

Submitted sir,

Sub: RWS&S-TDWSP- Muttunurgutta 60KL OHBR (30mtr) in Indervelly Mandal-
Komarambheem Asifabad Segment-Adilabad District-Designs -Approval-Reg.

Kindly pursue the Designs of the following 60KLOHBR at Muttunurgutta(V),
Indervelly (M), submitted by the Executive Engineer TDWSP Asifabad Division , Adilabad
district for approval.

1. 60 KL OHBR.

The Executive Engineer TDWSP Asifabad Division has submitted Structural
Designs & Drawings of 60KL 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 : 60kL
- 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 :4.75 mts
- Dia of Tank Inner to Inner :4.75 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	RR	BRJ
A	For Approval	15.02.16	15.02.16	15.02.16
		AKHB	RRG	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	TITLE :	
	60 KL capacity OHBR - Design Calculations	
NAME	SIGN	DATE
DSGN	AKHB	15.02.16
CHKD	RRG	15.02.16
APPD	BRJ	15.02.16

DOC./DRG. No.	SIZE	REV.
L E 1 5 0 8 8 3 - C - W S - C W - D C - 3 0 1 1	A4	B

RELEASED FOR	<input type="checkbox"/> PRELIMINARY	<input type="checkbox"/> INFORMATION	<input checked="" type="checkbox"/> APPROVAL	<input type="checkbox"/> CONSTRUCTION
--------------	--------------------------------------	--------------------------------------	--	---------------------------------------



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3011		DATE 29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE
Design of Over head Reservoir				
(1) DATA:				
	Capacity of Tank	60	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 =		5.00	m
	Rise of Top Dome, h =	=D/5	=5/5	1.00 m



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
Diameter of supporting shaft = D =					5.00	m
Rise of bottom dome , h = =D/5				=5/5	1.00	m
Height of water column in cylindtical portion of tank, H =					4.50	m
Free board, F.B =					0.30	m
Total Height of tank wall = H+FB-(1.8-h)				=4.5+0.3+(1.8-1)	5.60	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=				=4.5-1+0.3	3.80	m
Inner diameter of the tank = D-shaft thk+(wall thk/2)				=5-0.25+(0.25/2)	4.75	m
Volume of Cylindrical portion =V ₁ = (π/4)×(inner dia) ² ×H =				(π/4)×(4.75) ² ×4.5	79.74	m ³
Radius of curvature of bottom dome = R =				$[\frac{(D/2)^2+h^2}{2h}]$		
				$[\frac{(5/2)^2+1^2}{2 \times 1}]$	3.63	m
Volume of bottom dome =V ₂ = (π/3)×(r ² ×(3R-h))						
				$=(\pi/3) \times (1^2 \times (3 \times 3.63 - 1))$	10.36	m ³
Volume of internal shaft =V ₃ = (π/4)×(dia ² × (H-h))						
				$=(\pi/4) \times [1.4^2 \times (4.5 - 1)]$	5.39	m ³
Total volume of tank without free board = V ₁ -V ₂ -V ₃				=79.74-10.36-5.39	64.00	m ³
					OK	
Total volume of tank with free board =					68.85	m ³
(4) Design of Top dome:						
<p>The diagram shows a cross-section of a spherical dome. A vertical dashed line represents the axis of symmetry. The height of the dome from the chord to the top is 1.00 m. The horizontal distance from the axis to the edge of the chord is 2.50 m. The radius of curvature of the dome is 3.63 m. The angle between the vertical axis and the radius is labeled as θ = 43.53°. The thickness of the dome is indicated as 125 mm. The label 'Top Dome' points to the curved surface.</p>						
Figure 2: Top Dome.						
Radius of the chord, r =	5/2				2.50	m



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
Rise of the top dome, h =					1.00	m
Radius of the shell surface = $(r^2 + h^2)/2h =$	$(2.5^2 + 1^2)/(2 \times 1)$				3.63	m
Semi-central angle is given by						
$\sin \theta = r_3/R =$	0.69	that is,	$\theta =$	43.53°		
			=	0.760	rad	
Thicknes of the dome =					125	mm
Self weight of dome (w_g) = 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 = $2\pi Rhw_g =$	$2\pi \times 3.63 \times 1 \times 3.125 =$				71.27	kN
Live load on the dome = $2\pi Rhw_l =$	$2\pi \times 3.63 \times 1 \times 1.5 =$				34.21	kN
Total load on top dome =	71.27 + 34.21 =				105.48	kN
Meridional thrust = $N_o = (wR)/(1+\cos \theta) =$					9.73	kN/m
	Meridional Stress = $0.00973/0.125 =$				0.08	MPa
0.08 < 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 = $wR[\cos \theta - (1/(1+\cos \theta))] =$					2.44	kN/m
	Hoop stress =	$0.00244/0.0015$			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



PROJECT :	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
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	$= 2 \times \pi \times (5/2 + 350/1000 + 0.4/2) \times 0.4 \times (150/1000) \times 25$				28.75	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	$= T = N_o \cos(\theta)R =$				17.64	kN
				Where R =	2.50	m
Size of the web of the ring beam:						
		b =			350	mm
		D =			300	mm



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016	
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE	
	Area of tension steel required, $A_s =$	$= (17.64 \times 1000) / 130$			135.692	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 = $T / [A_g + (m-1)A_{st}] =$						
	$= (17.64 \times 1000) / [(350 \times 300) + (9.33-1) \times 603.19] =$				0.16	N/mm^2	
					0.16 < 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 = $2\pi (2.675) (0.35 \times 0.3) (25) =$				44.12	kN	
	(7) Design of vertical wall of tank						
	Total Wall height =				5.60	m	
	height of water column =	$= 4.5 + 0.3 =$			4.80	m	
	Radius of tank				2.50	m	
	Hoop tension, $T =$ unit weight of water $\times H \times D / 2$	$= 10 \times 4.8 \times 2.5$			120	kN/m	
	Thickness of wall =				250	mm	
		$H^2 / Dt =$			$= 5.6^2 / (4.75 \times 0.25)$	26.41	
	Since $(H^2) / (Dt)$ is more than 16, IS 3370 table cannot be used for moment and tension calculation						
From STAAD	Hoop tension for hinged base and top free						
	Sx from staad				0.385		
	Hoop tension = $S_x \times 250$	$= 0.385 \times 250$			96.25	kN/m	
	Maximum Hoop tension, $T =$				120.0	kN/m	
	Ast required on each face for max tension =	$= 120 \times 1000 / (130 \times 2)$			461.54	mm^2	
	Minimum Ast required as per IS 3370				0.24	%	
	Ast 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				170	mm	



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3011		DATE 29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE
Provide 10 mm dia @ 145 mm centres on both faces				
Area of steel provided				541.65 mm ²
Stress in concrete = $T/[A_g + (m-1)A_{st}] =$				
$= (120 \times 1000) / (1000 \times 250 + (9.33 - 1) \times 541.65)$				0.47 N/mm ²
0.47 < 1.5 (Safe)				
Vertical Steel				
From STAAD	Vertical Moment for Fixed base and top free			
	Moment from staad			4.49 kN-m
	Moment			4.49 kN-m
Area of steel required for moment				
$= 4.49 \times 10^6 / (130 \times (250 - 45 - 12/2) \times 0.86)$				201.814 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 $= 2 \times \pi \times 2.5 \times 5.6 \times 0.25 \times 25$				549.78 kN
(8) Design of bottom dome and internal shaft				
<p>The diagram shows a cross-section of a bottom dome. The dome is semi-circular with a vertical height of 1.00 units and a horizontal radius of 5.00 units. The dome has a thickness of 250 units. Below the dome, there is an internal shaft that slopes downwards from the base of the dome. The length of this shaft is 3.63 units, and it makes an angle theta with the vertical dashed line.</p>				
Figure 4: Bottom Dome.				



PROJECT :	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
Diameter at base of dome =					5.00	m
Rise of bottom dome = h =					1.00	m
Thickness of bottom dome, t =					250	mm
Radius of the shell surface = $(radius^2 + rise^2)/(2 \times rise) =$					3.63	m
Weight of the dome slab = $2 \times \pi \times 3.63 \times 1 \times 0.25 \times 25 =$					142.55	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)	$= 68.85 \times 10$				688.5	kN
Weight of vertical shaft = $= \pi \times ((1400 - 200)/1000) \times (200/1000) \times 3.8 \times 25$					71.63	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 =	$= 142.55 + 688.52 + 71.63 + 11.34$				914.04	kN
Load/unit area = w =	$= 914.04 / ((\pi/4) \times 5^2)$				46.55	kN/m ²
Meridional thrust = $T_1 =$			$= wR / (1 + \cos \theta)$		97.98	kN
			where, $\cos \theta =$		0.725	rad
Meridional stress =	$(97.98 \times 1000) / (130 \times 1000) =$				0.754	N/mm ²
					0.754 < 8 (Safe)	
Circumferential force = $wR [\cos \theta - (1/(1 + \cos \theta))] =$					24.44	kN
Hoop stress =	$(24.44 \times 1000) / (130 \times 1000) =$				0.19	N/mm ²
					0.19 < 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 =						
	$= 10 \times 3.8 \times ((1400 - 200)/1000)/2 =$				22.8	kN
Hoop stress =	$= (22.8 \times 1000) / (130 \times 1000) =$				0.18	N/mm ²
					0.18 < 8 (Safe)	
Provide minimum reinforcement of					0.24	%



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
	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 =		$=97.98 \cdot \cos(43.53)$			70.99 kN
	Net Hoop Tension force in ring beam, H =					70.99 kN
	Hoop compression =		$= 70.99 (5/2) =$			177.48 kN
	Dimensions of bottom ring beam :					
		b =				350 mm
		D =				400 mm
	Area of tension steel required		$=(177.475 \times 1000)/130$			1365.19 mm^2
	Provide minimum reinforcement of					0.24 %
	Minimum steel required, $A_{st} =$		$=(0.24/100) \times 350 \times 400$			336 mm^2
	Diameter of bar provided =					20 mm
	Number of bars required =					6 Nos.
	Area of tension steel provided					1885 mm^2
	Stress in concrete =	$T/[A_g + (m-1)A_{st}] =$				
			$=(177.475 \times 1000)/(350 \times 400 + (9.33-1) \times 1884.96)$			1.14 N/mm^2
	1.14 < 1.5 (Safe)					
	Provide a ring beam of size 350 mm by 400 mm.					
	Provide 3Y20 at top and 3Y20 at bottom					
	Provide 8 mm dia stirrups at 200 mm centres.					
	Weight of bottom ring beam =		$\pi \times 5 \times (0.35 \times 0.4) \times 25 =$			54.98 kN
	(10) Design of supporting cylindrical shaft					
	Centre to centre Diameter of shaft =					5.00 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					150 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



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
	Self weight of shaft above G.L.	= $\pi \times 5 \times 25 \times 30 \times 0.25 =$				2945.24
	Self weight of shaft below G.L.	= $\pi \times 5 \times 25 \times 2.35 \times 0.35 =$				322.99 kN
	Thickness of shaft wall above G.L. =					250 mm
	Loads acting on shaft at ground level:					
	(1) Top dome					105.48 kN
	(2) Top ring beam					44.12 kN
	(3) Balcony					28.75 kN
	(4) Tank wall					549.78 kN
	(5) Bottom spherical dome					142.55 kN
	(6) Internal shaft + platform					82.97 kN
	(7) Bottom ring beam					54.98 kN
	Weight of tank portion =					1008.62 kN
	(8) Supporting shaft					3268.23 kN
	Total Dead load on top of footing =					4276.85 kN
	(9) Weight of water (Hydro test condition)=					688.52 kN
	(10) Weight of water (Working condition)=					639.98 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					2816.29 kN-m
Wind load calculation	Area of cross section of shaft, $A =$	$\pi [(2.625)^2 - (2.375)^2] =$				3.93 m ²
	Second moment of area, $I :$					
		$I = (\pi/4) [(2.625^4) - (2.375^4)] =$				12.30 m ⁴
	Stress at base section:					
	Tank empty condition:					
	$W =$					4276.85 kN
	Outer dia of shaft, $D =$					5.35 m
	Mean radius of shaft, $r =$					2.5 m
	$M =$					2816.29 kN-m
	$e = (M/W) =$					0.66 m



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
	$e/r =$	$0.66/2.5 =$			0.264 m	
	$e/r \leq 1/2$ (OK)					
IS 11682-1985	<i>This section is under compression only</i>					
	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$				1.19 N/mm ²	
	$1.19 < 0.38 \times 30$ (Safe)					
	<i>Tank working condition + wind:</i>					
	P =				4916.83 kN	
	M =				2816.29 kN-m	
	e = M/W =				0.57 m	
	$e/r =$				$0.57/2.5 =$	
					0.23	
IS 11682-1985	$e/r \leq 1/2$ (OK)					
	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$				1.3 N/mm ²	
	$1.3 < 0.38 \times 30$ (Safe)					
	<i>Tank Hydro test condition</i>					
	W =				4965.37 kN	
	M =				0 N-mm	
	e = M/W =				0	
IS 11682-1985	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$				0.9 N/mm ²	
	$0.9 < 0.38 \times 30$ (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-3011	DATE	29/03/2016	
TITLE :	60 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	
	$I = (\pi/4) [(2.625^4) - (2.375^4)] =$					12.30 m ⁴	
	$l =$ length of staging =					30.00 m	
	$k =$					37436.84 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 =					1008.62 kN	
	Weight of 1/3 of staging = $(1/3) \times (2945.24) =$					981.75 kN	
	Seismic weight for tank empty condition, $W_s =$					1990.37 kN	
	Time period when tank empty, $T_e =$					$2\pi [(W_s/9.81) / k]^{0.5}$	
	$= 2\pi \times \{(1990.37/9.81)/(37436.84)\}^{0.5} =$					0.46 sec	
IS: 1893-2002	For rocky, or hard soil sites, corresponding $S_a/g =$					2.16	
	The design horizontal seismic coefficient, $A_h =$					0.06	
	Maximum horizontal seismic force acting at top of staging =					125.50 kN	
	<i>Moment due to seismic forces at top of footing:</i>						
	Total load, W =					4276.85 kN	
	Moment, M=					4060.06 kN-m	
	$e = M/W =$					0.95 m	
	$e/r =$					$0.95/2.5 =$	
						0.38	



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3011		DATE 29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE
IS 11682-1985	$e/r \leq 1/2$ (OK)			
	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			1.37 N/mm ²
	1.37 < 0.40 x 30 (Safe)			
	<i>Tank Full condition :</i>			
	Weight of tank Container =			1008.62 kN
	Weight of 1/3 of staging = (1/3) x (2945.24) =			981.75 kN
	Weight of water =			639.98 kN
	Seismic weight for tank full condition =			2630.34 kN
	Time period when tank full, T =			0.53 sec
IS: 1893-2002	For rocky, or hard soil sites, corresponding Sa/g =			2.16191
	The design horizontal seismic coefficient, A _h =			0.06
	Maximum horizontal seismic force acting at top of staging =			165.86 kN
	<i>Moment due to seismic forces at top of footing:</i>			
	Total load, W =			4916.83 kN
	Moment, M= =165.86*(30+2.35)			5365.51 kN-m
	e= M/W =			1.09
	e/r = 1.09/2.5 =			0.44
IS 11682-1985	$e/r \leq 1/2$ (OK)			
	$\sigma_{cv} = (W/2\pi r t)[1 + (2e/r)] =$			1.67 N/mm ²
	1.67 < 0.40 x 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. LE150883-C-WS-CW-DC-3011		DATE 29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE
<i>Where,</i>				
β = half the angle subtended by neutral axis				
as a chord on the circle of radius r =				
				0.20 rad
W = Total vertical load above section under				
consideration in N =				
				4917 KN
M = Moment in vertical plane at the section				
under consideration in N-mm =				
				5.37E+03 KN-m
$e = M/W$ =				
				1.091 m
r = Mean radius of circular shaft in m =				
				2.5 m
t = Thickness of shaft in mm =				
				250 mm
e/r =				
				0.437
IS 11682-	From table 1			3.25454 N/mm ²
1985	3.3 < 0.40 × 30 (Safe)			
(11) Design of raft foundations				
Total load from tank and shaft = (Dead load on top of footing + weight of water working condition)				
=4276.85KN+639.98KN				
				- (a) 4916.83 kN
From staad	Total weight of staircase =			
				1296 kN
Load from staircase =				
				- (b) 1296 kN
Diameter of raft slab, D_r =				
				8.9 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-3011	DATE	29/03/2016		
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE		
	$=(\pi/4) \times 8.9^2 \times 0.65 \times 25$				- (c)	1010.94	kN	
	Weight of Earth filling inside the shaft upto G.L.							
	$= [\pi (4.65^2)/4] \times 2.35 \times 18 =$				- (d)	718.35	kN	
	Weight of earth filling over the raft slab upto G.L.							
	$= [\pi (8.9^2 - 5.35^2)/4] \times 2.35 \times 18 =$				- (e)	1680.64	kN	
	Total load acting on raft slab, W =				=(a)+(B)+(c)+(D)+(e)	9622.75	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)=							
	$=150 \times 3 \times 18$					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 =				$=(\pi/4) \times 8.9^2$	62.21	m ²	
	Direct load, W =					9622.75	kN	
	Moment M = (Tank full condition under seismic)					5365.51	kN-m	
From staad	Moment from staircase column (seismic case) =					45.00	kN-m	
	Total moment =					5410.51	kN-m	
	Section modulus, Z=					69.21	m ⁴	
	Maximum intensity of soil pressure at base = $[W/A + M/Z] =$					232.85	kN/m ²	
	232.85 < 241.5 (Safe)							
	Minimum intensity of soil pressure at base = $[W/A - M/Z] =$					76.5	kN/m ²	
	76.5 > 0 (No tension)							
	Adopt Diameter of raft slab = 8.9 m							
	Projection of raft beyond face of shaft =					1.775	m	
	Maximum net soil pressure, w =							
	$=232.85 - (650/1000 \times 25) - (18 \times 2.35)$					174.30	kN/m ²	
	The loading at base is taken as annular loading on the mean diameter of the shaft.							
	Diameter of raft slab = 2a =					8.9	m	
	Diameter of the shaft = 2b =					5.00	m	
	Radial moment at centre of foundation is given by:							
	$M_r = \frac{W}{8\pi} \left[2 \log_e \left(\frac{a}{b} \right) + 1 - \left(\frac{b}{a} \right)^2 \right] - \frac{3}{16} w \cdot a^2 =$						56.41	kN-m/m
	Moment at junction of footing and tank walls at a radius of 2.5 m is given by:							



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		LE150883-C-WS-CW-DC-3011	DATE	29/03/2016
TITLE :	60 KL Capacity OHBR	DESIGNED	AKHB/RRG	CHECKED	RR	PAGE
	$M_{max} = \frac{W}{8\pi} \left[2 \log_e \left(\frac{a}{b} \right) + 1 - \left(\frac{b}{a} \right)^2 \right] - \frac{3}{16} W (a^2 - b^2) =$					260.67 kN-m/m
	Design ultimate moment = $M_{ur} =$		$(1.5 \times 260.67) =$			391.005 kN-m/m
	Effective depth required $d = [M_u / .133 f_{ck} b]^{0.5} =$					313.04 mm
	Effective depth provided at the section =					592.00 mm
						(OK SAFE)
	Compute parameter:					
			$M_u / bd^2 =$			1.116
	Refer Table-4 of SP : 16 and read out the percentage reinforcement as:					
			$p_r = 100 A_{st} / bd =$			0.26884
			Area of steel required, $A_{st} =$			1591.53 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 = $M_{uc} =$		$(1.5 \times 56.41) =$			84.615 kN-m/m
	Compute parameter:					
			$M_u / bd^2 =$			0.24
	Refer Table-4 of SP : 16 and read out the percentage reinforcement as:					
			$p_r = 100 A_{st} / bd =$			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 :					

CALCULATION OF STRESSES IN SHAFT SECTION AT BASE OF SHAFT
 (As per Clause 8.2.5.2 of IS:11682-1985)
 Tank Operating condition+SL - Table-1

LEVEL	Width of opening (m)	Grade of concrete	ID m	thk m	Axial load (KN)	Moment KN-m	BETA β (Deg)	ALPHA α (Rad)	BETA (Rad)	Modular ratio (m)
0.000	1.000	30	4.75	0.250	4916.8	5365.51	11.31	2.391101	0.1973954	9.3300

p	ALPHA (assumed) (Deg)	e m	e/r	A	B	A/B	σ_{cv}' N/mm ²	σ_{cv} N/mm ²	σ_{sy} N/mm ²
0.0025	137	1.09125	0.44	0.787315346	1.783109255	0.44	3.160	3.255 < 12 ok	4.627 < 249 ok

$$(e/r - A/B) = 0.00000$$

mp	1-p+mp	1-p	$\sin \alpha \cos \alpha$	$\sin \beta \cos \beta$	$\sin \beta \cos \alpha$	$\sin \alpha$	$\alpha \cos \alpha$	$\sin \beta$	$\beta \cos \alpha$	mp. $\pi \cdot \cos \alpha$
0.023325	1.020825	0.9975	-0.498782025	0.192307538	-0.143430142	0.681998	-1.74874	0.196116	-0.1443659	-0.053559183
				A	B	B	B'			
				0.787315346	1.783109	1.783109	4.261363			



PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.	DATE
		LE150883-C-WS-CW-DC-3011	29/03/2016
TITLE:	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR
			PAGE
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) =		32.8	m
Outer Diameter of the shaft (D) =		5.25	m
Ratio h/D = $32.8/5.25 =$		6.25	
From Table-18 use the coefficients for the nearest curve of h/D = 7			




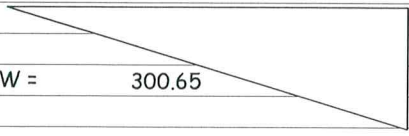
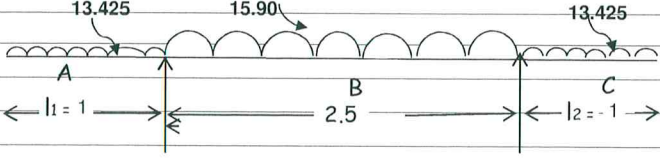
PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO.		DATE
		LE150883-C-WS-CW-DC-3011		29/03/2016
TITLE:	60 KL Capacity OHBR			PAGE
	θ in degrees	Shaft (C_{pe})	Wall (C_{pe})	
	0	1	1	
	15	0.8	0.8	
	30	0.1	0.1	
	45	-0.8	-0.8	
	60	-1.7	-1.7	
	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-3011	DATE 29/03/2016
TITLE:	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR
	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
			1.19
	15	0.8	0.2
			0.89
	30	0.1	0.2
			-0.15
	45	-0.8	0.2
			-1.48
	60	-1.7	0.2
			-2.82
	75	-2.2	0.2
			-3.56
	90	-2.2	0.2
			-3.56
	105	-1.7	0.2
			-2.82
	120	-0.8	0.2
			-1.48
	135	-0.6	0.2
			-1.19
	150	-0.5	0.2
			-1.04
	165	-0.5	0.2
			-1.04
	180	-0.5	0.2
			-1.04
	195	-0.5	0.2
			-1.04
	210	-0.5	0.2
			-1.04
	225	-0.6	0.2
			-1.19
	240	-0.8	0.2
			-1.48
	255	-1.7	0.2
			-2.82
	270	-2.2	0.2
			-3.56
	285	-2.2	0.2
			-3.56
	300	-1.7	0.2
			-2.82
	315	-0.8	0.2
			-1.48
	330	0.1	0.2
			-0.15
	345	0.8	0.2
			0.89

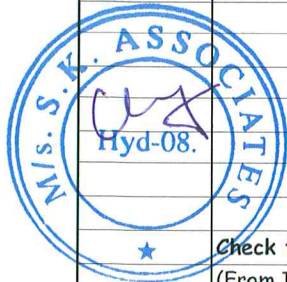


PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3011		DATE 29/03/2016		
TITLE:	60 KL Capacity OHBR	DESIGNED AKHB/RRG	CHECKED RR	PAGE		
		SUM =		5.37 0		
	Wind Load acting on the shaft (Case-2)					
	θ in degrees	Shaft (C_{pe})	Shaft (C_{pi})	wind force /m ²	$F_{along\ wind}$	$F_{across\ wind}$
	0	1	-0.2	1.78	1.78	0
	15	0.8	-0.2	1.48	1.43	0.383
	30	0.1	-0.2	0.45	0.39	0.225
	45	-0.8	-0.2	-0.89	-0.629	-0.629
	60	-1.7	-0.2	-2.23	-1.115	-1.931
	75	-2.2	-0.2	-2.97	-0.769	-2.869
	90	-2.2	-0.2	-2.97	0	-2.97
	105	-1.7	-0.2	-2.23	0.577	-2.154
	120	-0.8	-0.2	-0.89	0.445	-0.771
	135	-0.6	-0.2	-0.59	0.417	-0.417
	150	-0.5	-0.2	-0.45	0.39	-0.225
	165	-0.5	-0.2	-0.45	0.435	-0.116
	180	-0.5	-0.2	-0.45	0.45	0
	195	-0.5	-0.2	-0.45	0.435	0.116
	210	-0.5	-0.2	-0.45	0.39	0.225
	225	-0.6	-0.2	-0.59	0.417	0.417
	240	-0.8	-0.2	-0.89	0.445	0.771
	255	-1.7	-0.2	-2.23	0.577	2.154
	270	-2.2	-0.2	-2.97	0	2.97
	285	-2.2	-0.2	-2.97	-0.769	2.869
	300	-1.7	-0.2	-2.23	-1.115	1.931
	315	-0.8	-0.2	-0.89	-0.629	0.629
	330	0.1	-0.2	0.45	0.39	-0.225
	345	0.8	-0.2	1.48	1.43	-0.383
				Σ	5.37	0

	LARSEN & TOUBRO LIMITED		23	
	Water, Smart World & Communication IC			
	PROJECT :	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-WS-CW-DC-3011	DATE 29/03/16
	TITLE :	60 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 : 60 KL Capacity OHBR	24		
	DOCUMENT NO.		DATE
	LE150883-C-WS-CW-DC-3011		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	
$f_s = 0.58 * 415 * (143.51 / 628.32)$	=	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	$= l/d * M_{ft} * M_{fc}$	=	
Actual span/depth ratio	$= 2.5 * 1000 / 115$	=	
Actual span/depth ratio < Modified span/depth ratio		=	
		safe	

“Designs Vetted”



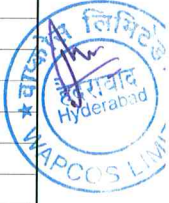
APPROVED

Dr SE, NIRMAL

Asst. Executive Engineer
 Asst. Executive Engineer
 TDWSP Asifabad

Dy. Executive Engineer
 Dy. Executive Engineer
 TDWSP Asifabad

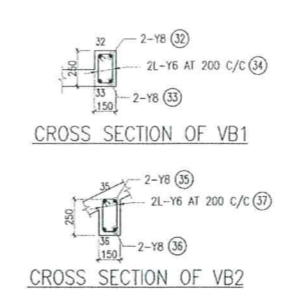
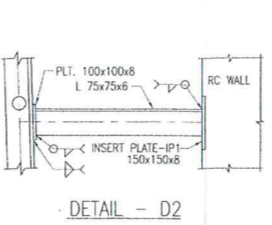
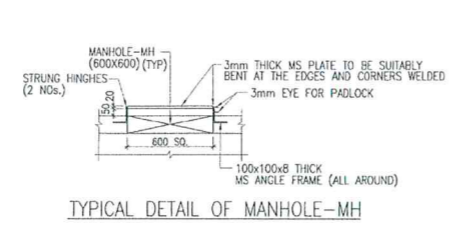
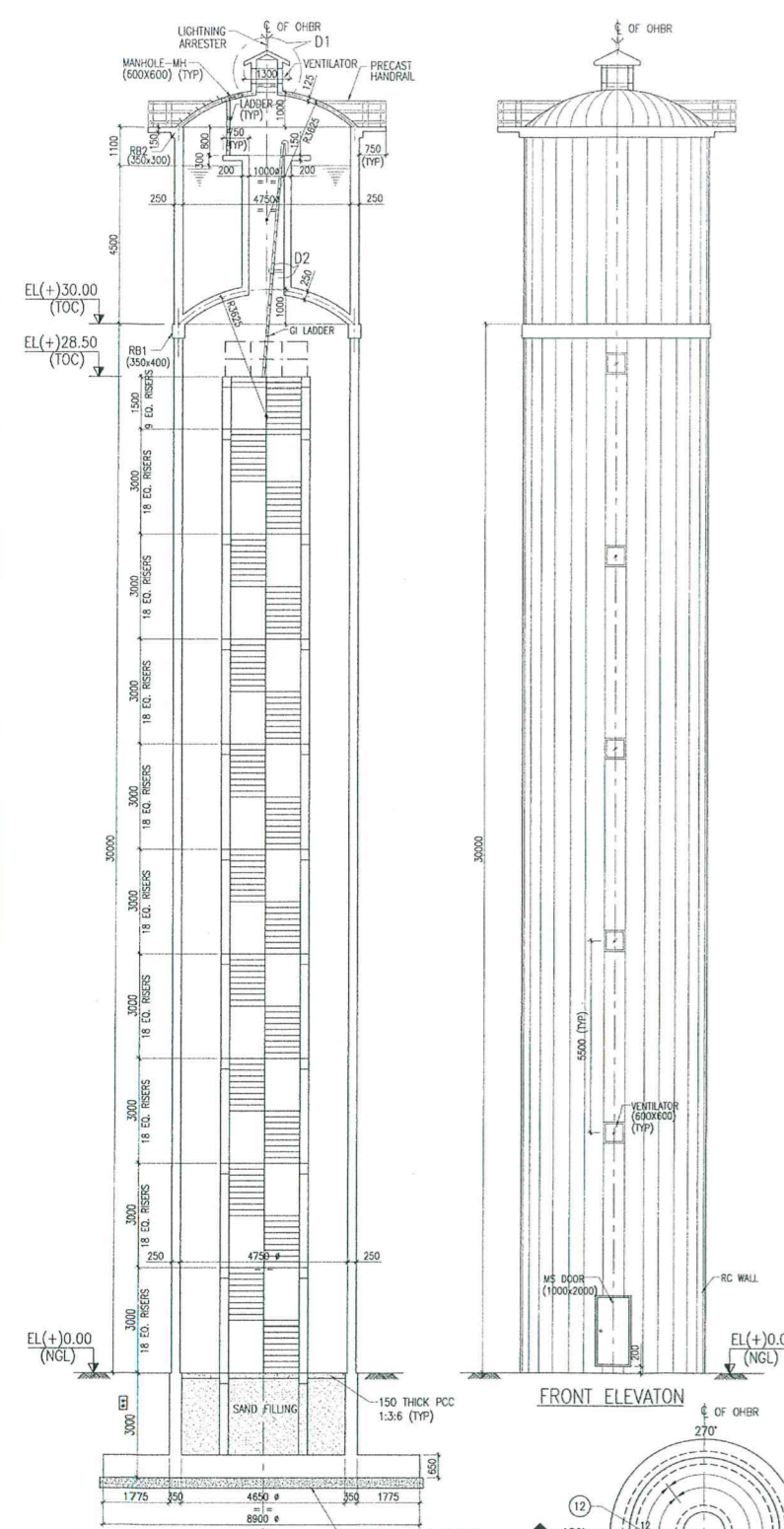
Executive Engineer
 Executive Engineer
 TDWSP Asifabad





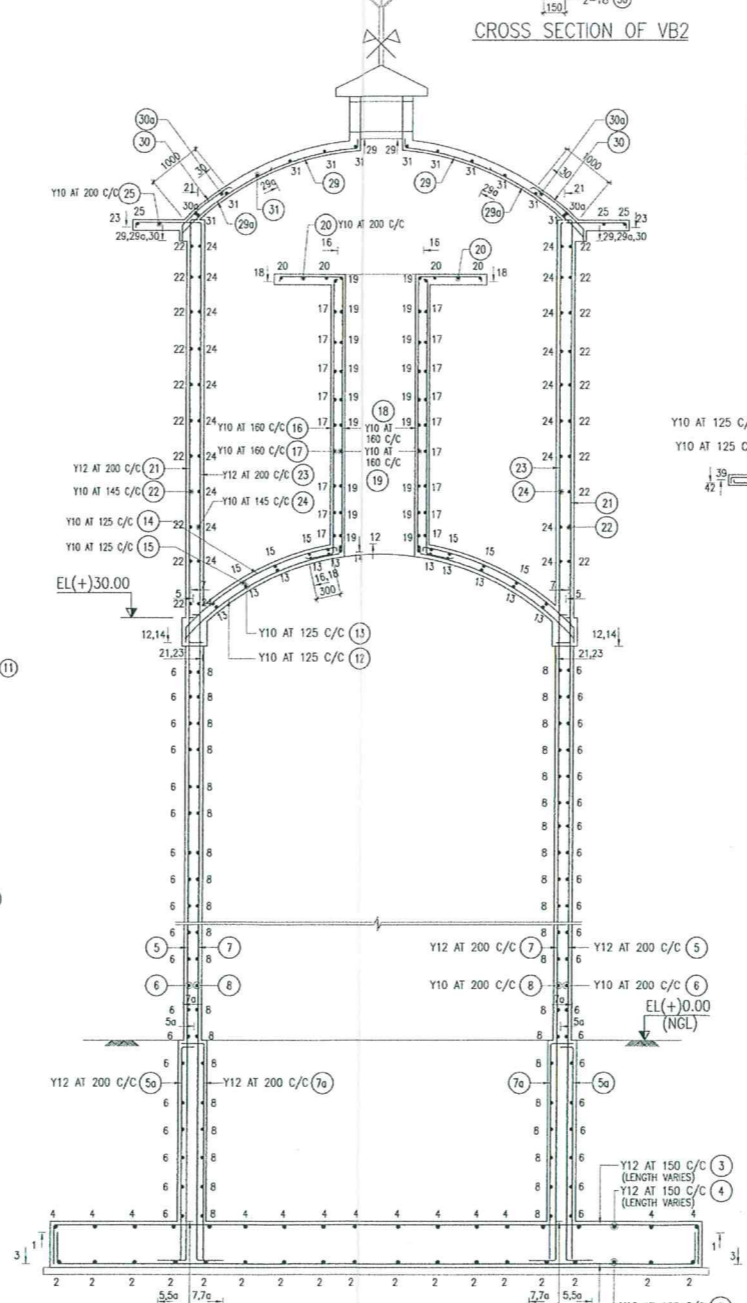
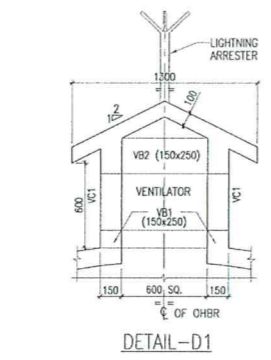
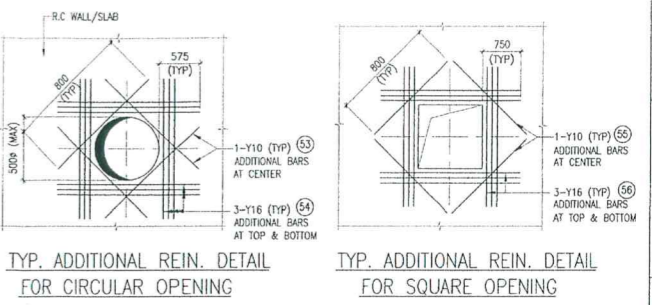
LARSEN & TOUBRO LIMITED
Water, Smart World & Communication IC

PROJECT:	Providing drinking water to habitations in Komarambheem-Asifabad Segment in Adilabad District	DOCUMENT NO. LE150883-C-W5-CW-DC-3011		DATE 07-Apr-2016
TITLE :	60 KL Capacity OHBR - 30 m staging height	DESIGNED AKHB/RRG	CHECKED RR	PAGE
APPENDIX				
(1) Stability Check - Tank empty conditon				
	Wind force			182.30 kN
	Moment due to wind force			2816.29 kN-m
	Seismic force			125.50 kN
	Moment due to seismic force			4060.06 kN-m
	Max. horizontal force			182.30 kN
	Max. overturning moment = OM			4060.06 kN-m
	Total vertical DL			
	=(Top container(without water) + shaft + stair case + raft + earth inside and outside)			8982.77 kN
	0.9 DL	=0.9 x 8982.77		8084.49 kN
	Restoring moment = RM	=DL x (raft dia)/2	=8982.77 x 8.9/2	39973.32 kN-m
	Check for safety against overturning			
	Factor of Safety	=OM/RM	= 4060.06/39973.32 =	9.85
	>1.5 safe Ok			
	Check for safety against sliding			
	Factor of Safety	=(0.9DL x μ)/(Max horizontal force)		=8084x0.4/182 17.74
	>1.25 safe Ok			
(2) Stability Check - Tank full conditon				
	Seismic force			165.86 kN
	Moment due to seismic force			5365.51 kN-m
	Max. horizontal force			182.30 kN
	Max. overturning moment = OM			5365.51 kN-m
	Total vertical DL			
	=(Top container (with water) + shaft + stair case + raft + earth inside and outside)			9622.75 kN
	0.9 DL	=0.9 x 9622.75		8660.47 kN
	Restoring moment = RM	=DL x (raft dia)/2	=9622.75 x 8.9/2	42821.23 kN-m
	Check for safety against overturning			
	Factor of Safety	=OM/RM	= 5365.51/42821.23 =	7.98
	>1.5 safe Ok			
	Check for safety against sliding			
	Factor of Safety	=(0.9DL x μ)/(Max horizontal force)		=8660x0.4/182 19.00
	>1.25 safe Ok			



SCHEDULE OF COLUMNS:

COLUMN MARKED	C1	VC1
TOP OF COLUMN	EL(+28.500)	TOP OF SLAB
VERTICAL REINF.	4 NOS. Y16 (D)	4 NOS. Y8 (C)
TIES	Y8 AT 200 C/C (1 TIE PER SET)	Y6 AT 200 C/C (1 TIE 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



GEOTECHNICAL INVESTIGATION REPORT

TELANGANA DRINKING WATER SUPPLY PROJECT

KOMARAM BHEEM - ASIFABAD- SEGMENT 22

ASIFABAD , ADILABAD DISTRICT

60 KL OHBR AT MUTTUNURGUTTA, INDRAVELLI (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

CONSULTING GEO TECHNICAL ENGINEER

FORMER PROFESSOR &HEAD OF CIVIL ENGINEERING

OSMANIA UNIVERSITY

Phone: 6663 8830, Mobile : 98490 – 39337

Email :dbaburao2000@yahoo.com

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:

Boring is performed using a combination of shell & auger technique, depending on the type of strata met with in the bore holes. 150 mm dia bores facilitate the collection of undisturbed samples(UD) and split spoon samples(SPT) .

Drilling was performed during 28 -29 December,2015.

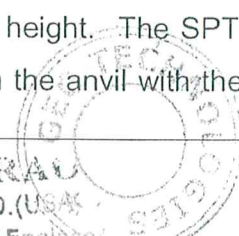
The following relevant data was recorded during Rotary drilling operations.

- Nature of strata
- Details of samples

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


D. BABU RAO
M.E., Ph.D.(USA)



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	10.5 m

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.


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



TELANGANA DRINKING WATER SUPPLY PROJECT

60 KL OHBR AT MUTTUNURGUTTA , INDRAVELLI (M) IN ADILABAD DT.

1. INTRODUCTION

M/s. L &T Construction, Water & Effluent Treatment is proposing to construct 60 KL OHBR at Muttunurgutta, Indravelli (M). The work is taken up under Segment 22 , Komaram Bheem Project , TDWSP, Asifabad in Adilabad Dt.

The present Report presents the results of one (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 Sump at 60 KL OHBR at Muttunurugutta, Indravelli (M)
- 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

- Specific gravity Bulk density
- Grain size distribution Direct shear test

All the Tests were conducted in accordance with IS: 2720 (Methods of Tests for Soils).

Fig 2 & 3 plot typical Grain size curve & Mohr's envelope.

5. SUB SOIL PROFILE

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

Depth	Strata	N value
0 – 4.5 m	Chalky sand with clay	44 - 49
4.5 – 10.5 m	Chalky silty sand	>50 Refusal

6.0 SHALLOW FOUNDATIONS

In general, the following pertains to foundations resting in soils.



. A properly designed foundation has to satisfy the following two limit states.

- 1) Limit state of collapse (i.e. Shear strength)
- 2) Limit state of serviceability (i.e. Settlement)

SHEAR CRITERIA:

The first criterion is depends on shear strength. The calculations are based on "TERZAGHI" bearing capacity equation as recommended by IS: 6403 (with factor of Safety) which takes care of L/B ratio (shape), foundation depth etc., along with other parameters.

SETTLEMENT CRITERIA:



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

The intensity of loading that will cause a permissible settlement or specified settlement of the structure is termed as allowable bearing pressure. The settlement in this type of layer will be elastic settlement.

These foundation settlements are evaluated using elastic theory. The pressure distribution below the footing is assumed as 2 V: 1 H for estimating the settlement. Since rock formation is available at shallow depth. The settlement will be within the permissible limit. Hence open foundation is suitable.

ALLOWABLE BEARING CAPACITY:

Allowable Bearing capacity (ABC) is the net intensity of the loading which the foundation will carry without undergoing settlement in excess of the permissible value for the structure under consideration but not exceeding the net safe bearing capacity (SBC).


7.0 DISCUSSION ON FOUNDATION OPTIONS


From sub soil profile and laboratory test data, it can be seen that sandy clay occurs to 4.5 m , followed by silty sand. Hence shallow foundation resting in sandy clay is recommended.

8.0 RECOMMENDATIONS

Based on Field Investigations and laboratory testing, the following Recommendations are made for construction of 60 KL OHBR at Muttunurgutta, Indravelli (M).

a) Open foundations resting in sandy clay ,at a depth of 3 m below GL ,are recommended. The foundation is likely to be saturated and inundated during long – time operation,


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

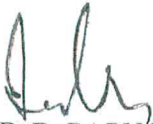


b) SBC is recommended as follows. Low SBC is recommended in view of clay content :

Location		BH 1
S. No.	Depth (m)	Recommended SBC t/ sq m
1	2.0	12 with sand bed
2	3.0	15 with sand bed
3	4.0	20

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

For ANJI 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



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

TELANGANA DRINKING WATER SUPPLY PROJECT

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

60 KL OHBR AT MUTTUNURGUTTA , INDRAVELLI (M) IN ADILABAD DT.

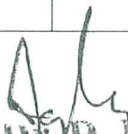
Type of Boring: Auger drilling

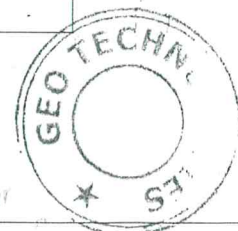
Dia of Boring: 1

Date : 28-29 Jan 2016

Drilled depth =10.5 m

Depth, m	Profile	Soil	Sample Depth m	N value	CR, %	RQD%	
0		Chalky clay with sand	0	44			
1.0			1.5	49			
2.0							
3.0			3	>50 Refusal			
4.0			4.5	>50 Refusal			
5.0		Chalky silty sand					
6.0			6.0	>50 Refusal			
7.0			7.5	>50 Refusal			
8.0							
9.0			9.0	>50 Refusal			
10.0							
11.0							
12.0							
13.0							
14.0							
15.0							
16.0							


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



BH No	Depth, m	Soil	Moisture content %	Specific Gravity	Grain size, percentage				γ KN/ Cum	Shear Parameters	
					Gr >4.75 mm	Sa 4.75 to 0.075mm	Si .075to .002mm	Cl <.002 mm		c	ϕ
1	1.5	Chalky clay/sand		2.65	17	40	12	31	17.8	22	20
	3	Do		2.65	13	65	0	22	17.8	37	25

TABLE 1

60 KL OHBR AT MUTTUNURGUTTA , INDRAVELLI (M) IN ADILABAD DT.

SUMMARY OF SOIL PROPERTIES

NOTATION : Gr ... Gravel Sa ... Sand Si ... Silt Cl... Clay γ ...Unit weight

c ...Cohesion, kN /sq ϕ ... Angle of internal friction , deg



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


APPENDIX

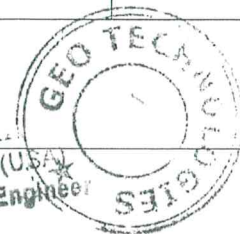
CALCULATION OF SBC

TELANGANA DRINKING WATER SUPPLY PROJECT

60 KL OHBR AT MUTTUNURGUTTA , INDRAVELLI (M) IN ADILABAD DT.

Project:	Geotechnical investigation of Proposed to construction of 60 kl OHBR at MUTTUNURGUTTA Adilabad dt.			
		Chalky clay with sand		
Structures	OHBR			
Reference Borehole	BH-1			
Bed Level/Ground Level				
Scour Level/Undisturbed GL	0.000			
Foundation Level	-3.000			
Thickness of overburden soil, m	3.000			
Depth of excavation required, m	3.000			
Width of foundation, m	6.00			
SPT value of the soil in the zone of influence	>50			
Angle of Internal friction, Degrees	35			
Unit weight of over-burden soil, kN/Cu.m.	18.00			
Length of foundation, m	6.00			
Shear strength of soil, kN/Sq.m.	0			
Bearing capacity factor Nc	46.12			
Bearing capacity factor Nq	33.30			
Bearing capacity factor Ny	48.03			
Depth factor, dc	1.26			
Depth factor, dq	1.13			
Depth factor, dy	1.13			
Shape Factor, sc	1.20			
Shape Factor, sq	1.20			
Shape Factor, sy	0.60			
Inclination Factor, ic	1.00			
Inclination Factor, iq	1.00			
Inclination Factor, iy	1.00			
Water Table Correction Factor, w	0.50			
Ultimate Bearing Capacity, UBC1, kN/Sq.m.	0.00			
Ultimate Bearing Capacity, UBC2, kN/sq.m.	1442.48			
Ultimate Bearing Capacity, UBC3, kN/Sq.m.	390.10			
Ultimate Bearing Capacity, UBC, kN/Sq.m.	1832.58			
SBC with a factor of safety of 2.5, kN/Sq.m.	733.03			


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



The above capacity is verified based on settlement criteria and calculations are provided below.

Allowable SBC on the basis of Settlements :

From IS : 8009 (Fig, 9) :

For B = 6, N = 50 Sett per meter of unit pressure (kg/sq cm) = 0.0055 m

For pressure of 15 t /sq m,
Settlement = $0.0055 \times 1000 \times 1.5$
= 6.75 mm OK


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


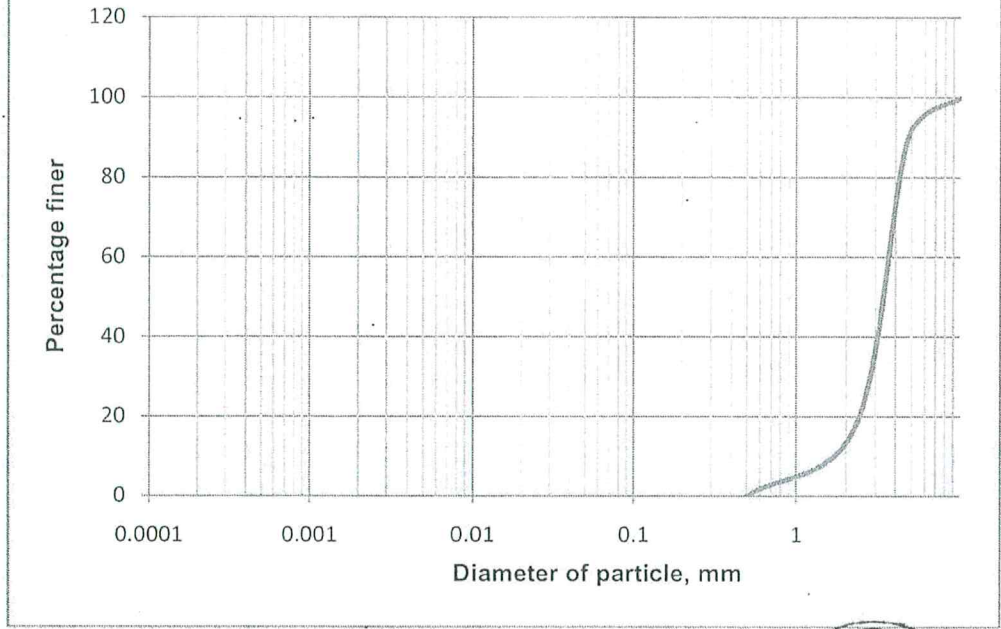


FIG.2 : GRAIN SIZE CURVE
Muttunurgutta site
BH1 DEPTH 3 m

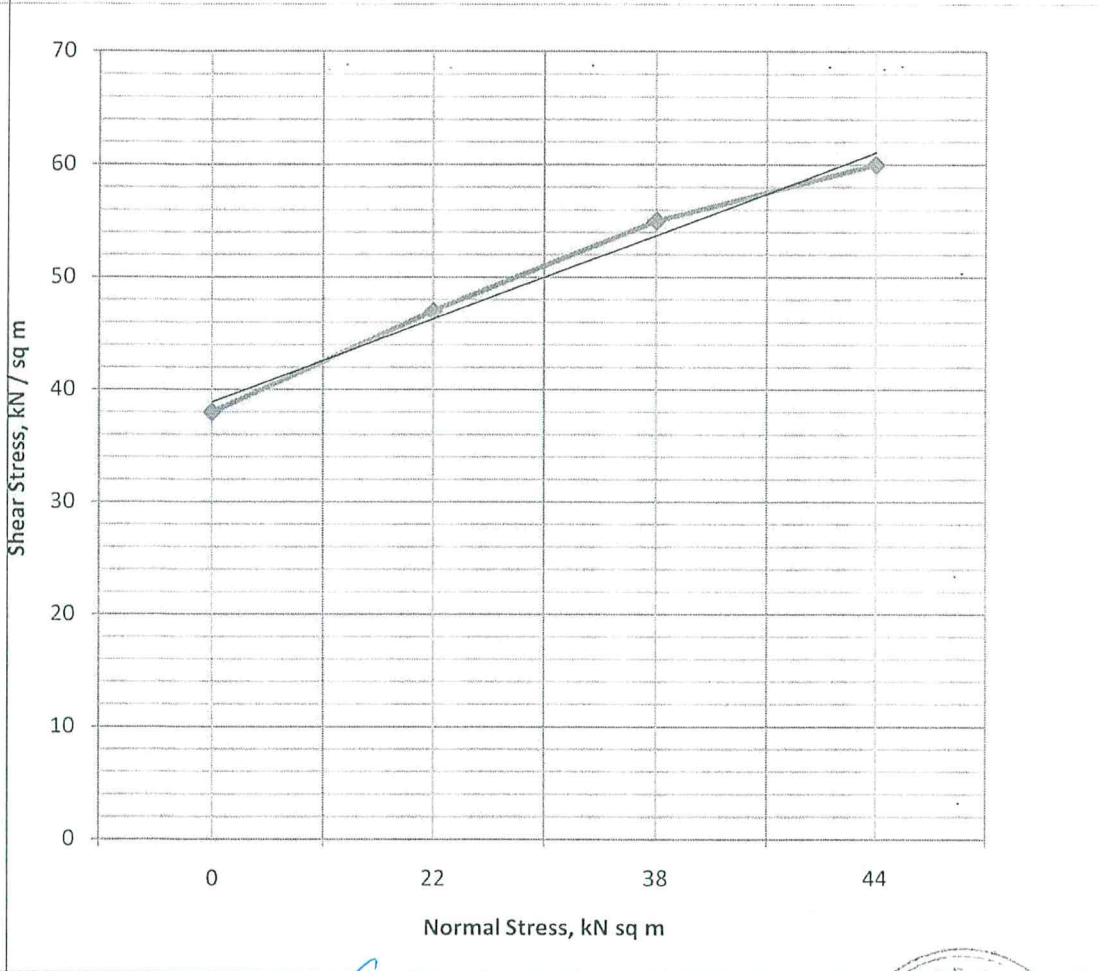



[Signature]
Dr. D. BABURAO
M.E., Ph.D.(USA)
Consulting Geotechnical Engineer

GEO TECHNOLOGIES

FIG. 3 : Muttunurgutta site, MOHR'S ENVELOPE, BH 1, D= 3 M

Cohesion = 37 kN / Sq m $\phi = 25$ deg




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




Asst. Executive Engineer
TDWSP Asifabad

Dy. Executive Engineer
TDWSP Asifabad

Executive Engineer
TDWSP Asifabad