ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

# Parametric Study of Multistorey RC Building with Different Type of Slabs in Seismic Zone IV

[1] Shriya bhatt,[2] Dr.(Prof.) Kailash Narayan
[1] M.tech Student, [2] Professor
[1][2] Institute of Engineering and Technology, Lucknow.

***Abstract:*-- Knowing the behavior of building and the response of all the possible earthquake loading effects has become very important in order to analyze seismic performance of the building. Correct determination of seismic load effects on the structural system is important in all types of buildings. Slabs are constructed to provide flat surfaces, usually horizontal, in building floors, roofs, bridges, and other types of structures.In the present study, 3 different types of slabs namely conventional slab, flat slab and waffle slab are compared in a multistory RC building in order to analyze their seismic performance by using elastic time history method in ETABS 2016 software according to rules and regulations of Indian standard code. The parameters taken into consideration are story stiffness , story drift and story displacement under seismic zone IV**

**key words: conventional slab, flat slab, waffle slab, RC building, time history method, story drift, displacement, stiffness.**

## I. INTRODUCTION

The rapid growth of urban population in the last 30 years has resulted in scarcity of space, wishes of big companies to built huge prestigious buildings, development of vertical growth of buildings and hence increase of multistory buildings in big cities have been seen enormously over the last few decades. As India is still a developing country,steel reserve is not as abundant in the west, whereas the raw materials for RC concreting are abundantly available throughout India and hence it leads to lesser cost than Steel. Due to both economical reasons as well as requirement of skilled labour in steel structures, the use of RC structures are more beneficial for a country like India. For these reasons it becomes important to know the behavior of reinforced concrete in a multi storeybuilding , determine all possible earthquake loading effects on reinforced building correctly and to design the structural system so as to resist seismic effects. The conventional, flat slab and waffle slab have different conditions in framework hence they behave differently when subjected to seismic excitation.

The framed structure where the slabs are supported with beams and columns are known as conventional slabs. Here the load is transmitted from slab to the beams and then to the column beneath it and ultimately to the foundation. In these kind of slabs, the thickness of slab is small whereas depth of beam is large and hence more formwork is needed as compared to that of flat and waffle slabs.In this type of slab the dead load is more than flat slab and also there is extra requirement of flat attractive appearance of ceilings. Flat slab is a reinforced concrete slab which are supported directly by concrete columns or caps and there is no provision of beams.They are supported on columns itself hence loads are directly transferred to columns and ultimately to the foundation below. In this type ofconstruction a plain ceiling is obtained because of the absence of beams thus giving attractive appearance from architectural point of view. The plain ceiling helps in the better diffusion of the light better and hence is considered less vulnerable in the case of fire. The flat slab is easier to construct and requires less formwork but is less resistant to earthquake as it is less flexible than slab beam system.

Waffle slabs structure can be used both as ceiling and floor. They are also known as two way ribbed flat slab and have two directional reinforcement on the outside of material giving them a shape of a waffle. Main purpose to provide waffle slab is to reduce the depth of foundation provided and they can also hold a greater amount of load as compared to that of flat slabs. Useof ribs reduce the amount of concrete to be used.Waffle slabs have economical and constructional benefits. They are used for heavy loads and large spans structures as they exhibit higher stiffness and smaller deflection than an equivalent flat slabs. Main advantage possessed by the waffle over flat slab is that they can be used for larger spans when subjected to earthquake loading.Hence, these slabs have been used for office buildings, vestibules, theatre halls, show rooms of shops etc.

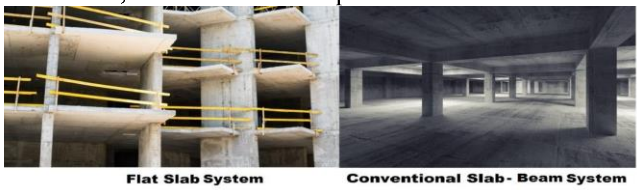


*Fig 1.1 and 1.2*

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

*Fig 1.3 Waffle slab*

**2) STRUCTURAL DETAILS**

In the present study three models have been generated by using ETABS software. All the models are used analyzed in seismic zone IV in a G+15 multistory building by using elastic time history method analysis.
MODEL 1- CONVENTIONAL SLAB
MODEL 2- FLAT SLAB WITHOUT DROP
MODEL 3- WAFFLE SLAB
Structural data is as follows:

| | | |
|---|---|---|
| 1 | Building type | Commercial building |
| 2 | Plan dimensions | 49X28m (X*Y) |
| 3 | No. of stories | G+15 |
| 4 | Floor to floor height | 3m |
| 5 | Total height of building | 45m |
| 6 | Slab thickness for conventional slab | 150mm |
| 7 | Slab thickness for flat slab | 180mm |
| 8 | Slab thickness for waffle slab | 100mm |

The plan view and the 3 dimensional view of the models have been shown as follows:

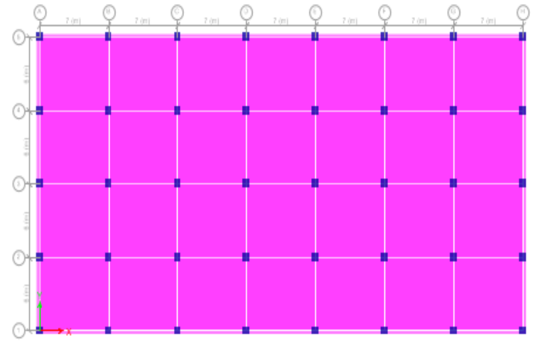

*Fig 1.4 Plan view of flat slab*

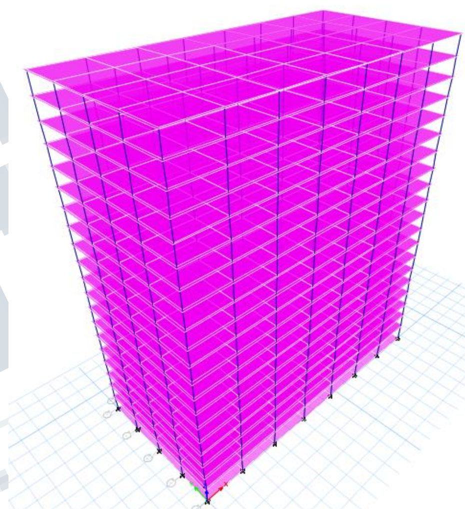

*Fig1.5 3-d view of flat slab*

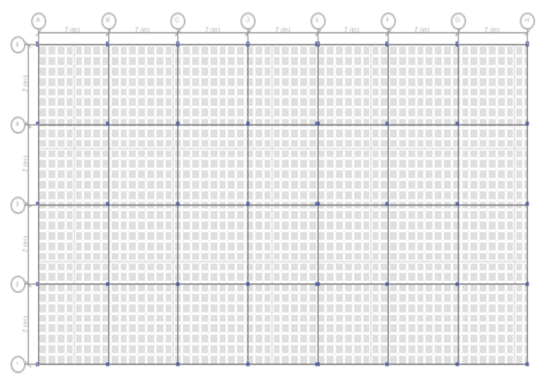

*Fig 1.6 Plan view of waffle slab*

 

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

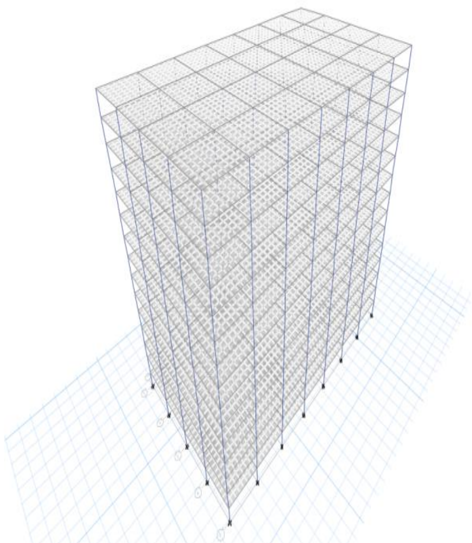

*Fig 1.7 3-d view of waffle slab*

### 3) RESULT AND DISCUSSION:

***3.1) STORY STIFFNESS:***

***Table 1.1 story stiffness***

| Story | MODEL 1 | MODEL 2 | MODEL 3 |
|---|---|---|---|
| | kN/m | kN/m | kN/m |
| Story15 | 458660.9 | 44840.665 | 336477.6 |
| Story14 | 572697.5 | 74073.641 | 436686.6 |
| Story13 | 594725.9 | 88497.162 | 459427.4 |
| Story12 | 599350.3 | 95113.815 | 464684.3 |
| Story11 | 600267.4 | 98079.281 | 465722.4 |
| Story10 | 600382.5 | 99472.507 | 465740.9 |
| Story9 | 600382.7 | 100349.37 | 465597 |
| Story8 | 600477.8 | 101337.99 | 465587.2 |
| Story7 | 600833.5 | 102960.75 | 465957.9 |
| Story6 | 601833.9 | 105872.48 | 467222.7 |
| Story5 | 604642.7 | 111184.55 | 470753 |
| Story4 | 612987 | 121212.76 | 480454.3 |
| Story3 | 639707.1 | 141940.72 | 508534 |
| Story2 | 739257.1 | 195355 | 603802.4 |
| Story1 | 1444266 | 485860.97 | 1233190 |

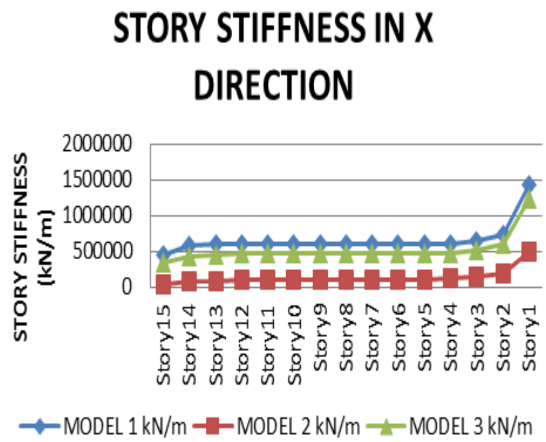


*Fig 1.8*

Indian code 1893:2002 recommends that for a building to be deemed regular, lateral stiffness in any story should not be less than 70 percent of that in the story above it or less than 80 percent of the average lateral stiffness of three storeys above it.

***3.2) Story drift***:

***Table 1.2 story drift***

| Story | MODEL 1 | MODEL 2 | MODEL 3 | IS CODE 1893:2002 |
|---|---|---|---|---|
| | mm | mm | mm | mm |
| Story15 | 2.698 | 11.241 | 3.554 | 12 |
| Story14 | 3.804 | 12.822 | 4.851 | 12 |
| Story13 | 4.962 | 14.813 | 6.235 | 12 |
| Story12 | 6.012 | 16.891 | 7.506 | 12 |
| Story11 | 6.912 | 18.854 | 8.605 | 12 |
| Story10 | 7.657 | 20.576 | 9.519 | 12 |
| Story9 | 8.258 | 21.971 | 10.256 | 12 |
| Story8 | 8.724 | 22.972 | 10.828 | 12 |
| Story7 | 9.069 | 23.506 | 11.247 | 12 |
| Story6 | 9.3 | 23.476 | 11.518 | 12 |
| Story5 | 9.411 | 22.734 | 11.625 | 12 |
| Story4 | 9.356 | 21.043 | 11.495 | 12 |
| Story3 | 8.963 | 18.022 | 10.894 | 12 |
| Story2 | 7.693 | 13.07 | 9.162 | 12 |
| Story1 | 3.87 | 5.196 | 4.426 | 12 |

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

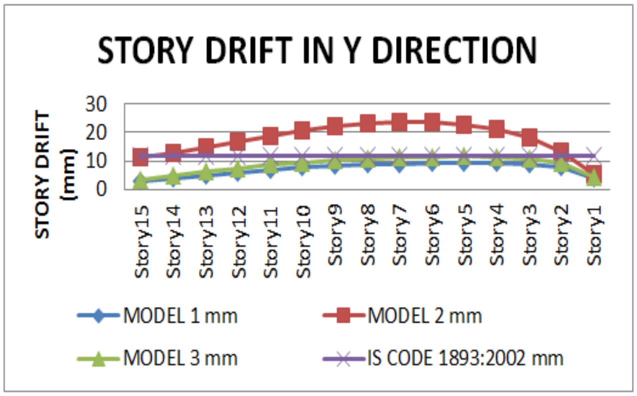


*Fig 1.9*

Story drift is an important criteria which represents the performance of structure as per IS 1893:2002 part 1, clause 7.11.1; story drift should be less than 0.004 times the height of the story under consideration. In this case it should be less than 12.

### *3.3) Story displacement:*

***Table 1.3 story displacement***

| Story | MODEL 1 | MODEL 2 | MODEL 3 | IS CODE 1893:2002 |
|---|---|---|---|---|
| | mm | mm | mm | mm |
| Story15 | 106.438 | 256.529 | 130.581 | 180 |
| Story14 | 103.745 | 246.069 | 127.054 | 168 |
| Story13 | 99.949 | 234.04 | 122.242 | 156 |
| Story12 | 94.998 | 220.034 | 116.06 | 144 |
| Story11 | 89.001 | 203.964 | 108.619 | 132 |
| Story10 | 82.106 | 185.942 | 100.09 | 120 |
| Story9 | 74.467 | 166.204 | 90.655 | 108 |
| Story8 | 66.229 | 145.073 | 80.492 | 96 |
| Story7 | 57.527 | 122.936 | 69.762 | 84 |
| Story6 | 48.48 | 100.249 | 58.618 | 72 |
| Story5 | 39.204 | 77.564 | 47.205 | 60 |
| Story4 | 29.817 | 55.575 | 35.687 | 48 |
| Story3 | 20.485 | 35.207 | 24.298 | 36 |
| Story2 | 11.544 | 17.753 | 13.504 | 24 |
| Story1 | 3.87 | 5.086 | 4.426 | 12 |

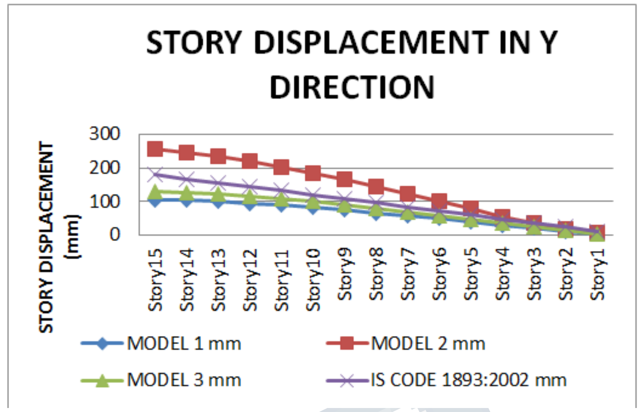


*Fig 1.10*

Story displacement is the displacement ofi th storey with respect to ground. According to IS 1893:2002 clause 7.11; maximum allowable deflection is calculated as h/250, where h is the height of the storey from the ground level. The variations of story displacement of each storey has been shown above.

## 4) CONCLUSION

The present research represents the study of conventional slab, flat slab without drop, waffle slab in a G+15 storey commercial building.Overall analysis shows that the conventional slab performance when subjected to seismic excitation in seismic zone IV is better as compared to waffle and flat slab. The execution would be easier in waffle slab in comparison to flat slab. Though the formwork required is more for waffle slab, it can be re-used many a times as construction is fast. Effect of different type of slab on the parameters taken into consideration and their comparison has been made by which we conclude the following results:

- Conventional slab show better performance during earthquake excitation as compared to the flat slab without drop and the waffle slab. The stiffness comes out to be maximum in case of conventional slab. As the flat slabs are used without drop and shear wall they show minimum stiffness as compared to waffle slab.

- The story drift is maximum in case of flat slab without drop and is exceeding the specified value according to Indian standard code i.e., 12mm; the maximum drift of waffle slab as compared to conventional slab at story 5 is 20-25% greater.

- The story displacement increases as the storey height increaseand maximum displacement is in flat slab case as compared to the conventional and waffle slab because of the lack of frame action which leads to excessive lateral deformation. The displacement of waffle slab as compared to conventional in approximately 23% greater.

- To increase the performance of flat slab structure with horizontal loads, particularly in seismic prone areas, flat slab should be strengthened by proving RC shear walls.

## 5) REFERENCES

1) Sarita R. Khot, kumar .T.Bharekar, Purval.D.Shiram "comparative study of waffle slabs with flat slab and RCC conventional slabs" IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163.

2) Mohammed Fatir, M.H.Kolhar, Anjum Algur "relative study of seismic analysis between flat slab and grid slab of rcc structures with different masonry infills in two different zones"IJRET: International Journal of Research in Engineering and Technology.

3) Mohana H.S, Kavan M.R "Comparative Study of Flat Slab and Conventional Slab Structure Using ETABS for Different Earthquake Zones of India" International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 03 | June-2015.

4) Sumit Pahwa, Vivek Tiwari, Madhavi Prajapati "Comparative Study of Flat Slab with Old Traditional Two Way Slab" International Journal of Latest Trends in Engineering and Technology (IJLTET)

5) Naziya Ghanchi1, Chitra V "waffle slab- analysis by different methods" International Journal of Scientific & Engineering Research, Volume 5, Issue 12, December-2014.

6) Anithu Dev , Jasmin S.P, Shinu Shajee "Analysis and Parametric Study of Waffle Slabs" International Journal of Innovative Research in Science, Engineering and Technology.

7) Alaa C. Galeb, Zainab F. Atiyah "Optimum design of reinforced concrete waffle slabs" International journal of civil and structural engineering Volume 1, No 4, 2011.