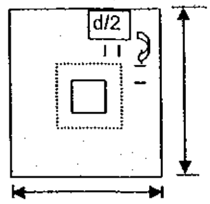
PROJECT: Detailed Design on Port Reactivation Project in La Union Province	Calc. File No.		Prepared by: R.Martinez
SECTION: Port Administration Building	Calc. Index No.		Checked by: A.MORIOKA
SUBJECT: Foundation Design	Date	July-02	Page 64 / 232

FOOTING DESIGN

Design for foundation F-3

a) Punching

For Column



2.20 m

2.20 m

Th = 80 cm

f'c = 210 kg/cm²
20.59 Mpa

ϕ= 0.85

Dead load P_D =	113.50	ton
Live load P_L=	45.14	ton
Seismic P_S =	1.83	ton
1.4D + 1.7L =	235.64	ton
0.75(1.4D + 1.7L + 1.87S) =	179.30	ton
Pu=	235.64	ton
d =	69.03	cm
Column width =	70.00	cm
Column base =	65.00	cm
bo=4(c+d)=	556.12	cm

Concrete shear strength, Vc ACI 11.12

βc = 1.077

αs = 40

$Vc1 = \phi(1+2/\beta c)\sqrt{f'c}\ b_o d/6$ = 719.26 ton

$Vc2 = \phi(2+\alpha s d/b_o)\sqrt{f'c}\ b_o d/12$ = 314.24 ton

$Vc3 = \phi(1/3)\sqrt{f'c}\ b_o d$ = 503.48

Vc = 314.24 > 235.64 o.k!!!

For Pile

ϕ= 0.85

Distance from edge = 27.50 cm

βc = 1

αs = 20

Dead load P_D =	30.70	ton/pile
Live load P_L=	11.29	ton/pile
Carga sismica P_S =	0.46	ton/pile
1.4D + 1.7L =	62.16	ton
0.75(1.4D + 1.7L + 1.87S) =	47.26	ton
Pu=	62.16	ton
d =	38.73	cm
Pile width =	45.00	cm
Pile base =	45.00	cm
bo=4(c+d)=	334.92	cm

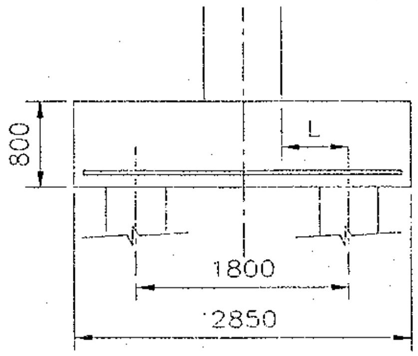
$Vc1 = \phi(1+2/\beta c)\sqrt{f'c}\ b_o d/6$ = 255.19 ton

$Vc2 = \phi(2+\alpha s d/b_o)\sqrt{f'c}\ b_o d/12$ = 303.03 ton

$Vc3 = \phi(1/3)\sqrt{f'c}\ b_o d$ = 170.12

Vc = 170.12 > 62.16 o.k!!!

b) Reinforcing Steel



fy = 4200 kg/cm²

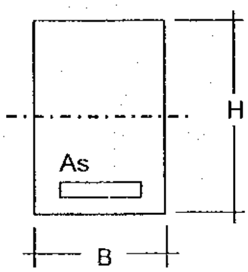
Moment generated by pile reaction

M = Pp x L

L = 0.50 m

M1 = 1.4D + 1.7L = 31.08 ton-m

M2 =0.75(1.4D + 1.7L + 1.87S) = 23.63 ton-m



H = 80.00 cm

b = 110.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Force for design: Mu z-z = 31.08 ton-m

d = 62.62 cm Clear cover = 5.00 cm

$fy^2/1.7bf'c\,As^2$ - fyd As + Mu/ϕ = ϕ = 0.90

336.90 As² 262999 As 3453443.3 = 0 As = 13.36 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 17.81 cm²

(14/fy) b d = 22.96 cm²

Asmin = 17.81 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 237.37 cm²

As = 17.81 cm² o.k!! As < Amax

Bar denomination, N = 7 Bar Area (Av) = 3.88 cm²

Number of bars = 4.59 Use 5 - N 7

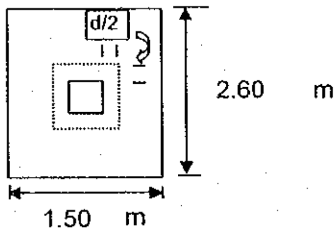
Pitch = 23.81 cm **7 @ 23.5 cm**

FOOTING DESIGN

Design for foundation F-4

a) Punching

For Column



ϕ= 0.85

Dead load PD =	102.55	ton
Live load PL=	26.86	ton
Seismic Ps =	28.68	ton
1.4D + 1.7L =	189.23	ton
0.75(1.4D + 1.7L + 1.87S) =	182.15	ton
Pu=	189.23	ton
d =	69.03	cm
Column width =	70.00	cm
Column base =	65.00	cm
bo=4(c+d)=	556.12	cm

Th = 80 cm

f'c = 210 kg/cm²
20.59 Mpa

Concrete shear strength, Vc ACI 11.12

βc = 1.077

αs = 40

Vc1 = $\phi(1+2/\beta c)\sqrt{f'c}$ bod/6 = 719.26 ton

Vc2 = $\phi(2+\alpha sd/bo)\sqrt{f'c}$ bod/12 = 314.24 ton

Vc3 = $\phi(1/3)\sqrt{f'c}$ bod = 503.48

Vc = 314.24 > 189.23 o.k!!!

For Pile

ϕ= 0.85

Distance from edge = 27.50 cm

βc = 1 αs = 20

Dead load PD =	55.02	ton/pile
Live load PL=	13.43	ton/pile
Carga sismica Ps =	14.34	ton/pile
1.4D + 1.7L =	99.86	ton
0.75(1.4D + 1.7L + 1.87S) =	95.01	ton
Pu=	99.86	ton
d =	43.73	cm
Pile width =	50.00	cm
Pile base =	50.00	cm
bo=4(c+d)=	374.92	cm

Vc1 = $\phi(1+2/\beta c)\sqrt{f'c}$ bod/6 = 322.54 ton

Vc2 = $\phi(2+\alpha sd/bo)\sqrt{f'c}$ bod/12 = 383.36 ton

Vc3 = $\phi(1/3)\sqrt{f'c}$ bod = 215.03

Vc = 215.03 > 99.86 o.k!!!

b) Shear Reinforcement

Base = 150 cm   fy = 4200 kg/cm²

d = 70.00 cm

$V_c = (1/6)\sqrt{f'c}\ b_o d =$ 81.01 ton

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

$V_u =$ 99.86 ton

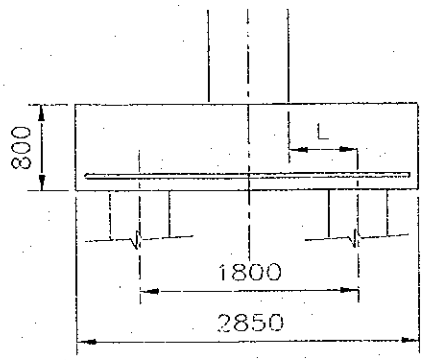
$V_s =$ 36,473.8 kg

Bar denomination = 4   Bar area = 1.27 cm²

# of legs = 2   Spacing, S_{req} = 20.42 cm

Use 2 legs of N 4 @ 20 cm

c) Reinforcing Steel



fy = 4200 kg/cm²

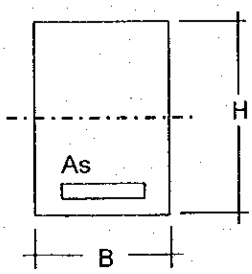
Moment generated by pile reaction

M = Pp x L

L = 0.50 m

M1 = 1.4D + 1.7L = 49.93 ton-m

M2 = 0.75(1.4D + 1.7L + 1.87S) = 47.50 ton-m



H = 80.00 cm

b = 150.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Force for design: Mu z-z = 49.93 ton-m

d = 62.62 cm Clear cover = 5.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi =$ $\phi = 0.90$

$247.06\ As^2 262999\ As\ 5547644.4 = 0$ As = 21.53 cm²

Asmin = (4/3)Asreq :
(4/3)Asreq = 28.71 cm²
(14/fy) b d = 31.31 cm² } Asmin = 28.71 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 323.69 cm²

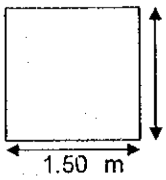
As = 28.71 cm² o.k!! As < Amax

Bar denomination, N = 7 Bar Area (Av) = 3.88 cm²

Number of bars = 7.40 Use 8 - N7

Pitch = 19.32 cm **7 @ 19 cm**

Design for foundation F-5


1.50 m

1.50 m

Thickness, h = 70 cm

d = 53.10 cm

Clear cover = 5.00 cm

- Shrinkage and temperature reinforcement, ACI 7.12.

Minimun Gross area ratio = 0.180% Total area of steel = 18.9 cm^2

Area by layer = As/2 = 9.45 cm^2

Bar denomination, N = 4 Bar Area (Av) = 1.27 cm^2

Number of bars = 7.46 Use 8 - N 4

Pitch = 19.46 cm **8 - N 4 @ 19 cm**

Minimum spacing for ties, ACI 11.5.4.

S1 = d/2 = 26.55 cm

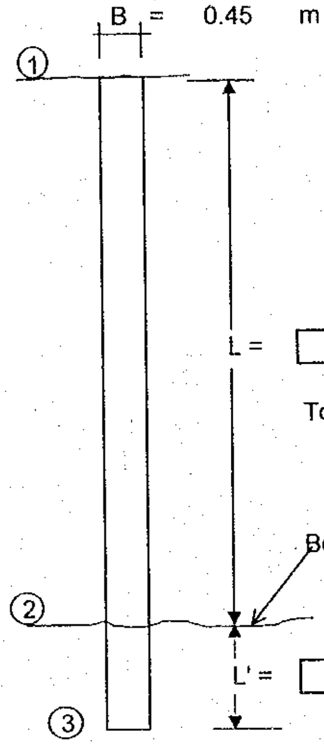
S2 = 60.00 cm

Use S = 25.00 cm

BEARING CAPACITY OF SQUARE DRIVEN CONCRETE PILES

B = 0.45 m   20xB = 9.00 m

Side dimension = 0.45 m



L = 4 m

Top Soil

Bearing Layer

L' = 1 m

	Properties In Top Soil:		Properties In Bearing Stratum:	
N of hits by SPT =	8	N	50	N
$\phi = \sqrt{12N} + 20$				
Ø =	29.80	°	42.39	°
γ =	1.430	ton/m³	1.840	ton/m³
Nq =	21		145	
δ =	22.35	°	31.79	°
KHc =	1		1	
Factor of safety (F.S.) =			3	

Pressure due to soil:

P1 = 0.00 ton/m³
P2 = 5.72 ton/m³
P3 = 7.56 ton/m³

Qult = Qt + Qf

- Tip Resistance (Qt)

Qp = PtxNqxAt   Pt = P3 = 7.56 ton/m²

Pile Area = 0.203 m²   **Qp = 222.01 ton**

- Friction Capacity (Qf)   Consider Friction ? N Y/N

Qf = Σ(KHc)xPoxTAN(δ)xS

S1 = 2BLD   S1 = 3.60 m²   Po1 = (P1 + P2)/2

S2 = 2BL'D   S2 = 0.90 m²   Po2 = (P2 + P3)/2

Po1 = 2.861 ton/mt²   Po2 = 6.641 ton/m²   **Qf = 0.00 ton**

Qult = Qt + Qf   Qult = 222.01 ton

Qadm = Qult / F.S.   **Qadm = 74.00 ton**

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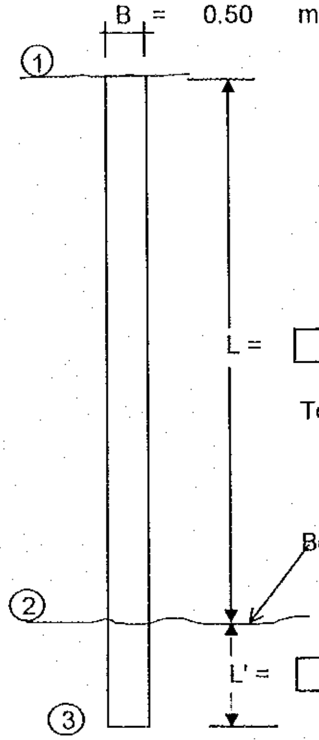
BEARING CAPACITY OF SQUARE DRIVEN CONCRETE PILES



B = 0.50 m

20xB = 10.00 m

Side dimension = 0.50 m

	Properties In Top Soil:		Properties In Bearing Stratum:	
N of hits by SPT =	8	N	50	N
$\phi = \sqrt{12N} + 20$				
Ø =	29.80	°	44.49	°
γ =	1.430	ton/m³	1.840	ton/m³
Nq =	21		145	
δ =	22.35	°	33.37	°
KHc =	1		1	
Factor of safety (F.S.) =			3	

L = 4 m

Top Soil

Bearing Layer

L' = 1 m

Pressure due to soil:

P1 = 0.00 ton/m³

P2 = 5.72 ton/m³

P3 = 7.56 ton/m³

Quit = Qt + Qf

- Tip Resistance (Qt)

Qp = PtxNqxAt   Pt = P3 = 7.56 ton/m²

Pile Area = 0.250 m²   **Qp = 274.05 ton**

- Friction Capacity (Qf)   Consider Friction ? n Y/N

Qf = Σ(KHc)xPoxTAN(δ)xS

S1 = 2BLD   S1 = 4.00 m²   Po1 = (P1 + P2)/2

S2 = 2BL'D   S2 = 1.00 m²   Po2 = (P2 + P3)/2

Po1 = 2.860 ton/mt²   Po2 = 6.640 ton/m²   **Qf = 0.00 ton**

Qult = Qt + Qf   Qult = 274.05 ton

Qadm = Qult / F.S.   **Qadm = 91.35 ton**

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PILE SEISMIC STRESS

based on chung equation

mark	size (cm)	length (m)	I (cm4)	kh (kg/cm3)	(cm-1) (cm-1)	L	I 3
P1	45	7	3.42E+05	2.901	0.00422	3.0	0.026
P2	50	7	5.21E+05	2.680	0.00383	2.7	0.029

	N of piles	nI 3	Q (t)	Q (t/n)	y0 (cm)	M0 (t m)	Mmax (t m)	lm (m)
	43	1.107	298.6	6.9	0.2	8.2	1.7	3.7
	30	0.876	236.1	7.9	0.2	10.3	2.1	4.1
Σ=	73	1.983	534.6					

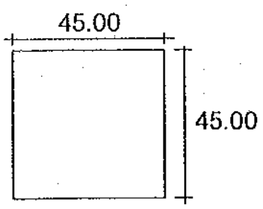
Young's Modulus, E = 3.00E+05 kg/cm2 N = 9

Seismic force, Q = 534.61 t E0 = 63

40 x 40		
L (cm)	M (t m)	Q (t)
0	8.2	6.9
-50	5.1	5.5
-100	2.7	4.2
-150	0.9	3.0
-200	-0.3	2.0
-250	-1.1	1.2
-300	-1.5	0.6
-350	-1.7	0.1
-400	-1.7	-0.2
-450	-1.6	-0.3
-500	-1.4	-0.4
-550	-1.1	-0.5
-600	-0.9	-0.5
-650	-0.7	-0.4
-700	-0.5	-0.4
-750	-0.3	-0.3

50 x 50		
L (cm)	M (t m)	Q (t)
0	10.3	7.9
-50	6.7	6.4
-100	3.9	5.0
-150	1.7	3.7
-200	0.1	2.6
-250	-1.0	1.7
-300	-1.6	1.0
-350	-2.0	0.5
-400	-2.1	0.1
-450	-2.1	-0.2
-500	-1.9	-0.4
-550	-1.7	-0.5
-600	-1.5	-0.5
-650	-1.2	-0.5
-700	-0.9	-0.5
-750	-0.7	-0.4

PILE DESIGN



f'c = 350.00 kg/cm²

At release, f'c = 280.00 kg/cm²

Section Area = 2025 cm²

Section Inertia = 341718.75 cm4

- Prestressing Force

Cables.
Uncoated seven wire stress relieved strands.
ϕ = 12.7 mm. Area = 92.90 mm.

Ultimate Strenght, Fpu = 17,500.0 kg/cm²

# of strands to use = 6

Prestressing force, Po = 0.70 Fpu A = 68.28 ton

Allowable stress

At service
0.4 f'c = 140 kg/cm²

At release
0.4 f'c = 112 kg/cm²

a) Stress at release

Axial Load, Pa = 0.00 ton

Excentricity, e = 0.00 cm

Moment, Ma = 0.00 ton-m

c = 22.50 cm

(Pa+Po) / A ± (Po e c / I + Ma c / I)

33.72 ± 0.00

Stress 1 = 33.72 kg/cm² < 0.4f'c o.k!!!

Stress 2 = 33.72 kg/cm² < 0.4f'c o.k!!!

b) Stress at Service

Axial Load, Pa = 74.00 ton

Excentricity, e = 0.00 cm

Moment, Ma = 8.22 ton-m

Prestress force, Pe = 58.04 cm (15% losses)

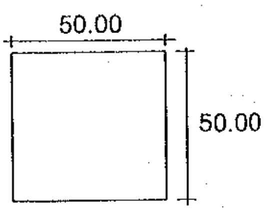
(Pa+Pe) / A ± (Pe e c / I + Ma c / I)

65.20 ± 54.12

Stress 1 = 119.32 kg/cm² < 0.4f'c o.k!!!

Stress 2 = 11.09 kg/cm² < 0.4f'c o.k!!!

PILE DESIGN



f'c = 350.00 kg/cm²

At release, f'c = 280.00 kg/cm²

Section Area = 2500 cm²

Section Inertia = 520833.3 cm4

- Prestressing Force

Cables.
Uncoated seven wire stress relieved strands.
ϕ = 12.7 mm. Area = 92.90 mm.

Ultimate Strenght, Fpu = 17,500.0 kg/cm²

# of strands to use = 6

Prestressing force, Po = 0.70 Fpu A = 68.28 ton

Allowable stress

At service

0.4 f'c = 140 kg/cm²

At release

0.4 f'c = 112 kg/cm²

a) Stress at release

Axial Load, Pa = 0.00 ton

Excentricity, e = 0.00 cm

Moment, Ma = 0.00 ton-m

c = 25.00 cm

(Pa+Po) / A ± (Po e c / I + Ma c / I)

27.31 ± 0.00

Stress 1 = 27.31 kg/cm² < 0.4f'c o.k!!!

Stress 2 = 27.31 kg/cm² < 0.4f'c o.k!!!

b) Stress at Service

Axial Load, Pa = 91.35 ton

Excentricity, e = 0.00 cm

Moment, Ma = 10.28 ton-m

Prestress force, Pe = 58.04 cm (15% losses)

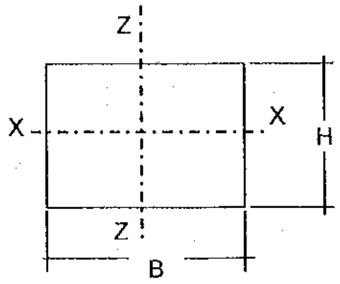
(Pa+Pe) / A ± (Pe e c / I + Ma c / I)

59.76 ± 49.35

Stress 1 = 109.10 kg/cm² < 0.4f'c o.k!!!

Stress 2 = 10.41 kg/cm² < 0.4f'c o.k!!!

COLUMN DESIGN (C1 FOR AXIS 1)



H = 0.70 m

B = 0.65 m

f 'c = 280 kg/cm²

fy = 4200 kg/cm²

Area = 4,550 cm²

Inertia z = 1,857,917 cm^4

Inertia Y = 1,601,979 cm^4

Forces and Moments

From Structural Analisis (ton , m) :

TYPE OF LOAD	AXIAL	MOMENT		SHEAR	
	P	Mz-z	Mx-x	Vx	Vz
Dead Load	31.11	2.56	0.86	1.50	0.56
Live Load	5.69	0.61	0.83	0.39	0.57
Seismic Load x	14.67	78.40	0.77	23.45	0.25
Seismic Load z	0.18	0.31	10.75	0.10	3.29

COMB.	Pu	Mu z-z	Mu x-x	Vu x	Vu z
C1	53.23	4.62	2.62	2.76	1.75
C2	58.46	115.81	---	35.70	---
C3	38.15	---	36.49	---	11.75

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Forces for design.

Pu z = 38.15 ton | Pu x = 58.46 ton

Mu x-x = 36.49 ton-m | Mu z-z = 115.81 ton-m

Vu z = 35.70 ton | Vu x = 11.75 ton

Ortogonal Combination

Mx = 100%EQX + 30%EQZ   Mz = 100%EQZ + 30%EQX

$Mx = Mx + Mz(H/B)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$ $Mz = Mz + Mx(B/H)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$

Slenderness.

iF klu/r > 22   Consider Slenderness .

k = 2.0   lu = 3.55 m   r = (Inetia/Area)^½

Y Direction
r = 0.188 m   klu/r = 37.839 > 22 Consider slenderness

Z Direction
r = 0.202 m   klu/r = 35.136 > 22 Consider slenderness

Slenderness

$Mc = \delta bMb + \delta sMs$

$\delta b = cm/(1 - Pu/\phi Pc)$ cm = 1.0

$Pc = \pi^2 EI / (klu)^2$ E = 2526713 ton/m²

Pu = Axial Force = 58.46 ton

X Dir. :			Z Dir. :		
Inertia =	0.0160	m²	Inertia =	0.0186	m²
Pc =	7924.98	ton	Pc =	9191.10	ton
δb =	1.011		δb =	1.006	

Mu x-x = 117.05 ton-m

Mu z-z = 36.71 ton-m

- Design by flexure and Axial load

Z Direction : $\phi = 0.70$

Gross Area (Ag) = 0.46 m² = 705.32 in²

h = 0.65 m = 25.59 in

P = 58.46 ton = 128.89 kips

M = 117.05 ton-m = 10159.70 kips-in

Pu/Ag = 0.18 Mu/Agh = 0.56

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ = 2.3 % As = Ag x ρ = 102.38 cm²

Bar denomination = 8 Bar area = 5.07 cm²

Quantity of bars = 20.20

Use 20 N 8

X Direction : $\phi = 0.7$

Gross Area (Ag) = 0.46 m² = 705.32 in²

h = 0.70 m = 27.56 in

P = 38.15 ton = 84.10 kips

M = 36.71 ton = 3186.27 kips-in

Pu/Ag = 0.12 Mu/Agh = 0.16

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ ? 1 % As = Ag x ρ = 45.50 cm²

Bar Denomination = 8 Bar area = 5.07 cm²

Quantity of bars = 8.98

Use 10 N 8

NIPPON KOEI CO.,LTD.

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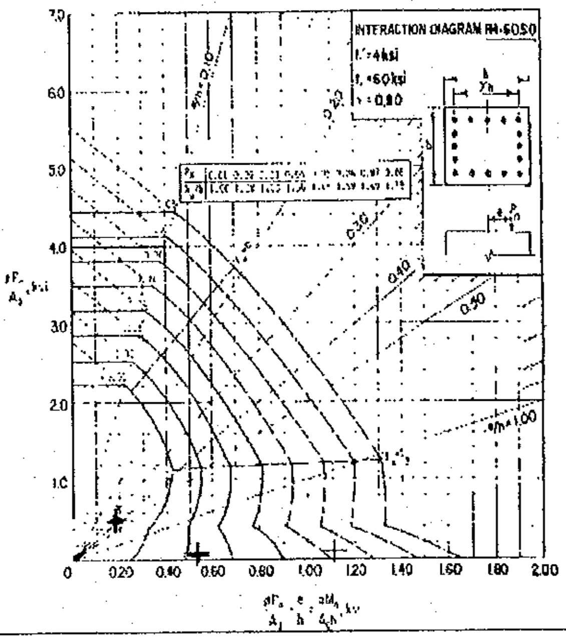
COLUMNS 7.4.4—Load-moment strength interaction diagram for R4-60.90 columns



SHEAR DESIGN.

X Direction :

bw = 650.00 mm

d = 637.30 mm

fy = 4200 kg/cm²
411.90 Mpa

f 'c = 280 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 361,789.8 Newton
36,891.0 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 58.46 ton
573,352 Newton

Vc = 394,353.8 Newton
40,211.5 kg

Vc = 36,890.97 kg

Vn = Vc + Vs   Vs = Vu/ϕ - Vc   ϕ = 0.85

Vu = 35.70 ton   Vs = 5,103.2 kg

Vs = Av fy d / s ; Sreq = Av fy d / Vs

Bar denomination = 3
Bar area = 0.71 cm^2
# of legs = 4

Spacing, S_{req} = 149.50 cm

Max. spacing of shear reinforcement.

d/2 = 31.87 cm
60 mm = 60 cm
S_2 = 31.87 cm

(1/3) ($\sqrt{f'c}$ / 6) bw d = 120596.6 Newton
12,297.0 kg > Vs, o.k.

S_2 = 31.87 cm

Minimun Shear Reinforcement

Av = (1/3) bw S / fy

S_3 = 3 Av fy / bw

S_3 = 54.19 cm

Use 4 legs of N 3 @ 30 cm

PROJECT: Detailed Design on Port Reactivation Project in La Union Province	Calc. File No.		Prepared by	R.Martinez
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Z Direction :

bw = 700.00 mm

fy = 4200 kg/cm²
411.90 Mpa

d = 587.30 mm

f 'c = 280.00 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 359,051.8 Newton
36,611.8 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 38.15 ton
374,107 Newton

Vc = 380,138.7 Newton
38,762.0 kg

Vc = 36,611.78 kg

Vn = Vc + Vs   Vs = Vu/ϕ - Vc   ϕ = 0.85

Vu = 11.75 ton   Vs = (22,783.2) kg

Vs = Av fy d / s ; Sreq = Av fy d / Vs

Bar denomination = 4   Bar area = 1.27 cm²

# of legs = 3   Spacing, S_{req} = -41.14 cm

Max. spacing of shear reinforcement.

d/2 = 29.37 cm
60 mm = 60 cm
S_2 = 29.37 cm

$(1/3)\ (\sqrt{f'c} / 6)\ bw\ d$ = 119683.9 Newton
12,203.9 kg > Vs, o.k.

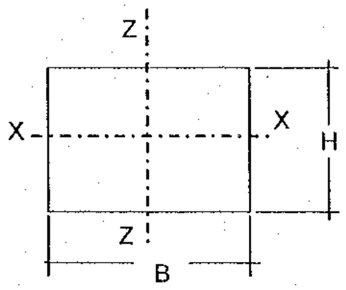
S_2 = 29.37 cm

Minimun Shear Reinforcement

Av = (1/3) bw S / fy S_3 = 3 Av fy / bw S_3 = 67.09 cm

Use 3 legs of N 4 @ 29 cm

COLUMN DESIGN (C1 FOR AXIS D)



H = 0.70 m

B = 0.65 m

f 'c = 280 kg/cm²

fy = 4200 kg/cm²

Area = 4,550 cm²

Inertia z = 1,857,917 cm^4

Inertia Y = 1,601,979 cm^4

Forces and Moments

From Structural Analisis (ton , m) :

TYPE OF LOAD	AXIAL	MOMENT		SHEAR	
	P	Mz-z	Mx-x	Vx	Vz
Dead Load	40.28	0.79	1.52	0.34	1.42
Live Load	4.95	0.16	0.10	0.10	0.10
Seismic Load x	0.86	26.33	1.83	9.11	1.42
Seismic Load z	10.67	6.77	91.53	2.40	0.10

COMB.	Pu	Mu z-z	Mu x-x	Vu x	Vu z
C1	64.81	1.38	2.30	0.65	2.16
C2	48.04	60.07	---	14.29	---
C3	61.80	---	137.29	---	4.58

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Forces for design.

Pu z = 61.80 ton　　Pu x = 48.04 ton

Mu x-x = 137.29 ton-m　　Mu z-z = 60.07 ton-m

Vu z = 14.29 ton　　Vu x = 4.58 ton

Ortogonal Combination

Mx = 100%EQX + 30%EQZ   Mz = 100%EQZ + 30%EQX

$Mx = Mx + Mz(H/B)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$ $Mz = Mz + Mx(B/H)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$

Slenderness.

iF klu/r > 22   Consider Slenderness .

k = 2.0   lu = 3.55 m   r = (Inetia/Area)^½

Y Direction

r = 0.188 m   klu/r = 37.839 > 22 Consider slenderness

Z Direction

r = 0.202 m   klu/r = 35.136 > 22 Consider slenderness

<u>Slenderness</u>

$Mc = \delta bMb + \delta sMs$

$\delta b = cm/(1 - Pu/\phi Pc)$ cm = 1.0

$Pc = \pi^2 EI / (klu)^2$ E = 2526713 ton/m²

Pu = Axial Force = 64.81 ton

X Dir. :   Z Dir. :

X Dir.			Z Dir.		
Inertia =	0.0160	m²	Inertia =	0.0186	m²
Pc =	7924.98	ton	Pc =	9191.10	ton
δb =	1.009		δb =	1.010	

Mu x-x = 60.59 ton-m

Mu z-z = 138.62 ton-m

- Design by flexure and Axial load

Z Direction : $\phi = 0.70$

Gross Area (Ag) = 0.46 m² = 705.32 in²

h = 0.65 m = 25.59 in

P = 48.04 ton = 105.92 kips

M = 60.59 ton-m = 5259.22 kips-in

Pu/Ag = 0.15 Mu/Agh = 0.29

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ = 1.0 % As =Ag x ρ = 45.50 cm²

Bar denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 5.57

Use 6 N 10

X Direction : $\phi = 0.7$

Gross Area (Ag) = 0.46 m² = 705.32 in²

h = 0.70 m = 27.56 in

P = 61.80 ton = 136.25 kips

M = 138.62 ton = 12032.22 kips-in

Pu/Ag = 0.19 Mu/Agh = 0.62

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

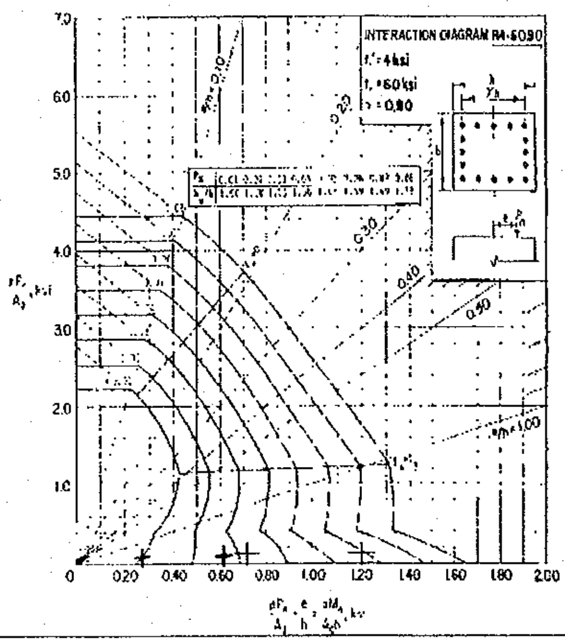
ρ ? 2.8 %. As = Ag x ρ = 127.40 cm²

Bar Denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 15.59

Use 16 N 10

COLUMNS 7.4.4—Load-moment strength interaction diagram for R4-60.90 columns



SHEAR DESIGN.

X Direction :

bw =	650.00	mm	fy =	4200	kg/cm²
				411.90	Mpa
d =	634.13	mm	f 'c =	280	kg/cm²
				27.46	Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 359,987.4 Newton
36,707.2 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 48.04 ton
471,170 Newton

Vc = 386,614.5 Newton
39,422.3 kg

Vc = 36,707.18 kg

$Vn = Vc + Vs$ $Vs = Vu/\phi - Vc$ $\phi = 0.85$

Vu = 14.29 ton Vs = (19,892.9) kg

$Vs = Av\ fy\ d / s$; $Sreq = Av\ fy\ d / Vs$

Bar denomination = 3

\# of legs = 4

Bar area = 0.71 cm²

Spacing, S_{req} = -38.16 cm

Max. spacing of shear reinforcement.

d/2 = 31.71 cm

60 mm = 60 cm

S_2 = 31.71 cm

$(1/3)(\sqrt{f'c} / 6)\ bw\ d$ = 119995.8 Newton

12,235.7 kg > Vs, o.k.

S_2 = 31.71 cm

Minimun Shear Reinforcement

$Av = (1/3)\ bw\ S / fy$

$S_3 = 3\ Av\ fy / bw$

S_3 = 54.19 cm

Use 4 legs of N 3 @ 30 cm

Z Direction :

bw = 650.00 mm

fy = 4200 kg/cm² = 411.90 Mpa

d = 584.13 mm

f'c = 280.00 kg/cm² = 27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 331,602.8 Newton
33,812.9 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 61.80 ton
606,100 Newton

Vc = 363,154.5 Newton
37,030.1 kg

Vc = 33,812.87 kg

Vn = Vc + Vs   Vs = Vu/ϕ - Vc ϕ = 0.85

Vu = 46.45 ton   Vs = 20,834.2 kg

Vs = Av fy d / s ; Sreq = Av fy d / Vs

Bar denomination = 4   Bar area = 1.27 cm²

\# of legs = 2   Spacing, S_{req} = 29.83 cm

Max. spacing of shear reinforcement.

d/2 = 29.21 cm
60 mm = 60 cm

S_2 = 29.21 cm

$(1/3)\ (\sqrt{f'c} / 6)\ bw\ d$ = 110534.3 Newton
11,271.0 kg < Vs, Reduce the max sp. to one half

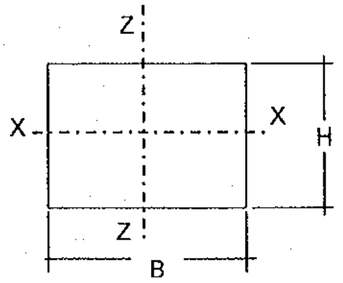
S_2 = 14.60 cm

Minimun Shear Reinforcement

Av = (1/3) bw S / fy $S_3 = 3\ Av\ fy / bw$ S_3 = 48.16 cm

Use 2 legs of N 4 @ 14 cm

COLUMN DESIGN (C1 GROUND LEVEL, 2-B)



H = 0.70 m

B = 0.65 m

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Area = 4,550 cm²

Inertia z = 1,857,917 cm^4

Inertia Y = 1,601,979 cm^4

Forces and Moments

From Structural Analisis (ton , m) :

TYPE OF LOAD	AXIAL P	MOMENT Mz-z	MOMENT Mx-x	SHEAR Vx	SHEAR Vz
Dead Load	102.55	0.49	0.31	0.30	0.27
Live Load	26.87	0.42	0.50	0.21	0.28
Seismic Load x	28.68	79.27	2.67	23.49	0.89
Seismic Load z	2.07	0.33	48.22	0.10	15.10

COMB.	Pu	Mu z-z	Mu x-x	Vu x	Vu z
C1	189.25	1.40	1.28	0.78	0.85
C2	172.57	122.51	---	36.75	---
C3	135.25	---	89.06	---	27.92

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Forces for design.

Pu z = 135.25 ton   Pu x = 172.57 ton

Mu x-x = 89.06 ton-m   Mu z-z = 122.51 ton-m

Vu z = 36.75 ton   Vu x = 27.92 ton

Ortogonal Combination

Mx = 100%EQX + 30%EQZ   Mz = 100%EQZ + 30%EQX

$Mx = Mx + Mz(H/B)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$ $Mz = Mz + Mx(B/H)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$

Slenderness.

iF klu/r > 22   Consider Slenderness .

k = 2.0   lu = 3.55 m   r = (Inetia/Area)^½

Y Direction

r = 0.188 m   klu/r = 37.839   > 22 Consider slenderness

Z Direction

r = 0.202 m   klu/r = 35.136   > 22 Consider slenderness

<u>Slenderness</u>

Mc = δbMb + δsMs

δb = cm/(1 - Pu/φPc)   cm = 1.0

$Pc = \pi^2 EI / (klu)^2$ E = 2526713 ton/m²

Pu = Axial Force = 189.25 ton

X Dir. :		Z Dir. :	
Inertia =	0.0160 m²	Inertia =	0.0186 m²
Pc =	7924.98 ton	Pc =	9191.10 ton
δb =	1.032	δb =	1.021

Mu x-x = 126.44 ton-m

Mu z-z = 90.97 ton-m

- Design by flexure and Axial load

Z Direction : $\phi = 0.70$

Gross Area (Ag) =	0.46	m²	=	705.32	in²
h =	0.65	m	=	25.59	in
P =	172.57	ton	=	380.45	kips
M =	126.44	ton-m	=	10975.22	kips-in

Pu/Ag = 0.54 Mu/Agh = 0.61

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ = 3.0 % As =Ag x ρ = 136.50 cm²

Bar denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 16.71

Use 18 N 10

X Direction : $\phi = 0.7$

Gross Area (Ag) =	0.46	m²	=	705.32	in²
h =	0.70	m	=	27.56	in
P =	135.25	ton	=	298.17	kips
M =	90.97	ton	=	7896.01	kips-in

Pu/Ag = 0.42 Mu/Agh = 0.41

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

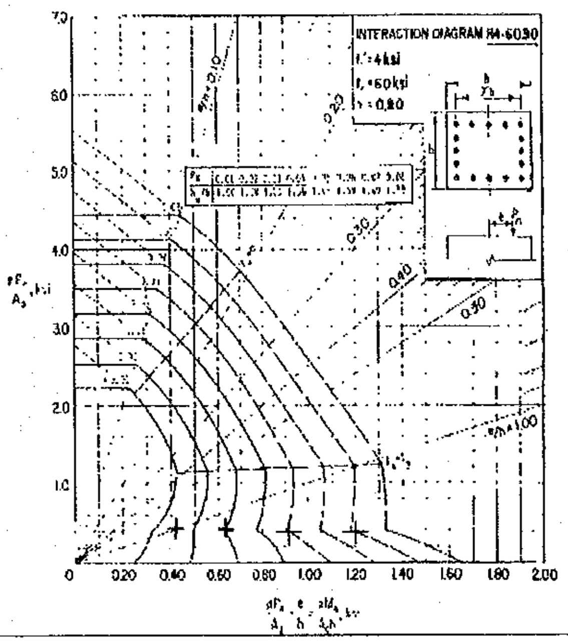
ρ ? 1.7 % As = Ag x ρ = 77.35 cm²

Bar Denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 9.47

Use 10 N 10

COLUMNS 7.4.4—Load-moment strength interaction diagram for R4-60.90 columns



SHEAR DESIGN.

X Direction :

bw = 650.00 mm

d = 634.13 mm

fy = 4200 kg/cm²
411.90 Mpa

f 'c = 280 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 359,987.4 Newton
36,707.2 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 172.57 ton
1,692,373 Newton

Vc = 455,628.3 Newton
46,459.5 kg

Vc = 36,707.18 kg

$Vn = Vc + Vs$ $Vs = Vu/\phi - Vc$ $\phi = 0.85$

Vu = 36.75 ton Vs = 6,530.1 kg

$Vs = Av\ fy\ d / s$; $Sreq = Av\ fy\ d / Vs$

Bar denomination = 3

\# of legs = 4

Bar area = 0.71 cm²

Spacing, S_{req} = 116.25 cm

Max. spacing of shear reinforcement.

d/2 = 31.71 cm
60 mm = 60 cm
} S_2 = 31.71 cm

$(1/3) (\sqrt{f'c} / 6)\ bw\ d$ = 119995.8 Newton
12,235.7 kg > Vs, o.k.

S_2 = 31.71 cm

Minimun Shear Reinforcement

$Av = (1/3)\ bw\ S / fy$

$S_3 = 3\ Av\ fy / bw$

S_3 = 54.19 cm

Use 4 legs of N 3 @ 30 cm

Z Direction :

bw = 700.00 mm

fy = 4200 kg/cm² ; 411.90 Mpa

d = 584.13 mm

f'c = 280.00 kg/cm² ; 27.46 Mpa

Shear Strenght provided by concrete.

$V_c = (\sqrt{f'c}/6)\, b_w\, d$

Vc = 357,110.7 Newton
36,413.9 kg

$V_c = (1+N_u/14A_g)(\sqrt{f'c}/6)\, b_w$

Nu = 135.25 ton
1,326,371 Newton

Vc = 431,468.8 Newton
43,996.0 kg

→ Vc = 36,413.86 kg

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

Vu = 27.92 ton Vs = (3,562.2) kg

$V_s = A_v f_y d / s$; $S_{req} = A_v f_y d / V_s$

Bar denomination = 4 Bar area = 1.27 cm²

# of legs = 3 Spacing, S_{req} = -261.73 cm

Max. spacing of shear reinforcement.

d/2 = 29.21 cm
60 mm = 60 cm

→ S_2 = 29.21 cm

$(1/3)(\sqrt{f'c}/6)\, b_w\, d$ = 119036.9 Newton
12,138.0 kg > Vs, o.k.

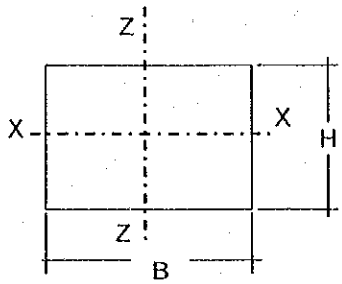
S_2 = 29.21 cm

Minimun Shear Reinforcement

$A_v = (1/3)\, b_w\, S / f_y$ $S_3 = 3 A_v f_y / b_w$ S_3 = 67.09 cm

Use 3 legs of N 4 @ 29 cm

COLUMN DESIGN (C1 GROUND LEVEL, 6-C)



H = 0.70 m

B = 0.65 m

f 'c = 280 kg/cm²

fy = 4200 kg/cm²

Area = 4,550 cm²

Inertia Z = 1,857,917 cm^4

Inertia Y = 1,601,979 cm^4

Forces and Moments

From Structural Analisis (ton , m) :

TYPE OF LOAD	AXIAL	MOMENT		SHEAR	
	P	Mz-z	Mx-x	Vx	Vz
Dead Load	96.52	0.30	3.15	0.21	1.28
Live Load	24.17	0.10	0.95	0.10	0.48
Seismic Load x	4.14	65.56	0.11	19.43	0.22
Seismic Load z	49.63	1.46	90.12	0.55	25.87

COMB.	Pu	Mu z-z	Mu x-x	Vu x	Vu z
C1	176.22	0.59	6.03	0.46	2.61
C2	129.34	111.96	---	33.27	---
C3	193.13	---	146.95	---	43.07

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Forces for design.

Pu z = 193.13 ton — Pu x = 129.34 ton

Mu x-x = 146.95 ton-m — Mu z-z = 111.96 ton-m

Vu z = 33.27 ton — Vu x = 43.07 ton

Ortogonal Combination

Mx = 100%EQX + 30%EQZ   Mz = 100%EQZ + 30%EQX

$Mx = Mx + Mz(H/B)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$ $Mz = Mz + Mx(B/H)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$

Slenderness.

iF klu/r > 22 Consider Slenderness .

k = 2.0 lu = 3.55 m r = (Inetia/Area)^½

Y Direction
r = 0.188 m klu/r = 37.839 > 22 Consider slenderness

Z Direction
r = 0.202 m klu/r = 35.136 > 22 Consider slenderness

Slenderness

$Mc = \delta bMb + \delta sMs$

$\delta b = cm/(1 - Pu/\phi Pc)$ cm = 1.0

$Pc = \pi^2 EI / (klu)^2$ E = 2526713 ton/m²

Pu = Axial Force = 193.13 ton

X Dir. :		Z Dir. :	
Inertia =	0.0160 m²	Inertia =	0.0186 m²
Pc =	7924.98 ton	Pc =	9191.10 ton
δb =	1.024	δb =	1.031

Mu x-x = 114.64 ton-m

Mu z-z = 151.50 ton-m

- Design by flexure and Axial load

Z Direction : $\phi = 0.70$

Gross Area (Ag) =	0.46	m²	=	705.32	in²
h =	0.65	m	=	25.59	in
P =	129.34	ton	=	285.15	kips
M =	114.64	ton-m	=	9950.44	kips-in

Pu/Ag = 0.40 Mu/Agh = 0.55

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ = 3.1 % As =Ag x ρ = 141.05 cm²

Bar denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 17.26

Use 18 N 10

X Direction : $\phi = 0.7$

Gross Area (Ag) =	0.46	m²	=	705.32	in²
h =	0.70	m	=	27.56	in
P =	193.13	ton	=	425.79	kips
M =	151.50	ton	=	13150.36	kips-in

Pu/Ag = 0.60 Mu/Agh = 0.68

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ ? 2.2 % As = Ag x ρ = 100.10 cm²

Bar Denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 12.25

Use 14 N 10

PROJECT: Detailed Design on Port Reactivation Project in La Union Province	Calc. File No.		Prepared by	R.Martinez	
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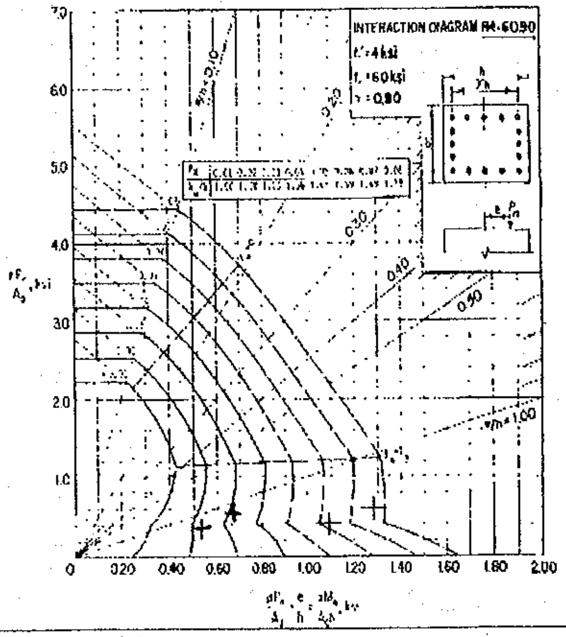
COLUMNS 7.4.4—Load-moment strength interaction diagram for R4-60.90 columns



SHEAR DESIGN.

X Direction :

bw = 650.00 mm

d = 634.13 mm

fy = 4200 kg/cm²
411.90 Mpa

f 'c = 280 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$V_c = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 359,987.4 Newton
36,707.2 kg

$V_c = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 129.34 ton
1,268,441 Newton

Vc = 431,670.7 Newton
44,016.6 kg

Vc = 36,707.18 kg

Vn = Vc + Vs   Vs = Vu/ϕ - Vc   ϕ = 0.85

Vu = 33.27 ton   Vs = 2,436.8 kg

Vs = Av fy d / s ; Sreq = Av fy d / Vs

Bar denomination = 3

Bar area = 0.71 cm²

# of legs = 4

Spacing, S_{req} = 311.52 cm

Max. spacing of shear reinforcement.

d/2 = 31.71 cm
60 mm = 60 cm
} S_2 = 31.71 cm

(1/3) ($\sqrt{f'c}$ / 6) bw d = 119995.8 Newton
12,235.7 kg > Vs, o.k.

S_2 = 31.71 cm

Minimun Shear Reinforcement

Av = (1/3) bw S / fy

S_3 = 3 Av fy / bw

S_3 = 54.19 cm

Use 4 legs of N 3 @ 30 cm

Z Direction :

bw = 700.00 mm

d = 584.13 mm

fy = 4200 kg/cm²
411.90 Mpa

f 'c = 280.00 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 357,110.7 Newton
36,413.9 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 193.13 ton
1,894,070 Newton

Vc = 463,294.8 Newton
47,241.2 kg

Vc = 36,413.86 kg

$Vn = Vc + Vs$ $Vs = Vu/\phi - Vc$ $\phi = 0.85$

Vu = 43.07 ton Vs = 14,258.9 kg

$Vs = Av\ fy\ d / s$; $Sreq = Av\ fy\ d / Vs$

Bar denomination = 4 Bar area = 1.27 cm²

# of legs = 3 Spacing, S_{req} = 65.39 cm

Max. spacing of shear reinforcement.

d/2 = 29.21 cm
60 mm = 60 cm

S_2 = 29.21 cm

$(1/3)\ (\sqrt{f'c} / 6)\ bw\ d$ = 119036.9 Newton
12,138.0 kg < Vs, Reduce the max sp. to one half

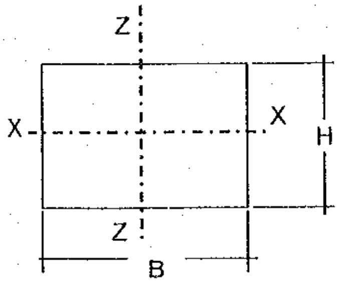
S_2 = 14.60 cm

Minimun Shear Reinforcement

$Av = (1/3)\ bw\ S / fy$ $S_3 = 3\ Av\ fy / bw$ S_3 = 67.09 cm

Use 3 legs of N 4 @ 14 cm

COLUMN DESIGN (C2 FOR GROUND LEVEL)



H = 0.75 m

B = 0.65 m

f 'c = 280 kg/cm²

fy = 4200 kg/cm²

Area = 4,875 cm²

Inertia z = 2,285,156 cm^4

Inertia Y = 1,716,406 cm^4

Forces and Moments

From Structural Analisis (ton , m) :

TYPE OF LOAD	AXIAL	MOMENT		SHEAR	
	P	Mz-z	Mx-x	Vx	Vz
Dead Load	269.68	0.10	2.30	0.04	0.78
Live Load	66.38	0.05	0.25	0.02	0.08
Seismic Load x	-4.61	87.98	2.06	26.01	0.67
Seismic Load z	-6.32	0.36	113.38	0.11	31.61

COMB.	Pu	Mu z-z	Mu x-x	Vu x	Vu z
C1	490.40	0.23	3.65	0.09	1.23
C2	337.64	145.97	---	42.80	---
C3	335.24	---	185.61	---	52.34

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Forces for design.

Pu z = 335.24 ton   Pu x = 337.64 ton

Mu x-x = 185.61 ton-m   Mu z-z = 145.97 ton-m

Vu z = 42.80 ton   Vu x = 52.34 ton

Ortogonal Combination

Mx = 100%EQX + 30%EQZ   Mz = 100%EQZ + 30%EQX

$Mx = Mx + Mz(H/B)\left(\frac{1-\beta}{\beta}\right)$ β = 0.65 $Mz = Mz + Mx(B/H)\left(\frac{1-\beta}{\beta}\right)$ β = 0.65

Slenderness.

iF klu/r > 22 Consider Slenderness .

k = 2.0   lu = 3.55 m   r = (Inetia/Area)^½

Y Direction
r = 0.188 m   klu/r = 37.839 > 22 Consider slenderness

Z Direction
r = 0.217 m   klu/r = 32.793 > 22 Consider slenderness

Slenderness

$Mc = \delta bMb + \delta sMs$

$\delta b = cm/(1 - Pu/\phi Pc)$ cm = 1.0

$Pc = \pi^2 EI / (klu)^2$ E = 2526713 ton/m²

Pu = Axial Force = 490.40 ton

X Dir. :		Z Dir. :	
Inertia =	0.0172 m²	Inertia =	0.0229 m²
Pc =	8491.04 ton	Pc =	11304.65 ton
δb =	1.060	δb =	1.044

Mu x-x = 154.77 ton-m

Mu z-z = 193.83 ton-m

- Design by flexure and Axial load

Z Direction : $\phi = 0.70$

Gross Area (Ag) = 0.49 m² = 755.70 in²

h = 0.65 m = 25.59 in

P = 337.64 ton = 744.36 kips

M = 154.77 ton-m = 13433.67 kips-in

Pu/Ag = 0.98 Mu/Agh = 0.69

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ = 3.5 % As = Ag x ρ = 170.63 cm²

Bar denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 20.88

Use 22 N 10

X Direction : $\phi = 0.7$

Gross Area (Ag) = 0.49 m² = 755.70 in²

h = 0.75 m = 29.53 in

P = 335.24 ton = 739.07 kips

M = 193.83 ton = 16824.12 kips-in

Pu/Ag = 0.98 Mu/Agh = 0.75

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

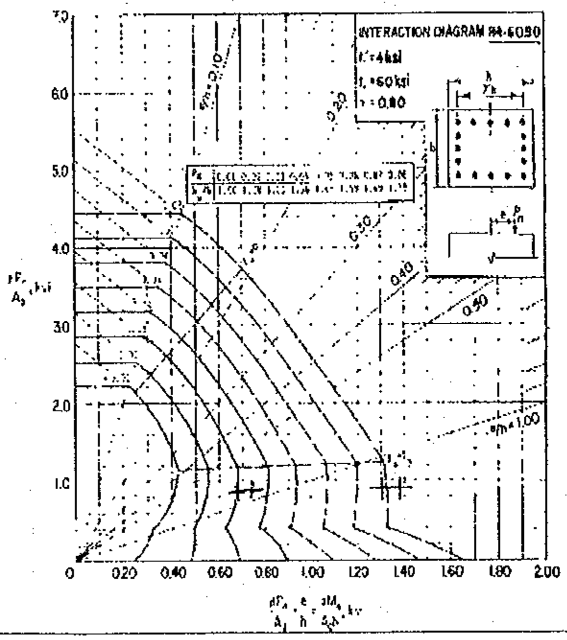
ρ ? 3.2 % As = Ag x ρ = 156.00 cm²

Bar Denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 19.09

Use 20 N 10

COLUMNS 7.4.4—Load-moment strength interaction diagram for R4-60.90 columns



SHEAR DESIGN.

X Direction :

fy = 4200 kg/cm²
411.90 Mpa

bw = 650.00 mm

d = 684.13 mm

f 'c = 280 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

Vc = (√f 'c / 6) bw d

Vc = 388,371.9 Newton
39,601.5 kg

Vc = (1+Nu/14Ag) (√f 'c / 6) bw

Nu = 337.64 ton
3,311,190 Newton

Vc = 576,792.9 Newton
58,814.4 kg

Vc = 39,601.50 kg

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

V_u = 42.80 ton V_s = 10,750.7 kg

$V_s = A_v f_y d / s$; $S_{req} = A_v f_y d / V_s$

Bar denomination = 3

Bar area = 0.71 cm²

# of legs = 4

Spacing, S_{req} = 76.18 cm

Max. spacing of shear reinforcement.

d/2 = 34.21 cm
60 mm = 60 cm
} S_2 = 34.21 cm

$(1/3)(\sqrt{f'c}/6)\, b_w d$ = 129457.3 Newton
13,200.5 kg > Vs, o.k.

S_2 = 34.21 cm

Minimun Shear Reinforcement

$A_v = (1/3)\, b_w S / f_y$

$S_3 = 3 A_v f_y / b_w$

S_3 = 54.19 cm

Use 4 legs of N 3 @ 30 cm

Z Direction :

fy = 4200 kg/cm² = 411.90 Mpa

bw = 750.00 mm

d = 584.13 mm

f 'c = 280.00 kg/cm² = 27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 382,618.6 Newton
39,014.8 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 335.24 ton
3,287,670 Newton

Vc = 566,929.7 Newton
57,808.7 kg

Vc = 39,014.85 kg

Vn = Vc + Vs   Vs = Vu/ϕ - Vc   ϕ = 0.85

Vu = 52.34 ton   Vs = 22,556.0 kg

Vs = Av fy d / s ; Sreq = Av fy d / Vs

Bar denomination = 4   Bar area = 1.27 cm²

\# of legs = 4   Spacing, S_{req} = 55.11 cm

Max. spacing of shear reinforcement.

d/2 = 29.21 cm
60 mm = 60 cm

S_2 = 29.21 cm

$(1/3)\ (\sqrt{f'c} / 6)\ bw\ d$ = 127539.5 Newton
13,004.9 kg < Vs, Reduce the max sp. to one half

S_2 = 14.60 cm

Minimun Shear Reinforcement

Av = (1/3) bw S / fy S_3 = 3 Av fy / bw S_3 = 83.49 cm

Use 4 legs of N 4 @ 14 cm

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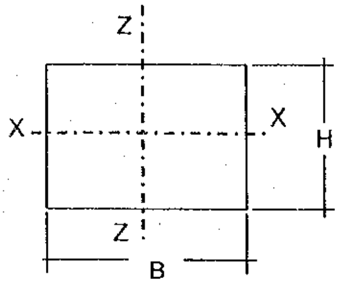
COLUMN DESIGN (C2 FOR FOURTH LEVEL)



H = 0.75 m

B = 0.65 m

f 'c = 280 kg/cm²

fy = 4200 kg/cm²

Area = 4,875 cm²

Inertia Z = 2,285,156 cm^4

Inertia Y = 1,716,406 cm^4

Forces and Moments

From Structural Analisis (ton , m) :

TYPE OF LOAD	AXIAL	MOMENT		SHEAR	
	P	Mz-z	Mx-x	Vx	Vz
Dead Load	195.42	1.14	12.08	0.27	0.99
Live Load	40.29	0.21	1.85	0.10	0.10
Seismic Load x	1.50	86.21	0.63	40.67	0.32
Seismic Load z	1.07	0.16	85.77	0.16	37.84

COMB.	Pu	Mu z-z	Mu x-x	Vu x	Vu z
C1	342.08	1.95	20.06	0.55	1.56
C2	244.28	139.28	---	64.95	---
C3	243.68	---	158.14	---	65.00

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Forces for design.

Pu z = 243.68 ton | Pu x = 244.28 ton

Mu x-x = 158.14 ton-m | Mu z-z = 139.28 ton-m

Vu z = 64.95 ton | Vu x = 65.00 ton

Ortogonal Combination

Mx = 100%EQX + 30%EQZ Mz = 100%EQZ + 30%EQX

$Mx = Mx + Mz(H/B)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$ $Mz = Mz + Mx(B/H)\left(\frac{1-\beta}{\beta}\right)$ $\beta = 0.65$

Slenderness.

iF klu/r > 22 Consider Slenderness .

k = 2.0 lu = 3.05 m r = (Inetia/Area)^½

Y Direction
r = 0.188 m klu/r = 32.509 > 22 Consider slenderness

Z Direction
r = 0.217 m klu/r = 28.175 > 22 Consider slenderness

Slenderness

Mc = δbMb + δsMs

δb = cm/(1 - Pu/φPc) cm = 1.0

$Pc = \pi^2 EI / (klu)^2$ E = 2526713 ton/m²

Pu = Axial Force = 342.08 ton

X Dir. :		Z Dir. :	
Inertia =	0.0172 m²	Inertia =	0.0229 m²
Pc =	11503.19 ton	Pc =	15314.89 ton
δb =	1.031	δb =	1.023

Mu x-x = 143.64 ton-m

Mu z-z = 161.81 ton-m

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- Design by flexure and Axial load

Z Direction : $\phi = 0.70$

Gross Area (Ag) = 0.49 m² = 755.70 in²

h = 0.65 m = 25.59 in

P = 244.28 ton = 538.55 kips

M = 143.64 ton-m = 12467.96 kips-in

Pu/Ag = 0.71 Mu/Agh = 0.64

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ = 2.9 % As = Ag x ρ = 141.38 cm²

Bar denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 17.30

Use 18 N 10

X Direction : $\phi = 0.7$

Gross Area (Ag) = 0.49 m² = 755.70 in²

h = 0.75 m = 29.53 in

P = 243.68 ton = 537.22 kips

M = 161.81 ton = 14045.51 kips-in

Pu/Ag = 0.71 Mu/Agh = 0.63

From the Load-Moment strength interaction diagram R4-60.90, the ρ value is:

ρ ? 2.8 % As = Ag x ρ = 136.50 cm²

Bar Denomination = 10 Bar area = 8.17 cm²

Quantity of bars = 16.71

Use 18 N 10

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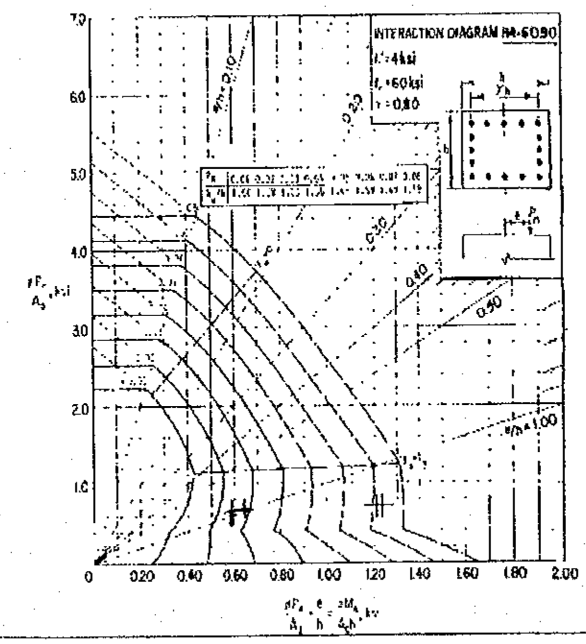
COLUMNS 7.4.4—Load-moment strength interaction diagram for R4-60.90 columns



SHEAR DESIGN.

X Direction :

bw = 650.00 mm

d = 684.13 mm

fy = 4200 kg/cm²
411.90 Mpa

f 'c = 280 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$Vc = (\sqrt{f'c} / 6)\ bw\ d$

Vc = 388,371.9 Newton
39,601.5 kg

$Vc = (1+Nu/14Ag)\ (\sqrt{f'c} / 6)\ bw$

Nu = 244.28 ton
2,395,663 Newton

Vc = 524,695.5 Newton
53,502.1 kg

Vc = 39,601.50 kg

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

Vu = 64.95 ton Vs = 36,809.2 kg

$V_s = A_v\, f_y\, d / s$; $S_{req} = A_v\, f_y\, d / V_s$

Bar denomination = 3

Bar area = 0.71 cm²

# of legs = 4

Spacing, S_{req} = 22.25 cm

Max. spacing of shear reinforcement.

d/2 = 34.21 cm
60 mm = 60 cm
} S_2 = 34.21 cm

$(1/3)\,(\sqrt{f'c}/6)\; b_w\, d$ = 129457.3 Newton
13,200.5 kg < Vs, Reduce the max sp. to one half

S_2 = 17.10 cm

Minimun Shear Reinforcement

$A_v = (1/3)\, b_w\, S / f_y$

$S_3 = 3\, A_v\, f_y / b_w$

S_3 = 54.19 cm

Use 4 legs of N 3 @ 17 cm

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Z Direction :

bw = 750.00 mm

fy = 4200 kg/cm²
411.90 Mpa

d = 584.13 mm

f 'c = 280.00 kg/cm²
27.46 Mpa

Shear Strenght provided by concrete.

$V_c = (\sqrt{f'c} / 6)\, b_w d$

Vc = 382,618.6 Newton
39,014.8 kg

$V_c = (1+N_u/14A_g)(\sqrt{f'c}/6)\, b_w$

Nu = 243.68 ton
2,389,749 Newton

Vc = 516,591.1 Newton
52,675.8 kg

} Vc = 39,014.85 kg

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

Vu = 65.00 ton Vs = 37,460.3 kg

$V_s = A_v f_y d / s$; $S_{req} = A_v f_y d / V_s$

Bar denomination = 3 Bar area = 0.71 cm²

# of legs = 4 Spacing, S_{req} = 18.67 cm

Max. spacing of shear reinforcement.

d/2 = 29.21 cm
60 mm = 60 cm
} S_2 = 29.21 cm

$(1/3)(\sqrt{f'c}/6)\, b_w d$ = 127539.5 Newton
13,004.9 kg < Vs, Reduce the max sp. to one half

S_2 = 14.60 cm

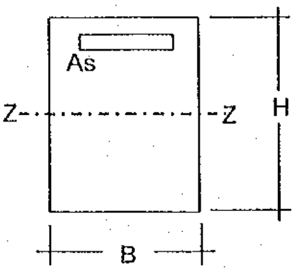
Minimun Shear Reinforcement

$A_v = (1/3)\, b_w S / f_y$ $S_3 = 3 A_v f_y / b_w$ S_3 = 46.96 cm

Use 4 legs of N 3 @ 14 cm

BEAM DESIGN (B-1, 2nd Floor)

Outer End



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	19.61
Live Load	7.91
Seismic Load x	0.10
Seismic Load z	43.77

COMBINATION	Mu z-z
C1	40.90
C2	30.82
C3	92.06

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 92.06 ton-m

d = 68.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\ As^2 - 286199\ As + 10229242 = 0$ As = 41.25 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 55.00 cm²
(14/fy) b d = 9.09 cm² Asmin = 9.09 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 93.93 cm²

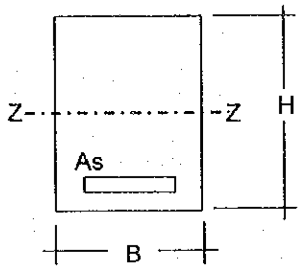
As = 41.25 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 5.05 **Use 6 - N10**

BEAM DESIGN (B-1, 2nd Floor)

Outer End



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	0.00
Live Load	0.00
Seismic Load x	0.10
Seismic Load z	45.93

COMBINATION	Mu z-z
C1	0.00
C2	0.14
C3	64.42

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 64.42 ton-m

d = 68.14 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\,As^2 - 286199\,As + 7157425 = 0$ As = 27.45 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 36.60 cm²
(14/fy) b d = 9.09 cm²   Asmin = 9.09 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 93.93 cm²

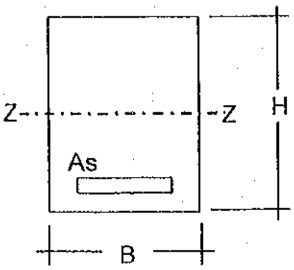
As = 27.45 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 3.36   **Use 4 - N10**

BEAM DESIGN (B-1, 2nd Floor)

Center



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	16.79
Live Load	6.86
Seismic Load x	0.20
Seismic Load z	3.50

COMBINATION	Mu z-z
C1	35.17
C2	26.66
C3	31.28

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 35.17 ton-m

d = 68.62 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\ As^2 - 288199\ As + 3907555.6 = 0$ As = 14.21 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 18.94 cm²
(14/fy) b d = 9.15 cm² Asmin = 9.15 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 94.59 cm²

As = 14.21 cm² o.k!! As < Amax

Bar denomination, N = 7 Bar Area (Av) = 3.88 cm²

Number of bars = 3.66 **Use 4 - N 7**

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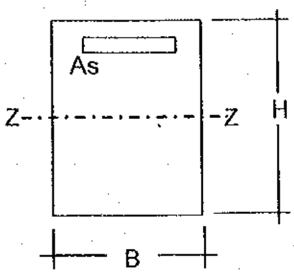
BEAM DESIGN (B-1, 2nd Floor)

Inner End



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	27.77
Live Load	7.54
Seismic Load x	0.68
Seismic Load z	40.40

COMBINATION	Mu z-z
C1	51.70
C2	39.73
C3	95.43

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 95.43 ton-m

d = 68.14 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\ As^2 - 286199\ As + 10603667 = 0$ As = 43.05 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 57.40 cm²
(14/fy) b d = 9.09 cm²   Asmin = 9.09 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 93.93 cm²

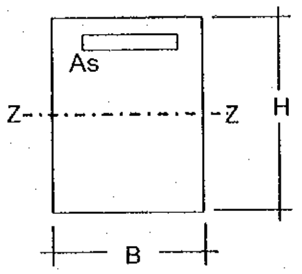
As = 43.05 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 5.27   **Use 6 - N10**

BEAM DESIGN (B-1 Other)

Inner End



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	19.94
Live Load	6.74
Seismic Load x	0.98
Seismic Load z	35.24

COMBINATION	Mu z-z
C1	39.37
C2	30.90
C3	78.95

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 78.95 ton-m

d = 68.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\, As^2 - fyd\, As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\, As^2 - 286199\, As + 8772733.3 = 0$ As = 34.51 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 46.01 cm²
(14/fy) b d = 9.09 cm² } Asmin = 9.09 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 93.93 cm²

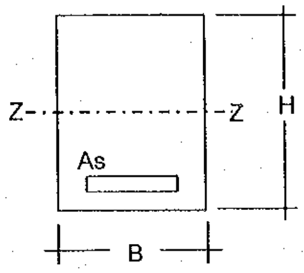
As = 34.51 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 4.22 **Use 5 - N10**

BEAM DESIGN (B-1 Other)

Center



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	16.98
Live Load	6.80
Seismic Load x	0.57
Seismic Load z	1.30

COMBINATION	Mu z-z
C1	35.33
C2	27.30
C3	28.32

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 35.33 ton-m

d = 68.14 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\,As^2 - 286199\,As + 3925777.8 = 0$ As = 14.39 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 19.18 cm²
(14/fy) b d = 9.09 cm²   Asmin = 19.18 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 93.93 cm²

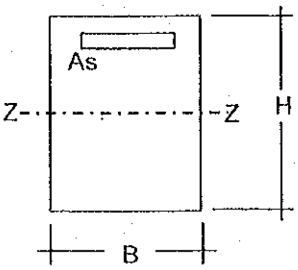
As = 19.18 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 2.35   **Use 3 - N10**

BEAM DESIGN (B-1 Other)

Outer End



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	16.11
Live Load	6.20
Seismic Load x	0.91
Seismic Load z	37.18

COMBINATION	Mu z-z
C1	33.09
C2	26.10
C3	76.97

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 76.97 ton-m

d = 68.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\ As^2 - 286199\ As + 8551716.7 = 0$ As = 33.52 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 44.69 cm²
(14/fy) b d = 9.09 cm² Asmin = 9.09 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 93.93 cm²

As = 33.52 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 4.10 **Use 5 - N10**

b) Shear Reinforcement

Base = 40 cm

fy = 4200 kg/cm²
411.89

d = 68.14 cm

f'c = 280 kg/cm²
27.46 Mpa

$V_c = (1/6)\sqrt{f'c}\ b_o d =$ 24.28 ton

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	12.30
Live Load	4.60
Seismic Load x	0.63
Seismic Load z	19.73

COMBINATION	Vy
C1	25.04
C2	19.66
C3	46.45

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 46.45 ton

Vs = 30,367.2 kg

Bar denomination = 4 Bar area = 1.27 cm²

\# of legs = 2 Spacing, S_{req} = 23.88 cm

Max. spacing of shear reinforcement.

d/2 = 34.07 cm
30 mm = 30 cm
} S_2 = 30.00 cm

$(1/3)(\sqrt{f'c}/6)\ b_w d =$ 1520323 Newton
155,024 kg > Vs, o.k.

S_2 = 30.00 cm

Minimun Shear Reinforcement

$A_v = (1/3)\ b_w S / f_y$ $S_3 = 3 A_v f_y / b_w$ S_3 = 7826.6 cm

Use 2 legs of N 4 @ 23 cm

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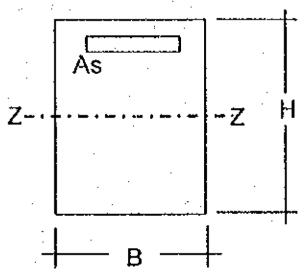
BEAM DESIGN (B-1A)

Outer End



H = 90.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	19.93
Live Load	5.90
Seismic Load x	4.50
Seismic Load z	96.08

COMBINATION	Mu z-z
C1	37.93
C2	34.76
C3	163.20

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 163.20 ton-m

d = 83.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\,As^2 - 349199\,As + 18133467 = 0$ As = 62.19 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 82.92 cm²
(14/fy) b d = 11.09 cm² } Asmin = 11.09 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 114.61 cm²

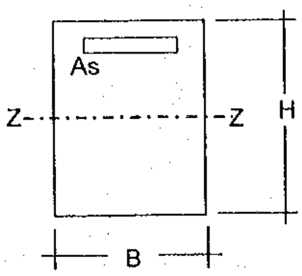
As = 62.19 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 7.61 **Use 8 - N10**

BEAM DESIGN (B-1A)

Inner End



H = 90.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	29.40
Live Load	6.78
Seismic Load x	1.50
Seismic Load z	85.91

COMBINATION	Mu z-z
C1	52.69
C2	41.62
C3	160.00

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 160.00 ton-m

d = 83.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\ As^2 - 349199\ As + 17778142 = 0$ As = 60.68 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 80.91 cm²
(14/fy) b d = 11.09 cm² } Asmin = 11.09 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 114.61 cm²

As = 60.68 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 7.43 **Use 8 - N10**

b) Shear Reinforcement

Base = 40 cm

d = 83.14 cm

fy = 4200 kg/cm²
411.89

f'c = 280 kg/cm²
27.46 Mpa

$Vc = (1/6)\sqrt{f'c}\ b_o d =$ 29.63 ton

$Vn = Vc + Vs$ $Vs = Vu/\phi - Vc$ $\phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	17.52
Live Load	4.60
Seismic Load x	2.07
Seismic Load z	21.91

COMBINATION	Vy
C1	32.35
C2	27.16
C3	54.99

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 54.99 ton

Vs = 35,067.4 kg

Bar denomination = 4 Bar area = 1.27 cm²

\# of legs = 2 Spacing, S_{req} = 25.23 cm

Max. spacing of shear reinforcement.

d/2 = 41.57 cm
30 mm = 30 cm
S_2 = 30.00 cm

$(1/3)(\sqrt{f'c}/6)\ bw\ d =$ 1854987 Newton
189,149 kg > Vs, o.k.

S_2 = 30.00 cm

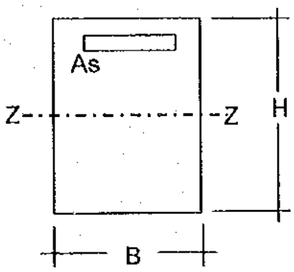
Minimun Shear Reinforcement

$Av = (1/3)\ bw\ S / fy$ $S_3 = 3\ Av\ fy / bw$ S_3 = 7826.6 cm

Use 2 legs of N 4 @ 25 cm

BEAM DESIGN (B-2, A to C Axis)

Outer End



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	4.30
Live Load	3.60
Seismic Load x	45.44
Seismic Load z	0.17

COMBINATION	Mu z-z
C1	12.14
C2	72.83
C3	9.34

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 72.83 ton-m

d = 57.14 cm

Clear cover = 5.00 cm (including Precast Slab support)

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 239999\ As + 8092733.3 = 0$ As = 41.21 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 54.95 cm²
(14/fy) b d = 6.67 cm²

Asmin = 6.67 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 68.92 cm²

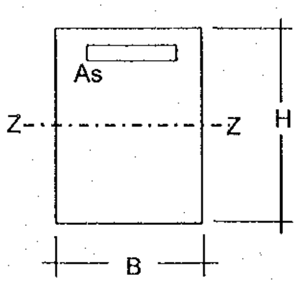
As = 41.21 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 5.04 **Use 6 - N10**

BEAM DESIGN (B-2, A to C Axis)

Inner End



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	6.26
Live Load	3.72
Seismic Load x	0.98
Seismic Load z	44.95

COMBINATION	Mu z-z
C1	15.09
C2	12.69
C3	74.36

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 74.36 ton-m

d = 57.14 cm   Clear cover = 5.00 cm (including Precast Slab support)

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8 As^2 - 239999\ As + 8262041.7 = 0$ As = 42.33 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 56.44 cm²
(14/fy) b d = 6.67 cm²   Asmin = 6.67 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 68.92 cm²

As = 42.33 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 5.18   **Use 6 - N10**

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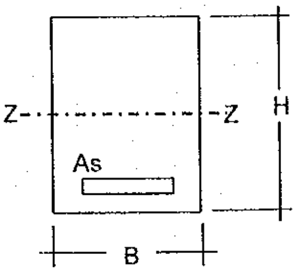
BEAM DESIGN (B-2, A to C Axis)

Center



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm^2

fy = 4200 kg/cm^2

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	6.80
Live Load	2.50
Seismic Load x	0.20
Seismic Load z	3.50

COMBINATION	Mu z-z
C1	13.77
C2	10.61
C3	15.24

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 15.24 ton-m

d = 58.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 244199\ As + 1692916.7 = 0$ As = 7.15 cm^2

Asmin = (4/3)Asreq :

(4/3)Asreq = 9.54 cm^2
(14/fy) b d = 6.78 cm^2 } Asmin = 6.78 cm^2

Asmax : ρb = 0.0459 Asmax ($0.75\rho b$) = 70.13 cm^2

As = 7.15 cm^2 o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm^2

Number of bars = 0.88 **Use 1 - N10**

b) Shear Reinforcement

Base = 35 cm

fy = 4200 kg/cm²
411.89

d = 58.14 cm

f'c = 280 kg/cm²
27.46 Mpa

Vc = $(1/6)\sqrt{f'c}$ bod = 18.13 ton

Vn = Vc + Vs   Vs = Vu/ϕ - Vc ϕ = 0.85

TYPE OF LOAD	SHEAR Vy
Dead Load	10.00
Live Load	3.58
Seismic Load x	13.90
Seismic Load z	0.19

COMBINATION	Vy
C1	20.09
C2	34.56
C3	15.33

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 34.56 ton

Vs = 22,529.6 kg

Bar denomination = 4   Bar area = 1.27 cm²

# of legs = 2   Spacing, S_{req} = 27.46 cm

Max. spacing of shear reinforcement.

d/2 = 29.07 cm
30 mm = 30 cm
} S_2 = 29.07 cm

(1/3) ($\sqrt{f'c}$ / 6) bw d = 1135062 Newton
115,740 kg > Vs, o.k.

S_2 = 29.07 cm

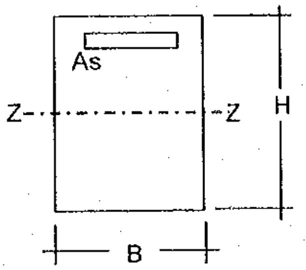
Minimun Shear Reinforcement

Av = (1/3) bw S / fy S_3 = 3 Av fy / bw S_3 = 8944.7 cm

Use 2 legs of N 4 @ 27 cm

BEAM DESIGN (B-3)

Inner End



H = 55.00 cm

b = 30.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	9.14
Live Load	4.94
Seismic Load x	6.73
Seismic Load z	1.20

COMBINATION	Mu z-z
C1	21.19
C2	25.33
C3	17.58

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 25.33 ton-m

d = 48.46 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1235.3As^2 - 203532\ As + 2814925 = 0$ As = 15.24 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 20.32 cm²
(14/fy) b d = 4.85 cm² Asmin = 4.85 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 50.10 cm²

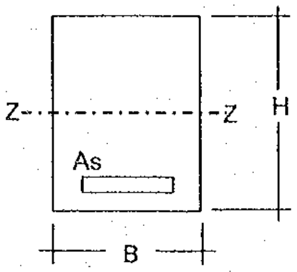
As = 15.24 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 3.01 **Use 4 - N 8**

BEAM DESIGN (B-3)

Center



H = 55.00 cm

b = 30.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	8.38
Live Load	5.22
Seismic Load x	0.20
Seismic Load z	3.50

COMBINATION	Mu z-z
C1	20.61
C2	15.74
C3	20.36

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 20.61 ton-m

d = 47.46 cm   Clear cover = 5.00 cm (including Precast Slab support)

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1235.3As^2 - 199332\ As + 2289555.6 = 0$ As = 12.45 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 16.59 cm²
(14/fy) b d = 4.75 cm²   Asmin = 4.75 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 49.07 cm²

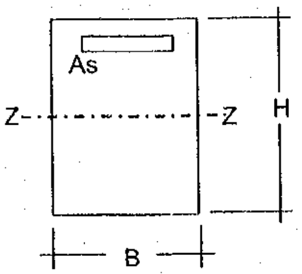
As = 12.45 cm²   o.k!! As < Amax

Bar denomination, N = 8   Bar Area (Av) = 5.07 cm²

Number of bars = 2.46   **Use 3 - N 8**

BEAM DESIGN (B-3)

Outer end



H = 55.00 cm

b = 30.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	6.15
Live Load	4.00
Seismic Load x	9.66
Seismic Load z	1.25

COMBINATION	Mu z-z
C1	15.41
C2	25.11
C3	13.31

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 25.11 ton-m

d = 48.46 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$1235.3As^2 - 203532\ As + 2789516.7 = 0$ As = 15.09 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 20.12 cm²
(14/fy) b d = 4.85 cm² Asmin = 4.85 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 50.10 cm²

As = 15.09 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 2.98 **Use 3 - N 8**

b) Shear Reinforcement

Base = 30.00 cm

d = 48.46 cm

fy = 4200 kg/cm²
411.89

f'c = 280 kg/cm²
27.46 Mpa

$V_c = (1/6)\sqrt{f'c}\ b_o d =$ 12.95 ton

Vn = Vc + Vs   Vs = Vu/ϕ - Vc   ϕ = 0.85

TYPE OF LOAD	SHEAR Vy
Dead Load	11.18
Live Load	5.96
Seismic Load x	2.75
Seismic Load z	0.10

COMBINATION	Vy
C1	25.78
C2	23.19
C3	19.48

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 25.78 ton

Vs = 17,383.2 kg

Bar denomination = 4   Bar area = 1.27 cm²

# of legs = 2   Spacing, S_{req} = 29.66 cm

Max. spacing of shear reinforcement.

d/2 = 24.23 cm
30 mm = 30 cm
→ S_2 = 24.23 cm

(1/3) ($\sqrt{f'c}$ / 6) bw d = 810890.9 Newton
82,685 kg > Vs, o.k.

S_2 = 24.23 cm

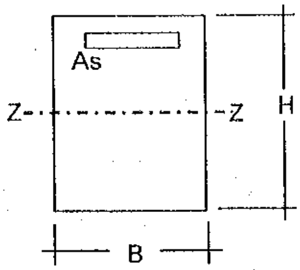
Minimun Shear Reinforcement

Av = (1/3) bw S / fy S_3 = 3 Av fy / bw S_3 = 10435.5 cm

Use 2 legs of N 4 @ 24 cm

BEAM DESIGN (B-5, 2nd Floor)

End



H = 40.00 cm

b = 25.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	6.31
Live Load	4.15
Seismic Load x	1.50
Seismic Load z	0.20

COMBINATION	Mu z-z
C1	15.89
C2	14.02
C3	12.20

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 15.89 ton-m

d = 32.46 cm Clear cover = 5.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1482.4 As^2 - 136332\ As + 1765444.4 = 0$ As = 15.59 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 20.79 cm²
(14/fy) b d = 2.71 cm² } Asmin = 2.71 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 27.97 cm²

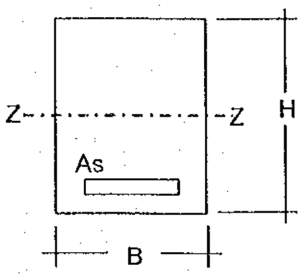
As = 15.59 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 3.08 **Use 4 - N 8**

BEAM DESIGN (B-5, 2nd Floor)

Center



H = 40.00 cm

b = 25.00 cm

f'c = 280 kg/cm^2

fy = 4200 kg/cm^2

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	4.16
Live Load	3.07
Seismic Load x	0.30
Seismic Load z	0.40

COMBINATION	Mu z-z
C1	11.04
C2	8.70
C3	8.84

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 11.04 ton-m

d = 32.46 cm Clear cover = 5.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1482.4As^2 - 136332\ As + 1227000 = 0$ As = 10.11 cm^2

Asmin = (4/3)Asreq :

(4/3)Asreq = 13.48 cm^2
(14/fy) b d = 2.71 cm^2 Asmin = 2.71 cm^2

Asmax : ρb = 0.0459 Asmax ($0.75\rho b$) = 27.97 cm^2

As = 10.11 cm^2 o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm^2

Number of bars = 2.00 **Use 2 - N 8**

b) Shear Reinforcement

Base = 25.00 cm

d = 32.46 cm

fy = 4200 kg/cm²
411.89

f'c = 280 kg/cm²
27.46 Mpa

$Vc = (1/6\sqrt{f'c}\ bod =$ 7.23 ton

$Vn = Vc + Vs$ $Vs = Vu/\phi - Vc$ $\phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	6.31
Live Load	4.15
Seismic Load x	1.75
Seismic Load z	0.10

COMBINATION	Vy
C1	15.89
C2	14.37
C3	12.06

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 15.89 ton

Vs = 11,463.8 kg

Bar denomination = 4 Bar area = 1.27 cm²

# of legs = 2 Spacing, S_{req} = 30.13 cm

Max. spacing of shear reinforcement.

d/2 = 16.23 cm
30 mm = 30 cm
S_2 = 16.23 cm

$(1/3)(\sqrt{f'c}/6)\ bw\ d =$ 452633.1 Newton
46,154 kg > Vs, o.k.

S_2 = 16.23 cm

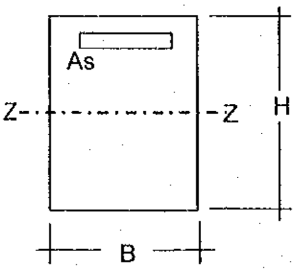
Minimun Shear Reinforcement

$Av = (1/3)\ bw\ S / fy$ $S_3 = 3\ Av\ fy / bw$ S_3 = 12522.6 cm

Use 2 legs of N 4 @ 16 cm

BEAM DESIGN (B-7 4th Floor)

Outer End



H = 60.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	16.11
Live Load	8.22
Seismic Load x	0.45
Seismic Load z	15.16

COMBINATION	Mu z-z
C1	36.53
C2	28.03
C3	48.66

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 48.66 ton-m

d = 52.14 cm

Clear cover = 5.00 cm (including Precast Slab support)

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 218999\,As + 5406433.3 = 0$ As = 28.66 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 38.21 cm²
(14/fy) b d = 6.08 cm²

Asmin = 6.08 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 62.89 cm²

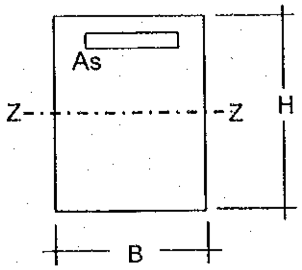
As = 28.66 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 3.51 **Use 4 - N10**

BEAM DESIGN (B-7 4th Floor)

Inner End



H = 60.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	19.28
Live Load	9.74
Seismic Load x	0.45
Seismic Load z	13.49

COMBINATION	Mu z-z
C1	43.55
C2	33.29
C3	51.58

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 51.58 ton-m

d = 52.46 cm

Clear cover = 5.00 cm (including Precast Slab support)

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 220332\ As + 5731358.3 = 0$ As = 30.48 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 40.63 cm²
(14/fy) b d = 6.12 cm²
Asmin = 6.12 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 63.27 cm²

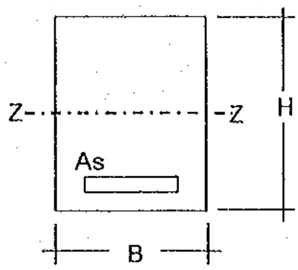
As = 30.48 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 6.01 **Use 7 - N 8**

BEAM DESIGN (B-7 4th Floor)

Center



H = 60.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	17.90
Live Load	9.74
Seismic Load x	1.04
Seismic Load z	0.50

COMBINATION	Mu z-z
C1	41.62
C2	32.67
C3	31.91

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 41.62 ton-m

d = 52.46 cm

Clear cover = 5.00 cm (including Precast Slab support)

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 220332\,As + 4624222.2 = 0$ As = 23.68 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 31.58 cm²
(14/fy) b d = 6.12 cm² } Asmin = 6.12 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 63.27 cm²

As = 23.68 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 4.67 **Use 5 - N 8**

b) Shear Reinforcement

Base = 35.00 cm

d = 52.46 cm

fy = 4200 kg/cm²
411.89

f'c = 280 kg/cm²
27.46 Mpa

$V_c = (1/6)\sqrt{f'c}\ b_od =$ 16.36 ton

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	9.97
Live Load	4.50
Seismic Load x	0.13
Seismic Load z	3.30

COMBINATION	Vy
C1	21.61
C2	16.39
C3	20.83

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 21.61 ton

Vs = 9,064.6 kg

Bar denomination = 4 Bar area = 1.27 cm²

# of legs = 2 Spacing, S_{req} = 61.58 cm

Max. spacing of shear reinforcement.

d/2 = 26.23 cm
30 mm = 30 cm
S_2 = 26.23 cm

$(1/3)\ (\sqrt{f'c}/6)\ bw\ d =$ 1024128 Newton
104,428 kg > Vs, o.k.

S_2 = 26.23 cm

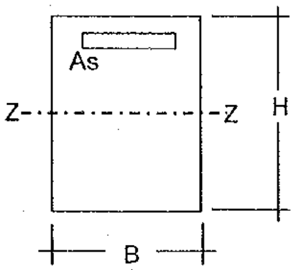
Minimun Shear Reinforcement

Av = (1/3) bw S / fy S_3 = 3 Av fy / bw S_3 = 8944.7 cm

Use 2 legs of N 4 @ 26 cm

B E A M   D E S I G N (B-2A, Roof for C & D Axis)

Outer End



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

2nd Floor Beam design

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	7.26
Live Load	1.50
Seismic Load x	0.53
Seismic Load z	39.76

COMBINATION	Mu z-z
C1	12.71
C2	10.28
C3	65.30

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 65.30 ton-m

d = 58.14 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 244199\ As + 7255433.3 = 0$ As = 35.03 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 46.71 cm²
(14/fy) b d = 6.78 cm²   Asmin = 6.78 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 70.13 cm²

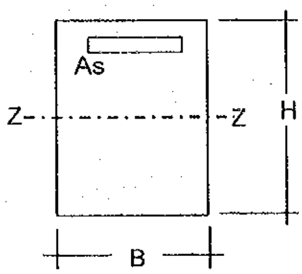
As = 35.03 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 4.29   **Use 5 - N10**

BEAM DESIGN (B-2A, Roof for C & D Axis)

For Cantilever



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	17.65
Live Load	2.50
Seismic Load x	0.40
Seismic Load z	31.84

COMBINATION	Mu z-z
C1	28.96
C2	22.28
C3	66.38

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 66.38 ton-m

d = 58.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 244199\ As + 7375066.7 = 0$ As = 35.74 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 47.65 cm²
(14/fy) b d = 6.78 cm² } Asmin = 6.78 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 70.13 cm²

As = 35.74 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 4.37 **Use 5 - N10**

b) Shear Reinforcement

Base = 35 cm

d = 58.14 cm

fy = 4200 kg/cm²
411.89

f'c = 280 kg/cm²
27.46 Mpa

$V_c = (1/6)\sqrt{f'c}\ b_o d =$ 18.13 ton

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	5.22
Live Load	0.60
Seismic Load x	0.10
Seismic Load z	2.13

COMBINATION	Vy
C1	8.33
C2	6.39
C3	9.23

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 9.23 ton

Vs = (7,265.6) kg

Bar denomination = 4 Bar area = 1.27 cm²

# of legs = 2 Spacing, S_{req} = -85.15 cm

Max. spacing of shear reinforcement.

d/2 = 29.07 cm
30 mm = 30 cm

S_2 = 29.07 cm

$(1/3)(\sqrt{f'c}/6)\ b_w d =$ 1135062 Newton
115,740 kg > Vs, o.k.

S_2 = 29.07 cm

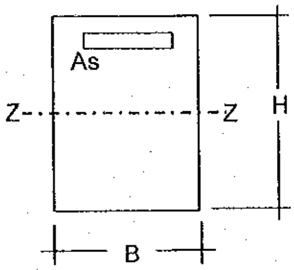
Minimun Shear Reinforcement

$A_v = (1/3)\ b_w S / f_y$ $S_3 = 3 A_v f_y / b_w$ S_3 = 8944.7 cm

Use 2 legs of N 4 @ 29 cm

BEAM DESIGN (B-4)

Cantilever



H = 60.00 cm

b = 30.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	11.36
Live Load	1.40
Seismic Load x	0.17
Seismic Load z	14.25

COMBINATION	Mu z-z
C1	18.28
C2	13.95
C3	33.70

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 33.70 ton-m

d = 53.46 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1235.3As^2 - 224532\ As + 3744291.7 = 0$ As = 18.57 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 24.77 cm²
(14/fy) b d = 5.35 cm² Asmin = 5.35 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 55.27 cm²

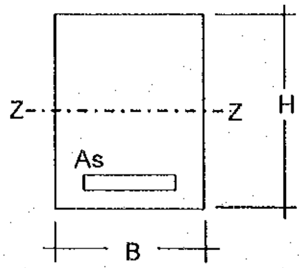
As = 18.57 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 3.67 **Use 4 - N 8**

BEAM DESIGN (B-4)

Center



H = 60.00 cm

b = 30.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	3.50
Live Load	0.32
Seismic Load x	0.20
Seismic Load z	7.41

COMBINATION	Mu z-z
C1	5.44
C2	4.36
C3	14.48

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 14.48 ton-m

d = 53.46 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1235.3As^2 - 224532\ As + 1608391.7 = 0$ As = 7.47 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 9.96 cm²
(14/fy) b d = 5.35 cm²   Asmin = 5.35 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 55.27 cm²

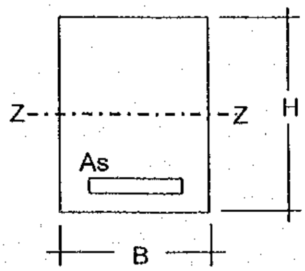
As = 7.47 cm²   o.k!! As < Amax

Bar denomination, N = 8   Bar Area (Av) = 5.07 cm²

Number of bars = 1.47   **Use 2 - N 8**

BEAM DESIGN (B-6)

Center



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	11.06
Live Load	1.52
Seismic Load x	1.13
Seismic Load z	4.45

COMBINATION	Mu z-z
C1	18.07
C2	15.14
C3	19.79

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 19.79 ton-m

d = 58.46 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8 As^2 - 245532\ As + 2199125 = 0$ As = 9.33 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 12.44 cm²
(14/fy) b d = 6.82 cm² } Asmin = 6.82 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 70.51 cm²

As = 9.33 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 1.84 **Use 2 - N 8**

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PROJECT: Detailed Design on Port Reactivation Project in La Union Province	Calc. File No.		Prepared by	R.Martinez
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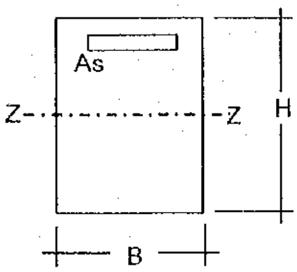
BEAM DESIGN (B-6)

Outer End



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	8.70
Live Load	1.85
Seismic Load x	12.08
Seismic Load z	5.76

COMBINATION	Mu z-z
C1	15.33
C2	28.44
C3	19.57

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 28.44 ton-m

d = 58.46 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8 As^2 - 245532\ As + 3159550 = 0$ As = 13.67 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 18.23 cm²
(14/fy) b d = 6.82 cm² Asmin = 6.82 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 70.51 cm²

As = 13.67 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 2.70 **Use 3 - N 8**

b) Shear Reinforcement

Base = 40 cm

d = 58.46 cm

fy = 4200 kg/cm²
411.89

f'c = 280 kg/cm²
27.46 Mpa

$V_c = (1/6)\sqrt{f'c}\ bod =$ 20.83 ton

$V_n = V_c + V_s$ $\quad V_s = V_u/\phi - V_c$ $\quad \phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	12.30
Live Load	4.60
Seismic Load x	0.63
Seismic Load z	19.73

COMBINATION	Vy
C1	25.04
C2	19.66
C3	46.45

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 46.45 ton

Vs = 33,817.4 kg

Bar denomination = 4 $\quad$ Bar area = 1.27 cm²

# of legs = 2 $\quad$ Spacing, S_{req} = 18.39 cm

Max. spacing of shear reinforcement.

d/2 = 29.23 cm
30 mm = 30 cm
} S_2 = 29.23 cm

$(1/3)\ (\sqrt{f'c} / 6)\ bw\ d =$ 1304297 Newton
132,997 kg > Vs, o.k.

S_2 = 29.23 cm

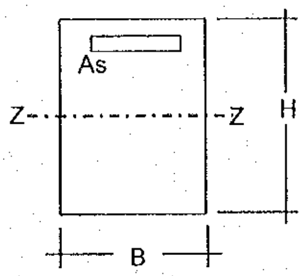
Minimun Shear Reinforcement

$A_v = (1/3)\ bw\ S / fy$ $\quad S_3 = 3\ A_v\ fy / bw$ $\quad S_3$ = 7826.6 cm

Use 2 legs of N 4 @ 18 cm

BEAM DESIGN (B-6A)

Outer End



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	12.28
Live Load	1.85
Seismic Load x	12.08
Seismic Load z	5.76

COMBINATION	Mu z-z
C1	20.34
C2	32.19
C3	23.33

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 32.19 ton-m

d = 58.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8 As^2 - 244199\ As + 3577216.7 = 0$ As = 15.72 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 20.96 cm²
(14/fy) b d = 6.78 cm² Asmin = 6.78 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 70.13 cm²

As = 15.72 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 1.92 **Use 2 - N10**

PROJECT: Detailed Design on Port Reactivation Project in La Union Province	Calc. File No.		Prepared by	R.Martinez
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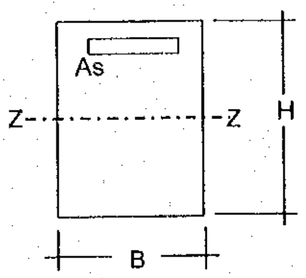
BEAM DESIGN (B-3A)

Outer End



H = 55.00 cm

b = 30.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	5.75
Live Load	1.96
Seismic Load x	1.80
Seismic Load z	7.60

COMBINATION	Mu z-z
C1	11.38
C2	11.06
C3	19.20

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 19.20 ton-m

d = 48.46 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\, As^2 - fyd\, As + Mu/\phi = 0$ $\phi = 0.90$

$1235.3 As^2 - 203532\, As + 2132833.3 = 0$ As = 11.25 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 15.00 cm²
(14/fy) b d = 4.85 cm² } Asmin = 4.85 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 50.10 cm²

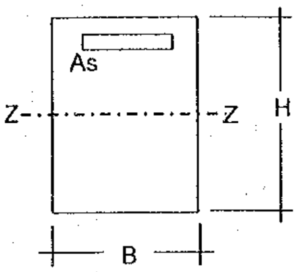
As = 11.25 cm² o.k!! As < Amax

Bar denomination, N = 8 Bar Area (Av) = 5.07 cm²

Number of bars = 2.22 **Use 3 - N 8**

BEAM DESIGN (B-1)

Outer End



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z	
Dead Load	28.75	15.66
Live Load	6.58	3.72
Seismic Load x	7.29	
Seismic Load z	48.97	56.55

COMBINATION	Mu z-z
C1	51.44
C2	48.80
C3	107.26

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 107.26 ton-m

d = 68.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\ As^2 - 286199\ As + 11917492 = 0$ As = 49.61 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 66.14 cm²
(14/fy) b d = 9.09 cm² Asmin = 9.09 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 93.93 cm²

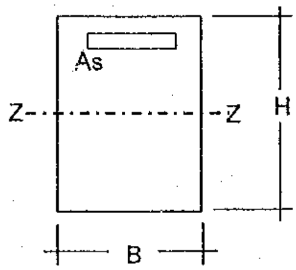
As = 49.61 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 6.07 **Use 7 - N10**

BEAM DESIGN (B-1)

Inner end



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	38.44
Live Load	7.32
Seismic Load x	2.53
Seismic Load z	49.53

COMBINATION	Mu z-z
C1	66.26
C2	53.24
C3	119.16

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 119.16 ton-m

d = 68.14 cm　　　Clear cover = 4.00 cm

$fy^2/1.7bf'c\ As^2 - fyd\ As + Mu/\phi = 0$　　　$\phi = 0.90$

$926.5\ As^2 - 286199\ As + 13240092 = 0$　　　As = 56.65 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 75.53 cm²
(14/fy) b d = 9.09 cm²　　　Asmin = 9.09 cm²

Asmax : ρb = 0.0459　　　Asmax (0.75ρb) = 93.93 cm²

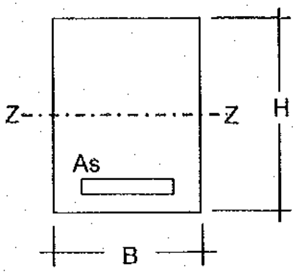
As = 56.65 cm²　　o.k!! As < Amax

Bar denomination, N = 10　　　Bar Area (Av) = 8.17 cm²

Number of bars = 6.93　　　**Use 7 - N10**

BEAM DESIGN (B-1)

Center



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	18.00
Live Load	3.68
Seismic Load x	0.20
Seismic Load z	1.20

COMBINATION	Mu z-z
C1	31.46
C2	23.87
C3	25.28

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 31.46 ton-m

d = 68.62 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\,As^2 - 288199\,As + 3495111.1 = 0$ As = 12.64 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 16.85 cm²
(14/fy) b d = 9.15 cm²   Asmin = 9.15 cm²

Asmax :   ρb = 0.0459   Asmax (0.75ρb) = 94.59 cm²

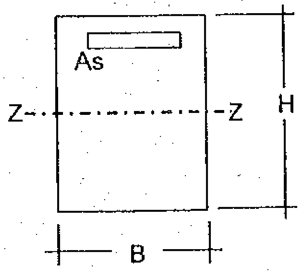
As = 12.64 cm²   **o.k!! As < Amax**

Bar denomination, N = 7   Bar Area (Av) = 3.88 cm²

Number of bars = 3.26   **Use 4 - N 7**

BEAM DESIGN (B-2)

Outer end



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	9.48
Live Load	2.80
Seismic Load x	0.86
Seismic Load z	49.18

COMBINATION	Mu z-z
C1	18.03
C2	14.73
C3	82.50

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 82.50 ton-m

d = 58.14 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 244199\,As + 9166550 = 0$ As = 47.19 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 62.93 cm²
(14/fy) b d = 6.78 cm²   Asmin = 6.78 cm²

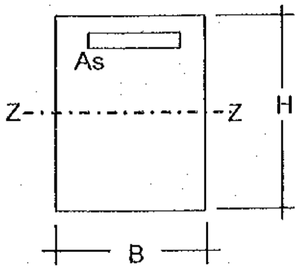
Asmax : ρb = 0.0459   Asmax (0.75ρb) = 70.13 cm²

As = 47.19 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 5.78   **Use 6 - N10**

BEAM DESIGN (B-2)
Inner End



H = 65.00 cm

b = 35.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	12.96
Live Load	3.15
Seismic Load x	0.98
Seismic Load z	45.00

COMBINATION	Mu z-z
C1	23.50
C2	19.00
C3	80.74

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 80.74 ton-m

d = 58.14 cm Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$1058.8As^2 - 244199\,As + 8970750 = 0$ As = 45.85 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 61.13 cm²
(14/fy) b d = 6.78 cm² } Asmin = 6.78 cm²

Asmax : ρb = 0.0459 Asmax (0.75ρb) = 70.13 cm²

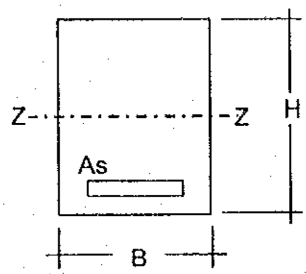
As = 45.85 cm² o.k!! As < Amax

Bar denomination, N = 10 Bar Area (Av) = 8.17 cm²

Number of bars = 5.61 **Use 6 - N10**

BEAM DESIGN (B-2)

Center



H = 75.00 cm

b = 40.00 cm

f'c = 280 kg/cm²

fy = 4200 kg/cm²

Forces and Moments, from Structural Analysis (ton , m) :

TYPE OF LOAD	MOMENT Mz-z
Dead Load	8.90
Live Load	2.64
Seismic Load x	2.30
Seismic Load z	1.20

COMBINATION	Mu z-z
C1	16.95
C2	15.94
C3	14.39

C1 = 1.4 DL + 1.7 LL

C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)

C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Mu z-z = 16.95 ton-m

d = 68.14 cm   Clear cover = 4.00 cm

$fy^2/1.7bf'c\,As^2 - fyd\,As + Mu/\phi = 0$ $\phi = 0.90$

$926.5\,As^2 - 286199\,As + 1883111.1 = 0$ As = 6.73 cm²

Asmin = (4/3)Asreq :

(4/3)Asreq = 8.97 cm²
(14/fy) b d = 9.09 cm²   } Asmin = 8.97 cm²

Asmax : ρb = 0.0459   Asmax (0.75ρb) = 93.93 cm²

As = 8.97 cm²   o.k!! As < Amax

Bar denomination, N = 10   Bar Area (Av) = 8.17 cm²

Number of bars = 1.10   **Use 2 - N10**

b) Shear Reinforcement

Base = 40 cm fy = 4200 kg/cm² (411.89)

d = 68.14 cm f'c = 280 kg/cm² (27.46 Mpa)

$V_c = (1/6)\sqrt{f'c}\ b_o d =$ 24.28 ton

$V_n = V_c + V_s$ $V_s = V_u/\phi - V_c$ $\phi = 0.85$

TYPE OF LOAD	SHEAR Vy
Dead Load	12.30
Live Load	4.60
Seismic Load x	0.63
Seismic Load z	19.73

COMBINATION	Vy
C1	25.04
C2	19.66
C3	46.45

C1 = 1.4 DL + 1.7 LL
C2 = 0.75(1.4DL + 1.7LL + 1.87SLy)
C3 = 0.75(1.4DL + 1.7LL + 1.87SLz)

Force for design: Vu = 46.45 ton

Vs = 30,367.2 kg

Bar denomination = 4 Bar area = 1.27 cm²

# of legs = 2 Spacing, S_{req} = 23.88 cm

Max. spacing of shear reinforcement.

d/2 = 34.07 cm
30 mm = 30 cm
→ S_2 = 30.00 cm

$(1/3)(\sqrt{f'c}/6)\ b_w d =$ 1520323 Newton
155,024 kg > Vs, o.k.

S_2 = 30.00 cm

Minimun Shear Reinforcement

$A_v = (1/3)\ b_w S / f_y$ $S_3 = 3 A_v f_y / b_w$ S_3 = 7826.6 cm

Use 2 legs of N 4 @ 23 cm