Structural Performance of Mivan Structural System Over Conventional Structural System

Nisarga K:
PG Student(Computer Aided Design Of Structures)
Department of Studies in Civil Engineering, University
B.D.T. College of Engineering,
Davangere, Karnataka, India

Madhukaran:
Assistant Professor
Department of Studies in Civil Engineering, University
B.D.T. College of Engineering,
Davangere, Karnataka, India

Abstract:- India's metropolitan population is now the world's second-largest, and its projected growth is causing more demand in housing. To deal with this problem, India must urgently prepare for the acquisition of land and the rapid construction of housing units. In recent years, there have been significant modifications in the construction process. Buildings were created with the aim of load-bearing in mind in ancient times, and the RCC framed approach was established later. The RC structural wall technology is widely used at the moment. Aluminium formwork, also known as Mivan technology, is a more advanced advancement of the current building approach. This technology uses an RC structural wall system to design the entire construction, which is also known as a Shear wall system. It is primarily meant to allow.

***Keywords*:-** *Mivan Structure(MS), Framed Structure(FS), Conventional Structure Shear wall, Storey Displacement, Storey Drift, Base Shear, Time Period, Frequencies, Response Spectrum Analysis, ETABS.*

I. INTRODUCTION

Mivan was created in Malaysia around the 1990s. The use of repeating formwork in the construction of large structures saves money. Looking around the world, India's use of mivan invention is small in comparison to other countries. Mivan enhances production & maintains a higher degree of quality when using good materials and machinery. The formwork is made of alminium since the slab, column, and beam were cast monolithically, placed on a clean surface & speedier assembly. It's a very simple and uncomplicated procedure. This strategy is also quickly accepted by labor. These light aluminum formworks can really be reused up to 250 times.

A. Mivan Structural System

Mivan Structures are earthquake & gravity load resistant because of shear walls & RC slabs. The major vertical components are RC structural walls of thicknesses varying about 150mm - 500mm based on the storey elevation and thermal insulation. Some basement walls are often used for commercial and parking operations.

B. Conventional Structural System

Beam-Column and Slab are key elements of structures and supports building weight and create safe load path from slab to the foundation, and effective to withstand vertical and horizontal loads. Brick walls consider non-load-bearing walls.

II. OBJECTIVES

- To analyze the G+5 and G+10 multi-storey building for mivan structural system over a conventional structural system in zone IV and V using ETABS.
- For opt models investigate the link between maximum storey displacement and height of storey.
- To look into the hook up between base shear and building altitude for considered models.
- To inquire about the relationship between storey elevation and storey drift.
- To examine the variations in the time period and natural frequencies for different building models of modes considered.
- To review the elite model with the excessive seismic affecting parameters.

III. MODELLING AND STRATEGY

Classic formwork and a regular building process are often used to produce the traditional beam-column system. The RC structural wall system is constructed using Aluminium form technology. G+5 and G+10 stories are chosen in a classic residential building concept. Analysis was done for both the traditional system and Shear wall system for the below typical plan. Both are modelled in ETABS under particular assumptions and analysed in the Response Spectrum Method for varied load Combinations.

A. Models Considered For Thesis

G+5 story Framed and Mivan structures in both zone IV and V

G+10 story Framed and Mivan structures in both zone IV and V

B. Analysis Considered For The Thesis

➢ *Response Spectrum Method*

The greatest possible responses of a spectrum of hypothetical single degree freedom systems of varied natural periods with similar damping, when subjected to the same earthquake ground motion at bases.

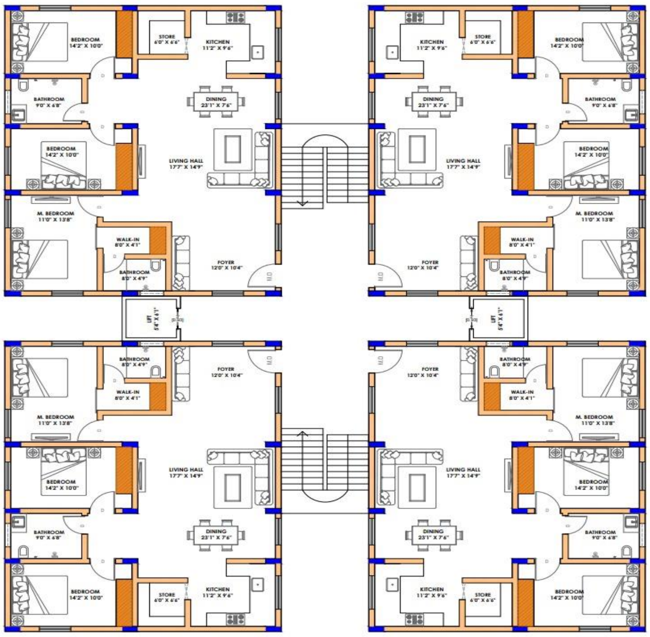

Fig. 1 Plan

C. Details of the Structures

Area of building = 715.5 sq m
Number of storey = Ground+5 and Ground+10
Storey elevation = 3m
Concrete Grade = M30
Steel Grade = Fe500

Frame Segments:
Beam = 300mm X 450mm
Column = 300mm X 600mm
Slab = 125mm
Shear wall thickness = 160mm
250mm
Non load bearing wall = 230mm

Loads considerations:
Super dead(wall) load = 11.73KN/ m^2
Service load = 2KN/sq m
Floor finish = 1KN/ m^2

Seismic Parameters:
Zone Factor for Zone IV = 0.24
Zone V = 0.36
Soil type = Medium {type 2}
Response reduction factor = 5

D. Models View

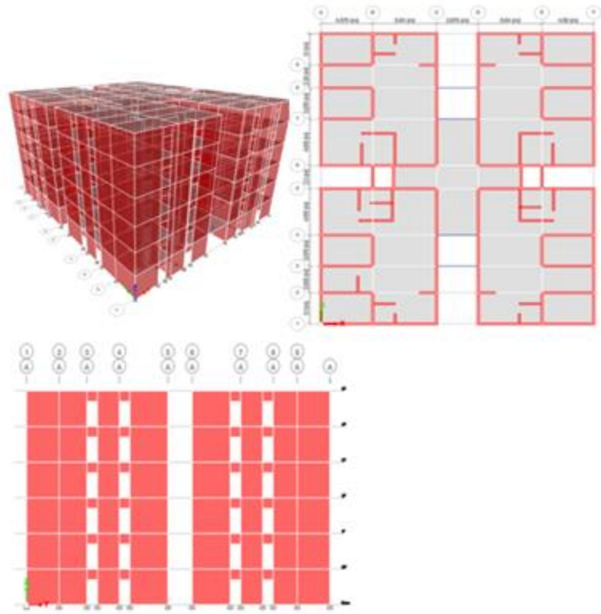

Fig. 2 G+5 Story Mivan Structure

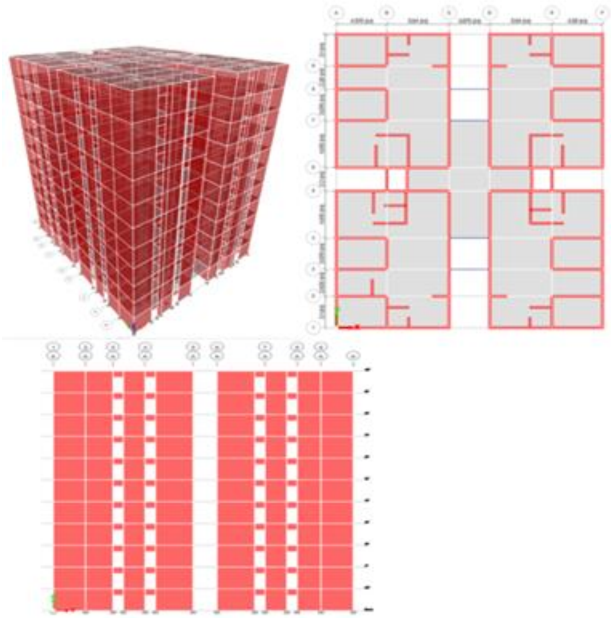

Fig. 3 G+10 Story Mivan Structure

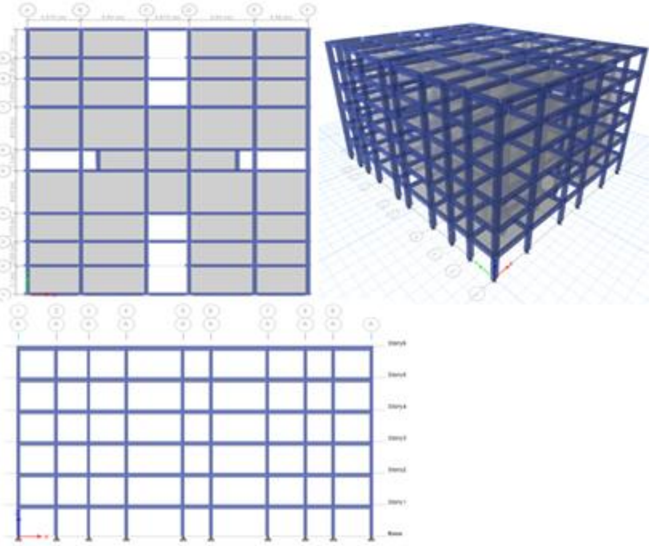

Fig. 4 G+5 Story Framed Structure

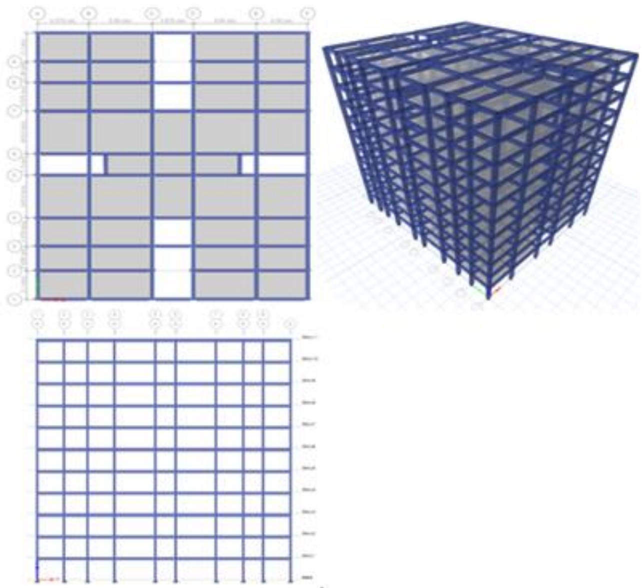

Fig. 5 G+10 Story Framed Structure

IV. RESULTS AND DISCUSSIONS

A. Displacement In Storey

Table 1: Displacement in mm in X-direction 1.5*(DL+SDL+EQX) of Ground+5

DISPLACEMENT IN MM IN X-DIRECTION (1.5DL+1.5SDL+1.5EQX) OF GROUND+5				
STOREY	**FS Z 4**	**MS Z 4**	**FS Z 5**	**MS Z 5**
vi	23.3	6.43	34.95	9.7
v	21.3	4.56	31.94	6.9
iv	17.84	2.98	26.8	4.5
iii	13.22	1.74	19.82	2.6
ii	7.98	0.82	11.96	1.2
i	2.92	1.04	4.4	1.1
0	0	0	0	0

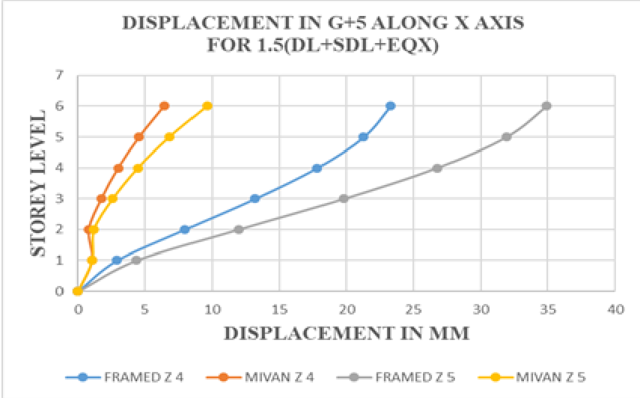

Fig. 6 Displacement in mm in X-direction 1.5*(DL+SDL+EQX) of Ground+5

Table 2 Displacement in mm in X-direction 1.5*(DL+SDL+EQX) of Ground+10

DISPLACEMENT IN MM IN X-DIRECTION (1.5DL+1.5SDL+1.5EQX) OF GROUND+10				
STOREY	**FS Z 4**	**MS Z 4**	**FS Z 5**	**MS Z 5**
xi	44.4	11.5	66.6	17.1
x	42.7	9.8	64.1	14.7
ix	40.2	8.3	60.3	12.4
viii	36.9	6.8	55.4	10.2
vii	32.95	5.5	49.5	8.2
vi	28.6	4.2	42.8	6.3
v	23.7	3.1	35.5	4.6
iv	18.5	2.1	27.8	3.1
iii	13.1	1.3	19.7	1.9
ii	7.7	0.9	11.6	1.1
i	2.8	1.1	4.2	1.2
0	0	0	0	0

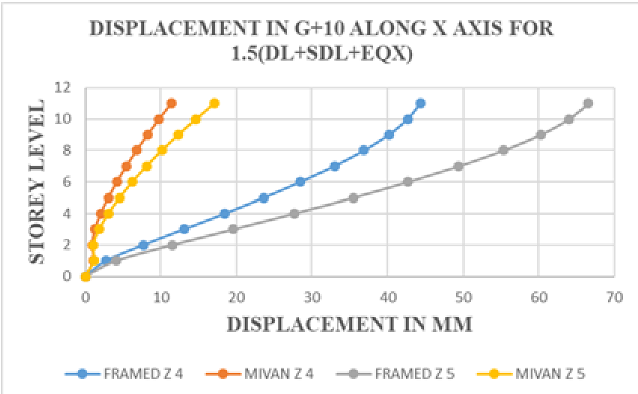

Fig. 7 Displacement in mm in X-direction 1.5*(DL+SDL+EQX) of Ground+10

- *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 V values in both X and Y directions are higher than the zone IV values.

B. Storey Drift

Table 3 Storey Drift in X-direction 1.5*(DL+ SDL+EQX) of Ground+5

STOREY DRIFT IN X-DIRECTION (1.5DL+1.5SDL+1.5EQX) OF GROUND+5				
STOREY	**FS Z 4**	**MS Z 4**	**FS Z 5**	**MS Z 5**
vi	0.0007	0.00006	0.001	6.7E-05
v	0.0012	5.9E-05	0.00173	6.1E-05
iv	0.0015	5.9E-05	0.00231	5.9E-05
iii	0.0017	5.7E-05	0.00262	5.7E-05
ii	0.0017	5.20E-05	0.00253	7.60E-05
i	0.001	1.90E-05	0.00146	2.80E-05
0	0	0	0	0

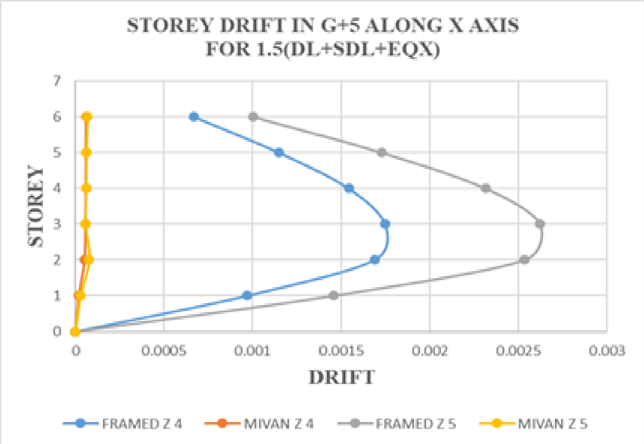

Fig. 8 Storey Drift in X-direction 1.5*(DL+SDL+EQX) in Ground+5

Table. 4 Storey Drift in X-direction 1.5*(DL+ SDL+EQX) in Ground+5

STOREY DRIFT IN X-DIRECTION (1.5DL+1.5SDL+1.5EQX) OF GROUND+10				
STOREY	**FS Z 4**	**MS Z 4**	**FS Z 5**	**MS Z 5**
xi	0.0006	0.00054	0.00085	0.00081
x	0.0008	0.00051	0.00126	0.00077
ix	0.0011	0.00049	0.00165	0.00073
viii	0.0013	0.00046	0.00197	0.00068
vii	0.0015	0.00042	0.00222	0.00063
vi	0.0016	0.00038	0.00242	0.00056
v	0.0017	0.00033	0.00259	0.00049
iv	0.0018	0.00028	0.0027	0.00041
iii	0.0018	0.00021	0.0027	0.00032
ii	0.0016	9.90E-05	0.00246	0.00015
i	0.0009	4.10E-05	0.00138	6.10E-05
0	0	0	0	0

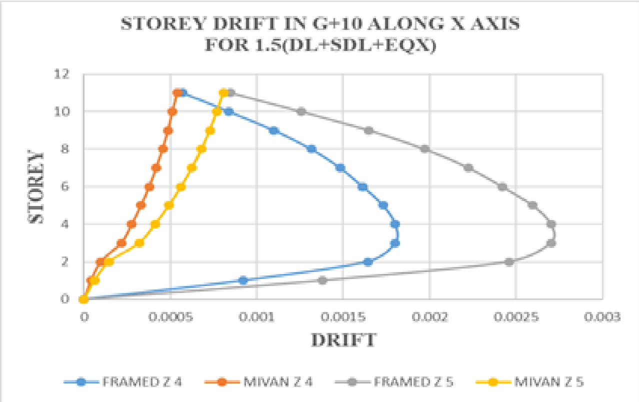

Fig. 9 Storey Drift in X-direction 1.5*(DL+SDL+EQX) in Ground+10

➢ *Observation And Discussion*

From the above facts, we can conclude that increasing the elevation of structurecauses an increase in drift and ultimately a reduction in both structures. When compared to the conventional structure, the mivan structure produces less drift. In both directions, the zone IV values are lower than the zone V. Mivan structure storey drift is reduced by 91% in 5 storey zone IV structure and 93.3% in zone V structure when compared to conventional structure. In 10 storey structure, mivan structure storey drift is reduced by 98.7% in zoneIV and 98.9% in zone V when compared to conventional structure.

C. Base Shear

Table 5 Base shear in X-direction 1.5*(DL+SDL+EQX) in Ground+5

BASE SHEAR IN X-DIRECTION (1.5DL+1.5SDL+1.5EQX) OF GROUND+5				
STOREY	**FS Z 4**	**MS Z 4**	**FS Z 5**	**MS Z 5**
GROUND+5	3825.8	4850.3	5738.7	7275.5

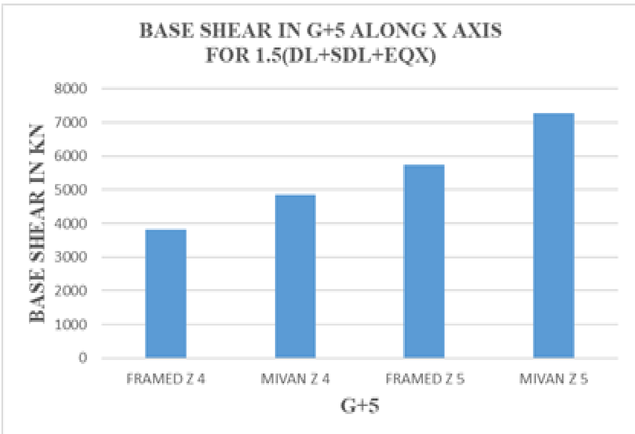

Fig. 10 Base shear in X-direction 1.5*(DL+SDL+EQX) in Ground+5

Table 6 Base shear in x-direction 1.5*(DL+SDL+EQX) in Ground+10

BASE SHEAR INX-DIRECTION (1.5DL+1.5SDL+1.5EQX) OF GROUND+10				
STOREY	**FS Z 4**	**MS Z 4**	**FS Z 5**	**MS Z 5**
GROUND+10	3562.9	8904.3	5344.3	13356.5

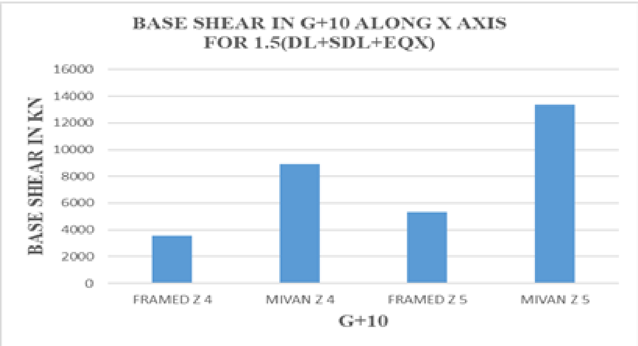

Fig. 11 Base shear in x-direction 1.5*(DL+SDL+EQX) in Ground+10

➢ *Observation and Discussion*

It is obvious from the foregoing data that base shear of mivan structure is the highest when compared to the traditional system. The base shear increases as the storey elevation rises, and zone V results are bigger in both directions than the zone IV results. When compared to traditional construction, the base shear of a mivan structure for zone IV is increased by 21% and for zone V by 21.2%, while the base shear of a mivan structure in zone IV got increased by 59.95% and in zone V 60% in a 10 storey structure.

D. Modal Time Period

Table 7 Time Period of Ground+5 Structures for zone IV

GROUND+5 IN Z -IV		
MODES	**FS**	**MS**
i	1.01	0.283
ii	0.85	0.283
iii	0.84	0.283
iv	0.34	0.283
v	0.27	0.283
vi	0.26	0.12
vii	0.19	0.093
viii	0.15	0.085
ix	0.145	0.066
x	0.14	0.067
xi	0.12	0.068
xii	0.11	0.069

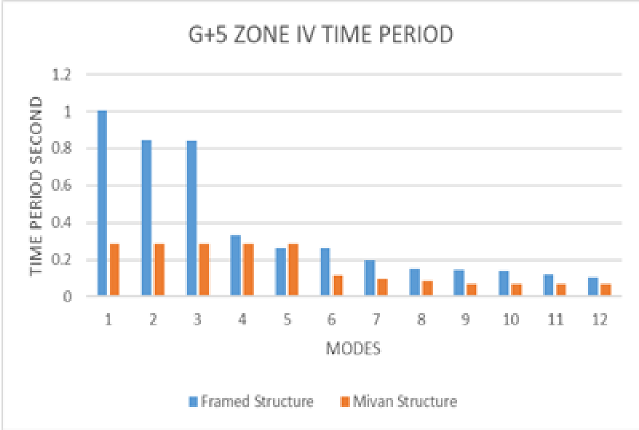

Fig. 12 Time Period of Ground+5 Structures for zone IV

Table 8 Time Period of Ground+5 Structures for zone V

GROUND+5 IN Z -V		
MODES	**FS**	**MS**
i	1.01	0.283
ii	0.85	0.283
iii	0.84	0.283
iv	0.34	0.283
v	0.27	0.283
vi	0.26	0.12
vii	0.19	0.093
viii	0.15	0.085
ix	0.145	0.066
x	0.14	0.067
xi	0.12	0.068
xii	0.11	0.069

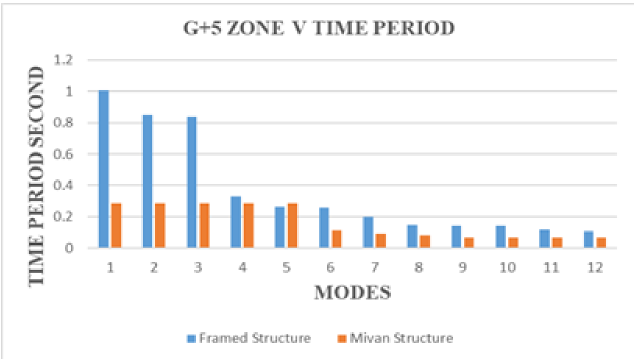

Fig. 13 Time Period of Ground+5 Structures for zone V

Table 9 Time Period of Ground+10 Structures for zone IV

GROUND+10 IN Z -IV		
MODES	**FS**	**MS**
i	1.58	0.3
ii	1.38	0.29
iii	1.36	0.29
iv	0.59	0.29
v	0.5	0.29
vi	0.49	0.29
vii	0.35	0.29
viii	0.28	0.29
ix	0.27	0.29
x	0.24	0.29
xi	0.2	0.285
xii	0.19	0.197

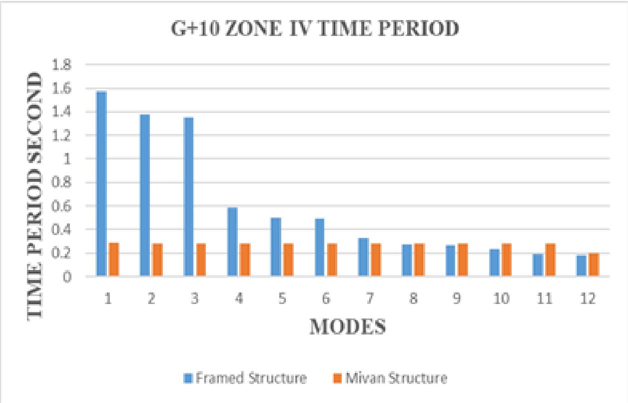

Fig. 14 Time Period of Ground+10 Structures for zone IV

Table 10 Time Period of Ground+10 Structures for zone V

GROUND+10 Z -V		
MODES	**FS**	**MS**
i	1.58	0.3
ii	1.38	0.29
iii	1.36	0.29
iv	0.59	0.29
v	0.5	0.29
vi	0.49	0.29
vii	0.35	0.29
viii	0.28	0.29
ix	0.27	0.29
x	0.24	0.29
xi	0.2	0.285
xii	0.19	0.197

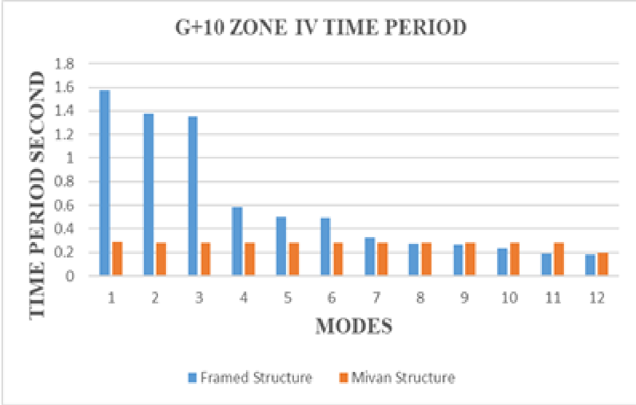

Fig. 15 Time Period of Ground+10 Structures for zone V

➢ *Observation And Discussion*

As seen by the above results, the mivan structure has a much shorter time period than the conventional system including both G+5 & G+10 structures. The time period lengthens as the storey height rises, and the values in zone V are greater than those in zone IV among both directions.

E. Frequencies

Table 11 Frequencies of Ground+5 for zone IV

GROUND+5 IN Z -IV		
MODES	**FS**	**MS**
i	0.99	3.52
ii	1.18	3.52
iii	1.2	3.52
iv	3.01	3.52
v	3.76	3.52
vi	3.82	8.85
vii	5.04	10.9
viii	6.74	11.98
ix	6.93	14.57
x	7.07	14.57
xi	8.47	14.57
xii	9.44	14.57

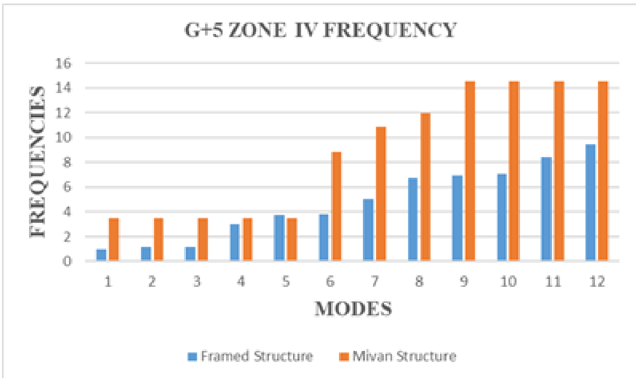

Fig. 16 Frequencies of Ground+5 for zone IV

Table 12 Frequencies of Ground+5 for zone V

GROUND+5 IN Z -V		
MODES	**FS**	**MS**
i	0.99	3.52
ii	1.18	3.52
iii	1.2	3.52
iv	3.01	3.52
v	3.76	3.52
vi	3.82	8.85
vii	5.04	10.9
viii	6.74	11.98
ix	6.93	14.57
x	7.07	14.57
xi	8.47	14.57
xii	9.44	14.57

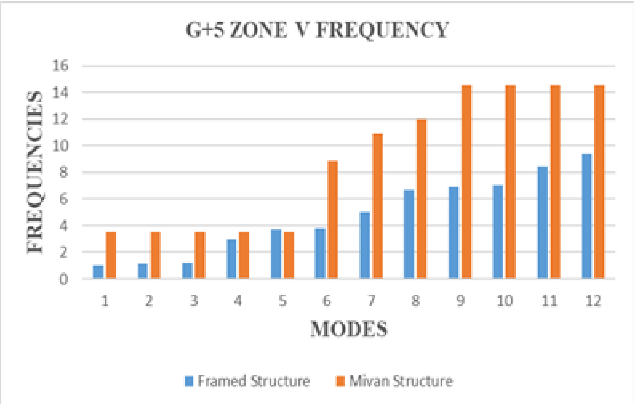

Fig. 17 Frequencies of Ground+5 for zone V

Table 13 Frequencies of Ground+10 for zone IV

GROUND+10 Z-IV		
MODES	**FS**	**MS**
i	0.64	3.43
ii	0.73	3.52
iii	0.74	3.52
iv	1.71	3.52
v	2.01	3.52
vi	2.03	3.52
vii	3.05	3.52
viii	3.7	3.52
ix	3.75	3.52
x	4.19	3.52
xi	5.26	3.55
xii	5.43	5.12

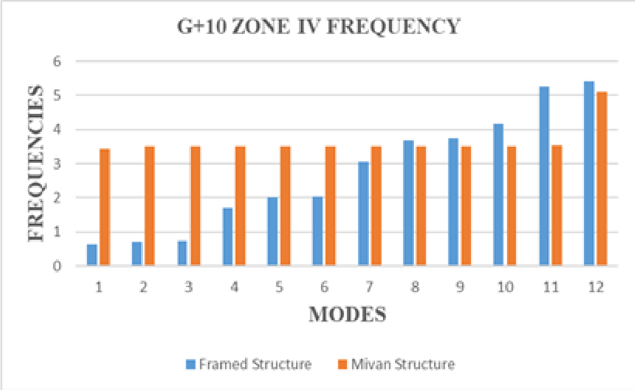

Fig. 18 Frequencies of Ground+10 for zone IV

Table 14 Frequencies of Ground+10 for zone V

GROUND+10 Z -IV		
MODES	**FS**	**MS**
i	0.64	3.43
ii	0.73	3.52
iii	0.74	3.52
iv	1.71	3.52
v	2.01	3.52
vi	2.03	3.52
vii	3.05	3.52
viii	3.7	3.52
ix	3.75	3.52
x	4.19	3.52
xi	5.26	3.55
xii	5.43	5.12

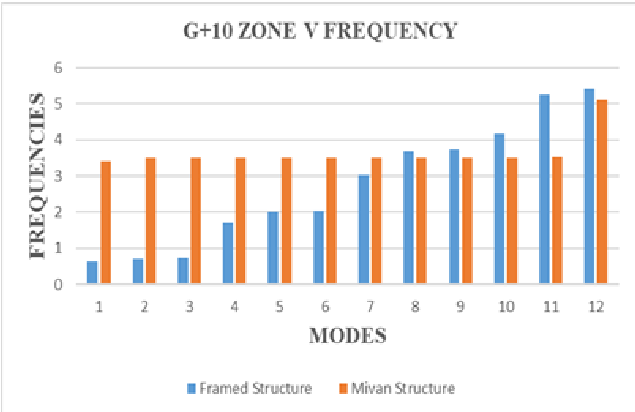

Fig. 19 Frequencies of Ground+10 for zone V

➢ *Observation And Discussion*

By observing the above results the Frequencies of conventional structure is lesser than mivan system in G+5 and G+10 structures. Both zone IV and zone V had the same results in both X and Y directions.

V. CONCLUSIONS

The following conclusion is made from this analytical study.

- When relative to a conventional construction, the optimum storey displacement in the mivan G+5 structure is 72.43% for zone IV & 72.5% fornventional building zone V, while the storey displacement in the mivan G+10 structure is 74.29% for zone IV and 74.4% for zone V.
- When compared to a conventional building, the inter-storey drift in the mivan G+5 structure is 91% for zone IV & 93.3% for zone V, & in the mivan G+10 structure it is 98.7% for zone IV & 98.9% for zone V.
- When compared to framed structures, base shear rose in mivan structures by 21% in zone IV and 21.2% in zone V for G+5 mivan structures and 59.98% in zone IV & 60% in zone V for mivan G+10 structures. In the x-direction, overall storey shear was larger than in the y-direction.
- G+5 structures have a time period of 1.004 secs for zone IV & 0.284 secs in zone V, whereas G+10 structures have a time period of 1.574 secs for zone IV & 0.292 secs in zone V. When compared to traditional constructions, mivan has a longer time period.
- This mivan structural system has greater natural frequencies over traditional structural systems. In both directions, zone 4 & zone 5 had almost the same values.
- Because the time period of a mivan structural system comes virtually equivalent to zero; the acceleration is 0 during structure vibration.
- Construction cost of less in mivan structural system than conventional structural system due to reuse of formwork.
- As mivan consists of RC elements it requires more concrete compared to conventional structures.
- When compared to a mivan structural system, a conventional building system requires more steel.
- Based on the analysis, Mivan structures are effective in resisting the lateral stresses of earthquakes.

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