Comparative Analysis Of G+10 High Rise Building Frame Considering Three Different Slabs

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Abstract- *Due to the freedom of space design, quicker construction time, architectural functionality, and economic factors, flat-slab building designs have significant advantages over typical slab-beam-column systems. The lack of deep beams and shear walls makes flat-slab structural systems far more flexible for lateral stresses than standard RC frame systems, which increases the system's susceptibility to seismic occurrences. The critical moment in design of these systems is the slab-column connection, i.e., the shear force in the slab at the connection, which should retain its bearing capacity even at maximal displacements.*

In this study we are comparing a G+10 High rise building frame considering three different slab conditions i.e. conventional slab, flat slab and flat slab with staggered beams. For analysis we are utilizing analysis tool ETABS.

Keywords- Response Spectrum Analysis, Flat Slab, Flat Slab with Perimeter Beam, ETABS , story displacement, story stiffness, story drift, time period.

I. INTRODUCTION

Buildings' flat surfaces (floors and ceilings) are provided by reinforced concrete slabs, which are an essential structural component. Slabs are typically divided into one-way slabs and two-way slabs depending on the reinforcement that is present, the support provided by the beam, and the ratio of the spans. The former is supported on two sides, and there is a greater than two-to-one ratio between the long and short spans. The latter, however, is supported on four sides and has a shorter long to short span ratio than two.

Regarding the type of building, architectural arrangement, aesthetic elements, and span length, various variables and requirements call for the selection of an acceptable and affordable concrete slab. Concrete slabs, therefore, are further classified into one-way joist slab, flat slab, flat plate, waffle slab, hollow core slab, precast slab, slabs on grade, hardy slab, and composite slab.

II. COMPONENTS OF FLAT SLAB

Panel

Panel is defined as a part of a slab bounded on-each of its four sides by the centre-line of a Column or centre-lines of adjacent-spans.

Drops

When available, the drops must have a rectangular plan and a length in each direction that is at least one-third the length of the panel in that direction. One-half the width of the drop for interior panels shall be required for drops at right angles to the non-continuous edge and measured from the centre line of the columns for exterior panels.

Column Head

When column heads are present, the section of the column head that is within the biggest right circular cone or pyramid with a vertex angle of 900 and that may be completely encapsulated within the outlines of the column and the column head shall be taken into consideration for design purposes.

Column Strip

The term "column strip" refers to a design strip that is placed on either side of the column's centre line and has a width of 0.25L2, but not more than 0.25L1, where L1 is the span measured from the centre of the supports in the direction moments are being calculated and L2 is the span measured from the centre of the supports in the direction L1 is the span transverse to L1.

Middle Strip

A design strip that has a column strip enclosing each of its opposite sides is referred to as the middle strip.

III. OBJECTIVES

1. To determine the behaviour of high rise building frame under seismic load as per I.S. 1893-I:2016
2. To determine the effectiveness of flat slab in comparison with conventional grid slab.
3. To determine the utilization of ETABS software in analysis of high rise RCC building structure.
4. To provide comparative analysis results of conventional, flat slab and flat slab with staggered beam structure in terms of forces, moment, displacement and drift.

IV. LITERATURE REVIEW

Ajinkya M. Balate and H. R. Magar Patil (2020) objective of the research paper was to evaluate the response reduction factors of eight storey flat slab building by using ETABS software and analyse the flat slab building using pushover analysis method for different response reduction factors and seismic zones. Parameters such as base shear, shear and bending stresses and deflection check in flat slab structure were examined using ETABS Software.

Results stated that the flat slab gave maximum bending moment at end corner as it behaves similarly to cantilever slab. Earthquake cases for Zone III and IV, the maximum bending moment is given which gives more difference. In these cases provide more depth then the slab depth. It is also necessary to construct a peripheral beam as well as to provide shear wall at the corner of building design so as to improve sustainability of it and will also provide extra bottom steel for slab.

I.Oviya et.al (2020) research paper directed relative concentrate on seismic way of behaving of level section building and customary structure and examination and plan of IT park including estimation of seismic reaction range, time history investigation and warm burden computation. The plan estimations were done physically and cross checked with the assistance of programming, displayed as 3D space outline in ETABS programming.

Results expressed that story removal was high at popular narrative and least at the foundation of the designs. As the level of the structure builds the worth of uprooting likewise increments. The removal worth of level piece without drop building was around 63% higher contrasted with regular RC Casing building and 45.2% higher contrasted with level chunk with drop building. Story float follows an explanatory way along story level with most extreme worth lying some place close to the story three. After story three, story float diminishes as the level of building increments. The story float of level section without drop building is around 42.56 % higher contrasted with regular RC Edge building and 25.12 % higher contrasted with level piece with drop building. Story float follows an explanatory way along story level with greatest worth lying some place close to the story three. After story three, story float diminishes as the level of building increments. The story float of level section without drop building is around 42.56 % higher contrasted with regular RC Casing building and 25.12 % higher contrasted with level chunk with drop building.

Nadeem Ahmed et.al (2020) research paper analyzed and investigated the comparative seismic performance of conventional and flat slab structures with and without shear wall using ETABS. This research was mainly based on Response spectrum analysis which was linear dynamic analysis to know the seismic performance of the structures. Analysis were done as per IS:1893-2002, and all the RCC members were designed as per IS: 456-2000. Load Calculations were calculated as per IS: 875 Codes.
Results provide best information on storey drifts, displacements, stiffness and storey shears and show its performance on different conditions of the structure.

S. DhanaSree and E. Arunakanthi (2020) research paper analyzed the effect of drop panels on the behavior of flat slab during lateral loads. Zone factor and soil conditions- the other two important parameters which influence the behavior of the structure, are also covered using ETABS. In this study relation between the number of stories, zone and soil condition was developed. Due to no beams with more depth, flat slab structures was able to take lateral loads and resulted in more vulnerability under seismic events.

Results stated that the maximum displacements of both the structures was within the permissible limit. Storey displacement is more at top storey and less at base of the structure. With increase in building height displacement also increases. Storey drifts are maximum in the middle stories. That means columns are stiffer in bottom and top stories and weaker in the mid level of the structure. Flat slab with proper design against earthquakes could resist the damage to a considerable extent.

Kalyani Gulabrao Ahirrao and Hemant Dahake (2020) in the research paper, a G+8, G+12 and G+15 multi-storied structure having level chunk with drop, level section without drop and regular piece has been broke down utilizing ETABS programming for that parameters such as story deformation, story drift, storey shear and time period.

Results stated that inter-story drifts decrease up to 15-20%.As per modal analysis after providing beam at periphery of the structure maximum story displacement was minimize. Storey drift as analyzed by linear static analysis was found to exceed maximum permissible limit to according to IS 1893: 2002. Thus, demanding lateral load resisting system so provision of shear wall is must in this case.

V. ANALYSIS RESULTS

In this research, three cases were considered as mentioned in the chapter above and a comparative analysis was conducted to obtain the appropriate slab type to understand its behaviour on a G+10 storey structure. The results were evaluated on parameters of storey displacement, storey drift, storey stiffness, axial forces and further conducted cost comparison.

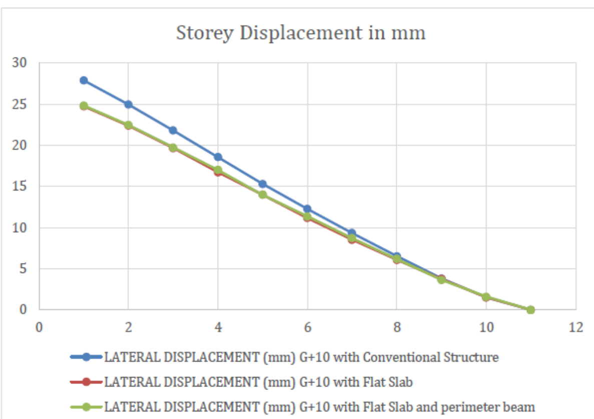

Fig 1 Storey Displacement in mm

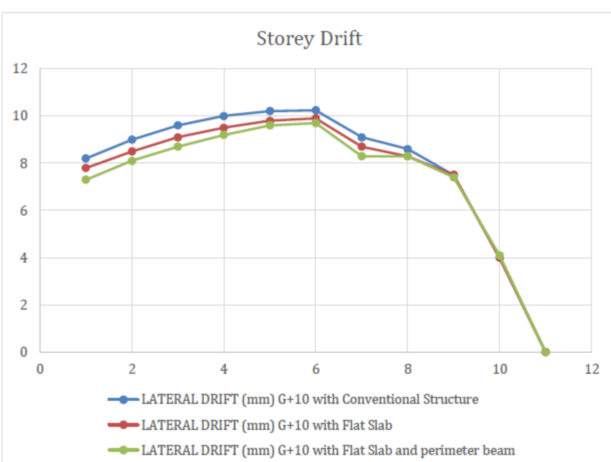

Fig 2 Lateral Drift in mm

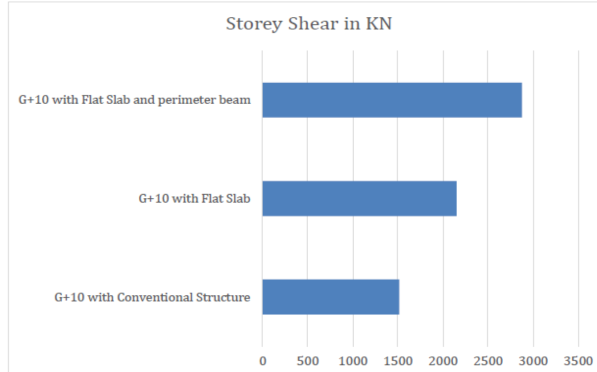

Fig 3 Storey Shear in KN

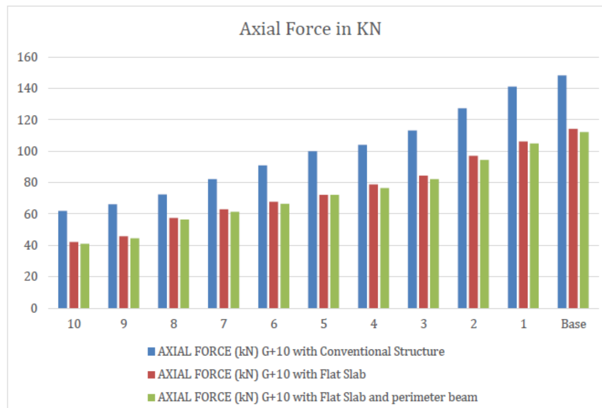

Fig 4 Axial Force in KN

Fig 5 Maximum Storey Stiffness in KN-m

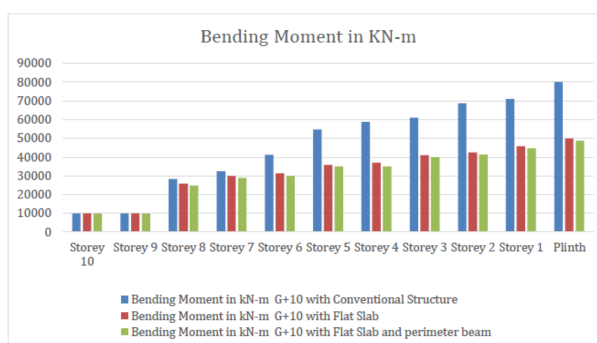

Fig 6 Bending Moment in KN-m

VII. CONCLUSION

Following are the ends according to the examination

Storey Displacement

When structures are subjected to lateral loads like earthquake and wind loads, lateral displacement is crucial. As a building's height rises and becomes more flexible to lateral loads, structures become more sensitive, hence lateral displacement is dependent on the height and slenderness of the structure. Lateral displacement was maximum for structure with conventional slab and structure with flat slab and structure with flat slab and perimeter beam were found stable in handling lateral forces. Marginal difference was seen of 0.2% in G+10 structure with flat slab and G+10 structure with flat slab and perimeter beam.

Storey Drift

Lateral (story) drift is the amount of sidesway between two adjacent stories of a building caused by lateral (wind and seismic) loads. For a single-story building, lateral drift equals the amount of horizontal roof displacement. Lateral drift was found least in G+10 structure with flat slab and perimeter beam proving to be 2.3% less than G+10 structure with Flat Slab and 4.5% less than G+10 structure with conventional slab. Maximum storey drift was visible in storey 5 and storey 6.

Storey Shear

Storey shear factor is the ratio of the story shear force when story collapse occurs to the story shear force when total collapse occurs. Through a series of dynamic analyses, simple equations are provisionally proposed to calculate the necessary story shear safety factor that can be used to prevent story collapse. Storey shear was maximum for G+10 structure with flat slab and perimeter beam, 12% higher when compared to G+10 structure with flat slab and 18% higher than G+10 structure with conventional slab. Maximum Storey shear for G+10 structure with flat slab and perimeter beam was 2876.87 KN.

Axial Force

Axial force refers to a load whose line of action runs along the length of a structure or perpendicular to the structure’s cross-section. Moreover, the line of force goes through the center of gravity of the member’s cross-section. When this load tends to compress the member along its line of action, it is an axial compression load and carries a negative sign by convention. While if the load extends the member along its line of action, it is an axial tension load, carrying a positive sign. Axial force was 7.12% higher in G+10 structure with conventional slab when compared to G+10 structure with flat slab and G+10 structure with Flab slab Perimeter beam.

Storey Stiffness

The bottom of the storey is the only part that is restricted from moving laterally; the remainder of the storey is free to rotate. Storey stiffness is calculated as the lateral force causing unit translational lateral deformation in that storey. Storey stiffness was 3.1% higher in G+10 structure with conventional slab when compared to G+10 structure with Flat Slab and G+10 structure with flat slab perimeter beam.

Bending Moment

Flat slab with staggered beam is comparatively more stable and observing low moment in comparison which states that it is comparatively more economical whereas flat slab case is second best in comparison.

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