

Submitted sir,

Sub: RWS&S-TDWSP- Sirpur U 90KL OHBR (30mtr) in Sirpur U Mandal-
Komarambheem Asifabad Segment-Adilabad District-Designs -Approval-Reg.

Kindly pursue the Designs of the following 90KLOHBR at Sirpur U (V), Sirpur U (M), submitted by the Executive Engineer TDWSP Asifabad Division, Adilabad district for approval.

1. 90 KL OHBR.

The Executive Engineer TDWSP Asifabad Division has submitted Structural Designs & Drawings of 90KL OHBR based on the field conditions and as per the estimate provisions, the structural designs & drawings for the above structure is verified and submitted for approval.

The following design parameters were considered:

- Capacity : 90kL
- Net SBC of Soil : 15.0 t/sqm
- Grade of concrete & Steel : M 30 & Fe 500
- Height of staging : 30 mts
- Dia of Shaft Inner to Inner :6.15 mts
- Dia of Tank Inner to Inner :6.15 mts
- Thickness of shaft :250mm
- Top Slab thickness: 125mm
- Bottom Slab thickness : 250 mm
- Raft Slab thickness: 650mm
- Depth of Foundation : 3.00 mts

As per the above parameters the structural design and drawings of the OHBR is verified, duly following IS codes, IS: 456-2000, SP: 16, 34, IS:3370 and IS 1893-2002 (seismic codes).The sizes and steel proposed in the designs and drawings of all components are safe and sufficient.

The additional points noted after checking the designs are:

- Detailed Estimate of the Structure with these specifications has to be prepared and compared with the provision made in sanctioned estimate. Such that deviation if any is within authorized limits. If any deviations noticed, the Estimate should be submitted for obtaining approval from the Competent Authority.

Subject to approval a draft memo addressed to the EE, TDWSP Asifabad Division, for communicating approved Structure is put up for kind perusal and approval.



AEE (Designs)
TDWSP, Nirmal Circle



DEE (Designs)
TDWSP, Nirmal Circle



Superintending Engineer,
TDWSP, Nirmal Circle

B	Revised as per client comments	29.03.16		31.03.16		31.03.16	
		AKHB	AKHB	RR	RR	BRJ	BRJ
A	For Approval	15.02.16		15.02.16		15.02.16	
		AKHB	AKHB	RRG	RRG	BRJ	BRJ
REV. NO.	DESCRIPTION	DESIGNED		CHECKED		APPROVED	

REVISIONS



LARSEN & TOUBRO LIMITED
CONSTRUCTION DIVISION
 Water, Smart World & Communication IC

CLIENT:
 TELANGANA DRINKING WATER SUPPLY PROJECT,
 GOVERNMENT OF TELANGANA

CONSULTANT :

PROJECT : Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District

SUPPLIER / CONTRACTOR : L&T CONSTRUCTION
 Water & Effluent Treatment SBG

JOB Ref. No. : LE150883

	NAME	SIGN	DATE
DSGN	AKHB	AKHB	15.02.16
CHKD	RRG	RRG	15.02.16
APPD	BRJ	BRJ	15.02.16

TITLE :
90 KL capacity OHBR - Design Calculations

DOC./DRG. No. **LE150883 - C - WS - CW - DC - 3021**

SIZE : A4
 REV. : B

RELEASED FOR PRELIMINARY INFORMATION APPROVAL CONSTRUCTION



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Design of Over head Reservoir

(1) DATA:				
	Capacity of Tank		90	m ³
	Unit weight of RCC=		25	kN/m ³
	Unit weight of PCC=		24	kN/m ³
	Unit weight of soil =		18	kN/m ³
	Unit weight of sand filling inside bottom of shaft =		18	kN/m ³
	Unit weight of water=		10	kN/m ³
	Staging Height		30	m
	Net S.B.C of Soil =		150	kN/m ²
(2) PERMISSIBLE STRESS:				
	Grade of concrete;	$f_{ck} =$	M30	N/mm ²
	Grade of steel;	$f_y =$	Fe500	N/mm ²
Ref Table 1 of IS:3370	Allowable stress as per IS:3370 relating to resistance to cracking			
	Allowable direct tensile stress in concrete	$\sigma_{at} =$	1.5	N/mm ²
	Allowable bending tensile stress in concrete	$\sigma_{bt} =$	2.0	N/mm ²
Ref Table 4 of IS:3370	Allowable stress in steel under direct tension, bending & shear = $\sigma_{st} =$		130	N/mm ²
	Allowable stress in steel under direct compression = $\sigma_{sc} =$		140	N/mm ²
		$\sigma_{st2} =$	150	N/mm ²
IS 456:200	Allowable stress in steel under direct tension, bending & shear = $\sigma_{st} =$		230	N/mm ²
	Allowable stresses as per IS:456 for strength calculations			
Ref Table 21 of IS:456	Allowable direct compressive stress in concrete		$\sigma_{cc} =$	8 N/mm ²
	Allowable bending compressive stress in concrete		$\sigma_{cbc} =$	10 N/mm ²
	Modular ratio =	$m = \frac{280}{3\sigma_{cbc}} =$	m =	9.33
	Neutral axis co-efficient;	$n = \frac{m\sigma_{cbc}}{m\sigma_{cbc} + \sigma_{st}} =$	n =	0.42
	Lever arm coefficient;	$j = 1 - n/3 =$	j =	0.86
	Moment coefficient =	$K = 0.5 \times \sigma_{cbc} \times (n \times j) =$	1.81	N/mm ²
(3) Volume calculation				
	Diameter of tank, D =		6.40	m
	Rise of Top Dome, h =	=D/5	=6.4/5	1.30 m



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	Diameter of supporting shaft = D =			6.40 m
	Rise of bottom dome , h = =D/5	=6.4/5	1.30 m	
	Height of water column in cylindtcal portion of tank, H =			4.10 m
	Free board, F.B =			0.30 m
	Total Height of tank wall = H+FB-(1.8-h)	=4.1+0.3+(1.8-1.3)	4.90 m	
	C/C Diameter of internal shaft			1.20 m
	Outer Diameter of Internal shaft = (Dia+thk of wall)=	1.2+0.2	1.40 m	
	Radius of Inner Shaft =	=1.2/2	0.60 m	
	Total height of Internal shaft = H-h+FB=	=4.1-1.3+0.3	3.10 m	
	Inner diameter of the tank = D-shaft thk+(wall thk/2)	=6.4-0.25+(0.25/2)	6.15 m	
	Volume of Cylindrical portion =V ₁ = (π/4)×(inner dia) ² ×H =	(π/4)×(6.15) ² ×4.1	121.79 m ³	
	Radius of curvature of bottom dome = R =[(D/2) ² +h ²]/(2h)			
		=[(6.4/2) ² +1.3 ²]/(2×1.3)	4.59 m	
	Volume of bottom dome =V ₂ = (π/3)×(r ² ×(3R-h))			
		=(π/3)×(1.3 ² ×(3×4.59-1.3))	22.07 m ³	
	Volume of internal shaft =V ₃ = (π/4)×(dia ² ×(H-h))			
		=(π/4)×[1.4 ² ×(4.1-1.3)]	4.31 m ³	
	Total volume of tank without free board = V ₁ -V ₂ -V ₃	=121.79-22.07-4.31	95.41 m ³	
				OK
	Total volume of tank with free board =			103.86 m ³
	(4) Design of Top dome:			
	<p>The diagram shows a cross-section of a dome. A vertical dashed line represents the axis of symmetry. The height from the base to the top of the dome is labeled as 1.30. The radius of curvature from the center of the dome to the base is labeled as 4.59. The horizontal distance from the axis to the base is labeled as 3.20. The angle between the radius and the vertical axis is labeled as θ = 44.20°. A thickness of 125 is indicated at the base of the dome.</p>			
	Figure 2: Top Dome.			
	Radius of the chord, r =	6.4/2	3.20 m	



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	Rise of the top dome, h =					1.30 m
	Radius of the shell surface = $(r^2 + h^2)/2h =$	$(3.2^2 + 1.3^2)/(2 \times 1.3)$				4.59 m
	Semi-central angle is given by					
	$\sin \theta = r_3/R =$	0.70	that is,	$\theta =$		44.20°
				=		0.771 rad
	Thicknes of the dome =					125 mm
	Self weight of dome (wg) = 0.125 X 25					3.125 kN/m ²
	Live load w _l =					1.50 kN/m ²
	Total load, w =	= 1.5 + 3.125 =				4.63 kN/m ²
	Weight of the dome = $2\pi Rhw_g =$	$2\pi \times 4.59 \times 1.3 \times 3.125 =$				117.16 kN
	Live load on the dome = $2\pi Rhw_l =$	$2\pi \times 4.59 \times 1.3 \times 1.5 =$				56.24 kN
	Total load on top dome =	117.16 + 56.24 =				173.40 kN
	Meridional thrust = $N_\theta = (wR)/(1+\cos \theta) =$					12.36 kN/m
		Meridional Stress = 0.01236/0.125	=			0.10 MPa
		0.1 < 1.5 (OK)				
	As the stress is only nominal, provide the min. reinforcement of					0.24 %
		$A_{sm} = 0.24 \times (125) \times (1000)/100$				300.00 mm ² /m
	Dia of bar =					10
	Spacing of bar required =					260 mm
	Provide 10 mm dia bar @ 125 mm c/c in meridional direction					
	Circumferential force = $wR[\cos \theta - (1/(1+\cos \theta))] =$					2.85 kN/m
		Hoop stress =	0.00285/0.0015			0.02 MPa
		0.02 < 1.5 (OK)				
	As the stress is only nominal, provide the min. reinforcement of					0.24 %
		$A_{sm} = 0.24 \times (125) \times (1000)/100$				300.00 mm ² /m
	Dia of bar =					10 mm
	Spacing of bar required =					260 mm
	Provide 10 mm dia bar @ 125 mm c/c in circumferential direction					
(5)	Design of beam at balcony level and balcony slab					
	<u>Design of balcony</u>					
	Clear width of walkway					0.75 m
	Width of beam at this level					350 mm
	Cantilever span of balcony from beam					0.40 m



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Thickness of slab						150 mm
Self weight of slab	$= (0.15) \times 25 \times 0.4 =$					1.50 kN/m
Live load on slab						1.50 kN/m ²
Load due to finishes						1.20 kN/m ²
Total load acting on the walkway slab	$= 0.15 \times 25 + 1.5 + 1.2 =$					6.45 kN/m ²
Max BM at Support	$= 6.45 \times 0.4^2 / 2 =$					0.52 kN-m
Effective Depth required	$= \sqrt{((BM \times 10^6) / (k \times 1000))} = \sqrt{((0.52 \times 10^6) / (1.81 \times 1000))}$					16.97 mm
Provided 150 mm uniform thickness for walkway slab						
Cover to the reinforcement						25 mm
Diameter of bar						12 mm
effective depth provided	$= 150 - 25 - 12$					119 mm
Area of steel required	$= (0.52 \times 10^6) / (0.86 \times 119 \times 130)$					39.09 mm ² /m
Minimum percentage of steel required	$=$					0.24 %
Minimum Area of steel required on center of slab	$= 0.0024 \times 150 \times 1000 =$					360.00 mm ² /m
Spacing of 12 mm dia steel	$=$					250 mm c/c
Spacing provided	$=$					200 mm c/c
Area of steel provided	$=$					565.49 mm ² /m
percentage of steel provided	$=$					0.48
Diameter of distribution bar	$=$					10 mm
Spacing of 10 mm dia tor steel	$=$					200 mm c/c
10 mm dia tor steel @ 200 mm c/c as distribution steel						
Provide 12 mm main bar @ 200 mm c/c						
Total weight of slab	$= 2 \times \pi \times (6.4/2 + 350/1000 + 0.4/2) \times 0.4 \times (150/1000) \times 25$					35.34 kN
(6) Design of Top ring Beam						
Hoop thrust on ring beam is same as the horizontal component of the meridional thrust from the top dome. The hoop tension in the ring beam is, therefore, equal to						
Hoop Tension	$= T = N_o \cos(\theta)R =$					28.36 kN
				Where R =		3.20 m
Size of the web of the ring beam:						
		b =				350 mm
		D =				300 mm



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	Area of tension steel required, $A_s =$	$= (28.36 \times 1000) / 130$			218.154	mm^2
	Minimum percentage of steel =				0.24	%
	Minimum steel $A_{\min} =$	$= (0.0024) \times 350 \times 300$			252.00	mm^2
	Cover to the reinforcement =				25	mm
	Dia of bar =				16	mm
	Number of bars required				2	Nos.
	Number of bars provided				3	Nos.
	Area of steel provided =				603	mm^2
	Stress in concrete = $T / [A_g + (m-1)A_{st}] =$					
	$= (28.36 \times 1000) / [(350 \times 300) + (9.33-1) \times 603.19] =$				0.26	N/mm^2
					0.26 < 1.5 (Safe)	
	Provide a ring beam of size 350 mm by 300 mm.					
	Provide 3Y16 at top and 3Y16 at bottom					
	Provide 8 mm dia stirrups at 250 mm centres.					
	Self weight of beam = $2\pi (3.375) (0.35 \times 0.3) (25) =$				55.67	kN
	(7) Design of vertical wall of tank					
	Total Wall height =				4.90	m
	height of water column =	$= 4.1 + 0.3 =$			4.40	m
	Radius of tank				3.20	m
	Hoop tension, $T =$ unit weight of water $\times H \times D/2$	$= 10 \times 4.4 \times 3.2$			140.8	kN/m
	Thickness of wall =				250	mm
		$H^2/Dt =$			$= 4.9^2 / (6.15 \times 0.25)$	15.616
	Calculating tension and moment from IS 3770 Part 4					
From IS 3370	Hoop tension for hinged base and top free					
	Coefficient from table 9 of IS 3370 Part 4				0.7714	
	Hoop tension = coefficient $\times w \times H \times R$	$= 0.77 \times 10 \times 4.9 \times 3.2$			120.955	kN/m
	Maximum Hoop tension, $T =$				140.8	kN/m
	A_{st} required on each face for max tension =	$= 140.8 \times 1000 / (130 \times 2)$			541.54	mm^2
	Minimum A_{st} required as per IS 3370				0.24	%
	A_{st} minimum required on each face	$= (0.0024 \times 1000 \times 250) / 2$			300	mm^2
	Dia of bar provided =				10	mm
	Spacing required on each face				145	mm



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Provide 10 mm dia @ 145 mm centres on both faces				
Area of steel provided				541.65 mm ²
Stress in concrete = $T/[A_g + (m-1)A_{st}] =$				
$= (140.8 \times 1000) / (1000 \times 250 + (9.33-1) \times 541.65)$				0.55 N/mm ²
0.55 < 1.5 (Safe)				
Vertical Steel				
From IS 3370	Vertical Moment for Fixed base and top free			
	Coefficient from table 10 of IS 3370 Part 4			0.00811
	Moment = coefficient x w x H ³	= 0.00811 * 10 * 4.9 ³	9.54258 kN-m	
Area of steel required for moment				
$= 9.54 \times 10^6 / (130 \times (250 - 45 - 12/2) \times 0.86)$				428.915 mm ²
Minimum area of steel on each face				300 mm ²
Diameter of bar provided				12 mm
Spacing required				250 mm
Spacing provided				200 mm
Provide 12 mm dia @ 200 mm centres on both faces				
Area of steel provided = $(\pi/4) \times 12^2 \times (1000/250)$				565.49 mm ²
Total weight of cylindrical wall = $2 \times \pi \times 3.2 \times 4.9 \times 0.25 \times 25$				615.75 kN
(8) Design of bottom dome and internal shaft				
Figure 4: Bottom Dome.				



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TITLE :	90 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
Diameter at base of dome =					6.40	m
Rise of bottom dome = h =					1.30	m
Thickness of bottom dome, t =					250	mm
Radius of the shell surface = $(\text{radius}^2 + \text{rise}^2)/(2 \times \text{rise}) =$					4.59	m
Weight of the dome slab = $2 \times \pi \times 4.59 \times 1.3 \times 0.25 \times 25 =$					234.32	kN
Thickness of walls of Internal shaft =					200	mm
Total Projection of platform required at top of internal shaft					750	mm
Thickness of platform					150	mm
Internal diameter of vertical shaft =	$=(2 \times 0.6) - 0.2$				1000	mm
External diameter =	$1000 + 2 \times 200 =$				1400	mm
Weight of water over bottom dome = (with FB)	$= 103.86 \times 10$				1038.6	kN
Weight of vertical shaft = $-\pi \times ((1400 - 200)/1000) \times (200/1000) \times 3.1 \times 25$					58.43	kN
Weight of circular platform						
	$= \pi \times (1000/1000 + 750/1000) \times (150/1000) \times (750 - 200)/1000 \times 25$				11.34	kN
Total weight on dome =	$= 234.32 + 1038.64 + 58.43 + 11.34$				1342.74	kN
Load/unit area = w =	$= 1342.74 / ((\pi/4) \times 6.4^2)$				41.74	kN/m ²
Meridional thrust = $T_1 =$	$= wR / (1 + \cos \theta)$				111.6	kN
	where, $\cos \theta =$				0.717	rad
Meridional stress =	$(111.6 \times 1000) / (130 \times 1000) =$				0.858	N/mm ²
					0.858 < 8 (Safe)	
Circumferential force = $wR [\cos \theta - 1/(1 + \cos \theta)] =$					25.73	kN
Hoop stress =	$(25.73 \times 1000) / (130 \times 1000) =$				0.2	N/mm ²
					0.2 < 1.5 (Safe)	
Provide minimum reinforcement of					0.24	%
Minimum steel required, $A_{st} =$					600	mm ²
Diameter of bar provided =					10	mm
Spacing of bar required =					125	mm
Provide 10 mm dia bar at 125 mm centres both radially and in circumferential direction.						
Maximum hoop compression in the internal shaft =						
	$= 10 \times 3.1 \times ((1400 - 200)/1000)/2 =$				18.6	kN
Hoop stress =	$= (18.6 \times 1000) / (130 \times 1000) =$				0.14	N/mm ²
					0.14 < 8 (Safe)	
Provide minimum reinforcement of					0.24	%



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	Minimum steel required, $A_{st} =$				480	mm^2	
	Diameter of bar provided =				10	mm	
	Spacing of bar required =				160	mm	
	Provide 10 mm dia bar at 160 mm centres in both directions.						
	(9) Design of bottom ring beam						
	Horizontal thrust from bottom dome =	$=111.6 \times \text{COS}(44.2)$			79.99	kN	
	Net Hoop Tension force in ring beam, H =				79.99	kN	
	Hoop compression =	$= 79.99 (6.4/2) =$			255.97	kN	
	Dimensions of bottom ring beam :						
		b =			350	mm	
		D =			500	mm	
	Area of tension steel required	$= (255.968 \times 1000) / 130$			1968.98	mm^2	
	Provide minimum reinforcement of				0.24	%	
	Minimum steel required, $A_{st} =$	$= (0.24/100) \times 350 \times 500$			420	mm^2	
	Diameter of bar provided =				20	mm	
	Number of bars required =				8	Nos.	
	Area of tension steel provided				2513	mm^2	
	Stress in concrete =	$T / [A_g + (m-1)A_{st}] =$					
		$= (255.968 \times 1000) / (350 \times 500 + (9.33-1) \times 2513.27)$			1.31	N/mm^2	
	1.31 < 1.5 (Safe)						
	Provide a ring beam of size 350 mm by 500 mm.						
	Provide 4Y20 at top and 4Y20 at bottom						
	Provide 8 mm dia stirrups at 200 mm centres.						
	Weight of bottom ring beam =	$\pi \times 6.4 \times (0.35 \times 0.5) \times 25 =$			87.96	kN	
	(10) Design of supporting cylindrical shaft						
	Centre to centre Diameter of shaft =				6.40	m	
	Height of shaft (above G.L.) =				30	m	
	Thickness of shaft wall above G.L. =				250	mm	
	Minimum thickness of shaft required as per IS: 11682-1985						
					151	mm	
	Total depth of foundation below G.L. =				3.00	m	
	Depth of shaft (below G.L.) =	$= 3 - 0.65 =$			2.35	m	
	Thickness of shaft wall below G.L. =				350	mm	



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	Self weight of shaft above G.L.	= $\pi \times 6.4 \times 25 \times 30 \times 0.25 =$				3769.91
	Self weight of shaft below G.L.	= $\pi \times 6.4 \times 25 \times 2.35 \times 0.35 =$				413.43 kN
	Thickness of shaft wall above G.L. =					250 mm
	Loads acting on shaft at ground level:					
	(1) Top dome					173.40 kN
	(2) Top ring beam					55.67 kN
	(3) Balcony					35.34 kN
	(4) Tank wall					615.75 kN
	(5) Bottom spherical dome					234.32 kN
	(6) Internal shaft + platform					69.77 kN
	(7) Bottom ring beam					87.96 kN
	Weight of tank portion =					1272.22 kN
	(8) Supporting shaft					4183.34 kN
	Total Dead load on top of footing =					5455.56 kN
	(9) Weight of water (Hydro test condition)=					1038.64 kN
	(10) Weight of water (Working condition)=					954.14 kN
	Wind pressure:					
	Basic wind speed, $V_b =$					50 m/s
	Risk Coefficient, $k_1 =$					1.08
	Terrain, height and structure size factor, $k_2 =$					1.11
	Topography factor, $k_3 =$					1
	Design wind speed, $V_z = V_b \times k_1 \times k_2 \times k_3 =$					59.94 m/s
	$P_z = 0.6 V_z^2 =$					2.16 kN/m ²
Ref Pg.	Total moment due to wind load about base of footing , M					3583.85 kN-m
Wind load calculation	Area of cross section of shaft, $A =$	$\pi [(3.325)^2 - (3.075)^2] =$				5.03 m ²
	Second moment of area, $I :$					
		$I = (\pi/4) [(3.325^4) - (3.075^4)] =$				25.78 m ⁴
	Stress at base section:					
	Tank empty condition:					
	$W =$					5455.56 kN
	Outer dia of shaft, $D =$					6.75 m
	Mean radius of shaft, $r =$					3.2 m
	$M =$					3583.85 kN-m
	$e = (M/W) =$					0.66 m



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	$e/r =$	$0.66/3.2 =$		0.206 m
	$e/r \leq 1/2$ (OK)			
IS 11682-1985	<i>This section is under compression only</i>			
	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			1.1 N/mm ²
	$1.1 < 0.38 \times 30$ (Safe)			
	<i>Tank working condition + wind:</i>			
	P =			6409.70 kN
	M =			3583.85 kN-m
	e = M/W =			0.56 m
	$e/r =$			$0.56/3.2 =$ 0.18
IS 11682-1985	$e/r \leq 1/2$ (OK)			
	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			1.23 N/mm ²
	$1.23 < 0.38 \times 30$ (Safe)			
	<i>Tank Hydro test condition</i>			
	W =			6494.20 kN
	M =			0 N-mm
	e = M/W =			0
IS 11682-1985	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			0.92 N/mm ²
	$0.92 < 0.38 \times 30$ (Safe)			
IS 11682-1985	Provide minimum longitudinal reinforcement of			0.25 %
	Area of steel required on each face, $A_{st} =$			312.5 mm ²
	Diameter of bar provided =			12 mm
	≥ 10 mm (OK)			
	Spacing of bar required =			360 mm
	Spacing of bar provided =			200 mm
	Provide 12 mm dia bar at 200 mm centres vertically on each faces.			
	Area of steel provided on each face =			565.5 mm ²
	<i>Circumferential reinforcement in shaft:</i>			
IS 11682-1985	Provide minimum circumferential reinforcement of			0.2 %
	Area of steel required on each face, $A_{st} =$			250 mm ²
	Minimum steel required per meter length on each face =			200 mm ²
	Diameter of bar provided =			10 mm
	Spacing of bar required =			310 mm



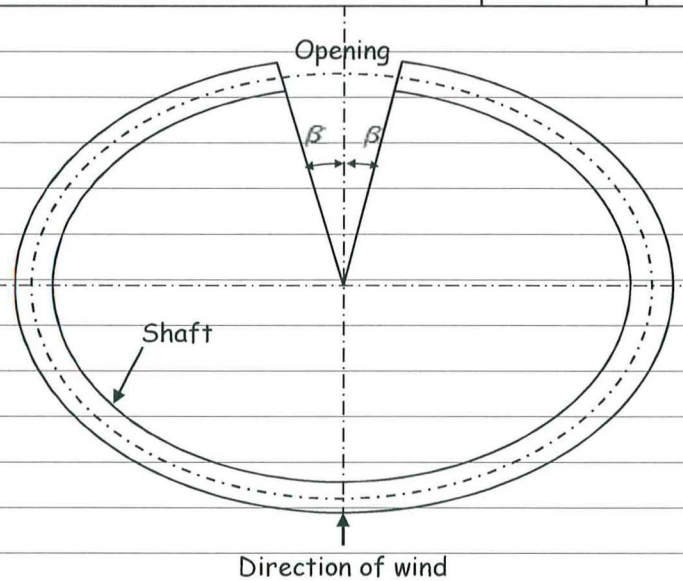
PROJECT :	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3021	DATE	29/03/2016	
TITLE :	90 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE	
	Spacing of bar provided =					200 mm	
	Area of steel provided per metre length of shaft=					392.70 mm ²	
						> 200 (OK)	
	Provide 10 mm dia bar at 200 mm centres circumferentially on each faces.						
	Area of steel provided =					392.7 mm ²	
	<i>Check for seismic forces</i>						
	Height of staging above ground level =					30.00 m	
	Stiffness of shaft, $k = 3 EI/l^3 =$						
IS 456-2000	$E = 5000(f_{ck})^{0.5} =$					27386.13 N/mm ²	
	$I = (\pi/4) [(3.325^4) - (3.075^4)] =$					25.78 m ⁴	
	$l =$ length of staging =					30.00 m	
	$k =$					78430.83 kN/m	
	Seismic coefficient is given by :					$A_h = \frac{Z I}{2 R} \left(\frac{S_a}{g} \right)$	
IS: 1893-2002	where, Zone Factor, Z =					0.1	
	Importance Factor, I =					1.75	
	Response reduction Factor R =					3	
	Spectral Acceleration, (S_a/g)						
	Tank Empty condition :						
	Weight of tank Container =					1272.22 kN	
	Weight of 1/3 of staging = $(1/3) \times (3769.91) =$					1256.64 kN	
	Seismic weight for tank empty condition, $W_s =$					2528.86 kN	
	Time period when tank empty, $T_e =$					$2\pi [(W_s/9.81) / k]^{0.5}$	
	$= 2\pi \times \{(2528.86/9.81)/(78430.83)\}^{0.5} =$					0.36 sec	
IS: 1893-2002	For rocky, or hard soil sites, corresponding $S_a/g =$					2.50	
	The design horizontal seismic coefficient, $A_h =$					0.07	
	Maximum horizontal seismic force acting at top of staging =					184.40 kN	
	<i>Moment due to seismic forces at top of footing:</i>						
	Total load, W =					5455.56 kN	
	Moment, M=					5965.21 kN-m	
	$e = M/W =$					1.09 m	
	$e/r =$					$1.09/3.2 =$	
						0.34	



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-W5-CW-DC-3021		DATE 29/03/2016
TITLE :	90 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE
IS 11682-				$e/r \leq 1/2$ (OK)
1985	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			1.3 N/mm ²
				$1.3 < 0.40 \times 30$ (Safe)
	<i>Tank Full condition :</i>			
	Weight of tank Container =			1272.22 kN
	Weight of 1/3 of staging = (1/3) × (3769.91) =			1256.64 kN
	Weight of water =			954.14 kN
	Seismic weight for tank full condition =			3483.00 kN
	Time period when tank full, T =			0.42 sec
IS: 1893-	For rocky, or hard soil sites, corresponding Sa/g =			2.5
2002	The design horizontal seismic coefficient, A _h =			0.07
	Maximum horizontal seismic force acting at top of staging =			253.97 kN
	<i>Moment due to seismic forces at top of footing:</i>			
	Total load, W =			6409.70 kN
	Moment, M= =253.97*(30+2.35)			8215.89 kN-m
	e= M/W =			1.28
	e/r = 1.28/3.2 =			0.4
IS 11682-				$e/r \leq 1/2$ (OK)
1985	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			1.64 N/mm ²
				$1.64 < 0.40 \times 30$ (Safe)
	<i>Check for stress at openings:</i>			
	<i>Size of opening :</i>		width =	1 m
			height =	2 m
	<i>Maximum vertical compressive stress in concrete at outside diameter of shaft shell is given by :</i>			
IS 11682-				
1985	$\sigma_{cv} = \frac{W}{2(\pi - \beta) r t} \left[1 + \frac{2 \left\{ \frac{e}{r} + \frac{\sin \beta}{\pi - \beta} \right\} \{ (\pi - \beta) \cos \beta + \sin \beta \}}{(\pi - \beta) - \frac{1}{2} \sin 2\beta - \frac{2 \sin^2 \beta}{(\pi - \beta)}} \right]$			



PROJECT :	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		DATE
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		AKHB/RRG	RR	



Where,

β = half the angle subtended by neutral axis as a chord on the circle of radius r =	0.16 rad
W = Total vertical load above section under consideration in N =	6410 KN
M = Moment in vertical plane at the section under consideration in N-mm =	8.22E+03 KN-m
$e = M/W =$	1.282 m
r = Mean radius of circular shaft in m =	3.2 m
t = Thickness of shaft in mm =	250 mm
$e/r =$	0.401
IS 11682-1985 substituting values in the above formula , we get $\sigma_{cv} =$	2.68 N/mm ²
	2.7 < 0.40 x 30 (Safe)

(11) Design of raft foundations

	Total load from tank and shaft = (Dead load on top of footing + weight of water working condition)	
	=5455.56KN+954.14KN	- (a) 6409.70 kN
From staad	Total weight of staircase : (seismic case) =	1642 kN
	Load from staircase =	- (b) 1642 kN
	Diameter of raft slab, $D_r =$	10.2 m
	Thickness of raft slab, t =	650 mm
	Self weight of footing = $(\pi/4) \times D_r^2 \times t =$	



PROJECT :	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3021	DATE	29/03/2016
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	$=(\pi/4) \times 10.2^2 \times 0.65 \times 25$				(c)	1327.83 kN
	Weight of Earth filling inside the shaft upto G.L.					
	$= [\pi (6.05^2)/4] \times 2.35 \times 18 =$				(d)	1216.02 kN
	Weight of earth filling over the raft slab upto G.L.					
	$= [\pi (10.2^2 - 6.75^2)/4] \times 2.35 \times 18 =$				(e)	1942.76 kN
	Total load acting on raft slab, W =				=(a)+(B)+(c)+(D)+(e)	12538.32 kN
	Net S.B.C. of soil =					150 kN/m ²
	Gross S.B.C at depth of 3 m below G.L. (For normal load)=					
	$=150+3 \times 18$					204 kN/m ²
	Gross S.B.C at depth of 2.35 m below G.L. (For seismic/wind load)=					
	$=150 \times 1.25 \times 3 \times 18$					241.5 kN/m ²
	Area of footing, A =				$=(\pi/4) \times 10.2^2$	81.71 m ²
	Direct load, W =					12538.32 kN
	Moment M = (Tank full condition under seismic)					8215.89 kN-m
From staad	Moment from staircase column (seismic case) =					55.00
	Total moment =					8270.89
	Section modulus, Z=					104.18 m ⁴
	Maximum intensity of soil pressure at base = $[W/A + M/Z] =$					232.83 kN/m ²
	232.83 < 241.5 (Safe)					
	Minimum intensity of soil pressure at base = $[W/A - M/Z] =$					74.05 kN/m ²
	74.05 > 0 (No tension)					
	Adopt Diameter of raft slab = 10.2 m					
	Projection of raft beyond face of shaft =					1.725 m
	Maximum net soil pressure, w =					
	$=232.83 - (650/1000 \times 25) - (18 \times 2.35)$					174.28 kN/m ²
	The loading at base is taken as annular loading on the mean diameter of the shaft.					
	Diameter of raft slab = 2a =					10.2 m
	Diameter of the shaft = 2b =					6.40 m
	Radial moment at centre of foundation is given by:					
	$M_r = \frac{W}{8\pi} \left[2 \log_e \left(\frac{a}{b} \right) + 1 - \left(\frac{b}{a} \right)^2 \right] - \frac{3}{16} w \cdot a^2 =$					-82.42 kN-m/m
	Moment at junction of footing and tank walls at a radius of 3.2 m is given by:					



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3021	DATE	29/03/2016	
TITLE :	90 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE	
	$M_{max} = \frac{W}{8\pi} \left[2 \log_s \left(\frac{a}{b} \right) + 1 - \left(\frac{b}{a} \right)^2 \right] - \frac{3}{16} w (a^2 - b^2) =$					252.20 kN-m/m	
	Design ultimate moment = $M_{ur} =$		(1.5 x 252.2) =			378.3 kN-m/m	
	Effective depth required $d = [M_u / .133 f_{ck} b]^{0.5} =$					307.92 mm	
	Effective depth provided at the section =					592.00 mm	
						(OK SAFE)	
	Compute parameter:						
			$M_u / bd^2 =$			1.079	
	Refer Table-4 of SP : 16 and read out the percentage reinforcement as:						
			$p_t = 100 A_{st} / bd =$			0.25954	
			Area of steel required, $A_{st} =$			1536.48 mm ² /m	
	Diameter of bar provided =					16 mm	
	Cover to the reinforcement =					50 mm	
	Actual effective depth at the section =					592	
	Spacing of bar required =					125 mm	
	Provide 16 mm dia bar at 125 mm centres both ways at bottom of footing.						
	Area of steel provided =					1608.50 mm ² /m	
	Design ultimate moment = $M_{uc} =$		(1.5 x -82.42) =			-123.63 kN-m/m	
	Compute parameter:						
			$M_u / bd^2 =$			0.35	
	Refer Table-4 of SP : 16 and read out the percentage reinforcement as:						
			$p_t = 100 A_{st} / bd =$			0.12	
			Area of steel required, $A_{st} =$			712.80 mm ² /m	
	Diameter of bar provided =					12 mm	
	Cover to the reinforcement =					50 mm	
	Effective depth at the section =					594	
	Spacing of bar required =					150 mm	
	Provide 12 mm dia bar at 150 mm centres both ways at top of footing.						
	Check for shear :						



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3021	DATE 29/03/2016
TITLE:	90 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR
Wind Load Calculation:			
Basic Wind Speed V_b (m/s) =		50	m/s
Risk Coefficient K_1 =		1.08	
Terrain Factor K_2 (For Category-1 & Class-B) =		1.11	
Topography factor K_3 =		1	
Design Wind Speed $V_z = V_b \times K_1 \times K_2 \times K_3 =$		59.94	m/s
Design Wind Pressure acting $P_z = 0.6 \times V_z^2 =$		2155.68	N/m ²
		2.16	kN/m ²
External Pressure Coefficient on shaft and top Cylindrical wall of bowl:			
Refer Table-18 (IS: 875 (Part-3) - 1987)			
Height of the Tank above ground level (h) =		32.45	m
Outer Diameter of the shaft (D) =		6.65	m
Ratio h/D = $32.45/6.65 =$		4.88	
From Table-18 use the coefficients for the nearest curve of h/D = 7			
<p>The diagram shows a circular wind direction indicator with 15 radial lines. The angles are labeled as follows: 0°, 15°, 30°, 45°, 60°, 75°, 90°, 112.5°, 135°, 157.5°, 180°, 202.5°, 225°, 247.5°, 270°, 292.5°, 315°, 337.5°. Four wind types are indicated with arrows: 'BACK WIND' at 180°, 'ACROSS WIND' at 270°, 'FRONT WIND' at 0°, and 'FRONT WIND' at 180° (pointing up).</p>			




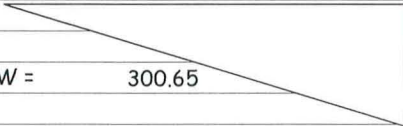
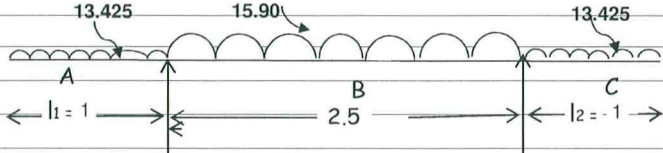
PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3021	DATE 29/03/2016
TITLE:	90 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR
	θ in degrees	Shaft (C_{pe})	Wall (C_{pe})
	0	1	1
	15	0.8	0.8
	30	0.1	0.1
	45	-0.8	-0.8
	60	-1.7	-1.7
	75	-2.2	-2.2
	90	-2.2	-2.2
	105	-1.7	-1.7
	120	-0.8	-0.8
	135	-0.6	-0.6
	150	-0.5	-0.5
	165	-0.5	-0.5
	180	-0.5	-0.5
	195	-0.5	-0.5
	210	-0.5	-0.5
	225	-0.6	-0.6
	240	-0.8	-0.8
	255	-1.7	-1.7
	270	-2.2	-2.2
	285	-2.2	-2.2
	300	-1.7	-1.7
	315	-0.8	-0.8
	330	0.1	0.1
	345	0.8	0.8
	Internal Pressure Coefficient :		
	Refer Clause 6.2.3.1 (IS: 875 (Part-3) - 1987)		




PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3021		DATE 29/03/2016		
TITLE:	90 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE		
	Internal Pressure coefficients for openings not more than 5% (C_{pi}) =			+0.2		
				-0.2		
	Wind Load acting on the shaft (Case-1)					
	θ in degrees	Shaft (C_{pe})	Shaft (C_{pi})	wind force / m	$F_{along\ wind}$	$F_{across\ wind}$
	0	1	0.2	1.5	1.5	0
	15	0.8	0.2	1.13	1.091	0.292
	30	0.1	0.2	-0.19	-0.165	-0.095
	45	-0.8	0.2	-1.88	-1.329	-1.329
	60	-1.7	0.2	-3.57	-1.785	-3.092
	75	-2.2	0.2	-4.51	-1.167	-4.356
	90	-2.2	0.2	-4.51	0	-4.51
	105	-1.7	0.2	-3.57	0.924	-3.448
	120	-0.8	0.2	-1.88	0.94	-1.628
	135	-0.6	0.2	-1.5	1.061	-1.061
	150	-0.5	0.2	-1.32	1.143	-0.66
	165	-0.5	0.2	-1.32	1.275	-0.342
	180	-0.5	0.2	-1.32	1.32	0
	195	-0.5	0.2	-1.32	1.275	0.342
	210	-0.5	0.2	-1.32	1.143	0.66
	225	-0.6	0.2	-1.5	1.061	1.061
	240	-0.8	0.2	-1.88	0.94	1.628
	255	-1.7	0.2	-3.57	0.924	3.448
	270	-2.2	0.2	-4.51	0	4.51
	285	-2.2	0.2	-4.51	-1.167	4.356
	300	-1.7	0.2	-3.57	-1.785	3.092
	315	-0.8	0.2	-1.88	-1.329	1.329
	330	0.1	0.2	-0.19	-0.165	0.095
	345	0.8	0.2	1.13	1.091	-0.292

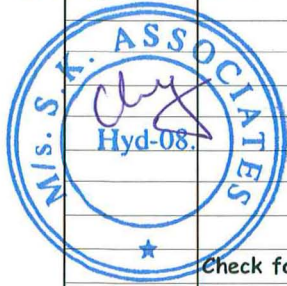


PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3021		DATE 29/03/2016		
TITLE:	90 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE		
		SUM =		6.8 0		
	Wind Load acting on the shaft (Case-2)					
	θ in degrees	Shaft (C_{pe})	Shaft (C_{pi})	wind force / m ²	$F_{along\ wind}$	$F_{across\ wind}$
	0	1	-0.2	2.26	2.26	0
	15	0.8	-0.2	1.88	1.816	0.487
	30	0.1	-0.2	0.56	0.485	0.28
	45	-0.8	-0.2	-1.13	-0.799	-0.799
	60	-1.7	-0.2	-2.82	-1.41	-2.442
	75	-2.2	-0.2	-3.76	-0.973	-3.632
	90	-2.2	-0.2	-3.76	0	-3.76
	105	-1.7	-0.2	-2.82	0.73	-2.724
	120	-0.8	-0.2	-1.13	0.565	-0.979
	135	-0.6	-0.2	-0.75	0.53	-0.53
	150	-0.5	-0.2	-0.56	0.485	-0.28
	165	-0.5	-0.2	-0.56	0.541	-0.145
	180	-0.5	-0.2	-0.56	0.56	0
	195	-0.5	-0.2	-0.56	0.541	0.145
	210	-0.5	-0.2	-0.56	0.485	0.28
	225	-0.6	-0.2	-0.75	0.53	0.53
	240	-0.8	-0.2	-1.13	0.565	0.979
	255	-1.7	-0.2	-2.82	0.73	2.724
	270	-2.2	-0.2	-3.76	0	3.76
	285	-2.2	-0.2	-3.76	-0.973	3.632
	300	-1.7	-0.2	-2.82	-1.41	2.442
	315	-0.8	-0.2	-1.13	-0.799	0.799
	330	0.1	-0.2	0.56	0.485	-0.28
	345	0.8	-0.2	1.88	1.816	-0.487
				Σ	6.76	0

	LARSEN & TOUBRO LIMITED Water, Smart World & Communication IC		22	
	PROJECT : Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3021		DATE 29/03/16
		TITLE : 90 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR
DESIGN OF STAIR CASE				
DESIGN OF STAIR CASE				
* Maximum span of flight is designed and the same reinforcement is provided for all flights and landing slab.				
Design data :				
	f_{ck}	=	25 N/mm ²	
	f_y	=	500 N/mm ²	
	Tread , T	=	250 mm	
	Rise , R	=	167 mm	
	Thickness of Waist slab , D	=	150 mm	
		T = 250		
	W = 300.65		R = 167	
				
Dead load :				
On landing area,	Self wt.of slab	=	3.75 KN/m ²	
	Finish load	=	1.2 KN/m ²	
	Total dead load	=	4.95 KN/m ²	
On Stair area,	Flight load = $1/T (D * W + T * R / 2) * 25$			
	= $1 / 0.25 (0.15 * 0.30 + 0.25 * 0.17 / 2) * 25$			
	=		6.60 KN/m ²	
	Span for stair area		2.5 m	
	Span for landing area	=		
		l_1 =	1 m	
		l_2 =	1 m	
	Clause 33.1., IS : 456, Effective span, ES = A + B + C =		2.5 m	
Live load :				
	Live on landing & stair area	=	4 KN/m ²	
Factored loads,				
	On landing area,	= $1.5 * (DL + LL)$		
		=	13.43 KN/m ²	
	On stair area,	= $1.5 * (DL + LL)$		
		=	15.90 KN/m ²	
Loading diagram ,				
				
From staad		R_a	= 33.33 KN	
From staad		R_b	= 33.33 KN	
	Maximum B.M.	M_u =	7.00 KN-m	

 LARSEN & TOUBRO LIMITED Water, Smart World & Communication IC PROJECT: Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District TITLE : 90 KL Capacity OHBR	23		
	DOCUMENT NO.		DATE
	LE150883-C-WS-CW-DC-3021		29/03/16
	DESIGNED	CHECKED	PAGE
AKHB/RRG	RR		
Clear cover in mm	=	30 mm	
Assuming dia of bar as	=	10 mm	
Effective depth, d	=	115 mm	
Table , SP : 16			
Reinforcement :			
Mu/bd^2	=	0.53 N/mm ²	
pt	=	0.12 %	
$Ast(req)$	=	143.51 mm ²	
Required	10 Dia.	@	
Provide	10 Dia.	@	
therefore,			
$pt(prov)$	=	0.55 %	
$Ast(prov)$	=	628.3 mm ²	
Minimum reinforcement required	$= (0.12/100) * 1000 * 150$	187.2 mm ²	
Provide 8 mm dia 200 mm spacing c/c		251.2 mm ²	
Reinforcement provided	$pt(prov)$	=	
		0.17 %	
Check for shear :			
Actual shear stress, V_u	=	33.33 KN	
T_v	=	0.29 N/mm ²	
for pt	=	0.55	
Allowable shear stress, T_c	=	0.507 N/mm ²	
		> T_v	
NO SHEAR REINFORCEMENT IS REQUIRED			
Check for deflection :			
(From IS:456:2000 clause 23.2)			
Allowable span /depth ratio	=	20.00	
% of tension reinforcement	=	0.55	
$fs = 0.58 * 415 * (143.51 / 628.32)$	=	54.98	
From Fig 4 Modification factor for tension R_{ft} (Mft)	=	2.00	
From Fig 5 Modification factor for tension R_{ft} (Mfc)	=	1.00	
Modified span /depth ratio	$= l/d \times M_{ft} \times M_{fc}$	=	
		40.00	
Actual span/depth ratio	$2.5 * 1000 / 115$	=	
		21.74	
Actual span/depth ratio < Modified span/depth ratio	=	safe	

“Designs Verified”



APPROVED

12/04/16
 SE, NIRMAL

Yusuf Ahmed
 Asst. Executive Engineer
 TDWSP Asifabad

Jayaram
 Dy. Executive Engineer
 TDWSP Asifabad

Kav
 Executive Engineer
 TDWSP Asifabad



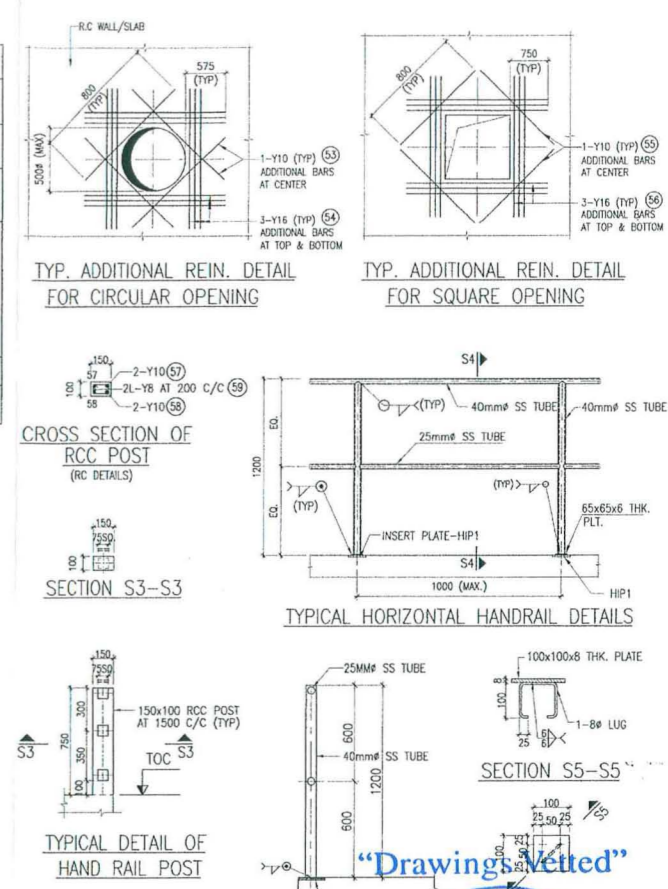
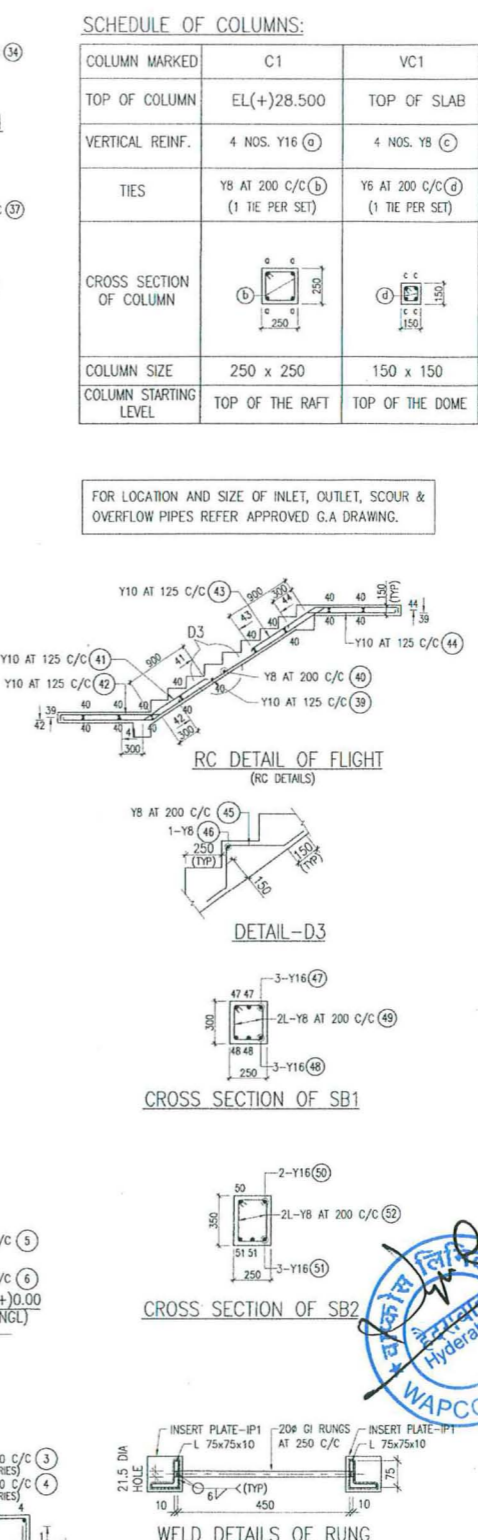
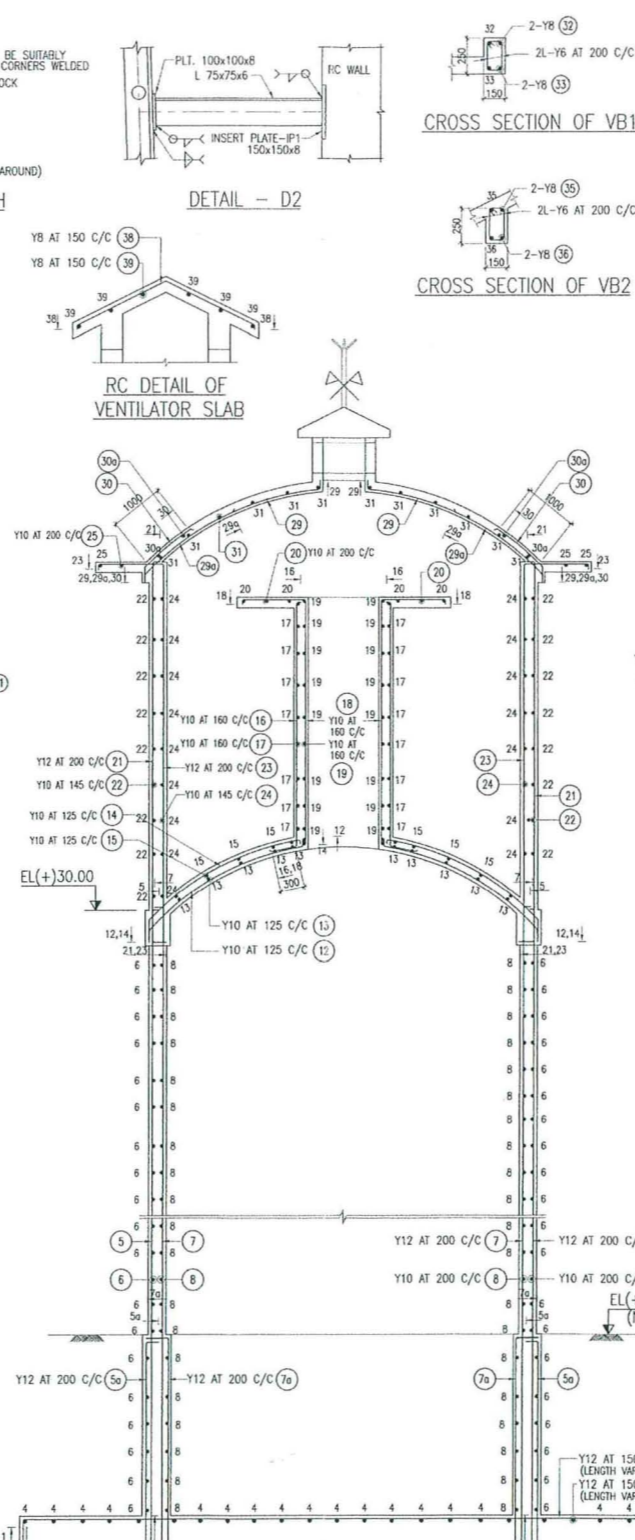
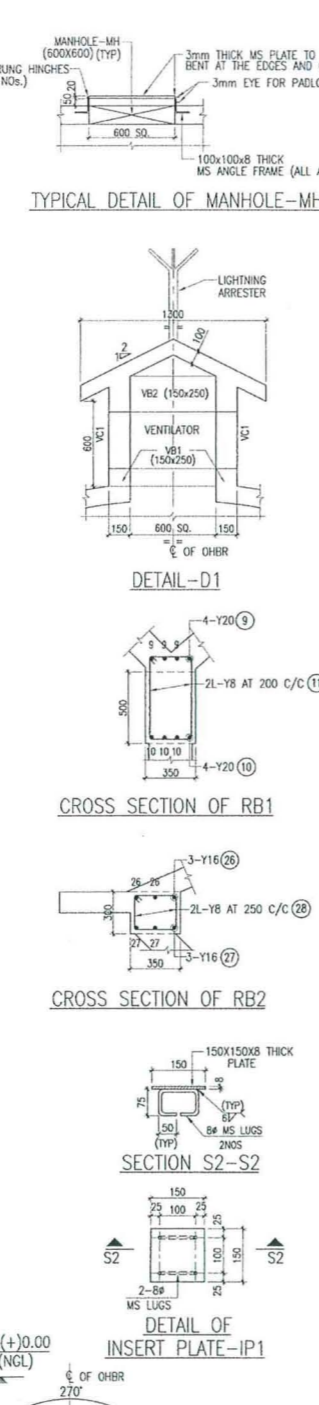
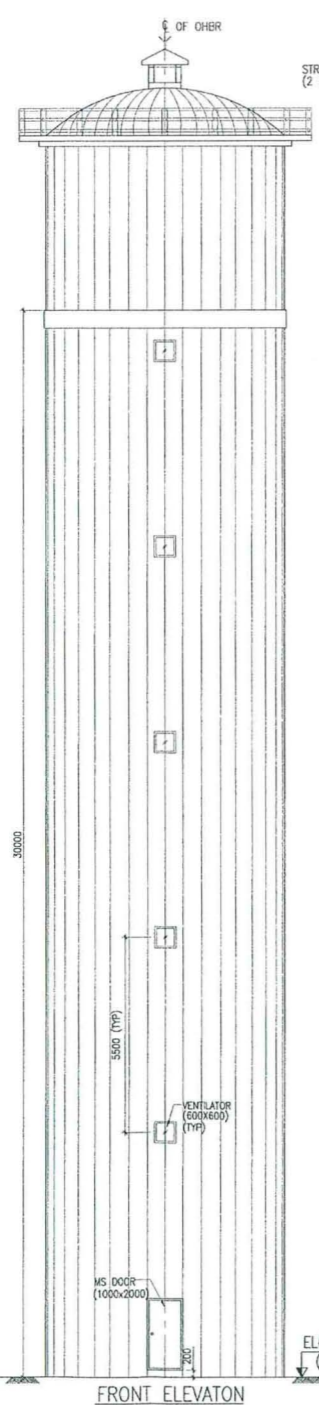
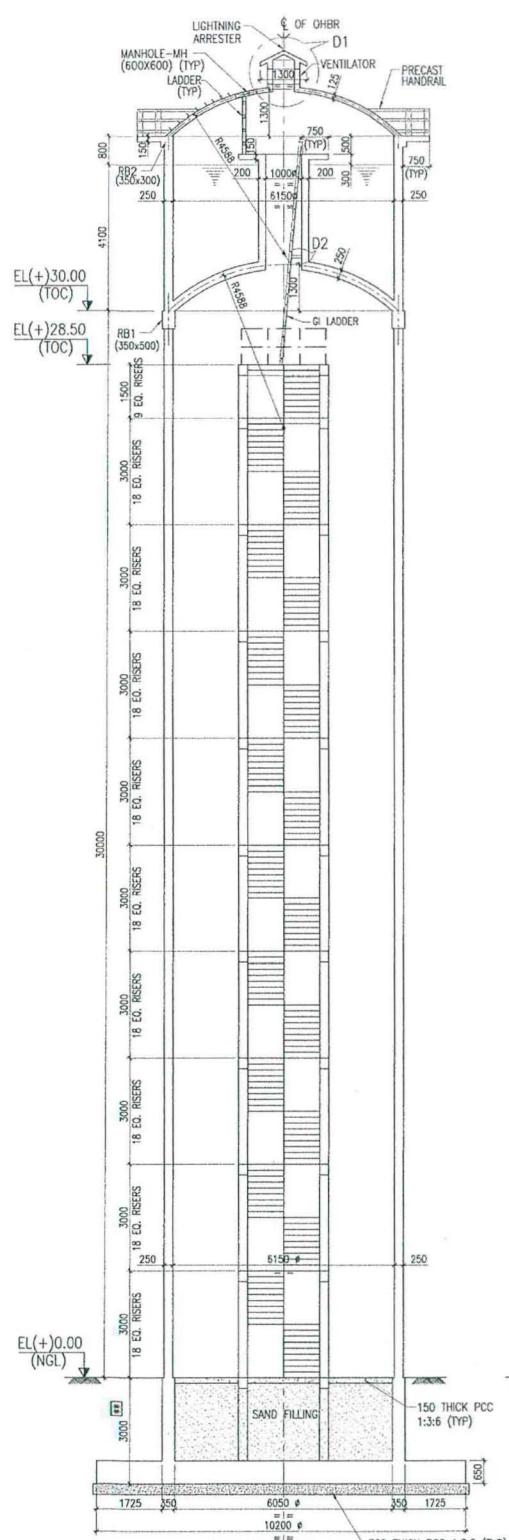


LARSEN & TOUBRO LIMITED
Water, Smart World & Communication IC

PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		DATE
		LE150883-C-WS-CW-DC-3021		07-Apr-2016
TITLE :	90 KL Capacity OHBR - 30 m staging height	DESIGNED	CHECKED	PAGE
		AKHB/RRG	RR	

APPENDIX

(1) Stability Check - Tank empty conditon			
Wind force			248.45 kN
Moment due to wind force			3583.85 kN-m
Seismic force			184.40 kN
Moment due to seismic force			5965.21 kN-m
Max. horizontal force			248.45 kN
Max. overturning moment = OM			5965.21 kN-m
Total vertical DL			
=(Top container(without water) + shaft + stair case + raft + earth inside and outside)			11584.17 kN
0.9 DL		=0.9 x 11584.17	10425.76 kN
Restoring moment = RM =DL x (raft dia)/2		=11584.17 x 10.2/2	59079.29 kN-m
Check for safety against overturning			
Factor of Safety =OM/RM		= 5965.21/59079.29 =	9.90
>1.5 safe Ok			
Check for safety against sliding			
Factor of Safety =(0.9DL x μ)/(Max horizontal force)		=10426x0.4/248	16.79
>1.25 safe Ok			
(2) Stability Check - Tank full conditon			
Seismic force			253.97 kN
Moment due to seismic force			8215.89 kN-m
Max. horizontal force			253.97 kN
Max. overturning moment = OM			8215.89 kN-m
Total vertical DL			
=(Top container (with water) + shaft + stair case + raft + earth inside and outside)			12538.32 kN
0.9 DL		=0.9 x 12538.32	11284.49 kN
Restoring moment = RM =DL x (raft dia)/2		=12538.32 x 10.2/2	63945.42 kN-m
Check for safety against overturning			
Factor of Safety =OM/RM		= 8215.89/63945.42 =	7.78
>1.5 safe Ok			
Check for safety against sliding			
Factor of Safety =(0.9DL x μ)/(Max horizontal force)		=11284x0.4/254	17.77
>1.25 safe Ok			



SCHEDULE OF COLUMNS:

COLUMN MARKED	C1	VC1
TOP OF COLUMN	EL(+28.500)	TOP OF SLAB
VERTICAL REIN.	4 NOS. Y16 @ (1 PER SET)	4 NOS. Y8 @ (1 PER SET)
TIES	Y8 AT 200 C/C (1 PER SET)	Y6 AT 200 C/C (1 PER SET)
CROSS SECTION OF COLUMN		
COLUMN SIZE	250 x 250	150 x 150
COLUMN STARTING LEVEL	TOP OF THE RAFT	TOP OF THE DOME

FOR LOCATION AND SIZE OF INLET, OUTLET, SCOUR & OVERFLOW PIPES REFER APPROVED G.A DRAWING.

LEGEND:
 NGL : NATURAL GROUND LEVEL
 TOC : TOP OF CONCRETE

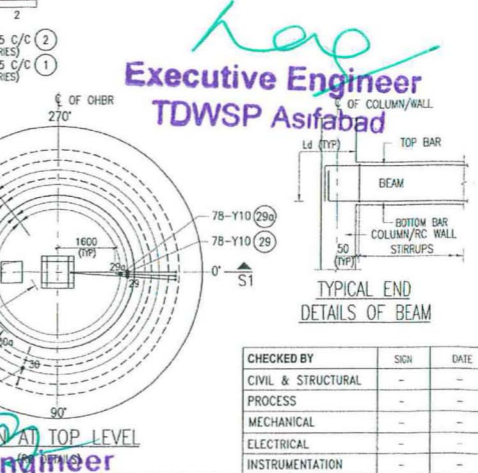
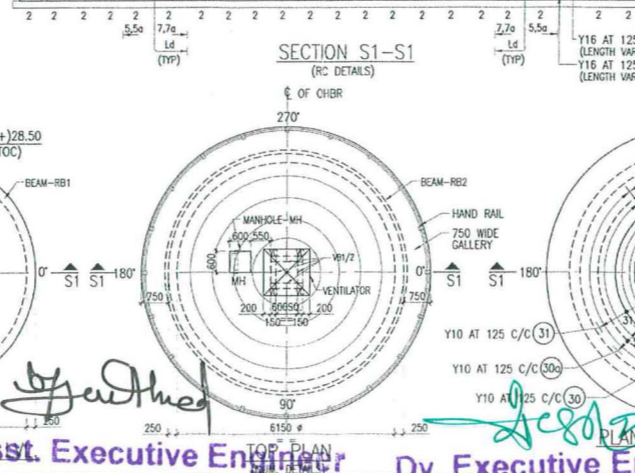
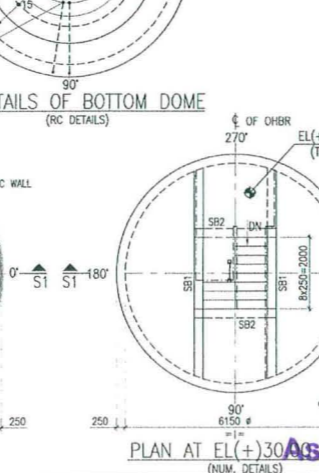
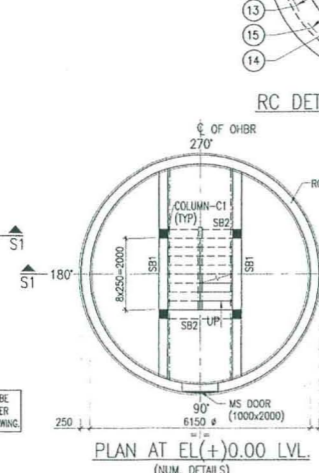
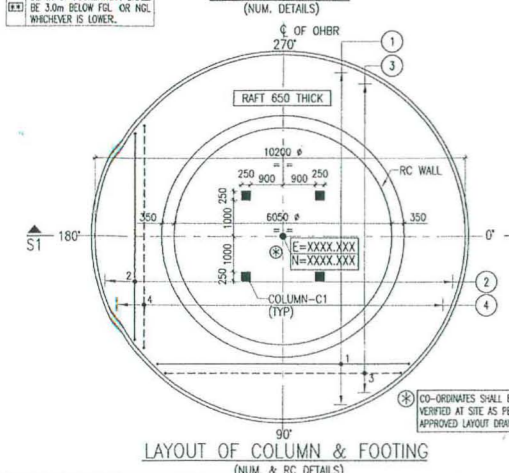
NOTES:-

- ALL DIMENSIONS ARE IN mm & ALL LEVELS SHALL BE IN METRES.
- GRADE OF CONCRETE SHALL BE M30 - 43 GRADE CEMENT, 20MM DOWN SIZE AGGREGATE WITH MINIMUM CEMENT CONTENT OF 320 kg/cum.
- Y INDICATES HYSD BARS OF GRADE Fe500 CONFORMING TO IS: 1786-1985.
- CLEAR COVER TO MAIN REINFORCEMENT SHALL BE :
 a) RAFT = 50mm
 b) BEAM (ALL ROUND) = 30mm
 c) COLUMNS = 40mm
 d) SHAFT = 30mm
 e) WALL = 30mm(FREE FACE), 45mm (WATER FACE)
 f) TOP DOME = 30mm
 g) BOTTOM DOME = 30mm(FREE FACE), 45mm (WATER FACE)
 h) LAPS SHALL BE 41 TIMES DIA OF BAR AND SHALL BE STAGGERED.
- THREE COATS OF EPOXY PAINT TO INNER SURFACE OF THE RESERVOIR INCLUDING ROOF AND 2 COATS OF WEATHER PROOF EMULSION PAINTING FOR EXTERNAL SURFACES.
- SAFE BEARING CAPACITY OF SOIL IS CONSIDERED AS 15T/Sqm.

APPROVED
 SE, NIRMAL

LAST BAR NO. (59)

REV. NO.	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
B	REVISED AS PER COMMENTS				
A	FOR APPROVAL				



CHECKED BY:

CHECKED BY	SIGN	DATE
CIVIL & STRUCTURAL		
PROCESS		
MECHANICAL		
ELECTRICAL		
INSTRUMENTATION		

L&T Construction
 Water, Smart world & Communication

CLIENT: GOVERNMENT OF TELANGANA
 RURAL WATER SUPPLY AND SANITATION DEPARTMENT

PROJECT: PROVIDING DRINKING WATER TO HABITATIONS IN KOMARAMBHEEM
 ASIFABAD SEGMENT IN ADILABAD DISTRICT

SUPPLIER/CONTRACTOR: **L&T Construction**
 Water & Effluent Treatment SBG

JOB No.: LE150883

TITLE: 90 KL CAPACITY OHBR AT SIRPUR-U & LOKARI-K NUMERATION & RC DETAILS

SCALE: 1:100, 1:50 & 1:25

PROJECTION:

DRG. No. LE150883-C-W-S-C-W-N-R-3022

RELEASED FOR: PRELIMINARY TENDER INFORMATION APPROVAL CONSTRUCTION

Asst. Executive Engineer
 TDWSP Asifabad

Dy. Executive Engineer
 TDWSP Asifabad

GEOTECHNICAL INVESTIGATION REPORT

TELANGANA DRINKING WATER SUPPLY PROJECT

KOMARAM BHEEM - ASIFABAD- SEGMENT 22

ASIFABAD , ADILABAD DISTRICT

90 KL BPT AT LOKARI (K) JN. , NARNOOR (M)

CONTRACTOR :

**M/s. LARSEN & TOUBRO LIMITED, L&T CONSTRUCTION,
WATER & EFFLUENT TREATMENT SBG, CHENNAI**

Drilling By:

M/s. ANJI DRILLING & GROUTING WORKS

Report Prepared by

DR. D. BABU RAO,

M.E.(IIT,Roorkee), Ph.D.(USA), MIGS

MCH Panellist No. 2490 /TP/2000-2

GEOTECHNOLOGIES

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TELANGANA DRINKING WATER SUPPLY PROJECT

90 KL BPT LOKARI (K) JN, NARNOOR (M) IN ADILABAD DT.

1. INTRODUCTION

M/s. L &T Construction, Water & Effluent Treatment is proposing to construct 90 KL BPT at Lokari (K); Jn, Narnoor (M), Asifabad (M) :The work is taken up under Segment 22 , Komaram Bheem Project , TDWSP, in Adilabad Dt.

The present Report presents the results of (1) Bore hole.

M/S Anji Drilling & Grouting works; Anantapur has carried out the drilling of bore holes, collection of soil and rock samples and conduct of Standard Penetration Tests at different levels in the respective bore holes at the proposed site.

Analysis of borehole data , Laboratory tests and geotechnical investigation report have been made by Prof. D Babu Rao, ME (IIT,R) , Ph.D. (USA), MIGS, Empanelled Consulting Geo technical Engineer &,Director, Geo technologies, Former Professor of Civil Engineering, Osmania University.

2. SCOPE OF WORK

The following is the scope of work of M/s. Anji Drilling and Grouting Works:

- Drilling Borehole at (1) location for BPT at Lokari (K) Jn, in Adilabad Dt.
- Conducting SPT at regular intervals, where feasible
- Collection of undisturbed / disturbed samples from the Bore holes
- Preparation of Technical Report recommending suitable foundations and safe bearing capacity


Dr. D. BABU RAO
M.E., Ph.D.(USA)
Consulting Geotechnical Engineer



Following is the scope of work of Prof. D Babu Rao ,

Testing of soil samples in the Laboratory

Preparation of Technical Report

3. SUB SOIL INVESTIGATION

The sub soil investigation was carried out to determine:

Nature of sub stratum and engineering properties of sub strata which may affect the mode of construction of the proposed work.

FIELD INVESTIGATION PROCEDURE:

The following technique is adopted for sub soil investigations.

a) BORINGS:

Rotary Drilling was done using TC / Diamond bits. The size of the casing used was 125 to 75 mm, yielding samples of NX size.

TC bits were employed for the overburden, and Impregnated Diamond Core bits were used for rock formation.

Drilling was performed on 26 - 27 Jan ,2016.

The following relevant data was recorded during Rotary drilling operations.

- Nature of strata
- Details of samples
- Core Recovery (CR)
- Rock Quality Designation (RQD)


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Consulting Geotechnical Engineer



b) STANDARD PENETRATION TEST (SPT):

SPT split spoon sampler of standard dimensions was driven into the soil from the borehole bottom using 63.5 kg hammer with a fall of 75 cm height. The SPT weight was lifted to the specified height and allowed to fall freely on the anvil with the use of cat-head winch with one to one and half turn of the drum. Blow counts for the penetration of every 15 cm were recorded and the 'N' value is reported as the blow counts for 30 cm penetration of the sampler excluding the first 15 cm penetration as seating drive.

When the number of blows exceeded 50 to penetrate the first or second 15 cm length of the sampler, the SPT 'N' is regarded as more than 100 as described in IS 2131 - 1981. The test is terminated in such case and a record of the penetration of the sampler under 50 blows is made. SPT refusal is recorded when there is no penetration of the sampler at any stage and also when a rebound of the sounding system is recorded. These tests were conducted at close intervals of 1.0m so that a continuous SPT 'N' profile is available.

Disturbed soil collected in the SPT sampler was preserved in polythene covers and transported to the laboratory. Additional polythene cover was used to prevent the loss of moisture during the transit period.

c) DEPTH OF BORING: The depth of the Bore hole was as follows:

BH No	Drilled depth
1	6 m



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d) LOG OF BORE HOLE:

All the results obtained from the field operations are presented in Log of Bore hole in Fig. 1 .

4. LABORATORY TESTING:

The laboratory tests are conducted in the laboratory of Geotechnologies, Hyderabad, an ISO- 9000 approved Laboratory.

From GL to 1.5 m , weathered rock was seen. N value exceeded 100 blows (Refusal) . This was followed by hard rock to 6 m

The following tests were conducted on cores from hard rock :

- Unconfined compressive strength (as per IS: 9143)


Table 1 gives the rock properties of Cores.


5. SUB SOIL PROFILE

Based on Field and Laboratory tests, the following idealized sub soil profile is evolved.

Depth	Strata	N value
0 – 1.5 m	Weathered rock	>100
1.5 – 6 m	Hard rock	Cores

. In Hard rock, no SPT can be conducted. However, in SDR strata, SPT can be conducted with N values tending to be 'refusal'. This is the criterion for distinguishing between Soft rock /Weathered rock and Hard rock.


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Consulting Geotechnical Engineer



exists from 1.5 to 6 m depth . Hence shallow foundation is feasible and same is recommended.

8.0 RECOMMENDATIONS

Based on Field Investigations and laboratory testing, the following Recommendations are made for construction of 90 KL BPT at Lokari (K), Jn, Narnoor (M), Asifabad (M)

a) Open foundations resting at 2 m below GL ,are recommended. The structure is likely to result in saturation and inundation of the sub soil during long – time operation,

b) SBC is recommended as follows :

Location		BH 1
S. No.	Depth (m)	Recommended SBC t/ sq m
1	2.0	30
2	3.0	35
3	4.5	40

c) The actual size of foundations will be based on loads from the superstructure.

For ANVI DRILLING AND GROUTING WORKS

(DR. D. BABU RAO)

M. E(IIT,R), Ph. D. (USA), MIGS

Former Professor of Civil Engineering

Consulting Geotechnical Engineer

MCH Panelist No. 2490/TP/2000-2



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Consulting Geotechnical Engineer

TELANGANA DRINKING WATER SUPPLY PROJECT

FIG 1 : Record of Boring, Bore Hole No : 1



90 KL BPT LOKARI (K) JN, NARNOOR (M) IN ADILABAD DT.

Type of Boring: Core drilling

Dia of Boring: NX

Date : 26-27 Jan 2016

Drilled depth : 6 m

Depth, m	Profile	Soil	Sample Depth m	N value	CR, %	RQD%	
0		Weathered rock	0	>100			
1.0			1.5		36	-	
2.0		Hard rock					
3.0			3.0		47	-	
4.0			4.5		63	21	
5.0							
6.0						-	
7.0							-
8.0							
9.0							
10.0							
11.0							
12.0							
13.0							
14.0							
15.0							
16.0							



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APPENDIX

CALCULATION OF SBC

90 KL BPT LOKARI (K) JN, NARNOOR (M) IN ADILABAD DT.

TYPICAL CALCULATIONS FOR OPEN FOUNDATIONS AT 2 M DEPTH

Foundations resting in Rock :

As per IS : 12070 -1987,

For q_c = Average uniaxial compressive strength of rock cores

$$= 300 \text{ kg/ sq cm}$$

N = Empirical coefficient =0.1, for discontinuities

Safe bearing pressure $q = q_c N$

$$= 300 \times 0.1 = 30 \text{ kg / sq cm} = 300 \text{ t / sq m}$$

Considering FS of 10, (in view of likely fissures and fissures in the rock)

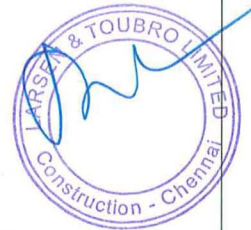
SBC = 30 t / sq m

Recommended Safe Bearing Capacity is 30 tonnes per sq m

Keeping the above considerations in view, Recommended Safe Bearing

Capacity is 25 t per sq m


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