A REVIEW PAPER ON BONDED & UNBONDED POST-TENSIONING SYSTEM FOR THE BUILDING FLOOR SYSTEM

[1] **Harshit Upadhyay**, [2] **Jyoti yadav**

[1] *M.tech Schlor, Civill Department, SRK University, M.P.India*
[2] *Asst.Professor, Civill Department, SRK University, M.P.India*

ABSTRACT

The Principal design objectives for structural engineers are safety, functionality, economy and now a day's legality of design. When selecting a structural building system, it is important for the engineers and architects to understand the appropriate application of post-tensioned concrete and the effects that may result. If properly analyzed and assembled, concrete structures from high quality materials can provide a superior combination of durability, sound control and fire safety needed in today's building market. Considering above factors post tensioning floor systems has been considered for the present study. Prestressing of concrete is defined as the application of compressive stresses to concrete members. There are two types of prestressing named pre-tensioning and post-tensioning. Post tensioning has many reason which increases the use of the post-tensioning, such as increased span to depth ratio resulting in a reduction in construction materials and a subsequent reduction in overall cost, positive deflection control, design flexibility, minimum construction joints, improve durability and increase span length.

Keyword: *Prestressing, Concrete, Joints*

---

1. INTRODUCTION

The development of pre-stressed concrete can be studied in the perspective of traditional building materials. In the ancient period, stones and bricks were extensively used. These materials are strong in compression, but weak in tension. For tension, bamboos and coir ropes were used in bridges. Subsequently iron and steel bars were used to resist tension. These members tend to buckle under compression. Wood and structural steel members were effective both in tension and compression.

In reinforced concrete, concrete and steel are combined such that concrete resists compression and steel resists tension. This is a passive combination of the two materials. In pre-stressed concrete high strength concrete and high strength steel are combined such that the full section is effective in resisting tension and compression. This is an active combination of the two materials.

1.1 PRE-STRESSED CONCRETE

The pre-stressing and pre-casting of concrete are inter-related features of the modern building industry. Through the application of imaginative design and quality control, they have, since the 1930's, had an increasing impact on architectural and construction procedures. Pre-stressing of concrete is the application of a compressive force to concrete members and may be achieved by either pre-tensioning high tensile steel strands before the concrete has set, or by post-tensioning the strands after the concrete has set. Although these techniques are commonplace, misunderstanding of the principles, and the way they are applied, still exists. This paper is aimed at providing a clear outline of the basic factors differentiating each technique and has been prepared to encourage understanding amongst those seeking to broaden their knowledge of structural systems.

1.2 HISTORY OF PRESTRESSING

Before the development of pre-stressed concrete, two significant developments of reinforced concrete are the invention of Portland cement and introduction of steel in concrete. These are also mentioned as the part of the history. The key developments are mentioned next to the corresponding year. Pre-stressed concrete was started to be used in building frames, parking structures, stadiums, railway sleepers, transmission line poles and other types of structures and elements. In India, the applications of pre-stressed concrete diversified over the years. The first pre-stressed concrete bridge was built in 1948 under the Assam Rail Link Project. Among bridges, the Pamban Road Bridge at Rameshwaram, Tamilnadu, remains a classic example of the use of pre-stressed concrete girders.

1.3 WHAT IS PRE-STRESSING?

Pre-stressed concrete is probably the latest discovery in man's continuing search for new construction materials and methods. Pre-stressing of concrete is defined as the application of compressive stresses to concrete members. Those zones of the member ultimately required to carry tensile stresses under working load conditions are given an initial compressive stress before the application of working loads so that the tensile stresses developed by these working loads are balanced by induced compressive strength. 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-tensioning applications include office and apartment buildings, parking structures, slabs-on ground, bridges, sports stadiums, rock and soil anchors, and water-tanks. In many cases, post-tensioning allows construction.

1.4 CLASSIFICATION OF PRESTRESSED CONCRETE

Pre-stressed concrete structures can be classified in a number of ways depending upon their features of design and construction.

1. Externally or Internally Pre-stressed
2. Linear or Circular Pre-stressing
3. Pre-tensioning and Post-tensioning.
4. End-Anchored and Non-End-Anchored Tendons.
5. Bonded or Unbonded Tendons.
6. Partial or Full Pre-stressing.

1.5 USES AND ADVANTAGES OF PRE-STRESSING:

Post-tensioning has found widespread use and effectiveness in a variety of structure types, including:

• Slabs-on-Ground: residential slab-on-ground foundations, light industrial foundations, heavy industrial foundations, mat foundations, sport courts, and pavements.
• Buildings: office buildings, condominiums/residential buildings, hotels, mixed-use, theaters, shopping centers/malls, schools, casinos, libraries, manufacturing plants, research/academic institutions, and governmental.
• Parking Structures: commercial, airport, underground parking structures, and mixed-use.
• Storage Structures: water storage tanks (floors, walls, roof), clarifiers, digesters, and silos.
• Grandstands and Stadiums
• Staged Construction: transfer plates, transfer podiums, transfer slabs, and transfer girders.
• Tension Members: tension rings and tie-beams.

2. LITERATURE REVIEW

Amorn pimanmas et al. The post-tensioned flat slab construction is widely used for constructing medium to high rise buildings in Thailand. Normally, the design of post-tensioned flat slab considers the effect of gravity load only while the shear wall is designed to resist wind forces. The distinctive features of post-tensioned flat slab reinforcement detail are 1) no transverse reinforcement in the slab column connection, 2) temperature and shrinkage bonded steels in the bottom of slab and 3) no tendons passing through the column. Under lateral forces, the slab-column connection is expected to transmit large moment, shear and torsion between slab and column. This may lead to the punching shear failure. This paper presents the result of reversed cyclic test of 3/5 scaled post-tensioned interior flat slab-column connection. The author have collected the architectural and structural data of five post-tensioned flat slab buildings constructed in Thailand and defined structural indices to characterize the structural behavior of the slab column connection. The test specimen was designed to have the structural indices as close as possible to the mean values of the actual buildings. The test results indicated complex transfer of forces around the connection. These forces include longitudinal and transverse moments, torsion and shear. The specimen can displace up to 2% story drift. The failure is caused by sudden punching shear occurring after most of top bars have yielded.

rajeh z. ai-zaid et.al. A simple and rational analytical model that allows the determination of the history of strain and stress distribution in un-cracked bonded post-tensioned RC concrete sections is proposed. Expressions for the direct computation of the time dependent strain are extended to consider a two-stage sustained loading and the state of shoring or un-shoring during the period of initial hardening. The analysis is performed at arbitrary points in time satisfying the conditions of force and moment equilibrium as well as the strain compatibility between all layers of steel and the surrounding concrete. The effects of the change in modulus of elasticity of concrete and the change in geometric properties due to grouting of tendon ducts are taken into account. A numerical example of a pre-cast post-tensioned beam is given to demonstrate the method.

ehab ellobod and colin g. et.al. This paper presents new fire tests conducted on bonded and unbonded post tensioned concrete slabs. A total of 16 tests were carried-out, of which four were conducted at ambient temperature to evaluate the capacity of the slabs in the cold condition. The remaining 12 tests were conducted under fire conditions, with the slabs subjected to the standard fire curve under a static load equal to 50% of the capacity of the unbonded slabs in the cold condition. The slabs were one-way simply-supported and reinforced with 15.7mm nominal diameter seven-wire mono-strand tendons. The effects of different aggregate types, boundary conditions and duct material (steel and plastic) in the bonded slabs have been investigated in the tests. The temperature distribution throughout the slab, the strains in the tendons, the deflection behavior and the longitudinal expansion were recorded during the tests. A nonlinear finite element model for the analysis of the slabs at elevated temperatures was also developed. The mechanical and thermal material nonlinearities of the concrete, pre-stressing tendon and anchorages were accurately modeled..

alan h. mattock, jun yamazaki and basil t. kattula et al. Tests were made of seven span beams of 28 ft span and of three beams continuous over two spans of 28 ft each. The primary variables were the presence or absence of bond; the amount of bonded unpre-stressed reinforcement; and the use of seven wire strand as bonded unpre-stressed reinforcement. The unbounded post tensioned beams with minimum recommended unpre-stressed bonded tensioned beams with minimum recommended unpre-stressed bonded reinforcement had serviceability characteristic, strength and ductility equal to or better than those of comparable bonded post tensioned beams. An expression is proposed for the ultimate stress in unbounded tendons. Seven wire strands can be used effectively as unpre-stressed bonded reinforcement.

bijan aalami et al. In this paper the author compares the bonded and unbounded system of post tensioning. First he gives the basic characteristics of the system such as the formation of bonded with concrete, anchorages for the system, construction procedure. Second he compares both the system regarding the differences in their design procedures. Unbounded system gives more eccentricity with greater ease as compared to bonded system which gives a greater lever arm and hence balances more moment. However ultimate strength of bonded section, as compared with minimum non pre-stressed reinforcement. This has been demonstrated with the help of a design example where in a beam of 19 mt. span is designed for both the systems taking in to consideration the code provision if ACI &

3. CONCLUSIONS

The PT reinforcement requirement for bonded system is comparatively more than the unbonded system. This can be attributed to the losses in friction. The friction coefficient for bonded tendons is more than unbonded tendons, resulting in the loss of effective stress in the tendons which ultimately results in the loss of effective pre stress force in the section. Hence the number of tendons required for bonded PT system as compared to unbonded PT system is more for same pre-stress force.

The Non PT reinforcement requirement for bonded PT system than unbonded PT system comes out to be more, comparatively. But this is attributed to the fact that for bonded system minimum amount of Non PT reinforcement as stipulated by code is 0.12% of the section. Therefore, the bars considered are through and no curtailment is done. But for unbonded PT system the Non PT reinforcement, as given by the software, is a curtailed one, wherein the bars are either top or bottom reinforcement. Hence the quantity of Non PT reinforcement for bonded PT system comes out to be more than unbonded PT system.

4. FUTURE SCOPE

This study is emphasized on two way post-tensioned unbonded floor systems. So one may extend this work as follows:

Study of the irregular building with same configurations.
Study the effect of variable grade of concrete and variable span.
Lateral load response of unbonded PT members
Influence of tendon distribution in a slab designed as a two way system
Fatigue strength comparison of bonded & unbonded PT members
Ductility of bonded & unbonded PT members
Comparative study of PT members using equivalent frame method & finite element method

5. REFERENCES

1) Aalami, B. O., (Oct. 1993) “One-Way and Two-Way Post-Tensioned Floor Systems,” Technical Note No. 3, Post-Tensioning Institute, Phoenix, AZ, pp. 10

2) Aalami, B. O., and Kelley, G. S., (January 2001) “Design of Concrete Floors with Particular Reference to Post-Tensioning,” Technical Note No. 11, Post-Tensioning Institute, Phoenix, AZ, pp. 16

3) Aalami B.O and Bonner Allan., (1999), “Design Fundaments of Post-Tensioned Concrete Floors”, Post-Tensioned Institute , Phoenix

4) A.S.T.M. A416/A416M - (2001), “Standard specification for steel strand, uncoated seven-wire for prestressed concrete”, vol. 1.04. Baltimore, (USA); pp. 225–229.

5) Bondy, K.B., (May 2005), “ Post-Tensione Concrete in Buildings – A40+Year Overview”, Post-tensioning Institute Technical Conference, Denver, pp. 1-8

6) Campbell TI, Chouinard KL., (1991), “Influence of non-prestressed reinforcement on the strength of unbonded partially prestressed concrete members”. ACI Structural Journal, pp. 546–551.

7) Cullington DW, Hill ME, Woodward RJ, Storrar DB., (1996), “Special inspections on post-tensioned bridges in England: report on progress”. Symposium papers of the FIP Symposium 1996 on post-tensioned concrete structures. pp. 483–491.

8) Ed. Cross., MIEAust., (2001), “Post-Tensioning in building structures”,Technical Director Austress Fressinet Pvt Ltd., pp. 1-21

9) Garlock M, Sause R, Ricles J., (2007) “Behavior and design of post-tensioned steel frames”. ASCE Journal of Structural Engineering; pp. 389–399.