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Comparative Analysis & Design of Elevated Storage Reservoir (ESR) By Manually & Software

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Abstract: ***Water tanks are important public utility and industrial structure. The design and construction method used in reinforced concrete are influenced by the prevailing construction practices ,the physical property of the material and the climatic conditions water tanks are classified on the basis of their shape and position of structure storage reservoirs and overhead tank are used to store water all tanks are designed as crack free structure to eliminate any leakage . The principle objective of this project is to plan, analysis and design a circular overhead tank of 750lakh litters capacity. In this project all structural elements of circular water tank are analysed and design by using manually and ETAB software . this project giuesin brief ,The theory behind the design of liquid retaining structures (Elevated circular water tank) using limit state method with reference to IS: 3370 (2009)and IS456:2000 The behaviour of structure for the parameters like story drift ,displacement stiffness ,deflection ,storey shear ,base shear , area of steel ,for circular water tank are studied on ETAB software and then comparison of the results is made between manually design By this study we say that the circular water tank analysis and design on ETAB software is more economical and safe than manually design of water tank.***

Keywords: Circular water tank , Seismic pressure, Population Forcasting, Limit state method ,working stress method , ETAB .

I. INTRODUCTION

Without water survival is impossible. Water is one of the most important substances on earth. All plants and animals must have water to survive. As water is very precious and due to the scarcity of drinking water in day to day life one has to take care of every drop. A water tank is used to store water for daily requirements like drinking ,washing etc.

An elevated water tank is a large water storage container constructed for the purpose of holding water supply at certain height to provide sufficient pressure in the water distribution system. These tanks have various types of supports structures like RC Braced Frame, Steel Frame, RC Shafts and even masonry pedestal. The most commonly used staging in practice is the frame type. The main components of this type of staging are columns and braces.

The staging acts like a bridge between the overhead container and foundation to transfer loads acting on the tank. Thus water tanks are very important for public utility and for industrial structure and also to withstand more design forces. The frame spport of the ELSR should have adequate strength to resists axial loads moment and shear force due to lateral loads. These forces depends upon total weight of structure, which varies with the amount of water present in the container

A. Objective

1) To collect the data and planning of ESR.
2) To analyse ESR design by manually .
3) To design the ESR by using software.
4) To compare the result obtained from manual design and software design.

B. Scope of the Project

1) We design a circular tank for a particular capacity and performed its manually analysis and design on software
2) It helps to find the overall demand and per capita demand for a particular area
3) To know about the design philosophy for the safe and economical design of water
4) To increase the design life period and serviceability of the structure

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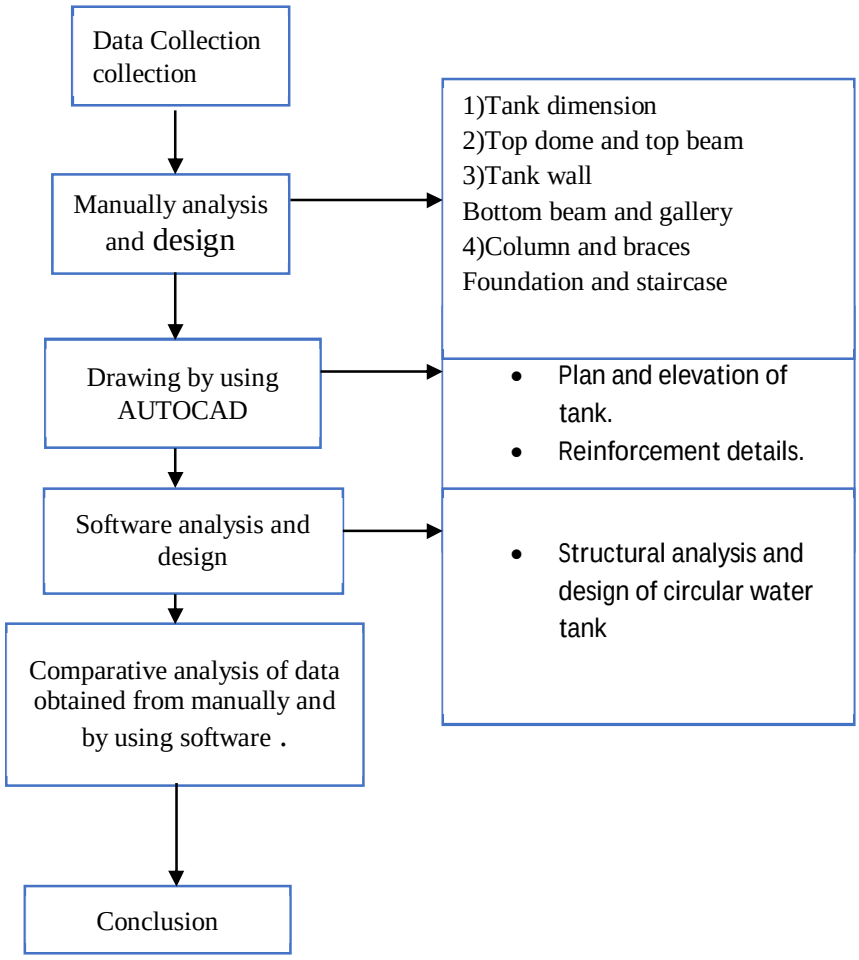
II. METHODOLOGY



III. DATA COLLECTION

Table 1: Details of data collection

1	Capacity of tank	7,50,000
2	Height of tankl from ground	19 m
3	Grade of concrete	M 25
4	Free board	0.2 m
5	Width of gallery	1 m
6	Water stored from	Warna river
7	Thickness of wall	320 mm
8	Use of water	For domestic use
9	Tank provided in area	A/P,Kini,Tal-Hatkanangle,Dist-Kolhapur
10	Current population in year 2011	7786
11	Population forecasting 2021	10782.66
12	Distribution system	By symphon

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Population Forecasting

Year	Population	Increase per decades
1971	2991	-
1981	4020	1029
1991	5235	1215
2011	7786	2251
	Average	1498.33

Permissible stresses for M25 and Fe415

$Б_{cbc}$ = 8.5 N/mm^2

$Б_{st}$ =130 N/mm^2

$Б_{cc}$ =6N/mm^2

Arithmetical progress method

Pn = Po+nx

P2031=7786+2x1498.33

P2031=10782.66

IV. MANUAL DESIGN OF CIRCULAR WATER TANK

The water tank is designed for the kini village population of 7786.based on the per capita demand for village the capacity of the watger tank is reached as 7,50,000.the salient features of the overhead water tank is tabulated below.

Table 2: Steel design in component by manual

Component name	Description	Ast provided
Water tank wall	At base - Total steel (Ast provided) Vertical steel- -In lower portion of vertical direction - Curtail alternate bars on outer face	3351mm2 2053mm2(16mmΦ@100mm c/c) 768mm2(10mmΦ@250mm c/c)
Circular base slab	-Steel at design moment -Steel at radial moment -Steel at circumferential -Steel at remaining surface	-4809.63mm2(10#25mmΦ@ 250mm c/c) -2325mm2(12#16mmΦ@ 150mm c/c) -2431mm2(8#20mmΦ@ 120mm c/c) -960mm2(12mmΦ@ 150mm c/c)
Bottom ring beam	- Reinforcement at support -Reinforcement at mid span Stirrups - Side face Reinforcement	-3949mm2(8#25mmΦ@ 140mm c/c) -1718mm2(4#25mmΦ@ 200mm c/c) -12mmΦ-2legged vertical stirrups @ 70mmc/c near support and 120mm in middle half portion -375mm2(2#16mmΦ@300mm c/c)
Column	- Main steel (Longitudinal bars) - Lateral ties	-8#32mmΦ -10mmΦ@300mmc/c
Bracing	- Ast pro - Stirrups	-3539mm2(8#25mmΦat top and bottom) -10mmΦ 2 legged stirrups @320mmc/c

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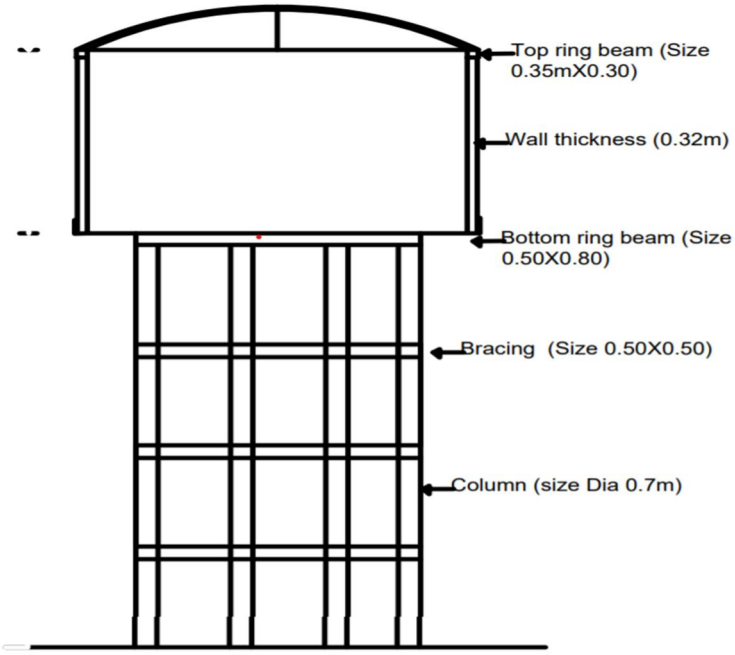
Design details of circular water tank (Diagram)



V. DESIGN OF CIRCULAR TYPE TANK ON SOFTWARE

A. Design Details on Software

1) *Step 1* – Defining material and section property . The material properties and section properties should be defined for the water tank modelling .

2) *Step 2* - Assigning the material and section properties . After the material and section properties , the properties are assigned for the structure in the software .

3) *Step – 3* Assigning pt supports . The fixed supports are assigned to the structure at the base to the columns after defining material and section property.

4) *Step 4* – Defining load patterns .The various loads acting on structure are dead load , live load , wind load ,earthquake load (seismic load) and water pressure these loads are defined .

5) *Step 5* – Assigning the loads . in ETABs Software the dead load of the structure is taken directly . we need not to apply dead load again .Then other remaining loads should be assigning for the structure as per IS codes.

a) Live load = 2KN/m^2per IS -875(part 2)

b) Seismic loads as per IS 1893 (PART_3)

-Zone 3(pune)
- Z = 0.10
- I = 1.5
- R =5
- Ta = 0.09h/√d

c) Wind load as per IS -875 PART 3

- Location = pune
- (Vb)m/ssec = 33m/sec
- (k1) = 1
- (k2) = 1
- (k3) = 1.046
- (V2) = Vb *K1 * K2* k3
- (Pz) = 0.6*Vz^2

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6) *Step 6*- Load combinations .In ETABs the load combinations will be automatically generated and can also be defined by user . there are 26 load combinations that are defined according to IS 875 (part 5) : 1987 based on serviceability conditions. After the completions of above steps the analysis iscarried and then results will be obtained .

7) *Step 7* – After completion of analysis the results are obtaining the software by that values the design is done manually by working stress and limit state method.

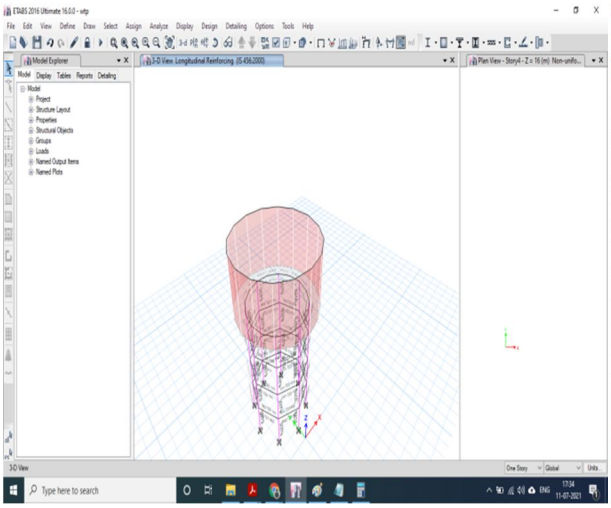

Photo 1. Loads Assinging the loads

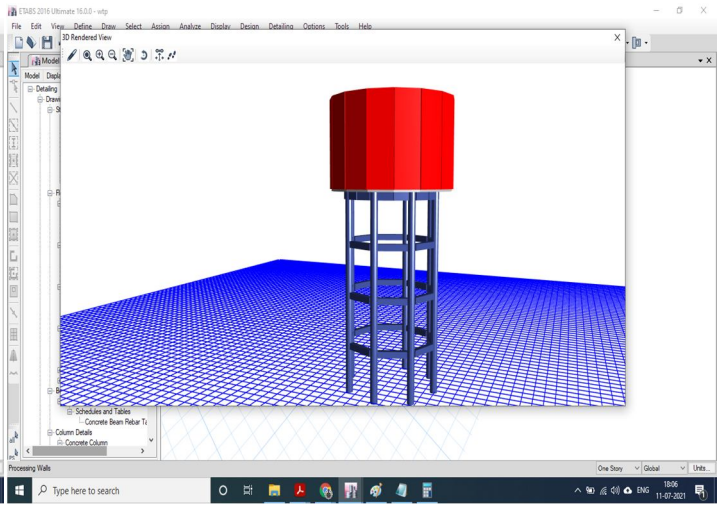

Photo 2. 3d Model of Tan

VI. SOFTWARE DESIGN OF CIRCULAR TANK

Table 3:Steel design in components by software

Component name	Description	Ast provided
Water tank wall	At base - Total steel (Ast provided) Vertical steel- -In lower portion of vertical direction - Curtail alternate bars on outer face	3056 mm2 12 mm ϕ@275 mm c/c 12mm ϕ@275mm c/c
Circular base slab	Steel at design moment Steel at radial moment Steel at circumferential Steel at remaining surface	4535 mm2(12#20mmΦ@ 200 mm c/c) 2049 mm2(6#20mmΦ@ 100 mm c/c) 2241 mm2(10#16mmΦ@ 100 mm c/c) 745 mm2(10 mmΦ@ 100mm c/c)
Bottom ring beam	Reinforcement at support Reinforcement at mid span Stirrups Side face Reinforcement	3539 mm2(8#16mmΦ@ 100 mm c/c) 1508 mm2(6#16mmΦ@ 150mm c/c) 12mmΦ-2legged vertical stirrups @ 70mmc/c near support and 120mm in middle half portion 300mm2(12mmΦ @275mm c/c)
Column	- Main steel (Longitudinal bars) - Lateral ties	18#12mmΦ 10mmΦ@100mmc/c
Bracing	- Ast pro - Stirrups	3149 mm2(12#20mmΦat top and bottom) 10mmΦ @250mmc/c

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VII. RESULT

Table 4:Quantity of steel design by manually and by software

SR NO	Component part of water tank	Quantity of steel (manual)(kg)	Quantity of steel (software)(kg)
1	wall	506.75	174.22
2	Base slab	984.07	798.91
3	Bottom ring beam	703.61	298.15
4	column	826.83	642.65
5	bracings	4544.06	4008.29
		Total=19775.57kg =19775.57/1000 =19.77tones	Total =15325kg =15325/1000 =15.32tone

VIII. CONCLUSION

Storage of water in the form of tanks for drinking and washing purpose swimming pools for exercise and enjoyment and sewage sedimentation tanks are gaining increasing importance in the present day life .For small capacities we go for rectangular water tanks while foe bigger capacities we provide circular water tanks.

Design of circular water tank is a very tedious method the whole structure is designed manually considering M20 grade concrete and fe415 steel.After manual design and analysis in ETAB our structure is safe for both structural design and sesmic analysis with respect to load applied

Software analysis and design is always beneficial over the conventional method of analysis and design of water tank . Manual analysis and design requires lengthy complicated procedure while software requires less time and easy design and analysis. In manually design of water tank the Total quantity of steel required 19 tone of whole structure. And other hand by using ETAB software the Total quantity of steel required 15 tone.Hence we finally conclude that using etab software there is saving 4.5 tone quantity of total steel in the whole structure design

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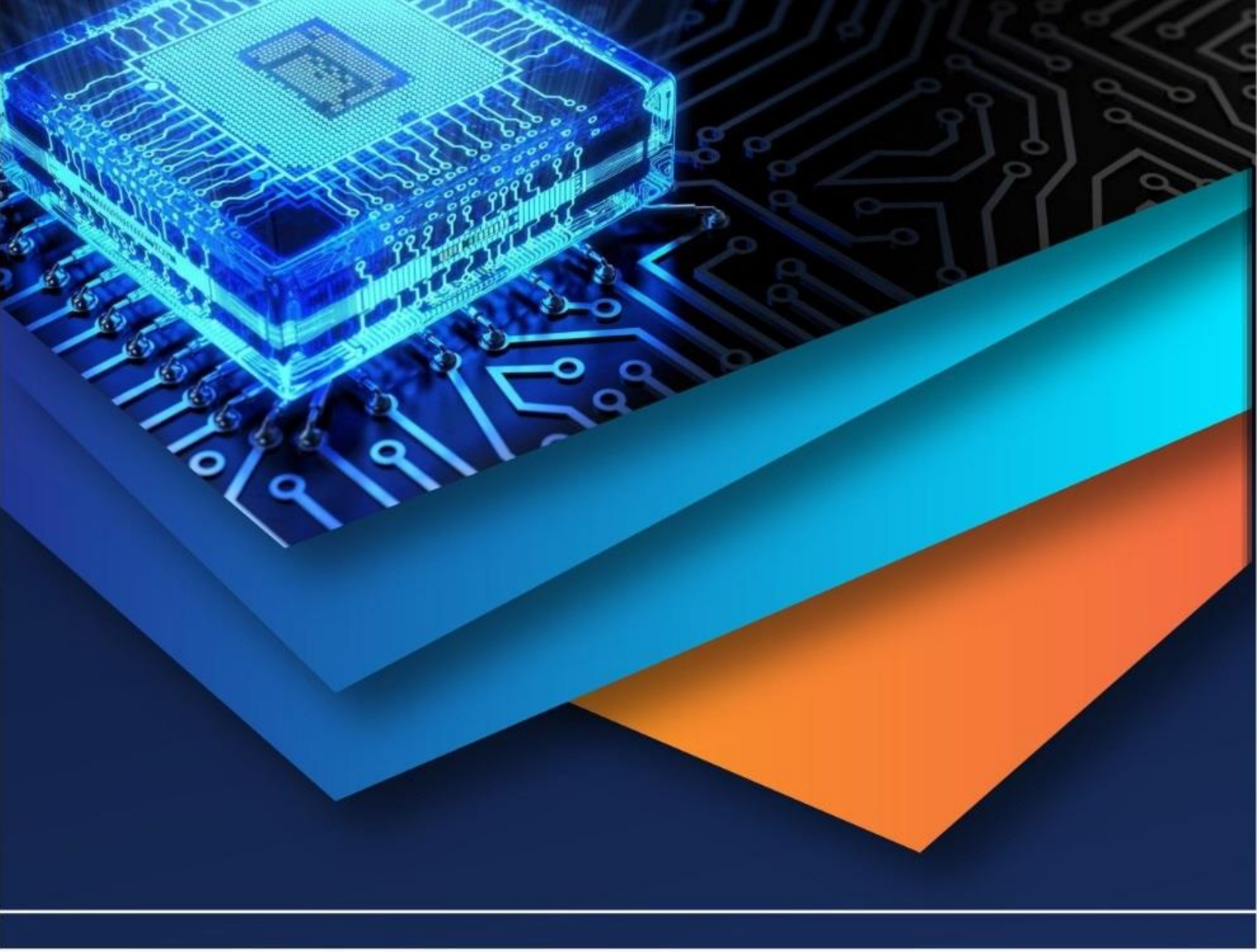

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