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Comparative Analysis of Water Tank with Varying Container Shape

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Abstract – We all know that w*ater is the most vital requirement of human being for better livelihood. As the population is growing day by day in our country with rapid speed it is the need of time to study on storage capacity and shapes of storage tanks. Present study deals with the Comparative analysis and design of three basic shapes of water tank, Square, Circular and Rectangular. After analyzing all models it is found that Square and Rectangular shape tank gives better results than circular shape tank.*

***Key Words*: Circular, Square, Rectangular, Staad Pro. Seismic Analysis**

1.INTRODUCTION

Water is human basic needs for daily life. Elevated water tanks consists of a huge water mass at a the top of slender staging which are most critical consideration for the failure of the tank during earthquakes, elevated water tanks are critical and strategic structures and damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and substantial economical loss. The performance of elevated water tanks during earthquakes is of much interest to engineers, not only because of the important of these tanks in controlling fires, but also because the simple structure of an elevated tank is relatively easy to analyse and, hence the study of tanks can de informative as to the behaviour of structures during earthquakes.

1.1 Definition Of Water Tank

A water tank is a container for storing water. The need for a water tank is as old as civilization, providing storage of water for drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other applications

1.2 Elevated Water Tank

Water is day by day essential requirement for each human life. A raised Reinforced Concrete roundabout tank is a water storage tank built with the end goal of holding water supply at certain tallness to pressurize the water circulation framework. Numerous new thoughts and developments have been made for the capacity of water and other fluid materials in distinctive structures and molds.

2. OBJECTIVES

1) To perform Seismic analysis for Circular, Rectangular and Square Elevated water tank.

2) To compare various parameters Such as Base Shear, Axial Forces etc.

3) To find the most efficient container shape.

3 LITERATURE REVIEW

Various Literatures have been studied related to present topic from all this literature study it is found that there is need of more study to be done on container shape based on geometric shapes. Various literatures which have been referred are listed in reference section

4. METHODOLOGY

The whole project work is divided into various sub phases which is as elaborated below

PHASE-I

a) To Decide Aim, Objective and Need of Work

As India is a country of villages, with rapidly increasing population there is a vast demand of water storages in various remote area of our country. purpose the present work aims to find the most efficient shape of water tank in various seismic zones of India

b) To Review Various Literatures, Codes and Journals

To achieve this precision various literatures were studied to decide the path of this current work.

c) To decide the flow of work i,e Methodology

To complete the work in a efficient form this work is divided in various standard phase to easily complete the work with high efficiency and with more precision

PHASE-II

a) Detail Study of all possible Structural

In the present study all detailed study related to types of water tank various structural elements of RCC tank, details of public water supply and the population details has been conducted to finalized project parameters

b) Effect of Earthquake and Its parameter

In the context of currently significantly varying seismic conditions of India it is must to study the effects of earthquake and design the structures to withstand this forces. Also as this structure belong to public sector it is more important that this structure should fulfill the future capacity demands as well as the seismic demands. So, various models were analyzed in seismic zones II and V as per IS-1893:2002

c) Types of loading and Methods of Analysis

After considering all general consideration, types of load and their effect on structure must be find out and their respective values to be considered. In the present work as the structure is water tank the main load to be consider is of water (10Kn/m^3), then self-weight of structure and Earthquake load. This earthquake load varies according to zones which were considered and their values are taken from IS-1893:2002. For analysis purpose Static Co-efficient method is used, as it was found in many research papers that static analysis gives higher values of base shear than dynamic method.

d) Fixing All general Structural Data and Case Considerations of Models

Once the types of loads acting on structure and their intensities are finalized the last step of phase-2 is to decide the structural constants and material constants. In the present work three basic geometric shapes were considered which are, Circular, Rectangular and Square. Their capacities and dimensions are calculated on the basis of population and future forecast of population. Reinforced cement concrete of grade M-30 and steel of grade Fe-415 were considered as material constants for all shapes of water tanks and in all seismic zones

PHASE –III

a) Analyzing all the selected model patterns

All predefined models were then analyzed with action of loads and loading combinations prescribed by IS 1893 using STAAD PRO V8i SS5 series software for getting the most efficient and precise results. Total 06 models will be analyzed as per IS 1893 (part2), which are divided as 03 models in Zone II, 03 models in Zone V,

b) Drafting of Comparative result Statements

After analyzing all models an separate comparisons will be made between all tanks within their respective zones and tank conditions, for various structural values obtained from analysis such as Base shear, Reactions, Overturning moment and Displacement.

c) Discussing all obtained Results

Depending upon the comparative results for above said water tank a detailed discussion will be carried out to understand all the possible perspective of various shapes and their behavior in different seismic zones and storage conditions.

d) Conclusions on results obtained after analysis and Discussion

Based on the results and discussions in the previous chapters final conclusions will be drafted to summaries the study which will help to decide the use of particular type of water tank in a specified seismic zone with varying storage conditions.

Table 01. Model Nomenclatures

Sr. No	Model Details	Labels
01	Circular shape water tank in Zone-II	C1
02	Circular shape water tank in Zone-V	C2
03	Square shape water tank in Zone-II	S1
04	Square shape water tank in Zone-V	S2
05	Rectangular shape water tank in Zone-II	R1
06	Rectangular shape water tank in Zone-V	R2

Table 02. Structural Parameters

Sr. No.	Structural Component	Value
01	Concrete	M40
02	Structural Steel	FE-500
03	Zone	II/V
04	Response Reduction Factor	5 (SMRF)
05	Importance factor	1.5
06	Type of Soil	Medium Stiff

07	Size of bracing Beam	300mm x 450mm
08	Size of column	-
	Circular Tank	600mm (dia.)
	Square Tank	530mm x 530mm
	Rectangular Tank	450mm x 630mm
09	Thickness of Side wall	450mm
10	Thickness of Top Slab	300mm
11	Thickness of Base Slab	450mm
12	Staging Height	3.00m
13	Depth of Foundation	1.5m

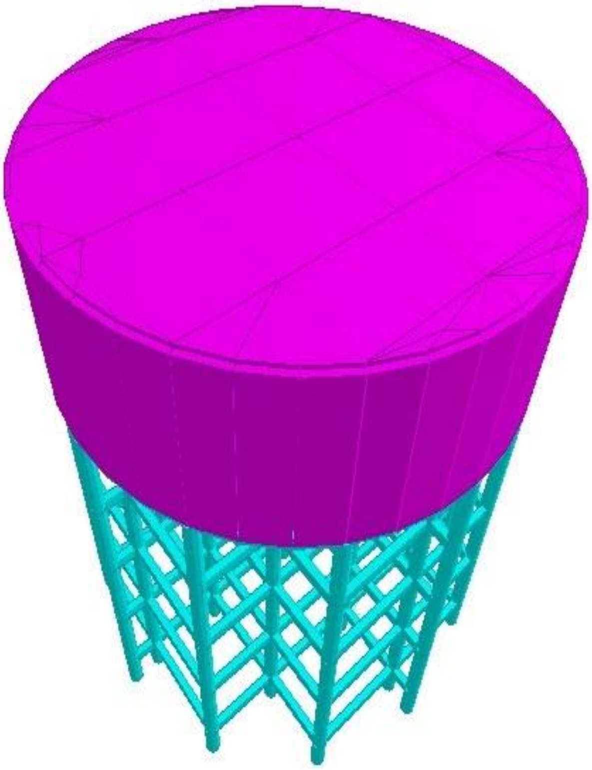

Fig. 01 3D View of Circular shape tank

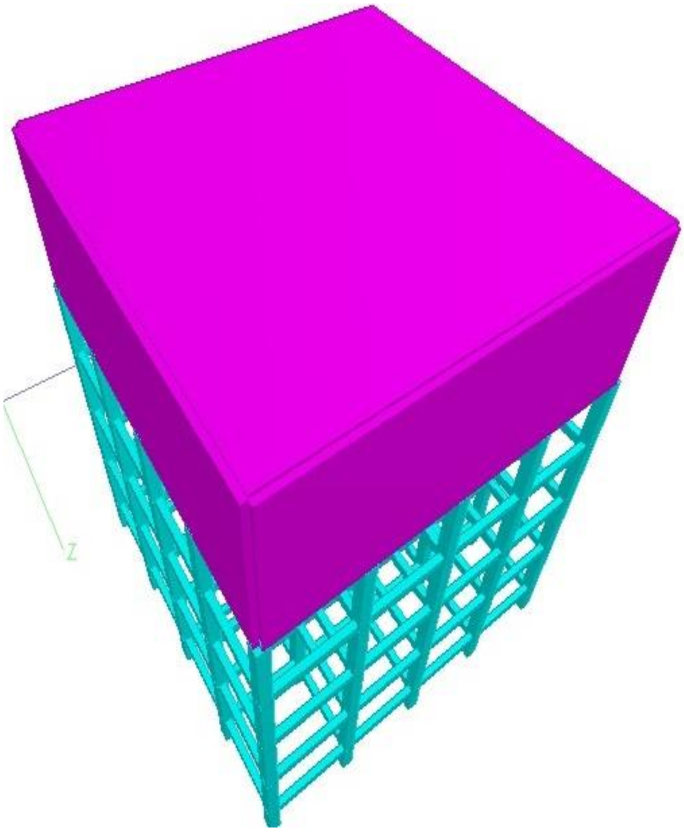

Fig. 02 3D View of Square shape tank

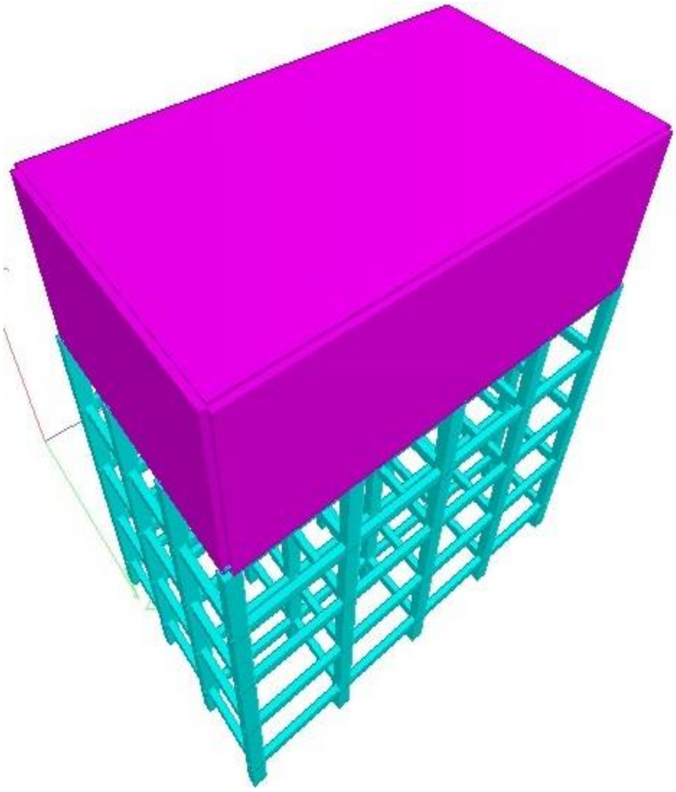

Fig. 03 3D View of Rectangular shape tank

5 Results and Comparison

After Analysis various models following results were obtained

5.1 Result Comparison of all models in Zone-II

Table 03 Results for al models in Zone-II

Sr No	Model	Max. Displacement (mm)	Max. Axial Force (KN)	Max. Moment (KN.M)	Base Shear (KN)	Quantity of Concrete (CUM)	Quantity of Reinforcement (KN)
01	C1	38.04	2611.015	219.51	801.518	244.20	151.24
02	R1	27.76	2916.75	313.36	649.39	179.90	120.19
03	S1	16.96	3064.83	223.18	374.37	224.30	140.90

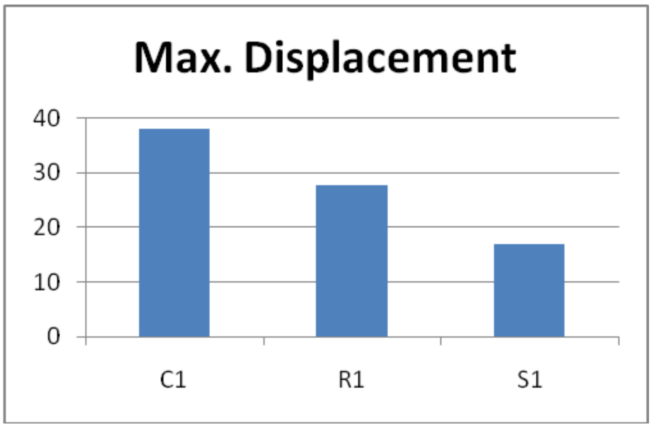

Fig.04. Comparison of Max. Displacement in Zone-II

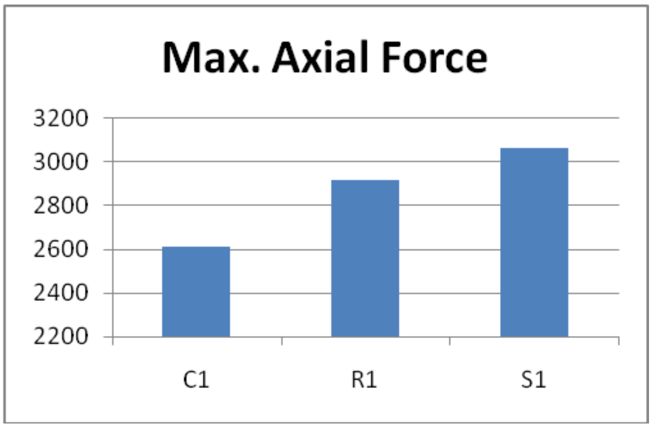

Fig.05. Comparison of Max. Axial Forces in Zone-II

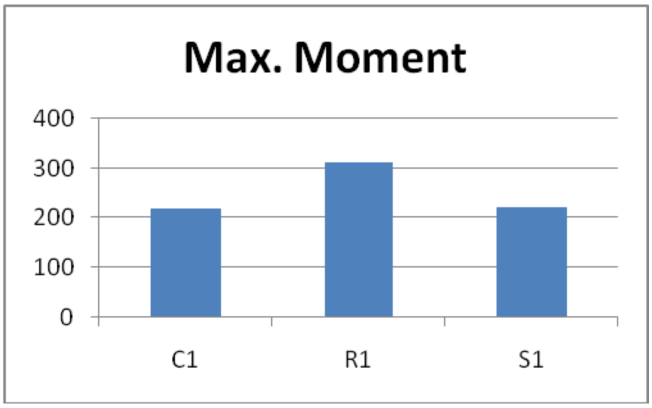

Fig.06. Comparison of Max. Moment in Zone-II

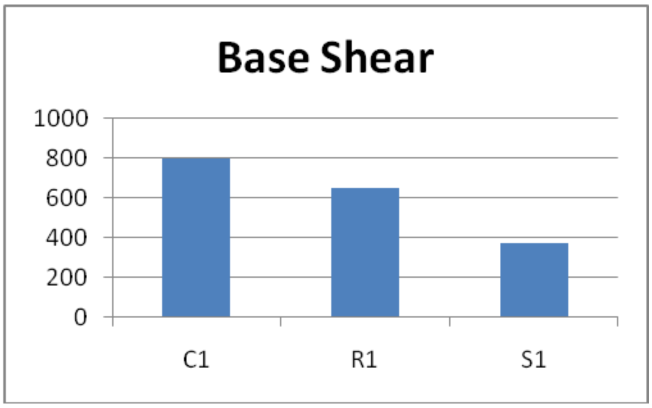

Fig.07. Comparison of Base Shear in Zone-II

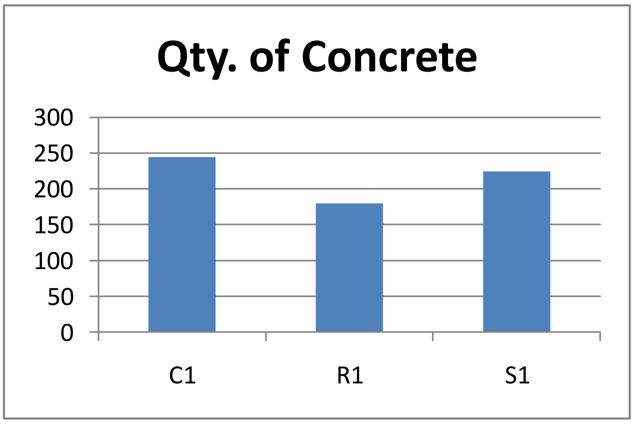

Fig.08. Comparison of Concrete Qty. in Zone-II

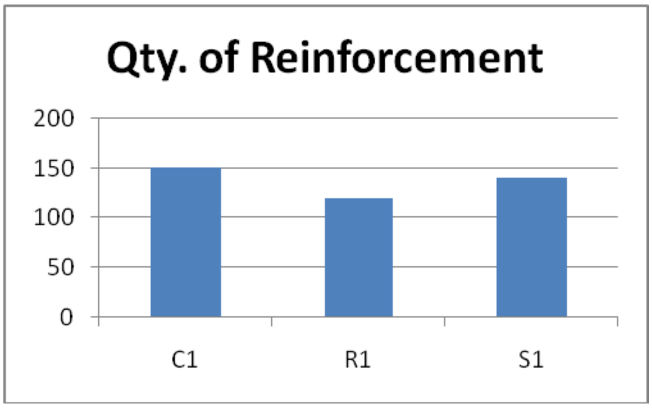

Fig.09. Comparison of Reinforcement Qty in Zone-II

5.2 Result Comparison of all models in Zone-V

Sr No	Model	Max. Displacement (mm)	Max. Axial Force (KN)	Max. Moment (KN.M)	Base Shear (KN)	Amount of Concrete (CUM)	Amount of Reinforcement (KN)
01	C2	87.73	3817.73	631.40	2885.46	241.40	286.45
02	R2	89.80	3676.66	732.39	2337.80	179.90	250.37
03	S2	39.16	3413.43	375.55	1347.72	224.30	180.14

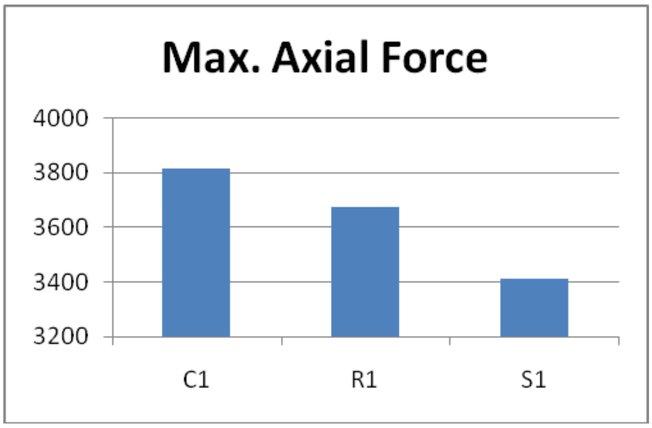

Fig.11. Comparison of Max. Axial Force Qty in Zone-V

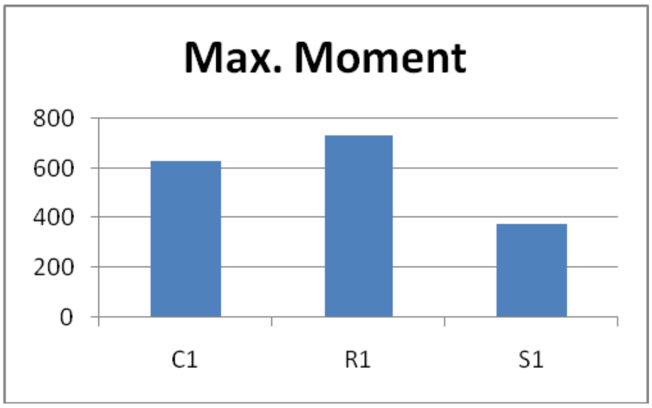

Fig.12. Comparison of Max. Moment Qty in Zone-V

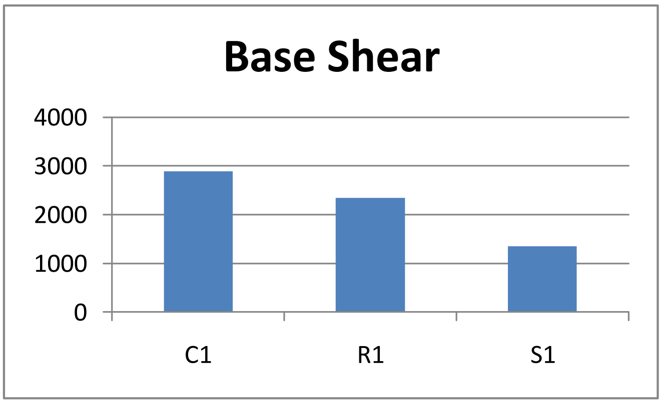

Fig.13. Comparison of Base Shear in Zone-V

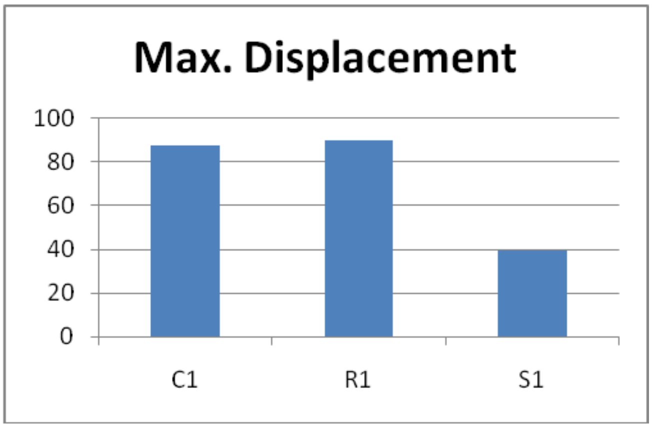

Fig.10. Comparison of Max. Displacement Qty in Zone-V

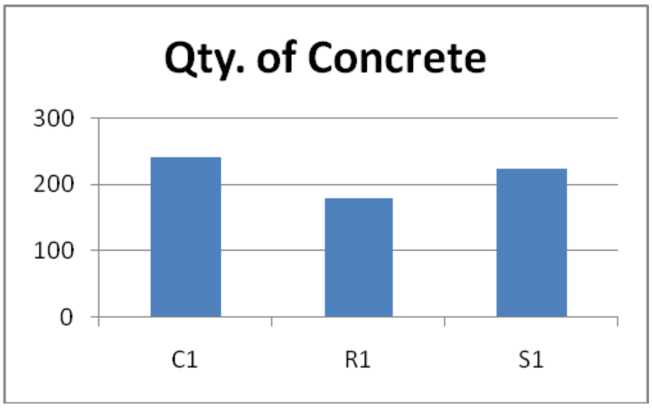

Fig.14. Comparison of Concrete Quantity in Zone-V

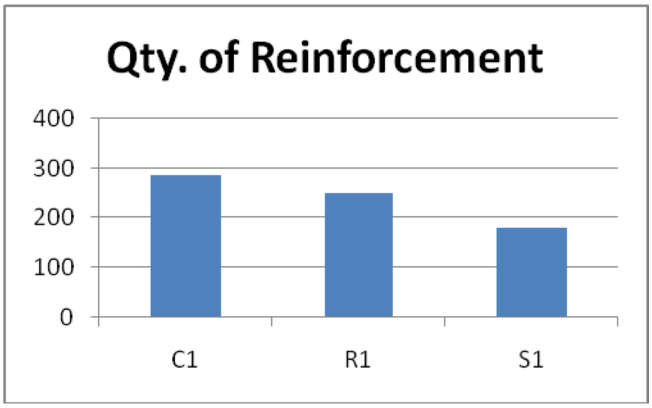

Fig.15. Comparison of Reinforcement Qty in Zone-V

6 CONCLUSIONS

From analysis and Above result comparisons following conclusions were drafted

1) Change in shape of tank made effect on seismic behavior of tank

2) In low seismic Zone square and rectangular tank gives better results than circular shape water tank

2) In high seismic zone square and rectangular tank behaves better than circular tank

3) both square and rectangular shape tank gives lower values of displacement, base shear and quantity of reinforcement compared to circular shaped tank

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