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A Stability Comparison between Mivan and Conventional Structures

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Abstract:** The rapid urbanization & housing demand in Indian cities have made construction speed, quality, & cost optimization critical for high-rise projects. This project report presents a comparative analysis between Conventional RCC framed structure with brick infill & MIVAN aluminum formwork technology for a G+20 storey building. The study evaluates both methods on key parameters: structural performance, quality of finish & suitability for repetitive high-rise construction. Conventional construction involves RCC beam-column frames with 230mm brick masonry walls, formwork, & internal/external plaster. MIVAN construction uses pre-engineered aluminum formwork panels to cast monolithic RCC shear walls & slabs together in a single pour, eliminating brickwork & plaster. Preliminary findings indicate that MIVAN technology reduces floor cycle time from 15-20 days to 7-10 days, increases carpet area by 5-8% due to thinner 150mm RCC walls, & provides superior dimensional accuracy with reduced seepage issues. However, it demands higher initial investment, complete design freeze before execution & is less flexible for architectural variations. Conventional method offers better thermal insulation, easier mid-way changes & lower setup cost but results in longer project duration & higher finishing costs. The report concludes break-even point for MIVAN investment & recommendations on selection criteria based on project scale, timeline, & design complexity. The study aims to help developers, contractors, & engineers in Tier-2 cities make informed decisions while adopting modern formwork technology for high-rise construction.

***Keywords:** MIVAN formwork, Conventional construction, G+20 building, Aluminum formwork, Floor cycle time, Cost comparison, High-rise construction, RCC shear wall, Project report.*

I. INTRODUCTION

A Mivan is an advanced aluminum formwork system used for fast, monolithic concrete construction. It originated from Mivan Company Ltd. of Malaysia in the 1990s & is now widely used in India for mass housing projects. it's a system formwork made of strong aluminum alloy panels that replace traditional timber/plywood shuttering. The panels are lightweight, modular, & pre-engineered to cast walls, slabs, beams, stairs, & balconies together in one continuous pour. MIVAN is an aluminum formwork technology used to build monolithic RCC structures fast & with high finish quality.

A. Functionality

- Assembly: Panels are assembled on site using a pin-wedge system as per approved drawings.
- Reinforcement: Steel is placed; conduits & door/window openings are fixed in the formwork itself.
- Concreting: Concrete is poured for walls & slab together, giving a box-type monolithic structure.
- De-shuttering: Vertical panels are removed after 12-24 hrs, slab panels after 36-72 hrs depending on span.
- Repeat: Same set moves to next floor, so typical floor cycle is 7-10 days.

B. Main Components

Table 1 Components

Component	Purpose
Wall panels	Form vertical RCC walls, 150-200mm thick
Deck panels	Form slab soffit
Beam components	Beam sides + soffit panels
Kickers	Base starter for wall alignment
Props & wailers	Support slab panels & align walls
Pin + Wedges	Quick connection system, no nuts/bolts

C. Construction Cycle

- Day 1-2: Erect wall panels + reinforcement + electrical conduits
- Day 3: Place deck panels, slab reinforcement
- Day 4: Concrete pour for walls + slab together
- Day 5: De-shutter walls after 12-24 hrs
- Day 7-8: De-shutter slab after 36-72 hrs depending on span
- Repeat: Same set of formwork moves to next floor → 7 to 10 day floor cycle

D. Developers Use MIVAN

- Speed: 4x faster than conventional brick + RCC frame for repetitive towers.
- Quality: 6mm tolerance, smooth concrete finish, no plaster needed. Reduces the seepage issues.
- More carpet area: 150mm RCC wall vs 230mm brick wall → gain 5-8% area.
- Less labor: 50-60% less skilled labor on site.
- Durability: 200-250 repetitions per set if handled well.
- Seismic performance: Box type structure behaves better in earthquakes.

E. Components of MIVAN Formwork

- Wall Components
- Slab/Deck Components
- Beam Components
- Staircase & Special Components
- Alignment & Support Accessories
- Miscellaneous items.

F. Wall Components

Table 2 Wall Components

Component	Function
Wall panel	Main flat aluminum panel 600-1200mm wide x 2400mm high, 4mm thick. Forms the face of RCC walls
Rocker	Base panel with sloped bottom, used at slab-wall junction for easy de-shuttering
Kicker	100-150mm high starter, fixed to slab before next lift to maintain wall alignment
Internal corner	L-shaped panel for internal corners of rooms
External corner	L-shaped panel for external corners of building
End panel	Closes the wall at openings or wall ends

II. LITERATURE REVIEW

1) "Comparative Study Between Regular Framed Structure and Mivan Structure"

The findings are based on the assumption that the main goal is to assess the cost differences between traditional & Mivan technologies. Using Mivan shuttering, the total cost of a structure with an area of 1350 square feet is 2,271,433/-, which is equivalent to 1,682/- per square foot, according to the calculations. In contrast, a building using traditional formwork costs a total of 1,786,384/-, or 1,323/- per square foot. According to the study, traditional shuttering needs 21 days for each bottom cycle, but Mivan formwork allows for 7 to 10 days.

2) "Optimizing Construction Efficiency with Mivan Formwork System"

This research aims to compare the cost implications of Mivan construction methods with traditional techniques, focusing specifically on material expenses. We will conduct a side-by-side analysis of these two construction methodologies, with the following objectives Evaluate the cost of Mivan construction, including materials, against a conventional building model. Contrast the Mivan construction approach with the traditional building model. Determine the construction duration for both methods. Utilize the findings to highlight the advantages & disadvantages of each technique.

3) "Comparative Analysis Between Conventional and Mivan Construction using Etabs Software"

Utilizing the ETABS software, this inquiry presents a comparative analysis between traditional development methods & the Mivan development technique. Conventional development strategies typically employ wooden, steel, or other materials for formwork, while the Mivan approach utilizes lightweight aluminum formwork systems. The objective of this evaluation is to ascertain the financial feasibility, developmental efficiency, & supplementary implementation of each development strategy. The ETABS software, a commonly utilized tool for facilitating research & planning, is employed for this investigation. Engineers can leverage ETABS to meticulously model & replicate auxiliary structures, enabling them to evaluate various parameters, such as stack conveyance, diversion, & stability. Methodology Collected from formwork related to construction.

4) "Comparative analysis of conventional technology and MIVAN technology"

The study was performed utilizing the ETABS 2013 software suite, employing direct dynamic analysis to evaluate the overall structural performance. This research focused on the seismic assessment of a 15-story reinforced concrete (R.C.) building & a Mivan construction across various seismic zones. The primary objectives were: (1) to evaluate the seismic performance of conventional & Mivan structural systems; (2) to compare the structural frameworks of conventional & Mivan buildings; (3) to quantify the material requirements for each building type; & (4) to conduct a comparative analysis of conventional & Mivan constructions considering parameters such as base shear, natural frequency, period, story drift, story shear, & story stiffness.

III. OBJECTIVES

The objective of the current research study is

1) To compare structural systems: Analyze the fundamental difference between MIVAN monolithic shear wall system & conventional RCC beam-column frame with infill walls under seismic loads.
2) To model MIVAN walls & conventional frame structures: create ETABS models of G+20 building using MIVAN walls & conventional frame as per IS 1893:2016
3) To evaluate lateral stiffness: Compare storey shear, lateral displacement, & storey drift of MIVAN walls & conventional frame structures for seismic zones II & III.
4) To assess base shear & time period: Determine & compare base shear, fundamental natural period, & mode shapes for MIVAN walls & conventional frame structures.
5) To analyze structural irregularity impact: Check performance of MIVAN walls & conventional frame structures with plan & vertical irregularities common in towers.
6) To recommend suitable system: Conclude which structural system is more seismically efficient for G+20 buildings in high seismic zones, considering safety, economy, & constructability.

IV. MODELLING AND STRATEGY

Step by step methodology for stability comparison between MIVAN & Conventional RCC Structure using ETABS for your G+20 is explained below:

1) Problem Definition & Data Collection

- Building details: Fix G+ 20 plans, floor height 3.35m plan is same for both cases.
- Material grades: M40 concrete, Fe500 steel.
- Location: Assume Seismic Zone II&III as per IS 1893:2016,
- Soil type: Medium soil, Type II.

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2) Structural System Definition

Table 3 System Definition

Parameter	MIVAN Model	Conventional Model
Vertical elements	150mm RCC shear walls	600x600mm columns + brick infill
Beams	Slab supported on walls	150x500mm,
Slab	150mm thick, monolithic with walls	150mm thick
Modeling	Wall elements as shell-thin	Frame elements beams/columns

3) ETABS Modeling Steps

- Grid & Storey: Define grid, 21 stories with typical floor height.
- Material & Section: Define M40, Fe500. Create wall, beam, column, slab sections.
- MIVAN model: Model all external & internal walls as shell elements. No columns. Meshing of walls at 1m x 1m.
- Conventional model: Model beams & columns as frame elements. Model slabs as shell thin. Add brick infill as equivalent UDL
- Loads: Dead load, floor finish 1.0 kN/sqm, wall load on beams for conventional, live load 2 kN/sqm . Applied as per IS 875.

4) Seismic Analysis Setup in ETABS

- Define mass source: DL + 0.5LL as per IS 1893:2016 Cl 7.3.1.
- Define load patterns: EQX, EQY using Response Spectrum Method & Equivalent Static Method for validation.
- Response spectrum: Use IS 1893:2016 spectra for Zone V, 5% damping, OMRF with R=3 for conventional model, R=3 for shear wall per Table 9.
- Load combinations: Generate combos per IS 456:2000 including 1.5DL+1.5LL, 1.2DL+1.2LL±1.2EQ/RS, 1.5DL±1.5EQ/RS, 0.9DL±1.5EQ/RS.

5) Analysis & Parameter Extraction

- Run analysis for both models

6) Comparison & interpretation

Table 4 Comparison

Comparison Point	Method
Stiffness	Plot storey drift & displacement graphs for both models
Performance	Tabulate time period, base shear, drift. Check which system is stiffer

7) Conclusion & Recommendation

Summarize which system performs better seismically for G+20, considering zone V.

A. Models Considered for Thesis

- G+20story Framed and Mivan structures in zone II
- G+20story Framed and Mivan structures in zone III

B. Analysis Considered For The Thesis

Response Spectrum Method

A linear-dynamic statistical simulation technique is employed to assess the maximum structural response to brief, non-deterministic, transient dynamic occurrences, including earthquakes or shocks. Rather than determining the precise behavior over time, the Response Spectrum Analysis (RSA) leverages structural natural frequencies along with a predetermined design curve to encapsulate the ultimate probable peak values of displacement, stress, and force.

Figure 1 Building plan

C. Details of the Structures

- Building details: Fix G+ 20 plans, floor height 3.35m plan is same for both cases.
- Material grades: M40 concrete, Fe500 steel.
- Location: Assume Seismic Zone 2&3 as per IS 1893:2016,
- Soil type: Medium soil, Type II.
- Column 600 X 600 mm & beam 150 X 500 mm for conventional building
- Slab thickness = 150 mm

Loads considerations:

- Wall load = 13.9 kN/m
- Parapet wall = 3.75 kN/m
- Slab Load = 3.75 kN/Sqm
- Floor Finish = 1.00 kN/Sqm

D. Models View

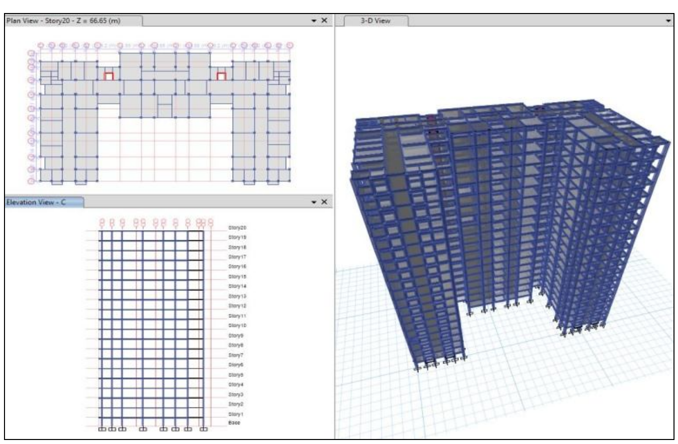

Figure 2 Plan Elevation & 3D View of Conventional System

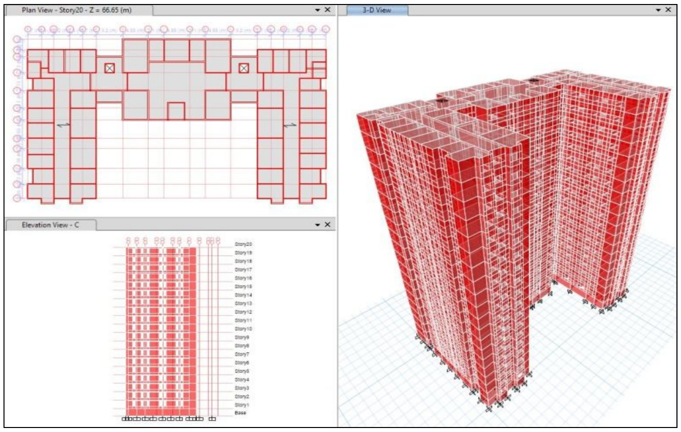

Figure 3 Plan, Elevation & 3D View of Mivan Construction

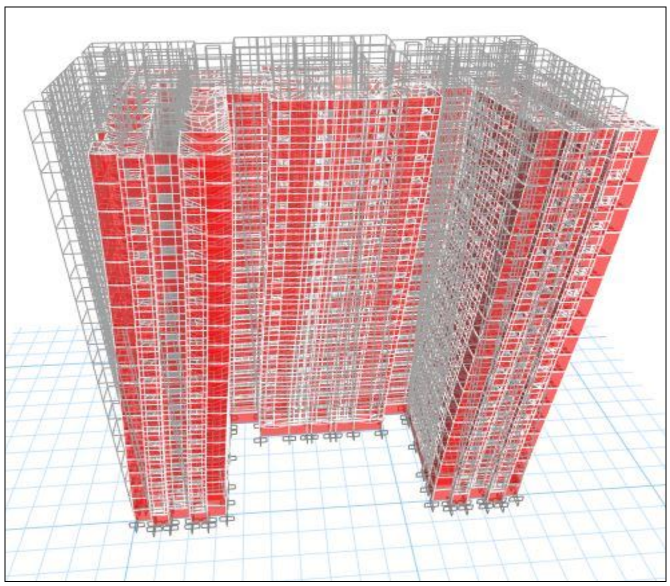

Figure 4 Deflection of Mivan Building

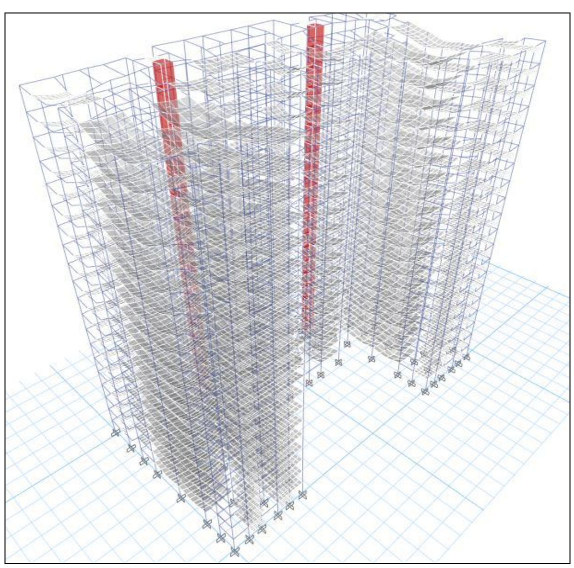

Figure 5 Deflection of Conventional Building

V. RESULTS AND DISCUSSION

A. *Displacement in Storey*

Table 5 Story Max Displacement in X

1.0DL + 0.8LL + 0.8RSX				
Story	Conven Zone II	Conven Zone III	Mivan Zone II	Mivan Zone III
20	20.222	32.783	2.833	6.236
19	19.844	32.156	2.731	5.971
18	19.384	31.395	2.622	5.693
17	18.825	30.477	2.504	5.400
16	18.166	29.398	2.378	5.090
15	17.41	28.163	2.243	4.766
14	16.561	26.78	2.099	4.427
13	15.624	25.255	1.947	4.076
12	14.604	23.599	1.788	3.716
11	13.507	21.818	1.623	3.347
10	12.339	19.924	1.454	2.974
9	11.104	17.923	1.282	2.599
8	9.809	15.828	1.108	2.226
7	8.461	13.649	0.935	1.859
6	7.068	11.397	0.764	1.503
5	5.64	9.09	0.598	1.162
4	4.196	6.761	0.44	0.842
3	2.78	4.477	0.293	0.551
2	1.471	2.368	0.162	0.298
0	0.427	0.687	0.11	0.250

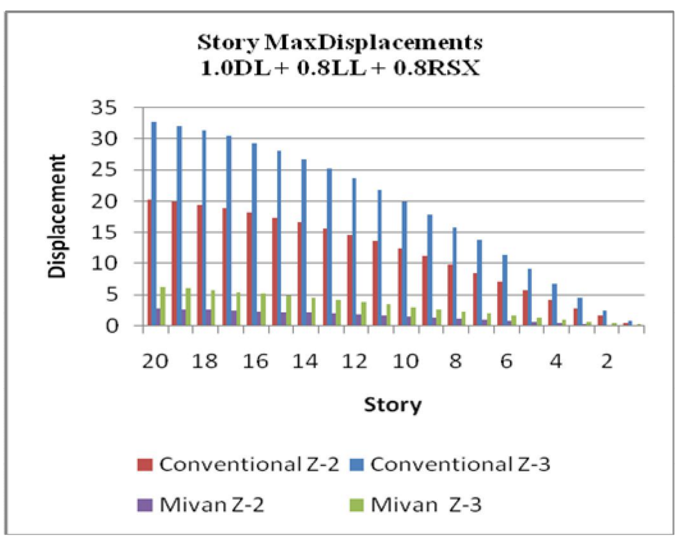

Figure 6 Story Max Displacement in X- Chart

Figure 7 Story Max Displacement in X - Graph

Table 6 Story Max Displacement in Y

1.0DL + 0.8LL + 0.8RSY				
Story	Conven Zone II	Conven Zone III	Mivan Zone II	Mivan Zone III
20	23.689	37.248	2.67	2.168
19	23.039	36.287	2.557	2.094
18	22.32	35.208	2.44	2.013
17	21.508	33.974	2.316	1.925
16	20.599	32.581	2.184	1.829
15	19.597	31.037	2.047	1.726
14	18.509	29.352	1.903	1.618
13	17.342	27.537	1.755	1.512
12	16.103	25.603	1.602	1.399
11	14.8	23.561	1.447	1.28
10	13.438	21.42	1.289	1.156
9	12.025	19.193	1.131	1.027
8	10.568	16.888	0.974	0.897
7	9.073	14.518	0.818	0.764
6	7.548	12.091	0.667	0.632
5	6.001	9.622	0.52	0.502
4	4.449	7.138	0.382	0.376
3	2.931	4.704	0.253	0.255
2	1.533	2.459	0.135	0.145
0	0.432	0.692	0.11	0.096

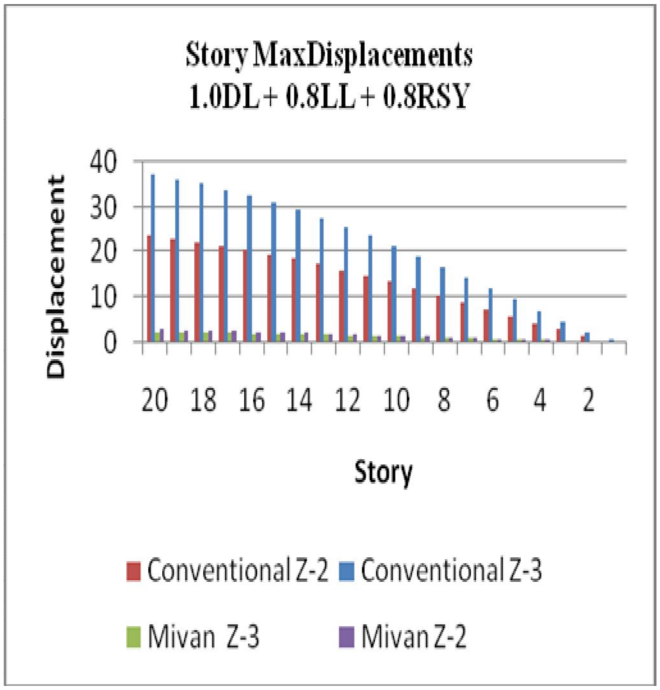

Figure 8 Story Max Displacement in Y - Chart

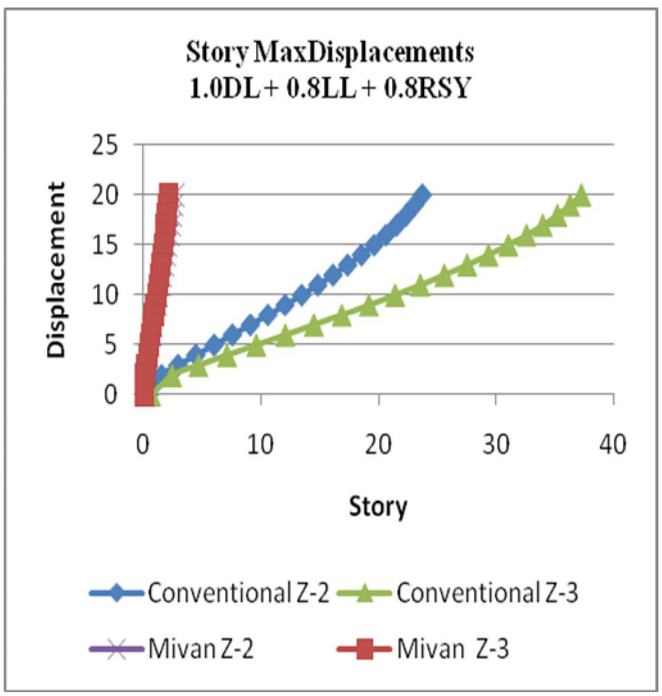

Figure 9 Story Max Displacement in Y- Graph

Observation and Discussion

We can conclude from the aforementioned findings that displacement is growing in both structures as building elevation grows. The mivan structure has less displacement than the conventional structure and the zone III values in both X and Y directions are higher than the zone II values. All calculated top-story displacements easily meet the standard code drift limit (H*0.004 = 266.6 mm), thereby ensuring safety across all four variants.

B. Storey Drift

Table 7 Storey Drift in X

1.0DL + 0.8LL + 0.8RSX				
Story	Conven Zone II	Conven Zone III	Mivan Zone II	Mivan Zone III
20	0.00014	0.00023	0.00003	0.00008
19	0.00018	0.00029	0.00003	0.00008
18	0.00022	0.00035	0.00004	0.00009
17	0.00025	0.00041	0.00004	0.00009
16	0.00028	0.00046	0.00004	0.00010
15	0.00031	0.00050	0.00004	0.00010
14	0.00033	0.00054	0.00005	0.00011
13	0.00035	0.00057	0.00005	0.00011
12	0.00037	0.00060	0.00005	0.00011
11	0.00039	0.00063	0.00005	0.00011
10	0.00040	0.00065	0.00005	0.00011
9	0.00042	0.00067	0.00005	0.00011
8	0.00043	0.00069	0.00005	0.00011
7	0.00043	0.00070	0.00005	0.00011
6	0.00044	0.00071	0.00005	0.00010
5	0.00044	0.00070	0.00005	0.00010
4	0.00043	0.00069	0.00004	0.00009
3	0.00039	0.00063	0.00004	0.00008
2	0.00031	0.00050	0.00009	0.00009
1	0.00014	0.00023	0.00006	0.00007
0	0.00000	0.00000	0.00000	0.00000

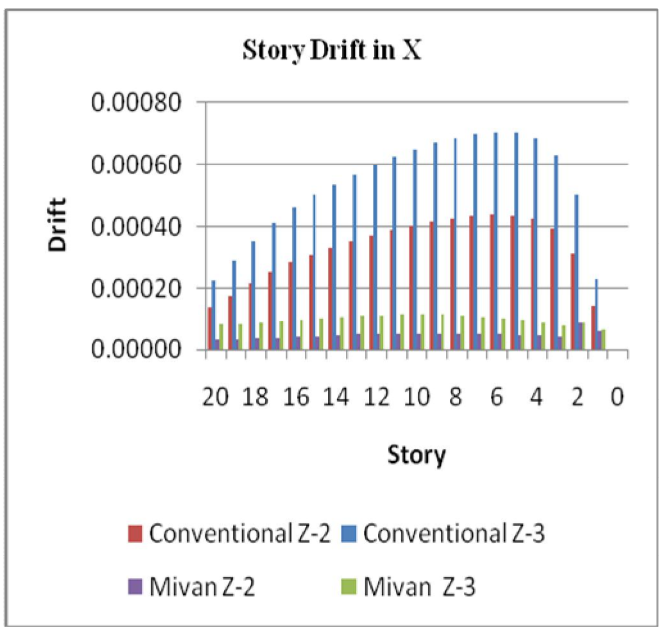

Figure 10 Max Drift in X - Chart

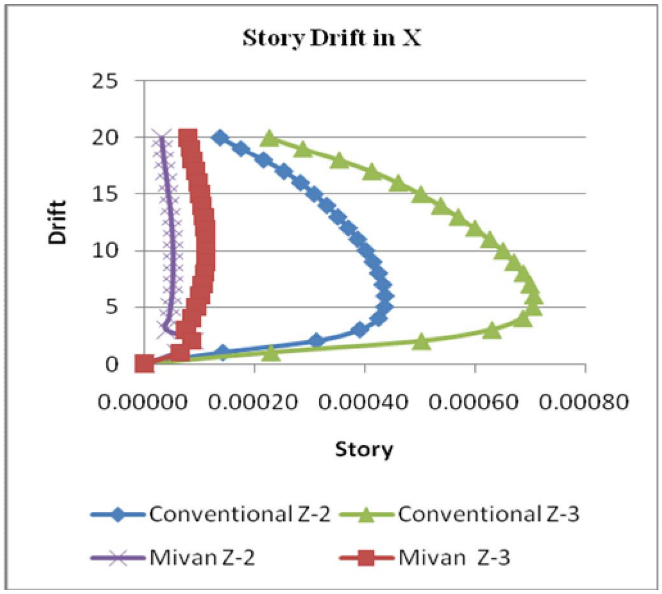

Figure 11 Max Drift in X Graph

Table 8 Storey Drift in Y

1.0DL + 0.8LL + 0.8RSY				
Story	Conven Zone II	Conven Zone III	Mivan Zone II	Mivan Zone III
20	0.00022	0.00033	0.00003	0.00002
19	0.00025	0.00038	0.00004	0.00002
18	0.00029	0.00045	0.00004	0.00003
17	0.00033	0.00051	0.00004	0.00003
16	0.00036	0.00056	0.00004	0.00003
15	0.00038	0.00060	0.00004	0.00003
14	0.00040	0.00063	0.00005	0.00004
13	0.00042	0.00066	0.00005	0.00004
12	0.00044	0.00068	0.00005	0.00004
11	0.00045	0.00071	0.00005	0.00004
10	0.00046	0.00072	0.00005	0.00004
9	0.00047	0.00074	0.00005	0.00004
8	0.00047	0.00075	0.00005	0.00004
7	0.00048	0.00076	0.00005	0.00004
6	0.00047	0.00076	0.00004	0.00004
5	0.00047	0.00075	0.00004	0.00004
4	0.00046	0.00073	0.00004	0.00004
3	0.00042	0.00067	0.00004	0.00003
2	0.00033	0.00053	0.00006	0.00006
1	0.00014	0.00023	0.00007	0.00004
0	0.00000	0.00000	0.00000	0.00000

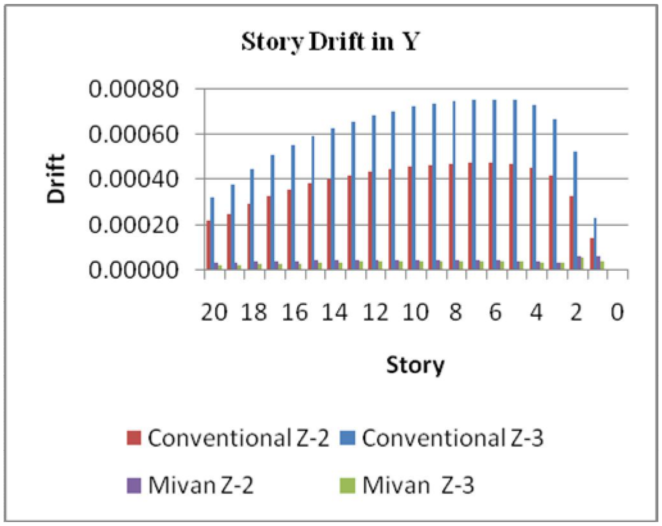

Figure 12 Max Drift in Y - Chart

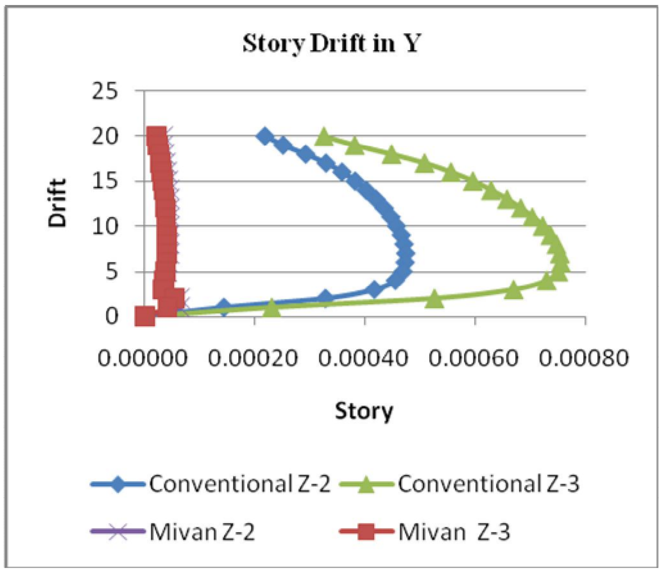

Figure 13 Max Drift in Y Graph

Observation And Discussion

Moving from Zone II to Zone III indicates a 120.12% increase in the Mivan building's X-direction displacement, although the absolute measurement remains comfortably within safe limits at 6.236 mm. The Mivan system shows a distinctive 18.80% decrease in Y-displacement when moving to Zone III, suggesting either dynamic load redistribution or a particularly rigid shear wall configuration along that axis.

C. Base Shear

Table 9 Base Shear X

1.0DL + 0.8LL + 0.8EQX			
Conven Zone II	Conven Zone III	Mivan Zone II	Mivan Zone III
1728.209	2765.135	7753.764	10866.402

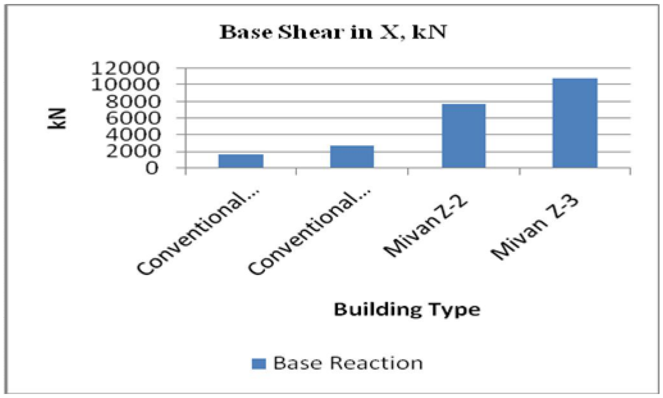

Figure 14 Base Shear in X - Chart

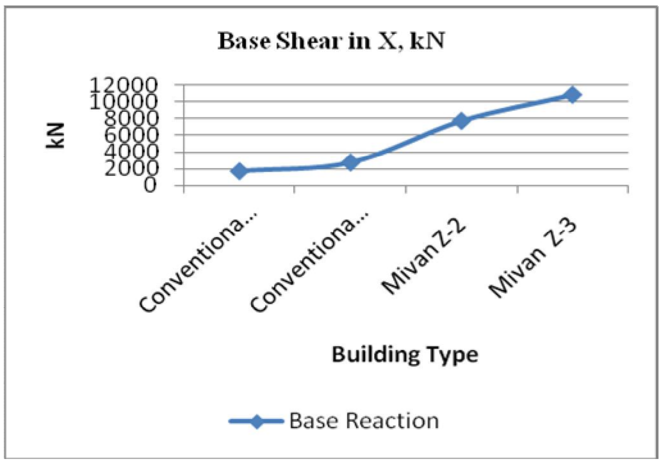

Figure 15 Base Shear in X - Graph

Table 10 Base Shear Y

1.0DL + 0.8LL + 0.8EQY			
Conven Zone II	Conven Zone III	Mivan Zone II	Mivan Zone III
1564.471	2503.154	7753.764	9236.467

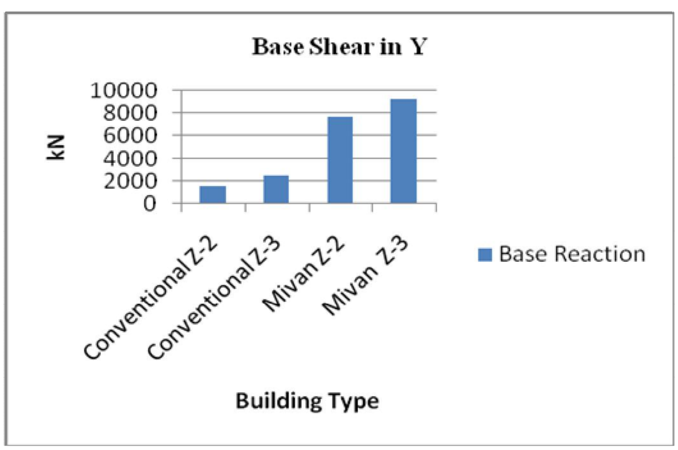

Figure 16 Base Shear in Y - Chart

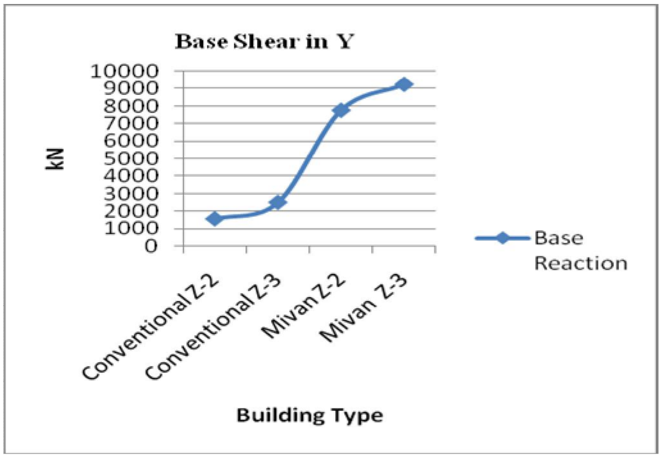

Figure 17 Base Shear in Y – Graph

Observation and Discussion

Moving from Zone II to Zone III, results in 60.00% increase in base shear for conventional buildings in both directions, which can be attributed to the higher zone factors. In contrast, Mivan structures exhibit a remarkable increase in base shear, with 348.66% rise in the X-direction solely within Zone II.

VI. CONCLUSION

Table 11 Displacement for all the 4 Models

Displacement at 20th floor(mm)		
Building and zone	X Dir	Y Dir
Conventional Zone II	20.222	23.689
Conventional Zone III	32.783	37.248
Mivan Zone III	2.833	2.670
Mivan Zone II	6.236	2.168

The ETABS analysis comparing G+20 tall buildings utilizing conventional and Mivan models in Zones II and III indicate that Mivan shear-wall buildings experience a significantly greater base shear while simultaneously achieving a notable decrease in top-story displacement relative to conventional frame structures.

1) Transitioning from Zone II to III, results in a precise 60.00% increase in base shear for conventional buildings in both directions, attributed to the elevated zone factors. In contrast, Mivan structures demonstrate a remarkable increase in base shear, with a staggering 348.66% rise in the X-direction solely within Zone II.
2) The introduction of continuous 150 mm RCC walls in Mivan buildings substantially enhances lateral stiffness, leading to a reduction in the fundamental time period and an increase in the seismic force coefficient. Mivan systems effectively manage top-story displacement, achieving a reduction of up to 94.18% in the Y-direction under Zone III conditions when compared to conventional frames.
3) The traditional framework (600x600 mm columns) demonstrates significantly greater flexibility, enabling its 20th-floor displacement to attain 37.248 mm in Zone III (Y-direction).
4) Transitioning from Zone II to III shows a 120.12% increase in the Mivan building's X-direction displacement, although the absolute measurement remains comfortably within safe limits at 6.236 mm. The Mivan system exhibits a distinctive 18.80% decrease in Y-displacement when advancing to Zone III, indicating either dynamic load redistribution or a particularly rigid shear wall configuration along that axis.

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5) All computed top-story displacements easily comply with the standard code drift limit (H*0.004 = 266.6 mm), thereby ensuring safety across all four variants.
6) Although Mivan technology necessitates more robust foundation designs due to increased base shear, it continues to be the optimal structural choice for high-rise buildings owing to its unmatched drift resistance.

VII. ACKNOWLEDGEMENT

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