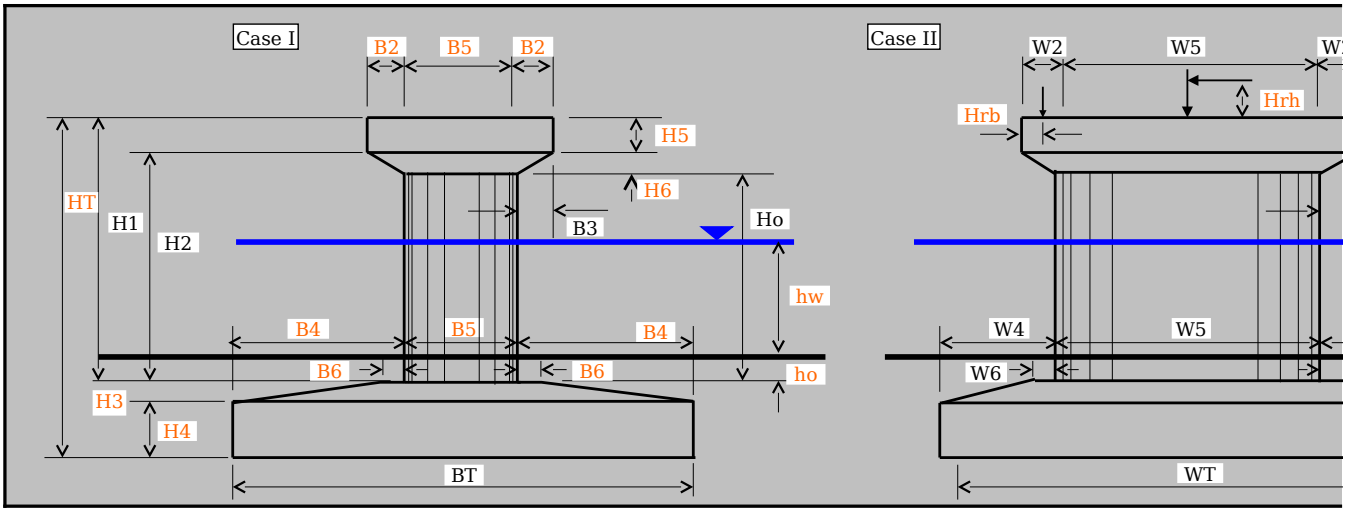
PIER : Bendung ....

DIMENSIONS OF PIER

Abutment Type	**AB 120A**
Super Structure Type	**T-beam Road Bridge**



1 Input

1) Dimensions (unit: m)

HT	Ho	H1	H2	H3	H4	H5	H6
12.00	9.80	10.80	10.20	**0.30**	**0.90**	**0.60**	**0.40**

ho	hw	Hrh	Hrb
0.80	**9.00**	**0.75**	**1.50**

B2	B3	B4	B5	B6	BT
0.20	**0.20**	**1.75**	**1.25**	**0.40**	4.75

W2	W3	W4	W5	W6	WT
0.25	**0.25**	**2.25**	**2.75**	**0.40**	7.25

Number of barrel	1

2) Design parameters

Unit Weight

Soil	**1,800**	kg/m3
Soil saturated	**2,000**	kg/m3
Concrete	**2,400**	kg/m3
water	**1,000**	kg/m3

Reaction

Normal	Vn=Rd+Rl	**275.92**	ton (normal,
Seismic	Ve=Rd	**142.54**	ton (seismic,
	He=	**25.66**	ton (He= 2 k
Type of bearing	left	**Fixed**	(He= kh
	right	**Movable**	or moval

(Input **Fixed** or **Movable**)

Internal friction angle (degree) ϕ	**30**	degree	Surcharge Load: **0** kg/m2
Friction Coefficient =Tan ϕ b =	**0.5**		Load per m: 0 ton/m

Allowale bearing capacity Qa	**21.87**	tf/m2 (normal)	(max. **30.0**	t/m2 for soil foundation)
	32.80	tf/m2 (seismic))	(max. **45.0**	t/m2 for soil foundation)

Horizontal seismic coefficient

kh : for earth	**0.18**	
for structure	0.18	

			Normal condition	Seismic condition
Concrete Design Strength	σc =	kgf / m2	**175**	**175**
Creep strain coefficient (concrete)			**0.0035**	**0.0035**
Reinforcement concrete				
Allowable stress				
Concrete	σcs =	kgf / m2	**60**	**90**
Re-bar	σsa =	kgf / m2	**1850**	**2775**
Shering	ta =	kgf / m2	**5.5**	**8.25**
Yielding Point of reinforcement Bar	σsy =	kgf / m2	**3000**	**3000**
Young Modulus (reinforcement bar)			**2,100,000**	**2,100,000**
Young Modulus ratio	n		**24**	**16**

2 Check

2.1 Stability analysis

	Case I, II Normal condition	Case I (parallel to bridge axis) Seismic condition	Case II (perpendicu
Overturning	-	e= 1.527 m BT/3= 1.583 m e ≦ (BT/3) **OK**	e= 1.596 BT/3= 2.417 e ≦ (BT/3) **OK**
Sliding	-	Fs=Hu/H 3.25 Fs ≧ **1.25** **OK**	Fs=Hu/H 3.25 Fs ≧ **1.25** **OK**
Sinking	Qmax = 11.95 t/m2 Qmax ≦ Qa **OK** Qa = **21.87** t/m2	Qmax = 30.15 t/m2 Qmax ≦ Qa **OK** Qa = **32.80** t/m2	Qmax = 19.24 Qmax ≦ Qa **OK** Qa = **32.80**

2.2 Structural analysis

(1) Body

Section A - A

			Case I (parallel to bridge axis) Normal	Seismic	Case II (perpe Normal
Bar arrangement					
Tensile bar	(vertical)	ϕ (mm)	**25**	**25**	**25**
		spacing (mm)	**200**	**200**	**200**
		As1 (cm2)	30.68	30.68	
Compressive bar	(vertical)	ϕ (mm)	**25**	**25**	**25**
		spacing (mm)	**200**	**200**	**200**
		As (cm2)	30.68	30.68	60.87
Hoop bar	(horizontal)	ϕ (mm)		**16**	
		interval (mm)		**200**	
		Max interval (mm)		2410	
Design dimensions					
	Effective width (whole width) (cm)		**125.0**	**125.0**	**248.0**
	Concrete cover (cm)		**7.0**	**7.0**	**7.0**
	Effective height (cm)		241.0	241.0	118.0
Design load		Mf (t m)	0.0	172.3	0.0
		Nd (t)	360.8	227.4	360.8
		S (t)	0.0	34.7	0.0
Checking of minimum reinforcement bar					
	1.7 Mf < Mc ? If no, check Mu		ok	ok	ok
	Mu > Mc ?				
	Required bar (cm2)		0	-10.71	0
Checking of allowable stress					
Compressive stress		σc kgf/cm2	0.0 ok	21.7 ok	0.0 ok
Bending stress		σs kgf/cm2	0.0 ok	160.8 ok	0.0 ok
		σs' kgf/cm2	-	332.9 ok	-
Mean shearing stress		τm kgf/cm2	0.0 ok	1.2 ok	0.0 ok

Section B - B

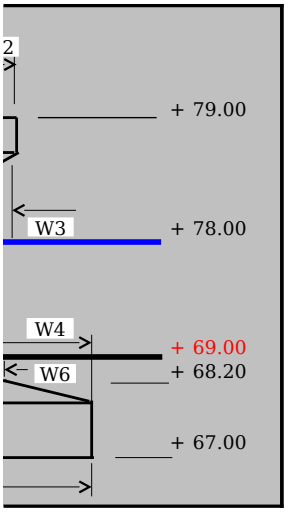
			Case I (parallel to bridge axis) Normal	Seismic	Case II (perpe Normal
Bar arrangement					
Tensile bar	(vertical)	ϕ (mm)	**25**	**25**	**25**
		spacing (mm)	**100**	**100**	**100**
		As1 (cm2)	61.36	61.36	
Compressive bar	(vertical)	ϕ (mm)	**25**	**25**	**25**
		spacing (mm)	**100**	**100**	**100**
		As (cm2)	61.36	61.36	121.74
Hoop bar	(horizontal)	ϕ (mm)		**16**	
		interval (mm)		**200**	
		Max interval (mm)		2410	
Design dimensions					
	Effective width (whole width) (cm)		**125.0**	**125.0**	**248.0**
	Concrete cover (cm)		**7.0**	**7.0**	**7.0**
	Effective height (cm)		241.0	241.0	118.0
Design load		Mf (t m)	0.0	373.3	0.0
		Nd (t)	360.8	227.4	360.8
		S (t)	0.0	42.8	0.0
Checking of minimum reinforcement bar					
	1.7 Mf < Mc ? If no, check Mu		ok	check Mu	ok
	Mu > Mc ?			ok	
	Required bar (cm2)		0.0	35.5	0.0
Checking of allowable stress					
Compressive stress		σc kgf/cm2	0.0 ok	45.1 ok	0.0 ok
Bending stress		σs kgf/cm2	0.0 ok	1,171.6 ok	0.0 ok
		σs' kgf/cm2	-	665.8 ok	-
Mean shearing stress		τm kgf/cm2	0.0 ok	1.5 ok	0.0 ok

(2) Footing

			Case I (parallel to bridge axis)				Case II (perpendicu	
			Normal		Seismic		Normal	
			Lower	Upper	Lower	Upper	Lower	Upper
Bar arrangement								
Upper face	(tensile bar)	ϕ (mm)		**22**		**22**		**22**
		spacing (mm)		**300** ok		**300** ok		**300**
		As5 (cm2, ≧As7/3)		60.19 >=40.1		60.19 >=40.1		91.87
	(additional bar)	ϕ (mm)		**22**		**22**		**22**
		spacing (mm)		**300** ok		**300** ok		**300**
		As6 (cm2, ≧As5/2 and As8/3)		60.19 >=40.1		60.19 >=40.1		91.87
Lower face	(tensile bar)	ϕ (mm)	**22**		**22**		**22**	
		spacing (mm)	**150**		**150**		**150**	
		As7 (cm2)	120.38		120.38		183.73	
	(additional bar)	ϕ (mm)	**22**		**22**		**22**	
		spacing (mm)	**150** ok		**150** ok		**150** ok	
		As8 (cm2, ≧As7/2)	120.38 >=60.2		120.38 >=60.2		183.73 >=91.9	
Design dimensions								
		Effective width (whole width) (cm)	**475**	**475**	**475**	**475**	**725**	**725**
		Concrete cover (cm)	**10**	**6**	**10**	**6**	**10**	**6**
		Effective height (cm)	110	114	110	114	110	114
Design load		Mf	**146.8**	**99.0**	**319.3**	**99.0**	**202.0**	**142.9**
		Nd	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
		S	**168.5**	**111.0**	**305.3**	**111.0**	**246.2**	**125.5**
Checking of minimum reinforcement bar								
		1.7 Mf < Mc ? If no, check Mu	ok	ok	ok	ok	ok	ok
		Mu > Mc ?						
		Required bar (cm2)	84.46	54.94	118.06	35.30	116.22	79.36
Checking of allowable stress								
	Compressive stress	σc kgf/cm2	20.0	16.7	50.9	19.8	18.0	15.8
			ok	ok	ok	ok	ok	ok
	Bending stress	σs kgf/cm2	1223.6	1548.5	2618.6	1529.8	1103.1	1465.5
			ok	ok	ok	ok	ok	ok
	Mean shearing stress	τm kgf/cm2	3.56	2.12	6.35	2.17	3.41	1.57
			ok	ok	ok	ok	ok	ok

(3) Beam

			Upper	Side
Bar arrangement				
Upper face		ϕ (mm)	**16**	**16**
		spacing (mm)	**300**	**300**
		As (cm2)	11.06	6.70
Lower face		ϕ (mm)	**16**	**16**
		spacing (mm)	**300**	**300**
		As (cm2)	11.06	6.70
Design dimensions				
		Effective width(cm)	165	100
		Concrete cover (cm)	**6**	**6**
		Effective height (cm)	94	159
Design load		Mf	2.9	0.5
		Nd	0.0	0.0
		S	4.0	0.7
Checking of minimum reinforcement bar				
		1.7 Mf < Mc ? If no, check Mu	ok	ok
		Mu > Mc ?		
		Required bar (cm2)	1.99	0.21
Checking of allowable stress				
	Compressive stress	σc kgf/cm2	2.5 ok	0.3 ok
	Bending stress	σs kgf/cm2	300.6 ok	52.1 ok
	Mean shearing stress	τm kgf/cm2	0.3 ok	0.0 ok
Stirrup	If shearing stress is not sufficient, put stirrup or increase thickness of concrete.			
		ϕ (mm)	**12**	
		spacing (mm)	**200**	
		As (cm2)	5.65	



left + right)
left + right)
n Rd, for fixed + fixed)
Rd, for fixed + movable
ble + movable)

ılar to bridge axis)	
m	
m	
t/m2	
t/m2	

ndicular to bridge axis)	
Seismic	
25	
200	
60.87	
25	
200	
60.87	
16	
200	
487	
248.0	
7.0	
118.0	
191.5	
227.4	
34.7	
check Mu	
ok	
38.1557	
48.0	ok
1,215.3	ok
650.2	ok
1.3	ok

ndicular to bridge axis)	
Seismic	
25	
100	
121.74	
25	
100	
121.74	
16	
200	
1180	
248.0	
7.0	
118.0	
392.6	
227.4	
42.8	
check Mu	
ok	
146.7	
72.7	ok
2,157.8	ok
966.0	ok
1.6	ok

ılar to bridge axis)		
Seismic		
Lower	Upper	
	22	
ok	**300**	ok
>=61.2	91.87	>=61.2
	22	
ok	**300**	ok
>=61.2	91.87	>=61.2
22		
150		
183.73		
22		
150	ok	
183.73	>=91.9	
725	**725**	
10	**6**	
110	114	
339.4	**142.9**	
0.0	**0.0**	
277.6	**125.5**	
ok	ok	
125.49	50.99	
35.4	18.8	
ok	ok	
1823.7	1447.8	
ok	ok	
3.78	1.61	
ok	ok	

21.854

1. WEIGHT OF ABUTMENT AND MOMENT

1) Dimensions (unit: m)

(unit: m)

HT	Ho	H1	H2	H3	H4	H5	H6	ho	hw	Hrh	Hrb
12.00	9.80	10.80	10.20	0.30	0.90	0.60	0.40	0.80	9.00	0.75	1.50

B2	B3	B4	B5	B6	BT
0.20	0.20	1.75	1.25	0.40	4.75

W2	W3	W4	W5	W6	WT
0.25	0.25	2.25	2.75	0.40	7.25

2) Design parameters

Unit Weight

Soil	1,800	kg/m3
Soil under water	2,000	kg/m3
Concrete	2,400	kg/m3
water	1,000	kg/m3
Internal friction angle (degree) ϕ	30.00	degree
Friction Coefficient =Tan ϕ b =	0.50	
Allowale bearing capacity Qa	21.87	tf/m2
	32.80	tf/m2

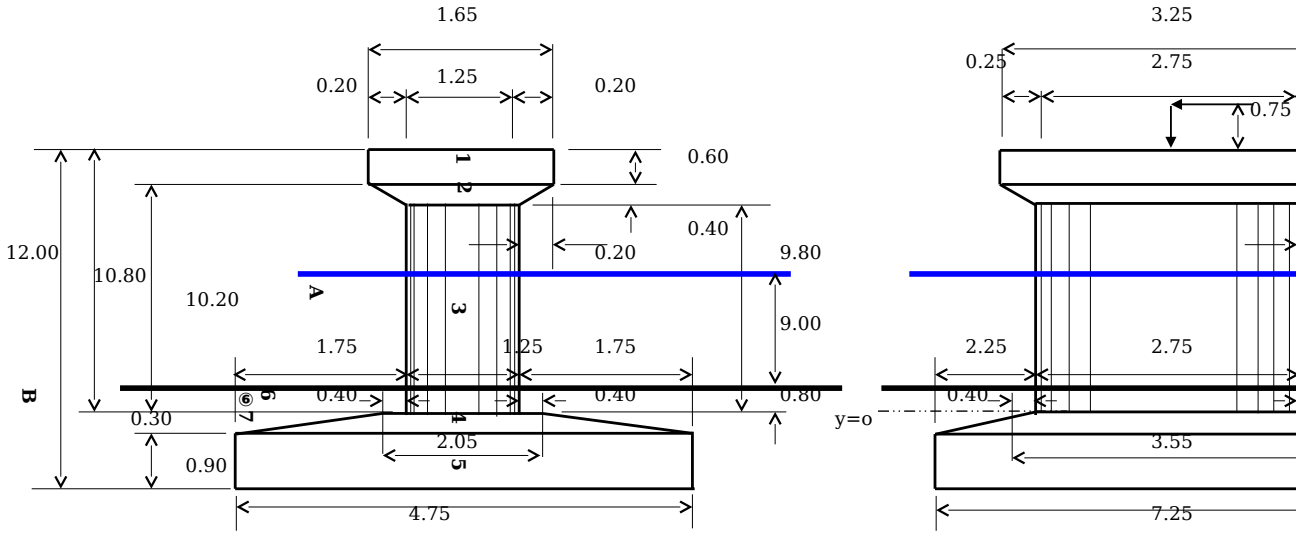
(max. 30.00 t/m2 for soil foundation)
(max. 45.00 t/m2 for soil foundation)

Horizontal seismic coefficient

kh : for earth	0.18	
for structure	0.18	

Reaction

Normal	Vn=Rd+Rl	275.92	ton (normal)
Seismic	Ve=Rd	142.54	ton (seismic))
	He=	25.66	ton (Superstructure
Surcharge Load		0.00	kg/m2
Load per m		0.00	ton/m



(1) Weigh and center

Section B-B

	No.	Volum m3	unit weight t/m3	Vertical Load t	Distance Y m	Moment WY t.m/m
Body	**1**	3.22	2.40	7.7	10.500	81.1
	2	1.75	2.40	4.2	10.015	42.0
	3	30.40	2.40	73.0	4.900	357.5
	4	5.76	2.40	13.8		
	5	30.99	2.40	74.4		
	Total	**72.12**		**173.1**		**480.6**
Soil	**6**	25.07	2.00	50.1		
	7	4.57	2.00	9.1		
	Total	**29.64**		**59.3**		**0.0**
G. Total		**101.76**		**232.4**		**480.6**

Section A-A

	No.	Volum m3	unit weight t/m3	Vertical Load t
Body	**1**	3.22	2.40	7.7
	2	1.75	2.40	4.2
	3	13.96	2.40	33.5
	4			
	5			
	Total	**18.92**		**45.4**
Soil	**6**			
	7			
	Total			
G. Total		**18.92**		**45.4**

(2) Inertia force H

Section B - B

H = (Total weight of 1 to 3) x kh
= 84.88 x 0.18 = 15.28 tf

Center y
y = 480.58 / 84.88 = **5.66** m

∴ 1.20 + 5.66 = 6.86

Section A - A

H = (Total weight of 1 to 3) x kh
= 45.42 x 0.18 =

Center y
y = 158.23 / 45.42 =

∴ 5.70 + 3.48 =

(3) Dynamic water pressure

Section B - B
b / h = 2.75 / 4.50 = 0.61111 < 2.00
Dynamic water pressure P
P = 3 / 8 x Kh x Wo x b x h2 ; (b/h> 2.0), 3/4 kh Wo b2 h (1-b/4h) ; (b/h < 2.0)
= 0.75 x 0.18 x 1 x 1.56 x 4.50 x 0.931 =
h/2 = 2.25 m
y= 2.25 + 6.50 = 8.75 m

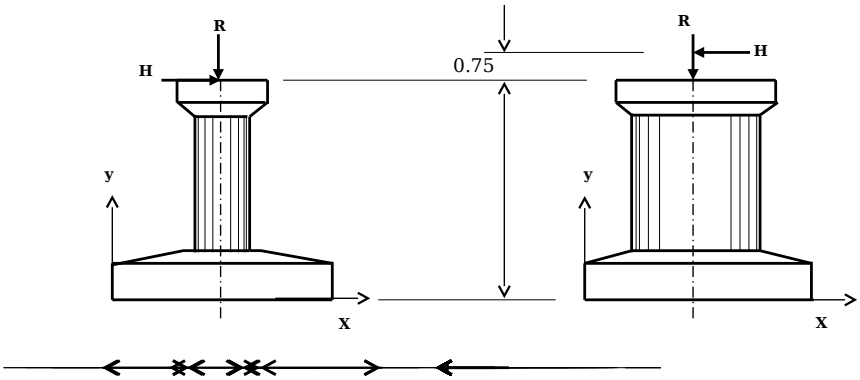
Section B - B
b / h = 2.75 / 9.80 = 0.28061 < 2.00
Dynamic water pressure P
P = 3 / 8 x Kh x Wo x b x h2 ; (b/h> 2.0), 3/4 kh Wo b2 h (1-b/4h) ; (b/h < 2.0)
= 0.75 x 0.18 x 1 x 1.56 x 9.00 x 0.965 =
h/2 = 4.5 m
y= 4.5 + 2.00 = 6.50 m

(4) Buoyancy u

Volume under water level Vo (body)
Vo = 68.88 + 27.92 = 96.79 m3

LOAD AND MOMENT

Case I-2 **Case II-2**



STABILITY ANALYSIS

Case I Normal Condition

1 Moment and Acting Point

Description	V Load V (t)	
Body	173.1	
Soil	59.3	
Reaction (bridge)	275.9	
Buoyancy u	-96.8	(100%)
Total	**411.5**	

1.1 Sinking (Bearing capacity)
Allowale bearing capacity Qa 21.87 tf/m2
Reaction from the Foundation

$$Q_{max(min)} = \frac{V}{WT \cdot BT}$$

Fondation Reaction Q
Q = 11.95 tf/m2 Q is smaller than Qa? OK

Case I-2 Seismic Condition

1 Moment and Acting Point

Description	V Load V (t)	HLoad H (t)	Distance (m) X	Y	Moment (t.m) Mx	My
Body	173.08	15.28	2.375	6.862	411.1	104.9
Soil	59.28		2.375		140.8	
Reaction (bridge)	142.54	25.66	2.375	12.000	338.5	307.9
Dynamic water pressure		1.83		6.500		11.9
Buoyancy (100%)	-96.79		2.375		-229.9	
Σ	**278.1**	**42.8**			**660.5**	**424.6**

Combined Acting
Xo=(ΣMx-ΣMy)/ΣV
0.848
Eccentric Distanc
e=(BT/2-Xo)
1.527
Bending Moment
424.64

2 Stability Analysis

2.1 Over Turnng

e<=(BT/3) e= 1.527 m BT/3 is larger than e? OK

BT/3= 1.583 m

BT/6= 0.792 m

2.2 Sliding

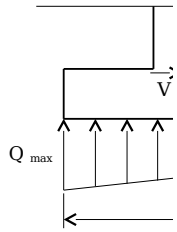
Friction Coefficient =Tan ϕ b = 0.5

Shearing registance force at base

Hu=V . Tan ϕ b 139.06 tf

Safety Rate anaginst sliding

Fs=Hu/H 3.251 Fs is larger than 1.25 ? OK



2.3 Sinking (Bearing capacity)

Allowale bearing capacity Qa 32.80 tf/m2

Reaction from the Foundation e > BT/6 ?

in case e<BT/6

$$Q_{max(min)} = \frac{V}{WT \cdot BT} \pm \frac{6M}{WT \cdot BT^2}$$

Maximiun Fondation Reaction Q max

Q max = 23.652 tf/m2

Minimum Fondation Reaction Q max

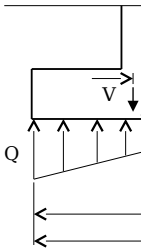
Q min = -7.500 tf/m2

in case e>BT/6

X=3(BT/2-e) = 2.544 m

Foundation Reaction Qe

Q=2V/(WT.X)= 30.153 tf/m2



Qmax is smaller than Qa? OK Qe is smaller than Qa? OK

Therefore

Qmax = 30.153 tf/m2

Qmin = 0.000 tf/m2

X = 2.544 m

Case II-2 Seismic Condition

1 Moment and Acting Point

Description	V Load V (t)	HLoad H (t)	Distance (m) X	Y	Moment (t.m) Mx	My
Body	173.1	15.3	3.625	6.862	627.4	104.9
Soil	59.3		3.625		214.9	
Reaction (bridge)	142.5	25.7	3.625	12.750	516.7	327.1
Dynamic water pressure		1.8		6.500		11.9
Buoyancy (100%)	-96.8		3.625		-350.9	
Σ	**278.1**	**42.8**			**1008.2**	**443.9**

Combined Acting

Xo=(ΣMx-ΣMy)/ΣV

2.029

Eccentric Distanc

e=(WT/2-Xo)

1.596

Bending Moment

443.89

2 Stability Analysis

2.1 Over Turnng

e<=(WT/3) e= 1.596 m WT/3 is larger than e? OK

WT/3= 2.417 m

WT/6= 1.208 m

2.2 Sliding

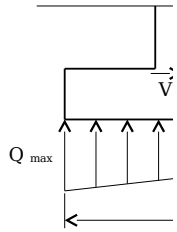
Friction Coefficient =Tan ϕ b = 0.5

Shearing registance force at base

Hu=V . Tan ϕ b 139.06 tf

Safety Rate anaginst sliding

Fs=Hu/H 3.251 Fs is larger than 1.25 ? OK



2.3 Sinking (Bearing capacity)

Allowale bearing capacity Qa 32.80 tf/m2

Reaction from the Foundation e > WT/6 ?

in case e<WT/6

$$Q_{max(min)} = \frac{V}{BT \cdot WT} \pm \frac{6M}{BT \cdot WT^2}$$

Maximiun Fondation Reaction Q max

Q max = 18.743 tf/m2

Minimum Fondation Reaction Q max

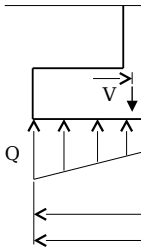
Q min = -2.591 tf/m2

in case e>WT/6

X=3(WT/2-e) = 6.087 m

Foundation Reaction Qe

Q=2V/(BT.X)= 19.238 tf/m2



Qmax is smaller than Qa? OK Qe is smaller than Qa? OK

Therefore

Qmax = 19.238 tf/m2

Qmin = 0.000 tf/m2

X = 6.087 m

Bearing Capacity of soil

(1) Design Data

ϕ_B	=	30.00	°	c_B	=	0.00	t/m²	γ_s'	=	1.00	
B	=	4.75	m	z	=	1.20	m	L	=	7.25	

(2) Ultimate Bearing Capacity of soil, (qu)

Calculation of ultimate bearing capacity will be obtained by appliying the following Terzaghi's formula :

$$qu = \alpha\ c\ Nc + \gamma_s'\ z\ Nq + \beta\ \gamma_s'\ B\ N\gamma$$

Shape factor (Table 2.5 of KP-06)

α = 1.23 β = 0.40

Shape of footing : rectangular, B x L

	Shape of footing		α
1	strip		1.00
2	square		1.30
3	rectangular, B x L		1.23
		(B ≤ L)	(= 1.09 + 0.21 B/L)
		(B > L)	(= 1.09 + 0.21 L/B)
4	circular, diameter = B		1.30

Bearing capacity factor (Figure 2.3 of KP-06, by Capper)

Nc = 36.0 Nq = 23.0 Nγ

ϕ	Nc	Nq	Nγ
0	5.7	0.0	0.0
5	7.0	1.4	0.0
10	9.0	2.7	0.2
15	12.0	4.5	2.3
20	17.0	7.5	4.7
25	24.0	13.0	9.5
30	36.0	23.0	20.0
35	57.0	44.0	41.0
37	70.0	50.0	55.0
39 >	82.0	50.0	73.0

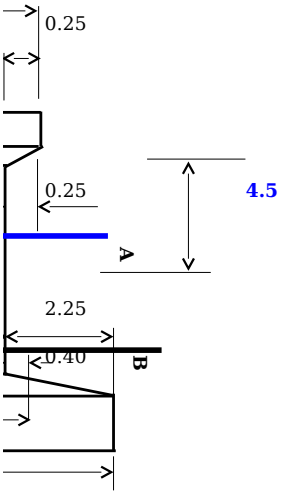
α c Nc	=	0.000
γ_s' z Nq	=	27.600
$\beta\ \gamma_s'$ B Nγ	=	38.000

qu = **65.600** t/m²

(3) Allowable Bearing Capacity of soil, (qa)

qa	=	qu / 3	=	**21.867** t/m²	(safety factor =	3	, normal c
qae	=	qu / 2	=	**32.800** t/m²	(safety factor =	2	, seismic c

e x kh)



Distance Y m	Moment WY t.m/m
6.000	46.3
5.515	23.1
2.650	88.8
	158.2

158.2

8.18 tf

3.48 m

9.18

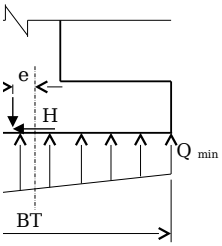
0.88 tf

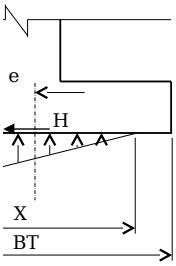
1.83 tf

Point

m
e

m
M =ΣV x e
t.m





Point

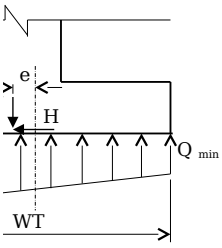
m

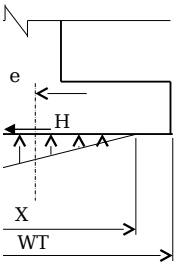
e

m

M =ΣV x e

t.m





t/m³ (=γ_{sat}-γ_w)
m

	β
	0.50
	0.40
	0.40
	0.30

= 20.0

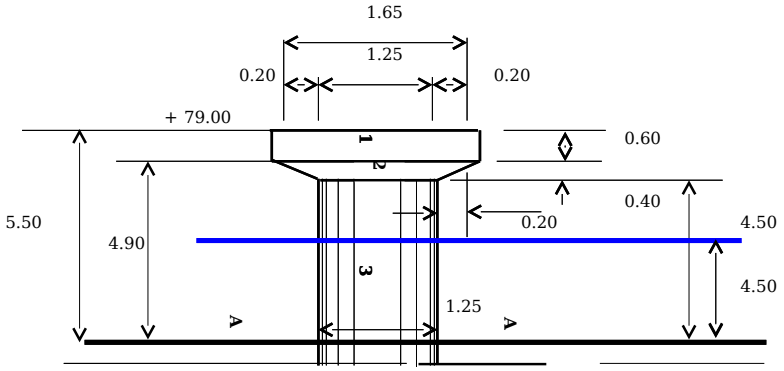
condition)
condition)

STRUCTURAL CALCULATION, PEIR BODY

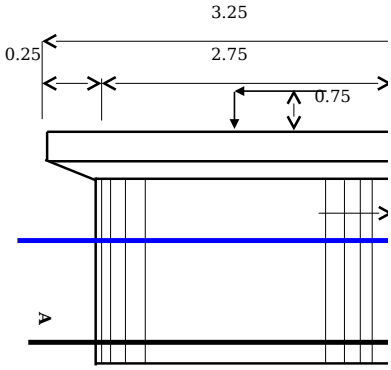
Section A - A

1 Load and Bending Moment of Peir Body

Case 1 (parallel to bridge a



Case II (perpendicular to bridge axi



Dimensions								unit:m
	B2	B3	B5	H1	H2	H5	H6	Ho
	0.20	0.20	1.25	10.80	10.20	0.60	0.40	9.80

Seismic Coefficient soil kh= 0.18 stryctur kh= 0.18

1) Normal condition (Case I-1 and II-1)

N = Rd + Rl + Dead load (1, 2, 3)
= 275.924 + 84.877
= 360.801 t
H = 0.000 t
M = 0.000 t m

2) Seismic

Case I-2

N = Rd + Dead load (1, 2, 3)
= 142.544 + 84.877
= 227.421 t
H = 34.718 t
M = 172.301 t m

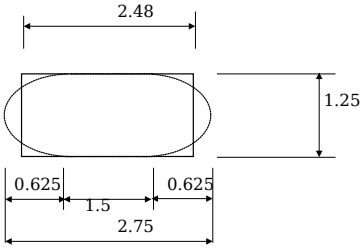
Case II-2

N = 227.421 t
H = 34.718 t
M = 191.545 t m

	Case I-2			Case II-2
Item	Horizontal Load t	Distance Y m	Moment My t.m	Distance Y m
He	25.658	5.500	141.119	6.250
Dead load x Kh	8.180	3.484	28.499	3.484
Dynamic water pressure P	0.880	3.050	2.684	3.050
Total	34.718		172.301	

2 Calculation of Required Reinforcement Bar

1) Effective section



Design $\pi d^2 / 4$ + bh = 3.1022
Calculation b h = 3.1022
Therefore

Case I b = 1.25 m
h = 2.48 m

Case II b = 2.48 m
h = 1.25 m

3 Summary of Intersectional Force

Description	Normal Condition			Seismic Condition		
	Moment M (tfm)	Load N (tf)	Shearing S (tf)	Moment M (tfm)	Load N (tf)	Shearing S (tf)
Case I	0.00	360.80	0.00	172.30	227.42	34.72
Case II	0.00	360.80	0.00	191.54	227.42	34.72

4 Calculation of Required Reinforcement Bar as Rectangular Beam, Normal Condition

1) Cracking Moment

			Case I			Case II
Mc=	Zc*(σ'ck + N/Ac)	Mc=	34957421	kgf.cm/m		17619668
		=	350	tf.m/m		176
where, Mc	Cracking Moment			kgf.cm		
Zc	Section Modulus					
	Zc=b*h1^2/6 b=125 cm		1281333	cm3	b=248 cm	645833
σ'ck	Tensile strength of Concrete (bending)					
	σ'ck = 0.5*σck^(2/3)		16	kgf/cm2		16
	σ ck= 175 kgf/cm2					
N	Axial force (kg)		360801	kgf		360801
Ac	Area of Concrete = b*h1		31000	cm2		31000
h1	thickness of section		248	cm		125
b			125	cm		248

2) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf		0.000	tf.m/m		0.000
Check Mf & Mc	1.7*Mf>Mc?, if yes check ultimate bending moment				
	1.7*Mf =	0.000	tf.m		0.000
	Mc=	349.574	tf.m		176.197
	1.7*Mf>Mc?	No, no need to check ultimate bending moment			No, no need to check ult

3) Ultimate Bending Moment

Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]}	Mu=	0	kgf.cm		Mu=	0
	=	0.000	tf.m		=	0.000
where,						
Mu	Ultimate Bending Moment		tf.m			
As	Area of Tensile Bar		cm2			
σ sy	Yielding point of Tensile Bar	3000	kgf/cm2	(Spec >295 N/mm2)		3000
d	Effective height = h1-cover	241	cm			118
	cover d1= 7 cm					
	h1= 248.0 cm, 125.0 cm					
σ'ck	Design Compressive Strength of Concrete	175	kgf/cm2			175
b	Effective Width	125	cm			248
	As=Mf/(σ sa*j*d)	0.000	cm2			0.000
	σ sa= Allowable Stress Rbar	1850	kgf/cm2			1850
	j= 1 -k/3 (=8/9)	0.854				0.854
	or k = n/{n+σ sa/σ ca)					
	n= Young's modulus ratio	24				24
	σ ca Allowable Stress Concrete	60	kgf/cm2			60
Check Mu & Mc	Mu =	0.000	tf.m		Mu =	0.000
	Mc =	349.574	tf.m		Mc =	176.197
	Mu>Mc?	not applicable				not applicabl

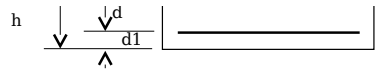
4) Bar Arrangement

Checking of Single or Double bar arrangement

M1= (d/Cs)^2*σsa*b >Mf?	M1=	81422113.063	kgf.cm			38727010
	=	814.221	tf.m			387.270
where, M1	Resistance moment					
Cs	={2m/[s*(1-s/3)]}^(1/2)	12.8436				12.8436
s	(n*σca)/(n*σca+σsa)	0.4377				0.4377
m	σsa/σca	30.8333				30.8333
σsa		1850	kgf/cm2			1850
σca		60	kgf/cm2			60
n		24				24
Check M1 > Mf?	M1=	814.221	tf.m			387.270
	Mf=	0.000	tf.m			0.000
	M1>Mf: Design Tensile Bar Only					***M1>Mf: Design Tensi***

(a) Tensile Bar

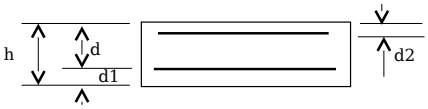
Max Bar Area As max =	0.02*b*d =	602.50	cm2				585.28
Min Bar Area As min =	b*4.5%=	5.63	cm2				11.16
Required Bar Area	As req=	0	cm2				0
Apply ϕ =	**25**	@	**200**	mm	**25**	@	**200**
Required Bar Nos	Nos=b/pitch =	6.250	nos				12.400
Bar Area	As =	30.680	cm2	ok		60.868	cm2
Mrs=σsa*As2(d-d2)	Mrs=	13677553	kgf.cm		Mrs=	13287109	
	=	136.776	tf.m		=	132.871	
where, Mrs Resistance Mooment by tensile bar As2							
As2= As-As1=As - M1/{σsa*(1-s/3)*d}							
	As2=	30.677			As2=	60.866	
	σsa=	1850			σsa=	1850	



		d=	241			d=	118
		d2=	0			d2=	0

(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2)
As' = M'/[σsa*(d - d2)]

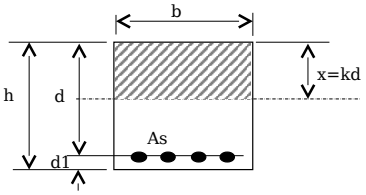


		M'=	0.000	tf.m			0.000
		As'=	0.000	cm2			0.000
		M1=	814.221	tf.m			387.270
		Mf=	0.000	tf.m			0.000
		d=	241	cm			118
		d2=	0	cm			0
		σsa=	1850	kgf/cm2			1850
Required Bar Area	As' req=		0	cm2			0
Apply ϕ =		25	@	200	mm	25	@
Bar Area	As' =		30.680	cm2	ok		60.868

5) Checking of Allowable Stress

(a) Tensile Bar Only

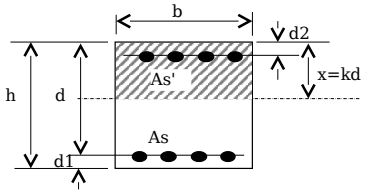
Mf			0.000	tf.m		0.000
S			0.000	tf		0.000
σs =	Mf/(As*j*d)		0.00	kgf/cm2	ok	0.00
σc =	2*Mf/(k*j*b*d^2)		0.00	kgf/cm2	ok	0.00
τm =	S/(b*j*d)		0.000	kgf/cm2	ok	0.000
	p=As/(b*d)		0.00102			0.00208
	k={(n*p)^2+2*n*p}^0.5 - n*p		0.19800			0.26997
	j= 1-k/3		0.93400			0.91001



b=	125	cm		248
d=	241	cm		118
n=	24			24

(b) Tensile Bar & Compressive Bar

Mf			0.000	tf.m		0.000
S			0.000	tf		0.000
σc =	Mf/(b*d^2*Lc)		0.00	kgf/cm2	ok	0.00
σs =	n*σc*(1-k)/k		0.00	kgf/cm2	ok	0.00
σs' =	n*σc*(k-d2/d)/k		0.00	kgf/cm2	ok	0.00
τm =	S/(b*j*d)		0.000	kgf/cm2	ok	0.000
	p=As/(bd)		0.001018			0.002080
	p'=As'/(bd)		0.001018			0.002080
	k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')		0.177552			0.231532
	Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)		0.107964			0.156751
	j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)		0.953593			0.946075



b=	125	cm	248
d2=	0	cm	0
d=	241	cm	118
n=	24		24

5 Calculation of Required Reinforcement Bar as Column, Seismic Condition

1) Minimum Area as Column

			Case I			Case II
Acmin = N/(0.008σsa+σca)		Acmin =	2026.929	cm2		2026.929
where, σsa	Allowable stress of Reinforcement bar		2775	kgf/m2		2775
σca	Allowable stress of Concrete		90	kgf/m2		90
N	Axial force		227.421	tf		227.421
check: Ac (design) = b*h>Acmin?	b*c=		31000	>	Acmin ok	31000

2) Cracking Moment

Mc=	Zc*(σ'ck + N/Ac)	=	29444381	kgf.cm		14840918
		=	294.444	tf.m		148.409
where, Mc	Cracking Moment			kgf.cm		
Zc	Section Modulus					
	Zc=b*h2^2/6		1281333.3333	cm3		645833.33
	b=		125	cm		248
σ'ck	Tensile strength of Concrete (bending)					
	σ'ck = 0.5*σck^(2/3)		15.643	kgf/cm2		15.643
	σ ck=		175	kgf/cm2		175
N	Axial force		227.421	tf		227.421

Ac	Area of Concrete = b*h2		31000	cm2		31000
h	thickness of section		248	cm		125
Minimum Reifircement Bar						
(a) As a beam		As min = b(m)*4.5 cm2	As min=	5.63	cm2	As min=
(b) As a column		As min=0.008*Ac min	As min=	16.22	cm2	As min=
Maximum Reinforcement Bar						
(a) As a beam		As max = 0.002*b*d	As max=	602.50	cm2	As max=
(b) As a column		As max = 0.006*Ac	As max=	1860.00	cm2	As max=

3) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf			172.301	tf.m	191.545
Check Mf & Mc	1.7*Mf>Mc?, if yes check ultimate bending moment				
		1.7*Mf =	292.912	tf.m	325.626
		Mc=	294.444	tf.m	148.409
	1.7*Mf>Mc?	No, no need to check ultimate bending moment			yes, check ultimate bend

4) Checking of Required Reinforcement Bar ***Compute under eccentric load condition***

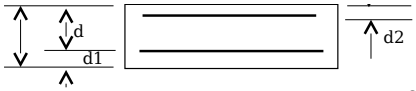
As={[σc*(s/2)-N/(b*d)]/σsa}*b*d		As=	-10.707	cm2	25.431
where,					
σc	Stress of concrete	σc=	54.725	kg.cm2	70.481
	solve the equation Eq1 below				
	Eq1 = σc^3 + [3*σsa/(2*n)-3*Ms/(b*d^2)]*σc^2 - 6*Ms/(n*b*d^2)*σsa*σc - 3*Ms/(n^2*b*d^2)*σsa^2 = 0				
σsa	Allowable stress of Reinforcement Bar	σsa =	2775	kg.cm2	2775
Ms	Eccentric Moment, Ms=N(e+c)	Ms=	43838447.419	kgf.cm	31776376
e	Essentric Distance e=M/N	e=	75.763	cm	84.225
M	Bending Moment	M=	172.301	tf.m	191.545
N	Axial Force	N=	227.421	tf	227.421
n	Young's Modulus Ratio	n=	16		16
c	c=h/2 - d1	c=	117.0	cm	55.5
h	Height of Section	h=	248.0	cm	125.0
b	Width of section	b=	125.0	cm	248.0
d1	Concrete Cover	d1=	7.0	cm	7.0
d	Effective Width of section d=h-d1	d=	241.0	cm	118.0
s	s=n*σc/(n*σc+σsa)	s=	0.240		0.289
	[3*σsa/(2*n)-3*Ms/(b*d^2)]=		242.04		232.55
	6*Ms/(n*b*d^2)*σsa=		6283.55		9575.97
	3*Ms/(n^2*b*d^2)*σsa^2=		544902		830416

σc (trial)=	54.725187	σc (trial)=	70.481349
Eq1 (trial)=	0.0006335 ok	Eq1 (trial)=	-2.115E-07 ok
cross check	0.0006335 ok	cross check	-2.114E-07 ok

5) Ultimate Bending Moment

Mu=c*(h/2-0.4X)+Ts'(h/2-d2)+Ts(h/2-d1)								
	Mu=min(Mu1,Mu2)	Mu=	0	kgf.cm				23307792
		=	0.000	tf.m				233.078
			in case X>0			in case X<0		in case X>0
where,		Mu1=	28200251.431		Mu2=	0		23307792
Mu	Ultimate Bending Moment (tf.m)							
c	0.68*σck*b*X	c=	227421		c=	0.00	c=	279367
σck	design strength of Concrete	σck=	175	kg/cm2				175
b	Width of section	b=	125	cm				248
X	solve the equation Eq2 below	X=	15.289		X=	0.000		9.466
Ts'	As'*Es*εcu*(X-d2)/X	Ts'=	0.000		Ts'=	0.000		24349
As'	Compressive Bar As'=0.5 As	As'=	0.000					12.716
As	Required Reinforcement Bar (Tensile)	As=	0.000					25.431
Es	Young's modulus (reinforcement bar)	Es=	**2100000**					**2100000**
εcu	Creep strain coefficient (concrete)	εcu=	**0.0035**					**0.0035**
h	Height of Section	h=	248	cm				125
d1	Concrete Cover (tensile side)	d1=	7	cm				7
d2	Concrete Cover (compressive side)	d2=	7	cm				7
Equation Eq2								
α*X^2 + (β-Ts-N)*X-β*d2=0								
α	0.68*σck*b	α=	14875					29512
β	As'*Es*εcu	β=	0					93460
Ts	As*σsy	Ts=	0					76294
σsy	Yielding point of Tensile Bar	σsy=	3000	kgf/cm2	(Spec >295 N/mm2)			3000
N	Axial Force	N=	227421	kgf				227421
	put a,b,c as follows	a=	α =	14875				α =
		b=	β-Ts-N =	-227421				β-Ts-N =
		c=	- β*d2 =	0				- β*d2 =
	then, X= (-b+(b^2-4ac)^0.2)/(2*a)	X=	15.289					9.466
	X= (-b-(b^2-4ac)^0.2)/(2*a)	X=	0.000					-2.342
Check Mc & Mu		Mu=	0.000	tf.m				233.078
		Mc=	294.444	tf.m				148.409
	Mu>Mc ?		not applicable					ok

6) Bar Arrangement

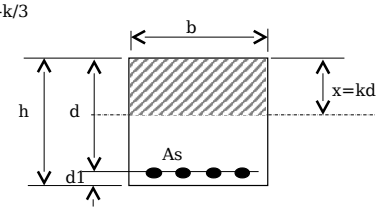


Max Bar Area	As max =				602.50	cm2			585.28
Min Bar Area	As min =				16.22	cm2			16.22
(a) Tensile Bar									
Required Bar Area	As req=				-10.707	cm2			25.431
Apply ϕ =		**25**	@	**200**	mm		**25**	@	**200**
Column width	b=			125	cm2				248
Bar Area	As =			30.680	cm2	ok			60.868
(b) Compressive Bar									
Required Bar Area	As' req=				0.000	cm2			12.716
Apply ϕ =		**25**	@	**200**	mm		**25**	@	**200**
Column width	b=			125	cm2				248
Bar Area	As' =			30.680	cm2	ok			60.868
(c) Hoop Bar									
Minimum Diameter	ϕ' min =			12	mm				12
Apply	ϕ' =			**16**	mm				**16**
Bar Interval shall satisfy the following conditions:									
	<=	d =		2410	mm				1180
Bar Interval: t mm	<=	12*ϕ =		300	mm				300
	<=	48*ϕ '		768	mm				768
then		t =		**200**	mm	ok			**200**

7) Checking of Allowable Stress, Seismic Condition

(a) Tensile Bar Only

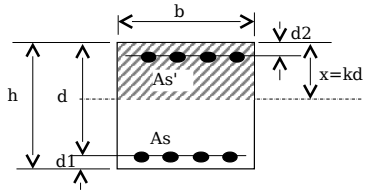
Mf		172.301	tf.m		191.545
S		34.718	tf		34.718
σs =	Mf/(As*j*d)	2465.95	kgf/cm2	ok	2884.99
σc =	2*Mf/(k*j*b*d^2)	30.45	kgf/cm2	ok	52.90
τm =	S/(b*j*d)	1.220	kgf/cm2	ok	1.283
	p=As/(b*d)	0.00102			0.00208
	k={(n*p)^2+2*n*p}^0.5 - n*p	0.16496			0.22685
	j= 1-k/3	0.94501			0.92438



b=	125	cm	248
d=	241	cm	118
n=	16		16

(b) Tensile Bar & Compressive Bar

Mf		172.301	tf.m		191.545
S		34.718	tf		34.718
σc =	Mf/(b*d^2*Lc)	27.72	kgf/cm2	ok	46.70
σs =	n*σc*(1-k)/k	2447.58	kgf/cm2	ok	2859.10
σs' =	n*σc*(k-d2/d)/k	359.57	kgf/cm2	ok	533.25
τm =	S/(b*j*d)	1.210	kgf/cm2	ok	1.272
	p=As/(bd)	0.00102			0.00208
	p'=As'/(bd)	0.00102			0.00208
	k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')	0.15342			0.20719
	Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)	0.08561			0.11878
	j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)	0.952107			0.932754



b=	125	cm	248
d2=	7	cm	7
d=	241	cm	118
n=	16		16

7 Check for stress of concrete and reinforcement bar

			Case I		
			Normal	Seismic	Normal
Height of section	h	cm	248	248	125
Effective width	b	cm	125	125	248
Concrete cover	d'	cm	7	7	7
Reinforcement bar	As	cm2	30.68	30.68	60.87
	As'	cm2	30.68	30.68	60.87
Morment	M	kgf cm	0	17230146	0
Axcis force	N	kgf	360801	227421	360801
Shearing force	S	kgf	0	34718	0
Yong modulu ratio	n		24	16	24
	c		117.000	117.000	55.500

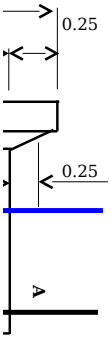
e	0.000	75.763	0.000
a1	-372.000	-144.711	-187.500
b1	0.052	3570.308	0.053
c1	-967631	-1087804	-217736
x	379.34458857	164.7969	193.83029
	89292.085869	46072.2	20104.182
	Check	Check	Check
a2	23709.037	10299.806	24034.956
b2	-2.448	69.068	-2.110
b3	227.101	348.508	418.298
b4	372.345	157.797	186.830
b5	227.101	348.508	418.298
b6	-138.345	76.203	-75.830
σc	0.00 ok	21.73 ok	0.00
σs	0.00 ok	160.77 ok	0.00
σs'	0.00 ok	332.91 ok	0.00
τc	0.000 ok	1.210 ok	0.000

SUMMARY OF DESIGN CALCULATION, PIER BODY

Case I

Description			Abbr.	unit	Normal Condition	Seismic Condition	Normal Con
Calculation Condition					Rectangular Beam	Column	Rectangular
Principle Dimensions							
Concrete Design Strength			σc	kgf/m2	**175**	**175**	**175**
Effective width of section, Bw			b	cm	125	125	248
Height of Section			h	cm	248	248	125
Concrete Cover (tensile)			d1	cm	**7**	**7**	**7**
Concrete Cover (compressive)			d2	cm	-	-	-
Effective height of Section			d	cm	241	241	118
Allowable Stress		Concrete	σca	kgf/m2	**60**	**90**	**60**
		Re-Bar	σsa	kgf/m2	**1850**	**2775**	**1850**
		Shearing	τma	kgf/m2	**5.5**	**8.25**	**5.5**
Yielding Point of Reinforcement Bar			σsy	kgf/cm2	**3000**	**3000**	**3000**
Reinforcement Bar							
Tensile Bar	Required		As req.	cm2	0.00	-10.71	0.00
	Designed		As	cm2	30.68 D25@200	30.68 D25@200	60.87
Compressive Bar	Required		As' req.	cm2	0.00	0.00	0.00
	Designed		As'	cm2	30.68 D25@200	30.68 D25@200	60.87
Hoop Bar	Designed		Aso			D16@200	
Design Load							
Design Bending Moment			Mf	tf.m	0.000	172.301	0.000
Design Axis Force			Nd	tf	360.801	227.421	360.801
Shearing Force			S	tf	0.000	34.718	0.000
Checking of Minimum Re-Bar							
Cracking Moment			Mc	tf.m	349.574	294.444	176.197
1.7*Mf					0.000	292.912	0.000
1.7*Mf < Mc ? If no, check Mu					ok	ok	ok
Ultimate Bending Moment			Mu	tf.m			
Mu > Mc ?							
Max Re-bar			As max	cm2	602.50	602.50	585.28
Min Re-bar			As min	cm2	5.63	16.22	11.16
Required Bar			As req.	cm2	0.00	-10.71	0.00
Area of Re-bar for Design			As	cm2	61.36	61.36	121.74
Checking of Allowable Stress as Rectangular Beam							
Young's Modulus Ratio			n		24	16	24
Effective height			d	cm	241	241	118
Compressive Stress			σc	kgf/cm2	0.00 ok		0.00
Bending Tensile Stress			σs	kgf/cm2	0.00 ok		0.00
			σs'	kgf/cm2	-		-
Mean Shearing Stress			τm	kgf/cm2	0.000 ok		0.000
Checking of Allowable Stress as Column							
Compressive Stress			σc	kgf/cm2	0.00 ok	21.73 ok	0.00
Bending Stress			σs	kgf/cm2	0.00 ok	160.77 ok	0.00
			σs'	kgf/cm2	0.00 ok	332.91 ok	0.00
Shearing Stress			τm	kgf/cm2	0.000 ok	1.210 ok	0.000

is)



+ 79.00
+ 78.40
+ 78.00

+ 78.00

+ 73.50

+ 68.20
+ 67.00

Moment My t.m
160.362
28.499
2.684
191.545

m⁴
m⁴

kgf.cm/m
tf.m/m
kgf.cm

cm3

kgf/cm2

kgf
cm2
cm
cm

tf.m/m

tf.m
tf.m
timate bending moment

kgf.cm
tf.m

tf.m
cm2
kgf/cm2 (Spec >295 N/mm2)
cm

kgf/cm2
cm

cm2
kgf/cm2

kgf/cm2

tf.m
tf.m
e

kgf.cm
tf.m

kgf/cm2
kgf/cm2

tf.m
tf.m
le Bar Only

cm2
cm2
cm2
mm
nos

ok

kgf.cm
tf.m

tf.m
cm2
tf.m
tf.m

cm
cm
kgf/cm2
cm2
200 mm
cm2 ok

tf.m
tf
kgf/cm2 ok
kgf/cm2 ok
kgf/cm2 ok

cm
cm

tf.m
tf
kgf/cm2 ok
kgf/cm2 ok
kgf/cm2 ok
kgf/cm2 ok

cm
cm
cm

cm2
kgf/m2
kgf/m2
tf
> Acmin ok

kgf.cm
tf.m
kgf.cm

cm3
cm

kgf/cm2
kgf/cm2
tf

cm2
cm

11.16 cm2
16.22 cm2

585.28 cm2
1860.00 cm2

tf.m

tf.m
tf.m
ding moment

cm2

kg.cm2

kg.cm2
kgf.cm
cm
tf.m
tf

cm
cm
cm
cm
cm

kgf.cm
tf.m
in case X<0
Mu2= 24909857

c= -278.67
kg/cm2
cm
X= -2.342
Ts'= 372827

cm
cm
cm

kgf/cm2 (Spec >295 N/mm2)
kgf
29512
-210255
-654222

tf.m
tf.m

cm2
cm2

cm2
mm
cm2
cm2 ok

cm2
mm
cm2
cm2 ok

mm
mm

mm
mm
mm
mm ok

tf.m
tf
kgf/cm2 check
kgf/cm2 ok
kgf/cm2 ok

cm
cm

tf.m
tf
kgf/cm2 ok
kgf/cm2 check
kgf/cm2 ok
kgf/cm2 ok

cm
cm
cm

Case II

Seismic
125
248
7
60.87
60.87
19154490
227421
34718
16
55.500

	84.225	
	65.174	
	3969.083	
	-393226	
	45.687967	
	19525.543	
	Check	
	5665.308	
	47.271	
	1183.081	
	38.688	
	1183.081	
	72.312	
ok	47.99	ok
ok	1215.32	ok
ok	650.21	ok
ok	1.272	ok

Case II

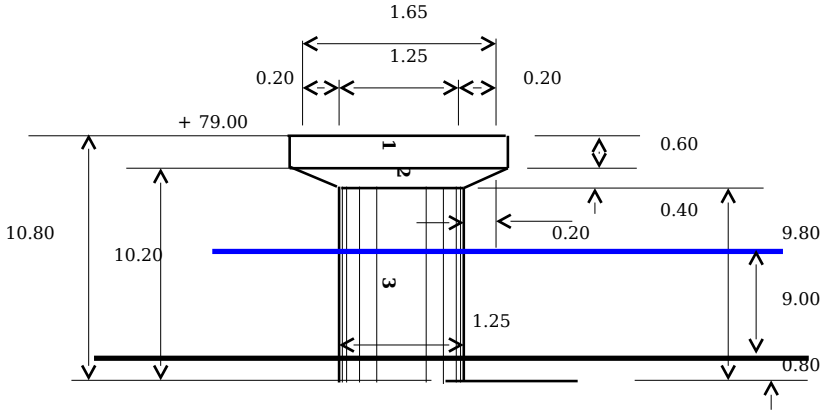
dition	Seismic Condition	
Beam	Column	
	175	
	248	
	125	
	7	
	-	
	118	
	90	
	2775	
	8.25	
	3000	
	25.44	
D25@200	60.87	D25@200
	12.72	
D25@200	60.87	D25@200
		D16@200
	191.545	
	227.421	
	34.718	
	148.409	
	325.626	
	check Mu	
	233.078	
	ok	
	585.28	
	16.22	
	38.16	
	121.74	
	16	
	118	
ok		
ok		
ok		
ok	47.99	ok
ok	1215.32	ok
ok	650.21	ok
ok	1.272	ok

STRUCTURAL CALCULATION, PEIR BODY

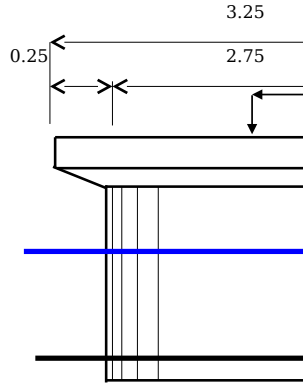
Section B - B

1 Load and Bending Moment of Peir Body

Case 1 (parallel to bridge a



Case II (perpendicular to



Dimensions unit:m

B2	B3	B5	H1	H2	H5	H6	ho
0.20	0.20	1.25	10.80	10.20	0.60	0.40	9.80

Seismic Coefficient soil kh= 0.18 stryctur kh= 0.18

1) Normal condition (Case I-1 and II-1)

N = Rd + Rl + Dead load (1, 2, 3)
= 275.924 + 84.877
= 360.801 t
H = 0.000 t
M = 0.000 t m

2) Seismic

Case I-2

N = Rd + Dead load (1, 2, 3)
= 142.544 + 84.877
= 227.421 t
H = 42.768 t
M = 373.321 t m

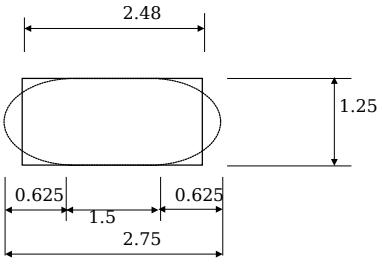
Case II-2

N = 227.421 t
H = 42.768 t
M = 392.565 t m

Case I-2			
Item	Horizontal Load t	Distance Y m	Moment My t.m
He	25.658	10.800	277.106
Dead load x Kh	15.280	5.662	86.517
Dynamic water pressure P	1.830	5.300	9.699
Total	42.768		373.321

2 Calculation of Required Reinforcement Bar

1) Effective section



Design $\pi d^2 / 4$ + bh =
Calculation b h =
Therefore

Case I b = 1.25 m
h = 2.48 m

Case II b = 2.48 m
h = 1.25 m

3 Summary of Intersectional Force

Description	Normal Condition Moment M (tfm)	Load N (tf)	Shearing S (tf)	Seismic Condition Moment M (tfm)	Load N (tf)	Shearing S (tf)
Case I	0.00	360.80	0.00	373.32	227.42	42.77
Case II	0.00	360.80	0.00	392.56	227.42	42.77

4 Calculation of Required Reinforcement Bar as Rectangular Beam, Normal Condition

1) Cracking Moment

Case I

Mc= Zc*(σ'ck + N/Ac) Mc= 34957421 kgf.cm/m
= 350 tf.m/m

where, Mc Cracking Moment kgf.cm
Zc Section Modulus
Zc=b*h1^2/6 b=125 cm 1281333 cm3 b=248 cm
σ'ck Tensile strength of Concrete (bending)
σ'ck = 0.5*σck^(2/3) 16 kgf/cm2
σ ck= 175 kgf/cm2
N Axial force (kg) 360801 kgf
Ac Area of Concrete = b*h1 31000 cm2
h1 thickness of section 248 cm
b 125 cm

2) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf 0.000 tf.m/m

Check Mf & Mc 1.7*Mf>Mc?, if yes check ultimate bending moment
1.7*Mf = 0.000 tf.m
Mc= 349.574 tf.m
1.7*Mf>Mc? No, no need to check ultimate bending moment No, no need

3) Ultimate Bending Moment

Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]} Mu= 0 kgf.cm Mu=
= 0.000 tf.m =

where,
Mu Ultimate Bending Moment tf.m
As Area of Tensile Bar cm2
σ sy Yielding point of Tensile Bar 3000 kgf/cm2 (Spec >295 N/mm2)
d Effective height = h1-cover 241 cm
cover d1= 7 cm
h1= 248.0 cm, 125.0 cm
σ'ck Design Compressive Strength of Concrete 175 kgf/cm2
b Effective Width 125 cm

As=Mf/(σ sa*j*d) 0.000 cm2
σ sa= Allowable Stress Rbar 1850 kgf/cm2
j= 1 -k/3 (=8/9) 0.854
or k = n/{n+σ sa/σ ca)
n= Young's modulus ratio 24
σ ca Allowable Stress Concrete 60 kgf/cm2

Check Mu & Mc Mu = 0.000 tf.m Mu =
Mc = 349.574 tf.m Mc =
Mu>Mc? not applicable n

4) Bar Arrangement

Checking of Single or Double bar arrangement

M1= (d/Cs)^2*σsa*b >Mf? M1= 81422113.063 kgf.cm
= 814.221 tf.m

where, M1 Resistance moment
Cs ={2m/[s*(1-s/3)]}^(1/2) 12.8436
s (n*σca)/(n*σca+σsa) 0.4377
m σsa/σca 30.8333
σsa 1850 kgf/cm2
σca 60 kgf/cm2
n 24

Check M1 > Mf? M1= 814.221 tf.m
Mf= 0.000 tf.m
M1>Mf: Design Tensile Bar Only ***M1>Mf: De***

(a) Tensile Bar

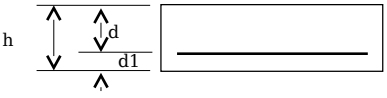
Max Bar Area As max = 0.02*b*d = 602.50 cm2
Min Bar Area As min = b*4.5%= 5.63 cm2
Required Bar Area As req= 0 cm2
Apply ϕ = **25** @ **100** mm **25** @
Required Bar Nos Nos=b/pitch = 12.500 nos

Bar Area As = 61.359 cm2 ok 121.737

Mrs=σsa*As2(d-d2) Mrs= 27356060 kgf.cm Mrs=
= 273.561 tf.m =

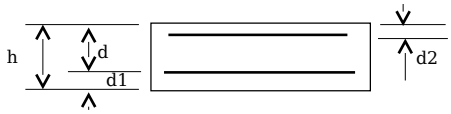
where, Mrs Resistance Mooment by tensile bar As2
As2= As-As1=As - M1/{σsa*(1-s/3)*d}

As2= 61.357 As2=
σsa= 1850 σsa=
d= 241 d=
d2= 0 d2=



(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2) — M'= 0.000 tf.m
As' = M'/[σsa*(d - d2)] — As'= 0.000 cm2
M1= 814.221 tf.m
Mf= 0.000 tf.m



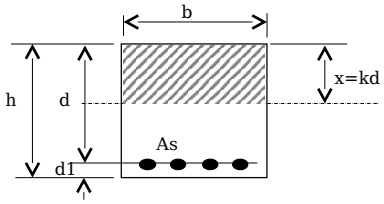
d= 241 cm
d2= 0 cm
σsa= 1850 kgf/cm2

Required Bar Area — As' req= 0 cm2
Apply ϕ = 25 @ 100 mm 25
Bar Area — As' = 61.359 cm2 ok

5) Checking of Allowable Stress

(a) Tensile Bar Only

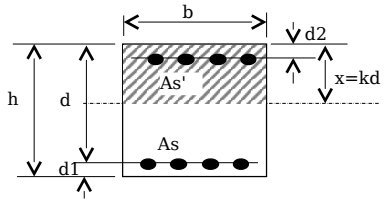
Mf 0.000 tf.m
S 0.000 tf
σs = Mf/(As*j*d) 0.00 kgf/cm2 ok
σc = 2*Mf/(k*j*b*d^2) 0.00 kgf/cm2 ok
τm = S/(b*j*d) 0.000 kgf/cm2 ok
p=As/(b*d) 0.00204
k={(n*p)^2+2*n*p}^0.5 - n*p 0.26759
j= 1-k/3 0.91080



b= 125 cm
d= 241 cm
n= 24

(b) Tensile Bar & Compressive Bar

Mf 0.000 tf.m
S 0.000 tf
σc = Mf/(b*d^2*Lc) 0.00 kgf/cm2 ok
σs = n*σc*(1-k)/k 0.00 kgf/cm2 ok
σs' = n*σc*(k-d2/d)/k 0.00 kgf/cm2 ok
τm = S/(b*j*d) 0.000 kgf/cm2 ok
p=As/(bd) 0.002037
p'=As'/(bd) 0.002037
k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p') 0.229839
Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d) 0.154999
j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3) 0.946251



b= 125 cm
d2= 0 cm
d= 241 cm
n= 24

5 Calculation of Required Reinforcement Bar as Column, Seismic Condition

1) Minimum Area as Column — **Case I**

Acmin = N/(0.008σsa+σca) — Acmin = 2026.929 cm2

where, σsa — Allowable stress of Reinforcement bar 2775 kgf/m2
σca — Allowable stress of Concrete 90 kgf/m2
N — Axial force 227.421 tf

check: Ac (design) = b*h>Acmin? b*c= 31000 > Acmin ok

2) Cracking Moment

Mc= Zc*(σ'ck + N/Ac) = 29444381 kgf.cm
= 294.444 tf.m

where, Mc — Cracking Moment kgf.cm
Zc — Section Modulus
Zc=b*h2^2/6 1281333.3333 cm3
b= 125 cm
σ'ck — Tensile strength of Concrete (bending)
σ'ck = 0.5*σck^(2/3) 15.643 kgf/cm2
σ ck= 175 kgf/cm2
N — Axial force 227.421 tf
Ac — Area of Concrete = b*h2 31000 cm2
h — thickness of section 248 cm

Minimum Reifircement Bar
(a) As a beam — As min = b(m)*4.5 cm2 — As min= 5.63 cm2
(b) As a column — As min=0.008*Ac min — As min= 16.22 cm2

Maximum Reinforcement Bar
(a) As a beam — As max = 0.002*b*d — As max= 602.50 cm2
(b) As a column — As max = 0.006*Ac — As max= 1860.00 cm2

3) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf = 373.321 tf.m

Check Mf & Mc — 1.7*Mf>Mc?, if yes check ultimate bending moment

1.7*Mf = 634.646 tf.m

Mc = 294.444 tf.m

1.7*Mf>Mc? — yes, check ultimate bending moment — yes, check u

4) Checking of Required Reinforcement Bar — *Compute under eccentric load condition*

As={[σc*(s/2)-N/(b*d)]/σsa}*b*d — As= 23.632 cm2

where,

σc	Stress of concrete	σc=	68.619	kg.cm2
	solve the equation Eq1 below			
	Eq1 = σc^3 + [3*σsa/(2*n)-3*Ms/(b*d^2)]*σc^2 - 6*Ms/(n*b*d^2)*σsa*σc - 3*Ms/(n^2*b*d^2)*σsa^2 = 0			
σsa	Allowable stress of Reinforcement Bar	σsa =	2775	kg.cm2
Ms	Eccentric Moment, Ms=N(e+c)	Ms=	63940416.792	kgf.cm
e	Essentric Distance e=M/N	e=	164.154	cm
M	Bending Moment	M=	373.321	tf.m
N	Axial Force	N=	227.421	tf
n	Young's Modulus Ratio	n=	16	
c	c=h/2 - d1	c=	117.0	cm
h	Height of Section	h=	248.0	cm
b	Width of section	b=	125.0	cm
d1	Concrete Cover	d1=	7.0	cm
d	Effective Width of section d=h-d1	d=	241.0	cm
s	s=n*σc/(n*σc+σsa)	s=	0.283	

[3*σsa/(2*n)-3*Ms/(b*d^2)]= 233.74

6*Ms/(n*b*d^2)*σsa= 9164.86

3*Ms/(n^2*b*d^2)*σsa^2= 794765

σc (trial)= 68.61883 — σc (trial)= 95.804976

Eq1 (trial)= -2.212E-09 ok — Eq1 (trial)= -0.0005851

cross check 0 ok — cross check -0.0005851

5) Ultimate Bending Moment

Mu=c*(h/2-0.4X)+Ts'(h/2-d2)+Ts(h/2-d1)

Mu=min(Mu1,Mu2) — Mu= 45176618 kgf.cm = 451.766 tf.m

			in case X>0		in case X<0	
where,		Mu1=	45176618.289	Mu2=	47430846	
Mu	Ultimate Bending Moment (tf.m)					
c	0.68*σck*b*X	c=	247942	c=	-291.78	c=
σck	design strength of Concrete	σck=	175 kg/cm2			
b	Width of section	b=	125 cm			
X	solve the equation Eq2 below	X=	16.668	X=	-2.452	
Ts'	As'*Es*εcu*(X-d2)/X	Ts'=	50374.981	Ts'=	###	
As'	Compressive Bar As'=0.5 As	As'=	11.816			
As	Required Reinforcement Bar (Tensile)	As=	23.632			
Es	Young's modulus (reinforcement bar)	Es=	**2100000**			
εcu	Creep strain coefficient (concrete)	εcu=	**0.0035**			
h	Height of Section	h=	248 cm			
d1	Concrete Cover (tensile side)	d1=	7 cm			
d2	Concrete Cover (compressive side)	d2=	7 cm			

Equation Eq2

α*X^2 + (β-Ts-N)*X-β*d2=0

α	0.68*σck*b	α=	14875	
β	As'*Es*εcu	β=	86847	
Ts	As*σsy	Ts=	70896	
σsy	Yielding point of Tensile Bar	σsy=	3000 kgf/cm2	(Spec >295 N/mm2)
N	Axial Force	N=	227421 kgf	

put a,b,c as follows — a= α = 14875; b= β-Ts-N = -211470; c= - β*d2 = -607929

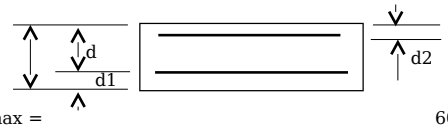
then, X= (-b+(b^2-4ac)^0.2)/(2*a) — X= 16.668

X= (-b-(b^2-4ac)^0.2)/(2*a) — X= -2.452

Check Mc & Mu — Mu= 451.766 tf.m; Mc= 294.444 tf.m

Mu>Mc ? — ok

6) Bar Arrangement



Max Bar Area As max = 602.50 cm2

Min Bar Area As min = 16.22 cm2

(a) Tensile Bar

Required Bar Area	As req=				23.632	cm2	
Apply ϕ =		**25**	@	**100**	mm	**25**	@
Column width	b=			125	cm2		
Bar Area	As =			61.359	cm2	ok	

(b) Compressive Bar

Required Bar Area	As' req=				11.816	cm2		
Apply ϕ =		**25**	@		**100**	mm	**25**	@
Column width	b=				125	cm2		
Bar Area	As' =				61.359	cm2	ok	

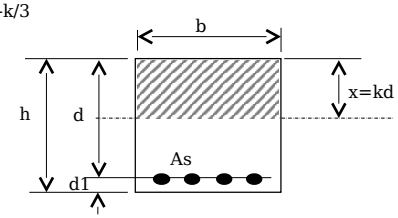
(c) Hoop Bar

Minimum Diameter	ϕ' min =		12	mm
Apply	ϕ' =		**16**	mm
Bar Interval shall satisfy the following conditions:				
	<=	d =	2410	mm
Bar Interval: t mm	<=	12*ϕ =	300	mm
	<=	48*ϕ '	768	mm
then		t =	**200**	mm ok

7) Checking of Allowable Stress, Seismic Condition

(a) Tensile Bar Only

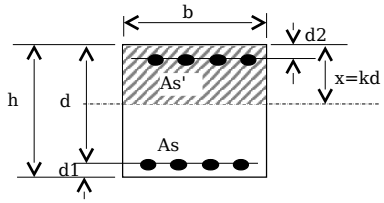
Mf			373.321	tf.m
S			42.768	tf
σs =	Mf/(As*j*d)		2729.04	kgf/cm2 ok
σc =	2*Mf/(k*j*b*d^2)		49.46	kgf/cm2 ok
τm =	S/(b*j*d)		1.535	kgf/cm2 ok
	p=As/(b*d)		0.00204	
	k={(n*p)^2+2*n*p}^0.5 - n*p		0.22478	
	j= 1-k/3		0.92507	



b=	125	cm
d=	241	cm
n=	16	

(b) Tensile Bar & Compressive Bar

Mf			373.321	tf.m
S			42.768	tf
σc =	Mf/(b*d^2*Lc)		42.41	kgf/cm2 ok
σs =	n*σc*(1-k)/k		2682.88	kgf/cm2 ok
σs' =	n*σc*(k-d2/d)/k		580.98	kgf/cm2 ok
τm =	S/(b*j*d)		1.509	kgf/cm2 ok
	p=As/(bd)		0.00204	
	p'=As'/(bd)		0.00204	
	k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')		0.20188	
	Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)		0.12124	
	j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)		0.940989	



b=	125	cm
d2=	7	cm
d=	241	cm
n=	16	

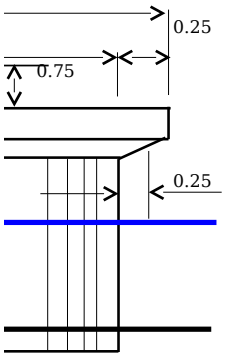
7 Check for stress of concrete and reinforcement bar

			Case I Normal	Case I Seismic
Height of section	h	cm	248	248
Effective width	b	cm	125	125
Concrete cover	d'	cm	7	7
Reinforcement bar	As	cm2	61.36	61.36
	As'	cm2	61.36	61.36
Morment	M	kgf cm	0	37332115
Axcis force	N	kgf	360801	227421
Shearing force	S	kgf	0	42768
Yong modulu ratio	n		24	16
	c		117.000	117.000
	e		0.000	164.154
	a1		-372.000	120.462
	b1		0.104	15471.310
	c1		-1935262	-3208620
	x		385.0524202	91.793196
			-7.357309E-05	2.0172E-06
			ok	ok
	a2		24065.776	5737.075
	b2		-4.351	93.402
	b3		447.469	1251.355
	b4		378.052	84.793
	b5		447.469	1251.355
	b6		-144.052	149.207
	σc		0.00 ok	45.05 ok
	σs		0.00 ok	1171.65 ok
	σs'		0.00 ok	665.84 ok
	τc		0.000 ok	1.509 ok

SUMMARY OF DESIGN CALCULATION, PIER BODY

Description			Abbr.	unit	Case I Normal Condition	Seismic Condition
Calculation Condition					Rectangular Beam	Column
Principle Dimensions						
Concrete Design Strength			σc	kgf/m2	**175**	**175**
Effective width of section, Bw			b	cm	125	125
Height of Section			h	cm	248	248
Concrete Cover (tensile)			d1	cm	**7**	**7**
Concrete Cover (compressive)			d2	cm	-	-
Effective height of Section			d	cm	241	241
Allowable Stress		Concrete	σca	kgf/m2	**60**	**90**
		Re-Bar	σsa	kgf/m2	**1850**	**2775**
		Shearing	τma	kgf/m2	**5.5**	**8.25**
Yielding Point of Reinforcement Bar			σsy	kgf/cm2	**3000**	**3000**
Reinforcement Bar						
Tensile Bar	Required		As req.	cm2	0.00	23.64
	Designed		As	cm2	61.36 D25@100	61.36 D25@100
Compressive Bar	Required		As' req.	cm2	0.00	11.82
	Designed		As'	cm2	61.36 D25@100	61.36 D25@100
Hoop Bar	Designed		Aso			D16@200
Design Load						
Design Bending Moment			Mf	tf.m	0.000	373.321
Design Axis Force			Nd	tf	360.801	227.421
Shearing Force			S	tf	0.000	42.768
Checking of Minimum Re-Bar						
Cracking Moment			Mc	tf.m	349.574	294.444
1.7*Mf					0.000	634.646
1.7*Mf < Mc ? If no, check Mu					ok	check Mu
Ultimate Bending Moment			Mu	tf.m		451.766
Mu > Mc ?						ok
Max Re-bar			As max	cm2	602.50	602.50
Min Re-bar			As min	cm2	5.63	16.22
Required Bar			As req.	cm2	0.00	35.46
Area of Re-bar for Design			As	cm2	122.72	122.72
Checking of Allowable Stress as Rectangular Beam						
Young's Modulus Ratio			n		24	16
Effective height			d	cm	241	241
Compressive Stress			σc	kgf/cm2	0.00 ok	
Bending Tensile Stress			σs	kgf/cm2	0.00 ok	
			σs'	kgf/cm2	-	
Mean Shearing Stress			τm	kgf/cm2	0.000 ok	
Checking of Allowable Stress as Column						
Compressive Stress			σc	kgf/cm2	0.00 ok	45.05 ok
Bending Stress			σs	kgf/cm2	0.00 ok	1171.65 ok
			σs'	kgf/cm2	0.00 ok	665.84 ok
Shearing Stress			τm	kgf/cm2	0.000 ok	1.509 ok

› bridge axis)



Case II-2	
Distance Y m	Moment My t.m
11.550	296.349
5.662	86.517
5.300	9.699
	392.565

3.1022 m⁴

3.1022 m⁴

Case II

17619668	kgf.cm/m
176	tf.m/m
	kgf.cm
645833	cm3
16	kgf/cm2
360801	kgf
31000	cm2
125	cm
248	cm
0.000	tf.m/m
0.000	tf.m
176.197	tf.m

to check ultimate bending moment

0	kgf.cm	
0.000	tf.m	
	tf.m	
	cm2	
3000	kgf/cm2	(Spec >295 N/mm2)
118	cm	
175	kgf/cm2	
248	cm	
0.000	cm2	
1850	kgf/cm2	
0.854		
24		
60	kgf/cm2	
0.000	tf.m	
176.197	tf.m	

ot applicable

38727010	kgf.cm
387.270	tf.m
12.8436	
0.4377	
30.8333	
1850	kgf/cm2
60	kgf/cm2
24	
387.270	tf.m
0.000	tf.m

esign Tensile Bar Only

585.28	cm2
11.16	cm2
0	cm2
100	mm
24.800	nos

cm2 ok

26574672	kgf.cm
265.747	tf.m
121.735	
1850	
118	
0	

0.000	tf.m		
0.000	cm2		
387.270	tf.m		
0.000	tf.m		
118	cm		
0	cm		
1850	kgf/cm2		
0	cm2		
@		100	mm
121.737	cm2		ok

0.000	tf.m	
0.000	tf	
0.00	kgf/cm2	ok
0.00	kgf/cm2	ok
0.000	kgf/cm2	ok
0.00416		
0.35803		
0.88066		
248	cm	
118	cm	
24		

0.000	tf.m	
0.000	tf	
0.00	kgf/cm2	ok
0.00	kgf/cm2	ok
0.00	kgf/cm2	ok
0.000	kgf/cm2	ok
0.004160		
0.004160		
0.289760		
0.230725		
0.942818		
248	cm	
0	cm	
118	cm	
24		

Case II

2026.929	cm2		
2775	kgf/m2		
90	kgf/m2		
227.421	tf		
31000	>	Acmin	ok

14840918	kgf.cm	
148.409	tf.m	
	kgf.cm	
645833.33	cm3	
248	cm	
15.643	kgf/cm2	
175	kgf/cm2	
227.421	tf	
31000	cm2	
125	cm	

As min=	11.16	cm2
As min=	16.22	cm2
As max=	585.28	cm2
As max=	1860.00	cm2

392.565 tf.m

667.360 tf.m
148.409 tf.m
ıltimate bending moment

97.798 cm2

95.805 kg.cm2

2775 kg.cm2
51878346 kgf.cm
172.616 cm
392.565 tf.m
227.421 tf
16
55.5 cm
125.0 cm
248.0 cm
7.0 cm
118.0 cm
0.356

215.09
15633.80
1355744

ok
ok

48749237 kgf.cm
487.492 tf.m
in case X>0 in case X<0
48749237 Mu2= 56434654

364889 c= -820.49
175 kg/cm2
248 cm
12.364 X= -6.895
155927 Ts'= 724297
48.899
97.798
2100000
0.0035
125 cm
7 cm
7 cm

29512
359408
293394
3000 kgf/cm2 (Spec >295 N/mm2)
227421 kgf
α = 29512
β-Ts-N = -161408
- β*d2 = -2515858

12.364
-6.895

487.492 tf.m
148.409 tf.m
ok

585.28 cm2
16.22 cm2

97.798 cm2
100 mm
248 cm2
121.737 cm2 ok

48.899	cm2	
100	mm	
248	cm2	
121.737	cm2	ok
12	mm	
16	mm	
1180	mm	
300	mm	
768	mm	
200	mm	ok
392.565	tf.m	
42.768	tf	
3041.30	kgf/cm2	check
83.15	kgf/cm2	ok
1.626	kgf/cm2	ok
0.00416		
0.30432		
0.89856		
248	cm	
118	cm	
16		
392.565	tf.m	
42.768	tf	
67.06	kgf/cm2	ok
2971.31	kgf/cm2	check
833.02	kgf/cm2	ok
1.589	kgf/cm2	ok
0.00416		
0.00416		
0.26530		
0.16953		
0.919729		
248	cm	
7	cm	
118	cm	
16		

Case II

Normal		Seismic	
125		125	
248		248	
7		7	
121.74		121.74	
121.74		121.74	
0		39256459	
360801		227421	
0		42768	
24		16	
55.500		55.500	
0.000		172.616	
-187.500		330.347	
0.106		16268.919	
-435473		-1307130	
198.54629		41.32691	
8.2655E-08		9.1735E-08	
ok		ok	
24619.740		5124.537	
-3.682		48.724	
816.725		2615.853	
191.546		34.327	
816.725		2615.853	
-80.546		76.673	
0.00	ok	72.69	ok
0.00	ok	2157.78	ok
0.00	ok	966.05	ok
0.000	ok	1.589	ok

Case II

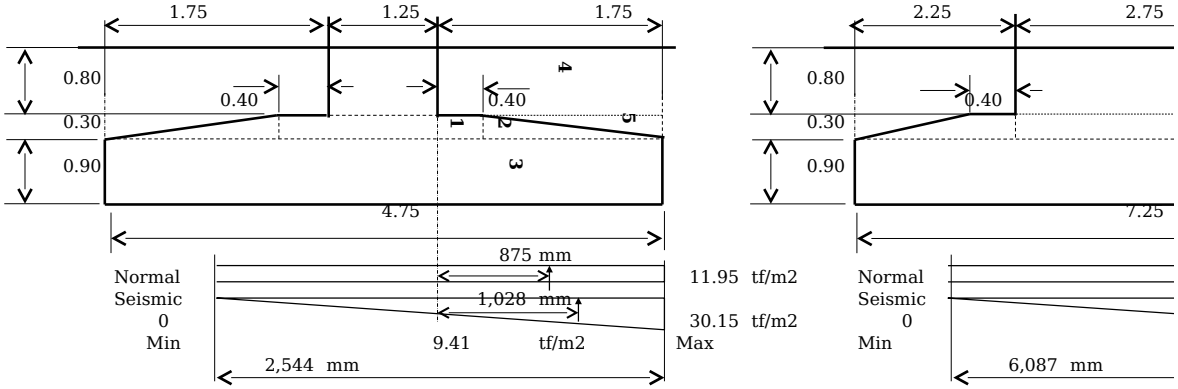
Normal Condition		Seismic Condition	
Rectangular Beam		Column	
175		**175**	
248		248	
125		125	
7		**7**	
-		-	
118		118	
60		**90**	
1850		**2775**	
5.5		**8.25**	
3000		**3000**	
0.00		97.80	
121.74	D25@100	121.74	D25@100
0.00		48.90	
121.74	D25@100	121.74	D25@100
			D16@200
0.000		392.565	
360.801		227.421	
0.000		42.768	
176.197		148.409	
0.000		667.360	
ok		check Mu	
		487.492	
		ok	
585.28		585.28	
11.16		16.22	
0.00		146.70	
243.48		243.48	
24		16	
118		118	
0.00	ok		
0.00	ok		
-			
0.000	ok		
0.00	ok	72.69	ok
0.00	ok	2157.78	ok
0.00	ok	966.05	ok
0.000	ok	1.589	ok

STRUCTURAL CALCULATION, FOOTING

1 Load and Bending Moment of Footing

1) Computation Conditions

Case 1 (parallel to bridge axis) **Case II (perpendicular t**



Dimensions

HT	ho	H3	H4	B4	B5	B6	BT	W4	W5	W6
12.00	0.80	0.30	0.90	1.75	1.25	0.40	4.75	2.25	2.75	0.40

Unit Weight of Material			
Soil	1800	kgf/m3	1.80 tf/m3
Concrete	2400	kgf/m3	2.40 tf/m3
Surcharge Load q	0	kgf/m3	0.00 tf/m3
q'= q seismic	0	kgf/m3	0 tf/m3

2) Load

Case I width = 7.25 m

	No.	Volume m3	unit weight tf/m3	Vertical Load tf	Distance X m	Moment Mx tf.m
Body	1	0.426	2.40	1.022	0.200	0.204
	2	1.218	2.40	2.924	0.850	2.485
	3	11.419	2.40	27.405	0.875	23.979
	sub-total			31.351		26.669
Soil	4	10.150	2.00	20.300	0.875	17.763
	5	1.468	2.00	2.936	1.300	3.817
	sub-total			23.236		21.580
	Total			54.588		48.249
	Distance *l1*		*l1* (X)	0.884 m		

Case II

No.	Volume m3	Vertical Load tf
1	0.246	0.590
2	1.637	3.929
3	9.619	23.085
		27.605
4	8.550	17.100
5	1.318	2.636
sub-total		19.736
		47.341
Distance *l1*		*l1* (X)

Buoyancy u

Volume under water level Vo

Vo = 12.6875 x 2.00

= **25.38 m3**

Volume under water level Vo

Vo = 10.6875 x

= **21.38 m3**

Shearing force

S1 = 54.588 - 25.38

= **29.208 tf**

S1 = 47.341 -

= **25.961 tf**

Morment

M1 = 48.249 - 25.380 x 0.875

= **26.04 tf m**

M1 = 53.627 -

= **29.57 tf m**

3) Reaction from Foundation

Reaction from the Foundation				
Normal	Case 1-1	Q	11.95	tf/m2
	Case II-1	Q	11.95	tf/m2
Seismic	Case I- 2	Qmax	30.15	tf/m2
		Qmin	9.41	tf/m2
	Case II-2	Qmax	19.24	tf/m2
		Qmin	12.13	tf/m2

Reaction from Foundation,

Normal Condition

Rat= Q Rat= 11.95 tf/m2 Cantilever length =B4=

Seismic Condition

Case 2-1

Reat= Q Reat= 30.15 tf/m2 Cantilever length =B4=

Rea't= Q*(X-B4)/X Reat'= 9.41 tf/m2

Rmean = (Reat+Rea't) / 2 Rmean = 19.78 tf/m2

Case 2-2

Reat= Q Reat= 19.24 tf/m2 Cantilever length =W4=

Rea't= Q*(X-B4)/X Reat'= 12.13 tf/m2

Rmean = (Reat+Rea't) / 2 Rmean = 15.68 tf/m2

4) Intersectional Force due Reaction

Normal condtion
Case I

Shearing force	S1 =	11.950	x	1.75	x	7.25	=	151.616 tf
Morment	M1 =	151.616	x	0.88			=	132.664 tf m

Seismic condition
Case I-2

Shearing force	S2-1 =	19.782	x	1.75	x	7.25	=	250.980 tf
Morment	M2-1 =	250.980	x	1.03			=	257.975 tf m

Case II-2

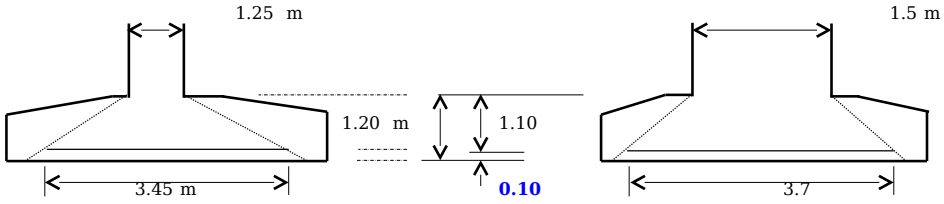
Shearing force	S2-2 =	15.683	x	2.25	x	4.75	=	167.608 tf
Morment	M2-2 =	167.608	x	1.21			=	202.810 tf m

	Normal Condition				Normal Condition			
	Case 1-1				*Case II-1*			
	(up)		*(down)*		*(up)*		*(down)*	
Description	Moment M (tf.m/m)	Shearing S (tf/m)	Moment M (tf.m/m)	Shearing S (tf/m)	Moment M (tf.m/m)	Shearing S (tf/m)	Moment M (tf.m/m)	Shearing S (tf/m)
Buoyancy	-26.041	-29.208	-26.041	-29.208	-29.574	-25.961	-29.574	-25.961
Reaction	132.664	151.616			132.664	151.616		
Total	106.622	122.408	-26.041	-29.208	103.089	125.655	-29.574	-25.961

	Seismic condition				Seismic condition			
	Case I-2				*Case II-2*			
	(up)		*(down)*		*(up)*		*(down)*	
Description	Moment Ms (tf.m/m)	Shearing Ss (tf/m)	Moment M (tf.m/m)	Shearing S (tf/m)	Moment Ms (tf.m/m)	Shearing Ss (tf/m)	Moment Ms (tf.m/m)	Shearing Ss (tf/m)
Buoyancy	-26.041	-29.208	-26.041	-29.208	-29.574	-25.961	-29.574	-25.961
Reaction	257.975	250.980			202.810	167.608		
Total	231.934	221.772	-26.041	-29.208	173.235	141.647	-29.574	-25.961

5) Effective width

Case 1 **Case II**



Normal condition

Case I-1
Lower reinforcement bar

Mo = 4.750/3.450 x 106.622 = 146.799 tf m

So = 4.750/3.450 x 122.408 = 168.533 tf

Upper reinforcementbar

Mo = 4.750/1.250 x 26.041 = 98.958 tf m

So = 4.750/1.250 x 29.208 = 110.989 tf

Case II-1
Lower reinforcement bar

Mo = 7.250/3.700 x

So = 7.250/3.700 x

Upper reinforcementbar

Mo = 7.250/1.500 x

So = 7.250/1.500 x

Seismic condition

Case I-2
Lower reinforcement bar

Mo = 4.750/3.450 x 231.934 = 319.329 tf m

So = 4.750/3.450 x 221.772 = 305.338 tf

Upper reinforcementbar

Mo = 4.750/1.250 x 26.041 = 98.958 tf m

So = 4.750/1.250 x 29.208 = 110.989 tf

Case II-2
Lower reinforcement bar

Mo = 7.250/3.700 x

So = 7.250/3.700 x

Upper reinforcementbar

Mo = 7.250/1.500 x

So = 7.250/1.500 x

5) Intersectional Force due Reaction

Axial Force = 0 tf/m

Description	Case I (lower) Normal Condition Moment M (tf.m/m)	Shearing S (tf/m)	Seismic Condition Moment Ms (tf.m/m)	Shearing Ss (tf/m)	Case 1 (up Normal Condition Moment M (tf.m/m)	Shearing S (tf/m)
Total	**146.799**	**168.533**	**319.329**	**305.338**	**98.958**	**110.989**

Description	Case II (lower) Normal Condition Moment M (tf.m/m)	Shearing S (tf/m)	Seismic Condition Moment Ms (tf.m/m)	Shearing Ss (tf/m)	Case I (upp Normal Condition Moment M (tf.m/m)	Shearing S (tf/m)
Total	**201.999**	**246.215**	**339.448**	**277.552**	**142.943**	**125.478**

same as

2 Calculation of Required Reinforcement Bar (Case 1, Lower and Lower, Normal condition)

1) Cracking Moment

					Case I-1 Lower	Upper	Lower
Mc=	Zc*(σ'ck + N/Ac)		Mc=	kgf.cm/m	70590445	70590445	164450316
				tf.m/m	705.904	705.904	1644.503
where,	Mc	Cracking Moment		kgf.cm			
	Zc	Section Modulus					
		Zc=b*h1^2/6		cm3	4512500	4512500	10512500
			b=	cm	475	475	725
	σ'ck	Tensile strength of Concrete (bending)					
		σ'ck = 0.5*σck^(2/3)		kgf/cm2	15.643	15.643	15.643
		σ ck=		kgf/cm2	175	175	175
	N	Axial force (=0)		tf	0	0	0
	Ac	Area of Concrete = b*h1		cm2	57000	57000	87000
	h1	thickness of section, H4		cm	120	120	120

2) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf = max(M,Me)			tf.m/m	146.799	98.958	201.999
Check Mf & Mc	**1.7*Mf>Mc?, if "Yes", check ultimate bending moment, if "No", no need to check ultimate bendin**					
	1.7*Mf =		tf.m	249.558	168.228	343.398
	Mc=		tf.m	705.904	705.904	1644.503
		1.7*Mf>Mc?		No	No	No

3) Ultimate Bending Moment

Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]}			kgf.cm	27417246	18596113	37788454
			tf.m	274.172	185.961	377.885
where, Mu	Ultimate Bending Moment		tf.m			
As	Area of Tensile Bar		cm2			
σ sy	Yielding point of Tensile Bar		kgf/cm2	3000	3000	3000
d	Effective height = h1-cover		cm	110	114	110
	cover d1=		cm	10	6	10
	h1=		cm	120	120	120
σ'ck	Design Compressive Strength of Concrete					
			kgf/cm2	175	175	175
b	Effective Width		cm	475	475	725
	As=Mf/(σ sa*j*d)		cm2	84.459	54.937	116.218
	σ sa= Allowable Stress Rbar					
			kgf/cm2	1850	1850	1850
j= 1 -k/3	(=8/9)			0.854	0.854	0.854
or	k = n/{n+σ sa/σ ca)					
	n= Young's modulus ratio			24	24	24
	σ ca Allowable Stress Concrete kgf/cm2			60	60	60
Check Mu & Mc	Mu =		tf.m	274.172	185.961	377.885
	Mc =		tf.m	705.904	705.904	1644.503
		Mu>Mc?		not applicable	not applicable	not applicabl

4) Bar Arrangement

Checking of Single or Double bar arrangement

M1= (d/Cs)^2*σsa*b >Mf?		M1=	kgf.cm/m	64458063	69231156	98383359
		=	tf.m/m	644.581	692.312	983.834
where, M1	Resistance moment					
Cs	={2m/[s*(1-s/3)]}^(1/2)			12.8436	12.8436	12.8436
s	(n*σca)/(n*σca+σsa)			0.4377	0.4377	0.4377
m	σsa/σca			30.8333	30.8333	30.8333
σsa			kgf/cm2	1850	1850	1850
σca			kgf/cm2	60	60	60
n				24	24	24
Check M1 & Mf	**M1>Mf?, if "Yes", design tensile bar only, if "No", design tensile + compressive bars.**					
	M1=		tf.m	644.581	692.312	983.834
	Mf=		tf.m	146.799	98.958	0.000
		M1 > Mf?		Yes	Yes	Yes

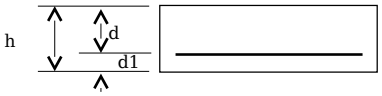
(a) Tensile Bar

Max Bar Area As max =	0.02*b*d =	cm2	1045.0		1083.0		1595.0	
Min Bar Area As min =	b*4.5%=	cm2	21.4		21.4		32.6	
Required Bar Area	As req=	cm2	84.459		54.937		116.218	
Apply ϕ =			22		22		22	
	@	mm	150		300		150	
Required Bar Nos	Nos=b/pitch =	nos	31.667		15.833		48.333	
Bar Area	As =	cm2	120.375	ok	60.188	ok	183.731	
Mrs=σsa*As2(d-d2)	Mrs=	kgf.cm	24495631		12692430		37388068	
	=	tf.m	244.956		126.924		373.881	

where, Mrs Resistance Moment by tensile bar As2

As2= As-As1=As - M1/{σsa*(1-s/3)*d}

As2=	120.372	60.182	183.725
σsa=	1850	1850	1850
d=	110	114	110
d2=	0	0	0

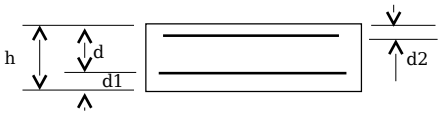


(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2)

As' = M'/[σsa*(d - d2)]

M'=	tf.m	0.000		0.000		0.000
As'=	cm2	0.000		0.000		0.000
M1=	tf.m	644.581		692.312		983.834
Mf=	tf.m	146.799		98.958		0.000
d=	cm	110		114		110
d2=	cm	0		0		0
σsa=	kgf/cm2	1850		1850		1850
As' req=	cm2	0.000		0.000		0.000
Apply ϕ =	mm	22		22		22
@	mm	300		150		300
As' =	cm2	60.188	ok	120.375	ok	91.865

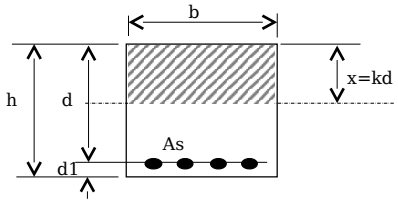


5) Checking of Allowable Stress

(a) Tensile Bar Only

Mf				tf.m/m	146.799		98.958		201.999
S	max(S,Ss)			tf/m	168.533		110.989		246.215
σs =	Mf/(As*j*d)	kgf/cm2	check σs < σsa ?		1223.59	ok	1548.48	ok	1103.11
σc =	2*Mf/(k*j*b*d^2)	kgf/cm2	check σc < σca ?		20.01	ok	16.72	ok	18.04
τm =	S/(b*j*d)	kgf/cm2	check τm < τa ?		3.560	ok	2.201	ok	3.407
	p=As/(b*d)				0.00230		0.00111		0.00230
	k={(n*p)^2+2*n*p}^0.5 - n*p				0.28182		0.20584		0.28182
	j= 1-k/3				0.90606		0.93139		0.90606

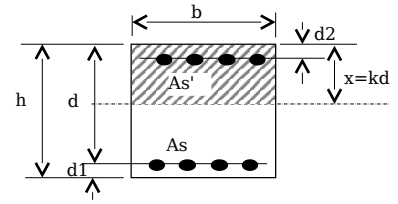
b= cm	475	475	725
d= cm	110	114	110
n=	24	24	24



(b) Tensile Bar & Compressive Bar

Mf				tf.m	146.799		98.958		201.999
S				tf	168.533		110.989		246.215
σc =	Mf/(b*d^2*Lc)	kgf/cm2	check σc < σca ?		17.46	ok	12.23	ok	15.74
σs =	n*σc*(1-k)/k	kgf/cm2	check σs < σsa ?		1193.89	ok	1491.82	ok	1076.33
σs' =	n*σc*(k-d2/d)/k	kgf/cm2	check σs' < σsa ?		419.02	ok	293.56	ok	377.76
τm =	S/(b*j*d)	kgf/cm2	check τm < τa ?		3.474	ok	2.120	ok	3.325
	p=As/(bd)				0.00230		0.00111		0.00230
	p'=As'/(bd)				0.00115		0.00222		0.00115
	k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')				0.25979		0.16442		0.25979
	Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)				0.14629		0.13106		0.14629
	j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)				0.92860		0.96676		0.92860

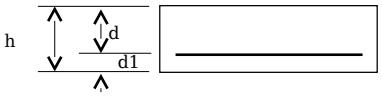
b= cm	475	475	725
d= cm	110	114	110
d2= cm	0	0	0
n=	24	24	24



3 Calculation of Required Reinforcement Bar (Case I, Case II, Lower and upper, Seismic Conditions)

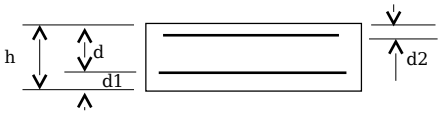
Case I-2

					Lower	**Upper**	**Lower**
1) Cracking Moment							
Mc=	Zc*(σ'ck + N/Ac)		Mc=	kgf.cm/m	58825371	58825371	137041930
				tf.m/m	588.254	588.254	1370.419
where,	Mc	Cracking Moment		kgf.cm			
	Zc	Section Modulus					
		Zc=b*h1^2/6		cm3	3760416.7	3760416.7	8760416.7
		b=		cm	475	475	725
	σ'ck	Tensile strength of Concrete (bending)					
		σ'ck = 0.5*σck^(2/3)		kgf/cm2	15.64	15.64	15.64
		σ ck=		kgf/cm2	175	175	175
	N	Axial force (=0)		tf	0	0	0
	Ac	Area of Concrete = b*h1		cm2	57000	57000	87000
	h1	thickness of section, H4		cm	120	120	120
2) Checking of Cracking Moment and Design Bending Moment							
Design Bending Moment Mf =				tf.m/m	319.329	98.958	339.448
Check Mf & Mc	**1.7*Mf>Mc?, if "Yes", check ultimate bending moment, if "No", no need to check ultimate bendin**						
	1.7*Mf =			tf.m	542.860	168.228	577.061
	Mc=			tf.m	588.254	588.254	1370.419
			1.7*Mf>Mc?		No	No	No
3) Ultimate Bending Moment							
Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]}				kgf.cm	38071026	11993607	40755988
				tf.m	380.710	119.936	407.560
where,							
Mu	Ultimate Bending Moment			tf.m			
As	Area of Tensile Bar			cm2			
σ sy	Yielding point of Tensile Bar			kgf/cm2	3000	3000	3000
d	Effective height = h1-cover			cm	110	114	110
	cover d1=			cm	10	6	10
	h1=			cm	120	120	120
σ'ck	Design Compressive Strength of Concrete			kgf/cm2	175	175	175
b	Effective Width			cm	475	475	725
	As=Mf/(σ sa*j*d)			cm2	118.057	35.301	125.494
	σ sa=	Allowable Stress Rbar		kgf/cm2	2775	2775	2775
	j= 1 -k/3	(=8/9)			0.886	0.886	0.886
	or	k = n/{n+σ sa/σ ca)					
		n= Young's modulus ratio			16	16	16
		σ ca	Allowable Stress Concrete		90	90	90
				kgf/cm2			
Check Mu & Mc		Mu =		tf.m	380.710	119.936	407.560
		Mc =		tf.m	588.254	588.254	1370.419
			Mu>Mc?		not applicable	not applicable	not applicabl
4) Bar Arrangement							
Checking of Single or Double bar arrangement							
M1= (d/Cs)^2*σsa*b >Mf?			M1=	kgf.cm/m	78297777	84095695	119507134
				tf.m/m	782.978	840.957	1195.071
where,	M1	Resistance moment					
	Cs	={2m/[s*(1-s/3)]}^(1/2)			14.2724	14.2724	14.2724
	s	(n*σca)/(n*σca+σsa)			0.3416	0.3416	0.3416
	m	σsa/σca			30.8333	30.8333	30.8333
	σsa			kgf/cm2	2775	2775	2775
	σca			kgf/cm2	90	90	90
	n				16	16	16
Check M1 & Mf	**M1>Mf?, if "Yes", design tensile bar only, if "No", design tensile + compressive bars.**						
		M1=		tf.m	782.978	840.957	1195.071
		Mf=		tf.m	319.329	98.958	339.448
			M1 > Mf?		Yes	Yes	Yes
(a) Tensile Bar							
	Max Bar Area As max =		0.02*b*d =	cm2	1045.0	1083.0	1595.0
	Min Bar Area As min =		b*4.5%=	cm2	21.4	21.4	32.6
	Required Bar Area		As req=	cm2	118.057	35.301	125.494
	Apply ϕ =				22	22	22
				@ mm	150	300	150
	Required Bar Nos		Nos=b/pitch =	nos	31.667	15.833	48.333
	Bar Area		As =	cm2	120.375 ok	60.188 ok	183.731
	Mrs=σsa*As2(d-d2)			Mrs= kgf.cm	36743695	19039423	56082481
				tf.m	367.437	190.394	560.825
	where, Mrs	Resistance Moment by tensile bar As2					
		As2= As-As1=As - M1/{σsa*(1-s/3)*d}			120.372	60.185	183.726
				σsa=	2775	2775	2775
				d=	110	114	110
				d2=	0	0	0



(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2)
As' = M'/[σsa*(d - d2)]



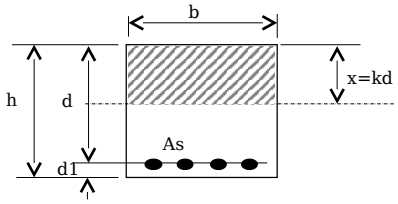
M'=	tf.m	0.000	0.000		0.000
As'=	cm2	0.000	0.000		0.000
M1=	tf.m	782.978	840.957		1195.071
Mf=	tf.m	319.329	98.958		339.448
d=	cm	110	114		110
d2=	cm	0	0		0
σsa=	kgf/cm2	2775	2775		2775
As' req=	cm2	0.000	0.000		0.000
Apply ϕ =		22	22		22
@	mm	300	150		300
As' =	cm2	60.188	ok	120.375	ok 91.865

Required Bar Area
Apply ϕ =
Bar Area

5) Checking of Allowable Stress

(a) Tensile Bar Only

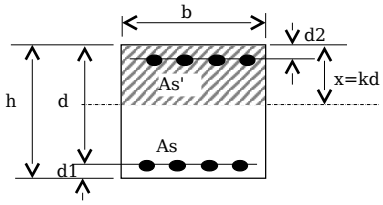
Mf			tf.m/m	319.329		98.958	339.448
S	max(S,Ss)		tf/m	305.338		110.989	277.552
σs =	Mf/(As*j*d)	check σs < σsa ?	kgf/cm2	2618.62	ok	1529.76 ok	1823.74
σc =	2*Mf/(k*j*b*d^2)	check σc < σca ?	kgf/cm2	50.88	ok	19.81 ok	35.43
τm =	S/(b*j*d)	check τm < τa ?	kgf/cm2	6.345	ok	2.174 ok	3.779
	p=As/(b*d)			0.00230		0.00111	0.00230
	k={(n*p)^2+2*n*p}^0.5 - n*p			0.23715		0.17165	0.23715
	j= 1-k/3			0.92095		0.94278	0.92095



b=	cm	475	475	725
d=	cm	110	114	110
n=		16	16	16

(b) Tensile Bar & Compressive Bar

Mf			tf.m	319.329		98.958	339.448
S			tf	305.338		110.989	277.552
σc =	Mf/(b*d^2*Lc)	check σc < σca ?	kgf/cm2	45.87	ok	15.49 ok	31.94
σs =	n*σc*(1-k)/k	check σs < σsa ?	kgf/cm2	2574.86	ok	1489.49 ok	1793.26
σs' =	n*σc*(k-d2/d)/k	check σs' < σsa ?	kgf/cm2	733.88	ok	247.82 ok	511.11
τm =	S/(b*j*d)	check τm < τa ?	kgf/cm2	6.239	ok	2.117 ok	3.716
	p=As/(bd)			0.00230		0.00111	0.00230
	p'=As'/(bd)			0.00115		0.00222	0.00115
	k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')			0.22180		0.14264	0.22180
	Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)			0.12113		0.10350	0.12113
	j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)			0.93660		0.96827	0.93660



b=	cm	475	475	725
d=	cm	110	114	110
d2=	cm	0	0	0
n=		16	16	16

4 Calculation of Required Reinforcement Bar (Upper, Normal Conditions)

1) Cracking Moment

Mc= Zc*(σ'ck + N/Ac) Mc= 58825371 kgf.cm/m = 588.254 tf.m/m

where,
- Mc — Cracking Moment — kgf.cm
- Zc — Section Modulus
  - Zc=b*h1^2/6 — 3760416.7 cm3
  - b= 475 cm
- σ'ck — Tensile strength of Concrete (bending)
  - σ'ck = 0.5*σck^(2/3) — 15.643 kgf/cm2
  - σ ck= 175 kgf/cm2
- N — Axial force (=0) — 0 tf
- Ac — Area of Concrete = b*h1 — 57000 cm2
- h1 — thickness of section, H4 — 120 cm

2) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf = max(M,Me) 98.958 tf.m/m

Check Mf & Mc 1.7*Mf>Mc?, if yes check ultimate bending moment

1.7*Mf = 168.228 tf.m

Mc= 588.254 tf.m 1.7*Mf>Mc? No, no need to check ultimate bend

3) Ultimate Bending Moment

Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]} Mu= 18653068 kgf.cm = 186.531

where, Mu	Ultimate Bending Moment			tf.m	
As	Area of Tensile Bar			cm2	
σ sy	Yielding point of Tensile Bar		3000	kgf/cm2	(Spec >295 N/mm2)
d	Effective height = h1-cover		110	cm	
	cover d1=	10 cm			
	h1=	120 cm			
σ'ck	Design Compressive Strength of Concrete		175	kgf/cm2	
b	Effective Width		725	cm	
	As=Mf/(σ sa*j*d)		56.934	cm2	
	σ sa= Allowable Stress Rbar		1850	kgf/cm2	
	j= 1 -k/3 (=8/9)		0.854		
	or k = n/{n+σ sa/σ ca)				
	n= Young's modulus ratio		24		
	σ ca Allowable Stress Concrete		60	kgf/cm2	

Check Mu & Mc Mu = 186.531 tf.m
Mc = 588.254 tf.m Mu>Mc? not applicable

4) Bar Arrangement

Checking of Single or Double bar arrangement

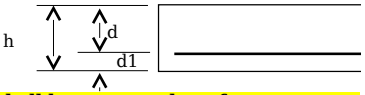
M1= (d/Cs)^2*σsa*b >Mf? M1= 98383359 kgf.cm/m = 983.834 tf.m/m

where, M1	Resistance moment			
Cs	={2m/[s*(1-s/3)]}^(1/2)	12.8436		
s	(n*σca)/(n*σca+σsa)	0.4377		
m	σsa/σca	30.8333		
σsa		1850	kgf/cm2	
σca		60	kgf/cm2	
n		24		

Check M1 > Mf? M1= 983.834 tf.m ***M1>Mf: Design Tensile Bar Only***
Mf= 98.958 tf.m

(a) Tensile Bar

Max Bar Area As max =		0.02*b*d =	1595.0	cm2	
Min Bar Area As min =		b*4.5%=	21.4	cm2	
Required Bar Area	As req=	56.934	cm2		
Apply ϕ =	22 @	150	mm		
Required Bar Nos	Nos=b/pitch =	31.667	nos		
Bar Area	As =	120.375	cm2	ok	



Pitch shall be same as that of toe

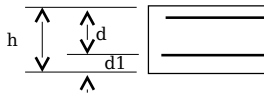
Mrs=σsa*As2(d-d2) Mrs= 24495234 kgf.cm =

where, Mrs Resistance Moment by tensile bar As2
As2= As-As1=As - M1/{σsa*(1-s/3)*d} As2= 120.370 cm2
σsa= 1850 kgf/cm2 d= 110 cm
d2= 0 cm

(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2)
M'= 0.000 tf.m

As' = M'/[σsa*(d - d2)] As'= 0.000 cm2



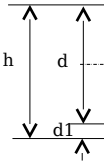
d=	110 cm	M1=	983.834	tf.m
d2=	0 cm	Mf=	98.958	tf.m
σsa=	1850 kgf/cm2			

Required Bar Area	As' req=	0.000	cm2	
Apply ϕ =	22 @	300	mm	
Bar Area	As' =	12.671	cm2	ok

5) Checking of Allowable Stress

(a) Tensile Bar Only

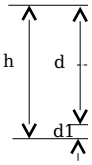
Mf		98.958	tf.m/m		
S	max(S,Ss)	110.989	tf/m		
σs =	Mf/(As*j*d)	810.97	kgf/cm2	check σs < σsa ?	ok
σc =	2*Mf/(k*j*b*d^2)	10.40	kgf/cm2	check σc < σca ?	ok
τm =	S/(b*j*d)	1.510	kgf/cm2	check τm < τa ?	ok



p=As/(b*d)	0.00151	b=	725	cm
k={(n*p)^2+2*n*p}^0.5 - n*p	0.23537	d=	110	cm
j= 1-k/3	0.92154	n=	24	

(b) Tensile Bar & Compressive Bar

Mf		98.958	tf.m		
S		110.989	tf		
σc =	Mf/(b*d^2*Lc)	10.17	kgf/cm2	check σc < σca ?	ok
σs =	n*σc*(1-k)/k	807.85	kgf/cm2	check σs < σsa ?	ok
σs' =	n*σc*(k-d2/d)/k	244.16	kgf/cm2	check σs' < σsa ?	ok
τm =	S/(b*j*d)	1.504	kgf/cm2	check τm < τa ?	ok



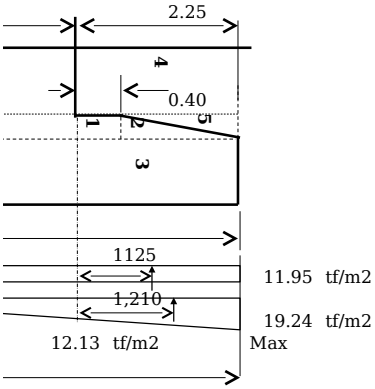
p=As/(bd)	0.00151
p'=As'/(bd)	0.00016
k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')	0.23209
Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)	0.11088
j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)	0.92510

b=	725 cm	d2=	0 cm
d=	110 cm	n=	24

SUMMARY OF DESIGN CALCULATION, FOOTING

Description			Abbr.	unit	Case I				
Calculation Condition					Normal		Seismic		Nor
					Lower	Upper	Lower	Upper	Lower
Principle Dimensions									
Concrete Design Strength			σc	kgf/m2	175	175	175	175	175
Effective width of section			b	cm	475	475	475	475	725
Height of Section, H4			h	cm	120	120	120	120	120
Concrete Cover (tensile)			d1	cm	10	6	10	6	10
Concrete Cover (compressive)			d2	cm	-	-	-	-	-
Effective height of Section			d	cm	110	114	110	114	110
Allowable Stress		Concrete	σca	kgf/m2	60	60	90	90	60
		Re-Bar	σsa	kgf/m2	1850	1850	2775	2775	1850
		Shearing	τa	kgf/m2	5.5	5.5	8.25	8.25	5.5
Yielding Point of Reinforcement Bar			σsy	kgf/cm2	3000	3000	3000	3000	3000
Reinforcement Bar									
Tensile Bar	Required		As req.	cm2	84.46	54.94	118.06	35.30	116.22
	Designed		As	cm2	120.38	60.19	120.38	60.19	183.73
					D22@150	D22@300	D22@150	D22@300	D22@150
Compressive Bar	Required		As' req.	cm2	0.00	0.00	0.00	0.00	0.00
	Designed		As'	cm2	60.19	120.38	60.19	120.38	91.87
					D22@300	D22@150	D22@300	D22@150	D22@300
Design Load									
Design Bending Moment			Mf	tf.m/m	146.80	98.96	319.33	98.96	202.00
Design Axis Force			Nd	tf/m	0.00	0.00	0.00	0.00	0.00
Shearing Force			S	tf/m	168.53	110.99	305.34	110.99	246.22
Checking of Minimum Re-Bar									
Cracking Moment			Mc	tf.m	705.90	705.90	588.25	588.25	1644.50
1.7*Mf					249.56	168.23	542.86	168.23	343.40
1.7*Mf < Mc ? If no, check Mu					ok	ok	ok	ok	ok
Ultimate Bending Moment			Mu	tf.m					
Mu > Mc ?									
Max Re-bar			As max	cm2	1,045.00	1,083.00	1,045.00	1,083.00	1,595.00
Min Re-bar			As min	cm2	21.38	21.38	21.38	21.38	32.63
Required Bar			As req.	cm2	84.46	54.94	118.06	35.30	116.22
Area of Re-bar for Design			As	cm2	180.56	180.56	180.56	180.56	275.60
Checking of Allowable Stress									
Young's Modulus Ratio			n		24	24	16	16	24
Effective height			d	cm	110	114	110	114	110
Compressive Stress			σc	kgf/cm2	20.01	16.72	50.88	19.81	18.04
					ok	ok	ok	ok	ok
Bending Tensile Stress			σs	kgf/cm2	1223.59	1548.48	2618.62	1529.76	1103.11
					ok	ok	ok	ok	ok
			σs'	kgf/cm2	-	-	-	-	-
Mean Shearing Stress			τm	kgf/cm2	3.560	2.120	6.345	2.174	3.407
					ok	ok	ok	ok	ok

o bridge axis)



unit:m

WT
7.25

width = 4.75 m

Distance X m	Moment Mx tf.m
0.200	0.118
1.017	3.995
1.125	25.971
	30.084
1.125	19.238
1.633	4.306
	23.543
	53.627
1.133 m	

2.00

21.38

21.380 x 1.125

1.75 m

1.75 m

2.25 m

103.089	=	201.999	tf m
125.655	=	246.215	tf
29.574	=	142.943	tf m
25.961	=	125.478	tf
173.235	=	339.448	tf m
141.647	=	277.552	tf
29.574	=	142.943	tf m
25.961	=	125.478	tf

per)	
Seismic Condition	
Moment Ms (tf.m/m)	Shearing Ss (tf/m)
98.958	110.989

per)	
Seismic Condition	
Moment Ms (tf.m/m)	Shearing Ss (tf/m)
142.943	125.478

s normal condition

Case II-1

	Upper
	164450316
	1644.503
	10512500
	725
	15.643
	175
	0
	87000
	120
	142.943

ıg moment.

	243.004
	1644.503
	No
	26876794
	268.768
	3000
	114
	6
	120
	175
	725
	79.355
	1850
	0.854
	24
	60
	268.768
	1644.503
e	not applicable

	105668606
	1056.686
	12.8436
	0.4377
	30.8333
	1850
	60
	24
	1056.686
	0.000
	Yes

	1653.0	
	32.6	
	79.355	
	22	
	300	
	24.167	
ok	91.865	ok
	19374414	
	193.744	
	91.865	
	1850	
	114	
	0	
	0.000	
	0.000	
	1056.686	
	0.000	
	114	
	0	
	1850	
	0.000	
	22	
	150	
ok	183.731	ok
	142.943	
	125.478	
ok	1465.47	ok
ok	15.83	ok
ok	1.630	ok
	0.00111	
	0.20584	
	0.93139	
	725	
	114	
	24	
	142.943	
	125.478	
ok	11.58	ok
ok	1411.85	ok
ok	277.82	ok
ok	1.570	ok
	0.00111	
	0.00222	
	0.16442	
	0.13106	
	0.96676	
	725	
	114	
	0	
	24	

Case II-2

	Upper
	137041930
	1370.419
	8760416.7
	725
	15.64
	175
	0
	87000
	120
	142.943
ıg moment.	
	243.004
	1370.419
	No
	17330798
	173.308
	3000
	114
	6
	120
	175
	725
	50.992
	2775
	0.886
	16
	90
	173.308
	1370.419
e	not applicable
	128356588
	1283.566
	14.2724
	0.3416
	30.8333
	2775
	90
	16
	1283.566
	142.943
	Yes
	1653.0
	32.6
	50.992
	22
	300
	24.167
ok	91.865 ok
	29060172
	290.602
	91.861
	2775
	114
	0

	0.000	
	0.000	
	1283.566	
	142.943	
	114	
	0	
	2775	
	0.000	
	22	
	150	
ok	183.731	ok

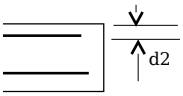
	142.943	
	125.478	
ok	1447.75	ok
ok	18.75	ok
ok	1.610	ok
	0.00111	
	0.17165	
	0.94278	
	725	
	114	
	16	

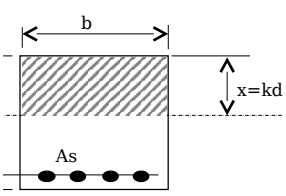
	142.943	
	125.478	
ok	14.66	ok
ok	1409.64	ok
ok	234.53	ok
ok	1.568	ok
	0.00111	
	0.00222	
	0.14264	
	0.10350	
	0.96827	
	725	
	114	
	0	
	16	

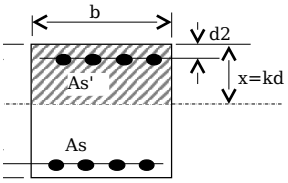
ing moment

tf.m

244.952 tf.m

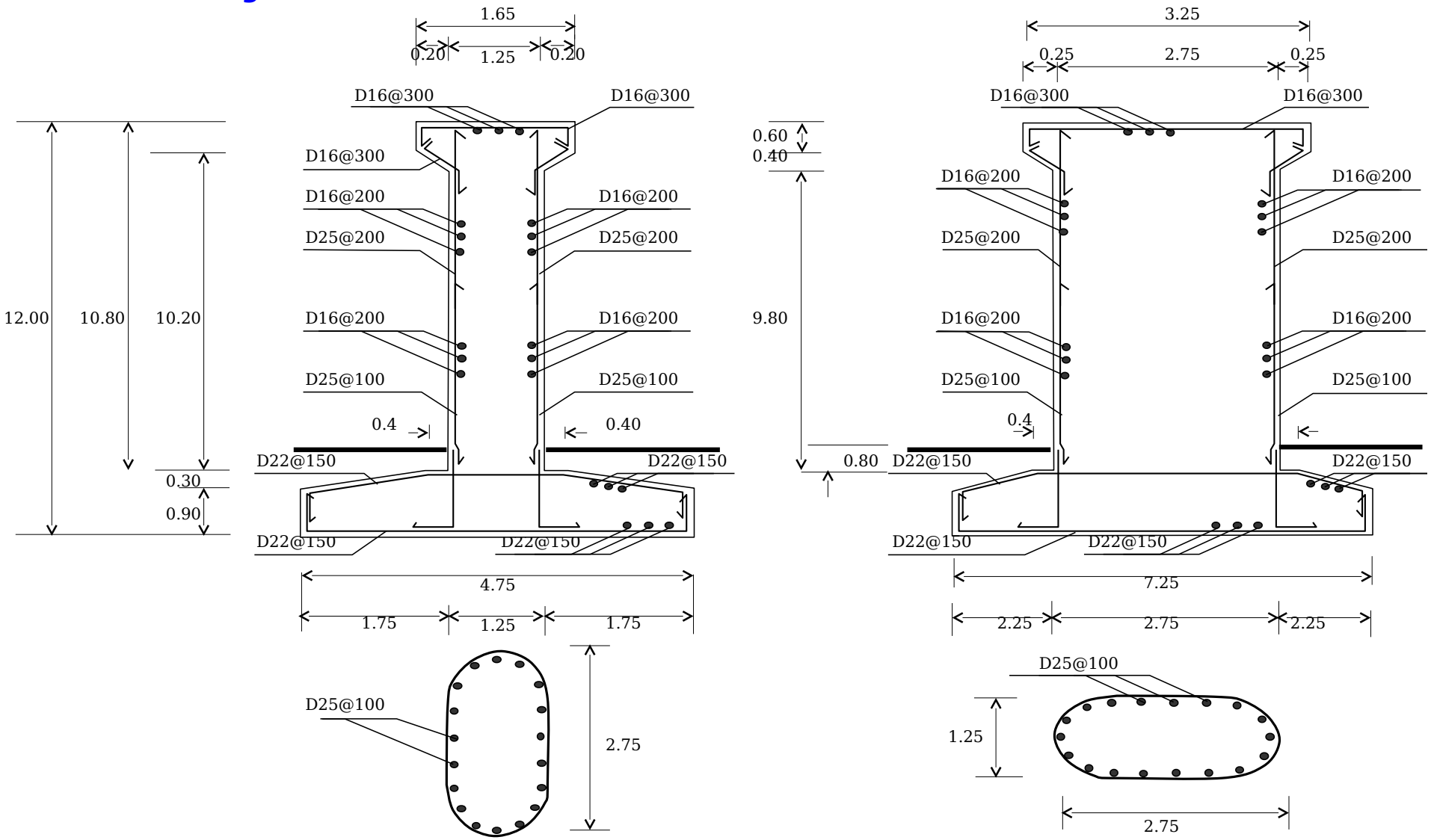


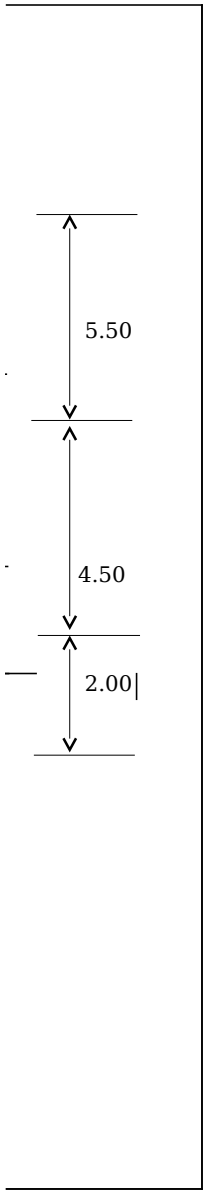




Case II		
mal	Seismic	
Upper	Lower	Upper
175	175	175
725	725	725
120	120	120
6	10	6
-	-	-
114	110	114
60	90	90
1850	2775	2775
5.5	8.25	8.25
3000	3000	3000
79.36	125.49	50.99
91.87	183.73	91.87
D22@300	D22@150	D22@300
0.00	0.00	0.00
183.73	91.87	183.73
D22@150	D22@300	D22@150
142.943	339.448	142.943
0.00	0.00	0.00
125.478	277.552	125.478
1644.50	1370.42	1370.42
243.00	577.06	243.00
ok	ok	ok
1,653.00	1,595.00	1,653.00
32.63	32.63	32.63
79.36	125.49	50.99
275.60	275.60	275.60
24	16	16
114	110	114
15.83	35.43	18.75
ok	ok	ok
1465.47	1823.74	1447.75
ok	ok	ok
-	-	-
1.570	3.779	1.610
ok	ok	ok

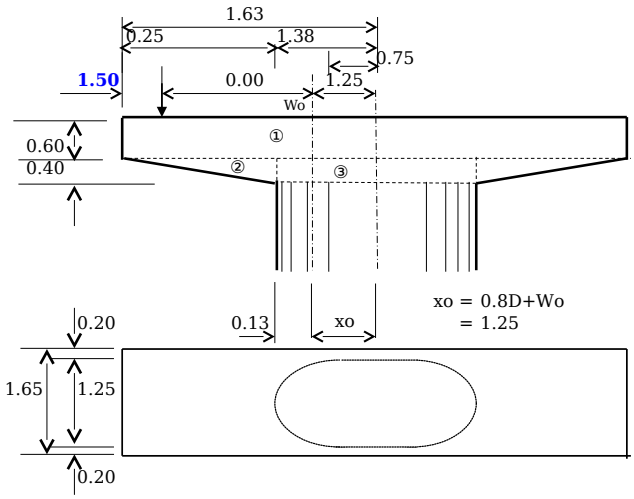
PIER : Bendung ....




5.50
4.50
2.00

STRUCTURAL CALCULATION, BEAM

1 Load and Bending Moment of Abutment Body



Dimensions

Wo	W2	W3	W5	H1	H2
1.38	0.25	0.20	2.75	10.80	10.20

Beam Width Bw= 1.65

Seismic Coefficient soil kh= 0.18

No.	Area m3	unit weight t/m3	Vertical Load t	Distance X m	Moment Mx tf.m/m
1	1.485	2.4	3.564	0.750	2.673
2	0.083	2.4	0.198	1.333	0.264
3	0.083	2.4	0.198	0.063	0.012
Total	1.650		3.96		2.949
l=	0.745				

Refrection R R= 0.0 t
H= 0.0 t

1) Load and Bending Moment (Vertical and Holizontal)

No.	Vertical Load t	Distance X m	Moment Mx tf.m/m	Horizontal Load t/m	Distance X m	Moment Mx tf.m/m
Noramal R	0.000	0.000	0.000	0.000	0.000	0.000
Dead load	3.960	0.745	2.949	0.713	0.745	0.531
Total	3.960		2.949			0.531

2) Intersectional Force due Reaction

Axial Force = 0 tf/m

Description	Upper *Normal Condition* Moment M (tf.m/m)	Upper *Normal Condition* Shearing S (tf/m)	Side *Seismic Condition* Moment Ms (tf.m/m)	Side *Seismic Condition* Shearing Ss (tf/m)
Dead Load, Earth	2.949	3.960	0.531	0.000
Reaction form Foundation	0.000	0.000	0.000	0.713
Total	2.949	3.960	0.531	0.713

2 Calculation of Required Reinforcement Bar (Upper)

1) Cracking Moment

Mc= Zc*(σ'ck + N/Ac) Mc= 7098153 kgf.cm/m = 70.982 tf.m/m

where, Mc Cracking Moment kgf.cm
Zc Section Modulus
Zc=b*h1^2/6 453750 cm3
b= 165 cm
σ'ck Tensile strength of Concrete (bending)
σ'ck = 0.5*σck^(2/3) 15.643 kgf/cm2
σ ck= 175 kgf/cm2
N Axial force (=0) 0 tf
Ac Area of Concrete = b*h1 16500 cm2
h1 thickness of section, H4 100 cm

2) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf = max(M,Me) 2.949 tf.m/m

Normal Condition M = 2.949 tf.m/m
Seismic Condition Me= 0.531 tf.m/m

Check Mf & Mc 1.7*Mf>Mc ?, if yes, check ultimate bending moment
1.7*Mf = 5.014 tf.m
Mc= 70.982 tf.m 1.7*Mf>Mc ? No, no need to check ultimate bending moment

3) Ultimate Bending Moment

Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]} Mu= 559252.64 kgf.cm = 5.593 tf.m

where, Mu	Ultimate Bending Moment		tf.m	
As	Area of Tensile Bar		cm2	
σ sy	Yielding point of Tensile Bar	3000	kgf/cm2	(Spec >295 N/mm2)
d	Effective height = h1-cover	94	cm	
	cover d1= 6 cm			
	h1= 100.0 cm			
σ'ck	Design Compressive Strength of Concrete	175	kgf/cm2	
b	Effective Width	165	cm	
	As=Mf/(σ sa*j*d)	1.986	cm2	
	σ sa= Allowable Stress Rbar	1850	kgf/cm2	
	j= 1 -k/3 (=8/9)	0.854		
	or k = n/{n+σ sa/σ ca)			
	n= Young's modulus ratio	24		
	σ ca Allowable Stress Concrete	60	kgf/cm2	

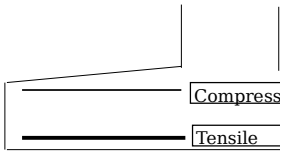
Check Mu & Mc Mu = 5.593 tf.m
Mc = 70.982 tf.m Mu>Mc ? not applicable

4) Bar Arrangement

Checking of Single or Double bar arrangement

M1= (d/Cs)^2*σsa*b >Mf? M1= 16350759 kgf.cm/m = 163.508 tf.m/m

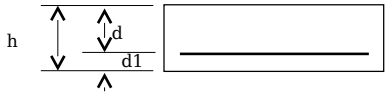
where, M1	Resistance moment		
Cs	={2m/[s*(1-s/3)]}^(1/2)	12.8436	
s	(n*σca)/(n*σca+σsa)	0.4377	
m	σsa/σca	30.8333	
σsa		1850	kgf/cm2
σca		60	kgf/cm2
n		24	



Check M1 > Mf ? M1= 163.508 tf.m ***M1>Mf: Design Tensile Bar Only***
Mf= 2.949 tf.m

(a) Tensile Bar

Max Bar Area	As max =	0.02*b*d =	310.20	cm2	
Min Bar Area	As min =	b*4.5%=	7.43	cm2	
Required Bar Area	As req=	1.986	cm2		
Apply ϕ =	16	@	300	mm	
Required Bar Nos	Nos=b/pitch =	5.5	nos		
Bar Area	As =	11.058	cm2	ok	



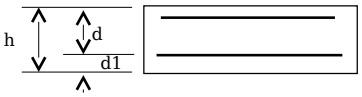
Mrs=σsa*As2(d-d2) Mrs= 1922865.4 kgf.cm = 19.229

where, Mrs Resistance Moment by tensile bar As2
As2= As-As1=As - M1/{σsa*(1-s/3)*d} As2= 11.057 cm2
σsa= 1850 kgf/cm2 d= 94 cm
d2= 0 cm

(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2)
M'= 0.000 tf.m

As' = M'/[σsa*(d - d2)] As'= 0.000 cm2



d=	94	cm	M1=	163.507592	tf.m
d2=	0	cm	Mf=	2.949375	tf.m
σsa=	0	kgf/cm2			

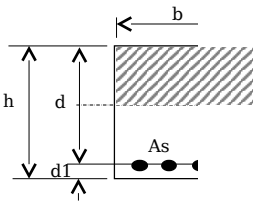
Required Bar Area	As' req=	0.000	cm2	
Apply ϕ =	16	@	300	mm
Bar Area	As' =	11.058	cm2	ok

5) Checking of Allowable Stress

(a) Tensile Bar Only

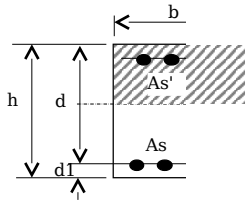
Mf		2.949	tf.m/m		
S	max(S,Ss)	3.960	tf/m		
σs =	Mf/(As*j*d)	300.64	kgf/cm2	check σs < σsa ?	ok
σc =	2*Mf/(k*j*b*d^2)	2.54	kgf/cm2	check σc < σca ?	ok
τm =	S/(b*j*d)	0.271	kgf/cm2	check τm < τa ?	ok

p=As/(b*d)	0.00071	b=	165 cm
k={(n*p)^2+2*n*p}^0.5 - n*p	0.16867	d=	94 cm
j= 1-k/3	0.94378	n=	24



(b) Tensile Bar & Compressive Bar

Mf		2.949 tf.m			
S		3.960 tf			
σc =	Mf/(b*d^2*Lc)	2.24 kgf/cm2	check σc < σca ?	ok	
σs =	n*σc*(1-k)/k	296.16 kgf/cm2	check σs < σsa ?	ok	
σs' =	n*σc*(k-d2/d)/k	53.87 kgf/cm2	check σs' < σsa ?	ok	
τm =	S/(b*j*d)	0.267 kgf/cm2	check τm < τa ?	ok	



p=As/(bd)	0.00071
p'=As'/(bd)	0.00071
k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')	0.15391
Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)	0.09012
j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)	0.95803

b=	165 cm	d2=	0 cm
d=	94 cm	n=	24

3 Calculation of Required Reinforcement Bar (Side)

1) Cracking Moment

Mc= Zc*(σ'ck + N/Ac) Mc= 2607219 kgf.cm/m = 26.072 tf.m/m

where, Mc	Cracking Moment		kgf.cm	
Zc	Section Modulus			
	Zc=b*h1^2/6		166667	cm3
	b=	100 cm		
σ'ck	Tensile strength of Concrete (bending)			
	σ'ck = 0.5*σck^(2/3)		15.643	kgf/cm2
	σ ck=	175 kgf/cm2		
N	Axial force (=0)		0	tf
Ac	Area of Concrete = b*h1		16500	cm2
h1	thickness of section, H4		165	cm

2) Checking of Cracking Moment and Design Bending Moment

Design Bending Moment Mf = 0.531 tf.m/m

Check Mf & Mc 1.7*Mf>Mc ?, if yes, check ultimate bending moment

1.7*Mf = 0.903 tf.m

Mc= 26.072 tf.m 1.7*Mf>Mc ? No, no need to check ultimate bending moment

3) Ultimate Bending Moment

Mu=As*σ sy{d-(1/2)*[As*σ sy]/[0.85*σ ck*b]} Mu= 100782.1 kgf.cm = 1.008 tf.m

where, Mu	Ultimate Bending Moment		tf.m	
As	Area of Tensile Bar		cm2	
σ sy	Yielding point of Tensile Bar		3000 kgf/cm2	(Spec >295 N/mm2)
d	Effective height = h1-cover		159 cm	
	cover d1=	6 cm		
	h1=	165.0 cm		
σ'ck	Design Compressive Strength of Concrete		175 kgf/cm2	
b	Effective Width		100 cm	
	As=Mf/(σ sa*j*d)		0.211 cm2	
	σ sa= Allowable Stress Rbar		1850 kgf/cm2	
	j= 1 -k/3 (=8/9)		0.854	
	or k = n/{n+σ sa/σ ca)			
	n= Young's modulus ratio		24	
	σ ca Allowable Stress Concrete		60 kgf/cm2	

Check Mu & Mc Mu = 1.008 tf.m

Mc = 26.072 tf.m Mu>Mc ? not applicable

4) Bar Arrangement

Checking of Single or Double bar arrangement

M1= (d/Cs)^2*σsa*b >Mf? M1= 28352576 kgf.cm/m = 283.526 tf.m/m

where, M1	Resistance moment		
Cs	={2m/[s*(1-s/3)]}^(1/2)	12.8436	
s	(n*σca)/(n*σca+σsa)	0.4377	
m	σsa/σca	30.8333	
σsa		1850	kgf/cm2
σca		60	kgf/cm2
n		24	

Check M1 > Mf ? M1= 283.526 tf.m ***M1>Mf: Design Tensile Bar Only***

Mf= 0.531 tf.m

(a) Tensile Bar

Max Bar Area	As max =	0.02*b*d =	318.00	cm2	
Min Bar Area	As min =	b*4.5%=	4.50	cm2	
Required Bar Area	As req=	0.211	cm2		
Apply ϕ =	16	@	300	mm	
Required Bar Nos	Nos=b/pitch =	3.33333333	nos		
Bar Area	As =	6.702	cm2	ok	



Pitch shall be same as that of toe

Mrs=σsa*As2(d-d2) Mrs= 1971080.3 kgf.cm = 19.711

where, Mrs = Resistance Moment by tensile bar As2

As2= As-As1=As - M1/{σsa*(1-s/3)*d} As2= 6.701 cm2

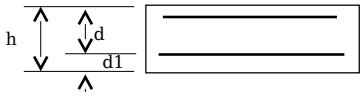
σsa= 1850 kgf/cm2 d= 159 cm

d2= 0 cm

(b) Compressive Bar, in case M1<Mf

M' = Mf - M1=σsa*As'*(d - d2)

M'= 0.00 tf.m



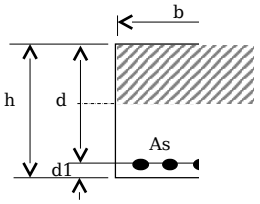
As' = M'/[σsa*(d - d2)] As'= 0.000 cm2

d=	159 cm	M1=	283.526 tf.m
d2=	0 cm	Mf=	0.531 tf.m
σsa=	1850 kgf/cm2		

Required Bar Area	As' req=	0.000	cm2		
Apply ϕ =	16	@	300	mm	
Bar Area	As' =	6.702	cm2	ok	

5) Checking of Allowable Stress

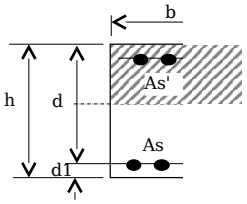
(a) Tensile Bar Only



Mf		0.531	tf.m/m	
S	max(S,Ss)	0.713	tf/m	
σs =	Mf/(As*j*d)	52.12	kgf/cm2	check σs < σsa ? ok
σc =	2*Mf/(k*j*b*d^2)	0.33	kgf/cm2	check σc < σca ? ok
τm =	S/(b*j*d)	0.047	kgf/cm2	check τm < τa ? ok

p=As/(b*d)	0.00042	b=	100 cm
k={(n*p)^2+2*n*p}^0.5 - n*p	0.13248	d=	159 cm
j= 1-k/3	0.95584	n=	24

(b) Tensile Bar & Compressive Bar



Mf		0.531	tf.m	
S		0.713	tf	
σc =	Mf/(b*d^2*Lc)	0.30	kgf/cm2	check σc < σca ? ok
σs =	n*σc*(1-k)/k	51.64	kgf/cm2	check σs < σsa ? ok
σs' =	n*σc*(k-d2/d)/k	7.27	kgf/cm2	check σs' < σsa ? ok
τm =	S/(b*j*d)	0.046	kgf/cm2	check τm < τa ? ok

p=As/(bd)	0.00042
p'=As'/(bd)	0.00042
k={n^2(p+p')^2+2n(p+p'*d2/d)}^05-n(p+p')	0.12344
Lc=(1/2)k(1-k/3)+(np'/k)(k-d2/d)(1-d2/d)	0.06930
j=(1-d2/d)+k^2/{2*n*p*(1-k)}*(d2/d-k/3)	0.96465

b=	100 cm	d2=	0 cm
d=	159 cm	n=	24

SUMMARY OF DESIGN CALCULATION, BEAM

Description			Abbr.	unit	Upper		Side		Remarks
Calculation Condition					Rectangular Beam		Rectangular Beam		
Principle Dimensions									
Concrete Design Strength			σc	kgf/m2	175		175		
Effective width of section			b	cm	165		100		
Height of Section, H4			h	cm	100		165		
Concrete Cover (tensile)			d1	cm	6		6		
Concrete Cover (compressive)			d2	cm	-		-		
Effective height of Section			d	cm	94		159		
Allowable Stress		Concrete	σca	kgf/m2	60		60		(K175)
		Re-Bar	σsa	kgf/m2	1850		1850		
		Shearing	τa	kgf/m2	5.5		5.5		
Yielding Point of Reinforcement Bar			σsy	kgf/cm2	3000		3000		
Reinforcement Bar									
Tensile Bar	Required		As req.	cm2	1.99		0.21		
	Designed		As	cm2	11.06	D16@300	6.70	D16@300	
Compressive Bar	Required		As' req.	cm2	0.00		0.00		
	Designed		As'	cm2	11.06	D16@300	6.70	D16@300	
Design Load									
Design Bending Moment			Mf	tf.m/m	2.949		0.531		
Design Axis Force			Nd	tf/m	0.000		0.000		
Shearing Force			S	tf/m	3.960		0.713		
Checking of Minimum Re-Bar									
Cracking Moment			Mc	tf.m	70.982		26.072		
1.7*Mf					5.014		0.903		
1.7*Mf<Mc ? If no, check Mu					ok		ok		
Ultimate Bending Moment			Mu	tf.m					
Mu>Mc ?									
Max Re-bar			As max	cm2	310.20		318.00		
Min Re-bar			As min	cm2	7.43		4.50		
Required Bar			As req.	cm2	1.99		0.21		
Area of Re-bar for Design			As	cm2	22.12		13.40		
Checking of Allowable Stress									
Young's Modulus Ratio			n		24		24		
Effective height			d	cm	94		159		
Compressive Stress			σc	kgf/cm2	2.54	OK	0.33	OK	
Bending Tensile Stress			σs	kgf/cm2	300.64	OK	52.12	OK	
			σs'	kgf/cm2	-		-		
Mean Shearing Stress			τm	kgf/cm2	0.271	OK	0.047	OK	

Stirrup (in case shearing stress is not OK.)

τa = 0.271 - 5.5 = -5.229 kgf/cm2

Design reinforcement bar to stirrup

diameter **12** mm

pitch **200** mm

As = 5.65 cm2

$\frac{\sigma sa \ As}{b \ P}$ = 3.170 OK

unit:m

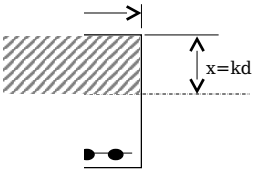
H5	H6	ho
0.60	0.40	9.80

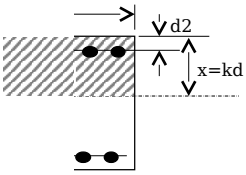
stryctur	kh=	0.18



tf.m

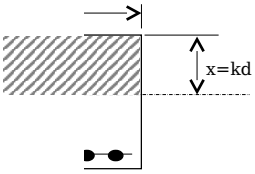


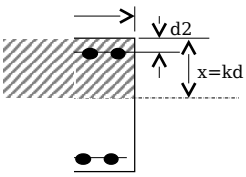



d2
x=kd

tf.m







Remarks

1 **Input Data**
"Input": Figure in red are input data.

2 **There are two try and error calculation except input data such as dimer**
To calculate them, click on the macro button at their right sides after i

(1) Sheet name "Body", G300 to K301 Button **Calculate σc**
(2) Sheet name "Body", H436 to N437. Button **Calculate x**

3 **Allowable stress for "Body"**
If allowable stress is "Check" for body, see Sheet "Body", calculation of stress

4 **Minimum reinforcement bar**

Step 1 Calculation of Md', find 1.7Md

Step 2 Comparison between Md' and Mc

if Md' > Mc go to step 3

Step 3 Calculation of Mu

Step 4 Comparison between Mu and Mc

Mu > Mc OK If No, effective height must be in

Revised

26-Nov-02 Discription of Case I-1, Case I-2, Case II-1, Case II-2 are as follows

	Direction	
Condition		
normal	Case I-1	Case II-1
seismic	Case I-2	Case II-2

The expression mantioned above are revised.

30-Nov-02 All sheets
Some of inputting cells and calculation result cells have been rearra
Safety factors against sliding have been set at the same figures as r

	previous figure	revised figur
normal condition	1.5	**2.0**
seismic condition	1.2	**1.25**

Reinforcement bar arrangements for additional bars and distributic

4-Dec-02 Modification of stress and additional bar arrangement

12-Dec-02 Minor change: sheets "Stability", "Body" and "Footing"

28-Dec-02 Minor correction: sheets "Body" and "Beam" (calculation results are

2-Feb-03	Sheet "Input"	
		Input Cell "L48"was modified to calculation cell.
		Input Cells "L49" and "L50" were added.
		Cells "I49", "K49", "K50", "L51", "N46", "N47", "N48", "]

nsion and condition.
nputting data.

creased.

anged.
etaining wall.
e

on bars have been added.

e same as revision 4)

N49" and "N50" were added.