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# A COMPARATIVE REVIEW ON BEHAVIOURAL ASPECT OF POST-TENSIONING VOIDED FLAT SLAB WITH OTHER SLAB SYSTEMS

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**Abstract** — *Plain (unreinforced) concrete is placed when the structure must resist mostly compression forces and when tensile stresses are low. Pre-stressed concrete is concrete that is pre-compressed by stressing the reinforcement before loads are applied. This greatly increases its ability to resist tensile forces without excessive cracking. when the requirement of large span slab without beam where flat slab preferred but deflection of flat slab is more compare with slab beam system. If we doing the post-tensioning in a flat slab may deflection can be control. Sometimes span of slab is more than 15 meters where post-tensioning flat slab not suitable because of the moment and deflection are very high due to self weight of slab and difficult can be controlled. Most of foreign country take the voided slab with post-tensioning because of the self weight of voided slab are less compare to solid slab. Here various different paper are describe related to flat slab ,voided slab and post-tensioning method.*

***Keywords***- *flat slab , voided slab , pre-stressed concrete , post-tensioning , pt slab*

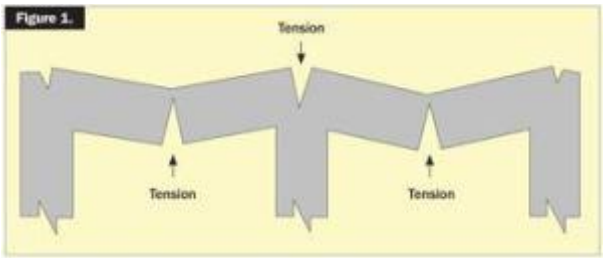
## I. INTRODUCTION

Structural Concrete Slabs are constructed to provide flat surfaces, usually horizontal, in building floors, roofs, bridges, and other types of structures. The slab may be supported by walls, by reinforced concrete beams usually cast monolithically with the slab, by structural steel beams, by columns, or by the ground. The depth of a slab is usually very small compared to its span.We discuss about Flat slab , Voided slab and Post-Tension slab.

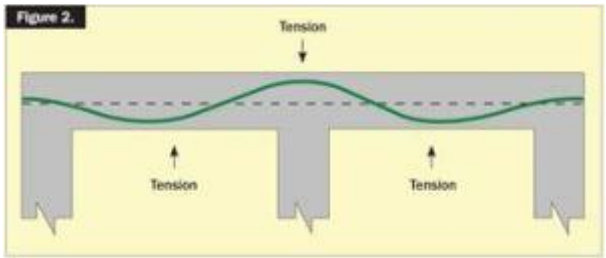
### i. Post-Tension Slab

All Post-tension flat slab construction has long been popular for medium to high rise building such as office buildings, hospitals, residential buildings, university, and parking buildings. The term pre-stressing is used to describe the process of introducing the internal force(or stress) in to a concrete element during the construction process in order to counteract the external load applied when the structure is put in to use. These internal forces are applied by tensioning high-strength steel, which can be done after the concrete is placed.

When a concrete floor slab is subjected to forces, it flexes and bends. These forces are a result of gravity pulling down on the slab while additional weight is applied to the top of the slab. The bending and flexing creates high tensile forces that can cause the concrete floor slab to crack (see Figure 1). Adding post-tensioned reinforcement instead of rebar alone combines the action of reinforcing the tension zones with the advantages of compressing the concrete slab. Additional benefits are obtained when the post-tensioned reinforcement is installed in a draped profile instead of running




(Fig.1 Location of crack due to tension)




(Fig.2 Position of tendon)

in a straight line. A typical draped profile in an elevated concrete slab would route the post-tensioned reinforcement through a high point over the slab's supports, and through a low point in between those supports (see Figure 2). Now optimum efficiency is obtained because the post-tensioned reinforcement is located in the tension zones, the concrete is compressed, and the post-tensioned reinforcement is creating an uplift force in the middle of the spans where it is needed the most.

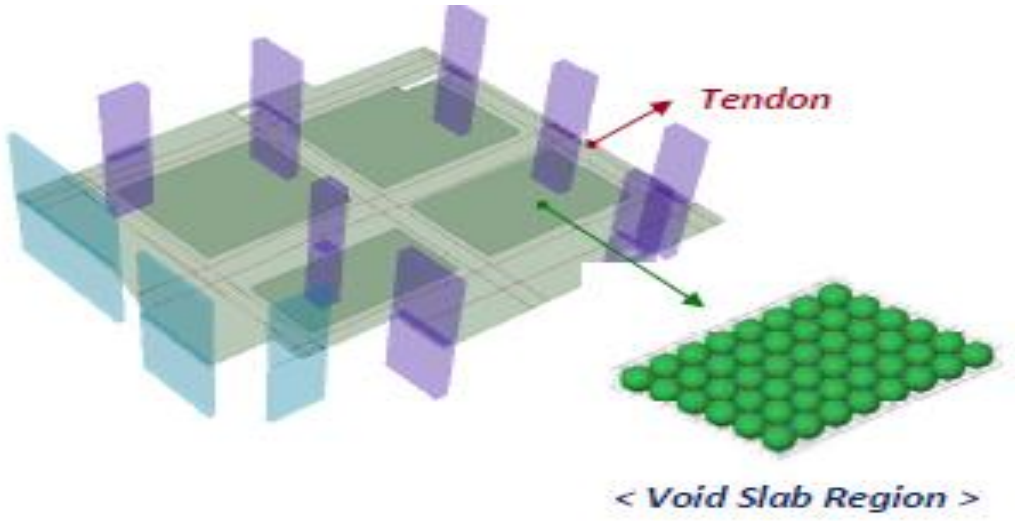
 

**ii. Flat slab:**

Flat slab is reinforcing concrete slab supported directly by concrete column without using beam. Flat slab are one of the most popular system used in various types of building , car park and many other structure where the clear floor to floor height is more require.

**iii. Voided Slab:**

The concept of bubble-voided flat slabs involves placing hollow recycled plastic shapes (typically spherical) in-between two layers of rebar, in the middle of a concrete slab. Due to the replacement of concrete with air, the slab will have a lower dead load and therefore a higher allowable span – up to 55 feet without using beams . The act of replacing concrete portions in the slab with plastic air bubbles will decrease the amount of concrete used, saving money and resources, as well as lighten the entire structure. Due to this smaller dead load, the columns and foundation will also decrease in size.



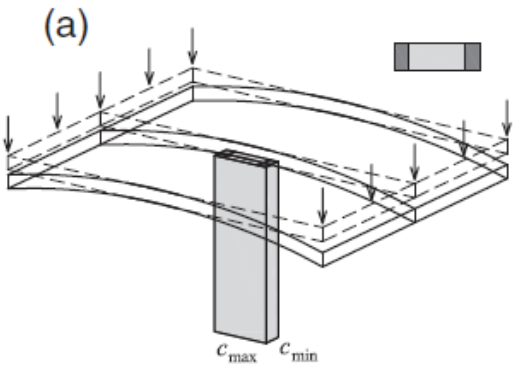

(Fig.3 Voided slab)

## II. LITERATURE REVIEW

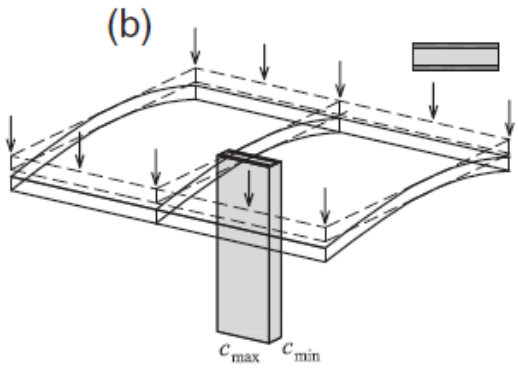
### A. Punching of flat slabs supported on rectangular columns" ; Engineering Structures 77 (2014) 17–33

**J. Sagaseta , L. Tassinari , M. Fernández Ruiz , A. Muttoni;** "Punching of flat slabs supported on rectangular columns" This paper investigates the structural behaviour of RC flat slabs supported on rectangular interior columns and the influence of the loading conditions (one or two-way bending) on their punching shear strength. The punching shear strength of slabs at rectangular columns can be lower than at equivalent square columns with a similar length of the control perimeter. The tests in this work showed that the failure mode, ultimate strength and rotation capacity were highly influenced by the orientation of the column with respect to the main spanning direction.

As shown figure the column direction is parallel to slab main span direction ,the shear distribution only two small edges(Fig.4) and if column direction perpendicular to the slab main direction,the shear distribution two large edges(Fig.5) so the capacity of punching shear is high.



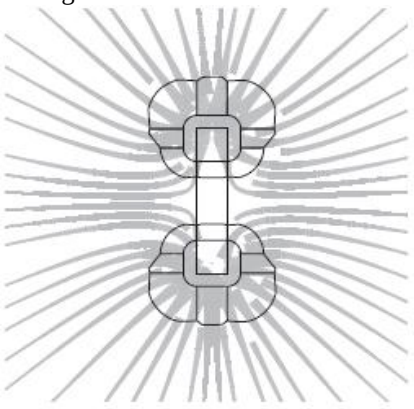

(Fig.4 one-way action in the direction of the elongated side of the column ($C_{max}$);



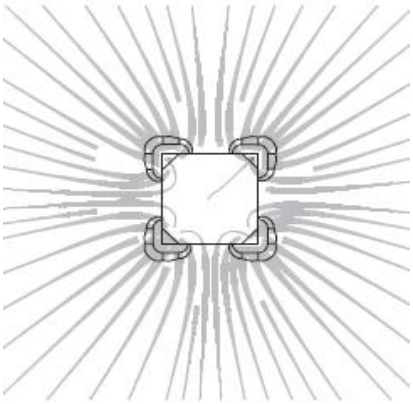

(Fig.5) one-way action in the direction perpendicular to

Column dimension also play important role in punching shear. With the change in column section ,the punching shear capacity also change. The shear distribution on rectangular and square column are shown in figure 6 and 7.



6.Two effective regions in an internal rectangular concentric loading

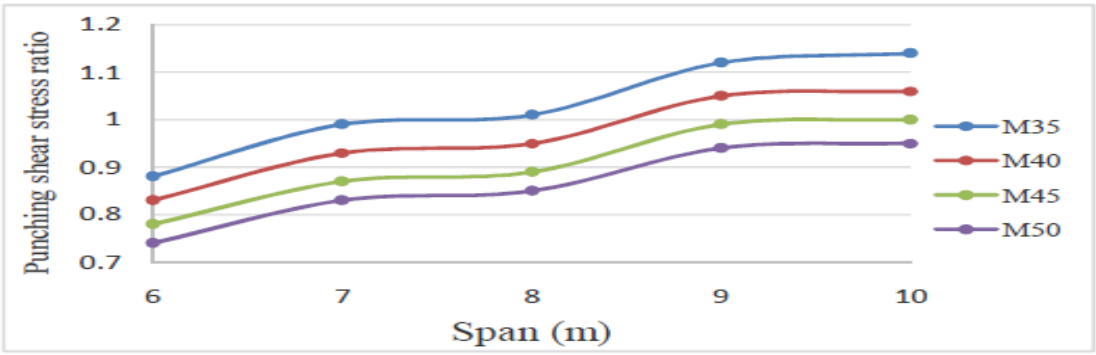


7. Four effective regions in an internal square column with concentric loading

**B. Comaparative parametric study for post-tension flat slab and flat slab with drop system"; International Journal of Civil Engineering and Technology (IJCIET), ISSN 0976-6308 ,Volume 8, Issue 5, May 2017**

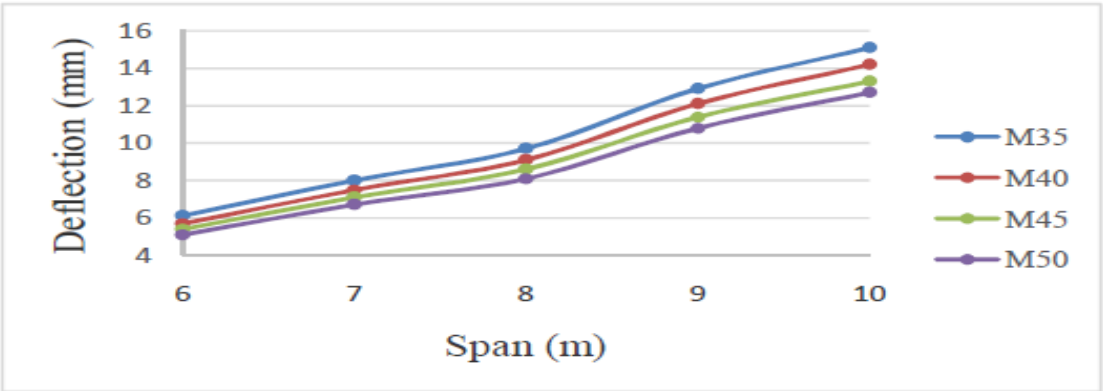
**Kamal Padhiar , Dr. C.D. Modhera , Dr. A. K. Desai ;**" Comaparative parametric study for post-tension flat slab and flat slab with drop system" , **,** This paper presented study about the two different floor post-tensioning floor systems have been considered for the present study, they are flat slab and flat slab with drop panel. They change the grade of concrete M35 to M50 , With changing grade of concrete, effect of punching shear ratio, factored moment at mid span and PT quantity are also studied.

The figure 8 are showing that with changing the span , change the punching shear ratio for the different grade of concrete.




(Figure 8 span Vs punching shear stress ratio)

The Figure 9 are showing that with changing the span ,the change in deflection for the different grade of concrete.




(Figure 9 span Vs total deflection of exterior span)

**C. Strengthening of flat slabs with post-tensioning using anchorages by bonding; Engineering Structures 33 (2011) 2025–2043**

**Duarte M.V. Faria , Válter J.G. Lúcio, A. Pinho Ramos; "**Strengthening of flat slabs with post-tensioning using anchorages by bonding" Discuss about to study a new flat slab strengthening technique based on post-tensioning with anchorages by bonding using an epoxy adhesive. This technique reduced the slabs' deflections at service loads up to 70% as compared with unstrengthened slabs, and reduced crack widths significantly. The research carried out also shows that there was a decrease in the average strains of the reinforcing bars, mainly in the bi directional strengthened slab.

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**D. Comparative design of RCC and Post-tension flat slab; Institute Of Technology , Nirma University , Ahemdabad – 382 481, 09-11 Dec., 2010**

**Boskey Bahoria, Prof.R. S. Deotale ,Dr D K Parbat "**Comparative Design of RCC & Post-tensioned flat slabs", The parametric study of the post-tensioned flat slab by varying the span by 0.5m interval is done and results of the different parameters such as thickness of slab, grade of concrete, loss due to stress, normal reinforcement, reinforcement for the shear, number of tendons, stressing force per tendon and deflection etc. are presented in the graphical form and show the deflection and slab thickness can be reduce by post-tensioning in slab.

**E. Voided Slab Design: Review Paper; 3rd International Conference on Multidisciplinary Research & Practice , ISSN 2321-2705 , Volume IV Issue I**

**Ashish Kumar Dwivedi, Prof. H. J Joshi, Rohit Raj, Prem Prakash Mishra, Mamta Kadhane, Bharati Mohabey** "Voided Slab Design: Review Paper" , Voided Slab Design: Review Paper", This paper reviewed the several study done on voided slab system. Author taking parameter like , shear strength, bending strength, deflection, fire resistance , punching shear , cost comparison , behaviour under seismic load and showing The benefits of using plastic voided slabs rather than solid slabs are greater for larger spans.

**F. Design Considerations for Reinforced Concrete Flat Slab Floor System;International Jouranal of Scientific & Engineering Research , Volume 5 , Isssue 12 , Dec-2014 ,59 ISSN**

**Harshal Deshpande, Radhika Joshi, Prashant Bangar**," Design Considerations for Reinforced Concrete Flat Slab Floor System" Discussed the review of design methods for flat plate/slab structure designs based on Indian Standard IS456:2000 and American Concrete Institute ACI-318 codes. The design of flat slabs irrespective of the methodology used must first assume a minimum slab and drop thickness and a minimum column dimension to ensure adequate stiffness of the system to control deflection. The IS 456:2000 code is not clear on these minimum conditions. RC design method prefer up to 10m and above 10m span post tensioning method are economical.

## III. CONCLUSION

From the above literature we conclude that

1) The punching shear strength of slabs at rectangular columns can be lower than at equivalent square columns with a similar length of the control perimeter.
2) For the flat plate slab and flat slab with drop panel the maximum span length is 8.0 meter and 13.0 meter respectively considering constant thickness and different grade of concrete. For the span above 8.0 and 13.0 meter slab fails in punching shear stress criteria. Deflection in flat slab is more than compare with the flat slab with drop panel.
3) If the slab are strengthen by bi-directional , The deflection and crack width can be reduce and decrease in the average strains of the reinforcing bars.
4) 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.
5) The amount of the concrete is more required in RCC flat slab compare with the PT slab so seismic weight og building reduce by using the post-tensioning flat slab floor system.
6) For the design of flat slabs first assume a minimum slab and drop thickness and a minimum column dimension to ensure adequate stiffness of the system to control deflection. The IS 456:2000 code is not clear on these minimum conditions

 

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