Comparative Study of Flat Slab and Conventional Slab Structure Based on Seismic Behaviourand Cost Effectiveness

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Abstract- *Slab that is absolutely flat Recent earthquakes, in which many concrete buildings were seriously damaged or collapsed, have illustrated the significance of determining building seismic adequacy. Approximately 60% of our country's land area is exposed to damaging levels of seismic danger. We won't be able to eliminate future earthquakes, but we can definitely minimise the amount of damage and failure by adopting good building construction practises. Flat-slab structures, as one of the unique reinforced concrete structural types, need additional attention. They have numerous advantages in terms of architectural versatility, space usage, formwork ease, and construction time. However, the flat-slab construction's structural efficiency is hampered by its low performance under earthquake loading. Due to the lack of deep beams or shear walls in the flat-slab system, inadequate lateral resistance has resulted in this undesirable activity. Also when earthquakes of moderate strength occur, this causes excessive deformations that cause damage to non-structural members.*

Keywords- Cost Effectiveness, Conventional Slab,Flat Slab, Seismic Behaviour

I. INTRODUCTION

The primary aim of this research is to investigate the behaviour of a flat slab structure under seismic loading and compare it to that of a typical beam-column structure. STAAD PROs software is used to perform the analysis. Traditional R.C.C. structures and flat slab structures of various heights are modelled and analysed to achieve the target for various combinations of static loading. Also when earthquakes of moderate strength occur, this causes excessive deformations that cause damage to non-structural members. Despite the rapid growth of flat plate/slab construction in India, the literature and resources available to designers to design and engineer flat plate/slabs are minimal, both in terms of Indian standards and research papers. Slab-column connections in India are often not planned or detailed for seismic effects. There is no shearing.

At slab-column links, reinforcement (such as stirrups or stud-rails) is given. Material developments in concrete quality available for building, improvements in construction quality, and simpler design and numerical techniques have all led to India's rapid technological growth.

II. OBJECTIVES AND SCOPE

current project entails a study of reinforced concrete building systems. The main goal is to compare the seismic behaviour of two types of multistorey buildings: one that uses slab, beam, and column, and the other that uses flat slabs. Buildings with varying numbers of storeys are examined, and a comparison is made.

III. SYSTEM METHODOLOGY

Slab-column connections in India are often not planned or detailed for seismic effects. At slab-column connections, no shear reinforcement (such as stirrups or stud-rails) is provided. While an orthogonal mesh of slab bottom m reinforcement bars is given to meet a minimum requirement for temperature and shrinkage effects, there may not be a continuous bottom bar passing through the column to protect against progressive collapse after punching shear failure.

The traditional design and construction practise is to support the slabs with beams and the beams with columns. This style of construction is known as beam-slab construction. The beams lower the net clear ceiling height available. As a result, in warehouses, offices, and public halls, beams are sometimes avoided and slabs are supported directly by columns. These kinds of structures are also appealing from an aesthetic standpoint. Flat Slabs are those slabs that are directly supported by columns. A typical flat slab is depicted in Figure 3.1.

IV. RESULTS

Result and Discussion of Time History Analysis

Acceleration and displacement are two important parameter which should be taken in to account while comparison. Fig 4.34 represent acceleration time history for **Koyna** earthquake. This time history data is used for analysis of building. Top node of (G+5) and (G+10) building for Koyna earthquake is observe for comparison.

Table 4.19: Frequency Vs Time Period F2

Mode	Frequency Hz	Period seconds
1	0.464	2.156
2	0.912	1.097
3	0.953	1.049
4	1.389	0.72
5	2.313	0.432
6	2.786	0.359

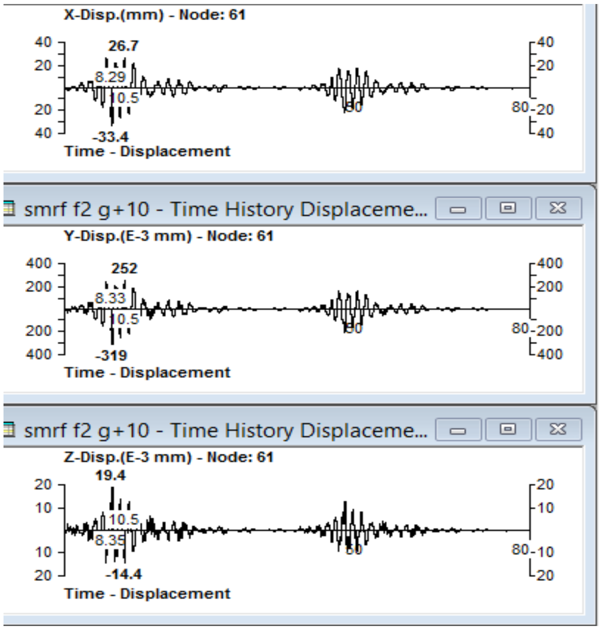


Fig 4.25: SMRF F2 Time Displacement

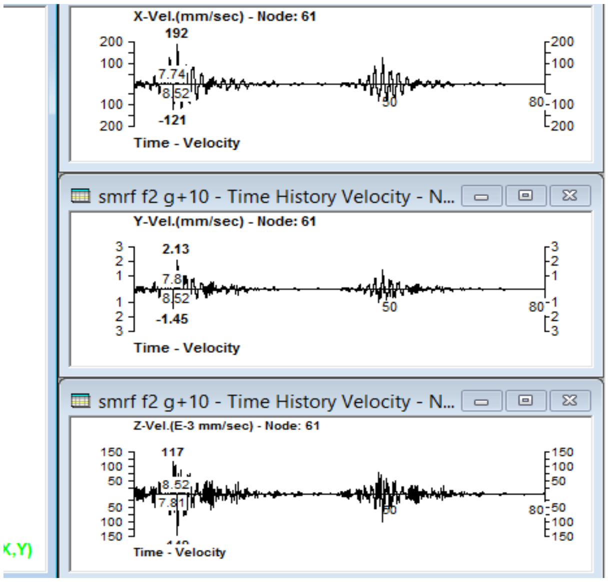


Fig 4.26: SMRF F2 Time Velocity

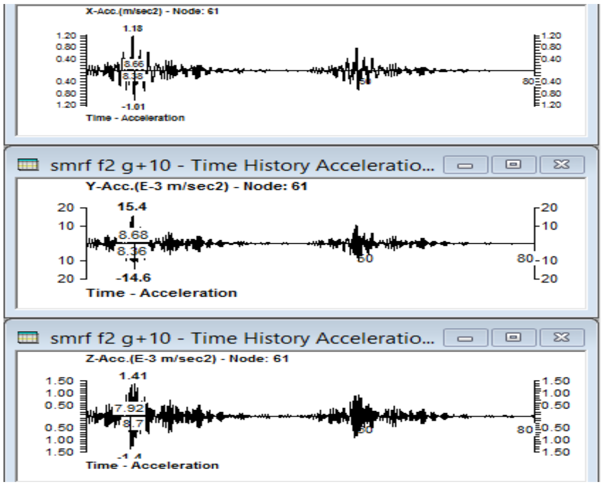
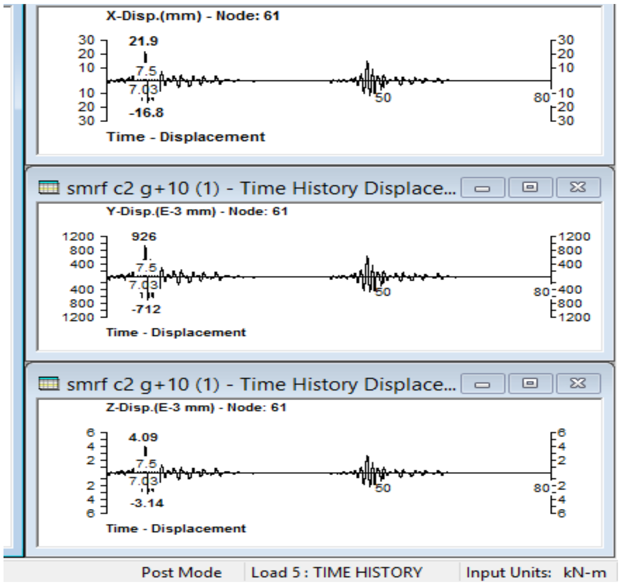


Fig 4.27: SMRF F2 Time Acceleration

Table 4.20: Frequency Vs Time Period C2

Mode	Frequency Hz	Period seconds
1	0.464	2.156
2	0.912	1.097
3	0.953	1.049
4	1.389	0.72
5	2.313	0.432
6	2.786	0.359



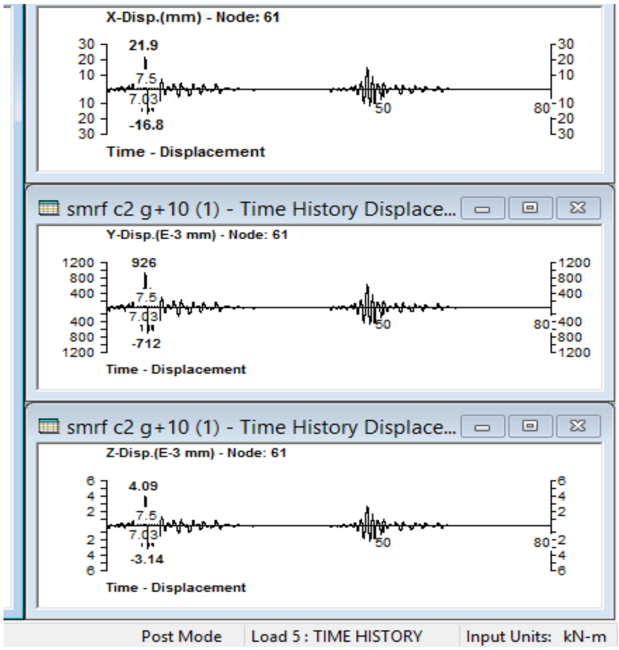


Fig 4.28: SMRF C2 Time Displacement

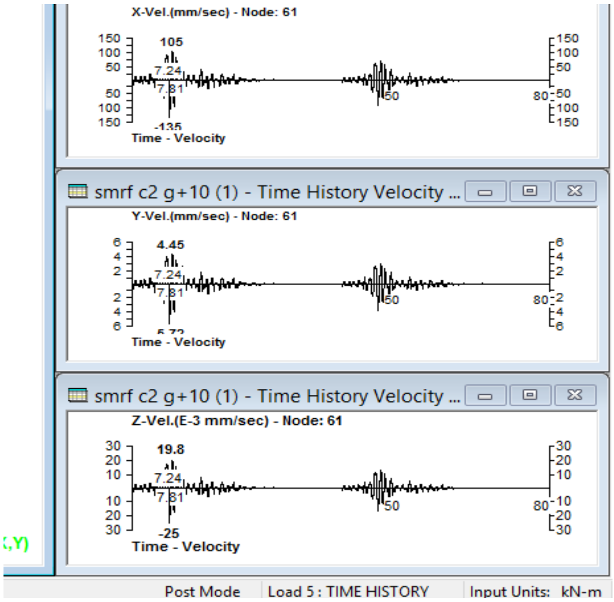


Fig 4.29: SMRF C2 Time Velocity

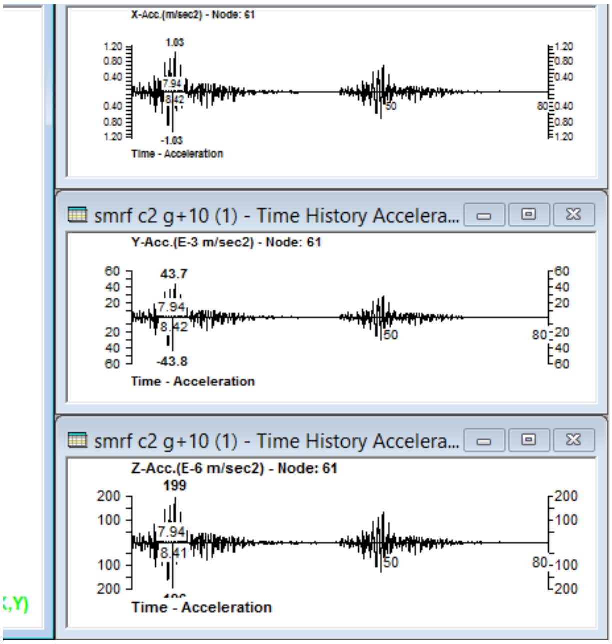


Fig 4.30: SMRF C2 Time Acceleration

Result and Discussion of Response Spectrum Analysis

In order to perform the seismic analysis and design of a structure to be built at a particular location, the actual time history record is required. However, it is not possible to have such records at each and every location. Further, the seismic analysis of structures cannot be carried out simply based on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. To overcome the above difficulties, earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions. This chapter deals with response spectrum method and its application to various types of the structures. The codal provisions as per IS:1893 (Part 1)-2002 code for response spectrum analysis of multi-story building is also summarized**.**

4.3.1 Base shear

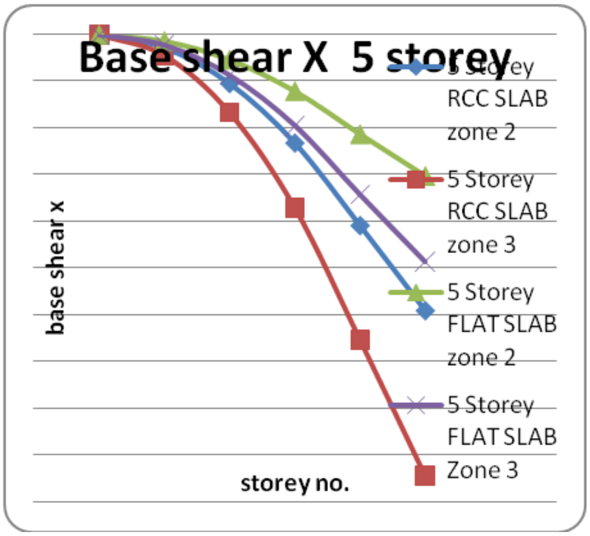
Two types of buildings are analyzedi.e. conventional beam-column building and building with flat slab for two different zones (II, III) using code response spectrum. The maximum base shears for different structures by SRSS method are given in Table 4.4.

Fig 4.20 represents the base shear for different types of structures. It is observed that base shear of conventional R.C.C building is more than of the flat slab building.

For all the structures, base shear increases as the height increases. It is observed that magnitude of base shear is significantly affected by flat slab structure. This is due to the flexibility of flat slab structure.

Table4.4: Base shear X 5 story

Name	5 Storey RCC SLAB	5 Storey RCC SLAB	5 Storey FLAT SLAB	5 Storey FLAT SLAB
	zone 2	zone 3	zone 2	Zone 3
base	0	0	0	0
storey 1	-1.39	-2.222	-0.686	-1.097
storey 2	-5.216	-8.345	-2.692	-4.307
storey 3	-11.578	-18.525	-6.056	-9.689
storey 4	-20.4	-32.651	-10.666	-17.066
storey 5	-29.49	-47.191	-15.153	-24.245



Graph4.1: Base shear X 5 story

Table4.5: Base shear X 10 story

Name	10 Storey RCC SLAB	10 Storey RCC SLAB	10 Storey FLAT SLAB	10 Storey FLAT SLAB
	Zone 2	Zone 3	Zone 2	Zone 3
base	0	0	0	0
Storey 1	-0.261	-0.418	-0.18	-0.206
Storey 2	-0.983	-1.573	-0.9	-0.809
Storey 3	-2.181	-3.489	-4.118	-1.81
Storey 4	-3.858	-6.17	-7.78	-3.211
Storey 5	-6.014	-9.622	-12.282	-5.013
Storey 6	-8.649	-13.838	-17.885	-7.215
Storey 7	-11.764	-18.823	-24.638	-9.854
Storey 8	-15.368	-24.589	-31.996	-12.94
Storey 9	-19.37	-30.995	-38.025	-15.601
Storey 10	-22.56	-36.097	-48.579	-15.003

V. CONCLUSION

A comparison of a typical beam-column building and a flat slab building subjected to seismic forces is carried out in this paper. The study's main aim is to better understand the behaviour of flat slab buildings when they are exposed to seismic loads. The following inference can be drawn based on this empirical analysis.

1. The normal time span of rises as the building's height (number of stories) increases, regardless of the form of construction (conventional or flat slab).
2. When contrasting a traditional RCC building to a flat slab building, the flat slab building takes longer than the conventional building.
3. As the height of the system increases, the base shear increases as well.
4. The base shear of a conventional RCC structure is greater than that of a flat slab structure.
5. As opposed to typical RCC construction, storey displacement in flat slab buildings is substantially higher.

REFERENCES

[1] Thomas H, K. Kang and John W. Wallace, ―Dynamic Responses of Flat Plate Systems with Shear Reinforcement‖, ACI Structural Journal, September-October 2005, pp-102-S78.

[2] Ahmad J Durrani, S.T. Mau and Amr Ahmed abou hashish and Yi Li, ―Earthquake response of flat slab structure‖, ASCE, 15 Sep 2011, pp 947-964.

[3] Emacoelho, Paulo candeias, Giorgiosanamateros, Raul zaharia, Fabio taucer and Artur v. pinto, ―Assessment of the seismic behavior of RC flat slab building structures‖, 13th World Conference on Earthquake Engineering, Canada, pp 2630.

[4] M. AltugErberik, Amr S. Elnashai, ―Fragility analysis of flat-slab structures‖, 23 February2004, pp. 937–948.

[5] Emad El-Dardiry, EndahWahyuni, TianjianJi and Brian R. Ellis, ―Improving FE models of a long-span flat concrete floor using natural frequency measurements‖, Computers and Structures, 80 (2002) pp2145–2156.

[6] M. AltugErberik and Amr S. Elnashai, ―Loss Estimation Analysis of Flat-Slab Structures‖, ASCE, pp.1527-6988-2006.

[7] Thomas H.-K. Kang, M. ASCE; John W. Wallace, M. ASCE and Kenneth J. Elwood, ―Nonlinear Modeling of Flat-Plate Systems‖, ASCE, pp 733-09-135:2-147

[8] Vipul Ahuja& Prof. B.M. Ahuja, ―Post tension flat slabs—earthquake engineering &misc aspects in high seismic zones in the india environment

[9] M. Anitha, B.Q. Rahman, JJ. Vijay "Analysis and Design of Flat Slabs Using Various Codes‖, International Institute of Information Technology, Hydrabad, 2007

[10] Kwam K. H., ―Analysis of Buildings Using Strain-Based Element with Rotational DOFs‖, Journal of Structural Engineering, ASCE, Vol. 118, No.5, May 1992, pp. 1191-1212.

[11] Avigdor Ruttenberg, ―The Seismic Shear of Ductile Cantilever Wall Systems in Multistory Structures‖, Earthquake Engineering and structural Dynamics, John Wiley & Sons, Ltd, 18 March 2004, 33:881-896, PP. 88 1-887.