Effects of Revision of IS 3370 on Design of Rectangular Tank

Rajesh Kumar Jain[1], Prof. Shikha Shrivastava[2], Prof. Saurabh Pare[3]
[2]Prof. and Head, Dept of Civil Engineering
[3] Prof. Dept of Civil Engineering
[1, 2] Saraswati Institute Of Engineering And Technology
[3]gyan Ganga Institute Of Technology And Sciences

Abstract- *In the year 2009, the codes for Design of Liquid retaining structures are revised. The revision in IS 3370 was awaited from a long time as it has not been revised since 1967. The earlier version of the IS Code recommended the design of Liquid Retaining structure (Water Tank) by Working Stress Method only. But the Revised Version of the code allows Limit State Method, along with the Working Stress Method. A major change made in the revised code along with introduction of Limit State Method is change in permissible steel stresses from 150 MPa to 130 MPa. The clause for minimum percentage of steel has also been revised from 0.30% to 0.35%. For concrete specification, IS code recommended the use of grade not less than M30 for liquid retaining structures. A rectangular tank of 6m x 5m x 4m, has been considered in this paper. The above specified tank is designed using Working Stress Method as per IS 3370-1967 and Limit State Method as per IS 3370-2009 and the results are discussed at the end.*

Keywords- Water Tank, Working Stress Method, Limit State Method, IS 3370 , Steel Stresses, Concrete, RCC

I. INTRODUCTION

A water tank is a construction for storing water. The need for water storage tank is as old as human civilization, providing scope of storing water for drinking water, irrigation of agriculture, fire fighting, growth of both plants and creatures, manufactured collecting, sustenance game plans well a similar number of various employments. Water repository parameters join the general arrangement of the tank, and check of improvement materials. Water storing structures are oppressed principally to hydrodynamic powers. The water storing structures can be constructed using steel plates, reinforced cement concrete (RCC), or prestressed concrete.
In general, according to position or placement of water tank, it can be classified as follows:

- Water tank resting on ground
- Overhead tank
- Underground tank

And according to shape of water tank, it can be of several types such as follows:

- Circular tank
- Rectangular tank
- Intze tank
- PSC tank

Where reasonable capacity of water is need to be stored, Rectangular water tank should be used . For larger capacity is required, circular tank is used as for smaller or moderate capacities, they are not recommended with an economical point of view, as the formwork required for circular tanks is expensive. It is desirable for rectangular tank that longer side should not be greater than twice the smaller side. The structures can be designed by two methods, namely-

- Working stress method,
- Limit state method.

Working Stress Method is based on traditional approach of design. Specifically for water tanks it is based primarily on crack resistance. It was found that the structures designed by WSM were more expensive and its strength was not utilized completely.

Limit state design method has been found the best when designed by elastic theory of design where the stress variation in concrete and steel are assumed linear according to IS 456. The structures designed by LSM are economically justified. There are two limit states-

- Limit State of Collapse and
- Limit State of Serviceability

Limit State of Serviceability includes deflection and cracking. IS 456:2000 recommends Limit State Method over any other method. IS 456 emphasizes on limit state method of design by presenting it in a full section (section 5) in IS 456:2000, while the working stress method has been given in

Annex B of the same standard.. It is important to point out here that a structure designed through limit state method when fails, the failure will be in plastic stage and not in elastic stage. Therefore, the cracking and cracking width can be noteworthy at the failure stage.

II. DESIGN METHODS

Working stress method of design has a few limitations. However , in circumstances where limit state method can't be practically applied, working stress method can be utilized as a substitute. It is anticipated that sooner or later the working stress method will be totally replaced by the limit state method. However, The decision of the method of design to be applied, is still left to the designer according to cl. 18.2 of IS 456:2000.

Working Stress method consolidated limited crack width in the liquid retaining structure and thus was the primary motivation behind why the Indian Standard IS: 3370 (1965) did not embrace the limit state design method But, IS:3370 received limit state design method in 2009 with the accompanying advantages –

Limit State Method of design considers the materials based on their specific properties , treats load on the basis of their nature , the structures also fails mostly under plastic state and not in elastic state and limit state method also checks for serviceability.

IS:3370-2009 recommends the Limit State Design method for designing water storing tanks with some particular precautions. It adopts the criteria limiting crack width. This is furnished by considering ultimate limit state and restricting the stresses to **130 MPa** in steel so that cracking width is not exceeded. This provision of IS 3370 ensures that the crack width is always less than 0.2 mm i.e. liquid storage is possible without any leakage due to cracking.

Based on IS 3370 1967 and IS 3370 2009, four Methods of Design of RCC water tanks are recommended-

1. Working stress method in accordance IS 3370 (1967).
2. Working stress method in accordance IS 3370 (2009).
3. Designing by Ultimate Limit State and then checking cracking width by limit state of serviceability IS 3370 (2009).
4. Limit state design method by limiting steel stresses in accordance IS 3370 (2009) and checking cracking width under serviceability.

In this paper , Working Stress Method based on IS 3370-1967 and Limit State Method based on IS 3370-2009 are adopted for design of rectangular water tank.

III. RESULT AND DISCUSSION

The design of section of the components has been discussed here. However the calculations from both methodologies have not been discussed in this paper.

Note : All the linear dimensions are in mm and area is in mm2

Table 1 : Result in Tabulated form

Parameter	IS: 3370-1967 (WSM)	IS:3370-2009 (LSM)
Long Wall		
Thickness (required)	212	135
% Change	100	-36.32
Reinforcement (Corner)	2958	1731
% Change	100	-41.48
Reinforcement (Mid)	2430	1364
% Change	100	-43.86
Reinforcement (Vertical)	525	910
% Change	100	73.33
Short Wall		
Thickness (required)	212	135
% Change	100	-36.32
Reinforcement (Mid)	3021	1050
% Change	100	-65.24
Reinforcement (Corner)	1049	1628
% Change	100	55.19
Reinforcement (Vertical)	252	1050
Base slab		
Thickness	150	200
% Change	100	33.33
Reinforcement	450	525
% Change	100	16.66

IV. DISCUSSION

- The minimum thickness required for tank wall was found maximum in WSM (IS 3370:1967), it was found minimum in the tank designed by LSM (IS 3370:2009)

- The reinforcement in corners of long wall of the tank decreased by 41.48% when designed by LSM (IS 3370:2009) when compared to WSM (IS 3370:1967)
- The vertical reinforcements, designed for cantilever action in long wall of the tank was found increasing by 73.33% , when designed by LSM (IS 3370:2009) when compared to WSM (IS 3370:1967)
- The reinforcement in corners of short wall of the tank was found increased by 55.20% when designed by LSM (IS 3370:2009)., when compared to WSM (IS 3370:1967)
- The reinforcement in mid span of short wall of the tank was decreased by 65.24% when designed by LSM (IS 3370:2009), when compared to WSM (IS 3370:1967)
- There was no change observed in the thickness required of the base increased by 33.33% in Limit State Method design.
- There was an increase of 16.6% in the reinforcements provided in base slab after the amendments in IS 3370,
- Limit State Method was found to be most economical for design of water tanks as the quantity of steel needed is less as compared to working stress methods of both the IS codes i.e IS 3370 (1967) .

REFERENCES

[1] Deign of RCC water tanks : IS 3390:2009 by Dr. Mahesh N Verma. (Ebook)
[2] IS 3370 (Part-I)-1967 Code of practice for Concrete Structures for the Storage of Liquids.
[3] IS 3370 (Part-II)-1967 Code of practice for Concrete Structures for the Storage of Liquids.
[4] IS 3370 (Part-III)-1967 Code of practice for Concrete Structures for the Storage of Liquids.
[5] IS 3370 (Part-IV)-1967 Code of practice for Concrete Structures for the Storage of Liquids.
[6] IS 3370 (Part-I)-2009 Code of practice for Concrete Structures for the Storage of Liquids.
[7] IS 3370 (Part-II)-2009 Code of practice for Concrete Structures for the Storage of Liquids.
[8] RCC Designs by Dr. B C Punmia, Ashok Kumar Jain and Arun Kumar Jain, tenth edition , Laxm Publication.
[9] SP-16 “Design Aids for reinforced concrete design” for IS 456