COMPARATIVE ANALYSIS OF FLAT SLABS & CONVENTIONAL RC SLABS WITH AND WITHOUT SHEAR WALL

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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.

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

1. 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 decrease 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.

1.1 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.

1.2 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.

2. 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 elements, 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 $25kN/m^3$. Column size for building up to 10^{th} floor is 1.5mx1.5m, while the beam size is 0.40mx0.60m.The Building models having each storey height of 3m.

EXPLANATION OF VARIOUS BUILDING MODELS

MODEL 1: FLAT SLAB SYSTEM OF 150mm WITHOUT SHEAR WALL.

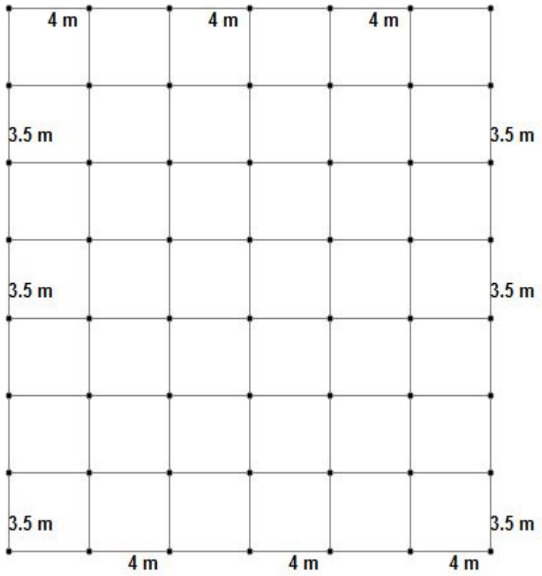
MODEL 2: CONVENTIONAL SLAB SYSTEM OF 150mm WITHOUT SHEAR WALL.

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: CONENTIONAL SLAB SYSTEM OF 150mm WITH SHEAR WALL ALONG Z DIRECTION.



PLAN AREA (24 X 24.5) m

FIG. A: PLAN OF CONVENTIONAL SLAB WITHOUT SHEAR WALL FOR 10 STOREY BLDG. .

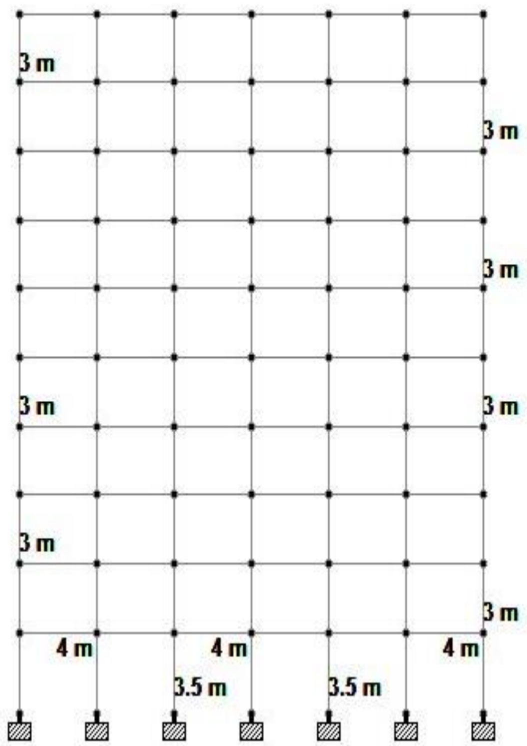


FIG. B: ELEVATION OF CONVENTIONAL SLAB WITHOUT SHEAR WALL FOR 10 STOREY BLDG

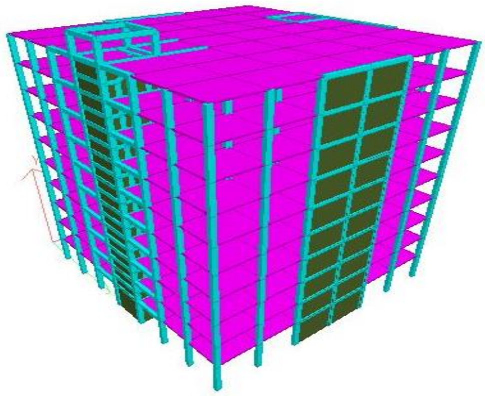


FIG. C: 3D VIEW OF FLAT SLAB WITH SHEAR WALL IN Z DIRECTION.

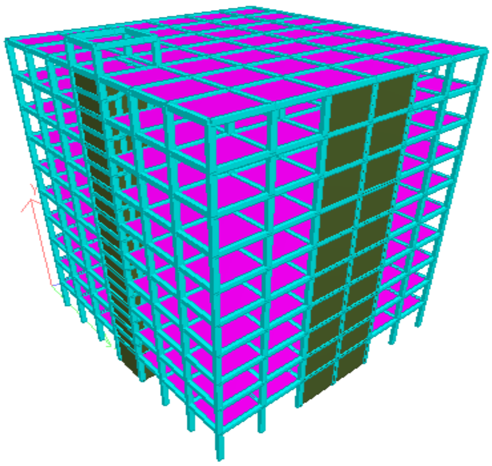


FIG.D: 3D VIEW OF CONVENTIONAL SLAB WITH SHEAR WALL IN Z DIRECTION.

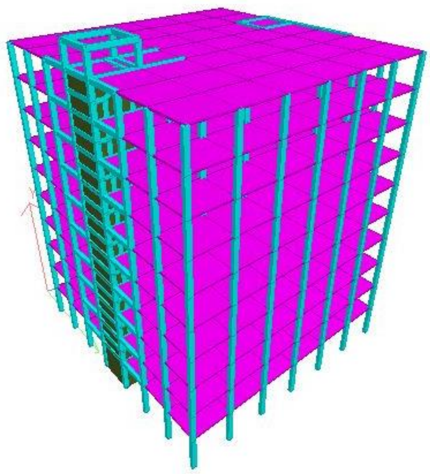


FIG. E: 3D VIEW OF FLAT SLAB WITHOUT SHEAR WALL

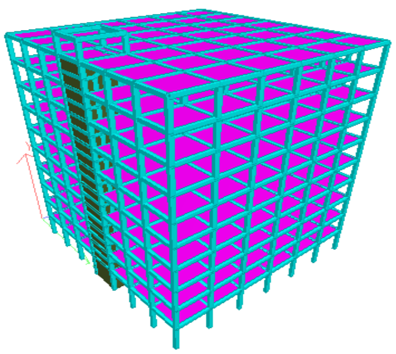


FIG. F: 3D VIEW OF CONVENTIONAL SLAB WITHOUT SHEAR WALL.

3. RESULTS AND DISCUSSIONS

The majority of the past studies on unlike buildings such symmetrical and unsymmetrical have adopted idealized structural models of flat slabs. Even though these models are sufficient to recognize the general behaviour and dynamic individuality, it would be remarkable to know how authentic building will respond to seismic forces. For this cause a hypothetical building located on a plane ground having analogous ground floor plan have been considered as structural system for the analysis.

3.1 STOREY SHEAR

The results are tabulated and represented in FIG 3.1, in which it is observed that the storey shear is maximum at base level and minimum at top level for all types of models. After the base level the storey shear decreases as the storey level increases.

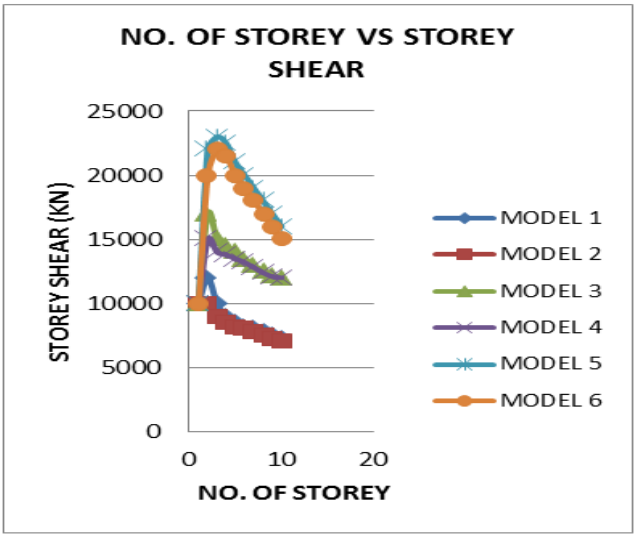


FIG 3.1: STOREY SHEAR FOR DIFFERENT MODELS OF TEN STOREY BUILDING.

3.2 LATERAL DISPLACEMENT

The analysis results have been tabulated and represented in FIG 3.2 , in which it is observed that the lateral displacement is maximum at top level for all types of models. Lateral displacement is minimum at base level and maximum at top level thus as the storey level increases lateral displacements also increases.

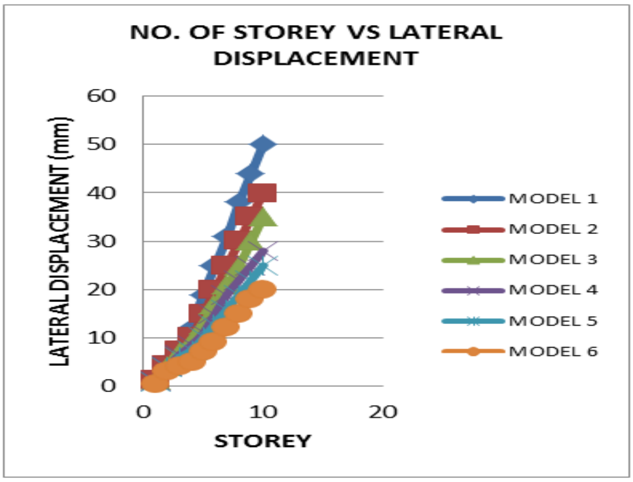


FIG 3.2: LATERAL DISPLACEMENT FOR DIFFERENT MODELS OF TEN STOREY BUILDING.

3.3 STOREY DRIFT

The results have been tabulated and represented in FIG 3.3, in which it is observed that the storey drift is minimum at base level, increases upto middle stories and then decreases upto top level for all types of models.

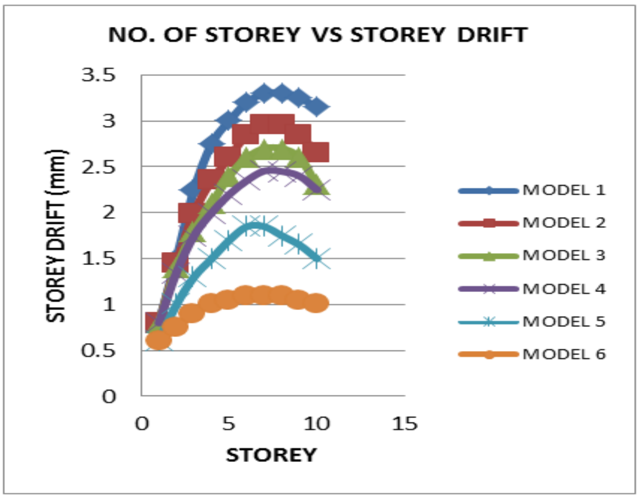


FIG 3.3: STOREY DRIFT FOR DIFFERENT MODELS OF TEN STOREY BUILDING.

3.4 SEISMIC BASE SHEAR

Comparison of base shear is made between ESA, RSA and THA. in FIG 3.4 , in which it clearly SHOWS that the Base shear obtained from THA gives considerably greater base shear values than ESA and RSA. By considering THA will leads to uneconomical design of structural members and over estimation of structural capacity of members.

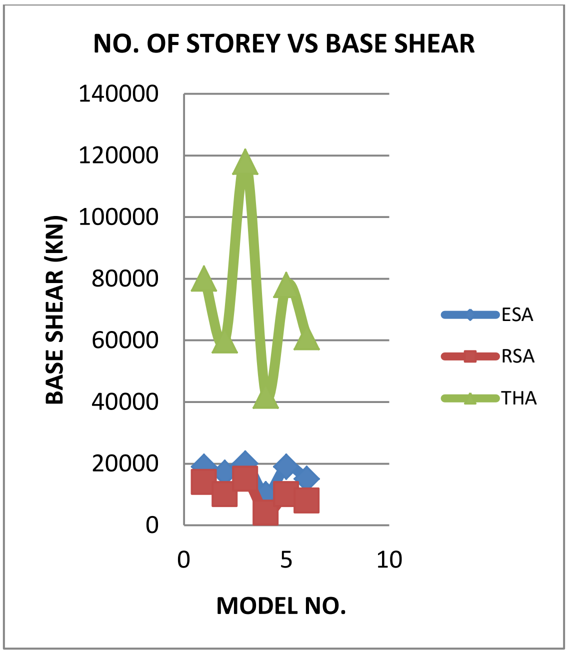


FIG 3.4: SEISMIC BASE SHEAR FOR DIFFERENT MODELS TEN STOREY BUILDING.

4. CONCLUSIONS

1) The Storey shear value is maximum at base level and minimum at top level for all types of models. After the base level the Storey shear decreases as the storey level increases. It is because the storey shear is seen as distribution of base shear along its storey based on stiffness and mass.

2) The Storey shear of flat slab building is more than the conventional slab building .It is due to the stiffness of conventional slab being more as compared to flat slab. Storey shear simply means the lateral forces because of earthquake at different floors.

3) The Lateral displacement is maximum at top level for all types of models. Lateral displacement is minimum at the base level and maximum at the top level thus as storey level increases lateral displacement also increases .It is because sway is directly proportional to height and slenderness of structure i.e. lateral displacement increases as height of building increases.

4) The Lateral displacement of flat slab building is more than conventional slab building. It is because of the presence of beam in conventional slab which has more stiffness compared to flat slab. Conventional slab also has higher load carrying capacity.

5) The Storey drift is minimum at base level, increases upto middle stories and decreases upto top level for all types of models .It is because storey drift of particular floor is inversely proportional to height of the floor.

6) The Storey drift with flat slab construction is significantly more as compared to the conventional slab building. It is because Storey drift is defined as the ratio of lateral displacement of two consecutive floor to height of that floor and also since stiffness of conventional slab being more than flat slab.

7) The Base shear obtained from THA gives considerably greater Base shear values than ESA and RSA. It is generally since THA stands for non-linear elastic analysis and dynamic analysis, in which all possible storey force are generated during entire duration of ground motion at equal interval while RSA is linear elastic analysis and dynamic analysis, in which storey forces value is generated on the basis of eigen vectors, storey accelerations and mass of the storey providing realistic dynamic response of the building. Similarly, ESA stands for linear elastic analysis and static analysis in which storey force value is generated on the basis of approximate period of the building, site specific ground acceleration and response spectrum curve. Seismic base shear is equal to the sum of all the storey shear forces at different floor

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