A Study Performance of Conventional Structure and Outrigger Structure with Dampers in Seismic Zone IV and V

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Abstract - *This study compares the seismic performance of a conventional high-rise building, designed following standard codes, with an outrigger structural system featuring additional lateral resisting elements like outriggers and friction dampers. The aim is to assess the effectiveness of the outrigger system in reducing seismic forces in high seismic zone IV, zone V and enhancing overall building performance. Through seismic analysis using ETABS and comparing in storey displacement results. The findings will offer valuable insights to aid engineers in making informed decisions for seismic-prone regions, leading to safer and more resilient high-rise structures.*

Key Words: conventional structure, outrigger structure, friction dampers, static and dynamic analysis (Response spectrum method)

1.INTRODUCTION

The conventional structural systems have been widely used for constructing high-rise buildings, but their seismic performance may be limited. To address this, friction dampers are integrated into conventional structures. Friction dampers are passive devices that dissipate seismic energy through frictional resistance, improving the building's ability to withstand seismic forces. This introduction outlines the need for enhanced seismic resilience and introduces the concept of friction dampers as an effective solution. The study aims to evaluate the performance of a conventional structure with friction dampers using advanced analysis ETABS software.

In modern seismic engineering, outrigger systems with friction dampers have emerged as an innovative approach to enhance the seismic performance of high-rise buildings. The conventional structural systems, while effective, may have limitations in withstanding dynamic forces during earthquakes. The outrigger system incorporates lateral resisting elements, such as outriggers and friction dampers, strategically distributed across the building height. These friction dampers dissipate seismic energy through frictional resistance, significantly reducing inter-story drift and enhancing the overall building's seismic resilience. This introduction presents an overview of the outrigger structural system with friction dampers, highlighting its potential advantages in mitigating seismic forces and improving the safety and stability of high-rise structures in seismic-prone regions.

Friction dampers are passive devices used in structural engineering to dissipate seismic energy by introducing frictional resistance between moving components. They help reduce inter-story drift and improve a building's seismic performance during earthquakes.

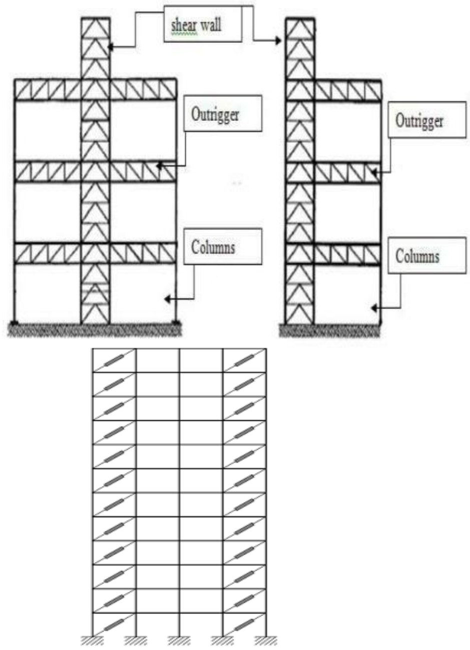

Figure 1.1 Friction dampers in structure

2. LITERATURE REVIEW

1) Jeddah Tower, the first one-kilometre-tall man-made building, chose an all-concrete superstructure for various benefits. However, addressing time-dependent creep and shrinkage effects in the concrete was crucial. This study explores the engineering solutions found by the authors to tackle these challenges in creating this unprecedented concrete tower.
2) This research introduces a novel damping outrigger system for tall buildings, using

buckling restricted bracings to replace diagonal members. The study compares four common outrigger configurations, proposing an optimal design with improved stiffness, strength, and energy dissipation. The findings demonstrate the system's effectiveness in enhancing structural performance for tall buildings, contributing to innovative seismic solutions.

3) This research paper presents a significant advancement with the damped outrigger system, effectively enhancing vibration management in tall buildings through added damping. Using a simplified model and ANSYS analysis, the optimal seismic performance of a single viscous damper-outrigger system is explored. The findings provide valuable insights to improve seismic performance and stability in tall buildings.
4) This research comprehensively compares 3D models of reinforced concrete buildings with and without outriggers. By varying flexural rigidity and outrigger positions, static and dynamic evaluations are conducted. The study analyses bending moments, shear force, deflection, and inter-storey drifts, providing valuable insights into outrigger effectiveness under various conditions.

3.OBJECTS

- To study behaviour of conventional structure with friction dampers and outrigger structure with dampers in seismic zone IV and V.
- The story displacement parameter result is compared with two models and conclusion result.

4.METHODOLOGY

Preparing drawing in AUTOCADD and importing into E TABS

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Modeling and assign material properties and section properties

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Analysing model in static and dynamic analysis

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Checking result and plot required graph

Figure 4.1 Flow chart of diagram

5.MODELS CONSIDERED FOR ANALYSIS

This study focuses on a commercial RCC building frame with a height of 94.5 meters, comprising a basement (B) and 30 stories above ground (G+30).

Model 1 represents the conventional RC framed structure with friction dampers, analyzed using Response Spectrum Analysis for seismic performance in zone-5.

Model 2 represent the outrigger structure RC framed structure with friction dampers, , analyzed using Response Spectrum Analysis for seismic performance in zone-5.

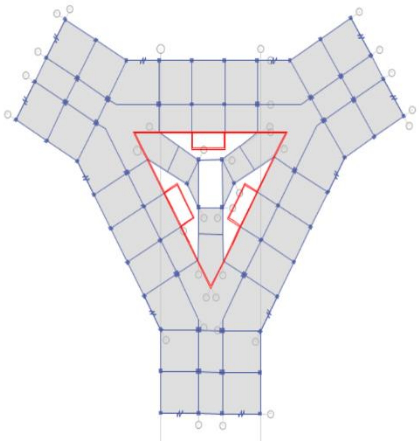

Figure 5.1 plan of conventional structure with friction dampers

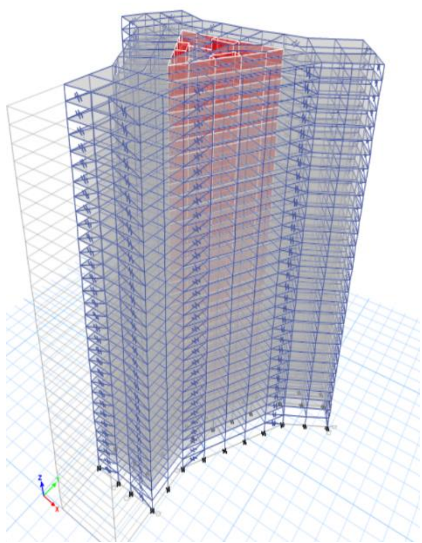

Figure 5.2 3D view of conventional structure with friction dampers

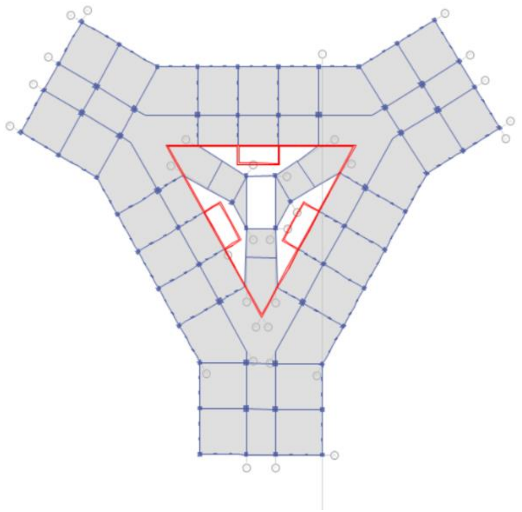

Figure 5.3 plan of outrigger structure with friction dampers

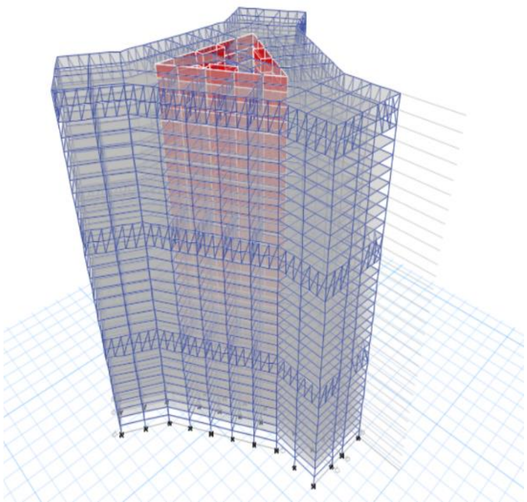

Figure 5.4 3D view of outrigger structure with friction dampers.

5.1 SECTION PROPERTIES

Table -1: Section Properties

Section	Sizes (mm)	grades
Beams	450 x 450	M25
	450 x 600	
	450 x 750	
Columns	750 x750	M40
	1000 x 1000	
Slabs	200	M25
outrigger	300 x 600	M30
Links	Dampers	Friction dampers

5.2 DESIGN LOADS

The loads which have been used for modelling are follow: Self weight, Live load, Floor finish, Wind load, Seismic load

1. Dead load as per IS: 875 (PART 1)-1987
   - Self-weight 0f slab (200mm) - 5 KN/m2
   - Floor finish loads - 1.5 KN/m2
2. Wall loads - 5.94 KN/m2
3. Live load as per IS:875 (part II)-1987
   - Live load on floor - 3 KN/m2
   - Live load on roof - 1.5 KN/m2
4. Earthquake loads IS:1893-2016
   - Zone factor for IV - 0.24
   - Zone factor for V - 0.36
   - Soil type - II
   - Importance factor - 1

The structural analysis encompassed dead load, live load, and seismic loads using Response Spectrum Analysis. Additionally, the combination of these loads was thoroughly examined. The existing members' structural adequacy was assessed following the guidelines outlined in IS-456-2000 and SP-16, ensuring compliance with the relevant design standards.

6.RESULT AND DISCCUSION.

In this study, a lateral load resisting method is employed to mitigate the seismic impact on buildings when subjected to earthquake loads. The seismic analysis models are capable of handling both gravity loads (dead and living loads) and earthquake loads. The analysis is conducted using the ETABS program, wherein the Equivalent Static Method is utilized for static analysis, and the Response Spectrum Method is employed for dynamic analysis. These methods adhere to the Indian Standard Codes, ensuring compliance with relevant structural configurations. The study evaluates the analytical performance outcomes, focusing on narrative descriptions, story displacement.

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6.1 STORY DISPLACEMENT

In this context, the lateral displacement of each story in relation to the building's base is a critical consideration. To mitigate excessive lateral displacement, an effective lateral force resisting system is implemented. This system plays a vital role in controlling the lateral movement of the building during wind load cases.

For wind load scenarios, there are generally acceptable limits on lateral displacement, which could be specified as either H/500 or H/400. Here, "H" represents the height of the building. Adhering to these prescribed limits ensures that the building maintains sufficient stability and avoids undue lateral movement, thereby enhancing its overall structural integrity and safety in the face of wind-induced forces.

Sl no	Zone	MODEL1	MODEL2
1	Zone IV	116.41	84.49
2	Zone V	174.61	126.7

Table2 Maximum displacement in X direction static analysis

Sl no	Zone	MODEL1	MODEL2
1	Zone IV	121.36	88.22
2	Zone V	182.04	132.2

Table3 Maximum displacement in Y direction static analysis

Sl no	Zone	MODEL1	MODEL2
1	Zone IV	77.85	61.14
2	Zone V	116.75	91.72

Table4 Maximum displacement in X direction dynamic analysis

Sl no	Zone	MODEL1	MODEL2
1	Zone IV	80.83	63.44
2	Zone V	121.24	95.16

Table5 Maximum displacement in X direction dynamic analysis

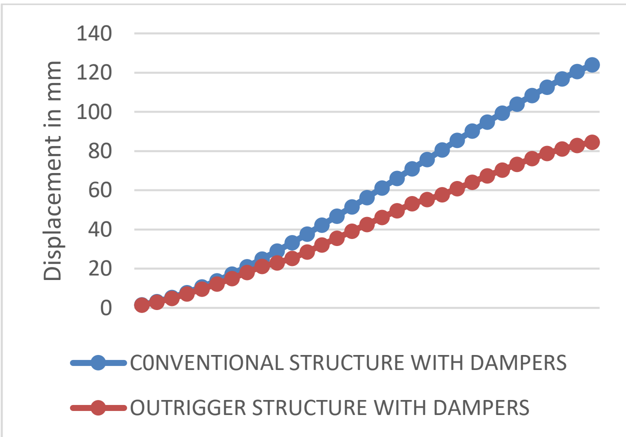

Figure 6.1 Maximum displacement in X direction static analysis in zone IV

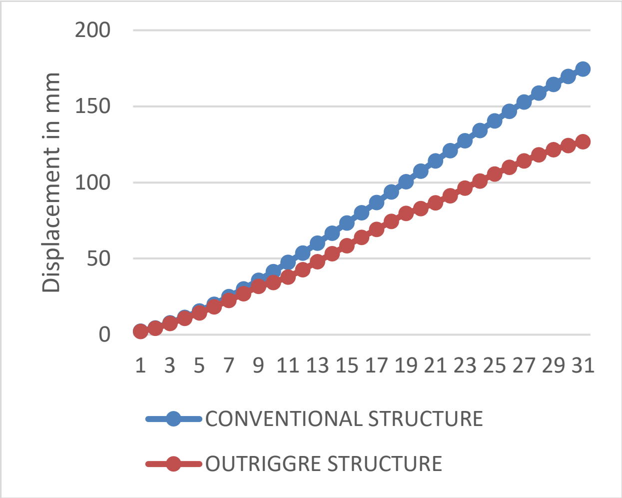

Figure 6.2 Maximum displacement in X direction static analysis in zone **V**

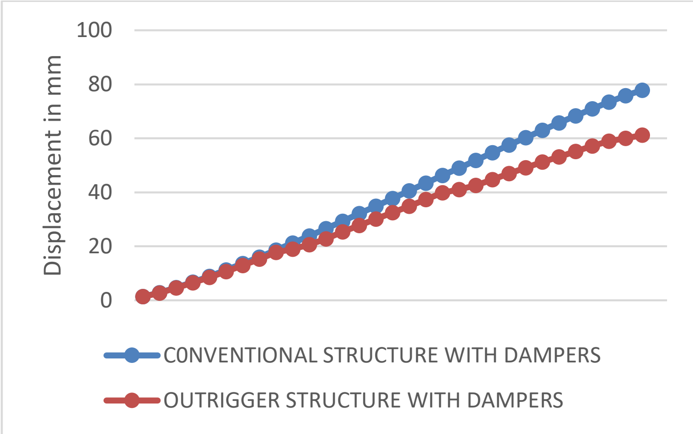

Figure 6.5 Maximum displacement in X direction static analysis in zone IV (response spectrum method)

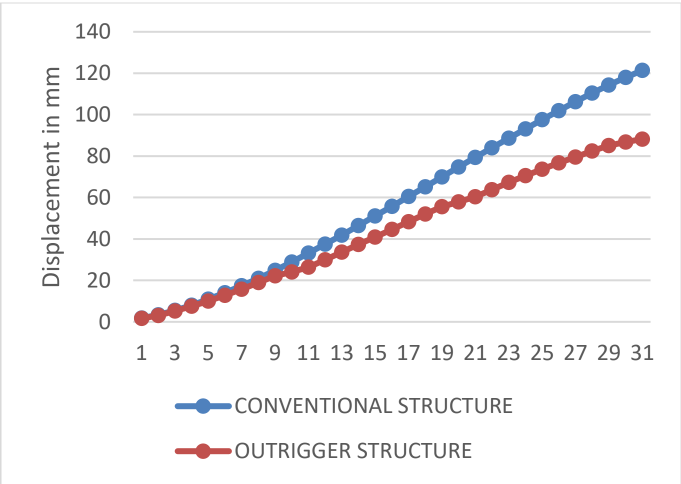

Figure 6.3 Maximum displacement in Y direction static analysis in zone IV

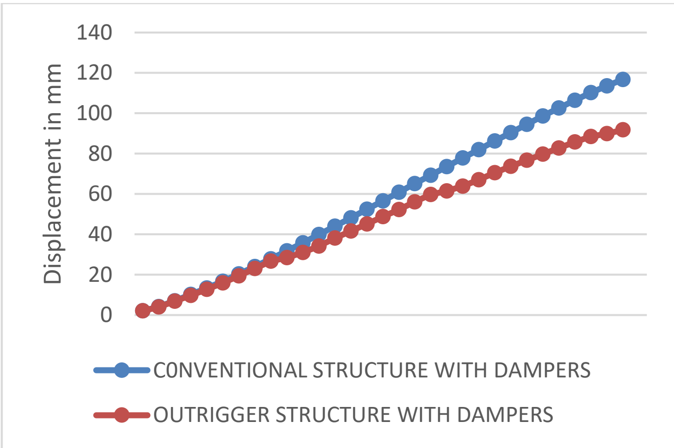

Figure 6.6 Maximum displacement in X direction static analysis in zone V (response spectrum method)

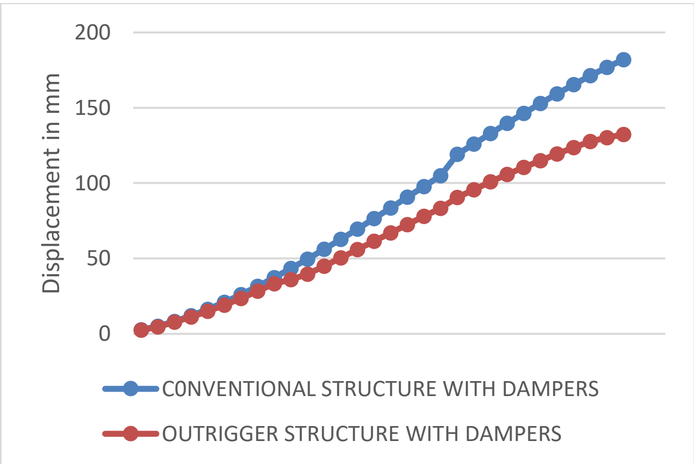

Figure 6.4 Maximum displacement in Y direction static analysis in zone V

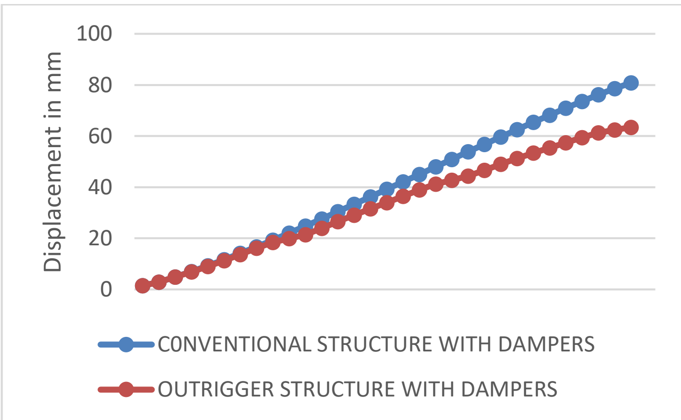

Figure 6.7 Maximum displacement in Y direction static analysis in zone IV (response spectrum method)

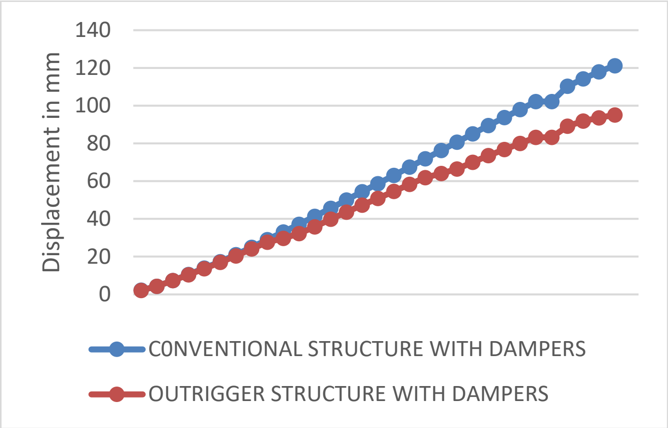

Figure 6.8 Maximum displacement in Y direction static analysis in zone V (response spectrum method)

7. CONCLUSION

- Outrigger structures, particularly those equipped with friction dampers, effectively minimize lateral displacement during dynamic earthquake loading. All models exhibit displacement values within the acceptable range of H/400 to H/500, ensuring optimal performance under seismic conditions.
- For zone IV, it is seen that the maximum displacement in X and Y direction in both static and response spectrum analysis for model conventional structure and outrigger structure with dampers is lower in model 2 outrigger with friction dampers displacement is reduced is about 30%.
- For zone V, it is seen that the maximum displacement in X and Y direction in both static and response spectrum analysis for model conventional structure and outrigger structure with dampers is lower in model 2 outrigger with friction dampers displacement is reduced is about 25%.

8.REFERENCE

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