DESIGN OF RCC FLAT SLAB STRUCTURE WITH DROP AND SHEAR WALL UNDER EARTHQUAKE LOADING USING ETABS SOFTWARE

Arbaaz Ali Khan [1], Vaijanath Halhalli [2]

[1]*PDA College of Engineering, Kalaburagi, Karnataka, India*
[2]*Associate Professor, PDA College of Engineering, Kalaburagi, Karnataka, India.*

Abstract - *Flat slab construction is now widely used in construction. It allows for greater design flexibility, more open space, a lower structural height, simpler formwork, and a shorter development period. Regardless, flat section building designs are more flexible than traditional concrete buildings since beams are not used, and they are more resistant to earthquakes. The goal of this study is to investigate the behaviour of a flat slab in four distinct cases: I) a flat slab construction without a drop, II) a flat slab structurally with a drop, III) a flat slab structure with a shear divider, and IV) a flat slab structure with both a drop and a shear divider. The analysis is carried out using the equivalent static technique and the response spectrum method, both of which are implemented using ETABS programming. The behaviour of the flat slab is investigated in terms of storey displacement, storey drift, storey stiffness, base shear, and time period. This study researches on which type of model is best for resisting the loads during seismic excitation.*

***Key Words*: ETABS, seismic load, Flat slab**

1. INTRODUCTION

Construction of a flat slab is a highly developing technology in the world. Flat slab is a R.C.C structural member which does not have beams in connection to column directly. It is used in car parks, high rise - buildings, residential cum commercial buildings and many other such structures. Flat slab supports professionals and architects because of their tremendous advantage. Flat slab does not include more number of beams as compare to conventional slab and hence economic performance of flat slab is much higher than conventional slab.

Lateral loads on a building results in sway of the structure. To minimise building wobble, it is preferable and more effective to use lateral load resisting devices. The shear wall is one of the most effective lateral load resisting systems. Shear walls have great strength and stiffness, allowing them to withstand the structure's strong lateral stresses. Because of its strengthening, shear walls may withstand lateral forces caused by earthquakes and wind.R.C.C. shear walls are often utilised in residential and commercial structures. Normally they are provided in between of column lines, in stairs, in lifts, shafts and such. They transfer the wind load or earthquake load to the foundation and hence resist the lateral load. Besides, the shear wall provides lateral stiffness to the structure and they also carry the gravity loads. Construction of a shear wall may increase the cost of the structure and hence it is inevitable in view of economy. When the shear walls are placed at right positions they can be the most efficient source of lateral load resisting systems. The plan position and shape of the shear wall have a significant impact on the building's behaviour.

2. OBJECTIVES OF THE STUDY

- To investigate the seismic behaviour of a structure with a flat slab system and composite columns with no drop, drop, shear wall, or drop and shear wall combined.
- To compare the model findings in terms of parameters such as lateral displacement, lateral drift, storey stiffness, base shear, and time period.

2.1METHODOLOGY

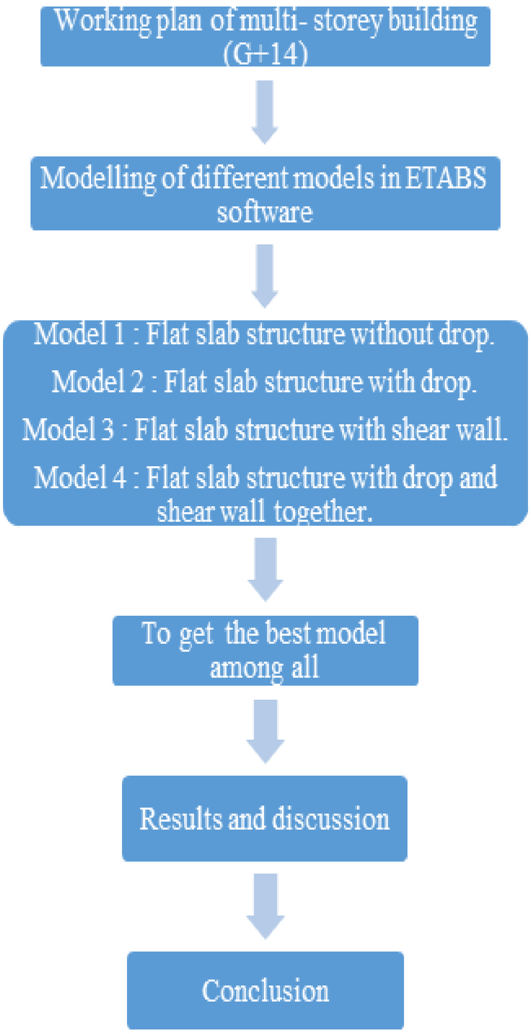
1. **Equivalent static analysis method /Linear static method**

This method is the most simple method among all the seismic analysis method. The computations carried out here are very less as the formulae are used as per standards code. The design base shear is computed first, and the resulting is spread along the structure's height. Latitudinal force is transferred to distinct lateral load resisting components at each floor.

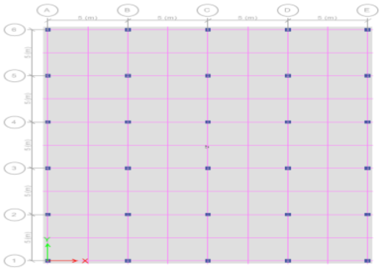
2. **Response Spectrum method**

The Response Spectrum technique is sometimes referred to as the linear dynamic method. In this technique of study, the design spectrum provides the assembly's extreme/peak reaction during seismic action. This method results in accurate result when compare to other methods. Several response modes of the structure during the seismic action are considered. The design spectrum is then taken from for each mode based on the modal mass and modal frequency response. By modal combination methods, the individual responses of the various modes are then summed/united to give an approximation of the overall response of the structure. For example, the square root of the sum of squares SRSS, the absolute sum ABS, and the complete quadratic combination CQC.

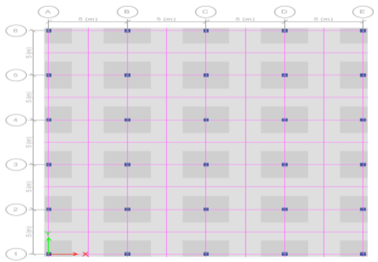
Methodology of the project considered is as follows:



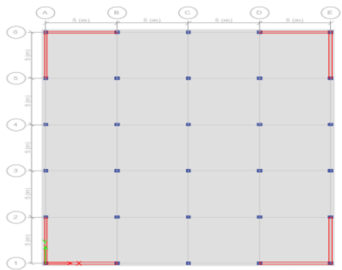
MODELLING AND ANALYSIS



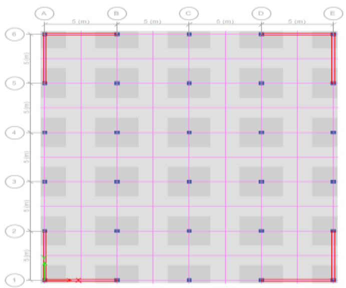
Plan of Model-1



Plan of Model-2



Plan of Model-3



Plan of Model-4

Design Data

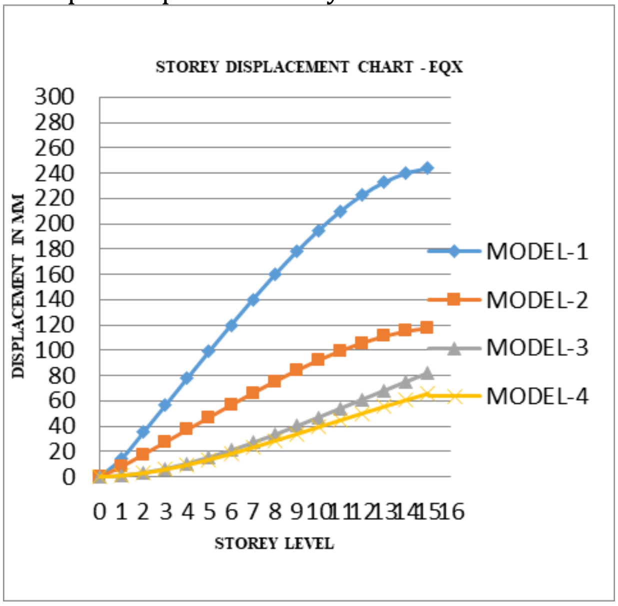
Material Properties:

PROPERTIES	VALUES
Concrete Young's modulus	25X10^6 kN/m^2
Reinforced concrete density	25 kN/m^2
Steel density	76.59 kN/m^3
Poisson's ratio of steel	0.3
Concrete Grade	M30
Steel Grade	Fe 500

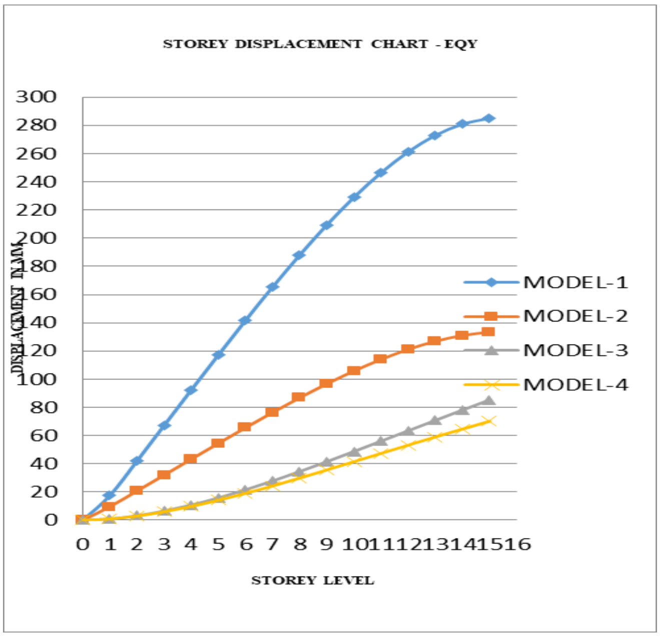
International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 07 | July 2021 www.irjet.net p-ISSN: 2395-0072

RESULTS

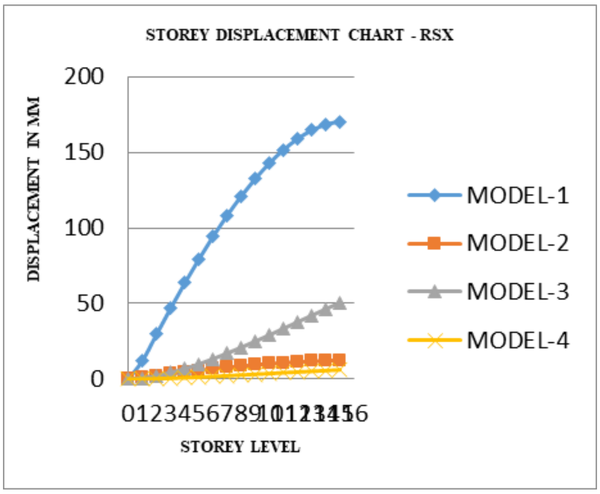
Following are the chart and tables for displacement, drift ratio, stiffness, base shear and time period analyzed by equivalent static analysis method and response spectrum analysis method.



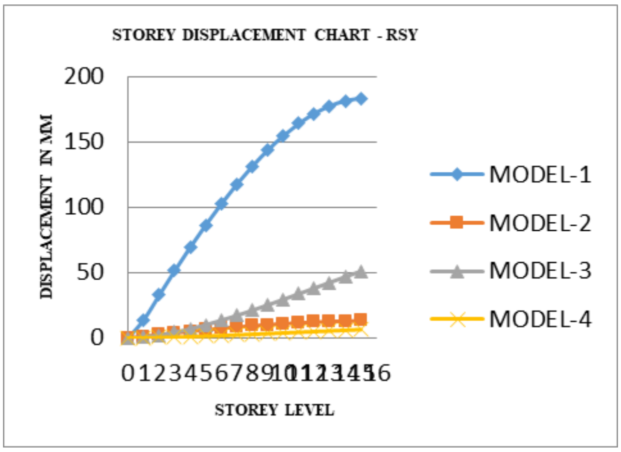
Storey wise displacements along X-direction in mm (Equivalent static method)



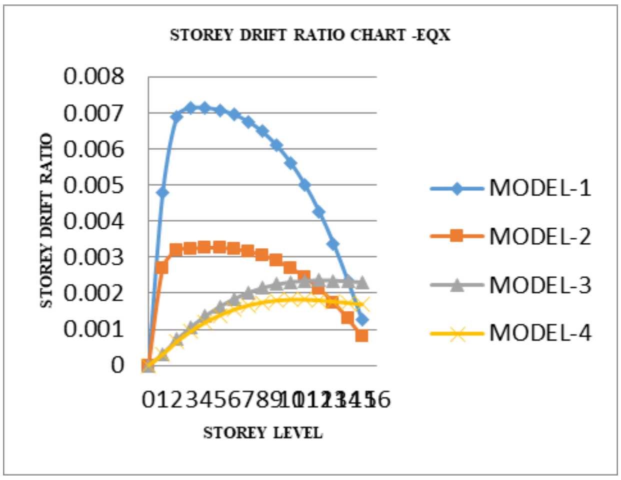
Storey wise displacements along Y-direction in mm (Equivalent static method)



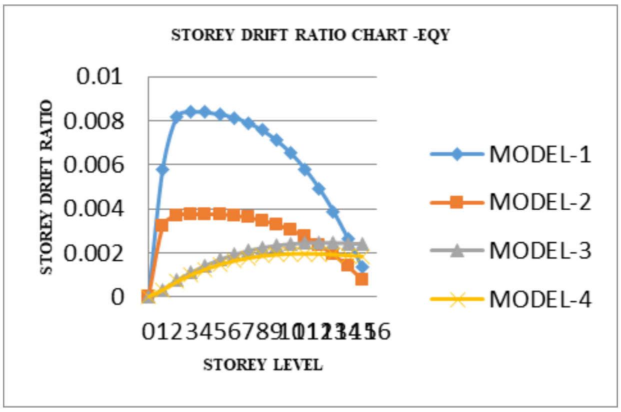
Storey wise displacements along X-direction in mm (Response spectrum)



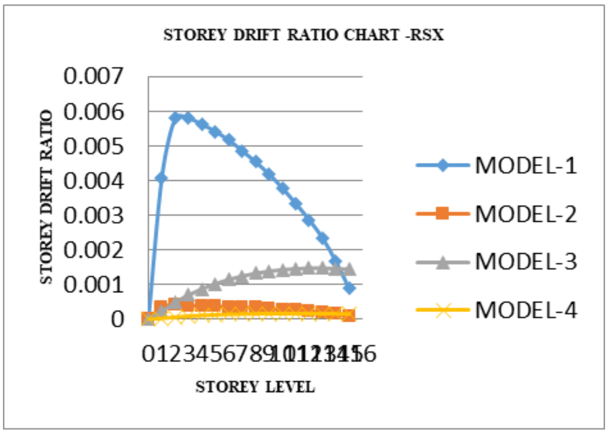
Storey wise displacements along Y-direction in mm (Response spectrum)



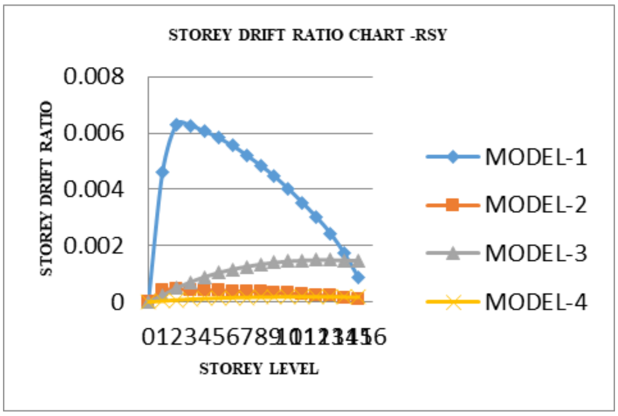
Storey wise storey drift ratio variation along X-direction (Equivalent static method)



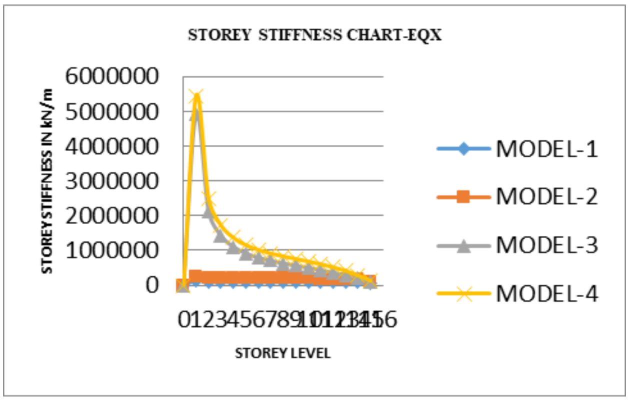
Storey wise storey drift ratio variation along Y-direction (Equivalent static method)



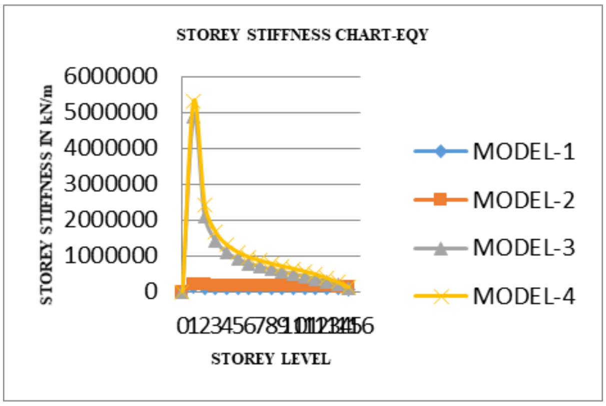
Storey wise storey drift ratio variation along X-direction (Response spectrum method)



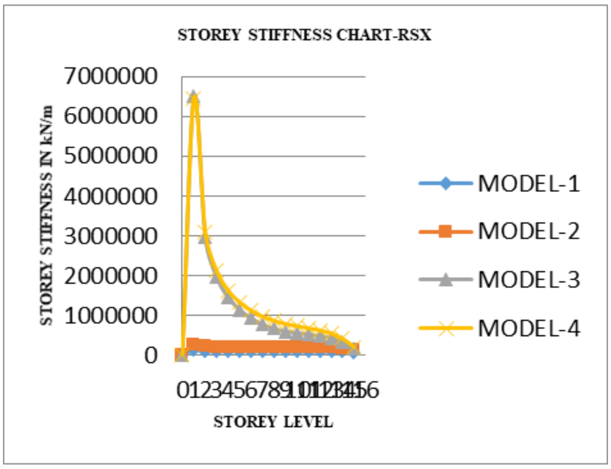
Storey wise storey drift ratio variation along Y-direction (Response spectrum method)



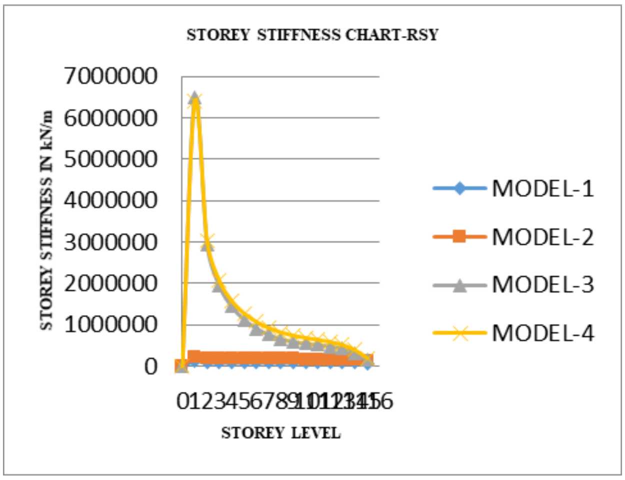
Storey wise storey stiffness along X-direction in kN/m (Equivalent static method)



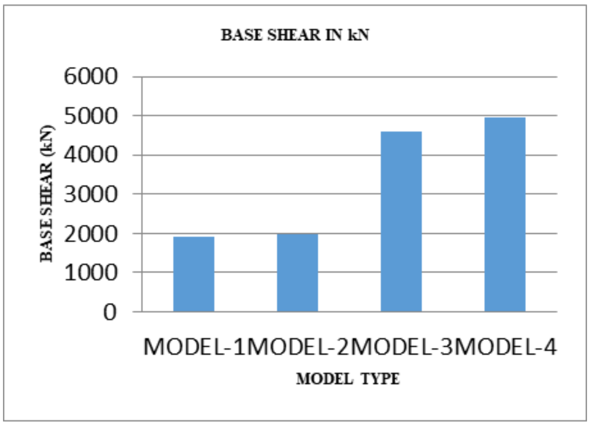
Storey wise storey stiffness along Y-direction in KN (Equivalent static method)



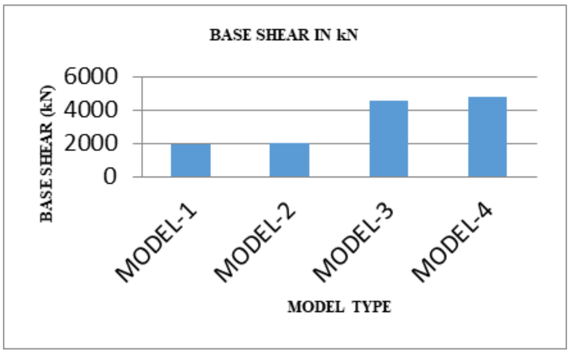
Storey wise storey stiffness along X-direction in kN/m (Response spectrum method)



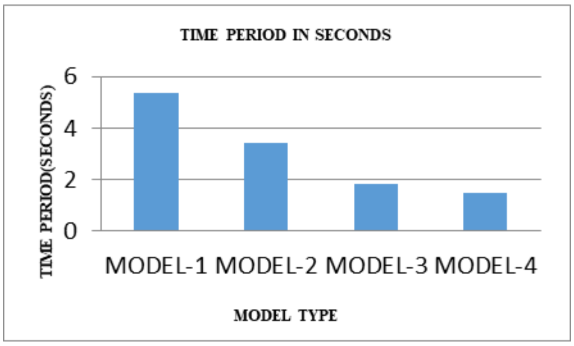
Storey wise storey stiffness along Y-direction in kN/m (Response spectrum method)



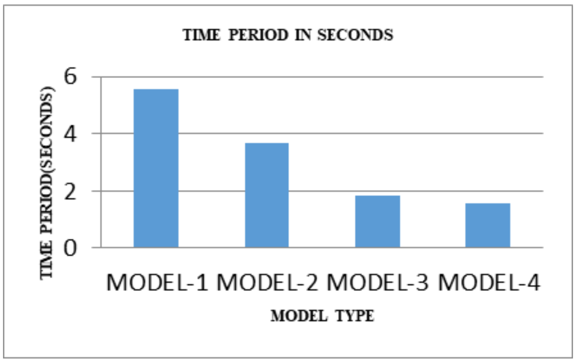
Maximum base shear comparison of all models due to seismic loads in X-direction



Maximum base shear comparison of all models due to seismic loads in Y-direction



Maximum time period comparison of all models due to seismic loads in X-direction



Maximum time period comparison of all models due to seismic loads in Y-direction

3. CONCLUSIONS

- In the X-direction, the percentage decrease in seismic displacement for models-2,-3, and-4 compared to model-1 is 52 percent, 66 percent, and 73 percent in comparable static analysis, and 93 percent, 70 percent, and 96 percent in response spectrum analysis.
- In the Y-direction, the percentage decrease in seismic displacement for model-2, model-3, and model-4 compared to model-1 is 60%, 70%, and 75%, respectively, in comparable static analysis, and 93, 72, and 96.5 percent, respectively, in response spectrum analysis.
- As a result, it is possible to deduce that seismic displacement can be limited to a bare minimum by combining a flat slab with a drop and a shear wall.
- In the X-direction, the percentage decrease in seismic drift ratio for models-2,-3, and-4 when compared to model-1 is 54 percent, 67 percent, and 74.5 percent in comparable static analysis, and 93 percent, 74.5 percent, and 97 percent when compared to model-1 in response spectrum analysis.

- In the Y-direction, the percentage reduction in seismic drift ratio for model-2, model-3, and model-4 compared to model-1 is 55 percent, 70.6 percent, and 76.6 percent in comparable static analysis, and 93 percent, 76 percent, and 97 percent in response spectrum analysis, respectively.
- As a result, it is possible to deduce that the seismic drift ratio may be lowered to a bare minimum by combining a flat slab with a drop and a shear wall.
- In comparable static analysis, the percentage increase in narrative stiffness for model-2, model-3, and model-4 compared to model-1 is 83 percent, 35.6 percent, and 39.5 percent, respectively, in X-direction, and is 83 percent, 47 percent, and 46.6 percent, respectively, in response spectrum analysis.
- In comparable static analysis, the percentage increase in narrative stiffness for model-2, model-3, and model-4 compared to model-1 is 76 percent, 40 percent, and 43 percent, respectively, and in reaction spectrum analysis, it is 75.6 percent, 53 percent, and 52 percent, respectively.
- As a result, it is possible to deduce that storey stiffness may be maximised by combining a flat slab with a drop and a shear wall.
- In the X-direction, the base shear of models 2, 3, and 4 is increased by 3%, 139 percent, and 157 percent, respectively, as compared to model 1.
- In the Y-direction, the base shear of models 2, 3, and 4 is increased by 2%, 137 percent, and 150 percent, respectively, as compared to model 1.
- As a result, it is possible to deduce that base shear rises with the supply of a drop in flat plate, and it increases even more with the provision of a shear wall in the structure.
- In the X-direction, the percentage reduction in time period of model-2, model-3, and model-4 compared to model-1 is 36%, 66%, and 72%, respectively.
- In the Y direction, the percentage reduction of time period of model-2, model-3, and model-4 compared to model-1 is 34%, 67%, and 72%, respectively. In the Y direction, the percentage reduction of time period of model-2, model-3, and model-4 compared to model-1 is 34%, 67%, and 72%, respectively.
- As a result, it is possible to deduce that the time period lowers with the inclusion of a drop in flat plate, and it further decreases with the inclusion of a shear wall in the structure.

ACKNOWLEDGEMENT

We would like to thank "PDA College of Engineering" for their support & our guide 'Prof. Vaijanath Halhalli' for their guidance & encouragement throughout the research.

REFERENCES

[1]. Arti Chandrakant Thakur, Roshni John, "Behavior of flat slab with drop and without drop" International Journal of Scientific & Engineering Research, ISSN 2229-5518 ,Volume 10,Page:329-335, Issue 5, May-2019.

[2]. Phyoe Hnin Thu Htun, Nyan Phone, Kyaw Zeyar Win "Comparative Study on Analysis and Design between Flat Slab and Flat Plate System for RC Building" International Journal of Science and Engineering Applications, ISSN:-2319–7560, Volume 7–Issue 09, Page:313-317, 2018.

[3]. Jaydeep Chodvadiya, Vipul Vyas, Dr. G.S. Doiphode, "PARAMETRIC STUDY ON FLAT SLAB WITH AND WITHOUT COLUMN DROP" IJARIIE-ISSN (O)-2395-4396, Page-1043-1050, Vol 3 Issue 1,2017.

[4]. Kumar Vanshaj, Prof. K Narayan "SEISMIC RESPONSE OF MULTISTOREY FLAT SLAB BUILDING WITH AND WITHOUT SHEAR WALL" International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 04, Page:573-578, Issue: 11, Nov -2017.

[5]. P. Srinivasulu, A. Dattatreya Kumar, "BEHAVIOUR OF RCC FLAT SLAB STRUCTURE UNDER EARTHQUAKE LOADING" International Journal of Engineering & Science Research (IJESR), ISSN 2277-2685, Page: 821-829,Vol-5, Issue-7 July 2015.

[6]. Athira.M.V, Sruthi K Chandran, "Seismic Analysis of Flat Slab Building with Shear Wall" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181,Page:1-4, Volume 5, Issue 08 – 2017.

[7]. D.S.Vijayan, S.Arvindan, K.Naveen Kumar, S Mohamed Javed, "Seismic Performance of Flat Slab in Tall Buildings with and without Shear wall" International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Page:2672-2675,Volume-9 Issue-1, October 2019.

[8]. Kavish Patwari, L. G. Kalurkar, "Comparative Study of Flat Slab Building with and Without Shear Wall to earthquake Performance" IJSDR1606051, International Journal of Scientific Development and Research (IJSDR), ISSN: 2455-2631, Page:284-291, Volume 1, Issue 6, June 2016.

BIOGRAPHIES

Arbaaz Ali Khan is a M.Tech Research Scholar in Structural Engineering, from the Department of civil Engineering, PDA College of Engineering, Kalaburagi Karnataka, India.

Vaijanath Halhalli is an Associate Professor in the Department of Civil engineering, PDA College of Engineering, Kalaburagi, Karnataka, India.