



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 9, September 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijirset@gmail.com

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A Study on Seismic Performance and Evaluation of RCC Frames with Dampers and Bracings on Different Types of Soil

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ABSTRACT: In this study, three different structural models were analyzed using ETABS software to assess their behavior under seismic forces in varying soil conditions. The first model represented a regular structure without any additional damping or bracing. The second model featured the same regular structure, but fluid viscous dampers were incorporated to enhance its seismic performance. The third model included bracing elements to provide lateral stiffness and further improve seismic resistance. The soft, medium, and hard soil conditions were simulated to understand how each model responded in different ground conditions. Response Spectrum Analysis, which considers the response of structures to a range of earthquake ground motion intensities, was employed for the evaluation.

KEYWORDS: Response spectrum analysis, Displacement, Storey shear, Auto lateral, Soil type.

I. INTRODUCTION

Earthquakes pose significant threats to the safety and stability of structures, making seismic-resistant design a paramount consideration in regions prone to seismic activity. To enhance our understanding of the behavior of buildings under seismic forces and to develop more effective strategies for seismic resilience, this study conducts a comprehensive analysis using the ETABS software. The investigation focuses on three different structural models: a regular structure without any additional enhancements, a structure with extra bracing element, a structure with fluid viscous dampers. These models are subjected to response spectrum analysis to evaluate their performance under seismic loads in soft, medium, and hard soil conditions. There are two objective in this study: first, to compare the seismic response of the three models to identify the most effective structural configuration in terms of lateral loads, displacements, and storey shears; and second, to examine how these models behave under varying soil conditions, considering autolateral loads, displacements, and storey shear distribution.

II. BUILDING DESCRIPTION

Table 1 Shows the parameters of the developed Regular RCC frame

Table 1 : Parameters of the developed regular RCC frame

Sl. No.	Parameter	Remarks
1	Structure type	G+9
2	Total No. of stories	10
3	Total height of building from base to terrace	30 m
4	Size of column	650 x 750mm
5	Size of beam	650 x 500mm
Sl. No.	Parameter	Remarks
6	Thickness of slab	200mm
7	RCC wall thickness	230 mm
8	Typical storey height	3 m
9	Base storey height	3 m
10	Grade of concrete for structural components	M 45
11	Grade of steel (rebar)	Fe 500
12	Density of concrete	25 kN/m ³
13	Live load	2 kN/m ²
14	Floor finish	1.5 kN/m ²
15	Soil type	Soft, Medium, Hard
16	Seismic zone	IV
17	Importance factor (EQ)	1
18	Response factor value	3

Table 2 shows the identity for the developed RCC frame models.

Table 2 : Identity for the developed RCC frame models

Sl. No.	Model ID	Description
1	M 1	RCC frame for Type I, Type II and Type III soil
2	M 2	RCC frame with Fluid Viscous Damper for Type I, Type II and Type III soil
3	M 3	RCC frame with X Bracingfor Type I, Type II and Type III soil

Figure 1 to 4 shows the plan and elevation of all the developed RCC models.

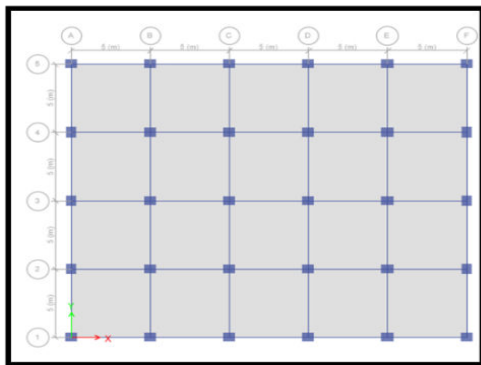


Fig 1 Plan for regular RCC model

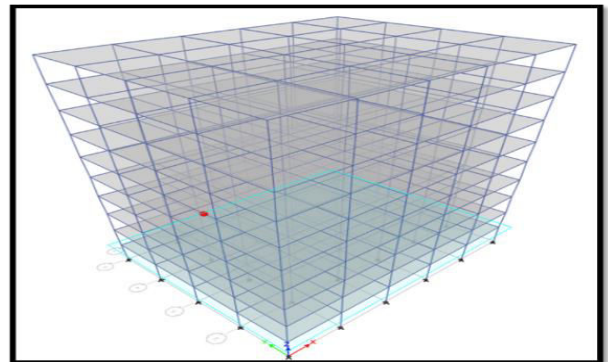


Fig 2 3D RCC MODEL

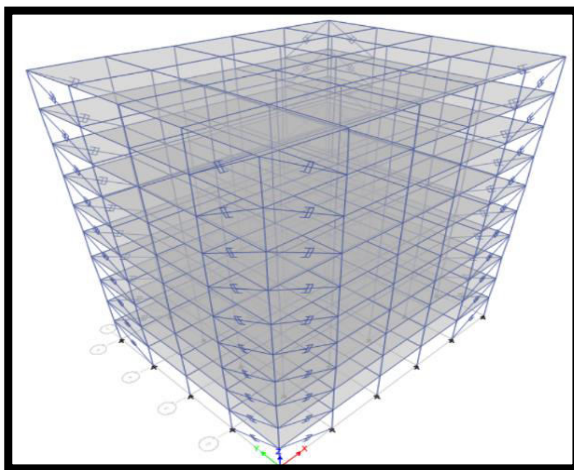


Fig 3 RCC frame with FVD

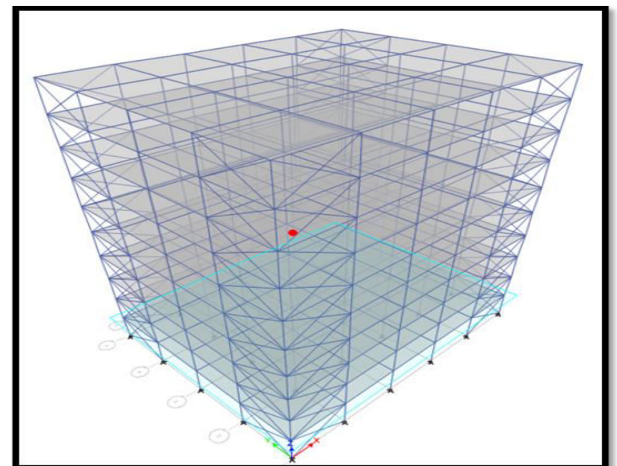


Fig 4 RCC frame with X Bracing

III. SEISMIC ANALYSIS OF RCC MODELS

Using ETABS 2017 software, the structures are developed and analysis is done by response spectrum analysis as per IS 1893–Part 1 (2002). Seismic parameters viz. storey displacement, storey shear and auto lateral loads are obtained from the analysis for all the developed models in seismic zone IV.

IV. RESULTS AND DISCUSSION

Figures 5 to 19 show the variation of storey displacement, storey shear and autolateral loads over the number of stories in both X and Y directions obtained for all the RCC models by response spectrum analysis.

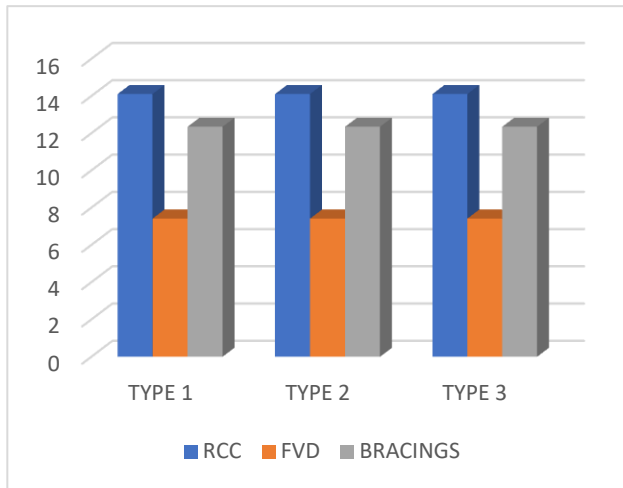


Fig. 5 Storey displacement in X-direction of all the models

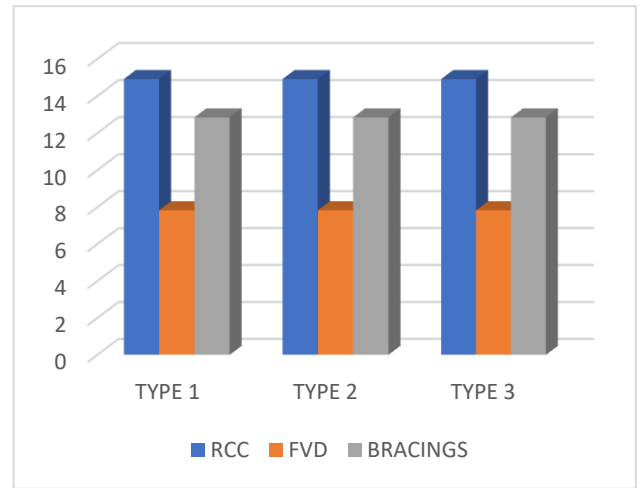


Fig.6 Storey displacement in Y-direction of all the models

Based on the final comparison of displacement for all soil conditions, the values for RCC, FVD, and bracing structures remain the same across all soil conditions. However, the comparison reveals that the FVD structure performs better in mitigating displacements compared to the RCC and bracing structures.

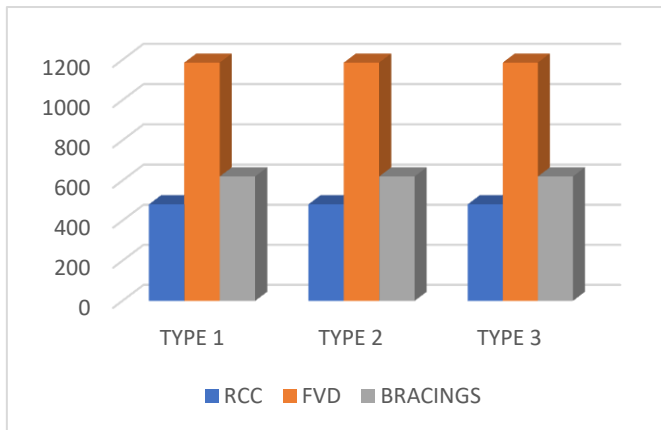


Fig. 7 Storey Shear in X-direction of all the models

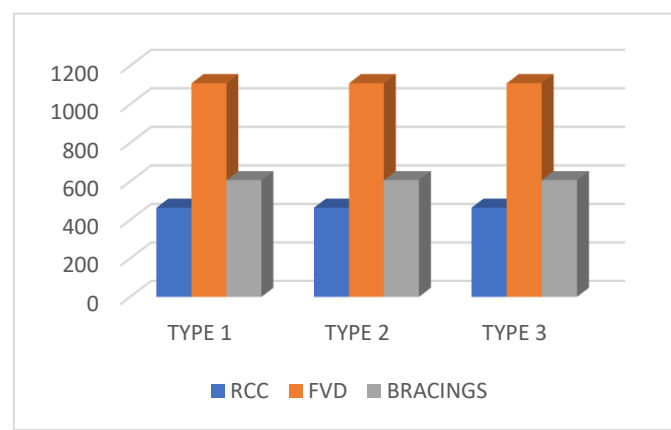


Fig. 8 Storey Shear in Y-direction of all the models

The final comparison of storey shear for all soil conditions shows that the values for the RCC, FVD, and bracing structures remain the same across all soil conditions, while the RCC model is better in comparison.

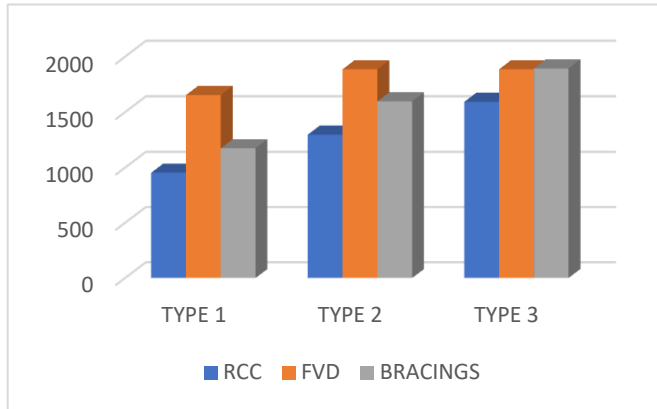


Fig. 8 Auto-lateral load in X-direction of all the models

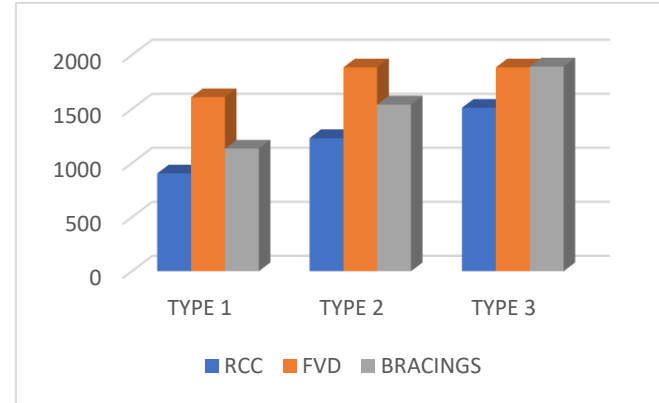


Fig. 9 Auto lateral load in Y-direction of all the models

The final comparison of autolateral loads for all soil conditions shows that the values for the RCC, FVD, and bracing structures increase from type 1 to type3 soil conditions, and the RCC model is better in comparison.

V. CONCLUSIONS

After conducting a comprehensive analysis of three different structural models (regular reinforced concrete - RCC, fluid viscous damper - FVD, and bracing) under various soil conditions (type 1 soft soil, type 2 medium soil, and type 3 hard soil) using autolateral loads, displacement, and storey shear, the following final conclusions can be drawn:

1. Autolateral Loads and Storey Shear:
 - The RCC structure consistently performs better in handling autolateral loads and storey shear forces across all soil conditions.
 - The FVD and bracing structures do not exhibit significant advantages over the RCC structure in reducing autolateral loads and storey shear forces.
2. Displacement:
 - The FVD structure outperforms the other models in reducing displacements in both the X and Y directions.
 - The RCC structure and the structure with bracing do not show significant improvements in displacement reduction compared to the FVD structure.
3. Overall Performance:
 - The RCC structure demonstrates robustness and consistent performance in resisting lateral loads and maintaining stability under different soil conditions.
 - The FVD structure excels in reducing displacements, making it beneficial for mitigating structural damage and improving occupant comfort during seismic events.
4. Selection Criteria:
 - The selection of the better model depends on the specific project requirements, design priorities, and seismic performance objectives.
 - If overall structural stability, lateral load resistance, and energy dissipation are key concerns, the RCC model is a reliable choice.
 - If minimizing displacements and ensuring occupant comfort during earthquakes are critical priorities, the FVD model may be preferred.

In conclusion, both the RCC and FVD models have their advantages and are suitable for different seismic design objectives. The RCC structure is a dependable choice for overall stability and lateral load resistance, while the FVD structure is effective in reducing displacements and enhancing seismic comfort. The final decision should be based on the project's unique needs and the engineer's professional evaluation to ensure a safe and reliable structural design.



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Impact Factor: 8.423



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