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A Review of Comparative Study on R. C. C. and Post Tensioned Flat Slab Considering Seismic Effect

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ABSTRACT

Post-tensioning is a method of reinforcing (strengthening) concrete or other materials with high-strength steel strands or bars, typically referred to as tendons. Post-tensioned construction is used more and more in industry today because of their advantages. Use of post tensioned flat slab is now a day becoming cost effective solution for improve seismic performance of construction industry. This review paper is focused on post tensioned and flat slab. In this paper, an attempt has been made for review comparative study on R.C.C and post tensioned flat slab considering seismic effect. For that the past papers related to the post tensioned and flat slab has been studied and the fruitful conclusion has been made.
Keywords: R.C.C, Post Tensioned, Flat slab, Strengthening and Concrete

I. INTRODUCTION

Post-tensioned concrete is a term heard more and more in the construction industry today. This method of reinforcing concrete enables a designer to take advantage of the considerable benefits provided by prestressed concrete while retaining the flexibility afforded by the cast-in-place method of building concrete structures.

A post tensioned slab is could be a pre-cast or in situ slab which uses the concept of Pre-stressing. Post tensioned slabs are quite common for large beam-less spans. The main components here are the high strength pre-stressing cables which help to keep the slab in a state of compression during its service life. Post-tensioned slabs are typically flat slabs, Band Beams and slabs or ribbed slabs. Post tensioned slabs offer the thinnest slab type, as concrete is worked to its strengths, mostly being kept in compression.

Post-tensioned slabs are use high strength tensioned steel strands to compress the slabs thickness keeping the majority of the concrete in compression. This gives a very efficient structure which minimizes material usages and decreases the economic span range when compared to reinforced concrete.

Post-tensioning is simple a method of producing prestressed concrete, masonry, and other structural elements. The term prestressing is used to describe the process of introducing internal forces (or stress) into a concrete or masonry element during the construction process in order to counteract the external loads applied when the structure is put into use (known as service loads). These internal forces are applied by tensioning high-strength steel, which can be done either before or after the concrete is placed. When the steel is tensioned before concrete placement, the process is called pre-tensioning. When the steel is tensioned after concrete placement, the process is called post-tensioning. Because pre-tensioning requires specially designed casting beds, it is used generally in the precast manufacturing process to make simple shapes that can be trucked to a jobsite. Post-tensioning is done onsite by installing post-tensioning tendons within the concrete form-work in a manner similar to installing rebar.

According to Park.E.H.Kim et al [3] and Y. H. Luo, A. Durrani [5] the most important advantages offered by post-tensioning systems are as follows

- By comparison with reinforced concrete, a considerable saving in concrete and steel since, due to the working of the entire concrete cross-section more slender designs are possible.

- Smaller deflections compared to with steel and reinforced concrete structures.
- Good crack behavior and therefore permanent protection of the steel against corrosion.
- Almost unchanged serviceability even after considerable overload, since temporary cracks close again after the overload has disappeared.
- High fatigue strength, since the amplitude of the stress changes in the prestressing steel under alternating loads are quite small.
- If significant part of the load is resisted by post-tensioning the non-prestressed reinforcement can be simplified and standardized to a large degree. Furthermore, material handling is reduced since the total tonnage of steel (non-prestressed + prestressed) and concrete is less than for a reinforced concrete floor.
- Assembling of precast elements by post-tensioning avoids complicated reinforcing bar connections with in-situ closure pours, or welded steel connectors, and thus can significantly reduce erection time.
- Usually the permanent floor load is largely balanced by draped post-tensioning tendons so that only the weight of the wet concrete of the floor above induces flexural stresses. These are often of the same order as the design live load stresses. Post-tensioning usually balances most of the permanent loads thus significantly reducing deflections and tensile stresses.
- The P/A stress provided by post-tensioning may prevent tensile stresses causing the floor to crack.

For the above reasons post-tensioned construction has also come to be used in many situations in buildings. In addition to the above mentioned general features of post-tensioned construction systems, the following advantages of post-tensioned slabs over reinforced concrete slabs are listed as follows:

- More economical structures resulting from the use of prestressing steels with a very high tensile strength instead of normal reinforcing steels.
- Larger spans and greater slenderness, which results in reduced dead load, which also has a beneficial effect upon the columns and foundations and reduces the overall height of buildings or enables additional floors to be incorporated in buildings of a given height.

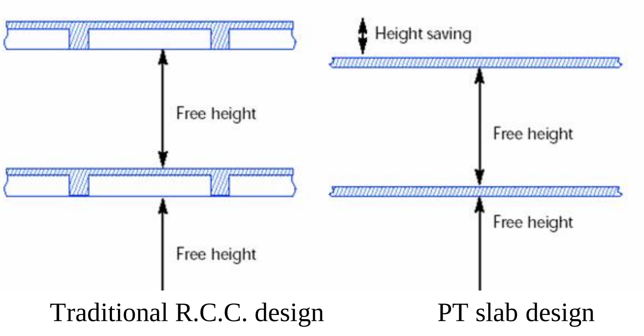

Figure 1: Height comparison of R.C.C. & PT slab design [3]

II. METHODS AND MATERIAL

Literature Review

Many researchers and authors have presented their views for analysis and design of post tensioned and flat slab which some of views are as follows:

Boskey Vishal Bahoria et al [1] considering a plan of the office building (G+4) which is designed a four cases with different floor systems which is post tensioned (PT) flat slab, Reinforce concrete (RC) flat slab, PT slab with RCC beam and RCC slab with RCC beam. Along calculated quantities of reinforcing steel, prestressing steel, concrete required for the slab, beam and column is calculated for the same and are presented in tabular form. Along with this total cost of the building per square meter is found and comparison of all the four cases with respect to cost which is given in table I and in chart form shown in figure 2.

III. RESULTS AND DISCUSSION

TABLE I: RATE ANALYSIS FOR THE CASES CONSIDERED [1]

Item	Concrete (m3)	Reinforcing steel (Kg)	Prestressing steel (Kg)	Form work	Rate per sqm (Rs.)
PT flat slab	507.52	31659	8400	2100	2800
RC flat slab	549.69	85550	-----	2100	3600
PT slab with R.C.C beam	641.33	42271	6720	2100	3200
RCC slab with RCC beam	626.31	86701	-----	2100	3800

According to the author some observation made from table which is following:

- Post-tensioned flat slab is the most economical among all four floor systems from the economic point of view and the reinforced concrete slab with reinforced concrete beam is the costlier one for this span.
- Post-tensioned flat slab is more economical than the post-tensioned slab with reinforced concrete beams from both post-tensioned floor system building.
- The reinforcing steel is more in case of post-tensioned slab with reinforced concrete beams because the slab transfers the load on the beam and more loads is taken by the beams itself.
- The amount of concrete required for a floor is more in-case of post-tensioned slab with reinforced concrete beams whiles it is least for the post-tensioned flat slab floor system.
- The reinforcing steel for the reinforced concrete flat slab is 41 Kg/m^2 while for the reinforced concrete slab and beam it is 40 Kg/m^2.
- If we consider the period of construction for a floor it is less in case of post- tensioned flat slab than the other three cases as the post-tensioning allows the earlier removal of the formwork. In case of post-tensioned slab with reinforced concrete beams the formwork of slab can be removed earlier but the formwork for the reinforced concrete beams cannot be removed earlier.
- The quantity of prestressing steel is 4 Kg/m^2 for post-tensioned flat slab and 3.2 Kg/m^2 for post-tensioned slab with reinforced concrete beams i.e. the prestressing steel required for the post-tensioned flat slab is greater.
- The reinforcing steel required for the post-tensioned flat slab and post- tensioned slab with reinforced concrete beam is 15 Kg/m^2 and 20.15 Kg/m^2 respectively.

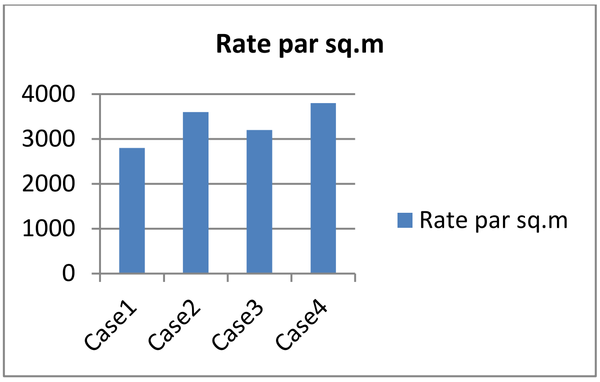

Figure 2: Variation of rate for each floor system

- If we consider the post-tensioned flat slab and reinforced concrete flat slab, the thickness of reinforced concrete flat slab is 12.5% greater and its cost is 27% greater than the post-tensioned flat slab.
- The reinforcing steel is more in case of post-tensioned slab with reinforced concrete beams because the slab transfers the load on the beam and more loads is taken by the beams itself.
- The floor to floor height available in case of post-tensioned flat and reinforced concrete flat slab is 2.65m while in case of post-tensioned slab with reinforced concrete beams and reinforced concrete slab and beams is 2.4m.

Thayapraba M [4] who's done an attempt is made to compare the cost effectiveness of Post-Tensioned flat slab systems with respect to reinforced concrete flat slab system. Both the systems were analyzed using SAP and MS Excel program was developed based on the design methodology. The results indicate that Post Tensioned flat slabs are cheaper than the RCC slab systems for different span which is (8x8)m, (9x9)m, (10x10)m, (11x11),m (12x12)m spans and G+8 building considered. The quantities and the cost of concrete, reinforcing steel, post tensioned steel and the shuttering excluding the labour charges for all the cases considered are given in Table II.

TABLE II RATE ANALYSES FOR THE PANELS CONSIDERED [4]

Description	Rates for different panel sizes (in Rs.)				
	(8x8) m	(9x9) m	(10x10) m	(11x11)m	(12x12) m
RCC(M25)	2986	3098	3388	3556	3744
RCC(M35)	2822	2988	3212	3426	3678
PT	1820	2084	2247	2523	2833

Dr. Uttamasha Gupta et al [2] checked to improve the performance of building having flat slabs under seismic loading, provision of part shear walls is proposed in the present work. In the paper work is to compare the behaviour of multi-storey buildings having flat slabs with drops with that of having two way slabs with beams and to study the effect of part shear walls on the performance of these two types of buildings under seismic forces and provides a good source of information on the parameters lateral displacement and storey drift.

According to the author observed that in shorter plans use of flat slabs with drops results in increase in drift values and from analysis that use of flat slabs with drops in place of beam slabs causes increase in percentage reinforcement in columns and in shorter plans increment observed is not significantly affected by presence of shear walls. Results reveals that in case of column design reinforcement percentage is more with master slave approach as compared to realistic case that is consideration of slabs along with frames.

IV. CONCLUSION

From, the above study it can be conclude that

- In R.C.C building reduce time period of construction formwork so labour charges will reduce in case of post-tensioned flat slab to compared R.C.C slab.
- Post-tensioned flat plate slab moment is less as compare to moment of RCC flat slab by equivalent frame method because as depth of Post tensioned flat slab 30 to 35% less than RCC slab, due to which self-weight of slab get reduced.
- To increases shear and moment of post-tensioning of flat plate slab on column so there is no much effect on axial force.
- The deflection at center of flat plate slab is controlled more effectively by parabolic and Trapezoidal tendon than triangular tendon.

V. REFERENCES

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