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Design of Water Tanks by E-Tab Software

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ABSTRACT: The design of circular water tanks requires a comprehensive understanding of structural behavior under static and dynamic loads, including hydrostatic pressure, seismic forces, wind loads, and the effects of water sloshing. Circular water tanks, due to their efficient geometry, are commonly used in both ground supported and elevated applications for water storage. However, their unique loading conditions and dynamic response present challenges in design and analysis.

This paper presents a method for the design of circular water tanks using ETABS (Extended Threedimensional Analysis of Building Systems), a widely-used structural engineering software. ETABS allows for accurate 3D modeling, load application, and analysis of circular water tanks, considering both static and dynamic effects. The software can simulate the hydrostatic pressure exerted by the stored water on the tank walls and base, along with dynamic effects such as seismic and wind forces, and sloshing during seismic events.

KEYWORDS: Structural Design, 3D tank modelling, Hydrostatic loads.

I. INTRODUCTION

Circular water tanks are commonly used in both elevated and ground-supported applications for water storage in residential, commercial, industrial, and municipal facilities. These tanks are typically designed to withstand the pressure exerted by the stored water, as well as dynamic loads such as seismic forces, wind, and sloshing effects. The design of circular water tanks is more complex than other types of tanks due to the unique geometric properties and behavior under different loading conditions.

ETABS (Extended Three-dimensional Analysis of Building Systems) is a powerful software tool that offers advanced capabilities for modeling, analysis, and design of circular water tanks. By leveraging ETABS, engineers can accurately simulate the behavior of these tanks, assess their structural integrity, and ensure they meet safety and performance standards..

II. LITERATURE

Water tanks are critical infrastructure for the storage and distribution of water. Their design requires attention to stability, crack control, seismic resistance, and durability, especially in liquid-retaining structures. ETABS is a powerful tool for structural analysis and design, widely used for buildings and liquid-retaining structures like water tanks. Its capability to model 3D structures, analyze loads, and simulate dynamic effects makes it suitable for water tank design. Ayazhussain M. Jabar, H. S. Patel. In this research, the elevated water tank to be designed according to the purpose of heavily damaged or collapse during earthquake. In this study, the main aim is to understand the behaviour of supporting system which is more effective under different earthquake time history record with SAP2000 software. The tank to be designed with the proper behaviour of supporting system of the tank against dynamic responses, and selecting the proper staggered system in the column of the tank. The main objective of this study is to analysed the critical responses of the tank with water filled and empty condition, also used of Lome Prieta Time history data and Kobe earthquake data for the analysis of the behaviour under seismic excitation.

Anshuman Nimade, Niraj Soni, Gautam verma. In this studies, the underground water storage tank to be design for the purpose of collection of rainwater, storage of drinking water, and waste water collection. The main objective of this

study is to find out the stress, node displacement, and the base pressure to be produced when the tank is empty or full with vary the length and width ratio with constant height. In this research, the variation of L/B ratio of the tank is considered and compare of this with shear stress, principle stress, Tresca stress, Von Mis stresses, bending moment, node displacement, and base pressure. In this research, it is concluded that when $L/B < 2$ then all the stress goes on negligible and whenever the $L/B > 2$ then effect of all the stresses is increases with increasing L/B ratio.

4) N Farasat, A Farasat, AR Heysami, N Moridi In this research, the designing of underground storage tank and non-underground storage tank were compared and it is found that the underground tanks gives better performance in terms of maximum displacement and stress against wall. In this research different parameters were studied like depth of underground tank, type of soil around the tank, the distribution of dynamic pressure by different fluids. The tension in the outer wall of the underground tank is very much low as compare to non-buried tank. Here for the seismic analysis El Centro earthquake record is applied in terms of time history. Here the dynamic pressure of the fluid is also calculated in the bottom of the tank .From this research, the dynamic responses of the underground storage tank and above ground storage tank are used to be calculated, and underground storage tank gives better response than the above ground storage tank. The main objective of this study is to examine the seismic response of the buried tank, half buried tank and visible tank, and also calculate the various dynamic responses of the tank.

Kalyani Vanjari, Dr. Prof. R. S. Talikoti In this study, the aspect ratio is more important for the proper dimension of the water tank. In this studies the various effect of the aspect ratio of tank wall on seismic force and behavior of ground supported water tank. In this studies, the various aspect ratios to be adopted and according to the aspect ratio the dimension of tank to be decided with the same volume of tank. The static analysis and response spectrum analysis to be carried out in ETABS software. The comparison of aspect ratio with the time history on Impulsive mode and convective mode.

In this research paper, it is noticed that, as the increasing aspect ratio, the base shear value decreases, and this is happen because of reduced height of tank walls. The vertical bending moment decreases with the increase in aspect ratio of the tank so that subsequently increase the horizontal moment of the tank.

III. METHODOLOGY

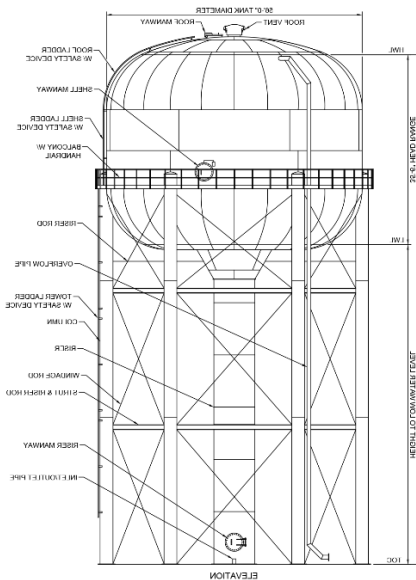
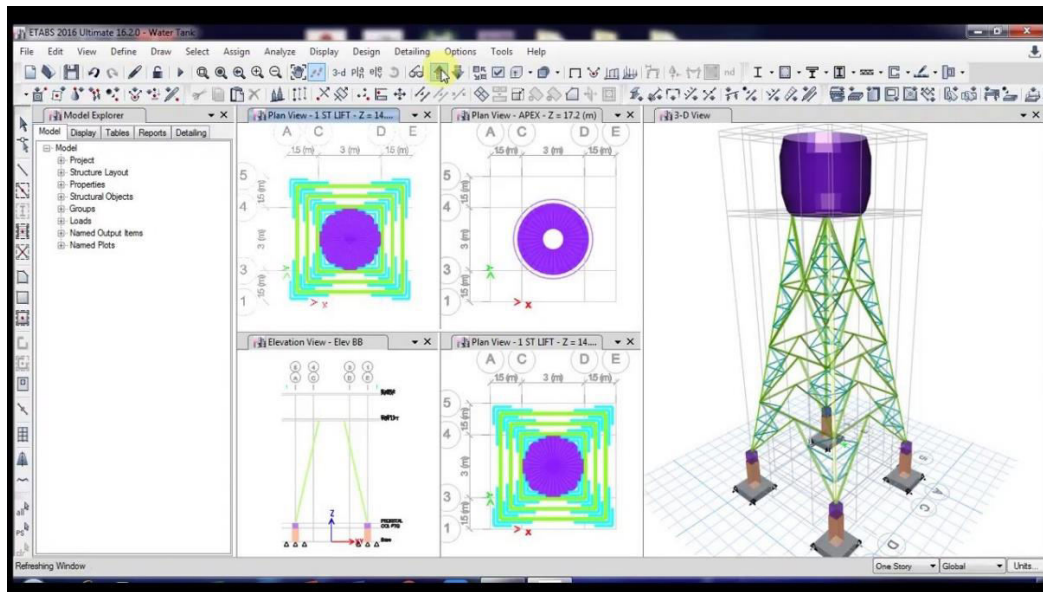
The design of a water tank using ETABS software involves a structured approach beginning with preliminary data collection. This includes determining the tank's capacity, type (elevated, underground, or ground-supported), shape (circular or rectangular), material properties (concrete and steel grades), and applicable loading conditions such as self-weight, water load, hydrostatic pressure, seismic, and wind loads.

The structural model is created in ETABS by defining materials, section properties, and modeling the tank components (walls, slabs, columns, and braces) using shell or membrane elements, ensuring appropriate boundary conditions. Loads, including dead, live, hydrostatic pressure, and environmental effects, are applied as per design standards, and load combinations are generated following codes like IS 456, IS 3370, or ACI 318. After defining these inputs, the model is analyzed for deflections, stresses, and forces, using static or dynamic analysis methods. The design of structural elements is performed using ETABS' inbuilt design tools, ensuring compliance with strength and serviceability criteria, while reinforcement detailing is checked for walls, slabs, and other components. The results are validated manually or using spreadsheets, and the design is optimized for material efficiency. Finally, detailed design reports and construction drawings are prepared, ensuring adherence to relevant standards like IS 456, IS 3370, IS 1893, and IS 875, ensuring a safe and efficient water tank design.

IV. RESULTS AND DISCUSSION

The results of the water tank design using ETABS software highlight the structural performance and adequacy of the tank under various loading conditions. The analysis reveals critical parameters such as stress distribution, deflection, and internal forces in the tank walls, slabs, and supporting structures. The software ensures that the design meets strength and serviceability criteria, with stresses and deflections remaining within permissible limits as per relevant codes like IS 3370 or ACI 318. The reinforcement detailing derived from the design aligns with practical constructability requirements. Additionally, the dynamic analysis for seismic loads demonstrates the tank's stability and resilience under earthquake conditions, while wind load analysis confirms the structural integrity of elevated tanks. The

discussion emphasizes the efficiency of ETABS in simplifying complex load applications and structural analysis, enabling precise modeling of hydrostatic pressure and other forces. The study also underscores the importance of manual validation to ensure the reliability of software-generated results. Overall, the design process using ETABS is efficient, accurate, and compliant with safety standards, providing a robust solution for water tank construction.



V. CONCLUSION

The design of a water tank using ETABS software demonstrates the efficiency and accuracy of modern structural analysis tools in handling complex engineering challenges. By utilizing ETABS, the entire process—from modeling to analysis and design—becomes streamlined, ensuring compliance with design standards such as IS 3370, IS 456, IS 1893, or ACI 318. The software's capability to simulate diverse loading conditions, including self-weight, hydrostatic pressure, seismic forces, and wind loads, ensures a realistic representation of the structural behavior. The analysis results provide detailed insights into stress distribution, deflection, and internal forces, ensuring the tank's structural

adequacy and safety under both static and dynamic conditions. The inbuilt design tools facilitate accurate reinforcement detailing for tank walls, slabs, and supports, optimizing material use while adhering to serviceability and strength requirements. Moreover, the dynamic analysis of seismic loads validates the tank's resilience in earthquake-prone areas, while wind load assessments confirm its stability. The ease of load application, automated calculations, and graphical representation of results make ETABS an invaluable tool for water tank design. However, the importance of manual validation and cross-verification cannot be overstated, as it ensures the reliability of software-generated results and highlights any potential discrepancies. Overall, the use of ETABS for designing water tanks not only enhances efficiency and accuracy but also supports sustainable and cost-effective construction practices, making it a preferred choice for engineers in the industry.

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