A Review Paper on Design and Analysis of Flat Slab using FEM

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Abstract: In today's construction activity the use of flat slab is quite common which enhances the weight reduction, speed up construction, and economical. Similarly, from the beginning conventional slab has got place in providing features like more stiffness, higher load carrying capacity, safe and economical also. Here large Bending Moment & Shear Forces are developed close to the columns. To prevent progressive collapse of flat slab-column connections, it is necessary to provide a secondary load carrying mechanism after punching shear failure. In this research, some suggestions for establishing an alternative mechanism in flat slab connections after punching failure are proposed. In the present study, RCC building is analysed, IS 456-2000 is used for the manual calculation of flat slab and the models are developed using SAFE 2016 with M30 grade concrete for beams, M30 grade concrete for columns and Fe 500 Mpa grade of steel for reinforcement are taken as material properties. The study aims to provide a better and easy understanding of flat slab analysis.

***Keywords* — flat slab analysis, deflection, stability of building, serviceability and ultimate loading.**

I. INTRODUCTION

Sustainable development is aimed at improving the quality of life for everyone, now and for generations to come. It encompasses environmental, economic and social dimensions, as well as the concept of stewardship, the responsible management of resource use. As society makes determined moves towards sustainability, construction has a very important role to play within this new agenda, not only because of its economic and social contribution, but also because of its impact on the quality of our lives, our comfort and safety.

Flat slab called beamless slab is a slab supported directly by columns without beams. A part of slab bounded on each of the four sides by center line of column is called a panel. Panel may be divided into column strip and middle strip. The flat slab is often thickened closed to supporting columns to provide adequate strength in shear and to reduce the amount of negative reinforcement in the support regions.

II. THEROTICAL CONTENT

Due to rapid increase in demand for space, construction of multi-storied buildings is becoming a necessary part of our living. The limitation of space is forcing us to raise the height of buildings as much as possible to accommodate maximum number of people. Resisting lateral loads like wind and earthquake also comes into picture with increase in height of the building. Flat slab buildings can be broadly

divided into RCC and Prestressed buildings. The flat slab or Post Tensioned Slab buildings in which slab is directly rested on columns, have been adopted in many buildings constructed recently due to the advantage of reduced floor to floor heights to meet the economical and architectural demands. But Punching shear failure observed during the transfer of unbalanced moment from slab to column is the main drawback of using flat slab. Also, its behavior during earthquake due to absence of beams is also the matter to study.

The traditional method of construction that is a common practice is to support slab by beam; and beam supported by column. This is called as a beam slab load transfer construction technique. Due to this traditional technique of construction net height of the room is reduced. Therefore, to improve the aesthetical and structural aspect of multi-storey, shopping malls, offices, warehouses etc. are constructed in such a way where slabs are directly on columns. This type of slab which is directly supported on columns is termed as flat slabs.

Fig 1: Aesthetic appearance of flat slab floor

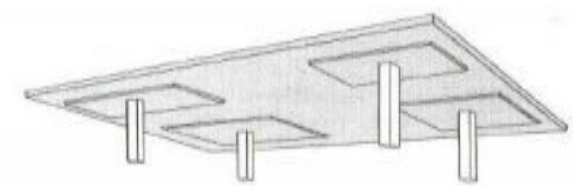

Fig 2: General view of flat slabs

Indian Code Recommendations for Proportioning Flat Slab

1) Thickness of flat slab: -

The thickness of flat slab shall be generally controlled by considerations of span to effective depth ratio.

2) Drops: -

The drops when provided shall be rectangular in plan, and have a length in each direction not less than one third of the panel length in each direction. For exterior panels, with drops at right angles to the non-continuous edge and measured from center line of the columns shall be equal to one half the width of drop for interior panels.

3) Column heads: -

When column heads are provided, that portion of column head which lies within the largest circular cone or pyramid that has vertex, angle of 90 and can be included entirely within the outlines of the column and the column head, shall be considered for design purposes.

Failure of RCC slab during severe earthquake has led to wide spread rejection of flat slab. Many of the existing flat slab buildings may not have designed for seismic forces. Hence it is important to study their response under seismic conditions and to evaluate seismic retrofit schemes. In order to study the response of flat slab under seismic conditions and to evaluate seismic retrofit schemes push over analysis is performed and by conducting push over analysis, we can know the weak zones in the structure and then we will decide whether particular part is retrofitted or rehabilitated according to the requirement. The retrofitting can be done by

1) Column jacketing

2) Addition of beams at floor

3) Column jacketing and addition of beams

Column jacketing and is a good cost-effective technique but it is adequate only when seismic deficiency is small.

The beam retrofitting reduces the sagging hinges significantly. Increasing the number of story of retrofitting by either column retrofitting alone or beam retrofitting

alone does not improve the behaviour significantly. When column jacketing and addition of beams are adopted simultaneously one or more number of stories, large increase in lateral strength and stiffness can be achieved. The pushover analysis of a structure is a static non-linear analysis under permanent vertical loads and gradually increasing lateral loads.

The equivalent static lateral loads approximately represent earthquake induced forces. A plot of the total base shear versus top displacement in a structure is obtained by this analysis that would indicate any premature failure or weakness. The analysis is carried out up to failure, thus it enables determination of collapse load and ductility capacity. This type of analysis enables weakness in the structure to be identified. The decision to retrofit can be taken in such studies.

III. LITERATURE REVIEW

Mohana H.S,[1] Studied that G+5 commercial multistoried building having flat slab and conventional slab has been analyzed for the parameters like base shear, storey drift, axial force, and displacement. The analysis of flat and conventional slab structure has been done by using ETABS software package. The performance and behavior of both structures on different criteria like storey shear, storey displacement, drift ratio, and axial design forces has been analyzed and discussed. There is a difference of 5% in between flat and conventional slab structure in zone II and zone III. Storey shear of flat slab is 6% more compared to conventional slab structure, and storey shear is Maximum at base and least at top storey. The design axial forces on flat slab are more compared to conventional structure the difference of forces is nearly 5.5%. Storey displacement is Maximum at roof level than at base, and storey displacement of flat slab structure is greater than conventional structure, there will be an average 4mm displacement variation in each seismic zone for both structures.

Malvade S, [2] In that review on the response and behavioral properties of Posttensioned flat slab during earthquake and compare with normal flat slab. Modelling and analysis of flat slab and PT flat slab is done using SAFE. Two-way PT Flat plate of size 8m X 8m is supported on 4 square columns of 400mm X400mm is modelled for different cases and respective properties are assigned. Experiment result show that Stretching of cables can be done 1st in x-direction then in y-direction, alternate stretching can be done to avoid the torsion of slab. Stretching one cable produces secondary moment and hence strip moments in both direction changes drastically. Hyper static moments are affecting during the construction stage. In stage wise construction hyper static moments play important role. Due to post-tensioning of flat plates slab, there is no much effect on axial force but shear and moment on column increases.

Saeed S. [3] In that experimental study, some suggestions for establishing an alternative mechanism in flat slab connections after punching failure are proposed Design assumptions included a concrete type C30, reinforcing steel yielding strength of 400 MPa, and reinforcing steel ultimate strength of 600 MPa. In concrete mixture, the maximum aggregate size was 25 mm, and water-cement ratio was approximately 0.45The span length of the original flat slab was assumed 6.8 m for loads including a superimposed dead load of 1.5 kPa and a live load of 2.5 kPa. In this study, 17 half-scale slabs were tested to study the behavior of flat slab-column connections after the punching shear failure. Test results showed that the increase of concrete cover thickness in the tensile region of slabs enhanced the punching and post punching strengths by 14% and 32%, respectively. The test results of this study showed that the bent-up integrity reinforcement increased the punching and post-punching strengths by 38%, and 97%, respectively.

More.R, [4] Studied that in recent times, due to space crunch, height limitations and other factors, deviations from a regular geometry and regular layout are becoming quite common. Also, behavior and response of flat slabs during

earthquake is a big question Unfortunately, earthquake experience has proved that this form of construction is vulnerable to failure, when not designed and detailed properly, in which the thin concrete slab fractures around the supporting columns and drops downward, leading potentially to a complete progressive collapse of a building as one floor cascades down onto the floors below. This paper gives information about major issues associated with the flat slab and different method for analysis of flat slab use to confirm the behavior of flat slab.

Deshpande-H [5] Studied that All the Negative & Positive moments are distributed in the column strips & Middle strips respectively using equivalent codes. IS 456-2000 gives Distribution of moments across panels for Exterior and interior Slab. Flat plate/slab construction is a developing technology in India Flat slabs has many advantages over conventional slabs and hence it can be a very good option for modern constructions demanding structural stability and state of art aesthetic aspects and prospects. Flat plate/slab can be designed and built either by conventional reinforce concrete. or post-tensioning. Design of conventional R.C. flat plate/slab in India, utilizing Indian codes, has many shortcomings, which have to be addressed and revised soon.

IV. Conclusion

1] The design axial forces on flat slab are more compared to conventional structure the difference of forces is nearly 5.5%.

2] Because of post-tensioning of flat plates slab there is no much effect on axial force but shear and moment on column increases.

3] Shear reinforcements can increase the punching shear strength of slabs, but these reinforcements may not increase the post-punching strength.

4] Flat plate/slab can be designed and built either by conventional R.C. or post-tensioning. However, due to issues with post- tensioning construction in India and its higher cost, conventional R.C design should be the preferred choice for spans up to 10 meters.

5] Total height of building is restricted using flat slab results in more stories accommodated within the set height.

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