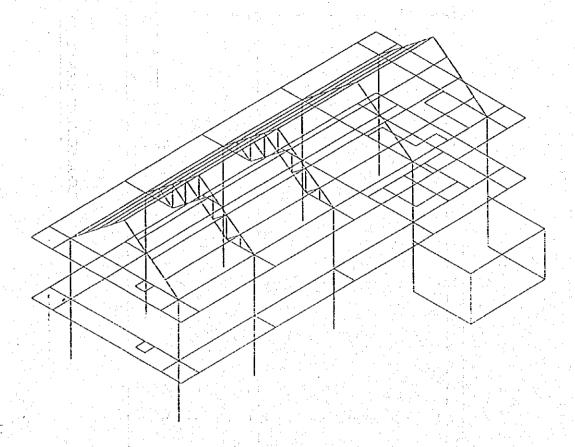
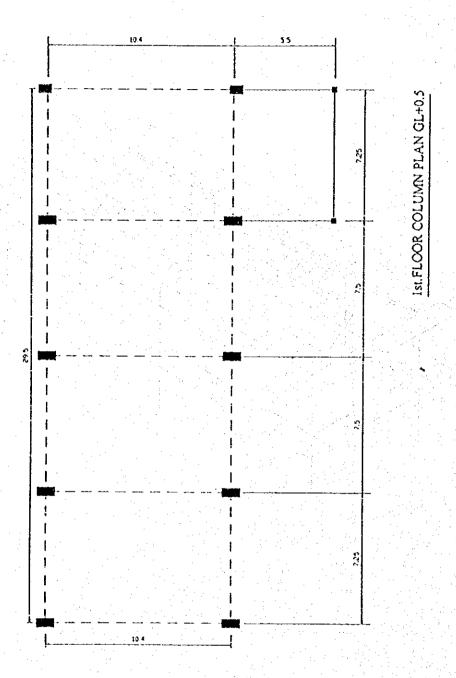
5.2 Design of Upper Structure of Hydropower Station

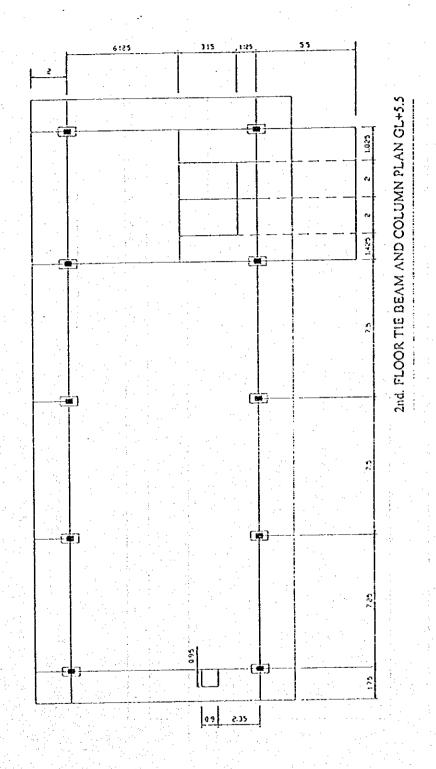
# JATIBARANG HYDROPOWER STATION UPPER STRUCTURE CALCULATION

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### 1. General Construction

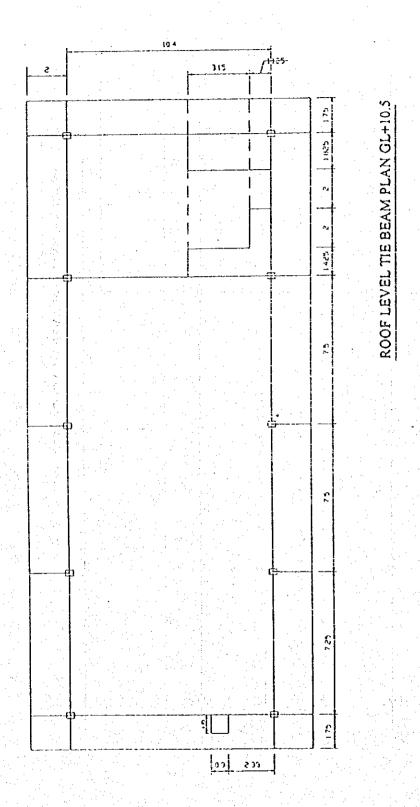


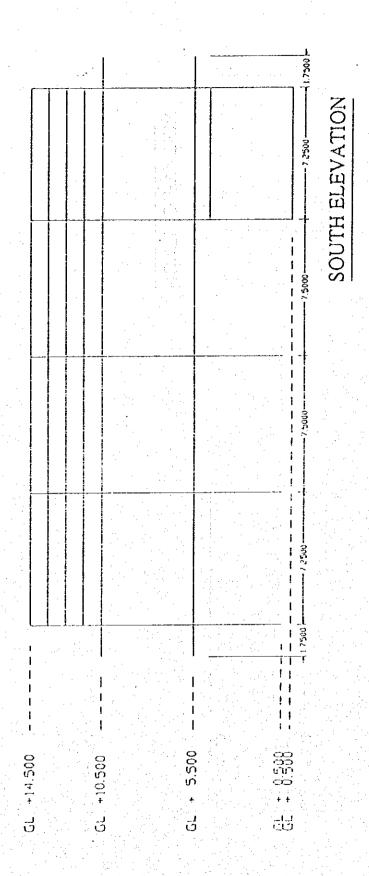




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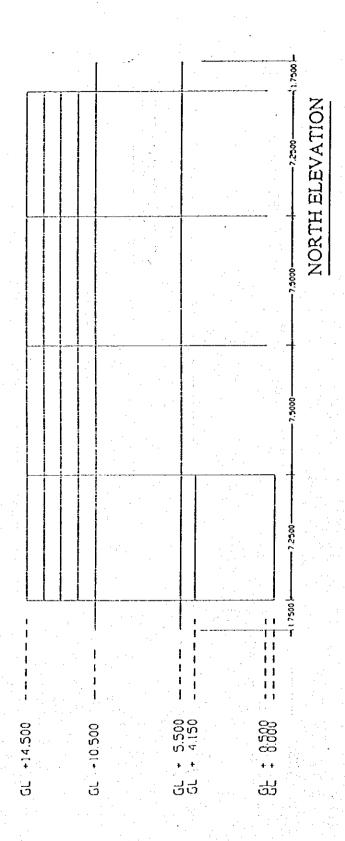
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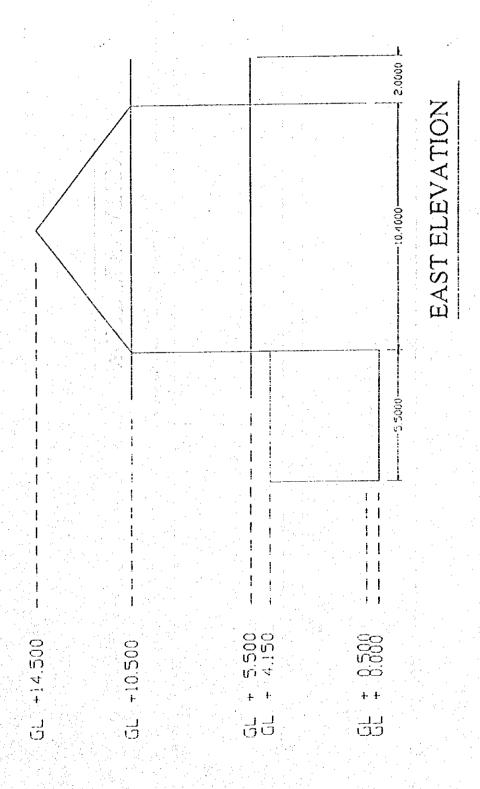


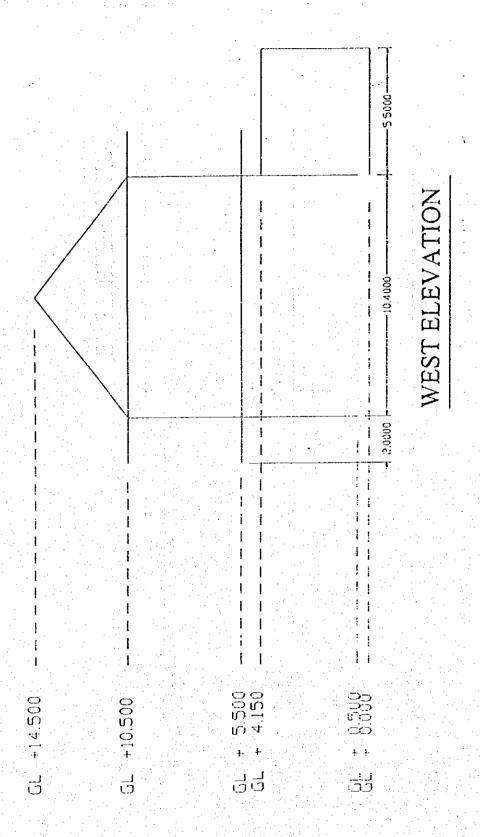


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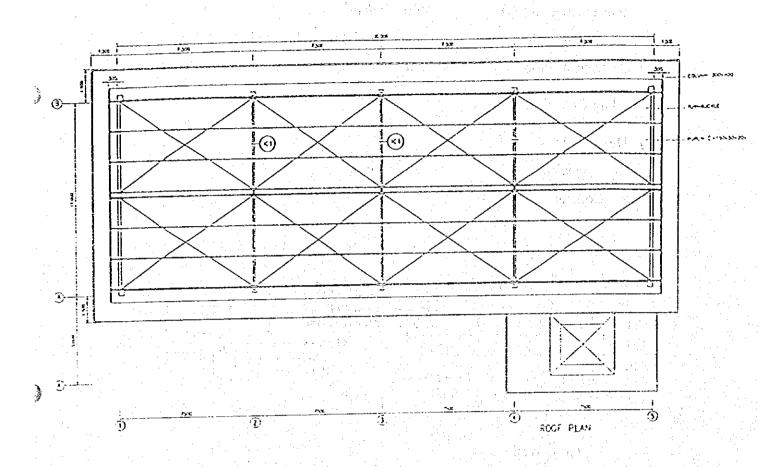


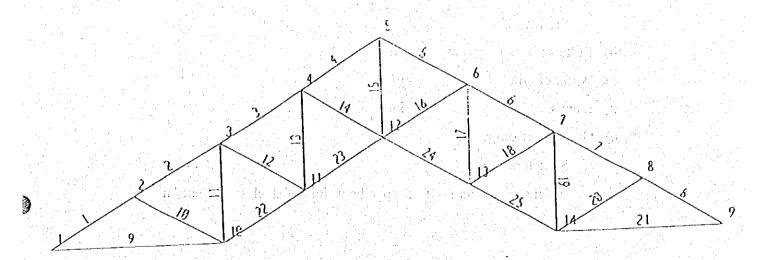




# 2. Design Of Roof Steel Truss

# a. Structure of Roof Steel Truss





#### b. Design Condition

- 1) Roof truss members

double angle steel

tensile strength (Fy)

: 2400 kg/cm<sup>2</sup>

2) Structural model

: plane (xy axis) truss, linear elastic

3) Analysis method

: static

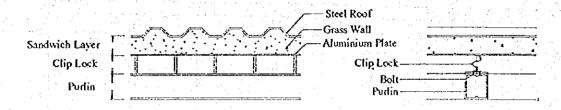
#### c. Loading Condition

#### 1) Dead load:

a) Sandwich Layer:

= 20 kg/m²

Contents:



- Grass Wall
- Aluminum Plate
- Steel Roof
- b) Bolts

= 2 kg/m²

c) Water of rain

 $= 2 \text{ kg/m}^2$ 

d) Lamps

= 20 kg

e) On point of support

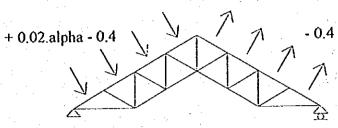
- Stretch of length

 $= 7.5 \, \mathrm{m}$ 

Weight of structure self : specific weight of steel = 7850 kg/m³

#### 2) Wind load:

$$P = V^2 / 16 \dots kg/m^2$$
  
Where  $V = 20 \text{ kg/m}^2$ 



 $Pmin = 25 \text{ kg/m}^2$ 

Alpha =  $\alpha$  = angle of roof

 $+0.02*\alpha - 0.4 = 0.02*30^{\circ} - 0.4$ 

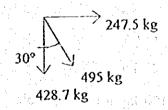
= 0.2

 $P_P = 25 \text{ kg/m}^2 + 0.2*25 \text{ kg/m}^2$ 

 $= 30 \text{ kg/m}^2$ 

where: Pp = pressure load

 $F_P = P_P * A_P = 30 \text{ kg/m}^2 * 7.5 \text{ m} * 6.6 \text{ m}$ 



= 1485 kg

 $i_{EP} = F_P / 3 = 495 \text{ kg}$ 

$$P_S = 25 \text{ kg/m}^2 - 0.4*25 \text{ kg/m}^2$$
  
= 15 kg/m<sup>2</sup>

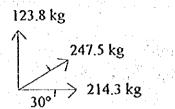
where : 
$$P_s = stuck load$$

$$F_S = P_S * A_S = 15 kg/m^2 * 7.5 m * 6.6 m$$

$$= 742.5 \text{ kg}$$

$$i_{FS} = F_s / 3$$

$$= 247.5 \text{ kg}$$



## 3) Live load:

$$= 75 \text{ kg}$$

= 100 kg for each people

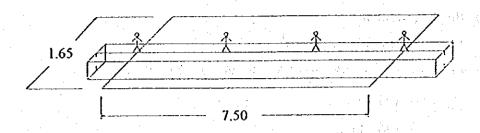
## d. Design of Purlin

#### Technique data:

$$= 1.65 \, \mathrm{m}$$

$$= 7.5 \text{ m} / 2$$

$$= 3.5 \, \text{m}$$



### 1) Dead load:

- Sandwich layer = 12 kg

– Bolt

= 2 kg

- Water of rain

= 2 kg

2) Wind load

= 30 kg +

Total Load

= 46 kg

Purlin load with purlin span 1.65 m

 $= 46 \times 1.65$ 

= 75.9 kg/m

≈ 76 kg/m

Purlin weight

= 15 kg/m

Q = 76 + 15

 $= 91^{\circ} \text{ kg/m}$ 

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

91 \* 0.866

= 78.086 kg/m

≈ 78 kg/m

3) Live load: weight of workers as point load = 100 kg

 $P_X = P_Y = P \cos \alpha$ 

 $= 100 \cos 30^{\circ}$ 

$$= 86.6$$

$$\approx 87 \text{ kg}$$

4) Bending Moment.

$$Mx = 1/8 \times Q_1 \times L^2 + 1/4 \times P_x \times L$$
 $Mx = 1/8 \times 78 \times 3.5^2 + 1/4 \times 87 \times 3.5$ 

= 195.56

 $\approx 196 \text{ kgm}$ 
 $Mx = My = 196 \text{ kgm} = 19600 \text{ kgcm}$ 

Tried type of Purlin Lip Channel in front to front arrangement 150x130x20x32

#### Checking:

Stresses:

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

= Mx/Wx + My/Wy

= 19600/143 + 19600/111

= 137.06 + 176.58

= 313.64

 $\approx$  314 <  $\sigma_{all} = 1400 \text{ kg/cm}^2$  (OK)

# Deflection: 14 (Mt); halfight the presentation

 $f_X = 5/384 \times Q_1 \times L^4/EI_x + 1/48 \times P_xL^3/EI_x$ 

 $= 5/384 \times 0.78 \times 350^4/2.1 \times 10^6 \times 1432$ 

 $+ 1/48 \times 87 \times 350^3 / 2.1 \times 10^6 \times 1432$ 

= 0.05 (+ 0.03) (+ 0.03)

fy =  $5/384 \times Q_1 \times L^4/EI_y + 1/48 \times P_yL^3/EI_y$ 

=  $5/384 \times 0.78 \times 350^4/2.1 \times 10^6 \times 834 + 1/48 \times 87 \times 350^3/2.1 \times 10^6 \times 834$ 

= 0.09 + 0.04

= 0.13 cm

$$f = (fx^2 + fy^2)^{1/2}$$

$$= (0.08^2 + 0.13^2)^{1/2}$$

$$= 0.15 \text{ cm} < f_{411} = 1/500 \text{ L} = 1/500 \text{ x} 750 = 1.50 \text{ cm} \text{ (OK)}$$

Shear Stress :

$$\sigma = \sqrt{(\sigma^2 + 3\tau^2)}$$
where  $\tau = 0.58 \times 1400$ 

$$= 812 \text{ kg/cm}^2$$

$$\sigma = \sqrt{(314^2 + 3\times812^2)}$$

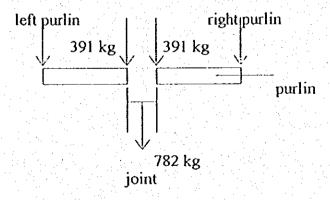
$$= 1441 \text{ kg/cm}^2 < 1.3 \sigma_{\text{all}} = 1820 \text{ kg/cm}^2 \text{ (OK)}$$

#### e. Design of Truss

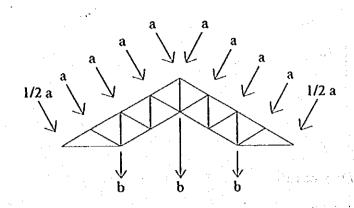
1) Point of support reaction on roof

Point of support reaction = load of roof + live load + purlin load  
= 
$$(46x1.65x7.5) + .100 + (15.6x7.5)$$
  
=  $781.75$   
 $\approx 782 \text{ kg}$ 

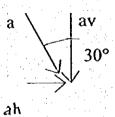
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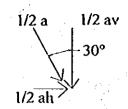
## 2) Truss calculation



- a = Point of support reaction caused load from roof + live load + purlin
  - = 782 kg
- b = load from hung lamp
  - = 20 kg



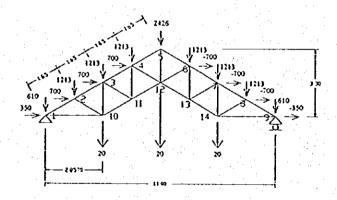
- $av = a \times cos 30^{\circ}$ 
  - $= 782 \times \cos 30^{\circ}$
  - = 677.23
  - ≈ 678 kg
- $ah = a \times sin 30^{\circ}$ 
  - $= 782 \times \sin 30^{\circ}$
  - = 391 kg



 $1/2av = 1/2a \times \cos 30^{\circ}$ = 391 x cos 30° = 338.6 \approx 339 kg

 $1/2ah = 1/2a \times \sin 30^{\circ}$ = 391 x sin 30° = 195.5 kg \approx 196 kg

egeny to a signal black as a collaboration as



# f. Prototype of Element

	and the state of t				
ſ	Profile	Plate Thickness	Ey	<u>Fu</u>	Diameter Bolt
		(mm)	(kg/cm <sup>2</sup> )	(kg/cm <sup>2</sup> )	(mm)
-	2 L - 70x70x7	8	3700	2400	17
	and the state of t		l	L	

# g. Recapitulation of Truss Element Force and Bolted Connection Design Maximum reactions and applied forces from three combinations.

<u>Joint</u>	Forces-X (Fx)	Forces-Y (Fy) (kg)	Moments (M) (kg.cm)
	(kg) 1847.20	5572.76	0
2	947.50	-1641.70	0 4
3	947.50	-1641.70	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
4	947.50	-1641.70	0
5	461.80	-2730.90	40 0
6	947.50	-1641.70	0
7	947.50	-1641.70	7 A A B O A SE
8	947.50	-1641.70	8 1 <b>0</b> 4 4 4
9	0 47	5573.00	0 1
10	0 1 2 2 2	-20.00	0
11	0 12 24 24	0	2 <b>0</b> 1 45
12	32.42 0 4.2.	-20.00	0
13	0.74.674	0	0
14	0 3 4 6 2	-20.00	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

#### Maximum from three combinations.

	Mambasa	Axial Force	Bolts	Stress	Status
<u>No</u>	<u>Members</u>	(kg)	DOILS	(kg/cm <sup>2</sup> )	Stress ≤ 1400 kg/cm <sup>2</sup>
		-11145.40	3	1048,82	OK!
2	2	-10050.80	3	945.81	OK!
3	3	-13386.60	3	1259.72	OK!
	4	-14533.70	4	1367.67	OK!
4	5	-15067.20	4	1166.92	OK!
5	6	-13224.80	3	1244.44	OK!
6	7	-10050.90	3	945.78	OK!
7		-11145.30	3	1048.76	OK!
8	8 9	11499.12	3	718.71	OK!
9		-2188.71	2	205.96	OK!
10	10		2	416.92	OK!
11	11	-4430.49	2	140.10	OK!
12	12	2241.64	2	210.95	OK!
13	13	-2241.67		13,45	OK!
14	14	215.15	2		OK!
15	15	12070.09	3	754.38	OK!
16	16	-1013.73	2	95.39	
17	17	-2651.14	2	249.48	OK!
18	18	2650.92	2	165.68	OK!
19	19	-4021.13	2	378.40	OK!
20	÷ 20 -	-2188.55	2	205.92	OK!
21	21	9651.94	3	603.25	OK!
22	22	11089.82	3	693.11	OK!
23	23	13331.47	4	833.22	OK!
24	24	12103.10	4	756.44	OK!
25	25	9452.07	3	590.75	OK!

# h. Checking of Members Strength

## 1) Due to tensile force

Maximum force on member 23.

Force (F) = 13331.47 kg

Length = 165 cm

Tried : 2 L - 70x70x7

Cross section area  $A = 2 \times 9.40 = 18.80 \text{ cm}^2$ 

$$\sigma_{sil} = 0.6 \text{ x Fy}$$

$$= 0.6 \text{ x 2400}$$

$$= 1440 \text{ kg/cm}^2$$

Stress

$$\sigma = F/A$$
= 13331.47/18.80
= 709.12 kg/cm<sup>2</sup> <  $\sigma_{411}$  (OK!)

2) Due to compression force

Maximum force on member 5.

Force 
$$(F) = 15067.20 \text{ kg}$$

Tried : 
$$2L - 70x70x7$$

Cross section area  $A = 2 \times 9.40 = 18.80 \text{ cm}^2$ 

$$ix = 2.28 cm$$

$$Ix = 2 \times 42.4 = 84.80 \text{ cm}^4$$

$$\lambda = L/ix$$

$$= 165/2.28$$

$$= 72.37$$

$$\lambda g = \pi (E/0.7x\sigma_1)^{1/2}$$

$$= 3.14 (2.1 \times 10^6 / 0.7 \times 2400)^{1/2}$$

$$= 111.07$$

$$\lambda s = \lambda / \lambda g$$

$$= 0.65$$

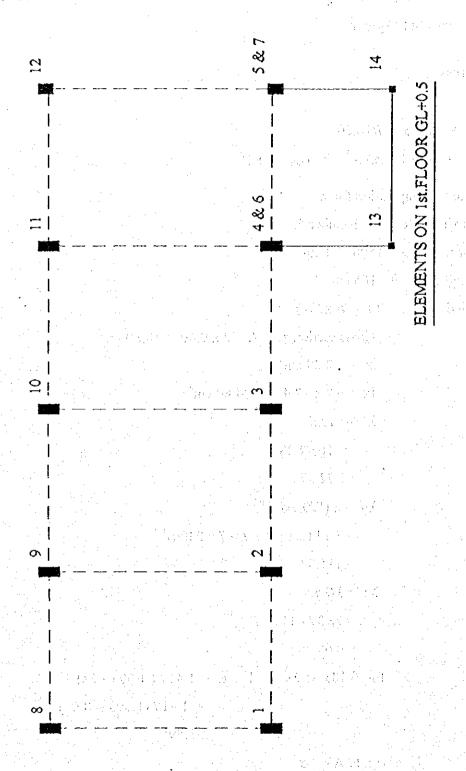
for 0.183 < 
$$\lambda$$
s < 1 :  $\omega = 1.41/(1.593 - \lambda s)$   
= 1.41/(1.593 - 0.65)  
= 1.495

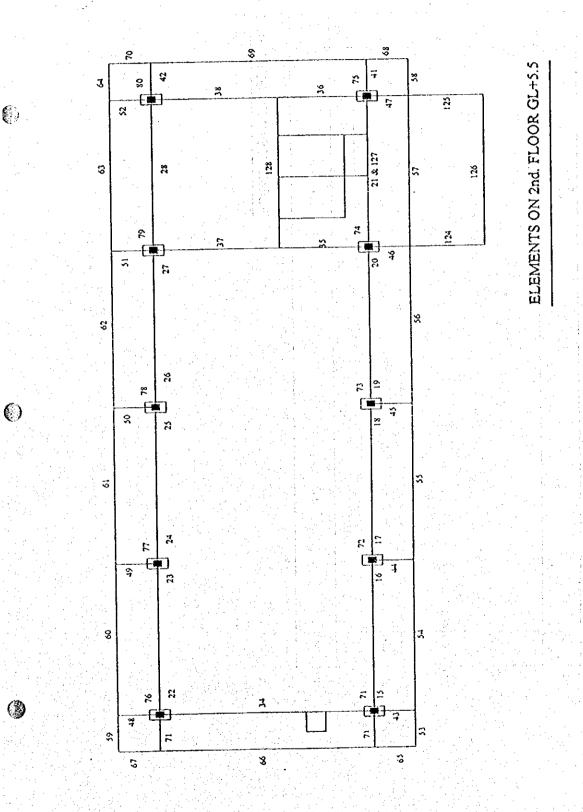
$$\omega \times F/A < \sigma$$

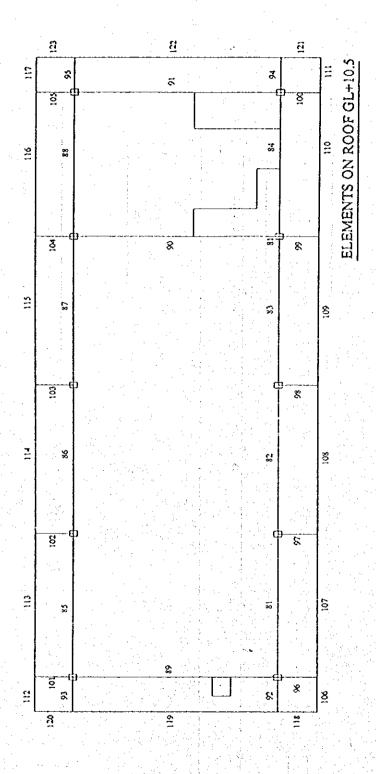
$$1.495 \times 15067.20/18.80 = 1202.17 < \sigma = 1400 \text{ kg/cm}^2 \text{ (OK!)}$$

#### 3. Design of Reinforcement Concrete Frame

## a. Structure of Reinforcement Concrete Frame







#### b. Dimensions

- length c-c column = 29.50 m
- width c c column = 10.40 m
- height ground to 2<sup>rd</sup> floor : 5.5 m
- height ground to roof truss: 10.5 m

#### c. Design Condition

)

- 1) Concrete compression strength fc' = 30 MPa (K-250 = (250 kg/cm²)
- 2) Reinforcing bar:
  - Plain bar fy = 2400 kg/cm<sup>2</sup> (BJTP 24)
    - Deformed bar fy =  $3700 \text{ kg/cm}^2(\text{BJTP }32)$
- 3) Structural model : space (xyz axis) frame
- 4) Analysis method : static rigid floor

#### d. Loading Condition

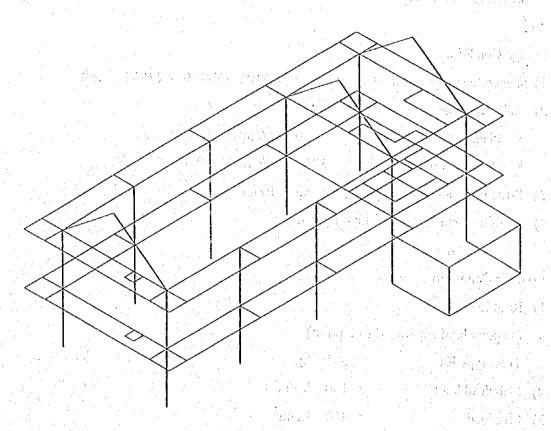
1) Roof load:

(as point load separated to 2 point)

Truss type K1 = 391 kg

- 2) Slab dead load =  $150 \text{ kg/m}^2$
- 3) Live load =  $400 \text{ kg/m}^2$
- 4) Concrete self weight = 2400 kg/m<sup>3</sup>
- 5) Brick wall 15 cm thick = 250 kg/m<sup>2</sup>

# e. Design of Frame



# f. Prototype of Element and Recapitulation of Frame Element Force

### 1) Column

### a) Column type 1

Prototype of Element

( )

	LIDIO	ype or	Licitor						ì
ſ	b	h	COVET	dia, main	dia.	fc .	i i fy	IV	l
١	(cm)	(cm)	(mm)	bar (mm)	surrup	(kg/cm²)	(kg/cm²)	(kg/cm²)	l
١				(deform)	(mm)		:		ļ
١	50	100	10	25	12	300	3700	2400	l
1						<u></u>	<u> </u>	L	•

	Frame	Element	Force		Design				
Members	Axial (kg)	Shear (kg)	Torsion (keen)	Moment (kgcm)	Main bar (mm)	Stinup (mm)	Pu (kg)	Mu (kg)	
	271730	7060	0	3886000	16D25	φ12-@150	639209	13659711	
	281350	2000	0	1101000	16D25	φ12-@150	639209	13659711	
- 2	269250	1430	0	789000	16D25	\$12-@150	639209	13659711	
4	398940	7890	0	3155000	16D25	φ12-@150	639209	13659711	
6	352880	20190	0	62640000	16D25	\$12-@150	639209	13659711	
8	271690	7030	0	3867000	16D25	\$12-@150	639209	13659711	
9	281690	1990	0	1096000	16D25	ბ12-@150	639209	13659711	
	267560	1280	0	708000	16D25	\$12-@150	639209	13659711	
10	367690	10790	0	5932000	16D25	φ12-@150	639209	13659711	

# b) Column type 2

Prototyne of Element

b (cm)	h (cm)		dia. main bar (mm) (deform)	dia. stirrup (rum)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
50	70	10	25	12	300	3700	2400

	<u></u>							1. (1.)	
ſ		Frame	Element	Force			Desi	gn	
l	Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mu (kg)
ŀ	5	317430	11490	0	4594000	16D25	φ12-@150	639209	13659711
ŀ	7	271340	20970	Ò	8352000	16D25	φ12 <i>-@</i> 150	639209	13659711
ł	12	283340	14660	0	8065000	16D25	φ12-@150	639209	13659711

# c) Column type 3

Prototype of Element

Č	Protot	fe	fv.					
	b (cm)	h (cm)		dia, main bar (mm) (deform)	dia. stirrup (mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)
ł	30	40	10	25 .	12	300	3700	2400

	Frame	Elemen	t Force		Design				
Members	Axial	Shear	Torsion	Moment	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mu (kg)	
71	(kg) 861300	(kg) 7950	(kgcm) 0	(kgcm) 2175000	8D25	φ12-@150	73559	2558345	
72	63820	1850	0	1648000	8D25	φ12-@150	73559	2558345	
73	61210	900	0	1653000	8D25	φ12-@150	73559	2558345	
74	87980	6530	. 0	1813000	8D25	φ12-@150	73559	2558345	
75	84960	3270	0	2846000	8D25	φ12-@150	n <b>73559</b>	2558345	
76	86150	7940	0	2173000	8D25	φ12-@150	73559	2558345	
77	63980	1800	0	1648000	8D25	φ12-@150	73559	2558345	
78	64210	900	0	1652000	8D25	ф12-@150	73559	2558345	
79	88140	6530	0	1824000	8D25	ф12-@150	73559	2558345	
80	84620	11200	0	2861000	8D25	φ12-@150	73559	2558345	

# d) Column type 4

Prototype of Element

b (cm)	h (cm)	cover	dia, main bar (mm) (deform)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fy (kg/cm²)
30	30	10	25	12	300	3700	2400

	Frame	Element	Force		Design				
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Mu (kg)	
13	69548	7500	0	2245897	8D25	φ12-@200	73559	2558345	
14	64287	7590	0	2145679	8D25	φ12 <i>-@2</i> 00	73559	2558345	

# 2) Beam

# a) Beam type a

Prototype of Element

	PIOLO	type of c	ениен				rate and the second	
	ь	b H cover		dia. Main bar	dia. stirrup	fc'	ſy	fv
i	(cm)	(cm)	(mm)	(mm)	(mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)
		1. 1. 1.	- 1 Miles	(deform)		2.0	<u> </u>	
	60	100	10	25	16	300	3700	2400

<u>, ,</u>		Frame Element	Force	
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)
15	2350	49780	2115000	7222000
16	2350	90360	2115000	10597000
17	1690	82450	171000	10430000
18	1690	80130	171000	9293000
19	1960	79720	2602000	9439000
20	1960	82860	2602000	9629000
22	2310	72230	2107000	10581000
23	2310	90520	2107000	10581000
24	1610	82810	188000	11090000
25	1640	79770	188000	9954000
26	1610	65920	2688000	9992000
$\frac{20}{27}$	1340	83880	2688000	11940000

 $(\cdot)$ 

		Design	
Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
15	D25	\$16@-250	12593676
16	D25	\$16-@250	12593676
17	D25	δ16-@250	12593676
18	D25	\$16-@250	12593676
19	D25	\$16-@250	12593676
20	D25	\$16-@250	12593676
22	D25	\$16 <i>-@</i> 250	12593676
23	D25	\$16-@250	12593676
24	D25	<b>♦16-@250</b>	12593676
25	D25	\$16-@250	12593676
26	D25	φ16-@250	12593676
27	D25	\$16-@250	12593676

				Desi	gn			11.00 7.	
Members		Left Bar	g-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1		Middle Bar			Right Ba	r
	Тор	Mid	Bottom	Top	Mid	Bottom	Тор	Mid	Bottom
15	9D25	4510	4D25	4D25	4\$10	9D25	9D25	4610	4D25
16	9D25	4ֆ10	4D25	4D25	4610	9D25	9D25	4 <b></b> 410	4D25
17	9D25	4610	4D25	4D25	4 <b>þ10</b>	9D25	9D25	4 <b>þ10</b>	4D25
18	9D25	4\$10	4D25	4D25	4610	9D25	9D25	4 <b></b> 410	4D25
19	9D25	4410	4D25	4D25	4510	9D25	9D25	4 <b>þ1</b> 0	4D25
20	9D25	4510	4D25	4D25	4610	9D25	9D25	4 <b>¢10</b>	4D25
22	9D25	4510	4D25	4D25	4510	9D25	9D25	4010	4D25
23	9D25	4410	4D25	4D25	4610	9D25	9D25	4510	4D25
24	9D25	4410	4D25	4D25	4510	9D25	9D25	4610	4D25
25	9D25	4510	4D25	4D25	4410	9D25	9D25	4510	4D25
26	9D25	4410	4D25	4D25	4610	9D25	9D25	4610	4D25
27	9D25	4\$10	4D25	4D25	4510	9D25	9D25	4510	4D25

#### b) Beam type b

Prototype of Element

b (cm)	h (cm)	cover (mm)	dia, Main bar (tum) (defortu)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
40	100	10	25	` 12	300	3700	2400

		Frame Element	Force		
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)		Moment (kgcm)
34	2100	53570	96000		8737000
35	3120	68780	1344000		12196000
36	3900	77270	1084000		13062000
37	3120	68420	1385000		11963000
38	3890	76790	1014000	1 14 1 2	12791000

		Design	
Members	Main Bar (mm)	Stirrup Bar (nun)	Mu (kgcm)
34	D25	\$12 <i>-@</i> 250	13139677
35	D25	\$12 <i>-@</i> 250	13139677
36	D25	<b>∮12-@250</b>	13139677
37	D25	\$12 <i>-@</i> 250	13139677
38	D25	φ12-@250	13139677

	10 mg	1 11 1		Des	ign						
Members	11.00	Left Bar	14.5		Middle Bar		4.7%	Right Bar			
in a second	Тор	Mid	Bottom	Тор	Mid	Bottom	Top	Mid	Bottom		
34	15D25	4610	6D25	6D25	4\$10	15D25	15D25	4 <b></b> 010	6D25		
35	15D25	4610	6D25	6D25	4610	15D25	15D25	4610	6D25		
36	15D25	4510	6D25	6D25	4610	15D25	15D25	4ф10	6D25		
37	15D25	4010	6D25	6D25	4\$10	15D25	15D25	4610	6D25		
38	15D25	.4010	6D25	6D25	4\$10	15D25	15D25	4610	6D25		

c) Beam type c

Prototype of Element

PIOIO	type or E	emein	r Bergere e e <u>e e e e e e</u>				
b	ħ	cover	dia. Main bar	dia. stirrup	fc'	fy 2	fv 2
(cm)	(cm)	(mm)	(mm)	(mm)	(kg/cm')	(kg/cm²)	(kg/cm <sup>-</sup> )
1 P		1.00	(deform)				
35	100	10	25	[A:10 : i -	300	3700	2400
1 1 7 7 1 1	1			F 1 2 2 2 3 3 4	1		

·	**************************************	Frame Element	Force	
Members	Axial (kg)	Shear (kg) 53540	Torsion (kgcm) 1244000	Moment (kgcm) 10685882
21 28	2156 2250	55470	1124000	13546854

n Bar (mm)	Design Stirrup Bar (mm)	Mu (kgcm)
D25	\$10 <i>-@</i> 40	11736664
D25	\$10-@40	11736664
	n Bar (mm) D25 D25	D25 \$10-@40

	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	17 a + 1,1				•					
-	Bad I	1 18 2 2	sza kar	<u> </u>		Design			Right Bar		
Ì	Members		Left Bar			Middle Bar					
1		Top	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Bottom	
١		ļ	4610	6D25	6D25	4410	13D25	13D25	4610	6D25	
ļ		13D25			6D25	4610	13D25	13D25	4610	6D25	
	28	13D25	4410	6D25	0023	1 4010	1	L	I	L	

# d) Beam type d

9

11.5	Proto	type of E	lement			60'	6	fe
	(cm)	h (cm)	(mm)	dia. Main bar (mm) (deform)	dia. stirrup (mm)	(kg/cm²)	(kg/cm <sup>-</sup> )	(kg/cm²)
	30	75	8	25	12	300	3700	2400

Jan 1947 Vill		Frame Element	Force	
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)
81	5050	14780	297000	2048000
	5660	14810	0	1989000
82	3820	14990	259000	44 91944 # 11 2103000
83	2340	14850	42000	2078000
81	5110	14790	297000	2042000
85	5740	14660	0	1989000
86	3810	15000	259000	2101000
87 88	2720	14840	41000	2080000

88	2720	74010	
		Design	
Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
81	D25	\$12 <i>-@</i> 50	2884256
82	D25	\$12-@50	2884256
83	D25	\$12 <i>-@</i> 50	2884256
81	D25	φ12-@50	2884256
	D25	\$12 <i>-@</i> .50	2884256
85	D25	\$12-@50	2884256
86	D25	φ12-@50	2884256
87	D25	\$12-@50	2884256
88	1 1023	1 7.2 (32	

	11 2			Design						
Members	Left Bar			Middle Bar			Right Bar			
	Тор	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Bottom	
. 81	3D25	4410	2D25	2D25	4 <b>¢10</b>	3D25	3D25	4610	2D25	
82	3D25	4010	2D25	2D25	4410	3D25	3D25	4610	2D25	
83	3D25	4610	2D25	2D25	4 <b>\$10</b>	3D25	3D25	4610	2D25	
84	3D25	4610	2D25	2D25	4410	3D25	3D25	4 <b>\$10</b>	2D25	
85	3D25	4010	2D25	2D25	4 <b>\$10</b>	3D25	3D25	4610	2D25	
86	3D25	4 <b>¢10</b>	2D25	2D25	4 <b>¢10</b> -	3D25	3D25	4410	2D25	
87	3D25	4410	2D25	2D25	4 <b>φ10</b>	3D25	3D25	4 <b>¢10</b>	2D25	
88	3D25	4410	2D25	2D25	4 <b></b> 410	3D25	3D25	4\$10	2D25	

#### e) Beam type e

Prototype of Element

(cm)	b h cover (cm) (cm) (mm)		dia. Main bar dia. stirr (nun) (mm) (deform)		fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)	
30	75	8	25	12	19 300	3700	2400	

	The second of th	Frame Element	Force		
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)	
89	5380	21980	0		3927000
90	5430	21980	0	to the property of the	4094000
91	10510	21980	0		39090(X)

		Design and the state of the sta						
Members	Main Bar (nun)	Stirrup Bar (mm)	Mu (kgcm)					
89	D25	\$12 <i>-6</i> 050	4611165					
90	D25	<b>\$12-@50</b>	4611165					
91	D25	<b>∮12-@50</b>	4611165					

	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			Des	ign	14 14 (1.1.)				
Members	Left Bar			14 74 £ i	Middle Bar			Right Bar		
	Тор	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Bottom	
89	5D25	4\$10	2D25	2D25	4610	5D25	5D25	4\$10	2D25	
90	5D25	4610	2D25	2D25	4410	5D25	5D25	4410	2D25	
91	5D25	4610	2D25	2D25	4610	5D25	5D25	4610	2D25	

## f) Beam type f

Prototype of Element

	LIOIO	type or E	iculciii					
	b	h	cover	dia. Main bar	dia. stirrup	fc'	fy	fy .
.	(cm)	(cm)	(mm)	(mm)	(mm)	(kg/cm <sup>-</sup> )	(kg/cm²)	(kg/cm²)
				(deform)				
	35	70	8	25	12	300	3700	2400
1								

		Frame Element	Force		
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)	
128	190	29030	0		2902000

. [			Design	
	Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
	128	D25	<b>ķ12-@50</b>	4261033

	100			Desi	ign			* * * * * * * * * * * * * * * * * * *	
Members	Fig. 1	Left Bar	3 - 1	1	Middle Bar			Right Ba	r
	Тор	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Bottom
128	5D25	4∳10	2D25	2D25	4610	5D25	5D25	4 <b>¢10</b>	2D25

## g) Beam type g

Prototype of Element

	1100	Cype Or Es	CHICH			r		
1	В	b	cover	dia. Main bar	dia. stirrup	ſĊ _	fy	(v
1	(cm)	(cm)	(mm)	(mm)	(mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)
			* .	(deform)				
	30	60	8	25	12	300	3700	2400
						and the second s		

ĺ					
	Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)
ı	124	3110	12970	55000	1470000
Ì	125	3100	13130	48000	1562000
1	126	3480	14580	5000	1458000
1	127	19240	14640	6000	1768000

		Design	
Members	Main Bar (mm)	Stirrup Bar (nım)	Mu (kgcm)
124	D25	φ12-@50	2127644
125	D25	<b>♦12-</b> @50	2127644
126	D25	\$12-@50	2127644
127	D25	φ12-@50	2127644

	<del></del>			Des	ien		1		
) (a b a		Left Bar			Middle Bar			Right Ba	r
Members	Тор	Mid	Bottom	Top	Mid	Bottom	Тор	Mid	Bottom
124	3D25	4410	2D25	2D25	4610	3D25	3D25	4\$10	2D25
124		4510	2D25	2D25	4610	3D25	3D25	4 <b>ộ10</b>	2D25
125	3D25		2D25	2D25	4610	3D25	3D25	4410	2D25
126	3D25	4910	2D25	2D25	4610	3D25	3D25	4510	2D25
127	3D25	4610	2023	2,172,5	<u> </u>	1	L		

()

# h) Beam type h

T		
UCATAT	VIDE AL	ribiliciii
FIUIUI	TUV VI	Element

b (cm)	h (cm)	cover	dia. Main bar (mm) (plain)	dia, stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)	
10	110	4	10	8	300	3700	2400	

		Frame Element	Force	The second second
Members	Axial	Shear	Torsion	Moment
	(kg)	(kg)	(kgcm)	(kgcm)
53	10	1950	0	195000
54	270	5930	0	766000
55	600	5230	. 0	706000
56	600	5230	0	706000
57	270	5930	0	766000
58	10	1950	0	195000
59	10	1940	0_	194000
60	10	1950	0_	195000
61	620	5250	0	707000
62	620	5250	0	707000
63	70	5990	0	772000
64	10	1950	8 F 10 O	195000
65	0	3970	0	472000
66	30	7400	0	1436000
67	0	3960	0	470000
68	0	3970	0	472000
69	30	7400	88 0	1436000
70	0	3960	0	470 <b>000</b>
106	10	: 1950	0	195000
107	270	5930	0	766000
108	600	5230	0	706000
109	600	5230	0	706000
110	270	5930	0	766000
111		1950	0	195000
112	10	1940	0	194000
113	10	1950	0	195000
114	620	5250	0	707000
	620	5250	0	707000
116	70	5990	0	772000
117	10	1950	0	195000
118	0	3970	0	472000
119	30	7400	2 2 2 2 0	1436000
120	0	3960	0	470000
121	0	3970	0	472000
122	30	7400	: 1 O	1436000
123	Walled A to 0	3960	0	470000

	area di	Design	
Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
53	φ10	¢8 <i>-@</i> 150	1767837
. 54	φ10	¢8-@150	1767837
55	φ10	<b>ķ8-@150</b>	1767837
56	φ10	<b>ċ</b> 8 <i>-@</i> 150	1767837
57	φ10	<b>48-@150</b>	1767837
58	φ10	<b>∳</b> 8-@150	1767837
59	φ10	<b>ф8-@150</b>	1767837
60	φ10	<b>ф8-@150</b>	1767837
61	φ10	<b>φ8-@150</b>	1767837
62	φ10	<b>ċ8-@150</b>	1767837
63	φ10	<b>¢8-@150</b>	1767837
64	φ10	<b>\$8-@150</b>	1767837
- 65	φ10	<b>ф8-@150</b>	1767837
66	<b>φ10</b>	¢8 <i>-</i> @150	1767837
67	φ <b>1</b> 0	¢8-@150	1767837
68	φ10	<b>\$8-@150</b>	1767837
69	φ10	<b>ბ</b> %-@150	1767837
70	φ10	<b>♦8-</b> @150	1767837
106	φ10	\$8-@150	1767837
107	<b>φ10</b>	<b>\$8-@150</b>	1767837
108	φ10	<b>\$8-@150</b>	1767837
109	<b>φ10</b>	<b></b>	1767837
110	φ10	<b>φ8-@150</b>	1767837
* 111	<b>φ10</b>	<b>\$3-@150</b>	1767837
112	φ10	¢8-@150	1767837
113	<b>φ10</b>	<b>\$8-@150</b>	1767837
114	<b>φ10</b>	ф8-@150	1767837
115	φ10	\$8-@150	1767837
116	φ10	<b>♦8-@150</b>	1767837
117	φI0	<b>¢8-@150</b>	1767837
118	φ <u>10</u>	<b>♦8-@150</b>	1767837
119	φ10	<b>₹8-@150</b>	1767837
120	φ10	<b>♦8-@150</b>	1767837
121	φ10	<b>\$</b> \$-@150	1767837
122	φ10	<b>\$8-@150</b>	1767837
123	\$10	<b>\$8-@150</b>	1767837

			-	Desi	gn				
Members		Left Bar		N	Middle Bar			Right Bar	
	Тор	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Botton
53	2φ10	12010	2φ10	2∳10	12410	2¢10	2 <b></b> 0 0	12410	2¢10
54	2φ10	12610	2φ10	2010	12410	2¢10	2610	12010	2¢10
55	2ტ10	12010	2\$10	. 2ბ10	12410	2φ10	2610	12410	2510
56	2¢10	12610	2ბ10	2ტ10	12010	2¢10	2ბ10	12\$10	2610
57	2ბ10	12010	2φ10	2ბ10	12010	2φ10	2¢10	12φ10	2 <b>¢1</b> 0
58	2¢10	12φ10	2610	2¢10	12010	2610	2ტ10	12φ10	2¢10
59	2010	12410	2φ10	2փ10	12510	2ტ10	2610	12410	2010
60	2010	12410	2410	2¢10	12010	2∳10	2¢10	12410	2∳10
61	2φ10	12410	2\$10	2փ10	12410	2610	2610	12410	2610
62	2գ10	12φ10	2φ10	2ბ10	12փ10	2ф10	2փ10	12\$10	2∳10
63	2¢10	12\$10	2փ10	2 <b></b> \$10	12\$10	2φ10	2¢10	12φ10	2410
64	2610	12φ10	2610	2փ10	12610	2ф10	2수10	12\$10	2\$10
65	2ბ10	12010	2φ10	2¢10	12510	2∳10	2010	12010	2410
66	2φ10	12φ10	2φ10	2¢10	12410	2010	2410	12010	2∳10
67	2 <b>\$10</b>	12410	2φ10	2610	12010	2ტ10	2∳10	12ბ10	<u>2610</u>
68	2¢10	12φ10	2φ10	2610	12φ10	2ტ10	2¢10	12410	2∳10
69	2\$10	12010	2փ10	2ბ10	12010	2փ10	2∳10	12010	2ტ10
70	2610	12410	2φ10	2ტ10	12¢10	2¢10	2510	12610	2610
106	2010	12010	2ф10	2φ10	12510	2φ10	2010	12010	2\$10
107	2010	12010	2φ10	2φ10	12010	2610	2010	12010	2¢10
108	2ტ10	12010	2010	2410	12510	2410	2910	12\$10	2 <b></b> 0
109	2010	12010	2φ10	2φ10	12610	2010	2¢10	12410	2 <b></b> 410
110	2610	12010	2φ10	2010	12610	2010	2610	12010	2610
111	2010	12510	2φ10	2φ10	12610	2수10	2610	12610	2&10
112	2փ10	12\$10	2410	2φ10	12610	2ტ10	2410	12410	2ఫ10
113	2010	12\$10	2ბ10	2010	12610	2փ10	2010	12410	2\$10
114	2∳10	12610	2φ10	2ф10	12610	2φ10	2010	12410	2410
115	2010	12510	2010	2510	12010	2∳10	2§!0	12410	2910
116	2010	12010	2010	2010	12410	2φ10	2∳10	12\$10	2¢10
117	2010	12010	2φ10	2010	12010	2610	2010	12010	2ტ10
118	2¢10	12\$10	2\$10	2610	12\$10	2 <b>∳10</b>	2610	12610	2610
119	2¢10	12010	2φ10	2610	12510	2610	2610	12010	2∳10
120	2¢10	12010	2\$10	2∳10	12010	2փ10	2∳10	12410	2ֆ10
121	2φ10	12010	2\$10	2910	12010	2610	2\$10	12610	2 <b></b> §10
122	2010	12410	2610	2∳10	12010	2610	2410	12510	2610
123	2φ10 2φ10	12010		2610	12010	2φ10	2010	12610	2∳10

### i) Beam type i

Prototype of Element

	Proto!	type of E	lement			ſo'	fv	fy	Ì
	b (cm)	h (cm)	cover (mm)	dia. Main bar (mm)	dia. stirrup (mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)	
41.50	(0.1.)		7327 6	(deform)	10	300	3700	2400	1
	20	50	4	]25	L	1			Ē.

		and the second of the second o			1
1	100		Design	46 <u>74 [14] 4 -</u>	
:	California Bar	Tangka Sasa i S	Left, Mid and Righ	it Bar	
	Stirrup Bar	Top	Mid	Botton	1
	(mm) 810-@150	6D25	2810	3D25	
	เ ธเบสตมวง	0025			

# j) Beam type j

6 (cm) (cm) (mm) (mm) (kg/cm²) (kg/cm²)	IV.	l fe	fo'			emem	type of El	- Proto
	(kg/cm²)	(kg/cm²)	(kg/cm²)	dia. stirrup (nun)	(mm)		h (cm)	b (cm)
(deform) 10 300 3700	2400	3700	300	10	(deform)			

		esign	Par
Stirrup Bar		N, Mid and Right Mid	Bottom
(mm)	Тор	2610	2D25
\$10-@150	3D25	2010	<u> </u>

### k) Beam type k

		IV I	IV I
b h cover dia. Main bar dia. stirrup	10 10 10 10 10 10 10 10 10 10 10 10 10 1	(kg/cm²)	(kg/cm²)
(cm) (cm) (mm) (mm) (k	kg/cm')	(vBcm)	("5"
(deform)		2700	2400
25 25 10	300 <u> </u>	3700	2400

		<u>na an an itan</u> Januari Barata		De	sign	. 14 144	14 4 4		
	r	Left Bar			Middle B	ar	stat ₹	Right B	ar
Stirrup Bar	70	Mid	Bottom	Top	Mid	Bottom	Тор	Mid	Bottom
(mm)	Top	iviiu	2D25	2D25		2D25	2D25	- >	2D25
\$10-@150	2D25	!	2025	1 ====		111			

Proto	type of El	ement			<u> </u>	ſv	fs
b (cm)	H (cm)	cover	dia. Main bar (mm)	dia. stirmp (mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)
			(deform)	10	300	3700	2400
20	30	4	1 2)	10	1	L	

	nder gestellt der g	Design	
Stirrup Bar	Bar		
(mm)	Тор	Mid	Bottom
\$10-@150	3D25	2410	, 3D25

### m) Beam type m

**(** )

	Proto	type of E	iement					
	b (cm)	h (cm)	cover (mm)	dia, Main bar (mm) (plain)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
1	10	75	4	10	8	300	3700	2400

	en en en en en en	Design	
Stirrup Bar		Bar	
(mm)	Тор	Mid	Bottom
<b>\$8-@150</b>	2410	10\$10	2∳10

### n) Beam type n

b (cm)	h (cm)	cover (mm)	dia. Main bar (mm) (deform)	dia. stirrup (mm)	fc (kg/cm²)	fy (kg/cm²)	(kg/cm²)
25	45	4	25	10	300	3700	2400

		. ya	1.00	Des	ign		147 1	2.7	
Stirrup Bar	1,476,47	Left Bar	- 15 11 11		Middle B	ar i 🚈 🗀	30.075	Right B	<del>r</del>
(mm)	Тор	Mid	Bottom	Top	Mid	Bottom	Top	Mid	Bottom
\$10-@150	3D25	2610	2D25	2D25	2ф10	3D25	3D25	2610	2D25

### o) Beam type o

	FIOLO	type of L	Cittone				I	
-	b	h	cover	dia. Main bar	dia. stirrup	lc .	l ly	lv ,
	(cm)	(cm)	(mm)	(mm)	(nun)	(kg/cm <sup>+</sup> )	(kg/cm²)	(kg/cm²)
1	777.74	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		(plain)				
	15	15	4	12	18/010 16/2	300	3700	2400
								5.77

			J. 5.4 Proces	Des	ign		51,75 (A) <u>1</u>		**************************************
Stirrup Bar		Left Bar			Middle F	Bar	4 4 4 1	Right B	ar
(mm)	Top	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Bottom
φ10@-150	2D12	9 <u>1</u> 15	2D12	2D12	-	2D12	2D12		2D12

### p) Beam type p

Prototype of Element

	LIOLO	COPO OF E	CHICH						
ļ	b	h	cover	dia. Main bar	dia, stirrup	fc'	er fy (	fv	İ
	(¢m)	(cm)	(mm)	(mm)	(aun)	(kg/cm²)	(kg/cm²)	(kg/cm²)	
				(deform)				181	
	15	20	4	- 16	8	300	3700	2400	

Design									
Stirrup Bar		Left Bar			Middle B	ar	1 11 11 1	Right B	ar
(mm)	Top	Mid	Bóttóm	Top	Mid	Bottom	Тор	Mid	Bottom
<b>♦8-@200</b>	2D16	-	2D16	2D16	-	2D16	2D16		2D16

## q) Beam type q

Prototype of Element

	11000	.) P = 0. ~	Citionic					
	b	h	cover	dia. Main bar	dia. stirrup	fc'	fy i	fv
	(cm)	(cm)	(mm)	(mm)	(mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)
. 1	:			(plain)		matika ba	the second	
	10	22	4	12	8	300	3700	2400

		Ocsign	
Stirrup Bar	L	cft, Mid and Rig	ht Bar
(nım)	Тор	Mid	Bottom
<b>♦8-@200</b>	2¢12		2¢12

### 3) Slab

# a) Slab of control office in the 2<sup>nd</sup> floor

t	1	W	cover	dia. Main bar	ſc'	fy	fv.
(cm)	max	max	(mm)	(mm)	(kg/cm²)	(kg/cm²)	(kg/cm²)
	(cm)	(cm)		(plain)			
15	750	622.5	4	12	300	3700	2400

ſ		 Moment		
Г	Mix (kgcm)	Mly (kgcm)	Mux (kgcm)	Mtiy (kgcm)
Г	72000	22000	- 110000	12000

Design (x and y dir	ection)
Point of support Bar	Yield Bar
φ12-@100	φ12-@150

b) Slab with lx = 1000 mm on canopy above windows and entrance ly = 1000 mm

			_ *					
t (cm)	(cm)	w (cm)	(mm)	dia, Main bar (mm) (plain)	(kg/cm²)	fy (kg/cm²)	fv (kg/cm²)	
15	100	100	4	10	300	3700	2400	

Design (x and y di	rection)
Point of support Bar	Yield Bar
\$10-@150	φ10-@150

c) Slab with 1x = 1000 mm between each console 1y = 1000 mm

t (cm)	(cm)	w (cm)	cover (mm)	dia. Main bar (num) (olain)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
12	100	100	4	12	300	3700	2400

Design (x and y di	rection)
Point of support Bar	Yield Bar
\$12-@100	φ12-@100

d) Slab with 1x = 1000 mm on stairs

ly = 1000 mm

	(cm)	(cm)	w (cm)	(mm)	dia. Main bar (mm) (plain)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
	15	100	100	4	12	300	3700	2400
Ī					10	<u> </u>	1 + 1	

Design (y direction	)	D16-@150
Design (x direction		ф12-@150

e) Slab of entrance roof

 32 to 30 to 30 to		5 12 1 1 1	i e	and the second s			
(cm)	l max	w max	cover (mm)	dia. Main bar (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
(cm)		1	(11111)	(plain)	\ <b>,</b>	,	, ,
	(cm)	(cm)_		(piaiti)			
15	750	150	4	12	300	3700	2100
		1				L	

Design (x and y dir	ection)
Point of support Bar	Yield Bar
\$12 <i>-@</i> 100	\$12 <i>-@</i> ,100

()

### 4. Design of Element Profile of Crane Andrews

Load crane = 25000 kg

Maximum moment = 1/4 PL

= 1/4 \* 25000 \* 750

= 4687500 kg.cm

Use IWF- 494 x 302 x 13 x 21

 $I_X = 83800 \text{ cm}^4$ 

 $Iy = 9660 \text{ cm}^4$ 

 $Wx = 3390 \text{ cm}^3$ 

 $Wy = 640 \text{ cm}^3$ 

#### Checking:

Stresses:

 $\sigma = M_{max}/Wx$ 

= 4687500/3390

=  $1382.74 < \sigma_{\text{all}} = 1400 \text{ kg/cm}^2$  (OK)

### Deflection :

$$f = 1/48 \times PL^3/EI_x$$

 $= 1/48 \times 25000 \times 750^3 / 2.1 \times 10^6 \times 83800$ 

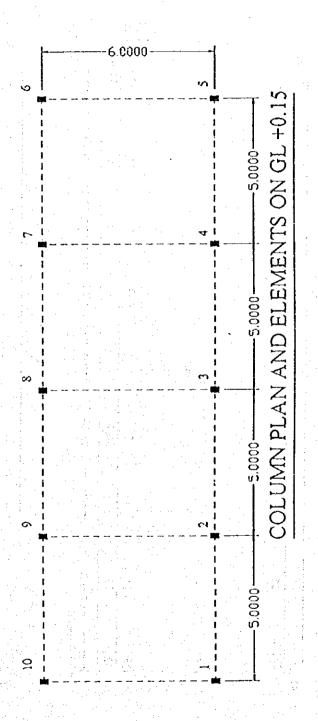
= 1.24 cm  $< f_{sll} = 1/500 L = 1/500 x 750 = 1.50 cm (OK)$ 

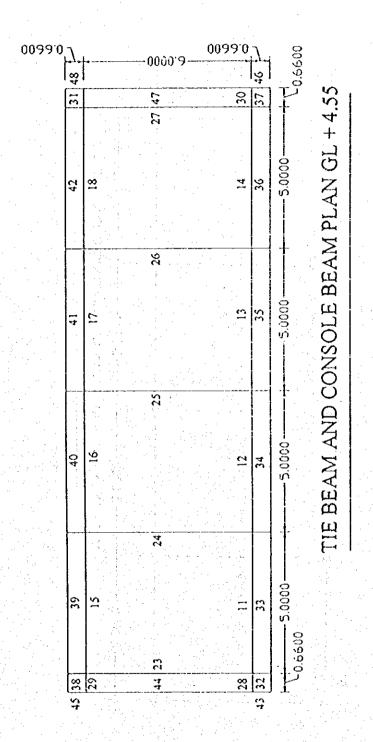
5.3 Design of Garage

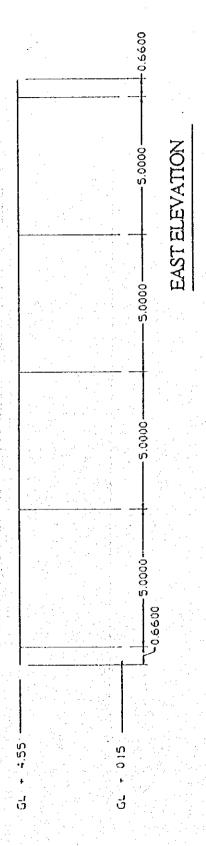
# JATIBARANG GARAGE STRUCTURE CALCULATION

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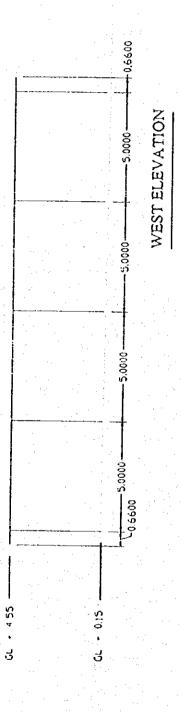
### 1. General Construction

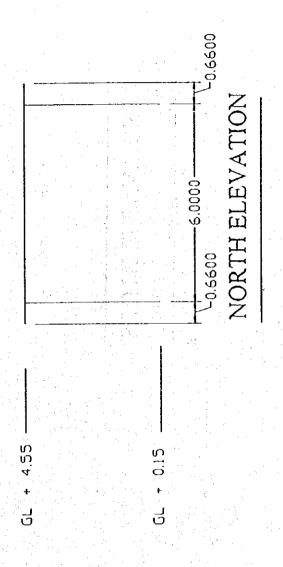


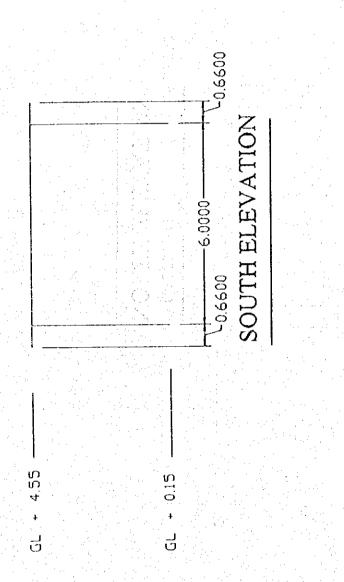




D



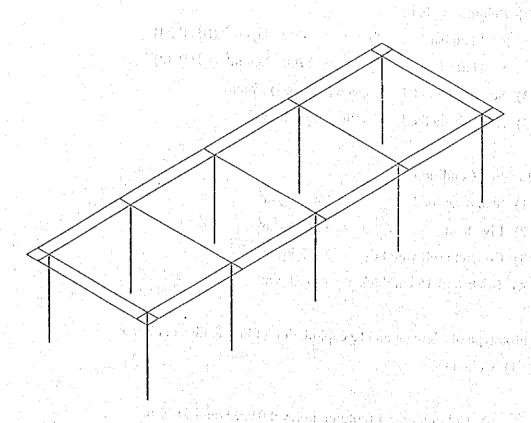




2. Design Of Reinforcement Concrete Frame

(

a. Structure of Reinforcement Concrete Frame



#### b. Dimensions

- length c c column = 20.00 m
- width  $c c \cot m = 6.00 \text{ m}$
- height ground to roof = 4.11 m

### c. Design Condition

- 1) Concrete compression strength fc'= 30 MPa (K-250 = 250 kg/cm²)
- 2) Reinforcing bar:
  - Plain bar fy =  $2400 \text{ kg/cm}^2 \text{ (BJTP 24)}$
  - Deformed bar fy =  $3700 \text{ kg/cm}^2$  (BJTP 32)
- 3) Structural model : space (xyz axis) frame
- 4) Analysis method : static rigid floor

#### d. Loading Condition

- 1) Slab dead load = 150 kg/m<sup>2</sup>
- 2) Live load =  $400 \text{ kg/m}^2$
- 3) Concrete self weight = 2400 kg/m<sup>3</sup>
- 4) Brick wall 15 cm thick = 250 kg/m<sup>2</sup>

# e. Prototype of Element and Recapitulation of Frame Element Force

1). Column

a) Column type I (column in level 0+000 until 5+500)

Prototype of Element

Prototy	/pe or .	Riemen					
b (cm)	h (cm)	cover (mm)	dia. main bar (mm) (deform)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
20	30	10	25	10	300	3700	2400

	Frame I	Element	Force			Desi	gn	
	Axial	Shear	Torsion	Moment	Main bar	Stirrup	Pu	Mu
Members	(kg)	(kg)	(kgcm)	(kgcm)	(mm)	(mm)	(kg)	(kgcm)
1	30410	1160	0	464000	4D25	\$10@-300	36354	611587
2	35290	1480	0	591000	4D25	φ10@-300	36354	611587
	34510	1480	0	591000	4D25	<b>♦10</b> @-300	36354	611587
3	35290	1480	0	591000	4D25	φ10@-300	36354	.611587
1.4 (15)			0	464000	4D25	<b>\$10</b> @-300	36354	611587
5	30410	1160		464000	4D25	\$10@-300	36354	611587
6	30410	1160	0	L	4D25	\$10/20-300	36354	611587
7	35290	1480		591000		<del></del>	36354	611587
8	34510	1480	0	590000	4D25	φ10@-300		
9	35290	1480	0	591000	4D25	\$10@-300	36354	611587
10	30410	1160	0	464000	4D25	φ10@-300	36354	611587

# 2). Beam (1997)

# a) Beam type a

Prototype of Element

b (cm)	h (cm)	cover	dia. Main bar (nun)	dia. stirwp (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)	
20	40	10	(deform) 16	10	300	3700	2100	j

		Frame Element	Force	
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)
11	80	6730	16000	666000
12	60	6990	0	664000
13	60	6990	0	664000
13	80	7140	16000	666000
15	80	7140	16000	666000
16	60	6990	0	664000
17	60	6990	0	664000
18	80	7140	16000	666000

Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
11	D16	ф10-@50	673254
12	D16	\$10 <i>-@5</i> 0	673254
13	D16	φ10-@50	673254
14	D16	φ10-@50	673254
15	D16	φ10-@50	673254
16	D16	φ10-@50	673254
17		φ10 <i>-(</i> @50	673254
18	D16	\$10-@50	673254

		•. •	·.	Desi	gn				
Members		Left Bar			Middle Bar			Right Ba	ı.
	Top	Mid	Bottom	Тор	Mid	Bottom	Top	Mid	Bottom
11	2D16	2410	2D16	2D16	2φ10	2D16	2D16	2\$10	2D16
12	2D16	2410	2D16	2D16	2010	2D16	2D16	2ф10	2D16
13	2D16	2610	2D16	2D16	2410	2D16	2D16	2410	2D16
14	2D16	2410	2D16	2D16	2010	2D16	2D16	2φ10	2D16
15	2D16	2010	2D16	2D16	2610	2D16	2D16	2410	2D16
16	2D16	2010	2D16	2D16	2610	2D16	2D16	2010	2D16
17	2D16	2010	2D16	2D16	2010	2D16	2D16	2410	2D16
18	2D16	2610	2D16	2D16	2610	2D16	2D16	2φ10	2D16

# b) Beam type b

Prototype of Element

b (cm)	h (cm)	(mm) cover	dia. Main bar (mm) (deform)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
20	40	10	16	10	300	3700	2400

		Frame Element	Force	ff out the back of the de-
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)
23	1150	11090	72000	1255000
24	1480	13240	4000	1661000
25	1480	12970	0	1621000
26	1480	13240	4000	[661000
27	1150	11090	72000	1255000

		Design	
Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
23	D19	φ10-@150	1756489
24	D19	φ10-@150	1756489
25	D19	φ10-@150	1756489
26	04 D19	φ10-@150	1756489
27	D19	φ10-@150	1756489

	1.11.15			Des	ign			<u>) (1 - 5 %)</u>	<u> 184</u> 0 a B	
Members	Left Bar				Middle Bar			Right Bar		
1. 14.1.1.1	Тор	Mid	Bottom	Тор	Mid	Bottom	Тор	Mid	Bottom	
23	3D16	2410	2D16	2D16	2φ10	3D16	3D16	∶2φ10	2D16	
24	3D16	2410	2D16	2D16	2610	3D16	3D16	2ф10	2D16	
25	3D16	2010	2D16	2D16	2010	3D16	3D16	2φ10	2D16	
26	3D16	2610	2D16	2D16	2410	3D16	3D16	2610	2D16	
27	3D16	2610	2D16	2D16	2410	3D16	3D16	2φ10	2D16	

### c) Beam type c

Prototype of Element

b (cm)	h (cm)	cover (mm)	dia. Main bar (mm) (deform)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)	
15	30	10	16	10	300	3700	2400	

		Frame Eleme	ent Force		
Members	Axial (kg)	Shear (kg)	Torsion (kgcm)	Moment (kgcm)	
28	0	5220	12000	590000	<u>;</u>
29	2001 0	2640	0	232000	
10	0	5220	12000	590000	
31	0	5220	12000	590000	4

		Design	
Members	Main Bar (mm)	Stirrup Bar (nun)	Mu (kgcm)
28	D16	φ10-@100	658457
29	D16	\$10-@100	658457
30	D16	ф10-@100	658457
31	D16	\$10-@100	658457

		F. 151.	Design	J. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.		
Members	3 2 3/4	Left Ba			Right Ba	ır
	Тор	Mid	Bottom	Тор	Mid	Bottom
28	3D16	2φ10	2D16	3D16	2ტ10	2D16
29	3D16	2610	2D16	3D16	2φ10	2D16
30	3D16	2φ10	2D16	3D16	2410	2D16
31	3D16	2610	2D16	3D16	2010	2D16

## d) Beam type d

b (cm)	h (cm)	cover (mm)	dia. Main bar (mm) (plain)	dia. stirrup (mm)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
10	95	10	10	8	300	3700	2400

	•					
		Frame Element	Force			
Members	Axial	Shear	Torsion	Moment		
MEHIOCIS	(kg)	(kg)	(kgcm)	(kgcm)		
32	5 St. 6 0 1 St.	900	7000	85000		
33	10	1340	0 0	117000		
- 34	10	1230	0	116000		
35	10	1290	0	116000		
36	10	1180	0	117000		
37	0	900	7000	85000		
. 38	0	900	7000	85000		
39	10	1340	0	117000		
40	10	1290	0	116000		
41	10	1290	0	0 116000		
42	10	1340	. 0	117000		
43	0	90000	7000	85000		
44	0	610	7000	42000		
45	10	1660	7000	241000		
46	10	1660	7000	241000		
47	0	610	7000	42000 State of 42000		
48	0	610	7000	42000		

		Design	
Members	Main Bar (mm)	Stirrup Bar (mm)	Mu (kgcm)
32	<b>φ10</b>	φ8-@150	245678
33	φ10	φ8-@:150	245678
34	φ10	<b>φ8-@150</b>	245678
35	φ10	<b>φ8-@150</b>	245678
. 36	φ10	<b>∮8-@150</b>	245678
37	φ10	φ8-@150	245678
38	φ10	ф8-@150	245678
39	φ10	φ8-@150	245678
40	<b>φ10</b>	<b>∮8-@150</b>	245678
41	ф10	ф8-@150	245678
42	φ10	<b>\$8-@150</b>	9 PER 245678
43	φ10	<b>\$8-@150</b>	245678
44	φ10	<b>∮8-@150</b>	245678
45	φ10	<b>φ8-@150</b>	245678
46	φ10	ф8-@150	245678
47 - 3	φ10	ф8-@150	245678
48	φ10	<b>∮8-@150</b>	245678

				Des	ign	·	· · · · · · · · · · · · · · · · · · ·		<del></del>
Members	ers Left Bar			Middle Bar			Right Bar		
32	Тор	Mid	Bottom	Тор	Mid	Bottom	Top	Mid	Bottom
33	2φ10	12φ10	2φ10	2φ10	12\phi10	2ф10	2φ10	12410	2φ10
34	2φ10	12010	2φ10	2φ10	12010	2փ10	2φ10	12410	2ф10
35	2φ10	12010	2φ10	2φ10	12410	2φ10	2φ10	12010	2∳10
36	2φ10	12φ10	2φ10	2¢10	12φ10	2φ10	2φ10	12010	2 <b>ģ1</b> 0
37	2010	12φ10	2φ10	2¢10	12410	2010	2410	12410	2610
38	2¢10	12φ10	2φ10	2410	12φ10	2φ10	2φ10	12φ10	2փ10
39	2φ10	12\$10	2610	2010	12\$10	2010	2φ10	12010	2ф10
40	2610	12010	2φ10	2φ10	12φ10	2φ10	2փ10	12ტ10	2∳10
41	2010	12410	2¢10	2φ10	12610	2փ10	2փ10	12φ10	2φ10
42	2φ10	12φ10	2φ10	2φ10	12φ10	2010	2¢10	12φ10	2∳10
43	2φ10	12010	2φ10	2φ10	12φ10	2∳10	2410	12010	2փ10
44	2410	12410	2φ10	2φ10	12φ10	2φ10	2¢10	12010	2φ10
45	2¢10	12010	2φ10	2φ10	12\$10	2φ10	2φ10	12010	2¢10
46	2φ10 2φ10	12010	2φ10	2410	12\$10	2610	2φ10	12010	2∳10
47	2φ10 2φ10	12010	2010	2φ10	12\$10	2¢10	2\$10	12410	2φ10
48	2010	12010	2¢10	2φ10	12\$10	2φ10	2φ10	12010	2ბ10

# 3). Slab between each console

t (cm)	(cm)	w (cm)	cover (mm)	dia. Main bar (mm) (plain)	fc' (kg/cm²)	fy (kg/cm²)	fv (kg/cm²)
12	100	100	1	12	300	3700	2400

Design (x and y dir	ection)
Point of support Bar	Yield Bar
φ12-@100	<b>∮12-@150</b>

