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DESIGN OF FLAT BOTTOM CIRCULAR TANK USING C++ PROGRAMME

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Keywords: Water Tank, Dome, Ring beams, bottom ring girder, cylindrical wall, C++ and water storage.

ABSTRACT
This Paper (or) work is more helpful to the design engineers simply to change the data. In present scenario, enormous need of water by the public is fluctuating in hour to hour and same in day by day, water has to be stored and supplied according to their needs. Water demand is not constant throughout the day. In order to supply constant amount of water, we need to store water. So to meet the public water demand, water tank need to be constructed. Storage reservoirs and overhead tanks are used to store water, liquid petroleum, petroleum products and similar liquids. This paper gives in brief about the designing stage of reservoir or tank using C++ program, the program consists of manual procedure i.e. design program as per (IS:3370-2009) code and comparative study of design between program and manual outputs.

INTRODUCTION
A water tank is used to store water to tide over the daily requirement, beside it can be used as for storage of liquid petroleum, petroleum products and similar liquids. The design 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. Water or raw petroleum retaining slab and walls can be of reinforced concrete with adequate cover to the reinforcement. Water and petroleum cannot react with concrete and, therefore, no special treatment to the surface is required. Industrial wastes can also be collected and processed in concrete tanks with few exceptions. The petroleum product such as petrol, diesel oil, Etc. are likely to leak through the concrete walls, therefore such tanks need special membranes to prevent leakage. Reservoir is a common term applied to liquid storage structure and it can be below or above the ground level. Reservoirs below the ground level are normally built to store large quantities of water whereas those of overhead type are built for direct distribution by gravity flow and are usually of smaller capacity. The design of structure is most essential for bearing from all loads i.e. self-weight, live load and finishes.
While designing the super structure i.e. water tank's components, it gets too late due to some more number of iterations or interpolations considerations. In present scenario, every field of works requires an automation technology. It may be a software or combination of software and hardware. Due to automation the work will be finish easier with accuracy and efficiency .Tanks or reservoirs are classified on basis of heads and shapes as shown below in table 1.(a) and components of tanks are specified in table 1.(b)

CLASSIFICATION OF TANKS

Table 1. (a)

Classification based on under three heads:	**Classification based on shapes**:
1. Tanks resting on ground 2.Elevated tanks supported on staging 3. Underground tanks.	1. Circular tanks 2. Rectangular tanks 3. Spherical tanks 4.Circular tanks with conical bottom 5.Intze Tank

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COMPONENTS OF CIRCULAR FLAT BOTTOM TANK

Table 1. (b)

1) Top Dome	**2) Top Ring Beam**
3) Cylindrical Wall	**4) Bottom Ring Beam**
5) Bottom Circular Girder	

Above elements of circular flat bottom tank are designed with limit state method (or) working stress method.

C++ Programming

C++ is immensely popular, particularly for applications that require speed and access to some low level features. It was created in 1979 by Bjarne Stroustrup, at first as a set of extensions to the C programming language

Advantage of C++ Programming

1. **Conciseness:** C++programming languages allow us to express common sequences of commands more concisely and provides some especially powerful short hands.
2. **Maintainability:** Modifying code is easier when its entails just a few text edits, instead of rearranging hundreds of processor instructions and further improves maintainability.
3. **Portability:** Different processors make different instruction available. Programs written as text can be translated into instructions for many different processors; one of C++'s strength is that it can be used to write programs for nearly any processor

REVIEW OF LITERATURE

Prof.R.V.R.K.Prasad et al (2012) In this research paper ,the overall objective of this paper is to comparative study of IS:3370(1965) and IS:3370(2009) and gives brief about theory behind the design of circular water tank using working stress and limit state method and they have concluded that IS3370:(1965),value of σst is 150 N/mm2 and in IS 3370:(2009) σst is 130 N/mm2. Design of water tank by Limit State Method is most economical as the quantity of material required is less as compared to working stress method Water tank is the most important container to store water therefore, Crack width calculation of water tank is also necessary.

M.K.Sharma et al (2012) In this research paper, the overall objective of this paper is to Automation of analysis and design of an overhead RCC Intze type tank with help of software developed in C++.the software is about designand estimate the material cost of the tank with less timeconsumption and explains the major design parameters whichdirectly affects the material cost of the tank. It also consists ofa parametric study and finding of conditions for the minimummaterial cost of the tank with exclusion of dynamic and hydrodynamiceffects

G.P.Deshmukh et al (2015) in this research paper, there have researched on analysis of elevated water storage structure using different staging system**,** there have analyzed the tank structure with five different staging system using staad pro software and concluded that Parametric study is carried out by using different patterns of bracings in staging of an elevated water tank. From the table it is clear that the base shear value, reduces for alternate bracing pattern in staging. This is apparent because of the reduction of overall stiffness of the structure.

M Bhandari et al (2014) in this research paper, there have studied on comparative study of design of water tank with reference to IS: 3370, they compared the IS: 3370(1965) and IS: 3370(2009) through problem formulation for overhead circular water tank, overhead square water tank and underground rectangular water tank concluded that limit state method is the economical method for designing water retaining structures as per IS: 3370(2009).

Aatishkumar et al (2013) in this research paper, there have studied the wind effects on overhead tank under different soil parameters and they developed a C++ Program for Intze tank and concluded that As the wind speed increases for the same bearing capacity volume of concrete and quantity of steel both are increased and the bearing capacity increases for the same wind speed volume of concrete and quantity of steel both are decreased.

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Snehal et al (2015) in this paper , there have studied on the cost optimization of elevated circular water storage tank using matlab software and they concluded thatwith the help of computer programming and giving a safe design with minimum cost of the elevated circular water storage tank, the design of the tank can be more economical, reliable and simple.

Ranjit Singh Lodhi et al (2014) in this paper, they have studied on the design of intze tank in perspective revision of IS: 3370 through considering each and every pressure and concluded thatWater tank design as per old code (IS: 3370-1965) is found unsafe in compliance to fulfil the requirement of new code (IS: 3370-2009). All design parameters of intze water tanks are changed due to the two basic reasons. First is the reducing the permissible limit of stress in steel in new IS Code: 3370-2009 and second is the considering earthquake force.

METHODOLOGY

GENERAL DESIGN REQUIREMENTS (Indian standard code practice (IS: 3370-(2009), PART II-IV)

Plain concrete member of reinforced concrete liquid structure may be designed against structure failure by allowing tension in plain concrete as per the permissible limit for tension in bending specified in IS: 456 (permissible stress in tension in bending may be taken to the same as permissible stress in shear). This will automatically take care of failure due to cracking.

PERMISSIBLE STRESS IN CONCRETE

a) For resistance to cracking: The permissible tensile stresses due to bending apply to the face of the member in contact with liquid. The member with thickness less than 225 mm and contact with the liquid on one side, these permissible stresses in bending apply also to the face remote from the liquid.
b) For strength calculation: In strength calculation the usual permissible stress, as per IS: 456-2000 is used. Where the calculated shear stresses in concrete above exceed the permissible value, reinforcement acting in conjunction with diagonal compression in concrete shall be provided to take whole of shear.

PERMISSIBLE STRESS IN STEEL

a) For resistance to cracking: When steel and concrete are assumed to act together for checking the tensile stress in concrete for avoidance of cracking the tensile stress in steel will be limited by the requirement that the permissible tensile stress in concrete is not exceeded so that tensile stress in steel shall be equal to the product of modular ratio of steel and concrete and the corresponding allowable tensile stress in concrete.
b) For strength calculation: In strength calculation the permissible stress in steel, in accordance IS: 3370 are used. When water is filled in tank container, the hydrostatic pressure will try to increase the diameter at any section of the tank. However, this increase in the diameter in all along the height of the tank will depend upon the nature of the joints. If the joint is flexible, it will be free to move outward and when the joint is fixed, no movement is possible, then a fixing moment will be induced.

Manual Design Using IS Codes:

1) ***Top Dome :***
   Top Dome is the top most cover of tank, two types of stresses are acting on dome which are called as meridional and circumferential stresses and the thickness of dome is depends up on basis of capacity of tank .if the capacity of tank is more then consider 100 mm as thickness otherwise take thickness as 75 mm. both stresses are to be find out by help of maximum meridional thrust, maximum circumferential force and thickness and after finding the stresses , required reinforcement area and spacing are determined
2) ***Top Ring Beam :***
   Top Ring beam is an element of superstructure where joints the top dome and cylindrical wall. In this component, there is a presence of tension due to load of top dome which is called as hoop tension. For this component hoop tension and hoop steel required is to be find out and with help of $\sigma_{ct\ value}$ from Indian standards (IS:3370-2009) the area of concrete section of ring beam is to be determine on basis of that we have to calculate the steel reinforcement

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3) Cylindrical Tank Wall :

Cylindrical tank wall is the element of superstructure where it transfers and controls the pressure from top dome and top ring beam to down component .in this section, the thickness of cylindrical tank wall can be assumed by 150 mm (or) 30(H) +50, whereas H is a depth of cylindrical wall and if required, we can adopt by our choice according IS Standards specifications and hoop reinforcement and vertical steel are calculated

4) Bottom Ring Beam :

Bottom ring beam is affected by load from its above component i.e. top dome, top ring beam, cylindrical tank wall and load of liquid in that tank and neutralized by transferring the load through circular girder. The thickness of base slab i.e. bottom ring beam is determined by from D/25 to D/30 as per (IS: 3370-1967).where D is a diameter of the tank with exclusion of wall thickness and from the two values, we have to consider the maximum value .by calculating the total load on element. We have to determine required steel reinforcement with considering the maximum positive & negative radial moment and maximum circumferential moment

5) Bottom Circular Girder :

Bottom Circular Girder is the main component in flat bottom tank, it bears and transfers whole structure load via staging to foundation for neutralizing and resisting load from top elements, firstly we have to assume required cross section size of circular girder and depth will be determine by D/15, where D is a diameter of the tank with inclusive of tank wall and total loads acting on circular girder 'w' should be determine by means of self-weight of each element and load of liquid in tank ,with help of k_1,k_2,k_3 coefficient for required number of columns 'n' from IS codes. Following parameter are to be determine:

Maximum Negative Bending Moment at Support = k_1.w.R

Maximum Positive Bending Moment between Supports = k_2.w.R

Maximum Torsional Moment =k_3.w.R

Maximum Shear Force = w/N. (i.e. N=2*n)

After finding out above parameters, design of the section should be done at supports, between supports and where torsional moment is maximum using above parameters depth and area of steel reinforcement required is defined .coming to design at torsion moment is maximum, the method is similar to torsion reinforcement method as per (IS: 456) and at last we have to find out the transverse reinforcement

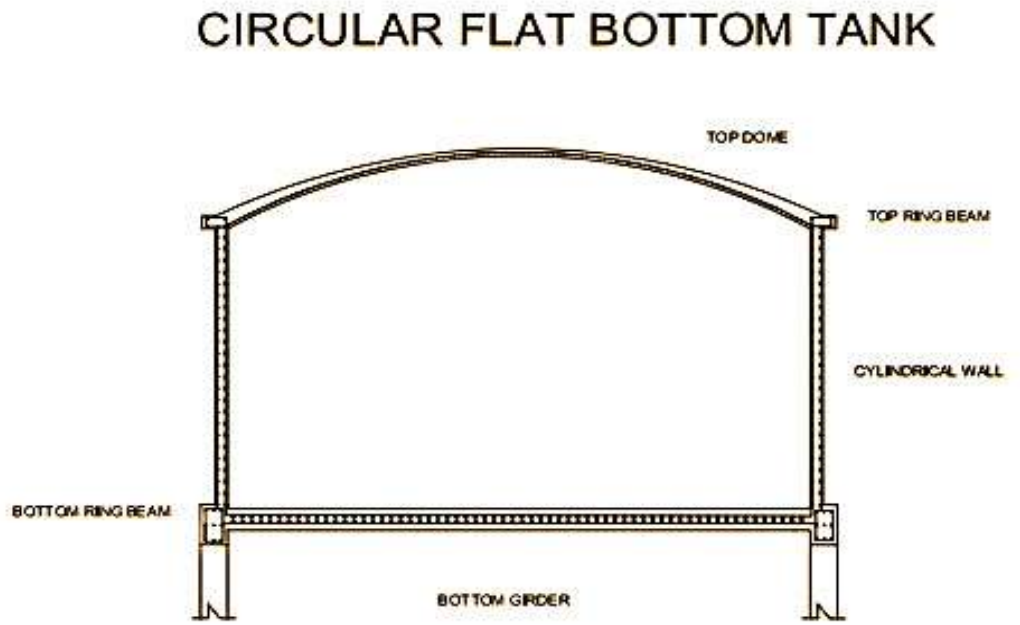

Fig 1: Circular Flat Bottom Tank

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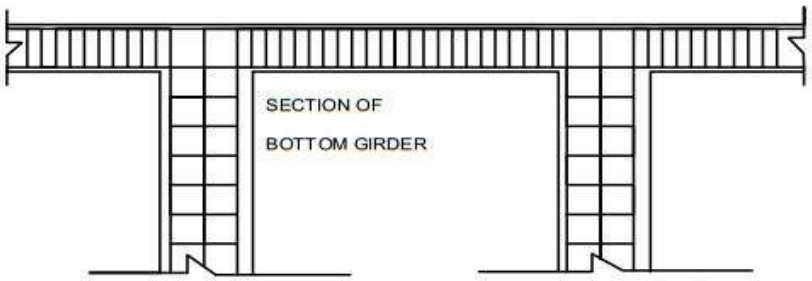

Fig 2: Section of Bottom Girder

Design using C++ Program:

Design Program/software are useful for designing the structure in less time and with efficiency. The inputs of program are required values from IS Codes, Loads and Required Diameter of steel bars with required

Spacing's. By giving above inputs to program the calculation will be easier than manual process and it gives the output in form of whether the design is suitable are not and structure is withstand to given cross section and loads acting on it. To make automated design of Overhead Circular flat bottom type tank for any height, any volume based on limit state method software was developed in C++ and compiled using developer C++. A number of inputs are required for designing the circular flat bottom type tank, following is a list of the major Input parameters used while compiling the results-

1. Capacity of the tank, m^3 – 150 m^3
2. Diameter of the tank, m – 7.5 m
3. Height of Cylindrical Wall, m- 3.6m
4. Number of columns- 06
5. Base diameter of the tank, m-7.66m

Following are the material properties and strength parameters are assumed while compiling the C++ software:

1. Grade of Concrete-M30
2. Grade of Steel-Fe415
3. Strength parameters as per IS: 3370

The outputs helped us to analyze the tank design and perform the study. The following outputs have been studied:

1. Area of steel required at every section
2.Stress and loading on Tank Components
3. Volume of concrete
4.Weight of steel reinforcement

RESULTS AND DISCUSSION

The values from C++ Program and Manual Design are compared as in table 2.(a) and values are nearly accurate to manual design and program still to bedevelop in some aspects i.e., seismic design and cost analysis.

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S.no	COMPONENTS OF TANK	MANUAL DESIGN			DESIGN USING C++ PROGRAMME		
		Dia (mm)	Spacing (mm)	Mini. A_{st} (mm^2)	Dia (mm)	Spacing (mm)	Mini .A_{st} (mm^2)
1)	Top Dome	6	75	180	6	78.5	182
2)	Top Ring Beam	12	170	363.6	12	170	370.88
3)	Cylindrical tank wall						
a)	Hoop steel	12	160	639.6	12	160	640
b)	Vertical steel	8	160	384	8	160	386.77
4)	Bottom circular base						
a)	Max.positive radial moment at Centre	25	120	3839	25	127	3836.6
b)	Max.Negative radial Moment	25	190	2559	25	191.81	2557.7
c)	Max.Circumferential moment	-	N.a	N.a	N.a	N.a	N.a
5)	Bottom ring girder						
a)	Section at supports						
	Section at between the supports	25	157	2626	25	156	2618.3
b)	Section at torsion is maximum	25	369	1330	25	370	1345
	I.Transverse Reinforcement	10	150	314.1	10	152	318.45

Table 1: results

CONCLUSION

As technology changes every field work of area requires an automation to get accurate and efficient work, to minimise the time period at design period .If software or programmes are accurate at design, the life span of structure will be more by neglecting human's errors

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REFERENCES

1. **Prof.R.V.R.K.Prasad** and **Akshaya B.Kamdi**, K.D.K College of Engineering, Nagpur University, Nagpur,"Effect of revision of IS: 3370 on water storage tanks", IJERA Publication Vol.2, Issue 5, September-October 2012.
2. **M.K.Sharma, Z.Ahmed, P.Bhardwaj and S.Choudhary**, NIT Silchar, India, "Parametric Study of an Intze Type Tank," Proc. of Int. Conf. on Structural and Civil Engineering 2012
3. **G.P.Deshmukh and Ankush.S.Patekhede,** PLIT Engineering College, Buldana,"analysis of elevated water storage structure using different staging system", IJRET Publication Vol-4, Issue-4, April 2015.
4. **M Bhandari and Karan deep Singh,** Dr B R Ambedkar National Institute of Technology, Jalandhar,**"** Comparative Study of Design of water Tank with Reference to IS: 3370", IJETAE Publication, Vol-4, Issue-11, November 2014.
5. **Aatishkumar, R.K Pandey and C.S.Mishra, "**Wind Effects on overhead tank under difficult soil parameters, "IJEAT Publication Vol-2, Issue-6, August-2013.
6. **SnehalWankhede, Prof.P.J.Salunke and Prof.N.G.Gore,** MGMCET, Navi Mumbai, India, "Cost Optimization of Elevated Circular Water storage tank**,"**IJES Publication, Vol-4, Issue-4, 2015
7. **Ranjit Singh, Dr.Abhay Sharma and Dr. Vivek Garg,** MANIT, Bhopal, India, "Design of Intze Tank in Perspective of Revision of IS: 3370,"IJSET Publication,Vol-3,Issue-09,1 September 2014

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International Journal OF Engineering Sciences & Management Research

8. **IS: 3370 (2009) (PART I)** "Code of Practice for Concrete Structures for the storage of Liquids" General Requirements, Bureau of Indian Standards, New Delhi
9. **IS: 3370 (2009) (PART II)** "Code of Practice for Concrete Structures for the storage of Liquids" General Requirements, Bureau of Indian Standards, New Delhi
10. **IS: 3370 (2009) (PART IV)** "Code of Practice for Concrete Structures for the storage of Liquids" General Requirements, Bureau of Indian Standards, New Delhi