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# Redesign of Hollow Core Slab by Using Various Core Shape

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**KEYWORDS**
Concrete, Cement, Fine Aggregate, Coarse Aggregate, Hollow-core slabs, trimmer, Cracking pattern, Ultimate load

**Abstract:-** Hollow core slabs represent a widely used structural element in the construction industry due to their exceptional structural efficiency, versatility, and cost-effectiveness. These precast concrete elements feature longitudinal voids, or cores, which not only reduce the overall weight of the slab but also provide an efficient means of incorporating mechanical and electrical services within the floor system. This abstract provides a comprehensive overview of hollow core slabs, focusing on their design, manufacturing process, structural behaviour, and applications.
The design of hollow core slabs involves considerations such as load-bearing capacity, span length, deflection limits, and fire resistance. Various design standards and guidelines govern the structural design process, ensuring compliance with safety and performance requirements. Manufacturing techniques for hollow core slabs typically involve extrusion or slip forming of precast concrete elements, followed by curing and finishing processes. These techniques result in consistent quality and dimensional accuracy, contributing to the reliability of hollow core slab systems.

## 1. Introduction

A hollow core slab, also known as a voided slab, hollow core plank, or concrete plank, is a precast and prestressed concrete slab commonly employed in constructing floors for multi-story apartment buildings. This slab type has gained popularity in regions focusings on precast concrete construction, particularly in Northern Europe and former socialist countries in Eastern Europe. The preference for precast concrete is often associated with its advantages in low-seismic zones and cost-effective assembly, stemming from rapid construction, reduced self-weight, and other factors.
The hollow core slab is characterized by tubular voids that extend the entire length of the slab, typically with a diameter ranging from 2/3 to 3/4 of the slab thickness. This design significantly reduces the weight of the slab compared to a solid concrete floor of equal thickness or strength. The lighter weight contributes to cost savings in both material and transportation. These slabs are typically 120 cm wide, with standard thicknesses ranging from 15 cm to 50 cm. Bending resistance is provided by reinforcing steel wire rope.
In the production of prestressed concrete slabs, the process involves extruding wet concrete and prestressed steel wire rope from a moving mould, creating continuous slabs that can be cut to the required lengths using a large diamond circular saw. Factory production offers advantages such as reduced time, labour, and training requirements.
Alternatively, hollow-core floor slabs in reinforced concrete (non-prestressed) can be produced using carousel production lines, cut to exact lengths as stock products. However, this method is typically limited to lengths of about 7-8 meters, especially in applications such as private housing in 0Belgium.
To meet modern standards of soundproofing, whether for hollow-core or massive slabs, it is common to cover the floor with a soft flooring material that dampens the sound of footsteps. The hollow cores of the slab can serve as conduits for various installations, and the interior can be coated for use as a ventilation duct. In summary, a hollow core slab offers a lightweight yet structurally robust solution with versatile applications in building construction.

## 2. Objectives

The project involves a comparative study of the structural behaviour of prestressed hollow core slabs and traditional reinforced concrete (RC) slabs. The research includes experimental investigations into the behaviour of hollow core slabs, comparing these results with different mix designs and casting methods. The reinforced hollow slab is cast by creating voids in the mould, while the

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prestressed hollow core slab is cast with zero-slump concrete in a factory setting, with a standardized dimension of 1m^3. Load tests are conducted using a loading frame on these slabs to evaluate their structural performance.

The research papers encompass the design and experimental testing of three types of slabs: normal reinforced solid slab, reinforced hollow core slab, and prestressed hollow core slab. The final results are then compared through load tests to analyse and identify any variations in structural behaviour among the different slab types.

In addition to the experimental work, the papers provide a comprehensive procedure for conducting finite element analysis (FEA) of hollow-core slab floors. This becomes particularly relevant in scenarios involving large floor openings. The research includes the presentation of formulas for the homogenization of floor properties, discussions on finite element modelling, and the formulation of formulas for stress recovery. To illustrate the application of the developed procedures, an example is presented where a floor with a 3 x 3.6 m opening is analysed using the finite element method. This example demonstrates the practical implementation and effectiveness of the proposed analysis techniques.

The project aims to contribute valuable insights into the structural performance of different types of slabs, offering practical implications for design considerations. The inclusion of experimental results, analytical procedures, and practical examples enriches the research, providing a comprehensive understanding of the behaviour of prestressed hollow core slabs in comparison to traditional RC slabs

## 3. Methods

**1. Planning and Design**

1.1. Requirements Analysis

Gather Client Requirements: Understand load requirements, span lengths, fire resistance, and any specific design criteria.

Regulatory Compliance: Ensure designs meet local building codes and standards.

1.2. Structural Analysis

Load Calculations: Calculate the loads (dead, live, seismic, wind) the slab needs to support.

Deflection Analysis: Ensure deflections are within permissible limits.

Stress Analysis: Evaluate stresses to ensure the slab can handle the applied loads without failure.

1.3. Design Optimization

Thickness and Void Optimization: Optimize slab thickness and the size/location of the hollow cores to balance weight reduction and structural integrity.

Reinforcement Design: Design pre-stressing strands or reinforcement based on structural requirements.

**2. Production**

2.1. Material Procurement

Material Selection: Choose high-quality concrete and steel reinforcement.

Supplier Evaluation: Ensure suppliers meet quality standards and timelines.

2.2. Moulding and Casting

Formwork Preparation: Set up the forms/moles to create the hollow cores.

Casting Process: Pour and compact concrete into melds, ensuring voids are properly formed.

Pre-stressing: Apply pre-stressing to reinforcement if required.

2.3. Curing

Curing Method: Implement appropriate curing methods (steam curing, wet curing) to achieve desired strength.

**3. Transportation**

3.1. Logistics Planning

Route Selection: Plan routes for transporting slabs from the factory to the site.

Transportation Vehicles: Choose suitable vehicles to handle the size and weight of slabs.

3.2. Handling

Loading and Unloading: Use appropriate lifting equipment to avoid damage during loading/unloading.

Storage: Store slabs at the site in a manner that prevents warping or damage.

**4. Installation**

4.1. Site Preparation

Foundation Preparation: Ensure the foundation or supporting structure is ready to receive the slabs.

Cranes and Equipment: Prepare cranes and other necessary equipment for lifting and placing the slabs.

4.2. Placement

Alignment and Levelling: Place slabs accurately according to the design layout.

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Joint Treatment: Fill joints between slabs to ensure structural continuity and fire resistance.

**5. Quality Control**

5.1. Inspection

Pre-installation Inspection: Inspect slabs before installation for cracks, voids, and other defects.

Post-installation Inspection: Ensure slabs are installed correctly and check alignment and levelling.

5.2. Testing

Material Testing: Perform tests on concrete samples to verify strength and durabilityq.

Load Testing: Conduct load tests if required to confirm slab performance.

5.3. Documentation

Record Keeping: Maintain detailed records of design calculations, material certificates, inspection reports, and testing results.

6. **Post-Construction**

6.1. Maintenance Planning

Maintenance Schedule: Develop a maintenance plan to ensure the longevity of the hollow core slabs.

Monitoring: Implement monitoring systems for early detection of any potential issues.

6.2. Feedback Loop

Client Feedback: Gather feedback from the client to improve future designs and processes.

Continuous Improvement: Use feedback and inspection data to refine methodologies and enhance quality.

**4. Results**

| TEST RESULTS | | | |
|---|---|---|---|
| SLAB | CRACKING LOAD (TON) | ULTIMATE LOAD (TON) | DEFLECTION (MM) |
| Rc hollow core slab M20 | 210 | 325 | 54 |
| Rc hollow-core slab M50 | 252 | 389 | 62 |
| Solid slab | 310 | 350 | 20 |
| Prestress hollow core slab | 410 | 490 | 10 |

**5. Discussion**

The study presented in the paper is very limited to only the experimental results of the hollow core slab. Many specimens with different characteristics should be studied to give conclusive patterns or behaviours. n Considering this limit the following conclusions can be drawn from this study. • The conventional flexural capacity equation for solid concrete slabs can predict the flexural capacity of hollow core concrete slabs with an accuracy of ± 19%. • The load-deflection behaviour and the serviceability performance of hollow core concrete slabs are significantly better than conventional solid concrete slabs.

Prestressed hollow core slabs are commonly used as load-bearing floors and roofs. In most cases, the upper surface of the hollow core slabs must be levelled with a cast-in-situ screed. Normally, the advantage of this topping layer as a composite construction is not taken because of the uncertainty concerning the bond strength between the precast and cast-in-situ concrete. Also, the thickness of the screed layer is often too small to increase the moment capacity of the structure significantly.

hollow core slabs offer a compelling solution for modern construction projects, combining structural efficiency, versatility, and cost-effectiveness. Their design and manufacturing processes, structural behaviour, and diverse applications make them integral components of contemporary building systems, contributing to the advancement of sustainable and efficient construction practices. the application of hollow core slabs in real-life construction projects is vast and varied, encompassing residential, commercial, industrial, institutional, and infrastructure developments. Their structural efficiency, versatility, and economic advantages make them indispensable components of modern construction practices. From high-rise buildings to bridges and beyond, hollow core slabs continue to shape the built environment, enabling architects, engineers, and developers to realise their vision for sustainable, resilient, and functional spaces.

The study presented in the paper is minimal containing only the experimental results of five slabs. Many specimens with different characteristics should be studied to give conclusive patterns or behaviours. Considering this limitation, the following conclusions can be drawn from this study.

The conventional flexural capacity equation for solid concrete slabs can predict the flexural capacity of hollow core concrete slabs with an accuracy of ± 19%.

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