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"Comparative Study of Multi-Storey RC Building Having Flat Slab with and without Shear Wall with Conventional Frame Structure Subjected To Earthquake."

Niharika .M. Keskar[1], Dr.S.P.Raut[2]

Yeshwantrao Chavan College of Engineering,

Nagpur

India

ABSTRACT

In present era, there has been a considerable increase in the number of tall buildings. In construction industry a conventional RC building were commonly adopted for constructing residential, commercial and office building till recent. The use of flat slab system is very common in public buildings. The Structural efficiency of the flat slab construction is poor under earthquake loadings. It has low stiffness. It can be improved their stiffness by adding a supplemental lateral load resisting system in the form of shear wall. In the present work, a G+9 multistoried commercial building having flat slab with and without shear wall and has been analyzed. Comparative study of these structures are analyzed on the parameters like base period, base shear, storey drift and storey displacements. As compared to the conventional frame structure model and flat slab with shear wall model behavior is better than flat slab without shear wall model.

Keyword: Flat slab, Shear Wall, Base Period, Storey Drift, Storey Displacement, Storey Shear.

I. INTRODUCTION

India at present is fast growing country in economy this brings demands in increasing of infrastructure facilities along with the growth of population. In this modern industrial era we can see huge construction activities taking place everywhere, we may face a shortage of land. So construction of tall structures is only solution to overcome this problem. Reinforced concrete has been used for building construction since the middle of the 19th century, initially for some parts of buildings, and then for the entire building structure.

Conventional columns, beams and slab Framed Structure System has been used since many years, in most vulnerable parts of world and these structures has proven themselves as earthquake resistant structures.

In conventional framed structure the brick/block walls are not designed to carry any load except self-load. They are considered as panel walls to provide enclosure. But when it comes to earthquake forces these walls although not designed to carry earthquake shear act as energy dissipating devices and transfer the earthquake load upto some extent to column beam slab system. These walls if constructed in Reinforced concrete and designed to carry gravity as well as earthquake forces, are known as Shear Walls. These Walls are placed at suitable locations and can be used to improve efficiency of flat slab with columns structure in earthquake zones.

Subhajit Sen et al. [1] studied the performance of flat slab buildings designed as per existing code guidelines under earthquake loading for five and a ten storied buildings with identical plans. These buildings have been designed as per guidelines of

Indian code, ACI code, Euro code and New Zealand code.Fromresults it is observed that the ultimate drift capacity of all the flat slab buildings, is slightly lower than the corresponding drift limits.

Xiaomeng Zhang et al. [2]proposed an innovative structural wall, named bundled lipped channel concrete composite wall. The wall consists of bundled lipped channels seam welded together and in-filled concrete. The specimens failed in the sequence of local buckling of the steel sheet, and the propagation of the fractures at the boundary of the wall. The presence of shear studs prevent the steel sheets from local buckling and allows the steel and concrete to act compositely and thus, increased the yield strength and delayed the occurrence of fracture and failure.

Amadeo Benavent-Climent etal.[3]studied the effective width of reinforced concrete flat slab structures subjected to seismic loading on the basis of dynamic shaking table tests. The study focuses on the effective slab width method, which in contrast to the torsional member method, can be easily used with conventional frame analysis software. From the results it is found that the effective width tends to increase withincreasing values of the peak acceleration applied to the structure. This increase is limited or even slowed down by the loss of adherencebetween the reinforcing steel and the surrounding concreteinduced by the strain reversals caused by cyclic loading.

Ahmad J. Durrani et al. [3]used four different models in the finite-element based dynamic and static analyses. The system identification results on natural frequencies, mode shapes, and inter storey drifts are used to validate the four analytical models. The dynamic analysis and system identification results indicate that the shear wall kept the drift level at the central core within the code limit. This seems to be typical of a flat-slab building with a central core of shear walls. The direct comparison of displacement and drift obtained from Static analysis according to code specification to those of the dynamic analysis and system identification may not be very meaningful, it is noted that the static results are much smaller than the other two results. The base shear calculated from the dynamic analysis is close to that of the static procedure in the NS direction but is twice as much in the EW direction.

S. Greeshma et al.[4]the study is carried out on floor slab and shear wall together which acts as a rigid jointed frame structure in resisting gravity loads and lateral forces caused by wind and earthquake. The behavior of the connection can influence the pattern and distribution of lateral forces among the vertical elements of the structure. The adequate transverse reinforcement, slab shear reinforcement, and proper detailing will provide better ductility, stiffness, and strength to the structural elements of the buildings. The performance of exterior shear wall diaphragm joints with nonconventional reinforcement detailing was examined experimentally and analytically.It is observed that theexperimental ultimate strength for Shear reinforcement in slabs is 28.13%higher than that of Conventional slab system, whereas the variation is19.2% in analytical results.

H.S.Kim et al. [5]proposedan efficient method for a three dimensional analysis of a high rise building structure with shear walls.Three-dimensional super elements for walls and floor slabs were developed and a substructure was formed by assembling the super elements to reduce the time required for the modelling and analysis. They concluded that the proposed method is very useful for an efficient and accurate analysis of high-rise building structures with significantly reduced computational time and memory.

II. METHODOLOGY

Comparative study of with and without shear wall with conventional frame structure was carried out. In this study, three models were analyzed,

Model 1 : Building was modelled as conventional framed structure as shown in (Fig.1) having slab thickness of 150mm, beams of 230X750mm and columns sizes of 300x900mm, 300X750mm, 300X600mm and 300X450mm respectively.

Model 2 : Building was modelled as flat slab structure as shown in (Fig.2) having slab thickness of 200mm, plan dimension of drop as 2200X2200mm having thickness of 300mm and column sizes of 900x900mm, 750X750mm, 600X600mm and 450X450mm respectively.

Model 3 : Building was modelled as flat slab with shear wall structure as shown in (Fig.3) having slab thickness of 200mm, column size having 450X600mm and shear wall having thickness of 200mm respectively.

The analysis has been done using commercial software. The material properties like Grade of Concrete, Steel, Density and Modulus of elasticity are defined initially. Various loads like dead load,live load, wind load, super dead load and seismic loads are defined and the following properties has been assigned,

Grade of concrete: M30

Grade of steel: Fe500

Modulus of Elasticity: $2x10^5$ N/mm^2

Live loads: 2.5 kN/m^2

Floor finish: 1.5 kN/m^2

Table 1. Structure Plan Details

Number of stories	**G+9**
Height of each storey	**3.6m**

Table 2: Earthquake load data

Seismic Zone`	**II**
Zone factor Z	**0.1**
Importance factor I	**1**
Response reduction factor	**5**
Type of soil	**Medium**

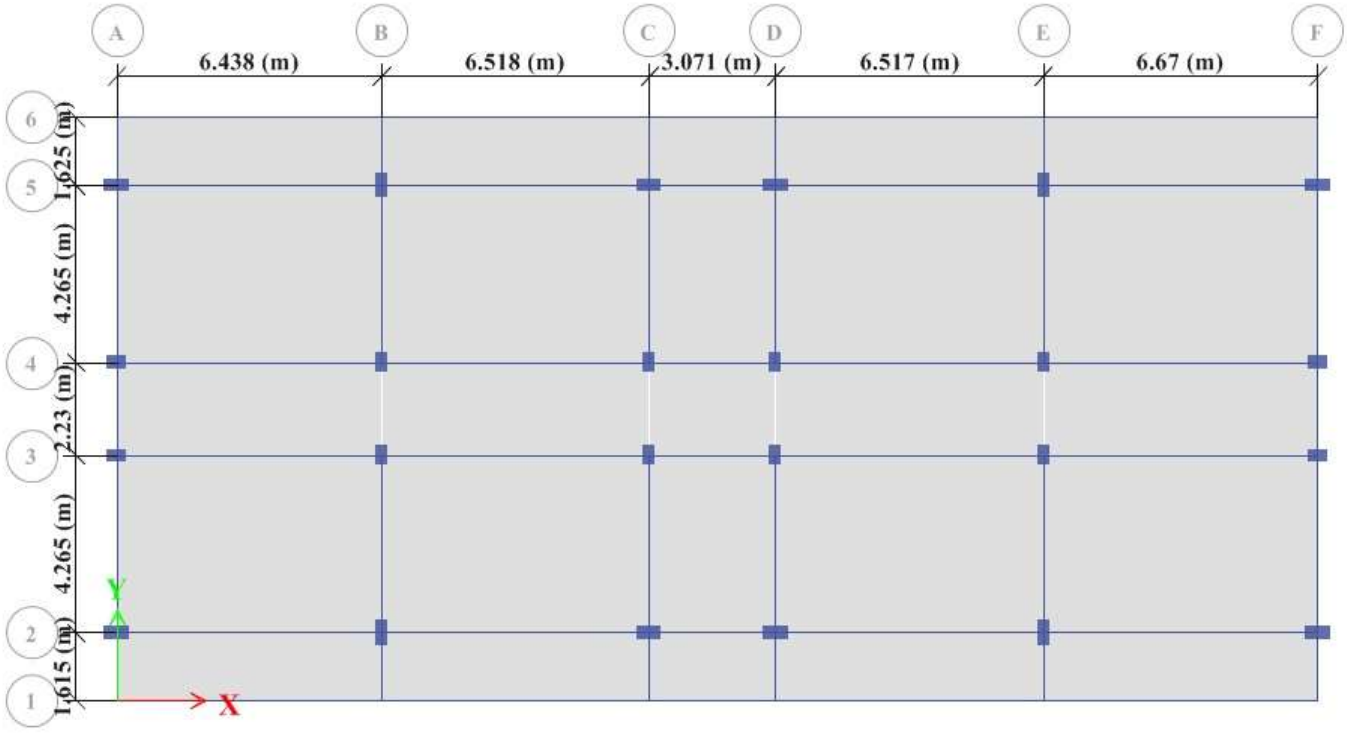

Fig 1.Plan of model 1

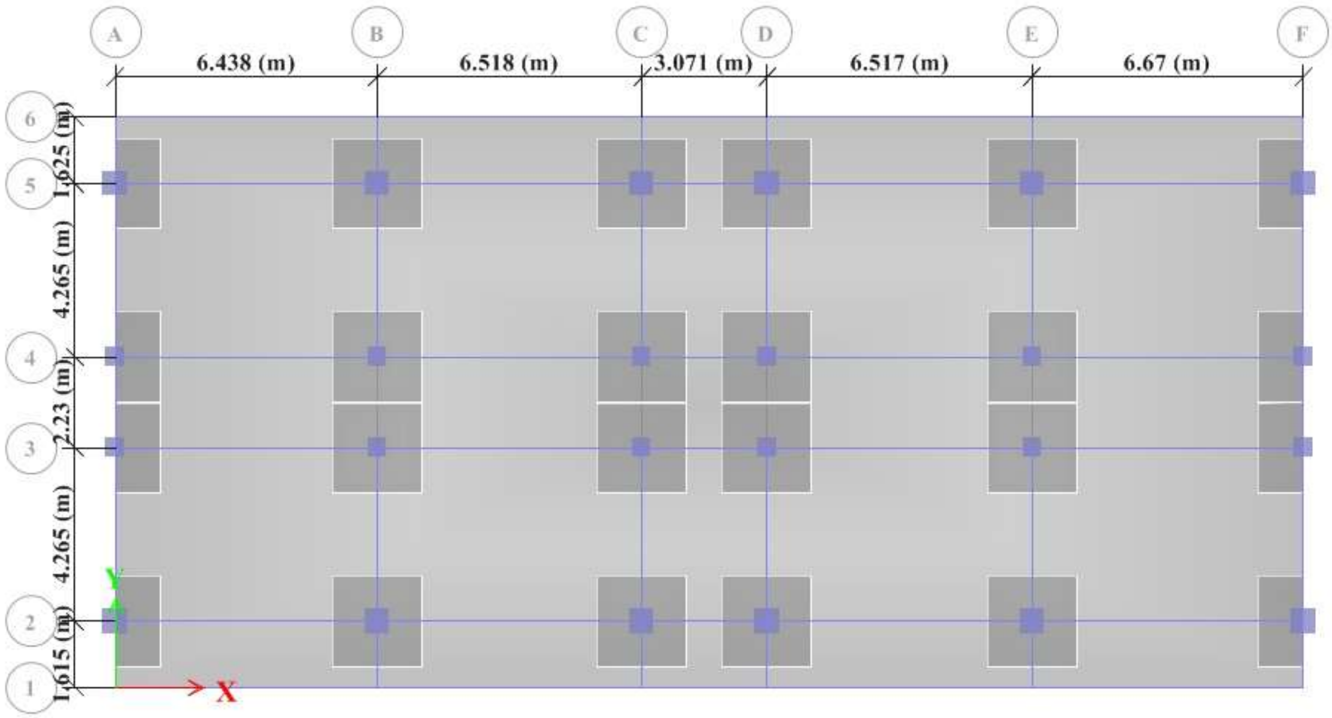

Fig. 2 .Plan of model 2

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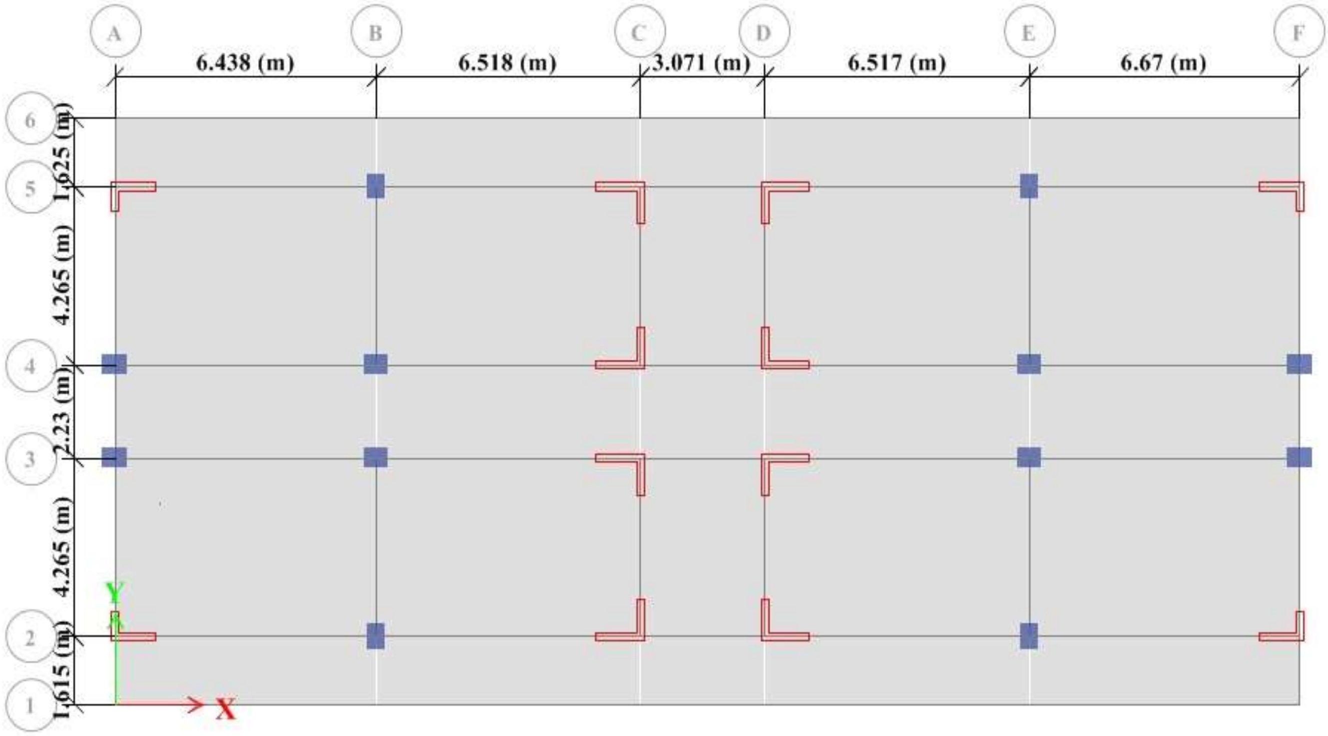

Fig 3.Plan of model 3

The analysis of the following three models has been done as per IS 456-2000 [6] and IS 1893-2002 [7]. The following flow chart shows the steps involved in the analysis of models by ETABS.

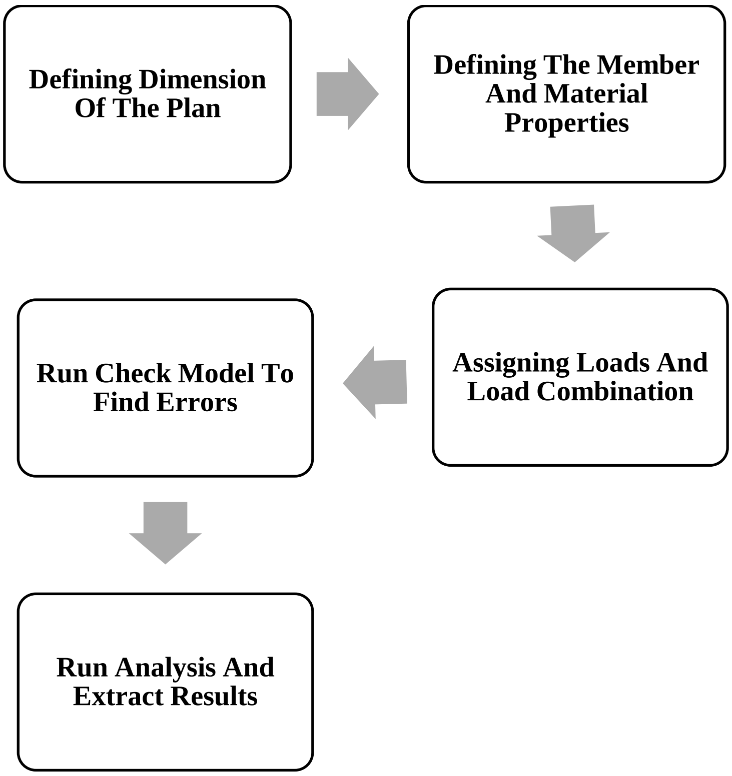

Fig 4.Flow Chart of Steps involved in Etabs

III. RESULTS AND DISCUSSION

The study examines the performance of multi-storey buildings having different types of slabs with and without shear walls. As it is discussed earlier that use of flat slabs makes the structure flexible under seismic loading, therefore, in present work beam slab arrangement is replaced by flat slabs and behavior of buildings is studied with and without shear walls.

To study the effectiveness of all these models, the time period, storey shear, storey drift, lateral displacement are worked out and are presented.

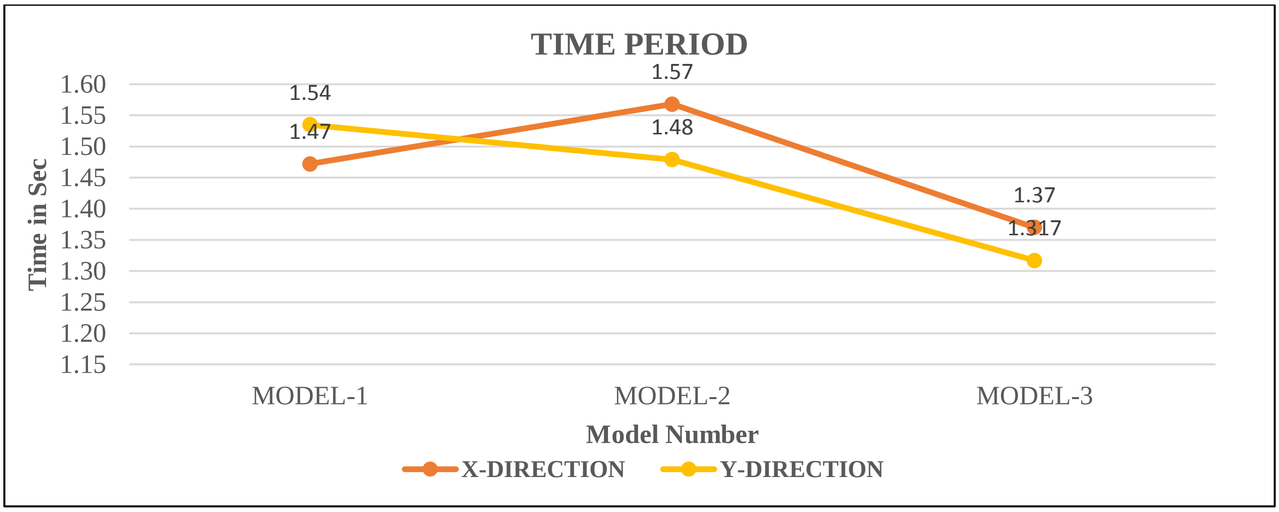

Fig 5. Time period (sec) VS Types of Models

In (Fig.5) model 1 time period in x-direction decreases but increases in y-direction.The time period in x-direction in model 2 increases due to the provision of square shaped drops instead of beams and the time period in y-direction decreases due to the rectangular plan area. In model 3 the time period in x and y direction comes same by provision of shear walls in both directions.

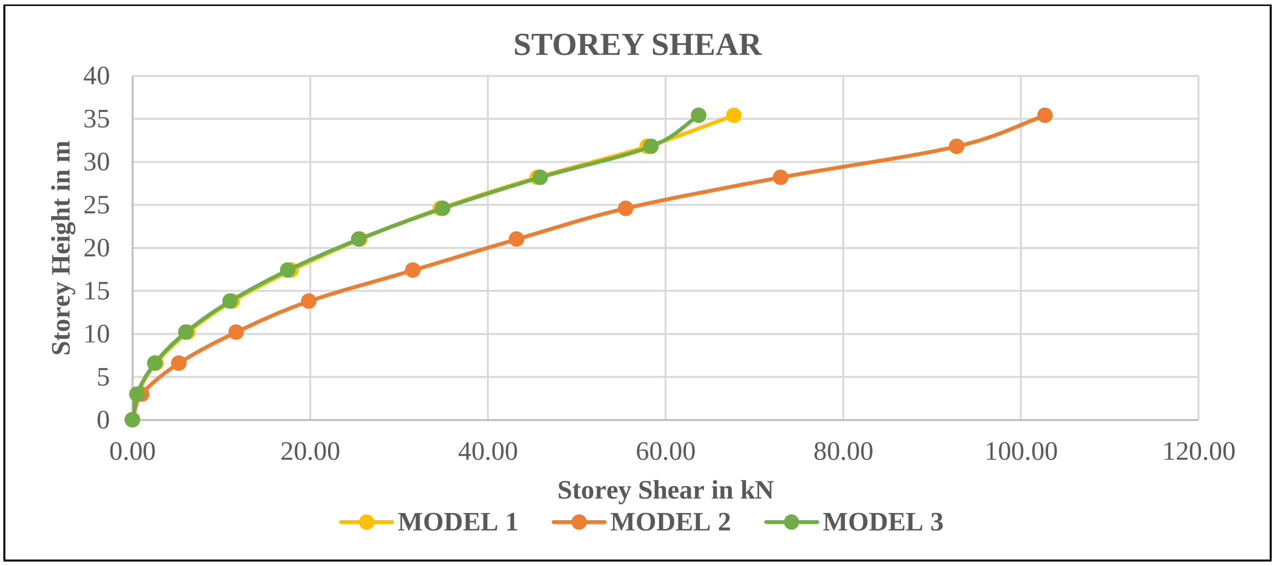

Fig 6. Storey Shear (kN) VS Storey Height (m)

In (Fig.6) model 1 storey shearincreasesat the top floor.The storey shear in model 2 increases due to the elimination of beams as the weight of building increases. In model 3 the storey shear is decreased by provision of shear walls in both directions.In model 2 storey shear is 38% more than model 1 and in model 3 it is 6% less than model 1 & 38% less than model 2.

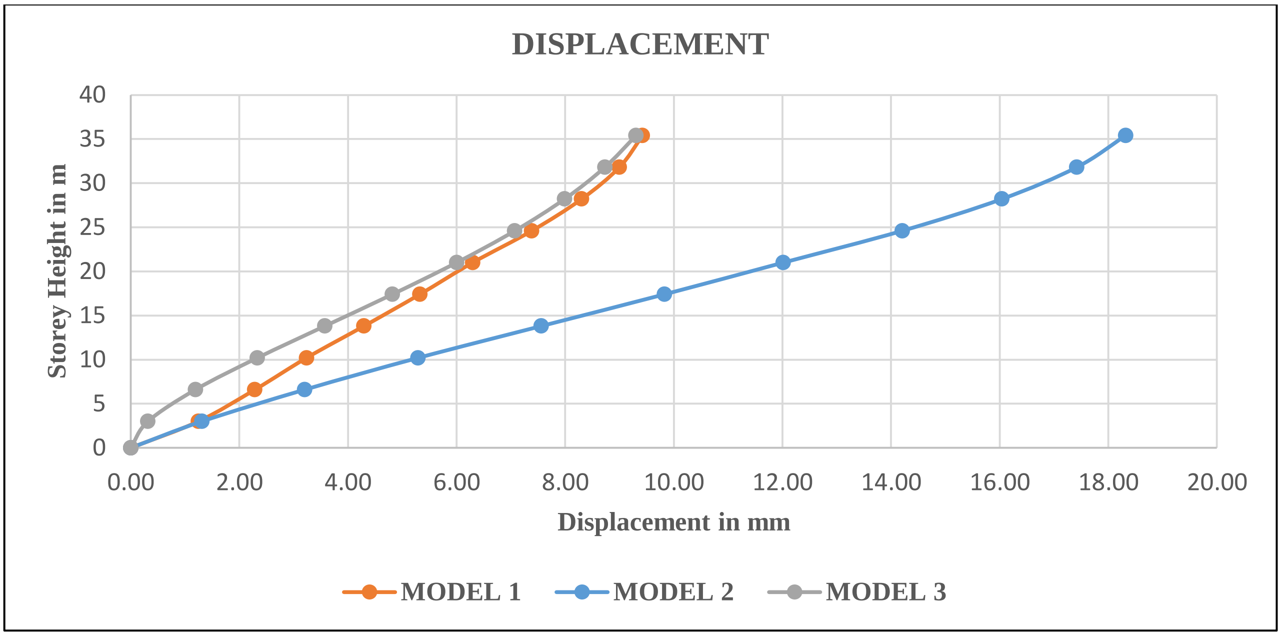

Fig 7. Storey Displacement (mm) VS Storey Height (m)

In (Fig.7) model 1 storey displacement at the top floor is maximum.The storey displacement in model 2 increases as the stiffness in that model is decreased by elimination of beams. In model 3 the storey displacement is decreased by provision of shear walls in both directions.In model 2 storey displacement is 49% more than model 1 and in model 3 it is 1.3% less than model 1 and 49% less than model 2.

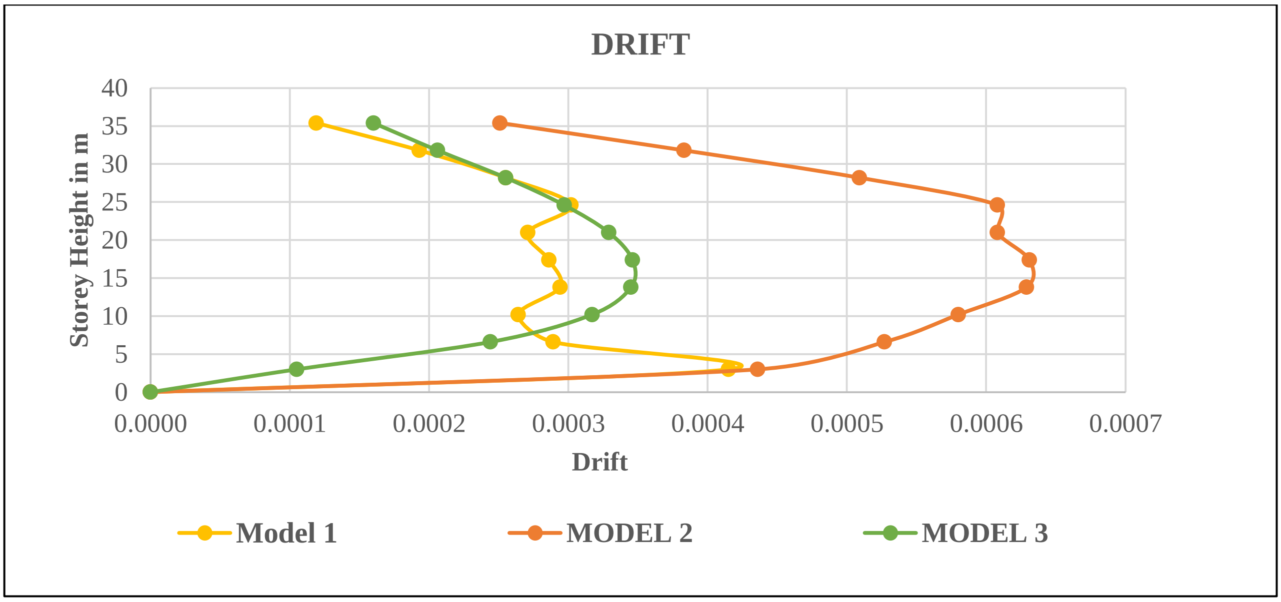

Fig 8. Storey Drift VS Storey Height (m)

In (Fig.8) model 1 storey drift at the first floor is maximum due to the soft storey effect.The storey drift in model 2 increases as the stiffness in that model is decreased by elimination of beams and due to open ground storey at first floor. In model 3 the storeydrift is decreased by provision of shear walls in both directions.In model 2 storey drift is 53% more than model 1 and in model 3 it is same in case of model 1 but it is 40% less than model 2.

IV. CONCLUSIONS

From the study and comparisons of results above Flat slab with column and drop structure, Flat slab with column and shear wall structure and Conventional Framed structure subjected to earthquake loading are concluded below.

1. Fundamental natural period of flat slab with shear wall structure is less than flat slab with drop column structure and conventional structure because we have provided shear walls in such a way that the time period along x and y direction are made nearly same.
2. Storey shear in flat slab with shear wall structure is much less than flat slab with columns and drop structure and is also less than conventional structure, as the stiffness in x and y direction come to almost same by providing shear walls at corner and centers.
3. Storey displacement in flat slab with shear wall structure is much lesser than flat slab with column structure and almost same as conventional frame structure because of use of shear walls in place of some columns.
4. Storey drift in flat slab with shear wall structure is much lesser than flat slab with columns structures and same as conventional structure.
5. The displacements and drift of all models are within permissible limit as per IS: 1893:2002.

V. REFERENCES

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