Comparative Study of Design of Water Tank With Old And New Provision

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Abstract- *Water is considered as the source of every creation and is thus a very crucial element for humans to live a healthy life. High demand of Clean and safe drinking water is rising day by day as one cannot live without water so design of water tank is safe. 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.

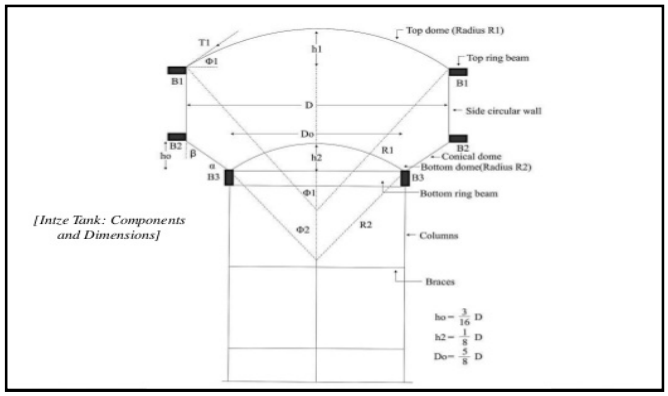

Fig.1.1 Components of Intze WaterTank

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. PERFORMANCE ANALYSIS

3.1 Design Steps

3.1.1 Underground rectangular tank

Design constants,

$$k = \frac{mc}{mc + \sigma_{st}}$$

Design of long wall,

$$P_a = K_a \gamma' H + \gamma_w H$$

Design of long wall,

$$P_a = K_a \gamma' (H - h) + \gamma_w (H - h)$$

Design of bottom slab,

$$P_u = wH_1$$

Where, m = modular ratio
C = compressive force.
= permissible stress in steel in tension.
Ka = coefficient of active e arth pressure.
H = Height.
γ_w = Unit weight of water
W = Total load

3.1.2 Tanks resting on ground

Design constants,

$$k = \frac{mc}{mc + \sigma_{st}}$$

Water pressure,

$$P = w(H - h)$$

Cantilever moment,

$$= wH \times \frac{h^2}{6}$$

Reinforcement at corners of l ong walls,

$$X = d - \frac{T}{2}$$

Where, m = modular ratio
C = compressive force.
σ_{st} = permissible stress in s teel in tension.
H = Height.
W = Total load
d = Effective depth
T = Torsional moment

3.1.3. Overhead tank

Dimensions of tank,

$$= \frac{\pi \times D^2}{4} \times rD$$

Max. Hoop tension at base of wall

$$F_1 = \frac{whD}{2}$$

Design of bottom spherical do me

$$R = \frac{\frac{D^2}{2} + r^2}{2r}$$

Total design load on the ring girder

$$W = \pi D w$$

Where, D = Diameter at base
R = Radius of the dome
r = central rise
w = density of water
h = depth of water
W = Design load

Assumptions of Design Water Tank

Capacity of tank = 1 million litres = 1000 m3
Height of supporting tower = 16 m
Number of columns = 8
Depth of foundations = 1 m below ground level.

IV.COMPARISION

Comparative Result Of Ground Type Of Water Tank

Structural Element	**WSM**		**LSM**	
	IS 3370 – 1965	**IS 3370 – 2009**	**Crack Theory**	**Deemed to Satisfy**
Top Dome				
Area of Steel Required	300mm^2	300mm^2	120mm^2	-
% of change	-	Nil	-60%	-
Thickness Required	100mm	100mm	100mm	100mm
% of Change	-	Nil	Nil	Nil
Roof Ring Beam				
Area of C/S	325000mm^2	325000mm^2	34500mm^2	34500mm^2
% of Change	-	Nil	-89.39%	-89.39%
Area of Steel Require	3484mm^2	3484mm^2	1801.62mm^2	4019mm^2

d				
% of Change	-	Nil	-48.29%	15.35%
Cylindrical Tank Wall				
Thickness	260mm	260mm	120mm	120mm
% of Change	-	Nil	-53.85%	-53.85%
Steel At Base	2804.4mm^2	2804.4mm^2	1351.72mm^2	3015.39mm^2
% of Change	-	Nil	-51.8%	17.52%
Base Slab				
Thickness	260mm	260mm	260mm	260mm
% of Change	-	Nil	-60%	-60%
Area of Steel Required	780mm^2	780mm^2	360mm^2	-
% of Change	-	Nil	-53.85%	

Comparative Result Of Intze Type Of Water Tank

Structural Element	**WSM**		**LSM**	
	IS 3370 – 1965	**IS 3370 – 2009**	**Crack Theory**	**Deemed to Satisfy**
Top Dome				
Area of Steel Required	300mm^2	175mm^2	120mm^2	-
% of change	-	-41.66%	- 60%	-
Thickness	100mm	100mm	100mm	100mm

Required				
% of Change	-	Nil	Nil	Nil
Top Ring Beam				
Area of C/S	105000mm^2	105000mm^2	34500mm^2	34500mm^2
% of Change	-	- 11.43%	- 67.14%	- 67.14%
Area of Steel Required	1001.32mm^2	1155.31mm^2	517.90mm^2	1155.31mm^2
% of Change	-	- 15.38%	- 48.28%	- 15.38%
Cylindrical Tank Wall				
Base Level Thickness	360mm	360mm	180mm	180mm
% of Change	-	Nil	- 50%	- 50%
Steel At Base	3966.67mm^2	4576.92mm^2	2051.72mm^2	4576.92mm^2
% of Change	-	15.38%	- 48.28%	15.38%
Top Level Thickness	200mm	200mm	100mm	100mm
% of Change	-	Nil	-50%	-50%
Steel At Top	700mm^2	807.69mm^2	586.20mm^2	807.69mm^2
% of Change	-	15.38%	-16.26%	15.38%
Bottom Ring Beam				

Area of C/S	720000m m^2	720000m m^2	720000m m^2	720000m m^2
% of Change	-	Nil	Nil	Nil
Area of Steel Required	6885.67m m^2	7280.46m m^2	3263.66m m^2	7280.46m m^2
% of Change	-	14.56%	-22.88%	-15.38%
Conical Dome				
Thickness	600mm	600mm	600mm	600mm
% of Change	-	Nil	Nil	Nil
Area of Steel Required	6309.73m m^2	7280.46m m^2	3263.66m m^2	7280.46m m^2
% of Change	-	15.38%	-48.28%	15.38%
Bottom Spherical Dome				
Thickness	300mm	300mm	300mm	300mm
% of Change	-	Nil	Nil	Nil
Area of Steel Required	1050mm^2	900mm^2	150.6mm^2	265.38m m^2
% of Change	-	-14.29%	43.43%	-74.75%

V. CONCLUSION

Design of water tank as per IS 3370: 2009 by limit state method is most economical as compared to IS 3370:1965 by working stress method. Area of steel for reinforcement is decreases in LSM as per IS code. The thickness of wall is decreases in limit state method. The size of member of ring beam is also decreases in limit state method. The quantity of material required is less in limit state method as compared to working stress method. Crack width calculations done in limit state method.

The thickness of wall and depth of base slab is comes to different for IS 3370:(1965) and IS 3370:(2009) because of the value of permissible stress in Steel (in direct tension ,bending and shear) IS 3370:(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.

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