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A REVIEW ON COMPARATIVE STUDY OF DESIGN OF WATER TANKWITH IS3370-1965 AND IS3370-2009

Parag R. Chopade[1], Dr. P. O. Modani[2]

[1]PG Student, Department of Civil Engineering, PankajLathad Institute of Technology and Management Studies, Buldana, India.
[2]Asst. Prof. Department of Civil Engineering, PankajLathad Institute of Technology and Management Studies, Buldana, India.

Abstract - *Indian standard has recently revised IS 3370 code of practice for concrete structures for storage of liquids. In that provisions of code IS 3370: 1965, the method which is adopt for designing the water storage tank is working stress method only. The new provision of IS 3370:2009 adopts both WSM and LSM. In this paper, comparison of the design provisions of water tank by IS 3370:1965 and IS 3370:2009. In IS 3370:2009 limit state method considering two aspects mainly it limits the stress in steel and limits the crack width.*

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

I. INTRODUCTION

Water is considered as the wellspring of each creation and is in this manner an extremely pivotal component for people to carry on with a solid life. Popularity of Clean and safe drinking water is rising step by step as one can't live without water. It ends up important to store water. Adequate water conveyance relies upon structure of a water tank in certain territory. A lifted water tank is an expansive water stockpiling compartment built to hold water supply at certain stature to pressurization the water dispersion framework. Water tanks can be named overhead, laying on ground or underground relying upon their area. The tanks can be made of steel or cement. Steel tanks are commonly utilized in railroad yards. Water tanks laying on ground are ordinarily roundabout or rectangular fit as a fiddle and are utilized where huge amounts of water should be put away. Overhead water tanks are utilized to circulate water specifically through gravity stream and are ordinarily of littler limit. As the overhead water tanks are available to general visibility, their shape is affected by the stylish view in the environment. Round tanks have least surface region when contrasted with different shapes for a specific limit of capacity required. Subsequently the amount of material required for round water tank is not exactly required for different shapes. The hoisted Water Tank (WT) comprises of tank upheld by organizing framework made out of segments, supports and establishments. Lifted water tanks have for the most part performed well in a seismic zones. Because of the absence of learning of supporting framework a portion of the water tank were fell or intensely harmed. So there is have to concentrate on seismic security of help structure as for exchange supporting framework which are protected amid quake.

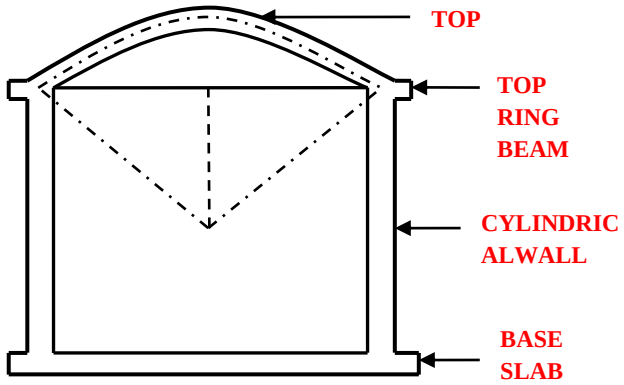

Fig.1.1 Components of Circular WaterTank

1.1 Basis of water tank - The primary parts of circular water tank is top dome, top ring beam, barrel shaped divider i.e. cylindrical wall, base slab. Top Dome is the best most piece of tank. Top dome is intended for self weight and live load. There are two sorts of stresses are following up on arch which are called as meridional and circumferential burdens and the thickness of vault is depends up on premise of limit of tank. Structure of ring pillar in water tank is important to oppose the flat segment of the push of the arch. The ring pillar will likewise be intended for the band pressure initiated. Round and hollow tank divider is the component of superstructure where it exchanges and controls the weight from best arch and best ring shaft to down segment. The base piece ought to be sufficiently able to transmit the heap from the fluid and the structure itself to the ground. The base chunk creates spiral and additionally circumferential pressure. According to seismic code IS 1893 (part):2002, more than

60% of india is prone to earthquake. After an earthquake property loss can be recovered to some extent however, the life loss cannot the main reason for life loss is collapse the structures. It is said that earthquake itself never kills people, it is badly constructed structure that kill. Hence it is important to analyze the structure properly for earthquake effects.

II. OBJECTIVE

1. To check about design philosophy for safe design of water tank.
2. To make the guidelines for the design of liquid retaining structure according to IS code.
3. To check economical design of water tank.
4. To make the study about the analysis and design of water tank.
5. This report is to provide guidance in the design and construction for Circular water tanks.

III. METHODOLOGY

3.1 FLOW CHART OF PROJECT

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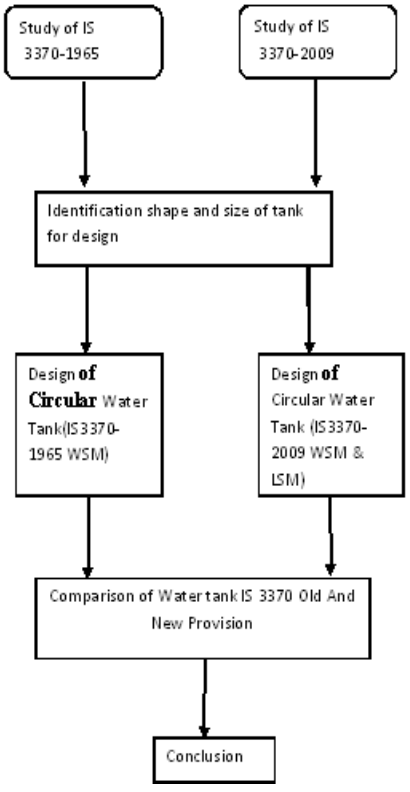

3.2.1Limit State Design:-

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 servicebilityshall 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/mm^{2}for plain bars and 130 N/mm^2 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. PERFORMANCE ANALYSIS

4.1 Design of circular water tank of capacity 5 lakh litre resting on ground and having rigid joint at base. Depth of tank is 3 m with a free board of 0.3m. Use M20 grade of concrete and Fe415 grade of steel. **Using WSM (1.IS 3370: 1965,2.IS 3370: 2009,)Using LSM. (1.IS 3370: 1965, 2.IS 3370: 2009,)**

Table 4.1 DESIGN COMPARISION

DIMENSION OF WATER TANK		1965 (WSM)	2009(WSM)	2009 (LSM)	UNIT
Capacity		**500000**	**500000**	**500000**	lit
Volume	V	**500**	**500**	**500**	m^3
Depth of water tank	H	**3**	**3**	**3**	m
Free board	F.B	**0.3**	**0.3**	**0.3**	m
Permissible stress of Steel	σ st	**150**	**130**	**230**	N/ mm^2
Permissible stress in concrete	σ ct	**1.2**	**1.5**	**2**	N/ mm^2
Depth of water		2.7	2.7	2.7	m
Area of water tank	A	185.18	185.18518	185.18	m^2
Diameter	D	16	16	16	m
Radius	r	8	8	8	m
DESIGN OF TOP DOME					
Rise of dome	r	2	2	2	m
Radius of curvature	R	17	17	17	m
Semicentral angle	θ	0.49	0.49	0.49	rad
		28.08	28.08	28.08	deg
Total load	W	3.5	3.5	3.5	kN/ m
Meridional thrust	T	31.61	31.61	31.61	kN
Meridional stress		0.32	0.32	0.32	N/ mm^2
Circumferential force	C	20.89	20.89	20.89	kN
Circumferential Stress		0.21	0.21	0.21	N/ mm^2
Area of steel	A st	300	175	120	mm^2
Spacing	S	167.46	287.08	418.66	mm

DIMENSION OF WATER TANK		1965 (WSM)	2009(WSM)	2009 (LSM)	UNIT
DESIGN OF RING BEAM					
Horizontal component	P	27.89	27.89	27.89	kN

Hoop tension	H. T.	223.125	223.125	223.125	kN
Area of steel	As t	1487.5	1716.34	970.10	mm^2
Dimension of ring beam		167596.625	127587.4519	99601.05978	
Width of ring beam	b	300	300	300	mm
Depth of ring beam	d	558.65	425.29	332.00	mm
CYLINDRICAL WALL					
Intensity of water pressure at base	P	29.43	29.43	29.43	kN/m^2
Hoop tension	H. T.	235.44	235.44	235.44	kN
Area of steel	As t	1569.6	1811.076923	1023.652174	mm^2
Width of wall	b	1000	1000	1000	mm
Thickness of wall	t	176.84	134.62	105.09	mm
BASE SLAB					
Thickness of base slab	t	200	200	300	mm
Reinforcement	As t	600	600	900	mm^2
Spacing	S	130.83	130.83	87.22	mm

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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