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A Comparative Study between Post Tensioned Slab and RCC Slab

Kuldeep Mali[1], Vikramaditya Ghatage[2], Pratiksha Patil[3], Aditya Shrivastav[4], Vishwjeet Bhosale[5], Satpal Mane[6]

[2,3,4,5,6]*Diploma Students, Civil Engineering, Rajarambapu Institute of Technology, Rajaramnagar, Maharashtra, India*

[1]*Professor, Dept. of Civil Engineering, Rajarambapu Institute of Technology, Maharashtra, India*

ABSTRACT –

The application ofPost Tensioned slab is increasing extensively due to its benefits over the RCC slab. In some countries including the U.S, Australia, South Africa, Thailand and India a number of Post Tensioned slab projects have been successfully constructed . Post Tensioned slabs are able to carry almost amount of dead load due to its tensioned tendons, Which helps to carry out live load acting on slabs and make it secure than conventional slab. In case of Economy point of view Post tensioned slabs are much better than RCC slab . In some research study it is prove that Post tensioned slab is compare to RCC slab with respect to strength, durability, Time for construction process, economy the Post tensioned Slab system is very economical. Post tensioned slab are suitable for longer span. Also the Post tensioned slab fulfill the all architectural requirements. Furthermore, result indicate that the use Post Tensioned slab is economical than RCC Slab.

Key Words: **RCC , Post Tensioned**

1. INTRODUCTION

In this fast moving and competitive world, the necessity of high rise building increased day by day. The floor system plays a important role in the overall cost of building, a Post tensioned slab is invented which method proves econocal. The first post tensioned slab were constructed in the USA in 1950 using unbonded post tensioning. In this project it is find that the system gives high strength structure in economical cost, After that the numerous of post tensioned slabs were designed and constructed .The design, structural behavior and techniques are simple and similar to RCC slab.

Post tensioned building saves quantity of material as compared to RCC. This system is suitable for medium to high rise building such as Office buildings , hospitals, residential buildings, Institutional and parking buildings. Post Tensioned slabs has cable tendons passing through it those are placed under tension , This tension make stronger with minimum reinforcement. It gives very efficient structure which material usages and economic cost.

Objectives :

The objectives of this project are as follows: -

- Study the Detailed Study of Post Tensioned slab and RCC Slab.
- Cost Comparison between RCC Slab and Post Tensioned Slab.

a. Scope

- Study the Detailed Study of Post Tensioned slab and RCC Slab.
- Cost Comparison between RCC Slab and Post Tensioned Slab.

b. Advantages:

- Post Tensioned slab has less slab thickness as compare to RCC slab.
- PT Slabs are Extremely strong and Durable.
- This slabs have less slab Thickness so there is less usage of materials.
- In the PT Slabs reduce occurrence of cracks.
- It is suitable for longer Spans.

c. Disadvantages:

- For the construction of PT slabs skilled labours are required.
- Advanced Machineries are required for the construction.
- Due to poor workmanship can lead to accidents

f. Materials used in Post Tensioned slab

➢ **Tendons**

Tendons have one or more piceses of steel cables coated with a protective coating andplacing through ducts these ducts are connected with anchorage.The diameter of Tendons is 15.7mm.There are two types of tendons Bonded and unbonded tendons.

• Bonded tendons – Bonded tendons consist of bundled strands placed inside ducts located within the surrounding concrete. To ensure full protection to the bundled strands, the ducts must be pressure- filled with a corrosion-inhibiting grout, without leaving any voids, following strand-tensioning. Tendon coating (unbonded tendons)

• Unbonded tendons- An unbonded tendon is one in which the pre-stressing steel is bonded to the concrete at the anchorages. The most common unbonded systems are monostrand (single- strand) tendons, which are used in slabs and beams for buildings, parking structures, and slabs- on-ground.

➢ **Anchorage**

Anchorage are used to anchor the tendons into the Concrete. The main function of anchorage is to transfer the stressing force into Concrete, Ones the stressing process is Complete.

➢ There are 3 type of anchorage

a) Dead end anchorage

b) Pan end anchorage

c) Live end anchorage

a) Dead end anchorage.

The dead end anchorage Consist anti bursting reinforcement, grounting pipes, strands and chairs. The anti bursting reinforcement will placed in the end of ducts from their upto one meter strands/ Tendons will explore and end will converted into the shape of onion by using hydraulic pump and stressing jack to get proper bonding. These will supported by chairs.

b) Live end anchorage

Live end anchorage is placed in the jacking end. Live end anchorage consist of anti bursting reinforcement , ducts, grouting pipes, Trumpet, Polystrine board , strand

c) Pan end anchorage

Pan end anchorage consist of anti bursting reinforcement, Trumpet, grouting pipe , Polystrineboard , Pan box. These will be used when don’t have to enough space to do stressing.

Ducts

Before the post-tensioning cables are embedded in. the concrete, ducts are utilized to enclose them. They guard the cables against rust and other types of harm.

Ducts for post-tensioned slabs are made of plastic or metal and placed in the formwork before the concrete is poured. Once the concrete has hardened, the tendons are inserted into the ducts and filled with grout. The number and size of the ducts will depend on the design of the slab. Properly designed and installed ducts are critical for long-term performance.Two types of ducts are available in the market Plastic Duct & GI Ducts.

➢ Polystyrene Board

Polystyrene board is placed instead of anchor block, Anchor block is a steel block proacted inside the concrete to avoid rusting. Once the stressing polystyrene board is removed and it is patched by cement , sand mortar, once the stressing process is complete.

Polystyrene boards, also known as EPS (expanded polystyrene) boards, can be used in post- tensioned slabs as a form of void material. When the post-tensioned slab is poured, the polystyrene boards are placed in strategic locations to create voids in the slab. The voids reduce the weight of the slab, which can be beneficial in areas with poor soil conditions or in multi-story buildings.

Wedges

Wedges used in post-tension slab construction are typically made of high-strength steel and are used to anchor post-tensioning cables to the concrete member, ensuring that the cables remain under tension and the structure remains stable. The wedges are inserted into the pocket that holds the post-tensioning cablein place and are then tightened using hydraulic jacks.

The high-strength steel wedges used in post-tension slab construction are used to secure post- tensioning cables to the concrete member, ensuring that the wires are kept under tension and the structure is stable. Hydraulic jacks are used to tighten the wedges once they have been placed into the pocket holding the post-tensioning cable in place.To avoid any potential structural problems, it is essential that the wedges used in post-tension slab construction are manufactured of high-quality materials and are set appropriately. For additional advice on the proper selection and installation of wedges for your particular project, it is advised that you speak with a professional engineer or a qualified post-tensioning specialist

2. Construction Procedure:

Bottom Shuttering Work

The term "bottom shuttering" refers to the construction of reinforced concrete slabs. In order to hold the concrete in place until it sets, temporary formwork or molds are positioned at the base of the slab during construction.

For the concrete to be poured onto, a level and homogeneous surface is created via bottom shuttering. Additionally, it stops the concrete from leaking or spreading outside the defined area. The bottom shuttering is checked to make sure it is level and well supported before pouring the concrete. The concrete is then poured over the reinforcement steel, which is then positioned on top of the shuttering. The bottom shuttering is taken off and the surface is finished in accordance with the project specifications once the concrete has had time to set.

Bottom shuttering must be installed correctly in order to guarantee the slab's quality and endurance. The shuttering needs to be robust enough to support the weight of the concrete as well as any additional loads that might be applied to it during construction. To avoid any seepage or leaking of the concrete during placement, it should be precisely constructed and put.

Placing Nominal Reinforcement

In the post tensioned slab Reinforcement is placed without providing bent up bars that is nominal reinforcement are laid. The design specifications, which include the size, spacing, and location of the reinforcing bars, are followed when placing the nominal reinforcement during construction.

To ensure the structural integrity and durability of post-tensioned slabs, nominal reinforcement placement is a crucial step. To ensure that the structure performs as intended, it must be done in accordance with the design requirements and industry standards.

Laying of ducts

In post-tensioned slab construction, ducts are used to house the post-tensioning tendons. The ducts are available in various materials such as galvanized iron (GI), polyethylene (PE), or polypropylene (PP), depending on the design requirements and local building codes. The layout of the ducts is determined on the basis of design specifications and construction drawings. The ducts are typically laid out in a straight line or a curved path, as per the building's architectural design. The ducts are installed by attaching them to the reinforcement using wire ties, plastic clips, or duct clamps. The ducts should be installed in a way that they are not damaged during the concrete placement.

Fixing ducts at end with Anchorages

When fixing ducts at the end with anchorages, the ducts are first laid out in the desired pattern and secured in place. The anchorages are then installed at each end of the ducts to hold the tendons in place.The anchorages consist of a fixed and a movable component. The fixed component is typically a steel plate that is embedded in the concrete, while the movable component is a wedge that is inserted into the duct and tightened to apply tension to the tendons. Once the anchorages are in place, the tendons are threaded through the ducts and pulled tight

Inserting Tendons into Ducts

Tendons are first put into ducts in post-tensioned slab construction before the concrete is poured. According to the technical and design specifications, the ducts are often composed of plastic or metaland are installed in the desired positions on the slab.

The tendons are then threaded through the ducts. The tendons are normally comprised of high- strength steel wires or strands. With the use of anchorages or wedges, the ends of the tendons are fastened to the slab's supports or the slab itself.

Concreting Process

After the completion of all the above process then concreteis poured into the formwork once the reinforcement has been installed. In order to sustain the tensioning of the cables, post-tensioned slab construction normally uses high-strength concrete with a minimum strength of 40 MPa.

Fixing wedges and stressing Tendons

Anchor blocks and wedges are fixed with tendons which are exposed and they provided packing to the coupler. By using Compressor machines tendons are stressed initially 25%.For the stressing the tendons stressing jack is used.

Cutting Excess Tendons and grouting duct

After stressing the tendons , remaining tendons are cut with the help of grinders and ducts which are having tendons inside it that gaps are filled using cement, sand and water and that process is known as grouting

Cost Comparison

- **Cost analysis of Two Way slab**

Size of slab =50x20 Feet

15.24x6.096 Meter

Thickness of slab = 0.15m (150mm)

Grade of concrete = M30

Proportion = 1:0.75:1:5

Volume of slab =13.93Cu.m

Step I -For Dry volume add 52% More

=13.93+(52/100x13.93)

=21.17Cu.m

Step II- Volume of cement

=Actual Dry Volume /Addition of proportion

=21.17 /1+0.75+1.5

=6.51Cu.m

Step III- Number of cement bags

= Volume of cement / Volume of one bag of cement

=6.51/0.035

=186 Bags

Step IV-Volume of Sand

=Volume of cement x 0.75

=6.51x0.75

=4.8825Cu.m

Sand in brass

1 Cubic meter = 0.353 brass

4.8852x0.353

=1.72 brass

Step V- Volume of aggregate

=Volume of cement x 1.5

=6.51 x 1.5

=9.765Cu.m

Aggregate in a brass

=9.765 x 0.353

=3.44 brass

Step VI- Volume of steel

= 1% of wet volume

=1/100 x 13.93

=0.1393 Cu.m

We know density of steel 7850 Kg/Cu.m

Weight of steel required

=Volume of steel x Density

=0.1393 x 7850

=1093.5Kg

Steel required =1095Kg Or 1.095 Ton

Binding Wire Required

= Steel Required / 100

=1095 / 100

= 10.95 Kg =11Kg

Material Cost for 1000 Sq.ft RCC Slab

1.Cement

Cost of Cement = Total Number of bags x Cost of one bag of cement

= 186 x 330

=61,380 Rs

2.Sand

Cost of Sand = Volume of sand in brass x Rate of sand in brass

=1.72 x 3600

=6,192 Rs

3.Aggregate

Cost of Aggregate = Volume of aggregate in brass x Rate of Aggregate

=3.44 x 2400

=8,256 Rs

4.Steel

Cost of steel =Steel in kg x Rate per kg

=1095 x 66

=72,270 Rs

5.Binding Wire

Cost of Binding Wire = Binding wire in kg x Rate per kg

=11 x 84

=924 Rs

Total Material Cost = 61,380+6,192+8,256+72,270+924

= 1,49,022 Rs

- **Cost analysis of Post Tensioned Slab**

Size of slab =50x20 Feet

15.24x6.096 Meter

Thickness of slab = 4 inch (100mm)

Grade of concrete = M30

Proportion = 1:0.75:1:5

Volume of slab =9.29 Cu.m

Step I -For Dry volume add 52% More

=9.29+(52/100x9.29)

=14.1208 Cu.m

Step II- Volume of cement

=Actual Dry Volume /Addition of proportion

=14.1208 /1+0.75+1.5

=4.34 Cu.m

Step III- Number of cement bags

= Volume of cement / Volume of one bag of cement

=4.34/0.035

=124 Bags

Step IV-Volume of Sand

=Volume of cement x 0.75

=4.34x0.75

=3.255Cu.m

Sand in brass

1 Cubic meter = 0.353 brass

3.255x0.353

=1.14 brass

Step V- Volume of aggregate

=Volume of cement x 1.5

=4.34 x 1.5

=6.51 Cu.m

Aggregate in a brass

=6.51 x 0.353

=2.29 brass

Step VI- Volume of steel

= 0.5% of wet volume

=0.5/100 x 13.93

=0.04645 Cu.m

We know density of steel 7850 Kg/Cu.m

Weight of steel required

=Volume of steel x Density

=0.04645 x 7850

=364.63 Kg

Steel required =365 Kg

Binding Wire Required

= Steel Required / 100

=365/ 100

= 3.65 Kg

Tendons Calculation

Diameter Of Tendon 0.5 inch (12.7mm)

Length of Tendon For 20 Feet side

=(22 x 2) x 4

=176 Ft

Length of Tendons For 50 Feet Side

= (52 x 2) x 4

= 416 Ft

Total length of Tendon required for 50 x 20 x 0.66 feet

=176 Ft+416 Ft

=592 Ft

= We considered 600 Feet

Material Cost for 1000 Sq.ft RCC Slab

1.Cement

Cost of Cement = Total Number of bags x Cost of one bag of cement

= 124x 330

=40,920 Rs

2.Sand

Cost of Sand = Volume of sand in brass x Rate of sand in brass

=1.14 x 3600

=4104 Rs

3.Aggregate

Cost of Aggregate = Volume of aggregate in brass x Rate of Aggregate

=2.29 x 2400

=5,496 Rs

4.Steel

Cost of steel =Steel in kg x Rate per kg

=365 x 66

= 24,090 Rs

5.Binding Wire

Cost of Binding Wire = Binding wire in kg x Rate per kg

=4 x 84

= 336 Rs

6.Tendons

Cost of Tendons is 75 Rs per feet

Cost of Tendons = Length of Tendons x 77

=600 x 77

= 46,200 Rs

Total Material Cost = 40,920+4104+5,496+24,090+336+46,200

=1,21,146 Rs

6. CONCLUSION

- In a comparative study between the two, post-tensioned slabs have several advantages over RCC slabs. Also in the cost study it is occur the cost of Post Tensioned slab is economical as compared to RCC Slab due to less reinforcement use and Less slab Thickness. Post-tensioned slabs are more efficient in terms of material usage, allowing for longer spans with thinner sections. However, post-tensioned slabs require specialized knowledge and expertise for design and installation. Post-tensioning allows for thinner and lighter slabs, which reduces the amount of concrete and steel required. Additionally, the post-tensioning method provides greater structural integrity and durability, reducing the need for maintenance and repair in the long term. The choice between RCC slab and post-tensioned slab depends on various factors, including span length, load requirements, site conditions. Post-tensioning allows for thinner and lighter slabs, which reduces the amount of concrete and steel required. Additionally, the post-tensioning method provides greater structural integrity and durability, reducing the need for maintenance and repair in the long term.

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