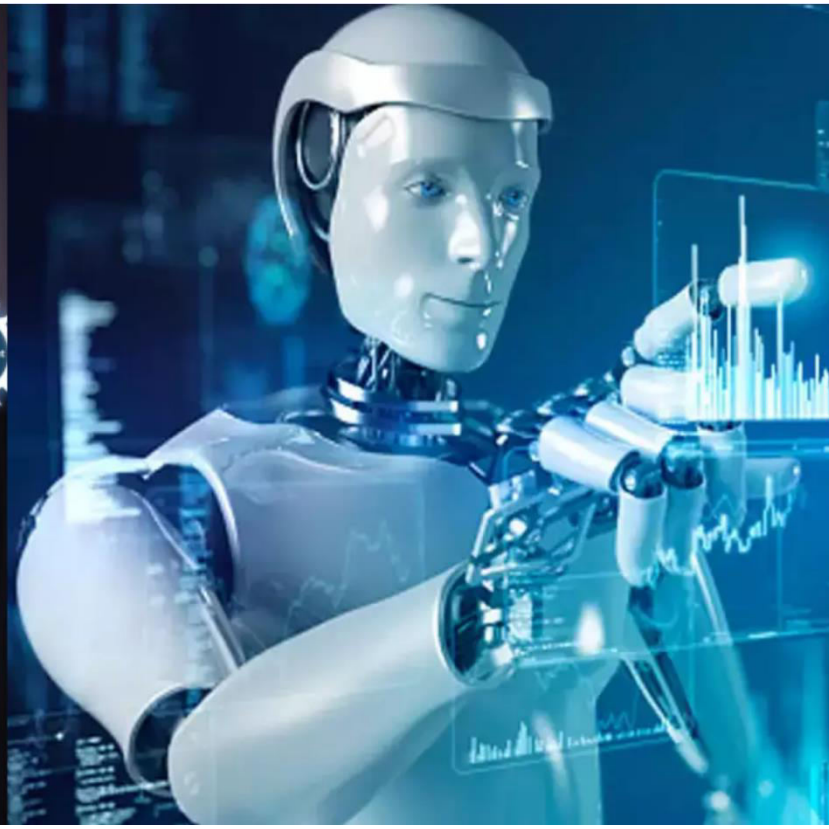
IJIRSET
International Journal of Innovative Research in Science | Engineering | Technology

ISSN(O): 2319-8753
ISSN(P): 2347-6710

International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 8, August 2025

International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)

Impact Factor 8.699

|www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 8, August 2025

|DOI: 10.15680/IJIRSET.2025.1408089|

Seismic Performance Analysis of Multistoried Building with Outrigger System

Kalyani K. Shinde, Prof. V. B. Chavan, Dr. L. S. Mahajan

Department of Civil Engineering, Shreeyash College of Engineering and Technology, Chhatrapati Sambhajinagar, Maharashtra, India

Associate Professor, Department of Civil Engineering, Shreeyash College of Engineering and Technology, Chhatrapati Sambhajinagar, Maharashtra, India

Head of Department, Department of Civil Engineering, Shreeyash College of Engineering and Technology, Chhatrapati Sambhajinagar, Maharashtra, India

ABSTRACT: An outrigger system is a structural technique widely used in tall buildings to enhance lateral stiffness and stability. In this study, a G+14 multistoried RCC building was analyzed using ETABS software under seismic forces as per IS 1893:2016, applying the Response Spectrum Method. Four structural configurations were compared: a conventional RCC frame, an outrigger system, a shear wall system, and an alternate outrigger system. Performance parameters included storey stiffness, displacement, drift, shear, and overturning moment. Results indicate that the alternate outrigger system provides the best performance, reducing displacement by up to 37.3% compared to RCC frames, while improving stiffness by more than 20%. Replacing RCC beams with steel outriggers reduced dead load and improved efficiency. The findings confirm that outrigger systems—particularly alternate arrangements—offer superior seismic performance for tall buildings.

KEYWORDS: Outrigger system, Seismic analysis, Response Spectrum Method, Storey displacement, High-rise structures

I. INTRODUCTION

The design of tall buildings requires effective resistance against lateral loads arising from wind and earthquakes. Conventional RCC frames are often insufficient, leading to excessive drift and displacement. Outrigger systems, consisting of stiff horizontal members connecting the building core to exterior columns, provide an economical and efficient solution. This study evaluates the seismic performance of a 14-storey RCC building with different lateral resisting systems using ETABS software and IS 1893:2016 provisions.

II. LITERATURE REVIEW

Previous studies highlight the effectiveness of outrigger systems:

- Kamath et al. (2022) emphasized optimal outrigger placement for seismic resistance.
- Shareef et al. (2022) reported improved lateral stability with outrigger beams.
- Alavi et al. (2021) introduced stiffness-based design methods.
- Habrah et al. (2021) developed simplified equations for lateral displacement reduction.

These findings collectively support outrigger adoption for improved seismic safety and economy.

III. METHODOLOGY

A G+14 RCC framed building (16 m × 18 m plan, 3.5 m floor height, total height 53.5 m) was analyzed in ETABS. Four structural models were considered:

1. Model 1 – Conventional RCC Frame
2. Model 2 – RCC with Outrigger System
3. Model 3 – RCC with Shear Wall System

International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)

Impact Factor 8.699

|www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 8, August 2025

|DOI: 10.15680/IJIRSET.2025.1408089|

4. Model 4 – RCC with Alternate Outrigger System

Loading was applied as per IS 875 (Dead and Live) and IS 1893:2016 (Seismic, Zone IV). Response Spectrum Method was used for analysis.

IV. RESULTS AND DISCUSSION

Table 1: Storey Displacement in X-Direction (Zone IV)

Storey	Model 1 (mm)	Model 2 (mm)	Model 3 (mm)	Model 4 (mm)
1	3.18	2.77	1.30	3.04
5	21.39	15.14	11.46	19.88
10	43.92	32.36	28.30	29.15
15	58.27	46.42	42.46	36.54

Observation: Model 4 reduced displacement by ~37.3% compared to Model 1.

Table 2: Storey Stiffness in X-Direction (Zone IV)

Storey	Model 1 (kN/m)	Model 2 (kN/m)	Model 3 (kN/m)	Model 4 (kN/m)
1	653,242	979,324	1,664,668	2,882,475
5	426,593	617,053	665,012	1,124,625
10	358,230	456,240	478,940	906,057
15	175,503	145,696	124,793	381,933

Observation: Model 4 achieved >20% higher stiffness than RCC.

Table 3: Storey Shear in X-Direction (Zone IV)

Storey	Model 1 (kN)	Model 2 (kN)	Model 3 (kN)	Model 4 (kN)
1	2034.72	2093.99	1166.90	1393.97
5	1976.56	2035.53	1133.19	1357.74
10	1533.22	1581.16	876.38	1047.47
15	314.51	331.36	163.35	232.04

Observation: Model 3 had maximum shear reduction (~42%), but Model 4 balanced stiffness and shear effectively.

International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)

Impact Factor 8.699

|www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 8, August 2025

|DOI: 10.15680/IJIRSET.2025.1408089|

Figures:

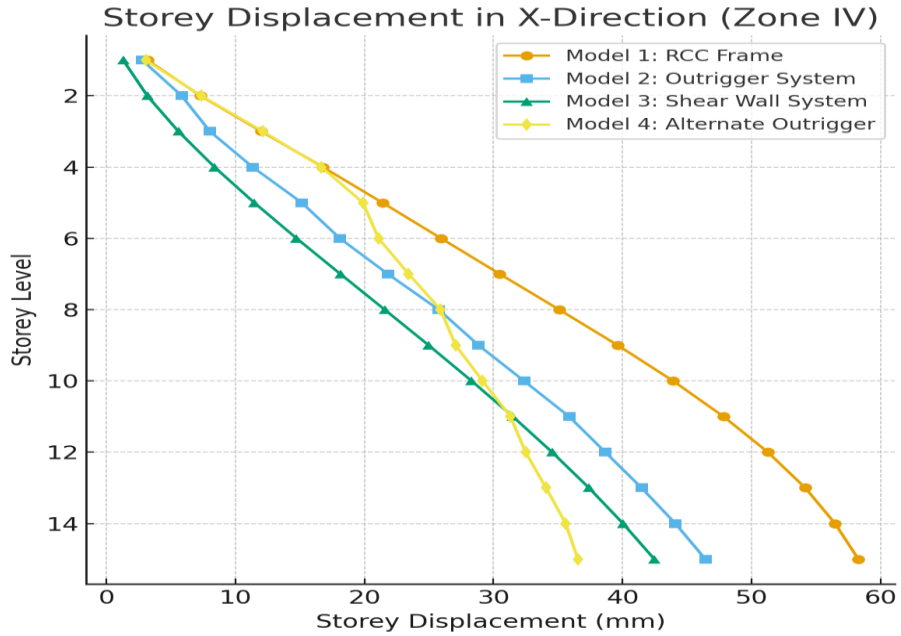


Figure 1: Storey Displacement vs Storey Level (X-Direction)

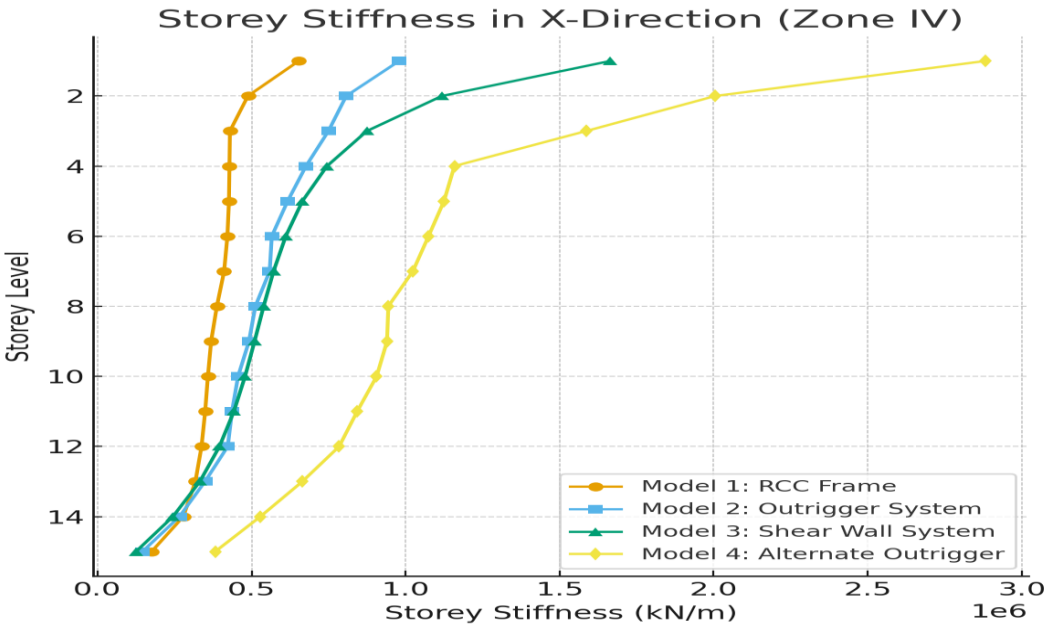


Figure 2: Storey Stiffness vs Storey Level (X-Direction)

International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)

Impact Factor 8.699

|www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 8, August 2025

|DOI: 10.15680/IJIRSET.2025.1408089|

V. CONCLUSION

1. Outrigger systems significantly enhance seismic performance in tall buildings.
2. The alternate outrigger system (Model 4) achieved the best balance, reducing displacement by ~37% and increasing stiffness by >20% compared to RCC frames.
3. Replacing RCC with steel outriggers reduced dead load while improving efficiency.

VI. FUTURE SCOPE

1. Extend analysis to **super-tall buildings (40+ storeys)**.
2. Apply **time-history analysis** using real earthquake records.
3. Explore outrigger integration with **composite/high-strength materials** for sustainability.

REFERENCES

[1] Mohammed S. Shareef et al., "Performance of Outrigger Systems in Tall Buildings," 2022.
[2] Gurkirat Singh et al., "Seismic Analysis of Composite Structures with Outriggers," 2022.
[3] Kiran Kamath et al., "Optimal Placement of Outriggers for Wind and Earthquake Resistance," 2022.
[4] ArsalanAlavi et al., "Stiffness-Based Design of Outrigger Systems," 2021.
[5] AlaaHabrah et al., "Lateral Displacement Control in Core-Outrigger Systems," 2021.
[6] Rajesh S. Londhe et al., "Comparative Study on Outrigger Performance," 2021.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

doi cross ref

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 6381 907 438 ijirset@gmail.com

www.ijirset.com

Scan to save the contact details