# DESIGN OF CIRCULAR WATER TANK BY USING STAAD PRO SOFTWARE

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## ABSTRACT

Water tanks are the storage containers for storing water. Elevated 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 have a great priority as it serves drinking water for huge population from major metropolitan cities to the small population living in towns and villages.

A different topic like Construction Aspects, Design Parameters, Details of Formwork, Details of reinforcement, Process of Water Treatment Plant and Execution have been dealt with in the course of our mini project.

## INTRODUCTION

**Water tanks** are storage containers of water; these tanks are usually storing water for human consumption. The need for water tanks is old as civilized man. Water tanks provide for the storage of drinking water potable, irrigation, agriculture, fire suppression, agricultural farming and live stoke, chemical manufacturing, food preparation and many other applications.

Various materials are used for constructing water tanks; plastic, polyethylene, polypropylene, fiberglass, and concrete, steel (welded or bolted, carbon or stainless). Earthen ponds are designed for water storage is also often referred to tanks.

"Ground water tank" is made of lined carbon steel, it may receive water from well or surface water allowing a large volume of water to be placed in inventory and used during peak demand cycles. Very large water tanks may be "Elevated water tanks" by elevating water tank, the increase elevation creates a distribution pressure at the tank outlet.

The profile of water tanks begins with the application parameters, thus the type of materials used and the design of water tank was dictated by these variables:

1. Location of the water tank (indoors, outdoors, above ground or underground).
2. Volume of water tank need to hold.
3. What the water will be used for?
4. Temperature of area where will be stored, concern for freezing.
5. Pressure required delivering water.
6. How the water to be delivers to the water tank.
7. Wind and earthquake design considerations allow water tanks to survive seismic and high wind events.

Throughout history, wood, ceramic and stone have been used as water tanks. These were all naturally occurring and manmade and some tanks are still in service.

There are many custom configurations that include various rectangular cubes shaped tanks, cone bottom and special shapes for specific design requirements.

A functional water tank/container should do no harm to the water is susceptible to a number of ambient negative influences, including bacteria, viruses, algae, changes in pH, and accumulation of minerals. Correctly designed water tank systems work to mitigate these negative effects.

## 2.0 LITERATURE OF REVIEW

From the review of earlier investigations it is found that considerable work has been done on the method of analysis and design of water towers. Attempts have also been made by various designers and research workers to give the ratio of optimized geometrical parameters for the design of container and optimized parameters for the design of staging. Very little work has been made on optimized design of foundation for various types of soil conditions

In 1956 an exact analysis of Intze tank based on membrane theory with continuity correction was formulated by Arya. This method was further generalized by Arya[1] for ax symmetric shell structures.

The supporting structure of reinforced concrete overhead tanks with columns and peripheral braces is highly indeterminate for lateral loads. S.K.Kundodeals with a simple method of approximating the shear due to lateral loads in different part of frame.

Mazhar Ali Khan has analyzed the water tower staging by the three dimensional frame analysis approaches.

Jain and choube suggested a rapid method of estimating deflection at the top required for calculating the seismic force on water tower. Jain, Prakash, Singh,Saxena have carried out a detailed analysis of cost and requirements for materials for Intze tank of various capacities , staging height , bearing capacities of soil and lateral forces due to wind or earthquake on the basis of analysis of number of equations for rapid estimation of cost and materials for the Intze tanks have been presented.

P.karunakar Rao and G.V. Sreekantiah suggest an alternative concept for the planning of large capacity water towers. For the same capacity, using twin cylindrical containers of equal capacity in place of single container achieved an overall economy. T.M.S. Raghawan and C.V.S.K. Rao have given the steps for the optimized design of Intze tanks on shaft.

Structural analysis of columns and braces in the supporting frame work overhead tanks for gravity, wind and earthquake loads in compact form to minimize the calculation and also to visualize the effect on various parameters like number of columns, number of braces etc on different quantities of interest, has been given by C.V.S.K. Rao

Worldwide concern about unexpectedly low durability is being observed. Low durability is being perceived as one of the potential threats to the future of the concrete industry (Mehta and Gerwick 1996). A report of the U.S. National Materials Advisory Board, for instance, indicates that in 1987 approximately 253,000 concrete bridge decks, some less than 20 years old, were found to be in varying states of deterioration. A survey of automobile parking garages in Canada (Litvan and Bickley 1987) found that several billion dollars would be needed for the repair of concrete structures which had shown serious deterioration much earlier than their designated service life. Cases of premature and serious deterioration have been reported from around the world with undersea tunnels and with marine structures in California and eastern Canada (Gerwick 1989). Even though no such data are available for India, undoubtedly the amount spent on repair and rehabilitation of concrete structures would be staggering.

Durability and service life of concrete structures is mainly governed by micro structural and transport properties of concrete and environmental exposed parameters. Some constitutive and simulation models for theoretical and mathematical prediction of durability and service life performance related micro structural engineering properties, e.g., porosity, permeability, surface area, volume of phases, etc., have been proposed and modified.

Methods for analytical and experimental determination of physical and chemical characteristics affecting the durability of concrete are proposed by Papadakis et al. (1992a, b). Some in situ and laboratory methods are devised to measure the durability parameters. The experience in applying these in situ test methods and interpreting their results in terms of state of durability of reinforced concrete structures is limited. Of the available in situ test methods, the better known are the initial surface absorption test after Fig's (1973) water absorption and air permeation tests. Test methods by Pihlajavaara and Paroll (1975) and Kasai et al. (1984) are reported. In addition, many other in situ test methods based on both water and gas permeation principles are suggested.

## TYPES OF WATER TANKS:

- **In general there are three kinds of water tanks:**
  - 3.1 Resting on the ground level
  - 3.2 Underground tanks
  - 3.3 Elevated tanks

The tanks resting on the ground like clean water reservoir, settling tanks, aeration tanks etc., are supported on the ground directly. The walls of these tanks are subjected to pressure of soil. The tanks may be covered on the top.

The tanks like purification tanks, imhoff tanks, septic tanks and gas holders are built under ground. The walls of these tanks are subjected to water pressure from inside and earth pressure from outside. The base is subjected to weight of water and soil pressure. These tanks may be covered on the top.

Elevated tanks are supported on staging which may consist of masonry walls, R.C.C. columns braced together. The walls are subjected to water pressure.

The base has to carry load of water and tank load. The staging has to carry load of water and tanks. The staging is also designed for wind forces.

- **From design point of view the tanks may be classified as per shape:**
  1. Circular tanks
  2. Square tanks

3. Rectangular tanks
4. Intze tanks
5. Spherical tanks
6. Conical bottom tanks
7. Polygon water tanks

### 3.1 Ground level water tanks

Under suitable circumstances, ground level storage tanks may be used to deliver water to users by gravity flow. Storage tanks are a very important part of a water system because they ensure the adequate quantities of water are available to meet demand. Storage tanks also help in preserving water quality.

This technical note discusses the design of ground level storage tanks and offer suggestions for locating a suitable site, determining adequate capacity and selecting appropriate construction materials. The technical note carefully and attempt to adopt the suggestion to the local environment to ensure successful design of the storage tank.

The design process should result in the following three items which should be given to the construction supervisor.

A map of the area showing the location of the storage tank in relations to the water source and community. Include important Land marks, elevations, if known, and distances on the map.

HEAD – Difference in water level known the inflow and outflow ends of a water system.

1. The list will help make sure that adequate quantities of materials are available to prevent construction delays.

2. A plan of the storage tank with dimensions. The plan shows a side, top and end view. Site selection and tank location. The most important consideration in the choice of a site for a storage tank is the elevation. The height of water stored, measured from the bottom of the tank, and must produce sufficient pressure to enable water to flow through a pipeline to the users. The height needed is determined by the height of the taps in the system and the amount of pressure desired for the distribution system.

A general rule to follow is that small water systems should have at least 14m of pressure. This means that the bottom of the storage tank must be at least 14m higher than the highest tap. A general rule is that the minimum water level in the storage tank should be 20-40m above the area served. Note that the elevation of the highest tap is 210m and that the system is built for a minimum of 14m pressure. The ground storage is on a hill at an elevation of 230m which provides sufficient pressure to reach the highest lap in the community. If no location of suitable height is available, an elevated storage tank may be needed.

In order to save money, try to locate the storage tank as close as possible to the water source and the population being served. If possible, put it between the source and the population to limit the need for long lines of pipe. This has the advantage of drawing water from the pump and tank drum peak demand periods.

## Tank Capacity

The capacity of the storage tank is important for the efficient operation of a water supply system. The tank should be large enough to store sufficient water to meet both average and peak daily demands. When designing a storage tank keep in mind that demand for water varies during the year. In the hotter months, people use more water than in cooler months and on certain religious or cultural occasions water use may increase. The first step in determining storage capacity is calculating the demand for water in the community.

Follow the steps below in estimating demand.

1. Determine the population of the community. Use census data or initiate a survey to obtain population figures. Therefore, use the estimated population for 25 years in the future to determine demand for water. Use the growth factors in when estimating future population. If money is short, the storage tank can be sized to serve only the current population and the size increased later on, if necessary For example, the present population of a community is approximately 1300 and it has been growing at a rate of 3 percent per year. To determine the population in 25 years multiply 1300 by the population growth factor 1.81 found in the row marked 20 and the 3 percent column in Population = 1300 x 1.81 Population = 2350 or approximately.

2. Once the population is known, the demand for water can be

calculated. Demand can be estimated by considering the type of distribution system used. Shows estimated water consumption rates for different types of distribution arrangements. Another important factor affecting demand is the use of water for purposes other than household drinking and cleaning. If the community has hotels and restaurants or if animals will be watered from the public system consumption figures would reflect these uses. The daily demand for water in human consumption is 135 liters/day/person. It estimated that 40 percent of the population will be served by multiple taps, 35 percent by single taps in the yard and 20 percent by standpipe. Five percent will have no service.

3. Once the total daily demand is determined, peak demand should be considered. Peak demand is the highest rate of demand during the day. Usually peak demand occurs during the morning when people get up to begin the day and in the early evening after work is completed. Peak demand is estimated by adding 20-40 percent to average demand by 1.2 or 1.4.

For example,

Average day = 120000 liters/day

Peak day = 1.2 x 120000 = 144000 Liters/day

A general rule to follow is that the capacity of the storage tank should be 20-40 percent of the peak day water demand. With a peak daily demand of 144000 liters x .2 = 30000 liters. At the 40 percent value, the tank would be $58m^{3:}$ 144000 liters x .4 = 58000 liters.

In this case, reservoir of between 40- Tank Design Ground level storage tanks are generally made from reinforced concrete, masonry or brick depending on the materials available. In the area and the skills of the local people. Steel tanks may be purchased.

Reinforced concrete is used in many areas. Its advantages are that it provides a very sturdy watertight structure that will last many years, and it uses less concrete than mass concrete structures which reduces construction costs. A disadvantage of using a reinforced structure is that steel, lumber for forms and skilled labor and supervision are needed to build the tank. If large building stone is available, the tank can be built of masonry. When building with masonry, no forms are necessary and construction is generally easier. Masonry tanks are not watertight, however. For best results, make thin masonry walls and fill in between them with concrete.

The storage tanks can be built either above or partially or completely below Ground Underground structures provide added support for the walls. If soil conditions permit and elevation is sufficient, a storage tank partially or totally underground is recommended. Where such a tank cannot be Installed, at least build the form work in the ground for support. If a steel tank is purchased, the tank will be placed directly on a concrete slab on the surface of the ground. Steel tanks provide good storage but may not be feasible in many places due to their cost.

All tanks must have covers. In some cases, reinforced concrete is used but forms are expensive and construction difficult. Cast-in-place roofing may not be possible. A concrete cover can be build by casting several sections flying them together on the top. The advantage of casting in sections is that the smaller sections can be cast at ground level and lifted into place.

## Ventilation

A screened ventilation pipe should be installed to allow air to escape from the tank when enters. The pipe should be screened so that no insects, bats or debris can enter the storage tank. Inlet, Outlet, Overflow and Drain. The inlet pipe should be located near the bottom of the tank. In many cases, the same pipe acts as both intake and outlet. The end of the pipe should be screened and should be at least 150mm above the floor of the tank. Below the intake-outlet pipe, water is not able to leave the reservoir. Instead, this area acts as a settling zone for particles. Plastic, PVC, or steel pipe can be used for the outlet. The choice depends on availability and cost. The overflow pipe should be located above the expected high water level in the tank. The overflow pipe should be screened. Water that overflows from the tank should be moved away from it to prevent contamination and the accumulation of standing water in which mosquitoes can breed. Lay rock around the tank or line a small diversion ditch to move all water away from the area. The overflow pipe can also serve as an air vent.

A drain pipe should be installed at the bottom of the tank. To ensure adequate drainage, slope the floor toward the drain; install a drain pipe with a diameter large enough, perhaps 200mm, so that sediment can be flushed without clogging the pipe.

Other Design Features:

To control the level of water in the tank, the installation of a float valve is recommended. If a float valve is not used, the operator must be well trained to ensure that water is pumped to storage when needed and not wasted through the overflow.

Small tanks can either be built as a single unit or divided into two sections. A wall divides the two storage compartments and pipes and valves are arranged so that each can be used separately. This arrangement allows for continuous service when side is being cleaned. One alternative is to build a single storage tank as in make a wall strong enough to act as a partition if expansion is desired in the future. Another compartment can be added when and if it is needed, and the cost can be postponed to a later date.

Ground level storage tanks are a good choice. They require a great deal of material for construction. Worksheet B shows the general calculations for a one compartment storage tank made of reinforced concrete. Using these calculations, determine the specific amounts needed and cost of all materials.

The concrete mixture should be 1 part cement to 2 parts sand to 3 parts gravel (1:2:3) and 10mm reinforcing bars laid in a grid pattern should be used for the walls and cover. All bars should be separated by 150mm. Where suitable conditions exist.

For all storage facilities, experienced builders are needed to do the work properly whether masonry tanks or reinforced tanks are built, construction expertise is essential. Never attempt construction without the expert advice of an engineer or builder.

### 3.3 Elevated water tanks

Elevated storage tanks are used to deliver water either through large distribution system or through standpipes located at or near the source or at other communal watering points.

Elevated storage tanks are used where ground storage tanks cannot be built due to lack of sufficient natural elevation and where standpipes are served from a well with a windmill or other powered pumps. Elevated tanks can serve either a large community or a small group of families. Elevated tanks do not have as large a capacity as ground storage due to the need for a tower structure to support the tank. This technical note discusses the design of elevated storage tanks and offers suggestions for choosing the appropriate tank design and construction materials. Read the technical note carefully and adapt the suggestions to local conditions to ensure that the storage meets user's needs.

## Conclusion

Water tanks are considered to be expensive; but they are constructed to reach present and future population. They are considered to highly economical and safely store the portable water. Water can be distributed to number of houses, Industries and public places by means of a network of a distribution system. Thus water tanks are considered to be supporting systems and useful for the society.

In circular tanks, as height increases as side wall thickness also increases and roof slab and floor slab depth decreases. Circular tanks are economical for moderate capacities.