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"Seismic analysis of R.C column with flat slab system for vertically irregular G+15 story building with and without bracing using response spectrum analysis by E-tabs"

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Abstract: Flat slab buildings have largely replaced traditional RC Frame structures in recent years because to its numerous advantages over the former, including lower costs, better utilization of space, simpler formwork, more design freedom, and quicker build periods. Flat slab construction's lacklustre performance under seismic stress is a major hindrance to how well it can support loads. The conventional RC frame building, the flat slab building with and without bracings, and their respective changes can be observed through seismic analysis. E-TABS is used for the analysis. To improve the performance of buildings with typical RC frame buildings and flat slabs under seismic loading, it is important to take additional steps to guide the development and design of these structures in seismic zones. The purpose of this research was to examine the response of standard RC slab structures, often known as flat slabs, to seismic pressures. The parameters of story drift, lateral displacement, seismic base shear, and story shear are all included in the present investigation.

Keywords**:** Flat Slabs, RC Frame building, story drift, lateral displacement, Response spectrum.

1. INTRODUCTION

India's rapid economic expansion and accompanying population increase need more investment in modern infrastructure. Property in metropolitan areas is in high demand, and the only way to keep up with growing prices is to build more homes. Challenges in mitigating lateral stresses from wind and earthquakes are a result of this sort of development.

Common design and construction technique involves using beams to support slabs and columns to further reinforce the structure. You might also refer to this as "beam slab" building. The net clear ceiling height is reduced due to the depth of the beams. As a result, slabs are often directly supported on columns rather than beams in places like workplaces, community halls, and homes. In this way, the physical form is given form via fabrication. Flat slabs refer to the types of slabs that rest directly on the base of the columns. These slabs are so flat that they don't need any support beams. Panel refers to the section of slab that is bordered on all four sides by the column's central axis. The panel is separated into column stripes and a central stripe. So that it can withstand shear forces and have a manageable level of negative reinforcement, the flat slab is enlarged near the columns that support it.
It was in 1914 when Eddy and Turner made history by becoming the first people to write on flat slabs. Since flat slabs rest directly on columns and walls above, any consistent information related to the accurate computation of stresses in flat slab construction is of enormous interest because of the advantages it provides, such as better lighting, lower costs, greater efficiency in appearance, faster construction, and increased safety. A study was conducted to learn how slab column connection's function. The failure mode is mostly determined by the kind and intensity of the stress. The gravity shear ratio affects the punching shear strength of the slab column connection. Lateral loads and unstable moments create a complex moment transmission mechanism between the slab and the column. Additional shear and torsion are generated at the connections and transferred into the column because of these unstable moments, resulting in superfluous cracking of the slab and a subsequent decrease in its stiffness.

A structure's construction is comprised of several components, the most important of which is the bracing system. A bracing system's primary functions are to maintain the stability of the main girders during construction, to contribute to the distribution of load effects, and to provide restraint to compression flanges or chords in areas where they would otherwise be free to buckle laterally. Bracing systems also play a role in contributing to the distribution of load effects.

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1.1 COMPARATIVE STUDY OF FLAT SLAB AND CONVENTIONAL SLAB

Many recently built buildings take use of the reduced floor-to-floor height made possible by using a construction method called "flat slab," in which the slab is directly supported by columns. Thin beams spaced at regular intervals in perpendicular directions make up the conventional slab system, which is heavy and covered with a slab.

Buildings with either a standard slab or a flat slab have similar seismic performance, although there are some distinctions. Shear strength is reduced in tall structures with a flat slab system, whereas buildings with a standard slab system are robust but shorter and less friendly.

As a result of their widespread use, flat slabs help reduce load, speed up construction, and keep costs down. A conventional slab has improved rigidity, increased load bearing ability, is both secure and cost-effective. Traditional methods of construction include the usage of Reinforced Concrete (RC) slab structures. When compared to traditional RC frame construction, the benefits of using a flat slab include more architectural freedom, better space use, less complicated formwork, and a quicker overall build time. When compared to traditional slab building, the bulk of a flat slab structure is lower.

1.2 ANALYSIS METHOD

Response Spectrum Analysis: - This approach is also known as modal method or mode superposition method. The approach may be used to constructions where the response is significantly affected by modes other than the basic one. This technique is often used to analyse the nonlinear behaviour of structures that are asymmetrical or have regions of discontinuity or irregularity.

Dynamic Analysis: - Except for buildings shorter than 15 metres in zone ii, all structures in that area must be subjected to a dynamic review. The code was used to determine factors like zone multiplicity and soil composition. A response spectrum was created when the same data was entered into Etabs. We now know where the horde came from. All you need to do is install the diaphragms! There was a special effort put towards creating the arduous seismic load cases. Base shears from the static earthquake were matched with those from the Response continuum to ensure accuracy.

2. METHODOLOGY

In this current thesis work G+15 story building is modelled in Etabs with the different plan irregularities as a conventional building (ordinary moment resistance) and as a flat slab building and the results are compared with conventional building to study how irregularity buildings with flat slab behave when compared to conventional moment resisting frames. In total six FM models made in Etabs and parameters such as

Base share

Story drift

Story displacement

Time period are studied

SECTION PROPERTIES: -

COLUMN = 900MM X 900MM

BEAM = 600MM X 750MM

SLAB = 250MM

DROP SLAB = 500MM

BRACING = COLUMN 750MMX750MM

A. THRE ARE EIGHT MODLES ARE MADE IN E-TABS AND COMPARE THE RESULT

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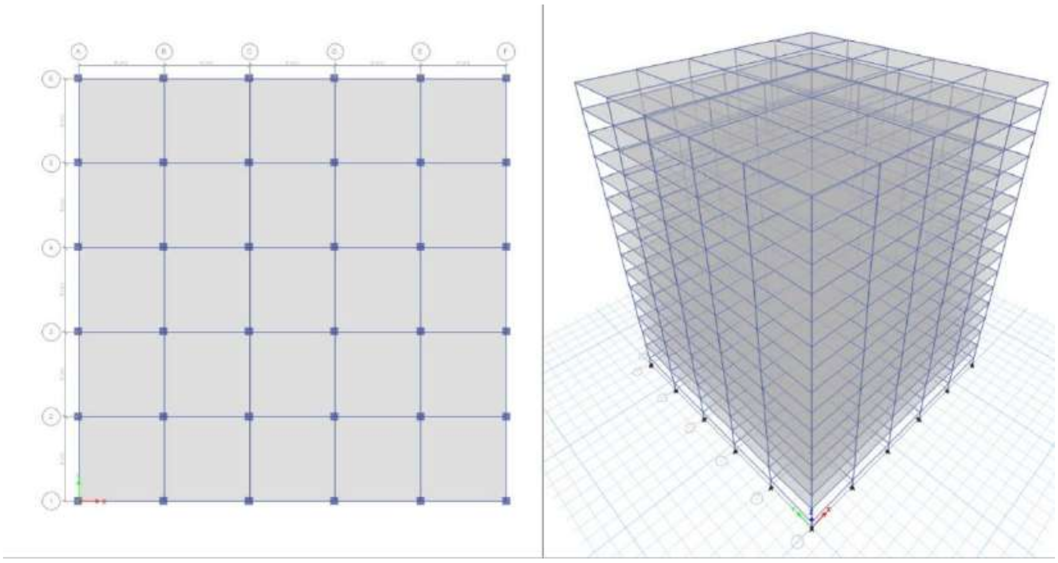

Fig 2.0 conventional slab square building without bracing

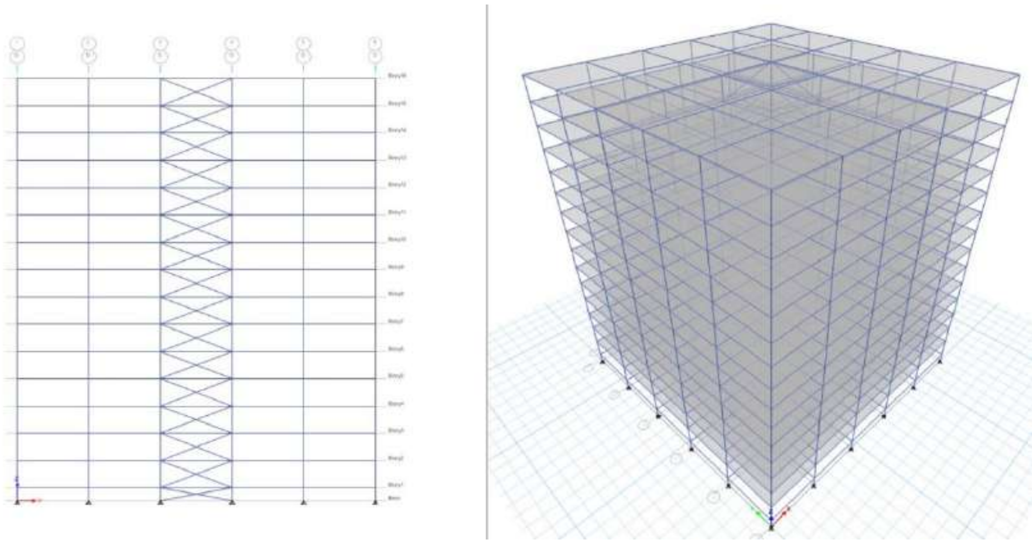

Fig 2.1 conventional slab square building with bracing at centre

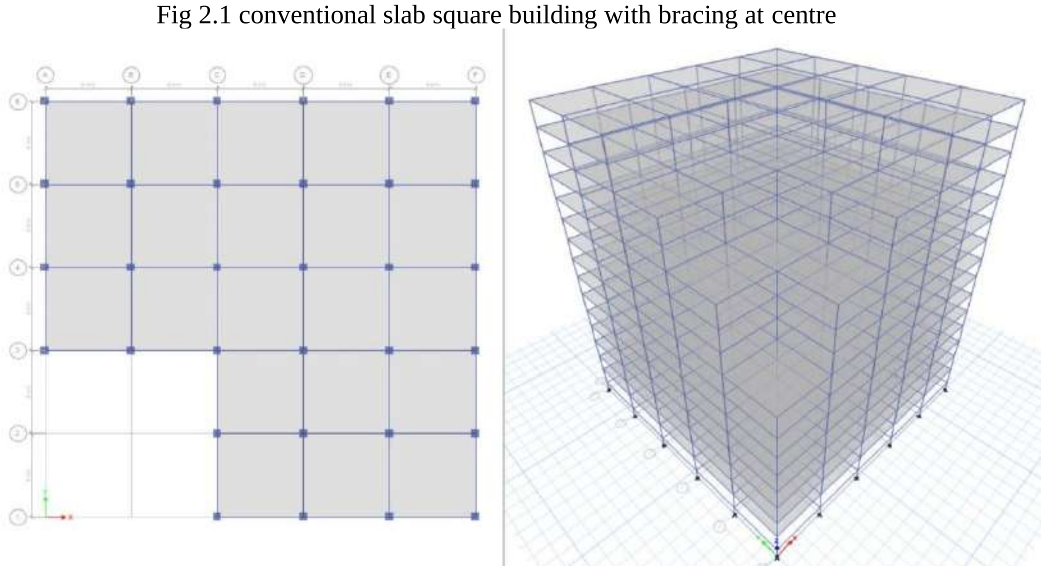

Fig 2.2 conventional slab building vertical irregularity without bracing

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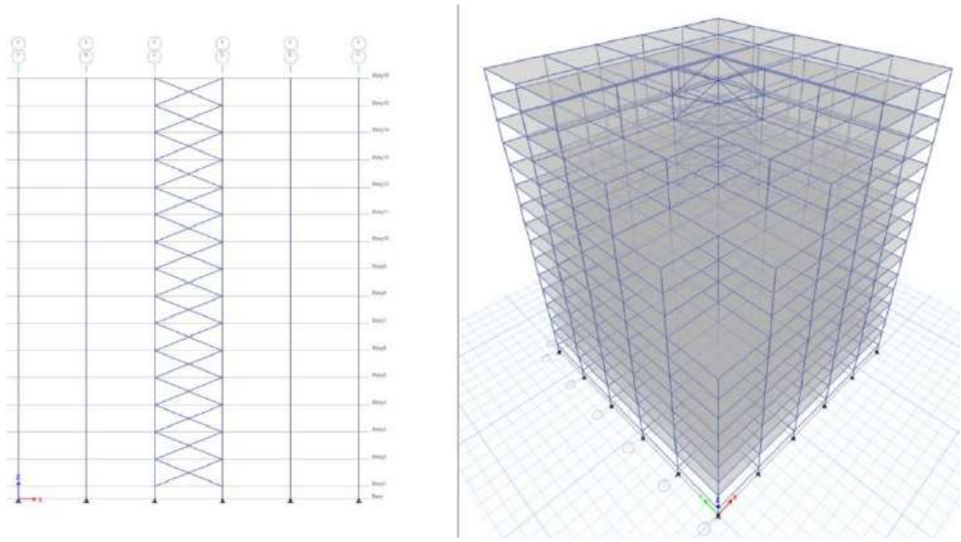

Fig 2.3 conventional slab building vertical irregularity with bracing at centre

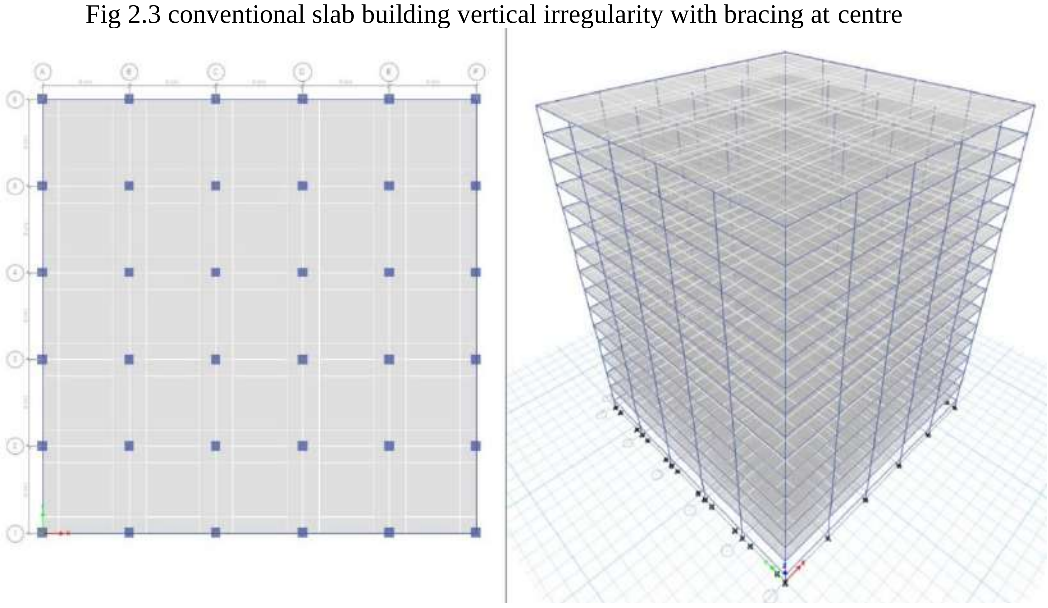

Fig 2.4 flat slab square building without bracing

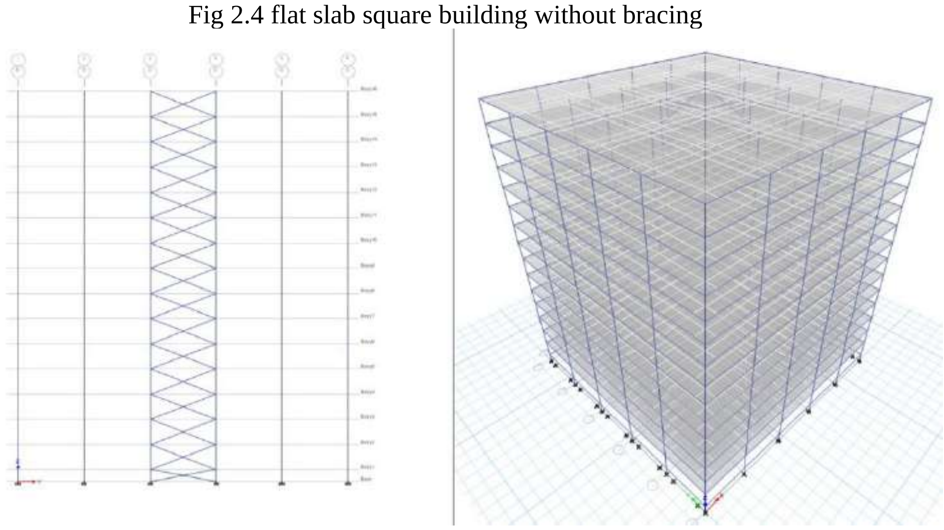

Fig 2.5 flat slab square building with bracing at centre

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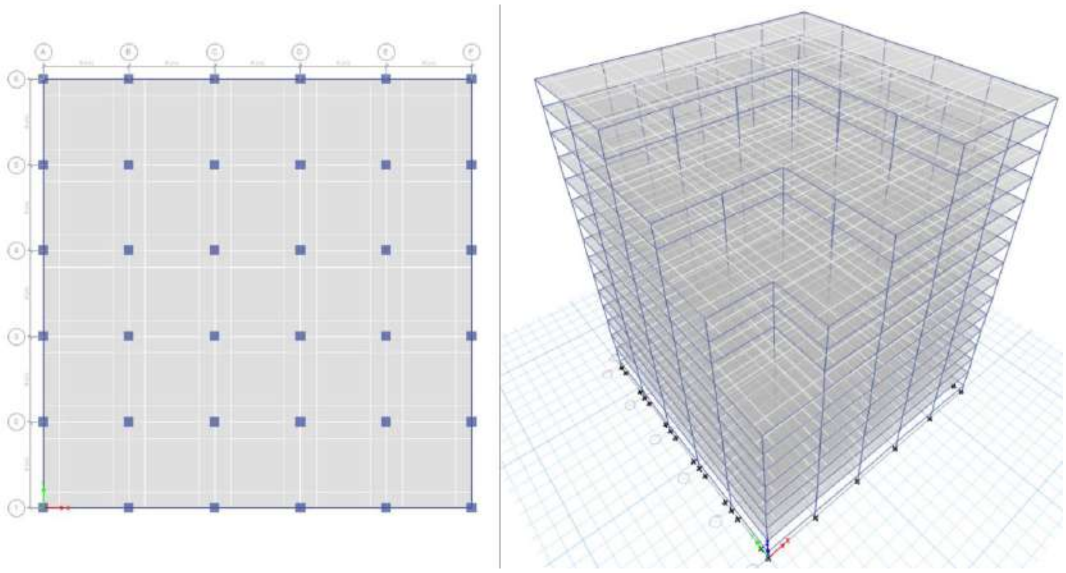

Fig 2.6 flat slab vertical irregular building without bracing

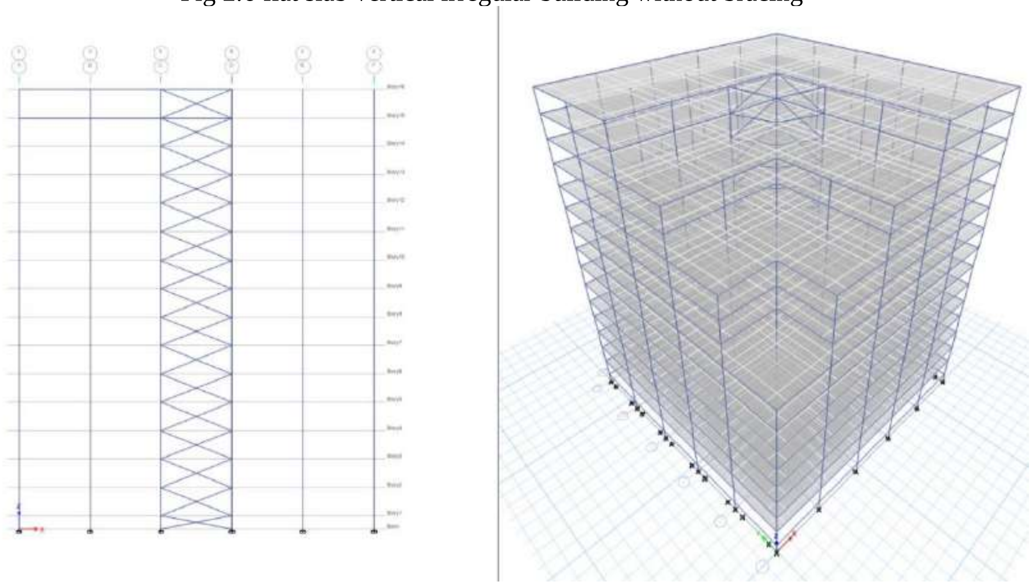

Fig 2.7 flat slab vertical irregular building with bracing at centre

B. Design loads

The loads which have been used for the modelling are as follows:

- Self-weight of the structure
- Floor finish
- Wall load
- Typical live load
- Roof live load
- Seismic load

1. Dead load as per IS: 875 (Part I)-1987

i) Self weight of slab (150 mm thick) - 3.75 kN/m2

ii) Loading due to Floor Finishes - 1.50 kN/m2

2. From masonry walls – 5.72kN/m 3.

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3. Live load as per IS: 875 (Part-II)-1987

i) Live load on floor – 3.00 kN/m2

ii) Live load on roof - 1.50 kN/m2

4. Earthquake load. IS: 1893-2016

i) Zone factor - 0.1

ii) Zone factor - 0.16

iii) Zone factor - 0.24

ii) Soil type - II

iii) Importance factor - 1

iv) Time period in X direction – 0.85

Time period in Y direction –0.85

The structure was analyzed for dead load, live load, seismic load, and their combinations. The structural adequacies of existing members were checked as per the guidelines in IS: 456-2000 and SP-16.

3. RESULT AND DISCUSSION

This chapter presents results of seismic analysis of all the models considered as per the model analysis. The results and discussions given are considered in detail with reference to required tables and figures.

3.1 DISPLACEMENT

For the most part, conventional structural models of flat slabs have been used in previous research on dissimilar structures like symmetrical and unsymmetrical ones. While these models are adequate for identifying the overall behaviour and dynamic character, it would be wonderful to understand how the actual structure would behave to seismic pressures. Because of this, the structural system for the study is a made-up building with a similar ground floor design that is situated on a flat surface.

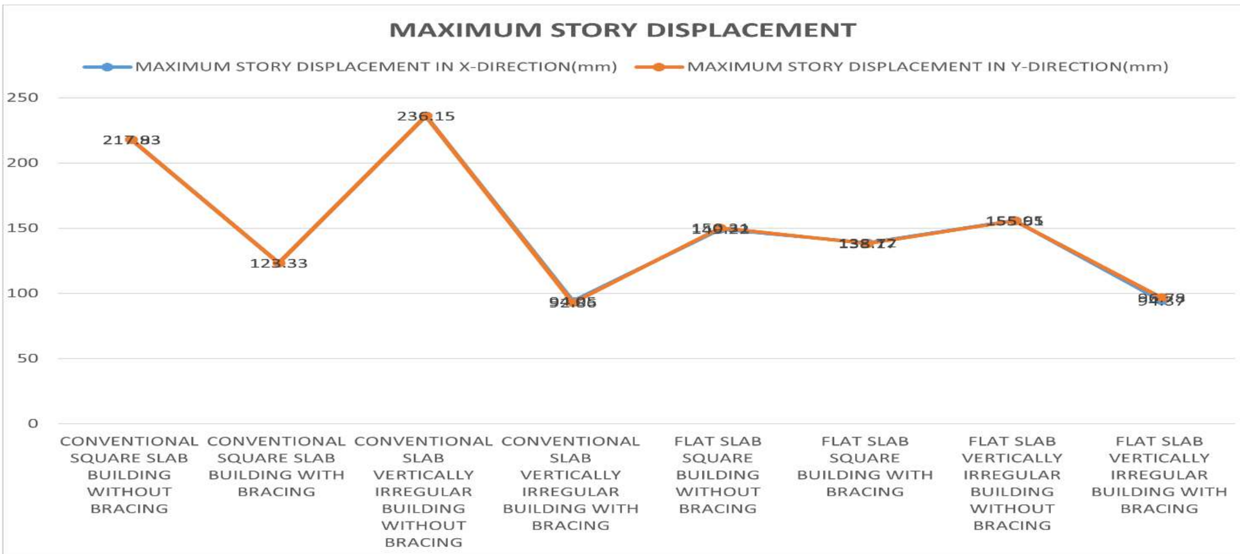

Fig 3.1 maximum story displacement

3.2 STORY DRIFT

The tabulated and represented results may be seen in FIG 3.2, which shows that the storey drift is lowest at the basement level, rises through the middle storeys, and finally decreases through the rooftop.

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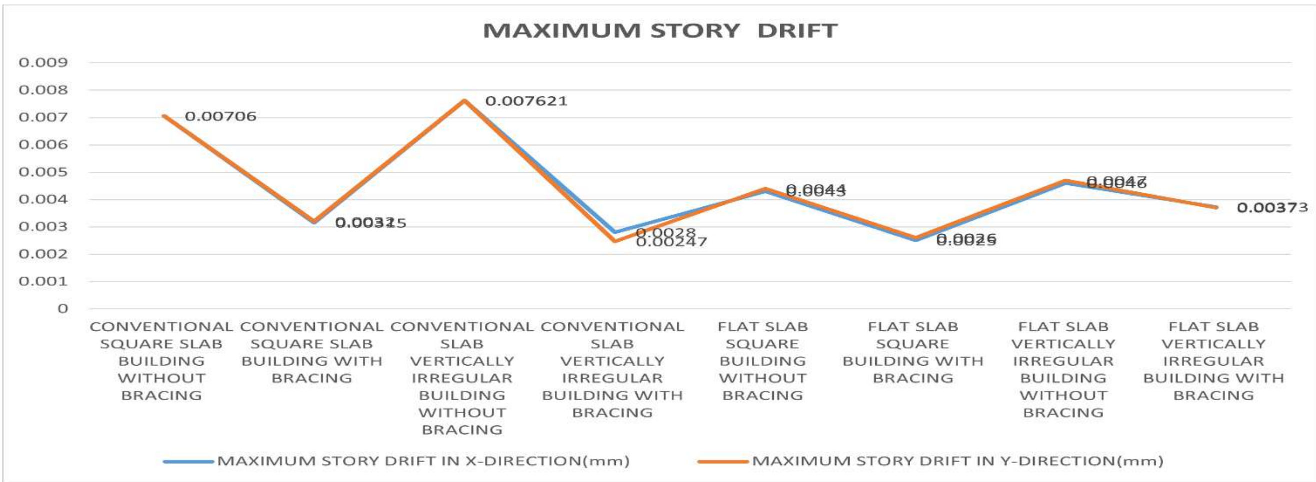

Fig 3.1 maximum story drift

3.3 BASE SHEAR

TABLE 3.3 MAXIMUM BASE SHEAR

SL NO	MODEL TYPE	MAXIMUM BASE SHEAR IN DIRECTION(KN)	MAXIMUM BASE SHEAR IN Y-DIRECTION(KN)
1	CONVENTIONAL SQUARE SLAB BUILDING WITHOUT BRACING	21436.83	21438.83
2	CONVENTIONAL SQUARE SLAB BUILDING WITH BRACING	28506.46	22996.64
3	CONVENTIONAL SLAB VERTICALLY IRREGULAR BUILDING WITHOUT BRACING	21093.27	21093.27
4	CONVENTIONAL SLAB VERTICALLY IRREGULAR BUILDING WITH BRACING	21372.92	21297.12
5	FLAT SLAB SQUARE BUILDING WITHOUT BRACING	28569.26	28567
6	FLAT SLAB SQUARE BUILDING WITH BRACING	30003.88	29869.82
7	FLAT SLAB VERTICALLY IRREGULAR BUILDING WITHOUT BRACING	27836.88	27858.08
8	FLAT SLAB VERTICALLY IRREGULAR BUILDING WITH BRACING	29346.13	29553.56

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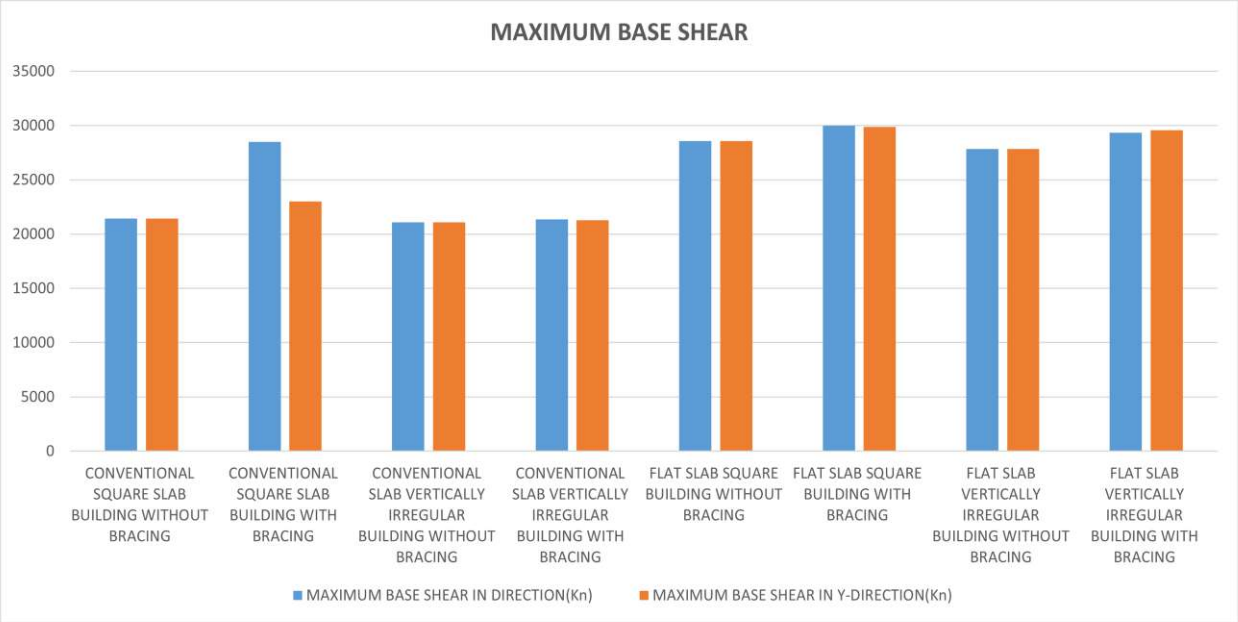

Fig. 3.3 Maximum Base Shear

3.4 Maximum Time Period

TABLE 3.4 MAXIMUM TIME PERIOD

SL NO	MODEL TYPE	MAXIMUM TIME PERIOD
1	CONVENTIONAL SQUARE SLAB BUILDING WITHOUT BRACING	2.478
2	CONVENTIONAL SQUARE SLAB BUILDING WITH BRACING	2.208
3	CONVENTIONAL SLAB VERTICALLY IRREGULAR BUILDING WITHOUT BRACING	2.355
4	CONVENTIONAL SLAB VERTICALLY IRREGULAR BUILDING WITH BRACING	1.976
5	FLAT SLAB SQUARE BUILDING WITHOUT BRACING	2.011
6	FLAT SLAB SQUARE BUILDING WITH BRACING	1.765
7	FLAT SLAB VERTICALLY IRREGULAR BUILDING WITHOUT BRACING	1.898
8	FLAT SLAB VERTICALLY IRREGULAR BUILDING WITH BRACING	1.417

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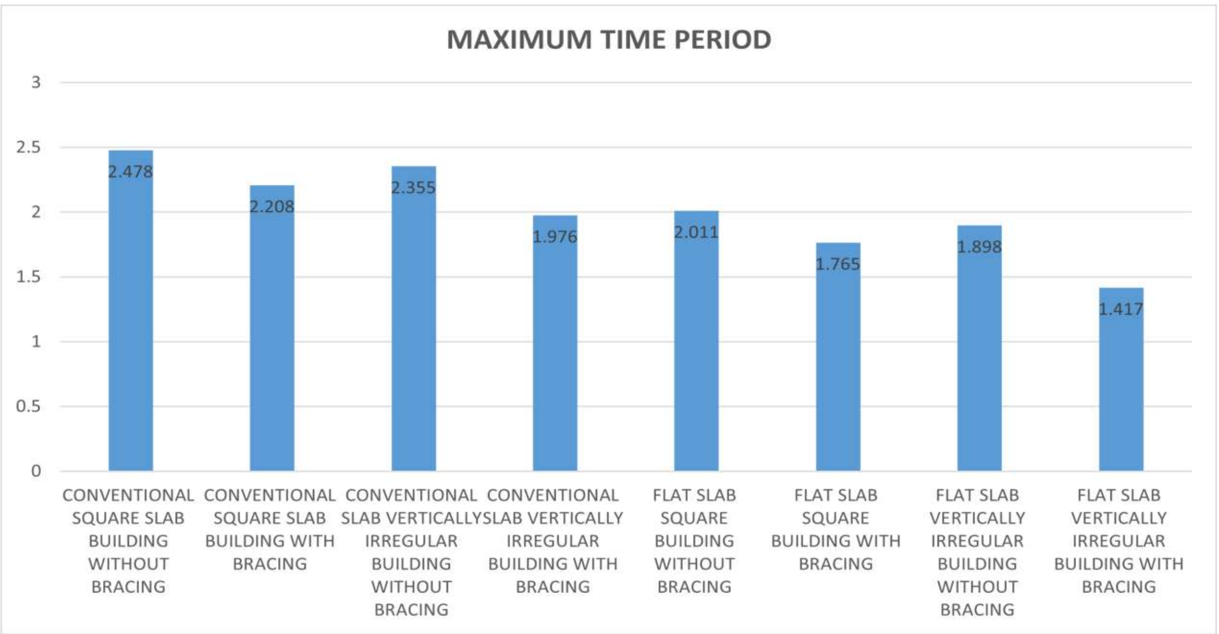

Fig. 3.4 Maximum time period

4. CONCLUSION

1. The Lateral displacement is maximum at top level for all types of models. Lateral displacement is minimum at the base level and maximum at the top level thus as storey level increases lateral displacement also increases. It is because sway is directly proportional to height and slenderness of structure i.e., lateral displacement increases as height of building increases.

2. The Lateral displacement of flat slab building is more than conventional slab building. It is because of the presence of beam in conventional slab which has more stiffness compared to flat slab. Conventional slab also has higher load carrying capacity.

3. The Storey drift is minimum at base level, increases up to middle stories and decreases up to top level for all types of models. It is because storey drift of particular floor is inversely proportional to height of the floor.

4. The Storey drift with flat slab construction is significantly more as compared to the conventional slab building. It is because Storey drift is defined as the ratio of lateral displacement of two consecutive floor to height of that floor and also since stiffness of conventional slab being more than flat slab.

5. from time period analysis obtained results the vertically irregular with flat slab building lesser than all types of the models.

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