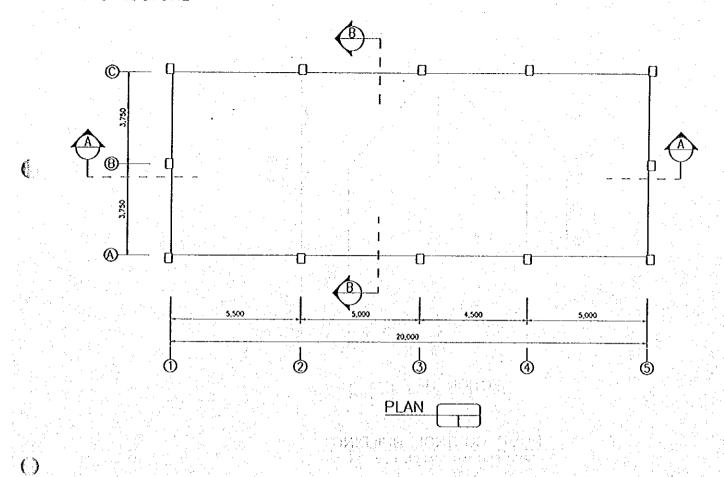
3.5 Pump Control Building

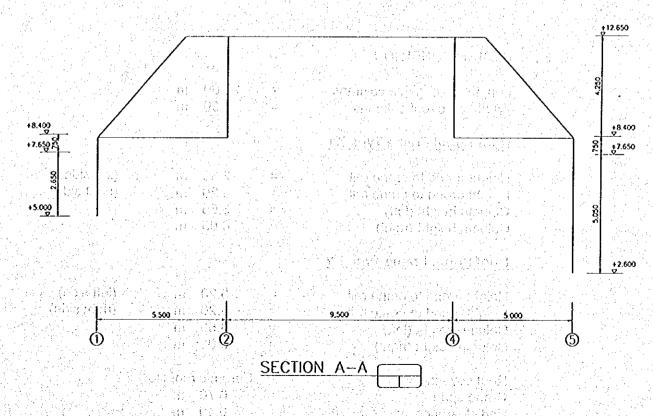
- 3.5 Pump Control Building
- 3.5.1 Structural Calculation

# STRUCTURE CALCULATION PUMP CONTROL BUILDING BARU PUMPING STATION COMPLEX

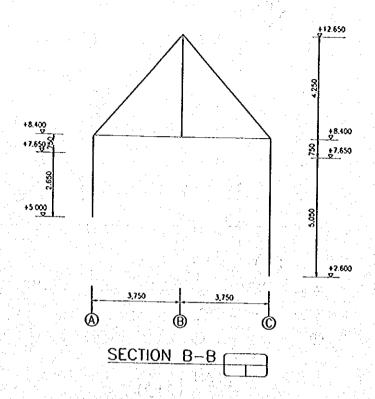
1 .	STRUCTURE	PAGE	1
2 .	DESIGN CONDITION	PAGE	2
3 .	LOADING CONDITION	PAGE	3
4 .	DESIGN OF MEMBERS	PAGE	5
5 .	DESIGN OF ROOF PORTAL FRAME	PAGE	6
6.	DESIGN OF WALL PORTAL FRAME	PAGE	

### 1. STRUCTURE





PUMP CONTROL BUILDING
BARU PUMPING STATION COMPLEX



# PUMP CONTROL BUILDING BARU PUMPING STATION COMPLEX

# 2. DESIGN CONDITION

Length c-c gable columns Width c-c roof columns	= 20.00 = 7.50	m m	
Roof Portal Frame Type K1			
Height grond to crane rail Height grond to crane rail Column height (left) Column height (right)	= 2.80 = 5.20 = 3.65 = 6.05	m m m	(left side) (right side)
Roof Portal Frame Type K2			
Height grond to crane rail Height grond to crane rail Column height (left) Column height (right)	= 5.20 = 5.20 = 3.65 = 6.05	m m m	(left side) (right side)
Roof covering Crane span End clearence	= Ceramic ( = 6.70 = 0.10	roof tile m m	
Weight of crane without carb Weight of carb	= 2.00 = 0.80	Ton Ton	

## 3. Loading Condition

#### a. Dead load

- Roof cover (ceramic tile + timber rafter) = 70 kg/m<sup>2</sup>
- Ceiling (fiber cement) = 10 kg/m<sup>2</sup>
- Reinforced concrete = 2,400 kg/m<sup>3</sup>
- Brick wall 0.15 m thick = 250 kg/m<sup>2</sup>
- Weight of a worker as point load = 100 kg

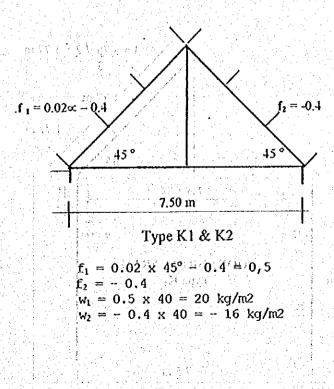
#### b. Wind Load

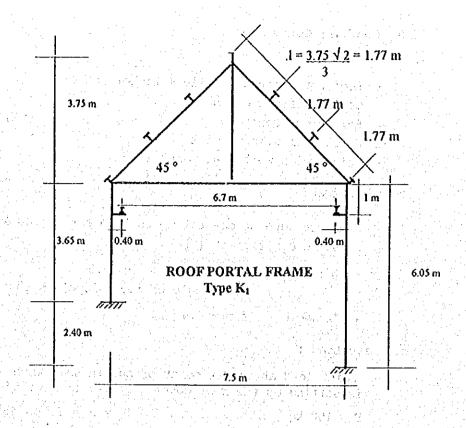
- Wind pressure at coastal up to 5 km far = 40 kg/m²
- Pressure coefficient (f)
  - Windward  $f = 0.02 \cdot x \propto -0.5$  $\propto = (angle of roof slope) \le 65^{\circ}$
  - Leeward f = -0.4

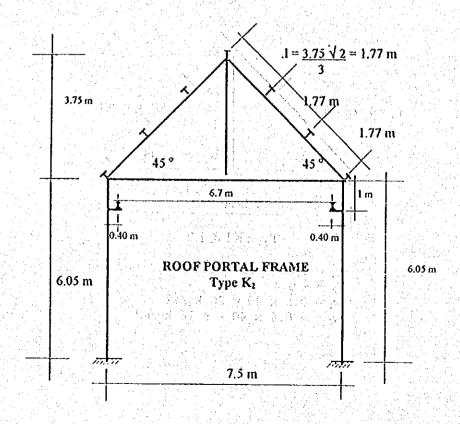
## c. Live Load:

 Point load at center point of purlin span when a worker is setting up the roof cover (rafter and ceramic tile)

$$P = 100 \text{ kg}$$
  $P_1 = P_2 = P \cos 45^{\circ}$   
= 71 kg

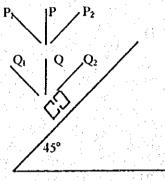






4. Design of members Purlins 5 m span ; 1.77 m centers Dead load :

$$q_1 = 1.77 \times 80 = 141.6 \approx 142 \text{ kg/m}^1$$
- Purlin self weight (q<sub>2</sub>) say = 15 kg/m<sup>1</sup>
 $Q = 157 \text{ kg/m}'$ 



$$Q_1 = Q_2 = Q \cos 45^{\circ}$$
  
= 157 Cos 45°  
= 111 kg/ m'

- Try purlin of Lip Channel type :

## Stress:

$$\sigma = \sigma \times + \sigma y$$
=  $\frac{Mx}{Wx} + \frac{My}{Wy}$ 
=  $\frac{43.563}{88.6} + \frac{43.563}{73.2}$ 

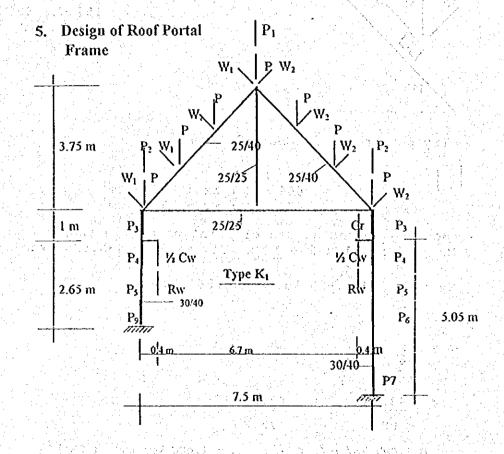
=  $\sigma 1,087 \text{ kg/cm}^2 < \overline{\sigma}_{\text{allowble}} = 1,400 \text{ kg/cm}^2$  (OK!)

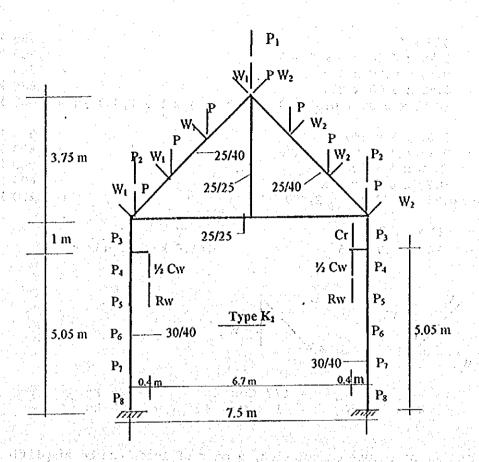
#### Deflection

fx = 
$$\frac{5 \times 111 \times 500^4}{384 \times 100} \times \frac{111 \times 500^4}{2.1E6 \times 664} \times \frac{11}{48} \times 71 \times \frac{500^3}{2.1E6 \times 664}$$
= 0.64 cm + 0.13 cm
= 0.77 cm

fy = 0.90 + 0.18
= 1.08
f =  $(0.77^2 + 1.08^2)^{1/2} = 1.3$  cm

 $\overline{f}_{all} = \frac{1}{360} = \frac{1}{360} = 1.4$  cm
 $\overline{g}_{all} = \frac{1}{360} \times \frac{1}{360} = \frac{1}{360} \times \frac{1}{3$ 





```
Loads
        Crane Weight = 2 Tons (alternate on right side)
  Cr =
        Carb Weight = 0.8 Ton
  CW =
        0.4 ton
1/2 CW =
        Rail Weight = 22.9 x 5 \approx 115 kg
  Rw ≡
        Roof Cover weight (include purlin self
   P =
        weight)
        Ridge reinforcement concrete (r.c.) beam
        25/40
        Ring r.c. beam 15/20
        Brick Wall weight
        Crane rail supported r.c. beam
        Brick wall weight
        Bracing r.c. beam
        Brick wall weight
        Tied beam weight (20/25)
   P_3 = Tied beam weight (25/40)
```

```
785 kg
     = 157 \times 5
Р
                                                                                       1,200 kg
    = 0.25 \times 0.40 \times 5 \times 2,400
\mathbf{p_1}
                                                                                           360 kg
         0.15 \times 0.20 \times 5 \times 2,400
         0.55 \times 5.00 \times 250
                                                                                           688 kg
    ==
         (0.55 \times 0.35 + 0.55 + 0.40 \times 0.15) \times 5 \times 2,400 \text{ kg} =
                                                                                           855 kg
                                                                                     = 3,313 \text{ kg}
         2.65 x 5 x 250
P_5 = 0.20 \times 0.25 \times 5 \times 2,400
                                                                                         600 kg
                                                                                     = 3,000 kg
P_7 = 2.40 \times 5 \times 250
P_3 = 0.20 \times 0.25 \times 5 \times 2,400
                                                                                     = ∶ 600 kg
                                                                                     = 1,200 \text{ kg}
P_9 = 0.25 \times 0.40 \times 5 \times 2,400
W_1 = 20 \times 1.77 \times 5
                                                   = 177 \text{ kg}
W_2 = -16 \times 1.77 \times 5
                                                   = -141.6 \text{ kg}
                         = W<sub>iy</sub>
                                    = 177 \text{ Cos } 45^{\circ}
                                                                     125 kg
```

- Further structure calculation, a part of loads can be simplified as:

 $= -142 \cos 45^{\circ}$ 

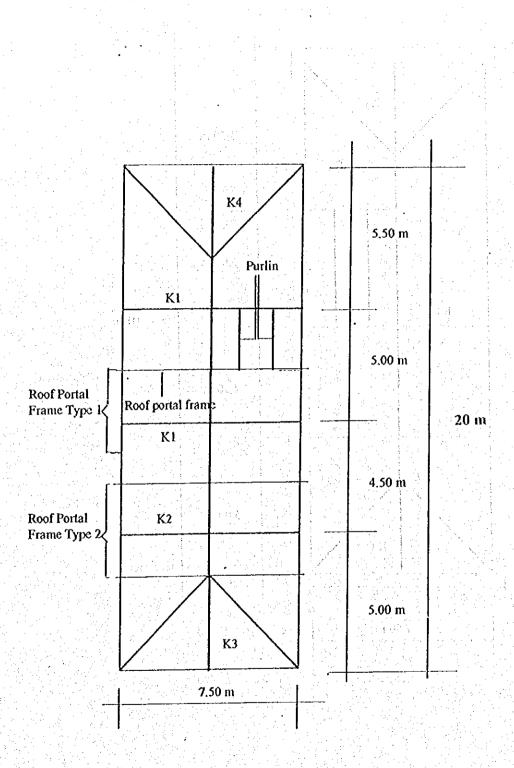
= -100 kg

a. Roof Portal Frame Type Kı

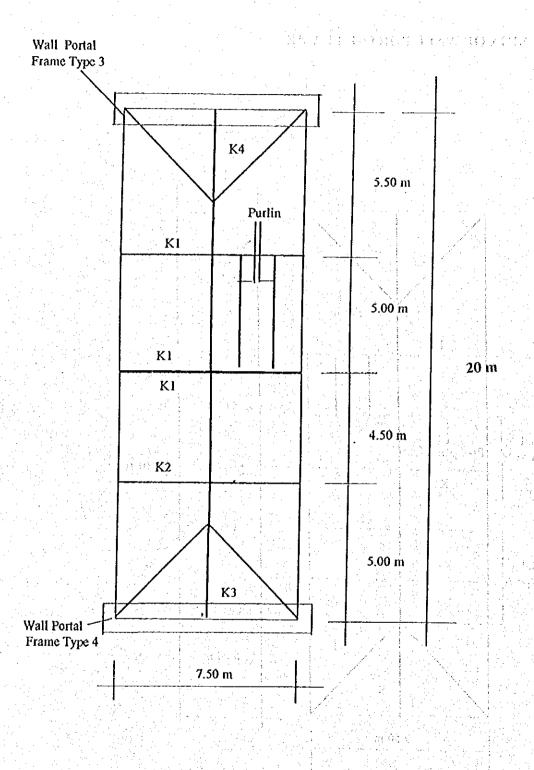
= Wzy

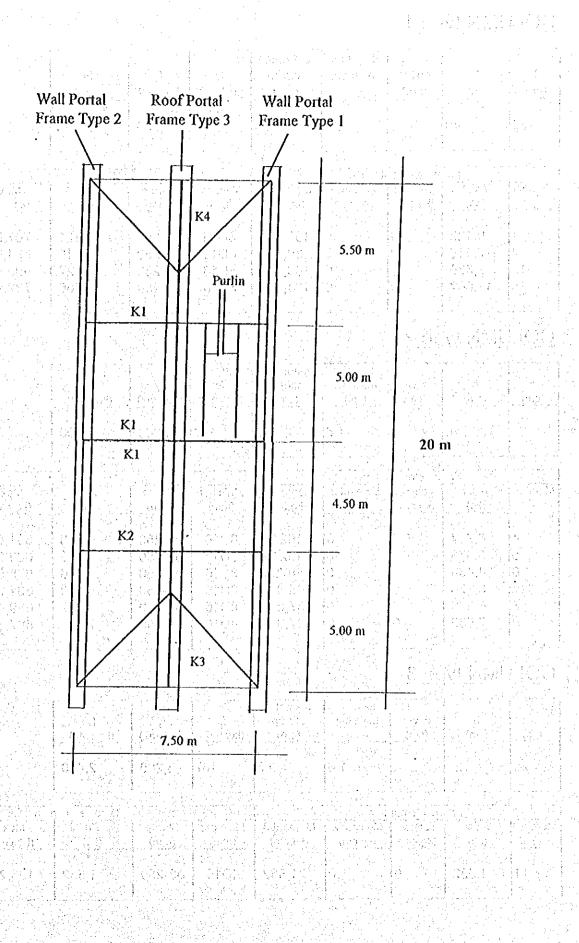
- Left Side :  $P_{\lambda} = P_2 + P_3 + P_4 + P_5 = 5,216 \text{ kg}$
- \* Right Side:  $P_3 = P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_9 = 10,016 \text{ kg}$
- b. Roof Portal Frame Type K
  - Right Side:  $P_A = P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8 = 9,416 \text{ kg}$
  - Left Side :  $P_3 = P_A = 9,416 \text{ kg}$
- Structure Calculation of Roof Portal Frame by using computer programming, including self weight of structure. The software is Structure Analysis and Design System (SANS/89) Version 3.5 (1994), Engineering Software Research, Indonesia.

# 6. DESIGN OF WALL PORTAL FRAME



()





# **COLUMN type 1**

b (cm)	h (cm)	cover (cm)	diameter main bar (cm)	diameter stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
30	40	4	1.6	0.8	187	3,200	2,400

	Fra	me elemer	nt Force	- \ \ \ \ T			Desi	a n	
Member	Axial (kg)	Torsion (kg.cm)	Moment 2 (kg.cm)	Moment 3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Max (kg.cm)	May (kg.cm)
1 2 13 15	9,122 7,416 7,380 12,662	0000	0 0 0	165,315 30,190 106,215 124,176	8D16 8D16 8D16 8D16	08-250 08-250 08-250 08-250	9,121 7,416 7,727 1,266	707,047 694,023 696,415 732,991	21,891 17,800 18,577 30,397

# COLUMN type 2

b (cm)	h (cm)	cover (cm)	diameter main bar (cm)	diameter stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	40	4	1.6	0.8	187	3,200	2,400

		me elemei	nt Force				Desi	a n	1 1/2 1/2 11
Member	Axial (kg)	Torsion (kg.cm)	Moment 2 (kg.cm)	Moment 3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Max (kg.cm)	May (kg.cm)
4 5 6 7 8 9	6,717 5,578 4,438 5,226 6,366 7,505	0 0 0 0 0	000000000000000000000000000000000000000	162151 162151 187366 165,803 57,863 87,386	8D16 8D16 8D16 8D16 8D16 8D16	08-250 08-250 08-250 08-250 08-250 08-250	6,718 5,579 4,440 5,229 6,367 7,504	691,885 683,815 675,596 681,294 689,416 697,363	15,115 12,554 9,920 11,765 14,326 16,886

# **COLUMN type 3**

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

	Fra	me elemer	nt Force			4.50 M 324	Desi	a n	
Member	Axial (kg)	Torsion (kg.cm)	Moment 2 (kg.cm)	Moment 3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Max (kg.cm)	May (kg.cm)
11	1,532	0		21,562	4D16	o8-250	1,532	195,257	3,447

	Mu (ka.cm)						Mu	127,296 127,296					Mu (ka.cm)	191,278 191,278
	Stirrup (mm)	o10-300 o10-200				-	Stirrup (mm)	08-200 08-200	7 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4				Stirrup (mm)	08-250 08-250
	s Bottom	2D16 2D16					Softom	2016 2016					Sattom	2016 2016
	Right bars Middle	2012 2012					Right bars						Right bars Middle	
	Top	3016 3016		erran Antak Orana		c		2016 2016				S C		2016 2016
	s i g Bottom	2016 2016					Bottom	2D16 2D16				  	Bottom	2D16 2D16
	D e Mid bars Middle	2012 2012				.   a	ğ	•	in the second			ص ص	Mid bars Middle	
	Top	3016 8016					Top	2D16 2D16					Top	2D16 2D16
	Bottom	2016 2016					Bottom	2D16 2D16					Bottom	2D16 2D16
fv (kg/cm2) 2,400	Left bars Middle	2012 2012		fv (kg/cm2)	2,400		Left bars Middle			fv (kg/cm2)	2,400		Left bars Middle	
fy (kg/cm2)	Top	3D16 3D16	es proportion of an estimated to the second	fy (kg/cm2)	3,200		Top	2D16 2D16		fy (kg/cm2)	3,200	3 : . - -	Top	2016 2016
fc (kg/cm2) 187	Main bar (mm)	D16 D16	an Aleman . Sun Market . I sain	fc (kg/cm2)	187		Main bar (mm)	D16 D16		fc (kg/cm2)	187		Main bar (mm)	00 66
diameter stirrup (cm)	Moment (kg.cm)	28,176 124,176		diameter stimup (cm)	8.0		Moment (kg.cm)	1,221		diameter stirrup (cm)	0.8		Moment (kg.cm)	36.857
diameter main bar (cm)	Torsion (kg.cm)	0		diameter main bar (cm)	1.6	t Force	Torsion (kg.cm)	00	(100 kg)	diameter main bar (cm)	1.6	t Force	Torsion (kg.cm)	00
cover (cm)	Frame Element Force II Shear Torsio	3,018	<u>α</u>	cover (cm)	4	Frame Element Force	Shear (kg)	88	OI	cover (cm)	4	Frame Element Force	Shear (kg)	516 340
(cm) 50	Axial (kg)	00	type	h (cm)	20	Fran	Axial (kg)	44		h (cm)	25	Fran	Axiai (kg)	4,141
Q (G)	Member	& <del>4</del>	BEAM type	(cm)	12		Member	16	BEAM type	(cm)	25		Member	22

# **COLUMN type 1**

(cm)	h (cm)	(cm) cover	diameter main bar (cm)	diameter stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
30	40	4	1.6	0.8	187	3,200	2,400

	Fra	me elemei	nt Force	3 3 3			Desi		
Member	Axial (kg)	Torsion (kg.cm)	Moment 2 (kg.cm)	Moment 3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Desi Pu (kg)	g n Max (kg.cm)	May (kg.cm)
1 2 13 15	9,859 7,323 7,819 12,755	0 0 0	0 0 0 0	113,536 24,258 161,532 258,070	8D16 8D16 8D16 8D16	08-250 08-250 08-250 08-250	9,865 124,489 7,819 12,758	712,628 412,345 697,126 733,645	23,677 29,877 18,766 30,619

# COLUMN type 2

b (cm)	h (cm)	cover (cm)	diameter main bar (cm)	diameter stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
25	40	4	1.6	0.8	187	3,200	2,400

		me elemer	nt Force	E HOUSE BASE HA			Desi		
Member	Axial (kg)	Torsion (kg.cm)	Moment 2 (kg.cm)	Moment 3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Max (kg.cm)	May (kg.cm)
4 5 6 7 8 9	6,613 5,474 4,334 5,187 6,326 7,446	0 0 0 0 0	0 0 0 0	170,149 170,149 183,050 155,583 37,564 38,928	8D16 8D16 8D16 8D16 8D16 8D16	08-250 08-250 08-250 08-250 08-250 08-250	6,614 5,476 4,336 5,189 6,328 7,465	691,156 683,070 674,819 681,010 689,139 697,091	14,882 12,321 9,758 11,676 14,238 16,797

# COLUMN type 3

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

		me eleme	nt Force		The state of	1.5	Daci	~ ~	
Member	Axial (kg)	Torsion (kg.cm)	Moment 2 (kg.cm)	Moment 3 (kg.cm)	Main bar (mm)	Stirrup (mm)	Pu (kg)	Max	May
11	1,491	0	0	27,467	4D16	08-250		(kg.cm) 195,079	(kg.cm) 335,566

121,989 121,989

2D16 012-200 2D16 012-200

2D16 2D16

Mu (kg.cm)

Stirrup (mm)

(a)
انه
ă
>
+1
5
$\mathbf{z}$
Шl
$\approx$
шI

		Μu	(kg.cm)	653,947 653,947
		Stirrup	(ww)	2012 3D16 012-300 2012 3D16 012-200
		S	Bottom	3D16 3D16
		Right bars	Middle	
	c		Top	3D16 3D16
	s i g	1.00	Bottom	3D16 2012 3D16 3D16 2012 3D16 3D16 3D16 3D16
	D e s	Mid bars	Middle	2012 2012
	1.4.2.4.4.4.		Top	3D16 3D16
fy (fr. ) (kg/cm2) (200 2,400	Service of the service of		Bottom	3D16 3D16
fv (kg/cm2) 2,400	6 1 pp 14	Left bars	Middle	2012 2012
<b>₹</b> ~	X 10 X 10 X 10 X 10 X 10 X 10 X 10 X 10		Тор	3D16 3D16
fc fy (kg/cm2) (kg/cm2 187 3,200		Main bar	(mm)	0.16 0.16
cover main bar stirrup fc (cm) (kg/cm2) (4 1.6 0.8 187	and the second	Moment	(kg.cm)	28,176 D16 124,176 D16
diameter main bar (cm) 1.6	at Force	Torsion	(kg.cm)	00
cover (cm)			(kg)	3,190
(cm) 50		٠.	(kg)	00
(cm) 30		Member		6 <del>4</del>
				- 1 July 1

**BEAM type b** 

61 A. 630		te ide			
<b> λ</b>	(kg/cm2)		2,400		
Α,	(kg/cm2)		3,200		
ပ္	(kg/cm2)		187		
h cover main bar stirrup fc fy fv	ം (cm)		0.8 187 3,200 2,400		
diameter main bar	(cm)	4 t	1.6	100 July 0.3	البا الريد من
cover	(CJ)		4	A. S. C. 10.	
<b>4</b>	(cm)		22		
a	(E)		12		

elle elle elle elle elle			s i g		Bottom	2D16 2D16
			Desi	Mid bars	Middle	
		A CONTRACTOR OF THE CONTRACTOR			Top	2D16 2D16
					Bottom	2D16 2D16 2D16 2D16
(kg/cm2)	2,400			Left bars	Middle	
kg/cm2) (kg/cm2) (kg/cm2)	187 3,200 2,400				Top	2016 2016
(kg/cm2) (kg/cm2) (kg/cm2)	187			Main bar	(mm)	0 0 0 0
(cm) (cm) (cm) (cm)	8.0		75 . T. 150 . S.	Moment	(kg.cm)	1,221
(cm)	9.1	المراث المراث	nt Force	Axial Shear Torsion	(kg.cm)	0
(cm)	4		Frame Element Force	Shear	(kg)	34 48 48 48
(cm)	20		٠i		(kg)	34 34
(cm)	12			Member		16 17
				. 3	[8]	

BEAM type c

	- 22	004
	fy cm2) (kg/cm2	2,4
	fc fy (kg/cm2)	187 3,200 2,400
	fc (kg/cm2)	,
diameter	main bar stirrup fc fc f(cm) (kg/cm2) (kg/	1.6
diameter	main bar (cm)	1.6
,	cover (cm)	4
	ი (ლე	25
1	ი (ლე	25

	T	me Flemer	nt Force													
			3							ם ב	E 8 - 8	5				
ember	Axia	Shear	Torsion	Moment	Main bar		Left bars			Mid bars		ır.	Right bars		Stirrup	Ma
	(kg)	(kg)	(kg.cm)	(kg.cm)	(mm)	Top	Middle	Bottom	Top	Middle	Middle Bottom	Т <mark>9</mark>	Middle	Bottom	(шш)	(ka.cm)
									***							
5	3,853	528	0	36,989	016	2D16		2016	2016	•	2016	2016		47.00	012.250	100 001
7	3.724	387	0	34, 777	0.16	2016		2016 2016	200		0 0	2000		2 6	20,42,410, 01,00	707,001
					)	)		)	2		- 1	2 7 7		0.04	007-710	102,80
				a constant to the second						_						
															_	

# WALL type 1 COLUMN type 1

b (cm)	h (cm)	cover	diameter main bar (cm)	diameter stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
30	40	4	1.6	0.8	187	3,200	2,400

		me elemer		1944 B. 1941		ya kasa A	Desi	g n	The second second
Member	Axial	Torsion	Moment 2	Moment 3	Main bar	Stirrup	Pu	Max	May
	(kg)	(kg.cm)	(kg.cm)	(kg.cm)	(mm)	· (mm)	(kg)	(kg.cm)	(kg.cm)
	- 400							r fall la	
1	7,888	0	0	116,443	8D16	o10-250	7,887	693,387	18,934
2	4,444	0	0	108,029	8D16	010-250	4,446	666,703	10,671
ა პ	727	0	0	585,203	8D16	o10-250	727	336,122	1,745
	14,209	0	0	22,000	8D16	o10-250	124,489	336,122	298,775
8	8,254	0	0	19,870	8D16	o10-250	124,489	640,845	298,775
9	1,194	0	0	47,294	8D16	o10-250	1,194	336,122	2,867
13	13,314	0	0	1,455	8D16	010-250	124,489	336,122	298,775
14	7,660	0	0	456	8D16	o10-250	124,489	336,122	298,775
15	1,155	0	0	2,478	8D16	o10-250	124,489	336,122	298,775
19	16,900	0	0	35,415	8D16	010-250	124,489	336,122	298,775
20	12,734	0	0	23,344	8D16	010-250	124,489	336,122	298,775
21	73,299	이	0	14,412	8D16	o10-250	124,489	336,122	298,775
22	1,113	0	0	3,614	8D16	010-250	124,489	404,152	298,775
27	16,739	이	0	16,574	8D16	o10-250	124,489	336,122	298,775
28	12,984	0	0	20,397	8D16	010-250	124,489	336,122	298,775
29	752	0	0	16,348	8D16	o10-250	124,489	336,122	298,775
30	1,101	0	0	42,563	8D16	010-250	1,101	640,092	2,644
35	9,405	0	0	78,808	8D16	ó10-250	9,406	705,750	22,575
36	7,369	이	0	93,767	8D16	010-250	7,369	689,454	17,687
37	4,162	0	0	909,773	8D16	010-250	4,164	664,584	9,995
38	886	0	0	48,275	8D16	010-250	686	636,726	1,647
42	10,548	. 0	0	115,549	8D16	010-250	10,550	713,132	25,320
43	19,302	0	0	28,048	8D16	010-250	124,489	336,122	289,775
44	18,132	0	0	5,042	8D16	010-250	124,489	336,122	289,775
	5 11 1								

Mu (kg.cm)

Stirrup (me)

Bottom

6016 6016 6016 6016

4016 4016 4016 4016

WALL type 1 BEAM type a

			ny dr.	n) (kg.cm)				200   131,277	
			Stimup	(mm)				08-200	
			ر اع	Bottom				2016	
			Right bars	Middle	2012	2012	2012	2012	2012
			=	Top	2D16	2016	2016	2016	2016
		-	5 1	Bottom	2D16	2016	2D16	2D16	2016
			Mid bars	Middle	2012	2012	2012	2012	2012
				Тор	2D16	2016	2D16	2D16	2016 2016
				Bottom	2016	.2016	2016	2016	2016
fv (kg/cm2)	2,400		Left bars	Middle	2012	2012	2012	2012	2012
fy (kg/cm2)	3,200 2,400		3	Тор	2016	-2016	2016	2016	2016
fc (kg/cm2)	187		Main bar	(mm)	18,240 D16	016	016	0,16	6 6
stirrup (cm)	8.0		Moment	(kg.cm)	48,240	38,530	36,052	32,658	39,674
cover main bar (cm)	1.6	The contract of the contract o	Torsion	(kg.cm)	0	0	0	0	0
cover (cm)	4	Laber of the Control	Frame Element Force	(kg)	499	445	422	406	454
	6		Axial	<b>§</b>	167	37	318	242	963
h (cm)	40		12	7	Ψ.	٠,,			j

131,328 131,311 131,298 131,277

WALL type 1 BEAM type b

*-		1111										
				ဝ	Mid bars	Middle		2012	2012	2012	2012	2012
						Top		6016	6D16	6D16	6D16	6016
		The second secon				Bottom		4016	4016	4D16	4016	4016
\$	(kg/cm2)	2,400	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Left bars	Middle	Property of the	2012	2012	2012	2012	2012
<b>^</b>	(kg/cm2)	3,200			1 J. 19	Top		6016	-91C9	6016	6016	6D16
ပ္	(kg/cm2)	187			Main bar	(mm)		0.16	 0.16	016	0 9	016
diameter stirrup	(cm)	0.8			Moment	(kg.cm)		305,410	242,802	233,031	203,982	246,114
diameter main bar	(cm)	1.0	The second second	nt Force	Torsion	(kg.cm)		0	0	0	0	0
cover	(cm)	4		Frame Element Force	Shear	(kg)		3,336	2,806	281	1,536	3,019
ų,	(cm)	9	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Fra	Axial	(kg)	1	383	278	336	31.	306
ø	(GII)	55			Member			'n		17	24	32
		iga 7	4 E.	11				. *				

180,444 180,196

WALL type 1 BEAM type c

b h cover main bar stirrup tc fy fv (cm) (cm) (cm) (cm) (cm) (cm) (m) (cm) (m) (m) (m) (m) (m) (m) (m) (m) (m) (		
diameter diameter to fy (cm) (cm) (kg/cm2) (kg/cm2) (kg/cm2) 4 1.6 0.8 187 3,200	(ka/cm2)	3,200. 2,400
diameter diameter fc main bar stirrup (kg/cm2) (cm) (kg/cm2) 4 1.6	fy (ka/cm2)	3,200
diameter diameter main bar stirrup (cm) (cm) 4 1.6 0.8	fc (ka/cm2)	187
diameter main bar (cm) 4 1.6	stirrup (cm)	20 40 4 1.6
4	main bar (cm)	1.6
cove (cm)	Sver Grag	4
t (cm) 40	æ (j)	40
(cm)	م ( <del>ق</del>	8

	و			
	Mu	(kg.cm)	252,768 252,774 252,773 180,349 252,781	
	Stirrup	(mm)	000000 000000 000000	_
	S	Bottom	2016 2016 2016 2016 2016	_
	Right bars	Middle	2012 2012 2012 2012 2012	
c		6 6	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	
e s		Bottom		
e 0	Mid bar	Middle	2012 2012 2012 2012 2012 2012	_
		Top	3016 3016 3016 3016 3016	
		Bottom		
	Left bars	Middle	20 20 20 20 20 20 20 20 20 20 20 20 20 2	
		Top	3016 3016 3016 2016 3016	
	Main bar	(mm)	0000 0000 0000 0000	
	Moment	(kg.cm)	247,682 205,611 201,927 166,963 203,710	
nt Force	Torsion	(kg.cm)	0000	
Frame Element Force	Shear	(kg)	269 2,427 2,421 2,180 2,452	_
Fra	Axial	(kg)	125 95 59 59	
	Member		6 12 18 33 33	_

WALL type 1 BEAM type d

diameter diameter for fy fv (kg/cm2) (kg/cm2)	cover main bar stirrup (cm) (cm) (cm)	b n cover main bar stirrup fc fy fv (cm) (cm) (cm) (cm) (cm) (cm)
diameter main bar (cm)	diameter cover main bar (cm) (cm)	h cover main bar (cm) (cm) (cm)
	cover (cm)	h cover (cm)

•													
nt Force	61						۵ 0	e s i g	c				
Torsic	n Moment	Main bar	2	Left bars			Mid bars			Right bars	S	Stirrup	ΩM
(kg.cg	(kg.cm)	(mm)	Тор	Middle	Middle Bottom	Top	Middle	Middle Bottom	Top		Middle Bottom	(mm)	(kg.cm)
00	129,036 159,038	016 016	2D16 2D16		2D16 2D16	2D16 2D16 2D16 2D16		2D16 2D16	2D16 2D16		2D16 2D16	08-80	180,444 180,196

348

WALL type 1 BEAM type e

fc fy fy (kg/cm2) (kg/cm2)	187 3,200 2,400
fy (ka/cm2)	3,200
	1 보험한 요미
diameter stirrup (cm)	0.8
diameter main bar (cm)	1.6
cover (cm)	4
r (mg)	40
ი (წე	25

	Fra	Frame Element F	nt Force							ه ۵	O O	c				
Member	Axial	Shear	Torsion	∴ Moment	Main bar		Left bars.			Mid bars		u.	Right bars	*	Stirup	Σ
	(gg)	(kg)	(ka.cm)	(kg.cm)	(mm)	Top	Middle	Top   Middle   Bottom   Top   Middle   Bottom	Top	Middle	Bottom	Top	Middle	Middle Bottom	(mm)	(Kg.
			0	0000												
జ	700	2,602	0	242,179	<b>D</b> 16	2016	2012	2016	2016	2012	2016		2012	2016	010-150	<b>6</b>
<del>4</del>	24	2,342	0	197,171	D16	2016	2012	2016	2016	2012	2016		2012	2016	010-150	· 66
41	202	1,254	0	197,856	016	2D16	2012	2D16 2012 2D16 2D16 2012 2D16	2016	2012	2D16		2012	2016	2D16   2012   2D16   010-150	3
3					The state of the s	1.										-

# WALL type 2 COLUMN type 1

b (cm)	h (cm)	(cm)	diameter main bar (cm)	diameter stirrup (cm)	fc (kg/cm2)	fy (kg/cm2)	fv (kg/cm2)
30	40	4	1.6	0.8	187	3,200	2,400

	Fra	me elemer	nt Force				Desi	g n	• 14 Land
Member	Axial	Torsion	Moment 2	Moment 3	Main bar	Stirrup	Pu	Max	May
	(kg)	(kg.cm)	(kg.cm)	(kg.cm)	(mm)	(mm)	(kg)	(kg.cm)	(kg.cm)
				1, 63, 5					
1	8,722	0	0	135,637	8D16	010-250	8,723	884,516	18,137
2	3,826	0	0	101,721	8D16	o10-250	3,828	661,927	9,188
3	509	0	0	434,188	8D16	o10-250	509	635,287	1,221
7	12,491	0	0	35,949	8D16	o10-250	124,489	358,262	298,775
8	6,917	0	0	15,630	8D16	010-250	124,489	336,122	298,775
9	732,592	0	0	47,357	8D16	o10-250	732	637,104	1,758
13	11,813	0	0	7,993	8D16	o10-250	124,489	336,122	298,775
14	6,492	0	0	8,427	8D16	o10-250	124,489	336,122	298,775
15	712	0	0	4,494	8D16	o10-250		636,939	1,709
19	13,251	0	0	90,174	8D16	o10-250	1,325	723,253	31,808
20	<sub>2</sub> 11,353	0	0	38,111	8D16	010-250	124,489	417,874	298,775
21	6,048	0	0	32,469	8D16	010-250	6,050	679,323	14,520
22	687	0	0	2,432	8D16	010-250	124,489	440,666	298,775
27	15,285	0	0	14,422	8D16	o10-250	124,489	336,122	298,775
28	11,371	0	0	: 17,718	8D16	o10-250	124,489	336,122	298,775
29	6,362	0	0	18,340	8D16	010-250	124,489	358,873	298,775
30	688	0	0	35,944	8D16	010-250	688	636,743	1,652
35	873	0	0	1,047	8D16	o10-250		699,714	20,950
36	6,625	0	0	716	8D16	o10-250		683,769	15,904
37	3,606	0	0	645	8D16	o10-250		660,181	8,659
38	488	0	0	690	8D16	o10-250		635,120	1,172

Mu (kg.cm)

1,276,057 1,275,547 1,275,544 1,275,707 1,276,066

WALL type 2 BEAM type a

	الا (ka/cm?)	2,400
	fy (ka/cm2)	3,200
	fc (kg/cm2)	187
diameter diameter	(cm) (cm) (cm) (cm) (cm) (ka/cm2) (ka/cm2) (ka/cm2)	15 20 4 1.6 0.8 187 3,200 2,400
diameter	main bar (cm)	1.6
5-	Cover (cm)	4
	ი (ლე	20
23	ρ ĴĘ	15

		The state of the s											-		
Security of the second	Fr	Frame Element Force	Ce			: .			ė	e .s i a	c.		-		
Member	į.	Shear Ton	Axial Shear Torsion Moment	Main bar	to the fact of the	Left bars		4	Aid bars			Right bars		Stirup	Mc
er in open more along them.	(RG)	(kg) (kg	cm) (kg.cm)	(mm)	Top	Middle	Bottom	Top	Middle	Middle Bottom	ရို	Middle	Bottom	(mm)	(kg.cm)
						1.000									
4	794	242 (	0 22,869	D16	2D16		2016	2D16	•	2016	- 1		2016	08-200	131.240
9	133	218	18.41	, D16	2D16		2D16	2016	•	2016			2016	08-200	131 24
16	190	218	18,444	1 D16	2D16		2D16	2016		2D16		•	2016	08-200	49.49
ි දූද	₩	196	0 15,004	± D16	2D16	1	2D16	2016	1	2D16	2016		2016	08-200	131,233
က	069	219 (	18,738	3 016	2D16		2D16	2016	•	2016		•••	2016	08-200	131,090
A CONTRACTOR OF THE PROPERTY O				3										!	

131,240 131,243 13,123 131,233 131,233

WALL type 2 BEAM type b

1	2 . 13 2	্র	
	.≥	(kg/cm2	2,400
	.≱	(kg/cm2)	3,200 2,
	ပ္	(kg/cm2)	187
	b h cover main bar stirrup fc	(cm) (cm) (cm) (cm) (cm) (kg/cm2) (kg/cm2)	55 50 2,400
7.7	nameter main bar	(cm)	1.6
	cover	(cm)	4
		(cm)	50
	۵	(CIII)	55

	Simin	(mm)	6D16 010-300 6D16 010-300 6D16 010-300 6D16 010-300 6D16 010-300
		Bottom	6016 6016 6016 6016 6016
	Right bars	Middle   Bottom	4D16 2012 4D16 2012 4D16 2012 4D16 2012 4D16 2012
c		Top	004 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
5		11	4 4 4 4 4 0 1 0 0 4 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0
D e s	Mid bars	Middle Bottom	99999 99999 94444
		Тор	6D16 6D16 6D16 8D16 8D16 8D16 8D16 8D16
		Bottom	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Left bars	Middle	2012 2012 2012 2012 1212
		Top	6016 6016 6016 6016 6106
	Main bar	(mm) Top	00000 60000
	Moment	(kg.cm)	272,464 209,476 217,458 168,519 218,726
nt Force	Torsion	(kg.cm)	0000
Frame Element Force	Shear	(B)	34 2,864 510 2,403 512 2,479 340 2,171 45 2,585
Frai	Axia	(kg)	34 512 512 340 45
	Member	A September 1	5 11 17 24 32

180,094

Mu (kg.cm)

WALL type 2 BEAM type c

. ≰.	(kg/cm2)	20 25 44 1.6 0.8 187 3,200 2,400
	(kg/cm2)	3,200
ပ္ပ	(Kg/cm2)	187
stirrup	(GB)	0.8
main bar	(cm)	1.6
Cover	(CH)	
ر (	(ED)	20 000025
<u>а</u> (	3	. 50
	b h cover main bar stirrup to fy h	b h cover main bar stirrup (cm) (cm) (cm) (cm) (kg/cm2) (kg/cm2) (kg/cm2)

Fram Fram Member Axiat (kg) 25 59 33 71	(kg) 1,986 2,208	Torsion (kg.cm)	Moment Main bar (kg.cm) (mm) 151,205 D16 184,013 D16	rent Main bar Left (mm) Top Mic (205 D16 2D16 3D16 3D16	70p 2D16 3D16	bars	eft bars Middle Bottom Top  2D16 2D16 - 2D16 2D16	2D16	Middle Bottom T	9 27 8	ight ba	Stirrup  Bottom (mm)  2D16  08-90	Stirrup (mm) 08-90
A Section of the sect				1. 				2	)	) ) )	1	) )	5

180,321 252,779

Mu (kg.cm)

> WALL type 2 BEAM type d

fv (kg/cm2)	2,400
fc fy fv fv g/cm2) (kg/cm2	187 3,200 2,400
fc (kg/cm2)	187
liameter diameter nain bar stimup (cm) (cm)	0.8
cover main bar (cm)	1.6
cover (cm)	4
h (cm)	25
(m)	20

		Stirrup	(mm)	06-80 80
		(2)	Middle Bottom	2D16 08-90 2D16 08-90
		Right bars	<u>_</u>	1 1
Mary and the same	ć	:	Top	2D16 2D16
	0	n	Bottom	2D16 2D16 - 2D16 -
	O e s i o	Aid bars	Middle Bottom	
The second secon		V	Top	2D16 2D16
			Bottom	2D16 2D16 2D16 2D16
		Left bars	Middle	
			J O	2D16 2D16
		nt Main bar	(mm)	235 D16 2D16 -
1 1000	and the second of the second of the	Moment	(kg.cm)	136,235 165,315
* * * * * * * * * * * * * * * * * * * *	t Force	Torsion	(ka.cm)	0
	rame Elemen	Shear	(kd)	1,758
	IL.	Axial	(gy	363
	and the second s	Member	The second secon	34 34

WALL type 2 BEAM type e

2,400
187 3,200 2,400
.8
8.0
1.6
4
25

	Fra	ame Element Force	nt Force		1.7				er.	о О	 S	c
Mem	er Axial	Shear	Torsion	Moment	Main bar		Left bars			Mid bars		3
	(kg)	(kg)	(kg.cm)	(kg.cm)	] (mm)	Тор	Middle	Bottom	Top	Middle	Bottom	Тор
	10 10 1 Land	3 6 5 6 5			7	1						
9	988	2.872	0	266,746	D16	2D16		2016	2D16	•	2016	1.0
12	129	2,563	0	215,817	010	2D16		2D16	2016	1	2D16	2D16
<u>~</u>	247	2,628	0	226,282	016	2D16	ı	2016	2D16		2D16	
				vy.		1					· · · · · · · · · · · · · · · · · · ·	

336,995 338,364 338,516

010-150 010-150 010-150

2D16 2D16 2D16

Miu (kg.cm)

Stirrup (mm)

Bottom

Right bars Middle

# Checking of Column reinforcement bar & stress of Roof Portal Frame Type K - 1

At support reaction of right column as the biggest bending moment.

Bending Moment = 178,841 kgcm  
b (width) = 30 cm  
h<sub>t</sub> (height) = 40 cm  
Concrete cover = 5 cm  
h = h<sub>t</sub> - d = 40 - 5 = 35 cm  
Fc = 225 kg/cm<sup>2</sup> 
$$\rightarrow \overline{\sigma}'_{b}$$
 = 130 kg/cm<sup>2</sup>  
Fu = 3,200 kg/cm<sup>2</sup>  $\overline{\sigma}_{a}$  = 2,600 kg/cm<sup>2</sup>  
n = 14

$$\delta = 1$$
 ( symetrical reinforcement )

$$\phi_0 = \frac{\sigma_a}{nx\sigma'_b} = \frac{2,600}{14x130} = 1.43$$

$$Ca = \frac{h}{\sqrt{\frac{nxM}{bx\sigma_a}}} = \frac{35}{\sqrt{\frac{14x178,841}{30x2,600}}} = 6.18$$

$$\Rightarrow \phi = 4.31 > \phi_0 = 1.43 \text{ (OK)}$$

$$\phi' = 8.11$$

$$n\omega = 0.028$$

### Stresses

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

$$\overline{\sigma}_{b} = \overline{\sigma}_{a} = \frac{2,600}{14 \times 4.31} = 43.09 \text{ kg/cm}^{2} < \overline{\sigma'}_{b} = 130 \text{ kg/cm}^{2} \text{ (OK)}$$

$$\sigma_a = \frac{\overline{\sigma}_a}{\phi'} = \frac{2,600}{8.11} = 320.59 \text{ kg/cm}^2 < \overline{\sigma}_a = 2,600 \text{ kg/cm}^2 \text{ (OK)}$$

#### . Reinforcement

A = 
$$\frac{\omega bh}{n}$$
 =  $\frac{0.028 \times 30 \times 35}{14}$  = 2.1 cm<sup>2</sup>

 $A_{\text{steel}} = 2.1 \text{ cm}^2 < 1 \% \times 900 \text{ cm}^2 \text{ (sectional area of column)}$ 

Hence applied:

A steel = 8 D 16  
= 
$$16.08 \text{ cm}^2 = \frac{16.08 \times 100 \text{ % A concrete}}{30 \times 40}$$
  
= 1.34 % A concrete (OK)

# Checking of Beam reinforcement bar & stress of Roof Portal Frame Type K - 1

At left side roof slope as the biggest bending moment.

25 cm b (width) 40 cmh. (height) 5 cm Concrete cover 40 - 5 = 35 cm  $h = h_t - d$  $kg/cm^2 \longrightarrow \overline{\sigma'}_b = 130 kg/cm^2$ 225 Fc  $kg/cm^2 \rightarrow \overline{\sigma}_a = 2,600 kg/cm^2$ 3,200 Fu 14  $\delta$  = 1 ( symetrical reinforcement )

$$\phi_{0} = \frac{\sigma_{a}}{nx\overline{\sigma}'_{b}} = \frac{2,600}{14x130} = 1.43$$

$$Ca = \frac{h}{\sqrt{\frac{nxM}{bx\sigma_{a}}}} = \frac{35}{\sqrt{\frac{14x187,366}{25x2,600}}} = 5.51$$

Stresses

$$\overline{\sigma}_{a} = 2,600 \text{ kg/cm}^{2}$$

$$\overline{\sigma}_{b} = \overline{\sigma}_{a} = \frac{2,600}{14x3.6} = 51.59 \text{ kg/cm}^{2} < \overline{\sigma'}_{b} = 130 \text{ kg/cm}^{2} \text{ (OK)}$$

$$\sigma_a = \overline{\sigma}_a = \frac{2,600}{6.65} = 390.98 \text{ kg/cm}^2 < \overline{\sigma}_a = 2,600 \text{ kg/cm}^2 \text{ (OK)}$$

Reinforcement

$$A = \frac{\text{wbh}}{n} = \frac{0.035 \times 25 \times 35}{14} = 2.19 \text{ cm}^2$$

$$= \frac{3.19 \text{ cm}^2}{14} < 1.900 \text{ cm}^2 = A_{\text{concrete}} \text{ (sectional area)}$$

A steel =  $2.19 \text{ cm}^2 < 1 \% \times 1,000 \text{ cm}^2 = \text{A}_{concrete}$  (sectional area)

Hence applied :

A steel = 8 D 16  
= 
$$16.08 \text{ cm}^2 = \frac{16.08 \text{ x } 100 \text{ % A concrete}}{25\text{x}40}$$

= 1.61 % A concrete (OK)

Checking of Beam reinforcement bar & stress of Wall Portal Frame Туре К - 1

On Rail Beam, member F5 as the biggest bending moment.

= 266,680 kgcmBending Moment

b (width) = 
$$50$$
 cm  
h<sub>t</sub> (height) =  $50$  cm

Concrete cover = 5 cm  

$$h = h_t - d$$
 = 50 - 5 = 45 cm  
 $= 225 kg/cm^2 \longrightarrow \overline{\sigma'}_b = 130 kg/cm^2$   
Fu = 3,200 kg/cm<sup>2</sup>  $\longrightarrow \overline{\sigma}_a = 2,600 kg/cm^2$   
 $= 14$   
 $\delta = 1$  ( symetrical reinforcement )

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

$$Ca = \frac{h}{\int n \times M} = \frac{45}{14 \times 266,680} = 8.39$$

. Stresses

∜bxσ<sub>a</sub>∵

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

V 50x2,600

$$\overline{\sigma}_b = \overline{\sigma}_a = \frac{2,600}{14 \times 5.45} = 34.08 \text{ kg/cm}^2 < \overline{\sigma'}_b = 130 \text{ kg/cm}^2 \text{ (OK)}$$

$$\sigma_a = \overline{\sigma}_a = \frac{2,600}{15.36} = 169.27 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2 \text{ (OK)}$$

. Reinforcement

$$A = \frac{\omega bh}{n} = \frac{0.0152 \times 50 \times 45 = 2.44 \text{ cm}^2}{14}$$

$$A_{\text{steel}} = 2.44 \text{ cm}^2$$

Hence applied:

$$A_{\text{steel}} = 10 \text{ D } 16$$
  
= 20.11 cm<sup>2</sup> >  $A_{\text{steel}} = 2.44 \text{ cm}^2$  (OK)

■ Checking of Beam reinforcement bar & stress of Wall Portal Frame
Type K - 1

On Tunnel Beam, member F39 as the biggest bending moment.

Bending Moment = 123,478 kgcm

b (width) = 25 cm

h<sub>t</sub> (height) = 40 cm

Concrete cover = 5 cm

h = h<sub>t</sub> - d = 40 - 5 = 35 cm

Fc = 225 kg/cm<sup>2</sup> 
$$\rightarrow \overline{\sigma}'_{b}$$
 = 130 kg/cm<sup>2</sup>

Fu = 3,200 kg/cm<sup>2</sup>  $\rightarrow \overline{\sigma}_{a}$  = 2,600 kg/cm<sup>2</sup>

$$n = 14$$
  
 $\delta = 1$  ( symetrical reinforcement )

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

$$Ca = \frac{h}{\sqrt{\frac{n \times M}{b \times \sigma_a}}} = \frac{35}{\sqrt{\frac{14 \times 123,478}{25 \times 2,600}}} = 6.79$$

$$\phi$$
 = 4.41 >  $\phi_0$  = 1.43 (OK)  
 $\phi'$  = 9.59  
 $n\omega$  = 0.023

# Stresses

$$\overline{\sigma}_{a} = 2,600 \text{ kg/cm}^{2}$$

$$\overline{\sigma}_{b} = \overline{\sigma}_{a} = 2,600 = 42.11 \text{ kg/cm}^{2} < \overline{\sigma'}_{b} = 130 \text{ kg/cm}^{2} \text{ (OK)}$$

$$\underline{\sigma}_{a} = \overline{\sigma}_{a} = 2,600 = 271.12 \text{ kg/cm}^{2} < \sigma_{a} = 2,600 \text{ kg/cm}^{2} \text{ (OK)}$$

# Reinforcement

$$A = \frac{\omega bh}{n} = \frac{0.023}{14} \times 25 \times 35 = 1.44 \text{ cm}^2$$

$$A_{steel} = 2.44 \text{ cm}^2$$

gradien from No. Sody (films of tobby). The Courty (

$$A_{\text{steel}} = 2 \text{ D } 16$$
  
= 4.16 cm<sup>2</sup> > A <sub>steel</sub> = 1.44 cm<sup>2</sup> (OK)

Sei Jahrell Colorente

#### · Checking of Column reinforcement bar & stress

On Column No. F5 (for loading combination 3)

Positive Bending Moment = 178,266 kgcm

Negative Bending Moment = 186,498 kgcm

b (width) = 30 cm

h<sub>t</sub> (height) = 50 cm

Concrete cover = 5 cm

h = h<sub>t</sub> - d = 50 - 5 = 45 cm

Fc = 225 kg/cm<sup>2</sup> 
$$\rightarrow$$
  $\sigma'_b$  = 130 kg/cm<sup>2</sup>

Fu = 3,200 kg/cm<sup>2</sup>  $\rightarrow$   $\sigma_a$  = 2,600 kg/cm<sup>2</sup>

ns = 14

 $\phi_0 = \overline{\sigma}_a = 2,600 = 1.43$ 

a) For Positive BM M = 178,266 kgcm

$$Ca = h = 45 = 7.96$$

$$\sqrt{\frac{\text{nM}}{\text{bo}_a}} \sqrt{\frac{14x178,266}{30x2,600}}$$

$$\delta = 1 \text{ (for symetrical reinforcement )}$$

$$\Rightarrow \phi = 5.25 > \phi_0 = 1.4$$

$$\rightarrow$$
  $\phi$  = 5.25 >  $\phi_0$  = 1.43 (OK)  
 $\phi'$  = 14.00  
 $n\omega$  = 0.0164

. Stresses

$$\frac{\overline{\sigma_a}}{\overline{\sigma_b}} = \frac{2,600 \text{ kg/cm}^2}{\frac{1}{n}} = \frac{2,600}{14 \times 5.25} = 35.37 \text{ kg/cm}^2 < \sigma_b' = 130 \text{ kg/cm}^2$$

$$\frac{\overline{\sigma_a}}{n} = \frac{2,600}{14 \times 5.25} = 185.71 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2$$

$$\frac{\overline{\sigma_a}}{\sigma_b'} = \frac{2,600}{14.00} = 185.71 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2$$

. Reinforcement

$$A = \omega bh = 0.0164 \times 30 \times 45 = 1.581 \text{ cm}^2$$

 $A_{\text{steel}} = 1.581 \text{cm}^2 < 1 \% \times 1,500 \text{ cm}^2 \text{ (sectional area of column)}$ 

Hence applied:

A steel = 8 D 16  
= 16.08 cm<sup>2</sup>  
= 
$$\frac{16.08 \times 100 \% \text{ A concrete}}{30 \times 50}$$

= 1.072 % A concrete (OK)

a) For Negative BM M = 186,498 kgcm

Ca = 
$$\frac{h}{\sqrt{\frac{nM}{b\sigma_a}}}$$
 =  $\frac{45}{\sqrt{\frac{14x186,498}{30x2,600}}}$  = 7.78

. Stresses

$$\frac{\overline{\sigma}_{a}}{\overline{\sigma}_{b}} = \frac{2,600 \text{ kg/cm}^{2}}{\frac{14x5.061}{14x5.061}} = \frac{2,600 \text{ kg/cm}^{2}}{\frac{36.70 \text{ kg/cm}^{2}}{14x5.061}} = \frac{36.70 \text{ kg/cm}^{2}}{\frac{36.70 \text{ kg/cm}^{2}}{14x5.061}}$$

$$\sigma_{a} = \frac{\overline{\sigma}_{a}}{\phi'} = \frac{2,600}{12.85} = 205 \text{ kg/cm}^{2} < \overline{\sigma}_{a} = 2,600 \text{ kg/cm}^{2}$$

. Reinforcement

A = 
$$\omega bh = \frac{0.018}{14} \times 30 \times 45 = 1.73 \text{ cm}^2$$

A  $_{\text{steel}} = 1.73 \text{ cm}^2 < 1 \% \text{ x } 900 \text{ cm}^2 \text{ (sectional area of column)}$ 

A steel used as A steel of Positive BM

$$A_{steel} = 8 D 16 (OK)$$

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## Checking of Beam reinforcement bar & stress

On Beam No. F118 & F119 (for loading combination 1)

42、企业的工作。1984。

Positive Bending Moment = 1,246,177 kgcm= 800,550 kgcm Negative Bending Moment b (width) = 25 cm ht (height) 50 cm Concrete cover 5 cm = 225 $kg/cm^2 \longrightarrow \sigma'_b = 130 kg/cm^2$ Fu = 3,200 kg/cm<sup>2</sup> $\rightarrow \sigma_a = 2,600 \text{ kg/cm}^2$ ns = 14  $\overline{\sigma}_{a} = 2,600 = 1.43$  $\vec{n} \sigma'_b = 14x130$ 

a) For Positive BM, M = 1,246,177 kgcm

b = 25  

$$h_t = 50$$
;  $d = 5$  \_\_\_\_\_h =  $h_t - d = 50 - 5 = 45$  cm

Ca = h = 45 = 2.75
$$\sqrt{\frac{\text{nM}}{\text{bo}_a}} \sqrt{\frac{14x1,246,177}{25x2,600}}$$
 $\delta = 0.4$  (required of minimum compression reinforce)

$$\delta$$
 = 0.4 ( required of minimum compression reinforcement bar )   
  $\rightarrow$   $\phi$  = 1.546 >  $\phi_0$  = 1.43 (OK)   
  $\phi'$  = 2.103   
  $n\omega$  = 0.1539

. Stresses

$$\overline{\sigma}_{a} = 2,600 \text{ kg/cm}^{2}$$

$$\overline{\sigma}_{b} = \overline{\sigma}_{a} = 2,600 = 120.13 \text{ kg/cm}^{2} < \sigma'_{b} = 130 \text{ kg/cm}^{2} \text{ (OK)}$$

$$\sigma_a = \frac{\overline{\sigma_a}}{2.103} = \frac{2,600}{1,236} = 1,236 \text{ kg/cm}^2 < \sigma_a = 2,600 \text{ kg/cm}^2 \text{ (OK)}$$

. Reinforcement bar

A steel (tensile) = 
$$0 \text{ bh}$$
 = 0.1539 x 25 x 45 = 12.37 cm<sup>2</sup>

A steel (compression) =  $\delta$  x A steel (tensile)

 $= 0.4 \times 12.37 \text{ cm}^2 = 4.948 \text{ cm}^2$ 

a) For Negative BM, M = 800,550 kgcm

Used A steel as A steel of Positive BM:

Used A steel (tensile) = 6 D 16 =  $12.06 \text{ cm}^2$  (OK)

Used A steel (compression) = 4 D 16 =  $8.04 \text{ cm}^2$  (OK)

