

Comparative Analysis of Flat Slabs with & Without Shear Wall under Seismic Effects - A Literature Review

Aakash Makker¹ Rahul Sharma²

¹PG Scholars ²Assistant Professor

^{1,2}Department of Civil Engineering

^{1,2}Prashanti Institute of Technology and Science, Ujjain, India

Abstract— In recent times, Flat slab buildings are generally used for the construction because use of flat slab building provides many advantages above conventional RC Frame building in terms of economy, make use of space, easier formwork, architectural flexibility and mostly shorter construction time. The structural effectiveness of the Flat slab construction is mainly difficult by its meager performance under earthquake loading. It is essential to analyze seismic behavior of buildings to observe what are the changes are going to arise for the conventional RC frame building, flat slab building with and without shear wall respectively. The analysis is done with STAAD .PRO V8i software. The characteristics seismic behavior of conventional RC frame building, flat slab buildings imply that supplementary measures for guiding the formation and design of these structures in seismic regions are desirable and to increase the performance of building having conventional RC building, flat slabs under seismic loading. The object of the present study covers the behavior of multi-storey buildings having conventional RC slab building, flat slabs and to study the performance of these types of buildings under seismic forces. Current study covers information on the parameters storey drift, lateral displacement, seismic base shear, storey shear.

Keywords: Flat Slabs, RC Frame building, storey drift, lateral displacement, Storey shear, Seismic Base shear, STAAD.PRO

I. INTRODUCTION

India at present is fastest growing country in economy which brings demands in rising of infrastructure amenities along with the development of population. The demand of property in urban areas is rising day by day, In order to neutralize this demand in these urban areas erect development is the only option. This type of development brings challenges to neutralize extra lateral loads due to wind and earthquake.

Widespread practice of design and construction is to maintain the slabs by beams and support the beams by columns. This may be called as beam slab construction. The depth of beams decreases the existing net clear ceiling height. Hence in offices, community halls and houses, occasionally beams are avoided and slabs are directly supported on columns. These types of construction develop the visual manifestation. These slabs which are directly supported on columns are called Flat slabs. These flat slabs are also called as beamless slabs. The part of slab surrounded on each of the four sides by centre line of column is called panel. Panel is divided into column stripe and middle stripe. The flat slab is thickened congested to supporting columns to provide tolerable strength in shear and to ease the amount of negative reinforcement.

In 1914 Eddy and Turner were first to write on flat slabs. The flat slabs directly rest on columns and walls above

added forms of construction and advantages are enhanced lightning, cheaper cost, better efficiency of appearance, speed of construction and improved safety is unanimously accepted as to render any consistent information related to the precise computation of stresses in flat slab construction is of enormous interest.

The research has been carried out to discover the behavior of slab column connection. The failure approach depends leading the type and degree of loading. Punching shear strength of slab column connection is of significance which depends on the gravity shear ratio. The system of transfer of moments from slab to column is very composite when subjected to lateral loading and unstable moments. These unstable moments produce further shear and torsion at the connections and then get transfer into the column which consequences in unnecessary cracking of slab leading to further decline in the stiffness of the slab.

A shear wall is a structural system composed of parallel walls that oppose the effects of lateral loads applied on a structure. Wind and seismic loads are mainly applied that shear walls are designed to carry.

Shear walls are not only designed to resist gravity/ vertical loads (due to self-weight and other living/ moving loads), but they are also designed for lateral loads due to earthquakes / winds. The walls are structurally included with roofs / floors and other lateral walls consecutively at right angles, thus giving the three dimensional stability to the building. Walls are made to resist the uplift forces caused by the drag of the wind. Walls also have to resist the shear forces that make an effort to push the walls over. Shear walls are rapid to construct, Shear walls don't need any additional plastering or finishing as the wall itself gives a high level of accuracy & it don't require plastering.

A. Comparative Study of Flat Slab and Conventional Slab

The Flat slab building in which slab is directly supported by columns, have been adopt in many building constructed a moment ago, due to the benefit of being reduction in floor to floor height. Conventional slab system comprises of thin beams placed at regular intervals in perpendicular directions, massive with slab. The seismic performance of buildings having conventional slab and flat slab is equivalent but the differences exist. Tall buildings with flat slab system are weaker in shear whereas those with conventional slab system are strong but taller and specially less friendly. Flat slab is quite general which enhances the weight drop, pace up construction, and cheap. Conventional slab has got features like more stiffness, higher load carrying capacity, safe and economical also. Conventional Reinforced Concrete (RC) slab buildings are generally used for the construction. The utilization of flat slab building provides many merits over conventional RC frame building in terms of architectural flexibility; make use of space, easier formwork and shorter

construction time. The mass of flat slab structure is less compared to conventional slab structure.

B. Analysis Methods

Equivalent Static Analysis: Seismic analysis of most of the structures is yet carried out on the theory that the lateral force is equivalent to the actual loading. This technique of finding design due to lateral forces is also known as the static method or the equivalent lateral force method or the seismic coefficient method.

Response Spectrum Analysis: This method is also known as modal method or mode superposition method. The method is relevant to those structures where modes other than the fundamental one extensively influence the response of the structure. Usually, the method is related to analysis of the dynamic response of structures, which are asymmetrical or enclose areas of discontinuity or irregularity, in their linear range of behaviour.

Time History Analysis: A time history analysis overcome all the demerits of a modal response spectrum analysis. This method require better computational efforts for finding the response at distinct times. One remarkable merit of such a method is that the comparative signs of response quantities are conserved in the response histories. This is significant when interaction property are taken along with stress resultants.

II. LITERATURE REVIEW

A brief review of previous studies on the comparative analysis of the Conventional and Flat slabs structure. This literature review also includes previous studies on comparative analysis of flat slab structure with and without shear wall. This literature review is on recent contribution related to Comparative Analysis of Flat slabs & Conventional RC slabs with and without shear wall and past efforts most closely related to aspects of present work.

- 1) Vikunj k.Tilva, Prof. B.A.Vyas (2011) in their paper presented that to aim a comparison between flat slab panel with drop and without drop in four storey lateral load resisting model. A four storey structure is subjected to gravity load + lateral load using ETABS software and each storey was exported to SAFE software for analyzing punching effect due to lateral loads. On the beginning of permissible punching shear criterion on accordance with IS 456, economical thickness of flat slab with drop and without drop are preferred the results showed that since economic point of view slab with drop provision is preferable. Also punching shear stress is abridged by adopting drop at slab-column connection.
- 2) Dr. Uttamasha Gupta, Shruti Ratnaparkhe, Padma Gome (2012) in their paper presented work to compare the behaviour of multi-storey buildings having flat slabs with drops with that of having two way slabs with beams and to analyze the cause of part shear walls on the performance of these two types of models under seismic forces. Present work provides a good source of information on the parameters lateral displacement, seismic base shear, storey shear and storey drift. Despite the cases taken drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey. Use of flat slabs with shear wall in increase in drift values in similar plans as compared to conventional slabs with shear wall. Still all drift values are within permissible limits even without shear walls. In zone V use of flat slabs with shear wall in comparison to conventional slab arrangements alters the maximum lateral displacement values, however, these all are well within permissible limits, even without shear walls. Similarly, storey shear for flat slabs with shear wall as compared to conventional slab system with shear wall has is increased to a great extent.
- 3) Sharad P. Desai, Swapnil B. Cholekar (2013) in their paper presented that the Dynamic response of Flat slab with drop and without drop and Conventional RC Framed Structures, for different height with and without masonry infill wall. Dynamic analysis for diverse types of building is done by using Response Spectrum method for earthquake zone III as per I S code. The consequence of Flat slab with drop and Flat slab without drop taking into consideration with and without masonry infill wall is evaluated. It was found a major alteration in the seismic parameters such as Fundamental Natural Period, Design Base Shear, Displacement and Axial Force of the structure.
- 4) Rajiv M S, Guru Prasad T N, (2015)in their paper analyzed about work to compare the behavior of multi-storey buildings having flat slabs with drops to that of having two way slabs (conventional slab). The consequence of part shear walls on the performance of different types of buildings [(G+7) and (G+14)] under seismic forces are considered. Equivalent static force method, Response spectrum method and Time history analysis were considered for diverse types of models and relative results were drawn. The natural mode (time) period increases as the height of building increases, irrespective of type of building conventional slab (bare), flat slab (bare) and flat slab with shear wall. On the other hand, the time period is more for conventional slab and flat slab with bare frame compared with that of flat slab with shear wall for dissimilar models due to stiffness participation factor being less in bare frame for both storeys. This presents a summary of the project work, for conventional R.C.C building, flat slab building and flat slab building with shear wall at diverse locations for different types of building [(G+7) and (G+14)] in the seismic region.
- 5) Rajini .A .T, Dr. Manjunath N Hegde (2016) in their paper analyzed about comparative study of the behaviour of flat slab and conventional slab structures of 20 stories in diverse cases. Conventional RC slab and flat slab structure, flat slab structure with column drop, conventional structure and flat slab structure with shear wall at diverse locations were analyzed by taking into consideration two typical zones of zone III and zone V, through dynamic response spectrum analysis by using ETABS software. Comparing the results of all models in condition of time period and frequency, lateral displacements, story shear and story drifts by plotting graphs.. Flat slab structure with arrangement of column drop and shear wall is performed extremely fine under seismic loads to decrease the displacements and drifts

- with enhancement in stiffness of building. This paper summarized a review of the study, for conventional R.C.
- 6) Mitan Kathrotiya, Dr. Kaushal Parikh (2017) in paper summarizes, the revised study of the performance of multi-storey building having conventional RC frame structure, flat Slabs and to study the consequence of the models under the seismic forces. The model was subjected to various loading condition in special Seismic Zone and for diverse Soil condition. The seismic performance of the flat Slab and the conventional RC building was analyzed using different software aid. Due to the seismic behavior, the performance of the building was analyzed. This study includes a variety of info on the seismic parameters say storey drift, seismic base shear, and natural time period, Depending on the study they concluded that Lateral Displacement at middle stories level is maximum. The displacement of the flat slab structure decreases by stipulation of shear wall. Due to the increase in the number of floor the lateral Displacement increases. The natural time period increases as the numbers of floors increases. Depending on assessment from different case studies, the subsequent conclusions are being carried out, as time period is more for conventional building than flat slab structure due to huge construction.

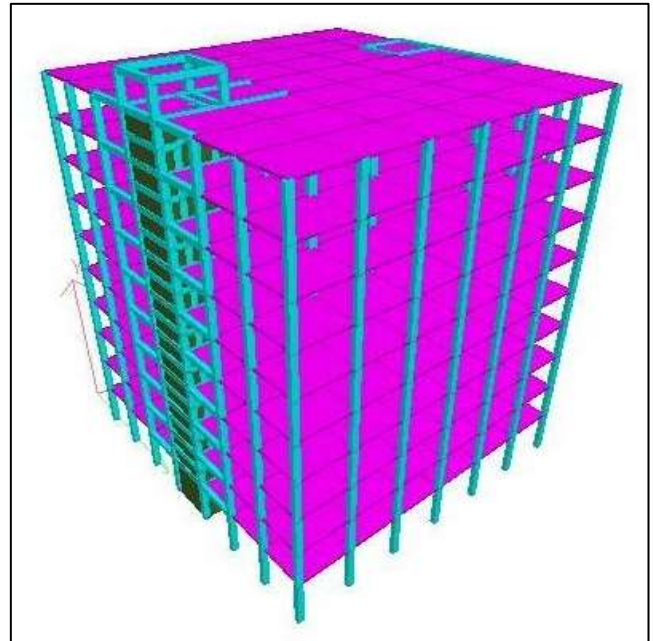
III. METHODOLOGY

The multi-storied RC slab buildings are modeled in STAAD.PRO software. The buildings consist of stories G+10 is unique moment resisting frame assumed to be situated in seismic zone V. Buildings are modeled in STAAD.PRO software, are subjected to gravity and dynamic loads are analyzed by equivalent static analysis, response spectrum analysis, time history analysis is carried out taking data. Beams and column members have been defined as concrete area elements. Conventional Slabs are defined as area elements having the properties of concrete area elements and plate element, Flat slabs having the properties of plate element, Also shear walls are defined as surface elements. Buildings having grade of concrete for beam, column, slab is M40 with unit weight of concrete being 25kN/m³. Column size for building up to 10th floor is 1.5m x 1.5m, while the beam size is 0.40m x 0.60m. The Building models having each storey height of 3m.

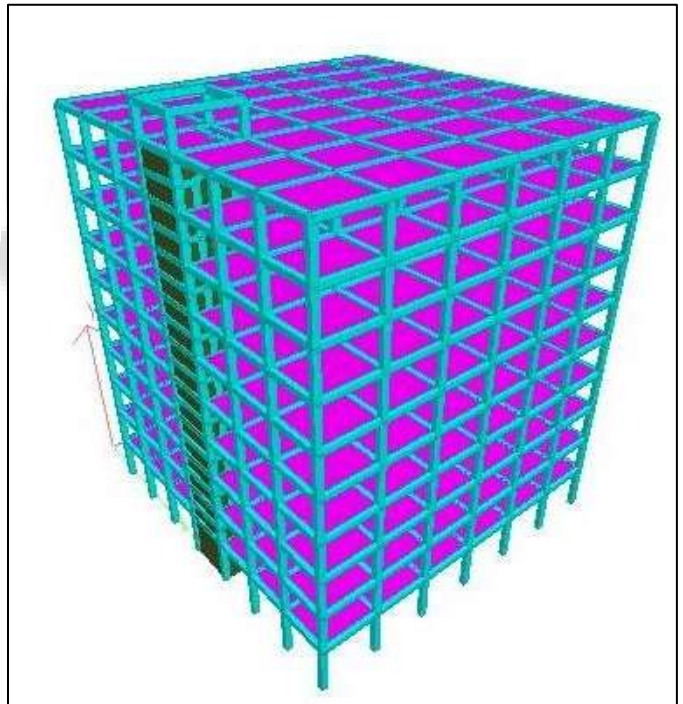
A. Explanation of Various Building Models

- MODEL 1: FLAT SLAB SYSTEM OF 150mm WITHOUT SHEAR WALL.
- MODEL 2: CONVENTIONAL SLAB SYSTEM OF 150mm WITHOUT SHEAR WALL.
- MODEL 3: FLAT SLAB SYSTEM OF 150mm WITH SHEAR WALL ALONG X DIRECTION.
- MODEL 4: CONVENTIONAL SLAB SYSTEM OF 150mm WITH SHEAR WALL ALONG X DIRECTION.
- MODEL 5: FLAT SLAB SYSTEM OF 150mm WITH SHEAR WALL ALONG Z DIRECTION.
- MODEL 6: CONVENTIONAL SLAB SYSTEM OF 150mm WITH SHEAR WALL ALONG Z DIRECTION.

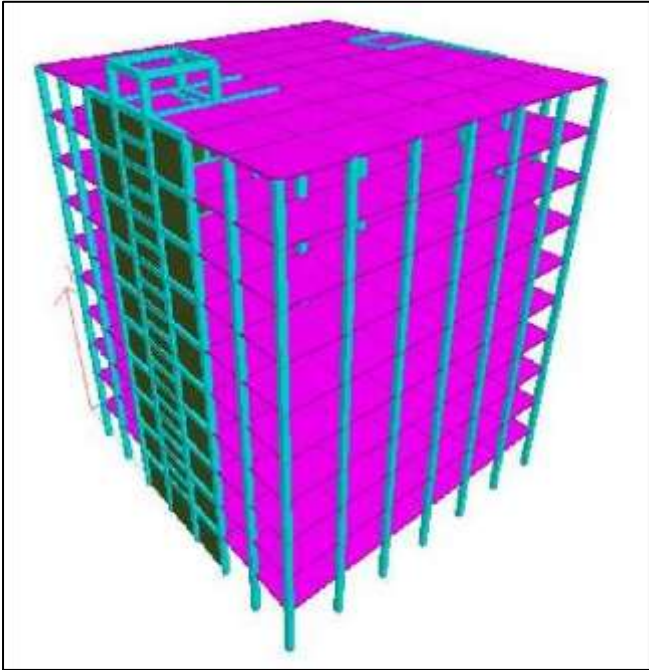
Here is 3-dimensional view of structure representing the structure models in their details shown in (fig 3.04, 3.05, 3.06, 3.07, 3.08, 3.09).



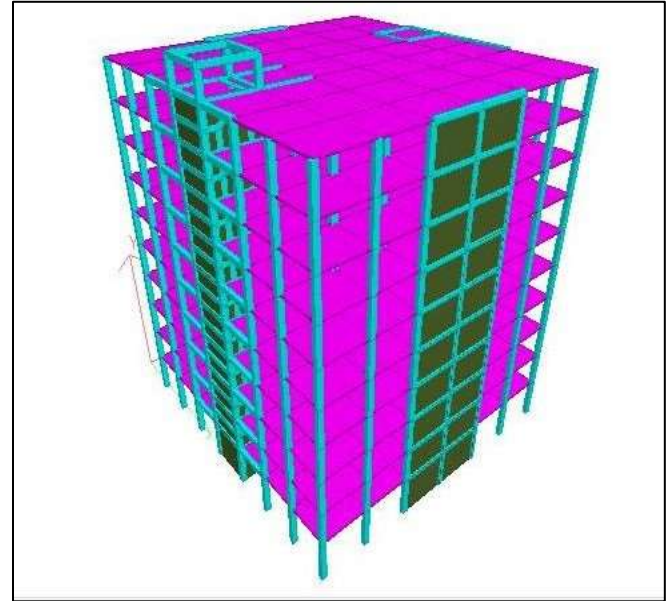
3-D model of model 1 of Flat slab without shear wall.



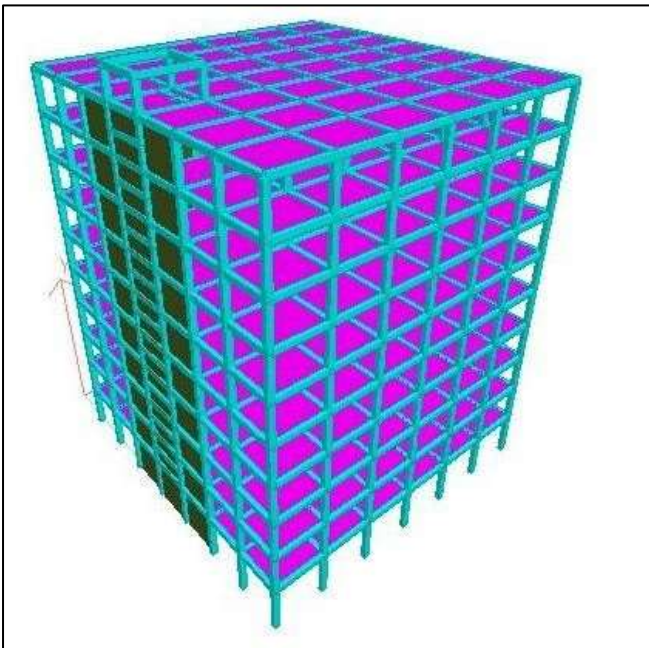
3-D model of model 2 of Conventional slab without shear wall.



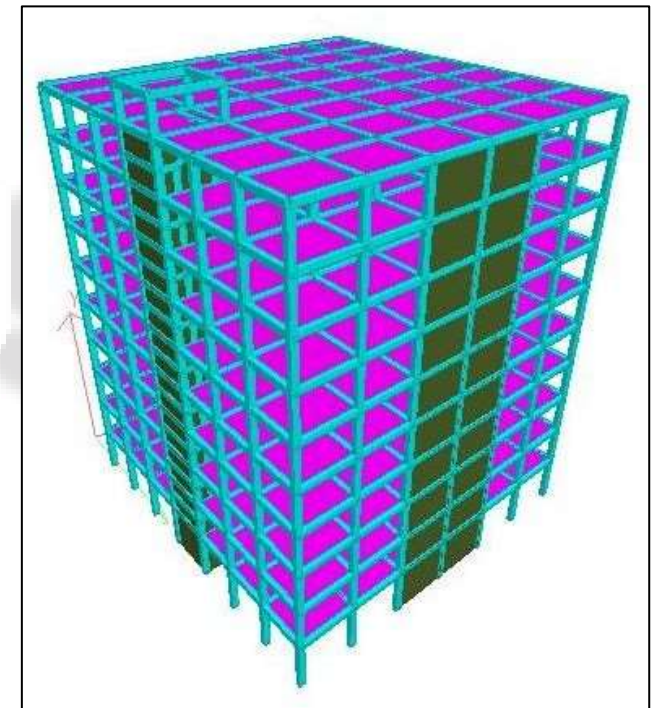
3-D model of model 3 of Flat slab with shear wall in X-direction.



3-D model of model 5 of Flat slab with shear wall in Z-direction.



3-D model of model 4 of Conventional slab with shear wall in X-direction.



3-D model of model 6 of Conventional slab with shear wall in Z-direction.

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