60000 LITRE OHT WITH 12m STAGING HEIGHT-ZONE III

DESIGN OF ROOF SLAB

	fy	=	415	N/mm^2
	f_{ck}	=	30	N/mm^2
	σ_{cbt}	=	2.00	N/mm^2
	σ_{st}	=	130	N/mm^2
	σ_{cbc}	=	10	N/mm^2
Clear cover - Severe		=	45	mm
	m	=	9	
	k	=	0.409	
	j	=	0.864	
	R	=	1.767	
Thickness of slab		=	**230**	mm
Thickness of side wall		=	**170**	mm
Dia of Tank		=	**5**	m
Effective span		=	5.17	m
	R	=	2.585	m

Structural Design Proof - checked and Found Satisfactory

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LOADS

Self weight of roof slab	=	5.75	kN/m^2	
Floor Finish		**0.75**	kN/m^2	
Live load	=	**1.5**	kN/m^2	
TOTAL	=	8	kN/m^2	

BOTTOM CENTRE-Mesh

M^+	=	10.02	kNm	
ϕ	=	**10**	mm	
deff	=	180	mm	
A_{st}	=	495.77	mm^2	0.28 %
Spacing, req	=	158.34	mm	
Spacing,prov	=	**150**	mm c/c	
$A_{st,prov}$	=	523	mm^2	0.29 %

10 mm at 150 mm c/c mesh on bothways .

SUPPORT TOP-Circumferential

Mx^-	=	6.68	kNm	
ϕ	=	**8**	mm	
deff	=	181	mm	
$A_{st,req}$	=	328.6892	mm^2	0.183 %
Spacing, req	=	153	mm	
Spacing,prov	=	**150**	mm	
$A_{st,prov}$		335	mm^2	0.19 %

8 mm 150 mm c/c circumferentially

SUPPORT TOP-Radial

Ast	=	276	mm^2	0.153 %
ϕ	=	**8**	mm	
Spacing, req	=	182	mm	
Spacing,prov	=	**150**	mm	
$Ast_{,prov}$	=	335	mm^2	0.19 %

8 mm 150 mm c/c radially

DEFLECTION

pt	=	0.291	%
fst	=	228.169	N/mm^2
M.F	=	**1.61**	
$deff_{,req}$	=	160.559	mm
$deff_{,prov}$	=	180	mm

60000 LITRE CAPACITY OHT WITH 12m STAGING HEIGHT-ZONE III

DESIGN OF SIDE WALL

fy	=	415	N/mm^2	
f_{ck}	=	30		
σ_{cbc}	=	10	N/mm^2	
σ_{cbt}	=	2.00	N/mm^2	
σ_{st}	=	130	N/mm^2	
σ_{cbc}	=	10	N/mm^2	
Clear cover - Severe	=	45	mm	
m	=	9		
k	=	0.409		
j	=	0.864		
R	=	1.767		
Tickness of side wall	=	**170**	mm	
Diameter of TANK	=	**5.00**	m	
Storage Depth	=	**3.10**	m	
Scour Depth	=	**0.15**	m	
Free Board	=	**0.30**	m	
Total Depth(H)	=	3.55	m	
H^2 / Dt	=	14.83		

Side wall is fixed at bottom and free at top

BM Coefficient AS PER TABLE 9 OF IS 3370

B.M Coeff.	1.0H	=	**-0.00854**	
B.M Coeff.	0.8H	=	**0.00213**	
Maximum Hoop Tension	0.7H	=	**0.675**	
(Tension near water face)	Mx^-	=	3.82	kNm
(Tension away from water face)	Mx^+	=	0.95	kNm
Max hoop Tension	T	=	59.88	kN

INNER FACE (Water Face)

Mx^-	=	3.82	kNm	
ϕ	=	**10**	mm	
deff	=	120	mm	
A_{st}	=	283.00	mm^2	0.17 %
Spacing ,req	=	170	mm	
Spacing,prov	=	**170**	mm	
Ast ,prov	=	462	mm^2	0.27 %

10 mmVertical rods at 170 mm c/c 130mm c/c

OUTER FACE (Away from water face)

Mx^+	=	0.9529	kNm	
ϕ	=	**10**	mm	
deff	=	120	mm	
A_{st}	=	204	mm^2	0.12 %
Spacing ,req	=	170	mm	
Spacing,prov	=	**170**	mm	
Ast ,prov	=	462	mm^2	0.27 %

10 mm Vertical rods at 170 mm c/c 130mm c/c

HOOP TESION

Maximum Hoop Tension(T)	=	59.88	kN	
ϕ	=	**8**	mm	
A_{st}	=	230	mm^2	0.14 %
Spacing ,req	=	218	mm	
Spacing,prov	=	**200**	mm	
Ast ,prov	=	251	mm^2	0.15 %

8 mm hoop rods (rings) at 200 mm c/c in each face 150mm c/c

CRACKING STRESS

n	=	85	mm		
I	=	418471867	mm^4		
y	=	85	mm		
M	=	3820700	N.mm		
f	=	0.78	N/mm^2	<	2.00 N/mm^2

8 mm Haunch rods at 170 mm c/c

60000 LITRE CAPACITY OHT WITH 12m STAGING HEIGHT-ZONE III

DESIGN OF FLOOR SLAB

			f_y	=	415	N/mm^2
			f_{ck}	=	30	N/mm^2
			σ_{cbt}	=	2.00	N/mm^2
			σ_{st}	=	130	N/mm^2
			σ_{cbc}	=	10	N/mm^2
			Clear cover - Severe	=	45	mm
			σ_{st}	=	130	
			m	=	9	
			k	=	0.409	
			j	=	0.864	
			R	=	1.767	
			Floor thickness	=	**260**	mm
			Dia of Tank		**5.00**	m
			C/c column	=	**3.66**	m
MOMENTS						
	Support	Mx^-		=	**20**	kNm
	Mid	Mx^+		=	**26**	kNm
	Cantilever	Mx^-			**20**	kNm
SQUARE PANEL						
Bottom Centre						
			Mx^+	=	26.00	kNm
			ϕ	=	**12**	mm
			deff		209	mm
			$A_{st,req}$	=	1107.567	mm^2 0.53 %
			Spacing , req	=	102	mm
			$Spacing_{,prov}$	=	**100**	mm c/c
			$A_{st,prov}$	=	1130	mm^2 0.541 %
12 mm dia at 100 mm c/c in the form of mesh on bothways .						
Support Top						
			Mx^-	=	20.00	kNm
			A_{st}	=	852	mm^2
			Ast from cranked up bars	=	565	mm^2
			Area of inner face wall	=	**10** **170**	mm
			Area of steel from the side wall inner face	=	**462**	mm^2
			Total Ast provided	=	1027 > 852	mm^2
			Additional Reinforcement		**0**	
			ϕ	=	**0**	mm
			Spacing , req	=		mm
			$Spacing_{,prov}$	=	**0**	mm c/c
			Additional steel Area provided	=	0	mm^2
			Total Area of steel provided	=	1027 > 852	mm^2
No additional Reinforcement is required						
CANTILEVER PANEL						
Support Top			Mx^-	=	**20**	kNm
			ϕ	=	**10**	mm
			deff	=	210	
			A_{st}	=	852	mm^2
			Steel area provided due to cranked up bars	=	565	mm^2
			Area of steel due to innner vertical rods from side wall	=	462	mm^2
			Total area of steel provided at support	=	1027 > 852	mm^2
			Additional Reinforcement		0	
			ϕ	=	**0**	mm
			Spacing , req	=		mm
			$Spacing_{,prov}$	=	**0**	mm c/c

	Area provided	=		mm^2		
	Total Area of steel provided	=	1027	>	852	mm^2
	No additional Reinforcement is required					
Cicumferential rod	Ast,req	=	**250.80**	mm^2		
	ϕ	=	**10**	mm		
	Spacing , req	=	**313.00**	mm		
	Spacing,prov	=	**250.00**	mm	0.67	m

10 mm at 250 mm c/c Circumferencially

DEFLECTION

pt	=	0.435	%
fst	=	235.92	N/mm^2
M.F	=	1.421	
deff,req	=	128.78	mm
deff,prov	=	209	mm

DESIGN OF FLOOR BEAM

		f_{ck}	=	30	N/mm^2		
		fy	=	415	N/mm^2		
		σ_{cbt}	=	2.00	N/mm^2		
		σ_{st}	=	130	N/mm^2		
		σ_{cbc}	=	10	N/mm^2		
	Clear cover - Severe		=	45	mm		
		m	=	9			
		k	=	0.409			
		j	=	0.864			
		Q	=	1.767			
		L		3.66	m		
Mid-Bottom		Mx^+	=	47	kNm		
Support-Top		Mx^-	=	70	kNm		
Mid-Bottom		V		2	kN		
Support-Top		V	=	145	kN		
		B	=	300	mm		
		D	=	450	mm		

BOTTOM CENTRE

		Mx^+	=	47.000	kNm		
		A_{st}	=	1059.36	mm^2	0.894	%
		ϕ	=	20	mm		
		deff,req		297.76	mm		
		deff,prov	=	395.00	mm		
		Required	=	3.373	*Nos.*		
		Proposed		4	*Nos.*		
	Area provided		=	1256	mm^2	1.06	%

20 mm dia rods 4 nos at Bottom

SUPPORT TOP

		Mx^-	=	70.000	kNm		
		A_{st}	=	1577.77	mm^2	1.331	%
		ϕ	=	20	mm		
		Required	=	5.025	Nos.		
		Proposed	=	6	Nos.		
	Area provided		=	1884	mm^2	1.59	%

20 mm dia rods 6 nos at Support Top

Hence provide 20mm dia 3 nos and 16dia 4nos at Top

SHEAR

Mid		pt		1.06	%		
		V	=	2.000	kN		
		τ_v	=	0.017	N/mm^2		
		τ_c	=	0.67	N/mm^2		
		2		10	mm		
		Vc	=	79395	N		
		V_s	=	-77395	N		
		Required	=	250	mm		
		Providec	=	250	mm		

2 Legged 10mm Φ at 250c/c

Support		pt		1.59	%		
		V	=	145.000	kN		
		τ_v	=	1.224	N/mm^2		
		τ_c	=	0.78	N/mm^2		
		2		10	mm		
		Vc	=	92430	N	length,req	790 mm
		V_s	=	52570	N	length,rpro	600 mm
		Required	=	153	mm		
		Provided	=	150	mm	length	790 mm

2 Legged 10Φ at 150 c/c 600mm length from support on both side

DEFLECTION

pt	=	0.93	%
fst	=	203.02	N/mm^2
M.F	=	**1.08**	
$deff,_{req}$	=	169.13	mm
$deff,_{prov}$	=	395.00	mm

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DESIGN OF BRACING

Support-Top	Mu	=	139	kNm		
Mid -Bottom	Mu	=	2	kNm		
Support-Top	Vu	=	80	kN		
Mid -Bottom	Vu	=	80	kN		
Support-Top	Tu	=	0	kN.m		
Mid -Bottom	Tu		0	kN.m		
	L	=	3.66	m		
	B	=	300	mm		
	D	=	450	mm		
	fck	=	30	N/mm^2		
	fy	=	415	N/mm^2		
	d'	=	30	mm		

MOMENTS

Support-Top	Mu	=	139	kNm		
	M_t	=	0	kNm		
	M_{e1}	=	139	kN.m		
Mid-Bottom	Mu	=	2	kNm		
	M_t	=	0	kNm		
	M_{e1}	=	2	kNm		

Mu,Limit

	Mu.lim	=	208.78	kNm		
			Mu<Mu.lim			
	Support		**Singly**			
	Mid		**Singly**			

REINFORCEMENT

Support -Top	Mu/bd^2	=	2.76			
	pt	=	0.87	%		
	Ast,req	=	1065.18	mm^2		
	Φ		20	mm		
	nos		4	nos		
	Ast pro	=	1256	mm^2	1.02	%
	4 No - 20Φ Top					
Mid -Bottom	Mu/bd^2	=	0.03966			
	pt	=	0.20	%		
	Ast,req	=	251.928	mm^2		
	nos	=	2	nos		
	Φ	=	20			
	d,eff	=	410	mm		
	Ast,prov	=	628	mm^2	0.51	%
	2 No - 20Φ Bottom					

SHEAR

Support	Ve	=	80	kN		
	tve	=	0.65	N/mm^2	tc.max	
	pt	=	0.87	%	4.546	N/mm^2
	tc	=	0.67	N/mm^2		
	Minimum shear reinforcement					
	ϕ	=	8	mm	2	Legged
V,by stirrups			0	kN		
Required spacing		=	300	mm	2d	820 mm

Provided spacing = **100** mm **430** mm

2 Legged 8Φ at 100 c/c upto a length of 430mm from inner edge on both side of support

Mid	Ve	=	80.00	kN	tc.max	
	tve	=	0.65	N/mm^2	4.546	N/mm^2
	pt	=	0.20			
	tc	=	0.33	N/mm^2		

Provide shear reinforcement

	ϕ	=	**8**	mm	**2** Legged
V,by stirrups		=	39.9911	kN	
Provided spacing		=	300	mm	
Provided spacing		=	**250**	mm	Length

2 Legged 8Φ at 250 c/c

DEFLECTION

$l/d_{,basic}$		**26**	
pt		0.51057	%
fst	=	204.13	
M.F	=	1.43	
$l/d_{,max}$	=	37.18	
$deff_{,req}$	=	98.44	mm
$deff_{,prov}$		410	

60000 LITRE OHT WITH 12m STAGING HEIGHT- ZONE III

DESIGN OF COLUMN

fy	=	415	N/mm^2	
fck	=	30	N/mm^2	
B	=	350	mm	
D	=	350	mm	
Pu (Fact)	=	543	kN	
Mux(Fact)	=	102	kNm	
Muy(Fact)	=	0	kNm	
lx	=	3	m	
ly	=	3	m	
Kx	=	0.65		
Ky	=	0.65		
lex	=	1.95	m	
ley	=	1.95	m	
Stirrups,φ	=	8	mm	
Clear cover	=	40	mm	
d'	=	58.00	mm	
p	=	2.05	%	
Mux\Muy	=	102.00	0.00	kNm
M due to "e"	=	10.86	10.86	kNm
Total Moments	=	112.86	10.86	kNm
p/fck	=	0.068		
Pu/fckbD	=	0.148	0.15	
d'/D and d'/B	=	0.17	0.17	
Mux1/fckB* D^2	=	0.096	0.096	
Mux1 and Muy1	=	123.48	123.48	kNm
Puz	=	2401.47	kN	
	=	0.990	≤1	
Ast,req	=	2511.25	mm^2	
ϕ	=	20	mm	
nos,req	=	8.00		
nos,prov	=	8		
Ast,prov	=	2512	mm^2	
p,prov	=	2.05	%	

20 mm dia rods 8 nos

TIES

ϕ	=	8	mm
Spacing of rods should be minimum of to			
s<=b	=	350.00	mm
s<=16 ϕ_{main}	=	320	mm
s<= 48 ϕ_{tie}	=	384	mm
Spacing required	=	320	mm
Spacing provided	=	150	mm

8 mm at 150 mm c/c

60000 LITRE CAPACITY OHT WITH 12mSTAGING HEIGHT-ZONE III

DESIGN OF ISOLATED FOUNDATION

		f_{ck}	=	30	N/mm^2	
		f_y	=	415	N/mm^2	
	Clear cover - Severe		=	50	mm	
INPUT						
Mx (Un fact)			=	41	kNm	
Load(Un Fact)			=	714	kN	
Add 10% for self wt. of footing			=	71.4	kN	
Total load on footing			=	785.4	kN	
Size of column						
		B	=	350	mm	
		L	=	350	mm	
		SBC	=	100	kN/m^2	
SOIL PRESSURE						
Zxx			=	3.28	m^3	
Size of Footing			=	2.7	m	
			=	2.7	m	
			=	7.29	m^2	
W/A+M/Z			=	120.2347	kN/m^2	
W/A-M/Z			=	89.28663	kN/m^2	
Increased SBC 33.33%			=	133	kN/m^2	
			=	**Hence OK**		
MOMENTS						
		p	=	161.6	kN/m^2	
		M	=	301	kNm	
		B	=	2700	mm	1525
		f_{ck}	=	30	N/mm^2	
equalent rectangle of width			=	643.75	mm	
	Hence	d	=	336	mm	
		D	=	600	mm	
		do	=	300	mm	1823.36
	Effective Cover		=	56	mm	
	effective depth		=	544	mm	
	A_{st}		=	2321	mm^2	0.158 %
	Ave.Depth		=	450	mm	
		ϕ	=	12	mm	
	Breadth -'b'		=	2700	mm	
	Effective Depth-'d'		=	544	mm	
	Spacing Required		=	131	mm	2441.66
	Spacing Provided		=	125	mm	
	Area of Reinforcement Provided		=	2441.664	mm^2	0.166 %
	12 RTS rods	**125 mm c/c in both ways**				
SHEAR-ONEWAY						
Shear force	Vu	at d	=	275	kN	
	Lx1		=	1175		
	deff1 at free end		=	244	Trep Area	161 1438
	d'		=	405	mm	244 2700
	Top width of the section		=	1438	mm	
		τ_v	=	0.277	N/mm^2	
		Pt	=	0.17	%	
		τ_c	=	0.31		
		Hence OK				
SHEAR-TWO WAY						
		b	=	894.00	mm	
		d	=	894.00	mm	

DESIGN OF ISOLATED FOUNDATION

	Vu	=	1049	kN		
	d	=	544	mm		
	τ_v	=	0.54	N/mm^2		
	τ_c	=	1.37			
		=	1.37	>	0.54	N/mm^2

Hence OK

v) **DEVELOPMENT LENGTH**

τ_{bd}	=	1.5	N/mm2	
Factor due to deformed bars	=	1.6		
		38	ϕ	
	=	456	mm	
Length of rod available at one side	=			
		1125	>	456 mm

Hence OK

Structural Design Proof - checked and Found Satisfactory

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