

Performance Evaluation of Multi-Storey Symmetric and Asymmetric Flat and Conventional Slab Structures by Time History Analysis

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ABSTRACT: The rapid growth of urban population needs to construct dig prestigious buildings for companies and industrial purpose. The construction of multi-storey buildings and large span structures is becoming a necessary part of our living style. Construction of large span structure using flat slab system is simple to construct and also provides maximum clear height. Analysis of large industrial structures constructed using 10m and 7m panels of flat slab for square shape and rectangular shape layout is carried out with the help of ETABS software in reference with the IS 456-2000 code. In this study we have designed symmetric conventional slab building, asymmetric conventional slab building, symmetric flat slab building and asymmetric flat slab building. For all these structures the shape is designed in C shape, L shape building for G+10 stories. The performance of flat slab and conventional slab were studied and analyzed for seismic zone III consideration. It is necessary to analyzed seismic behavior of building to estimate the changes occurred when the height of conventional R.C frame building and flat slab building changes. The objectives of the present work are to compare the behavior of multi-storey building having flat slabs with drop and conventional R.C frame. The obtained results are compared in terms of time period, maximum shear, maximum displacement, storey drift and storey stiffness.

KEYWORDS: Flat slab, Time history analysis, Storey displacement, Storey drift, Storey shear and storey stiffness.

I. INTRODUCTION

The reality that suitable for building / constructing sites are limited and expensive, especially in areas where people live mostly, indicates the need for a good inspection of these areas. Progressively prices leads to higher construction costs so that the performance of both estimation and costs are significant and necessary. In the construction of a building, the properties of the objects that carry the acquisition system are determined by the use of engineering skills and experience accumulated over time. Throughout the design of the house, the pre-sized details provided are usually not adjusted to the maximum size available for every second or - as the size of the carrier company's equipment is taken from third-party solutions. In addition, the network operator's system can be limited to unlimited possibilities in a way that ensures all necessary conditions, and the cost of a separate carrier system will vary from one to another. The primary goal of engineering is to find a low-cost design and to ensure predictable limitations.

The flat building slab system is one of the terminating beams used in traditional construction methods. The slab sits directly on the column, and the load from the slab is transferred directly to the column and then to the base. The thickness of the slab around the support of the column increases to withstand a heavy load are called drops, Columns are usually supplied with extended heads called column heads or capitals. The reduction of the beam provides a simpler roof, a better structural appearance and thus a lower risk of fire when the beam is used under normal circumstances. Basic Definition of Flat Slab is columns, slabs, and beams are commonly used in standard frame construction. However, the building is constructed without beams, structure of frame consists slabs, columns. Such slabs are called flat slabs because their action is similar to flat plate 2 bending. A straight concrete column that directly supports reinforced concrete slab with no supports.

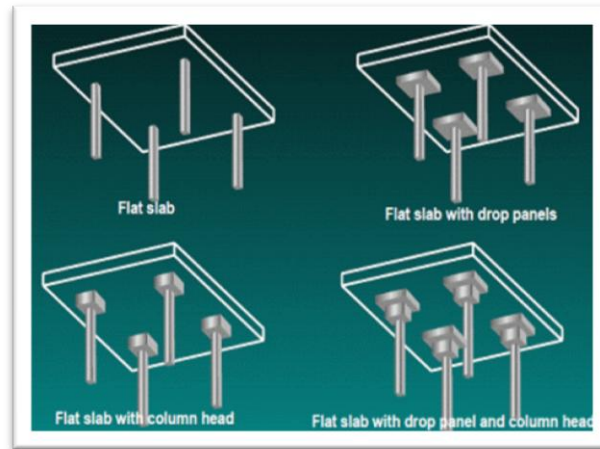


Fig.1. Types of Flat Slab

II. RELATED WORK

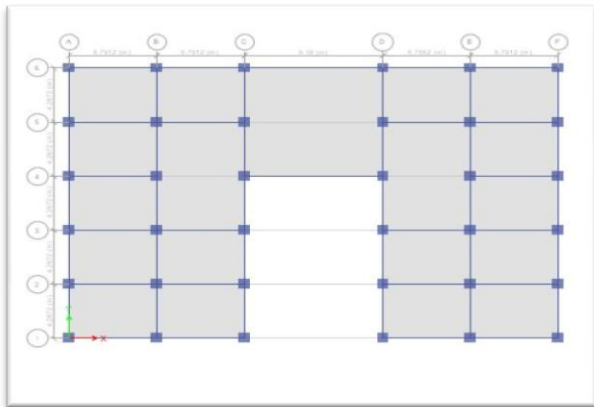
The concept of flat slab is studied by Mohd Rizwan Bhina, Arnab Banerjee, D.K. Paul et.al. (07October2014) [1], "Estimation of varies characteristics of R.C. flat slab building over normal R.C. frame building". This journal paper helps us to perform static analysis on three storey building with flat or traditional slab by using IS 456-2000 and euro code. We conclude that Indian code suggest more reinforcement and stiffness as compared to euro code. Performance of seismic is far better for traditional structure when compared to flat slab building. Overall performance statics of flat slab building is less when compared to conventional building. Displacement and base shear are normally high for flat slab building compared to traditional building. K.N. Mate and P.S. Patil et.al., (June 2015)8 [2], "Analyzing of flat slab". This journal paper combines analysis and flat slab design according to Indian Code of Practice IS456:2000. Flat slab system is RCC's basic structure that gives long clear space, good height, simple shaping and no delay in construction. It's observed that the flat slab is more practical and versatile relative to other slabs. This paper manages us to select drop panel width, slab thickness and reinforcement detailing. B. Anjaneyulu, K Jaya Prakash Volume 4, issue 2 et.al., (02 feb2016) [3], "Design and study of flat slab". This journal paper provides more structural stability to the building and gives the aesthetic view to the building. For designing purpose of flat slab, we can use post tensioning as well as conventional reinforced concrete. The designing cost of post tensioning is more when compare to reinforced concrete. Designing of reinforced concrete has many defects needs to be directed and updated in the future.

III. METHODOLOGY

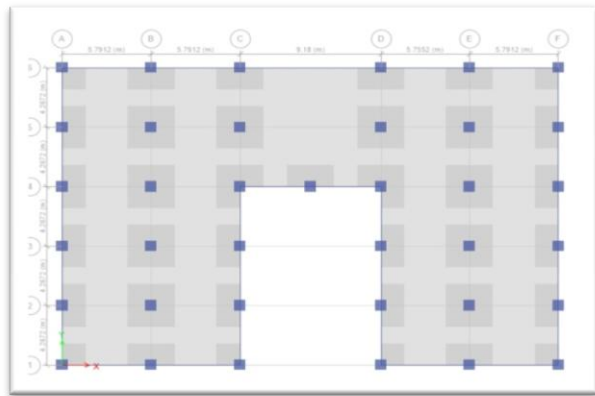
Analyzes were performed using the framework of dynamic analysis in ETABS2017. ETABS2017 model calculates floor shear, acceleration value and displacement. Preliminary data of conventional building is type of structure is commercial, G+10, floor to floor height is 3 m, column size is 750x750 mm, beam size 650x550 mm, slab thickness is 200 mm, thickness of wall is 230 mm, grade of concrete is M45, grade of steel is Fe550, self-weight of reinforced concrete is 25 kN/m³, Self-weight of bricks is 18 kN/m³, self-weight of masonry wall is 18.75 kN/m³, self-weight of ceiling plaster (12 mm) is 0.25 kN/m³, self-weight of cement plaster is 20.40 kN/m³, masonry wall load is 11.47 kN/m, live load on all floors is 3 kN/m², live load on roof is 1.5 kN/m², floor finish on floors is 1 kN/m², floor finish on roof is 0.4 kN/m², mass source is 25% of live load, damping ratio 0.05, soil type II (MEDIUM), seismic zone factor III (Z) = 0.16, Importance factor is 1.5, response reduction factor is 3 (OMRF), data of flat slab building column size is 750x750 mm, peripheral beam size is 650x550 mm, slab thickness is 200 mm, thickness of drop is 250 mm, area of drop is 3.1 x 3.1 m.

Table 1: Abbreviation of Models

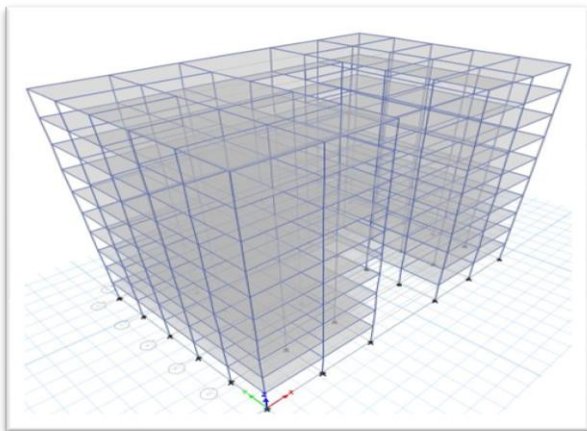
SI No.	Model No.	Description
1	M1	Symmetric Conventional Structure
2	M2	Symmetric Flat Slab Structure
3	M3	Asymmetric Conventional Building
4	M4	Asymmetric Flat Slab Building



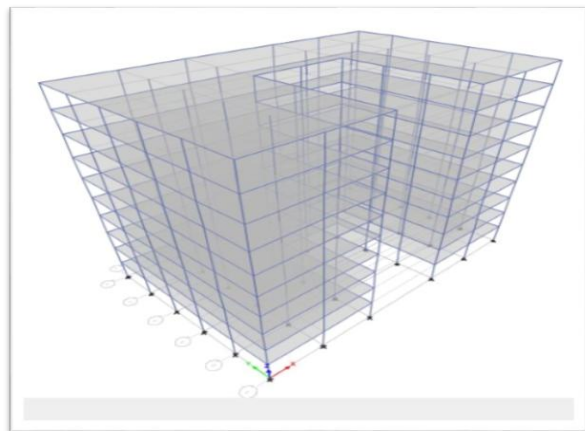
2(a)



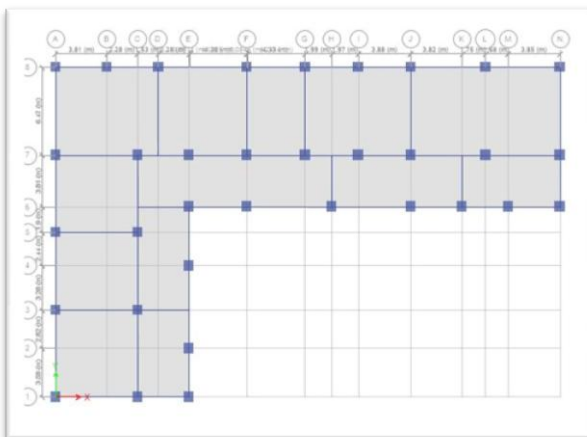
3(a)



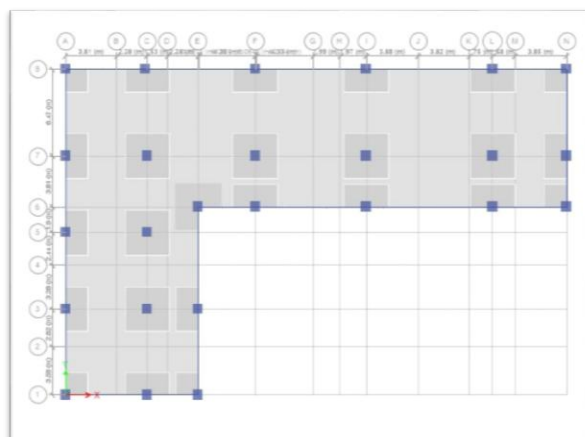
2(b)



3(b)



4(a)



5(a)

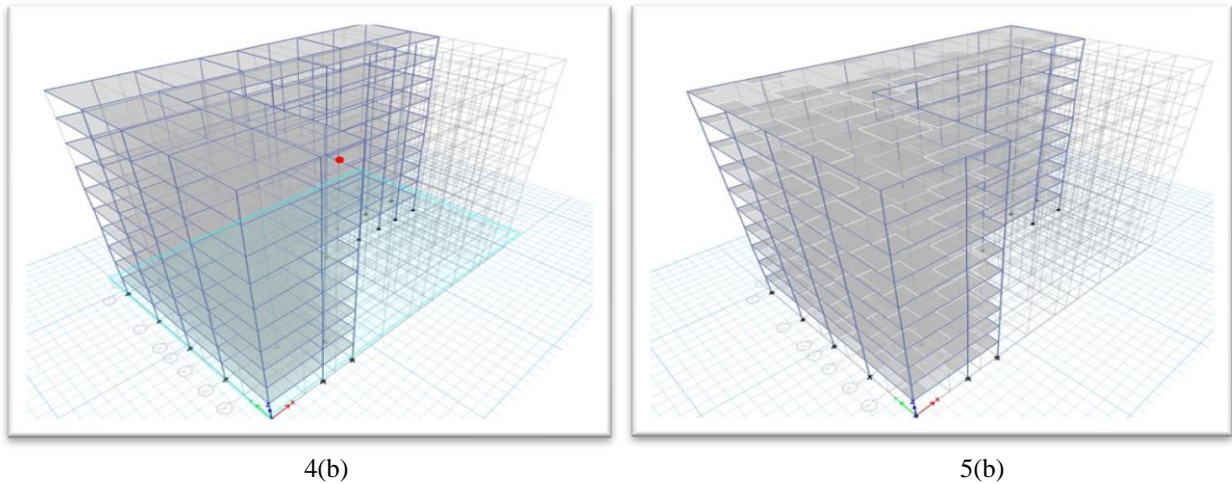


Fig.2. Symmetric Conventional Structure, (a)Floor plan, (b)3d view.
 Fig.3. Symmetric Flat Slab Structure, (a)Floor plan, (b)3d view.
 Fig.4. Asymmetric Conventional Building, (a)Floor plan, (b)3d view.
 Fig.5. Asymmetric Flat Slab Building, (a)Floor plan, (b)3d view.

IV. EXPERIMENTAL RESULTS

Maximum storey displacement

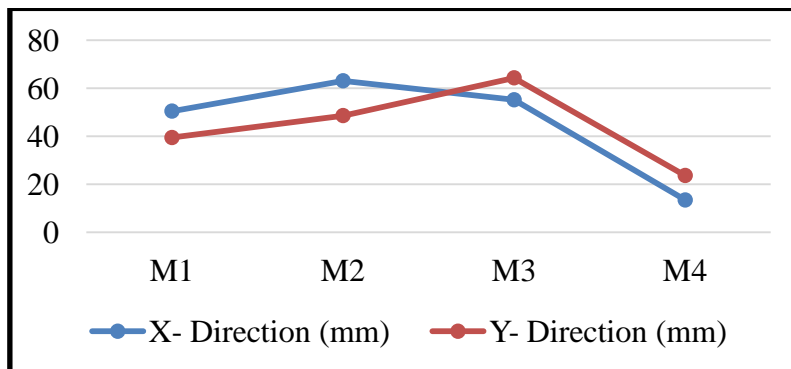


Fig.6. Graph of maximum storey displacement of M1 M2 M3 M4.

Maximum storey drift

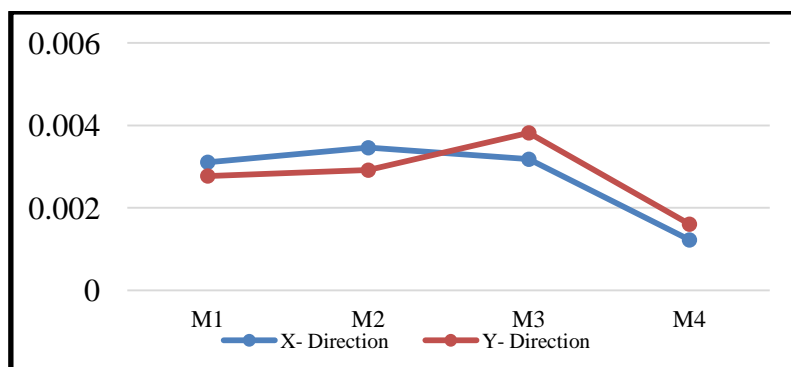


Fig.7. Graph of maximum storey drift of M1 M2 M3 M4.

Maximum storey shear

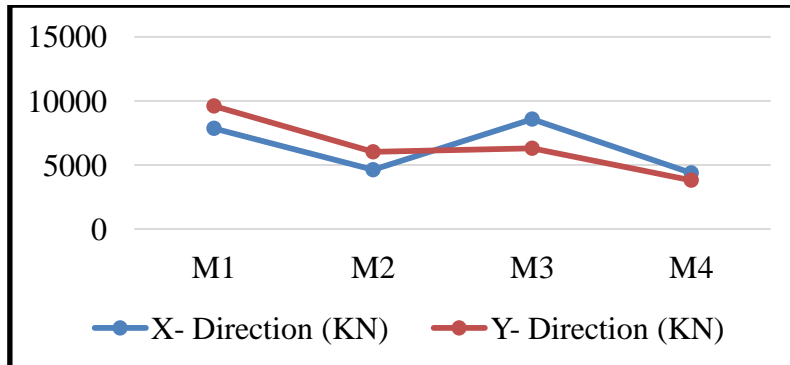


Fig.8. Graph of maximum storey shear of M1 M2 M3 M4.

Maximum storey stiffness

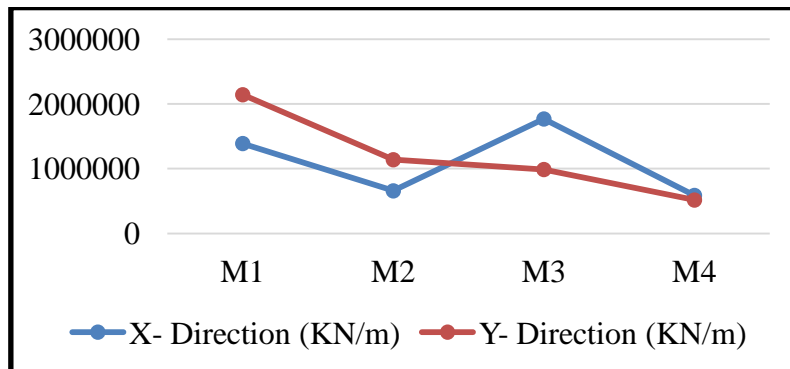


Fig.9. Graph of maximum storey stiffness of M1 M2 M3 M4.

V. CONCLUSION

- [1] Considering the displacement, model M4 is having a minimum displacement compared to all other models. Models M1, M2 and M3 has an increase in displacement values up to 40.12 %, 51.38 %, 63.26 % respectively compared to model M4. However, for conclusion model M4 performs better compared to all other models.
- [2] Considering the drift analysis, model M4 is having a minimum drift ratio compared to all other models. Models M1, M2 and M3 has an increase in drift ratio values up to 42.12 %, 44.92 %, 57.95 % respectively compared to model M4. However, for conclusion model M4 performs better compared to all other models.
- [3] Considering the shear analysis, model M1 is having a maximum shear compared to all other models. Models M2, M3 and M4 has an decrease in shear forces up to 37.28 %, 34.37 %, 60.29 % respectively compared to model M1.
- [4] Considering the stiffness analysis, model M1 is having a maximum stiffness compared to all other models. Models M2, M3 and M4 has a decrease in the stiffness values up to 46.84 %, 53.89 %, 75.91 % respectively compared to model M1.
- [5] From the above results so obtained from displacement and drift it is clear that model M4 performs better than all other models.
- [6] Finally, model M4 proves to be more resistant to earthquake activities in earthquake zones and offer stable structure.
- [7] An analysis of the time history of the corresponding models is shown, two types of forces considered for peak ground velocity and peak ground acceleration are reported and real-time production of real-time values.

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