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SEISMIC BEHAVIOUR OF MULTISTOREY BUILDINGS HAVING DIFFERENT TYPES OF SLABS

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***Abstract*— The Flat slab system of construction is one in which the beam is used in the conventional methods of construction done away with the directly rests on column and the load from the slabs is directly transferred to the columns and then to the foundation. Drops or columns are generally provided with column heads or capitals. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement.**

The object of the present work is to study and compare the behavior of multistory buildings having slabs with beams, flat slabs with and without drops and grid slab under seismic loading and observe the effect on the parameters as lateral displacement and storey drift. For this purpose three cases of multi-storey buildings are considered having 10 storey, 15 storey and 20 storey. All the three cases are considered having conventional frame, flat slab with and without drops and grid slab systems and also analyzed for zone III, zone IV and zone V by using software Staad.Pro.

Observation shows that the provision of flat slab system is more flexible for seismic loadings as compared to other slab systems. From the analysis result parameters lateral displacement and storey drift of the building increases from lower to higher zones because the magnitude of intensity will be more for higher zones. Present work provides a good source of information on the parameters lateral displacement and storey drift in the multistory buildings having different types of slabs.

***Keywords*— Flat Slab, Grid Slab, Seismic Forces, Lateral Displacement, Storey Drift.**

I. INTRODUCTION

Seismic design of RCC structures is a continuing area of research since the earthquake engineering is widely used not in India only but also in other developing countries. Still the structures collapse due to various reason during earthquakes. The structural configuration system has played a very important role in disaster in spite of all the weaknesses in that structure, whichever code imperfections or inaccuracy in analysis and design. For the construction of floors, roofs, bridges, etc, structural concrete slabs are provided to have flat surfaces, typically horizontal. And this slab may be supported by walls, by reinforced concrete beams usually constructed monolithically with the slab, by steel beams, by columns, or by the ground. The depth of a slab is usually very small compared to its span. The various types of slabs are one way slab, two way slab, flat slab, grid slab.

When a rectangular slab is supported on 2 opposite edges only and the length-to-breadth ratio is equal to or more than 2 it can be said as one-way slab spanning in the direction perpendicular to the edges.

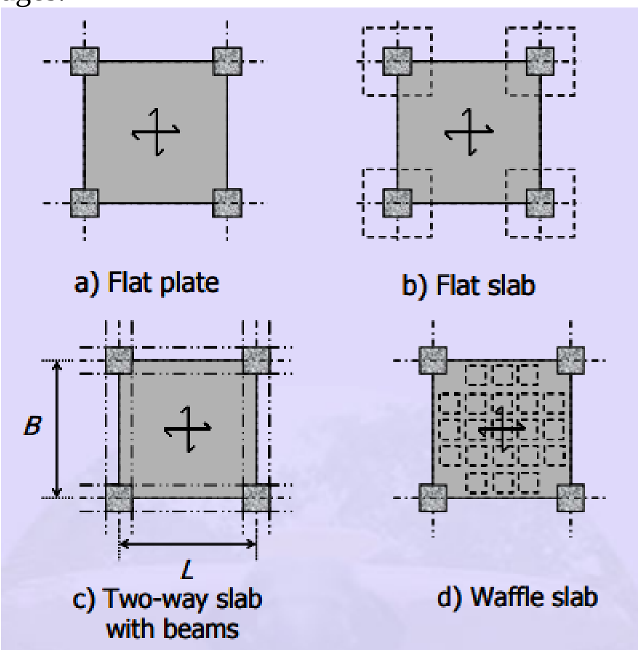

Fig. 1 Types of slabs

A slab is said to be two way slabs when it is supported on all the sides and the length-to-breadth ratio is less than 2. This slab spans in both the orthogonal directions. A circular slab is a two-way slab. In general, when any slab does not satisfy the category of one-way slab then it is considered to be a two-way slab.

Typical frame construction utilizes columns, slabs and Beams. But it may be possible to construct a structure without providing beams, in that case the system would consist of slab and column without beams. These types of Slabs are known as flat slabs. The slab is directly supported by the column and load from the slab is directly transferred to the columns and then to the foundation.

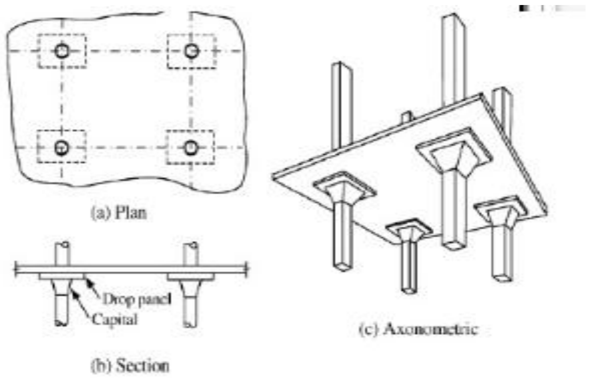

Fig. 2 Components of flat slab

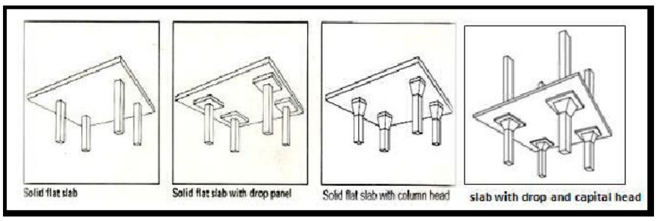

Fig. 3 Types of flat slab

Grid floor systems comprises of beams spaced at standard intervals and monolithic with slab in perpendicular directions. They are generally provided for architectural purposes for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where the main aim is to have a column free space.

II. Problem Formulation & Analysis

The object of the present work is to compare the behaviour of multi-storey buildings having different types of slab under seismic forces. For this purpose three cases of multi-storey buildings are considered. Each case is analysed for the models of conventional building, flat slab without drop, flat slab with drop and grid slab by using Staad.Pro software.

In case-I, building area provided is 35 m x 35 m with 10 storeys.

In case-II, building area provided is 35 m x 35 m with 15 storeys.

In case-III, building area provided is 35 m x 35 m with 20 storeys.

To study the behaviour the response parameters selected are lateral displacement and storey drift. All the cases are assumed to be located in zone III, zone IV and zone V. For all the three cases four models are to be compared:

a) Conventional Frame - CF
b) Flat Slab Without Drop - FS
c) Flat Slab With Drop - FS+D
d) Grid Slab - GS

TABLE I
Summary of Variables

Parameters	Variables
Zones	III, IV and V
Plot size/Building Height/No. of Storeys	35m x 35m/36m/10 35m x 35m/54m/15 35m x 35m/72m/20

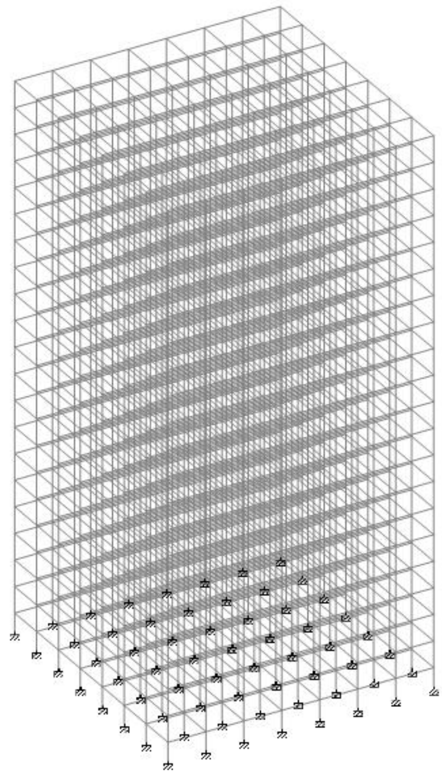

Fig. 4 Conventional frame

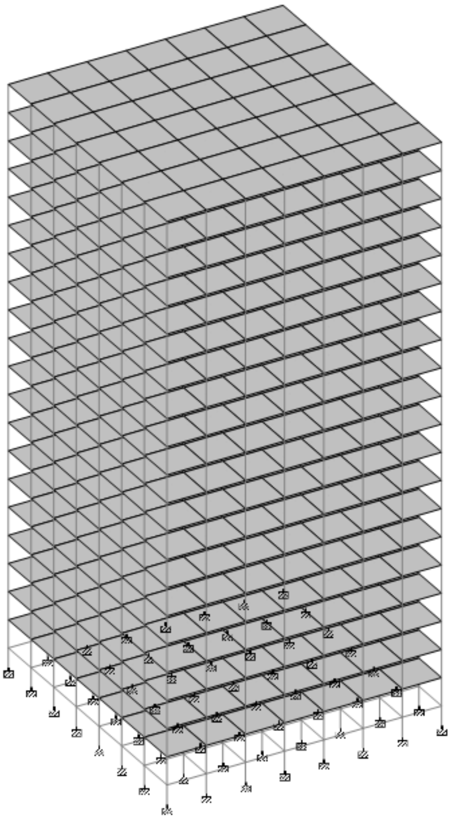

Fig. 5 Flat slab without drop

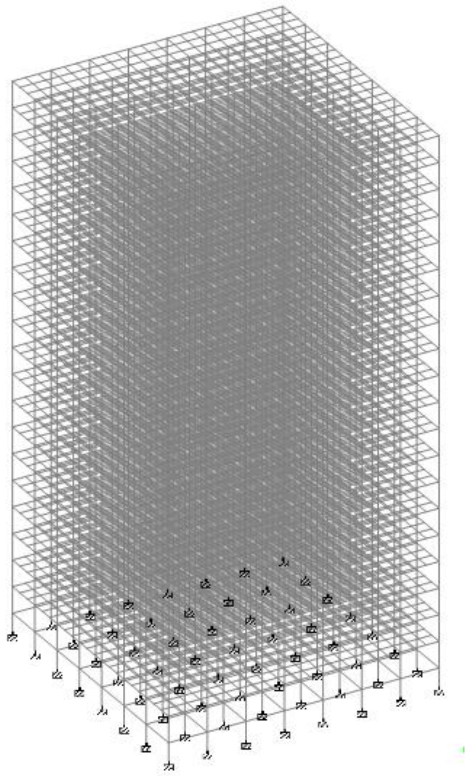

Fig. 7 Grid slab

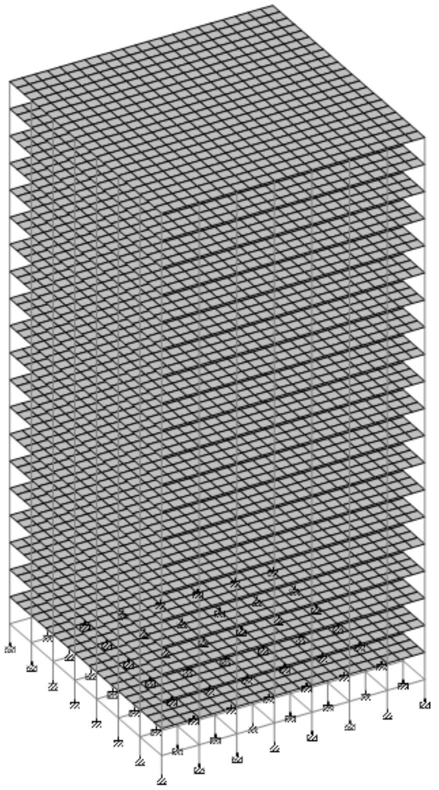

Fig. 6 Flat slab with drop

Details of all the cases:

1. Storey height provided in all the cases is 3.6m.
2. Sizes of beams are taken as 300mm x 500mm in all the cases.
3. Thickness of slab is 125mm.
4. Thickness of flat slab and grid slab without drop is 150mm.
5. Thickness of flat slab with drop is 150mm throughout and 300mm at drops.
6. Size of columns in case-I is 600mm x 600mm, in case-II is 700mm x 700mm and in case-III is 800mm x 800mm.
7. Loadings considered are:

a). Dead Load- It is taken by software itself.
b). Live Load- 4 KN/m2 on all the floors.
c). Earthquake Load- As per IS 1893 (part-I):2002.

8. Load combinations considered are:

a). 1.5(DL + LL)
b). 1.5(DL + EQL)
c). 1.2(DL + LL + EQL)

III. RESULTS AND DISCUSSIONS

The study examines the performance of different types of slabs in multi-storey buildings for seismic forces in zone III, zone IV and zone V. 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 also grid slab and behaviour of buildings is studied. To study the effectiveness of all these models, the storey drift and lateral displacement are worked out and are presented here.

A. EFFECT OF PARAMETERS STUDIED ON STOREY DRIFT

1. According to IS:1893:2002 (part I), maximum limit for storey drift with partial load factor 1.0 is 0.004 times of storey height. Here, for 3.6m height and load factor of 1.5, though maximum drift will be 21.6mm.
2. It is observed that for all the cases considered drift values follow approximately a parabolic path along floor height with maximum value lying somewhere near the third or fourth storey.
3. It is observed here that in all the models drift values are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones.
4. As it is discussed earlier, flat slabs are more flexible for seismic forces, so here drift values for flat slab models increases as compared to other models.
5. The storey drift in models with flat slab without drop is significantly more as compared to conventional frame and grid slab model. As a result, additional moments are developed. Therefore, the columns of such buildings should be designed by considering additional moments caused by the drift.
6. For improving the drift conditions of flat slab system in higher seismic zones, the stiffness of columns should be increased.
7. From the results it is observed that storey 3 and 4 experiences maximum drift values in all the models.

B. EFFECT OF PARAMETERS STUDIED ON LATERAL DISPLACEMENT:

1. According to IS:456:2000, maximum limit for lateral displacement is H/500, where H is building height. For 10 storey building model it is 72mm, for 15 storey building model it is 108mm, for 20 storey building model it is 144mm.
2. It is observed that for all the models considered displacement values follow around similar gradually increasing straight path along floor height.
3. In all the models displacement values are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones.
4. The lateral displacement is maximum at the top storey and least at the base of structure.
5. Above tables and figures shows that displacement of flat slab without drop building is slight more than conventional frame and grid slab buildings, but highly more than flat slab with drop building in all the seismic zones.
6. The differences of lateral displacement of flat slab without drop with conventional frame and grid slab is about 0.5 mm to 1.5 mm and that between flat slab with drop is about 2 mm to 5.5 mm.

IV. CONCLUSIONS

Within the scope of present work following conclusions are drawn:

1. For all the cases considered drift values follow approximately a parabolic path along floor height with maximum value lying somewhere near the third or fourth storey and displacement values follow around similar gradually increasing straight path along floor height.
2. For all the models drift values and lateral displacements are less for lower zones and it goes on increases for higher zones.
3. In all the models maximum drift values are near about 3 and 4 storey and lateral displacement is maximum at top storey and least at the base of structure.
4. It is experienced in all the models that storey drift and lateral displacement of flat slab without drop building is slight more than conventional frame and grid slab buildings, but

highly more than flat slab with drop building in all the seismic zones.

REFERENCES

[1] 2015, Mohana H.S, Kavan M.R, "*Comparative Study of Flat Slab and Conventional Slab Structure Using ETABS for Different Earthquake Zones of India*".

[2] 2015, Salman I Khan and Ashok R Mundhada, "*Comparative Study of Seismic Performance of Multistoried RCC Buildings with Flat Slab and Grid Slab: A Review*".

[3] 2014, Sumit Pahwa, Vivek Tiwari, Madhavi Prajapati, "*Comparative Study of Flat Slab with Old Traditional Two Way Slab*".

[4] 2013, R.S.More, V. S. Sawant, Y. R. Suryawanshi, "*Analytical Study of Different Types of Flat Slab Subjected to Dynamic Loading*".

[5] 2012, Dr. Uttamasha Gupta, Shruti Ratnaparkhe, Padma Gome, "*Seismic Behaviour of Buildings Having Flat Slabs with Drops*".

[6] 2008, R. P. Apostolska, G. S. Necevska-Cvetanovska, J. P.Cvetanovska and N. Mircic, "*Seismic performance of flat-slab building structural systems*".

[7] 2004, Ema Coelho, Paulo Candeias, Giorgios Anamateros, Raul Zaharia, Fabio Taucer, Artur V. PINTO, "*Assessment of the seismic behaviour of RC flat slab building structures*".

[8] 2004, H.-S. Kim, D.-G. Lee, "*Efficient analysis of flat slab structures subjected to lateral loads*".

[9] 2004, Hyun-Su Kim, Dong-Guen Lee, "*Efficient Seismic Analysis of Flat Plate System Structures*".

[10] Amit A. Sathawane, R.S. Deotale, "*Analysis And Design Of Flat Slab And Grid Slab And Their Cost Comparison*".

[11] Sang-Whan Han, Ph.D., P.E.; Young-Mi Park; and Seong-Hoon Kee, "*Stiffness Reduction Factor for Flat Slab Structures under Lateral Loads*".