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Analysis and Design of Post Tension Slab Using ETABS Software

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Abstract:- At the present in construction industry the post tensioning method used widely due to its advantages. In developing countries like India the benefit of post-tensioning slab are yet to be recognized. By using post tensioning method we can achieve the most economical and safe design for residential as well as commercial buildings. This paper deals with the study 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 consider 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. Multistory 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 give 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 apply to the various type of structure.Post-tensioned slab had analyzed and designed using ETABS software.

Keywords:- *ETABS, RC Flat Slab, PT Slab, Post Tensioning, Multi-Storied.*

I. INTRODUCTION

Now a days post tension slab system is more recognized in construction field, The reinforcing concrete method enables a designer to take benefits of the advantage provided by pre-stressed concrete . Analysis & design of slab having post-tensioning system can be done manually as well as using software's like ETABS, SAFE, ADAPT, etc. By using ETABS Software, a post-tensioned slab is designed and calculated. It also provides structurally more efficient slab which is more promising in all matters. Software like ETABS, gives user more Free Hand in Designing part. However, in Calculation part the software itself calculates and provides user with more appropriate calculations. User can give respective loads to calculate the structures strength whichever needed by giving a Single Load or Multiple Loads on a Single Structure. In case if some section fails, it provides user with that section's details and its properties. Software also gives each Section Properties if needed. To calculate the Multistory Buildings Strength and to calculate its properties is very difficult and time consuming, however the software makes it with ease and rapidly. The Software also provides the Multistory Buildings 3-D View. Some important advantages shows by post- tensioning system as follows :

- Considerable saving in steel as well as concrete is obtained by using this method.
- Smaller deflection compared to with steel reinforced concrete structure.
- This method shows good crack behavior and hence it prevent steel from corrosion up to some extent than that of conventional RC slab.
- Even after considerable overload nearly there no change in serviceability, as temporary cracks disappeared again after the overloads was removed.
- High fatigue strength, since the amplitude of the stress changes in the pre stressing steel under alternating loads are quite small.
- Due to Post tensioning, the formwork is stripped below 10 days, thus achieving higher recycling of shuttering and speedy floor to floor construction cycletime.
- The Post-tensioning technique leads to the reduction in weight of the building as compared to reinforced concrete building having same number of floors in it. This leads to having less loads on the foundation of the structure, it has advantage while designing for the seismically proneareas.
- Construction of column free space or larger span for IT Parks, Commercial / shopping complexes can be easily done by PT.
- Apart from the above mentioned advantage post tensioning offers several other advantages.

Basically post-tensioning method is applied for long span structure i.e. commercial building parking structure, slab on bridge as well as ground . One of the main reasons of providing post tensioning method is to provide simultaneously weight deflection and cracking issue. For spans of 7m to 12m, the live load up nearly upto 5kn/m 2 , flat slab or slab with shallow main beam running in one direction without column head drop or flairs, slab with main beam in both direction or waffle slabs are used. So in this paper we tried compare the strength serviceability and cost saving of post tension flat slab system with RC flat slab system. The comparison is only in terms of concrete and steel.

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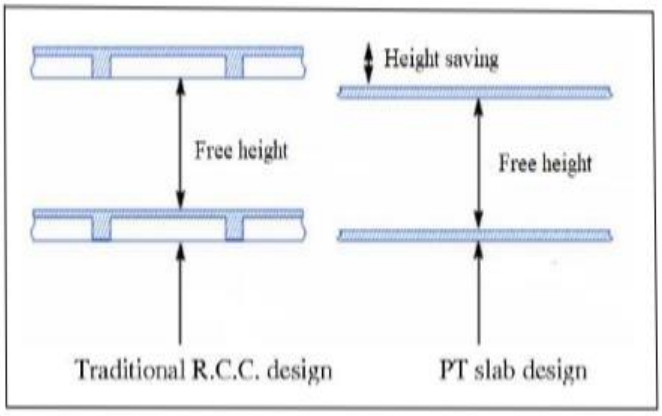


Fig 1:- Height comparison of RCC and PT slab design (source :-Boskey Vishal bahoria IACSIT Journal [10])

II. LITERATUREREVIEW

Dr Manmohan R Kalgal [9] shows in their paper the construction industry the importance of post tensioning. The main advantages of post-tensioning method is that Post-tensioning can achieved the economy and also saving of steel and concrete. The Post-tensioning slabs shows greater spans and larger slenderness. By using this method the construction time is reduced because of earlier placing of the formwork. V.G.Kiran Kumar et al. (2014) [5] shows that by using post- tensioning method, thickness of the slab is reduced. If thickness of slab is reduced, this creates a chain reaction that is number of columns and beams is reducing which will leads to the structure being more economic and eco-friendly. in their paper they use ETABS software for multistory building. They also gives calculation of dead load, wind load and by this the design of PT slab was studied. They concluded that using this method there is considerable reduction in thickness of slab which results in decreasing no. Of columns and beams and hence economy and eco-friendly structure can be achieved. Jnanesh Reddy et al. (2017) [4] Shows us comparision between RC flat slab and PT slab in multistory construction building, The concrete required for RC flat slab is quite more than that of PT slab. It is shows that the stiffness and strength of PT slab is more when compared with RC flat slab. Due to reduction in thickness the beauty of the structure will be increased and as dead load gets reduced the structure gets lighter. Through the manual calculation of quantitative and qualitative analysis of PT slab explained by Sreenivasa Prasad Joshi [6] and they compare PT slab floor with conventional slab and he observe following points which is PT floor is large span, Water resistance, Cost saving and increased effective height of floor and reduced or had negligible deflection. Y.H. Luo and A. J. Durrani, (1995) [1] studied the flat slab building by applying lateral and gravity loading. They use same effective slab width for interior and exterior connection of slab-column and they observe moment transfer mechanism was different from interior and exterior connection. By adding composition of mineral admixture in concrete at very low water cement ratio. It increase property of concrete and applying supplementary cementing material of mineral origin performed main role in high performance concrete [11].

From these it is concluded that the drop panels and columns only give a directly support for slab in types of building. Due to direct support of drop panels and column of the building floor to floor height of building reduces so space available is more for our use. By comparing flat pt slab and conventional slab we get result as reinforcement is 15% more and cost also 30% more than that of pt flat slab. Reinforcement required more in post tensioning slab due to provision of the beam support more load so required more reinforcement. In post tensioning with reinforcement beam we can removed formwork earlier but in conventional case we can not remove formwork in earlier period. Quantity of concrete required more in PT slab with reinforced concrete beam for one floor is more than that of PT slab method.

III. METHODOLOGY

The step by step process which was carried out for the modeling of structure and analyzing and designing of slab is represent in the below.

1. Modelling of structure in ETABS

a) A G+7 structure was modeled in ETABS
b) Grid of flat slab with prop cap was laid in the ETABS
c) Modeling of structure according to the plan in ETABS
d) Modeling of structural members like column, slab and drop

2. Assigning of dead load and live load

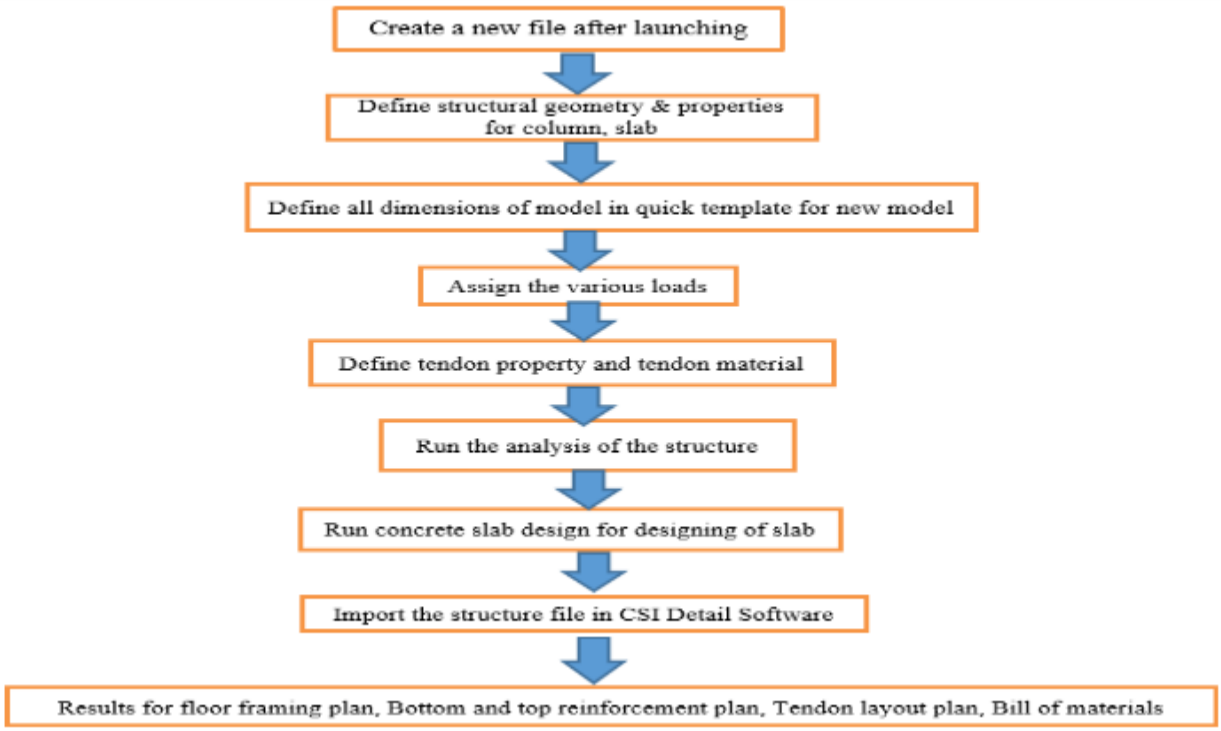
a) The input of diameter of various type of reinforcement was given
b) Different types of loads were defined like dead load, live load
c) Loads like dead load and live load was assign to structure as per specification of IS875

3. Analysis of structure

a) Finalization of model was done
b) Checking of error in model prior to analysis
c) Correction of error In the model done by the ETABS software

4. Design of structure

a) Different members were designed in the ETABS software
b) Selecting the preferences for the reinforcement detailing work
c) Reinforcement detailing was done using CSI detail software
d) Report generation was done by same software



Flowchart 1. process to analyze and design the slab

IV. ANALYSIS ANDDESIGN

For the Analysis and design of multistory building the loads such as dead load, live loads, properties of section, we need to assign to the structure. In case if some section fails, ETABS software provides user with that section's details and its properties. Software also gives each Section Properties if needed. The data provided to analyze and design the structure for the multistory building is shown below;

- Purpose of building: commercial
- Building shape: rectangular
- Total no. of floor: G+7floors
- Story height: 3.5m (for bottom story), and 4.5m for above stories
- Grade of concrete and steel: M30 and fe500
- Dead load: 1.5 kn/m^2
- Live load: 4kn/m^2
- Column size: 600*600mm^2
- Tendon size: cold drawnsteel
- Modulus of elasticity: 196500N/mm^2
- Yield stress: 1865N/mm^2
- Total jacking force: 1488N/mm^2
- Diameter of strand: 0.5 inch(12.7mm).
- No. of wires: Total 7 wires in one strand(including one king wire & otherwires)

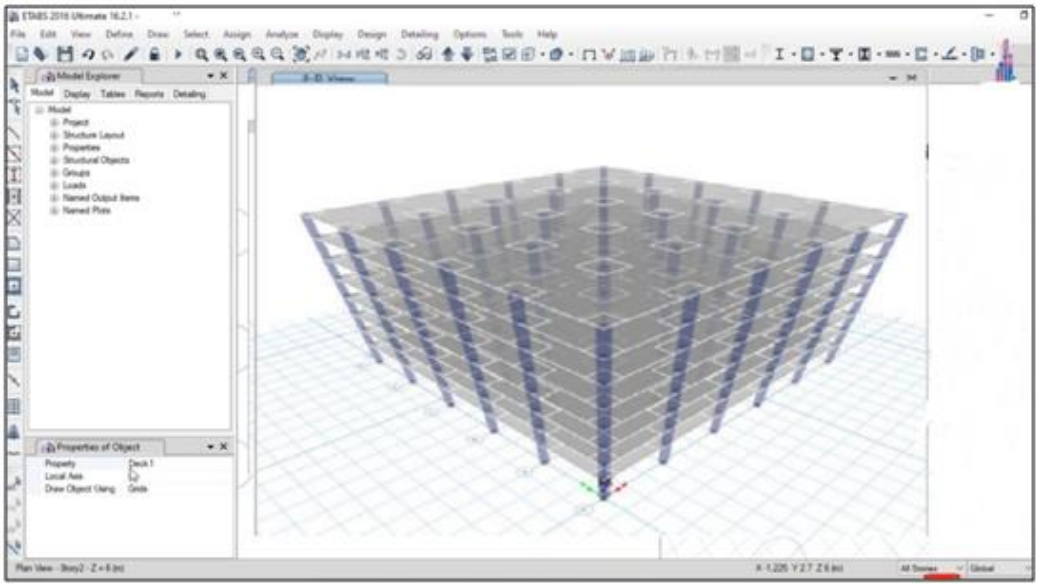


Fig 2:- 3D view of Building in ETABS Software during analysis

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For the application of design procedure residential building is consider as a case study. The plan of residential building (G+7) is considered the PT slab analysis and design is a most complicated process because it involves primary moments. Form basic frame analysis & secondary moment from PT forces. The ETABS is an essential tool for analysis & amp; design of the PT slab 3 dimensionally under gravity as well as horizontal loads. In the present study we are analyzing for gravity load condition.

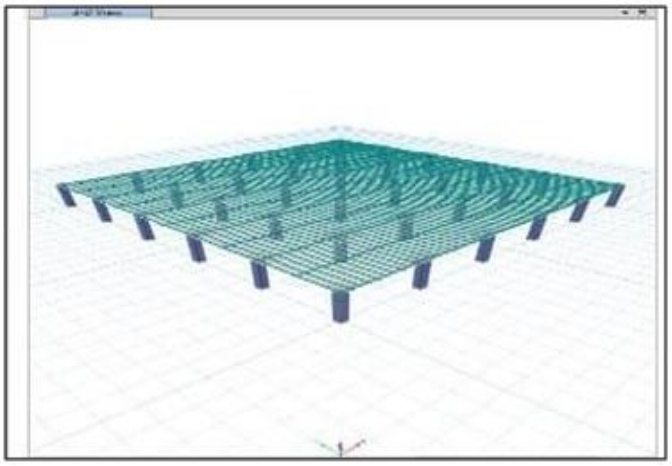

Fig 3:- 3D view of Tendon in ETABS Software after analysis (8th story in X & Y direction.)

The design code adopted for PT slab as per IS 456:200 of plain & reinforced concrete IS 1343:2012 of pre stressed concrete. SP 34:7987 This handbook of practice is supposed to give information on properties of reinforcing steel & detailing requirements, including storage, fabrication & assembly, welding & placing of reinforcement. In accordance with Indian standard code IS 456:2000.

V. RESULT

Below are the results generated for the detailing of post-tensioned slab by CSI Detail software. For that, we have to import the model analyzed & designed in CSI ETABS to CSI Detail software.

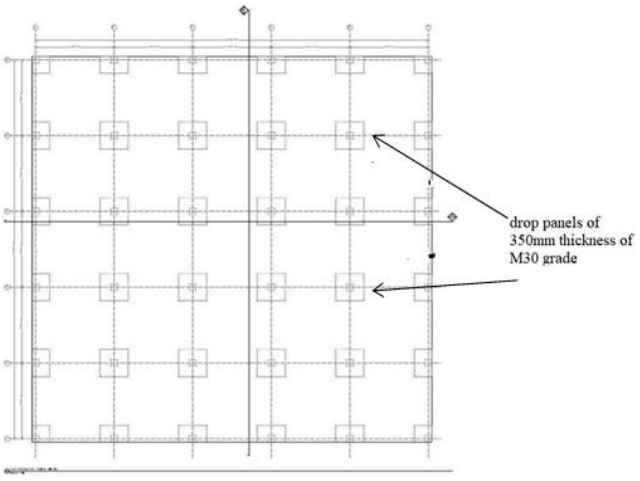

Fig 4:- Shows The floor framing plan for 8th story in ETABS software after analysis

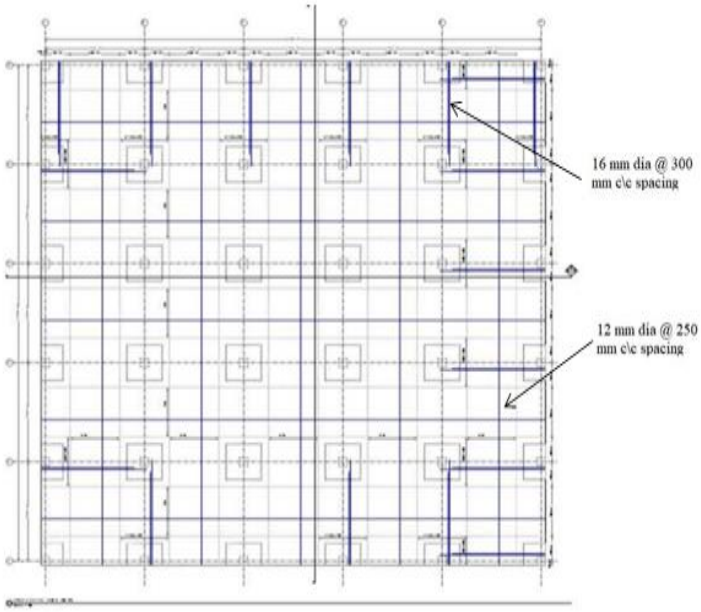

Fig 5:- Shows the bottom Reinforcement plan in ETABS software after analysis

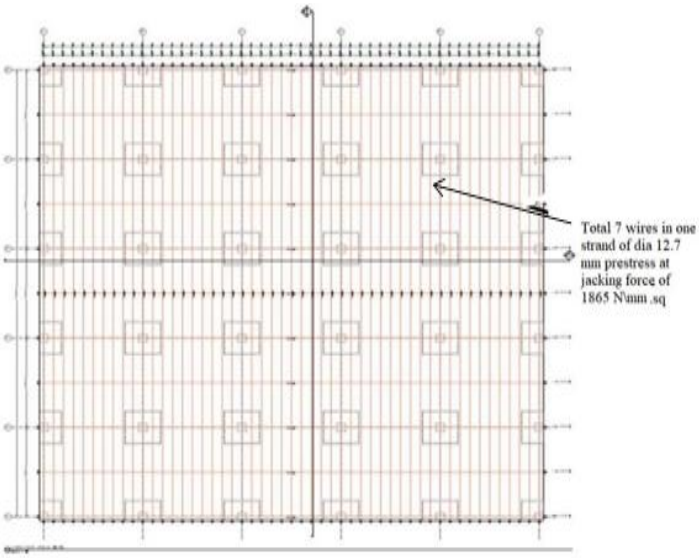

Fig 6:- shows Tendon layout plan in ETABS Software after analysis

Sr. No	ITEMS	QUANTITIES	UNITS
1	Slab area, A	1,438.97	SQ. M
2	Concrete volume, V	313.535	CU. M
3	Average thickness, T=V/A	218	MM
5	Rebars per area, W/A	3.084	Kg/SQ. M
6	Rebars ratio, W/V	14.1541	Kg/CU. M

Table 1:- Bill of materials for 8th story using CSI detail software

VI. CONCLUSION

Now a days designer give more preference to the building with slabs of large span as there is more demand in the market for the free space without any structural obstructions due high price in commercial market. Post-tensioning method is the economical method of having slabs with large span. For slabs having span more than 8 meters post-tensioning technology is effective as well as cost-saving method. The length of the tendon affects total cost of the post-tensioned slab to a greater extent. Some others affect the total cost of slab to higher and lower extent. Hence, it is always helpful to known the total cost from the Post-tensioning expert agency, which also have been contracted for post-tensioning work. Generally, for post-tensioned slabs the system of Flat slab, Flat slab with Drop caps and Flat slab with banded beams is used to reduce the cost of the slab. Still some considerations like total height between two consecutive floors, floor usage type, architectural requirements, etc. are taken into considerations deciding the type of the slab and total floor height between two consecutive floors. In construction of High-rise buildings, the type of Slab system is decided, while considering the feasibility of design of formwork and the time required for completion of next slab cycle.

According to the result obtained for the 8th story, the structure may reduce the cost of construction because of lesser thickness of slab and as slab thickness is reduced the number of columns and beams required is less which results in less quantity of concrete and steel. Hence post tensioning method is the economical method of having slab with large span. For slabs having span more than 8 meter post tensioning technology is effective as well as cost saving method.

REFERENCES

[1] Y. H. Luo and A. Durrani, “Equivalent BeamModel for Flat-Slab Buildings: Interior Connections,” ACI Structural Journal, vol. 92, no.1, pp. 115-124,1995.
[2] IACSIT International journal of Engineering and Technology, Vol. 5, NO. 1, February2013
[3] Dr. Manmohan R kalgal, “Post-Tensioned Concrete in BuildingSector”.
[4] Jnanesh reddy , “Comparative study of post tensioned and RCC flat slab in multi storeycommercial building”,2017
[5] V.G.KiranKumarandN.LokeshwarReddy,“Designandan alysisofacommercialcomplexbyusingpost tensioned method”,2014
[6] Srenivasa Prasad Joshi, “Evaluation of post tensioned slabs – qualitative and quantitative analysis”,2016
[7] Code of Practice for Prestressed Concrete Is: 1343 – 1980, BIS, Indian Standard Institution, NewDelhi.
[8] Plain and Reinforced Concrete Code of Practice Is: 456 - 2000, BIS, Indian Standard Institution, NewDelhi. tware” ,2016
[9] Dr. Manmohan R kalgal, “Post-Tensioned Concrete in BuildingSector”.
[10] IACSIT International Journal of Engineering and Technology, Vol. 5,No. 1, February2013
[11] Bhalchandra V. Khode and Sujesh D. Ghodmare, “Effect of Mineral and chemical admixure for Improvement of high-performance concrete” , 2019s