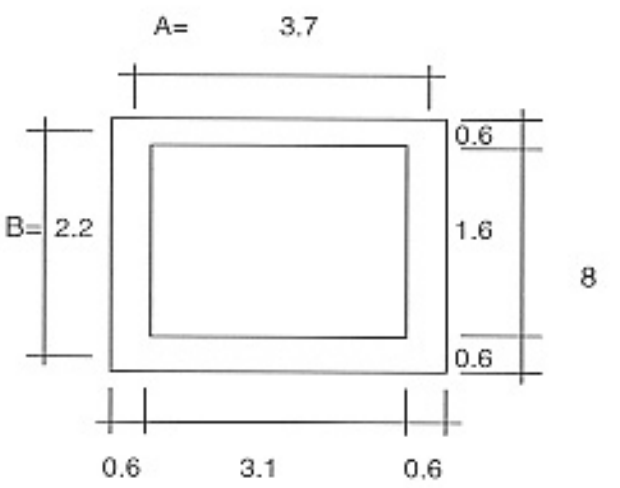
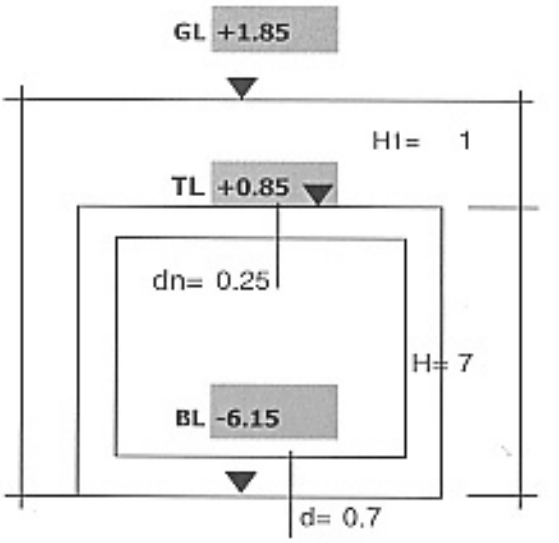
CHAPTER 3
INTERCEPTOR SEWER CONSTRUCTION PROJECT (PACKAGE C)

3.1

Civil Design

CALCULATION FOR MAIN INTERCEPTOR MANHOLE (1)

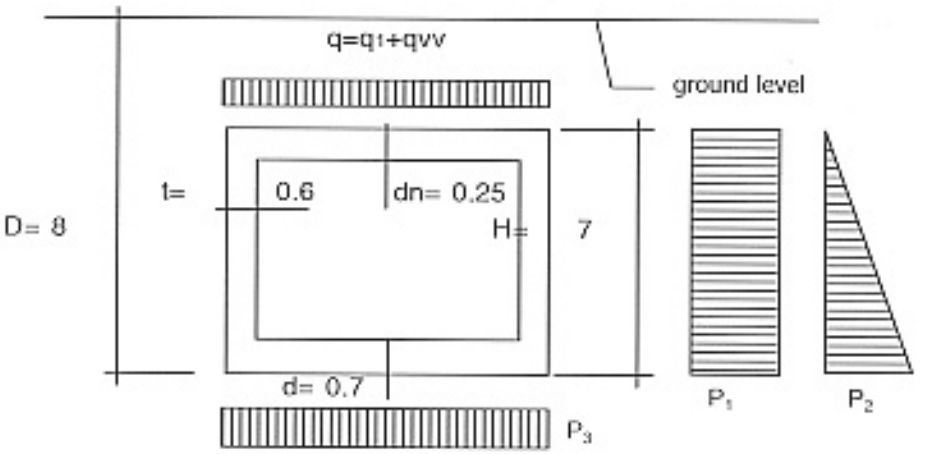




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*7*	m
Depth of manhole	*D=*	*8*	m
Width of manhole	*B =*	*2.2*	m
Length of manhole	*A=*	*3.7*	m
Thickness of cover slab	d_n =	*0.25*	m
Thickness of wall	*t =*	*0.6*	m
Thickness of bottom slab	*d =*	*0.7*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level: + 0.00

Weight of soil: γ = 1.8 T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_0 = tg^2(45^0 - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{de} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i: 0.3

P_{de} = 11.35T/m

q_w = Pde/(B+t) 4.05 T/m²

Horizontal vehicle load from both sides of the manhole:

$p_{hw} = 1.0xK_o =$ 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 1.8 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 1.4 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_o$ 8.82 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 1.4 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 7 T/m²

C. Self load :

-Load due to cover slab:

$Q_c = 2.5x(A+t)x(B+t)xdn=$ 7.53 Ton

-Load due to walls:

$Q_w = 2.5x(A+B)x2x(H-dn-d)xt=$ 107.09 Ton

-Load due to bottom slab:

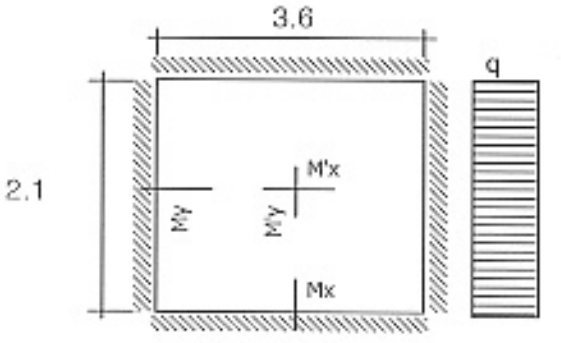
$Q_b = 2.5x(A+t)x(B+t)xd=$ 21.07 Ton

D. Live load (with full of water in manhole) :

qw = 6.05 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+q_{vv}+2.5x_{dn} =$ 6.48 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n b h_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Raho$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.71

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0438	Mx	2.1447	0.0766	0.96011	6.98	12	125
0.0152	My	0.74428	0.02658	0.98653	2.36	12	250
0.02	M'x	0.9793	0.03498	0.9822	3.12	12	250
0.0069	M'y	0.33786	0.01207	0.99393	1.06	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -5.45

-Uniform distributed loads :

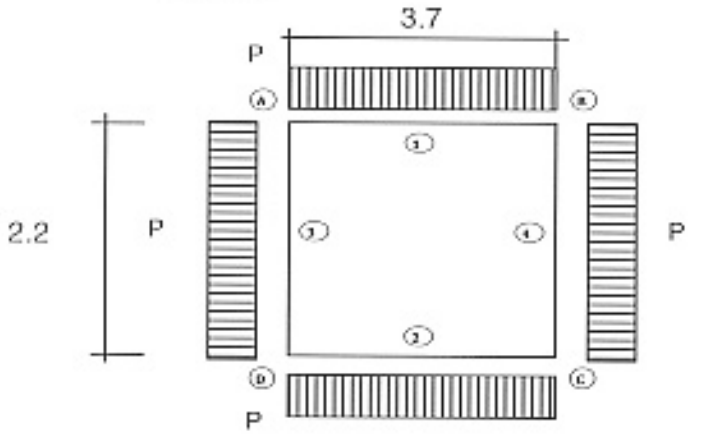
$P_1 = p_{hv}+p_{11}=$ 1.90 T/m²

$P_2 = p_{22}=$ 8.82 T/m²

$P=P_1+P_2=$ 10.72 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

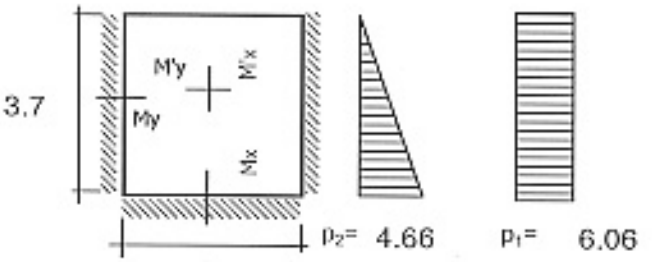
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	9.06	0.04608	0.97641	10.94	14	125
M_A	9.49	0.04826	0.97526	11.47	14	125
M_3	4.6	0.02339	0.98816	5.49	14	250

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 3.7 m

-Length of slab B 3.7 m

-Triangular distributed loads p_2= 4.66 T/m

-Uniform distributed loads p_1= 6.06 T/m

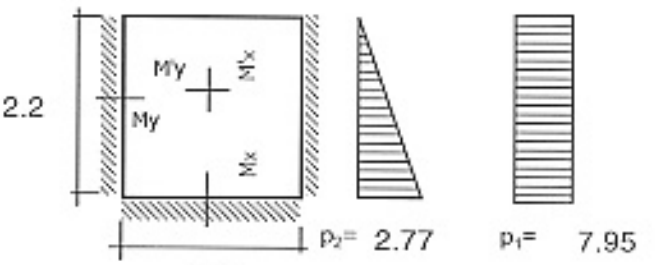
-Thickness of bottom slab d= 0.6 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							O(mm)	a(mm)
0.0598	0.0559	Mx	6.54431	0.03	0.98307	7.8502	12	125
0.0538	0.0664	My	7.22365	0.04	0.98128	8.6810	12	125
0.0172	0.0084	M'x	1.24552	0.01	0.99682	1.4735	12	250
0.0246	0.0257	M'y	2.91642	0.01	0.99253	3.4651	12	250

Diagram calculation for analysis in the direction B :



-Width of slab: A 2.2 m

-Length of slab B 2.2 m

-Triangular distributed loads p_2= 2.77 T/m

-Uniform distributed loads p_1= 7.95 T/m

-Thickness of bottom slab d= 0.6 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	2.55153	0.01	0.99347	3.0287	12	250
0.0538	0.0664	My	2.9152	0.01	0.99253	3.4636	12	250
0.0172	0.0084	M'x	0.43852	0.00	0.99888	0.5177	12	250
0.0246	0.0257	M'y	1.15366	0.01	0.99706	1.3645	12	250

B. Calculation for wall at level : -3.15

-Uniform distributed loads :

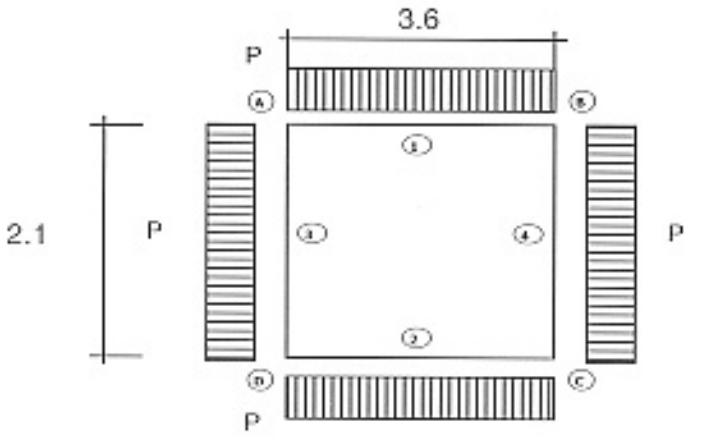
$P_1 = p_{hv} + p_{11} =$ 1.90 T/m²

$P_2 = p_{22} =$ 5.60 T/m²

$P = P_1 + P_2 =$ 7.50 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

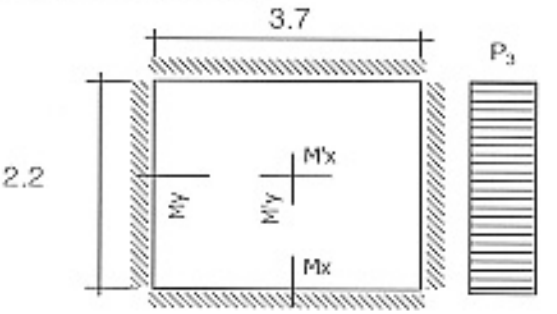
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	6.02	0.03062	0.98445	7.21	12	125
M_A	6.24	0.03173	0.98387	7.48	12	125
M_3	1	0.00509	0.99745	1.18	12	250

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+q_{vv}+p_u+(Q_c+Q_w+Q_b)/[(A+t)x(B+t)]=$ 24.12 T/m²

-Thickness of bottom slab: 0.7 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.68

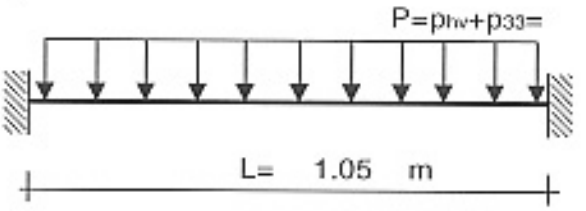
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0438	Mx	8.59993	0.02908	0.98524	9.41	14	125
0.0152	My	2.984	0.01009	0.99493	3.23	12	250
0.02	M'x	3.927	0.01328	0.99332	3.92	12	250
0.0069	M'y	1.355	0.0046	0.9977	1.35	12	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A.The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 1.90 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.174563	0.01108	0.99443	0.55	12	250
M2	0.087281	0.00554	0.99722	0.27	12	250

7-Checking for shearing forces of wall:

At level -5.45

-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

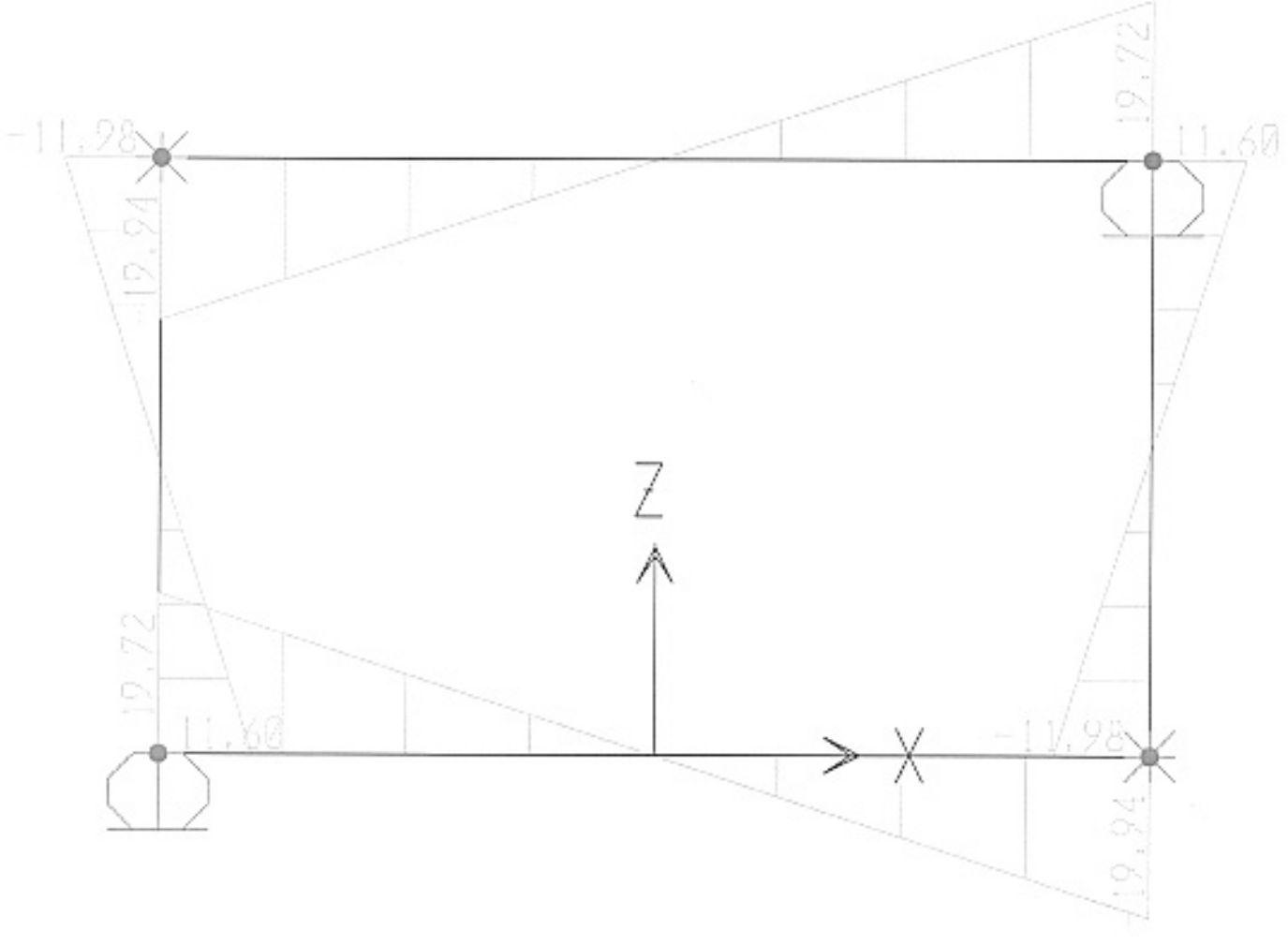
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	13.40	2.50	3.60	OK!!!

At level -3.15

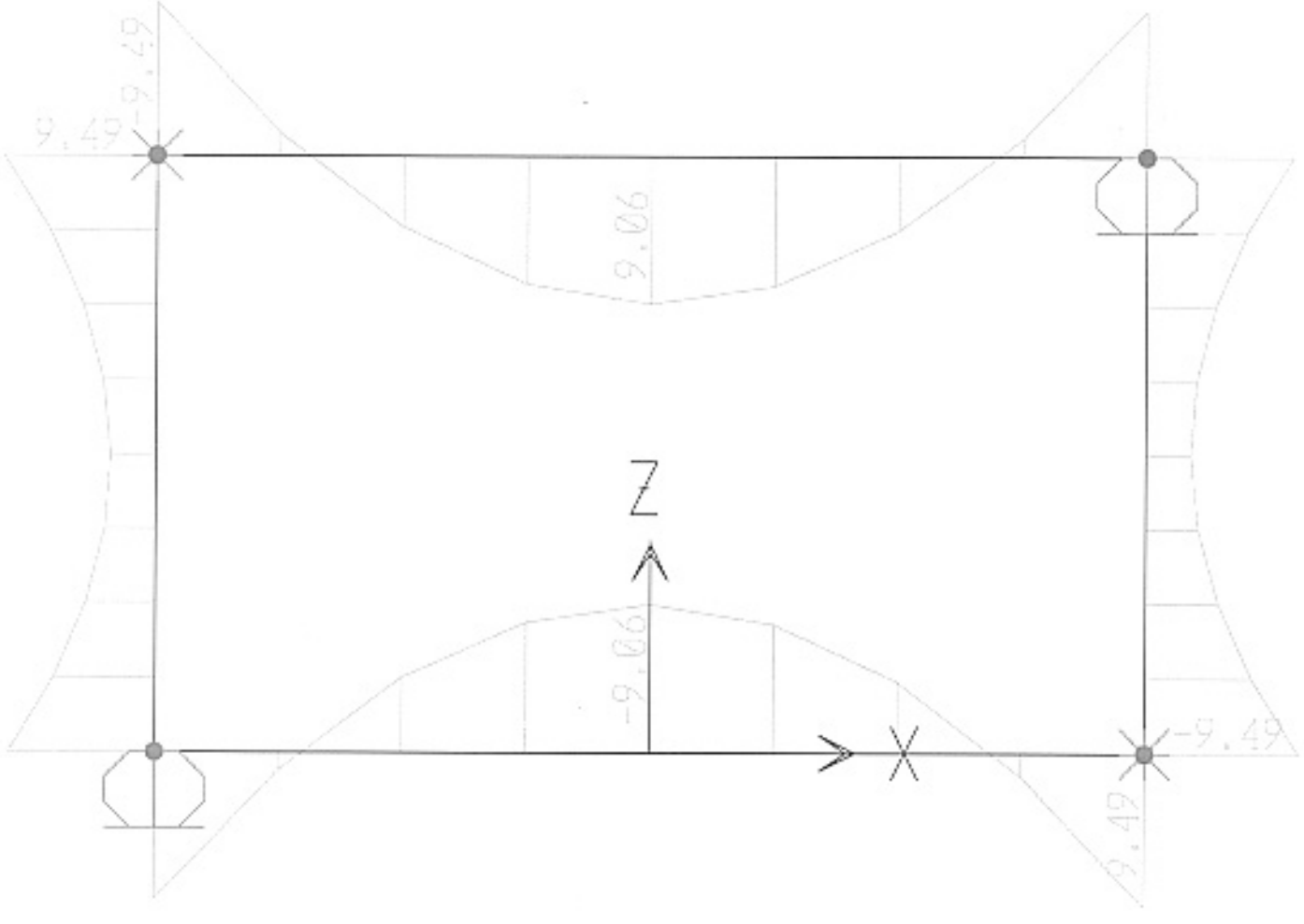
-Height of hand for supporting wall s= 0 , so the section need to be checked

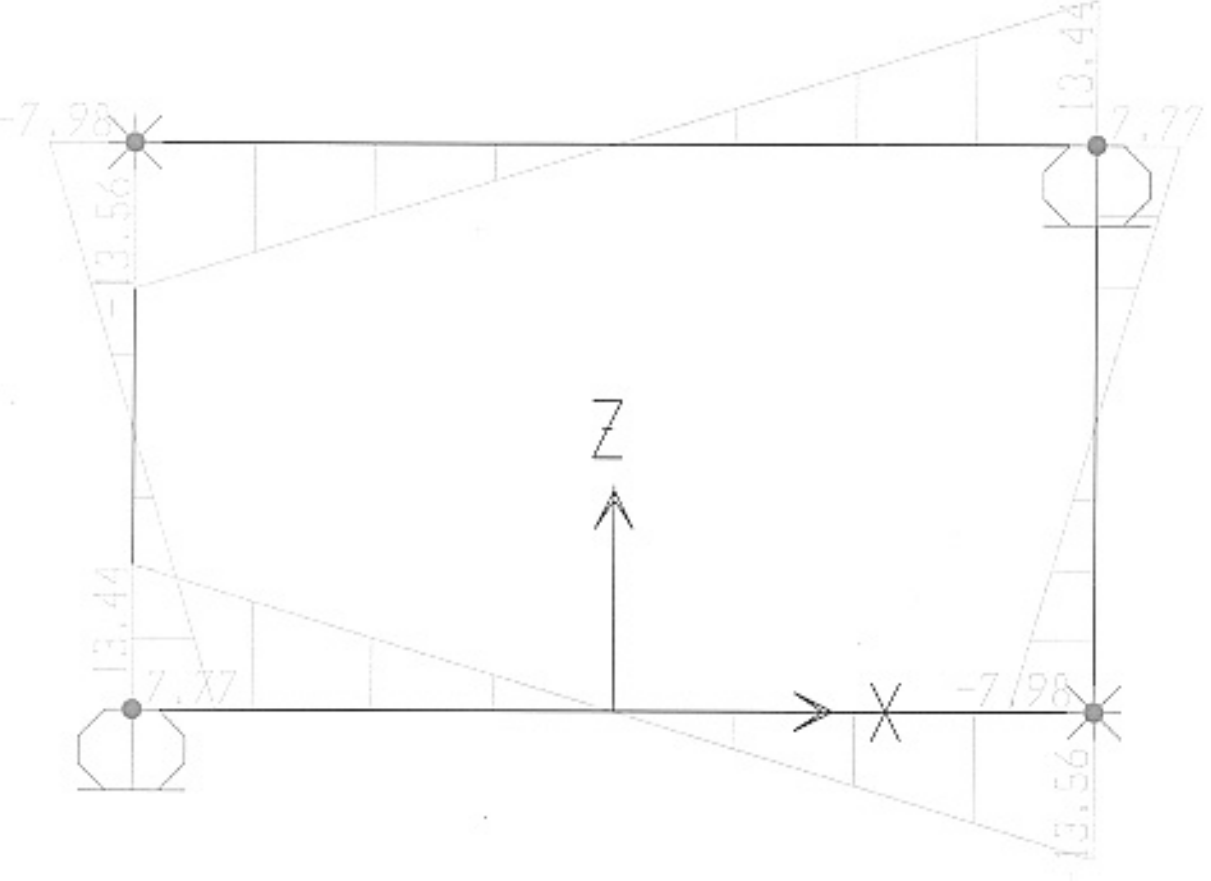
shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

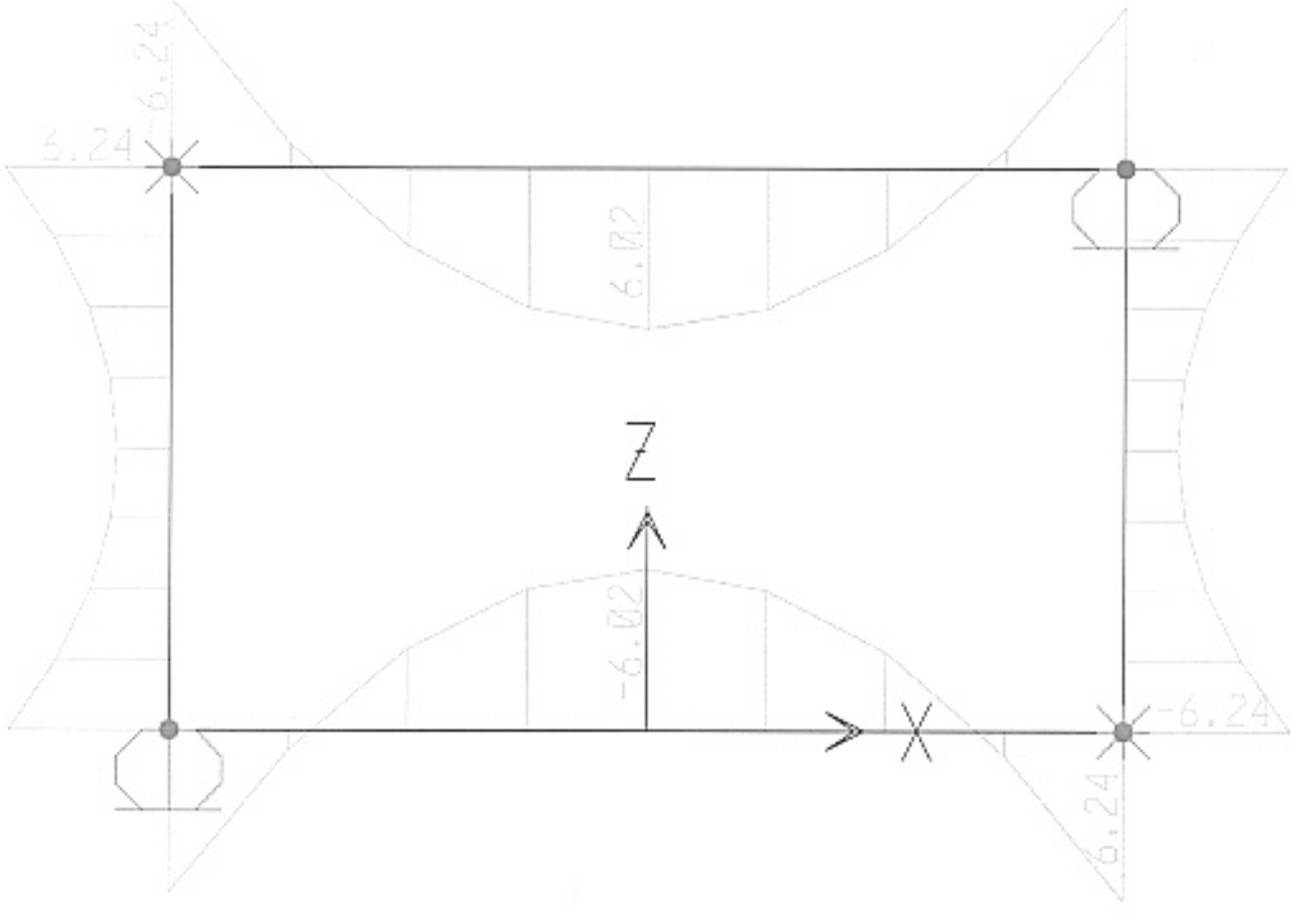
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	9.75	1.80	3.60	OK!!!



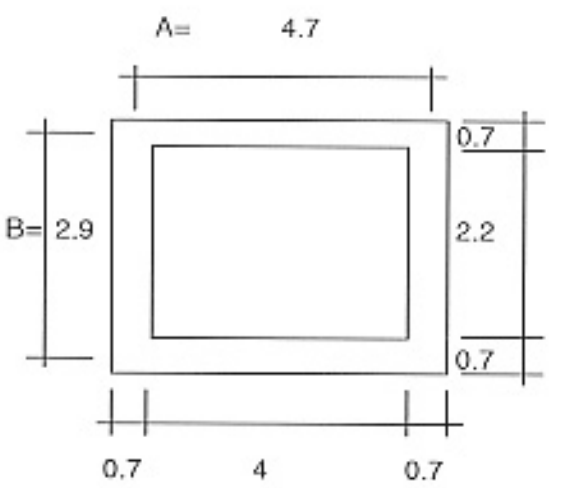
SAP2000 v6.11 - File:MHtype11 - Shear Force 2-2 Diagram (LOAD1) - Ton-m Units

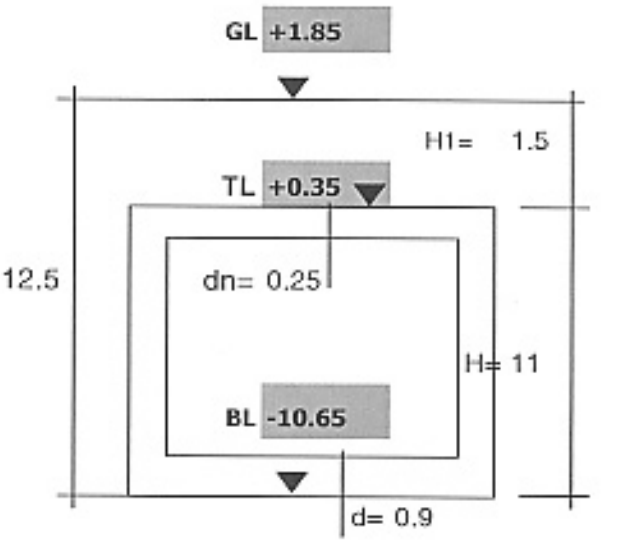

-9.49
-9.49
9.06
Z
-9.06
X
-9.49
9.49


-7.96
-13.56
13.44
7.77
-7.96
-13.56
13.44
7.77
Z
X


6.24
-6.24
6.02
-6.02
-6.24
6.24

CALCULATION FOR MAIN INTERCEPTOR MANHOLE (2)

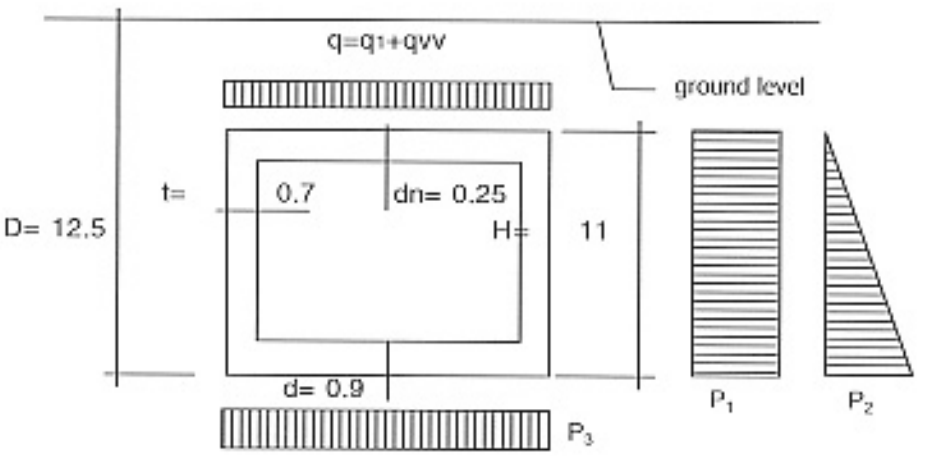




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*11*	m
Depth of manhole	*D=*	*12.5*	m
Width of manhole	*B =*	*2.9*	m
Length of manhole	*A=*	*4.7*	m
Thickness of cover slab	d_n =	*0.25*	m
Thickness of wall	*t =*	*0.7*	m
Thickness of bottom slab	*d =*	*0.9*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level: + 0.00

Weight of soil: γ = 1.8 T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_a = tg^2(45^o - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{dc} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i= 0.3

P_{dc} = 11.35T/m

q_w = Pde/V 3.55 T/m²

Horizontal vehicle load from both sides of the manhole:

$p_{hw} = 1.0xK_o =$ 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 2.7 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 2.1 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{12}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_o$ 14.14 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 2.1 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 11 T/m²

C. Self load :

-Load due to cover slab:

Q_c = 2.5x(A+t)x(B+t)xdn= 12.15 Ton

-Load due to walls:

Q_w = 2.5x(A+B)x2x(H-dn-d)xt= 262.01 Ton

-Load due to bottom slab:

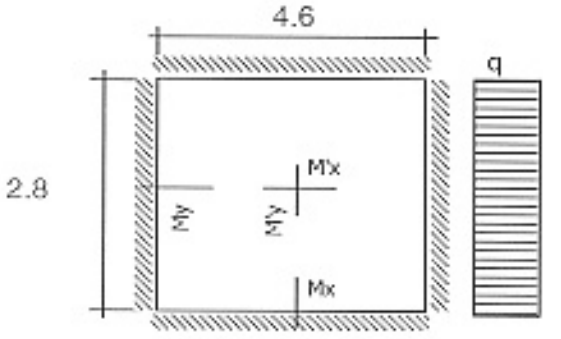
Q_b = 2.5x(A+t)x(B+t)xd= 43.74 Ton

D. Live load (with full of water in manhole) :

qw = 9.85 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+q_{vv}+2.5xd_n =$ 6.87 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n bh_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Rah_o$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.64

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0446	Mx	3.94672	0.14095	0.9237	13.35	16	125
0.0164	My	1.45126	0.05183	0.97338	4.66	14	250
0.0202	M'x	1.7875	0.06384	0.96699	5.78	14	250
0.0074	M'y	0.65484	0.02339	0.98817	2.07	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -9.75

-Uniform distributed loads :

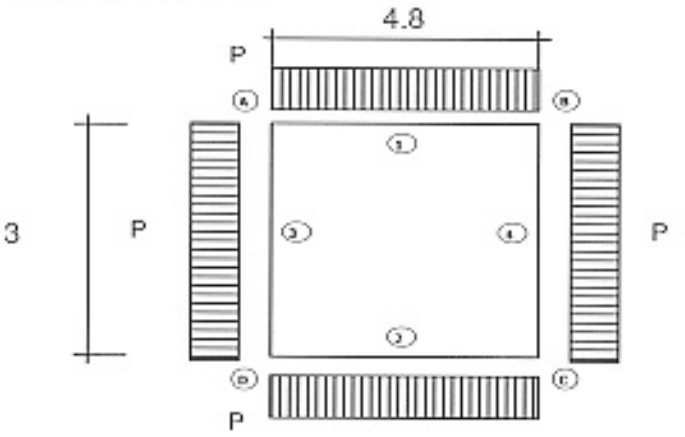
$P_1 = p_{hv}+p_{11}=$ 2.60 T/m²

$P_2 = p_{22}=$ 14.14 T/m²

$P=P_1+P_2=$ 16.74 T/m²

Thickness of wall: 0.8 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

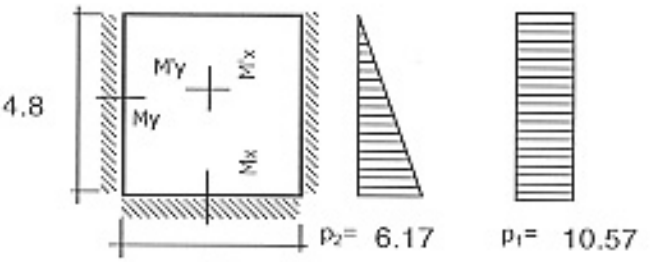
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	23.6	0.06327	0.9673	20.89	20	125
M_A	25.13	0.06737	0.9651	22.29	20	125
M_3	5.7	0.01528	0.9923	4.92	12	125

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 4.8 m

-Length of slab B 4.8 m

-Triangular distributed loads p_2= 6.17 T/m

-Uniform distributed loads p_1= 10.57 T/m

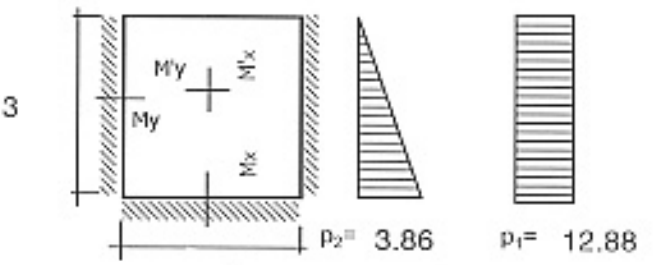
-Thickness of bottom slab d= 0.8 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							O(mm)	a(mm)
0.0598	0.0559	Mx	17.8639	0.05	0.97545	15.6793	16	125
0.0538	0.0664	My	19.9944	0.05	0.97244	17.6037	18	125
0.0172	0.0084	M'x	3.26822	0.01	0.9956	2.8105	12	250
0.0246	0.0257	M'y	8.00727	0.02	0.98915	6.9307	12	125

Diagram calculation for analysis in the direction B :



-Width of slab: A 3 m

-Length of slab B 3 m

-Triangular distributed loads p_2= 3.86 T/m

-Uniform distributed loads p_1= 12.88 T/m

-Thickness of bottom slab d= 0.8 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	7.5195	0.02	0.98982	6.5042	12	125
0.0538	0.0664	My	8.63289	0.02	0.98829	7.4787	12	125
0.0172	0.0084	M'x	1.27249	0.00	0.99829	1.0913	12	250
0.0246	0.0257	M'y	3.40688	0.01	0.99541	2.9303	12	250

B. Calculation for wall at level : -5.65

-Uniform distributed loads :

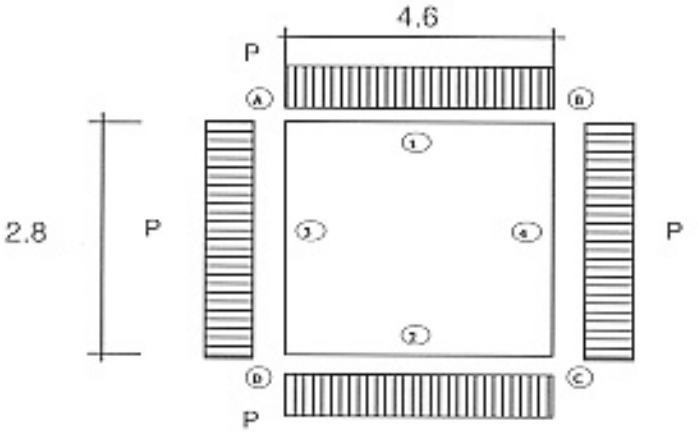
$P_1 = p_{hv} + p_{11} =$ 2.60 T/m²

$P_2 = p_{22} =$ 8.40 T/m²

$P = P_1 + P_2 =$ 11.00 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

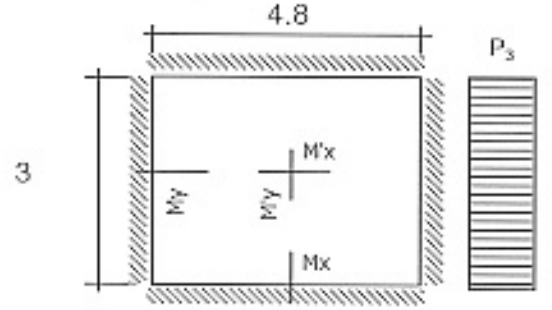
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	14.32	0.07283	0.96215	17.55	18	125
M_A	14.99	0.07623	0.96031	18.41	18	125
M_3	4	0.02034	0.98972	4.77	12	125

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+q_{vv}+p_u+(Q_c+Q_w+Q_b)/[(A+t)x(B+t)]=$ 33.60 T/m²

-Thickness of bottom slab: 0.9 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.60

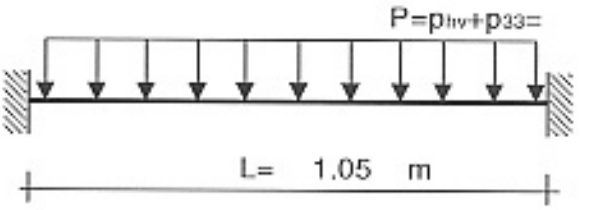
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0452	Mx	21.8685	0.04324	0.97789	17.92	18	125
0.0177	My	8.564	0.01693	0.99146	6.92	12	125
0.0205	M'x	9.918	0.01961	0.9901	7.54	12	125
0.008	M'y	3.871	0.0077	0.99616	2.93	12	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A. The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 2.60 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.238875	0.01517	0.99236	0.75	12	250
M2	0.119438	0.00758	0.99619	0.37	12	250

7-Checking for shearing forces of wall:

At level -9.85

-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.80 m far from center of wall

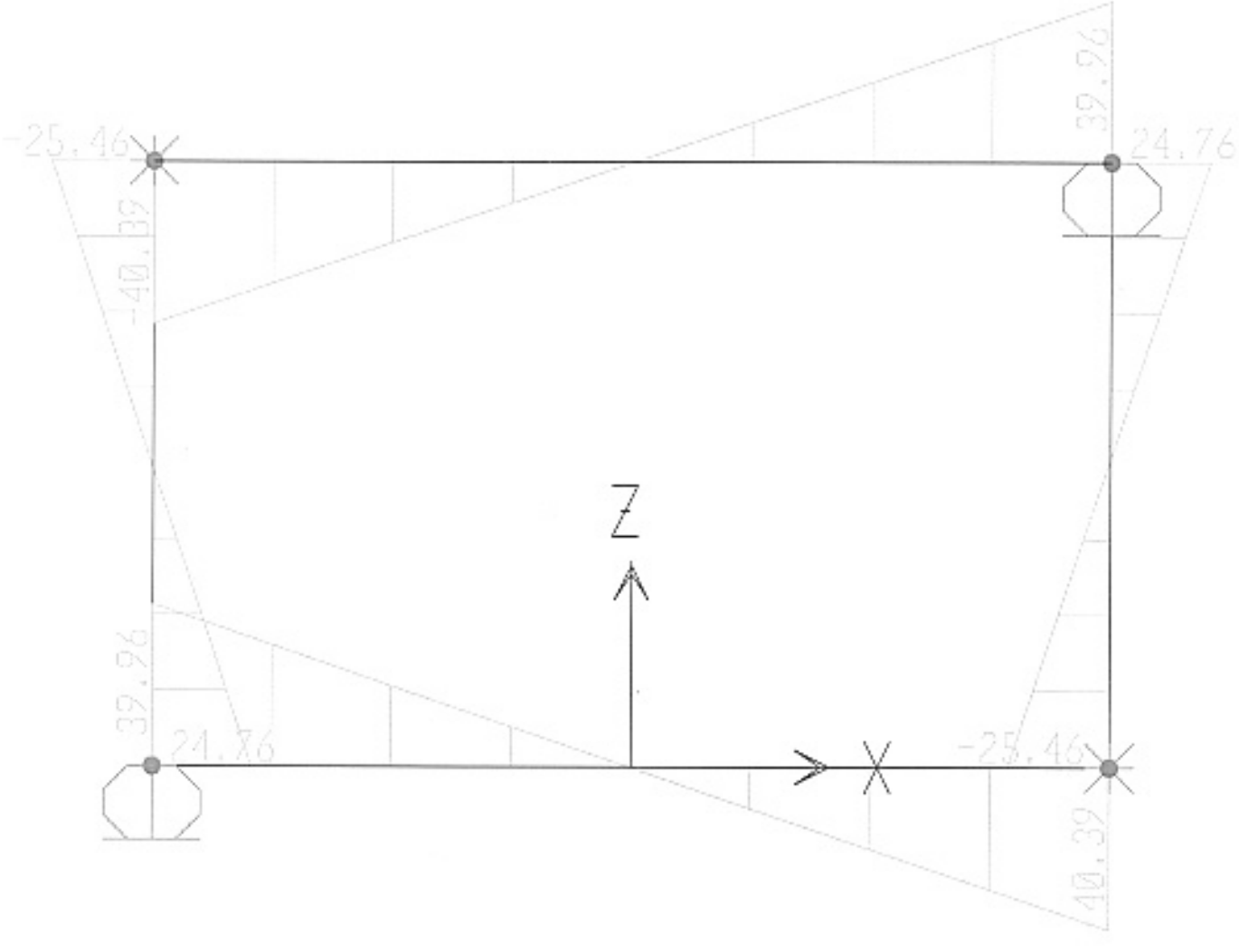
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	26.78	3.60	3.60	OK!!!

At level -5.65

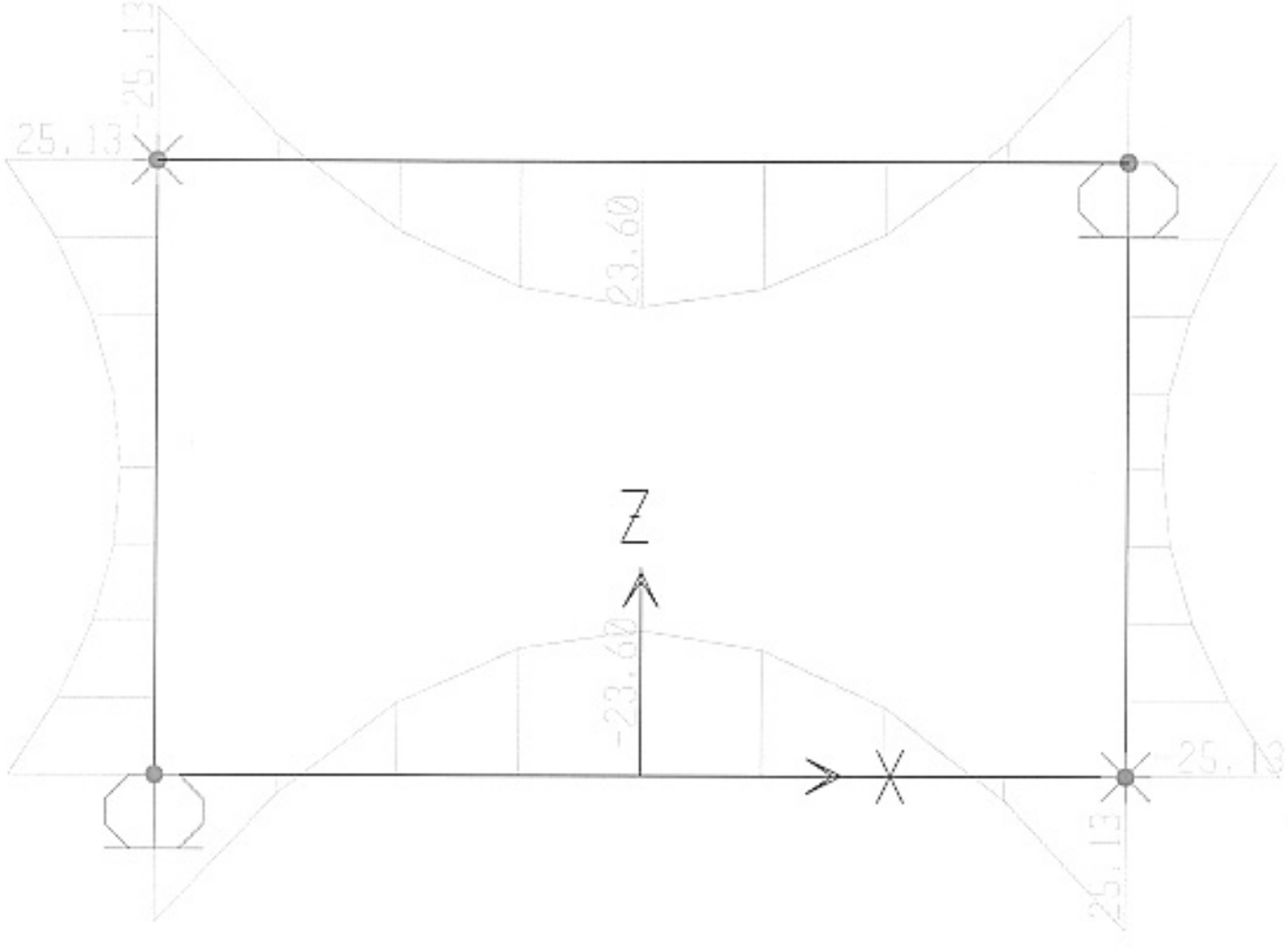
-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

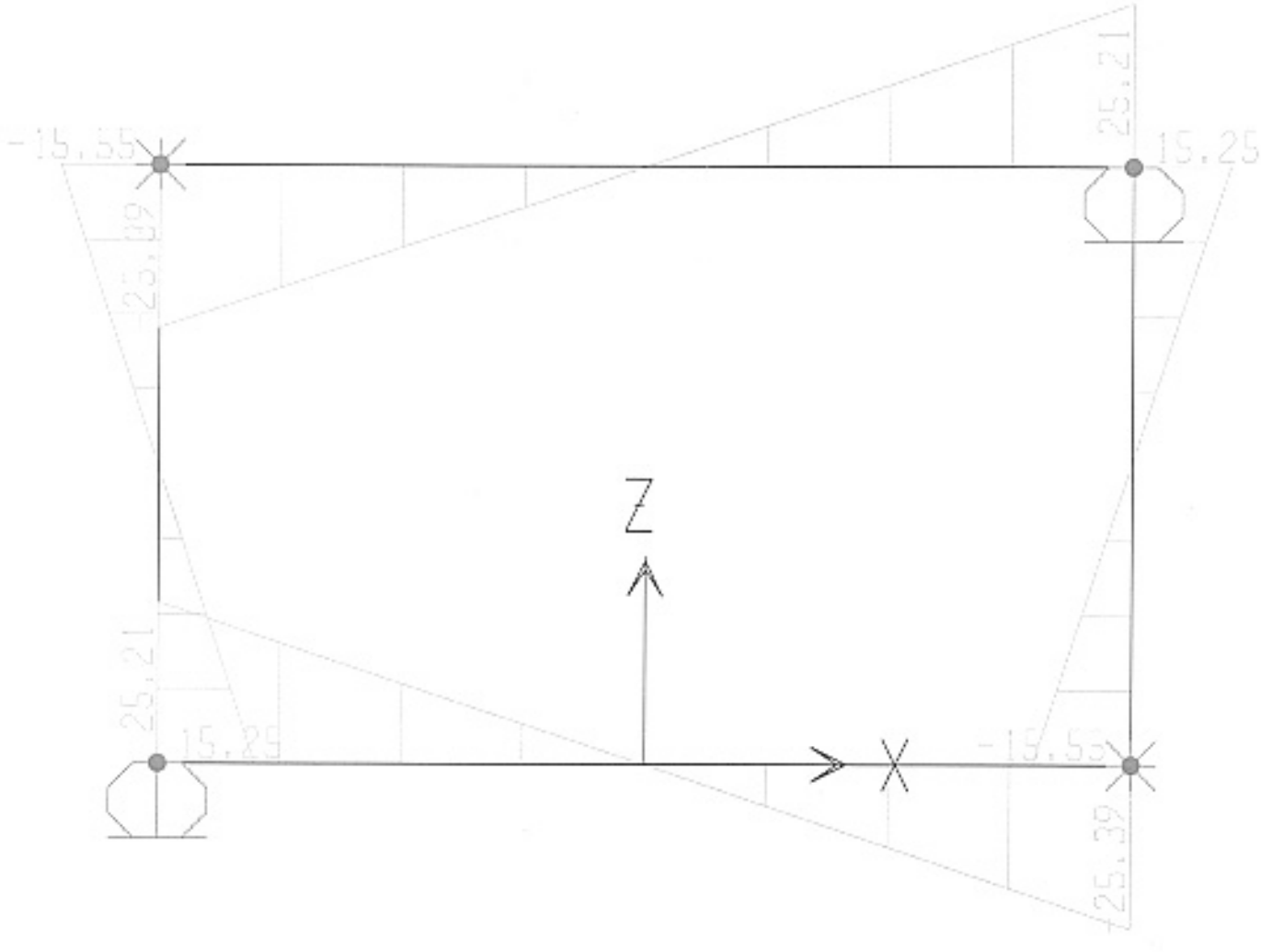
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	18.70	3.50	3.60	OK!!!

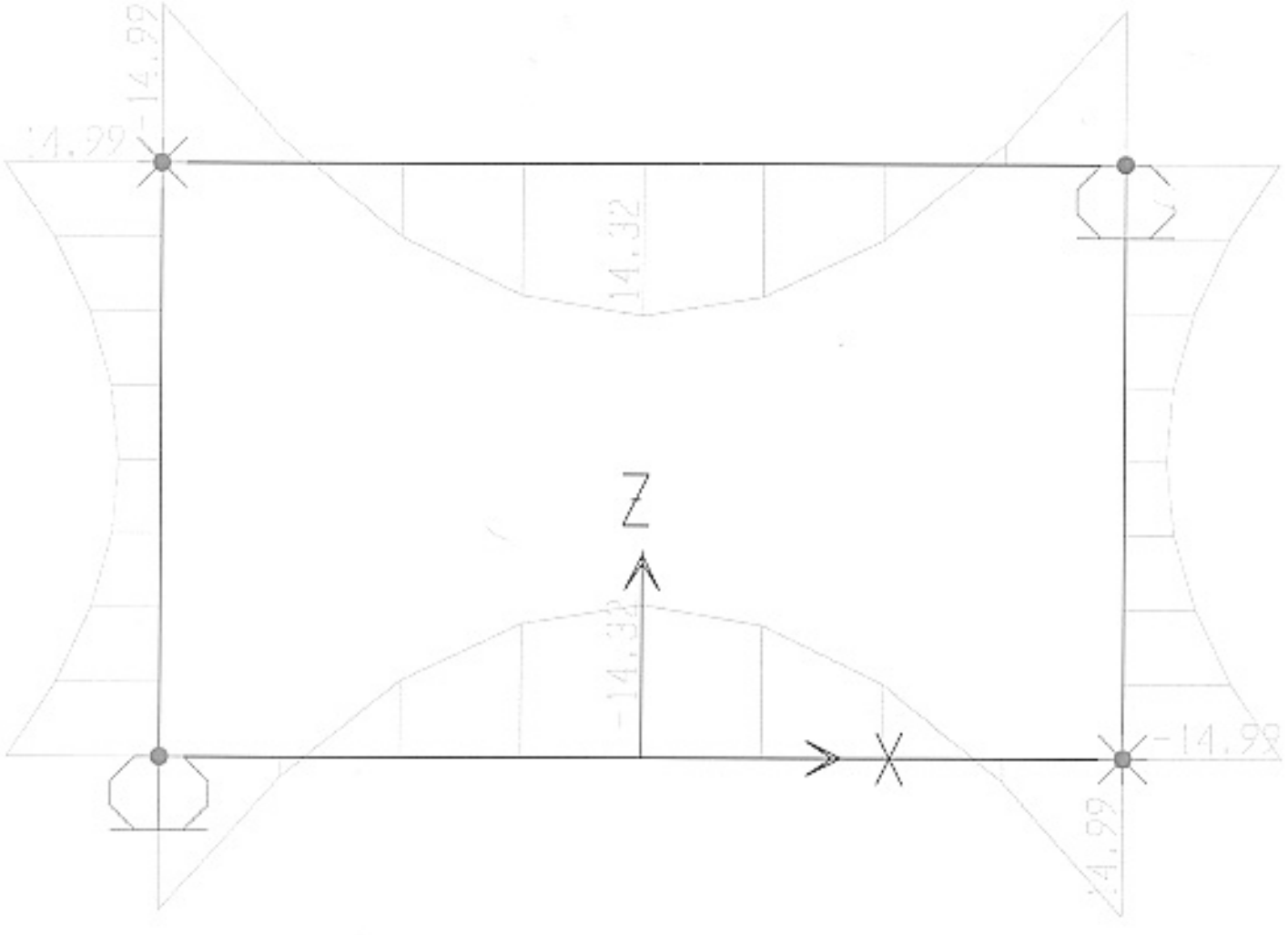


SAP2000 v6.11 - File:MHtype21 - Shear Force 2-2 Diagram (LOAD1) - Ton-m Units

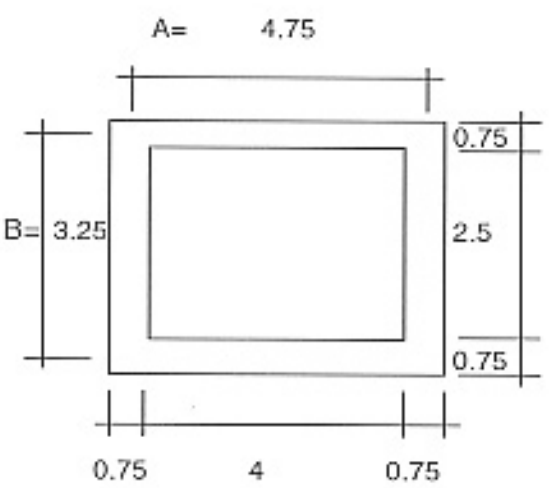


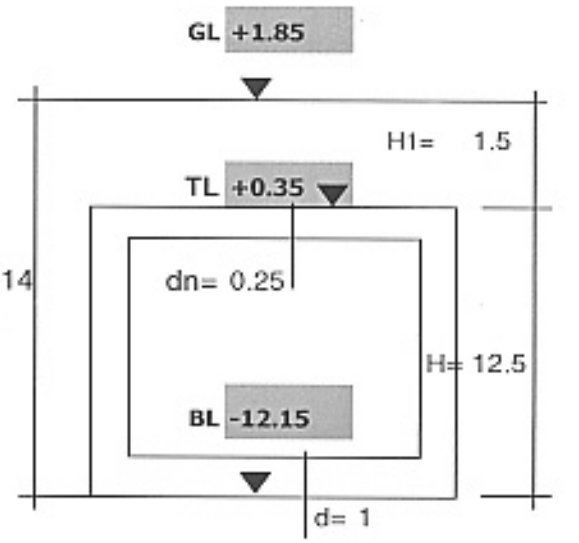
SAP2000 v6.11 - File:MHtype21 - Moment 3-3 Diagram (LOAD1) - Ton-m Units


-15.55
25.21
15.25
25.39
25.21
15.29
-15.53
25.39
Z
X


-14.99
14.99
14.32
Z
-14.32
-14.99
14.99

CALCULATION FOR MAIN INTERCEPTOR MANHOLE (3)

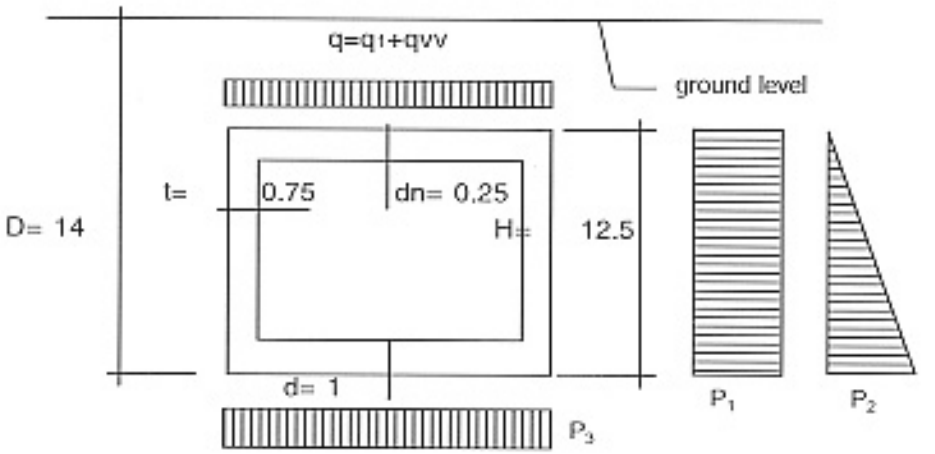




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*12.5*	m
Depth of manhole	*D=*	*14*	m
Width of manhole	*B =*	*3.25*	m
Length of manhole	*A=*	*4.75*	m
Thickness of cover slab	d_o =	*0.25*	m
Thickness of wall	*t =*	*0.75*	m
Thickness of bottom slab	*d =*	*1*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level: + 0.00

Weight of soil: γ = 1.8 T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_a = tg^2(45^0 - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{de} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i= 0.3

P_{de} = 11.35T/m

q_w = Pde/V 3.55 T/m²

Horizontal vehicle load from both sides of the manhole:

p_{hv} = $1.0xK_o$ = 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 2.7 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 2.1 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_a$ 16.1 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 2.1 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 12.5 T/m²

C. Self load :

-Load due to cover slab:

Q_c = 2.5x(A+t)x(B+t)xdn= 13.75 Ton

-Load due to walls:

Q_w = 2.5x(A+B)x2x(H-dn-d)xt= 337.50 Ton

-Load due to bottom slab:

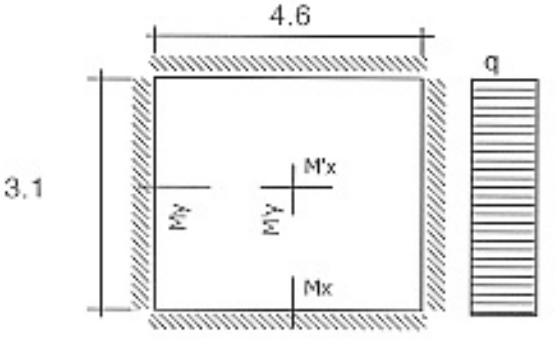
Q_b = 2.5x(A+t)x(B+t)xd= 55.00 Ton

D. Live load (with full of water in manhole) :

qw = 11.25 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+qvv+2.5xdn =$ 6.87 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n bh_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/_{\gamma}Raho$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.46

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0464	Mx	4.54593	0.16235	0.91088	15.60	16	125
0.0206	My	2.01824	0.07208	0.96256	6.55	12	125
0.0208	M'x	2.0378	0.07278	0.96218	6.62	12	125
0.0093	M'y	0.91115	0.03254	0.98346	2.90	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -11.15

-Uniform distributed loads :

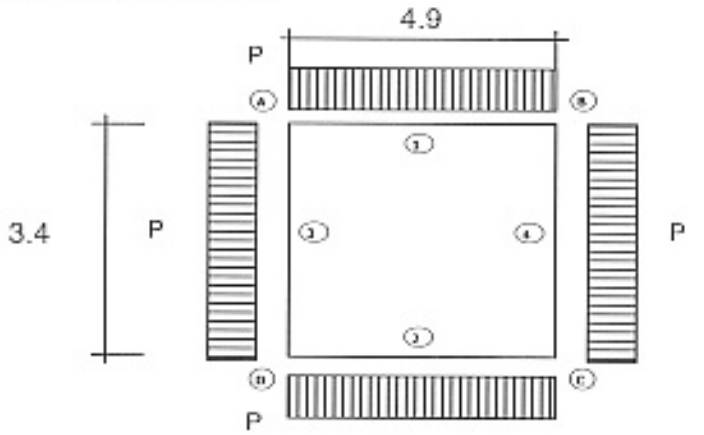
$P_1 = phv+p11=$ 2.60 T/m²

$P_2 = p22=$ 16.10 T/m²

$P=P_1+P_2=$ 18.70 T/m²

Thickness of wall: 0.9 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

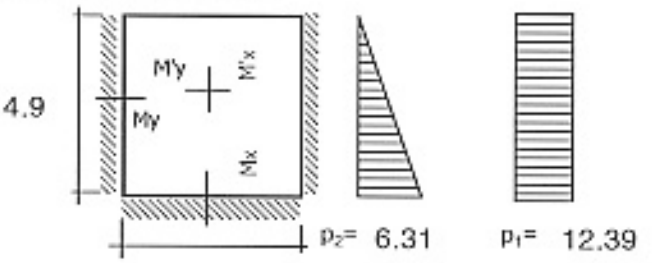
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	26.66	0.05528	0.97155	20.66	20	125
M_A	30.04	0.06229	0.96782	23.37	20	125
M_3	4.5	0.00933	0.99531	3.87	14	250

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 4.9 m

-Length of slab B 4.9 m

-Triangular distributed loads p_2= 6.31 T/m

-Uniform distributed loads p_1= 12.39 T/m

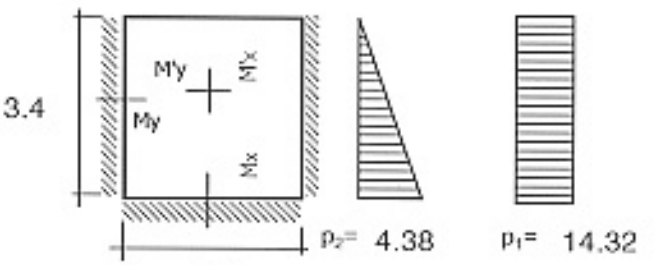
-Thickness of bottom slab d= 0.9 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
							O(mm)	a(mm)
0.0598	0.0559	Mx	21.1585	0.04	0.97756	16.2984	18	125
0.0538	0.0664	My	23.8272	0.05	0.97465	18.4088	18	125
0.0172	0.0084	M'x	3.8018	0.01	0.99604	2.8742	12	250
0.0246	0.0257	M'y	9.50844	0.02	0.99004	7.2320	12	125

Diagram calculation for analysis in the direction B :



-Width of slab: A 3.4 m

-Length of slab B 3.4 m

-Triangular distributed loads p_2= 4.38 T/m

-Uniform distributed loads p_1= 14.32 T/m

-Thickness of bottom slab d= 0.9 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	10.7678	0.02	0.98871	8.2009	12	125
0.0538	0.0664	My	12.3542	0.03	0.98702	9.4252	14	125
0.0172	0.0084	M'x	1.82597	0.00	0.9981	1.3776	12	250
0.0246	0.0257	M'y	4.87726	0.01	0.99492	3.6914	12	250

B. Calculation for wall at level : -5.65

-Uniform distributed loads :

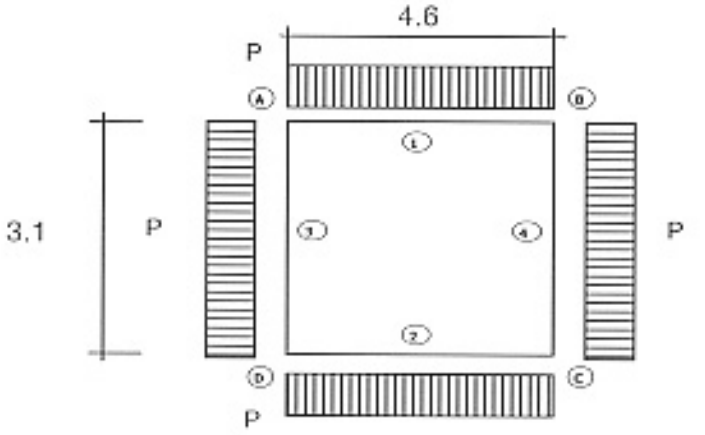
$P_1 = p_{hv} + p_{11} =$ 2.60 T/m²

$P_2 = p_{22} =$ 8.40 T/m²

$P = P_1 + P_2 =$ 11.00 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

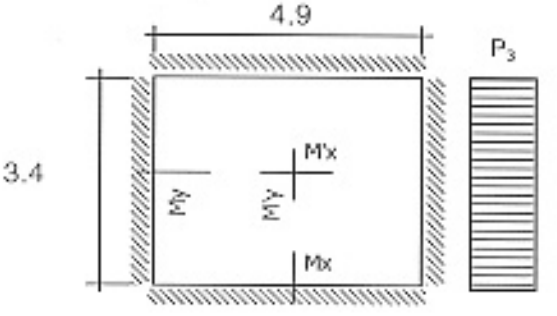
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	13.07	0.06647	0.96558	15.96	16	125
M_A	14.33	0.07288	0.96213	17.56	18	125
M_3	4.47	0.02273	0.9885	5.33	12	125

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+q_{vv}+p_u +(Q_c+Q_w+Q_b)/[(A+t)x(B+t)]=$ 37.21 T/m²

-Thickness of bottom slab: 1 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.44

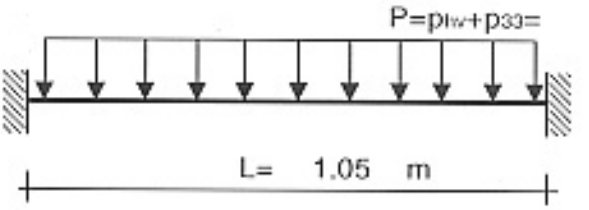
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0464	Mx	28.7653	0.04553	0.97669	20.92	20	125
0.0206	My	12.771	0.02021	0.98979	9.16	14	125
0.0208	M'x	12.895	0.02041	0.98969	8.76	14	125
0.0093	M'y	5.765	0.0091	0.99542	3.89	14	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A.The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 2.60 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.238875	0.01517	0.99236	0.75	12	250
M2	0.119438	0.00758	0.99619	0.37	12	250

7-Checking for shearing forces of wall:

At level -11.15

-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.90 m far from center of wall

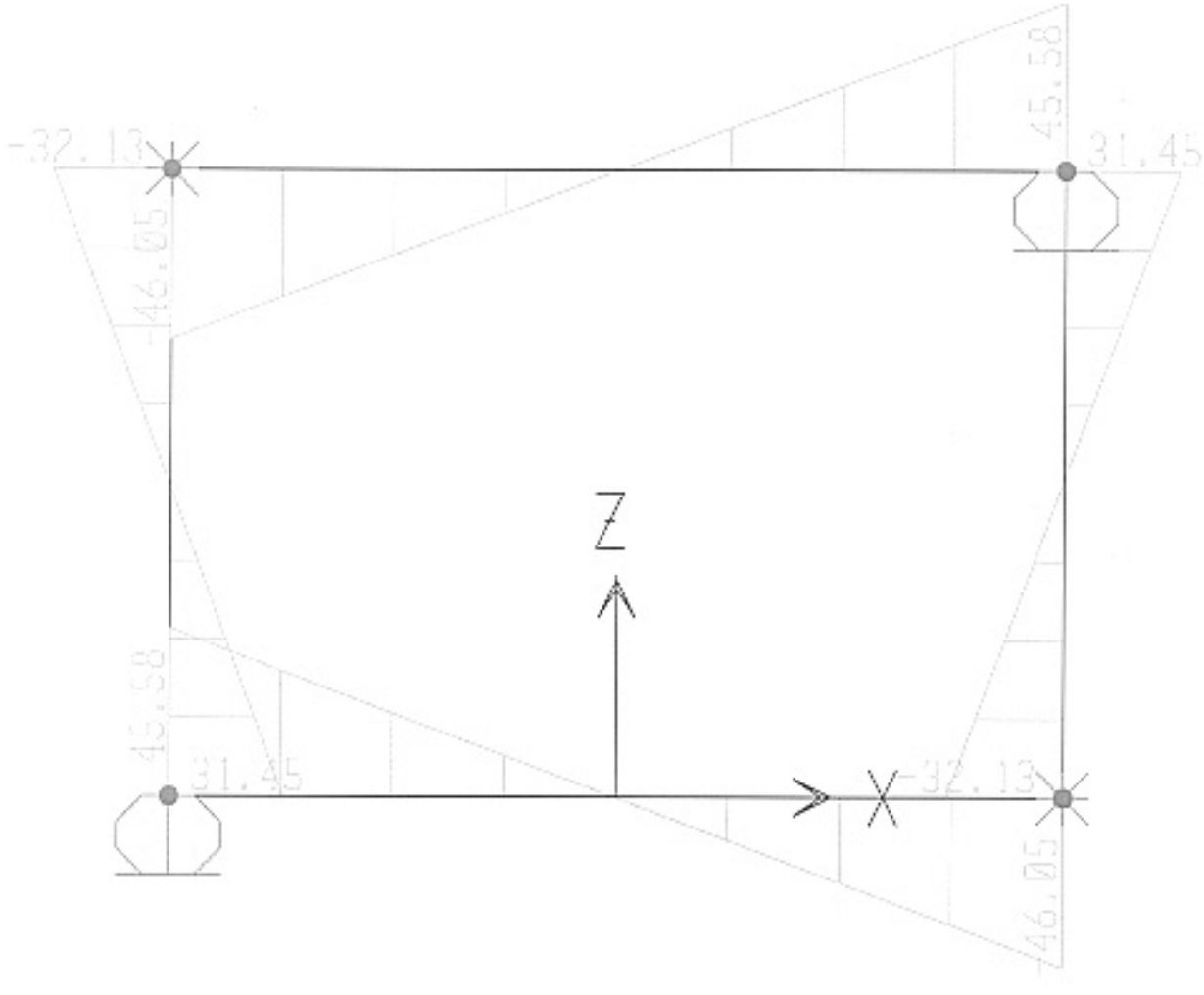
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	30.56	3.60	3.60	OK!!!

At level -5.65

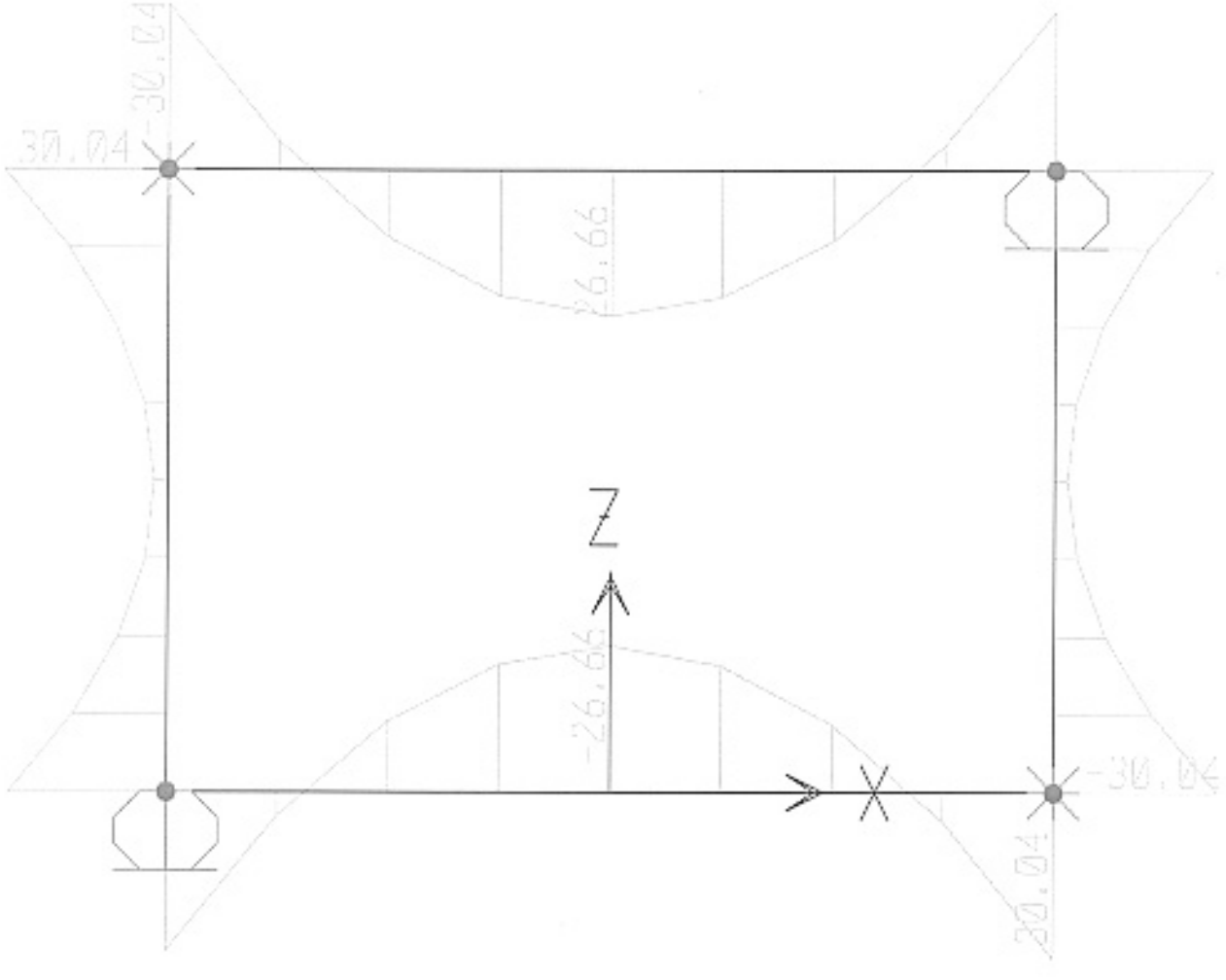
-Height of hand for supporting wall s= 0 , so the section need to be checked

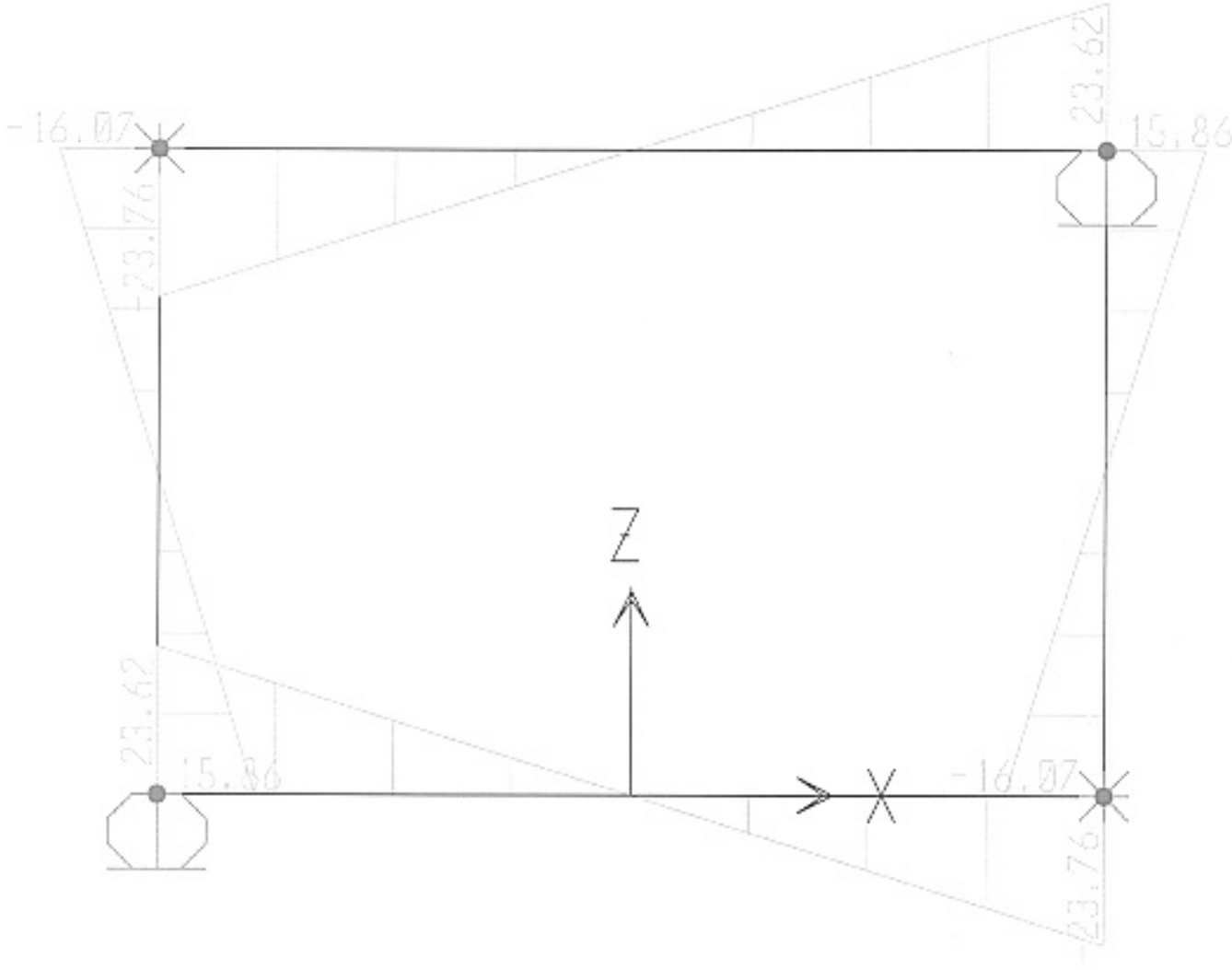
shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

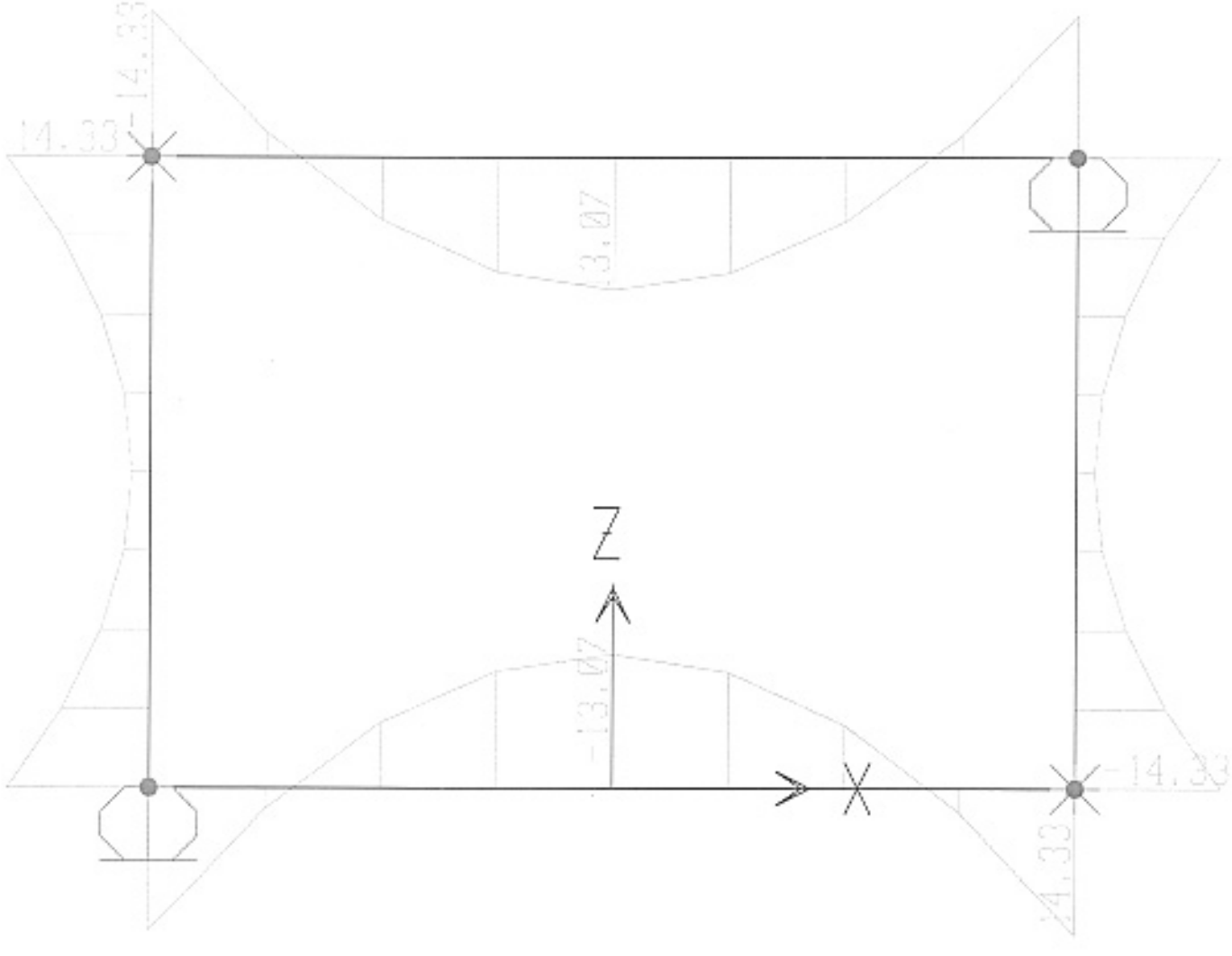
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	17.51	3.30	3.60	OK!!!



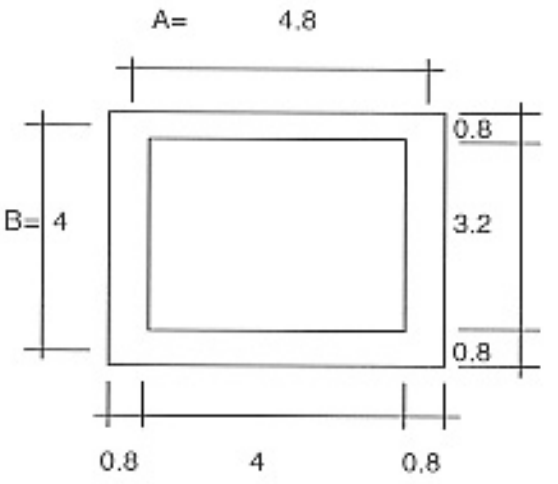
SAP2000 v6.11 - File:MHtype31 - Shear Force 2-2 Diagram (LOAD1) - Ton-m Units

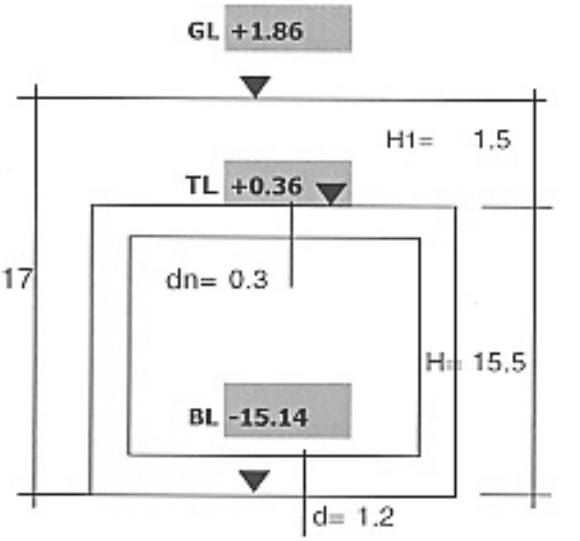

30.04
-30.04
-26.66
Z
-26.66
-30.04
30.04


-16.07
23.62
15.86
23.76
Z
23.62
15.86
-16.07
23.76


-14.33
-14.33
-3.07
Z
-13.07
X
-14.33
-14.33

CALCULATION FOR MAIN INTERCEPTOR MANHOLE (4)

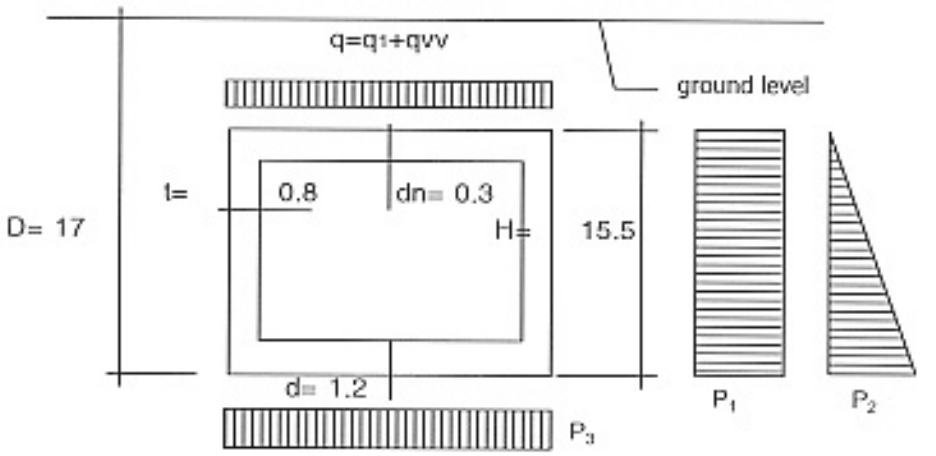




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*15.5*	m
Depth of manhole	*D=*	*17*	m
Width of manhole	*B =*	*4*	m
Length of manhole	*A=*	*4.8*	m
Thickness of cover slab	d_n =	*0.3*	m
Thickness of wall	*t =*	*0.8*	m
Thickness of bottom slab	*d =*	*1.2*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level:		+ 0.00	
Weight of soil:	γ =	1.8	T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_a = tg^2(45^0 - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{dc} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i= 0.3

P_{dc} = 11.35T/m

q_w = Pde/V 3.55 T/m²

Horizontal vehicle load from both sides of the manhole:

p_{hv} = $1.0xK_a$ = 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 2.7 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_a+H_1x1.0=$ 2.1 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_a$ 20.02 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_a$ 2.1 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 15.5 T/m²

C. Self load :

-Load due to cover slab:

Q_c = 2.5x(A+t)x(B+t)xdn= 20.16 Ton

-Load due to walls:

Q_w = 2.5x(A+B)x2x(H-dn-d)xt= 492.80 Ton

-Load due to bottom slab:

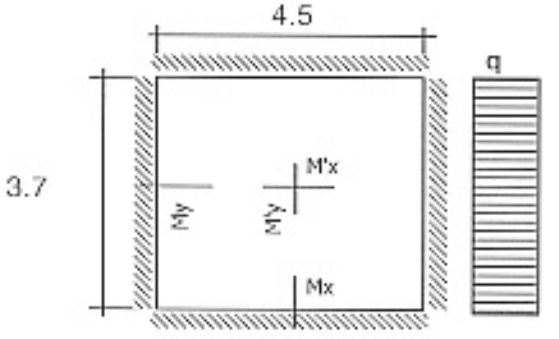
Q_b = 2.5x(A+t)x(B+t)xd= 80.64 Ton

D. Live load (with full of water in manhole) :

qw = 14 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+qvv+2.5xdn =$ 7.00 T/m²

-Thickness of cover slab : 0.3 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n b h_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Rah_o$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.22

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.047	Mx	5.47429	0.12513	0.93294	15.95	16	125
0.0314	My	3.65729	0.0836	0.95629	10.39	14	125
0.0205	M'x	2.3877	0.05458	0.97192	6.68	14	250
0.0137	M'y	1.5957	0.03647	0.98142	4.42	14	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -13.94

-Uniform distributed loads :

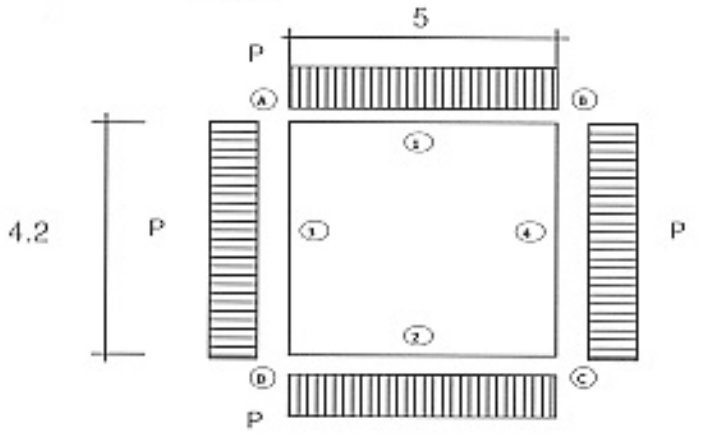
$P_1 = p_{hv}+p_{11}=$ 2.60 T/m²

$P_2 = p_{22}=$ 20.02 T/m²

$P=P_1+P_2=$ 22.62 T/m²

Thickness of wall: 1 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

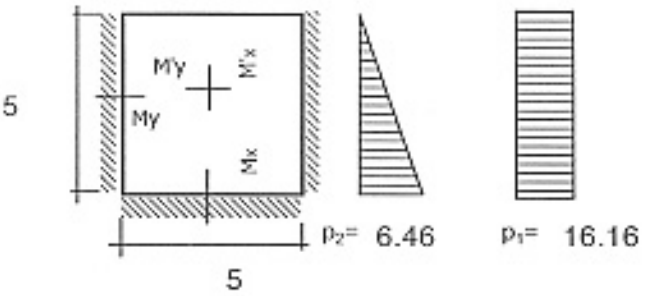
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	29.87	0.04934	0.97469	20.60	20	125
M_A	41.17	0.068	0.96476	28.68	22	125
M_3	9.08	0.015	0.99244	6.15	14	250

Compare with three sides fix diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 5 m

-Length of slab B 5 m

-Triangular distributed loads p_2= 6.46 T/m

-Uniform distributed loads p_1= 16.16 T/m

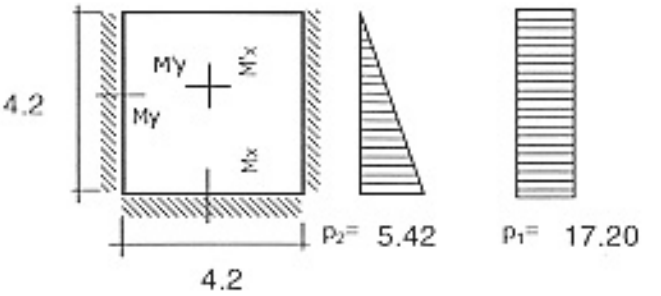
-Thickness of bottom slab d= 1 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	27.4137	0.05	0.97682	18.8603	18	125
0.0538	0.0664	My	31.1719	0.05	0.97356	21.5178	20	125
0.0172	0.0084	M'x	4.78249	0.01	0.99603	3.2268	12	250
0.0246	0.0257	M'y	12.3699	0.02	0.98968	8.3998	12	125

Diagram calculation for analysis in the direction B :



-Width of slab: A 4.2 m

-Length of slab B 4.2 m

-Triangular distributed loads p_2= 5.42 T/m

-Uniform distributed loads p_1= 17.20 T/m

-Thickness of bottom slab d= 1 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							O(mm)	a(mm)
0.0598	0.0559	Mx	19.817	0.03	0.98336	13.5433	16	125
0.0538	0.0664	My	22.7148	0.04	0.98087	15.5630	16	125
0.0172	0.0084	M'x	3.37088	0.01	0.99721	2.2717	12	250
0.0246	0.0257	M'y	8.97245	0.01	0.99253	6.0752	14	250

B. Calculation for wall at level : -10.14

-Uniform distributed loads :

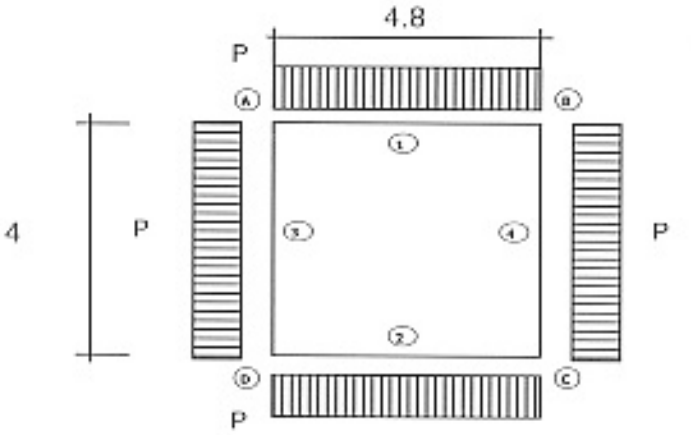
$P_1 = p_{hv}+p_{11}=$ 2.60 T/m²

$P_2 = p_{22}=$ 14.00 T/m²

$P=P_1+P_2=$ 16.60 T/m²

Thickness of wall: 0.8 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	20.36	0.05458	0.97192	17.94	18	125
M_A	27.66	0.07415	0.96144	24.63	20	125
M_3	5.57	0.01493	0.99248	4.80	14	250

C. Calculation for wall at level : -4.14

-Uniform distributed loads :

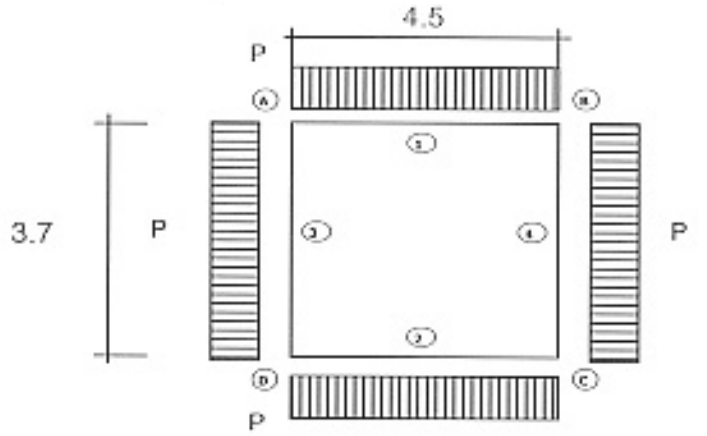
$P_1 = p_{hv}+p_{11}=$ 2.60 T/m²

$P_2 = p_{22}=$ 6.30 T/m²

$P=P_1+P_2=$ 8.90 T/m²

Thickness of wall: 0.5 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

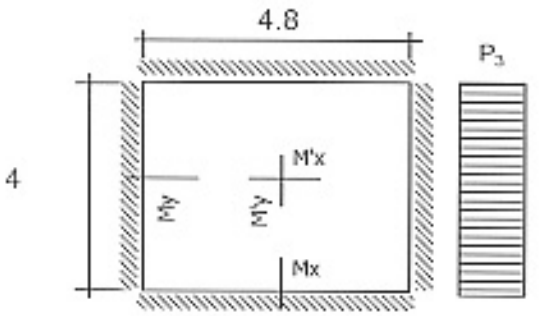
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_n	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	9.7	0.07494	0.96101	14.67	16	125
M_A	12.87	0.09944	0.94753	19.74	18	125
M_3	2.41	0.01862	0.9906	3.54	12	250

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+qvv+pu +(Qc+Qw+Qb)/[(A+t)x(B+t)]=$ 43.83 T/m²

-Thickness of bottom slab: 1.2 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.20

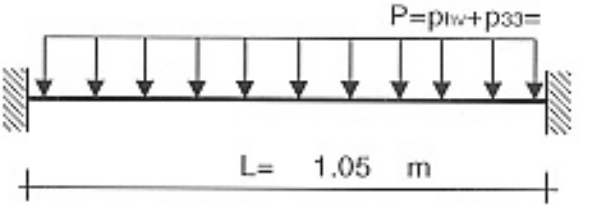
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_n	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.047	Mx	39.5511	0.04272	0.97816	23.40	20	125
0.0314	My	26.423	0.02854	0.98552	15.52	18	125
0.0205	M'x	17.251	0.01863	0.99059	9.63	14	125
0.0137	M'y	11.529	0.0125	0.99373	6.42	14	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A.The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 2.60 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.238875	0.01517	0.99236	0.75	12	250
M2	0.119438	0.00758	0.99619	0.37	12	250

7-Checking for shearing forces of wall:

At level -14.14

-Height of hand for supporting wall s= 0.00 m , so the section need to be checked

shear bearing capacity is [t+s/2]= 1.00 m far from center of wall

Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V_{A-1}	33.90	3.60	3.60	OK!!!

At level -10.14

-Height of hand for supporting wall s= 0.00 m , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.80 m far from center of wall

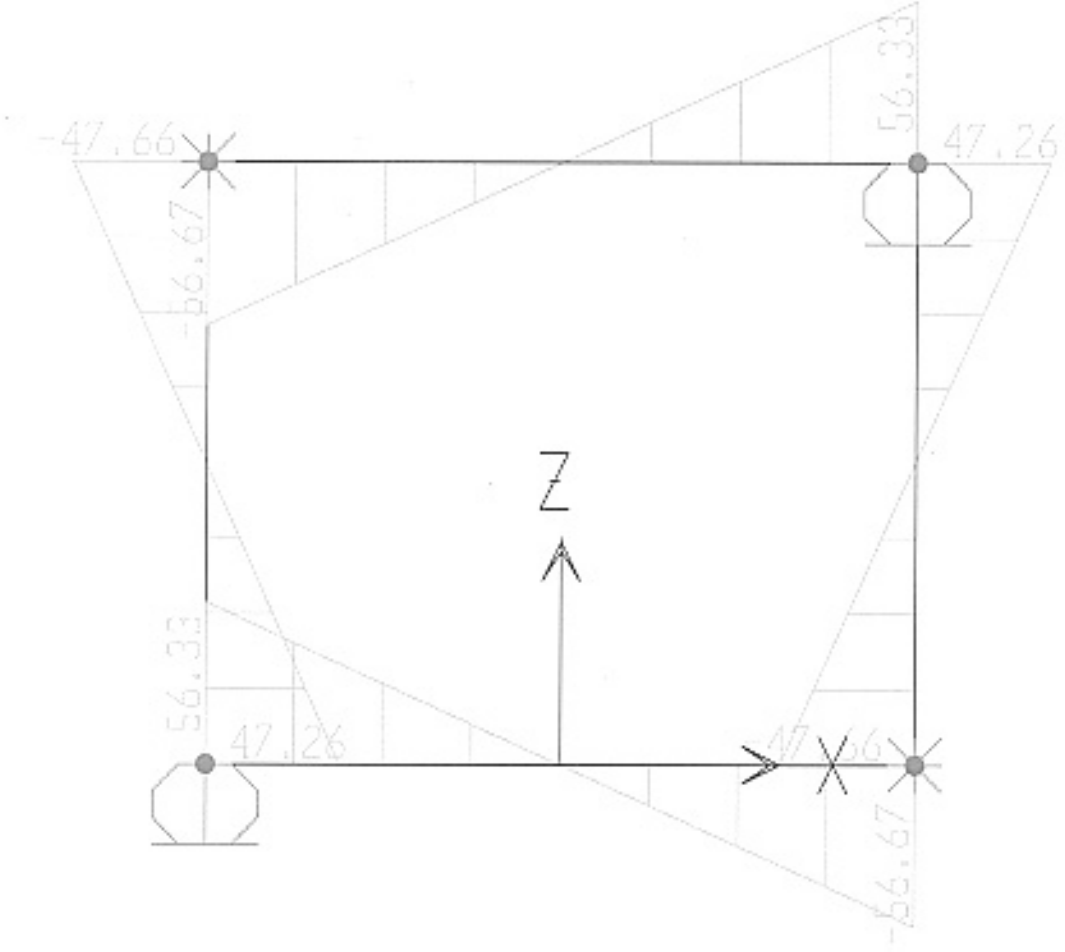
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V_{A-1}	26.56	3.60	3.60	OK!!!

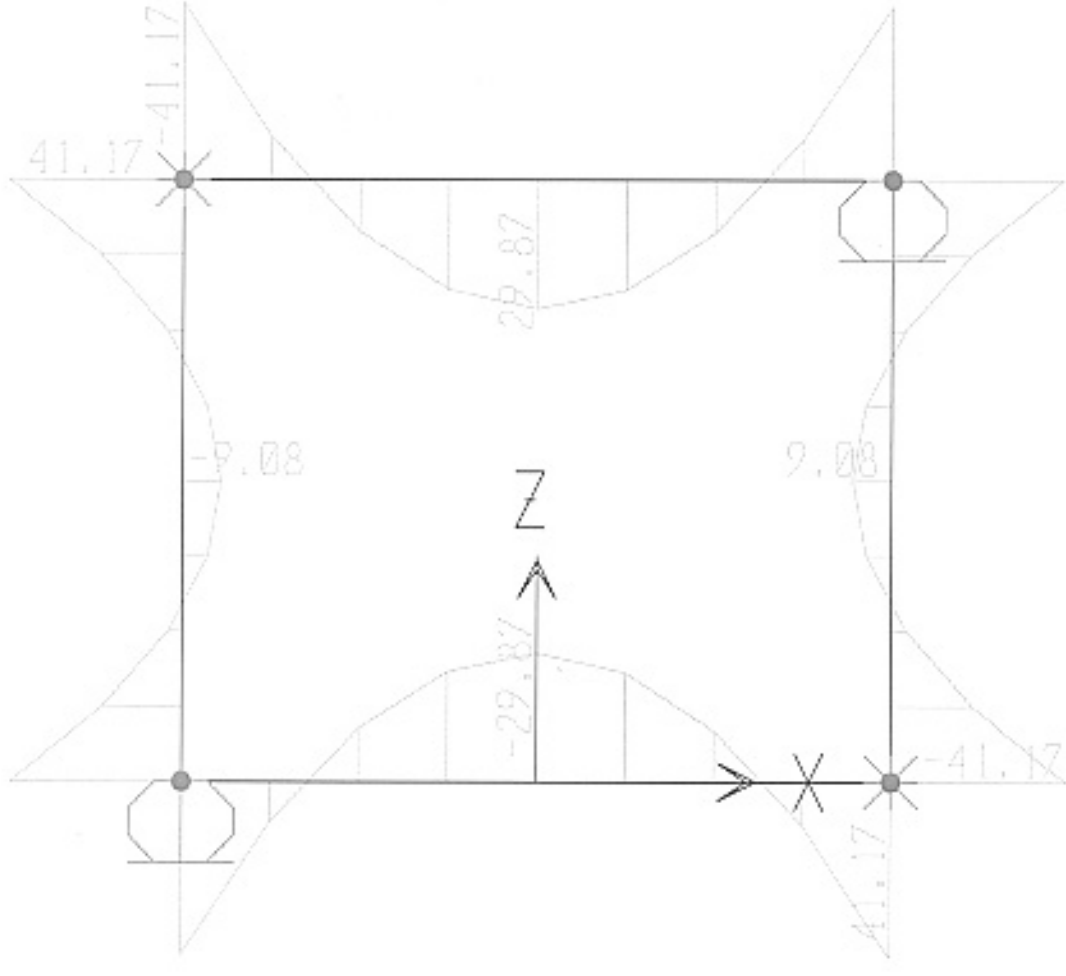
At level -4.14

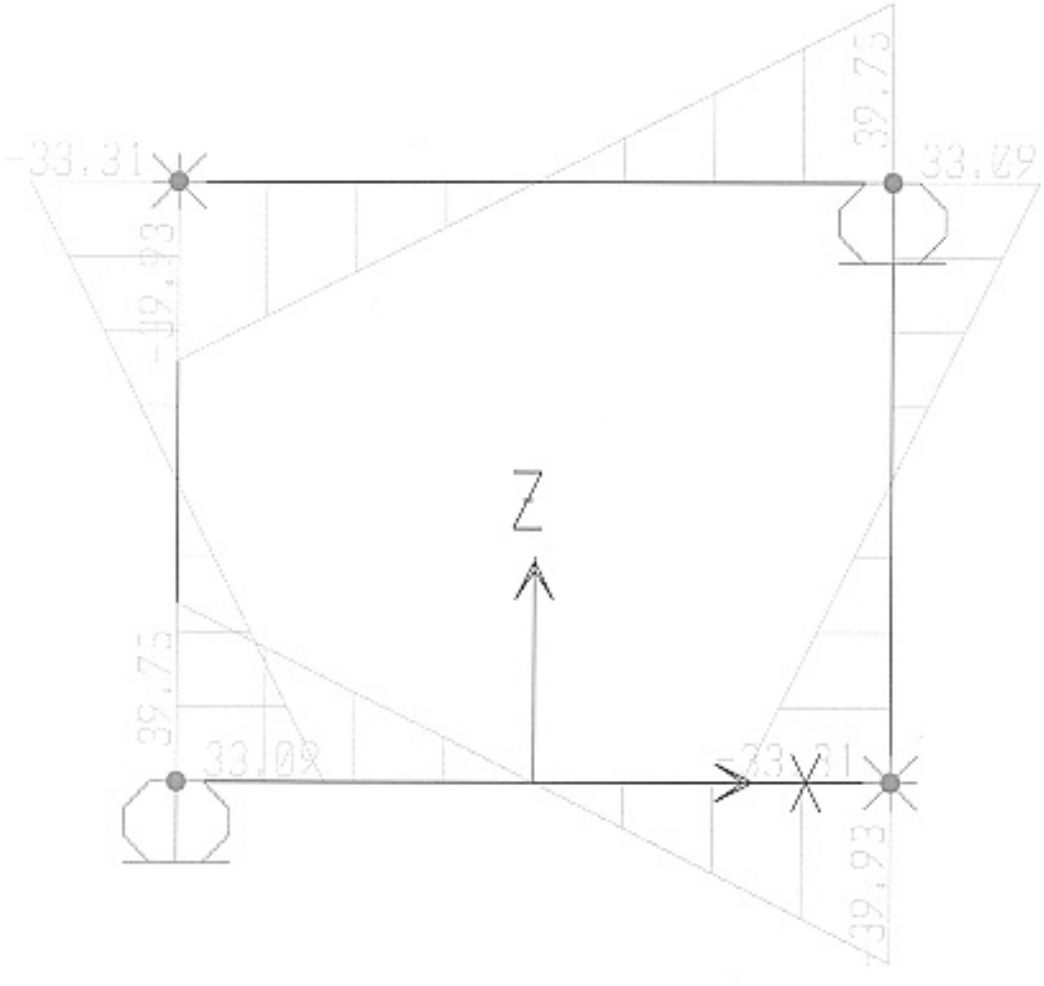
-Height of hand for supporting wall s= 0.00 m , so the section need to be checked

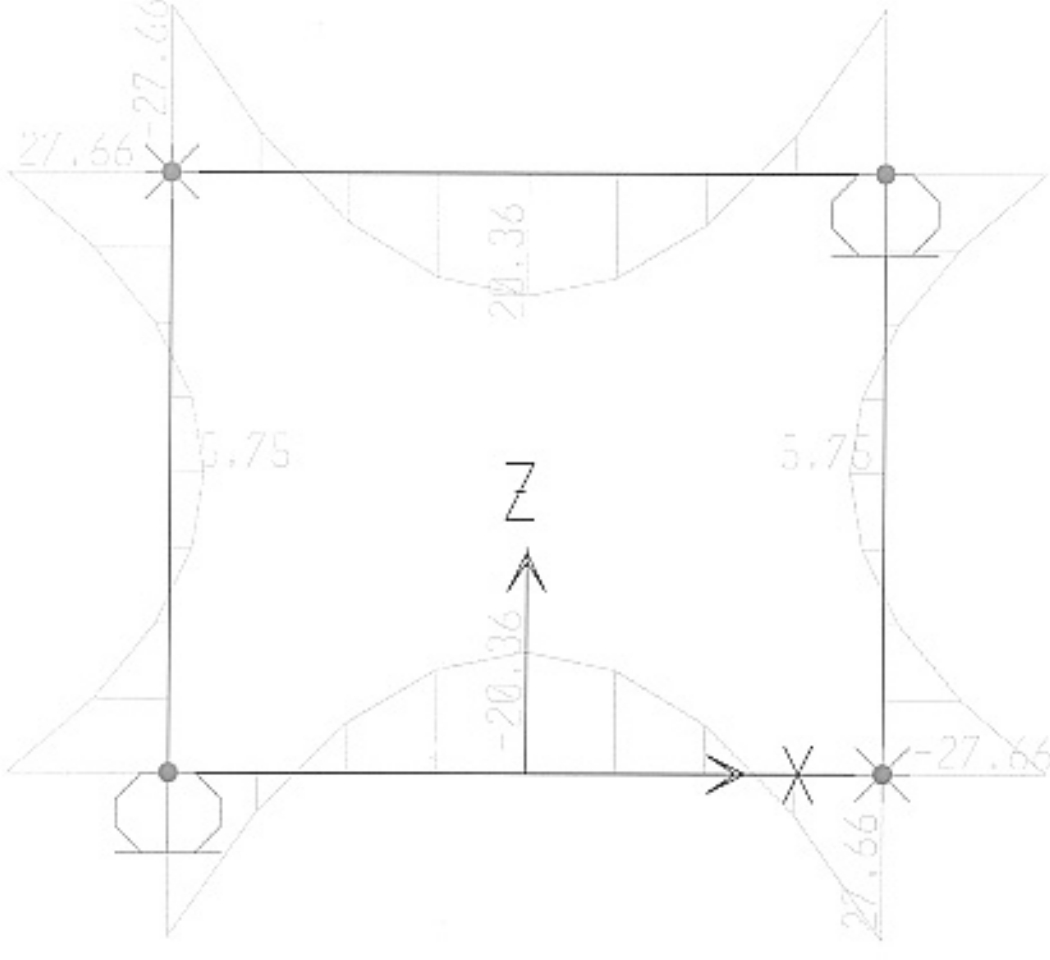
shear bearing capacity is [t+s/2]= 0.50 m far from center of wall

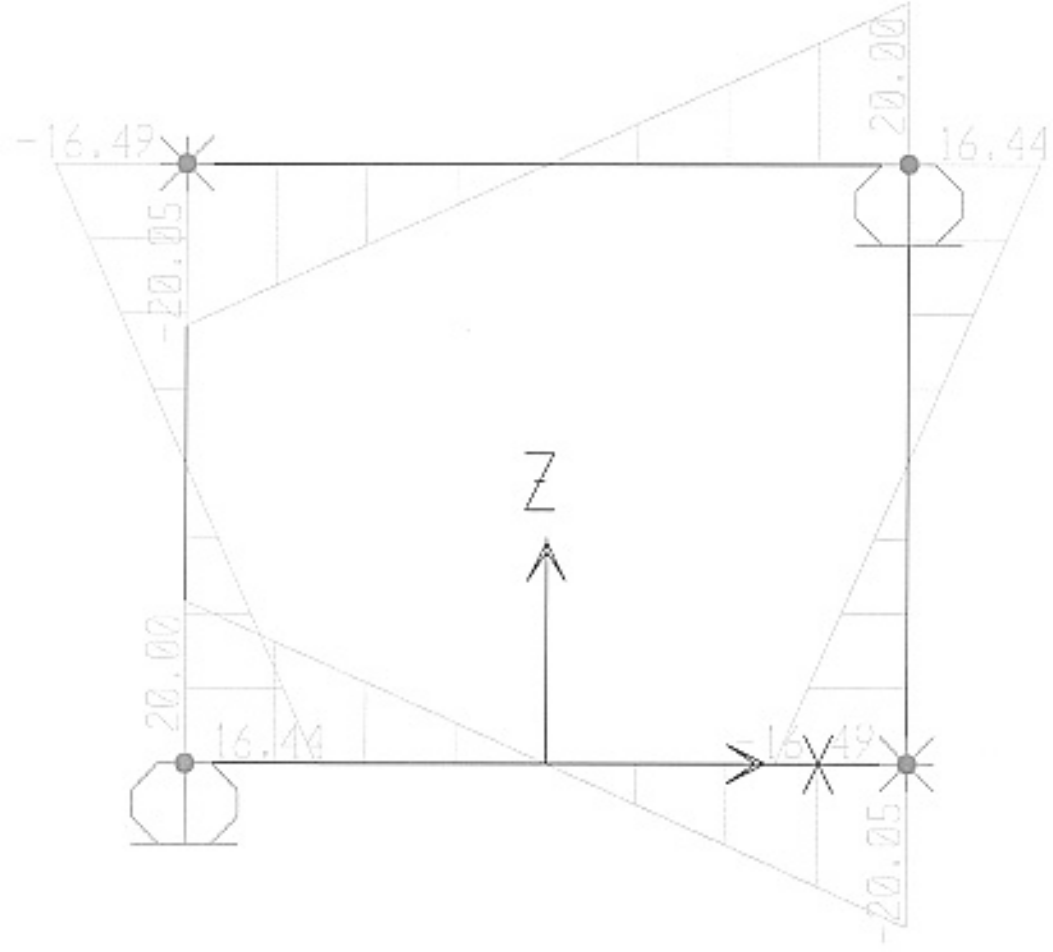
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V_{A-1}	15.58	3.60	3.60	OK!!!

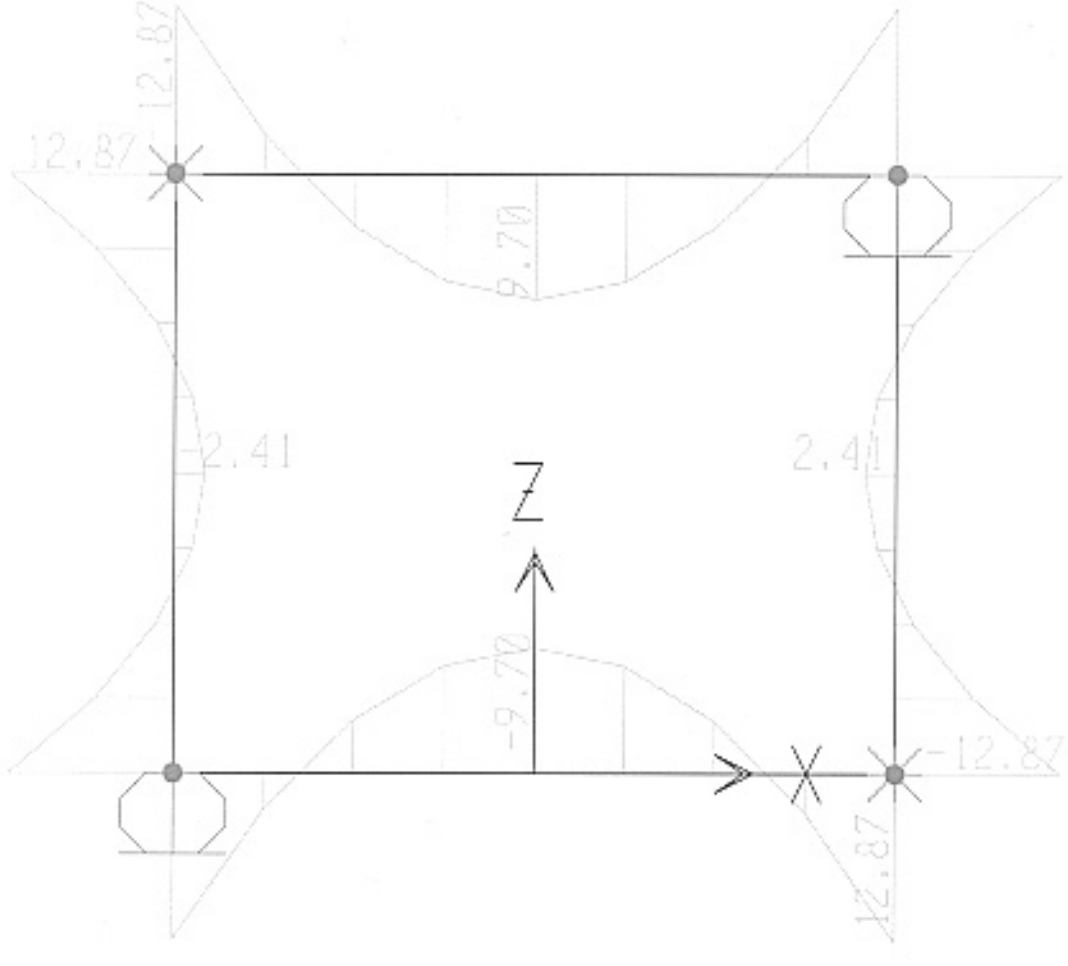

-47.66
56.33
47.26
-56.67
Z
56.33
47.26
47.66
-56.67


41.17
-41.17
29.87
-9.08
9.08
Z
-29.87
-41.17
41.17

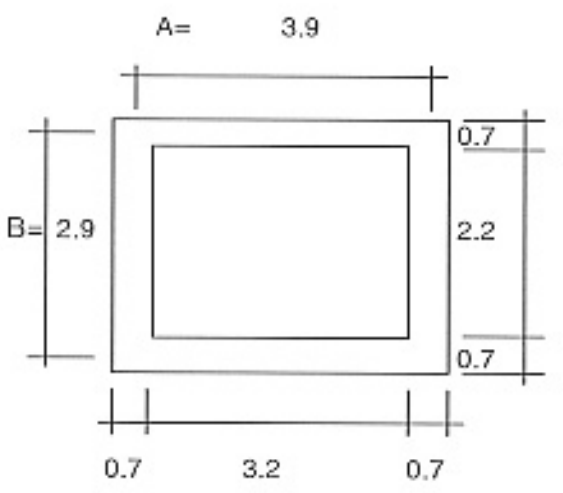

-33.31
39.75
33.09
-39.93
33.09
-23.21
39.93
Z

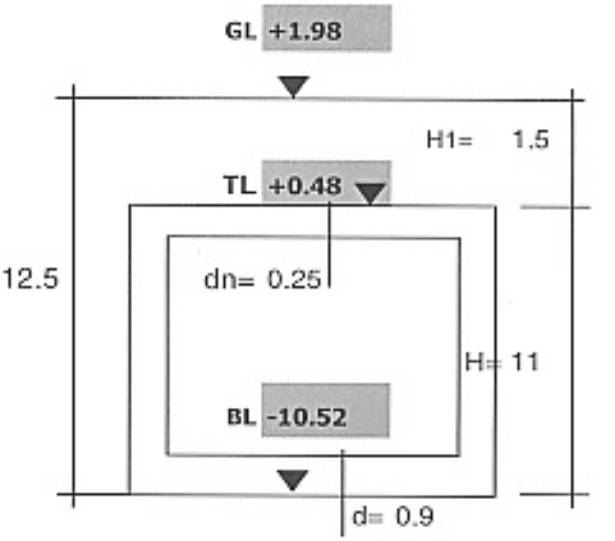

27.66
-27.66
20.36
5.75
5.75
Z
-20.36
-27.66
27.66


-16.49
20.00
16.44
-20.05
Z
20.02
16.44
16.49
-20.05


12.87
12.87
9.70
2.41
2.41
Z
-9.70
-12.87
12.87

CALCULATION FOR MAIN INTERCEPTOR MANHOLE (5)

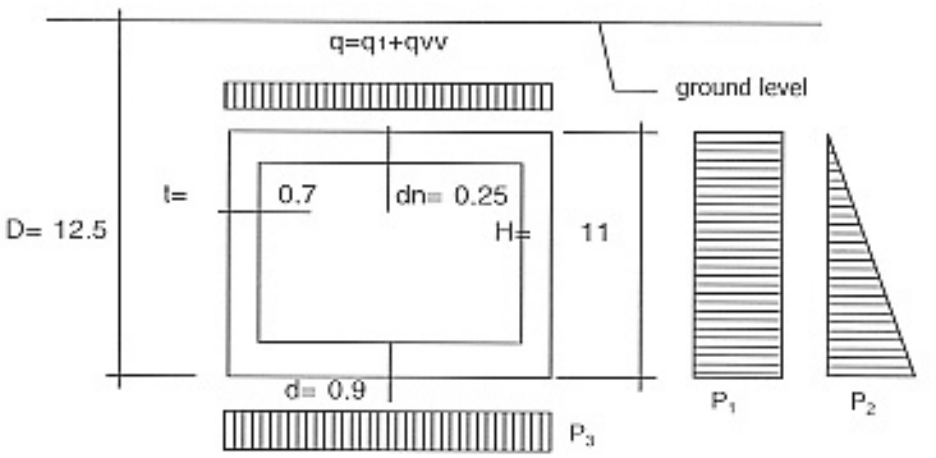




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*11*	m
Depth of manhole	*D=*	*12.5*	m
Width of manhole	*B =*	*2.9*	m
Length of manhole	*A=*	*3.9*	m
Thickness of cover slab	d_n =	*0.25*	m
Thickness of wall	*t =*	*0.7*	m
Thickness of bottom slab	*d =*	*0.9*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level:		+ 0.00	
Weight of soil:	γ =	1.8	T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_o = tg^2(45^o - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{de} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i= 0.3

P_{de} = 11.35T/m

q_w = Pde/V 3.55 T/m²

Horizontal vehicle load from both sides of the manhole:

$p_{hw} = 1.0xK_o =$ 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 2.7 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 2.1 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_o$ 14.14 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 2.1 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 11 T/m²

C. Self load :

-Load due to cover slab:

$Q_c = 2.5x(A+t)x(B+t)xdn=$ 10.35 Ton

-Load due to walls:

$Q_w = 2.5x(A+B)x2x(H-dn-d)xt=$ 234.43 Ton

-Load due to bottom slab:

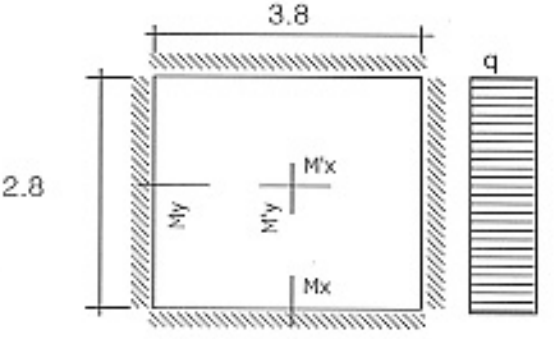
$Q_b = 2.5x(A+t)x(B+t)xd=$ 37.26 Ton

D. Live load (with full of water in manhole) :

qw = 9.85 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+q_{vv}+2.5xd_n =$ 6.87 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_nbh_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Raho$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.36

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0474	Mx	3.46502	0.12375	0.93373	11.60	14	125
0.0262	My	1.91526	0.0684	0.96454	6.21	14	250
0.021	M'x	1.5351	0.05483	0.97179	4.94	12	250
0.0115	M'y	0.84067	0.03002	0.98476	2.67	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -9.62

-Uniform distributed loads :

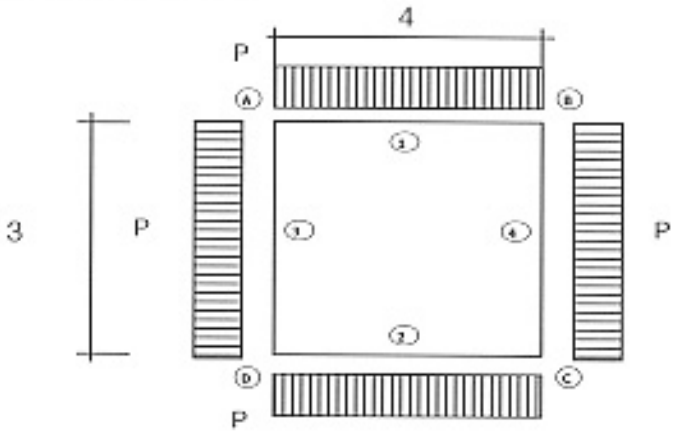
$P_1 = p_{hv}+p_{11}=$ 2.60 T/m²

$P_2 = p_{22}=$ 14.14 T/m²

$P=P_1+P_2=$ 16.74 T/m²

Thickness of wall: 0.8 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

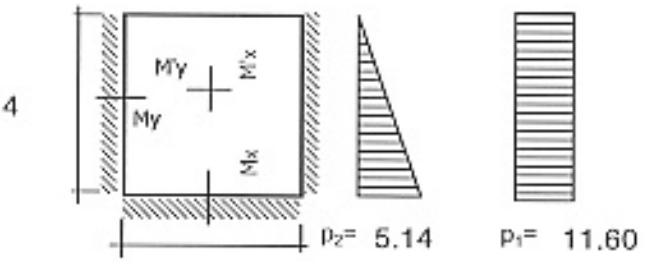
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	15.35	0.04115	0.97898	13.42	16	125
M_A	18.45	0.04946	0.97463	16.21	18	125
M_3	0.7	0.00188	0.99906	0.60	12	250

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 4 m

-Length of slab B 4 m

-Triangular distributed loads p_2= 5.14 T/m

-Uniform distributed loads p_1= 11.60 T/m

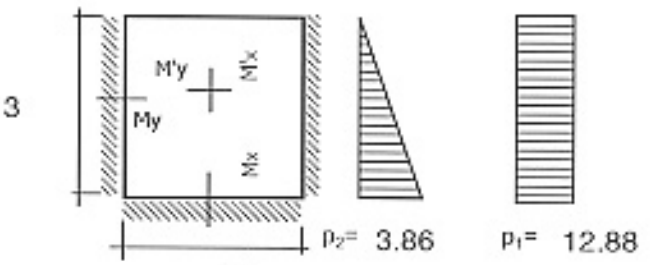
-Thickness of bottom slab d= 0.8 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	12.8333	0.03	0.98249	11.1832	14	125
0.0538	0.0664	My	14.5349	0.04	0.98012	12.6967	16	125
0.0172	0.0084	M'x	2.26631	0.01	0.99695	1.9463	12	250
0.0246	0.0257	M'y	5.78108	0.02	0.99219	4.9885	14	250

Diagram calculation for analysis in the direction B :



-Width of slab: A 3 m

-Length of slab B 3 m

-Triangular distributed loads p_2= 3.86 T/m

-Uniform distributed loads p_1= 12.88 T/m

-Thickness of bottom slab d= 0.8 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							O(mm)	a(mm)
0.0598	0.0559	Mx	7.5195	0.02	0.98982	6.5042	12	125
0.0538	0.0664	My	8.63289	0.02	0.98829	7.4787	12	125
0.0172	0.0084	M'x	1.27249	0.00	0.99829	1.0913	12	250
0.0246	0.0257	M'y	3.40688	0.01	0.99541	2.9303	12	250

B. Calculation for wall at level : -5.52

-Uniform distributed loads :

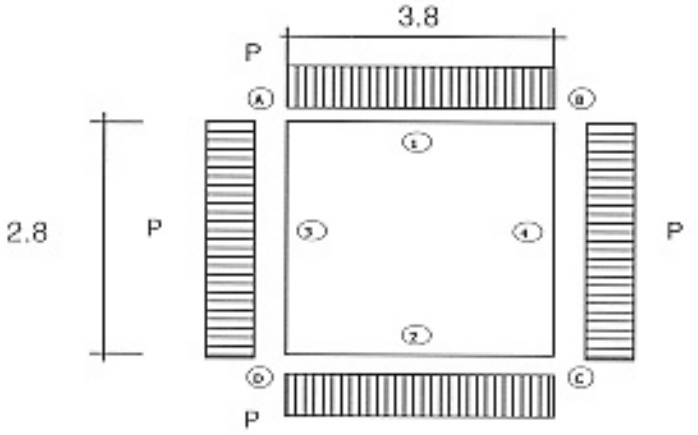
$P_1 = p_{hv} + p_{11} =$ 2.60 T/m²

$P_2 = p_{22} =$ 8.40 T/m²

$P = P_1 + P_2 =$ 11.00 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

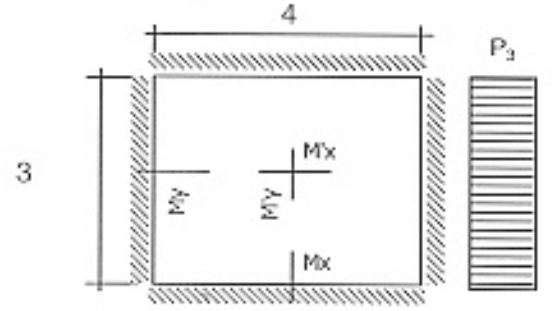
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	9.19	0.04674	0.97606	11.10	14	125
M_A	10.8	0.05493	0.97174	13.11	16	125
M_3	0.11	0.00056	0.99972	0.13	12	250

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+qvv+pu+(Qc+Qw+Qb)/[(A+t)x(B+t)]=$ 34.28 T/m²

-Thickness of bottom slab: 0.9 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.33

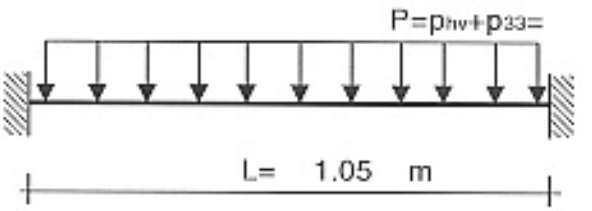
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0474	Mx	19.4967	0.03855	0.98034	15.94	18	125
0.0271	My	11.147	0.02204	0.98886	9.03	12	125
0.0209	M'x	8.597	0.017	0.99143	6.53	12	125
0.0119	M'y	4.895	0.0097	0.99514	3.70	12	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A.The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 2.60 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.238875	0.01517	0.99236	0.75	12	250
M2	0.119438	0.00758	0.99619	0.37	12	250

7-Checking for shearing forces of wall:

At level -9.62

-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.80 m far from center of wall

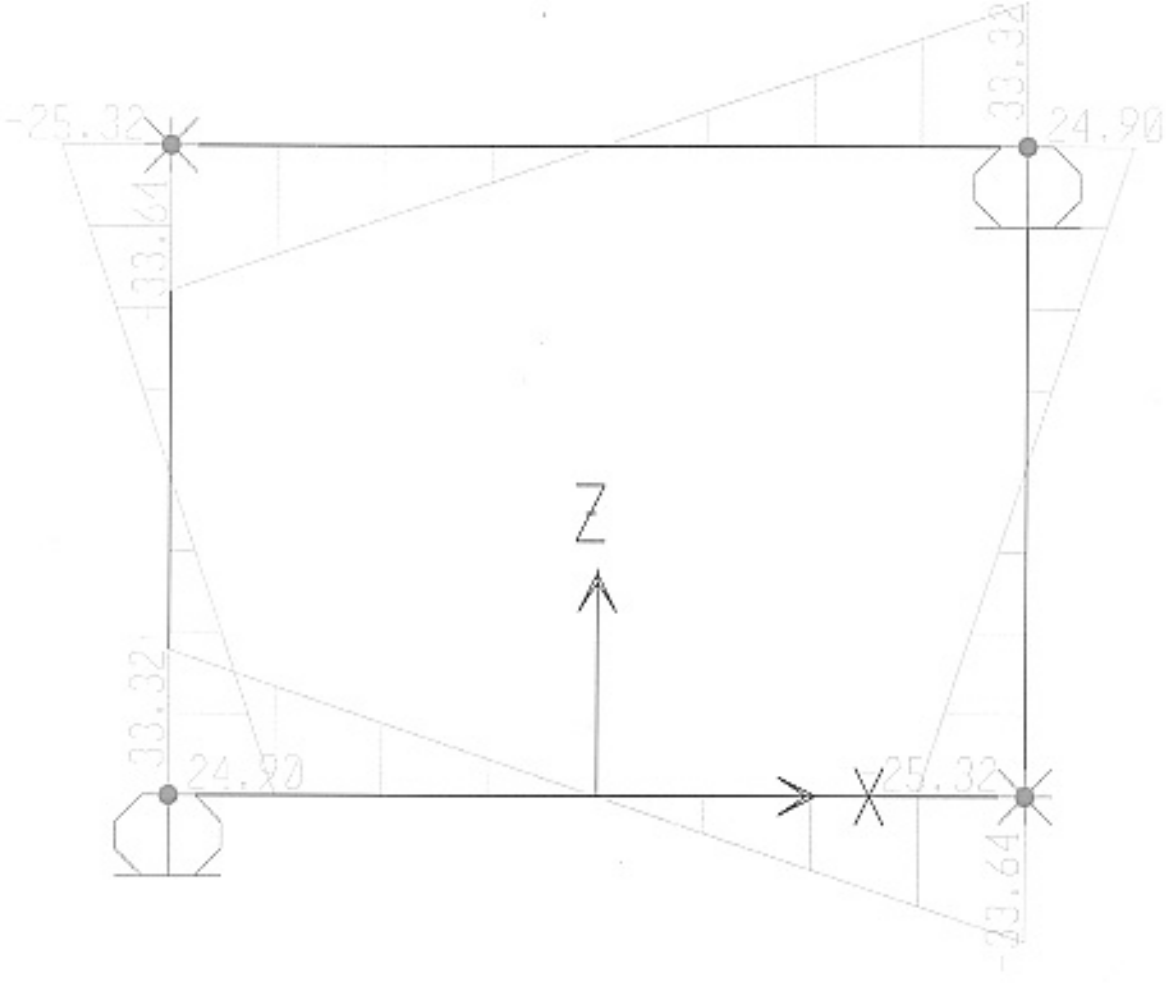
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	20.09	2.70	3.60	OK!!!

At level -5.52

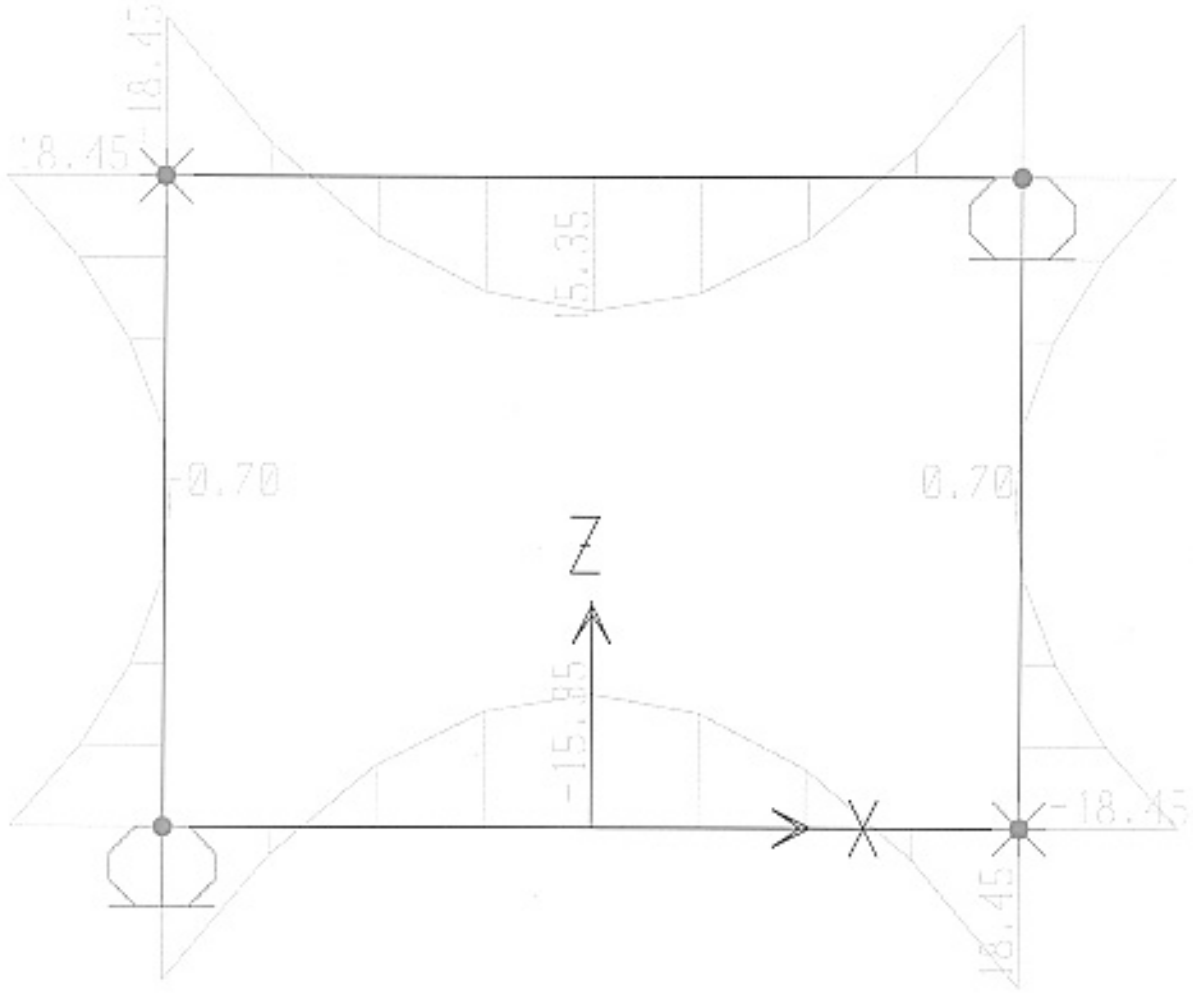
-Height of hand for supporting wall s= 0 , so the section need to be checked

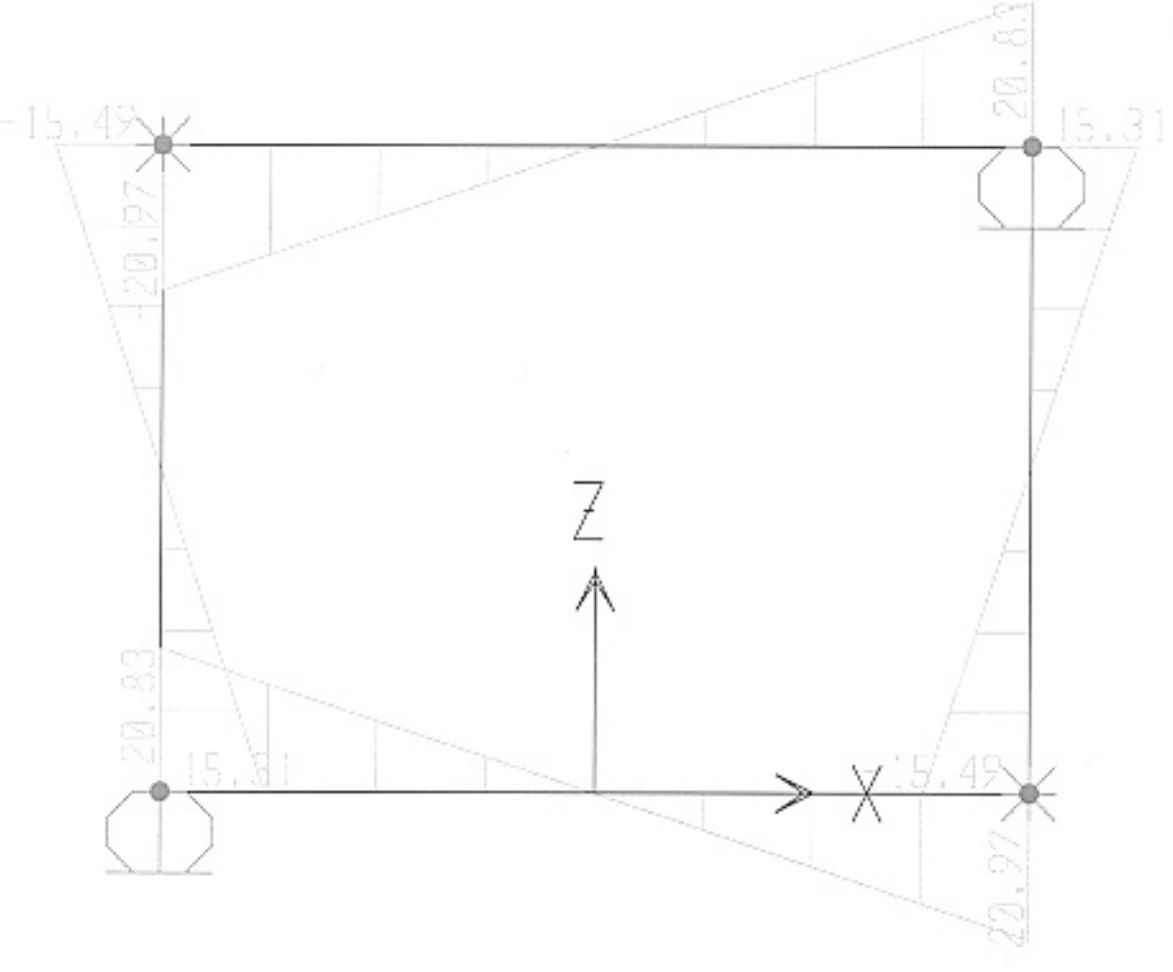
shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

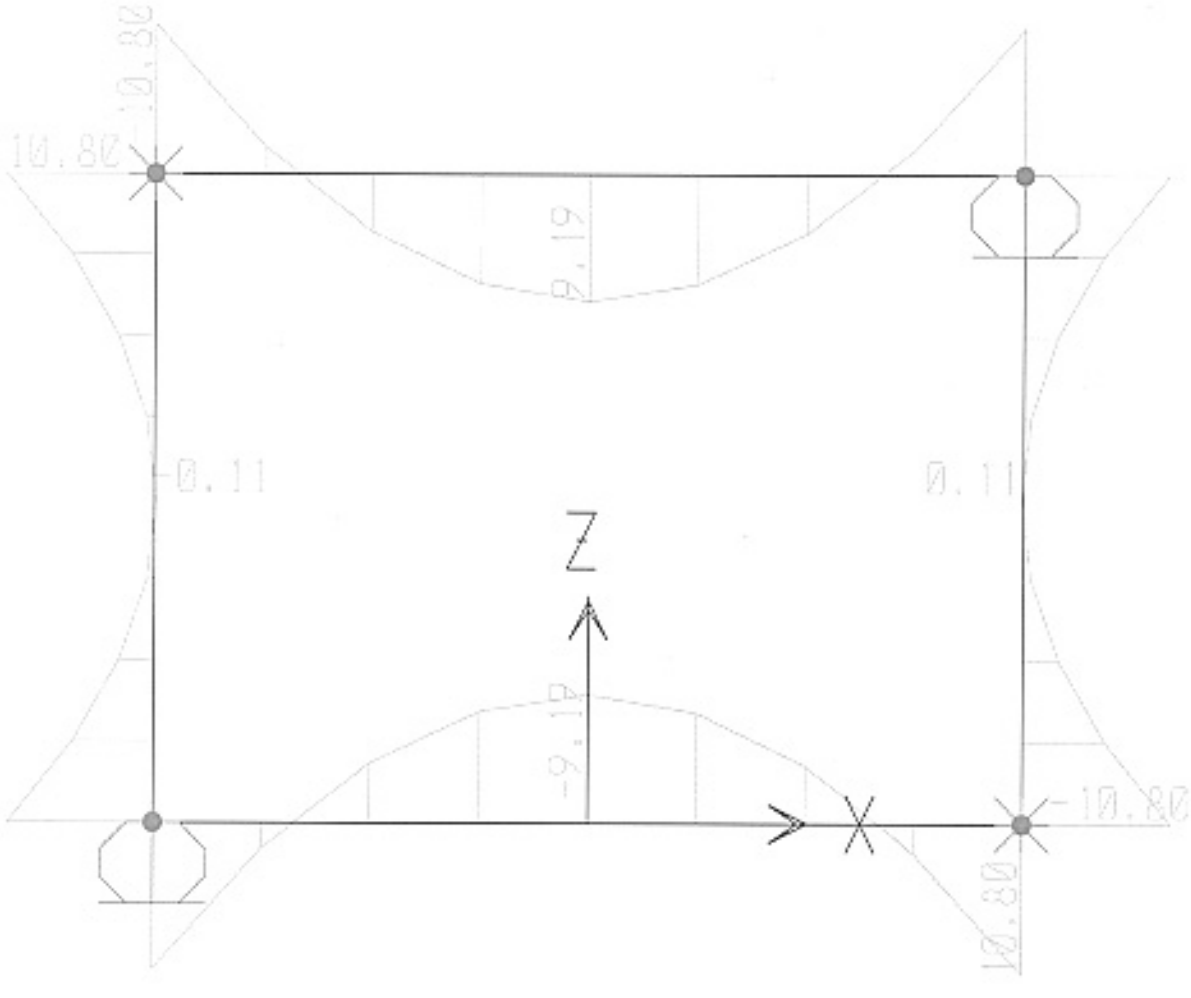
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	14.30	2.60	3.60	OK!!!



SAP2000 v6.11 - File:MHtype51 - Shear Force 2-2 Diagram (LOAD1) - Ton-m Units

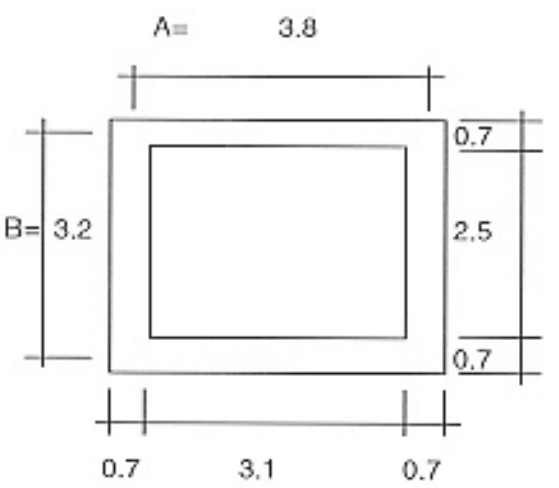

-18.45
-15.35
-0.70
0.70
Z
-15.35
-18.45
-18.45

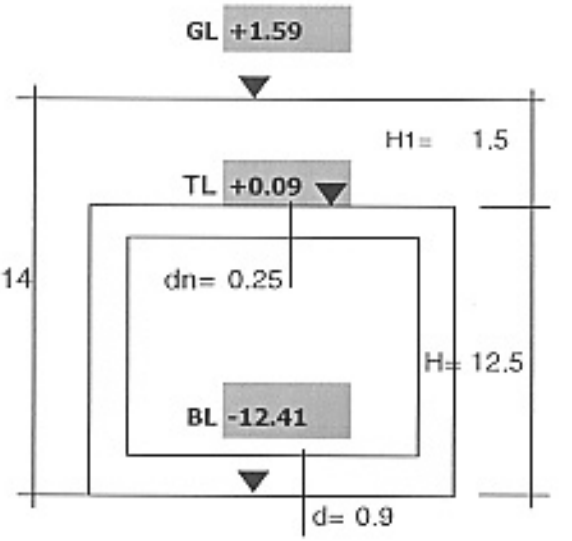

-15.49
20.83
15.31
-20.97
20.83
15.31
15.49
22.97
Z



3-1-53

CALCULATION FOR MAIN INTERCEPTOR MANHOLE (6)

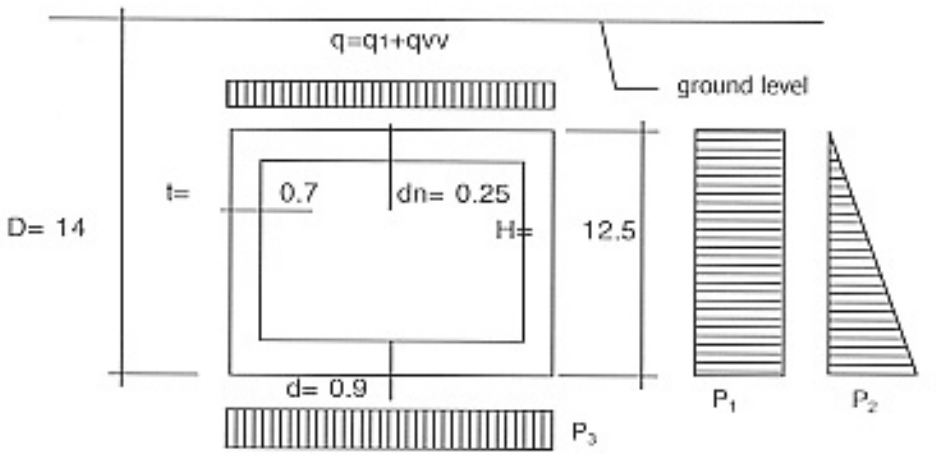




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*12.5*	m
Depth of manhole	*D=*	*14*	m
Width of manhole	*B =*	*3.2*	m
Length of manhole	*A=*	*3.8*	m
Thickness of cover slab	d_n =	*0.25*	m
Thickness of wall	*t =*	*0.7*	m
Thickness of bottom slab	*d =*	*0.9*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level:		+ 0.00	
Weight of soil:	γ =	1.8	T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_0 = tg^2(45^0 - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{de} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i= 0.3

P_{de} = 11.35T/m

q_w = Pde/V 3.55 T/m²

Horizontal vehicle load from both sides of the manhole:

$p_{lw} = 1.0xK_o =$ 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 2.7 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 2.1 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_o$ 16.24 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{13}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 2.1 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 12.5 T/m²

C. Self load :

-Load due to cover slab:

Q_c = 2.5x(A+t)x(B+t)xdn= 10.97 Ton

-Load due to walls:

Q_w = 2.5x(A+B)x2x(H-dn-d)xt= 278.08 Ton

-Load due to bottom slab:

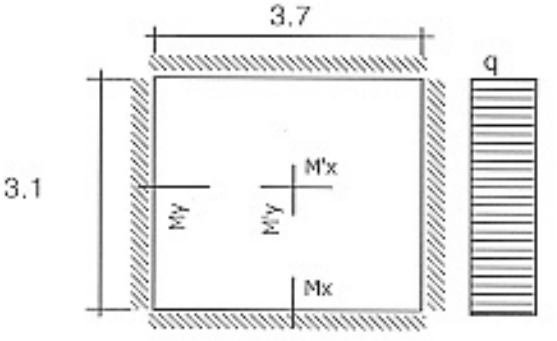
Q_b = 2.5x(A+t)x(B+t)xd= 39.49 Ton

D. Live load (with full of water in manhole) :

qw = 11.35 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+q_{vv}+2.5xd_n =$ 6.87 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n b h_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Rah_o$ Where: $\gamma = 0.5 + ((1-2A_o)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.19

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0468	Mx	3.68803	0.13172	0.92912	12.40	16	125
0.0325	My	2.56113	0.09147	0.95196	8.41	12	125
0.0204	M'x	1.6076	0.05741	0.97042	5.18	14	250
0.0142	M'y	1.11902	0.03996	0.9796	3.57	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -11.51

-Uniform distributed loads :

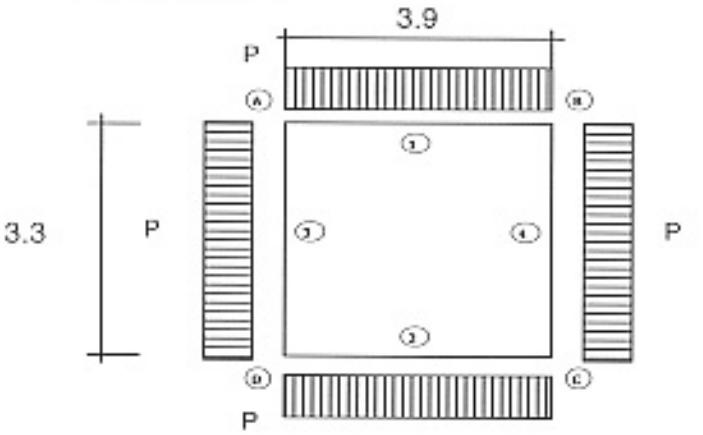
$P_1 = p_{hv}+p_{11}=$ 2.60 T/m²

$P_2 = p_{22}=$ 16.24 T/m²

$P=P_1+P_2=$ 18.84 T/m²

Thickness of wall: 0.8 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

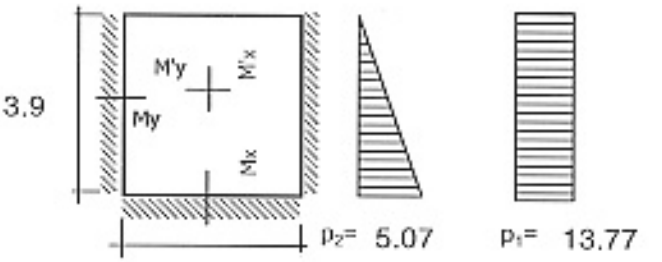
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	15.05	0.04035	0.9794	13.16	16	125
M_A	20.98	0.05624	0.97104	18.50	18	125
M_3	4.87	0.01306	0.99343	4.20	12	250

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 3.9 m

-Length of slab B 3.9 m

-Triangular distributed loads p_2= 5.07 T/m

-Uniform distributed loads p_1= 13.77 T/m

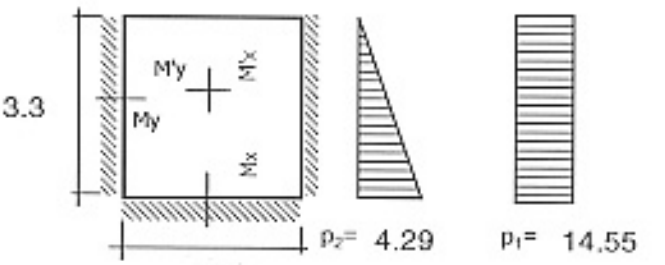
-Thickness of bottom slab d= 0.8 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	14.0148	0.04	0.98085	12.2332	14	125
0.0538	0.0664	My	15.9832	0.04	0.9781	13.9907	16	125
0.0172	0.0084	M'x	2.42249	0.01	0.99674	2.0808	12	250
0.0246	0.0257	M'y	6.3318	0.02	0.99144	5.4679	14	250

Diagram calculation for analysis in the direction B :



-Width of slab: A 3.3 m

-Length of slab B 3.3 m

-Triangular distributed loads p_2= 4.29 T/m

-Uniform distributed loads p_1= 14.55 T/m

-Thickness of bottom slab d= 0.8 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	10.2549	0.03	0.98606	8.9040	12	125
0.0538	0.0664	My	11.7789	0.03	0.98395	10.2491	14	125
0.0172	0.0084	M'x	1.73275	0.00	0.99767	1.4870	12	250
0.0246	0.0257	M'y	4.64717	0.01	0.99373	4.0038	12	250

B. Calculation for wall at level : -5.91

-Uniform distributed loads :

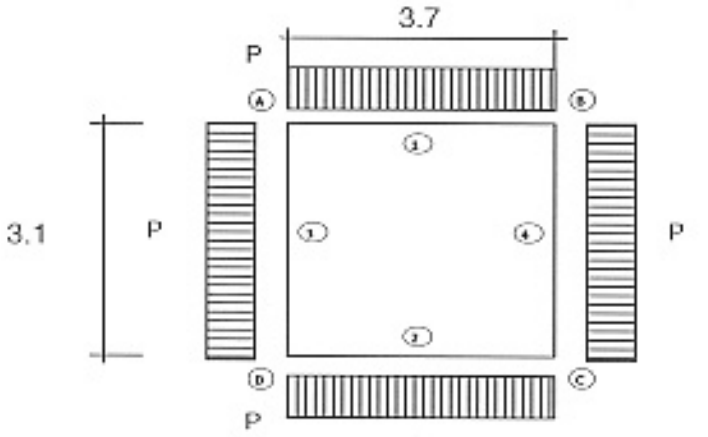
$P_1 = p_{liv} + p_{11} =$ 2.60 T/m²

$P_2 = p_{22} =$ 8.40 T/m²

$P = P_1 + P_2 =$ 11.00 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

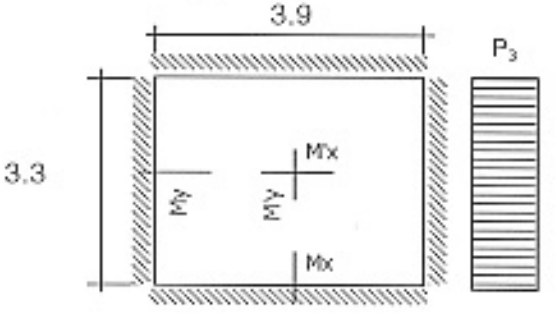
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	7.98	0.04058	0.97928	9.61	14	125
M_A	10.92	0.05554	0.97142	13.26	16	125
M_3	2.37	0.01205	0.99394	2.81	12	250

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+q_{VV}+p_u+(Q_c+Q_w+Q_b)/[(A+t)x(B+t)]=$ 37.47 T/m²

-Thickness of bottom slab: 0.9 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.18

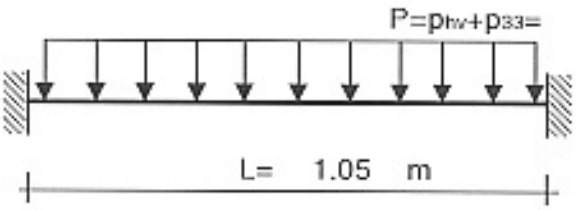
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0468	Mx	22.5659	0.04462	0.97717	18.50	18	125
0.0325	My	15.671	0.03099	0.98426	12.76	16	125
0.0204	M'x	9.836	0.01945	0.99018	7.48	12	125
0.0142	M'y	6.847	0.0135	0.99318	5.19	14	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A.The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 2.60 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.238875	0.01517	0.99236	0.75	12	250
M2	0.119438	0.00758	0.99619	0.37	12	250

7-Checking for shearing forces of wall:

At level -11.51

-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.80 m far from center of wall

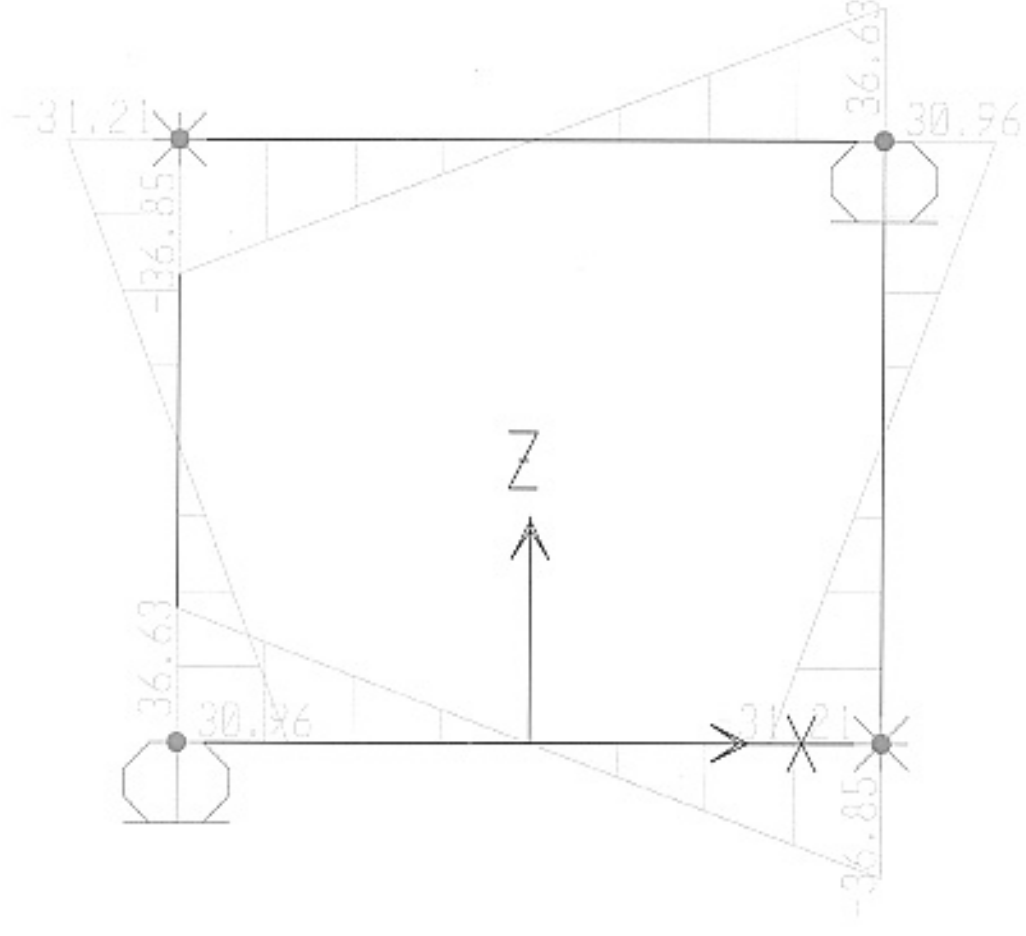
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	21.67	2.90	3.60	OK!!!

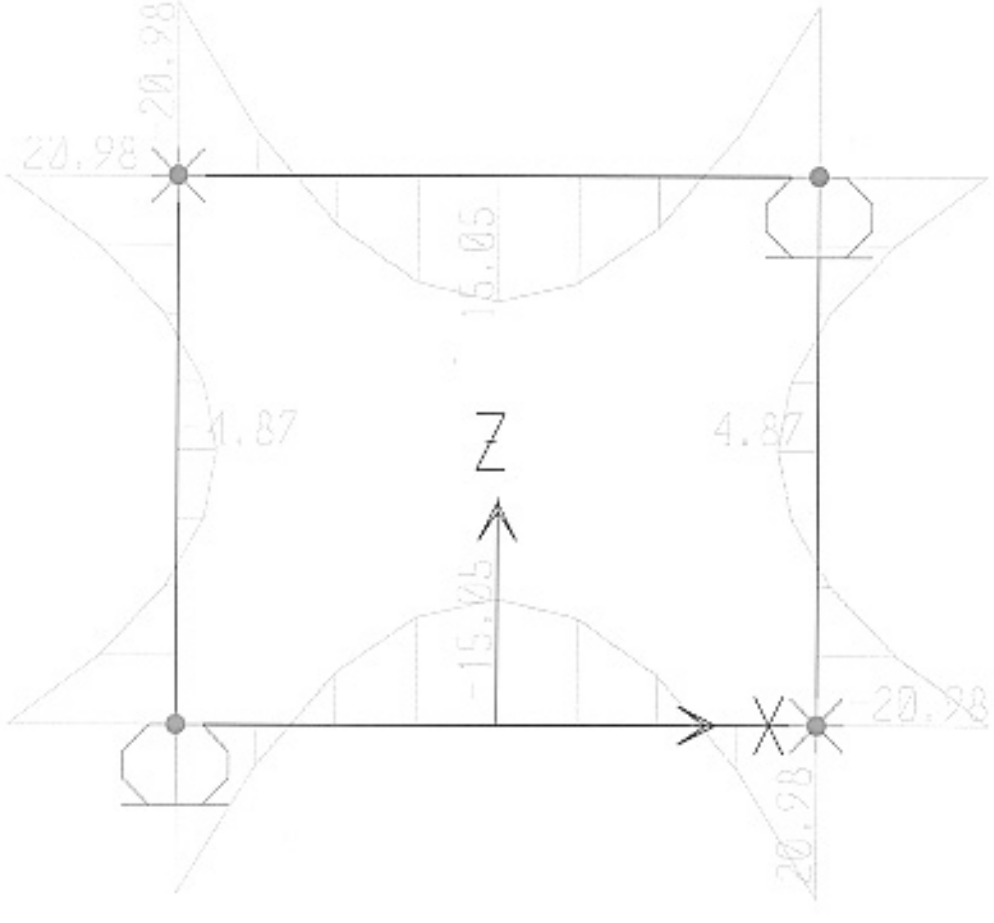
At level -5.91

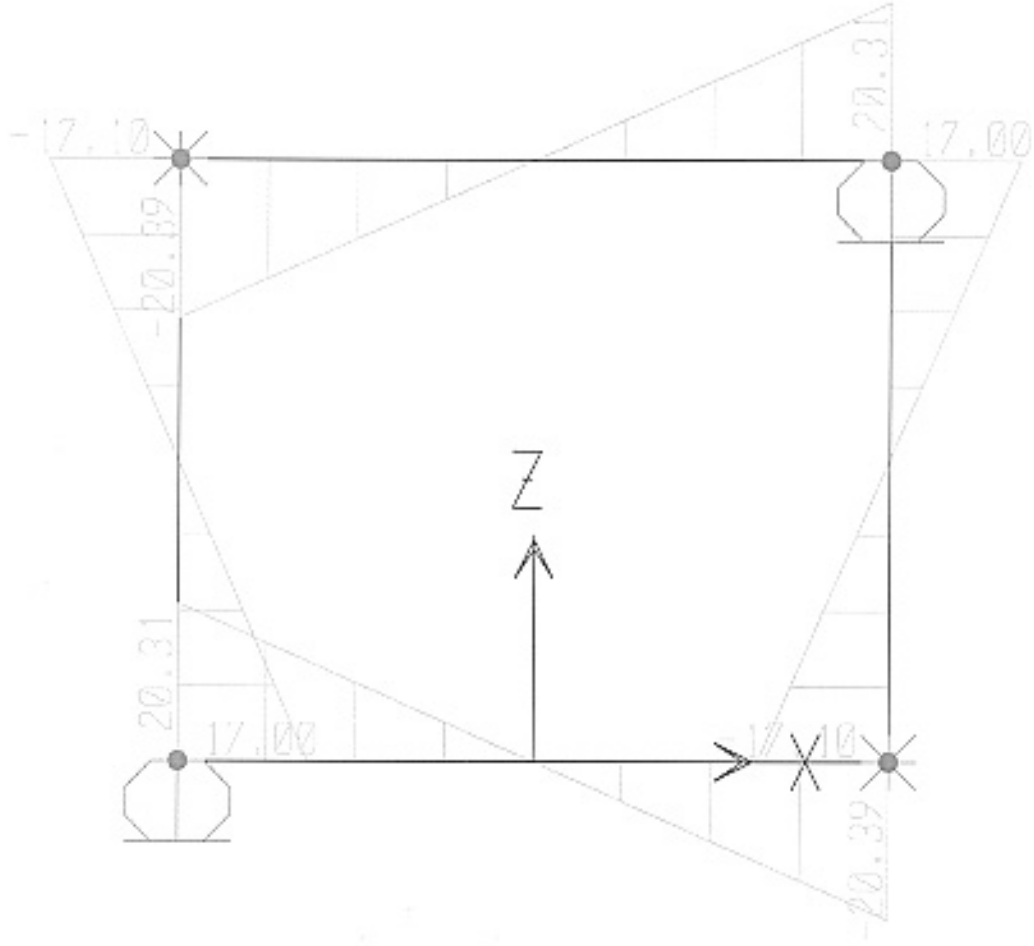
-Height of hand for supporting wall s= 0 , so the section need to be checked

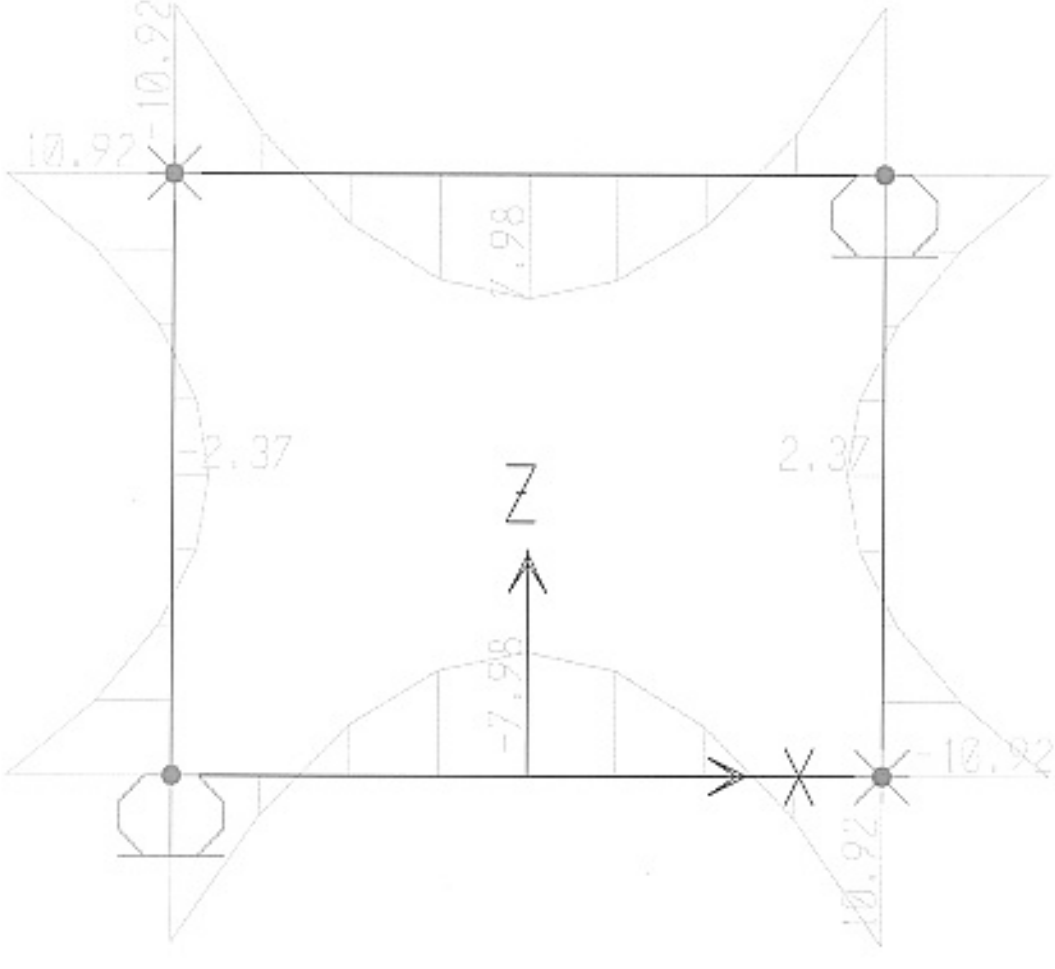
shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	13.75	2.50	3.60	OK!!!


-31.21
36.63
30.96
-36.85
Z
36.63
30.96
31.21
-36.85

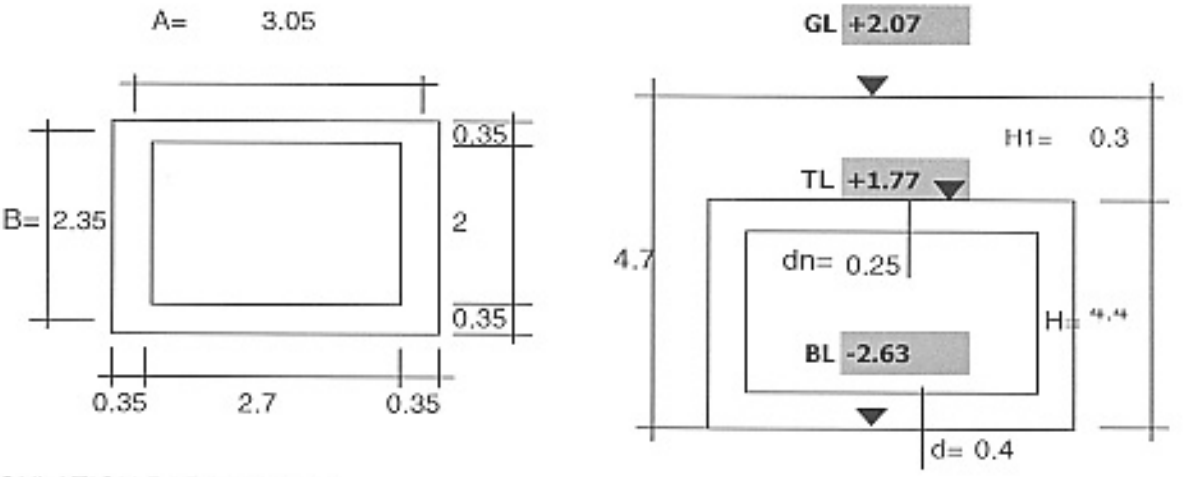

20.98
20.98
15.05
4.87
4.87
Z
-15.05
20.98
20.98


-17.10
20.31
17.00
-20.89
20.31
17.00
17.10
-20.39
Z



SAP2000 v6.11 - File:MHtype62 - Moment 3-3 Diagram (LOAD1) - Ton-m Units

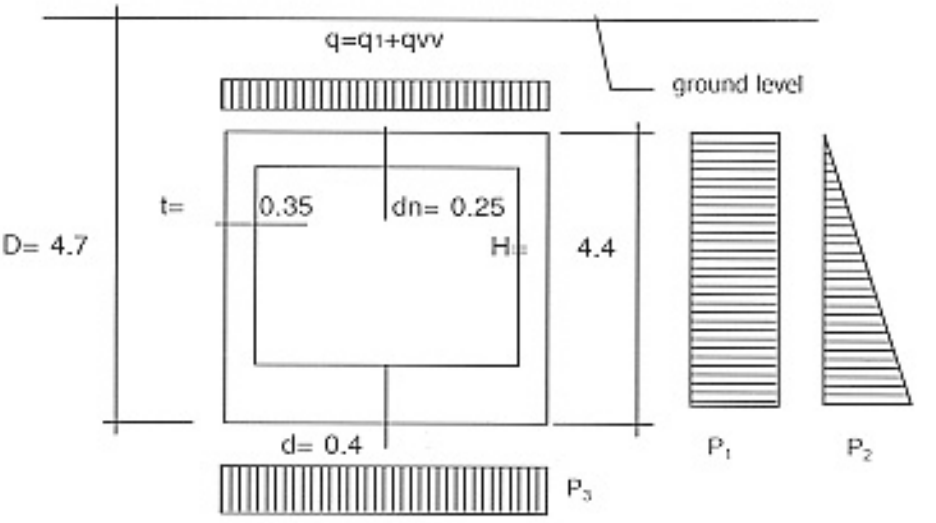
CALCULATION FOR DIVERSION CHAMBER TYPE DC 1



1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*4.4*	m
Depth of manhole	*D=*	*4.7*	m
Width of manhole	*B =*	*2.35*	m
Length of manhole	*A=*	*3.05*	m
Thickness of cover slab	d_n =	*0.25*	m
Thickness of wall	*t =*	*0.35*	m
Thickness of bottom slab	*d =*	*0.4*	m



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level: + 0.00

Weight of soil: γ = 1.8 T/m³

Soil internal friction angle : φ = 20^0 = 0.349066 (RAD)

$$K_o = tg^2(45^o - \frac{\varphi}{2}) = \quad 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{de} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o= 2.75 m

i, impact coefficient, i= 0.3

P_{de} = 11.35T/m

q_w = Pde/(B+t) 4.20 T/m²

Horizontal vehicle load from both sides of the manhole:

$p_w = 1.0xK_o =$ 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 0.54 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 0.42 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_o$ 5.6 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 0.42 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 4.4 T/m²

C. Self load :

-Load due to cover slab:

Q_c = 2.5x(A+t)x(B+t)xdn= 5.74 Ton

-Load due to walls:

Q_w = 2.5x(A+B)x2x(H-dn-d)xt= 35.44 Ton

-Load due to bottom slab:

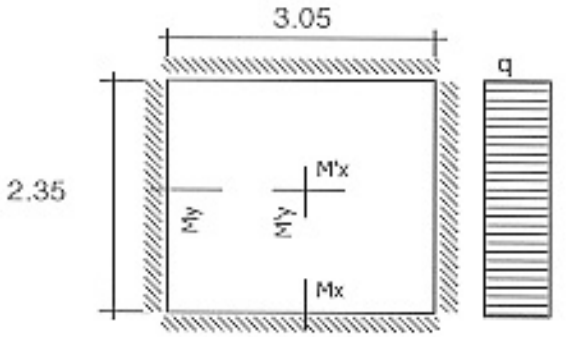
Q_b = 2.5x(A+t)x(B+t)xd= 9.18 Ton

D. Live load (with full of water in manhole) :

qw = 3.75 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+q_{vv}+2.5xd_n =$ 5.37 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n b h_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Raho$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.30

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	fa cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0475	Mx	1.82724	0.06526	0.96623	5.91	14	250
0.0281	My	1.08095	0.03861	0.98031	3.45	12	250
0.0208	M'x	0.8001	0.02858	0.9855	2.54	12	250
0.0123	M'y	0.47316	0.0169	0.99148	1.49	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -2.23

-Uniform distributed loads :

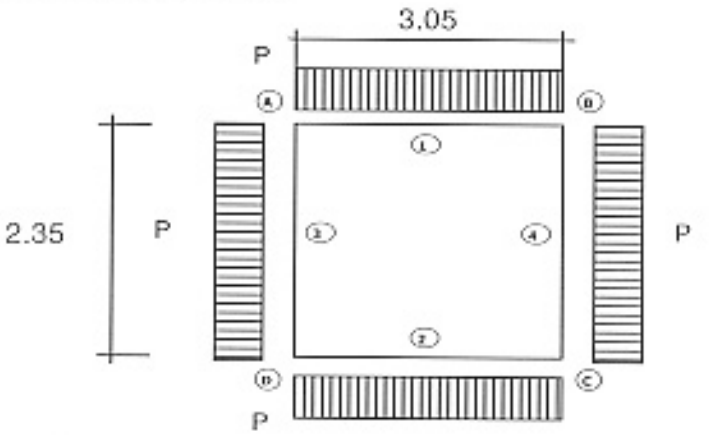
$P_1 = p_{hv}+p_{11}=$ 0.92 T/m²

$P_2 = p_{22}=$ 6.52 T/m²

$P=P_1+P_2=$ 6.52 T/m²

Thickness of wall: 0.35 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

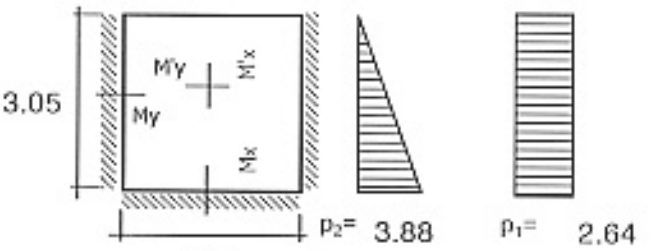
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	3.42	0.06232	0.9678	4.17	12	250
M_A	4.18	0.07617	0.96034	5.13	14	250
M_3	0.34	0.0062	0.99689	0.40	12	250

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



3.05

-Width of slab: A 3.05 m

-Length of slab B 3.05 m

-Triangular distributed loads p_2= 3.88 T/m

-Uniform distributed loads p_1= 2.64 T/m

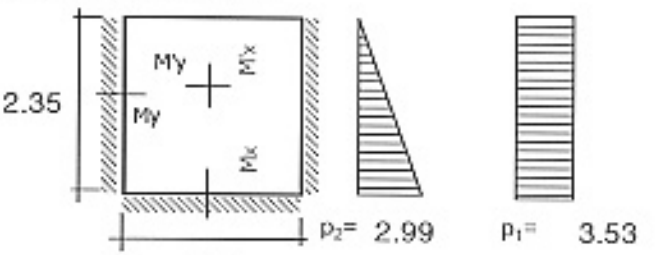
-Thickness of bottom slab d= 0.35 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	2.45159	0.04	0.97714	5.6003	14	250
0.0538	0.0664	My	2.60094	0.05	0.97571	5.9502	14	250
0.0172	0.0084	M'x	0.5167	0.01	0.99527	1.1588	12	250
0.0246	0.0257	M'y	1.07488	0.02	0.99011	2.4233	12	250

Diagram calculation for analysis in the direction B :



2.35

-Width of slab: A 2.35 m

-Length of slab B 2.35 m

-Triangular distributed loads p_2= 2.99 T/m

-Uniform distributed loads p_1= 3.53 T/m

-Thickness of bottom slab d= 0.6 m

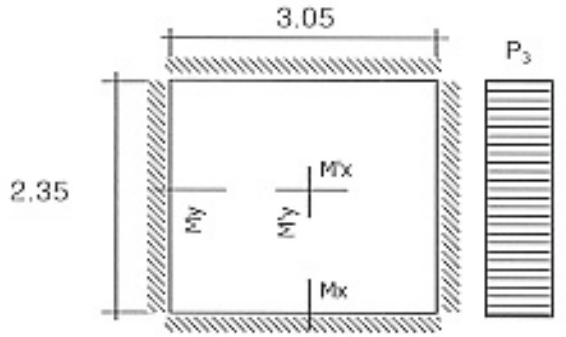
-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	1.58332	0.03	0.98536	3.5867	12	250
0.0538	0.0664	My	1.73841	0.03	0.9839	3.9439	12	250
0.0172	0.0084	M'x	0.30576	0.01	0.99721	0.6844	12	250
0.0246	0.0257	M'y	0.70404	0.01	0.99354	1.5817	12	250

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+q_{VV}+p_u+(Q_c+Q_w+Q_b)/[(A+t)x(B+t)]=$ 14.63 T/m²

-Thickness of bottom slab: 0.4 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.30

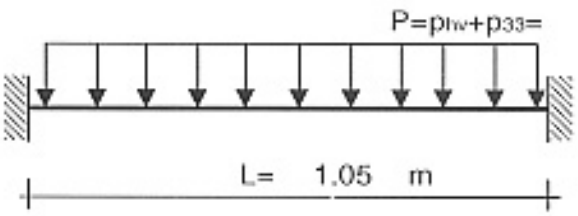
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0475	Mx	4.97996	0.05808	0.97007	11.46	14	125
0.0281	My	2.946	0.03436	0.98252	6.69	12	125
0.0208	M'x	2.181	0.02543	0.98712	4.18	12	250
0.0123	M'y	1.290	0.0150	0.99242	2.46	12	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A. The wall is in the direction A & B :

Diagram calculation for analysis :



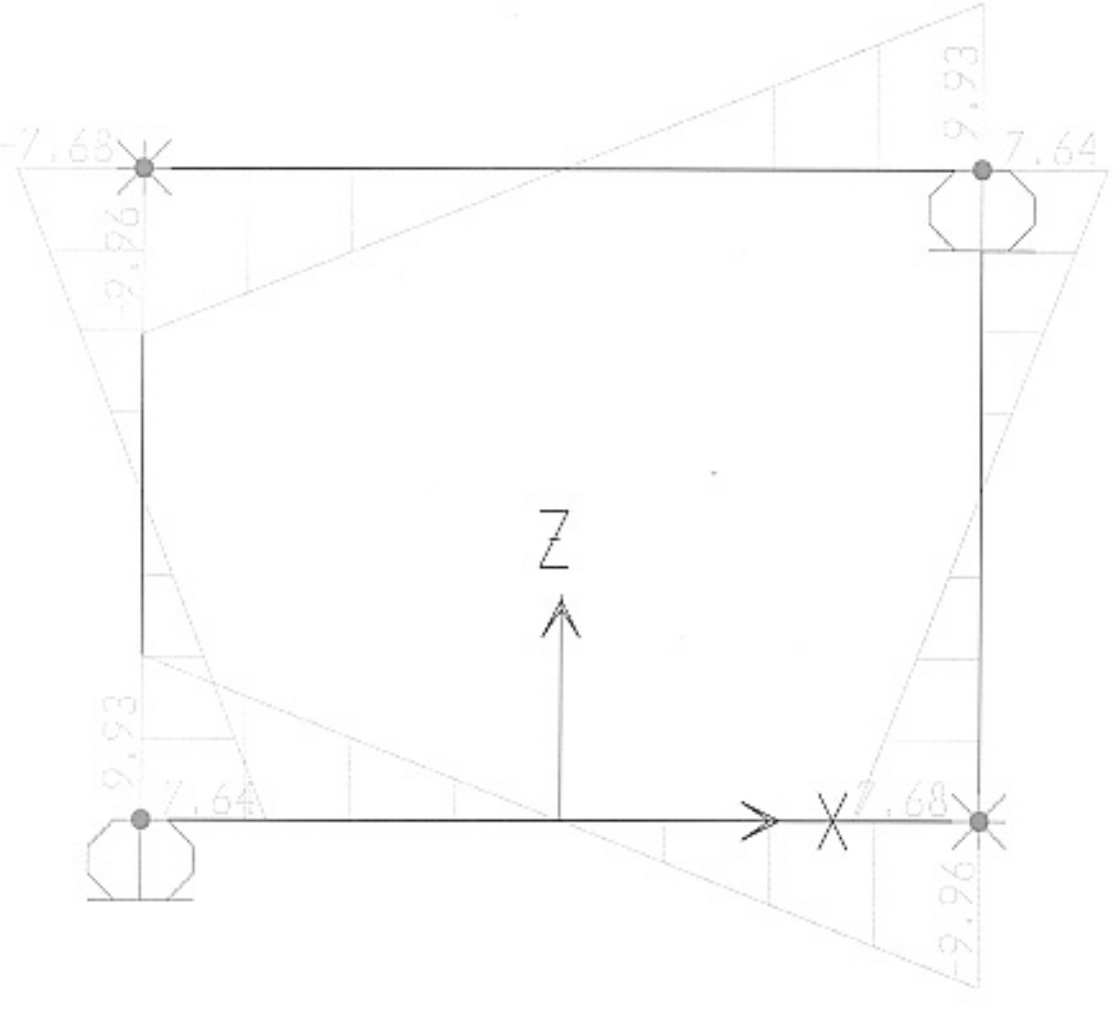
-Uniform distributed loads : 0.92 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.084525	0.00537	0.99731	0.26	12	250
M2	0.042263	0.00268	0.99866	0.13	12	250


-7.68
9.93
7.64
-9.96
Z
9.93
7.64
7.68
-9.96

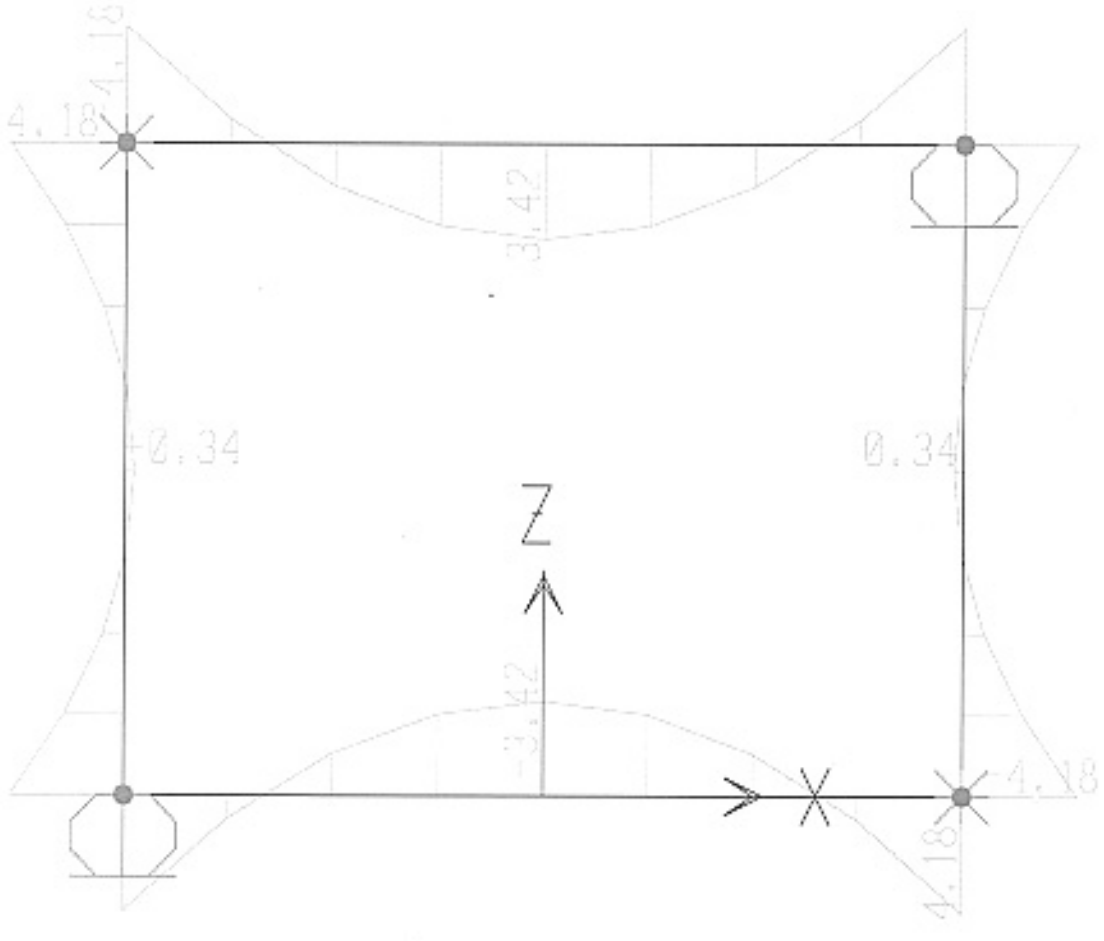
7-Checking for shearing forces of wall:

At level -2.23

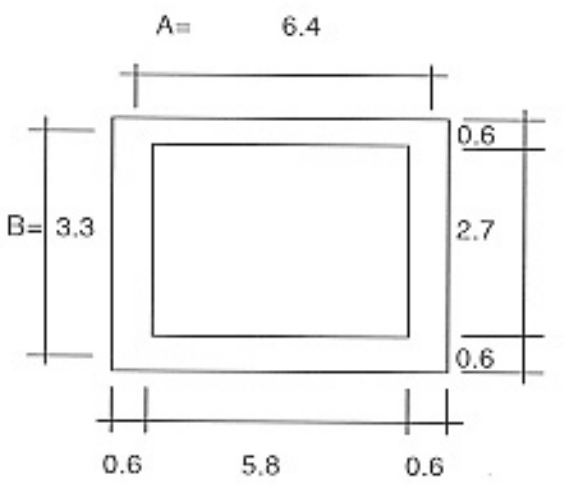
-Height of hand for supporting wall s= 0 , so the section need to be checked

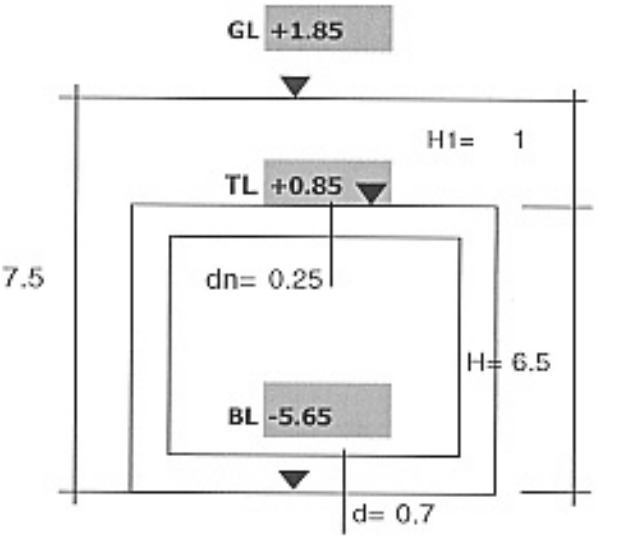
shear bearing capacity is [t+s/2]= 0.35 m far from center of wall

Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	7.66	2.70	3.60	OK!!!


4.18
3.42
0.34
0.34
Z
3.42
4.18
4.18

CALCULATION FOR DIVERSION CHAMBER TYPE DC 2

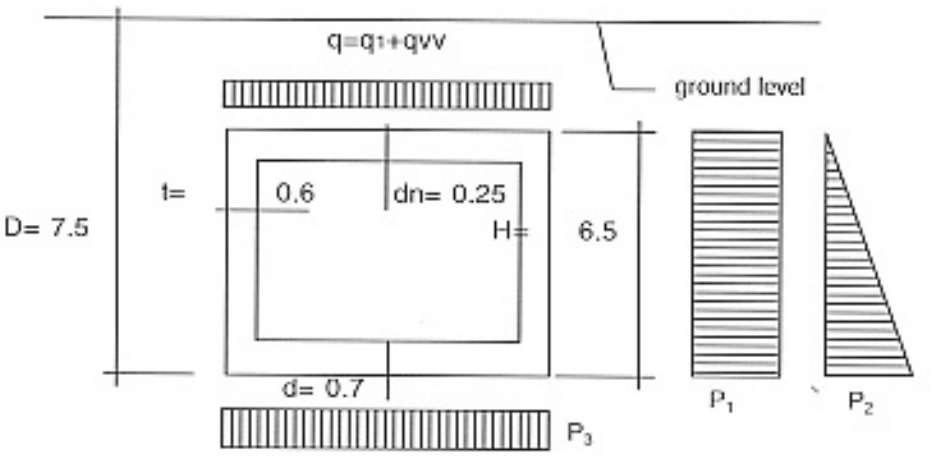




1.CALCULATION PARAMETER :

A.Geometry dimension :

High of manhole	*H =*	*6.5*	m	*3.2*
Depth of manhole	*D=*	*7.5*	m	
Width of manhole	*B =*	*3.3*	m	
Length of manhole	*A=*	*6.4*	m	
Thickness of cover slab	d_n =	*0.25*	m	
Thickness of wall	*t =*	*0.6*	m	
Thickness of bottom slab	*d =*	*0.7*	m	



B.Material parameter :

Grade of concrete:	210		
	Rn=	70	kg/cm²
	Rs=	3.6	kg/cm²
Weight of concrete:	γ =	2.5	T/m³
Steel stress:	Ra=	1600	kg/cm²

C. Geology conditions :

Ground water level: + 0.00

Weight of soil: γ = 1.8 T/m³

Soil internal friction angle : $\varphi = 20^0 = 0.349066$ (RAD)

$$K_o = tg^2(45^0 - \frac{\varphi}{2}) = 0.5$$

2. OPERATING LOAD : ground water is up to ground surface level (permanent case)

A. Vehicle load :

Vehicle type: H30 So design load is calculated as following formula:

$P_{de} = (1+i)2P/W_o$

Where: P, weight of back wheel = 12 Ton

W_o, width of occupied area of vehicle W_o = 2.75 m

i, impact coefficient, i= 0.3

P_{de} = 11.35T/m

q_w = Pde/(B+t) 2.91 T/m²

Horizontal vehicle load from both sides of the manhole:

$p_w = 1.0xK_o =$ 0.5 T/m²

Where: 1.0 T/m² is vertical uniform load due to vehicle for wall calculation

B. Cover soil load :

-Vertical uniform distributed load due to submerged cover soil:

$q_1=H_1x(\gamma_s-1)+H_1x1.0=$ 1.8 T/m²

-Horizontal uniform distributed load due to submerged cover soil from both side of the manhole:

$p_{11}=H_1x(\gamma_s-1)xK_o+H_1x1.0=$ 1.4 T/m²

-Horizontal triangle load due to submerged soil from both side of the manhole:

$p_{22}=(H-d)x\gamma_w+(\gamma_s-\gamma_w)x(H-d)xK_o$ 8.12 T/m²

-Horizontal triangle load due to submerged soil from both side of the operating open:

$p_{33}=H1x\gamma_w+(\gamma_s-\gamma_w)xH1xK_o$ 1.4 T/m²

-Uplift pressure due to ground water:

$p_u=Hx1.0=$ 6.5 T/m²

C. Self load :

-Load due to cover slab:

Q_c = 2.5x(A+t)x(B+t)xdn= 17.06 Ton

-Load due to walls:

Q_w = 2.5x(A+B)x2x(H-dn-d)xt= 161.51 Ton

-Load due to bottom slab:

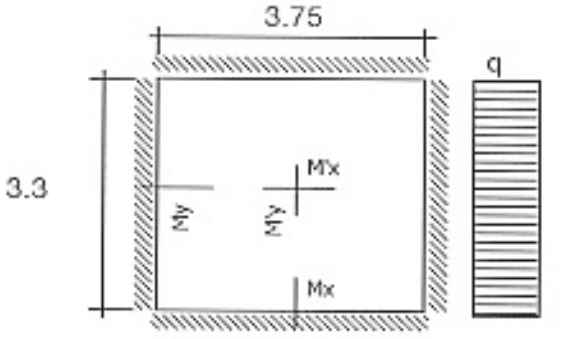
Q_b = 2.5x(A+t)x(B+t)xd= 47.78 Ton

D. Live load (with full of water in manhole) :

qw = 5.55 T/m²

3. CALCULATING FOR COVER SLAB OF MANHOLE :

Diagram calculation for analysis :



$q = q_1+q_{vv}+2.5xd_n =$ 5.33 T/m²

-Thickness of cover slab : 0.25 m

-Factor related to Moment, bearing area and compress :

$A_o =$ $M/R_n b h_o^2$

Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

-Required area of reinforcement :

Fa= $M/\gamma Raho$ Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.14

Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.0461	Mx	3.04303	0.10868	0.94233	10.09	14	125
0.0349	My	2.30373	0.08228	0.95701	7.52	12	125
0.02	M'x	1.3202	0.04715	0.97584	4.23	12	250
0.015	M'y	0.99014	0.03536	0.98199	3.15	12	250

4. CALCULATING FOR WALL OF MANHOLE :

A. Calculation for wall at level : -4.95

-Uniform distributed loads :

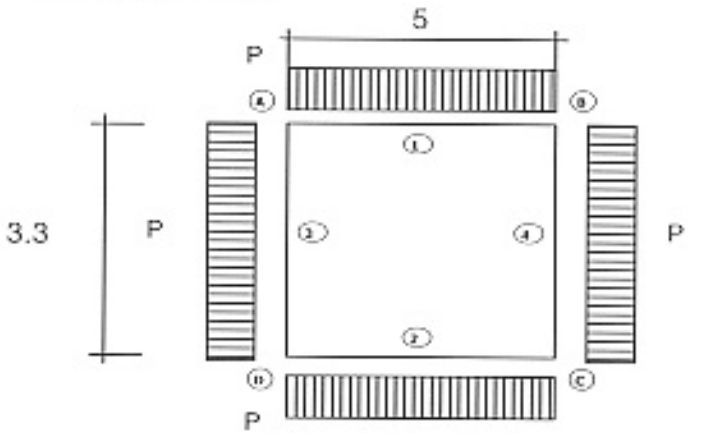
$P_1 = p_{hv}+p_{11}=$ 1.90 T/m²

$P_2 = p_{22}=$ 8.12 T/m²

$P=P_1+P_2=$ 10.02 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

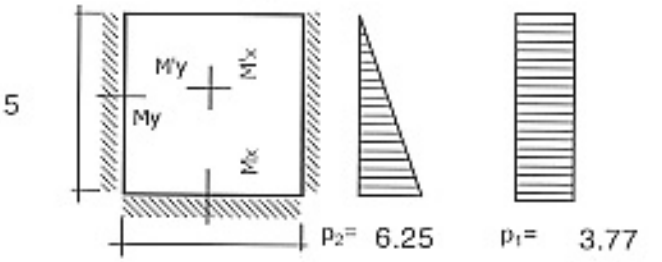
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	15.12	0.0769	0.95995	18.57	18	125
M_A	16.36	0.0832	0.95651	20.17	18	125
M_3	2.55	0.01297	0.99347	3.03	12	250

Compare with three fix sides diagram:

Diagram calculation for analysis in the direction A :



-Width of slab: A 5 m

-Length of slab B 5 m

-Triangular distributed loads p_2= 6.25 T/m

-Uniform distributed loads p_1= 3.77 T/m

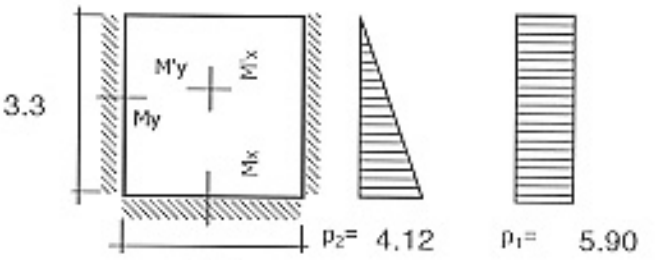
-Thickness of bottom slab d= 0.6 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	9.94295	0.05	0.97404	12.0376	14	125
0.0538	0.0664	My	10.4651	0.05	0.97264	12.6881	16	125
0.0172	0.0084	M'x	2.13543	0.01	0.99454	2.5320	12	250
0.0246	0.0257	M'y	4.34539	0.02	0.98883	5.1822	14	250

Diagram calculation for analysis in the direction B :



-Width of slab: A 3.3 m

-Length of slab B 3.3 m

-Triangular distributed loads p_2= 4.12 T/m

-Uniform distributed loads p_1= 5.90 T/m

-Thickness of bottom slab d= 0.6 m

-Ratio of A and B : A/B= 1

Internal force and selection reinforce table:

COEFFICIENT MULTIPLY 1	COEFFICIENT MULTIPLY 2	MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
							Ø(mm)	a(mm)
0.0598	0.0559	Mx	4.93245	0.03	0.9873	5.8914	14	250
0.0538	0.0664	My	5.47212	0.03	0.98589	6.5454	16	250
0.0172	0.0084	M'x	0.92557	0.00	0.99764	1.0941	12	250
0.0246	0.0257	M'y	2.20275	0.01	0.99437	2.6123	12	250

B. Calculation for wall at level : -2.35

-Uniform distributed loads :

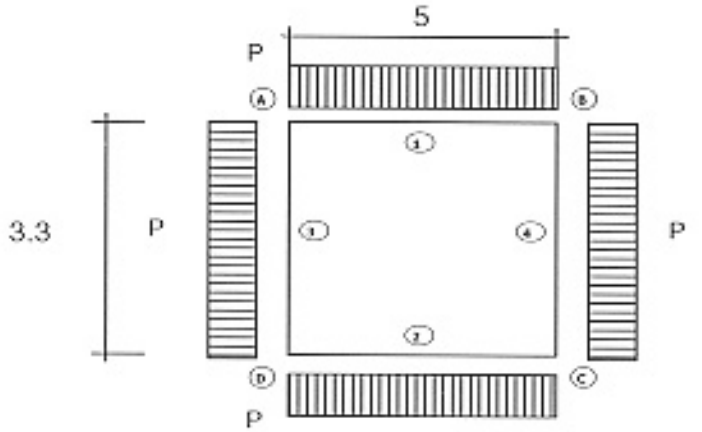
$P_1 = p_{hv} + p_{11} =$ 1.90 T/m²

$P_2 = p_{22} =$ 4.48 T/m²

$P = P_1 + P_2 =$ 6.38 T/m²

Thickness of wall: 0.6 m

Diagram calculation for analysis :



Calculation for stresses and forces for the above scheme :

(Results and inlustrated diagram attached at the end of this calculation)

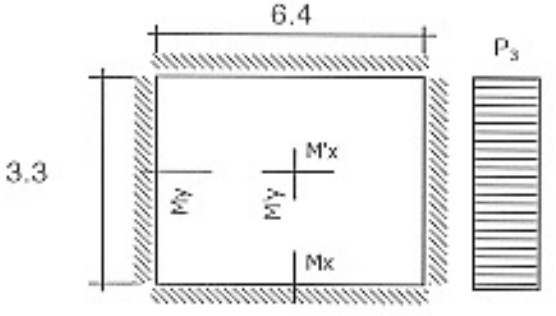
Reinforcement arrangement:

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm^2	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M_1	9.63	0.04898	0.97488	11.65	14	125
M_A	10.42	0.05299	0.97276	12.63	16	125
M_3	1.62	0.00824	0.99586	1.92	12	250

5. CALCULATING FOR BOTTOM SLAB OF MANHOLE :

Diagram calculation for analysis :



$P_3 = q_1+q_{vv}+p_u +(Q_c+Q_w+Q_b)/[(A+t)x(B+t)]=$ 19.50 T/m²

-Thickness of bottom slab: 0.7 m

Reinforcement arrangement:

-Ratio of A and B : A/B= 1.94

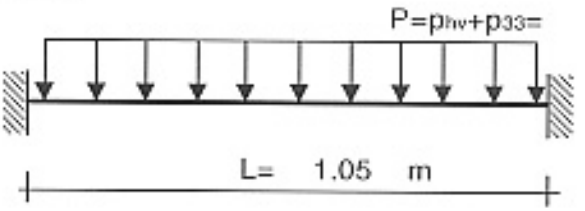
Internal force and selection reinforce table :

COEFFICIENT MULTIPLY	MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
						D(mm)	@(mm)
0.04	Mx	16.4736	0.0557	0.97133	18.28	18	125
0.0107	My	4.407	0.0149	0.99249	4.78	14	250
0.0183	M'x	7.537	0.02548	0.98709	7.57	12	125
0.0046	M'y	1.894	0.0064	0.99679	1.89	12	250

6. CALCULATING FOR WALL OF OPERATING OPEN :

A.The wall is in the direction A & B :

Diagram calculation for analysis :



-Uniform distributed loads : 1.90 T/m

-Thickness of wall : 0.25 m

Reinforcement arrangement :

Internal force and selection reinforce table :

MOMENT	VALUE (Tm)	A_o	γ	f_a cm²	SET REINFORCED FOR FORMAT	
					D(mm)	@(mm)
M1	0.174563	0.01108	0.99443	0.55	12	250
M2	0.087281	0.00554	0.99722	0.27	12	250

7-Checking for shearing forces of wall:

At level -4.95

-Height of hand for supporting wall s= 0 , so the section need to be checked

shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

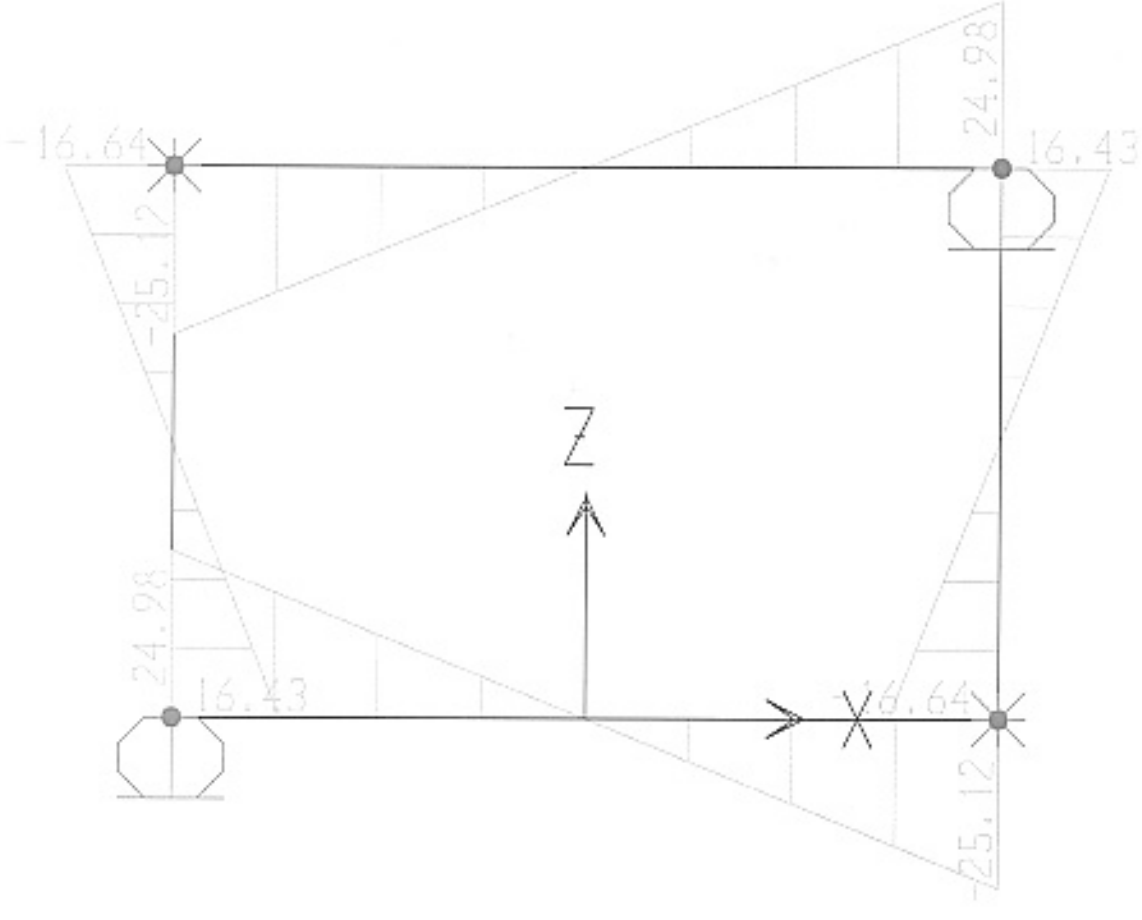
Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	19.04	3.50	3.60	OK!!!

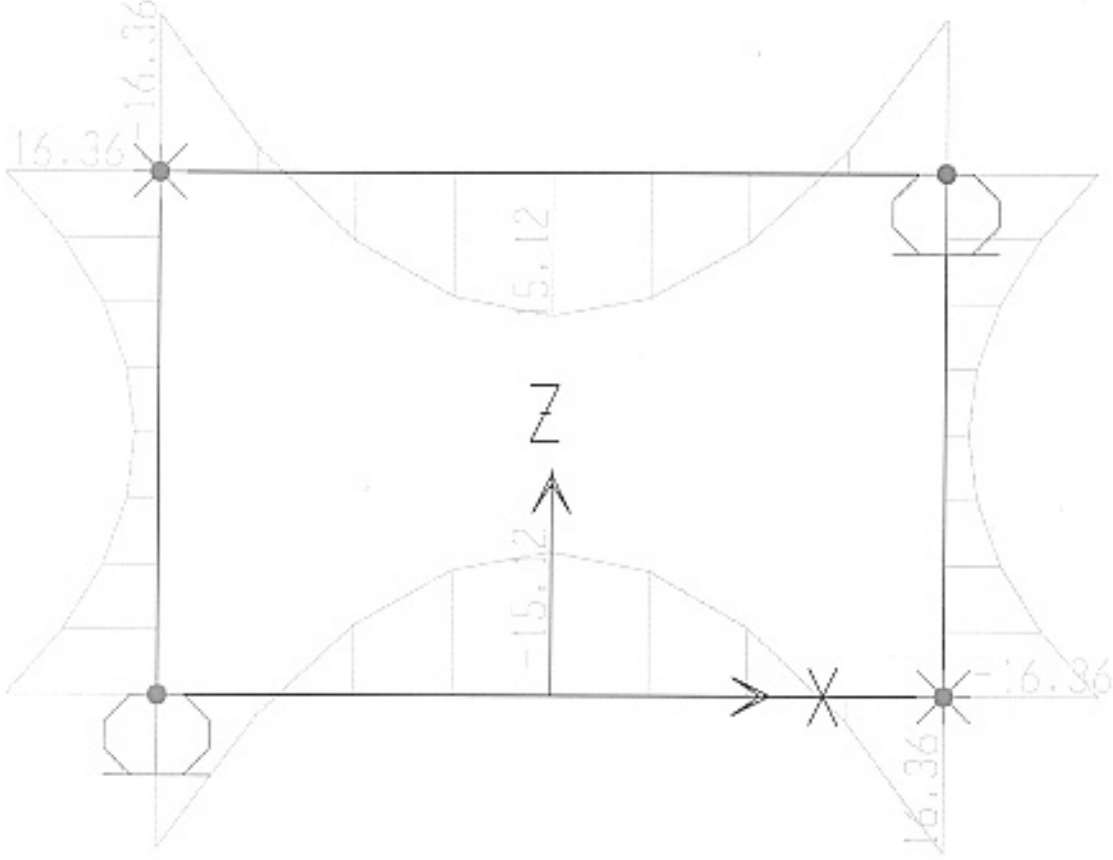
At level -2.35

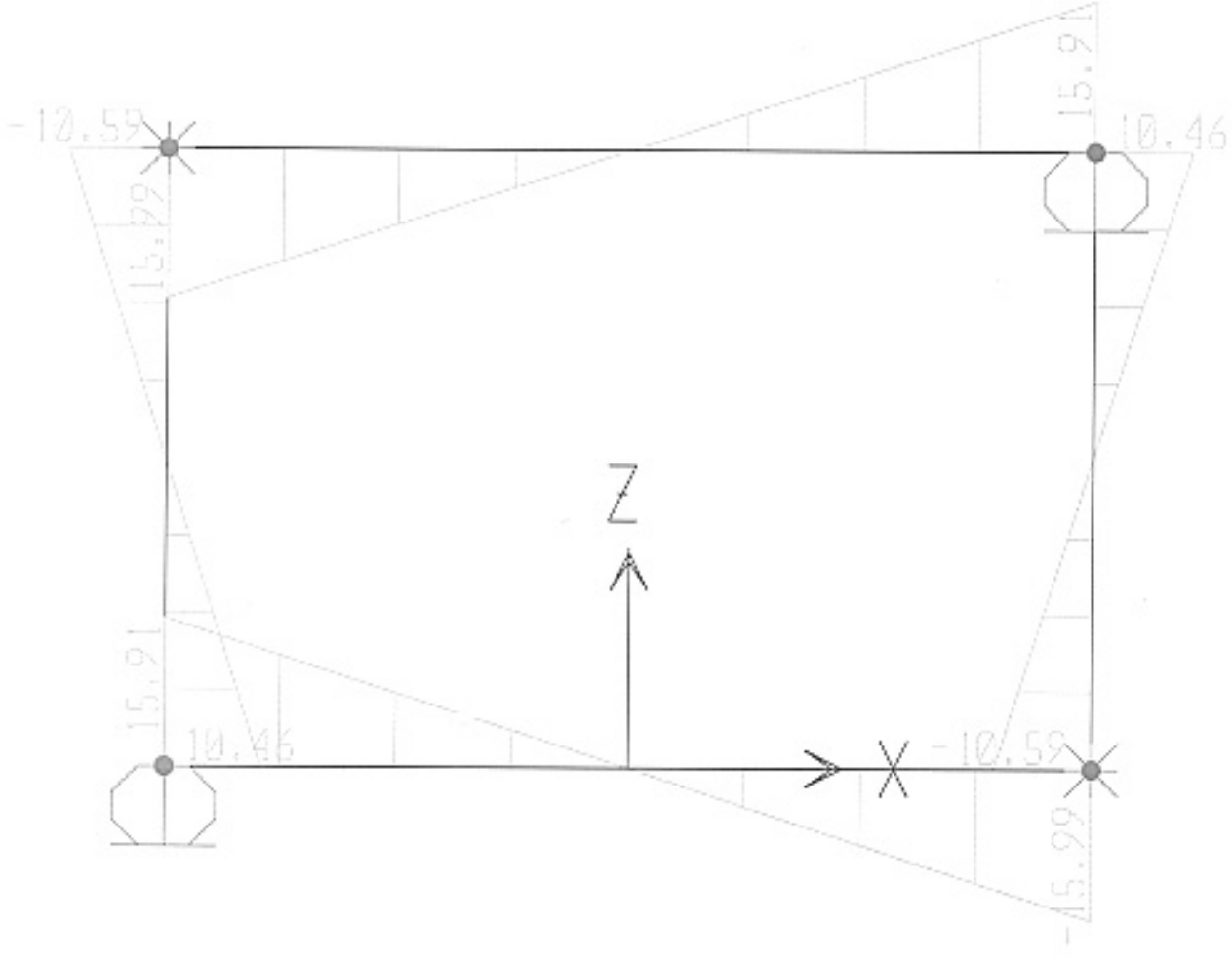
-Height of hand for supporting wall s= 0 , so the section need to be checked

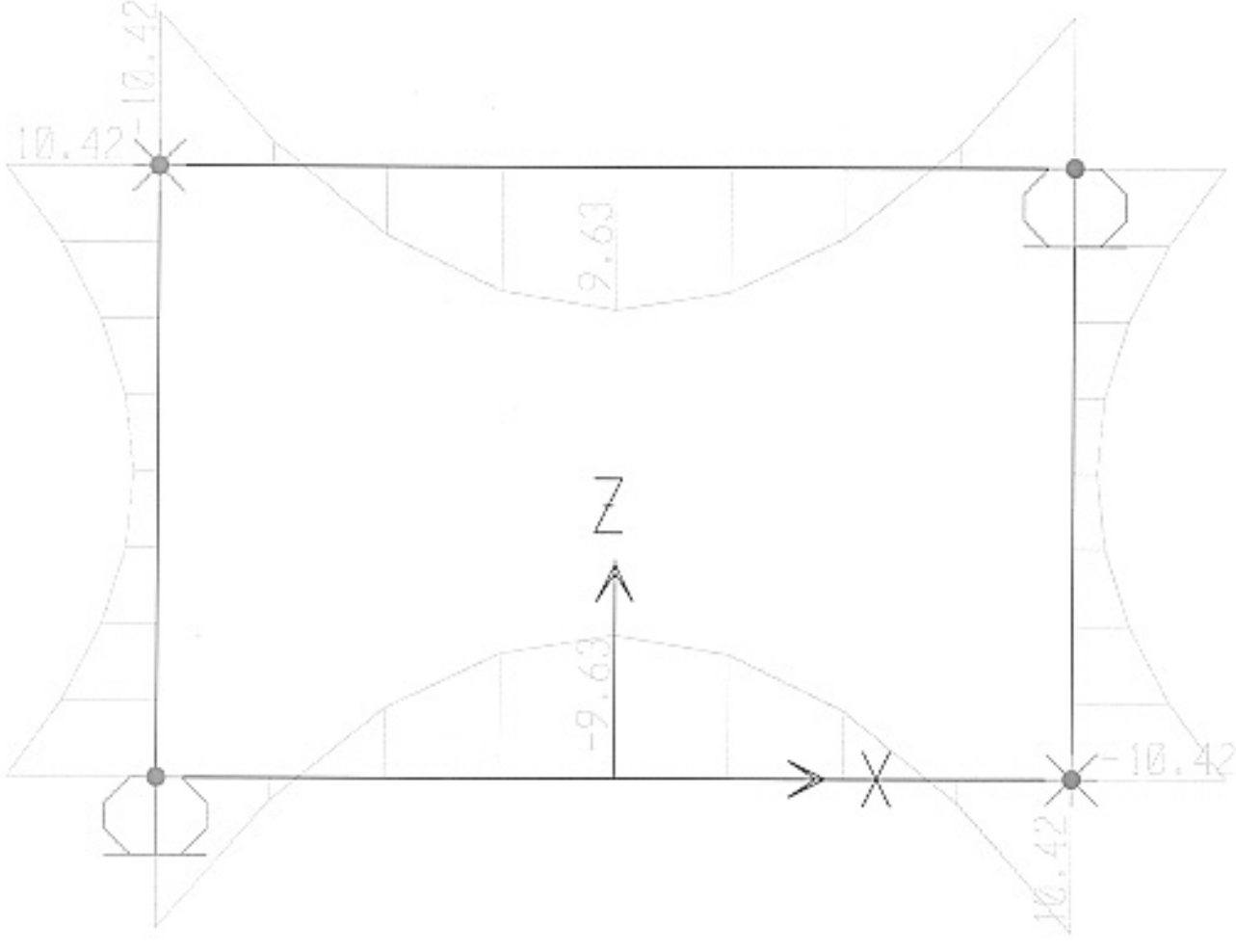
shear bearing capacity is [t+s/2]= 0.60 m far from center of wall

Shears	Values (T)	Shearing stresses (Kg/cm2)	Degn Shearing stress (Kg/cm2)	Compare &Conclude
V	12.76	2.40	3.60	OK!!!


-16.64
24.98
16.43
-25.12
Z
24.98
16.43
-16.64
-25.12


16.36
-14.36
5.12
Z
-15.12
-16.36
16.36


-10.59
15.91
10.46
15.91
10.46
-10.59
-15.99
Z



SAP2000 v6.11 - File:DC22 - Moment 3-3 Diagram (LOAD1) - Ton-m Units