

COMPARATIVE STUDY OF FLAT SLABS AND CONVENTIONAL RC SLABS IN HIGH SEISMIC ZONE

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Abstract - Recently, Flat slab buildings are commonly used for the construction because use of flat slab building provides many advantages over conventional RC Frame building in terms of economical, use of space, easier formwork, architectural flexibility and importantly shorter construction time. The structural efficiency of the Flat slab construction is most difficult by its poor performance under earthquake loading. It is necessary to analyse seismic behaviour of buildings for various heights to see what are the changes are going to occur for the conventional RC frame building, flat slab building with and without drops. The analysis is done with E-Tabs V9.7.4 software. The characteristics seismic behaviour of conventional RC frame building, flat slab buildings suggest that additional measures for guiding the conception and design of these structures in seismic regions are needed and to improve the performance of building having conventional RC building, flat slabs under seismic loading. The object of the present study covers the behaviour of multi storey buildings having conventional RC frame building, flat slabs and to study the effect of height of the building on the performance of these types of buildings under seismic forces. Present study covers information on the parameters storey drift, lateral displacement, seismic base shear, natural time period.

Key Words: Flat Slabs, RC Frame building, storey drift, lateral displacement. Etabs.

1. INTRODUCTION

India at present is fast growing country in economy which brings demands in increasing of infrastructure facilities along with the growth of population. The demand

of land in urban areas increasing day by day, In order to counteract this demand in these urban areas vertical development is the only option. This type of development brings challenges to counteract additional lateral loads due to wind and earthquake.

Common practice of design and construction is to support the slabs by beams and support the beams by columns. This may be called as beam slab construction. The beams reduce the available net clear ceiling height. Hence in offices, public halls and houses, sometimes beams are avoided and slabs are directly supported by columns. These types of construction improve the aesthetic appearance. These slabs which are directly supported by columns are called Flat slabs. These flat slabs are also called as beamless slabs. The part of slab bounded on each of the four sides by centre line of column is called panel. Panel may be divided into column strip and middle strip. The flat slab is thickened closed to supporting columns to provide adequate strength in shear and to reduce the amount of negative reinforcement in

In 1914 Eddy and Turner were first wrote on flat slabs, The flat slabs directly rests on columns and walls over other forms of construction and advantages are better lightning, lower cost, greater neatness of appearance, rapidity of construction and increased safety is universally conceded as to render any reliable information relative to the scientific computation of stresses in flat slab construction of great interest.

The research has been carried out to find the behaviour of slab column connection. The failure mode depends upon the type and extent of loading. Punching shear strength of slab column connection is of importance which depends on the gravity shear ratio. The mechanism of transfer of moments from slab to column is very complex when subjected to lateral loading and unbalanced moments. These unbalanced moments produce additional shear and torsion at the connections and then get transferred into the column which results in excessive

cracking of slab leading to further reduction in the stiffness of the slab.

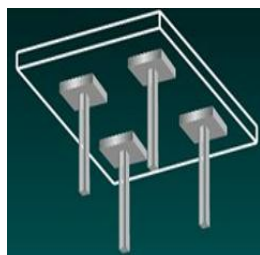
1.1 Types of Flat slab

The following are the different types of flat slab as shown in fig (1.1)

1. Flat plate
2. Flat slab with drop panel
3. Flat slab with column head or column capital
4. Flat slab with drop panel and column head



Flat Plate



Flat Slab with Drop



Flat Slab with Column Head



Flat Slab with Drop Panel and Column Head

Fig.1.1: Types of Flat Slabs

1.2 Uses of Drop panel

1. Stiffen the slab and hence reduce deflection.
2. Increase negative moment capacity of slab.
3. Increases shear strength of slab.

1.3 Uses of column head

1. Reduces the moment in the slab by reducing the effective or clear span
2. Increases shear strength of slab.

1.4 Analysis methods

Equivalent Static Analysis: Seismic analysis of most structures is still carried out on the assumption that the lateral force is equivalent to the actual loading. This

method of finding design lateral forces is also known as the static method or the equivalent lateral force method or the seismic coefficient method.

Response Spectrum Analysis: This method is also known as modal method or mode superposition method. The method is applicable to those structures where modes other than the fundamental one significantly affect the response of the structure. Generally, the method is applicable to analysis of the dynamic response of structures, which are asymmetrical or have areas of discontinuity or irregularity, in their linear range of behaviour.

Time History Analysis: A time history analysis overcomes all the disadvantages of a modal response spectrum analysis. This method requires greater computational efforts for calculating the response at discrete times. One interesting advantage of such a procedure is that the relative signs of response quantities are preserved in the response histories. This is important when interaction effects are considered among stress resultants.

2. METHODOLOGY

The multi storied RC frame buildings are modelled in ETABS nonlinear software. The buildings consist of stories G+4, G+9, G+14 and G+29 are special moment resisting frame considered to be situated in seismic zone V. Both buildings are modelled in Etabs software, are subjected to gravity and dynamic loads are analysed by equivalent static analysis, response spectrum analysis, time history analysis is carried out taking data of Elcentro. Beams and column members have been defined as frame elements and the columns have been restrained in all six degrees of freedom at the base. Conventional Slabs are defined as area elements having the properties of membrane elements and have been modelled as rigid diaphragms, Flat slabs having the properties of shell area element, Also concrete bracings and shear walls are defined as frame elements and shell area elements respectively.

Buildings having grade of concrete for beam, column, slab is M40 with unit weight of concrete being 25kN/m³. Column size for building up to 14th floor is 1.5mx1.5m, 15th floor is 1.2mx1.2m, 16th to 30th floor is 0.8mx0.8m, while the beam size is 0.40mx0.60m. The flat slab thickness without drop is 0.150m, with drop panel is 0.125m Building models having 5,10,15,30 storeys with 8 bays in X and 6 in Y directions, width of bay in X direction is 6 m and in Y direction is 6 m. The Building models having each storey height of 3m.

2.1 DESCRIPTION OF VARIOUS BUILDING MODELS

For the particular study, the plan of the building is kept symmetrical for all models.

Model 1: Building modeled as Conventional slab 150mm.

Model 2: Building has Flat slab with drop 125mm.

Model 3: Building has Flat slab without drop 150mm.

Model 4: Building has Flat slab with shear wall in outrigger patterns in the middle bay in every storey in all four sides.

Model 5: Building has Flat slab with bracings in outrigger patterns in the middle bay in every storey in all four sides.

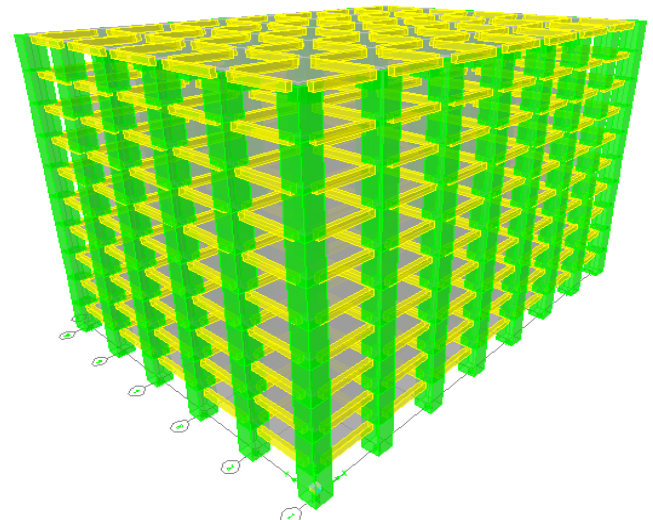


Fig -2: Elevation and 3D view of bare frame buildings

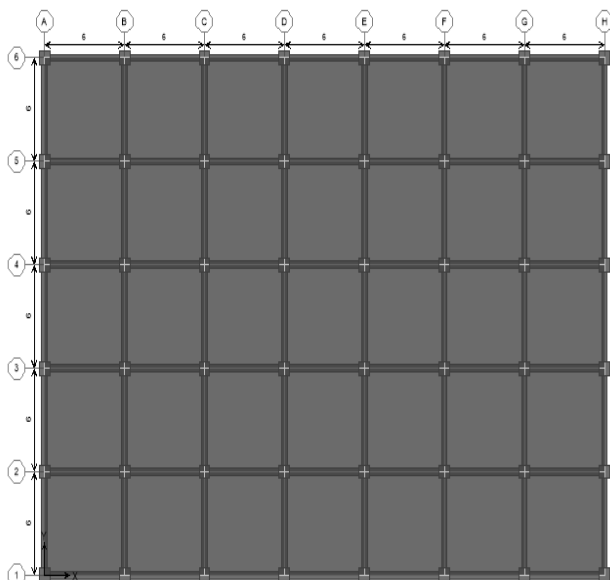
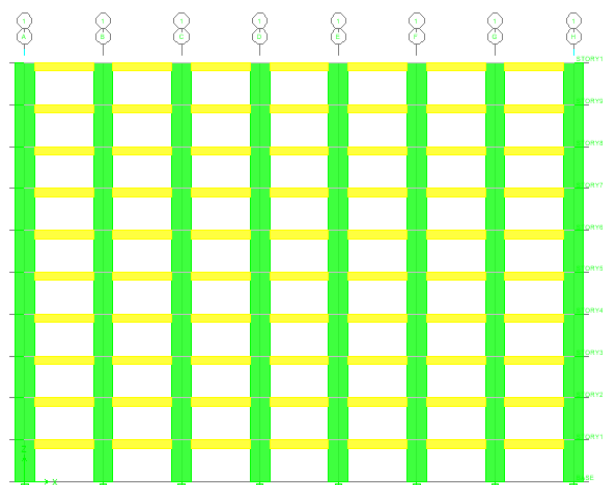


Fig -1: Plan layout



3.RESULTS AND DISCUSSIONS

Most of the earlier studies on different buildings such symmetrical and unsymmetrical have adopted idealized structural systems of flat slabs. Although these systems are sufficient to understand the general behaviour and dynamic characteristics, it would be interesting to know how real building will respond to seismic forces. For this reason a hypothetical building located on a plane ground having similar ground floor plan have been taken as structural system for the study.

3.1 LATERAL DISPLACEMENT

The analysis results have been tabulated and represented in chart. From the chart it can be observed that the lateral displacement is maximum at terrace level for all types of buildings. Lateral displacement is minimum at plinth level and maximum at terrace level thus as the storey level increases lateral displacements also increases.

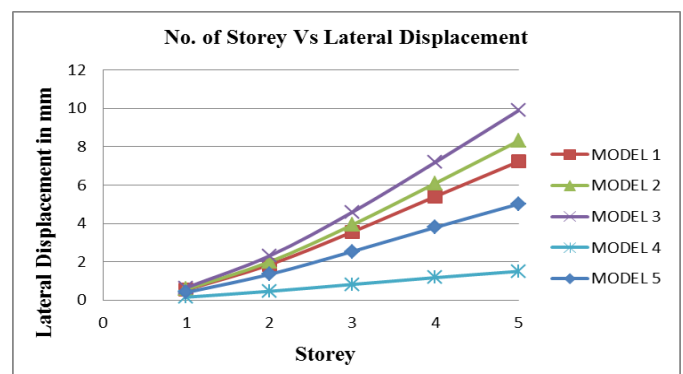


Fig.3.1: Comparison of lateral Displacement along longitudinal direction for different models of five storey building.

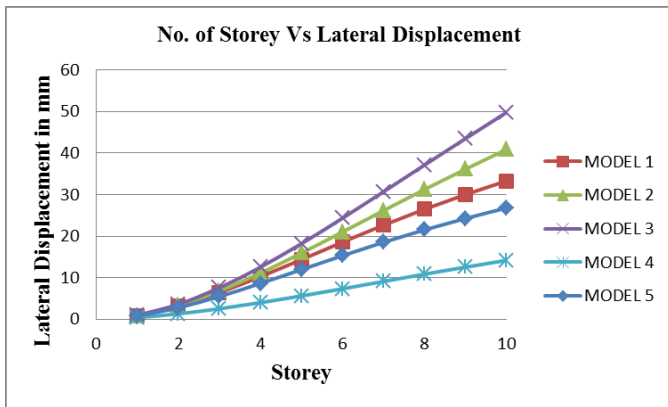


Fig.3.2: Comparison of lateral Displacement along longitudinal direction for different models of ten Storey building.

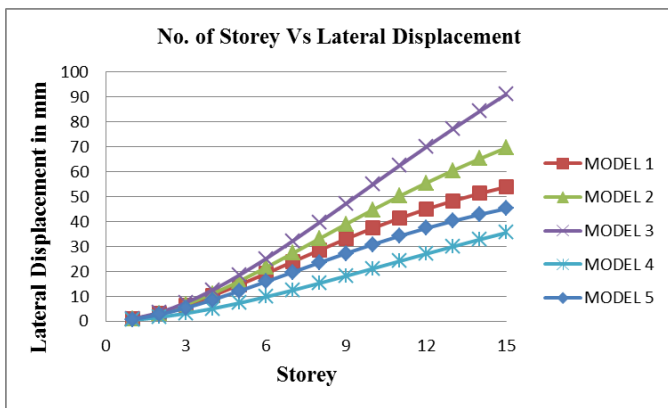


Fig.3.3: Comparison of lateral Displacement along longitudinal direction for different models of fifteen storey building.

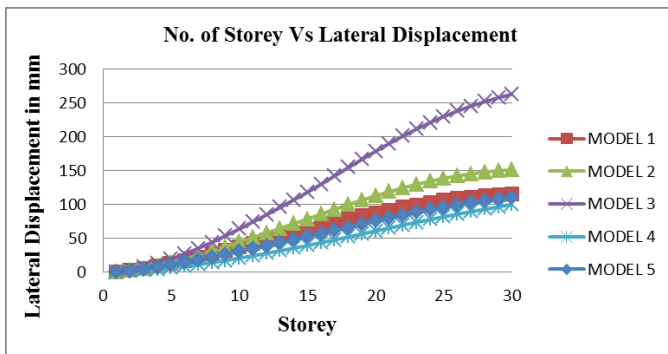


Fig.3.4: Comparison of lateral Displacement along longitudinal direction for different models of thirty storey building.

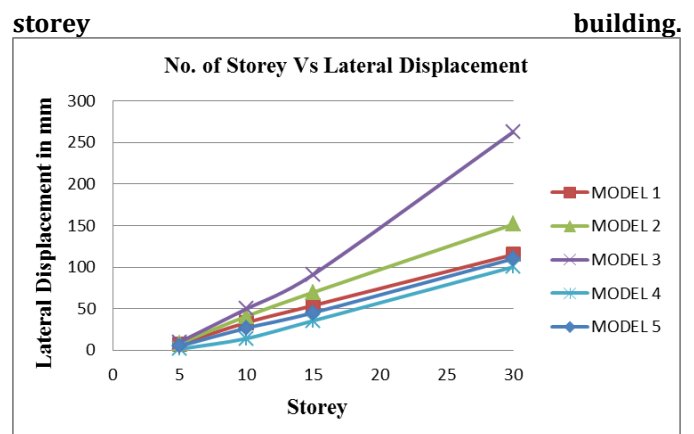


Fig.3.5: Comparison of lateral Displacement along longitudinal direction for different models of five, ten, fifteen and thirty storey building.

3.2 STOREY DRIFT

The results have been tabulated and represented in chart. From the chart it can be observed that the storey drift is minimum at plinth level, increases at middle stories and decrease's at terrace level for all types of buildings.

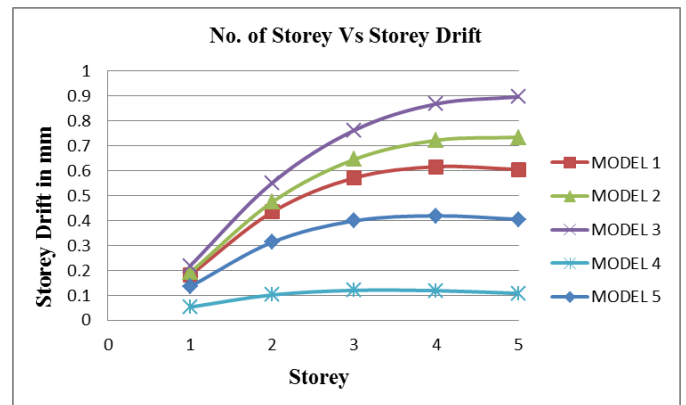


Fig.3.5: Comparison of Storey Drift along longitudinal direction for different models of five storey building.

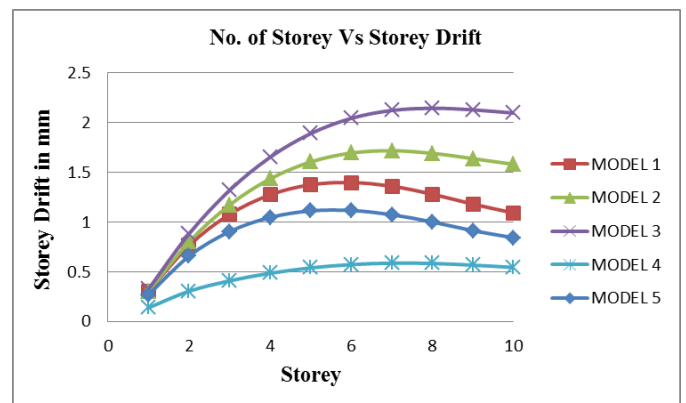


Fig.3.6: Comparison of Storey Drift along longitudinal direction for different models of ten storey building.

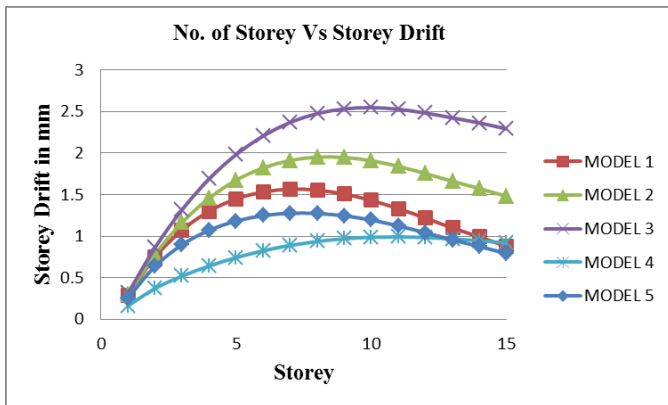


Fig.3.7: Comparison of Storey Drift along longitudinal direction for different models of fifteen storey building.

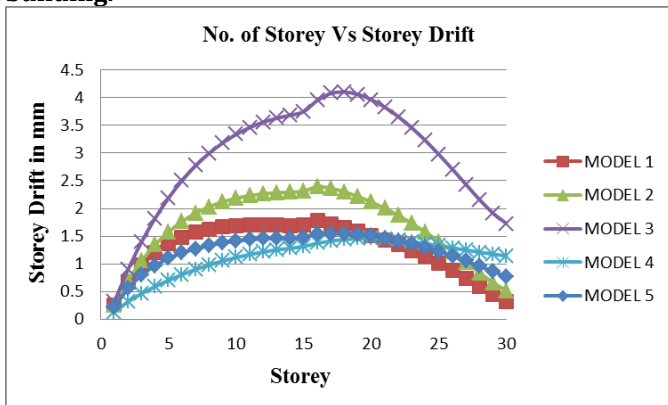


Fig.3.8: Comparison of Storey Drift along longitudinal direction for different models of thirty storey building.

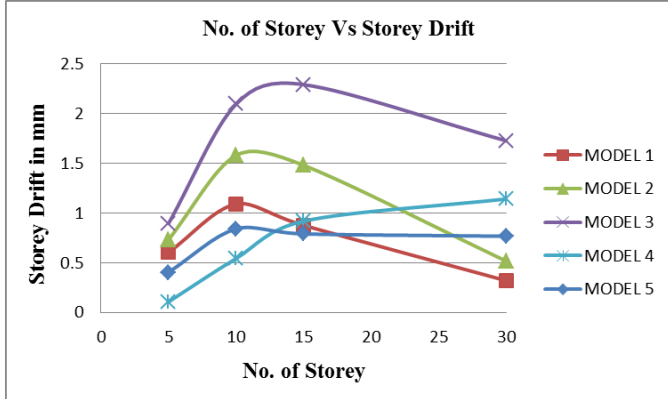


Fig.3.9: Comparison of Storey Drift along longitudinal direction for different models of five, ten, fifteen and thirty storey building.

3.3 STOREY SHEAR

The results are tabulated and represented in chart. From the chart it can be observed that the storey shear is maximum at plinth level and minimum at terrace level for all types of buildings. After the plinth level the storey shear decreases as the storey level increases. As the total

number of stories increases storey shear at plinth level increases.

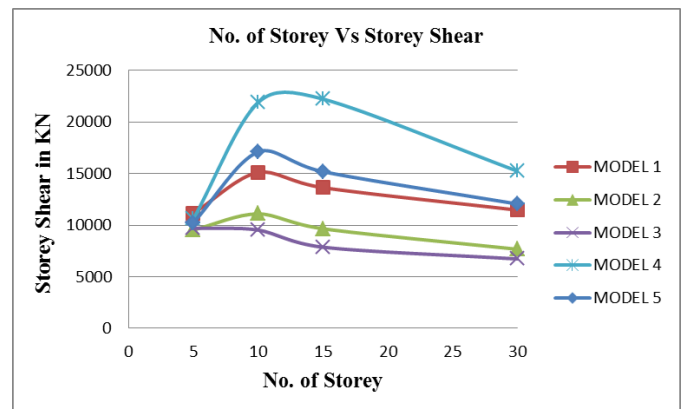


Fig.3.10: Comparison of Storey Shear along longitudinal direction for different models of five, ten, fifteen and thirty storey building.

3.4 NATURAL TIME PERIOD

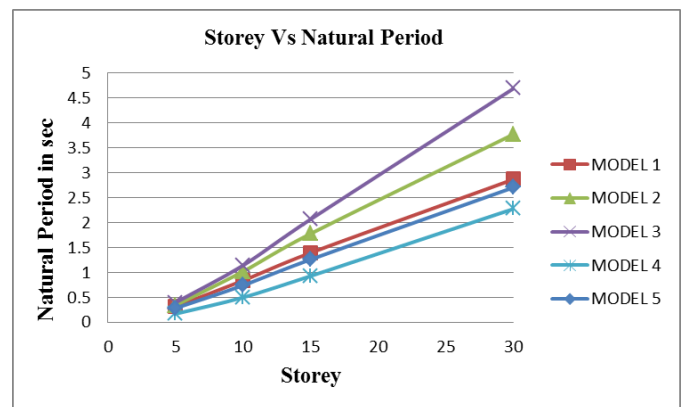


Fig.3.11: Comparison of Natural Time Period along longitudinal direction for different models of five, ten, fifteen and thirty storey building.

3.5 SEISMIC BASE SHEAR

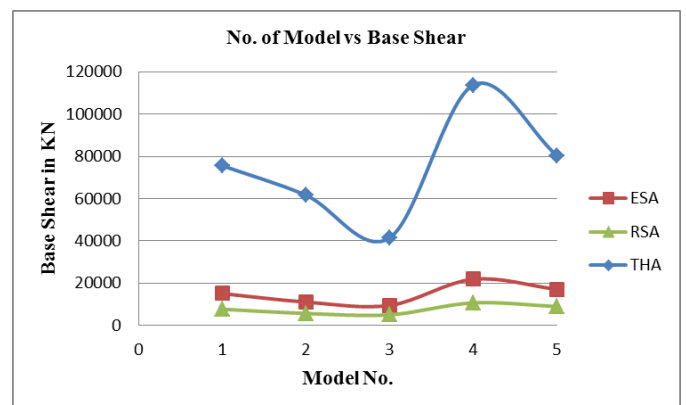


Fig.3.12: Model Vs Seismic Base Shear for different models along longitudinal direction.

Comparison of base shear is made between ESA, RSA and THA. From fig it is clearly shows that the Base shear obtained from THA gives considerably greater base shear values than ESA and RSA. By considering THA will leads to uneconomical design of structural members and over estimation of structural capacity of members

4. CONCLUSIONS

Lateral displacement is minimum at plinth level and maximum at terrace level, as the number of stories increases lateral displacement also increases. Storey drift is minimum at plinth, top stories and maximum at middle stories, thus extra stiffness of column requires at middle stories compared to other stories. The Natural period increases as number of Stories increases. The Base shear value is maximum at plinth level and minimum at terrace level, as total number of stories increases base shear increases.

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