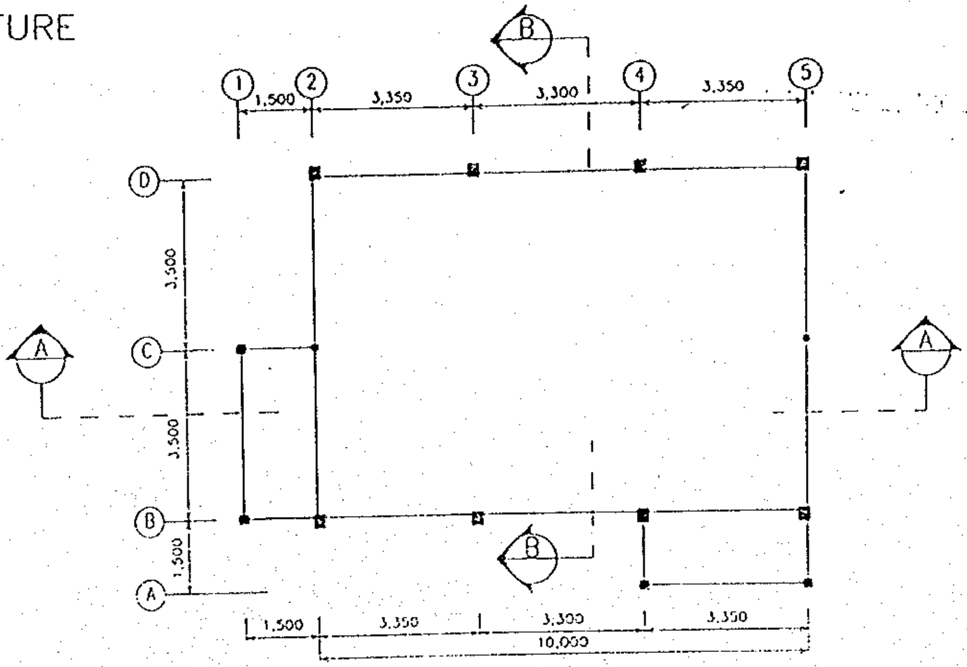
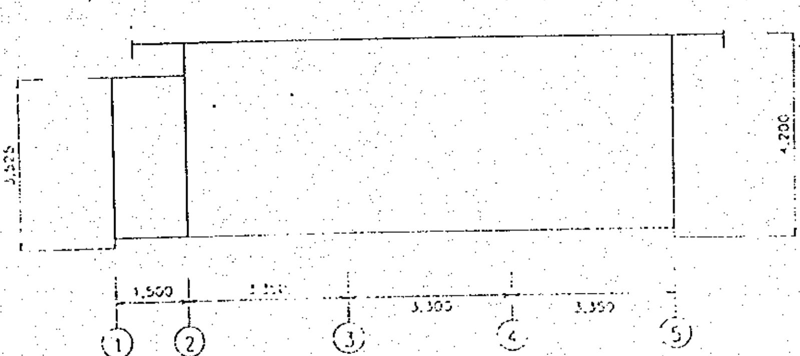
4.7.3. STORAGE HOUSE 1
STRUCTURE CALCULATION

1 STRUCTURE
2 DESIGN CONDITION
3 LOADING CONDITION
4 DESIGN OF FOOTING

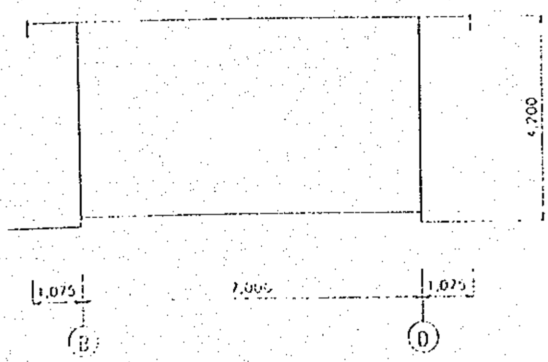
1. STRUCTURE



PLAN



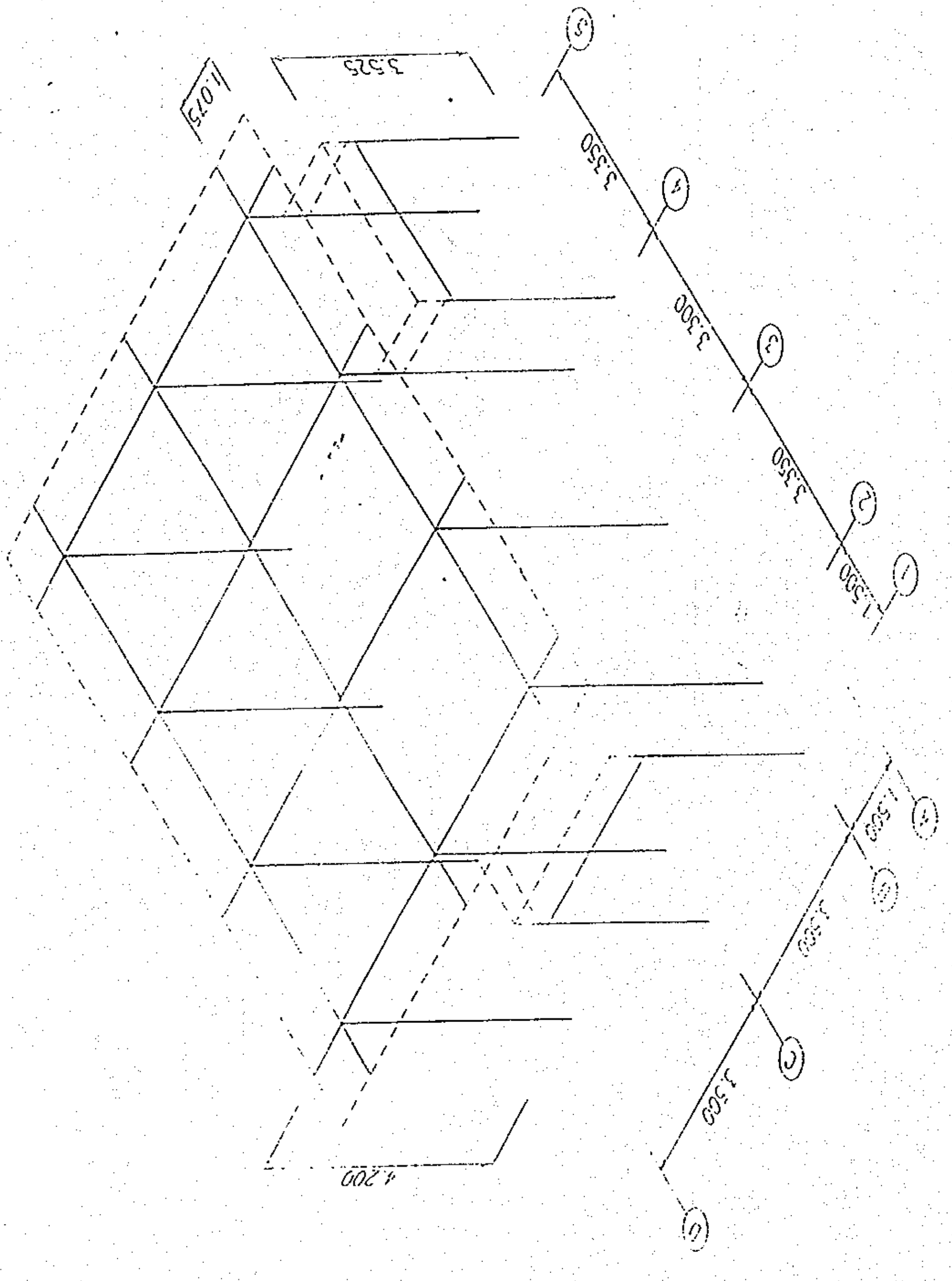
SECTION A-A



SECTION B-B

S T O R A G E I

SIMONGAN WIER MANAGEMENT COMPLEX



ISOMETRY
S T O R A G E I
SIMONGAN WEIR MANAGEMENT COMPLEX

2. Design Condition

a. Dimensions :

- width	:	7.50 m
- length	:	10.00 m
- height	:	4.10 m

b. Frame member :

- Concrete , Fc = 225 kg/ cm^2

c. Structural model :

- Space frame
- Linear elastic

d. Analysis method :

- Static

3. Loading condition

a. Dead load

- Roof cover (concrete slab 12 cm)	= 288 kg/m^2
- Water stop (concrete 3 cm)	= 72 kg/m^2
	360 kg/m^2

b. Live load

Weight of workers as point load = 100 kg

BEAM TYPE 1

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	30	4	1.6	0.8	187	3,200	2,400

Frame elemen Force					Design											
						Left bars			Mid bars			Right bars				
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Stirrup (mm)	Mu (kg.cm)
4	119	60	0	95,357	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-120	231,837
5	99	61	0	85,130	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-120	231,836
6	119	60	0	95,356	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-120	231,837

COULOM type 1

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	30	4	1.6	0.8	187	3,200	2,400

Frame elemen Force				Design				
Member	Axial (kg)	Moment-2 (kg.cm)	Moment-3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mox (kg.cm)	Moy (kg.cm)
32	9,469	264,016	33,303	8D16	ø8-90	8,470	460,973	380,381
33	11,194	311,237	5,939	8D16	ø8-90	11,196	29,871	357,960
34	11,194	311,238	5,939	8D16	ø8-90	11,196	29,873	357,995
35	9,469	264,919	33,302	8D16	ø8-90	8,470	460,973	380,382
38	8,456	264,926	33,302	8D16	ø8-90	8,451	460,841	380,355
39	11,179	311,221	5,939	8D16	ø8-90	11,191	29,895	358,014
40	11,179	311,221	5,930	8D16	ø8-90	11,181	29,809	358,014
41	9,455	264,902	33,202	8D16	ø8-90	8,451	460,840	380,354
54	10,168	728,898	2,430	4D16	ø8-90	10,332	24,788	245,202
55	12,171	689,239	2,856	4D16	ø8-90	12,334	29,603	253,846
56	12,171	689,242	2,856	4D16	ø8-90	12,334	29,503	253,845
57	10,166	728,987	2,430	4D16	ø8-90	10,332	24,786	245,202
58	10,152	728,771	2,430	4D16	ø8-90	10,319	24,785	245,143
59	12,157	689,349	2,856	4D16	ø8-90	12,321	29,571	253,560
60	12,157	689,350	2,856	4D16	ø8-90	12,321	29,571	253,560
61	10,152	728,770	2,430	4D16	ø8-90	10,318	24,784	245,140

BEAM TYPE b

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	25	4	1.6	0.8	187	3,200	2,400

Frame Element Force					Design											
						Left bars			Mid bars			Right bars				
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Stirrup (mm)	Mu (kg.cm)
42	153	246	4,393	14,660	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,517
43	71	237	0	12,977	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,459
44	153	246	4,393	14,660	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,517
45	153	246	4,393	14,660	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,517
46	71	237	0	12,977	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,459
47	153	246	4,393	14,660	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,517
48	304	1,449	1,960	2,124	D16	3D16	-	2D16	2D16	-	2D16	2D16	-	3D16	ø8-90	252,781
49	304	1,449	1,960	63,414	D16	2D16	-	3D16	2D16	-	2D16	3D16	-	2D16	ø8-90	252,781
50	2,043	504	0	63,414	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,537
51	2,043	504	0	221,238	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,537
52	304	1,449	1,960	221,238	D16	3D16	-	2D16	2D16	-	2D16	2D16	-	3D16	ø8-90	252,781
53	304	1,449	1,960	221,245	D16	2D16	-	3D16	2D16	-	2D16	3D16	-	2D16	ø8-90	252,781

BEAM TYPE c

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	30	4	1.2	0.8	187	2,400	2,400

Frame Element Force					Design											
						Left bars			Mid bars			Right bars				
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Stirrup (mm)	Mu (kg.cm)
						2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	569,583
18	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	745,144
19	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,203
20	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,202
21	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,372
22	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,377
23	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,437
24	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,437
25	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,343
26	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,343
27	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,191
28	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	570,175
29	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	569,619
30	0	639	0	15,318	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-70	569,574

BEAM TYPE [illegible]

Prototype

b (cm)	h (cm)	cover (cm)	dia main bar (cm)	dia stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	45	4	1.6	0.8	187	3,200	2,400

Frame element Force					Design											
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Left bars			Mid bars			Right bars			Stirrup (mm)	Mu (kg.cm)
						Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom		
10	997	4,981	29,106	682,910	D16	3D16	2ø12	2D16	2D16	2ø12	3D16	3D16	2ø12	4D16	ø8-120	231,850
11	1,092	6,022	11,253	962,319	D16	3D16	2ø12	2D16	2D16	2ø12	3D16	4D16	2ø12	6D16	ø8-120	231,830
12	1,092	6,022	11,252	962,320	D16	3D16	2ø12	2D16	2D16	2ø12	3D16	4D16	2ø12	6D16	ø8-120	231,817
13	997	4,981	29,106	682,914	D16	3D16	2ø12	2D16	2D16	2ø12	3D16	3D16	2ø12	4D16	ø8-120	231,807
14	997	4,967	29,106	682,908	D16	3D16	2ø12	4D16	2D16	2ø12	3D16	3D16	2ø12	2D16	ø8-120	231,801
15	1,092	6,007	11,253	962,319	D16	4D16	2ø12	6D16	2D16	2ø12	3D16	3D16	2ø12	2D16	ø8-120	231,797
16	1,092	6,007	11,252	962,320	D16	4D16	2ø12	6D16	2D16	2ø12	3D16	3D16	2ø12	2D16	ø8-120	231,795
17	997	4,967	29,106	682,911	D16	3D16	2ø12	4D16	2D16	2ø12	3D16	3D16	2ø12	2D16	ø8-120	231,795

BEAM TYPE [illegible]

Prototype

b (cm)	h (cm)	cover (cm)	dia main bar (cm)	dia stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	45	4	1.6	0.8	187	3,200	2,400

Frame element Force					Design											
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Left bars			Mid bars			Right bars			Stirrup (mm)	Mu (kg.cm)
						Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom		
1	119	2,006	19,290	133,895	D16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,210
2	98	1,640	0	116,803	D16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,225
3	119	2,006	19,289	133,895	D16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,210
7	119	2,006	19,291	95,356	D16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,210
8	98	1,640	0	116,801	D16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,225
9	119	2,006	19,289	133,895	D16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,210

COULOM type 2

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	20	4	1.6	0.8	187	3,200	2,400

Frame elemen Force				Design				
Member	Axial (kg)	Moment-2 (kg.cm)	Moment-3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mox (kg.cm)	Moy (kg.cm)
36	1,391	4	3,860	4D16	o8-70	1,391	138,131	139,131
37	1,891	3	21,825	4D16	o8-70	1,891	131,931	131,931

- Checking of Beam reinforcement bar & stress

On Beam No. F12

Positive Bending Moment	= 682,910	kgcm	
b (width)	= 25	cm	
h_t (height)	= 45	cm	
Concrete cover	= 4	cm	
Fc	= 225	kg/cm²	$\longrightarrow \bar{\sigma}'_b = 130$ kg/cm²
Fu	= 3,200	kg/cm²	$\longrightarrow \bar{\sigma}_a = 2,600$ kg/cm²
ns	= 14		

$$\phi_0 = \frac{\bar{\sigma}_a}{n\,\bar{\sigma}'_b} = \frac{2,600}{14 \times 130} = 1.43$$

a) For Positive BM, M = 962,320 kgcm

$b = 25$

$h_t = 45$; $d = 4 \longrightarrow h = h_t - d = 45 - 4 = 41$ cm

$$Ca = \frac{h}{\sqrt{\frac{nM}{b\sigma_s}}} = \frac{41}{\sqrt{\frac{14 \times 682,910}{25 \times 2600}}} = 3.22$$

$\delta = 0.6$ (required of minimum compression reinforcement bar)

$\longrightarrow \phi = 1.985 > \phi_0 = 1.43$ (OK)

$\phi' = 2.830$

$n\omega = 0.1071$

. Stresses

$\bar{\sigma}_a = 2,600$ kg/cm²

$\bar{\sigma}_b = \frac{\bar{\sigma}_a}{n\phi} = \frac{2,600}{14 \times 1.985} = 95.55$ kg/cm² $< \bar{\sigma}'_b = 130$ kg/cm² (OK)

$\sigma_a = \frac{\bar{\sigma}_a}{\phi'} = \frac{2,600}{2.83} = 918.72$ kg/cm² $< \sigma_a = 2,600$ kg/cm² (OK)

. Reinforcement bar

$A_{steel\ (tensile)} = \frac{\omega b h}{14} = 0.1071 \times 25 \times 41 = 7.84$ cm²

$A_{steel\ (compression)} = \delta \times A_{steel\ (tensile)}$

$= 0.6 \times 7.84$ cm² $= 4.704$ cm²

Used $A_{steel\ (tensile)}$ = 4 D 16 = 8.042 cm² (OK)

Used $A_{steel\ (compression)}$ = 3 D 16 = 6.03 cm² (OK)

- Checking of Column reinforcement bar & stress

Random sampling
On Column No. F32

Positive Bending Moment	= 264,916 kgcm
b (width)	= 25 cm
h_t (height)	= 30 cm
Concrete cover	= 4 cm
$h = h_t - d$	= 30 - 4 = 26 cm
Fc	= 225 kg/cm² ⟶ $\overline{\sigma}'_b$ = 130 kg/cm²
Fu	= 3,200 kg/cm² ⟶ $\overline{\sigma}_a$ = 2,600 kg/cm²
ns	= 14

$$\phi_0 = \frac{\overline{\sigma}_a}{n\,\overline{\sigma}'_b} = \frac{2,600}{14 \times 130} = 1.43$$

a) For Positive BM M = 726,866 kgcm

$$Ca = \frac{h}{\sqrt{\frac{nM}{b\sigma_s}}} = \frac{26}{\sqrt{\frac{14 \times 264,916}{25 \times 2600}}} = 3.44$$

$\delta = 1$ (for symetrical reinforcement)

⟶ $\phi = 2.279 > \phi_0 = 1.43$ (OK)

$\phi' = 3.390$

$n\omega = 0.09492$

. Stresses

$\overline{\sigma}_a = 2,600$ kg/cm²

$$\overline{\sigma}_b = \frac{\overline{\sigma}_a}{n\,\phi} = \frac{2,600}{14 \times 2.279} = 81.49 \text{ kg/cm}^2 < \sigma'_b = 130 \text{ kg/cm}^2$$

$$\sigma_a = \frac{\overline{\sigma}_a}{\phi'} = \frac{2,600}{3.390} = 760.96 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2$$

. Reinforcement

$$A = \omega b h = \frac{0.09492}{14} \times 25 \times 26 = 4.4 \text{ cm}^2$$

Hence applied :

A_{steel} = 8 D 16

= 16.08 cm²

$= \frac{16.08}{30 \times 25} \times 100\ \%\ A_{concrete}$

$= 0.02\ \%\ A_{concrete}$ (OK)

DESIGN OF FOOTING

All of footing design are represented by support reaction of joint no.1&3 or column no.6 (the biggest)for loading Combination 1, the axial force :

N = 9.916 E3 kg
Mx = 2.092 E4 kg
Mz = 4.997 E4 kg
Shear x, = 428 kg
Shear z, = 303 kg

- Soil stress beneath footing :

$$\sigma = \frac{N}{A} \pm \frac{Mx}{Wx} \pm \frac{Mz}{Wz}$$

$$\sigma\ max = \frac{9.916\times10^3}{(150)^2} + \frac{2.0923\times10^4}{1/6\times150\times150^2} + \frac{4.997\times10^4}{1/6\times150\times150^2}$$

$= 0.44 + 0.04 + 0.09$

$= 0.57\ kg/cm^2 < \sigma_{all} = 1,0\ kg/cm^2$ (ok)

$\sigma\ min = 0.44 - 0.04 - 0.09$

$= 0.31\ kg/cm^2$

When earthquake occur (loading Combination 3.,Support reaction of joint 3 or column no.7 is :

N = 9.533 E4 kg
Mx = 6.3578 E4 kgcm
Mz = 19.1868 E4 kgcm
Shear x = 477 kg
Shear z = 1,1121 kg

The soil stress beneath footing is

$$\sigma\ max = \frac{9.533\times10^3}{(150)^2} + \frac{6.3578\times10^4}{1/6\times150\times150^2} + \frac{19.1868\times10^5}{1/6\times150\times150^2}$$

$= 0.42 + 0.11 + 0.34$

$= 0.87\ kg/cm^2 < 1.5 \times \sigma_{all} = 1.5\ kg/cm^2$ (ok)

$\sigma\ min = 0.42 - 0.11 - 0.34$

$-0.03\ kg/cm^2$

Note :

$\sigma = 1\ kg/cm^2$

= Soil compression stress was given JICA Study Team

All of footing concrete reinforcement is calculated by "n" method (Indonesian Code)

Mz = [illegible].177 E4 kgcm

Concrete : $fc = 225\ kg/cm^2$ ------- $\sigma'b = 130\ kg/cm^2$

Steel bar : $fy = 3200\ kg/cm^2$ ------- $\sigma'a = 2600\ kg/cm^2$

ns = 14

$\phi_0 = \frac{\sigma_E}{\sigma_b n} = \frac{2,600}{130x14} = 1.43$

Footing slab thich ht = 25 cm ; b = 150 cm
Cocrete cover d = 5 cm
h = ht - d

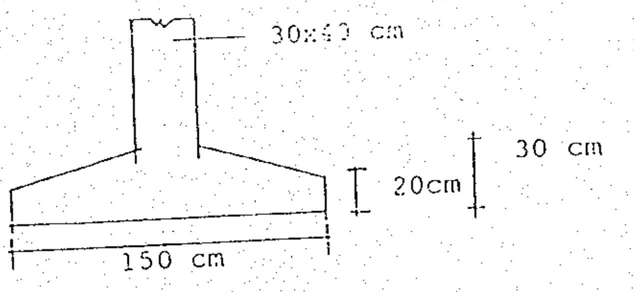
$$Ca = \frac{h}{\sqrt{\frac{nM}{b\sigma_a}}} = \frac{20}{\sqrt{\frac{14x49,970}{150x2600}}} = 14.93$$

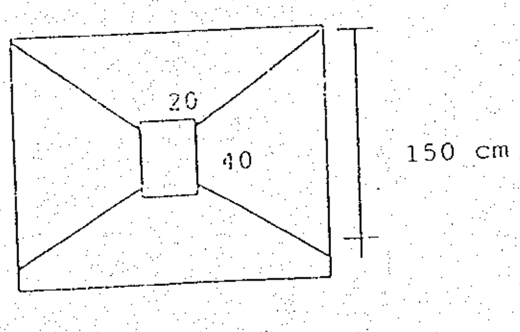
for δ = 1
ϕ = 8.091 > ϕ_0 = 1.43 (ok)
ϕ' = 89 ; 100nω = 0.69

A = ωbh
$= \frac{0.69}{100} x 150 x 20 = 20,7 \ cm^2$

Astell = D16 - 15 cm(two way) ≈ 11 x 2.01 = 22.12 cm^2 (ok)

Mx = 2.0993E4 kgcm
Astell = D16 - 15 cm can be adobted





Support reaction of joint no. 2, 4, 6, 7, 9 and 11 due to applied loading column no.2, 4, 5, 6, 7 and 9, each supported by their continous wet masonry foundation with 6 m length.
For example : column no.2 at joint no. 2 (loading Combination 1)

N = 1.7025 E4 kg
Mx = 4.3720 E4 kgcm
Mz = 1.09209 E5 kgcm
Shear x = 387.5 kg
Shear z = 0
brickwall unit weight = 875 kg/m' (3m height)

- Soil stress beneth foundation

$$\sigma \text{ max} = \frac{1.7025 \times 10^4}{100 \times (750-750)} + \frac{4.3720 \times 10^4}{1/6 \times 600 \times 100^2} + \frac{1.09209 \times 10^5}{1/6 \times 100 \times 600^2} + \frac{875}{100 \times 100}$$

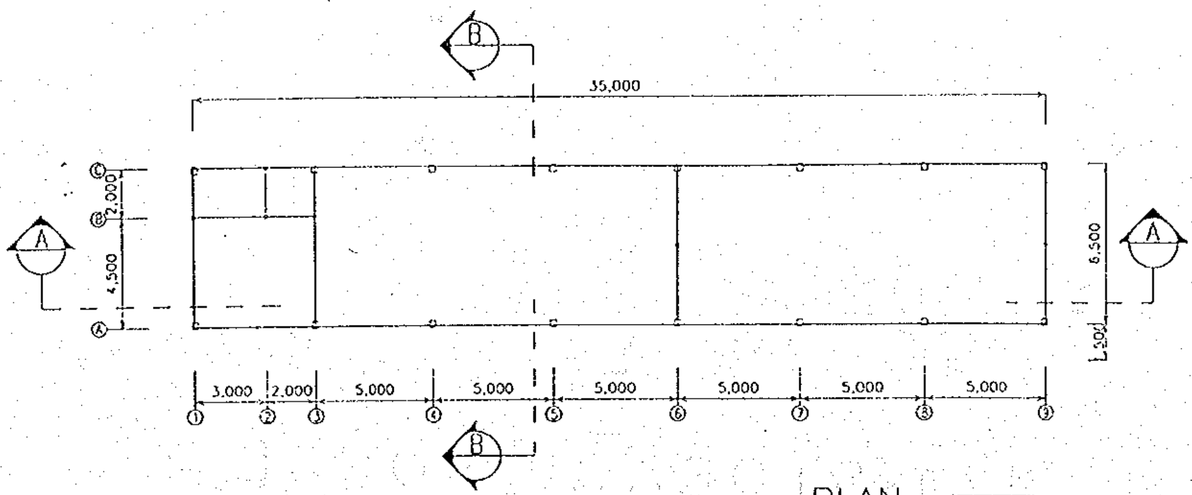
$$= 0.28 + 0.04 + 0.02$$

$$= 0.34 \text{ kg/cm}^2 < \sigma \text{ all} = 1{,}0 \text{ kg/cm}^2 \text{ (ok)}$$

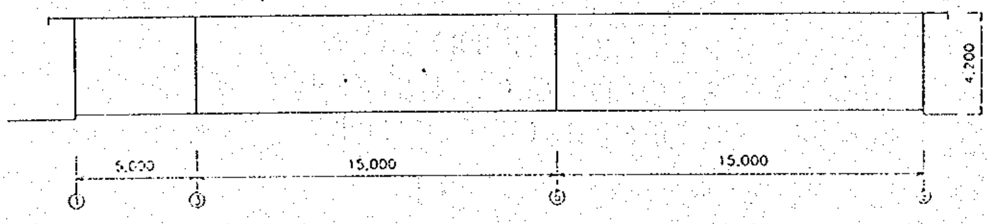
4.7.4. STORAGE HOUSE 2
STRUCTURE CALCULATION

1 STRUCTURE
2 DESIGN CONDITION
3 LOADING CONDITION
4 DESIGN OF FOOTING

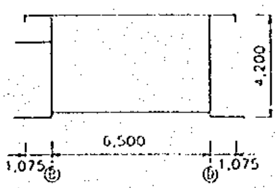
1. STRUCTURE



PLAN



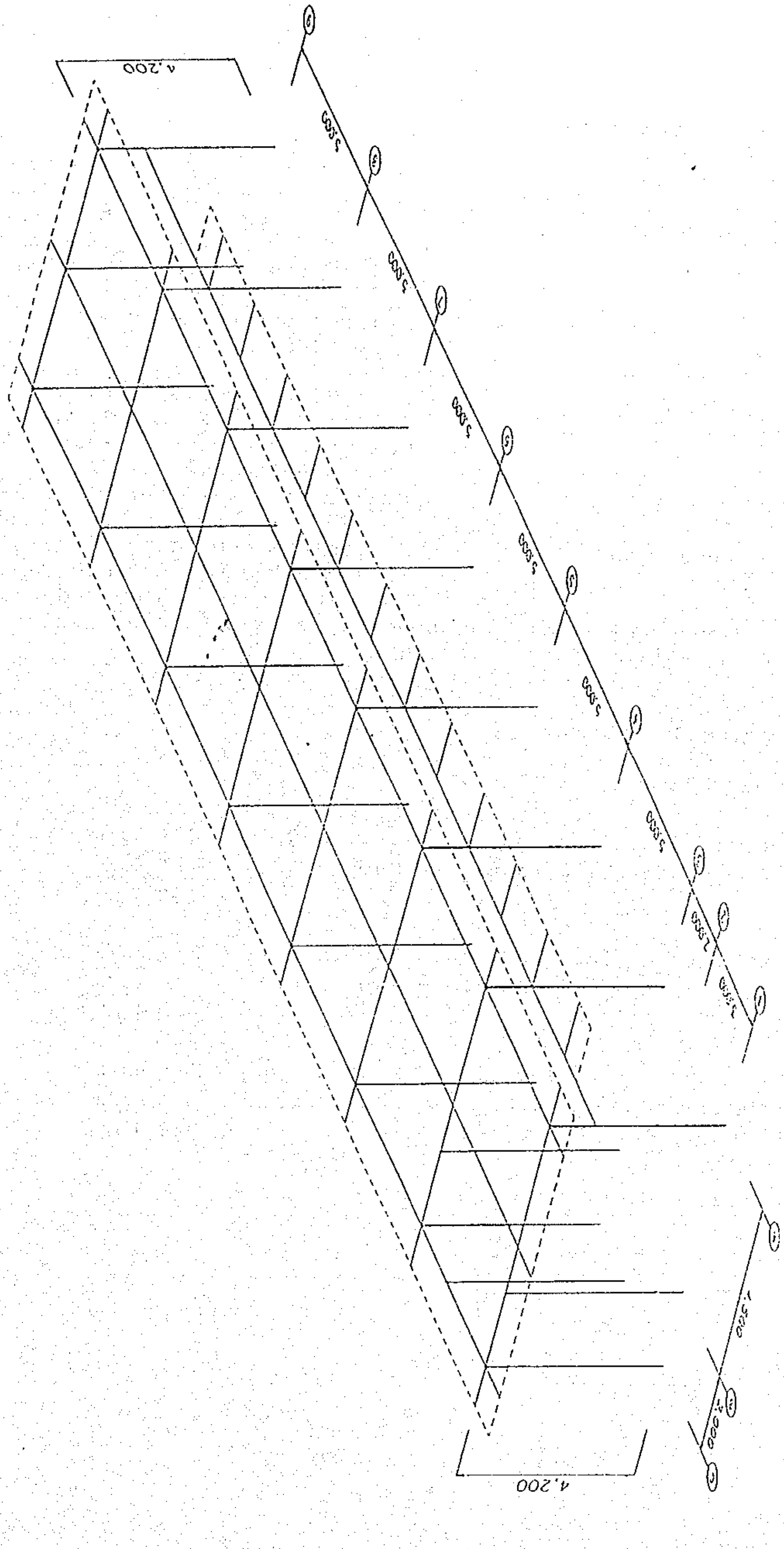
SECTION I-I



SECTION II-II

STORAGE II

SIMONGAN WIER MANAGEMENT COMPLEX



ISOMETRY
STORAGE II
SIMONGAN WEIR MANAGEMENT COMPLEX

2. Design Condition

a) Roof slab : - concrette, thickness = 0,12 mm
- main bar diameter = 10 mm

Tie beam : - Fc = 225 kg/cm2 on cubic sample, or
Fc = 187 kg/cm2 on cylinder sample
- main bar diameter = 16 mm
Fy = 3200 kg/cm2
- Stirrup bar diameter = 8,0 mm
Fv = 2400 kg/cm2

Column : - Fc = 225 kg/cm2 on cubic sample, or
- Fc = 187 kg/cm2 on cylinder sample
- Main bar diameter = 16 mm
Fy = 3200 kg/cm2
- Stirrup bar diameter = 0,8 mm
- Fy= 2400 kg/cm2

Foundation : - Foot plate concrette
Fc = 225 kg/cm2 on cubic sample,or
Fc = 187 kg/cm2 on cylinder sample

b) Structural model : space (xyz axis) frame, linear elastic

c) Analysis method : static

3. Loading Condition

a) Dead Load :

- Concrette slab roof = 2400 x 0,12 = 288 kg/m^2
- Water-stop slab roof = 2400 x 0,03 = 72 kg/m^2

360 kg/m^2

- Concrette slab console = 2400 x 0,12 = 288 kg/m^2
- Water-stop slab console = 2400 x 0,03 = 72 kg/m^2

360 kg/m^2

- Concrette slab leufel = 2400 x 0,12 = 288 kg/m^2
- Water-stop slab leufel = 2400 x 0,03 = 72 kg/m^2

360 kg/m^2

- Rolling door, say = 50 kg/m^2

b) Live load :

- Living load, say = 125 kg/m2

BEAM TYPE 5

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	25	4	1.6	0.8	187	3,200	2,400

Frame element Force					Design												
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Left bars			Mid bars			Right bars			Stirrup (mm)	Mu (kg.cm)
						Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom		
163	1,362	475	29	22,342	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,238
164	1,425	470	1,986	54,664	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,268
165	1,422	468	243	53,913	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,267
166	1,430	468	136	53,810	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,271
167	1,509	468	161	54,100	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,309
168	1,567	469	250	54,569	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,345
169	1,606	470	2,017	53,769	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,354
170	1,470	474	3	55,901	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	181,291
171	582	377	121	35,455	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,792
172	261	361	17	29,959	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,596
173	251	362	7	30,752	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,574
174	218	361	87	30,173	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,552
175	268	361	107	29,792	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,565
176	295	360	28	29,803	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,606
177	611	377	180	27,094	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,810
178	361	441	13	46,753	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,449
179	1,937	430	12	51,521	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,535
180	1,612	373	23	33,708	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,547
181	1,573	360	71	30,700	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,553
182	1,611	373	47	33,721	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,547
183	1,940	431	6	51,710	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,537
184	367	441	98	46,744	D16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	ø8-90	180,431

BEAM TYPE c

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	45	4	1.6	0.8	187	3,200	2,400

	Frame elemen Force				Design											
						Left bars			Mid bars			Right bars				
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Stirrup (mm)	Mu (kg.cm)
1	857	4,135	25,606	251,369	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	569,583
2	622	1,491	21,210	527,579	D16	2D16	2o12	3D16	2D16	2o12	3D16	4D16	2o12	3D16	o8-120	745,144
3	5,584	4,979	18,375	570,933	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,203
4	5,420	4,672	21,049	496,953	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,202
5	3,982	4,579	19,457	435,512	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,372
6	3,917	4,949	19,492	525,768	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,377
7	3,443	4,761	21,055	493,500	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,437
8	3,443	4,794	16,012	500,547	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,437
9	3,972	5,037	25,513	534,030	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,343
10	4,034	4,693	20,159	449,256	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,343
11	5,470	4,770	23,320	509,680	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,191
12	5,634	5,065	20,357	585,499	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,175
13	635	5,389	22,108	542,931	D16	4D16	2o12	3D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	569,619
14	872	4,209	31,097	467,158	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	569,574
29	436	4,354	25,970	465,198	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,553
30	409	5,931	16,912	616,380	D16	2D16	2o12	3D16	2D16	2o12	3D16	4D16	2o12	2D16	o8-120	745,602
31	283	5,381	19,060	589,159	D16	4D16	2o12	3D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,619
32	267	5,119	16,823	524,016	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,623
33	266	5,207	19,777	525,565	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,625
34	260	5,255	16,869	537,525	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,627
35	250	5,216	19,994	535,651	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,631
36	275	5,254	14,991	544,174	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,631
37	276	5,341	24,875	545,003	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,622
38	292	5,322	20,566	539,239	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,620
39	425	5,221	19,153	537,507	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,620
40	451	5,487	21,404	603,820	D16	2D16	2o12	3D16	2D16	2o12	3D16	4D16	2o12	2D16	o8-120	745,620
41	877	6,067	18,016	632,803	D16	4D16	2o12	3D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-120	570,476
42	452	4,422	31,821	481,450	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	570,546
43	877	4,309	7,786	571,862	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,508

Member	Frame elemen Force				Design											
	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Left bars Top	Left bars Middle	Left bars Bottom	Mid bars Top	Mid bars Middle	Mid bars Bottom	Right bars Top	Right bars Middle	Right bars Bottom	Stirrup (mm)	Mu (kg.cm)
44	22	3,471	1,838	496,621	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,750
45	876	4,843	198	676,059	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,505
46	15	3,540	2,099	506,473	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,749
47	870	4,725	3,964	657,854	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,505
48	10	3,504	1,310	504,105	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,748
49	875	4,768	736	664,389	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,504
50	21	3,517	1,402	506,569	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,748
51	914	4,908	5,953	698,666	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,495
52	21	3,704	105	561,958	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,748
53	950	5,000	3,829	726,325	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,486
54	17	3,745	2,151	568,896	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,748
55	967	5,118	259	745,260	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,483
56	24	3,674	3,087	559,063	D16	3D16	2o12	2D16	2D16	2o12	3D16	2D16	2o12	3D16	o8-150	570,749
57	930	4,430	13,583	605,761	D16	3D16	2o12	2D16	2D16	2o12	3D16	3D16	2o12	4D16	o8-120	745,496
58	852	4,254	5,456	571,257	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	745,509
59	21	3,440	6,853	496,247	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,749
60	880	4,820	572	676,707	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,504
61	24	3,500	890	505,570	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,748
62	880	4,723	2,281	658,772	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,505
63	25	3,493	253	504,179	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,748
64	883	4,742	7	664,451	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,505
65	26	3,496	1,431	506,402	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,748
66	923	4,883	5,082	696,709	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,505
67	26	3,693	1,683	562,006	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,748
68	960	5,000	2,046	727,263	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,505
69	25	3,707	871	567,973	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,748
70	970	5,104	589	745,962	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,505
71	23	3,645	8,171	555,444	D16	2D16	2o12	3D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-150	570,748
72	914	4,388	10,891	605,221	D16	3D16	2o12	4D16	2D16	2o12	3D16	3D16	2o12	2D16	o8-120	745,505

BEAM TYPE f

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	20	4	1.2	0.8	187	2,400	2,400

Member	Frame elemen Force				Design											
	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Left bars			Mid bars			Right bars			Stirrup (mm)	Mu (kg.cm)
						Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom		
185	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
186	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
187	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
188	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
189	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
190	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
191	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
192	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
193	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
194	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
195	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446
196	0	173	0	12,960	ø12	2ø12	-	2ø12	2ø12	-	2ø12	2ø12	-	2ø12	ø8-75	87,446

BEAM TYPE 9

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	20	4	1.2	0.8	107	2,400	2,400

Member	Frame elemen Force: Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Design: Main bar (mm)	Left bars: Top	Left bars: Middle	Left bars: Bottom	Mid bars: Top	Mid bars: Middle	Mid bars: Bottom	Right bars: Top	Right bars: Middle	Right bars: Bottom	Stirrup (mm)	Mu (kg.cm)
73	20	829	1,101	69,338	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,441
74	0	636	3,497	58,320	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,448
75	4	1,475	1,659	13,104	ø12	4ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	154,168
76	5	823	795	78,057	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,446
77	5	1,304	1,289	11,535	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077
78	2	736	856	69,349	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,446
79	3	1,377	621	121,894	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077
80	0	750	321	70,839	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
81	3	1,379	228	122,168	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	121,077
82	2	733	1,217	398,869	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
83	5	1,304	1,171	115,320	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077
84	5	822	804	78,234	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,446
85	4	1,480	1,580	131,382	ø12	4ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	154,168
86	0	635	3,276	58,499	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,448
87	20	824	1,853	68,571	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,444
88	3	836	2,745	69,895	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,446
89	1	598	4,052	54,743	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,446
90	2	1,535	47	57,473	ø12	4ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	154,168
91	0	753	1,171	71,721	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
92	2	1,362	295	120,779	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	121,077
93	0	721	114	68,138	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
94	2	1,386	70	122,719	ø12	4ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	154,168
95	1	726	306	68,580	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
96	2	1,389	818	123,034	ø12	4ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	154,166
97	0	722	464	68,617	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
98	2	1,363	200	120,738	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	121,077
99	0	754	1,195	72,049	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
100	2	1,539	148	136,719	ø12	4ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-60	154,168
101	1	596	3,845	54,951	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
102	2	832	3,629	69,093	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,444
103	3	1,118	4,606	997,854	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077
104	3	644	303	56,568	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
105	0	1,115	4,293	99,694	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077
106	4	1,125	3,613	100,094	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077
107	3	630	289	55,868	ø12	2ø12	-	2ø2	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	87,445
108	0	1,123	3,503	100,086	ø12	3ø12	-	3ø12	2ø12	-	2ø2	2ø12	-	2ø2	ø8-75	121,077

BEAM LEUPEL

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
10	40	4	1.2	0.6	187	2,400	2,400

	Frame elemen Force				Design											
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main bar (mm)	Left bars Top	Left bars Middle	Left bars Bottom	Mid bars Top	Mid bars Middle	Mid bars Bottom	Right bars Top	Right bars Middle	Right bars Bottom	Stirrup (mm)	Mu (kg.cm)
197	135	496	1,980	44,412	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,592
198	292	647	5,725	40,052	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,589
199	445	497	4,056	41,711	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,587
200	551	460	3,274	32,112	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,585
201	614	512	3,769	30,822	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,585
202	653	532	4,169	37,011	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,584
203	670	514	4,167	36,390	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,584
204	671	517	3,815	37,377	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,584
205	654	531	4,560	37,149	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,584
206	616	511	3,743	31,353	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,585
207	552	462	3,399	32,528	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,585
208	447	496	4,192	42,332	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,587
209	294	652	5,766	40,754	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,589
210	136	493	2,266	44,833	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,592
211	139	506	2,259	47,028	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594
212	37	677	5,973	44,621	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,593
213	58	527	4,827	44,574	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,592
214	75	501	3,698	37,295	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,591
215	86	530	4,193	36,999	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,591
216	93	529	4,226	37,380	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,591
217	96	525	4,289	37,310	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,590
218	97	529	3,942	38,344	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,590
219	94	529	4,622	37,527	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,591
220	88	529	4,176	37,547	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,591
221	76	502	3,815	37,747	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,592
222	58	525	4,960	45,114	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,593
223	67	683	6,017	45,262	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594
224	13	501	2,562	47,561	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594
225	16	787	2,631	97,702	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594
226	5	785	2,465	98,095	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594
227	17	794	3,045	10,087	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594
228	4	792	2,858	10,116	o12	2012	2012	2012	2012	2012	2012	2012	2012	2012	o8-150	199,594

COULOM type 1

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
30	30	4	1.6	0.8	187	3,200	2,400

Frame elemen Force				Design				
Member	Axial (kg)	Moment-2 (kg.cm)	Moment-3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mux (kg.cm)	Muy (kg.cm)
123	10,701	263,094	158,269	8D16	ø8-120	10,684	470,339	470,339
124	16,870	260,228	577,962	8D16	ø8-120	16,711	469,374	469,734
125	15,591	276,570	940,581	8D16	ø8-120	15,936	38,245	471,477
126	15,166	277,458	336,236	8D16	ø8-120	16,006	38,415	471,311
127	16,429	289,302	392,084	8D16	ø8-120	16,269	39,045	470,708
128	16,079	300,409	94,436	8D16	ø8-120	16,423	39,415	470,362
129	17,382	302,804	583,290	8D16	ø8-120	100,891	74,595	303,856
130	10,899	273,947	166,158	12D16	ø8-120	10,880	594,158	594,158
131	12,101	148,688	481,843	8D16	ø8-120	12,517	31,381	472,636
132	35,033	146,349	371,539	8D16	ø8-120	19,861	47,667	483,114
133	49,161	143,943	11,625	8D16	ø8-120	19,107	45,857	479,762
134	49,346	144,432	10,451	8D16	ø8-120	19,157	46,002	480,031
135	49,607	151,339	10,824	8D16	ø8-120	19,429	46,631	481,199
136	49,652	158,189	11,430	8D16	ø8-120	19,600	47,040	481,956
137	35,454	163,823	375,320	8D16	ø8-120	20,283	48,681	484,979
138	12,214	159,654	445,456	8D16	ø8-120	12,641	30,338	473,496
139	13,393	555,303	535,467	8D16	ø8-120	13,724	32,938	473,159
140	38,589	599,825	82,961	8D16	ø8-120	92,146	221,149	251,111
141	50,668	60,618	32,667	8D16	ø8-120	92,146	221,149	260,641
142	50,895	61,246	8,792	8D16	ø8-120	92,146	221,149	261,743
143	51,158	65,356	8,949	8D16	ø8-120	20,989	50,396	488,112
144	51,158	69,062	3,280	8D16	ø8-120	21,166	50,799	48,844
145	37,010	68,954	84130	8D16	ø8-120	21,850	52,438	491,806
146	13,505	60,590	53,986	8D16	ø8-120	13,834	33,202	473,281
147	11,623	24,749	135,931	8D16	ø8-120	11,650	471,661	471,661
148	17,670	265,174	27,839	8D16	ø8-120	18,712	44,909	477,994
149	17,474	267,625	3,534	8D16	ø8-120	17,472	41,933	472,404
150	17,662	268,736	1,937	8D16	ø8-120	17,640	42,334	473,163
151	17,930	280,813	5,093	8D16	ø8-120	17,907	42,976	474,371
152	17,970	292,593	3.577	8D16	ø8-120	17,952	43,084	474,574
153	19,261	291,219	29,590	8D16	ø8-120	19,242	46,180	480,363
154	11,828	262,858	140,773	8D16	ø8-120	11,854	471,911	471,911
155	12,837	50,159	192,025	8D16	ø8-120	12,864	30,872	473,841
156	20,277	52,899	151,291	8D16	ø8-120	92,146	221,149	247,654
157	19,040	52,020	4,327	8D16	ø8-120	92,146	221,149	262,556
158	19,224	52,231	2,556	8D16	ø8-120	92,145	221,149	261,520
159	19,492	56,473	3,999	8D16	ø8-120	19,469	46,725	481,374
160	19,535	50,883	15,935	8D16	ø8-120	19,519	46,845	481,595
161	20,806	62,746	15,934	8D16	ø8-120	20,793	49,902	487,212
162	13,043	58,354	2,056	8D16	ø8-120	13,064	31,352	472,549

Checking of Beam reinforcement bar & stress

Random sample :
On Beam No. F70

Positive Bending Moment	= 745,962	kgcm	
b (width)	= 25	cm	
h_t (height)	= 45	cm	
Concrete cover	= 4	cm	
Fc	= 225	kg/cm^2	$\longrightarrow \bar{\sigma}'_b = 130\ kg/cm^2$
Fu	= 3,200	kg/cm^2	$\longrightarrow \bar{\sigma}_a = 2,600\ kg/cm^2$
ns	= 14		

$$\phi_0 = \frac{\bar{\sigma}_a}{n\,\bar{\sigma}'_b} = \frac{2,600}{14 \times 130} = 1.43$$

a) For Positive BM, M = 745,962 kgcm

$b = 25$
$h_t = 45$; $d = 4 \longrightarrow h = h_t - d = 45 - 4 = 41$ cm

$$Ca = \frac{h}{\sqrt{\frac{nM}{b\sigma_a}}} = \frac{41}{\sqrt{\frac{14 \times 745,962}{25 \times 2600}}} = 3.23$$

$\delta = 0.6$ (required of minimum compression reinforcement bar)
$\longrightarrow \phi = 1.985 > \phi_0 = 1.43$ (OK)
$\phi' = 2.820$
$n\omega = 0.1071$

. Stresses

$\bar{\sigma}_a = 2,600\ kg/cm^2$

$$\bar{\sigma}_b = \frac{\bar{\sigma}_a}{n\phi} = \frac{2,600}{14 \times 1.985} = 93.56\ kg/cm^2 < \bar{\sigma}'_b = 130\ kg/cm^2 \text{ (OK)}$$

$$\sigma_a = \frac{\bar{\sigma}_a}{\phi'} = \frac{2,600}{2.820} = 921.99\ kg/cm^2 < \sigma_a = 2,600\ kg/cm^2 \text{ (OK)}$$

. Reinforcement bar

$$A_{steel\ (tensile)} = \frac{\omega b h}{14} = 0.1071 \times 25 \times 41 = 7.84\ cm^2$$

$$A_{steel\ (compression)} = \delta \times A_{steel\ (tensile)}$$

$$= 0.6 \times 7.84\ cm^2 = 4.704\ cm^2$$

Used $A_{steel\ (tensile)}$ = 4 D 16 = 8.04 cm^2 (OK)

Used $A_{steel\ (compression)}$ = 3 D 16 = 6.03 cm^2 (OK)

- Checking of Column reinforcement bar & stress

On Column No. F139

Positive Bending Moment	= 555,303 kgcm	
b (width)	= 30 cm	
h_t (height)	= 30 cm	
Concrete cover	= 4 cm	
$h = h_t - d$	= 30 - 4 = 26 cm	
Fc	= 225 kg/cm^2	⟶ $\overline{\sigma}'_b$ = 130 kg/cm^2
Fu	= 3,200 kg/cm^2	⟶ $\overline{\sigma}_a$ = 2,600 kg/cm^2
ns	= 14	

$$\phi_0 = \frac{\overline{\sigma}_a}{n\,\overline{\sigma}'_b} = \frac{2,600}{14 \times 130} = 1.43$$

a) For Positive BM M = 178,266 kgcm

$$Ca = \frac{h}{\sqrt{\frac{nM}{b\sigma_a}}} = \frac{26}{\sqrt{\frac{14 \times 555,303}{30 \times 2600}}} = 2.61$$

$\delta = 1$ (for symetrical reinforcement)

⟶ ϕ = 1.778 > ϕ_0 = 1.43 (OK)

ϕ' = 2.462

$n\omega$ = 0.1705

. Stresses

$\overline{\sigma}_a$ = 2,600 kg/cm^2

$$\overline{\sigma}_b = \frac{\overline{\sigma}_a}{n\,\phi} = \frac{2,600}{14 \times 1.778} = 104.45 \text{ kg/cm}^2 < \sigma'_b = 130 \text{ kg/cm}^2$$

$$\sigma_a = \frac{\overline{\sigma}_a}{\phi'} = \frac{2,600}{2.462} = 1056.05 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2$$

. Reinforcement

$$A = \omega bh = \frac{0.1705}{14} \times 30 \times 26 = 9.5 \text{ cm}^2$$

Hence applied :

A_{steel} = 8 D 16

= 16.08 cm^2

$= \frac{16.08}{30 \times 30} \times 100$ % $A_{concrete}$

= 1.79 % $A_{concrete}$ (OK)

4 DESIGN OF FOOTING

All of footing design are represented by support reaction of joint no.1&3 or column no.6 (the biggest) for loading Combination 1, the axial force :

N	= 9.916 E3 kg
Mx	= 2.092 E4 kg
Mz	= 4.997 E4 kg
Shear x	= 428 kg
Shear z	= 303 kg

- Soil stress beneath footing :

$$\sigma = \frac{N}{A} \pm \frac{Mx}{Wx} \pm \frac{Mz}{Wz}$$

$$\sigma\ max = \frac{9.916x10^3}{(150)^2} + \frac{2.0923X10^4}{1/6x150x150^2} + \frac{4.997x10^4}{1/6x150x150^2}$$

$$= 0.44 + 0.04 + 0.09$$

$$= 0.57\ kg/cm^2 < \sigma'all = 1,0\ kg/cm^2\ (ok)$$

$$\sigma\ min = 0.44 - 0.04 - 0.09$$

$$= 0.31\ kg/cm^2$$

When earthquake occur (loading Combination 3), Support reaction of joint 3 or column no.3 is :

N	= 9.533 E4 kg
Mx	= 6.3578 E4 kgcm
Mz	= 19.1868 E4 kgcm
Shear x	= 477 kg
Shear z	= 1,1121 kg

then soil stress beneth footing is

$$\sigma\ max = \frac{9.533x10^3}{(150)^2} + \frac{6.3578x10^4}{1/6x150x150^2} + \frac{19.1868x10^5}{1/6x150x150^2}$$

$$= 0.42 + 0.11 + 0.34$$

$$= 0.87\ kg/cm^2 < 1.5 \times \sigma_{all} = 1.5\ kg/cm^2\ (ok)$$

$$\sigma\ min = 0.42 - 0.11 - 0.34$$

$$= -0.03\ kg/cm$$

Note :

σ = 1 kg/cm[illegible]
= Soil compression stress was given JICA Study Team

All of footing concrete reinforcement is calculated by "n" method (Indonesian Code)

Mz = 8.177 E4 kgcm
Concrete : fc = 225 kg/cm^2 ——— σ'b = 130 kg/cm^2
Steel bar : fy = 3200 kg/cm^2 ——— σ'a = 2600 kg/cm^2

ns = 14

$\phi_0 = \dfrac{\sigma_b}{\sigma_b n} = \dfrac{2,600}{130 \times 14} = 1.43$

Footing slab thich ht = 25 cm ; b = 150 cm
Cocrete cover d = 5 cm
h = ht - d

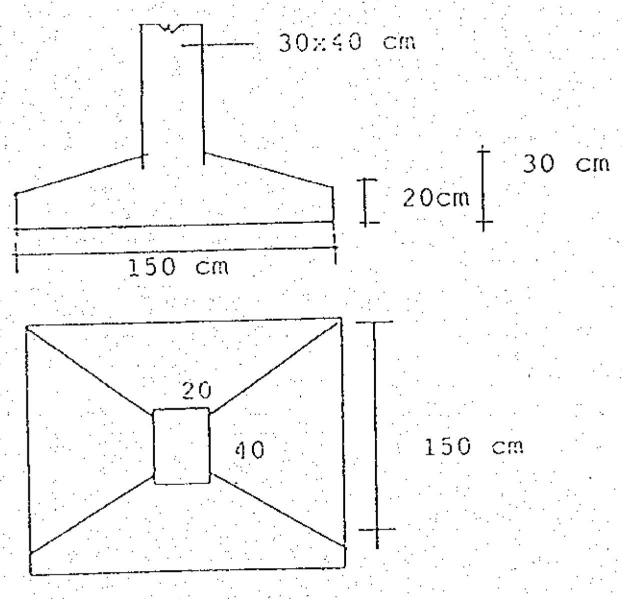
$Ca = \dfrac{h}{\sqrt{\dfrac{nM}{b\sigma_a}}} = \dfrac{20}{\sqrt{\dfrac{14 \times 49{,}970}{150 \times 2600}}} = 14.93$

for - δ = 1
$\phi = 8.091 > \phi_0 = 1.43$ (ok)
$\phi' = 89$; $100n\omega = 0.69$

$A = \omega bh$
$= \dfrac{0.69}{100} \times 150 \times 20 = 20{,}7\ cm^2$

Astell = D16 - 15 cm(two way) ≈ 11 x 2.01 = 22.12 cm^2 (ok)

Mx = 2.0993E4 kgcm
Astell = D16 - 15 cm can be adobted



Support reaction of joint no. 2, 4, 6, 7, 9 and 11 due to applied loading column no.2, 4, 5, 6, 7 and 9, each supported by their continous wet masonry foundation with 6 m length.
For example : column no.2 at joint no. 2 (loading Combination 1)

N = 1.7025 E4 kg
Mx = 4.3720 E4 kgcm
Mz = 1.09209 E5 kgcm
Shear x = 387.5 kg
Shear z = 0
brickwall unit weight = 875 kg/m' (3m height)

- Soil stress beneth foundation

$$\sigma\ max = \frac{1.7025x10^4}{100x(750-750)} + \frac{4.3720x10^4}{1/6x600x100^2} + \frac{1.09209x10^5}{1/6x100x600^2} + \frac{875}{100x100}$$

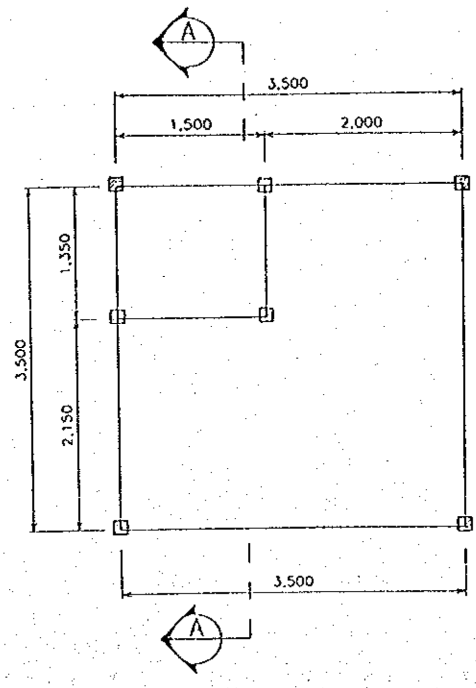
$$= 0.28 + 0.04 + 0.02$$

$$= 0.34\ kg/cm^2 < \sigma\ all = 1,0\ kg/cm^2\ (ok)$$

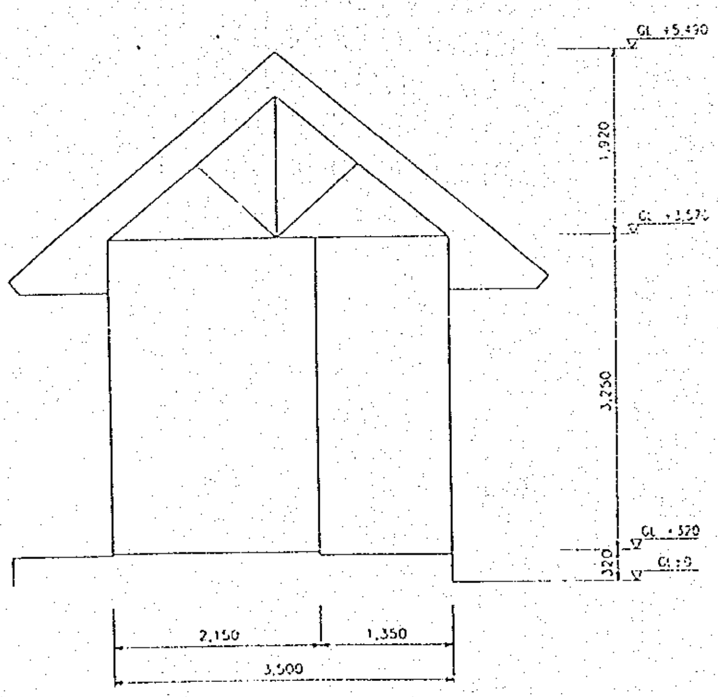
4.7.5. GUARD HOUSE STRUCTURE CALCULATION

1 STRUCTURE
2 DESIGN CONDITION
3 LOADING CONDITION
4 DESIGN OF PURLIN
5 DESIGN OF ROOF TRUSS

1. STRUCTURE



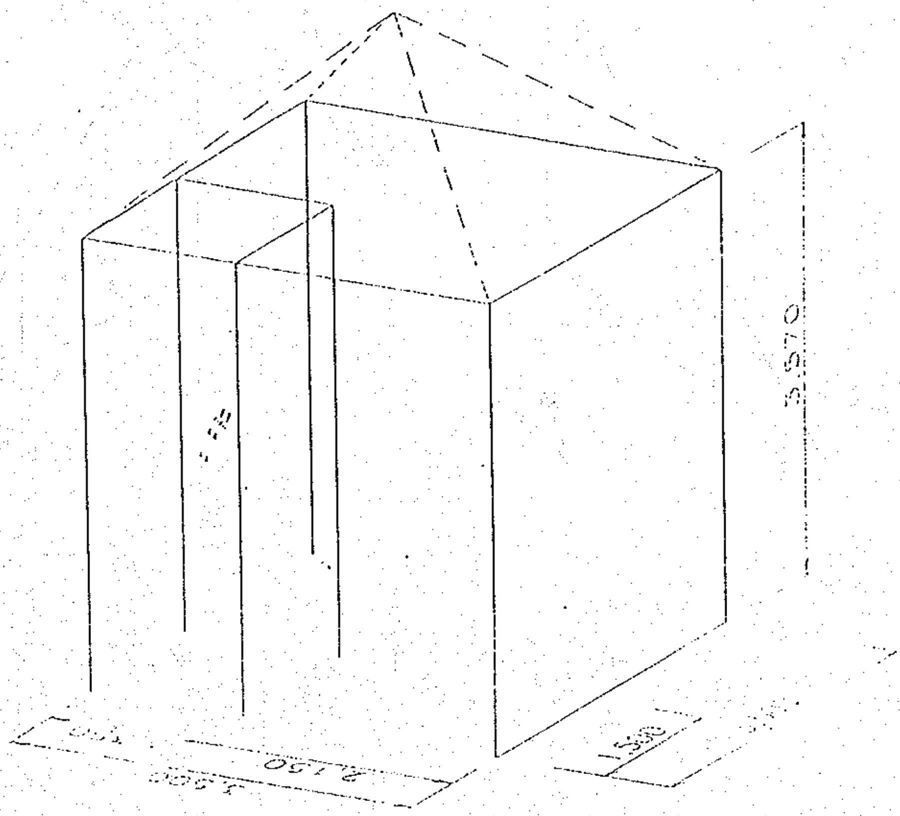
PLAN



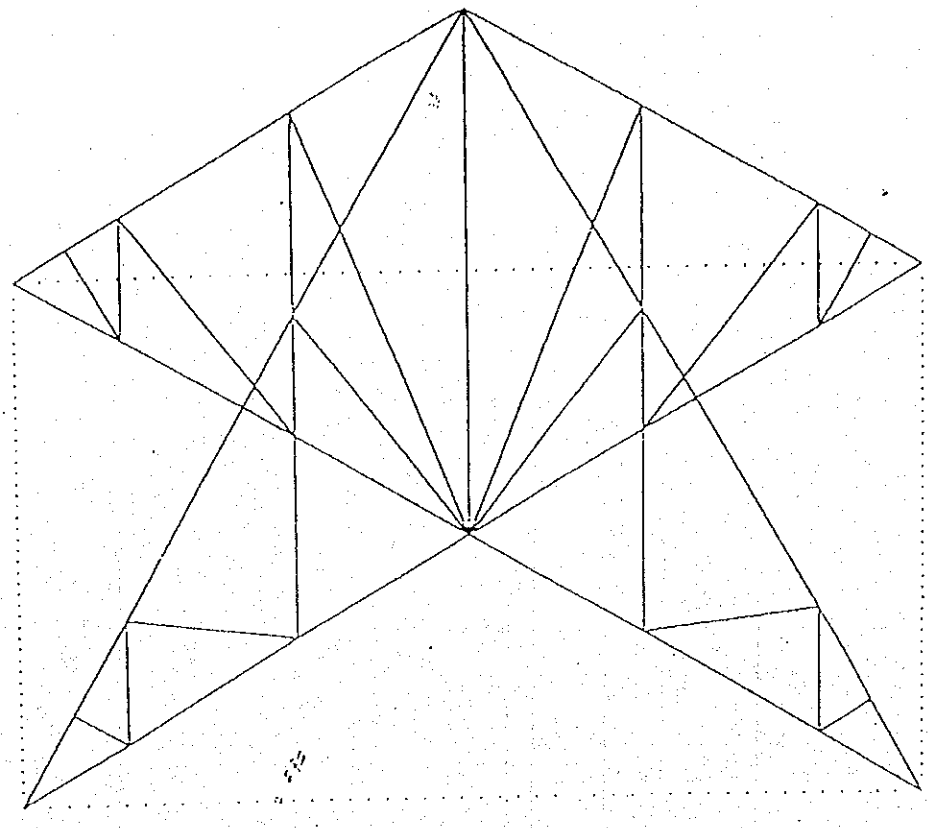
SECTION A–A

GUARD HOUSE

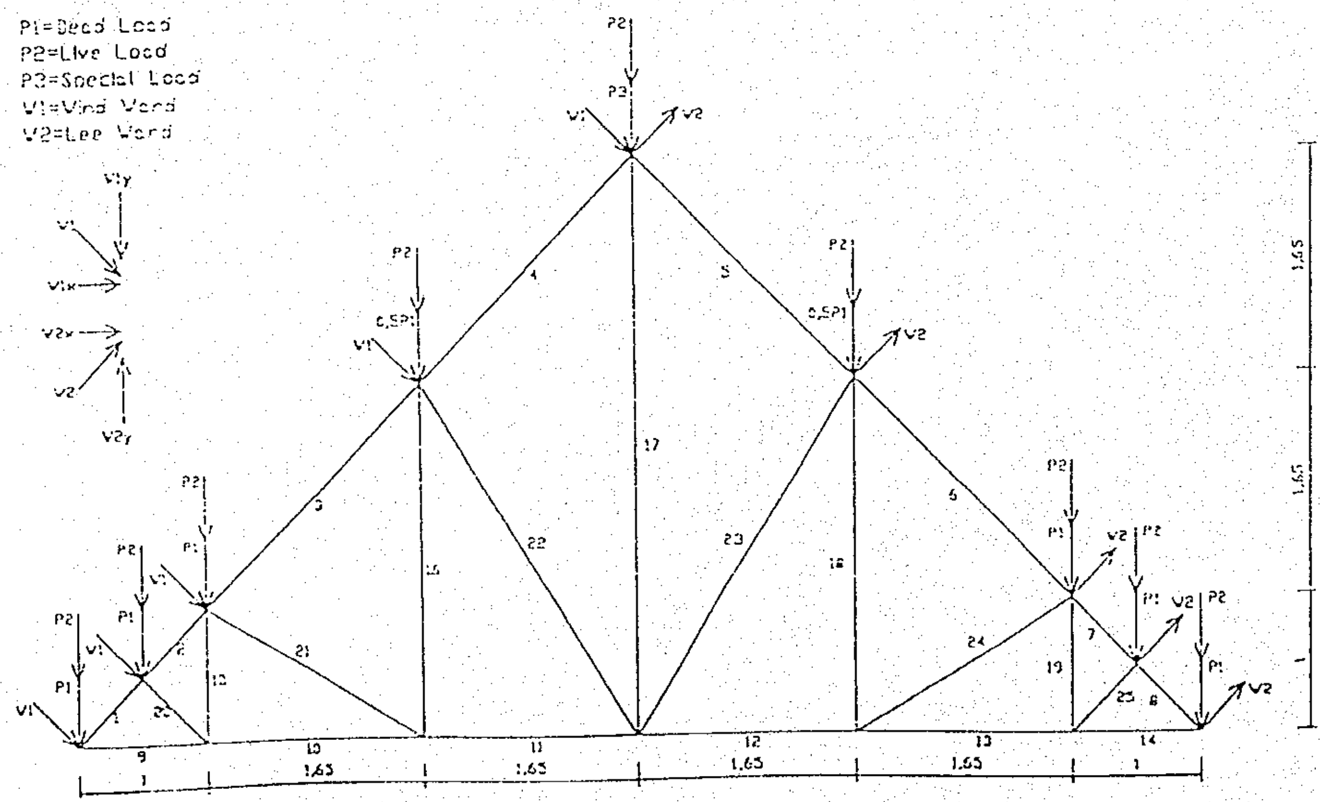
SIMONGAN WIER MANAGEMENT COMPLEX



ISOMETRY
GUARD HOUSE
MONGAN WEIR MANAGEMENT COMPLEX



SECURITY ROOF TYPE K1



2. Design Condition

a. Dimensions
- length : 4.50 m
- roof slope : 45°

b) Roof truss members : - double angle steel
- Tensile strength (Fy) : 2400 kg/cm^2

c) Structural model : plane (xy axis) truss, linear elastic

d) Analysis method : static

3. Loading Condition

a) Dead Load :
- Roof cover (ceramic tile + timber rafter) = 70 kg/m^2
- Ceiling (fibre cement) = 10 kg/m^2
80 kg/m^2

b) Live load
- Weight of workers as point load = 100 kg

c) Wind load
- Wind pressure = 40 kg/m^2
- Pressure coefficient (f)
. wind ward -0.5
. lee ward -0.4
$W1 = 0.5 \times 40\ kg/m^2 = 20\ kg/m^2$
$W2 = 0.4 \times 40\ kg/m^2 = 16\ kg/m^2$

4. Design of Roof Truss

a. Dead load
- P_1 = (15X3.5) + (1.25X3.5X80) = 400 kg
- P_2 = (15X1.75) + (1.25X1.75X80) = 201.25 kg
- P_3 = 150 Kg (PLN)

b. Wind load
- $W_1 = 1.3 \times 3.5 \times 20 = 91$ kg
$W_{1x} = W_{1y} = 91 \sin 45^\circ = 64.34\ kg \cong 65$ KG

c. Live load
- P_2 = 100 kg

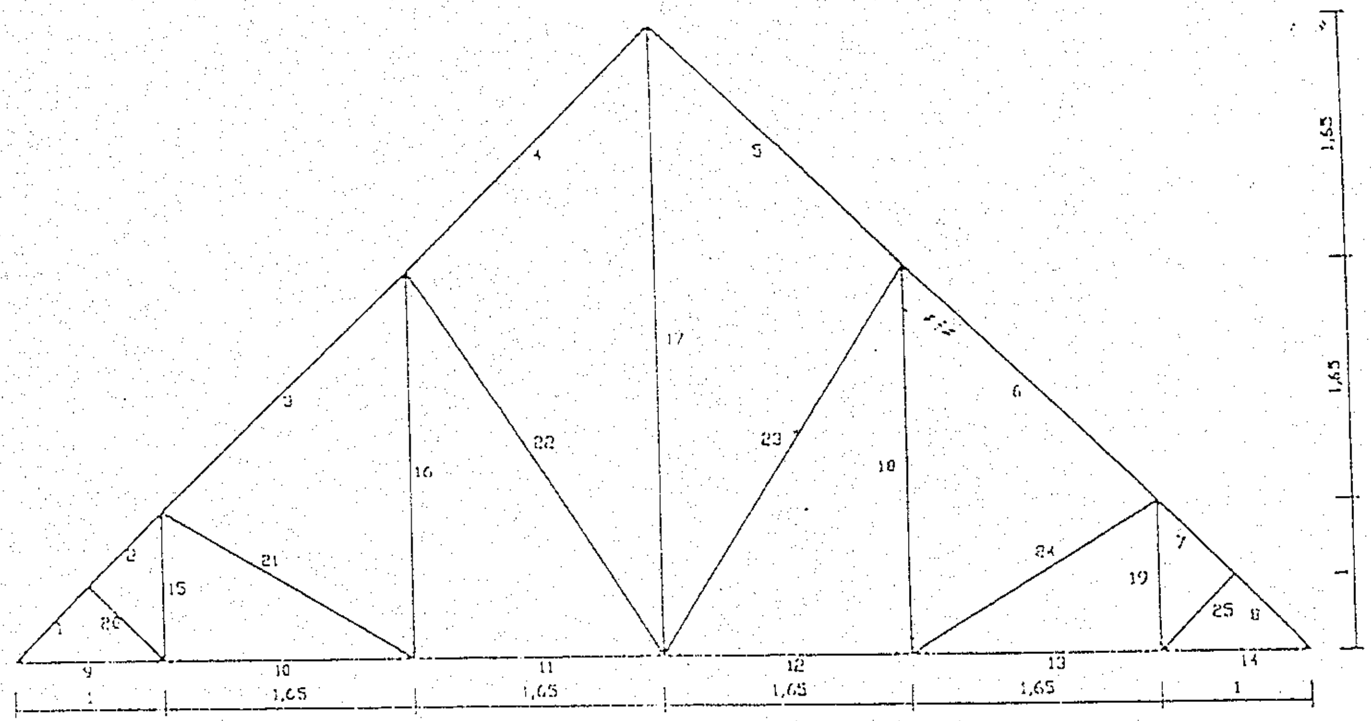
Roof Truss
Security Base Simongan

Prototype

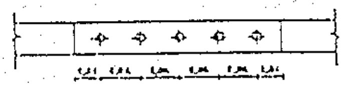
Profile	Plate Thickness (cm)	Fy (kg/cm2)	Fu (kg/cm2)	dia. Bolt (mm)
L 50.50.5	0.5	3,700	2,400	1.2

Member	Profile	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	n Bolt	d Bolt (mm)
1	L 50.50.5	714	2	0	33	2	12
2	L 50.50.5	719	2	0	33	2	12
3	L 50.50.5	55	3	0	102	2	12
4	L 50.50.5	31	3	0	101	2	12
5	L 50.50.5	25	3	0	101	2	12
6	L 50.50.5	63	2	0	102	2	12
7	L 50.50.5	723	2	0	33	2	12
8	L 50.50.5	728	4	0	33	2	12
9	L 50.50.5	506	3	0	94	2	12
10	L 50.50.5	510	3	0	73	2	12
11	L 50.50.5	41	3	0	72	2	12
12	L 50.50.5	42	3	0	72	2	12
13	L 50.50.5	510	3	0	72	2	12
14	L 50.50.5	506	4	0	94	2	12
15	L 50.50.5	7	2	0	33	2	12
16	L 50.50.5	152	0	0	0	2	12
17	L 50.50.5	708	3	0	109	2	12
18	L 50.50.5	523	0	0	0	2	12
19	L 50.50.5	137	3	0	170	2	12
20	L 50.50.5	240	0	0	0	2	12
21	L 50.50.5	138	3	0	171	2	12
22	L 50.50.5	525	4	0	0	2	12
23	L 50.50.5	708	3	0	109	2	12
24	L 50.50.5	1525	0	0	0	2	12
25	L 50.50.5	8	2	0	33	2	12

ROOF TYPE K1



NO. Member	Profil	Bolt		Plate Thickness t (mm)
		Total	∅ mm	
1 - 8	T 50.50.5	2 - 2	14	6
2 - 7	T 50.50.5	2 - 2	14	6
3 - 6	T 50.50.5	2 - 2	14	6
4 - 5	T 50.50.5	2 - 2	14	6
9 - 14	⊥ 50.50.5	2 - 2	14	6
10 - 13	⊥ 50.50.5	2 - 2	14	6
11 - 12	⊥ 50.50.5	2 - 2	14	6
15 - 19	⊢ 50.50.5	2 - 2	14	6
16 - 18	⊢ 50.50.5	2 - 2	14	6
17	⊢ 50.50.5	2 - 2	14	6
20 - 25	T 50.50.5	2 - 2	14	6
21 - 24	T 50.50.5	2 - 2	14	6
15 - 19	T 50.50.5	2 - 2	14	6



- Checking of members Strength of roof steel Truss Type K-1 base on the axial force:

a. Due to Tensile force

Maximum force on member T24
Force F = 1,525 kg

Try : Double angle steel of 50.50.5
Cross section area A = 9.6 cm^2

σ_{all} = 0.6xFy
= 0.6x2,400 = 1,440 kg/cm^2

Stress

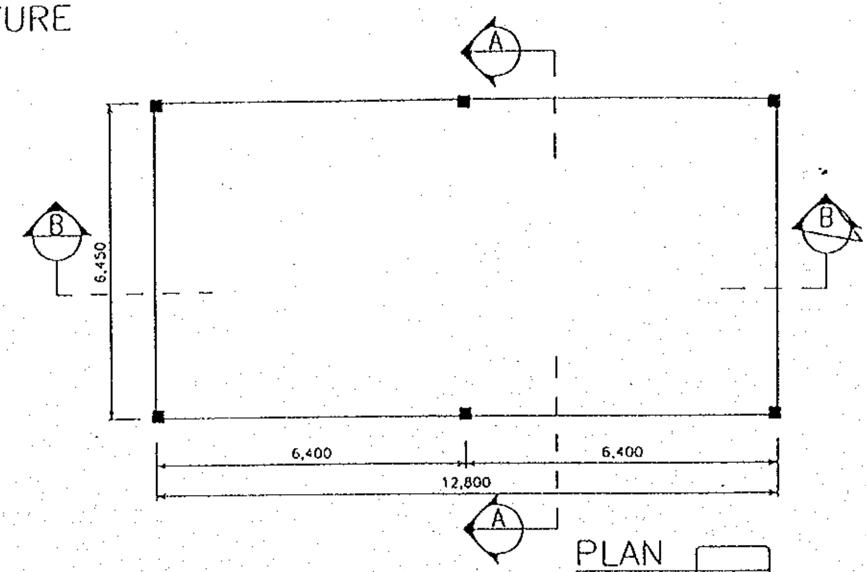
$\sigma = \frac{F}{A} = \frac{1,525}{9.6} = 158.85\ kg/cm^2 < \sigma_{all} = 1,440\ kg/cm^2$ (OK)

Hence double angle steel of 50.50.5 can be used as the members of roof truss type K - 1

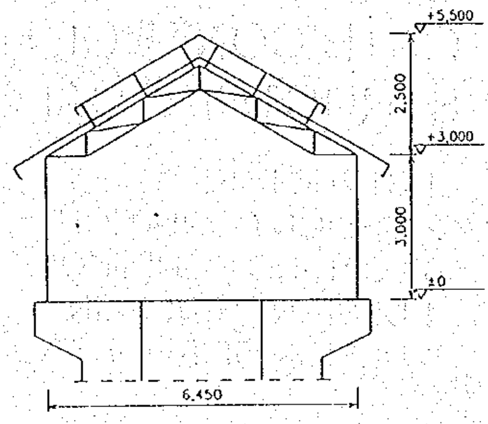
4.7.6. GATE CONTROL HOUSE 1 & 4 STRUCTURE CALCULATION

1 STRUCTURE
2 DESIGN CONDITION
3 LOADING CONDITION
4 DESIGN OF PURLIN
5 DESIGN OF ROOF TRUSS

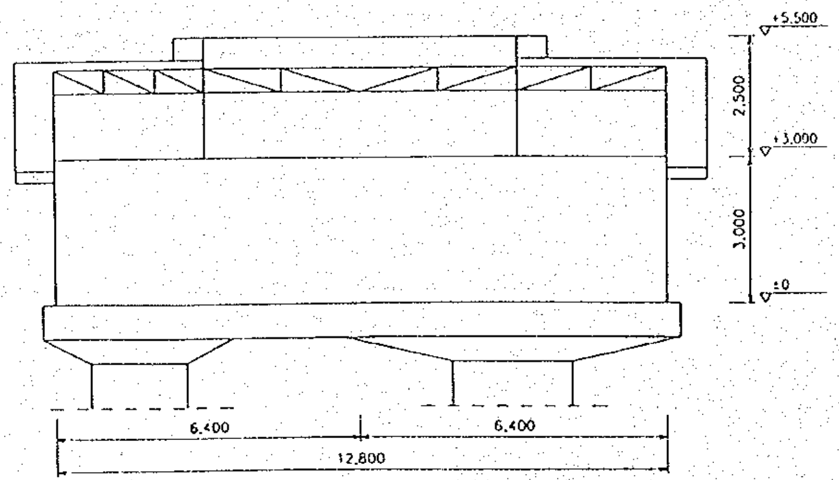
1. STRUCTURE



PLAN



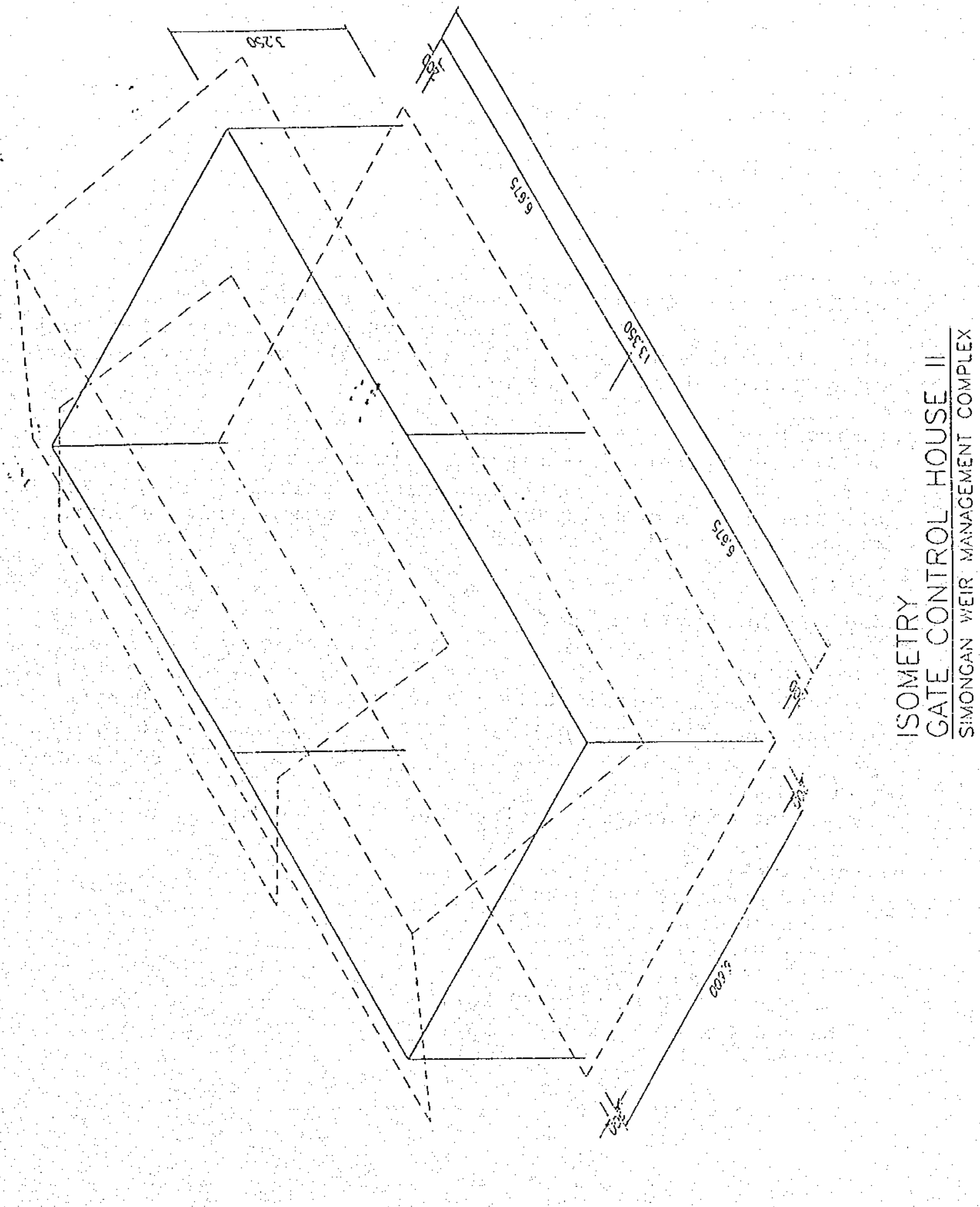
SECTION A–A



SECTION B–B

GATE CONTROL HOUSE II (1,4)

SIMONGAN WIER MANAGEMENT COMPLEX


ISOMETRY
GATE CONTROL HOUSE II
SIMONGAN WEIR MANAGEMENT COMPLEX

2. Design Condition

Dimensions

a) Framing

- width : 6.45 m
- length : 13.35 m
- height : 3.00 m

b) Roof

- length : 6.45 m
- height : 1.57 m
- roof slope : 45°

Roof truss :

a) Roof truss members : - double angle steel
- Tensile strength (Fy) : 2400 kg/cm^2

b) Structural model : plane (xy axis) truss, linear elastic

c) Analysis method : static

Framing :

a) Framing members : - biaxial column
- Characteristic strength (Fc') = 225 kg/cm^2

b) Structural model : space (xyz axis) rame, linier elastic

c) anaysis method : static

3. Loading Condition for roof

a) Dead Load :

- Roof cover (ceramic tile + timber rafter) = 70 kg/m^2
- Ceiling (fibre cement) = 10 kg/m^2

80 kg/m^2

b) Live load

- Weight of workers as point load = 100 kg

c) Wind load

- Wind pressure = 40 kg/m^2
- Pressure coefficient (f)
  . wind ward -0.5
  . lee ward -0.4

$W1 = 0.5 \times 40$ kg/m^2 = 20 kg/m^2

$W2 = 0.4 \times 40$ kg/m^2 = 16 kg/m^2

4. Design of Purlin

A. Roof Truss Type K-1

- Purlin distance (c/c) = 1.63 m
- Purlin span = 165.00 m
- Purlin self weight say = 15.00 kg/m'

q_1 = 1.63 x 80 kg/m² ≈ 131 kg/m'
q_2 (self weight) = 15 kg/m'

Q = 146 kg/m'

$Q_1 = Q_2 = Q \cos 45^o$
$= 146 \cos 45^o$
≈ 105 kg/m'

- Live Load
  $Px = Py = P \cos \alpha = 100 \cos 45^o \approx 71$ kg

- Bending moment

$Mx = 1/8 \times Q_1 \times L^2 + 1/4 \times P_1 \times L$

$Mx = 1/8 \times 105 \times 1.65^2 + 1/4 \times 71 \times 1.65 = 65.02$ kgm

$My = Mx = 65.02$ kgm = 6502 kgcm

- Try Purlin of Lip Channel (in front to front arrangement) type :

150 x 130 x 20 x 3.2
$Ix = 664 cm^4$; $Wx = 88.6 cm^3$
$Iy = 476 cm^4$; $Wy = 73.2 cm^3$

- Stresses

$\sigma = \sigma x + \sigma y$
$= \frac{Mx}{Wx} + \frac{My}{Wy}$
$= \frac{6502}{88.6} + \frac{6502}{73.2} = 107.25 + 88.825$
$= 196.07$ kg $< \sigma_{all} = 1,400$ kg/cm² (OK)

- Deflection

$fx = \frac{5}{384} \times Q_1 \times \frac{L^4}{EI_x} + \frac{1}{48} \frac{PL^3}{EI_x}$

$= \frac{5}{384} \times 1.05 \times \frac{165^4}{2.1x10^6 x664} + \frac{1}{48} \frac{71 \times 165^3}{2.1x10^6 x664}$

$= 0.532 + 0.0047 = 0.5362$ cm

$f = (0.5362^2 + 0.5362^2)^{1/2} = 0.76$ cm

Design of Roof Truss

a. Dead load

- $P_1 = 1.65 \times (131 + 15) = 240.9$ kg

b. Wind load

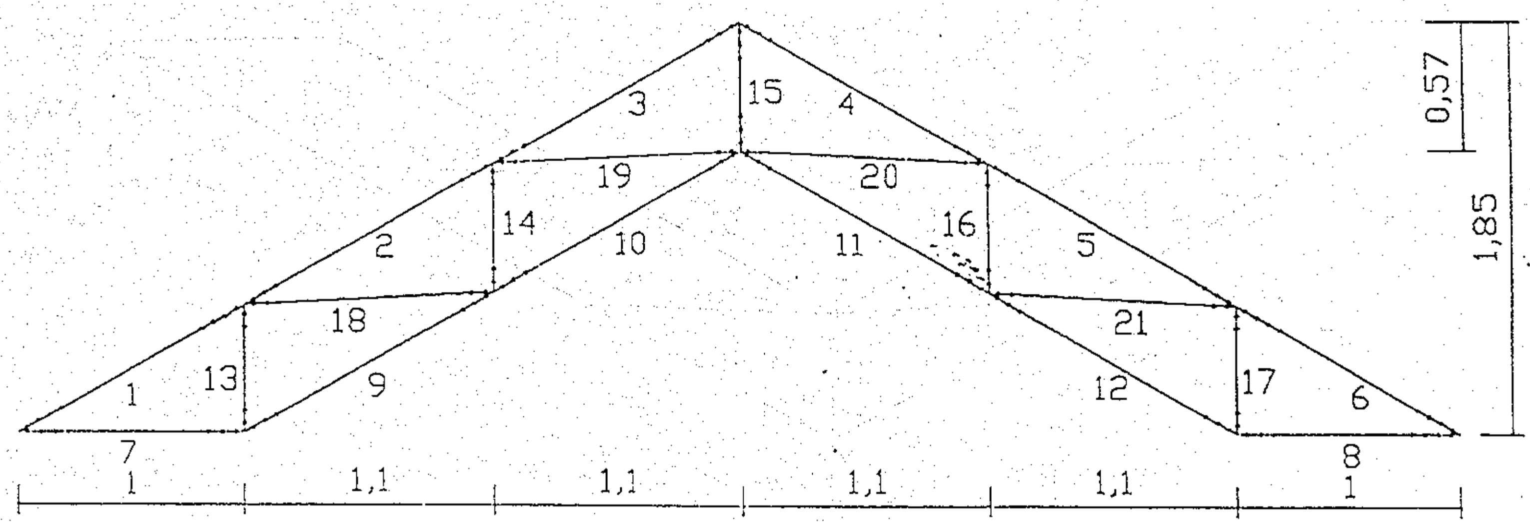
- $W_1 = 1.65 \times 1.63 \times 20 = 53.76$ kg
- $W_2 = 1.65 \times 1.63 \times 16 = -43.032$ kg

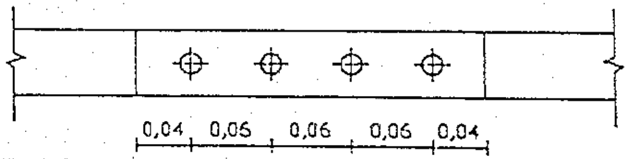
$W_{1X} = W_{1Y} = 53.76 \text{ Cos } 45^o = 38.01$ kg
$W_{2X} = W_{2Y} = -43.03 \text{ Cos } 45^o = -30.41$ kg

c. Live load

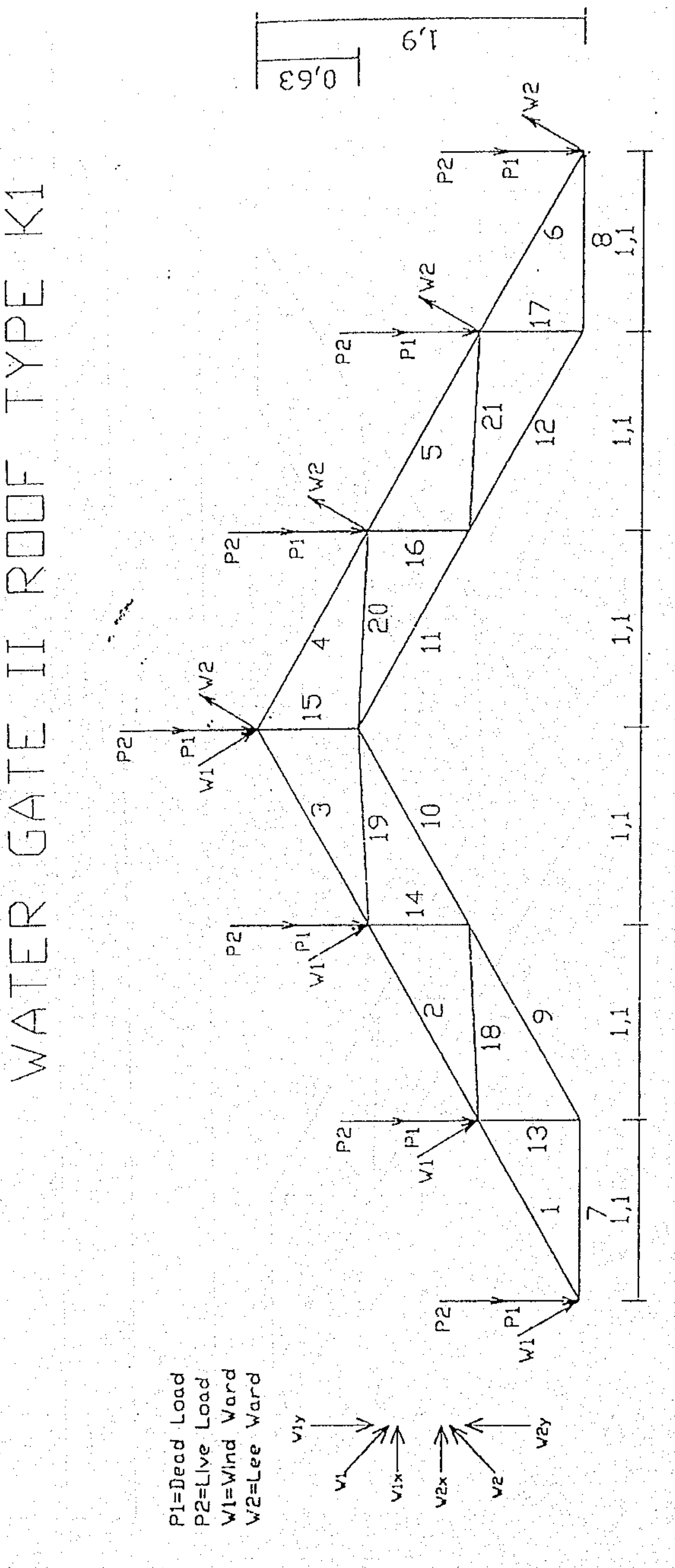
- $P_2 = 100$ kg

WATER GATE ROOF TYPE K1

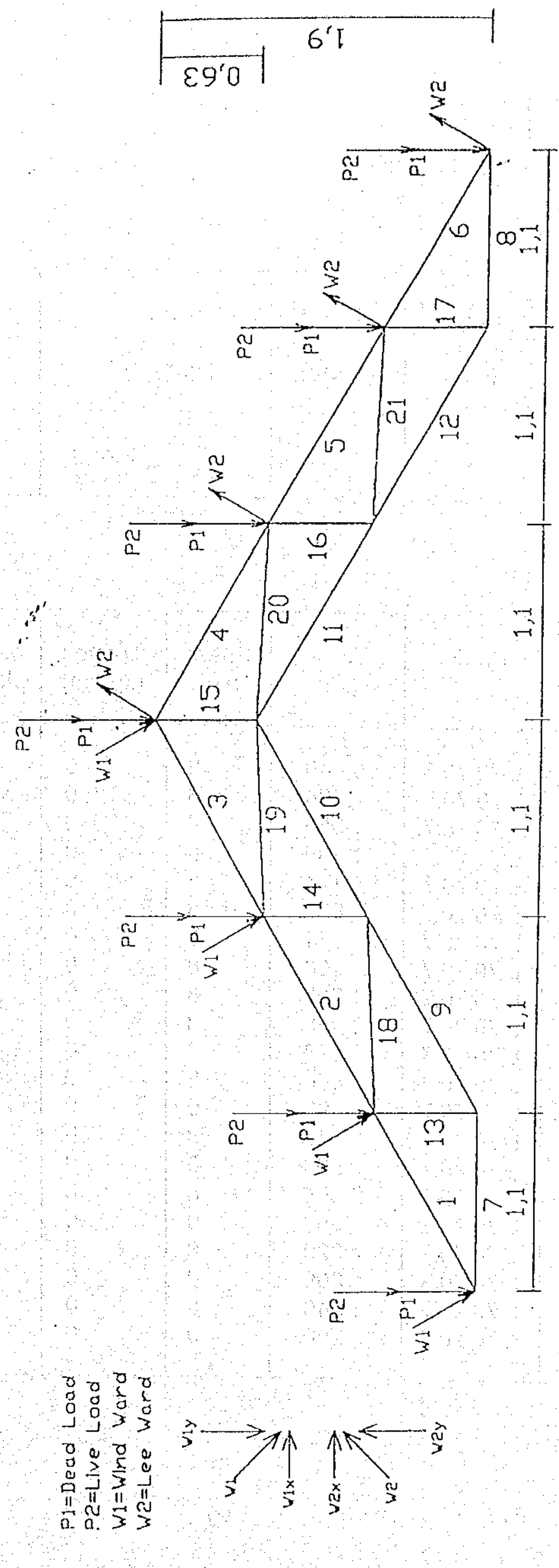




NO. Member	Profil	Bolt		Plate Thickness t (mm)
		Total	ø mm	
1 = 6	⊤75.75.7	4 – 4	14	10
2 = 5	⊤75.75.7	3 – 3	14	10
3 = 4	⊤75.75.7	3 – 3	14	10
7 = 8	⊥75.75.7	4 – 3	14	10
9 = 12	⊤75.75.7	3 – 3	14	10
10 = 11	⊤75.75.7	3 – 3	14	10
13 = 17	⊢50.50.5	2 – 2	14	10
14 = 16	⊢50.50.5	2 – 2	14	10
15	⊢50.50.5	3 – 3	14	10
18 = 21	⊥50.50.5	2 – 2	14	10
19 = 20	⊥50.50.5	2 – 2	14	10


WATER GATE II ROOF TYPE K1
1,9
0,63
1,1
1,1
1,1
1,1
1,1
1,1
P2
P1
W1
W2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
V1y
V1
V1x
V2x
V2
V2y
P1=Dead Load
P2=Live Load
W1=Wind Ward
W2=Lee Ward

WATER GATE II ROOF TYPE K2



Roof K-1

WATER GATE II SIMONGAN

Prototype

Profile	Plate Thickness (cm)	Fy (kg/cm2)	Fu (kg/cm2)	dia. Bolt (cm)
L 70.70.7	1	3,700	2,400	1.6

Member	Profile	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	n Bolt	d Bolt (mm)
1	L 70.70.7	5,649	8	0	258	2	16
2	L 70.70.7	4,224	8	0	258	2	16
3	L 70.70.7	1,385	8	0	258	2	16
4	L 70.70.7	1,485	8	0	258	2	16
5	L 70.70.7	4,174	8	0	258	2	16
6	L 70.70.7	5,833	8	0	258	2	16
7	L 70.70.7	131	8	0	258	2	16
8	L 70.70.7	156	8	0	258	2	16
9	L 70.70.7	1,702	8	0	258	2	16
10	L 70.70.7	2,068	8	0	258	2	16
11	L 70.70.7	522	8	0	258	2	16
12	L 70.70.7	456	8	0	223	2	16
13	L 70.70.7	93	0	0	0	2	16
14	L 70.70.7	1,340	8	0	223	2	16
15	L 70.70.7	809	0	0	0	2	16
16	L 70.70.7	2,554	8	0	223	2	16
17	L 70.70.7	358	0	0	0	2	16
18	L 70.70.7	2,229	8	0	223	2	16
19	L 70.70.7	809	0	0	0	2	16
20	L 70.70.7	1,340	8	0	223	2	16
21	L 70.70.7	290	0	0	0	2	16

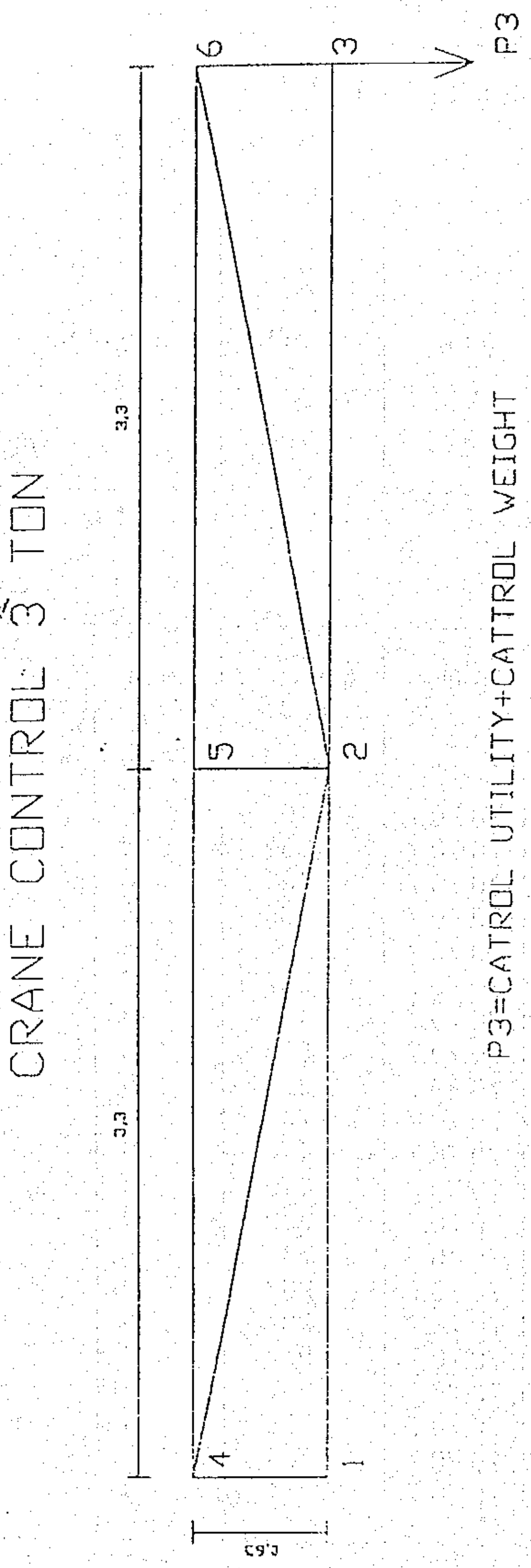
Roof K-2

WATER GATE II SIMONGAN

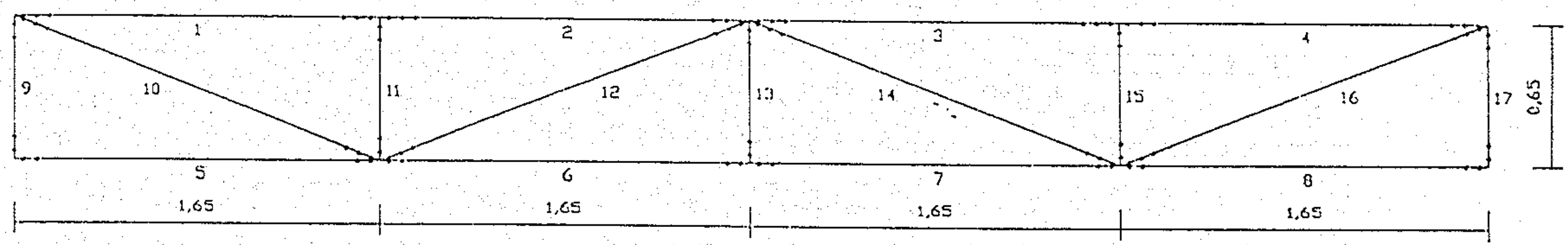
Prototype

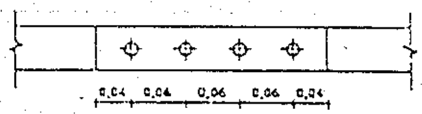
Profile	Plate Thickness (cm)	Fy (kg/cm2)	Fu (kg/cm2)	dia. Bolt (cm)
L 70.70.7	1	3,700	2,400	1.6

Member	Profile	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	n Bolt	d Bolt (mm)
1	L 70.70.7	3,102	8	0	258	2	16
2	L 70.70.7	2,332	8	0	258	2	16
3	L 70.70.7	150	8	0	258	2	16
4	L 70.70.7	365	8	0	258	2	16
5	L 70.70.7	2,397	8	0	258	2	16
6	L 70.70.7	3,392	8	0	258	2	16
7	L 70.70.7	444	8	0	258	2	16
8	L 70.70.7	508	8	0	258	2	16
9	L 70.70.7	374	8	0	258	2	16
10	L 70.70.7	741	8	0	258	2	16
11	L 70.70.7	142	8	0	258	2	16
12	L 70.70.7	119	8	0	223	2	16
13	L 70.70.7	239	0	0	0	2	16
14	L 70.70.7	734	8	0	223	2	16
15	L 70.70.7	288	0	0	0	2	16
16	L 70.70.7	1,987	8	0	223	2	16
17	L 70.70.7	522	0	0	0	2	16
18	L 70.70.7	1,662	8	0	223	2	16
19	L 70.70.7	178	0	0	0	2	16
20	L 70.70.7	764	8	0	223	2	16
21	L 70.70.7	51	0	0	0	2	16


CRANE CONTROL 3 TON
P3=CATROL UTILITY+CATTROL WEIGHT
P3
6
3
5
2
4
1
3,3
3,3

CRANE CONTROL 3 TON





NO. Member	Profil	Bolt		Plate Thockness t. (mm)
		Total	ø mm	
1 = 4	⊥ 50.50.5	3 - 3	14	8
2 = 3	⊥ 50.50.5	3 - 3	14	8
5 = 8	⊥ 50.50.5	2 - 2	14	8
6 = 7	⊥ 50.50.5	2 - 2	14	8
9 = 17	⊢ 50.50.5	2 - 2	14	8
10 = 16	⊤ 50.50.5	3 - 3	14	8
11 = 15	⊢ 50.50.5	2 - 2	14	8
12 = 14	⊤ 50.50.5	3 - 3	14	8
13	⊢ 50.50.5	2 - 2	14	8

Roof Truss Crane
Water Gate II Simongan

Prototype

Profile	Plate Thickness (cm)	Fy (kg/cm2)	Fu (kg/cm2)	dia. Bolt
L 70.70.7	1	3,700	2,400	1.6

Member	Profile	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	n Bolt	d Bolt (mm)
1	L 70.70.7	10944	24	0	2009	4	16
2	L 70.70.7	0	24	0	2009	2	16
3	L 70.70.7	5216	24	0	2009	2	16
4	L 70.70.7	16160	24	0	2009	6	16
5	L 70.70.7	969	0	0	0	2	16
6	L 70.70.7	5321	24	0	2009	2	16
7	L 70.70.7	4319	0	0	0	2	16
8	L 70.70.7	16476	24	0	2009	6	16
9	L 70.70.7	3124	0	0	0	2	16

- Checking of members Strength of roof steel Truss Type Crane base on the axial force:

a. Due to Tensile force

Maximum force on member T8
Force $F = 16,476$ kg

Try : Double angle steel of 70.70.7
Cross section area $A = 18.8\ cm^2$

$\sigma_{all} = 0.6 \times Fy$
$= 0.6 \times 2,400 = 1,440\ kg/cm^2$

Stress
$\sigma = \frac{F}{A} = \frac{16,476}{18.8} = 876.38\ kg/cm^2 < \sigma_{all} = 1,440\ kg/cm^2$ (OK)

Hence double angle steel of 70.70.7 can be used as the members of roof truss type Crane

BEAM TYPE a
Water Gate II Simongan

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	45	4	1.6	0.8	187	3,200	2,400

Member	Frame Element Force				Design											
	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main Bar (mm)	Left baars			Middle baars			Right baars			Stirrup (mm)	Mu (kg.cm)
						Top	Middle	Botom	Top	Middle	Botom	Top	Middle	Botom		
7	1,251	2,571	37	401,432	16	2D16	2ø12	2D16	2D16	2ø12	2D16	3D16	2ø12	2D16	ø8-150	561,351
8	1,251	2,571	36	401,393	16	3D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	561,351
9	1,278	2,692	36	418,884	16	2D16	2ø12	2D16	2D16	2ø12	2D16	3D16	2ø12	2D16	ø8-150	561,351
10	1,278	2,695	36	418,816	16	3D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	561,351
11	2,199	835	1	80,310	16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	387,482
12	972	835	1	80,479	16	2D16	2ø12	2D16	2D16	2ø12	2D16	2D16	2ø12	2D16	ø8-150	386,918

COULOM type I
Water Gate II Simongan

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	25	4	1.6	0.8	187	3,200	2,400

Member	Frame Element Force			Design				
	Axial (kg)	Moment-2 (kg.cm)	Moment-3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mox (kg.cm)	Moy (kg.cm)
1	5436	6330	250720	8D16	ø8-90	8435	668534	668534
2	10456	21935	21936	4D16	ø8-90	64377	144848	144848
3	4621	61589	61589	8D16	ø8-90	4622	338530	338530
4	5548	63315	63346	8D16	ø8-90	5546	338300	338300
5	10670	21820	21820	4D16	ø8-90	64377	144848	144848
6	4733	31222	61634	8D16	ø8-90	4733	338625	338625
13	3256	755	755	4D16	ø8-90	3256	202870	7325
14	3256	1671	1671	4D16	ø8-90	3256	202870	7325
15	1774	733	734	4D16	ø8-90	1774	196368	3991
16	1774	1645	165	4D16	ø8-90	1774	196368	3991

- Checking of Beam reinforcement bar & stress

Random sample
On Beam No. F9

Positive Bending Moment	= 418,884	kgcm	
b (width)	= 20	cm	
h_t (height)	= 45	cm	
Concrete cover	= 4	cm	
Fc	= 225	kg/cm²	⟶ $\bar{\sigma}'_b$ = 130 kg/cm²
Fu	= 3,200	kg/cm²	⟶ $\bar{\sigma}_a$ = 2,600 kg/cm²
ns	= 14		

$$\phi_0 = \frac{\bar{\sigma}_a}{n\bar{\sigma}'_b} = \frac{2,600}{14 \times 130} = 1.43$$

a) For Positive BM, M = 418,884 kgcm

b = 20
h_t = 45 ; d = 4 ⟶ h = h_t − d = 45 − 4 = 41 cm

$$Ca = \frac{h}{\sqrt{\frac{nM}{b\sigma_s}}} = \frac{41}{\sqrt{\frac{14 \times 418,884}{20 \times 2600}}} = 3.86$$

δ = 0.6 (required of minimum compression reinforcement bar)

⟶ ϕ = 2.33 > ϕ_0 = 1.43 (OK)

ϕ' = 3.5

$n\omega$ = 0.07759

. Stresses

$\bar{\sigma}_a$ = 2,600 kg/cm²

$$\bar{\sigma}_b = \frac{\bar{\sigma}_a}{n\phi} = \frac{2,600}{14 \times 2.33} = 79.71 \text{ kg/cm}^2 < \bar{\sigma}'_b = 130 \text{ kg/cm}^2 \text{ (OK)}$$

$$\sigma_a = \frac{\bar{\sigma}_a}{\phi'} = \frac{2,600}{3.15} = 825.40 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2 \text{ (OK)}$$

. Reinforcement bar

$$A_{steel\ (tensile)} = \frac{\omega bh}{14} = 0.07759 \times 20 \times 41 = 4.54 \text{ cm}^2$$

$A_{steel\ (compression)}$ = δ × $A_{steel\ (tensile)}$

= 0.6 × 4.54 cm² = 2.724 cm²

Used $A_{steel\ (tensile)}$ = 3 D 16 = 6.03 cm² (OK)

Used $A_{steel\ (compression)}$ = 2 D 16 = 4.02 cm² (OK)

- Checking of Column reinforcement bar & stress

On Column No. F5

Positive Bending Moment = 61,589 kgcm
b (width) = 25 cm
h_t (height) = 25 cm
Concrete cover = 4 cm
$h = h_t - d$ = 25 - 4 = 21 cm
Fc = 225 kg/cm² ⟶ $\bar{\sigma}'_b$ = 130 kg/cm²
Fu = 3,200 kg/cm² ⟶ $\bar{\sigma}_a$ = 2,600 kg/cm²
ns = 14

$$\phi_0 = \frac{\bar{\sigma}_a}{n\,\bar{\sigma}'_b} = \frac{2,600}{14 \times 130} = 1.43$$

For Positive BM M = 61,589 kgcm

$$Ca = \frac{h}{\sqrt{\dfrac{nM}{b\sigma_a}}} = \frac{21}{\sqrt{\dfrac{14 \times 61,589}{25 \times 2600}}} = 5.77$$

$\delta = 1$ (for symetrical reinforcement)
⟶ $\phi = 3.762 > \phi_0 = 1.43$ (OK)
$\phi' = 7.182$
$n\omega = 0.03243$

. Stresses

$\bar{\sigma}_a = 2,600$ kg/cm²

$$\bar{\sigma}_b = \frac{\bar{\sigma}_a}{n\,\phi} = \frac{2,600}{14 \times 5.25} = 35.37 \text{ kg/cm}^2 < \bar{\sigma}'_b = 130 \text{ kg/cm}^2$$

$$\sigma_a = \frac{\bar{\sigma}_a}{\phi'} = \frac{2,600}{14.00} = 185.71 \text{ kg/cm}^2 < \bar{\sigma}_a = 2,600 \text{ kg/cm}^2$$

. Reinforcement

$$A = \omega bh = \frac{0.03243}{14} \times 25 \times 21 = 1.22 \text{ cm}^2$$

A_{steel} = 1.22cm² < 1 % x 1,500 cm² (sectional area of column)

Hence applied :
A_{steel} = 4 D 16
= 8.04 cm²

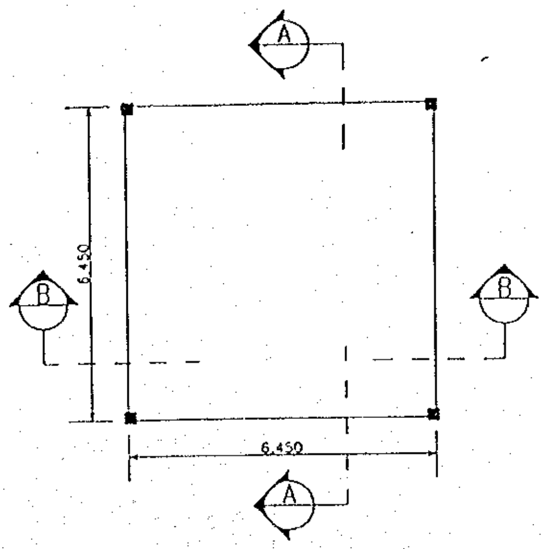
$$= \frac{8.04}{25 \times 25} \times 100\ \%\ A_{concrete}$$

= 0.0129 % $A_{concrete}$ (OK)

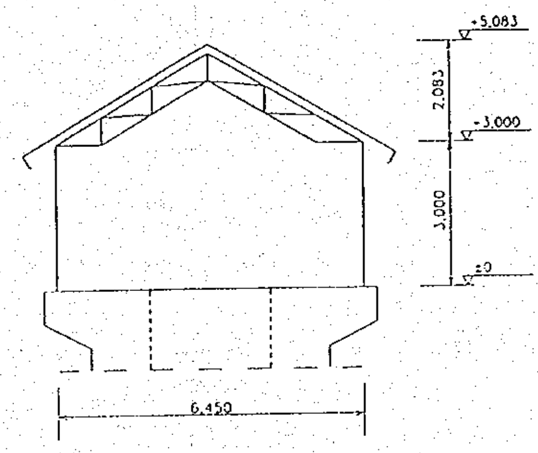
4.7.7. GATE CONTROL HOUSE 2 & 3 STRUCTURE CALCULATION

1 STRUCTURE
2 DESIGN CONDITION
3 LOADING CONDITION
4 DESIGN OF PURLIN
5 DESIGN OF ROOF TRUSS

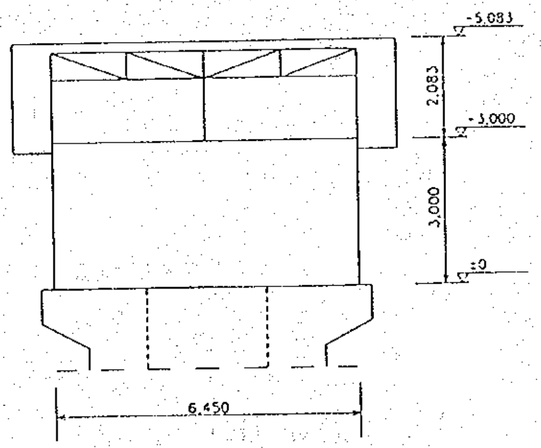
1. STRUCTURE



PLAN



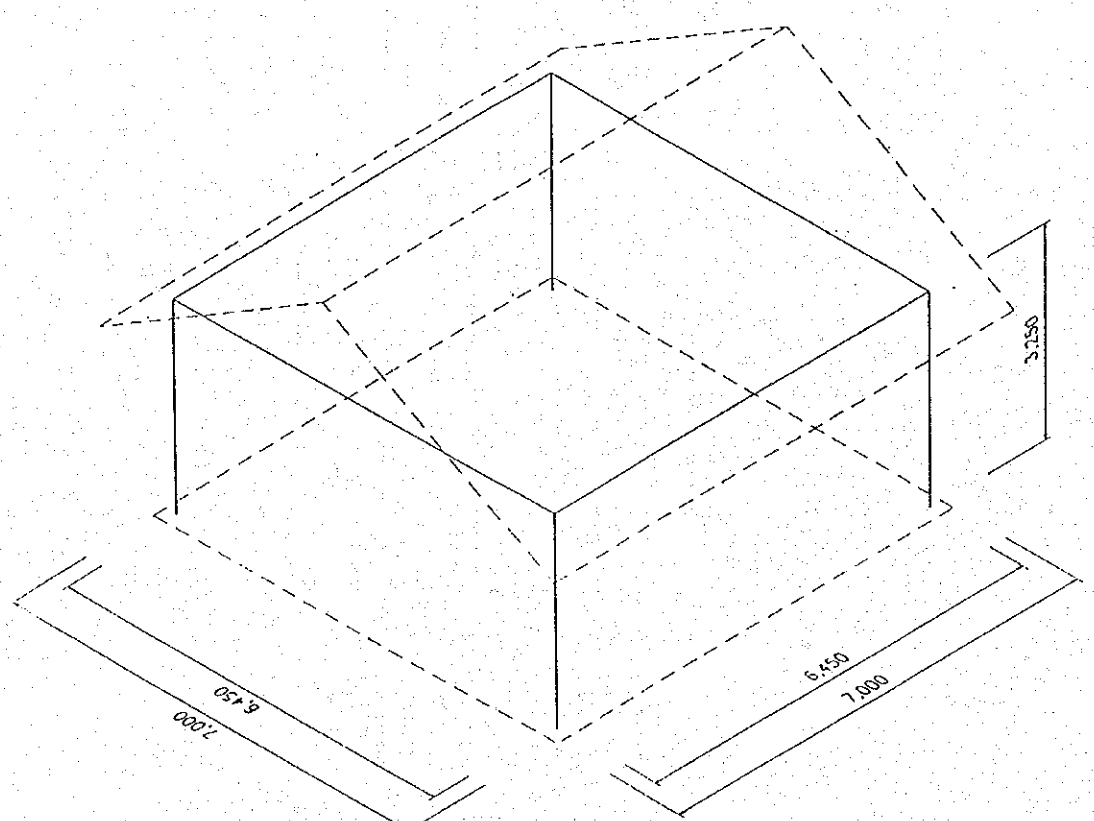
SECTION A–A



SECTION B–B

GATE CONTROL HOUSE I (2,3)

SIMONGAN WIER MANAGEMENT COMPLEX



ISOMETRY
GATE CONTROL HOUSE I
SIMONGAN WEIR MANAGEMENT COMPLEX

2. Design Condition

a. Dimensions

- length : 6.45 m
- roof slope : 30°
- height : 1.85 m

b) Roof truss members : - double angle steel
  - Tensile strength (Fy) : 2400 kg/cm^2

c) Structural model : plane (xy axis) truss, linear elastic

d) Analysis method : static

3. Loading Condition

a) Dead Load :

- Roof cover (ceramic tile + timber rafter) = 70 kg/m^2
- Ceiling (fibre cement) = 10 kg/m^2

80 kg/m^2

b) Live load

- Weight of workers as point load = 100 kg

c) Wind load

- Wind pressure = 40 kg/m^2
- Pressure coefficient (f)
  . wind ward -0.5
  . lee ward -0.4

$W1 = 0.5 \times 40\ kg/m^2 = 20\ kg/m^2$

$W2 = 0.4 \times 40\ kg/m^2 = 16\ kg/m^2$

4. Design of Purlin

A. Roof Truss Type K-1

- Purlin distance (c/c) = 1.24 m
- Purlin span = 3.3 m
- Purlin self weight say = 15.00 kg/m'

$q_1 = 1.24 \times 80\ kg/m^2 \approx 99.2\ kg/m'$

q_2 (self weight) = 15 kg/m'

Q = 114.2 kg/m'

$Q_1 = Q_2 = Q \cos 30^\circ$

$= 114.2 \cos 30^\circ$

$\approx 98.9\ kg/m'$

- Live Load

  $Px = Py = P \cos \alpha = 100 \cos 30^0 \approx 86.6$ kg

- Bending moment

  $Mx = 1/8 \times Q_1 \times L^2 + 1/4 \times P_1 \times L$

  $Mx = 1/8 \times 114.2 \times 3.3^2 + 1/4 \times 86.6 \times 3.3 = 226.9$ kgm

  $My = Mx = 226.9$ kgm $= 26,900$ kgcm

- Try Purlin of Lip Channel (in front to front arrangement) type :

  150 x 130 x 20 x 3.2

  $Ix = 664 cm^4$; $Wx = 88.6 \ cm^3$

  $Iy = 476 \ cm^4$; $Wy = 73.2 \ cm^3$

- Stresses

$$\sigma = \sigma x + \sigma y$$

$$= \frac{Mx}{Wx} + \frac{My}{Wy}$$

$$= \frac{26,900}{88.6} + \frac{26,900}{73.2} = 303.61 + 372.57$$

$$= 676.18 \text{ kg} < \sigma_{all} = 1,400 \text{ kg/cm}^2 \text{ (OK)}$$

- Deflection

$$fx = \frac{5}{384} \times Q_1 \times \frac{L^4}{EI_x} + \frac{1}{48} \frac{PL^3}{EI_x}$$

$$= \frac{5}{384} \times 1.142 \times \frac{330^4}{2.1 \times 10^6 \times 664} + \frac{1}{48} \frac{86.6 \times 330^3}{2.1 \times 10^6 \times 664}$$

$$= 0.12 + 0.046 = 0.166 \text{ cm}$$

$$f = (0.166^2 + 0.166^2)^{1/2} = 0.234 \text{ cm}$$

$$f = 0.234 \text{ cm} < \bar{f}_{all} = \frac{1}{360} L = \frac{330}{360} = 0.916 \text{ cm (OK)}$$

5. Design of Roof Truss

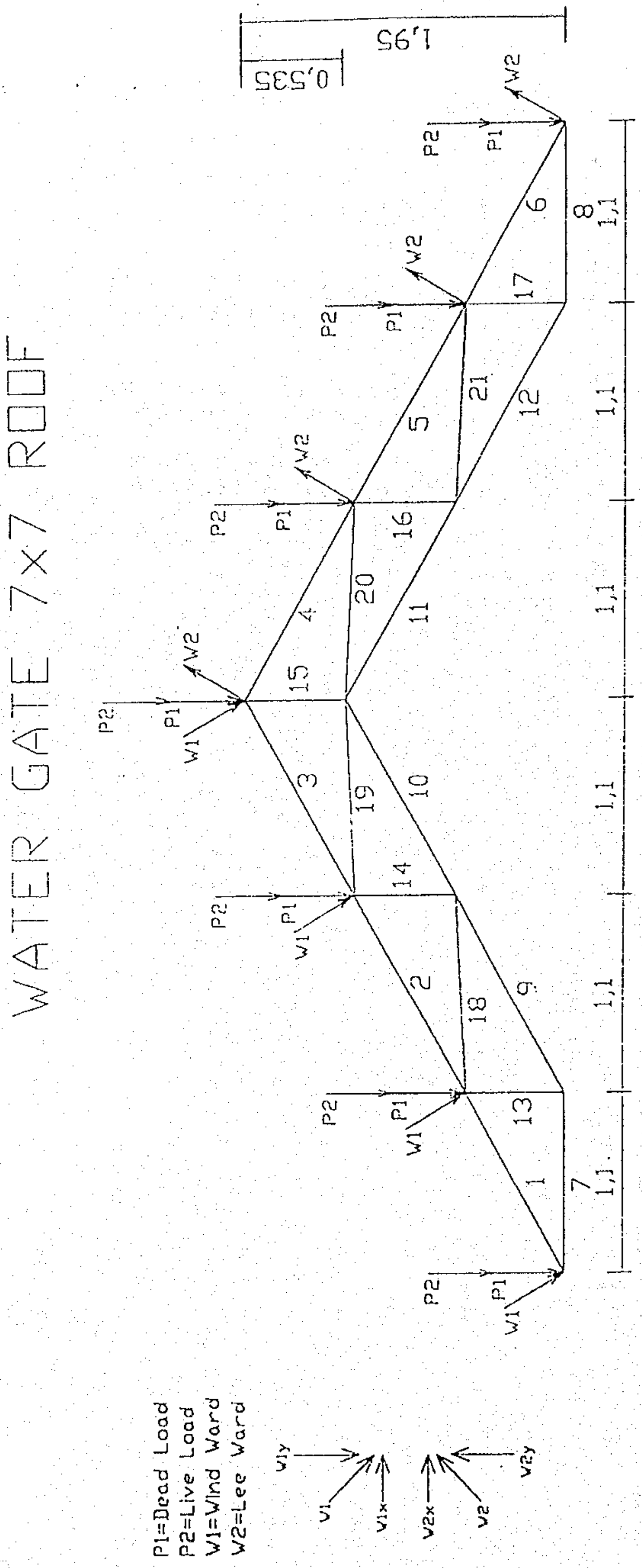
a. Dead load
- $P_1 = 3.30 \times (114.2 + 15) = 426.36$ kg
- Load of Cattroll = 3 ton

b. Wind load
- $W_1 = 3.30 \times 1.24 \times 20 = 81.84$ kg
- $W_2 = 3.30 \times 1.24 \times 16 = -65.47$ kg

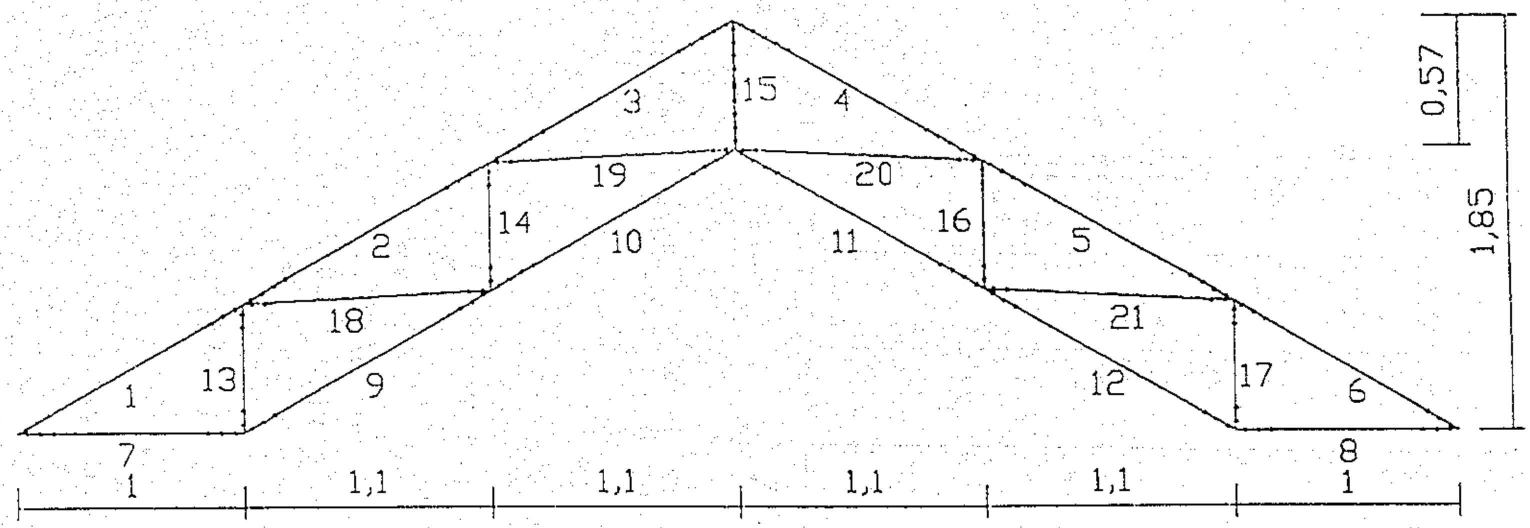
$W_{1X} = 81.84 \text{ Cos } 30^\circ = 70.87$ kg
$W_{1Y} = 81.84 \sin 30^\circ = 40.92$ kg

$W_{2Y} = -65.47 \sin 30^\circ = -32.735$ kg
$W_{2X} = -65.47 \text{ Cos } 30^\circ = -56.69$ kg

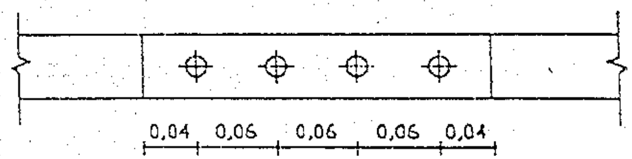
c. Live load
- $P_2 = 100$ kg


WATER GATE 7x7 ROOF
1,95
0,535
P1=Dead Load
P2=Live Load
W1=Wind Ward
W2=Lee Ward
1,1
1,1
1,1
1,1
1,1
1,1
1,1

WATER GATE 7x7 ROOF



NO. Member	Profil	Bolt		Plate Thickness t (mm)
		Total	ø mm	
1 = 6	T75.75.7	3 - 3	14	10
2 = 5	T75.75.7	4 - 4	14	10
3 = 4	T75.75.7	5 - 5	14	10
7 = 8	⊥75.75.7	3 - 3	14	10
9 = 12	T75.75.7	3 - 3	14	10
10 = 11	T75.75.7	4 - 4	14	10
13 = 17	⊢50.50.5	2 - 2	14	10
14 = 16	⊢50.50.5	2 - 2	14	10
15	⊢50.50.5	5 - 5	14	10
18 = 21	⊥50.50.5	2 - 2	14	10
19 = 20	⊥50.50.5	2 - 2	14	10



Roof Truss K1
Water Gate Simongan 7 x 7

Prototype

Profile	Plate Thickness (cm)	Fy (kg/cm2)	Fu (kg/cm2)	dia. Bolt
L 75.75.7	1	3.700	2.400	1,60
L 50.50.5	1	3.700	2.400	1,60

Member	Profile	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	n Bolt	d Bolt (mm)
1	L 75.75.7	938	9	0	277	2	14
2	L 75.75.7	1.783	9	0	277	4	14
3	L 75.75.7	2.006	9	0	277	6	14
4	L 75.75.7	2.006	9	0	277	6	14
5	L 75.75.7	1.783	9	0	277	4	14
6	L 75.75.7	9.389	9	0	277	2	14
7	L 75.75.7	808	9	0	277	2	14
8	L 75.75.7	977	9	0	277	2	14
9	L 75.75.7	1.783	9	0	277	4	14
10	L 75.75.7	1.783	9	0	277	4	14
11	L 75.75.7	977	9	0	277	2	14
12	L 50.50.5	808	9	0	277	2	14
13	L 50.50.5	521	0	0	0	2	14
14	L 50.50.5	736	4	0	1.144	2	14
15	L 50.50.5	258	0	0	0	2	14
16	L 50.50.5	195	4	0	1.144	2	14
17	L 50.50.5	1.842	0	0	0	2	14
18	L 50.50.5	195	4	0	1.144	2	14
19	L 50.50.5	248	0	0	0	2	14
20	L 50.50.5	735	4	0	1.144	2	14
21	L 50.50.5	521	0	0	0	2	14
			4				

- Checking of members Strength of roof steel Truss Type K-1 base on the axial force:

  a. Due to Tensile force

  Maximum force on member T6
  Force F = 9,389 kg

  Try : Double angle steel of 75.75.7
  Cross section area A = 20.2 cm^2

  σ_{all} = 0.6xFy
  = 0.6x2,400 = 1,440 kg/cm^2

  Stress
  $\sigma = \dfrac{F}{A} = \dfrac{9,389}{20.2} = 464.6$ kg/cm^2 $< \sigma_{all}$ = 1,440 kg/cm^2 (OK)

  Hence double angle steel of 75.75.7 can be used as the members of roof truss type K - 1

BEAM TYPE a
Water Gate Simongan 7 x 7

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	40	4	1,6	0,8	187	3.200	2.400

Member	Frame Element Force: Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main Bar (mm)	Design: Left baars Top	Left baars Middle	Left baars Botom	Middle baars Top	Middle baars Middle	Middle baars Botom	Right baars Top	Right baars Middle	Right baars Botom	Stirrup (mm)	Mu (kg.cm)
1	848	1.703	1.736	1.612	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	334.120
2	1.100	2.868	1.400	10.425	16	2D16	2o12	2D16	2D16	2o12	2D16	2D15	2o12	2D16	8	333.904
3	863	1.737	509	15.287	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	334.108
4	1.408	189	1.232	25.054	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	335.628
5	1.299	3.585	358	22.786	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	335.574
6	1.420	3.368	336	303.730	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	333.618
7	1.465	389	378	22.141	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	335.656
8	1.459	3.730	373	211.800	16	2D16	2o12	2D16	2D16	2o12	2D16	2D16	2o12	2D16	8	335.653

BEAM TYPE b
Water Gate Simongan 7 x 7

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	25	4	1,6	0,8	187	3.200	2.400

Member	Frame Element Force: Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main Bar (mm)	Design: Left baars Top	Left baars Middle	Left baars Botom	Middle baars Top	Middle baars Middle	Middle baars Botom	Right baars Top	Right baars Middle	Right baars Botom	Stirrup (mm)	Mu (kg.cm)
21	118	2.008	340	257.104	16	4D16	-	3D16	2D16	-	2D16	2D16	-	2D16	8	334.120
22	133	199	298	74.277	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	333.904
23	104	199	164	242.325	16	2D16	-	2D16	3D16	-	2D16	2D16	-	2D16	8	334.108
24	0	396	0	43.560	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	335.628
25	0	396	0	43.560	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	335.574
26	0	396	0	43.560	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	333.618

BEAM TYPE c
Water Gate Simongan 7 x 7

Prototype

b (cm)	h (cm)	cover (cm)	dia. main bar (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	20	4	1,6	0,8	187	3.200	2.400

Frame Element Force						Design										
Member	Axial (kg)	Shear (kg)	Torsion (kg.cm)	Moment (kg.cm)	Main Bar (mm)	Left baars			Middle baars			Right baars			Stirrup	Mu
						Top	Middle	Botom	Top	Middle	Botom	Top	Middle	Botom	(mm)	(kg.cm)
9	18.818	414	2.594	2.836	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	334.120
10	962	109	1.911	8.036	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	333.904
11	1.822	177	2.610	14.533	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	334.108
12	2.018	377	2.348	28.582	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	335.628
13	933	7	1.859	879	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	335.574
14	2.017	394	2.381	29.460	16	2D16	-	2D16	2D16	-	2D16	2D16	-	2D16	8	333.618

COULOM type I
Water Gate Simongan 7 x 7

Prototype

b (cm)	h (cm)	cover (cm)	ia. main ba (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
20	20	4	1,6	0,8	187	3.200	2.400

Frame Element Force				Design				
Member	Axial (kg)	Moment-2 (kg.cm)	Moment-3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mox (kg.cm)	Moy (kg.cm)
15	3608	11280	170355	4D16	o8-90	3607	200561	200561
16	3767	49077	170177	4D16	o8-90	3766	201074	201074
17	5206	29110	284533	8D16	o8-90	5204	328775	328775
18	5411	19148	286130	8D16	o8-90	5407	328024	328024

COULOM type II
Water Gate Simongan 7 x 7

Prototype

b (cm)	h (cm)	cover (cm)	ia. main ba (cm)	dia. Stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	25	4	1,6	0,8	187	3.200	2.400

Frame Element Force				Design				
Member	Axial (kg)	Moment-2 (kg.cm)	Moment-3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mox (kg.cm)	Moy (kg.cm)
19	1808	638	638	4D16	o8-90	1808	76483	76483
20	1609	1610	1610	4D16	o8-90	1609	76865	76865