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Study of Dynamic Behaviour of MIVAN Structure with Different Percentage of Openings and Different Seismic Zones

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ABSTRACT

It is understood that the building constructed using MIVAN technology has more merits compared to conventional building. This work can be done by within a week per floor. MIVAN Formwork material has an influence on the compressive strength and durability of concrete. The surface strength varies with the rate of water absorption of formworks. In other cases brick material is used as infill. However, a detailed study is done to understand structural behaviour of the building with and without openings in MIVAN building will be carried out. The analysis is carried out for different percentage of openings. In the present study a 10 storey structure with the provision of with and without openings for various percentage i.e. 20%, 40% and 60% are taken into consideration. The seismic behaviour of 3D structure for these cases is compared for several seismic zones keeping the soil condition as constant. Response Spectrum method is used for linear dynamic analysis by ETABS. The amounts of variation in the building for the structure with and without openings for various percentages are compared with all other parameters in the form of graph. Comparison is made in such a way that by keeping one parameter as constant and vice versa. The structure with which percentage of opening is suitable for all conditions is selected. The best structure out of all the openings is finally selected which will satisfy all the conditions with safety. This paper reveals about significance of MIVAN.

Keywords: *Dynamic Analysis, Seismic Loading, Different Percentage of openings, Structural Performance, ETABS.*

1. INTRODUCTION

Mivan is a structure which is constructed using mivan technology. It is more effective way existing for the construction of low rise, medium and high rise reinforced concrete structure.it is aluminum fabricated engineered form work 003

. The structural elements such as beams, columns, walls, slabs are poured simultaneously or together. The approach to this technology of construction is systemized and well-disciplined for more speed which results in daily fast work cycle and more productivity. The output can be achieved as 4/5 day per floor and other work cycle to suit our project needs.

The design of mivan is more flexible and it creates many architectural and structural configurations as given by stairs, windows and work of curved futures. The advanced technology results in quick construction. Mivan is a concrete formwork it uses the molds and supports structure in which concrete is poured to get structural elements.

According to the building needs and challenges, the type of formwork will be choosing. By making use of materials like timber, wood and aluminum will be generated and for that concrete should be placed. It is after allowed to dry to get hard for some days and formwork will be stripped off or it can be further left as part of structure. It allows constructing the main parts of the structure that are needed strong and provide strength to the building like walls, stairs, floors, etc. mivan is most advanced in its formwork and need little maintenance considering the durability as a main factor. It is fully pre-engineered system where the finest details are planned by the complete methodology. The structural components like slabs, columns and beams are casted at only one pour of concrete at once continuously.

2. LITERATURE REVIEW

PB Kulkarni, studies [1] Seismic and deflection behavior of mivan for different openings "in this study the performance is viewed on the behavior of open first story of with and without openings. By studying this we can conclude, it has deflection which is too more when considering the case of bare frame that of opening with infill frame. The deflection is minimized accordingly when the infill wall is considered. The earthquake forces acting on end story is more effective compare to other stories so the deflection is also large in this story. When the opening is given in center the deflection is high when compared to opening given at corner panel.

Magarpatil HR [2] "Modeling the effect of mivan walls on seismic performance" In this study, the building vulnerability to seismic forces with soft story is taken into consideration. G+10 3D IS taken as an example of steel frame. In multistoried building of urban the main functional requirement of first story in open is very much important and it cannot be eliminated. To increase the stiffness of the 1st story some measures which are special are required to be adopted this specific situation. With infill and open first story between the first and second SMRF building balancing of stiffness is proposed. By the profile of the building by considering the lateral displacement, the effect of stiffness on the first story is analyzed.

TC Noor [3]"Shear strength consideration for different section of mivan structure "shear strength reduction due to infill panel opening and response of shear strength are ignored. Numerical models of two varieties are needed to perform basic modeling method and also micro modeling method to define macro modeling method of in filled frame. This technique that analyses a model of one strict equivalent needed to replace the panel gives output that is not invalidated to that procedure of macro modeling. Frame shear response up to load at failure models will be made by both the methods. This technique is also used for nonlinear analysis of frame structures.

3. METHODOLOGY

Procedure for modelling the structural system

It consists of several series of step by step procedure which should be carried out in a well-defined manner. The first step is to prepare the model according to the required dimension. Once the model is prepared then next step is to defining of various parameters.

These parameters include defining property of materials, sections, components dimensions, and definition of diaphragm and mass sources and after the loads will be given to the model with appropriate calculation. Then analysis is done and the results are taken out and from there comparisons of results were made and then the conclusion is predicted.

I) **Defining of material properties**

The properties of material that need to be defined must be specified. The properties of material like poisons ratio, weight per volume, modulus of elasticity, mass per volume, material type and area data's should be mentioned. Mass of the building is calculated by using mass per volume formula and similarly weight of the building by weight by volume. The materials include bricks, concrete, reinforced concrete, steel, timber taken based on which the material used. This material has different values of specific gravity and density.

Material property definitions

Defining sections

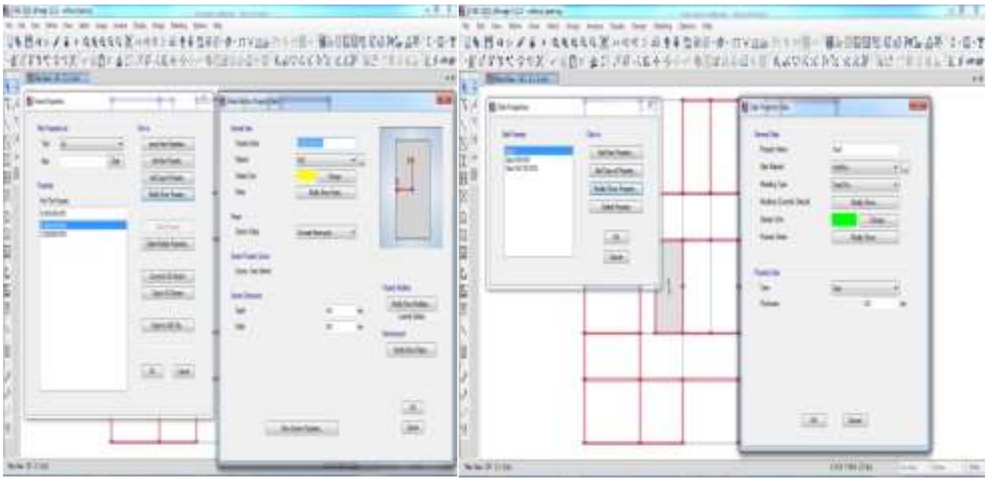
In this the sections of structures like beams, columns and struts if needed will come under this. The dimensions of these components which are derived as per equations and designs are computed. Here the shape of the sections taken and their center of gravity points should be considered. And it is need to be differentiating whether it is a structure of concrete section or steel section or some other material.

Defining walls and slab sections

In ETABS, by the time of performing the defining process, there are three types of options will be there. They are namely Shell, membrane and plate type. This is divided based on behavior property. To achieve the proper connectivity shell elements is divided into finer parts for analysis.

Defining Diaphragm

In the menu of assign, by making use of rigid diaphragm‟ sections of slabs are modeled as rigid to achieve the in-plane rigidity of the building. Each floor mass will automatically take at mass center. If the configuration of the building is irregular than semi rigid frames are considered for analysis.



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Defying mass source

In earthquake analysis, weight is not considered, instead weight is considered. In ETABS in seismic analysis mass of the structure is considered as the self-mass by default assumptions. To give the mass correctly its loads, type of loads and co-efficient are checked properly.

Defining with Functions of response spectrum

With relate to the zone of seismicity and type of soil suitable function of response spectrum need to be defined according to IS: 1893-2002(Part 1). Making use of available options, methods which are suitable like directional and modal combination need to be specified. To change the normalized value to the units of appropriation specification of scaling factor should be made. And to perform this without error the earthquake forces in x direction and y- direction is exactly selected and the seismic forces in other directions are randomly taken. This is carried out only in the case of dynamic analysis and not in case of static analysis. The parameters considered for dynamic analysis are analyzed during the analysis. The forces acting in z- direction is neglected. In this case it is vertical and the force will never act in vertical direction in any of the cases.

Loads considered for building:

1) Dead loads

Floor finishes 1.5 kN/m^2

Service loads 0.5 kN/m^2

Sunken filling (soil) 4.0 kN/m^2

Toilets (cinder) 1.5 kN/m^2

Step load 1.7 kN/m^2

2) Live loads

Rooms and kitchen 2 kN/m^2

Toilets and bathrooms 2 kN/m^2

Corridors 3 kN/m^2

Balconies 3 kN/m^2

3) Lateral loads:

Seismic load parameters considered,

Seismic zone 2, 3, 4 and 5

Zone factor 0.1, 0.16

Site type hard 1

Importance factor 1

Response reduction factor 5

4) Wind load parameters considered

Wind speed 33m/s

Terrain category 3

Structure class C

Risk coefficient factor (k1) 1

Topography factor (K3) 1

Time period 0.981 sec

Codes Used;

IS 456: 2000 - Plain and reinforced concrete

IS 1893: 2002 - Earthquake resistant design

IS 875: 1987(part 1) - Dead loads

IS 875: 1987(Part 2) - Imposed loads

Consideration of dynamic parameters:

- Base shear
- Frequency
- Time period
- Story drifts
- Story shear
- Modal directional factors
- Modal participating mass ratio

MODELS

In this project we have considered 4 models of which are having different percentage of openings,

I) without openings in building

ii) 20% openings in building

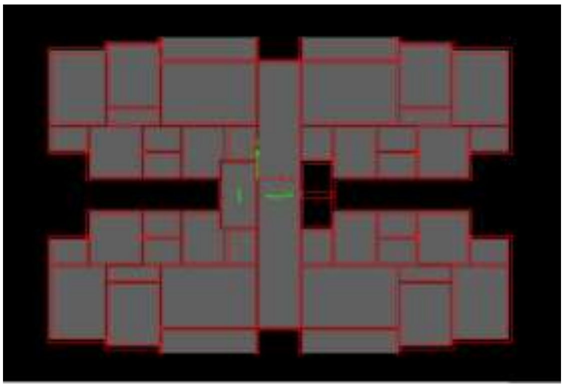
iii) 40% openings in building

iv) 60% openings in building

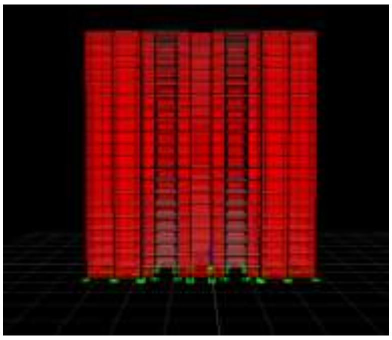
4. CALCULATIONS OF OPENINGS

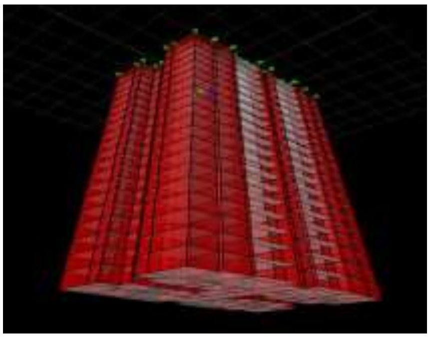
1) Building with no openings

Since there are no openings in this case, it is taken completely filled walls. Therefore there is no matter of calculation of openings. According to the dimensions taken for the building, model is prepared



Top view of the building





Front elevation of the building without opening 3d view of the building without openings

Building with 20% openings

We have,

Width of the wall = 3.75m

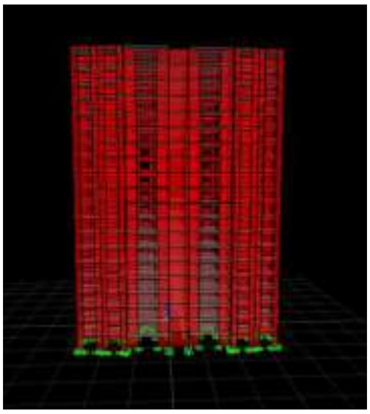
Height of each story = 3m

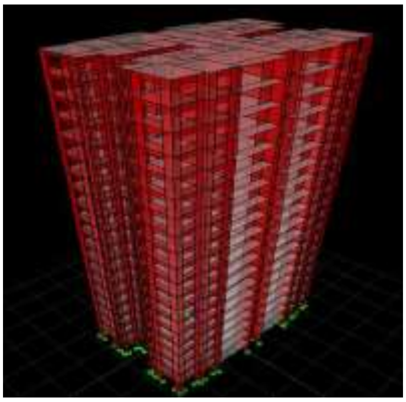
Area of the wall = 3.75*3 = 11.25m2

20% of the area to be removed = 0.2 * 11.25 = 2.25m^2

Assuming window height = 1.2m

Width of the window = 2.25/1.2 = 1.875mAssuming spandrel/beam depth below floor = 700mm above floor is 1100mm





Elevation of the building with 20% opening 3d elevation of 20% openings of the building

Building with 40% openings

We have,

Width of the wall = 3.75m

Height of each story = 3m

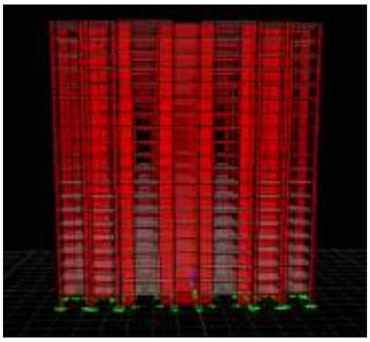
Area of the wall = 3.75*3 = 11.25m2

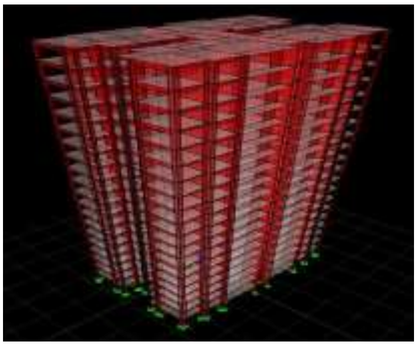
40% of the area to be removed = 0.4* 11.25 = 4.5m2

Here, taking square root on area obtained, square root of 4.5 = 2.12m

Height of story (3-2.12) = 0.44m

Take spandrel/beam depth below floor = 440mm above floor is 440mm





Elevation of the building with 40%openings 3d elevation of 40%opening building

Building with 60% openings

We have,

Width of the wall = 3.75m

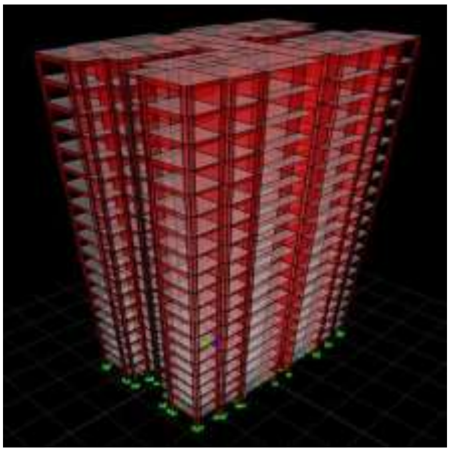
Height of the wall = 3m

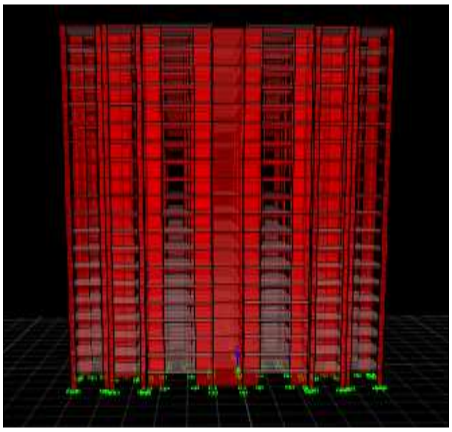
Area of the wall = 3.75*3 = 11.25m2

60% of the area to be removed = 0.6* 11.25 = 6.75m2

Here, taking square root on area obtained, square root of 6.75 =2.6m

Height of story (3 – 2.6) = 0.4m (take only below)





3d view of the building Elevation of the building with 60% openings

RESULT ANALYSIS

In this case analysis is done by two methods, static equivalent method and dynamic response spectrum method. Loads that are considered as dynamic nature which are opposes to seismic load. For regular and simple building static method is adopted. In most of the codes it is accepted to medium and low rise building. Base shear load is estimated in the beginning and it is and it is distributed on every story according to calculations.

.The codes provisions for two methods of analysis.

1. Equivalent static method

2. Dynamic method

a. Response spectrum analysis

b. Time history analysis.

1 **Equivalent static load method:**

To get the results reasonably and to perform analysis this is simple procedure and method for an engineer to adopt and to proceed to perform. The investigation which is done basically which is the subset of examination on seismic waves and it calculate the building reaction rate and it resembles as building outline where the common thing is tremors.

- This analysis performs the calculation of seismic forces which are there at different levels of the building at the time of earthquake.
- By making use of laws of physics and equations in mathematics examination of structure is done and to know its structural responses.
- The basic aim of this analysis is to find stresses, due to different effects of loads the result of deformation and internal forces in the building.
- This method is also known as lateral force method and in this method loadings from static transverse are taken to be same as earthquake effects. InRayleigh method, the loading in inertia gives an approximation at its best to the shape of natural vibration of the system
- The components of lateral load resisting system such as walls and columns without having any interruption they should reach top from base.

DYNAMIC METHODS

A) Response spectrum method:

This method is used when except fundamental one the other modes will gets affected for the structure response. When the structure become very much uneven, very tall and in this reaction method will become improper and proper correction is needed.

- Dynamic analysis in which the dynamic loading is considered and the flexible property and its behavior is considered.
- Dynamic load continuously varies with time.
- Dynamic load consists of seismic and live wind load.

The value of inertial force is given in formula as, F=M*a

Where,F = inertial force, M = inertial mass, a = acceleration

b) Time history analysis:

The main merit of this method is that it will preserve the response qualities of relative signs in the response background and this comes under very important when consideration is made to take effects of interaction in resultants of stresses. The motion equation for MDOF system in the form of matrix could be written as;

[m]{X}+[c] {x} + [k] {x} = -mg (t) [m] {I}

Where,

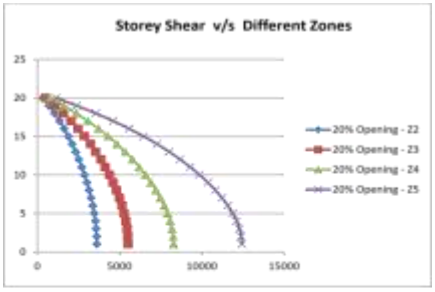
[m] = mass matrix

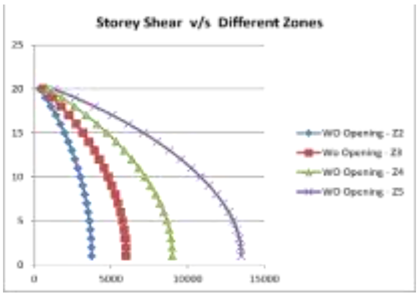
[c]= damping matrix

[k] = stiffness matrix

Mg (t) =acceleration.

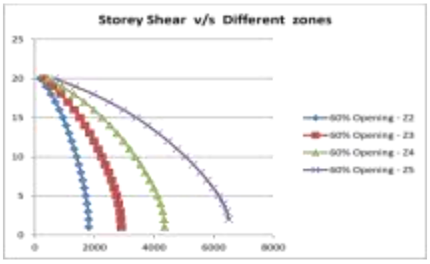
4. RESULTS & DISCUSSIONS

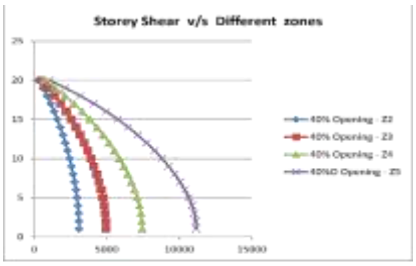




Storey shear vs. zones with 0% openings

Storey shear v/s zones with 20% openings





Storey shear v/s zones with 40% openings

Storey shear v/s zone with 60% openings

5. CONCLUSION

From the modal direction factor criterion it is preferable to have openings between less than 60% since for structure with opening more than 40% induces torsional displacement in the very first mode which is highly undesirable. The torsion induces higher forces on the walls which results in higher area of reinforcement required. Hence walls with less than 60% behave much better under modal direction considerations.

Walls with percentage of openings between 20% to 60% contribute more mass in the first three modes, however walls with 60% opening do not contribute mass for the first mode in UY direction and walls with 20% and without opening also contribute zero mass for first two modes in rotational direction RZ. Since walls with 40% opening contribute large amount of mass for basic first three modes, buildings with an average of 40% opening tend to have good modal mass participation behaviour.

Base shear decreases with increase in the percentage of openings in all the zones, for walls with 60% opening base shear is very less and for walls without openings base shear is too high. This shows that stiffer the building more will be the forces induced in the elements due to earthquake, which intern increases the demand for higher capacity of the elements making the building more uneconomical. But if the flexibility of the building is more the base shear will decrease but the lateral displacements will increase, which is not desirable for tall buildings. So it is preferable to adopt suitably stiffer or flexible system so that the base shear and the lateral displacements are within the limits.

From the lateral drift consideration buildings with higher percentage of openings induces higher and higher drifts for increased seismic zones. But lower percentage of openings show lesser storey drifts in all the seismic zones.

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