PLANNING, ANALYSIS AND DESIGN OF A OVER HEAD CIRCULAR WATER TANK IN N.B.K.R.I.S.T USING STAAD Pro SOFTWARE

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Abstract: **Overhead tank is an important and very common public utility structure. Water tank is a structure used to store water for supplying to households as drinking purpose, for industries as a coolant and irrigational water for agricultural farming in some areas. Water tanks are classified on bases of their shapes and position of structure. Storage reservoirs and overhead tank are used to store water. All tanks are designed as crack free structures to eliminate any leakage. The principle objective of this paper is to plan, analysis and design a Circular Overhead Tank of 15 lakh litres capacity at N.B.K.R. Institute of Science and Technology, Vidyanagar. In this paper all structural elements of circular water tank are analyzed and designed by using STAAD.Pro software.**

Keywords: Circular water tank, STAAD Pro

I. INTRODUCTION:

Elevated tanks are supported on staging which may consist of masonry walls, R.C.C. columns braced together. The walls are subjected to water pressure. The base has to carry load of water and tank load. The staging has to carry load of water and tanks. The staging is also designed for wind forces..

NBKR Institute of Science and Technology (NBKRIST) is an autonomous engineering college established in 1979 located at Vidyanagar, Kota mandal, Nellore, Andhra Pradesh. It was established in the year 1979 under the stewardship of former chief minister Sri. N. Janardhana Reddy. The College is the second oldest of all the private Engineering Colleges in undivided Andhra Pradesh. It was proposed to construct a over head circular water tank of 15 lakh capacity and to provide quality drinking water to all around the NBKRIST College campus.

II. LITERATURE REVIEW:

[1] Mr. Manoj Nallanathel et al., had done "Design and analysis of water tanks using Staad pro" In that paper, they discussed about the design of water tanks of both overhead and underground tanks of shapes rectangular, square and circular shapes are designed and analysed using Staad pro.

[2] Issar Kapadia et al. had done the "Design, analysis and comparison of underground rectangular water tank by using Staad Pro software". This paper includes the study of UG Rectangular tank that how the shape deflected and what are the actions will be produced when tank empty or full by using STAAD Pro software is discussed.

[3] Thalapathy .M et al., had done "Analysis and economical design of water tanks". In this paper he said this project gives the detailed analysis of the design of liquid retaining structure using working stress method. This paper gives idea for safe design with minimum cost of the tank and gives the designer relationship curve between design variable. This paper helps in understanding the design philosophy for the safe and economical design of water tank.

From the review of earlier investigations it is found that considerable work has been done on the method of analysis and design of water towers. Attempts have also been made by various designers and research workers to give the ratio of optimized geometrical parameters for the design of container and optimized parameters for the design of staging. Very little work has been made on optimized design of foundation for various types of soil conditions.

III. PLAN OF A OVERHEAD CIRCULAR WATER TANK:

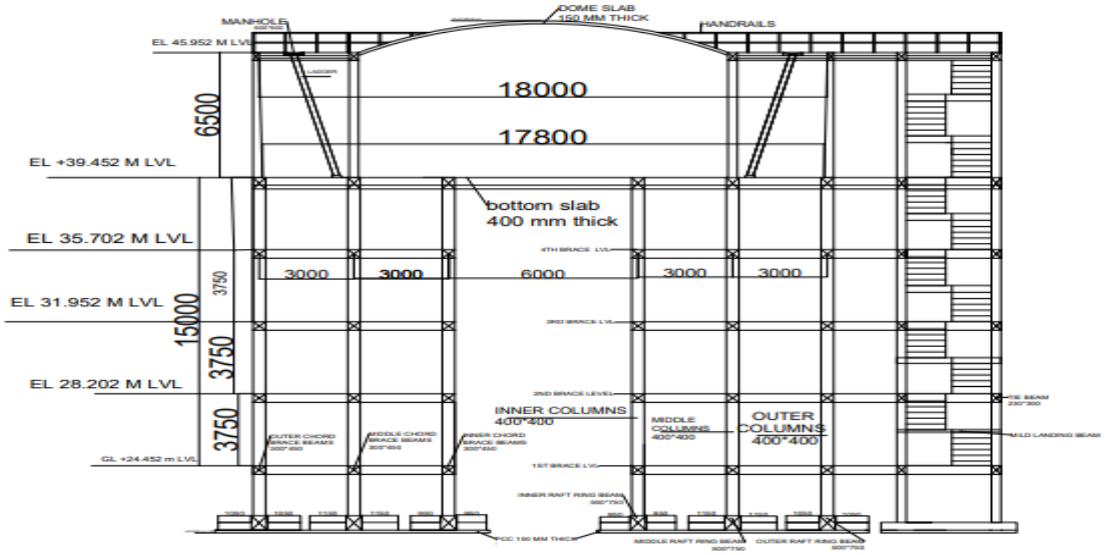

Figure 3.1: Plan of overhead circular water tank

IV. DESIGN CRITERIA:

ELSR Capacity	:	1500 KL
Type	:	Circular
Staging	:	15m
Staging type	:	Columns
SBC	:	20 t/m^2
Depth of foundation	:	2 m
Average G.L	:	14.5 m

A. MATERIALS OF CONSTRUCTION:

The following main material has been proposed for the construction of the Over head circular water tank.

1.	Reinforcement	:	HYSD /T.M.T bars of grade Fe500.
2.	PCC	:	M15 Grade of concrete
3.	Reinforced concrete	:	M30(f_{ck} = 30N/mm^2) for all elements
4.	BRICK	:	Confirming to IS :1077,class5.0, Minimum compressive strength = 3.5N/mm^2

B. LOADS:

1) DEAD LOAD:

The weight of all permanent construction including domes, ring beams, shafts, walls, stair case, slabs and foundation are considered. The unit weights of materials are in accordance with IS: 875-1987. The unit weight of Concrete (RCC),Soil,, Structural steel and brick masonry is taken as 25 kN/m^3 ,18 kN/m^3 ,78.5 kN/m^3 and 19.1 kN/m^3.

2) LIVE LOAD: The Live load on roof slab, walk way slab and staircase be 1.5 kN/m^2, 1.5 kN/m^2 and 2.0 kN/m^2 respectively.

3) WATER LOAD:

Weight of water due to gross volume is calculated and applied on bottom of container unit wt. of water is 10 kN/m^3

4) WIND LOAD:

As per figure -1 IS: 875(PART-3)-1978) design wind pressure = $0.6Vz^2$ = 2117.01 N/m^2

5) EARTH QUAKE LOAD (EQ):

It is in zone-III as per IS 1893 part1 2002

Seismic coefficient	αh	$= \beta I F_o (Sa/g)$
β , coefficient of depending upon soil foundation		= 1
I, factor depending upon importance of factor		= 1.5
F_o, seismic zone factor for average acceleration spectra		= 0.16

S_a/g is considered as per CI 6.3.5,(IS 1893,part-1).

C. STRUCTURAL DESIGN OF RCC OHSR

1) DESIGN DATA:

Capacity	V	=	1500 KL
Staging	S	=	15 m
SBC of soil	q	=	20 t/m^2
Depth of foundation	d_f	=	3.00 m

2) PIPE SIZE:

Inlet		=	400 mm
Outlet		=	450 mm
Overflow		=	450 mm
Washout		=	200 mm
Dead storage water column	d_s	=	150 mm
Free board from beam bottom	f_b	=	300 mm
Ground level	(G.L)	=	+14.50 m
Low water level	LWL	=	+29.650 m
Max water level	MWL	=	+34.800 m
Live load on top dome	L_d	=	1500 N/m^2
Live load on balcony and staircase	L_{bs}	=	1500 N/m^2
Grade of concrete	f_{ck}	=	M30 N/m^2
Nominal maximum size of coarse aggregate		=	20 mm
Grade of steel	f_y	=	500 N/m^2

3) DIMENSIONS:

WATER TANK

No.of columns in inner dia	N	=	8 Nos
Centre to centre inner dia of columns	D_d	=	6 m
No.of columns in middle diameter	N	=	16 Nos
Centre to centre middle dia of columns	D_d	=	12 m
No.of columns in outer diameter	N	=	16 Nos
Centre to centre outerdia of columns	D_d	=	18 m
Top dome			
Rise	h_1	=	1.50m

	Thickness	t_1	=	150 mm
Bottom slab				
	Rise	h_2	=	0.00m
	Thickness	t_2	=	400 mm
Inner top roof ring beam				
	Width	b_{i1}	=	300 mm
	Depth	d_{i1}	=	400 mm
Inner bottom ring beam				
	Width	b_{i2}	=	400 mm
	Depth	d_{i2}	=	750 mm
Middle bottom ring beam				
	Width	b_{i2}	=	400 mm
	Depth	d_{i2}	=	750 mm
Outer ring beam				
	Width	b_{i2}	=	400 mm
	Depth	d_{i2}	=	750 mm
Inner Dimensions of Submerged Column				
	No.of columns		=	16 Nos
	Circular column	D_O	=	300 mm
Dimensions of Inner Annular Roof Slab				
	Thickness	t_{ia}	=	150 mm
	Length	L_{ia}	=	5 m
Centre to centre outer dia of columns		D_o	=	18.00m
Vertical wall				
	Thickness at top	t_3	=	200 mm
	Thickness at bottom	t_4	=	300 mm
Balcony				
	Width		=	1000 mm
	Depth		=	150 mm

TANK SUPPORTING TOWER:

Total number of columns supporting OHSR		n_{cl}	=	40 Nos
Dimensions of inner row columns				
	Width		=	400 mm
	Depth		=	1400 mm
Size of inner chord brace beams				
	Width	b_{bi}	=	300 mm
	Depth	d_{di}	=	450 mm
Dimensions of middle row columns				
	Width	B_i	=	400 mm
	Depth	D_i	=	400 mm
Size of middle chord braces beams				
	Width	b_{bi}	=	300 mm
	Depth	d_{di}	=	450 mm

No.of columns in outer dia n_{co} = 16 no.s

Dimensions of outer row columns

Width B_o = 400 mm

Depth D_m = 400 mm

Size of outer chord brace beam

Width b_{bo} = 300 mm

Depth d_{do} = 450 mm

No.of braces proposed n_b = 4 nos

Size of radial brace beams

Width b_{bo} = 300 mm

Depth d_{do} = 450 mm

Foundation ring beam below inner row columns

Width b_{fi} = 400 mm

Depth d_{fi} = 600 mm

Foundation ring beam below middle row columns

Width b_{fi} = 400 mm

Depth d_{fi} = 750 mm

Foundation ring beam below outer row column

Width b_{fo} = 400 mm

Depth d_{fo} = 750 mm

D) VOLUME CALCULATION OF WATER TANK:

Dia of outer row columns = 18 m

Dia of inner row column = 6m

Radius of inner row columns r_i = 3m

Rise of bottom dome h_2 = 0 m

No of columns supporting middle dia = 16 Nos

Effective water depth H = 5.150 m

Average thickness of side wall = 250 mm

Inner diameter of container at top = 17.80 m

Inner diameter of container at bottom = 17.70 m

Volume of water (v) $= \frac{\pi*(\text{Davg}^2)*H}{4} - \frac{\pi*h_2*(3*r_i{}^2+h_2{}^2)}{6} - 5.82$

$= \frac{\pi*17.75^2*5.15}{4} - \frac{\pi*0*(3*3^2+0^2)}{6} - 5.82$

$= 1274.530 - 0 - 5.82$

$= 1268.71 > 1500$ VOLUME OK.

E) .**ANALYSIS AND DESIGN:**

The over head circular water tank with 1500 KL capacity with the above dimensions and then analysed and designed in STAAD Pro.

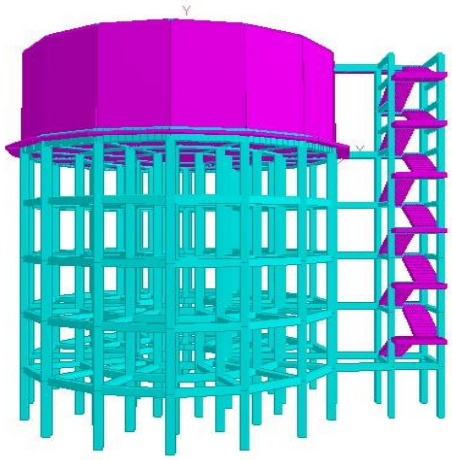

Figure 5.1: Modelling of overhead circular water tank in STAAD Pro

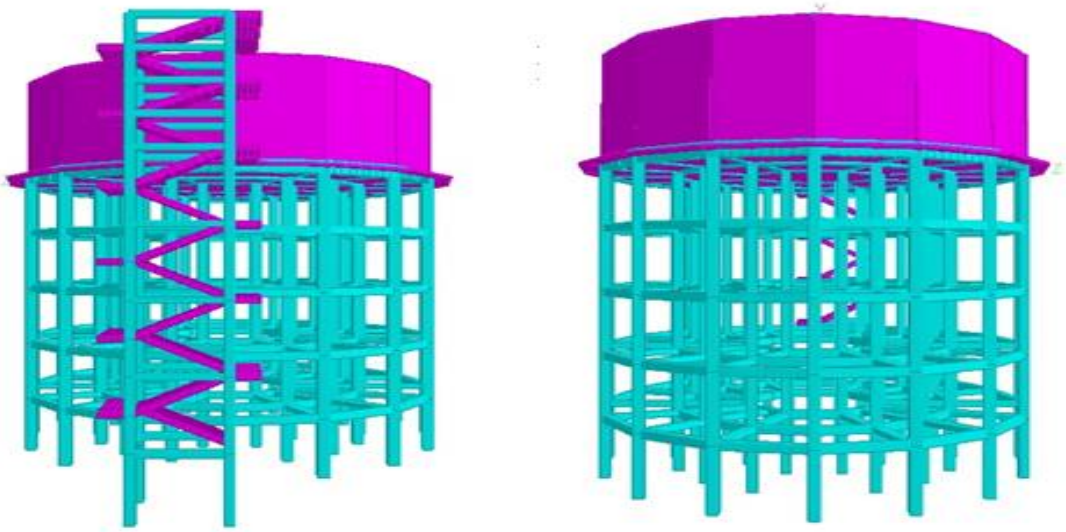

Figure 5.2: 3-D Rendering View in +X and –X Direction

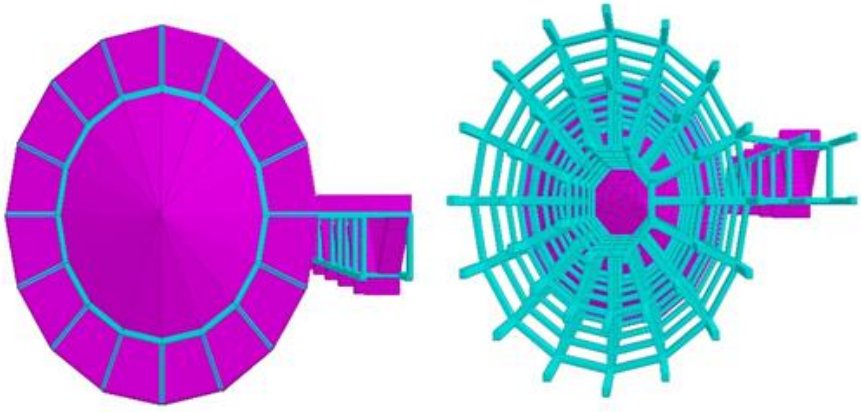

Figure 5.3: 3D Rendering View in +Y & -Y Direction

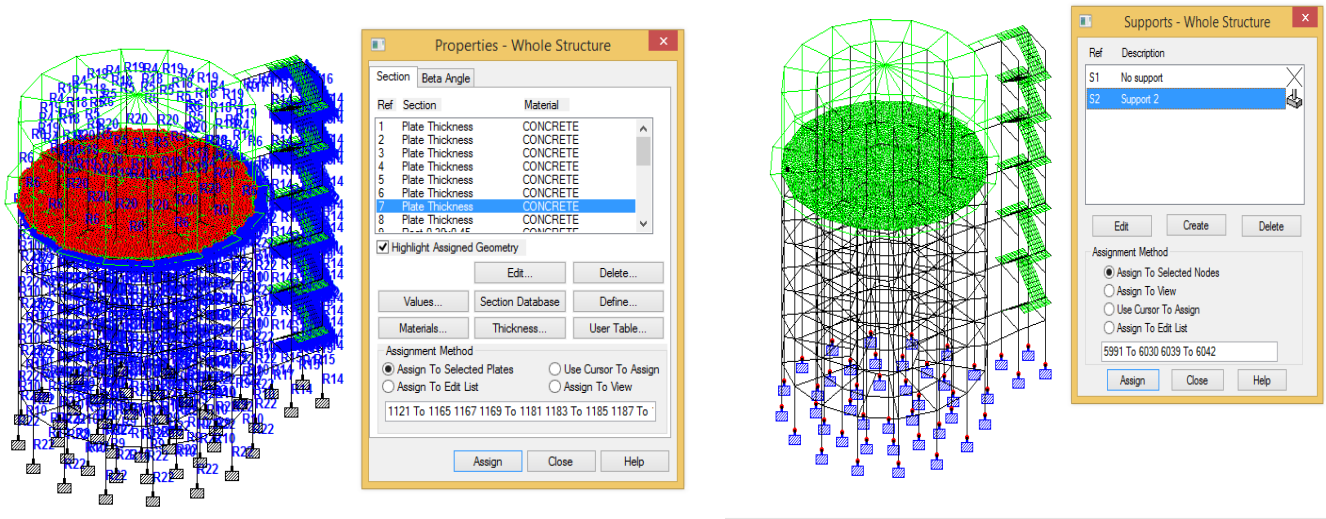

Figure 5.4:Assigning Property and supports

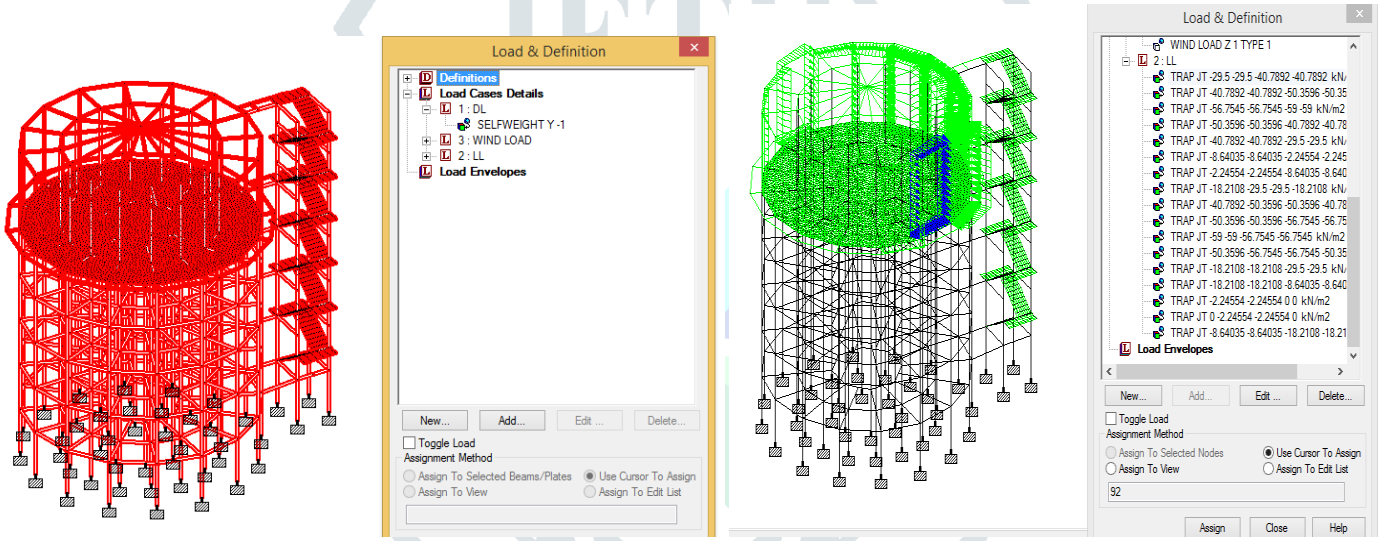

Figure 5.5:Assigning Dead Load and Live Load

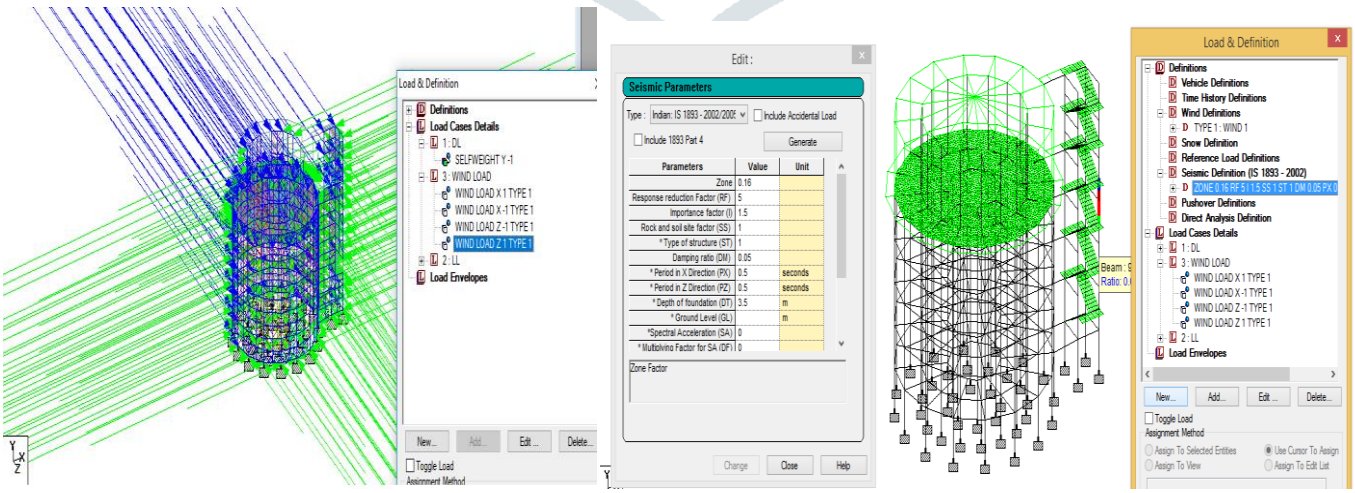

Figure 5.6:Assigning Wind load and seismic load

V. CONCLUSIONS:

- The proposed tank in NBKRIST College campus designed in STAAD Pro software
- Design of tank is safe from the software design with respect to loads applied.
- For small capacities we go for rectangular water tanks while for bigger capacities we provide circular water tanks. Since our proposed tank is of 12lakh capacity we had Planned analyzed and designed the circular over head tank in STAAD Pro software
- Design of water tank is a very tedious method.

VI. REFERNCES:

1) DESIGN AND ANLYSIS OF WATER TANKS USING STAAD PRO By Mr. Manoj Nallanathel [1]
2) IssarKapadia, Purav Patel, NileshDholiya and Nikunj Patel (2017). "Design, Analysis and Comparison of Underground Rectangular water tank by using STAAD Provi8 software". International Journal of Scientific Development and Research (IJSDR), January 2017, Volume 2, Issue 1, ISSN: 2455-2631.
3) Thalapathy.M, Vijaisarathi.R.P, Sudhakar.P, Sridharan.V, Satheesh.V. S (2016). "Analysis and Economical Design of Water Tanks". International Journal of Innovative Science, Engineering & Technology, Vol. 3, Issue 3, ISSN 2348 – 7968.
4) IS: 456-2000 : Code of practice for plain and reinforced concrete.
5) IS:875-1987(PART-2) : Design loads for buildings and structures.
6) IS:1893-1984 : Criteria for earthquake resistant design of structures.
7) IS: 3370-2009 : Concrete structures for storage of liquids.
8) IS: 1905-1987 : Code of practice for structural use of unreinforced masonry.
9) IS:6403-1981 : Code of practice for determination of bearing capacity
10) IS:11682 : Criteria for design of RCC staging for overhead water tanks.