International Journal of Engineering Science Invention Research & Development; Vol. IV, Issue XII, JUNE 2018
www.ijesird.com, E-ISSN: 2349-6185

SEISMIC BEHAVIOUR OF FLAT SLAB STRUCTURES UNDER STATIC AND DYNAMIC ANALYSIS

Monika Pagare[1], Sourabh Dashore[2]
Dept. Of Civil Engg., SIMS, Indore
[1]pagare.monika6@gmail.com, [2]sourabhdashore20@gmail.com

Abstract— **For the construction of floors, roofs, bridges, etc, structural concrete slabs are provided to have flat surfaces, typically horizontal. Also this structural concrete slab might be supported by walls, by reinforced concrete beams usually constructed monolithically with the slab, by steel beams, by columns, or by the ground. RC flat slabs are one of the most popular floor systems used in residential buildings, car parks and many other structures. They represent well-designed and easy-to-construct floor systems. Flat slabs are favoured by both architects and clients because of their artistic look and economic advantage. It is often the choice for heavier loads such as multi-storey car parking, libraries and also multi-storey buildings where larger spans are required.**

The object of the present work is to compare the behaviour of multi-storey buildings with different plan shapes having flat slab under seismic forces. For this purpose square and L shape plans are considered to analyze under seismic forces using static and dynamic analysis methods. Plan area of square building is 28 m x 28 m and of L shape building 28 m x 12 m in web and flange both. All the models are analysed for zone III, zone IV and zone V using Staad.Pro v8i software. To study the seismic behavior of the buildings the response parameters selected are displacement, storey drift and base shear.

Observation shows that the provision of flat slab in L shape building is more flexible for seismic loadings as compared to square shape building. From the analysis result parameters displacement, storey drift and base shear of the building models increases from lower to higher zones because the magnitude of intensity will be more for higher zones. In comparison to methods of analysis, dynamic method of analysis gives more appropriate results.

Present work provides good information on the result parameters displacement, storey drift and base shear in the multistorey buildings with flat slabs.

Keywords— **Flat Slab, Static and Dynamic Analysis, Storey Drift, Displacement, Base Shear.**

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. Also this structural concrete slab might 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.

RC flat slabs are one of the most popular floor systems used in residential buildings, car parks and many other structures. They represent well-designed and easy-to-construct floor systems. Flat slabs are favoured by both architects and clients because of their artistic look and economic advantage. It is often the choice for heavier loads such as multi-storey car parking, libraries and also multi-storey buildings where larger spans are required.

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.

Following are the advantages of flat slab:

1. The flat slab system requires lesser depth and hence there will be reduction in storey height.
2. There is reduction in dead loads and foundation loads since overall weight and height of structure are decreased.
3. Form work is simple and cheaper.
4. Plain ceiling gives an attractive appearance having the best property of diffusing light.

5. Due to flat surface it is easier to install sprinkler and other piping and utilities.
6. Due to plain ceiling it is considered less vulnerable in the case of fire than the usual beam slab construction.
7. It is easier and faster to construct.
8. Concrete is more logically used in this type of construction, and hence in the case of large spans and heavy loads, the total cost is considerably less.
9. Curing is easy because of flat surface.

Following are the disadvantages of flat slab:

1. Flat slabs are more flexible than beam-column frame structure.
2. Flat slabs have excessive lateral drifts when subjected to lateral loads.
3. Certain proportions of slab geometry are limited.

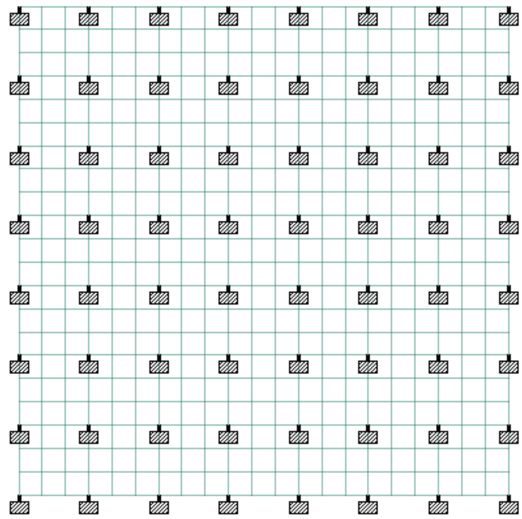

Fig. 1 Plan of square shape building

II. Problem Formulation & Analysis

The object of the present work is to compare the behaviour of multi-storey buildings with different plan shapes having flat slab under seismic forces. For this purpose square and L shape plans are considered. Following are the details of the buildings considered:

Shape of building: Square shape, L shape.
Area of square shape building: 28 m x 28 m
Area of L shape building: 28 m x 12 m (Web and flange both)
Number of storeys: 8 storey, 12 storey and 16 storey
Storey height: 3.6 m
Column grid: 4 m x 4 m
Plinth beam: 300 mm x 400 mm
Columns of 8 storey: 400 mm x 400 mm
Columns of 12 storey: 500 mm x 500 mm
Columns of 16 storey: 600 mm x 600 mm
Thickness of slab: 150 mm.

All the models are analyzed for zone III, zone IV and zone V by using Staad.Pro software. To study the behavior the response parameters selected are lateral displacement, storey drift and base shear. These parameters are compared by static analysis and dynamic analysis methods.

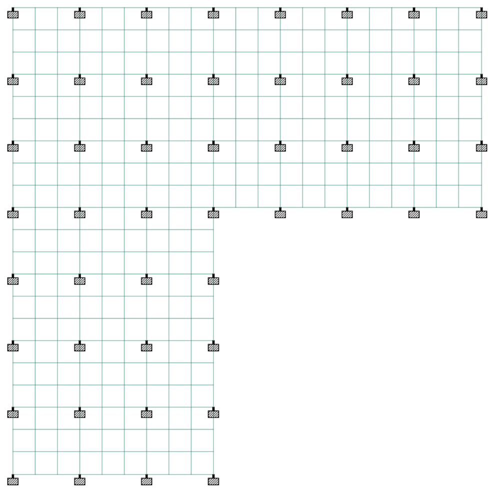

Fig. 2 Plan of L shape building

III. Results And Discussions

The study examines the performance of flat slab having different shapes in multi-storey buildings for seismic forces in zone III, zone IV and zone V using static and dynamic analysis. As it is discussed earlier that use of flat slabs makes the structure flexible under seismic loading, therefore, in present work it seems that flat slab structures becomes failure in many cases.

To study the effectiveness of all the models considered, the displacement, storey drift and base shear are worked out. The results organized in various tables and figures are discussed in detail.

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 from tables and figures 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. Drift values slightly increases in L shape plan as compared to square shape plan by 1mm to 2mm in static analysis, but in dynamic analysis it increases by 2mm to 5mm.
5. From the results it is observed that drift values of dynamic analysis are less in comparison to static analysis. At the higher floors it becomes almost half in dynamic analysis than in static analysis.
6. In the 8 storey models from zone III to zone V for square shape drift values varies from 3.06mm to 19.15mm in static analysis whereas in dynamic analysis it reduces from 1.61mm to 12.46mm. Also in L shape building models these values varies from 3.5mm to 20.72mm in static analysis and in dynamic analysis from 2.57mm to 17.89mm.
7. In the 12 storey models from zone III to zone V for square shape drift values varies from 3.68mm to 21.45mm in static analysis whereas in dynamic analysis it reduces from 1.31mm to 11.40mm. Also in L shape building models these values varies from 3.63mm to 23.71mm in static analysis and in dynamic analysis from 1.99mm to 15.86mm.
8. In the 16 storey models from zone III to zone V for square shape drift values varies from 3.39mm to 24.61mm in static analysis whereas in dynamic analysis it reduces from 1.42mm to 13.06mm. Also in L shape building models these values varies from 4.23mm to 27.59mm in static analysis and in dynamic analysis from 2.30mm to 18.10mm.
9. As limiting values of storey drift is 21.6 mm, according to this 12 storey model of zone V in L shape building fails slightly by 1mm to 2mm on the 3rd to 6th storey only in static analysis. Also in 16 storey building model in zone V square shape building model fails at 4th to 9th storey by 1mm to 3 mm and L shape building model fails at 3rd to 10th storey by 2 mm to 6 mm only in static analysis.
10. By using dynamic method of analysis all the building models are safe under permissible limits.
11. For improving the drift conditions of flat slab system in higher seismic zones using static analysis, the stiffness of columns should be increased.
12. From the results it is observed that storey 3 and 4 experiences maximum drift values in all the models.

Effect of parameters studied on displacement:

1. According to IS:456:2000, maximum limit for lateral displacement is H/500, where H is building height. For 8 storey building model it is 57.6mm, for 12 storey building model it is 86.4mm, for 16 storey building model it is 115.2mm.
2. It is observed from tables and figures 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. As compared to square shape and L shape building plans, values of displacement are more in L shape building plan.
6. From the results it is observed that displacement values of dynamic analysis are less in

comparison to static analysis. At the higher floors it becomes almost half in dynamic analysis than in static analysis.

7. In the 8 storey models from zone III to zone V for square shape drift values varies from 5.93mm to 117.28mm in static analysis whereas in dynamic analysis it reduces from 4.27mm to 72.29mm. Also in L shape building models these values varies from 6.18mm to 127.44mm in static analysis and in dynamic analysis from 5.78mm to 104.34mm.
8. In the 12 storey models from zone III to zone V for square shape drift values varies from 6.78mm to 194.07mm in static analysis whereas in dynamic analysis it reduces from 3.29mm to 96.18mm. Also in L shape building models these values varies from 5.91mm to 216.38mm in static analysis and in dynamic analysis from 4.35mm to 135.48mm.
9. In the 16 storey models from zone III to zone V for square shape drift values varies from 5.42mm to 294.58mm in static analysis whereas in dynamic analysis it reduces from 3.19mm to 146.05mm. Also in L shape building models these values varies from 5.77mm to 332.55mm in static analysis and in dynamic analysis from 4.21mm to 204.96mm.
10. As limiting value of displacement in 8 storey is 57.6mm, in 12 storey is 86.4mm and in 16 storey it is 115.2mm. In all the cases both in static and dynamic analysis methods at the higher zones model fails at higher storeys. To improve this behavior from past researches it is suggested to increase the stiffness of columns, to provide shear walls or perimeter beams.

Effect of parameters studied on base shear:

In structural system base shear depends on dead weight of building and A_h factor. As dead weight of building increases the base shear of structure also increases. This will results in resisting lateral forces and with increase in zone factor base shear will also increases. Hence in all the models base shear 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. Base shear increases with increase in number of stories in both the static and dynamic method of analysis. As compared to shapes of building the values of base shear are less in L shape building models than in square shape building models both in static and dynamic methods of analysis.

IV. CONCLUSIONS

Within the scope of present work following conclusions are drawn:

1. In all the considered building models 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, displacements and base shear 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 displacement is maximum at top storey and least at the base of structure.
4. It is experienced in all the models that the values of drift and displacement are less in square shape building as compared to L shape building, whereas, base shear is more in square shape building as compared to L shape building.
5. It is observed that values of drift, displacement and base shear of dynamic analysis are less in comparison to static analysis for square shape and L shape both the building models.

REFERENCES

[1] 2018, Pooja Biradar, Kishor Kulkarni, Nikhil Jamble, “Seismic Performance Of High Rise Flat Slab Building With Various Lateral Load Resisting Systems”.
[2] 2017, Bhojarajakumara M, Dr. Shreepad Desai, “Seismic Performance Of Flat Slab Structures Under Static And Dynamic Loads”.
[3] 2017, Nishant S. Borse, Prof. Vijaykumar P.Bhusare, “Review on Seismic Performance of Flat Slab Structures by Evaluation of R Factor”.
[4] 2017, Renuka Ramteke, “Parametric study of multistoried R.C.C. flat slab structure under seismic effect having different plan aspect ratio and slenderness ratio”.
[5] 2016, Mohit Jain, Dr. Sudhir S. Bhadauria, Danish Khan, “Seismic Analysis Of Flat Slab And Wide Beam System”.
[6] 2016, Sukanya Sawant, Prof. K. R. Dabhekar, “Seismic Analysis of Flat Slab Structure”.
[7] 2015, Basavaraj H. S., Rashmi B. A., “Seismic Performance Of RC Flat Slab Building Structural Systems”.
[8] 2015, Mohana H.S, Kavan M.R, “Comparative Study of Flat Slab and Conventional Slab Structure Using ETABS for Different Earthquake Zones of India”.

[9] 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".
[10] 2014, Sumit Pahwa, Vivek Tiwari, Madhavi Prajapati, "Comparative Study of Flat Slab with Old Traditional Two Way Slab".
[11] 2013, R.S.More, V. S. Sawant, Y. R. Suryawanshi, "Analytical Study of Different Types of Flat Slab Subjected to Dynamic Loading".
[12] 2012, Dr. Uttamasha Gupta, Shruti Ratnaparkhe, Padma Gome, "Seismic Behaviour of Buildings Having Flat Slabs with Drops".
[13] 2008, R. P. Apostolska, G. S. Necevska-Cvetanovska, J. P.Cvetanovska and N. Mircic, "Seismic performance of flat-slab building structural systems".
[14] 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".
[15] 2004, H.-S. Kim, D.-G. Lee, "Efficient analysis of flat slab structures subjected to lateral loads".
[16] 2004, Hyun-Su Kim, Dong-Guen Lee, "Efficient Seismic Analysis of Flat Plate System Structures".