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Comparative Study on Seismic Performance of Flat Slab and Conventional Slab

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Abstract:
Recent market conditions show that the modern infrastructure development is aimed to utilize the available resources to their optimum levels, may the resources be in terms of economy or in terms of space. The use of flat slab is quite common nowadays which aids in reducing the weight, speed up construction, and economical. Similarly from the beginning conventional slab aids in providing features like more stiffness, higher load carrying capacity, safe and economical. As the advancement era began practice of flat slab becomes quite common. In this study a G+7 Residential multistoried building having flat slab and conventional slab has been analyzed using ETABS and Safe for the parameters like base shear, Deflection, Punching Shear. Designed for analyzed results and Detailing is done for both slabs. The performance and behavior of both the structures is studied and compared.

Keywords: ETABS, SAFE-V12, Flat slab, conventional slab, Response spectrum analysis, Design and detailing.

I. INTRODUCTION

Earthquakes are one of the most destructive natural phenomenons and their occurrence is beyond human control. Most of these earthquakes are manmade. Thus, we human beings are responsible to provide protective and safety measures to withstand this earthquake to some extent. Human being faced a large number of natural disasters like earthquake, floods, tornadoes, hurricanes and volcanic eruptions from time to time. Though the disaster caused by floods, tornadoes, hurricane and volcanic eruptions are much more severe than those of earthquake, but the occurrence of earthquake are totally unexpected. Most of the earthquake in the present scenario is mainly due to high rise buildings in the developing countries with huge number of population. The disasters caused during the earthquake are not because of the earthquake itself but because of human acts of poorly designed constructed buildings.

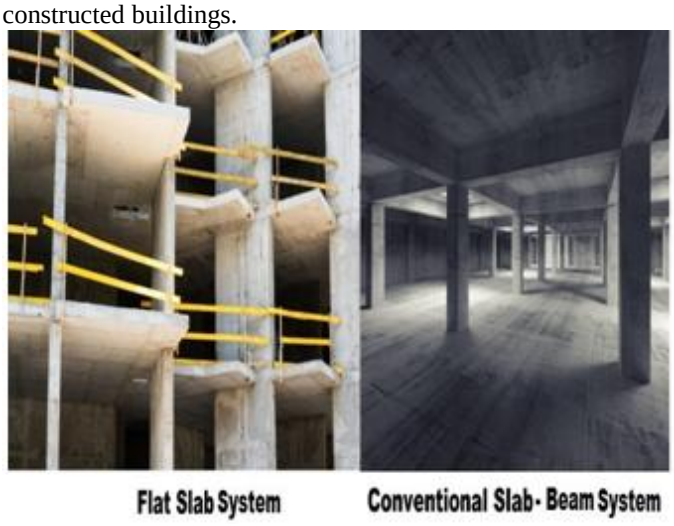


Figure.1. Flat and Conventional Slab Systems

In present era, conventional RC Frame buildings are commonly used for the construction. The use of flat slab building provides many advantages over conventional RC Frame building in terms of architectural flexibility, use of space, easier formwork and shorter construction time. The slab directly rests on the column and load from the slab is directly conveyed by the columns and then to the foundation. These types of slabs are called flat slabs. In two- way slab, the slab is supported by beams, the load of both slab and beams is transferred to columns and then to footings. Configuration of the building is much important for the good seismic performance of building.

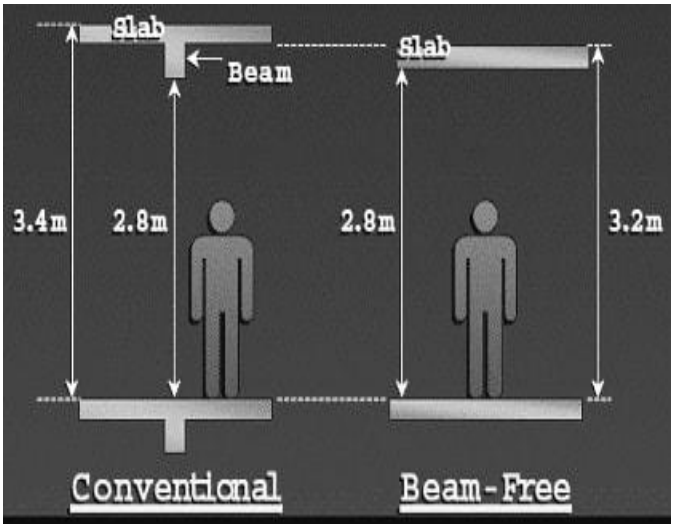


Figure.2. Comparison of Flat and Conventional Slab

In general normal RC frame construction uses columns, slabs and Beams. However it may be possible to carry out construction without providing beams, in such a case the RC frame system would consist of slab and column without beams.

1. Objectives

In this study, the seismic Behaviour Comparison of Flat slab and Conventional slab buildings have been investigated through (Linear Dynamic) Response spectrum analysis.

➢ To study the Dynamic performance of flat slab and conventional slab system subjected Seismic loading.

➢ To study the behaviour of both the structure for the parameters like Base shear and Deflections.

➢ Design and detailing both the Flat slab & Conventional slabs.

➢ Estimating & comparing the quantity of Materials. (i.e., Concrete & Steel)

3. METHODOLOGY

In this modern world the most commonly used FEM software is Etabs, to analyze the most critical buildings. The same has been used here to analyze the G+8 building for both gravity and Dynamic analysis.

➢ Building is Modelled and Analysed in ETABS using Response Spectrum Analysis

➢ Exporting the flat slab floor level to the safe in SAFE V12.f2k text format.

➢ Update the material properties accordingly, based on the required criteria

➢ Strips to be drawn both in X &Y direction @ an interval of 1m keeping the strip width of 0.5m.

➢ Then it's required to satisfy both one way shear & Punching Shear.

➢ Analyse the particular floor for the Loads applied in the Etabs model.

➢ The floor should be analysed for envelope combinations which includes all the load combinations.

➢ Design and detailing should be done for Safe flat slab model.

4. MODELLING DETAILS

In the present study, two G + 7 story buildings having conventional and flat slab buildings .The modelling is carried out in ETABS-9.7 and SAFE-V12 softwares and the loads are applied. The models are analyzed for different combinations of gravity and lateral loads and for II zone.

SAFE-V12:

SAFE offers a single user interface to perform: Modelling, Analysis, Design, Detailing and Reporting. . SAFE is the ultimate tool for designing concrete floor and foundation systems. Generating pattern surface loads is easily done by SAFE with an automated option.

Design strips can be generated by SAFE or drawn in a completely arbitrary manner by the user, the punching shear check and design in SAFE considers column location, openings, and slab edges. In safe design can be done as strip based and FEM or contour based. Design strips can be non-orthogonal and of varying width and finite element based design does not require design strips.

Table.1. Model Details

Building Type	
Number of storey-	8-storey
Thickness of conventional slab	125mm
Thickness of Drop slab	225mm
Beam Size	0.2X0.4m
Column Size	0.25X0.45m
Steel and Concrete	Fe500 and M_{25}
Design loads	
Live load	3 kN/m²
Floor finish	1.5kN/m²
Earthquake parameters	
Seismic zone	(Z= 0.10) II
Importance factor	1
Response reduction factor	5
Type of soil	(Type II medium)
Damping of structure	5%
Codes Used	: IS 456-2000, IS 1893-2002, IS-875, Part1to 3

4.1 ETABS models

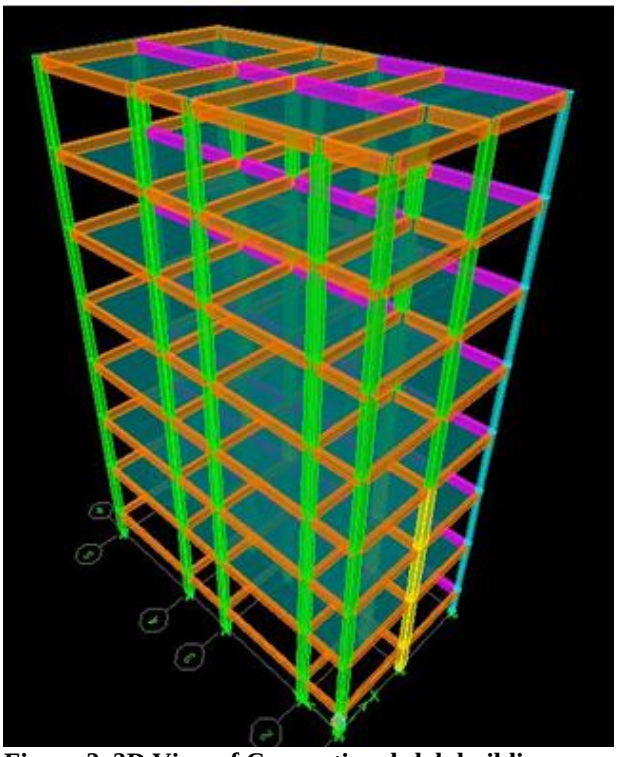


Figure.3. 3D View of Conventional slab building

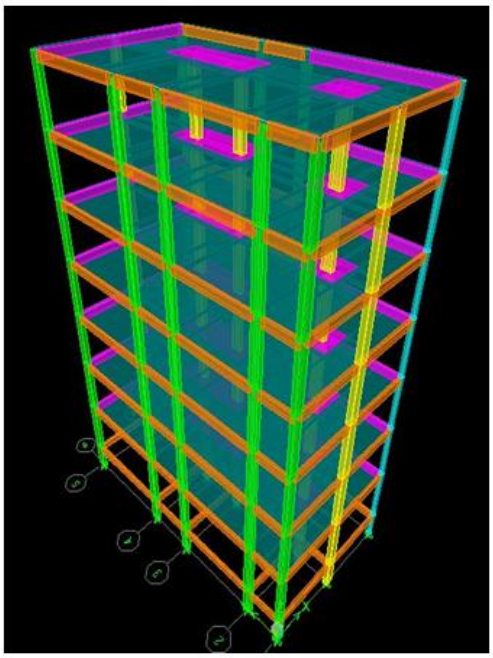
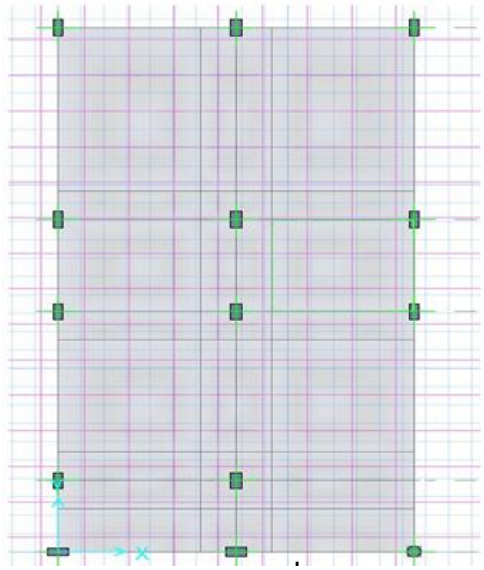
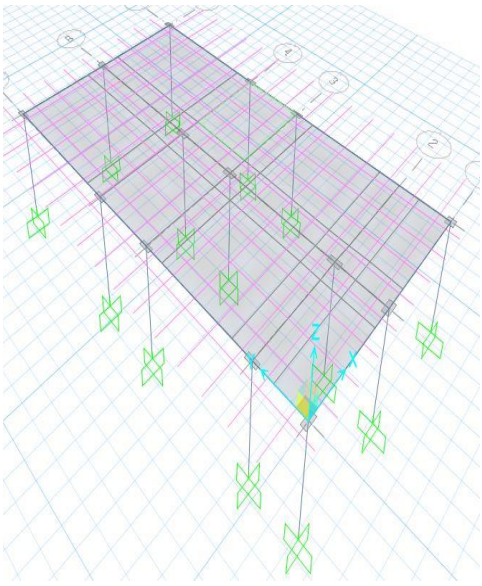


Figure.4. 3D View of Flat slab building

4.2 SAFE models



Plan view



3D view

Figure.5. Plan and 3D Views SAFE slab models

5. RESULTS AND DISCUSSIONS

After making the models analysed using (Dynamic) Response Spectrum analysis. The results obtained from these analyses are such as Floor loads from any floor level (2nd) are exported from Etabs-9.7 and then imported in SAFE-V12. And modelled and analysed in SAFE to study the behaviour of the structure for the parameters like Base Shear, deflection of the slabs, Steel and Concrete quantity comparisons and designed and detailing the same.

5.1 Base Shear

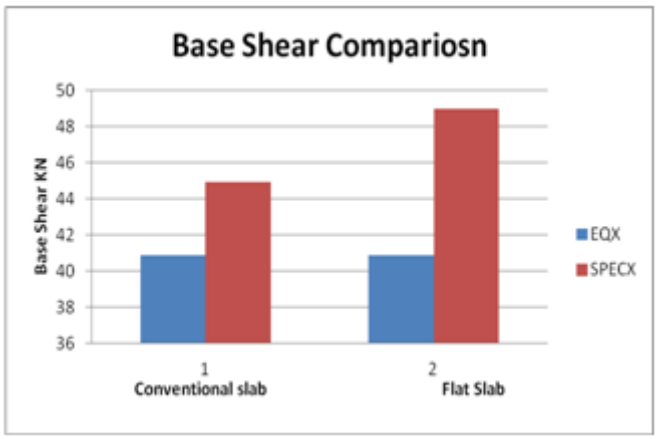


Figure.6. Base Shear Comparison

Table.2. Base Shear Comparison

Conventional Slab	Flat Slab
EQX = 40.88 KN	EQX = 44.92 KN
SpecX=40.86KN	SpecX= 48.97KN

As the buildings which we are going to analyse for both conventional & flat slab is analysed by Response spectrum method. In the above table we are trying to match the base shear of both static and dynamic values so that the ratio will be 1. And also we can clearly observe that the flat slab system has baser shear as compared to conventional slab beam system. It is for the obvious reason like the sway in the flat slab system is more and the load carrying by each column is more than the conventional columns. We can also observe that the base shear is increased by 15 to 20 % in case of the Flat slab.

5.2 Deflections

5.2.1 Flat Slab

Even though we don't have beams in the flat slab the thickness of the slab used is more in the flat slab as compared to conventional slabs. R5And if the framing is done accurately we can reduce the deflection in comparison to the conventional slabs as we have shown in the below images.

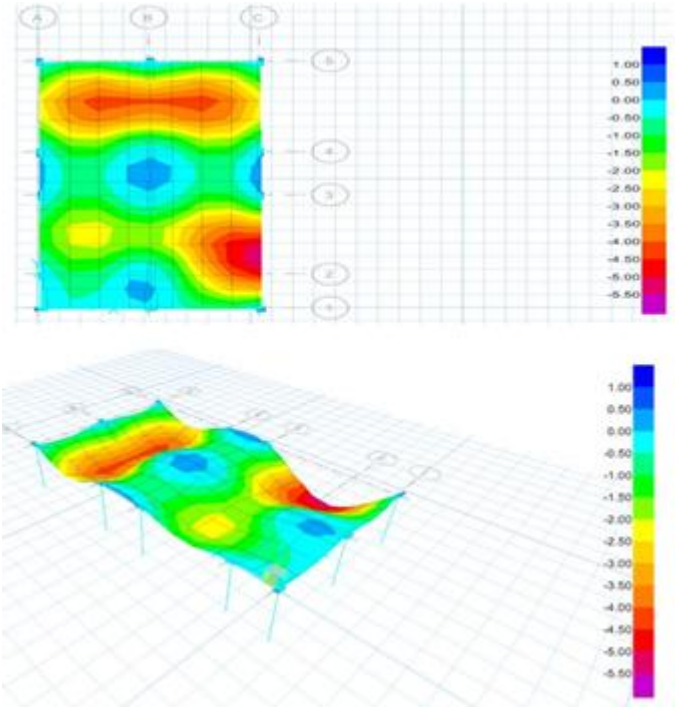


Figure.7. Plan and 3D View of Flat slab building

5.2.2 Conventional Slab

Table.3. Deflections Details of Conventional slab

S.NO	Panel	Deflection
1	S1	25.98
2	S2	26.09
3	S3	25.98
4	S4	24.75
5	S5	25.98

5.3 Detailing of conventional and flat slab

5.3.1 Flat slab

Top Bar: Layer-A

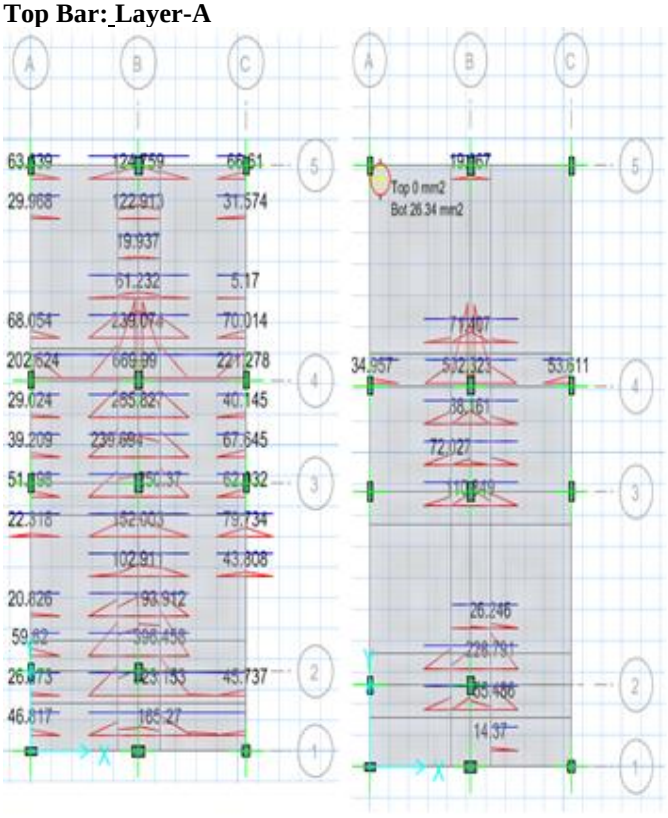


Figure.8. (a) First Layer (b) Second Layer

Layer-B

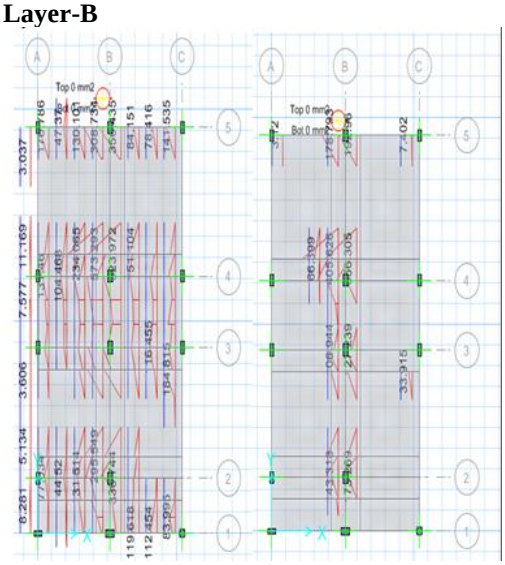


Figure.9. (a) First Layer (b) Second Layer

Bottom Bar: Layer-A

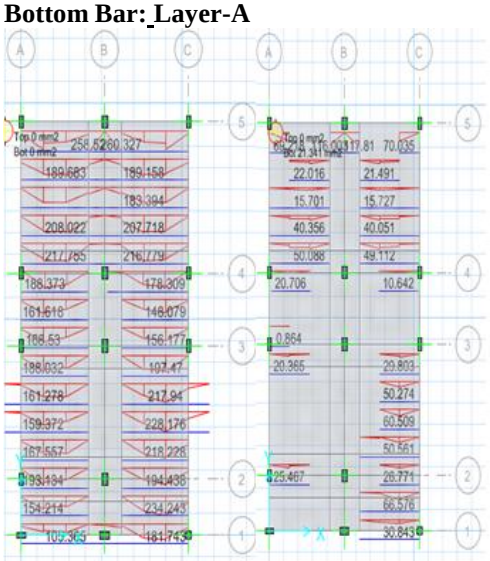


Figure.10. (a) First Layer (b) Second Layer

Layer-B

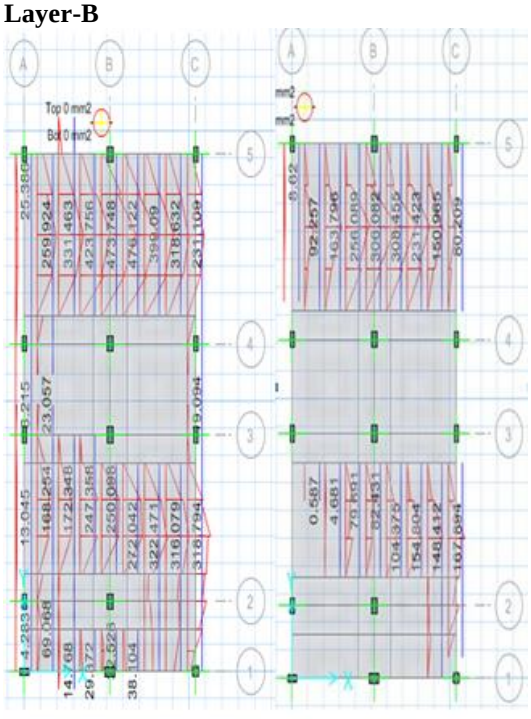


Figure.11. (a) First Layer (b) Second Layer

5.4. Steel and concrete quantity comparison

Table.4. Material comparison

Materials	Conventional	Flat slab
Steel	0.635 T	0.581 T
Concrete	38.59 T	30.64 T

As it is already mentioned above, there will be a lot of saving in terms of money. Here is the small comparative example for the clear understanding; we can see the table mentioned for steel and concrete quantities.
Steel used for conventional slab is 0.635 T and the steel used for the same area in flat slab is 0.581 T. The same happens to Concrete also the concrete used for conventional slab is 38.59 T and for flat slab is 30.64 T.

5.5 Punching Shear

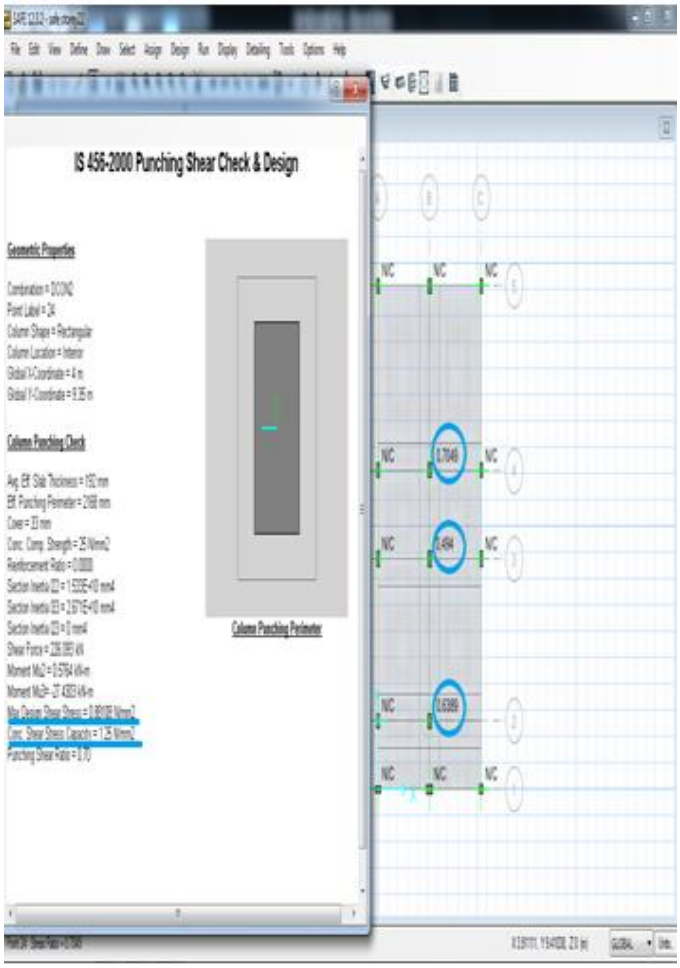


Figure.12.Punching shear ratio
From the figure 11 we can see that the punching shear ratio i.e $\tau_v / \tau_c = 0.88/1.25 = 0.704$.
τ_c- Shear stress capacity(permissible), τ_v- Design Shear stress
Hence we know that to satisfy two way shear or punching shear $\tau_v < \tau_c$ i.e $0.88 < 1.25$. Hence punching shear is satisfied.

6. CONCLUSIONS

- **Base shear:** It is observed that the base shear is increased by 15 to 20 % in case of the Flat slab when compare to Conventional slabs. It leads to slight increase in quantity of concrete and steel. But it will be compensated by eliminating beams.
- **Deflection:** It is concluded that the deflection is reduced in flat slabs compare to Conventional one because of the greater slab thickness.
- **Estimation:** It has been concluded that from the above calculations that the quantity used for flat slab is comparatively low than the conventional slabs. It is observed that the saving will be more than 20 to 25% in the flat slab.
- **Punching Shear:** It is also concluded that the flat slab is safe against Punching or two way shear.

7. SCOPE FOR THE FUTURE STUDY

To study the behavior of soft story using only one story as flat slab for parking keeping all others as conventional Beam column system. This study can be further extended to using Linear Time-History Analysis.

8. REFERENCES

[1].Mohana H.S1, Kavan M.R June-2015 "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) e-ISSN: 2395-0056 Volume: 02 Issue: 03.

[2].Amrut Manvi, Sandeep Gouripur, Pooja Sambrekar, Ramanjeet kaur, Dr.Kishor S. Kulkurni "Cost Comparison Between Conventional And Flat Slab Structures" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 03 | June-2015.

[3].Sumit Pawah, Vivek Tiwari, Madhavi Prajapati "Analytical Approach to Study Effect of Shear Wall on Flat Slab &Two Way Slab" International Journal of Emerging Technology and Advanced Engineering Website: www. ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 7, July 2014) 244.

[4]. Saumia Meenathethil Alex, Sreedevi Lekshmi "Study of Progressive Collapse Analysis of Flat Slab Building" International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391 Volume 5 Issue 7, July 2016.

[5].Mustansir S. Ezzy , Ashok R. Mundhada "Comparative Study of Wind Performance of Multistoried RCC Buildings with Flat Slab &Grid Slab" A Review international journal of research in engineering science and technology IJREST Vol-1 No-8 Dec-2015.

[6].Meera Pradeep, Sabeena M V "Seismic Behaviour of Flat Slab Building Strengthened with Perimeter Beams, Shear Walls and Beam Slab in Alternate Storey's" International Journal of Innovative Research in Science, Engineering and Technology *(An ISO 3297: 2007 Certified Organization)* Vol. 5, Issue 8, August 2016 Copyright to IJIRSET DOI: 10.15 680/IJIRSET.2016.0508042 14617.

[7]. GOURAMMA G &Dr. JAGADISH KORI G "Seismic Performance of Different Rc Slab Systems For Tall Building" International Journal of Engineering Research Vol.3. Issue.4. 2015 (July-Aug) 63 RESEARCH ARTICLE ISSN: 2321-7758.

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

[9]. Pradip S. Lande, Aniket B. Raut "Seismic Behaviour of Flat Slab Systems" Journal of Civil Engineering and Environmental Technology Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 2, Number 10; April-June, 2015 pp. 7-10.

[10].Mitan Kathrotiya1 Dr. Kaushal Parikh "Study on Flat Slab and Conventional Slab" *IJSRD - International Journal for Scientific Research & Development| Vol. 5, Issue 01, 2017 | ISSN (online): 2321-0613* .

[11]. IS 456-2000, "Plain and reinforced concrete-code of practice", bureau of Indian standards, New Delhi.

[12]. IS 875 (Part-I, II, III):1987, "code of practice for design loads for buildings and structures".

[13]. IS 1893 (Part-I):2002, "Criteria for Earthquake resistant design of structures, general provisions for buildings.

[14]. ETABS-9.7 Manuals and Tutorials.

[15]. SAFE-V12 Manuals and Tutorials.