



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 7, July 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Comparative Study on RCC Slab, Post-Tension Slab & RC Flat Slab : A Review

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ABSTRACT: The buildings are constructed mostly based on the usual standard codes considering the gravity loads consisting of the self-weight of the structure and the live load. These structures are experiencing low magnitude loads in their design life that leads only to elastic response, however strong loads such as sudden earthquake will lead the structure beyond the elastic limit. Seismic design is a vital process of structural analysis while designing a building which is subjected to earthquake motions. Thus seismic analysis is a tool to estimate the structural response of the structure while designing earthquake resistant structures or vulnerably existing structures. This article covers some of the methodologies and strategies pioneered by previous studies, as well as their success in different types of slab structures. In the present study an attempt is made to be compare the design and cost effectiveness of post-tensioned flat slab with respect to the reinforced concrete flat slab & RCC slab systems. The seismic behaviour of multi-storied building frame during an earthquake motion depends upon the distribution of strength, mass and stiffness in both horizontal and vertical planes

KEYWORDS: : Flat Slabs, seismic analysis, post- tension slab, RCC slab, base shear, stiffness, Flat plate, earthquake..

I. INTRODUCTION

Urbanization is increasing rapidly in present world. There is an increase in housing requirement with increased population and urbanization. Therefore, the creation of high-rise constructions became very often. Urbanization is beneficial but, the problem arises when the high-rise buildings are not designed and constructed properly. Before construction of any high-rise buildings, the building should be analysed under seismic loads and wind loads. A building as a shelter represents a physical division of the human habitat. Seismic force is the major cause for collapse of many high-rise structures. Seismic zone plays an influential role in the earthquake resistant design of building structures. Building with Conventional slab is the slab resting on ordinary beam and columns. In conventional slab, load transfers from slab to columns, Columns to beams and beams to Foundation. Flat slab is a concrete slab which is supported directly by columns without the usage of beams. Flat slab with drop panel is more effective compared to flat slab without drop panel. Flat slab is easy to construct and requires less form work. PT techniques are widely used in concrete to prevent cracking and minimize the deflection which is resulted by externally applied load. Stresses are transferred after concrete pouring and reach required hardening and strength.

Reinforced Concrete Structures

The reinforced concrete structure refers to the members, such as beams, columns, roof trusses, consisting of concrete and steel bars. Reinforced concrete structures can be classified based on different parameters. On the basis of regularity, they are classified as regular and irregular structures. Irregularity can be further sub classified as mass irregular stiffness irregular and geometric irregular. Geometric irregularity is again divided as horizontally irregular (plan) and vertically irregular buildings.

Post tensioned structures

Post-tensioning is simply a method of producing prestressed concrete, masonry, and other structural elements. When the steel is tensioned before concrete placement, the process is called pretensioning. When the steel is tensioned after concrete, placement, the process is called post-tensioning. A post tension slab is a concrete slab that has steel cables

running through it that have been placed under 33,000 +/- pounds of tension. This tension makes the concrete slab and foundation much stronger than concrete without reinforcement and helps reduce cracking.

II. LITERATURE SURVEY

CH. Lokesh Nishanth, Y. Sai Swaroop, Durga Chaitanya Kumar Jagarapu, Pavan Kumar Jogi [1] analyse and design a commercial building with different slab arrangements, i.e., Conventional slab, Flat slab with drop panels, Grid/ Waffle slab, and building with load bearing wall. A commercial building is one in which at least 50 percent of its floor space is used for commercial activities. The effect of seismic and wind forces on buildings with different slab arrangements have been analysed by utilizing ETABS software. ETABS is an engineering software product which is utilized for analysis and design of structures. Analysis and design are done as per IS 456-2000 code book. M30 grade of concrete and Fe-500 steel is adopted. Load combinations are taken as per IS: 875-part 5 (2015) code book. Live loads are taken as per IS 875-part 1. Wind speed of 55 m/s and earthquake zone 5 is adopted for analysis. Load combinations of 1.2(DL + LL + EQ) and 1.5(DL + LL + WL) are considered. There are several concerns which affect the performance of structure from which storey drift, base shear and storey displacement play a crucial role in finding the behaviour of structure against the wind and seismic loads. Results are conveyed in form of tables, bar charts. Storey displacement increased with storey height. The result shows that building with grid slab is stable and economical, contrasting to all other slab arrangements used in the building analysis against wind and seismic loads.

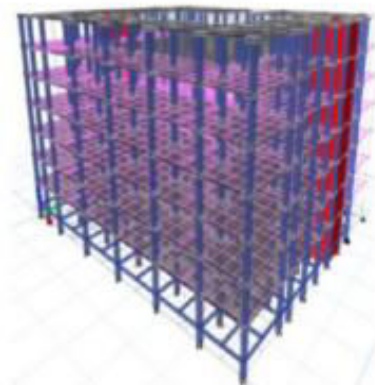


Fig.1 Building with flat slab [1]

Iosif Toroka, Attila Puskasa, Jacint Virag [2] describe the post-tensioning methods possible to use for flat slabs of public buildings. The analysis follows the process of the structural design, considering in the analysis the advantages the method might present in future of the analyzed constructions, with all the advantages the method might present. This method can be efficiently used for buildings with spans larger than 7 meters, where the relative openings do not present major variation. Although the post-tensioning of flat slabs is widely used in some countries, in Romania it is still avoided in the realization of reinforced concrete slabs due to the reduced knowledge in design and execution of post-tensioned slabs.

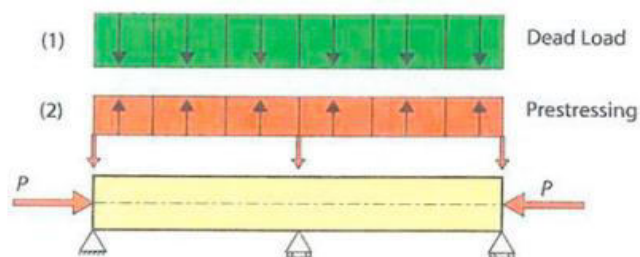


Fig.2 Representation of the uplift force given by the prestressing (red diagram) [2]

H.-S. Kim, D.-G. Lee [3] Proposed an efficient analytical method in this study to obtain accurate results in significantly reduced computational time. The proposed method employs super elements developed using the matrix condensation technique and fictitious beams are used in the development of super elements to enforce the compatibility at the interfaces of super elements. The stiffness degradation due to cracking in the flat slab system considered in the equivalent frame method was taken into account by reducing the modulus of elasticity of floor slabs based on linear elastic finite element analysis in this study. Static and dynamic analyses of example structures were performed and the efficiency and accuracy of the proposed method were verified by comparing the results with those of the refined finite element model and the equivalent frame method.

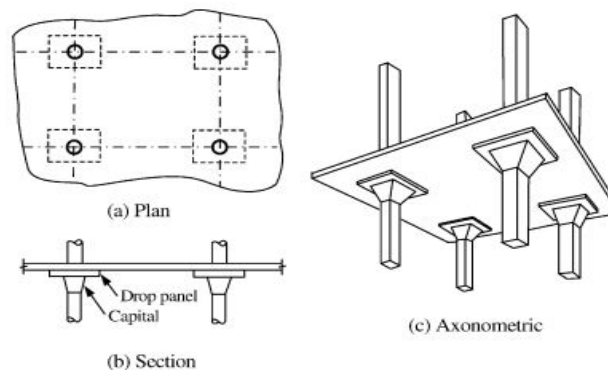


Fig.3 Flat slab structure having capital and drop panel [3]

Duarte M.V. Faria, Valter J.G. Lucio, A. Pinho Ramos [4] studied a new flat slab strengthening technique based on post-tensioning with anchorages by bonding using an epoxy adhesive. The main advantages of this technique over the traditional prestress strengthening systems that use mechanical anchorages are that it does not need external permanent anchorages, meaning that the forces are introduced into the concrete gradually instead of being localized, thereby preserving aesthetics and useable space. The seven tested slab models show that this technique meets its objective as it is able to reduce reinforcement strains at service loads by up to 80% if the strengthening technique is applied in two directions and slab deformations by up to 70%, consequently making crack widths smaller. It can also increase punching load capacity by as much as 51% when compared to non-strengthened slabs.

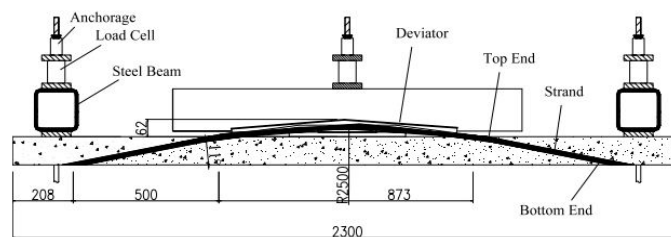


Fig.4 Detailed prestress profile, for slabs [4]

Latha M.S, Pratibha K [5] studied 12 stories structure of symmetric and asymmetric for regular, plan irregular and vertical irregular structure for both conventional slab and grid slab is considered, analyzed and compared for both gravity load and lateral load conditions as per IS codes. The structures are analyzed using ETABS software. For regular and plan irregular structures static analysis is done as per IS code 1893:2002(Part 1) and for vertical irregular structures dynamic analysis is done for both conventional and grid slab structure as per IS code 1893:2002(Part 1). And compared the results of conventional slab and grid slab for parameters of deflection, storey shear, displacement and storey stiffness.

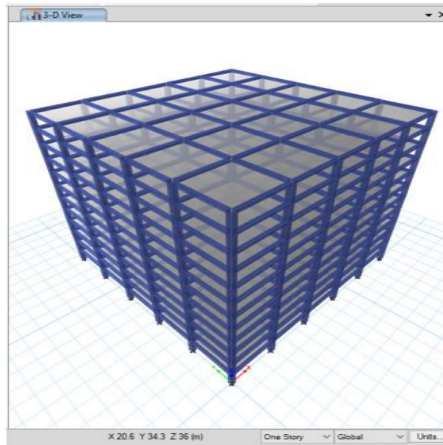


Fig.5 Symmetric regular conventional slab structure [5]

Arvind Jayalakshmi Satyanarayanan, Helen Santhi Mariadhas and Prabu Dhanapalan [6] An office floor with a typical grid size of 10.8x8 m in a multistorey building was considered for design with flat-slab, flat-plate, and beam-slab systems. In all cases, both RC and post-tensioned systems were used for the comparison of structural performance and cost together with safety. The slab systems were designed using three different codes of practice: Indian Standard (IS), British Standard (BS), and American Concrete Institute (ACI) standards. From the cost analysis, it is observed that the post-tensioned flat-slab system provides better cost reduction of approximately 16.5 and 20% in the case of IS and BS standards, respectively. In the case of ACI standards, the RC and post-tensioned flat slab systems yield 17.7 and 12.5% cost reduction, respectively. From the study, it was concluded that the post-tensioned flat-slab system using ACI standards is considered to be durable because the tensile stress is restricted and designed as an uncracked section, whereas the IS and BS allow 0.2-mm crack width.

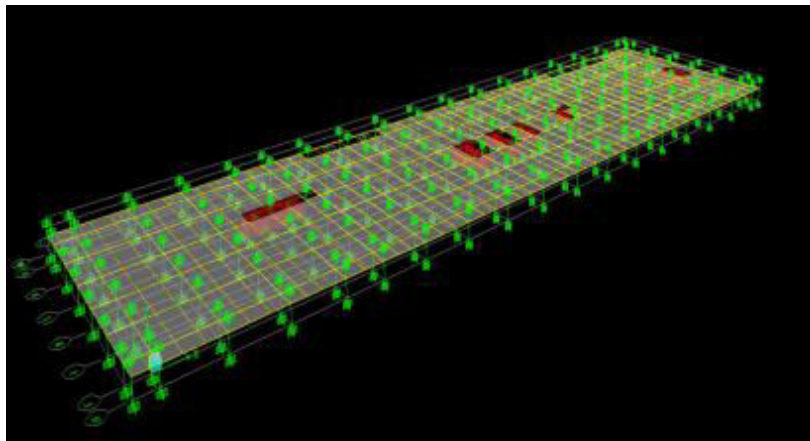


Fig.6 ETABS model of the RC slab system [6]

Shubham Nighot, Sopan Chinchole, Rohan Kapgate, Sujesh D. Ghodmare [7] studied of post tension flat slab with respect to cost estimate, strength and serviceability. The design was analyzed by using ETABS software. For this application of design procedure, a commercial building is considered as a case study. The plan of the commercial building (G+7) is considered. The results indicate that PT slab has cost better than that of RC flat slab system. Multistorey structure like shopping mall, Residential building post tensioning method is mostly preferred. By application of this method in the building construction it increases strength as well as durability of structure. Due to post tensioning technique the structure gives better aesthetic look and economic solution as that of conventional method. Now a days PT slab used is large scale due is its Superiority and also it can be applied to the various type of structure. Post-tensioned slab had analysed and designed using ETABS software.

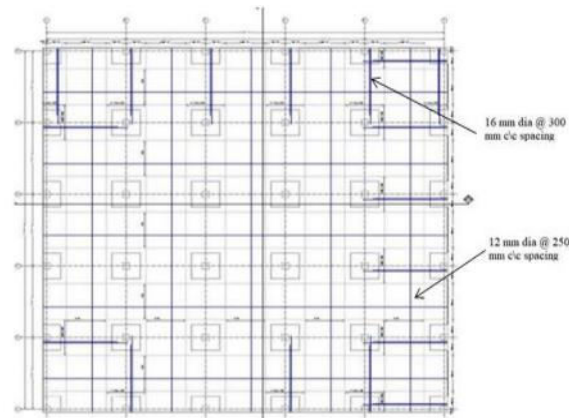


Fig.7 Shows the bottom Reinforcement plan in ETABS software after analysis [7]

Mr. Pradeep Karnawat, Prof. Rahul Sharma [8] examines the Seismic Analysis of Large Span Commercial Building with the use of different types Slabs for Zone III. In this a 10-storey building is modelled with the various types of types slab are chosen. This slab includes Normal slab, flats slab, waffle & ribbed slab. This project focuses of commercial building project of 10 Storey Building. For the part or partially distribution of area as per the requirement the large span structure taken as 8m. The seismic analysis is carried out for the structure under Zone III with city taken as Ujjain, Madhya Pradesh.

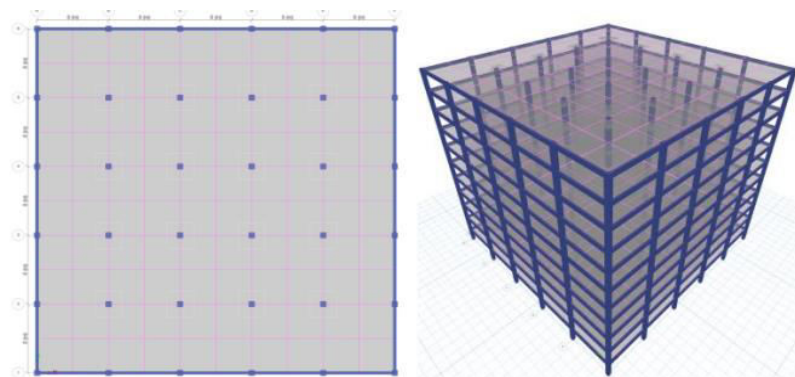


Fig.8 Building having Flat Slab with Drop Panels and Perimeter Beam [8]

III. CONCLUSION

After reviewing all the previous researches, we found out that thickness of the building having flat slab with shear wall changes with the storey height. Indian code use for deign flat slab suggest more reinforcement and stiffness as compare to European code flat slab provides more flexibility to the building as compare to conventional slab., we can design flat slab by post tensioning and as well as by conventional reinforced concrete but we prefer reinforce concrete more as cost of post tensioning is higher. Flat slab also provides more stability and aesthetic view to the building. In case of industrial structures constructed in a square and rectangular layout the displacement is more is case of flat slab as compare to waffle system and displacement is increases with the increases in the height of the building. However Indian code for flat slab has many shortcomings, which have to be revised soon.

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