iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** XI **Month of publication:** November 2026

DOI: https://doi.org/10.22214/ijraset.2026.85767

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue XI Nov 2026- Available at www.ijraset.com

Study of Mivan Structure with Different Percentage of Openings having Different Seismic Zones

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Abstract: ***Structures constructed using Mivan technology offer significant advantages over traditional construction method. The specific material used in Mivan formwork directly impacts both the durability and compressive strength of the resulting concrete. A detailed study is done to understand structural behaviour of the building with opening in Mivan building will be carried out. In the present study a G+11, G+13 and G+15 stories structure with the provision of various percentage of openings (20%, 35% and 50%) are taken into consideration.***

The seismic behaviour of 3D structure for these cases is compared for different seismic zones (Zone 3, Zone 4 and Zone 5) keeping the soil condition as constant. Equivalent Static Method and Response Spectrum Method is used for dynamic analysis of the G+11 (20%, 35% and 50% openings with Zone 3, 4 and 5), G+13 (20%, 35% and 50% openings with zone 3,4 and 5) and G+15 (20%, 35% and 50% openings with zone 3, 4 and 5) story building using ETABS. Structural key parameters such as time period, maximum story displacement, base shear and story stiffness are compared with different building configurations in the form of tables and graphs.

Based on the comparison done on different structural parameters a possible suitable structural configuration is selected in order to satisfy all the conditions in optimistic way.

Keywords: Different Percentage of openings, Seismic Zones, ETAB Software, Static and Dynamic Analysis, Story responses.

I. INTRODUCTION

Mivan construction is a modern formwork-based building system widely used for constructing reinforced concrete structures, particularly residential and high-rise buildings. The system uses specially designed aluminium formwork to create the walls, slabs, columns, beams, and other structural components of a building. Unlike conventional construction methods that often involve brickwork and separate plastering, Mivan technology allows many structural elements to be cast together, resulting in a strong and uniform structure.

Mivan construction offers benefits such as faster execution, improved dimensional accuracy, reduced material wastage, and consistent quality. However, it requires careful planning, skilled labour, proper coordination of services, and a significant initial investment in formwork. Because of these characteristics, Mivan technology has become an important construction technique for large-scale and repetitive building projects.

The study aims to modelling of G+11 (with 20%, 35%, and 50% opening in Zone 3, 4, and 5), G+13 (with 20%, 35%, and 50% opening in Zone 3, 4, and 5), and G+15 (with 20%, 35%, and 50% opening in Zone 3, 4, and 5) building and analyze their structural key parameters and identify the seismic behaviour of the structures.

II. MODELLING AND ANALYSIS OF THE STRUCTURE -

In the present study 27 models were developed using ETABS 22.5.0, and dead, live and seismic loads were applied in accordance with IS 1893 (Part 1): 2016.

For G+11 building (Model 1 to Model 9) total 9 models were developed. Similarly for G+13 (Model 10 to Model 18) and for G+15 (Model 19 to Model 27) were modelled.

All structural configurations were modelled with the same plan dimensions. Static and Dynamic analysis for all the models are performed using Equivalent Static Analysis and Response Spectrum Analysis.

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Table 1 Structural parameters for G+11, G+13, and G+15 building Model

Parameters	G+11	G+13	G+15
Floor Height	3 m	3 m	3 m
Concrete Grade	M35	M35	M35
Steel Grade	HYSD500	HYSD500	HYSD500
Beam	600 mm*400mm	750mm*400mm	800mm*400mm
Column	600mm*600mm	750mm*750mm	800mm*800mm
Slab (Thickness)	150mm	150mm	150mm
Wall (Thickness)	180mm	180mm	180mm
Seismic Zones	III, IV, V	III, IV, V	III, IV, V

Table 2 Seismic data used for analysis of structure

Constraint	Data used for all buildings
Soil Type	Medium
Seismic Zone	III, IV, V
Zone factor (Z)	0.16, 0.24, 0.36
Response reduction factor	4
Importance factor	1.0
Mode shapes	12
Damping ratio	5%
Type of analysis	Equivalent Static Method and Dynamic (Response Spectrum Method)
Code used	IS 1893 (Part 1):2016

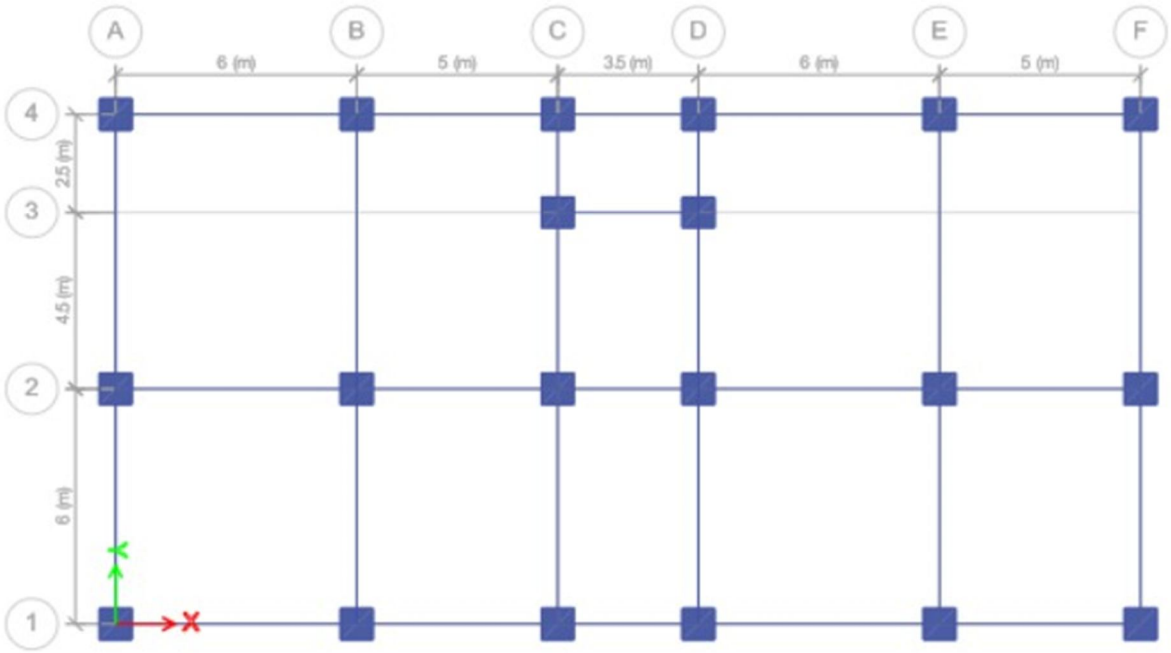

Fig. 1 Plan View of the building

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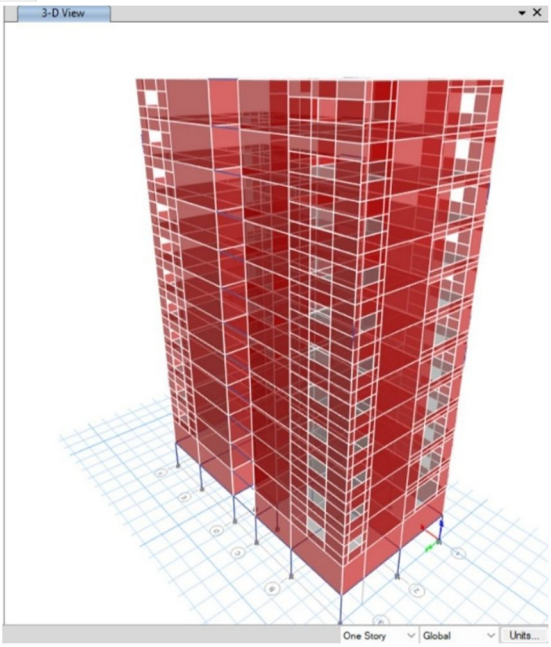
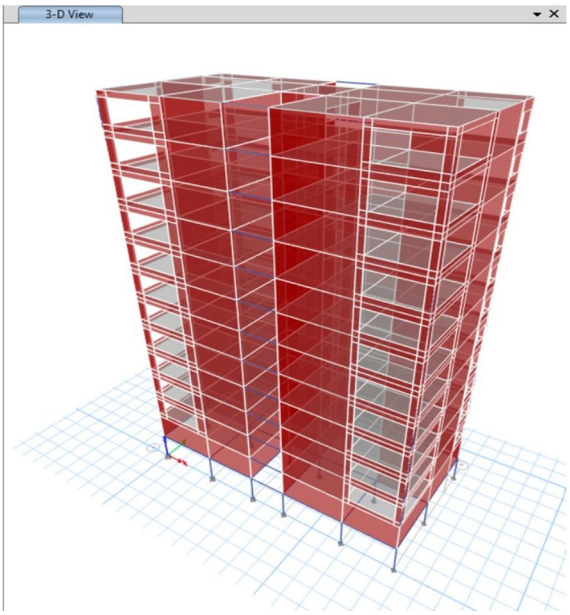


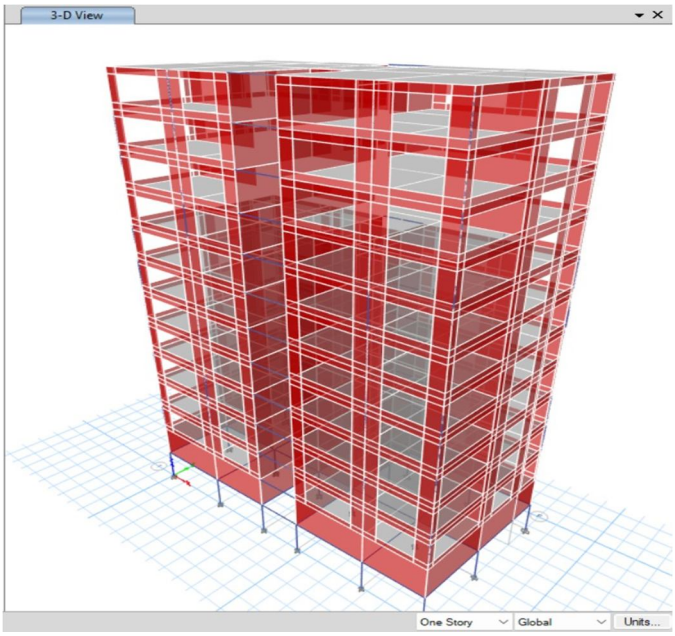
Model with 20% Opening



Model with 35% Opening

Height of each Story = 3 m
Width of the wall = 51 m
Length of the wall = 26 m
Area of the wall = 231 m^2
20% Opening area = 46.2 m^2

Height of each Story = 3 m
Width of the wall = 51 m
Length of the wall = 26 m
Area of the wall = 231 m^2
35% Opening area = 80.85 m^2



Model with 50% Opening

Height of each Story = 3 m
Width of the wall = 51 m
Length of the wall = 26 m
Area of the wall = 231 m^2
50% Opening area = 115.5 m^2

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III. RESULT AND DISCUSSION

After modelling all the structural configurations of G+11, G+13 and G+15 buildings using ETABS 22.5.0, the structural response was evaluated based on the following key parameters:

- Time period
- Maximum Storey displacement
- Base Shear
- Storey Stiffness

To ensure fair comparison each result was extracted under the same loading and boundary conditions. The summarized findings are presented below:

1) Time Period - The time period is an important dynamic property of a structure that represents the time required to complete one full cycle of vibration. It depends mainly on the mass and stiffness of the building.

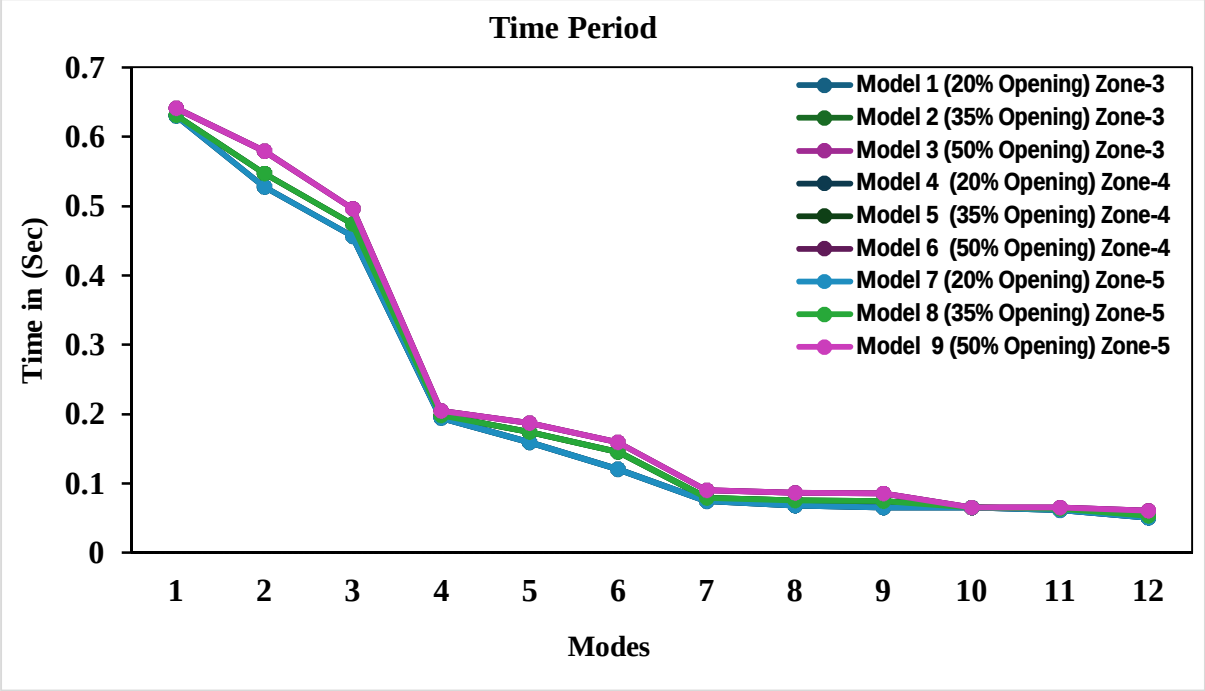

Fig. 2: Time period for G+11 buildings with different percentage of openings

The increase in opening percentage from 20% to 50% results in an increase in the fundamental time period (Fig. 2) from 0.630 to 0.641 seconds for G+11, 0.634 to 0.663 seconds for G+13 and 0.783 to 0.823 seconds for G+15 building configurations. Shorter time periods suggest higher stiffness and higher resistance to seismic vibrations. The comparison of the results for Zone 3, Zone 4, and Zone 5 reveals that the seismic zone classification does not produce any observable variation in the modal time periods which is expected when the structural geometry, mass, stiffness and support conditions remain same.

2) Maximum Story Displacement - Story displacement is the absolute lateral movement of a specific floor (story) measured from its original, un-deformed position relative to the fixed base of a structure.

The maximum story displacement in the X-direction for G+11 building configurations, subjected to earthquake loading in X-direction (EQX) in Zone 3 increase from 4.557 mm (20% opening) to 5.174 mm (35% opening) and 5.983 mm (50% opening), in zone 4 and in zone 5 the results indicate that maximum displacement generally increases with an increase in opening percentage. Similarly, for G+13 and G+15 building configurations, results indicate that as the percentage of opening increases from 20% to 35% and 35% to 50%, the maximum displacement increases.

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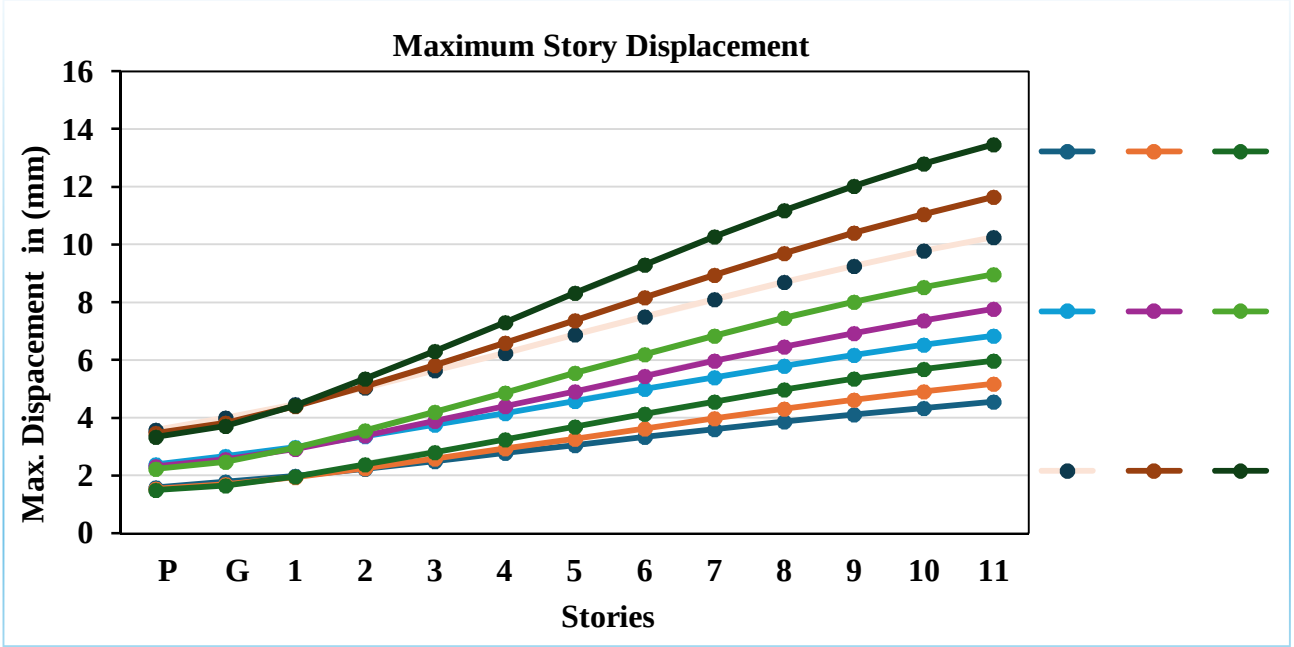

Fig. 3: Maximum Story Displacement EQX in X-Direction for G+11 Building

The maximum story displacement in the Y-direction (Fig. 4) for G+11 buildings configurations, subjected to earthquake loading in Y-direction (EQY) in Zone 3 increase from 4.916 mm (20% opening) to 5.053 mm (35% opening) and 5.395 mm (50% opening), also in zone 4 and Zone 5, as the percentage of openings increases, the value of maximum displacement increases. Similarly, for G+13 and for G+15 Building configurations, results show the same trend as obtained for G+11 structural models.

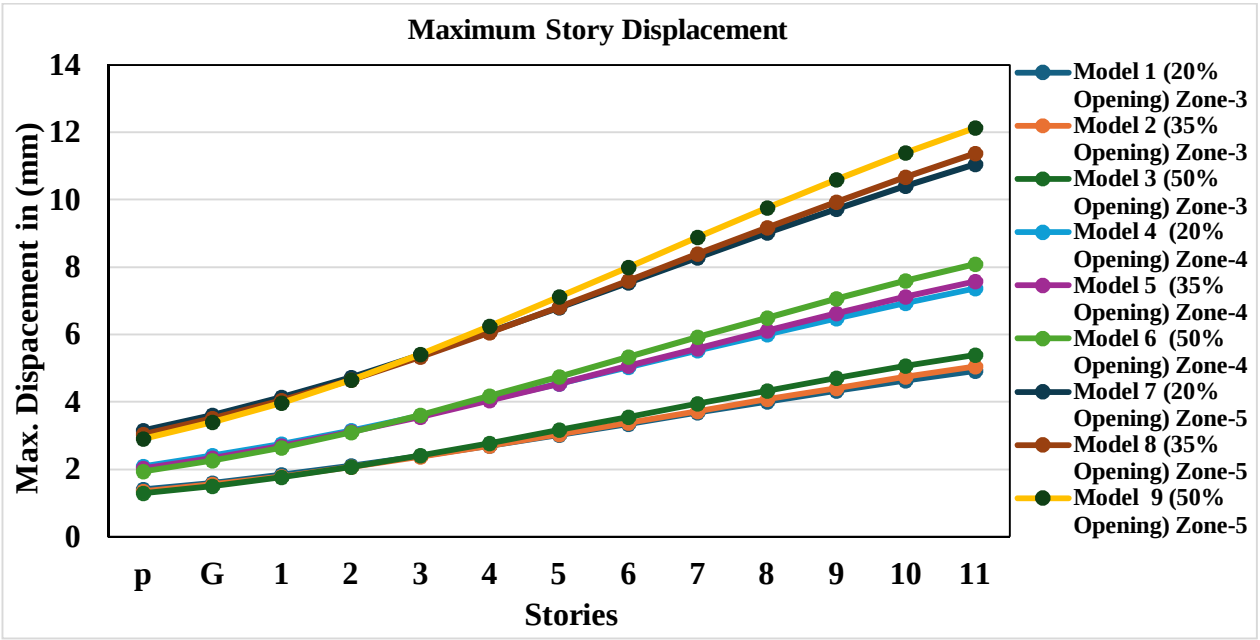

Fig. 4: Maximum Story Displacement EQY in Y-Direction for G+11 Building

The maximum story displacement (Fig. 5) in the X-direction for G+11 buildings, subjected to earthquake loading in X-direction (RSX), in zone 3 increase from 4.04 mm (20% opening) to 4.589 mm (35% opening) and 5.223 mm (50% opening), in zone 4 and zone 5 the value increases as the percentage of openings increases from 20% to 35% and 35% to 50%.

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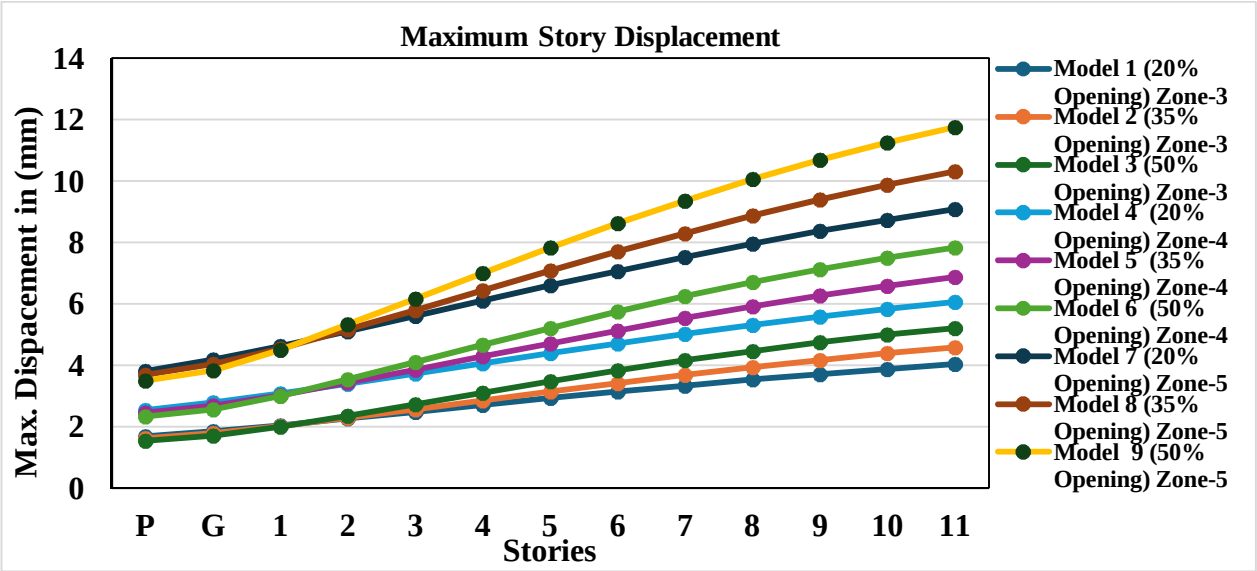

Fig. 5: Maximum Story Displacement RSX in X-Direction for G+11 Building

Similarly, for G+13 and for G+15 Building configurations, the maximum storey displacement follows similar trend as obtained in G+11 Building Configuration.

The maximum story displacement (Fig. 6) in the Y-direction for G+11 buildings, subjected to earthquake loading in Y-direction (RSY) is presented below, which shows the similar trends as obtained above structural configurations.

Similarly, for G+13 and for G+15 Building configurations, the results indicate that maximum displacement generally increases with an increase in opening percentage.

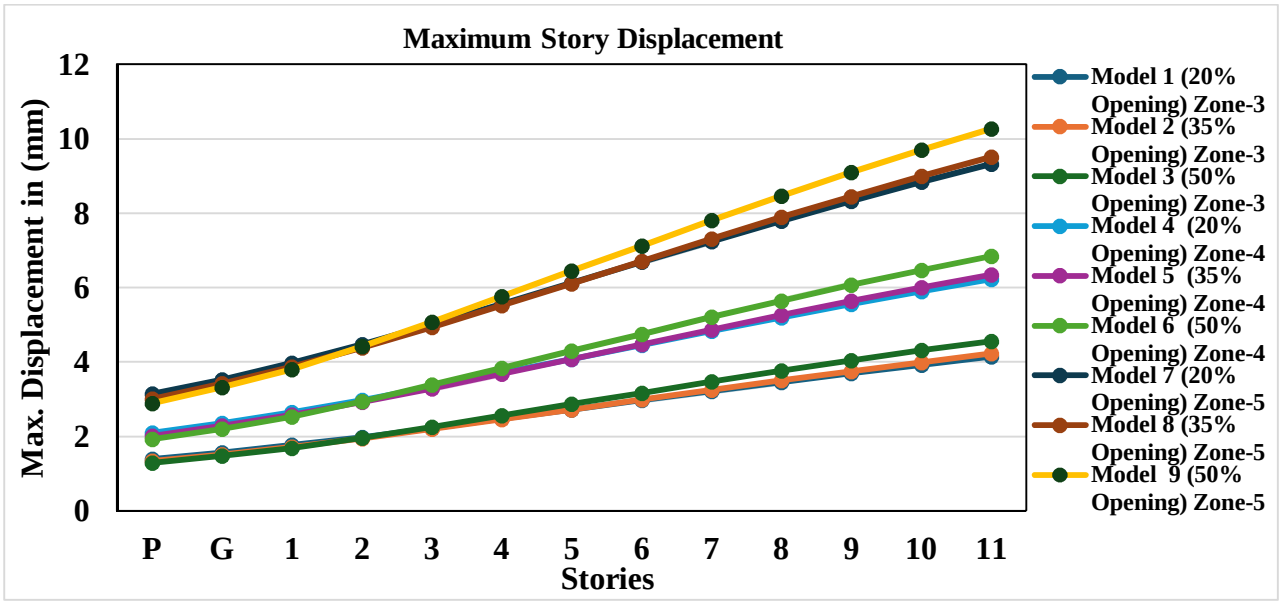

Fig. 6: Maximum Story Displacement RSY in Y-Direction for G+11 Building

This behaviour indicates that increasing the percentage of opening can influence the effective stiffness of the structural system. Therefore, the 50% opening configuration generally exhibits higher displacement than the 20% and 35% opening configuration in all three building heights.

The influence of seismic zone on maximum story displacement is clearly observed in all three building configurations. The displacement values increase progressively from Zone 3 to Zone 4 and Zone 5.

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3) Base Shear - Base shear is one of the most important parameters in the seismic analysis of buildings. It represents the total lateral seismic force acting at the base of a structure due to earthquake excitation.

The comparison of base shear values for the G+11, G+13, and G+15 buildings indicates that the base shear generally increases with an increase in building height.

Considering 20% opening configuration (Fig. 7) in Zone 3, the base shear obtained from Equivalent Static Analysis is 3407.7658 KN for G+11 building (Model 1), 3664.1812 KN for G+13 building (Model 10), and 3681.0203 KN for G+15 building (Model 19). Similarly, in Zone 4, the corresponding base shear values are 5111.6487 KN, 5496.2953 KN, and 5521.5303 KN respectively and in Zone 5, the base shear values increase to 7667.4731 KN, 8244.4077 KN, and 8282.2953 KN for G+11, G+13, and G+15 respectively.

For all the three building heights and seismic zones, the base shear decreases as the opening percentage increases from 20% to 35% and 50%. The reduction in base shear with increasing opening percentage may be associated with a reduction in the effective structural mass due to the removal of material from the opening regions.

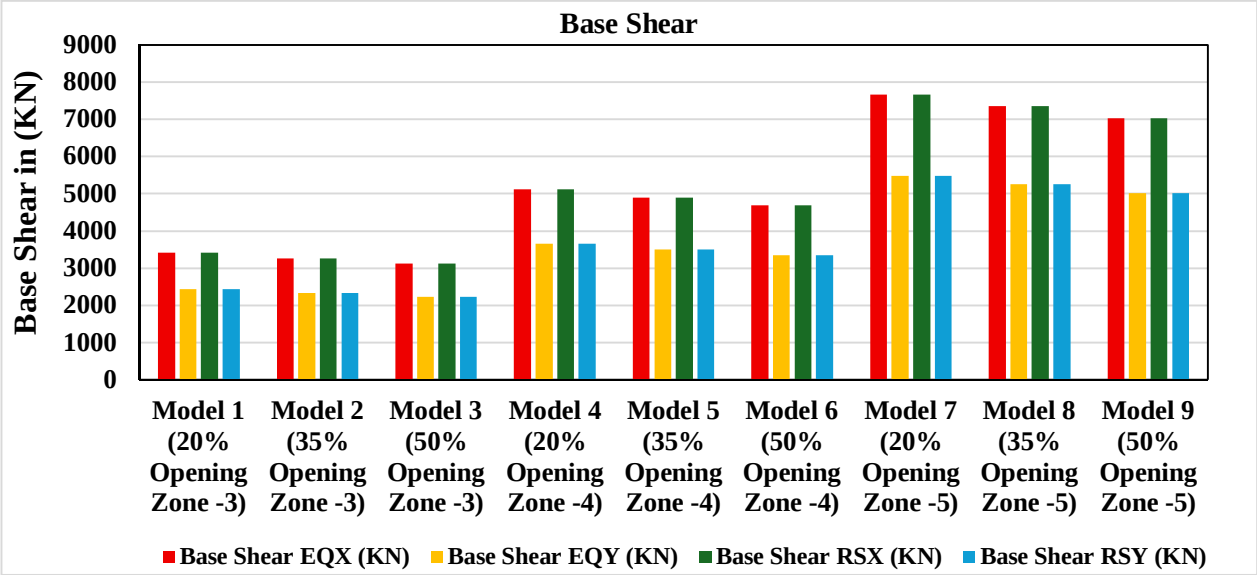

Fig. 7: Base Shear For G+11 building

The comparison of the results for Zone 3, Zone 4, and Zone 5 shows a significant increase in base shear with an increase in seismic zone severity. For all three building heights and opening configuration, the maximum base shear is observed in Zone 5, followed by Zone 4 and Zone 3.

4) Storey Stiffness - Story stiffness is an important structural parameter that indicates the resistance of a building against lateral deformation. A higher stiffness value indicates greater resistance to lateral displacement, whereas a reduction in stiffness may result in increased lateral deformation under earthquake loading.

In the X-direction (Fig. 8) under EQX loading conditions, for G+11 building, the stiffness at the first story decreases from 1,51,61,784 KN/m for 20% openings to 1,27,18,870 KN/m for 35% openings and 94,83,629 KN/m for 50% openings.

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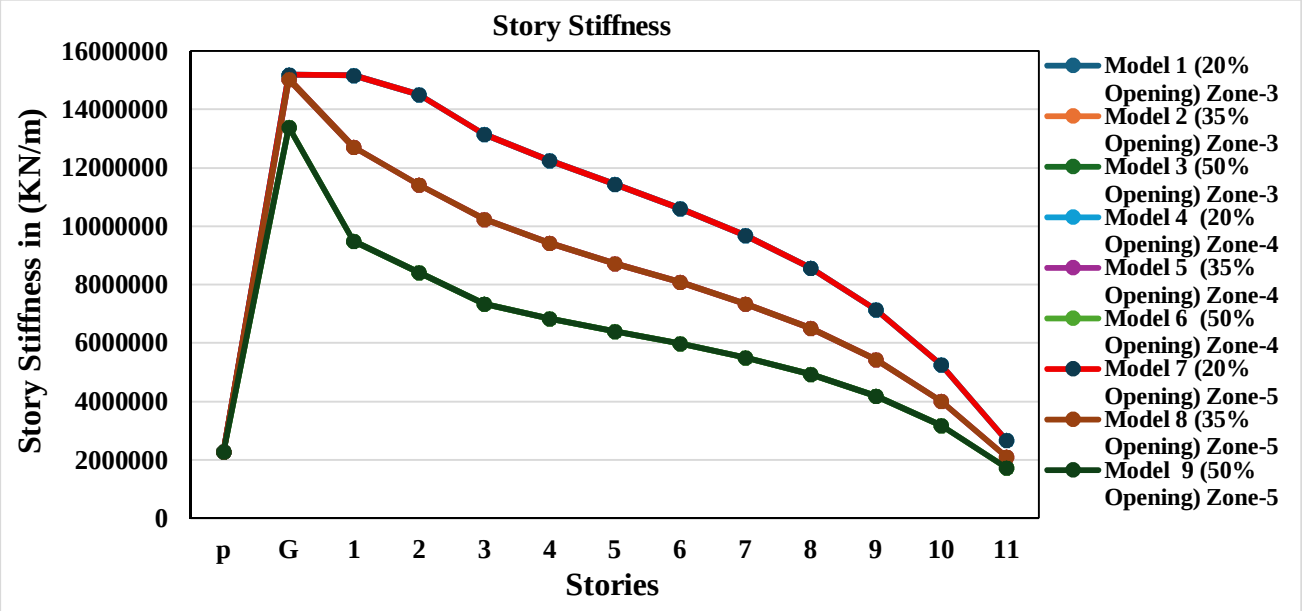

Fig. 8: Story Stiffness EQX in X-direction for G+11 building

Similarly, for G+13 and G+15 building models, the stiffness at the first story decreases as the percentage of openings increases (20% to 35% to 50%).

In the Y-direction (Fig. 9) under EQY loading conditions, for G+11 building, the stiffness at the first story decreases from 97,94,944 KN/m for 20% openings to 90,79,165 KN/m for 35% openings and 79,81,663 KN/m for 50% openings. Similarly, for G+13 and G+15 building configurations, the analysis indicates that story stiffness decreases with an increase in percentage of openings in the infill walls.

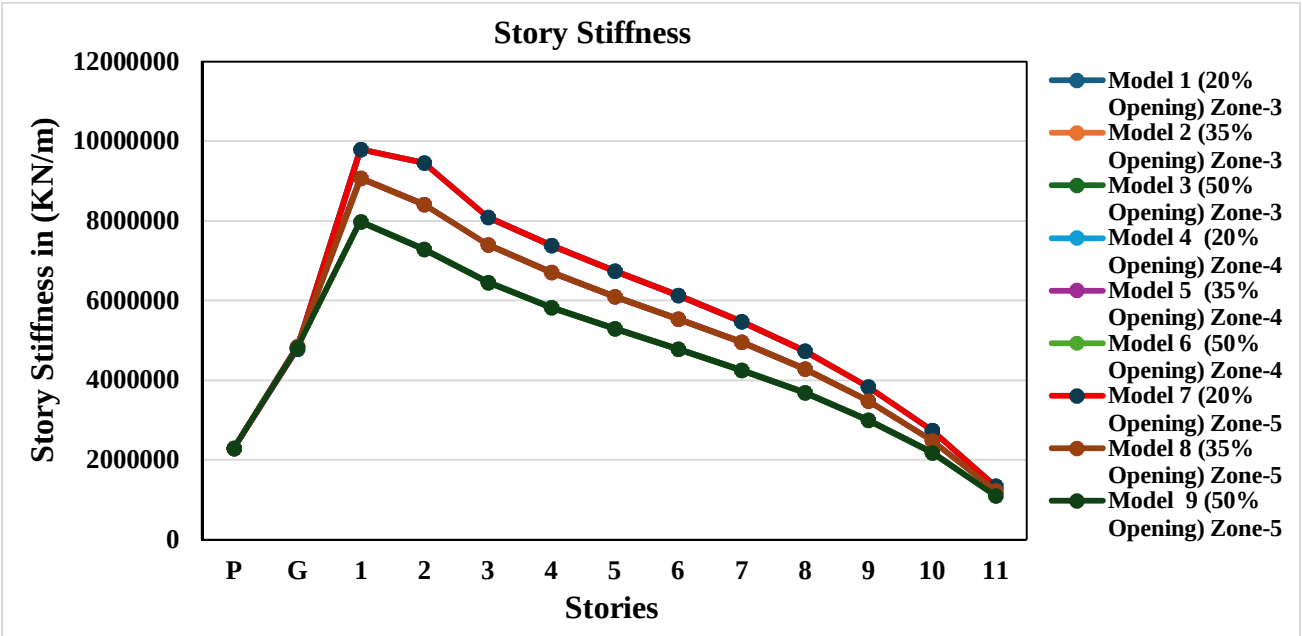

Fig. 9: Story Stiffness EQY in -direction for G+11 building

In the X-direction (Fig. 10) under RSX loading conditions, for the stiffness at the first story decreases from 1,64,75,851 KN/m for 20% openings to 1,38,14,190 KN/m for 35% openings and 1,01,39,227 KN/m for 50% openings. Similarly, for G+13 and G+15 building configurations, as the percentage of openings increases, the stiffness value decreases.

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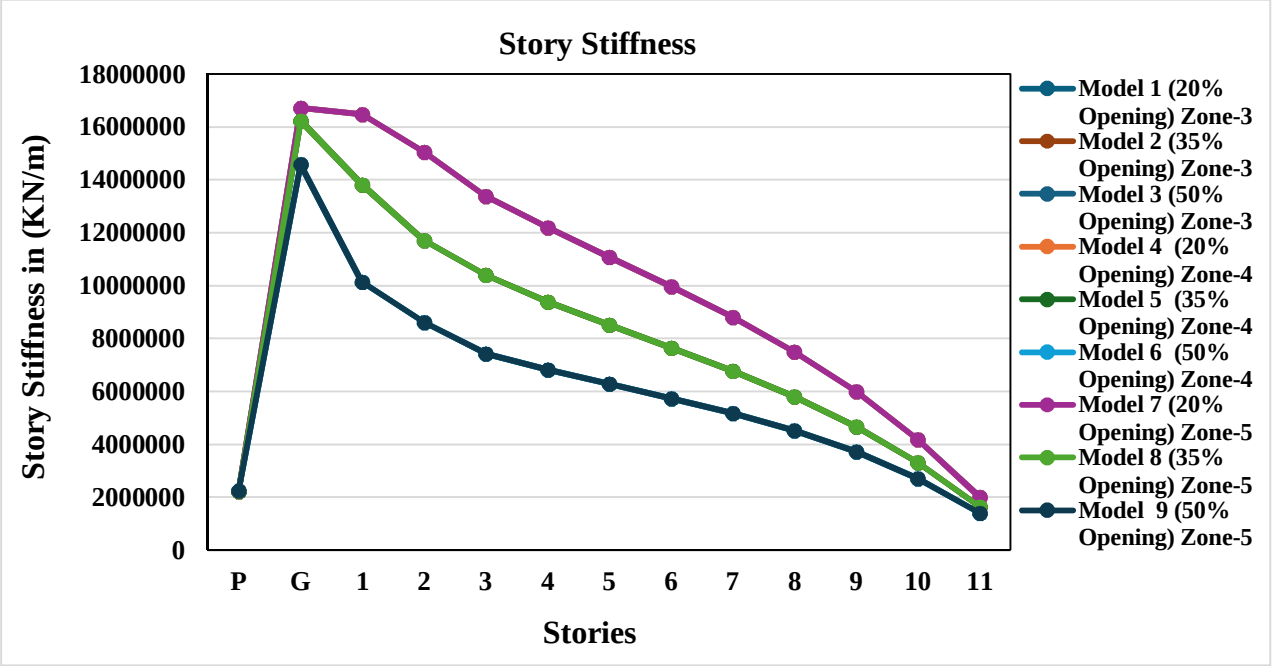

Fig. 10: Story Stiffness RSX in X-direction for G+11 building

Story stiffness values of G+11, G+13 and G+15 building in the Y-direction (Fig. 11) under RSY loading conditions, shows the same trend as obtained in above structural configurations.

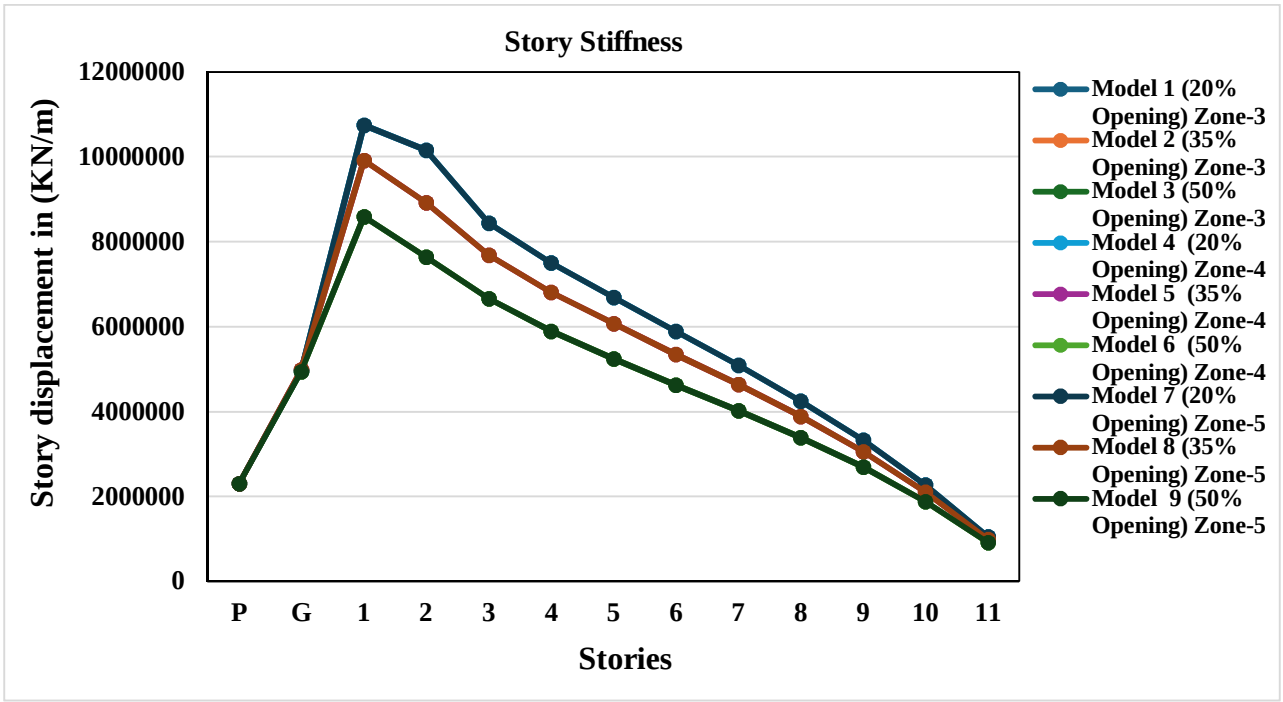

Fig. 11: Story Stiffness RSY in Y-direction for G+11 building

Among the three configurations, the building with 20% opening exhibits the highest stiffness, followed by 35% and 50% openings. The story stiffness generally decreases with increasing story level. The lower story exhibit higher stiffness values compared with the upper story.

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IV. CONCLUSIONS

1) The percentage increase in the fundamental time period when the opening percentage changes from 20% to 50% for G+11, G+13 and G+15 building configurations is approximately 1.75%, 4.57% and 5.11%.

2) The maximum story displacement for G+11 building configurations, subjected to earthquake loading in (EQX, EQY, RSX and RSY) X and Y- directions, for all opening percentages, the displacement in Zone 4 is approximately 50% higher than that in Zone 3 for the same percentage of openings, while the displacement in Zone 5 is approximately 50% higher than that in Zone 4.

3) The base shear increases with an increase in building height. The G+15 building shows approximately 8.16% higher average base shear in the X-direction and 8.14% higher average base shear in the Y-direction compared with the G+11 building. An increase in opening percentage from 20% to 35% results in an average reduction of approximately 4% in base shear, whereas an increase from 20% to 50% results in an average reduction of approximately 8%. Also, Among the three opening zones, Zone 5 exhibits higher base shear values, followed by Zone 4 and Zone 3, for corresponding opening configuration.

4) Story stiffness decreases with an increase in opening percentage. The 20% opening model demonstrates better stiffness characteristics compared with 35% and 50% openings model. Hence, the opening percentage should be carefully considered during the structural planning and design of multi-story buildings to maintain adequate lateral stiffness.

V. FUTURE SCOPE

The present study established a strong foundation for evaluating the seismic behaviour of Mivan model structural configuration. However, several critical avenues remain open for future investigation to enhance the depth and practical applicability of this research.

Integrating Response Spectrum analysis and Time history analysis can deliver a more precise understanding of how these structural systems behave under real, recorded earthquake condition. Also assessing the impact of advanced materials such as high-performance concrete or lightweight aggregate within Mivan construction would yield substantial structure and economic efficiency gains. In addition, developing detailed simulations to compare cost, execution time and Quality matrix across diverse building heights and floor layouts would provide valuable data to support policy-level decision.

REFERENCES

[1] Anagha M and Anoop P P, “Earthquake Response of Different Shapes of Tall Vertically Irregular Mivan Wall Building”, International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 5 Issue 08, August-2016.

[2] Bansal P.P, Singh. S and Kuashik S.K,” Performance Evaluation of Monolithic and Conventional RCC Structures in Seismic Zones”, *Journal of Structural Engineering (ASCE)*, vol. 147, no. 4, 04021049, 2021.

[3] Bhanulatha G.N., Reddy M. Sreenivasulu and Dr. Reddy Y. Ramalinga, “Study of Dynamic Behaviour of MIVAN Structure with Different Percentage of Openings and Different Seismic Zones”, International Journal of Advances in Scientific Research and Engineering (IJASRE), Vol.3 (9) Oct - 2017.

[4] Choubey Anuj, Maru Savita “Optimum Shape for High Rise MIVAN and Conventional Structure in Seismic Loading” (IJRTE) Volume-8 Issue-5, January 2020.

[5] Ganar, A. S., & Patil, S. D. (2015), “Comparative analysis on cost and duration of MIVAN formwork building and Conventional Formwork building”, International Journal on Recent and Innovation Trends in Computing and Communication (IJRITCC), 3(12), 6472–6474.

[6] Hinduja Anmol, Sankle Tarun, Ahmed Mahroof, “Comparative Study of Mivan Technology and Conventional RCC Structures in High Seismic Zones”, International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 13 Issue VI June 2025 ISSN: 2321-9653.

[7] Jamkar SS, “Structural behaviour of Mivan Structure for Dynamic Case”, International Journal Engineering Sciences & and Research Technology, 2013 ISSN:2277 [9-14].

[8] Kolekar Prasad, Nigade, V, Hajare Shivaji, “Analysis and Comparison of Mivan Formwork System with Conventional Formwork System” , International Research Journal of Engineering & Technology, Volume: 07 Issue: 06 | p-ISSN: 2395-0072, PP 4906-4910.

[9] Kote Aarti Nanasaheb, Nandeshwar Aahuti Ramesh, “Duration Comparison of Mivan Formwork over the Conventional Formwork”, International Journal Engineering Application for & Research in Management (IJREAM) ISSN: 2454-9150, 2020.

[10] Kulkarni P.B, “Seismic and deflection behavior of Mivan for Different Openings”, Pros ASCE. Structural Division Journal ST – 1 Vol 92 331- 403.

[11] Kushwaha Jatin, Kumar Nirmal Pradeep, Singh Lokesh “Analysis of a Tall Structure Considering Mivan Technology Under Lateral Load Using ETABS - A Review”, 2022 International Journal of Scientific Research in Civil Engineering | IJSRCE | Volume 6 | Issue 5 | ISSN: 2456-6667.

[12] Magarpatil HR, “Modeling the effect of Mivan walls on seismic performance”, Indian Concrete Journal, Volume 85, Page 15-43, 2012.

[13] Nisarga K, Madhukaran, “Structural Performance of Mivan Structural System Over Conventional Structural System”, International Journal of Scientific Research and Modern Technology (IJSRMT) Volume 1 Issue 1 2022.

[14] Patekar, N. B., & Shaikh, A. F. (2023),” Assessing the impact of conventional formwork and Mivan formwork on construction productivity and efficiency”, World Journal of Advanced Engineering Technology and Sciences, 9(1), 240–247. DOI: 10.30574/wjaets.2023.9.1.0168.

[15] Prajwal M L, Dr Murthy M Keshava, “Comparative Seismic Analysis of Multistorey Mivan Structures Over Conventionl RC Structures”, Journal of Emerging Technologies and Innovative Research (JETIR) July 2025, Volume 12, Issue 7 ISSN-2349-5162.

[16] Rana. R, Verma. A and Choudhary. R,” Cost-Benefits Analysis of Mivan and RCC Construction Methods,” *International Journal of Civil Engineering Research*, vol. 11, no. 2, pp. 98-110, 2020.

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[17] Sajeet S. B, Gowda Supreeth S, “Earthquake Response of different shapes of Mivan wall Tall Buildings”, International Journal of Research in Engineering and Technology (IJRET), Volume: 04 Issue: 10 | Oct 2015.
[18] Singh. R, Kumar. A and Gupta. P, “Seismic Behaviour and Performance of Mivan Technology Buildings”, *Engineering Structures*, Volume 238, 112221, 2022.
[19] Walvekar Pawan M, Sonawadekar Hemant L, “Seismic Performance Evaluation of Mivan Structural System v/s Conventional Structural System with Effect of SSI by Pushover Analysis”, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 06 | June -2017.
[20] Computers and Structures Inc., *ETABS version 22.5.0: Integrated Software for Structural Analysis and Design*, Berkely, California, USA,2022.

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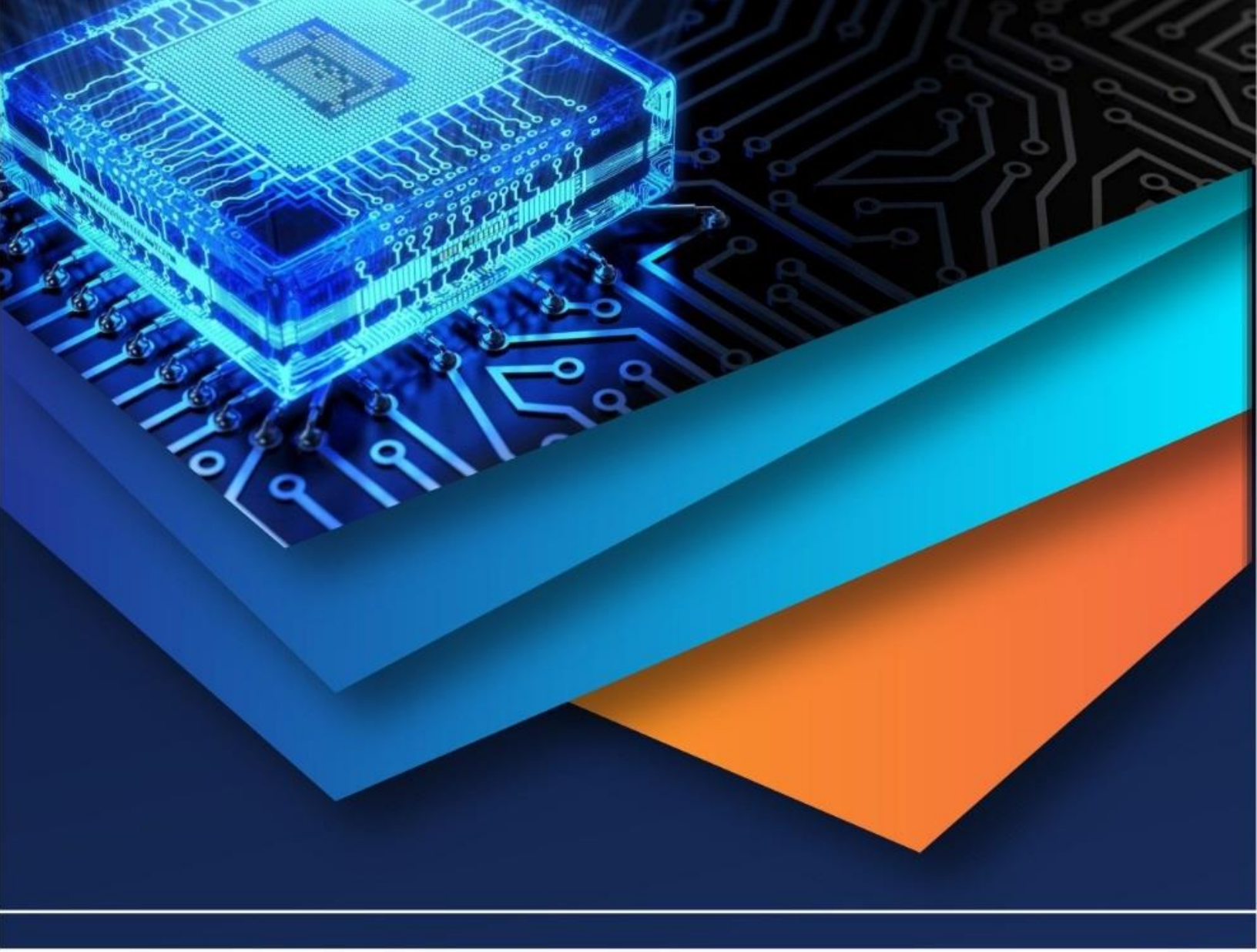

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