iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: VI Month of publication: June 2025

DOI: https://doi.org/10.22214/ijraset.2025.72670

Comparative Study of Mivan Technology and Conventional RCC Structures in High Seismic Zones

Anmol Hinduja[1], Tarun Sankle[2], Mahroof Ahmed[3]
[1]M.TECH Scholar, Department of Structural Engineering, Sushila Devi Bansal College of Engineering, Indore
[2]Professor, Department of Structural Engineering, Sushila Devi Bansal College of Technology, Indore
[3]Professor, Department of Structural Engineering, Sushila Devi Bansal College of Engineering, Indore

Abstract: The growing demand for rapid urban development, coupled with the increasing risk of earthquakes in certain regions, has necessitated the adoption of construction technologies that offer both structural safety and speed of execution. This research presents a comparative study between Mivan formwork construction and conventional Reinforced Cement Concrete (RCC) systems. A G+12 residential building model was developed and analysed under seismic and wind loads using advanced structural analysis software. Key structural parameters such as storey displacement, inter-storey drift, base shear, and natural time period were examined for both construction systems.

The findings demonstrate that Mivan structures, due to their monolithic and joint-free construction technique, perform better under lateral forces, showing reduced displacement and drift. Moreover, the speed of construction and labour efficiency in Mivan technology make it a suitable choice for mass housing projects in seismic zones. This study provides valuable insights into the selection of structural systems for safe, efficient, and durable high-rise construction.

Keywords: Mivan Formwork, RCC, Seismic Analysis, Base Shear, Storey Drift, ETABS, Earthquake Loads, High-Rise Building, IS 1893

I. INTRODUCTION

The construction industry is constantly evolving to meet the challenges posed by urbanization, safety, speed, and sustainability. In seismic-prone countries like India, the demand for construction systems that can not only resist earthquake forces but also allow faster and cost-effective execution has grown significantly. Two such systems that are widely used in practice are Reinforced Cement Concrete (RCC) [4] and Mivan construction technology [5].

RCC, the conventional system, involves separate construction of beams, columns, and slabs with brick infill walls. It offers design flexibility and adaptability but is time-consuming, labour-intensive, and prone to workmanship variability. In contrast, Mivan technology uses aluminium formwork for the monolithic casting of walls and slabs [5]. Originally developed in Malaysia, it has gained popularity in India for its ability to reduce construction time, improve quality, and enhance seismic performance due to its rigid, joint-free structure [6]. Earthquake resilience has become a fundamental consideration in structural design. According to IS 1893 (Part 1): 2016 [2], buildings must be designed to withstand lateral seismic forces without significant damage or collapse. This study explores the seismic behaviour of both construction systems by modelling a G+12 residential building in ETABS 21.0.1[9], applying loads per Indian standards, and comparing critical parameters such as storey displacement, inter-storey drift, base shear, and natural time period. The objective of this research is to provide an in-depth comparison of Mivan and RCC structures under identical conditions to determine which system offers better performance, safety, and construction efficiency in high seismic zones.

II. METHODOLOGY

This study involves a comparative modelling and analysis of two structural systems: one constructed using Mivan formwork and the other using conventional RCC. A G+12 residential building was designed in ETABS 21.0.1[9] software, and seismic, wind, and gravity loads were applied in accordance with IS 1893 (Part 1): 2016[2] and IS 875 (Parts 1 to 3) [3].

Both models share the same plan dimensions, number of storeys, and loading assumptions to ensure uniformity in comparison. The main difference lies in the wall and slab system: Mivan uses monolithic walls with shear wall action, whereas RCC follows a framed system with beams, columns, and brick infill walls [4].

TABLE I. Comparison of Structural Systems Adopted

Parameter	Mivan Construction	Conventional RCC
Structural Type	Shear wall with monolithic wall-slab cast	Beam-column frame with brick infill
Formwork	Aluminium (reusable up to 100+ cycles)	Plywood/wood (limited reusability)
Construction Speed	7 days/floor (approx.)	21–28 days/floor
Labor Requirement	Reduced (by approx. 30–40%)	High
Quality Control	High – due to factory precision	Depends on site execution
Initial Cost	High (₹2500/m²)	Moderate (₹600/m²)

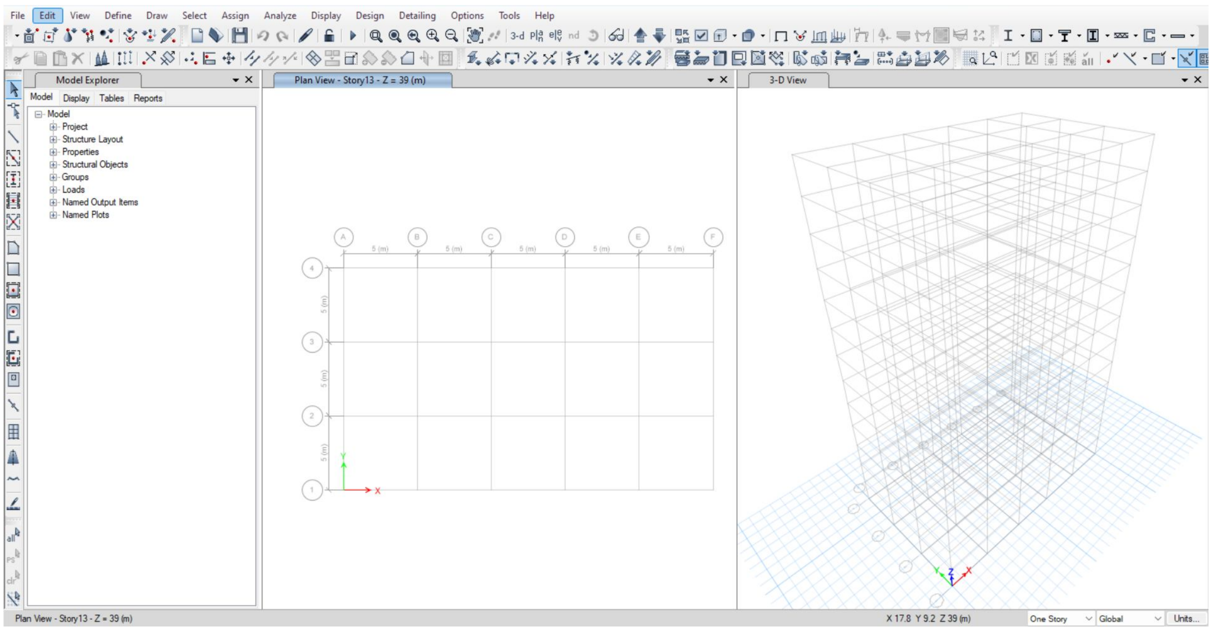


Figure 1- 3D and Plan View of G+12 Structural Model in ETABS

The structural model was developed using ETABS 21.0.1[9], and the entire load application, analysis, and result interpretation were carried out within the software environment. Both models were analysed using Equivalent Static Method and compared based on key response parameters.

III.RESULTS AND DISCUSSION

After modelling both the Mivan and RCC structures using ETABS 21.0.1, seismic and lateral loads were applied in accordance with IS 1893 (Part 1): 2016 [2] and IS 875[3]. The structural response was assessed for the following key parameters:

- Storey displacement
- Storey drift
- Base shear
- Time period and frequency

Each result was extracted under the same loading and boundary conditions to ensure unbiased comparison. The summarized findings are presented below.

A. Storey Displacement

The maximum lateral displacements were observed at the top storey (roof level) for both systems. Mivan structures consistently exhibited lower displacement values compared to RCC due to the monolithic nature of their construction [5].

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VI June 2025- Available at www.ijraset.com

TABLE II. Storey Displacement Values at Roof Level

Construction Type	Displacement in X (mm)	Displacement in Y (mm)
Mivan Structure	42.5	38.2
RCC Structure	56.8	52.7

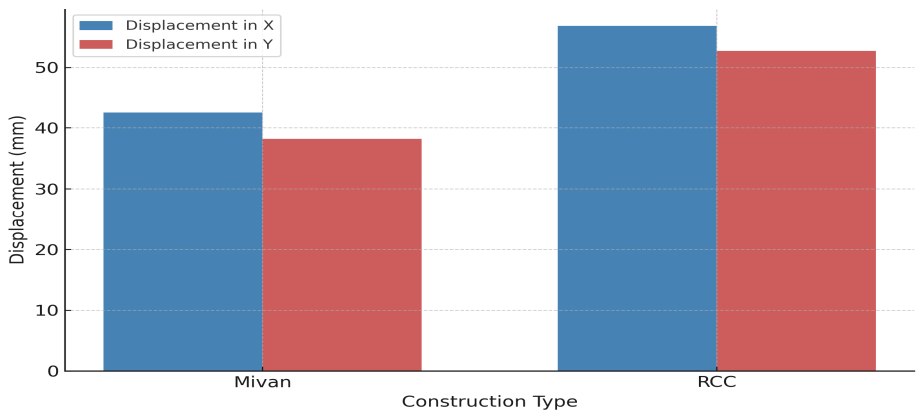


Figure 2. Displacement Comparison between Mivan and RCC Structures

Note: Displacement in Mivan is reduced by approximately 25–30%, improving serviceability and seismic resistance.

B. Inter-Storey Drift

Inter-storey drift indicates the relative displacement between two consecutive floors and is a key parameter in seismic design. Lower drift values are preferable to avoid structural and non-structural damage [7].

TABLE III. MAXIMUM STOREY DRIFT VALUES

Construction Type	Drift in X (%)	Drift in Y (%)
Mivan Structure	0.0032	0.0029
RCC Structure	0.0046	0.0043

Both structures are within IS 1893 drift limit of 0.004 h, but Mivan clearly performs better.

C. Base Shear

TABLE IV. BASE SHEAR UNDER EQX DIRECTION

Construction Type	Base Shear (KN)
Mivan Structure	3846
RCC Structure	4185

Lower base shear in Mivan is due to its reduced mass and optimized load paths through rigid walls [6].

D. Time Period and Frequency

TABLE V. NATURAL TIME PERIOD AND FREQUENCY

Construction Type	**Time Period (sec)**	**Frequency (Hz)**
Mivan Structure	1.21	0.826
RCC Structure	1.47	0.680

Shorter time periods in Mivan suggest higher stiffness and better resistance to seismic vibrations [7].

Interpretation:

These results collectively establish that Mivan structures outperform conventional RCC in terms of:

- Lateral stiffness
- Drift control
- Seismic stability
- Structural efficiency

They are better suited for high-rise construction in Zone III to V, especially when rapid execution and long-term durability are required.

IV. CONCLUSIONS

This research presents a structured comparative evaluation of Mivan and conventional RCC construction systems, with focus on their seismic performance in high-rise residential buildings. A G+12 structural model was analyzed under identical seismic and gravity load combinations, allowing for a uniform and unbiased comparison of both technologies.

The results indicate that the Mivan system outperforms RCC construction in several key aspects. The monolithic wall-slab configuration and high formwork precision of Mivan structures contribute to:

1) Lower lateral displacements
2) Reduced inter-storey drift
3) Enhanced lateral stiffness
4) A shorter fundamental time period

These properties significantly enhance the structural resilience of buildings in high seismic zones.

From a construction management standpoint, Mivan technology offers notable advantages in terms of speed, quality, labor efficiency, and long-term cost-effectiveness. Its high repeatability and minimal site variability make it suitable for large-scale housing and infrastructure projects, especially where consistency and rapid execution are critical.

Although conventional RCC construction remains widely used due to its design flexibility, it is more vulnerable to seismic deformations and requires more time and labour resources. These limitations can be particularly challenging in post-disaster scenarios or projects with tight deadlines.

In conclusion, Mivan technology is a structurally robust, economically viable, and operationally efficient construction method. It is highly recommended for multi-storey developments in seismic Zones III, IV, and V, where performance, safety, and rapid delivery are of paramount importance.

V. FUTURE SCOPE

The present study provides a strong foundation for understanding the seismic performance of Mivan and RCC structural systems. However, there are several opportunities for future work to enhance the depth and applicability of this research:

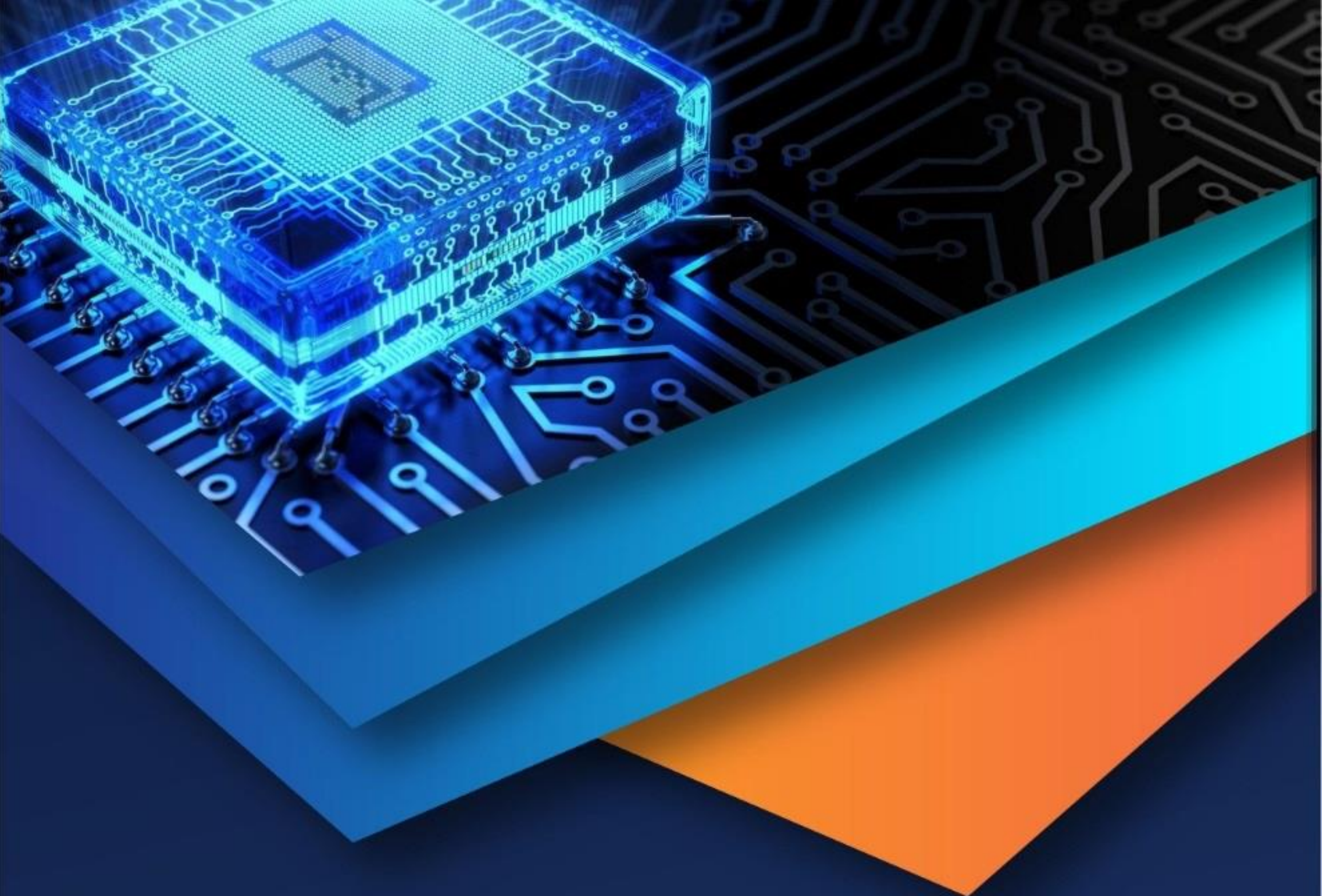
1) Dynamic Analysis: Incorporating Response Spectrum and Time History analyses can provide a more detailed understanding of structural behaviour under real earthquake conditions.
2) Material Optimization: Studying the influence of advanced materials like high-performance concrete or lightweight aggregates in Mivan construction could lead to further efficiency gains.
3) Cost-Time-Quality Triad Modelling: A detailed simulation comparing cost, time, and quality metrics across various building heights and layouts could support policy-level decisions.
4) Field Validation: Actual site-based monitoring of Mivan and RCC buildings in seismic zones would validate and reinforce analytical findings.
5) Sustainability Assessment: Future studies can include lifecycle assessments to evaluate environmental impacts and long-term sustainability of both techniques.

By addressing these areas, the research can evolve into a comprehensive decision-making framework for developers, structural engineers, and policymakers working in high-risk seismic zones.

REFERENCES

[1] P. Agarwal and M. Shrikhande, *Earthquake Resistant Design of Structures*, PHI Learning Pvt. Ltd., New Delhi, 2019.
[2] Bureau of Indian Standards (BIS), *IS 1893 (Part 1): Criteria for Earthquake Resistant Design of Structures – General Provisions and Buildings*, New Delhi, India, 2016.

[3] Bureau of Indian Standards (BIS), *IS 875 (Part 1–3): Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures*, New Delhi, India, 1987.
[4] A. Sharma and R. Patel, "Comparative Study of Conventional RCC and Mivan Construction in Terms of Cost and Time," *International Journal of Construction Management*, vol. 20, no. 3, pp. 345–359, 2020.
[5] S. Patil, K. Jadhav, and P. Kulkarni, "Mivan Formwork: A Revolution in Construction Technology," *International Journal of Engineering Research & Technology (IJERT)*, vol. 7, no. 4, pp. 556–560, 2018.
[6] R. Rana, A. Verma, and R. Choudhary, "Cost-Benefit Analysis of Mivan and RCC Construction Methods," *International Journal of Civil Engineering Research*, vol. 11, no. 2, pp. 98–110, 2020.
[7] R. Singh, A. Kumar, and P. Gupta, "Seismic Behaviour and Performance of Mivan Technology Buildings," *Engineering Structures*, vol. 238, 112221, 2022.
[8] P. P. Bansal, S. Singh, and S. K. Kaushik, "Performance Evaluation of Monolithic and Conventional RCC Structures in Seismic Zones," *Journal of Structural Engineering (ASCE)*, vol. 147, no. 4, 04021049, 2021.
[9] Computers and Structures Inc., *ETABS Ultimate 21.0.1: Integrated Software for Structural Analysis and Design*, Berkeley, California, USA, 2021.



10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY