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Static Analysis of Rcc, Partially Encased & Fully Encased Composite Column Supported Elevated Water Tank

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Abstract – *Water is one of the basic needs of humans; therefore, the proper storage of water is an essential requirement for a community. So that, it is required to make elevated water tanks perform better during earthquakes and make them safer. This paper contains the static analysis of square elevated water tank with RCC, Partially Encased & Fully Encased Column Supported Elevated Water Tank. The study is based on the advancements in construction technology to better use composite structures for earthquake resting structures. The analysis and comparisons are made for the combinations of different Staging Heights of 20m, 25m, & 30m and various Soil Conditions for the capacity of 10 lakh liters of water. The models are prepared with ETABS Software. The analysis is done based on the provisions given in IS 1893-Part 2: 2014, and the seismic parameters like Deflection, Drift, Fundamental Time &Base Shear have been compared.*

Keywords - *Static Analysis, Fully Encased Section, Partially Encased Section, Deflection, Drift, Fundamental Time, Base Shear.*

I. INTRODUCTION

Construction technology is rapidly growing, and lots of research has been done on the composite structural system. Studies prove that the composite structural system can be advantageous over the conventional RCC Structural system in the context of structural cost and better performance during earthquakes. The water tanks are considered a substantial structure and should be capable of resisting higher magnitude earthquakes. This study analyzes an elevated water tank with different supporting systems and different soil conditions and compares them for various seismic parameters. For research purposes, data have been picked up hypothetically, and models have been prepared using ETABS Software. The seismic analysis has been performed on RCC, Partially Encased & Fully Encased column supported elevated water tanks.

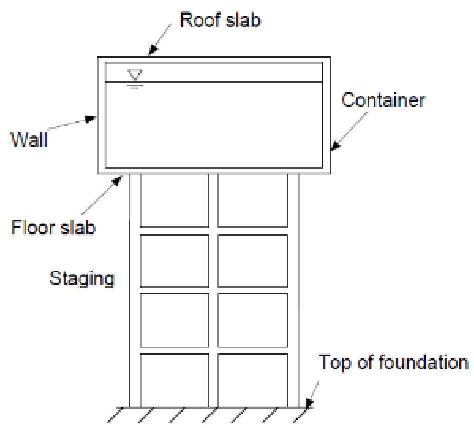


Fig.1 Elevated Water Tank

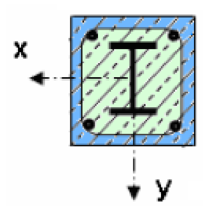


Fig. 2(a) Fully Encased Section

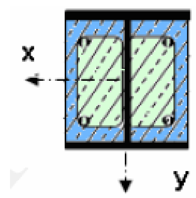


Fig. 2(b) Partially Encased Section

There are mainly two types of systems used in the composite columns: Concrete filled tube sections and Concrete Encased Sections. From this, we have used Concrete Encased sections as Partially Encased & Fully Encased Section as shown in figure 2.

II. Methodology

For the parametric study, the tank model has been prepared for 10 lakh liter capacity, with heights of 20m, 25m, & 30m. The tank models are three types, RCC, Partially Encased & Fully Encased column supporting system resting on Soft, Medium, and Hard soil strata. The models simulated on ETABS. The results are obtained for the parameters like Deflection, Drift, Base shear &Fundamental Time. Fundamental Time The Model configurations are as follows:

A. Model Configurations

The capacity of the tank: 10 lakh liters

Soil Condition: Soft, Medium, Hard

Earthquake Zone: IV

RF for RCC System: 2.5

RF for Composite System: 3.3

Dimension of container: 15m X 15m X 4.8m

Free Board: 0.3 m

The thickness of top slab: 120 mm

The thickness of bottom slab: 200 mm

The thickness of sidewall: 200 mm

Size of RCC Column: 400 X 400 mm

Size of RCC Beam: 400 x 400 mm

Member Used in PE Column: ISHB 250 @ 64.96 kg/m Wt.

Member Used in PE Beam: ISMB 350 @ 52.4 kg/m Wt.

Member Used in FE Column: ISHB 350 @ 67.4 kg/m Wt.

Member Used in FE Beam: ISMB 300 @ 56.26 kg/m Wt.

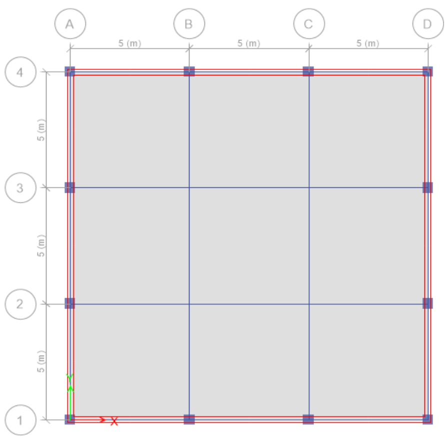


Fig. 3 (a) Plan view of ETABS Model For RCC and Composite Elevated Water Tank.

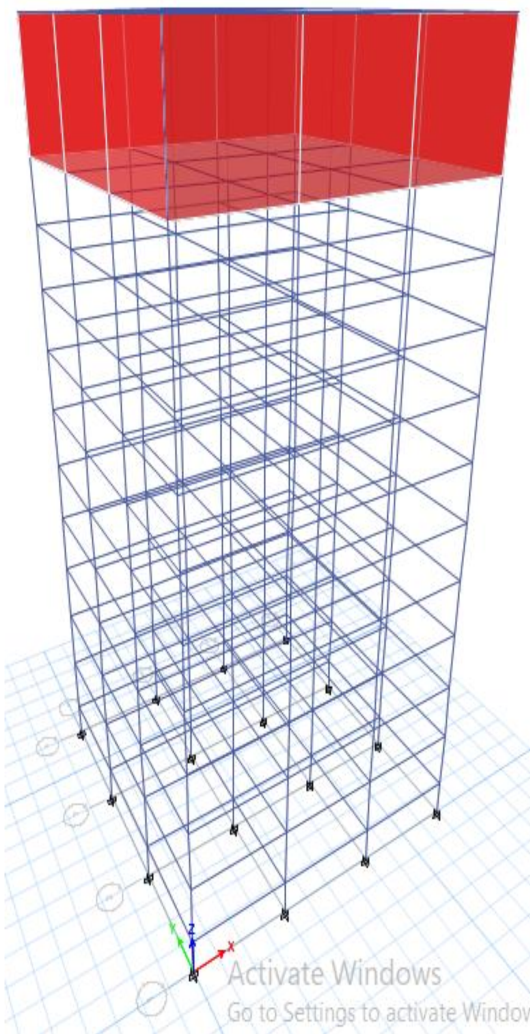


Fig. 2 (b) Side (3D) view of ETABS Model For RCC and Composite Elevated Water Tank.

B. Effective flexural stiffness

$(EI)_{eff} = E_a I_a + E_s I_s + K_c E_{cm} I_c$

Where,

- Kc is a correction factor that is 0.6,
- I_a, I_e, and I_s are the second moments of area of the structural steel section, the un-cracked concrete section, and the reinforcement for the bending plane being considered.

III. Results & Discussion

As per the above-shown data, the seismic analysis was performed. The results obtained are listed below, corresponding to the soil condition.

A. For Soft Soil

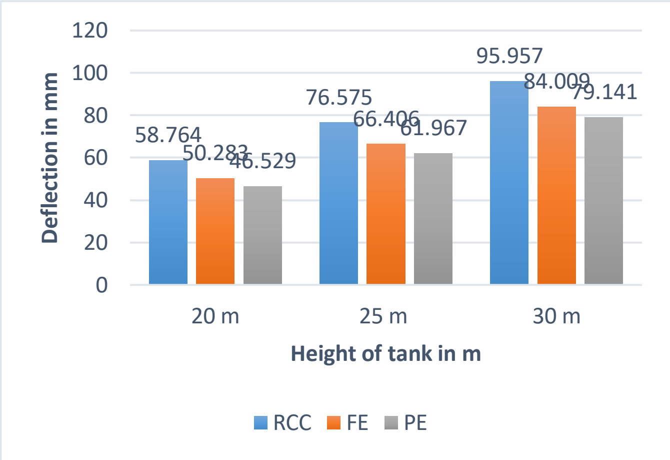


Chart 1 (a) Maximum Deflection in mm

1) Chart 1(a) shows that the maximum deflection is reduced by about 15% in the Fully Encased Section and about 20% in the Partially Encased Section than that of the RCC Section.

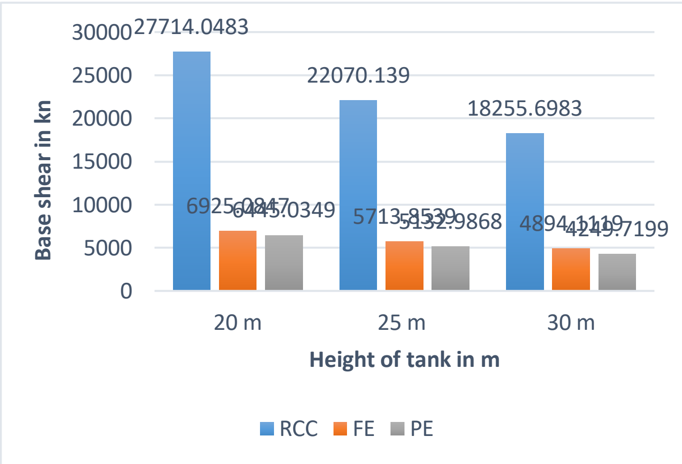


Chart 1 (b) Base Shear in KN

2) Chart 1(b) shows that the Base Shear is reduced by 73% to 77% in Partially & Fully Encased Sections than that of the RCC Section.

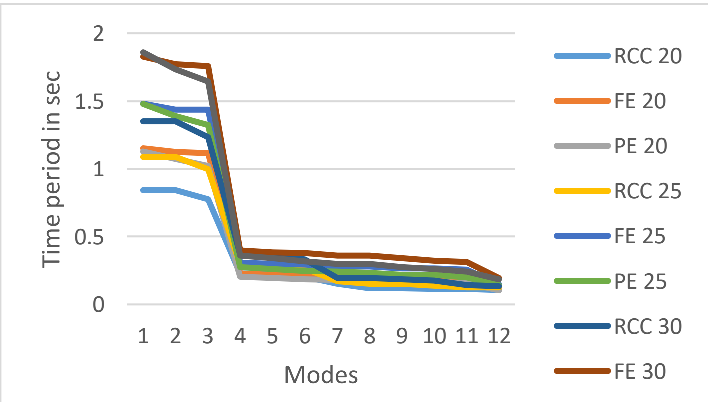


Chart 1 (c) Fundamental Time in Sec against Mode

3) From Chart 1(c), The Fundamental Time is seen to be increased by 20% to 30% in Partially and Fully Encased Sections than that of RCC Section.

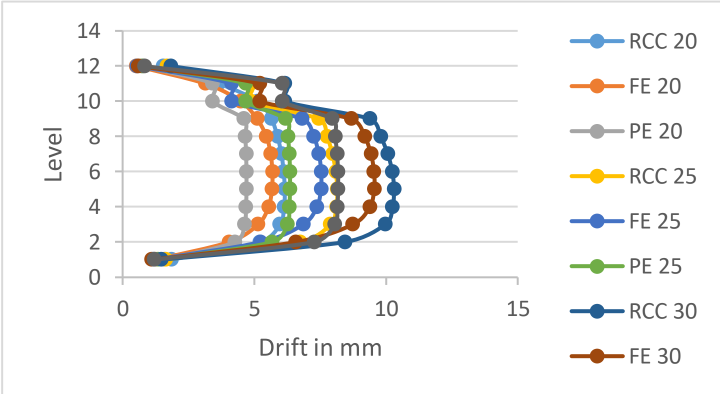
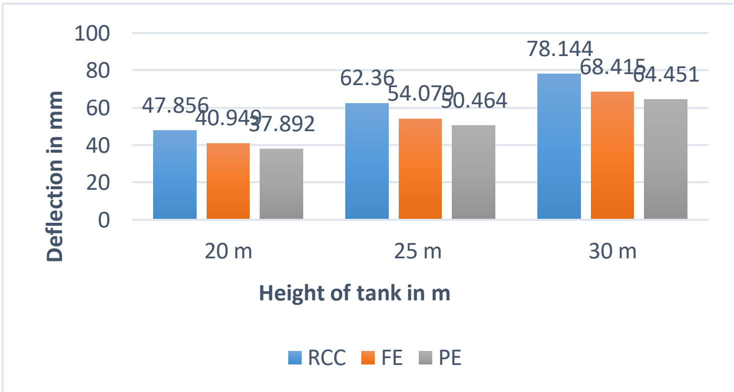


Chart 1 (d) Drift in mm

4) Chart 1(d) shows that the drift is reduced by 15% to 20% in the Partially & Fully Encased



Section than that of the RCC Section.

B. For Medium Soil

1) Chart 2(a) shows that the maximum deflection

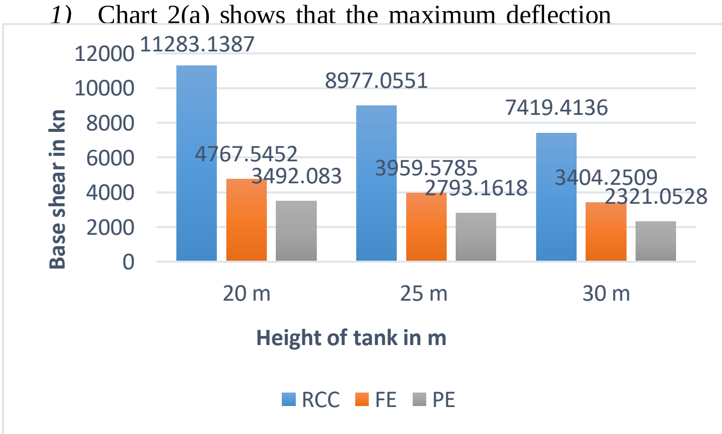


Chart 2 (b) Base Shear in KN

2) Chart 2(b) shows that the Base Shear is reduced by 73% to 78% in Partially & Fully Encased Sections than that of the RCC Section.

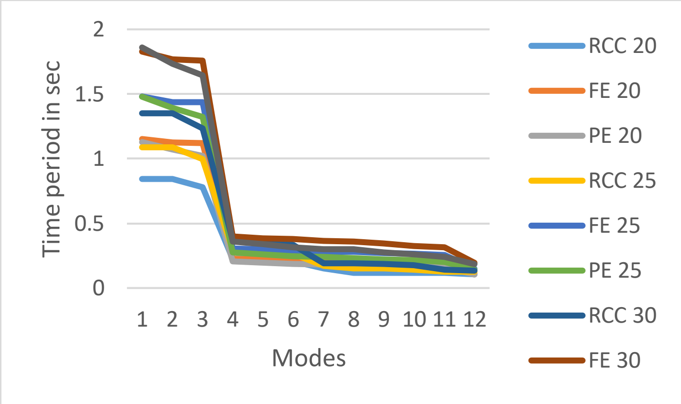


Chart 2 (c) Fundamental Time in Sec against Mode

3) From Chart 2(c), The Fundamental Time is seen to be increased by 20% to 30% in Partially and Fully Encased Sections than that of RCC Section.

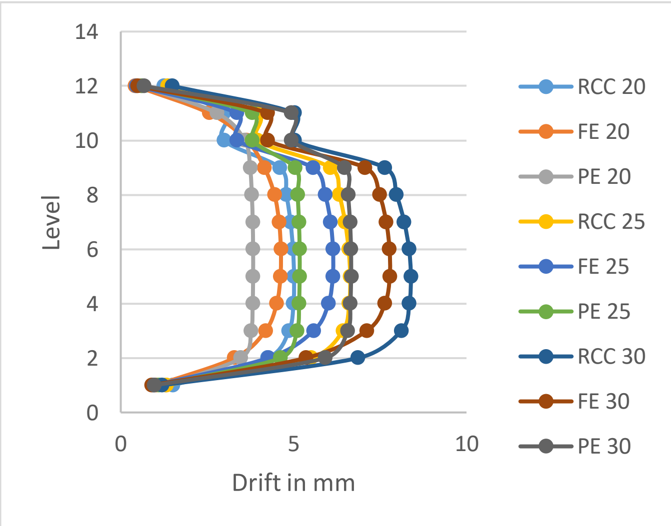


Chart 2 (d) Drift in mm

4) Chart 2(d) shows that the drift is reduced by 20% to 25% in the Partially & Fully Encased Section than that of the RCC Section.

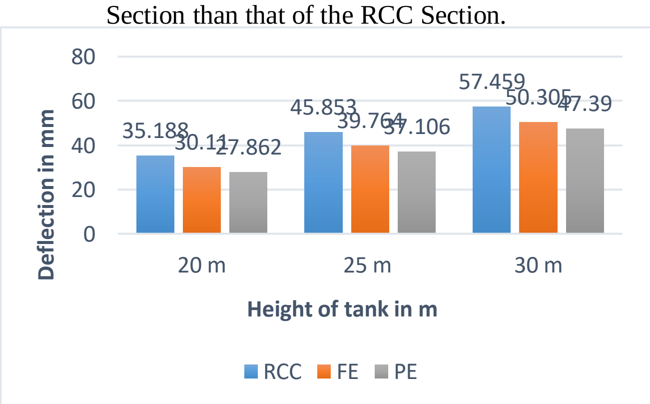


Chart 3 (a) Maximum Deflection in mm

1) Chart 3(a) shows that the maximum deflection is reduced by about 12% in the Fully Encased Section and about 18% in the Partially Encased

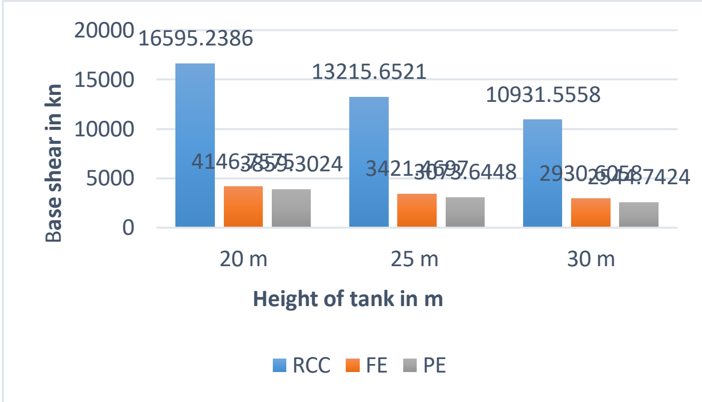


Chart 3 (b) Base Shear in KN

2) Chart 3(b) shows that the Base Shear is reduced by 75% to 77% in Partially & Fully Encased Sections than that of the RCC Section.

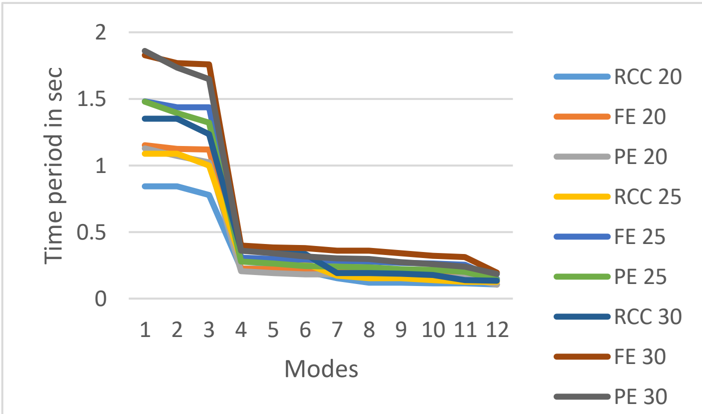


Chart 3 (c) Fundamental Time in Sec against Mode

3) From Chart 3(c), The Fundamental Time is seen to be increased by 20% to 30% in Partially and Fully Encased Sections than that of RCC Section.

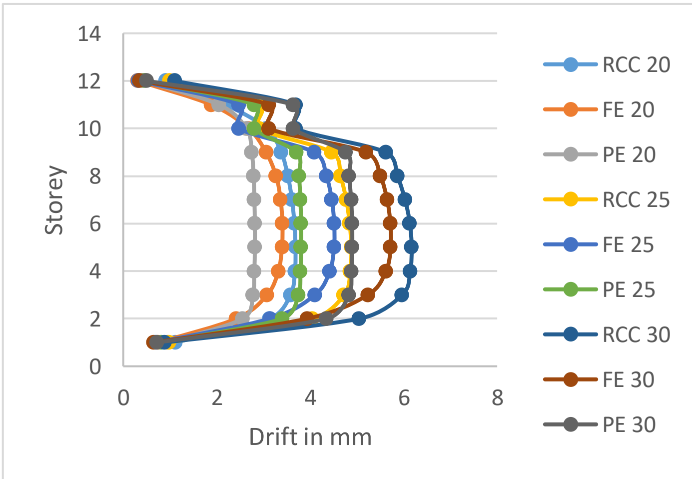


Chart 3 (d) Drift in mm

4) Chart 3(d) shows that the drift is reduced by 15% to 25% in the Partially & Fully Encased Section than that of the RCC Section.

IV. CONCLUSIONS

The model study has been carried on a 10 lakh liter elevated water tank with various height combinations and three soil conditions. From the results discussed above, the summarized conclusions are as follows.

1) The maximum deflection was found out to be reduced by 12% in soft soil & 15% in hard soil in the Fully Encased section And 18% in soft soil & 22% in hard soil in the Partially Encased section.
2) The Base shear was found out to be reduced by 73% in the Fully Encased section And 78% in the Partially Encased section for all the soil conditions.
3) The Fundamental Time was increased about 30% in the Fully Encased section And 20% in the Partially Encased section in all the soil conditions.
4) The drift was found out to be reduced by 15% in hard soil & 20% in soft soil And by 20% in hard soil & 25% in soft soil in the Fully Encased section & the Partially Encased section, respectively.

It can be further brief up that the Composite Sections has performed well in all the aspects. To be precise, The Fully Encased Composite Section has served better among all and should be considered for the design of elevated water tanks.

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