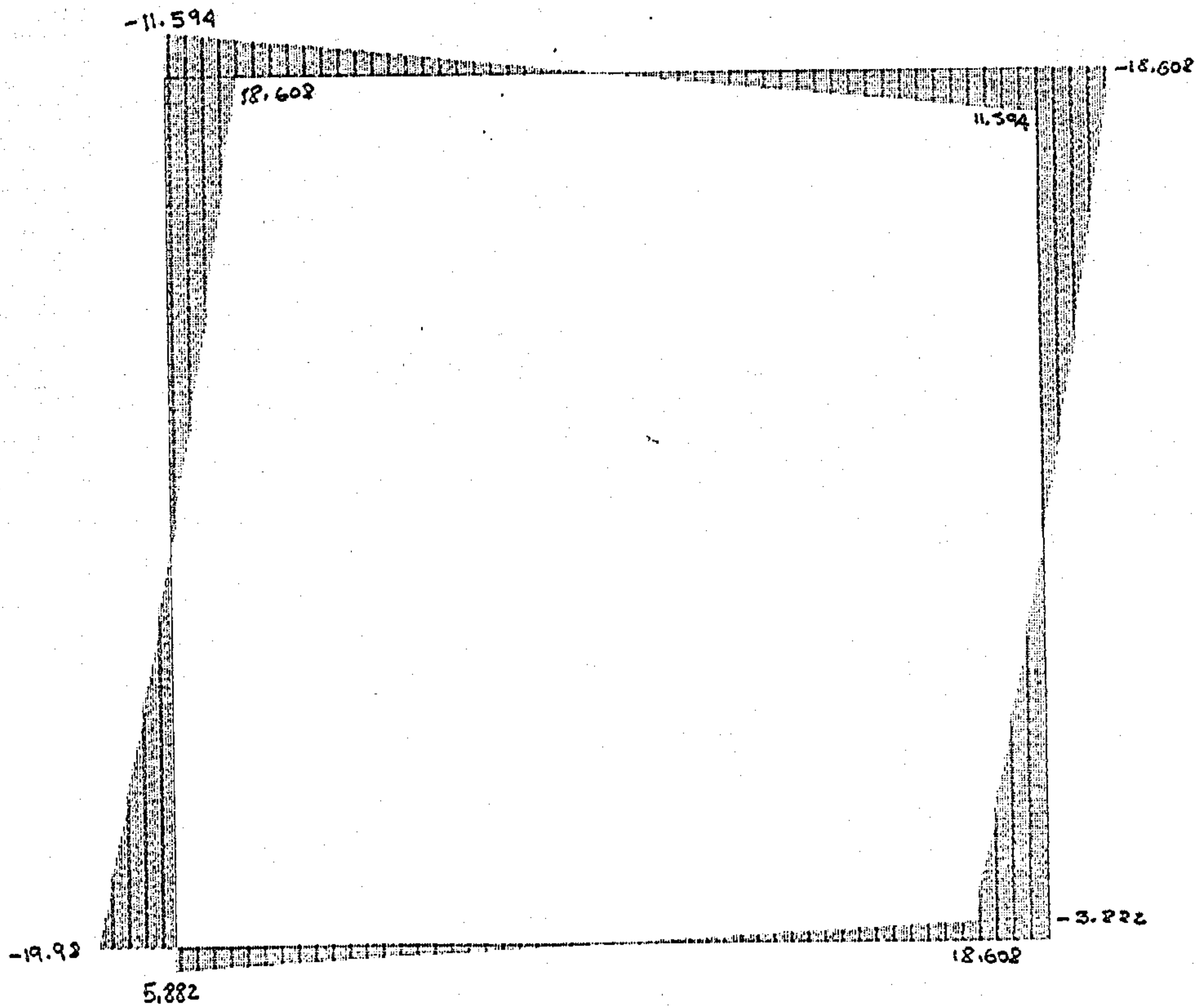


sil

FRAME
OUTPUT V22
LOAD 1

MIN < 12>
-.3935E+02
AT .00
MAX < 14>
.3935E+02
AT .01

SAP90



Y
X

sil

FRAME
OUTPUT V22
LOAD 2

MIN < 1>
-.1998E+02
AT .00
MAX < 10>
.1998E+02
AT .54

SAP90

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

TEC

IFON h=5.0 sil h = 5.0 pressure of water

RAME ELEMENT FORCES

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				
		[illegible]	[illegible]	[illegible]				

		.550			
	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	

IFON h=5.0 si1

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				

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			

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	-5.847	-7.002	
.010	-5.882	-7.061	
.010			.000

```
      $$$$$$$$      $$$$$$$$$$    $$$$$$$        $$$$$$$$      $$$$$$$
    $$$$$$$$$$     $$$$$$$$$$   $$$$$$$$$$     $$$$$$$$$$$   $$$$$$$$$$
   $$            $$      $$   $$        $$   $$        $$   $$        $$
  $$            $$      $$   $$        $$   $$        $$   $$        $$
  $$$$$$$$     $$$$$$$$$$   $$$$$$$$$$     $$$$$$$$$$   $$        $$
        $$    $$      $$   $$                     $$   $$        $$
       $$    $$      $$   $$                     $$   $$        $$
$$$$$$$$$$  $$      $$   $$          $$$$$$$$$$    $$$$$$$$$$
$$$$$$$$   $$      $$   $$           $$$$$$$$        $$$$$$$
```

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

IFON h=10.0 si1

RAME ELEMENT FORCES

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				

ELT ID	LOAD COMB	DIST ENDI	SHEAR	MOMENT	AXIAL FORCE
		.550			------
	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	

RAME ELEMENT FORCES

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			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				

IFON h=5.0 si1

RAME ELEMENT FORCES

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			

STEC

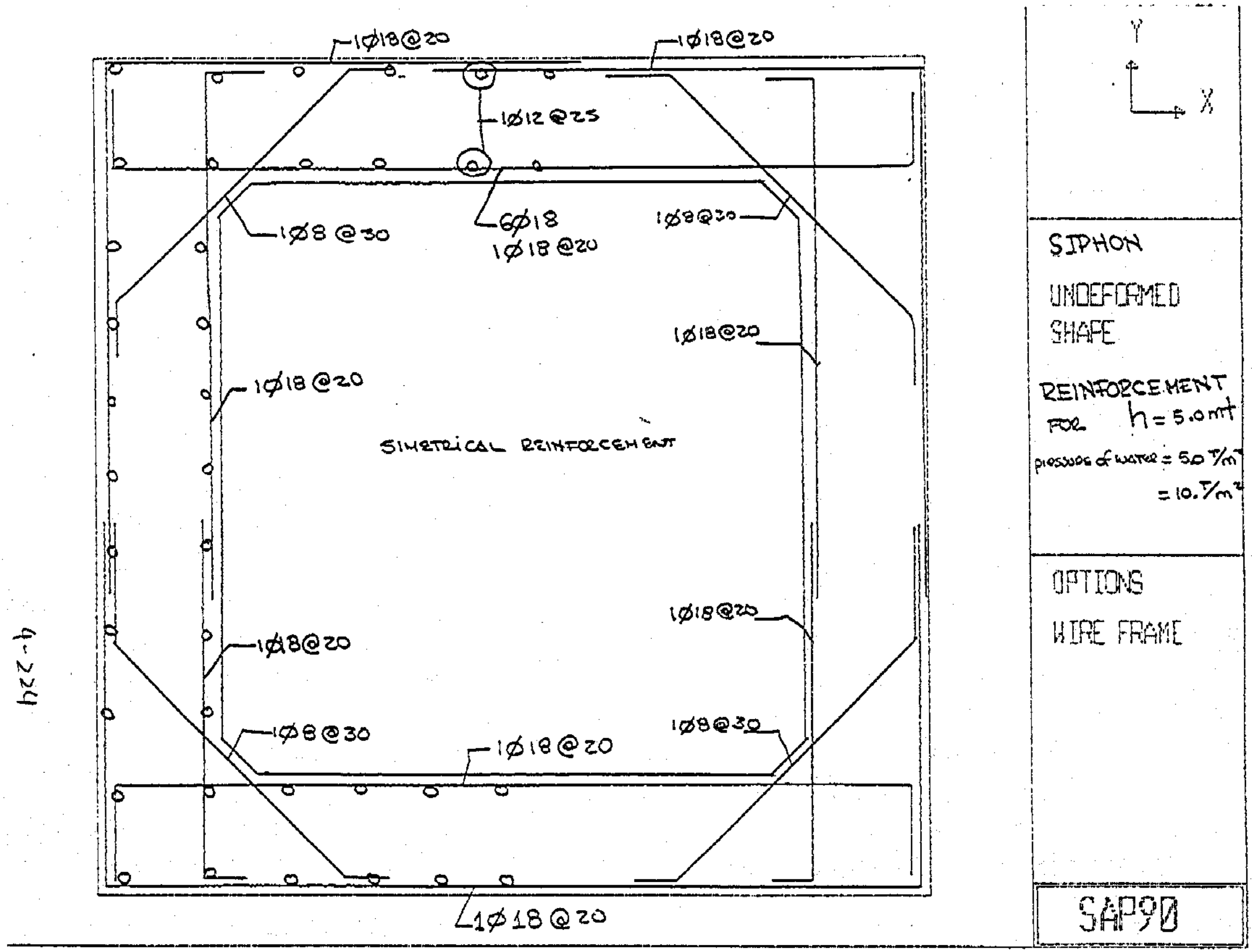
SIFON h=5.0 si1

FRAME ELEMENT FORCES

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			

2	.000			.000
	.000	-20.212	-15.414	
	.010	-20.332	-15.616	
	.010			.000

9-223


1Ø18@20
1Ø18@20
1Ø12@25
6Ø18
1Ø18@20
1Ø8@30
1Ø8@30
1Ø18@20
1Ø18@20
SIMETRICAL REINFORCEMENT
1Ø18@20
1Ø8@20
1Ø8@30
1Ø18@20
1Ø8@30
1Ø18@20
Y
X
SIPHON
UNDEFORMED SHAPE
REINFORCEMENT FOR h = 5.0 mt
pressure of water = 5.0 T/m²
= 10. T/m²
OPTIONS
WIRE FRAME
SAP90

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

TCC

ITION h=15.0 all

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

ELT ID	LOAD COND	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			40.494			
		.000	-48.399	24.172				
		.010	-48.399	23.688				
		.010			40.494			
2								
	1	.000			-33.634			
		.000	20.015	-17.493				
		.540	13.095	-8.574				
		.540			-33.634			
	2	.000			40.494			
		.000	-48.399	23.688				
		.540	-31.761	2.067				
		.540			40.494			
3								
	1	.000			-33.634			
		.000	13.095	-8.574				
		1.136	.000	-1.320				
		2.300	-11.342	-8.131				
		2.300			-33.634			
	2	.000			40.494			
		.000	-31.761	2.067				
		1.079	.000	-14.394				
		2.300	33.336	5.833				
		2.300			40.494			
4								
	1	.000			-33.634			
		.000	-11.342	-8.131				

4-225

		.550			[illegible]
	[illegible]	.000			40.494
		.000	33.336	5.833	
		.550	47.819	28.230	
		.550			40.494
	1	.000			-16.011
		.000	33.635	-15.680	
		.550	22.753	-.173	

[illegible]

BEAM ELEMENT FORCES

ELT NO	LOAD COMB	DIST FROM I	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			47.819			
		.000	-40.494	28.230				
		.550	-27.393	9.561				
		.550			47.819			
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			47.819			
		.000	-27.393	9.561				
		1.150	.000	-6.190				
		2.300	27.393	9.561				
		2.300			47.819			
7	1	.000			-16.011			
		.000	-22.753	-.173				
		.550	-33.635	-15.680				
		.550			-16.011			
	2	.000			47.819			
		.000	27.393	9.561				
		.550	40.494	28.230				
		.550			47.819			
8	1	.000			-33.634			
		.000	16.011	-15.680				
		.550	11.362	-8.131				
		.550			-33.634			
	2	.000			40.494			
		.000	-47.819	28.230				
		.550	-33.336	5.833				
		.550			40.494			
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			40.494			
		.000	-33.336	5.833				

SIFON H=5.0 sil

FRAME ELEMENT FORCES

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
		1.271	.000	-[illegible].694				
		2.300	31.761	2.047				
		2.300			40.494			
10								
	1	.000			-33.634			
		.000	-13.095	-6.574				
		.540	-20.015	-17.493				
		.540			-33.634			
	2	.000			40.494			
		.000	31.761	2.047				
		.540	48.399	23.686				
		.540			40.494			
11								
	1	.000			-33.634			
		.000	-20.015	-17.493				
		.010	-20.015	-17.693				
		.010			-33.634			
	2	.000			40.494			
		.000	48.399	23.686				
		.010	48.399	24.172				
		.010			40.494			
12								
	1	.000			.000			
		.000	-39.347	17.693				
		.010	-39.115	17.301				
		.010			.000			
	2	.000			.000			
		.000	34.782	-24.172				
		.010	34.577	-23.825				
		.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	34.577	-23.825				
		1.690	-.000	5.393				
		3.380	-34.577	-23.825				
		3.380			.000			

STED

SIFON H=5.0 sil

FRAME ELEMENT FORCES

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
14								
	1	.000			.000			
		.000	39.115	17.301				
		.010	39.347	17.693				
		.010			.000			

4-357

[illegible]	-34.577	23.625	
[illegible]	-34.732	-24.172	
[illegible]			050

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.40

IFOR **h=18.0** S11

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			49.164			
		.000	-56.925	29.305				
		.010	-56.925	28.736				
		.010			49.164			
2								
	1	.000			-33.634			
		.000	20.015	-17.493				
		.540	13.095	-8.574				
		.540			-33.634			
	2	.000			49.164			
		.000	-56.925	28.736				
		.540	-37.532	3.255				
		.540			49.164			
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			49.164			
		.000	-37.532	3.255				
		1.087	.000	-16.966				
		2.300	39.425	7.235				
		2.300			49.164			
4								
	1	.000			-33.634			
		.000	-11.362	-8.131				

		.550			[illegible]
	2	.000			49.164
		.000	39.495	7.235	
		.550	56.582	33.680	
		.550			49.164
5	1	.000			-16.011
		.000	33.635	-15.680	
		.550	22.753	-.173	

FRAME ELEMENT FORCES

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
		.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	-33.635	-15.680				
		.550			-16.011			
	2	.000			56.582			
		.000	33.258	11.014				
		.550	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	-13.025	-8.574				
		2.300			-33.634			
	2	.000			49.164			
		.000	-39.495	7.235				

[illegible]

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

ELT ID	LOAD COND	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQUE
		1.2??	.000	-16.966				
		2.300	37.?3?	4.255				
		2.300			49.164			
10								
	1	.000			-33.634			
		.000	-13.???	-3.574				
		.340	-20.015	-17.493				
		.340			-33.634			
	2	.000			49.164			
		.000	37.?32	3.255				
		.340	56.?25	20.736				
		.340			49.164			
11								
	1	.000			-33.634			
		.000	-20.015	-17.493				
		.010	-20.015	-17.693				
		.010			-33.634			
	2	.000			49.164			
		.000	56.025	28.736				
		.010	56.025	29.305				
		.010			49.164			
12								
	1	.000			.000			
		.000	-39.347	17.693				
		.010	-39.115	17.301				
		.010			.000			
	2	.000			.000			
		.000	43.452	/ -29.305				
		.010	43.196	-28.872				
		.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	43.196	-28.872				
		1.690	-.000	7.629				
		3.380	-43.196	-28.872				
		3.380			.000			

STEC

PAGE
PROGRAM:SAP90/FILE:si1.F3

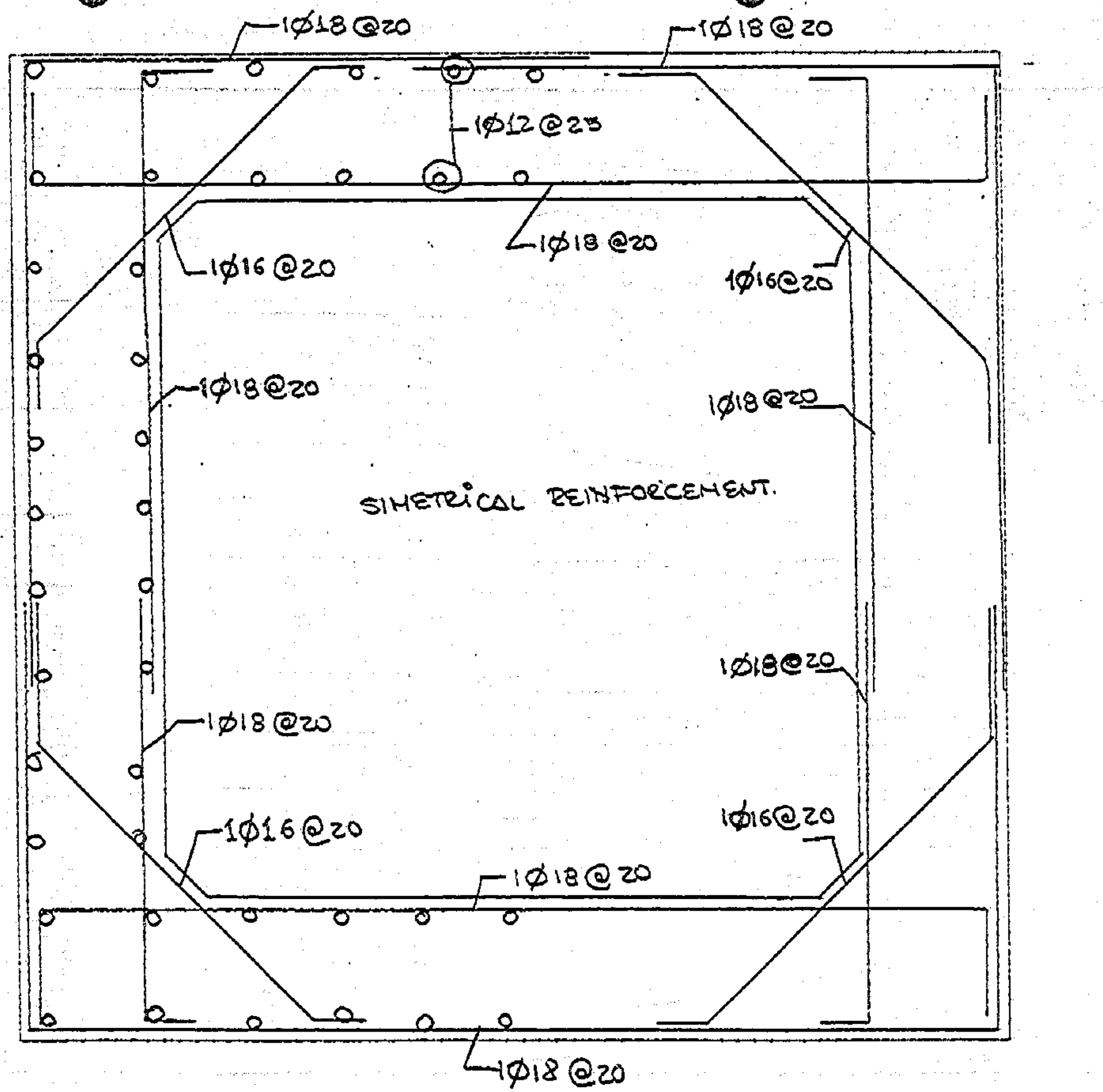
SIFON H=5.0   si1

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

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

4-231

2	1.000			.000
	.000	43.196	28.872	
	.010	43.452	29.705	
	.010			.000



SIPHON

UNDEFORMED
SHAPE

REINFORCEMENT
FOR h= 5
pressure of water = 15T/m²
18T/m²

OPTIONS
WIRE FRAME

SAP90

JAPAN INTERNATIONAL COOPERATION AGENCY - AGENCIA INTERNACIONAL DE COOPERACION DEL JAPON

JICA STUDY TEAM - GRUPO DE ESTUDIOS JICA | Date: / Fecha:

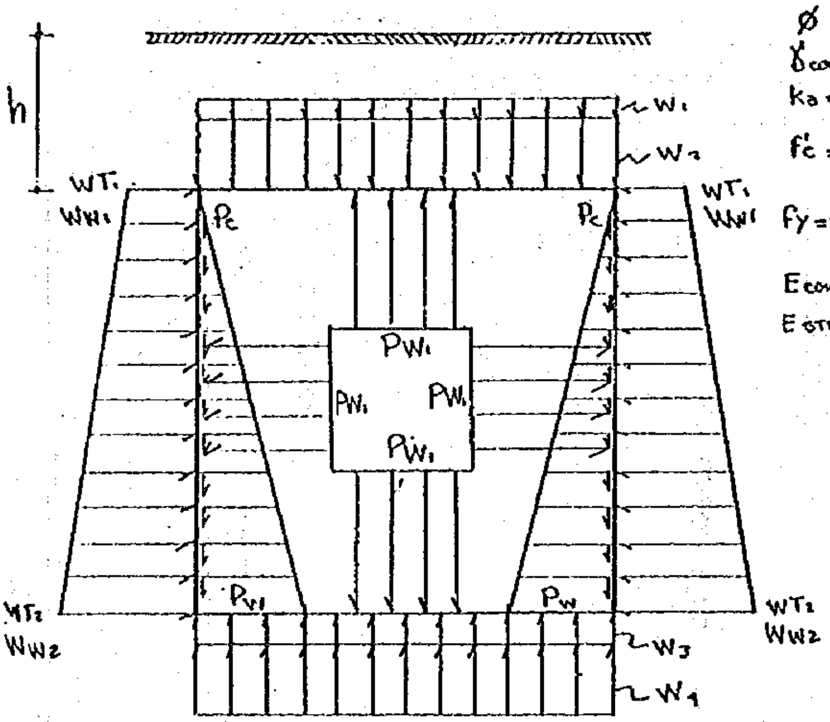
DAULE-PERIPA-LA ESPERANZA TRANSBASIN (TRASVASE DAULE PERIPA-LA ESPERANZA) | Calculated by: / Calculado por: CESAR MEDINA S.

MEMBRILLO OUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO) | Sheet / Hoja ___ of / de ___

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

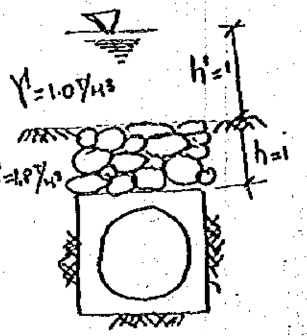
- THE LOADS APPLIED IN THE DESIGN OF CIRCULAR SIPHON ARE AS FOLLOWS :

W_1: LIVE LOAD OF HS-20-44 TRAILER
W_2: VERTICAL LOAD OF EARTH WEIGHT AND SELF WEIGHT OF TOP SLAB
W_3: SURCHARGE OF THE UPLIFT ACT ON BOTTOM SLAB.
W_4: REACTION LOAD ACT ON BOTTOM SLAB
WT: LATERAL EARTH PRESSURE
P_W: LATERAL WATER PRESURE
P_C: 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
$K_a = 0.50$ COEFFICIENT OF EARTH PRESSURE
$f'_c = 180\ Kg/cm^2$ STRENGTH OF CONCRETE
$f_y = 1200\ Kg/cm^2$ 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	W_1	W_2	W_3	W_4	WT_1	WT_2	P_C	P_{V1}	P_{W1}	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	6.7	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:

JAPAN INTERNATIONAL COOPERATION AGENCY - AGENCIA INTERNACIONAL DE COOPERACION DEL JAPON

JICA STUDY TEAM - GRUPO DE ESTUDIOS JICA	Date: / Fecha:
DAULE-PERIPA-LA ESPERANZA TRANSBASIN (TRASVASE DAULE PERIPA-LA ESPERANZA)	Calculated by: / Calculado por:
MEMBRILLO OUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO)	Sheet / Hoja ___ of / de ___

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

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

$W_2 = 0.5 \times 2.4 + 6.25 \times 1.8 = 12.45\ t/m^2$

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

$W_{T1} = 0.5 \times 1.8 \times 6.25 = 5.625\ t/m^2$

$W_{T2} = 0.5 \times 1.8 \times 9.95 = 8.955\ t/m^2$

$P_W = 3.7 \times 1.0 = 3.7\ t/m^2$

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

$W_2 = 0.5 \times 2.4 + 1 \times 0.8 + 1.0 \times 1.0 = 3.0\ T/m^2$

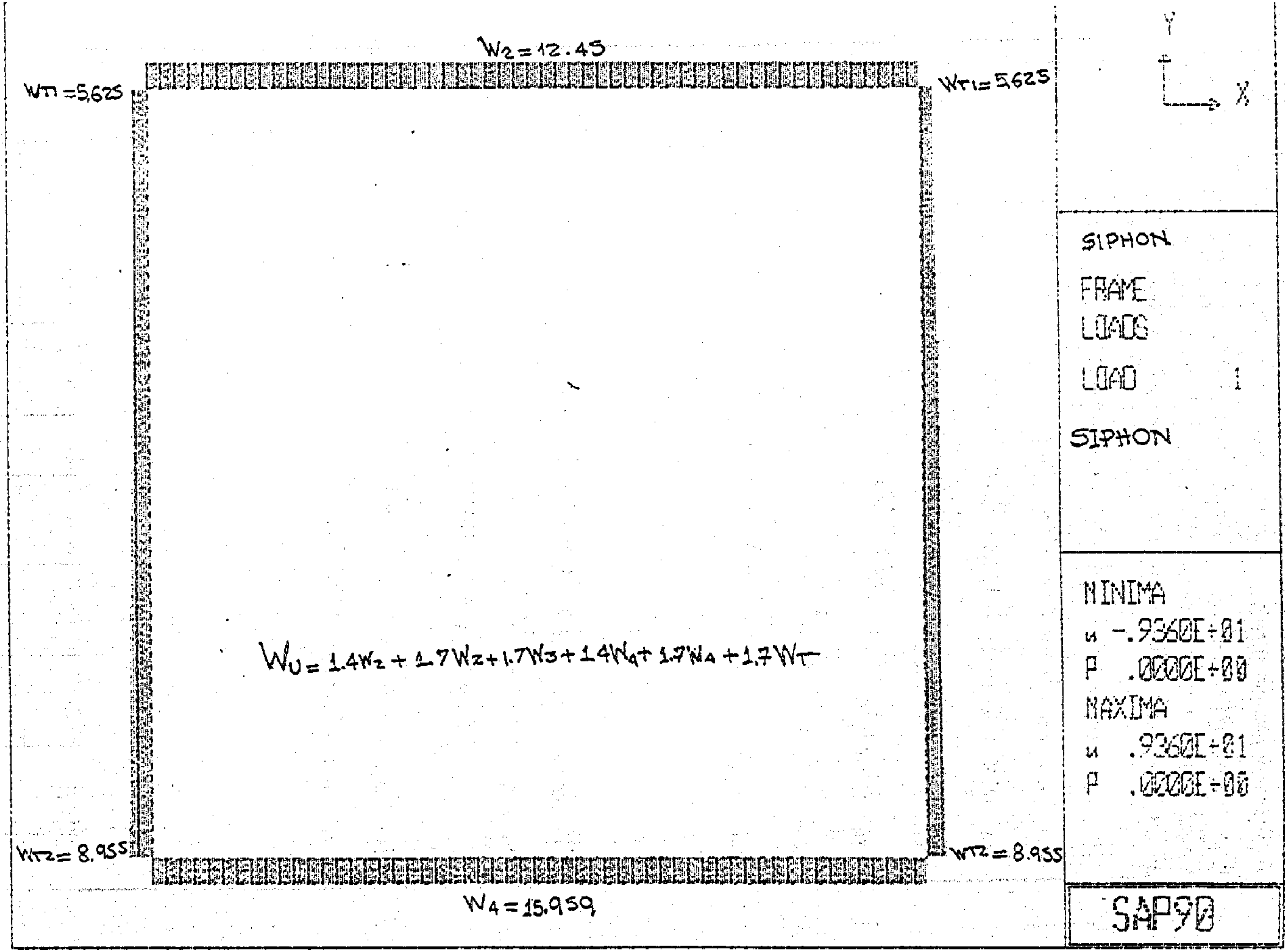
$W_3 = 1 \times 5.7 = 5.7\ t/m^2$

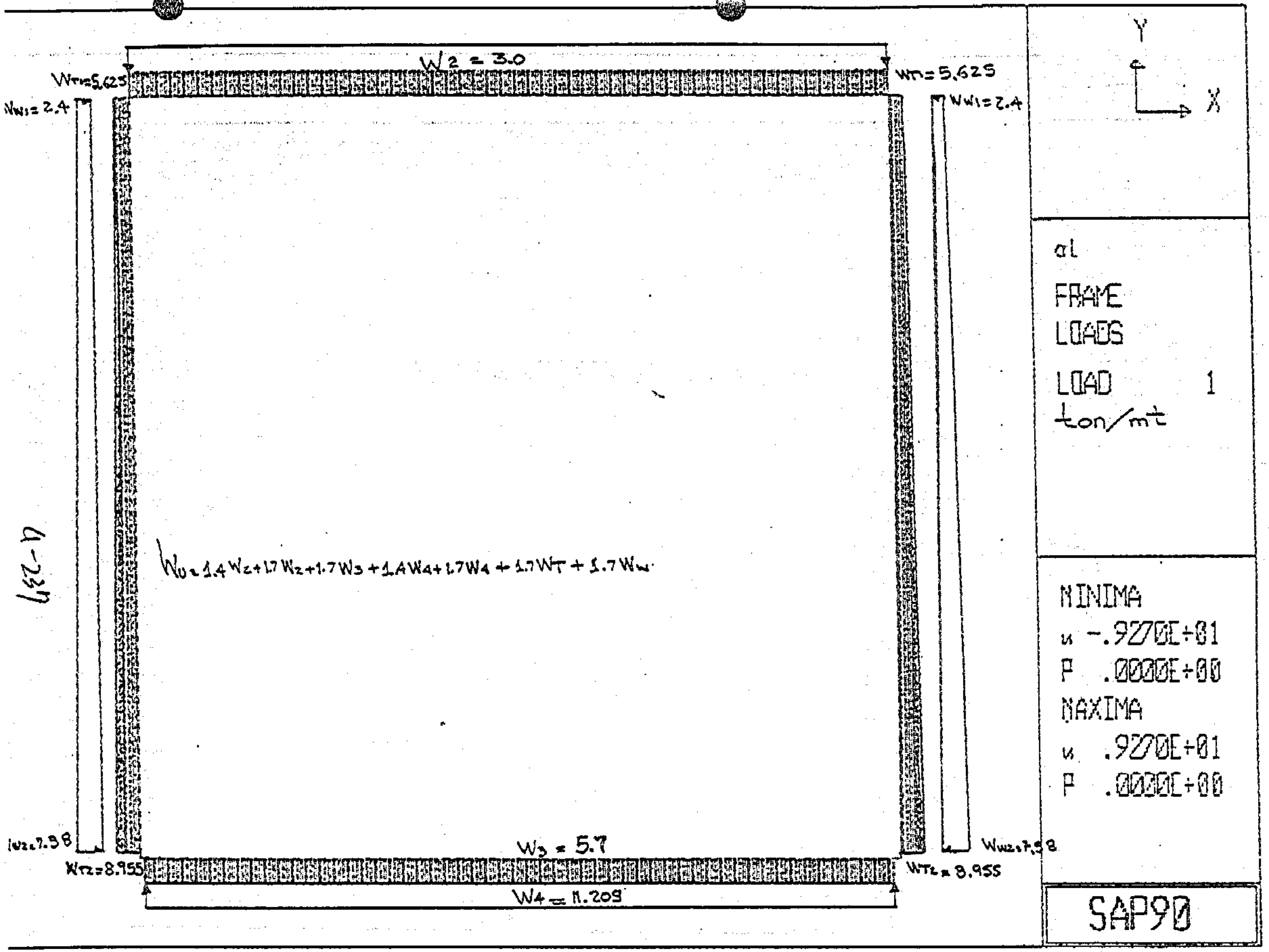
$W_4 = 3.0 + \frac{2 \times 6.492}{3.7} + 5.7 = 12.209$

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

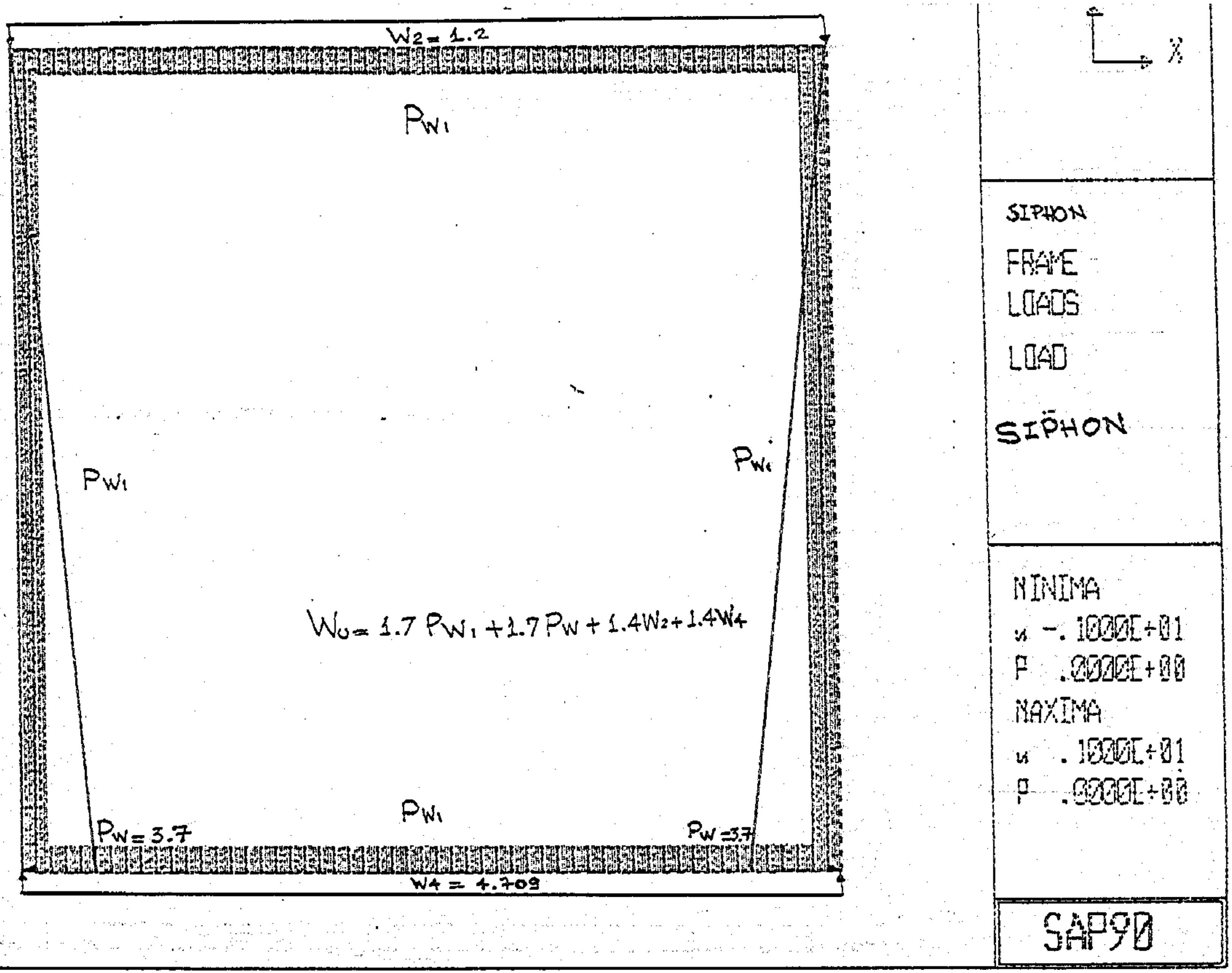
$W_{T2} = 4.7 \times 0.8 \times 0.5 + 1 \times 5.7 = 7.58$

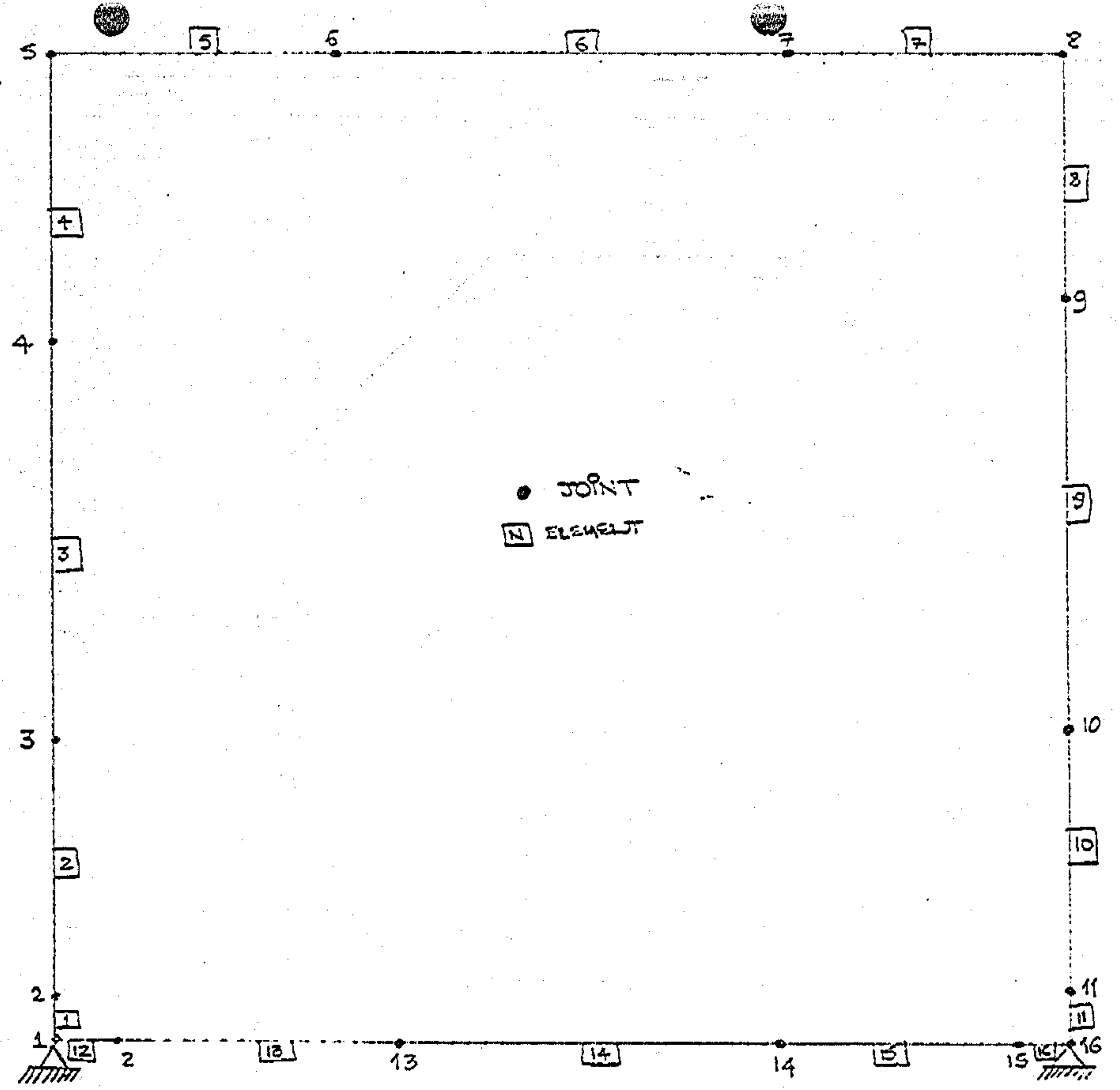
Revision	Checked by / Revisado por	Date (Fecha)	Approved by: / Aprobado por:	Date (Fecha)	Revision	Checked by: / Revisado por	Date (fecha)	Approved by: / Aprobado por:	Date (Fecha) / Aprobado por:


Y
X
$W_2 = 12.45$
$W_{T1} = 5.625$
$W_{T1} = 5.625$
$W_U = 1.4W_2 + 1.7W_2 + 1.7W_3 + 1.4W_4 + 1.7W_4 + 1.7W_T$
$W_{T2} = 8.955$
$W_{T2} = 8.955$
$W_4 = 15.959$
SIPHON
FRAME
LOADS
LOAD 1
SIPHON
MINIMA
u -.9360E+01
P .0000E+00
MAXIMA
u .9360E+01
P .0000E+00
SAP90



W2 = 3.0
WT1=5.625
WT1=5.625
WW1=2.4
WW1=2.4
WU = 1.4 W2+1.7 W2+1.7 W3 +1.4 W4+1.7 W4 + 1.7 WT + 1.7 WW
W3 = 5.7
W4 = 11.209
WT2=8.955
WT2 = 8.955
WW2=7.58
WW2=7.58
Y
X
al
FRAME
LOADS
LOAD 1
ton/mt
MINIMA
u -.9270E+01
P .0000E+00
MAXIMA
u .9270E+01
P .0000E+00
SAP90


W2 = 1.2
Pw1
Pw1
Pw1
Wu = 1.7 Pw1 + 1.7 Pw + 1.4W2 + 1.4W4
Pw1
Pw = 3.7
Pw = 3.7
W4 = 4.709
SIPHON
FRAME
LOADS
LOAD
SIPHON
MINIMA
u -.1000E+01
P .0000E+00
MAXIMA
u .1000E+01
P .0000E+00
SAP90



Y
X

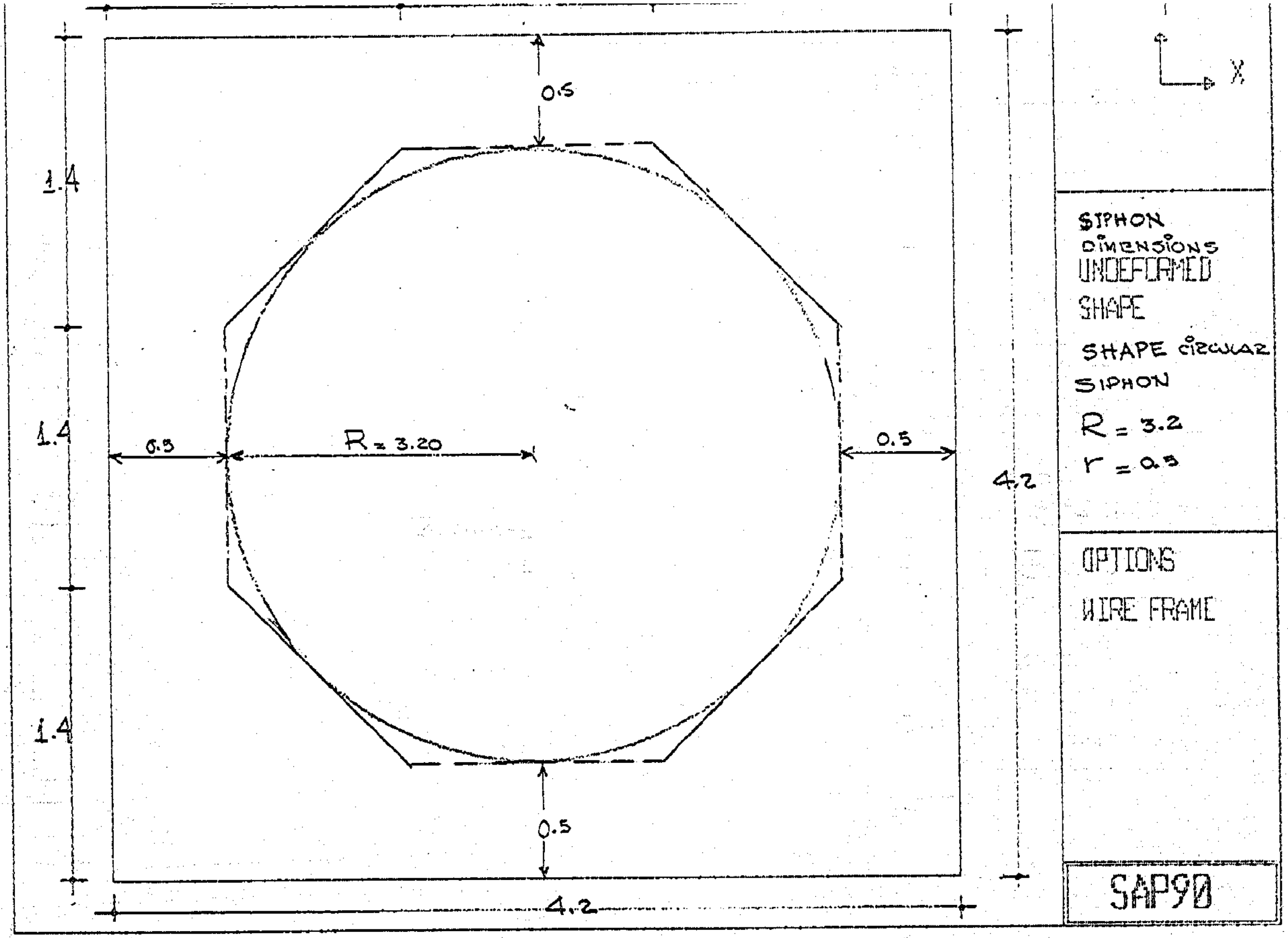
MODEL SHAPE

UNDEFORMED
SHAPE

CIRCULAR
SIPHON
R = 3.2 × 0.5
r = 0.07

OPTIONS
WIRE FRAME

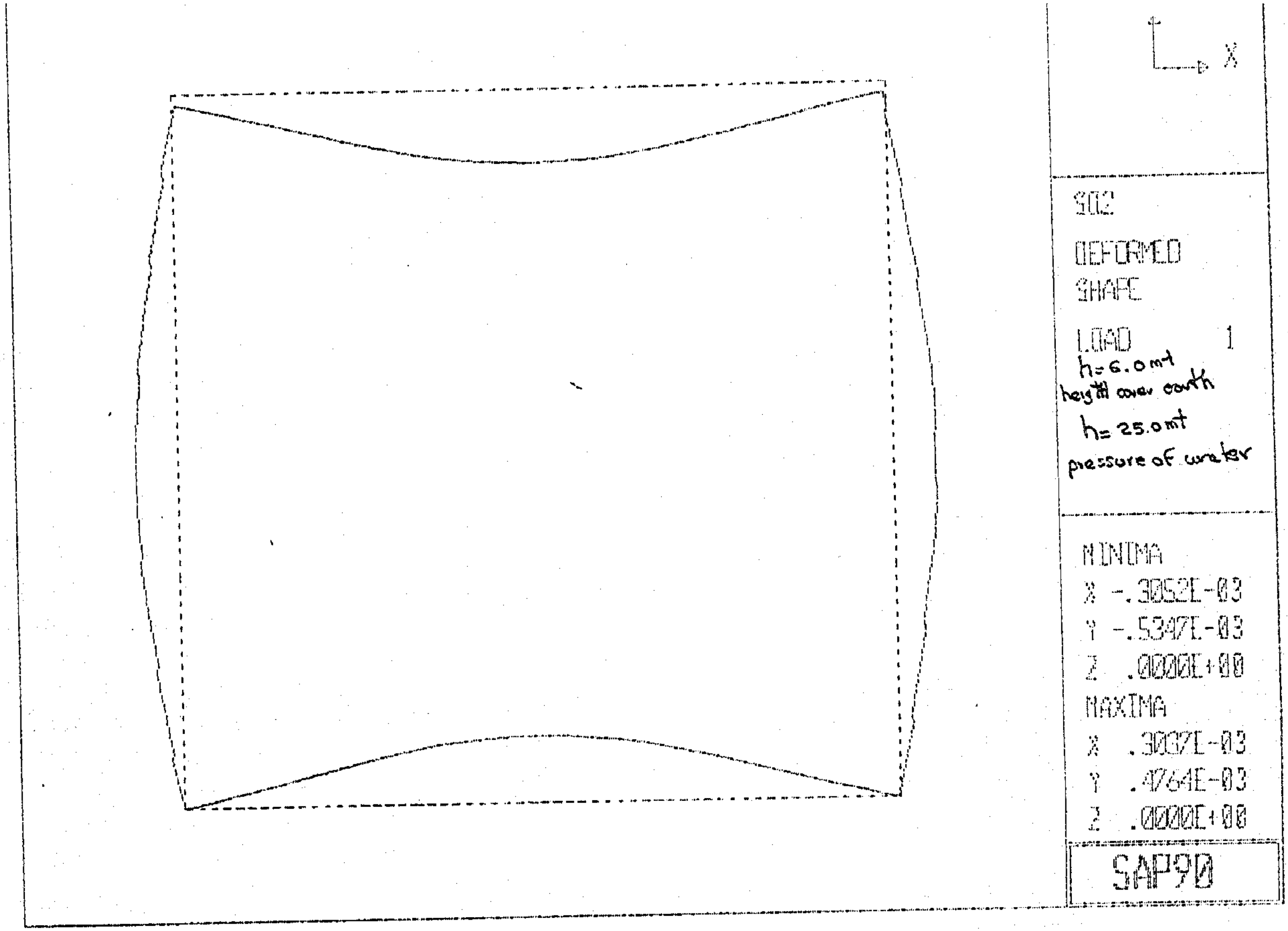
SAP90

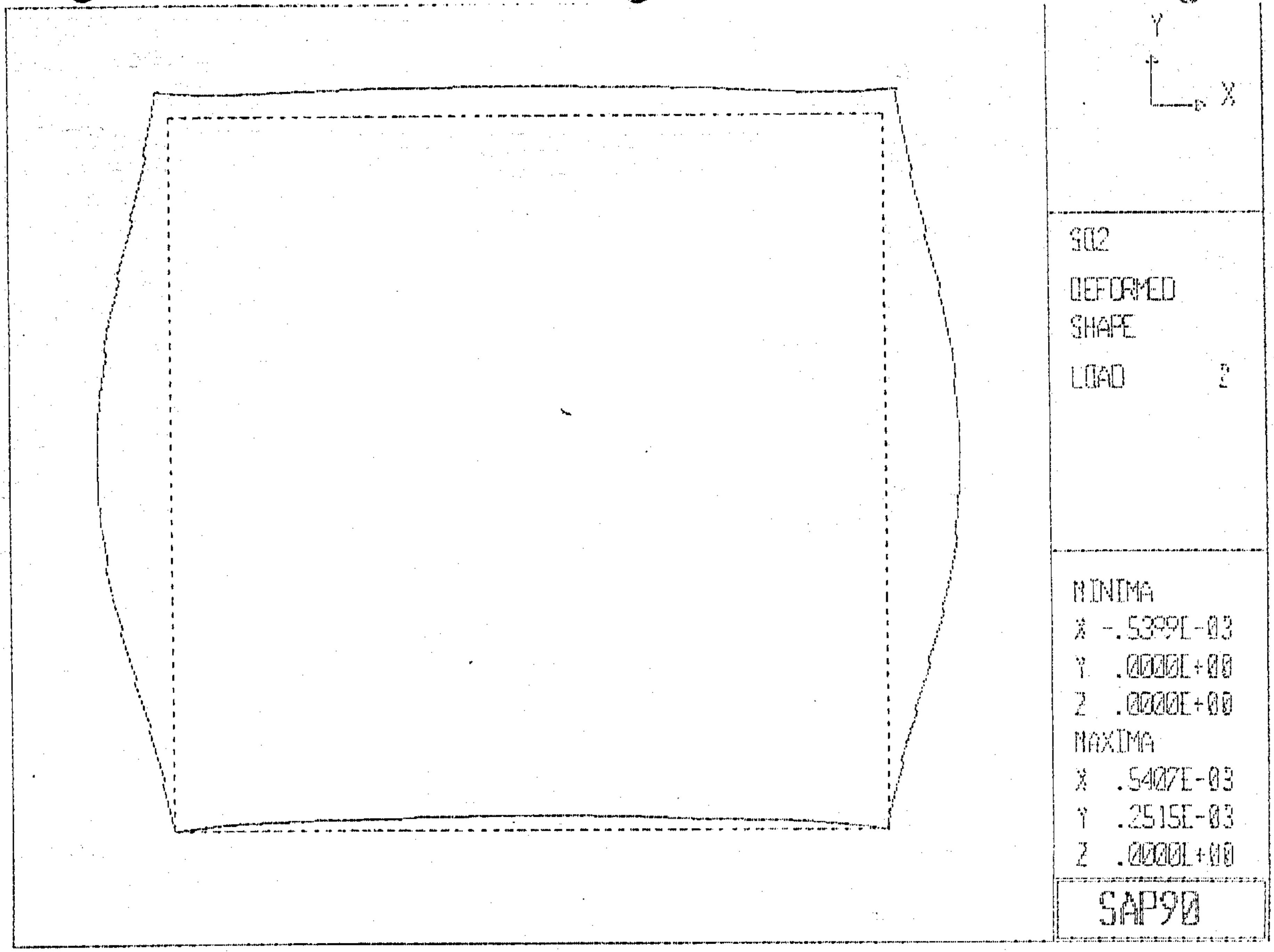

0.5
1.4
1.4
1.4
0.5
R = 3.20
0.5
0.5
4.2
4.2
X
SIPHON DIMENSIONS
UNDEFORMED SHAPE
SHAPE CIRCULAR SIPHON
R = 3.2
r = 0.5
OPTIONS
WIRE FRAME
SAP90

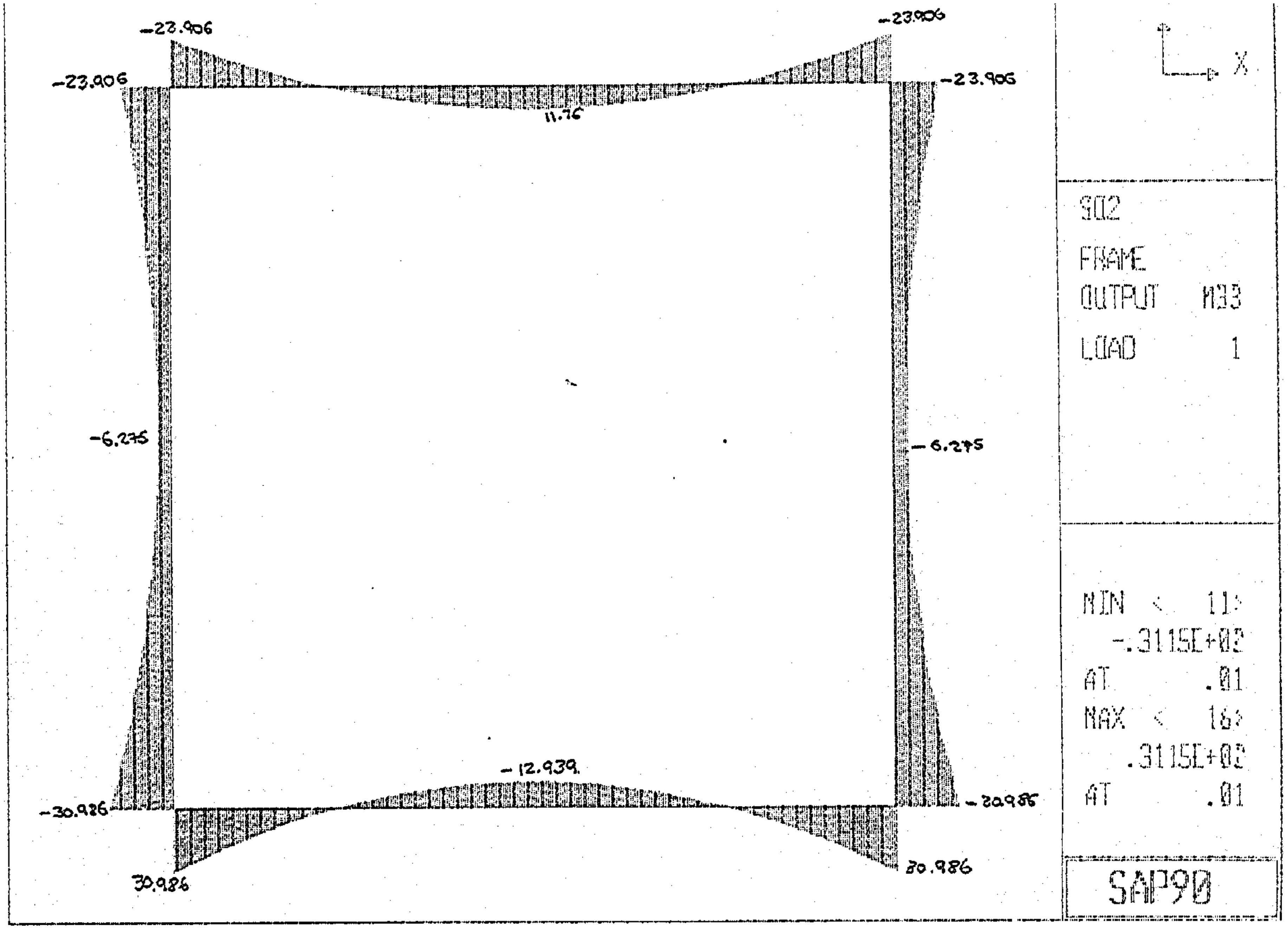
```
FON CIRCULAR h=1 ; h'=1
STEM
5

INTS
  X=0   Y=0    Z=0
  X=0   Y=0.01 Z=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
  X=.01  Y=0.
  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
SH=R T=1.4,1      E=2100000.
SH=R T=.50,1
WL=0,-1.8         :w2
WL=0,-1.2         :w2
WL=0,5.7          :w3
WL=0,7.5          :w4
WL=0,4.709        :w4
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
1 2  M=1,1,1              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 16 m=1,1,1
 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
```

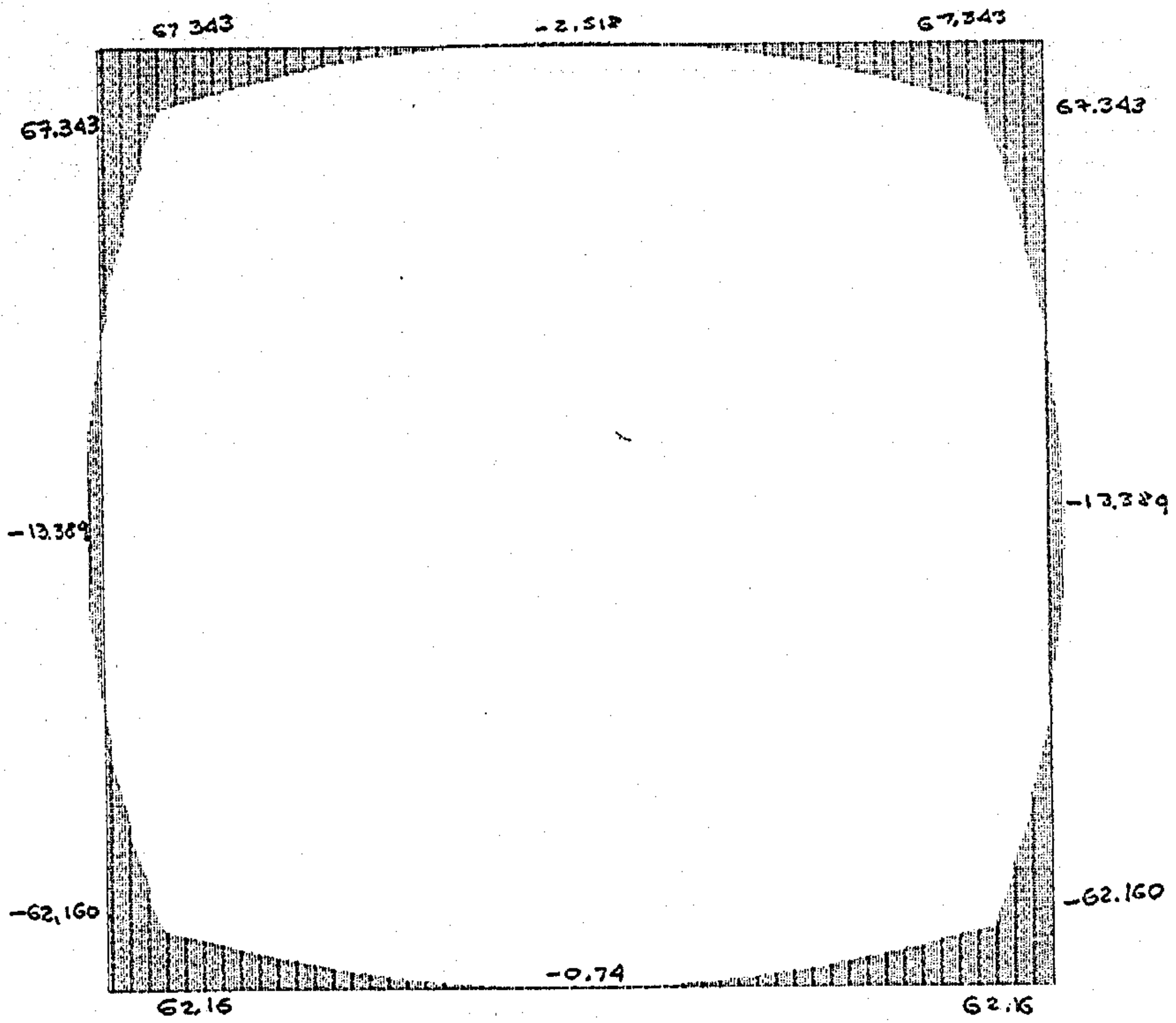
```
mbo
c=1.7,1.4,1.7
c=0,1.4,0,1.7,1.7


FON CIRCULAR h=6
STEM
5

INTS
  X=0    Y=0     Z=0
  X=0    Y=0.01  Z=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
  X=.01   Y=0.
  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
SH=R T=1.4,1      E=2100000.
SH=R T=.50,1
WL=0,-11.25       :w2
WL=0,-1.20        :w2
WL=0              :w3
WL=0,11.25        :w4
WL=0,4.709        :w4
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
 wl=0,-30.         :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
1 2  M=1,1,1              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 10 m=1,1,1
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

nbo
:=1.7,1.4
:=0,1.4,0,1.7,1.7
```


X
SOIL
DEFORMED
SHAPE
LOAD 1
h=6.0mt
height cover earth
h=25.0mt
pressure of water
MINIMA
X -.3052E-03
Y -.5347E-03
Z .0000E+00
MAXIMA
X .3037E-03
Y .4764E-03
Z .0000E+00
SAP90


Y
X
S02
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


X
-23.906
-23.906
-23.906
-23.906
11.76
-6.275
-6.275
-12.939
-30.986
30.986
-30.986
30.986
SO2
FRAME
OUTPUT M33
LOAD 1
MIN < 11>
-.3115E+02
AT .01
MAX < 16>
.3115E+02
AT .01
SAP90



Y

X

902

FRAME

OUTPUT M33

LOAD 2

MIN < 16?

-.7545E+02

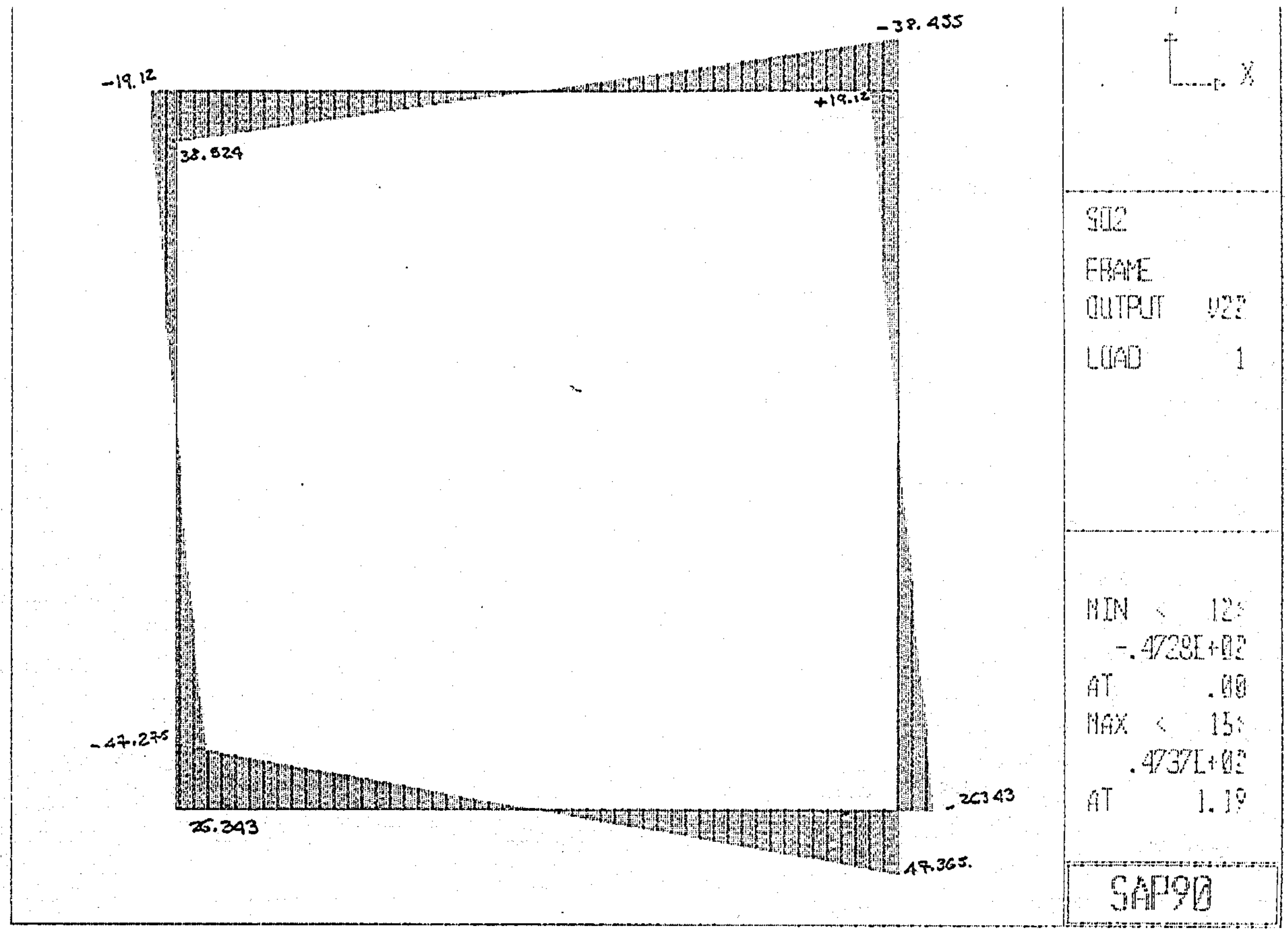
AT .01

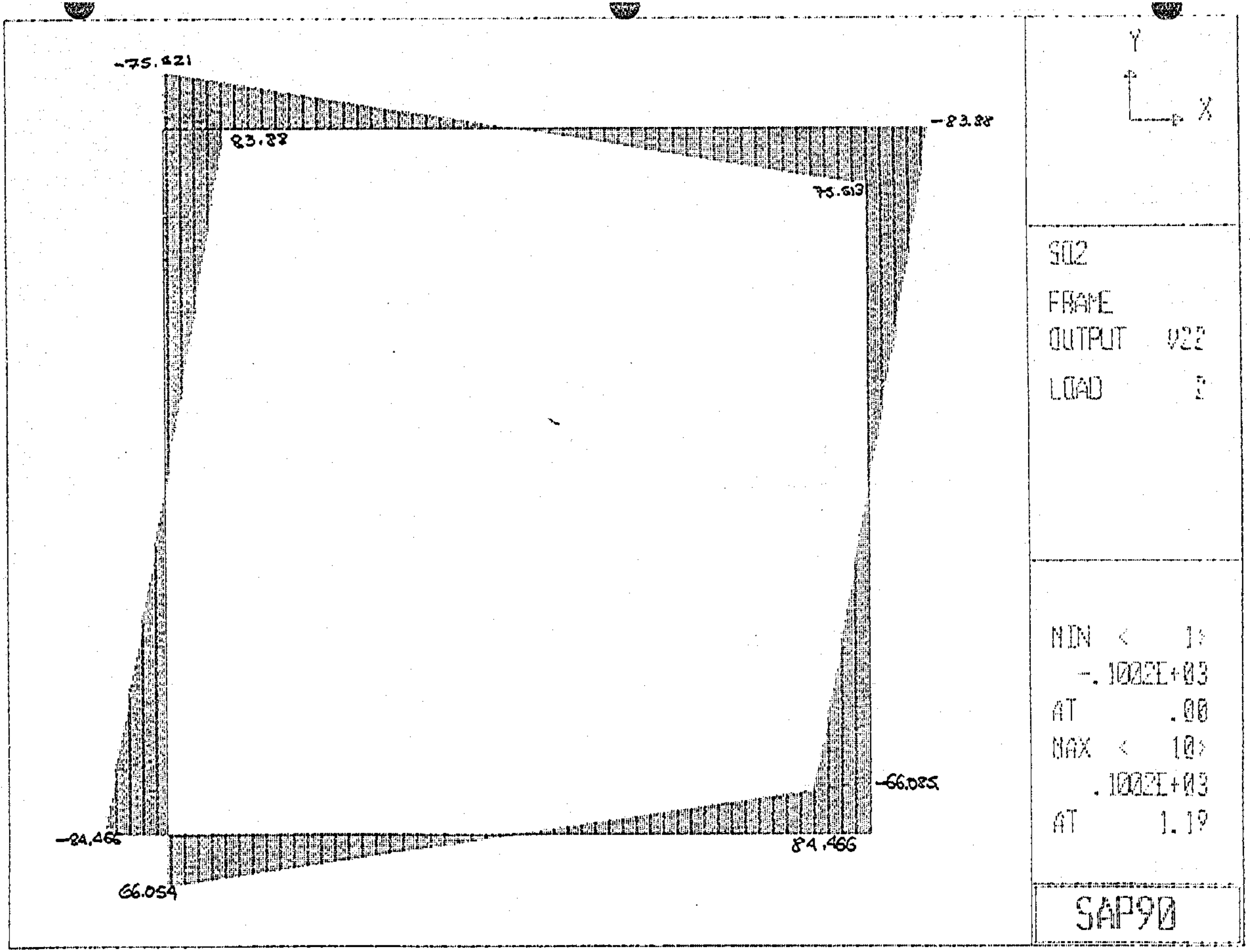
MAX < 4?

.8032E+02

AT 1.20

SAP90


-38.455
-19.12
+19.12
38.824
-47.275
26.343
-26343
47.365.
X
S02
FRAME
OUTPUT V22
LOAD 1
MIN < 12
-.4728E+02
AT .00
MAX < 15
.4737E+02
AT 1.19
SAP90



-75.821
83.88
-83.88
75.613
-84.466
66.054
-66.085
84.466
Y
X
SD2
FRAME
OUTPUT V22
LOAD
MIN < 1>
-.1002E+03
AT .00
MAX < 10>
.1002E+03
AT 1.19
SAP90

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.40

CIRCULAR b=4 h= 25 mt pressure of water

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

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	.000			-38.524			
	.000	26.343	-30.986				
	.010	26.343	-30.723				
	.010			-38.524			
2	.000			75.521			
	.000	-84.466	62.160				
	.010	-84.466	61.315				
	.010			75.521			
1	.000			-38.524			
	.000	26.343	30.723				
	1.180	9.463	-9.310				
	1.190	9.463	-9.715				
	1.190			-38.524			
2	.000			75.521			
	.000	-84.466	61.315				
	1.180	-28.097	-4.860				
	1.190	-27.672	-5.139				
	1.190			75.521			
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			75.521			
	.000	-27.672	-5.139				
	.598	.000	-13.389				
	1.300	31.666	-2.232				
	1.300			75.521			

	.000	[illegible]	[illegible]		
	[illegible]	[illegible]	23.713		
	[illegible]	[illegible]	[illegible]		
	[illegible]			[illegible]	
2	.000			[illegible]	
	.000	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]			[illegible]	

[illegible]

[illegible] F O R C E S

MEMBER ID	LOAD	DIST	IN-PLANE SHEAR	MOMENT	AXIAL FORCE	OUT-OF-PLANE SHEAR	MOMENT	AXIAL TORQ
5	1	.000			-19.120			
		.000	33.524	-23.906				
		1.200	13.558	7.343				
		1.200			-19.120			
	2	.000			83.880			
		.000	-75.521	67.343				
		1.200	-26.537	6.108				
		1.200			83.880			
6	1	.000			-19.120			
		.000	13.558	7.343				
		.652	.000	11.760				
		1.300	-13.489	7.388				
		1.300			-19.120			
	2	.000			83.880			
		.000	-26.537	6.108				
		.650	.000	-2.518				
		1.300	26.529	6.102				
		1.300			83.880			
7	1	.000			-19.120			
		.000	-13.489	7.388				
		1.200	-38.455	-23.779				
		1.200			-19.120			
	2	.000			83.880			
		.000	26.529	6.102				
		1.200	75.513	67.327				
		1.200			83.880			
8	1	.000			-38.455			
		.000	19.120	-23.779				
		1.190	6.648	-8.230				
		1.200	6.648	-8.164				
		1.200			-38.455			
	2	.000			75.513			
		.000	-83.880	67.327				
		1.190	-32.091	-1.917				
		1.200	-31.666	-2.236				
		1.200			75.513			
9	1	.000			-38.455			

(1-25)

CIRCULAR BA6

ELEMENT FORCES

LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	.000	6.668	3.164				
	.562	.000	-6.273				
	1.300	-9.463	-9.713				
	1.300			-38.455			
2	.000			75.513			
	.000	-31.666	2.236				
	.700	.000	-13.393				
	1.300	27.672	-5.143				
	1.300			75.513			
1	.000			-38.455			
	.000	-9.463	-9.713				
	1.180	-26.343	-30.626				
	1.190	-26.343	-30.889				
	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			
1	.000			-38.455			
	.000	-26.343	-30.889				
	.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			
1	.000			.000			
	.000	-47.275	30.986				
	.010	-47.275	30.513				
	.010			.000			
2	.000			.000			
	.000	66.054	-62.160				
	.010	66.054	-61.499				
	.010			.000			
1	.000			.000			
	.000	-47.275	30.513				
	1.190	-16.671	-7.535				
	1.190			.000			

CIRCULAR BA6

ELEMENT FORCES

LOAD COMB	DIST ENDI	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				

[illegible]					
	1	.000			.000
		.000	[illegible]	-7.5[illegible]	
		.048	[illegible]	12.[illegible]	
		1.200	[illegible].761	-7.477	
		1.200			.000
	2	.000			.000
		.000	[illegible]	[illegible]	
		.250	.000	[illegible].764	
		2.300	-23.356	-8.340	
		2.300			.000
15					
	1	.000			.000
		.000	66.761	7.477	
		1.190	47.365	30.679	
		1.190			.000
	2	.000			.000
		.000	-23.356	-8.340	
		1.190	-66.085	-61.557	
		1.190			.000
16					
	1	.000			.000
		.000	47.365	30.679	
		.010	47.365	31.153	
		.010			.000
	2	.000			.000
		.000	-66.085	-61.557	
		.010	-66.085	-62.218	
		.010			.000

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.40

[illegible] CIRCULAR [illegible] h = 30.0 mt pessure 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			-38.524			
		.000	26.343	-30.986				
		.010	26.343	-30.723				
		.010			-38.524			
	2	.000			91.246			
		.000	-100.174	75.392				
		.010	-100.174	74.390				
		.010			91.246			
2								
	1	.000			-38.524			
		.000	26.343	-30.723				
		1.180	9.463	-9.810				
		1.190	9.463	-9.715				
		1.190			-38.524			
	2	.000			91.246			
		.000	-100.174	74.390				
		1.180	-33.775	-4.403				
		1.190	-33.265	-4.738				
		1.190			91.246			
3								
	1	.000			-38.524			
		.000	9.463	-9.715				
		.733	.000	-6.275				
		1.300	-6.648	-8.166				
		1.300			-38.524			
	2	.000			91.246			
		.000	-33.265	-4.738				
		.668	.000	-14.815				
		1.300	37.124	-1.919				
		1.300			91.246			
4								

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 TORQUE
		.000	[illegible]	[illegible]				
		1.190	[illegible].120	-23.715				
		1.200	[illegible].120	-23.906				
		1.200			-38.524			
	2	.000			91.246			
		.000	37.124	1.915				
		1.190	39.027	79.[illegible]				
		1.200	99.537	80.325				
		1.200			91.246			

PAGE
PROGRAM:SAP90/FILE:so22.F3

FEG

IFON 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 ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQUE
5								
	1	.000			-19.120			
		.000	38.524	-23.906				
		1.200	13.558	7.343				
		1.200			-19.120			
	2	.000			99.537			
		.000	-91.246	80.325				
		1.200	-32.062	6.340				
		1.200			99.537			
6								
	1	.000			-19.120			
		.000	13.558	7.343				
		.652	.000	11.760				
		1.300	-13.489	7.388				
		1.300			-19.120			
	2	.000			99.537			
		.000	-32.062	6.340				
		.650	.000	-4.082				
		1.300	32.054	6.334				
		1.300			99.537			
7								
	1	.000			-19.120			
		.000	-13.489	7.388				
		1.200	-38.455	-23.779				
		1.200			-19.120			
	2	.000			99.537			
		.000	32.054	6.334				
		1.200	91.238	80.309				
		1.200			99.537			
8								
	1	.000			-38.455			
		.000	19.120	-23.779				
		1.190	6.648	-8.230				
		1.200	6.648	-8.164				
		1.200			-38.455			
	2	.000			91.238			
		.000	-99.537	80.309				
		1.190	-37.633	-1.549				
		1.200	-37.124	-1.922				
		1.200			91.238			
9								
	1	.000			-38.455			

A-255

SIFON CIRCULAR Nro.

FRAME ELEMENT FORCES

ELT ID	LOAD COND	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		.000	6.648	-6.164				
		.562	.000	-6.273				
		1.300	-9.463	-9.713				
		1.300			-38.455			
	2	.000			91.238			
		.000	-37.124	-1.922				
		.697	.000	-14.819				
		1.300	33.265	-4.742				
		1.300			91.238			
10	1	.000			-38.455			
		.000	-9.463	-9.713				
		1.180	-26.343	-30.626				
		1.190	-26.343	-30.889				
		1.190			-38.455			
	2	.000			91.238			
		.000	33.265	-4.742				
		1.180	99.664	73.450				
		1.190	100.174	74.449				
		1.190			91.238			
11	1	.000			-38.455			
		.000	-26.343	-30.889				
		.010	-26.343	-31.153				
		.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	30.986				
		.010	-47.275	30.513				
		.010			.000			
	2	.000			.000			
		.000	81.694	-75.392				
		.010	81.694	-74.575				
		.010			.000			
13	1	.000			.000			
		.000	-47.275	30.513				
		1.190	-16.671	-7.535				
		1.190			.000			

STEC

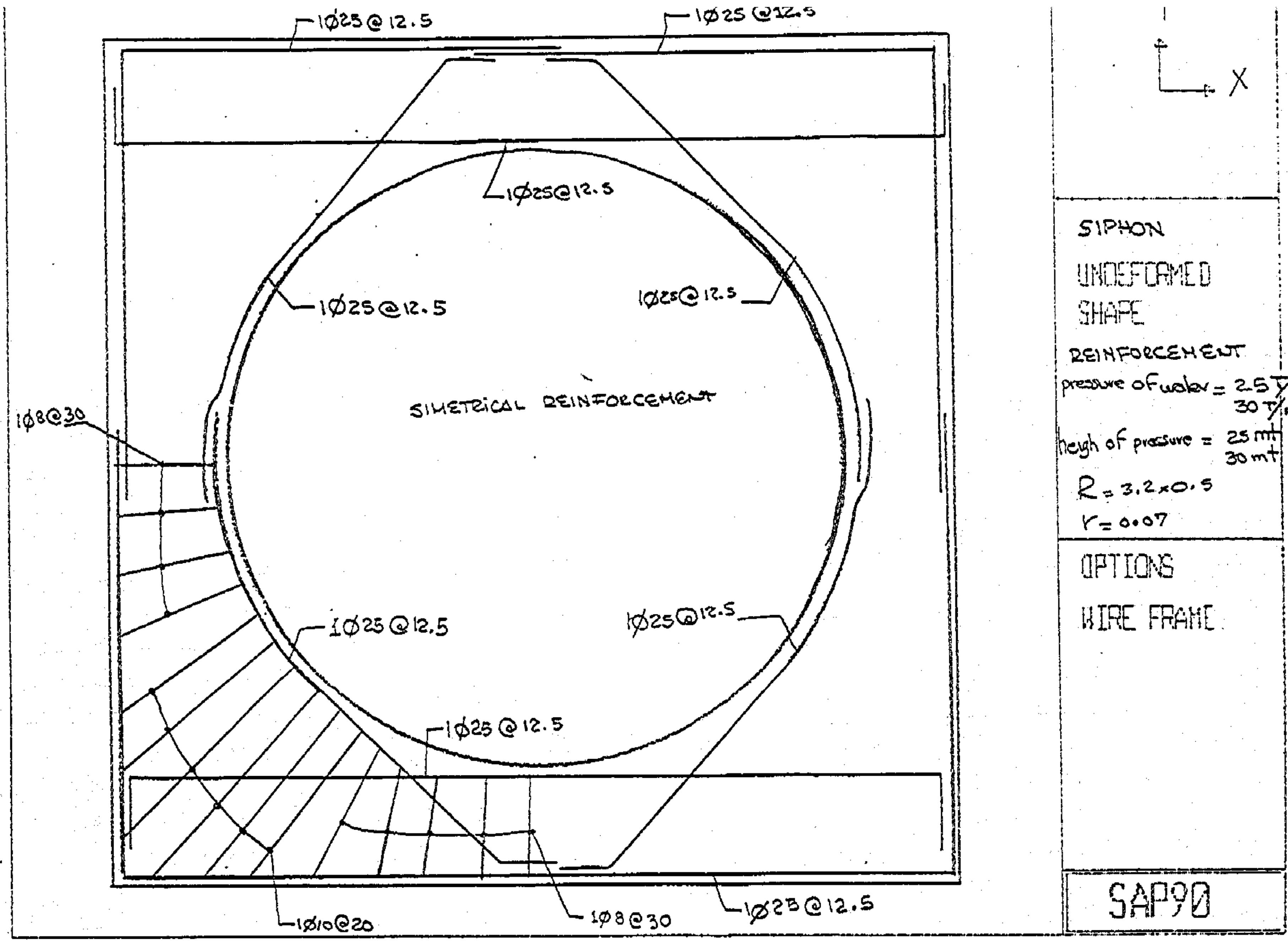
SIFON CIRCULAR Nro.

FRAME ELEMENT FORCES

ELT ID	LOAD COND	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
		.000			.000			

4-256

		[illegible]	28.849	-8.002	
		[illegible]			.000
14					
	1	.000			.000
		.000	16.671	-7.335	
		.000	.000	12.[illegible]	
		1.360	16.761	-7.477	
		1.360			.000
	2	.000			.000
		.000	28.849	-8.002	
		.000	.000	.549	
		1.360	-28.881	-8.822	
		1.360			.000
15					
	1	.000			.000
		.000	16.761	-7.477	
		1.190	47.365	30.679	
		1.190			.000
	2	.000			.000
		.000	-28.881	-8.822	
		1.190	-81.725	-74.633	
		1.190			.000
16					
	1	.000			.000
		.000	47.365	30.679	
		.010	47.365	31.153	
		.010			.000
	2	.000			.000
		.000	-81.725	-74.633	
		.010	-81.725	-75.450	
		.010			.000


1Ø25@12.5
1Ø25@12.5
1Ø25@12.5
1Ø25@12.5
1Ø25@12.5
SIMETRICAL REINFORCEMENT
1Ø8@30
1Ø25@12.5
1Ø25@12.5
1Ø25@12.5
1Ø10@20
1Ø8@30
1Ø25@12.5
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

SAP90

STRUCTURAL ANALYSIS PROGRAMS

VERSION [illegible]

IRON CIRCULAR R=35 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 TOR
1								
	1	.000			-38.524			
		.000	26.343	-30.966				
		.010	26.343	-30.723				
		.010			-38.524			
	2	.000			106.971			
		.000	-115.881	88.624				
		.010	-115.881	87.465				
		.010			106.971			
2								
	1	.000			-38.524			
		.000	26.343	-30.723				
		1.180	9.463	-9.810				
		1.190	9.463	-9.715				
		1.190			-38.524			
	2	.000			106.971			
		.000	-115.881	87.465				
		1.180	-39.453	-3.243				
		1.190	-38.858	-4.337				
		1.190			106.971			
3								
	1	.000			-38.524			
		.000	9.463	-9.715				
		.738	.000	-6.275				
		1.300	-6.648	-8.164				
		1.300			-38.524			
	2	.000			106.971			
		.000	-38.858	-4.337				
		.615	.000	-16.784				
		1.300	42.881	-1.605				
		1.300			106.971			
4								

4-259

		.000	[illegible]	[illegible]	
		1.190	-19.120	23.7[illegible]	
		1.200	-19.120	23.906	
		1.200			-38.524
	1	.000			106.971
		.000	42.5[illegible]	[illegible]	
		1.190	114.600	92.[illegible]	
		1.200	115.195	93.307	
		1.200			106.971

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
5	1	.000			-19.120			
		.000	38.524	-23.906				
		1.200	13.558	7.343				
		1.200			-19.120			
	2	.000			115.195			
		.000	-106.971	93.307				
		1.200	-37.587	6.571				
		1.200			115.195			
6	1	.000			-19.120			
		.000	13.558	7.343				
		.652	.000	11.760				
		1.300	-13.489	7.388				
		1.300			-19.120			
	2	.000			115.195			
		.000	-37.587	6.571				
		.650	.000	-5.646				
		1.300	37.579	6.566				
		1.300			115.195			
7	1	.000			-19.120			
		.000	-13.489	7.388				
		1.200	-38.455	-23.779				
		1.200			-19.120			
	2	.000			115.195			
		.000	37.579	6.566				
		1.200	106.963	93.291				
		1.200			115.195			
8	1	.000			-38.455			
		.000	19.120	-23.779				
		1.190	6.648	-8.230				
		1.200	6.648	-8.164				
		1.200			-38.455			
	2	.000			106.963			
		.000	-115.195	93.291				
		1.190	-43.176	-1.180				
		1.200	-42.581	-1.609				
		1.200			106.963			
9	1	.000			-38.455			

PROGRAM:SAP90/FILE:[illegible]
[illegible]IFON CIRCULAR h=6

FRAME ELEMENT FORCES

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 TOR
		.000	[illegible]	-8.164				
		.562	.000	-6.[illegible]				
		1.300	-9.463	-9.71[illegible]				
		1.300			-38.455			
	2	.000			106.963			
		.000	-42.503	-1.609				
		.683	.000	16.248				
		1.300	38.858	-4.340				
		1.300			106.963			
10	1	.000			-38.455			
		.000	-9.463	-9.713				
		1.130	26.343	-30.626				
		1.190	26.343	-30.889				
		1.190			-38.455			
	2	.000			106.963			
		.000	38.858	-4.340				
		1.180	115.286	86.368				
		1.190	115.881	87.524				
		1.190			106.963			
11	1	.000			-38.455			
		.000	-26.343	-30.889				
		.010	-26.343	-31.153				
		.010			-38.455			
	2	.000			106.963			
		.000	115.881	87.524				
		.010	115.881	88.682				
		.010			106.963			
12	1	.000			.000			
		.000	-47.275	30.986				
		.010	-47.275	30.513				
		.010			.000			
	2	.000			.000			
		.000	97.334	-88.624				
		.010	97.334	-87.651				
		.010			.000			
13	1	.000			.000			
		.000	-47.275	30.513				
		1.190	-16.671	-7.535				
		1.190			.000			

SIFOR CIRCULAR h=6

FRAME ELEMENT FORCES

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
	2	.000			.000			
		.000	97.334	-87.651				

		[illegible]	[illegible]		[illegible]
		.000			.000
		.000	-16.671	-7.535	
		.640	.000	[illegible]	
		1.300	[illegible]	7.477	
		1.300			.000
		.000			.000
		.000	34.374	-9.385	
		.650	-.000	[illegible]	
		1.300	-34.406	-9.305	
		1.300			.000
[illegible]					
	1	.000			.000
		.000	16.761	-7.477	
		1.190	47.365	30.679	
		1.190			.000
	2	.000			.000
		.000	-34.406	-9.305	
		1.190	-97.365	-87.709	
		1.190			.000
16					
	1	.000			.000
		.000	47.365	30.679	
		.010	47.365	31.153	
		.010			.000
	2	.000			.000
		.000	-97.365	-87.709	
		.010	-97.365	-88.682	
		.010			.000

JAPAN INTERNATIONAL COOPERATION AGENCY - AGENCIA INTERNACIONAL DE COOPERACION DEL JAPON

JICA STUDY TEAM - GRUPO DE ESTUDIOS JICA — Date: / Fecha:

DAULE-PERIPA-LA ESPERANZA TRANSBASIN (TRASVASE DAULE PERIPA-LA ESPERANZA) — Calculated by: / Calculado por:

MEMBRILLO OUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO) — Sheet / Hoja ___ of / de ___

- DATA FOR CALCULATION OF THE REINFORCEMENT

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

$f_y = 4200\ Kg/cm^2$

$b = 100\ cm$

$d = 43\ cm$

$r = 7\ cm$

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

$$A_s = \frac{88.62 \times 10^5}{0.9 \times 4200 \times 133} = 17.63\ cm^2$$

$$a = \frac{17,63}{0.85 \times 210 \times 100} = 9,88 \times 10^{-4}\ cm$$

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

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

$A_{s\,temp} = 0.0020 \times 100 \times 140 = 28\ cm^2/2\ face \Rightarrow 1\varnothing 16 @ 16.5$

- SHEAR STRESS CHECK

$V_U = 115,881\ ton$

$V_c = 0.85 \times 0.53 \sqrt{210} \times 100 \times 133 = 86.827.25$

$V_s = 115881 - 86827.25 = 29.053.742$

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

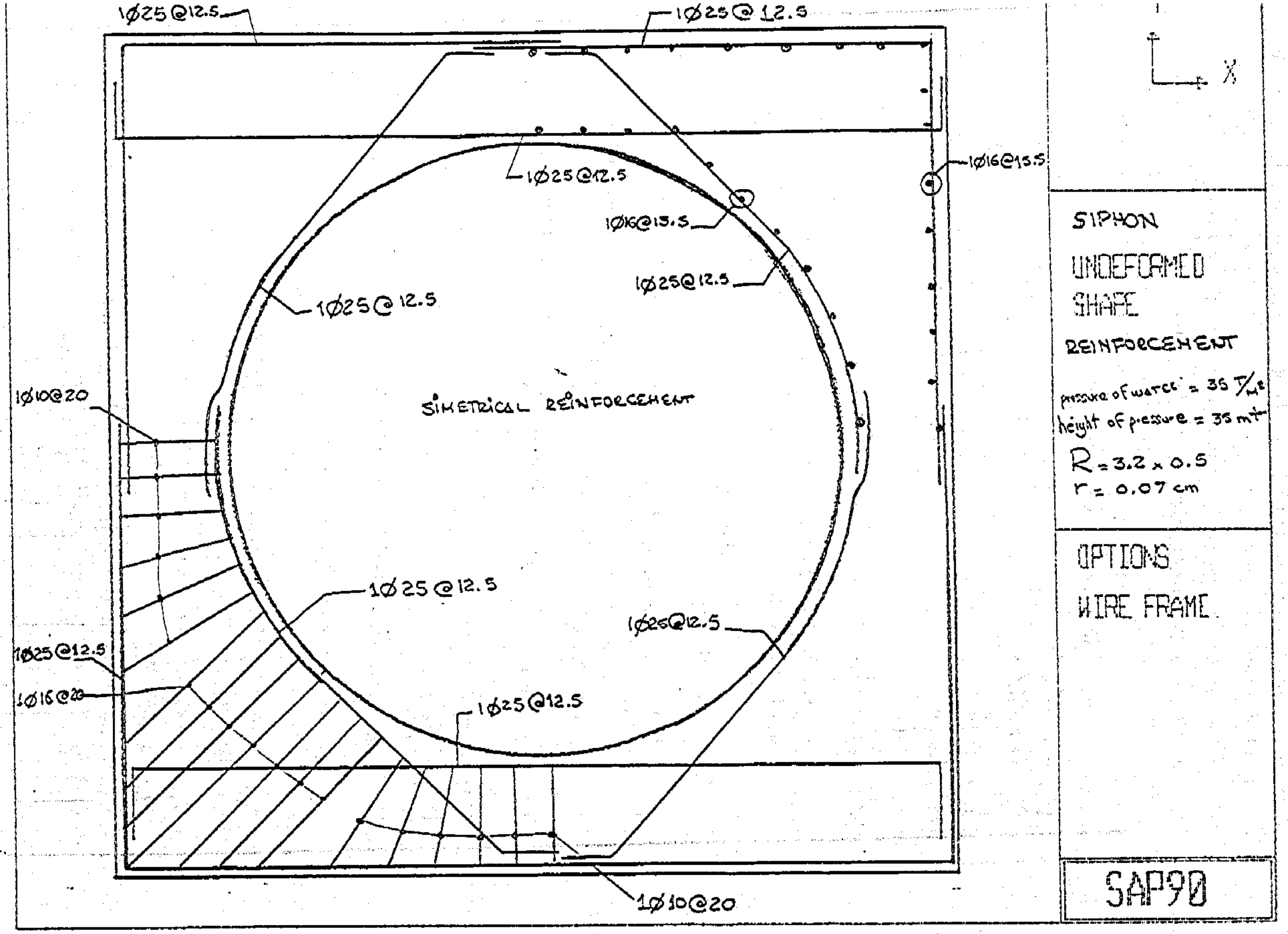
$V_c = 0.85 \times 0.53 \sqrt{210} \times 100 \times 43 = 28.071.97$

$V_U = 39.453\ kg.$

$V_s = 39.453 - 28.071.97 = 11.381.02$

$$A_v = \frac{11.381.02}{0.86 \times 4200 \times \sin 45} = 4.51 \Rightarrow 6\varnothing 10$$

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:


1Ø25@12.5
1Ø25@12.5
1Ø16@13.5
1Ø25@12.5
1Ø16@13.5
1Ø25@12.5
1Ø25@12.5
1Ø10@20
SIMETRICAL REINFORCEMENT
1Ø25@12.5
1Ø25@12.5
1Ø25@12.5
1Ø16@20
1Ø25@12.5
1Ø10@20
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 PROGRAMS

VERSION 5.[illegible]

TEC

PAGE
PROGRAM:SAP90/FILE:[illegible]22.F[illegible]

[illegible]TION CIRCULAR h=40 pressure of water.

[illegible]RAME ELEMENT FORCES

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 TOR
1								
	1	.000			-38.524			
		.000	26.343	-30.986				
		.010	26.343	-30.723				
		.010			-38.524			
	2	.000			122.696			
		.000	-131.589	101.856				
		.010	-131.589	100.540				
		.010			122.696			
2								
	1	.000			-38.524			
		.000	26.343	-30.723				
		1.180	9.463	-9.810				
		1.190	9.463	-9.715				
		1.190			-38.524			
	2	.000			122.696			
		.000	-131.589	100.540				
		1.180	-45.130	-3.488				
		1.190	-44.450	-3.935				
		1.190			122.696			
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			122.696			
		.000	-44.450	-3.935				
		.620	.000	-17.676				
		1.300	48.033	-1.292				
		1.300			122.696			
4								

a-265

		.000	-6.648	-8.166				
		1.190	-19.120	-23.715				
		1.200	-19.120	-23.906				
		1.200			-38.524			
	2	[illegible]			122.696			
		.000	48.0[illegible]	1.2[illegible]				
		1.190	130.172	106.[illegible]				
		1.200	130.852	106.288				
		1.200			122.696			

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
5								
	1	.000			-19.120			
		.000	38.524	-23.906				
		1.200	13.553	7.343				
		1.200			-19.120			
	2	.000			130.852			
		.000	-122.696	106.288				
		1.200	-43.112	6.803				
		1.200			130.852			
6								
	1	.000			-19.120			
		.000	13.550	7.343				
		.652	.000	11.760				
		1.300	-13.489	7.388				
		1.300			-19.120			
	2	.000			130.852			
		.000	-43.112	6.803				
		.650	.000	-7.210				
		1.300	43.104	6.798				
		1.300			130.852			
7								
	1	.000			-19.120			
		.000	-13.489	7.388				
		1.200	-38.455	-23.779				
		1.200			-19.120			
	2	.000			130.852			
		.000	43.104	6.798				
		1.200	122.688	106.273				
		1.200			130.852			
8								
	1	.000			-38.455			
		.000	19.120	-23.779				
		1.190	6.648	-8.230				
		1.200	6.648	-8.164				
		1.200			-38.455			
	2	.000			122.688			
		.000	-130.852	106.273				
		1.190	-48.718	-.812				
		1.200	-48.038	-1.296				
		1.200			122.688			
9								
	1	.000			-38.455			

FRAME ELEMENT FORCES

ELT ID	LOAD COND	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TOR
		.000	[illegible]	[illegible]				
		.562	.000	[illegible]				
		1.300	-9.463	[illegible]				
		1.300			[illegible]			
	2	.000			122.688			
		.000	[illegible]	[illegible]				
		.630	.000	[illegible]				
		1.300	44.450	[illegible]				
		1.300			122.688			
10	1	.000			-38.455			
		.000	-9.463	[illegible]				
		1.180	-26.343	-30.626				
		1.190	-26.343	-30.889				
		1.190			-38.455			
	2	.000			122.688			
		.000	44.450	-3.939				
		1.180	130.909	99.236				
		1.190	131.589	100.599				
		1.190			122.688			
11	1	.000			-38.455			
		.000	-26.343	-30.889				
		.010	-26.343	-31.153				
		.010			-38.455			
	2	.000			122.688			
		.000	131.589	100.599				
		.010	131.589	101.915				
		.010			122.688			
12	1	.000			.000			
		.000	-47.275	30.936				
		.010	-47.275	30.513				
		.010			.000			
	2	.000			.000			
		.000	112.974	-101.856				
		.010	112.974	-100.726				
		.010			.000			
13	1	.000			.000			
		.000	-47.275	30.513				
		1.190	-16.671	-7.535				
		1.190			.000			

FRAME ELEMENT FORCES

ELT ID	LOAD COND	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TOR
	2	.000			.000			
		.000	112.974	-100.726				

a-287

		1.190			.000
[illegible]	1	.000			.000
		.000	16.671	-7.583	
		.640	.000	-12.262	
		1.300	16.761	-7.477	
		1.300			.000
	2	.000			.000
		.000	-39.899	-9.767	
		.650	-.000	3.195	
		1.300	-39.931	-9.788	
		1.300			.000
15	1	.000			.000
		.000	16.761	-7.477	
		1.190	47.365	30.679	
		1.190			.000
	2	.000			.000
		.000	-39.931	-9.788	
		1.190	-113.005	-100.785	
		1.190			.000
16	1	.000			.000
		.000	47.365	30.679	
		.010	47.365	31.153	
		.010			.000
	2	.000			.000
		.000	-113.005	-100.785	
		.010	-113.005	-101.915	
		.010			.000

JAPAN INTERNATIONAL COOPERATION AGENCY - AGENCIA INTERNACIONAL DE COOPERACION DEL JAPON

JICA STUDY TEAM - GRUPO DE ESTUDIOS JICA — Date: / Fecha:

DAULE-PERIPA-LA ESPERANZA TRANSBASIN (TRASVASE DAULE PERIPA-LA ESPERANZA) — Calculated by: / Calculado por:

MEMBRILLO OUTLET ACCESS ROAD (CAMINO DE ACCESO SALIDA MEMBRILLO) — Sheet of / Hoja de

h = 5 heigth of earth ; h = 40 mt pressure of water

- DATA FOR CALCULATION OF THE REINFORCEMENT

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

$f_y = 4200\ kg/cm^2$

$b = 100\ cm$

$d = 43\ cm$

$r = 7.0\ cm$

$M_u = 30.986$

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

$M_u = 101,856\ ton\cdot mt$

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

$\rho = \frac{20.26}{100 \cdot 133} = 0.001523 < \rho_{min}$

$A_s\ min = 0.0033 \times 100 \times 133 = 44.89\ cm^2 \Rightarrow 9\phi 25 \Rightarrow 1\phi 25 @ 12.5$

$A_{s\,temp} = 0.002 \times 100 \times 140 = 28\ cm^2/2\ FACE \Rightarrow 1\phi 16 @ 13.5$

shrinkage

- SHEAR STRESS CHECK.

$V_u = 131.589\ Kg$

$V_c = 86.827.25\ Kg < V_u$

$V_s = 113.589 - 86.827.25 = 44\,762.25\ kg.$

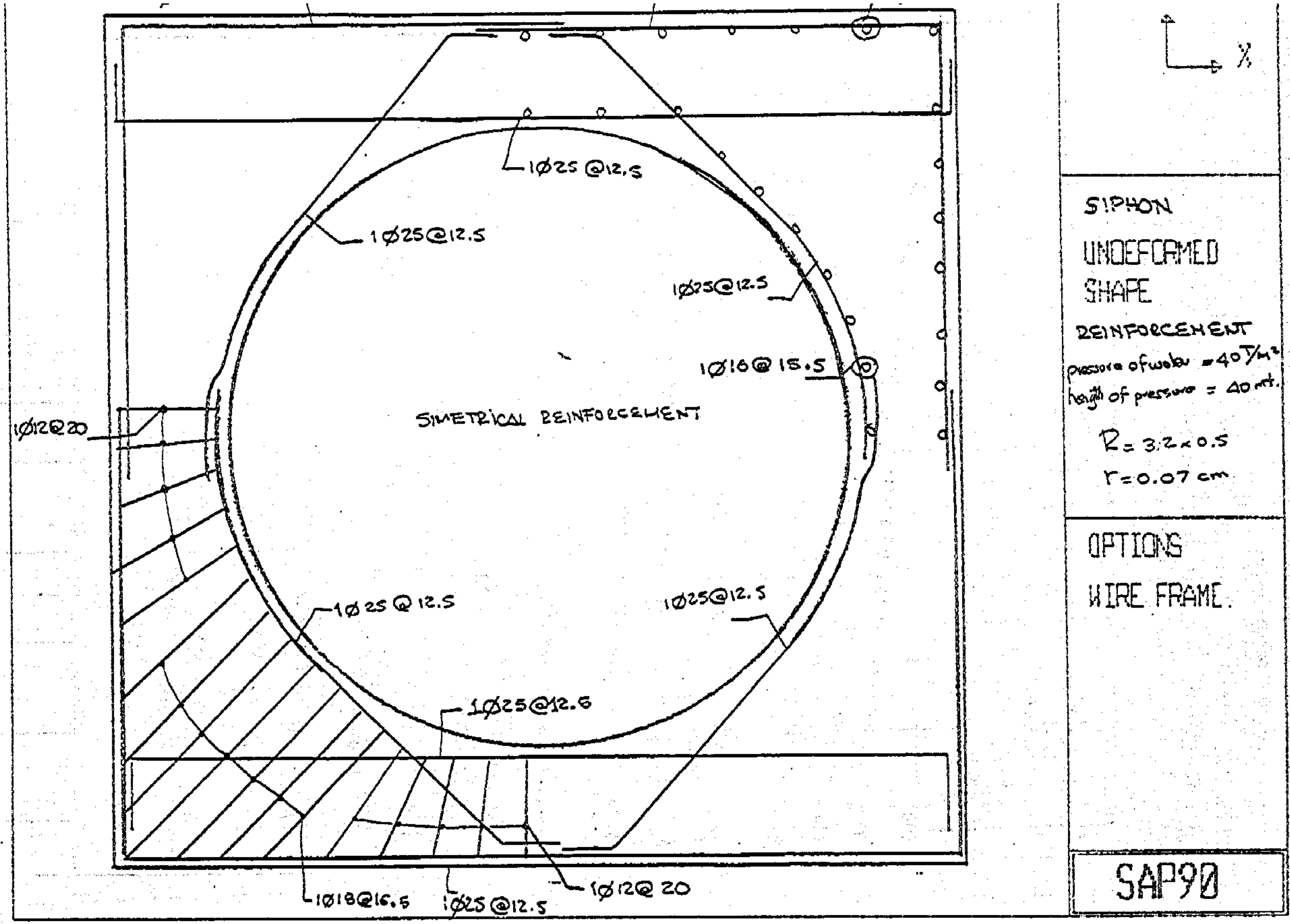
$A_v = \frac{44.762.25}{0.85 \times 4200 \times \sin 45°} = 17.73\ cm^2 = 7 \quad 7\phi 18 \Rightarrow 1\phi 18 @ 16.5$

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

$V_s = 45.130 - 28.071.97 = 17.058.03$

$A_v = \frac{17.058.03}{0.85 \times 4200 \times \sin 45°} = 6.75\ cm^2 \Rightarrow 1\phi 12 @ 20$

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:


X
SIPHON
UNDEFORMED
SHAPE
REINFORCEMENT
pressure of water = 40 T/m²
height of pressure = 40 mt.
R = 3.2 x 0.5
r = 0.07 cm
OPTIONS
WIRE FRAME.
SAP90
SIMETRICAL REINFORCEMENT
1Ø25 @12.5
1Ø25@12.5
1Ø25@12.5
1Ø16@15.5
1Ø12@20
1Ø25 @ 12.5
1Ø25@12.5
1Ø25@12.6
1Ø18@16.5
1Ø25 @12.5
1Ø12@ 20

9-270

STRUCTURAL ANALYSIS PROGRAM

VERSION 5.41

ON CIRCULAR H=*4-7 pressure of water.*

FRAME ELEMENT FORCES

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			-38.524			
		.000	26.343	-30.986				
		.010	26.343	-30.723				
		.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				
		1.180	9.463	-9.810				
		1.190	9.463	-9.715				
		1.190			-38.524			
	2	.000			144.711			
		.000	-153.580	118.845				
		1.180	-53.079	-2.847				
		1.190	-52.280	-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	-52.280	-3.374				
		.625	.000	-19.683				
		1.300	55.678	-.854				
		1.300			144.711			
4								

4-271

	.000	-6.648	-8.166				
	1.190	-19.120	-23.715				
	1.200	-19.120	-23.906				
	1.200			-35.524			
2	.000			144.711			
	.000	55.678	-.858				
	1.190	151.978	122.980				
	1.200	152.772	124.463				
	1.200			144.711			

SF CIRCULAR R=6

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

ELT LOAD ID COMB	POINT DIST	1-2 PLANE SHEAR	MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	MOMENT	AXIAL TORQ
5							
1	.000			-19.120			
	.000	35.524	-23.906				
	1.200	13.558	7.343				
	1.200			-19.120			
2	.000			152.772			
	.000	-144.711	124.463				
	1.200	-50.847	7.128				
	1.200			152.772			
6							
1	.000			-19.120			
	.000	13.558	7.343				
	.652	.000	11.760				
	1.300	-13.489	7.388				
	1.300			-19.120			
2	.000			152.772			
	.000	-50.847	7.128				
	.650	.000	-9.399				
	1.300	50.839	7.122				
	1.300			152.772			
7							
1	.000			-19.120			
	.000	-13.489	7.388				
	1.200	-38.455	-23.779				
	1.200			-19.120			
2	.000			152.772			
	.000	50.839	7.122				
	1.200	144.703	124.447				
	1.200			152.772			
8							
1	.000			-38.455			
	.000	19.120	-23.779				
	1.190	6.648	-8.230				
	1.200	6.648	-8.164				
	1.200			-38.455			
2	.000			144.703			
	.000	-152.772	124.447				
	1.190	-56.477	-.297				
	1.200	-55.678	-.858				
	1.200			144.703			
9							
1	.000			-38.455			

A-272

R CIRCULAR N=6

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

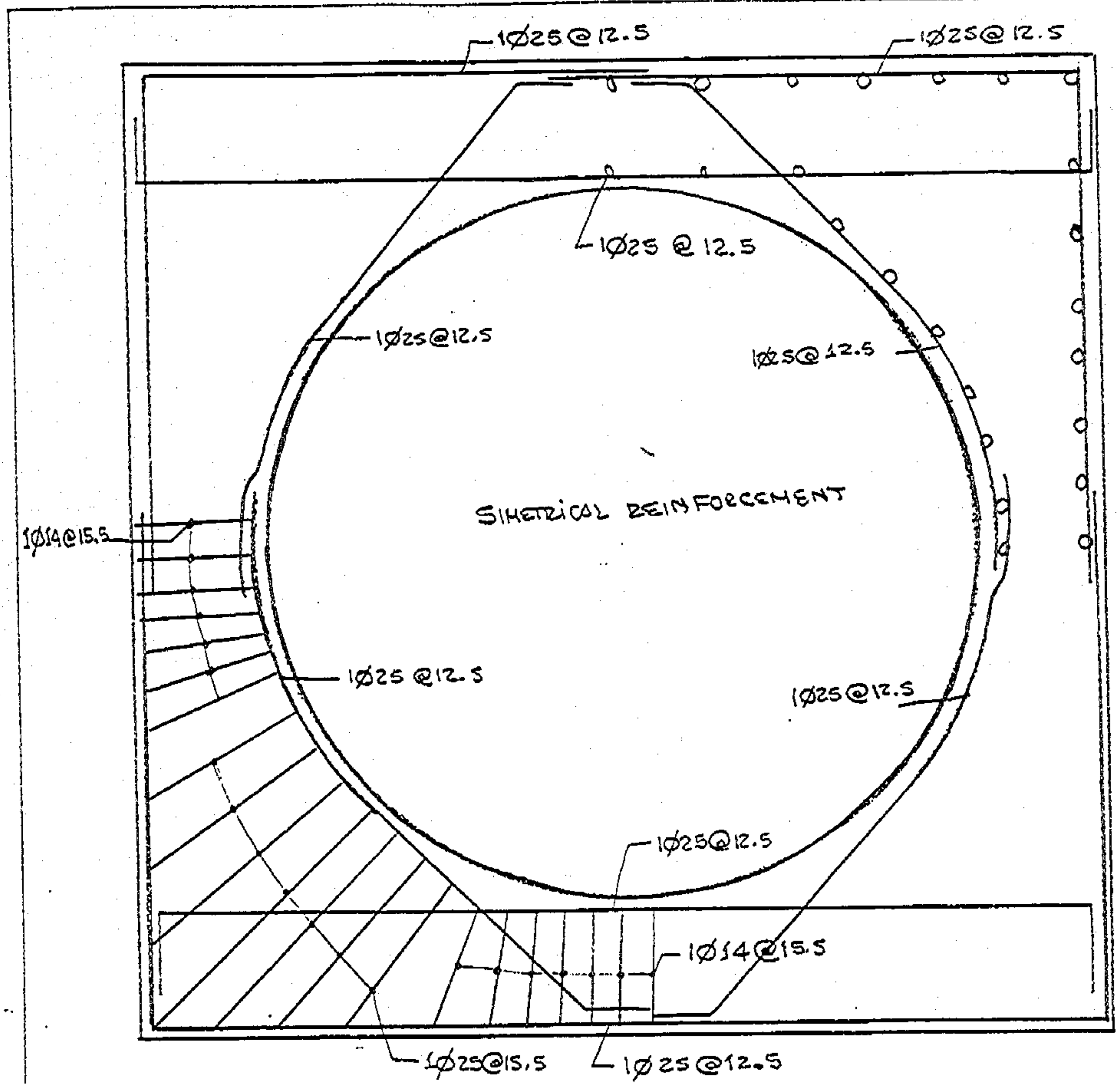
Y LOAD D COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ
	.000	6.646	-8.164				
	.562	.000	-6.273				
	1.300	-9.463	-9.713				
	1.300			-38.455			
2	.000			144.703			
	.000	-53.678	[illegible]				
	.675	.000	-19.686				
	1.300	52.280	-3.377				
	1.300			144.703			
)							
1	.000			-38.455			
	.000	-9.463	-9.713				
	1.180	-26.343	-30.626				
	1.190	-26.343	-30.889				
	1.190			-38.455			
2	.000			144.703			
	.000	52.280	-3.377				
	1.180	152.781	117.372				
	1.190	153.580	118.904				
	1.190			144.703			
1							
1	.000			-38.455			
	.000	-26.343	-30.889				
	.010	-26.343	-31.153				
	.010			-38.455			
2	.000			144.703			
	.000	153.580	118.904				
	.010	153.580	120.440				
	.010			144.703			
2							
1	.000			.000			
	.000	-47.275	30.986				
	.010	-47.275	30.513				
	.010			.000			
2	.000			.000			
	.000	134.870	-120.381				
	.010	134.870	-119.032				
	.010			.000			
3							
1	.000			.000			
	.000	-47.275	30.513				
	1.190	-16.671	-7.535				
	1.190			.000			

R CIRCULAR N=6

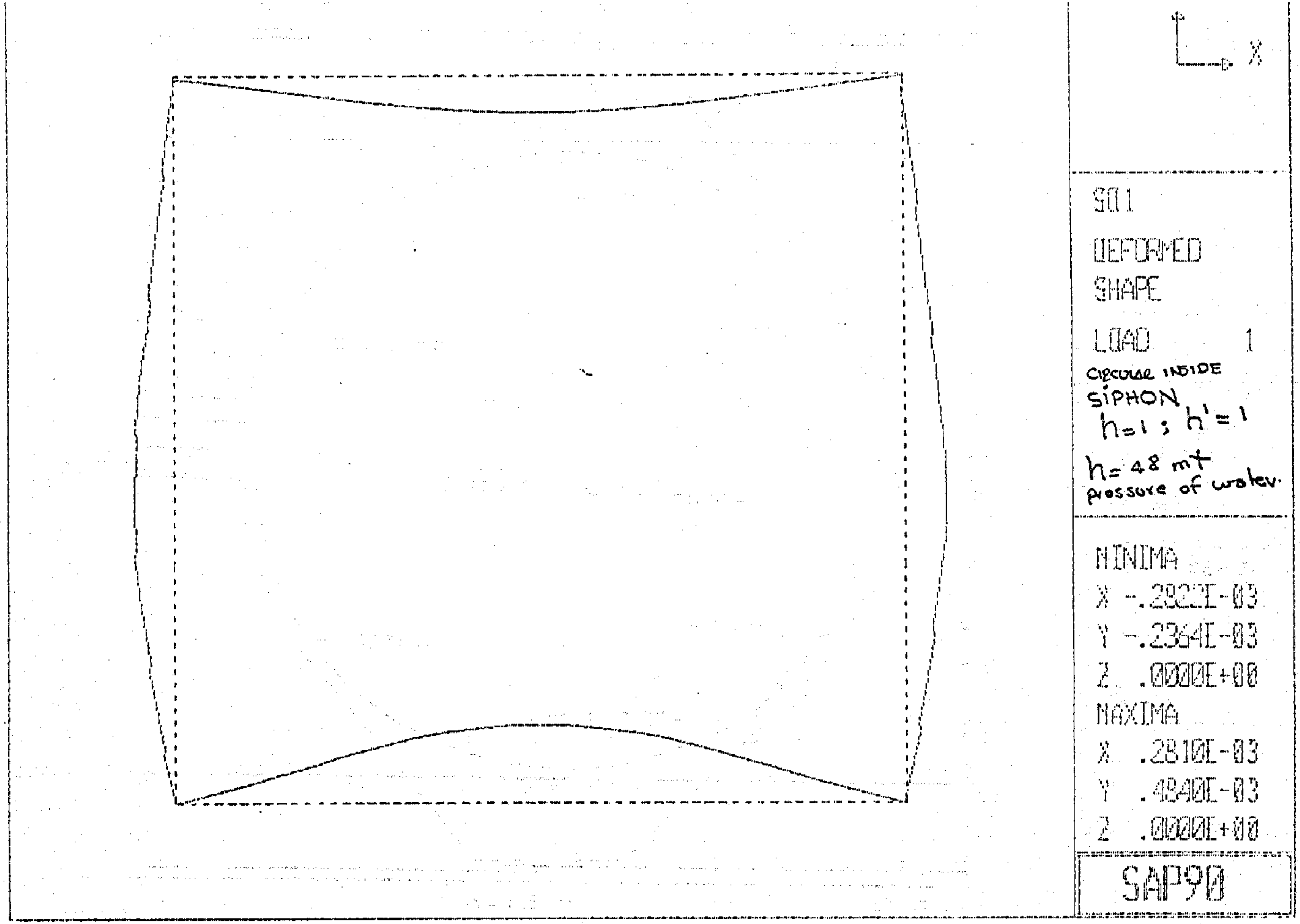
A M E E L E M E N T F O R C E S

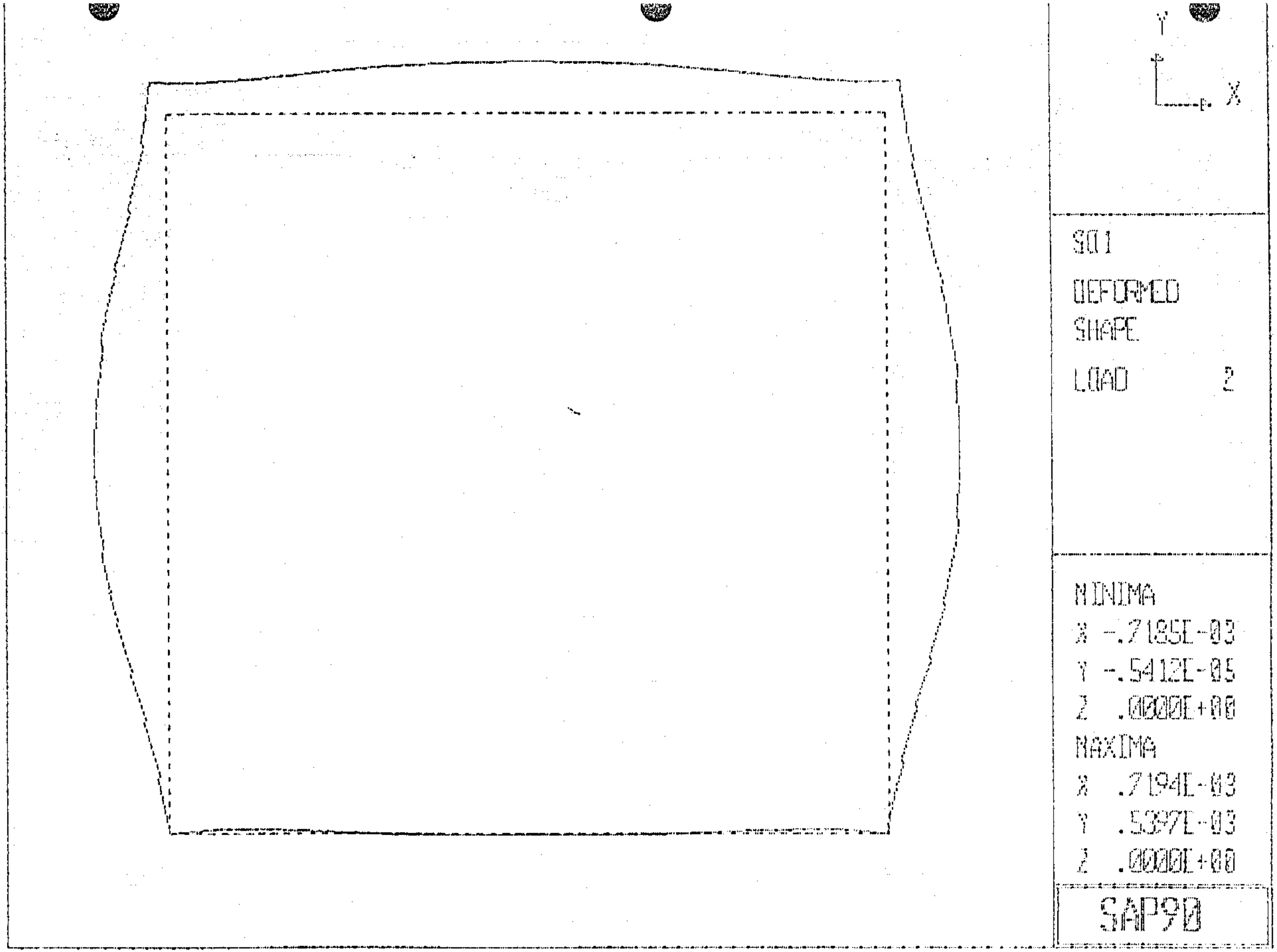
Y LOAD D COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE	1-3 PLANE SHEAR	1-3 PLANE MOMENT	AXIAL TORQ

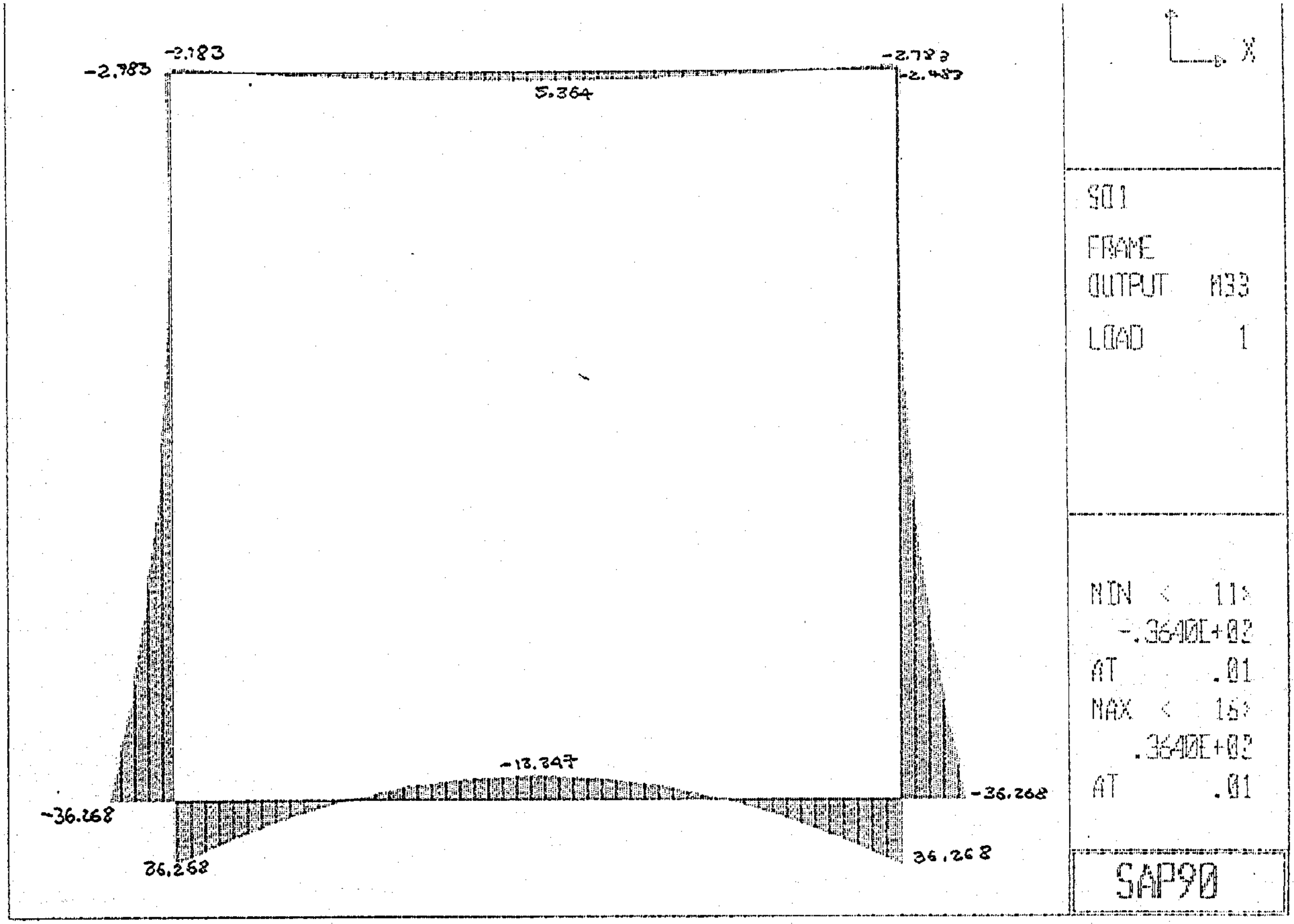
2	.000			.000
	.000	34.270	[illegible]	
	[illegible]	47.634	-10.443	
	[illegible]			.000
1	.000			.000
	.000	-16.671	-7.553	
	.646	.000	-12.???	
	1.300	16.761	-7.477	
	1.300			.000
2	.000			.000
	.000	47.634	-10.463	
	.650	.000	5.033	
	1.300	-47.666	-10.463	
	1.300			.000
1	.000			.000
	.000	16.761	-7.477	
	1.190	47.365	30.679	
	1.190			.000
2	.000			.000
	.000	-47.666	-10.463	
	1.190	-134.901	-119.091	
	1.190			.000
1	.000			.000
	.000	47.365	30.679	
	.010	47.365	31.153	
	.010			.000
2	.000			.000
	.000	-134.901	-119.091	
	.010	-134.901	-120.440	
	.010			.000

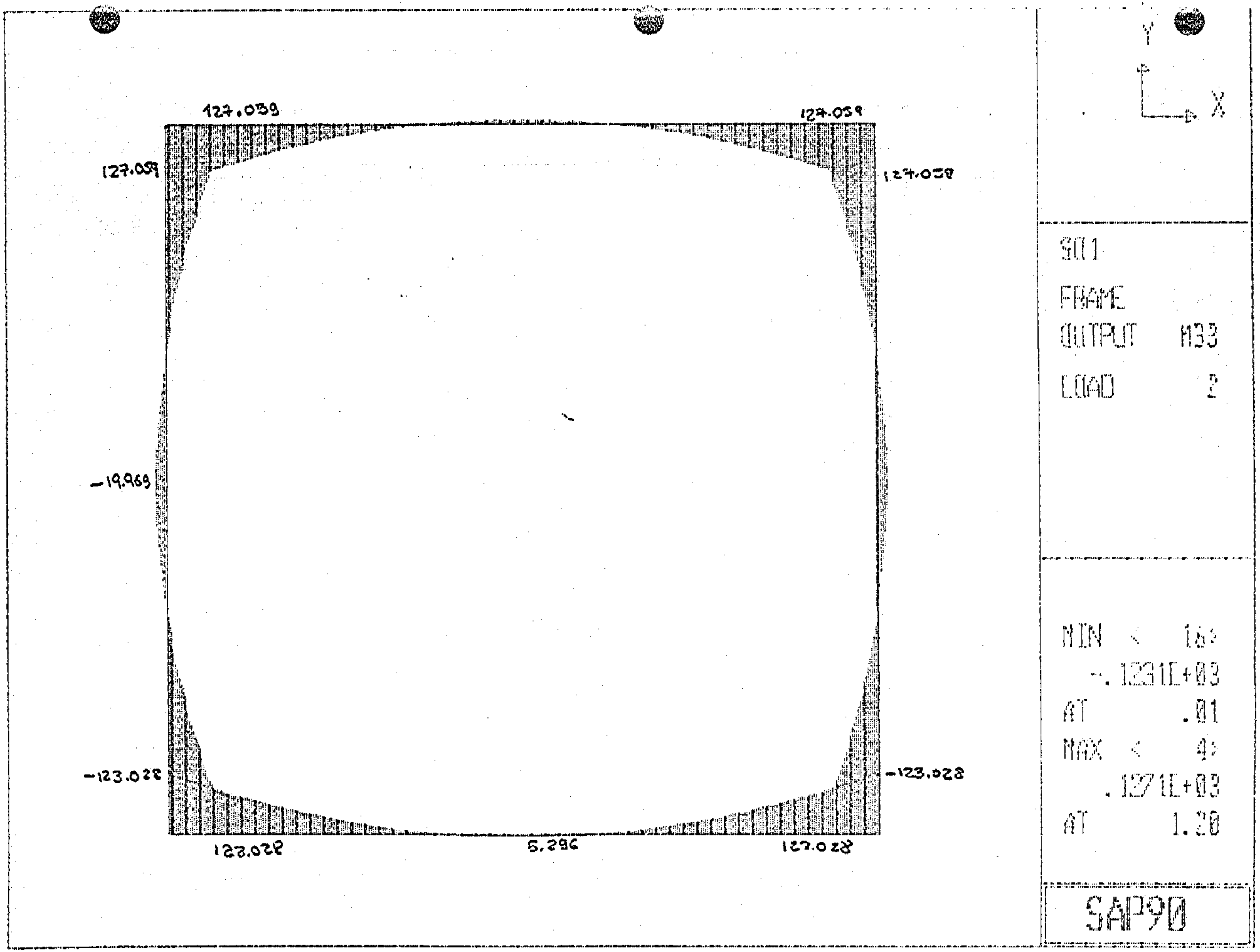


Y X
SIPHON UNDEFORMED SHAPE REINFORCEMENT pressure of water = 47.0 t/m² heigth of pressure = 47.0 m R = 3.2 x 0.5 r = 0.07 cm
OPTIONS WIRE FRAME
SAP90

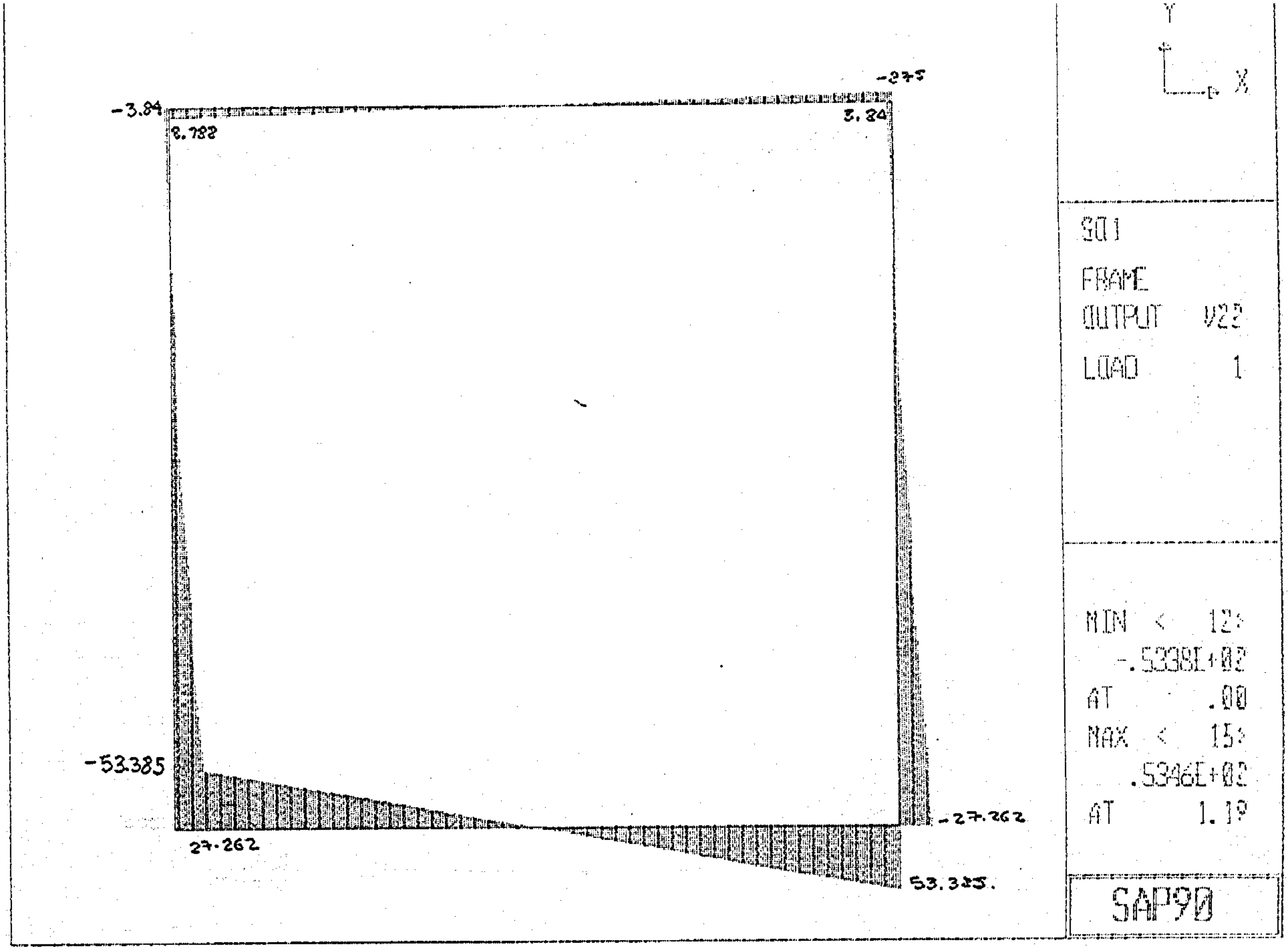

X
S01
DEFORMED
SHAPE
LOAD 1
Circular INSIDE
SIPHON
h=1 ; h'=1
h= 48 mt
pressure of water.
MINIMA
X -.2822E-03
Y -.2364E-03
Z .0000E+00
MAXIMA
X .2810E-03
Y .4840E-03
Z .0000E+00
SAP90

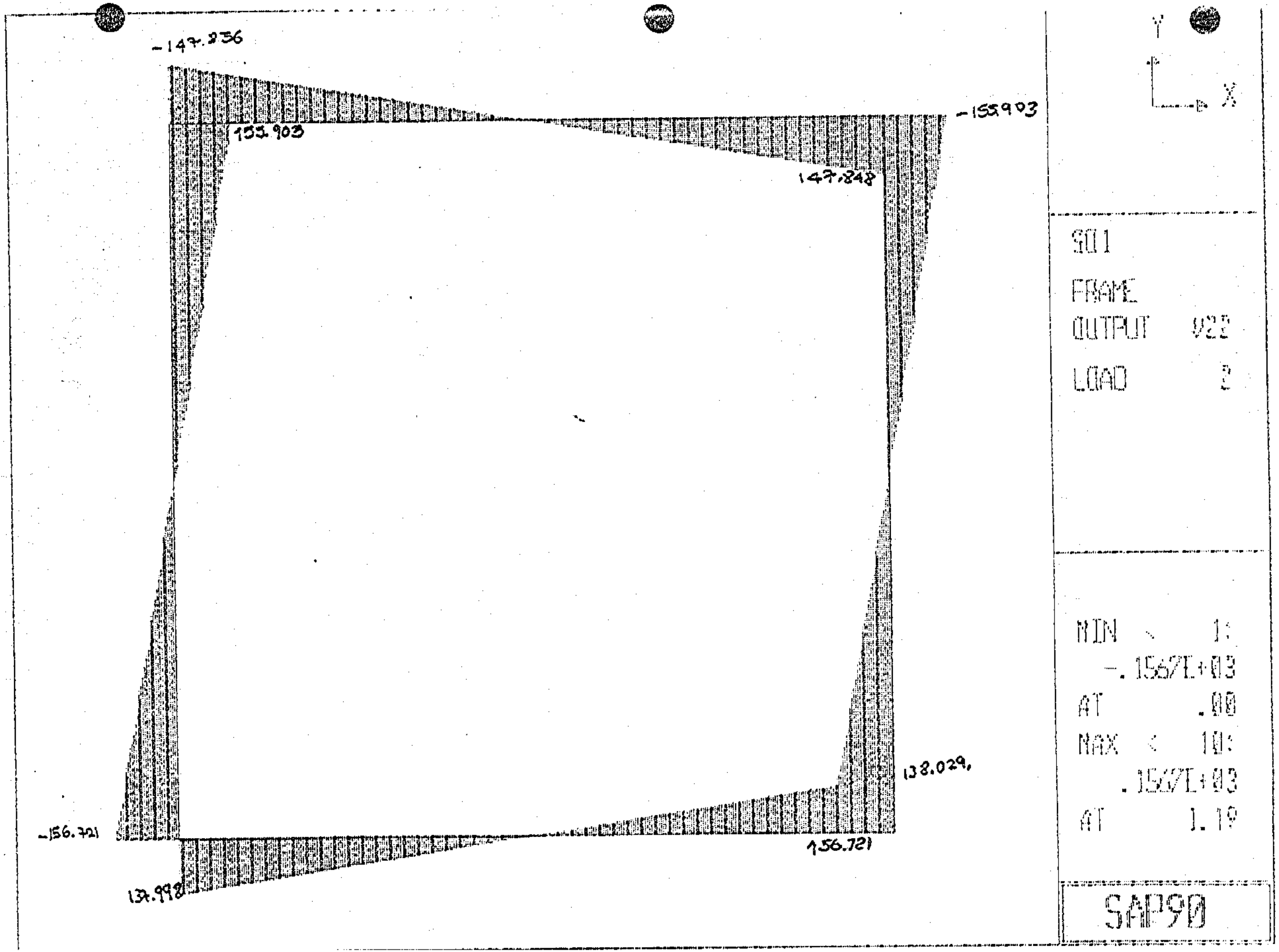

Y
X
SD1
DEFORMED
SHAPE
LOAD 2
MINIMA
X -.7185E-03
Y -.5412E-05
Z .0000E+00
MAXIMA
X .7194E-03
Y .5397E-03
Z .0000E+00
SAP90


-2.783
-2.183
5.364
-2.783
-2.483
-13.347
-36.268
36.268
-36.268
36.268
SO1
FRAME
OUTPUT M33
LOAD 1
MIN < 11>
-.3640E+02
AT .01
MAX < 16>
.3640E+02
AT .01
SAP90



127.059
127.059
127.059
127.058
-19.969
-123.028
-123.028
123.028
5.296
127.028
Y
X
S01
FRAME
OUTPUT M33
LOAD 2
MIN < 16>
-.1231E+03
AT .01
MAX < 4>
.1271E+03
AT 1.20
SAP90


Y
X
-3.84
8.782
-2.75
3.84
-53.385
27.262
-27.262
53.385.
S01
FRAME
OUTPUT V22
LOAD 1
MIN < 12>
-.5338E+02
AT .00
MAX < 15>
.5346E+02
AT 1.19
SAP90


Y
X
-147.236
-155.903
155.903
147.848
138.029,
-156.721
156.721
137.998
SD1
FRAME
OUTPUT V22
LOAD 2
MIN
-.1567E+03
AT .00
MAX
.1567E+03
AT 1.19
SAP90

STRUCTURAL ANALYSIS PROGRAMS

VERSION 5.41

REC

[illegible] CIRCULAR [illegible] h = 4-8 presure 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			-8.788			
		.000	27.262	-36.268				
		.010	27.262	-35.996				
		.010			-8.788			
	2	.000			147.856			
		.000	-156.721	123.028				
		.010	-156.721	121.460				
		.010			147.856			
2								
	1	.000			-8.788			
		.000	27.262	-35.996				
		1.180	13.742	-12.135				
		1.190	13.742	-11.997				
		1.190			-8.788			
	2	.000			147.856			
		.000	-156.721	121.460				
		1.180	-54.215	-2.755				
		1.190	-53.399	-3.293				
		1.190			147.856			
3								
	1	.000			-8.788			
		.000	13.742	-11.997				
		1.300	2.714	-1.737				
		1.300			-8.788			
	2	.000			147.856			
		.000	-53.399	-3.293				
		.626	.000	-19.969				
		1.300	56.770	-.791				
		1.300			147.856			
4								
	1	.000			-8.788			
		.000	2.714	-1.737				
		.422	.000	-1.179				
		1.190	-3.841	-2.744				
		1.200	-3.841	-2.783				
		1.200			-8.788			
	2	.000			147.856			
		.000	56.770	-.791				
		1.190	155.088	125.505				

		1.200			147.836			

STEC PAGE
PROGRAM:SAP90/FILE:soil.F

SIFON CIRCULAR h=1 ; h'=1

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
5								
	1	.000			-3.841			
		.000	6.760	-2.783				
		1.200	3.100	4.350				
		1.200			-3.841			
	2	.000			155.903			
		.000	-147.856	127.059				
		1.200	-51.952	7.174				
		1.200			155.903			
6								
	1	.000			-3.841			
		.000	3.100	4.350				
		.654	.000	5.364				
		1.300	-3.062	4.375				
		1.300			-3.841			
	2	.000			155.903			
		.000	-51.952	7.174				
		.650	.000	-9.712				
		1.300	51.944	7.169				
		1.300			155.903			
7								
	1	.000			-3.841			
		.000	-3.062	4.375				
		1.200	-8.750	-2.713				
		1.200			-3.841			
	2	.000			155.903			
		.000	51.944	7.169				
		1.200	147.848	127.044				
		1.200			155.903			
8								
	1	.000			-8.750			
		.000	3.841	-2.713				
		.768	.000	-1.147				
		1.190	-2.714	-1.705				
		1.200	-2.714	-1.732				
		1.200			-8.750			
	2	.000			147.848			
		.000	-155.903	127.044				
		1.190	-57.586	-.223				
		1.200	-56.770	-.795				
		1.200			147.848			

STEC PAGE
PROGRAM:SAP90/FILE:soil.F

SIFON CIRCULAR h=1 ; h'=1

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
9								
	1	.000			-8.750			
		.000	-2.714	-1.732				

4-283

ELT ID	LOAD COMB	DIST ENDI	1-2 PLANE SHEAR	1-2 PLANE MOMENT	AXIAL FORCE
		1.300			-8.750
	2	.000			147.848
		.000	-56.770	-.725	
		.674	.000	-19.973	
		1.300	53.399	-3.297	
		1.300			147.848
10	1	.000			-8.750
		.000	-13.742	-11.993	
		1.180	-27.262	-35.853	
		1.190	-27.262	-36.126	
		1.190			-8.750
	2	.000			147.848
		.000	53.399	-3.297	
		1.180	155.906	119.956	
		1.190	156.721	121.519	
		1.190			147.848
11	1	.000			-8.750
		.000	-27.262	-36.126	
		.010	-27.262	-36.399	
		.010			-8.750
	2	.000			147.848
		.000	156.721	121.519	
		.010	156.721	123.086	
		.010			147.848
12	1	.000			.000
		.000	-53.385	36.268	
		.010	-53.385	35.734	
		.010			.000
	2	.000			.000
		.000	137.998	-123.028	
		.010	137.998	-121.648	
		.010			.000
13	1	.000			.000
		.000	-53.385	35.734	

SIFON CIRCULAR h=1 ; h'=1

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
		1.190	-18.836	-7.237				
		1.190			.000			
	2	.000			.000			
		.000	137.998	-121.648				
		1.190	48.739	-10.539				
		1.190			.000			
14	1	.000			.000			
		.000	-18.836	7.237				
		.649	.000	-13.347				
		1.300	18.906	-7.191				
		1.300			.000			
	2	.000			.000			

	.650	[illegible]	[illegible]	
	1.500	-48.771	[illegible]6.560	
	1.500			.000
7	.000			.000
	.000	15.706	7.101	
	1.[illegible]	5[illegible]	35.064	
	1.190			.000
7	.000			.000
	.000	-48.771	-10.560	
	1.190	-138.029	-121.706	
	1.190			.000
1	.000			.000
	.000	33.455	35.064	
	.010	33.455	36.399	
	.010			.000
2	.000			.000
	.000	-138.029	-121.706	
	.010	-138.029	-123.086	
	.010			.000

4-385

h=1 ; h'=1 ; pressure of water 48 T/M²

- DATA FOR CALCULATION OF THE REINFORCEMENT.

$f'_c = 210$ Kg/cm²

$f_y = 4200$ Kg/cm²

$b = 100$ cm

$d = 133$ cm

$r = 7$ cm

$M_u = 123,028$ ton

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

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

As_{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

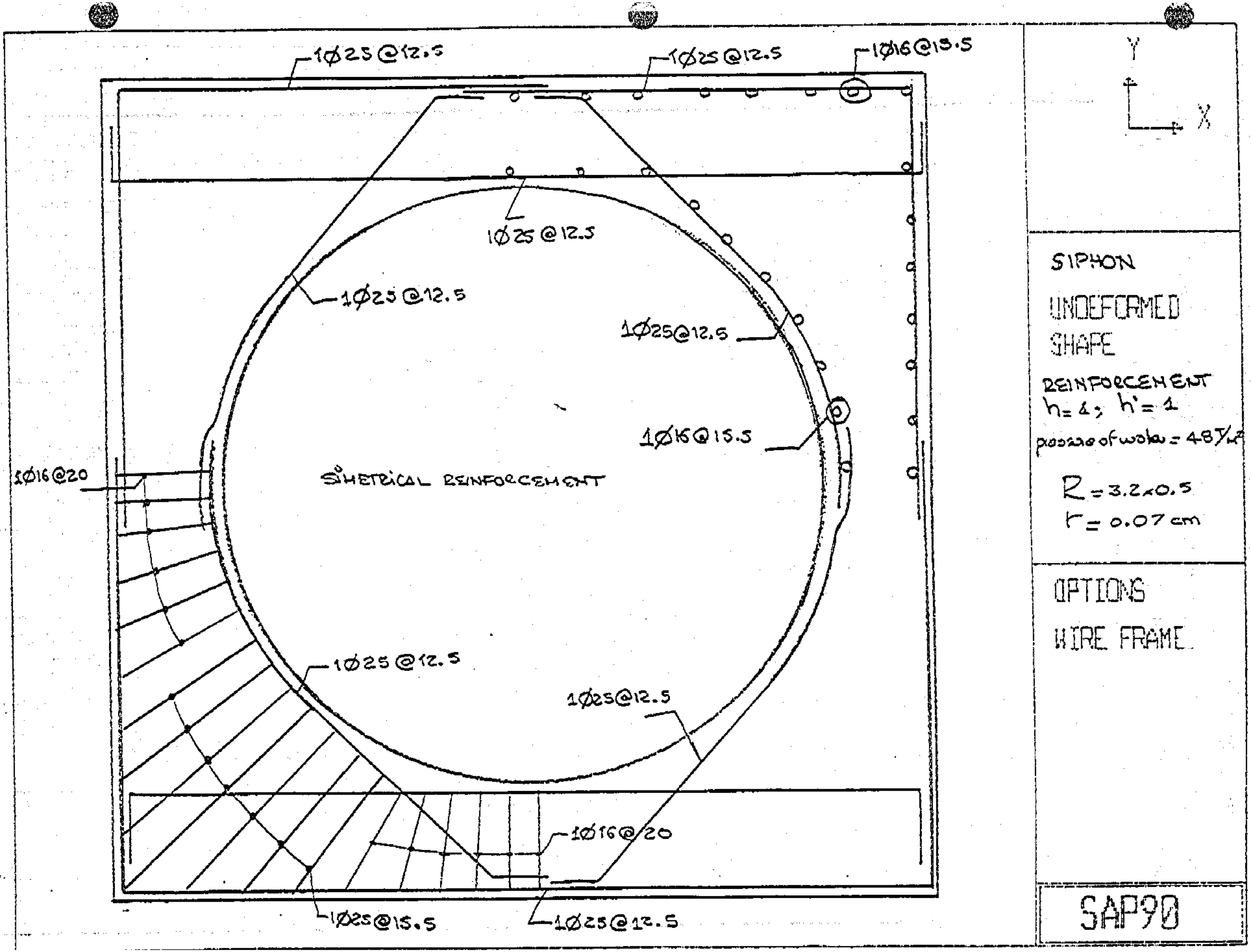
$$Av = \frac{69824.00}{0.85 \times 4200 \times \sin 45} = 27.69 cm^2 \Rightarrow 1 \varnothing 25 @ 15.5$$

$V_u = 56.77$ ton

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

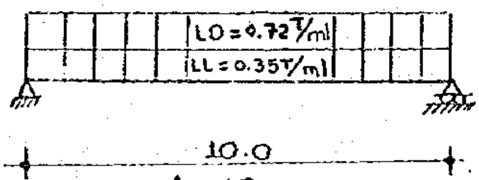
$$A_v = \frac{28.70 \times 10^3}{0.85 \times 4200 \times \sin 45} = 11.37 cm^2 \Rightarrow 1 \varnothing 16 @ 20$$

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:

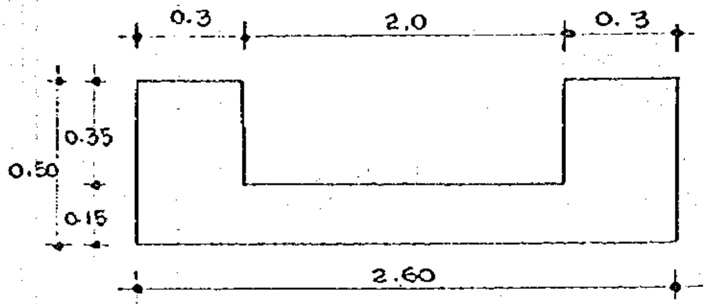


1Ø25@12.5
1Ø25@12.5
1Ø16@15.5
Y
X
1Ø25@12.5
1Ø25@12.5
1Ø25@12.5
1Ø16@15.5
1Ø16@20
SIMETRICAL REINFORCEMENT
1Ø25@12.5
1Ø25@12.5
1Ø16@20
1Ø25@15.5
1Ø25@12.5
SIPHON
UNDEFORMED
SHAPE
REINFORCEMENT
h = 4; h' = 1
pressure of water = 48 T/m²
R = 3.2×0.5
r = 0.07 cm
OPTIONS
WIRE FRAME
SAP90

PEDESTRAIN BRIDGE DESIGN



- SHAPE AND DIMENSIONS



DATA

$f'_c = 210$ Kg/cm²

$f_y = 4200$ Kg/cm²

$b = 30$ cm

$d = 46$ cm

$r = 4$ cm

$LD = \underset{b}{0.3} \times \underset{h}{0.5} \times \underset{\gamma_{concrete}}{2.4} + \underset{h_{slab}}{0.15} \times \underset{b}{1} \times \underset{\gamma_{concrete}}{2.4} = 0.72$ T/m²

$LL = 0.35$ T/m²

$W_U = 1.4 \times \overset{LD}{0.72} + 1.7 \times \overset{LL}{0.35} = 1.603$ T/ml

$M_U = \dfrac{1.603 \times \overline{10.0}^2}{8} = 20.04$ ton-mt $\qquad M_U = \dfrac{W_U L^2}{8}$

$V_U = \dfrac{1.603 \times 10}{2} = 8.02$ ton $\qquad V_U = \dfrac{W_U \times L}{2}$

$A_S = \dfrac{20.04 \times 10^5}{0.9 \times 4200 \left(46 - \frac{4}{2}\right)} = 12.05$ cm²

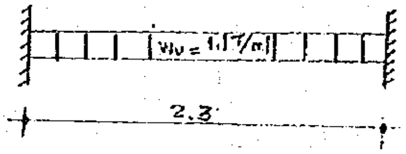
$a = \dfrac{12.05 \times 4200}{0.85 \times 210 \times 30} = 9.45$ cm

$A_S = \dfrac{20.04 \times 10^5}{0.9 \times 4200 \left(46 - \frac{9}{2}\right)} = 12.77$ cm² $= 5\varnothing 18$

$A_{S\,min} = 0.0033 \times 30 \times 46 = 4.55$ cm² $= 3\varnothing 14$

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/cm²
$f_y = 4200$ Kg/cm²
b = 100
d = 2.5
r = 2.5

L = 2.3 mt

LD = 0.15 × 2.4 × 1 = 0.36 T/m²

LL = 0.35 T/m²

$W_U = 1.4 \times 0.36 + 1.7 \times 0.35 = 1.10$ T/m²

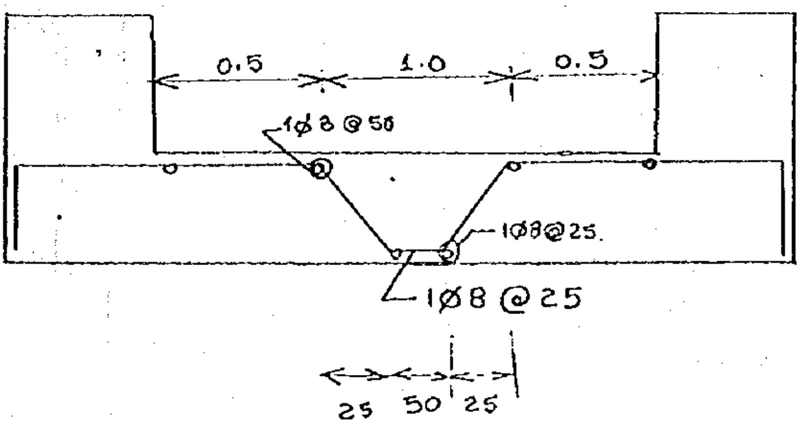
$M(-) = \frac{1.1 \times \overline{2.3}^2}{12} = 0.48$ ton-mt

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

$A_s = \frac{0.48 \times 10^5}{0.9 \times 4200 \left(12.5 - \frac{2.5}{2}\right)} = 1.13$ cm² $\rho = \frac{1.13}{100 \times 12.5} = 0.0009 < \rho_{min}$

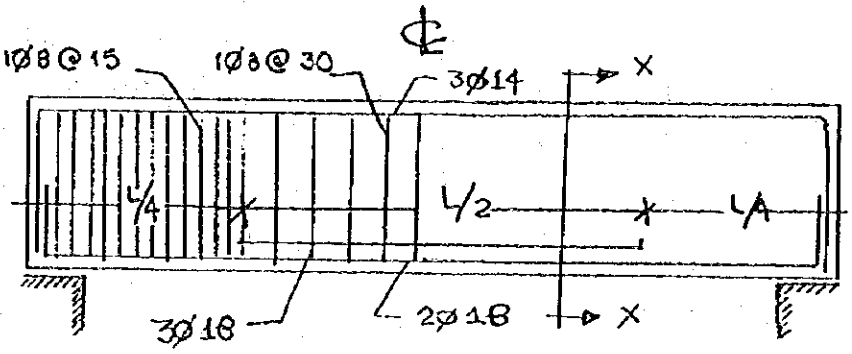
$A_s = \frac{0.24 \times 10^5}{0.9 \times 4200 \left(12.5 - \frac{2.5}{2}\right)} = 0.57$ cm² $\rho = \frac{0.57}{100 \times 12.5} = 0.0004 < \rho_{min}$

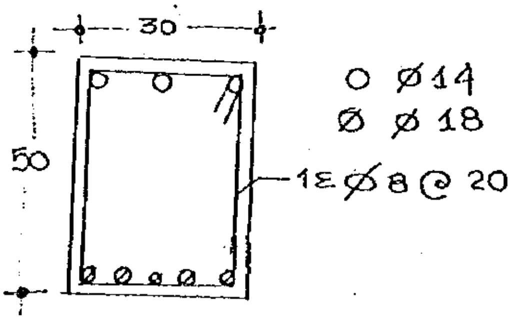
$\rho_{min} = 0.002$ $A_s = 0.002 \times 100 \times 15.0 = 3.0$ cm²/face /2 ⇒ 4Ø8 ⇒ 1Ø8 @ 50



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:

DETAIL OF REINFORCEMENT FOR BEAM





SECTION X-X

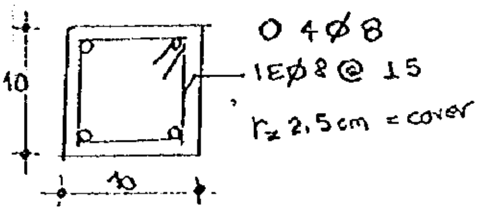
STRESS SHEAR CHECK

$V_u = 8.02$ ton

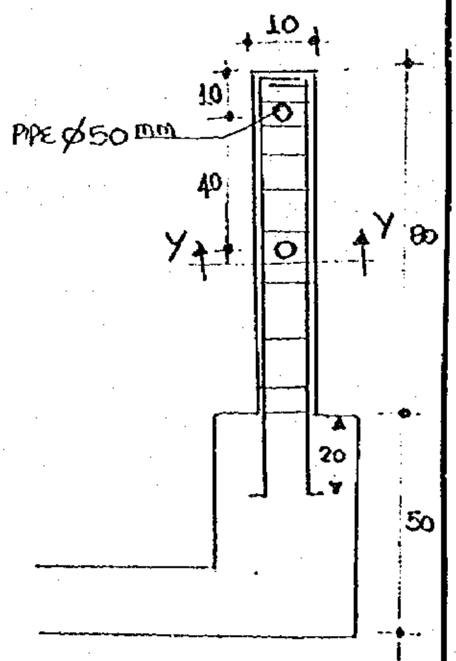
$V_c = 0.85 \times 0.53\sqrt{210} \times 30 \times 46 = 9.009,14$ kg.

$V_c > V_u$ NO REQUIRED STIRRUPS

$1Ø8$ TO $\frac{d}{2}$ NORMATIVE.



SECTION Y-Y



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:

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.

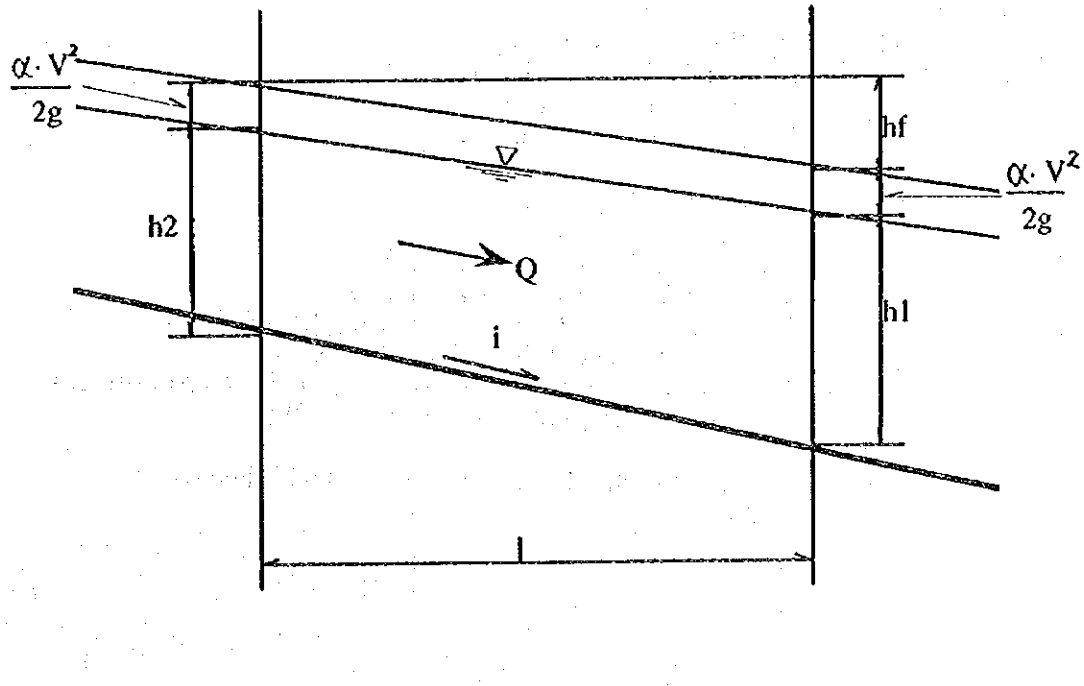
(2) Daule Peripa ~ La Esperanza Diversion Tunnel

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 m^3/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.

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

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



where, Q : discharge (m^3/sec)
i : gradient of tunnel invert
α : 1.1
n : roughness coefficient (0.015)
g : acceleration of gravity (9.8 m/sec^2)

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 m^3/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 ~ 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 m^3/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 (m^3/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 m/sec^2)

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/sec)

Station No.	Distance (m)	Accum. dis. from outlet (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (m)
Outlet channel	0	0	60.500	3.000	15.600	1.154	63.500
E.P. of tunnel	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
Inlet	0	8295.83	66.031	2.972		0.000	69.002

(Q = 14 m3/sec)

Station No.	Distance (m)	Accum. dis. from outlet (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (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	63.508
+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
Inlet	0	8295.83	66.031	2.414		0.000	68.445

(Q = 10 m3/sec)

Station No.	Distance (m)	Accum. dis. from outlet (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (m)
Outlet channel	0	0	60.500	3.000	15.600	0.641	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	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	6.001	1.666	67.690
8+285.83m	285.83	8285.83	66.024	1.857	6.001	1.666	67.881
8+295.83m	10	8295.83	66.031	1.898	7.023	1.424	67.929
Inlet	0	8295.83	66.031	1.922		0.000	67.953

(Q = 7.5 m3/sec)

Station No.	Distance (m)	Accum. dis. from outlet (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (m)
Outlet channel	0	0	60.500	3.000	15.600	0.481	63.500
E.P. of tunnel	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
Inlet	0	8295.83	66.031	1.606		0.000	67.637

(Q = 5.0 m3/sec)

Station No.	Distance (m)	Accum. dis. from outlet (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (m)
Outlet channel	0	0	60.500	3.000	15.600	0.321	63.500
E.P. of tunnel	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
Inlet	0	8295.83	66.031	1.270		0.000	67.301

(Q = 2.5 m3/sec)

Station No.	Distance (m)	Accum. dis. from outlet (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (m)
Outlet channel	0	0	60.500	3.000	15.600	0.160	63.500
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	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	275.83	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
Inlet	0	8295.83	66.031	0.896		0.000	66.927

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

(Q=16 m3/sec)

Sec. No.	Distance (m)	Accum. dis. (m)	Bottom El. (m)	Water Depth h (m)	Flow area (m2)	Flow velocity (m/sec)	Water Level (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	8.844	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
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	38.00	11,495.05	107.363	2.859	10.006	1.599	110.222
Open Channel	12.00	11,507.05	107.762	2.500	11.501	1.391	110.262

Hydraulic Calculation of Poza Honda~Mancha Grande Diversion Tunnel

(Q = 4 m3/sec)

	Dis. from EP (1/3900)	Invert El. (m)	Water Depth (m)	Flow Area (m2)	Velocity (m3/sec)	Water Level (m)
End of transition	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)

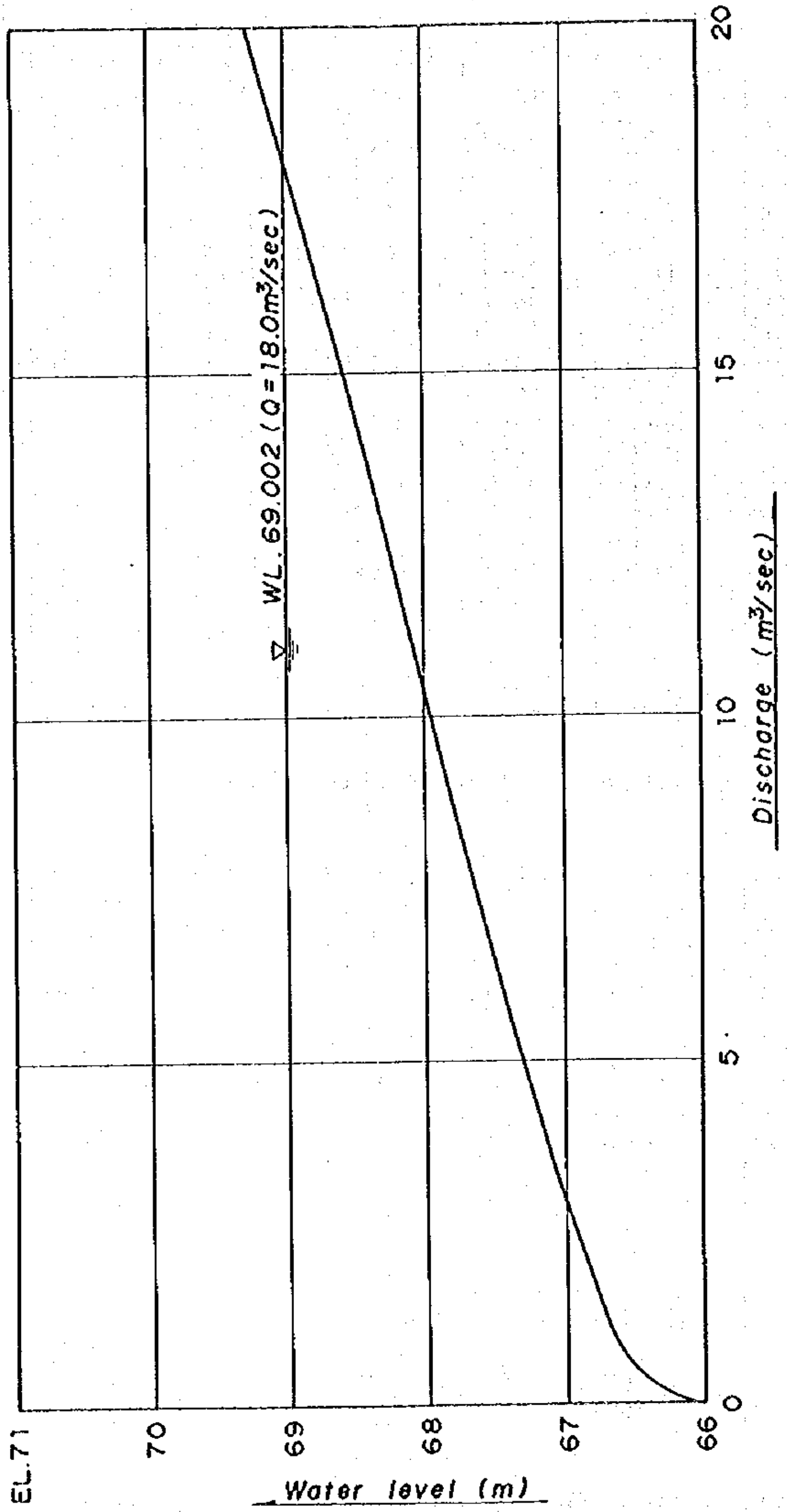
	Dis. from EP (1/3900)	Invert El. (m)	Water Depth (m)	Flow Area (m2)	Velocity (m3/sec)	Water Level (m)
End of transition	4082.930	90.047	1.564	3.507	0.856	91.611
BP of transition	4092.930	90.049	1.573	3.931	0.763	91.622
Inlet	4092.930	90.050	1.579			91.629

(Q = 2 m3/sec)

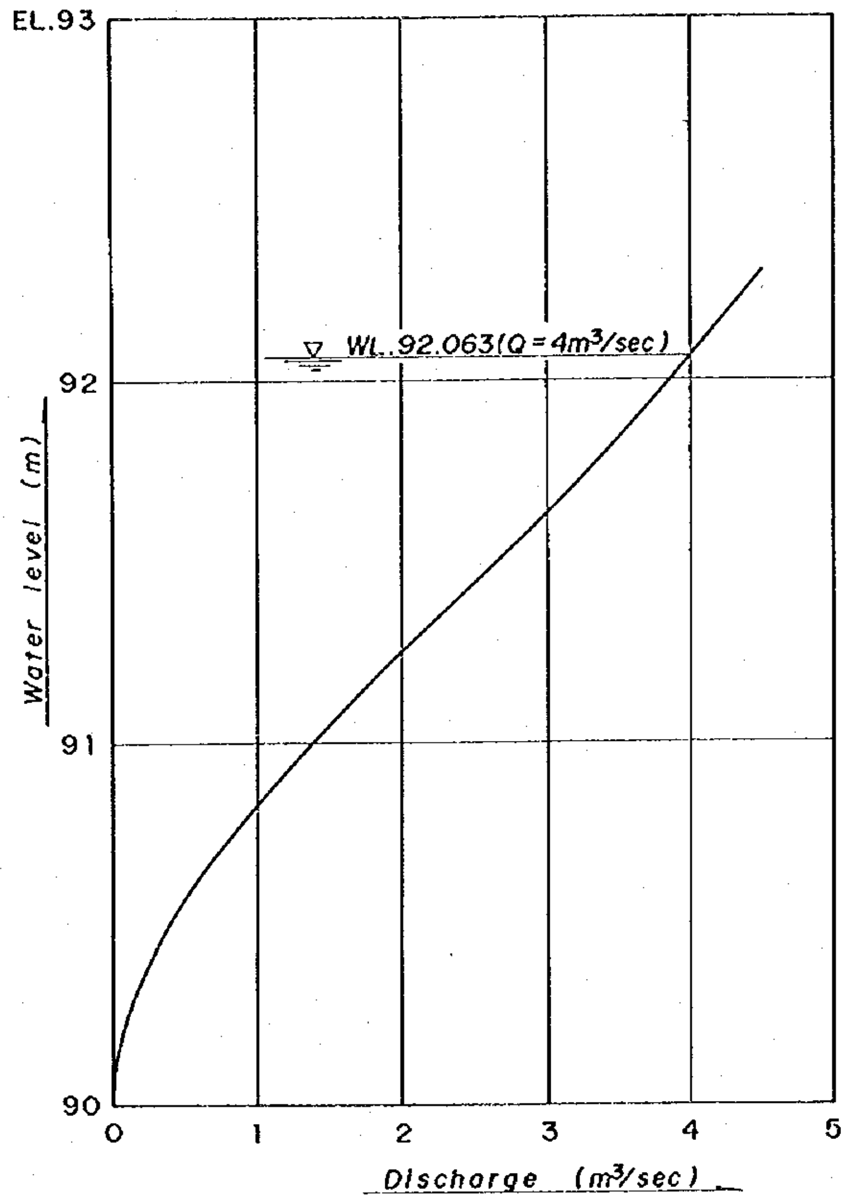
	Dis. from EP (1/3900)	Invert El. (m)	Water Depth (m)	Flow Area (m2)	Velocity (m3/sec)	Water Level (m)
End of transition	4082.930	90.047	1.186	2.569	0.779	91.233
BP of transition	4092.930	90.049	1.194	2.986	0.670	91.244
Inlet	4092.930	90.050	1.200			91.250

(Q = 1 m3/sec)

	Dis. from EP (1/3900)	Invert El. (m)	Water Depth (m)	Flow Area (m2)	Velocity (m3/sec)	Water Level (m)
End of transition	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 Conguillo Inlet



Discharge Curve at Poza Honda Inlet

5.2 Tunnel Structural Analysis by FEM

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).

(1) Daule-Peripa ~ La Esperanza Diversion Tunnel

(A) Procedure of Analysis

The analysis is composed of 2 steps. The first step is an analysis of bending 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.

(i) Primary Lining

- Shotcrete

  - Design compressive strength : 210 kgf/cm^2
  - Shear strength : 42 kgf/cm^2
  - Unit weight : 2.40 t/m^3
  - Elastic modules : 235,000 kgf/cm^2(at age of 28 days)
  - Thickness : 10 cm or 15 cm

- Rock bolt (SD35, D25)

  - Tensile strength : 17.6 t/m^2
  - Cross sectional area : 5.067 cm^2
  - Elastic modules : 2,100,000 kg/cm^2
  - Length : 2.0 m

(ii) Secondary Lining

- Lining concrete

  - Design compressive strength : 210 kgf/cm^2
  - Unit weight : 2.40 t/m^3
  - Elastic modules : 235,000 kgf/cm^2
  - 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/cm^2, 0.3 kgf/cm^2 and 6.4 kgf/cm^2, 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/cm^2, maximum tensile stress is 0.5 kgf/cm^2 and maximum shear stress is 9.5 kgf/cm^2 as shown in Table 5.2.4. Out of those stresses, maximum shear stress is over its allowable stress (8.5 kgf/cm^2), but it is acted at the limited portion and average maximum shear stress is 8.4 kgf/cm^2. 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 (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/cm^2) is over the allowable one (8.5 kgf/cm^2). However, it is occurred at the limited part, and average maximum shear stress in the lining concrete is 8.0 kgf/cm^2, 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)

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

1/ $\sigma y = 1.7\ t/m^3 \times 60\ m = 102\ t/m^2$

1/ $\sigma x = \lambda \cdot \sigma y = 0.7 \times 102\ t/m^2 = 71\ t/m^2$

2/ $\sigma y = 1.8\ t/m^3 \times 140\ m = 252\ t/m^2$

2/ $\sigma x = \lambda \cdot \sigma y = 0.7 \times 252\ t/m^2 = 176\ t/m^2$

3/ $\sigma y = 1.8\ t/m^3 \times 250\ m = 450\ t/m^2$

3/ $\sigma x = \lambda \cdot \sigma y = 0.7 \times 450\ t/m^2 = 315\ t/m^2$

4/ $\sigma y = 1.8\ t/m^3 \times 320\ m = 576\ t/m^2$

4/ $\sigma x = \lambda \cdot \sigma y = 0.7 \times 576\ t/m^2 = 403\ t/m^2$

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/cm^2)	10,000	20,000
3.	Cohesion C (kgf/cm^2)	2.0	5.0
4.	Internal Friction Angle (degree)	30	40
5.	Unit Weight (t/m^3)	1.8	2.0
6.	Poisson's Ratio	0.25	0.2
7.	Creep		
	α	0.50	0.5
	β (5 days loading)	0.016	0.033
8.	Initional Stress		
	a) Vertical σy (t/m^2)	1/ 108	2/ 600
	b) Horizontal σx (t/m^2)	1/ 76	2/ 420

1/ σy = $1.8\ t/m^3 \times 60\ m = 108\ t/m^2$

σx = $\sigma x = \lambda \cdot \sigma y = 0.7 \times 108 = 76\ t/m^2$

2/ σy = $2.0\ t/m^3 \times 300\ m = 600\ t/m^2$

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

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

CASE A-1 (t = 10 cm)

Elapsed time from tunneling	Shotcrete			Judgment	Rock Bolt	Judgment
	N (ton)	M (tm)	s (kgf/cm^2)		Tensile Force (ton)	
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 A-2 (t = 10 cm)

Elapsed time from tunneling	Shotcrete			Judgment	Rock Bolt	Judgment
	N (ton)	M (tm)	s (kgf/cm^2)		Tensile Force (ton)	
Immediately after	46.7	0.094	52.3	satisfied	4.9	satisfied
1 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 from tunneling	Shotcrete			Judgment	Rock Bolt	Judgment
	N (ton)	M (tm)	s (kgf/cm^2)		tensile Force (ton)	
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
6 months after	205.2	0.123	212.5	unsatisfied	16.1	satisfied
12 month after	205.6	0.123	212.9	unsatisfied	16.1	satisfied

Remark. N: Axial force
M: Bending moment
s: Compressive stress
Allowable stress: sa = 210 kgf/cm^2 (shotcrete)
Tensile Strength = 17.6 ton (rock bolt)

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

CASE A-4 (t = 15 cm)

Elapsed time from tunneling	Shotcrete			Judgment	Rock Bolt	Judgment
	N (ton)	M (tm)	s (kgf/cm^2)		Tensile Force (ton)	
Immediately after	130.0	0.673	104.6	satisfied	9.9	satisfied
1 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 from tunneling	Shotcrete			Judgment	Rock Bolt	Judgment
	N (ton)	M (tm)	s (kgf/cm^2)		Tensile Force (ton)	
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

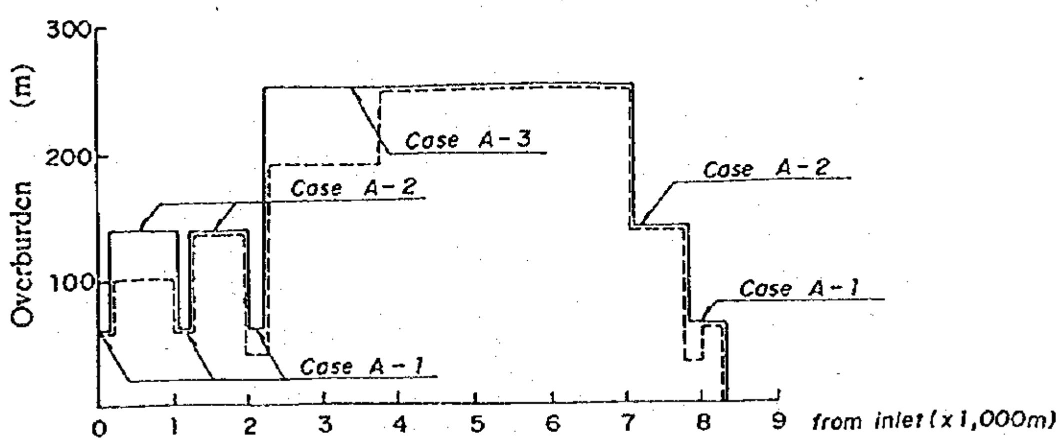
CASE B-2 (t = 15 m)

Elapsed time from tunneling	Shotcrete			Judgment	Rock Bolt	Judgment
	N (ton)	M (tm)	s (kgf/cm^2)		Tensile Force (ton)	
Immediately after	129.6	0.763	106.8	satisfied	9.7	satisfied
1 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

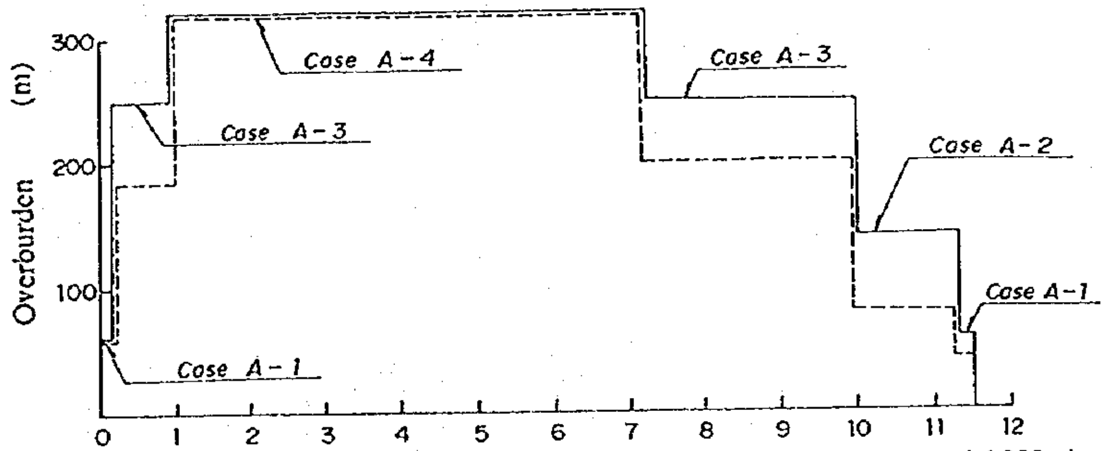
Remark. N: Axial force
M: Bending moment
s: Compressive stress
Allowable stress : sa = 210 kgf/cm^2 (shotcrete)
: Tensile strength = 17.6 ton (rock bolt)

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

Case of Analysis	Maximum Compressive Stress (kgf/cm^2)	Judgment	Maximum Tensile Stress (kgf/cm^2)	Judgment	Maximum Shear Stress (kgf/cm^2)		Judgment
					Limited Part	Average in Section	
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

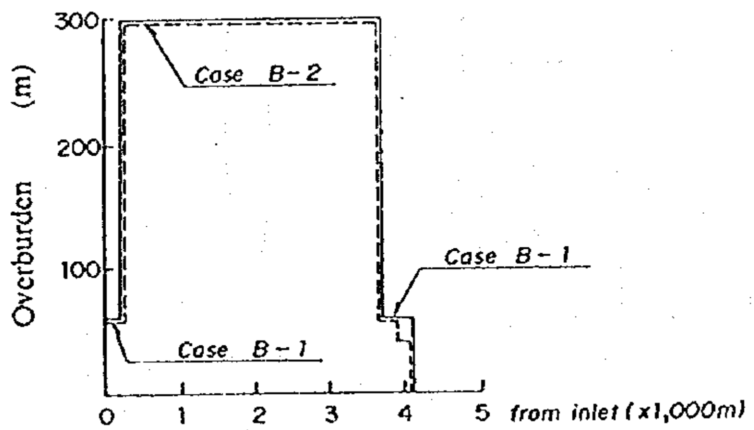


Daule-Peripa~La Esperanza Diversion Tunnel



La Esperanza~Poza Honda Diversion Tunnel

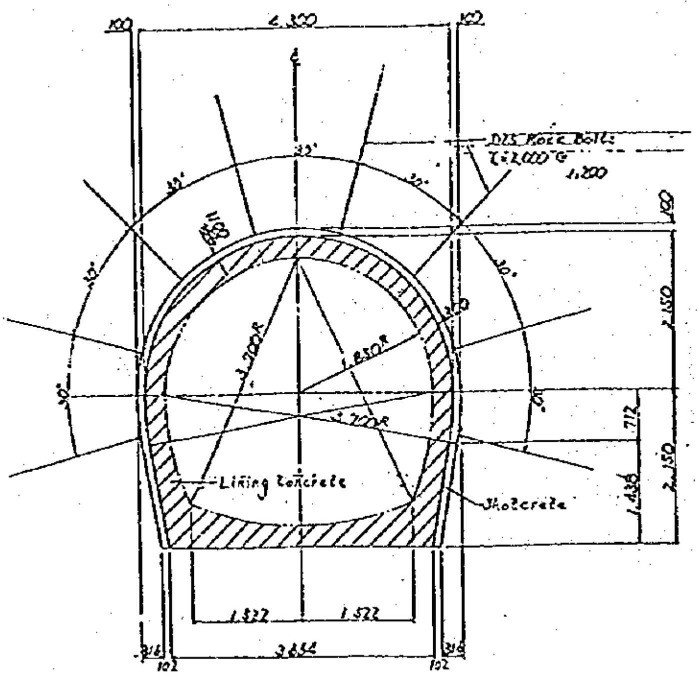
from inlet (x1,000m)



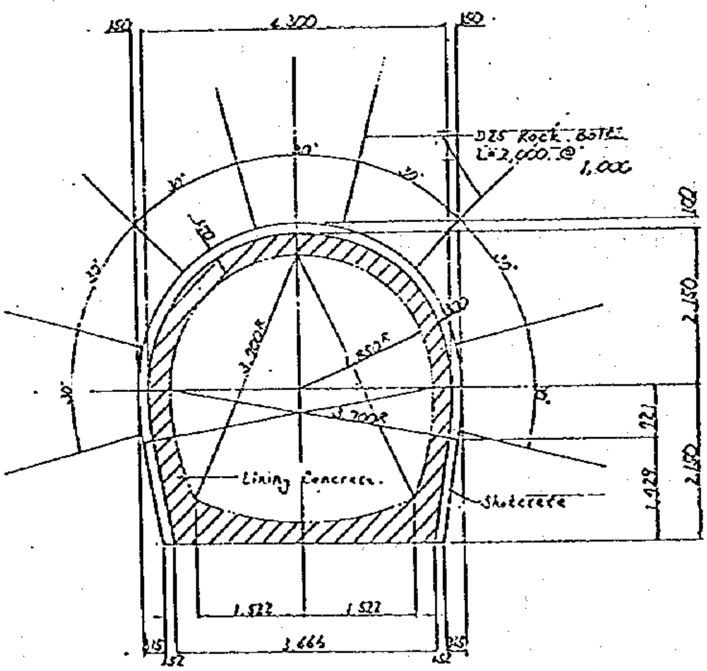
Poza Honda~Mancha Grande Diversion Tunnel

- 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 DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS*	TITLE Cases of Tunnel Structural Analysis based on the Overburden, Geological Condition and Cross Section
JAPAN INTERNATIONAL COOPERATION AGENCY	



Type II



Type III

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)

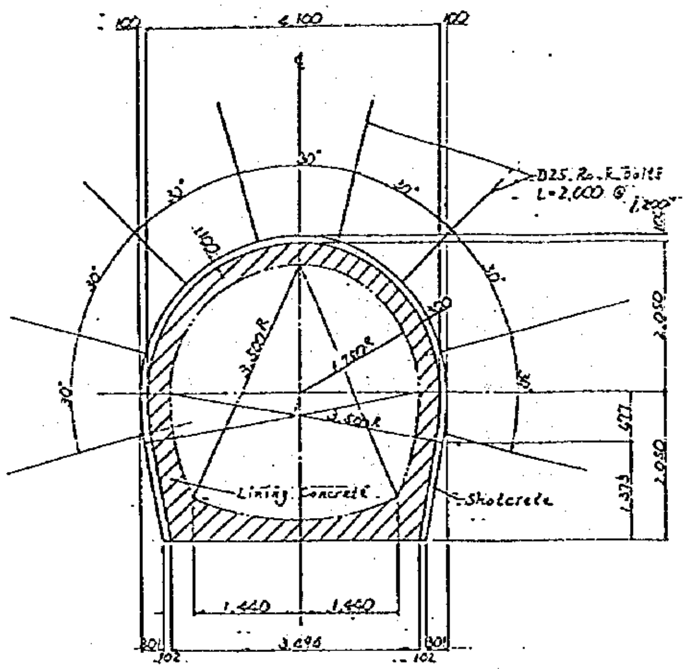
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

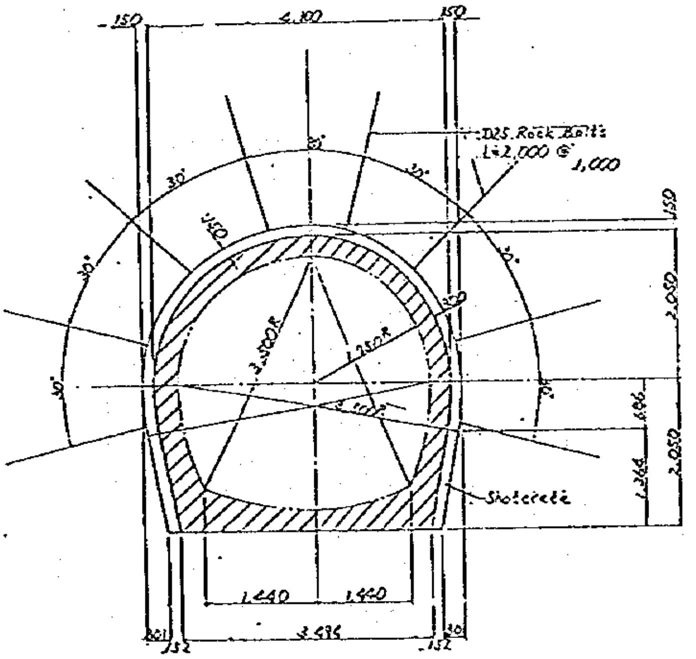
TITLE

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

FIGURE 5.2.3



Type II



Type III

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)

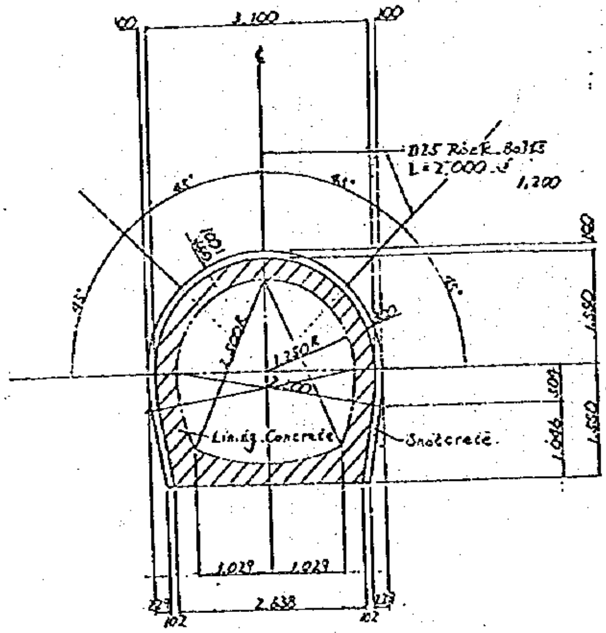
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

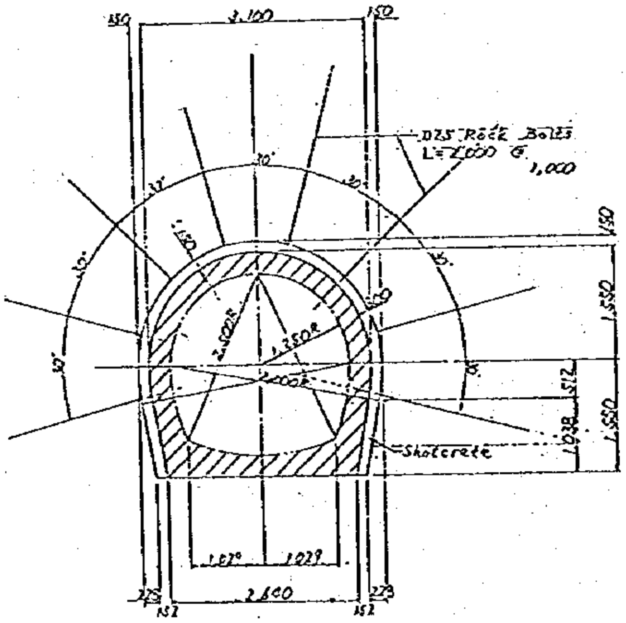
TITLE

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

FIGURE 5.2.4



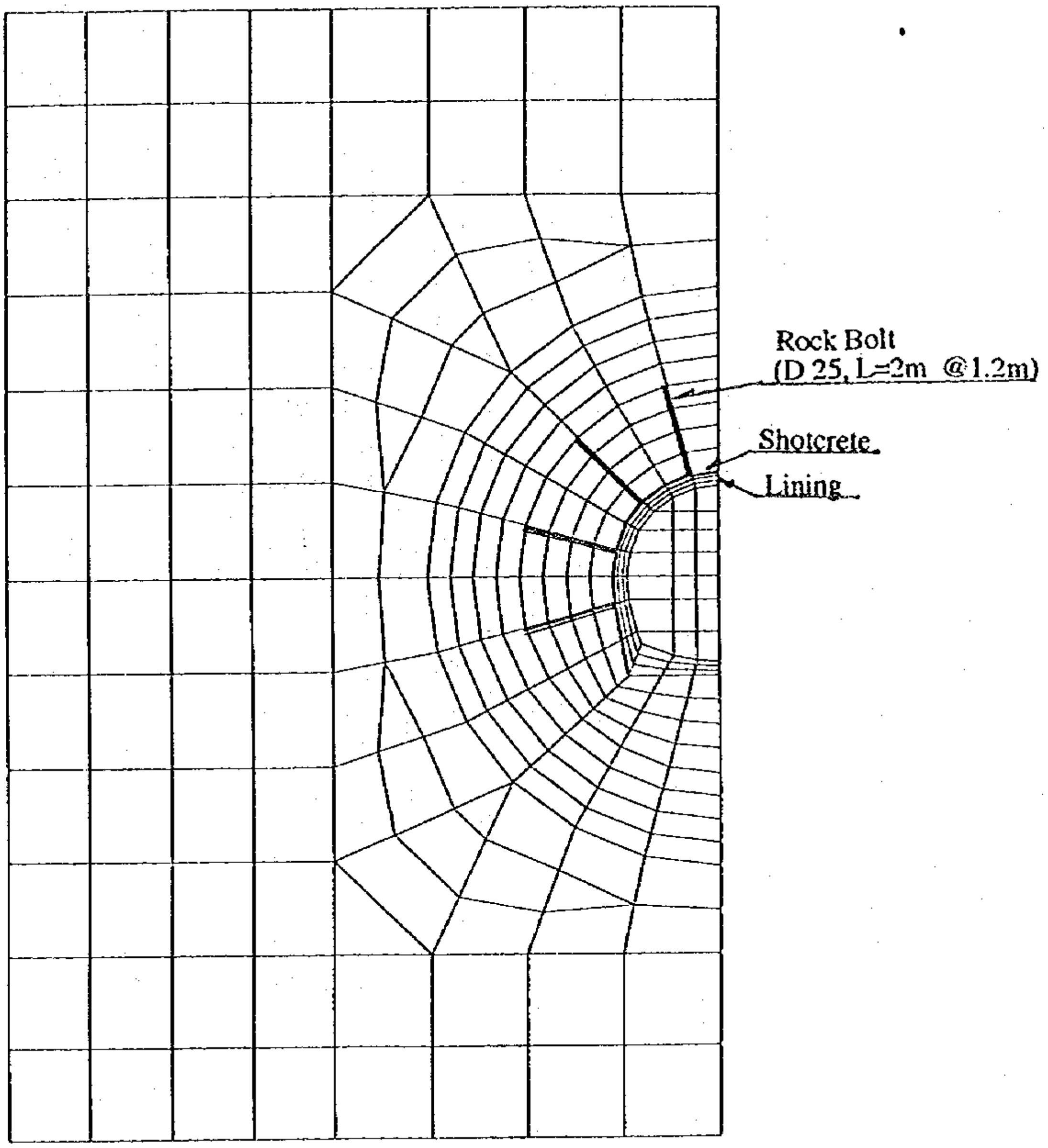
Type II.



Type III

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	Typical Cross Section,Types II and III (Poza Honda~Mancha Grande Diversion Tunnel)
JAPAN INTERNATIONAL COOPERATION AGENCY	

FIGURE 5.2.5



FOR STRUCTURE

0 5.0 M
(1 : 150)

LEGEND
TOTAL ELEMENTS = 297
TOTAL NODES = 285

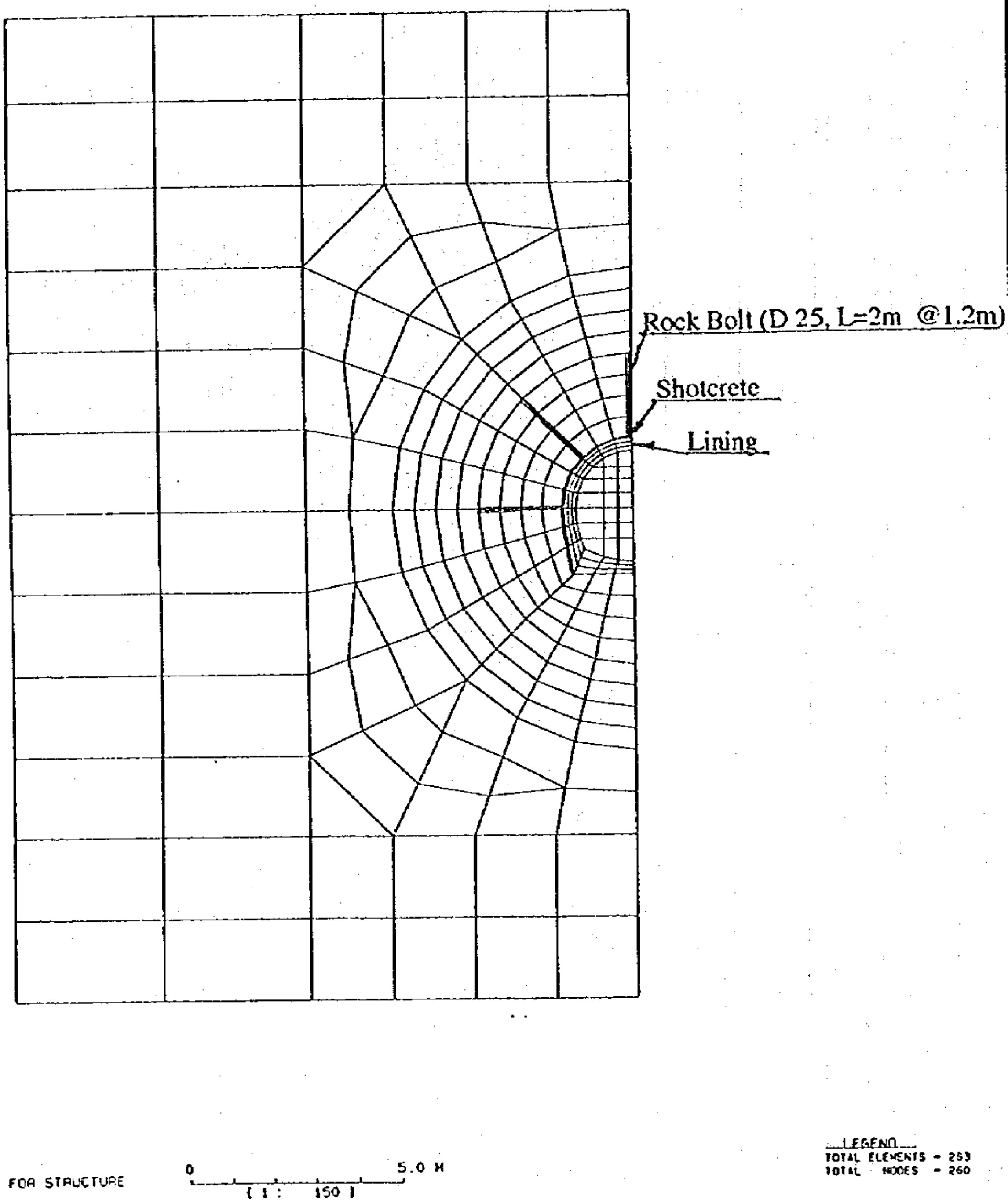
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACIÓN DE MANABI (CRM)

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

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Imput Data Meshs
(Cases A-1,A-2,A-3 and A-4)



GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)

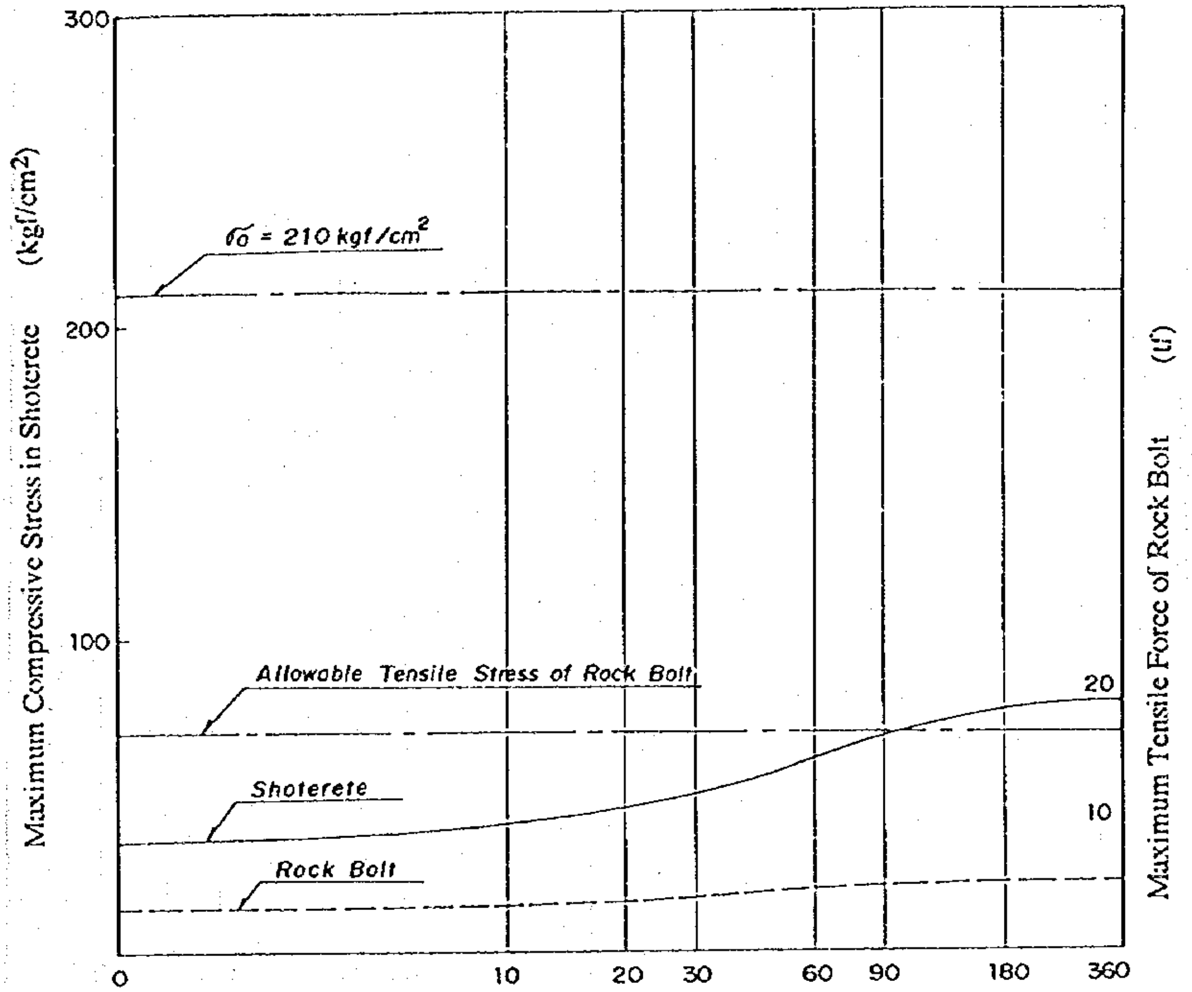
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

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

FIGURE 5.2.7



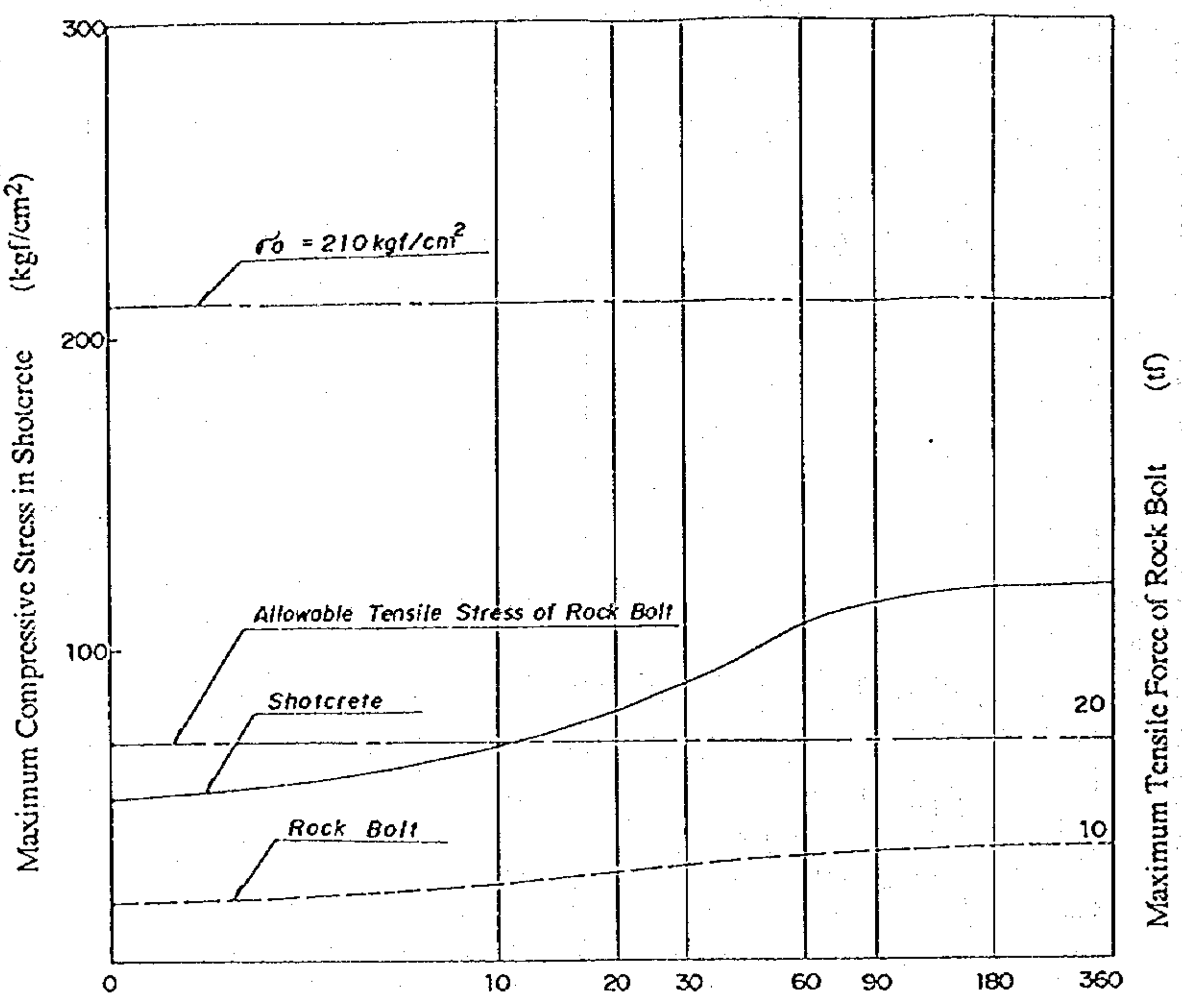
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)

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

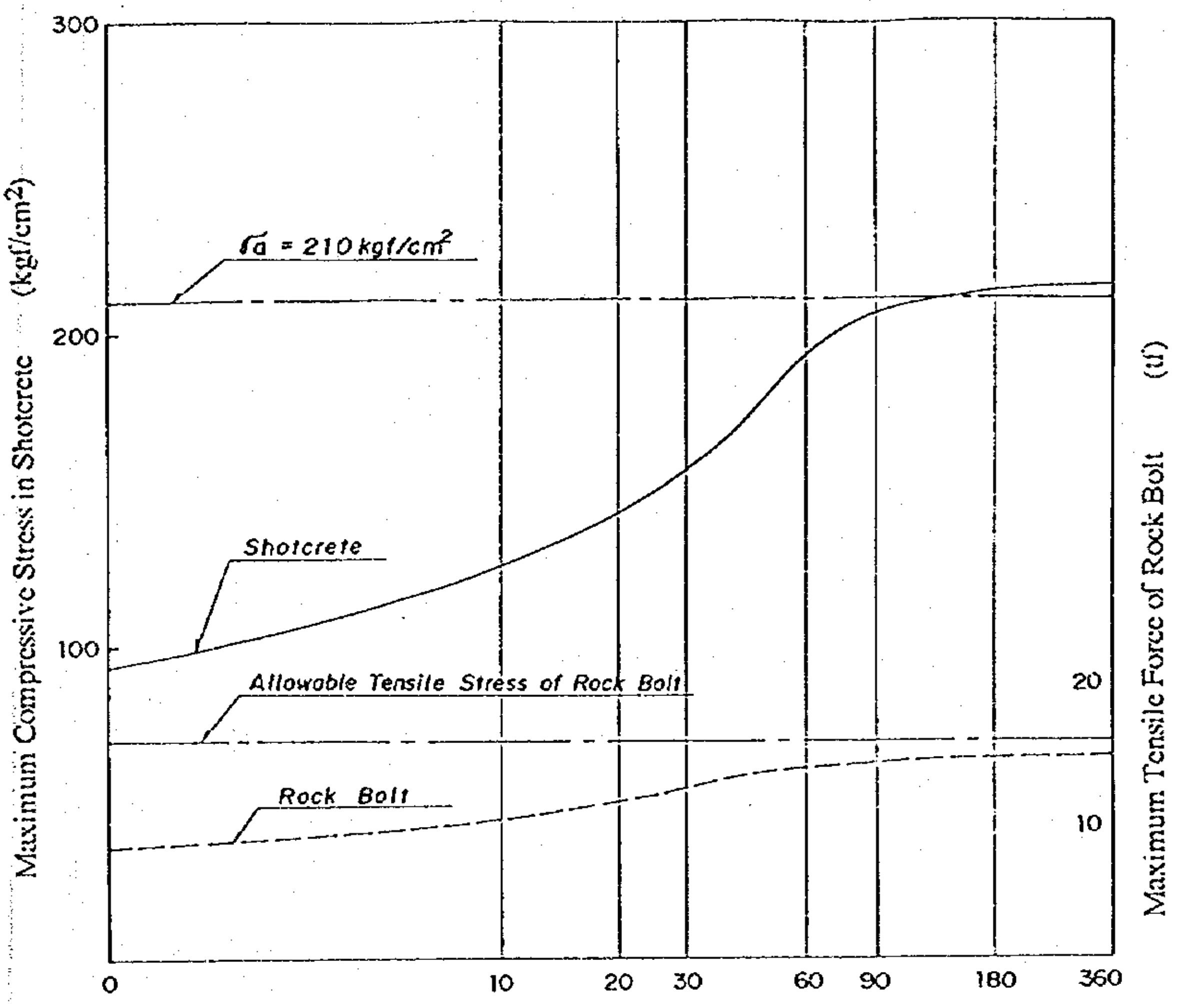
JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

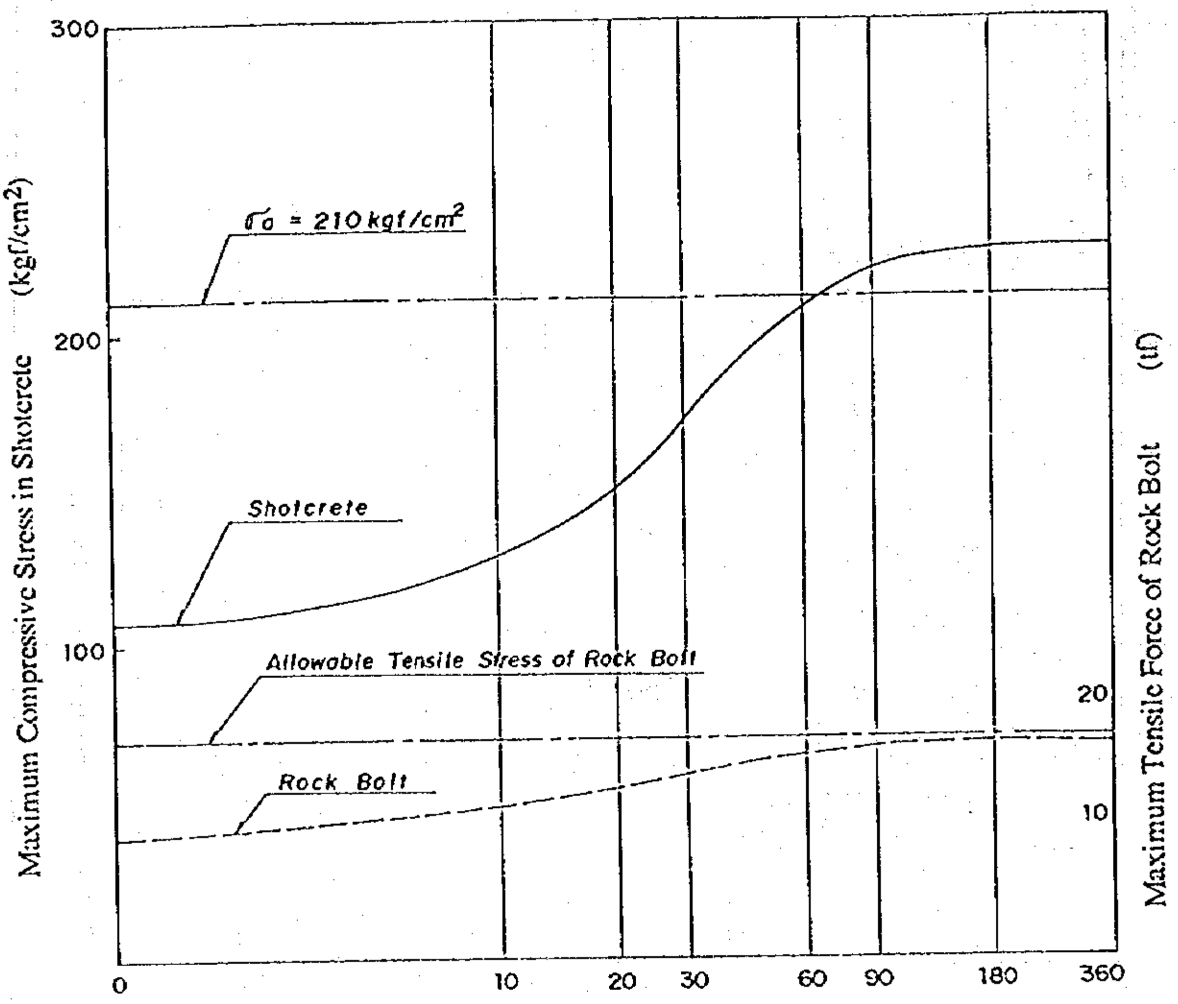
Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case A-1)



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*	TITLE Maximum Compressive Stress in Shotcrete and Tensile Force of Rock Bolt(Case A-2)
JAPAN INTERNATIONAL COOPERATION AGENCY	



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)



GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)

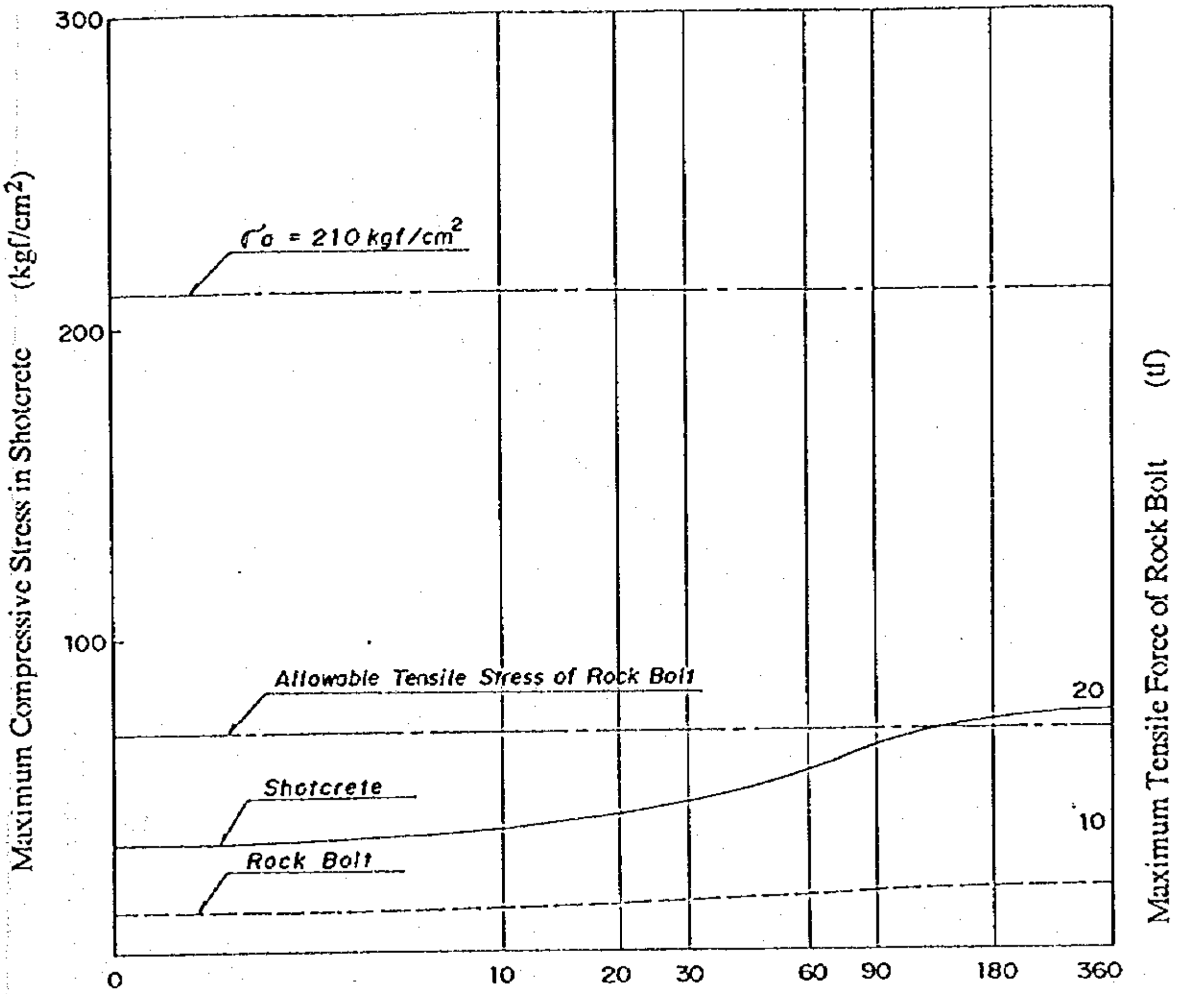
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

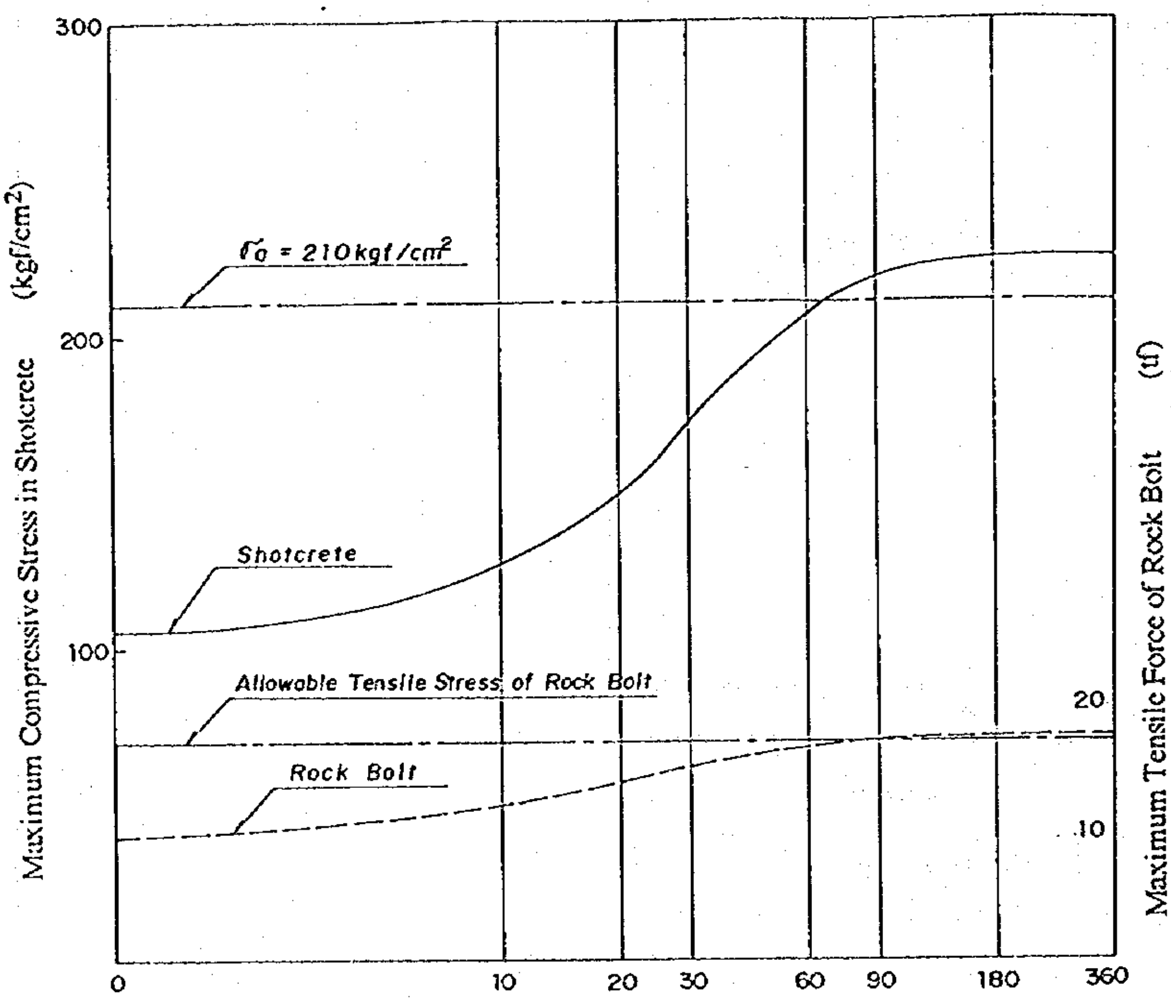
TITLE

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

FIGURE 5.2.11



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 B-1)



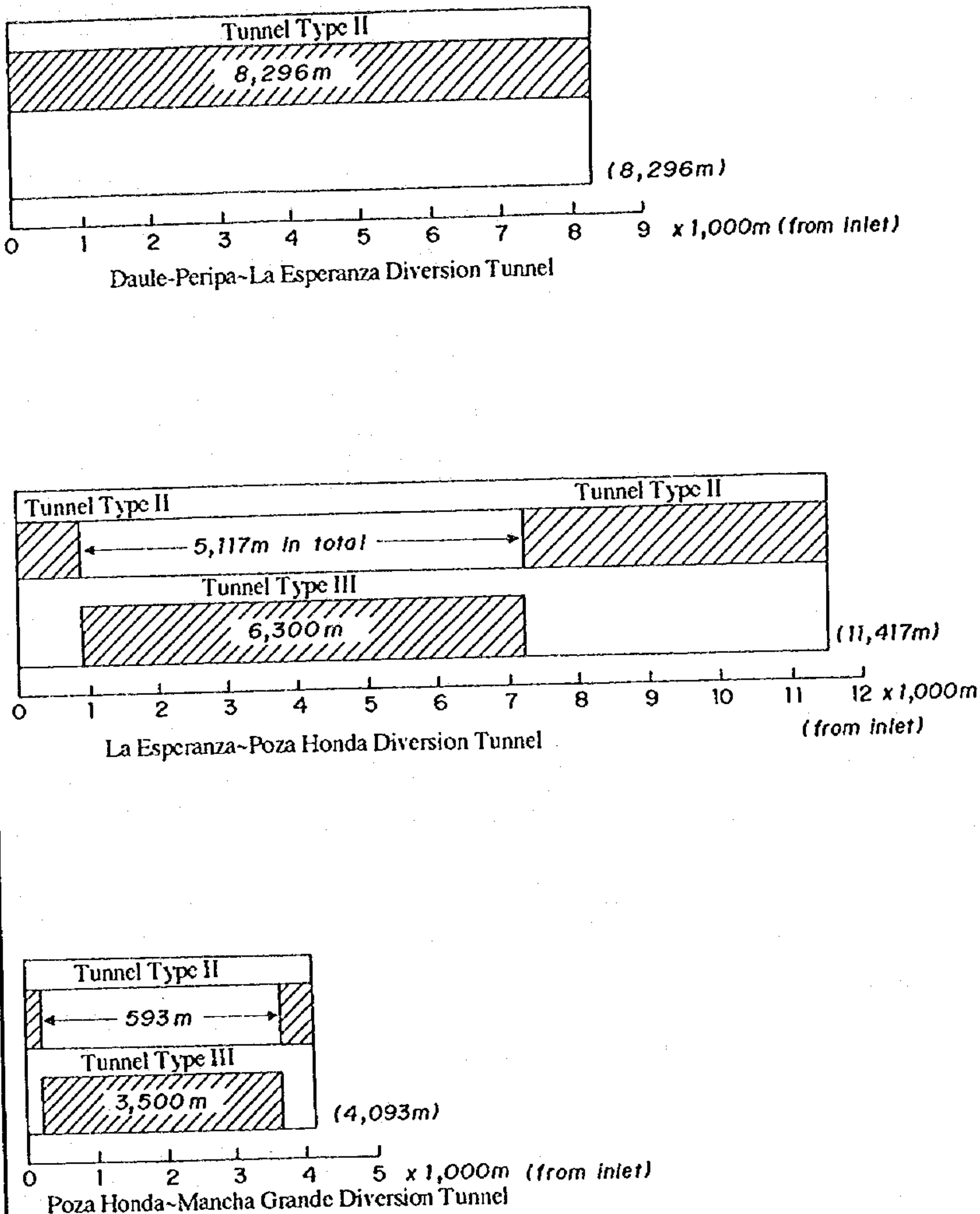
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)

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 B-2)



Tunnel Type II : Shotcrete t=100mm, Rockbolt : 1.2m interval

Tunnel Type III : Shotcrete t=150mm, Rockbolt : 1.0m interval

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 Determination of Tunnel Types based on the Tunnel Structural Analysis