AFRICAN DEVELOPMENT BANK

GOVERNMENT OF MAURITIUS

BEAU BASSIN - PORT LOUIS LINK ROAD

CALCULATION NOTE

FOR

SUPERSTRUCTURES

OF

AQUADUCT

SEPTEMBER 1980

Japan International Cooperation Agency

CONTENTS

1. Aquaduct at STA. 22

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CONTENTS

§§ /. DESIGN CONDITION

§ 1. DESIGN CONDITION

TYPE	POST TENTIONED PRESTRESSED CONCRETE BOX-GIRDER BRIDGE
BRIDGE LENGTH	
GIRDER LENGTH	
SPAN	21.650 + 24.050
LIVE LOAD	WATER 0.4 T/M
	FOOTWAY LOADING 0.51 T/M

ULTIMATE LOAD FACTORS

1.5 D + 2.5 L

2.0 (D + L)

§ 2. MATERIAL STRENGTH AND PERMISSIBLE STRESS

I. CONCRETE

I) MAIN GIRDER

SPECIFIED WORKS CUBE STRENGTH

AT 28 DAYS	40	N/mm^2
	(408	$Kg/Cm.^2$)
AT TRANSFER	34	N/mm^2
	(347	Kg/cm^2)

PERMISSIBLE COMPRESSIVE STRESS

AT WORKING LOAD	13.2	N/mm^2
	(135	Kg/cm^2)
AT TRANSFER	17.0	N/mm^2
	(173	Kg/cm^2)

PERMISSIBLE TENSILE STRESS

AT WORKING LOAD	0	
AT TRANSFER	- 1	N/mm^2
	(- 10	Kg/cm^2)

LIMITTING PRINCIPAL TENSILE STRESS

AT WORKING LOAD - 1 N/mm^2

(- 10 Kg/cm^2)

AT ULTIMATE LOAD - 2.4 N/mm^2

(- 24 Kg/cm^2)

MODULUS OF ELASTICITY

AT 28 DAYS 31 KN/mm^2

(3.2×10^5 Kg/cm^2)

AT TRANSFER 29 KN/mm^2

(3.0×10^5 Kg/cm^2)

2 PRESTRESSING STEEL

1) LONGITUDINAL CABLE

12-Ø 7 mm WIRE

SPECIFIED CHARACTERISTIC STRENGTH

$$Aps\ fpu = 60.4 \times 12 = 724.8\ KN$$

$$Aps = 38.5 \times 12 = 462.0\ mm^2$$

$$fpu = 1.57\ KN/mm^2$$

PERMISSIBLE TENSILE STRESS

AT TRANSFER $fpi = 1.099\ KN/mm^2$

$(112\ Kg/cm^2)$

MODULUS OF ELASTICITY

$$Ep = 200\ KN/mm^2$$

$(2.0 \times 10^6\ Kg/cm^2)$

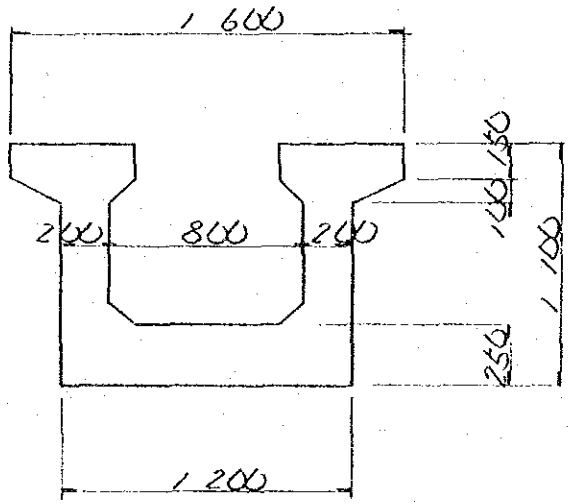
§§ 2. DESIGN OF GIRDER

§ 1. SECTION FORCE DUE TO DESIGN LOAD

1. DEAD LOAD I

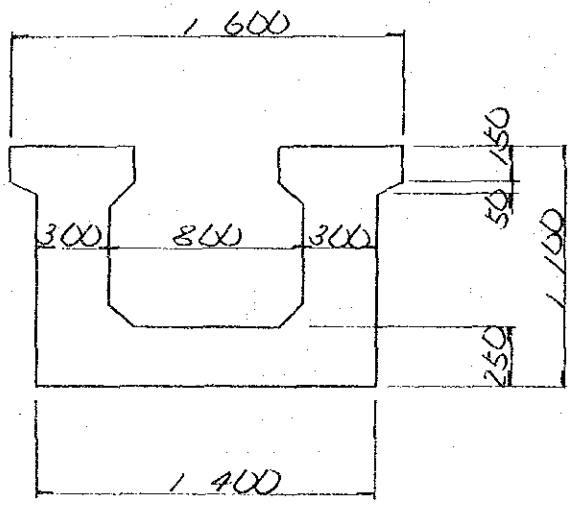
1). GIRDER

MIDSPAN



$A = 0.770\ m^2$

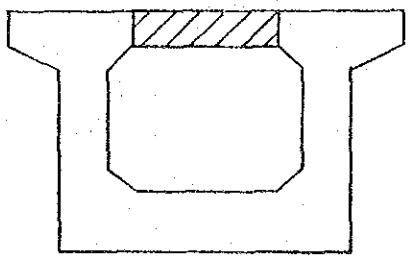
SUPPORT



$A = 0.940\ m^2$

2. DEAD LOAD II

1). STRAD

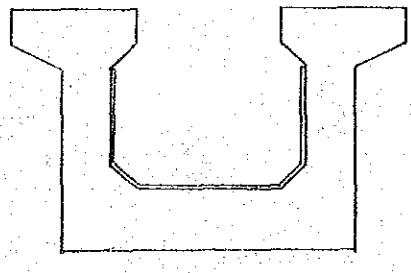


A = 0.600 × 0.150 = 0.09 m^2

WIDTH ; 0.30 m

SPACING ; 2.000 m

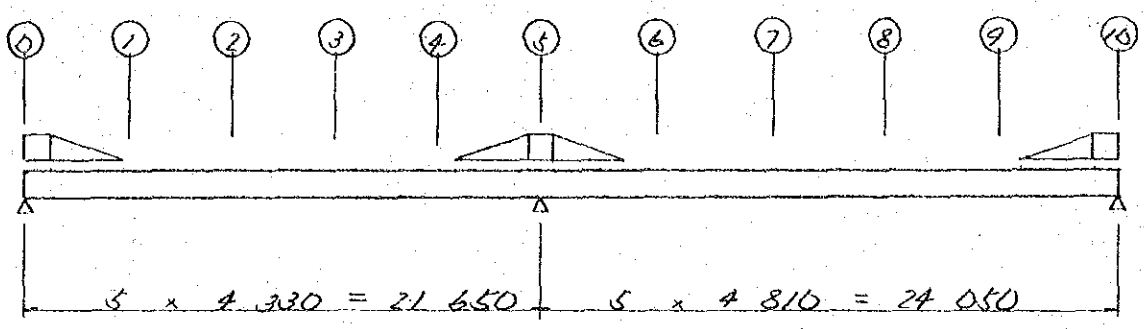
2) MORTAR (WATER PROOF)



L = 1.883 m

THICKNESS ; 0.02 m

SECTION FORCE



DEAD I SELF WEIGHT $w = 0.77 \times 2.41 = 1.856$ t/m

$P = 0.175 \times 2.41 \times 1.0 = 0.422$ t

$\Delta P = \frac{1}{2} \times 0.175 \times 3.0 \times 2.41 = 0.633$ t

DEAD II STRAD $w = 0.15 \times 0.60 \times 0.30 \times \frac{2.41}{2.0} = 0.033$ t/m

MORTAR $w = 1.883 \times 0.02 \times 2.15 = 0.081$ t/m

LIVE CROWD LOAD $w = 0.51 \times 1.0 = 0.51$ t/m

WATER $w = 0.40$ t/m

BENDING MOMENT

(t·m)

		①	②	③	④	⑤	⑥	⑦	⑧	⑨
DEAD I		46.4	56.6	32.2	-27.2	-122.2	-12.5	54.2	78.6	61.1
DEAD II		2.8	3.4	2.0	- 1.7	- 7.4	- 0.8	3.3	4.8	3.7
LIVE	MAX	26.1	35.1	27.1	7.7	0	8.0	35.0	43.9	32.4
	MIN	- 3.8	- 7.6	-11.4	-21.2	-59.2	-14.1	- 8.5	- 5.7	- 2.8
TOTAL	MAX	75.3	95.1	61.3	-21.2	-129.6	- 5.3	92.5	127.3	97.2
	MIN	45.4	52.4	22.8	-50.1	-188.8	-27.4	49.0	77.7	62.0

SHEAR FORCE

(t)

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5
DEAD I		15.4	6.3	-1.7	-9.8	-17.8	-26.9
DEAD II		0.9	0.4	-0.1	-0.6	-1.1	-1.6
LIVE LOAD	MAX	8.0	4.4	1.8	0.6	0.1	0
	MIN	-0.9	-1.1	-2.3	-5.3	-8.7	-12.7
TOTAL	MAX	24.3	11.1	0	-9.8	-18.8	-28.5
	MIN	15.4	5.6	-4.1	-15.7	-27.6	-41.2

(t)

		SEC-6	SEC-7	SEC-8	SEC-9	SEC-10
DEAD I		16.7	7.7	-1.2	-10.1	-20.1
DEAD II		1.0	0.4	-0.1	-0.7	-1.2
LIVE LOAD	MAX	3.7	2.3	1.6	3.2	5.3
	MIN	-5.2	-3.2	-2.1	-3.1	-4.7
TOTAL	MAX	21.4	10.4	-0.3	-7.6	-16.0
	MIN	12.5	4.9	-3.4	-13.9	-26.0

***** SEC - 0 *****

GROSS SECTION

A	CM2	9400.00
I	CM4	11629696.50
Y'	CM	60.89
Y	CM	-49.11
w'	CM3	191006.08
w	CM3	-236792.38
R2	CM2	1237.20

NET SECTION

AS	CM2	15.90
N		8
AC	CM2	9272.77
IC	CM4	11621822.00
YC'	CM	60.99
YC	CM	-49.01
EC	CM	7.84
wC'	CM3	190544.67
wC	CM3	-237144.41
WCG	CM3	1482467.55
RC2	CM2	1253.33

EQUIVALENT SECTION

AP	CM2	4.62
N		8
AE1	CM2	9503.65
IE1	CM4	11635666.50
YE1'	CM	60.80
YE1	CM	-49.20
EE1	CM	7.65
wE1'	CM3	191369.21
wE1	CM3	-236507.79
WEG1	CM3	1521189.11
RE12	CM2	1224.34

***** TORTIONAL RIGIDTY *****

ANU = 110.00 CM ANL = 110.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 10725. CM2

AN (CM)	B (CM)	AN/B
110.00	.00	110.000
110.00	25.00	4.400
97.50	30.00	3.250
97.50	30.00	3.250
	TOTAL1	120.900

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
140.00	25.00	.2958	647136.38
85.00	30.00	.2592	594948.17
85.00	30.00	.2592	594948.17
		TOTAL2	1837032.72 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 5642677.87 CM4

***** SEC - 1 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10528106.00	IC	CM4	10430067.50
Y'	CM	59.40	YC'	CM	58.94
Y	CM	-50.60	YC	CM	-51.06
			LC	CM	-27.96
w'	CM3	177226.63	wC'	CM3	176953.08
w	CM3	-208084.92	wC	CM3	-204281.89
			wCG	CM3	-372971.35
R2	CM2	1367.29	RC2	CM2	1377.32

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10605301.25
YE1'	CM	59.77
YE1	CM	-50.23
EE1	CM	-27.14
WE1'	CM3	177435.05
wE1	CM3	-211134.99
wEG1	CM3	-390799.09
RE12	CM2	1359.02

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) + TOTAL2 = 4271961.19 CM4

***** SEC - 2 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10528106.00	IC	CM4	10414639.25
Y'	CM	59.40	YC'	CM	58.91
Y	CM	-50.60	YC	CM	-51.09
			EC	CM	-30.09
w'	CM3	177226.63	wC'	CM3	176796.39
w	CM3	-206084.92	wC	CM3	-205839.04
			wCG	CM3	-346100.30
R2	CM2	1367.29	RC2	CM2	1375.28

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10617513.75
YE1'	CM	59.80
YE1	CM	-50.20
EE1	CM	-29.20
WE1'	CM3	177556.86
WE1	CM3	-211495.08
WEG1	CM3	-363599.76
RE12	CM2	1360.58

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.b**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 4271961.19 CM4

***** SEC - 3 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10528106.00	IC	CM4	10414639.25
Y'	CM	59.40	YC'	CM	58.91
Y	CM	-50.60	YC	CM	-51.09
			EC	CM	-30.09
w'	CM3	177226.63	wC'	CM3	176796.39
w	CM3	-208084.92	wC	CM3	-203859.04
			wCG	CM3	-346100.30
R2	CM2	1367.29	RC2	CM2	1375.28

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10617513.75
YE1'	CM	59.80
YE1	CM	-50.20
EE1	CM	-29.20
WE1'	CM3	177556.86
WE1	CM3	-211495.08
WEG1	CM3	-363599.76
RE12	CM2	1360.58

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) + TOTAL2 = 4271961.19 CM4

***** SEC - 4 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10528106.00	IC	CM4	10518055.00
Y'	CM	59.40	YC'	CM	59.55
Y	CM	-50.60	YC	CM	-50.45
			EC	CM	8.90
w'	CM3	177226.63	wC'	CM3	176619.89
w	CM3	-208084.92	wC	CM3	-208491.83
			wCG	CM3	1181907.03
R2	CM2	1367.29	RC2	CM2	1368.93

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10535778.75
YE1'	CM	59.29
YE1	CM	-50.71
EE1	CM	8.64
wE1'	CM3	177703.52
wE1	CM3	-207759.24
wEG1	CM3	1219995.87
RE12	CM2	1350.11

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) + TOTAL2 = 4271961.19 CM4

***** SEC - 5 *****

			AS	CM2	15.90
			N		8
A	CM2	9400.00	AC	CM2	9272.77
I	CM4	11629696.50	IC	CM4	11358014.50
Y'	CM	60.89	YC'	CM	61.52
Y	CM	-49.11	YC	CM	-48.48
			EC	CM	46.51
w'	CM3	191006.08	wC'	CM3	186654.87
w	CM3	-236792.38	wC	CM3	-234203.55
			wCG	CM3	244198.89
R2	CM2	1237.20	RC2	CM2	1224.86

AP	CM2	4.62
N		8
AE1	CM2	9503.65
IE1	CM4	11845343.50
YE1'	CM	60.39
YE1	CM	-49.61
EE1	CM	45.38
WE1'	CM3	196159.96
WE1	CM3	-236750.71
WEG1	CM3	261017.65
RE12	CM2	1246.40

***** TORSIONAL RIGIDTY *****

ANU = 110.00 CM ANL = 110.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 10725. CM2

AH (CM)	B (CM)	AH/B
110.00	.00	110.000
110.00	25.00	4.400
97.50	30.00	3.250
97.50	30.00	3.250
	TOTAL1	120.900

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
140.00	25.00	.2958	647136.38
85.00	30.00	.2592	594948.17
85.00	30.00	.2592	594948.17
		TOTAL2	1837032.72 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 5642677.01 CM4

***** SEC - 6 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10526106.00	IC	CM4	10527932.25
Y'	CM	59.40	YC'	CM	59.41
Y	CM	-50.60	YC	CM	-50.59
			EC	CM	.32
w'	CM3	177226.63	wC'	CM3	177207.88
w	CM3	-206084.92	wC	CM3	-208103.30
			wCG	CM3	32798943.00
R2	CM2	1367.29	RC2	CM2	1390.24

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10527955.50
YE1'	CM	59.40
YE1	CM	-50.60
EE1	CM	.31
WE1'	CM3	177236.61
wE1	CM3	-208064.71
wEG1	CM3	33798999.00
RE12	CM2	1349.11

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	F (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 4271961.19 CM4

***** SEC - 7 *****

A	CM2	7700.00
I	CM4	10528106.00
Y'	CM	59.40
Y	CM	-50.60
W'	CM3	177226.63
W	CM3	-208084.92
R2	CM2	1367.29

AS	CM2	15.90
N		8
AC	CM2	7572.77
IC	CM4	10414659.25
YC'	CM	58.91
YC	CM	-51.09
EC	CM	-30.09
WC'	CM3	176796.39
WC	CM3	-203839.04
WCG	CM3	-346100.30
RC2	CM2	1375.28

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10617513.75
YE1'	CM	59.80
YE1	CM	-50.20
EE1	CM	-29.20
WE1'	CM3	177556.86
WE1	CM3	-211495.08
WEG1	CM3	-363599.76
RE12	CM2	1360.58

***** TORTIONAL RIGIDIY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 4271961.19 CM4

***** SEC - 8 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10528106.00	IC	CM4	10414639.25
Y'	CM	59.40	YC'	CM	58.91
Y	CM	-50.60	YC	CM	-51.09
			EC	CM	-50.09
w'	CM3	177226.63	wC'	CM3	176796.39
w	CM3	-208084.92	wC	CM3	-203839.04
			wCG	CM3	-346100.30
R2	CM2	1367.29	RC2	CM2	1375.26

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10617513.75
YE1'	CM	59.80
YE1	CM	-50.20
EE1	CM	-29.20
WE1'	CM3	177556.86
WE1	CM3	-211495.08
WEG1	CM3	-363599.76
RE12	CM2	1360.58

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 4271961.19 CM4

***** SEC - 9 *****

			AS	CM2	15.90
			N		8
A	CM2	7700.00	AC	CM2	7572.77
I	CM4	10526106.00	IC	CM4	10420977.00
Y'	CM	59.40	YC'	CM	58.92
Y	CM	-50.60	YC	CM	-51.08
			EC	CM	-29.24
w'	CM3	177226.63	wC'	CM3	176861.62
w	CM3	-208064.92	wC	CM3	-204019.41
			wCG	CM3	-356422.62
R2	CM2	1367.29	RC2	CM2	1376.11

AP	CM2	4.62
N		8
AE1	CM2	7803.65
IE1	CM4	10612503.50
YE1'	CM	59.79
YE1	CM	-50.21
EE1	CM	-28.37
wE1'	CM3	177506.18
WE1	CM3	-211348.34
wEG1	CM3	-374039.69
RE12	CM2	1359.94

***** TORTIONAL RIGIDITY *****

AN.U = 100.00 CM AN.L = 100.00 CM BHH = 97.50 CM
A = (AN.U + AN.L) / 2 * BHH = 9750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
97.50	20.00	4.875
97.50	20.00	4.875
	TOTAL1	113.750

A (CM)	B (CM)	C	C.A.b**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
85.00	20.00	.2839	193067.17
85.00	20.00	.2839	193067.17
		TOTAL2	929104.11 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 4271961.19 CM4

***** SET - 10 *****

			AS	CM2	15.90
			N		8
A	CM2	9400.00	AC	CM2	9272.77
I	CM4	11629696.50	IC	CM4	11621822.00
Y'	CM	60.89	YC'	CM	60.99
Y	CM	-49.11	YC	CM	-49.01
			EC	CM	7.84
w'	CM3	191006.08	wC'	CM3	190544.67
w	CM3	-236792.38	wC	CM3	-237144.41
			WCG	CM3	1482465.92
R2	CM2	1237.20	RC2	CM2	1253.33

AP	CM2	4.62
N		8
AE1	CM2	9503.65
IE1	CM4	11635666.50
YE1'	CM	60.80
YE1	CM	-49.20
EE1	CM	7.65
wE1'	CM3	191369.21
wE1	CM3	-236507.79
wEG1	CM3	1521187.41
RE12	CM2	1224.34

***** TORTIONAL RIGIDTY *****

ANU = 110.00 CM ANL = 110.00 CM BHH = 97.50 CM
A = (ANU + ANL) / 2 * BHH = 10725. CM2

AN (CM)	B (CM)	AN/B
110.00	.00	110.000
110.00	25.00	4.400
97.50	30.00	3.250
97.50	30.00	3.250
	TOTAL1	120.900

A (CM)	B (CM)	C	C.A.b**3(CM4)
180.00	.00	.3333	.00
140.00	25.00	.2958	647136.38
85.00	30.00	.2592	594948.17
85.00	30.00	.2592	594948.17
		TOTAL2	1837032.72 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 5642677.67 CM4

§ 3. BENDING STRESS DUE TO DESIGN LOAD

(kg/cm²)

		SEC-1		SEC-2		SEC-3	
		TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
DEAD	I	26.2	-22.7	32.0	-27.8	18.2	-15.8
DEAD	II	1.6	-1.3	1.9	-1.6	1.1	-0.9
LIVE LOAD	MAX	14.7	-12.4	19.8	-16.6	15.3	-12.8
	MIN	-2.1	1.8	-4.3	3.6	-6.4	5.4

		SEC-4		SEC-5		SEC-6	
		TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
DEAD	I	-15.4	13.0	-66.2	52.2	-7.1	6.0
DEAD	II	-1.0	0.8	-3.8	3.1	-0.5	0.4
LIVE LOAD	MAX	4.3	-3.7	0	0	4.5	-3.8
	MIN	-11.9	10.2	-30.2	24.8	-8.0	6.8

		SEC-7		SEC-8		SEC-9	
		TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
DEAD	I	30.7	-26.6	44.5	-38.6	34.5	-29.9
DEAD	II	1.9	-1.6	2.7	-2.3	2.1	-1.8
LIVE LOAD	MAX	19.7	-16.5	24.7	-20.8	18.3	-15.3
	MIN	-4.8	4.0	-3.2	2.7	-1.6	1.3

§ 4. PRESTRESS

I. LOSS OF PRESTRESS

I) LOSSES DUE TO FRICTION

FRICTION IN THE DUCT DUE TO UNINTENTIONAL VARIATION FROM THE SPECIFIED PROFILE.
THE STRESS IN PRESTRESSING STEEL σ_x AT ANY DISTANCE x m FROM THE JACK CAN BE CALCULATED FROM THE FORMURA:

$$\sigma_x = \sigma_o \, e^{-kx}$$

WHERE σ_o = TENSILE STRESS IN THE STEEL AT THE JACKING END

e = THE BASE OF NAPIERIAN LOGARISMS.

k = CONSTANT DEPENDING ON THE TYPE OF DUCT, OR SHEATH EMPLOYED, THE NATURE OF ITS INSIDE SURFACE, THE METHOD OF FORMING IT AND THE DEGREE OF VIBRATION EMPLOYED IN PLACING THE CONCRETE = 0.004

FRICTION IN THE DUCT DUE TO CURVATURE OF THE TENDON

$$\sigma_x = \sigma_o \, e^{-\mu x/Rps}$$

WHERE Rps=RADIUS OF CURVATURE

μ =0.30

2) LOSS OF PRESTRESS DURING ANCHORING

$$A = \Delta l \, Ep$$

Δl : MOVEMENT OF STEEL AT THE ANCHORAGE

= 5 mm FOR 12- 7 mm WIRE

3) LOSS OF PRESTRESS DUE TO ELASTIC DEFORMATION OF THE CONCRETE

$$\delta p = 1/2 \; n \; \delta cg$$

WHERE n = MODULER RATIO

δcg THE STRESS IN THE ADJACENT CONCRETE

$$\delta cg = \delta ctg + \delta cdg$$

δctg = PRESTRESS AT THE CENTROID OF TENDONS

δcdg = THE STRESS DUE TO SELF-WEIGHT AT THE CENTROID OF TENDONS

XXXX CALCULATION OF CABLE-LANGTH XXXX

*** C-1 CABLE ***

NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						.200
2 ---	1	5.006	5.034	********	.10472	.726
3 ---	2	.836	.838	8.000	.10472	.770
4 ---	1	7.717	7.717	********	.00000	.770
5 ---	2	2.071	2.094	8.000	.26180	.497
6 ---	1	.503	.521	********	-.26180	.363
7 ---	2	2.071	2.094	-8.000	.26180	.090
8 ---	1	7.494	7.494	********	.00000	.090
9 ---	2	2.071	2.094	-8.000	.26180	.363
10 ---	1	.503	.521	********	.26180	.497
11 ---	2	2.071	2.094	8.000	.26180	.770
12 ---	1	10.117	10.117	********	.00000	.770
13 ---	2	.836	.838	8.000	.10472	.726
14 ---	1	5.006	5.034	********	-.10472	.200
TOTAL		46.300	46.489			

*** C-2 CABLE ***

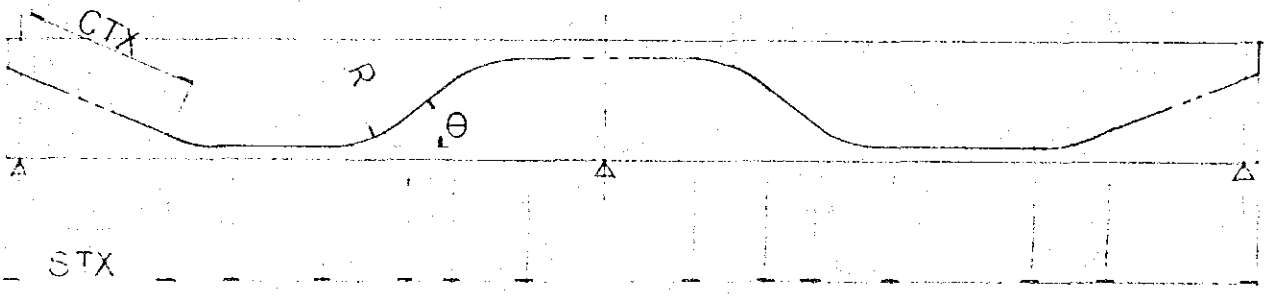
NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						.400
2 ---	1	3.864	3.885	********	.10472	.806
3 ---	2	.836	.838	8.000	.10472	.850
4 ---	1	9.861	9.861	********	.00000	.850
5 ---	2	2.071	2.094	8.000	.26180	.577
6 ---	1	.801	.830	********	-.26180	.363
7 ---	2	2.071	2.094	-8.000	.26180	.090
8 ---	1	4.894	4.894	********	.00000	.090
9 ---	2	2.071	2.094	-8.000	.26180	.363
10 ---	1	.801	.830	********	.26180	.577
11 ---	2	2.071	2.094	8.000	.26180	.850
12 ---	1	12.261	12.261	********	.00000	.850
13 ---	2	.836	.838	8.000	.10472	.806
14 ---	1	3.864	3.885	********	-.10472	.400
TOTAL		46.300	46.498			

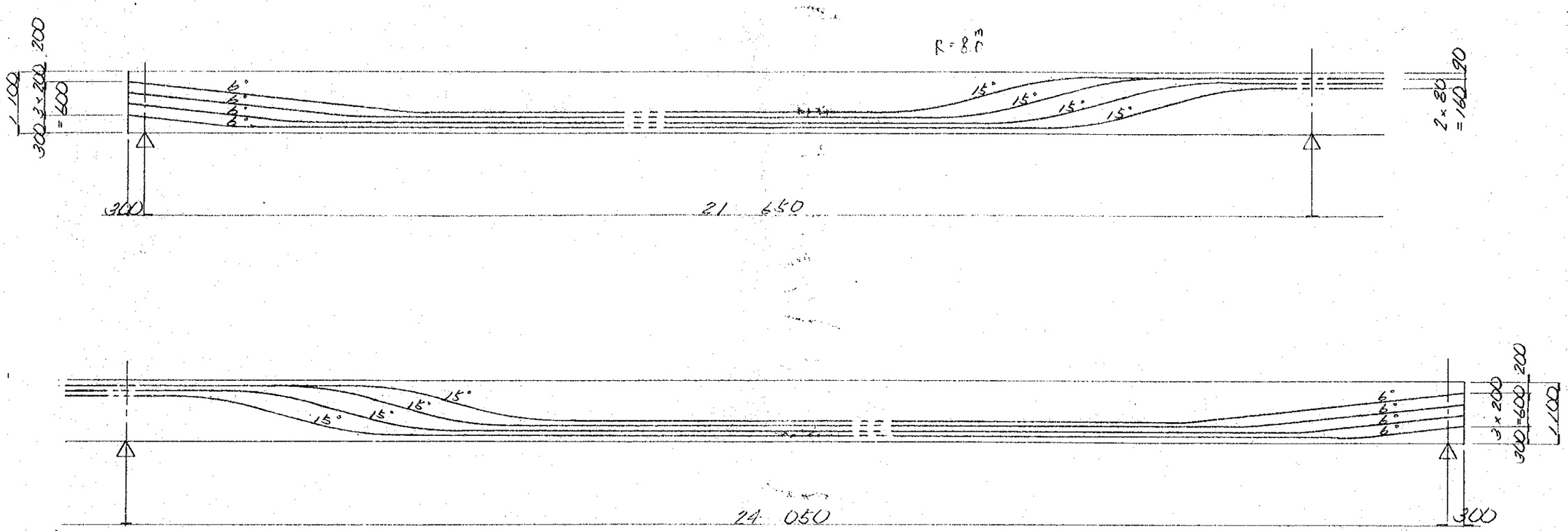
*** C-3 CABLE ***

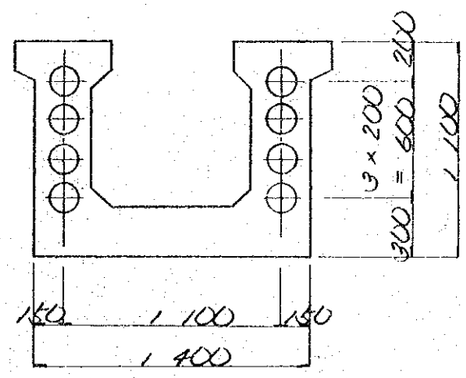
NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						.600
2 ---	1	2.723	2.738	********	.10472	.886
3 ---	2	.836	.838	8.000	.10472	.930
4 ---	1	12.002	12.002	********	.00000	.930
5 ---	2	2.071	2.094	8.000	.26180	.657
6 ---	1	.801	.830	********	-.26180	.443
7 ---	2	2.071	2.094	-8.000	.26180	.170
8 ---	1	2.894	2.894	********	.00000	.170
9 ---	2	2.071	2.094	-8.000	.26180	.443
10 ---	1	.801	.830	********	.26180	.657
11 ---	2	2.071	2.094	8.000	.26180	.930
12 ---	1	14.402	14.402	********	.00000	.930
13 ---	2	.836	.838	8.000	.10472	.886
14 ---	1	2.723	2.738	********	-.10472	.600
TOTAL		46.300	46.485			

*** C-4 CABLE ***

NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1	---					.800
2	--- 1	1.581	1.590	********	.10472	.966
3	--- 2	.836	.838	8.000	.10472	1.010
4	--- 1	14.144	14.144	********	.00000	1.010
5	--- 2	2.071	2.094	8.000	.26180	.737
6	--- 1	.801	.830	********	-.26180	.523
7	--- 2	2.071	2.094	-8.000	.26180	.250
8	--- 1	.894	.894	********	.00000	.250
9	--- 2	2.071	2.094	-8.000	.26180	.523
10	--- 1	.801	.830	********	.26180	.737
11	--- 2	2.071	2.094	8.000	.26180	1.010
12	--- 1	16.544	16.544	********	.00000	1.010
13	--- 2	.836	.838	8.000	.10472	.966
14	--- 1	1.581	1.590	********	-.10472	.800
TOTAL		46.300	46.472			







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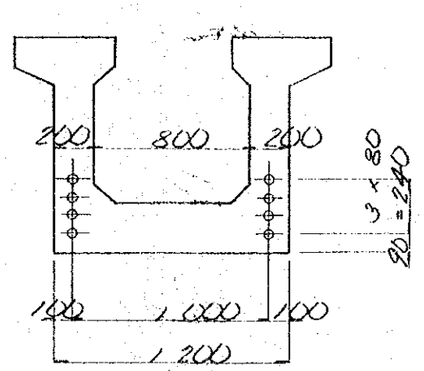

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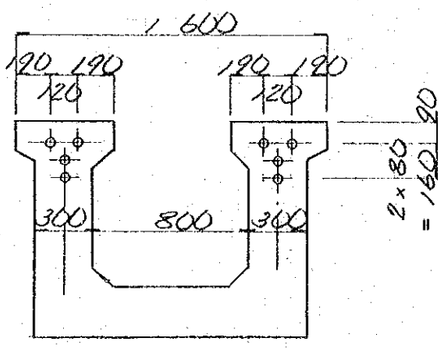


SUPPORT

XxxXx CALCULAITION OF PC-CABLE HIGHT XXXXX
(FROM UPPER SURFACE)

	SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1 * 2	.232	.687	.770	.770	.111	.090	.161
C-2 * 2	.432	.850	.850	.850	.315	.090	.441
C-3 * 2	.632	.930	.930	.930	.660	.170	.773
C-4 * 2	.832	1.010	1.010	1.010	.940	.250	.989
AVELAGE	.532	.869	.890	.890	.507	.150	.591

	SEC-7	SEC-8	SEC-9	SEC-10
C-1 * 2	.770	.770	.736	.232
C-2 * 2	.850	.850	.850	.432
C-3 * 2	.930	.930	.930	.632
C-4 * 2	1.010	1.010	1.010	.832
AVELAGE	.890	.890	.882	.532

XxxXx CALCULAITION OF PC-CABLE ANGLE XXXXX

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1	* 2	.10472	.10472	.00000	.00000	.07297	.00000	.13330
C-2	* 2	.10472	.00878	.00000	.00000	.23763	.00000	.26180
C-3	* 2	.10472	.00000	.00000	.00000	.26033	.00000	.19671
C-4	* 2	.10472	.00000	.00000	.00000	.13279	.00000	.07247

		SEC-7	SEC-8	SEC-9	SEC-10
C-1	* 2	.00000	.00000	.09166	.10472
C-2	* 2	.00000	.00000	.00000	.10472
C-3	* 2	.00000	.00000	.00000	.10472
C-4	* 2	.00000	.00000	.00000	.10472

XXXX CALCULATION OF FRICTION-LOSS , SLIDING-LOSS XXX

*** C-1 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	17.295
POINT - 2	.00000	5.006	5.034	109.767	12.830
POINT - 3	.10472	.836	.836	106.017	5.329
POINT - 4	.00000	6.381	6.381	103.352	.000
POINT - 5	.00000	1.336	1.336	102.794	.000
POINT - 6	.26180	2.071	2.094	94.237	.000
POINT - 7	.00000	.503	.521	94.041	.000
POINT - 8	.26180	2.071	2.094	86.212	.000
POINT - 9	.00000	4.947	4.947	84.532	.000
POINT -10	.00000	2.547	2.547	84.532	.000
POINT -11	.26180	2.071	2.094	85.369	.000
POINT -12	.00000	.503	.521	93.142	.000
POINT -13	.26180	2.071	2.094	93.337	.000
POINT -14	.00000	3.713	3.713	101.812	.000
POINT -15	.00000	6.403	6.403	103.356	.000
POINT -16	.10472	.836	.838	106.017	5.322
POINT -17	.00000	5.006	5.034	109.767	12.824
POINT -18	.00000	.000	.000	112.000	17.289

*** C-2 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	17.900
POINT - 2	.00000	3.864	3.885	110.273	14.446
POINT - 3	.10472	.836	.838	106.505	6.910
POINT - 4	.00000	8.271	8.271	103.050	.000
POINT - 5	.00000	1.569	1.589	102.386	.000
POINT - 6	.26180	2.071	2.094	93.663	.000
POINT - 7	.00000	.801	.830	93.552	.000
POINT - 8	.26180	2.071	2.094	85.764	.000
POINT - 9	.00000	3.647	3.647	84.525	.000
POINT -10	.00000	1.247	1.247	84.525	.000
POINT -11	.26180	2.071	2.094	84.944	.000
POINT -12	.00000	.801	.830	92.658	.000
POINT -13	.26180	2.071	2.094	92.966	.000
POINT -14	.00000	3.963	3.963	101.408	.000
POINT -15	.00000	8.298	8.298	103.055	.000
POINT -16	.10472	.836	.838	106.505	6.900
POINT -17	.00000	3.864	3.885	110.273	14.436
POINT -18	.00000	.000	.000	112.000	17.890

*** C-3 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	18.468
POINT - 2	.00000	2.723	2.738	110.760	16.028
POINT - 3	.10472	.836	.838	106.995	8.458
POINT - 4	.00000	10.120	10.120	102.766	.000
POINT - 5	.00000	1.882	1.882	101.960	.000
POINT - 6	.26180	2.071	2.094	93.490	.000
POINT - 7	.00000	.801	.830	93.160	.000

POINT - 8	.26180	2.071	2.094	85.423	.000
POINT - 9	.00000	2.647	2.647	84.524	.000
POINT -10	.00000	.247	.247	84.524	.000
POINT -11	.26180	2.071	2.094	84.607	.000
POINT -12	.00000	.801	.830	92.290	.000
POINT -13	.26180	2.071	2.094	92.597	.000
POINT -14	.00000	4.251	4.251	101.005	.000
POINT -15	.00000	10.150	10.150	102.773	.000
POINT -16	.10472	.836	.838	106.995	6.443
POINT -17	.00000	2.723	2.738	110.780	16.013
POINT -18	.00000	.000	.000	112.000	16.453

*** C-4 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	19.004
POINT - 2	.00000	1.581	1.590	111.290	17.584
POINT - 3	.10472	.836	.838	107.487	9.979
POINT - 4	.00000	11.936	11.936	102.498	.000
POINT - 5	.00000	2.208	2.208	101.575	.000
POINT - 6	.26180	2.071	2.094	93.119	.000
POINT - 7	.00000	.801	.830	92.611	.000
POINT - 8	.26180	2.071	2.094	85.085	.000
POINT - 9	.00000	.894	.894	84.761	.000
POINT -10	.00906	.073	.073	84.537	.000
POINT -11	.00906	1.998	2.022	84.537	.000
POINT -12	.00000	.801	.830	91.924	.000
POINT -13	.26180	2.071	2.094	92.230	.000
POINT -14	.00000	4.575	4.575	100.605	.000
POINT -15	.00000	11.969	11.969	102.508	.000
POINT -16	.10472	.836	.838	107.487	9.959
POINT -17	.00000	1.581	1.590	111.290	17.564
POINT -18	.00000	.000	.000	112.000	16.984

XXXX CALUCULATION OF FRICTION-LOSS / SLIDING-LOSS XXXX

--- DESIGN SECTION

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1	* 2	94.84	96.77	101.99	102.91	88.42	84.94	89.37
C-2	* 2	94.23	99.28	101.37	102.92	92.85	84.93	92.77
C-3	* 2	93.67	98.98	100.79	102.60	93.54	84.93	94.59
C-4	* 2	93.13	98.43	100.24	102.05	97.25	84.93	98.26
AVELAGE		93.97	98.37	101.10	102.62	93.01	84.93	93.75

		SEC-7	SEC-8	SEC-9	SEC-10
C-1	* 2	102.32	102.39	97.41	94.84
C-2	* 2	102.34	101.78	99.78	94.24
C-3	* 2	102.35	101.20	99.20	93.68
C-4	* 2	102.36	100.65	98.65	93.15
AVELAGE		102.34	101.50	98.76	93.98

XXXX CALCULATION OF FRICTION-LOSS & SLIDING-LOSS XXXX

--- DESIGN SECTION

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1	* 2	111.87	109.94	104.71	102.91	88.42	84.94	89.37
C-2	* 2	111.87	106.82	104.73	102.92	92.85	84.93	92.77
C-3	* 2	111.87	106.55	104.74	102.93	93.54	84.93	94.59
C-4	* 2	111.87	106.56	104.75	102.94	97.25	84.93	98.26
AVELAGE		111.87	107.47	104.73	102.92	93.01	84.93	93.75

		SEC-7	SEC-8	SEC-9	SEC-10
C-1	* 2	102.32	104.32	109.30	111.87
C-2	* 2	102.34	104.33	106.33	111.87
C-3	* 2	102.35	104.35	106.35	111.87
C-4	* 2	102.36	104.37	106.37	111.87
AVELAGE		102.34	104.34	107.09	111.87

*** STATICALLY INDETERMINATE MOMENT (T.M) ***

** SUPPORTS MOMENT **

M2 = 35.150

** TWO END SUPPORTS = HINGE ** M1 = 0. M3 = 0.

** 2-JI MOMENT AT DESIGN SECTION **

1	.000	2	7.030
3	14.060	4	21.090
5	28.120	6	35.150
7	28.120	8	21.090
9	14.060	10	7.030
11	.000		

XXXX DECREASE ON ELASTIC DISPLACEMENT XXXX

SIGN	UNIT	SEC - 0	SEC - 1	SEC - 2	SEC - 3
FPT'	(KG/MM2)	111.866	107.467	104.733	102.924
N		8	8	8	8
AC	(CM2)	9272.766	7572.766	7572.766	7572.766
WCG*10**5	(CM3)	14.825	-3.730	-3.461	-3.461
EC	(CM)	7.840	-27.965	-30.091	-30.091
MDO	(T.M)	.000	46.400	56.600	32.200
PT	(T)	413.241	396.990	386.891	380.208
FCTG	(KG/CM2)	46.750	82.189	84.728	83.264
FDOG	(KG/CM2)	.000	-12.441	-16.354	-9.304
D.FP	(KG/CM2)	155.834	232.495	227.913	246.535
D.FP	(KG/MM2)	1.558	2.325	2.279	2.465
FPT'	(KG/MM2)	93.967	98.366	101.100	102.620
D.FP	(KG/MM2)	1.558	2.325	2.279	2.465
FPT	(KG/MM2)	92.409	96.041	98.821	100.155

SIGN	UNIT	SEC - 4	SEC - 5	SEC - 6	SEC - 7
FPT'	(KG/MM2)	93.013	84.934	93.749	102.343
N		8	8	8	8
AC	(CM2)	7572.766	9272.766	7572.766	7572.766
WCG*10**5	(CM3)	11.819	2.442	327.989	-3.461
EC	(CM)	8.899	46.511	.321	-30.091
MDO	(T.M)	-27.200	-122.200	-12.500	54.200
PT	(T)	343.596	313.753	346.315	378.063
FCTG	(KG/CM2)	47.960	93.595	45.735	82.794
FDOG	(KG/CM2)	-2.301	-50.041	-.038	-15.660
D.FP	(KG/CM2)	152.194	145.160	152.323	223.781
D.FP	(KG/MM2)	1.522	1.452	1.523	2.238
FPT'	(KG/MM2)	93.013	84.934	93.749	102.343
D.FP	(KG/MM2)	1.522	1.452	1.523	2.238
FPT	(KG/MM2)	91.491	83.482	92.225	100.105

SIGN	UNIT	SEC - 8	SEC - 9	SEC - 10
FPT'	(KG/MM2)	104.343	107.088	111.866
N		8	8	8
AC	(CM2)	7572.766	7572.766	9272.766
WCG*10**5	(CM3)	-5.461	-3.564	14.825
EC	(CM)	-30.091	-29.238	7.840
MDO	(T.M)	78.600	61.100	.000
PT	(T)	385.452	395.592	413.241
FCTG	(KG/CM2)	84.412	84.690	46.750
FDOG	(KG/CM2)	-22.710	-17.143	.000
D.FP	(KG/CM2)	205.674	225.157	155.834
D.FP	(KG/MM2)	2.057	2.252	1.558
FPT'	(KG/MM2)	101.503	98.758	93.980
D.FP	(KG/MM2)	2.057	2.252	1.558
FPT	(KG/MM2)	99.446	96.506	92.422

XXXX P.C CABLE TENSILE STRESS XXXX
(ELASTIC DISPLACEMENT OF SECONDARY MOMENT)

SIGN	UNIT	SEC-0	SEC-1	SEC-2	SEC-3
DMPTS	(T.M)	.000	7.030	14.060	21.090
wCG*10**5	(CM3)	14.825	-3.730	-3.461	-3.461
FCSG	(KG/CM2)	.000	-1.865	-4.062	-6.094
D.FP	(KG/CM2)	.000	-6.283	-13.541	-20.312
D.FP	(KG/MM2)	.000	-.063	-.135	-.203
FPT'	(KG/MM2)	92.409	96.041	96.821	100.155
D.FP	(KG/MM2)	.000	-.063	-.135	-.203
FPT	(KG/MM2)	92.409	96.104	96.957	100.358

SIGN	UNIT	SEC-4	SEC-5	SEC-6	SEC-7
DMPTS	(T.M)	28.120	35.150	28.120	21.090
wCG*10**5	(CM3)	11.819	2.442	327.989	-3.461
FCSG	(KG/CM2)	2.379	14.394	.086	-6.094
D.FP	(KG/CM2)	7.931	47.980	.286	-20.312
D.FP	(KG/MM2)	.079	.480	.003	-.203
FPT'	(KG/MM2)	91.491	83.482	92.225	100.105
D.FP	(KG/MM2)	.079	.480	.003	-.203
FPT	(KG/MM2)	91.411	83.003	92.223	100.308

SIGN	UNIT	SEC-8	SEC-9	SEC-10
DMPTS	(T.M)	14.060	7.030	.000
wCG*10**5	(CM3)	-3.461	-3.564	14.825
FCSG	(KG/CM2)	-4.062	-1.972	.000
D.FP	(KG/CM2)	-13.541	-6.575	.000
D.FP	(KG/MM2)	-.135	-.066	.000
FPT'	(KG/MM2)	99.446	96.506	92.422
D.FP	(KG/MM2)	-.135	-.066	.000
FPT	(KG/MM2)	99.582	96.572	92.422

2. EFFECTIVE PRESTRESS

1) LOSS OF PRESTRESS DUE TO RELAXATION OF STEEL

JACKING FORCE $P_o = 112$ kg/mm²

$\gamma = 8\ \%$

$$\delta_{pr} = \gamma \times \delta_{pt}$$

2) LOSS OF PRESTRESS DUE TO SHRINKAGE OF CONCRETE

$$\delta_{ps} = 200 \times 10^{-6} \times E_p$$

3) LOSS OF PRESTRESS DUE TO CREEP OF CONCRETE

$$\delta_{pc} = 36 \times 10^{-6} \times \frac{40}{U_t} \times E_p \times \delta_{cg}$$

	δ_{pt}	δ_{pr}	δ_{ps}	δ_{pc}	δ_{pe}	η
SEC-0	92.409	7.393	4.000	3.206	77.810	0.842
SEC-1	96.104	7.688	4.000	6.101	78.315	0.815
SEC-2	98.957	7.917	4.000	6.646	80.394	0.812
SEC-3	100.358	8.027	4.000	6.740	81.589	0.813
SEC-4	91.411	7.313	4.000	3.913	76.185	0.833
SEC-5	83.003	6.640	4.000	7.593	64.770	0.780
SEC-6	92.223	7.378	4.000	3.735	77.110	0.836
SEC-7	100.308	8.025	4.000	6.736	81.547	0.813
SEC-8	99.582	7.967	4.000	6.687	80.928	0.813
SEC-9	96.572	7.726	4.000	6.340	78.506	0.813
SEC-10	92.422	7.394	4.000	3.206	77.822	0.842

3. PRESTRESS

(Kg/cm²)

	PRESTRESS AT TRANSFER		EFFECTIVE PRESTRESS	
	TOP FIBER	BOTTOM FIBER	TOP FIBER	BOTTOM FIBER
SEC-0	50.9	25.5	42.9	21.5
SEC-1	-9.2	95.5	-7.5	77.8
SEC-2	-13.9	102.2	-11.3	83.0
SEC-3	-14.1	103.7	-11.5	84.3
SEC-4	61.6	30.2	51.3	25.2
SEC-5	110.3	-27.8	86.0	-21.7
SEC-6	45.6	44.5	38.1	37.2
SEC-7	-14.1	103.6	-11.5	84.2
SEC-8	-14.0	102.9	-11.4	83.7
SEC-9	-11.9	98.2	-9.7	79.8
SEC-10	50.9	25.5	42.9	21.5

§ 5. BENDING STRESS DUE TO STATICALLY INDETERMINATE MOMENT

	AT TRANSFER		AT WORKING LOAD	
	TOP FIBER	BOTTOM FIBER	TOP FIBER	BOTTOM FIBER
SEC-1	4.0	− 3.4	3.3	− 2.8
SEC-2	8.0	− 6.9	6.5	− 5.6
SEC-3	11.9	− 10.3	9.7	− 8.4
SEC-4	15.9	− 13.5	13.2	− 11.2
SEC-5	19.0	− 15.0	14.8	− 11.7
SEC-6	15.9	− 13.5	13.3	− 11.3
SEC-7	11.9	− 10.3	9.7	− 8.4
SEC-8	8.0	− 6.9	6.5	− 5.6
SEC-9	4.0	− 3.4	3.3	− 2.8

§ 6. CHECK ON STRESS

SEE PAGE 6. FOR CALCULATION SECTION

SEC - O

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	50.9	25.5
2	EFFECTIVE PRESTRESS	42.9	21.5
3	DEAD LOAD I	0	0
4	DEAD LOAD II	0	0
5	2ND MOMENT AT TRANSFER	0	0
6	AT WORKING LOAD	0	0
7	LIVE LOAD MAX	0	0
8	MIN	0	0
9	AT TRANSFER	50.9	25.5
10	AT WORKING LOAD EXCEPT LIVE	42.9	21.5
11	AT WORKING LOAD MAX	42.9	21.5
12	AT WORKING LOAD MIN	42.9	21.5

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 1

(Kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 9.2	95.5
2	EFFECTIVE PRESTRESS	− 7.5	77.8
3	DEAD LOAD I	26.2	− 22.7
4	DEAD LOAD II	1.6	− 1.3
5	2ND MOMENT AT TRANSFER	4.0	− 3.4
6	AT WORKING LOAD	3.3	− 2.8
7	LIVE LOAD MAX	14.7	− 12.4
8	MIN	− 2.1	1.8
9	AT TRANSFER	21.0	69.4
10	AT WORKING LOAD EXCEPT LIVE	23.6	51.0
11	AT WORKING LOAD MAX	38.3	38.6
12	AT WORKING LOAD MIN	21.5	52.8

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 2

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 13.9	102.2
2	EFFECTIVE PRESTRESS	− 11.3	83.0
3	DEAD LOAD I	32.0	− 27.8
4	DEAD LOAD II	1.9	− 1.6
5	2ND MOMENT AT TRANSFER	8.0	− 6.9
6	AT WORKING LOAD	6.5	− 5.6
7	LIVE LOAD MAX	19.8	− 16.6
8	MIN	− 4.3	3.6
9	AT TRANSFER	26.1	67.5
10	AT WORKING LOAD EXCEPT LIVE	29.1	48.0
11	AT WORKING LOAD MAX	48.9	31.4
12	AT WORKING LOAD MIN	24.8	51.6

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 3

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 14.1	103.7
2	EFFECTIVE PRESTRESS	− 11.5	84.3
3	DEAD LOAD I	18.2	− 15.8
4	DEAD LOAD II	1.1	− 0.9
5	2ND MOMENT AT TRANSFER	11.9	− 10.3
6	AT WORKING LOAD	9.7	− 8.4
7	LIVE LOAD MAX	15.3	− 12.8
8	MIN	− 6.4	5.4
9	AT TRANSFER	16.0	77.6
10	AT WORKING LOAD EXCEPT LIVE	17.5	59.2
11	AT WORKING LOAD MAX	32.8	46.4
12	AT WORKING LOAD MIN	11.1	64.6

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 4

(Kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	61.6	30.2
2	EFFECTIVE PRESTRESS	51.3	25.2
3	DEAD LOAD I	-15.4	13.0
4	DEAD LOAD II	-1.0	0.8
5	2ND MOMENT AT TRANSFER	15.9	-13.5
6	AT WORKING LOAD	13.2	-11.2
7	LIVE LOAD MAX	4.3	-3.7
8	MIN	-11.9	10.2
9	AT TRANSFER	62.1	29.7
10	AT WORKING LOAD EXCEPT LIVE	48.1	27.8
11	AT WORKING LOAD MAX	52.4	24.1
12	AT WORKING LOAD MIN	36.2	38.0

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 6

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	110.3	-21.8
2	EFFECTIVE PRESTRESS	86.0	-21.7
3	DEAD LOAD I	-66.2	52.2
4	DEAD LOAD II	-3.8	3.1
5	2ND MOMENT AT TRANSFER	19.0	-15.0
6	AT WORKING LOAD	14.8	-11.7
7	LIVE LOAD MAX	0	0
8	MIN	-30.2	24.8
9	AT TRANSFER	63.1	9.4
10	AT WORKING LOAD EXCEPT LIVE	30.8	21.9
11	AT WORKING LOAD MAX	30.8	21.9
12	AT WORKING LOAD MIN	0.6	46.7

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 6

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	45.6	44.5
2	EFFECTIVE PRESTRESS	38.1	37.2
3	DEAD LOAD I	-7.1	6.0
4	DEAD LOAD II	-0.5	0.4
5	2ND MOMENT AT TRANSFER	15.9	-13.5
6	AT WORKING LOAD	13.3	-11.3
7	LIVE LOAD MAX	4.5	-3.8
8	MIN	-8.0	6.8
9	AT TRANSFER	54.4	37.0
10	AT WORKING LOAD EXCEPT LIVE	43.8	32.3
11	AT WORKING LOAD MAX	48.3	28.5
12	AT WORKING LOAD MIN	35.8	39.1

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC – 7

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 14.1	103.6
2	EFFECTIVE PRESTRESS	− 11.5	94.2
3	DEAD LOAD I	30.7	− 26.6
4	DEAD LOAD II	1.9	− 1.6
5	2ND MOMENT AT TRANSFER	11.9	− 10.3
6	AT WORKING LOAD	9.7	− 8.4
7	LIVE LOAD MAX	19.7	− 16.5
8	MIN	− 4.8	4.0
9	AT TRANSFER	28.5	66.7
10	AT WORKING LOAD EXCEPT LIVE	30.8	57.6
11	AT WORKING LOAD MAX	50.5	41.1
12	AT WORKING LOAD MIN	26.0	61.6

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 8

(Kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 14.0	102.9
2	EFFECTIVE PRESTRESS	− 11.4	83.7
3	DEAD LOAD I	44.5	− 38.6
4	DEAD LOAD II	2.7	− 2.3
5	2ND MOMENT AT TRANSFER	8.0	− 6.9
6	AT WORKING LOAD	6.5	− 5.6
7	LIVE LOAD MAX	24.7	− 20.8
8	MIN	− 3.2	2.7
9	AT TRANSFER	38.5	57.4
10	AT WORKING LOAD EXCEPT LIVE	42.3	37.2
11	AT WORKING LOAD MAX	67.0	16.4
12	AT WORKING LOAD MIN	39.1	39.9

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC – 9

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 11.9	98.2
2	EFFECTIVE PRESTRESS	− 9.7	29.8
3	DEAD LOAD I	34.5	− 29.9
4	DEAD LOAD II	2.1	− 1.8
5	2ND MOMENT AT TRANSFER	4.0	− 3.4
6	AT WORKING LOAD	3.3	− 2.8
7	LIVE LOAD MAX	18.3	− 15.3
8	MIN	− 1.6	1.3
9	AT TRANSFER	26.6	64.9
10	AT WORKING LOAD EXCEPT LIVE	30.2	45.3
11	AT WORKING LOAD MAX	48.5	30.0
12	AT WORKING LOAD MIN	28.6	46.6

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 10

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	50.9	25.5
2	EFFECTIVE PRESTRESS	42.9	21.5
3	DEAD LOAD I	0	0
4	DEAD LOAD II	0	0
5	2ND MOMENT AT TRANSFER	0	0
6	AT WORKING LOAD	0	0
7	LIVE LOAD MAX	0	0
8	MIN	0	0
9	AT TRANSFER	50.9	25.5
10	AT WORKING LOAD EXCEPT LIVE	42.9	21.5
11	AT WORKING LOAD MAX	42.9	21.5
12	AT WORKING LOAD MIN	42.9	21.5

9 : 1 + 3 + 5

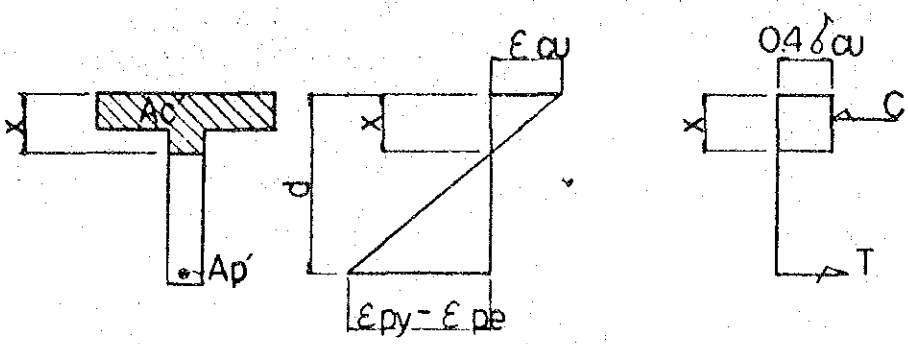
10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

§ 7. ULTIMATE STRENGTH

CALUCULATION OF ULTIMATE BALANCED STEEL (RATIO)



$$\frac{\varepsilon cu}{x} = \frac{\varepsilon py - \varepsilon pe}{d - x}$$

$$x = \frac{\varepsilon cu}{\varepsilon cu + \varepsilon py - \varepsilon pe}\, d$$

ε cu ; ULTIMATE STRAIN IN CONCRETE
= 0.0035

ε py ; ULTIMATE STRAIN IN STEEL

d ; EFECTIVE DEPTH

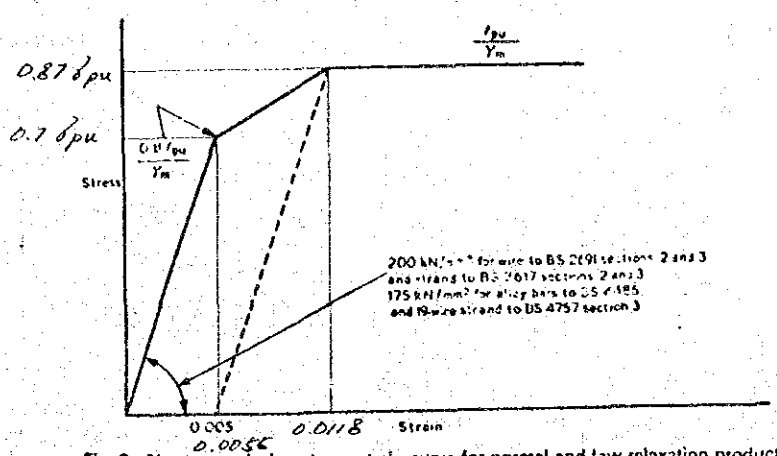


Fig. 3. Short term design stress-strain curve for normal and low relaxation products

CONPRESSIVE FORCE

$C = 0.4 \acute{o}cu\ Ac$

TENSILE FORCE

$T = Ap \cdot 0.87\ \acute{o}pu$

$$Ap = \frac{0.4\ \acute{o}cu\ Ac}{0.87\ \ pu} \quad > Ap' \qquad \text{CASE I}$$

$$< Ap' \qquad \text{CASE 2}$$

WHERE Ap' = EXISTING AREA OF ST EL

$E_p = 200\ KN/mm^2$

I) CASE I

TENSILE FORCE $T = Ap'\ 0.87\ \acute{o}pu$

COMPRESSIVE FORCE $C = 0.4\ \acute{o}cu\ Ac'$

$$Ac' = \frac{Ap'\ 0.87\ \acute{o}pu}{0.4\ \ \acute{o}cu}$$

ULTIMATE STRENGTH

$Mur = Ap'\ 0.87 \acute{o}pu\ (\ d - kx\ )$

WHERE kx DISTANCE FROM COMPRESSIVE FIBER TO THE CENTROID OF Ac'

2) CACE 2

TENSILE FORCE $T = A_{p'} \cdot \acute{O}_p$

$$\acute{O}_p = E_p\left(\varepsilon_{cu}\frac{d-x}{x} + \varepsilon_{pe}\right)$$

COMPRESSIVE FORCE $C = 0.4 \cdot \acute{O}cu \cdot Ac$

X IS GIVEN BY THE FOLLOWING

$$A_{p'} \cdot E_p\left(\varepsilon_{cu}\frac{d-x}{x} + \varepsilon_{pe}\right) = 0.4 \cdot \acute{O}cu \cdot Ac$$

ULTIMATE STRENGTH

$$Mur = A_{p'} \cdot \acute{O}_p(d - kx)$$

SEC - 5

$$x = \frac{0.0035}{0.0035 + 0.0118 - 0.0032} \times 95 = 27.48 \text{ cm}$$

$$Ac = 3\,649 \text{ cm}^2$$

$$Hp = \frac{0.4 \times 400 \times 3\,649}{0.87 \times 16\,000} = 41.94 \text{ cm}^2 > 36.94 \text{ cm}^2$$

$(8 \times 12\phi 7)$

$$Ac' = \frac{36.94 \times 0.87 \times 16\,000}{0.4 \times 400} = 3\,214 \text{ cm}^2$$

$$kx = 11.48 \text{ cm}$$

ULTIMATE STRENGTH

$$Mur = 36.94 \times 0.87 \times 16\,000 \times (95 - 11.48)$$

$$= 429.5 \text{ t·m}$$

ULTIMATE MOMENT. SAFETY FACTOR

$Mu1 = 342.4$ t·m 1.25

$Mu2 = 377.6$ t·m

SEC - 8

$$x = \frac{0.0035}{0.0035 + 0.0118 - 0.0040} \times 89.0 = 27.57^{cm}$$

$$A_c = 2002.8\ cm^2$$

$$A_p = \frac{0.4 \times 400 \times 2002.8}{0.87 \times 16000} = 23.02 < 36.94\ cm^2$$

$$x = \frac{0.0035}{0.0035 + 0.0055 - 0.0040} \times 89 = 62.3\ cm$$

$$A_c = 3392\ cm^2$$

$$A_p = \frac{0.4 \times 400 \times 3392}{0.87 \times 16000} = 39.00 > 36.94\ cm^2$$

$$\therefore E_p = 4.32 \times 10^5\ kg/cm^2$$

$$36.94 \times \left\{ 2.0 \times 10^6 \times 0.0055 + 4.32 \times 10^5 \times \left(0.0035 \times \frac{89 - x}{x} - 0.0015\right)\right\} = 0.4 \times 400 \times (900 + 40x)$$

$$\therefore x = 45.57\ cm$$

$$\sigma = 2.0 \times 10^6 \times 0.005 + 4.32 \times 10^5 \times \left(0.0035 \times \frac{89 - 45.57}{45.57} - 0.0015\right) = 10793$$

ULTIMATE STRENGTH

$Mur = 36.94 \times 10\ 793 \times (89 - 17.73)$

$= 284.1$ t·m

ULTIMATE MOMENT			SAFETY FACTOR
$Mu1$	=	234.9 t·m	1.21
$Mu2$	=	254.6 t·m	

§ 8. SHEAR

1. CALCULATION OF THE PRINCIPAL TENSILE STRESS

SHEAR STRESS

$$\tau = \frac{S\,Q}{B\,I}$$

WHERE S: SHEAR FORCE (S - Sp)

Q: GEOMETRICAL MOMENT OF AREA

B: WIDTH OF WEB

I: MOMENT OF INERTIA OF AREA

THE PRINCIPAL TENSILE STRESS

$$\sigma_i = 1/2\left(\sigma_c - \sqrt{\sigma_c^2 + 4\tau^2}\right)$$

SHEAR FORCE DUE TO PRESTRESS

$$S_p = Pe \sin\alpha$$

	Pe	$\Sigma \sin\alpha$	Pe sin α
SEC - 0	35.93	0.8362	30.04
SEC - 1	36.16	0.2266	8.19
SEC - 2	37.12	0	0
SEC - 3	37.67	0	0
SEC - 4	35.18	1.3962	49.12
SEC - 5	29.91	0	0
SEC - 6	35.61	1.3264	47.23
SEC - 7	37.66	0	0
SEC - 8	37.37	0	0
SEC - 9	36.25	0.1831	6.64
SEC -10	35.94	0.8362	30.05

	AT WORKING LOAD		AT ULTIMATE LOAD	
	S	S - Sp	S'	S' - Sp
SEC - 0	24.3	—	44.5	14.5
SEC - 1	11.1	2.9	21.1	12.9
SEC - 2	4.1	4.1	8.2	8.2
SEC - 3	15.7	15.7	28.9	28.9
SEC - 4	27.6	—	50.1	1.0
SEC - 5	41.2	41.2	74.5	74.5
SEC - 6	21.4	—	35.8	—
SEC - 7	10.4	10.4	17.9	17.9
SEC - 8	3.4	3.4	7.2	7.2
SEC - 9	13.9	7.3	24.0	17.4
SEC -10	26.0	—	43.7	13.7

SEC - 3

SHEAR STRESS

AT WORKING LOAD (AT THE CENTROID OF SECTION)

$$\tau = \frac{15\ 700 \times 76\ 207}{40 \times 10\ 528\ 106} = 2.8 \ kg/cm^2$$

AT ULTIMATE LOAD (AT THE CENTROID OF SECTION)

$$\tau = \frac{28\ 900 \times 76\ 207}{40 \times 10\ 528\ 106} = 5.2 \ kg/cm^2$$

THE PRINCIPAL TENSILE STRESS

AT WORKING LOAD

$$\sigma_i = 1/2 \times (40.1 - \sqrt{40.1^2 + 4 \times 2.8^2})$$

$$= -0.2 \ kg/cm^2$$

AT ULTIMATE LOAD

$$\sigma_i = 1/2 \times (40.3 - \sqrt{40.3^2 + 4 \times 5.2^2})$$

$$= -0.7 \ kg/cm^2$$

SEC - 5

SHEAR STRESS

AT WORKING LOAD (AT THE CENTROID OF SECTION)

$$\tau = \frac{41\,200 \times .97\,354}{60 \times 11\,629\,696} = 5.7 \ kg/cm^2$$

AT ULTIMATE LOAD

AT THE CENTROID OF SECTION

$$\tau = \frac{74\,500 \times .97\,354}{60 \times 11\,629\,696} = 10.4 \ kg/cm^2$$

AT THE POINT WHERE BENDING STRESS IS 0

$$\tau = \frac{74\,500 \times 148\,534}{60 \times 11\,629\,696} = 15.9 \ kg/cm^2$$

THE PRINCIPAL TENSILE STRESS

AT WORKING LOAD

$$\sigma_i = 1/2 \times \left(26.1 - \sqrt{26.1^2 + 4 \times 5.7^2} \right)$$

$$= -1.2 \ kg/cm^2$$

AT ULTIMATE LOAD

AT THE CENTROID OF THE SECTION

$$\sigma_i = 1/2 \times \left(26.2 - \sqrt{26.2^2 + 4 \times 10.4^2} \right)$$

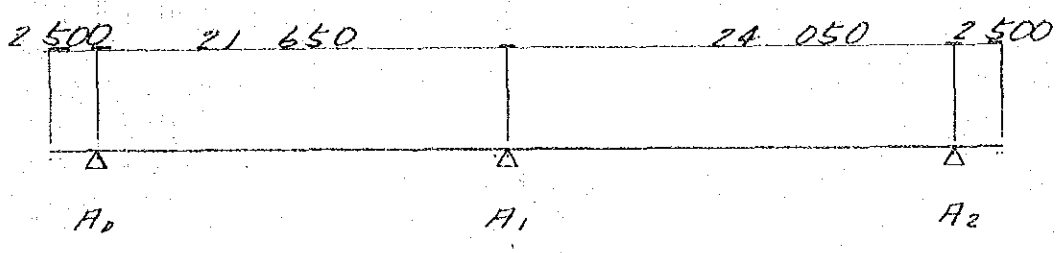
$$= -3.6 \quad kg/cm^2$$

AT THE POINT WHERE BENDING STRESS IS 0.

$$\sigma_i = -15.9 \quad kg/cm^2$$

§§ 3. REACTION

§ 1. REACTION



		R0	R1	R2
DEAD I		21.13	54.30	23.65
DEAD II		1.18	3.25	1.34
LIVE LOAD	MAX	8.67	25.91	9.42
	MIN	- 0.87	0	- 0.60
TOTAL	MAX	30.98	83.46	34.41
	MIN	21.44	57.55	24.39

2. Aquaduct at STA. 57

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CONTENTS

§§ /. DESIGN CONDITION

§ 1. DESIGN CONDITION

TYPE	POST TENTIONED PRESTRESSED CONCRETE BOX-GIRDER BRIDGE	
BRIDGE LENGTH		
GIRDER LENGTH		
SPAN	31.000 + 31.000	
LIVE LOAD	WATER	0.4 T/M
	FOOTWAY LOADING	0.51 T/M^2

ULTIMATE LOAD FACTORS

1.5 D + 2.5 L

2.0 (D + L)

§ 2. MATERIAL STRENGTH AND PERMISSIBLE STRESS

I. CONCRETE

I) MAIN GIRDER

SPECIFIED WORKS CUBE STRENGTH

AT 28 DAYS	40	N/mm^2
	(408	Kg/cm^2)
AT TRANSFER	34	N/mm^2
	(347	Kg/cm^2)

PERMISSIBLE COMPRESSIVE STRESS

AT WORKING LOAD	13.2	N/mm^2
	(135	Kg/cm^2)
AT TRANSFER	17.0	N/mm^2
	(173	Kg/cm^2)

PERMISSIBLE TENSILE STRESS

AT WORKING LOAD	0	
AT TRANSFER	- 1	N/mm^2
	(- 10	Kg/cm^2)

LIMITTING PRINCIPAL TENSILE STRESS

AT WORKING LOAD	- 1 N/mm^2
	(- 10 Kg/cm^2)
AT ULTIMATE LOAD	- 2.4 N/mm^2
	(- 24 Kg/cm^2)

MODULUS OF ELASTICITY

AT 28 DAYS	31 KN/mm^2
	(3.2×10^5 Kg/cm^2)
AT TRANSFER	29 KN/mm^2
	(3.0×10^5 Kg/cm^2)

2 PRESTRESSING STEEL

1) LONGITUDINAL CABLE

12-Ø 7 mm WIRE

SPECIFIED CHARACTERISTIC STRENGTH

$$Aps\ fpu = 60.4 \times 12 = 724.8\ KN$$

$$Aps = 38.5 \times 12 = 462.0\ mm^2$$

$$fpu = 1.57\ KN/mm^2$$

PERMISSIBLE TENSILE STRESS

AT TRANSFER $fpi = 1.099\ KN/mm^2$

$(112\ Kg/cm^2)$

MODULUS OF ELASTICITY

$$Ep = 200\ KN/mm^2$$

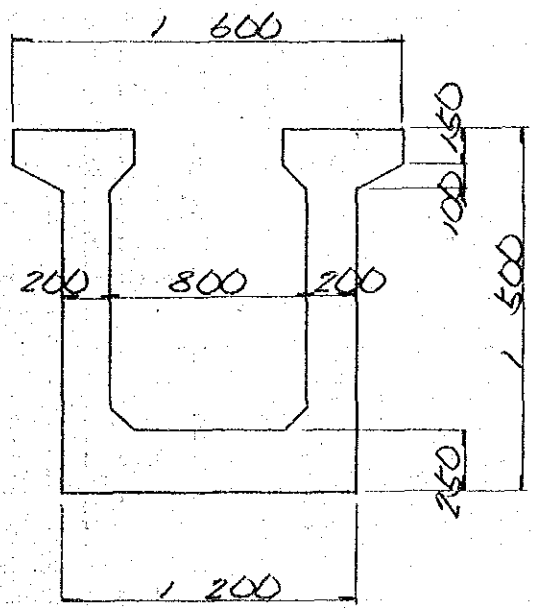
$$(2.0 \times 10^6\ Kg/cm^2)$$

§§ 2. DESIGN OF GIRDER

§ 1. SECTION FORCE DUE TO DESIGN LOAD

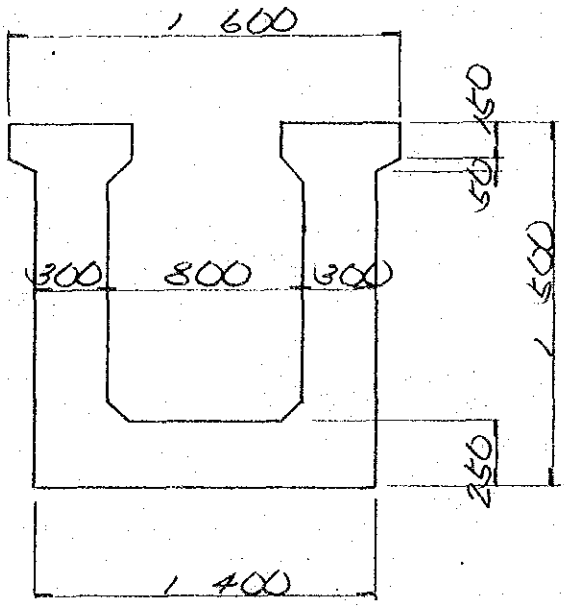
1. DEAD I

1) GIRDER



$A = 0.9300\ m^2$

MIDSPAN

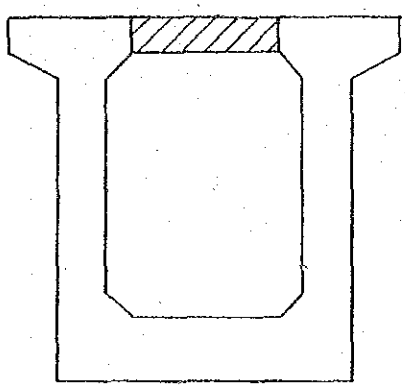


$A = 1.1800\ m^2$

SUPPORT

2. DEAD Ⅱ

1) STRAD

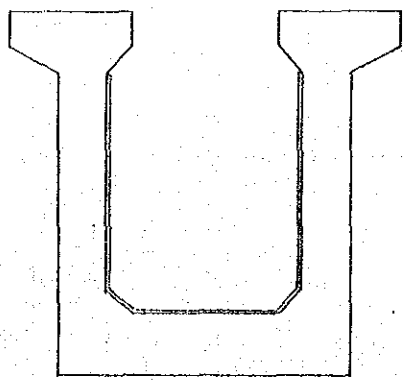


$A = 0.600 \times 0.150 = 0.0900\ m^2$

WIDTH : 0.30 m

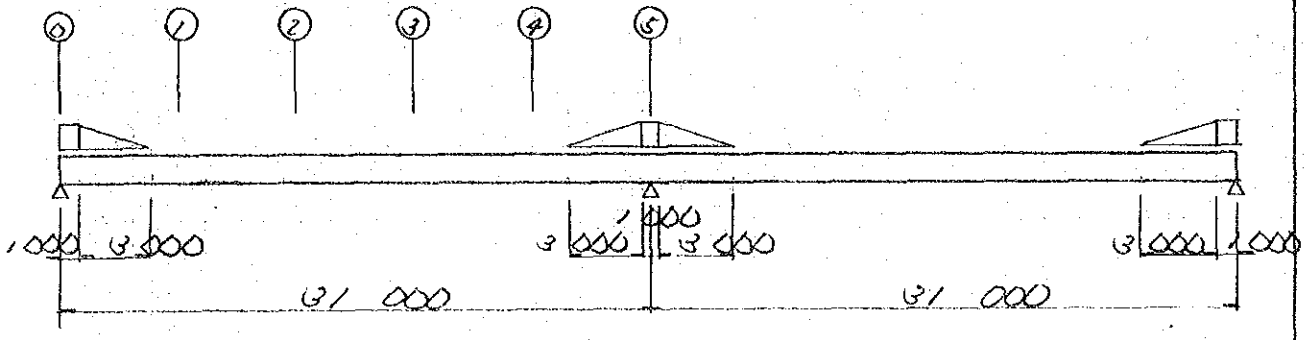
SPACING : 2.00 m

2) MORTAR (WATER PROOF)



$L = 2.6828\ m$

THICKNESS : 0.02 m



DEAD I : SELF WEIGHT $w = 0.93 \times 2.41$. $= 2.241\ t/m$

$\Delta p = 0.255 \times 2.41 \times 1.0 = 0.615\ t$

$\Delta p' = 1/2 \times 0.255 \times 2.41 \times 3.0 = 0.922\ t$

DEAD II : STRAD $w = 0.60 \times 0.15 \times 0.3 \times 2.41/2.0 = 0.033\ t/m$

MORTAR $w = 2.6828 \times 0.02 \times 2.15 = 0.115\ t/m$

LIVE : CROWD LOAD $w = 0.51 \times 1.0 = 0.51\ t/m$

WATER $w = 0.40\ t/m$

BENDING MOMENT

(t·m)

		⓪	①	②	③	④	⑤
DEAD I		0	119.7	151.6	97.2	− 43.3	−271.3
DEAD II		0	7.8	10.0	6.4	− 2.8	− 17.8
LIVE	MAX	0	54.2	73.5	57.7	14.7	0
	MIN	0	− 6.1	− 12.3	− 18.4	− 32.2	−109.3
TOTAL	MAX	0	181.7	235.1	161.3	− 31.4	−289.1
	MIN	0	121.4	149.3	85.2	− 78.3	−398.4

SHEAR FORCE

(t)

		⓪	①	②	③	④	⑤
DEAD	I	27.2	12.4	− 1.5	− 15.4	− 29.3	− 43.5
DEAD	II	1.7	0.8	− 0.1	− 1.1	− 2.0	− 2.9
LIVE	MAX	6.9	4.1	2.1	0.8	0.2	0
	MIN	− 1.0	− 1.4	− 2.5	− 4.4	− 6.7	− 9.9
TOTAL	MAX	35.8	17.3	− 3.7	− 15.7	− 31.1	− 46.4
	MIN	27.9	11.8	− 4.1	− 20.9	− 38.2	− 56.3

***** SEC-0 *****

GROSS SECTION

A	CM2	11800.00
I	CM4	27506905.00
Y'	CM	82.06
Y	CM	-67.94
W'	CM3	335196.02
W	CM3	-404863.34
R2	CM2	2331.09

NET SECTION

AS	CM2	15.90
N		14
AC	CM2	11577.34
IC	CM4	27498836.00
YC'	CM	82.17
YC	CM	-67.83
EC	CM	5.97
WC'	CM3	334638.26
WC	CM3	-405436.92
WCG	CM3	4605673.31
RC2	CM2	2375.23

EQUIVALENT SECTION

AP	CM2	4.62
N		14
AE1	CM2	11981.38
IE1	CM4	27512754.00
YE1'	CM	81.97
YE1	CM	-68.03
EE1	CM	5.77
WE1'	CM3	335629.99
WE1	CM3	-404441.51
WEG1	CM3	4768819.75
RE12	CM2	2296.29

***** TORTIONAL RIGIDTY *****

ANU = 110.00 CM ANL = 110.00 CM BHH = 137.50 CM
A = (ANU + ANL) / 2 * BHH = 15125. CM2

AN (CM)	B (CM)	AN/B
110.00	.00	110.000
110.00	25.00	4.400
137.50	30.00	4.583
137.50	30.00	4.583
	TOTAL1	123.567

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
140.00	25.00	.2958	647136.38
125.00	30.00	.2829	954902.72
125.00	30.00	.2829	954902.72
		TOTAL2	2556941.81 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 9962357.25 CM4

***** SEC - 1 *****

GROSS SECTION

A	CM2	9300.00
I	CM4	24177681.00
Y'	CM	80.58
Y	CM	-69.42
w'	CM3	300036.60
w	CM3	-346293.43
R2	CM2	2599.75

NET SECTION

AS	CM2	15.90
N		14
AC	CM2	9077.34
IC	CM4	23888220.00
YC'	CM	79.71
YC	CM	-70.29
EC	CM	-36.48
wC'	CM3	299692.51
wC	CM3	-339847.96
wCG	CM3	-654877.55
RC2	CM2	2631.63

EQUIVALENT SECTION

AP	CM2	4.62
N		14
AE1	CM2	9461.38
IE1	CM4	24402927.00
YE1'	CM	81.26
YE1	CM	-68.74
EE1	CM	-34.92
wE1'	CM3	300293.64
wE1	CM3	-355021.62
wCG1	CM3	-696765.09
RE12	CM2	2573.77

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 137.50 CM
A = (ANU + ANL) / 2 * BHH = 13750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
137.50	20.00	6.875
137.50	20.00	6.875
	TOTAL1	117.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
125.00	20.00	.2997	299733.73
125.00	20.00	.2997	299733.73
		TOTAL2	1142437.22 CM4

GJ = (4*A**2 / TOTAL1) + TOTAL2 = 7564942.44 CM4

***** SEC - 2 *****

GROSS SECTION

A	CM2	9300.00
I	CM4	24177681.00
Y'	CM	80.58
Y	CM	-69.42
w'	CM3	300036.60
w	CM3	-346293.43
R2	CM2	2599.75

NET SECTION

AS	CM2	15.90
N		14
AC	CM2	9077.34
IC	CM4	23874862.00
YC'	CM	79.69
YC	CM	-70.31
EC	CM	-37.31
wC'	CM3	299599.89
wC	CM3	-339561.57
wCG	CM3	-639897.12
RC2	CM2	2630.16

EQUIVALENT SECTION

AP	CM2	4.62
N		14
AE1	CM2	9481.38
IE1	CM4	24415345.00
YE1'	CM	81.28
YE1	CM	-68.72
EE1	CM	-35.72
wE1'	CM3	300364.35
wE1	CM3	-355253.58
WEG1	CM3	-683454.35
RE12	CM2	2574.87

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 137.50 CM
A = (ANU + ANL) / 2 * BHH = 13750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
137.50	20.00	6.875
137.50	20.00	6.875
	TOTAL1	117.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
125.00	20.00	.2997	299733.73
125.00	20.00	.2997	299733.73
		TOTAL2	1142437.22 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 7564942.44 CM4

***** SEC-2 *****

GROSS SECTION

A	CM2	9300.00
I	CM4	24177681.00
Y'	CM	80.58
Y	CM	-69.42
W'	CM3	300036.60
W	CM3	-348295.43
R2	CM2	2599.75

NET SECTION

AS	CM2	15.90
N		14
AC	CM2	9077.34
IC	CM4	23674862.00
YC'	CM	79.69
YC	CM	-70.31
LC	CM	-37.31
WC'	CM3	299599.89
WC	CM3	-339561.57
WCG	CM3	-639897.12
RC2	CM2	2630.16

EQUIVALENT SECTION

AP	CM2	4.62
N		14
AE1	CM2	9481.38
IE1	CM4	24415345.00
YE1'	CM	81.28
YE1	CM	-68.72
EE1	CM	-35.72
WE1'	CM3	300364.35
WE1	CM3	-355253.58
WEG1	CM3	-683454.35
RE12	CM2	2574.87

***** TORTIONAL RIGIDTY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 137.50 CM
A = (ANU + ANL) / 2 * BHH = 13750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
137.50	20.00	6.875
137.50	20.00	6.875
	TOTAL1	117.750

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
125.00	20.00	.2997	299733.75
125.00	20.00	.2997	299733.75
		TOTAL2	1142437.22 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 7564942.44 CM4

***** SEC – 4 *****

GROSS SECTION

A	CM2	9300.00
I	CM4	24177681.00
Y'	CM	80.58
Y	CM	-69.42
W'	CM3	300036.60
W	CM3	-346293.43
R2	CM2	2599.75

NET SECTION

AS	CM2	15.90
N		14
AC	CM2	9077.34
IC	CM4	24174749.00
YC'	CM	80.50
YC	CM	-69.50
LC	CM	-3.49
WC'	CM3	300311.77
WC	CM3	-347852.30
WCG	CM3	-6923206.19
RC2	CM2	2603.20

EQUIVALENT SECTION

AP	CM2	4.62
N		14
AE1	CM2	9481.38
IE1	CM4	24179465.00
YE1'	CM	80.65
YE1	CM	-69.35
LE1	CM	-3.34
WE1'	CM3	299816.16
WE1	CM3	-346646.60
WEG1	CM3	-7232838.50
RE12	CM2	2550.21

***** TORTIONAL RIGIDITY *****

ANU = 100.00 CM ANL = 100.00 CM BHH = 137.50 CM
A = (ANU + ANL) / 2 * BHH = 13750. CM2

AN (CM)	B (CM)	AN/B
100.00	.00	100.000
100.00	25.00	4.000
137.50	20.00	6.875
137.50	20.00	6.875
	TOTAL1	117.750

A (CM)	B (CM)	C	C.A.b**3(CM4)
180.00	.00	.3333	.00
120.00	25.00	.2896	542969.77
125.00	20.00	.2997	299733.73
125.00	20.00	.2997	299733.73
		TOTAL2	1142437.22 CM4

GJ = (4*A**2 / TOTAL1) * TOTAL2 = 7564942.44 CM4

***** SEC - 5 *****

GROSS SECTION

A	CM2	11800.00
I	CM4	27506905.00
Y'	CM	82.06
Y	CM	-67.94
W'	CM3	335196.02
W	CM3	-404863.34
R2	CM2	2331.09

NET SECTION

AS	CM2	15.90
N		14
AC	CM2	11577.34
IC	CM4	26797248.00
YC'	CM	83.14
YC	CM	-66.86
EC	CM	56.98
WC'	CM3	322324.79
WC	CM3	-400760.88
WCG	CM3	470258.80
RC2	CM2	2314.63

EQUIVALENT SECTION

AP	CM2	4.62
N		14
AE1	CM2	11961.38
IE1	CM4	28064995.00
YE1'	CM	81.22
YE1	CM	-68.78
LE1	CM	55.06
WE1'	CM3	345560.88
WE1	CM3	-406014.99
WEG1	CM3	509694.29
RE12	CM2	2342.38

***** TORTIONAL RIGIDTY *****

ANU = 110.00 CM ANL = 110.00 CM BHH = 137.50 CM
A = (ANU + ANL) / 2 * BHH = 15125. CM2

AN (CM)	B (CM)	AN/B
110.00	.00	110.000
110.00	25.00	4.400
137.50	30.00	4.583
137.50	30.00	4.583
	TOTAL1	123.567

A (CM)	B (CM)	C	C.A.B**3(CM4)
180.00	.00	.3333	.00
140.00	25.00	.2958	647136.38
125.00	30.00	.2829	954902.72
125.00	30.00	.2829	954902.72
		TOTAL2	2556941.81 CM4

GJ = (4*A**2 / TOTAL1) + TOTAL2 = 9962357.25 CM4

§ 3. BENDING STRESS DUE TO DESIGN LOAD

		SEC-1		SEC-2		SEC-3	
		TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
DEAD	I	39.9	-35.2	50.6	-44.6	32.4	-28.6
DEAD	II	2.6	-2.2	3.3	-2.8	2.1	-1.8
LIVE LOAD	MAX	18.0	-15.3	24.5	-20.7	19.2	-16.2
	MIN	-2.0	1.7	-4.1	3.5	-6.1	5.2

		SEC-4		SEC-5		SEC-6	
		TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
DEAD	I	-14.4	12.4	-84.2	67.7		
DEAD	II	-0.9	0.8	-5.2	4.4		
LIVE LOAD	MAX	4.9	-4.2	0	0		
	MIN	-10.7	9.2	-31.6	26.8		

		SEC-7		SEC-8		SEC-9	
		TOP	BOTTOM	TOP	BOTTOM	TOP	BOTTOM
DEAD	I						
DEAD	II						
LIVE LOAD	MAX						
	MIN						

§ 4. PRESTRESS

I. LOSS OF PRESTRESS

I) LOSSES DUE TO FRICTION

FRICTION IN THE DUCT DUE TO UNINTENTIONAL VARIATION FROM THE SPECIFIED PROFILE.
THE STRESS IN PRESTRESSING STEEL σ_x AT ANY DISTANCE x m FROM THE JACK CAN BE CALCULATED FROM THE FORMURA:

$$\sigma_x = \sigma_o e^{-kx}$$

WHERE σ_o = TENSILE STRESS IN THE STEEL AT THE JACKING END

e = THE BASE OF NAPIERIAN LOGARISMS

k = CONSTANT DEPENDING ON THE TYPE OF DUCT, OR SHEATH EMPLOYED, THE NATURE OF ITS INSIDE SURFACE, THE METHOD OF FORMING IT AND THE DEGREE OF VIBRATION EMPLOYED IN PLACING THE CONCRETE = 0.004

FRICTION IN THE DUCT DUE TO CURVATURE OF THE TENDON

$$\sigma_x = \sigma_o e^{-\mu x/Rps}$$

WHERE Rps = RADIUS OF CURVATURE

μ = 0.30

2) LOSS OF PRESTRESS DURING ANCHORING

$$A = \Delta l \, Ep$$

Δl : MOVEMENT OF STEEL AT THE ANCHORAGE

=

= 5 mm FOR 12- 7 mm WIRE

3) LOSS OF PRESTRESS DUE TO ELASTIC DEFORMATION OF THE CONCRETE

$$\delta p = 1/2 \; n \; \delta cg$$

WHERE n = MODULER RATIO

δcg THE STRESS IN THE ADJACENT CONCRETE

$$\delta cg = \delta ctg + \delta cdg$$

δctg = PRESTRESS AT THE CENTROID OF TENDONS

δcdg = THE STRESS DUE TO SELF-WEIGHT AT THE CENTROID OF TENDONS

XXXX CALCULATION OF CABLE-LANGTH XXXX

*** C-1 CABLE ***

NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						.180
2 ---	1	6.615	6.651	********	.10472	.875
3 ---	2	1.045	1.047	10.000	.10472	.930
4 ---	1	12.988	12.988	********	.00000	.930
5 ---	2	2.588	2.618	10.000	.26180	.589
6 ---	1	.592	.613	********	-.26180	.431
7 ---	2	2.588	2.618	-10.000	.26180	.090
8 ---	1	9.967	9.967	********	.00000	.090
9 ---	2	2.588	2.618	-10.000	.26180	.431
10 ---	1	.592	.613	********	.26180	.589
11 ---	2	2.588	2.618	10.000	.26180	.930
12 ---	1	12.988	12.988	********	.00000	.930
13 ---	2	1.045	1.047	10.000	.10472	.875
14 ---	1	6.615	6.651	********	-.10472	.180
TOTAL		62.800	63.038			

*** C-2 CABLE ***

NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						.360
2 ---	1	5.663	5.694	********	.10472	.955
3 ---	2	1.045	1.047	10.000	.10472	1.010
4 ---	1	14.692	14.692	********	.00000	1.010
5 ---	2	2.588	2.618	10.000	.26180	.669
6 ---	1	.890	.921	********	-.26180	.431
7 ---	2	2.588	2.618	-10.000	.26180	.090
8 ---	1	7.867	7.867	********	.00000	.090
9 ---	2	2.588	2.618	-10.000	.26180	.431
10 ---	1	.890	.921	********	.26180	.669
11 ---	2	2.588	2.618	10.000	.26180	1.010
12 ---	1	14.692	14.692	********	.00000	1.010
13 ---	2	1.045	1.047	10.000	.10472	.955
14 ---	1	5.663	5.694	********	-.10472	.360
TOTAL		62.800	63.048			

*** C-3 CABLE ***

NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						.540
2 ---	1	4.712	4.738	********	.10472	1.035
3 ---	2	1.045	1.047	10.000	.10472	1.090
4 ---	1	16.393	16.393	********	.00000	1.090
5 ---	2	2.588	2.618	10.000	.26180	.749
6 ---	1	.890	.921	********	-.26180	.511
7 ---	2	2.588	2.618	-10.000	.26180	.170
8 ---	1	6.367	6.367	********	.00000	.170
9 ---	2	2.588	2.618	-10.000	.26180	.511
10 ---	1	.890	.921	********	.26180	.749
11 ---	2	2.588	2.618	10.000	.26180	1.090
12 ---	1	16.393	16.393	********	.00000	1.090
13 ---	2	1.045	1.047	10.000	.10472	1.035
14 ---	1	4.712	4.738	********	-.10472	.540
TOTAL		62.800	63.038			

*** C-4 CABLE ***

NO		ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1	---						.720
2	---	1	3.760	3.761	********	.10472	1.115
3	---	2	1.045	1.047	10.000	.10472	1.170
4	---	1	18.095	18.095	********	.00000	1.170
5	---	2	2.588	2.618	10.000	.26180	.829
6	---	1	.890	.921	********	-.26180	.591
7	---	2	2.588	2.618	-10.000	.26180	.250
8	---	1	4.867	4.867	********	.00000	.250
9	---	2	2.588	2.618	-10.000	.26180	.591
10	---	1	.890	.921	********	.26180	.829
11	---	2	2.588	2.618	10.000	.26180	1.170
12	---	1	18.095	18.095	********	.00000	1.170
13	---	2	1.045	1.047	10.000	.10472	1.115
14	---	1	3.760	3.781	********	-.10472	.720
TOTAL			62.800	63.027			

*** C-5 CABLE ***

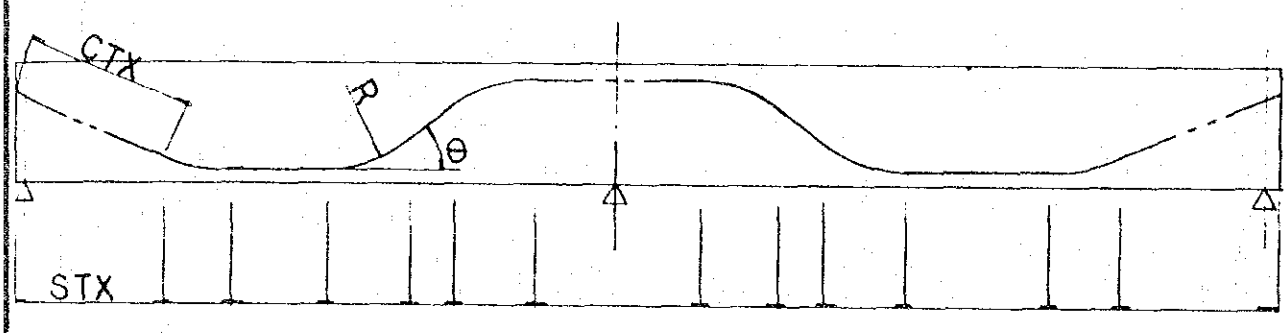
NO		ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1	---						.900
2	---	1	2.809	2.824	********	.10472	1.195
3	---	2	1.045	1.047	10.000	.10472	1.250
4	---	1	19.796	19.796	********	.00000	1.250
5	---	2	2.588	2.618	10.000	.26180	.909
6	---	1	.890	.921	********	-.26180	.671
7	---	2	2.588	2.618	-10.000	.26180	.330
8	---	1	3.367	3.367	********	.00000	.330
9	---	2	2.588	2.618	-10.000	.26180	.671
10	---	1	.890	.921	********	.26180	.909
11	---	2	2.588	2.618	10.000	.26180	1.250
12	---	1	19.796	19.796	********	.00000	1.250
13	---	2	1.045	1.047	10.000	.10472	1.195
14	---	1	2.809	2.824	********	-.10472	.900
TOTAL			62.800	63.017			

*** C-6 CABLE ***

NO		ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1	---						1.080
2	---	1	1.658	1.868	********	.10472	1.275
3	---	2	1.045	1.047	10.000	.10472	1.330
4	---	1	21.497	21.497	********	.00000	1.330
5	---	2	2.588	2.618	10.000	.26180	.989
6	---	1	.890	.921	********	-.26180	.751
7	---	2	2.588	2.618	-10.000	.26180	.410
8	---	1	1.867	1.867	********	.00000	.410
9	---	2	2.588	2.618	-10.000	.26180	.751
10	---	1	.890	.921	********	.26180	.989
11	---	2	2.588	2.618	10.000	.26180	1.330
12	---	1	21.497	21.497	********	.00000	1.330
13	---	2	1.045	1.047	10.000	.10472	1.275
14	---	1	1.658	1.868	********	-.10472	1.080
TOTAL			62.600	63.006			

*** C-7 CABLE ***

NO	ISET	STX (M)	CTX (M)	R(M)	SITA(RAD)	H(M)
1 ---						1.260
2 ---	1	.906	.911	********	.10472	1.355
3 ---	2	1.045	1.047	10.000	.10472	1.410
4 ---	1	23.199	23.199	********	.00000	1.410
5 ---	2	2.588	2.618	10.000	.26180	1.069
6 ---	1	.890	.921	********	-.26180	.831
7 ---	2	2.588	2.618	-10.000	.26180	.490
8 ---	1	.367	.367	********	.00000	.490
9 ---	2	2.588	2.618	-10.000	.26180	.831
10 ---	1	.890	.921	********	.26180	1.069
11 ---	2	2.588	2.618	10.000	.26180	1.410
12 ---	1	23.199	23.199	********	.00000	1.410
13 ---	2	1.045	1.047	10.000	.10472	1.355
14 ---	1	.906	.911	********	-.10472	1.260
TOTAL		62.800	62.996			



XxxXX CALCULAITION OF PC-CABLE HIGHT XXXXX
(FROM UPPER SURFACE)

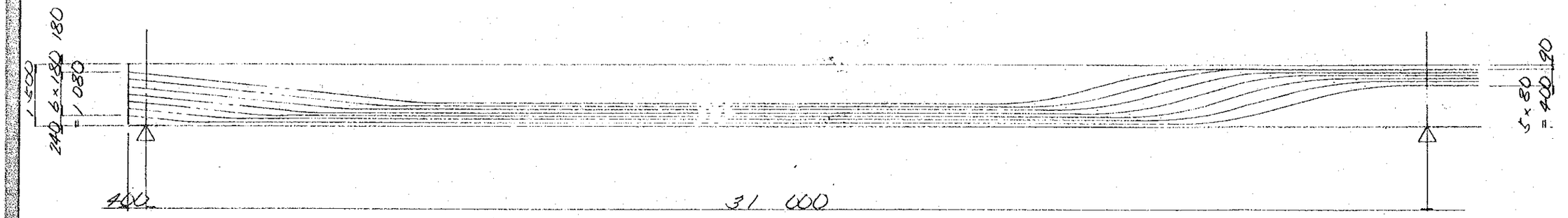
	SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1 * 2	.222	.874	.930	.930	.164	.090	.164
C-2 * 2	.402	1.009	1.010	1.010	.350	.090	.350
C-3 * 2	.582	1.090	1.090	1.090	.626	.170	.626
C-4 * 2	.762	1.170	1.170	1.170	.902	.250	.902
C-5 * 2	.942	1.250	1.250	1.250	1.129	.330	1.129
C-6 * 2	1.122	1.330	1.330	1.330	1.298	.410	1.298
C-7 * 2	1.302	1.410	1.410	1.410	1.410	.490	1.410
AVELAGE	.762	1.162	1.170	1.170	.840	.262	.840

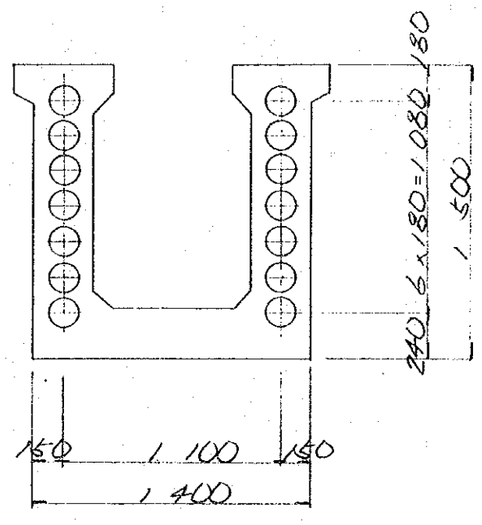
	SEC-7	SEC-8	SEC-9	SEC-10
C-1 * 2	.930	.930	.874	.222
C-2 * 2	1.010	1.010	1.009	.402
C-3 * 2	1.090	1.090	1.090	.582
C-4 * 2	1.170	1.170	1.170	.762
C-5 * 2	1.250	1.250	1.250	.942
C-6 * 2	1.330	1.330	1.330	1.122
C-7 * 2	1.410	1.410	1.410	1.302
AVELAGE	1.170	1.170	1.162	.762

XxxXX CALCULATION OF PC-CABLE ANGLE XXXXX

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1	* 2	.10472	.10472	.00000	.00000	.12195	.00000	.12195
C-2	* 2	.10472	.01081	.00000	.00000	.22864	.00000	.22864
C-3	* 2	.10472	.00000	.00000	.00000	.26180	.00000	.26180
C-4	* 2	.10472	.00000	.00000	.00000	.23203	.00000	.23203
C-5	* 2	.10472	.00000	.00000	.00000	.15558	.00000	.15558
C-6	* 2	.10472	.00000	.00000	.00000	.08004	.00000	.08004
C-7	* 2	.10472	.00000	.00000	.00000	.00495	.00000	.00495

		SEC-7	SEC-8	SEC-9	SEC-10
C-1	* 2	.00000	.00000	.10472	.10472
C-2	* 2	.00000	.00000	.01081	.10472
C-3	* 2	.00000	.00000	.00000	.10472
C-4	* 2	.00000	.00000	.00000	.10472
C-5	* 2	.00000	.00000	.00000	.10472
C-6	* 2	.00000	.00000	.00000	.10472
C-7	* 2	.00000	.00000	.00000	.10472





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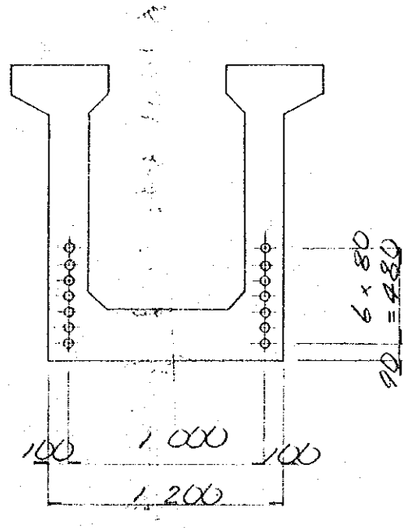

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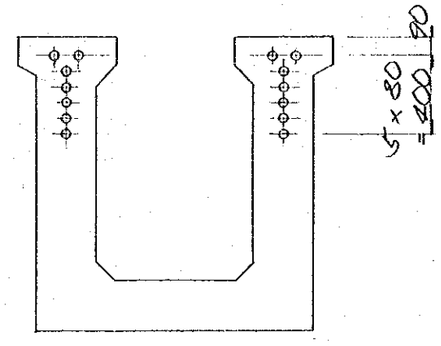


SUPPORT

XXXX CALUCULATION OF FRICTION-LOSS , SLIDING-LOSS XXX

*** C-1 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	16.299
POINT - 2	.00000	6.615	6.651	109.060	10.416
POINT - 3	.10472	1.045	1.047	105.245	2.788
POINT - 4	.00000	3.398	3.396	103.651	.000
POINT - 5	.00000	9.590	9.590	99.917	.000
POINT - 6	.26180	2.588	2.618	91.407	.000
POINT - 7	.00000	.592	.613	91.163	.000
POINT - 8	.26180	2.588	2.618	83.418	.000
POINT - 9	.00000	4.983	4.983	81.768	.000
POINT -10	.00000	4.983	4.983	81.768	.000
POINT -11	.26180	2.588	2.618	83.418	.000
POINT -12	.00000	.592	.613	91.163	.000
POINT -13	.26180	2.588	2.618	91.407	.000
POINT -14	.00000	9.590	9.590	99.917	.000
POINT -15	.00000	3.398	3.398	103.651	.000
POINT -16	.10472	1.045	1.047	105.245	2.788
POINT -17	.00000	6.615	6.651	109.060	10.416
POINT -18	.00000	.000	.000	112.000	16.299

*** C-2 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	16.854
POINT - 2	.00000	5.663	5.694	109.478	11.810
POINT - 3	.10472	1.045	1.047	105.649	4.151
POINT - 4	.00000	5.058	5.058	103.573	.000
POINT - 5	.00000	9.635	9.635	99.619	.000
POINT - 6	.26180	2.588	2.618	91.135	.000
POINT - 7	.00000	.890	.921	90.799	.000
POINT - 8	.26180	2.588	2.618	83.066	.000
POINT - 9	.00000	3.933	3.933	81.760	.000
POINT -10	.00000	3.933	3.933	81.760	.000
POINT -11	.26180	2.588	2.618	83.066	.000
POINT -12	.00000	.890	.921	90.799	.000
POINT -13	.26180	2.588	2.618	91.135	.000
POINT -14	.00000	9.635	9.635	99.619	.000
POINT -15	.00000	5.058	5.058	103.573	.000
POINT -16	.10472	1.045	1.047	105.649	4.151
POINT -17	.00000	5.663	5.694	109.478	11.810
POINT -18	.00000	.000	.000	112.000	16.854

*** C-3 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	17.375
POINT - 2	.00000	4.712	4.738	109.897	13.169
POINT - 3	.10472	1.045	1.047	106.053	5.481
POINT - 4	.00000	6.675	6.675	103.313	.000
POINT - 5	.00000	9.719	9.719	99.322	.000
POINT - 6	.26180	2.588	2.618	90.663	.000
POINT - 7	.00000	.890	.921	90.529	.000

POINT - 8	.26180	2.588	2.618	82.619	.000
POINT - 9	.00000	3.183	3.183	81.778	.000
POINT -10	.00000	3.183	3.183	81.778	.000
POINT -11	.26180	2.568	2.618	82.619	.000
POINT -12	.00000	.890	.921	90.529	.000
POINT -13	.26180	2.588	2.618	90.863	.000
POINT -14	.00000	9.719	9.719	99.322	.000
POINT -15	.00000	6.675	6.675	103.313	.000
POINT -16	.10472	1.045	1.047	106.053	5.481
POINT -17	.00000	4.712	4.738	109.697	13.169
POINT -18	.00000	.000	.000	112.000	17.375

*** C-4 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPI'	D. FP
POINT - 1	.00000	.000	.000	112.000	17.865
POINT - 2	.00000	3.760	3.781	110.319	14.503
POINT - 3	.10472	1.045	1.047	106.460	6.786
POINT - 4	.00000	8.259	8.259	103.067	.000
POINT - 5	.00000	9.836	9.836	99.027	.000
POINT - 6	.26180	2.568	2.618	90.593	.000
POINT - 7	.00000	.890	.921	90.260	.000
POINT - 8	.26180	2.568	2.618	82.573	.000
POINT - 9	.00000	2.433	2.433	81.777	.000
POINT -10	.00000	2.433	2.433	81.777	.000
POINT -11	.26180	2.588	2.618	82.573	.000
POINT -12	.00000	.890	.921	90.260	.000
POINT -13	.26180	2.588	2.618	90.593	.000
POINT -14	.00000	9.836	9.836	99.027	.000
POINT -15	.00000	8.259	8.259	103.067	.000
POINT -16	.10472	1.045	1.047	106.460	6.786
POINT -17	.00000	3.760	3.781	110.319	14.503
POINT -18	.00000	.000	.000	112.000	17.865

*** C-5 CABLE ***

	ANGLE	S-LENGHT	C-LENGHT	FPI'	D. FP
POINT - 1	.00000	.000	.000	112.000	16.329
POINT - 2	.00000	2.809	2.824	110.742	15.813
POINT - 3	.10472	1.045	1.047	106.668	8.066
POINT - 4	.00000	9.812	9.812	102.635	.000
POINT - 5	.00000	9.984	9.984	98.732	.000
POINT - 6	.26180	2.588	2.618	90.324	.000
POINT - 7	.00000	.890	.921	89.992	.000
POINT - 8	.26180	2.588	2.618	82.327	.000
POINT - 9	.00000	1.683	1.683	81.777	.000
POINT -10	.00000	1.683	1.683	81.777	.000
POINT -11	.26180	2.588	2.618	82.327	.000
POINT -12	.00000	.890	.921	89.992	.000
POINT -13	.26180	2.588	2.618	90.324	.000
POINT -14	.00000	9.984	9.984	98.732	.000
POINT -15	.00000	9.812	9.812	102.635	.000
POINT -16	.10472	1.045	1.047	106.668	8.066
POINT -17	.00000	2.809	2.824	110.742	15.813
POINT -18	.00000	.000	.000	112.000	16.329

*** C-6	CABLE ANGLE	*** S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	18.769
POINT - 2	.00000	1.858	1.868	111.166	17.102
POINT - 3	.10472	1.045	1.047	107.278	9.325
POINT - 4	.00000	11.339	11.339	102.615	.000
POINT - 5	.00000	10.158	10.158	98.439	.000
POINT - 6	.26180	2.588	2.618	90.055	.000
POINT - 7	.00000	.890	.921	89.724	.000
POINT - 8	.26180	2.588	2.618	82.062	.000
POINT - 9	.00000	.933	.933	81.777	.000
POINT -10	.00000	.933	.933	81.777	.000
POINT -11	.26180	2.588	2.618	82.062	.000
POINT -12	.00000	.890	.921	89.724	.000
POINT -13	.26180	2.588	2.618	90.055	.000
POINT -14	.00000	10.158	10.158	98.439	.000
POINT -15	.00000	11.339	11.339	102.615	.000
POINT -16	.10472	1.045	1.047	107.278	9.325
POINT -17	.00000	1.858	1.868	111.166	17.102
POINT -18	.00000	.000	.000	112.000	18.769

*** C-7	CABLE ANGLE	*** S-LENGHT	C-LENGHT	FPT'	D. FP
POINT - 1	.00000	.000	.000	112.000	19.189
POINT - 2	.00000	.906	.911	111.593	18.374
POINT - 3	.10472	1.045	1.047	107.669	10.567
POINT - 4	.00000	12.844	12.844	102.406	.000
POINT - 5	.00000	10.356	10.356	98.146	.000
POINT - 6	.26180	2.588	2.618	89.707	.000
POINT - 7	.00000	.890	.921	89.457	.000
POINT - 8	.26180	2.588	2.618	81.838	.000
POINT - 9	.00000	.183	.183	81.778	.000
POINT -10	.00000	.183	.183	81.778	.000
POINT -11	.26180	2.588	2.618	81.838	.000
POINT -12	.00000	.890	.921	89.457	.000
POINT -13	.26180	2.588	2.618	89.787	.000
POINT -14	.00000	10.356	10.356	98.146	.000
POINT -15	.00000	12.844	12.844	102.406	.000
POINT -16	.10472	1.045	1.047	107.669	10.567
POINT -17	.00000	.906	.911	111.593	18.374
POINT -18	.00000	.000	.000	112.000	19.189

XXXX CALUCULATION OF FRICTION-LOSS , SLIDING-LOSS XXXX

--- DESIGN SECTION

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1	* 2	95.88	98.64	103.14	100.59	87.07	81.79	87.07
C-2	* 2	95.32	101.10	103.15	100.60	89.84	81.78	89.84
C-3	* 2	94.80	100.92	103.16	100.62	90.69	81.78	90.69
C-4	* 2	94.31	100.41	102.96	100.63	91.53	81.78	91.53
C-5	* 2	93.85	99.93	102.48	100.64	93.70	81.78	93.70
C-6	* 2	93.41	99.47	102.02	100.66	95.85	81.78	95.85
C-7	* 2	92.99	99.03	101.59	100.68	97.99	81.78	97.99
AVELAGE		94.37	99.93	102.64	100.63	92.38	81.78	92.38

		SEC-7	SEC-8	SEC-9	SEC-10
C-1	* 2	100.59	103.14	98.64	95.88
C-2	* 2	100.60	103.15	101.10	95.32
C-3	* 2	100.62	103.16	100.92	94.80
C-4	* 2	100.63	102.96	100.41	94.31
C-5	* 2	100.64	102.48	99.93	93.85
C-6	* 2	100.66	102.02	99.47	93.41
C-7	* 2	100.68	101.59	99.03	92.99
AVELAGE		100.63	102.64	99.93	94.37

XXXX CALUCULATION OF FRICTION-LOSS , SLIDING-LOSS XXXX

--- DESIGN SECTION

		SEC-0	SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6
C-1	* 2	111.82	109.07	103.14	100.59	87.07	81.79	87.07
C-2	* 2	111.82	106.04	103.15	100.60	89.84	81.78	89.84
C-3	* 2	111.82	105.71	103.16	100.62	90.69	81.78	90.69
C-4	* 2	111.82	105.72	103.18	100.63	91.53	81.78	91.53
C-5	* 2	111.82	105.74	103.19	100.64	93.70	81.78	93.70
C-6	* 2	111.82	105.76	103.21	100.66	95.85	81.78	95.85
C-7	* 2	111.82	105.78	103.23	100.68	97.99	81.78	97.99
AVELAGE		111.82	106.26	103.18	100.63	92.38	81.78	92.38

		SEC-7	SEC-8	SEC-9	SEC-10
C-1	* 2	100.59	103.14	109.07	111.82
C-2	* 2	100.60	103.15	106.04	111.82
C-3	* 2	100.62	103.16	105.71	111.82
C-4	* 2	100.63	103.18	105.72	111.82
C-5	* 2	100.64	103.19	105.74	111.82
C-6	* 2	100.66	103.21	105.76	111.82
C-7	* 2	100.68	103.23	105.78	111.82
AVELAGE		100.63	103.18	106.26	111.82

*** STATICALLY INDETERMINATE MOMENT (T.M) ***

** SUPPORTS MOMENT **

M2 = 107.360

** TWO END SUPPORTS = HINGE ** M1 = 0. M3 = 0.

** 2-JI MOMNT AT DESIGN SECTION **

1	.000	2	21.472
3	42.944	4	64.416
5	85.888	6	107.360
7	85.888	8	64.416
9	42.944	10	21.472
11	.000		

XXXX DECREASE ON ELASTIC DISPLACEMENT XXXX

SIGN	UNIT	SEC - 0	SEC - 1	SEC - 2	SEC - 3
FPT'	(KG/MM2)	111.821	106.259	103.178	100.631
N		14	14	14	14
AC	(CM2)	11577.340	9077.340	9077.340	9077.340
WCG*10**5	(CM3)	46.057	-6.549	-6.399	-6.399
EC	(CM)	5.971	-36.477	-37.310	-37.310
MDO	(T.M)	.000	119.700	151.600	97.200
PT	(T)	722.884	686.928	667.011	650.546
FCTG	(KG/CM2)	63.377	113.938	112.372	109.598
FDOG	(KG/CM2)	.000	-18.278	-23.691	-15.190
D.FP	(KG/CM2)	211.255	318.865	295.603	314.695
D.FP	(KG/MM2)	2.113	3.189	2.956	3.147
FPT'	(KG/MM2)	94.368	99.929	102.642	100.631
D.FP	(KG/MM2)	2.113	3.189	2.956	3.147
FPT	(KG/MM2)	92.255	96.741	99.686	97.484

SIGN	UNIT	SEC - 4	SEC - 5	SEC - 6	SEC - 7
FPT'	(KG/MM2)	92.380	81.779	92.380	100.631
N		14	14	14	14
AC	(CM2)	9077.340	11577.340	9077.340	9077.340
WCG*10**5	(CM3)	-69.233	4.703	-69.233	-6.399
EC	(CM)	-3.492	56.984	-3.492	-37.310
MDO	(T.M)	-43.300	-271.300	-43.300	97.200
PT	(T)	597.206	528.673	597.206	650.546
FCTG	(KG/CM2)	66.092	109.727	66.092	109.598
FDOG	(KG/CM2)	.625	-57.692	.625	-15.190
D.FP	(KG/CM2)	222.392	173.451	222.392	314.695
D.FP	(KG/MM2)	2.224	1.735	2.224	3.147
FPT'	(KG/MM2)	92.380	81.779	92.380	100.631
D.FP	(KG/MM2)	2.224	1.735	2.224	3.147
FPT	(KG/MM2)	90.156	80.045	90.156	97.484

SIGN	UNIT	SEC - 8	SEC - 9	SEC - 10
FPT'	(KG/MM2)	103.178	106.259	111.821
N		14	14	14
AC	(CM2)	9077.340	9077.340	11577.340
WCG*10**5	(CM3)	-6.399	-6.549	46.057
EC	(CM)	-37.310	-36.477	5.971
MDO	(T.M)	151.600	119.700	.000
PT	(T)	667.011	686.928	722.884
FCTG	(KG/CM2)	112.372	113.938	63.377
FDOG	(KG/CM2)	-23.691	-18.278	.000
D.FP	(KG/CM2)	295.603	318.865	211.255
D.FP	(KG/MM2)	2.956	3.189	2.113
FPT'	(KG/MM2)	102.642	99.929	94.368
D.FP	(KG/MM2)	2.956	3.189	2.113
FPT	(KG/MM2)	99.686	96.741	92.255

XXXX P.C CABLE TENSILE STRESS XXXX
(ELASTIC DISPLACEMENT OF SECONDARY MOMENT)

SIGN	UNIT	SEC-0	SEC-1	SEC-2	SEC-3
DMPTS	(T.M)	.000	21.472	42.944	64.416
WCG*10**5	(CM3)	46.057	-6.549	-6.399	-6.399
FCSG	(KG/CM2)	.000	-3.279	-6.711	-10.067
D.FP	(KG/CM2)	.000	-10.929	-22.370	-33.555
D.FP	(KG/MM2)	.000	-.109	-.224	-.336
FPT'	(KG/MM2)	92.255	96.741	99.686	97.484
D.FP	(KG/MM2)	.000	-.109	-.224	-.336
FPT	(KG/MM2)	92.255	96.850	99.909	97.820

SIGN	UNIT	SEC-4	SEC-5	SEC-6	SEC-7
DMPTS	(T.M)	85.888	107.360	85.888	64.416
WCG*10**5	(CM3)	-69.233	4.703	-69.233	-6.399
FCSG	(KG/CM2)	-1.241	22.830	-1.241	-10.067
D.FP	(KG/CM2)	-4.135	76.100	-4.135	-33.555
D.FP	(KG/MM2)	-.041	.761	-.041	-.336
FPT'	(KG/MM2)	90.156	80.045	90.156	97.484
D.FP	(KG/MM2)	-.041	.761	-.041	-.336
FPT	(KG/MM2)	90.198	79.284	90.198	97.820

SIGN	UNIT	SEC-8	SEC-9	SEC-10
DMPTS	(T.M)	42.944	21.472	.000
WCG*10**5	(CM3)	-6.399	-6.549	46.057
FCSG	(KG/CM2)	-6.711	-3.279	.000
D.FP	(KG/CM2)	-22.370	-10.929	.000
D.FP	(KG/MM2)	-.224	-.109	.000
FPT'	(KG/MM2)	99.686	96.741	92.255
D.FP	(KG/MM2)	-.224	-.109	.000
FPT	(KG/MM2)	99.909	96.850	92.255

2. EFFECTIVE PRESTRESS

1) LOSS OF PRESTRESS DUE TO RELAXATION OF STEEL

JACKING FORCE $P_o = 112$ kg/mm²

$\gamma = 8\ \%$

$$\delta_{pr} = \gamma \times \delta_{pt}$$

2) LOSS OF PRESTRESS DUE TO SHRINKAGE OF CONCRETE

$$\delta_{ps} = 200 \times 10^{-6} \times E_p$$

3) LOSS OF PRESTRESS DUE TO CREEP OF CONCRETE

$$\delta_{pc} = 36 \times 10^{-6} \times \frac{40}{U_t} \times E_p \times \delta_{cg}$$

	δ_{pt}	δ_{pr}	δ_{ps}	δ_{pc}	δ_{pe}	η
SEC-0	92.255	7.380	4.000	4.340	76.535	0.830
SEC-1	98.850	7.748	4.000	3.621	78.481	0.794
SEC-2	99.909	7.993	4.000	3.033	78.883	0.790
SEC-3	97.820	7.826	4.000	3.844	77.150	0.789
SEC-4	90.198	7.216	4.000	5.357	73.625	0.816
SEC-5	79.284	6.343	4.000	8.831	60.110	0.758
SEC-6						
SEC-7						
SEC-8						
SEC-9						
SEC-10						

3. PRESTRESS

(kg/cm²)

	PRESTRESS AT TRANSFER		EFFECTIVE PRESTRESS	
	TOP FIBER	BOTTOM FIBER	TOP FIBER	BOTTOM FIBER
SEC - 0	62.2	42.7	51.6	36.4
SEC - 1	- 7.2	136.2	- 5.7	108.1
SEC - 2	- 9.3	142.1	- 7.3	112.3
SEC - 3	- 9.1	139.1	- 7.2	109.7
SEC - 4	57.5	70.1	46.9	57.2
SEC - 5	134.9	- 25.6	102.3	- 21.7
SEC - 6				
SEC - 7				
SEC - 8				
SEC - 9				
SEC - 10				

§ 5. BENDING STRESS DUE TO STATICALLY INDETERMINATE MOMENT

(Kg/cm²)

	AT TRANSFER		AT WORKING LOAD	
	TOP FIBER	BOTTOM FIBER	TOP FIBER	BOTTOM FIBER
SEC-1	7.2	− 6.3	5.7	− 5.0
SEC-2	14.3	− 12.6	11.3	− 10.0
SEC-3	21.5	− 19.0	17.0	− 15.0
SEC-4	28.6	− 24.7	23.3	− 20.2
SEC-5	33.3	− 26.8	25.2	− 20.3
SEC-6				
SEC-7				
SEC-8				
SEC-9				

§ 6. CHECK ON STRESS

SEE PAGE 7 FOR CALCULATION. SECTION.

SEC – O

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	62.2	42.7
2	EFFECTIVE PRESTRESS	51.6	35.4
3	DEAD LOAD I	0	0
4	DEAD LOAD II	0	0
5	2ND MOMENT AT TRANSFER	0	0
6	AT WORKING LOAD	0	0
7	LIVE LOAD MAX	0	0
8	MIN	0	0
9	AT TRANSFER	62.2	42.7
10	AT WORKING LOAD EXCEPT LIVE	51.6	35.4
11	AT WORKING LOAD MAX	51.6	35.4
12	AT WORKING LOAD MIN	51.6	35.4

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 1

(kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	− 7.2	136.2
2	EFFECTIVE PRESTRESS	− 5.7	108.1
3	DEAD LOAD I	39.9	− 35.2
4	DEAD LOAD II	2.6	− 2.2
5	2ND MOMENT AT TRANSFER	7.2	− 6.3
6	AT WORKING LOAD	5.7	− 5.0
7	LIVE LOAD MAX	18.0	− 15.3
8	MIN	− 2.0	1.7
9	AT TRANSFER	39.9	91.7
10	AT WORKING LOAD EXCEPT LIVE	42.5	65.7
11	AT WORKING LOAD MAX	60.5	50.4
12	AT WORKING LOAD MIN	10.5	67.4

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 2

(Kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	- 9.3	142.1
2	EFFECTIVE PRESTRESS	- 7.3	112.3
3	DEAD LOAD I	60.6	- 44.6
4	DEAD LOAD II	3.3	- 2.8
5	2ND MOMENT AT TRANSFER	14.3	- 12.6
6	AT WORKING LOAD	11.3	- 10.0
7	LIVE LOAD MAX	24.5	- 20.7
8	MIN	- 4.1	3.5
9	AT TRANSFER	55.6	84.9
10	AT WORKING LOAD EXCEPT LIVE	67.9	54.9
11	AT WORKING LOAD MAX	82.4	84.2
12	AT WORKING LOAD MIN	53.8	58.4

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 3

(kg/cm^2)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	- 9.1	139.1
2	EFFECTIVE PRESTRESS	- 7.2	109.7
3	DEAD LOAD I	32.4	- 28.6
4	DEAD LOAD II	2.1	- 1.8
5	2ND MOMENT AT TRANSFER	21.5	- 17.0
6	AT WORKING LOAD	17.0	- 15.0
7	LIVE LOAD MAX	19.2	- 16.2
8	MIN	- 6.1	5.2
9	AT TRANSFER	44.8	91.5
10	AT WORKING LOAD EXCEPT LIVE	44.3	64.3
11	AT WORKING LOAD MAX	63.5	48.1
12	AT WORKING LOAD MIN	38.2	69.5

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC - 4

(Kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	57.5	70.1
2	EFFECTIVE PRESTRESS	46.9	57.2
3	DEAD LOAD I	-14.4	12.4
4	DEAD LOAD II	- 0.9	0.8
5	2ND MOMENT AT TRANSFER	28.6	-24.7
6	AT WORKING LOAD	23.3	-20.2
7	LIVE LOAD MAX	4.9	- 4.2
8	MIN	-10.7	9.2
9	AT TRANSFER	71.7	57.8
10	AT WORKING LOAD EXCEPT LIVE	54.9	50.2
11	AT WORKING LOAD MAX	59.8	46.0
12	AT WORKING LOAD MIN	44.2	59.4

9 : 1 + 3 + 5

10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

SEC – 5

(Kg/cm²)

		TOP FIBER	BOTTOM FIBER
1	PRESTRESS AT TRANSFER	134.9	−28.6
2	EFFECTIVE PRESTRESS	102.3	−21.7
3	DEAD LOAD I	−84.2	67.7
4	DEAD LOAD II	−5.2	4.4
5	2ND MOMENT AT TRANSFER	33.3	−26.8
6	AT WORKING LOAD	25.2	−20.3
7	LIVE LOAD MAX	0	0
8	MIN	−31.6	26.8
9	AT TRANSFER	84.0	12.3
10	AT WORKING LOAD EXCEPT LIVE	38.1	30.1
11	AT WORKING LOAD MAX	38.1	30.1
12	AT WORKING LOAD MIN	6.5	56.9

9 : 1 + 3 + 5

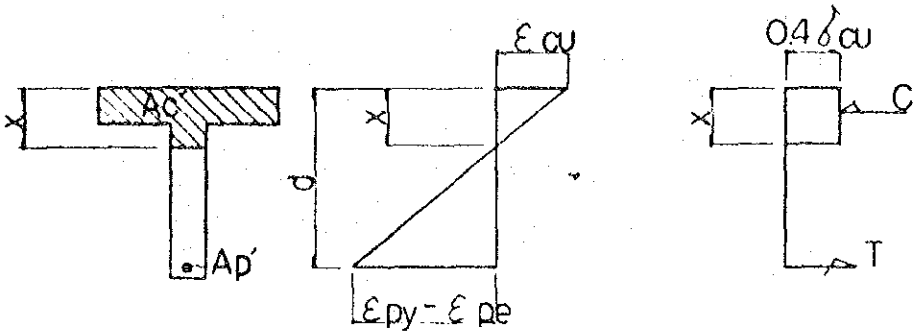
10 : 2 + 3 + 4 + 6

11 : 2 + 3 + 4 + 6 + 7

12 : 2 + 3 + 4 + 6 + 8

§ 7. ULTIMATE STRENGTH

CALUCULATION OF ULTIMATE BALANCED STEEL (RATIO)



$$\frac{\varepsilon cu}{x} = \frac{\varepsilon py - \varepsilon pe}{d - x}$$

$$x = \frac{\varepsilon cu}{\varepsilon cu + \varepsilon py - \varepsilon pe}\, d$$

ε cu ; ULTIMATE STRAIN IN CONCRETE
= 0.0035

ε py ; ULTIMATE STRAIN IN STEEL

d ; EFECTIVE DEPTH

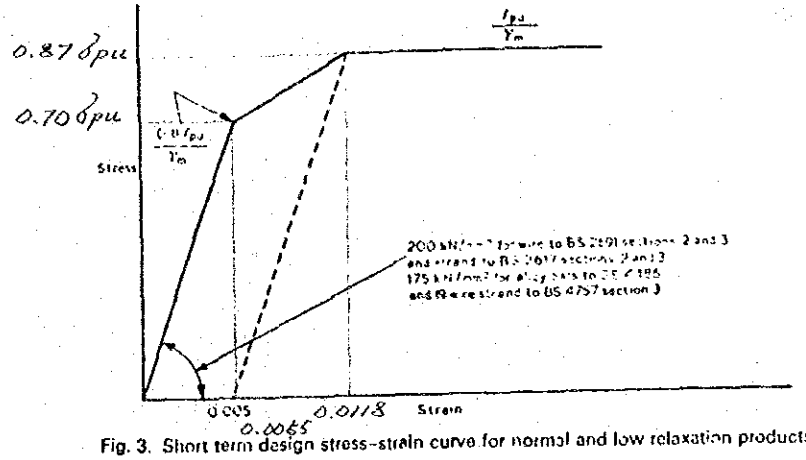


Fig. 3. Short term design stress-strain curve for normal and low relaxation products

CONPRESSIVE FORCE

$$C = 0.4 \sigma_{cu} A_c$$

TENSILE FORCE

$$T = A_p \cdot 0.87 \sigma_{pu}$$

$$A_p = \frac{0.4 \sigma_{cu} A_c}{0.87 \sigma_{pu}} \quad > A_p' \qquad \text{CASE I}$$

$$< A_p' \qquad \text{CASE 2}$$

WHERE A_p' = EXISTING AREA OF ST EL

$E_p = 200 \ KN/mm^2$

I) CASE I

TENSILE FORCE $T = A_p' \ 0.87 \sigma_{pu}$

COMPRESSIVE FORCE $C = 0.4 \sigma_{cu} A_c'$

$$A_c' = \frac{A_p' \ 0.87 \sigma_{pu}}{0.4 \ \sigma_{cu}}$$

ULTIMATE STRENGTH

$$M_{ur} = A_p' \ 0.87 \sigma_{pu} \ (d - kx)$$

WHERE kx DISTANCE FROM COMPRESSIVE FIBER TO THE CENTROID OF A_c'

2) CACE 2

TENSILE FORCE $T = A_{p'} \cdot \acute{O}_p$

$$\acute{O}_p = E_p\left(\varepsilon_{cu}\frac{d-x}{x} + \varepsilon_{pe}\right)$$

COMPRESSIVE FORCE $C = 0.4 \cdot \acute{O}cu \cdot Ac$

X IS GIVEN BY THE FOLLOWING

$$A_{p'} \cdot E_p\left(\varepsilon_{cu}\frac{d-x}{x} + \varepsilon_{pe}\right) = 0.4 \cdot \acute{O}cu \cdot Ac$$

ULTIMATE STRENGTH

$$Mur = A_{p'} \cdot \acute{O}_p (d - kx)$$

SEC - ②

$$x = \frac{0.0035}{0.0035 + 0.0118 - 0.0039} \times 117 = 35.9 \text{ cm}$$

$$Ac = 2336 \text{ cm}^2$$

$$Ap = \frac{0.4 \times 400 \times 2336}{0.87 \times 16000} = 26.9 \text{ cm}^2 < 64.68 \text{ cm}^2$$

CASE (2)

$$x = \frac{0.0035}{0.0035 + 0.0055 - 0.0039} \times 117 = 80.3 \text{ cm}$$

$$Ac = 4112 \text{ cm}^2$$

$$Ap = \frac{0.4 \times 400 \times 4112}{0.87 \times 16000} = 47.3 \text{ cm}^2 < 64.68 \text{ cm}^2$$

$$\therefore Ep = 2.0 \times 10^6 \text{ kg/cm}^2$$

$$64.68 \times 2.0 \times 10^6 \times \left(0.0035 \times \frac{117 - x}{x} + 0.0039\right)$$

$$= 0.4 \times 400 \times (900 + 40x)$$

$$x = 84.1 \text{ cm}$$

$$\sigma_p = 2.0 \times 10^6 \times \left(0.0035 \times \frac{117 - 84.1}{84.1} + 0.0039\right)$$

$$= 10538 \text{ kg/cm}^2$$

ULTIMATE STRENGTH

$$Mur = 64.68 \times 10\,538 \times (117 - 34.8) \times 10^{-5}$$

$$= 560.3 \ t \cdot m$$

ULTIMATE MOMENT	SAFETY FACTOR
$Mu1 = 426.2 \ t \cdot m$	1.31
$Mu2 = 470.2 \ t \cdot m$	

SEC - (4)

$$x = \frac{0.0035}{0.0035 + 0.0118 - 0.0030} \times 123.8 = 35.2 \text{ cm}$$

$$Ac = 4112 \text{ cm}^2$$

$$Ap = \frac{0.4 \times 400 \times 4112}{0.87 \times 16000} = 47.26 \text{ cm}^2 < 64.68 \text{ cm}^2$$

$$x = \frac{0.0035}{0.0035 + 0.0055 - 0.0030} \times 123.8 = 72.2 \text{ cm}$$

$$Ac = 6332 \text{ cm}^2$$

$$Ap = \frac{0.4 \times 400 \times 6332}{0.87 \times 16000} = 72.78 \text{ cm}^2 > 64.68 \text{ cm}^2$$

$$\therefore Ep = 4.32 \times 10^5 \text{ kg/cm}^2$$

$$64.68 \times \{ 2.0 \times 10^6 \times 0.0055 + 4.32 \times 10^5 \times (0.0035 \times \frac{123.8 - x}{x} - 0.0025) \} = 0.4 \times 400 \times (2000 + 60x)$$

$$x = 63.54 \text{ cm}$$

$$\sigma p = 2.0 \times 10^6 \times 0.0055 + 4.32 \times 10^5 \times (0.0035 \times \frac{123.8 - 63.54}{63.54} + 0.0030 - 0.0055) = 11354 \text{ kg/cm}^2$$

ULTIMATE STRENGTH

$Mur = 64.68 \times 11354 \times (123.8 - 25.14)$

$= 724.5\ t \cdot m$

ULTIMATE MOMENT		SAFETY FACTOR
Mu_1	$706.9\ t \cdot m$	1.02
Mu_2	$796.8\ t \cdot m$	