Design of Intze tank — Shaft SUPPORT

Data :-

			name	values	Required
Capacity of tank	va	253 kl	V	250 Kl	
Tank Top diameter		DIA is OK	td	10 m	DIA is OK
Thickness of side wall at top			ti	0.2 m	
Diameter of staging			ds	7 m	
Internal shaft openinig diameter			isd	1.5 m	
Side wall height			swh	2.50 m	total ht
Inclined wall Vertical height			ish	1.50 m	4.3
Rise of top dome			h	1.7 m	
Thickness of top dome			tt	0.125 m	
Rise of bottom dome			bdh	1.2 m	
Thickness of bottom dome			bst	0.25 m	
Allowable stress in steel			rst	130 n/mm2	
Grade of concrete			g	30 N/mm2	
Allowable bending tensile stress in concrete			allowbt	2.0 n/mm2	
Allowable direct tensile stress in concrete			allowdt	1.5 n/mm2	
Allowable bending compressive stress in concrete			cbc	10.0 n/mm2	
Allowable direct compressive stress in concrete			allowdc	8.0 n/mm2	
Height of free board			hf	0.3 m	
Angle of inclination of inclined wall			th	45 Degrees	

Volume of concrete

Concrete vol. of top dome	st*tt	10.95 cum
Concrete volume of top ring bea	pi()*(td+trb)*trb*trd	2.91 cum
Concrete vol. of vertical wall	pi()*(td+(ti+tii)/2)*(ti+tii)/2*(swh-trd)	14.10 cum
Concrete vol. of middle ring bear	pi()*(td+mrb)*mrb*mrd	4.95 cum
Concrete vol. of conical shell	pi()*(td/2+ds/2)*ist*ish/SIN(th*PI()/180)	16.99 cum
Concrete vol. of bottom dome	sti*bst	10.75 cum
Concrete vol. of bottom ring bea	pi()*(ds)*brb*brd	4.45 cum
Concrete vol. of balcony	bw*0.1*pi()*(td+mrb+bw)	0.00 cum
Total volume of concrete		**65.11** cum

Volume calculations

Volume of cylindrical portion	pi()*(td/2)^2*(swh+trd+mrd)		243
Volume of conical portion	pi()/3*((td/2)^2+(td/2*ds/2)+(ds/2)^2)*ish		86 vcp
Volume of bottom dome portion	PI()/6*(3*(ds/2)^2+bdh^2)*bdh		-24 vbdp
Volume of internal shaft	PI()*isd^2/4*(swh+ish-bdh)		-5
	Net volume	va	**301** kl
Allowable stress in concrete under bending		cbc	10.0 N/mm2

Design of Top dome

Thickness of top dome		tt	0.125 m	
Live load on top dome		Ll	1.5 kn/sqm	
Diameter of steel bars	STEEL Dia is OK	dia	**8** mm	
Area of steel		Ast	300 mm2	
Spacing of steel bars		Spp	125 mm	168
Minimum percentage of steel		Mpt	0.240 %	
Meridional stress		Ms	0.188 n/mm2	
Circumferencial stress		cs	0.079 n/mm2	

The stresses are compressive and with in permissible limits

Calculations

Radious of top dome	((td/2)^2+h^2)/(2*h)		Rt	8.20 m
	Sth	0.610	Cth	0.793
Surface area of top dome	2*pi()*Rt*h		St	87.62 sqm
Weight of top dome &finishings	(tt*25+0.50)		wt	3.63 kn/sqm
Dead and live load per sqm	wt+Ll		twt	5.13 kn/sqm
Meridional thrust	WxR/(1+Cos(th))		Mt	23.45 kn/m
Circumferencial thrust	twt*rt*(cth-1/(1+cth))		ct	9.88 kn/m

Meridional stress	Mt*1000/(tt*1000*1000)	Ms	0.19 n/mm2
Circumferencial stress	Ct*1000/(tt*1000*1000)	Cs	0.08 n/mm2

The stresses are compressive and with in permissible limits

Min. percentage of steel	IF(ds<=15,0.24%,0.35%)	Mpt	0.24 %
Area of steel required	Mpt*tt*1000*1000/100	Ast	300 mm2
Spacing of steel	pi()*(dia)^2/(4)*1000/Ast	Sp	168 mm

Design of Top ring beam

Top ring beam breadth	Tensile stress with in limits	0.68	n/mm2	trb	0.30 m	OK
Top ring beam depth		OK		trd	0.3 m	0.16
Dia of steel bars				trds	12 mm	
Number of bars				trnb	6 Nos	5
Area of steel provided		Safe		Astp	679 mm2	501
Hoop tension in the top ring beam				Ht	65 kn/m	
Tensile stress in concrete	Tensile stress with in limits			tss	0.68 n/mm2	

Provide 2L - 10 for stirrups at 200 mm c/c

Calculations

Hoop tension in the top ring beam	mt*Cth*(td/2)	Ht	65 kn/m
Area of hoop reinforcement	Ht*1000/rst	Astr	501 mm2
Tensile stress in concrete	ht*1000/((trb*trd)*10^6+(m-1)*Astp), tss=		0.68 n/mm2

Design of side wall

		hoop			bendg
Thickness of side wall at top	all Tensions in limits	0.33	ti	0.200 m	0.76
Thickness of side wall at bottom	Thickness is adequate hoop		tii	0.200 m	0.12
Dia of vertical steel on water face	steel Dia is OK		vsd	10 mm	
Spacing of bars			wfs	200 mm	200
Dia of vertical steel on outer face	steel Dia is OK		vsdi	10 mm	
Spacing of bars			ofs	200 mm	200
Dia of hoop steel bars	steel Dia is OK		hsd	10 mm	
Spacing of bars on each face			sphs	200 mm	200
Vertical steel on water face			wsas	302 mm2	
Vertical steel on out side face			osas	240 mm2	
Vertical steel at mid height			mhasi	240 mm2	
Total Hoop steel	for two faces		has	506 mm2	
Area of hoop steel provided	for two faces		hasp	785 mm2	
Hoop Tensile stress in concrete			tsc	0.33 N/mm2	
Maximum hoop tension			hopt	66 kn/m	
Maximum moment on water face				-5.08 knm	
Maximum bending tensile stress in concrete			btsc	0.76 N/sqmm	

Calculations

Bending moment coefficients from table 10 of IS: 3370 (Pt IV)

H^2/(Dxt) = swh^2/(td*(ti+tii)/2) hdr 3.13

Height from top	m	Mom.Coef	Moment knm	Thikness mm	Ast mm2
0.1*swh	0.25	0.00056	0.088	16	5.24
0.2*swh	0.50	0.00229	0.357	33	21.30
0.3*swh	0.75	0.00446	0.697	46	41.54
0.4*swh	1.00	0.00680	1.063	56	63.31
0.5*swh	1.25	0.00870	1.359	64	80.99
0.6*swh	1.50	0.00945	1.477	67	87.98
0.7*swh	1.75	0.00760	1.188	60	70.75
0.8*swh	2.00	0.00134	0.209	25	12.45
0.9*swh	2.25	-0.01141	-1.783	73	-106.25
1.0*swh	2.50	-0.03249	-5.076	123	-302.45

Maximum negative steel	wsas	302 mm2
Maximum positive steel	osas	240 mm2
Area of steel at mid height	mhasi	240 mm2

Hoop tension coefficients from table 12 of IS: 3370 (Part IV)

T = Coeff*w*swh*td/2

H^2/(d*t)		hdr	3.13	

	ht from top m	Coeff.	Force kn/m	Thikness mm	Steel mm2
0	0	0.067	8	6	64
0.1*swh	0.25	0.174	22	14	167
0.2*swh	0.50	0.278	35	23	267
0.3*swh	0.75	0.374	47	31	360
0.4*swh	1.00	0.452	56	38	434
0.5*swh	1.25	0.511	64	43	491
0.6*swh	1.50	0.527	66	44	506
0.7*swh	1.75	0.488	61	41	469
0.8*swh	2.00	0.384	48	32	369
0.9*swh	2.25	0.216	27	18	207

Maximum hoop steel	has	506	mm2
Maximum hoop tension	hopt	66	Kn/m

Design of Middle ring beam

Depth of middle ring beam	Tensile stress with in limits	Mrd	0.3	m	
Breadth of middle ring beam	Tensile stress= 1.22	Mrb	0.5	m	
Balcony width		bw	0	m	
Dia of hoop steel bars provided		hsdia	**16**	mm	
Number of hoop bars provided		nhb	8	Nos	8
Area of hoop steel provided		hopsp	1608	mm2	1538
Total hoop tension due to vertical load and water		thopt	200	kn	
Hoop tensile stress in concrete		hoti	1.22	n/mm2	
Stirrups	Provide 10mm dia @ 200 mm C/C				

Calculations

Load due to top dome	st*twt		449	kn
Load due to top ring beam	PI()*(td+trb)*trb*trd*25		73	kn
Load due to cylindrical wall	pi()*(td+(ti+tii)/2)*(ti+tii)/2*swh*25		401	kn
Self weight of middle ring beam	pi()*(td+mrb)*mrb*mrd*25		124	kn
Weight of balcony and live load	pi()*(td+2*tii+bw)*bw*4.75		0	kn
Total vertical load		vtmrb	**1046**	kn
Load per unit length of beam	vtmrb/(pi()*(td+mrb))	vlpm	32	kn/m
Horizontal compo. Of inclined reaction (ve	vlpm/(TAN(th*pi()/180))	hpt	32	kn/m
~~Hoop tension due to vertical load~~	~~hpt*(td+tii)/2~~	~~hoptv~~	~~162~~	~~kn~~
Hoop tension due to water pressure	(10*swh*mrd*(td+tii)/2)	hoptw	38	kn
Total Hoop tension on Middle ring beam		thopt	**200**	kn
Area of steel required	thopt*1000/rst	hopst	1538	mm2
Hoop tensile stress in ring beam	thopt*1000/(mrb*mrd*10^6+(m-1)*hopsp)	hoti	1.22	n/mm2

Design of conical SIDE WALLS (Shell)

Inclined slab thickness	Thickness is adequate	1.73	ist	0.3 m	0.28
Dia of **hoop** steel bars	Tensions in limits	0.76	hsdi	**16** mm	
Spacing of hoop bars on both faces	steel Dia is OK		hssp	200 mm	229
Dia of **radial** steel bars	steel Dia is OK		rsdi	**16** mm	
Spacing of radial bars on both faces			rssp	150 mm	214
Height of the cone			ish	1.50 m	
Slope of the conical shell in radians			thr	0.785 radians	
Area of hoop steel required			ash	1754 mm2	
Area of radial steel			asri	940 mm2	
Maximum hoop tension			mht	228 kn/m	
Max. hoop tensile stress			hts	0.76 N/mm2	

Calculations

Weight of top dome,ring beam,side wall and middle ring beam				1046 kn
Weght of water over inclined shell	(PI()/3*((td/2)^2+(td/2*ds/2)+(ds/2)^2)*ish-(PI()*ds^2/4*ish))*10+ +PI()*(td^2-ds^2)/4*swh*10		wwis	1284 kn
Self weight of inclined shell	pi()*(td/2+ds/2)*ist*ish/SIN(th*PI()/180)*25		wis	425 kn
Total load on the conical slab			flcs	**2755** kn
Total load per unit length	tlcs/(pi()*ds)		tlrb	125 kn/m
Meridional thrust	tlrb/SIN(th*pi()/180)		npi	177 kN/m
Hoop tension in the shell	(10*(swh+ish-y)+25*ist*COS(thr))*(ds/2+y/TAN(thr))/SIN(thr)			
Hoop tension at **bottom** of inclined slab	yi =	0.00	tci	224 kn/m
Hoop tension at 1/4 height from **bottom**	ayi =	0.38	atci	228 kn/m
Hoop tension at **middle** of inclined slab	yii =	0.75	tcii	227 kn/m
Hoop tension at 3/4 height from **bottom**	ayii =	1.13	atcii	223 kn/m
Hoop tension at **top** of inclined slab	yiii =	1.50	tciii	214 kn/m
USING SOLVER tcmax=	ymax =	0.515	tcmax	227.99 kn/m
Area of hoop steel required	MAX(tcmax*1000/rst,0.24 or 0.35*ist*10^4)		ash	1754 mm2

Design of inclined slab for bending

Load on the slab per meter	tlcs/(pi()*(td+tii+ds)/2)	lis	101.97 kn/m2
Bending moment	lis*ish/(SIN(th*PI()/180))/10		21.63 knm
BM due to compression	vlpm/SIN(th*PI()/180)*(ist-0.045-rsdi/2000-ist/2)		4.35 knm
		bmis	25.98 knm
Thickness required for un-cracked	Sqrt(6*bmis*10^3/(allowbt))	istr	279 mm
Area of steel required	bmis*10^6/(ist*j*(ist*1000-45-rsdi/2))	asri	940 mm2
Minimum % of steel	(0.24 or 0.35)/2		0.120 %
Minimum area of steel	tcmax*1000/(ist*1000*1000+(m-1)*1000/(hssp)*PI()*(hsdi)^2/4*2)	asr	360 mm2
Bending(T) stress in the conical shell	6*bmis*10^3/(ist*1000)^2	bts	1.73 n/mm2
Hoop Tensile stress in the conical shell		hts	0.76 n/mm2

Design of bottom dome

Thickness of bottom dome		bst	0.25 m	
Dia of steel bars	steel Dia is OK	bdia	**10** mm	
Spacing of steel bars in two layers		Spsi	200 mm	262
Minimum percentage of steel		Mpti	0.120 %	
Area of steel required		asti	300 mm2	
Meridional stress		Msi	0.46 N/mm2	
Circumferencial stress		Csi	0.19 N/mm2	

The stresses are with in permissible limits

Calculations

Radious of bottom dome	((ds/2)^2+bdh^2)/(2*bdh)	Rb	5.70 m
	Sthi 0.614	Cthi	0.790
Surface area of bottom dome	2*pi()*Rb*bdh	Sti	43.01 sqm
Weight of bottom dome &finishings	(bst*25+0.75)*sti	wti	301 kN
Weight of water on bottom dome	pi()*10*((ds/2)^2*(swh+ish)-(3*(ds/2)^2+bdh^2) *bdh/6-(isd)^2/4*(swh+ish-bdh))	wwi	1250 kN
Total unit load on bottom dome	(wti+wwi)/sti	twb	36 kN/m2
Meridional thrust	twb*rb/(1+cthi)	Mti	115 kN/m
Circumferencial thrust	twb*rb*(Cthi-1/(1+cthi))	Cti	47 kN/m
Meridional stress	Mti*1000/(bst*10^6)	Msi	0.46 N/mm^2
Circumferencial stress	Cti*1000/(bst*10^6)	Csi	0.19 N/mm^2
Min. percentage of steel	(0.24 or 0.35)	Mpti	0.240 %
Area of steel required	Mpti*bst*10000	Asti	300 mm^2

Design of bottom ring beam (thickend shaft @ TOP)

Bottom ring beam depth	Beam under compression	brd	0.45 m
Bottom ring beam breadth	section is Safe	brb	0.45 m
Cover to top steel		dd	0.045 m
Dia of bars for hoop tension		ssdi	**16** mm
Number of bars for hoop tension		brhs	8 Nos
Dia of stirrups		sdi	**10** mm
Spacing of two leg stirrups			**200** mm
Thrust from the bottom dome		htbd	91 kN/m
Tthrust from the Conical walls		htcd	125 kN/m
Net force on the ring beam	Beam under compression	nht	35 kN/m
Hoop compression		Hoc	121 kN
Stirrups	Provide 10mm dia @ 200mm C/C		

Calculations

Thrust from the bottom dome	Mti*Cthi	htbd	91 kN/m
Tthrust from the Conical dome	npi*COS(th*pi()/180)	htcd	125 kN/m
Net force on the ring beam	htcd-htbd	nht	35 kN/m
		Beam under compression	
Hoop compression	nht*ds/2	Hoc	120.81 kN
Compresive stress	hoc*1000/(brb*brd*10^6)	hcs	0.60 N/mm^2 Safe
Hoop tension	nht*ds/2	Hot	0.00 kN
Tensile stress in the beam	hot*1000/((brb*brd*10^6-hsrbi)+(m-1)*hsrbi)	hst	0 N/mm^2
Area of steel required for hoop tension		hsrb	0 mm2
Area of steel required in the bottom ring beam		hsrbi	1620 mm2

Total loads for Tank Portion

Weight of top dome	twt*ts		449 kn
Weight of top ring beam	pi()*(td+trb)*trb*trd*25		52 kn
Weight of side wall	pi()*(td+(ti+tii)/2)*(ti+tii)/2*swh*25		401 kn
Weight of middle ring beam	pi()*(td+mrb)*mrb*mrd*25		124 kn
Weight of inclined shell	wis		425 kn
Weight of bottom dome	wti		301 kn
Weight of water	wwis+wwi		2534 kn
Load per meter up to bottom ring beam			195 kN/m
Self weight of the beam	brb*brd*25		5 kN/m
Total load per meter on SHAFT SUPPORT @TOP		wsi	200 kN/m

Side face reinforcement on each face IF(brd>0.45,0.1*brb*brd/2*100,0) 0.00 cm2

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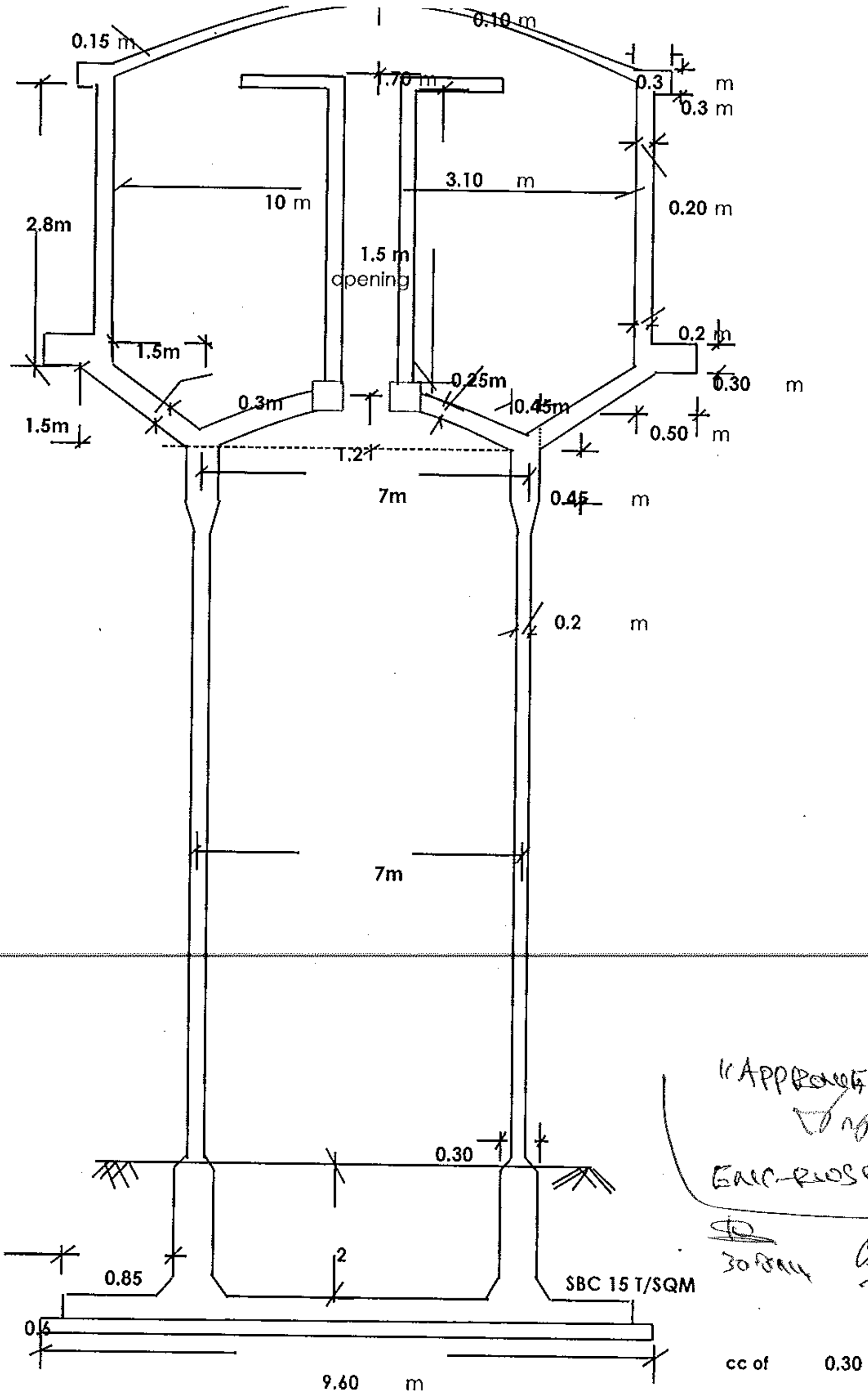

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Design of Shaft type supporting structure for 250KL capacity OHBR

	Staging height	25	m			
Location of tank	MUDHOLE HW					
DATA :	Location of tank		Plain Ground			
Basic Wind speed	44	m/s	500	kM away from sea		
Net SBCof the Soil assumed				15	t/m2	
Depth of foundation up to top of raft			df	2.00	m	
TANK DETAILS					total net water volume	
Capacity of tank			v	250	kl	253
Height of staging			hs	25.00	m	
Dia of stagging/ Shaft			ds	7.00	m	compression
Dia of tank			td	10.00	m	
Top slab / Dome	tst	0.125	h	1.70	m	R2=8.2
Top ring beam	trd	0.300	trb	0.300		free board
Side wall ht above middle RB	swh	2.500	swt	0.200		0.3
Middle ring beam	mrd	0.300	mrb	0.500		
Dia of central opening	copt	0.20	copdi	1.5		
Inclined slab	Ist	0.300	ish	1.500	2.121	
Bottom ring beam	brd	0.450	brb	0.450		
Bottom Dome	bst	0.250	bdh	1.200	R1=	5.70
Wind constants	ki	1.000	kii10	1.050		
	kii15	1.090	kii20	1.120		
	kii30	1.150	kiii	1.000		
Basic wind speed	158.4	Km/h	vb	44	m/sec	
		Shaft details				
Grade of concrete			g	30	n/mm2	WS
Grade of steel medium assure	Fe415		equivallent fy	343	n/mm2 ⟷	190
Thick ness of shaft		Safe	ts	0.2	m	
opening width			wp	1	m	
~~Dia of vertical steel bars proposed~~			~~di~~	~~10~~	~~mm~~	
Spacing of vertical reinforcement on both the faces			sp	✓ 200	mm	209
Dia of circumferencial steel bars proposed			cdi	10	mm	
Spacing provided horizontally on both the faces			sph	✓ 200	mm	200
Height of shaft above raft t	hs-brd-0.15+df		sh	26.4	m	
Stress in the shell	compression			4.31	kg/cm2	
Nature of stress				Comp		
Tensile stress due to ring moment		safe		0.83	Kg/cm2	21.00
	No Comparision of eri and er needed					
	er	0.176	eri	scv Governs		
			alpa	168.00		
Maximum compressive stress in shaft		safe		23.98	Kg/cm2	114.00
Area of vertical steel required				5.00	cm2	
spacing required				300	mm	
Area of circumferential steel required				4.80	cm2	
spacing required				200	mm	

for verticals and hoops Pls provide @150 c/c.

Ring beam(thickend shaft) on Raft						
Width of ring beam @ bottom of shaft			rb	0.30	m	
Depth of ring beam @ bottom of shaft			rd	2.00	m	
Dia of vertical bars			rsdi	10	mm	
Spacing of bars			rbsi	200	mm	209
Dia of circumferencial bars			rsdii	10	mm	
Spacing of bars			rbsii	200	mm	209
	Design of raft					
haunch width on raft	0.30	m	Safe	Safe	dia cc	
CC layer below the raft	thickness	0.3	projection	0.30	9.6	9.46
Dia of raft provided	<= 11.4 m	Safe	d	9.00	m	8.86
Overall depth of raft		Safe	dr	0.60	m	0.420
Dia of bottom bars			db	20	mm	
Spacing of bottom bars arranged as mesh			space	150	mm	175
Dia of top bars			dbi	20	mm	
Spacing of top bars arranged as mesh			spacei	150	mm	165
Effective depth provided (de)			de	0.53	m	
Radial Moments						
Radial distance from centre	0.00	1.75	3.35	3.65	4.50	m
Radial moments Mr	-18.69	-8.44	17.65	15.83	0.00	tm
Area of steel in cm2	**19.0**	**8.5**	**18.0**	**16.0**	**0.0**	
	Moment in tm	Ast in cm2	Spacing in mm			
Maximum negative moment	**-18.69**	**19.0**	165	mm		
Maximum positive moment	**17.65**	**18.0**	175	mm		
Minimum area of steel	mas	**7.20**	cm2			
Circumferencial Moments						
Radial Distance from centre	0.00	1.75	3.35	3.65	4.50	m
Circumferencial moment Mt	-18.69	-17.84	-15.01	0.94	0.23	tm
Area of steel in cm2	**19**	**18**	**15**	**1**	**0.5**	
	Moment in tm	Ast in cm2	Spacing in mm			
Maximum negative moment	**-18.69**	**19.0**	165 mm			
Maximum positive moment	**0.94**	**1.0**	436 mm			

Design Calculations

Weight of tank						
DL+Finishings on dome / m2	tst*2.5+0.075		wdl	0.3875	t/m2	
Top slab / Dome	@if(h=0,(pi*(td+2*swt)^2/4*tst*2.5),(2*pi*((td/2)^2/h+h)/2*h*wdl))					
				33.95	t	
Top ring beam	pi*(td+trb)*trb*trd*2.5			7.28	t	
Side wall	pi*(td+swt)*swh*swt*2.5			40.05	t	
Middle ring beam	pi*(td+2*swt+(mrb-swt))*(mrb-sw			12.37	t	
Inclined wall	pi*((td+ist)+ds)/2*ist*sqrt(ish^2+((td+ist-ds)/2)^2)*2.5					
				45.45	t	
Bottom ring beam	pi*ds*brb*brd*2.5			11.13	t	
Bottom slab / Dome	@if(bdh=0,pi*(td+2*swt)^2/4*bst*2.5,pi*2*rii*bdh*bst*2.5)					
				26.88	t	

Total weight of tank portion				**178**	t	
Staging						
Weight of shaft	pi*ds*ts*sh*2.5			290.27	t	
Weight of ring beam over raf	pi*ds*(rb-ts)*rd*2.5			11.00	t	
Total weight of staging				**302**	t	
Total weight of tank & staging			wt	**480**	t	
Volume of tank						
Radious of bottom dome	((ds/2)^2/bdh+bdh)/2		rii	5.70	m	38
Weight of water Q1	pi()td^2/4*(swh+trd+mrd)			243.47		
Q2	pi()/3*((td/2)^2+td/2*ds/2+(ds/2)^2)*ish					
				86.00		
Q3	pi()/6*(3*(ds/2)^2+bdh^2)*bdh			-24.00		
Q4	pi()/4*((copdi)^2)*(ish+mrd+swh-b			-5.48		
Weight of water			ww	300.00	t	
Wind analysis						
Design pressure	pz10	0.6*(ki*kii10*kiii*vb)^		1281	n/sqm	
	pz15	0.6*(ki*kii15*kiii*vb)^		1380	n/sqm	
	pz20	0.6*(ki*kii20*kiii*vb)^		1457	n/sqm	
	pz30	0.6*(ki*kii30*kiii*vb)^		1536	n/sqm	
Moment due to wind on tank	Ht.	Area	pressure	force	LA	Moment
	m	m2	N/m2	N	m	tm
Top slab / Dome	30.68	11.76	1636	13472	30.66	41.30
Top ring beam	28.70	3.18	1636	3642	29.80	10.85
Side wall	28.85	19.76	1636	22632	28.70	64.95
Middle ring beam	26.50	3.30	1636	3780	29.10	11.00
Inclined wall	25.60	12.98	1536	13953	28.20	39.35
Bottom slab / Dome	24.85	0.00	1536	0	27.33	0.00
Bottom ring beam	24.85	3.35	1536	3605	27.10	9.77
			wfi	61083	wmt	**177.22**
Moment due to wind on staging	H	Area	pressure	force	LA	Moment
On shaft	24.4	175.68	1536	215906	14.80	319.54
			wfii	215906	wms	**319.54**
Total wind moment on the base			mb	**497.00**	tm	mb'
weight of raft	pi*d^2/4*dr*2.5		wr	95	t	
weight of soil	pi*d^2/4*df*1.0		ws	127	t	
When Tank full +raft wt	ww+wt+wr		pfull	875.42	t	
When tank Empty (with out	wt+wr		p	575	t	
soil weight)						
Dia of CC required for soil safe bearing capacity				9.46	m	
Dia required to avoid tension in raft base	8*mb/(P+ws)			5.66	m	
Max Dia required for both factors				9.46	m	
tension in base (Empty condition)						
Section modulus of raft			z	71.57	m^3	
Area of raft			ai	63.62	m^2	
Chek for stability						
Tank empty condition	(wt+wr+ws)/ai-mb/z			4.10	t/sqm	Safe
Max.pressure on soil tank full		(ww+wt+wr)/ai+mb/z		20.71	t/sqm	Safe

condition with out soil weight		(ww+wt+wr)/ai-mb/z		6.82	t/sqm	
Pressure on soil when no wind		(ww+wt+wr)/ai		13.76	t/sqm	Safe
Design of Shaft	pl check UH VARYANI Biaxial Bending RCC Book					
Weight of tank & wt of water			w	780	t	
Moment due to wind at top of raft			LA	Moment		
Top slab / Dome			30.06	40.49	tm	
Top ring beam			29.20	10.64	tm	
Side wall			28.10	63.60	tm	
Middle ring beam			28.50	10.77	tm	
Inclined wall			27.60	38.51	tm	
Bottom slab / Dome			26.73	0.00	tm	
Bottom ring beam			26.50	9.55	tm	
Wind on shaft			14.2	306.59	tm	
Total			mbi	**481.00**	tm	
Ring moment in the shaft	3.3*wps*(ds/2)^2/100		rm	62.10	tm	
Tensile stress due to ring moment				0.83	Kg/cm2	
Allowable circumferential tensile stress due to ring moment				21.00	Kg/cm2	
Vertical stress in circular shaft						
eccentricity	mbi/w		e	0.62	m	
e/r ratio	e/(0.5*ds)		er	0.18		
Max. vertical comp.stress in	w/(pi()*ds*ts)*(1+4*e/ds)/10, scv=				23.98	Kg/cm2
concrete when e/r < 0.5						
Allowable compressive stress			0.38*g*10	114.00	Kg/cm2	
Total vertical steel area/Total concrete area						
	Pi()^2*ds*di^2/(2*sp*1000*ars)					
			scr	0.00393		
'If er>0.5 Compare value of eri with er by changing value of alpa						
Angle alpha			alpa	168.00	degs	
			alp	2.93	rads	
modular ratio			m	13.00		
AC	0.5*(1-scr)*(alpa-sin(alp)*cos(alp))-0.5*(1-scr+m*scr)*(bita+sin(bit)*cos(bit)					
	-2*cos(alpa)*sin(bit))+0.5*m*pi()*scr					
			ac	79.51		
BC	(1-scr)*(sin(alp)-alpa*cos(alp))-(1-scr+m*scr)*(sin(bit)-bita*cos(alp))-m*scr*pi()*cos(alp)					
			bc	155.57		
AC/BC			eri	0.000		
	w/(ds*ts*10)*((COS(bit)-COS(alp))/((1-scr)*(SIN(alp)-alpa*COS(alp))-(1-scr+m*scr)*(SIN(bit)					
	-bita*COS(alp)))-m*scr*PI()*COS(alp))					
			scvi	9.45	Kg/cm2	
Max. compressive stress for	scvi*(1+ts/(ds*cos(bit)*(cos(bit)-cos(alp))))					
e/r > 0.5			scvii	9.58	Kg/cm2	
Maximum compressive stress	IF(er<0.5,scv,scvii)			23.98	114.00	kg/cm2
in shaft						
Annular section with one opening						

bita	ATAN(wp/ds)		bita	8.13	degs	
			bit	0.14	rads	
e/r ratio	1/(2*(PI()-bita))*(((PI()-bita)^2-(SIN(bit))^2)/((PI()-bita)*COS(bit)+SIN(bit))-3*SIN(bit))					
			ero	0.56		
Area of shaft	pi*ds*ts		ars	4.40	m2	
Modulus of section	pi*((ds+ts)^4-(ds-ts)^4		zi	7.49	m3	
Allowable buckling stress	min(0.25*g/(1+g/(0.2*5700*SQRT			45.00	Kg/cm2	
Stress on shaft wall	w/ars+mbi/zi		safe	24.16	Kg/cm2	
Stress on shaft wall	wt/ars-mbi/zi			4.49	kg/cm2	
If the stress in shell is compressive provide Min. steel				Comp		
min vertical steel of 0.25%but 0.8% as per IS456			pst	0.25	0.8	
Req.area of concrete per 1mtr, vertical loads only			1.5*w/(pi*ds)/(0.45*g/100)=			394
Area of steel	0.8%	IS456-2000		3.15	cm2/m	
Area of steel	ts*100*pst	IS11682-1985		5.00	cm2/m	
Area of steel	MAX(3.15 ,5)			5.00	cm2/m	
Provide steel of dia			di	10		
Spacing of reinforcement required				300	mm	
Spacing provided vertically				200	mm	
Minimum circumferential steel per m ht			aci	4.80	cm2	
provide dia of circumferential bar			cdi	10	mm	
Spacing of horizontal steel	MIN(300,ts*1000,PI()*cdi^2*2/(4*aci))*10					
				200	mm	

Design of Raft

Using the equations from the book RCC by Dayaratnam						
Moments due to Load	aa=	4.50	cc=	3.5		
Radial moments						
r<cc @ r= rid Mriw	w*(3*((rid/aa)^2-1)+2*(2*ln(aa/cc)+1-(cc/aa)^2))/(16*pi)					
				-18.69		
r<cc @ r= riid Mriiw	w*(3*((riid/aa)^2-1)+2*(2*ln(aa/cc)+1-(cc/aa)^2))/(16*pi)					
				-11.65		
r=cc @ r= riiid Mriiiw	w*(3*((riiid/aa)^2-1)+2*(2*ln(aa/cc)+1-(cc/aa)^2))/(16*pi)					
				7.11		
r>cc @ r= rivd Mrivw =	w*(3*((rivd/aa)^2-1)+2*(2*ln(aa/rivd)-(cc/aa)^2+(cc/rivd)^2))/(16*pi)					
				6.83		
r>cc @ r= rvd Mrvw =	w*(3*((rvd/aa)^2-1)+2*(2*ln(aa/rvd)-(cc/aa)^2+(cc/rvd)^2))/(16*pi)					
				0.00		
Circumferencial moments						
r<cc @ r= rid Mtiw =	w*(((rid/aa)^2-3)+2*(2*ln(aa/cc)+1-(cc/aa)^2))/(16*pi)					
				-18.69		
r<cc @ r= riid Mtiiw =	w*(((riid/aa)^2-3)+2*(2*ln(aa/cc)+1-(cc/aa)^2))/(16*pi)					
				-16.35		
r=cc @ r= riiid Mtiiiw =	w*(((riiid/aa)^2-3)+2*(2*ln(aa/cc)+1-(cc/aa)^2))/(16*pi)					
				-10.09		
r>cc @ r= rivd Mtivw =	w*(((rivd/aa)^2-3)+2*(2*ln(aa/rivd)-(cc/aa)^2-(cc/rivd)^2+2))/(16*pi)/(16*pi)					
				-0.17		
r>cc @ r= rvd Mtvw =	w*(((rvd/aa)^2-3)+2*(2*ln(aa/rvd)-(cc/aa)^2-(cc/rvd)^2+2))/(16*pi)/(16*pi)					
				-0.13		

Due to wind moment Radial moments						
r<cc @ r= rid Mrim =	mb*rid*(3*aa^2-2*cc^2-cc^4/aa^2)/(4*pi*aa^2*cc^2)-5*mb*rid*(aa^2-rid^2)/(12*pi*aa^4)					
				0.00		
r<cc @ r= riid Mriim =	mb*riid*(3*aa^2-2*cc^2-cc^4/aa^2)/(4*pi*aa^2*cc^2)-5*mb*riid*(aa^2-riid^2)/					
	(12*pi*aa^4)			3.21		
r=cc @ r= riiid Mriiim	mb*riiid*(3*aa^2-2*cc^2-cc^4/aa^2)/(4*pi*aa^2*cc^2)-5*mb*riiid*(aa^2-riiid^2)/					
	(12*pi*aa^4)			10.54		
r>cc @ r= rivd Mrivm =	mb*(2*(aa^2-rivd^2)+cc^2*(aa^4-rivd^4)/(aa^2*rivd^2))/(4*pi*aa^2*rivd)-5*mb*rivd*					
	(aa^2-rivd^2)/(12*pi*aa^4)			9.00		
r>cc @ r= rvd Mrvm =	mb*(2*(aa^2-rvd^2)+cc^2*(aa^4-rvd^4)/(aa^2*rvd^2))/(4*pi*aa^2*rvd)-5*mb*rvd*					
	(aa^2-rvd^2)/(12*pi*aa^4)			0.00		
Circumferencial moments						
r<cc @ r= rid Mtim =	mb*rid*(3*aa^2-2*cc^2-cc^4/aa^2)/(24*pi*aa^2*cc^2)-5*mb*rid*(5*aa*rid-3*rid^2)/(36*pi*aa^4)					
				0.00		
r<cc @ r= riid Mtiim =	mb*riid*(3*aa^2-2*cc^2-cc^4/aa^2)/(24*pi*aa^2*cc^2)-5*mb*riid*(5*aa*riid-3*riid^2)/(36*pi*aa^					
				-1.49		
r=cc @ r= riiid Mtiiim =	mb*riiid*(3*aa^2-2*cc^2-cc^4/aa^2)/(24*pi*aa^2*cc^2)-5*mb*riiid*(5*aa*riiid-3*riiid^2)/(36*pi*aa^4)					
				-4.92		
r>cc @ r= rivd Mtivm =	mb*(2*(3*aa^2-rivd^2)-cc^2*(3*aa^4+rivd^4)/(aa^2*rivd^2))/(24*pi*aa^2*rivd)-mb*rivd*					
	(5*aa*rivd-3*rivd^2)/(36*pi*aa^4)			1.11		
r>cc @ r= rvd Mtvm =	mb*(2*(3*aa^2-rvd^2)-cc^2*(3*aa^4+rvd^4)/(aa^2*rvd^2))/(24*pi*aa^2*rvd)-mb*rvd*					
	(5*aa*rvd-3*rvd^2)/(36*pi*aa^4)			0.36		
Summary of moments						
Radial Distance from center	0	1.75	3.35	3.65	4.50	m
Radial moments						
Due to W	-18.69	-11.65	7.11	6.83	0.00	
Due to M	0.00	3.21	10.54	9.00	0.00	
Total	**-18.69**	**-8.44**	**17.65**	**15.83**	**0.00**	
Circumferential Moments						
Due to W	-18.69	-16.35	-10.09	-0.17	-0.13	
Due to M	0.00	-1.49	-4.92	1.11	0.36	
Total	**-18.69**	**-17.84**	**-15.01**	**0.94**	**0.23**	
Maximum moment		Mmax	17.65	tm		
from working stress method						
σ_{cbc}=	10	n/mm2	t=	190	n/mm2	
k=	0.329		j=	1.00		
Q=	1.647	n/mm2				
Effective depth of raft requi	sqrt(Mmax*10^7/(Q*1000))/1000				,MR=Q b d^2	
effective depth required=		0.33	m			
from working stress method						
Radial Steel						
Radial Distance	0.00	1.75	3.35	3.65	4.50	m
Radial steel required in cm^2	**19.0**	**8.5**	**18.0**	**16.0**	**0.0**	cm2
Spacing required in mm	165	370	175	196	0	
Circumferencial steel						
Radial Distance	0	1.75	3.35	3.65	4.50	m
Circumferencial steel require	**19.0**	**18.0**	**15.0**	**1.0**	**0.5**	cm2

Spacing required in mm	165	175	209	3142	6283	mm
Check for Shear	for shear ,Limit state method					
critical section for shear			rcri	3.77	m from center	
Shear force at critical sectio	w*(1-rcri^2/aa^2)		qc	233.99	t	
Shear stress tv	qc*1.5/(2*pi*rcri*de)/100			0.28	N/mm2	
% of steel, pt			ptr	0.40		
	MAX(0.8*g/(6.89*ptr)		beetai	8.81		
allowable shear stress in con	0.85*sqrt(.8*g)*(sqrt(1+5*beetai)-1)/(6*beetai)					
			tc	0.45	N/mm2	Safe

ASST. ENGINEER
RWS&S PROJECTS

Dy. Executive Engineer
R.W.S. & S.
Sub Division, Bhainsa

Superintending Engineer
R.W.S. & S. Circle, Adilabad

Executive Engineer
R.W.S. & S. Division, Adilabad

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30/8
ENC, RWS, Hyd

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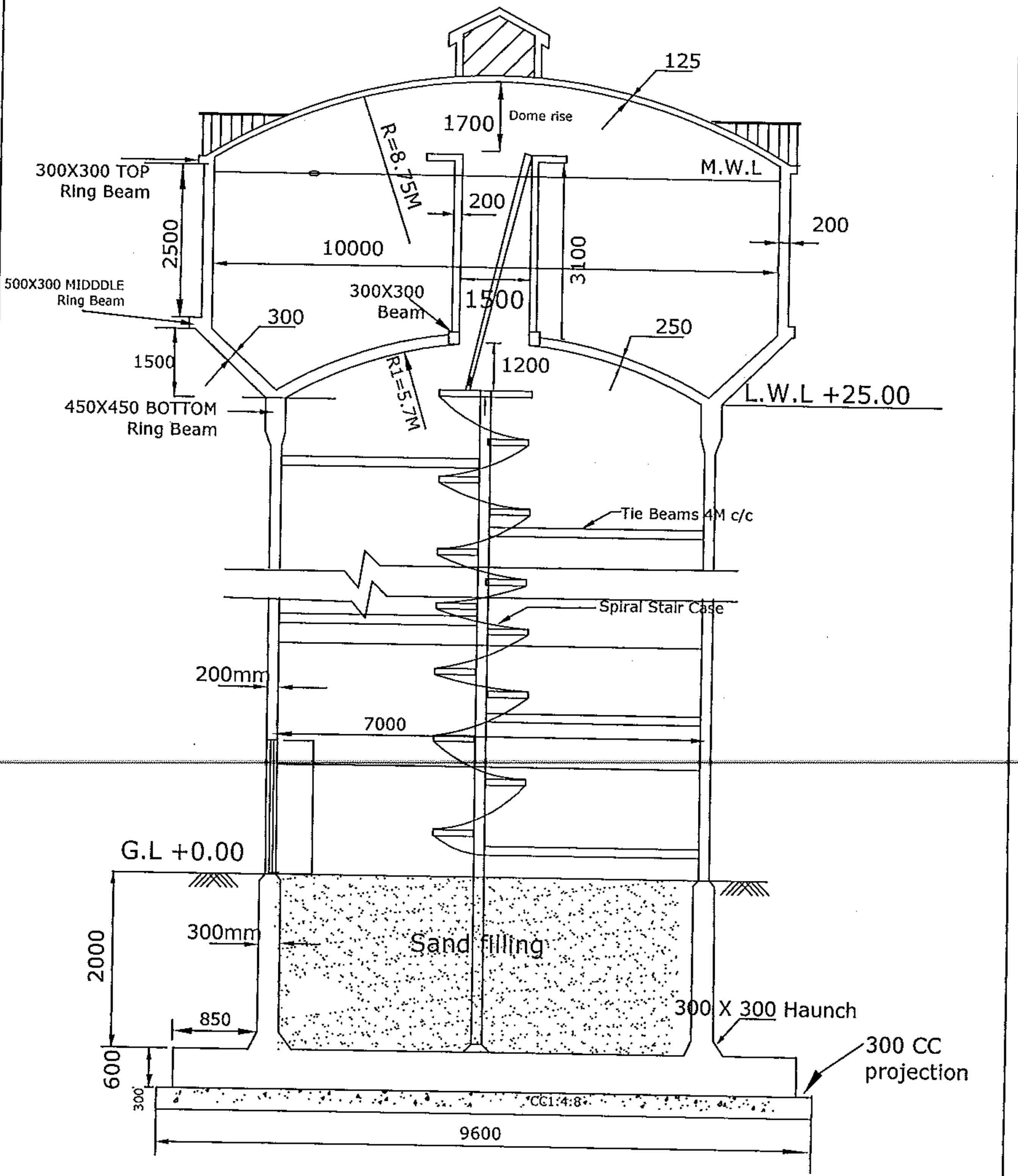
30/8/14



250 KL OHBR SHAFT
ON PLAIN GROUND

250KL OHBR 25M
44 m/s Basic WIND
SBC 15T/SQM

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Sub Division, Bhainsa

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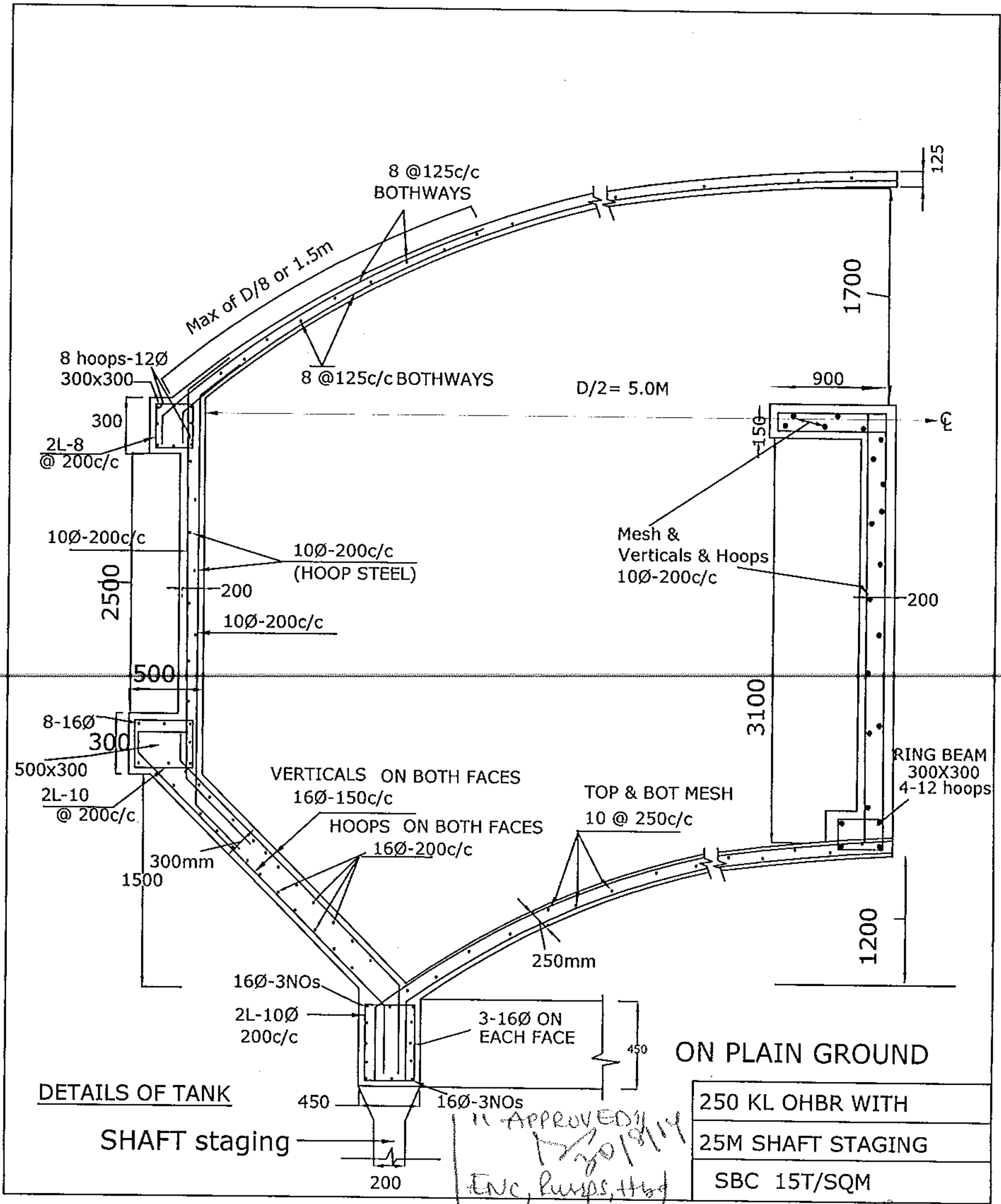
Superintending Engineer
R.W.S. & S. Circle, Adilabad



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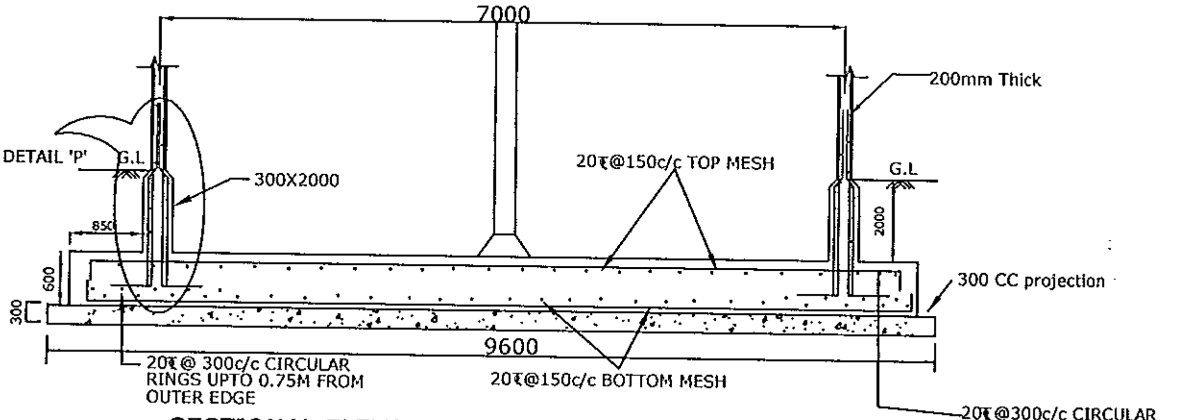
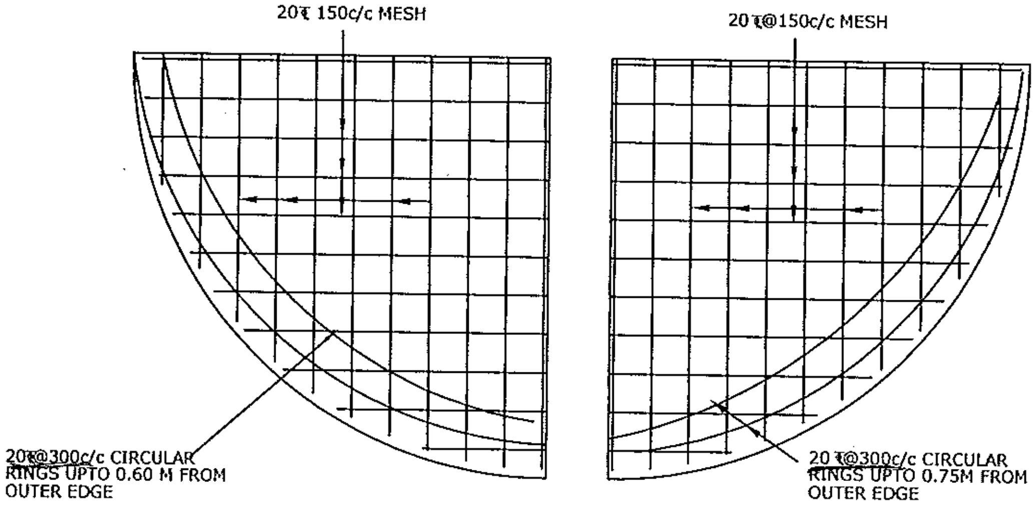
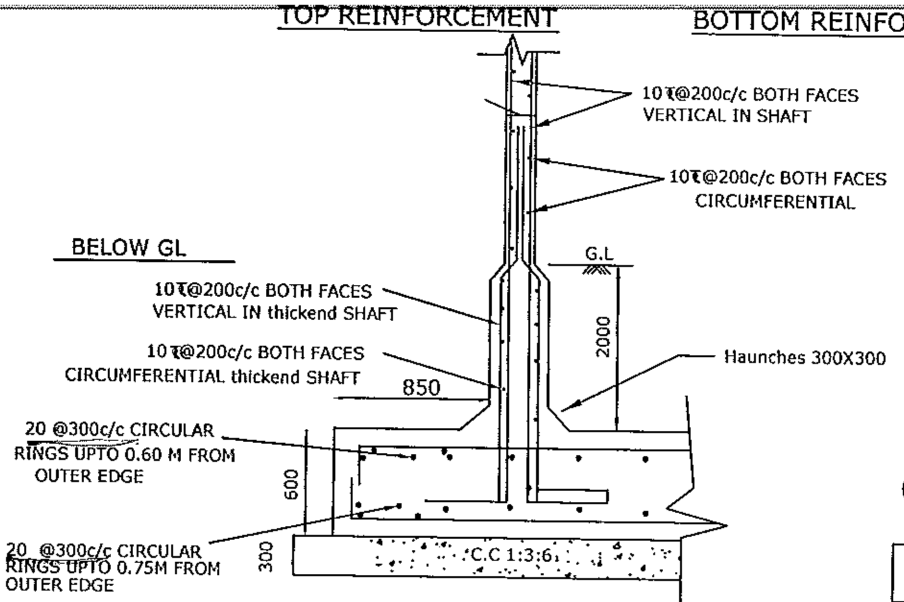


SECTIONAL ELEVATION OF RAFT



TOP REINFORCEMENT

BOTTOM REINFORCEMENT



DETAIL 'P'

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30/8/14
30/8/14

ON PLAIN GROUND

250KL OHBR 25M
44m/s Basic WindSpeed
SBC 15T/SQM

ASST. ENGINEER
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Design of Intze tank — Shaft SUPPORT

Data :-

			name	values	Required
Capacity of tank	va	203 kl	V	200 Kl	
Tank Top diameter		DIA is OK	td	9 m	DIA is OK
Thickness of side wall at top			ti	0.2 m	
Diameter of staging			ds	6 m	
Internal shaft openinig diameter			isd	1.5 m	
Side wall height			swh	2.45 m	total ht
Inclined wall Vertical height			ish	1.50 m	4.25
Rise of top dome			h	1.5 m	
Thickness of top dome			tt	0.125 m	
Rise of bottom dome			bdh	1 m	
Thickness of bottom dome			bst	0.25 m	
Allowable stress in steel			rst	130 n/mm2	
Grade of concrete			g	30 N/mm2	
Allowable bending tensile stress in concrete			allowbt	2.0 n/mm2	
Allowable direct tensile stress in concrete			allowdt	1.5 n/mm2	
Allowable bending compressive stress in concrete			cbc	10.0 n/mm2	
Allowable direct compressive stress in concrete			allowdc	8.0 n/mm2	
Height of free board			hf	0.3 m	
Angle of inclination of inclined wall			th	45 Degrees	

Volume of concrete

Concrete vol. of top dome	st*tt	8.84 cum
Concrete volume of top ring bea	pi()*(td+trb)*trb*trd	2.19 cum
Concrete vol. of vertical wall	pi()*(td+(ti+tii)/2)*(ti+tii)/2*(swh-trd)	12.72 cum
Concrete vol. of middle ring bear	pi()*(td+mrb)*mrb*mrd	4.48 cum
Concrete vol. of conical shell	pi()*(td/2+ds/2)*ist*ish/SIN(th*PI()/180)	14.99 cum
Concrete vol. of bottom dome	sti*bst	7.85 cum
Concrete vol. of bottom ring bea	pi()*(ds)*brb*brd	3.82 cum
Concrete vol. of balcony	bw*0.1*pi()*(td+mrb+bw)	0.00 cum
Total volume of concrete		**54.89** cum

Volume calculations

Volume of cylindrical portion	pi()*(td/2)^2*(swh+trd+mrd)		191
Volume of conical portion	pi()/3*((td/2)^2+(td/2*ds/2)+(ds/2)^2)*ish		67 vcp
Volume of bottom dome portion	PI()/6*(3*(ds/2)^2+bdh^2)*bdh		-15 vbdp
Volume of internal shaft	PI()*isd^2/4*(swh+ish-bdh)		-5
	Net volume	va	**238** kl
Allowable stress in concrete under bending		cbc	10.0 N/mm2

Design of Top dome

Thickness of top dome		tt	0.125 m	
Live load on top dome		Ll	1.5 kn/sqm	
Diameter of steel bars	STEEL Dia is OK	dia	8 mm	
Area of steel		Ast	300 mm2	
Spacing of steel bars		Spp	125 mm	168
Minimum percentage of steel		Mpt	0.240 %	
Meridional stress		Ms	0.171 n/mm2	
Circumferencial stress		cs	0.075 n/mm2	

The stresses are compressive and with in permissible limits

Calculations

Radious of top dome	((td/2)^2+h^2)/(2*h)		Rt	7.50 m
	Sth	0.600	Cth	0.800
Surface area of top dome	2*pi()*Rt*h		St	70.69 sqm
Weight of top dome &finishings	(tt*25+0.50)		wt	3.63 kn/sqm
Dead and live load per sqm	wt+Ll		twt	5.13 kn/sqm
Meridional thrust	WxR/(1+Cos(th))		Mt	21.35 kn/m
Circumferencial thrust	twt*rt*(cth-1/(1+cth))		ct	9.40 kn/m

Meridional stress	Mt*1000/(tt*1000*1000)	Ms	0.17 n/mm2	
Circumferencial stress	Ct*1000/(tt*1000*1000)	Cs	0.08 n/mm2	

The stresses are compressive and with in permissible limits

Min. percentage of steel	IF(ds<=15,0.24%,0.35%)	Mpt	0.24 %	
Area of steel required	Mpt*tt*1000*1000/100	Ast	300 mm2	
Spacing of steel	pi()*(dia)^2/(4)*1000/Ast	Sp	168 mm	

Design of Top ring beam

Top ring beam breadth	Tensile stress with in limits	0.65	n/mm2	trb	0.30 m	OK
Top ring beam depth		OK		trd	0.25 m	0.13
Dia of steel bars				trds	**12** mm	
Number of bars				trnb	4 Nos	4
Area of steel provided		Safe		Astp	452 mm2	394
Hoop tension in the top ring beam				Ht	51 kn/m	
Tensile stress in concrete	Tensile stress with in limits			tss	0.65 n/mm2	

Provide 2L - 10 for stirrups at 200 mm c/c

Calculations

Hoop tension in the top ring beam	mt*Cth*(td/2)	Ht	51 kn/m
Area of hoop reinforcement	Ht*1000/rst	Astr	394 mm2
Tensile stress in concrete	ht*1000/((trb*trd)*10^6+(m-1)*Astp), tss=		0.65 n/mm2

Design of side wall

		hoop			bendg	
Thickness of side wall at top	all Tensions in limits	0.30	ti	0.200 m		0.69
Thickness of side wall at bottom	Thickness is adequate hoop		tii	0.200 m	0.12	
Dia of vertical steel on water face	steel Dia is OK		vsd	**10** mm		
Spacing of bars			wfs	200 mm	200	
Dia of vertical steel on outer face	steel Dia is OK		vsdi	**10** mm		
Spacing of bars			ofs	200 mm	200	
Dia of hoop steel bars	steel Dia is OK		hsd	**10** mm		
Spacing of bars on each face			sphs	200 mm	200	
Vertical steel on water face			wsas	273 mm2		
Vertical steel on out side face			osas	240 mm2		
Vertical steel at mid height			mhasi	240 mm2		
Total Hoop steel	for two faces		has	480 mm2		
Area of hoop steel provided	for two faces		hasp	785 mm2		
Hoop Tensile stress in concrete			tsc	0.30 N/mm2		
Maximum hoop tension			hopt	59 kn/m		
Maximum moment on water face				-4.58 knm		
Maximum bending tensile stress in concrete			btsc	0.69 N/sqmm		

Calculations

Bending moment coefficients from table 10 of IS: 3370 (Pt IV)

H^2/(Dxt) = swh^2/(td*(ti+tii)/2) hdr 3.33

Height from top	m	Mom.Coef	Moment knm	Thikness mm	Ast mm2
0.1*swh	0.25	0.00050	0.073	15	4.38
0.2*swh	0.49	0.00210	0.309	30	18.39
0.3*swh	0.74	0.00406	0.598	42	35.61
0.4*swh	0.98	0.00630	0.926	53	55.17
0.5*swh	1.23	0.00820	1.205	60	71.82
0.6*swh	1.47	0.00903	1.328	63	79.13
0.7*swh	1.72	0.00743	1.093	57	65.12
0.8*swh	1.96	0.00157	0.231	26	13.74
0.9*swh	2.21	-0.01059	-1.558	68	-92.83
1.0*swh	2.45	-0.03112	-4.577	117	-272.72

Maximum negative steel	wsas	273 mm2
Maximum positive steel	osas	240 mm2
Area of steel at mid height	mhasi	240 mm2

Hoop tension coefficients from table 12 of IS: 3370 (Part IV)

T = Coeff*w*swh*td/2

H^2/(d*t)			hdr		3.33

	ht from top	Coeff.	Force	Thikness	Steel
	m		kn/m	mm	mm2
0	0	0.055	6	4	47
0.1*swh	0.25	0.165	18	12	140
0.2*swh	0.49	0.272	30	20	230
0.3*swh	0.74	0.372	41	27	316
0.4*swh	0.98	0.456	50	33	386
0.5*swh	1.23	0.519	57	38	440
0.6*swh	1.47	0.539	59	40	457
0.7*swh	1.72	0.504	56	37	427
0.8*swh	1.96	0.399	44	29	338
0.9*swh	2.21	0.225	25	17	191

Maximum hoop steel	has	480	mm2
Maximum hoop tension	hopt	59	Kn/m

Design of Middle ring beam

Depth of middle ring beam	Tensile stress with in limits	Mrd	0.3	m	
Breadth of middle ring beam	Tensile stress= 1.04	Mrb	0.5	m	
Balcony width		bw	0	m	
Dia of hoop steel bars provided		hsdia	**16**	mm	
Number of hoop bars provided		nhb	8	Nos	7
Area of hoop steel provided		hopsp	1608	mm2	1307
Total hoop tension due to vertical load and water		thopt	170	kn	
Hoop tensile stress in concrete		hoti	1.04	n/mm2	
Stirrups	Provide 10mm dia @ 200 mm C/C				

Calculations

Load due to top dome	st*twt		362	kn
Load due to top ring beam	PI()*(td+trb)*trb*trd*25		55	kn
Load due to cylindrical wall	pi()*(td+(ti+tii)/2)*(ti+tii)/2*swh*25		354	kn
Self weight of middle ring beam	pi()*(td+mrb)*mrb*mrd*25		112	kn
Weight of balcony and live load	pi()*(td+2*tii+bw)*bw*4.75		0	kn
Total vertical load		vlmrb	**883**	kn
Load per unit length of beam	vlmrb/(pi()*(td+mrb))	vlpm	30	kn/m
Horizontal compo. Of inclined reaction (ve	vlpm/(TAN(th*pi()/180))	hpt	30	kn/m
~~Hoop tension due to vertical load~~	~~hpt*(td+tii)/2~~	~~hoptv~~	~~136~~	~~kn~~
Hoop tension due to water pressure	(10*swh*mrd*(td+tii)/2)	hoptw	34	kn
Total Hoop tension on Middle ring beam		thopt	**170**	kn
Area of steel required	thopt*1000/rst	hopst	1307	mm2
Hoop tensile stress in ring beam	thopt*1000/(mrb*mrd*10^6+(m-1)*hopsp)			
		hoti	1.04	n/mm2

Design of conical SIDE WALLS (Shell)

Inclined slab thickness	Thickness is adequate	1.68	ist	0.3 m	0.27
Dia of **hoop** steel bars	Tensions in limits	0.66	hsdi	**16** mm	
Spacing of hoop bars on both faces	steel Dia is OK		hssp	200 mm	264
Dia of **radial** steel bars	steel Dia is OK		rsdi	**16** mm	
Spacing of radial bars on both faces			rssp	150 mm	221
Height of the cone			ish	1.50 m	
Slope of the conical shell in radians			thr	0.785 radians	
Area of hoop steel required			ash	1522 mm2	
Area of radial steel			asri	909 mm2	
Maximum hoop tension			mht	198 kn/m	
Max. hoop tensile stress			hts	0.66 N/mm2	

Calculations

Weight of top dome,ring beam,side wall and middle ring beam				883 kn
Weght of water over inclined shell	(PI()/3*((td/2)^2+(td/2*ds/2)+(ds/2)^2)*ish-(PI()*ds^2/4*ish))*10+ +PI()*(td^2-ds^2)/4*swh*10		wwis	1113 kn
Self weight of inclined shell	pi()*(td/2+ds/2)*ist*ish/SIN(th*PI()/180)*25		wis	375 kn
Total load on the conical slab			tlcs	**2371** kn
Total load per unit length	tlcs/(pi()*ds)		tlrb	126 kn/m
Meridional thrust	tlrb/SIN(th*pi()/180)		npi	178 kN/m
Hoop tension in the shell	(10*(swh+ish-y)+25*ist*COS(thr))*(ds/2+y/TAN(thr))/SIN(thr)			
Hoop tension at **bottom** of inclined slab	yi =	0.00	tci	190 kn/m
Hoop tension at 1/4 height from **bottom**	ayi =	0.38	atci	196 kn/m
Hoop tension at **middle** of inclined slab	yii =	0.75	tcii	198 kn/m
Hoop tension at 3/4 height from **bottom**	ayii =	1.13	atcii	196 kn/m
Hoop tension at **top** of inclined slab	yiii =	1.50	tciii	190 kn/m
USING SOLVER tcmax=	ymax =	0.740	tcmax	197.83 kn/m
Area of hoop steel required MAX(tcmax*1000/rst,0.24 or 0.35*ist*10^4)			ash	1522 mm2

Design of inclined slab for bending

Load on the slab per meter	tlcs/(pi()*(td+tii+ds)/2)	lis	99.31 kn/m2
Bending moment	lis*ish/(SIN(th*PI()/180))/10		21.07 knm
BM due to compression	vlpm/SIN(th*PI()/180)*(ist-0.045-rsdi/2000-ist/2)		4.06 knm
		bmis	25.13 knm
Thickness required for un-cracked	Sqrt(6*bmis*10^3/(allowbt))	istr	275 mm
~~Area of steel required~~	~~bmis*10^6/(tst*j*(ist*1000-45-rsdi/2))~~	asri	909 mm2
Minimum % of steel	(0.24 or 0.35)/2		0.120 %
Minimum area of steel		asr	360 mm2
	tcmax*1000/(ist*1000*1000+(m-1)*1000/(hssp)*PI()*(hsdi)^2/4*2)		
Bending(T) stress in the conical shell	6*bmis*10^3/(ist*1000)^2	bts	1.68 n/mm2
Hoop Tensile stress in the conical shell		hts	0.66 n/mm2

Design of bottom dome

Thickness of bottom dome		bst	0.25 m	
Dia of steel bars	steel Dia is OK	bdia	**10** mm	
Spacing of steel bars in two layers		Spsi	200 mm	262
Minimum percentage of steel		Mpti	0.120 %	
Area of steel required		asti	300 mm2	
Meridional stress		Msi	0.40 N/mm2	
Circumferencial stress		Csi	0.18 N/mm2	

The stresses are with in permissible limits

Calculations

Radious of bottom dome	((ds/2)^2+bdh^2)/(2*bdh)	Rb	5.00 m
	Sthi 0.600	Cthi	0.800
Surface area of bottom dome	2*pi()*Rb*bdh	Sti	31.42 sqm
Weight of bottom dome &finishings	(bst*25+0.75)*sti	wti	220 kN
Weight of water on bottom dome	pi()*10*((ds/2)^2*(swh+ish)-(3*(ds/2)^2+bdh^2) *bdh/6-(isd)^2/4*(swh+ish-bdh))	wwi	918 kN
Total unit load on bottom dome	(wti+wwi)/sti	twb	36 kN/m2
Meridional thrust	twb*rb/(1+cthi)	Mti	101 kN/m
Circumferencial thrust	twb*rb*(Cthi-1/(1+cthi))	Cti	44 kN/m
Meridional stress	Mti*1000/(bst*10^6)	Msi	0.40 N/mm^2
Circumferencial stress	Cti*1000/(bst*10^6)	Csi	0.18 N/mm^2
Min. percentage of steel	(0.24 or 0.35)	Mpti	0.240 %
Area of steel required	Mpti*bst*10000	Asti	300 mm^2

Design of bottom ring beam (thickend shaft @ TOP)

Bottom ring beam depth	Beam under compression	brd	0.45 m
Bottom ring beam breadth	section is Safe	brb	0.45 m
Cover to top steel		dd	0.045 m
Dia of bars for hoop tension		ssdi	**16** mm
Number of bars for hoop tension		brhs	8 Nos
Dia of stirrups		sdi	**10** mm
Spacing of two leg stirrups			**200** mm
Thrust from the bottom dome		htbd	80 kN/m
Tthrust from the Conical walls		htcd	126 kN/m
Net force on the ring beam	Beam under compression	nht	45 kN/m
Hoop compression		Hoc	136 kN
Stirrups	Provide 10mm dia @ 200mm C/C		

Calculations

Thrust from the bottom dome	Mti*Cthi	htbd	80 kN/m
Tthrust from the Conical dome	npi*COS(th*pi()/180)	htcd	126 kN/m
Net force on the ring beam	htcd-htbd	nht	45 kN/m
		Beam under compression	
Hoop compression	nht*ds/2	Hoc	135.89 kN
Compresive stress	hoc*1000/(brb*brd*10^6)	hcs	0.67 N/mm^2 Safe
Hoop tension	nht*ds/2	Hot	0.00 kN
Tensile stress in the beam	hot*1000/((brb*brd*10^6-hsrbi)+(m-1)*hsrbi)	hst	0 N/mm^2
Area of steel required for hoop tension		hsrb	0 mm2
Area of steel required in the bottom ring beam		hsrbi	1620 mm2

Total loads for Tank Portion

Weight of top dome	twt*ts		362 kn
Weight of top ring beam	pi()*(td+trb)*trb*trd*25		37 kn
Weight of side wall	pi()*(td+(ti+tii)/2)*(ti+tii)/2*swh*25		354 kn
Weight of middle ring beam	pi()*(td+mrb)*mrb*mrd*25		112 kn
Weight of inclined shell	wis		375 kn
Weight of bottom dome	wti		220 kn
Weight of water	wwis+wwi		2031 kn
Load per meter up to bottom ring beam			185 kN/m
Self weight of the beam	brb*brd*25		5 kN/m
Total load per meter on SHAFT SUPPORT @TOP		wsi	190 kN/m

Side face reinforcement on each face IF(brd>0.45,0.1*brb*brd/2*100,0) 0.00 cm2

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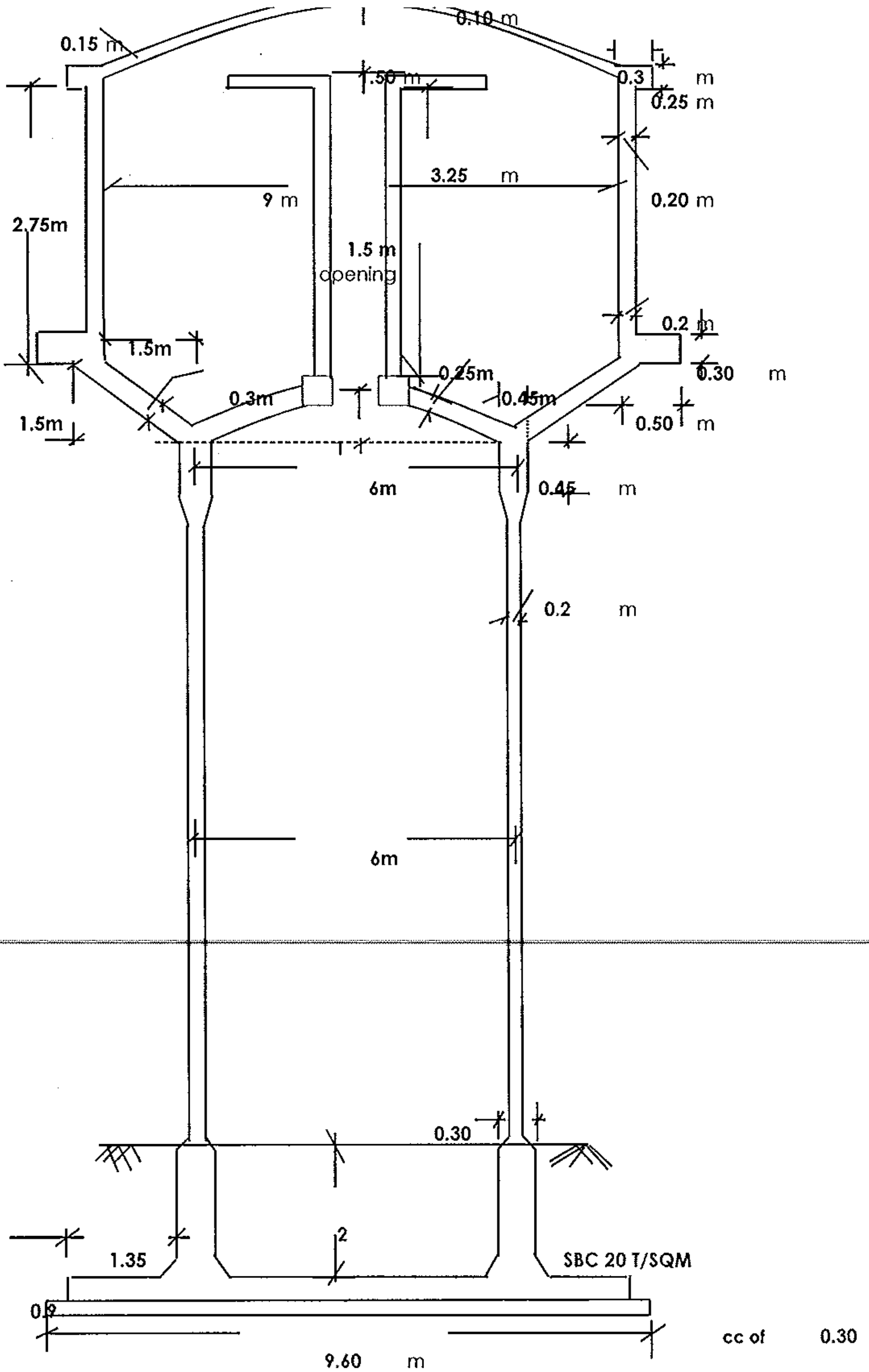

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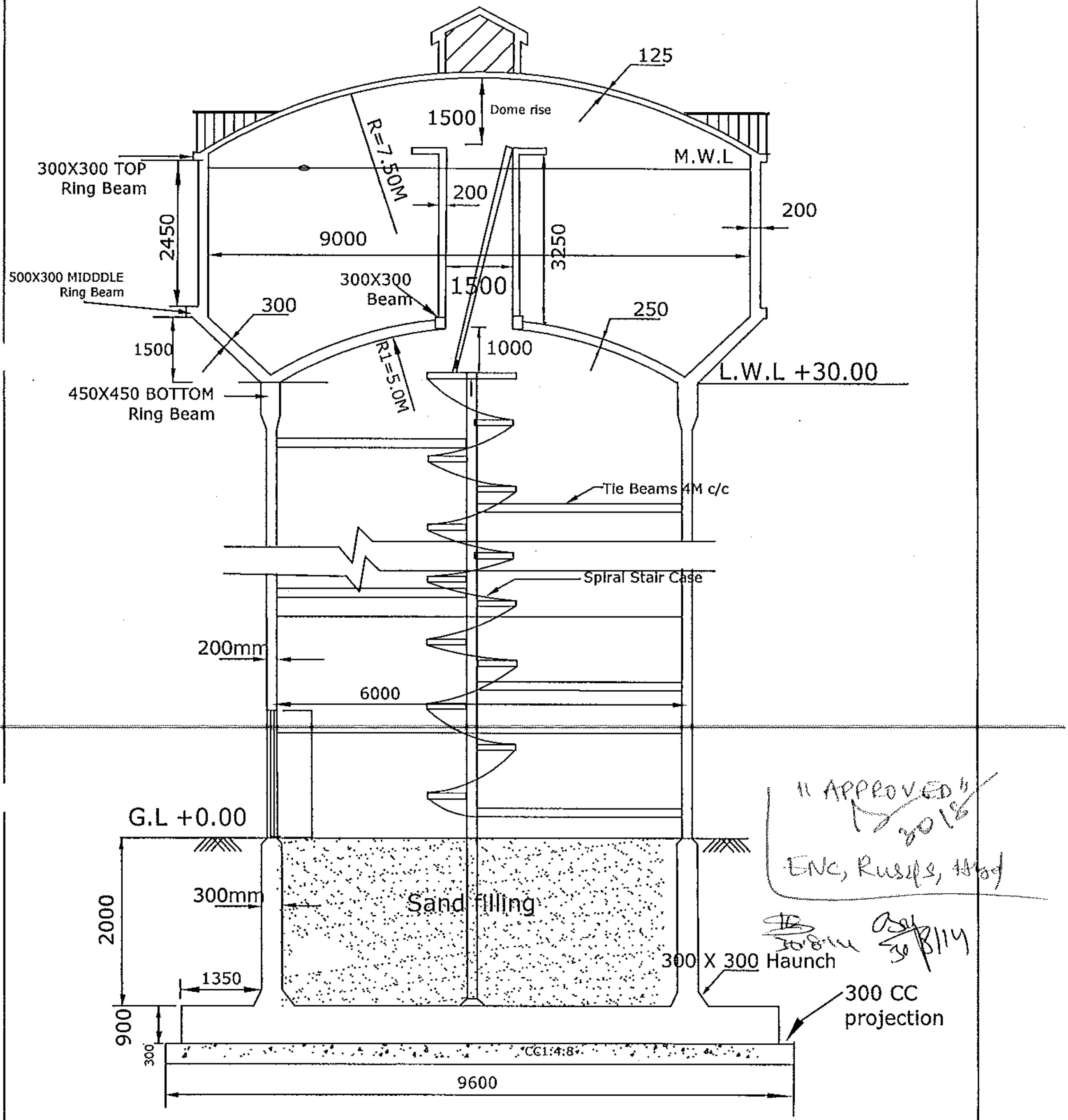
Design of Shaft type supporting structure for 200KL capacity OHBR						
	Staging height	30	m			
Location of tank	MUDHOLE HW					
DATA :	Location of tank		Plain Ground			
Basic Wind speed	44	m/s	500	kM away from sea		
Net SBCof the Soil assumed				15	t/m2	
Depth of foundation up to top of raft			df	2.00	m	
TANK DETAILS					total net water volume	
Capacity of tank			v	**200**	kl	203
Height of staging			hs	30.00	m	
Dia of stagging/ Shaft			ds	6.00	m	compression
Dia of tank			td	9.00	m	
Top slab / Dome	tst	0.125	h	1.50	m	R2=7.5
Top ring beam	trd	0.300	trb	0.300		free board
Side wall ht above middle RB	swh	2.450	swt	0.200		0.3
Middle ring beam	mrd	0.300	mrb	0.500		
Dia of central opening	copt	0.20	copdi	1.5		
Inclined slab	Ist	0.300	ish	1.500	2.121	
Bottom ring beam	brd	0.450	brb	0.450		
Bottom Dome	bst	0.250	bdh	1.000	R1=	5.00
Wind constants	ki	1.000	kii10	1.050		
	kii15	1.090	kii20	1.120		
	kii30	1.150	kiii	1.000		
Basic wind speed	158.4	Km/h	vb	44	m/sec	
		Shaft details				
Grade of concrete			g	30	n/mm2	WS
Grade of steel medium assure	Fe415	equivallent fy		343	n/mm2 ⟷	**190**
Thick ness of shaft		Safe	ts	**0.2**	m	
opening width			wp	1	m	
~~**Dia of vertical steel bars proposed**~~			~~di~~	~~10~~	~~mm~~	
Spacing of vertical reinforcement on both the faces			sp	200	mm	209
Dia of circumferencial steel bars proposed			cdi	10	mm	
Spacing provided horizontally on both the faces			sph	200	mm	200
Height of shaft above raft t	hs-brd-0.15+df		sh	31.4	m	
Stress in the shell	compression			2.04	kg/cm2	
Nature of stress				Comp		
Tensile stress due to ring moment		safe		0.83	Kg/cm2	21.00
	No Comparision of eri and er needed					
	er	0.264	eri	scv Governs		
			alpa	168.00		
Maximum compressive stress in shaft		safe		28.23	Kg/cm2	114.00
Area of vertical steel required				5.00	cm2	
spacing required				300	mm	
Area of circumferential steel required				4.80	cm2	
spacing required				200	mm	

Ring beam(thickend shaft) on Raft						
Width of ring beam @ bottom of shaft			rb	0.30	m	
Depth of ring beam @ bottom of shaft			rd	2.00	m	
Dia of vertical bars			rsdi	10	mm	
Spacing of bars			rbsi	200	mm	209
Dia of circumferencial bars			rsdii	10	mm	
Spacing of bars			rbsii	200	mm	209
	Design of raft					
haunch width on raft	0.30	m	Safe	Safe	dia cc	
CC layer below the raft	thickness	0.3	projection	0.30	9.6	9.58
Dia of raft provided	<= 9.9 m	Safe	d	9.00	m	8.98
Overall depth of raft		Safe	dr	0.90	m	0.562
Dia of bottom bars			db	20	mm	
Spacing of bottom bars arranged as mesh			space	125	mm	143
Dia of top bars			dbi	12	mm	
Spacing of top bars arranged as mesh			spacei	150	mm	209
Effective depth provided (de)			de	0.83	m	
Radial Moments						
Radial distance from centre	0.00	1.50	2.85	3.15	4.50	m
Radial moments Mr	-3.70	10.51	34.32	30.20	0.00	tm
Area of steel in cm2	**2.5**	**7.0**	**22.0**	**19.5**	**0.0**	
	Moment in tm	Ast in cm2	Spacing in mm			
Maximum negative moment	**-3.70**	**2.5**	209	mm		
Maximum positive moment	**34.32**	**22.0**	143	mm		
Minimum area of steel	mas	**10.80**	cm2			
Circumferencial Moments						
Radial Distance from centre	0.00	1.50	2.85	3.15	4.50	m
Circumferencial moment Mt	-3.70	-2.24	-0.55	3.50	1.57	tm
Area of steel in cm2	**2.5**	**1.5**	**0.5**	**2.5**	**1**	
	Moment in tm	Ast in cm2	Spacing in mm			
Maximum negative moment	**-3.70**	**2.5**	209 mm			
Maximum positive moment	**3.50**	**2.5**	291 mm			

for verticals, hoop bars pls provide @ 150 c/c



200 KL OHBR SHAFT
ON PLAIN GROUND

200KL OHBR 30M
44 m/s Basic WIND
SBC 15T/SQM

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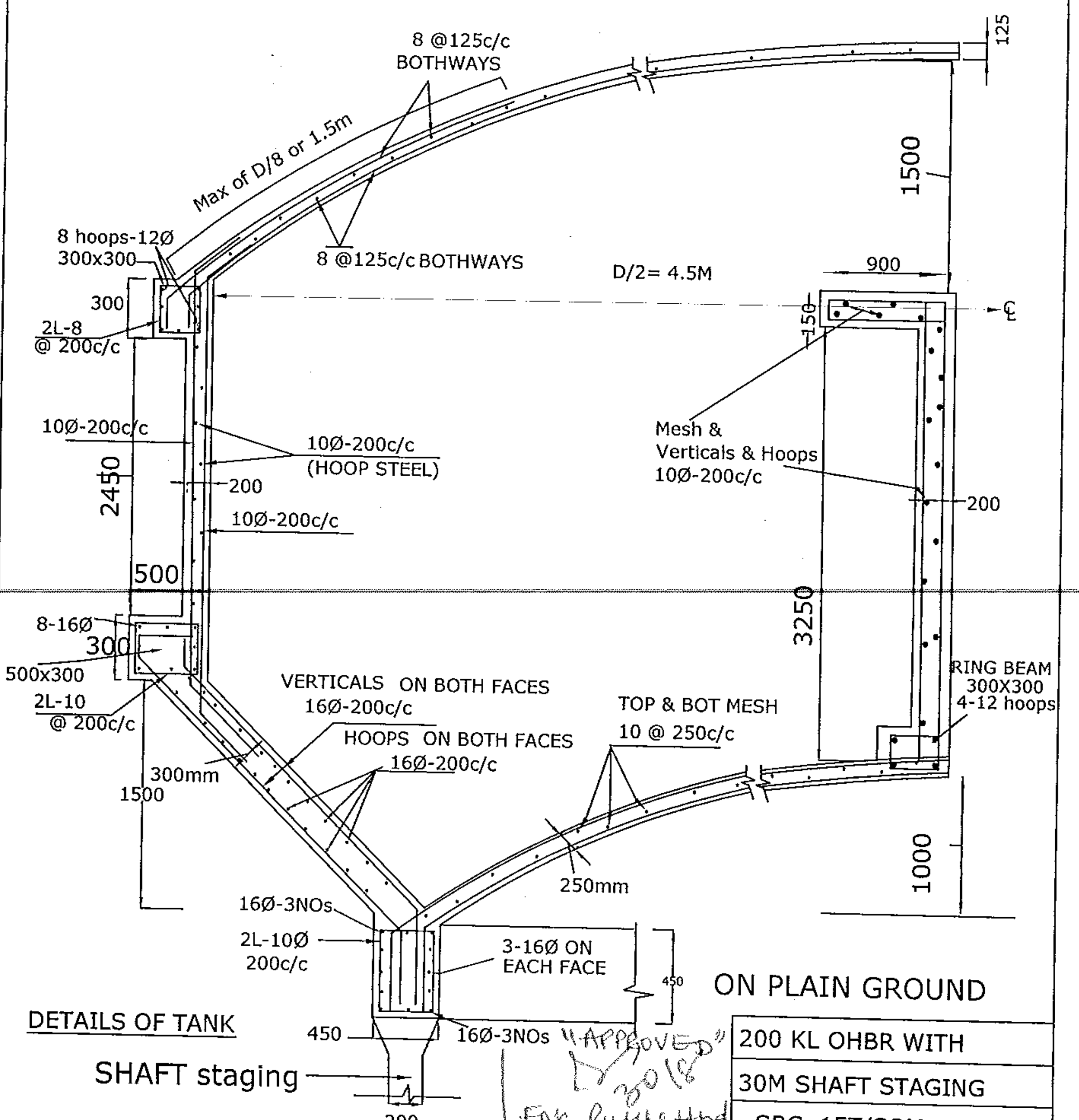

200 KL OHBR WITH
30M SHAFT STAGING
SBC 15T/SQM

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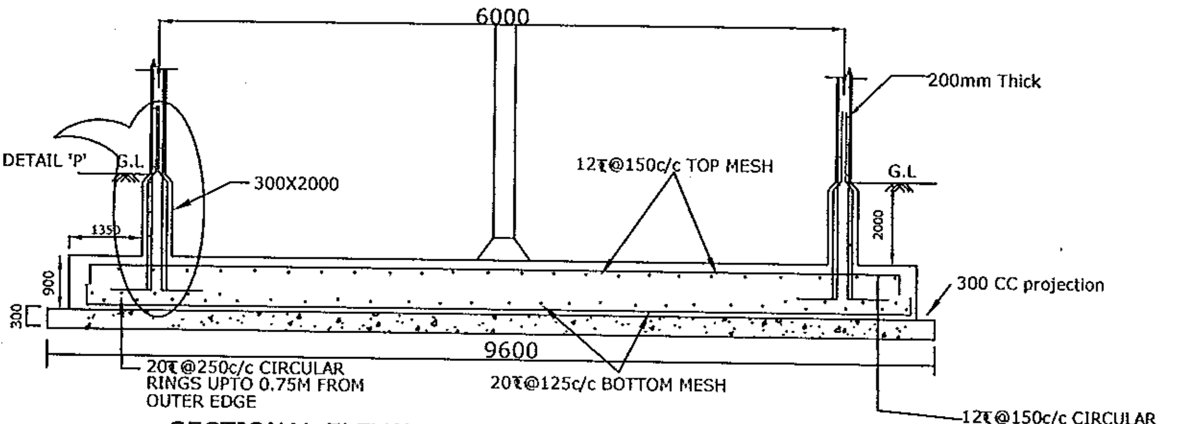
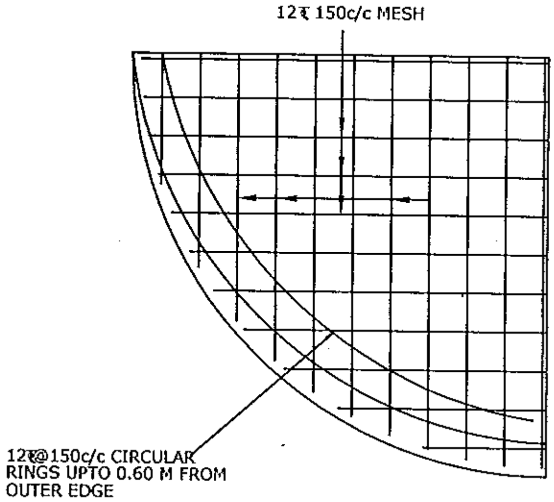
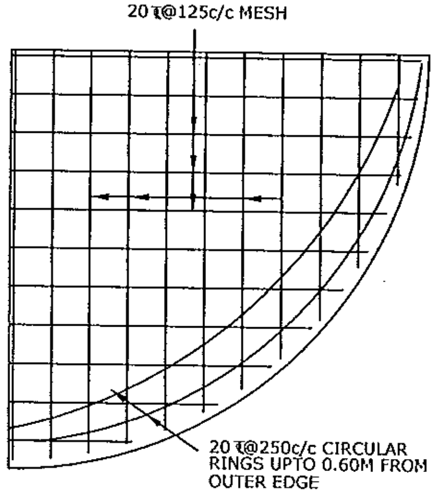


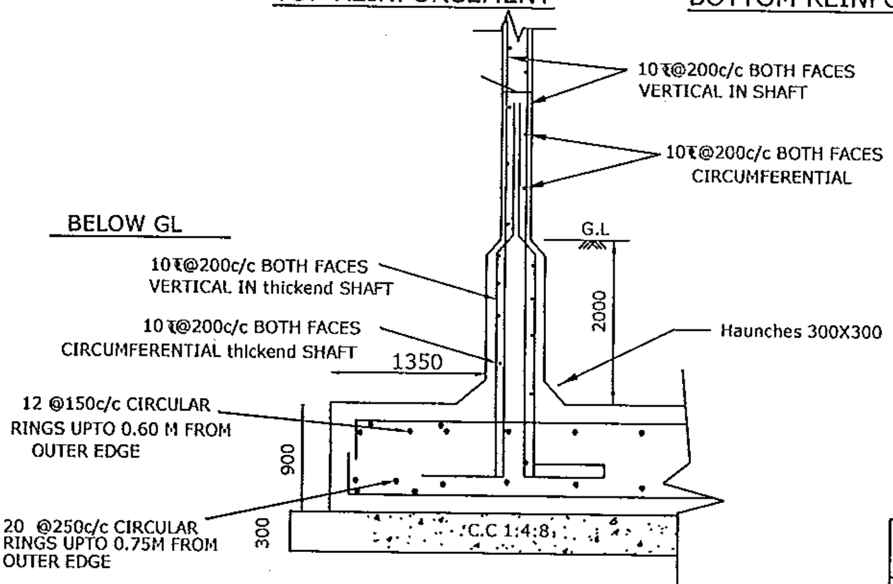
SECTIONAL ELEVATION OF RAFT



TOP REINFORCEMENT



BOTTOM REINFORCEMENT



DETAIL 'P'

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ON PLAIN GROUND

200KL OHBR 30M
44m/s Basic WindSpeed
SBC 15T/SQM

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Design of Column type supporting structure and ring foundation for O H S R

Staging height					**15.00**	**m**	
DATA :	Grade of concrete			g	30	N/mm2	
Location of tank							
AREA of Region		TELANGANA					
Radial Distance from the sea coast=		500 kM					
Located on Hill portion		no					
Net SBC of the Soil					15	t/m2	
Depth of foundation up to top of raft				df	2.00	m	
Tank details							
Capacity of tank				v	150	kl	151.6 kl
Staging Height	ınge to suit the height of column segment			sh	15.00	m	
Dia of staging				ds	5.50	m	
Height of each stage **Clear of braces**				hs	3.09	m	3.09
Number of stagings				ns	4	nos	
Number of columns				nc	6		
Tank Diameter				td	8.00	m	
Height of dead storage				hds	0.15	m	
Top slab / Dome		tst	0.125	h	1.250	m	
Top ring beam		trd	0.250	trb	0.300	m	
Side wall		swh	2.350	swt	0.200	m	
Middle ring beam		mrd	0.300	mrb	0.450	m	
Inclined slab		ist	0.250	ish	1.250	m	
Bottom ring beam		brd	0.850	brb	0.450	m	
Bottom slab / Dome		bst	0.200	bdh	0.950	m	
Brace		brcd	0.550	brcb	0.300	m	

Wind constants	ki	0.991	kii10	1.000		
	kii15	1.050	kii20	1.070		
	kii30	1.120	kiii	1.000	1.1 to 1.16 for hill top	
Basic wind speed	158 Km/hr		vb	44	m/sec	
Size of column	seismic moment governs		cbxcb	0.35	m	

Seismic coefficients	Zone	=	2	Zone	2	3
Beeta(from table 3 of IS 1893)		sbe	1.00	sbe	1.00	1.00
i (from table 4 of IS 1893)		sei	1.50	sei	1.50	1.50
Alpha0(from table 2 of IS 1893)		a0	0.02	a0	0.02	0.04

~~*** Note: nellore & vijayawada Zone 3, other dist. Are Zone 2 in AP~~

Design of column

Leeward column		seismic moment governs						
Factored Load on Leeward column					factcl	105	t	
Moment on column					cm	4.02	tm	
	Pu/(fck*BD)				lr	0.29		
	Mu/fckBD^2					0.05		
Refering SP 16	P/fck	d'/D=	0.151		ps	0.02	enter value from SP 16-chart	
Windward column								
Load on Windward column		column under compression			nfc	10.5	(-ve indicates tension)	
Moment on column					cm	4.02	tm	
	Tu/fckBD		safe			0.0000		
	Mu/fckBD2					0.0000		
Refering to SP-16 chart	P/fck				sp	0.00	enter value from SP 16	
Dia of main steel			sd		16	16	mm	
No of bars			nb		4	4		5
Area of steel provided			Safe		clasp	**16.08**	cm2	9.80 cm2
						Steel within 4%		
		Provide laterals of 8mm dia @				200	mm c/c	

Design of brace

Clear cover		ccb	0.045 m	
Breadth of brace		brcb	0.30 m	
Depth of brace		brcd	0.55 m	
Factored moment		bm	139 knm	
Area of steel required			8.46 cm2	
Dia of main steel		dib	20 mm	
Number of bars provided	safe	ni	3 nos	
Dia of stirrup		diib	10 mm	
Spacing of stirrups		sii	200	300 mm

Design of ring Raft beam

Width of beam		rb	0.45 m	
Overall Depth of beam		rd	0.75	0.59 m
Clear cover to steel		ccrb	0.08 m	
Factored moment at support		tm*1.5	281.05 knm	
Factored moment at Mid span		(Mtb*10+Msp)*1.5	187.31 knm	
Support section				
Bottom steel (tensile)		asti	12.48 cm2	
Dia of bottom bars		dii	16 mm	
Number of bars	Safe	bsb	7	
Mid span section				
Steel at Top (Tensile)		astii	6.91 cm2	
Dia of top bars		diii	16 mm	
Number of bars		tsb	4	
Dia of stirrups		di	12 mm	
Spacing of stirrups		spi	115	126 mm
Side face reinforcement IF(rd>0.45,0.1*rb*rd/2*100,0) on each face			1.69 cm2	
dia of sideface reinforcement		sfd	16 mm	
no. of bars on each face		nsr	2	

Design of ring type raft

	Safe	Safe	Safe	Required
Grade of concrete		g	30 N/mm2	
Grade of steel		Fy	415 N/mm2	
Width of raft		br	1.60 m	1.45
Overall depth of raft	Safe	dr	0.35 m	0.23
Overal depth of raft at edge		de	0.25 m	
~~Clear cover to steel~~		~~cr~~	~~0.06 m~~	
Dia of radial bars in raft		db	12 mm	
Spacing of steel @ ring beam location		space	200 mm	259
Dia of circumferential reinforcing bars		dbi	12 mm	
Spacing of rings		spacei	200 mm	225
Dia of reinforcement on top face			12 mm	
Spacing of bars			200 mm	
Straight portion of raft		a	0.50 m	
Outer dia of ring			7.10 m	
Inner dia of ring			3.90 m	

Qtyof concrete	**96.29 m3**
Qty of steel	**4.89 t**

Design calculations

Weight of tank

Top slab / Dome	IF(h=0,(pi*(td+2*swt)^2/4*tst*2.5),(2*pi*((td/2)^2+h^2)/(2*h)*h*tst*2.5))		17.24 t
Top ring beam	pi*(td+trb)*trb*trd*2.5		4.89 t
Side wall	pi*(td+swt)*swh*swt*2.5		30.27 t
Middle ring beam	pi*(td+mrb)*mrb*mrd*2.5		8.96 t
Inclined wall	pi*((td+ist)+ds)/2*ist*sqrt(ish^2+((td+ist-ds)/2)^2)*2.5		25.08 t
Bottom ring beam	pi*ds*brb*brd*2.5		16.52 t
Bottom slab / Dome	@if(bdh=0,pi*(td+2*swt)^2/4*bst*2.5,2*pi*((ds/2)^2+bdh^2)/(2*bdh)*bdh*bst*2.5)		13.30 t
Add for ladder railing etc.,			5.00 t
Total weight of tank		tw	**121.00** t
Weight of staging			
Weight of brace	brl*nc*brcd*brcb*ns*2.5		27.22
Weight of columns	nc*cb*cb*((hs+brcd)*ns-brd+df)*2.5		28.87
Total		wwi	**56.09**
Total weight of tank & staging		wt	**178** t
Weight of water			
Cylindrical portion	pi*td^2/4*(swh+mrd)		133.20
Vol.of inclined portion	1/3*pi*((td/2)^2+td*ds/4+(ds/2)^2)*ish		45.24
Vol. of bottom dome	pi()/6*(3*(ds/2)^2+bdh^2)*bdh		11.73
Total		ww	**166.71** t
Inclination of slant wall	ATAN(ish/((td-ds)/2))*180/pi	th	45.00 Rad

Wind analysis

Terrain catregory-2 Probable life of Structure= 50 yrs

Located on Hill portion

basic velocity	→	44 m/s
Tatal Ht of the structural		21.1 m

Wind constants

FACTORS	above GL Height	Risk factor k1	Terrain 2nd catogory k2	Topography k3	design wind velocity V_z	Desing Wind Pressure P_z in N/sqm	
height uoto 10m from GL	10	0.99	1.00	1.00	43.59	1140	n/sqm
height from 10m to 15m	15	0.99	1.05	1.00	45.77	1257	n/sqm
height from 15m to 20m	20	0.99	1.07	1.00	46.64	1305	n/sqm
height from 20m to 30m	30	0.99	1.12	1.00	48.82	1430	n/sqm
height from 30m to 50m	50	0.99	1.17	1.00	51.00	1561	n/sqm

FACTORS	above GL Height	Wind Pressure at Z elevation P_z in N/sqm	Area averaging factor Ka	Wind Directionality Factor, Kd	Desing Wind Pressure P_d in N/sqm
FOR TANK PORTION					
Bottom Ring beam	**14.85**	1253.547	0.9	1	1128.192
Conical slab portion	**16.10**	1267.689	0.9	1	1140.920
Middle Ring beam	**16.40**	1270.589	0.9	1	1143.530
Cylindrical Side wall	**18.75**	1293.311	0.9	1	1163.980
Top ring beam	**19.00**	1295.728	0.9	1	1166.155
Top slab / Dome	**20.25**	1308.518	0.9	1	1177.666

Vertical load on Dome

Top slab / Dome	**1.25**	1140.184	0.9	1	1026.166

Moment due to wind on tank @ top of footing

	Ht.	Area	pressure	coefficient	force	LA	Moment
	m	m2	n/m2	C_f	N	m	tm
Top slab / Dome	19.96	6.88	1178	0.70	5672	19.98	11.33
Top ring beam	18.46	2.15	1166	0.70	1755	19.09	3.35
Side wall	18.46	15.12	1164	0.70	12320	18.04	22.22
Middle ring beam	16.26	2.67	1143.53	0.70	2137.26	18.26	3.90
Inclined wall	15.49	6.53	1140.92	0.70	5216.14	17.49	9.12
Bottom ring beam	14.86	5.06	1128	0.70	3994	16.44	6.56
				wfi	31094	wmt	**56.49**

Moment due to wind on staging

		Ht.	Area	pressure	coefficient	force	LA	Moment
On braces		m	m2	N/m2	C_f	N	m	tm
1st brace from top	hi	10.92	4.54	1257	1.00	5704	12.65	7.21
2nd brace from top	hii	7.28	4.54	1140	1.00	5173	9.005	4.66
3rd brace from top	hiii	3.64	4.54	1140	1.00	5173	5.365	2.78
4th brace from top	hiv	0	0.00	0	1.00	0	0	0.00
5th brace from top	hv	0	0.00	0	1.00	0	0	0.00
6th brace from top	hvi	0.00	0.00	0.00	1.00	0	0.00	0.00
7th brace from top	hvii	0.00	0.00	0.00	1.00	0	0.00	0.00
On columns		14.01	29.42	1199	1.60	56423	9.005	50.81
					wfii	72474	wms	**65.46**

Total moment @ top of footing mbw **122.00** tm

Moment due to wind on tank @ bottom of footing @ bottom of raf

	Ht.	Area	pressure	coefficient	force	LA	Moment
	m	m2	N/m2	C_f	N	m	tm
Top slab / Dome	19.84	6.88	1178	0.70	5672	21.33	12.10
Top ring beam	18.46	2.15	1166	0.70	1755	20.69	3.63
Side wall	18.46	15.12	1164	0.70	12320	18.39	22.65
Middle ring beam	16.26	2.67	1144	0.70	2137	18.61	3.98
Inclined wall	15.49	8.59	1141	0.70	6863	17.84	12.24
Bottom ring beam	14.86	5.06	1128	0.70	3994	16.79	6.70
					32741	wmti	**61.30**

Moment due to wind on staging @bottom of fotting

		Ht.	Area	pressure	coefficient	force	LA	Moment
On braces		m	m2	N/m2	C_f	N	m	tm
1st brace from top	hi	10.92	4.54	1257	1.00	5704	12.995	7.41
2nd brace from top	hii	7.28	4.54	1140	1.00	5173	9.355	4.84
3rd brace from top	-hiii	3.64	4.54	1140	1.00	5173	5.715	2.96
4th brace from top	hiv	0	0.00	0	1.00	0	0	0.00
5th brace from top	hv	0	0.00	0	1.00	0	0	0.00
6th brace from top	hvi	0.00	0.00	0	1.00	0	0	0.00
7th brace from top	hvii	0.00	0.00	0	1.00	0	0	0.00
On columns		14.01	29.42	1199	1.60	56423	9.355	52.78
						72474	wmsi	**67.99**

Total moment at bottom of footing wmti+wmsi mbwi **130.00** tm

Moment due to Seismic force at ground level

Horizontal seismic coeff	sbe*sei*a0	alpha0	0.03	
Moment at the base	alpha0*((tw+ww)*(hc+brd+(ish+swh+0.5*h)/2)+wwi*hc/2)			
		mbse	158.28	tm
		seismic moment governs		

Design moment

At the base	Max(mbse,mbw)	mb	**158.28**	tm
At the bottom of footing	max(mbwi,mbse)	mbi	**158.28**	tm
	1.6			
weight of ring beam	pi*ds*rb*(rd-dr)*2.5	wrb	8	t
weight of raft	pi*ds*br*dr*2.5	wr	24	t
Weight When Tank full	ww+wt+wr	pfull	368.90	t
When tank Empty	wt+wr	p	202	t
Section modulus of raft	pi*((ds+br)^4-(ds-br)^4)/32/(ds+br)	z	31.94	m^3

Area of raft	pi*ds*br	ai	27.65	m^2
Chek for stability				
Tank empty condition	(wt+wr+wrb)/ai-mbi/z	Mist	2.64	t/sqm
			Safe	
Max. pressure on soil	(ww+wt+wr+wrb)/ai+mbi/z	mss	18.58	t/sqm
Tank full condition	(ww+wt+wr+wrb)/ai-mbi/z	miss	8.67	t/sqm
Pressure on soil when there is no wind	(ww+wt+wr+wrb)/ai Safe	msnw	13.63	t/sqm
			Safe	

Design of columns

Weight of tank & wt of water	wt+ww	w	345	t
Wind reaction on leeward column				
	(mb*ds/2)/(nc/2*(ds/2)^2)	rw	19	t
Total load on wind ward column				
Tank empty condition	wt/nc-rw	nfc	10.48	t
	Column is under		Compression	
Total horizontal wind on tank & Staging				
	(wfi+wfii)/10^4	hw	10.36	t
Horizontal wind reaction on each column	hw/nc	hwr	1.73	t
min. eccentricity moment	=cl *0.02 **1.53**		**1.53**	tm
due to .wind moment	hwr*(hs+brcd)/2		3.14	tm
Moment in the columns	As per DEVDAS MENON , design M=1.15*sqrt(Mx^2+My^2)	cm	**4.02**	tm
Design of Leeward column				
Load on Leeward column	(ww+wt)/nc+rw	cl	76.64	t

Factored Load on Leeward column

1.5*(DL+IL)+WL	1.5*(DL+WL)+IL	1.2*(DL+WL+IL)			
105	101	92	factcl	105	t

Pu/(fck*BD)	factcl*10*10^3/(g*cb^2*10^6)		0.29	
Mu/fckBD^2	cm*10*10^6*1.5/(g*cb^3*10^9)		0.05	
Area of steel				

MAX((cl*1.5*10000-0.4*g*cb*1000*cb*1000)/(0.67*415-0.4*g),0.8*cb*cb*10^4,ps*g*cb^2*10^4)/100

		ast	9.80	cm2
Spacing of 8 mm dia lateral steel	MIN(16*sd,cb*1000,48*8)			
	8 mm		256	mm
Design of wind ward column (Empty condition)				
Load on wind ward column			10.48	t
		ten	0.00	t
Tu/fckBD	IF(nfc>0,0,+ten*10^4*1.5/(g*(cb*1000)^2))		0.00	
Mu/fckBD2	cm*10*10^6*1.5/(g*cb^3*10^9)		0.00	
Ast required	sp*g*cb*cb*100	astr	0.00	cm2
Area of steel required		clas	9.80	cm2
Area provided	pi*(sd/10)^2/4*nb	clasp	16.08	cm2
Tensile stress	ABS(ten)*10000/(cb^2*10^6-clasp*100+(mi-1)*clasp*100)			
		ts	0.00	n/mm2
	column under compression			

Design of brace

Factored Moment in the brace				
	2*cm*1/SIN(2*PI()/nc)*10*1.5	bm	139.25	knm
	(0.36*g*brcb*1000*0.479*((brcd-ccb-dib/2000)*1000)^2*0.8)/10^6			
		Mulim	304.22	Knm
Area of compression steel required				
IF(bm>mulim,(bm-mulim)*10^3/(fsc*(brcd-2*ccb-2*dib/2000)),0)		asc	0.00	mm2
	(brcd-ccb-dib/2000)*brcb*g/415*10^6	aai	10735	
	brcb*g*10^9/(0.87*415^2)	aaii	60066	
Area of tension steel required				

MAX((aai-SQRT(aai^2-(4*aaii*MIN(bm,mulim))))/2+asc*fsc/(0.87*415),0.85/415*brcd*brcb*10^6)

		asb	846	mm2
Shear in the brace	bm*2/brl+(brl*brcd*brcb)*2.5*10*1.5/2	sfb	109.78	Kn

Length of brace	(ds*SIN(pi/nc))	brl	2.75	m
Shear stress	sfb*10^3/(brcb*(brcd-ccb-dib/2000)*10^6)	towu	0.74	n/mm2
% of steel	PI()*dib^2*ni/4/(brcb*(brcd-ccb-dib/2000)*10^6)*100			
		ptb	0.63	%
	MAX(0.8*g/(6.89*ptb),1)	beeta	5.49	
Allowable stress	0.85*sqrt(.8*g)*(sqrt(1+5*beeta)-1)/(6*beeta)			
		towcb	0.55	n/mm2
Area of stirrups	2*pi*diib*diib/4	asvb	157	mm2
Balance Shear force	IF(towu<towcb,0,(towu-towcb)*brcb*(brcd-ccb-dib/2000)*10^3)			
Spacing of stirrups		vusb	28.42	Kn
IF(towu<towcb,asvb*415/(brcb*10^3*0.4),MIN(0.87*415*asvb*(brcd-ccb-dib/2000)/vusb,asvb*415/(brcb*10^3*0.4)))				
		sib	543	mm
Spacing of stirrups	MIN(sib,0.75*(brcd-ccb-dib/2000)*1000,450)		371	mm

Design of ring beam

Total wt on the tank	(wt+ww)/(pi*ds)	wsi	26.61	t/m		
Dia of ring beam		dia	5.50	m		
central angle by brace chord	qang 60deg		1.05	rad		
Coffs for support moment		ci	0.089			+1/2*(-1/T/
coeff for span moment		cii	0.045			+1/2*(1/SII
coeff for torsional moment		ciii	0.009			+1/2*(COS
angle @ max shear		phi	0.222		12.73 deg	+ASIN(2/q
span of beam	pi*dia/nc	lg	2.88	m		
support moment	wsi*(dia/2)^2*ci*2*pi/nc	Mst	18.74	tms		
Torsional moment	wsi*(dia/2)^2*ciii*2*pi/nc	T	1.91	tms		
BM due to torsion	T*(1+rd/rb)/1.7	Mtb	2.99	tms		
Span moment	wsi*(dia/2)^2*cii*2*pi/nc	Msp	94.99	Knm		
Max fact span moment	(Mtb*10/3+Msp)*1.5		157.42	Knm		
Total moment	(Mst)*10	tm	187.37	Knm		
Eff. depth reqd	SQRT(tm*1.5*1000000/(.137*g*rb*1000))/1000					
		derd	0.39	m		
Effective depth provided		dp	0.66	m		
check:			O K			
Mulimit	(0.36*g*rb*1000*0.479*((rd-0.04)*1000)^2*0.8)/10^6					
		mulrb	938.81	Knm		
	dp*rb*g/415*10^6	aair	21535			
	rb*g*10^9/(0.87*415^2)	aaiir	90099			
Steel @ support						
Area of tension steel	MAX((aair-SQRT(aair^2-(4*aaiir*MIN(tm*1.5,mulrb))))/200+ascr*fsc/(0.87*415)/100,0.85/415*rb*rd*10^4)					
required		asti	12.48	cm2		
Area of compression	IF(tm*1.5>mulrb,(tm*1.5-mulrb)*10^3/(fsc*dp)/100,0)					1.80569
steel required		ascr	0.00	cm2		
Steel @ mid span						
Area of tension steel	MAX((aair-SQRT(aair^2-(4*aaiir*MIN((Msp+Mtb*10)*1.5,mulrb))))/200+ascrs*fsc/(0.87*415)/100,0.85/415*rb*rd*10^4)					
required		astii	6.91	cm2		
Area of compression	MAX(IF(Msp*1.5>mulrb,(Msp*1.5-mulrb)*10^3/(fsc*dp)/100,0),0)					
steel required		ascrs	0.00	cm2		
Check for Shear :						
Shear @ support	wsi*lg/2	vs	38.32	tons		
Stress	vs*1.5/(rb*dp*10)	tow	1.93	n/mm2		
distance @ max shear		x	0.61	m		
Shear @ max torsion	vs*(lg/2-x)*2/lg	vt	22.05	tons		
equivalent shear	vt+1.6*T/rb	ve	28.83	tons		
shear stress	ve*1.5/(rb*dp*10)	towii	1.45	n/mm2		
% of steel	pi()*dii^2/4*d71/(rb*10^4*dp)	pt	0.47	Safe		
	MAX(0.8*g/(6.89*pt),1)	beetar	7.37			
Allowable stress	0.85*sqrt(.8*g)*(sqrt(1+5*beetar)-1)/(6*beetar)					
		towc	0.49	n/mm2		
Area of stirrups	2*pi*di*di/4	asv	226.19	mm2		

Balance Shear force	(@max(tow,towii)-towc)*rb*dp*10^3		
		vus	430.26 Kn
Spacing of stirrups			
IF(@max(tow,towii)<towc,asv*415/(rb*10^3*0.4),MIN(0.87*415*asv*dp/vus,asv*415/(rb*10^3*0.4)))			
		si	126 mm
Minimum transverse steel			
(asv/(T*1.5*10000000/((rb*1000-50)*(dp*1000-25)*.87*415)+vus*1000/(2.5*(dp*1000-25)*.87*415)))			
		sv	214 mm
Spacing of stirrups	MIN(si,sv,0.75*dp*1000,300)		126 mm
Side face reinforcement on each face			
	IF(rd>0.45,0.1*rb*rd/2*100,0)		1.6875 cm2

Design of Raft

Total load on raft including self wt			
	ww+wt+wrb	twr	352.48 t
Area of raft reqd	(twr+wr)/sbc + wind load	area	25.11 sqm
Width of raft reqd	area/(pi()*ds)		1.45 m
Upward pressure	twr/ai+mbi/z	q	17.71 t/m2
			safe
Maximum B. M	q*(br-rb)^2/8	Mmax	2.93 tm
Eff.depth reqd	sqrt(Mmax*1.5*10^7/(0.138*g*1000))	dreqd	0.10 m
Eff depth provided		dre	0.28 m
Reinforcement			
	1000*dre*1000*g/fy	aa	20530
	10^7*1000*g/(0.87*fy*fy)	bb	2002192
Area of steel(Radial)	(aa-@sqrt(aa^2-4*bb*1.5*Mmax))/200	asr	4.38 cm2
Spacing of radial bars	10*pi()*db^2/4/asr		259 mm
Circumferential steel	1.25*asr	asri	5.03 cm2
Spacing of circular rings	10*pi()*dbi^2/4/asri		225 mm
Check for Shear:			
Cantilever Projection	(br-rb)/2	l	0.575 m
length of tapered portion	l-a	li	0.075 m
Critical section is @ distance 'd' from face of ring beam			
Shear force @ critical section	q*(l-dre)	sf	5.15 t
depth @ critical section	IF((a>dre),dre,((de+(Li-dre+a)*(dr-de)/Li)-cr-db/2000))		
		dc	0.28 m
Shear stress	sf*1.5*1000/(1000*(dc*1000-60))	tv	0.35 n/mm2
% of steel, pt		ptr	0.23
	MAX(0.8*g/(6.89*ptr),1)	beetai	15.40
Allowable shear stress in	0.85*sqrt(.8*g)*(sqrt(1+5*beetai)-1)/(6*beetai)		
	Safe	tc	0.35 N/mm2
Check for edge depth			
B.M @ li/2	q*(li/2)^2/2	bml	0.01 tm
depth reqd	sqrt(bml*1.5*10^7/(.138*g*1000))		6.72 mm
depth @ the section (i.e. @ li/2)	de+(dr-de)/2-cr-db/2000		0.234 m
shear force @ section	q*li/2		0.66 t
Shear stress		tvi	0.04 n/mm2
			Safe

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Quantity of concrete

Tank portion			
I)Top slab/dome	IF(h=0,(pi*(td+2*swt)^2/4*tst),(2*pi*((td/2)^2+h^2)/(2*h)*h*tst))		6.90
ii)top ring beam	pi*(td+trb)*trb*trd		1.96
iii)side wall	pi*(td+swt)*swh*swt		12.11
iv)middle ring beam	pi*(td+mrb)*mrb*mrd		3.58
v)inclined wall	pi*((td+ist)+ds)/2*ist*sqrt(ish^2+((td+ist-ds)/2)^2)		10.03
vi)bottom ring beam	pi*ds*brb*brd		6.61
vii)bottom slab/dome	@if(bdh=0,pi*(td+2*swt)^2/4*bst,2*pi*((ds/2)^2+bdh^2)/(2*bdh)*bdh*bst)		5.32
			46.50 m3
Staging			
viii)columns	nc*cb*cb*(sh+df-0.15-brd)		11.76
ix)bracings	brl*brb*brd*nc*ns		25.24
			37.00 m3
Foundation			
Ring beam on raft	pi()*ds*rb*(rd-dr)		3.11
Raft	pi()*ds*br*dr		9.68
			12.79 m3
Total quantity of concrete		cq	**96.29 m3**

Quantity of steel

staging			
Columns			
main steel	nb*nc*(sh+df-0.15-brd+dr+.3)*pi()*(sd/1000)^2/4*7.8		0.63 t
Sec steel	IF(nb=8,2*nc*4*cb*((sh+df-0.15-brd+dr)*1000/F57)*PI()*(8/1000)^2/4*7.8, nc*4*cb*((sh+df-0.15-brd+dr)*1000/F57)*PI()*(8/1000)^2/4*7.8)		0.27 t
			0.90 t
Braces			
main steel	2*ni*(brl-cb+2*56*di/1000)*nc*ns*pi*(dib/1000)^2/4*7.8		1.321 t
Stirrups	ns*nc*brl*1000/sii*4*pi()*(diib/1000)^2/4*2*(brcb+brcd-2*ccb)*7.8		1.229 t
			2.55 t
Ringbeam @ raft			
Topsteel	pi()*ds*pi()*(dii/1000)^2/4*bsb*7.8		0.19 t
Bottom steel	pi()*ds*tsb*pi()*(diii/1000)^2/4*7.8		0.11 t
Stirrups	pi()*(di/1000)^2/4*2*pi()*ds*1000/spi*2*(rb+rd-2*ccrb)*7.8		0.55 t
Sideface reinforcement	pi()*(sfd/1000)^2/4*nsr*2*pi()*ds*7.8		0.11 t
			0.96 t
RingRaft			
Bottomsteel			
Radial	pi()*ds*1000/space*br*pi()*(db/1000)^2/4*7.8		0.12 t
Circumferential	pi()*ds*pi()*(dbi/1000)^2/4*br*1000/spacei*7.8		0.12 t
Topsteel	pi()*(f107/1000)^2/4*pi()*ds*br*1000*2/f108*7.8		0.24 t
			0.488 t
Total quantity of steel		qs	**4.89 t**

Design of Intze tank

Data :-								
Capacity of tank		va	152	kl	V	150	Kl	
Tank diameter			OK		td	8.00	m	
Diameter of staging					ds	5.50	m	
Internal shaft diameter					isd	0.00	m	
Side wall height					swh	2.35	m	
Inclined wall Vertical height			total Ht	3.9	ish	1.25	m	
Rise of top dome					h	1.25	m	
Rise of bottom dome					bdh	0.95	m	
Allowable stress in steel					rst	130	n/mm2	
Grade of concrete					g	30	N/mm2	
Height of free board					hf	0.30	m	
Angle of inclination of inclined wall					th	45	Degrees	
Volume of concrete								
Concrete vol. of top dome		st*tt				6.90	cum	
Concrete volume of top ring bea		pi()*(td+trb)*trb*trd				1.96	cum	
Concrete vol. of vertical wall		pi()*(td+(ti+tii)/2)*(ti+tii)/2*(swh-trd)				10.82	cum	
Concrete vol. of middle ring bear		pi()*(td+mrb)*mrb*mrd				3.58	cum	
Concrete vol. of conical shell		pi()*(td/2+ds/2)*ist*ish/SIN(th*PI()/180)				9.37	cum	
Concrete vol. of bottom dome		sti*bst				5.32	cum	
Concrete vol. of bottom ring bea		pi()*(ds)*brb*brd				6.61	cum	
Concrete vol. of balcony		bw*0.1*pi()*(td+mrb+bw)				0.00	cum	
Total volume of concrete						**44.56**	cum	
Volume calculations								
Volume of cylindrical portion		pi()*(td/2)^2*(swh+mrd)				133		
Volume of conical portion		pi()/3*((td/2)^2+(td/2*ds/2)+(ds/2)^2)*ish				45	vcp	
Volume of bottom dome portion		PI()/6*(3*(ds/2)^2+bdh^2)*bdh				-12	vbdp	
Volume of internal shaft		PI()*isd^2/4*(swh+ish-bdh-hf)				0		
		volume of water			va	**167**	kl	
Allowable stress in concrete under bending					cbc	10.0	N/mm2	
Design of Top dome								
Data:-							Required	
Thickness of top dome		Tapered thick 150mm to 100mm			tt	0.125	m	
Live load on top dome					Ll	1.5	kn/sqm	
Diameter of steel bars			Dia is OK		dia	8	mm	
Area of steel					Ast	300	mm2	
Spacing of steel bars					Spp	**125**	mm	125
Minimum percentage of steel					Mpt	0.240	%	
Meridional stress					Ms	0.158	n/mm2	
Circumferencial stress					cs	0.079	n/mm2	
	The stresses are compressive and with in permissible limits							
Calculations								
Radious of top dome		((td/2)^2+h^2)/(2*h)			Rt	7.03	m	
		Sth	0.569		Cth	0.822		
Surface area of top dome		2*pi()*Rt*h			St	55.17	sqm	
Weight of top dome &finishings		(tt*25+0.50)			wt	3.63	kn/sqm	
Dead and live load per sqm		wt+Ll			twt	5.13	kn/sqm	
Meridional thrust		WxR/(1+Cos(th))			Mt	19.76	kn/m	
Circumferencial thrust		twt*rt*(cth-1/(1+cth))			ct	9.84	kn/m	
Meridional stress		Mt*1000/(tt*1000*1000)			Ms	0.16	n/mm2	
Circumferencial stress		Ct*1000/(tt*1000*1000)			Cs	0.08	n/mm2	
	The stresses are compressive and with in permissible limits							
Min. percentage of steel		IF(td<15,0.24,0.35)			Mpt	0.240	%	

Area of steel required			Mpt*tl*1000*1000/100			Ast	300	mm2	
Spacing of steel			pi()*(dia)^2/(4)*1000/Ast			Sp	168	mm	
Design of Top ring beam									
Data:-								Required	
Top ring beam breadth		Tensile stress with in limits			0.60	n/mm2 trb	0.30	m	
Top ring beam depth						trd	0.25	m	0.15
Dia of steel bars						trds	12	mm	
Number of bars						trnb	6	Nos	4
Area of steel provided					Safe	Astp	679	mm2	344
Hoop tension in the top ring beam						Ht	45	kn	
Tensile stress in concrete						tss	0.60	n/mm2	
					Provide 2L - 8 tor stirrups at 200 mm c/c				
Calculations									
Hoop tension in the top ring beam				mt*Cth*(td/2)		Ht	45	kn	
Area of hoop reinforcement			Ht*1000/rst			Astr	344	mm2	
Tensile stress in concrete									
	ht*1000/((trb*trd)*10^6+(m-1)*Astp)					tss	0.60	n/mm2	
Design of side wall									
Data:-								Required	
Thickness of side wall at top			Tension in limits		0.60	ti	0.200	m	
Thickness of side wall at bottom			Thickness adequate			tii	0.200	m	0.15
Dia of vertical steel on water face				bar Dia is OK		vsd	10	mm	
Spacing of bars						wfs	**200**	mm	300
Dia of vertical steel on outer face				bar dia is OK		vsdi	10	mm	
Spacing of bars						ofs	**200**	mm	300
Dia of hoop steel bars				bar Dia is OK		hsd	10	mm	
Spacing of bars on each face						sphs	**200**	mm	300
Vertical steel on water face						wsas	240	mm2	
Vertical steel on out side face						osas	240	mm2	
Vertical steel at mid height						mhasi	240	mm2	
Total Hoop steel						has	480	mm2	
Area of steel provided						hasp	785	mm2	
Tensile stress in concrete			tsc	hoop	0.26	bending	0.60	N/mm2	
Maximum hoop tension						hopt	51	kn	
Maximum moment on water face							-3.94	knm	
Calculations									
Bending moment coefficients from table 10 of IS: 3370 (Pt IV)									
	H^2/(Dxt)	=	swh^2/(td*(ti+tii)/2)			hdr	3.45		
		Height from top		Mom.Coef	Moment	Thikness	Ast		
ko=	3.45		m		knm	mm	mm2		
a=	1	0.1*swh	0.24	0.00046	0.060	13	3.59		
		0.2*swh	0.47	0.00199	0.259	28	15.42		
		0.3*swh	0.71	0.00384	0.499	39	29.71		
		0.4*swh	0.94	0.00602	0.781	48	46.52		
		0.5*swh	1.18	0.00792	1.027	56	61.21		
		0.6*swh	1.41	0.00880	1.142	59	68.02		
		0.7*swh	1.65	0.00734	0.952	53	56.75		
		0.8*swh	1.88	0.00170	0.220	26	13.12		
		0.9*swh	2.12	-0.01014	-1.316	63	-78.40		
		1.0*swh	2.35	-0.03036	-3.941	109	-234.80		

		Maximum negative steel				wsas	240	mm2	
		Maximum positive steel				osas	240	mm2	
		Area of steel at mid height				mhasi	240	mm2	
Hoop tension coefficients from table 12 of IS: 3370 (Part IV)									
		T =	Coeff*w*swh*td/2						
			H^2/(d*t)		hdr	3.45			
		Height from top		Coeff.	Force	Steel			
			m		**kn**	**mm2**			
		0	0	0.048	5	35			
		0.1*swh	0.24	0.160	15	116			
		0.2*swh	0.47	0.268	25	194			
		0.3*swh	0.71	0.371	35	269			
		0.4*swh	0.94	0.458	43	331			
		0.5*swh	1.18	0.524	49	379			
		0.6*swh	1.41	0.546	51	395			
		0.7*swh	1.65	0.512	48	371			
		0.8*swh	1.88	0.408	38	295			
		0.9*swh	2.12	0.231	22	167			
		Maximum hoop steel for both faces				has	480	mm2	
		Maximum hoop tension				hopt	51	Kn	
Design of Middle ring beam									
Data:-									
Depth of middle ring beam			Tensile stress with in limits			Mrd	**0.30**	m	
Breadth of middle ring beam					1.04	Mrb	**0.45**	m	0.36
Balcony width						bw	0.00	m	
Dia of hoop steel bars provided						hsdia	16	mm	
Number of hoop bars provided						nhb	8	Nos	6
Area of hoop steel provided						hopsp	1608	mm2	1082
Total hoop tension due to vertical load and water						thopt	141	kn	
Hoop tensile stress in concrete						hoti	1.04	n/mm2	
Stirrups		Provide 8mm dia @ 200 mm C/C							
Calculations									
Load due to top dome			st*twt				283	kn	
Load due to top ring beam			PI()*(td+trb)*trb*trd*25				49	kn	
Load due to cylindrical wall			pi()*(td+(ti+tii)/2)*(ti+tii)/2*swh*25				303	kn	
Self weight of middle ring beam			pi()*(td+mrb)*mrb*mrd*25				90	kn	
Weight of balcony and live load			pi()*(td+2*tii+bw)*bw*4.75				0	kn	
Total vertical load						vlmrb	**724**	kn	
Load per unit length of beam			vlmrb/(pi()*(td+mrb))			vlpm	27	kn/m	
Horizontal compo. of vertical load			vlpm/(TAN(th*pi()/180))			hpt	27	kn	
Hoop tension due to vertical load			hpt*(td+tii)/2			hoptv	112	kn	
Hoop tension due to water pressu			(10*swh*mrd*(td+tii)/2)			hoptw	29	kn	
Total Hoop tension on Middle ring beam						thopt	**141**	kn	
Area of steel required			thopt*1000/rst			hopst	1082	mm2	
Hoop tensile stress in ring beam			thopt*1000/(mrb*mrd*10^6+(m-1)*hopsp)						
						hoti	1.04	n/mm2	
Design of conical Shell									
Data:-									
Inclined slab thickness			Thickness is adequate			ist	**0.25**	m	0.23
Dia of **hoop** steel bars			Tension in limits		0.65	hsdi	**12**	mm	

Spacing of hoop bars on both faces	bar Dia is OK	hssp	**150**	mm	180
Dia of **radial** steel bars	bar Dia is OK	rsdi	**16**	mm	
Spacing of radial bars on both faces		rssp	**225**	mm	250
Height of the cone		ish	**1.25**	m	
Slope of the conical shell in radians		thr	0.785	radians	
Total Area of hoop steel required		ash	1255	mm2	
Area of radial steel		asri	803	mm2	
Maximum hoop tension		mht	163	kn/m	
Max. hoop tensile stress		hts	0.65	N/mm2	

Calculations

Weight of top dome,ring beam,side wall and middle ring beam			724	kn
Weght of water over inclined shell				
(PI()/3*((td/2)^2+(td/2*ds/2)+(ds/2)^2)*ish-(PI()*ds^2/4*ish))*10+PI()*(td^2-ds^2)/4*swh*10		wwis	858	kn
Self weight of inclined shell	pi()*(td/2+ds/2)*ist*ish/SIN(th*PI()/180)*25			
		wis	234	kn
Total load on the conical slab		tlcs	**1816**	kn
Total load per unit length	tlcs/(pi()*ds)	tlrb	105	kn/m
Meridional thrust	tlrb/SIN(th*pi()/180)	npi	149	kN/m
Hoop tension in the shell	(10*(swh+ish-y)+25*ist*COS(thr))*(ds/2+y/TAN(thr))/SIN(thr)			
Hoop tension at **bottom** of inclined slab	yi = 0.00	tci	157	kn/m
Hoop tension at 1/4 height from **bottom**	ayi = 0.31	atci	162	kn/m
Hoop tension at **middle** of inclined slab	yii = 0.63	tcii	163	kn/m
Hoop tension at 3/4 height from **bottom**	ayii = 0.94	atcii	162	kn/m
Hoop tension at **top** of inclined slab	yiii = 1.25	tciii	158	kn/m
Area of hoop steel required				
	MAX(MAX(tci,atci,tcii,atcii,tciii)*1000/rst,if(td>15,.35,0.24)*max(0.1,ist/2)*10^4)			
		ash	1255	mm2
Design of inclined slab for bending				
Load on the slab per meter	tlcs/(pi()*(td+tii+ds)/2)	lis	84.393	kn/m2
Bending moment	lis*ish/(SIN(th*PI()/180))/10		14.92	knm
BM due to compression	vlpm/SIN(th*PI()/180)*(ist-0.045-rsdi/2000-ist/2)		2.78	knm
		bmis	17.70	knm
Thickness required for un-crackec	Sqrt(bmis*10^6*6/(2*1000))	istr	230	mm
Area of steel required	bmis*10^6/(if(ist>225,175,150)*(ist*1000-45-rsdi/2)*0.87)			
		asri	803	mm2
Minimum % of steel			0.240	%
Minimum area of steel		asr	600	mm2
	MAX(tci,atci,tcii,atcii,tciii)*1000/(ist*1000*1000)			
Tensile stress in the conical shell		hts	0.65	n/mm2

Design of bottom dome

Data:-

Thickness of bottom dome		bst	**0.20**	m	
Dia of steel bars		bdia	**10**	mm	
Spacing of steel bars in two layers	bar Dia is OK	Spsi	200	mm	300
Minimum percentage of steel		Mpti	0.240	%	
Area of steel required		asti	480	mm2	
Meridional stress		Msi	0.45	N/mm2	
Circumferencial stress		Csi	0.18	N/mm2	
	The stresses are with in permissible limits				

Calculations

Radious of bottom dome	((ds/2)^2+bdh^2)/(2*bdh)	Rb	4.46	m
	Sthi 0.617	Cthi	0.787	
Surface area of bottom dome	2*pi()*Rb*bdh	Sti	26.59	sqm

Weight of bottom dome &finishing		(bst*25+0.75)*sti			wti	153	kN	
Weight of water on bottom dome								
pi()*10*((ds/2)^2*(swh+ish)-(3*(ds/2)^2+bdh^2)*bdh/6-(isd)^2/4*(swh+ish-bdh))					wwi	809	kN	
Total unit load on bottom dome		(wti+wwi)/sti			twb	36	kN/m2	
Meridional thrust		twb*rb/(1+cthi)			Mti	90	kN/m	
Circumferencial thrust		twb*rb*(Cthi-1/(1+cthi))			Cti	37	kN/m	
Meridional stress		Mti*1000/(bst*10^6)			Msi	0.45	N/mm2	
Circumferencial stress		Cti*1000/(bst*10^6)			Csi	0.18	N/mm2	
Min. percentage of steel		IF(ds<=15,0.24,0.35)			Mpti	0.240	%	
Area of steel required		Mpti*bst*10000			Asti	480	mm2	
Design of bottom ring beam								
Data:-								
Bottom ring beam depth		Depth is adequate			brd	**0.85**	m	0.810
Bottom ring beam breadth		Tensile stress with in limits			brb	**0.45**	m	Safe
Number of columns		Shear stress with in max. limit			nc	**6**	Nos	
Cover to top steel		towii	0.81		dd	0.05	m	
Dia of bars at support at top		temax	1.50		nsdi	**20**	mm	
Number of bars for -ve BM					nnb	**4**	Nos	
Dia of bars at Mid span at bottom					psdi	**16**	mm	
Number of bars for + ve BM					nnp	**4**	Nos	
Dia of bars for hoop tension					ssdi	**16**	mm	
Number of bars for hoop tension				0	brhs	**2**	Nos	
Dia of stirrups					sdi	**12**	mm	
Spacing of two leg stirrups			provided	**125**	**<OK**	162	mm	
Spacing of four leg stirrups				250		325	mm	
Thrust from the bottom dome					htbd	71	kN/m	
Tthrust from the Conical dome					htcd	105	kN/m	
Net force on the ring beam		Beam under compression			nht	34	kN/m	
Hoop compression					Hoc	94	kN	
Area of steel at support at top					nast	1113	mm2	
Area of steel at mid span at bottom					past	766	mm2	
Calculations								
Thrust from the bottom dome		Mti*Cthi			htbd	71	kN/m	
Tthrust from the Conical dome		npi*COS(th*pi()/180)			htcd	105	kN/m	
Net force on the ring beam		htcd-htbd			nht	34	kN/m	
					Beam under compression			
Hoop compression		nht*ds/2			Hoc	93.86	kN	
Compresive stress	hoc*1000/(brb*brd*10^6)				hcs	0.25	N/mm2	Safe
Hoop tension		nht*ds/2			Hot	0.00	kN	
Tensile stress in the beam		hot*1000/((brb*brd*10^6-hsrbi)+(m-1)*hsrbi)						
					hst	0	N/mm2	
Area of steel required for hoop tension					hsrb	0	mm2	
Area of steel required in the bottom ring beam					hsrbi	765	mm2	
Design for aditional moments when supported on columns								
Weight of top dome		twt*ts				283	kn	
Weight of top ring beam		pi()*(td+trb)*trb*trd*25				34	kn	
Weight of side wall		pi()*(td+(ti+tii)/2)*(ti+tii)/2*swh*25				303	kn	
Weight of middle ring beam		pi()*(td+mrb)*mrb*mrd*25				90	kn	
Weight of inclined shell		wis				234	kn	
Weight of bottom dome		wti				153	kn	
Weight of water		wwis+wwi				1667	kn	
Load per meter up to bottom ring beam						160	kN/m	
Self weight of the beam		brb*brd*25				10	kN/m	
Total load per meter on bottom ring beam					wsi	**170**	kN/m	

Maximum positive bending moment **coefficient**						cp	0.045		
Maximum negative bending moment **coefficient**						cn	0.089		
Maximum tortion moment **coefficient**						tc	0.009		
Angular distance for max. tortion				0.22	$\phi_{\tau max}$	phi	**12.73**	Deg	
Equi. BM due to Torsion multipler k=				0.90	θ	thita	1.05	Rad	
Maximum **+ve** bending moment			cp*wsi*(ds/2)^2*thita			pbm	60.41	kNm	
Maximum **-ve** bending moment			cn*wsi*(ds/2)^2*thita			nbm	119.47	kNm	
Maximum **tortion** moment			tc*wsi*(ds/2)^2*thita			T	12.08	kNm	
Span of beam						lg	2.88	m	
Equivalent BM due to torsion			T*(1+brd/brb)/1.7			ebm	20.53	kNm	
Total **-ve** moment **at face of support**				(nbm @ face+ebm at face)			89.5		
Total **+ve** moment at mid span			pbm	(nbm near mid+ebm near mid)			61.6		
	M_ϕ=wR^2[θ/2*sinφ+θ/2*cot(θ/2)*cosφ-1]								
	T_ϕ=wR^2[θ/2*cosφ-θ/2*cot(θ/2)*sinφ-θ/2+φ]								
	φ	M_ϕ	T_ϕ	M_ϕ+T_ϕ/1.7*(1+b/D)					
	0.52	60.50	0.00	60.5					
	0	-119.34	0.00	-119.34					
	0.22	0.00	12.14	10.9					
				φ max=					
	φ max	M_ϕ	T_ϕ	M_ϕ+T_ϕ/1.7*(1+b/D)					
	0.05	-84.48	-5.54	**-89.5**					
	0.48	59.43	2.40	**61.6**	using solver				
absence of Dynamic analysis			increase 10% value of static analysis values						
Total **-ve** moment **at face of support**						tebm	**98.41**	KNm	
Total **+ve** moment at mid span						tpbm	**67.75**	kNm	
Total depth required		SQRT(6*tebm*10^6/(f*brb*1000))				810	mm	f=2.0n/sqmm	
Effective depth required			SQRT(tebm*10^6/(Q*brb*1000))			derd	349	mm	
Effective depth provided						dp	790	mm	
Moment of resistance of Balanced section									
		brb*brd^2*10^9*cbc*n*(1-n/3)/10^6				Mbal	1169	kNm	
% of steel for balanced section				50*n*cbc/rst		bpt	1.61	%	
Area of steel required at support						nast	1113	mm2	
for BM	IF(tebm>mbal,(bpt*brd*brd*10^6/100+(tebm-mbal)*10^6/(rst*(dp-dd))),tebm*10^6/(rst*j*dp))								
Area of steel required at mid span			tpbm*10^6/(rst*j*dp*1000)			past	766	mm2	
for bending moment						min steel area	711	mm2	
Check for Shear :									
Shear @ support			wsi*lg/2			vs	244	kN	
Shear stress			vs*1000/(brb*dp*10^6)			tow	0.69	n/mm2	
Total equivalent shear			vs+1.6*T/brb			ve	287	kN	
shear stress			ve*1000/(brb*dp*10^6)			towii	0.81	n/mm2	
Maximum permissible shear stress						temax	**1.50**	n/mm2	
					Shear stress is with in max. limit				
% of steel		nnb*pi()nsdi^2/4/(brb*10^6*dp)*100				pt	0.35	%	
from table for Allowable shear stress in beams									
i=	5		th column in table						
VLOOKUP(+pt,datai,+i)*10				towci	2.50	Kg/cm2			
VLOOKUP(+pt+.1,datai,+i)*10				towcii	2.80	Kg/cm2			
Allowable stress						towc	0.27	n/mm2	
Area of stirrups			2*pi()*sdi^2/4			asv	113	mm2	
Spacing of two legged stirrups						sv	162	mm	
Side face reinforcement on each			IF(brd>0.45,0.1*brb*brd/2*100,0)				1.91	cm2	

ASST. ENGINEER
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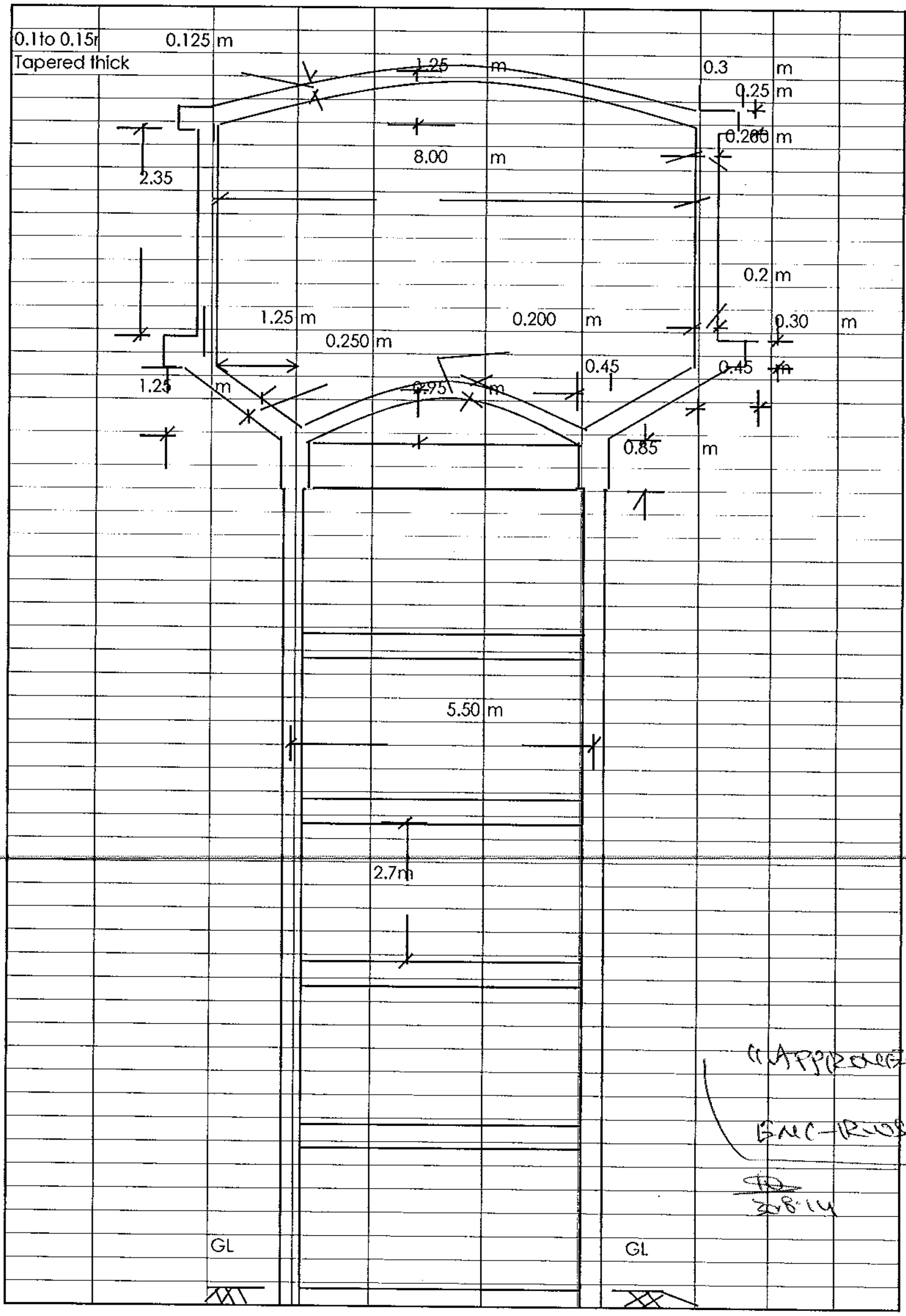
Superintending Engineer
R.W.S. & S. Circle, Adilabad

|| APPROVED ||
ENC, RWS, Hyd



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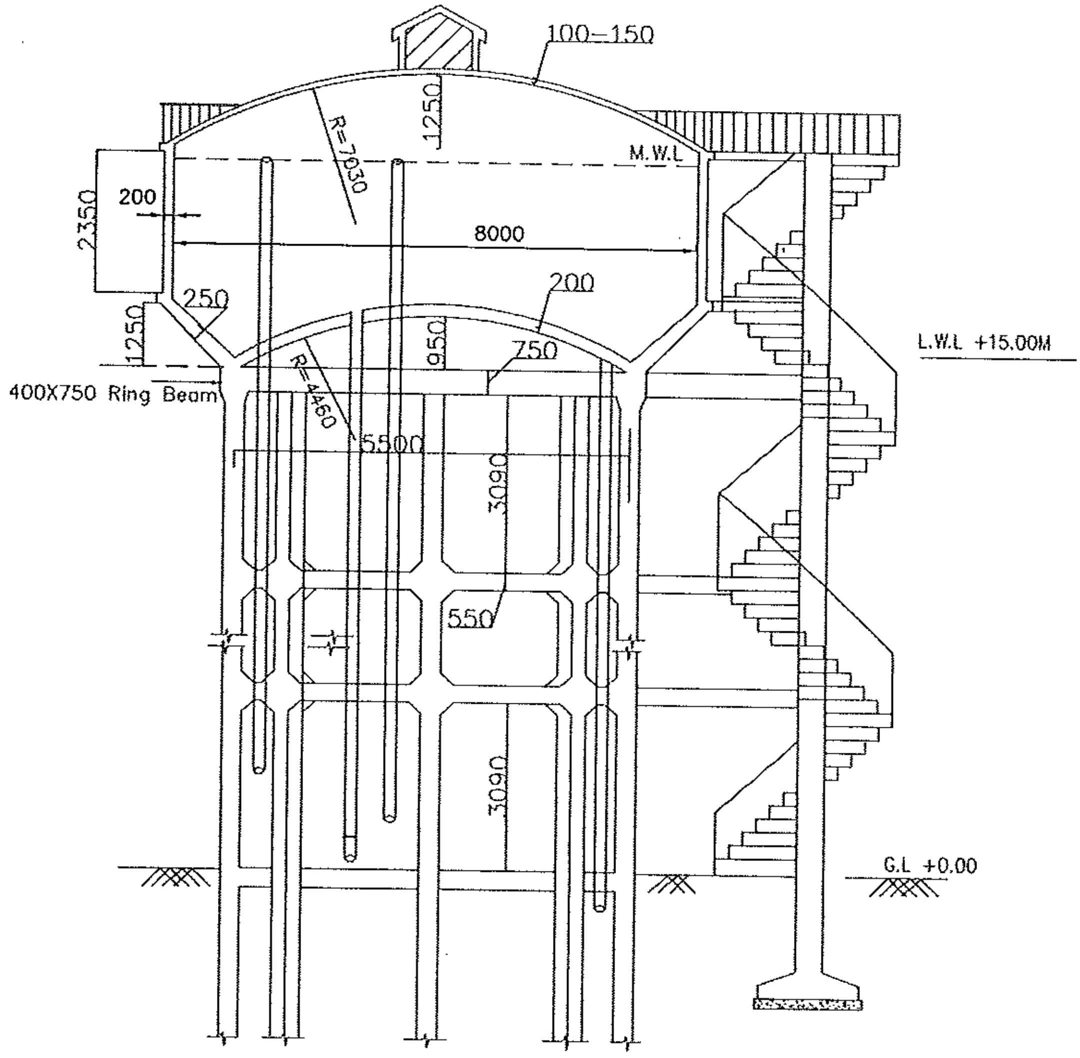
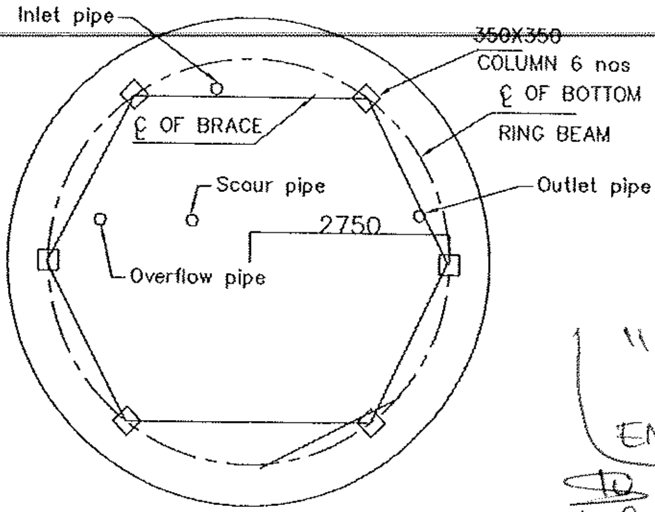


ELEVATION



PLAN

"APPROVED"
30/8
ENC, RWS, Hyd
30/8/14
30/8/14

NOTE:

1. GRADE OF CONCRETE : M30
2. GRADE OF STEEL : Fe415
BASIC WIND SPEED : 44m/sec
3. DEPTH OF FOUNDATION: 2m BELOW GROUND LEVEL UPTO TOP OF RAFT

150 KL OHBRwith 6columns
STAGING 15m

ASST. ENGINEER

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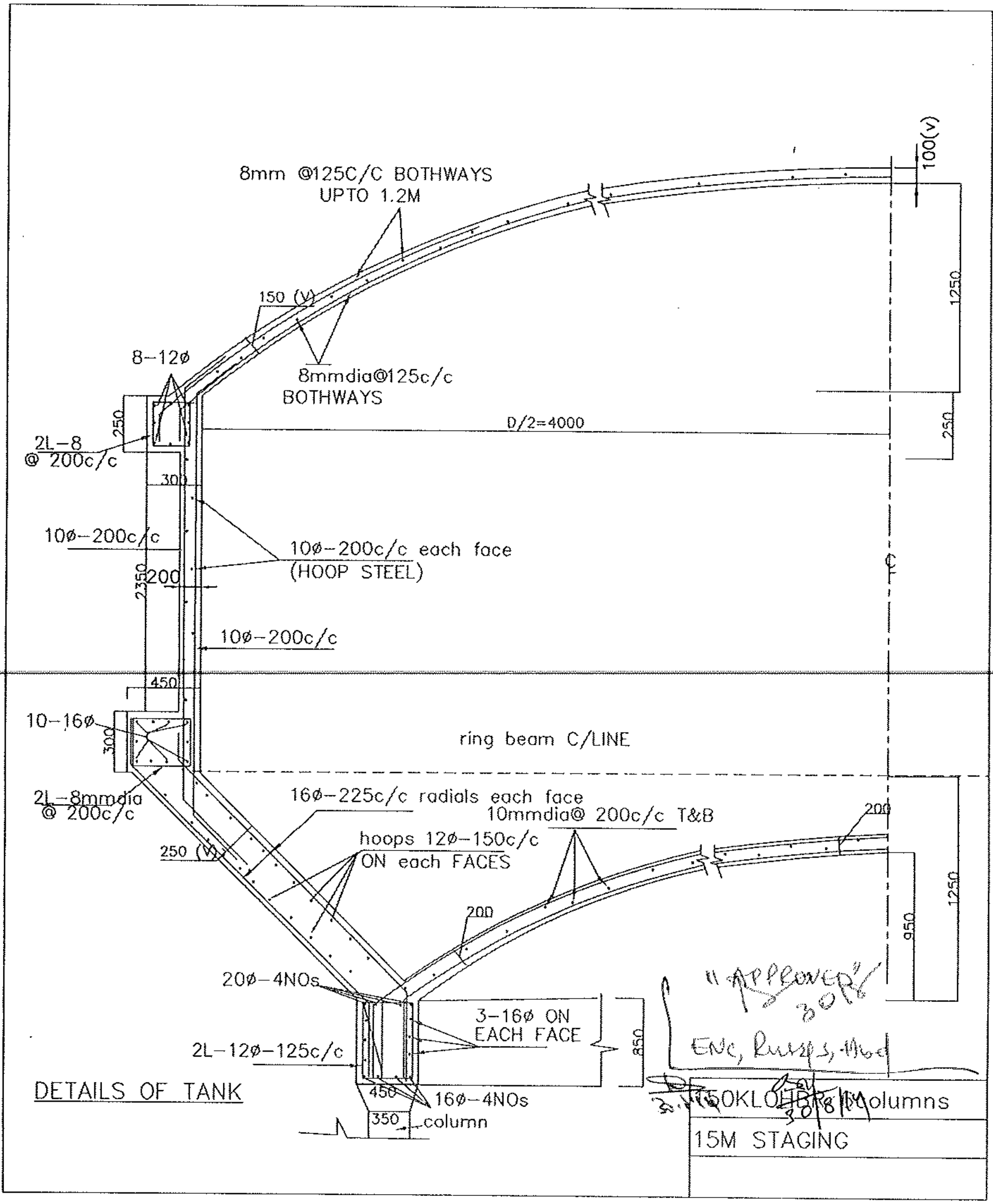

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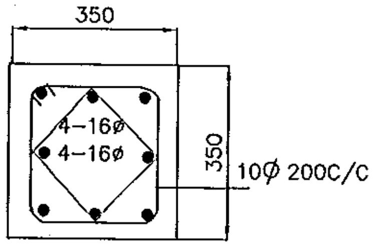
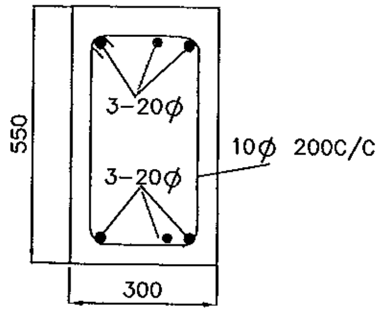


SECTION OF COLUMN



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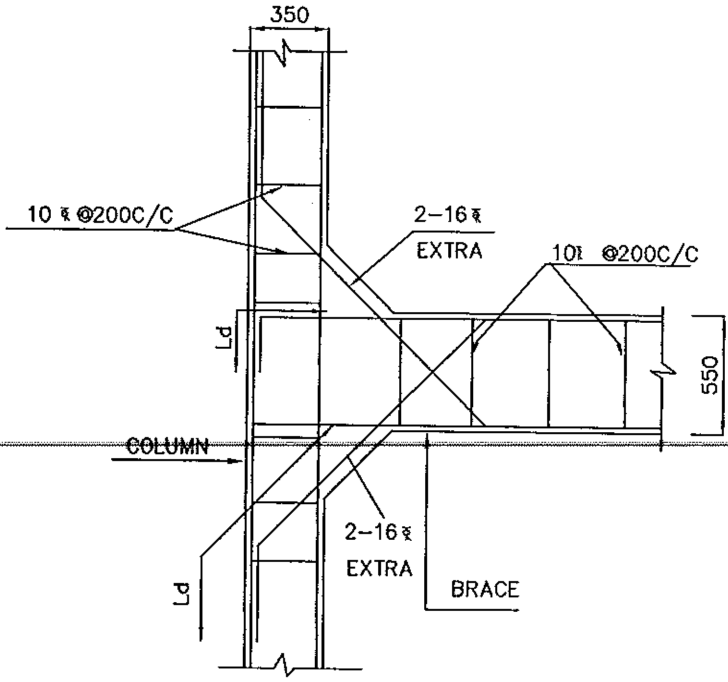

COLUMN BRACE JUNCTION

"APPROVED"
30/8
ENC, RWSS, Hyd

Grade of concrete : M30

wind speed 44m/s
150KL O.H.B.R 15m stg
SBC OF SOIL 15T/M²

30/8/14 30/8/14

ASST. ENGINEER
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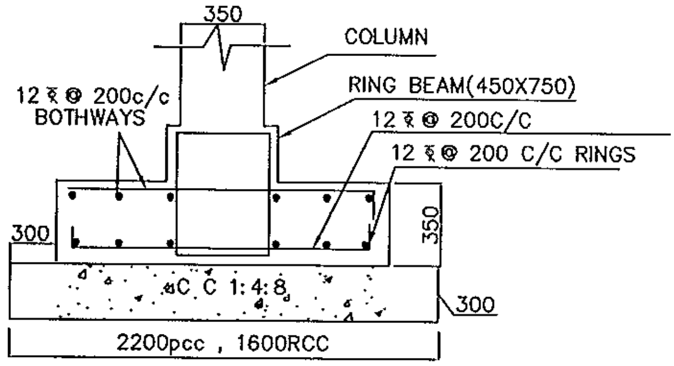
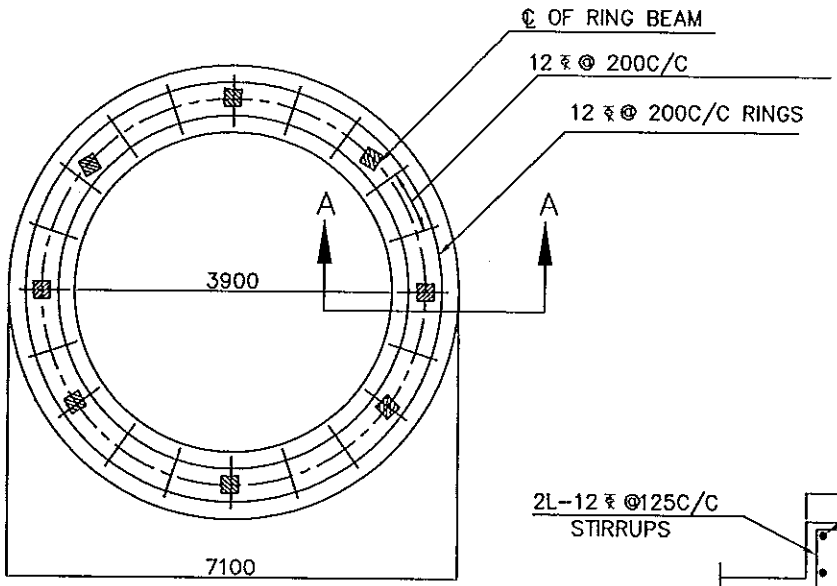
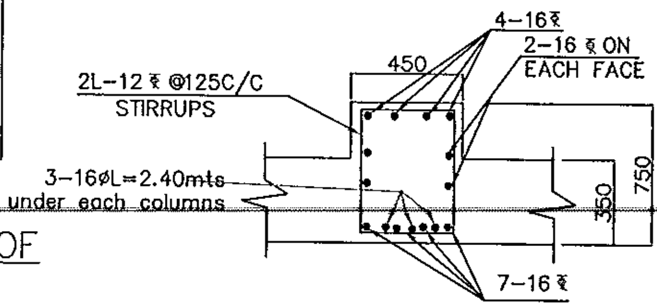


SECTION A–A



BOTTOM REINFORCEMENT OF RING FOUNDATION



SECTION OF RING BEAM

NOTE:

1. Grade of concrete :M30
   Grade of steel :Fe415
2. Basic wind speed :44M/sec
3. Depth below foundation :2.0M
4. Staging height :15m
   Clear height between the braces :3.09
   No of stagings 4
5. 8Nos of 16 diagonal bars shall be provided at column brace junction
6. For detailing of reinforcement IS Sp–34 shallbe followed
7. All covers minimum 45mm

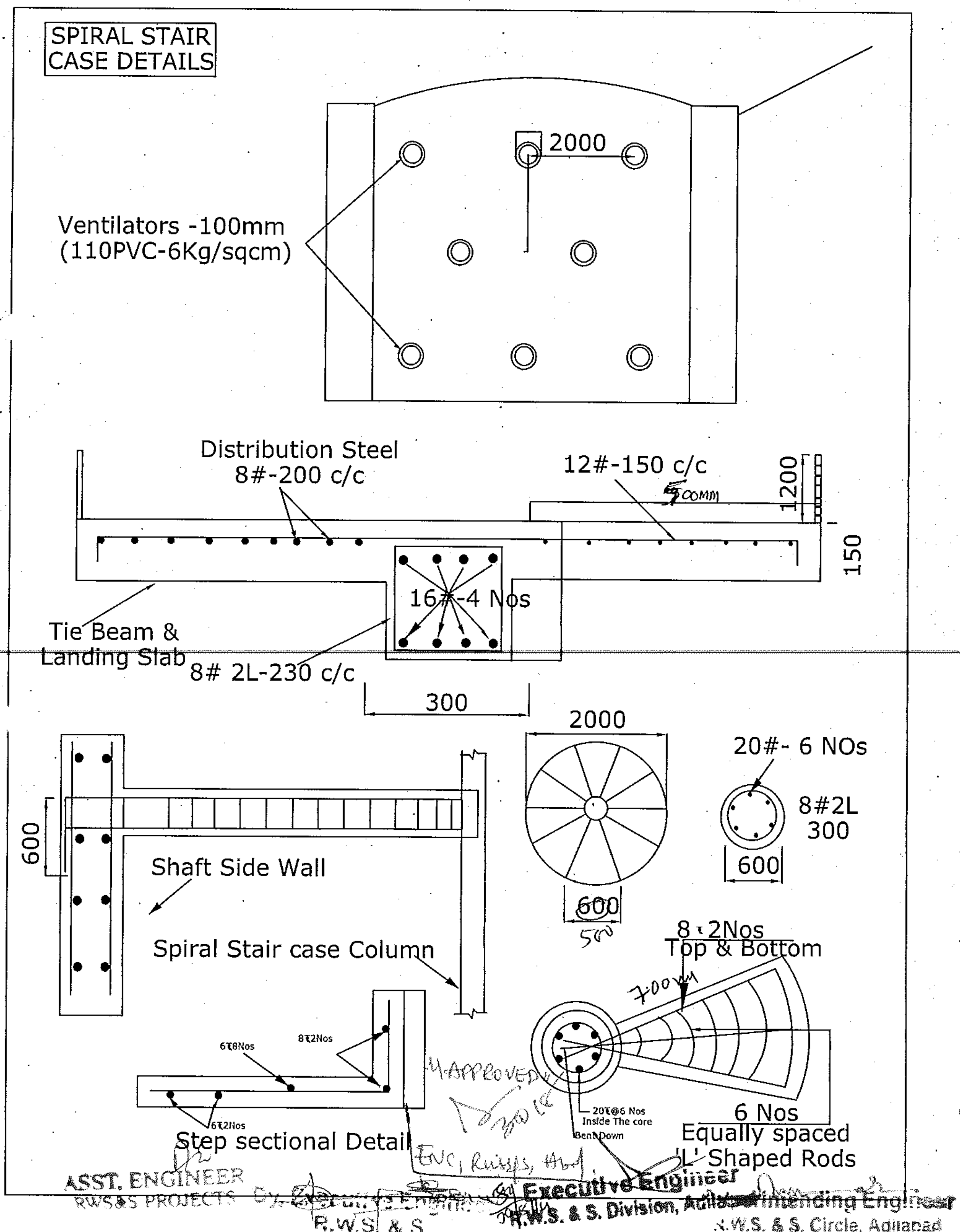
wind speed 44 m/s
FOUNDATION DETAILS OF
150KL O.H.B.R 15m stg
SBC OF SOIL 15T/M²

ASST. ENGINEER
RWS&S PROJECTS

Dy. Executive Engineer
R.W.S. & S.
Sub Division, Bhainsa

Executive Engineer
R.W.S. & S. Division

Superintending Engineer
R.W.S. & S. Circle, Adilabad


SPIRAL STAIR CASE DETAILS
2000
Ventilators -100mm (110PVC-6Kg/sqcm)
Distribution Steel 8#-200 c/c
12#-150 c/c
500MM
1200
150
16#-4 Nos
Tie Beam & Landing Slab
8# 2L-230 c/c
300
2000
20#- 6 NOs
8#2L 300
600
600
600
500
Shaft Side Wall
Spiral Stair case Column
8 ɛ 2Nos Top & Bottom
700MM
6ɛ8Nos
8ɛ2Nos
6ɛ2Nos
Step sectional Detail
APPROVED
20ɛ@6 Nos Inside The core Bent Down
6 Nos Equally spaced 'L' Shaped Rods
ASST. ENGINEER
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