



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Analysis and Design of Post Tensioned Members for a Three Storey Building Using Ram Concept

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ABSTRACT: In the contemporary construction industry, the widespread adoption of post-tensioning methods is attributed to their numerous advantages. However, in developing nations like India, the full potential and benefits of post-tensioned slabs are yet to be fully realized. The application of post-tensioning techniques offers a pathway to achieving the most cost-effective and secure designs for both residential and commercial buildings. The analysis and design processes were executed using the ETABS software, employing a commercial building (G+3) as a case study. The findings underscore that post-tensioned slabs exhibit superior cost efficiency compared to traditional reinforced concrete flat slab systems. This is particularly significant in multi-storey structures like shopping malls and residential buildings, where the post-tensioning method is increasingly favoured. The application of post-tensioning in building construction not only enhances structural strength and durability but also contributes to a more aesthetically pleasing and economically viable solution compared to conventional methods. The utilization of post-tensioning has become widespread due to its demonstrated superiority and adaptability across various types of structures. The study further validates the efficacy of post-tensioned slabs through the analysis and design performed using the ETABS software. The study, using ETABS software for a G+3 commercial building, found that post-tensioned slabs offer significant advantages over traditional reinforced concrete slabs. These slabs reduce material costs by requiring less concrete and reinforcement steel, and speed up construction, lowering labour costs and project timelines. Structurally, post-tensioned slabs provide improved load-bearing capacity and durability, enhancing the building's overall strength. Additionally, they allow for longer spans without intermediate supports, offering more design flexibility and aesthetic benefits. The study highlights the potential for cost-effective, durable, and aesthetically pleasing construction using post-tensioning methods.

KEYWORDS: Analysis, Designs, ETABS, Post-tensioning, Cost-effectiveness, Flat slabs

I. INTRODUCTION

Post-tensioning is a revolutionary approach in the dynamic field of structural engineering that provides unmatched durability and efficiency in contemporary building. In the context of a three-story structure, this research undertakes a thorough investigation of the analysis and design complexities inherent in post-tensioned slab.

With the goal of elucidating the theoretical foundations, useful techniques, and practical applications of post-tensioning, this research will offer priceless insights to scholars, stakeholders, and practicing engineers alike. Through an analysis of the intricacies involved in the design of post-tensioned members in a three-story building context, our aim is to provide light on the way forward for more durable and effective structural solutions in the built environment.

The use of RAM Concept software, a sophisticated instrument well-known for its aptitude at modelling the behaviour of concrete buildings under various stress scenarios, is essential to our inquiry. Engineers may carefully model, examine, and improve the design of post-tensioned members with this programme, guaranteeing both structural integrity and best performance.

II. OBJECTIVE

- To assess how controlling building height, optimizing construction efficiency, and utilizing post-tensioned slabs and flat slab construction methods can enhance structural integrity, meet design standards, and reduce costs.
- To enhance structural efficiency and streamline construction processes in building projects, the study aims to evaluate the benefits of reducing the number of columns in multi-storey structures.
- To decrease material usage and enhance structural efficiency in construction projects, the study seeks to analyse the effects of minimizing reinforcement quantity while utilizing post tensioned members.

III. METHODOLOGY

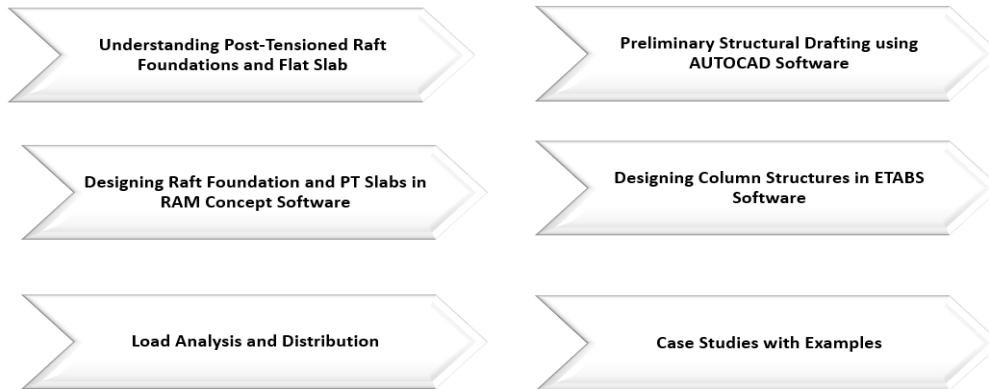


Fig 1: Flowchart of methodology

1. ARCHITECTURAL PLAN IN AUTO CAD

The architectural plan shown below is a B+G+3 story building of a specific shape including many shop rooms of total 8500 square feet per floor. The ground floor and typical floor consists of rental shops, and the basement consist the total number of parking according to the government rule. The primary purpose of the building should dictate its design. This involves understanding the needs of the occupants and ensuring that the spaces within the building are designed to support those needs efficiently.

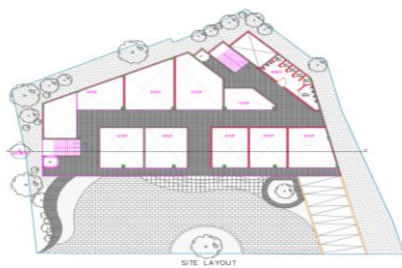


Fig 2: Architectural plan for Site Plan



Fig 3: Architectural plan for Basement Floor



Fig 4: Architectural plan for Ground Plan



Fig 5: Architectural plan for Typical Floor

2. MATERIALS

| Member | Material |
|----------|-----------|
| Tendon | A416Gr270 |
| Steel | HYSD500 |
| Concrete | M35 |

Table 1: Material property data

3. MODEL IN ETABS

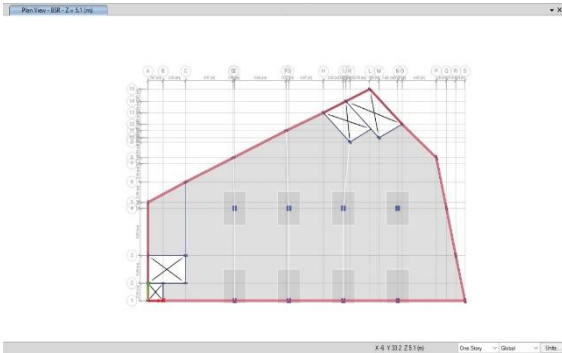


Fig 6: Plan view of Structure in E-TABS

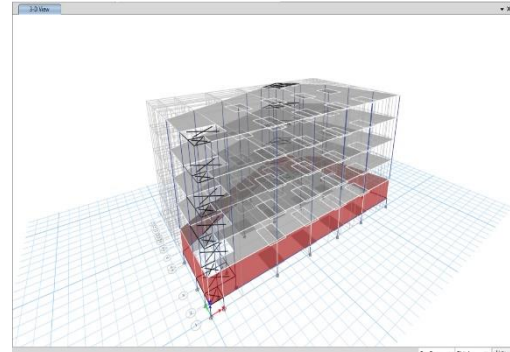


Fig 7: 3D view of Structure in E-TABS

IV. EXPERIMENTAL RESULTS

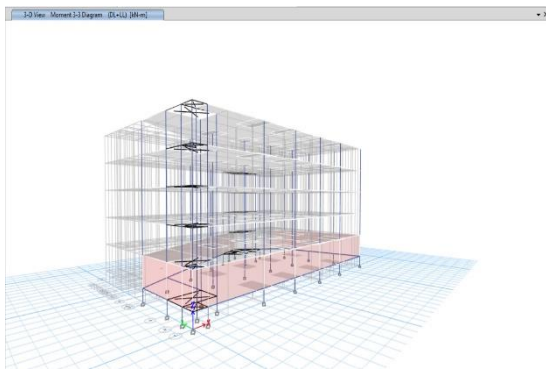


Fig 8: Members passing the Analysis in E-TABS

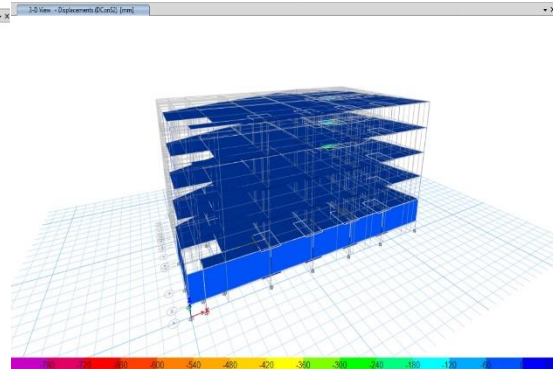


Fig 9: Displacement DConS2 combination in E-TABS

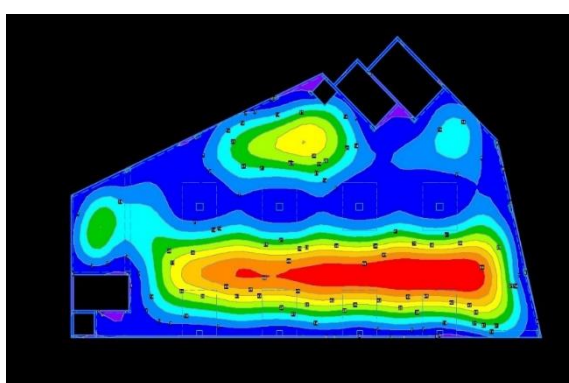


Fig 10: Resultant of Platform in X-Direction

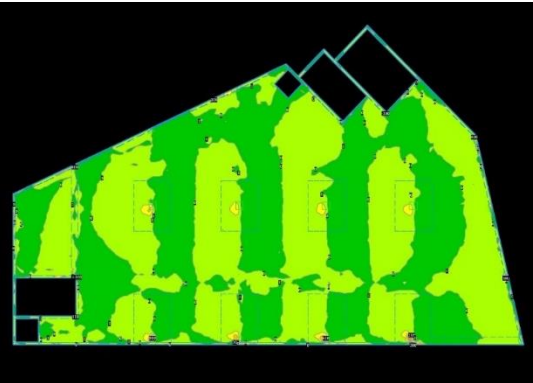
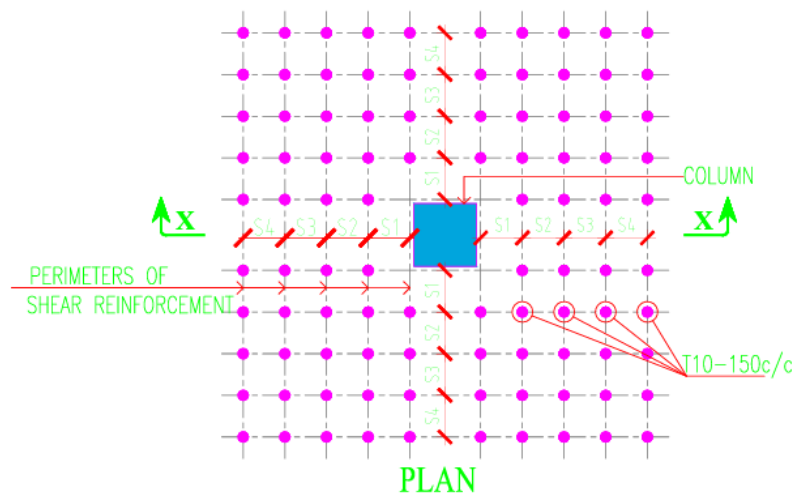


Fig 11: Resultant of Platform in YDirection

| SCHEDULE OF BFR BEAMS -MIX -(M35) | | | | | | | | |
|-----------------------------------|-------|----------------------|----------------|-------------------|-----------|--------------------|-----------------|---------|
| ELEMENTS | SIZE | BOTTOM REINFORCEMENT | BOTTOM CURTAIL | TOP REINFORCEMENT | TOP EXTRA | STIRRUPS @ SUPPORT | STIRRUPS @ REST | REMARKS |
| PTBM-1 | 50X40 | 4T20 | -- | 4T20 | -- | 4T8@12c/c | 4T8@20c/c | -- |
| PTBM-2 | 60X30 | 6T16 | -- | 6T16 | -- | 4T8@12c/c | 4T8@17c/c | -- |
| BM-1 | 30X50 | 3T20 | -- | 3T20 | -- | 2T8@12c/c | 2T8@17c/c | -- |
| BM-2 | 20X50 | 3T20 | -- | 3T20 | -- | 2T8@15c/c | 2T8@20c/c | -- |
| BM-3 | 30X50 | 3T20 | -- | 3T20 | 3T20 | 2T8@10c/c | 2T8@19c/c | -- |
| BM-4 | 20X40 | 3T16 | -- | 3T16 | -- | 2T8@14c/c | 2T8@21c/c | -- |
| BM-5 | 20X30 | 2T12 | -- | 2T12 | -- | 2T8@16c/c | 2T8@16c/c | -- |

Table 2: Reinforcement Details of Beams

PUNCHING SHEAR REINFORCEMENT DETAILS



PUNCHING SHEAR REINFORCEMENT DETAIL FOR ALL COLUMN (P.S-1) WITHOUT DROP PANELS

| SCHEDULE OF PUNCHING SHEAR REINFORCEMENT | | | | | |
|--|-------------------|------|-------|-------|-------|
| TYPE | NO. OF PERIMETERS | S1 | S2 | S3 | S4 |
| P.S-1 | 4 | 75mm | 100mm | 100mm | 150mm |

Fig 12: Punching Reinforcement Details For Columns

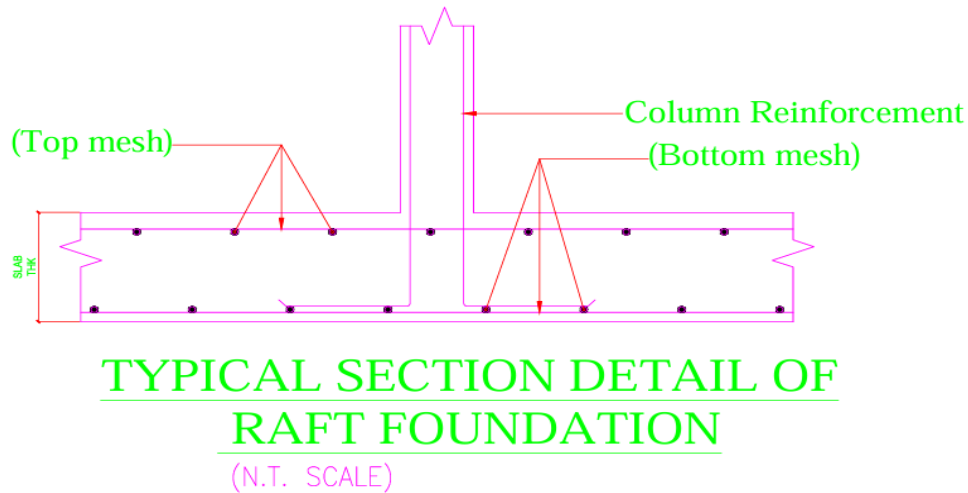


Fig 13: Typical Section Detail of Raft Foundation

V. CONCLUSION

1. Essential for structural integrity, regulatory compliance, and construction efficiency. Height control enhances stability, streamlines processes, and aligns with design standards. Factors like site conditions and architectural needs influence optimal height decisions.
2. Reduces material usage, improves structural efficiency, and cuts costs. Post-tensioning offers economic benefits, lowers carbon footprint, and promotes sustainability. Further research should refine design parameters and establish implementation guidelines.
3. Enhances structural efficiency, architectural flexibility, and construction speed. Optimizes space utilization, expands design possibilities, and accelerates timelines. Considerations include load distribution, seismic performance, and functional requirements.

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