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DESIGN OF INTZE WATER TANK USING JAVA PROGRAM

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Abstract— This Paper presents the work which will be helpful to the design engineers simply to change the data 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.. This paper gives in brief about the designing stage of reservoir or tank using **JAVA** program, Water tanks are traditionally designed by working stress method but as per revised IS 3370 water tank can also be designed by limit state method . The paper consists of manual procedure i.e. design program as per working stress method. Comparative study of design between program and manual outputs..

Index Terms : Design of Intze Tank, Working stress, Limit state, IS 3370,comparative study, Mannual design, JAVA design

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1. Introduction

Reinforced Concrete Water tank design is based on IS 3370: 2009 (Parts I – IV). The design is governed by the location of tanks, i.e. overhead, on ground or underground water tanks. The tanks can be made in different shapes and sizes, Usually circular and rectangular shapes are widely used. The overhead tanks are usually elevated from the roof top through column. 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. A special type of tank named Intze tank is used for storing large amount of water. The overhead tanks are supported by the column structure which is known as staging. These column can be braced for increasing strength. [1]

In this report the study is converged to RCC circular overhead water tanks.

2 METHODOLOGY

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

The 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).

2.2 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.[6]

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.[5]

2.3 PERMISSIBLE STRESS IN STEEL

The stress in steel must not be allowed to exceed the following values under different positions to prevent cracking of concrete.

1. When steel is placed near the face of the members in contact with liquid 115 N/ sq mm for mild steel Bars and 150 N/ sq mm for HYSD bars.
2. When steel is placed on face away from liquid for members less than 225 mm in thickness same as earlier.
3. When steel is placed on the face away from the liquid for members 225 mm or more in thickness: 125 N/ sq mm for M.S. bars and 190 N/sq mm for HYSD bars.

2.4 DESIGN OF INTZE TYPE TANK

It is found that for storing large volumes of water an elevated circular tank, provided with flat floor

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slab, works out to an uneconomical design. It is mainly on account of the fact that the floor slab becomes too thick for large diameters tanks. Intze tank is best suitable under such circumstances. An Intze tank essentially consist of a top dome (roof), the cylindrical wall and the floor slab, which is a combination of conical dome and bottom spherical dome. Being subjected to direct compression the thickness of the domical floor, works out to be much less and hence it proves to be economical alternative to flat slab floor.

2.5 THE TOP DOME AND TOP RING BEAM :

The dome and ring beam are assumed to be freely connected to the cylindrical wall of the tank with the help of shear key. We shall design the top dome and its ring beam on membrane analysis, considering these to be independent of the tank wall which is assumed to be free at top.

2.6 THE CYLINDRICAL WALL:

Let the diameter of tank be D and the height of cylindrical portion be H. The walls are assumed to be free at top and bottom. Due to this, tank walls will be subjected to hoop tension only without any B.M. Maximum hoop tension will occur at base, its magnitude being equal to W.h.d/2 per unit height. The tank walls are adequately reinforced with horizontal rings provided at both faces. In addition to this, vertical reinforcement is provided on both the faces in the form of distribution reinforcement.

Find hoop tension in the beam by the formula H = H_1 x + H_2 x Where H_1 is the horizontal component of the thrust T, due to w_1. w_2 being the load transmitted through the tank wall at the top of the conical dome. The value of H_1 is given by $H_1 = w_1 \tan(\beta)$ And H_2 is the horizontal force due to water pressure at the top of the conical dome and its value is given by H_2 = w x h x d Where d is the assumed depth of the beam and h is the depth of water upto the centre of beam. Having calculated H, the beam can be designed in a similar manner as the top ring beam. It is desirable to keep the depth of the beam less, so as to get more width, which may serve as walkway or inspection gallery around the tank

2.7 DESIGN OF CONICAL DOME :

The steps to be followed in the design are:
1. Find the weight of water on the conical dome by taking average diameter and the corresponding depth of water. To this value add the self-weight of the conical dome slab and the load (w_1) transmitted through the tank wall at the top of the conical dome.
2. Divide the total load obtained above by the perimeter of the conical dome at base, to get load per meter run at the conical dome base.
3. Find Meridonial thrust in the slab due to (w_2) by the formula $T = W2/\cos\beta$
4. Find hoop tension due to water pressure and self-weight of the conical dome slab, we know that the water pressure will act, normal to the inclined slab surface. Let the intensity of water pressure at a depth h meter above conical dome base be „p‟ and let, Dh be the diameter of the conical dome at this depth.

Hoop tension is then given by a general formula,

$$H = (P/\cos\beta + q.\tan\beta)$$

Where „q‟ is the weight of the conical slab per square meter of the surface area.
5. With the help of the above formulae, find the value of hoop stress at bottom, mid height and top of the inclined conical dome slab and provide necessary hoop reinforcement.

2.8. DESIGN OF BOTTOM RING BEAM

The steps to be followed in the design are:

1. Find the net horizontal force (P) on the ring beam given by the formula,

$$P = T_1 \times \cos\alpha \sim \cos\gamma$$

2. If $T_1 \cos\alpha > \cos\gamma$, the result will be net inward force per meter i.e. the force will be compressive in nature.

Find hoop stress given by,
☐ = x (compressive)

Being compressive in nature and normally very small in magnitude, its effect can be neglected. (In a well-proportioned tank the net horizontal force should be much less.)
Find vertical load per meter run, given by= $T_1 \cos\beta$ x $T_2 \sin\gamma$ Alternatively: Vertical load per meter can also be found by dividing the total vertical loads by the perimeter of the bottom ring beam.

3. *DESIGN USING JAVA 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 or not and structure is withstand to given cross section and loads acting on it. To make automated design of Overhead Intze type tank for any height, any volume based on working stress method software was developed in Java and compiled.
A number of inputs are required for designing the circular Intze type tank, following is a list of the major input parameters.

3.1. Input parameters used while compiling the results-

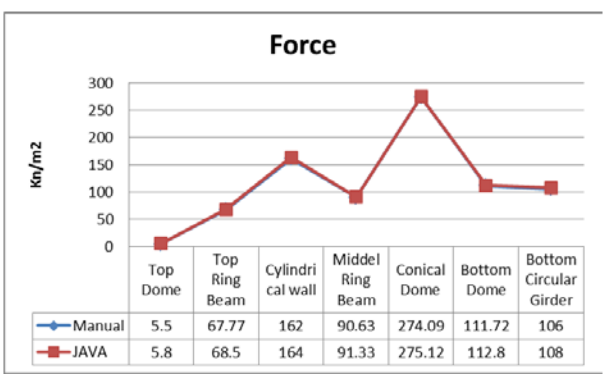
1. Capacity of the tank, m_3 – 250 m_3
2. Diameter of the tank, m – 9 m
3. Height of Cylindrical Wall, m- 3.6m
4. Depth of water – 3.6m
5. Rise of Top Dome – 1.8m
6. Height of bottom dome – 1.3m
7. Height of Conical dome – 1.5m
4. Number of columns- 06
5. Base diameter of the tank, m-7.66m

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

1. Grade of Concrete-M20
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:

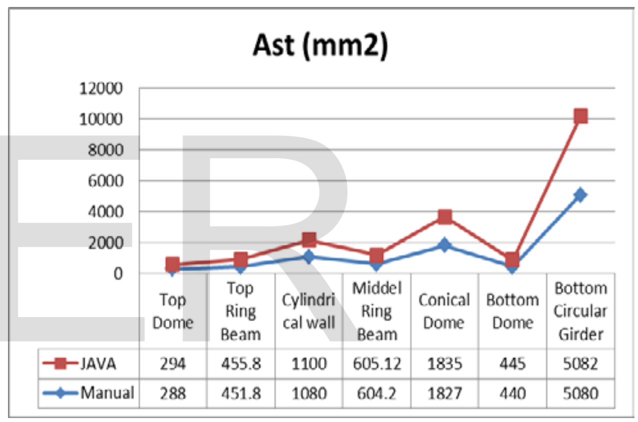
1. Area of steel required at every section
2.Stress and loading on Tank Components



Graph 1. Comparative graph for Forces

FORCE	Manual	JAVA	Unit
Top Dome	5.5	5.8	Kn/m2
Top Ring Beam	67.77	68.5	Kn/m2
Cylindrical wall	162	164	Kn/m2
Middel Ring Beam	90.63	91.33	Kn/m2
Conical Dome	274.09	275.12	Kn/m2
Bottom Dome	111.72	112.8	Kn/m2
Bottom Circular Girder	106	108	Kn/m2

Table 1. Comparitive table for Forces



Graph 2. Comparative graph for AST

AST	Manual	JAVA	Unit
Top Dome	288	294	mm2
Top Ring Beam	451.8	455.8	mm2
Cylindrical wall	1080	1100	mm2
Middel Ring Beam	604.2	6r05.12	mm2
Conical Dome	1827	1835	mm2
Bottom Dome	440	445	mm2
Bottom Circular Girder	5080	5082	mm2

Table 2.. Comparative table for Area of steel

4. Conclusion :

- As technology changes every field work of area requires an automation to get accurate and efficient work, to minimize 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.

- The program gives all the references in the form of compiled results, a provision in which shows the linked document or opens a linked program on a single click. That has made it very easy to refer the corresponding table of clause in a code which is not possible in MS Excel.

- Also this program can be enhanced using more drawings of reinforcements and details of different components in the water tank. The program needs to be incorporated with STAAD.Pro and AutoCAD so that after calculations, it will print the results and structural drawings.

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