A Review on Seismic Performance of Different Types of Flat Slab Building Systems with Composite Columns

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Abstract - *As flat slab building structures are comparatively more flexible than conventional concrete framed structure, so it becomes more vulnerable to seismic loading. In composite column construction, steel and concrete are integrated in that manner that the advantages of the materials are recruited in efficient manner. The main objective of this study is only to study the seismic behavior of different types of flat slab building system with composite column at different soil conditions. Seismic parameters are followed by IS-1893-2016. And also there are many types of composite columns and from those concrete encased composite column are taken for the analysis. G+15 storied Model analyses preferred from previous studies by using Etabs-2017 (Structural Analysis Software). The results expected as in the previous studies, may be flat slabs with perimeter beams gives comparatively better results. Composite column design parameters are followed by Eurocode-4 and flat slab design parameters are followed by IS-456-2000.*

Key Words*: *flat slabs, composite columns, seismic performance, etabs, response spectrum analysis, linear static analysis

1. INTRODUCTION

Reinforced concrete flat slab, also called as beamless slab, is a slab directly supported on columns without beams. A flat slab may have a drop panel and a capital both or it may be of uniform thickness without a drop panel and a capital. Slabs of overall same thickness which don't have column capitals or drop panels are referred to as flat plates. The strength of the flat plate structure is often limited due to punching shear action around columns, and consequently they are used for light loads and for relatively small spans.

A concrete-steel column is a compression column member. In a composite framed structure, columns are usually referred as load-carrying members. A steel column fabricated from built up and rolled steel shapes and encased in structural concrete or fabricated from steel pipe or tubing and filled with structural concrete where the structural steel portion accounts for minimum 4 percent of the gross area of column. A composite column is a compression member, comprising either a concrete encased hot-rolled steel section or a concrete filled hollow section of hot-rolled steel. Ggenerally it is used as a load-bearing member in a composite framed structure.

1.1 Problem Statement

In our study we are focusing on the behavior of flat slab RCC structure of different types such as flat slab with drops, flat slab without drops and flat slabs with perimeter beams which involves its behavior to earthquake condition with composite columns. As it is clear from previous literature that flat slab structure are unstable for seismic forces, we are analytically investigating the effect of flat slab generally with concrete encased composite columns and in various soil conditions. The method considering for the analysis are Response spectrum analysis method, Linear static analysis method as per IS provisions. And by using ETABS software.

2. LITERATURE REVIEW

Sanjay P. N. et al 2014 (1) works under the title, Behavior of flat slab RCC structure under earthquake loading. Flat slabs building structure are more flexible than conventional framed structure and to improve the performance of building having flat slabs under seismic loading, provision of flat slab with and without drop considered in this study. The object of this study is to comparison of the behavior of multi-storied building having flat slab with and without drop on the performance under seismic forces. Two models are analyzed, flat slabs without drop and flat slab with drop. The G+5 building structure with storey height 3.5 m is modeled in Etab software. They concluded that the drift value follows a parabolic curve along storey height with maximum value up to fourth storey. The fundamental natural period value is higher in flat slab with drop structures as compared to without drops.

Hajira Nausheen, et al 2015 (2) worked the comparison of seismic behavior of a structure with composite and conventional columns. The comparison of composite and conventional structure by keeping all other structural members same for both the structures modeled in Etabs analysis software. Composite column design is carried out by Eurocode-4 and conventional column design by IS-456-2000. And concrete enclosed composite columns to be used for analysis. The G+10 building structure is preferred to analysis the seismic behavior. After comparison the parameters, base shear for composite structure is 8 times more than conventional structure. The low overturning moment nearly 8 to 9 times difference is observed. Comparatively storey drift and displacement is less in conventional column. After this result study, conclusion is the composite column is not suitable for low rise buildings.

Niharika M. Keskar, et al 2017(3) worked on comparative study of multi-storey RC building having flat slab with and without shear wall with conventional frame structure subjected to earthquake loading. In this study, analysis of G+9 multi-storied commercial building having flat slab and with and without shear wall is done. There are three models are analyzed that are conventional framed structure, flat slab structure and flat slab with shear walls which are located at corners and centers. Study of this structure analyzed based on the parameters such as base period, base shear, and storey drift and storey displacement. After study of results they concluded that the fundamental natural period, storey shear, storey displacement, storey drift in flat slab with shear wall is comparatively much less because of shear walls provided at the corners and centers of the structure.

Vishesh P. Thakkar, et al 2017 (4) The comparative study carried out for seismic behavior of flat slab and conventional RC framed structure. In this study, different storey level buildings having flat slab with drop, without drop and conventional slab building has been analyzed. The 9 models are analyzed in Etabs software such as, G+5, G+8 and G+11 with conventional RCC, flat slab with drop, flat slab without drop. After studied the results, conclusions were made those are, conventional building has superior performance in earthquake against flat slab with drop and without drop. Flat slab with drop and column head is reduce large shear force and negative bending moment.

Vidhya Purushothaman, et al 2017 (5) The study carried out for comparison on seismic analysis of multi-storied buildings with composite column. The main objective of this paper is to comparison of composite columns with concrete filled steel tube and composite encased I-section column. Also the structural behavior of G+15 multi-storied buildings for different plan shapes such as rectangular, C-shape, L-shape, H-shapes, with two different column properties is carried out in Etabs analysis software. Conclusions are the concrete filled steel tube columns performed better in regular buildings and concrete encased I-section columns performed well in irregular shape buildings.

Athira K.B, et al 2017 (6) in this study, the seismic analysis of G+15 storey building with RCC and composite columns with GFRG (glass fiber reinforced gypsum) is carried out to study the performance of structure with RCC column and composite columns. The seismic behavior of the frames is evaluated by response spectrum analysis by Etabs software. Three models were analyzed, one with conventional concrete framed structure, and other two by using two types of composite columns, fully concrete encased steel section and partially concrete encased section. Conclusions are pointed that the conventional building can best in terms of base shear than the composite building. Storey drifts are higher in case of composite building and if compared between composite buildings, the fully concrete encased steel sections column has better performance.

Kamlesh Parihar, et al 2017 (7) works on seismic performance of flat slab shear-wall-core building. In this study, behavior of 8, 12 and 16 storey flat slab building systems without shear wall core, with 2-shear wall core as well as 4-shear wall cores have been studied at different levels of seismic conditions which are classified in IS-1893-2002 by using model analysis in SAP 2000. Conclusion of this study is the flat slab building systems acts fully different as compared to regular framed structure, due to its great lateral flexibility. And due to adding shear wall core, its lateral stiffness is fixed significantly which increases seismic performance of this dual system.

Siddalingaprasad Y. B, et al 2018 (8) worked on the composite and regular column building. And in this study, the comparative analysis of those buildings under seismic loads has been studied. For analysis and design, G+6 storey multi-storey regular building modeling by SAP-2000 is done with help of earthquake parameters zone-3 as described in IS-1893-2002. Conclusion was the composite columns performance is better than regular concrete column building also with minimum cross sectional area of the column. And composite columns are suitable for all types of buildings.

Dr. Ramkrishna Hegde, et al 2018 (9) described the comparative study on seismic analysis of conventional slab, flat slab and grid slab system for RC framed structure. In this study, G+14 storey building is considered for design and analysis for the comparison of conventional, flat and grid slab system. Models are analyzed in Etabs 2015 with IS-456-2000 parameters. The equivalent static method is used to analysis and designs the structures as described by IS-1893-2002. After observation of results, conclusion were pointed those are, seismic behavior of grid slab structure is comparatively better than flat slab and conventional slab, storey drift of grid and flat slab is 10 % less than conventional slab. And also base shear of flat slab is lower than conventional slab and grid slab.

3. SUMMARY

Some of the papers studies about the analysis of different types of flat slabs and composite columns with various conditions such as building shapes, building heights etc. It is seen that, flat slabs building with shear walls shows better results in terms of storey shear, base shear, storey drifts as compared to other types of flat slabs systems. Some studies are related to the comparison between types of composite columns. The result shows that, the concrete filled steel tube columns can gives comparatively better results. Some studies concluded that shear wall at the centers and corners shows better results as compared to other positions. Some studies deals with the comparison of different types of slabs such as conventional, flat and grid slabs. Hence it was concluded that seismic behavior of grid slab structure is comparatively better than flat slab and conventional slab.

4. CONCLUSION

Many experimental, analytical, performance and comparative works has been done by many researchers related with flat slab building system as well as composite columns. The analysis of different types of flat slabs with conventional columns has been studied in previous researches, also the performance based studies on composite columns with their different types has been done. The limited works are done on combination of flat slab and composite columns.

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