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ANALYSIS AND DESIGN THE CIRCULAR WATER TANK USING STAAD PRO

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ABSTRACT

Every design comes out when there is a problem. A design is created to solve the existing problems. People in the region where there is scarcity of water, don't get enough flow or speed or discharge especially those living on the upper floors in a multi-storied building. As a consequence people suffer from lack of water due to insufficient supply for compensating their daily needs. As a first solution of this problem, one needs to develop a water storage project as has been designed with the help of STAAD principles, known as Overhead Water Reservoir. The present study reports the analysis and design of an elevated circular water tank using STAAD.Pro V8i. The design involves load calculations manually and analyzing the whole structure by STAAD.Pro V8i. The design method used in STAAD.Pro analysis is Limit State Design and the water tank is subjected to wind load, dead load, self – weight and hydrostatic load due to water.

1. INTRODUCTION

Water tanks parameters include the general design of the tank and choice of construction materials, linings. Reinforced concrete water tank design is based on IS code. The design depends on the location of tank i.e., overhead, on the ground or underground water tanks. Tanks can be made of RCC or even of steel. The overhead tanks are usually elevated from the ground level using a number of column and beams. On the other hand, the underground tanks rest below the ground level**.** Water tanks can be classified into two types:

Based on location –

Tanks resting on ground

- Tanks under ground
- Elevated tanks

Based on shapes

Circular tanks

Rectangular tanks

- Square tanks

- Spherical tanks
- Intel tanks

The elevated water tanks must remain functional even after the earthquakes as water tanks are required to provide water for drinking and firefighting purpose.

These structures has large mass concentrated at the top of slender supporting structure hence these structure are especially vulnerable to horizontal forces due to earthquakes. All over the world, the elevated water tanks were collapsed or heavily damaged during the earthquakes because of unsuitable design of supporting system or wrong selection of supporting system and underestimated demand or overestimated strength.

1.1 Proposed Site

The proposed site for our project is located at Ghumri village of Karjat taluka at Ahmednagar district. Our site situated at the place where all the natural condition are suitable for the construction of elevated overhead water tank. This location is one of the developing areas, where there is steady increase in population in recent years. The population of the area according to recent survey is around 1816. Thus this location requires a periodic water supply system at least twice a week. This location consist nearly 50% agricultural land. Around

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450+ houses are there and so it requires more than 100 m³ capacity water tank. From the three major types of water tank, we had adopted elevated overhead circular water tank because the location needs pressurized water supply

1.2 Sources of Water Supply

The various sources of water can be classified into two categories:

Surface sources

Ponds and lakes

- Streams and rivers
- Storage reservoir
- Oceans

Sub surface sources

Springs

- Infiltration wells
- Wells and tube wells

1.1 OBJECTIVE

To make a study about the analysis and design of water tanks.

To make a study about the guidelines for the design of liquid retaining structure according to IS Code.

To know about the design philosophy for the safe and economical design of water tank.

To develop programs for the design of water tank of flexible base and rigid base and the underground tank to avoid the tedious calculations.

In the end, the programs are validated with the results of manual calculation given in "Concrete Structure" book.

WATER TANKS CLASSIFICATIONS

Classification based on under three heads:

- Tanks resting on ground
- Elevated tanks supported on staging
- Underground tanks.
- Classification based on shapes
- Circular tanks
- Rectangular tanks
- Spherical tanks
- Intze tanks
- Circular tanks with conical bottom

2. 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.

3. METHODOLOGY OVERHEAD CIRCULAR WATER TANK

PLAN OF A OVERHEAD CIRCULAR WATER TANK

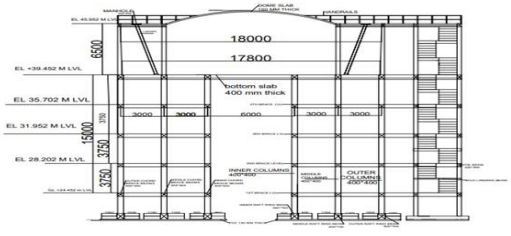

Figure 3.1: Plan of overhead circular water tank

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DESIGN CRITERIA:

ELSR Capacity	:	1000 KL
Type	:	Circular
Staging	:	15m
Staging type	:	Columns
SBC	:	20 t/m^2
Depth of foundation	:	2 m
Average G.L	:	14.5 m

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(fck = 30N/mm^2) for all elements
BRICK	Confirming to IS :1077,class5.0, Minimum compressive strength = 3.5N/mm^2

LOADS:

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.

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.

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

WIND LOAD:

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

STRUCTURAL DESIGN OF RCC OHSR

DESIGN DATA:

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

2) PIPE SIZE:				
Inlet		=	400	mm
Outlet		=	450	mm
Overflow		=	450	mm
Washout		=	200	mm
Dead storage water column	ds	=	150	mm
Free board from beam bottom	fb	=	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	Ld	=	1500 N/m^2	
Live load on balcony and staircase	Lbs	=	1500 N/m^2	
Grade of concrete	fck	=	M30 N/m^2	
Nominal maximum size of coarse aggregate		=	20 mm	
Grade of steel	fy	=	500 N/m^2	
3) DIMENSIONS:				
WATER TANK				
No. of columns in inner dia	N	=	8 Nos	

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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	Bi	=	400	mm
Depth	Di	=	400	mm
Size of middle chord braces beams				
Width	bbi	=	300	mm
Depth	ddi	=	450	mm

Width		B_c	=	400	mm
Depth		D_m	=	400	mm
Size of outer chord brace beam					
	Width	b_{bs_c}	=	300	mm
	Depth	d_{d_c}	=	450	mm
No. of braces proposed		n_b	=	4 no	s
Size of radial brace beams					
	Width	b_{bs_c}	=	300	mm
	Depth	d_{d_c}	=	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_{f_c}	=	400	mm
Depth		d_{f_c}	=	750	mm

4. STAAD PRO SOFTWARE

About STAAD Pro Software

STAAD Pro full form stands for Structural Analysis and Designing Program. STAAD Pro is a structural analysis & design computer program that was being developed by Research Engineers International (REL) at Yorba Linda, California in 1997. Today, STAAD Pro is one of the popular and widely used software for structural analysis and design across the globe by Civil engineers. It supports all types of various steel, concrete, and timber design codes. Using STAAD Pro, civil engineers can design any type of structure, and later share the synchronized model data amongst the entire design team. It ensures on-time and budget-friendly completion of structures and designs related to steel, concrete, timber, aluminium, and cold-formed steel projects, irrelevant to the complexities. STAAD Pro helps structural engineers to automate their tasks by removing the tedious and long procedures of the manual methods. It allows civil engineers to analyze and design various types of structures on virtual platforms. Structural engineering firms, consultancies, various departments of construction companies, and government firms use STAAD pro extensively.

Today, many online platforms and apps provide certification in STAAD Pro that gives complete knowledge on this designing software. To learn this dynamic software, you don't need a special degree or something; however, having a Civil Engineering is a must to pursue this course. It's better to do some research and check the reviews and ratings before you enrol for this course online. Suppose you plan to make a career in structural designing; however, you don't have sufficient time to attend traditional offline classes. In this case, you can opt for an online certification program from a reputable institute or tech educational platform for STAAD Pro training. It is really helpful for individuals who are working as professional or full-time students. Online training will offer the flexibility to learn at your own pace and convenient location. You decide your learning hours and the best time

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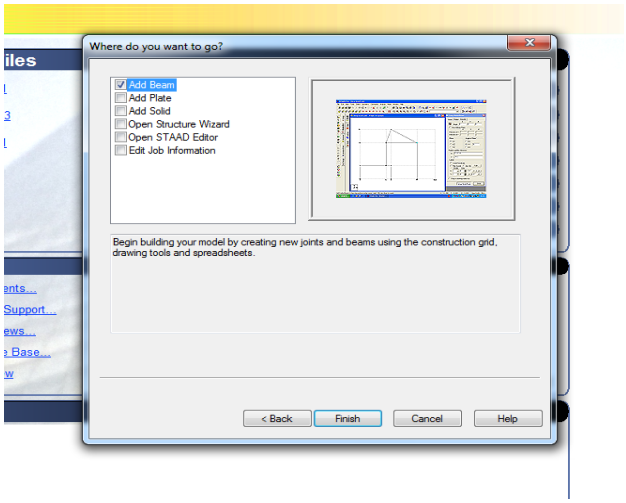
suitable for it. If you want to reap all the benefits of STAAD Pro software, make sure you choose a reputable institute, app, or online platform in India.

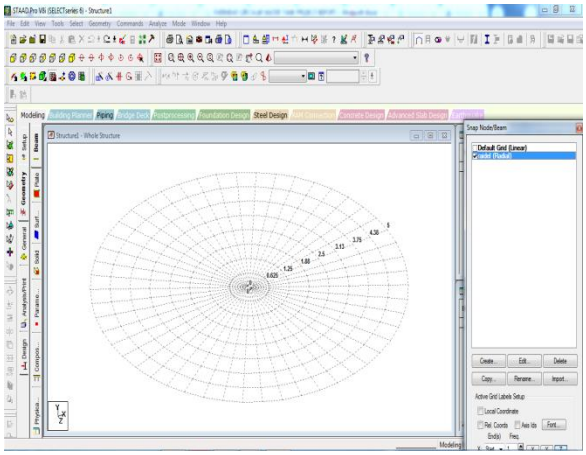
5. DESIGN PARAMETERS CONSIDERED FOR OVERHEAD TANK

Over head tanks	Length/Radius	breadthh	depth	heightt	Windloads
Circular	3.30m	-	2.45m	12m	40m/s

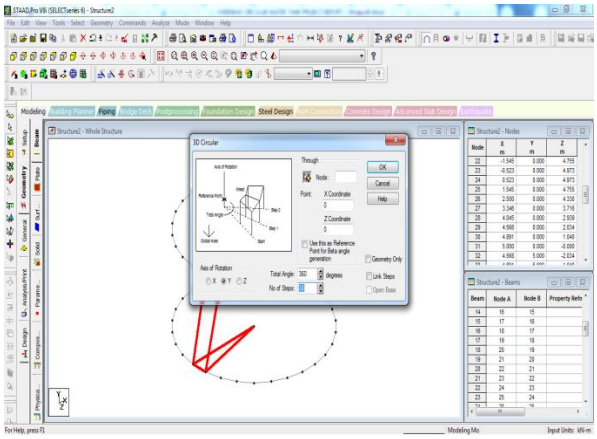
Overhead circular water tank STAAD PRO NEW FIL



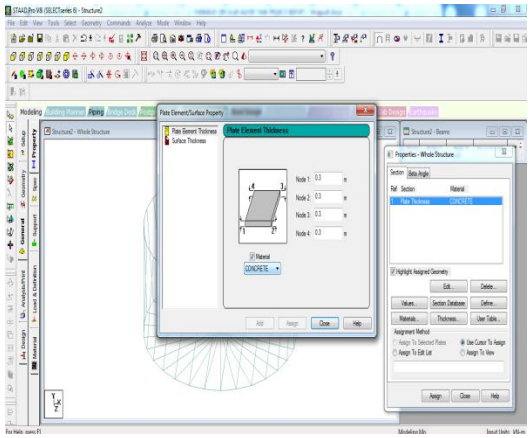
Overhead circular water tank STAAD PRO SECLET ADD BEAM



Overhead circular water tank STAAD PRO SECLET node



Overhead circular water tank STAAD PRO SECLET lines



Overhead circular water tank STAAD PRO SECLET plate element thickness

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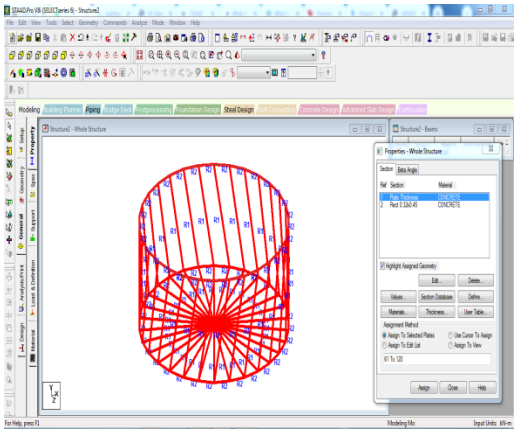
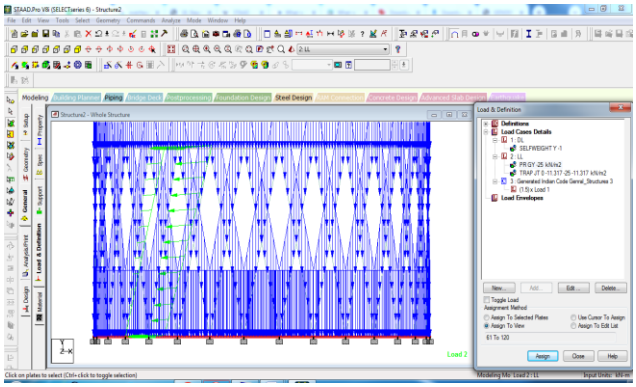
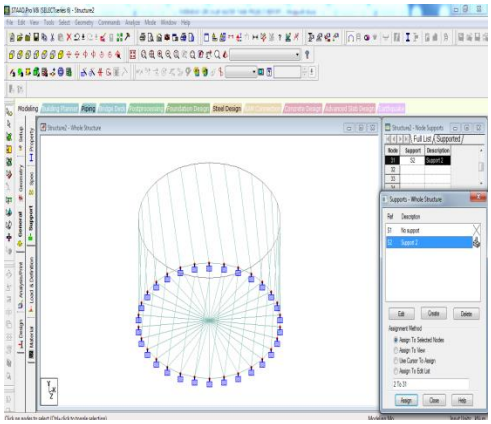


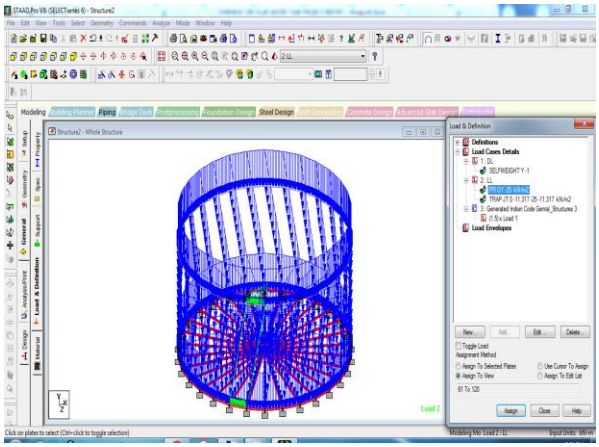
Overhead circular water tank STAAD PRO SECLET thickness assigns



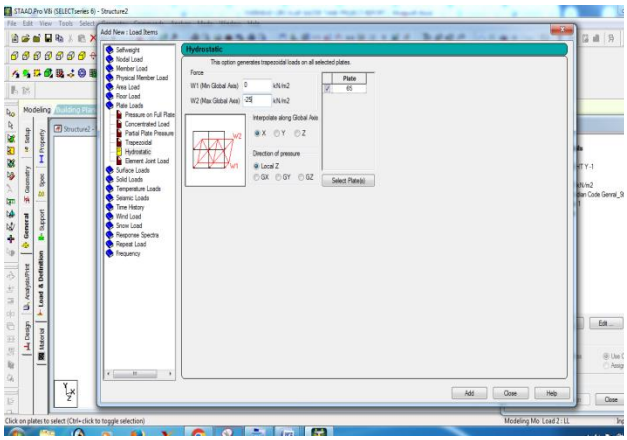
Overhead circular water tank STAAD PRO SECLET live load



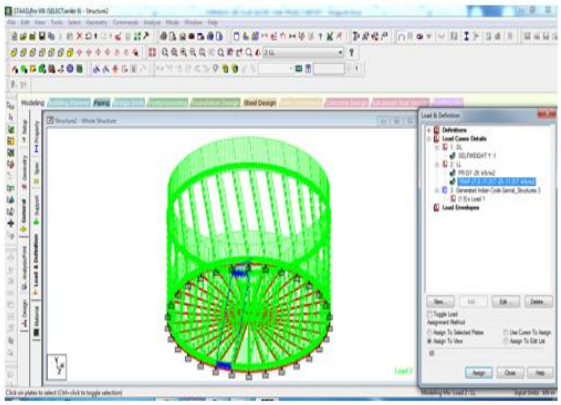
Overhead circular water tank STAAD PRO create support



Overhead circular water tank STAAD PRO SECLET live load (PRGY)



Overhead circular water tank STAAD PRO SECLET hydrostatic



Overhead circular water tank STAAD PRO SECLET live load (TRAP)

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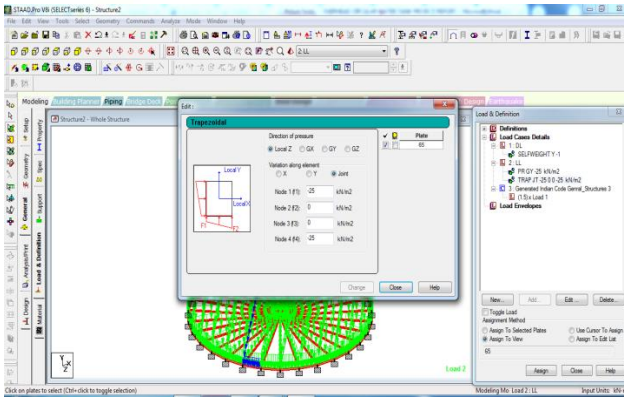
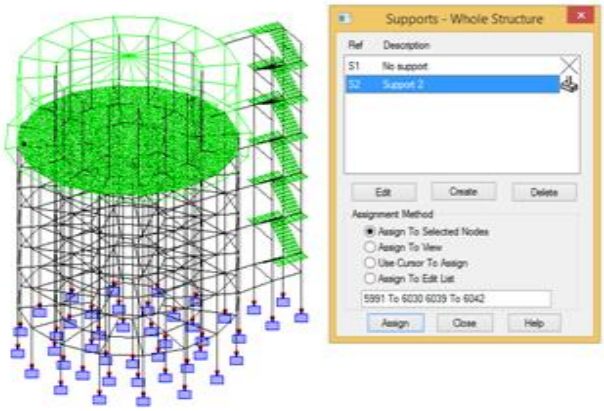
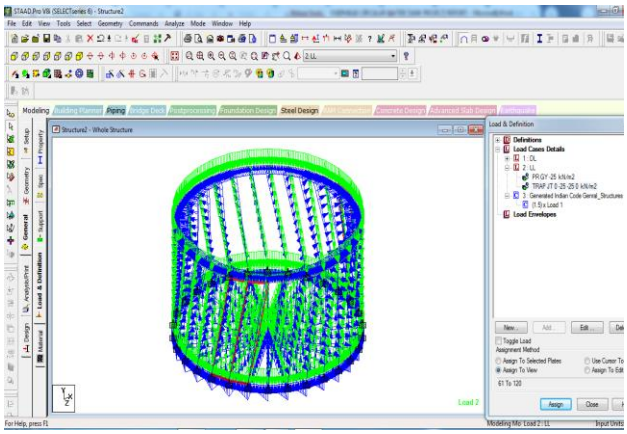
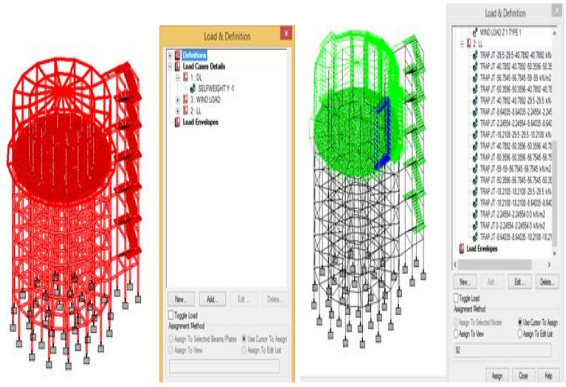


Overhead circular water tank STAAD PRO SECLET NODE LOAD

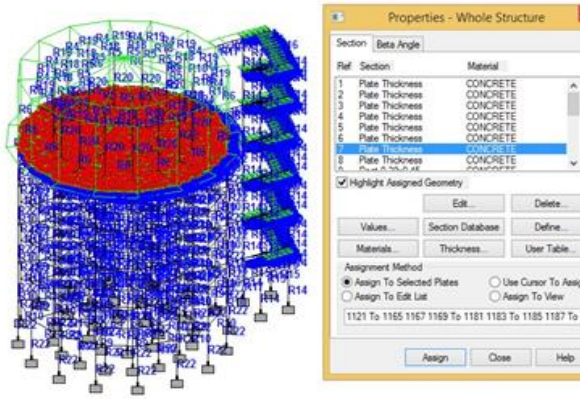




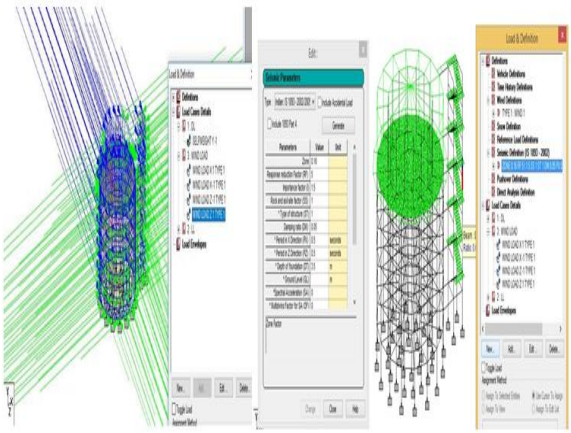
Overhead circular water tank STAAD PRO SECLET live load ASSIGNS



Assigning Dead Load and Live Load



Assigning Property and supports



Assigning Wind load and seismic load

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FOR PARTIALLY FILLED

1. 1.5(DL+HL+WL(+X))
2. 1.5(DL+HL+WL(-X))
3. 1.5(DL+HL+WL(+Z))
4. 1.5(DL+HL+WL(-Z))
5. 1.5(DL+WL(+X))
6. 1.5(DL+WL(-X))
7. 1.5(DL+WL(+Z))
8. 1.5(DL+WL(-Z))
9. 1(DL+HL+WL(+X))
10. 1(DL+HL+WL(-X))
11. 1(DL+HL+WL(-X))
12. 1(DL+HL+WL(+Z))
13. 1(DL+HL+WL(-Z))

FOR FULLY FILLED TANK

1. 1.5(DL+HL(HALF)+WL(+X))
2. 1.5(DL+HL(HALF)+WL(-X))
3. 1.5(DL+HL(HALF)+WL(+Z))
4. 1.5(DL+HL(HALF)+WL(-Z))
5. 1(DL+HL(HALF)+WL(+X))
6. 1(DL+HL(HALF)+WL(-X))
7. 1(DL+HL(HALF)+WL(+Z))
8. 1(DL+HL(HALF)+WL(-Z))

6. SHEAR STRESS AND BENDING MOMENT VALUES OBTAINEDAFTER ANALYSIS

Water Tanks Based On Shape	SQX		SQY		MX		MY	
	Min	Max	Min	Max	Min	Max	Min	Max
Circular	-0.0189	0.0189	-0.5593	0.7328	-0.627	0.882	-131.437	30.099

CONCLUSIONS:

- The proposed tank in overhead circular water tank 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. Sinceour proposed tank is of 10 lakh capacity we had Planned analyzed and designed the circular over head tank in STAAD Prosoftware
- Design of water tank is a very tedious method.

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