

Analysis and Design of Double Decker Overhead Water Tank Using STAAD Pro

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Abstract - Water storage structures are essential components of modern water supply systems, particularly in densely populated regions where available land is limited and the demand for water is continuously increasing. A double decker overhead water tank provides an effective solution by increasing storage capacity vertically without requiring additional ground area. The present study focuses on the structural analysis and design of a double decker reinforced concrete overhead water tank using STAAD Pro software by considering the provisions of relevant Indian Standard codes. The structural model was developed considering the effects of self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic load to evaluate the overall stability and performance of the tank. The design of major structural elements such as the tank walls, slabs, beams, columns, and supporting system was carried out using the limit state approach as per IS 3370:2009 and IS 456:2000. The analysis results obtained from STAAD Pro, including displacement, bending moment, and shear force responses, were examined to ensure the safety and serviceability of the structure under critical loading conditions. The study demonstrates that a double decker RCC overhead water tank can provide a reliable, space-efficient, and structurally safe solution for high-capacity water storage. The adoption of advanced structural analysis software and code-based design methodology improves the accuracy of design and contributes to the development of durable and economical water storage systems.

Keywords: Double Decker Water Tank, Reinforced Concrete, STAAD Pro, Structural Analysis, Hydrostatic Pressure, Seismic Load, Wind Load, IS Codes.

1. INTRODUCTION

Water is one of the most essential natural resources required for domestic, commercial, industrial, and agricultural activities. A reliable water supply system requires adequate storage facilities to maintain continuous distribution and meet fluctuations in daily water demand. Overhead water tanks are among the most important components of water distribution networks because they store water at an elevated height and provide the necessary pressure through gravitational flow. These structures play a vital role in ensuring uninterrupted water supply, especially in rapidly developing urban areas where population growth and increasing water consumption demand efficient storage solutions.

Conventional overhead water tanks generally consist of a single storage container supported on a staging system. However, in densely populated regions, availability of land for constructing large-capacity storage structures is often limited. Increasing the horizontal dimensions of a tank requires more ground area and higher construction cost. To overcome this limitation, a double decker overhead water tank provides a practical alternative by arranging two water storage compartments vertically over a common supporting system. This arrangement increases the total storage capacity without increasing the foundation area and makes the system suitable for urban areas, industrial facilities, public institutions, and municipal water supply schemes.

A double decker reinforced concrete (RCC) overhead water tank is a complex structure subjected to several types of loading conditions. The structural components, including the tank walls, slabs, beams, columns, and staging system, must safely resist dead loads, live loads, hydrostatic pressure due to stored water, wind forces, and earthquake-induced forces. Since the mass of water is concentrated at an elevated level, lateral loads significantly influence the behavior and stability of the structure. Therefore, accurate structural analysis and proper design are necessary to prevent excessive deformation, cracking, and possible structural failure.

The advancement of computational analysis techniques has significantly improved the accuracy and efficiency of designing liquid retaining structures. STAAD Pro, based on finite element analysis principles, allows engineers to create three-dimensional structural models and evaluate their behavior under different loading combinations. The software helps in determining important structural parameters such as displacement, bending moment, shear force, and axial force, which are required for the safe design of structural members.

In the present study, a double decker RCC overhead water tank is analyzed and designed using STAAD Pro software in accordance with the provisions of IS 3370:2009 for liquid retaining structures, IS 456:2000 for plain and reinforced concrete, IS 875 (Part 1 and Part 3) for dead and wind loads, and IS 1893 for earthquake-resistant design. The structural model includes circular upper and lower tanks supported on a common RCC staging system. The complete analysis is carried out by considering self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic effects.

The objective of the study is to develop a structurally stable, durable, and economical water storage system capable of storing a large quantity of water within a limited area. The obtained results from STAAD Pro analysis are used to evaluate the structural response of the tank and verify the adequacy of the selected structural components.

1.1 Objectives of the Study

The major objectives of the present research work are as follows:

- To study the structural requirements and design considerations of a double decker RCC overhead water tank.
- To determine the required storage capacity based on projected population and water demand.
- To develop a three-dimensional finite element model of the double decker water tank using STAAD Pro software.
- To analyze the behavior of the structure under different loading conditions such as self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic load.
- To evaluate structural responses such as displacement, bending moment, shear force, and axial force generated in different structural components.
- To design major structural components including tank walls, slabs, beams, columns, and staging members according to relevant Indian Standard codes.
- To assess the feasibility of a double decker arrangement as a space-efficient and economical solution for high-capacity water storage.

1.2 Need and Advantages of Double Decker Overhead Water Tank

The adoption of double decker overhead water tanks has increased due to the growing demand for high-capacity water storage in areas where land availability is restricted. The vertical arrangement of two tanks on a common staging system provides greater storage capacity while minimizing the required construction footprint. Compared to constructing two separate tanks, the double decker configuration reduces the overall land requirement and offers better utilization of structural components.

Table 1: Advantages of Double Decker RCC Overhead Water Tank

Sr. No.	Advantages	Description
1	Space Optimization	Provides higher water storage capacity within limited land area.
2	Increased Capacity	Two tanks arranged vertically provide greater storage volume.
3	Gravity-Based Distribution	Maintains adequate water pressure and reduces pumping requirements.
4	Economical Construction	Common staging system reduces the need for separate supporting

		structures.
5	Structural Efficiency	Properly designed RCC members provide strength and long service life.
6	Reliable Water Supply	Ensures continuous availability of water for different applications.



Figure 1: Overhead Water Tank



Figure 2: Circular Water Tank Configuration

2. METHODOLOGY AND DESIGN PARAMETERS

The methodology adopted in the present study involves the determination of water demand, estimation of required storage capacity, selection of suitable tank dimensions, structural modelling, application of design loads, and analysis of the double decker RCC overhead water tank using STAAD Pro software. The complete process is carried out systematically to ensure that the proposed structure satisfies the requirements of strength, stability, serviceability, and durability according to the provisions of relevant Indian Standard codes.

The initial stage of the study includes the collection of population data and estimation of future water demand for the selected study area. Based on the projected population and per capita water requirement, the total storage capacity of the water tank is calculated. The required capacity is then distributed between the lower and upper tanks to achieve a practical double decker arrangement. After finalizing the

dimensions, a three-dimensional finite element model of the tank is developed in STAAD Pro by defining the geometry, material properties, member sections, support conditions, and loading cases.

The structural analysis is performed by considering self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic forces. The obtained responses such as displacement, bending moment, shear force, and axial force are used for the design and verification of the structural members.

2.1 Methodology Flow

The complete methodology adopted for the analysis and design of the double decker overhead water tank is illustrated in the flow chart shown below.

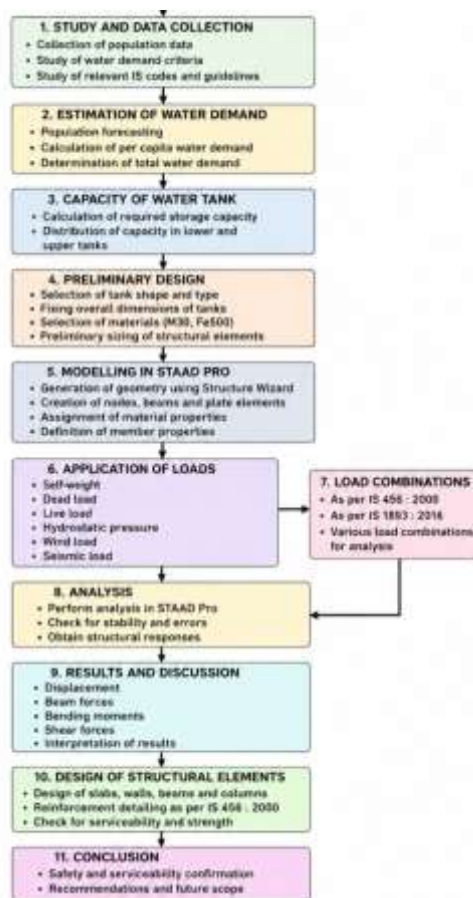


Figure 3: Methodology Flow for Analysis and Design of Double Decker RCC Overhead Water Tank

2.2 Study Area and Population Forecasting

The selected study area for the present research is Nandanvan Colony, Shantipura Area, Chhatrapati Sambhajanagar. The population recorded in the year 2011 was 9,379 persons. Since the design of an overhead water tank should satisfy future water requirements, population forecasting was carried out to estimate the ultimate design population. In this study, the Geometric Increase Method was adopted by considering an annual population growth rate of 2%.

The population forecast is calculated using the following equation:

$$P_n = P_0 \times (1 + r)^n$$

Where,

P_n = Forecasted population after n years

P_0 = Initial population

r = Annual population growth rate

n = Number of years

The estimated population for different design years is calculated as follows:

For the year 2028:

$$P_{2028} = 9379 \times (1 + 0.02)^{17}$$

$$P_{2028} = 13,133 \text{ persons}$$

For the year 2043:

$$P_{2043} = 9379 \times (1 + 0.02)^{32}$$

$$P_{2043} = 17,675 \text{ persons}$$

For the year 2058 (Ultimate Design Year):

$$P_{2058} = 9379 \times (1 + 0.02)^{47}$$

$$P_{2058} = 23,788 \text{ persons}$$

The forecasted population values considered for the design of the double decker RCC overhead water tank are presented in Table 2.

Table 2: Forecasted Population Using Geometric Increase Method

Design Year	Estimated Population (Persons)
2028	13,133
2043	17,675
2058 (Ultimate Design Year)	23,788

2.3 Estimation of Water Demand

The water demand for the proposed water supply system is determined based on the projected population of the ultimate design year and a per capita water requirement of 135 litres per person per day (LPCD). The total daily water requirement is calculated using the projected population.

The total daily water demand is calculated as:

$$\text{Total Daily Demand} = \text{Population} \times \text{Per Capita Demand}$$

$$\text{Total Daily Demand} = 23,788 \times 135$$

$$\text{Total Daily Demand} = 3,211,380 \text{ litres/day}$$

$$\text{Total Daily Demand} = 3211.38 \text{ m}^3/\text{day}$$

An additional 20% allowance is considered to account for water losses due to leakage and transmission losses. Therefore, the gross water demand is obtained as:

Gross Water Demand = 1.2×3211.38

Gross Water Demand = 3853.656 m^3

Hence, the total storage capacity of the proposed double decker overhead water tank is considered as 3853.656 m^3 to satisfy the future water requirement of the study area.

2.4 Distribution of Tank Capacity

To achieve an efficient double decker arrangement, the total storage capacity is divided into lower and upper tanks. The lower tank is designed with a higher storage capacity, whereas the upper tank provides additional storage while maintaining the advantage of vertical space utilization.

Table 3: Distribution of Storage Capacity

Tank Level	Capacity (m^3)
Lower Tank	2353.656
Upper Tank	1500
Total Capacity	3853.656

2.5 Design Parameters

Based on the required storage volume and structural requirements, the dimensions and material properties of the proposed water tank are finalized. The tank is considered circular in shape because of its efficient stress distribution and economical use of construction materials.

Table 4: Design Parameters of Double Decker RCC Water Tank

Parameter	Specification
Shape of Tank	Circular
Total Capacity	3853.656 m^3
Lower Tank Diameter	18 m
Lower Tank Height	9.62 m
Upper Tank Diameter	18 m
Upper Tank Height	6.25 m
Grade of Concrete	M30
Grade of Reinforcement Steel	Fe500

2.6 Material and Design Standards

The analysis and design of the double decker overhead water tank are carried out using the provisions of relevant Indian Standard codes. The selection of materials and design criteria ensures adequate strength, durability, and service life of the structure.

Table 5: Indian Standards Considered in the Study

IS Code	Description
IS 3370:2009	Code for concrete structures for storage of liquids
IS 456:2000	Plain and reinforced concrete design
IS 875 (Part 1)	Dead load calculations

IS 875 (Part 3)	Wind load calculations
IS 1893	Criteria for earthquake resistant design

3. STRUCTURAL MODELLING AND LOADING CONDITIONS

The structural modelling of the double decker RCC overhead water tank is carried out using STAAD Pro software by adopting a three-dimensional finite element modelling approach. The software enables accurate representation of the structural geometry, material properties, support conditions, and external loading. The complete model consists of circular tank walls, top and bottom slabs, ring beams, supporting beams, columns, and the staging system. The developed model is analysed to determine the structural response under different loading combinations and to ensure safety and serviceability of the proposed structure.

The modelling process begins with the creation of the tank geometry using the STAAD Pro Structure Wizard. The required dimensions of the circular tanks and supporting framework are defined by generating nodes, beam elements, and plate elements. The final model consists of a lower and upper circular storage tank supported on a common RCC staging arrangement.

3.1 Development of STAAD Pro Model

STAAD Pro provides a user-friendly environment for creating and analysing complex structures subjected to different loading conditions. The modelling procedure involves the generation of geometry, assignment of material properties, specification of sectional dimensions, application of support conditions, and definition of load cases.

The sequence followed for modelling the double decker overhead water tank is presented through the figures obtained from the project model.



Figure 4: STAAD Pro Interface

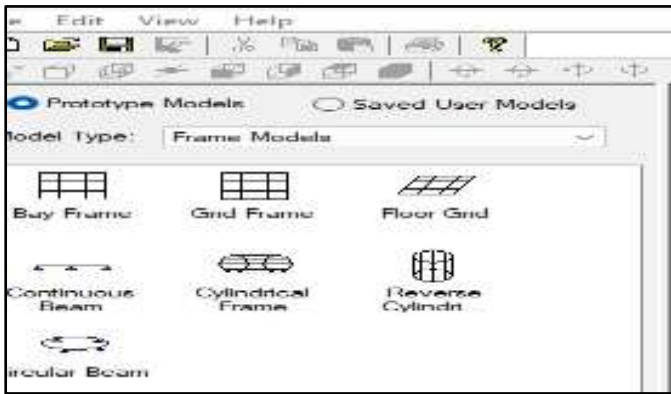


Figure 5: Structure Wizard Used for Geometry Generation

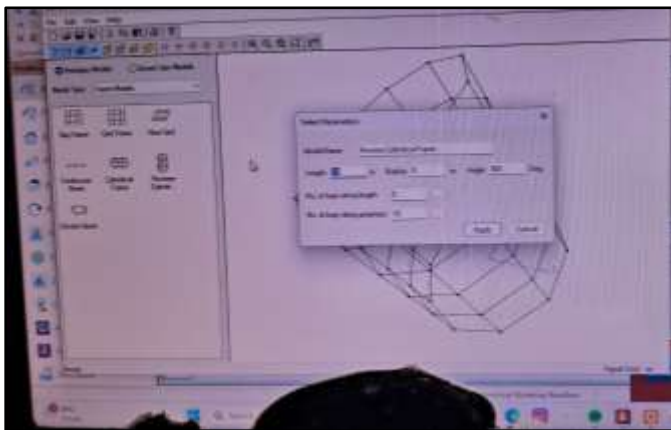


Figure 6: Initial Structural Model of Double Decker Water Tank

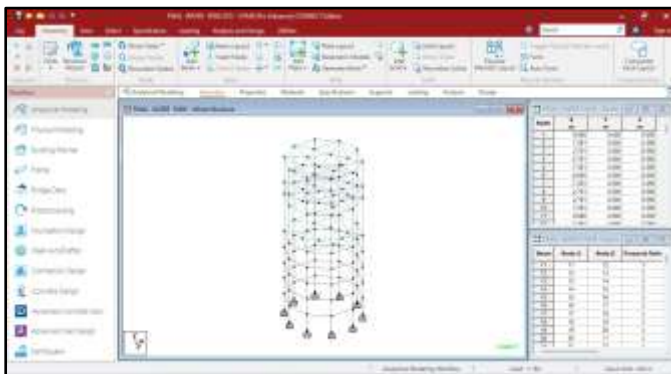


Figure 7: Final Three-Dimensional Geometry of Water Tank

3.2 Structural Properties and Support Conditions

After generation of the geometry, suitable material properties and sectional dimensions are assigned to the structural components. The tank is designed using M30 grade concrete and Fe500 grade reinforcement steel. The dimensions of columns, beams, and slab elements are selected considering the loading requirements and structural stability.

Table 6: Sectional Properties of Structural Components

Structural Component	Section Size
Columns	0.70 m × 0.70 m
Beams	0.50 m × 0.70 m
Slab Thickness	0.37 m
Concrete Grade	M30
Reinforcement Grade	Fe500

The assigned structural properties in the STAAD Pro model are illustrated in the following figures:



Figure 8: Column Section Properties

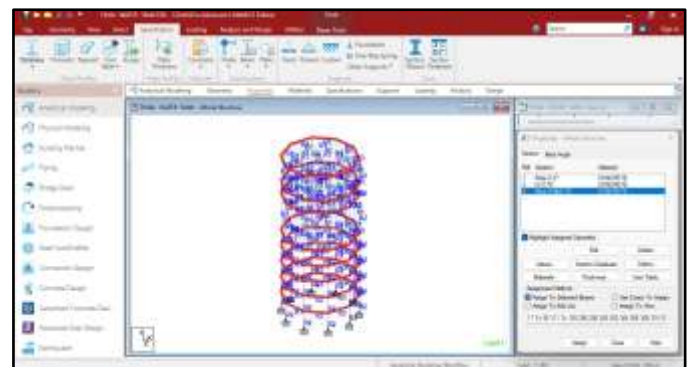


Figure 9: Beam Section Properties



Figure 10: Slab Thickness and Plate Properties

The foundation level of the staging system is considered as a fixed support to provide adequate restraint against translational and rotational movements. Proper support

conditions are essential to achieve realistic structural behavior during analysis.

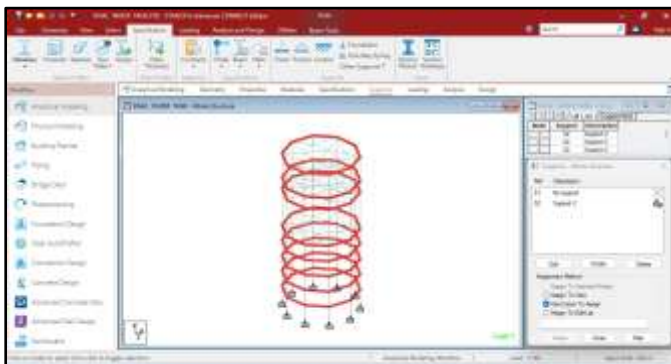


Figure 11: Support Condition of Double Decker Water Tank

3.3 Loading Conditions

The structural performance of the double decker overhead water tank is influenced by various gravity and lateral loads. Therefore, the STAAD Pro model is analysed by considering self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic load according to the relevant Indian Standard provisions.

a) Dead Load

Dead load includes the self-weight of all structural components such as slabs, beams, columns, and tank walls. The self-weight is automatically generated in STAAD Pro based on the assigned material density, while additional permanent loads are applied as per the recommendations of IS 875 (Part 1).



Figure 12: Self-Weight Load Applied on Water Tank



Figure 13: Dead Load Applied on Water Tank

b) Live Load

Live loads represent temporary loads acting on accessible portions such as the roof slab, walkway, and staircase. As per the design consideration, a live load of 1.5 kN/m^2 is applied to the respective structural components.



Figure 14: Live Load Applied on Water Tank

c) Wind Load

Wind load is an important lateral load for elevated structures due to their significant height and exposed surface area. The wind load is calculated according to the provisions of IS 875 (Part 3), considering a basic wind speed of 39 m/s applicable to the selected location.

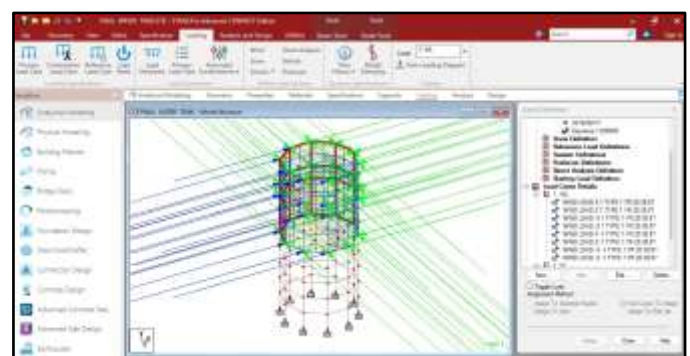


Figure 15: Wind Load Applied on Water Tank

d) Hydrostatic Pressure

Hydrostatic pressure is generated due to the stored water acting on the tank walls and bottom slabs. The pressure increases linearly with water depth and is calculated using the relation:

$$P = \rho g h$$

Where:

- P = Hydrostatic pressure (N/m^2)
- ρ = Density of water (1000 kg/m^3)
- g = Acceleration due to gravity (9.81 m/s^2)
- h = Height of water column (m)

The hydrostatic pressure is applied as a varying load over the tank surfaces in the STAAD Pro model.



Figure 16: Hydrostatic Pressure Applied on Water Tank

3.4 Structural Analysis Procedure

After defining the complete geometry, material properties, support conditions, and loading cases, the model is analysed in STAAD Pro using finite element analysis techniques. The analysis provides important structural responses such as nodal displacement, bending moment, shear force, and axial force. These responses are used for checking the stability of the structure and designing the required reinforcement for different structural components.



Figure 17: Analysis and Design of Double Decker Water Tank

The detailed analysis results obtained from STAAD Pro are discussed in the next section to evaluate the behaviour of the double decker RCC overhead water tank under various loading conditions.

4. RESULTS AND DISCUSSION

The structural analysis of the double decker RCC overhead water tank was performed using STAAD Pro after the complete development of the finite element model and application of all design loads. The analysis considered the combined influence of self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic load to evaluate the structural response of the tank and its supporting staging system.

The software-generated results provide detailed information regarding displacement, internal forces, bending moments, and shear forces developed in various structural members. These parameters play a significant role in evaluating the stability, strength, and serviceability of the water tank. The obtained results are used to verify the adequacy of the selected member sizes and to ensure that the structure performs safely under critical loading conditions.

4.1 Beam Displacement Response

The displacement response represents the movement of structural members due to applied loading conditions. The displacement values obtained from STAAD Pro indicate the stiffness and overall stability of the supporting system. Proper control of displacement is essential to prevent excessive deformation and to maintain the serviceability of the overhead water tank.

Table 7: Beam Displacement Results

Beam Displacement Detail Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	320	4-HP	5.562	0.884	-19.255	-0.712	19.288
Min X	315	4-HP	5.562	-0.417	-19.292	-0.795	19.313
Max Y	314	3-LL	2.781	-0.001	0.564	0.000	0.564
Min Y	315	4-HP	2.225	-0.321	-19.828	-1.022	19.857
Max Z	32	4-HP	5.562	-0.036	-10.405	0.075	10.405
Min Z	314	4-HP	0	0.075	-19.310	-1.359	19.358
Max Rot	323	4-HP	2.225	0.306	-19.810	-1.347	19.858

4.2 Beam End Displacement Response

Beam end displacement results provide information about translational and rotational movement at the ends of beam members. These values are important for understanding the interaction between beams and supporting columns and help in assessing the structural behavior of the staging system.

Table 8: Beam End Displacement Results

Beam End Displacement Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	320	142	4-HP	0.884	-19.255	-0.712	19.288
Min X	315	137	4-HP	-0.417	-19.292	-0.795	19.313
Max Y	314	135	3-LL	-0.001	0.564	0	0.564
Min Y	314	136	4-HP	-0.257	-19.332	-1.172	19.369
Max Z	32	33	4-HP	-0.036	-10.405	0.075	10.405
Min Z	314	135	4-HP	0.075	-19.310	-1.359	19.358
Max Rot	314	136	4-HP	-0.257	-19.332	-1.172	19.369

4.3 Beam Force Analysis

The internal forces generated in beam members, such as axial forces, shear forces, and bending moments, are obtained through finite element analysis in STAAD Pro. These forces are considered during the reinforcement design process to ensure that the structural members possess sufficient strength to resist the applied loading conditions.

Table 9: Beam Force Results

Beam Force Detail Summary

Sign convention as per diagram: positive above the axis, negative below the axis except for where positive is compression. Distance d is given from beam end A.

Beam	L/C	d (mm)	Axial			Shear			Bending		
			Fx (kN)	Fy (kN)	Fz (kN)	Vx (kN)	Vy (kN)	Vz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
Max Fx	322	0.000	0	168.288	-0.000	0.000	0.000	-0.000	34.188	0.000	0.000
Min Fx	82	0.000	0	-167.891	-0.000	0.000	0.000	0.000	-34.188	0.000	0.000
Max Fy	318	0.000	0	0.000	11.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Fy	120	0.000	0	0.000	-11.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Fz	40	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Fz	40	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Vx	120	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Vx	120	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Vy	40	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Vy	40	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max Vz	120	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min Vz	120	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

4.4 Maximum Bending Moment Analysis

Bending moment is one of the most critical parameters in the design of RCC members. The maximum bending moments obtained from the analysis identify the critical locations where higher tensile and compressive stresses are developed. These results are used for determining the required reinforcement and ensuring that the structural components satisfy the limit state design requirements.

The obtained bending moment values indicate that the selected beam and column sections provide adequate resistance against flexural effects generated due to vertical and lateral loads. Proper reinforcement detailing based on these moments ensures the structural safety and long-term durability of the water tank.

4.5 Maximum Shear Force Analysis

Shear force analysis is performed to determine the transverse forces developed in structural members. Excessive shear may result in diagonal cracking and reduction in structural performance; therefore, accurate evaluation of shear forces is necessary for designing suitable shear reinforcement.

Beam Maximum Shear Forces Cont...

Beam	Node A	Length (m)	L/C	d (mm)	Max Fx (kN)	d (mm)	Max Fy (kN)
			3:1L	Max +ve	0	5.562	17.854
			Max -ve	0	-0.000	0	-17.854
			4:HP	Max +ve	0	0.423	0
			Max -ve	0	0	-4.561	0
321	142	5.562	1:WL	Max +ve	0	0	0
			Max -ve	0	0	0	0
			2:DL	Max +ve	0	0.061	0
			Max -ve	0	0	0	0
			3:1L	Max +ve	0	5.562	17.854
			Max -ve	0	-0.000	0	-17.854
			4:HP	Max +ve	0	0.245	0
			Max -ve	0	0	-4.902	0
322	143	5.562	1:WL	Max +ve	0	0	0
			Max -ve	0	0	0	0
			2:DL	Max +ve	0	0.105	0
			Max -ve	0	0	0	0
			3:1L	Max +ve	0	5.562	17.854
			Max -ve	0	0.000	5.562	17.854
			4:HP	Max +ve	0	0.489	0
			Max -ve	0	0	0	-4.505
323	144	5.562	1:WL	Max +ve	0	0	0
			Max -ve	0	0	0	0
			2:DL	Max +ve	0	0.160	0
			Max -ve	0	0	0	0
			3:1L	Max +ve	0	5.562	17.854
			Max -ve	0	0.000	5.562	17.854
			4:HP	Max +ve	0	0.586	0
			Max -ve	0	0	0	-13.384

Table 11: Maximum Shear Force Results

The shear force results confirm that the structural members are capable of resisting the applied loading conditions when designed with appropriate reinforcement and sectional dimensions.

4.6 Structural Stability Verification

A static check is carried out in STAAD Pro to verify the equilibrium between the applied external loads and the resisting forces generated within the structure. The satisfactory static check confirms the accuracy of the analytical model and indicates that the developed structural system remains stable under the considered loading cases.

Statics Check Results

L/C		FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
1:WL	Loads	0	0	0	0	0	0
1:WL	Reactions	0	0	0	0	0	0
	Difference	0	0	0	0	0	0
2:DL	Loads	0	-37.86+3	0	0.016	0	-0.010
2:DL	Reactions	-0.000	37.86+3	0.000	-0.01603	0.000	0.010
	Difference	-0.000	-0.000	0.000	-0.000	0.000	0.000
3:1L	Loads	0	2.88E+3	0	-0.002	0	0.002
3:1L	Reactions	0.000	-2.88E+3	-0.000	0.002	-0.000	-0.002
	Difference	0.000	0.000	-0.000	-0.000	-0.000	-0.000
4:HP	Loads	0	-72.56+3	0	-0.000	0	0.000
4:HP	Reactions	-0.000	72.56+3	0.000	-0.000	0.000	0.000
	Difference	-0.000	-0.000	0.000	-0.000	0.000	0.000

Table 12: Static Check Results

4.7 Discussion of Overall Structural Performance

The overall analysis demonstrates that the double decker RCC overhead water tank exhibits satisfactory structural behavior under the considered loading conditions. Hydrostatic pressure acts as the primary vertical load influencing the tank walls and bottom slabs, while wind and seismic forces significantly affect the lateral stability of the elevated staging system. The finite element analysis performed using STAAD Pro enables accurate prediction of displacement, bending moments, and shear forces, allowing proper design of RCC members.

The results indicate that the selected dimensions, material grades, and supporting arrangement provide adequate strength and stability for the proposed storage capacity. The double

decker configuration effectively increases water storage without requiring additional ground area, making it a practical and economical solution for urban water supply systems where land availability is limited.

5. CONCLUSION

The major conclusions drawn from the present study are summarized as follows:

- The double decker RCC overhead water tank was successfully analyzed and designed using STAAD Pro by considering relevant Indian Standard provisions for liquid retaining structures and reinforced concrete design.
- The projected water demand of the selected study area was effectively fulfilled by providing a total storage capacity of 3853.656 m³, consisting of a 2353.656 m³ lower tank and a 1500 m³ upper tank.
- The three-dimensional finite element model developed in STAAD Pro accurately represented the structural behavior of the tank under various loading conditions, including self-weight, dead load, live load, hydrostatic pressure, wind load, and seismic load.
- The analysis results in terms of displacement, beam forces, bending moments, and shear forces confirmed that the selected structural components possess adequate strength, stiffness, and stability to safely resist the applied loads.
- The adoption of M30 grade concrete and Fe500 reinforcement steel provided suitable strength, durability, and serviceability for the long-term performance of the water retaining structure.
- The double decker configuration proved to be an efficient solution for increasing water storage capacity without increasing the required ground area, making it highly suitable for urban regions with limited land availability.
- The common staging system for both tanks contributes to better utilization of structural elements and provides a more economical solution compared with constructing separate overhead tanks.
- The use of STAAD Pro and finite element analysis techniques improves the accuracy of structural analysis and helps in achieving a safe, reliable, and optimized design.
- The proposed double decker overhead water tank can be effectively implemented in municipal water supply systems, industrial areas, residential complexes, and other locations requiring large-capacity and continuous water storage.

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