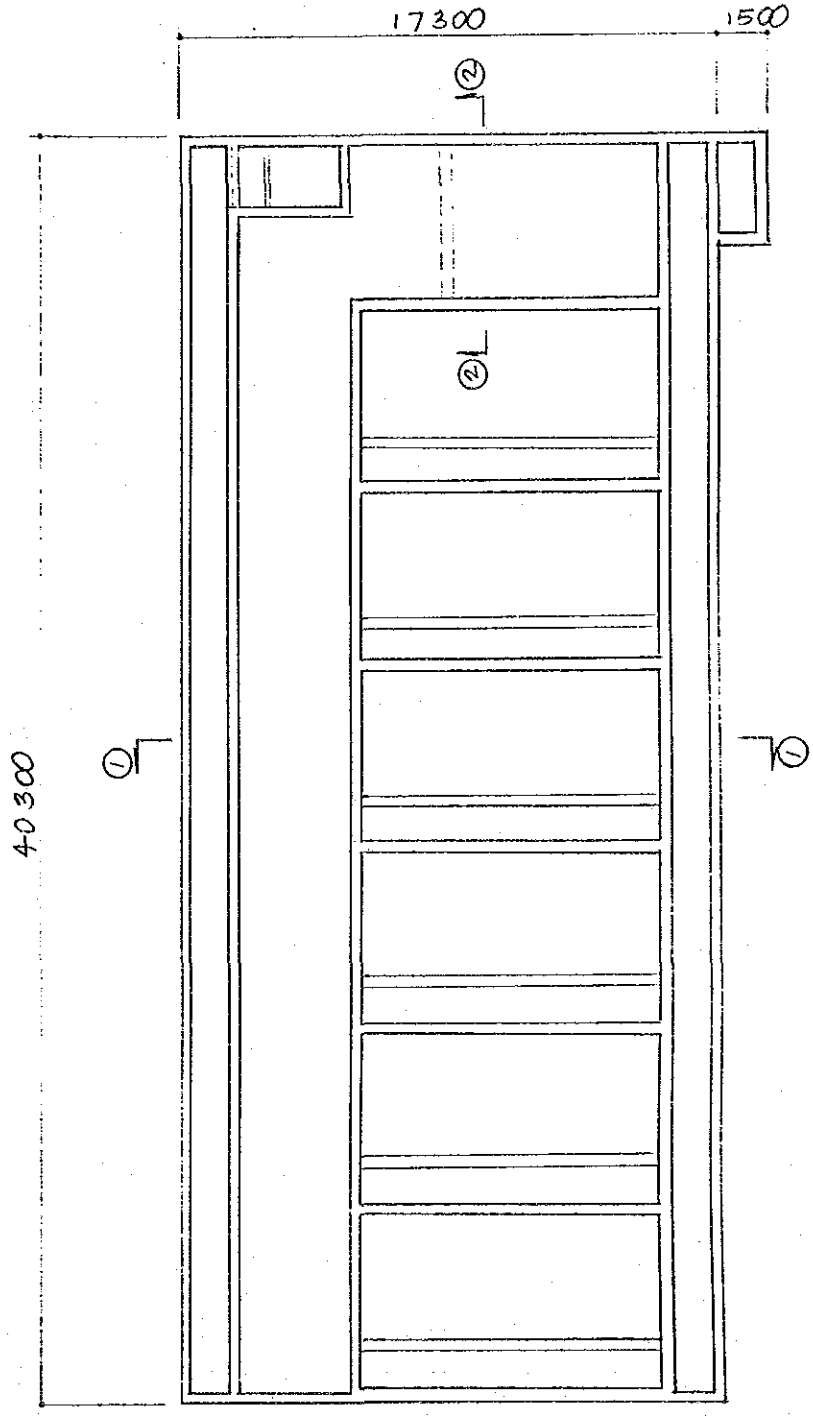
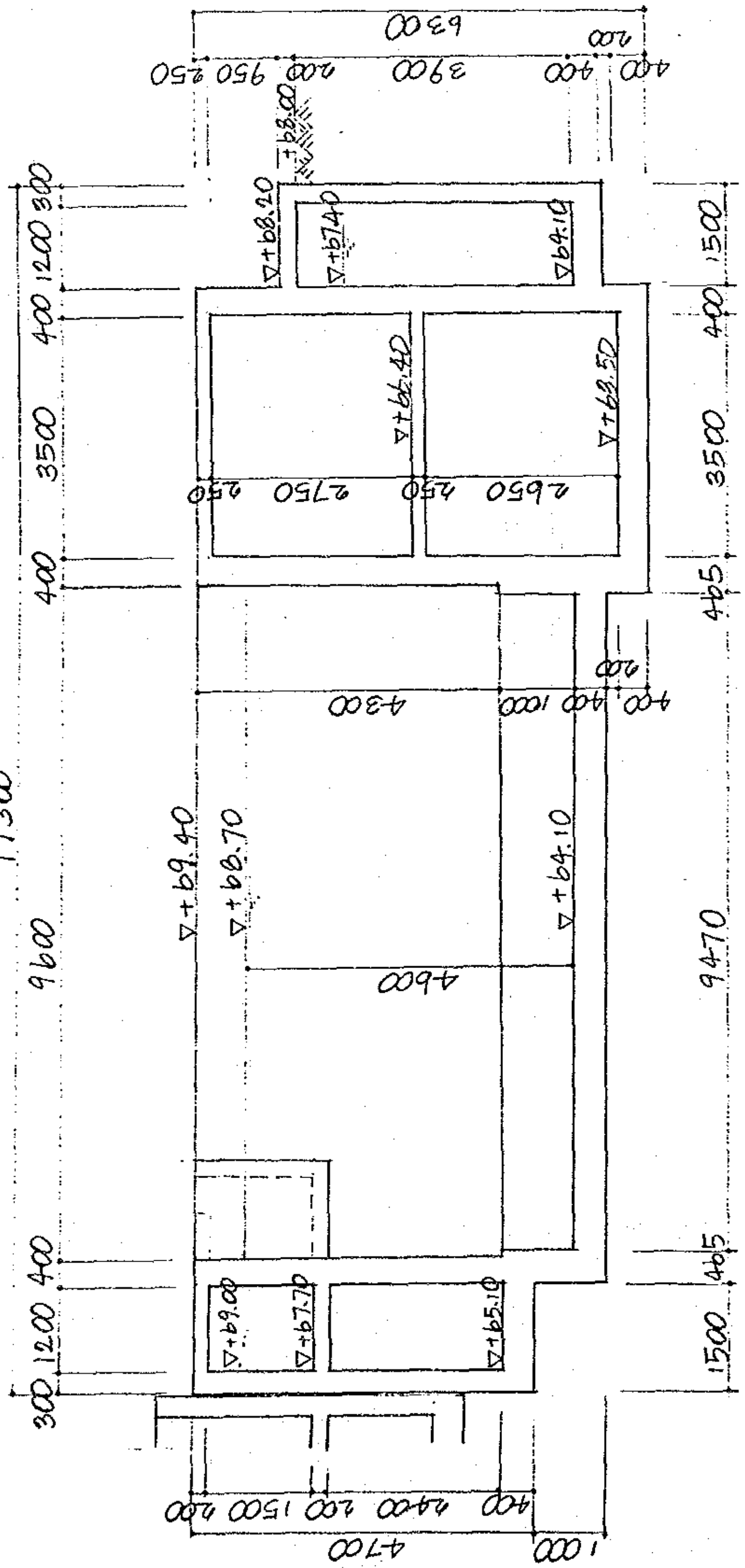
4. RAPID SAND FILTER

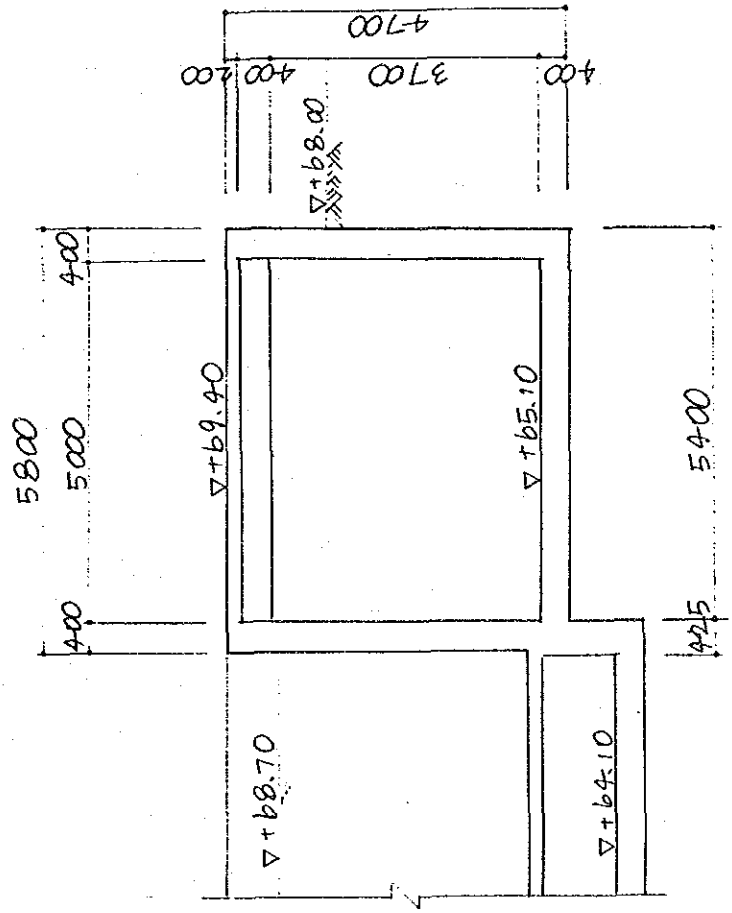
SHEET NO :

1. PLAN AND SECTION





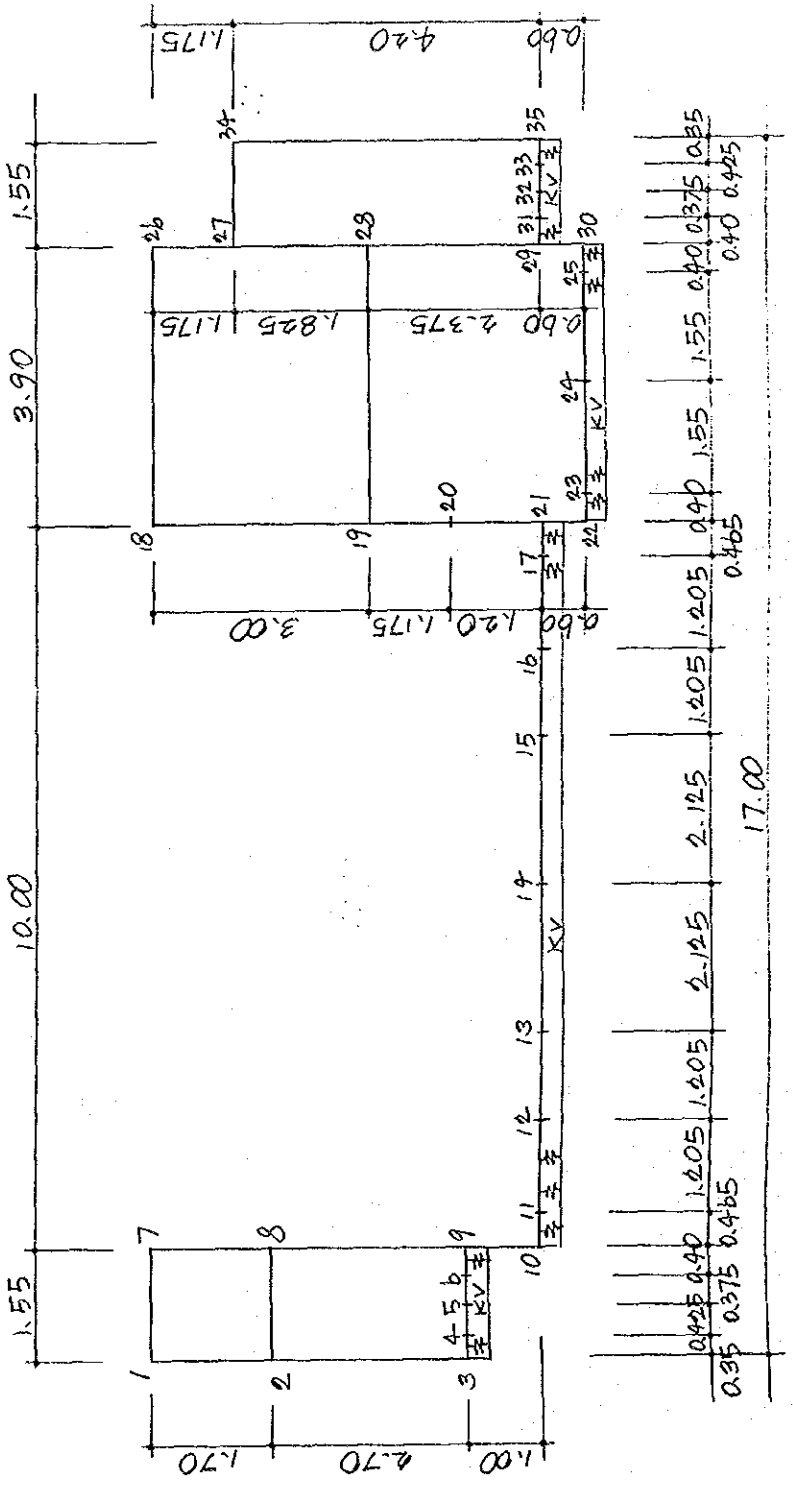
SECTION ①-①


4700
400
3700
400
200
▽+68.80
400
5800
5000
400
▽+69.40
▽+65.10
5400
425
▽+68.70
▽+64.10

SECTION ②-②

2. FRAME OF SECTION ①-①

2-1 DIMENTION OF FRAME



$$Kv = Kv0 \left(\frac{Bv}{30}\right)^{-3/4}$$

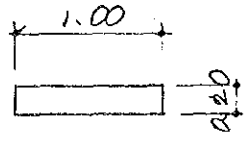
$$Kv0 = \frac{1}{30} \times 1 \times 28 \times 50 = 46.67 \ kg/cm^3$$

$$Bv = \sqrt{4030 \times 1730} = 2640 \ cm$$

$$Kv = 46.67 \times \left(\frac{2640}{30}\right)^{-3/4} = 1.62 \ kg/cm^3 = 1620 \ t/m^3$$

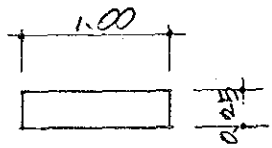
$$Kv = 1620 \times 1.00 = 1620 \ t/m^2$$

2-2 INERTIA AND AREA



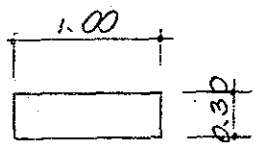
$$I = \frac{1}{12} \times 1.00 \times 0.20^3 = 0.0007\ m^4$$

$$A = 1.00 \times 0.20 = 0.20\ m^2$$



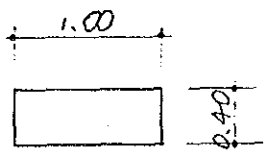
$$I = \frac{1}{12} \times 1.00 \times 0.25^3 = 0.0013\ m^4$$

$$A = 1.00 \times 0.25 = 0.25\ m^2$$



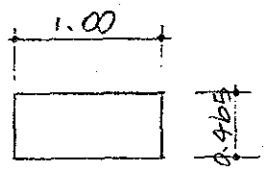
$$I = \frac{1}{12} \times 1.00 \times 0.30^3 = 0.0023\ m^4$$

$$A = 1.00 \times 0.30 = 0.30\ m^2$$



$$I = \frac{1}{12} \times 1.00 \times 0.40^3 = 0.0053\ m^4$$

$$A = 1.00 \times 0.40 = 0.40\ m^2$$



$$I = \frac{1}{12} \times 1.00 \times 0.465^3 = 0.0084\ m^4$$

$$A = 1.00 \times 0.465 = 0.47\ m^2$$

$A_1 = 0.20\ m^2$ $\quad I_1 = 0.0007\ m^4$

$A_2 = 0.25$ $\quad I_2 = 0.0013$

$A_3 = 0.30$ $\quad I_3 = 0.0023$

$A_4 = 0.40$ $\quad I_4 = 0.0053$

$A_5 = 0.47$ $\quad I_5 = 0.0084$

2-3 CALCULATION OF LOAD

2-3-1 VERTICAL LOAD

(1) SLAB (1)

DEAD LOAD $0.20 \times 2.5 = 0.50^{t/m^2}$

LIVE LOAD $= 0.30$ "

$W_1 = 0.80^{t/m^2}$

$P_1 = 0.80 \times 0.15 = 0.12^{t}$

(2) SLAB (2)

DEAD LOAD $0.25 \times 2.5 = 0.63^{t/m^2}$

LIVE LOAD $= 0.30$ "

$W_2 = 0.93^{t/m^2}$

$P_2 = 0.93 \times 0.20 = 0.19^{t}$

(3) SLAB (3)

$W_3 = 0.20 \times 2.5 = 0.50^{t/m^2}$

WATER LOAD $W_4 = 1.30 \times 1.0 = 1.30^{t/m^2}$

(4) WALL

$t = 30^{cm}$ $P_{W1} = 0.30 \times 2.5 = 0.75^{t/m^2}$

$t = 40^{cm}$ $P_{W2} = 0.40 \times 2.5 = 1.00$ "

$t = 46.5^{cm}$ $P_{W3} = 0.465 \times 2.5 = 1.16$ "

(5) BASE SLAB (1)

DEAD LOAD	0.40 × 2.5	=	1.00 t/m²
DEAD LOAD	0.205 × 2.5	=	0.51 "
GRAVEL SAND	1.20 × 2.0	=	2.40 "
		W5 =	3.91 t/m²

WATER LOAD $W_6 = (4.60 - 1.20 - 0.205) \times 1.0 = 3.20\ t/m^2$

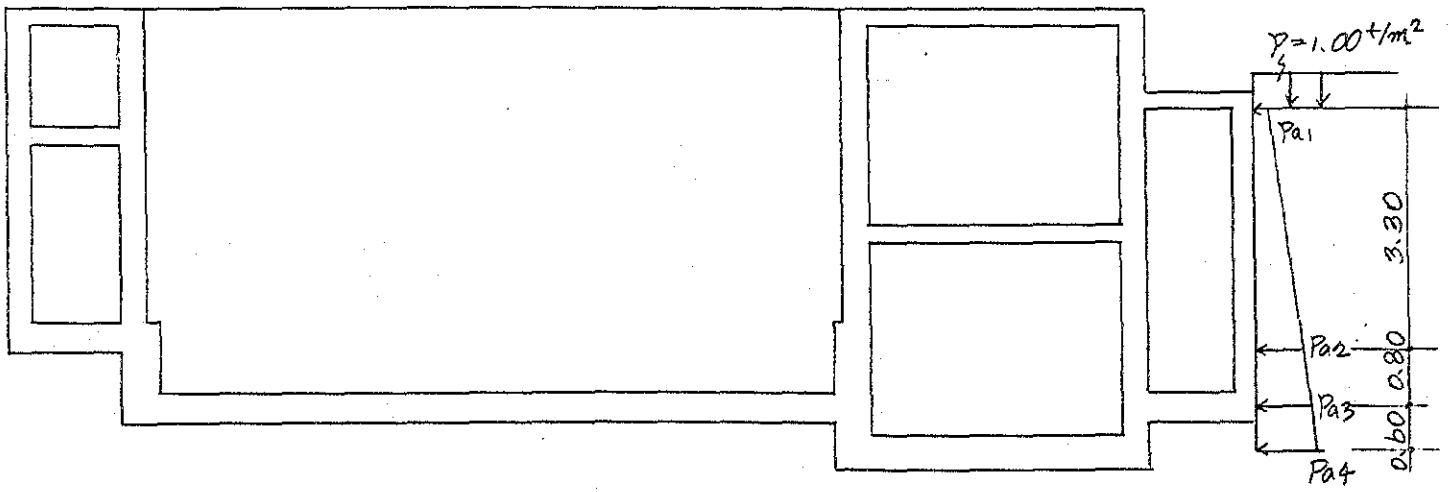
(6) BASE SLAB (2)

DEAD LOAD	0.40 × 2.5	=	1.00 t/m²
P.L CONCRETE	0.07 × 2.3	=	0.16 "
LIVE LOAD		=	0.50 "
		W7 =	1.66 t/m²

(7) BASE SLAB (3)

DEAD LOAD	W8 = 0.40 × 2.5	=	1.00 t/m²
WATER LOAD	W9 = 3.30 × 1.0	=	3.30 "

2-3-2 EARTH PRESSURE



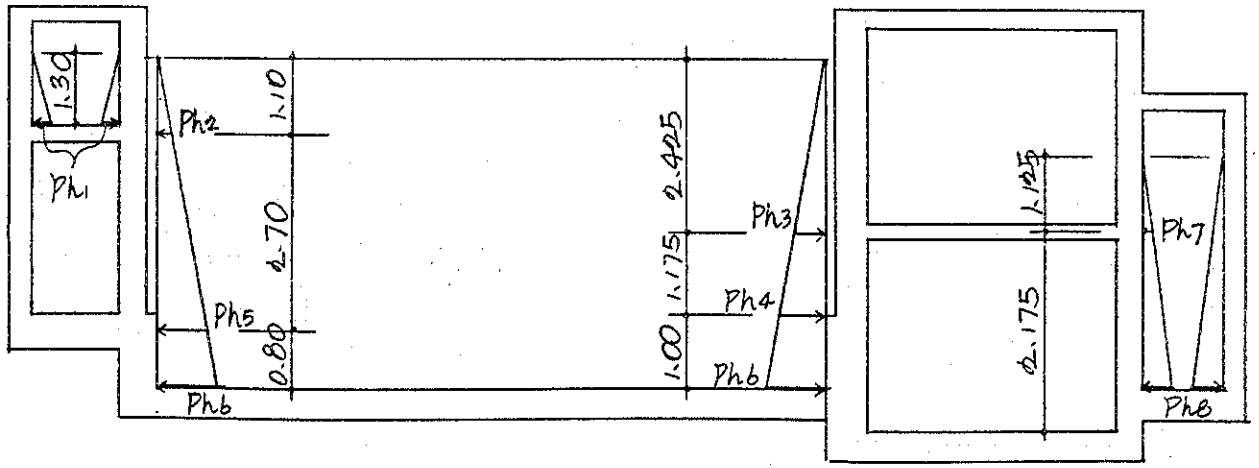
$Pa_1 = 1.00 \times 0.5 = 0.50\ t/m^2$

$Pa_2 = (1.00 + 1.8 \times 3.30) \times 0.5 = 3.47$ "

$Pa_3 = (1.00 + 1.8 \times 4.10) \times 0.5 = 4.19$ "

$Pa_4 = (1.00 + 1.8 \times 4.70) \times 0.5 = 4.73$ "

2-3-3 WATER PRAESSURE



Ph1 = 1.30 × 1.0 = 1.30 t/m²

Ph2 = 1.10 × 1.0 = 1.10 "

Ph3 = 2.425 × 1.0 = 2.43 "

Ph4 = 3.60 × 1.0 = 3.60 "

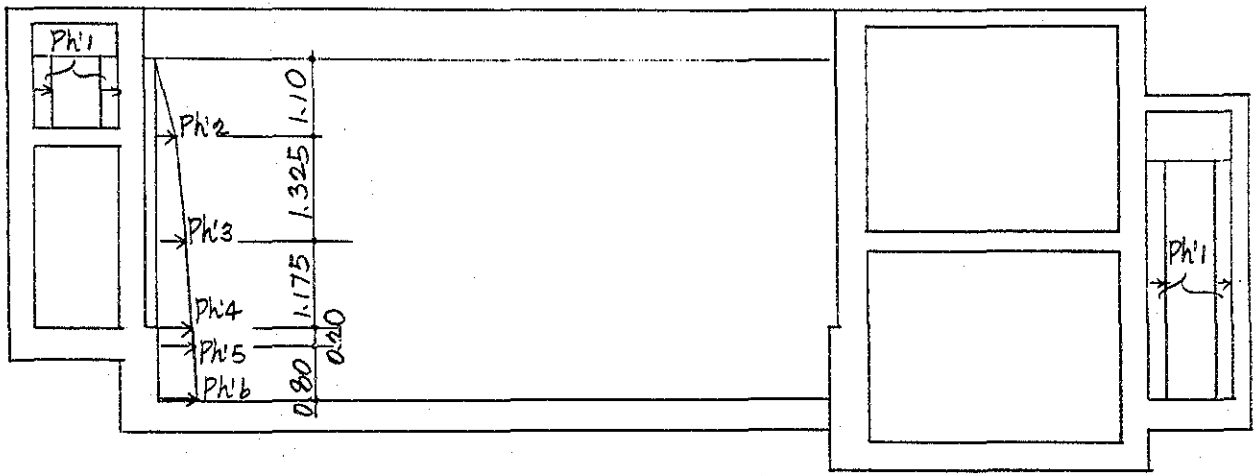
Ph5 = 3.80 × 1.0 = 3.80 t/m²

Ph6 = 4.60 × 1.0 = 4.60 "

Ph7 = 1.125 × 1.0 = 1.13 "

Ph8 = 3.30 × 1.0 = 3.30 "

2-3-4 DYNAMIC WATER PRESSURE



$Ph'1 = 0.60 \times 1.0 \times 0.05 = 0.03\ t/m^2$

$Ph'2 = \sqrt{3} \times 0.05 \times 1.0 \times 4.60 \times \left\{ \frac{1.10}{4.60} - \frac{1}{2} \times \left(\frac{1.10}{4.60} \right)^2 \right\} = 0.08\ t/m^2$

$Ph'3 = \sqrt{3} \times 0.05 \times 1.0 \times 4.60 \times \left\{ \frac{2.425}{4.60} - \frac{1}{2} \times \left(\frac{2.425}{4.60} \right)^2 \right\} = 0.15\ "$

$Ph'4 = \sqrt{3} \times 0.05 \times 1.0 \times 4.60 \times \left\{ \frac{3.60}{4.60} - \frac{1}{2} \times \left(\frac{3.60}{4.60} \right)^2 \right\} = 0.19\ "$

$Ph'5 = \sqrt{3} \times 0.05 \times 1.0 \times 4.60 \times \left\{ \frac{3.80}{4.60} - \frac{1}{2} \times \left(\frac{3.80}{4.60} \right)^2 \right\} = 0.19\ "$

$Ph'6 = \sqrt{3} \times 0.05 \times 1.0 \times 4.60 \times \left\{ \frac{4.60}{4.60} - \frac{1}{2} \times \left(\frac{4.60}{4.60} \right)^2 \right\} = 0.20\ "$

2-3-5 EARTHQUAKE LOAD

$P_{E1} = 0.80^{t/m^2} \times 0.95 \times 0.05 = 0.04^{t}$

$P_{E2} = 0.93\ " \times 2.15 \times 0.05 = 0.10\ "$

$P_{E3} = 0.50\ " \times 0.60 \times 0.05 = 0.02\ "$

$P_{E4} = 0.80\ " \times 0.75 \times 0.05 = 0.03\ "$

$P_{E5} = 0.93\ " \times 1.75 \times 0.05 = 0.08\ "$

WALL

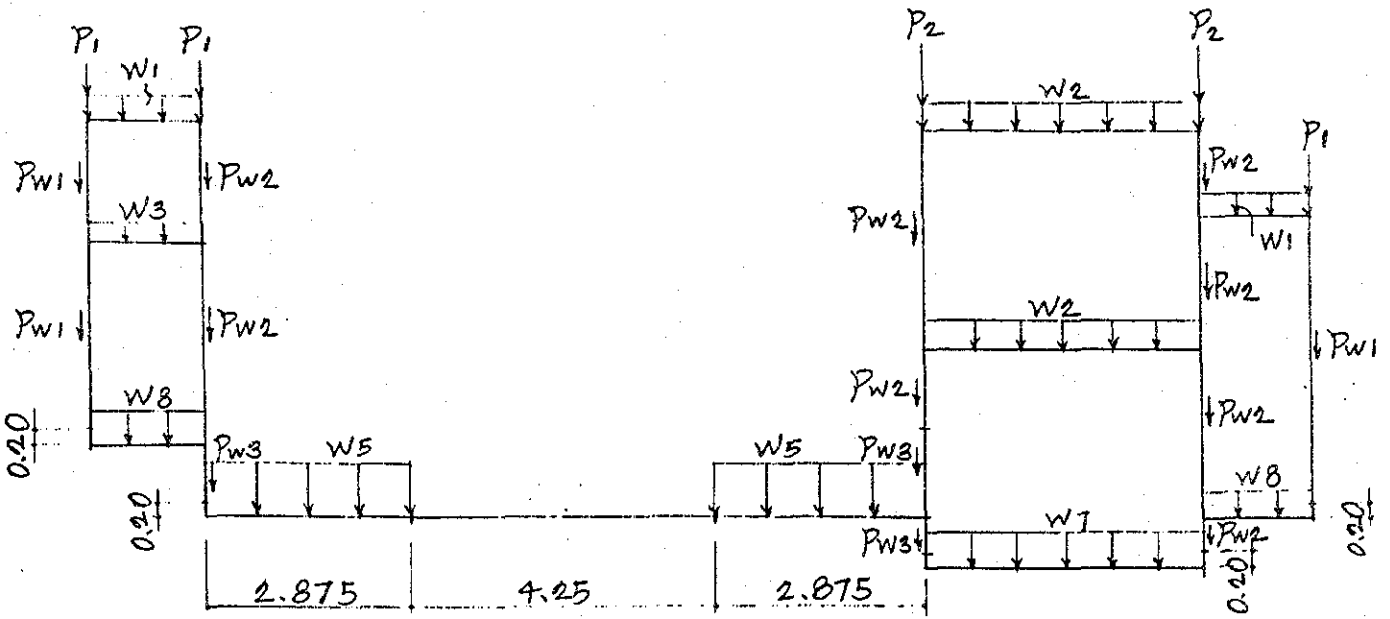
$W_{E1} = 0.30 \times 2.5 \times 0.05 = 0.04^{t/m^2}$

$W_{E2} = 0.40 \times 2.5 \times 0.05 = 0.05\ "$

$W_{E3} = 0.465 \times 2.5 \times 0.05 = 0.06\ "$

2-4 LOADING CHART

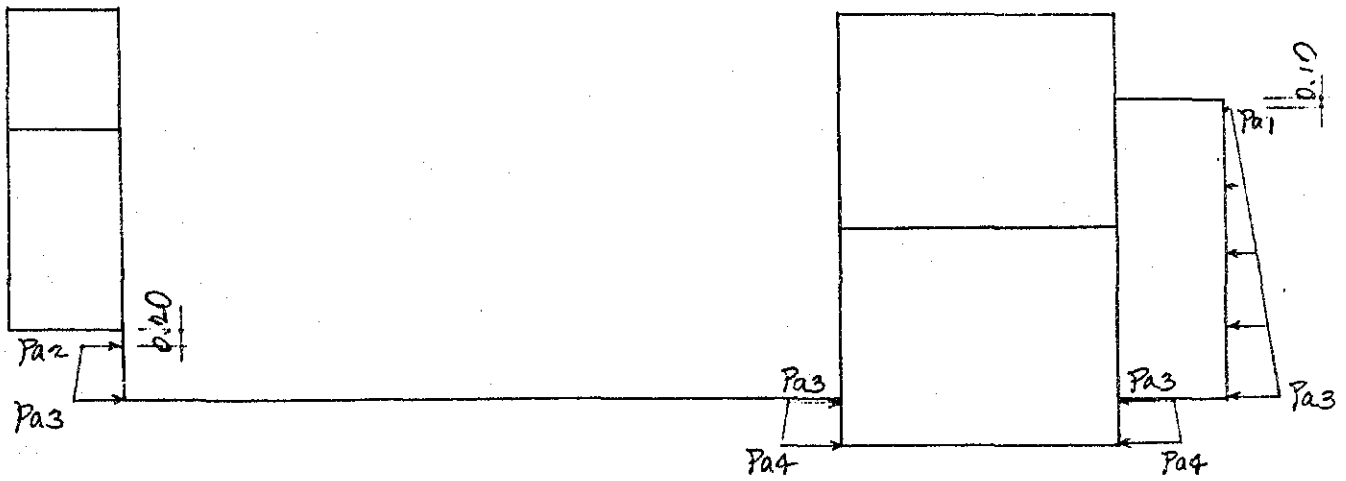
CASE 1 VERTICAL LOAD



$W_1 = 0.80^{t/m^2}$ $W_2 = 0.93^{t/m^2}$ $W_3 = 0.50^{t/m^2}$ $W_5 = 3.91^{t/m^2}$ $W_7 = 1.66^{t/m^2}$ $W_8 = 1.00^{t/m^2}$

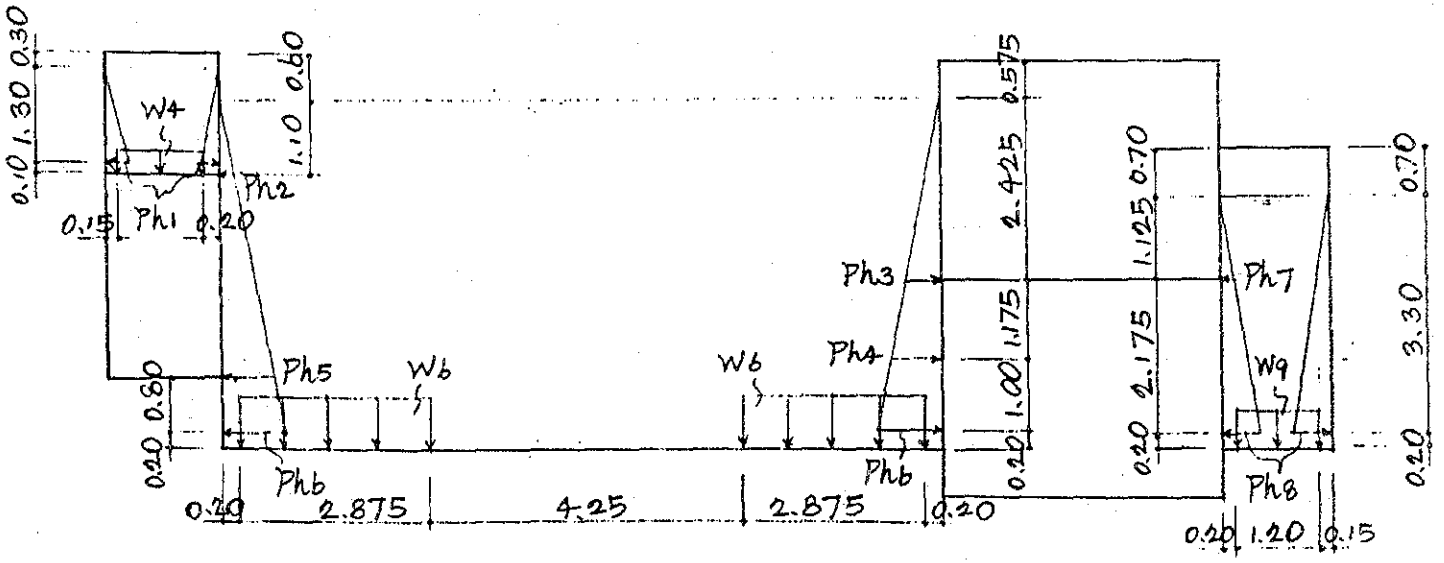
$P_{W1} = 0.75^{t/m^2}$ $P_{W2} = 1.00^{t/m^2}$ $P_{W3} = 1.16^{t/m^2}$ $P_1 = 0.12^{t}$ $P_2 = 0.19^{t}$

CASE 2 EARTH PRESSURE



$Pa1 = 0.50^{t}/m^{2}$ $Pa2 = 3.47^{t}/m^{2}$ $Pa3 = 4.19^{t}/m^{2}$ $Pa4 = 4.73^{t}/m^{2}$

CASE 3 WATER PRESSURE



W4 = 1.30 t/m² Wb = 3.20 t/m² W9 = 3.30 t/m²

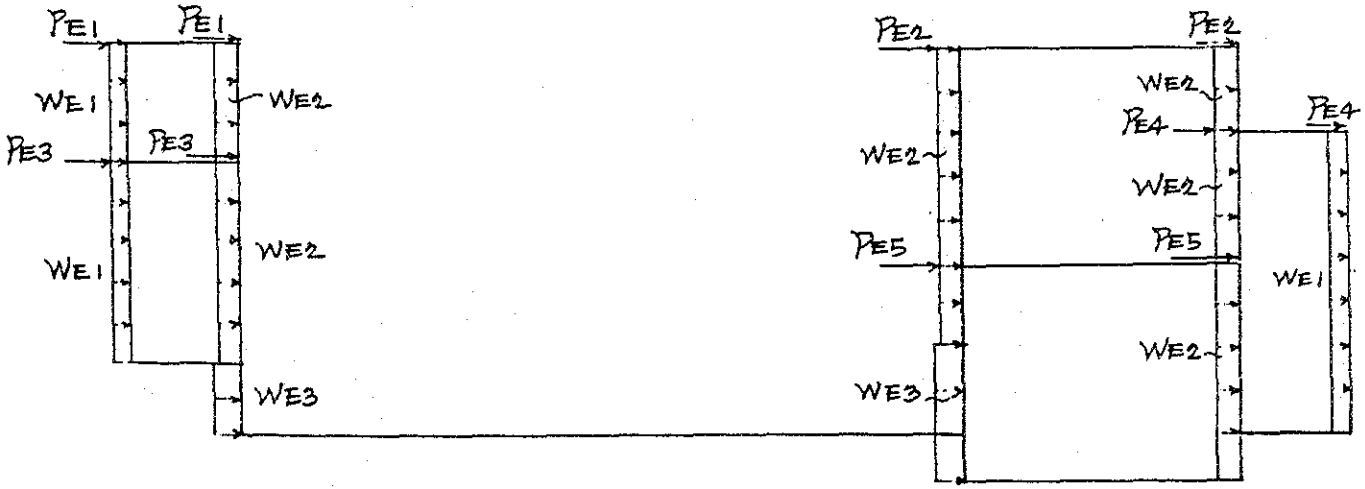
Ph1 = 1.30 t/m² Ph2 = 1.10 t/m² Ph3 = 2.43 t/m² Ph4 = 3.60 t/m²

Ph5 = 3.80 t/m² Phb = 4.60 t/m² Ph7 = 1.13 t/m² Ph8 = 3.30 t/m²

CASE 4 DYNAMIC WATER PRESSURE

$Ph'1 = 0.03\ t/m^2$ $Ph'2 = 0.08\ t/m^2$ $Ph'3 = 0.15\ t/m^2$ $Ph'4 = 0.19\ t/m^2$ $Ph'5 = 0.19\ t/m^2$ $Ph'6 = 0.20\ t/m^2$

CASE 5 EARTHQUAKE LOAD



$P_{E1} = 0.04^{t}$ $P_{E2} = 0.10^{t}$ $P_{E3} = 0.02^{t}$ $P_{E4} = 0.03^{t}$ $P_{E5} = 0.08^{t}$

$W_{E1} = 0.04^{t/m^2}$ $W_{E2} = 0.05^{t/m^2}$ $W_{E3} = 0.06^{t/m^2}$

PERMANENT LOAD

CASE 6 = ① + ②

7 = ① + ② + ③

8 = ① + ③

TEMPORARY LOAD (α = 0.667)

CASE 9 = ① + ② + ⑤

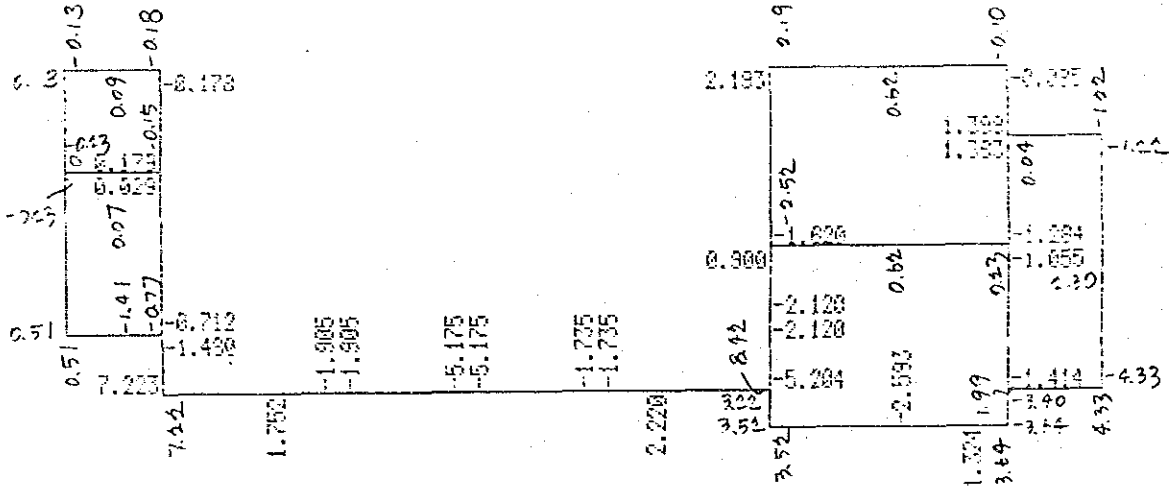
10 = ① + ② − ⑤

11 = ① + ② + ③ + ④ + ⑤

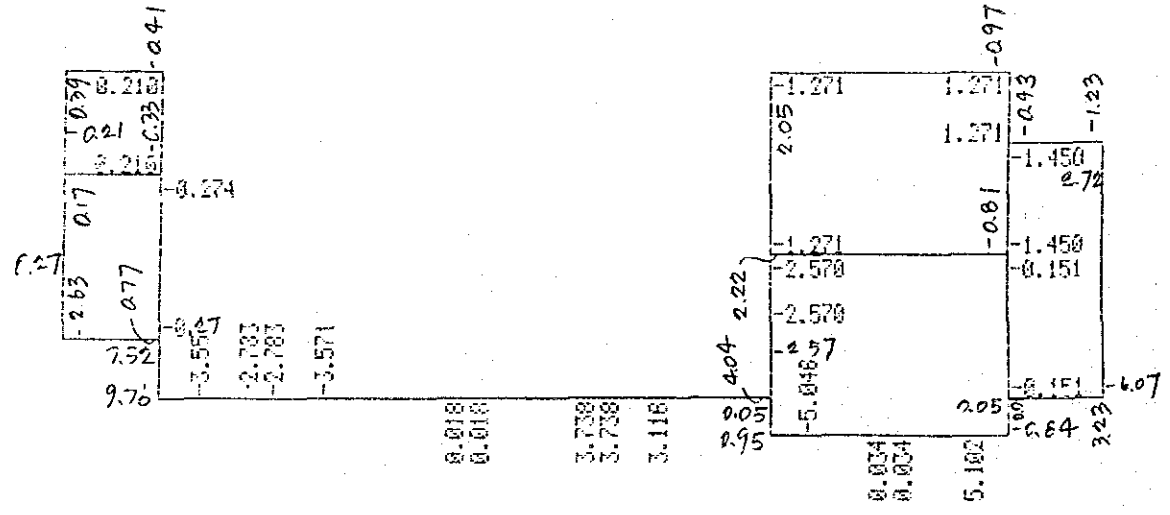
12 = ① + ② + ③ − ④ − ⑤

CASE 6 PERMANENT LOAD

MOMENT

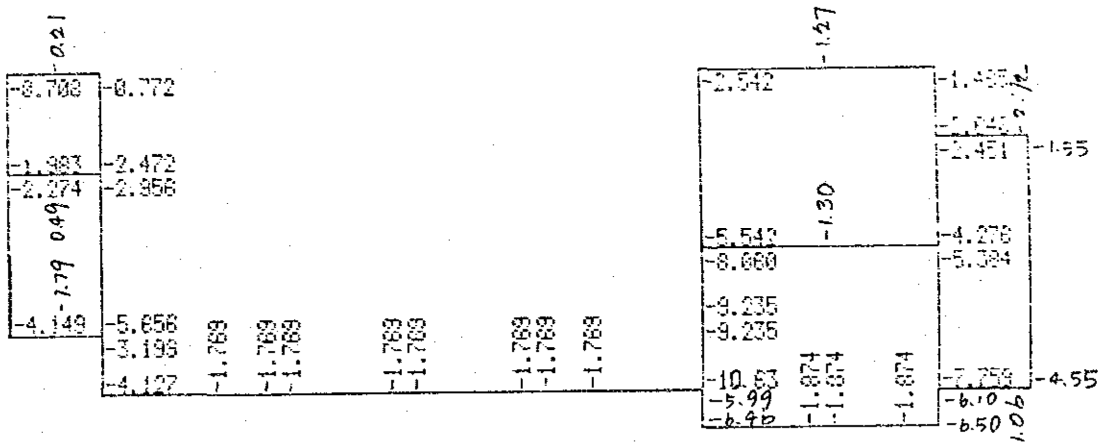


SHEAR



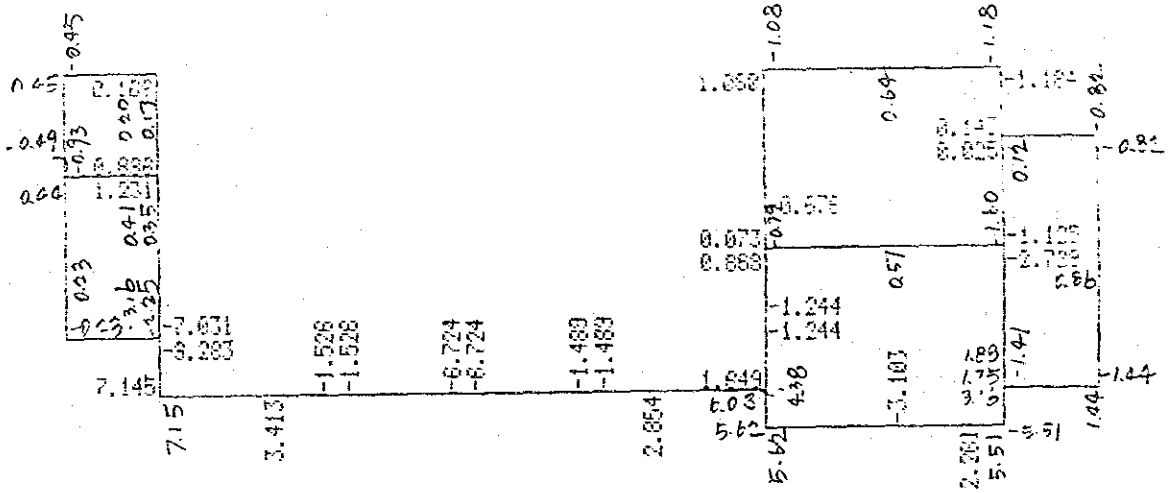
CASE b PERMANENT LOAD

AXIAL

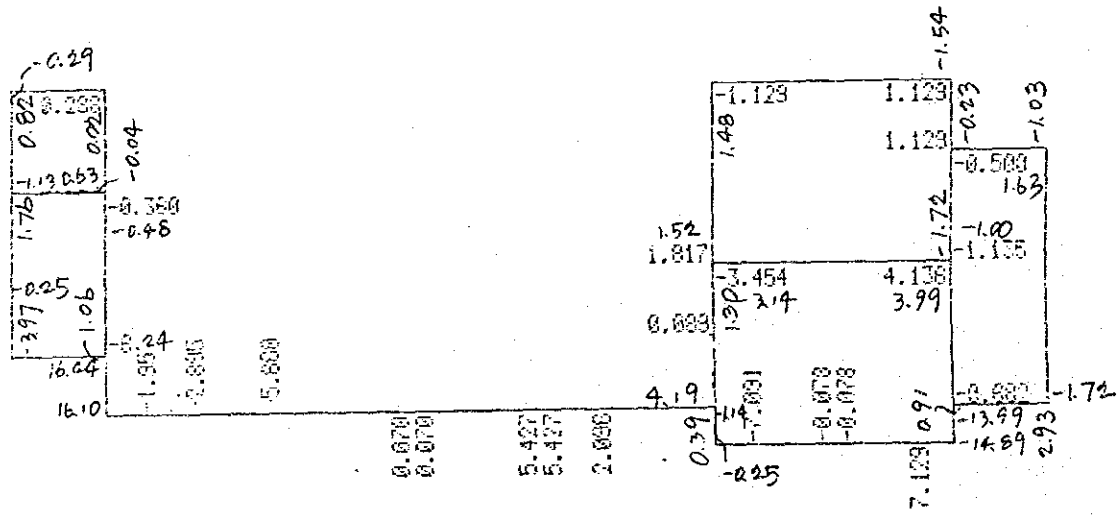


CASE 7 PERMANENT LOAD

MOMENT

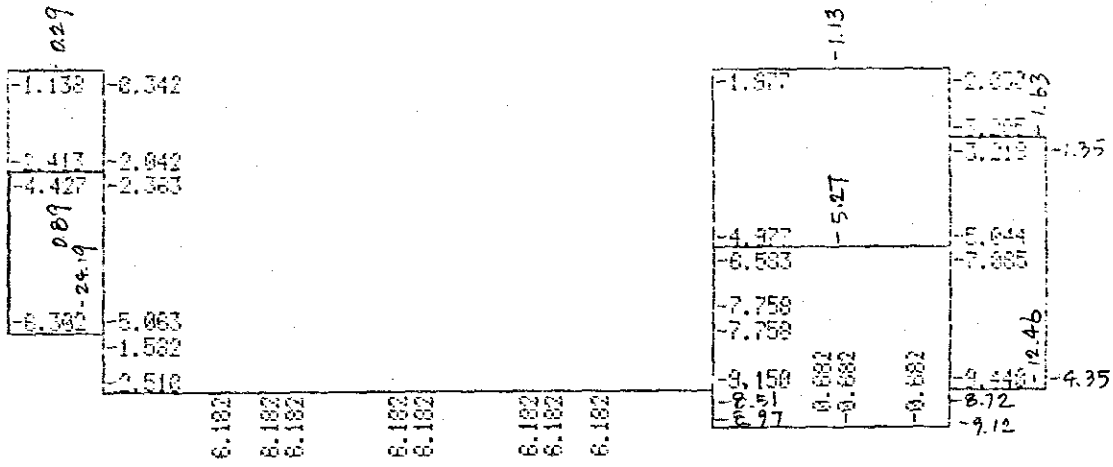


SHEAR



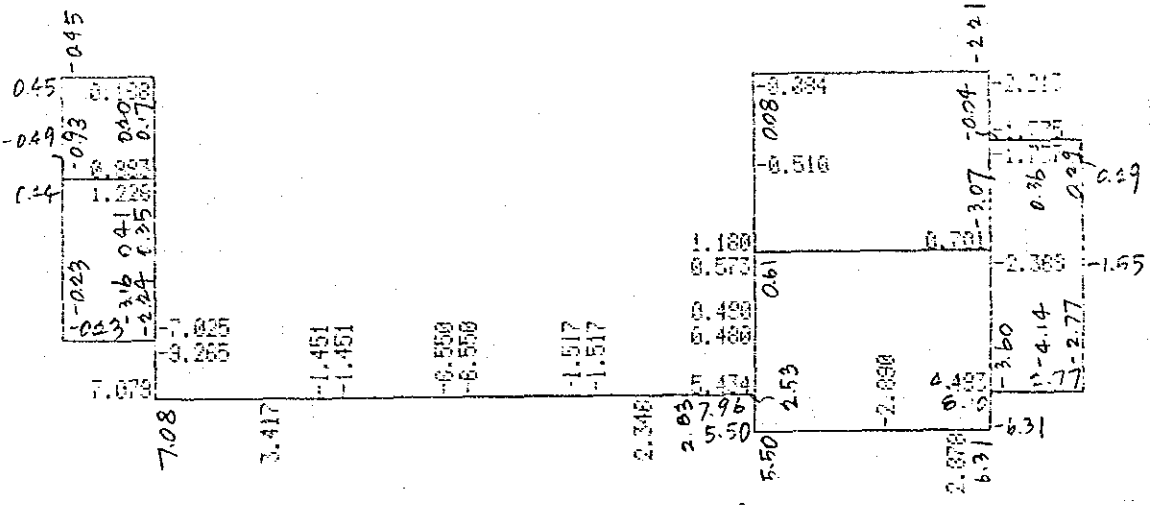
CASE 7 PERMANENT LOAD

AXIAL

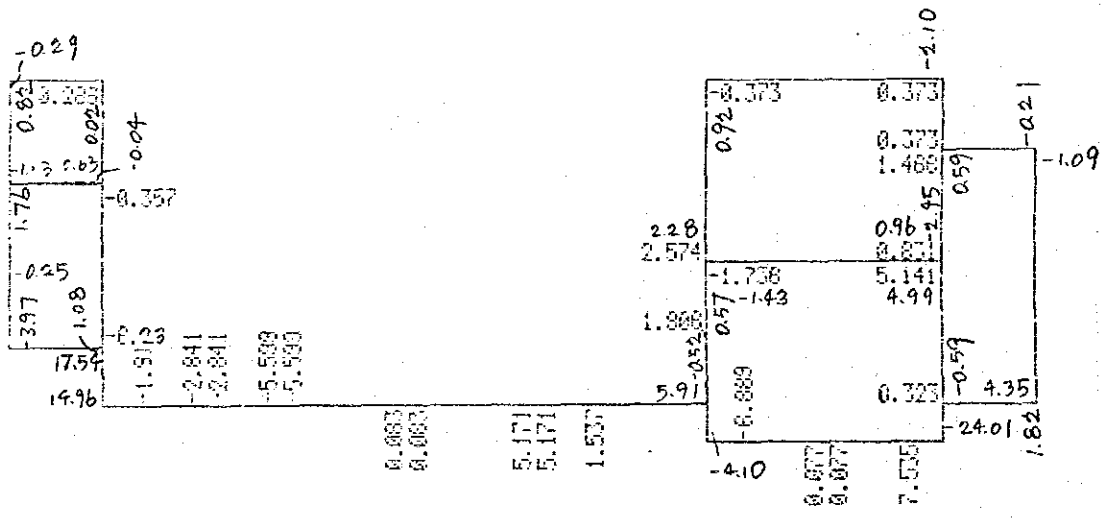


CASE 8 PERMANENT LOAD

MOMENT

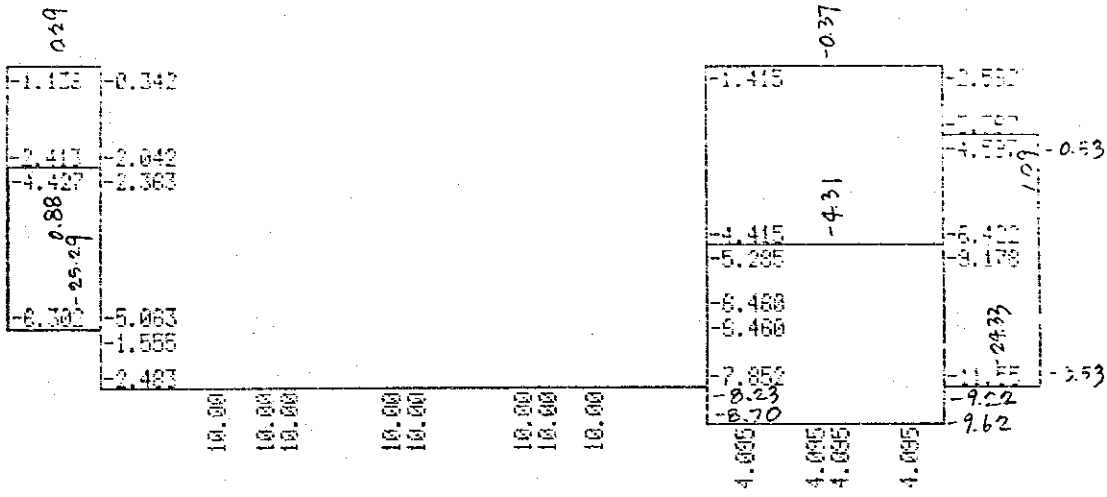


SHEAR



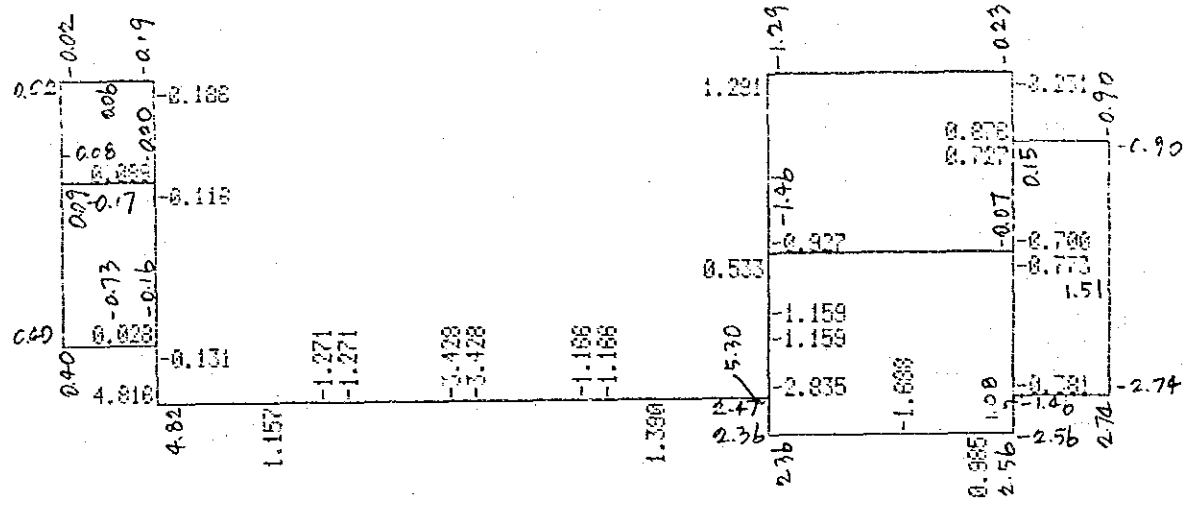
CASE 6 PERMANENT LOAD

AXIAL

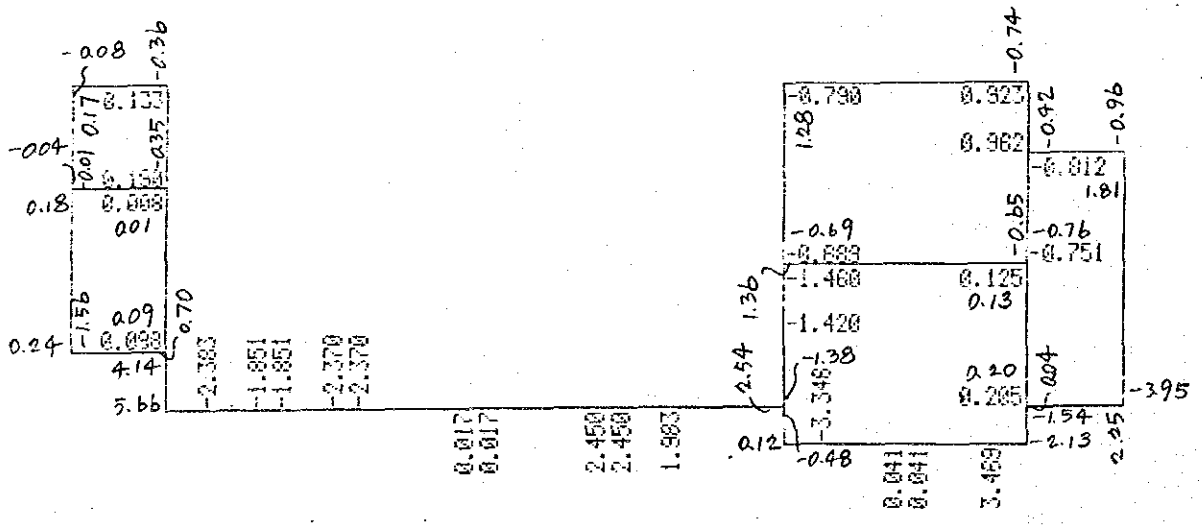


CASE 9 TEMPORARY LOAD

MOMENT

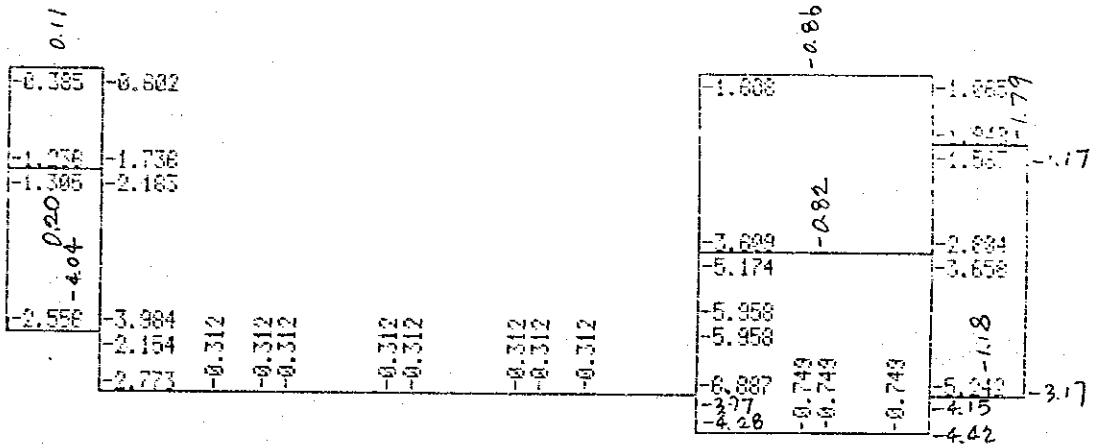


SHEAR



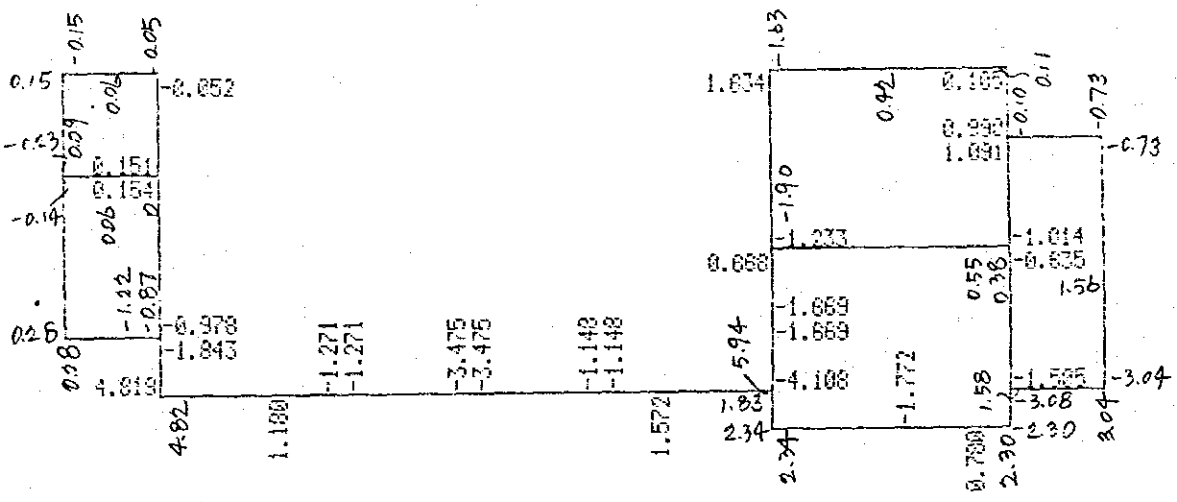
CASE 9 TEMPORARY LOAD

AXIAL

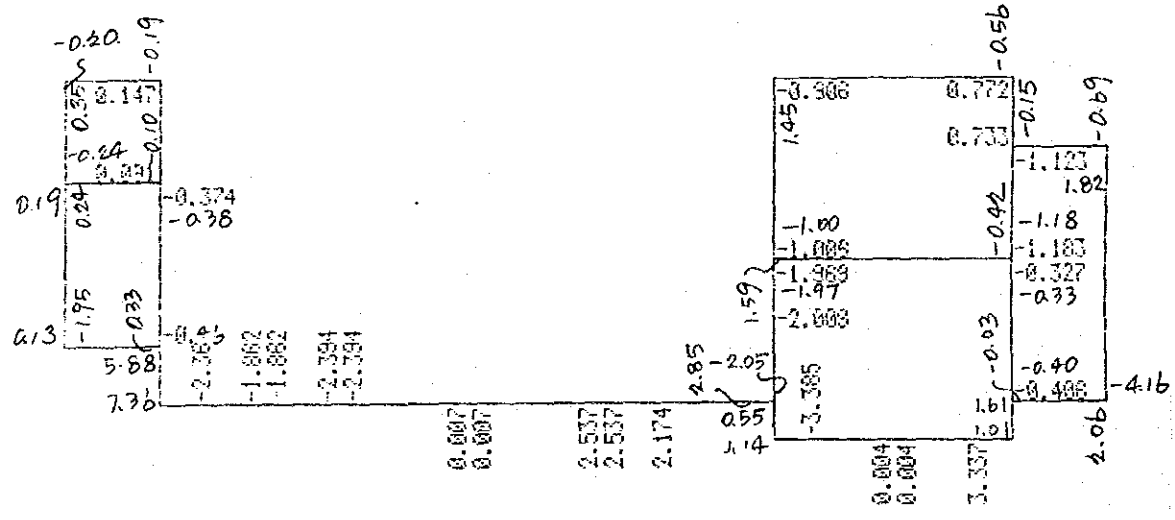


CASE 10 TEMPORARY LOAD

MOMENT

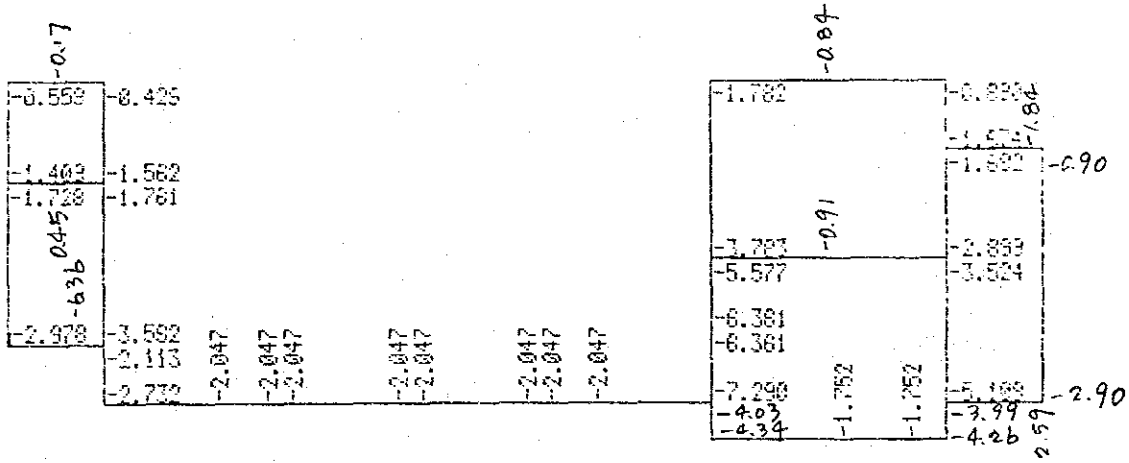


SHEAR



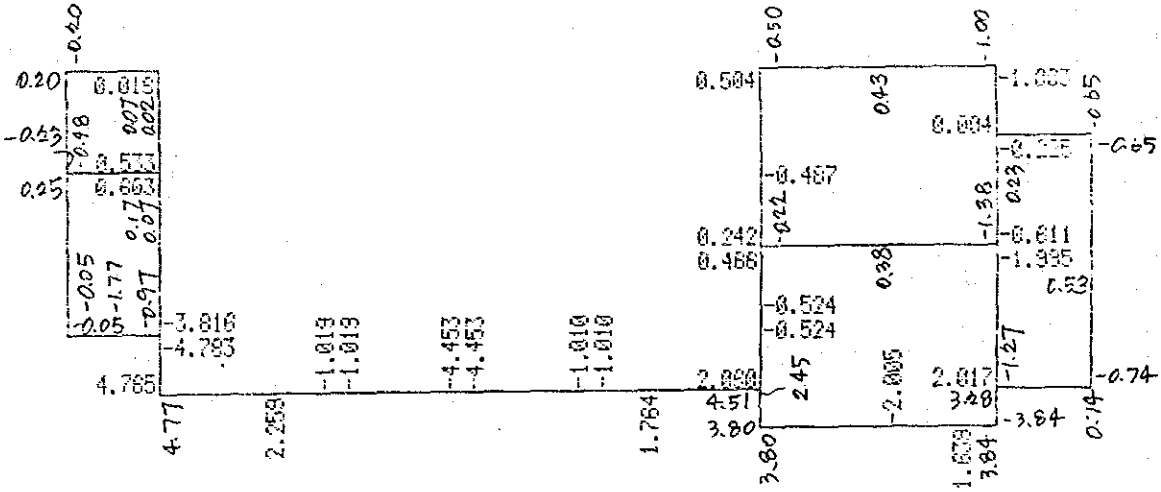
CASE 10 TEMPORARY LOAD

AXIAL

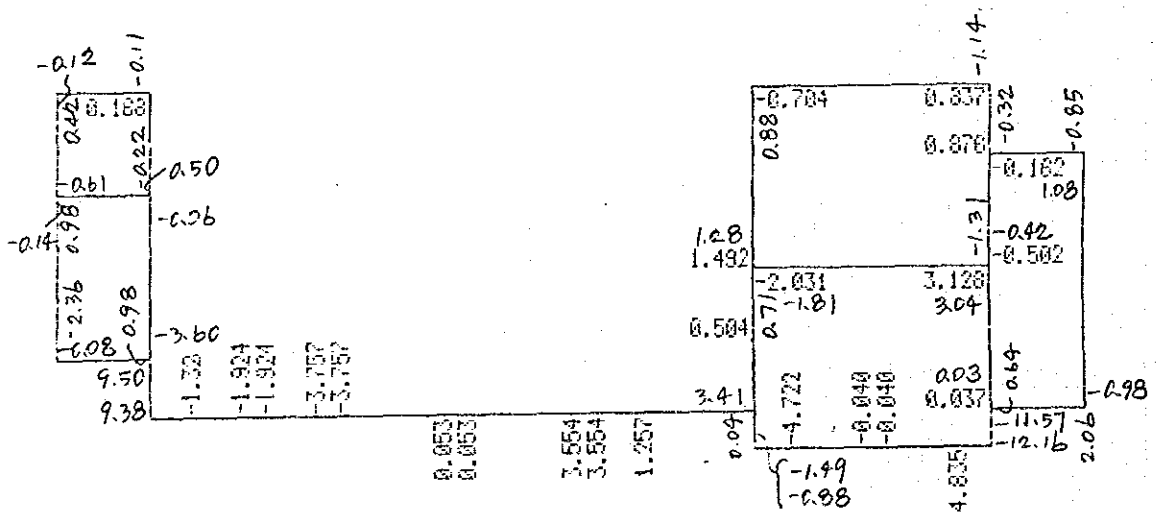


CASE// TEMPORARY LOAD

MOMENT

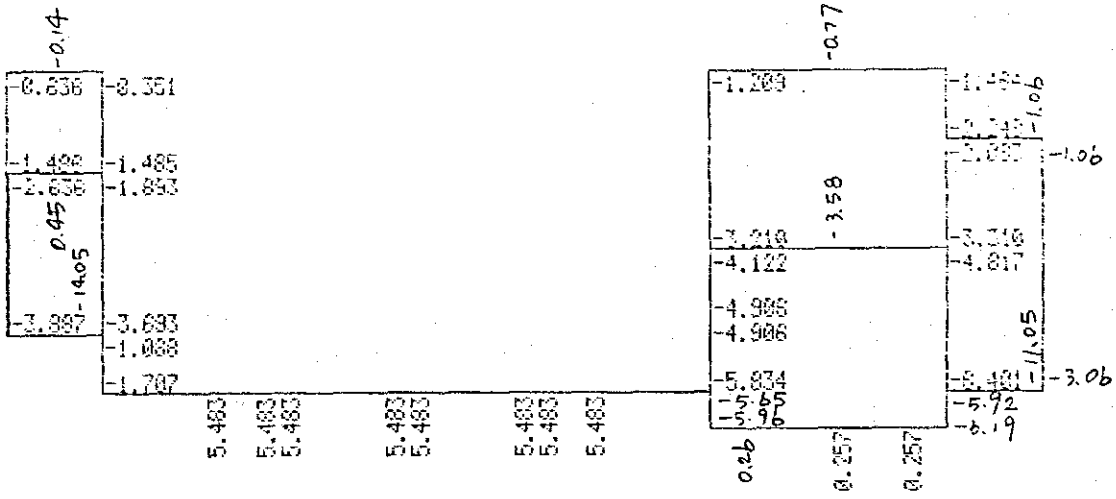


SHEAR



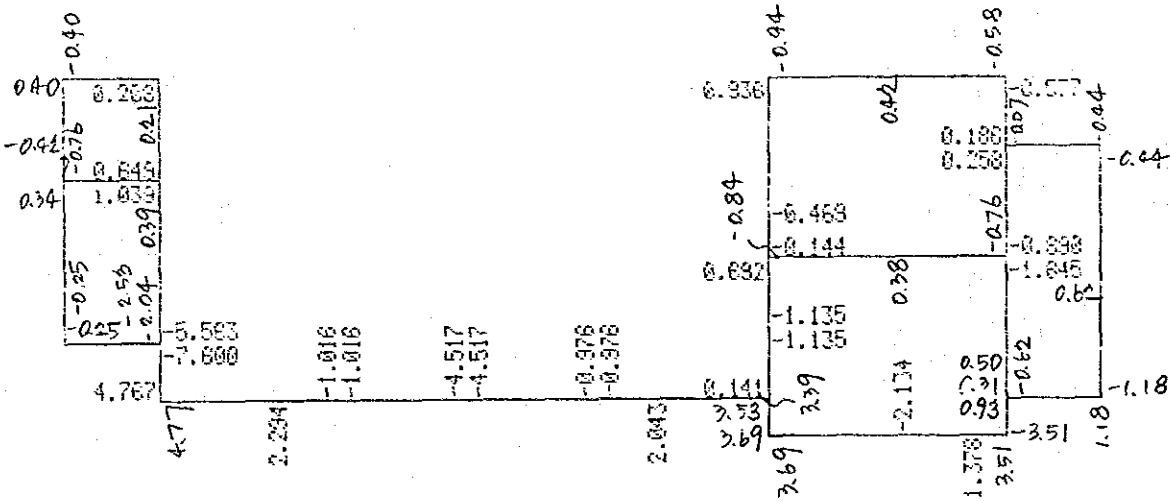
CASE // TEMPORARY LOAD

AXIAL

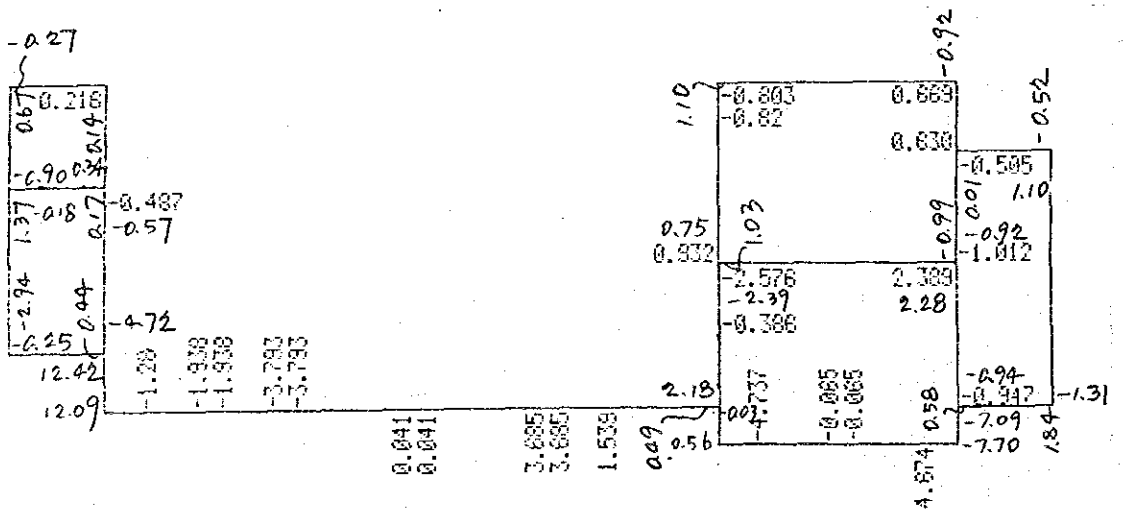


CASE 12 TEMPORARY LOAD

MOMENT

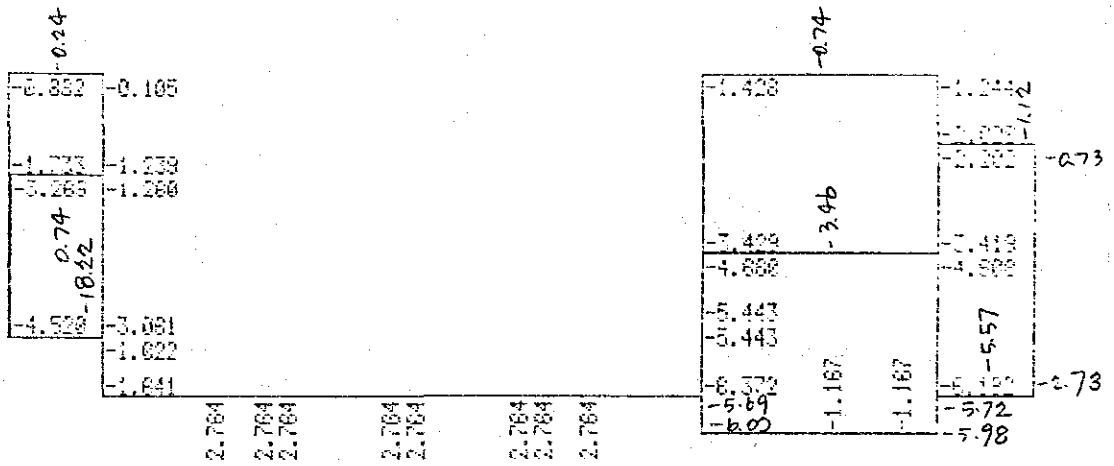


SHEAR



CASE;2 TEMPORARY LOAD

AXIAL



2-5 DESIGN OF SECTION

SLAB 1.7

MOMENT	M	(t·m)	=	0.450	Case7
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.810	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	20.000	
EFFECTIVE DEPTH	d	(〃)	=	15.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200 上
AREA OF REINFORCEMENT	As′	(〃)	=	6.330	〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	15.13
TENSILE STRESS	σs	(〃)	=	521.43
SHEARING STRESS	τ	(〃)	=	0.59

SLAB 2.8

MOMENT	M	(t·m)	=	0.930	Case8
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	1.760	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	20.000	
EFFECTIVE DEPTH	d	(〃)	=	15.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200 上
AREA OF REINFORCEMENT	As′	(〃)	=	6.330	〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	31.27
TENSILE STRESS	σs	(〃)	=	1077.63
SHEARING STRESS	τ	(〃)	=	1.29

SLAB

18.26

MOMENT	M	(t·m)	=	2.210	Case 8
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	2.100	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	25.000	
EFFECTIVE DEPTH	d	(〃)	=	20.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	9.930	D16@200上
AREA OF REINFORCEMENT	As′	(〃)	=	6.330	D13@200下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	37.73
TENSILE STRESS	σs	(〃)	=	1253.12
SHEARING STRESS	τ	(〃)	=	1.18

SPAN 18-26 Case 8

MOMENT	M	(t·m)	=	0.700	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	25.000	
EFFECTIVE DEPTH	d	(〃)	=	20.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200 下
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200 上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	14.36
TENSILE STRESS	σs	(〃)	=	608.38
SHEARING STRESS	τ	(〃)	=	0.00

SPAN 19-28 Case 8

MOMENT	M	(t·m)	=	3.070	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	2.450	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	25.000	
EFFECTIVE DEPTH	d	(〃)	=	20.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	14.320	D19@200 上
AREA OF REINFORCEMENT	As′	(〃)	=	6.330	D13@200 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	45.64
TENSILE STRESS	σs	(〃)	=	1230.46
SHEARING STRESS	τ	(〃)	=	1.40

SPAN
19-18

MOMENT	M	(t·m)	=	0.840	Case 8
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	25.000	
EFFECTIVE DEPTH	d	(〃)	=	20.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200 下
AREA OF REINFORCEMENT	As′	(〃)	=	14.320	D19@200 上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	17.17
TENSILE STRESS	σs	(〃)	=	730.87
SHEARING STRESS	τ	(〃)	=	0.00

SPAN
27,34

MOMENT	M	(t·m)	=	1.220	Case 6
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	1.230	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	20.000	
EFFECTIVE DEPTH	d	(〃)	=	15.000	
CONCRETE COVER	d′	(〃)	=	5.000	
CONCRETE COVER	d″	(〃)	=	5.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200 上
AREA OF REINFORCEMENT	As′	(〃)	=	6.330	〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	41.03
TENSILE STRESS	σs	(〃)	=	1413.67
SHEARING STRESS	τ	(〃)	=	0.90

WALL 9 — Case 7

MOMENT	M	(t·m)	=	7.030	
AXIAL FORCE	N	(t)	=	5.060	
SHEAR FORCE	S	(t)	=	6.240	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200+D13@200 内
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200 外

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	43.84
TENSILE STRESS	σs	(〃)	=	1316.32
SHEARING STRESS	τ	(〃)	=	2.16

WALL 7,8 — Case 7

MOMENT	M	(t·m)	=	1.230	
AXIAL FORCE	N	(t)	=	2.360	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	9.930	D16@200
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	〃

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	9.13
TENSILE STRESS	σs	(〃)	=	292.55
SHEARING STRESS	τ	(〃)	=	0.00

WALL 1,2,3 — Case 8

MOMENT	M	(t·m)	=	0.450	
AXIAL FORCE	N	(t)	=	4.430	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	30.000	
EFFECTIVE DEPTH	d	(〃)	=	23.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200
AREA OF REINFORCEMENT	As′	(〃)	=	6.330	〃

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	5.24
TENSILE STRESS	σs	(〃)	=	30.72
SHEARING STRESS	τ	(〃)	=	0.00

WALL 9,10 — Case 7

MOMENT	M	(t·m)	=	9.280	
AXIAL FORCE	N	(t)	=	1.580	
SHEAR FORCE	S	(t)	=	16.440	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	46.500	
EFFECTIVE DEPTH	d	(〃)	=	39.500	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200+D13@200 内外
AREA OF REINFORCEMENT	As′	(〃)	=	16.270	〃

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	41.37
TENSILE STRESS	σs	(〃)	=	1563.36
SHEARING STRESS	τ	(〃)	=	4.75

WALL 9,10 Case 6

MOMENT	M	(t·m)	=	7.220	
AXIAL FORCE	N	(t)	=	4.180	
SHEAR FORCE	S	(t)	=	9.760	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	46.500	
EFFECTIVE DEPTH	d	(〃)	=	39.500	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200↑D13@200外
AREA OF REINFORCEMENT	As′	(〃)	=	16.270	〃 内

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	32.37
TENSILE STRESS	σs	(〃)	=	1126.47
SHEARING STRESS	τ	(〃)	=	2.82

WALL 18,19,20 26,27,28 Case 6

MOMENT	M	(t·m)	=	2.190	
AXIAL FORCE	N	(t)	=	2.540	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	9.930	D16@200
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	〃

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	16.46
TENSILE STRESS	σs	(〃)	=	604.11
SHEARING STRESS	τ	(〃)	=	0.00

WALL 21,22 Case 8

MOMENT	M	(t·m)	=	7.960
AXIAL FORCE	N	(t)	=	8.230
SHEAR FORCE	S	(t)	=	8.910
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	46.500
EFFECTIVE DEPTH	d	(〃)	=	39.500
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	14.320 D19@200 内
AREA OF REINFORCEMENT	As′	(〃)	=	9.930 D16@200 外

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	38.76
TENSILE STRESS	σs	(〃)	=	1274.82
SHEARING STRESS	τ	(〃)	=	2.57

WALL 29,30 Case 8

MOMENT	M	(t·m)	=	8.100
AXIAL FORCE	N	(t)	=	9.220
SHEAR FORCE	S	(t)	=	0.000
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	40.000
EFFECTIVE DEPTH	d	(〃)	=	33.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	16.270 D16@200+D13@200 内
AREA OF REINFORCEMENT	As′	(〃)	=	16.270 〃 外

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	49.17
TENSILE STRESS	σs	(〃)	=	1419.05
SHEARING STRESS	τ	(〃)	=	0.00

WALL 34 Case b

MOMENT	M	(t·m)	=	1.220	
AXIAL FORCE	N	(t)	=	1.550	
SHEAR FORCE	S	(t)	=	2.720	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	30.000	
EFFECTIVE DEPTH	d	(〃)	=	23.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	6.330	D13@200 外
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200 内

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	20.27
TENSILE STRESS	σs	(〃)	=	766.85
SHEARING STRESS	τ	(〃)	=	1.35

WALL 35 Case b

MOMENT	M	(t·m)	=	4.330	
AXIAL FORCE	N	(t)	=	4.550	
SHEAR FORCE	S	(t)	=	6.070	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	30.000	
EFFECTIVE DEPTH	d	(〃)	=	23.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200+D13@200 外
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200 内

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	49.75
TENSILE STRESS	σs	(〃)	=	1180.33
SHEARING STRESS	τ	(〃)	=	3.01

BASE

3,4,5, 6,9	MOMENT	M	(t·m)	= 3.160	Case 8
	AXIAL FORCE	N	(t)	= 0.000	
	SHEAR FORCE	S	(t)	= 3.970	
	WIDTH	b	(cm)	= 100.000	
	DEPTH	h	(〃)	= 40.000	
	EFFECTIVE DEPTH	d	(〃)	= 33.000	
	CONCRETE COVER	d′	(〃)	= 10.000	
	CONCRETE COVER	d″	(〃)	= 7.000	
	MODULAR RATIO	n=Es/Ec		= 15	
	AREA OF REINFORCEMENT	As	(cm2)	= 9.930	D16@200上
	AREA OF REINFORCEMENT	As′	(〃)	= 9.930	〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	25.02
TENSILE STRESS	σs	(〃)	=	1044.58
SHEARING STRESS	τ	(〃)	=	1.30

BASE

10,11,12	MOMENT	M	(t·m)	= 7.220	Case 6
	AXIAL FORCE	N	(t)	= 0.000	
	SHEAR FORCE	S	(t)	= 3.560	
	WIDTH	b	(cm)	= 100.000	
	DEPTH	h	(〃)	= 40.000	
	EFFECTIVE DEPTH	d	(〃)	= 29.000	
	CONCRETE COVER	d′	(〃)	= 8.000	
	CONCRETE COVER	d″	(〃)	= 11.000	
	MODULAR RATIO	n=Es/Ec		= 15	
	AREA OF REINFORCEMENT	As	(cm2)	= 19.860	D16@200+D16@200下
	AREA OF REINFORCEMENT	As′	(〃)	= 9.930	D16@200上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	52.33
TENSILE STRESS	σs	(〃)	=	1436.41
SHEARING STRESS	τ	(〃)	=	1.40

BASE 14 Case 7

MOMENT	M	(t·m)	=	6.720	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	32.000	
CONCRETE COVER	d′	(〃)	=	11.000	
CONCRETE COVER	d″	(〃)	=	8.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200+D13@200上
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	46.01
TENSILE STRESS	σs	(〃)	=	1440.18
SHEARING STRESS	τ	(〃)	=	0.00

BASE 16,17,21 Case 6

MOMENT	M	(t·m)	=	8.420	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	4.040	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	29.000	
CONCRETE COVER	d′	(〃)	=	8.000	
CONCRETE COVER	d″	(〃)	=	11.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	24.260	D16@200+D19@200下
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	56.78
TENSILE STRESS	σs	(〃)	=	1386.98
SHEARING STRESS	τ	(〃)	=	1.61

BASE 22,23 Case 7

MOMENT	M	(t·m)	=	5.620
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	7.090
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	40.000
EFFECTIVE DEPTH	d	(〃)	=	30.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	10.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	14.320 D19@200 下
AREA OF REINFORCEMENT	As′	(〃)	=	9.930 D16@200 上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	42.89
TENSILE STRESS	σs	(〃)	=	1471.12
SHEARING STRESS	τ	(〃)	=	2.65

BASE 24 Case 7

MOMENT	M	(t·m)	=	3.100
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	0.000
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	40.000
EFFECTIVE DEPTH	d	(〃)	=	33.000
CONCRETE COVER	d′	(〃)	=	10.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	9.930 D16@200 上
AREA OF REINFORCEMENT	As′	(〃)	=	9.930 〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	24.55
TENSILE STRESS	σs	(〃)	=	1024.75
SHEARING STRESS	τ	(〃)	=	0.00

BASE 25,30 Case 8

MOMENT	M	(t·m)	=	6.310	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	7.540	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	30.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	10.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200+D13@200 下
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	〃 上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	45.81
TENSILE STRESS	σs	(〃)	=	1462.97
SHEARING STRESS	τ	(〃)	=	2.84

BASE 33,35 Case 6

MOMENT	M	(t·m)	=	4.330	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	3.230	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	30.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	10.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	16.270	D16@200+D13@200 下
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	D16@200 上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	31.43
TENSILE STRESS	σs	(〃)	=	1003.90
SHEARING STRESS	τ	(〃)	=	1.21

BASE

29,31,32

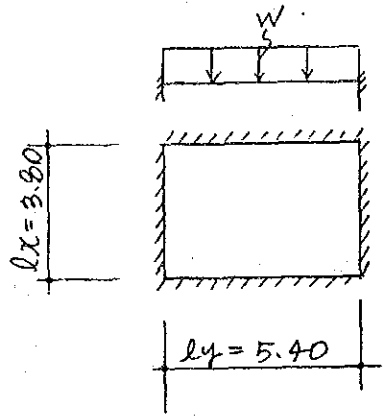
Case 8

MOMENT	M	(t·m)	=	4.140	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	10.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	9.930	D16@200 上
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	32.79
TENSILE STRESS	σs	(〃)	=	1368.54
SHEARING STRESS	τ	(〃)	=	0.00

3. DESIGN OF SLAB

3-1 MOMENT AND SHEAR



$$\frac{ly}{lx} = 1.42$$

$$W = 0.20 \times 2.5 + 0.30 \ t/m^2 = 0.80 \ t/m^2$$

$$-Mx1 = -0.80 \times 3.80^2 \times 0.073 = -0.84 \ t\cdot m$$

$$-My1 = -0.80 \times 3.80^2 \times 0.057 = -0.66 \ "$$

$$Mx2 = 0.80 \times 3.80^2 \times 0.032 = 0.37 \ "$$

$$My2 = 0.80 \times 3.80^2 \times 0.012 = 0.14 \ "$$

$$Qx1 = 0.80 \times 3.80 \times 0.52 = 1.58 \ t$$

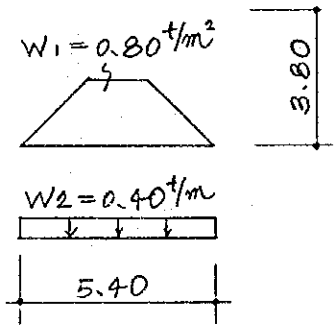
3-2 DESIGN OF SECTION

$$As = \frac{0.84 \times 10^5}{1600 \times 0.875 \times 15} = 4.00 \ cm^2 < D13@200$$

$$\tau = \frac{1.58 \times 10^3}{100 \times 0.875 \times 15} = 1.2 \ kg/cm^2 < 4.25 \ kg/cm^2 \ OK$$

4. DESIGN OF BEAM (1)

4-1 MOMENT AND SHEAR



$$\frac{l_y}{l_x} = 1.42$$

$$\frac{C}{W_1} = 3.7$$

$$\frac{M_0}{W_1} = 6.0$$

$$\frac{Q}{W_1} = 3.3$$

$$C = 2 \times 3.7 \times 0.80 + \frac{1}{12} \times 0.40 \times 5.40^2 = 6.89 \ ^{t\cdot m}$$

$$M_0 = 2 \times 6.0 \times 0.80 + \frac{1}{8} \times 0.40 \times 5.40^2 = 11.06 \ ''$$

$$Q = 2 \times 3.3 \times 0.80 + \frac{1}{2} \times 0.40 \times 5.40 = 6.36 \ ^{t}$$

END $\quad M = 0.6 \times 6.89 = 4.13 \ ^{t\cdot m}$

CENTER $\quad M = 11.06 - 0.35 \times 6.89 = 8.65 \ ''$

$$Q = 6.36 \ ^{t}$$

4-2 DESIGN OF SECTION

END

MOMENT	M	(t·m)	=	4.130
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	6.360
WIDTH	b	(cm)	=	40.000
DEPTH	h	(〃)	=	60.000
EFFECTIVE DEPTH	d	(〃)	=	53.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	8.590 D19-3上
AREA OF REINFORCEMENT	As′	(〃)	=	11.460 D19-4下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	23.79
TENSILE STRESS	σs	(〃)	=	1005.53
SHEARING STRESS	τ	(〃)	=	3.32

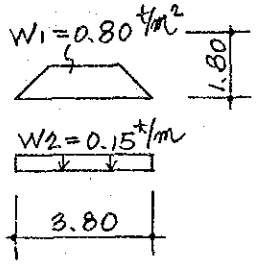
CENTER

MOMENT	M	(t·m)	=	8.650
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	0.000
WIDTH	b	(cm)	=	40.000
DEPTH	h	(〃)	=	60.000
EFFECTIVE DEPTH	d	(〃)	=	53.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	11.460 D19-4下
AREA OF REINFORCEMENT	As′	(〃)	=	8.590 D19-3上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	46.32
TENSILE STRESS	σs	(〃)	=	1594.55
SHEARING STRESS	τ	(〃)	=	0.00

5. DESIGN OF BEAM (2)

5-1 MOMENT AND SHEAR



$$\frac{ly}{lx} = 2.11$$

$$\frac{C}{W_1} = 0.95$$

$$\frac{M_0}{W_1} = 1.52$$

$$\frac{Q}{W_1} = 1.23$$

$$C = 2 \times 0.95 \times 0.80 + \frac{1}{12} \times 0.15 \times 3.80^2 = 1.70^{tm}$$

$$M_0 = 2 \times 1.52 \times 0.80 + \frac{1}{8} \times 0.15 \times 3.80^2 = 2.70^{"}$$

$$Q = 2 \times 1.23 \times 0.80 + \frac{1}{2} \times 0.15 \times 3.80^2 = 2.25^{t}$$

END $\quad M = 0.6 \times 1.70 = 1.02^{tm}$

CENTER $\quad M = 2.70 - 0.35 \times 1.70 = 2.11^{"}$

$$Q = 2.25^{t}$$

5-2 DESIGN OF SECTION

END

MOMENT	M	(t·m)	=	1.020	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	2.250	
WIDTH	b	(cm)	=	30.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	5.950	D16-3 上
AREA OF REINFORCEMENT	As′	(〃)	=	5.950	〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	18.66
TENSILE STRESS	σs	(〃)	=	592.84
SHEARING STRESS	τ	(〃)	=	2.59

CENTER

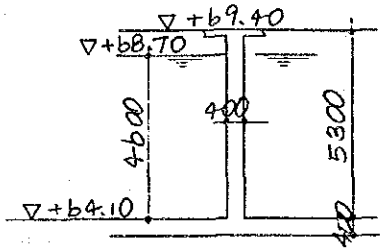
MOMENT	M	(t·m)	=	2.110	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	30.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	5.950	D16-3 下
AREA OF REINFORCEMENT	As′	(〃)	=	5.950	〃 上

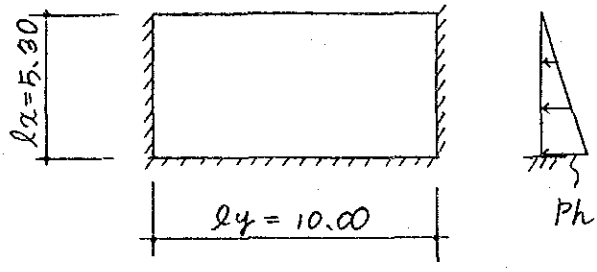
COMPRESSIVE STRESS	σc	(Kg/cm2)	=	38.60
TENSILE STRESS	σs	(〃)	=	1226.36
SHEARING STRESS	τ	(〃)	=	0.00

b. DESIGN OF WALL (1)

b-1 MOMENT AND SHEAR

CASE 1 WATER PRESSURE





$\frac{ly}{lx} = 1.89$

$Ph = 4.60 \times 1.0 = 4.60\ t/m^2$

$-Mx1 = -4.60 \times 5.30^2 \times 0.08 = -10.34\ tm$

$-My1 = -4.60 \times 5.30^2 \times 0.06 = -7.75\ "$

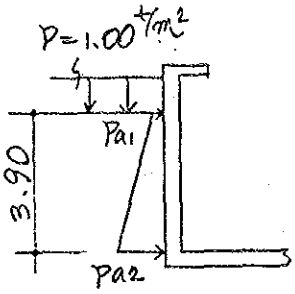
$My2 = 4.60 \times 5.30^2 \times 0.026 = 3.36\ "$

$Mx2 = 4.60 \times 5.30^2 \times 0.014 = 1.81\ "$

$Qx1 = 4.60 \times 5.30 \times 0.45 = 10.97\ t$

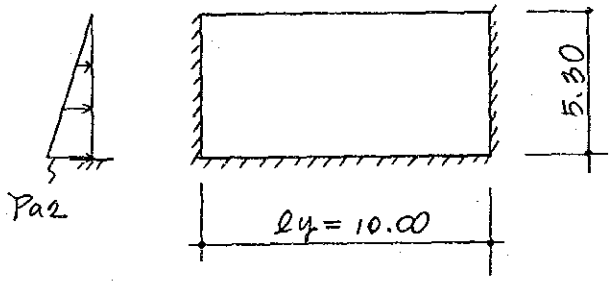
$Qy1 = 4.60 \times 5.30 \times 0.26 = 6.34\ "$

CASE2 EARTH PRESSURE



$Pa1 = 1.00 \times 0.5 = 0.50\ t/m^2$

$Pa2 = (1.00 + 1.8 \times 3.90) \times 0.5 = 4.01$ "



$\frac{ly}{lx} = 1.89$

$-Mx1 = -4.01 \times 5.30^2 \times 0.08 = -9.01\ t\cdot m$

$-My1 = -4.01 \times 5.30^2 \times 0.06 = -6.76$ "

$My2 = 4.01 \times 5.30^2 \times 0.026 = 2.93$ "

$Mx2 = 4.01 \times 5.30^2 \times 0.014 = 1.58$ "

$Qx1 = 4.01 \times 5.30 \times 0.45 = 9.56\ t$

$Qy1 = 4.01 \times 5.30 \times 0.26 = 5.53$ "

6-2 DESIGN OF SECTION

$-Mx1 = -10.34^{t\cdot m}$

$$As = \frac{10.34 \times 10^5}{1600 \times 0.875 \times 33} = 22.38^{cm^2} < D16@200 + D19@200$$

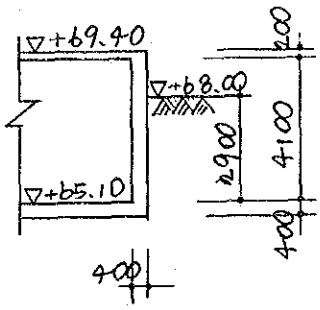
$-My1 = -7.75^{t\cdot m}$

$$As = \frac{7.75 \times 10^5}{1600 \times 0.875 \times 31} = 17.86^{cm^2} < D16@100$$

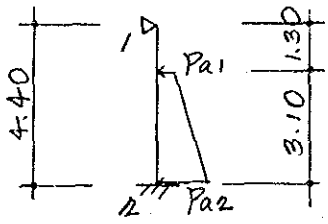
$$\tau = \frac{10.97 \times 10^3}{100 \times 0.875 \times 33} = 3.8^{kg/cm^2} < \tau a$$

7. DESIGN OF WALL (2)

7-1 DIMENSION OF WALL

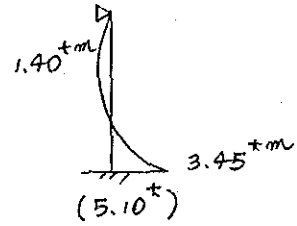


7-2 MOMENT AND SHEAR



$Pa1 = 1.00 \times 0.5 = 0.50^{t/m^2}$

$Pa2 = (1.00 + 1.8 \times 3.10) \times 0.5 = 3.29^{"}$



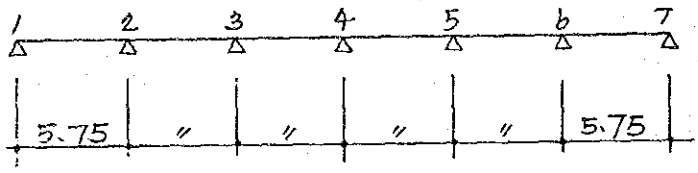
7-3 DESIGN OF SECTION

MOMENT	M	(t·m)	=	3.450	
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	5.100	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	33.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	7.000	
MODULAR RATIO	n = Es / Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	9.930	D16@200
AREA OF REINFORCEMENT	As′	(〃)	=	9.930	〃

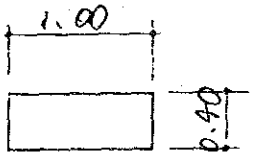
COMPRESSIVE STRESS	σc	(Kg/cm2)	=	26.10
TENSILE STRESS	σs	(〃)	=	1158.39
SHEARING STRESS	τ	(〃)	=	1.70

8. DESIGN OF BASE SLAB

8-1 DIMENTION OF CONTINUOUS SLAB



8-2 INERTIA AND AREA



$$I = \frac{1}{12} \times 1.00 \times 0.40^3 = 0.0053\ m^4$$

$$A = 1.00 \times 0.40 = 0.40\ m^2$$

8-3 CALCULATION OF LOAD

8-3-1 VERTICAL LOAD

$$W_1 = (0.15 \times 1.40 + 0.40 \times 5.15) \times 2.5 \times \frac{1}{5.75} = 0.99^{t/m^2}$$

$$W_2 = (0.15 \times 0.90 + 0.40 \times 5.15) \times 2.5 \times \frac{1}{2.875} = 1.91^{\prime\prime}$$

8-3-2 EARTH PRESSURE

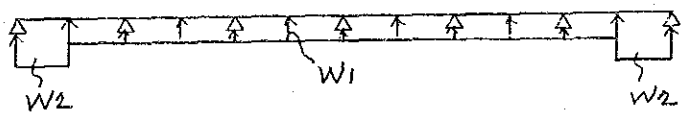
$$M_1 = 9.01 + 9.56 \times 0.20 = 10.92^{t\,m}$$

8-3-3 WATER PRESSURE

$$M_2 = 10.34 + 10.97 \times 0.20 = 12.53^{t\,m}$$

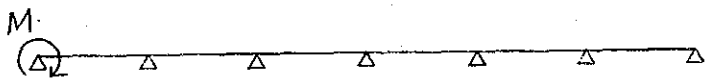
8-4 LOADING CHART

CASE 1 VERTICAL LOAD



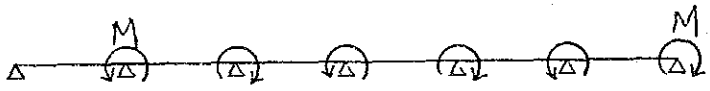
$W_1 = 0.99\ t/m^2$ $W_2 = 1.91\ t/m^2$

CASE 2 EARTH PRESSURE



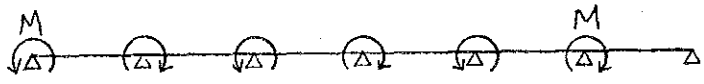
$M = 10.92\ t\cdot m$

CASE 3 WATER PRESSURE (1)



$M = 12.53\ t\cdot m$

CASE 4 WATER PRESSURE (2)



$M = 12.53\ t\cdot m$

CASE 5 = ① + ②

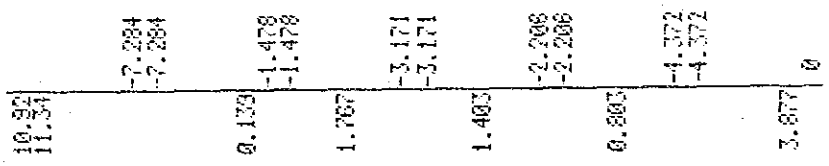
6 = ① + ② + ③

7 = ① + ② + ③ + ④

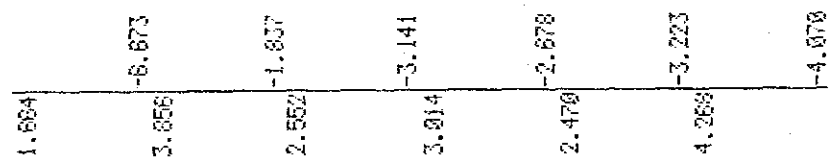
8 = ① + ④

CASE 5

MOMENT

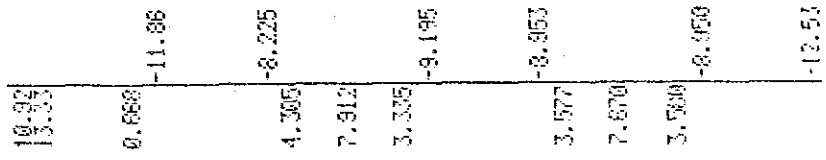


SHEAR

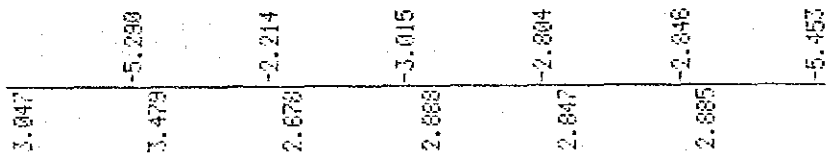


CASE 6

MOMENT

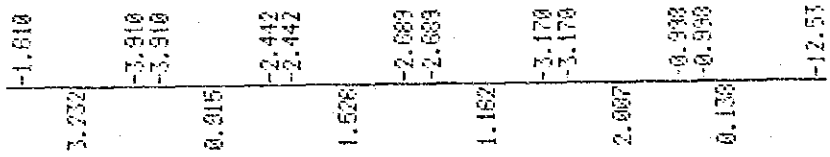


SHEAR

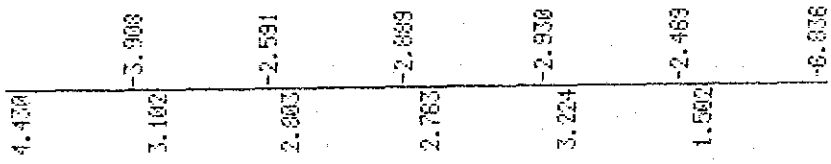


CASE 7

MOMENT

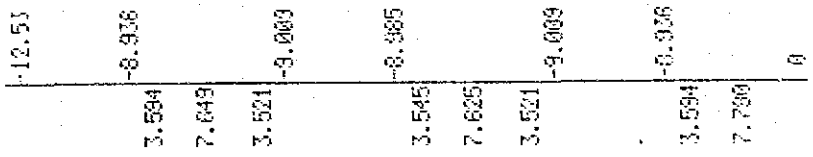


SHEAR

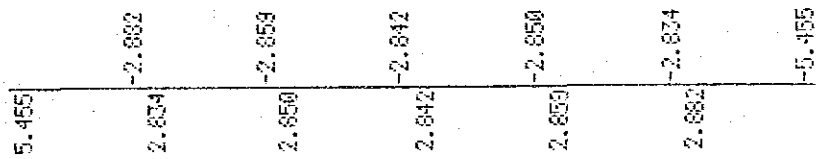


CASE 8

MOMENT



SHEAR



8-5 DESIGN OF SECTION

Case 6

MOMENT	M	(t·m)	=	10.920
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	3.050
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	40.000
EFFECTIVE DEPTH	d	(〃)	=	30.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	10.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	33.680 D19@200+D22@200下
AREA OF REINFORCEMENT	As′	(〃)	=	28.650 D19@100上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	55.91
TENSILE STRESS	σs	(〃)	=	1279.33
SHEARING STRESS	τ	(〃)	=	1.20

Case 8

MOMENT	M	(t·m)	=	12.530
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	6.840
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	40.000
EFFECTIVE DEPTH	d	(〃)	=	33.000
CONCRETE COVER	d′	(〃)	=	10.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	28.650 D19@100上
AREA OF REINFORCEMENT	As′	(〃)	=	33.680 D19@200+D22@200下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	62.33
TENSILE STRESS	σs	(〃)	=	1557.63
SHEARING STRESS	τ	(〃)	=	2.43

2-b	MOMENT	M	(t·m)	=	11.860 Case b
	AXIAL FORCE	N	(t)	=	0.000
	SHEAR FORCE	S	(t)	=	3.480
	WIDTH	b	(cm)	=	100.000
	DEPTH	h	(〃)	=	40.000
	EFFECTIVE DEPTH	d	(〃)	=	33.000
	CONCRETE COVER	d′	(〃)	=	10.000
	CONCRETE COVER	d″	(〃)	=	7.000
	MODULAR RATIO	n=Es/Ec		=	15
	AREA OF REINFORCEMENT	As	(cm2)	=	28.650 D19@100上
	AREA OF REINFORCEMENT	As′	(〃)	=	14.320 D19@200下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	61.19
TENSILE STRESS	σs	(〃)	=	1459.47
SHEARING STRESS	τ	(〃)	=	1.22

〃	MOMENT	M	(t·m)	=	4.310 Case b
	AXIAL FORCE	N	(t)	=	0.000
	SHEAR FORCE	S	(t)	=	0.000
	WIDTH	b	(cm)	=	100.000
	DEPTH	h	(〃)	=	40.000
	EFFECTIVE DEPTH	d	(〃)	=	30.000
	CONCRETE COVER	d′	(〃)	=	7.000
	CONCRETE COVER	d″	(〃)	=	10.000
	MODULAR RATIO	n=Es/Ec		=	15
	AREA OF REINFORCEMENT	As	(cm2)	=	14.320 D19@200下
	AREA OF REINFORCEMENT	As′	(〃)	=	28.650 D19@100上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	31.22
TENSILE STRESS	σs	(〃)	=	1139.30
SHEARING STRESS	τ	(〃)	=	0.00

SPAN 1-2

MOMENT	M	(t·m)	=	13.330	Case 6
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	30.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	10.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	33.680	D19@200+D22@200下
AREA OF REINFORCEMENT	As′	(〃)	=	28.650	D19@100上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	68.26
TENSILE STRESS	σs	(〃)	=	1561.67
SHEARING STRESS	τ	(〃)	=	0.00

SPAN 2-3 ~6-7

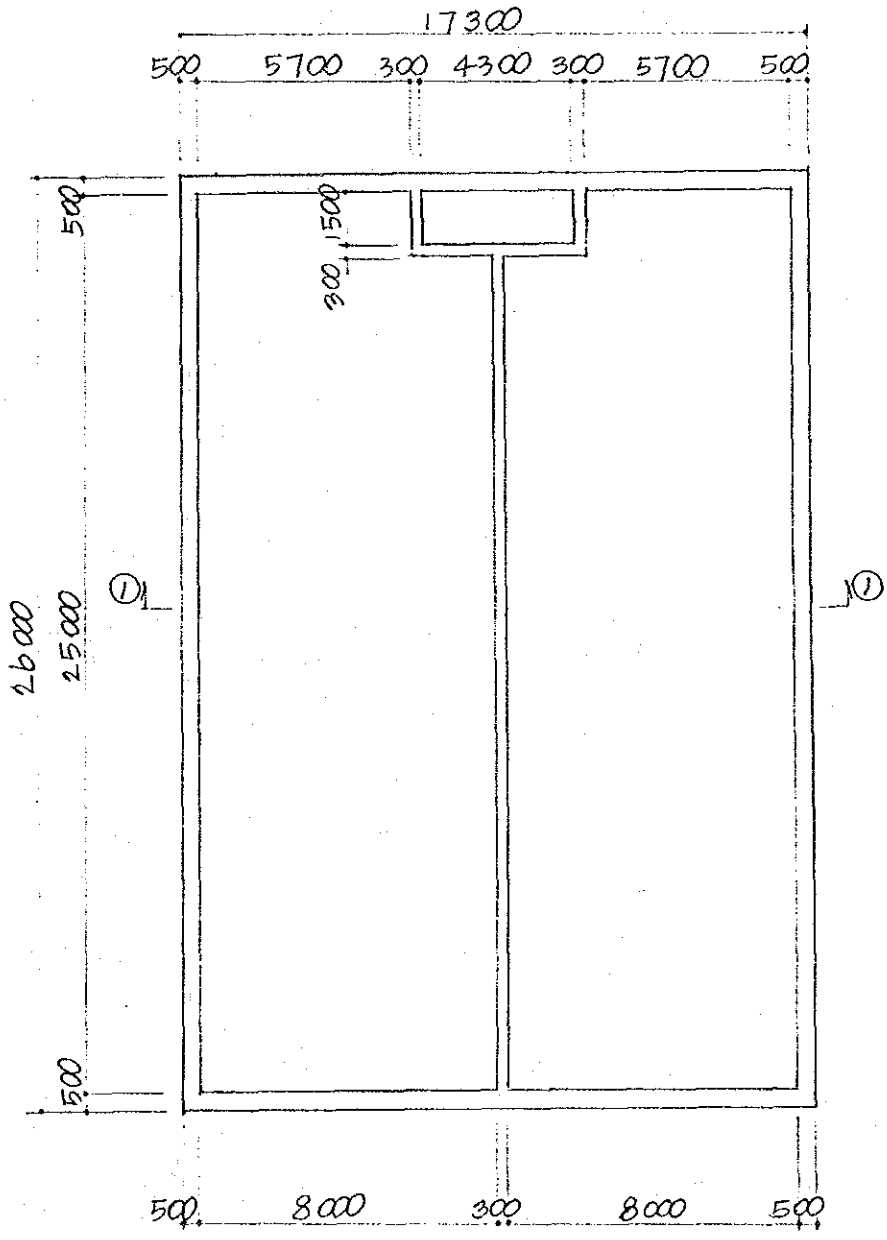
MOMENT	M	(t·m)	=	7.910	Case 6
AXIAL FORCE	N	(t)	=	0.000	
SHEAR FORCE	S	(t)	=	0.000	
WIDTH	b	(cm)	=	100.000	
DEPTH	h	(〃)	=	40.000	
EFFECTIVE DEPTH	d	(〃)	=	30.000	
CONCRETE COVER	d′	(〃)	=	7.000	
CONCRETE COVER	d″	(〃)	=	10.000	
MODULAR RATIO	n=Es/Ec		=	15	
AREA OF REINFORCEMENT	As	(cm2)	=	24.260	D19@200+D16@200下
AREA OF REINFORCEMENT	As′	(〃)	=	14.320	D19@200上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	48.57
TENSILE STRESS	σs	(〃)	=	1258.01
SHEARING STRESS	τ	(〃)	=	0.00

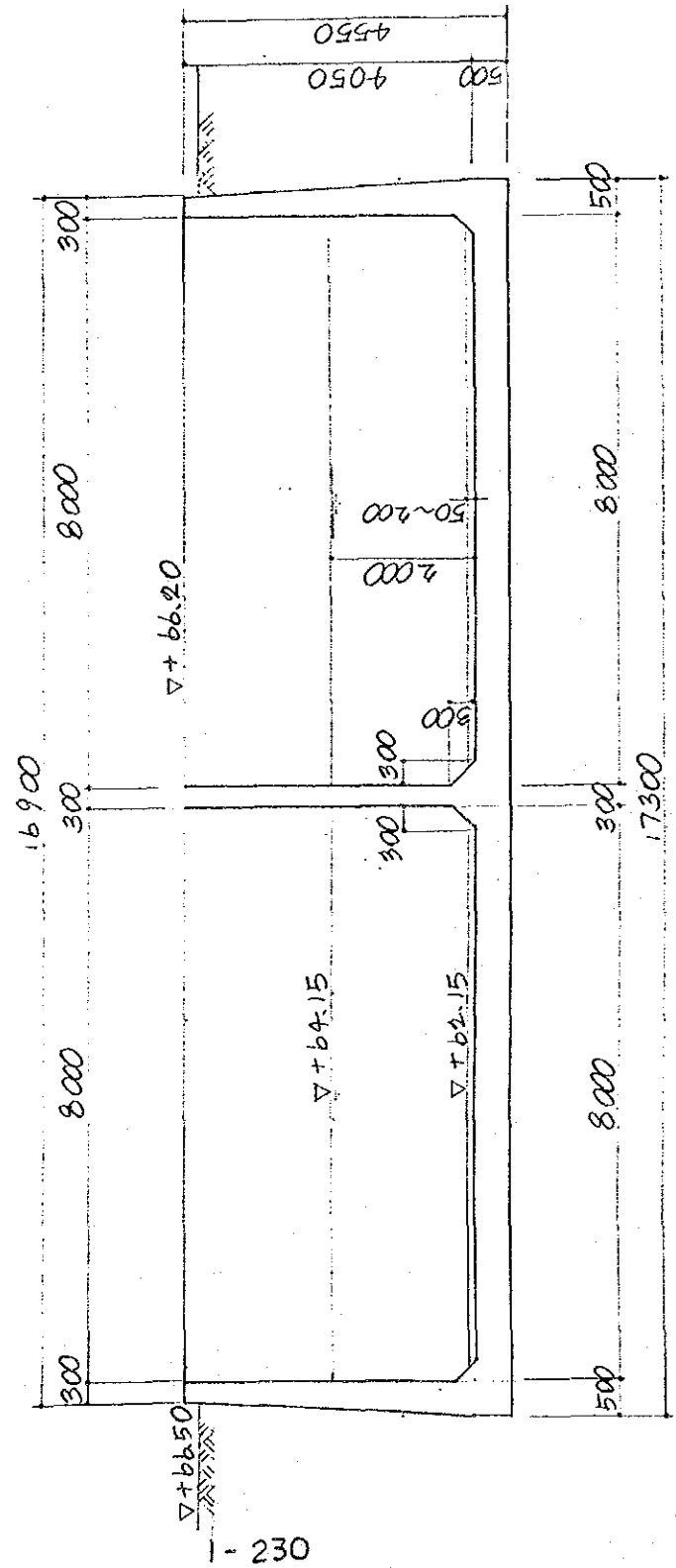
5. WASTEWATER AND SLUDGE POND

SHEET NO.

1. PLAN AND SECTION



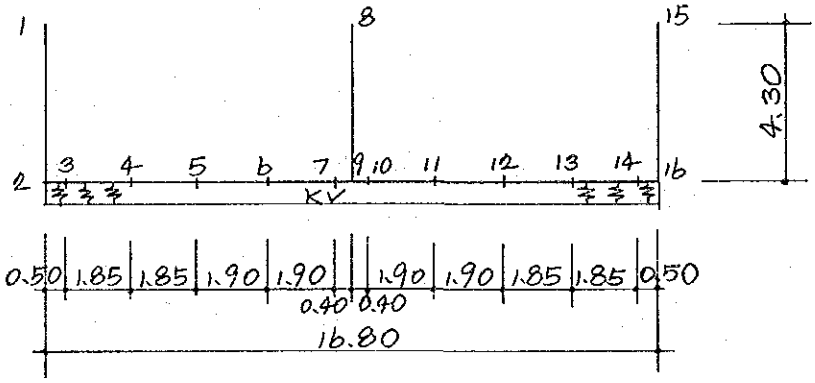
PLAN


4550
4050
500
300
8000
50~200
2000
▽+66.20
500
300
16900
300
300
17300
▽+64.15
▽+64.15
8000
8000
300
500
▽+66.50

SECTION ①-①

2. FRAME OF SECTION ①-①

2-1 DIMENSION OF FRAME



$$Kv = Kvo \left(\frac{Bv}{30} \right)^{-3/4}$$

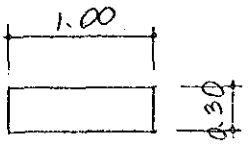
$$Kvo = \frac{1}{30} \times 1 \times 28 \times 25 = 23.33 \ kg/cm^3$$

$$Bv = \sqrt{1730 \times 2600} = 2121 \ cm$$

$$Kv = 23.33 \times \left(\frac{2121}{30} \right)^{-3/4} = 0.96 \ kg/cm^3 = 960 \ t/m^3$$

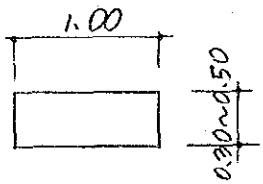
$$Kv = 960 \times 1.00 m = 960 \ t/m^2$$

2-2 INERTIA AND AREA



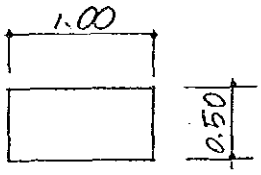
$I = \frac{1}{12} \times 1.00 \times 0.30^3 = 0.0023\ m^4$

$A = 1.00 \times 0.30 = 0.30\ m^2$



$I = \frac{1}{12} \times 1.00 \times 0.40^3 = 0.0053\ m^4$

$A = 1.00 \times 0.40 = 0.40\ m^2$



$I = \frac{1}{12} \times 1.00 \times 0.50^3 = 0.0104\ m^4$

$A = 1.00 \times 0.50 = 0.50\ m^2$

$I_1 = 0.0023\ m^4$ $A_1 = 0.30\ m^2$

$I_2 = 0.0053$ $A_2 = 0.40$

$I_3 = 0.0104$ $A_3 = 0.50$

2-3 CALCULATION OF LOAD

2-3-1 VERTICAL LOAD

(1) BASE SLAB

DEAD LOAD $0.50 \times 2.5 = 1.25^{t/m^2}$

P.L CONCRETE $0.125 \times 2.3 = 0.29$ "

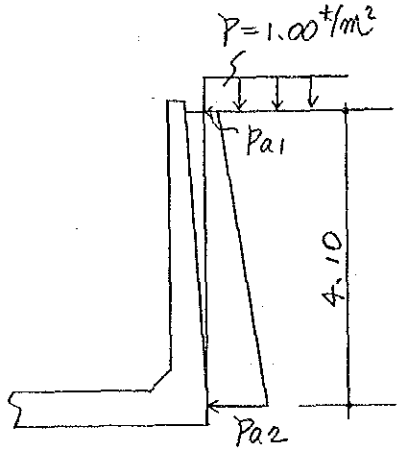
$W1 = 1.54^{t/m^2}$

$$P_1 = \left\{(0.30+0.50) \times 4.05 \times \frac{1}{2} + 0.30 \times 0.30 \times \frac{1}{2}\right\} \times 2.5 = 4.16^{t}$$

$$P_2 = \left(0.30 \times 4.05 + 0.30 \times 0.30 \times \frac{1}{2} \times 2\right) \times 2.5 = 3.26"$$

WATER LOAD $W2 = (2.00 - 0.125) \times 1.0 = 1.88^{t/m^2}$

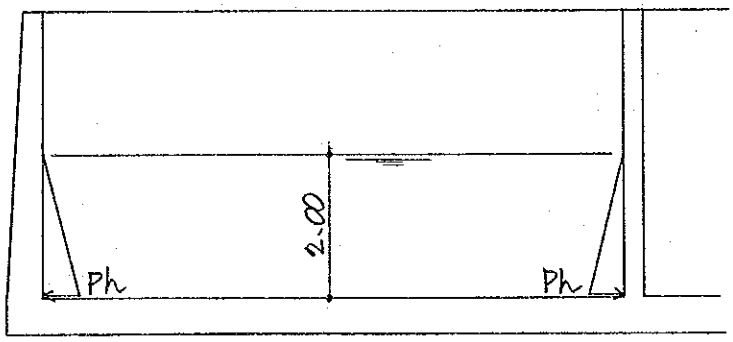
2-3-2 EARTH PRESSURE



$Pa_1 = 1.00 \times 0.5 = 0.50\ t/m^2$

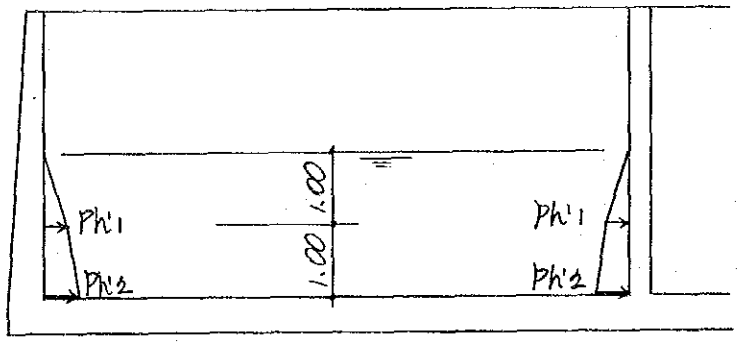
$Pa_2 = (1.00 + 1.8 \times 4.10) \times 0.5 = 4.19$ "

2-3-3 WATER PRESSURE



$$Ph = 2.00 \times 1.0 = 2.00\ t/m^2$$

2-3-4 DYNAMIC WATER PRESSURE



$$Ph'1 = \sqrt{3} \times 0.05 \times 1.0 \times 2.00 \times \left\{ \frac{1.00}{2.00} - \frac{1}{2} \times \left(\frac{1.00}{2.00} \right)^2 \right\} = 0.06 \ t/m^2$$

$$Ph'2 = \sqrt{3} \times 0.05 \times 1.0 \times 2.00 \times \left\{ \frac{2.00}{2.00} - \frac{1}{2} \times \left(\frac{2.00}{2.00} \right)^2 \right\} = 0.09 \ "$$

2-3-5 EARTH QUAKE LOAD

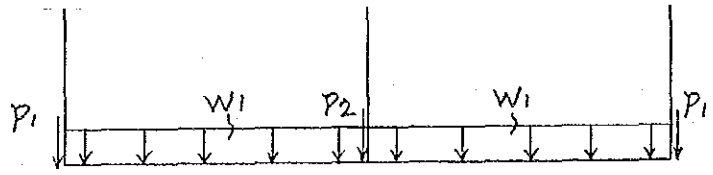
WALL

$WE1 = 0.30 \times 2.5 \times 0.05 = 0.04\ t/m^2$

$WE2 = 0.50 \times 2.5 \times 0.05 = 0.06$ "

2-4 LOADING CHART

CASE 1 VERTICAL LOAD

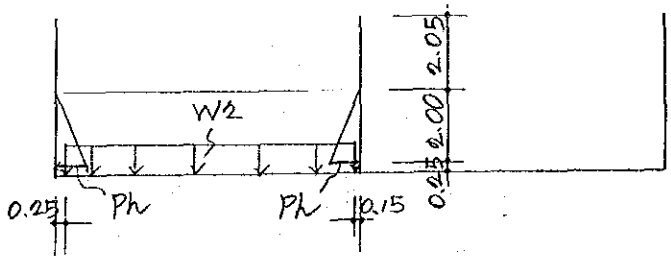


$W_1 = 1.54\ t/m^2$ $P_1 = 4.16\ t$ $P_2 = 3.26\ t$

CASE 2 EARTH PRESSURE

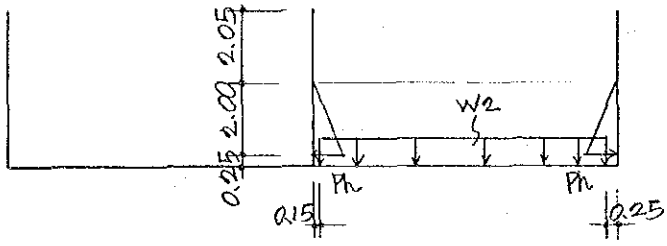
$Pa_1 = 0.50\ t/m^2$ $Pa_2 = 4.19\ t/m^2$

CASE 3 WATER PRESSURE (1)



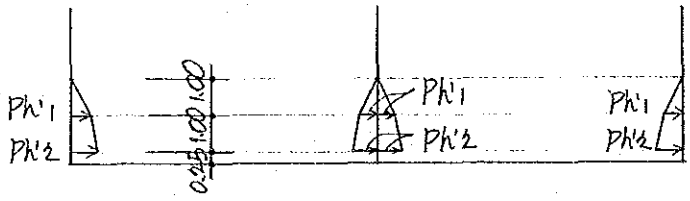
$W_2 = 1.88\ t/m^2$ $Ph = 2.00\ t/m^2$

CASE 4 WATER PRESSURE (2)



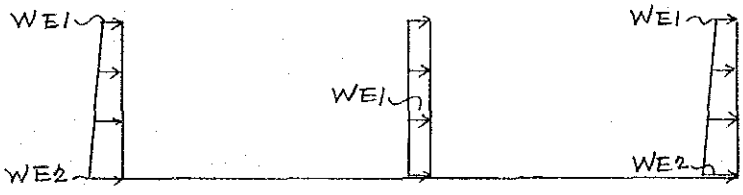
$W2 = 1.88\ t/m^2$ $Ph = 2.00\ t/m^2$

CASE 5 DYNAMIC WATER PRESSURE



$Ph'1 = 0.06\ t/m^2$ $Ph'2 = 0.09\ t/m^2$

CASE 6 EARTHQUAKE LOAD



$WE1 = 0.04\ t/m^2$ $WE2 = 0.06\ t/m^2$

PERMANENT LOAD

CASE 7 = ① + ②

8 = ① + ② + ③

9 = ① + ② + ③ + ④

10 = ① + ③

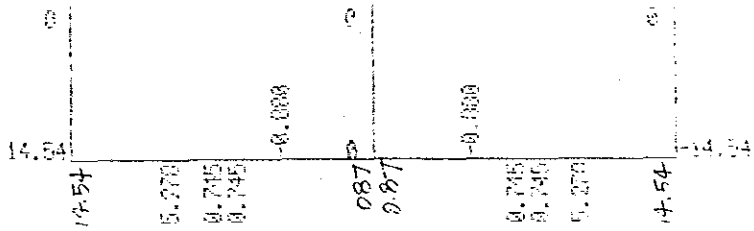
TEMPORARY LOAD ($\alpha = 0.667$)

CASE 11 = ① + ② + ⑥

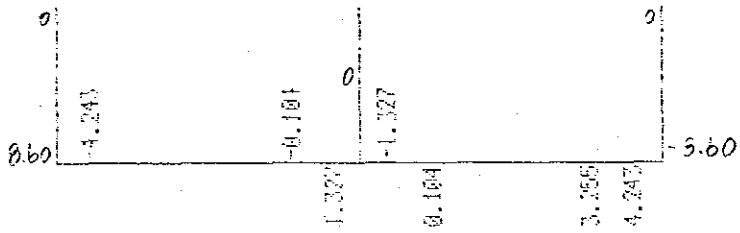
12 = ① + ② + ③ + ④ + ⑤ + ⑥

CASE 7 PERMANENT LOAD

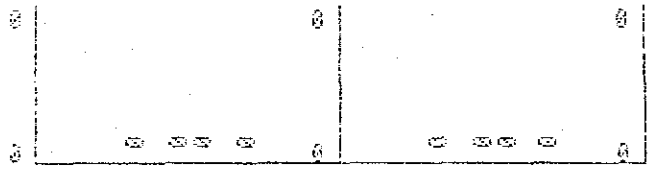
MOMENT



SHEAR

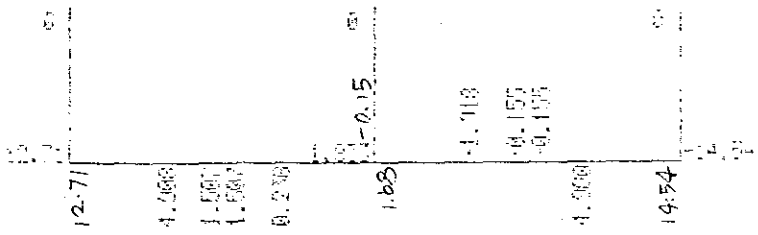


AXIAL

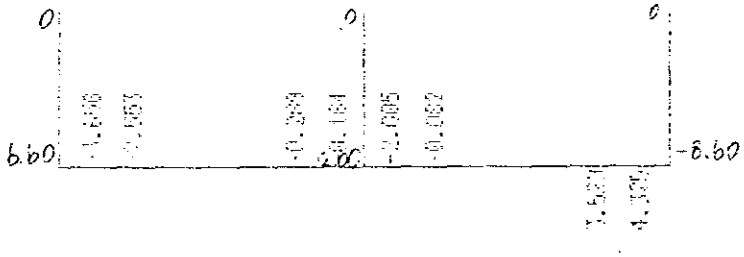


CASE 8 PERMANENT LOAD

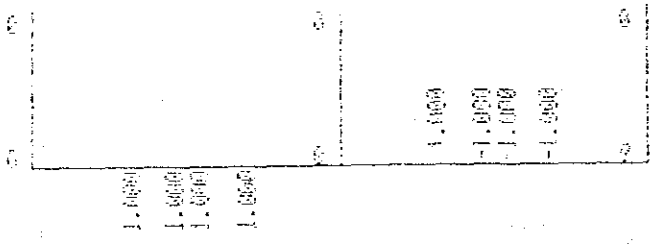
MOMENT



SHEAR

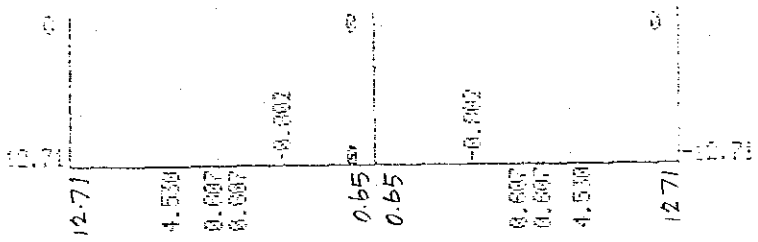


AXIAL

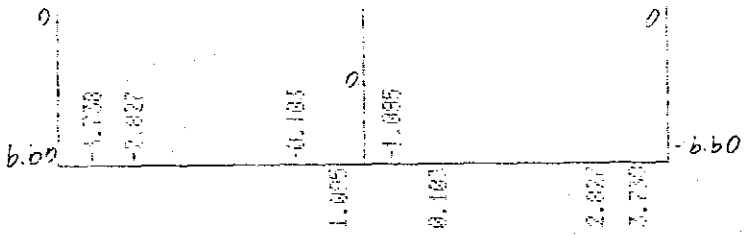


CASE 9 PERMANENT LOAD

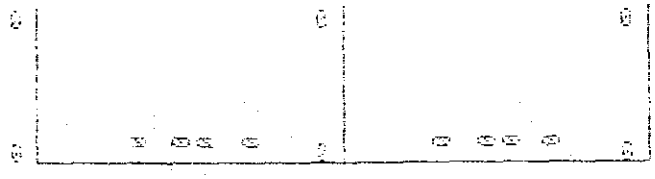
MOMENT



SHEAR

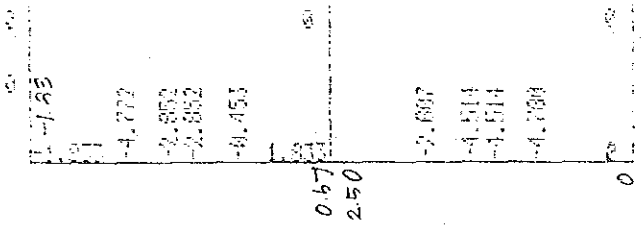


AXIAL

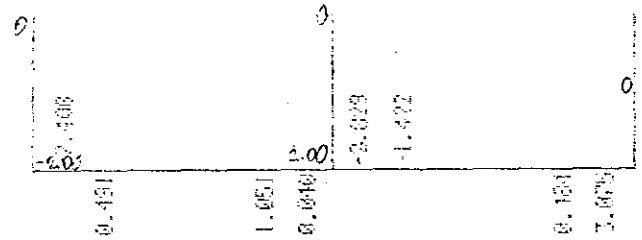


CASE 10 PERMANENT LOAD

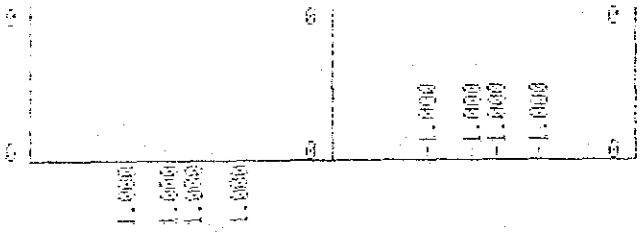
MOMENT



SHEAR

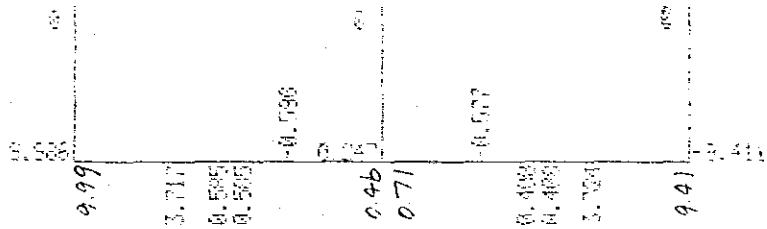


AXIAL

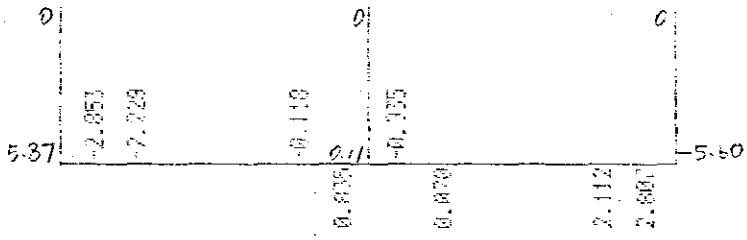


CASE // TEMPORARY LOAD

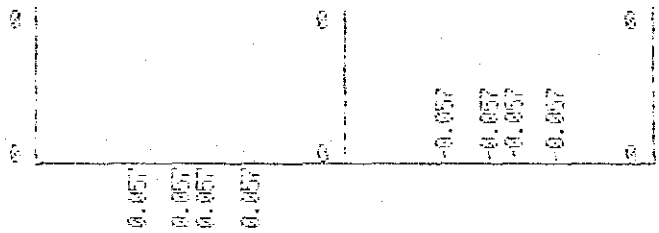
MOMENT



SHEAR

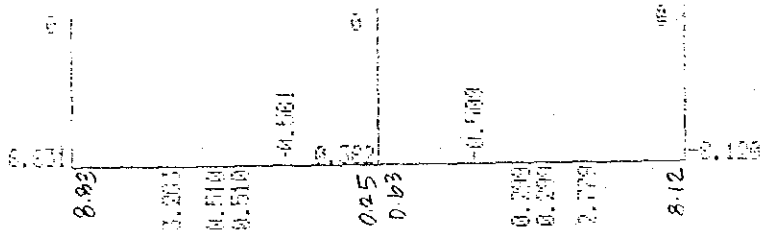


AXIAL

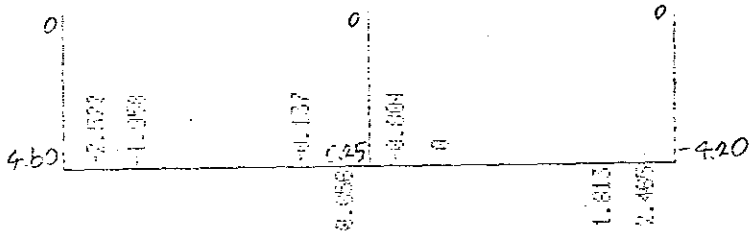


CASE 12. TEMPORARY LOAD

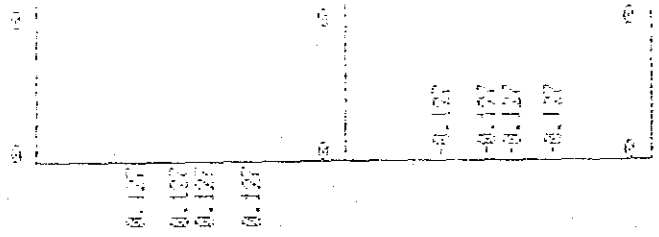
MOMENT



SHEAR



AXIAL



2-5 DESIGN OF SECTION

WALL 9 — Case 8

MOMENT	M	(t·m)	=	※ 1.330
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	2.000
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	30.000
EFFECTIVE DEPTH	d	(〃)	=	23.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	6.330 D13@200
AREA OF REINFORCEMENT	As′	(〃)	=	6.330 〃

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	22.53
TENSILE STRESS	σs	(〃)	=	983.33
SHEARING STRESS	τ	(〃)	=	0.93

WALL 2,16 — Case 7

MOMENT	M	(t·m)	=	14.540
AXIAL FORCE	N	(t)	=	0.000
SHEAR FORCE	S	(t)	=	8.600
WIDTH	b	(cm)	=	100.000
DEPTH	h	(〃)	=	50.000
EFFECTIVE DEPTH	d	(〃)	=	43.000
CONCRETE COVER	d′	(〃)	=	7.000
CONCRETE COVER	d″	(〃)	=	7.000
MODULAR RATIO	n=Es/Ec		=	15
AREA OF REINFORCEMENT	As	(cm2)	=	29.290 D16@200+D22@200 外
AREA OF REINFORCEMENT	As′	(〃)	=	9.930 D16@200 内

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	46.54
TENSILE STRESS	σs	(〃)	=	1312.27
SHEARING STRESS	τ	(〃)	=	2.27

201

BASE

Case 7

2,3,4	MOMENT	M	(t·m)	=	14.540
13,14,16	AXIAL FORCE	N	(t)	=	0.000
	SHEAR FORCE	S	(t)	=	4.240
	WIDTH	b	(cm)	=	100.000
	DEPTH	h	(〃)	=	50.000
	EFFECTIVE DEPTH	d	(〃)	=	40.000
	CONCRETE COVER	d′	(〃)	=	7.000
	CONCRETE COVER	d″	(〃)	=	10.000
	MODULAR RATIO	n=Es/Ec		=	15
	AREA OF REINFORCEMENT	As	(cm2)	=	29.290 D16@200下 D22@200下
	AREA OF REINFORCEMENT	As′	(〃)	=	9.930 D16@200上

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	52.52
TENSILE STRESS	σs	(〃)	=	1417.44
SHEARING STRESS	τ	(〃)	=	1.21

BASE

Case 10

5~12	MOMENT	M	(t·m)	=	4.510
	AXIAL FORCE	N	(t)	=	0.000
	SHEAR FORCE	S	(t)	=	0.000
	WIDTH	b	(cm)	=	100.000
	DEPTH	h	(〃)	=	50.000
	EFFECTIVE DEPTH	d	(〃)	=	43.000
	CONCRETE COVER	d′	(〃)	=	10.000
	CONCRETE COVER	d″	(〃)	=	7.000
	MODULAR RATIO	n=Es/Ec		=	15
	AREA OF REINFORCEMENT	As	(cm2)	=	9.930 D16@200上
	AREA OF REINFORCEMENT	As′	(〃)	=	9.930 〃 下

COMPRESSIVE STRESS	σc	(Kg/cm2)	=	22.91
TENSILE STRESS	σs	(〃)	=	1143.98
SHEARING STRESS	τ	(〃)	=	0.00

6. GENERAL DESCRIPTION FOR BUILDING WORKS

I. GENERAL DESCRIPTION

I.1 GENERAL

The major design criteria applied in this calculations are standard requirements conforming to "Architectural Institute of Japan Standard for Structural Calculation of Reinforced Concrete Structures and Commentary" and "Architectural Institute of Japan Standard for Structural Calculation of Steel Structures".

I.2 DESIGN CRITERIA

Loading Conditions

In this structural calculations, the loads and external forces that act on the structure are the following.

(A) Dead load
(B) Live load

Table 1 Combination of Loads

Conditions of Stresses		Combination of Stresses
Permanent stresses	Normal time	G + P

where ;

G ; stress due to dead load
P ; stress due to live load

The dead and live loads of each part of building are applied in accordance with the Japanese Building Standard Law Enforcement Order.

I.3 Structural analysis

(1) Structural analysis

Stress analyses of reinforced concrete frames are carried out through a computer , NEC PC-9801 RA.

Structural analysis for the vertical load is obtained through the stiffness matrix method considering the axial, flexural and shering deformations based on the elastic theory.

(2) Modulus of Elasticity

Module of elasticity are as follows :

Concrete : Ec = 215.2 t/cm²

Sher modulus of elasticity are as follows :

Concrete : Gc = 92.2 t/cm²

I.4 Design of Members

The design of reinforced concrete structure shall be based on "AIJ Standard for Structural Calculation of Reinforced Concrete Structure".

Compressive strength of concrete at 28 days shall be 210 kg/cm² and more.

Reinforcement bar materials shall comply with deformed bar, "SD35 ". (JIS G 3112)

Weight of reinforced concrete shall be calculated as 2.4 t/m³ and the "Young Ratio" of reinforcement bar to concrete shall be "n = 15".

I.5 Allowable Design Stress of Materials

(c) Concrete and Reinforcing Bar

Allowable design stress of concrete and reinforcing bar will be summarized as follws :

Type of Str- / Materials — ess	For permanent load		
	Tension	Compression	Shear
Concrete (c=210kg/cm²)	——	Fc/3=70	4.25
Rein.-bar (JIS G3112)	1,800	1,800	1,000

Allowable bond stress per unit surfaces of reinforcing bar shall be shown as follws :

Type of Str- / Materials — ess	For permanent load	
	*Top bars	Other bars
Deformed bar	Fc/15 14.0	Fc/10 21.0

* Top bar, in reference to load, shall be holizontal bar so placed that more than 30cm of concrete is casted in the member below the bar.

(d) Allowable Bearing Capacity of Soil

The bearing capacity of soil is 30 t/m² for permanent load.

7. OPERATION BUILDING

§ .1 ASSUMED LOAD

FLOOR LOAD TABLE

TITLE	MATERIAL	(t/m3)	TICK. (cm)	WEIGHT (kg/m2)		DL (kg/m2)	LL (kg/m2)	TL (kg/m2)	NOTE
ROOF	WATER PROOFING			10	TO FLOOR	560	180	540	
	CEMENT MORTAR	2.00	2.0	40					
	SLAB	2.40	12.0	288	TO BEAM		180	540	
	CEILING			20					
					TO FRAME		130	490	
FLOOR	FINISHED	2.00	3.0	60	TO FLOOR	400	300	700	
	SLAB	2.40	13.0	312					
	CEILING			20	TO BEAM		300	700	
					TO FRAME		180	580	
CANOPY	WATER PROOFING			10	TO FLOOR	430	180	610	
	CEMENT MORTAR	2.00	2.0	40					
	SLAB	2.40	15.0	360	TO BEAM		180	610	
	CEILING			20					
					TO FRAME		130	560	
BALCONY	CEMENT MORTAR	2.00	2.0	40	TO FLOOR	460	180	640	
	SLAB	2.40	16.5	396					
	CEILING			20	TO BEAM		180	640	
					TO FRAME		130	590	

DEAD LOAD OF GIRDER,COLUMN,WALL

① GIRDER,BEAM

NO	B	D	CONCRETE	FINISHED	WEIGHT
	30.0	50.0	274	56	330
	30.0	65.0	382	71	460
	30.0	75.0	454	81	540
	30.0	70.0	504	0	510

② COLUMN

NO	B	D	CONCRETE	FINISHED	WEIGHT
	35.0	35.0	294	75	370

③ WALL

NO	t	CONCRETE	FINISHED	WEIGHT
CB20	20.0	310	100	410
CB10	10.0	110	100	210
W20	20.0	480	100	580
W10	10.0	240	100	340

4.2 PREPARTORY CALCULATION

2.1 CALCULATION of AXIAL FORCE of COLUMNS

NO	FLOOR	TITLE	CALCULATION		W ( )	Σw ( )
C-1	2F	PARAPET	0.60×7.7ℓ	2.8		
		ROOF	0.98×2.15×2.0	9.1		
			0.66×1.3×6.8ℓ	9.7		
		G	0.96×(2.97ℓ+1.9ℓ)	2.2		
		B	0.33×1.8ℓ/2	0.3		
		C	0.37×3.6/2	0.6	14.8	
	1F	FL	0.68×2.33ℓ×2.17ℓ	4.2		
			0.69×1.13ℓ×2.17ℓ	1.4		
		W	0.39×1.1×2.17ℓ	0.8		
		G	0.64×(2.97ℓ+1.9ℓ)	2.6		
		B		0.3		
		C	0.37×(3.6+3.8)/2	1.4		
		CB	0.91×4.8×2.8ℓ	6.6	16.3	31.1
	F	FG	0.61×(2.97ℓ+1.9ℓ)	2.4		
		C	0.37×3.8/2	0.7		
		CB	0.91×4.8×2.0ℓ	6.0		
					9.1	40.2
B-1	2F	PARAPET	0.60×6.0	2.6		
		ROOF	0.98×2.0×6.0	9.9		
			0.66×1.3×6.0	5.6		
		G	0.96×3.66ℓ+0.33×1.8ℓ	2.7		
		B		0.3		
		C		0.6	19.6	
	1F	FL	0.68×2.17ℓ×6.0	6.3		
		G	0.64×3.66ℓ+0.33×1.8ℓ	3.1		
		B		0.3		
		C		1.9		
		CB	0.91×3.66×2.8ℓ	6.9		
			0.81×1.8ℓ×2.0+2.17ℓ×2.6)	7.7	19.2	38.8
	F	FG	0.61×3.66ℓ	2.4		
		C		0.7		
		CB	0.91×3.66×2.0ℓ	6.6	9.9	48.7

NO	FLOOR	TITLE	CALCULATION		W (t)	Σw (t)
A-1	RF	PARAPET	0.50×6.9ℓ	3.2		
		ROOF	0.49×3.0×1.9ℓ	1.9		
			0.46×1.3×6.1ℓ	3.7		
		W	0.96×(1.9+6.7+1.67ℓ)	1.6		
		C		0.6	10.9	
	1F	FL	0.69×3.17ℓ×3.00ℓ	3.6		
			0.69×1.12ℓ×3.0	1.3		
		W	0.39×1.1×3.17ℓ	0.8		
		W	0.69×(1.92ℓ+1.67ℓ)	1.9		
		C		1.9		
		CB	0.91×3.6ℓ×3.9ℓ	9.1	13.1	34.0
	F	FW	0.61×(1.92ℓ+1.67ℓ)	1.9		
		C		0.7		
		CB	0.91×3.6ℓ×3.0ℓ	9.9	6.9	39.9
C-2	RF	PARAPET	0.61×9.0	3.0		
		ROOF	0.99×9.0×3.1ℓ	6.2		
			0.66×1.3×9.0	3.9		
		W	0.96×(3.66ℓ+3.97ℓ)	3.0		
		B	0.33×3.7/2	0.6		
		C		0.9	16.1	
	1F	FL	0.68×9.0×3.32ℓ	7.7		
			0.69×1.12ℓ×9.0	3.7		
		W	3.39×1.1×9.0	1.6		
		W	0.69×3.6ℓ+0.96×3.97ℓ	3.3		
		B		0.6		
		C		1.9		
		CB	0.91×3.66ℓ×3.9ℓ	9.3	31.5	34.6
	F	FW	0.61×3.66ℓ	1.9		
		C		0.7		
		CB	0.91×3.66ℓ×3.0ℓ	9.6	7.2	43.8

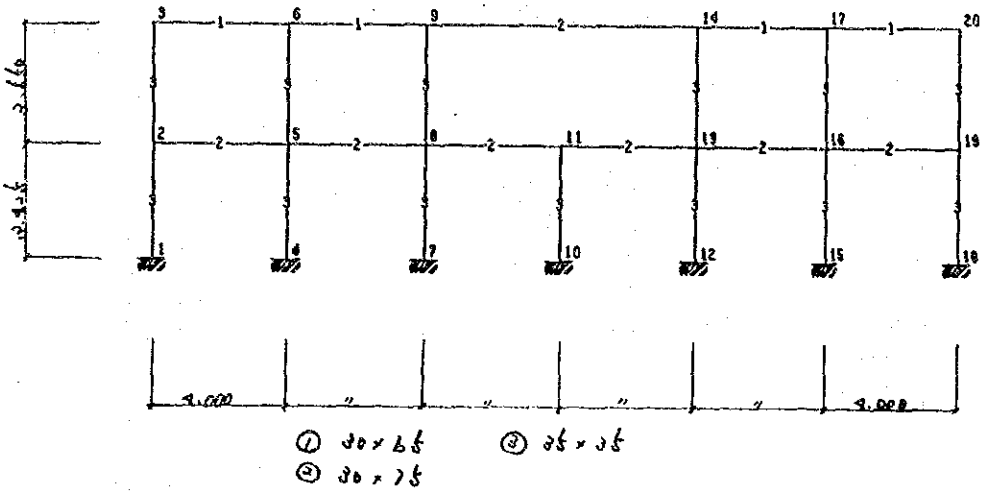
NO	FLOOR	TITLE	CALCULATION		W (t)	Σw (t)
B-2	2F	ROOF	0.49 × 9.0 × 6.0	9.8		
		小	0.96 × 0.975 + 0.22 × (3.65 + 1.675)	3.1		
		R		0.6		
		C		0.6	14.1	
	1F	FL	0.59 × 9.0 × 6.0	11.6		
		小		3.1		
		B		0.6		
		C		1.9		
		CB	0.21 × (2.65 × 2.0 + 9.0 × 2.6 + 1.675 × 3.0)	6.3	23.0	37.1
	F	C		0.7	0.7	37.8
A-2	2F	PARAPET	0.6 × 9.0	5.0		
		ROOF	0.96 × 9.0 × 1.85	3.9		
			0.65 × 1.3 × 9.0	2.9		
		小	0.96 × 2.65 + 0.33 × 1.675	3.3		
		C		0.6	11.1	
	1F	FL	0.59 × 9.0 × 3.025	9.7		
			0.59 × 1.125 × 9.0	3.7		
		W	0.39 × 1.1 × 4.0	1.6		
		小	0.69 × 3.65 + 0.33 × 1.675	3.5		
		C		1.9		
		CB	0.91 × 0.65 × 2.85	4.3		
			0.21 × 1.675 × 3.0	1.1	18.2	29.3
	F	F小	0.61 × 3.65	1.9		
		C		0.7		
		CB	0.91 × 2.65 × 3.05	4.6	7.2	36.5

NO	FLOOR	TITLE	CALCULATION		W (t)	Σw (t)
C-3	2F	PARAPET	0.60 × 6.7	3.9		
		Roof	0.99 × (9.0 × 6.15 + 2.0 × 3.15)	63.2		
			0.56 × 2.0 × 6.2	1.6		
		4	0.69 × (3.95 × 7 − 0.975) + 0.95 × (1.95 × 5 + 1.95)	5.9		
		B	0.33 × 1.95 / 2 + 0.69 × 3.95 / 2 + 0.95 × 3.95	3.1		
		C		0.6	27.2	
	1F	FL	0.69 × (9.0 × 2.3 − 5 + 2.0 × 1.95)	9.8		
			0.69 × 1.15 × 2.0	1.3		
		W	0.39 × 1.1 × 2.0	0.7		
		4	0.69 × 2.65 + 0.95 × 9.9	9.2		
		B	0.33 × (3.7 / 2 + 1.95)	1.3		
		C		1.9		
		CB	0.91 × (0.65 × 3.95 + 1.95 × 2.95)	6.9		
			0.31 × 3.975 × 3.75	1.7	36.7	63.9
	F	FL	0.61 × 3.65	1.9		
		C		0.7		
		CB	0.91 × 3.65 × 3.05	9.1	7.2	61.1
C-4	1F	FL	0.69 × 9.0 × 6.15	11.9		
		4	0.69 × 3.65 + 0.95 × 9.9	9.2		
		B	0.33 × (3.7 / 2 + 3.7)	1.9		
		C	0.37 × 3.9 / 2	0.7		
		CB	0.91 × 9.0 × 3.95	9.7	33.3	
	F	FL	0.61 × 3.65	1.9		
		C		0.7		
		CB	0.91 × 3.65 × 3.05	9.6	7.2	30.5

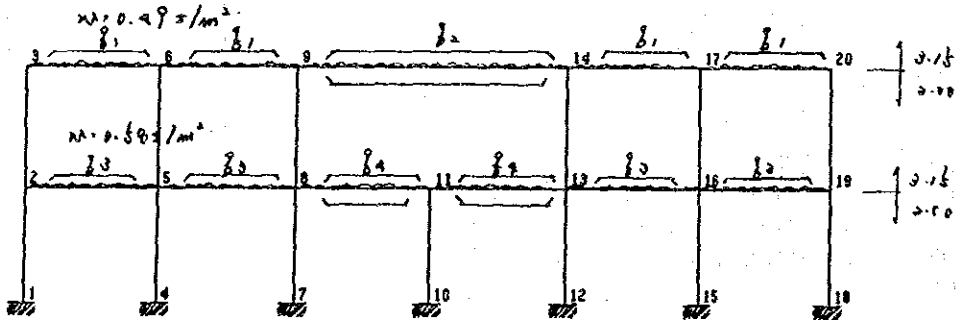
§. 3 CALCULATION OF STRESS

3.1 INPUT DATA

ⓐ FRAME



① 30 × 65　② 35 × 35
③ 30 × 70



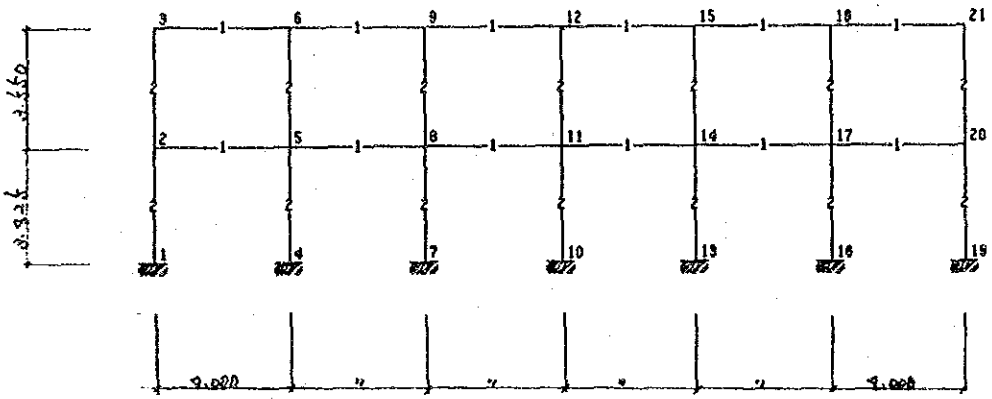
g_{b1} = 0.96 + 0.60 + 0.56 × 1.3 = 1.89 t/m

g_{b2} = 0.54 t/m

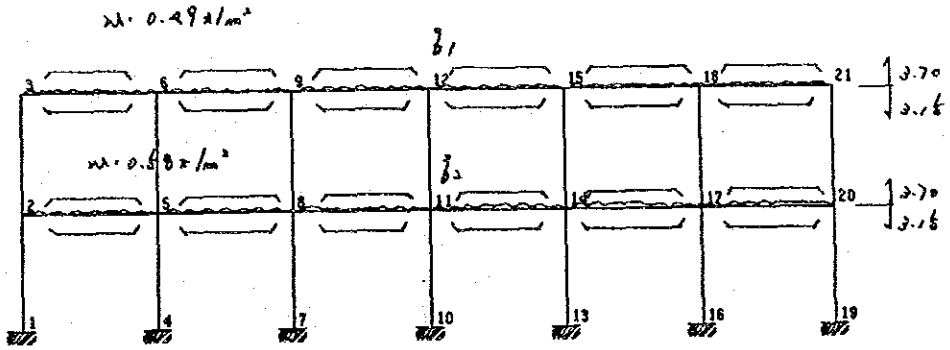
g_{b3} = 0.54 + 0.34 × 1.2 + 0.59 × 1.3 + 0.41 × 0.85 = 3.98 t/m

g_{b4} = 0.59 t/m

Ⓑ FRAME



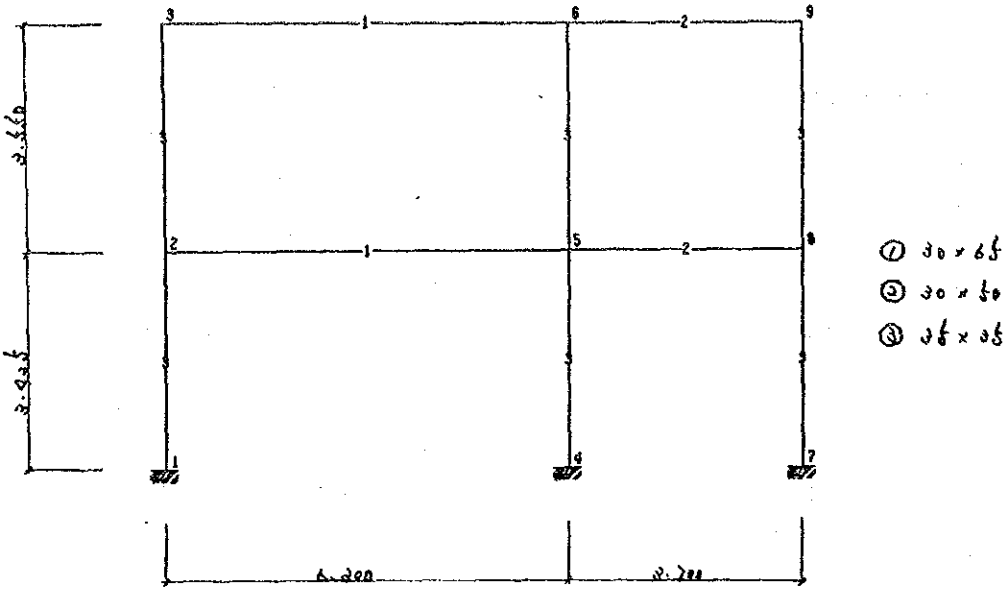
① 30 × 50
② 35 × 35

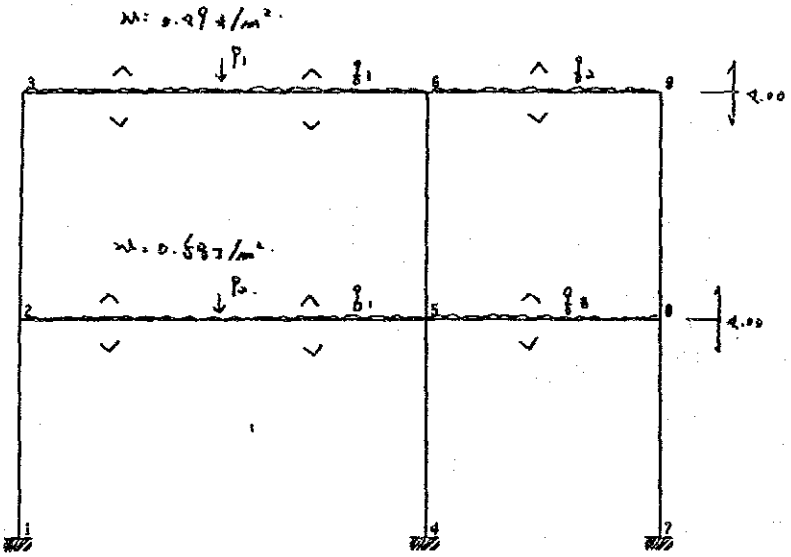


g_1 = 0.33 t/m

g_2 = 0.33 + 0.41 × 3.00 = 1.56 t/m

② FRAME





g_1 = 0.54 t/m

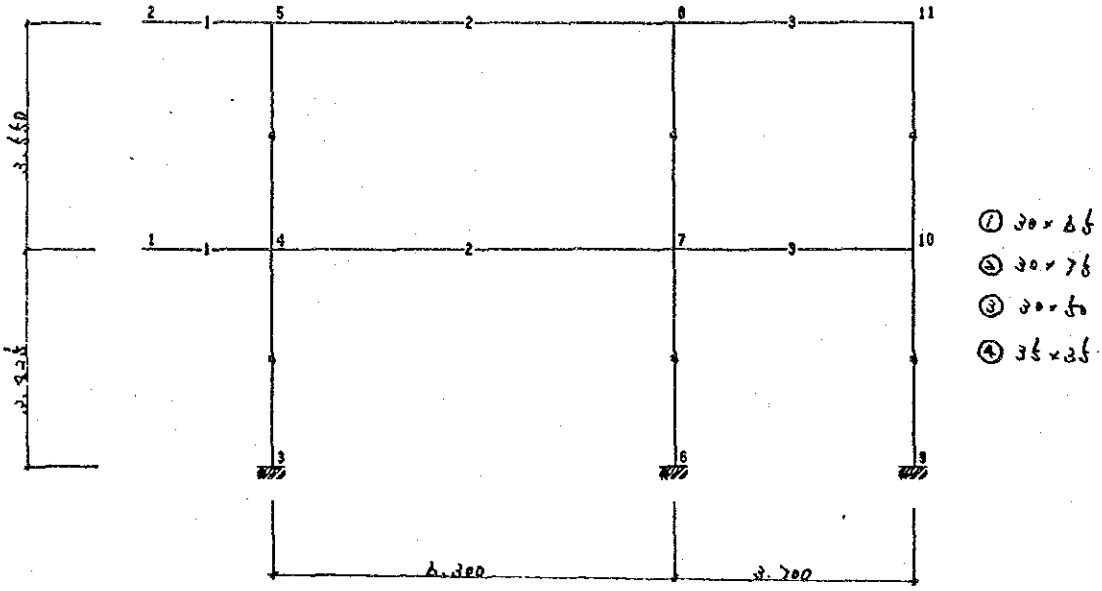
g_2 = 0.33 t/m

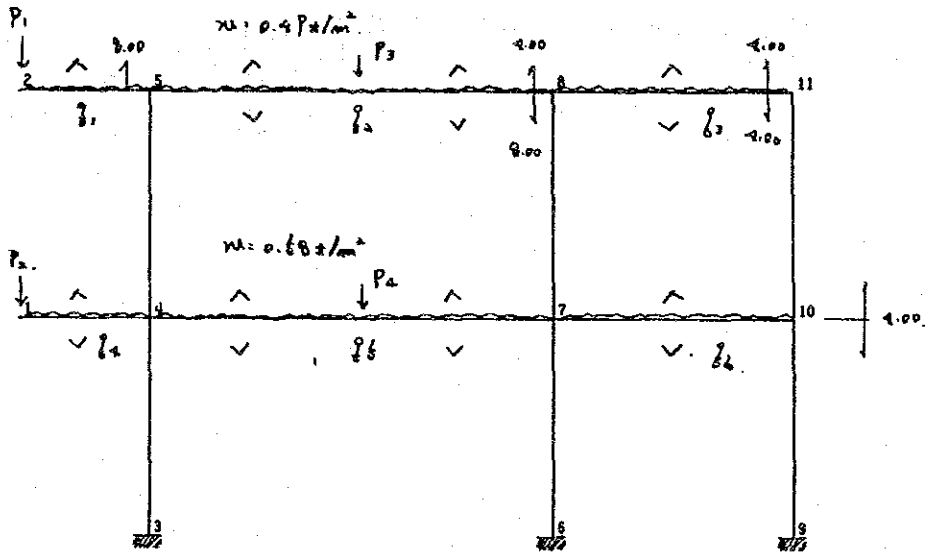
g_3 = 0.33 + 0.21 × 2.00 = 0.96 t/m

P_1 = 0.33 × 3.7 = 1.22 t

P_2 = 0.33 × 3.7 + 0.21 × 4.00 × 3.00 = 3.74 t

③ FRAME





P_1 = 0.50 × 4.0 + 0.26 × 3.85 + 0.49 × 3.50 = 5.29t

P_2 = 0.41 × 3.0 + 0.33 × 1.85 + 0.68 × 1.50 = 1.90t

P_3 = 0.69 × 3.85 + 0.33 × 1.85 = 3.05t

P_4 = 0.33 × 3.7 + 0.41 × 4.00 × 3.00 = 3.74t

g_1 = 0.24 + 0.50 = 0.74t/m

g_2 = 1.54t/m

g_3 = 0.33t/m

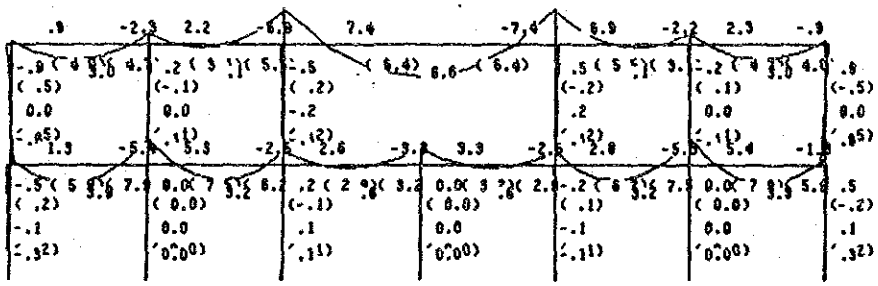
g_4 = 0.24 + 0.41 × 3.85 = 1.83t/m

g_5 = 0.69 + 0.41 × 3.75 = 2.22t/m

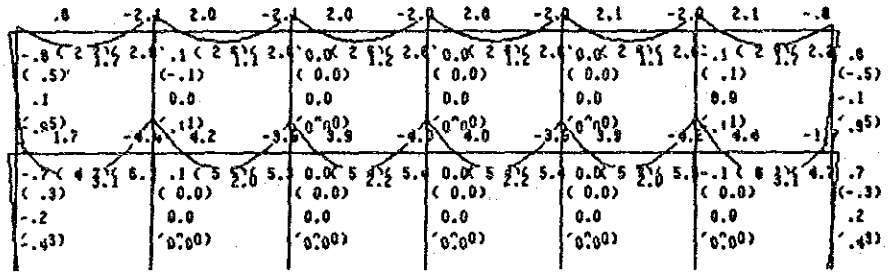
g_6 = 0.33 + 0.41 × 3.00 = 0.96t/m

3.3 STRESS DIAGRAM

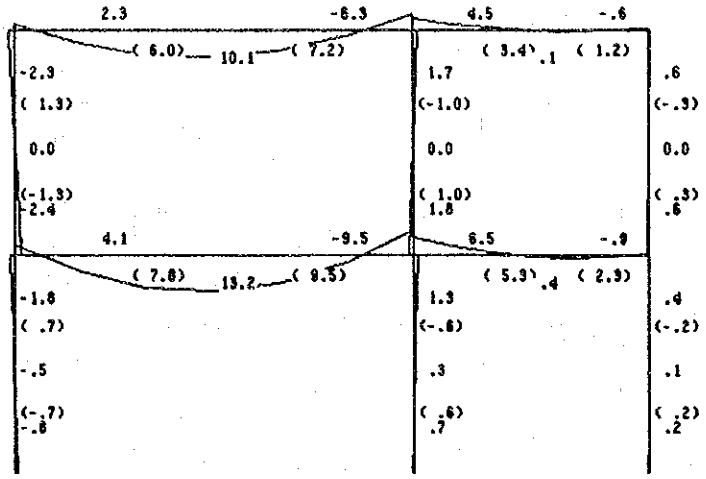
ⓒ FRAME



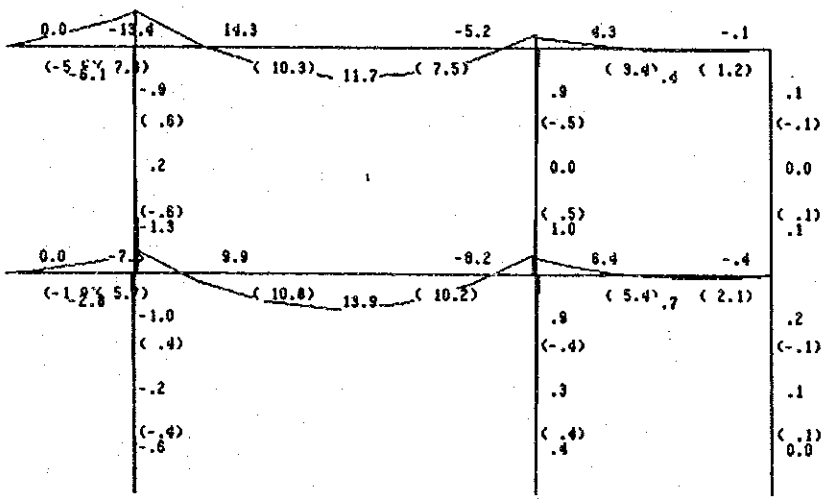
Ⓚ FRAME



⑤ FRAME



⑨ FRAME



6.4 DESIGN OF GIRDER AND COLUMN

4.1 GIRDER

NO (1')	PLACE	SECTION b (cm)	SECTION D (cm)	SECTION d (cm)	M (tm) L.L	M (tm) E	M (tm) T.L	Q (t) L.L	Q (t) E	Q (t) T	MAIN BAR C (kg/cd)	MAIN BAR Pt (%)	MAIN BAR pt (cm)	STIRRUP	STIRRUP	TOP BAR / BOTTOM BAR
RG1 C 1N2	D.E	30	65	59	0.9			9.0				0.27				2 D19
	C				0.0							0.30		D10@	200	3
	I.E				2.3			9.0				0.98		0.71	0.00	3
RG1A C 2N3	⑤ D.E	30	65	59	0.2			2.1				0.27				2 D19
	C				0.1									D10@	200	3
	⑥ I.E				6.9			6.6				7.43		2.66	0.00	4
RG2 C 3N4	E	30	75	69	7.9			6.9				6.91		3.63	0.00	4 D19
	C				6.6							6.07		D10@	200	3
	E															
RG3 B 1N2	D.E	30	50	44	6.9			9.0				1.30				2 D19
	C				2.0							9.33		D10@	200	3
	I.E				0.3			9.2				2.32		0.64	0.00	3
RG4 1 BNC	D.E	30	65	59	2.3			6.0				2.98				2 D19
	C				10.1							10.97		D10@	200	4
	I.E				6.3			7.2				6.79		4.65	0.00	3
RG5 1 AN B	D.E	30	65													2 D19
	C													D10@	200	3
	I.E															3
RG6 2 BNC	D.E	30	65													2 D19
	C													D10@	200	4
	I.E															3

Qu - QL

NO	PLACE	SECTION			M (tm)			Q (t)			MAIN BAR			STIRRUP		
		b (cm)	D (cm)	d (cm)	LE	E	TE	L	E	T	C (kg/cm²)	Pt (%)	ψt (cm)	τ (kg/cm²)	pw	TOP BAR
(′)		bd (10²cm²)	bd² (10³cm³)	j (cm)	LF	E′	TF	Q0		Q0	f	at (cm²)	ψF (cm)	a		BOTTOM BAR
RG 7		30	60	44	6.6			4.2				0.87				3 D19
A ~ B	0.E															3
																3
	C				0.1									D10 @	200	3
					4.5			3.4				0.99		0.94	0.20	3
( )	1.E															3
RG 8		30	75	69	14.3			10.3				13.6		5.69	0.20	5 D19
B ~ C	0.E													1.33		3
																3
	C				11.7							10.77		D10 @	200	4
					5.2			7.6				5.78				3
( )	1.E															3
R CG 1		30	65	59	12.9			7.9				15.92		5.10	0.28	6 D19
	E													1.13		3
	C													D13 @	200	
( )	E															
G																D
	E															
	C															
( )	E															
G																D
	E															
	C															
( )	E															
G																D
	E															
	C															
( )	E															
G																D
	E															
	C															
( )	E															

NO (1')	PLACE	SECTION b (cm)	SECTION D (cm)	SECTION d (cm)	M (tm) L.E	M (tm) R	M (tm) T.E	Q (t) L.	Q (t) E	Q (t) T	MAIN BAR C (kg/cd)	MAIN BAR pt (%)	MAIN BAR pk (cm)	STIRRUP		TOP BAR / BOTTOM BAR
		bd (10³cd)	bd² (10⁴cd)	j (cm)	L.F	R'	T.F	Qm		Qm	τ	αt (cd)	pF (cm)	τ	pw	
1G1		30	75	69	11.3			8.9				1.20				3 D19
C	D.E															3
1N2																3
	C				2.9							2.59		0.10 @	200	3
					8.4			7.9				9.97		9.26	0.20	3
( )	I.E													2.00		3
1G3		30	60	44	1.7			9.7				2.96				3 D19
B	D.E															3
1N2																3
	C				2.1							2.97		0.10 @	200	3
					9.9			6.1				6.28		6.29	0.20	3
( )	I.E													1.62		3
1G4		30	75	69	9.1			2.9				2.77				3 D19
1	D.E															3
B~C																3
	C				13.2							12.76		0.10 @	200	5
					9.6			9.6				9.79		6.09	0.20	3
( )	I.E													1.23		3
1G5		30	75	69	2.9			2.3				2.93				3 D19
1	D.E															3
A~B																3
	C				1.9							0.37		0.10 @	200	3
					6.5			6.2				6.79		2.98	0.20	3
( )	I.E															3
1G6		30	75	69	9.1			2.8				2.91				3 D19
2	D.E															3
B~C																3
	C				13.2							12.31		0.12 @	200	4
					9.5			9.5				10.22		6.13	0.21	4
( )	I.E													1.19		3
1G7		30	50	44	0.9			2.3				1.20				3 D19
2	D.E															3
A~B																3
	C				2.9							0.68		0.10 @	200	3
					6.6			6.3				9.38		9.69	0.30	4
( )	I.E													1.06		3
1G8		30	65	69	9.9			10.8				10.65		6.97	0.37	4 D19
3	D.E													1.06		3
B~C																3
	C				13.9							12.96		0.13 @	200	6
					9.2			10.2				9.82				4
( )	I.E															3
1CG1		30	65	69	7.6			6.9				8.18		3.81	0.20	6 D19
	B.E															3
														0.10 @	200	

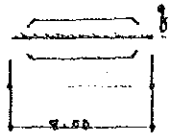
4.2 COLUMN

NO		SECTION				STRESS				MAIN BAR				HOOP		Y → X
		b(cm)	D(cm)	bD (10³cm²)	bD² (10³cm³)	\	P (t)	M (tm)	Q (t)	P/bD (kg/cm²)	M/bD² (kg/cm²)	Pt (%)	at (cm²)	τ (kg/cm²)	nφ (@ (cm))	Σn φ
C1 2-C	X	35	35			L										
						E										
						T₁										
						T₂										
	Y					L	16.1	2.4	1.3			0.12				
						E										
						T₁									D10	4-D19
						T₂							1.47	1.46	@100	
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										

5.5 DESIGN OF BEAM AND SLAB

5.1 BEAM

B1



λ = 1.07 W = 0.78 t/m²
λ = W =
q = 0.33 + 0.21 × 3.0 = 0.96 t/m
p =

C = 2 × 1.6 × 0.70 + 1.3 = 3.5 tm
M0 = 2 × 3.5 × " + 1.9 = 5.9
Q0 = 2 × 1.9 × " + 1.9 = 4.6

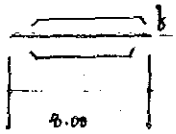
B × D = 30 × 50 (d = 44)

(D.L) M = 0.6C = 2.1 tm
Q =
at = 3.0 cm² { 3 – D·9 / 3 –
τ =

(C) M = M0 − 0.6 × 5C = 3.1 tm
at = 4.4 cm² { 3 – / 3 –

(L.L) M = 1.2C = 4.2 tm
Q = 4.6 + 0.5 × 6.1
at = 6.0 cm² { 3 – / 3 –
τ = 4.42 kg/cm² < αfs
α = 1.39
D10 @200

B3



λ = 2.54 W = 0.52 t/m²
λ = W =
q = 0.46 t/m
p =

C = 2 × 7.8 × 0.52 + 2.5 = 10.9 tm
M0 = 2 × 11.9 × " + 3.7 = 16.6
Q0 = 2 × 5.1 × " + 1.8 = 7.3 t

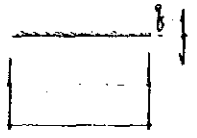
B × D = 30 × 75 (d = 69)

(E) M = 0.6C = 6.5 tm
Q = 7.3 t
at = 5.98 cm² { 3 – D·9 / 3 –
τ = 4.03 kg/cm² < fs
D10 @200

(C) M = M0 − 0.2C = 14.4 tm
at = 13.2 cm² { 3 – / 5 –

( ) M =
Q =
at = { – / –
τ =

B2



λ =　　W =
λ =　　W =
q =
p =

C =
M0 =
Q0 =

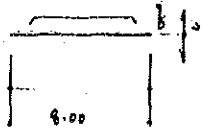
B × D =　　×　　(d =　　)

(　) M =　　at =　　{ − D
Q =　　τ =　　 −

(　) M =　　at =　　{ −
 −

(　) M =　　at =　　{ −
Q =　　τ =　　 −

B4



λ = 4.00　W = 0.70 t/m²
λ =　　W =
q = 0.96 + 0.91 = 1.87 ≒ 0.95 t/m
p =

C = 6.2 × 0.7 + 5.1 = 9.7 cm
M0 = 7.8 × 11 + 7.6 = 93.1
Q0 = 2.5 × 11 + 3.8 = 6.3 t

B × D = 30 × 65 (d = 59)

(E) M = 0.6C = 5.2 tm　　at = 6.60 cm²　　{ 3 − D 19
Q = 6.3 t　　τ = 4.07 kg/cm² < 5.5　　{ 3 −
D10 @200

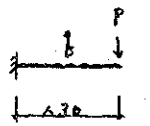
(C) M = M0 − 0.2C = 11.9 tm　　at = 12.27 cm²　　{ 3 −
5 −

(　) M =　　at =　　{ −
Q =　　τ =　　 −

5.2 DESIGN OF SLAB

	NAME	Wo	LL	Lx	Ly	reqt	W	NO	t	PLACE		M	At		
1	ROOF	70	180	315	400	8.39	538	S1	12.0	MAIN BAR X	(U)	0.32	2.55	D10	@200
											(D)	0.21	1.70	D10	@200
										MAIN BAR Y	(U)	0.22	2.02	D10	@200
											(D)	0.15	1.35	D10	@200
2	ROOF	70	180	370	400	9.50	538	S1	12.0	MAIN BAR X	(U)	0.35	2.81	D10	@200
											(D)	0.24	1.87	D10	@200
										MAIN BAR Y	(U)	0.31	2.78	D10	@200
											(D)	0.20	1.86	D10	@200
3	ROOF	70	180	315	800	9.35	538	S2	12.0	MAIN BAR X	(U)	0.43	3.45	D10 D13	@200
											(D)	0.29	2.30	D10	@200
										MAIN BAR Y	(U)	0.22	2.02	D10	@200
											(D)	0.15	1.35	D10	@200
4	FL	80	300	315	400	9.08	692	S3	13.0	MAIN BAR X	(U)	0.41	2.92	D10	@200
											(D)	0.28	1.94	D10	@200
										MAIN BAR Y	(U)	0.29	2.27	D10	@200
											(D)	0.19	1.51	D10	@200
5	FL	80	300	370	400	10.26	692	S3	13.0	MAIN BAR X	(U)	0.46	3.22	D10	@200
											(D)	0.30	2.14	D10	@200
										MAIN BAR Y	(U)	0.39	3.13	D10	@200
											(D)	0.26	2.09	D10	@200

(CS1)



$w_b = 0.61\ t/m$

$P = 0.50\ t$

$M = 0.5 \times 3.3 + 0.6 \times 3.3 = 3.63\ tm$

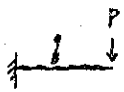
$Q = 1.9 + 0.6 = 2.5\ t$

$t = 15\ cm$ $(d = 11\ cm)$

$a_t = 6.75\ cm^2 < 15 a_t = 10.13$ D13 @100

$\tau = 1.34\ kg/cm^2 < f_s$

(CS2)



$w_b = 0.64\ t/m$

$P = 0.24 \times 1.1 = 0.37\ t$

$M = 0.54 + 0.98 = 1.52\ tm$

$Q = 0.83 + 1.37 = 2.20\ t$

$t = 18\ cm$ $(d = 14\ cm)$

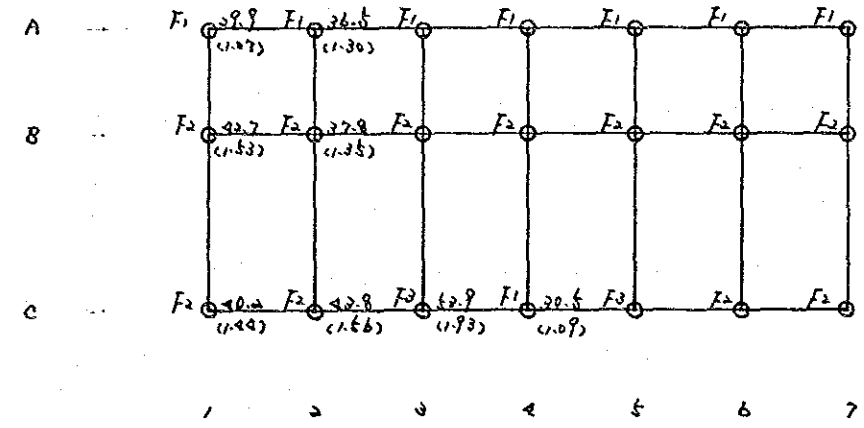
$a_t = 4.63\ cm^2 < 15 a_t = 6.72$ D13 @150

$\tau = 0.98\ kg/cm^2 < f_s$

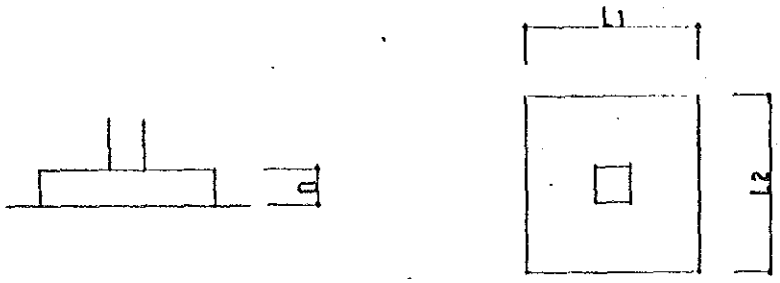
6.6 DESIGN OF FOUNDATION

・ f_{a1} = 30.0 t/m²

f_{a2} = 30.0 − 2.0 × 1.0 × 1.0² = 28.0 t/m²　　( ) : Frame A



F1　1200 × 1200
F2　1800 × 1800
F3　1500 × 1500



F1　L1 X L2 = 1300 × 1300　D = 450　(d = 36cm)

M = 28.0 × 1.3 × 0.42 5^2/2 = 8.0 tm
Q = 〃 × 0.42 5 = 19.3 t

at = 5.44 cm^2　5 - D16
Ø = 22.2 cm
τ = 3.99 kg/cm^2 < f_s

F2　L1 X L2 = 1300 × 1300　D = 500　(d = 40cm)

M = 28.0 × 1.3 × 0.47 5^2/2 = 9.1 tm
Q = 〃 × 0.47 5 = 17.3 t

at = 5.51 cm^2　5 - D16
Ø = 23.64 cm
τ = 3.90 kg/cm^2 < f_s

F3　L1 X L2 = 1500 × 1500　D = 550　(d = 46cm)

M = 28.0 × 1.5 × 0.57 5^2/2 = 6.9 tm
Q = 〃 × 0.57 5 = 24.2 t

at = 9.74 cm^2　8 - D16
Ø = 29.27 cm
τ = 4.10 kg/cm^2 < f_s

F　L1 X L2 =　D =　(d =)

M =
Q =

at =
Ø =
τ =

8. CHEMICAL BUILDING

§ .1 ASSUMED LOAD

FLOOR LOAD TABLE

TITLE	MATERIAL	(t/m3)	TICK. (cm)	WEIGHT (kg/m2)		DL (kg/m2)	LL (kg/m2)	TL (kg/m2)	NOTE
ROOF	WATER PROOFING			10	TO FLOOR	340	180	520	
	CEMENT MORTAR	2.00	2.0	40	TO BEAM		180	520	
	SLAB	2.40	12.0	288	TO FRAME		130	470	
3F TANK	WATER	1.00	145.0	1450	TO FLOOR	1850		1850	
	WATER PROOFING	2.00	2.0	40	TO BEAM			1850	
	SLAB	2.40	15.0	360	TO FRAME			1850	
3FL	SLAB	2.40	12.0	288	TO FLOOR	290	180	470	
					TO BEAM		180	470	
					TO FRAME		130	420	
2FL	FINISHED	2.00	3.0	60	TO FLOOR	380	300	680	
	SLAB	2.40	13.0	312	TO BEAM		300	680	
					TO FRAME		180	560	
2FL	FINISHED	2.00	3.0	60	TO FLOOR	380	2000	2380	
	SLAB	2.40	13.0	312	TO BEAM		2000	2380	
					TO FRAME		2000	2380	
1F TANK	WATER	1.00	200.0	2000	TO FLOOR	2380		2380	
	WATER PROOFING			20	TO BEAM			2380	
	SLAB	2.40	15.0	360	TO FRAME			2380	

DEAD LOAD OF GIRDER,COLUMN,WALL

① GIRDER,BEAM

NO	B	D	CONCRETE	FINISHED	WEIGHT
	50.0	50.0	274	56	330
	30.0	65.0	382	71	460
	35.0	50.0	319	58	380
	30.0	60.0	346	66	420
	30.0	70.0	504	0	510

② COLUMN

NO	B	D	CONCRETE	FINISHED	WEIGHT
	35.0	35.0	294	75	370
	30.0	30.0	216	65	290

③ WALL

NO	t	CONCRETE	FINISHED	WEIGHT
CB20	20.0	310	100	410
CB10	10.0	110	100	210
W20	20.0	480	100	580
W10	10.0	240	100	340

5.2 PREPARTORY CALCULATION

2-1 CALCULATION OF AXIAL FORCE OF COLUMNS

1.

NO	FLOOR	TITLE	CALCULATION		W (t)	ΣW (t)
D-1	3	Roof	0.47×1.8×1.6	1.6		
		4	0.33×(1.6+1.2)	1.9		
		C	0.37×2.6/2	0.7	2.2	
	2	TANK	1.8×1.6×0.9	1.9		
		W20	0.6×2.0×1.7	2.0		
		B	0.46×2.0	0.9		
		C	2.9×1.1	0.3		
		FL	0.92×2.7×2.6	2.9		
		W10	0.24×1.1×5.2	2.0		
		4	0.33×(1.6+1.2)	1.9		
		C	0.37×(2.6+2.6)/2	1.3	13.3	16.6
	1	FL	2.38×1.2×0.7	2.7		
		4	0.92×(1.6+1.2)	1.3		
		C	0.37×2.6	1.3		
		CB20	0.4×2.9×2.9	2.9	13.6	29.1
	F	4	0.6×(1.6+1.2)	1.6		
		C	0.37×2.6/2	0.6		
		CB20	0.4×2.9×2.9	2.9	6.4	39.6
C-1	3	Roof	0.9×1.2×2.6	2.3		
		4	0.33×(1.6+2.1)	1.6		
		C		0.7	4.6	
	2	TANK	1.8×1.6×3.6	7.9		
		W20	0.6×2.6×1.7	2.6		
		B	0.46×4.6	2.1		
		C		0.3		
		FL	0.92×2.7×2.6	2.9		
		W10	0.24×1.1×2.6	1.3		
		4		1.6		
		C		1.3	21.6	37.0
	1	FL	2.38×1.2×1.6	4.9		
			0.44×1.2×4.8	2.3		
		4	0.92×(1.6+2.6)	3.8		
		C		1.3		
		CB20	0.4×2.6×3.0	2.9	16.2	53.3

NO	FLOOR	TITLE	CALCULATION		W (t)	Σw (t)
	F	FL	0.61×2.16	1.6		
		C		0.6		
		CBOD	0.41×2.16×0.9	2.7	5.9	49.2
A-1	3				8.2	
	2				10.3	18.5
	1	G		1.2		
		C		1.2		
		CBOD		2.4		
		WOD	0.59×10.9×0.9 + 2.25×2.67/2	9.7	18.6	36.1
	F	TANK	2.29×1.96×1.67	7.7		
		FL		1.6		
		FB	0.61×1.16+1.15/2	1.1		
		C		0.6		
		WOD		9.7	18.6	41.7
B-3	3	ROOF	0.97×0.76×2.6	1.9		
		G	0.33×(2.9+2.6)	1.8		
		C		0.7	7.0	
	2	TANK	1.96×2.76×2.6	14.0		
		FL	0.92×2.76×2.6	4.0		
		G		1.8		
		C		1.2	24.9	31.9
	1	FL	0.56×0.76×2.0	0.8		
		G	0.92×(2.0+2.15)	3.8		
		C		1.2		
		WOD	0.59×(2.9+1.15)×2.9/2	3.0	9.7	40.6
	F	TANK	2.29×0.76×1.6	2.8		
		FG	0.61×(2.9+1.15)	1.8		
		C		0.6		
		WOD		2.0	18.2	58.8

3.

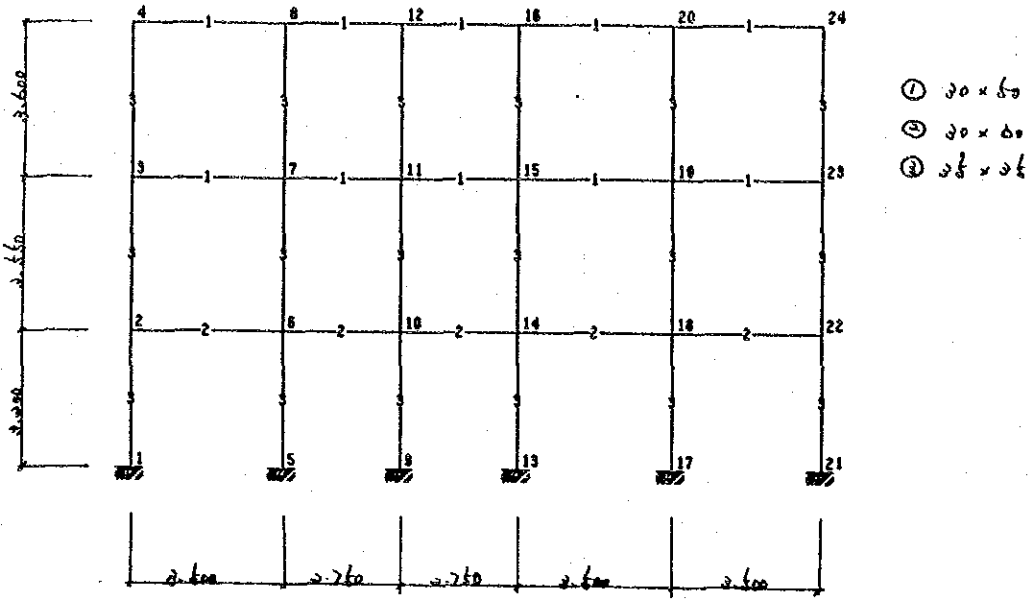
NO	FLOOR	TITLE	CALCULATION		W (t)	Σw (t)
A-3	3.	Roof	0.97 × 2.7ℓ × 1.67ℓ	3.3		
		Lg	0.23 × (3.9 + 1.32ℓ)	1.0		
		C		0.7	9.1	
	2	TANK	1.9ℓ × 2.7ℓ × 0.9	4.6		
		W20	0.69 × 2.7ℓ × 1.7	3.7		
		B	0.96 × (2.7ℓ + 0.9)	1.7		
		C		0.7		
		FL	0.93 × 2.7ℓ × 1.ℓ	2.9		
		W10	0.39 × 1 × 2.7ℓ	1.0		
		Lg		1.2		
		C		1.3	16.1	30.2
	1	Lg	0.93 × (3.9 + 1.32ℓ)	1.6		
		C		1.3		
		CB20	1.91 × 2.9 × 3.0	3.0		
		W20	0.69 × 3.72ℓ × 0.9/2	2.1	9.0	29.2
	F	FL	3.39 × 2.7ℓ × 1.67ℓ	11.9		
		FG	0.ℓ × (3.9 + 1.32ℓ)	1.9		
		C		0.6		
		W20		3.1	16.6	45.8
B-6	3.	Roof	0.97 × 3.ℓ × 1.67ℓ	3.3		
		Lg	0.23 × (3.1ℓ + 1.32ℓ)	1.ℓ		
		C		0.7	5.0	
	2	TANK	1.9ℓ × 3.ℓ × 0.9	5.9		
		W20	0.69 × 3.ℓ × 1.7	3.ℓ		
		B	0.96 × (3.ℓ + 0.9)	2.0		
		C		0.7		
		FL	0.93 × 3.ℓ × 2.ℓ	3.7		
		W10	0.39 × 1.1 × 3.ℓ	1.3		
		Lg		1.ℓ		
		C		1.3	19.9	34.9
	1	FL	3.39 × 3.ℓ × 0.67ℓ	13.0		
		Lg	0.93 × (3.1ℓ + 1.32ℓ)	1.9		
		C		1.3		
		CB20	0.91 × 3.1ℓ × 2.9	3.7	20.9	45.7

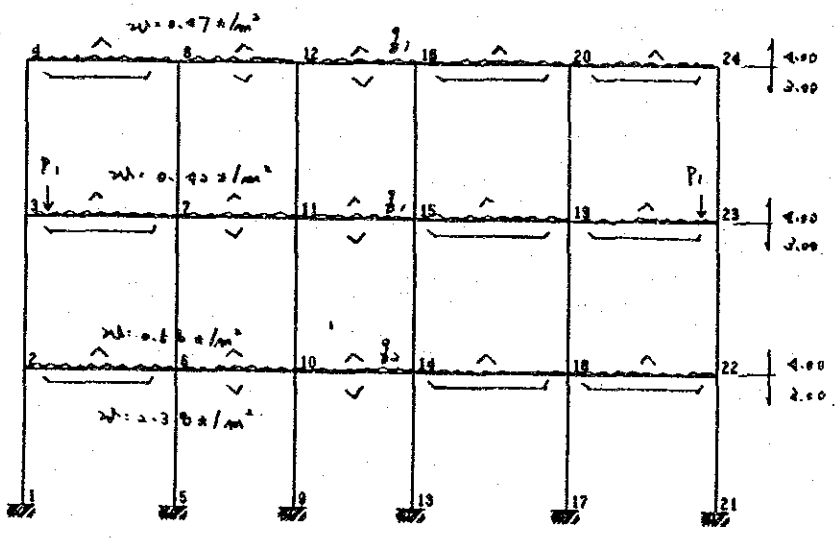
NO	FLOOR	TITLE	CALCULATION		W (t)	ΣW (t)
	F	FL	0.61 × 2.6	1.6		
		C		0.6		
		CB=0	0.91 × 2.6 × 2.9	3.7	6.9	51.6
C-6	3	ROOF	0.97 × 2.6 × 2.6	6.9		
		4	0.33 × 6.3	2.1		
		C		0.7	9.8	
	2	TANK	1.96 × 2.6 × 2.6	22.7		
		B	2.96 × 6.2	2.9		
		FL	2.42 × 2.6 × 2.6	6.1		
		4		2.1	34.1	92.7
		C		1.2		
	1	FL	2.38 × 2.6 × 1.6	10.6		
			0.66 × 2.6 × 2.0	2.8		
		6	0.33 × 6.3	2.6		
		C		1.2	17.2	62.9
	F	C		0.6	0.6	60.6

3. CALCULATION OF STRESS

3.1 INPUT DATA

© FRAME



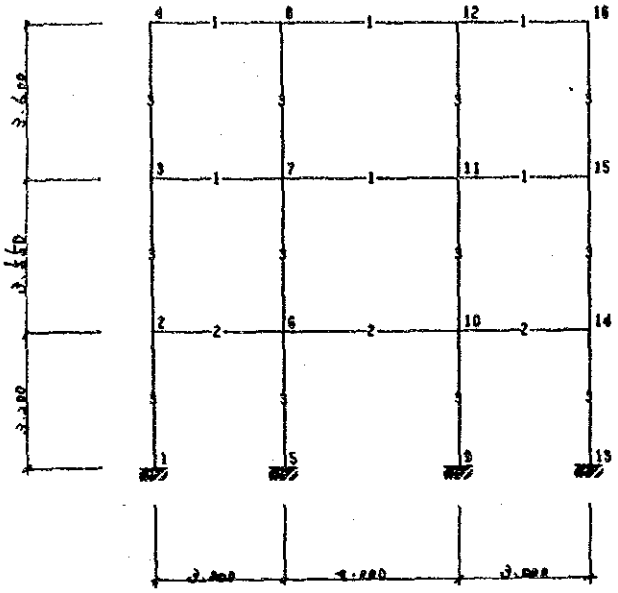


g_1 = 0.33 t/m

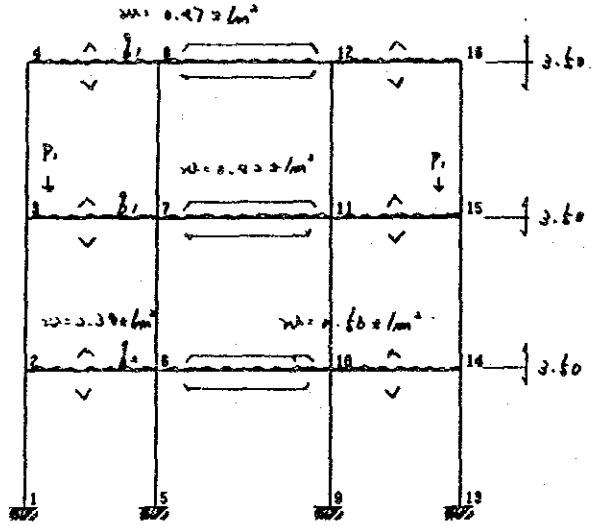
g_2 = 0.42 t/m

P_1 = 1.86 × 2.2 × 1.9 + 0.96 × 4.6 + 0.58 × 1.7 × 2.2 = 13.98 t

④ FRAME



① 30 × 60
② 30 × 60
③ 25 × 25



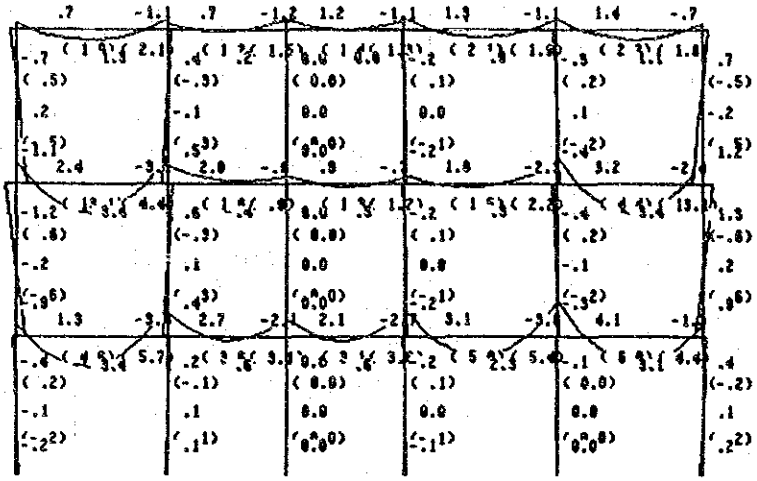
g_1 : 0.23 t/m

g_2 : 0.42 t/m

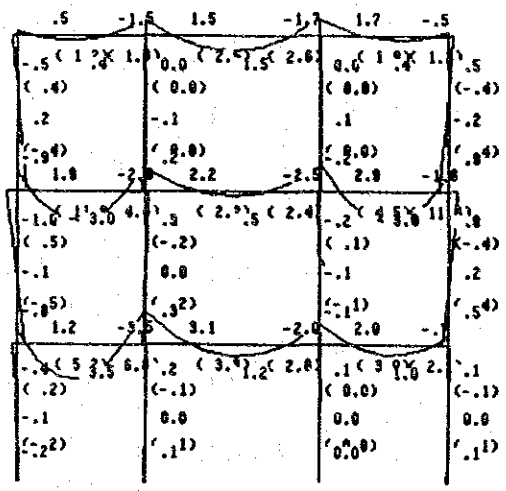
P_1 : 1.85 × 3.6 × 1.2 + 0.46 × 7.7 + 0.69 × 1.7 × 3.6 = 13.89 t

3.2 STRESS DIAGRAM

ⓒ FRAME



ⓓ FRAME



4.1 GIRDER

NO (1')	PLACE	SECTION b (cm) / bd (10³cd)	D (cm) / bd² (10⁴cd²)	d (cm) / j (cm)	M (tm) L.E / L.F	M (tm) E / E'	M (tm) T.E / T.F	Q (t) L.L / Ql	Q (t) E / Qe	Q (t) T / Qo	MAIN BAR C (kg/cd) / t	MAIN BAR Pt (%) / at (cd)	MAIN BAR ps (cm) / pt (cm)	STIRRUP v (kg/cd) / a	STIRRUP pw / a/b	TOP BAR / BOTTOM BAR
RG1 C 5×6	D.E	30	50	44	0.7			1.9				1.01				3 - D.P
																3
																3
	C				1.1							1.59		0.10 @	200	3
					1.4			9.3				2.22		1.96		3
( )	I.E															3
2G1A C 5×6	D.E	35	60	54	0.4			9.6				2.93				3 - D.P
																3
																3
	C				3.4							4.00		0.13 @	200	3
					3.3			10.1				2.76		2.90		3
( )	I.E													3.00		3
2G1		30	60													3 - D.P
	D.E															3
																3
	C													0.10 @	200	3
																3
( )	I.E															3
2G1 C 5×6	D.E	30	60	54	0.3			9.9				1.62				3 - D.P
																3
																3
	C				3.1							3.64		P.10 @	200	3
					4.1			6.0				4.82		4.23	0.22	3
( )	I.E															3
RG2 4 B×C		30	50	44	1.7			3.6				2.26		0.25	0.20	3 - D.P
	E															3
																3
	C				2.6							2.06		0.10 @	200	3
( )	E															
2G2A 4 B×C		30	50	44	3.5			0.9				3.61		0.05	0.28	3 - D.P
	E															3
																3
	C				0.6							0.72		0.10 @	0.80	3
( )	E															
2G2 4 A×C		35	60	54	1.9			1.9				2.03		1.20	0.00	3 - D.P
	D.E													0.00		3
																3
	C				3.0							3.53		0.13 @	200	3
					2.9			4.4				2.41				3
( )	I.E															3

0.0 ~ 0.L

NO (ケ)	PLACE	SECTION b (cm) / bd (10²cm²)	D (cm) / bd² (10³cm³)	d (cm) / j (cm)	M (tm) LE / LF	E / E'	TE / TF	Q (t) L / QL	E / [illegible]	T / Q0	MAIN BAR C (kg/cm²) / f	pt (%) / at (cm²)	pc (cm) / pF (cm)	STIRRUP r (kg/cm²) / a	pw / [illegible]	TOP BAR / BOTTOM BAR
1G2		30	60	54	1.2			6.2				1.91				3 D19
4	0.E															3
B~C																3
	C				3.6							4.13		D10@	200	3
					3.6			6.2				4.13		4.37	0.44	3
( )	1.E													1.96		3
G																- D
	E															
	C															
( )	E															
FG1		35	70													3 D19
	E															3
																3
	C													D10@	200	3
( )	E															
G																- D
	E															
	C															
( )	E															
G																- D
	E															
	C															
( )	E															
G																- D
	E															
	C															
( )	E															
G																- D
	E															
	C															
( )	E															

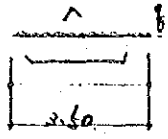
2.3 COLUMN

NO		SECTION					STRESS			MAIN BAR				HOOP		Y - Y ΣN φ
		b(cm)	D(cm)	bD (10³cm²)	bD² (10³cm³)		P (t)	M (tm)	Q (t)	P/bD (kg/cm²)	M/bD² (kg/cm²)	Pt (%)	at (cm²)	τ (kg/cm²)	nφ @ (cm)	
C1 C-1	X					L	3.5	2.2	0.6			0.07				 4-D19
						E										
						T₁										
		35	35			T₂							0.86	0.68	D10 @100	
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										

5.6 DESIGN OF BEAM AND SLAB

5.1 BEAM

B9



入 = 1.00 W = 1.85 t/m²
入 = 1.96 W =
q = 0.96 t/m
p =

C = (1.1 + 1.0) × 1.85 + 0.5 = 4.4 t/m
MO = (1.8 + 1.5) × " + 0.7 = 4.9
QO = (1.6 + 1.4) × " + 0.8 = 6.2 t

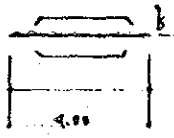
B × D = 30 × 60 (d = 54)

(0.5) M = 0.5C = 2.2 tm — at = 2.06 cm² — (σ − D/9 / σ −
Q = — τ =

(C) M = MO − 0.65 C = 4.0 tm — at = 4.70 cm² — (σ − / σ −

(1.5) M = 1.2C = 5.3 tm — at = 6.23 cm² — (σ − / σ −
Q = 6.2 + 0.8 = 7.0 t — τ = 8.94 kg/cm² — α = 1.66 pw = 0.20% D10 @200

B8



入 = 1.14 W = 1.85 t/m²
入 = 1.96 W =
q = 0.96 t/m
p =

C = (1.6 + 1.5) × 1.85 + 0.6 = 6.4 t/m
MO = (2.6 + 2.3) × " + 0.9 = 10.0
QO = (2.0 + 1.8) × " + 0.9 = 7.9 t

B × D = 30 × 60 (d = 54)

(0.5) M = 0.6C = 3.8 tm — at = 4.47 cm² — (σ − D/9 / σ −
Q = — τ =

(C) M = MO − 0.65 C = 6.8 tm — at = 6.92 cm² — (σ − / σ −

(1.5) M = 1.2C = 7.7 tm — at = 9.06 cm² — (σ − / σ −
Q = 7.9 + 1.0 = 8.9 t — τ = 6.28 kg/cm² — α = 1.65 pw = 0.33% D10 @200

B 1

λ = 1.64 W = 0.68 t/m²
λ = 4.00 W =
q = 0.33 t/m
P =

C = (1.4 + 0.6) × 0.68 + 0.9 = 1.9 tm
MO = (3.2 + 1.8) × " + 0.7 = 3.8
QO = (1.7 + 0.9) × " + 0.7 = 3.4 t

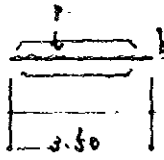
B × D = 30 × 60 (d = 49)

(E) M = 0.6C = 1.1 tm — σt = 1.69 kg/cm² — σ − D/f
Q = 3.4 t — τ = 3.08 kg/cm² < fs — σ −
8-D @200

(C) M = MO - 0.2C + 3.4 tm — σt = 3.96 kg/cm² — σ −
σ −

( ) M = — σt = — −
Q = — τ = — −

B 2



λ = 1.46 W = 0.97 t/m²
λ = 4.82 W =
q = 0.39 t/m
P = 1.85 × 1.46 × 1.20 + 0.69 × 1.7 × 3.65 + 0.33 × 3.65 + 6.71 t

C = (1.0 + 0.3) × 0.97 + 0.4 + 2.9 = 3.19 tm
MO = (1.8 + 0.5) × " + 0.6 + 5.9 = 7.9
QO = (1.4 + 0.5) × " + 0.7 + 3.4 = 6.9 t

B × D = 35 × 50 (d = 44)

(E) M = 0.6C = 2.3 tm — σt = 3.32 kg/cm² — σ − D/f
Q = 4.9 t — τ = 3.64 kg/cm² < fs — σ −
8-D @200

(C) M = MO - 0.2C = 6.6 tm — σt = 9.62 kg/cm² — σ −
ε −

( ) M = — σt = — −
Q = — τ = — −

FB1

λ =　　W =
λ =　　W =
q =
β =

C =
Mo =
Qo =

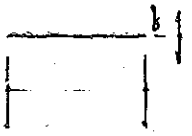
B x D = 30 x 70　(d =)

(All) M =　　at =　　{ 3 − D/3 / 3 − / 2-D16 @...
Q =　　τ =

( ) M =　　at =　　{ − / −

( ) M =　　at =　　{ −
Q =　　τ =　　{ −

B



λ =　　W =
λ =　　W =
q =
β =

C =
Mo =
Qo =

B x D =　　x　　(d =　　)

( ) M =　　at =　　{ − D / −
Q =　　τ =

( ) M =　　at =　　{ − / −

( ) M =　　at =　　{ −
Q =　　τ =　　{ −

§.2 DESIGN OF SLAB

	NAME	Wo	LL	Lx	Ly	reqt	W	NO	t	PLACE		M	At		
1	ROOF	50	180	350	400	9.02	518	S1	12.0	MAIN BAR X	(U)	0.33	2.65	D10	@200
											(D)	0.22	1.76	D10	@200
										MAIN BAR Y	(U)	0.26	2.40	D10	@250
											(D)	0.18	1.60	D10	@250
2	ROOF	50	180	300	350	7.56	518	S1	12.0	MAIN BAR X	(U)	0.25	2.00	D10	@200
											(D)	0.17	1.33	D10	@200
										MAIN BAR Y	(U)	0.19	1.76	D10	@250
											(D)	0.13	1.17	D10	@250
3	ROOF	50	180	275	300	6.59	518	S1	12.0	MAIN BAR X	(U)	0.19	1.52	D10	@200
											(D)	0.13	1.01	D10	@200
										MAIN BAR Y	(U)	0.16	1.48	D10	@250
											(D)	0.11	0.99	D10	@250
4	ROOF	50	180	275	400	7.31	518	S1	12.0	MAIN BAR X	(U)	0.27	2.12	D10	@200
											(D)	0.18	1.41	D10	@200
										MAIN BAR Y	(U)	0.16	1.48	D10	@250
											(D)	0.11	0.99	D10	@250
5	FL	1490	0	320	370	14.75	1850	S2	15.0	MAIN BAR X	(U)	1.01	5.84	D13	@200
											(D)	0.67	3.90	D13	@200
										MAIN BAR Y	(U)	0.79	5.01	D13	@250
											(D)	0.53	3.34	D13	@250
6	FL	1490	0	240	290	10.95	1650	S3	15.0	MAIN BAR X	(U)	0.60	3.49	D10 D13	@200
											(D)	0.40	2.33	D10 D13	@200
										MAIN BAR Y	(U)	0.44	2.82	D10 D13	@250
											(D)	0.30	1.88	D10 D13	@250
7	FL	60	300	350	400	9.77	672	S4	13.0	MAIN BAR X	(U)	0.43	3.05	D10	@200
											(D)	0.29	2.03	D10	@200
										MAIN BAR Y	(U)	0.34	2.72	D10	@250
											(D)	0.23	1.81	D10	@250
8	FL	60	300	275	400	7.94	672	S4	13.0	MAIN BAR X	(U)	0.35	2.44	D10	@200
											(D)	0.23	1.63	D10	@200
										MAIN BAR Y	(U)	0.21	1.68	D10	@250
											(D)	0.14	1.12	D10	@250
9	FL	60	2000	270	320	14.91	2420	S5 2	15.0	MAIN BAR X	(U)	0.98	5.63	D13	@200
											(D)	0.65	3.75	D13	@200
										MAIN BAR Y	(U)	0.74	4.67	D13	@250
											(D)	0.49	3.11	D13	@250
10	FL	60	2000	275	300	14.61	2420	S5 2	15.0	MAIN BAR X	(U)	0.89	5.16	D13	@200
											(D)	0.60	3.44	D13	@200
										MAIN BAR Y	(U)	0.76	4.84	D13	@250
											(D)	0.51	3.23	D13	@250
11	FL	2020	0	275	300	14.43	2380	S5 2	15.0	MAIN BAR X	(U)	0.88	5.07	D13	@200
											(D)	0.59	3.38	D13	@200
										MAIN BAR Y	(U)	0.75	4.76	D13	@250
											(D)	0.50	3.17	D13	@250

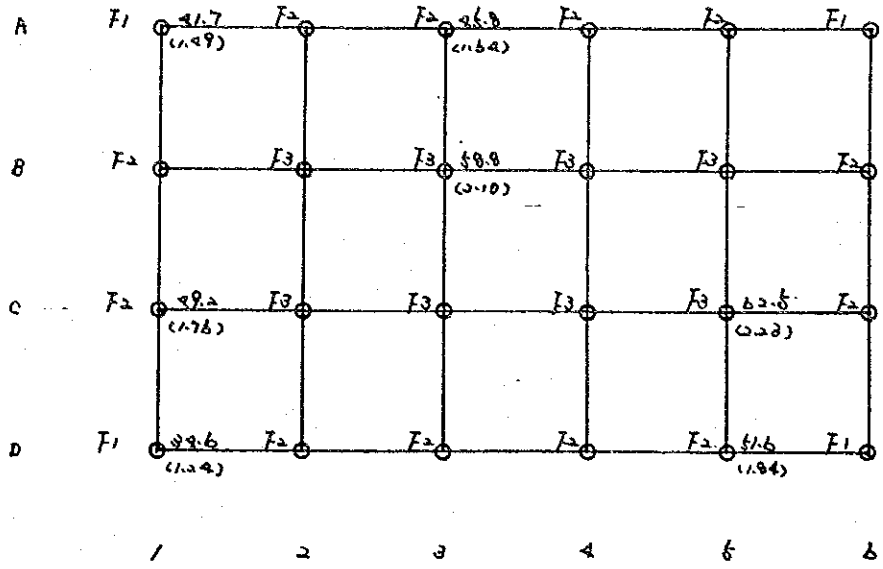
No. 42

§.6 DESIGN OF FOUNDATION

σ_a = 30.0 t/m².

σ_a' = 30.0 − 2.0 × 1.0 × 1.0² = 28.0 t/m²

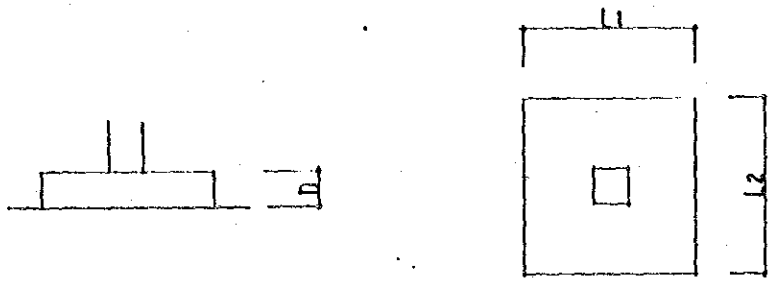
( ) : ref A



F1 : 1,300 × 1300 (A= 1.69 m²)

F2 : 1,600 × 1,600 (A= 2.56 m²)

F3 : 1,800 × 1,800 (A= 3.24 m²)



F 1　L1 X L2 = 1.300 × 1.300　D = 500　(d = 40cm)

M = 28.0 × 1.3 × 0.497² / 2 = 4.14tm
Q = 〃 × 0.497 = 17.3t

at = 6.51cm²　δ = 0.6
Ø = 32.54cm
τ = 2.80 kg/cm² < fs

F 2　L1 X L2 = 1.600 × 1.600　D = 550　(d = 495cm)

M = 28.0 × 1.60 × 0.572² / 2 = 7.84tm
Q = 〃 × 0.572 = 29.2t

at = 9.24cm²　δ = 0.6
Ø = 29.27cm
τ = 4.10 kg/cm² < fs

F 3　L1 X L2 = 1.800 × 1.800　D = 600　(d = 50cm)

M = 28.0 × 1.80 × 0.632² / 2 = 9.98tm
Q = 〃 × 0.632 = 29.0t

at = 11.17cm²　δ = 0.6
Ø = 30.06cm
τ = 4.00 kg/cm² < fs

F　L1 X L2 =　D =　(d =　)

M =
Q =

at =
Ø =
τ =

9. WORKSHOP

§ .1 ASSUMED LOAD

FLOOR LOAD TABLE

TITLE	MATERIAL	(t/m3)	TICK. (cm)	WEIGHT (kg/m2)		DL (kg/m2)	LL (kg/m2)	TL (kg/m2)	NOTE
	WATER PROOFING			10	TO				
	CEMENT MORTAR	2.00	2.0	40	FLOOR		180	540	
	SLAB	2.40	12.0	288	TO				
ROOF	CEILING			20	BEAM	360	180	540	
					TO				
					FRAME		130	490	

DEAD LOAD OF GIRDER,COLUMN,WALL

① GIRDER,BEAM

NO	B	D	CONCRETE	FINISHED	WEIGHT
	30.0	60.0	346	65	420
	30.0	70.0	504	0	510

② COLUMN

NO	B	D	CONCRETE	FINISHED	WEIGHT
	35.0	35.0	294	75	370

③ WALL

NO	t	CONCRETE	FINISHED	WEIGHT
CB20	20.0	310	100	410
CB10	10.0	110	100	210

§2. PREPARTORY CALCULATION

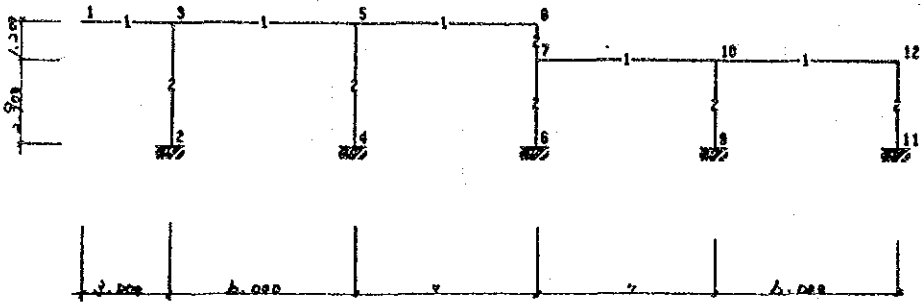
2.1 CALCULATION OF AXIAL FORCE OF COLUMNS.

NO	FLOOR	TITLE	CALCULATION		W (t)	Σw (t)
1-D	1	RooF	0.99×0.12×2.16	0.9		
		4	0.92×2.82×2	0.9		
		B	0.92×0.82/2	0.6		
		C	0.32×2.2	0.8		
					9.7	
	F	FA	0.61×2.82×2	0.9		
		C		0.8		
		CB+D	0.91×2.0×2×2.8	8.8		
					10.5	21.2
1-C	1	RooF	0.99×(2.12+6.0+2.82×2.12)	12.7		
		4	0.92×(6.66+6.66)	9.7		
		B	2.92×(6.7/2+0.66)	2.8		
		C		0.8	21.6	
	F	FA	0.61×6.66	2.9		
		C		0.8		
		CB+D	0.91×2.82×2.8	4.8		
					8.1	29.7
2-D	1	RooF	0.99×6.0×2.17	8.3		
		4	0.92×(6.66+2.82)	3.6		
		B	0.92×2.82	1.2		
		C		0.8	14.9	
	F	FA	0.61×6.66	0.9		
		C		0.8		
		CB+D	0.91×6.66×2.8	8.8		
					13.5	27.4
2-C	1	RooF	0.99×6.0×2.1	12.6		
		4	0.92×6.66×2	9.7		
		B	0.92×6.7	2.4		
		C		0.8	35.5	
	F	C		0.8		
					0.8	36.3

3.3 CALCULATION OF STRESS

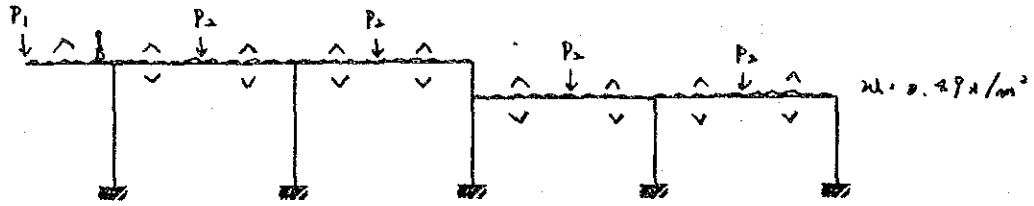
3.1 INPUT DATA

C FRAME



① 300 × 600
② 350 × 350

C FRAME

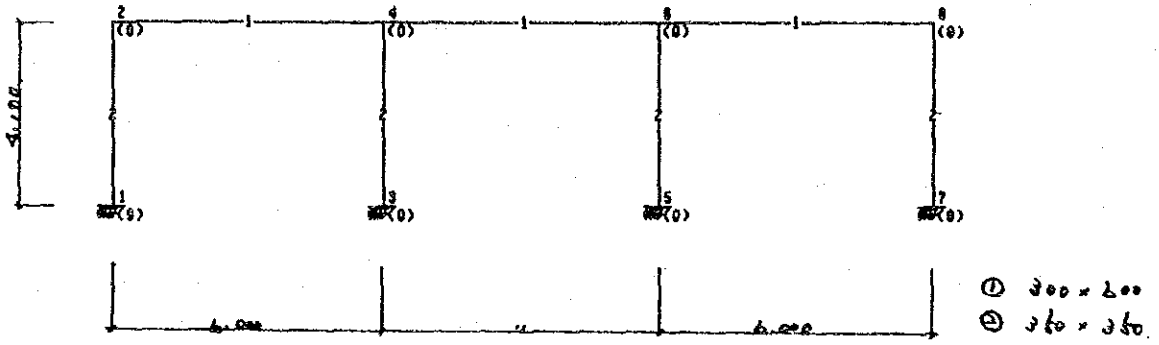


g = 0.92 t/m

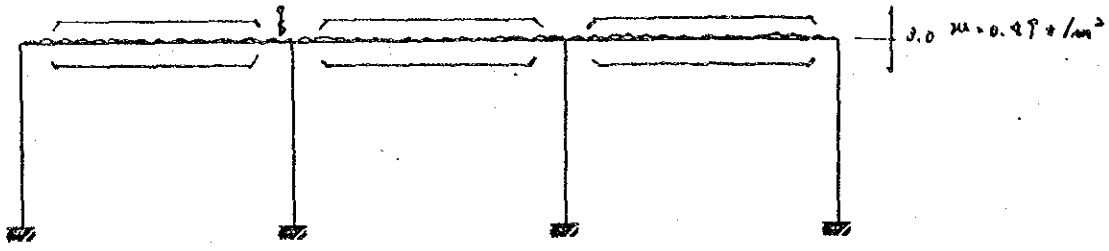
P1 = (0.92 + 0.60) × 3.00 = 4.56 t

P2 = 0.92 × 6.7 = 6.39 t

2 FRAME.



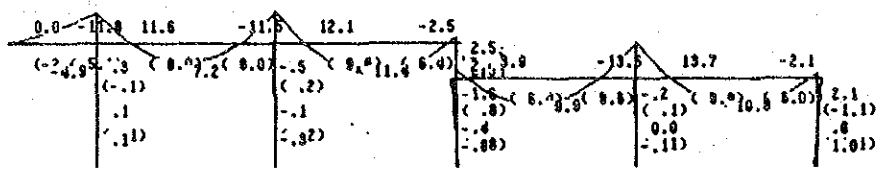
a FRAME



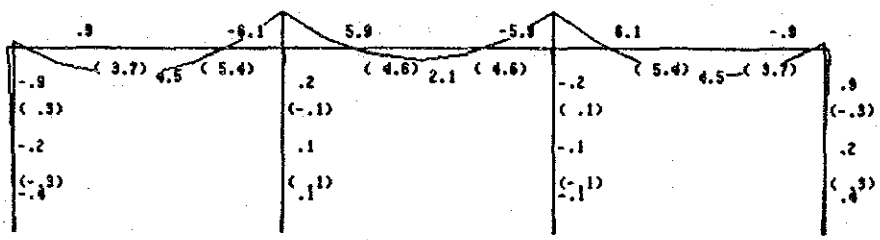
g=0.9t/m

3.3 STRESS DIAGRAM

⑥ FRAME



⑨ FRAME



4.1 GIRDER

NO (ㄱ)	PLACE	SECTION b (cm) / bd (10³cd)	D (cm) / bd² (10⁴cd²)	d (cm) / j (cm)	M (tm) L± / L F	M (tm) R / R'	M (tm) T± / T F	Q (t) L. / (b)	Q (t) E / (b)'	Q (t) T / (b)₀	MAIN BAR C (kg/cd) / r	MAIN BAR Pt (%) / at (cd)	MAIN BAR φ± (cm) / φF (cm)	STIRRUP φ (kg/cd) / s	STIRRUP Pw / aw/s	TOP BAR / BOTTOM BAR
G1		30	60	54	11.6			9.0				12.64		6.84	0.313	4 D22
C	E													4.09		3
1N2																3
	C				7.2							9.47		D10@	1.50	3
	E															
G2		30	60	54	6.9			9.6				6.94		3.06	0.20	3 D19
2	E															3
2N2																3
	C				2.1							2.97		D10@	2.00	3
	E															
G																D
	E															
	C															
	E															
cG1		30	60	54												6 D22
	B.E															3
																3
	C													D10@	2.00	3
	E															
G																D
	E															
	C															
	E															
FG1		30	70													3 D19
	E															3
																3
	C													D10@	2.00	3
	E															
G																D
	E															
	C															
	E															

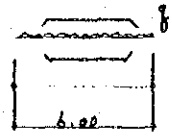
4.2 CALUMN

NO		SECTION					STRESS			MAIN BAR				HOOP		Y ☐ X ΣN φ
		b(cm)	D(cm)	bD (10²cm²)	bD² (10³cm³)		P (t)	M₀ (tm)	Q (t)	P/bD (kg/cm²)	M/bD² (kg/cm²)	Pt (%)	at (cm²)	τ (kg/cm²)	ΦΦ @ (cm)	
C1 c-3	X	35	25			L	25.5	2.5	0.3			0	0	2.34	D10 @100	 4-D19
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C1 c-5	X	35	35			L	21.6	2.1	1.1			0	0	1.24	D10 @100	 4-D19
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										
C	X					L										
						E										
						T₁										
						T₂										
	Y					L										
						E										
						T₁										
						T₂										

§.6 DESIGN OF BEAM AND SLAB

§.1 BEAM

B 1 (B1A)



入 = 0.00 W = 0.64 t/m²
入 = W =
q = 0.92 t/m
p =

C = 2 × 4.0 × 0.69 + 1.3 = 5.6 tm
M0 = 2 × 6.2 × " + 1.9 = 8.6
Q0 = 2 × 3.4 × " + 1.3 = 2.9 t

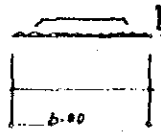
B × D = 30 × 60 (60) (d = 55)

(0.E) M = 0.6C = 3.4 tm
Q =
at = 4.91 cm² { 3 – D16
3 –

(C) M = M0 – 0.65C = 5.0 tm
at = 2.23 cm² { 3 –
3 –

(1.E) M = 1.2C = 6.7 tm
Q = 2.9 + 0.6 × 5.6
at = 3.67 cm² { 4 –
3 –
τ = 4.76 kg/cm²
d = 1.06
pw = 0.228%
D10 @200

B 2



入 = 0.00 W = 0.64 t/m²
入 = W =
q = 0.92 + 0.50 = 0.92 t/m
p =

C = 4.0 × 0.64 + 2.8 = 4.9 tm
M0 = 6.2 × " + 4.1 = 7.6
Q0 = 3.4 × " + 2.8 = 4.6 t

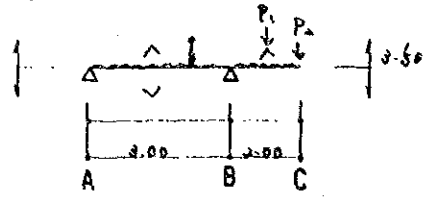
B × D = 30 × 60 (d = 55)

(E) M = 0.6C = 2.9 tm
Q = 2.6 t
at = 1.78 cm² { 3 – D16
3 –
τ = 2.90 kg/cm² < fs
D10 @200

(C) M = M0 – 0.2C = 6.6 tm
at = 3.38 cm² { 3 –
4 –

( ) M =
Q =
at = { –
τ = –

CB1



(A~B)

入 = 1.00 W = 0.64 t/m²

入 = W =

q = 0.92 t/m

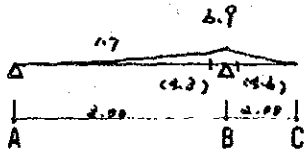
p =

C = 2 × 0.7 × 0.64 × 0.9 = 1.2 t·m

M0 = 2 × 1.2 × ⅔ + 0.6 = 1.8

Q0 = 2 × 1.2 × ½ + 0.9 = 2.2 t

(STRESS)



(B~C)

W = 0.64 t/m² W =

q = 0.92 + 0.50 = 0.92 t/m

p_1 = 0.64 × 1.00 = 0.64 t

P_2 = 0.64 × 1.05 + 0.92 × 1.75 + 0.50 × 1.75 = 3.29 t

M = 1.8 + 0.5 + 3.6 = 5.9 t·m

Q = 1.8 + 0.5 + 2.3 = 4.6 t

B × D = 30 × 50 (d=44)

(A E.) M = 0.60 × 0.7 t·m. at = 1.91 cm² { 3 – D 19 / 3 –

(CENT.) M = 1.7 t·m. at = 3.45 cm² { 3 – / 3 –

(B E.) M = 5.9 t·m at = 9.96 cm² { 5 – / 3 – D 13 @ 200

Q = 4.6 t τ = 3.98 kg/cm² < f_s

(C E.) { 3 – / 3 –

5.2 DESIGN OF SLAB

	NAME	Wo	LL	Lx	Ly	reqt	W	NO	t	PLACE		M	At	配筋	
1	ROOF	70	180	300	600	8.64	538	S1	12.0	MAIN BAR X	(U)	0.38	3.01	D10	@200
											(D)	0.25	2.01	D10	@200
										MAIN BAR Y	(U)	0.20	1.83	D10	@250
											(D)	0.13	1.22	D10	@250
2	ROOF	70	180	400	600	11.73	538	S2	12.0	MAIN BAR X	(U)	0.60	4.75	D10 D13	@200
											(D)	0.40	3.17	D10	@200
										MAIN BAR Y	(U)	0.36	3.25	D10	@200
											(D)	0.24	2.17	D10	@200

(CS1)

$g = 0.64$ t/m
$P = 0.60$ t

$M = 0.07 + 0.50 = 0.57$ tm
$Q = 0.64 + 0.60 = 1.04$ t

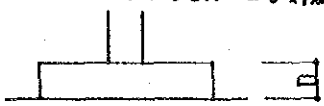
$d = 15$ cm ($d = 11$ cm)

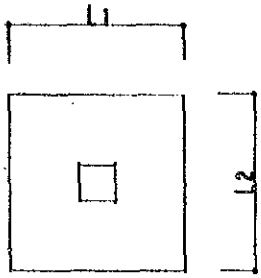
$a_t = 4.44$ cm² ($1.6 a_t = 6.67$) D13 @150
$\tau = 1.08$ kg/mm² < f_s

5.5 DESIGN OF FOUNDATION

σ_e = 30 t/m²

σ_e' = 30 − 1.0 × 1.0² × 3.0 = 28 t/m²





F1 L1 × L2 = 1.200 × 1.200 D = 450 (d = 375 mm)

M = 28.8 × 1.2 × 0.425²/2 = 3.9 tm

Q = 28.8 × 1.2 × 0.425 = 14.7 t

(N = 29.7 t req. A = 1.06 m²)

at = 5.49 cm² 4 - D16

ø = 22.34 cm

τ = 3.89 kg/cm² < σ_a

F L1 × L2 = D = (d =)

M =

Q =

at =

ø =

τ =

F L1 × L2 = D = (d =)

M =

Q =

at =

ø =

τ =

F L1 × L2 = D = (d =)

M =

Q =

at =

ø =

τ =