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ijirset@gmail.com

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Comparative Analysis of Position of Water Tank as Fluid Viscous Damper on G+15 Multistorey Building Using ETABS

Sandesh T, Nidarshana D P

Post Graduation Student, Department of Civil Engineering, Bapuji Institute of Engineering and Technology College,
Davangere, Karnataka, India

Assistant Professor, Department of Civil Engineering, Bapuji Institute of Engineering and Technology College,
Davangere, Karnataka, India

ABSTRACT: In this analysis done using ETABS, we are evaluating the behaviour of a multi-story overhead tank equipped with FVD under seismic forces. The 1st step involves modelling the structure in the software, considering the tank walls, columns, beams, and slabs. We assign appropriate material properties to these elements, like concrete and steel. After applying relevant loads, such as dead and live loads, we introduce the water mass inside the tank using FVD which is then incorporated into the model as a special link element, and we define its damping coefficient. To estimate the best position for the FVD, we perform response spectrum analysis. This involves defining the SRS due to the relevant design code and regulations, specifying parameters like Displacement, story shear and auto lateral loads. We create for each model with relevant load cases and FVD position, applying the seismic forces to the building. By running the analysis for each case, we obtain the structure's responses, including displacements and accelerations, particularly at critical locations like position of the tank and each store from top to base of the structure and compare damper positions. The ideal position will be the one that minimizes the structure's response to seismic forces, thereby enhancing its overall stability and safety during earthquakes. Analysed results suggest further optimization, adjustments to the FVD's location and damping coefficient can be made to achieve the desired level of vibration control and seismic performance. Ultimately, this comprehensive analysis helps in designing a resilient and well-protected multistorey structure with overhead tank against seismic events, ensuring the safety of both the structure and its occupants.

KEYWORDS: Fluid Viscous Damper, Seismic Response Spectra, Response spectrum.

I. INTRODUCTION

In a world that increasingly relies on complex and sophisticated structures, ensuring the safety and stability of these buildings is of utmost importance. One such critical infrastructure is the multistorey overhead tank, which plays a crucial role in storing and distributing water to meet the demands of growing urban populations. However, these tall and slender structures are susceptible to dynamic forces, especially during seismic events. To enhance their resilience and mitigate the potential risks posed by earthquakes, engineers are exploring innovative strategies, such as incorporating FVDs into the design. FVD- Fluid Viscous Damper are devices that offer controlled energy dissipation, effectively mitigating the structural response to dynamic forces by absorbing and dissipating seismic energy.

This study aims to investigate overhead tank with a FVD under seismic forces using the powerful structural analysis software, ETABS. By simulating various damper positions and conducting response spectrum analysis, we seek to identify the optimal location for the FVD that minimizes the structure's response to earthquake. Here the zone 4 severe intensity zone is taken and medium soil type are taken during analysis.

The outcomes of this research will contribute to designing more robust and earthquake-resistant multistorey structure, ensuring the safety of communities and infrastructure in seismic-prone regions. Through this investigation, we aspire to provide valuable insights into the integration of fluid viscous dampers as an effective seismic mitigation strategy for multistorey overhead tanks, ushering in a new era of safer and more resilient infrastructure. By incorporating FVD and reducing the seismic vulnerability of multistorey overhead tanks. Ultimately, our research aims to foster the



development of safer and more resilient structures, ensuring the structure to withstand the seismic conditions and loads exerted on structure.

II. METHODOLOGY

Response Spectrum Method

To do this performs the seismic analysis and design on a structure, actual-time history record is important that will be designed in an exact location. The availability of such records everywhere is not possible. Also, it is unable to do a seismic study of a structure based upon the optimum value of ground acceleration because a structure's response due to frequency distribution of the motion of the earth and its own motion properties. The best method for structural seismic analysis is the earthquake response spectrum.

This component deals with response spectrum method and its use to different types of the structures. A code of provisions as per IS: 1893 (Part 1)-2002 code for the response spectrum analysis of high-rise buildings is also summarized. The modelling and design of the models were carried out in ETABS software. Model description and parameters were tabulated below. Position of the water tank is taken through core left and right and bottom left and right side of structure.

Fluid Viscous Damper

FVDs are devices that offer controlled energy dissipation, effectively mitigating the structural response to dynamic forces by absorbing and dissipating seismic energy. This study focuses on using the advanced structural analysis software, ETABS, to evaluate the effectiveness of (FVDs) in reducing the seismic vulnerability of multistorey overhead tanks. The primary objective is to find the optimal position of the FVD within the tank structure to achieve the best possible seismic response. To achieve this goal, we first create a detailed 3D model of the multi-storey overhead tank in ETABS, incorporating all relevant structural components and material properties. We consider various loading scenarios, including dead loads, live loads, and wind loads, to simulate the real-life conditions the tank may encounter.

Table 1: Parameters consider for the model

SL. NO	PARTICULARS	VALUES
1	No. of Story	G+15
2	Ground floor height	3m
3	Height of tank	2m
4	Column size	[C1]750mmx750mm [C2]600mmx600mm
5	Beam size	[B1]750mmx550mm [B2]600mmx450mm
6	Shade	130mm
7	Thickness of slab	200mm
7	Thickness of slab	200mm
8	Wall thickness	230mm
9	Grade of concrete	M45
10	Grade of Steel	Fe550
11	FVD	250KN
12	Seismic Zone	IV
13	Code book consideration	1) IS: 1893 (part-1)-2002, 2) IS 456- 2000

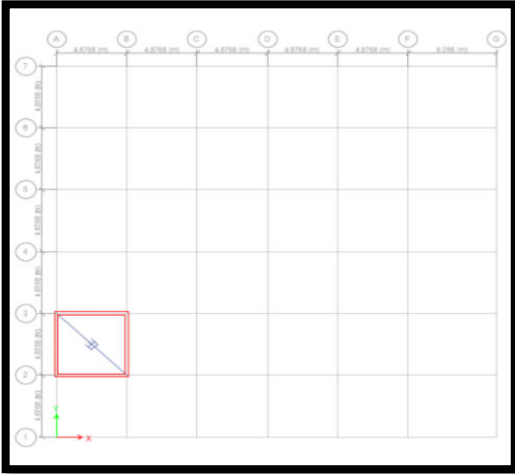


Fig. 1: 2D Frame of Model 1

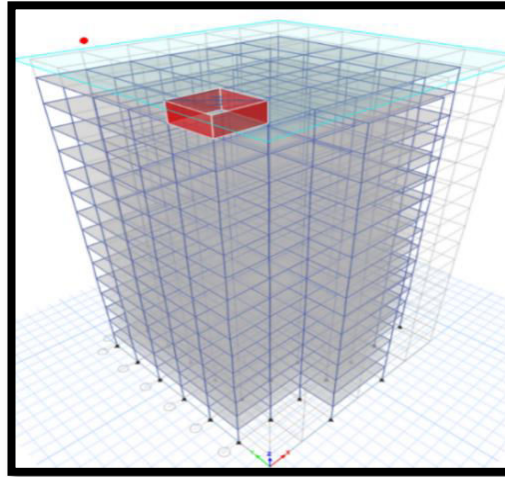


Fig. 2: 3D Frame of Model 1

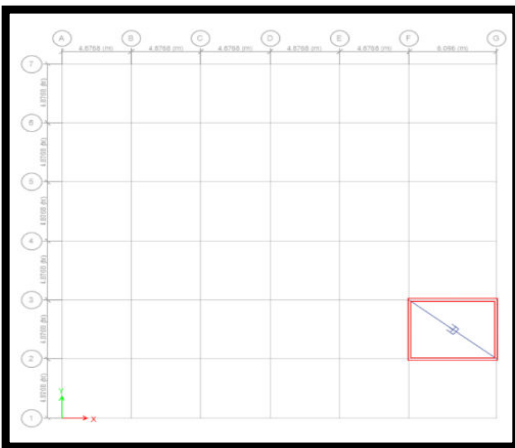


Fig. 3: 2D Frame of Model 2

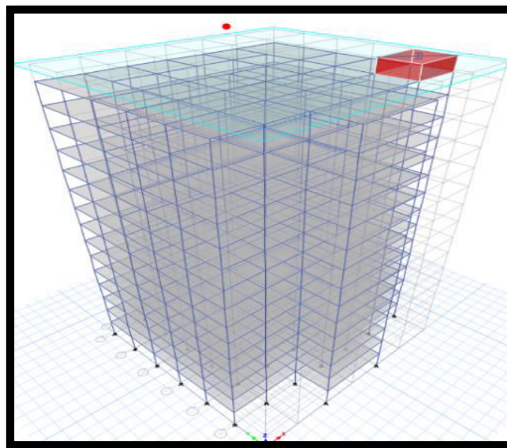


Fig. 4: 3D Frame of Model 2

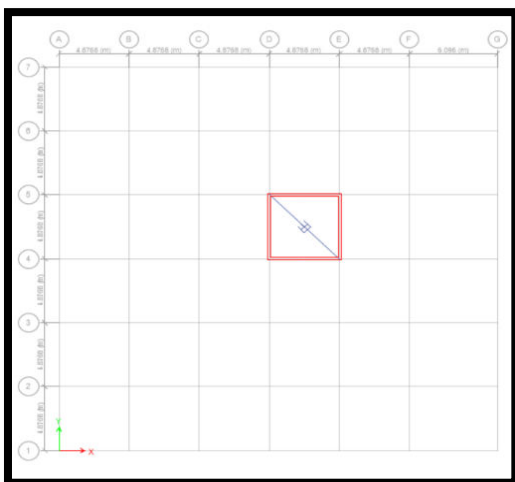


Fig. 5: 2D Frame of Model 3

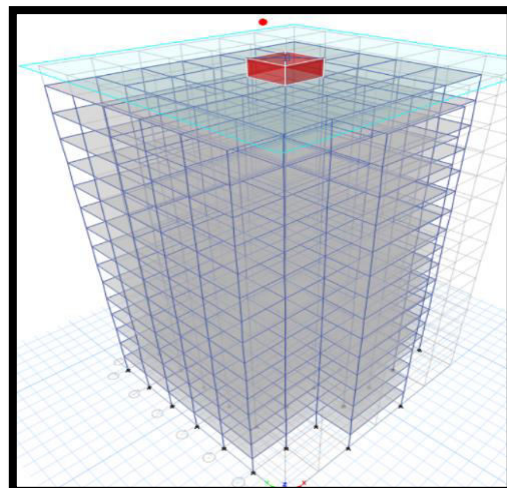


Fig. 6: 3D Frame of Model 3

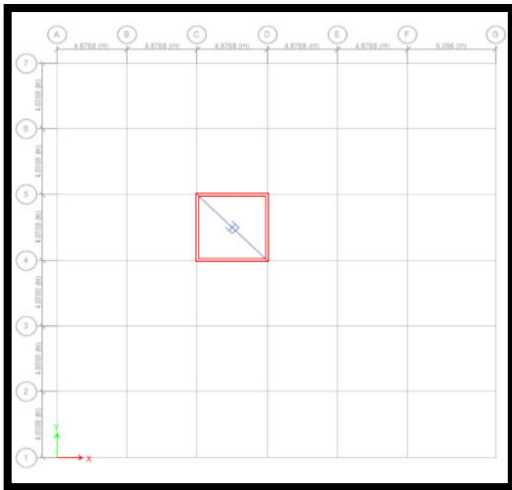


Fig. 7: 2D Frame of Model 4

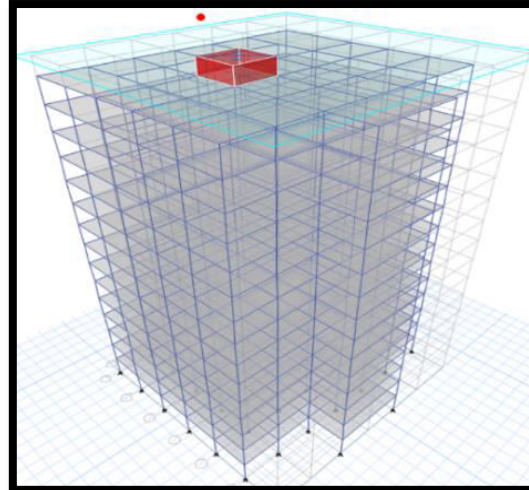


Fig. 8: 3D Frame of Model 4

III. RESULT AND DISCUSSION

Maximum and minimum Value of Story displacement, Story shear, auto lateral loads are taken to consideration from the ETABS and comparing of all the models the max and minimum values are made into tables and chart to find optimal position of the tanks. The values are taken from the graph and tables of Project “Comparative Analysis of Position of Water Tank as Fluid Viscous Damper On G+15 Multistorey Building Using ETABS”.

Story Displacement

Story displacement in (mm)		
Model	X direction	Y direction
Model 1	28.967	26.977
Model 2	28.848	30.329
Model 3	28.137	28.291
Model 4	28.127	27.719

Table 2: Comparison of Story Displacement

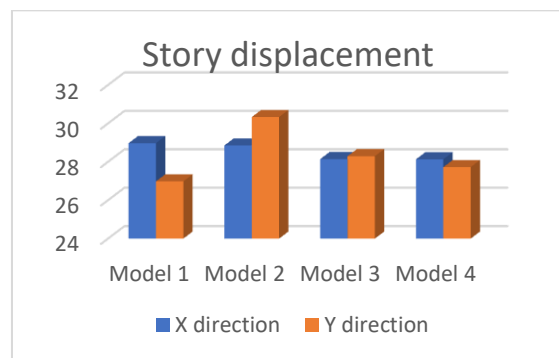


Chart 1: Comparison of Story Displacement in X and Y direction

From the above table the Story displacement towards X direction and Y direction is taken consider and the comparisons of all the models is done and through comparison the model 4 and 3 shows minimum displacement in X direction and model 1 and 4 in Y direction.



Story Shear

Story Shear in (KN)		
Model	X direction	Y direction
Model 1	21.8356	13.9938
Model 2	16.1537	22.8348
Model 3	21.1829	14.444
Model 4	21.1695	14.2072

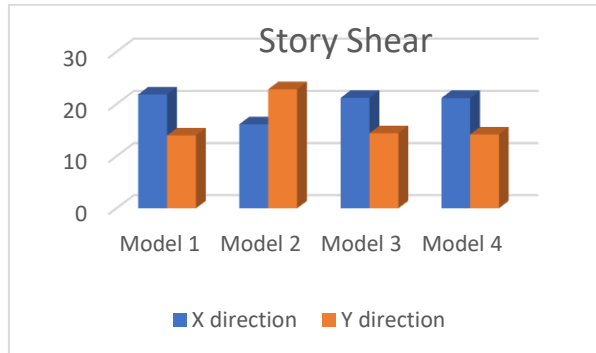


Table 3: Comparison of Story Drift

Chart 2: Comparison of Story Drift in X and Y direction

From comparison of story shear from all the models the model 2 and 4 shows minimum story shear in X direction and model 1 and 4 shows minimum story shear in Y direction. Thus model 4 shows more suitable

Auto lateral Load

Auto lateral load in (KN)		
Model	X direction	Y direction
Model 1	25.5073	25.9818
Model 2	28.6789	29.1593
Model 3	25.5118	25.9738
Model 4	25.5118	25.9777

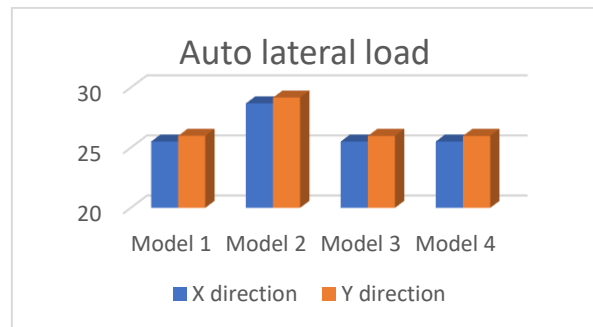


Table 4: Comparison of Auto lateral Load

Chart 3: Comparison of Auto lateral Load in X and Y direction

From comparison of auto lateral load from all the models the auto lateral load of model 1,3 and 4 shows minimum values in X direction. model 3 and 4 value shows minimum values in Y direction. From all the comparison from story drift, story displacement and auto lateral load the model; 4 shows better results.

IV. CONCLUSION

In conclusion, based over analysis results of G+15 structure with different position of water tank as FVD using ETABS, it is evident that the model with where the tank placed at the core positions exhibit satisfactory performance in several aspects and the core left side of the structure gives decimal difference between the model 3 and model 4. Preferable position for position of tank is either core left or core right side.

- Based on the provided results, apparently, the "CORE LEFT SIDE" and "CORE RIGHT SIDE" positions are both considered good for different aspects of the structure's seismic response.
- It is good for minimizing lateral displacements in X direction, and it has a marginal decimal value difference for auto lateral loads in X direction.
- This position is effective in reducing the story shear forces in X direction.
- Since both positions offer good seismic performance with marginal differences, you may want to prioritize practical aspects such as ease of installation, cost-effectiveness, and potential impacts on the building's functionality when making the final decision.



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