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The structure Investigation of Rectangular Underneath and Ground-level Water Containers Using Advanced Simulation Tools

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Abstract

Water tanks are critical public and industrial structures. The prevalent construction practices, the physical characteristic of the material, and the climatic circumstances all influence the design and construction procedures employed in reinforced concrete. Before beginning the design, the most appropriate type of tank staging and accurate load estimation are performed as well as structural statically equilibrium, particularly with regard to overturning of overhanging members. When the tank is full and empty, the design takes into account the worst conceivable combination of loads, moments, and shears caused by vertical and horizontal loads operating in either direction. By analyzing a subterranean rectangular water tank and resting on a ground rectangular water tank in this project.

INTRODUCTION

Water storage systems are a crucial component of urban infrastructure, essential for managing water supply, maintaining sanitation standards, and ensuring availability during emergency situations. Among various types of water storage solutions, underground and ground-level water containers (or tanks) play a pivotal role in storing large volumes of water. These containers are commonly used in both residential and industrial applications, ranging from household storage to fire suppression systems and emergency reservoirs. With the expansion of cities and increasing water demands, it has become vital to optimize the structural integrity and efficiency of these storage systems. In this context, advanced simulation tools offer a powerful approach to analyze and enhance the design of water containers, especially in terms of durability, cost-effectiveness, and long-term performance.

Importance of Structural Integrity in Water Containers

Rectangular water containers, whether positioned beneath the ground or at ground level, are subject to complex stress distributions due to hydrostatic pressure, soil pressure, and external environmental loads. Ensuring the structural integrity of these containers is critical, as failure could lead to costly water losses, structural damage, and safety hazards. The design process must consider multiple factors, including material strength, load-bearing capacity, and the influence of environmental conditions like soil type, groundwater levels, and seismic activity. By using advanced simulation tools, engineers can accurately model these factors, allowing for a more detailed understanding of the forces at play and a better-informed design that minimizes risk.

Advanced Simulation Tools for Structural Analysis

In recent years, simulation software such as Finite Element Analysis (FEA) tools, computational fluid dynamics (CFD) models, and other structural analysis programs have transformed how engineers approach water container design. These tools enable the virtual testing of designs under varied stress conditions, predicting possible failure points and optimizing the thickness, material composition, and geometry of containers to ensure durability and safety. Simulations also allow for iterative testing, where multiple design configurations can be tested quickly, efficiently, and without physical prototypes. This not only reduces project costs and time but also enhances the accuracy of the design, making the simulation an indispensable asset in modern engineering.

Significance of the Study

The purpose of this study is to explore the structural behavior of rectangular water containers located both below and at ground level. By employing advanced simulation tools, we aim to assess the impact of different load conditions, including internal water pressure, external soil pressure, and any additional dynamic loads, on the structural stability of these containers. The findings from this study will contribute to better design practices, providing insights that can improve the resilience and reliability of water storage infrastructure in various settings. Ultimately, this research is expected to support engineers and architects in designing more effective water storage systems that can withstand both anticipated and unforeseen stresses over prolonged operational periods.

This investigation will focus on creating and validating simulation models that accurately replicate real-world conditions for rectangular water containers. The research objectives include understanding the deformation patterns, stress distribution, and potential points of failure under various loading scenarios. The approach involves setting up controlled simulation environments, using advanced tools to run stress tests, and analyzing the outcomes to identify critical factors influencing structural performance. These insights will help develop recommendations for improved design standards and materials, enhancing the longevity and reliability of water storage containers.

Types of Water Tank:

Based on placement of water tank-

- Resting on ground
- Underground
- Elevated

Based on shape of tank-

- Circular
- Rectangular
- Intze

The primary reason for elevating the water tank is to increase the water pressure. A tank that has been raised to the proper height can produce water pressure that is comparable to that produced by a huge pump.

Removes the need for electric pump to pump water out, resulting in reduced fossil fuel consumption and hence less environmental harm; local water supply may be expensive, unreliable, or non-existent, making it less reliable. If the tank is raised high enough above the piping in the home, it may be able to generate enough pressure. This saves time and money by eliminating the cost and installation of a pump. Even when water is scarce, there is enough water for gardening, car washing, and other purposes.

Because pests have a harder time getting into an elevated tank, elevating water tanks may help avoid water pollution from rats or mice. If the tank is open at the top, however, there is a possibility of contamination from pollutants in the air.

What Causes Tanks to Fail

- Corrosion
- Improper structure
- Incompatible seismic zone design with area
- Age/UV concerns
- Events or internal/external forces (fire, flood impact etc.)

Catastrophically - can occur very quickly, causing damage or loss to neighboring equipment as well as being a hazard to people. It might be an explosion or a complete roof collapse.

Slow general corrosion problems that aren't catastrophic can typically be fixed while they're still minor. Pinhole leaks, for example, or general corrosion

Weld failures and wall failures are both caused by inadequate welding procedures. Corrosion - pitting, cracking, and general thinning can cause loss of containment if the specific gravity of the liquid is too high for the tank's wall thickness.

Figure1.2: Tank Resting on Ground

Because they're underground, water storage tanks won't harm landscapes and can fit in enormous commercial buildings/organizations. Underground water storage tanks are simple to build and provide piece of mind. Tanks Direct erected an underground water tank in Tennessee's Chilhowee Recreation Area. This provides pure water without obstructing the view. You can install a water tank underground or above ground. You must select the appropriate tank for your needs. We'll compare underground and above-ground

water tanks to help you choose. Well Water Solutions installs above-ground water tanks.
Underground storage saves acreage compared to above-ground storage.
You may still see some pipes, but not a massive tank, which isn't aesthetically pleasant. Underground water tanks are the only unseen option.
Underground tanks are naturally protected from excessive cold and heat, thus they keep a constant temperature year-round.
Their positioning protects them against vandalism, accidents, and harsh weather.
Underground tanks are expensive, from excavation to reinforcement. You'll also need a pump to draw water from below ground.
It's hard to detect if your tank has cracks or other damage.
High-clay soils are undesirable for subterranean water tanks.
Their above-ground location makes them more vulnerable to storms, vandalism, and accidents.
Can you control spills or shut off the water supply if your tank fails?
These tanks are supported on staging which may consist of masonry walls, R.C.C tower or R.C.C column braced together. The walls are subjected to water pressure from inside. The base is subjected to weight of water, weight of walls and weight of roof. The staging has to carry the entire load of entire tanks with water and is subjected to wind loads. Water tank parameters include the general design of the tanks, choice of materials of construction, as well as following:

1. Location of the water tanks (indoors, outdoors, above the ground or underground) determines color and construction characteristics.
2. Volume of water tank will need to hold to meet design requirements.
3. Purpose for which the water tanks will be used, human consumption or industrial determines the concerns for materials that do not have side effects for human.
4. Temperature of area where water will be stored, may create concern freezing and delivery off setting heat.
5. Delivery pressure requirements, domestic pressure range from 35-60 PSI, the demand for a given GPM (gallon per minute) of delivered flow requirements.
6. How the water to be delivered to the point of use, into and out of the water tank i.e. pumps, gravity or reservoir.
7. Wind and earthquake design considerations allow a design of water tank parameters to survive seismic and high wind events.
8. Back flow prevention, are check valve mechanism to allow single direction of water flow.
9. Chemical injection systems for algae, bacteria and virus control to allow long term storage of water.

Algae in water tanks can be mitigated by removing sunlight from access to the water being stored.

Water Tank Underground

Septic tanks and clarifier filters in water treatment plants are examples of underground storage tanks. The inside walls of these tanks are subjected to water pressure, while the exterior walls are subjected to earth pressure. The inside of the tanks is subjected to water pressure, while the outside is subjected to earth pressure. The tanks' bases were subjected to water pressure from within and soil reaction from below. These are always covered at the top. These tanks should be constructed for the most detrimental loading. The design concepts for underground tanks are the same as for above-ground tanks. Inside water pressure and outer earth pressure are applied to the walls. The wall segment is designed to withstand both independent and simultaneous ground pressure. Soil and earth get saturated whenever the water table has the potential to rise. These tanks are often rectangular or round in shape.

LITERATURE REVIEW

"shaik. subhani, t. sai latha, naga babu", "*Design & analysis of intze type water tank*", International Journal of Advance Scientific Research & Engineering Trends June2021

In this study Wind Forces and Seismic Forces acting on an Intze Type Water tank for Indian conditions are studied. According to seismic code IS 1893(Part-1) more than 60% of India is prone to earthquakes. The analysis was conducted as per the specifications of IS 3370, IS 456, IS 800, IS 875, IS 1893. The Intze type water tank was designed for 10Lakh Litres capacity of water for the Agiripalli Town at Krishna District in Andhra Pradesh. Different loads such as Dead Load, Live Load, and wind load will be applied on STAAD.Pro model as well manual design at appropriate location as per codes used for Loading. All the results obtain from STAAD.Pro will be compared with the results of manual design

"Sufiyan ahmad and Mr. Rajiv Banerjee", *An Analytical study of overhead water tank subjected to seismic load*" Compliance Engineering Journal, 2021

In this research paper, the effect of seismic load for overhead water tank, the water is the most essential element to a life on the earth. There is two different types of tank, of same capacity but having different height and different diameter of the overhead water tank in seismic zone (zone IV and V), this study on displacement of tank, time period, base shear and base moment coefficient of different height and diameter of overhead water tank, seismic plays an important in design of tank structure because of dynamic nature. Effect of seismic is predominant on tank structure, height of the structure in this paper the compression of the tank their height and its different diameter on tank for analysis of seismic loads on tanks

"Priyanka M. Mankar; H.R. Nikhade", "Analysis of Circular Rest on Ground and Underground Service Reservoir Using STAAD Pro by Considering the Effect of Continuity" Elsevier 02/07/2021
The main purpose of this research is to determine the importance of continuity analysis in practical application and use of Staad pro software to analyse a Rest on Ground and Underground circular water tank. The bottom joint of water tank is examined using continuity effect. This is the common joint where base slab, wall, bottom rings beam, gallery, column and base beam join. Water tank is subjected to self-weight and hydrostatic Pressure due to water. Continuity effect increase stress, Hoop tension, BM hence its necessary to consider its effect while designing the tank. The results obtained from STAAD.Pro software are nearly same with manual result. This indicated that STAAD.Pro is suitable for design and analysis of water tanks

"Mainak Ghosal", "Water Tank Analysis Using STAAD PRO", International Transaction on Engineering & Science, January 2019
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 a Rest on Ground and Underground 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.

"Dasari Venkata Siva Naga Krishna", "*Seismic analysis of RCC Rest on Ground and Underground liquid storage tank with different supporting systems and their behaviour in various earthquake zones*" JES July 2020
The main objective of this study is to understand the behaviour of supporting system which is more effective under different earthquake characteristics or earthquake zones with STAAD.Pro V8i software. A sample of a reinforced concrete Rest on Ground and Underground water tank (Intze type), with 900 cubic meters and with a height of 18m from ground level is considered. Here two different staging patterns such as radial bracing and cross bracing are compared with basic supporting system for various fluid filling conditions. The seismic zones of Zone-III & Zone-V and the corresponding earthquake characteristics have been taken. Consequently, the water mass has been considered in two parts as impulsive and convective suggested by GSDMA guidelines. Tank responses including base shear, overturning moment and roof displacement have been observed, and then the results have been compared. The result shows that the structure responses are exceedingly influenced by the presence of water and the earthquake characteristics. Finally, study discloses the importance of suitable staging configuration to remain withstands against heavy damage or failure of Rest on Ground and Underground water tank during seismic events.

"Dhritiman Mondal", "*Comparative study on various shapes of RCC underground & rest on ground water reservoir"*, International Journal of Innovative Research & Studies April 2018
This paper presents a Comparative study of R.C.C. underground & rest on ground water tanks of various shape (circular and rectangular) for a capacity of 500000 lit. Or 130000 gallons (US). The work includes the design and estimates for circular and rectangular R.C.C. underground & resting on ground water tanks. At times the more than one choice available for construction types leads to confusion. The best way is to select the type of construction, depending on the circumstances and type of structure. The aim of this paper is to design large capacity R.C.C water tanks of various shapes and then compare the results. For both water tanks the analysis is done in STAAD PRO software. The idea is to reach a definite conclusion regarding the superiority of the two techniques over one another for specified capacity

"Chirag N. Patel & Mehul S. Kishori", "*Analytical and Software Based Comparative Analysis of on Ground Circular Water Tank*" International Journal of Civil Engineering (IJCE), Apr - May 2016;
This paper presents comparative study of analytical and software-based methods used for the analysis of on ground concrete circular water tank. Analytical methods consider as per IS 3370 and as given by PCA (Portland cement association), which are also compare with the result of FE analysis using software Staad pro. Importance of the present study is to observe actual behaviour of tank subjected to static loading condition with special emphasis on IS: 3370. Hoop tension and bending moment shows similarity in the considered analytical approach but significant advantage of software-based approach due to finite element modeling. Also, it reveals that, engineers can apply software-based approach more flexibly and efficiently to fulfil the practical tasks of structure modeling and analysis in engineering to achieve economy.

"Chetan Jagtap, Siddharth Pastariya", "Seismic analysis on cylindrical ground supported water tank by varying their aspect ratio", OAIJSE, October 2020
This method leads to thicker and heavily reinforced sections. The use of limit state method of design was then adopted in the revised code IS 3370: 2009 and provision for checking the crack width was included in the code. This study is carried out to analyze the cost of

overhead water tanks of a fixed capacity, having different heights and diameters so as to determine the most economical height to diameter (H/D) ratio to be adopted in the design of the tank. To optimize the results and check the accuracy of design, six circular water tanks of 500 kL, with top and bottom dome pattern, were designed by varying H/D ratio from 0.15 to 1.05 in STAAD. Pro. After assuring the safety of all the structures, further analysis is done to calculate the cost-effectiveness of the structures by comparing the approximate total cost of materials. It was found that the aspect ratio (H/D) of 0.60 led to the most efficient design

"Vaseem Akhtar, Shaik Rehman, S Zubeeruddin", "*Design And Analysis Of Rest on Ground and Underground Water Tank By Using Staad Pro*" International Journal of Research, Volume 08 Issue 03 March 2021

This project gives in brief, the theory behind the design of liquid retaining structure. Water tanks are the storage containers for storing water. Rest on Ground and Underground water tanks are constructed in order to provide required head so that the water will flow under the influence of gravity the construction practice of water tanks is as old as civilized man. The water tanks project has a great priority as it serves drinking water for huge population from major metropolitan cities to the small population living in towns and villages.

"C. Pavithraa, J. Yogeshwaran", "Seismic Evaluation of a RC Rest on Ground and Underground Water Tank" International Journal of Control Theory and Applications, Number 12, 2017

In this study, a RC Rest on Ground and Underground rectangular tank of volume 900m3 is subjected to seismic forces and dynamic analysis is carried out to assess the behaviour of the tank. This study includes hydrodynamic pressure generation, different fluid levels of the tank and the reaction of the tank with respective to the various level of filling conditions. Findings: Analytical study using STAAD Pro and response spectra as per IS 1893 (Part II): 2002 were studied on an Rest on Ground and Underground fluid storage tank for various soil conditions is analysed.

"Aman Jain, Armanjai Ratia, Hari Kishan Dewangan", "Design of Cylindrical Overhead Water Tank by STAAD Pro Software" International Journal of Innovations in Engineering and Science, Vol 5, No.3, 2020

The purpose of study of the ESR is to design and analysis safe ESR, where in the damage to the structure and its structural components even by natural hazard such as earthquake can be minimized. Indian standard for the design of liquid retaining structures have been revised in 2009. This revised edition Incorporated limits state design method. Limit state design method for water retaining structure was not adopted so far as liquid retaining structure should be crack free. However, this edition of Indian standard adopts limit state method mainly considering two aspects. Firstly, it limits the stresses in steel so that concrete is not over stressed and in second aspect it limits the cracking width. This project gives in brief, the theory behind the design of liquid retaining structure.

"Mohammad Quais Khan, Mr. Babar Hussain", "*Analysis and Design of Intze water tank as Per IS: 3370 & IS: 456 -2000 using STAAD Pro Software*", IJARIIE 2019

Water tanks are important public utility and industrial structure. The design and construction methods in reinforced concrete are influenced by the prevailing construction practices, the physical property of the material and the climatic conditions. The analysis is conducted as per the specifications of IS 3370, IS 800:2002, IS 875, IS 1893 Design of tank by the dome, Ring beam supporting the dome, Cylindrical walls, Ring beam at the junction of the cylindrical walls and the conical wall , Conical slab, Floor of the tank, The ring girder, Columns, Tower with bracings, Foundations as per IS 3370 -Part III will be done by using 2-Dimensional STAAD model for 3,00,000 Litres capacity tank .Different loads such as Dead Load, Live Load, Wind load, Earthquake Load will be applied on STAAD model at appropriate location as per codes used for Loading. These Rest on Ground and Underground water tanks are especially vulnerable to horizontal forces such as wind and earthquakes.

"Himanshu Dwivedi", "*Analysis and Design of Water Tank Employing STAAD Pro for Cost Optimization",* International Journal of Scientific Research and Engineering Development Aug 2019

In this project, we have planned and designed an circular reinforced cement concrete tank. A circular water tank is manually designed. It is further analyzed using the premiere analysis software STAADPRO. The design and detailed drawings are presented in this project work. Limit state design method for water retaining structure was not adopted so far as liquid retaining structure should be crack free. However, this edition of Indian standard adopts limit state method mainly considering two aspects. Firstly, it limits the stresses in steel so that concrete is not over stressed and in second aspect it limits the cracking width. Structure has been designed using the LSM, as the LSM gives less area of reinforcement of steel and hence the check for crack width has been done. Further to make the structure most economical STAAD.Pro is used. For quick cost prediction of tanks, this study therefore examines the cost effectiveness in terms of amount of materials. At the end of the project, it concludes that total amount of concrete and steel used for construction of circular tank

Ayub patel, sourabh dashore, "*seismic analysis of Rest on Ground and Underground RCC water tanks having different capacities*", international journal of engineering science invention research & development, December 2017

Observation shows that the provision of circular water tank is more flexible for seismic loadings as compared to square water tank. From the analysis result parameters deflection and base shear of the water tanks increases from lower to higher zones because the magnitude of intensity will be more for higher zones. Present work provides good information on the result parameters deflection and base shear in the water tanks having different staging heights.

"Chandana Imadabathuni", "*Analysis and Design of Intze Water Tank by Using STAAD Pro*" Web of Conferences 309, 01178 (2021)

Water tank is a water storage structured built for long term use. These tanks were utilized for various uses like distribution of water, firefighting, agriculture, food industry, paper mills etc. It comes in handy when there is an intermittent supply of water or scarcity of water. Materials like concrete, PVC Galvanized Iron, fibre is used to manufacture tanks. Water is pumped through pipe by using pumps from a source. For distribution purpose water can be distributed either gravity or pump to reach individual with desired pressure and velocity. Volume is calculated based upon population and their usage and demand. Water demand varies hour to hour. A continues supply water tanks are best suited. To meet water demand by public water tanks are to be constructed. Design and analysis are similar for any liquid present in water tank but is should be crack free to avoid leakage

"Chaman Mamtani", "*Comparison of Concrete and Steel Quantity between Rest on Ground and Underground Services Reservoirs with Circular and Rectangular Tanks of Varying Capacities on Different Heights",* International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 6, Issue 5, May 2021

The time is coming when there is a need to preserve and store water. At such times is very much important of develop cost effective ways for storing and distributing water. The water stored in overhead water tanks can be distributed to the nearby areas without pumping. The cost effectiveness of the overhead storage water tanks depends majorly on the quantity of the concrete and steel required for the construction of the tank. In this research paper, the concrete and steel quantity for circular and rectangular shaped overhead water tanks of capacities 5 lakh litres, 10 lakh litres, 15 lakh litres and 20 lakh litres on staging heights 15 m, 18m, 21 m and 24 m is compared. The quantities are represented in the tables and the comparison is made through graphs.

"Affan M Ashfak Aakhunji, Keval L Vanpariya", "*Analysis of Intze Type Water Tank with Different Staging System & its Optimal Design*", GRD Journal for Engineering | Emerging Research and Innovations in Civil Engineering (ERICE - 2019)

In this paper, at first by studying the losses occurred in water tanks during past earthquakes and the reasons for these occurred damages, the analysis was done for different staging patterns to overcome these damages in this structure in coming future. It was determined while comparing different staging patterns that X type of frame staging have shown better seismic behavior to the resistance against lateral loads as they reduce most of displacement and time period but it increases the base shear due to the increase in volume of concrete.

"Komal K Wagh, Akshay K Ghuge", "Design and Analysis of underground water tank by using Staad Pro" International Research Journal of Engineering and Technology (IRJET) Apr 2021

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. In this paper, we had discussed about the design of underground water tank of rectangular shape are Designed and analysed using Staad pro. Underground water tank faces different type of loads compared to other structures, they mainly face horizontal or lateral loads due to earth pressure and water pressure or any liquid pressure which is been stored in the tank. The side walls of the underground water tank will face greater load at the bottom and the load linearly decreases towards the top.

"Alok kumar M.Thakur", Seismic Analysis of Rest on Ground and Underground Water Tank with Variations of H/D Ratio and Container Shape using staad-pro v8i,, International Journal of Trend in Research and Development, Sep-Oct 2017

As known from very upsetting experiences, liquid storage tanks were collapsed or heavily damaged during the earthquakes all over the word. The economic lifetime of concrete or steel tanks is usually in the range. Damage or collapse of the tanks causes some unwanted events such as shortage of drinking and utilizing water, uncontrolled fires and spillage of dangerous fluids. Due to this reason numerous studies done for dynamic behavior of fluid containers; most of them are concerned with cylindrical tanks. In this study, Seismic forces acting on a Rest on Ground and Underground water tank e.g. circular Tank and rectangular tank are studied with constant staging height. Seismic forces acting on the tank are also calculated changing the Seismic Response Reduction Factor(R). IS: 1893-1984/2002 for seismic design and then checked the Design of Tanks by using the software STAAD PRO.

"Dhruv Saxena", Study of Continuity Analysis in INTZE Type Tank using Conventional and Finite Element Method American Journal of Engineering Research (AJER), 2019

In this study only Intze type tank is considered, because in the present scenario of fast and large-scale infrastructure development, most of water tanks are constructed of large to medium capacity having heavy load on bottom dome and its diameter is large, the ring

beam needs large amount of reinforcement. It becomes more economical to reduce its diameter by introducing a conical dome to reduce the ring tension. The bottom ring beam in Intze tank required much lighter reinforcement as the thrust from the conical dome opposes the force from the bottom dome, hence Intze tank is economical. This study is carried out to know the importance of continuity analysis for practical consideration. In this study analysis of Intze type container of water tank is carried out by both methods by using conventional method and finite element method. In conventional method, the analysis of Intze type tank carried out in two parts as under,

1) Considering only membrane forces, and
2) Considering effect of continuity along with membrane forces.

"Mr. Suraj P. Shinde" Computer aided analysis and Design of Underground water tank as per BIS, International Journal of Advance Engineering and Research Development Technophilia-2018.

Storage reservoirs and overhead tank are used to store water, liquid petroleum, petroleum products and similar liquids. The force analysis of the reservoirs or tanks is about the same irrespective of the chemical nature of the product. All tanks are designed as crack free structures to eliminate any leakage. In the construction of concrete structure for the storage of water and other liquids the imperviousness of concrete is most essential. The permeability of any uniform and thoroughly compacted concrete of given mix proportions is mainly dependent on water cement ratio. Where space is limited, underground tanks can be placed under driveways or lawns. Underground tanks are protected from fires and other natural disasters such as hurricanes. In an agricultural or wildlife situation, underground tanks are protected from animal that may rub against or otherwise damage above ground tanks. Manual Analysis and design of Underground Water tank by using IS code method is compare with STAAD-PRO and SAP software design result, comparison of reinforcement is done and optimize results are determined. This report gives in brief, the theory behind the design of liquid retaining structure (Rectangular water tank) using working stress method.

"sai latha, naga babu", "Design & analysis of intze type water tank", International Journal of Advance Scientific Research & Engineering Trends June2021

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Benefits and Uses of water tank

1. Structural Integrity Assessment: Provides detailed insights into stress distribution, deformation, and load-bearing capacity, ensuring the container's robustness under various conditions.
2. Design Optimization: Enables the optimization of material usage and structural design, resulting in cost-effective and efficient containers without compromising safety.
3. Durability Forecasting: Predicts long-term performance, accounting for environmental factors like temperature changes, water pressure, and soil movements.
4. Failure Prevention: Identifies potential failure points and weak zones early in the design phase, allowing for proactive rectifications.
5. Customization for Specific Applications: Facilitates tailored designs for different capacities, shapes, and operational environments.
6. Environmental Adaptability: Simulates varying conditions such as seismic activities, groundwater pressure, and dynamic loads, ensuring the structure can withstand site-specific challenges.
7. Regulatory Compliance: Ensures the design adheres to international standards and local building codes through detailed simulations.
8. Time and Cost Efficiency: Reduces the need for extensive physical prototyping by replacing it with accurate virtual models, saving both time and resources.

Uses of Rectangular Water Containers

1. Underground Water Storage: Effective for rainwater harvesting, groundwater recharge, and emergency water storage.
2. Ground-Level Water Storage: Commonly used in residential, commercial, and industrial applications for direct water supply.
3. Agricultural Irrigation: Serves as reservoirs for irrigation in regions with fluctuating water availability.
4. Firefighting Storage: Provides emergency water supply for firefighting in urban and remote areas.
5. Industrial Applications: Supports water storage for cooling systems, manufacturing processes, and waste management.
6. Urban Infrastructure: Functions as a key component in water management systems, including stormwater drainage and public water supply systems.
7. Remote and Rural Areas: Offers a reliable water storage solution in areas lacking continuous water supply networks.
8. Disaster Management: Useful for temporary water storage in disaster-prone areas to address shortages during emergencies.

WORK NEEDED AND OUTPUT

In today's world, water storage in the form of tanks for drinking and washing, swimming pools for exercise and recreation, and sewage sedimentation tanks are becoming increasingly important. We use rectangular

water tanks for small capacities and circular water tanks for larger capacities.
Water tank design is a time-consuming process. The design of an underground water tank, in particular, necessitates numerous mathematical formulae and calculations. The entire construction was hand-designed using M25 concrete grade.

The structural investigation of rectangular underneath and ground-level water containers involves a systematic approach beginning with data collection. This includes conducting a detailed site survey to understand soil conditions, groundwater levels, and environmental factors, as well as determining the operational loads such as water pressure, soil pressure, and any additional live or seismic loads. The material properties of concrete, steel reinforcement, and waterproofing agents must be specified based on project requirements and standards. Using this data, the design parameters are developed, incorporating dimensions, capacity, and any regulatory compliance considerations. Advanced simulation software like ANSYS, Abaqus, or SAP2000 is then utilized to create a 3D model of the water container. Accurate boundary conditions are defined, including soil-structure interaction, load applications, and support constraints, while material properties are carefully assigned. Finite Element Analysis (FEA) is performed to simulate the container's behavior under various static and dynamic loads, such as hydrostatic pressure, lateral earth pressure, and thermal stresses. Mesh generation ensures detailed and precise calculations, with multiple load cases evaluated to identify stress distribution, deflection, and potential failure zones. The results are validated against analytical models or existing design data to ensure accuracy. Finally, the findings are documented in a detailed report, including visual outputs, recommendations for design optimization, and construction guidelines.

The investigation provides a comprehensive understanding of the water container's structural performance under different load conditions. Key outputs include stress and strain distribution maps highlighting critical areas prone to failure, as well as deflection and deformation diagrams to assess serviceability. The study also evaluates the container's load-bearing capacity and safety factors, ensuring the design meets or exceeds required performance standards. Recommendations for material optimization, reinforcement layout, and design adjustments are derived to improve cost-efficiency and functionality. Additionally, the container's resilience to environmental conditions, such as seismic activity and temperature fluctuations, is assessed to ensure long-term durability. A final report consolidates all findings, including compliance verification with local and international standards, practical construction guidelines, and visuals of stress contours and deformation patterns, supporting informed decision-making for the design and construction process.

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