



Analysis and Design of Structural Behaviour of High-Rise Mivan Structure in Seismic Loading

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ABSTRACT:

Construction depends on time and cost. So, we introduced the new technology day by day. The technology of Mivan absolutely provides high strength and quality of structure compared to conventional systems. It has modern technology for the construction of large-scale projects. The brand name Mivan is very popular in Southeast Asia. The structure may be reduced effectively in torsional effect; the use of steel quantity minimizes the displacement and reduces the lateral forces. This project is compared to the analysis of MIVAN structural technology over conventional framed structure systems. Structural modelling and analysis will be done using Etabs software. The design should follow IS code, adopting the Limit State Method.

KEYWORDS:

Mivan Structural System; Seismic analysis; Response spectrum methods; Equivalent static methods; Storey response

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1. Introduction

The most crucial factor to consider while planning a building is earthquakes. So, we have to take care while constructing the building; the structure should be an earthquake-resistant structure. As times change, new methods and resources are used. In the current generation, due to advancement, the construction industry has started focusing on new technology and modern ways of working. The construction industry has started using new technologies and is proceeding towards them. In order to increase the strength and life of the project, a lot of research and development is carried out in the construction industry. These formwork systems were first manufactured by the Malaysian company MIVAN Company Limited.

The Mivan Technology System was developed by Malaysia's Mivan Company Ltd. in the late 1990s as a method for building large numbers of homes in underdeveloped nations. With all these advantages, there is a technology used across the globe named Mivan Technology. It is appropriate for building a larger number

of houses in a short period of time by using room-diameter forms to construct RCC walls and slabs in one continuous concrete pour. This is one of the methods that has been found to be especially suitable for large-scale construction in India, where outstanding quality and speed may be achieved.

2. Objective

(i) Seismic analysis will be used to investigate the behaviour of the Mivan and framed structural systems. (ii) To determine Total Seismic weight of building. (iii) The relationship between Time period, storey drift, and base shear, the storey displacement when compared to conventional system. (iv) To determine which structure is better for seismic areas (Mivan or conventional)

3. Methodology

The building shall be analyzed as a 3-D structure with RC walls and columns as vertical members and beams and slabs as horizontal members. Analysis will be carried out

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for both vertical and horizontal (lateral) loads for different combinations of loads. The analysis and design of the idealized model shall be carried out using the “ETABS” computer program. For seismic analysis, the slab at each floor is idealized as a rigid or flexible diaphragm (as applicable) considering the building plan. Response spectrum analysis shall be done for the structural performance of these buildings. The slab panels shall be designed for dead and live loads as per IS 456-2000.

The elements of the reinforced concrete structure must be developed using the Limit State Method, as outlined in IS 456-2000, IS 16700-2023 and standards and expert literature. Appropriate loads and their combinations, as per relevant clauses in IS codes, are used. Calculated Wind loads as per IS 875 (Part 3)-2015.

As line elements, beams are modelled. Slabs of flooring are modelled as shell components, as appropriate. It is assumed that the diaphragms on the floors are semi-rigid. RCC walls have been modelled as shell elements in elevation and defined as piers. Appropriate meshing has been assigned to these walls.

In this paper, we started with an analysis and detailed study of the conventional formwork system, and after that, we passed out. Then we started a detailed study to overcome the drawbacks and identify problems.

4. Modelling Information

According to IS code IS 1893 {Part I}: 2016 regulations, design loads and their combinations are considered in the study.

Table 1: Structural Information and Material Characteristics

S.No.	Data of Structural	Property
1	Concrete Grade	M35
2	Directional Symmetry Type	Isotropic
3	Concrete Weight	25 KN/m3
4	Poisson’s Ratio, U	0.2
5	Grade of Steel	Fe 550
6	Elasticity Modulus, E	29580 Mpa
7	Depth of Foundation	3m
8	Weight	76.97 KN/m3
9	Number of Stories	G+15+Roof
10	Storey Height	4.0m/3.0m
11	Beam size	Varies
12	Column size	450 X 900
13	Wall Thickness	160 & 200mm
14	Slab Thickness	130mm

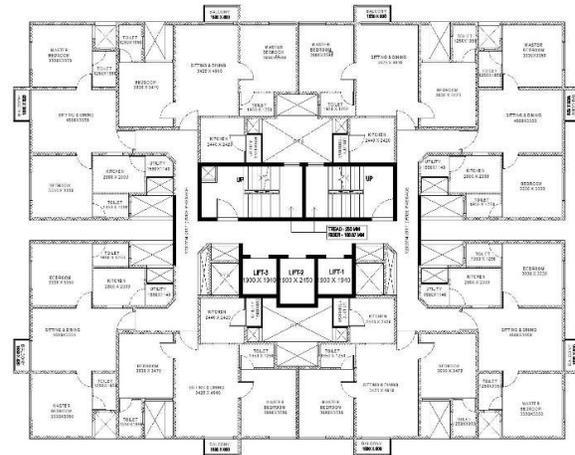


Fig. 1: Typical Floor plan

4.1 Wind Load

The wind pressure shall be calculated based on the basic wind speed recommended by client and other provisions laid in IS 875 (part 3) – 2015. The basis wind speed is considered in the analysis for 30 m/sec.

$$\text{Wind Speed } V_z = V_b \times k_1 \times k_2 \times k_3 \times k_4$$

Where V_z = Design Wind Speed

k_1 – 1.00 (probability factor)

k_2 – 1.21 (Terrain height)

k_3 – 1.00 (Topography factor)

k_4 – 1.15 (Importance factor) as per clause 6.6.

$$\text{Design Wind Speed} = 30 \times 1 \times 1.21 \times 1 \times 1.15 = 41.75 \text{ m/sec.}$$

$$\text{Wind pressure} = 0.6 V_z^2 = 0.6 \times 36.32 = 1045.84 \text{ N/m}^2.$$

For design of building wind pressure 1.05 kN/m² is considered.

$$\text{Design wind pressure (Pd)} = K_d \times K_a \times K_c \times P_z.$$

Where,

$$K_d = 1.0 \text{ (wind directionality factor)}$$

$$K_a = 0.8 \text{ (area average factor)}$$

$$K_c = 0.9 \text{ (combination factor)}$$

$$\text{Design Wind pressure} = 1.05 \times 1 \times 0.8 \times 0.9 = 0.756 \text{ kN/m}^2.$$

4.2 Seismic Loads

Table 2: Seismic Parameters

No.	Parameters	Value
1	Seismic Coefficient	
	Zone (Seismic)	II
	Zone Factor	0.1
	Type of Soil	II
	Importance Factor (I)	1.2
	Response Factor (R)	4
2	Dead Load	
	Wall Load on Beam	6.63 kN/m ²
	Floor Finish Load	1.50 kN/m ²
3	Imposed Load	

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For Floor	2 kN/m ²
For Staircase	4 kN/m ²

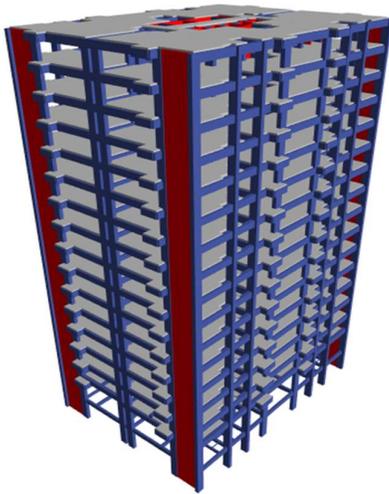


Fig. 2: Typical Floor plan

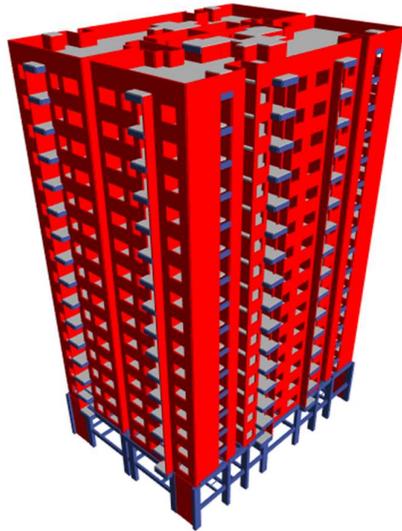


Fig. 3: Typical Floor plan

1	1.484	0.799
2	1.32	0.698
3	1.142	0.682
4	0.411	0.24
5	0.378	0.224
6	0.327	0.217
7	0.196	0.184
8	0.173	0.116
9	0.122	0.112
10	0.114	0.078
11	0.078	0.059
12	0.06	0.044

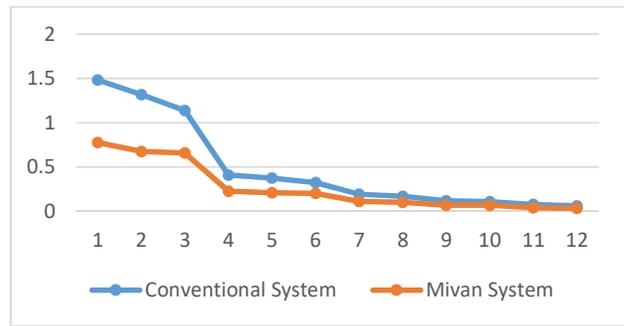


Fig. 4: Time Period (sec)

5.2 Comparison Of Seismic Weight Of Building

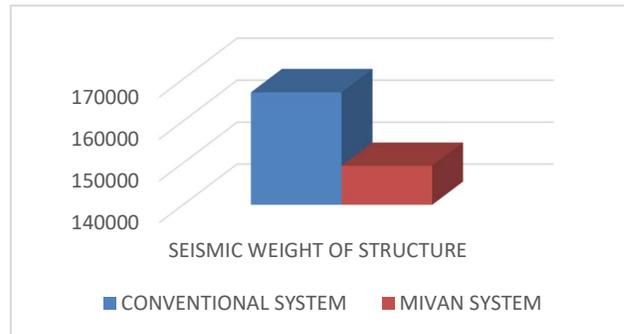


Fig. 5: Difference of Seismic Weight of Building

5. Results and discussion

This conclusion was estimated by research on conventional high-rise structures and Mivan high-rise structures, considering material strength, design loadings, and building analysis and design codes. Then the structure is analysed in the ETABs software. The comparison of Time period, storey displacement, storey drift, base shear is observed for different Structural System. The table displays the findings of both system analyses.

5.1 Comparison of Time Period

Table 3: Mode shape and Time period

Mode	Conventional System	Mivan System
	Time period (sec.)	Time period (sec.)

5.3 Comparison of storey Drift in Earthquake X and Y-Direction

Table 4: Maximum Storey Drift

Story	Levels (m)	Maximum Story Drifts (X)		Maximum Story Drifts (Y)	
		Framed System	Mivan System	Framed System	Mivan System
ROOF	50	0.00020	0.00012	0.00034	0.00018
15TH	47	0.00020	0.00012	0.00032	0.00018
14TH	44	0.00021	0.00013	0.00032	0.00018
13TH	41	0.00023	0.00013	0.00033	0.00019

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12TH	38	0.00024	0.00014	0.00035	0.00019
11ST	35	0.00025	0.00014	0.00036	0.00020
10TH	32	0.00026	0.00014	0.00037	0.00020
9TH	29	0.00026	0.00015	0.00038	0.00020
8TH	26	0.00026	0.00015	0.00039	0.00020
7TH	23	0.00026	0.00015	0.00039	0.00020
6TH	20	0.00026	0.00014	0.00038	0.00019
5TH	17	0.00025	0.00014	0.00037	0.00019
4TH	14	0.00023	0.00013	0.00035	0.00021
3RD	11	0.00021	0.00014	0.00032	0.00024
2ND	8	0.00019	0.00022	0.00028	0.00027
1ST	4	0.00020	0.00027	0.00023	0.00024
G.F	0	0.00014	0.00023	0.00014	0.00019

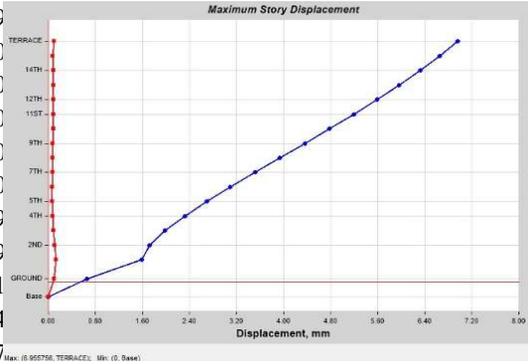


Fig. 8: Max. Displacement (X)

5.4 Comparison Of Max Displacement:

5.4.1 Conventional Structural System

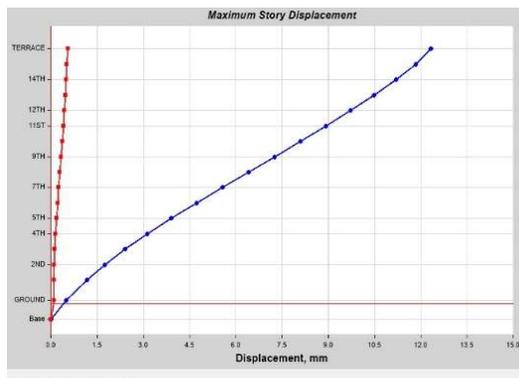


Fig. 6: Max. Displacement (X)

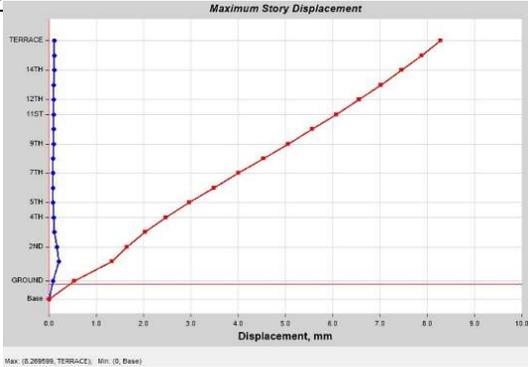


Fig 9: Max. Displacement (Y)

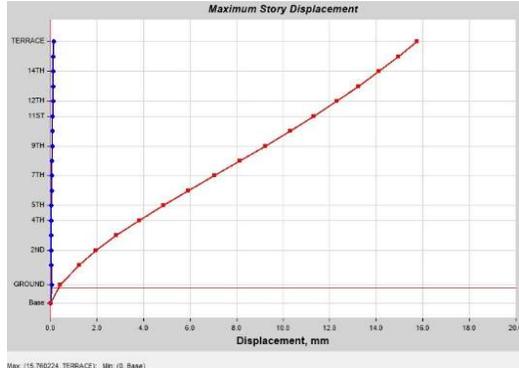


Fig 7: Max. Displacement (Y)

5.4.2 Mivan Structural System

6. Conclusion

The present project focuses on the seismic analysis of the G+15 Mivan and conventional RC structure systems. Zone 2 seismic zone with medium soil is taken into consideration, and 1.2 is the important factor. Analysis of Framed structural system vs. Mivan structural system, using ETABS software.

- [1] The Time period of the Mivan structural system in general decreases (0.799) when compared with the framed structural system (1.484), which increases time period.
- [2]. The seismic weight of the Building increases in the conventional structural system (166876kN), while in the Mivan structural system it decreases (149343kN). It happens more often when concrete and steel materials are used resulting in the loss of additional material waste.
- [3] When it comes to severe lateral loading, the Mivan structural system performs better than the framed structural system.
- [4] The Mivan structural system offers superior overall displacement resistance in the lateral direction. The building's displacement in Mivan is smaller than that of a typical conventional RC construction because the walls were intended to be shear walls.
- [5] The results of displacement at terrace level at framed structural systems X direction 12.3mm, Y direction 15.7mm, and Mivan structural system X direction 6.90mm and Y direction 8.26mm. The Mivan system outperforms the convention system in terms of displacement.
- [6] Compared to conventional buildings, Mivan wall buildings have a lower drift.

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