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Conventional and Morden Techniques in Highrise Building Construction

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ABSTRACT—

The adoption of post-tensioned flat slabs with drop panels represents a significant advancement in structural engineering, offering improved performance and economic benefits over conventional slab systems. This paper conducts a comparative analysis between post-tensioned flat slabs with drop panels and conventional slabs, aiming to elucidate the advantages and limitations of each structural system. The findings of this study provide valuable insights into the relative merits of post-tensioned flat slabs with drop panels and conventional slabs, offering guidance for optimal structural design and construction practices. This research contributes to the ongoing discourse on innovative building techniques, empowering stakeholders to make informed decisions towards achieving safer, more sustainable, and cost-effective structures.

Keywords*— Post-tensioned flat slabs; Drop panels; Comparative analysis; Structural engineering; Performance evaluation*

I. Introduction

Building taller structures like high-rise buildings has become more important nowadays due to factors like urbanization and limited space. However, these buildings need to be designed to handle more weight than expected to ensure safety. In the ever-evolving landscape of structural engineering, the quest for more efficient and cost-effective building solutions has led to the development and refinement of various construction techniques. Among these, post-tensioned flat slabs with drop panels represent a significant advancement, offering a compelling alternative to traditional concrete slab systems. By introducing high-strength steel tendons into the concrete slab and applying tension after the concrete has hardened, post-tensioning enhances the structural performance and durability of flat slabs. This innovative approach allows for longer spans, reduced material usage, and increased flexibility in architectural design, making it an attractive choice for a wide range of construction projects. This prospective comparative study was carried out under the Prafulved Infra PVT. LTD. & Praful Deshmukh & Co. Consortium at West side orange city mall square, Sita Nagar, Jai Prakash Nagar, Somalwada, Nagpur, Maharashtra 440025.

Project Details: Plot area: 3363.037 Sq. m.

Total Build-up area: 22730.55 Sq. m.

Total Basement area: 3148 Sq. m. No. Of Floors B1+B2+G+11

Cost of construction: 68 crores (As per RPF Document)

II. Materials

A. Cement and Aggregate

Ordinary Portland cement, adhering to IS 8112 specifications and graded as 43 grade, was utilized consistently along the concrete grade M45. The fine aggregates employed were sourced from clean river sand, with a maximum size of 4.75mm, meeting the requirements of zone II classification according to IS383-1970, boasting a specific gravity of 2.6. Coarse aggregates utilized were derived from machine-crushed stone, characterized by angular shapes, passing through a 20mm IS sieve and retained on a 4.75mm IS sieve, with a specific gravity of 2.7.

B. AAC Blocks

Autoclaved aerated concrete (AAC) is a lightweight, precast, cellular concrete building material, eco-friendly, suitable for producing concrete-like blocks. It is composed of quartz sand, calcined gypsum, lime, Portland cement, water and aluminum powder and Size: 600mm x 200mm x 100-300mm.

C. Steel

We have used TMT bars of various diameter 12mm, 16mm, 20mm, 25mm, 32mm, 40mm of 550 grade.

D. Covers

20mm and 25mm provided to beam, 40mm rounded provided to shear wall, 50 mm provided to column and foundation.

E. Unbonded Tendons

Unbonded tendons, also called post-tensioning tendons, are high-strength steel wires encased in a protective sheath used to reinforce concrete structures. Unlike bonded tendons, they are not bonded to the concrete, allowing for more flexibility and faster installation. They are tensioned before the concrete is fully cured and provide reinforcement against tensile stresses. Unbonded tendons are widely used in various structures like bridges and buildings, offering efficiency, durability, and flexibility in design and construction. Regular inspections are recommended to maintain their integrity.

III. Machinery

A. Rebar Coupler

A rebar coupler is a technical product that is necessary when long length of bar is required. The primary work of this coupler in reinforcement is to join two TMT bars for continuous reinforcement. The rebar coupler is used in all the construction fields, such as, constructions of buildings, bridges, dams, towers, etc.

B. Bar Threading Machine

A bar threading machine is a tool used in metalworking to create threads on the end of cylindrical metal bars or rods. It operates by feeding the bar through the machine, where it's clamped and rotated against dies with thread profiles, forming threads via a process called thread rolling. These machines come in various sizes and can be manual or automated. They offer increased efficiency, accuracy, and thread strength compared to traditional threading methods. They are commonly used in industries like construction, automotive, aerospace, and manufacturing.

C. RMC Mixer

A Ready-Mix Concrete (RMC) mixer is a machine used in construction to efficiently mix pre-prepared concrete batches. It ensures uniform mixing of ingredients like cement, aggregates, water, and additives, delivering consistent quality and strength. RMC mixers come in various types, such as drum mixers and volumetric mixers, and are vital for large-scale construction projects.

D. Belt Conveyor

A belt conveyor is a mechanical system with a continuous belt loop used for transporting materials or items from one location to another. It's commonly used in industries like mining, manufacturing, and logistics for moving bulk materials or products efficiently over short or long distances.

A hydraulic pin puller is a tool that uses hydraulic pressure to remove stubborn pins from machinery or equipment efficiently and without damage. It consists of a hydraulic cylinder and pulling attachment, exerting force to extract tightly fitted pins. It's commonly used in industries like construction and mining for disassembling heavy equipment

IV. Experimental Details

A. Concrete mix proportion

We have used M45 Grade of concrete throughout the project**.**

Cement	Fine Aggregate	Coarse Aggregate
1	2.42	3.19

A. Punching Shear

Punching shear is a type of structural failure that can occur in reinforced concrete elements when subjected to concentrated loads. It happens when the shear stresses around a load exceed the concrete's capacity to resist, leading to failure along a critical perimeter. Reinforcements are used to prevent this failure by strengthening the concrete around the loaded area.

B. Post Tensioning Tendons

Post-tensioning tendons are high-strength steel cables or bars used in reinforced concrete construction to apply compressive forces to the concrete after it has been cast and hardened. This technique, known as post-tensioning, helps improve the performance and durability of concrete structures by counteracting tensile stresses and increasing their load-bearing capacity. Post-tensioning tendons are commonly used in a variety of structures, including bridges, parking structures, slabs, and high-rise buildings. They offer several advantages over traditional reinforcing methods, such as reducing the overall weight of the structure, minimizing cracking, and allowing for longer spans between supports.

C. Stressing Pocket

A stressing pocket is a component used in post-tensioned concrete construction. It's a specially designed recess or pocket formed in concrete structures where post-tensioning tendons are anchored and stressed. These pockets are strategically located within the concrete elements in which one is the dead end which is fixed and one is the live end from where the stressing pockets are locate to stressing the tendons.

D. Drop Panel

A drop panel is a reinforced concrete slab with a thickened or dropped section around supports like columns or walls. It enhances load-bearing capacity and stiffness in areas where heavier or concentrated loads are expected, commonly used in high-rise buildings and parking structures. The thickness of drop panel was 400mm.

Conclusions

In the construction of a G+11 building, the use of post-tensioning tendons, drop panels, and punching shear arrangements offers significant structural advantages. Post-tensioning tendons enhance strength and durability by applying compressive forces to hardened concrete, enabling longer spans and architectural flexibility. Drop panels around column supports reinforce critical areas, redistributing loads efficiently to enhance load-bearing capacity.

Punching shear arrangements prevent shear failure, ensuring safety and stability under concentrated loads. Together, these techniques optimize structural integrity and efficiency, vital for constructing resilient high-rise buildings.

Overall, the combination of post-tensioning tendons, drop panels, and punching shear arrangements in the construction of a G+11 building results in a structurally sound and efficient design, offering enhanced performance, durability, and safety for occupants.

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