Analysis of a Tall Structure Considering Mivan Technology Under Lateral Load Using ETABS

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ABSTRACT

High rise structures are prepared to resist seismic loads besides such massive stcutures are even subjected to wind load due to the magnitude and nature of wind load, hence such load factors are determined to understand its behaviour.
This research is primarily focused to understand the behaviour of the wind response on high rise structures considering a G+15 structure. Mivan structure was analyzed in the study considering slab wall system instead of moment resisting fame for the structure. This study focuses on the level anomalies by considering various shapes in the arrangement of the building. Extents of wind loads are reliant upon the space of openness of the structure, thus the state of the structure must be considered with due significance as the space of openness is subject to shape. The diverse formed structures will have various reactions to the applied lateral load. Henceforth in this study, an endeavor has been made to foresee the impact of various states of structures for wind loads.
The wind load is applied as per I.S. 875 part III:2015 specifications.

Keywords: Mivan Technology, Horizontal Irregularities, wind analysis, forces. Stresses, displacement.

I. INTRODUCTION

Urbanization is responsible for population growth which has further led to a race between entities for new architecture and such competition has led to rise in the economy around the globe. This peculiarity has prompted development vertical, as the level developments have arrived at a degree of immersion. Henceforth High ascent structures have become more predominant in the greater part of the urban communities, supplanting huge spaces of little houses. The race towards new statures and design is related to many difficulties. In tall structures, Lateral load will be of essential concern rather than just gravity loads. Lateral forces initiate weighty moments and forces on the tall structures. The presence of unevenness in the arrangement of the great ascent building adds intricacy to the structure as it presents torsional impacts. Henceforth the investigation of reactions of various kinds of underlying components utilized and the various states of the building took on is vital to pick the ideal blend of the primary component and the state of a structure that limits the lateral displacement.

Advancement in structural engineering is primarily motivated towards safe guard of new structures towards lateral loads whether its wind load or seismic load. This research is focused towards presenting comparative analysis of a conventional framework and a mivan framework. Here the modelling and analysis of both the cases was done using analytical application ETABS. The primary framework considered is an underlying divider framework which is broadly embraced because of its sufficient benefits, in the development of tall structures in recent years.

Mivan Technology

Civil engineering is one of the primary aspects of the development of any civilization which is valued at over 2.7 trillion Indian rupees. India is the second-largest country in terms of population which has even further led to an increase in demand for infrastructure and housing. There is a developing acknowledgement today that the speed of development should be given more prominent significance particularly for enormous infrastructure projects for accomplishing the public target of making a huge stock to defeat the briefest conceivable time. One such innovation taking into account a quicker speed of development is Mivan innovation. Mivan is an Aluminum formwork framework that has engaged and spurred mass development projects all through the world. Mivan innovation has a wide scope of benefits like quick enduring, efficient, and versatile and produces brilliant quality work which decreases the expense of maintenance. Mivan innovation is the most ideal for the non-industrial nations like India since completely cast in situ substantial constructions can be raised effectively with the assistance of aluminum structure work.

A Malaysian based organization called Mivan Company Ltd. Found out about Mivan Technology. It at first presented and created this alumina structure work in mid 1990's thus the name Mivan Technology. In the later stages a Construction organization in Europe fostered this Mivan innovation to bigger degree. At the moment more than 30 thousand sq meters of formworks are in use of aluminium formwork system throughout the entire globe. In India particularly in Mumbai, numerous structures have been worked with the assistance of Mivan innovation. This aluminium structure work framework is ended up being the fittest sort of structure work for a sort of development climate in India. Mivan innovation is generally utilized in Asia, Europe, Gulf nations and different pieces of the globe moreover. Reception of steam relieving permits the untimely expulsion of moulds consequently adding to the pace of development, around two pads for a day. Every activity is arranged in assembly line manner.Thus, this system produces well controlled and more precise and superior production at optimal cost in shorter time period. The forms are finished tough and care is taken that the finished forms are fabricated with high precision. Concrete is made in prepared substantial blend plants under firm type control and shipped to the site with travel blenders. Before cementing, the casings for entryways, windows, and conduits are set in the structure for administration. Flight of stairs, additionally unique pre-created things are merged under that design.

II. LITERATURE REVIEW

Radha D. Potdar and Dr. P.P.bhangale (2019) research paper presented nonlinear performance and behaviour of Mivan Structures compared with Conventional Structures. Both types of structure were modelled with the same material and loading configuration with identical plan and elevation. Line-of-balance (LOB) is a variety of direct booking strategies that permits the adjusting of tasks with the end goal that every action is consistently performed. The significant advantage of the LOB approach is that it gives creation rate and term data as an effectively deciphered illustrations design. The LOB plot can show initially what's up with the advancement of a movement and can recognize expected future bottlenecks. Clearly, LOB permits a superior handle of a task made out of monotonous exercises than some other planning method, since it permits the likelihood to change exercises' paces of creation. It permits a smooth and effective. The goal of the exploration was to introduce the idea of LOB and MIVAN Technology, comprehend the connection between LOB and MIVAN Technology and assessment of LOB in MIVAN Technology utilizing the product.

The outcomes expressed that the Conventional formwork framework is generally taken on the planet yet it has more burn-through time and is expensive in a development project. Ordinary formwork isn't reasonable where the populace is huge, less land accessible and development project work is needed rapid. These all conditions fulfil in the MIVAN formwork framework. Mivantechnology gives better outcomes in Cost-viability, Speed of development with the higher solidness of building structure. In Mivan formwork, the speed of development can be accomplished by a 4-day cycle per floor. Eliminating floor chunk structures without eliminating prop is conceivable, while in ordinary unrealistic. Relocation of the customary framework is 86% more than that of the Mivan primary framework.

Aarti Nanasaheb Kote and Aahuti Ramesh Nandeshwar (2020) research introduced cost examination of mivan innovation with ordinary development innovation. The innovation of Mivan was totally fine with cost, quality and efficient as contrast with regular.

Contrasted with the ordinary technique, development costs with MIVAN formwork are ascending by Approximately 25-30 percent.Construction cost for every individual. Sq.ft in MIVAN is pretty much as high as 33% contrasted with the regular method.T he per distinction. Sq.ft development cost increments by right around 392 Rs/Sq.ft in MIVAN. The term of development in MIVAN is not exactly the regular technique by Almost 25% and 534 days, for example 1.5 years.

Abhijit V Bidare and Deepali Bhagaje (2021) the primary objective of the research paper was to check the dominance of conventional structure and mivan structures under earthquake loading and investigate the form works of conventional and mivan structures. Comparing the number of structures depending on the materials needed in every one of them and do the relative investigation between the traditional and mivan development, considering factors base shear, recurrence, time-frame, story floats, story shear and story solidness. The examination has been completed utilizing ETABS 2013 Version programming interface. Straight Dynamic examination is thought of and assess their general presentation. Underlying Modeling was finished 15story's R.C building and the Mivan building was examined with various Seismic Zones.

Results stated that Mivan building was more dominant and it shows more stability compared with a conventional structure, base shear is more in mivan structure and less in conventional structure. Story Stiffness is more in Mivan structure and Less in Conventional Structure. Story Stiffness is increasing with seismic parameter and Low in Zone 3 and High in Zone 5. Mivan Structure required more steel quantity and Conventional structure required Less quantity of Steel.

Objectives of the Study

The primary objective of research are listed below:

- Analysis of a tall structure utilizing mivan technology considering wind load using ETABS.
- To determine a comparative analysis of Mivan formwork and conventional formwork
- To determine the effect of wind load over a tall structure as per I.S. 875:III:2015 code.
- To determine the Parameter of comparative analysis in terms of base shear, storey drift, storey shear, time period and storey stiffness.

III. Methodology

Step 1 Designing the plan of the structure:

This step presents the selection of matrix for the measurement and define the guidelines for selection of materials as ETABs being an international software for designing, it supports american, australian, Chinese and Indian codes for the analysis.the display units is selected for metric SI where the steel design code is selected as IS 800:2007 and concrete design code as IS 456:2000. And assigning geometrical description of the structure.

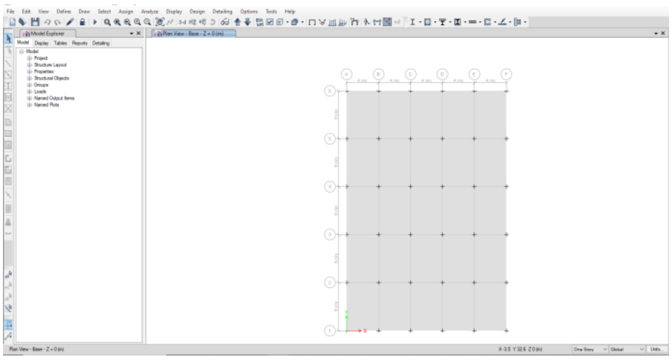


Fig 1 Plan of the Structure

Step 2 Defining material properties to the beam, column and slab

In this step creating material properties as per Indian standard and specifications

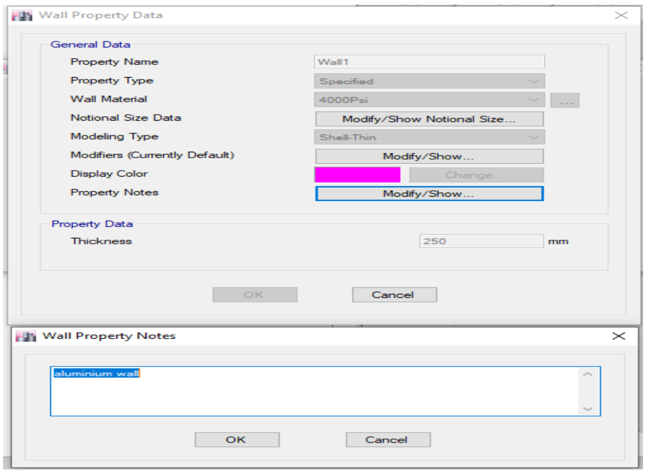


Fig 2 Defining Wall Property Data

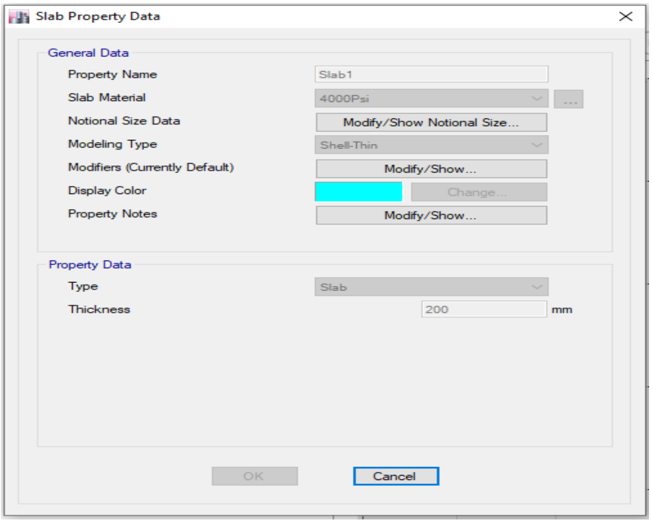


Fig 3 Defining Slab properties

Step 3 Defining Section Properties to the structure, beam and column

In this step creating beam column and other structural elements as per sectional sizes adopted in this study.

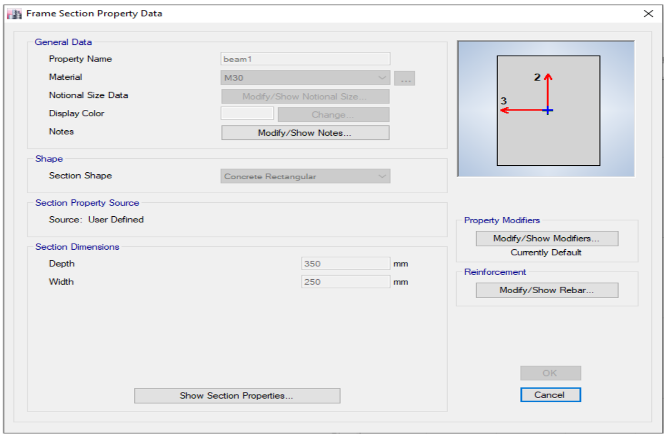


Fig 4 Defining Beam Section

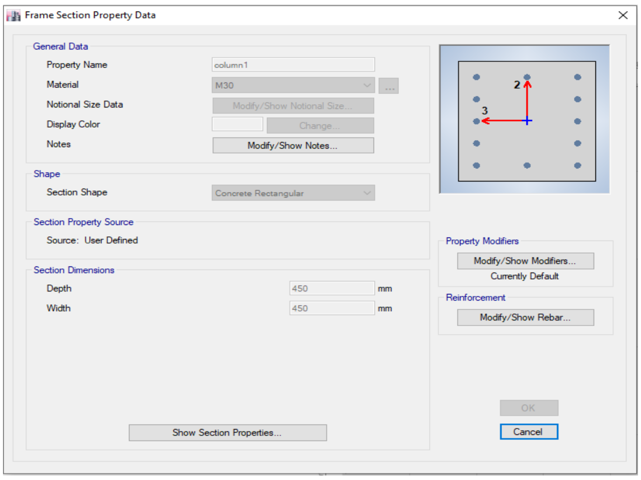


Fig 5 Defining column size

Step 4 Defining Loading condition:

In this step assigning loading condition as per calculation. Consider Vb 39 m/s and non linear analysis.

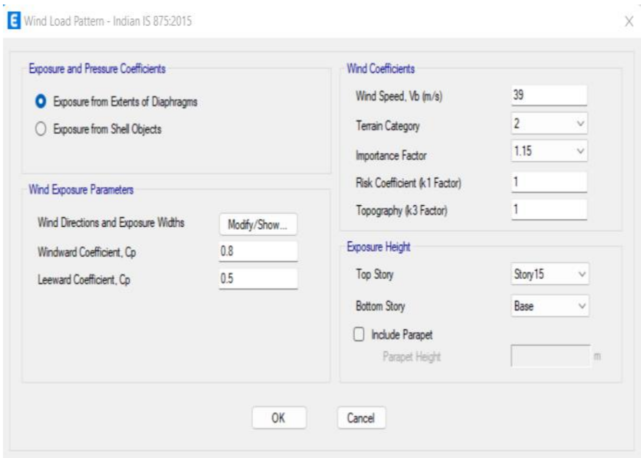


Fig 6 Defining wind load as per I.S. 875:III:2015

Step 5 Assigning Non Linear Load Case

In this step assigning non linear analysis method for wind load considering acceleration.

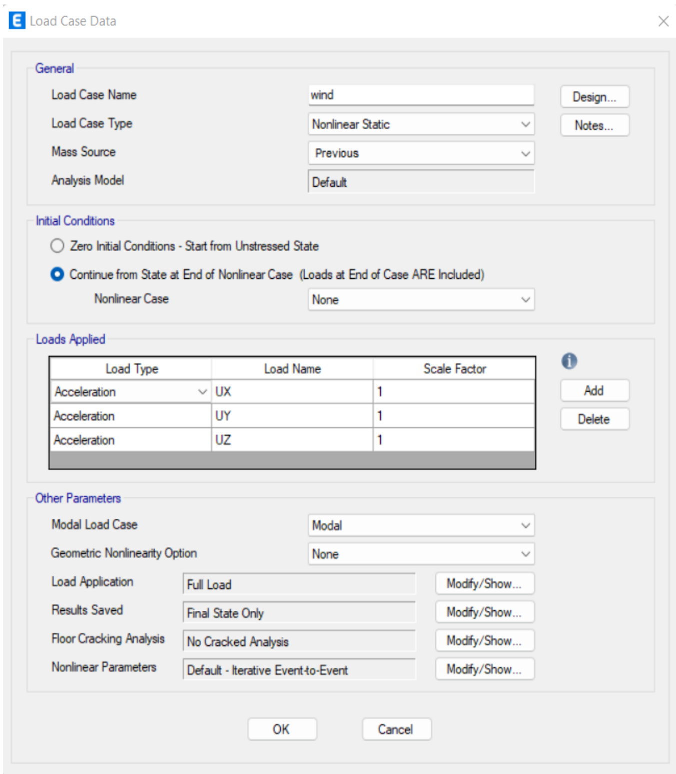


Fig 7 Lon Linear Load Case

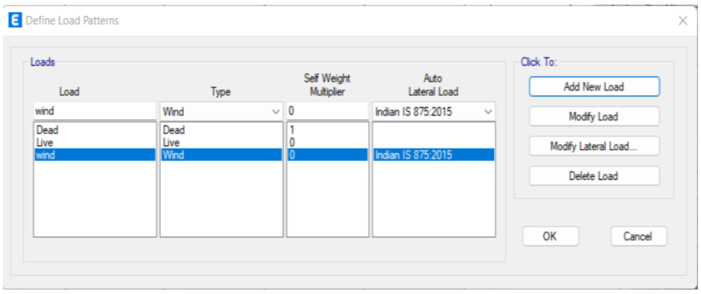


Fig 8 Load Patterns

Step 6 Stress Analysis

In this step presenting outcome of analysis in term of stresses.

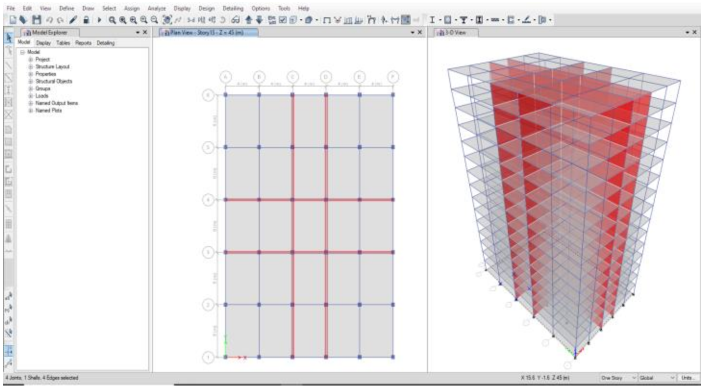


Fig 9 Mivan Wall

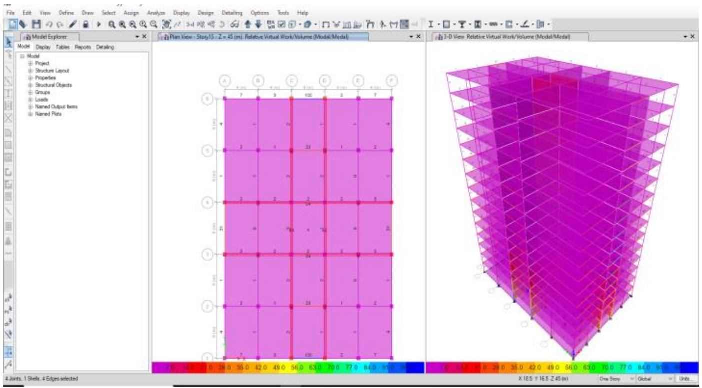


Fig 10 Virtual Stress Analysis

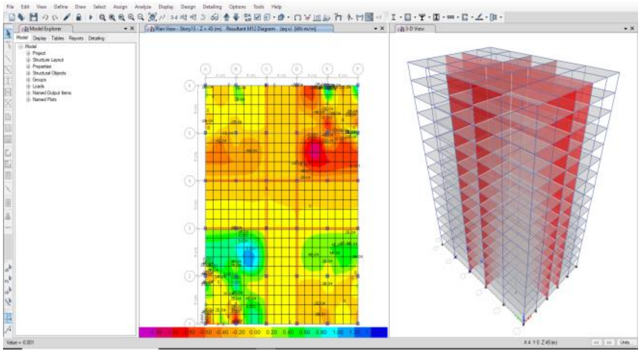


Fig 11 Slab Stress

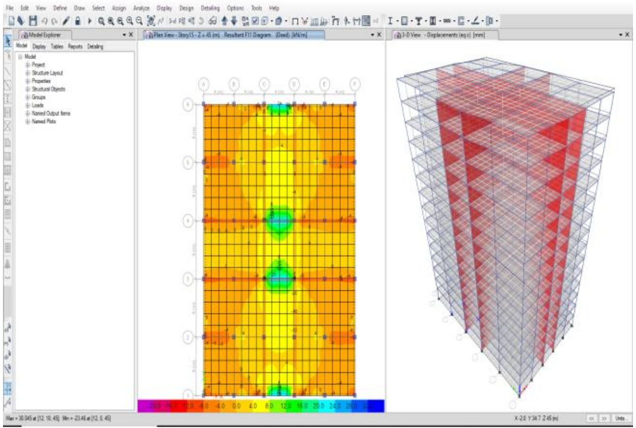


Fig 12 Displacement

Table 1 Section Properties

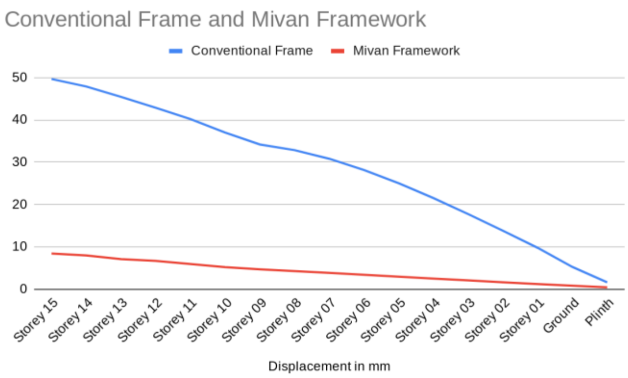
Beam	350x250
column	450x450
Floor height	3m each
Seismic zone	V
Soil Type	Soft Soil
Plan	20x30

Table 2 Building Configuration

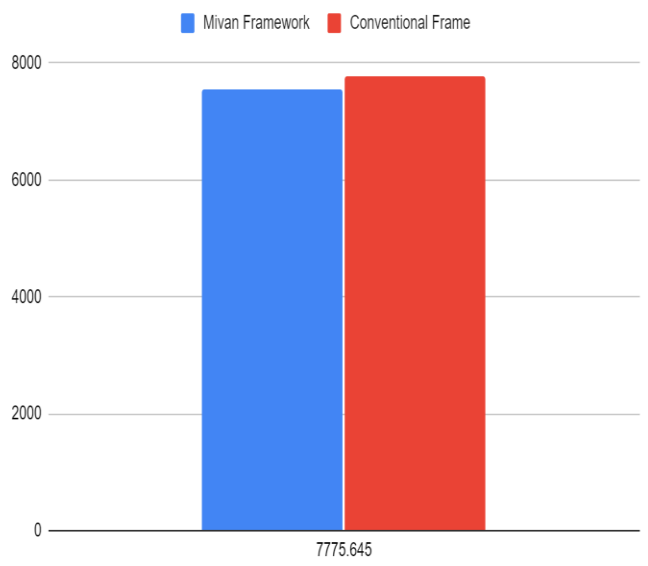
Building Configuration	
Plan	20m x 30m
No. of Bays	5 Bays
Slab Panel	4m x 6m
Floor Height	3m

Wind Speed	39 m/s
Type of Soil	Soft Soil
Material Properties	
Grade of Concrete	M30
Grade of Steel	Fe 415
Density of Concrete	25 kN/m3
Density of Brick Wall	20 kN/m3
Members Dimension	
Column	450 x 450 mm
Beam	350 x 250 mm
Wall Thickness	150 mm
Slab Thickness	150 mm
Dead Load	
Type of Load	Load Calculation
Wall Load on Beam	12 kN/m
Live Load	
Floor Live Load	5 kN/m2
WIND PARAMETERS AS PER I.S. 875:III:2015	
Wind Zone	39 m/s as per Appendix A
Type of Structure	R.C.C.
Importance Factor	1.15

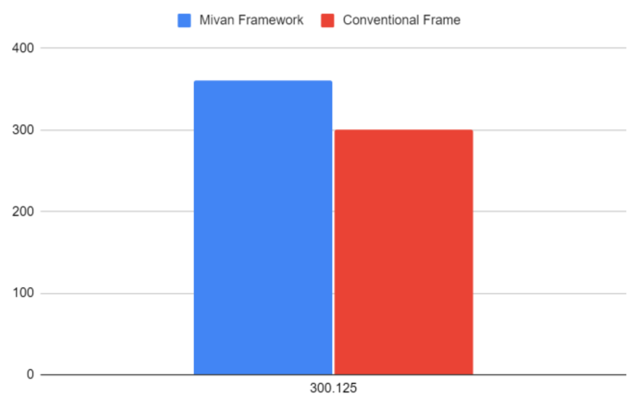
IV. ANALYSIS RESULTS



Discussion: it can be noticed that the maximum deflection for frame structure for G+15 is 49.67 mm and that for Mivan structural System of G+15 is 8.44 mm similarly it is observed that Mivan structures have less displacement as compared to the Conventional structural system. Mivan structural system is rigid and have better resistance to lateral loads hence the displacement is less in mivan Structural system.



Discussion: Axial load is the force acting on an object, parallel and on its axis. A buried pipeline may experience axial loads due to ground movement induced by slope instability. Some pipes made of flexible material may even experience changes in the cross-sectional area due to axial loading. The axila load on the column in conventional frame was found to be 7.1% higher in comparison to mivan structure.



Discussion: A bending moment (BM) is a measure of the bending effect that can occur when an external force (or moment) is applied to a structural element. This concept is important in structural engineering as it is can be used to calculate where, and how much bending may occur when forces are applied. Bending Moment was to 300.125 kN for conventional structure and 360.152 kN for Mivan Structure turning up to be 4.9% on higher side.

Table 3 Storey Stiffness (kN/m2)

Storey Stiffness (kN/m2)		
	Conventional Frame	Mivan Framework
Storey 15	101,000.00	499,000.00
Storey 14	109,000.00	579,000.00
Storey 13	116,000.00	648,000.00
Storey 12	129,000.00	712,000.00
Storey 11	141,000.00	897,000.00
Storey 10	154,000.00	1,010,000.00
Storey 09	161,000.00	1,530,000.00
Storey 08	196,000.00	3,130,000.00
Storey 07	207,000.00	4,350,000.00
Storey 06	211,000.00	5,310,000.00
Storey 05	214,000.00	6,090,000.00
Storey 04	216,000.00	6,730,000.00

Storey 03	218,000.00	7,310,000.00
Storey 02	219,000.00	7,870,000.00
Storey 01	221,000.00	8,750,000.00
Ground	224,000.00	8,980,000.00
Plinth	593,000.00	15,700,000.00

Discussion: the stiffness of the different structure for same loading patterns. The mivan structure is stiffer compared to conventional structure. As mivan structure is stiffer gives better resistance to the lateral loads. Since Mivan system is having large rigidity, the deformation is also less in such system.

Storey Shear Force (kN)

Storey force is an estimate of the most predicted lateral force in an effort to arise because of seismic ground motion at each storey level of the structure.

Table 4 Storey Shear force (kN)

Storey Force kN		
	Conventional Frame	
Storey 15	102.00	
Storey 14	144.00	
Storey 13	187.00	
Storey 12	210.00	
Storey 11	267.00	
Storey 10	301.00	
Storey 09	339.00	
Storey 08	401.00	
Storey 07	548.00	
Storey 06	664.00	
Storey 05	722.00	
Storey 04	814.00	
Storey 03	884.00	
Storey 02	898.00	

Discussion: it is noticed that conventional structure has lesser storey force as that of mivan structure. This is due to the conventional structural system being more flexible as that of mivan structural system.

CONCLUSIION:

This research made an effort to evaluate the seismic performance of Mivan structural system v/s Conventional structural system, using the codes specified design spectrum in the elastic and inelastic framework, using ETABS software. The results of the study lead to the following conclusions.

Storey Displacement

It can be noticed that the maximum deflection for frame structure for G+15 is 49.67 mm and that for Mivan structural System of G+15 is 8.44 mm similarly it is observed that Mivan structures have less displacement as compared to the Conventional structural system. Mivan structural system is rigid and have better resistance to lateral loads hence the displacement is less in mivan Structural system.

Axial Force

Axial load is the force acting on an object, parallel and on its axis. A buried pipeline may experience axial loads due to ground movement induced by slope instability. Some pipes made of flexible material may even experience changes in the cross-sectional area due to axial loading. The axila load on the column in conventional frame was found to be 7.1% higher in comparison to mivan structure.

Bending Moment

A bending moment (BM) is a measure of the bending effect that can occur when an external force (or moment) is applied to a structural element. This concept is important in structural engineering as it is can be used to calculate where, and how much bending may occur when forces are applied. Bending Moment was to 300.125 kN for conventional structure and 360.152 kN for Mivan Structure turning up to be 4.9% on higher side.

Storey Drift

it is observed that the storey drift of mivan structure is very less as that of conventional structure both for linear and nonlinear cases. This is due to Mivan structural system provides better resistance to lateral loads.

Stiffness

the stiffness of the different structure for same loading patterns. The mivan structure is stiffer compared to conventional structure. As mivan structure is stiffer gives better resistance to the lateral loads. Since Mivan system is having large rigidity, the deformation is also less in such system.

Storey Shear Force

it is noticed that conventional structure has lesser storey force as that of mivan structure. This is due to the conventional structural system being more flexible as that of mivan structural system.

Time Period

Natural Period Tn of a building is the time taken by it to undergo one complete cycle of oscillation. It is an inherent property of a building controlled by its mass m and stiffness k. These three quantities are related by its units are seconds (s). Here the time period of conventional structure was found to be 1.706 sec and 1.8619 sec for mivan framework.

Future Scope

Following future scope can be consider for this study are as follows:

1. In this study R.C.C structure is considered whereas in future steel or composite structure can be considered.
2. In this study seismic loading is considered whereas in future wind load can be consider.
3. In this study ETABS software is consider whereas in future any other analysis software can be utilize.

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