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COST COMPARISON OF POST TENSIONING, PRESTRESSING AND CONVENTIONAL RCC DESIGN

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Abstract: The aim of project is to check the cost effectiveness of Post-Tensioning Slab with other design methods. For that purpose Multipurpose hall is chosen with the footprint of 6m x 8 m having the total slab area is (768 sq m). The Analysis done by hand calculation & using the following methods 1) Flat Plate (Without drop and capital) and Post-Tensioning Slab by using equivalent frame methods 2)Flat slab with drop and capital by using Direct Design methods and`3)Grid Slab by using IS code Methods .It is also analysis by using **M 35** and **Fe 415** grade of concrete and Steel .After designing the slab, Thickness of slab, Total Dead load ,Moments , Shear stress and over all construction cost are compared . It concludes that construction cost of grid slab is more economical than other three methods for particular span of slab.

Keywords- Non Linear, Soft Storey

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INTRODUCTION

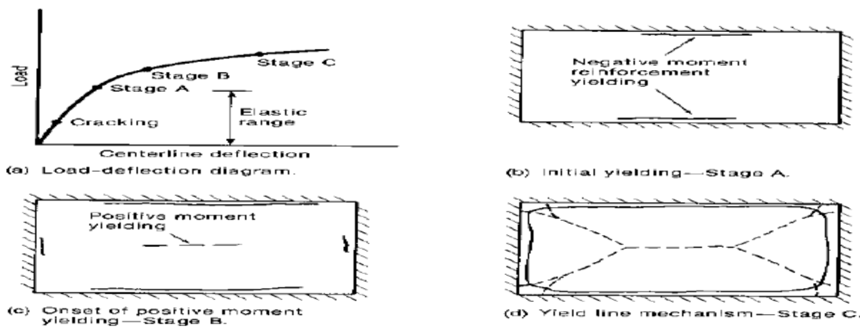
Post – Tensioned construction has for many year occupied a very important position, especially in the construction of bridges and storage tanks. Now a days It has been used for the slab system also. Post tensioning Flat slab are not complex where the construction technique, structural behavior and design are all simple. The tendon install provide a suspension system within the slab and simple balancing load were used. The principle of designing post tensioning flat slab is based the parabolic tendon profile which exert to upward pressure and balance to the downward loading. The Flat Plate system of construction is one in which the beam is used in the conventional methods of construction done away with the directly rests on column and the load from the slabs is directly transferred to the columns and then to the foundation. Slabs of constant thickness which do not have drop panels or column capitals are referred to as flat plates. The strength of the flat plate structure is often limited due to punching shear action around columns, and consequently they are used for light loads and relatively small spans.

The Flat Slab system of construction is one in which A part of the slab bounded on each of the four sides by centre line of column is called panel. 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. The thickened portion i.e. the projection below the slab is called drop or drop panel. In some cases, the section of column at top, as it meets the floor slab or a drop panel, is enlarged so as to increase primarily the perimeter of the critical section, for shear and hence, increasing the capacity of the slab for resisting two-way shear and to reduce negative bending moment at the support. Such enlarged or flared portion of and a capital. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement.

1) METHODS:

2) 1) Yield-Line Analysis

Yield-line analysis uses rigid plastic theory to find both the lines in the slab where the slab will yield and the failure loads corresponding to the moment that causes the yielding. Yield lines are assumed to act like plastic hinges separating elastic plates. The yield lines must be straight because the plates formed in between the yield lines rotate about them. Figure 3.1 below illustrates the formation of these yield lines in a slab. In Figure 3.1, follow (a), a load versus centerline deflection diagram for the slab, through the various stages of yield line analysis. The first yield lines form in (b) at areas of highest negative moment. The slab rotates along the yield line as more load is applied because the slab. In Figure 3.1, follow (a), a load versus centerline deflection diagram for the slab, through the various stages of yield line analysis. The first yield lines form in (b) at areas of highest negative moment. The slab rotates along the yield line as more load is applied because the slab cannot resist more than its yield load at the yield line. The additional moment is redistributed to the elastic areas of the slab. Additional yield lines form in the slab, as shown in (c), and a plastic mechanism eventually forms, as shown in (d). If loads are increased after the formation of this plastic mechanism, the slab collapses. The mechanism shown in (d) corresponds to the plastic mechanism commonly assumed in two-way rectangular slabs



3) 2.Direct Design methods

It is simple and easy method of obtaining the moments in two way continuous slabs. The development of this method is based on the test results available for two way slabs and flat slabs. To ensure the two way slab behavior it is necessary to impose limitations. If the limitations are prescribed below are not satisfied then alternative solution is use

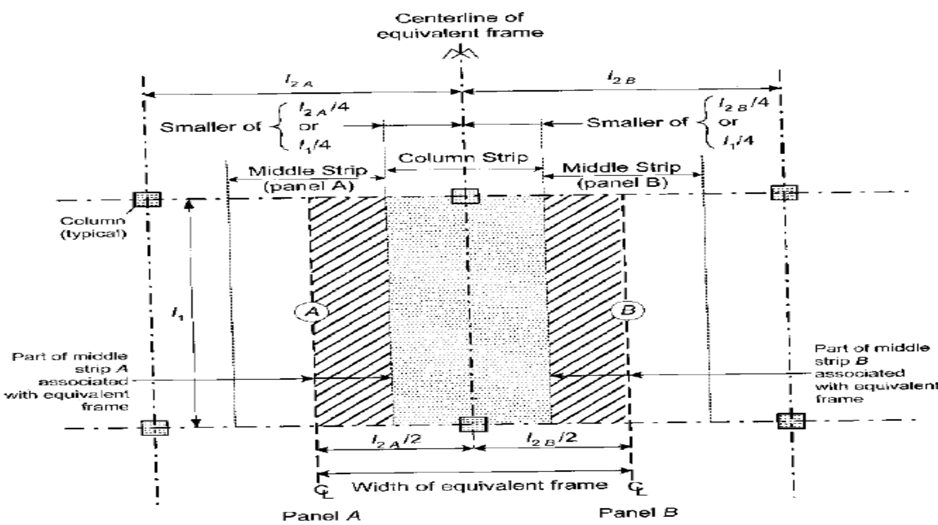
2.1 Limitation of Direct design methods according to IS 456 There shall be minimum of three continuous spans in each direction.

The panels shall be rectangular, and the ratio of the longer span to the shorter span within a panel shall not be greater than 2.0

It shall be permissible to offset columns to a maximum of 10% of the span in the direction of the offset notwithstanding the provision in above. The successive span lengths in each direction shall not differ by more than one – third of the longer span. The end pans may be shorter but not longer than the internal spans. The design live load shall not exceed three times the design dead load Load should be gravitational (vertical only) .They should be uniformly distributed in the entire panel In two way slabs with beams on all sides , DDM should also satisfy the following additional condition . Denoting α1 as the average of the two ratio of flexural stiffness (EI)of the beam in the longer direction L_1 to that of the slab between centers of adjacent panels on each side of the beam α1 as the above average ratio in the shorter directions L_2 .The ratio of beam relative stiffness in the two directions is given by the expiration (α1/α2)/($L2/L1)2$ must lie between 0.2 and 0.5

4) Equivalent Frame Methods

In the equivalent frame method the slab of a building is divided into middle strips and column strips for analysis. Figure 3.3 below illustrates how the middle and column



strips are defined in a slab. ACI 318-05 defines the width of a column strip as 0.25l_1 or 0.25l_2 whichever is less. The middle strip width is determined by the two column strips that bound it. The moments in the column strip frames are calculated using the moment distribution method. The equivalent frame method assumes the moments to be uniform across the strips. The stiffness of the slab and columns must be found, as well as the carryover factors, in order to determine the moments across the section of frame using moment distribution. The moments and shears may Equivalent Frame Methods and Direct Design Methods are used For Designing the Post-Tensioned Slab and Flat slab with and without Drop is used

Methods of Analysis of Grid Slab:-

1 Approximate methods

2 Rankin Grashoff Theory

3 By plate Theory

1) Approximate methods

According to the Indian Standard Code IS :456-2000 the ribbed slab system can be analyzed as solid slab, if the following requirements regarding spacing of beams , thickness of slab and edge beams are satisfied

1) The spacing of the rib should not be greater than 1.5 m and it should not be greater than 12 times the flange thickness.

2) In situ Rib should not be less than 65 mm wide

3) Beam should be formed along each edge parallel to the span, having width equal to that of the bearing

4) The moment and shear per unit width of grid are determined from the table 26 IS : 456-2000 Code and the reinforcements are designed in the ribs. The slab reinforcements are generally consist of a mesh or fabric. Design done by using the approximate methods for the comparison point of view

5) Measured Design Out Put :-

Designing the slab by various methods as mentioned above . Following result has been observed as shown below methods

Types	Flat slab with Drop	Flat Slab without Drop	Post-Tensioning Slab	Grid Slab
Total Load of slab KN/mm^2	16.92	18.75	13.67	11.25
Max mom nets KN-m	342.67	450	40.8	0.81 / 52.704 (beam)
Interior Column N/mm^2	0.227	1.47	1.474	2.17
Corner Column N/mm^2	0.217	1.09	2.17	

From the Above table

1)It is observed that the Total Dead load on the slab is more in Flat slab without drop and its comparatively less in Grid Slab.

2)Moments develops in grid slab is negligible due to the rib provision at interval of 1.5 m .The moment produce in Rib is (52.704KNm),While in PT slab it is (40.8 KNm).

3)Shear stress developed in flat slab with drop is much less due to Column Capital and Drop. Drop and capital in column improve the punching shear at the junction of column and slab

Location	Flat Slab without drop Panel (KNm)	Flat Slab with Drop panel (KNm)	Post-Tensioned slab (KNm)
End span			
-ve	40.64	46.88	5.124
+ve	41.28	31.10	34.76
-ve	218.6	58.86	42.65
Interior Span			
Ve	209.4	55.68	43.35
+ve	25.00	23.98	21.57
-ve	160.53	55.68	42.65

Moments in Column Strips

From the Below table It is found that moment produce in Post-Tensioned slab is less as compare to others two methods, due to some load is balanced by the strand Reinforcements Details in Column Region along the transverse Direction.

Location	Flat Slab Without Drop		Flat slab With Drop		PT Slab	
	No	Spacing	No	Spacing	No	Spacing
End Span	04	16@ 300 mm c/c	04	14 @200 mm c/c	10 -7 wire Strands	4 strands provided in column regions
	04	16@ 300 mm c/c	04	12@ 220 mm c/c	8	12@130 mm c/c
	14	16@ 70 mm c/c	05	14 @210 mm c/c		
Interior span	14	16@70 mm c/c	05	14 @210 mm c/c		
	4	16 @ 300 mm c/c	03	12@200 mm c/c		
	10	16 @ 100 mm c/c	04	14 @ 200 mm c/c		

Cost Comparison:

The Relative economics of post tensioning versus other form of construction vary according to the individual requirements of each case. In any basic Comparison between the post-tensioned and other type of reinforced concrete structure .For comparison purpose considering the cost and quantity of concrete, cost of steel and post tensioning materials, cost of shuttering is not consider and Other Rate is consider as per DSR and Rate Analysis Done by LASA . On that basic.

Following table are prepare and graphs are to be drawn for the comparison purpose.

Type of Slab	Depth of Slab	concrete per cu.m	steel Quantity Kg	Cost Concrete Rs	Cost Of reinforcements Rs	Overall Cost	Rate /sq.m
Pt Slab	200	9.6	104.48	63638.4	39217.26	102855.66	2142.826
Grid Slab	100	7	110	46403	6090.44	52493.44	1093.613
Flat slab without drop panel	300	14.4	179.06	95457.6	17422.56	112880.16	2351.67
Flat slab with drop	300	14.89	160.86	98705.81	8495.64	107201.45	2233.364

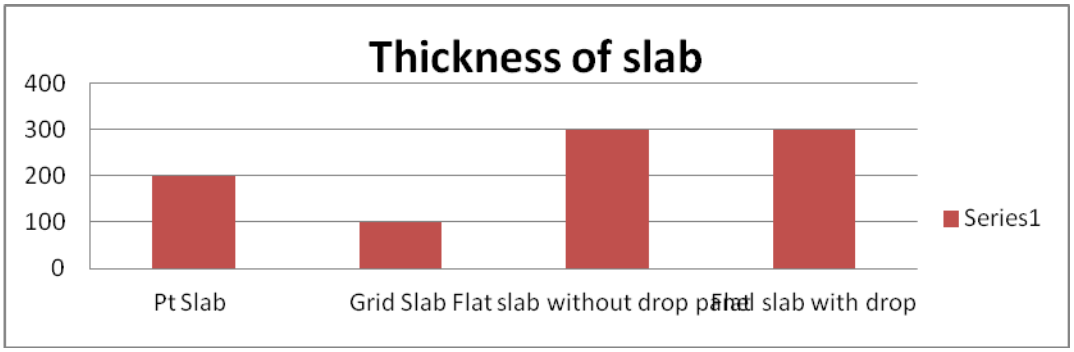


Fig:- Type of Slab VS Depth of Slab

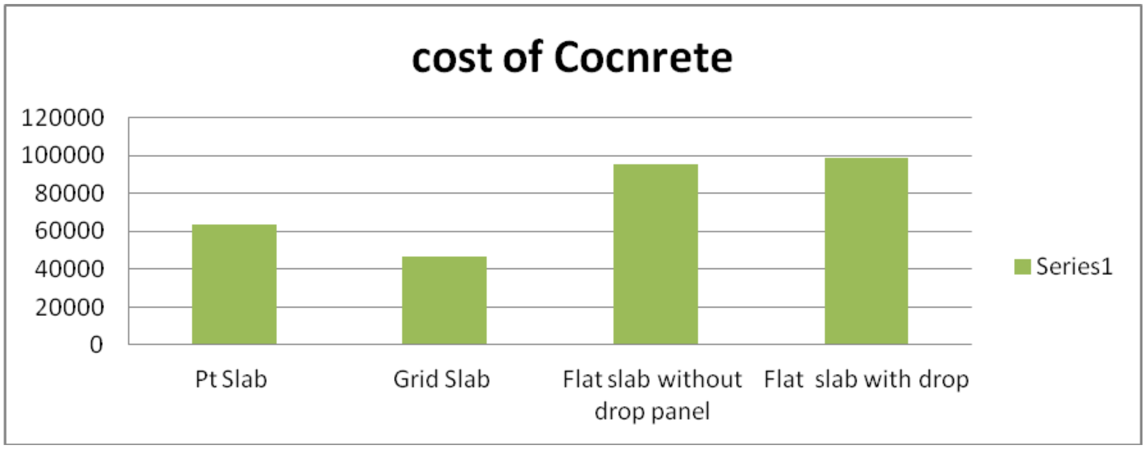


Fig:- Type Of Slabs VS Cost Of Concrete

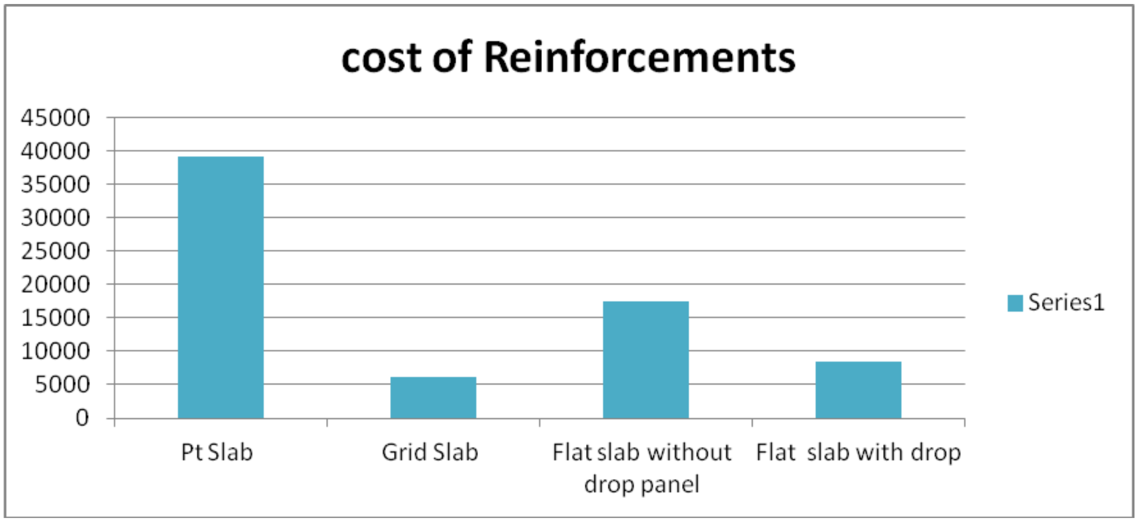


Fig:- Type Of Slabs VS Cost Of Reinforcements

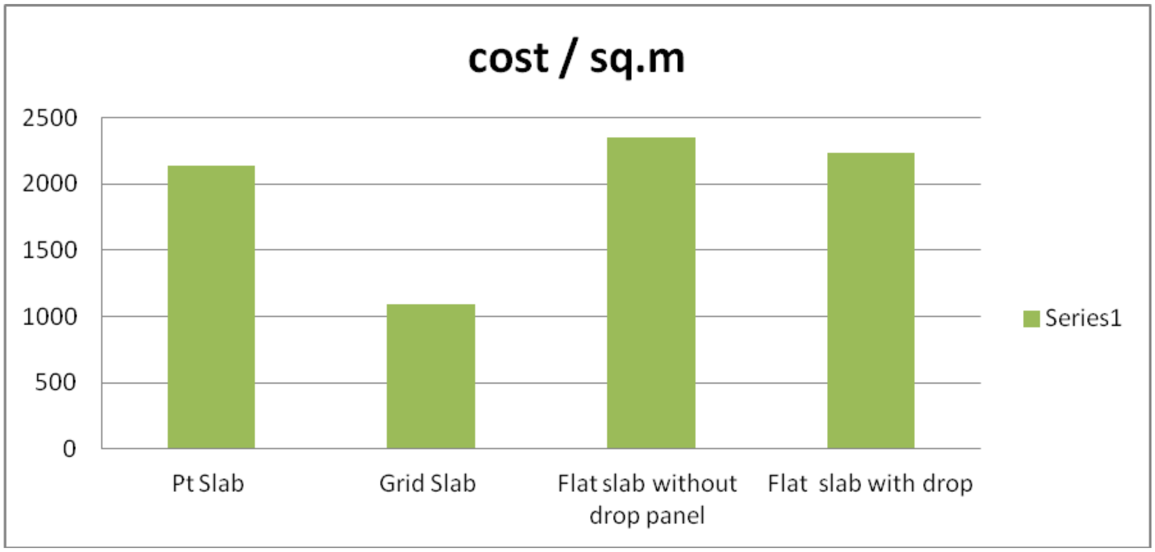


Fig:- Type of Slabs VS Cost/ sq.m

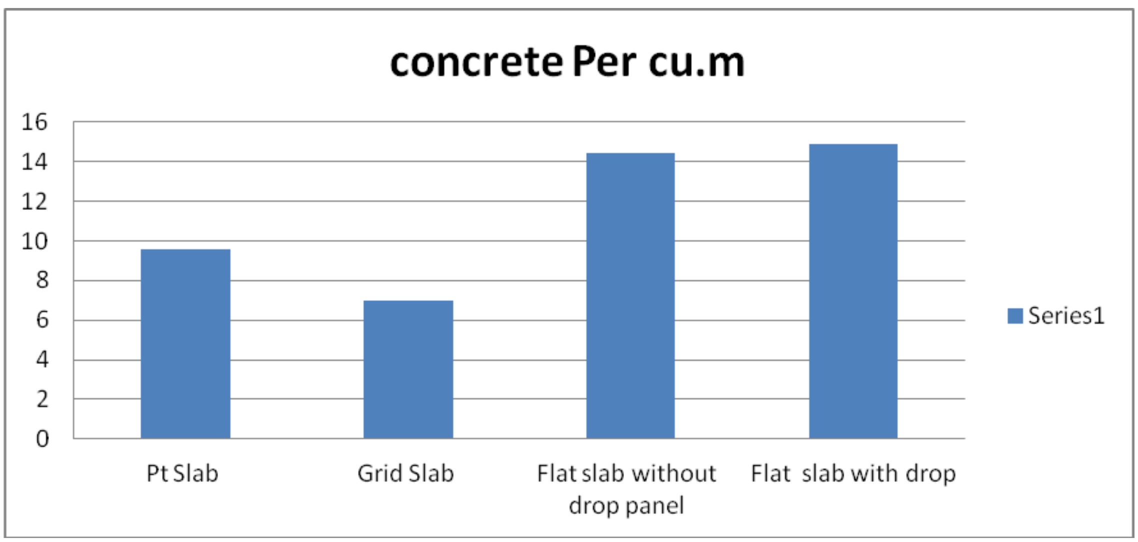


Fig:- Type of Slabs VS Volume of Concrete

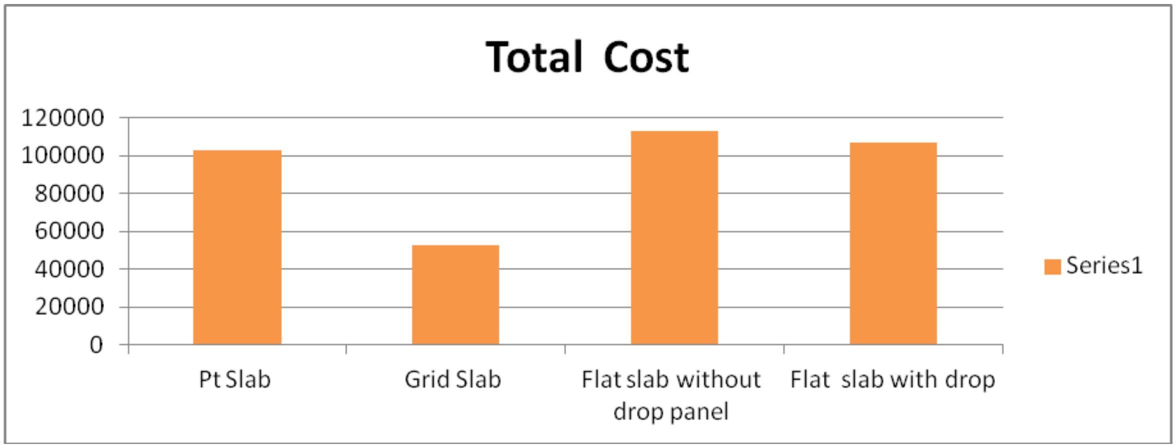


Fig:- Types of Slabs VS Total Cost

CONCLUSION :-

1. From the Calculation, It is observed that stress developed in flat slab without drop is much less as compare to other slabs, So Drops are important criteria in increasing the shear strength of the slab.

2. Concrete required in Grid slab is less as compared to Flat slab with Drop and Flat slab without Drop.

3. Steel required in Flat slab without Drop is more as compared to Post tensioning slab. Flat slab with Drop and Grid slab

4. Without considering the shuttering cost , Grid Slab is economical than other slab.

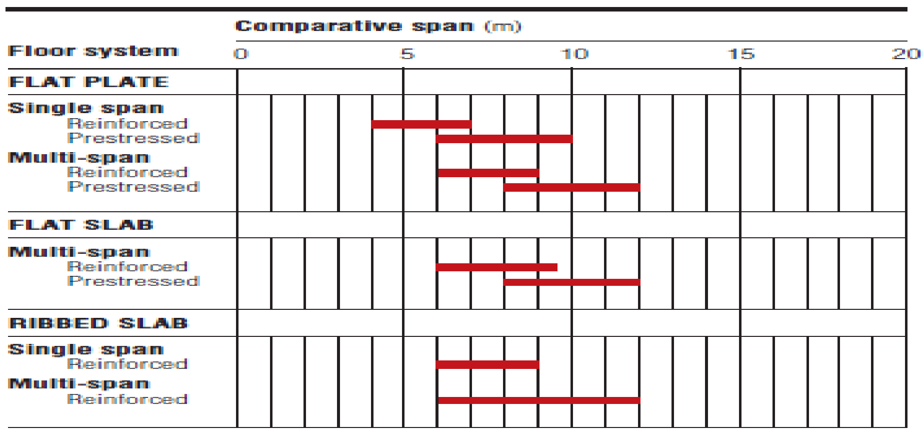
5. Depth of grid slab is less , But it required the Rib in each direction at shorter spacing, Where as in Post –Tensioning Slab for particular span it required depth of only 200 mm. It helps to reduce the overall dead weight on structure than other two methods.

6. Rate Per square meter of grid slab(1093.66 Rs/sq.m) is very less as compare with the other Post tension slab (2142.28),flat slab without drop panel (2351.67) and slab with drop panel and capital (2233.67)

7. From the graph ,It is concluded that conclusion driven by CCAA(Cement Concrete Association of Australia) in below bar chart is nearly same as that of we find for the span of 6m x 8 m

8. From the graph, It is observed that the thickness of slab is less as compare to other methods, So It is beneficial, where the constraint in height . In that place you can achieved one more floor with in the limited FSI as compared to others methods.

9. Speed up the Construction activity very Fastly in Post-Tensioning, So you can rented or relocate with in shorter duration of time.



From the above graph , It is Concluded that for longer span Post –Tensioning Slab is more economical.

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