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A Review on Comparative Analysis of Various Geometrical Shapes of Water Tanks Resting Over Ground for Same Capacity.

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ABSTRACT:

Water is life. Water must be stored and kept safe for future use. Water tanks are the best way to store water. These water tanks need to be analyzed and designed properly. A stable and economical analysis of water tank is essential so that no failure occurs due to various loads and factors acting on the water tank after its construction. For analyzing a water tank, its shape and location must be confirmed. A stable and economical water tank can be analyzed with the help of Staad-Pro.

Keywords: Water Tank resting over ground, Analysis, Staad-Pro, Maximum Absolute Stress Values.

Introduction:

The Popular phrase which says 'Water is Life' reminds us the seriousness of water in our life. High demand for harmless and fresh water is increasing day by day as one cannot live without water. Considering this serious need and demand of water, necessity of storing water is very important. Thus, it becomes necessary to store water, water is stored generally in water tanks and later on it is pumped to different areas to help public. A water tank is a container for storing liquid. These water tanks are to be analyzed and designed as stable and economical water tanks for all over convenience. So in this paper it is studied that by using Staad pro the analysis of different geometries of water tanks resting over ground can be done.

Aim:- Comparative analysis of various geometrical shapes of water tanks resting over ground for same capacity.

Objective:-

1. To study classification of different types of water tanks.
2. To study supports and different types of loads acting on water tank.
3. To study the analysis of water tank using Staad Pro.

Scope:-

The study over here is related to the comparative analysis of various geometrical shapes of water tank resting over ground for same capacity. The study over here is also done, for fulfillment of the purpose of achieving the desired objective.

Need:-

For designing and analyzing a water tank resting over ground, the geometry of shape must be determined. For determination of best geometry of water tank, different geometries are to be compared. Different shapes and their geometries are to be studied and analyzed. Analysis of water tank can be done easily and accurately in Staad pro software. Analyzing these different shapes of water tanks of same capacity resting over ground in Staad pro software is needed for finding displacement, deflection and Maximum Absolute Stress Values. This need of analyzing the water tank for achieving the use of storage, low construction cost and desirable strength must be fulfilled for the welfare of community.

LITERATURE REVIEW:

Following are some of the literatures reviewed by different authors who have studied, designed and analysed different water tanks. These literatures are reviewed in different articles, books, research papers, etc.

Dhritiman Mondal [1] et.al 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 liters or 130000 gallon (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.

Jay R. Dholariya [2] et.al. In this paper, limit state method of design for circular ground supported water tank of 8 Lac liters is illustrated. LSM design of water tank is compared with WSM. Further to understand the effect of dimensions on economy, height to diameter ratio of water tank is varied in range of 0.10 to 1.0. Quantity of reinforcing steel and concrete are compared for water tank designed with WSM and LSM. From the study, it has been observed that the quantity of reinforcing steel and concrete for water tank designed as per limit state method is less as compared to working stress method. Height to diameter ratio is also the governing parameter in the design of the circular tank.

Chandana Imadabathuni [3] et.al Water tank is 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; fiber 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. For a continuous supply water tanks are best suited. To meet water demand by public water tanks are to be constructed.

Since, various literatures have been reviewed and from that it can be said that further more progressive work can be done in analyzing and designing the water tanks.

METHODOLOGY:

Water tanks are used to provide storage of water for use in many application, drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other uses. Water is stored generally in concrete water tanks and later on it is pumped to different areas to serve the community. This paper concerns the study of comparison between circular, square and rectangular reinforced concrete water tanks resting over ground. So in this paper the study of analysis of different geometries of water tanks resting over ground will be done.

Analyzing the design of water tank by means of software helps the accurate output to come with less time period. Staad pro is one of the most important software used for the analyzing and designing the water tanks. Analysis of this comparative study will be done using Staad pro. Analyzing each shape separately by keeping the capacity same, results will be noted and hence comparison will be made for the best. The report will include the study of water tank based on their classifications, the study of different supports and loads acting on the water tank, the study of analysis of various shapes of water tank using Staad-Pro.

So for a comparative analysis of water tank, it is required to check which geometry of water tank gives the best result as compared to other geometries.

The study of comparative analysis of various geometrical shapes of water tanks resting over ground for same capacity will definitely help in determining a perfect shape of water tank which resists most forces as compared to others.

A comparative study for analysis of various shapes of water tank can be successfully completed. The conclusion is derived from all the above study and analysis.

DETAIL STUDY:

1) Study of classification of different types of water tanks:

Water tank can be classified in two types are as follows:

a) Classification of water tanks based on location:

In recent years, there has been much emphasis on water supply projects all over the world, which are very essential for the social and industrial development of the country. Water tanks can be of different capacity depending upon the requirement of consumption. Based on the location the water tanks are classified into three ways:

- Water tanks Resting over ground
- Underground water tanks
- Elevated or Over head water tanks

1) <u>Water tanks Resting over ground</u>: These are used for strong water reservoirs, settling tanks, aeration tanks etc. these tanks indirectly rest on the ground. The walls of these tanks are exposed to water pressure from inside and the base is exposed to weight of water from inside and soil reaction from

under the base. The tank may be exposed at upper or covered. Water tank is completed of lined carbon steel, it may accept water from water well or from surface water permitting a large volume of water to be placed in inventory and used through peak demand series. Tanks resting on ground are normally circular or rectangular in shape and are used where large quantity of water need to stored. Water tank parameters include the general design of the tank, and choice of construction materials and linings.

Fig no.1 Water Tank Resting over ground

2) Underground water tanks: Where access to groundwater is limited, rainwater harvesting in underground tanks can be an effective and low-cost alternative. Water stored in the wet season can be used in the dry season and lifted from the tank with a rope pump or with a deep well pump, which can elevate water up to 30 m. These tanks can be constructed of concrete blocks or with other materials. The tanks are partly (1.5 m) built below the soil surface. These tanks can store up to 20,000 litres of water, used for domestic use and crop cultivation. Water extraction can be done with hand pumps or small and efficient motor pumps. A rope and bucket can be used but risk of contamination increases. In such a case, household water treatment should be advocated.

Fig no.2 Underground water tank

3) Elevated tanks: Overhead water tanks of various shapes can be used as service reservoirs, as a balancing tank in water supply schemes and for replenishing the tanks for various purposes. For an efficient water distribution system, overhead water tanks or elevated storage reservoirs are one of the most important components. The basic purpose of elevated water tanks is to secure constant water supply with sufficient flow to wide area by gravity. The height of the elevated tank depends on the area to be covered for the water supply. Wider the area to be served higher will be the required elevation of the tank.

Fig no.3 Elevated water tanks Also, the water tanks are classified based on shape:

b) Classification of water tanks based on shape:

Reinforced concrete water tanks are constructed for storing water. The design of reinforced concrete water tank is based on IS 3370: 2009 (Parts I – IV). The design depends on the location of tanks, i.e. overhead, on ground or underground water tanks. The tanks can be made in different shapes usually circular and rectangular shapes are mostly used. Following are the different types of water tanks based on their shape:

1) Circular water tanks
2) Rectangular water tanks
3) Square shaped water tanks
4) Conical water tanks
5) Intze water tanks
6) Spherical water tanks

2) Study of supports and different types of loads acting on water tank:

a) Types of Supports:

Major types of supports are:

- ✓ Fixed Support
- ✓ Hinged or Pinned Support
- ✓ Roller Support

a) Fixed Support: Fixed supports can resist vertical and horizontal forces as well as a moment. Since they restrain both rotation and translation, they are also known as rigid supports. This means that a structure only needs one fixed support in order to be stable. All three equations of equilibrium can be satisfied.

b) Hinged or Pinned Support: Pinned support or hinged support can resists both vertical and horizontal forces but they cannot resist moment. It means hinged support is restrained against translation. Using equations of equilibrium, one can find out the components of horizontal and vertical forces.

c) Roller Support: A roller support allows rotation about any axis and translation (horizontal movement) in any direction parallel to the surface on which it rests. It restrains the structure from movement in a vertical direction.

b) Loads acting on water tank:

Mainly 3 types of loads are acting on a water tank resting over ground.

- ✓ Dead Load
- ✓ Live Load
- ✓ Combination Load

1) Dead Load: Simply Dead load is a self weight of those elements which is depends on its own parameters such as size, density, material, etc. Dead is one of the major loads of any structure. Almost dead load covers a 50 to 60% of total load. That means the any structural design is mostly affected by its own weight, especially is RCC structure design. In case of steel structures the dead load is slightly lesser or larger than other load. For water tank the dead load is considered as the self weight of the structure i.e. the self weight of the water tank itself. Thus, the total self weight of the water tank is considered as the dead load for carrying out analysis in Staad-pro.

Application of dead load on water tank:

Types of dead load acting on water tank resting over ground:

a) Self weight of the water tank: It carries the total weight of plates and beams of the water tank assigned while performing the analysis in Staad-pro. In Staad-Pro usually -1 self weight factor is used for all materials, not only for the concrete, so that the self weight of the structure would be considered during the analysis. It is negative; because it is acting in the negative direction of vertical Y axis. Thus, the self weight of the water tank is assigned as -1 in Y-direction as dead load in this analysis.

2) Live Load: Live load is the second major load on a structure. From its name we can easily understand that the live load is a load of live things, such as human, animals, things etc. Live loads are also called as imposed loads.

Application of live load on water tank:

Types of live load acting on water tank resting over ground:

a) **Hydrostatic Pressure acting on all inner walls of the water tank:** Hydrostatic pressure is the pressure that is exerted by a fluid at equilibrium at a given point within the fluid, due to the force of gravity. Hydrostatic pressure increases in proportion to depth measured from the surface because of the increasing weight of fluid exerting downward force from above. For a water tank resting over ground, the hydrostatic pressure acts on the inner walls of the water tank and this hydrostatic pressure acts as a live load on all the inner walls of the water tank. The hydrostatic pressure is assigned separately on all the walls of water tank. The hydrostatic pressure on the plate of the wall is maximum at the bottom and minimum at top.

b) **Pressure on full plate of water tank:** Pressure on full plate of water tank is used to define a pressure load that acts on the full surface of an element. This load is a type of live load that works as a pressure load acting on the full surface of an element such as plate or beams.

3) Combination Load

a) 1.5 x Load case 1 (Dead Load)

b) 1.5 x Load case 2 (Live Load)

3) To study the analysis of water tank using Staad Pro:

a) Shapes of water tank to be studied in this paper:

There are different shapes of water tank as we have seen in our previous study. Following are the types of water tanks for our study:

- Circular water tank
- Rectangular water tank
- Square shaped water tank

b) Geometry of the shapes of water tanks:

1) **Circular water tank:** Considering the radius of the circular water tank as 6.77199177 m and height of the tank as 6 m and then calculating the volume of circular water tank by the formulae $V = \pi r^2 h$ where 'r' is the radius of the circular tank and 'h' is the height of the circular tank, we get the total volume of the water tank as 864 m^3. So the total capacity of the circular water tank is 864000 litres or 864 m^3.

2) **Rectangular water tank:** Considering the length of rectangular water tank as 16m, the width as 9 m and height as 6 m, the total volume of the rectangular shaped water tank can be derived by the formulae v = l x b x h where 'l' is the length, 'b' is the width and 'h' is the height of the tank. So the total volume derived is 864000 litres or 864 m^3. So the total capacity of the rectangular water tank is 864000 litres or 864 m^3.

3) **Square shaped water tank:** Considering the side of the square shaped water tank as 12m and height of the water tank as 6 m, the total volume of the square shaped water tank can be derived by the formulae $v = a^2 x h$ where 'a' is the side length and 'h' is the height of the tank. So the total volume derived is 864000 litres or 864 m^3. So the total capacity of the square shaped water tank is 864000 litres or 864 m^3.

All the above water tanks are to be analyzed for the same capacity i.e. 864000 litres or 864 m^3.

c) Analysis of the water tanks in Staad pro:

Considering the capacity of all the above water tanks as 864000 litres, the analysis of these water tanks can be done in Staad Pro.

Following are the steps performed in Staad Pro for analysis of water tank resting over ground:

- Inserting the decided geometrical parameters of the water tank in command of run structure wizard in Staad Pro and also assigning the plates to all the required sides of the water tank.
- Selecting proper supports for the water tank and applying the loads acting on the water tank resting over ground.
- After application of loads run analysis command is to be given.
- The analysis we have performed should give the result of zero errors, zero warnings and zero notes.
- When we see zero errors, zero warnings and zero notes in our analysis we can further enter into the post processing mode.
- In the post processing mode we can know the displacements, reactions and deflections produced in the water tank.
- Performing the same process for analysis of the desired shapes and support conditions, comparison between the values of displacements, reactions and deflections produced in the water tank can be done.
- The above comparison gives us the excepted result from the analysis done.

All the above steps give the complete analysis of water tank resting over ground for the required capacity. Same analysis has to be performed for all the three tanks and by comparing their displacement, deflection and Maximum Absolute Stress Values a perfect, stable and economical shape of water tank can be derived depending on the result conditions.

Conclusion

The Report summarises the study of analysis of various shapes of water tank for same capacity in Staad pro, depending on various objectives that have been fulfilled according to our study.

The study of classification of water tanks on the basis of their shape and location, different supports and load assigned to the water tank and analysis of water tank for desired shape and geometry has been done. Now, serious need of storing water can be solved by analyzing and designing a stable and economical water tank by performing comparative study of different shapes of water tank.

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