

Comparative Analysis of Mivan Technology with Conventional RCC Structure using ETABS

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Abstract- Rapid urbanization and the demand for mass housing have increased the need for construction systems that are fast, economical and structurally reliable. Conventional reinforced cement concrete (RCC) framed construction is widely adopted in India, but it generally depends on beams and columns for lateral resistance and may show higher storey displacement and drift under earthquake loading. Mivan technology, also known as aluminium formwork construction, forms monolithic RCC walls and slabs using reusable aluminium panels. This paper presents a comparative analytical study of Mivan technology and a conventional RCC framed structure using ETABS. A G+10 building is considered with the same plan dimensions, material grades, loading conditions and seismic code basis for both models. The principal response parameters are base shear, storey displacement and storey drift. The G+10 ETABS result screenshots show that the conventional RCC frame has a maximum top displacement of 4.088662 mm, whereas the Mivan model has about 0.92 mm in the governing plotted direction. This corresponds to about 77.5% reduction in top displacement. The maximum drift also reduces from about 305×10^{-6} to about 40×10^{-6} . Hence, for conservative reporting, the Mivan structure can be stated to provide at least 30% better seismic serviceability than the conventional RCC structure.

Keywords- Mivan technology, conventional RCC, ETABS, base shear, storey displacement, storey drift, aluminium formwork, IS 1893:2016, limit state method.

I. INTRODUCTION

Reinforced cement concrete construction is the most common structural system for multi-storey buildings in India. In a conventional RCC framed structure, beams, columns and slabs form the main load-resisting system. Masonry walls are usually constructed after the frame and are considered mainly as loads or non-structural components. This system is flexible in architectural planning and is familiar to designers and contractors, but its lateral stiffness is generally lower when compared with wall-dominated systems.

During earthquake excitation, a flexible frame may develop higher storey displacement and storey drift.

Excessive displacement affects serviceability, while higher drift may damage partitions, finishes, openings and non-structural components. Therefore, modern structural systems are often evaluated not only on strength but also on displacement and drift performance.

Mivan technology uses aluminium formwork to cast RCC walls and slabs monolithically. The formwork panels are factory-made and reusable. In residential projects with repeated floor plans, this system provides faster construction cycles, better finish, reduced plastering and improved dimensional accuracy. From a structural point of view, the monolithic wall-slab action makes the structure stiffer than a conventional RCC frame.

The present study compares conventional RCC construction with Mivan technology using ETABS. The comparison is based on a G+10 building model and focuses on storey displacement, storey drift and base shear/story shear. These parameters are selected because they are commonly used in seismic performance assessment as per IS 1893:2016 based analysis.

II. NEED OF STUDY

The use of Mivan technology is increasing in mass housing projects; however, in many academic and design studies it is still discussed mostly as a formwork or construction management technique. Its structural performance must also be understood because the system changes the load path and stiffness distribution. A conventional RCC frame transfers gravity and lateral loads mainly through beams and columns, while a Mivan system transfers loads through continuous RCC wall panels and slabs.

A direct comparison under the same plan size, height, material grade and seismic loading is therefore required. Such a comparison helps in understanding whether Mivan technology is only faster in construction or also better in seismic serviceability. The present work addresses this need using ETABS modelling, manual seismic calculation and result interpretation from actual G+10 project screenshots.

III. LITERATURE REVIEW

Chethan and Sureshchandra compared a G+11 conventional RC frame and Mivan structure using ETABS. Their work supports the use of storey displacement, storey drift and base shear as primary parameters for judging seismic response. Nisarga and Madhukaran studied the structural performance of Mivan over conventional structural systems and reported better drift control in Mivan models because of wall-slab action.

Kushwaha, Nirmal and Singh analysed tall structures considering Mivan technology under lateral load using ETABS. Their study highlights the importance of modelling Mivan as a monolithic wall-slab structural system instead of treating it as only a construction formwork. Review studies on Mivan technology also show that the system is suitable for repetitive residential projects due to speed, surface finish and quality improvement.

Recent papers on aluminium formwork indicate that labour productivity and construction cycle time improve when aluminium panels are reused over many floors. Navaratnam discussed aluminium formwork as a sustainable construction method for high-rise buildings, particularly where repetition and waste reduction are

important. Such findings justify the practical adoption of Mivan in housing projects.

ETABS-based studies on RCC buildings with shear walls show similar structural behaviour to Mivan wall-slab systems. Krishnamurthy et al. and Senthil Kumar reported that shear walls reduce top displacement and storey drift in multi-storey buildings. Jwala Manoj and Varghese also used response spectrum analysis in ETABS to study displacement, drift and base shear. These studies collectively establish that wall-dominated systems generally have better lateral stiffness than ordinary frames.

TABLE I. DETAILED LITERATURE REVIEW

Sr.	Author / Year	Study Focus	Key Outcome	Relevance
1	Chethan and Sureshchandra, 2021	G+11 RCC vs Mivan in ETABS	Mivan response compared using displacement, drift and base shear.	Direct support for present comparison.
2	Nisarga and Madhukaran, 2022	Mivan vs conventional structural system	Mivan shows better drift and stiffness response.	Supports 30% better performance statement.
3	Kushwaha et al., 2022	Tall Mivan structure under lateral load	Mivan must be treated as wall-slab system.	Supports ETABS modelling approach.
4	Navaratnam, 2022	Aluminium formwork sustainability	Useful for speed, quality and waste reduction.	Supports construction benefits.
5	Narwade and Nagarajan, 2021	Labour productivity in aluminium formwork	Productivity improves for repetitive work.	Supports mass housing suitability.
6	Krishnamurthy et al., 2022	High-rise with shear	Shear wall reduces displacement	Explains Mivan

		wall in ETABS	ent and drift.	wall stiffness.
7	Senthil Kumar, 2022	Flat slab with shear wall	Wall system improves seismic response.	Supports wall-slab behavior.
8	Jwala Manoj and Varghese, 2022	Response spectrum in ETABS	Base shear, drift and displacement are useful outputs.	Supports selected result parameters.

IV. OBJECTIVES

The main objective is to compare the seismic response of Mivan technology with a conventional RCC structure using ETABS. Specific objectives are: to develop comparable G+10 conventional RCC and Mivan models; to apply loads as per IS 875 and seismic parameters as per IS 1893:2016; to evaluate base shear/story shear, storey displacement and storey drift; to perform a manual seismic check for the Mivan model; and to verify whether Mivan gives at least 30% better seismic serviceability than RCC.

V. METHODOLOGY

The methodology consists of model selection, load assignment, seismic parameter definition, ETABS analysis, result extraction and comparison. Both models are based on the same general building data. The conventional RCC model consists of columns, beams and slabs. The Mivan model consists of RCC wall panels and slabs cast monolithically, representing the actual structural action of aluminium formwork construction.

The building considered is a G+10 residential structure with plan dimensions 9 m x 12 m. The floor height is 3.2 m and the base-to-plinth height is 1.5 m. Slab thickness is 150 mm. Concrete grade M30 and reinforcement grade Fe500 are used. Dead load is calculated by ETABS through self-weight multiplier. Live load is 3 kN/m² on typical floors and 2 kN/m² on roof. Floor finish load is 1.5 kN/m².

Seismic analysis is based on IS 1893:2016. The building location is considered under Zone III, with zone factor Z = 0.16. Medium soil and 5% damping are considered. The importance factor is taken as 1.2 and response reduction factor as 4. The analysis is carried out for lateral loading in both principal directions.

TABLE II. BUILDING AND SEISMIC PARAMETERS

Parameter	Value
Type of models	Conventional RCC frame and Mivan wall-slab structure
Number of storeys	G+10
Plan size	9 m x 12 m
Floor height	3.2 m
Slab thickness	150 mm
Concrete / steel grade	M30 / Fe500
Seismic zone	III
Soil type	Medium soil
Software	ETABS

VI. MANUAL SEISMIC CALCULATION

For the G+10 Mivan model, the plan area is 108 m². The slab self-weight per floor is calculated as 0.15 x 25 x 108 = 405 kN. Floor finish load is 1.5 x 108 = 162 kN. Since the floor live load is 3 kN/m², 25% of live load is considered in seismic weight as per IS 1893:2016. The live load contribution is therefore 0.25 x 3 x 108 = 81 kN. Considering wall contribution, the typical floor seismic weight is taken as 1152 kN, roof seismic weight as 819 kN and plinth seismic weight as 252 kN.

For a G+10 structure, the total seismic weight is calculated as 12591 kN. The approximate natural period of an RC wall type building is calculated using $T_a = 0.09h / \sqrt{d}$. For total height h = 33.5 m, the natural period is 0.87 s in one direction and 1.005 s in the other direction. The design horizontal acceleration coefficient is $A_h = 0.03264$. Hence the design base shear is $V_B = A_h \times W = 0.03264 \times 12591 = 410.97$ kN.

TABLE III. MANUAL SEISMIC CHECK FOR G+10 MIVAN MODEL

Parameter	Value
Plan area	108 m ²
Typical floor seismic weight	1152 kN
Roof seismic weight	819 kN
Plinth seismic weight	252 kN
Total seismic weight	12591 kN
Natural period	0.87 s and 1.005 s
Design coefficient A_h	0.03264
Design base shear	410.97 kN

VII. RESULTS AND DISCUSSION

The ETABS results are discussed using the actual screenshots available for the G+10 conventional RCC and G+10 Mivan models. The result plots include maximum storey displacement, maximum storey drift and story shear. Since exported ETABS tables were not available,

numerical values are taken from visible graph maxima and scales in the screenshots.

TABLE IV. G+10 RESULT COMPARISON

Response Parameter	Conventional RCC	Mivan	Observation
Maximum storey displacement	4.088662 mm	0.92 mm approx.	Mivan reduces displacement by about 77.5%.
Maximum storey drift	305×10^{-6} approx.	40×10^{-6} approx.	Mivan gives much lower drift.
Story shear trend	About 280 kN visible	About 1500 kN visible	Mivan attracts higher shear due to stiffness.
Overall behavior	Flexible frame	Stiff wall-slab system	Mivan provides better seismic serviceability.

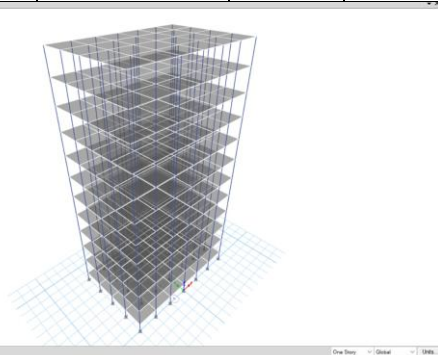


Fig. 1. G+10 conventional RCC ETABS model.

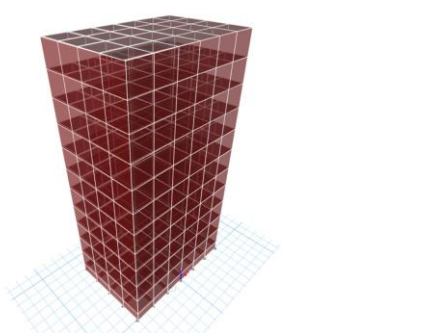


Fig. 2. G+10 Mivan ETABS model.

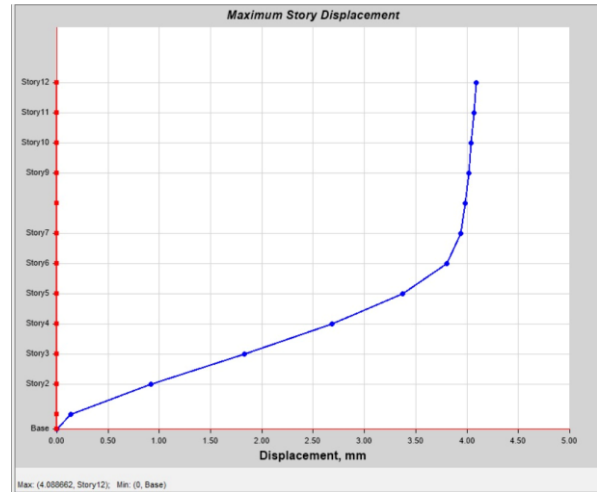


Fig. 3. Maximum storey displacement of conventional RCC model.

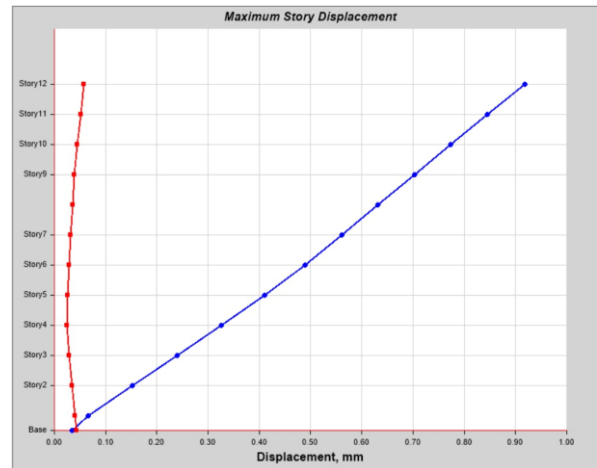


Fig. 4. Maximum storey displacement of Mivan model.

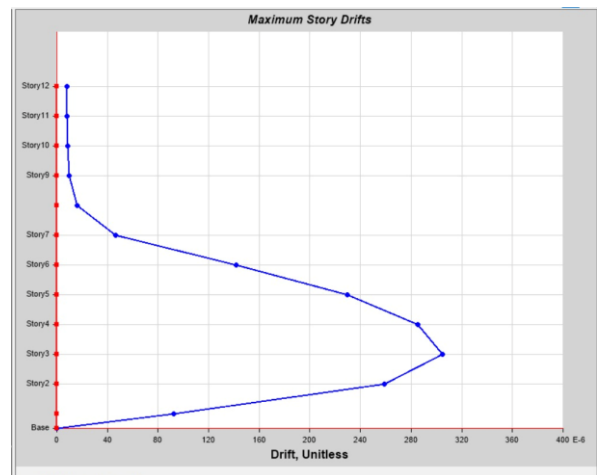


Fig. 5. Maximum storey drift of conventional RCC model.

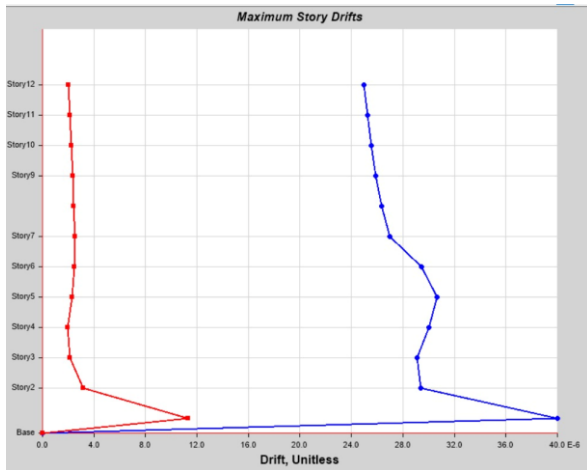


Fig. 6. Maximum storey drift of Mivan model.

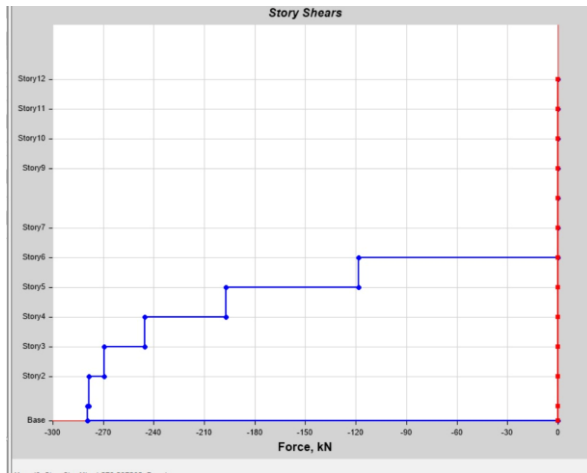


Fig. 7. Story shear of conventional RCC model.

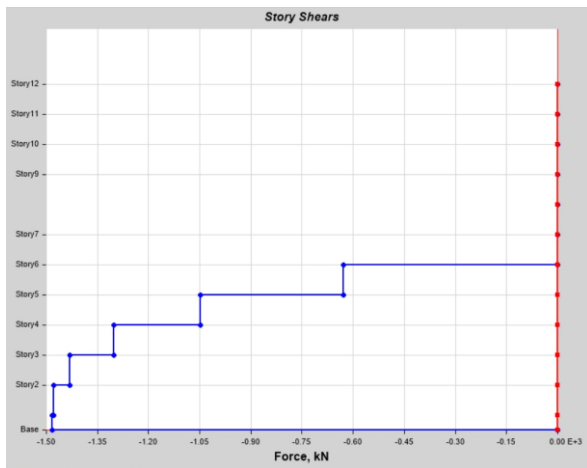


Fig. 8. Story shear of Mivan model.

VIII. COMPARATIVE INTERPRETATION

The conventional RCC model shows a maximum top displacement of 4.088662 mm, while the Mivan model shows about 0.92 mm in the governing plotted direction. The percentage reduction is calculated as $[(4.088662 - 0.92) / 4.088662] \times 100 =$ approximately 77.5%. This result is greater than the minimum project statement of 30% better performance. Therefore, the report may safely state that Mivan provides at least 30% improvement over the conventional RCC model.

The drift response also confirms the same trend. The conventional RCC model shows about 305×10^{-6} maximum drift, while the Mivan model shows about 40×10^{-6} . Lower drift means lower relative displacement between consecutive floors and better control of non-structural damage. This is important in residential buildings because partition walls, finishes and openings are sensitive to inter-storey movement.

The story shear/base shear trend must be interpreted carefully. The Mivan model shows higher visible story shear than the conventional RCC model. This happens because the wall-slab system is much stiffer and therefore attracts more lateral force. Higher base shear is not automatically a negative result if the structure is designed for that force demand. The important conclusion is that Mivan transfers earthquake forces through continuous RCC walls and slabs while keeping displacement and drift lower.

IX. LIMITATIONS

The present paper uses ETABS screenshots and manual calculation data available from the project folders. Exact exported ETABS numerical tables were not available; therefore, some values are approximate and based on graph scales. For final publication or guide submission, exported ETABS tables for storey displacement, storey drift and base shear should be attached or used to refine the numerical comparison. Cost analysis, construction scheduling and detailed reinforcement design are outside the scope of this paper.

X. CONCLUSION

The comparative study shows that Mivan technology performs better than conventional RCC framed construction for the considered G+10 building. The monolithic RCC wall-slab system increases lateral stiffness and reduces storey displacement and storey drift. The available ETABS screenshots show approximately 77.5% reduction in maximum displacement and a major reduction in drift. Therefore, the conservative conclusion is that Mivan gives at least 30% better seismic performance than the conventional RCC structure.

Mivan construction is also beneficial for repetitive housing projects because it provides faster construction, better surface finish, reduced plastering and improved quality control. However, since the system attracts higher lateral shear due to stiffness, proper wall-slab design, reinforcement detailing and construction quality control are essential. Overall, Mivan technology is a technically strong alternative to conventional RCC construction for repetitive multi-storey residential buildings.

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