5.4 Superstructures

5.4.1 Conguillo Inlet

(1) Structural System

The structure is a tridimensions frame conformed by beams and columns. The roof is a reinforced concrete slab supported on beams.

(2) Design Conditions

(A) Loads

(a) Unit weight of materials

Materials	Unit Weight
Concrete, plain	2.30 tf/m^3
Concrete, reinforced	2.40 tf/m^3
Mortar	2.00 tf/m^3
Steel	7.80 "

(b) Dead Load

Dead load is the structure self weight.

(3) Seismic Force

Seismic force acting on the structure is computed by the following formulae:

$$F = \Sigma W \cdot kh$$

where:

F = seismic load

ΣW = total dead load

kh = coefficient of horizontal earthquake = 0.15

(B) Factored Loads

The structure and its members were analyzed according to the following factored loads: dead load D and live load L for ultimate strength design.

$$U = 1.4\,D + 1.7\,L$$

For seismic analysis, including the seismic force E, the following load combinations were used:

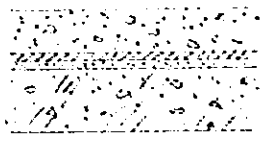
$$U = 1.05\,D + 1.275\,L + 1.87\,E$$
$$U = 0.9\,D + 1.43\,E$$

(3) Structural Analysis and Design

The structural analysis was made with the computer program SAP90.

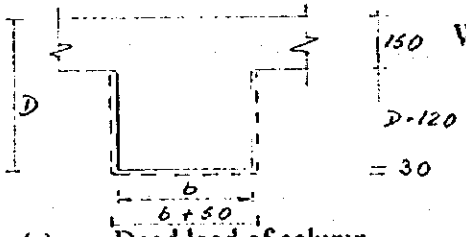
(A) Load Assumption

(a) Roof dead load



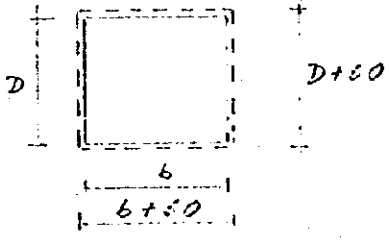
- Concrete 10 cm thick	230	kgf/m²
- 3 ply built-up roofing	20	"
- Base mortar 3 cm	60	"
- Concrete slab 15 cm	360	"
	670	kgf/m²

(b) Dead load of beams



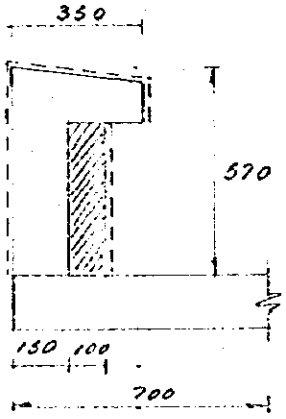
Weight = 2.4 (b + 0.05) (D-12) = t/m
= 2.4 (0.45) 0.48
= 0.52 tf/m

(c) Dead load of column



Weight = 2.4 (b + 0.05) (D + 0.05) = t/m
b x d 60 x 60
P = 2.4 (0.6 + 0.05) (0.6 + 0.05)
= 1.02 tf/m

(d) Parapets dead weight



- Concrete	2.4 x 0.15 (0.57 + 0.2)	=	0.28 tf/m
- Brick	2.0 x 0.10 x 0.42	=	0.09 "
- Finish	2.0 x 0.03 x 1.49	=	0.09 "
			0.46 tf/m
- Roof slab	0.67 x 0.7	=	0.47
- Roof live load		=	180 kgf/m^2

(B) Structural Analysis

The structural model for the analysis has 12 joints, 13 frame type elements and 2 shell bending type elements. For simplifying the analysis the curved beams were considered straight. In the structural design the resultant torsion was included.

Because of lack of symmetry the structure was studied for the following load combinations:

1. 1.4 D + 1.7 L
2. 1.05 D + 1.275 L + 1.4 Ex
3. 1.05 D + 1.275 L + 1.4 Ey
4. 0.9 D + 1.43 Ex
5. 0.9 D + 1.43 Ey

Enclosed are the computer output for the structural analysis and figures SC1, SC2, SC3 and SC4 where are shown the structural model and joint displacement, bending moments and shear forces for load combination No. 1.

The structural design was made by the computer program SAPCON, a post processor program for the structural analysis program SAP90, for reinforced concrete design.

The concrete design was made in accordance to the ACI 318-89.

Enclosed are the design computer outputs.

(a) Check the assumed slab depth

The minimum depth of slab shall be:

$$h = \frac{\ln (800 + fy / 1.5)}{36{,}000 + 5{,}000\beta\,(1 + \beta s)}$$

where:

ln	:	larger clear span
fy	:	yield strength of reinforcement
β	:	ratio of long to short spans
βs	:	ratio of continuous edges to panel perimeter

ln	:	6.2 m average
lc	:	4.2 m average

$$\beta = \frac{6.20}{4.20} = 1.476$$

$$\beta s = 1.0$$

$$h = \frac{6{,}200\,(800 + 420 / 1.5)}{36{,}000 + 5{,}000 \times 1.476(1+1)}$$

$$= 131.9 \text{ mm}$$

But no need to be larger than:

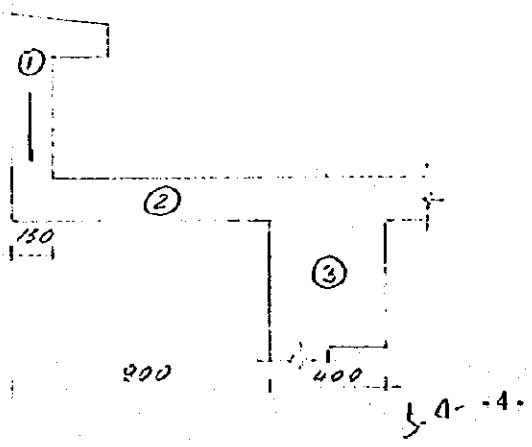
$$h = \frac{\ln(800 + fy / 1.5)}{36{,}000}$$

$$h = \frac{6{,}200\,(800 + 420 / 1.5)}{36{,}000} = 186 \text{ mm}$$

the assumed depth is 150 mm

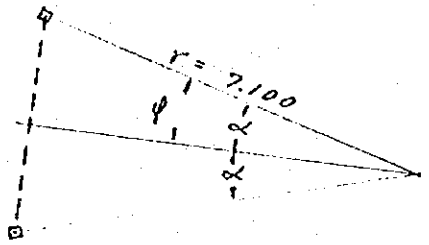
131.9 < 150 < 186 <u>OK</u>

(b) Compute the torsion effect



Self weight

(1)	Parapet	=	0.46 tf/m	
(2)	Slab	=	0.47 tf/m^2	
(3)	Beam	=	0.52 tf/m	
(4)	Live load	=	0.18 tf/m^2	

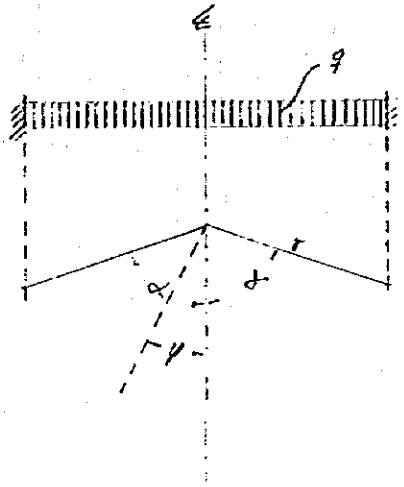


α = 15° = 0.2618 rad

φ = 15°

λ = 1.0

Horizontally curved beam both ends fixed



$$\frac{EI}{GI_t} = 1;$$

$$M = X\cos\varphi - qr^2(1 - \cos\varphi);$$

$$Mt = X\,\text{sen}\,\varphi - qr^2(\varphi - \text{sen}\varphi);$$

$$X = qr^2\left(\frac{2\,\text{sen}\,\alpha - \alpha\cos\alpha}{\alpha} - 1\right)$$

$$q = 0.46 + 0.47 \times 0.9 + 0.52 + 0.18 \times 1.3$$

$$= 1.64 \text{ tf/m}$$

$$X = 1.64\left(\frac{2\,\text{sen}\,15° - 0.2618\cos 15°}{0.2618} - \right) 7.1$$

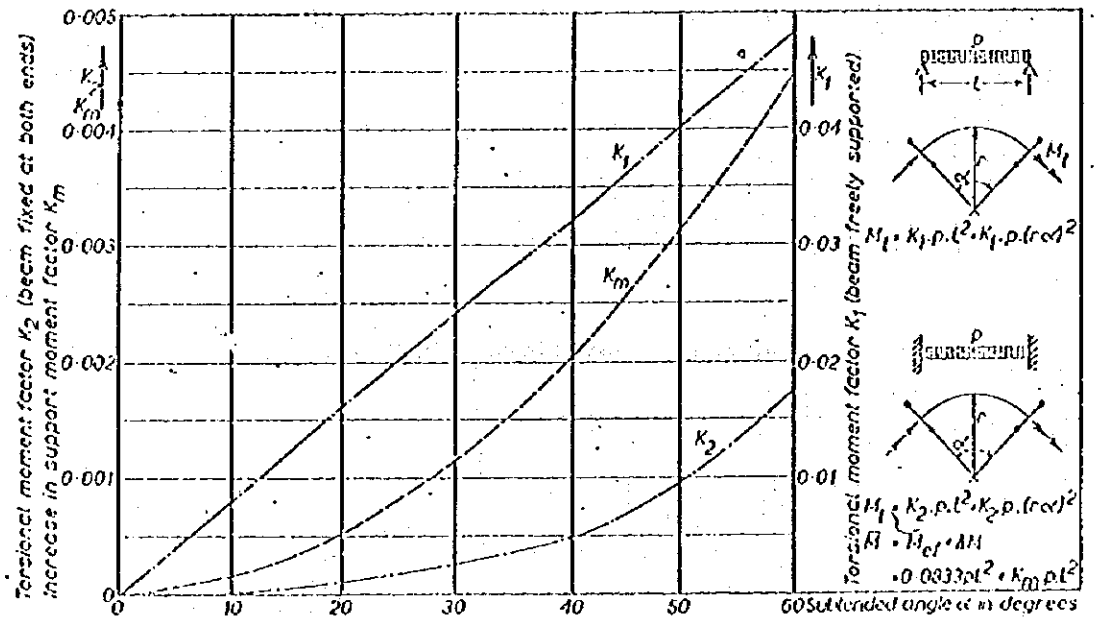
$$= 0.934$$

$$Mt = 0.934 \text{ sen } 15° - 1.64 \times 7.1\ (0.2618 - \text{sen } 15°)$$

$$= 0.0047 \text{ tf-m}$$

Compute the torsion moment by a different method

Chart 8 Factors for increase in support moment and for torsional moments for single span loaded uniformly



K_2 = 0.00025

M_T = 0.00025 x 1.64 $(7.1 \times 2 \times 0.2618)^2$

= 0.0057 tf-m

Torsional moment is too small so it is neglected.

(c) Slab design

From the computer output the maximum slab bending moment for joint 11 for load combination No. 4 is 148.22 kg-m).

Mu = 14822 kgf-cm

$$Kn = \frac{Mu}{\phi f'c\, bd^2} = \frac{14822}{0.9 \times 210 \times 100 \times 12^2} = 0.0054$$

$\rho < \rho min = 0.0033$

As = 0.0033 x 100 x 12 = 4.0 cm^2

For negative reinforcement ø 12 @ 20 top

For positive reinforcement ø 10 @ 20 bottom

Check at cantiliver See figure in page 4.

$$M_D = 0.46\left(0.90 - \frac{0.15}{2}\right) + 0.47 \times \frac{0.90}{2} = 0.57 \text{ tf-m}$$

$$M_L = 0.18 \times \frac{0.75}{2} = 0.51 \text{ tf-m}$$

$$M_U = 1.4 \times 0.57 + 1.7 \times 0.051$$

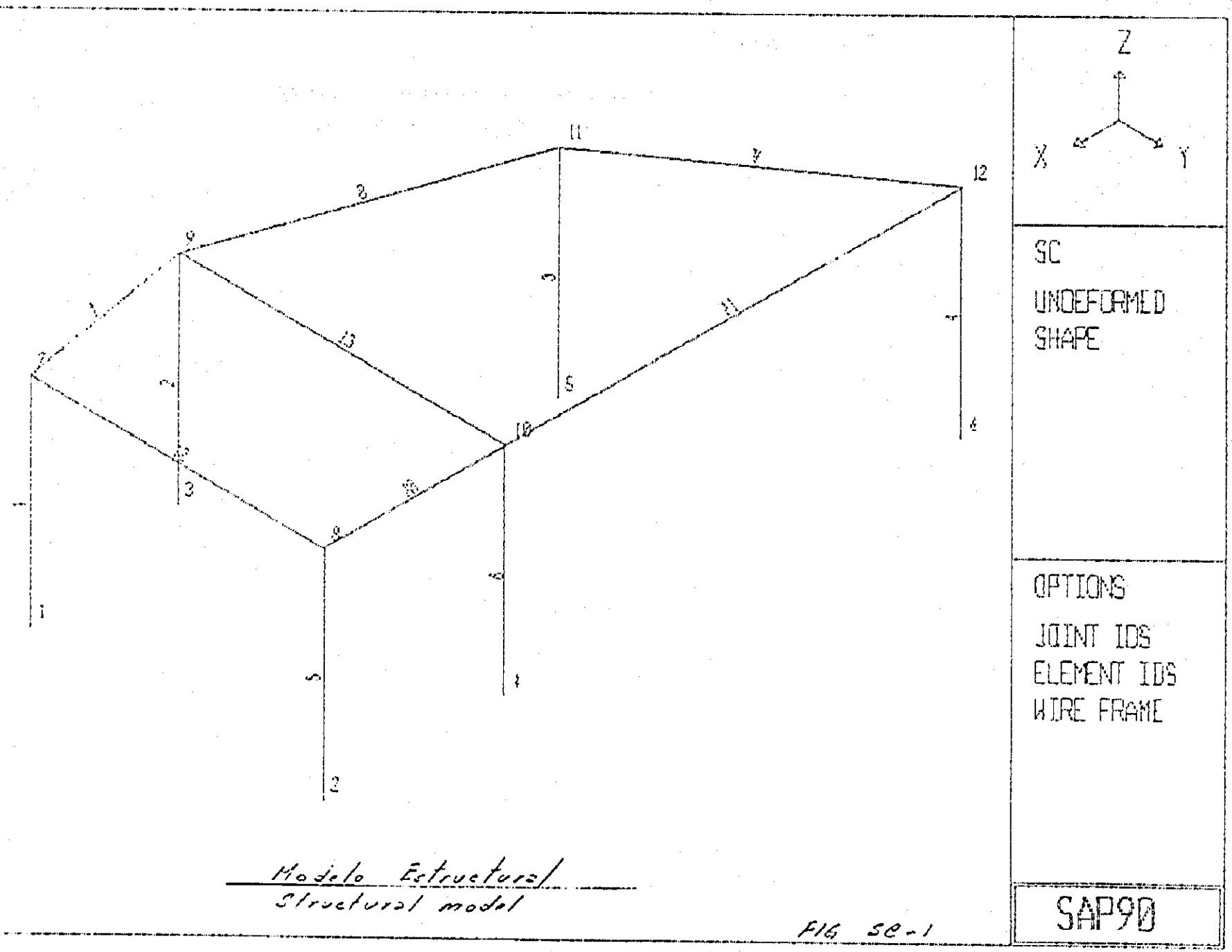
$$= 0.885 \text{ tf/m}$$

$$kn = 0.0325 \qquad \rho < \rho min = 0.0033$$

So reinforcement is as for the slab.

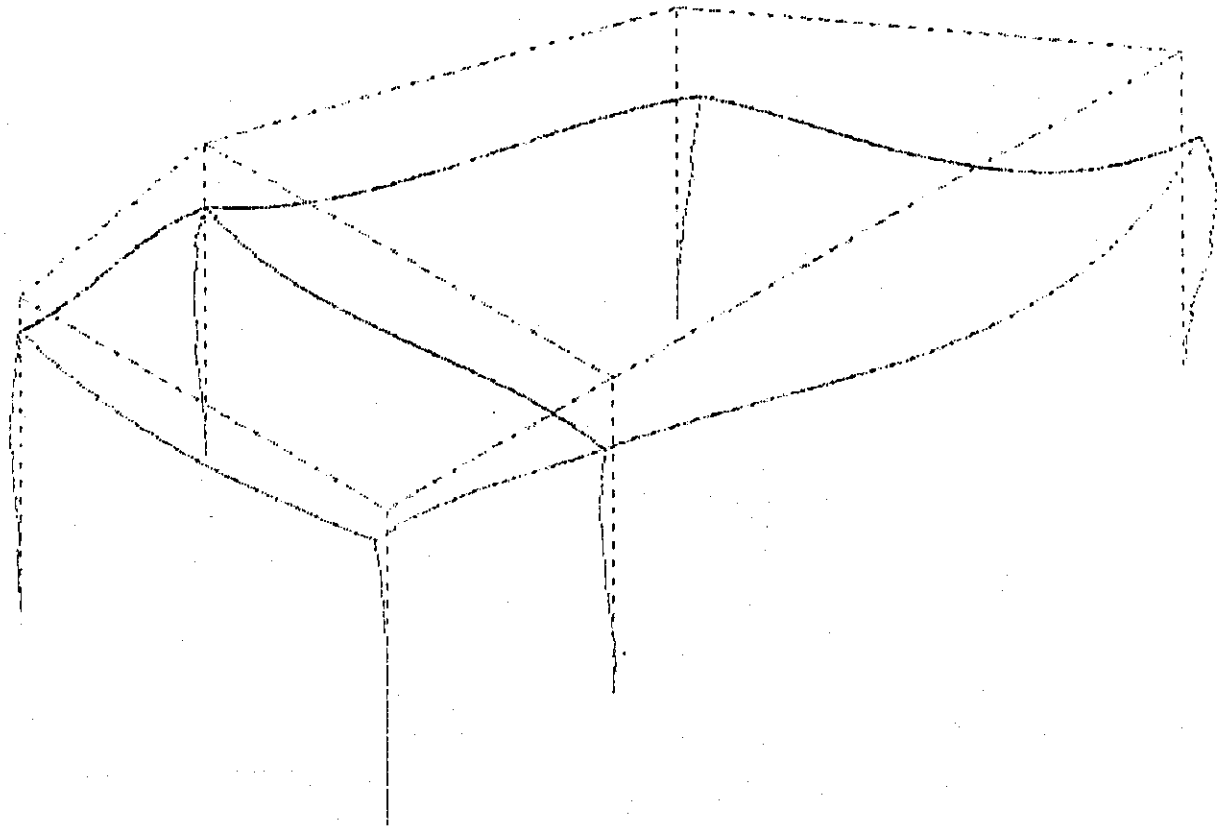
```
SUPERESTRUCTURA TOMA CONGUILLO
SYSTEM
L=4
:
JOINTS
1  X=10.5  Y=0.55   Z=0
2          Y=5.4
3  X=7.5   Y=0.0
4          Y=5.4
5  X=2.80  Y=1.55
6  X=0.0   Y=5.4
7  X=10.5  Y=0.55   Z=3.6
8          Y=5.4
9  X=7.5   Y=0.0
10         Y=5.4
11 X=2.80  Y=1.55
12 X=0.0   Y=5.4
:
RESTRAINTS
1,6,1  R=1,1,1,1,1,1
:
POTENTIAL
7,12,1  P=101,100
:
FRAME
NM=4   X=0,0,0.15   Y=0,0,0.15   Z=-1.0
1 1H=R D=0.6,0.6  E=2.1E9 W=1020
2 2H=R D=0.6,0.4          W=520
3 3H=R D=0.6,0.4          W=930
4 4H=R D=0.6,0.4          W=1450
: COLUMNAS
1,1,7  M=1 RE=0,0.6  LP=2,0
1,3,9      RE=0,0.6
1,5,11     RE=0,0.6
1,6,12     RE=0,0.6
7,1,5      RE=0,0.6
7,4,10     RE=0,0.6
: VIGAS
7,7,8  M=4  RE=0.3,0.3  RE=0.5  LP=2,0
7,9,11      RE=0.3,0.3  RE=0.5
7,11,12     RE=0.3,0.3  RE=0.5
10,8,11 M=3 RE=0.3,0.3  RE=0.5
11,10,12    RE=0.3,0.3  RE=0.5
10,7,8      RE=0.3,0.3  RE=0.3  LP=3,0
10,9,10  M=2  RE=0.3,0.3 RE=0.5  LP=3,0
:
THETA
NM=2  X=0,0,0,0.15  Y=0,0,0.15  Z=-1.0  P=0,-1.0
1  E=2.1E9  U=0.15  W=4470
1  TH=0,10,7,9  ETYPE=2  M=1  TH=0.15,0.15  LP=0
2  TH=10,12,9,11 ETYPE=2  M=1 TH=0.15,0.15  LP=0
:
TIMEO
1  D=1.4,1.7
2  D=1.05,1.275,1.4
3  D=1.05,1.275,0,1.4
4  D=0.9,0,1.43
5  D=0.9,0,0,1.43
:

FIN
```



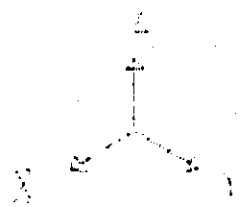
Modelo Estructural
Structural model

FIG SC-1



Deformada. Caso N°1
Joint Displacement Load N°1

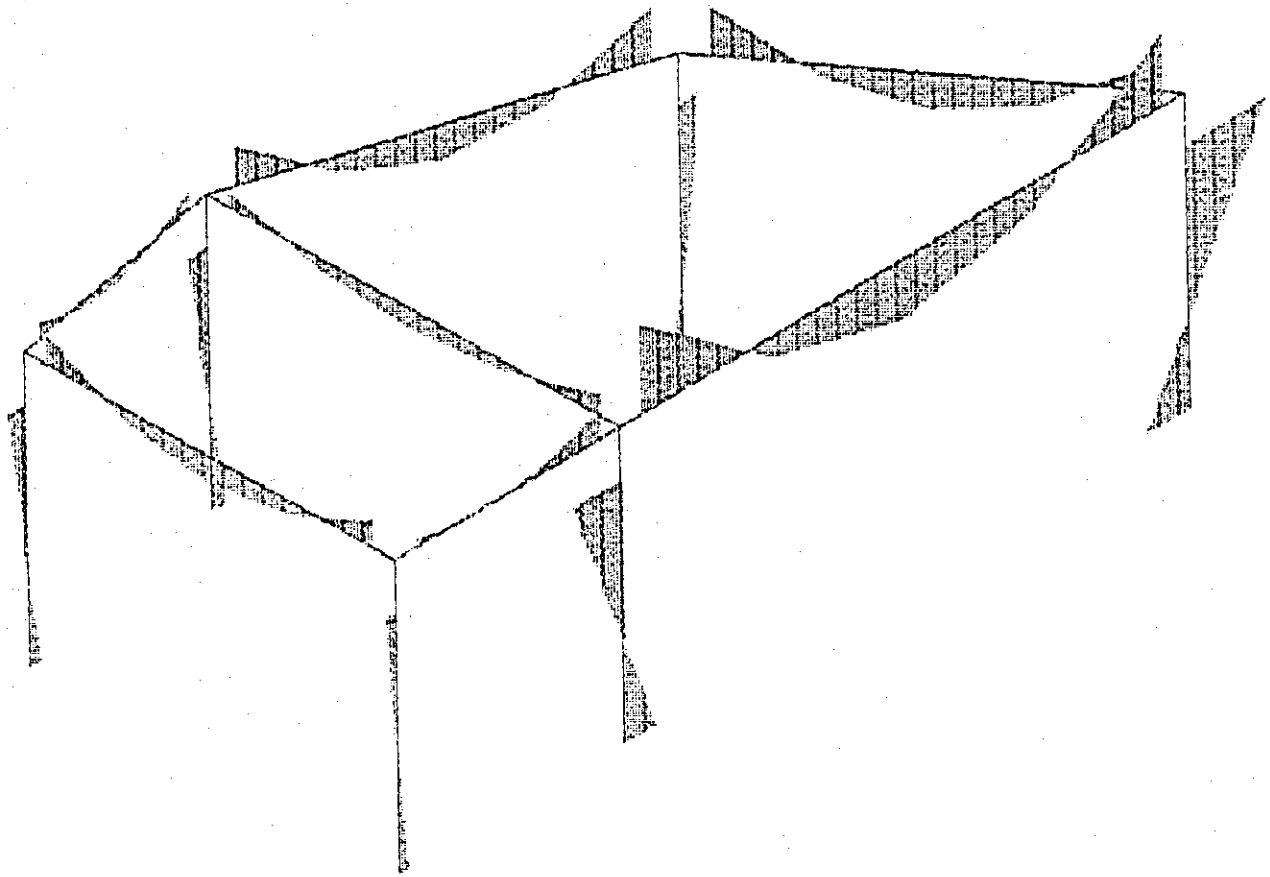
FIG. SC-2



SC
DEFORMED
SHAPE
LOAD 1

MINIMA
X .0000E+00
Y -.6296E-05
Z -.1297E-03
MAXIMA
X .5159E-04
Y .1069E-03
Z .0000E+00

SAP90



Z

X

Y

SC

FRAME

OUTPUT M33

LOAD 1

MIN < 11

-.5167E+04

AT .30

MAX < 4

.5442E+04

AT 3.00

SAP90

Diagrama de Momentos
Bending Moments

FIG. SC-3

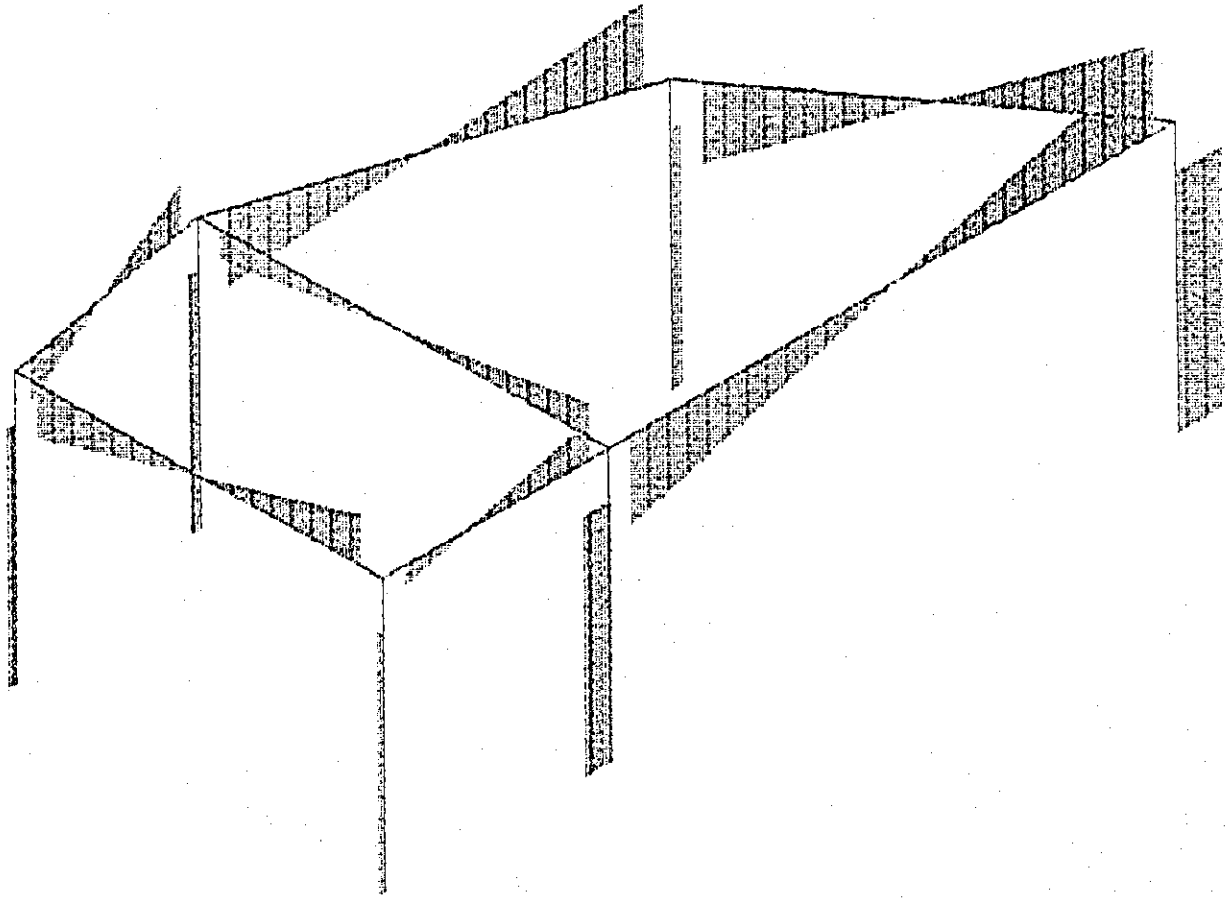
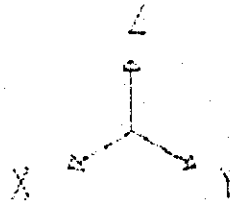


Diagrama de Corte
Shear Diagram

FIG. 5C-4



5C
FRAME
OUTPUT V22
LOAD 1

MIN < 11>
-.4589E+04
AT 7.20
MAX < 11>
.4978E+04
AT .30

SAP90

SUPERESTRUCTURA TOMA CONGUILLO

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			-16167.713			.684
		.000	-610.752	676.783		896.114	-973.089	
		3.000	-610.752	-1155.473		896.114	1715.253	
		3.600			-11026.913			.684
	2	.000			-11635.247			-201.224
		.000	-994.218	1347.346		-1827.070	3722.702	
		3.000	-994.218	-1635.309		-1184.470	-794.608	
		3.600			-7779.647			-201.224
	3	.000			-14771.297			-74.664
		.000	-3355.651	5513.658		542.174	-661.365	
		3.000	-2713.051	-3589.394		542.174	965.158	
		3.600			-10915.696			-74.664
	4	.000			-9127.538			-206.228
		.000	-931.062	1289.517		-1975.352	3921.437	
		3.000	-931.062	-1503.669		-1318.982	-1020.064	
		3.600			-5822.738			-206.228
	5	.000			-12330.789			-76.957
		.000	-3343.096	5545.107		444.662	-556.574	
		3.000	-2686.726	-3499.626		444.662	777.411	
		3.600			-9025.989			-76.957
2								
	1	.000			-28203.986			-32.324
		.000	-686.635	770.989		1118.849	-1203.850	
		3.000	-686.635	-1288.915		1118.849	2152.698	
		3.600			-23063.186			-32.324
	2	.000			-18530.902			-249.334
		.000	-719.259	923.266		-2584.117	5367.377	
		3.000	-719.259	-1234.510		-1941.517	-1421.074	
		3.600			-14675.302			-249.334
	3	.000			-19600.732			-162.298
		.000	-4119.599	6360.400		886.988	-956.444	
		3.000	-3476.999	-5034.498		886.988	1704.521	
		3.600			-15745.134			-162.298
	4	.000			-13407.538			-250.768
		.000	-649.893	854.172		-2776.097	5631.391	
		3.000	-649.893	-1095.507		-2119.727	-1712.345	
		3.600			-10102.738			-250.768
	5	.000			-14500.295			-161.868
		.000	-4123.098	6407.815		769.389	-827.940	
		3.000	-3466.728	-4976.923		769.389	1480.227	
		3.600			-11195.495			-161.868

5·4-13

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
3								
	1	.000			-22570.672			-39.506
		.000	584.533	-456.277		659.092	-339.194	
		3.000	584.533	1297.323		659.092	1638.081	
		3.600			-17429.871			-39.506
	2	.000			-15368.425			-87.986
		.000	1340.926	-938.778		-2861.414	6640.547	
		3.000	1340.926	3084.001		-2218.814	-979.794	
		3.600			-11512.824			-87.986
	3	.000			-16140.482			-195.949
		.000	-2180.474	4653.513		556.362	517.457	
		3.000	-1537.874	-924.010		556.362	2186.542	
		3.600			-12284.883			-195.949
	4	.000			-11789.394			-84.947
		.000	1286.658	-885.775		-3000.862	6819.952	
		3.000	1286.658	2974.200		-2344.492	-1198.079	
		3.600			-8484.594			-84.947
	5	.000			-12577.996			-195.224
		.000	-2310.201	4826.351		490.151	565.653	
		3.000	-1653.831	-1119.697		490.151	2036.107	
		3.600			-9273.196			-195.224
4								
	1	.000			-23224.018			-3.073
		.000	2765.977	-2855.732		-1016.334	1445.550	
		3.000	2765.977	5442.200		-1016.334	-1603.452	
		3.600			-18083.217			-3.073
	2	.000			-19046.660			432.748
		.000	2697.175	-2547.424		-3985.509	7742.556	
		3.000	2697.175	5544.102		-3342.909	-3250.072	
		3.600			-15191.061			432.748
	3	.000			-16619.596			166.059
		.000	-290.163	2420.865		-863.206	1915.580	
		1.355	.002	2224.333		-863.206	746.244	
		3.000	352.437	2514.276		-863.206	-674.038	
		3.600			-12763.996			166.059
	4	.000			-15225.754			441.861
		.000	2403.417	-2230.359		-3946.686	7732.371	
		3.000	2403.417	4979.893		-3290.316	-3123.132	
		3.600			-11920.954			441.861
	5	.000			-12746.681			169.457
		.000	-647.936	2844.394		-757.476	1780.531	
		3.000	8.434	1885.142		-757.476	-491.897	
		3.600			-9441.881			169.457
5								
	1	.000			-14667.821			-8.566
		.000	-331.557	428.942		-964.015	1036.097	
		3.000	-331.557	-565.729		-964.015	-1855.948	
		3.600			-9527.021			-8.566

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
	2	.000			-12601.611			-153.669
		.000	-578.532	937.158		-3142.911	5137.548	
		3.000	-578.532	-798.439		-2500.311	-3327.286	
		3.600			-8746.012			-153.669
	3	.000			-13712.467			64.588
		.000	-3316.442	5592.332		-626.549	605.100	
		3.000	-2673.842	-3393.095		-626.549	-1274.547	
		3.600			-9856.867			64.588
	4	.000			-10298.188			-156.356
		.000	-540.268	902.462		-3092.205	5121.236	
		3.000	-540.268	-718.343		-2435.835	-3170.823	
		3.600			-6993.388			-156.356
	5	.000			-11432.848			66.577
		.000	-3336.848	5657.390		-521.920	491.664	
		3.000	-2680.478	-3368.599		-521.920	-1074.097	
		3.600			-8128.047			66.577
6	----------							
	1	.000			-29806.648			-15.669
		.000	-1721.566	1962.883		-693.706	761.125	
		3.000	-1721.566	-3201.816		-693.706	-1319.993	
		3.600			-24665.848			-15.669
	2	.000			-23797.797			-370.315
		.000	-1746.092	2228.335		-3844.243	6746.339	
		3.000	-1746.092	-3009.940		-3201.643	-3822.489	
		3.600			-19942.197			-370.315
	3	.000			-20136.066			-30.993
		.000	-4982.934	7448.958		-495.770	541.246	
		3.000	-4340.334	-6535.944		-495.770	-946.064	
		3.600			-16280.467			-30.993
	4	.000			-18345.574			-376.662
		.000	-1568.852	2040.081		-3845.032	6803.260	
		3.000	-1568.852	-2666.475		-3188.662	-3747.280	
		3.600			-15040.774			-376.662
	5	.000			-14605.379			-30.068
		.000	-4875.055	7372.575		-424.806	465.201	
		3.000	-4218.685	-6268.036		-424.806	-809.217	
		3.600			-11300.578			-30.068
7	----------							
	1	.000			-605.324			27.680
		.300	2404.717	-783.463		31.057	-18.348	
		1.485	-.012	640.838		31.057	18.442	
		2.750	-2568.783	-984.444		31.057	57.742	
		3.050			-605.324			27.680
	2	.000			-1302.548			132.329
		.300	2523.911	-1411.253		-587.024	428.713	
		1.958	-.009	680.742		-90.515	-132.882	
		2.260	-460.138	611.210		.002	-146.559	
		2.750	-1206.214	202.926		146.771	-110.598	
		3.050			-1135.073			132.329

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
	3	.000			-1496.938			71.696
		.300	4150.113	-3646.678		306.546	-264.722	
		2.750	419.988	1951.696		172.017	321.517	
		3.050			-583.438			71.696
	4	.000			-1246.697			132.352
		.300	2261.806	-1323.334		-604.153	440.728	
		2.033	-.008	636.730		-73.925	-146.892	
		2.275	-315.359	598.626		.002	-155.823	
		2.750	-935.444	301.460		145.366	-121.287	
		3.050			-1075.633			132.352
	5	.000			-1445.252			70.420
		.300	3922.856	-3606.661		308.565	-267.567	
		2.750	725.606	2087.704		171.153	320.087	
		3.050			-512.177			70.420
8	----------							
	1	.000			-1348.967			61.470
		.300	4256.618	-2374.504		-51.911	115.416	
		2.397	-.020	2088.254		-51.911	6.565	
		4.649	-4571.831	-3059.933		-51.911	-110.345	
		4.949			-1348.967			61.470
	2	.000			-1945.195			194.415
		.300	2985.377	-1134.786		-696.710	513.936	
		2.261	-.015	1792.135		-129.672	-296.269	
		2.709	-682.737	1639.055		.003	-325.343	
		4.649	-3635.960	-2549.476		560.931	218.685	
		4.949			-2417.170			194.415
	3	.000			-2233.626			211.668
		.300	4155.951	-3707.261		-296.280	344.783	
		3.030	-.015	1964.966		-35.954	-108.665	
		3.407	-574.014	1856.759		.001	-115.443	
		4.649	-2465.386	-31.135		118.475	-41.853	
		4.949			-802.476			211.668
	4	.000			-1810.868			190.302
		.300	2535.576	-891.882		-704.442	508.938	
		2.243	-.013	1571.392		-130.530	-302.229	
		2.685	-576.719	1443.957		.003	-331.071	
		4.649	-3139.856	-2205.885		580.150	238.665	
		4.949			-2292.957			190.302
	5	.000			-2105.481			207.924
		.300	3731.234	-3519.481		-295.430	336.160	
		3.159	-.013	1814.660		-16.912	-110.363	
		3.333	-226.589	1794.988		.001	-111.831	
		4.649	-1944.198	366.421		128.212	-27.456	
		4.949			-643.663			207.924
9	----------							
	1	.000			-1254.107			46.764
		.300	4561.989	-2920.557		30.672	-77.211	
		2.547	-.019	2205.488		30.672	-8.281	
		4.461	-3883.856	-1509.866		30.672	50.403	
		4.761			-1254.107			46.764

5-4-16

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
	2	.000			-506.765			.123
		.300	1779.206	1179.338		-507.289	327.717	
		1.469	-.014	2218.936		-297.991	-142.815	
		3.132	-2533.228	111.467		.002	-390.720	
		4.461	-4555.178	-4595.397		237.852	-232.779	
		4.761			-1679.090			.123
	3	.000			-1546.906			9.683
		.300	3636.940	-2585.183		-442.400	50.129	
		2.096	901.795	1491.696		.002	-347.251	
		2.689	-.014	1758.768		145.868	-304.050	
		4.461	-2697.444	-630.790		582.169	340.886	
		4.761			-694.306			9.683
	4	.000			-364.561			-5.137
		.300	1254.265	1567.112		-522.637	345.926	
		1.261	-.012	2169.863		-346.811	-71.901	
		3.157	-2474.051	-175.320		.002	-400.645	
		4.461	-4175.207	-4509.199		238.471	-245.212	
		4.761			-1562.007			-5.137
	5	.000			-1426.990			4.628
		.300	3151.807	-2278.078		-456.358	62.389	
		2.114	784.166	1292.410		.002	-351.590	
		2.715	-.012	1528.010		151.152	-306.176	
		4.461	-2277.665	-459.636		590.166	340.746	
		4.761			-556.120			4.628
10	----------							
	1	.000			-341.308			34.912
		.300	1132.084	-362.118		10.707	-8.532	
		1.125	-.008	104.943		10.707	.303	
		2.700	-2160.716	-1596.477		10.707	17.166	
		3.000			-341.308			34.912
	2	.000			-413.616			148.964
		.300	1151.225	-668.893		-404.128	405.941	
		1.419	-.006	-24.908		-173.881	82.606	
		2.264	-869.419	-392.201		.001	9.150	
		2.700	-1318.375	-869.472		89.792	28.738	
		3.000			-413.616			148.964
	3	.000			-1537.998			35.399
		.300	3436.090	-3546.248		-132.158	216.682	
		2.700	966.490	1736.848		-132.158	-100.497	
		3.000			-920.598			35.399
	4	.000			-370.567			147.891
		.300	1014.024	-614.072		-414.493	416.088	
		1.450	-.005	-31.166		-172.816	78.475	
		2.272	-725.111	-329.230		.001	7.439	
		2.700	-1102.776	-720.573		90.011	26.710	
		3.000			-370.567			147.891
	5	.000			-1519.043			31.893
		.300	3347.851	-3553.085		-136.695	222.774	
		2.700	1231.051	1941.597		-136.695	-105.295	
		3.000			-888.413			31.893

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
11								
	1	.000			-2053.153			21.455
		.300	4877.503	-5167.446		-15.948	52.151	
		3.855	-.021	3502.393		-15.948	-4.546	
		7.200	-4589.297	-4173.133		-15.948	-57.892	
		7.500			-2053.153			21.455
	2	.000			-1945.395			83.934
		.300	3800.678	-4241.102		-772.238	811.893	
		3.994	-.015	2777.924		-12.100	-636.615	
		7.200	-3299.422	-2511.768		647.782	382.517	
		7.500			-1945.395			83.934
	3	.000			-3122.082			88.093
		.300	4156.372	-5434.378		-84.172	245.483	
		4.339	-.015	2959.902		-84.172	-94.511	
		7.200	-2943.728	-1250.757		-84.172	-335.307	
		7.500			-1578.582			88.093
	4	.000			-1721.933			83.111
		.300	3286.376	-3714.994		-786.592	822.119	
		4.026	-.013	2407.604		-3.336	-649.543	
		7.200	-2799.424	-2035.013		663.857	398.683	
		7.500			-1721.933			83.111
	5	.000			-2923.835			87.360
		.300	3649.691	-4933.841		-83.782	243.572	
		4.438	-.013	2617.320		-83.782	-103.117	
		7.200	-2436.109	-746.980		-83.782	-334.523	
		7.500			-1347.260			87.360
12								
	1	.000			-974.722			28.290
		.300	2925.215	-1591.571		-9.751	24.056	
		2.432	-.013	1526.827		-9.751	3.267	
		4.550	-2905.785	-1550.281		-9.751	-17.384	
		4.850			-974.722			28.290
	2	.000			-376.255			35.305
		.300	994.850	1342.531		164.917	-367.599	
		1.267	-.010	1823.447		164.917	-208.154	
		4.550	-3378.400	-3722.515		164.917	333.296	
		4.850			-1374.385			35.305
	3	.000			-494.391			22.752
		.300	2284.561	-1429.885		-460.604	286.379	
		2.520	-.010	1106.179		-3.690	-229.031	
		4.550	-2088.689	-1013.656		414.046	187.442	
		4.850			-494.391			22.752
	4	.000			-264.558			32.954
		.300	655.048	1569.232		169.701	-378.602	
		1.043	-.009	1812.479		169.701	-252.566	
		4.550	-3093.452	-3612.375		169.701	342.628	
		4.850			-1284.076			32.954

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	.000			-385.225			20.132
		.300	1972.396	-1262.592		-469.224	289.390	
		2.536	-.009	942.820		.866	-234.301	
		4.550	-1776.104	-845.470		424.169	193.649	
		4.850			-385.225			20.132
13	----------							
	1	.000			-667.050			-53.583
		.300	1665.897	-816.912		9.721	-28.690	
		2.588	-.008	1089.141		9.721	-6.445	
		5.100	-1828.503	-1207.166		9.721	17.972	
		5.400			-667.050			-53.583
	2	.000			164.799			-34.956
		.300	-114.828	2640.276		214.313	-475.423	
		5.100	-2735.628	-4200.819		214.313	553.279	
		5.400			-424.881			-34.956
	3	.000			-543.755			-30.684
		.300	1233.372	-569.828		-209.321	27.280	
		2.217	186.760	791.278		.001	-173.340	
		2.559	-.006	823.219		37.354	-166.952	
		5.100	-1387.428	-939.561		314.839	280.521	
		5.400			-543.755			-30.684
	4	.000			246.019			-28.616
		.300	-325.413	2805.254		217.486	-481.458	
		5.100	-2571.813	-4148.086		217.486	562.476	
		5.400			-356.297			-28.616
	5	.000			-477.719			-24.253
		.300	1051.678	-473.639		-215.226	32.016	
		2.230	148.627	684.413		.001	-175.632	
		2.547	-.005	708.014		35.425	-170.006	
		5.100	-1194.722	-816.944		320.166	283.873	
		5.400			-477.719			-24.253

SUPERESTRUCTURA TOMA CONGUILLO

C O N T R O L D A T A

EXECUTION MODE - - - - - - - - - - - - -	0
CODE TYPE - - - - - - - - - - - - - - - -	1 (ACI 318-89)
ELEMENT PRINT SUPPRESSION FLAG - - - -	0
NUMBER OF INTERACTION CURVES - - - - - -	5
NUMBER OF POINTS PER CURVE - - - - - - -	11
CURVE PRINT SUPPRESSION FLAG - - - - -	1
TYPE OF UNITS - - - - - - - - - - - - - -	M
COLUMN PRINT SUPPRESSION FLAG - - - - -	1
BEAM PRINT SUPPRESSION FLAG - - - - - -	0
INTERACTION CAPACITY RATIO CUTOFF - - -	.0005

S E C T I O N P R O P E R T Y D A T A

COLUMN-TYPE SECTION PROPERTIES

PROP ID	SECTION TYPE	SECTION SHAPE	DIMENSION T3 {m}	DIMENSION T2 {m}	CONCRETE COVER {m}	BAR AREA {m}
1	R	RR-3-3	.6000	.6000	.03000	.000000

BEAM-TYPE SECTION PROPERTIES

PROP ID	SECTION TYPE	DEPTH T3 {m}	WIDTH T2 {m}	SLAB THICK {m}	WEB WIDTH {m}	TOP COVER {m}	BOTTOM COVER {m}
2	R	.6000	.4000	.00000	.00000	.03000	.03000
3	R	.6000	.4000	.00000	.00000	.03000	.03000
4	R	.6000	.4000	.00000	.00000	.03000	.03000

5.9.20

SUPERESTRUCTURA TOMA CONGUILLO

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

MEMBRANE FORCES ARE IN FORCE PER UNIT LENGTH
BENDING MOMENTS ARE IN MOMENTS PER UNIT LENGTH

ELEMENT ID 1 ----------
LOAD COMBO 1 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	1.3378E+01	1.5310E+01	4.6358E-01	1.5415E+01	1.3272E+01	77.18
10	-3.9108E+01	-3.6373E+00	7.0877E+00	-2.2735E+00	-4.0472E+01	79.11
7	5.9496E+00	1.2742E+01	-2.1200E-02	1.2742E+01	5.9495E+00	-89.82
9	-2.4074E+00	1.7538E+01	3.5114E+00	1.8138E+01	-3.0075E+00	80.30
MIDPT	V1	V2		VMAX		ANGLE
	-1.0651E+01	3.7239E+00		1.1283E+01		160.73

LOAD COMBO 2 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-2.1458E+01	-9.2813E+01	-1.7046E+00	-2.1417E+01	-9.2854E+01	-1.37
10	-3.4982E+01	-1.3067E+02	-9.3041E-01	-3.4973E+01	-1.3068E+02	-.56
7	-1.7248E+01	1.0496E+02	4.2662E+00	1.0511E+02	-1.7397E+01	88.00
9	5.4811E+01	1.4708E+02	7.2668E+00	1.4765E+02	5.4242E+01	85.52
MIDPT	V1	V2		VMAX		ANGLE
	1.1046E+01	4.7149E+01		4.8426E+01		76.82

LOAD COMBO 3 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-1.2458E+02	-4.0618E+00	1.1686E+01	-2.9392E+00	-1.2571E+02	84.51
10	9.3916E+01	1.5458E+01	-4.4088E+00	9.4163E+01	1.5211E+01	-3.21
7	-1.2532E+02	-1.8467E+01	2.1861E+00	-1.8423E+01	-1.2536E+02	88.83
9	1.1255E+02	3.0668E+01	4.3434E+00	1.1278E+02	3.0439E+01	3.03
MIDPT	V1	V2		VMAX		ANGLE
	7.5882E+01	-3.2788E+00		7.5953E+01		-2.47

LOAD COMBO 4 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-2.2538E+01	-9.6566E+01	-1.8967E+00	-2.2489E+01	-9.6614E+01	-1.47
10	-3.2157E+01	-1.3345E+02	-1.7671E+00	-3.2126E+01	-1.3348E+02	-1.00
7	-1.7415E+01	1.0585E+02	4.3691E+00	1.0600E+02	-1.7569E+01	87.97
9	5.5197E+01	1.4822E+02	6.9956E+00	1.4874E+02	5.4674E+01	85.72
MIDPT	V1	V2		VMAX		ANGLE
	1.1885E+01	4.7799E+01		4.9254E+01		76.04

LOAD COMBO 5 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-1.2787E+02	-5.9129E+00	1.1781E+01	-4.7854E+00	-1.2900E+02	84.53
10	9.9503E+01	1.5814E+01	-5.3201E+00	9.9840E+01	1.5477E+01	-3.62
7	-1.2780E+02	-2.0231E+01	2.2445E+00	-2.0184E+01	-1.2784E+02	88.81
9	1.1417E+02	2.9310E+01	4.0096E+00	1.1436E+02	2.9121E+01	2.70
MIDPT	V1	V2		VMAX		ANGLE
	7.8111E+01	-3.7101E+00		7.8199E+01		-2.72

ELEMENT ID 2 ----------
LOAD COMBO 1 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
10	6.2101E-01	4.3371E+00	2.8000E+00	5.8394E+00	-8.8133E-01	61.78
12	4.7453E+01	4.9843E+01	-3.5326E+00	5.2377E+01	4.4919E+01	-54.34
9	2.8557E+01	2.4079E+01	4.9907E+00	3.1788E+01	2.0848E+01	32.92
11	-3.8381E+00	-9.4299E+00	3.0254E+00	-2.5145E+00	-1.0754E+01	23.63

UPERESTRUCTURA TOMA CONGUILLO

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

LEMENT ID 2 ----------

IDPT	V1	V2	VMAX	ANGLE
	1.8639E+00	-4.7190E+00	5.0738E+00	-68.45

OAD COMBO 2 ----------

OINT	M11	M22	M12	MMAX	MMIN	ANGLE
10	-3.5748E+01	-1.2685E+02	1.6961E+01	-3.2692E+01	-1.2991E+02	10.21
12	2.4570E+01	-7.3387E+01	6.6331E+01	5.8045E+01	-1.0686E+02	26.78
9	6.6802E+01	1.5490E+02	1.3147E+01	1.5682E+02	6.4882E+01	81.69
11	-1.3326E+01	1.7459E+02	-4.2642E+01	1.8381E+02	-2.2550E+01	-77.79

IDPT	V1	V2	VMAX	ANGLE
	-1.4627E+01	6.2174E+01	6.3871E+01	103.24

OAD COMBO 3 ----------

OINT	M11	M22	M12	MMAX	MMIN	ANGLE
10	-6.0936E+01	-7.4560E+00	-1.7143E+00	-7.4011E+00	-6.0991E+01	-88.17
12	1.0743E+02	8.1113E+01	2.2420E+01	1.2027E+02	6.8275E+01	29.80
9	-5.3362E+01	1.2412E+01	1.2991E+01	1.4885E+01	-5.5835E+01	79.22
11	1.1204E+02	-6.9325E+00	5.4855E+01	1.3347E+02	-2.8365E+01	21.34

IDPT	V1	V2	VMAX	ANGLE
	3.4881E+01	1.5544E-01	3.4881E+01	.26

OAD COMBO 4 ----------

OINT	M11	M22	M12	MMAX	MMIN	ANGLE
10	-3.7386E+01	-1.3047E+02	1.6904E+01	-3.4412E+01	-1.3344E+02	9.98
12	1.9822E+01	-8.1036E+01	6.8455E+01	5.4418E+01	-1.1563E+02	26.81
9	6.3706E+01	1.5542E+02	1.2799E+01	1.5717E+02	6.1953E+01	82.20
11	-1.2186E+01	1.7944E+02	-4.3715E+01	1.8894E+02	-2.1688E+01	-77.74

IDPT	V1	V2	VMAX	ANGLE
	-1.4878E+01	6.4188E+01	6.5890E+01	103.05

OAD COMBO 5 ----------

OINT	M11	M22	M12	MMAX	MMIN	ANGLE
10	-6.3114E+01	-8.5163E+00	-2.1719E+00	-8.4301E+00	-6.3200E+01	-87.73
12	1.0446E+02	7.6775E+01	2.3604E+01	1.1798E+02	6.3254E+01	29.81
9	-5.9034E+01	9.8748E+00	1.2640E+01	1.2120E+01	-6.1279E+01	79.93
11	1.1586E+02	-5.9723E+00	5.5872E+01	1.3760E+02	-2.7714E+01	21.26

IDPT	V1	V2	VMAX	ANGLE
	3.5691E+01	8.4118E-01	3.5701E+01	1.35

SUPERESTRUCTURA TOMA CONGUILLO

FLEXURAL AND SHEAR DESIGN OF BEAM-TYPE ELEMENTS (ACI 318-89)

ELEM ID	SECTION SIZE WIDTH (m)	X	DEPTH (m)	STATN LOC (m)	<------REQUIRED REINFORCING------> TOP (sqcm)	<LC>	BOT (sqcm)	<LC>	SHR (sqcm/m)	<LC>	<-DESIGN FORCES-> -M33 (T-m)	+M33 (T-m)	V22 (T)
7	.40	X	.60										
				.30	7.63	< 3>	7.63	< 0>	14.84	< 1>	4	2	20
				.91	7.63	< 5>	7.63	< 0>	13.93	< 1>	1	1	19
				1.52	7.63	< 0>	7.63	< 1>	13.13	< 1>	1	1	18
				2.14	7.63	< 0>	7.63	< 3>	14.05	< 1>	1	1	19
				2.75	7.63	< 1>	7.63	< 5>	14.96	< 1>	1	2	20
8	.40	X	.60										
				.30	7.63	< 3>	7.63	< 0>	10.50	< 1>	4	2	14
				1.39	7.63	< 0>	7.63	< 2>	8.87	< 1>	1	1	12
				2.47	7.63	< 0>	7.63	< 1>	7.48	< 1>	1	2	10
				3.56	7.63	< 0>	7.63	< 3>	9.11	< 1>	1	2	12
				4.65	7.63	< 1>	7.63	< 0>	10.73	< 1>	3	2	15
9	.40	X	.60										
				.30	7.63	< 1>	7.63	< 4>	11.06	< 1>	3	2	15
				1.34	7.63	< 0>	7.63	< 2>	9.50	< 1>	1	2	13
				2.38	7.63	< 0>	7.63	< 1>	7.95	< 1>	1	2	11
				3.42	7.63	< 0>	7.63	< 1>	9.00	< 1>	1	1	12
				4.46	7.63	< 2>	7.63	< 0>	10.56	< 1>	5	2	14
10	.40	X	.60										
				.30	7.63	< 5>	7.63	< 0>	14.18	< 1>	4	2	19
				.90	7.63	< 5>	7.63	< 0>	13.57	< 1>	2	0	18
				1.50	7.63	< 0>	7.63	< 0>	13.72	< 1>	1	0	19
				2.10	7.63	< 0>	7.63	< 5>	14.33	< 1>	1	1	19
				2.70	7.63	< 1>	7.63	< 5>	14.93	< 1>	2	2	20
11	.40	X	.60										
				.30	7.63	< 3>	7.63	< 0>	8.24	< 1>	5	3	11
				2.03	7.63	< 0>	7.63	< 1>	6.49	< 1>	1	1	9
				3.75	7.63	< 0>	7.63	< 1>	4.75	< 1>	1	3	6
				5.47	7.63	< 0>	7.63	< 3>	6.28	< 1>	1	2	9
				7.20	7.63	< 1>	7.63	< 0>	8.02	< 1>	4	2	11
12	.40	X	.60										
				.30	7.63	< 1>	7.63	< 4>	9.69	< 1>	2	2	13
				1.36	7.63	< 0>	7.63	< 2>	8.62	< 1>	1	2	12
				2.42	7.63	< 0>	7.63	< 1>	7.54	< 1>	1	2	10
				3.49	7.63	< 0>	7.63	< 1>	8.60	< 1>	1	1	12
				4.55	7.63	< 2>	7.63	< 0>	9.68	< 1>	4	2	13
13	.40	X	.60										
				.30	7.63	< 0>	7.63	< 4>	7.90	< 1>	1	3	11
				1.50	7.63	< 0>	7.63	< 2>	7.25	< 1>	1	2	10
				2.70	7.63	< 0>	7.63	< 1>	6.73	< 1>	1	1	9
				3.90	7.63	< 4>	7.63	< 0>	7.37	< 1>	1	1	10
				5.10	7.63	< 2>	7.63	< 0>	8.02	< 1>	4	2	11

5-9-23

PERESTRUCTURA TOMA CONGUILLO

M DESIGN OF COLUMN-TYPE ELEMENTS (ACI 318-89)

ELEM ID	STATN LOC {m}	REBAR {sqcm}	<LC>	<---DESIGN POINT---> P {T}	M33 {T-m}	M22 {T-m}	<DESIGN FACTORS> DB33	DB22	<--FAILURE POINT--> PC {T}	MC33 {T-m}	MC22 {T-m}
1											
	.00	36.0	< 5>	11	6	1	1.00	1.00	11	6	1
	3.00	36.0	< 5>	11	3	1	1.00	1.00	11	3	1
2											
	.00	36.0	< 5>	13	6	1	1.00	1.00	13	6	1
	3.00	36.0	< 5>	13	5	1	1.00	1.00	13	5	1
3											
	.00	36.0	< 5>	11	5	1	1.00	1.00	11	5	1
	3.00	36.0	< 5>	11	1	2	1.00	1.00	11	1	2
4											
	.00	36.0	< 5>	11	3	2	1.00	1.00	11	3	2
	3.00	36.0	< 5>	11	2	0	1.00	1.00	11	2	0
5											
	.00	36.0	< 5>	10	6	0	1.00	1.00	10	6	0
	3.00	36.0	< 5>	10	3	1	1.00	1.00	10	3	1
6											
	.00	36.0	< 5>	13	7	0	1.00	1.00	13	7	0
	3.00	36.0	< 5>	13	6	1	1.00	1.00	13	6	1

HEAR DESIGN OF COLUMN-TYPE ELEMENTS (ACI 318-89)

ELEM ID	SECTION SIZE T3 {m}	X	T2 {m}	SECTION SHAPE	STATN LOC {m}	<SHEAR ALONG 2-2 AXIS> AV {sqcm/m}	<LC>	V22 {T}	PU {T}	<SHEAR ALONG 3-3 AXIS> AV {sqcm/m}	<LC>	V33 {T}	PU {T}
1	.60	X	.60	RR-3-3									
					.00	26.36	< 0>	36	14	26.36	< 0>	36	14
					3.00	26.36	< 0>	36	14	26.36	< 0>	36	14
2	.60	X	.60	RR-3-3									
					.00	27.75	< 0>	38	26	27.75	< 0>	38	26
					3.00	27.75	< 0>	38	26	27.75	< 0>	38	26
3	.60	X	.60	RR-3-3									
					.00	27.10	< 0>	37	20	27.10	< 0>	37	20
					3.00	27.10	< 0>	37	20	27.10	< 0>	37	20
4	.60	X	.60	RR-3-3									
					.00	27.17	< 0>	37	21	27.17	< 0>	37	21
					3.00	27.17	< 0>	37	21	27.17	< 0>	37	21
5	.60	X	.60	RR-3-3									
					.00	26.19	< 0>	36	12	26.19	< 0>	36	12
					3.00	26.19	< 0>	36	12	26.19	< 0>	36	12
6	.60	X	.60	RR-3-3									
					.00	27.93	< 0>	38	27	27.93	< 0>	38	27
					3.00	27.93	< 0>	38	27	27.93	< 0>	38	27

5.4.2 Poza Honda Inlet

(1) Structural System

The structure is a tridimensions frame conformed by beams and columns. The roof is a reinforced concrete slab supported on beams.

Framing plan is shown in

(2) Design Conditions

(A) Loads

(1) Unit weight of materials

Materials	Unit Weight
Concrete, plain	2.30 tf/m^3
Concrete, reinforced	2.40 tf/m^3
Mortar	2.00 tf/m^3
Steel	7.80 tf/m^3

(b) Dead Load

Dead load is the structure self weight.

(c) Seismic Force

Seismic force acting on the structure is computed by the following formulae:

$$F = \Sigma W \cdot kh$$

where:

F = seismic load

ΣW = total dead load

kh = coefficient of horizontal earthquake = 0.15

(B) Factored Loads

The structure and its members were analyzed according to the following factored loads: dead load D and live load L for ultimate strength design.

$$U = 1.4\,D + 1.7\,L$$

For seismic analysis, including the seismic force E, the following load combinations were used:

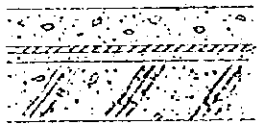
$$U = 1.05\,D + 1.275\,L + 1.87\,E$$
$$U = 0.9\,D + 1.43\,E$$

(3) Structural Analysis and Design

The structural analysis was made with the computer program SAP90.

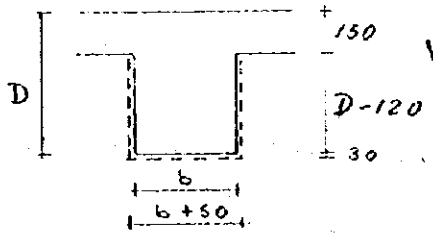
(A) Load Assumption

(a) Roof dead load



- Concrete 10 cm thick	230 kgf/m²
- 3 ply built-up roofing	20 "
- Base mortar 3 cm	60 "
- Concrete slab 15 cm	360 "
	670 kgf/m²

(b) Dead load of beams

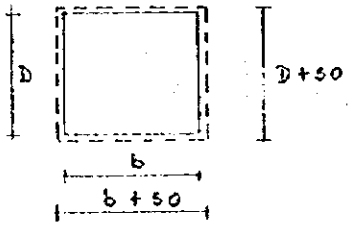


Weight = 2.4 (b + 0.05) (D-.12) = t/m

= 2.4 (0.45) 0.48

= 0.52 tf/m

(c) Dead load of column



Weight = 2.4 (b + 0.05) (D + 0.05) = t/m

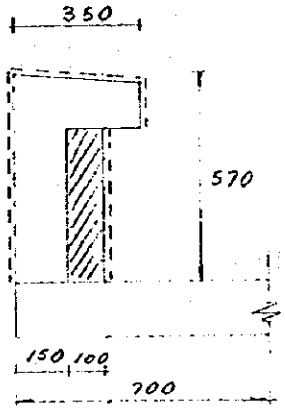
b x d 60 x 60

P = 2.4 (0.6 + 0.05) (0.6 + 0.05)

= 1.02 tf/m

5-4-2t

(d) Parapets dead weight



- Concrete	2.4 x 0.15 (0.57 + 0.2)	=	0.28 tf/m
- Brick	2.0 x 0.10 x 0.42	=	0.09 "
- Finish	2.0 x 0.03 x 1.49	=	0.09 "
			0.46 tf/m
- Roof slab	0.67 x 0.7	=	0.47
- Roof live load		=	180 kgf/m^2

(B) Structural Analysis

The structural model for the analysis has 12 joints, 13 frame type elements and 2 shell bending type elements. For simplifying the analysis the curved beams were considered straight. In the structural design the resultant torsion was included.

Because of lack of symmetry the structure was studied for the following load combinations:

1. 1.4 D + 1.7 L
2. 1.05 D + 1.275 L + 1.4 Ex
3. 1.05 D + 1.275 L + 1.4 Ey
4. 0.9 D + 1.43 Ex
5. 0.9 D + 1.43 Ey

Enclosed are the computer output for the structural analysis and figures SPH1, SPH2, SPH3 and SPH4 where are shown the structural model and joint displacement, bending moments and shear forces for load combination No. 1.

The structural design was made by the computer program SAPCON, a post processor program for the structural analysis program SAP90, for reinforced concrete design.

The concrete design was made in accordance to the ACI 318-89.

Enclosed are the design computer outputs.

(a) Check the assumed slab depth

The minimum depth of slab shall be:

$$h = \frac{\ln (800 + fy / 1.5)}{36{,}000 + 5{,}000\beta\,(1 + \beta s)}$$

where:

ln	:	larger clear span
fy	:	yield strength of reinforcement
β	:	ratio of long to short spans
βs	:	ratio of continuous edges to panel perimeter

ln : 6.2 m average

lc : 4.2 m average

$$\beta = \frac{6.20}{4.20} = 1.476$$

$$\beta s = 1.0$$

$$h = \frac{6{,}200\,(800 + 420 / 1.5)}{36{,}000 + 5{,}000 \times 1.476(1+1)}$$

$$= 131.9 \text{ mm}$$

But no need to be larger than:

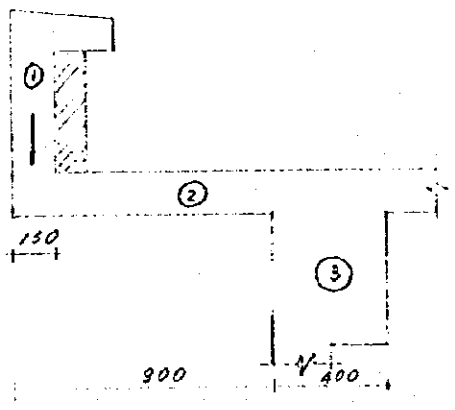
$$h = \frac{\ln(800 + fy / 1.5)}{36{,}000}$$

$$h = \frac{6{,}200\,(800 + 420 / 1.5)}{36{,}000} = 186 \text{ mm}$$

the assumed depth is 150 mm

131.9 < 150 < 186 <u>OK</u>

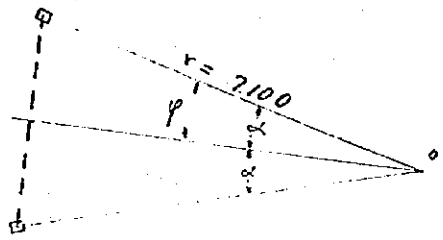
(b) Compute the torsion effect



Self weight

(1)	Parapet	=	0.46 tf/m	
(2)	Slab	=	0.47 tf/m^2	
(3)	Beam	=	0.52 tf/m	
(4)	Live load	=	0.18 tf/m^2	

5-4-78

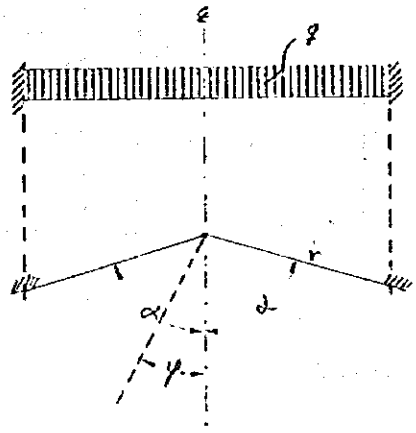


$\alpha = 15° = 0.2618$ rad

$\varphi = 15°$

$\lambda = 1.0$

Horizontally curved beam both ends fixed



$$\frac{EI}{GI_t} = 1;$$

$$M = X\cos\varphi - qr^2(1 - \cos\varphi);$$

$$Mt = X\,\text{sen}\,\varphi - qr^2(\varphi - \text{sen}\varphi);$$

$$X = qr^2\left(\frac{2\,\text{sen}\,\alpha - \alpha\cos\alpha}{\alpha} - 1\right)$$

$$q = 0.46 + 0.47 \times 0.9 + 0.52 + 0.18 \times 1.3$$

$$= 1.64 \text{ tf/m}$$

$$X = 1.64\left(\frac{2\,\text{sen}\,15° - 0.2618\cos 15°}{0.2618} - 1\right) 7.1$$

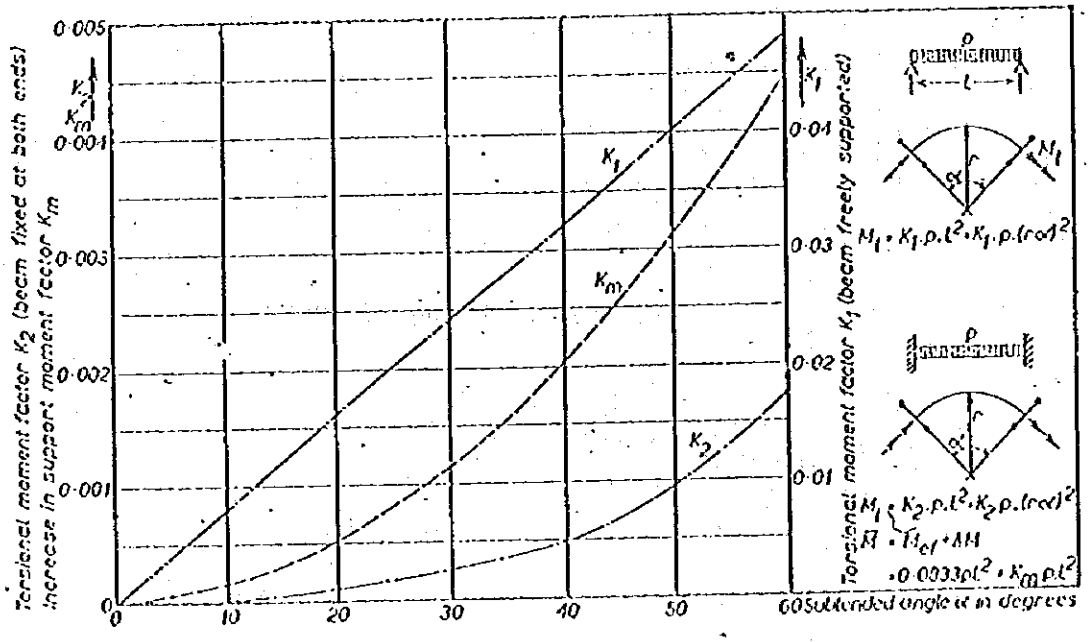
$$= 0.934$$

$$Mt = 0.934\,\text{sen}\,15° - 1.64 \times 7.1\,(0.2618 - \text{sen}\,15°)$$

$$= 0.0047 \text{ tf-m}$$

Compute the torsion moment by a different method

Chart 3 Factors for increase in support moment and for torsional moments for single span loaded uniformly



K_2 = 0.00025

M_T = 0.00025 x 1.64 $(7.1 \times 2 \times 0.2618)^2$

= 0.0057 tf-m

Torsional moment is too small so it is neglected.

(c) Slab design

From the computer output the maximum slab bending moment for joint 11 for load combination No. 4 is 160,49 kg-m).

Mu = 16,049 kgf-cm

$$Kn = \frac{Mu}{\phi f'c\, bd^2} = \frac{16{,}049}{0.9 \times 210 \times 100 \times 12^2} = 0.0059$$

$\rho < \rho min = 0.0033$

As = 0.0033 x 100 x 12 = 4.0 cm^2

5 · 4 · 3C

For negative reinforcement ø 12 @ 20 top

For positive reinforcement ø 10 @ 20 bottom

Check at cantiliver See figure in page 4.

$$M_D = 0.46\left(0.90 - \frac{0.15}{2}\right) + 0.47 \times \frac{0.90}{2} = 0.57 \text{ tf-m}$$

$$M_L = 0.18 \times \frac{0.75}{2} = 0.51 \text{ tf-m}$$

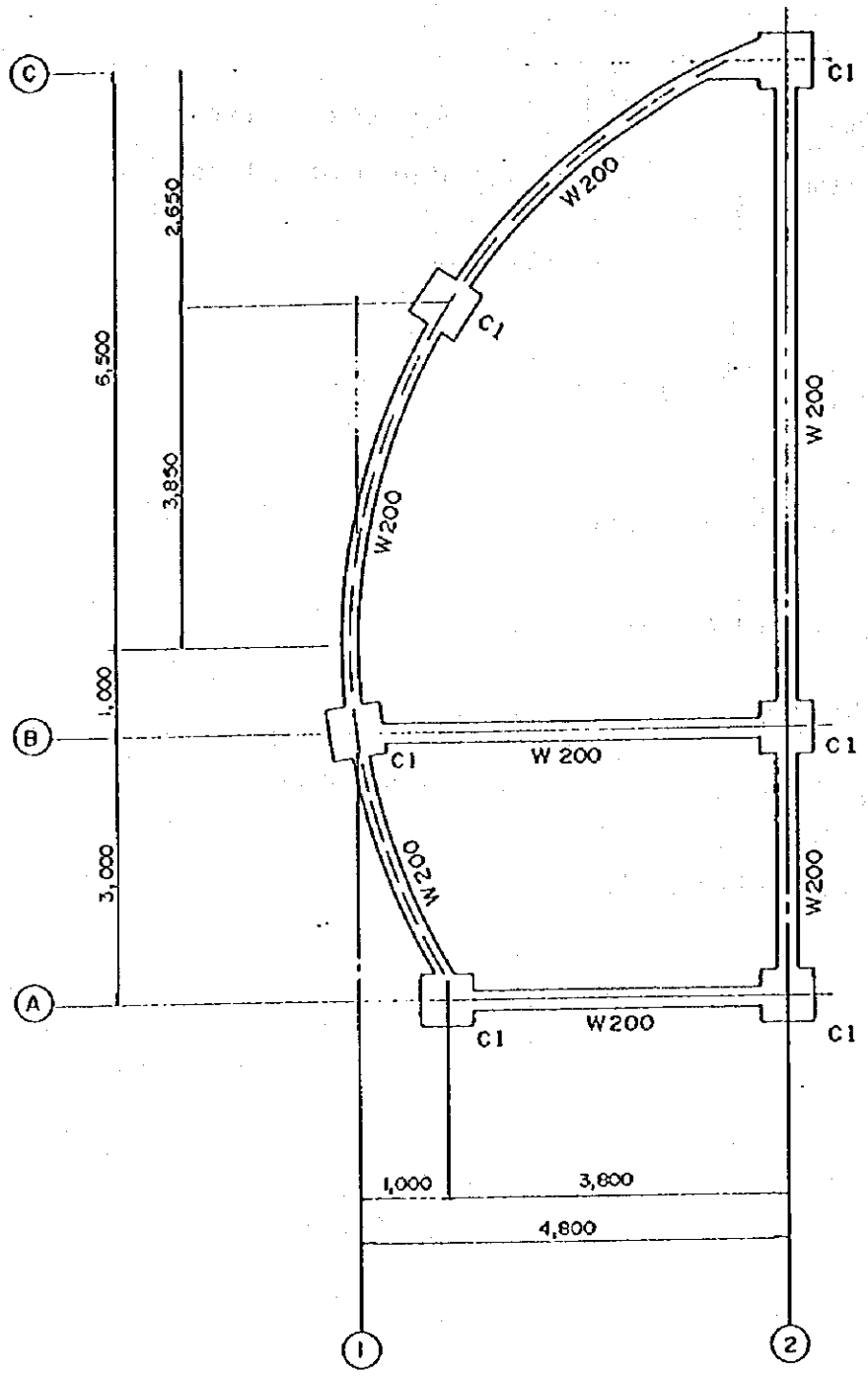
$$M_U = 1.4 \times 0.57 + 1.7 \times 0.051$$

$$= 0.885 \text{ tf/m}$$

$$kn = 0.0325 \qquad \rho < \rho min = 0.0033$$

So reinforcement is as for the slab.

5-(1-3)



PLANTA ESTRUCTURAL (EL. 112.60)

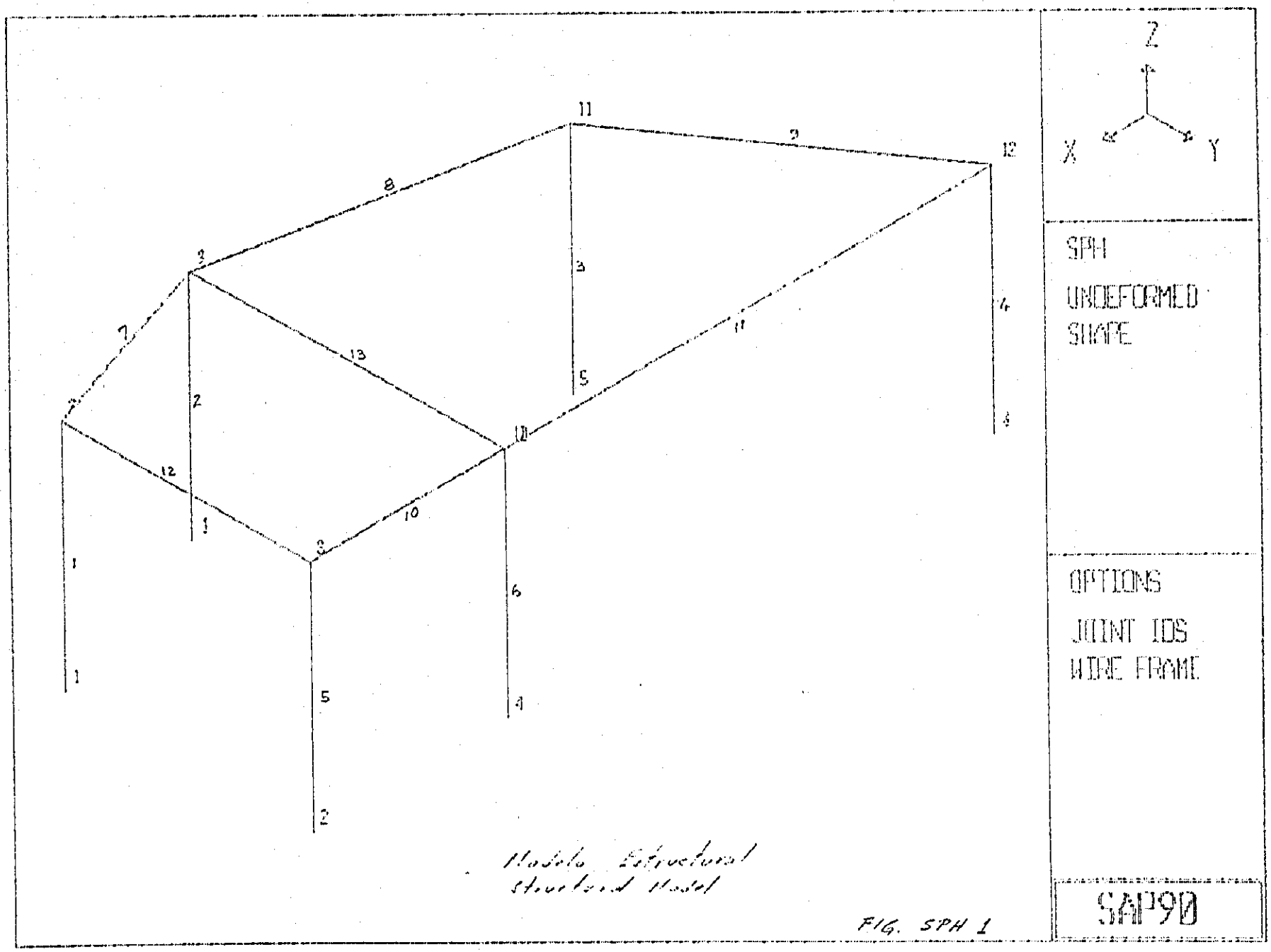
FRAMING PLAN *(EL. 112.60)*

ESCALA A

SCALE A

FIG. 1.

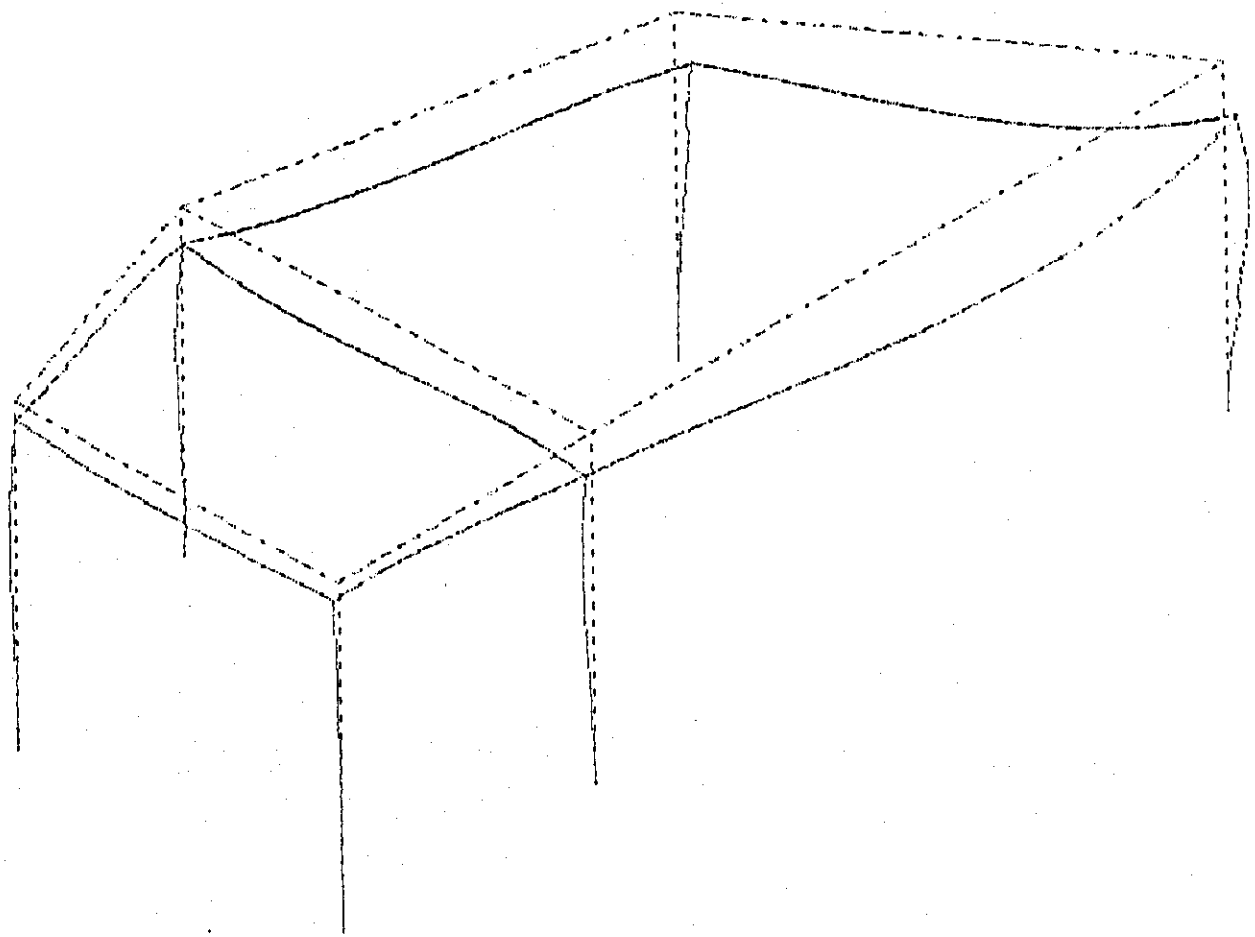
5-11-72



Models Structural
Structural Model

FIG. SPH 1

5-0-33



Deformed
Joint Displacement

FIG. SPH-2

Z
X Y

SPH

DEFORMED
SHAPE

LOAD 1

MINIMA
X .0000E+00
Y -.1850E-05
Z -.1220E-03
MAXIMA
X .4896E-04
Y .1036E-03
Z .0000E+00

SAP90

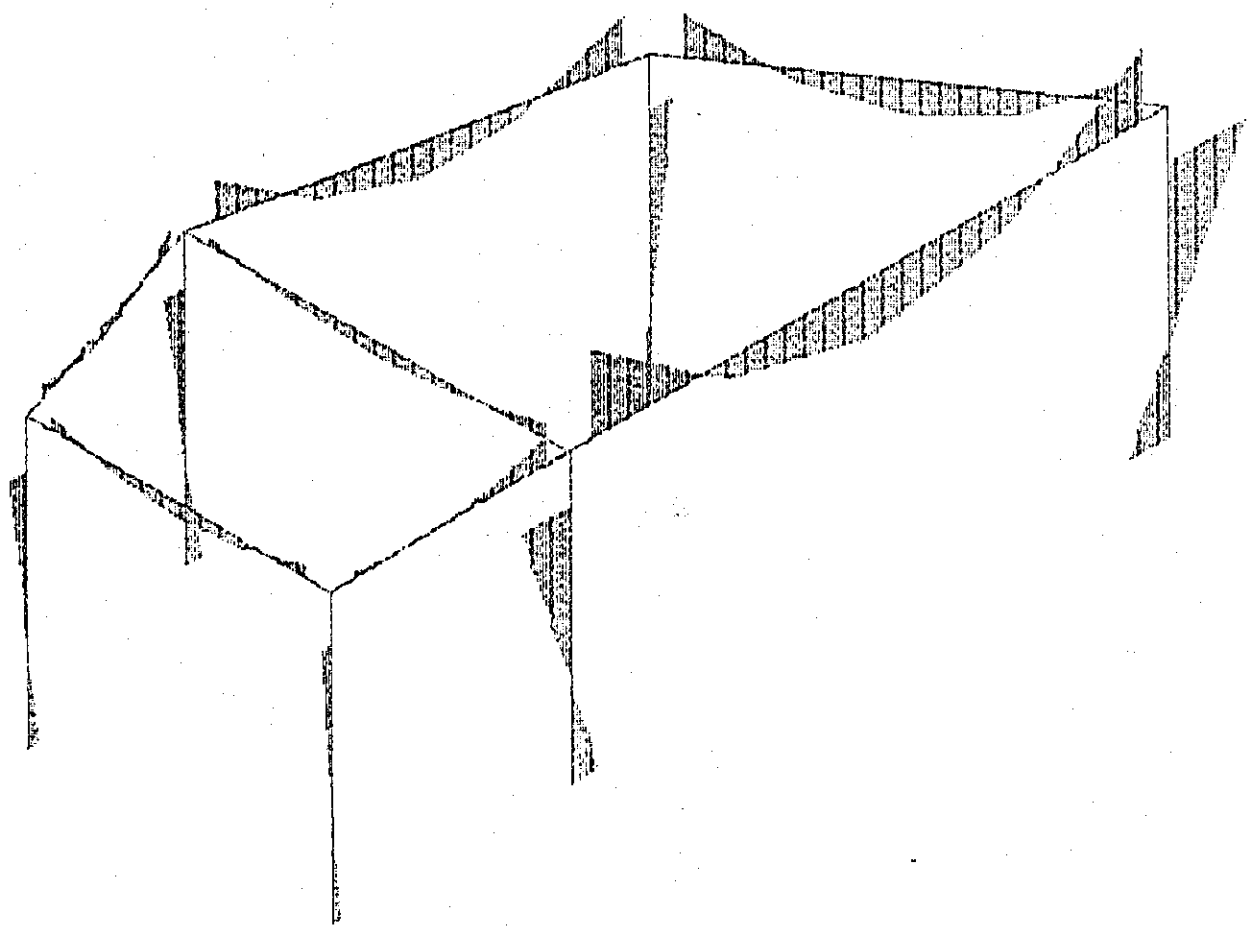
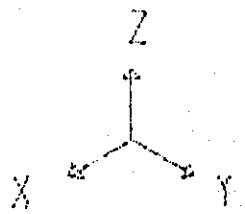


Diagrama de Momentos
(Bending Moments)

FIG. SPH-3



SPH
FRAME
OUTPUT M33
LOAD 1

MIN < 11>
-.5164E+04
AT .30
MAX < 4>
.5371E+04
AT 3.00

SAP90

54.4.35

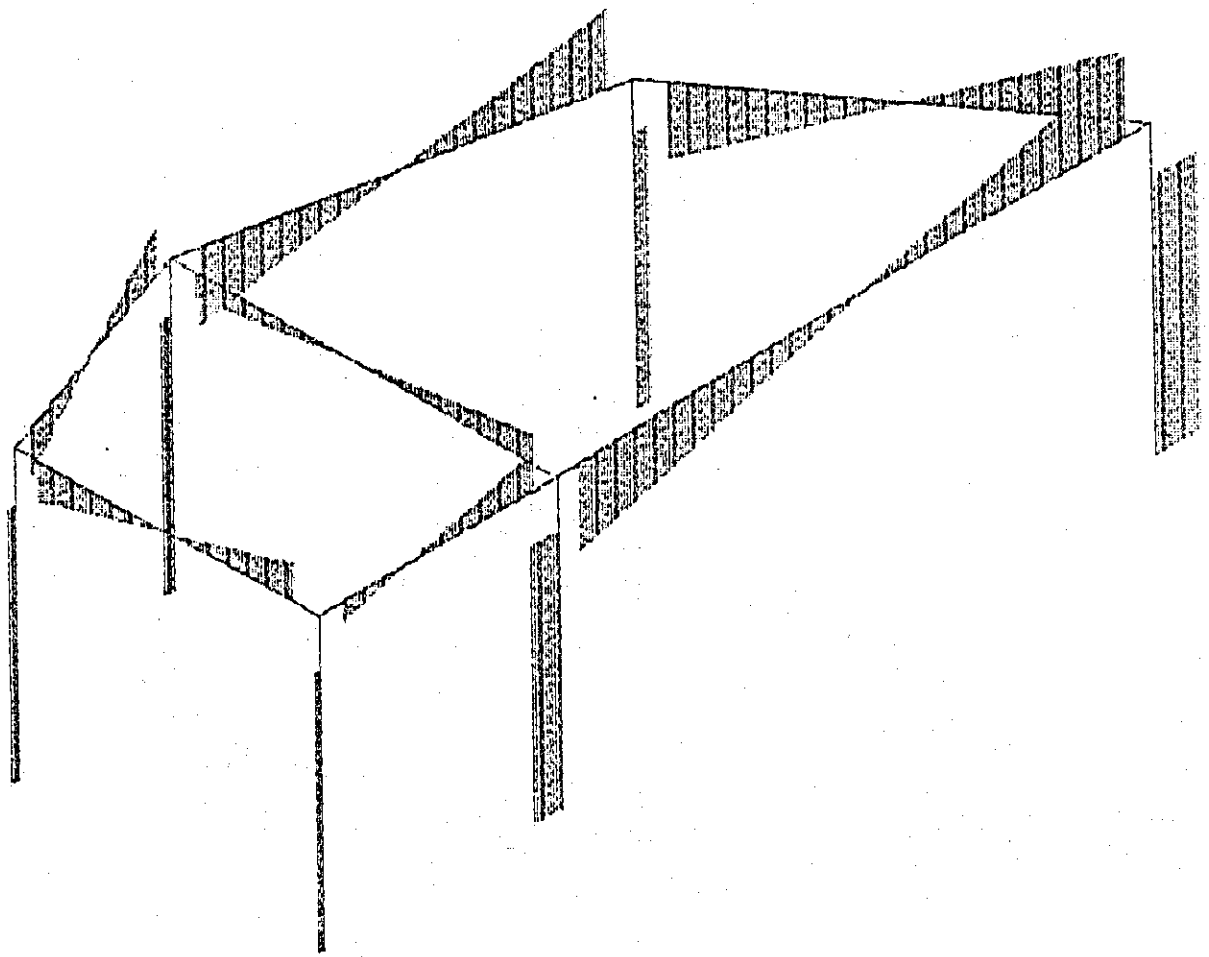


Diagrama de Corte
(Shear Diagram)

FIG SPH-4

Z
X Y

SPH
FRAME
OUTPUT V23
LOAD 1

MIN < 11>
-.4592E+04
AT 7.20
MAX < 11>
.4975E+04
AT .30

SAP90

96-11-5

```
SUPERESTRUCTURA TOMA POZA HONDA
SYSTEM
L=4
:
JOINTS
1  X=10.5  Y=1.0   Z=0
2          Y=4.8
3  X=7.5   Y=0.0
4          Y=4.8
5  X=2.65  Y=1.0
6  X=0.0   Y=4.8
7  X=10.5  Y=1.0   Z=3.6
8          Y=4.8
9  X=7.5   Y=0.0
10         Y=4.8
11 X=2.65  Y=1.0
12 X=0.0   Y=4.8
:
RESTRAINTS
1,6,1  R=1,1,1,1,1,1
:
POTENTIAL
7,12,1  P=180,180
:
FRAME
NM=4   X=0,0,0,0.15   Y=0,0,0.15   Z=-1.0
1 SH=R T=0.6,0.6  E=2.1E9 W=1020
2 SH=R T=0.6,0.4          W=520
3 SH=R T=0.6,0.4          W=980
4 SH=R T=0.6,0.4          W=1450
C COLUMNAS
1,1,7  M=1 RE=0,0.6  LP=2,0
2,3,9      RE=0,0.6
3,5,11     RE=0,0.6
4,6,12     RE=0,0.6
5,2,8      RE=0,0.6
6,4,10     RE=0,0.6
C VIGAS
7,7,9   M=4  RE=0.3,0.3  RZ=0.5  LP=2,0
8,9,11       RE=0.3,0.3  RZ=0.5
9,11,12      RE=0.3,0.3  RZ=0.5
10,8,10 M=3  RE=0.3,0.3  RZ=0.5
11,10,12     RE=0.3,0.3  RZ=0.5
12,7,8       RE=0.3,0.3  RZ=0.5  LP=3,0
13,9,10  M=2  RE=0.3,0.3 RZ=0.5  LP=3,0
:
SHELL
NM=1  X=0,0,0,0.15  Y=0,0,0.15  Z=-1.0  P=0,-1.0
1  E=2.1E9  U=0.15  W=4470
1  JQ=8,10,7,9  ETYPE=2  M=1  TH=0.15,0.15  LP=0
2  JQ=10,12,9,11 ETYPE=2  M=1 TH=0.15,0.15  LP=0
:
COMBO
1  C=1.4,1.7
2  C=1.05,1.275,1.4
3  C=1.05,1.275,0,1.4
4  C=0.9,0,1.43
5  C=0.9,0,0,1.43
:

END
```

5-a-37.

STRUCTURA TOMA POZA HONDA

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			-14740.720			-3.200
	.000	-628.376	691.993		431.529	-464.269	
	3.000	-628.376	-1193.135		431.529	830.319	
	3.600			-9599.920			-3.200
2	.000			-10240.653			-184.561
	.000	-996.843	1313.638		-2079.785	3700.701	
	3.000	-996.843	-1676.892		-1437.185	-1574.755	
	3.600			-6385.053			-184.561
3	.000			-13474.987			-20.543
	.000	-3152.879	5227.288		99.476	-185.739	
	3.000	-2510.279	-3267.447		99.476	112.689	
	3.600			-9619.387			-20.543
4	.000			-8013.686			-188.781
	.000	-932.598	1253.836		-2175.088	3834.710	
	3.000	-932.598	-1543.956		-1518.718	-1705.998	
	3.600			-4708.885			-188.781
5	.000			-11317.326			-21.248
	.000	-3134.834	5251.351		50.872	-135.012	
	3.000	-2478.464	-3168.595		50.872	17.605	
	3.600			-8012.527			-21.248
1	.000			-26973.080			-28.889
	.000	-768.996	856.876		927.018	-994.620	
	3.000	-768.996	-1450.111		927.018	1786.435	
	3.600			-21832.279			-28.889
2	.000			-17609.715			-247.921
	.000	-766.583	823.318		-2545.933	5022.530	
	3.000	-766.583	-1476.430		-1903.333	-1651.370	
	3.600			-13754.114			-247.921
3	.000			-19141.012			-127.632
	.000	-4045.436	6227.899		640.137	-767.813	
	3.000	-3402.836	-4944.511		640.137	1152.599	
	3.600			-15285.411			-127.632
4	.000			-12799.482			-249.860
	.000	-688.073	740.721		-2713.543	5253.262	
	3.000	-688.073	-1323.497		-2057.173	-1902.813	
	3.600			-9494.682			-249.860
5	.000			-14363.592			-126.992
	.000	-4037.188	6261.114		540.800	-661.160	
	3.000	-3380.818	-4865.894		540.800	961.240	
	3.600			-11058.792			-126.992

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
3								
	1	.000			-22285.781			-42.248
		.000	704.525	-638.580		782.539	-486.347	
		3.000	704.525	1474.995		782.539	1861.270	
		3.600			-17144.980			-42.248
	2	.000			-15009.344			-104.213
		.000	1439.546	-1318.215		-2609.803	6060.686	
		3.000	1439.546	3000.423		-1967.203	-804.824	
		3.600			-11153.744			-104.213
	3	.000			-15922.170			-208.596
		.000	-2061.420	4313.522		640.486	249.647	
		3.000	-1418.820	-906.839		640.486	2171.104	
		3.600			-12066.570			-208.596
	4	.000			-11466.913			-101.244
		.000	1373.547	-1252.107		-2760.393	6247.583	
		3.000	1373.547	2868.534		-2104.023	-1049.040	
		3.600			-8162.113			-101.244
	5	.000			-12399.300			-207.864
		.000	-2202.440	4500.310		559.545	312.021	
		3.000	-1546.070	-1122.455		559.545	1990.658	
		3.600			-9094.500			-207.864
4								
	1	.000			-22847.865			-12.877
		.000	2734.679	-2827.215		-1005.966	1457.018	
		3.000	2734.679	5376.321		-1005.966	-1560.879	
		3.600			-17707.064			-12.377
	2	.000			-18821.063			358.820
		.000	2641.957	-2495.367		-3952.229	7589.708	
		3.000	2641.957	5430.503		-3309.629	-3303.079	
		3.600			-14965.462			358.820
	3	.000			-16345.165			142.613
		.000	-230.961	2244.121		-797.066	1745.828	
		1.078	.002	2119.604		-797.066	886.387	
		3.000	411.639	2515.138		-797.066	-645.369	
		3.600			-12489.564			142.613
	4	.000			-15088.748			367.587
		.000	2351.749	-2182.074		-3913.887	7574.840	
		3.000	2351.749	4873.174		-3257.517	-3182.265	
		3.600			-11783.947			367.587
	5	.000			-12559.796			146.747
		.000	-582.731	2658.975		-691.113	1605.734	
		2.663	.002	1882.945		-691.113	-234.997	
		3.000	73.639	1895.338		-691.113	-467.604	
		3.600			-9254.996			146.747
5								
	1	.000			-13081.813			-8.749
		.000	-326.933	417.976		-583.862	634.587	
		3.000	-326.933	-562.822		-583.862	-1116.999	
		3.600			-7941.014			-8.749

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			-11703.448			-138.447
	.000	-574.441	930.580		-2708.454	4373.809	
	3.000	-574.441	-792.743		-2065.854	-2787.654	
	3.600			-7847.849			-138.447
3	.000			-12250.973			38.981
	.000	-3153.256	5296.145		-299.059	245.196	
	3.000	-2510.656	-3199.724		-299.059	-651.982	
	3.600			-8395.372			38.981
4	.000			-9711.113			-140.861
	.000	-537.454	897.485		-2695.151	4390.171	
	3.000	-537.454	-714.878		-2038.781	-2710.729	
	3.600			-6406.313			-140.861
5	.000			-10270.370			40.369
	.000	-3171.530	5356.597		-234.127	173.087	
	3.000	-2515.160	-3173.437		-234.127	-529.293	
	3.600			-6965.570			40.369
---	---	---	---	---	---	---	---
1	.000			-28187.988			-13.418
	.000	-1714.900	1949.765		-551.259	611.194	
	3.000	-1714.900	-3194.935		-551.259	-1042.583	
	3.600			-23047.189			-13.418
2	.000			-22703.713			-372.836
	.000	-1743.636	2222.065		-3540.921	6114.304	
	3.000	-1743.636	-3008.841		-2898.321	-3544.559	
	3.600			-18848.113			-372.836
3	.000			-18953.629			-11.140
	.000	-4793.174	7125.009		-283.974	238.495	
	3.000	-4150.574	-6290.613		-283.974	-613.428	
	3.600			-15098.029			-11.140
4	.000			-17650.600			-379.585
	.000	-1567.172	2034.838		-3552.717	6175.924	
	3.000	-1567.172	-2666.678		-2896.347	-3497.671	
	3.600			-14345.799			-379.585
5	.000			-13820.155			-10.138
	.000	-4682.057	7042.845		-225.978	174.205	
	3.000	-4025.687	-6018.773		-225.978	-503.730	
	3.600			-10515.355			-10.138
7	---	---	---	---	---	---	---
1	.000			-632.300			54.955
	.300	2518.849	-851.583		31.314	-25.389	
	1.541	-.013	711.126		31.314	13.466	
	2.862	-2682.575	-1061.339		31.314	54.846	
	3.162			-632.300			54.955
2	.000			-1518.418			161.547
	.300	2595.561	-1514.600		-588.187	454.199	
	2.005	-.010	697.859		-95.712	-128.760	
	2.336	-504.467	614.283		.002	-144.616	
	2.862	-1305.507	138.139		151.988	-104.633	
	3.162			-1213.918			161.547

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
	3	.000			-1474.648			82.267
		.300	3959.841	-3477.558		304.580	-216.919	
		2.862	58.774	1670.846		57.854	247.409	
		3.162			-561.148			82.267
	4	.000			-1464.569			158.833
		.300	2322.923	-1421.572		-605.225	467.526	
		2.080	-.008	645.849		-80.004	-142.336	
		2.351	-353.855	597.874		.002	-153.182	
		2.862	-1020.850	246.564		150.811	-114.642	
		3.162			-1153.544			158.833
	5	.000			-1419.861			77.854
		.300	3716.437	-3426.594		306.672	-217.973	
		2.862	372.665	1812.115		54.660	244.943	
		3.162			-486.786			77.854
8	----------							
	1	.000			-1406.863			69.677
		.300	4323.120	-2494.941		-46.184	105.210	
		2.430	-.020	2108.352		-46.184	6.855	
		4.652	-4511.480	-2904.813		-46.184	-95.785	
		4.952			-1406.863			69.677
	2	.000			-2113.717			187.806
		.300	3122.169	-1406.621		-700.792	499.265	
		2.351	-.015	1794.672		-89.220	-310.772	
		2.650	-455.512	1726.531		.003	-324.118	
		4.652	-3503.781	-2237.014		597.097	273.623	
		4.952			-2418.217			187.806
	3	.000			-2255.082			196.342
		.300	4239.947	-3890.122		-203.058	269.392	
		3.085	-.015	2013.705		-31.816	-57.655	
		3.602	-787.804	1809.884		.001	-65.886	
		4.652	-2386.003	144.079		64.548	-32.007	
		4.952			-778.257			196.342
	4	.000			-1976.893			182.673
		.300	2665.683	-1151.428		-709.391	495.353	
		2.343	-.013	1571.125		-87.156	-318.192	
		2.629	-373.406	1517.703		.003	-330.660	
		4.652	-3013.703	-1908.724		616.310	292.807	
		4.952			-2287.918			182.673
	5	.000			-2121.288			191.391
		.300	3807.413	-3688.147		-200.991	260.554	
		3.218	-.013	1866.028		-17.746	-58.536	
		3.500	-368.738	1813.934		.001	-61.043	
		4.652	-1871.972	523.392		72.349	-19.373	
		4.952			-612.817			191.391
9	----------							
	1	.000			-1228.304			48.453
		.300	4387.243	-2625.577		24.291	-60.105	
		2.461	-.019	2115.285		24.291	-7.606	
		4.333	-3799.268	-1439.995		24.291	37.856	
		4.633			-1228.304			48.453

5-6-91

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			-546.172			40.999
	.300	1605.889	1396.804		-530.244	403.474	
	1.355	-.014	2243.726		-346.525	-58.926	
	3.344	-3029.024	-769.405		.002	-403.629	
	4.333	-4533.994	-4507.374		172.174	-318.532	
	4.633			-1703.272			40.999
3	.000			-1431.968			30.684
	.300	3530.508	-2404.347		-441.902	54.910	
	2.069	836.776	1459.131		.002	-336.012	
	2.619	-.014	1689.079		137.277	-298.286	
	4.333	-2609.375	-546.993		565.340	303.809	
	4.633			-625.043			30.684
4	.000			-407.846			36.423
	.300	1099.060	1752.040		-545.268	421.065	
	1.142	-.012	2214.849		-395.432	24.936	
	3.365	-2900.583	-1008.668		.002	-414.518	
	4.333	-4163.697	-4427.440		172.202	-331.180	
	4.633			-1589.741			36.423
5	.000			-1312.624			25.887
	.300	3064.920	-2130.565		-455.033	65.033	
	2.084	737.276	1260.301		.002	-340.771	
	2.649	-.012	1468.568		144.136	-300.054	
	4.333	-2197.837	-382.193		573.792	304.497	
	4.633			-488.407			25.887
1	.000			-345.554			6.825
	.300	1119.514	-346.358		17.911	-18.656	
	1.116	-.008	110.388		17.911	-4.041	
	2.700	-2173.286	-1610.886		17.911	24.331	
	3.000			-345.554			6.825
2	.000			-344.192			131.574
	.300	1138.978	-655.784		-408.844	422.384	
	1.407	-.006	-25.429		-181.047	95.913	
	2.287	-905.249	-423.620		.001	16.277	
	2.700	-1330.622	-885.758		85.076	33.862	
	3.000			-344.192			131.574
3	.000			-1604.438			4.261
	.300	3302.935	-3377.500		-49.613	89.998	
	2.700	833.335	1586.024		-49.613	-29.073	
	3.000			-987.038			4.261
4	.000			-300.021			133.610
	.300	1004.408	-603.989		-420.111	434.024	
	1.439	-.005	-32.087		-180.726	91.911	
	2.299	-758.300	-358.062		.001	14.222	
	2.700	-1112.392	-733.570		84.393	31.163	
	3.000			-300.021			133.610
5	.000			-1587.272			3.569
	.300	3214.736	-3384.027		-53.182	94.516	
	2.700	1097.936	1791.178		-53.182	-33.120	
	3.000			-956.642			3.569

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
11								
	1	.000			-2051.998			17.525
		.300	4875.233	-5163.865		-15.439	53.142	
		3.853	-.021	3497.903		-15.439	-1.720	
		7.200	-4591.567	-4185.220		-15.439	-53.389	
		7.500			-2051.998			17.525
	2	.000			-1851.748			91.867
		.300	3794.773	-4228.559		-768.112	813.931	
		3.988	-.015	2768.673		-9.154	-619.285	
		7.200	-3305.327	-2539.969		651.908	413.029	
		7.500			-1851.748			91.867
	3	.000			-3193.289			78.945
		.300	4128.396	-5351.372		-81.865	247.391	
		4.312	-.015	2930.289		-81.865	-81.057	
		7.200	-2971.704	-1360.781		-81.865	-317.478	
		7.500			-1649.789			78.945
	4	.000			-1627.424			91.730
		.300	3280.102	-3700.709		-782.448	824.085	
		4.019	-.013	2398.535		-.688	-632.137	
		7.200	-2805.698	-2064.017		668.001	429.241	
		7.500			-1627.424			91.730
	5	.000			-2997.712			78.531
		.300	3620.874	-4847.581		-81.496	245.405	
		4.405	-.013	2584.804		-81.496	-89.163	
		7.200	-2464.926	-859.561		-81.496	-316.919	
		7.500			-1421.137			78.531
12								
	1	.000			-601.773			37.627
		.300	2221.260	-855.147		-18.621	32.396	
		1.919	-.010	942.957		-18.621	2.248	
		3.500	-2169.140	-771.754		-18.621	-27.192	
		3.800			-601.773			37.627
	2	.000			-248.214			52.919
		.300	178.202	1711.442		230.248	-390.019	
		.473	-.008	1726.873		230.248	-350.143	
		3.500	-3114.598	-2986.793		230.248	346.776	
		3.800			-1030.255			52.919
	3	.000			-249.446			14.424
		.300	1857.541	-1034.374		-379.097	210.179	
		2.105	-.008	642.234		-7.588	-138.842	
		3.500	-1435.259	-358.722		279.463	50.764	
		3.800			-249.446			14.424
	4	.000			-179.687			49.924
		.300	-92.748	1855.907		237.433	-402.361	
		3.500	-2915.148	-2956.727		237.433	357.425	
		3.800			-978.485			49.924

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	.000			-180.945			10.603
	.300	1622.578	-948.748		-384.970	210.699	
	2.140	-.007	543.745		1.746	-141.803	
	3.500	-1199.822	-272.340		287.702	55.070	
	3.800			-180.945			10.603
1	.000			-517.909			-54.506
	.300	1431.788	-515.441		8.456	-23.399	
	2.267	-.007	892.537		8.456	-6.769	
	4.500	-1625.812	-922.893		8.456	12.115	
	4.800			-517.909			-54.506
2	.000			232.712			-11.175
	.300	-394.166	2670.459		236.080	-450.214	
	4.500	-2687.366	-3800.760		236.080	541.320	
	4.800			-291.448			-11.175
3	.000			-251.722			-37.538
	.300	1141.966	-564.686		-177.282	-3.112	
	1.923	255.549	569.730		.001	-147.018	
	2.392	-.005	629.534		51.112	-135.056	
	4.500	-1151.234	-584.147		281.358	215.446	
	4.800			-251.722			-37.538
4	.000			297.151			-4.102
	.300	-582.315	2799.053		239.769	-456.208	
	4.500	-2547.915	-3774.429		239.769	550.823	
	4.800			-238.241			-4.102
5	.000			-197.664			-31.030
	.300	986.735	-505.416		-182.451	.475	
	1.936	221.203	482.527		.001	-148.746	
	2.408	-.004	534.804		52.722	-136.285	
	4.500	-978.865	-488.889		286.017	217.965	
	4.800			-197.664			-31.030

SUPERESTRUCTURA TOMA POZA HONDA

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

MEMBRANE FORCES ARE IN FORCE PER UNIT LENGTH
BENDING MOMENTS ARE IN MOMENTS PER UNIT LENGTH

ELEMENT ID 1 ----------
LOAD COMBO 1 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	1.3053E+01	1.2850E+01	-1.4128E+00	1.4368E+01	1.1535E+01	-42.95
10	-3.9077E+01	-5.9293E+00	8.4264E+00	-3.9103E+00	-4.1096E+01	76.53
7	5.6677E+00	7.6937E+00	7.8160E-01	7.9602E+00	5.4012E+00	71.17
9	-3.5767E+00	1.6086E+01	4.9672E+00	1.7270E+01	-4.7602E+00	76.60
MIDPT	V1	V2		VMAX		ANGLE
	-1.0623E+01	4.5776E+00		1.1568E+01		156.69

LOAD COMBO 2 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-2.1699E+01	-8.9733E+01	-8.1441E+00	-2.0737E+01	-9.0695E+01	-6.73
10	-3.5871E+01	-1.2397E+02	-8.7159E+00	-3.5017E+01	-1.2482E+02	-5.60
7	-2.2851E+01	9.6791E+01	5.3572E+00	9.7031E+01	-2.3090E+01	87.44
9	5.0632E+01	1.3948E+02	8.0850E+00	1.4021E+02	4.9902E+01	84.84
MIDPT	V1	V2		VMAX		ANGLE
	1.3264E+01	5.3167E+01		5.4797E+01		75.99

LOAD COMBO 3 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-1.1549E+02	-4.0193E+00	1.8655E+01	-9.8020E-01	-1.1853E+02	80.75
10	8.7078E+01	2.0361E+01	-9.5671E+00	8.8423E+01	1.9016E+01	-8.00
7	-1.1849E+02	-2.6115E+01	3.4214E+00	-2.5989E+01	-1.1862E+02	87.88
9	1.0170E+02	1.7334E+01	4.9841E+00	1.0199E+02	1.7040E+01	3.37
MIDPT	V1	V2		VMAX		ANGLE
	7.0152E+01	-9.2030E+00		7.0753E+01		-7.47

LOAD COMBO 4 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-2.2822E+01	-9.3106E+01	-8.3046E+00	-2.1854E+01	-9.4074E+01	-6.65
10	-3.2982E+01	-1.2632E+02	-9.8388E+00	-3.1957E+01	-1.2734E+02	-5.95
7	-2.3141E+01	9.8124E+01	5.3767E+00	9.8362E+01	-2.3379E+01	87.47
9	5.1133E+01	1.4068E+02	7.6513E+00	1.4132E+02	5.0484E+01	85.15
MIDPT	V1	V2		VMAX		ANGLE
	1.4194E+01	5.3882E+01		5.5720E+01		75.24

LOAD COMBO 5 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
8	-1.1863E+02	-5.5549E+00	1.9069E+01	-2.4256E+00	-1.2176E+02	80.68
10	9.2601E+01	2.1106E+01	-1.0708E+01	9.4170E+01	1.9537E+01	-8.34
7	-1.2083E+02	-2.7417E+01	3.3994E+00	-2.7293E+01	-1.2096E+02	87.92
9	1.0329E+02	1.5908E+01	4.4839E+00	1.0352E+02	1.5679E+01	2.93
MIDPT	V1	V2		VMAX		ANGLE
	7.2302E+01	-9.8246E+00		7.2966E+01		-7.74

ELEMENT ID 2 ----------
LOAD COMBO 1 ----------

JOINT	M11	M22	M12	MMAX	MMIN	ANGLE
10	8.3668E-01	2.7274E+00	2.9345E+00	4.8651E+00	-1.3010E+00	53.93
12	4.5848E+01	4.5914E+01	-2.2559E+00	4.8137E+01	4.3625E+01	-45.42
9	2.2908E+01	2.2287E+01	5.3579E+00	2.7964E+01	1.7231E+01	43.34
11	2.7653E+00	-3.0228E+00	3.3923E+00	4.3303E+00	-4.5878E+00	24.77

5-9-45

'ERESTRUCTURA TOMA POZA HONDA

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

```
:MENT ID      2 ------------------------
)PT          V1          V2                      VMAX                    ANGLE
     2.7423E+00 -3.5166E+00                 4.4595E+00                  -52.05
AD COMBO      2 ------------------------
INT         M11         M22         M12         MMAX        MMIN       ANGLE
 10 -3.2897E+01 -1.2254E+02  1.1725E+01 -3.1389E+01 -1.2405E+02        7.33
 12  2.9136E+01 -8.4271E+01  5.8702E+01  5.4049E+01 -1.0918E+02       23.00
  9  5.3951E+01  1.4284E+02  1.0462E+01  1.4405E+02  5.2736E+01       83.38
 11  9.8698E+00  1.5675E+02 -3.6073E+01  1.6513E+02  1.4885E+00      -76.92
)PT          V1          V2                      VMAX                    ANGLE
    -1.0027E+01  6.2303E+01                 6.3105E+01                   99.14
AD COMBO      3 ------------------------
INT         M11         M22         M12         MMAX        MMIN       ANGLE
 10 -5.6979E+01 -2.2334E+00  5.3261E-01 -2.2283E+00 -5.6985E+01       89.44
 12  1.0493E+02  7.3990E+01  1.8487E+01  1.1357E+02  6.5353E+01       25.04
  9 -6.2959E+01 -3.0044E-01  1.1424E+01  1.7173E+00 -6.4977E+01       79.98
 11  1.0584E+02 -2.4386E+00  4.6573E+01  1.2311E+02 -1.9715E+01       20.35
DPT          V1          V2                      VMAX                    ANGLE
     3.3064E+01 -2.2410E+00                 3.3140E+01                   -3.88
AD COMBO      4 ------------------------
INT         M11         M22         M12         MMAX        MMIN       ANGLE
 10 -3.4432E+01 -1.2585E+02  1.1560E+01 -3.2992E+01 -1.2729E+02        7.10
 12  2.4650E+01 -9.1686E+01  6.0443E+01  5.0367E+01 -1.1740E+02       23.05
  9  5.1433E+01  1.4333E+02  9.9970E+00  1.4440E+02  5.0358E+01       83.86
 11  1.0515E+01  1.6049E+02 -3.7102E+01  1.6917E+02  1.8386E+00      -76.84
DPT          V1          V2                      VMAX                    ANGLE
    -1.0334E+01  6.4175E+01                 6.5001E+01                   99.15
AD COMBO      5 ------------------------
INT         M11         M22         M12         MMAX        MMIN       ANGLE
 10 -5.9030E+01 -2.9663E+00  1.2836E-01 -2.9660E+00 -5.9031E+01       89.87
 12  1.0207E+02  6.9965E+01  1.9367E+01  1.1117E+02  6.0863E+01       25.17
  9 -6.7982E+01 -2.8752E+00  1.0979E+01 -1.0736E+00 -6.9783E+01       80.68
 11  1.0854E+02 -2.1036E+00  4.7315E+01  1.2601E+02 -1.9578E+01       20.27
DPT          V1          V2                      VMAX                    ANGLE
     3.3680E+01 -1.7527E+00                 3.3726E+01                   -2.98
```

5-a-96

STEC

SAP90_FILE:sph/SAPCON_FILE:sphcon.CON

SUPERESTRUCTURA TOMA POZA HONDA

C O N T R O L D A T A

EXECUTION MODE - - - - - - - - - - - - -	0
CODE TYPE - - - - - - - - - - - - - - - -	1 (ACI 318-89)
ELEMENT PRINT SUPPRESSION FLAG - - - -	0
NUMBER OF INTERACTION CURVES - - - - -	5
NUMBER OF POINTS PER CURVE - - - - - -	11
CURVE PRINT SUPPRESSION FLAG - - - - -	1
TYPE OF UNITS - - - - - - - - - - - - - -	M
COLUMN PRINT SUPPRESSION FLAG - - - - -	1
BEAM PRINT SUPPRESSION FLAG - - - - - -	0
INTERACTION CAPACITY RATIO CUTOFF - - -	.0005

S E C T I O N P R O P E R T Y D A T A

COLUMN-TYPE SECTION PROPERTIES

PROP ID	SECTION TYPE	SECTION SHAPE	DIMENSION T3 {m}	DIMENSION T2 {m}	CONCRETE COVER {m}	BAR AREA {m}
1	R	RR-3-3	.6000	.6000	.03000	.000000

BEAM-TYPE SECTION PROPERTIES

PROP ID	SECTION TYPE	DEPTH T3 {m}	WIDTH T2 {m}	SLAB THICK {m}	WEB WIDTH {m}	TOP COVER {m}	BOTTOM COVER {m}
2	R	.6000	.4000	.00000	.00000	.03000	.03000
3	R	.6000	.4000	.00000	.00000	.03000	.03000
4	R	.6000	.4000	.00000	.00000	.03000	.03000

5-11-97

RESTRUCTURA TOMA POZA HONDA

DESIGN OF COLUMN-TYPE ELEMENTS (ACI 318-89)

M D	STATN LOC {m}	REBAR {sqcm}	<LC>	<---DESIGN POINT---> P {T}	M33 {T-m}	M22 {T-m}	<DESIGN FACTORS> DB33	DB22	<--FAILURE POINT--> PC {T}	MC33 {T-m}	MC22 {T-m}
1											
	.00	36.0	< 5>	10	5	0	1.00	1.00	10	5	0
	3.00	36.0	< 5>	10	3	0	1.00	1.00	10	3	0
2											
	.00	36.0	< 5>	13	6	1	1.00	1.00	13	6	1
	3.00	36.0	< 5>	13	5	1	1.00	1.00	13	5	1
3											
	.00	36.0	< 5>	11	5	0	1.00	1.00	11	5	0
	3.00	36.0	< 5>	11	1	2	1.00	1.00	11	1	2
4											
	.00	36.0	< 5>	11	3	2	1.00	1.00	11	3	2
	3.00	36.0	< 5>	11	2	0	1.00	1.00	11	2	0
5											
	.00	36.0	< 5>	9	5	0	1.00	1.00	9	5	0
	3.00	36.0	< 5>	9	3	1	1.00	1.00	9	3	1
6											
	.00	36.0	< 5>	12	7	0	1.00	1.00	12	7	0
	3.00	36.0	< 5>	12	6	1	1.00	1.00	12	6	1

AR DESIGN OF COLUMN-TYPE ELEMENTS (ACI 318-89)

EM ID	SECTION T3 {m}	X	SIZE T2 {m}	SECTION SHAPE	STATN LOC {m}	<SHEAR ALONG 2-2 AXIS> AV <LC> {sqcm/m}	V22 {T}	PU {T}	<SHEAR ALONG 3-3 AXIS> AV <LC> {sqcm/m}	V33 {T}	PU {T}
1	.60	X	.60	RR-3-3							
					.00	26.20 < 0>	36	12	26.20 < 0>	36	12
					3.00	26.20 < 0>	36	12	26.20 < 0>	36	12
2	.60	X	.60	RR-3-3							
					.00	27.61 < 0>	37	24	27.61 < 0>	37	24
					3.00	27.61 < 0>	37	24	27.61 < 0>	37	24
3	.60	X	.60	RR-3-3							
					.00	27.07 < 0>	37	20	27.07 < 0>	37	20
					3.00	27.07 < 0>	37	20	27.07 < 0>	37	20
4	.60	X	.60	RR-3-3							
					.00	27.13 < 0>	37	20	27.13 < 0>	37	20
					3.00	27.13 < 0>	37	20	27.13 < 0>	37	20
5	.60	X	.60	RR-3-3							
					.00	26.01 < 0>	35	11	26.01 < 0>	35	11
					3.00	26.01 < 0>	35	11	26.01 < 0>	35	11
6	.60	X	.60	RR-3-3							
					.00	27.75 < 0>	38	26	27.75 < 0>	38	26
					3.00	27.75 < 0>	38	26	27.75 < 0>	38	26

SUPERESTRUCTURA TOMA POZA HONDA

FLEXURAL AND SHEAR DESIGN OF BEAM-TYPE ELEMENTS (ACI 318-89)

ELEM ID	SECTION SIZE WIDTH X DEPTH {m}	STATN LOC {m}	<------REQUIRED REINFORCING------> TOP <LC> {sqcm}	BOT <LC> {sqcm}	SHR <LC> {sqcm/m}	<-DESIGN FORCES-> -M33 {T-m}	+M33 {T-m}	V22 {T}
7	.40 X .60							
		.30	7.63 < 3>	7.63 < 0>	14.35 < 1>	3	2	19
		.94	7.63 < 5>	7.63 < 0>	13.39 < 1>	1	0	18
		1.58	7.63 < 0>	7.63 < 1>	12.56 < 1>	1	1	17
		2.22	7.63 < 0>	7.63 < 3>	13.52 < 1>	1	1	18
		2.86	7.63 < 1>	7.63 < 5>	14.47 < 1>	1	2	20
8	.40 X .60							
		.30	7.63 < 3>	7.63 < 0>	10.54 < 1>	4	2	14
		1.39	7.63 < 0>	7.63 < 2>	8.92 < 1>	1	1	12
		2.48	7.63 < 0>	7.63 < 1>	7.43 < 1>	1	2	10
		3.56	7.63 < 0>	7.63 < 3>	9.05 < 1>	1	2	12
		4.65	7.63 < 1>	7.63 < 0>	10.68 < 1>	3	1	14
9	.40 X .60							
		.30	7.63 < 1>	7.63 < 4>	11.17 < 1>	3	2	15
		1.31	7.63 < 0>	7.63 < 2>	9.67 < 1>	1	2	13
		2.32	7.63 < 0>	7.63 < 1>	8.16 < 1>	1	2	11
		3.32	7.63 < 0>	7.63 < 1>	9.23 < 1>	1	1	13
		4.33	7.63 < 2>	7.63 < 0>	10.74 < 1>	5	2	15
10	.40 X .60							
		.30	7.63 < 5>	7.63 < 0>	14.17 < 1>	3	2	19
		.90	7.63 < 5>	7.63 < 0>	13.56 < 1>	2	0	18
		1.50	7.63 < 0>	7.63 < 0>	13.73 < 1>	1	0	19
		2.10	7.63 < 0>	7.63 < 5>	14.34 < 1>	1	1	19
		2.70	7.63 < 1>	7.63 < 5>	14.94 < 1>	2	2	20
11	.40 X .60							
		.30	7.63 < 3>	7.63 < 0>	8.23 < 1>	5	3	11
		2.03	7.63 < 0>	7.63 < 1>	6.49 < 1>	1	1	9
		3.75	7.63 < 0>	7.63 < 1>	4.75 < 1>	1	3	6
		5.47	7.63 < 0>	7.63 < 3>	6.28 < 1>	1	2	9
		7.20	7.63 < 1>	7.63 < 0>	8.03 < 1>	4	2	11
12	.40 X .60							
		.30	7.63 < 3>	7.63 < 4>	11.64 < 1>	1	2	16
		1.10	7.63 < 0>	7.63 < 2>	10.83 < 1>	1	2	15
		1.90	7.63 < 0>	7.63 < 1>	10.03 < 1>	1	1	14
		2.70	7.63 < 4>	7.63 < 1>	10.80 < 1>	1	1	15
		3.50	7.63 < 2>	7.63 < 0>	11.60 < 1>	3	1	16
13	.40 X .60							
		.30	7.63 < 0>	7.63 < 4>	8.68 < 1>	1	3	12
		1.35	7.63 < 0>	7.63 < 2>	8.12 < 1>	1	2	11
		2.40	7.63 < 0>	7.63 < 1>	7.70 < 1>	1	1	10
		3.45	7.63 < 4>	7.63 < 0>	8.26 < 1>	1	1	11
		4.50	7.63 < 2>	7.63 < 0>	8.82 < 1>	4	2	12

5.5 Utilities for Inlet Structures

CONGUILLO INLET

CONDUCTOR CALCULATION

1. MAIN CONDUCTOR

Total (VA) load = 15,930 VA

The biggest motor is the 4.0 Kw (4.7 KVA)

Max load for conductor = 1.25 x 4,700 + (15,930 - 4,700)
= 17,105 VA

$$I = \frac{17{,}105 VA}{\sqrt{3}\, x\, 220 V} = 44.9\ Amp.$$

From "CABLEC" catalog, we need a 4 x 4 AWG cable or
4C x 22 mm^2 cable
with 48 Amp. capacity

The Conduit required:

The external diameter of the 4 x 4 AWG cable is 26.6 mm, then, from the table 92 of the ANDERSON CATALOG (see below):

$$\frac{26.6}{25.4} \times 1.35 = 1.41"$$

Conduit required is ø 1½"
or 26.6 x 1.35 = 35.9 mm (use ø 42 mm)

Voltage drop:

ΔV (%) = K x KVA x L (m) (see next table)

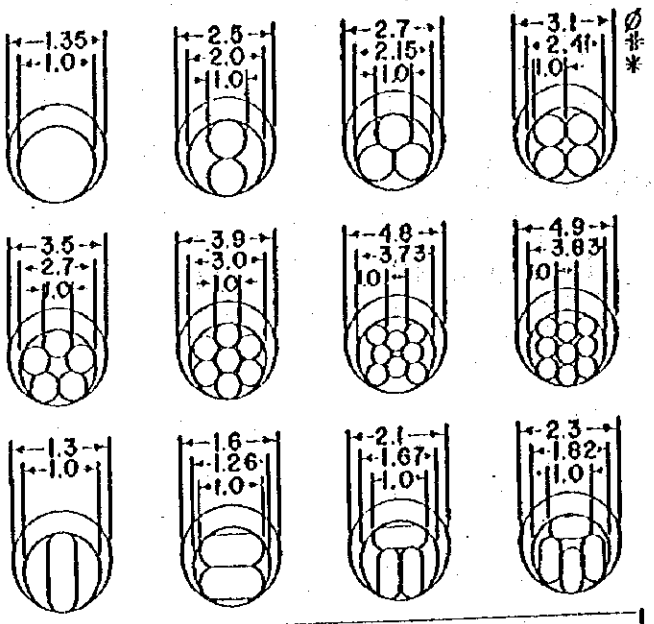
$$K = \frac{R \cos \varnothing + x \operatorname{sen} \varnothing}{10\,(V)^2}$$ cos ø load power factor

V. Davila

Table 91

CONDUIT SIZES FOR CABLES

Multipliers for One or More Cables Per Conduit



Shown at left is the multiplier # for the smallest equivalent diameter of a group of cables and the multiplier Θ to determine the required internal diameter of the conduit for the same, expressed in terms of the diameter of a single cable*.

Note: The multiplier shown to obtain the required conduit diameter is for cables up to 250 MCM and runs not over 100 feet long having not more than two 90° bends or a total of 180° in bends. (More than 180° in bends between pull boxes is not recommended.)

For more difficult conduit runs, and runs having three or more cables over 250 MCM, increase the internal diameter of the conduit to 120%.

Example 1: To determine the required minimum internal diameter, in inches, of a conduit for three, #2/0—3000 volt, single conductor cables.

Diameter of one, #2/0—3000 volt cable=1.0 × .795= .795"

Minimum internal diameter of conduit=2.7 × .795= 2.146"

From table below a 2½" conduit is required.

Minimum group diameter of the three cables is 2.15 × .795=1.709"

Example 2: To determine the required minimum internal diameter, in inches, of a conduit for two, 4-conductor #9, 600 volt cables.

Diameter of one, 4-conductor #9, cable=1.0 × .788= .788"

Minimum internal diameter of conduit=2.5 × .788= 1.97"

From table below a 2" conduit is required.

Minimum group diameter of the two cables is 2.0 × .788=1.576".

INTERNAL DIAMETERS OF IRON CONDUITS									
½"	¾"	1"	1¼"	1½"	2"	2½"	3"	3½	4
.623	.824	1.05	1.38	1.61	2.07	2.47	3.07	3.55	4.03

Table 92

RIGID METAL CONDUIT

Trade Size, Inches	Length	External Diam., Inches	Nominal Internal Diam., Inches	Nominal Wall Thickness Inches	Minimum Weight 10 Lengths Pounds	Threads Per Inch
½	9' 11¼"	0.840	0.622	0.109	79	14
¾	9' 11¼"	1.050	0.824	0.113	105	14
1	9' 11"	1.315	1.049	0.133	153	11½
1¼	9' 11"	1.666	1.380	0.140	201	11½
1½	9' 11"	1.900	1.610	0.145	249	11½
2	9' 11"	2.375	2.067	0.154	334	11½
2½	9' 10½"	2.875	2.469	0.203	527	8
3	9' 10½"	3.500	3.068	0.216	690	8
3½	9' 10¼"	4.000	3.548	0.226	831	8
4	9' 10¼"	4.500	4.026	0.237	982	8
5	9' 10"	5.563	5.047	0.258	1,344	8
6	9' 10"	6.625	6.065	0.280	1,770	8

Table 93

ELECTRICAL METALLIC TUBING

Weight and Dimensions

SIZE INCHES	DIAMETER, INCHES		Approx. Wt. Per 100 Ft. Lbs.
	External	Internal	
⅜	0.577	0.493	23
½	0.706	0.622	28.5
¾	0.922	0.824	43.5
1	1.163	1.049	64
1¼	1.508	1.380	95
1½	1.738	1.610	110
2	2.195	2.067	140

5-5-2

DESCRIPCION TRABAJO FACTORES PARA CALCULO DE REGULACION DE REDES AREAS Y SUBTERRANEAS

TENSION: 440V - Sistema Trifásico 60 Hz COS ϕ: 0.9 UNIDADES: % / KVA-METRO

mm²	CALIBRE AWG MCM / mm²	CONDUCTORES DE ALUMINIO (Aislamiento termoplástico) AEREO (20°C)	CONDUCTORES DE ALUMINIO (Aislamiento termoplástico) SUBTERRANEO (30°C)	CONDUCTORES DE COBRE (Aislamiento termoplástico) AEREO (20°C)	CONDUCTORES DE COBRE (Aislamiento termoplástico) SUBTERRANEO (THW 75°C)
x1,23	8 / 8,34			$12,8 \times 10^{-4}$	$12,16 \times 10^{-4}$
7,65	6 / 13,30	$10,38 \times 10^{-4}$		$7,94 \times 10^{-4}$	$7,63 \times 10^{-4}$
x1,96	4 / 21,15	$7,21 \times 10^{-4}$		$4,69 \times 10^{-4}$	$4,38 \times 10^{-4}$
x2,47	2 / 33,63	$4,8 \times 10^{-4}$		$3,22 \times 10^{-4}$	$2,82 \times 10^{-4}$
x2,78	1 / 42,41	$3,98 \times 10^{-4}$		$2,7 \times 10^{-4}$	$2,3 \times 10^{-4}$
x3,12	1/0 / 53,48	$3,26 \times 10^{-4}$		$2,27 \times 10^{-4}$	$1,83 \times 10^{-4}$
x3,50	2/0 / 67,43	$2,71 \times 10^{-4}$		$1,94 \times 10^{-4}$	$1,5 \times 10^{-4}$
x3,93	3/0 / 85,03	$2,28 \times 10^{-4}$		$1,66 \times 10^{-4}$	$1,26 \times 10^{-4}$
2	4/0 / 107,2	$1,93 \times 10^{-4}$		$1,44 \times 10^{-4}$	$1,05 \times 10^{-4}$
x3,67	250 / 126,8				$0,75 \times 10^{-4}$
2x4,06	300 / 152,7				$0,66 \times 10^{-4}$
2x3,45	350 / 177,4				$0,59 \times 10^{-4}$
2x3,69	400 / 202,7				$0,54 \times 10^{-4}$
2x4,12	500 / 253,10				$0,47 \times 10^{-4}$
	1000				$0,2455 \times 10^{-4}$

$$\Delta V(\%) = K \times KVA \times L(m)$$

$$K = \frac{R\cos\phi + X\,\mathrm{sen}\,\phi}{10\,(V)^2}$$

$$K_{440} = K_{208}\left(\frac{208}{440}\right)^2 = 1$$

$$\boxed{K_{440} = K_{208} \times (0.22)}$$

$$K_{480} = K_{440} \times \left(\frac{440}{480}\right)^2$$

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	A.M.G.		VII-23-90	1 de 1

$$K_{220} = K_{440}\left(\frac{440}{220}\right)^2 = K_{440} \times 4$$

Then, for No.4 AWG $K_{440} = 4.33 \times 10^{-4}$

$$\Delta V\ (\%) = 4.33 \times 10^{-4} \times 4 \times 17.105\ \text{KVA} \times 20\ \text{m}$$

$$= 0.6\ \%$$ (4 AWG is ok.)

2. FAN MOTOR

The fan motor is 4.0 KW (4.7 KVA)

We take 25 % for conductor calculation:

$$1.25 \times 4{,}700\ \text{VA} = 5{,}875\ \text{VA}$$

$$I = \frac{5{,}875\ \text{VA}}{\sqrt{3} \times 220\ \text{V}} = 15.42\ \text{Amp.}$$

From "CABLEC" catalog, we need a 4 x 12 AWG or
4C x 3.5 mm^2 cable
with 16 Amp. capacity

The conduit required:

The external diameter of the 4 x 12 AWG cable is: 14.8 mm.

Then:

$$\frac{14.8}{25.4} \times 1.35 = 0.79''$$

and from ANDERSON catalog conduit required is ø 3/4"

or 14.8 x 1.35 = 19.98 mm (use 22 mm)

The voltage drop:

$$\Delta V\ (\%) = K \times KVA \times L\ (m)$$
$$= 30.4 \times 10^{-4} \times 4 \times 5.875\ KVA \times 12m$$
$$= 0.9\ \%\ \text{(cable 4 x 12 AWG is ok)}$$

3. MOTOR FOR VALVE OPERATION

Motor is 1.5 Kw (1.75 KVA)

$$1.25 \times 1.75 = 2{,}188\ VA$$

$$I = \frac{2{,}188\ VA}{\sqrt{3} \times 220\ V} = 5.74\ Amp.$$

We shall use a: 4 x 12 AWG or
4C x 3.5 mm^2 cable
with 16 Amp. capacity

The conduit required is ø 3/4" or ø 22 mm.

The voltage drop:

$$\Delta V\ (\%) = K \times KVA \times L\ (m)$$
$$= 30.4 \times 10^{-4} \times 4 \times 2.19\ KVA \times 42\ m$$
$$= 1.1\ \%\ \text{(cable 4 x 12 AWG is ok.)}$$

4. SUMP PUMP MOTOR

Motor is 0.75 kw (880 KVA)

$$1.25 \times 880 = 1{,}100\ VA$$

$$I = \frac{1{,}100\ VA}{\sqrt{3} \times 220\ V} = 2.9\ Amp.$$

5-5-5

5

ΔV (%) $= 30.4 \times 10^{-4} \times 4 \times 1.1$ KVA $\times$ 47 m

$= 0.6$ % (12 AWG is ok)

Use 4 x 12 AWG or
4C x 3.5 mm^2 cable
and conduit ø 3/4" or ø 22 mm

CONGUILLO INLET

LIGHTING DESIGN

Lighting system is designed to obtain the functional and economical features as well as easy maintenance. From these points, location of lighting fixtures and arrangement of circuit are determined adequately in Conguillo inlet.

1. CONTROL ROOM

- Illumination level: 300 lux
- Area: 25.6 m^2
- Mounting height = 3.1 m
- Luminaire, type A; pipe pendant fluorescent light, 40 W x 2 (see drawings)

$$\text{Room ratio} = \frac{\text{Width x length}}{\text{Work plane to mounting height (width + lenght)}}$$

$$RR = \frac{25.6\ m^2}{(3.1m - 0.76m)\ (7.1m + 3.61m)} = \frac{25.6}{2.34 \times 10.71}$$

$$RR = 1.02$$

From:

IES LIGHTING HANDBOOK, (Illuminating Engineering Society U.S.A 1961)
WESTINGHOUSE LIGHTING HANDBOOK (Westinghouse Electric Corporation, U.S.A 1978)

For:

Ceiling reflectance	80%
Walls reflectance	50%
Floor reflectance	10%

we get from tables for the above luminaire the COEFFICIENT OF UTILIZATION (CU);

CU = 0.41, and
Maintenance factor = 0.7

Then:

$$\text{Required lumens} = \frac{\text{Desired illumination x area}}{\text{Coefficient of utilization x maintenance factor}}$$

$$= \frac{300 \text{ lux x } 25.6 \text{ m}^2}{0.41 \text{ x } 0.7}$$

$$= 26{,}760 \text{ lumens}$$

$$\text{Number of lamps} = \frac{\text{Required lamp lumens}}{\text{Roted initial lamp lumens *}}$$

* (From OSRAM, catalog, for 40 W lamp, 1.2 m length, cool whithe, 38 mm bulb diam, 3,000 lumens).

Then:

$$\text{Number of lamps} = \frac{26{,}760}{3{,}000} = 8.9$$

$$= 9 \text{ lamps}$$

$$\text{Number of luminaire} = \frac{\text{Number of lamps}}{\text{Number of lamps per luminaire}}$$

$$= \frac{9}{2} = 4.5 \quad \text{(use 5)}$$

Number of luminaires = 5 luminaires 40 W x 2

2. FAN ROOM

- Illumination level : 200 lux
- Area = 4.9 x 3.0 = 14.7 m^2
- Mounting height = 3.1 m

- Luminaire, type A; pipe pendant fluorescent light, 40W x 2 (see drawings)

$$\text{Room Ratio} = \frac{4.9 \times 3.0}{(3.1 - 0.76)(4.9 + 3.0)}$$

$$= 0.795$$

Then, from tables:

Maintenance factor = 0.7 and
Coefficient of utilization = 0.35

$$\text{Required lumens} = \frac{200 \times 14.7}{0.35 \times 0.7}$$

$$= 12{,}000 \text{ lumens}$$

$$\text{Number of lamps} = \frac{12{,}000}{3{,}000} = 4 \text{ lamps}$$

Number of luminaires = 2 luminaires 40 W x 2

3. VALVE ROOM

- Illumination level : 200 lux
- Area = 95.6 m^2
- Mounting height = 2.6 m
- Luminaire, type A, pipe pendant fluorescent light, 40W x 2 (see drawings)

$$\text{Room ratio} = \frac{95.6}{(2.6 - 0.76)(12 + 7.95)}$$

$$= 2.6$$

Then from tables:

Maintenance factor = 0.65
Coefficient of utilization = 0.61

Required lumens $= \dfrac{200 \times 95.6}{0.61 \times 0.65}$

$= 48{,}222$ lumens

Number of lamps $= \dfrac{48{,}222}{3{,}000} = 16.1$ (use 16)

Number of luminaires = 6 luminaire 40 W x 2,

4 luminaire 40W x 1, type B on the wall

Note: Luminaire type B; ceiling of wall mounted fluorescent light, with acrylic cover,40W x 1 (see drawings).

CONGUILLO INLET

EARTHING SYSTEM

1. SHORT CIRCUIT CALCULATION

The energy for the valve motors operation and lighting in Conguillo inlet shall be provided by a portable diesel engine generator of 20 KVA.

In this case the maximum short circuit current will be 4.5 or 5 time the rated current, or also assuming this kind or generator has a Xd" = 20%

Then:

$$Xd'' = 0.20$$

$$Is.c. = \frac{1.0}{0.2} = 5.0 \text{ (pu)}$$

$$I_{BASE} = \frac{20.0 \text{ KVA}}{\sqrt{3} \times 0.22 \text{ KV}} = 52.5 \text{ Amp}$$

$$Is.c. = 5.0 \times 52.5 = 263 \text{ Amp.}$$

Now, we con suppose that sometime this station will be served from the Manabí Electric System; in that case the one line diagram could be:

a) System impedance

We are going to assume the equivalent system impedance on the 138 KV bus in Portoviejo S/S could be:

$Zs = j\,0.087$ in 100 MVA base system

b) Portoviejo S/S

Two transformers 138/69 KV, 65 MVA each

$X_T = 10\%$ $X(pu) = 0.1 \times \frac{100}{75} = j\,0.133$

c. 69KV Transmission line

Portoviejo S/S to Calceta S/S

- 47.5 Km
- Conductor: 281.4 MCM (5005)

GMD ≅ 2.5 m (8 feet)

$X_L = Xa + Xd$

$= (0.513 + 0.26)$ ohm/mile

$X_L = j\,22.8$ ohm

$$X_L(pu) = \frac{22.8 \times 100{,}000}{(69)^2 \times 1{,}000} = j\,0.479$$

d) Calceta S/S

Two transformers 69/13.8 KV, 2.5 MVA each.

$X_T = 7\%$

$$X(pu) = 0.07 \times \frac{100}{2.5} = j\,2.8$$

e) 13.8 KV distribution line

Calceta S/S to Conguillo inlet

- 40 Km, conductor 4/0 AWG ASC

GMD = 1.5 m

X_L = Xa + Xd

= (0.607 + 0.2) ohm/mile

X_L = j 20.06 ohm

$$X_L(pu) = \frac{20.06 \times 100{,}000}{\overline{13.8}^2 \times 1{,}000} = j\ 10.53$$

f) A distribution transformer at Conguillo

13,800 - 220/127V, 50KVA

X_T = 5%

$$X\,(pu) = 0.05 \times \frac{100}{0.05} = j\ 100.0$$

1.1 Short-circuit on 220 V bus

The reactances diagram:

5-5-13

$$MVA\ s.c.\ 3\Phi = \frac{100.0}{112.56} = 889\ KVA$$

$$I\ s.c.\ 3\Phi = \frac{1.0}{112.56} \times \frac{100{,}000}{\sqrt{3} \times 0.22} = 2{,}332\ Amp$$

$$I\ s.c. = 2.3\ KA$$

2. GROUNDING MESH CONDUCTOR

$$A = I \times \sqrt{\frac{\frac{tc\,\delta_r\,\rho_r \times 10^4}{TCAP}}{\ln\left(1 + \frac{Tm - Ta}{Ko + Ta}\right)}}$$

Shall use the same data that for Severino P/S, but:

tc = 3.0 sec.

Then:

$$A = 2.332 \times \sqrt{\frac{\frac{3.0 \times 0.00381 \times 1.7774 \times 10^4}{3.422}}{\ln\left(1 + \frac{450 - 40}{242 + 40}\right)}}$$

$A = 19\ mm^2 \Rightarrow$ No. 4 AWG or 22 mm^2
use 50 mm^2 or 1/0 AWG

3 GROUNDING MESH RESISTANCE

$$r = \sqrt{\frac{A}{\pi}} \quad \text{and} \quad R = \frac{\rho}{2\pi r} + \frac{\rho}{L}$$

Where:

$A = 2{,}253\ mm^2$ (grounding wesh area that is covering structure of Conguillo inlet.).

$\rho_{concrete}$ = 90 ohm - meter

L = 565 m

Then:

$$r = \sqrt{\frac{2{,}253}{\pi}} = 26.8 \text{ m}$$

$$R = \frac{90.0}{2\pi \times 26.8} + \frac{90.0}{565}$$

R = 0.69 ohm

VALVES CHAMBER CONGUILLO INLET VENTILATING SYSTEM

1. SPACE TO BE VENTILATED

1.1. Description

Oval cross section chamber of 20 m x 16 m, with three subterranean levels: EL. 70.231. EL. 74.000, EL. 82.000; and a control room at EL. 90.200.

1.2 Volumes:

V(70) = A(70) x H(70)
= 137 $m.^2$ x 3.769 m.
= 517 m^3

V(74) = A(74) x H(74)
=274 m^2 x 8 m.
=2192 $m.^3$

V(82) = A(82) x H(82)
= 274 $m.^2$ x 8.2 m.
= 2242 m^3

V (90) = A (90) x H (90)
= 25.5 $m.^2$ x 3.5 m.
= 90 $m.^3$

2 FLOW RATE

2.1 Service Conditions:

Valve chambers:

Occasionally personnel presence:

One person for operation inspections and not more than four persons for maintenance.

In the minimum level reservoir periods, it is possible objectionable odors generation because de organic material of water putrefaction.

It is possible an air flow from the inlet chamber to the tunnel because the water flow induction.

2.2 Control Room

One operator presence.

There are two control panels

2.3 Volume Changes/Hour

Valve chamber 4 changes/hour

Control room 4 changes/hour

2.4 Flow rates

Q = # Changes/h x volume

$Q_1 = 4 \times (517 + 2192 + 2242)$ cmh $Q_2 = 4 \times 90$ cmh

$Q_1 = 19800$ cmh = 5,50 cms $Q_2 = 360$ cmh

$Q_T = (19800 + 360)$ cmh = 20160 cmh

$Q_T = 5.60$ cms

Air density = 1.204 Kg./m.^{3}, (20°C)

3 Design:

3.1 Intake louver:

Based on 2.5 m/s.frontal velocity V

5-5-17

$$\text{Área} = \frac{Q}{V} = \frac{5.6\ m^3/s}{2.5\ m/s} = 2.24 m^2$$

Entry losses: 2mm ca

Louver size: 1500 x 1500 (mm x mm)

3.2 Initial duct velocity

For low velocity system; initial duct velocity V = 9 m/s

Duct seccion: 0.611 m^2

Initial size: 800mm. x 800 mm.

Friction losses/length 0.12 mm ca /m

3.3 Duct Sizing

The static regain method is used calculate de duct sizes.

Nex tables give the results and supporting sumary.

See the ventilating plans for section numbers asigned to the system.

3.4

LENGTHS TABLE

DUCT SECCION	ELEMENT	STRAIGHT LENGTH	ADDITIONAL EQUIVALENT L	TOTAL LENGTH
V-1	DUCT	2.40		
	ELBOW		5.00	7.40
1-2	DUCT	9.50		
	2 ELBOWS		7.08	16.58
2-9	DUCT	2.00		
	ELBOW		3.25	5.25
9-10	DUCT	7.00		
	ELBOW		1.47	8.47
2-8	DUCT	4.20		
	2 ELBOW		2.90	7.10
2-4	DUCT	8.00		8.00
4-12	DUCT	2.00		
	ELBOW		2.05	4.05
12-13	DUCT	7.00		
	ELBOW		1.76	8.76
4-11	DUCT	4.20		
	2 ELBOW		2.94	7.14
4-5	DUCT	5.00		5.00
5-14	DUCT	4.20		
	2 ELBOW		2.40	6.60
5-15	DUCT	2.00		
	2 ELBOW		2.40	4.40
3-17	DUCT	2.00		
	ELBOW		3.25	5.25
17-18	DUCT	7.00		
	ELBOW		1.47	8.47
3-16	DUCT	4.20		
	2 ELBOW		2.90	7.10
3-6	DUCT	8.00		8.00
6-20	DUCT	2.00		
	ELBOW		2.05	4.05
20-21	DUCT	7.00		
	ELBOW		1.76	8.76
6-19	DUCT	4.20		
	2 ELBOW		2.94	7.14
6-7	DUCT	5.00		5.00
7-22	DUCT	4.20		
	2 ELBOW		2.40	6.60
7-23	DUCT	2.00		
	2 ELBOW		2.40	4.40

3.5 DUCT DESIGN, BASED ON THE STATIC REGAIN METHOD

SECTION	AIRFLOW $Q = m^3/h$	TOTAL EQ. LENGTH M	L/Q RATIO	VELOCITY m/s	AREA m^2	DUCT SIZE	DUCT LOSSES
V-1	19800	7.4		9.0	0.610	800 x 800	0.84
1-2	9900	16.58	0.29	7.2	0.382	800 x 500	
2-9	2960	5.25	0.18	6.2	0.133	400 x 350	
9-10	1480	9.05	0.47	4.6	0.089	300 x 300	
2-8	1480	7.10	0.31	5.7	0.072	400 x 200	
2-4	5460	8.00	0.195	6.2	0.245	500 x 500	
4-12	2960	4.05	0.14	5.5	0.149	500 x 300	
12-13	1480	8.76	0.44	4.2	0.098	500 x 200	
4-11	1480	7.14	0.36	4.8	0.086	500 x 200	
4-5	1020	5.00	0.33	4.9	0.058	300 x 200	
5-14	510	6.60	0.67	3.6	0.039	250 x 200	
5-15	510	6.60	0.67	3.6	0.039	250 x 200	
3-17	2960	5.25	0.29	6.2	0.133	400 x 350	
17-18	1480	9.05	0.18	4.6	0.089	300 x 300	
3-16	1480	7.10	0.47	5.7	0.072	400 x 200	
3-6	5460	8.00	0.31	6.2	0.245	500 x 500	
6-20	2960	4.05	0.195	5.5	0.149	500 x 300	
20-21	1480	8.76	0.14	4.2	0.098	500 x 200	
6-19	1480	7.14	0.44	4.8	0.086	500 x 200	
6-7	1020	5.00	0.36	4.9	0.058	300 x 200	
7-22	510	6.60	0.33	3.6	0.039	250 x 200	
7-23	510	6.60	0.67	3.6	0.039	250 x 200	

3.6 Register Selection

3.6.1 Side outlet register, 1480 CMH capacity

Volume control damper 14.6 m throw with deflection blades at 45°

Register size	400 x 200	mm x mm
Static presure losses	24,0 mm. w.c.	

3.6.2 Side outlet register 510 CMH capacity

Volume control damper. 9.1 m thow with deflection blades al 45°

Register size:	200 x 150	mm x mm
Static pressure losses:	24,0 mm. wc.	

3.7 FAN SELECTION

3.7.1 Static Pressure

$$H = \underset{\text{intake}}{h_e} + \underset{\text{filters}}{h_f} + \underset{\text{velocity}}{h_v} + \underset{\text{ducts}}{h_d} + \underset{\text{register static presure}}{h_r}$$

$$= 2\text{ mm} + 4\text{ mm} + 4\text{ mm} + 1\text{ mm} + 24\text{ mm c.a.}$$

$$= 35\text{ mm. c.a.}$$

3.7.2 Power

$$\text{Power} = 2.757 \times 10^{-6} \times Q\text{ (cmh)} \times H\text{ (mm)} \times \frac{1}{n}$$

$Q = 20160$ cmh

$H = 35$ mm.

$n = 50\%$

$$\text{Power} = (2.757 \times 10^{-6} \times 20160 \times 35 \times \frac{1}{0.50})\text{ KW}$$

Power = 3.89 KW

POZA HONDA INLET

CONDUCTOR CALCULATION

1. MAIN CONDUCTOR

Total (VA) load = 11,890 VA

The biggest motor is the 2.3 Kw (2.7 KVA)

Max. load for conductor = 1.25 x 27,00 + (11,890 - 27,00)
= 12,565 VA

$$I = \frac{12{,}565 \text{ VA}}{\sqrt{3} \times 220 \text{ V}} = 33 \ Amp.$$

From "CABLEC" catalog, we need a 4 x 6 AWG, but for uniformity with Conguillo inlet equipment (same diesel engine 20 KVA) will use a

4 x 4 AWG cable or

4C x 22 mm^2 cable, with 48 Amp capacity

Same as Conguillo inlet the conduit required shall be:

cable Ø = 26.6 mm

$$\frac{26.6}{25.4} \times 1.35 = 1.41", \quad \text{(see table):}$$

Ø 1 ½" or Ø 42 mm

Voltage drop: (see voltage drop table)

$$\Delta V\ (\%) = 4.33 \times 10^{-4} \times 4 \times 12.565 \text{ KVA} \times 20 \text{ m}$$

0.4 % (4 x 4 AWG is ok.)

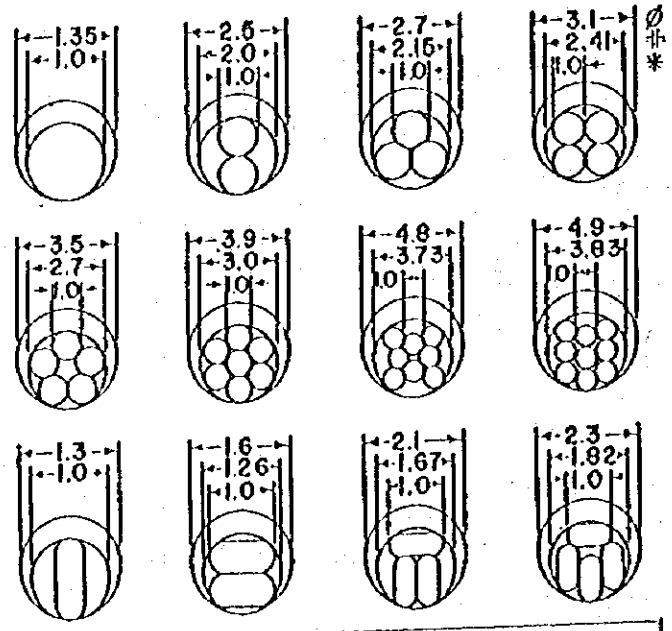
5-5-22

V. Davila

Table 91

CONDUIT SIZES FOR CABLES

Multipliers for One or More Cables Per Conduit



Shown at left is the multiplier # for the smallest equivalent diameter of a group of cables and the multiplier Θ to determine the required internal diameter of the conduit for the same, expressed in terms of the diameter of a single cable*.

Note: The multiplier shown to obtain the required conduit diameter is for cables up to 250 MCM and runs not over 100 feet long having not more than two 90° bends or a total of 180° in bends. (More than 180° in bends between pull boxes is not recommended.)

For more difficult conduit runs, and runs having three or more cables over 250 MCM, increase the internal diameter of the conduit to 120%.

Example 1: To determine the required minimum internal diameter, in inches, of a conduit for three, #2/0—3000 volt, single conductor cables.

Diameter of one, #2/0—3000 volt cable=1.0 × .795= .795"

Minimum internal diameter of conduit=2.7 × .795= 2.146"

From table below a 2½" conduit is required.

Minimum group diameter of the three cables is 2.15 × .795=1.709"

Example 2: To determine the required minimum internal diameter, in inches, of a conduit for two, 4-conductor #9, 600 volt cables.

Diameter of one, 4-conductor #9, cable=1.0 × .788= .788"

Minimum internal diameter of conduit=2.5 × .788= 1.97"

From table below a 2" conduit is required.

Minimum group diameter of the two cables is 2.0 × .788=1.576".

INTERNAL DIAMETERS OF IRON CONDUITS									
½"	¾"	1"	1¼"	1½"	2"	2½"	3"	3½	4
.623	.824	1.05	1.38	1.61	2.07	2.47	3.07	3.55	4.03

Table 92

RIGID METAL CONDUIT

Trade Size, Inches	Length	External Diam., Inches	Nominal Internal Diam., Inches	Nominal Wall Thickness Inches	Minimum Weight 10 Lengths Pounds	Threads Per Inch
½	9' 11¼"	0.840	0.622	0.109	79	14
¾	9' 11¼"	1.050	0.824	0.113	105	14
1	9' 11"	1.315	1.049	0.133	153	11½
1¼	9' 11"	1.666	1.380	0.140	201	11½
1½	9' 11'	1.900	1.610	0.145	249	11½
2	9' 11'	2.375	2.067	0.154	334	11½
2½	9' 10½'	2.875	2.469	0.203	527	8
3	9' 10½'	3.500	3.068	0.216	690	8
3½	9' 10¼'	4.000	3.548	0.226	831	8
4	9' 10¼'	4.500	4.026	0.237	982	8
5	9' 10'	5.563	5.047	0.258	1,344	8
6	9' 10'	6.625	6.065	0.280	1,770	8

Table 93

ELECTRICAL METALLIC TUBING

Weight and Dimensions

SIZE INCHES	DIAMETER, INCHES		Approx. Wt. Per 100 Ft. Lbs.
	External	Internal	
⅜	0.577	0.493	23
½	0.706	0.622	28.5
¾	0.922	0.824	43.5
1	1.163	1.049	64
1¼	1.508	1.380	95
1½	1.738	1.610	110
2	2.195	2.067	140

5-5-73

DESCRIPCION TRABAJO: FACTORES PARA CALCULO DE REGULACION DE REDES AREAS Y SUBTERRANEAS

TENSION: 440V - Sistema Trifásico 60 Hz COS φ: 0.9 UNIDADES: % / KVA-METRO

mm² Cu/Al	CALIBRE AWG MCM / mm²	CONDUCTORES DE ALUMINIO (Aislamiento termoplástico) AEREO (20°C)	CONDUCTORES DE ALUMINIO (Aislamiento termoplástico) SUBTERRANEO (30°C)	CONDUCTORES DE COBRE (Aislamiento Termoplástico) AEREO (20°C)	CONDUCTORES DE COBRE (Aislamiento Termoplástico) SUBTERRANEO (THW 75°C)
7x1,23	8 / 8,21			$12,8 \times 10^{-4}$	$12,16 \times 10^{-4}$
7x1,55	6 / 13,30	$10,38 \times 10^{-4}$		$7,94 \times 10^{-4}$	$7,63 \times 10^{-4}$
7x1,96	4 / 21,15	$7,21 \times 10^{-4}$		$4,69 \times 10^{-4}$	$4,38 \times 10^{-4}$
7x2,47	2 / 33,63	$4,8 \times 10^{-4}$		$3,22 \times 10^{-4}$	$2,82 \times 10^{-4}$
7x2,78	1 / 42,41	$3,98 \times 10^{-4}$		$2,7 \times 10^{-4}$	$2,3 \times 10^{-4}$
7x3,12	1/0 / 53,48	$3,25 \times 10^{-4}$		$2,27 \times 10^{-4}$	$1,83 \times 10^{-4}$
7x3,50	2/0 / 67,43	$2,71 \times 10^{-4}$		$1,94 \times 10^{-4}$	$1,5 \times 10^{-4}$
7x3,93	3/0 / 85,03	$2,28 \times 10^{-4}$		$1,66 \times 10^{-4}$	$1,26 \times 10^{-4}$
7x4,42	4/0 / 107,2	$1,93 \times 10^{-4}$		$1,44 \times 10^{-4}$	$1,05 \times 10^{-4}$
12x3,67	250 / 126,8				$0,75 \times 10^{-4}$
12x4,04	300 / 152,3				$0,66 \times 10^{-4}$
19x3,45	350 / 177,6				$0,59 \times 10^{-4}$
19x3,69	400 / 202,7				$0,54 \times 10^{-4}$
19x4,12	500 / 253,10				$0,47 \times 10^{-4}$
	1000				$0,2755 \times 10$

$$\Delta V(\%) = K \times KVA \times L(m)$$

$$K = \frac{R\cos\phi + X\,\mathrm{sen}\,\phi}{10\,(V)^2}$$

$$K_{440} = K_{208}\left(\frac{208}{440}\right)^2 =$$

$$\boxed{K_{440} = K_{208} \times (0.22)}$$

$$K_{480} = K_{440} \times \left(\frac{440}{480}\right)$$

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	A.M.G.		VII-23-90	

5-5-50

2. FAN MOTOR

The fan motor is2.3 KW (2.7 KVA)

$$1.25 \times 2{,}700 \text{ VA} = 3{,}375 \text{ VA}$$

$$I = \frac{3{,}375 \text{ VA}}{\sqrt{3} \times 220 \text{ V}} = 8.9 \text{ Amp.}$$

Use 4 x 12 AWG cable or
4C x 3.5 mm^2 cable

The conduit:

Cable diameter = 14.8 mm,

Then:

$$\frac{14.8}{25.4} \times 1.35 = 0.79'' \text{ (see table)}$$

Then the Conduit required is ∅ 3/4" or ∅ 22 mm

Voltage drop:

$$\Delta V\ (\%) = K \times KVA \times L\ (m)$$
$$= 30.4 \times 10^{-4} \times 4 \times 3.375 \text{ KVA} \times 12\text{m}$$
$$= 0.5\ \%$$ (4 x 12 AWG cable is ok.)

3. MOTOR FOR VALVE OPERATION

Motor is 0.75 KW (880 VA)

1.25 x 800 = 1,100 VA

$$I = \frac{1{,}100 \text{ VA}}{\sqrt{3} \times 220 \text{ V}} = 2.9 \text{ Amp.}$$

Voltage drop:

ΔV (%) $= 30.4 \times 10^{-4} \times 4 \times 1.1$ KVA $\times$ 40 m

$= 0.5$ %

Use 4 x 12 AWG cable or
4C x 3.5 mm^2
and Conduit Ø 3/4" or Ø 22 mm

4. SUMP PUMP MOTOR

Motor is 0.75 kw (880 VA)

1.25 x 880 VA = 1,100 VA

$$I = \frac{1{,}100 \text{ VA}}{\sqrt{3} \times 220 \text{ V}} = 2.9 \text{ Amp.}$$

Voltage drop:

ΔV (%) $= 30.4 \times 10^{-4} \times 4 \times 1.1$ KVA $\times$ 41 m

$= 0.6$ %

Use 4 x 12 AWG cable or
4C x 3.5 mm^2 cable
and Conduit ø 3/4" or ø 22 mm

5

POZA HONDA INLET

LIGHTING DESIGN

Lighting system is designed to obtain the functional and economical features as well as easy maintenance. From these points, locations of lighting fixtures and arrangement of circuit are determined adequately in Poza Honda inlet.

1. CONTROL ROOM

- Illumination level: 300 lux
- Area: 25.6 m^2
- Mounting height = 2.8 m
- Luminaire, type A; Pipe pendent fluorescent light, 400 W x 2 (See drawings)

$$\text{Room ratio} = \frac{\text{Width x Length}}{\text{Work Plane to Mounting Height (Width + Length)}} \ *$$

$$RR = \frac{25.6}{(2.8 - 0.76)\ (7.1 + 3.61)} = 1.17$$

* From: IES LIGHTING HANDBOOK, (Illuminating Engineering Society U.S.A), WESTINGHOUSE LIGHTING HANDBOOK (Westinghouse Electric Co. U.S.A 1978)

For:

Ceiling reflectance	80%
Walls reflectance	50%
Floor reflectance	10%

We get from tables for the above luminaire the COEFFICIENT OF UTILIZATION (CU);
CU = 0.44, and
Maintenance factor = 0.7

Then:

$$\text{Required lumens} = \frac{\text{Desired Illumination x Area}}{\text{Coefficient of Utilization x Maintenance Factor}}$$

$$\text{Required lumens} = \frac{300 \times 25.6}{0.44 \times 0.7}$$

$$= 24{,}935 \text{ lumens}$$

$$\text{Number of Lamps} = \frac{\text{Required Lamp Lumens}}{\text{Rated Initial Lamp Lumens } *}$$

* (From OSRAM Catalog, for 40W lamp, 1.2 m length, cool withe, 38 mm bulb diameter, 3,000 lumens).

Then,

$$\text{Number of Lamps} = \frac{24{,}935}{3{,}000}$$

$$= 8.3 \text{ lamps} \qquad \text{(use 9)}$$

$$\text{Number of luminaries} = \frac{9}{2} = 4.5 \quad \text{(se usa 5)}$$

$$= 5 \qquad \text{luminaires 40W x2}$$

2. FAN ROOM

- Illumination level: 200 lux
- Area = 11.33 m^2, mounting height = 2.8 m

$$RR = \frac{11.33}{(2.8 - 0.76)(2.8 + 4.05)}$$

$$= 0.68$$

Then, from tables:

Maintenance factor = 0.7
Coefficient of utilization = 0.353

Required lumens $= \frac{200 \times 11.33}{0.353 \times 0.7}$

= 9,170 lumens

Number of lamps $= \frac{9,170}{3,000} = 3.1$ (use 4)

Number of luminaires = 2 luminaire 40W x 2

3. VALVE ROOM

- Illumination level: 200 lux
- Area = 73.5 m^2
- Mounting height = 2.0 m
- Luminaire, type B-1, for ceiling and wall mounting light, with acrylic cover, 40W x 2

$$RR = \frac{73.5}{(2.0 - 0.76)(9.5 + 7.7)}$$

$$= 3.45$$

Then, from tables:

Maintenance factor = 0.7
Coefficient of utilization = 0.603

Required lumens $= \frac{200 \times 73.5}{0.603 \times 0.7}$

= 34,826 lumens

Number of lamps $= \frac{34,826}{3,000} = 11.6$ (use 12)

Number of luminaire = 6 luminaires 40 W x 2

 5-5-29

POZA HONDA INLET

EARTHING SYSTEM

1. SHORT-CIRCUIT CALCULATION

The energy for the valve motors operation and lighting in Poza Honda inlet shall be provided by a portable diesel engine generator of 20 KVA.

In this case the maximum short-circuit current will be 4.5 or 5 times the rated current or also assuming this kind of generators has a Xd" = 20%

Then:

$$Xd'' = 0.20$$

$$Isc = \frac{1.0}{0.2} = 5.0 \text{ (pu)}$$

$$I_{BASE} = \frac{20.0 \text{ KVA}}{\sqrt{3} \times 0.22 \text{ KV}} = 52.5 \text{ Amp}$$

$$Isc = 5.0 \times 52.5 = 263 \text{ Amp.}$$

Now, we con suppose that sometime this station will be server form the Manabí Electric System, in that case the one line diagram could be:

a) System impedance

We are going to assume the equivalent system impedance on the 138 KV bus in Portoviejo S/S could be:

$Zs = j\,0.087$ in 100 MVA base system.

b) Portoviejo S/S

Two transformers 138/69 KV, 75 MVA each

$X_T = 10\%$ $X(pu) = 0.1 \times \frac{100}{75} = j\,0.133$

c. 69KV transmission line

Portoviejo S/S to Santa Ana S/S

- 12.8 Km
- Conductor: 266.8 MCM (ACSR)

GMD ≅ 2.5 m (8 feet)

$X_L = Xa + Xd$

$= (0.465 + 0.26)$ ohm/mile

$X_L = j\,5.77$ ohm

$$X_L(pu) = \frac{5.77 \times 100{,}000}{69^2 \times 1{,}000} = j\,0.121$$

d) Santa Ana S/S

A transformer 69/13.8 KV, 5 MVA

$X_T = 7\%$

$$X(pu) = 0.07 \times \frac{100}{5} = j\,1.4$$

e) 13.8 KV distribution line

Santa Ana S/S to Poza Honda inlet

- 28 Km, conductor 4/0 AWG ASC

GMD = 1.5 m

X_L = Xa + Xd

= (0.607 + 0.2) ohm/mile

X_L = j 14.04 ohm

$$X_L(pu) = \frac{14.04 \times 100{,}000}{13.8^2 \times 1{,}000} = j\,7.37$$

f) A distribution transformer at Poza Honda

13,800 - 220/127V, 50KVA

X_T = 5%

$$X\,(pu) = 0.05 \times \frac{100}{0.05} = j\,100.0$$

1.1 Short-circuit on 220 V bus

The reactances one line diagram:

$$MVA\ sc\ 3\Phi = \frac{100.0}{109.05} = 917\ KVA$$

$$I\ sc\ 3\Phi = \frac{1.0}{109.05} \times \frac{100{,}000}{\sqrt{3} \times 0.22} = 2{,}407\ Amp$$

$$Isc = 2.4\ KA$$

2. GROUNDING MESH CONDUCTOR

$$A = I \times \sqrt{\frac{\frac{tc\,\mathcal{L}_r\ \rho_r \times 10^4}{TCAP}}{\ln\left(1 + \frac{Tm - Ta}{Ko + Ta}\right)}}$$

Shall use the same data that for Severino P/S, but:

tc = 3.0 sec.

Then:

$$A = 2.407 \times \sqrt{\frac{\frac{3.0 \times 0.00381 \times 1.7774 \times 10^4}{3.422}}{\ln\left(1 + \frac{450 - 40}{242 + 40}\right)}}$$

$= 19.6\ mm^2 \quad \Rightarrow$ No. 4 AWG or 22 mm^2
use 50 mm^2 or 1/0 AWG

3 GROUNDING MESH RESISTANCE

$$r = \sqrt{\frac{A}{\pi}} \quad \text{and} \quad R = \frac{\rho}{2\pi r} + \frac{\rho}{L}$$

Where:

$A = 1{,}704\ m^2$ (grounding mesh area that is covering the structure of Poza Honda inlet).

$L = 480$ m

$\rho_{concrete} = 90.0$ ohm - meter

Then:

$$r = \sqrt{\frac{1{,}704}{\pi}} = 23.3 \text{ m}$$

$$R = \frac{90.0}{2\pi \times 23.3} + \frac{90.0}{480}$$

$$R = 0.8 \text{ ohm}$$

VALVES CHAMBER POZA HONDA INLET VENTILATING SYSTEM

1. SPACE TO BE VENTILATED

1.1. Description

Oval cross section chamber of 18.4 m x 14.4 m, with three subterranean levels: EL. 93.050 EL. 95.500, EL. 104.000; and a control room at EL. 112.500.

1.2 Volumes:

V(93) = A(93) x H(93)
= 104 $m.^2$ x 2.25 m.
= 234 m^3

V(95) = A(95) x H(95)
= 208 m^2 x 8.50 m.
= 1768 $m.^3$

V(104) = A(104) x H(104)
= 208 $m.^2$ x 8.50 m.
= 1768 m^3

V (control) = A (control) x H (control)
= 25.5 $m.^2$ x 3.4 m.
= 87 $m.^3$

2 FLOW RATE

2.1 Service Conditions:

Valve chambers: Occasionally personnel presence:

One person for operation inspections and not more than four persons for maintenance.

In the minimum level reservoir periods, it is possible objectionable odors generation because de organic material of water putrefaction.

5-5-35

It is possible an air flow from the inlet chamber to the tunnel because the water flow induction.

2.2 Control Room

One operator presence.

There are two control panels

2.3 Volume Changes/Hour

Valve chamber 4 changes/hour

Control room 4 changes/hour

2.4 Flow rates

Q = # Changes/h x volume

$Q_1 = 4 \times (234 + 1768 + 1768)$ cmh

$Q_1 = 15080$ cmh = 4.18 cms

$Q_2 = 4 \times 87$ cmh

$Q_2 = 348$ cmh

$Q_T = (15080 + 348)$ cmh = 14.428 cmh

$Q_T = 4{,}24$ cms

Air density = 1.204 Kg./m.^{3}, (20°C)

3 Design:

3.1 Intake louver:

Based on 2.5 m/s.frontal velocity V

$$\text{Área} = \frac{Q}{V} = \frac{4.29\ m^3/s}{2.5\ m/s} = 1.71 m^2$$

Entry losses: 2mm wc

5-5-36

Louver size: 1500 x 1500 (mm x mm)

3.2 Initial duct velocity

For low velocity system; initial duct velocity V = 9,40 m/s

Duct seccion: 0.477 m^2

Initial size: 800 mm. x 800 mm.

Friction losses/length 0.16 mm wc /m

3.3 Duct Sizing

The static regain method is used to calculate de duct sizes.

Nex tables give the results and supporting sumary.

See the ventilating plans for section numbers asigned to the system.

 5-5-37

3.4 Duct Design, Based on the Static Regain Method

SECTION	AIRFLOW	LENGHT	TOTAL EQ. LENGHT	L/Q RATIO	VELOCITY M/S	AREA M^2	DUCT SIZE mm x mm	LOSSES mm wc
V - 1	15120	2.4	7.0	(0.16)	9.40	0.457	800 x 600	1.1
1 - 2	7560	8.5	13.5	0.260	7.65	0.275	750 x 400	
2 - 9	2360	2.0	4.0	0.160	6.65	0.099	350 x 300	
9 - 10	1180	6.0	7.5	0.420	5.05	0.065	350 x 200	
2 - 8	1180	4.0	6.5	0.340	6.00	0.055	300 x 200	
2 - 4	4020	8.5	8.5	0.240	6.35	0.176	650 x 300	
4 - 12	2360	2.0	4.0	0.160	5.65	0.116	400 x 300	
12 - 13	1180	6.0	7.5	0.120	4.40	0.075	400 x 200	
4 - 11	1180	4.0	6.5	0.380	4.85	0.068	350 x 200	
4 - 5	480	5.0	5.0	0.500	4.70	0.028	250 x 150	
5 - 14	240	4.0	6.4	1.000	3.20	0.021	250 x 150	
5 - 15	240	2.0	4.4	0.650	3.50	0.020	250 x 150	
1 -3	7560	10,5	15,5	0.310	7.40	0.284	750 x 400	
3 - 17	2360	2.0	4.0	0.160	6.45	0.102	350 x 300	
17 - 18	1180	6.0	7.5	0.420	4.90	0.067	350 x 200	
3 - 16	1180	4.0	6.5	0.340	5.80	0.057	300 x 200	
3 - 6	4020	8.5	8.5	0.240	6.20	0.180	650 x 300	
6 - 20	2360	2.0	4.0	0.160	5.45	0.120	400 x 300	
20 - 21	1180	6.0	7.5	0.420	4.20	0.078	400 x 200	
6 - 19	1180	4.0	6.5	0.380	4.80	0.068	350 x 200	
6 - 7	480	5.0	5.0	0.500	4.60	0.029	250 x 150	
7 - 22	240	4.0	6.4	1.000	3.10	0.022	250 x 150	
7 - 23	240	2.0	4.4	0.650	3.40	0.020	250 x 150	

5-5-38

3.5 Register Selection

3.5.1 Side outlet register, 1180 CMH capacity

Volume control damper 10.5 m throw with deflection blades at 45°

Register size	400 x 200	mm x mm
Static presure losses	16 mm. w.c.	

3.6.2 Side outlet register 240 CMH capacity

Volume control damper. 5.5 m thow with deflection blades al 45°

Register size:	200 x 150	mm x mm
Static pressure losses:	12 mm. wc.	

3.7 FAN SELECTION

3.7.1 Static Pressure

H = he + hf + hv + hd + hr + hda

H = Total pressure, milimeters of water column mm wc

he = Entry losses mm wc

hf = Filter losses mm wc

hv = Velocity pressure

hd = Duct losses

hr = Outlet operating pressure

H = (2 + 4 + 4 + 1 + 16) mm wc

H = 27 mm wc

3.5.2 Power

Power = $2.757 \times 10^{-6} \times Q\ (CMH) \times H\ (mm\ wc) \times \frac{1}{n}$

Power = $2.757 \times 10^{6} \times 15480 \times 27 \times \frac{1}{0.50}$

Power = 2.3 kw

5-5-96

REFERENCES:

A C G I H	Industrial Ventilation. A manual of recommended practices. 15 th ed. American Conference of Governmental Industrial Hygienists.
A S H R A E	1989 Fundamentals Handbook
A S H R A E	1961 Guide and Data book, Fundamentals and Equipment.
CARRIER COMPANY.	1972 Hand book of Air Conditioning System Design

6. Access Road

6. Access Road

6.1 Hydraulic Calculation

1. Discharge of crossing river

Discharge of crossing river is calculated according to design criteria. Conclusion of calculation are shown in attached tables.

2. Types of culverts

There are seven types of culverts as follows.

1) ø600 mm pipe
2) ø800 mm pipe
3) ø1,000 mm pipe
4) 1.2 x 1.2 m box
5) 1.5 x 1.5 m box
6) 2.0 x 2.0 m box
7) 2.5 x 2.0 m box

Type of culvert is decided according to the discharge of each crossing river, which clearance is possible to make the maximum discharge flow at 80% depth of water by Manning formula. Results of calculation are shown in attached tables.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA POZA HONDA - LOS CUYUYES

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
1	5.00	250.00	70.00	2.24	10.00	160.00	0.40	0.89		
2	4.38	475.00	120.00	3.81	10.00	160.00	0.40	0.78		
3	16.88	550.00	270.00	3.30	10.00	160.00	0.40	3.00		
4	41.25	975.00	280.00	6.31	10.00	160.00	0.40	7.33		
5	7.50	500.00	250.00	3.05	10.00	160.00	0.40	1.33		
6	5.63	350.00	182.00	2.28	10.00	160.00	0.40	1.00		
7	8.75	525.00	255.00	3.20	10.00	160.00	0.40	1.56		
8	71.25	1,275.00	250.00	8.99	10.00	160.00	0.40	12.67		
9	71.25	1,275.00	185.00	10.09	10.00	160.00	0.40	12.67		
10	1.25	250.00	40.00	2.77	10.00	160.00	0.40	0.22		
11	11.25	500.00	235.00	3.12	10.00	160.00	0.40	2.00		
12	263.13	2,250.00	308.00	15.99	16.00	136.00	0.40	39.76		
13	62.50	1,250.00	122.00	11.58	12.00	144.00	0.40	10.00		
14	12.50	750.00	66.00	8.13	10.00	160.00	0.40	2.22		
15	47.50	775.00	70.00	8.26	10.00	160.00	0.40	8.44		
16	160.00	2,050.00	322.00	14.11	14.00	138.00	0.40	24.53		
17	17.50	850.00	141.00	7.02	10.00	160.00	0.40	3.11		
18	8.75	425.00	65.00	4.24	10.00	160.00	0.40	1.56		
19	3.75	250.00	45.00	2.65	10.00	160.00	0.40	0.67		
20	4.38	375.00	50.00	4.06	10.00	160.00	0.40	0.78		
21	38.75	1,425.00	300.00	9.53	10.00	160.00	0.40	6.89		
22	9.38	575.00	60.00	6.21	10.00	160.00	0.40	1.67		
23	10.00	375.00	40.00	4.45	10.00	160.00	0.40	1.78		
24	20.00	525.00	200.00	3.51	10.00	160.00	0.40	3.56		
25	30.00	1,500.00	260.00	10.68	11.00	146.00	0.40	4.87		
26	332.50	2,250.00	280.00	16.58	17.00	127.00	0.40	46.92		
27	30.00	1,000.00	205.00	7.33	10.00	160.00	0.40	5.33		
28	76.88	1,125.00	292.00	7.33	10.00	160.00	0.40	13.67		
29	222.50	2,625.00	282.00	19.76	20.00	111.00	0.40	27.44		
30	15.63	500.00	105.00	4.26	10.00	160.00	0.40	2.78		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.40 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA POZA HONDA - LOS CUYUYES

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
31	5,638.80	13,750.00	240.00	142.36	142.00	31.00	0.40	194.23		
31	5,638.80	13,750.00	240.00						84.61	Calculado para una lluvia de 1 hora
31	5,638.80	13,750.00	240.00						108.05	Calculado para una lluvia de 6 horas
31	5,638.80	13,750.00	240.00						162.66	Calculado para una lluvia de 12 horas
31	5,638.80	13,750.00	240.00						269.95	Calculado para una lluvia de 24 horas
32	94.38	1,600.00	250.00	11.68	12.00	144.00	0.40	15.10		
33	38.75	1,500.00	282.00	10.35	10.00	160.00	0.40	6.89		
34	7.50	550.00	153.00	4.11	10.00	160.00	0.40	1.33		
35	4.38	375.00	95.00	3.17	10.00	160.00	0.40	0.78		
					LA SECA					
1	28.75	750.00	200.00	5.31	10.00	160.00	0.40	5.11		
2	25.00	725.00	200.00	5.10	10.00	160.00	0.40	4.44		
3	28.75	650.00	200.00	4.50	10.00	160.00	0.40	5.11		
4	186.88	1,875.00	240.00	14.26	14.00	138.00	0.40	28.65		
5	130.63	800.00	230.00	5.42	10.00	160.00	0.40	23.22		
6	33.75	800.00	239.00	5.34	10.00	160.00	0.40	6.00		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc > = 10', c = 0.40 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LAS CARRETERAS POZA HONDA (INLET) Y MEMBRILLO (OUTLET)

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
POZA HONDA										
1	2,700	260,00	120,00	1,90	10,00	160,00	0,40	0,480		
2	0,400	60,00	20,00	0,70	10,00	160,00	0,40	0,071		
3	1,350	100,00	40,00	0,96	10,00	160,00	0,40	0,240		
3A	4,050	360,00	160,00	2,48	10,00	160,00	0,40	0,720		3a = A1 + a3
4	1,080	170,00	50,00	1,63	10,00	160,00	0,40	0,192		
4A	5,130	530,00	210,00	3,49	10,00	160,00	0,40	0,912		4a = A1 + A3 + A4
MEMBRILLO										
1	370,450	3.460,00	270,00	27,64	28,00	87,00	0,40	35,810		
2	1,120	120,00	40,00	1,19	10,00	160,00	0,40	0,199		
3	0,700	120,00	40,00	1,19	10,00	160,00	0,40	0,124		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA SEVERINO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
1	1.90	250.00	25.00	3.32	10.00	160.00	0.40	0.34		
2	1.30	200.00	15.00	3.13	10.00	160.00	0.40	0.23		
2A	5.00	200.00	15.00	3.13	10.00	160.00	0.40	0.89		2A = A2 + A3 + A4 + A5
3	0.60	100.00	20.00	1.26	10.00	160.00	0.40	0.11		
4	0.60	50.00	10.00	0.74	10.00	160.00	0.40	0.11		
5	2.50	150.00	10.00	2.62	10.00	160.00	0.40	0.44		
6	3.80	350.00	90.00	2.99	10.00	160.00	0.40	0.68		
7	7.50	500.00	200.00	3.32	10.00	160.00	0.40	1.33		
8	15.00	550.00	260.00	3.35	10.00	160.00	0.40	2.67		
9	18.10	600.00	235.00	3.85	10.00	160.00	0.40	3.22		
10	10.00	350.00	190.00	2.24	10.00	160.00	0.40	1.78		
11	10.60	400.00	200.00	2.57	10.00	160.00	0.40	1.88		
12	125.00	1,800.00	355.00	11.70	12.00	144.00	0.40	20.00		
13	3.80	100.00	25.00	1.15	10.00	160.00	0.40	0.68		
14	5.00	400.00	85.00	3.57	10.00	160.00	0.40	0.89		
15	77.50	1,500.00	350.00	9.53	10.00	160.00	0.40	13.78		
16	6.30	550.00	150.00	4.14	10.00	160.00	0.40	1.12		
17	6.90	700.00	210.00	4.81	10.00	160.00	0.40	1.23		
18	18.80	250.00	30.00	3.10	10.00	160.00	0.40	3.34		
19	70.00	1,800.00	320.00	12.17	12.00	144.00	0.40	11.20		
20	11.30	800.00	225.00	5.46	10.00	160.00	0.40	2.01		
21	1.30	200.00	30.00	2.39	10.00	160.00	0.40	0.23		
22	1.30	350.00	40.00	4.09	10.00	160.00	0.40	0.23		
23	318.10	3,000.00	335.00	21.58	22.00	100.00	0.40	35.34		
23A	340.80	3,000.00	335.00	21.58	22.00	100.00	0.40	37.87		23A=A23+A32+.....A39
24	0.60	100.00	30.00	1.07	10.00	160.00	0.40	0.11		
25	0.60	100.00	20.00	1.26	10.00	160.00	0.40	0.11		
26	4.40	250.00	110.00	1.88	10.00	160.00	0.40	0.78		
26A	25.70	300.00	80.00	2.62	10.00	160.00	0.40	4.57		26A=A26+A27+.....A31
27	2.50	200.00	120.00	1.40	10.00	160.00	0.40	0.44		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA SEVERINO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
28	1.90	150.00	120.00	1.01	10.00	160.00	0.40	0.34		
29	3.80	100.00	110.00	0.65	10.00	160.00	0.40	0.68		
30	0.60	50.00	40.00	0.43	10.00	160.00	0.40	0.11		
31	12.50	300.00	80.00	2.62	10.00	160.00	0.40	2.22		
32	1.90	150.00	60.00	1.31	10.00	160.00	0.40	0.34		
33	3.80	250.00	90.00	2.03	10.00	160.00	0.40	0.68		
34	3.10	100.00	30.00	1.07	10.00	160.00	0.40	0.55		
35	6.30	250.00	50.00	2.54	10.00	160.00	0.40	1.12		
36	1.90	100.00	10.00	1.64	10.00	160.00	0.40	0.34		
37	1.30	50.00	10.00	0.74	10.00	160.00	0.40	0.23		
38	1.30	100.00	30.00	1.07	10.00	160.00	0.40	0.23		
39	3.10	150.00	50.00	1.41	10.00	160.00	0.40	0.55		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA CONGUILLO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
1	0.63	100.00	10.00	1.64	10.00	160.00	0.40	0.11		
2	1.25	80.00	10.00	1.27	10.00	160.00	0.40	0.22		
3	1.88	80.00	15.00	1.08	10.00	160.00	0.40	0.33		
4	710.00	4,050.00	390.00	28.78	29.00	85.00	0.40	67.06		
5	6.25	500.00	200.00	3.32	10.00	160.00	0.40	1.11		
6	11.25	460.00	190.00	3.08	10.00	160.00	0.40	2.00		
6A	18.08	460.00	190.00	3.08	10.00	160.00	0.40	3.21		6A=A6+A11+A12
7	3.75	500.00	245.00	3.07	10.00	160.00	0.40	0.67		
7A	10.00	500.00	245.00	3.07	10.00	160.00	0.40	1.78		7A=A7+A10+A13
8	1.88	500.00	250.00	3.05	10.00	160.00	0.40	0.33		
8A	6.88	500.00	250.00	3.05	10.00	160.00	0.40	1.22		8A=A8+A9+A14
9	3.75	420.00	210.00	2.67	10.00	160.00	0.40	0.67		
9A	5.00	420.00	210.00	2.67	10.00	160.00	0.40	0.89		9A=A9+A14
10	5.00	330.00	175.00	2.16	10.00	160.00	0.40	0.89		
10A	6.25	330.00	175.00	2.16	10.00	160.00	0.40	1.11		10A=A10+A13
11	4.33	250.00	90.00	2.03	10.00	160.00	0.40	0.77		
11A	6.83	250.00	90.00	2.03	10.00	160.00	0.40	1.21		11A=A11+A12
12	2.50	220.00	30.00	2.67	10.00	160.00	0.40	0.44		
13	1.25	120.00	75.00	0.93	10.00	160.00	0.40	0.22		
14	1.25	130.00	100.00	0.92	10.00	160.00	0.40	0.22		
15	2.50	150.00	90.00	1.12	10.00	160.00	0.40	0.44		
16	0.63	140.00	40.00	1.42	10.00	160.00	0.40	0.11		
17	1.88	160.00	40.00	1.66	10.00	160.00	0.40	0.33		
18	3.75	250.00	105.00	1.91	10.00	160.00	0.40	0.67		
19	7.50	240.00	55.00	2.34	10.00	160.00	0.40	1.33		
20	5.00	260.00	80.00	2.22	10.00	160.00	0.40	0.89		
21	2.50	200.00	90.00	1.57	10.00	160.00	0.40	0.44		
22	3.13	220.00	100.00	1.68	10.00	160.00	0.40	0.56		
23	6.25	410.00	100.00	3.45	10.00	160.00	0.40	1.11		
24	10.00	500.00	150.00	3.71	10.00	160.00	0.40	1.78		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA CONGUILLO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	
25	5.63	250.00	150.00	1.67	10.00	160.00	0.40	1.00		
26	8.75	520.00	125.00	4.17	10.00	160.00	0.40	1.56		
27	2.50	230.00	75.00	1.98	10.00	160.00	0.40	0.44		
28	6.25	280.00	150.00	1.90	10.00	160.00	0.40	1.11		
29	2.50	120.00	60.00	1.02	10.00	160.00	0.40	0.44		
30	18.13	650.00	245.00	4.16	10.00	160.00	0.40	3.22		
31	14.33	490.00	245.00	3.00	10.00	160.00	0.40	2.55		
32	3.13	240.00	70.00	2.13	10.00	160.00	0.40	0.56		
33	8.75	500.00	230.00	3.15	10.00	160.00	0.40	1.56		
34	8.75	600.00	250.00	3.76	10.00	160.00	0.40	1.56		
35	5.00	110.00	80.00	0.82	10.00	160.00	0.40	0.89		
36	0.63	90.00	50.00	0.78	10.00	160.00	0.40	0.11		
37	25.00	425.00	85.00	3.83	10.00	160.00	0.40	4.44		
38	5.00	420.00	90.00	3.69	10.00	160.00	0.40	0.89		
39	2.50	250.00	60.00	2.37	10.00	160.00	0.40	0.44		
40	12.50	950.00	180.00	7.26	10.00	160.00	0.40	2.22		
41	5.63	450.00	180.00	3.06	10.00	160.00	0.40	1.00		
42	2.50	280.00	190.00	1.73	10.00	160.00	0.40	0.44		
43	6.25	170.00	50.00	1.63	10.00	160.00	0.40	1.11		
44	1,456.00	4,750.00	295.00	38.52	39.00	71.00	0.40	114.86		
44A	1,629.70	4,750.00	295.00	38.52	39.00	71.00	0.40	128.57		44A=A44+A20+A21+.....A43+A60
45	5.63	450.00	60.00	4.68	10.00	160.00	0.40	1.00		
46	3.75	280.00	45.00	3.02	10.00	160.00	0.40	0.67		
47	7.50	500.00	125.00	3.98	10.00	160.00	0.40	1.33		
48	6.88	500.00	160.00	3.62	10.00	160.00	0.40	1.22		
49	11.25	875.00	170.00	6.75	10.00	160.00	0.40	2.00		
50	13.25	650.00	130.00	5.31	10.00	160.00	0.40	2.36		
51	1.88	120.00	130.00	0.75	10.00	160.00	0.40	0.33		
52	6.25	120.00	40.00	1.19	10.00	160.00	0.40	1.11		
53	7.50	250.00	100.00	1.95	10.00	160.00	0.40	1.33		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHEMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

8-1-7

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA CONGUILLO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	
54	6.25	320.00	80.00	2.82	10.00	160.00	0.40	1.11		
55	4.33	260.00	80.00	2.22	10.00	160.00	0.40	0.77		
56	92.50	220.00	110.00	1.62	10.00	160.00	0.40	16.44		
57	3.75	220.00	70.00	1.93	10.00	160.00	0.40	0.67		
58	3.13	190.00	60.00	1.73	10.00	160.00	0.40	0.56		
59	1.88	130.00	25.00	1.56	10.00	160.00	0.40	0.33		
60	3.13	90.00	30.00	0.95	10.00	160.00	0.40	0.56		
61	1.88	140.00	40.00	1.42	10.00	160.00	0.40	0.33		
62	1.25	120.00	40.00	1.19	10.00	160.00	0.40	0.22		
63	1.88	80.00	30.00	0.83	10.00	160.00	0.40	0.33		
64	1.25	80.00	25.00	0.89	10.00	160.00	0.40	0.22		
65	1.25	90.00	25.00	1.02	10.00	160.00	0.40	0.22		
66	1.25	70.00	30.00	0.71	10.00	160.00	0.40	0.22		
67	3.25	80.00	65.00	0.62	10.00	160.00	0.40	0.58		
68	6.25	500.00	90.00	4.52	10.00	160.00	0.40	1.11		
69	1.88	80.00	20.00	0.97	10.00	160.00	0.40	0.33		
70	3.75	450.00	80.00	4.19	10.00	160.00	0.40	0.67		
71	7.50	380.00	95.00	3.22	10.00	160.00	0.40	1.33		
72	6.25	370.00	50.00	4.00	10.00	160.00	0.40	1.11		
73	7.50	500.00	90.00	4.52	10.00	160.00	0.40	1.33		
74	7.50	500.00	120.00	4.04	10.00	160.00	0.40	1.33		
75	3.13	340.00	120.00	2.59	10.00	160.00	0.40	0.56		
76	21.25	700.00	170.00	5.22	10.00	160.00	0.40	3.78		
77	1,588.75	8,750.00	280.00	79.60	80.00	45.00	0.40	79.44		
77A	1,595.00	8,750.00	280.00	79.60	80.00	45.00	0.40	79.75		77A=A77+A61+A62+A63+A66
78A	18.75	480.00	150.00	3.54	10.00	160.00	0.40	3.33		
78B	0.63	170.00	50.00	1.63	10.00	160.00	0.40	0.11		
79	3.75	220.00	60.00	2.05	10.00	160.00	0.40	0.67		
80	1.88	250.00	45.00	2.65	10.00	160.00	0.40	0.33		
81	1.88	180.00	25.00	2.27	10.00	160.00	0.40	0.33		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA CONGUILLO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	
82	6.88	500.00	85.00	4.62	10.00	160.00	0.40	1.22		
83	199.38	2,750.00	170.00	25.34	25.00	95.00	0.40	21.05		
84	5.63	400.00	60.00	4.08	10.00	160.00	0.40	1.00		
85	6.25	450.00	100.00	3.84	10.00	160.00	0.40	1.11		
86	12.50	670.00	155.00	5.14	10.00	160.00	0.40	2.22		
87	4.38	400.00	90.00	3.49	10.00	160.00	0.40	0.78		
88	1.88	180.00	70.00	1.53	10.00	160.00	0.40	0.33		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA CONGUILLO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (mhs)	Tc SELECCIONADO (mhs)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
4	710.00	4,050.00	390.00	28.78	29.00	85.00	0.40	67.06	43.19	Calculado para una lluvia de 1 hora
4	710.00	4,050.00	390.00	28.78	29.00	85.00	0.40	67.06	37.21	Calculado para una lluvia de 6 hora
4	710.00	4,050.00	390.00	28.78	29.00	85.00	0.40	67.06	62.36	Calculado para una lluvia de 12 hora
4	710.00	4,050.00	390.00	28.78	29.00	85.00	0.40	67.06	113.62	Calculado para una lluvia de 24 hora
44	1,456.00	4,750.00	295.00	38.52	39.00	71.00	0.40	114.86	71.15	Calculado para una lluvia de 1 hora
44	1,456.00	4,750.00	295.00	38.52	39.00	71.00	0.40	114.86	57.96	Calculado para una lluvia de 6 hora
44	1,456.00	4,750.00	295.00	38.52	39.00	71.00	0.40	114.86	98.30	Calculado para una lluvia de 12 hora
44	1,456.00	4,750.00	295.00	38.52	39.00	71.00	0.40	114.86	178.57	Calculado para una lluvia de 24 hora
44A	1,629.00	4,750.00	295.00	38.52	39.00	71.00	0.40	128.51	79.62	Calculado para una lluvia de 1 hora
44A	1,629.00	4,750.00	295.00	38.52	39.00	71.00	0.40	128.51	64.71	Calculado para una lluvia de 6 hora
44A	1,629.00	4,750.00	295.00	38.52	39.00	71.00	0.40	128.51	108.19	Calculado para una lluvia de 12 hora
44A	1,629.00	4,750.00	295.00	38.52	39.00	71.00	0.40	128.51	198.64	Calculado para una lluvia de 24 hora
77	1,588.75	8,750.00	280.00	79.60	80.00	45.00	0.40	79.44	46.50	Calculado para una lluvia de 1 hora
77	1,588.75	8,750.00	280.00	79.60	80.00	45.00	0.40	79.44	45.99	Calculado para una lluvia de 6 hora
77	1,588.75	8,750.00	280.00	79.60	80.00	45.00	0.40	79.44	74.15	Calculado para una lluvia de 12 hora
77	1,588.75	8,750.00	280.00	79.60	80.00	45.00	0.40	79.44	130.62	Calculado para una lluvia de 24 hora
77A	1,595.00	8,750.00	280.00	79.60	80.00	45.00	0.40	79.75	46.71	Calculado para una lluvia de 1 hora
77A	1,595.00	8,750.00	280.00	79.60	80.00	45.00	0.40	79.75	46.18	Calculado para una lluvia de 6 hora
77A	1,595.00	8,750.00	280.00	79.60	80.00	45.00	0.40	79.75	74.46	Calculado para una lluvia de 12 hora
77A	1,595.00	8,750.00	280.00	79.60	80.00	45.00	0.40	79.75	131.21	Calculado para una lluvia de 24 hora

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS. CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

11-1-7

RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA ENTRADA AL TUNEL EN CAÑA DULCE

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
1	2.50	200.00	50.00	1.97	10.00	160.00	0.40	0.44		
1A	28.70/2.50	300.00	80.00	2.62	10.00	160.00	0.40	0.44	[illegible]	1A=A1+26A EN SEVERINO
2	1.25	100.00	10.00	1.64	10.00	160.00	0.40	0.22		
3	3.75	200.00	50.00	1.97	10.00	85.00	0.40	0.35		
4	2.50	200.00	40.00	2.14	10.00	160.00	0.40	0.44		
5	6.25	360.00	85.00	3.16	10.00	160.00	0.40	1.11		
6	18.13	550.00	205.00	3.67	10.00	160.00	0.40	3.22		
7	3.75	400.00	100.00	3.35	10.00	160.00	0.40	0.67		
8	2.50	200.00	45.00	2.05	10.00	160.00	0.40	0.44		
9	161.88	2,500.00	395.00	16.40	16.00	136.00	0.40	24.46		Alcantarilla
10	131.25	1,800.00	360.00	11.63	12.00	144.00	0.40	21.00		Alcantarilla
11	4.38	450.00	200.00	2.94	10.00	160.00	0.40	0.78		
12	26.88	1,000.00	335.00	6.07	10.00	160.00	0.40	4.78		

Q5 CALCULADO POR LA FORMULA RACIONAL, Tc >= 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

21-1-9

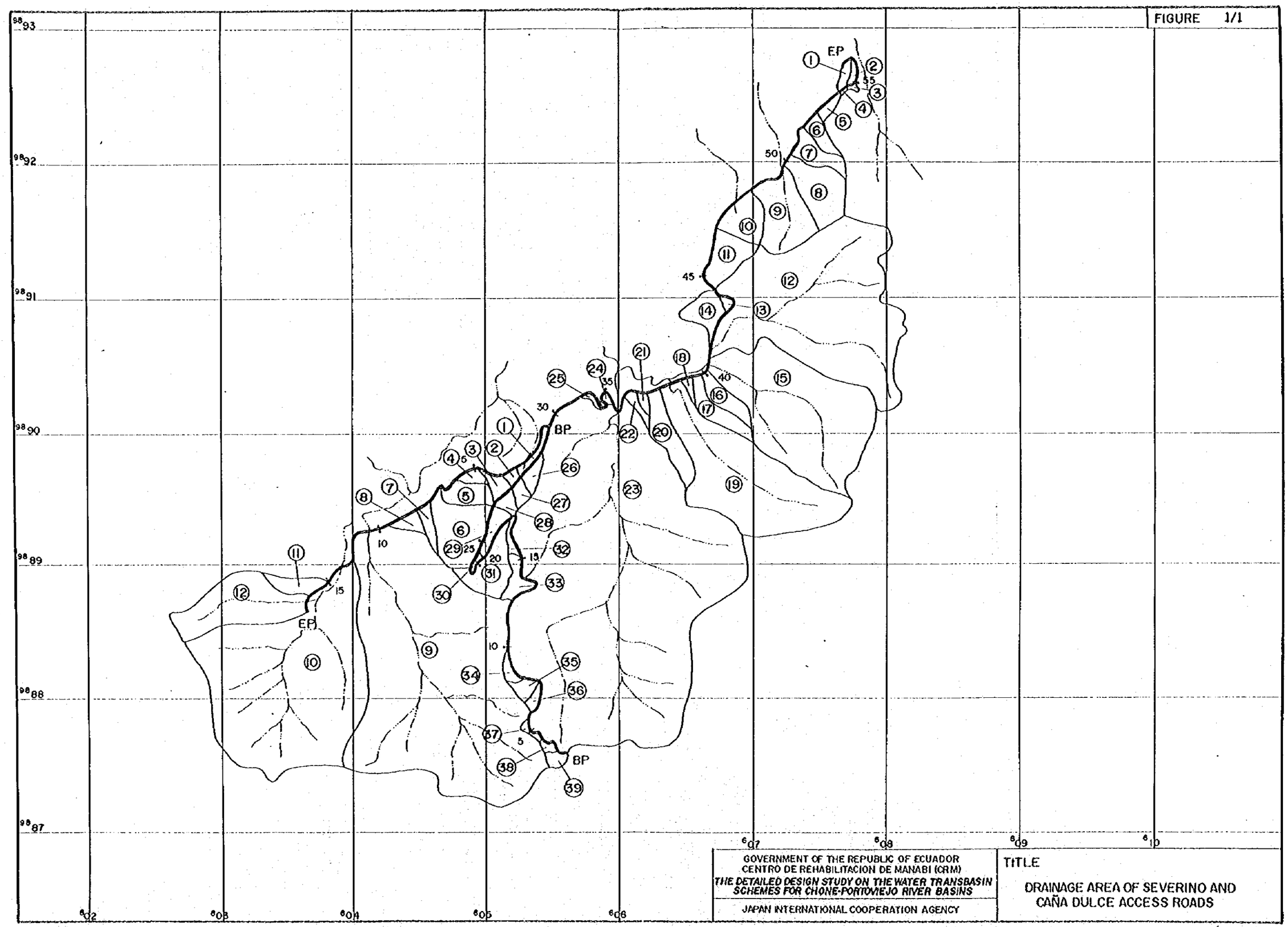
RESULTADOS DEL CAUDAL MAXIMO DE LOS RIOS Y ESTEROS PARA EL DISEÑO DE LA CARRETERA MEMBRILLO Y ACCESO AL GUASMO

CUENCA DE DRENAJE	AREA (Ha)	L (m)	H (m)	Tc (min)	Tc SELECCIONADO (min)	I (mm/h)	C	Q5 (m3/s)	* Q5 (m3/s)	OBSERVACIONES
MEMBRILLO										
1	179.40	3,060.00	270.00	23.99	24.00	96.00	0.40	19.14		
1A	349.48	3,060.00	270.00	23.99	24.00	96.00	0.40	37.28		1A=A1+(A46+.....+A59 EN CONGUILLO)
2	6.25	500.00	120.00	4.04	10.00	160.00	0.40	1.11		
3	2.50	300.00	80.00	2.62	10.00	160.00	0.40	0.44		
4	6.25	140.00	20.00	1.85	10.00	160.00	0.40	1.11		
5	3.13	280.00	80.00	2.42	10.00	160.00	0.40	0.56		
GUASMO										
1	1.25	320.00	100.00	2.59	10.00	160.00	0.40	0.22	✓	
1A	1.25	450.00	80.00	4.19	10.00	160.00	0.40	0.22	✓	1A=A1+(A70 EN CONGUILLO)
2	1.25	230.00	50.00	2.31	10.00	160.00	0.40	0.22	✓	
3	4.38	360.00	85.00	3.16	10.00	160.00	0.40	0.78	✓	
4	13.10	750.00	169.00	5.66	10.00	160.00	0.40	2.33		
4A	13.10	750.00	169.00	5.66	10.00	160.00	0.40	2.33		4A=A4+(A68+A69 EN CONGUILLO)
5	4.38	260.00	55.00	2.37	10.00	160.00	0.40	0.78		
6	115.00	1,950.00	240.00	14.92	15.00	135.00	0.40	17.25		
6A	115.00	1,950.00	240.00	14.92	15.00	135.00	0.40	17.25		6A=A6+(A64+A65+A67 EN CONGUILLO)

Q5 CALCULADO POR LA FORMULA RACIONAL. Tc > = 10', c = 0.4 y Tr = 5 años

* Q5 CALCULADO POR PHIMA CON EL PROGRAMA HIDRO PARA UN PERIODO DE RETORNO DE 10 AÑOS, CON UN TIEMPO DE CONCENTRACION DE 1 HORA Y UN CN DE 84.

FIGURE 1/1



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
DRAINAGE AREA OF SEVERINO AND CAÑA DULCE ACCESS ROADS

6-1-14

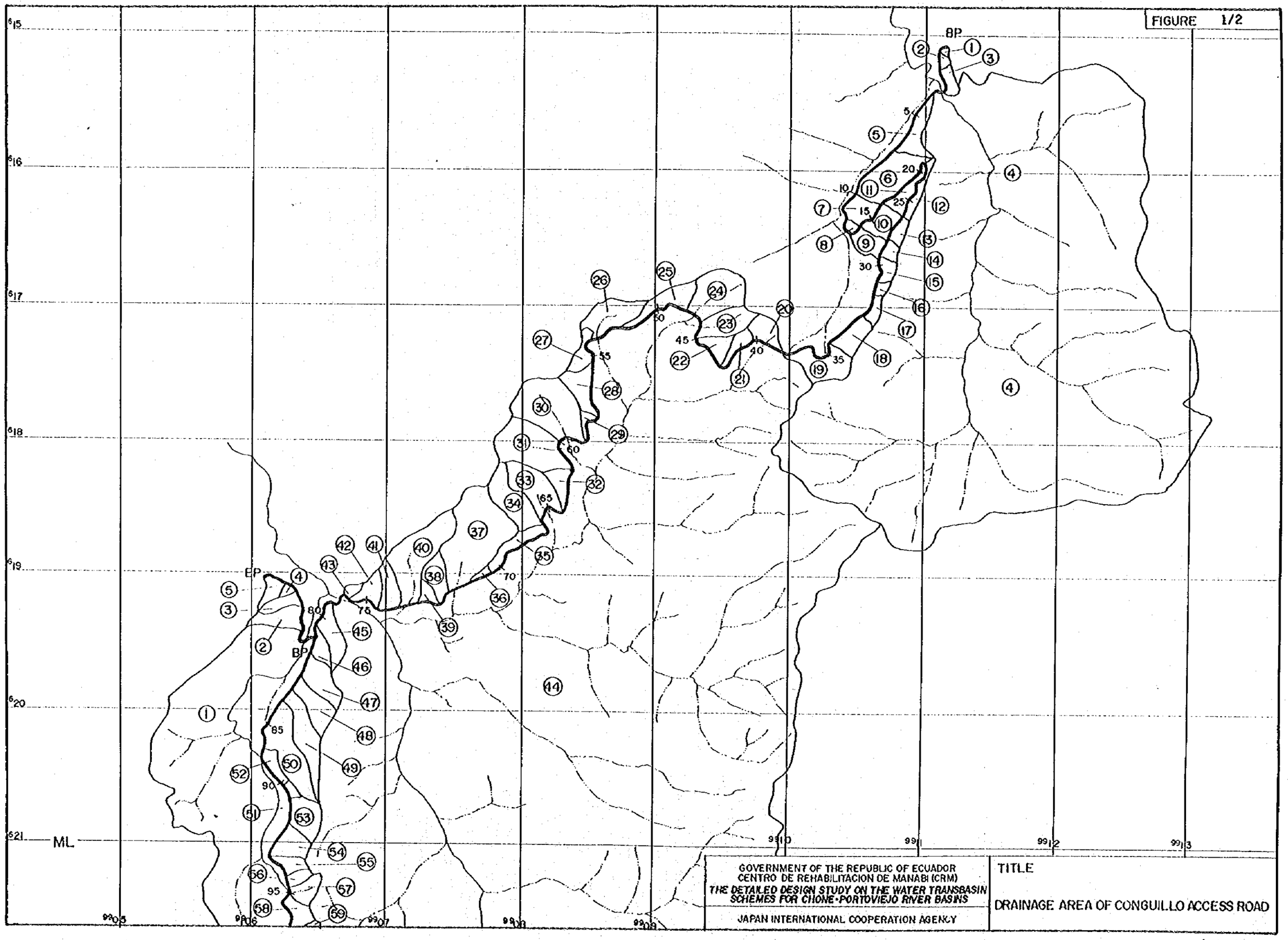


FIGURE 1/2
BP
EP
BP
ML
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE
DRAINAGE AREA OF CONGUILLO ACCESS ROAD

6-1-15

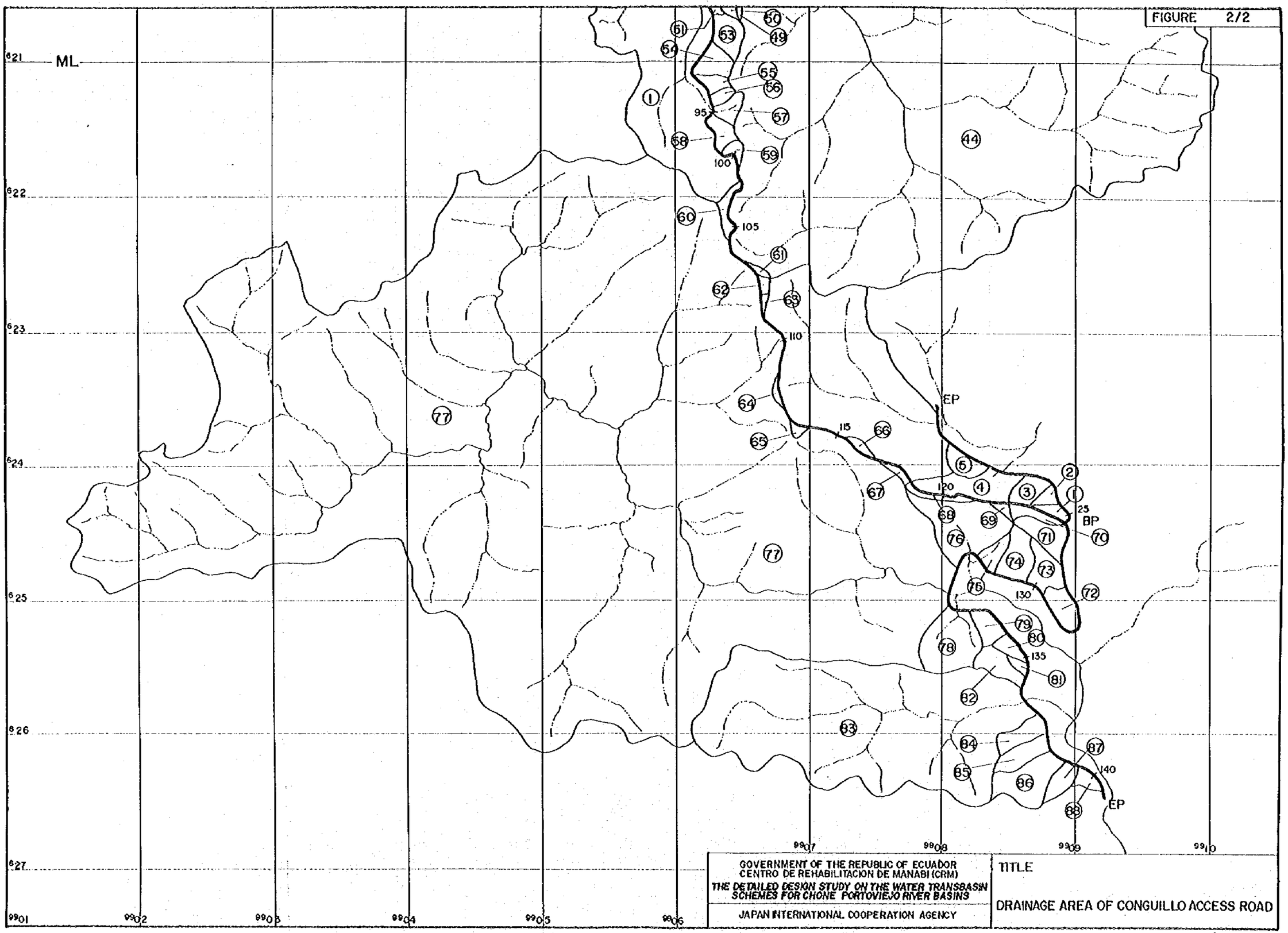


FIGURE 2/2
ML
EP
BP
EP
95
100
105
110
115
120
125
130
135
140
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE
DRAINAGE AREA OF CONGUILLO ACCESS ROAD

6-1-16

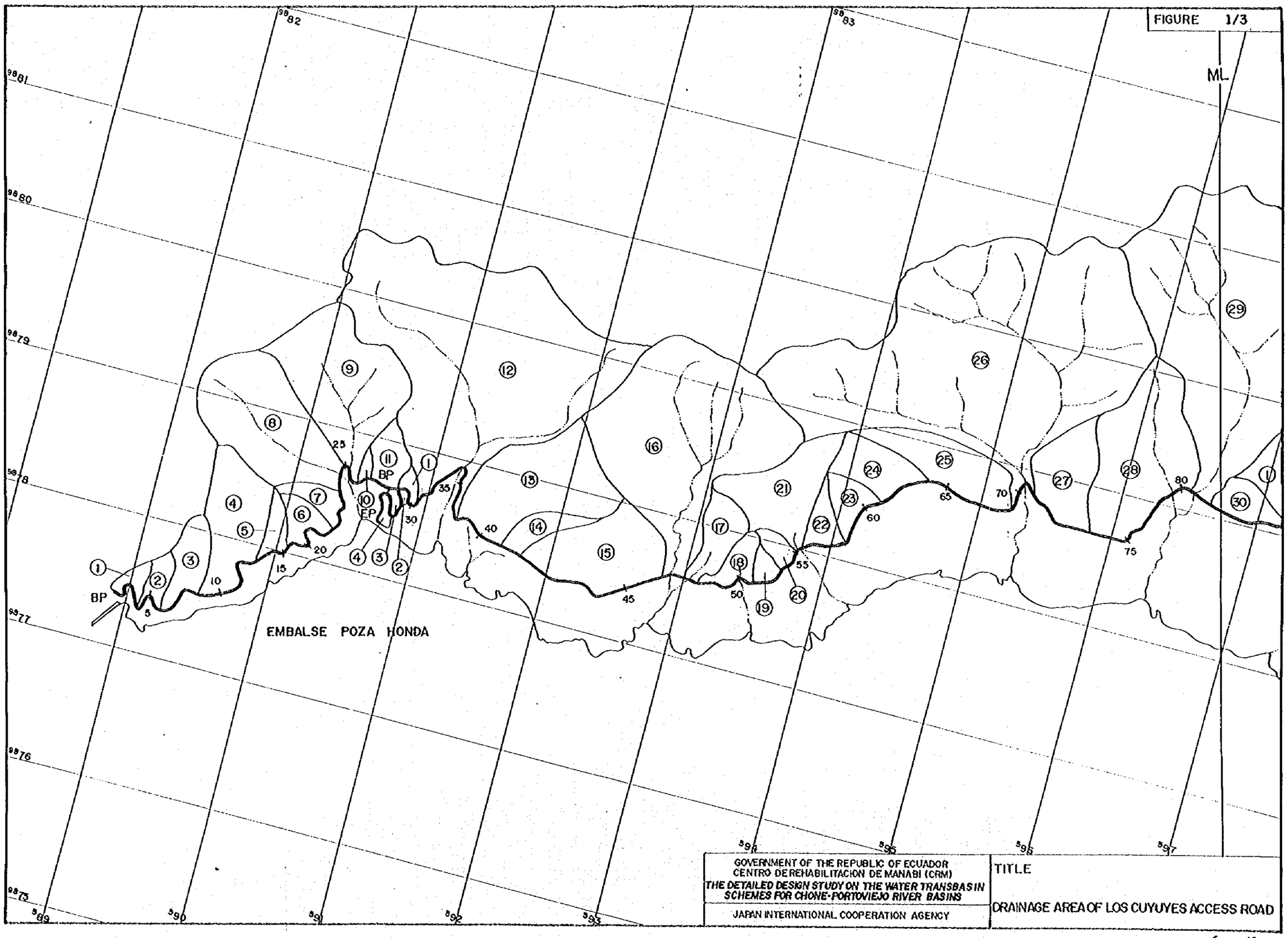


FIGURE 1/3
ML
BP
EP
EMBALSE POZA HONDA
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE DETAILED DESIGN STUDY ON THE WATER TRANSBASIN SCHEMES FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE
DRAINAGE AREA OF LOS CUYUYES ACCESS ROAD

6-1-17

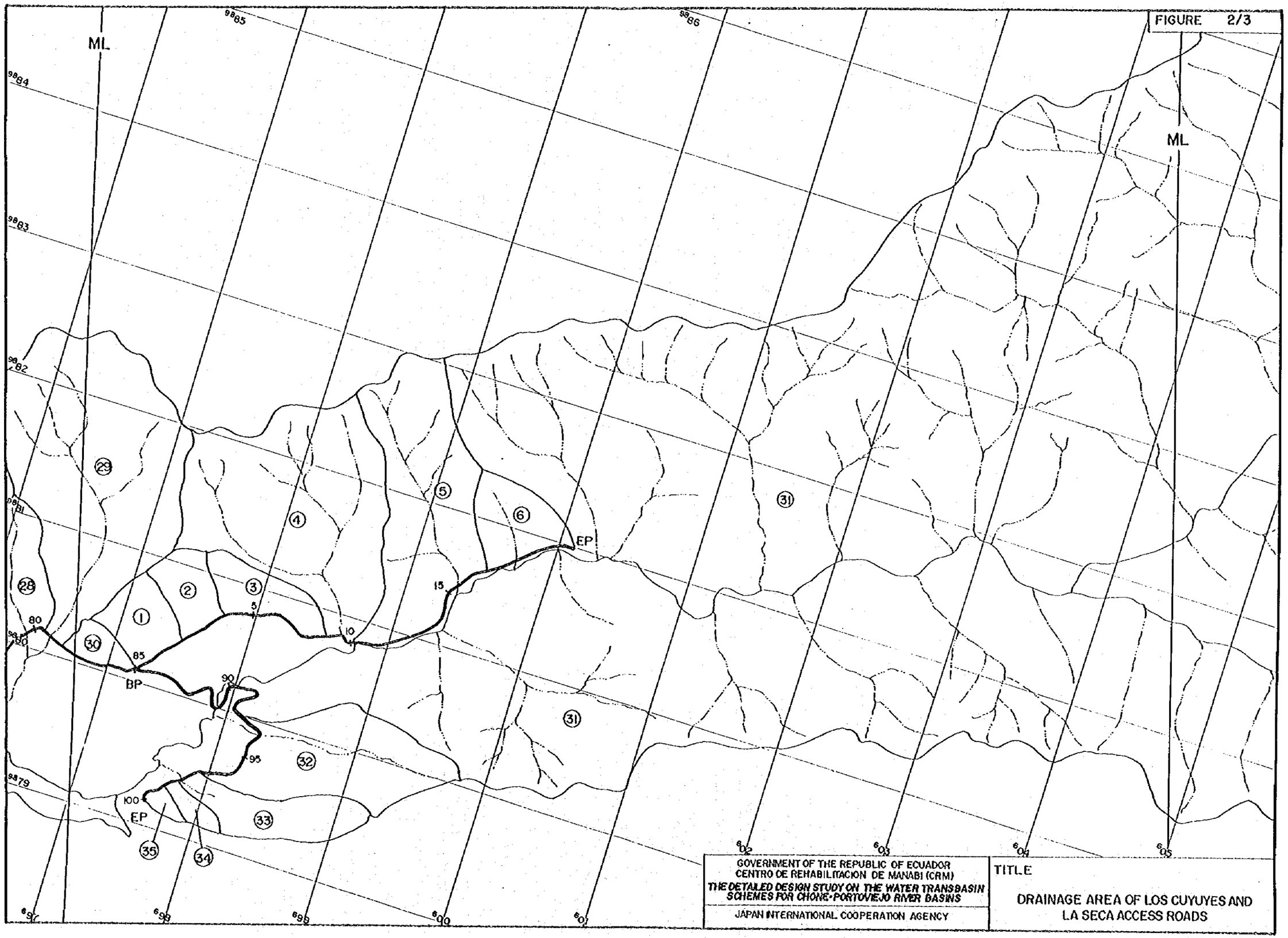


FIGURE 2/3
ML
ML
9885
9886
9884
9883
9882
9881
9880
9879
6902
6903
6904
6905
6997
6998
6999
6000
6001
1
2
3
4
5
6
28
29
30
31
31
32
33
34
35
80
85
90
95
100
5
10
15
BP
EP
EP
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
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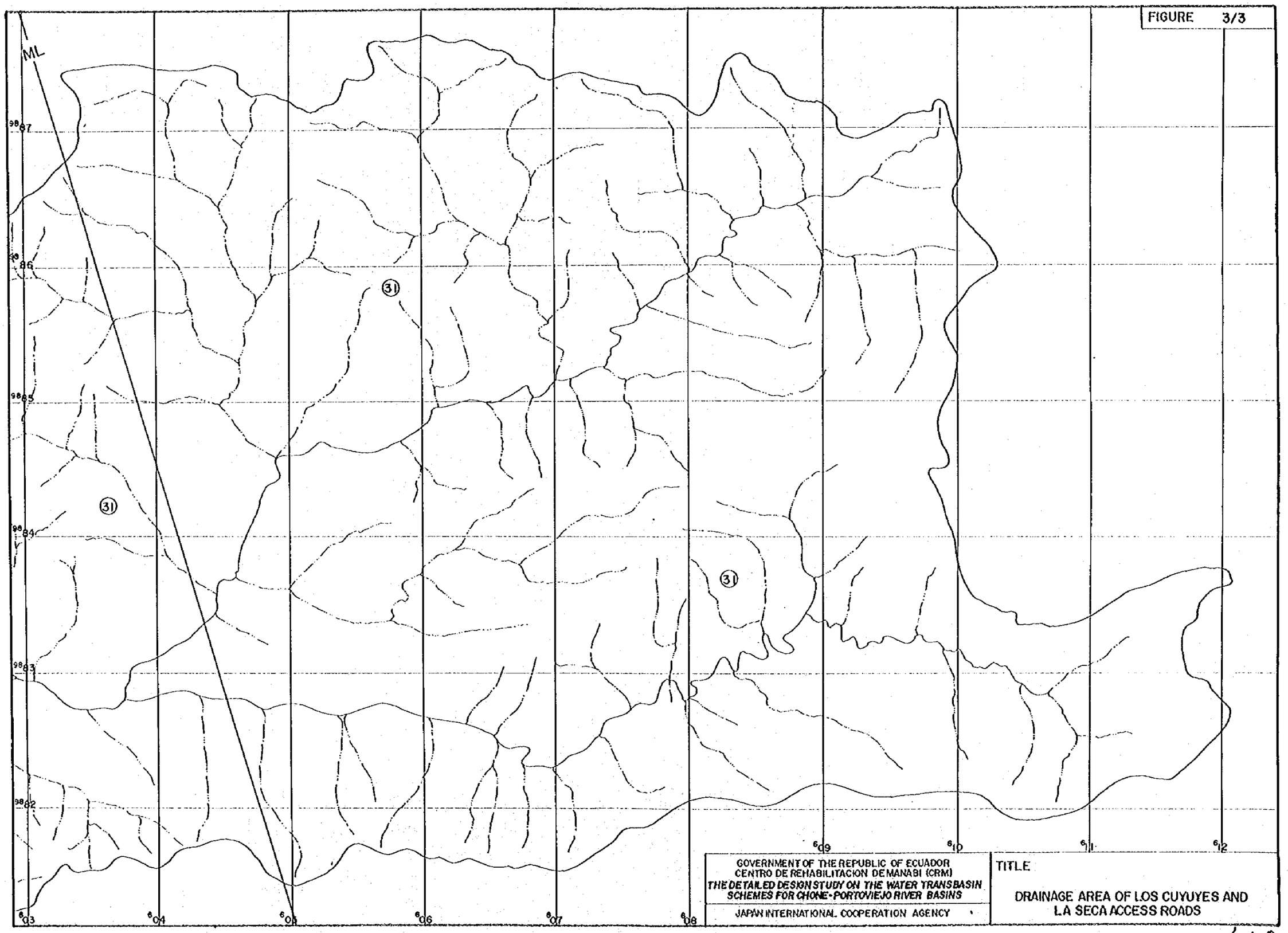
JAPAN INTERNATIONAL COOPERATION AGENCY
TITLE
DRAINAGE AREA OF LOS CUYUYES AND LA SECA ACCESS ROADS

FIGURE 3/3



GOVERNMENT OF THE REPUBLIC OF ECUADOR
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JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

DRAINAGE AREA OF LOS CUYUYES AND LA SECA ACCESS ROADS

6-1-7

CONGUILLO 1

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+522.00	67.060	0.135	2.5 X 2.0 m (I)
D-2	1+980.00	1.110	0.230	Ø600mm (A)
D-3	3+784.00	0.440	0.333	Ø600mm (A)
D-4	3+852.00	0.110	0.313	Ø600mm (A)
D-5	4+070.00	0.330	0.100	Ø600mm (A)
D-6	4+334.00	0.670	0.071	Ø600mm (B)
D-7	4+400.00	0.670	0.321	Ø600mm (C)
D-8	4+904.00	0.890	0.260	Ø600mm (C)
D-9	6+712.00	1.560	0.280	Ø600mm (B)
D-10	7+768.00	3.220	0.100	Ø800mm (C)
D-11	7+930.00	2.550	0.067	Ø800mm (A)
D-12	8+610.00	1.560	0.192	Ø600mm (B)
D-13	9+062.00	0.110	0.140	Ø600mm (B)
D-14	9+647.00	4.440	0.100	Ø1,000mm (C)
D-15	9+947.00	1.330	0.136	Ø600mm (A)
D-16	10+093.00	2.220	0.533	Ø600mm (C)
D-17	10+813.00	1.000	0.151	Ø600mm (C)

CONGUILLO 2

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+360.00	1.220	0.239	Ø600mm (C)
D-2	0+440.00	2.000	0.025	Ø1,000mm (C)
D-3	0+720.00	0.240	0.020	Ø600mm (A)
D-4	0+827.10	2.120	0.050	Ø800mm (C)
D-5	1+287.08	1.440	0.295	Ø600mm (C)
D-6	1+480.70	1.330	0.232	Ø600mm (C)
D-7	1+756.10	1.110	0.189	Ø600mm (C)
D-8	2+158.18	0.670	0.233	Ø600mm (C)
D-9	2+539.16	0.560	0.420	Ø600mm (C)
D-10	2+635.00	0.330	0.208	Ø600mm (A)
D-11	3+188.39	0.560	0.181	Ø600mm (C)
D-12	3+655.00	0.330	0.020	Ø600mm (A)
D-13	3+490.00	0.550	0.020	Ø600mm (A)
D-14	4+446.00	0.220	0.390	Ø600mm (C)
D-15	5+000.00	0.220	0.366	Ø600mm (C)
D-16	5+395.52	0.220	0.212	Ø600mm (A)
D-17	5+520.00	0.220	0.316	Ø600mm (B)
D-18	5+737.12	0.380	0.143	Ø600mm (C)
D-19	5+880.00	0.200	0.020	Ø600mm (A)
D-20	6+560.00	1.110	0.378	Ø600mm (C)
D-21	6+845.84	0.330	0.015	Ø600mm (C)
D-22	7+127.07	0.670	0.180	Ø600mm (C)
D-23	7+320.00	1.330	0.420	Ø600mm (C)
D-24	8+160.00	0.560	0.049	Ø600mm (C)
D-25	8+394.00	0.550	0.333	Ø600mm (C)
D-26	8+600.00	1.330	0.065	Ø800mm (C)
D-27	8+804.66	1.330	0.110	Ø600mm (C)
D-28	8+935.50	0.560	0.066	Ø600mm (A)
D-29	9+083.50	0.570	0.059	Ø600mm (C)
D-30	9+160.00	2.640	0.080	Ø800mm (C)
D-31	9+244.60	0.570	0.100	Ø600mm (A)
D-32	9+673.20	3.330	0.050	Ø1,000mm (C)
D-33	9+809.25	0.110	0.270	Ø600mm (C)
D-34	10+059.97	0.670	0.125	Ø600mm (C)
D-35	10+429.00	0.660	0.100	Ø600mm (C)

EL GUASMO

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+227.50	0.440	0.190	Ø600mm (C)
D-2	0+477.00	0.780	0.283	Ø600mm (C)
D-3	0+856.40	2.330	0.050	Ø800mm (B)
D-4	1+000.00	0.780	0.224	Ø600mm C)
D-5	1+482.62	17.250	0.010	2.5 X 2.0 m (II)

SEVERINO TRAMO 1

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+100.00	0.78	0.175	ø600mm (A)
D-2	0+588.00	0.34	0.010	ø600mm (A)
D-3	0+920.00	1.12	0.128	ø600mm (C)
D-4	1+699.48	0.68	0.050	ø600mm (C)
D-5	2+387.48	0.34	0.355	ø600mm (B)
D-6	2+808.48	2.22	0.245	ø600mm (C)
D-7	3+460.00	0.79	0.248	ø600mm (C)

SEVERINO TRAMO 2

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	1+313.07	3.22	0.244	ø800mm (C)
D-2	3+048.99	20.00	0.030	2.0 x 2.0 m (I)
D-3	3+186.00	13.78	0.140	1.2 x 1.2 m
D-4	3+487.00	11.20	0.100	1.2 x 1.2 m
D-5	3+640.00	2.01	0.300	ø600mm (C)
D-6	3+865.00	0.46	0.065	ø600mm (B)
D-7	3+988.00	1.89	0.136	ø600mm (C)
D-8	4+050.00	35.98	0.058	2.0 x 2.0 m (II)
D-9	4+182.50	0.11	0.100	ø600mm (B)

CA'NA DULCE

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+060.00	5.01	0.060	1.2 x 1.2 m
D-2	1+059.77	1.11	0.030	ø800mm (B)
D-3	1+850.00	24.45	0.030	2.0 x 2.0 m (III)
D-4	2+268.00	21.00	0.050	2.0 x 2.0 m (II)
D-5	2+500.00	0.78	0.080	ø600mm (A)

LA SECA

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+414.50	2.00	0.050	ø800mm (B)
D-2	0+879.50	23.22	0.030	2.0 x 2.0 m (I)
D-3	2+014.00	28.65	0.065	2.0 x 2.0 m (III)
D-4	2+700.00	1.70	0.040	ø800mm (A)
D-5	3+100.00	2.22	0.100	ø800mm (A)
D-6	3+450.00	1.70	0.100	ø800mm (A)

6-1-23

LOS CUYUYES

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+160.00	0.89	0.020	ø800mm (B)
D-2	0+920.00	3.00	0.223	ø800mm (B)
D-3	1+600.00	7.33	0.080	1.2 x 1.2 m
D-4	1+860.00	1.33	0.060	ø800mm (A)
D-5	2+260.00	1.00	0.080	ø600mm (C)
D-6	2+645.00	1.56	0.045	ø800mm (A)
D-7	2+900.00	12.67	0.120	1.2 x 1.2 m
D-8	2+960.00	12.67	0.100	1.5 x 1.5 m
D-9	4+133.50	39.76	0.120	2.0 x 2.0 m (III)
D-10	4+660.00	10.00	0.030	1.5 x 1.5 m
D-11	5+286.41	2.11	0.020	ø1000mm (A)
D-12	6+150.00	2.11	0.273	ø600mm (C)
D-13	6+320.00	24.53	0.015	2.5 x 2.5 m (I)
D-14	6+860.00	1.56	0.080	ø800mm (C)
D-15	7+105.00	0.67	0.040	ø600mm (C)
D-16	7+460.00	6.89	0.223	ø1000mm (C)
D-17	7+895.00	1.78	0.090	ø800mm (C)
D-18	8+545.00	3.56	0.070	ø1000mm (C)
D-19	8+660.00	4.87	0.100	ø1000mm (A)
D-20	9+590.00	46.92	0.100	2.0 x 2.0 m (II)
D-21	11+086.69	13.67	0.070	1.5 x 1.5 m
D-22	11+230.00	27.44	0.060	2.0 x 2.0 m (II)
D-23	13+596.25	15.10	0.106	1.5 x 1.5 m
D-24	14+378.00	6.89	0.072	1.2 x 1.2 m
D-25	14+453.00	1.33	0.026	ø800mm (A)
D-26	14+584.41	0.68	0.090	ø600mm (B)

POZA HONDA INLET

N°/No.	Estacion *Station*	Q m3/s	I	Tipo *Type*
D-1	0+049.50	0.48	0.080	ø600mm (C)
D-2	0+402.00	0.72	0.050	ø600mm (C)
D-3	0+493.91	0.91	0.050	ø600mm (C)

6-1-24