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A Research on Comparison of R.C.C and Post Tensioned Flat Slab with or Without Drop Using Software

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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 research paper is focused on post tensioned slab with or without drop and flat slab. In this paper, an attempt has been made to parametric study of Post-Tensioned Flat slab with or without drop and r.c.c flat slab for different panel size. These types of slab have been analysed and designed by Etabs and ADAPT_pt@2012 software, for the different span (6m to 10m) which are the most common spans used in practices.

Keywords: R.C.C, Post Tensioned, Flat slab with or without drop, Strengthening and Concrete, Rate analysis per sq m, Etabs and ADAPT_pt@2012 software

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 posttensioning the non-prestressed reinforcement can be simplified and standardized to a large degree. Furthermore, material handling is reduced since the total tonnage of steel (nonprestressed + prestressed) and concrete is less than for a reinforced concrete floor.
- Assembling of precast elements by posttensioning 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 posttensioned 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.

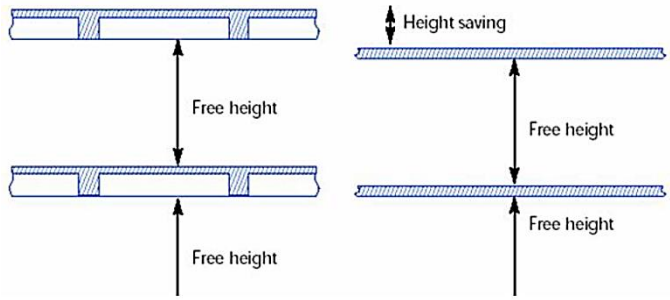

Figure 1: Height comparison of R.C.C. & PT slab design [3]

II. METHODS AND MATERIAL

Scope of Study

Of all Structural costs, floor framing is usually the largest component. Likewise, the majority of a structure's formwork cost is usually associated with the horizontal elements. Consequently, the first priority in designing for economy is selecting the structural system that offers lowest overall cost while meeting load requirements. Posttensioning is the key to cost-effective multifamily construction. In addition, Post-tensioned structures can be designed to have minimal deflection and cracking, even under full load. Thinner floors provide lower building weight, which creates a corresponding reduction in other structural elements. There are also some associated labour and time savings. Hence, the present study aims to compare the cost effectiveness of Post-Tensioned flat slab systems with reinforced concrete flat slab systems. For this purpose, a multistorey building with both the slab systems with different panels was considered. Both the systems are analysed using Etabs and Adapt_pt@2012. Finally, cost comparison graphs are plotted for RCC and Post Tensioned slab systems with respect to span of the member.

Parametric Study

For the purpose of parametric study of reinforced concrete flat slab and post tensioned flat slab with and

without drop varying from 6m to 10m at an interval of 1m are considered.

Story height: 3m
No of bay: 5
Panel sizes: 6x6m, 7x7m, 8x8m, 9x9m, 10x10m
Concrete grade for RCC and PT
Flat Slab: M35
Beam and Slab: M35
Concrete grade for PT: M35
Strength of steel in RCC: 415 N/mm2
Post-Tensioning details
Nominal diameter: 12.9 mm
Nominal area: 98.7 mm2
Weight: 0.785 Kg/m
Strength of steel: 860 N/mm2
The above mentioned floor systems of r.c.c and Post Tensioning are analyzed using Etabs and adpat_pt@2012 are done according to the specifications given in IS456:2000, IS 1343: 1980 and IS 1343:2004 respectively.

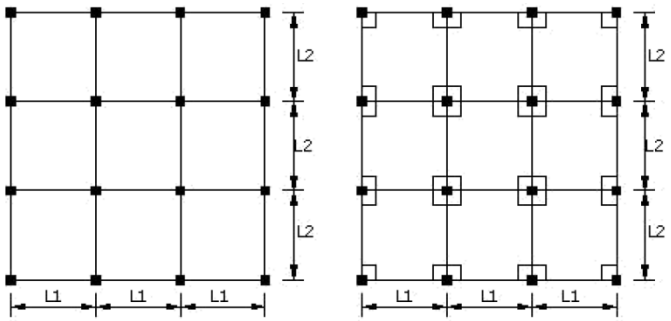

Figure 2: Plan of slab with drop and without drop

Where, L1 and L2 are panel sizes which are varying from 6m to 10m at an interval of 1 m.

Analytical Study

Flat and PT slabs in concrete are widely used because of their economy and fast construction, especially for buildings with long spans. The analysis and design of such slabs are complicated and time consuming. Therefore, in the present study Etabs and Adpat software is used to analyze rcc and post tensioned slabs. Subsequently, rcc flat slabs were designed and checked using Etabs software. Likewise, post tensioned slabs were also designed and checked using adapt_pt@2012 software. The details of the reinforcements are obtained from these designs and they are converted in quantities and corresponding cost for each system is calculated. Finally, the cost comparison graphs are generated for rcc and post Tensioned flat slab with or without drop. The typical view of the (7×7) m panel in Etabs and Adapt is shown in Figure 3 and Figure 4 respectively.

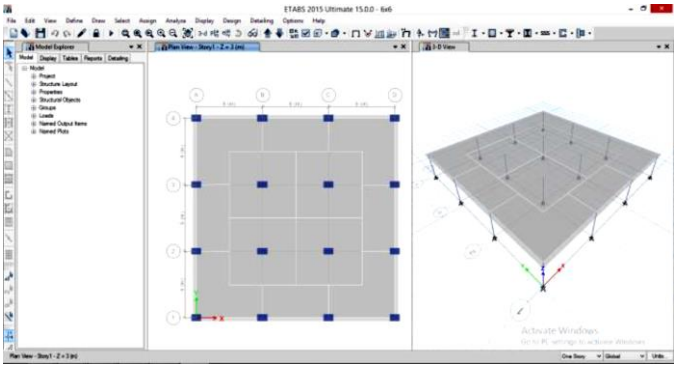

Figure 3: The typical view of the (7×7) m panel in Etabs

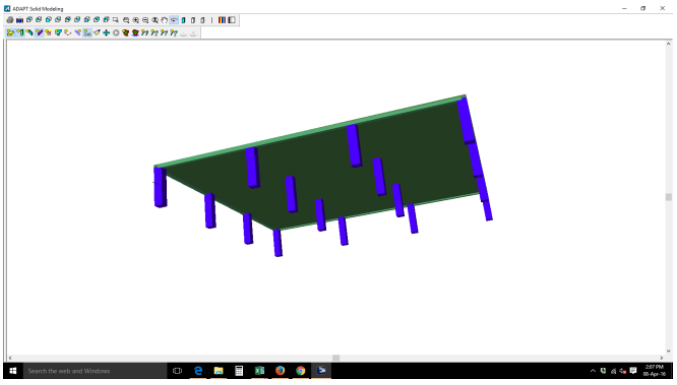

Figure 4: The typical view of the (7×7) m panel in Adapt

Estimating and Costing

From the analysis and design results of the panel the total estimation for the quantities for a typical floor is calculated. The quantities of concrete, reinforcing steel, prestressing steel and the formwork and their cost according to the current rate excluding the labour charges for the r.c.c flat slab, post tensioning slab without drop and post tensioning slab with drop are given in the table I, II and III receptively. Rates are taken from Surat Urban Development Authority (SUDA 2015).

(Rate of concrete=4400/-per m3, Rate of steel=50/-per kg, Rate of form work=400/- per m2), Rate of prestressing steel=130/-per kg)

Table I: The quantities of r.c.c flat slab

Panel size (m)	Concrete (m^3)	Reinforcing steel (Kg)	Prestressing steel (Kg)	Form work (m^2)	Rate per (m^2)
6x6	15.97	1470	-	85	4801
7x7	25.47	2188	-	115	5458
8x8	30.08	3126	-	128	5636
9x9	42.93	4345	-	162	5814
10x10	57.02	6011	-	200	6314

Table II: The quantities of PT without drop

Panel size (m)	Concrete (m^3)	Reinforcing steel (Kg)	Prestressing steel (Kg)	Form work (m^2)	Rate per (m^2)
6x6	10.70	543	61.22	47	4750
7x7	17.40	809	72.47	61	4857
8x8	20.40	1156	78.26	70	5070
9x9	28.79	1433	85.53	85	5477
10x10	38.75	2224	93.16	110	6046

Table III: The quantities of PT with drop

Panel size (m)	Concrete (m^3)	Reinforcing steel (Kg)	Prestressing steel (Kg)	Form work (m^2)	Rate per (m^2)
6x6	8.59	522	132.23	50	4712
7x7	12.35	776	156.75	65	4816
8x8	20.44	1109	169.04	76	5005
9x9	24.21	1375	183.44	91	5334
10x10	27.51	2135	201.22	118	5789

III. RESULTS AND CONCLUTION

The analysis, design and the estimation of the panel for the three different floor systems is done and finally the thickness of this different panel sizes are found out. The fig .5 shows the variation of the thickness for these three different cases with different panel sizes. The observation made from the above work is as follows:

1. For the 6x6m panel sizes, the cost is almost same so up to 6m panel size r.c.c flat slab is economy compare to all cases, for the 7x7m and 8x8m panel sizes, the cost is almost same so up to 7m panel size post tensioning slab without drop is economy, for the 9x9m panel size, the post tensioning slab with drop is economy.

Table IV: Thickness foe different panel size

	Designed Thickness (mm)				
	6x6	7x7	8x8	9x9	10x10
R.C.C Flat slab	175	205	285	365	400
PT without drop	130	175	200	300	345
PT with drop	115	130	150	175	225

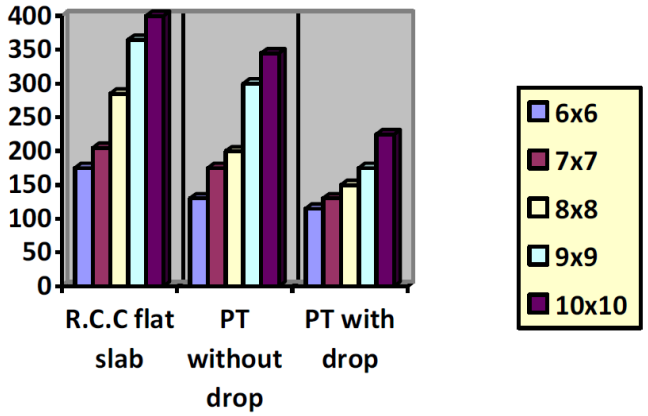

Figure 5. Thickness comparison bar chart for each panel size

2. From the economic point of view the post-tensioned flat slab with drop is the most economical among all three cases and the reinforced concrete flat slab is the costlier one for this all panel size of slab.
3. If we consider the post-tensioned flat slab without drop and reinforced concrete flat slab, the post-tensioned flat slab with drop and the post-tensioned flat slab without drop, the thickness of reinforced concrete flat slab are 26% and 35% greater respectively and its cost are 27% and 30% greater respectively.
4. For the increase in the panel sizes, the cost is also increasing gradually.
5. From both post-tensioned slab system building the post-tensioned flat slab with drop is more economical than the post-tensioned flat slab without drop.
6. The quantity of prestressing steel is 4 Kg/m_2 for post-tensioned flat slab without drop and 3.2 Kg/m_2 for post-tensioned flat slab with drop. i.e. the prestressing steel required for the post-tensioned flat slab without drop is greater.
7. The reinforcing steel required for the post-tensioned flat slab with drop, post- tensioned flat slab without drop and reinforced concrete flat slab are 15 Kg/m_2, 20.15 Kg/m_2 and 25.15 Kg/m_2 respectively.
8. The amount of concrete required for a floor is more in case of reinforced concrete flat slab while it is

least for the post-tensioned flat slab with drop and the post-tensioned flat slab without drop.

9. The floor to floor height is more available in case of post-tensioned flat slab with drop with compare to reinforced concrete flat slab and post-tensioned flat slab without drop.
10. If we consider the period of construction for a floor it is less in case of post- tensioned flat slab system than the reinforced concrete flat slab as the post-tensioning allows the earlier removal of the formwork. In case of reinforced concrete flat slab cannot be removed earlier of the formwork.
11. While estimating the cost of the each building the labour charges are not considered, as the time period reduce the labour charges will reduce in case of post-tensioned flat slab system compare to reinforced concrete flat slab.
12. The wall load is considered on all over the floor (KN/m^2) for the post-tensioned building While analysis. So there is flexibility to the user to construct a wall wherever required in case of post-tensioning.

IV. REFERENCES

[1] Boskey Vishal Bahoria and Dhananjay K. Parbat, "Analysis and Design of RCC and Post-tensioned Flat Slabs Considering Seismic Effect," (IACSIT) International Journal of Engineering and Technology, Vol. 5, No. 1, February 2013.

[2] Dr. Uttamasha Gupta, Shruti Ratnaparkhe and Padma Gome, "Seismic Behaviour of Buildings Having Flat Slabs with Drops," International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, Volume 2, Issue 10, October 2012.

[3] E. H. K. Park, "RC Flat Plate under Combined in-Plane & Out-Of-Plane Loads," Journal of Structural Engineering, vol. 125, no. 10, October,1999.

[4] Thayapraba M, "Cost Effectiveness of Post - Tensioned and Reinforced Concrete Flat Slab Systems," International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-3, Issue-12, May 2014.

[5] Y. H. Luo and A. Durrani, "Equivalent Beam Model for Flat-Slab Buildings: Interior Connections," ACI Structural Journal, vol. 92, no.1, pp. 115-124, 1995.

[6] Harshal Deshpande, Radhika Joshi and Prashant Bangar, "Design Considerations for Reinforced Concrete Flat Slab Floor System," International Journal of Scientific & Engineering Research, ISSN 2229 5518, Volume 5, Issue 12, December-2014

[7] S.S.Patil and Rupali Sigi, "Analysis And Design Of Flat Slabs Using Various CodeS," IJRET: International Journal of Research in Engineering and Technology, ISSN: 2319-1163, ISSN: 2321-7308, Volume: 03 Issue: 04 Apr-2014

[8] A. C. Scordelis, T. Y Lin, and R. Itaya , "Behavior of continuous slab prestressed in both direction," Journal of American Concrete Institute, vol. 40, no.3, December 1959.

[9] A .Pan and J. P.Moehle, "Lateral Displacement Ductility of R/C Flat Plates," ACI Structural Journal, vol. 86, no. 3, pp. 250-258, 1989.

[10] A. J. Duran, S. T. Mau and A. A. Abouhashish, "Earthquake response of flat-slab buildings." Journal of Structural Engineering, vol. 120, no.3, March, 1994.