A Review on Comparative Study of Design of Water Tank With Old And New Provision

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Abstract- *As per the provisions of the code (IS 3370-1965), the designing of water tanks was permitted by working stress method only and on the philosophy of no cracking. This code has been revised in 2009. As per IS 3370:2009, use of limit state method has been permitted and provision for checking the crack width is also included in this code. Hence this study was undertaken to compare the provisions of IS 3370: 1965 and IS 3370: 2009.*

Keywords- IS 3370:1965, IS 3370:2009, Working Stress Method, Limit State Method, Crack Width Theory

I. INTRODUCTION

Water is the life line facility that must remain functional following disaster. Most municipalities in India have water supply system which depends on elevated tanks for storage. Elevated water tank is a large elevated water storage container constructed for the purpose of holding a water supply at a height sufficient to pressurize a water distribution system. Water storage tanks are designed as per the provisions of IS 3370. As per the provisions of the code (IS 3370-1965), the designing of water tanks was permitted by working stress method only and on the philosophy of no cracking. This code has been revised in 2009. As per IS 3370:2009, use of limit state method has been permitted and provision for checking the crack width is also included in this code. Hence this study was undertaken to compare the provisions of IS 3370: 1965 and IS 3370: 2009. Prasad and Kamdi (2012) had given effect of revised IS 3370 on water tank and concluded that thickness of wall and width of base slab is different for both codes because the value of permissible stress in steel is different and also concluded design of water tank by LSM is most economical as the quantity of material required is less as compared to WSM. Bhandari and Karan Deep Singh (2014) gives the comparison of IS 3370:1965 and IS 3370:2009 for WSM and LSM and other aspects. Design of three different types of water tank with reference to the IS 3370:1965 and IS 3370:2009 with different capacities. After concluded the design of water tank is most economical in LSM as compared to WSM and the quantity of material required is less in LSM. Lodhi, Sharma, Garg (2014) Design of intze water tank as per IS 3370:1965 without considering earthquake forces and after redesign the intze water tank with same parameter as per IS 3370:2009 with considering earthquake forces and concluded that design of intze water tank as per old IS code was unsafe in hoop tension. With considering earthquake forces in design of intze water tank the thickness of cylindrical wall, conical dome and bottom dome is increased. As per new IS code required reinforcement is also increases. Jindal and Singhal (2012) compared the IS 3370:1965 and IS 3370:2009 code of practice for concrete structures for the storage of liquids. It gives the comparison of WSM and LSM.

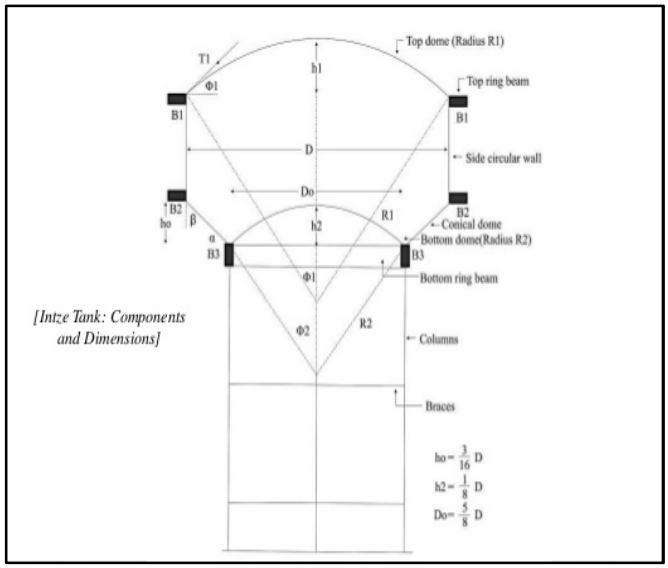


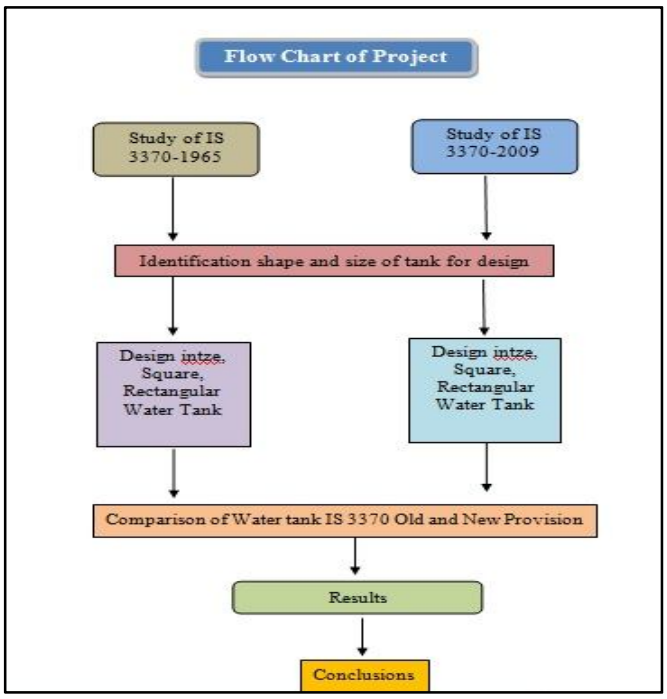
Fig.1.1 Components of Intze WaterTank

II.OBJECTIVE

1. To study the analysis and design of water tank.
2. To check about design philosophy for safe design of water tank.
3. To check economical design of water tank.
4. This report is to provide guidance in the design and construction for various types of water tanks.

III. METHODOLOGY

3.1 FLOW CHART OF PROJECT



3.2.1Limit State Design:-

Limit State Requirement

All relevant limit States shall be considered in the design to ensure an adequate degree of safety and serviceability.

Limit state of collapse

The recommendations given in IS 456 shall be followed.

Limit states of serviceability

a) Deflection - The limits of deflection shal1be as per IS 456.
b) Cracking- The maximum calculated surface width of cracks for direct tension and flexure or restrained temperature and moisture effects shall not exceed 0.2 mm with specified cover.
Partial safety factors

The recommendations given in IS 456 for partial safety factor for serviceability shall be followed.

Basis of Design

Design and detailing of reinforced concrete shall be as specified in Section 5 of IS 456 except that 37.1.1 of IS 456 shall not apply.

Crack widths

Crack widths due to the temperature and moisture effects shall be calculated as given in Annex A and that in mature concrete shall be calculated as given in Annex B.

Crack widths for reinforced concrete members in direct tension and flexural tension may be deemed to be satisfactory if steel Stress under service conditions does not exceed 115 N/mm2for plain bars and 130 N/mm2 for high strength deformed bars.

3.2.2Working Stress Design

Basis of Design

The design of members shall be based on adequate resistance to cracking and adequate strength. Calculation of stresses shall be based on the following assumptions:

a) At any cross-section plane section remains plane after bending.
b) Both steel and concrete are perfectly elastic and the modular ratio has the value given in IS 456.
c) In calculation of stresses for both flexural and direct tension (or combination of both) relating to resistance to cracking the whole section of concrete including the cover together with the reinforcement can be taken into account provided the tensile stress in concrete is limited
d) In strength calculations the concrete has no tensile strength.

3.3 Major Variations In IS 3370: 1965 and IS 3370: 2009

In IS 3370:1965 design criteria adopts working stress method and in revised version of IS 3370:2009 adopts working stress method as well as limit state method with crack width theory. IS:3370 adopted limit state design method in 2009 with the following advantages - limit state design method considers the materials according to their properties , treats load according to their nature , the structures also fails mostly under limit state and not in elastic state and limit state method also checks for serviceability. IS:3370-2009 adopts limit state design method with precautions. It adopts the criteria for limiting crack width when the structures are designed by considering ultimate limit state and restricts the stresses to 130 MPa in steel so that cracking width is not exceeded this is considered to be deemed to be satisfy condition. This precaution ensures cracking width to be less than 0.2 mm i.e. fit for liquid storage. This also specifies clearly how a liquid storage structure differs with other structures. The value of permissible stress in Steel (in direct tension, bending and shear) in IS 3370: (1965) σst is 150 N/mm2 and in IS 3370: (2009) σst is 130 N/mm2.

IV.DESIGN DETAIL

Working stress method of design, considered as the method of earlier times, has several limitations. However, in situations where limit state method cannot be conveniently applied, working stress method can be employed as an alternative. It is expected that in the near future the working stress method will be completely replaced by the limit state method. Though the choice of the method of design is still left to the designer as per cl. 18.2 of IS 456:2000.

Working Stress method incorporated limited cracking width in the liquid retaining structure and hence was the main reason why the Indian Standard IS: 3370 (1965) did not adopt the limit state design method. However, adopted limit state design method in 2009 with the following advantages – Limit State Method of design considers the materials according to their properties , treats load according to their nature , the structures also fails mostly under limit state and not in elastic state and limit state method also checks for serviceability. IS:3370-2009 recommends the use of Limit State Design method for designing water storing tanks with some specified precautions. It adopts the criteria for limiting crack width. This is done by considering ultimate limit state and restricting the stresses to 130 MPa in steel so that cracking width is not exceeded. this is considered to satisfy the required condition. This precaution ensures us that the crack width remains less than 0.2 mm i.e. liquid storage is possible without any leakage due to cracking. This also suggests the difference between liquid storage structures and other structures. A thorough study through both the versions of IS:3370 reveals four methods of designs:

- Working stress method in accordance IS 3370 (1965).
- Working stress method in accordance IS 3370 (2009).
- Designing by Ultimate Limit State and then checking cracking width by limit state of serviceability IS 3370 (2009).
- Limit state design method by limiting steel stresses in accordance IS 3370 (2009) and checking cracking width under serviceability.

To prevent the leakage, IS 456 guidelines are recommended (based on working stress method.) The strength of the structure and imperviousness is achieved by employing rich concrete mix (recommended concrete mixes are M25 and M30.) imperviousness can be achieved by keeping a minimum clear cover of 40 mm and providing smaller diameter bars at closer intervals and good construction practices.

Example problem statementIn order to carry out the design of circular water tank were considered for this study. Circular water tank was designed for capacity 5 lakh liters. The design of water tank was done by IS3370:1965 (WSM) and IS 3370:2009 (WSM & LSM). The grade of concrete is M30 and grade of steel is fe415. The values of permissible stresses in steel as per IS 3370:1965 σst =150 N/mm2 and in IS 3370:2009 σst =130 N/mm2. The value of permissible stresses in concrete related to resistance to cracking for shear is 2.2 N/mm2 and for direct tension is 1.5 N/mm2.

V. CONCLUSION

Circular water tank is designed by two methods WSM and LSM by two IS codes 3370: 1965 and revised version 3370: 2009. Design of water tank by IS 3370: 1965 adopts only WSM whereas IS 3370: 2009 adopts both WSM and LSM. As per design results circular water tank by IS 3370: 2009 by limit state method is most economical as compared to IS 3370:1965 (WSM) and IS 3370: 2009 (WSM).

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