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EXPERIMENTAL BEHAVIOUR OF PRESTRESS HOLLOW CORE SLAB, RC HOLLOW CORE SLAB AND NORMAL RC SOLID SLAB

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ABSTRACT - *The project consists of comparative studies on structural behaviour of prestress hollow core slab and RC slabs. The project consists of experimental behaviour of hollow core slabs and comparison of this result with different mix and casting. Reinforced hollow slab is casting by making the hole in mould. Then the prestress hollow core slab is casted with zero slump concrete in factory. The slab has the dimension of 1m³. The load test is done in these slabs by loading frame. These papers include design and experimental test of normal reinforced solid slab, reinforced hollow core slab and prestressed hollow core slab. Final result will be compared between these three slabs by load test.*

Key words: Prestress, hollow core slab, solid slab, cracking pattern, ultimate load.

1. INTRODUCTION

A hollow core slab, also called as a voided slab, hollow core plank or simply a concrete plank is a precast slab of prestressed concrete typically used in the construction of floors in multi-story apartment building. The slab has been popular in present modern construction. The precast concrete slab has tubular voids extending the full length of the slab. This holes makes the slab much lighter than a reinforced solid concrete slab of equal thickness or strength. The reduced weight is important because it lowers the costs of transportation as well as material (concrete) costs.

1.1 Hollow Core Slabs

Hollow core slabs are precast, prestressed concrete elements that are generally used for flooring. A hollow core slab is consist of continuous voids provided to reduce weight and cost. This hollow core slabs are primarily used as a floor deck system in residential and commercial buildings as well as in parking structures because this slabs are more economical, have good fire resistance and sound insulation properties, and also capable of spanning long distances with relatively small depths.

1.2 Advantages Of Hollow Core Slab.

- The slabs have between four and six longitudinal holes running through the slab, the primary purpose of the holes being to reduce the weight, and material within the floor.
- To increase the strength of the hollow core slab, the slabs are reinforced with 12mm diameter steel strand, running longitudinally.
- Currently we offer a range of five slab depths; 200, 220, 300, 320 and 400 millimetre slabs.
- Depending on the project requirements, in particular span and particular slab depth is chosen.
- The long horrow cores (voids) can be used to run mechanical and electrial equipment.
- The long span capabilities in hollow-core slab provides long and clear spans, opening interior spaces in projects and allows designers to maximize functional layouts.
- The high-strength hollow-core slabs can provide floors that support heavy loads.
- Especially tall buildings that use hollow-core slabs have less vibration than conventional allow, along with a strong acoustical performance.
- Hollow-core slabs are most helpful in meeting the requirement of separating parking and other functional areas of the mixed-usage facility.
- Hollow-core slabs act as a ceiling and flooring unit and reduces the building height while saving the cost.
- The ducts in the Hollow-core slabs can save material and time by eliminating ductwork.
- The Hollow-core slab can also be used as vertical or horizontal wall panels.

1.3 Disadvantage

- Does not incorporate well into a timber framed house.
- Only small openings can be made (10 inches or less) in the hollow core slabs at erection sites. All other openings must be shown on the approved shop drawings and cut at the factory.

- Limited building design flexibility.

1.4 SPECIFICATION OF SLAB

A specification of reinforced hollow core slabs,
Length = 1000mm
Breadth = 1000mm
Thickness = 150mm
Diameter of hole = 40mm
Spacing of rod = 10mm
A specification of prestressed hollow core slab
Length = 12.09m
Thickness = 250mm
Breadth = 1200mm
Camber of hollow core slab = 25mm

1.5 Preparation of Mould

The mould is prepared by wooden material. The mould has the depth of 150mm, length 1000mm and breadth 1000mm. Hole is made at the centre of the mould by drilling machine. The diameter of hole is 50mm in one direction.

The reinforcement rod is provided at the base cover of 15mm.

Fig 1: mould of hollow slab

Fig 2: 40mm diameter pipe

2 OBJECTIVE

The main objective of this study is to find the deflection, cracking pattern, ultimate load carrying capacity of the hollow slab, stresses in slab and cracking load of the normal reinforced solid slab, reinforced hollow core slab and prestress hollow core slab. This test also used to find the experimental behaviour of these three slab with different type of casting and mix design.

3 THEORETICAL DESIGN

It gives the theoretical design value of hollow core slab. The reinforced solid slab and hollow core slab is designed as per IS 456-2000. This design value of load carrying capacity, maximum bending moment and deflection is compared with experimental value by testing the slab.
Here four types of slab is designed and tested. There are normal Reinforced concrete solid slab(S_1) of M50 grade of concrete, reinforced concrete hollow core slab of M50 grade concrete(S_2), reinforced concrete hollow core slab of M20 grade concrete(S_3) and prestressed concrete hollow core slab (S_4) .

3.1 Design Of Reinforced Hollow Core Slab M20

GIVEN
Length = 1m
Breadth = 1m
Depth = 150mm
Diameter of hole = 50mm
Number of hole = 5
Cover = 15mm
Grade of concrete = M20
Grade of steel = fe450
DESIGN
Step 1
Slabs spanning in two direction (two way slab) Ratio of longer span and shorter span = l < 2
STEP 2
Depth required for simply supported slab = span/(20 x modification factor)
= 1000/ (20 x1.1)
= 50 + cover + half of the diameter
= 50 + 15 + 4
= 69mm
Depth provided = 150mm
Hence safe

Step 3 Moment calculation

$M_u = 0.87 f_y A_{st} d \left(1 - \frac{f_y A_{st}}{bd\, f_{ck}}\right)$

$M_u = 0.87 \times 415 \times 552.98 \times 150 \,(1 - 0.0765)$
= 27657124.02 Nmm
= 27 kNm

Step 4 Bending moment and shear force

$M_u = \frac{wl^2}{8}$

W = 221.2 kN/m

3.2 Design Of Prestressed Hollow Core Slab

Step 1. Given

Length = 1m
Thickness = 150mm
Breadth = 1m
Camber of hollow core slab = 25mm

Camber is the upward deflection of a prestressed flexural member and results from the prestressing force being eccentric from the centre of gravity of the cross-section.

Both prestressing force and eccentricity are established by the required design load and span length of the slab, camber is a result of the design rather than a design parameter.

Net camber can be calculated as:

Camber = $Pel^2/8EI - 5Wl^4/384EI$

Where,

P = Effective force in prestressing steel after all losses (KN)
e = Distance from neutral axis to centroid of prestressed reinforcement (m)
ℓ = Span length (m)
w = uniformly distributed load (KN/m)
I = Cross-sectional moment of inertia (mm4)
E= Modulus of elasticity of concrete (N/mm2)

Precast/Prestressed Concrete Institute (PCI) deals with Hollow core slab as simply supported beam:-

Therefore,

Max deflection = $5Wl^4/384EI$
Max moment = $Wl^2/8$
= $0.125wl^2$,
Max shear = 0.5wl

4 EXPERIMENTAL SETUP

4.1 Testing Of Reinforced Hollow Core Slabs

Fig 3: Testing of prestress hollow core slab

4.2 Test Arrangement

Hollow core slab is supported by 2 sides simply supported beam. Slab is load by loading frame, The initial crack is appeared for M20 concrete slab is 220 Ton and then the ultimate load is 320 Ton. Similarly S_2, S_3 and S_4 slab is tested and value should be tabulated refer table 1.

Graph 1 shows the load and Deflection behavior of M20 grade concrete hollow core slab.

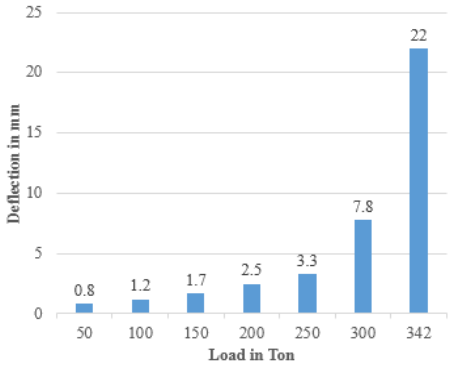

Chart -1: Load and deflection for M20 concrete

Table -1: Test results

Test result				
S no	Slab	Cracking load (TON)	Ultimate load (TON)	Deflection (mm)
1	R.c hollow core slab M_{20}	220	310	55
2	R.c hollow core slab M_{50}	250	380	64
3	Solid slab	300	390	22
4	Prestress hollow core slab	400	490	9

5 CONCLUSION

From this experimental test, prestress hollow core slab is more efficient than reinforced concrete slab.

- Reinforced hollow core slab, prestress hollow core slab is tested and ultimate load, cracking load and efficiency of slab is tabulated.
- Cost efficiency of prestress hollow core slab is high compare to reinforced concrete hollow core slab.
- Load carrying capacity slab is 20 % less when compare to prestress hollow core slab.

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