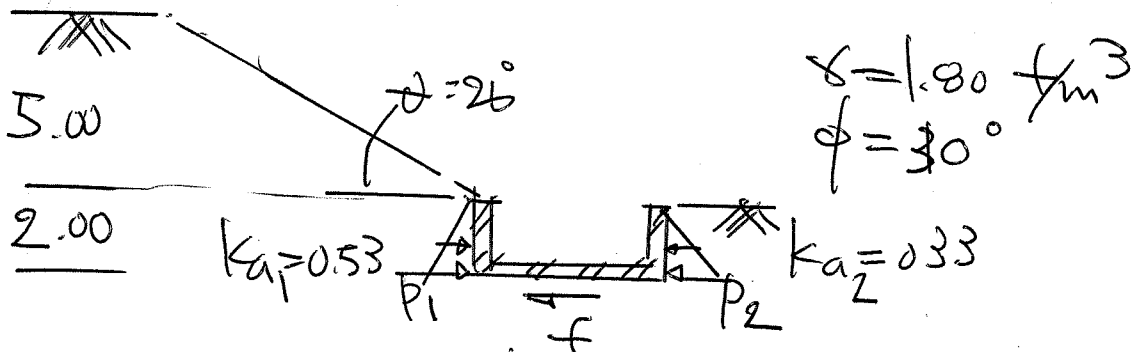


# CALCULATION SHEET

PROJECT	JOB ID	
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Channel = SECTION D.



$$k_a = \frac{\cos\theta \left( \cos\theta - \sqrt{\cos^2\theta - \cos^2\phi} \right)}{\cos\theta + \sqrt{\cos^2\theta - \cos^2\phi}}$$

$$= 0.90 \cdot \frac{0.9 - \sqrt{0.9^2 - 0.87^2}}{0.9 + \sqrt{0.9^2 - 0.87^2}}$$

$$= 0.53$$

$$P_{a1} = k_{a1} \cdot \frac{1}{2} \gamma H^2$$

$$= 0.53 \times 0.5 \times 1.8 \times 2.0^2$$

$$= 1.908 \text{ t/m}$$

$$P_{a2} = k_{a2} \cdot \frac{1}{2} \gamma H^2$$

$$= 0.33 \times 0.5 \times 1.8 \times 2.0^2$$

$$= 1.188 \text{ t/m}$$

$$\Delta p = 1.908 - 1.188$$

$$= 0.72 \text{ t/m}$$

$$f = p_0 \cdot \tan\delta \cdot A_f$$

Assume  $t = 0.30 \text{ m}$ .

$$p_0 = 960 \text{ kg/m}^2$$

$$\delta = \frac{3}{4} \phi$$

$$f = 960 \cdot \tan 22.5 \cdot 4.50$$

$$= 1.79 \text{ t/m}$$

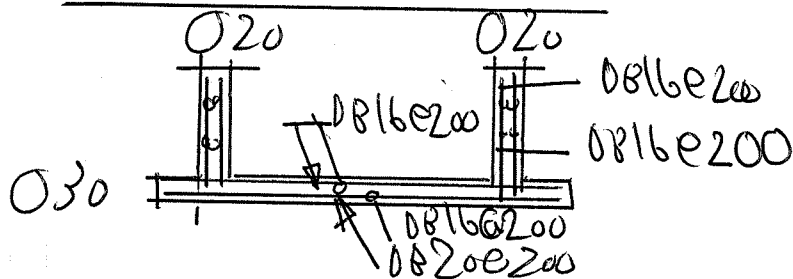
$$\gamma_F = \frac{1.79}{0.72}$$

$$= 2.48 > 1.50 \text{ OK}$$

# CALCULATION SHEET

PROJECT	JOB ID	
SUBJECT	DESIGNED	PAGE
	CHECKED	SHEET

## Channel Section D.



## Base slab (0.30 m. thk.)

$$M_u^E = 12600 \text{ kg-m/m}$$

$$A_{st} = 15.26 \text{ cm}^2/\text{m} = \text{DB } 20 @ 200 \text{ (B)}$$

$$M_u^W = 3566 \text{ kg-m/m}$$

$$A_{st} = 4.12 \text{ cm}^2/\text{m} = \text{DB } 16 @ 200 \text{ (T)}$$

$$A_{st_{min}} = 5.40 \text{ cm}^2/\text{m} = \text{DB } 16 @ 200 \text{ (E.F.)}$$

## Rc Wall (0.20 m thk)

$$M_u = 2060 \text{ kg-m/m}$$

$$A_{st} = 5.96 \text{ cm}^2/\text{m} = \text{DB } 16 @ 200 \text{ (E.F.)}$$

**Job Information**

Engineer                      Checked                      Approved

Name:                      PSJ  
 Date:                      11-Feb-09

Design of  
Open channel

*Comments*

Channel Section D

Structure Type    PLANE FRAME

Number of Nodes                      4    Highest Node                      4  
 Number of Elements                      3    Highest Beam                      3

Number of Basic Load Cases                      4  
 Number of Combination Load Cases                      8

*Included in this printout are data for:*

All                      The Whole Structure

*Included in this printout are results for load cases:*

Type	L/C	Name
Combination	11	S1:DL
Combination	12	S2:DL+LL
Combination	13	S3:DL+UP
Combination	14	S4:DL+LL+UP

**Section Properties**

Prop	Section	Area (cm <sup>2</sup> )	I <sub>yy</sub> (cm <sup>4</sup> )	I <sub>zz</sub> (cm <sup>4</sup> )	J (cm <sup>4</sup> )	Material
1	Rect 0.20x1.00	2E 3	1.67E 6	66.7E 3	233E 3	CONCRETE
2	Rect 0.30x1.00	3E 3	2.5E 6	225E 3	730E 3	CONCRETE

**Materials**

Mat	Name	E (kN/mm <sup>2</sup> )	v	Density (kg/m <sup>3</sup> )	α (1/°K)
1	STEEL	205.000	0.300	7.83E 3	12E -6
2	ALUMINUM	68.948	0.330	2.71E 3	23E -6
3	CONCRETE	21.718	0.170	2.4E 3	10E -6

**Supports**

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN/m/deg)	rY (kN/m/deg)	rZ (kN/m/deg)
1	-	800.00	Fixed	Fixed	Fixed	-
2	-	800.00	Fixed	Fixed	Fixed	-

**Basic Load Cases**

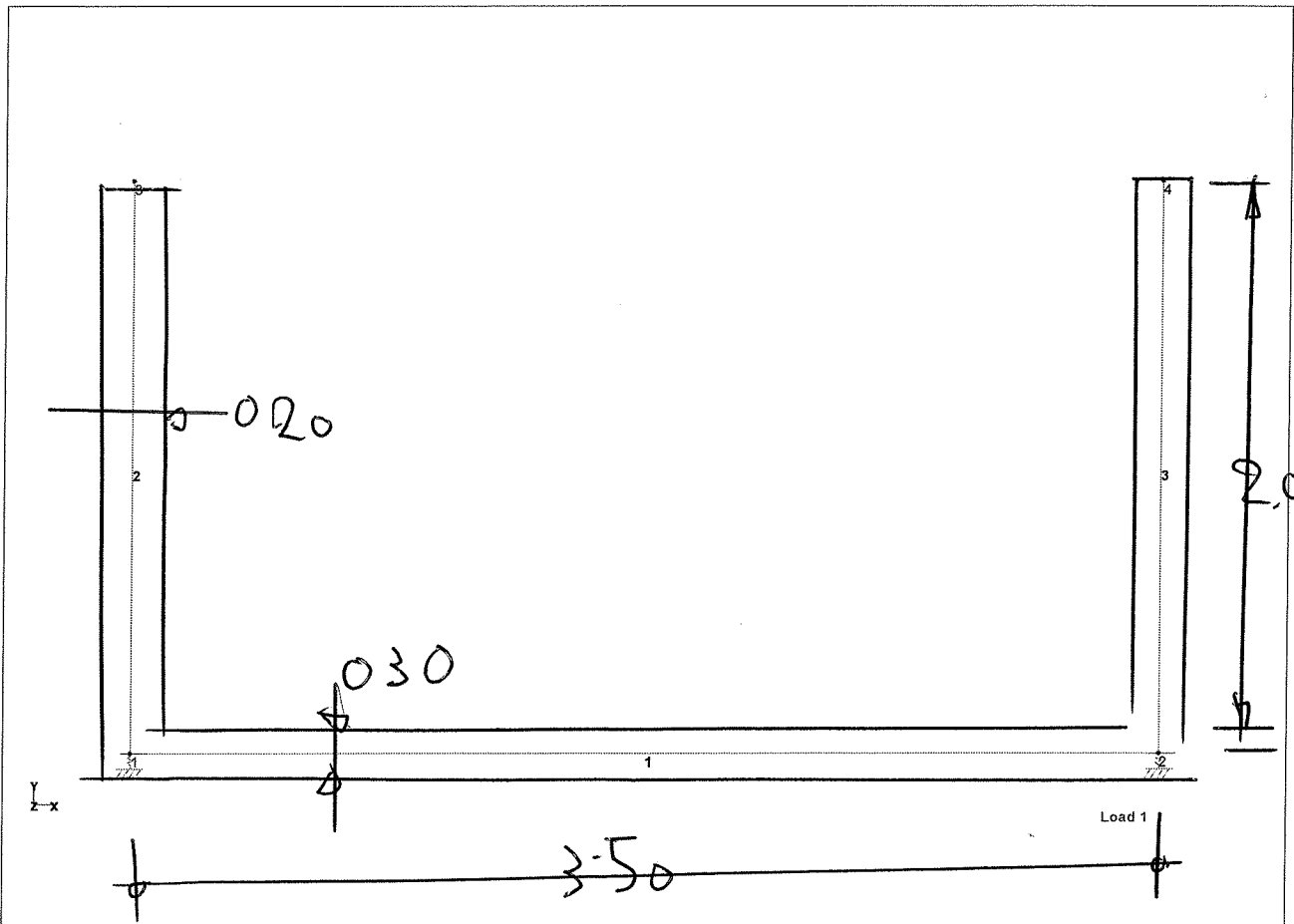
Number	Name
1	SW
2	DL
3	LL
4	UPLIFT

### Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
11	S1:DL	1	SW	1.00
		2	DL	1.00
12	S2:DL+LL	1	SW	1.00
		2	DL	1.00
		3	LL	1.00
13	S3:DL+UP	1	SW	1.00
		2	DL	1.00
		4	UPLIFT	1.00
		1	SW	1.00
14	S4:DL+LL+UP	2	DL	1.00
		3	LL	1.00
		4	UPLIFT	1.00
		1	SW	1.70
		2	DL	1.70
21	U1:DL	1	SW	1.70
		2	DL	1.70
		3	LL	2.00
22	U2:DL+LL	1	SW	1.70
		2	DL	1.70
		3	LL	2.00
		4	UPLIFT	2.00
23	U3:DL+UP	1	SW	1.70
		2	DL	1.70
		4	UPLIFT	2.00
		1	SW	1.27
		2	DL	1.27
24	U4:DL+LL+UP	3	LL	1.50
		4	UPLIFT	1.50

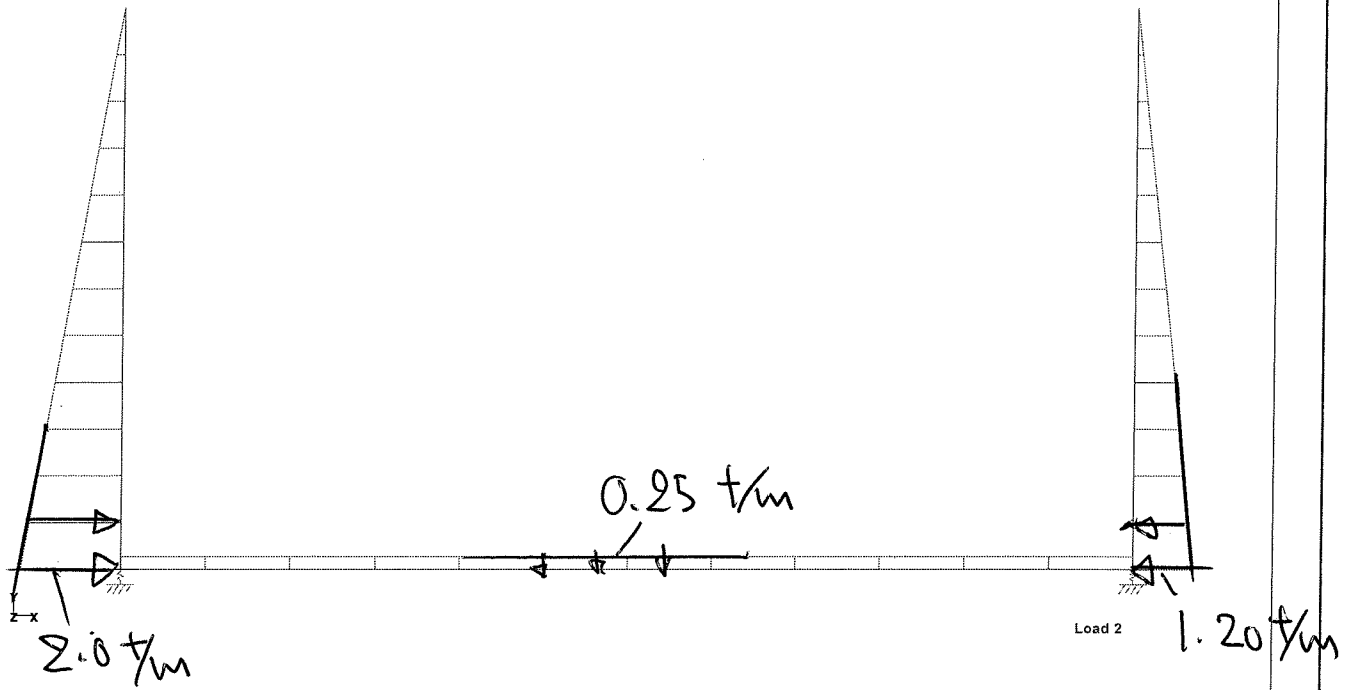
### Load Generators

There is no data of this type.



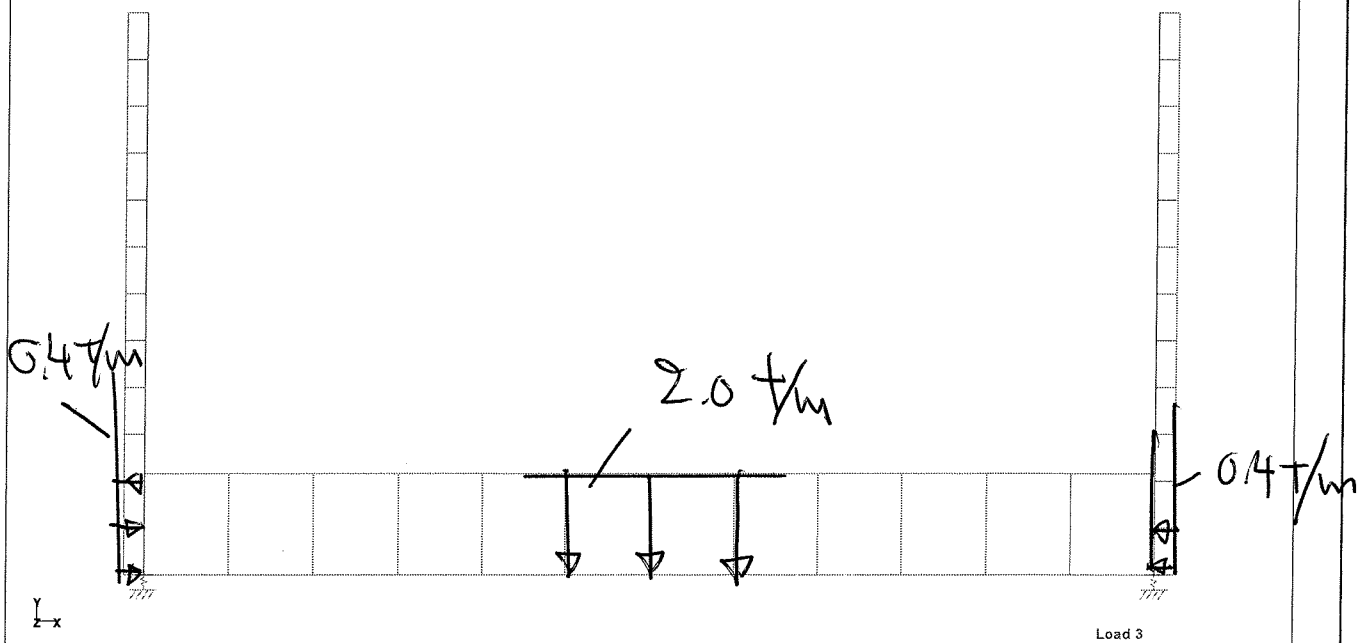
Whole Structure

# LOAD 2: DL



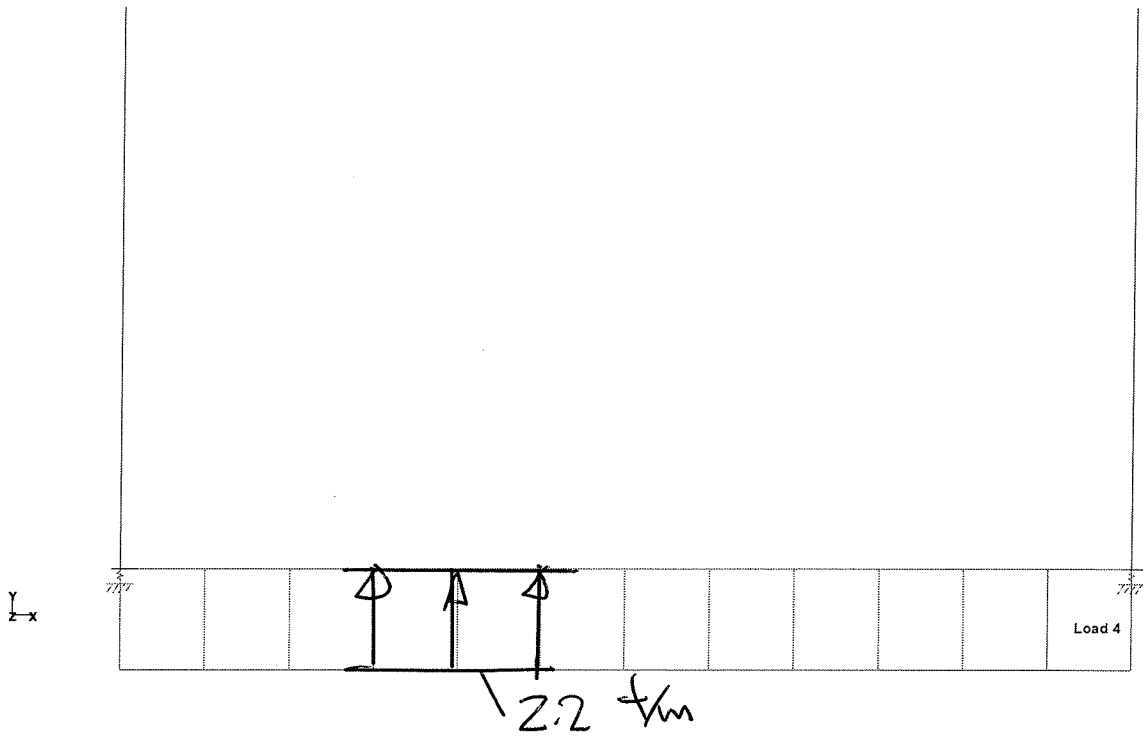
Whole Structure Loads 10.1972kg:1m 2 DL

# LOAD 3: LL

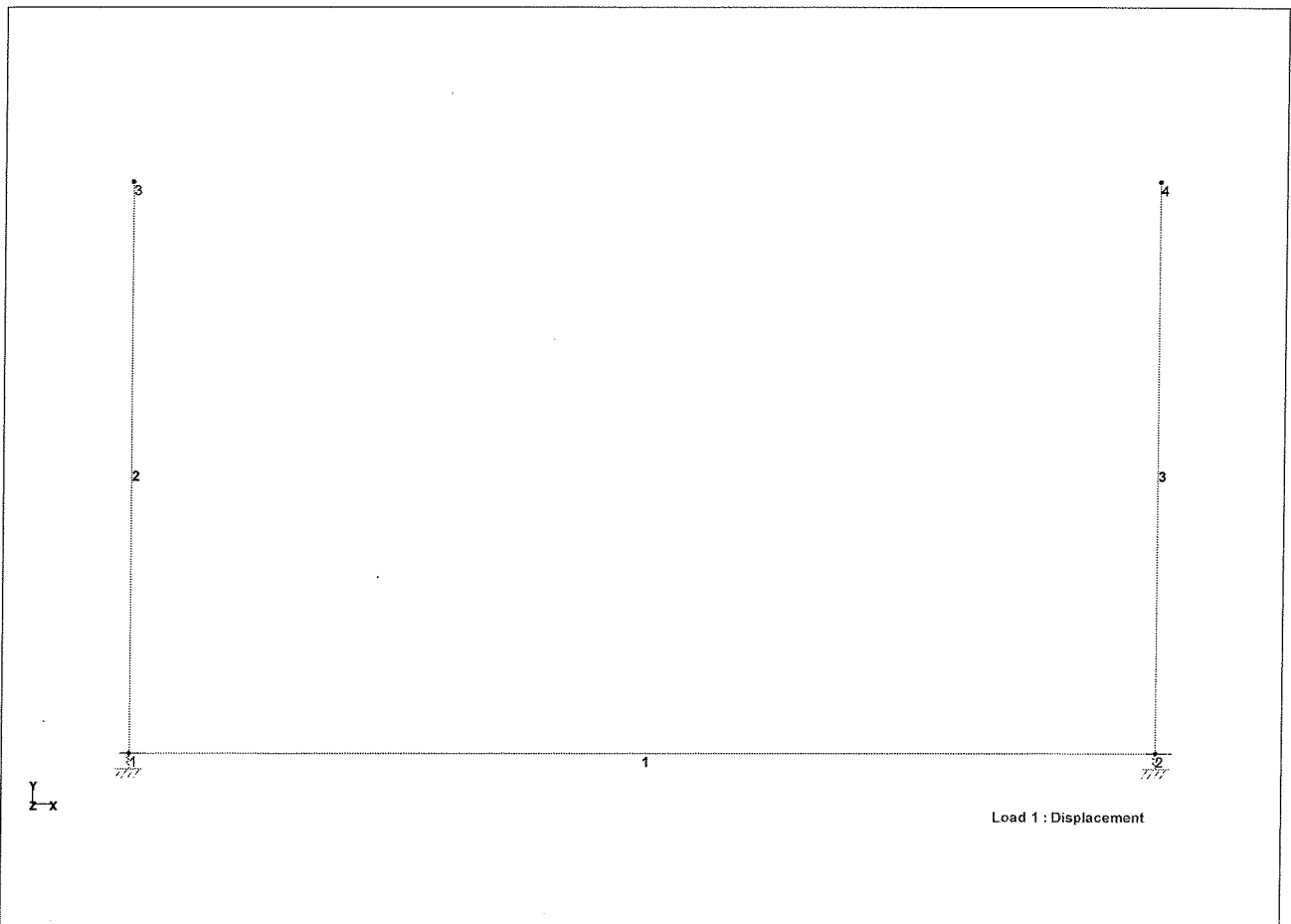


Whole Structure Loads 10.1972kg:1m 3 LL

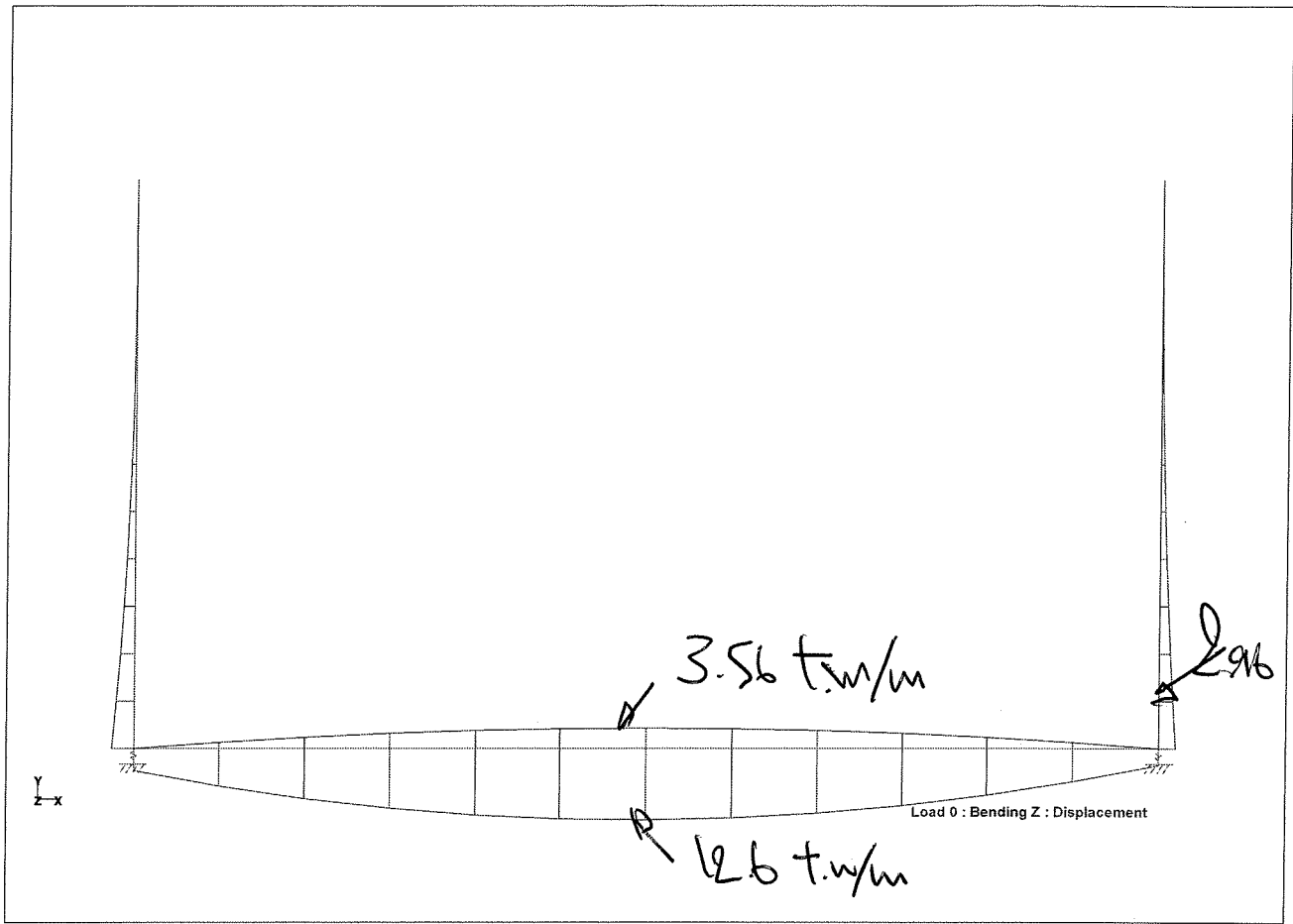
# LOAD 4: Uplift



Whole Structure Loads 10.1972kg:1m 4 UPLIFT



Whole Structure Displacements 1000mm:1m 1 SW



Whole Structure Mz 50MTon-m:1m Displacements 1000mm:1m 0 Envelope

Node Displacements

Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
1	11:S1:DL	42.8E 3	-0.03	0.00	42.8E 3	0.00	0.00	-0.00
	12:S2:DL+LL	42.8E 3	-0.08	0.00	42.8E 3	0.00	0.00	-0.00
	13:S3:DL+UP	42.8E 3	0.02	0.00	42.8E 3	0.00	0.00	0.00
	14:S4:DL+LL+I	42.8E 3	-0.03	0.00	42.8E 3	0.00	0.00	-0.00
2	11:S1:DL	42.8E 3	-0.04	0.00	42.8E 3	0.00	0.00	0.00
	12:S2:DL+LL	42.8E 3	-0.08	0.00	42.8E 3	0.00	0.00	0.00
	13:S3:DL+UP	42.8E 3	0.01	0.00	42.8E 3	0.00	0.00	-0.00
	14:S4:DL+LL+I	42.8E 3	-0.03	0.00	42.8E 3	0.00	0.00	0.00
3	11:S1:DL	42.8E 3	-0.03	0.00	42.8E 3	0.00	0.00	-0.00
	12:S2:DL+LL	42.9E 3	-0.08	0.00	42.9E 3	0.00	0.00	-0.00
	13:S3:DL+UP	42.8E 3	0.01	0.00	42.8E 3	0.00	0.00	-0.00
	14:S4:DL+LL+I	42.9E 3	-0.03	0.00	42.9E 3	0.00	0.00	-0.00
4	11:S1:DL	42.8E 3	-0.04	0.00	42.8E 3	0.00	0.00	0.00
	12:S2:DL+LL	42.8E 3	-0.08	0.00	42.8E 3	0.00	0.00	0.00
	13:S3:DL+UP	42.8E 3	0.01	0.00	42.8E 3	0.00	0.00	0.00
	14:S4:DL+LL+I	42.8E 3	-0.03	0.00	42.8E 3	0.00	0.00	0.00

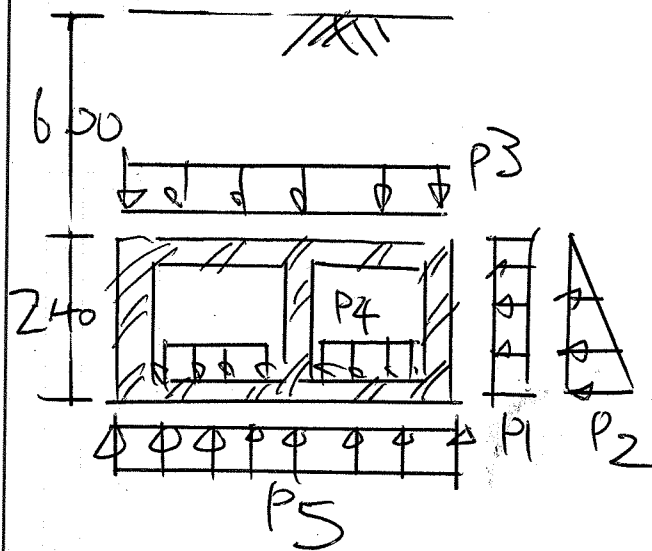
Reactions

Node	L/C	Horizontal			Moment		
		FX (Mton)	FY (Mton)	FZ (Mton)	MX (MTon'm)	MY (MTon'm)	MZ (MTon'm)
1	11:S1:DL	0.00	2.56	0.00	0.00	0.00	0.00
	12:S2:DL+LL	0.00	6.16	0.00	0.00	0.00	0.00
	13:S3:DL+UP	0.00	-1.40	0.00	0.00	0.00	0.00
	14:S4:DL+LL+I	0.00	2.20	0.00	0.00	0.00	0.00
2	11:S1:DL	0.00	2.86	0.00	0.00	0.00	0.00
	12:S2:DL+LL	0.00	6.46	0.00	0.00	0.00	0.00
	13:S3:DL+UP	0.00	-1.10	0.00	0.00	0.00	0.00
	14:S4:DL+LL+I	0.00	2.50	0.00	0.00	0.00	0.00

# CALCULATION SHEET

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## Box Culvert



$$\text{Surcharge} = 1.00 \text{ t/m}^2$$

$$\gamma = 1.80 \text{ t/m}^3$$

$$k_a = 0.33$$

1) DL

$$P_1 = k_a \cdot \gamma \cdot H$$

$$= 0.33 \times 1.8 \times 6.0$$

$$= 3.564 \text{ t/m}^2$$

$$P_2 = k_a \cdot \gamma \cdot h$$

$$= 0.33 \times 1.8 \times 2.4$$

$$= 1.61 \text{ t/m}^2$$

$$P_3 = \gamma H$$

$$= 1.8 \times 6.0$$

$$= 10.8 \text{ t/m}^2$$

$$P_4 = 0.25 \text{ t/m}^2$$

### 2) LL

$$P_1 = 1.0 \times 0.33 = 0.33 \text{ t/m}^2$$

$$P_2 = -$$

$$P_3 = 1.0 \text{ t/m}^2$$

$$P_4 = 2.4 \text{ t/m}^2$$

### 3) uplift

$$P_5 = -870 \text{ t/m}^2$$

$$0.97 - 0.97 - 0.23$$

$$0.97 - 0.97 + 0.23$$

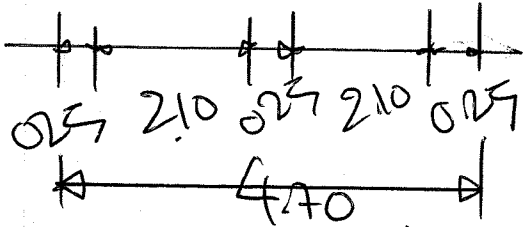
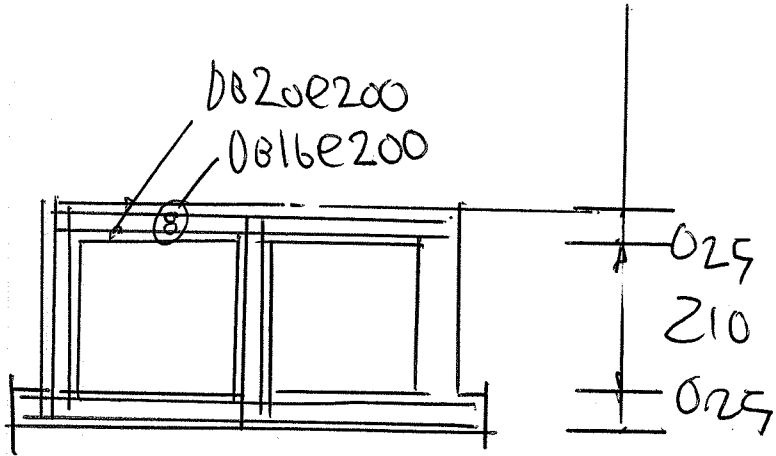
$$0.636$$

$$|-1$$



# CALCULATION SHEET

PROJECT	JOB ID	
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$$M_u = 0.100 \text{ kNm/m}$$

$$A_{st} = 15.70 \text{ cm}^2/\text{m} = \underline{18 20 @ 200}$$

$$\underline{A_{smi} = 4.50 \text{ cm}^2}$$

$$8 16 @ 200$$

**Job Information**

Engineer                      Checked                      Approved

Name:                      PSJ  
 Date:                      11-Feb-09

Design of  
Boxculvert

**Comments**

Culvert 2 x 2.10 x 2.10

**Structure Type**      PLANE FRAME

Number of Nodes              6    Highest Node              6  
 Number of Elements        7    Highest Beam                7

Number of Basic Load Cases              4  
 Number of Combination Load Cases      8

*Included in this printout are data for:*

**All**                      The Whole Structure

*Included in this printout are results for load cases:*

Type	L/C	Name
Combination	11	S1:DL
Combination	12	S2:DL+LL
Combination	13	S3:DL+UP
Combination	14	S4:DL+LL+UP

**Section Properties**

Prop	Section	Area (cm <sup>2</sup> )	I <sub>yy</sub> (cm <sup>4</sup> )	I <sub>zz</sub> (cm <sup>4</sup> )	J (cm <sup>4</sup> )	Material
1	Rect 0.30x1.00	3E 3	2.5E 6	225E 3	730E 3	CONCRETE
2	Rect 0.30x1.00	3E 3	2.5E 6	225E 3	730E 3	CONCRETE

**Materials**

Mat	Name	E (kN/mm <sup>2</sup> )	v	Density (kg/m <sup>3</sup> )	α (1/°K)
1	STEEL	205.000	0.300	7.83E 3	12E -6
2	ALUMINUM	68.948	0.330	2.71E 3	23E -6
3	CONCRETE	21.718	0.170	2.4E 3	10E -6

**Supports**

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN°m/deg)	rY (kN°m/deg)	rZ (kN°m/deg)
1	-	800.00	Fixed	Fixed	Fixed	-
2	-	800.00	Fixed	Fixed	Fixed	-
5	-	800.00	Fixed	Fixed	Fixed	-
6	Fixed	Fixed	Fixed	-	-	-

**Basic Load Cases**

Number	Name
1	SW
2	DL
3	LL
4	UPLIFT

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
11	S1:DL	1	SW	1.00
		2	DL	1.00
12	S2:DL+LL	1	SW	1.00
		2	DL	1.00
		3	LL	1.00
13	S3:DL+UP	1	SW	1.00
		2	DL	1.00
		4	UPLIFT	1.00
		1	SW	1.00
14	S4:DL+LL+UP	2	DL	1.00
		3	LL	1.00
		4	UPLIFT	1.00
		1	SW	1.70
21	U1:DL	2	DL	1.70
		1	SW	1.70
22	U2:DL+LL	1	SW	1.70
		2	DL	1.70
		3	LL	2.00
23	U3:DL+UP	1	SW	1.70
		2	DL	1.70
		4	UPLIFT	2.00
		1	SW	1.27
24	U4:DL+LL+UP	2	DL	1.27
		3	LL	1.50
		4	UPLIFT	1.50

Selfweight : 1 SW

Direction Factor

Y	-1.000
---	--------

Beam Loads : 2 DL

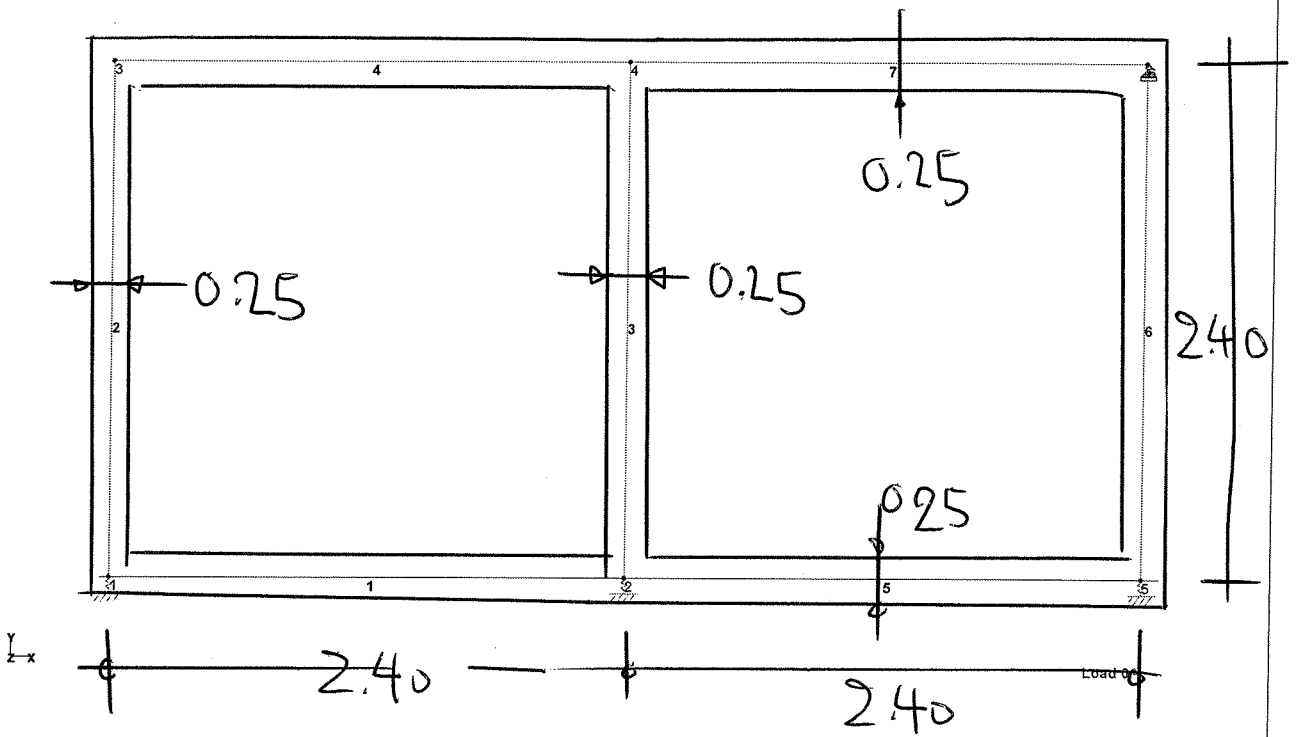
Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI	MTon/m	GY	-0.250	-	-	-
2	UNI	MTon/m	GX	3.565	-	-	-
	TRAP	MTon/m	GX	1.610	-	0.000	-
4	UNI	MTon/m	GY	-10.800	-	-	-
5	UNI	MTon/m	GY	-0.250	-	-	-
6	UNI	MTon/m	GX	-3.565	-	-	-
	TRAP	MTon/m	GX	-1.600	-	0.000	-
7	UNI	MTon/m	GY	-10.800	-	-	-

Beam Loads : 3 LL

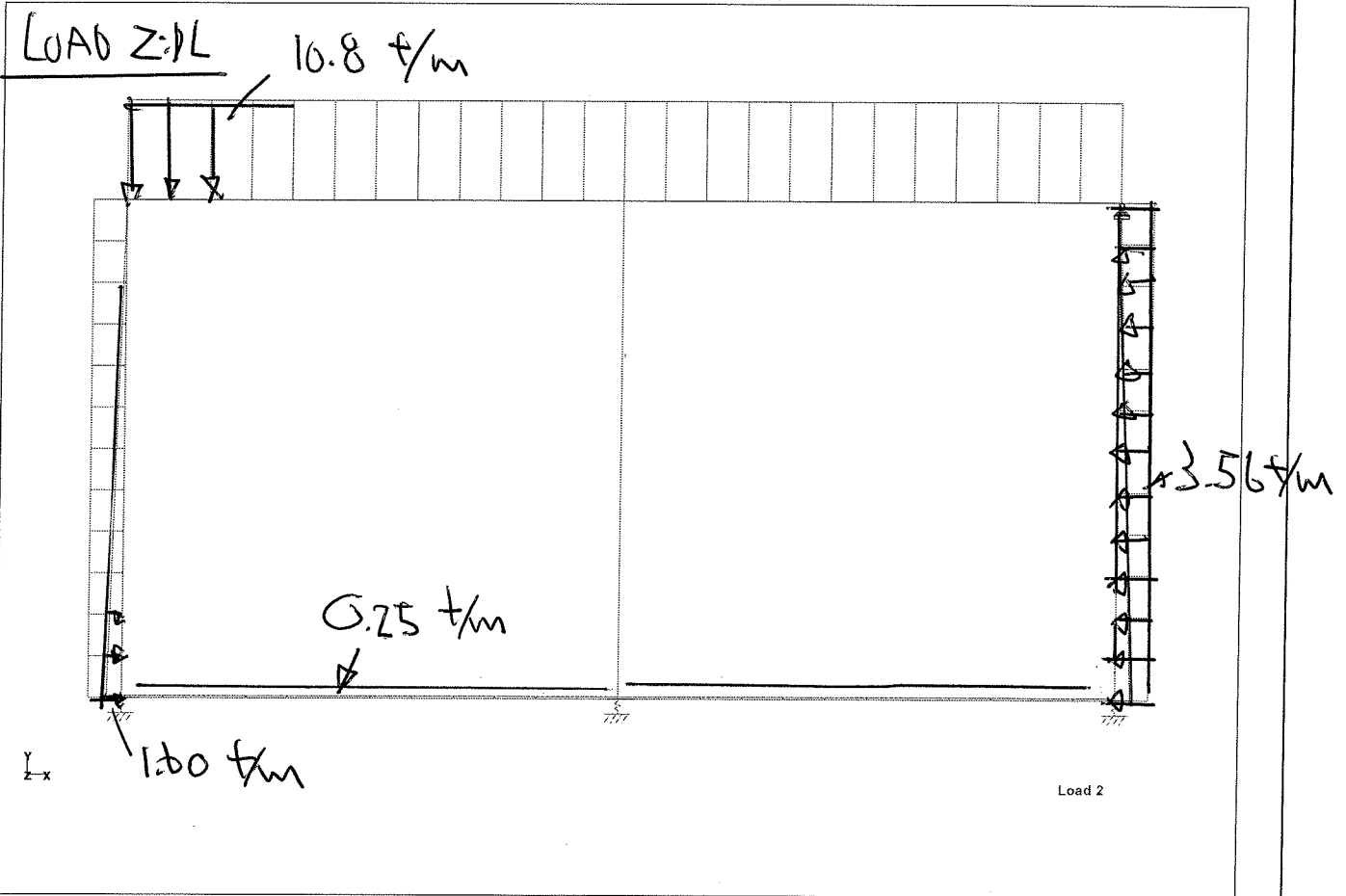
Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI	MTon/m	GY	-2.100	-	-	-
2	UNI	MTon/m	GX	0.350	-	-	-
4	UNI	MTon/m	GY	-1.000	-	-	-
5	UNI	MTon/m	GY	-2.100	-	-	-
6	UNI	MTon/m	GX	-0.350	-	-	-
7	UNI	MTon/m	GY	-1.000	-	-	-

Beam Loads : 4 UPLIFT

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI	MTon/m	GY	8.700	-	-	-
5	UNI	MTon/m	GY	8.700	-	-	-

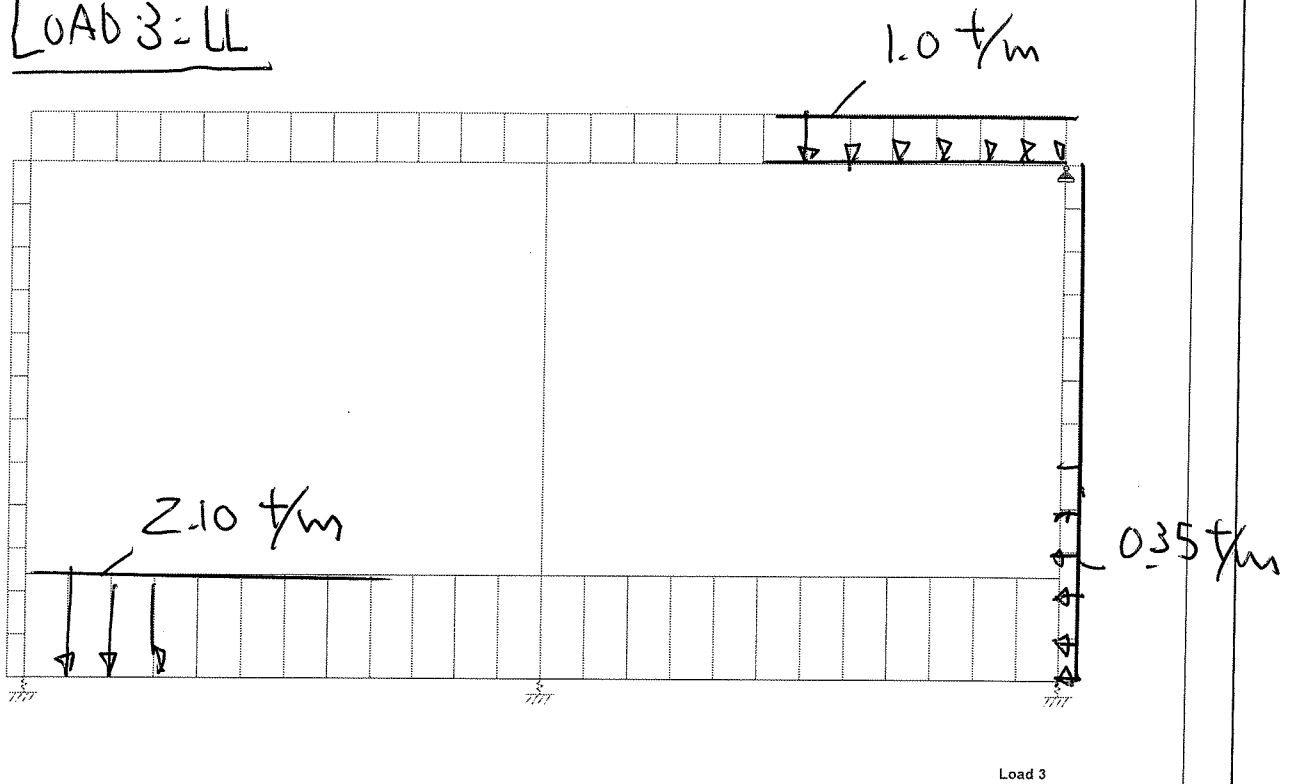


Whole Structure



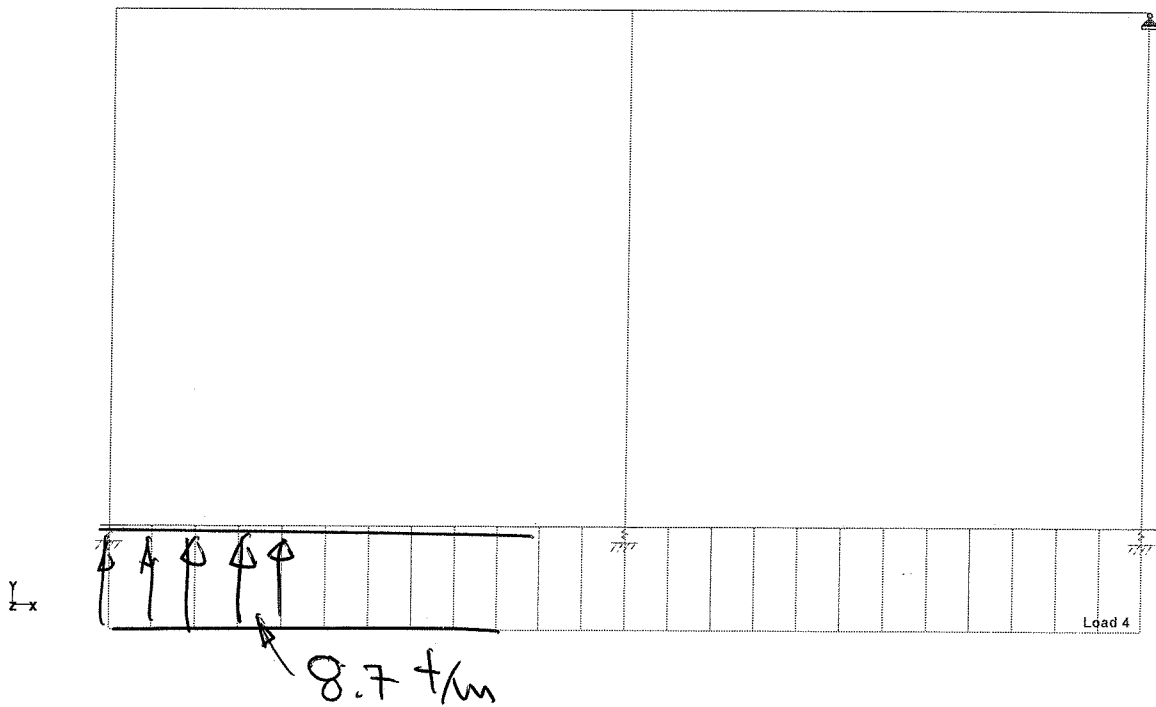
Whole Structure Loads 10.1972kg:1m 2 DL

# LOAD 3: LL

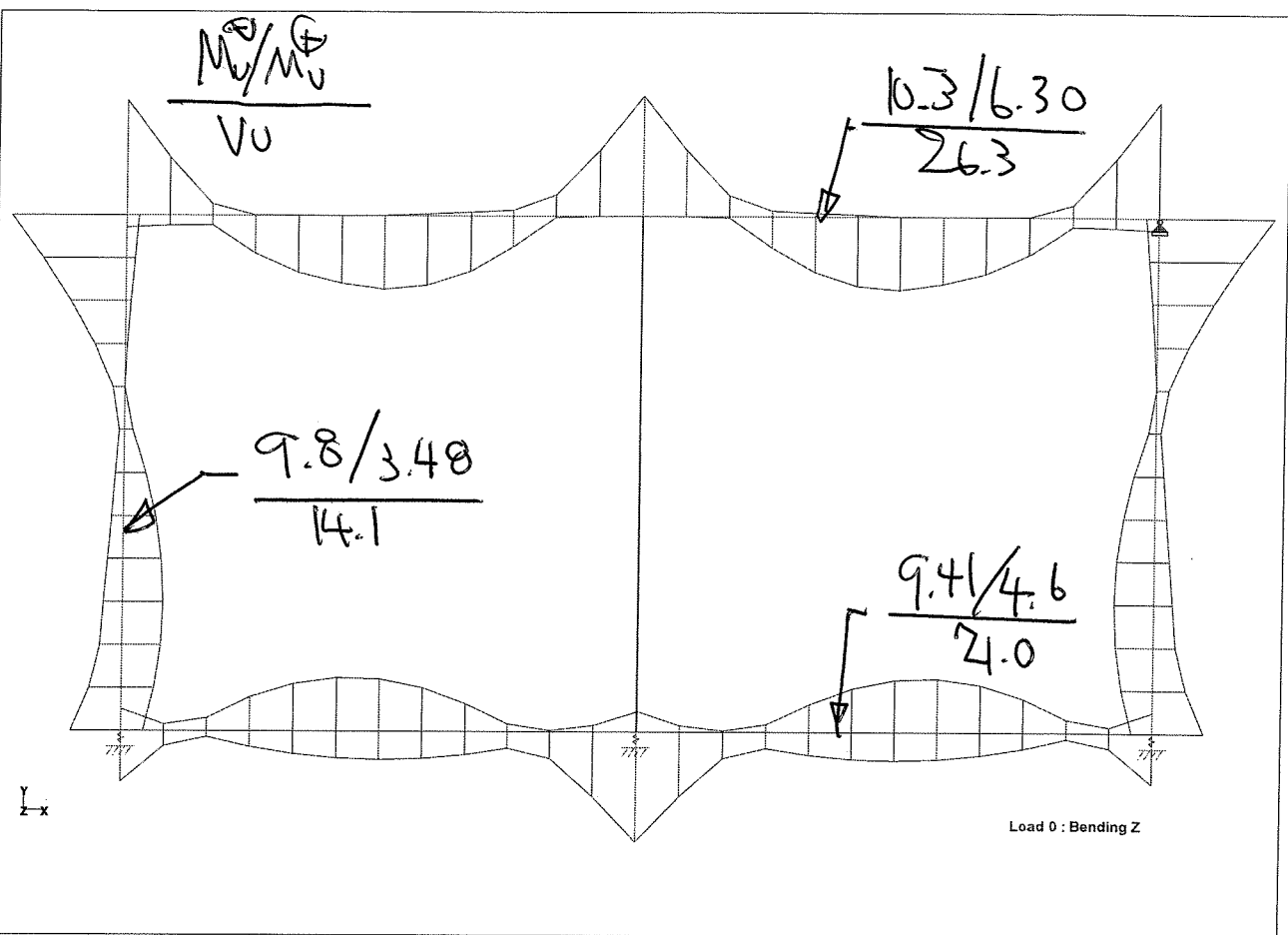


Whole Structure Loads 10.1972kg:1m 3 LL

# LOAD 4: Uplift



Whole Structure Loads 10.1972kg:1m 4 UPLIFT



Whole Structure Mz 180kNm:1m 0 Envelope

Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	1	12:S2:DL+LL	0.18	-0.25	0.00	0.31	0.00	0.00	-0.00
Min X	6	11:S1:DL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max Y	5	13:S3:DL+UP	0.06	0.02	0.00	0.07	0.00	0.00	-0.00
Min Y	4	12:S2:DL+LL	0.03	-0.58	0.00	0.58	0.00	0.00	0.00
Max Z	1	11:S1:DL	0.15	-0.21	0.00	0.26	0.00	0.00	-0.00
Min Z	1	11:S1:DL	0.15	-0.21	0.00	0.26	0.00	0.00	-0.00
Max rX	1	11:S1:DL	0.15	-0.21	0.00	0.26	0.00	0.00	-0.00
Min rX	1	11:S1:DL	0.15	-0.21	0.00	0.26	0.00	0.00	-0.00
Max rY	1	11:S1:DL	0.15	-0.21	0.00	0.26	0.00	0.00	-0.00
Min rY	1	11:S1:DL	0.15	-0.21	0.00	0.26	0.00	0.00	-0.00
Max rZ	6	12:S2:DL+LL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Min rZ	3	14:S4:DL+LL+t	0.05	-0.18	0.00	0.19	0.00	0.00	-0.00
Max Rst	4	12:S2:DL+LL	0.03	-0.58	0.00	0.58	0.00	0.00	0.00

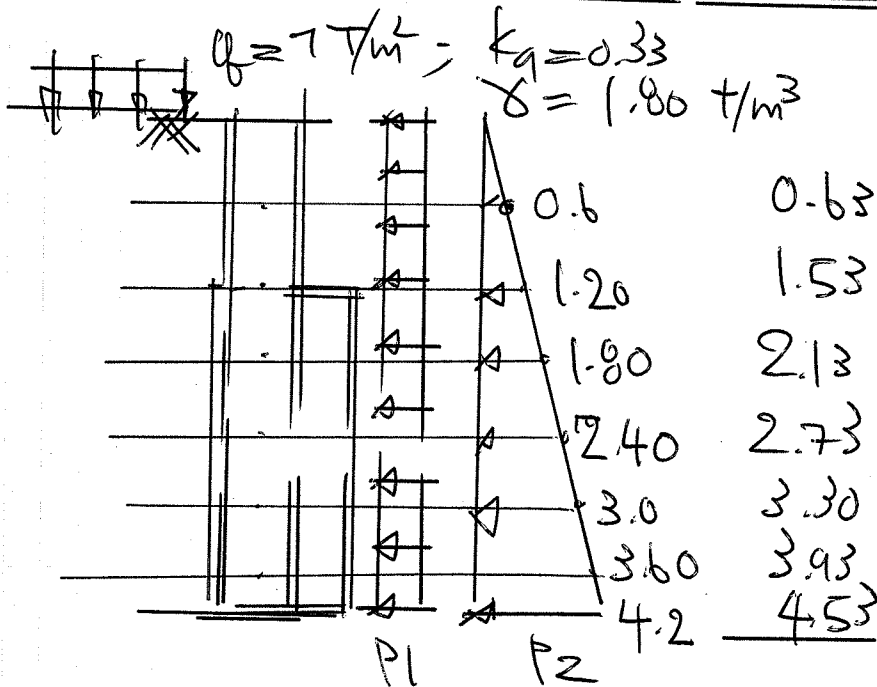
Reactions

Node	L/C	Horizontal FX (Mton)	Vertical FY (Mton)	Horizontal FZ (Mton)	Moment MX (Mton'm)	Moment MY (Mton'm)	Moment MZ (Mton'm)
1	11:S1:DL	0.00	16.99	0.00	0.00	0.00	0.00
	12:S2:DL+LL	0.00	20.73	0.00	0.00	0.00	0.00
	13:S3:DL+UP	0.00	6.56	0.00	0.00	0.00	0.00
	14:S4:DL+LL+t	0.00	10.30	0.00	0.00	0.00	0.00
2	11:S1:DL	0.00	31.18	0.00	0.00	0.00	0.00
	12:S2:DL+LL	0.00	38.58	0.00	0.00	0.00	0.00
	13:S3:DL+UP	0.00	10.28	0.00	0.00	0.00	0.00
	14:S4:DL+LL+t	0.00	17.68	0.00	0.00	0.00	0.00
5	11:S1:DL	0.00	0.51	0.00	0.00	0.00	0.00
	12:S2:DL+LL	0.00	1.04	0.00	0.00	0.00	0.00
	13:S3:DL+UP	0.00	-1.67	0.00	0.00	0.00	0.00
	14:S4:DL+LL+t	0.00	-1.14	0.00	0.00	0.00	0.00
6	11:S1:DL	-0.01	16.47	0.00	0.00	0.00	0.00
	12:S2:DL+LL	-0.01	19.68	0.00	0.00	0.00	0.00
	13:S3:DL+UP	-0.01	8.22	0.00	0.00	0.00	0.00
	14:S4:DL+LL+t	-0.01	11.42	0.00	0.00	0.00	0.00

# CALCULATION SHEET

PROJECT	JOB ID	
SUBJECT	DESIGNED	PAGE
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Mantle = 3.30 x 6.30 x 0.30 m



$P_1 = 0.33 \times 4.2 = 1.386 \text{ t}$

$P_2 = \gamma H \cdot k_a$

Uplift = 8700 t/m<sup>2</sup>

Base Slab.

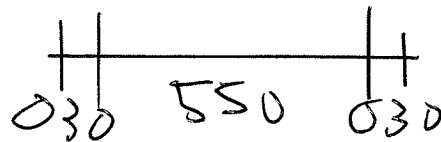
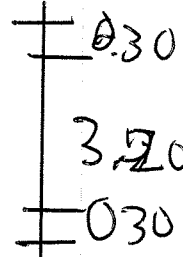
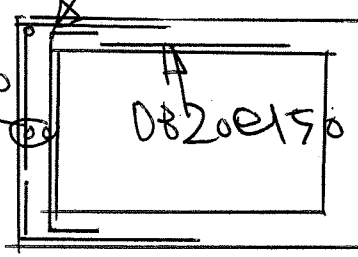
DL = 960 k/m

UP = 8700 "

7740 "

DB20@150

DB16@200



$M = 6811$

$M_u = 11580$

$A_s = 13.85 \text{ cm}^2/\text{m} - \text{DB20@200 (Top)}$

# CALCULATION SHEET

PROJECT	JOB ID	
SUBJECT	DESIGNED	PAGE
	CHECKED	SHEET

Top slab ( $t = 0.30$  m)

$$DC = 2400 \text{ kg/m}^3$$

$$U = 1000 \text{ ''}$$

$$Soil = 3600 \text{ ''}$$

$$\underline{5560 \text{ ''}}$$

$$M = \frac{1}{12} \times 5560 \times 3.2^2$$

$$= 4745 \text{ kg-m/m}$$

$$M_U = 8067 \text{ kg-m/m}$$

$$A_{st} = 9.54 \text{ cm}^2/\text{m} = \underline{DB16e200 (T2B)}$$

RC Wall ( $t = 0.30$ )

$$M_{Umax} = 12740 \text{ kg-m/m}$$

$$A_{st} = 15.44 \text{ cm}^2/\text{m} - DB20e200.$$

$$A_{stmin} = 5.40 \text{ cm}^2/\text{m} - DB16e200.$$



Job Information

	Engineer	Checked	Approved
Name:			
Date:	07-Aug-00		
Structure Type	SPACE FRAME		
Number of Nodes	4	Highest Node	4
Number of Elements	4	Highest Beam	4
Number of Basic Load Cases	1		
Number of Combination Load Cases	0		

Design of  
Manhole  
5.20x3.20x0.30f

Included in this printout are data for:  
All The Whole Structure

Included in this printout are results for load cases:

Type	LJC	Name
Primary	1	LAT-1

Section Properties

Prop	Section	Area (cm <sup>2</sup> )	I <sub>yy</sub> (cm <sup>4</sup> )	I <sub>zz</sub> (cm <sup>4</sup> )	J (cm <sup>4</sup> )	Material
1	Rect 1.00x0.35	3.5E 3	357E 3	2.92E 6	1.11E 6	MATERIAL1
2	Rect 1.00x0.35	3.5E 3	357E 3	2.92E 6	1.11E 6	MATERIAL1
3	Rect 1.00x0.75	7.5E 3	3.52E 6	6.25E 6	7.59E 6	MATERIAL1
4	Rect 1.00x0.75	7.5E 3	3.52E 6	6.25E 6	7.59E 6	MATERIAL1

Supports

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN <sup>2</sup> m/deg)	rY (kN <sup>2</sup> m/deg)	rZ (kN <sup>2</sup> m/deg)
1	-	Fixed	-	Fixed	-	Fixed
2	-	Fixed	-	Fixed	-	Fixed
3	-	Fixed	-	Fixed	-	Fixed
4	-	Fixed	-	Fixed	-	Fixed

Basic Load Cases

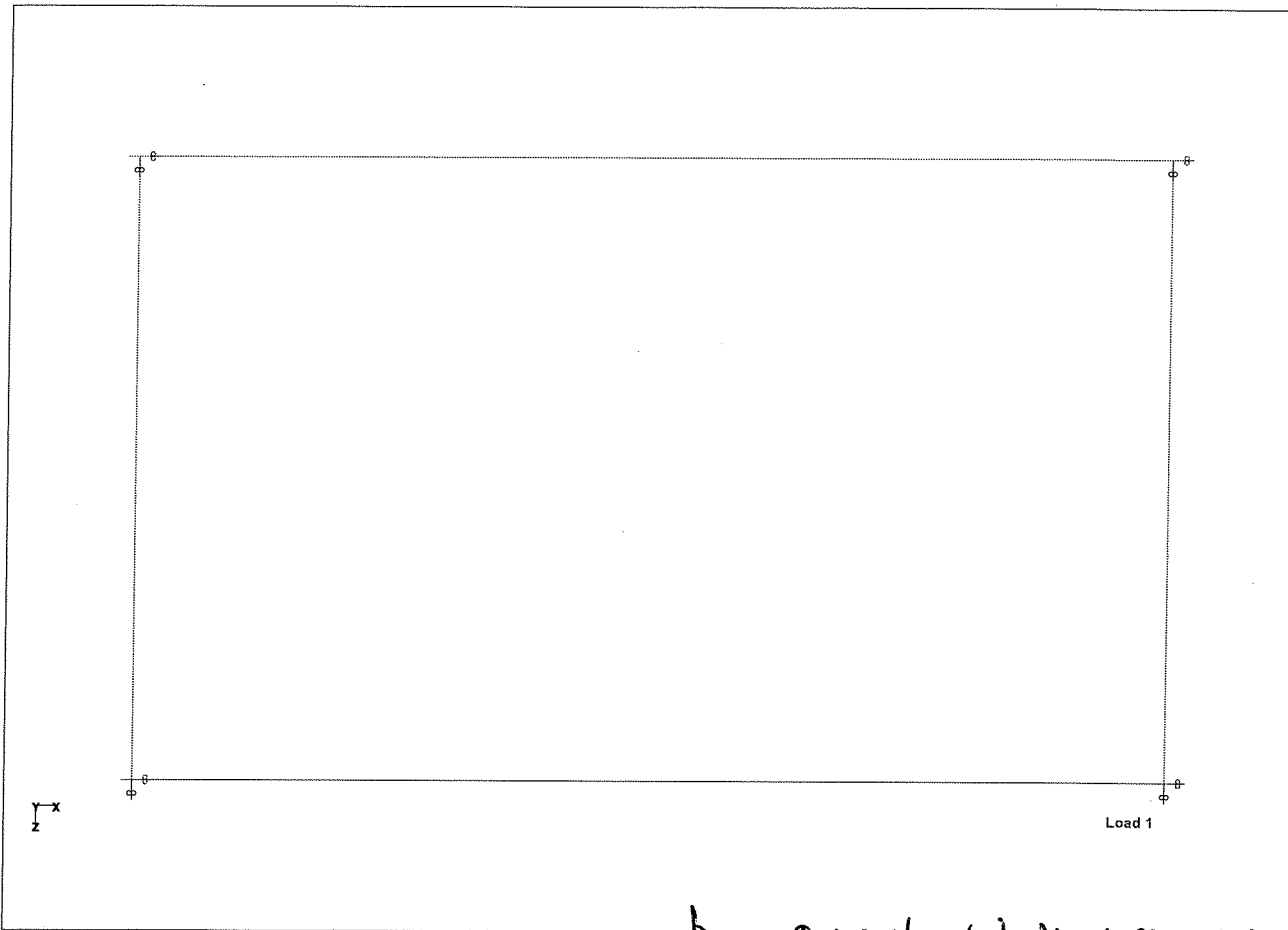
Number	Name
1	LAT-1

Combination Load Cases

There is no data of this type.

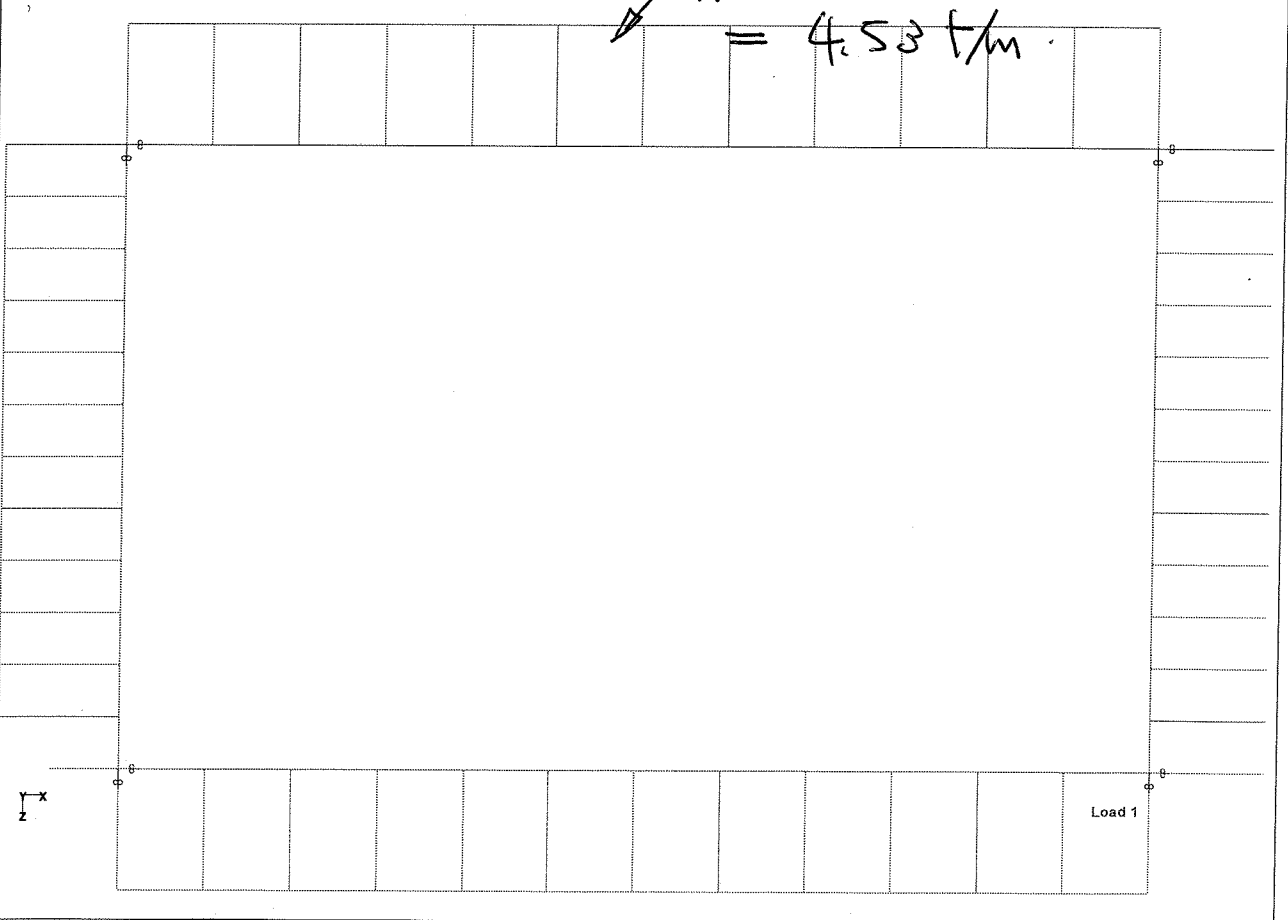
Beam Loads : 1 LAT-1

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI	MTon/m	GZ	4.530	-	-	-
2	UNI	MTon/m	GX	-4.530	-	-	-
3	UNI	MTon/m	GZ	-4.530	-	-	-
4	UNI	MTon/m	GX	4.530	-	-	-

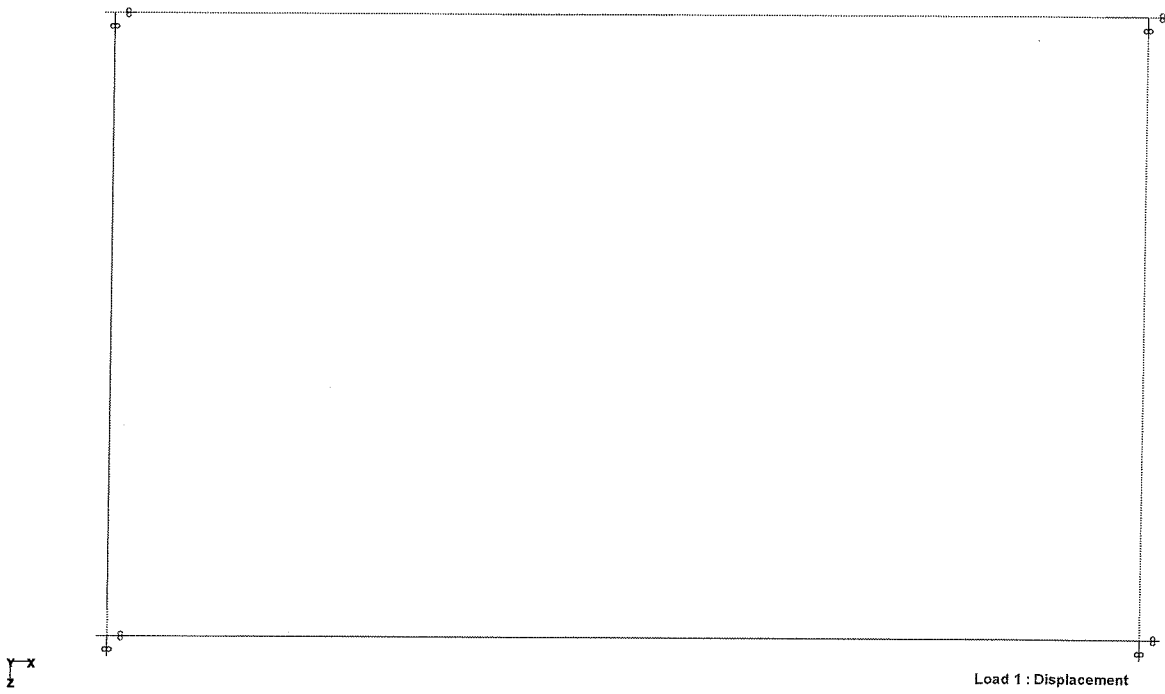


Whole Structure

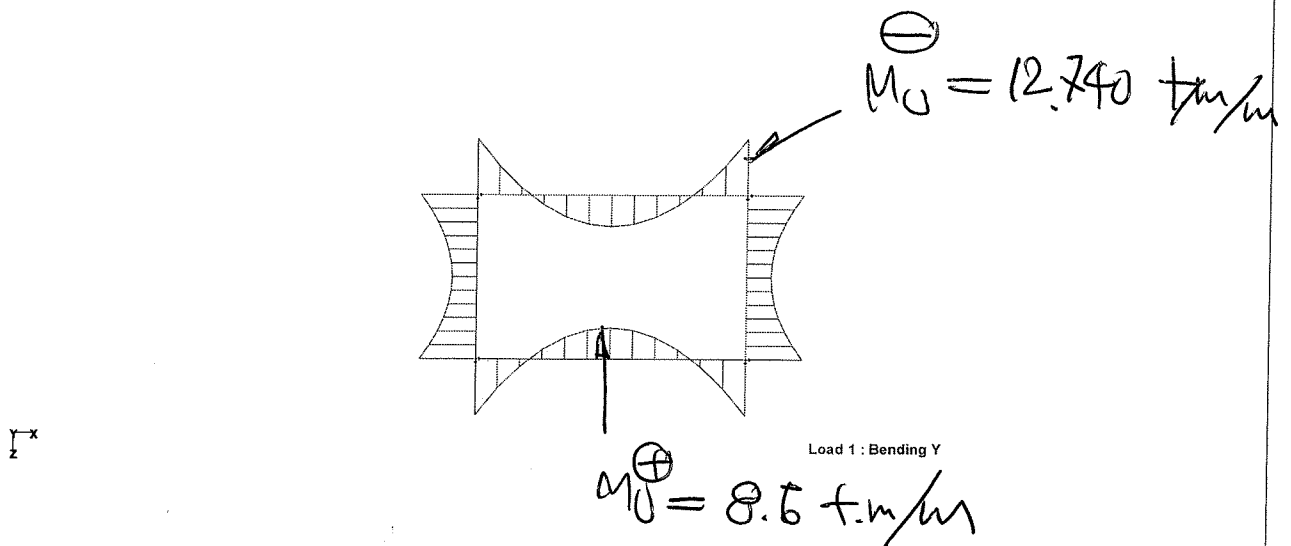
$$P_w = 0.33 \times 1.0 + 0.33 \times 1.80 \times 7.0 = 4.53 \text{ t/m}$$



Whole Structure Loads 10.1972kg/1m 1 LAT-1

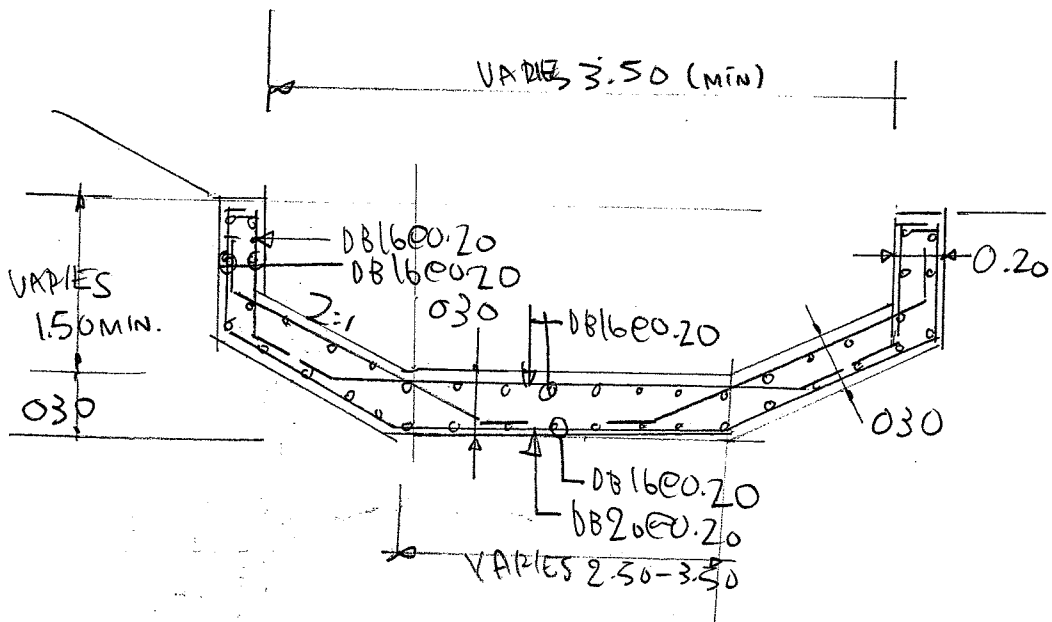


Whole Structure Displacements 1000mm:1m 1 LAT-1

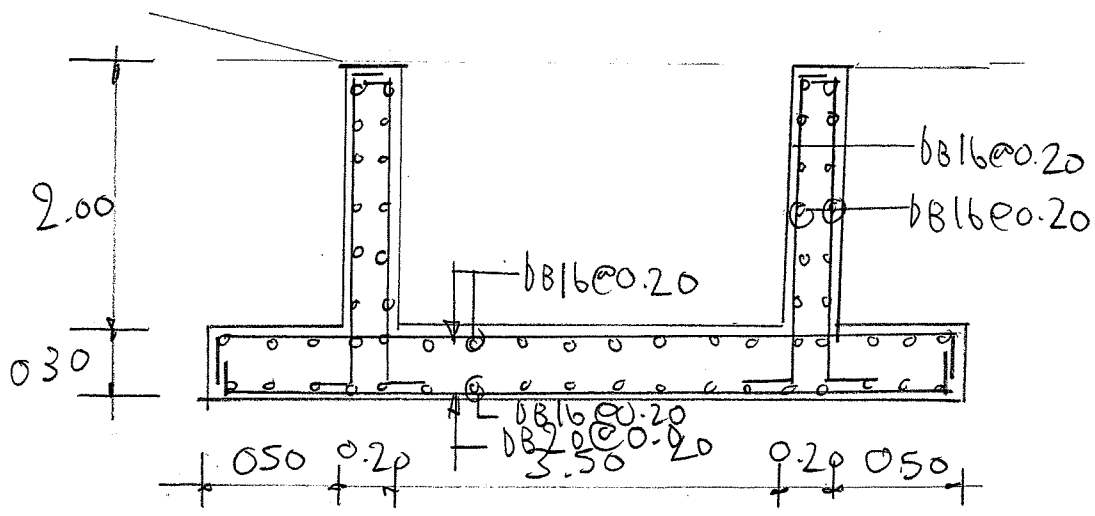


Whole Structure My 10.1972MTon-m:1m 1 LAT-1

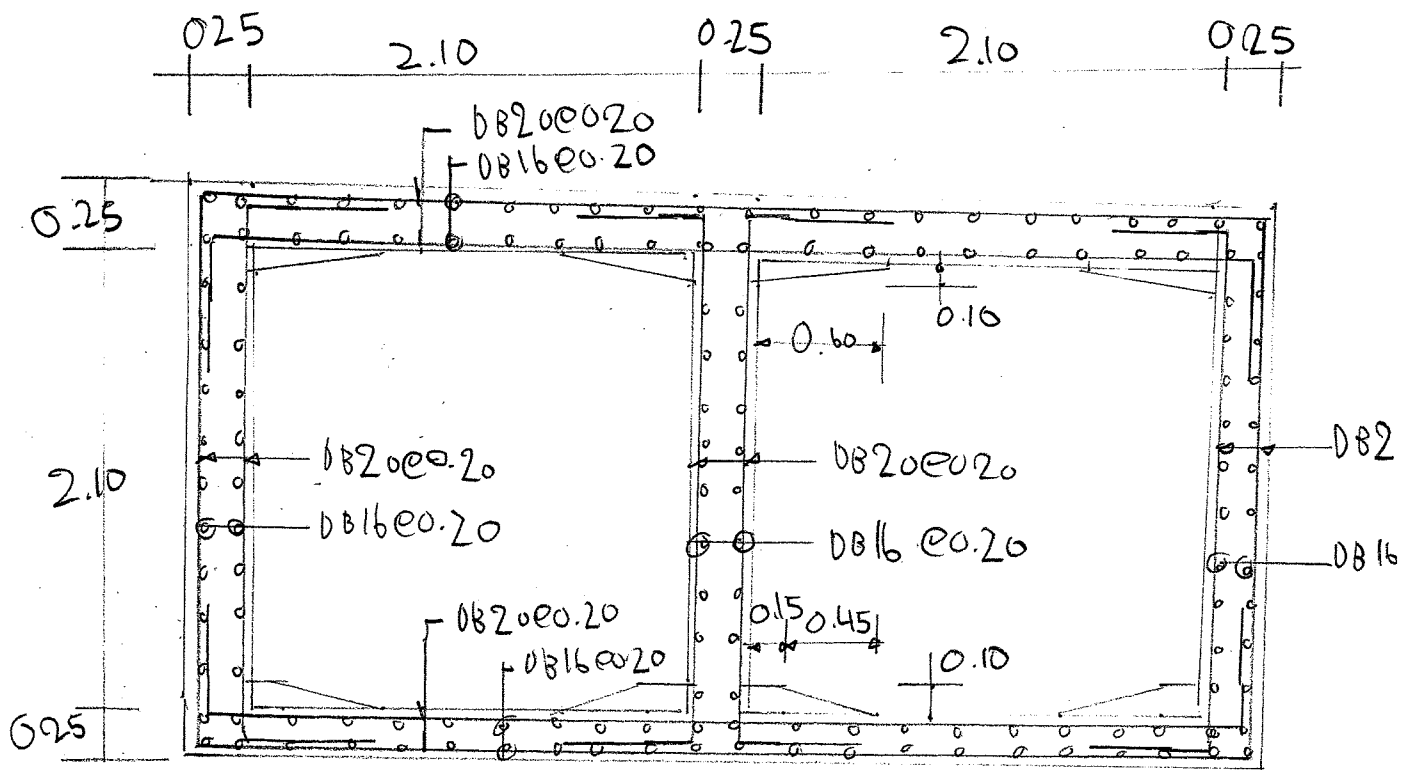




SECTION C

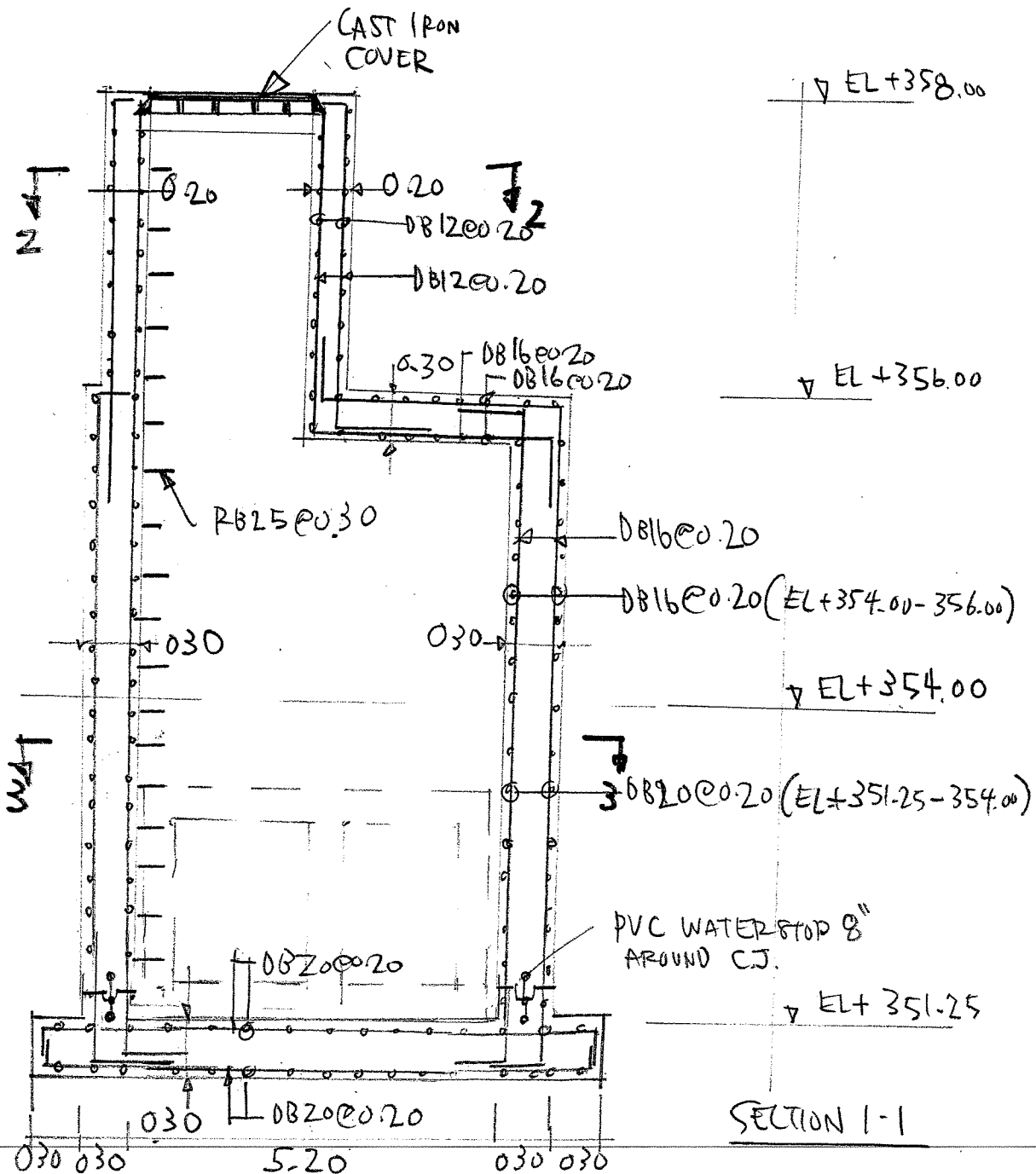


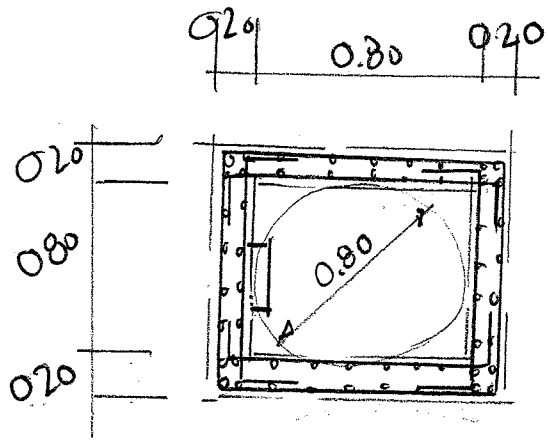
SECTION D



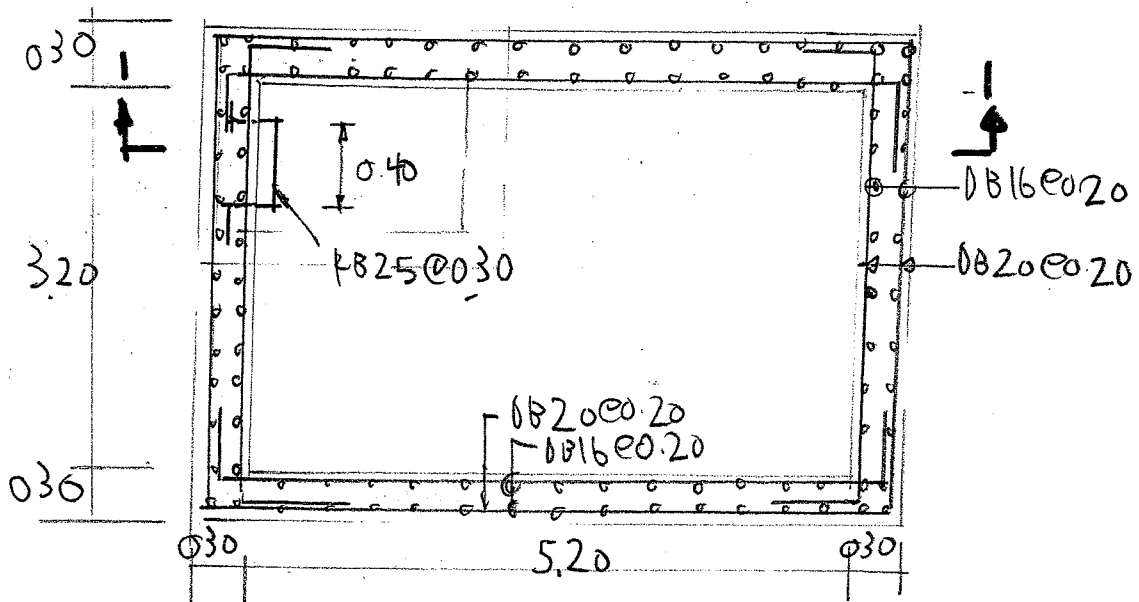
SECTION A.

# MANHOLE RC DETAIL





SECTION 2-2



SECTION 3-3