IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 39-43

Comparative Analysis and Design of ESR by Manual and Software

[1]Rashadus Sadain, [2]Aakif Anjum, [3]Tauseef Ahmed
[1](Civil Engineering Department, Sandip University, Nasik, India)
[2](Mechanical Engineering Department, MMANTC, Malegaon, India)
[3](Stantec, UAE)

Abstract: *Most water supply systems in developing countries, such as India, where urbanizing is increasing day by day rely on overhead storage tanks and hence there is need to construct more number of water tanks. Earlier design of water tanks was being done using the working stress method given in IS: 3370 1965. This method leads to thicker and heavily reinforced sections. The use of limit state method of design has been adopted in the revised code IS 3370: 2009 and provision for checking the crack width is also included in this code. All tanks are designed as crack free structures to eliminate any leakage. STAAD Pro is also used to analyze and design the elevated water tank. This paper summarize the difference in results of manual and software calculations.*

Keywords: *Water Tank, Beam, RCC, STAAD Pro, Steel*

I. Introduction

Safe drinking water is one of the basic elements for humans to sustain healthy life. Reservoir is common term applied to liquid storage structures and it can be below or above the ground level. Reinforced concrete overhead water tanks are widely used to provide the safe drinking water. Most water supply systems in developing countries, such as India, where urbanizing is increasing day by day rely on overhead storage tanks and hence there is need to construct more number of water tanks. Earlier design of water tanks was being done using the working stress method given in IS: 3370 1965. This method leads to thicker and heavily reinforced sections. The use of limit state method of design has been adopted in the revised code IS 3370: 2009 and provision for checking the crack width is also included in this code. All tanks are designed as crack free structures to eliminate any leakage. STAAD Pro is also used to analyze and design the elevated water tank.

M.Bhandari And Karan Deep Singh (DEC 2014) has work done on comparative economic design of different shapes of water tank by L.S.M method. While Snehal Wankhede, Prof.P.J.Salunke and Prof.N.G.Gore has done the work on cost optimization of elevated water tank. They give the focus on economical, reliable & simple design of elevated water tank. Soheil Soroushnia, Sh.Vousitafreshi, F.Omidinasab, N.Beheshtian and Sajad Sroushnia (2011) has work done on seismic performance of RC elevated water tanks. Ajagbe, W.O, Adedokun, S.I & Oyesile W.B done the study on comparative study on design of elevated rectangular & circular water tanks. They concluded that the material used for construction of rectangular water tank is comparative more than circular water tank & rectangular water tank is easy to construct than circular water tank. Nibedita Sahoo (May 2008) has work done on design of water tank. . She concluded that in design of water tank in walls lots of mathematical formulae and calculation are required. It is time consuming hence programme gives solution to above mention problem. So, no one researcher has done the comparative study on manual and staad pro analysis and design. So we will do the comparative study on analysis and design of elevated water tank by manual and software method.

II. Structure Configuration Details

Location	: Pune, India.
Length	: 6.2 m
Width	: 6.2 m
Total height	: 18.44 m (clear)
Seismic zone	: III

Wind speed	: 39 m/sec
Wind terrain category	: A
Wind Class	: II
Capacity of tank	: 1.21 lakh litre
Soil type	: Medium

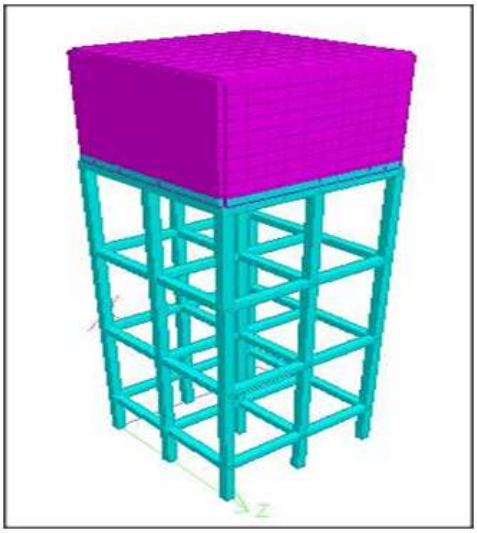

Fig.1 3D Model of water tank

III. Methodology

A First analyze the square shape water tank of capacity 121 cubic meter at height 15.5m from ground floor manually. Dimension of water tank is 4m*5.5m*5.5m. After analysis of water tank designing will be done with the help of IS 456 (for plain and reinforced concrete and IS3370 part 1,2,3,4 (for design of liquid retaining structures). After completion of manual calculation, STAAD PRO analysis and designing is done and then compare of both the results.

3.1 Manual Analysis And Design

Major forces which act on elevated water tank are earthquake force and wind force. So for the purpose of analysis, effect of these two forces is to be analyzed. By virtue of its height, high rise structures are affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. In some cases effects of earthquake are found to be dominant and more critical than wind effects and in some cases wind effects are dominant. This depends on various factors defined by IS codes. Seismic zone V and wind zone VI are the most severe zones for earthquake and wind respectively according to IS codes. Hence in this paper an attempt has been made to analyze high rise structure situated in wind zone VI and compare their performance to the structures situated in seismic zone V of India so as to study the severity of wind forces against seismic forces. This analysis is done according to the Indian standard codes IS: 875 and IS: 1893 (Part 1) for wind and earthquake respectively. The effects can be found out by analyzing buildings for earthquake and wind forces. Codes used: IS 875: 1987, IS 456:2000, IS 1893:2002(part 1) Concrete mix weaker than M20 is not used. The minimum quantity of cement in the concrete mix shall be not less than 30 kN/m^3.The design of the concrete mix shall be such that the resultant concrete is sufficiently impervious. Efficient compaction preferably by vibration is essential.

3.2 Staad Pro Analysis And Design.

STAAD Pro V8i features state of the art user interface, visualization tools, powerful analysis and design engines with advanced finite element (FEM) and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification STAAD Pro V8i is the professional first choice. STAAD Pro V8i was developed by practicing engineers around the globe. It has evolved over 20 years and meets the requirements of ISO 9001 certification.

3.3 Steps of design and Principles Loads on Structure

The determination of the loads acting on a structure is a complex problem. The nature of the loads varies essentially with the architectural design, the materials, and the location of the structure. Loading conditions on the same structure may change from time to time, or may change rapidly with time.

3.3.1 Model generation

For designing or analyzing any structure on STAAD Pro V8i, we first have to create a model of it. For modeling in STAAD Pro V8i various types of properties, members, steel tables, materials are available. Not only this, there are the design codes of various countries feed. In STAAD Pro V8i beams and columns act as

line element and slabs, walls and shear walls, etc. act as plate element. Firstly a complete model is to be prepared. Once the whole modelling is done then using properties, it should be given the desired properties by which we are going to design the structure. The modeling and analysis of a slab is demonstrated in the third step. Slabs and other surface entities like walls are modeled using plate elements. Large surface entities may have to be defined using several elements and this sometimes requires a tool called a mesh generator. This shows the simple techniques as well as the mesh generation method for generating the finite element model of the slab. It also shows the methods by which one can check the results for plate elements. In forth step component designs such as for a rectangular footing, base plate, cantilever retaining wall, moment connection, bolt group, etc. and one can familiarize themselves with the process of utilizing STAAD.etc to perform secondary analysis and design tasks on a structure for which the primary analysis and design is done using STAAD Pro.

3.3.2 Loading

After modelling the loading conditions are to be defined. For the loading dead, live, wind and seismic loads are to be taken into consideration to assign them to the structure. For the proper load assessment, the loading conditions which are defined should according to the following sequence

- Earthquake
- Dead
- Live
- Wind

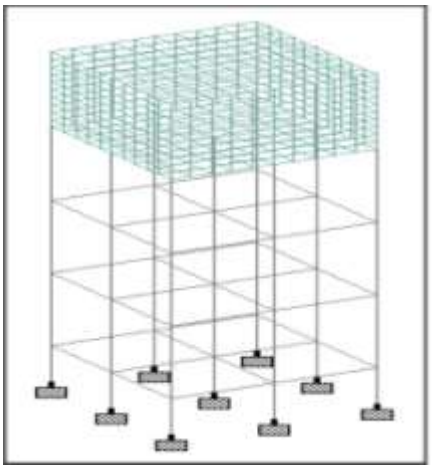

Fig. 2. Model of water tank

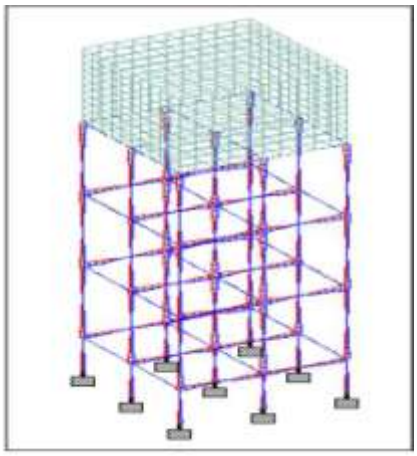

Fig. 3. Stress Analysis of Beams and Column

Table NO. 1. Details of ESR in STAAD PRO

Number of nodes	638	Highest node	638
Number of elements	132	Highest beam	132
Number of plates	600	Highest plate	732
Number of load cases	6	Number of combination	21
		load cases	

A overhead water tank of capacity 1.21 lakh liter is to be design for village with a minimum water head of 12.8m from general ground level.

i. Internal (actual) dimension : 5.5 x 5.5 x 4
ii. External dimension with adding F.B & tank wall thickness : 6.2 x 6.2 x 4.2

Assume the following dimension

i. Thickness of wall = 350mm
ii. Size of columns = 300 x 300
iii. Beams at tank level = 300mm x 600mm

The design will be carried out in following sequence.

i. Elements at tank level
   (a) Base slab
   (b) Side walls

IV. Result

4.1 Base Slab Comparision

Table No. 2. Steel Required

DESCRIPTION	MANUAL RESULT	STAAD RESULT
TOTAL STEEL	1750 MM^2	1584 MM^2
STEEL ON EACH FACE	875 MM^2	792 MM^2

Table No. 3. Steel Provided

DESCRIPTION	MANUAL RESULT	STAAD RESULT
TOTAL STEEL	1848 MM^2	1745 MM^2
STEEL ON EACH FACE	ALTERNATE 16MM# & 12MM#	ALTERNATE 16MM#& 12MM#
BOTH WAY	@ 170 MM C/C = 924 MM^2	@ 180 MM C/C = 872 MM^2

4.2. Side Wall Comparision

Table No.4: Steel Required In Longitudinal Direcion

DESCRIPTION	MANUAL RESULT	STAAD RESULT
TOTAL STEEL	3803 MM^2	1744 MM^2
REMOTE FACE	1795.3 MM^2	600 MM^2
LIQUID FACE	2008.8 MM^2	1144 MM^2

Table No.5 Steel Required For Vertical Distribution

DESCRIPTION	MANUAL RESULT	STAAD RESULT
TOTAL STEEL	648 MM^2	600 MM^2
REMOTE FACE	324 MM^2	300 MM^2
LIQUID FACE	324 MM^2	300 MM^2

Table No.6. Steel Provided In Longitudinal Direction

DESCRIPTION	MANUAL RESULT	STAAD RESULT
TOTAL STEEL		
REMOTE FACE	20MM# @170MM C/C	16MM# @ 270MM C/C
LIQUID FACE	20MM# @150MM C/C	16MM# @ 170MM C/C

Table No. 7 Steel Provided In Vertical Direction

DESCRIPTION	MANUAL RESULT	STAAD RESULT
REMOTE FACE	10 MM #@220MM C/C	10 MM #@250MM C/C
LIQUID FACE	10 MM #@220MM C/C	10 MM #@250MM C/C

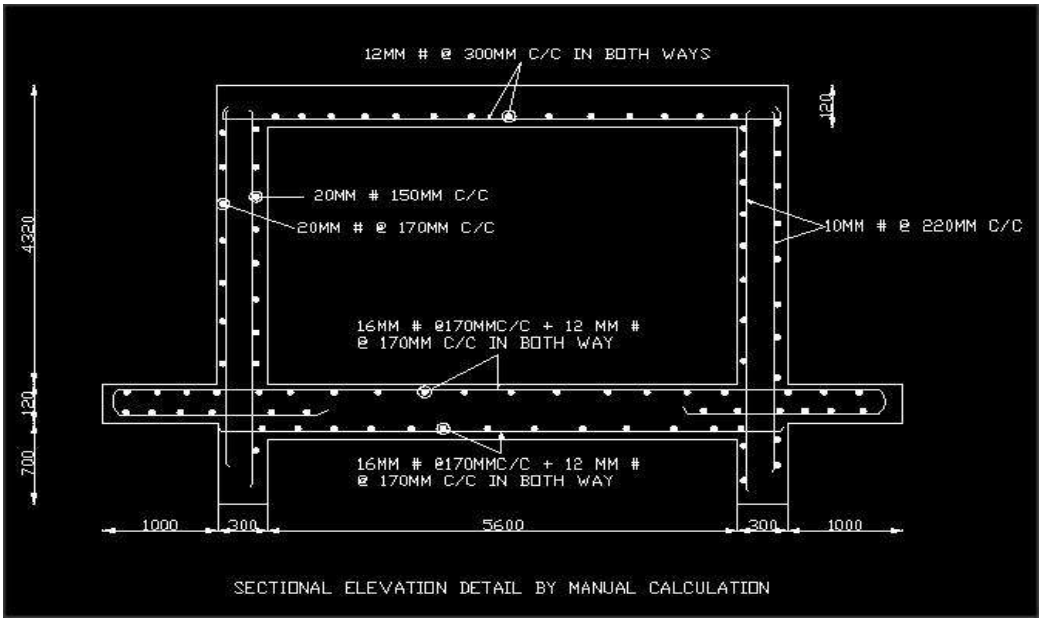

Fig.4. Sectional elevation detail by manual calculation

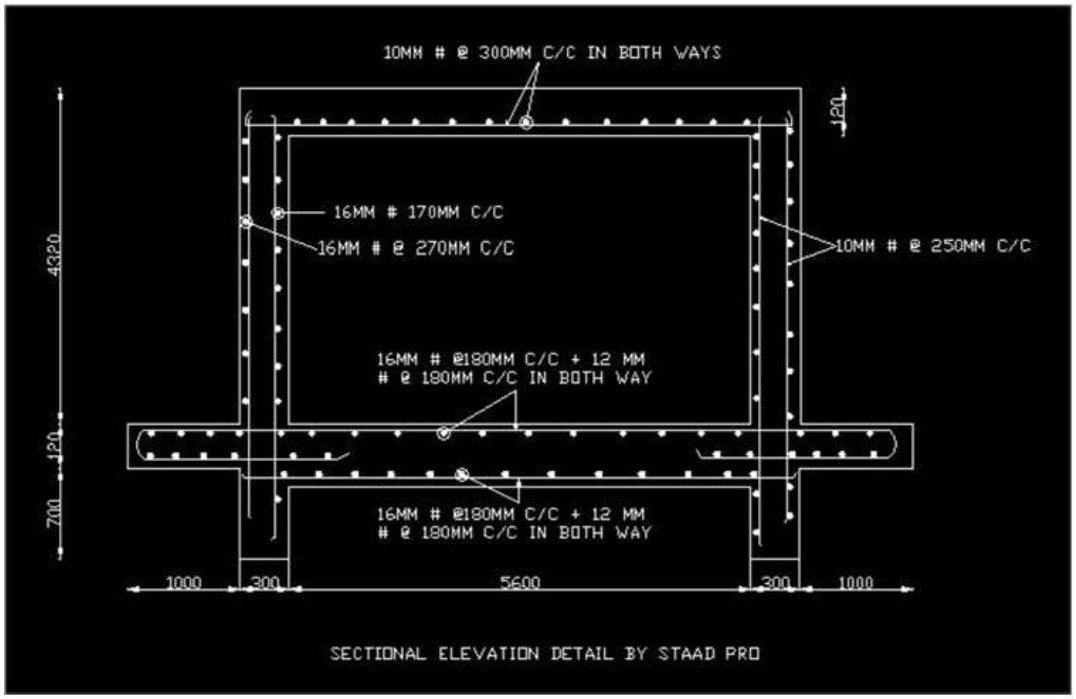

Fig.5. Sectional elevation by staad pro calculation

V. Conclusion

SATAAD PRO analysis and design is always beneficial over the conventional method of analysis and design of water tank. Manual analysis and design requires lengthy and complicated procedure while STAAD PRO requires less time & easy design &analysis process. By using STAAD PRO software there is saving of 15 % to 20 % of total steel in the whole structure.

References

[1]. Ajagbe, W.O., Adedokun, S.I and Oyesil W.B. (2012). "Comparative study on the design of the elevated rectangular & circular water tanks" International journal of engineering research & and development, volume 1, No.1 (2012) , PP . 22-30
[2]. Bhandari M, K.D. Singh (2014), "Comparative Study Of The Design Of The Water Tank With Reference To IS: 3370" International
[3]. Journal Of Emerging Technology And Advance Engineering, Volume 4, No.11, (2014).
[4]. IS:456-2000 , Plain & Reinforced Concrete – Code Of Practice
[5]. IS: 3370 (Part 1st) – 1965, Code Of Practice For Concrete Structures For The Storage Of The Liquids.
[6]. IS: 3370 (Part 2nd) – 1965, Code of Practice for Concrete Structures for the Storage Of the Liquids.
[7]. IS: 3370 (Part 4th) – 1965, Code of Practice for Concrete Structures for the Storage of the Liquids.
[8]. IS: 3370 (Part 2) – 2009, Concrete Structures for the Storage of the Liquids – Code of Practice.
[9]. Ramamrutan S, "Design of Reinforce Concrete Structures" (New Delhi : DhanpatRai Publishing Company Pvt .Ltd . 2006)
[10]. Saroushnia S., Tafreshi S.T., F. Omidinasab, N. Behestian, "Seismic Performance of RC Elevated Water Tanks with Frame Stagging& Exhibition Damage Pattern", Science Direct, Procedia Engineering 14 (2011), Pp 3076 – 3087.
[11]. Dr.H.J. Shah "Reinforced Concrete Volume 2nd" (Gujarat, India: Charotar Publishing House Pvt Ltd 2012).
[12]. Wankhede S., Salunke .P.J., N.G. Gore (2015), "Cost Optimization of Elevated Circular Water Storage Tank." The International Journal Of Engineering And Science (IJES), Volume 4 , NO.4(2015), Pp 28 - 31 .