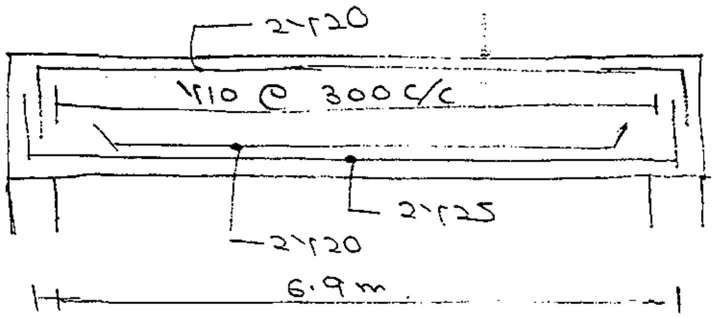
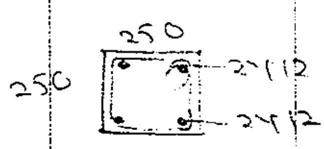
DAYANANDA ASSOCIATES	PROJECT		JOB REF
CONSULTING ENGINEERS	CALCULATIONS BY	CHECKED BY	CALC SHEET
	PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT
	$M = 66$ kNm. RB1 – 300×450	
	$\frac{M}{f_{cu}bd^2} = \frac{66\times10^6}{25\times250\times397.5^2} = 0.067$	
	$z = 0.908 \times 397.5 = 360.93$	
	$A_{st} = \frac{66\times10^6}{0.87\times450\times361} = 467$ –	2Y20 (628)
	$v_u = \frac{94\times10^3}{250\times397.5} = 0.95$	
	$\frac{100A_s}{bd} = \frac{100\times628}{250\times397.5} = 0.63$	
	$v_c = 0.57$	
	$b(v - v_c) = 250(0.95 - 0.57) = 95$ Y10 @ 300 c/c	



RB3 beam. – 250×250

nominal r/f = $0.0013 \times 250 \times 250 = 81.25$ – 2Y12 (226.

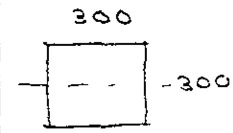


DAYANANDA ASSOCIATES — CONSULTING ENGINEERS

PROJECT		JOB REF
CALCULATIONS BY	CHECKED BY	CALC SHEET
PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT

column C_2 - 300 x 300



N = 99 M = 66 kNm.

$l_{ox} = 3.0 - 0.45 = 2.55$

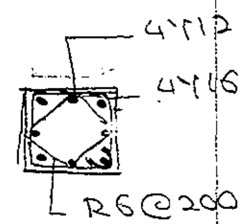
$l_{ex} = 1.2 \times 2.55$.

$\frac{l_{ex}}{h} = \frac{1.2 \times 2.55}{0.3} = 10.2$

$\frac{N}{bhf_{cu}} = \frac{99 \times 10^3}{300^2 \times 25} = 0.044$

$\frac{M}{bh^2 f_{cu}} = \frac{66 \times 10^6}{300 \times 300^2 \times 25} = 0.098$

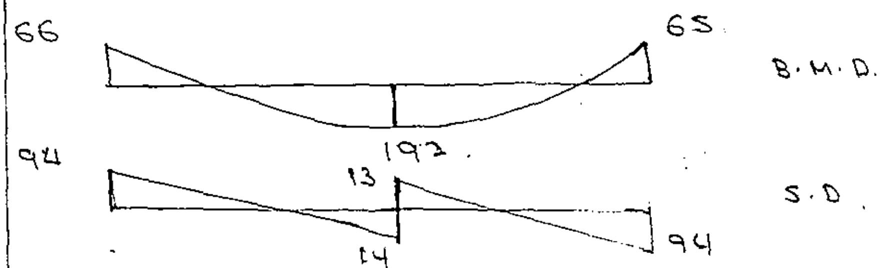
Nominal A ok



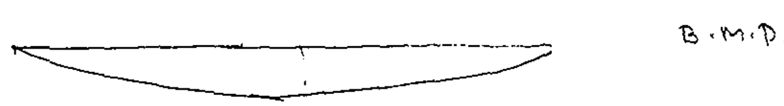
provide 1% = 900 - 4Y16

beam RB1 - 250 x 450

case 1



case 2



M = 192 kNm.

$\frac{M}{f_{cu}bd^2} = \frac{192 \times 10^6}{25 \times 250 \times 397^2} = 0.195$

d = 450 - 40 - 25/2 = 397.5

$z = 0.777 \times 397.5 = 308.86$

$A_{sc} = \frac{(0.195 - 0.156) \times 25 \times 250 \times 397^2}{0.87 \times 450 \times (397 - 50)} = 283$ — 2Y16 (402)

92

$A_{st} = \frac{0.156 \times 25 \times 250 \times 397^2}{0.87 \times 450 \times 309} + 283 = 1553$ - 2Y25 + 2Y20 (1609)

DAYANANDA ASSOCIATES	PROJECT		JOB REF
CONSULTING ENGINEERS	CALCULATIONS BY	CHECKED BY	CALC SHEET
	PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT

column - C1 - 300×300

N = 303 kN

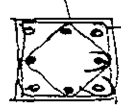
l_{ox} = 3200 - 450 = 2750

$\frac{l_{ox}}{h} = \frac{2750}{300} = 9.17$

M min = 0.05 × 0.3 × 303 = 4.55

$\frac{N}{bhf_{cu}} = \frac{303\times10^3}{300^2\times25} = 0.135$

$\frac{M}{bh^2f_{cu}} = \frac{10\times10^6}{300\times300^2\times25} = 0.015$



1% r/f = 900.

RB6 - 250×250

w_d = 1.34 × (2.5 + 2.6)/2 + 0.25×0.45×24 = 6.12

w_s = 0.75 × " = 1.91

4.02 1.572

n = 1.4 × 6.12 + 1.6 × 1.91 = 11.62 kN/m

$M_{span} = \frac{wl^2}{8} = 11.62 \times \frac{4.02^2}{8} = 23.47$

$M_{support} = \frac{wl^2}{12} = 11.62 \times \frac{4.02^2}{12} = 15.65$ kNm

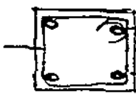
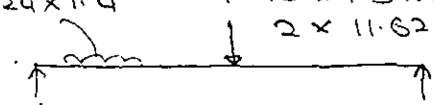
$\frac{M}{f_{cu}bd^2} = \frac{24\times10^6}{25\times250\times200^2} = 0.096$

z = 0.861 × 200 = 172.2

$A_{st} = \frac{24\times10^6}{0.87\times450\times172} = 356$ - 2Y16 (402)

$V_{max} = 11.62 \times (\frac{4.02}{2} + 1.572) = 41.62$ kN.

DAYANANDA ASSOCIATES	PROJECT		JOB REF
CONSULTING ENGINEERS	CALCULATIONS BY	CHECKED BY	CALC SHEET
	PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT
RB6	$V_u = \frac{42\times10^3}{250\times200} = 0.84$	Y10 @ 150 c/c, 2Y12, 2Y16 
	$\frac{100 A_s}{bd} = \frac{100\times402}{250\times200} = 0.804$	
	$V_c = 0.695$	
	$b(V-V_c) = 250(0.84-0.69) = 37.5$	
	provide $0.4\times250 = 100$ − Y10 @ 150 c/c	
	$M = 16$ kNm.	
	$\frac{M}{f_{cu}bd^2} = \frac{16\times10^6}{25\times250\times200^2} = 0.064$	
	$z = 0.912\times200 = 182.4$	
	$A_{st} = \frac{16\times10^6}{0.87\times450\times182} = 225$ − 2Y12	
	RBS − 250 × 450	
	3.78 = 0.25 × 0.45 × 24 × 1.4 ; P. 15 × 1.5 × 1.2 + 2 × 11.62 × $\frac{4.02}{2}$ } = 73.71 kN	
	 5.823	
	$M_{span} = 74\times\frac{5.823}{4} + \frac{4\times5.823^2}{8}$	
	$= 124.68$ kNm.	
	$\frac{M}{f_{cu}bd^2} = \frac{125\times10^6}{25\times250\times397.5^2} = 0.127$	
	$z = 0.803\times397.5 = 319$	
	$A_{st} = \frac{125\times10^6}{0.87\times450\times319} = 1001$ −	2Y25 + 1Y12 (1094)
	$V = \frac{74}{2} + \frac{4}{2}\times5.823 = 48.65$ kN	

DAYANANDA ASSOCIATES	PROJECT		JOB REF
CONSULTING ENGINEERS	CALCULATIONS BY	CHECKED BY	CALC SHEET
	PART OF STRUCTURE		DATE

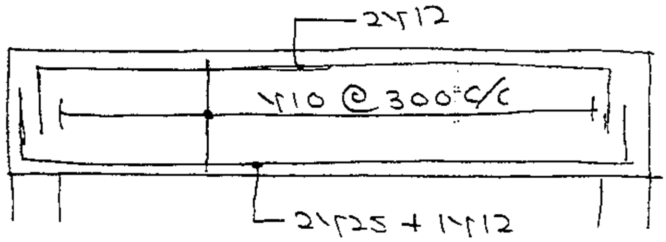
MEMBER REF	CALCULATIONS	OUT PUT
RBS		

$$V_u = \frac{49 \times 10^3}{250 \times 397.5} = 0.493$$

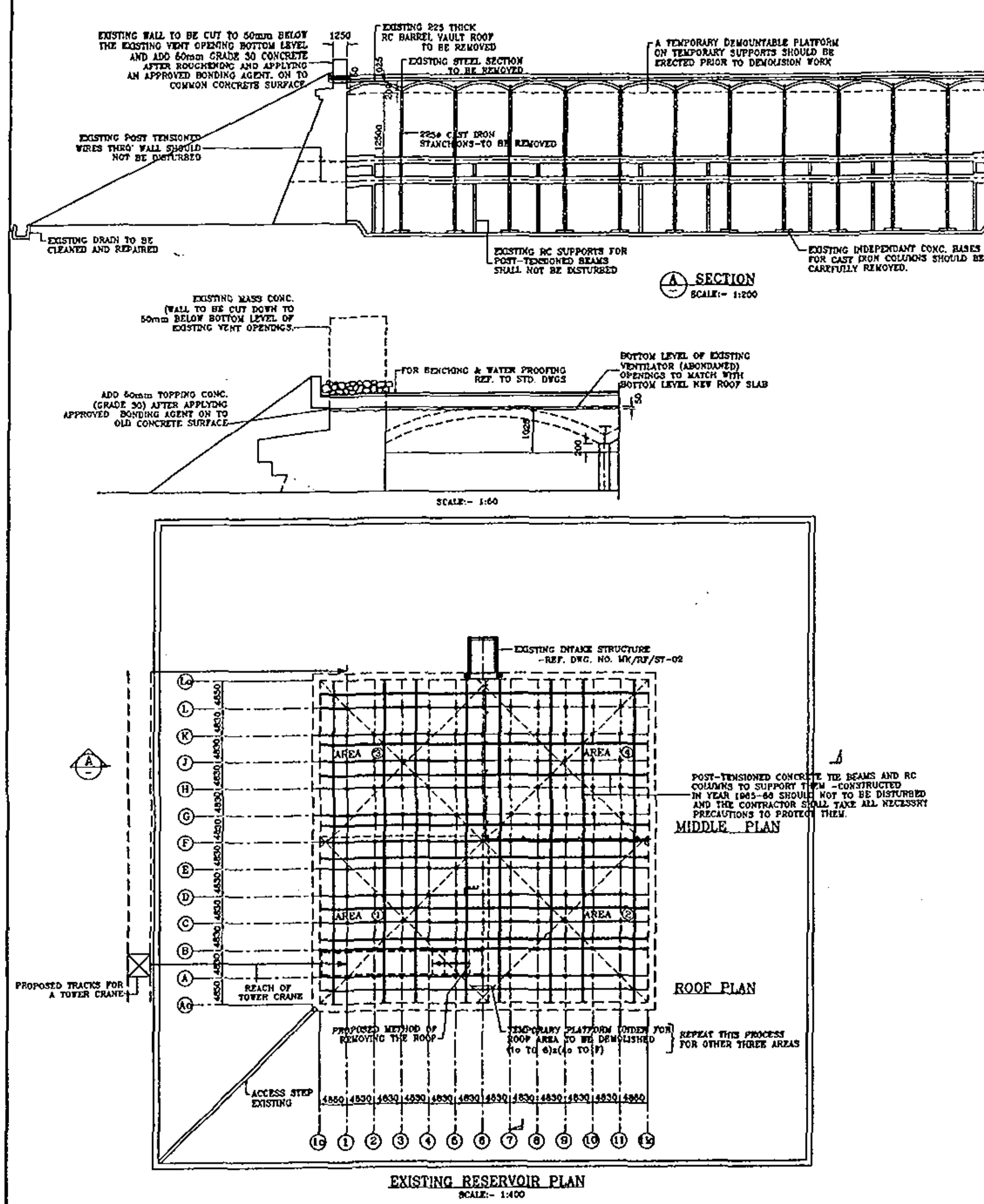
$$\frac{100 A_s}{bd} = \frac{100 \times 1094}{250 \times 397.5} = 1.1$$

$V_c = 0.65$

provide $0.4 \times 250 = 100$ Y10 @ 300 c/c



ROOF REHABILITATION OF EXISTING MALIGAKANDA RESERVOIR



NOTES:-

1. The drawings shall not be scaled. The contractor, prior to start with rehabilitation works, shall verify dimensions and all information in connection with the existing structure at site and satisfy himself. He also should get prior approval of the engineer for methodology, program, and the entire operation of rehabilitation works.
2. The main rehabilitation works in brief, is as listed below. As a precautionary measure to safeguard the existing post-tensioned concrete beams and rc column, which support them within the reservoir, the walls and the reservoir base, the contractor shall erect a temporary platform under the existing steel girders of the "barrel vault" roof. Since the steel tie rods which should provide horizontal support for the "barrel vaults" are severely corroded/or damaged it is necessary to provide temporary *horizontal ties system prior to removing the roof.*
   - Existing reinforced concrete (rc) "barrel vault" roof structure should be cut into pieces with the help of a high pressure water jet, electrically or mechanically operated diamond tipped circular saw or an approved equivalent, and be carefully removed part by part.
   - The existing steel girders which support the barrel vault roof, should be cut into pieces with the help of an oxy-acetylene flame or an electric saw or any approved equivalent and carefully removed part by part. It is necessary to *provide lateral supports to the existing cast iron columns when removing the* existing steel girders.
   - The existing cast iron columns and bases which support the roof structure should be carefully removed.
   - The perimeter concrete wall should be cut with the help of a high pressure water jet or a diamond tipped circular saw, to 50-75 mm below the bottom level of the proposed new rc roof slab and carefully be removed roughened the exposed surface and finished with topping concrete with approved bonding agent.
   - Since there are post-tensioned beams and their supports within the reservoir, the contractor shall be careful if necessary to erect a tower crane or heavy equipment within the reservoir to facilitate demolition or construction work.
   - The contractor may erect a motorized gantry to span between existing reservoir walls with centre support on the existing base of the reservoir and the cut pieces may be brought to a place reachable to a tower crane erected outside the perimeter earth fill.
   - The earth fill around the existing perimeter mass concrete wall of the reservoir should be made to a constant slope by filling the depressions with fresh soil. The filling should be carried out manually and tamping should be done with the help of a manual tamper, so that there will be no vibrations passed on to the existing structure. Prior to filling operation, the top soil should be removed. The filled area should be finished with turfing with approved grass.
   - The existing toe drain along the perimeter of the reservoir should be cleaned, and repaired where necessary, to have a constant gradient for the water to flow *into the nearest manhole.*
   - No heavy constructions equipment shall not be allowed on the existing embankment, specially when the reservoir is empty and the roof structure is removed.
   - The possible tracks for a tower crane to facilitate removal of debris is as shown on the layout plan. This can be changed to suit the contractor's proposal for rehabilitation works.
   - Carry out new construction work as indicated on drawings and rehabilitation work related to existing intake structure. Ref. Dwg. No. *MK/RF/ST-02* for details.

The cement used to produce concrete for the foundation structure such as the base slab of the reservoir shall be Portland Cement complying to BS 12 mixed with 25 % pulverized fuel ash (pfa). The cement content of the concrete shall be not less than 380 kg/m^3 and the maximum free water cement ratio shall be 0.45.

DO NOT SCALE

NATIONAL WATER SUPPLY AND DRAINAGE BOARD THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA	SUB PROJECT: MALIGAKANDA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN	TITLE: REHABILITATION OF EXISTING RESERVOIR ROOF DEMOLISION PLAN
DATE	JAN 2001
CONTRACT No.	NRW/CW
DWG No.	MK/RF/ST-01

PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

REF	CALCULATIONS	OUT PUT

Since the existing columns are on a grid of 4.83 x 4.83 metres a similar grid was selected to support a rc flat slab type roof.

4.83m x 4.83 m grid

Loading -roof slab

Dead load

Slab	=	0.25*24 = 6 kN/m2
Pebbles	=	0.25 * 20 = 5 kN/m2
Mortar	=	0.25*22 = 5.5 kN/m2

Output: 16.5kN/m2

Imposed load

Output: 2.5kN/m2

For 4.83 m width,

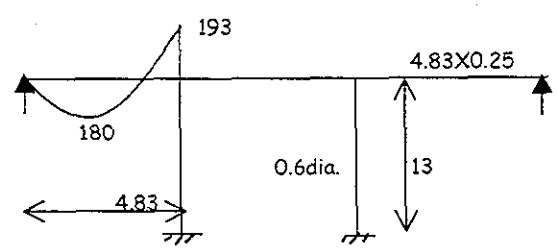
Case 1

SLS total dead load (wd) =4.83*16.5
=79.69 kN\m
total super load (ws)=2.5*4.83
=12.08 kN\m

Case 2

ULS total dead load (wd) =4.83*16.5*1.4
=111.57 kN\m
total super load (ws)=2.5*4.83*1.6
=19.32 kN\m

Refer to computer analysis output sheets



width of the column strip = 4.83/2 = 2.415 m

PROJECT	Reduction of non-revenue water in the Greater Colombo Area	
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir	
REF	CALCULATIONS	OUT PUT

SLS

	Col strip	Mid strip
Near centre of 1st span,	0.55*182/(4.83/2) =41.51kNm	0.45*182/(4.83/2) =34kNm
1st interior support,	-0.75*233/(4.83/2) =72.4 kNm	-0.25*233/(4.83/2) =24.1 kNm

ULS

	Col strip	Mid strip
Near centre of 1st span,	0.55*273/(4.83/2) =62.17 kNm	0.45*273./(4.83/2) =50.87kNm
1st interior support,	-0.75*330./(4.83/2) =102.5 kNm	-0.25*330./(4.83/2) =34.2 kNm

R/f for thermal & shrinkage crack control in immature concrete

area of steel (A_{st}) $= 112.5*10^3*2*12*10^{-6}(25+14)Ø/(6*0.2*2)$

A_{st} = 44Ø

selected bar dia. = 10 mm

A_{st} = 786 mm2/m — OUT PUT: y10@100mm

R/f for flexure

overall depth of slab (h) = 250 mm

cover to main r/f in botom face = 50 mm

cover to main r/f in botom face = 40 mm

Effective depth (d) = 250-40-10 = 200 mm

PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

REF	CALCULATIONS			OUT PUT
	SLS	Near centre of 1st span,	1st interior support	
	Moment (M_{sls})	41.5 kNm/m	72.4 kNm/m	
	$K=M/bd^2f_{cu}$	0.03 <.156	0.056 <.156	
		no compression steel required	no compression steel required	
	$z=d\{.5+[0.25-(k/0.9)]^{1/2}\}$	180.5 mm	177.41 mm	
	$A_s=M\backslash 0.87f_yz$	532 mm^2/m	991 mm^2/m	
		Y12-100c/c	Y16-100c/c + Y10-100c/c	Crackwidth 0.172 mm
	ULS			
	col strip,			
	(-ve) M_{ult}	= 102.5 kNm		
	$2/3^{rd}$ of an half col strip	= 4.83/4	= 1.21 m	
		= 2/3*(102.5)*4.83/2		
		= 165./1.21 kNm/m		
		= 136.4 kNm/m		
	A_s	= 1921 mm^2/m		
		Y16-100c/c + Y10-100c/c	provided and is ok	

PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

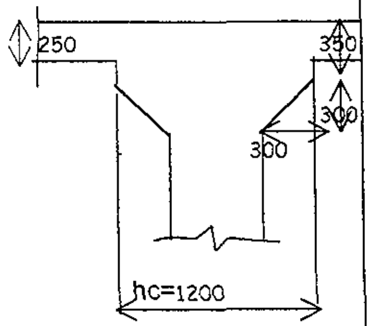
REF	CALCULATIONS	OUT PUT

Column head and 600mm dia. Column

Shear @ column head = (16.5*1.4+2.5*1.6)*4.83^2 kN

= 27.1 * 4.83^2

(V_u) = 632.21 kN



h_c < 0.25*4830

= 1207 mm

Vu = [632.21-p*1.6^2*27.1/4]*1.15*10^3/[p*1600*200]

= 0.66 N/mm^2

A_{st} = Y16-100c/c

+

Y10-100c/c

= 2796 mm^2/m

v_c = 0.94 N/mm^2 > Vu

Vu /m width = 659.48/[(22/7)*1.6]

= 131.2 kN/m

Typ column head,

Nu = 632.21 KN

since Vu <Vc -nominal R/F is required in the column heads

nominalk r/F = (0.0035/2) * 250 x 10^3

Y 16 -400 c/c is ok

Provide 14 numbers of Y 16 bars to be in line with column reinforcement

4.83m simply supported span,

M_{sls} = (16.5+2.5)*4.83^2/8

= 55.41 kNm

M_{ult} = (16.5*1.4+2.5*1.6)*4.83^2/8

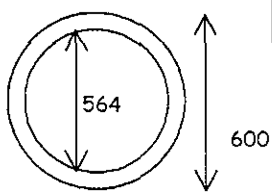
= 79 kNm

PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

REF	CALCULATIONS	OUT PUT

600 mm dia column to support the flat slab

REF	CALCULATIONS	OUT PUT
	clear height (l_0) = 13 m (say)	
	l_0 <= $60*500*10^{-3}$ m	o.k
	N = (451.477+38.72) + $\pi*6.6^2*24*1.0*13/4$	
	= 578.4 kN	
	l/r = $1.3*13*10^3/600$	
	= 28	slender column
	ß = 0.39	
	M_{add} = 578.4*0.39*0.6 kNm	
	= 135.35 kNm	
From computer analysis	M_{sls} = 23.88 kNm	
	$(M_x)_{sls}$ = 159.23 kNm	
	Bi-Axial Bending	
	M_x/h' = M_y/b'	
	$N/(A_c*f_{cu})$ = $578.4*10^3/(\pi/4)*600^2*35$	
	= 0.06	
	ß = 0.93	
	uniaxial bending to be considered	
	Therefore,	
	Enhanced bending moment = 159.23*1.93	
	M_{sls} = 307.29 kNm	
	M = 307.3 kNm	
	N = 578.4 kN	
	R = 30 cm	
	R_s = 23.4 cm	
Design charts	A_s = 112.59 cm^2 (4% A_c)	14Y32
	f_c = 117.3 N/mm^2	

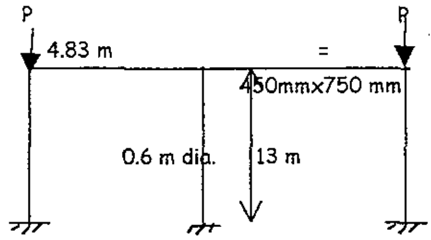


PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

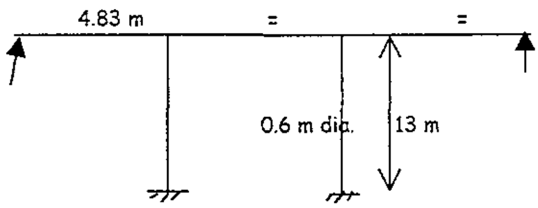
REF	CALCULATIONS	OUTPUT

Roof Beams

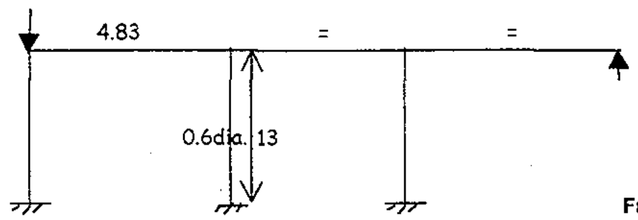
Typical frames considered in the analysis



frame F_1



Frame F_2



Frame F_3

Loading

due to slab,

w_d = 16.5 kN/m^2

ws = 2.5 kN/m^2

Loads on frame

File name
M-NRF1

F_1 -u.d.l

w_d = 16.5*4.83 +0.45*0.5*24
= 79.69+5.40
= 85 kN/m

ws = 2.5*4.83
= 12.08 kN/m

PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

REF	CALCULATIONS	OUT PUT
	Load P	
	Point load P_d = 16.5*4.83²/2 + 5.4*4.83/2	
	= 205.5 kN	
	Point load P_s = 2.5*4.83²/2	
	= 29.16 kN	
	F_2	
M-NRF2	w_d = 85 kN/m	
	ws = 12.08 kN/m	
	F_3	
M-NRF3	w_d = 85 kN/m	
	ws = 12.08 kN/m	

	Typical Forces	
	F_1	450x750
	Span moments	
	M_{sls} = 152 kNm — provide 4Y20	
	M_{ult} = 232 kNm	
	Support moments	
	M_{sls} = 271 kNm	
	M_{ult} = 384 kNm — provide 4Y20 +	
	V_u = 405 kN — 5Y25	
	A_{st} - min for 750 face = (750*250)*2*12*10⁻⁶*32φ/(6*0.2*2)	
	= 60 φ	
	φ — A_{st}	
	16 — 960mm² — 5Y16	
	20 — 1200mm² — 4Y20	
	A_{st} - min for 450 face = (450/750)*60φ	
	φ — A_{st}	
	16 — 576mm² — 3Y16	
	20 — 720mm² — 3Y20	
	v_c -4Y20 = 0.53 N/mm² — Y10-150c/c	
	End support,	
	V_u = 274 kN	
	v_c -4Y20 = 0.53 N/mm² — Y10-250c/c	o.k

PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

REF	CALCULATIONS				OUTPUT
	F_2 & F_3				
	Span moments				
	M_{sls}	=	182 kNm	4Y20	
	M_{ult}	=	273 kNm		
	Support moments				
	M_{sls}	=	235 kNm		
	M_{ult}	=	332 kNm	provide 4Y20 +	
	v_u	=	401 kN	4Y16	
	v_c -4Y20	=	0.53 N/mm^2	Y10-150c/c	
	End support,				
	v_u	=	286 kN		
	v_c - 4Y20	=	0.53 N/mm^2	Y10-250c/c	o.k

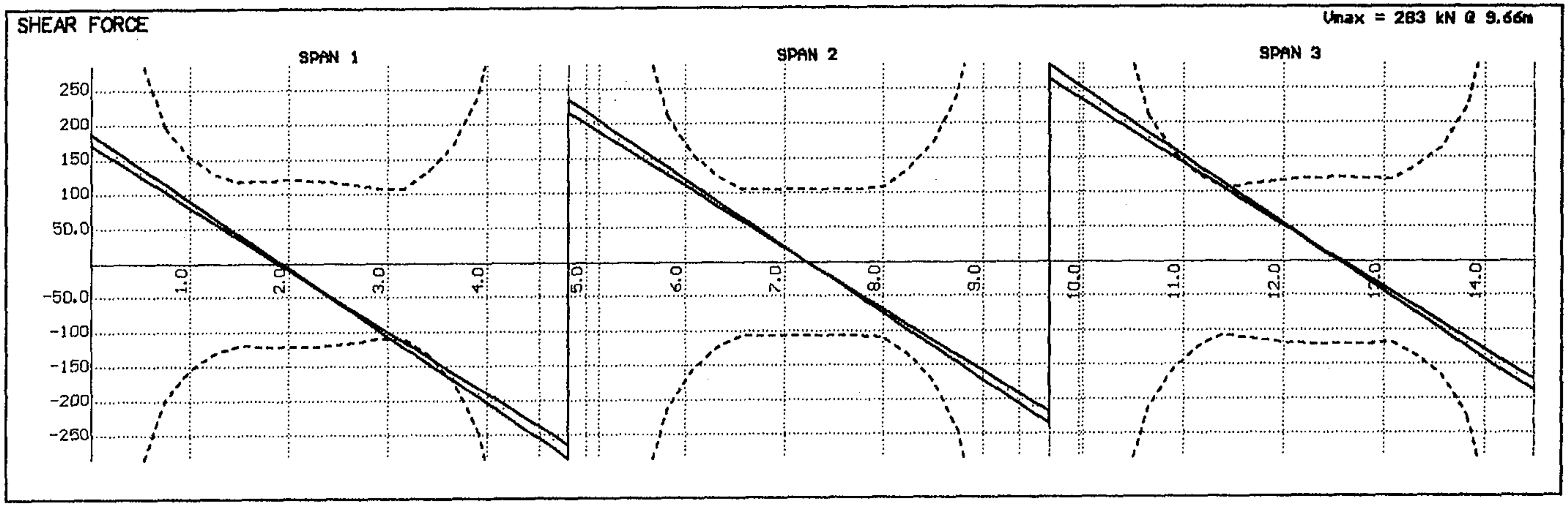
PROJECT	Reduction of non-revenue water in the Greater Colombo Area
PART OF STRUCTURE	Maligakanda -Rehabilitation of Existing reservoir

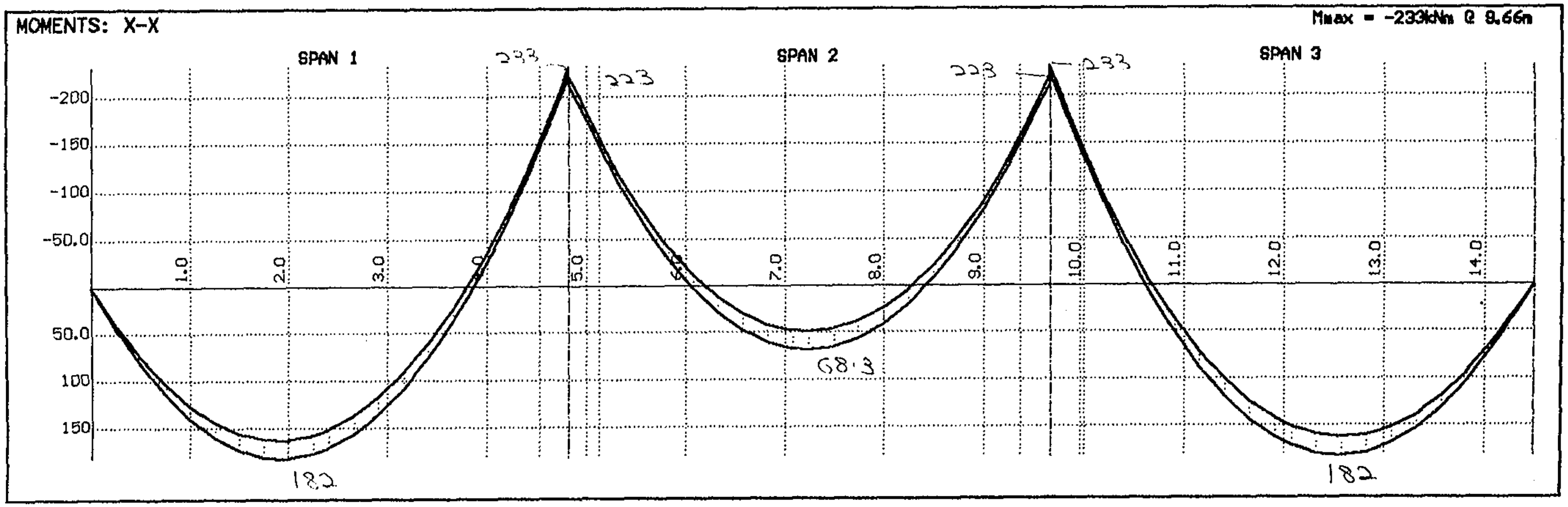
REF	CALCULATIONS	OUTPUT
Base Slab		
	From comp analysis	
	M_{ult} = 63.1 kNm	
	M_{sls} = 63.1 /1.4 Y12-100 c/c is ok for Msls	
	= 45.07 kNm with enhancement of 25%	
	56.34	
	h = 300	d=300-50-12
	d = 300-50-12 = 238 mm	=238
	Ast for M_{ult} = 712 mm^2	
	v_u = (27.1x4.83^2+PIx0.6^2x24x13x1.4/4)1.15	
	= 869.07 kN/m	
	= $869.07*10^3$ /(PI*1290*230)	
	= 0.93 N/mm^2	
	v_c (A_s=4273 mm^2/m) 0.99 N/mm^2 Y12-100c/c (1130)+ Y20-100c/c (3141) provided	ok
	Thermal & Shrinkage crack control steel,	
	T_1 = 30 ^0c	
	T_2 = 14 ^0c	
	Steel ratio (r) = $12*10^{-6}$ *44f/(3*0.2*2)	
	A_s = $4.4*150*10^3*f*10^{-4}$	
	= 66f	

f	A_{st}	
12	792	Y 12 -100 c/c is ok
16	1056	

M- NRF2S

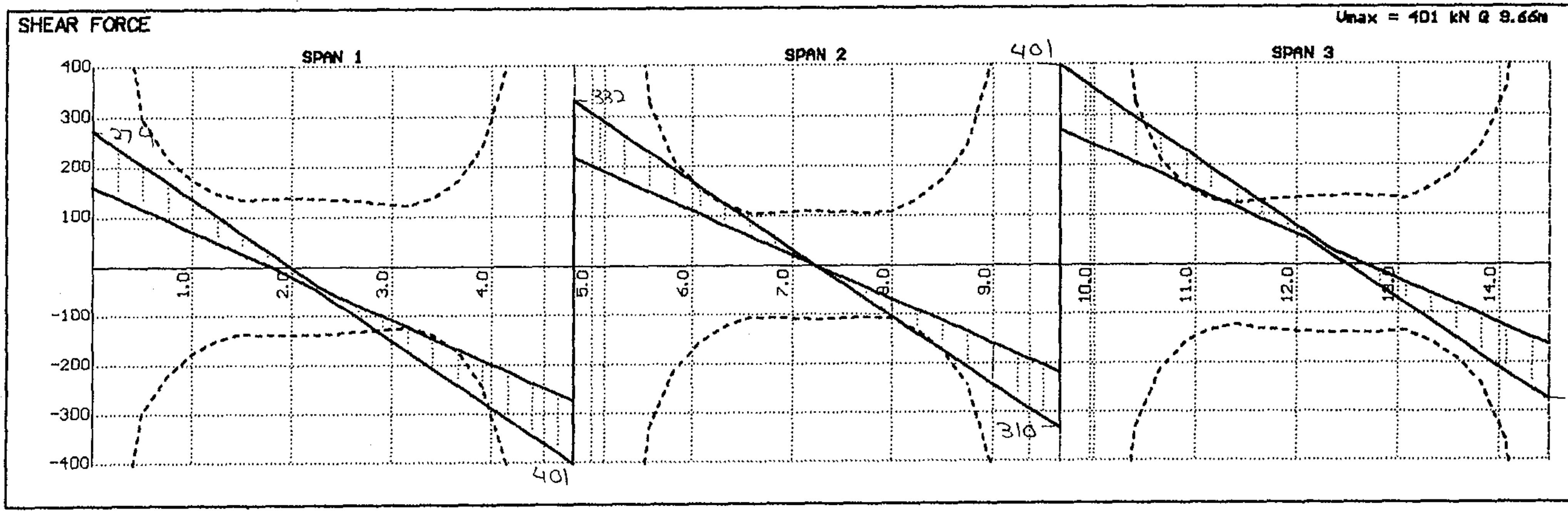
BUILDING-SUB FRAME-M-NRF1S

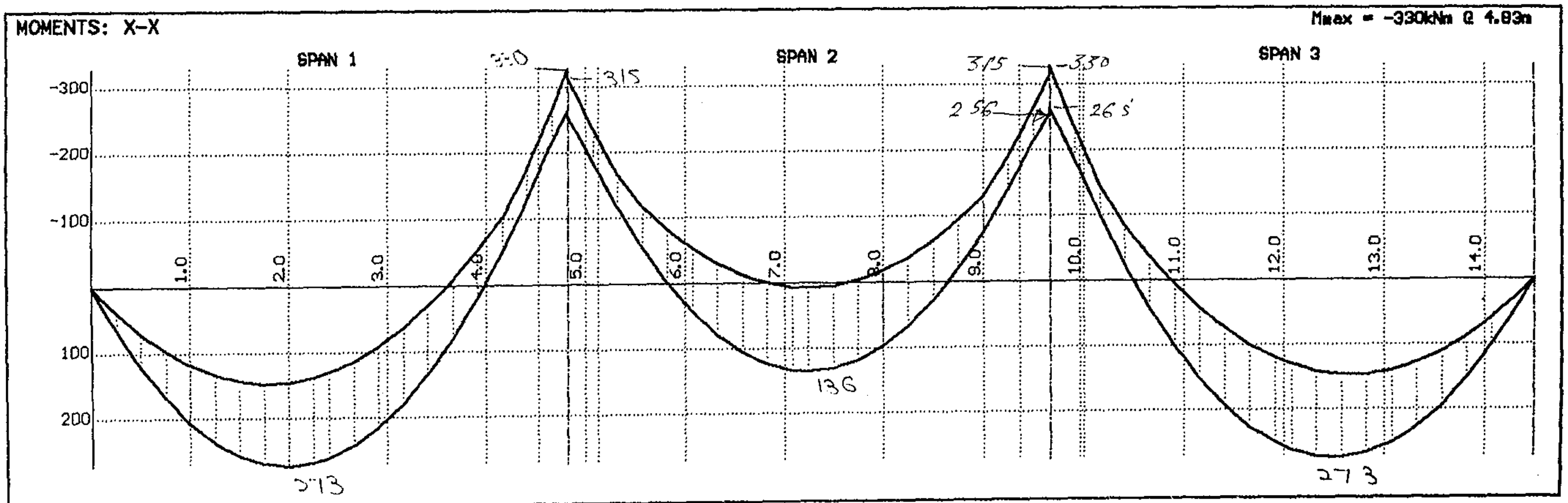




MKR-11

NEW ROOF-M-NRF2U





Maligakanda reservoir rehab- base slab						
		1st layer	2nd layer			
Dia of Bar mm		12	0	fy N/mm^2	450	
Spacing mm		100	125	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		300	space-mm			
Clear cover mm		50	50			
Service M (kNM)		60.00				
				wcr(8007)	0.209	mm
				max 0.2mm		
Ast-mm^2	1131	1131	0			
Effect Depth mm			244			
fst N/mm^2		242.66				
fst All'ble		360.00				
fcb N/mm^2		7.19				
fcb all'ble		15.75				
			M-kanda			
Maligakanda reservoir rehab- base slab						
		1st layer	2nd layer			
Dia of Bar mm		12	20	fy N/mm^2	450	
Spacing mm		100	100	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		300	space-mm			
Clear cover mm		50	50			
Service M (kNM)		150				
				wcr(8007)	0.199	mm
				max 0.2mm		
Ast-mm^2	4274	1131	3142.86			
Effective Depth			195			
fst N/mm^2		219.85				
fst All'ble		360.00				
fcb N/mm^2		17.48				
fcb all'ble		15.75				

User ID: Research Engineers, Inc.

MX CONTOUR

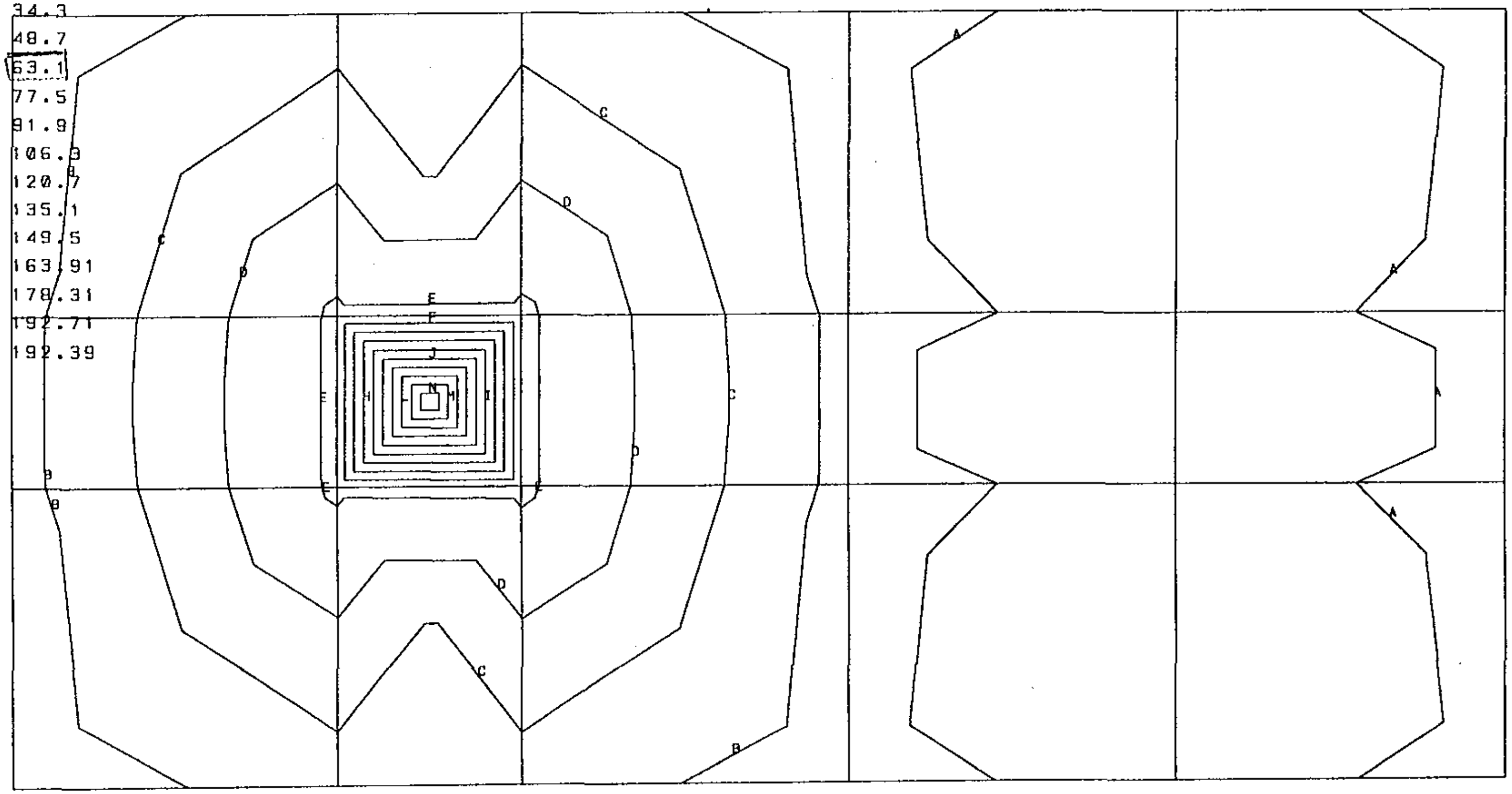
MN/ELEM

STOR LOAD= 1

A	-8.9
B	5.5
C	19.9
D	34.3
E	48.7
F	63.1
G	77.5
H	91.9
I	106.3
J	120.7
K	135.1
L	149.5
M	163.91
N	178.31
O	192.71
	192.39

STRUCTURE DATA

TYPE = SPACE
NJ = 484
NM = 0
NE = 441
NS = 0
NRJ= 484
NL = 3
XMAX= 19.9
YMAX= .0
ZMAX= 19.9



J=484,E=441

UNIT MET KNS

S T A A D P O S T - P L O T (REV: 22.3a)

DATE: NOV 22, 2000

TITLE: "M-BASE2.STD" MALIGAKANGA OLD RERSERVOIR

User ID: Research Engineers, Inc.

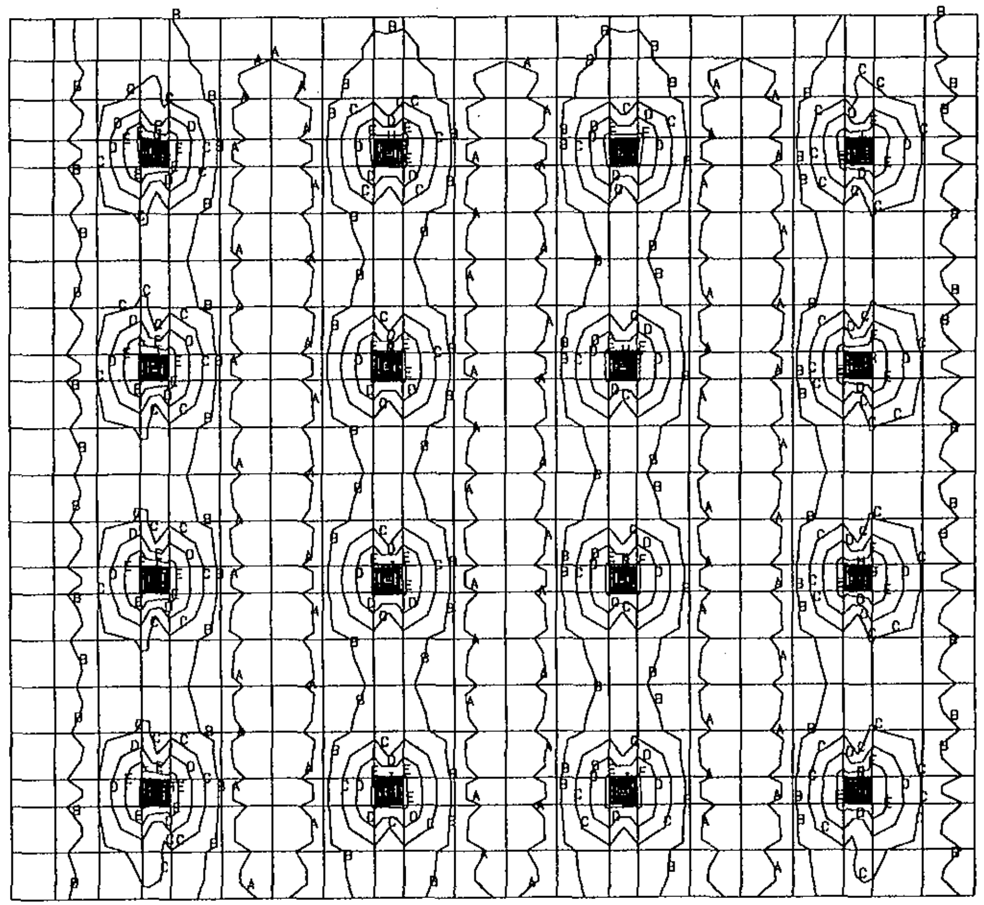
STRUCTURE DATA

TYPE =	SPACE
NJ =	484
NM =	0
NE =	441
NS =	0
NRJ=	484
NL =	3
XMAX=	19.9
YMAX=	.0
ZMAX=	19.9

MX CONTOUR

A	-8.9
B	5.5
C	19.9
D	34.3
E	48.7
F	63.1
G	77.5
H	91.9
I	106.3
J	120.7
K	135.1
L	149.5
M	163.91
N	178.31
O	192.71
	207.11

MN/ELEM
STDR LOAD= 1



J=484,E=441

UNIT MET KNS

S T A A D P O S T - P L O T (REV: 22.3a)

DATE: NOV 22, 2000

TITLE: "M-BASE2.STD" MALIGAKANGA OLD RERSERVOIR

MKK-15

1. STAAD SPACE "M-BASE2.STD" MALIGAKANGA OLD RERSERVOIR BASE
2. *MALIGAKANDA RESERVOIR BASE SLAB
3. *BASE FOR THE OLD RESERVOIR
4. *BASE THICKNESS CHANGED 0.4 TO 0.3

ELEMENT FORCES FORCE,LENGTH UNITS= KNS METE
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT	LOAD	QX VONT	QY VONB	MX FX	MY FY	MXY FXY
22	1	-3.40	-28.39	-.03	4.39	-6.94
		851.78	851.78	.00	.00	.00
23	1	13.39	10.80	3.94	1.81	-11.26
		1320.73	1320.73	.00	.00	.00
24	1	-15.70	57.84	14.89	-1.58	-9.81
		1527.64	1527.64	.00	.00	.00
25	1	-15.31	87.71	10.99	-2.32	-1.44
		1492.41	1492.41	.00	.00	.00
26	1	-13.96	55.55	7.80	-1.51	6.79
		973.15	973.15	.00	.00	.00
27	1	-24.57	-19.65	-12.07	.79	5.12
		1020.90	1020.90	.00	.00	.00
28	1	24.13	-20.51	-12.33	.85	-5.26
		1049.31	1049.31	.00	.00	.00
29	1	10.85	51.90	6.12	-1.40	-7.45
		976.82	976.82	.00	.00	.00
30	1	.99	80.48	16.93	-2.47	.06
		1219.39	1219.39	.00	.00	.00
31	1	-9.09	51.86	6.51	-1.31	7.54
		996.36	996.36	.00	.00	.00

ELEMENT	LOAD	QX VONT	QY VONB	MX FX	MY FY	MXY FXY
32	1	-23.18	-20.63	-11.54	1.13	5.27
		1013.07	1013.07	.00	.00	.00
33	1	23.24	-20.63	-11.53	1.14	-5.27
		1012.47	1012.47	.00	.00	.00
34	1	9.38	51.82	6.54	-1.30	-7.55
		997.19	997.19	.00	.00	.00
35	1	-.77	80.47	16.97	-2.45	-.07
		1121.49	1121.49	.00	.00	.00
36	1	-11.69	51.76	6.19	-1.38	7.41
		973.47	973.47	.00	.00	.00
37	1	-24.01	-20.89	-12.29	1.00	5.16
		1040.21	1040.21	.00	.00	.00
38	1	24.65	-20.50	-12.09	.88	-5.36
		1041.36	1041.36	.00	.00	.00
39	1	14.35	53.97	7.47	-1.33	-7.31
		1006.10	1006.10	.00	.00	.00
40	1	13.94	80.47	16.16	-2.36	.31
		1417.91	1417.91	.00	.00	.00
41	1	12.81	63.88	14.34	-.11	-9.43
		1369.21	1369.21	.00	.00	.00

ELEMENT	LOAD	QX VONT	QY VONB	MX FX	MY FY	MXY FXY
42	1	-3.09	-20.80	2.27	3.70	8.99
		1059.97	1059.97	.00	.00	.00
43	1	.54	-22.41	-1.62	7.10	-6.07
		882.12	882.12	.00	.00	.00
44	1	83.44	-12.88	1.43	11.71	-11.73
		1441.17	1441.57	.00	.00	.00
45	1	162.01	270.79	34.12	19.19	-1.54
		2134.51	2134.81	.00	.00	.00
46	1	-4.60	319.11	21.71	57.34	-.88
		2177.49	2177.49	.00	.00	.00

47	1	-197.11	249.59	23.13	17.40	-.43
		1705.37	1705.37	.00	.00	.00
48	1	-55.91	-36.11	-19.46	9.55	5.11
		1755.54	1755.54	.00	.00	.00
49	1	51.17	-35.11	-19.97	[illegible]	-[illegible]
		1741.17	1741.17	.00	.00	.00
50	1	186.37	134.47	11.15	16.71	-.6
		1619.11	1619.11	.00	.00	.00
51	1	.04	331.60	19.29	37.35	.16
		2155.55	2155.55	.00	.00	.00

ELEMENT	LOAD	QX VONT	QY VONE	MX FX	MY FY	MXY FXY
52	1	-263.91	233.68	10.51	16.76	.64
		1619.11	1618.11	.00	.00	.00
53	1	-51.63	-35.61	-19.27	8.56	5.11
		1748.10	1748.10	.00	.00	.00
54	1	51.69	-35.61	-19.26	8.57	-5.09
		1747.56	1747.56	.00	.00	.00
55	1	263.96	233.63	10.54	16.77	-.63
		1618.90	1618.90	.00	.00	.00
56	1	.01	331.52	19.29	37.34	-.06
		1156.50	1156.50	.00	.00	.00
57	1	-266.47	234.29	11.21	16.73	.48
		1610.17	1610.17	.00	.00	.00
58	1	-52.49	-35.60	-19.01	8.41	4.94
		1779.24	1779.24	.00	.00	.00
59	1	54.62	-36.72	-19.67	9.49	-5.23
		1774.30	1774.30	.00	.00	.00
60	1	276.91	245.91	12.51	17.15	.01
		1681.19	1681.19	.00	.00	.00
61	1	8.11	314.63	11.01	37.91	.31
		1197.91	1197.91	.00	.00	.00

ELEMENT FORCES FORCE,LENGTH UNITS= KIPS METS
FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT	LOAD	QX VONT	QY VONE	MX FX	MY FY	MXY FXY
62	1	-231.88	249.56	39.41	29.92	1.60
		1988.11	1988.11	.00	.00	.00
63	1	-19.47	-40.03	.91	11.74	9.03
		1317.05	1317.05	.00	.00	.00
64	1	-19.79	-10.50	-1.97	6.34	-3.19
		650.60	650.60	.00	.00	.00
65	1	97.75	-1.59	1.17	14.63	-3.17
		1159.31	1159.31	.00	.00	.00
66	1	359.15	6.59	45.41	21.27	-1.44
		1619.97	1619.97	.00	.00	.00
67	1	-1.31	-.64	116.53	163.61	-9.93
		18.44	18.44	.00	.00	.00
68	1	-471.11	-11.19	37.31	17.91	-.71
		1762.11	1762.11	.00	.00	.00
69	1	-[illegible]	-7.99	-11.41	13.13	-.19
		1074.99	1074.99	.00	.00	.00
70	1	94.85	-6.95	-23.11	12.91	.06
		2107.47	2107.47	.00	.00	.00
71	1	380.51	-8.16	16.51	17.24	.13
		1551.97	1551.97	.00	.00	.00

ELEMENT	LOAD	QX VONT	QY VONE	MX FX	MY FY	MXY FXY
72	1	.05	-.41	144.07	197.67	.59
		17.61	17.61	.00	.00	.00
73	1	-378.55	-6.77	16.96	17.35	-.09
		1572.80	1572.80	.00	.00	.00
74	1	-94.60	-9.68	-21.51	13.15	.07

ELEMENT	LOAD	QX / VOUT	QY / VONB	MX / FX	MY / FY	MXY / FXY
		2081.78	2081.78	.00	.00	.00
75	1	94.65	-9.69	-11.49	13.15	-.06
		2181.59	2181.59	.00	.00	.00
76	1	378.55	-6.93	16.97	17.35	.09
		1573.39	1573.39	.00	.00	.00
77	1	-.06	-.41	145.19	147.75	-.61
		17.61	17.61	.00	.00	.00
78	1	-381.70	-8.41	16.47	17.15	-.16
		1551.61	1551.61	.00	.00	.00
79	1	-95.43	-9.24	-11.15	12.41	-.11
		2114.96	2114.96	.00	.00	.00
80	1	98.93	-8.79	-11.74	13.09	-.17
		2093.32	2093.32	.00	.00	.00
81	1	399.95	-8.34	19.69	17.81	.42
		1720.99	1720.99	.00	.00	.00

ELEMENT	LOAD	QX / VOUT	QY / VONB	MX / FX	MY / FY	MXY / FXY
82	1	1.19	-.97	204.53	198.57	6.11
		18.42	18.42	.00	.00	.00
83	1	-348.94	16.13	39.16	11.31	1.71
		2070.16	2070.16	.00	.00	.00
84	1	-38.57	-23.71	.94	19.55	3.01
		1256.01	1256.01	.00	.00	.00
85	1	8.66	-13.71	-.98	5.55	.22
		407.55	407.55	.00	.00	.00
86	1	70.78	19.86	3.54	10.36	5.01
		938.93	938.93	.00	.00	.00
87	1	144.36	-248.38	38.42	15.39	-1.79
		2119.00	2119.00	.00	.00	.00
88	1	-21.30	-311.77	11.39	31.64	-1.14
		1920.48	1920.49	.00	.00	.00
89	1	-136.10	-200.15	11.35	11.63	-1.10
		1505.89	1505.89	.00	.00	.00
90	1	-57.16	32.43	-18.19	7.99	-5.02
		1654.32	1654.32	.00	.00	.00
91	1	52.31	32.16	-19.10	8.00	4.91
		1704.93	1704.93	.00	.00	.00

FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT	LOAD	QX / VOUT	QY / VONB	MX / FX	MY / FY	MXY / FXY
92	1	233.09	-202.73	19.96	22.74	.90
		1410.59	1410.59	.00	.00	.00
93	1	1.15	-331.09	17.74	31.69	.09
		1779.15	1779.15	.00	.00	.00
94	1	-232.96	-203.65	19.34	22.84	-.69
		1422.78	1422.78	.00	.00	.00
95	1	-53.09	31.05	-18.70	8.07	-4.81
		1690.50	1690.50	.00	.00	.00
96	1	53.11	31.05	-19.70	8.07	4.93
		1690.69	1690.69	.00	.00	.00
97	1	232.94	-203.91	19.35	22.84	.70
		1422.94	1422.94	.00	.00	.00
98	1	-1.15	-331.19	17.73	31.69	-.10
		1779.19	1779.19	.00	.00	.00
99	1	-233.51	-202.67	19.59	22.73	-.93
		1408.92	1408.92	.00	.00	.00
100	1	-52.75	31.93	-19.31	8.00	-5.00
		1721.21	1721.21	.00	.00	.00
101	1	56.86	32.67	-19.61	8.07	4.54
		1676.54	1676.54	.00	.00	.00

FORCE OR STRESS = FORCE/WIDTH/THICK, MOMENT = FORCE-LENGTH/WIDTH

ELEMENT	LOAD	QX	QY	MX	MY	MXY

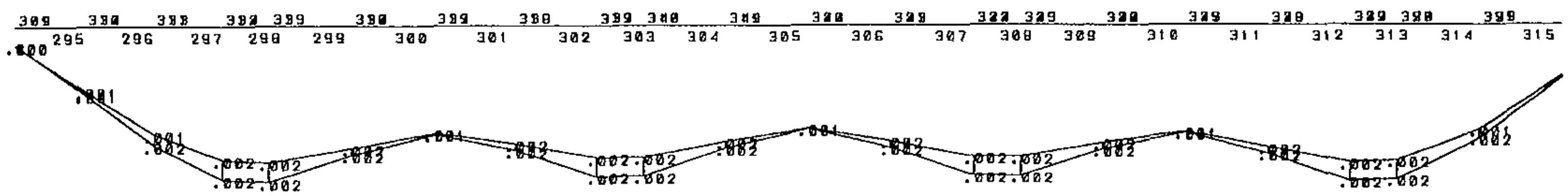
		VONT	VONE	FX	FY	FXY
102	1	240.00	-200.75	21.83	22.94	.95
		1497.63	1497.63	.00	.00	.00
103	1	21.69	-311.86	21.12	31.14	1.04
		1939.35	1939.35	.00	.00	.00
104	1	-212.80	-209.74	32.31	24.96	2.06
		1969.70	1969.70	.00	.00	.00
105	1	-34.63	2.89	2.87	10.59	-3.27
		736.45	736.45	.00	.00	.00
106	1	-.52	-11.91	1.33	-.99	.92
		171.24	171.24	.00	.00	.00

User ID: Research Engineers, Inc.

STRUCTURE DATA

TYPE = SPACE
NJ = 484
NM = 0
NE = 441
NS = 0
NRJ= 484
NL = 1
XMAX= 19.9
YMAX= .0
ZMAX= 19.9

MN/ELEM
DFOR LOAD= 1



Max Displ= .002
J=484,E=441

UNIT MET KNS

S T A A D P O S T - P L O T (REV: 22.3a) DATE: OCT 14, 2000

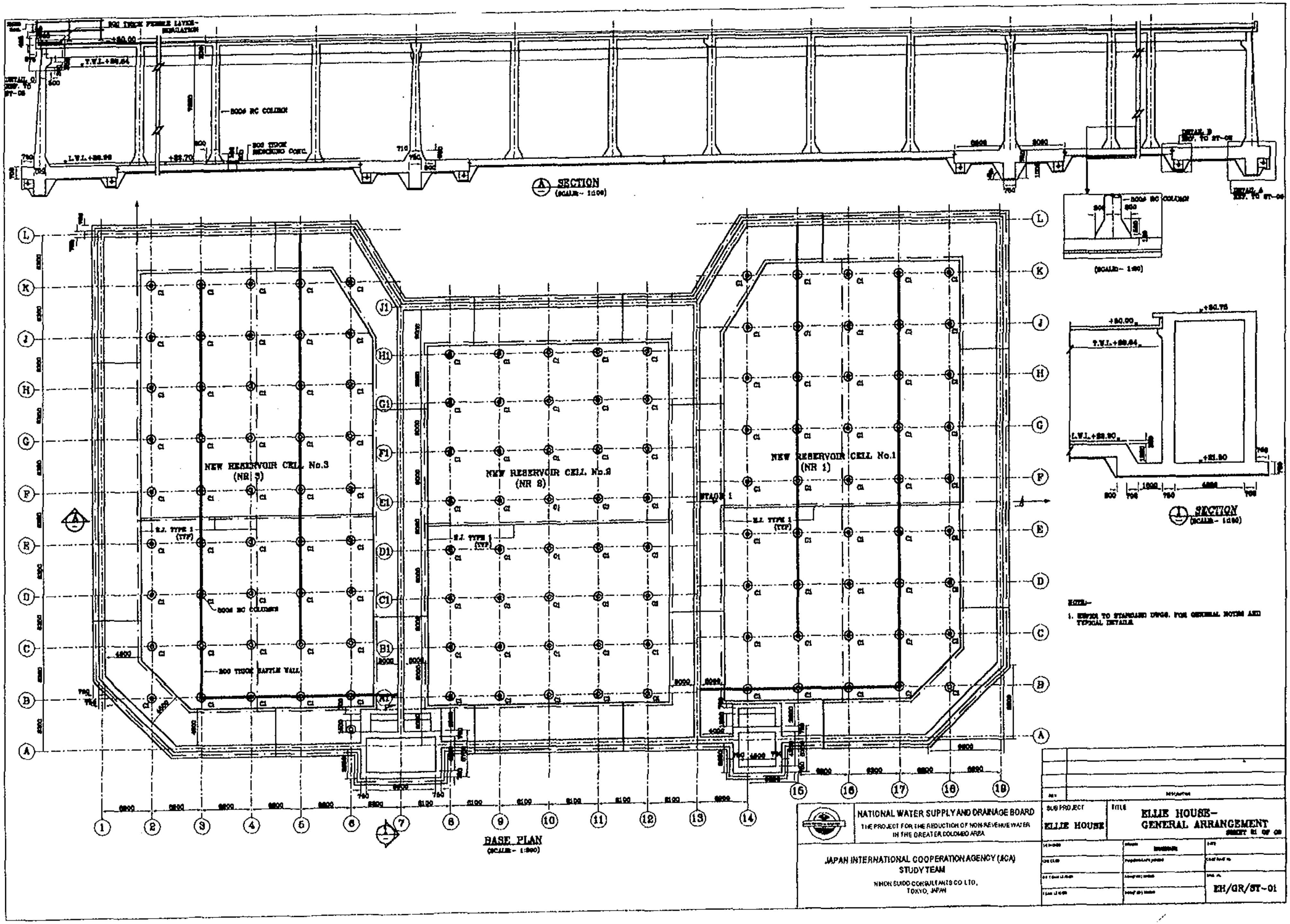
TITLE: "M-BASE2.STD" MALIGAKANGA OLD RERSERVOIR

Maligakanda reservoir rehab- Roof slab -free span						.
		1st layer	2nd layer			
Dia of Bar mm		10	16	fy N/mm^2	450	
Spacing mm		150	150	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		250	space-mm			
Clear cover mm		50	0			
Service M (kNM)		59.33				
				wcr(8007)	0.122	mm
				max 0.2mm		
Ast-mm^2	1865	524	1341			
Effect Depth mm			186			
fst N/mm^2		199.47				
fst All'ble		360.00				
fcb N/mm^2		9.48				
fcb alI'ble		15.75				
			M-kanda			
Maligakanda reservoir rehab- Roo						
		1st layer	2nd layer			
Dia of Bar mm		16	0	fy N/mm^2	450	
Spacing mm		75	150	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		250	space-mm			
Clear cover mm		50	0			
Service M (kNM)		59.33				
				wcr(8007)	0.148	mm
				max 0.2mm		
Ast-mm^2	2682	2682	0.00				not used.
Effective Depth			192			
fst N/mm^2		136.90				
fst All'ble		360.00				
fcb N/mm^2		8.05				
fcb alI'ble		15.75				

Maligakanda reservoir rehab- Roof slab -5.0 m avg. free span						.
		1st layer	2nd layer			
Dia of Bar mm		10	12	fy N/mm^2	450	
Spacing mm		150	150	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		250	space-mm			
Clear cover mm		40	0			
Service M (kNM)		59.33				
				wcr(8007)	0.170	mm
				max 0.2mm		
Ast-mm^2	1278	524	754			
Effect Depth mm			199			
fst N/mm^2		265.43				
fst All'ble		360.00			gamma St	1.28
fcb N/mm^2		9.58				
fcb alI'ble		15.75				
			M-kanda			
Maligakanda reservoir rehab- Roo[illegible]						
		1st layer	2nd layer			
Dia of Bar mm		10	12	fy N/mm^2	450	
Spacing mm		150	150	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		250	space-mm			
Clear cover mm		40	0			
Service M (kNM)		59.33				
				wcr(8007)	0.170	mm
				max 0.2mm		
Ast-mm^2	1278	524	754.29			
Effective Depth			199			
fst N/mm^2		265.43				
fst All'ble		360.00			gamma St	1.28
fcb N/mm^2		9.58				
fcb alI'ble		15.75				

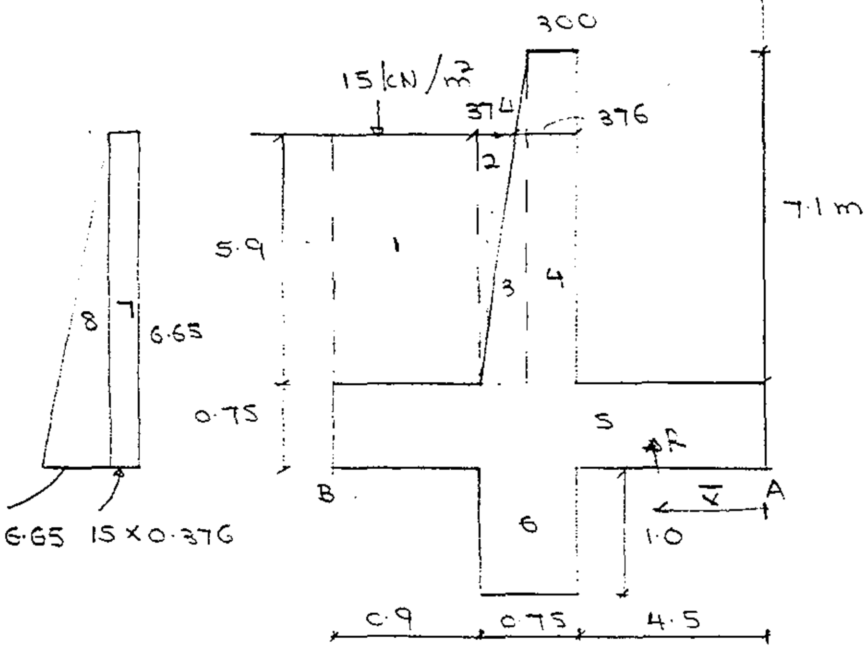
Used

ELLIE HOUSE RESERVOIR


SECTION
NEW RESERVOIR CELL No.3
(NR 3)
NEW RESERVOIR CELL No.2
(NR 2)
NEW RESERVOIR CELL No.1
(NR 1)
BASE PLAN
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO LTD, TOKYO, JAPAN
ELLIE HOUSE
ELLIE HOUSE-
GENERAL ARRANGEMENT
EH/GR/ST-01

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY	SHEET.........OF..........
	SCHEME ELLIE - HOUSE - RESERVOIR COMPONENT Ext - WALL.	DATE

ITEM	CALCULATIONS	OUT PUT



ka = 0.376
ϕ = 27°
5.9 m earth fill - no burm.

part	weight		L. Arm about A horiz	vert	Moment about A
1	15 (0.9 + 0.374)	= 19.11	5.887	-	112.5
	0.9 × 5.9 × 20	= 106.2	5.7	-	605.34
2.	0.5 × 0.374 × 5.9 × 20	= 22.06	5.125	-	113.06
3	0.5 × 0.45 × 7.1 × 24	= 38.34	4.95	-	189.78
4	0.3 × 7.1 × 24	= 51.12	4.65	-	237.71
5	0.75 × 6.15 × 24	= 110.7	3.075	-	340.4
6	1.0 × 0.75 × 24	= 18.0	4.875	-	87.75
	ΣW	365.53			Mr = 1686.54
7.	15 × 0.376 × 6.65	= 37.5	3.325		124.69
8.	50 × 6.65 × 0.5	= 166.25	2.22		369.08
	ΣFa	203.75			Mo = 493.77

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ITEM	CALCULATIONS	OUT PUT

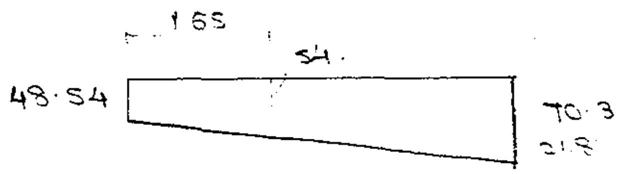
F/s overturning $= \frac{1686.54}{493.77} = 3.42$ o.k .

$\bar{x} = \frac{1686.54 - 493.77}{365.53} = 3.263$

$\bar{e} = 6.15/2 - 3.263 = -0.188$.

$f = \frac{365.53}{6.15} \pm \frac{365.53 \times 0.188}{1/6 \times 1 \times 6.15^2}$

$= 59.44 \pm 10.9$



SLS .

Applied horizontal force Fn = 203.75 kN.

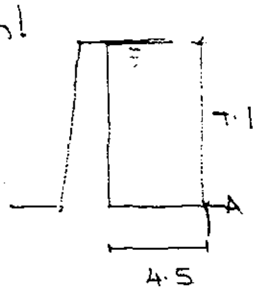
μ conc to soil ≈ 30° .58

horizontal resistance force =

$365.53 \times 0.58 + 2.65 \times 20 \times 1 \times 1/2 \times 1 + 20 \times 1 \times 4.5 = 328.51$ kN

F/s sliding $= \frac{328.51}{203.75} = 1.61 > 1.5$ o.k .

Ext. wall with water pressure 7.1m height



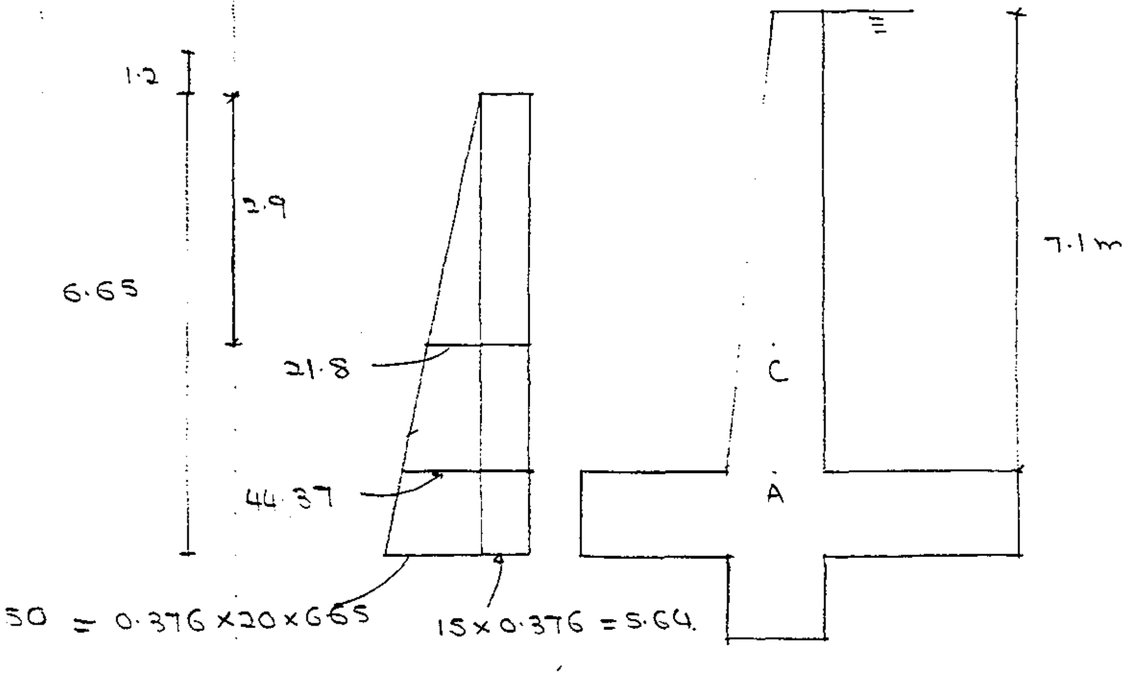
$\Sigma W = 365.53 + 71 \times 4.5 = 685$ kN

$\overleftarrow{M_{r-A}} = 1686.54 + 71 \times 4.5 \times 2.25 = 2405$ kNm

$\overrightarrow{M_{o-A}} = 493.77 - (71 \times 7.1/2)(7.1/3 + 0.75)$
$= -291.79$ kNm .

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY	SHEET..........OF ....
	SCHEME COMPONENT Ext. WALL.	DATE

ITEM	CALCULATIONS	OUT PUT



Ext. wall
outer face of 7.1 m height

$\overset{\frown}{MA} = 44.37 \times \frac{5.9^2}{6} + 5.64 \times \frac{5.9^2}{2} = 355.58$ kNm/m SLS

$V = (44.37 \times \frac{5.9}{2}) + 5.64 \times 5.9) \times 1.4 = 229.83$ kN. ULT

provide Y25 - 125 c/c.

INNER face.

$\overset{\frown}{MA} = 71.0 \times \frac{7.1^2}{2} = 596.5$ kNm SLS

$V = 71 \times \frac{7.1}{2} \times 1.4 = 352.87$ kN. ULT.

provide Y25 - 125 c/c + Y20 - 125 c/c.
1st layer 2nd layer.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT	JOB NO.
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME COMPONENT	DATE

ITEM	CALCULATIONS	OUT PUT
	outer face @ 4.1m height	
	$M_C = 21.8 \times \frac{2.9^2}{6} + 5.64 \times \frac{2.9^2}{2} = 54.27$ kNm	SLS
	$V = (21.8 \times \frac{2.9}{2} + 5.64 \times 2.9) \times 1.4 = 111.4$ kN	ULT.
	Provide Y16 - 125 c/c	
	Inner face	
	$M_C = 41 \times \frac{4.1^2}{6} = 114.9$ kNm	SLS
	$V = 41 \times \frac{4.1}{2} \times 1.4 = 117.67$ kN	ULT
	Provide Y16 - 125 c/c.	

Ellie House -Ext wall at 7.1 m height-outer face

		1st layer	2nd layer			T1 and T2 resp
						deg C
Dia of Bar mm		25	0	fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	49.26
Bredth of Sect mm		1000				
Depth of sect mm		750	space-mm			
Clear cover mm		66	75			
Service M (kNm)		355.58				
				wcr(8007)	0.155 mm	
				max 0.2mm		
Ast-mm^2	3929	3929	0			
Effect Depth mm			672			

		% of R/F	0.59	
fst N/mm^2	152.23			
fst All'ble	360.00	gamma St	2.15	
fcb N/mm^2	5.18	Vu -kN		229.83
fcb alI'ble	15.75	vu -n/mm^2		0.342
		vc -n/mm^2		0.591
		Shear design		OK
		Ast temp -dia		16
	0	Ast temp -mm		2570
		spacing mm c/c		78

Ellie House -Ext wall at 7.1 m height-inner face

		1st layer	2nd layer		
Dia of Bar mm		25	20	fy N/mm^2	450
Spacing mm		125	125	fcuN/mm^2	35
Bredth of Sect mm		1000			
Depth of sect mm		750	space-mm		
Clear cover mm		66	75		
Service M (kNm)		596.5			
				wcr(8007)	0.187 mm
				max 0.2mm	
Ast-mm^2	6443	3929	2514.29		
Effective Depth			633		

fst N/mm^2	170.24			
fst All'ble	360.00	gamma St	1.62	
fcb N/mm^2	8.16	Vu -kN		352.87
fcb alI'ble	15.75	vu -n/mm^2		0.557
		vc -n/mm^2		0.711
		Shear design		ok

Ellie House -Ext wall at 4.1 m height-outer face

		1st layer	2nd layer			T1 and T2 resp
						deg C
Dia of Bar mm		16	0	fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	42.26
Bredth of Sect mm		1000				
Depth of sect mm		560	space-mm			
Clear cover mm		66	75			
Service M (kNm)		54.27				
				wcr(8007)	-0.018 mm	
				max 0.2mm		
Ast-mm^2	1609	1609	0			
Effect Depth mm			486			

		% of R/F	0.33
fst N/mm^2	76.32		
fst All'ble	360.00	gamma St	3.51
fcb N/mm^2	1.86	Vu -kN	111.40
fcb alI'ble	15.75	vu -n/mm^2	0.229
		vc -n/mm^2	0.489
		Shear design	OK
		Ast temp -dia	16
	0	Ast temp -mm	2290
		spacing mm c/c	88

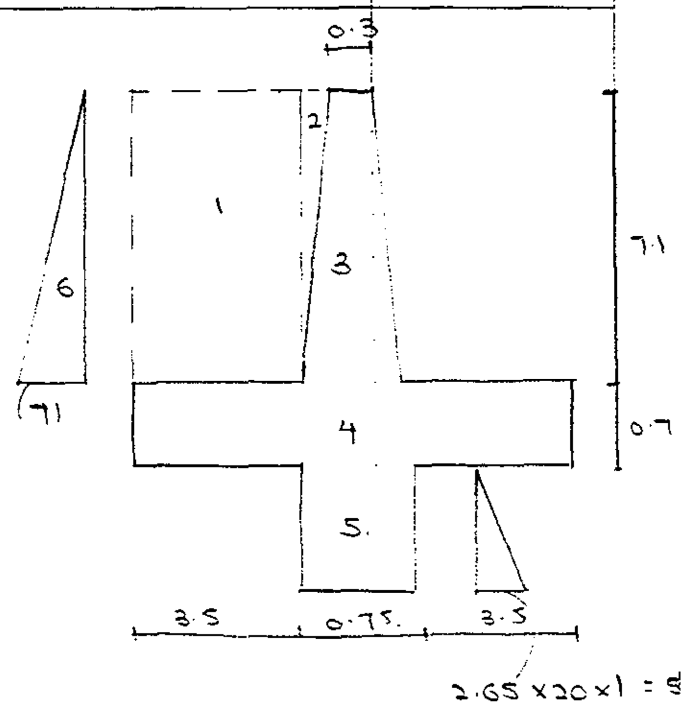
Ellie House -Ext wall at 4.1 m height-inner face

		1st layer	2nd layer		
Dia of Bar mm		16	0	fy N/mm^2	450
Spacing mm		125	150	fcuN/mm^2	35
Bredth of Sect mm		1000			
Depth of sect mm		560	space-mm		
Clear cover mm		66	75		
Service M (kNm)		114.9			
				wcr(8007)	0.106 mm
				max 0.2mm	
Ast-mm^2	1609	1609	0.00		
Effective Depth			486		

fst N/mm^2	161.59		
fst All'ble	360.00	gamma St	2.45
fcb N/mm^2	3.93	Vu -kN	117.67
fcb alI'ble	15.75	vu -n/mm^2	0.242
		vc -n/mm^2	0.489
		Shear design	ok

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME ELLIE - HOUSE COMPONENT CENTRE WALL.	DATE

ITEM	CALCULATIONS	OUT PUT



	Pv		lh.	Mr.
① 3.5 × 7.1 × 10	=	248.5	6.0	1491
② 0.225/2 × 7.1 × 10	=	7.99	4.175	33.36
③ 0.525 × 7.1 × 24	=	89.46	3.875	346.66
④ 7.75 × 0.75 × 24	=	139.5	3.875	540.56
⑤ 0.75 × 1.0 × 24	=	18.0	3.875	69.75
		503.45		2481.33
	Ph.		lv	Mo
⑥ $71 \times \frac{7.1}{2}$	=	252.05	3.117	785.64

$$F/s \text{ overturning} = \frac{2481.33}{785.64} = 3.16 \quad o.k.$$

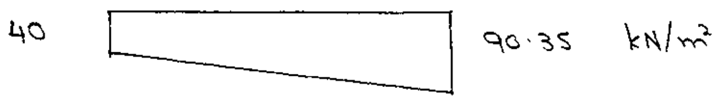
→ Papplied = 252.05 kN

← Presistance = $503.45 \times 0.58 + \frac{2.663 \times 20}{2} + 20 \times 3.5$
= 388.63 kN.

$$F/s \text{ sliding} = \frac{388.63}{252.05} = 1.54 > 1.5 \quad o.k.$$

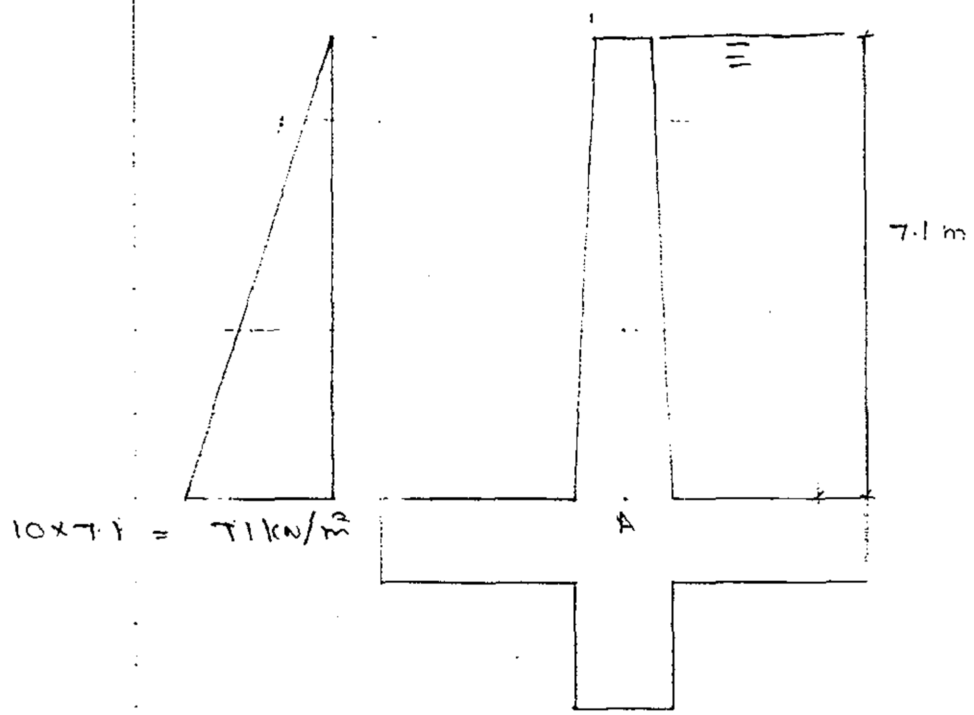
CEYWATER CONSULTANT (PVT) LTD.	PROJECT	JOB NO.
INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	CALCULATIONS BY	SHEET..........OF ....
	SCHEME COMPONENT	DATE

ITEM	CALCULATIONS	OUT PUT
	$\bar{X} = \frac{2481.33 - 785.64}{503.45} = 3.37$	
	$\bar{e} = 7.75/2 - 3.37 = 0.505$	
	$f = \frac{503.45}{7.75 \times 1} \pm \frac{503.45 \times 0.505}{1/6 \times 7.75^2}$	
	$= 64.96 \pm 25.39$	
	$= 90.35$ or 39.57 kN/m²	



CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT	JOB NO.
	CALCULATIONS BY	SHEET.........OF..........
	SCHEME EILIE HOUSE RESERVOIR COMPONENT CENTER WALL.	DATE

ITEM	CALCULATIONS	OUT PUT



@ 7.1 m height.

→ $\widehat{MA} = 71.0 \times \frac{7.1^2}{6} = 596.5$ kNm/m. SLS

→ $V = 71.0 \times \frac{7.1}{2} \times 1.4 = 352.87$ kN ULT

→ Provide Y25–125 c/c.

$d = 663$

$1.5d =$

$V_u = 61.06 \times \frac{6.106}{2} \times 1.4 = 260.96$

@ 4.1 m height

→ $\widehat{MA} = 41.0 \times \frac{4.1^2}{6} = 114.9$ kNm

$V = 41 \times \frac{4.1}{2} \times 1.4 = 117.67$ kN

Provide Y16 – 125 c/c.

Ellie House -Center wall-@ 7.1m height · T1 and T2 resp

		1st layer	2nd layer			deg C
Dia of Bar mm		25	20	fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	49.26
Bredth of Sect mm		1000				
Depth of sect mm		750	space-mm			
Clear cover mm		66	75			
Service M (kNm)		596.50				
				wcr(8007)	0.187 mm	
				max 0.2mm		
Ast-mm^2	6443	3929	2514			
Effect Depth mm			633			

		% of R/F	1.02
fst N/mm^2	170.24		
fst All'ble	360.00	gamma St	1.62
fcb N/mm^2	8.16	Vu -kN	352.87
fcb alI'ble	15.75	vu -n/mm^2	0.557
		vc -n/mm^2	0.711
		Shear design	OK
		Ast temp -dia	16
	0	Ast temp -mm	2570
		spacing mm c/c	78

Ellie House -Center wall-@ 4.1m height

		1st layer	2nd layer		
Dia of Bar mm		16	0	fy N/mm^2	450
Spacing mm		125	150	fcuN/mm^2	35
Bredth of Sect mm		1000			
Depth of sect mm		560	space-mm		
Clear cover mm		66	75		
Service M (kNm)		114.9			
				wcr(8007)	0.106 mm
				max 0.2mm	
Ast-mm^2	1609	1609	0.00		
Effective Depth			486		

fst N/mm^2	161.59		
fst All'ble	360.00	gamma St	2.45
fcb N/mm^2	3.93	Vu -kN	117.67
fcb alI'ble	15.75	vu -n/mm^2	0.242
		vc -n/mm^2	0.489
		Shear design	ok

DAYANANDA ASSOCIATES CONSULTING ENGINEERS	PROJECT NRW		JOB REF
	CALCULATIONS BY	CHECKED BY	CALC SHEET
	PART OF STRUCTURE Ellie house Reservoir		DATE

MEMBER REF	CALCULATIONS	OUT PUT

Base slab

Applied UDL = 10 × 6.1 + 0.5 × 24
73.0 kN/m²

h = 400 mm

Column load = $844 + \frac{\pi}{4} \times (0.5)^2 \times 6.55 \times 24$ kN
= 875 kN

From computer output,

Mx - SLS = 115 × 1.25 = 143.75 kNm   with enhancement of 25%

Mx - ULT = 143.75 × 1.4 = 201.25 kNm

R/F to control thermal & shrinkage cracking,

$$A_{st} = \frac{\alpha (T_1 + T_2) b h \phi}{3 \times \omega_{max} \times 2}$$

$$= \frac{12 \times 10^{-6} \times (34.5 + 15) \times 10^3 \times 200 \phi}{3 \times 0.2 \times 2}$$

$$= 99 \phi$$

ϕ	Ast
16	1584
20	1980
25	2475

provide Y20 @ 125 c/c (2513)   Mx - SLS o.k.

Mx - ULT = 201 kNm

$d_{avg} = 400 - 50 - 20$
= 330

$$\frac{M}{f_{cu} b d^2} = \frac{201 \times 10^6}{35 \times 10^3 \times 330^2} = 0.053$$

$$A_{st} = \frac{201 \times 10^6}{0.87 \times 450 \times 0.928 \times 330}$$

$$= 1676 \text{ mm}^2/\text{m}$$

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ITEM	CALCULATIONS	OUT PUT

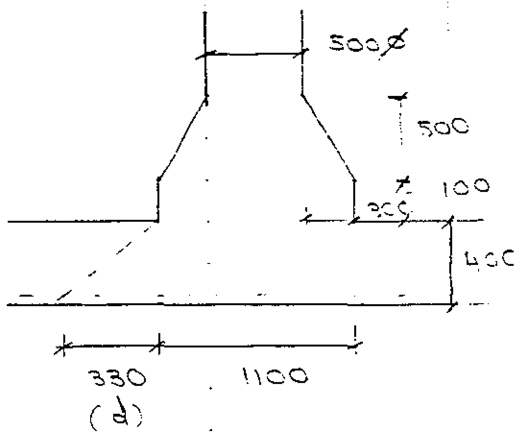
Typical column 500⌀.

Average pressure $= \dfrac{875}{6.35 \times 6.2}$

$= 22.23$ kN/m²

$$V_u = \frac{\{875 - (22 \times \pi \times \frac{1.76^2}{4})\} \times 1.4 \times 1.15 \times 10^3}{\pi \times 1760 \times 330}$$

$= 0.72$ N/mm²



$\dfrac{100 A_s}{bd} = \dfrac{100 \times 5026}{10^3 \times 330} = 1.52$

$V_c = 0.77$ N/mm²

Provide Y20 - 125 c/c + Y20 - 125 c/c over support.

Ellie House -base slab · T1 and T2 resp

		1st layer	2nd layer			deg C
Dia of Bar mm		20		fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	34.5
Bredth of Sect mm		1000				
Depth of sect mm		400	space-mm			
Clear cover mm		50	-10			
Service M (kNm)		144.00				
				wcr(8007)	0.193 mm	
				max 0.2mm		
Ast-mm^2	2514	2514	0			
Effect Depth mm			340			

			% of R/F	0.74
fst N/mm^2	192.63			
fst All'ble	360.00		gamma St	1.65
fcb N/mm^2	7.56		Vu -kN	192.00
fcb alI'ble	15.75		vu -n/mm^2	0.565
			vc -n/mm^2	0.666
			Shear design	OK
			Ast temp -dia	20
		0	Ast temp -mm	1980
			spacing mm c/c	159

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT	JOB NO.
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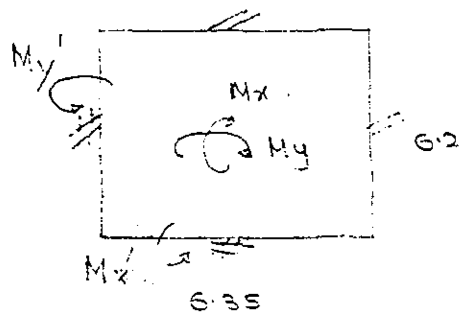
	SCHEME COMPONENT	DATE

ITEM	CALCULATIONS	OUT PUT

Roof slab & beams.
6.35 × 6.2 m grid. 200mm slab

loading

			SLS		ULT
slab	0.2 × 24	=	4.8	× 1.4	21.42
benching	0.25 × 22	=	5.5		
pebbles	0.25 × 20	=	5.0		
super	2.5	=	2.5	× 1.6	4.0
			17.8		25.42 kN/m²



$\frac{l_y}{l_x} = 1.024$

$M_x' = 17.8 \times 6.2^2 \times 0.049 = 33.52$ kNm — SLS
$M_x = \quad " \quad \times 0.037 = 25.32$ "

$M_x' = 25.42 \times 6.2^2 \times 0.049 = 47.88$ — ULT
$M_x = \quad " \quad \times 0.037 = 36.15$

$M_y' = 17.8 \times 6.2^2 \times 0.045 = 30.79$ — SLS
$M_y = \quad \times 0.034 = 23.26$

$M_y' = \quad = 43.97$ — ULT
$M_y = \quad = 33.22$

R/f to control thermal & shrinkage cracking

$Ast\text{-}min = \frac{12 \times 10^{-6} \times (28.75 + 15) \times 200 \times 10^3 \times \phi}{3 \times 0.2 \times 2}$

$= 875\ \phi$ — on both faces

ϕ	Ast		
10	875	→ Y10 - 150 c/c	- (523 × 2)
12	1050	→ Y12 - 200 c/c	- (565 × 2)

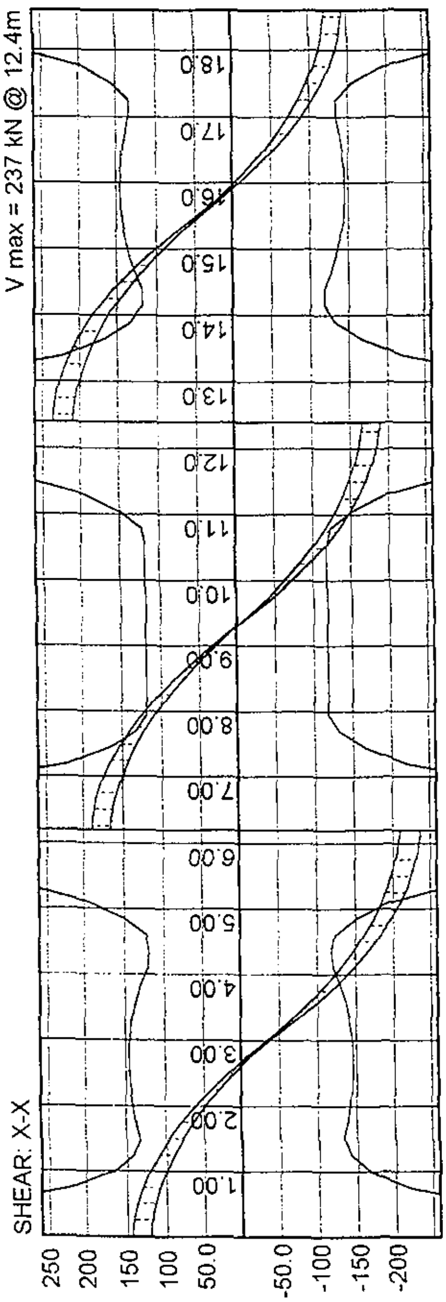
Ellie House -roof slab -top over support -short span

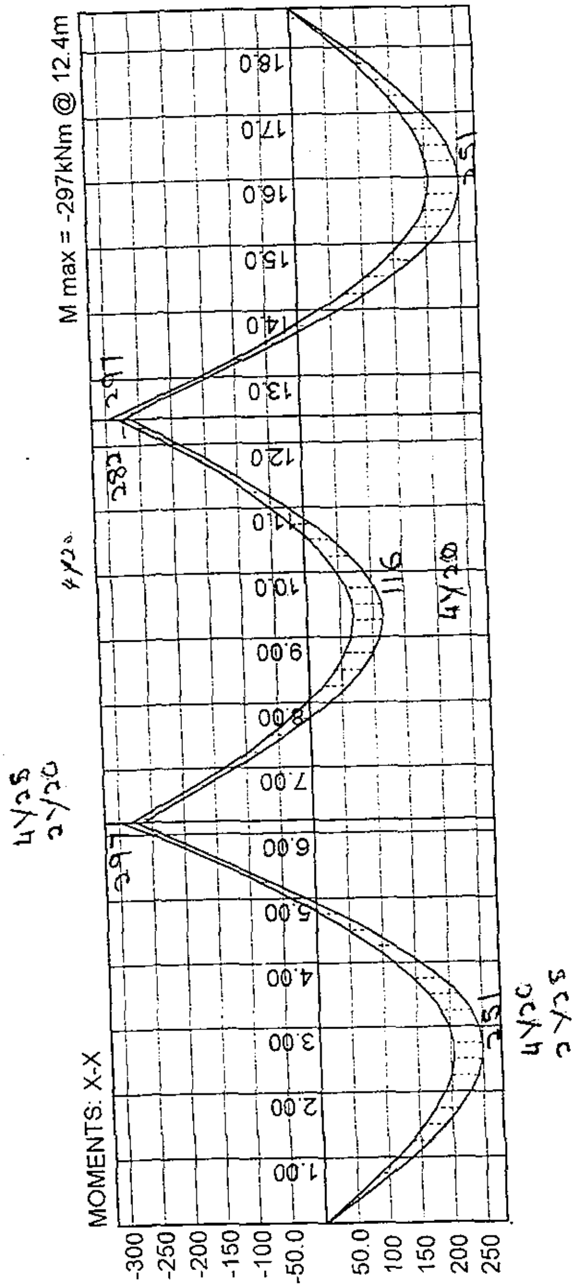
		1st layer	2nd layer		T1 and T2 resp	
					deg C	
Dia of Bar mm		12	10	fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	28.75
Bredth of Sect mm		1000				
Depth of sect mm		200	space-mm			
Clear cover mm		50	-10			
Service M (kNm)		34.00				
				wcr(8007)	0.181 mm	
				max 0.2mm		
Ast-mm^2	1534	905	629			
Effect Depth mm			144			
				% of R/F		1.07
fst N/mm^2		180.36				
fst All'ble		360.00				
fcb N/mm^2		8.92				
fcb alI'ble		15.75				
			0			

Ellie House -roof slab -bottom r/f -short span

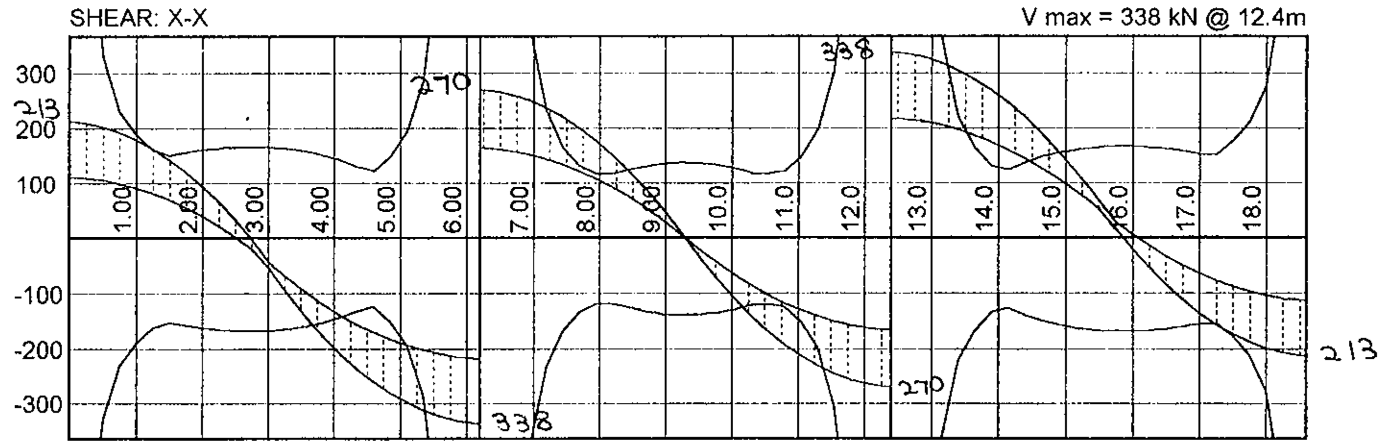
		1st layer	2nd layer			
Dia of Bar mm		12	0	fy N/mm^2	450	
Spacing mm		100	150	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		200	space-mm			
Clear cover mm		50	75			
Service M (kNm)		25.32				
				wcr(8007)	0.182 mm	
				max 0.2mm		
Ast-mm^2	1131	1131	0.00			
Effective Depth			144			
fst N/mm^2		178.32				
fst All'ble		360.00		gamma St	1.72	
fcb N/mm^2		7.27		Vu -kN		50.00
fcb alI'ble		15.75		vu -n/mm^2		0.347
				vc -n/mm^2		0.652
				Shear design		ok

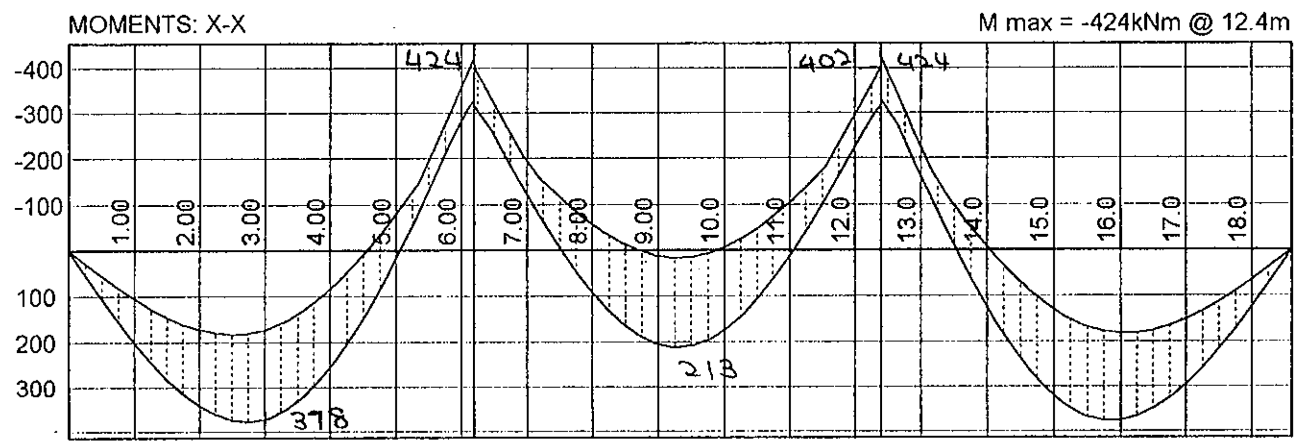
RB1. (R-BIS)





KBI. (R-B14)


SHEAR: X-X
V max = 338 kN @ 12.4m
300
200
100
-100
-200
-300
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
213
270
338
338
270
213


MOMENTS: X-X
M max = -424kNm @ 12.4m
-400
-300
-200
-100
100
200
300
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
424
402
424
378
213

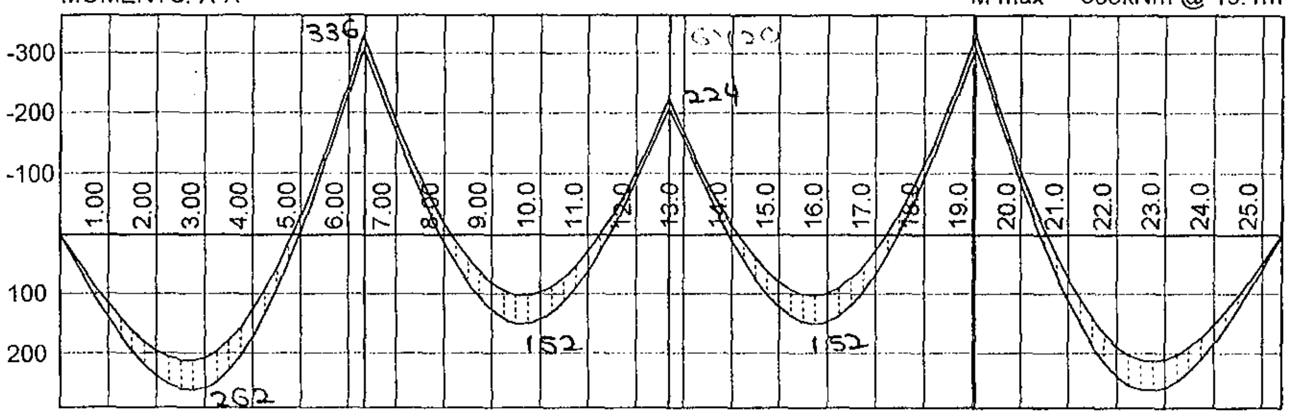
	Location	Ellie house reservoir-Roof beam-Rb1-1st span			
Dist bet two layers	25				
Bar Dia layers 1 & 2	20	25	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		90.00	
Clear cover mm	50				
Service M (kNm)	251.00	Ult M (kNm)		378	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	982		
Total Ast mm^2	2239	Ast1	1257	1541	0
Effective Depth mm	669.17				
fst N/mm^2	190.84		Defln	1.411	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	7.74				
fcb allowable	15.75				
			Wcr 8007	0.19	
			mm 0.2		
	Location	Ellie house reservoir-Roof beam-Rb1-1st support			
Dist bet two layers	25				
Bar Dia layers 1 & 2	25	20	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		83.33	
Clear cover mm	50				
Service M (kNm)	297.00	Ult M (kNm)		424	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	629		
Total Ast mm^2	2593	Ast1	1964	1723	0
Effective Depth mm	675.98				
fst N/mm^2	194.51		Defln	1.318	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	8.58				
fcb allowable	15.75				
			Wcr 8007	0.20	
			mm 0.2		

	Location	Ellie house reservoir-Roof beam-Rb1-2nd span			
Dist bet two layers	25				
Bar Dia layers 1 & 2	20	0	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		90.00	
Clear cover mm	50				
Service M (kNm)	116.00	Ult M (kNm)		213	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	0		
Total Ast mm^2	1257	Ast1	1257	815	0
Effective Depth mm	690.00				
fst N/mm^2	147.88		Defln	2.152	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	4.17				
fcb allowable	15.75				
			Wcr 8007	0.09	
			mm 0.2		

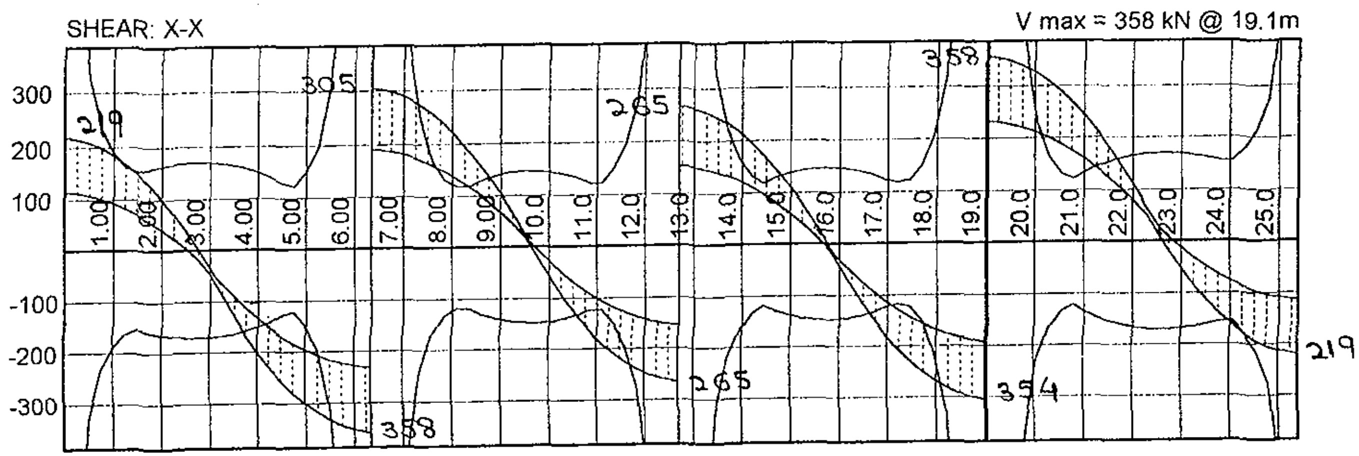
	Location	Ellie house reservoir-Roof beam-Rb1-2nd support			
Dist bet two layers	25				
Bar Dia layers 1 & 2	25	20	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		83.33	
Clear cover mm	50				
Service M (kNm)	297.00	Ult M (kNm)		424	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	629		
Total Ast mm^2	2593	Ast1	1964	1723	0
Effective Depth mm	675.98				
fst N/mm^2	194.51		Defln	1.318	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	8.58				
fcb allowable	15.75				
			Wcr 8007	0.20	
			mm 0.2		

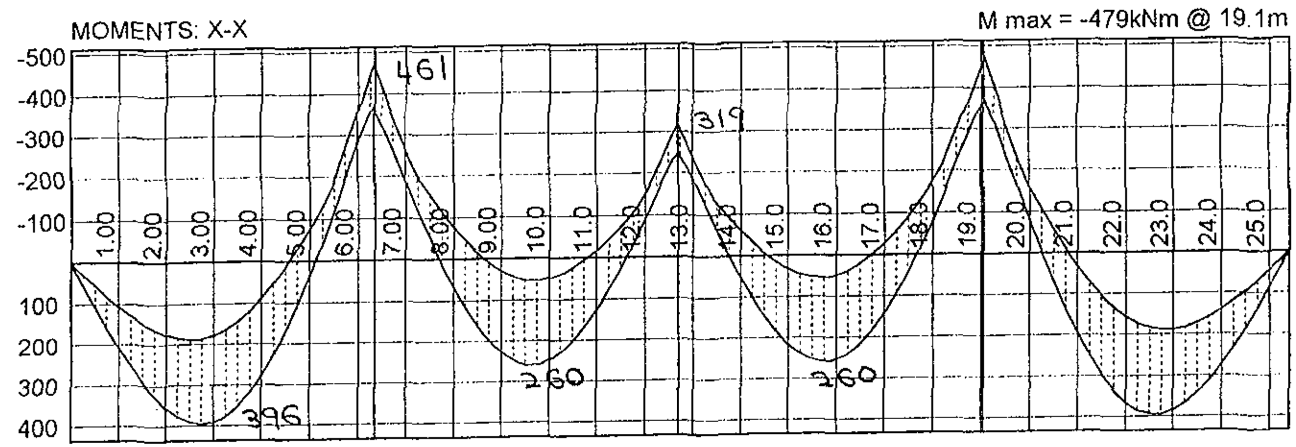
BEAM DESIGN (BS:8110)		Ellie house reservoir roof beam			
====================					
Project	NRW				
Beam	Roof beam -RB1				
fcu (N/mm^2) =	35	35	35	35	35
fy (N/mm^2) =	450	450	450	450	450
bw (mm) =	450				
h (mm) =	750				
d (mm) =	676				
d' (mm) =	75				
bf (mm) =	450				
hf (mm) =	200				
m (kNm) =	378	424	213		0
redist % =	0	0	0	0	0
DESIGN FOR BENDI					
k' =	0.156	0.156	0.156	0.156	0.156
k (M/bd^2fcu) =	0.053	0.059	0.030	0.000	0.000
z (mm) =	634	628	642	642	642
x (mm) =	93	106	75	75	75
fsc (N/mm^2) =	138	204	1	1	1
======================================					
As (mm^2) =	1523	1723	847	0	0
As' (mm^2) =	0	0	0	0	0
======================================					
DESIGN FOR SHEAR					
V (kN) =	213	338	270		
As (mm^2) =	1256	2591	2591		
bv (mm) =	450	450	450	450	450
d (mm) =	676	676	676	676	676
v (N/mm^2) =	0.70	1.11	0.89	0.00	0.00
100As/bd =	0.41	0.85	0.85	0.00	0.00
vc (N/mm^2) =	0.53	0.67	0.67	0.00	0.00
b(v-vc) =	78	198	98	0	0
b*0.4 =	180	180	180	180	180
======================================					
Links R6 2legs	68	62	68	68	68
Links Y10 2legs	311	282	311	311	311
Links, Max spaci	507	507	507	507	507
======================================					

RB7. (R-B25)



EH-21


SHEAR: X-X
V max = 358 kN @ 19.1m


MOMENTS: X-X
M max = -479kNm @ 19.1m

BEAM DESIGN (BS:8110)		Ellie house reservoir roof beam			
====================					
Project	NRW				
Beam	Roof beam -RB2 (RB7)				
fcu (N/mm^2) =	35	35	35	35	35
fy (N/mm^2) =	450	450	450	450	450
bw (mm) =	450				
h (mm) =	750				
d (mm) =	669				
d' (mm) =	75				
bf (mm) =	450				
hf (mm) =	200				
m (kNm) =	396	461	260	319	0
redist % =	0	0	0	0	0
DESIGN FOR BENDI					
k' =	0.156	0.156	0.156	0.156	0.156
k (M/bd^2fcu) =	0.056	0.065	0.037	0.045	0.000
z (mm) =	624	616	636	633	636
x (mm) =	99	117	74	79	74
fsc (N/mm^2) =	172	252	-6	35	-6
As (mm^2) =	1620	1911	1045	1286	0
As' (mm^2) =	0	0	0	0	0
DESIGN FOR SHEAR					
V (kN) =	219	358	305	150	265
As (mm^2) =	1963	3221	3221	1256	1256
bv (mm) =	450	450	450	450	450
d (mm) =	669	669	669	669	669
v (N/mm^2) =	0.73	1.19	1.01	0.50	0.88
100As/bd =	0.65	1.07	1.07	0.42	0.42
vc (N/mm^2) =	0.61	0.72	0.72	0.53	0.53
b(v-vc) =	51	210	131	-14	158
b*0.4 =	180	180	180	180	180
Links R6 2legs	68	59	68	68	68
Links Y10 2legs	311	267	311	311	311
Links, Max spaci	502	502	502	502	502

	Location	Ellie house reservoir-Roof beam-Rb2-1st span			
Dist bet two layers	25				
Bar Dia layers 1 & 2	25	20	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		83.33	
Clear cover mm	50				
Service M (kNm)	262.00	Ult M (kNm)		396	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	629		
Total Ast mm^2	2593	Ast1	1964	1601	0
Effective Depth mm	675.98				
fst N/mm^2	171.59		Defln	1.455	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	7.57				
fcb allowable	15.75				
			Wcr 8007	0.17	
			mm 0.2		

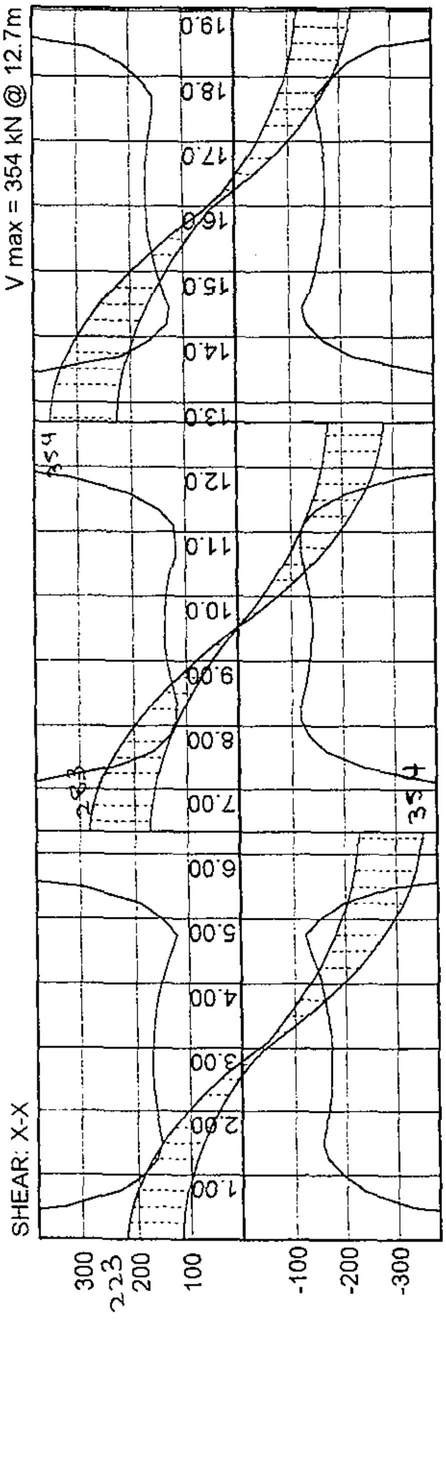
	Location	Ellie house reservoir-Roof beam-Rb2-1st support			
Dist bet two layers	25				
Bar Dia layers 1 & 2	25	20	fy N/mm^2	450	
Number of bars	4	4	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		83.33	
Clear cover mm	50				
Service M (kNm)	336.00	Ult M (kNm)		461	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	1257		
Total Ast mm^2	3221	Ast1	1964	1911	0
Effective Depth mm	668.96				
fst N/mm^2	181.35		Defln	1.274	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	9.22				
fcb allowable	15.75				
			Wcr 8007	0.19	
			mm 0.2		

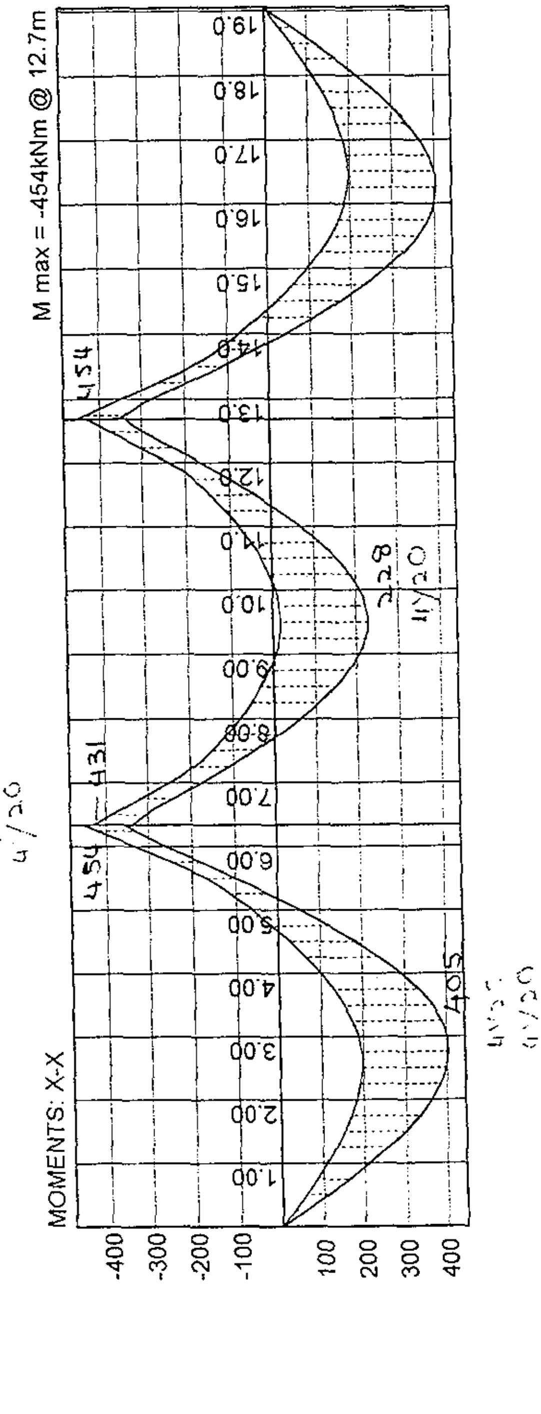
EH-2'

	Location	Ellie house reservoir-Roof beam-Rb2-2nd span			
Dist bet two layers	25				
Bar Dia layers 1 & 2	25	0	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		83.33	
Clear cover mm	50				
Service M (kNm)	152.00	Ult M (kNm)		260	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	0		
Total Ast mm^2	1964	Ast1	1964	1007	0
Effective Depth mm	687.50				
fst N/mm^2	127.17		Defln	2.028	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	4.68				
fcb allowable	15.75				
			Wcr 8007	0.10	
			mm 0.2		

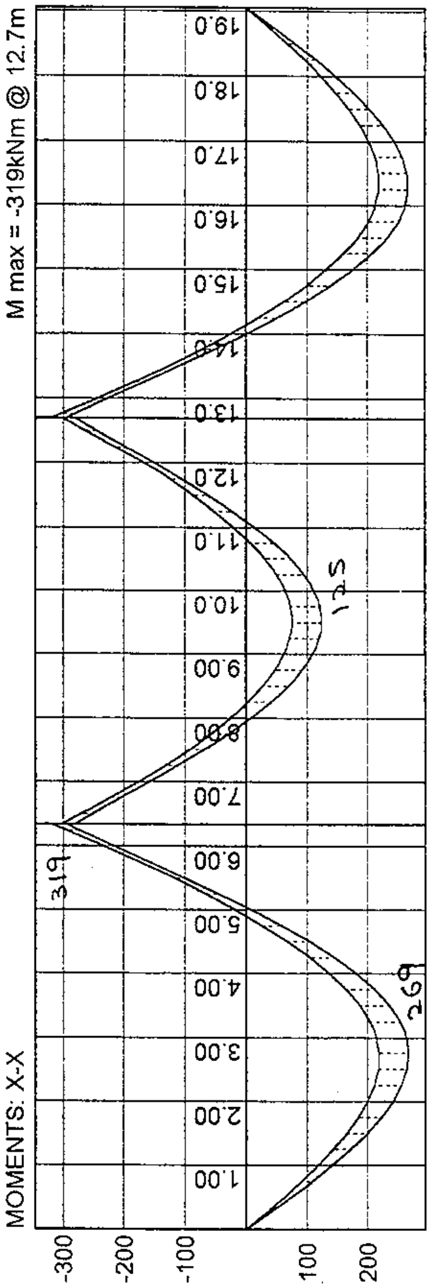
	Location	Ellie house reservoir-Roof beam-Rb2-2nd support			
Dist bet two layers	25				
Bar Dia layers 1 & 2	20	20	fy N/mm^2	450	
Number of bars	4	2	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		90.00	
Clear cover mm	50				
Service M (kNm)	224.00	Ult M (kNm)		319	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	629		
Total Ast mm^2	1886	Ast1	1257	1273	0
Effective Depth mm	675.00				
fst N/mm^2	198.60		Defln	1.464	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	7.22				
fcb allowable	15.75				
			Wcr 8007	0.19	
			mm 0.2		

RB6 (R-B34)





RBG (R-B3S)


MOMENTS: X-X
M max = -319kNm @ 12.7m
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
-300
-200
-100
100
200
319
269
125

EH-28

	Location	Ellie house reservoir-Roof beam-Rb3-1st span			
Dist bet two layers	25				
Bar Dia layers 1 & 2	20	20	fy N/mm^2	450	
Number of bars	4	4	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		90.00	
Clear cover mm	50				
Service M (kNm)	269.00	Ult M (kNm)		405	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	1257		
Total Ast mm^2	2514	Ast1	1257	1664	0
Effective Depth mm	667.50				
fst N/mm^2	183.80		Defln	1.389	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	8.02				
fcb allowable	15.75				
			Wcr 8007	0.19	
			mm 0.2		
	Location	Ellie house reservoir-Roof beam-Rb3-1st support			
Dist bet two layers	25				
Bar Dia layers 1 & 2	25	20	fy N/mm^2	450	
Number of bars	4	4	fcuN/mm^	35	
Breadth of sect mm	450				
Depth of sect mm	750	Space bet bars		83.33	
Clear cover mm	50				
Service M (kNm)	319.00	Ult M (kNm)		454	
Es (kN/mm^2)	200	Depth to Asc		75	
Ec (kN/mm^2)	28			Ast- Mult	Asc-Mult
		Ast2	1257		
Total Ast mm^2	3221	Ast1	1964	1879	0
Effective Depth mm	668.96				
fst N/mm^2	172.18		Defln	1.325	
fst Allowable	360.00		Coeiff:		
fcb N/mm^2	8.76				
fcb allowable	15.75				
			Wcr 8007	0.18	
			mm 0.2		

		Location	Ellie house reservoir-Roof beam-Rb3-2nd span			
Dist bet two layers		25				
Bar Dia layers 1 & 2		20		fy N/mm^2	450	
Number of bars		4	4	fcuN/mm^	35	
Breadth of sect mm		450				
Depth of sect mm		750	Space bet bars		90.00	
Clear cover mm		50				
Service M (kNm)		125.00	Ult M (kNm)		228	
Es (kN/mm^2)		200	Depth to Asc		75	
Ec (kN/mm^2)		28			Ast- Mult	Asc-Mult
			Ast2	0		
Total Ast mm^2		1257	Ast1	1257	875	0
Effective Depth mm		690.00				
fst N/mm^2		159.36		Defln	2.041	
fst Allowable		360.00		Coeiff.		
fcb N/mm^2		4.49				
fcb allowable		15.75				
				Wcr 8007	0.11	
				mm 0.2		

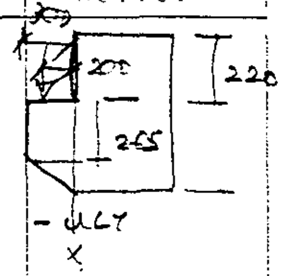
		Location	Ellie house reservoir-Roof beam-Rb3-2nd support			
Dist bet two layers		25				
Bar Dia layers 1 & 2		25	20	fy N/mm^2	450	
Number of bars		4	4	fcuN/mm^	35	
Breadth of sect mm		450				
Depth of sect mm		750	Space bet bars		83.33	
Clear cover mm		50				
Service M (kNm)		319.00	Ult M (kNm)		454	
Es (kN/mm^2)		200	Depth to Asc		75	
Ec (kN/mm^2)		28			Ast- Mult	Asc-Mult
			Ast2	1257		
Total Ast mm^2		3221	Ast1	1964	1879	0
Effective Depth mm		668.96				
fst N/mm^2		172.18		Defln	1.325	
fst Allowable		360.00		Coeiff.		
fcb N/mm^2		8.76				
fcb allowable		15.75				
				Wcr 8007	0.18	
				mm 0.2		

BEAM DESIGN (BS:8110)		Ellie house reservoir roof beam			
=====================					
Project	NRW				
Beam	Roof beam -RB3 (RB6)				
fcu (N/mm^2) =	35	35	35	35	35
fy (N/mm^2) =	450	450	450	450	450
bw (mm) =	450				
h (mm) =	750				
d (mm) =	676				
d' (mm) =	75				
bf (mm) =	450				
hf (mm) =	200				
m (kNm) =	405	454	228		0
redist % =	0	0	0	0	0
DESIGN FOR BENDI					
k' =	0.156	0.156	0.156	0.156	0.156
k (M/bd^2fcu) =	0.056	0.063	0.032	0.000	0.000
z (mm) =	631	625	642	642	642
x (mm) =	101	114	75	75	75
fsc (N/mm^2) =	178	239	1	1	1
==========					
As (mm^2) =	1640	1856	907	0	0
As' (mm^2) =	0	0	0	0	0
==========					
DESIGN FOR SHEAR					
V (kN) =	223	354	283	100	
As (mm^2) =	1256	3221	3221	1256	
bv (mm) =	450	450	450	450	450
d (mm) =	676	676	676	676	676
v (N/mm^2) =	0.73	1.16	0.93	0.33	0.00
100As/bd =	0.41	1.06	1.06	0.41	0.00
vc (N/mm^2) =	0.53	0.72	0.72	0.53	0.00
b(v-vc) =	93	199	94	-89	0
b*0.4 =	180	180	180	180	180
==========					
Links R6 2legs	68	62	68	68	68
Links Y10 2legs	311	281	311	311	311
Links, Max spaci	507	507	507	507	507
==========					

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT	JOB NO.
	CALCULATIONS BY	SHEET ... OF ...
	SCHEME COMPONENT	DATE

ITEM	CALCULATIONS	OUTPUT

Continuous corbel off beam



P_u Max $= 15.3 \times \frac{6.35}{2} \times 1.4 + 2.5 \times \frac{6.35}{2} \times 1.6 = 80.71$ kN/m

$M_x = 80.71 \times 0.2$ kNm

$d = 530 - 2 \times 50 = 480.$

$= 0.0013 \times 10^3 \times \frac{(330+265)}{2}$

$A_{st} =$ mm² / m (min) — Y10 - 150 c/c

X [- considering effective depth as 265 - 50 = 215

A_{st} min $= 279.5$ mm²/m (Y10 - 225 (349) ok.]

$V_u = 80.71 \times 10^3 / 10^3 \times 480$

$= 0.19$ N/mm²

$V_c = 0.38$ N/mm²

Main beam nib — Mahagalkanda Reservoir $P = 226.2$ kN/m.

— Ellai House reservoir $P_u = 220.70 <$

Hence repeat beam nib for Mahagalkanda.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT	JOB NO.
	CALCULATIONS BY	SHEET ......OF ......
	SCHEME COMPONENT	DATE

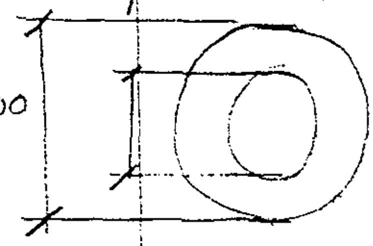
ITEM	CALCULATIONS	OUT PUT

500 φ column

$N_{scs} = 843 + \frac{\pi}{4} \times 0.5^2 \times 24 \times 6.75$ kN

$= 875.0$ kN

$M_{scs} = 21.03$ — computer out-put



$\frac{l}{r} = 1.3 \times 6.75 \times 10^3 / 500$

$= 17.55$

$M_{add\,scs} = 875 \times 0.15 \times 0.5$

$= 65.61$ kNm

$R = 250$ mm

$P_{steel} = 250 - 50 - 10 - 15$

$= 175$ mm

$\frac{M_x}{h'} = \frac{M_y}{b'}$

$\frac{N}{A_c f_{cu}} = \frac{875 \times 10^3}{\frac{\pi}{4} \times 500^2 \times 35} = 0.13$

$\beta = 0.85$

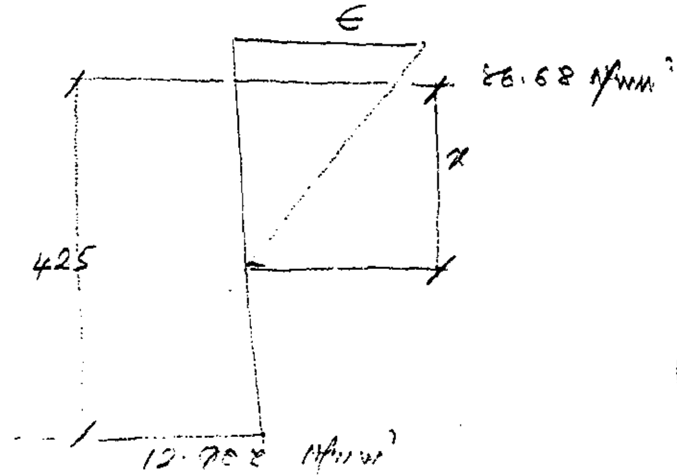
$M_{add\,uniaxial\,scs}$ $(21.03 + 65.61) \times 1.85 = 160.28$

$M_{scs} =$	16.02 TM
$N =$	87.5 T

```
----Ellie house Reservoir circular column----

M      = 16.02 (T.M)
N      = 87.5 (T)
R      = 25 (CM)
Rs     = 17.5 (CM)
AS     = 72.38 (CM^2)
--------------------------------
NP    = .55272
RS/R = .7
E/R   = .7323428
M!       = 37.895 (T.M)
M!/R3= 242.528 (KG/CM2)
C     = .5322453
S     = .2382605
-------------------------------------
Stress in concrete Sig-C= 129.0844 (KG/CM2)
Stress in steel    Sig-S= 866.7726 (KG/CM2)
```

12 Φ 32 (4.92%)



$$\frac{86.68/15}{x} = \frac{12.708}{425 - x}\ ;\quad x = 131.4\ \text{mm}$$

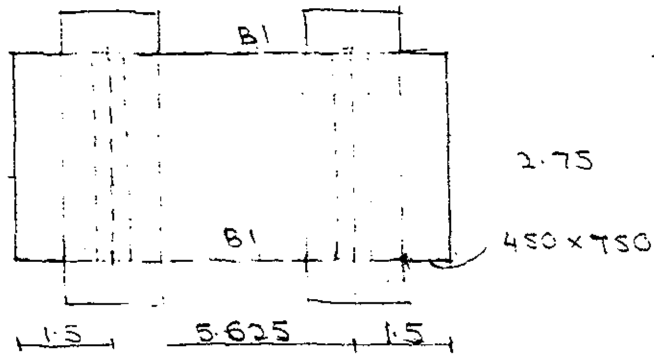
$$\epsilon = \frac{131.4 + [illegible]}{131.4} \times \frac{86.68}{200\ \text{mm}^2} = [illegible]$$

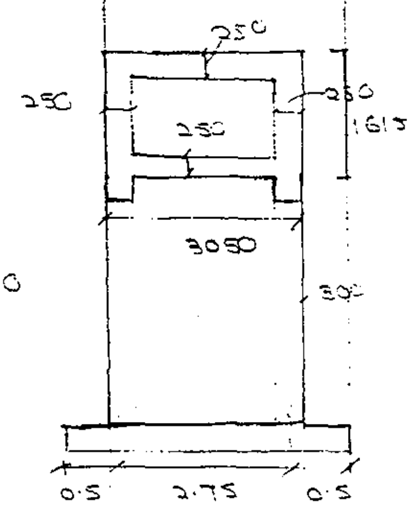
W_{cr} < [illegible] C_a = [illegible] mm

= 0.05 mm < 0.2 OK.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME INLET CHANNEL COMPONENT - ELLIE HOUSE - RESERVOIR	DATE

ITEM	CALCULATIONS	OUT PUT





loading

Dead 0.25 × 24 = 6.0
finishes = 1.0
7.0 kN/m²

super
water 10 × 1.115 = 11.13
surcharge 15 = 15 - } = 26.13 kN/m² Total super

Top slab loading
u_{d1} = 7.0 kN/m²
u_{s1} = 15.0 kN/m²

bottom slab loading
u_{d2} = 7.0 kN/m²
u_{s2} = 11.15 "

load on B1
ωd = 14 × 2.75/2 + 0.25 × 24 × 1.115 + self
83.69 + self . kN/m
ωs = 26.13 × 2.75/2 = 35.93 kN/m

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PROJECT		JOB REF
CALCULATIONS BY	CHECKED BY	CALC SHEET
PART OF STRUCTURE		DATE

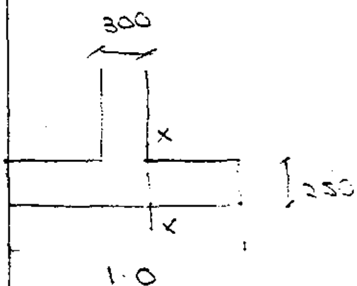
MEMBER REF	CALCULATIONS	OUTPUT

wall load on foundation =

		SLS	ULT
14 × (5.625/2 + 1.5)	=	60.38	84.53
26.13 × (")	=	112.69	180.29
0.45 × 0.75 × 4.313 × 2 × 24	=	69.87	97.82
0.3 × 3.05 × 5.2 × 24	=	114.19	159.87
1.0 × 3.75 × 0.25 × 24	=	22.5	31.50
0.25 × 1.115 × 4.313 × 2 × 24	=	57.7	80.79 kN
		437.33	634.80

bearing pressure $= \frac{438}{1.0 \times 3.75} = 117\ kN/m^2$ SLS.

$169\ kN/m^2$ ULT



$M_{x-x} = 170 \times \left(\frac{1.0 - 0.3}{2}\right)^2 \times \frac{1}{2}$

$= 10.41\ kNm$

$A_{st} = 152$

$d = 250 - 50 - \ldots$
$= 194.$

$V = 100 \times 0.35 = 35\ kN$

$V_u = 0.18\ N/mm^2$

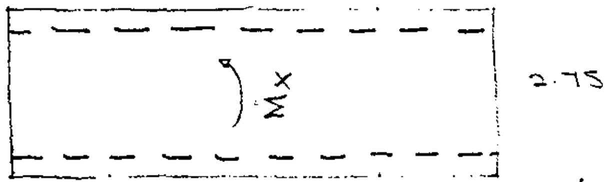
$V_c = 0.53\ N/mm^2$

$A_{st\,min}$ (temp) = Y10 – 150 c/c (523)

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT	JOB NO.
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME COMPONENT	DATE

ITEM	CALCULATIONS	OUT PUT

TOP SLAB & BOTTOM SLAB.



n = 7.0 + 15 = 22 kN/m² — SLS

n = 1.4 × 7.0 + 1.6 × 15 = 33.8 kN/m² — ULT

Mx = 0.086 × 33.8 × 2.75² = 21.98 kNm — ULT

Mx = 0.086 × 22/6 × 2.75² = 14.31 kNm

$d = 250 - 50 - \frac{12}{2}$
$= 194$

$\frac{M}{f_{cu}bd^2} = \frac{22 \times 10^6}{35 \times 10^3 \times 194^2} = 0.017$

z = 0.95d

Ast = 305 — Y10 - 150 c/c (523)

$f_s = \frac{5}{8} \times 450 \times \frac{305}{523} = 164$

$\frac{M}{bd^2} = 0.58$

$\gamma_{st} = 0.55 + \frac{(477 - 164)}{120(0.9 + 0.58)} = 2.31$

$d = \frac{2.75 \times 10^3}{20 \times 2} = 68.75 < d$ o.k.

Ast min (temp) = Y10 - 144 c/c

Provide Y10 - 125 c/c.

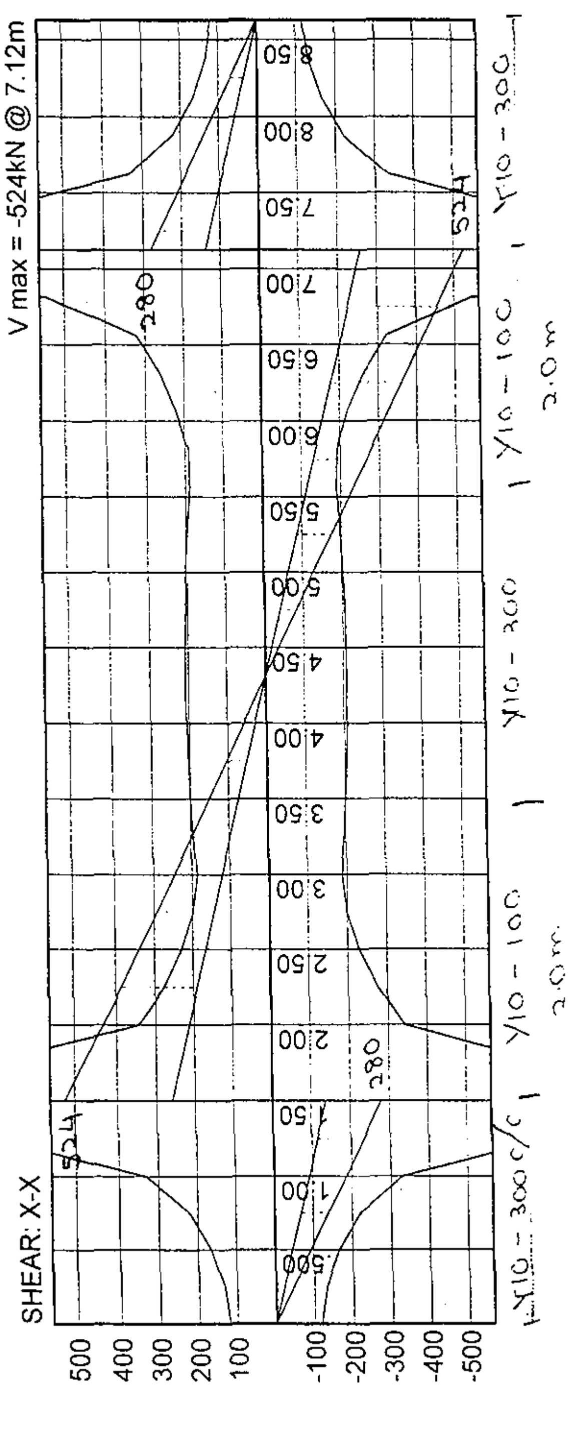
Y10 - 125 c/c both dirⁿ top & botᵐ.

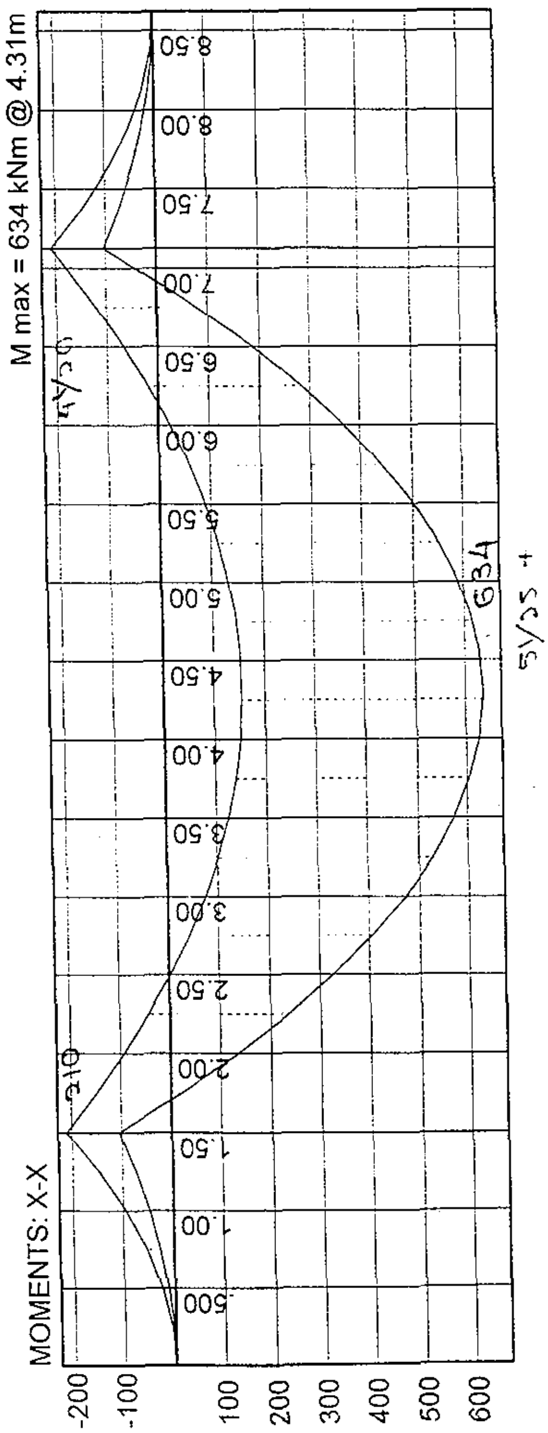
Ellie House -Inlet roof slab

		1st layer	2nd layer			T1 and T2 resp deg C
Dia of Bar mm		10		fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	28.75
Bredth of Sect mm		1000				
Depth of sect mm		250	space-mm			
Clear cover mm		50	-10			
Service M (kNm)		15.00				
				wcr(8007)	0.038	mm
				max 0.2mm		
Ast-mm^2	629	629	0			
Effect Depth mm			195			

			% of R/F	0.32
fst N/mm^2	134.44			
fst All'ble	360.00		gamma St	2.76
fcb N/mm^2	3.22		Vu -kN	47.00
fcb alI'ble	15.75		vu -n/mm^2	0.241
			vc -n/mm^2	0.580
			Shear design	OK
			Ast temp -dia	10
		0	Ast temp -mm	547
			spacing mm c/c	144

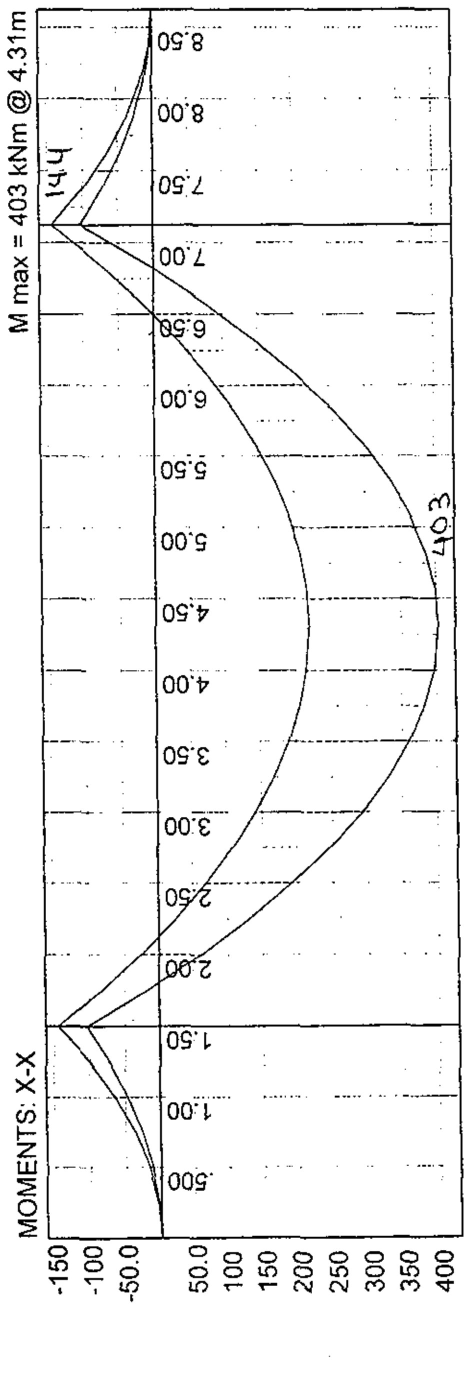
I-B14


SHEAR: X-X
V max = -524kN @ 7.12m
500
400
300
200
100
-100
-200
-300
-400
-500
.500
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50
524
280
280
524
Y10 - 300 c/c
Y10 - 100
2.0m
Y10 - 300
Y10 - 100
2.0m
Y10 - 300


MOMENTS: X-X
M max = 634 kNm @ 4.31m
-200
-100
100
200
300
400
500
600
.500
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50
210
634
5Y25 +
4Y20

06

I - BIS


MOMENTS: X-X
M max = 403 kNm @ 4.31m
144
403
-150
-100
-50.0
50.0
100
150
200
250
300
350
400
.500
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50

07

12/27/00

BEAM DESIGN (BS:8110)		Ellie house reservoir inlet floor beam			
====================					
Project	NRW				
Beam	Inlet beam -INL-B1				
fcu (N/mm^2) =	35	35	35	35	35
fy (N/mm^2) =	450	450	450	450	450
bw (mm) =	450				
h (mm) =	750				
d (mm) =	676				
d' (mm) =	75				
bf (mm) =	450				
hf (mm) =	250				
m (kNm) =	210	634			0
redist % =	0	0	0	0	0
DESIGN FOR BENDING					
k' =	0.156	0.156	0.156	0.156	0.156
k (M/bd^2fcu)=	0.029	0.088	0.000	0.000	0.000
z (mm)=	642	602	642	642	642
x (mm)=	75	165	75	75	75
fsc (N/mm^2)=	1	382	1	1	1
==============================					
As (mm^2)=	835	2692	0	0	0
As'(mm^2)=	0	0	0	0	0
==============================					
DESIGN FOR SHEAR					
V (kN) =	280	524	200		
As (mm^2)=	1257	1257	1257		
bv (mm)=	450	450	450	450	450
d (mm)=	676	676	676	676	676
v (N/mm^2)=	0.92	1.72	0.66	0.00	0.00
100As/bd =	0.41	0.41	0.41	0.00	0.00
vc (N/mm^2)=	0.53	0.53	0.53	0.00	0.00
b(v-vc) =	177	538	59	0	0
b*0.4 =	180	180	180	180	180
==============================					
Links R6 2legs @	68	23	68	68	68
Links Y10 2legs @	311	104	311	311	311
Links, Max spacing	507	507	507	507	507
==============================					

		Location	Ellie house reservoir-Inlet floor beam-INL-B1-1st span			
Dist bet two layers		25				
Bar Dia layers 1 & 2		25	25	fy N/mm^2	450	
Number of bars		5	2	fcuN/mm^2	35	
Breadth of sect mm		450				
Depth of sect mm		750	Space bet bars		56.25	
Clear cover mm		50				
Service M (kNm)		403.00	Ult M (kNm)		634	
Es (kN/mm^2)		200	Depth to Asc		75	
Ec (kN/mm^2)		28			Ast- Mult	Asc-Mult
			Ast2	982		
Total Ast mm^2		3438	Ast1	2455	2706	0
Effective Depth mm		673.21				
fst N/mm^2		203.27		Defln	1.140	
fst Allowable		360.00		Coeiff:		
fcb N/mm^2		10.73				
fcb allowable		15.75				
				Wcr 8007	0.20	
				mm 0.2		
		Location	Ellie house reservoir-Inlet floor beam-INL-B1-1st support			
Dist bet two layers		25				
Bar Dia layers 1 & 2		20	0	fy N/mm^2	450	
Number of bars		4	2	fcuN/mm^2	35	
Breadth of sect mm		450				
Depth of sect mm		750	Space bet bars		90.00	
Clear cover mm		50				
Service M (kNm)		144.00	Ult M (kNm)		210	
Es (kN/mm^2)		200	Depth to Asc		75	
Ec (kN/mm^2)		28			Ast- Mult	Asc-Mult
			Ast2	0		
Total Ast mm^2		1257	Ast1	1257	803	0
Effective Depth mm		690.00				
fst N/mm^2		183.58		Defln	1.831	
fst Allowable		360.00		Coeiff:		
fcb N/mm^2		5.18				
fcb allowable		15.75				
				Wcr 8007	0.13	
				mm 0.2		

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME ELLIE HOUSE COMPONENT VALVE HOUSE	DATE

ITEM	CALCULATIONS		OUT PUT
	load. at 29.3 level.		
	dead.	SLS.	ULT
	slab 0.2 × 24 = 4.8		
	[illegible] = 1.43		
	6.23	6.23	8.72
	super 10.0	10.0	16
		16.23	24.72 kN/m²
	bkk. 4.95 × 3.0 = 14.85	14.85	20.79 kN/m.
	load at roof level.		
	dead. = 1.34.	1.34	1.87
	super 0.75	0.75	1.2
		2.09	3.07 kN/m²

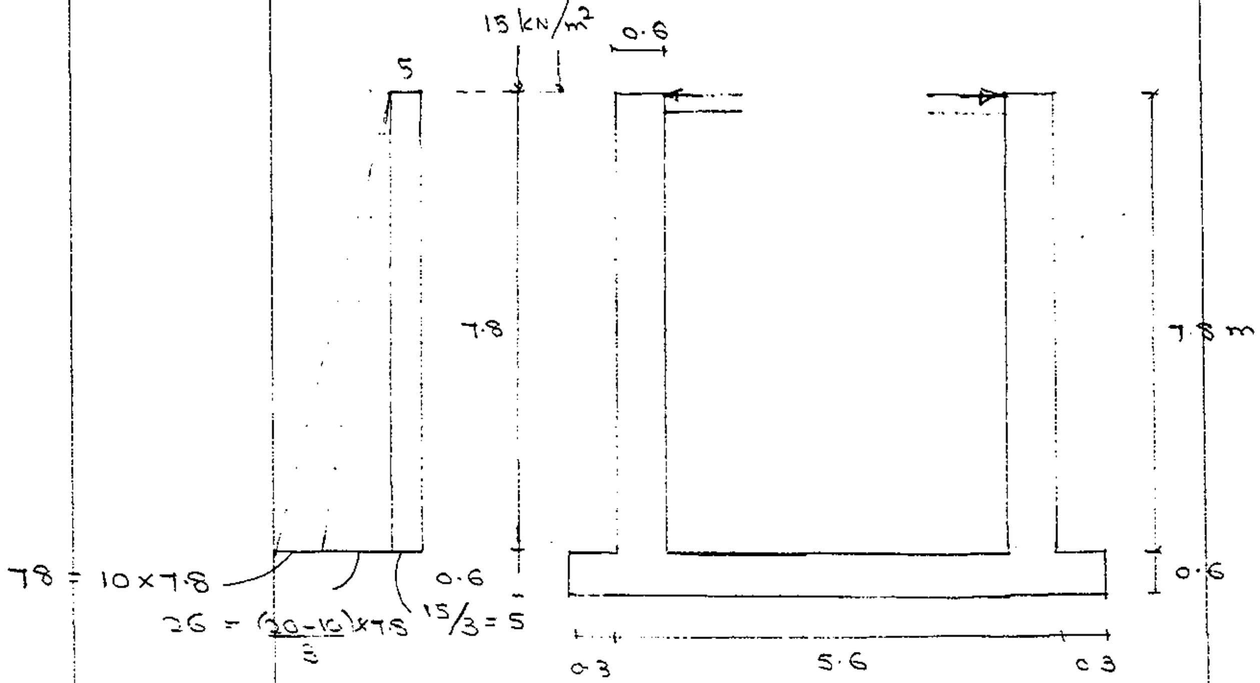
Total load at base	SLS	ULT
= 16.23 × 4.733 × 6.75	= 518.5	789.75
2.09 × 4.733 × 6.75	= 66.77	98.08
16.23 × 4.733 × 1.75	= 134.43	204.75
0.6 × 7.8 × 24 × 4.733 × 2	= 1063.22	1488.51
0.6 × 5.6 × 4.733 × 24	= 382	534.8
10 × 4.733 × 4.4	= 208.25	333.2
14.85 × (4.733 × 3 + 6.75)	= 311.09	435.53
0.3 × 0.75 × 24 × 14.18	76.57	107.2
	2760.83	3991.82

bearing pressure = $\frac{2766.83}{4.733 \times 6.2}$ = 94.29 ; ULT: $\frac{3991.82}{4.733 \times 6.2}$ = 136.0 kN/m²

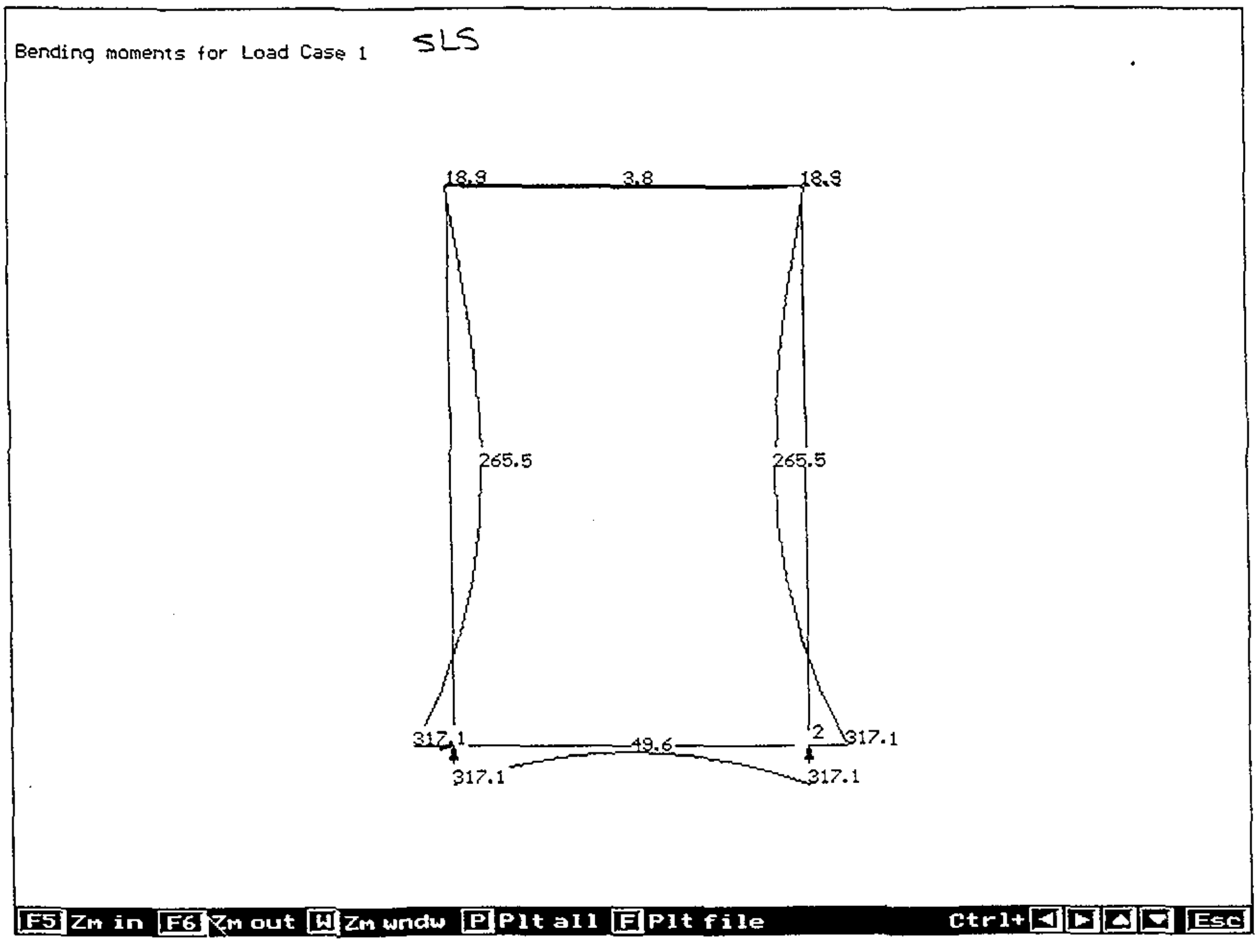
CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME Ellie house Reservoir COMPONENT Valve house	DATE

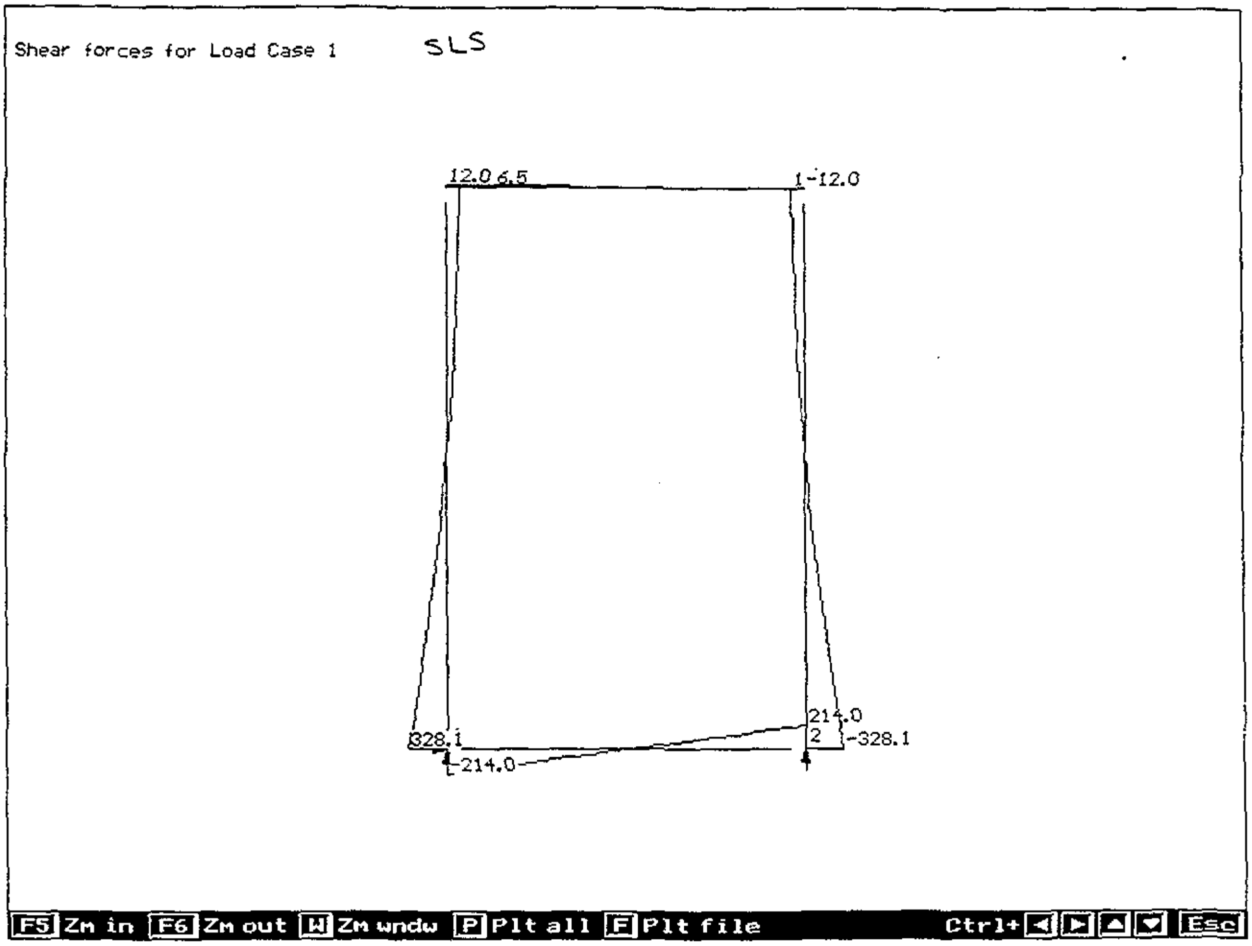
ITEM	CALCULATIONS	OUT PUT

wall.

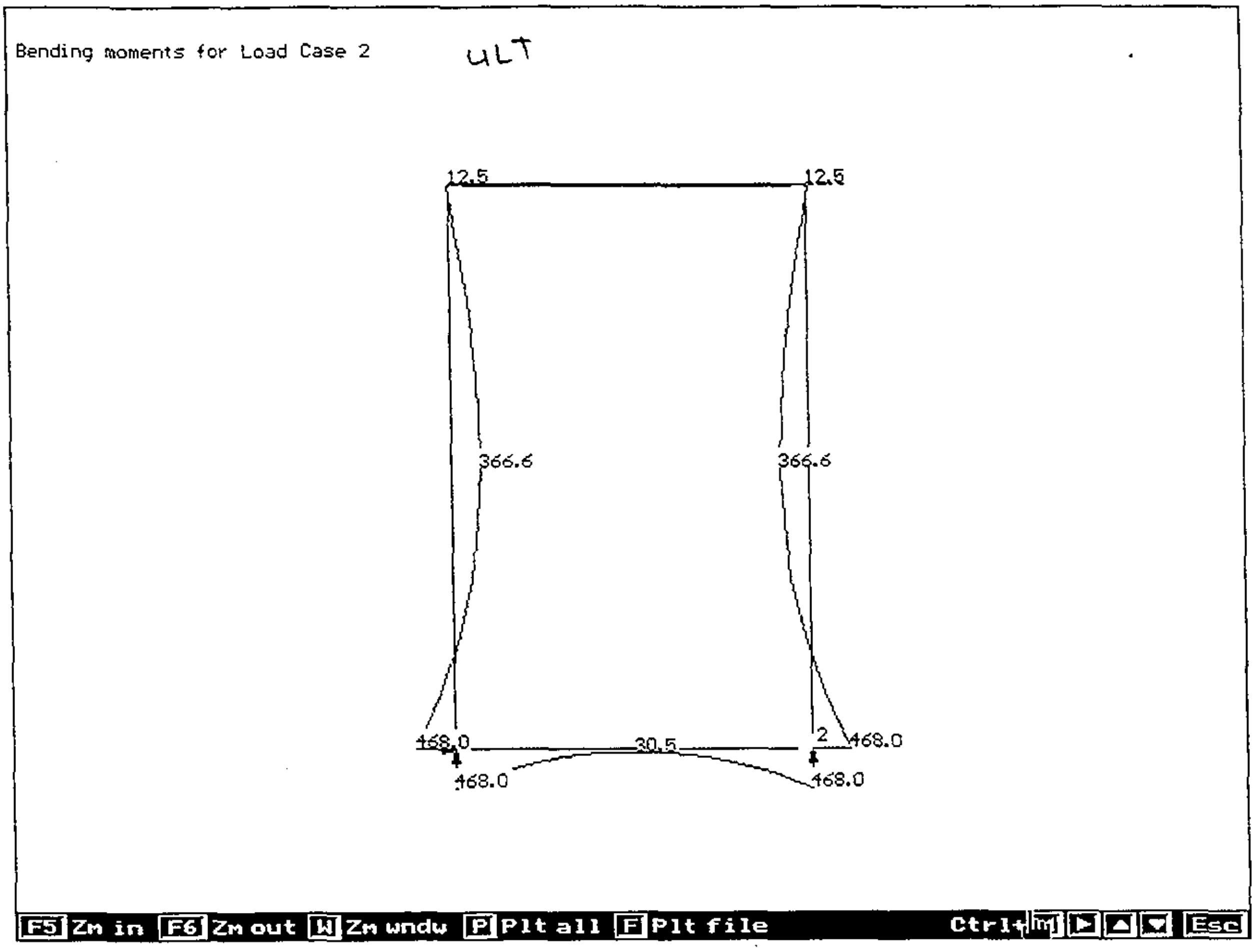


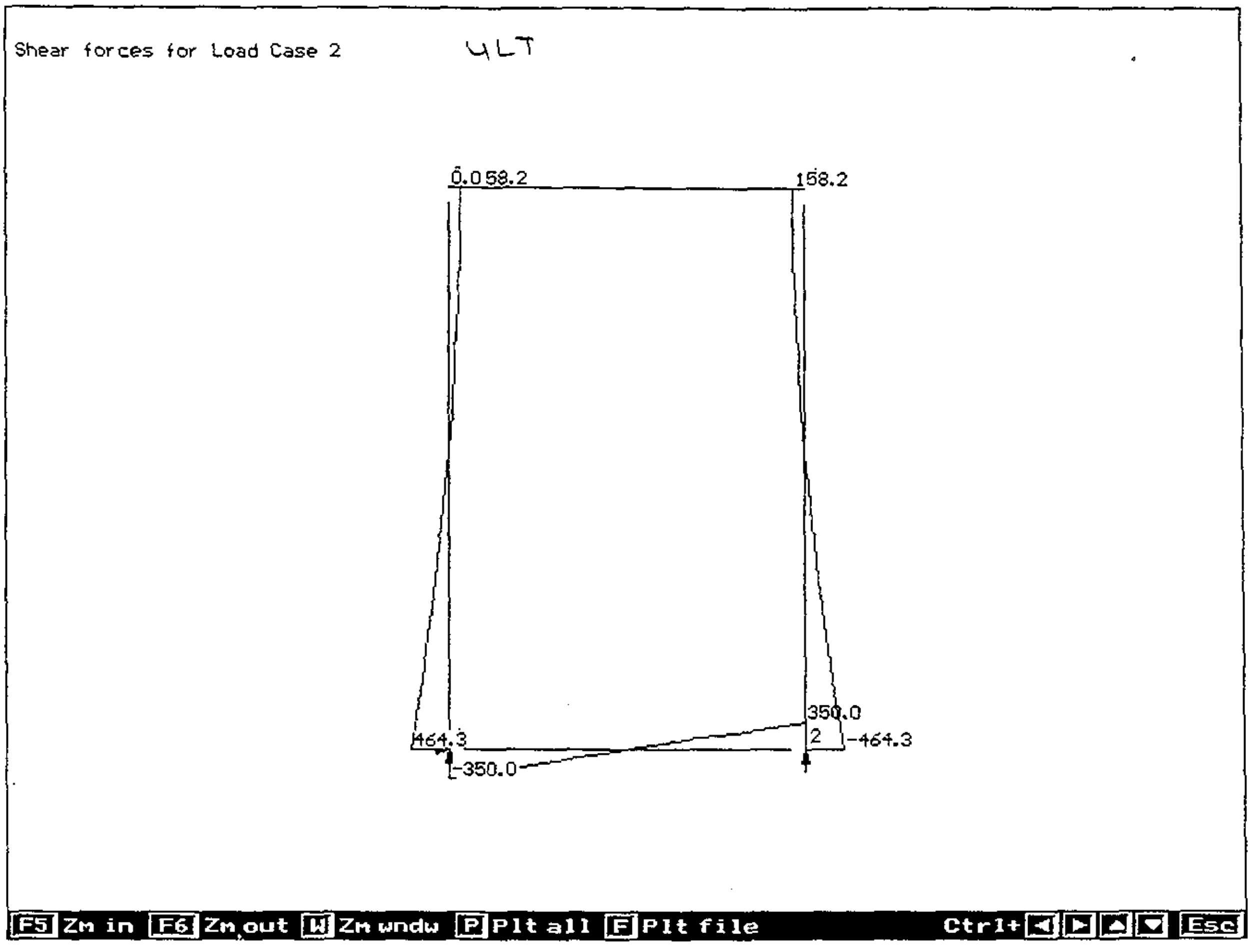
Tot = 109


Bending moments for Load Case 1
SLS
18.9
3.8
18.9
265.5
265.5
317.1
49.6
2
317.1
317.1
317.1
F5 Zm in F6 Zm out W Zm wndw P Plt all F Plt file Ctrl+ Esc


Shear forces for Load Case 1
SLS
12.0 6.5
1 -12.0
214.0
2
-328.1
328.1
-214.0
F5 Zm in F6 Zm out W Zm wndw P Plt all F Plt file
Ctrl+ Esc

05


Bending moments for Load Case 2
ULT
12.5
12.5
366.6
366.6
468.0
30.5
2
468.0
468.0
468.0
F5 Zm in F6 Zm out W Zm wndw P Plt all F Plt file
Ctrl+ Esc


Shear forces for Load Case 2
4LT
0.0
58.2
158.2
350.0
2
-464.3
464.3
-350.0
F5 Zm in F6 Zm out W Zm wndw P Plt all F Plt file Ctrl+ Esc

Ellie House -valve house wall at 7.8 m ~~height~~ depth

		1st layer	2nd layer			T1 and T2 resp deg C
Dia of Bar mm		25	12	fy N/mm^2	450	15
Spacing mm		125	125	fcuN/mm^2	35	44.28
Bredth of Sect mm		1000				
Depth of sect mm		600	space-mm			
Clear cover mm		66	75			
Service M (kNm)		317.00				
				wcr(8007) max 0.2mm	0.175	mm
Ast-mm^2	4834	3929	905			
Effect Depth mm			504			

		% of R/F	0.96
fst N/mm^2	151.03		
fst All'ble	360.00	gamma St	1.81
fcb N/mm^2	6.97	Vu -kN	328.00
fcb alI'ble	15.75	vu -n/mm^2	0.651
		vc -n/mm^2	0.697
		Shear design	OK
		Ast temp -dia	16
	0	Ast temp -mm	2371
		spacing mm c/c	85

Ellie House -valve house wall at 4.0 m ~~height~~ depth

		1st layer	2nd layer			
Dia of Bar mm		25	0	fy N/mm^2	450	
Spacing mm		125	150	fcuN/mm^2	35	
Bredth of Sect mm		1000				
Depth of sect mm		600	space-mm			
Clear cover mm		66	75			
Service M (kNm)		266				
				wcr(8007) max 0.2mm	0.169	mm
Ast-mm^2	3929	3929	0.00			
Effective Depth			522			

fst N/mm^2	148.63		
fst All'ble	360.00	gamma St	2.01
fcb N/mm^2	5.90	Vu -kN	0.00
fcb alI'ble	15.75	vu -n/mm^2	0.000
		vc -n/mm^2	0.643
		Shear design	ok

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PROJECT		JOB REF
CALCULATIONS BY	CHECKED BY	CALC SHEET
PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT
	Valve house wall	
	at 7.5 m depth	
	M_{ULT} = 468 kNm	h = 600
	$\frac{M}{f_{cu}bd^2}$ = 0.049	d = 600 − 50 − 16 − 25/2 =
	z = 0.935 d	= 521.5
	Ast = 2459 − Y25 − 125 c/c (3929)	
	V = 464 kN	
	Vu = 0.89	
	$\frac{100 As}{bd}$ = 0.76	
	Vc = 0.65 > Vu. o.k.	
	at 4.0 m depth	
	M_{ULT} = 367 kNm	
	$\frac{M}{f_{cu}bd^2}$ = 0.039	
	z = 0.949	
	Ast = 1900 − Y20 − 125 c/c	

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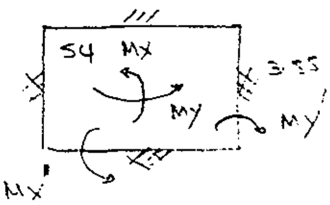
	CALCULATIONS BY	SHEET.........OF ....
	SCHEME ELLIE VALVE House COMPONENT Floor slab r/f	DATE

ITEM	CALCULATIONS	OUTPUT

5.45 slab at 29.3



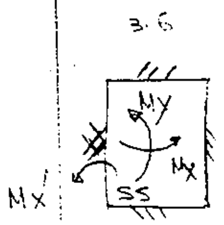
$\frac{l_y}{l_x} = \frac{5.45}{3.55} = 1.54$

$d = 200 - 25 - \frac{10}{2}$
$= 170$

Ast (349)

$M_x = 0.052 \times 24.72 \times 3.55^2$ = 16.2 - 256 - Y10-225
$M_x' = 0.069 \times$ " = 21.5 - 340 - Y10-200
$M_y = 0.023 \times$ = 7.2 - 114 - Y10-300
$M_y' = 0.037 \times$ = 11.5 - 182 - Y10-300

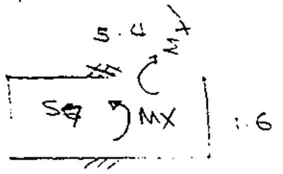
0.56 $M_x = 16.2$
206 $\gamma_{st} = 2.8$
$d = 89 < 170$ o.k.



$\frac{l_y}{l_x} = 1.4$

Ast

$M_x = 0.06 \times 24.72 \times 3.6^2$ = 19.22 - 304 - Y10-200 (3
$M_x' = 0.08 \times$ " = 25.63 - 405 - Y10-150
$M_y = 0.043 \times$ " = 13.78 - 218 - Y10-250



Ast

$M_x = 0.086 \times 24.72 \times 1.5^2$ = 5.44 - 86 - Y10-300
$M_y = 0.086 \times$ " = "

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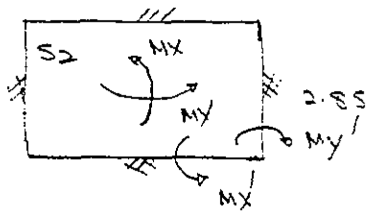
PROJECT		JOB REF
CALCULATIONS BY	CHECKED BY	CALC SHEET
PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT

5.4



$\frac{l_y}{l_x} = \frac{5.4}{2.85} = 1.89$

Ast

Mx = 0.064 × 24.72 × 2.85^2 = 12.85 – 203 – Y10 – 250 (3[illegible]

Mx' = 0.084 × " = 16.87 – 267 – Y10 – 225 (3[illegible]

My = 0.028 × " = 5.60 – 89 – Y10 – 300

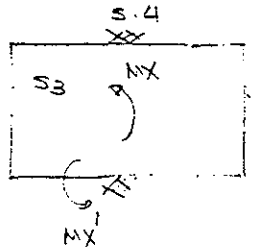
My' = 0.037 × " = 7.43 – 115 – Y10 – 300

MX = 12.85

0.45 γst = 2.34

181 d = 71 < 170 o.k

5.4



2.15

$\frac{l_y}{l_x}$ =

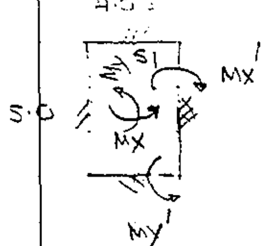
Ast

Mx = 0.086 × 24.72 × 2.15^2 = 9.82 – 155 – Y10 – 300 (2[illegible]

034 γst = 2.0

167 d = 54 < 170 o.k.

4.05



$\frac{l_y}{l_x}$ = 1.23

Ast (3[illegible]

Mx = 0.046 × 24.72 × 4.05^2 = 18.65 – 295 – Y10 – 2[illegible]

Mx' = 0.062 × = 25.14 – 395 – Y10 – 1[illegible] (5[illegible]

My = 0.035 × = 14.19 – 224 – Y10 – 2[illegible]

My' = 0.047 × = 19.06 – 301 – Y10 – 2[illegible]

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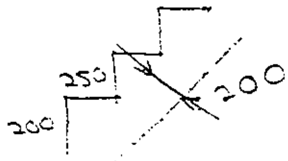
CONSULTING ENGINEERS

PROJECT		JOB REF
CALCULATIONS BY	CHECKED BY	CALC SHEET
PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT
	stair case .	



load.

waist $0.2 \times 24 \times 1.28 = 6.14$ kN/m²

steps $0.2/2 \times 24 = 2.4$ ″

finishes $0.065 \times 22 \times 1.28 = 1.83$

10.37 ″

super $= 5.0$

$n = 1.4 \times 10.37 + 1.6 \times 5 = 22.52$ kN/m²

span $0.95 + 2.45 + 1.0 = 4.4$.

$M = 22.52 \times \frac{4.4^2}{8} = 54.49$ kNm

$d = 200 - 20 - . = 174$

Ast = 889. - Y12 - 100 (1130)

$\gamma st = 1.34$

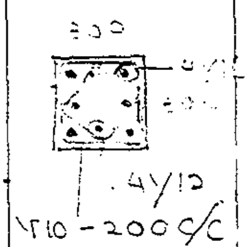
$d = 164 < 174$ o.k.

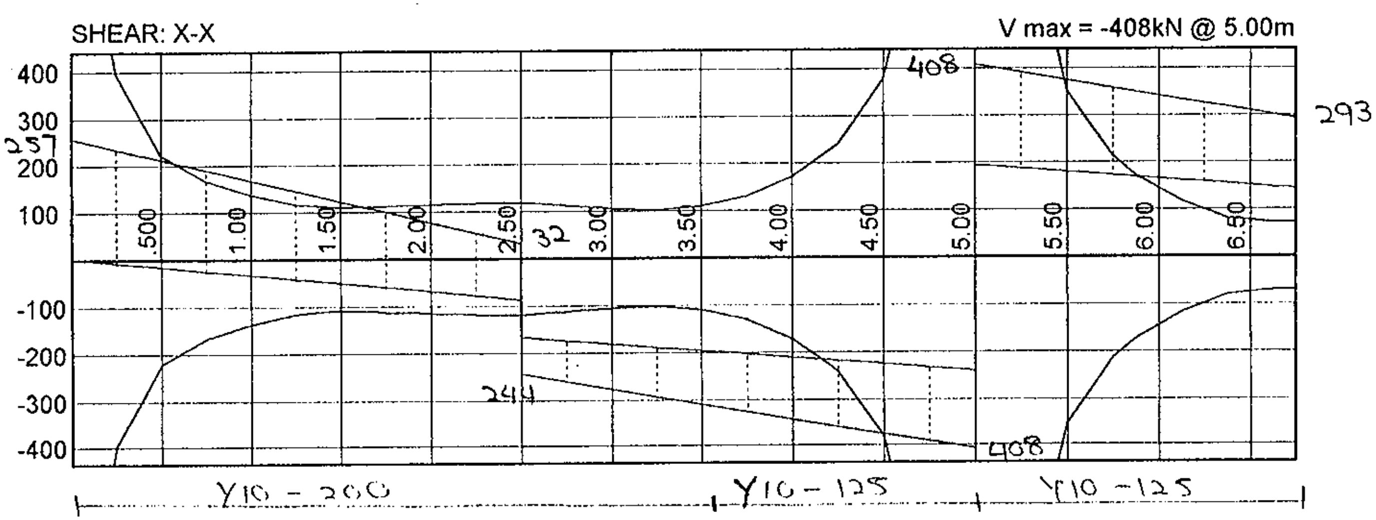
nominal r/f = 260 - Y10 @ 250 c/c.

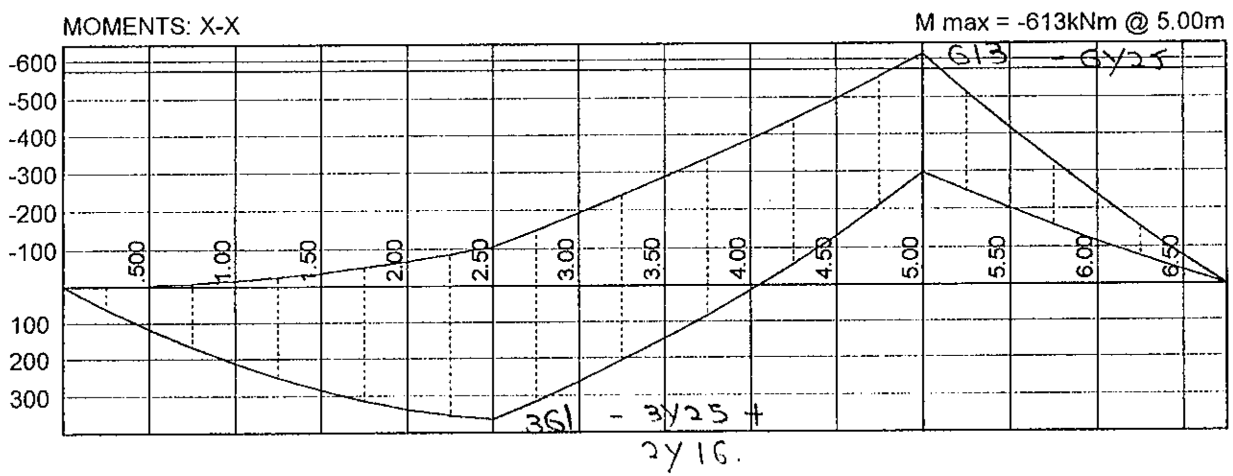
DAYANANDA ASSOCIATES

CONSULTING ENGINEERS

PROJECT		JOB REF
CALCULATIONS BY	CHECKED BY	CALC SHEET
PART OF STRUCTURE		DATE

MEMBER REF	CALCULATIONS	OUT PUT
	column C_1 - 300×300	
	Total column load.	
	N = (6.23 × 1.75/2 + 0.3×0.75×24) × 2.647 × 1.4	
	0.3×0.3×24 × 2.25 × 1.4 +	
	10.0 × 1.75/2 × 2.647 × 1.6	
	= 84 kN.	
	Provide nominal r/f.	
	Asc = 1% = 900 — 4Y16	
	links Y10 - 200 c/c.	


SHEAR: X-X
V max = -408kN @ 5.00m
400
300
257
200
100
-100
-200
-300
-400
.500
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
408
293
32
244
408
Y10 - 200
Y10 - 125
Y10 - 125


MOMENTS: X-X
M max = -613kNm @ 5.00m
-600
-500
-400
-300
-200
-100
100
200
300
.500
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
613 - 6Y25
361 - 3Y25 +
2Y16.

13

BEAM DESIGN (BS:8110)		Ellie house valve house floor beam			
====================					
Project	NRW				
Beam	Floor-B4				
fcu (N/mm^2) =	25	25	25	25	25
fy (N/mm^2) =	450	450	450	450	450
bw (mm) =	300				
h (mm) =	750				
d (mm) =	690				
d' (mm) =	60				
bf (mm) =	300				
hf (mm) =	200				
m (kNm) =	361	613			0
redist % =	0	0	0	0	0
DESIGN FOR BENDI					
k' =	0.156	0.156	0.156	0.156	0.156
k (M/bd^2fcu) =	0.101	0.172	0.000	0.000	0.000
z (mm) =	601	536	656	656	656
x (mm) =	198	342	77	77	77
fsc (N/mm^2) =	392	392	152	152	152
As (mm^2) =	1534	2881	0	0	0
As' (mm^2) =	0	227	0	0	0
DESIGN FOR SHEAR					
V (kN) =	257	276	408	293	
As (mm^2) =	1472	1472	2945	1472	
bv (mm) =	300	300	300	300	300
d (mm) =	690	690	690	690	690
v (N/mm^2) =	1.24	1.33	1.97	1.42	0.00
100As/bd =	0.71	0.71	1.42	0.71	0.00
vc (N/mm^2) =	0.56	0.56	0.71	0.56	0.00
b(v-vc) =	203	231	378	255	0
b*0.4 =	120	120	120	120	120
Links R6 2legs	61	53	33	48	102
Links Y10 2legs	276	243	148	219	467
Links, Max spaci	518	518	518	518	518

GOTHATUWA -KOLONNAWA PUMP HOUSE

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 01 OF ......
	SCHEME COMPONENT KMU – PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

1. DATA:

A) DEAD LOADS:

PUMP HOUSE STAGING AREA SLAB 200 MM THICK. = 4.8 kN/m²

SCREED & TERRAZZO = 1.8 kN/m²

200mm THICK PEBBLE LAYER ON ROOF = 4.0 kN/m²

ZINC ALUMINUM ROOFING WITH PURLINS, BOLTS etc. = 0.5 kN/m²

100mm BENCHING CONCRETE = 2.4 kN/m²

200mm BLOCK WALL (incl. plaster) = 3.3 kN/m²

CONCRETE DENSITY = 24.0 kN/m³

DENSITY OF WATER = 10.0 kN/m³

B) LIVE LOADS

ON ROOF (INACCESSIBLE) = 1.0 kN/m²

ON STAGING AREA SLAB = 10.0 kN/m²

ON RESERVOIR ROOF = 2.5 kN/m²

C) WIND FORCES

BASIC WIND SPEED = 54.0 m/s.

CHARACTERISTIC WIND PRESSURE

$W_K = 0.613 V_s^2$ N/m².

Where $V_s = S_1 S_2 S_3 \cdot V$

$S_1 = 1.0$, $S_3 = 1.0$ & $S_2 = 0.83$.
for H = 5.0m &
Topogr. factor = 1.

D). ALLOWABLE SOIL BEARING PRESSURE = 250 kN/m²

CONCRETE f_{cu} = 35.0 N/mm²

REINFORCEMENT f_y = 460.0 N/mm²

MILD STEEL = 250.0 N/mm²

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 02 OF ....
	SCHEME COMPONENT KMU – PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
2.	CALCULATION OF WIND FORCES.	
	$W_K = 0.613\ V_s^2$	
	$= 0.613 \times (1.0 \times 0.83 \times 1.0 \times 34)^2$	
	$= 0.488\ KN/m^2$	$W_K = 0.488\ KN/m^2$
	BUILDING DIMENSIONS:	
	$l = 21.0m,\ b = 10.0m,\ h = 5.0m.$	
	$h \not> \frac{1}{2} b.$	
	ROOF SLOPE = 15°	
	WIND AT RIGHT ANGLE TO BUILDING.	
	$\therefore C_{pe} = -0.8\ \&\ -0.4$	
	WIND PARALLEL TO BUILDING.	
	$C_{pe} = -0.8\ \&\ -0.6.$	
	∴ TOTAL WIND FORCE F PER FRAME	
	$F = W_K \cdot A\ (C_{pe_1} - C_{pe_2})$	
	$= 0.488 \times 4.125 \times h\ (-0.8-(-0.4))$	
	$= -0.81h\ KN.$ – MAXᵐ SUCTION.	
	h = height.	
	WIND FORCE ON ROOF FRAME	WIND FORCE
	$= -0.81\ KN/m.$	$F = -0.81\ KN/m$

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 03 OF ......
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
3.	DESIGN OF STAGING AREA SLAB.	
	MAX^m. SPAN = 4·25m – ONE WAY SINGLE SPAN.	
	ULS. DESIGN LOAD = 1·4Gk + 1·6QK. SECTION 3.5. BS 8110 Part I : 1985.	
	∴ DES. LOAD n = 1·4×(4·8+1·8)+1·6×10·0	
	n = 25·24 KN/m².	n = 25·24 kN/m²
	∴ SINGLE SPAN MAX^m. BM $= \frac{wl^2}{8}$ $= \frac{25.24 \times 4.25^2}{8}$ = 57.00 kNm /m.	Ult. Des BM = 57·00 kNm/m
	REINFORCEMENT	
	BS 8110 : Part I : 1985 clause 3.5.4 - slabs & clause 3.4.4 for beams.	
	SLAB THICKNESS = 200 mm.	
	EFFECTIVE DEPTH d = 200 − 40 − $\frac{10}{2}$ = 155 mm.	40, d = 155 mm
	$\frac{M}{bd^2} = \frac{57.0 \times 10^6}{1000 \times 155^2} = 2.37$.	
	USING CHARTS OF BS 8110 : Part 3 : 1985 chart 2. for f_{cu} = 25·0 N/mm²	
	$\frac{100 A_s}{bd}$ = 0·64. ∴ $A_s = \frac{0.64 \times 1000 \times 155}{100}$ = 992·0 mm².	
	MAIN BARS PROVIDE T12 @ 100 c/c → As = 1130·0 mm²	Main Bars T12 @ 100.

ITEM	CALCULATIONS	OUT PUT
3.1	SECONDARY REINFORCEMENT. BS 8110 : Part I : 1985 clause 3.12.5.3. DIST. BARS = 0.13 bh. = 0.13 × 1000 × 200 = 260.0 mm². PROVIDE T10 @ 300 c/c. As = 261.0 mm². AT SUPPORT : BS8110: Part I : 1985 clause 3.12.10.3.2 $A_s = \frac{1}{2} \times 643.5 = 321.8 mm^2$ MINIMUM REQUIRED = 0.13 bh = 260.0 mm² ∴ PROVIDE T10 @ 200 c/c. As = 392.0 mm².	DIST. BARS T10 @ 300 c/c AT SUPPORT T10 @ 200 c/c
3.2	DEFLECTION : BS 8110 : Part I : 1985, clause 3.5.7 & Table 3.10 & 3.11. BASIC l/d = 20 S/S. CONDITION. MODIFICATION FACTOR FOR TENSION RFT $f_s = \frac{5 f_y A_{s.req}}{8 A_{s.prov.}} \cdot \frac{1}{\beta_b}$, $\beta_b = 1.0$ $= \frac{5 \times 460 \times 392.0}{8 \times 1130.0} = 252.4 N/mm^2$ ∴ MOD. FACTOR $= 0.55 + \frac{(477 - 252.4)}{120(0.9 + 2.37)}$ = 1.122 CONSIDERING T12 @ 100 c/c TOP BARS. As = 1130.0 mm²	

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW.	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 05 OF ....
	SCHEME KMU - PUMP HOUSE & COMPONENT RESERVOIR	DATE

ITEM	CALCULATIONS	OUT PUT
	MOD. FACTOR FOR COMPRESSION AREA REINFORCEMENT $= 1 + \frac{100 \times 1130.0}{1000 \times 154} \Big/ \left(3 + \frac{100 \times 1130.0}{1000 \times 154}\right)$ $= 1.197.$ ALLOWABLE SPAN $= 20 \times 1.122 \times 1.197 \times 154$ $= 4136.5 \text{ mm} < 4250 \text{ mm}.$ CHANGE BOTTOM BARS TO T16 @ 150 → $A_s = 1340.0 \text{ mm}^2$ MOD. FACTOR $f_s = \frac{5}{8} f_y \times \frac{A_{s\,req}}{A_{s\,prov}} \times \frac{1}{\beta_b}$ $= \frac{5}{8} \times 460 \times \frac{992}{1340} \times 1$ $= 212.8 \text{ N/mm}^2.$ MOD. FACTOR $= 0.55 + \left(\frac{477 - 212.8}{120(0.9 + 2.37)}\right)$ $= 1.245.$ ∴ ALLOWABLE SPAN $= 20 \times 1.245 \times 1.197 \times 154$ $= 4590.0 > 4250.$ ∴ ok.	∴ SLAB TOP BARS T12 @ 100. & BOTTOM BARS T16 @ 150. DEFLECTION OK.

DESIGN OF CRACK.

BS 8007 : 1987

Pump House Staging Slab

DESIGN SURFACE CRACK WIDTH $\omega = \dfrac{3acr.Em}{1+2\left(\dfrac{acr - Cmin}{h - x}\right)}$

$$\varepsilon m = \varepsilon_1 - \frac{bt\,(h - x)(a' - x)}{3Es.\,As\,(d - x)}$$

SERVICE MOMENT M = 37.5 KNM/M

h (mm) = 200 Cmin = 40 (mm) Φ = 16.00 mm

d = h - Cmin - Φ/2 d = 152.00 mm

CONCRETE f cu = 35 N/mm^2

fy = 460 N/mm^2

REINFORCEMENT PROVIDED BAR DIAMETER Φ = 16 mm

BAR SPACING S = 150 mm

Asp = 1340.41 mm^2

Ec = 28 KN/mm^2

Es = 200 KN/mm^2

αe = Es/ 1/2Ec = 14.29

ρ = 0.00882

$\alpha e.\rho$ = 0.126

THEREFORE $\dfrac{x}{d} = -\alpha e\,(\rho + \rho') + \sqrt{\alpha e^2\,(\rho + \rho')^2 + 2\alpha e\left(\rho + \dfrac{d'}{d}\rho'\right)}$ = 0.392

CONSIDERING $\rho' = 0$

THEREFORE x = 59.51 mm

z = d - 1/3 x = 132.16 mm

$fs = \dfrac{M}{Asp.z}$ = 211.68 N/mm^2

$\varepsilon s = \dfrac{fs}{Es \times 1000}$ = 0.0010584

$$\varepsilon 1 = \frac{(h - x)}{(d - x)} * \varepsilon s = 0.001608$$

$$\varepsilon m = 0.0013424$$

1) CRACK UNDER THE BAR DIRECTLY

$acr = C_{min} =$ 40 mm

$\omega = 3.acr.\varepsilon m =$ **0.161 mm**

< **0.2mm** O.K

2) CRACK AT MIDWAY BETWEEN TWO BARS

$$acr + \phi/2 = \sqrt{(S/2)^2 + (\phi/2 + C_{min})^2} = 89.04$$

$acr =$ 81.04 mm

$\omega =$ **0.206 mm**

~ **0.2mm** O.K

THEREFORE REINFORCEMENT T16 @ 150 C/C O.K

CHECK FOR THERMAL CRACK

Staging area Slab

BS 8007, APPENDIX A.3

CRACK SPACING $S_{max} = \frac{f_{ct}}{f_b} \times \frac{\Phi}{2\rho}$

FROM TABLE A.1 $\frac{f_{ct}}{f_b}$ = 0.67

FOR R/F PROVIDED — BAR DIAMETER Φ = 16 mm

BAR SPACING S = 150 mm

Asp = 1340.95 mm^2

USING SURFACE ZONES AS PER FIG A.2 BS 8007 — h = 100 mm

$\rho = \frac{Asp}{1000*h}$ = 0.0134095

Smax = 399.72 mm

MAXIMUM CRACK WIDTH DUE TO CHANGE IN TEMPERATURE T1 & T2

BS 8007 - APPENDIX A.3 — $\omega_{max} = S_{max} \cdot \frac{\alpha(T1+T2)}{2}$

α = 0.00001 / °C

T1= 25^0C FOR WALL OF 200mm THICK

THEREFORE — T1 = 25 °C

T2 = 15 °C

ω_{max} = **0.0799432 mm** **< 0.2mm**

THERMAL CRACK OK

CHECK FOR THERMAL CRACK

Staging area Slab

BS 8007, APPENDIX A.3

CRACK SPACING $S_{max} = \frac{f_{ct}}{f_b} \times \frac{\Phi}{2\rho}$

FROM TABLE A.1 $\frac{f_{ct}}{f_b}$ = 0.67

FOR R/F PROVIDED BAR DIAMETER Φ = 12 mm

BAR SPACING S = 100 mm

Asp = 1131.43 mm^2

USING SURFACE ZONES AS PER FIG A.2 BS 8007 h = 100 mm

$\rho = \frac{Asp}{1000*h}$ = 0.0113143

Smax = 355.30 mm

MAXIMUM CRACK WIDTH DUE TO CHANGE IN TEMPERATURE T1 & T2

BS 8007 - APPENDIX A.3 $\omega max = Smax \cdot \alpha \frac{(T1+T2)}{2}$

α = 0.00001 /°C

T1= 25°C FOR WALL OF 200mm THICK

THEREFORE

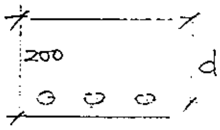
T1 = 25 °C

T2 = 15 °C

ωmax = **0.0710606 mm** **< 0.2mm**

THERMAL CRACK OK

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 10 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR	DATE

ITEM	CALCULATIONS	OUT PUT
4.	DESIGN OF RESERVOIR ROOF SLAB	
	SPAN = 4.5 m. S/S. ONE WAY.	
	BS 8110 : Part 1 : 1985 clause 3.5	
	ULT. DESIGN LOAD $n = 1.4 G_k + 1.6 Q_k$.	
	$= 1.4(4.8+4.0+2.4)+1.6\times2.5$	Ult. Des. Load
	$= 19.68$ kN/m²	$n = 19.68$ kN/m².
	BENDING MOMENT.	
	Max^m SINGLE SPAN BM $= \frac{Wl^2}{8}$	
	$= \frac{19.68 \times 4.5^2}{8}$	Ult. DES
	$= 49.82$ kNm. /m.	BM = 49.82 kNm.
	REINFORCEMENT BS 8110 : Part 1 : 1985 clause 3.5.4 for SLABS & clause 3.4.4 for BEAMS.	
	SLAB THICKNESS = 200 mm.	
	$d = 200 - 40 - \frac{10}{2} = 155$ mm.	
	$\frac{M}{bd^2} = \frac{49.82\times10^6}{1000\times155^2} = 2.07$.	
	BS 8110 : Part 3 : 1985, chart 2 for $f_{cu} = 25.0$ N/mm²	
	$\frac{100 A_s}{bd} = 0.56$	
	$\therefore A_s = \frac{0.56\times1000\times155}{100} = 868.0$ mm²	
	MAIN BARS PROVIDE T12@125 c/c.	Main Bars
	$\Rightarrow A_s = 904.0$ mm²	T12 @ 125c/c

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD LUTHFY.	SHEET 11 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
4.1	SECONDARY REINFORCEMENT. SIMILAR TO ITEM 3.1 T10 @ 300 c/c OK	DIST. BARS T10 @ 300 c/c.
4.2	DEFLECTION: SIMILAR TO ITEM 3.2 PROVIDE T16 @ 150 c/c BOTTOM BARS & T12 @ 100 c/c TOP BARS. ∴ DEFLECTION OK.	

(12)

DESIGN OF CRACK.

BS 8007 : 1987

Reservoir Roof Slab

DESIGN SURFACE CRACK WIDTH $\omega = \dfrac{3 a_{cr}.E_m}{1+2\left(\dfrac{a_{cr} - C_{min}}{h - x}\right)}$

$$\varepsilon_m = \varepsilon_1 - \frac{b_t (h - x)(a' - x)}{3 E_s . A_s (d - x)}$$

SERVICE MOMENT M = 34.7 KNM/M

h (mm) = 200 Cmin = 40 (mm) Φ = 16.00 mm

$d = h - C_{min} - \Phi/2$ d = 152.00 mm

CONCRETE f_{cu} = 35 N/mm^2

f_y = 460 N/mm^2

REINFORCEMENT PROVIDED BAR DIAMETER Φ = 16 mm

BAR SPACING S = 150 mm

Asp = 1340.41 mm^2

Ec = 28 KN/mm^2

Es = 200 KN/mm^2

$\alpha e = Es/ 1/2Ec$ = 14.29

ρ = 0.00882

$\alpha e.\rho$ = 0.126

THEREFORE $\dfrac{x}{d} = -\alpha e (\rho + \rho') + \sqrt{\alpha e^2 (\rho + \rho')^2 + 2\alpha e \left(\rho + \dfrac{d'}{d}\rho'\right)}$ = 0.392

CONSIDERING $\rho' = 0$

THEREFORE x = 59.51 mm

$z = d - 1/3\, x$ = 132.16 mm

$f_s = \dfrac{M}{Asp.z}$ = 195.88 N/mm^2

$\varepsilon_s = \dfrac{f_s}{E_s \times 1000}$ = 0.0009794

$$\varepsilon 1 = \frac{(h - x)}{(d - x)} * \varepsilon s = 0.001488$$

$$\varepsilon m = 0.0012224$$

1) <u>CRACK UNDER THE BAR DIRECTLY</u>

$a_{cr} = C_{min} = 40$ mm

$\omega = 3.a_{cr}.\varepsilon m =$ **0.147 mm**

< **0.2mm** O.K

2) <u>CRACK AT MIDWAY BETWEEN TWO BARS</u>

$a_{cr} + \phi/2 = \sqrt{(S/2)^2 + (\phi/2 + C_{min})^2} = 89.04$

$a_{cr} =$ 81.04 mm

$\omega =$ **0.188 mm**

< **0.2mm** O.K

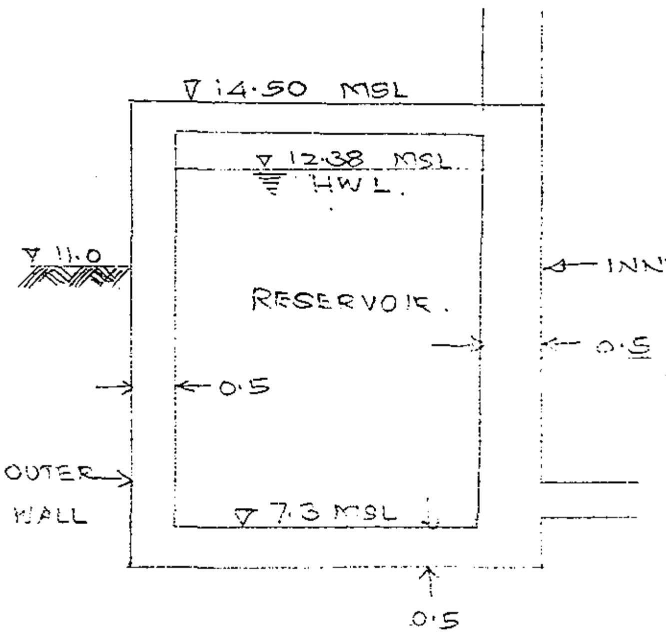
THEREFORE REINFORCEMENT T16 @ 150 C/C O.K

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY	SHEET 14 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

5. DESIGN OF RESERVOIR WALLS & BASE SLAB.

THIS PART OF DESIGN IS MADE IN ACCORDANCE WITH BS 8007 : 1987 & BS 8110 : Parts 1,2 & 3 : 1985



FOR SOIL
$K_a = 0.333$
$K_p = 3.0$
$\theta = 30°$

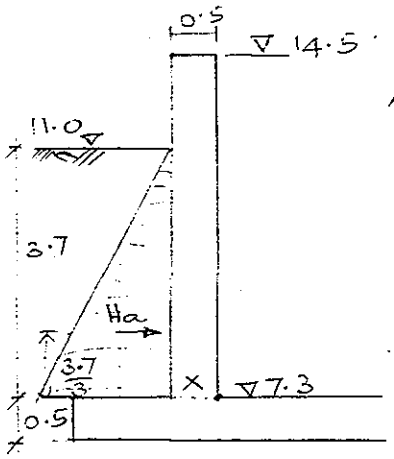
HWL = 12.38 MSL

GL = 11.0 MSL

$K_a = 0.333$
$K_p = 3.0$
$\theta = 30°$.

5.1. DESIGN OF OUTER WALL.

5.1.1 CASE OF EMPTY RESERVOIR



ACTIVE EARTH PRESSURE

$q_a = k_a \gamma h$
$= 0.333 \times 20 \times 3.7$
$= 24.64$ kN/m²

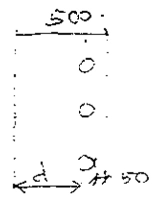
$\therefore H_a = \frac{1}{2} \times 24.64 \times 3.7$
$= 45.6$ kN/m. run.

$\therefore$ BM at X (SERVICE) $= 45.6 \times \frac{3.7}{3} = 56.2$ kNm

SHEAR at X (SERVICE) $= 45.6$ kN/m run.

$\therefore$ ULT. BM $= 1.4 \times 56.2 = 78.7$ kNm. /m.
" SF $= 1.4 \times 45.6 = 63.8$ kN /m.

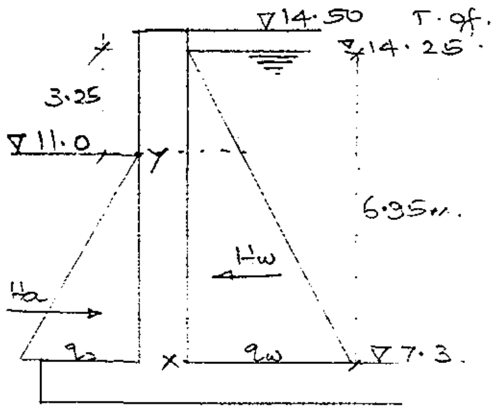
CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY	SHEET 15 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
	REINFORCEMENT. BS 8110 : Part I : 1985 & BS 8007 : 1987 clause 3.2.1 & 3.2.2	
	WALL THICKNESS = 500 mm.	
	EFFECTIVE DEPTH $d = 500 - 50 - \frac{20}{2}$ $= 440$ mm.	$d = 440$ mm.
	$\frac{M}{bd^2} = \frac{78.7 \times 10^6}{1000 \times 440^2} = 0.41 < 0.5$.	
	PROVIDE NOMINAL REINFORCEMENT.	
	BS 8007 APPENDIX 'A' TABLE A1. MIN^m. REINFORCEMENT $\rho_{crit} = 0.0035$.	
	$\therefore A_s = 0.0035 \times 1000 \times 500$ $= 1750.0$ mm^2.	
	PROVIDE T20 @ 150 c/c -> $A_s = 2094.0$ mm^2 VERTICAL BARS.	WALL VERTICAL BARS T20 @ 150 c/c

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 16 OF ....
	SCHEME COMPONENT KMU- PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
5.1.2	CASE OF RESERVOIR FULL.	

HWL = 12.38 MSL.
POSSIBILITY OF HWL RISING TO 14.25 MSL AS THE RESERVOIR HAS NO OVERFLOW SYSTEM.



FROM 5.1.1

$q_z = 24.64$ kN/m²

$H_a = 45.6$ kN/m run.

$q_w = 6.95 \times 10 = 69.5$ kN/m²

$H_w = \frac{1}{2} \times 69.5 \times 6.95$
$= 241.50$ kN/m.

CONSIDERING VERTICAL WALL WITH THE ROOF SLAB AS PROPPED CANTILEVER.

BM AT THE BOTTOM OF WALL X
(SERVICE) $= \frac{2WL}{15} = \frac{2 \times 241.5}{15} \times 6.95$
$= 223.8$ kNm /m.

MAX^m BM (SERVICE) = 0.0596 WL
= 0.0596 × 241.5 × 6.95
= 100.0 kNm/m.

LOCATION OF MAX^m. BM = 0.447 L FROM THE TOP OF WALL
= 0.447 × 6.95
= 3.107 m.

SHEAR AT X $= \frac{4 \times 241.5}{5} = 193.2$ kN/m.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 17 OF ....
	SCHEME COMPONENT KMU – PUMP HOUSE & RESERVOIR	DATE

ITEM	CALCULATIONS	OUT PUT

BM AT Y (SERVICE) $= \frac{1}{2} \times 32.5 \times 3.25 \times \frac{3.25}{3}$

$= \underline{57.2}$ kNm/m.

SHEAR AT Y $= \frac{1}{2} \times 32.5 \times 3.25$

$= \underline{52.8}$ kN/m.

∴ ULTIMATE BM's & SF's.

AT X BM $= 1.4 \times 223.8 = \underline{313.3}$ kNm/m

SF $= 1.4 \times 193.2 = \underline{270.5}$ kN/m

AT Y BM $= 1.4 \times 57.2 = \underline{80.1}$ kNm/m

SF $= 1.4 \times 52.8 = \underline{73.9}$ kN/m.

REINFORCEMENT.

BS 8110 : PART 1&3 1985 &
BS 8007 : 1987, CLAUSE 3.2.1, & 3.2.2

ULTIMATE LIMIT STATE.

WALL THICKNESS = 500 mm.
EFFECTIVE DEPTH $= 500 - 50 - \frac{20}{2}$
$= \underline{440}$ mm

$\frac{M}{bd^2} = \frac{313.3 \times 10^6}{1000 \times 440^2} = 1.62$

USING BS 8110, PART 3, CHARTS
CHART 2 FOR $f_{cu} = 35.0$ N/mm²

$\frac{100 A_s}{bd} = 0.45$

$\therefore A_s = 0.45 \times 1000 \times 440 / 100$
$= \underline{1980.0}$ mm²

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 18 OF ....
	SCHEME COMPONENT KNU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
	BS 8007, APPENDIX 'A' TABLE A.1 MINIMUM REINFORCEMENT $\rho_{crit} = 0.0035$ $\therefore A_s = 0.0035 \times 1000 \times 500$ $= 1750.0\ mm^2 < 1980\ mm^2$ $\therefore$ ADOPT T20 @ 150 c/c $A_s = 2094.0\ mm^2$. CHECK FOR SHEAR. $v = \frac{270.5 \times 10^3}{1000 \times 440} = 0.615\ N/mm^2$ $\frac{100 A_s}{bd} = \frac{100 \times 2094}{1000 \times 440} = 0.48\%$ $\therefore v_c = 0.55\ N/mm^2 < 0.615\ N/mm^2$ ADOPT T25 @ 150 c/c. $A_s = 3272.0\ mm^2$ $\therefore \frac{100 A_s}{bd} = \frac{100 \times 3272}{1000 \times 440} = 0.744\%$ $\therefore v_c = 0.636\ N/mm^2 > 0.615\ N/mm^2$ $\therefore$ NO SHEAR REINFORCEMENT NECESSARY.	VERTICAL BARS T25@150 c/c SHEAR OK.

DESIGN OF CRACK.

BS 8007 : 1987

Reservoir Outer Wall

DESIGN SURFACE CRACK WIDTH $\omega = \dfrac{3acr.Em}{1+2\dfrac{(acr - Cmin)}{(h-x)}}$

$$\varepsilon m = \varepsilon_1 - \frac{bt\,(h-x)(a'-x)}{3Es.\,As\,(d-x)}$$

SERVICE MOMENT M	=	223.8 KNM/M
h (mm) = 500 Cmin = 50 (mm) ϕ	=	25.00 mm
$d = h - Cmin - \phi/2$ d	=	437.50 mm
CONCRETE $f\,cu$	=	35 N/mm^2
fy	=	460 N/mm^2
REINFORCEMENT PROVIDED BAR DIAMETER ϕ	=	25 mm
BAR SPACING S	=	150 mm
Asp	=	3272.49 mm^2
Ec	=	28 KN/mm^2
Es	=	200 KN/mm^2
$\alpha e = Es/\,1/2Ec$	=	14.29
ρ	=	0.00748
$\alpha e.\rho$	=	0.107

THEREFORE $\dfrac{x}{d} = -\alpha e\,(\rho + \rho') + \sqrt{\alpha e^2\,(\rho + \rho')^2 + 2\alpha e\,(\rho + \dfrac{d'}{d}\rho')}$ = 0.368

CONSIDERING $\rho' = 0$

THEREFORE x	=	160.84 mm
$z = d - 1/3\,x$	=	383.89 mm
$fs = \dfrac{M}{Asp.z}$	=	178.15 N/mm^2
$\varepsilon s = \dfrac{fs}{Es \times 1000}$	=	0.0008907

$$\varepsilon 1 = \frac{(h - x)}{(d - x)} * \varepsilon s = 0.001092$$

$$\varepsilon m = 0.0008802$$

1) CRACK UNDER THE BAR DIRECTLY

$acr = Cmin = 50$ mm

$\omega = 3.acr.\varepsilon m =$ **0.132 mm**

< **0.2mm** O.K

2) CRACK AT MIDWAY BETWEEN TWO BARS

$$acr + \phi/2 = \sqrt{(S/2)^2 + (\phi/2 + Cmin)^2} = 97.63$$

$acr = 85.13$ mm

$\omega =$ **0.186 mm**

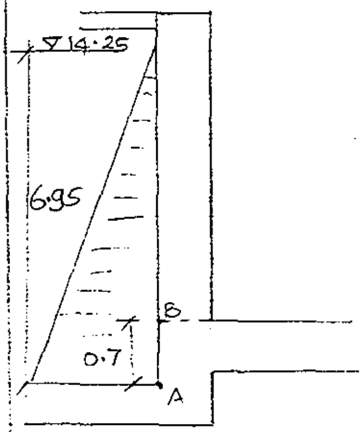
< **0.2mm** O.K

THEREFORE REINFORCEMENT T25 @ 150 C/C O.K

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 21 OF ....
	SCHEME COMPONENT KIMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

5·2 DESIGN OF INNER WALL.



HWL = 12·38 MSL.

POSSIBILITY OF HWL RISING TO 14·25 MSL AS THE RESERVOIR HAS NO OVERFLOW SYSTEM.

CONSIDER THE PORTION OF THE WALL ABOVE THE POINT B.

WATER PRESSURE AT B.

$$q_i = (6\cdot95 - 0\cdot7) \times 10 = 62\cdot5 \text{ kN/m}^2$$

$$\therefore H_w = \tfrac{1}{2} \times 62\cdot5 \times 6\cdot25 = \underline{190\cdot3} \text{ kN.}$$

CONSIDERING VERTICAL WALL WITH THE ROOF SLAB AS PROPPED CANTILEVER

$$\text{BM AT B SERVICE} = \frac{2}{15} WL = \frac{2}{15} \times 190\cdot3 \times 6\cdot25$$

$$= \underline{162\cdot8} \text{ kNm./m.}$$

MAX^{M}. SERVICE BM ABOVE 'B'

$$= 0\cdot0596\ WL$$
$$= 0\cdot0596 \times 190\cdot3 \times 6\cdot25$$
$$= \underline{70\cdot9} \text{ kNm./m.}$$

LOCATION OF MAX^{M} BM FROM TOP OF WALL $= 0\cdot447 L = 0\cdot447 \times 6\cdot25$
$= \underline{2\cdot794}$ m.

$$\text{SHEAR AT B} = \frac{4}{5} \times 190\cdot3$$
$$= \underline{152\cdot2} \text{ kN/m.}$$

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW.	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 22 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
	ULTIMATE BM's & SF's.	
	BM = 1.4 × 162.8 = 227.92 kNm/m	
	SF = 1.4 × 152.2 = 213.1 kN/m.	
	CONSIDERING THE FIGURES USED IN SECTION 5.1.2.	
	BM = 227.92 < 313.3	
	SF = 213.1 < 270.5	
	∴ USING 500 mm THICK WALL & T25 @ 150 c/c REINFORCEMENT SATISFY ALL CONDITIONS.	VERTICAL BARS T25 @ 150 c/c.

CEYWATER CONSULTANT (PVT) LTD.	PROJECT NRW	JOB NO.
INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	CALCULATIONS BY MOHD. LUTHFY.	SHEET 23 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
6.0	CHECK THERMAL CRACK.	

BS 8007, APPENDIX A.3.

CRACK SPACING $S_{max} = \frac{f_{ct}}{f_b} \times \frac{\phi}{2\rho}$

TABLE A.1 → $\frac{f_{ct}}{f_b} = 0.67$

FOR BASE SLAB

USING $\phi = 20$ mm.

ρ FOR T20 @ 150

$A_s = 2094.0$ mm².

USING SURFACE ZONES, FIGURE A.1 BS 8007.

$\rho = \frac{2094}{1000 \times 250} = 0.008376.$

$\therefore S_{max} = 0.67 \times \frac{20}{2 \times 0.008376}$

$= 799.9$ mm Say 800 mm.

MAXIMUM CRACK WIDTH DUE TO TEMPERATURE CHANGES T1 & T2.

BS 8007 - APPENDIX A.3.

$\omega_{max} = S_{max} \cdot \frac{\alpha}{2} (T_1 + T_2)$

USING BS 8110, PART 2 : 1985, TABLE 7.3

$\alpha = 10 \times 10^{-6} /°C.$

$T_1 = 35°C$ & $T_2 = 15°C$

$\omega_{max} = 800 \times \frac{10 \times 10^{-6}}{2} (35 + 15)$

$= \underline{0.2}$ mm — OK.

$\therefore$ T20 @ 150 c/c SATISFACTORY.

FOR WALLS T25 @ 150 c/c ADOPTED

$\therefore$ THERMAL CRACKS SATISFACTORY.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 24 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
7.0	CHECK FOR FLOTATION.	

CALCULATION OF DEAD WEIGHT OF THE STRUCTURE.

ROOF STRUCTURE = 0.5 X 22.5 x 11.5 = 129.4 kN

RC ROOF FRAMES = 6x12x0.3x0.4x24 = 207.4 "

RC COLUMNS = (6x0.3x0.5x5.2 + 6x0.3x0.5x1.9) x24 = 153.4 "

RC CORBELS = [0.9x0.4 + ½(0.9+0.4) x0.4] x 2 x 20 x 24 = 595.2 "

FLOOR SLAB AT 11.25 MSL = (4.25x10 + 16.25x4) x0.2 x 24 = 516.0 "

RC WALLS

WALLS 1, 4 & 5 = (21+9+9) x0.5 x24 = 468.0 "

WALL 2 = 21x7.2x0.5 x24 = 1814.0 "

WALL 3 = (16x7.2x0.5x24 + 4.5x3.25x24x0.5) = 1557.9 "

WALL 6 & PART OF 4 = (6.5+6.5)x0.5 x3.25 x24 = 507.0 "

WALL 7 = 15x1.5x0.2x24 = 108.0 "

BLOCK WALLS = (20x5.2+20x1.9 + 10x5.2x2 + 10/2 x1.0x2) x3.3 = 844.8 "

RC ROOF OF SUMP = 16x5x0.2x24 = 384.0 "

SCREED & PEBBLES ON ROOF = (0.15x24 + 0.2x20) x 16x5.0 = 608.0 "

RC BASE SLAB WITH 1.0m EXT. ALL AROUND = (17.5x23.5 + 2.0x7.5) x0.5x24 = 5115.0

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW.	JOB NO.
	CALCULATIONS BY MOHD. LUTHER.	SHEET 25 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

TOTAL DEAD WEIGHT = 13008.1 KN.

A). RECORDED MAX^M. FLOOD LEVEL 8.0MSL.

UPLIFT = (23.5×11.0)×(8−7.5)×10
+ 17.0×5.5×(8−6.8)×10
+ 6×6.5×(8−7.5)×10
= 2609.5 KN

FOS = 13008.1 / 2609.5

= 4.985 > 1.1

B). FLOOD LEVEL REACHING 10.0 MSL.

UPLIFT = [(23.5×11.0 + 6×6.5)(10−7.5)
(− 23.5×1.0 − 11.0×1.0
− 6×1.0 − 6.5×1.0)
× (10 − 8.0) ×] ×10

+ (17.0×5.5)×(10 − 6.8)×10
(− 5.5×1.0 − 17×1.0)×(10−7.3)×10

= 8788.0 KN.

FOS = 13008.1 / 8788.0 = 1.48 > 1.1

C) FLOOD LEVEL REACHING 11.25 MSL.

UPLIFT = [(23.5×11.0 + 6×6.5)(11.25−7.5)
− (23.5+11+6+6.5)1.0(11.25−8)] ×10
+ (17.0×5.5)(11.25−6.8)×10
− (5.5+17)×1.0×(11.25−7.3)×10

= 12900.8 KN.

FOS = 13008.1 / 12900.8 = 1.01 < 1.1

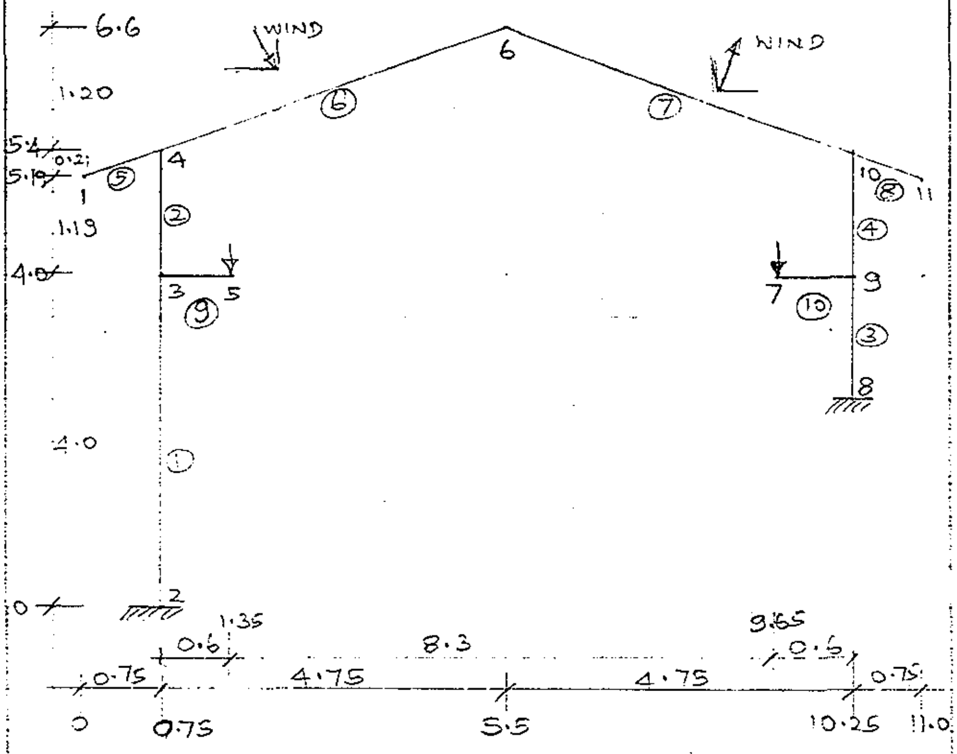
WHEN CONSIDERING EXTRA WEIGHTS OF THRUST BLOCKS, PUMPS ETC., FOS > 1.1 ∴ SATISFACTORY

FOS AGAINST FLOATATION OK.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW.	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 26 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

8.0 ANALYSIS OF PUMP HOUSE RC FRAME.



NO. OF NODES = 11
NO. OF ELEMENTS = 10
NO. OF MATERIALS = 3.

MATERIAL	AREA(m^2)	I(m^4)	ELEMENTS
1 - 300X500	0.15	3.125E-3	1/4
2 - 300X400	0.12	1.6E-3	5/8
3 - 300X800	0.24	1.28E-2	9 10

LOADS: DL = 0.5×4 + 0.12×24 = 4.88 kN/m.
LL = 1.0×4.0 = 4.0 "
WL = 0.81 ↘ = ↓0.78 & →0.20

DL = −4.88 kN/m ELEM. 5/8 & −32.0 kN/m EL. 9/10
LL = −4.0 " " 5/8
WL = −0.78↓, +0.21→ 5/6, +0.78↑, →+0.21→ 7/8

CRANE: Node 5 −32.0↓ & NODE 7, −8.0↓
NODE 5 −8.0↓ & NODE 7, −32.0↓.

STRUCTURE DATA

COORDINATE DATA (m) / **BOUNDARY DATA**

ODE	1-COOR	2-COOR	1-B	2-B	3-B
1	0.00	5.19			
2	0.75	0.00	L	L	F
3	0.75	4.00			
4	0.75	5.40			
5	1.35	4.00			
6	5.50	6.60			
7	9.65	4.00			
8	10.25	2.80	L	L	F
9	10.25	4.00			
10	10.25	5.40			
11	11.00	5.19			

ELEMENT DATA

LEM	1-NODE	2-NODE	HINGE	MATERIAL
1	2	3		1
2	3	4		1
3	8	9		1
4	9	10		1
5	1	4		2
6	4	6		2
7	6	10		2
8	10	11		2
9	3	5		3
10	7	9		3

MATERIAL DATA

MATE	E-MODULUS (KN/m^2)	AXIAL-AREA (m^2)	INERTIA (m^4)
1	2.100D+07	1.500D-01	3.125D-03
2	2.100D+07	1.200D-01	1.600D-03
3	2.100D+07	2.400D-01	1.280D-02

LOAD CASE #1 : DEAD LOAD

UNIFORM LOAD DATA

ELEM	1-UNIFORM (KN/m)	2-UNIFORM (KN/m)

OAD CASE #1 : DEAD LOAD

*UNIFORM LOAD DATA**

LEM	1-UNIFORM (KN/m)	2-UNIFORM (KN/m)
5	0.000D+00	-4.880D+00
6	0.000D+00	-4.880D+00
7	0.000D+00	-4.880D+00
8	0.000D+00	-4.880D+00
9	0.000D+00	-9.200D+01
10	0.000D+00	-9.200D+01

LOAD CASE #2 : LIVE LOAD

UNIFORM LOAD DATA

LEM	1-UNIFORM (KN/m)	2-UNIFORM (KN/m)
5	0.000D+00	-4.000D+00
6	0.000D+00	-4.000D+00
7	0.000D+00	-4.000D+00
8	0.000D+00	-4.000D+00

LOAD CASE #3 : WIND LOAD

UNIFORM LOAD DATA

ELEM	1-UNIFORM (KN/m)	2-UNIFORM (KN/m)
5	2.100D-01	-7.800D-01
6	2.100D-01	-7.800D-01
7	2.100D-01	7.800D-01
8	2.100D-01	7.800D-01

LOAD CASE #4 : CRANE LOAD

NODAL FORCE DATA

NODE	1-FORC (KN)	2-FORC (KN)	3-FORC (KN-m)
5	0.000D+00	-3.200D+01	0.000D+00
7	0.000D+00	-8.000D+00	0.000D+00

LOAD CASE #5 : CRANE LOAD 2

NODAL FORCE DATA

NODE	1-FORC (KN)	2-FORC (KN)	3-FORC (KN-m)
5	0.000D+00	-8.000D+00	0.000D+00
7	0.000D+00	-3.200D+01	0.000D+00

****
*   *
*   COMBINATION   *
*   *
****

ISPLACEMENT COMBINATION <2D-FRAME SYSTEM>
LOAD FACTOR : 1.4/1.6/0/1.6/0

ODE	1-DISP (m)	2-DISP (m)	3-DISP (Rad)
1	-1.3015D-02	1.6101D-04	-6.0427D-04
2	0.0000D+00	0.0000D+00	4.2475D-03
3	-1.2578D-02	-2.6264D-04	9.3861D-04
4	-1.2887D-02	-2.9747D-04	-6.3302D-04
5	-1.2578D-02	2.7904D-04	8.8707D-04
6	-1.0113D-02	-1.1558D-02	-6.2155D-04
7	-3.1331D-03	-1.7568D-03	2.8353D-03
8	0.0000D+00	0.0000D+00	2.5117D-03
9	-3.1331D-03	-5.9917D-05	2.8095D-03
10	-7.2810D-03	-8.9784D-05	3.2512D-03
11	-6.6024D-03	2.3323D-03	3.2225D-03

STRESS COMBINATION <2D-FRAME SYSTEM>
LOAD FACTOR : 1.4/1.6/0/1.6/0

ELEM	MA	HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
1	1		0.00	-2.0683D+02	-2.7143D+01	3.8147D-06
			4.00	-2.0683D+02	-2.7143D+01	-1.0857D+02
2	1		0.00	-7.8351D+01	-2.7143D+01	-5.4670D+01
			1.40	-7.8351D+01	-2.7143D+01	-9.2670D+01
3	1		0.00	-1.5728D+02	2.7143D+01	-3.0518D-05
			1.20	-1.5728D+02	2.7143D+01	3.2572D+01
4	1		0.00	-6.7201D+01	2.7143D+01	1.7065D+00
			1.40	-6.7201D+01	2.7143D+01	3.9707D+01
5	2		0.00	-1.2341D-03	-7.7486D-05	-3.1590D-06
			0.19	6.6772D-01	-2.3892D+00	-2.3260D-01
			0.39	1.3367D+00	-4.7783D+00	-9.3038D-01
			0.58	2.0056D+00	-7.1674D+00	-2.0933D+00
			0.78	2.6746D+00	-9.5565D+00	-3.7215D+00

RESS COMBINATION <2D-FRAME SYSTEM>
AD FACTOR : 1.4/1.6/0/1.6/0

EM	MA HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
6	2	0.00	-4.3077D+01	5.9694D+01	-9.6392D+01
		1.22	-3.9228D+01	4.4460D+01	-3.2607D+01
		2.45	-3.5380D+01	2.9226D+01	1.2518D+01
		3.67	-3.1531D+01	1.3991D+01	3.8984D+01
		4.90	-2.7682D+01	-1.2431D+00	4.6791D+01
7	2	0.00	-2.4951D+01	1.2054D+01	4.6791D+01
		1.22	-2.8799D+01	-3.1807D+00	5.2225D+01
		2.45	-3.2648D+01	-1.8415D+01	3.9000D+01
		3.67	-3.6497D+01	-3.3649D+01	7.1152D+00
		4.90	-4.0345D+01	-4.8884D+01	-4.3429D+01
8	2	0.00	2.6756D+00	9.5565D+00	-3.7216D+00
		0.19	2.0066D+00	7.1674D+00	-2.0934D+00
		0.39	1.3376D+00	4.7783D+00	-9.3038D-01
		0.58	6.6869D-01	2.3892D+00	-2.3254D-01
		0.78	-2.5755D-04	9.2745D-05	1.1128D-04
9	3	0.00	0.0000D+00	1.2848D+02	-5.3903D+01
		0.60	0.0000D+00	5.1200D+01	1.3542D-04
10	3	0.00	0.0000D+00	-1.2800D+01	2.5320D-04
		0.60	0.0000D+00	-9.0080D+01	-3.0865D+01

PPORT REACTIONS <2D-FRAME SYSTEM>
AD FACTOR : 1.4/1.6/0/1.6/0

DE	1-REACTION (KN)	2-REACTION (KN)	3-REACTION (KN-m)
2	2.7143D+01	2.0683D+02	0.0000D+00
8	-2.7143D+01	1.5728D+02	0.0000D+00

COMBINATION

ISPLACEMENT COMBINATION <2D-FRAME SYSTEM>
LOAD FACTOR : 1.4/1.6/0/0/1.6

NODE	1-DISP (m)	2-DISP (m)	3-DISP (Rad)
1	-1.8251D-02	-2.9230D-04	5.4494D-05
2	0.0000D+00	0.0000D+00	5.2607D-03
3	-1.6731D-02	-2.1981D-04	2.0270D-03
4	-1.8261D-02	-2.5671D-04	2.5739D-05
5	-1.6731D-02	9.8523D-04	2.0012D-03
6	-1.5222D-02	-1.2568D-02	-1.1658D-03
7	-5.5421D-03	-2.9817D-03	4.8640D-03
8	0.0000D+00	0.0000D+00	4.5214D-03
9	-5.5421D-03	-7.2767D-05	4.8124D-03
10	-1.2135D-02	-1.0056D-04	4.7376D-03
11	-1.1144D-02	3.4364D-03	4.7089D-03

STRESS COMBINATION <2D-FRAME SYSTEM>
LOAD FACTOR : 1.4/1.6/0/0/1.6

ELEM	MA	HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
1	1		0.00	-1.7310D+02	-2.6526D+01	-2.2888D-05
			4.00	-1.7310D+02	-2.6526D+01	-1.0611D+02
2	1		0.00	-8.3020D+01	-2.6527D+01	-7.5242D+01
			1.40	-8.3020D+01	-2.6527D+01	-1.1238D+02
3	1		0.00	-1.9101D+02	2.6526D+01	-1.2207D-04
			1.20	-1.9101D+02	2.6526D+01	3.1831D+01
4	1		0.00	-6.2532D+01	2.6526D+01	-2.2075D+01
			1.40	-6.2532D+01	2.6526D+01	1.5062D+01
5	2		0.00	4.9013D-04	-4.9424D-04	8.9586D-05
			0.19	6.6944D-01	-2.3896D+00	-2.3255D-01
			0.39	1.3384D+00	-4.7787D+00	-9.3037D-01
			0.58	2.0073D+00	-7.1678D+00	-2.0934D+00
			0.78	2.6763D+00	-9.5569D+00	-3.7216D+00

MICROFEAP-P1 DATE: 11-05-2000 <COMB> P.2
JECT : AMBATALE PUMP HOUSE ROOF FRAME FILENAME: AMBRFRM
THORITY: KANDIAH SRIBALASKANDARAJAH ENGINEER: MOHD. LUTHFY

RESS COMBINATION <2D-FRAME SYSTEM>
AD FACTOR : 1.4/1.6/0/0/1.6

EM	MA HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
6	2	0.00	-4.3622D+01	6.4372D+01	-1.1610D+02 ←
		1.22	-3.9773D+01	4.9138D+01	-4.6587D+01
		2.45	-3.5924D+01	3.3903D+01	4.2676D+00
		3.67	-3.2076D+01	1.8669D+01	3.6463D+01
		4.90	-2.8227D+01	3.4347D+00	5.0000D+01
7	2	0.00	-2.3209D+01	1.6429D+01	5.0000D+01
		1.22	-2.7058D+01	1.1948D+00	6.0793D+01
		2.45	-3.0907D+01	-1.4040D+01	5.2926D+01
		3.67	-3.4755D+01	-2.9274D+01	2.6401D+01
		4.90	-3.8604D+01	-4.4508D+01	-1.8783D+01
8	2	0.00	2.6748D+00	9.5562D+00	-3.7215D+00
		0.19	2.0059D+00	7.1671D+00	-2.0934D+00
		0.39	1.3369D+00	4.7780D+00	-9.3041D-01
		0.58	6.6796D-01	2.3888D+00	-2.3265D-01
		0.78	-9.8997D-04	-2.7347D-04	-7.1824D-05
9	3	0.00	0.0000D+00	9.0081D+01	-3.0862D+01
		0.60	0.0000D+00	1.2801D+01	1.3351D-05
10	3	0.00	0.0000D+00	-5.1198D+01	7.4148D-04
		0.60	0.0000D+00	-1.2848D+02	-5.3906D+01

PPORT REACTIONS <2D-FRAME SYSTEM>
AD FACTOR : 1.4/1.6/0/0/1.6

DE	1-REACTION (KN)	2-REACTION (KN)	3-REACTION (KN-m)
2	2.6526D+01	1.7310D+02	0.0000D+00
8	-2.6526D+01	1.9101D+02	0.0000D+00

COMBINATION

ISPLACEMENT COMBINATION <2D-FRAME SYSTEM>
OAD FACTOR : 1.2/1.2/1.2/1.2/0

ODE	1-DISP (m)	2-DISP (m)	3-DISP (Rad)
1	-9.9292D-03	1.9219D-04	-5.7796D-04
2	0.0000D+00	0.0000D+00	3.3052D-03
3	-9.6918D-03	-2.1661D-04	6.5839D-04
4	-9.8061D-03	-2.4591D-04	-6.0319D-04
5	-9.6918D-03	1.6149D-04	6.1790D-04
6	-7.6053D-03	-9.1841D-03	-3.6385D-04
7	-2.2854D-03	-1.2987D-03	2.0897D-03
8	0.0000D+00	0.0000D+00	1.8225D-03
9	-2.2854D-03	-4.8426D-05	2.0685D-03
10	-5.3565D-03	-7.1216D-05	2.4305D-03
11	-4.8491D-03	1.7397D-03	2.4094D-03

TRESS COMBINATION <2D-FRAME SYSTEM>
OAD FACTOR : 1.2/1.2/1.2/1.2/0

LEM	MA	HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
1	1		0.00	-1.7058D+02	-2.1712D+01	-5.7220D-06
			4.00	-1.7058D+02	-2.1712D+01	-8.6850D+01
2	1		0.00	-6.5938D+01	-2.1712D+01	-4.3938D+01
			1.40	-6.5938D+01	-2.1712D+01	-7.4336D+01
3	1		0.00	-1.2712D+02	2.2423D+01	-3.0518D-05
			1.20	-1.2712D+02	2.2423D+01	2.6908D+01
4	1		0.00	-5.1278D+01	2.2423D+01	1.2747D+00
			1.40	-5.1278D+01	2.2423D+01	3.2667D+01
5	2		0.00	1.1035D-03	5.4628D-05	-3.5398D-05
			0.19	5.7440D-01	-2.0965D+00	-2.0413D-01
			0.39	1.1477D+00	-4.1931D+00	-8.1646D-01
			0.58	1.7210D+00	-6.2897D+00	-1.8370D+00
			0.78	2.2943D+00	-8.3862D+00	-3.2658D+00

RESS COMBINATION <2D-FRAME SYSTEM>
AD FACTOR : 1.2/1.2/1.2/1.2/0

EM	MA HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
6	2	0.00	-3.5124D+01	5.0169D+01	-7.7602D+01
		1.22	-3.1825D+01	3.6804D+01	-2.4339D+01
		2.45	-2.8527D+01	2.3439D+01	1.2554D+01
		3.67	-2.5229D+01	1.0075D+01	3.3078D+01
		4.90	-2.1930D+01	-3.2901D+00	3.7233D+01
7	2	0.00	-2.0861D+01	7.5203D+00	3.7233D+01
		1.22	-2.3762D+01	-3.6520D+00	3.9602D+01
		2.45	-2.6662D+01	-1.4824D+01	2.8287D+01
		3.67	-2.9563D+01	-2.5997D+01	3.2880D+00
		4.90	-3.2463D+01	-3.7169D+01	-3.5395D+01
8	2	0.00	2.0172D+00	7.0055D+00	-2.7282D+00
		0.19	1.5131D+00	5.2541D+00	-1.5346D+00
		0.39	1.0089D+00	3.5026D+00	-6.8207D-01
		0.58	5.0477D-01	1.7512D+00	-1.7055D-01
		0.78	6.2974D-04	-2.4530D-04	-4.8079D-05
9	3	0.00	0.0000D+00	1.0464D+02	-4.2911D+01
		0.60	0.0000D+00	3.8400D+01	-1.1086D-04
10	3	0.00	0.0000D+00	-9.5997D+00	-3.5858D-04
		0.60	0.0000D+00	-7.5840D+01	-2.5633D+01

UPPORT REACTIONS <2D-FRAME SYSTEM>
OAD FACTOR : 1.2/1.2/1.2/1.2/0

ODE	1-REACTION (KN)	2-REACTION (KN)	3-REACTION (KN-m)
2	2.1712D+01	1.7058D+02	0.0000D+00
8	-2.2423D+01	1.2712D+02	0.0000D+00

COMBINATION

DISPLACEMENT COMBINATION <2D-FRAME SYSTEM>
LOAD FACTOR : 1/0/1.4/0/0

NODE	1-DISP (m)	2-DISP (m)	3-DISP (Rad)
1	-5.0215D-03	4.4515D-05	-2.2497D-04
2	0.0000D+00	0.0000D+00	1.6085D-03
3	-4.8245D-03	-1.1196D-04	4.0147D-04
4	-4.9734D-03	-1.2661D-04	-2.3800D-04
5	-4.8245D-03	1.2338D-04	3.8915D-04
6	-3.9485D-03	-4.2892D-03	-1.5667D-04
7	-1.2783D-03	-7.2072D-04	1.1561D-03
8	0.0000D+00	0.0000D+00	1.0260D-03
9	-1.2783D-03	-2.8920D-05	1.1438D-03
10	-2.8993D-03	-3.8126D-05	1.2254D-03
11	-2.6432D-03	8.7628D-04	1.2172D-03

STRESS COMBINATION <2D-FRAME SYSTEM>
LOAD FACTOR : 1/0/1.4/0/0

ELEM	MA	HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
1	1		0.00	-8.8165D+01	-9.9010D+00	8.5831D-06
			4.00	-8.8165D+01	-9.9010D+00	-3.9604D+01
2	1		0.00	-3.2965D+01	-9.9010D+00	-2.3044D+01
			1.40	-3.2965D+01	-9.9010D+00	-3.6906D+01
3	1		0.00	-7.5915D+01	1.0730D+01	7.6294D-06
			1.20	-7.5915D+01	1.0730D+01	1.2876D+01
4	1		0.00	-2.0715D+01	1.0730D+01	-3.6844D+00
			1.40	-2.0715D+01	1.0730D+01	1.1338D+01
5	2		0.00	7.7285D-04	7.8976D-05	-2.5470D-05
			0.19	2.8783D-01	-1.0824D+00	-1.0540D-01
			0.39	5.7488D-01	-2.1648D+00	-4.2153D-01
			0.58	8.6194D-01	-3.2472D+00	-9.4843D-01
			0.78	1.1490D+00	-4.3297D+00	-1.6861D+00

RESS COMBINATION <2D-FRAME SYSTEM>
AD FACTOR : 1/0/1.4/0/0

EM	MA	HINGE	SECTION (m)	AXIAL F. (KN)	SHEAR (KN)	MOMENT (KN-m)
6	2		0.00	-1.6637D+01	2.5178D+01	-3.8592D+01
			1.22	-1.4985D+01	1.8281D+01	-1.1977D+01
			2.45	-1.3334D+01	1.1384D+01	6.1897D+00
			3.67	-1.1682D+01	4.4864D+00	1.5909D+01
			4.90	-1.0031D+01	-2.4110D+00	1.7180D+01
7	2		0.00	-9.9721D+00	2.6424D+00	1.7180D+01
			1.22	-1.1159D+01	-1.6973D+00	1.7758D+01
			2.45	-1.2347D+01	-6.0369D+00	1.3022D+01
			3.67	-1.3534D+01	-1.0377D+01	2.9703D+00
			4.90	-1.4721D+01	-1.4716D+01	-1.2397D+01
8	2		0.00	8.2558D-01	2.7191D+00	-1.0589D+00
			0.19	6.1921D-01	2.0393D+00	-5.9562D-01
			0.39	4.1284D-01	1.3595D+00	-2.6473D-01
			0.58	2.0647D-01	6.7974D-01	-6.6208D-02
			0.78	1.0566D-04	-3.9518D-05	-4.4715D-05
9	3		0.00	0.0000D+00	5.5200D+01	-1.6560D+01
			0.60	0.0000D+00	9.7275D-05	-1.1253D-04
10	3		0.00	0.0000D+00	-5.6839D-04	1.2851D-04
			0.60	0.0000D+00	-5.5201D+01	-1.6561D+01

JPPORT REACTIONS <2D-FRAME SYSTEM>
)AD FACTOR : 1/0/1.4/0/0

)DE	1-REACTION (KN)	2-REACTION (KN)	3-REACTION (KN-m)
2	9.9010D+00	8.8165D+01	0.0000D+00
8	-1.0730D+01	7.5915D+01	0.0000D+00

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 37 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
8.1	DESIGN OF REINFORCEMENT	
	ELEMENTS 5, 6, 7 & 8	
	Max^m: BM = 116.1 kNm.	
	Max^m. SF = 64.4 kN.	
	BEAM SECTION 300 x 400.	
	USING BS 8110 ; PART III : 1985 DESIGN CHARTS FOR f_{cu} = 35.0	
	$\frac{M}{bd^2} = \frac{116.1 \times 10^6}{300 \times 352^2} = 3.12$	
	$\therefore \frac{100 A_s}{bd} = 0.89$	
	$\therefore A_s = 0.89 \times 300 \times 352 / 100 = 940.0 \ mm^2$.	
	PROVIDE 3T20 → A_s = 942.5 mm^2	MAIN BARS 3T20
	SHEAR. $v = \frac{64.4 \times 10^3}{300 \times 352} = 0.61 \ N/mm^2$	
	$v_c = 0.675 \ N/mm^2$	
	$0.5 v_c < v < v_c + 0.4$	
	NOMINAL SHEAR LINKS.	
	$\Rightarrow \frac{A_{sv}}{S_v} \geq \frac{0.4 b_v}{0.87 f_{yv}} \geq \frac{0.4 \times 300}{0.87 \times 460}$.	
	$\therefore S_v \leq 3.335 \ A_{sv}$.	
	USING T8 BARS 2 Legs. A_{sv} = 100.5 mm^2	LINKS
	$\therefore S_v \leq 335.2$ mm.	T8@200.
	T8 @ 200 c/c LINKS OK.	

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 38 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

DESIGN OF BASE SLAB.

TOTAL DEAD LOAD = 13008.1 kN.
LIVE LOAD ON ROOF = 1.0 kN/m²
LIVE LOAD ON STAGING AREA = 10.0 kN/m²
LIVE LOAD ON PUMP FLOOR = 10.0 "
WATER LOAD = 69.5 kN/m².

∴ TOTAL SERVICE PRESSURE ON THE GROUND $= \frac{13008.1}{23.5 \times 17.5} + 1.0+10+10+69.5$

$= 31.6 + 90.5$

$= \underline{122.1}$ kN/m². < 250.0 kN/m²

∴ ok.

ULTIMATE DESIGN PRESSURE IN SUMP BASE

$= (31.6+69.5) \times 1.4 + 2.5 \times 1.6$

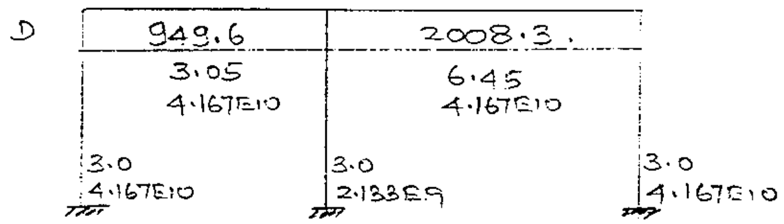
145.5 kN/m²

ULTIMATE DESIGN PRESSURE IN PUMP HOUSE BASE

$= 1.4 \times 31.6 + 1.6 \times 21.0$

$= \underline{77.84}$ kN/m².

PUMP HOUSE BASE SLAB ANALYSED AS INVERTED FLOOR SLAB FRAMING WITH RC WALLS & COLUMN. (4000 mm WIDE SLAB)



TITLE PUMP HOUSE BASE SLAB

F.O.S FOR DL= 1 ***F.O.S. FOR IMPL= 1
STRUCTURE INFORMATION NO.OF SPANS= 2

SPAN NO	SPAN LTH-m	Iz- mm^4
1	3.05	4.167E+10
2	6.45	4.167E+10

COLUMN ROW	LENGTH(m)	2ND MOMENT OF AREA(mm^4)	
1.00	0.00	0.00	ABOVE
1.00	3.00	%41670000000.00	BELOW
2.00	0.00	0.00	ABOVE
2.00	3.00	%2133000000.00	BELOW
3.00	0.00	0.00	ABOVE
3.00	3.00	%41670000000.00	BELOW

******LOADING INFORMATION******

SP.NO	LOAD-kN	ST.DIST-m	COV.DIST-m	DD/IMP
1	949.60	0.00	3.05	D
2	2008.30	0.00	6.45	D

CANT.CHR.D.MT LHS= 0 kNm CANT.CHR.IMP.MT.LHS = 0 kNm
CANT.CHR.D.MT RHS= 0 kNm CANT.CHR.IMP.MT.RHS = 0 kNm

MAX.SHEARS AND MOMENTS. SF-kN BM-kNm

SPAN NO.	SHEAR	HOG.MT	SAG.MT
1			
	158.33	0.00	53.89
	-791.27	-911.35	0.00

MAX.SPAN MNT= 93.73001 kNm AT A DISTANCE= .45 m

SPAN NO.	SHEAR	HOG.MT	SAG.MT
2			
	1019.41	-947.59	0.00
	-988.89	-849.17	0.00

MAX.SPAN MNT= 720.8 kNm AT A DISTANCE= 3.22 m

COLUMN MOMENTS, kN.m

COLUMN ROW	COLUMN MOMENTS ABOVE	BELOW
1.00	0.00	-53.89
2.00	0.00	36.25
3.00	0.00	-849.17

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW.	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY.	SHEET 40 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT

MAX^{M}. (–) VE BM AT SUPPORT.
= 947.6 KNm.

COLUMN STRIP 75% = 710.7 KNm.

MIDDLE STRIP 25% = 236.9 KNm.

MAX^{M}. +VE BM AT MID SPAN = 720.8 KNm.

COLUMN STRIP 55% = 396.4 KNm

MIDDLE STRIP 45% = 324.4 KNm.

WIDTH OF COLUMN STRIP = 2000 mm.
WIDTH OF MIDDLE STRIP = 2000 mm.

REINFORCEMENT.
AT SUPPORT – BOTTOM BAR.

M = 720.8 KNm.
b = 2000 mm.
$d = 500 - 50 - \frac{20}{2}$
= 440 mm.

$\frac{M}{bd^2} = \frac{720.8 \times 10^6}{2000 \times 440^2} = 1.86$

$\frac{100 A_s}{bd} = 0.51 \rightarrow A_s = \frac{0.51 \times 2000 \times 440}{100}$
= 4488.0 mm^2
= 2244 mm^2/m.

PROVIDE T20 @ 125 c/c → A_s = 2513.0 mm^2

PROVIDE BOTTOM BAR. AT SUPPORT. T20 @ 125 c/c

MIDDLE STRIP – BOTTOM BAR

M = 236.9 KNm.
b = 2000 mm
d = 440 mm.

$\frac{M}{bd^2} = \frac{236.9 \times 10^6}{2000 \times 440^2} = 0.61$

$\frac{100 A_s}{bd} = 0.17 \rightarrow A_s = 0.17 \times 2000 \times 440 / 100$
= 1496.0 mm^2
= 748.0 mm^2/m.

NOMINAL → 0.35%. → A_s = 1750.0 mm^2/m.
PROVIDE T20 @ 150 → A_s = 2094.0 mm^2

MIDDLE STRIP BOTTOM BAR T20 @ 150.

CEYWATER CONSULTANT (PVT) LTD. INFRASTRUCTURE & ENVIRONMENTAL ENGINEERS AND PLANNERS	PROJECT NRW	JOB NO.
	CALCULATIONS BY MOHD. LUTHFY	SHEET 41 OF ....
	SCHEME COMPONENT KMU - PUMP HOUSE & RESERVOIR.	DATE

ITEM	CALCULATIONS	OUT PUT
	COLUMN STRIP TOP BAR	
	$M = 396.4$ kNm.	
	$b = 2000$ mm	
	$d = 440$ mm.	
	$\frac{M}{bd^2} = \frac{396.4 \times 10^6}{2000 \times 440^2} = 1.02.$	
	$\frac{100 A_s}{bd} = 0.28 \rightarrow A_s = 0.28 \times 2000 \times 440/100$	
	$= 2464.0$ mm^2	
	$= 1232.0$ mm^2/m.	
	NOMINAL $\rightarrow$ 0.35% $\rightarrow A_s = 1750$ mm^2/m.	TOP BAR T20 @ 150 c/c.
	PROVIDE T20 @ 150 c/c.	
	PUNCHING SHEAR.	
	SHEAR NOMINAL.	
	∴ NO SHEAR REINFORCEMENT NECESSARY.	

DESIGN OF CRACK.

BS 8007 : 1987

Pump House Base Slab

DESIGN SURFACE CRACK WIDTH $\omega = \dfrac{3a_{cr}.\varepsilon_m}{1+2\left(\dfrac{a_{cr} - C_{min}}{h - x}\right)}$

$$\varepsilon_m = \varepsilon_1 - \frac{b_t (h - x)(a' - x)}{3E_s . A_s (d - x)}$$

	SERVICE MOMENT M	=	253.8 KNM/M
h (mm) = 500 Cmin = 50 (mm)	Φ	=	20.00 mm
d = h - Cmin - Φ/2	d	=	440.00 mm
	CONCRETE f cu	=	35 N/mm^2
	fy	=	460 N/mm^2
REINFORCEMENT PROVIDED	BAR DIAMETER Φ	=	20 mm
	BAR SPACING S	=	100 mm
	Asp	=	3141.59 mm^2
	Ec	=	28 KN/mm^2
	Es	=	200 KN/mm^2
	αe = Es/ 1/2Ec	=	14.29
	ρ	=	0.00714
	$\alpha e.\rho$	=	0.102

THEREFORE $\dfrac{x}{d} = -\alpha e(\rho + \rho') + \sqrt{\alpha e^2 (\rho + \rho')^2 + 2\alpha e \left(\rho + \dfrac{d'}{d}\rho'\right)}$ = 0.361

CONSIDERING $\rho' = 0$

THEREFORE	x	=	158.86 mm
	z = d - 1/3 x	=	387.05 mm
	$f_s = \dfrac{M}{Asp.z}$	=	208.73 N/mm^2
	$\varepsilon_s = \dfrac{f_s}{E_s \times 1000}$	=	0.0010436

$$\varepsilon 1 = \frac{(h - x)}{(d - x)} * \varepsilon s = 0.001266$$

$$\varepsilon m = 0.0010468$$

1) <u>CRACK UNDER THE BAR DIRECTLY</u>

$acr = Cmin = 50\ mm$

$\omega = 3.acr.\varepsilon m =$ **0.157 mm**

< **0.2mm** O.K

2) <u>CRACK AT MIDWAY BETWEEN TWO BARS</u>

$$acr + \phi/2 = \sqrt{(S/2)^2 + (\phi/2 + Cmin)^2} = 78.10$$

$acr = 68.10$ mm

$\omega =$ **0.193 mm**

< **0.2mm** O.K

THEREFORE REINFORCEMENT T20 @ 100 C/C O.K