An Experimental Study On Structural Behaviour Of Hollow Core Concrete Slab

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Abstract-A precast hollow core slab to reduce weight, cost of building structures. Precast concrete floors offer significant advantages in many types of building construction. They offer design, time and cost advantages for use with all structural systems, i.e. concrete, masonry and steel. In our country precast concrete elements are not widely used for construction of most buildings. The conventional cast in-situ construction require lots of formwork and construction time, and also the precast beam-slab system construction require propping and construction time too which increases the total cost of a project. When precast hollow core slab elements are introduced in vast amount in the construction of buildings, an economical construction could be achieved. The greatest production efficiency is obtained by mixing slabs with the same reinforcing requirements from several projects on a single production line. This implies that best efficiency for a single project is obtained if slab requirements are repetitive.

Key words: Hollow core slab, precast unit, dead load, flextural strength.

1.INTRODUCTION

GENERAL

The use of inexpensive construction system in building construction is usually associated with the question of how economical the system will be, if it is used instead of the usual or traditional ones. However, the evaluation of the economical benefits gained from using such systems requires a thorough study on the system. There are various methods of precast concrete flooring construction to give the most economic solution to various types of loadings having long spans. These floors give maximum structural performance with minimum weight and can be used with or without structural toppings and non-structural finishes.

1.2.DESCRIPTION OF PRECAST HOLLOW CORE SLAB

Cores are typically either circular or elliptical. Slabs may be reinforced. The hollow cores afford a reduction in self weight of 30% or more compared with a solid slab of the same depth. For most applications, no propping is necessary during construction, but crane access is essential. An erection rate of up to 600m² per day per floor is possible.

1.3. CONNECTIONS IN HOLLOW CORE SLABS

Connections will be required in hollow core slab systems for a wide variety of reasons. Most connection requirements will be for localized forces ranging from bracing a partition or beam to hanging a ceiling. Connections are an expense to a project and, if used improperly, may have detrimental effects by not accommodating volume change movements that occur in a precast structure. Connections may develop forces as they restrain these movements.

1.3OBJECTIVE OF THE STUDY

The main objective of the project is to investigate the advantage of precast hollow core concrete slab elements. This is achieved by making a cost comparison of floor slabs, analyzed and designed by the precast hollow core concrete slab system and the precast beam-block slab system.

1.4 SCOPE OF THE INVESTIGATION

The hollow-core slab concrete was compared with solid slab using Ordinary Portland cement (OPC 53) concrete then it is suggested that the low weight Concrete slab should be utilized as a building material.

EHSAN AHMED (2008) Externally bonded carbon fiber reinforced polymer (CFRP) composite laminates have been successfully applied to reinforced concrete (RC) beams and other structural elements for the purpose of increase load carrying capacity of such elements. This paper presents the experimental results on the flexural strengthening of reinforced concrete beams by CFRP laminates attached to the tensile soffit of the beams by epoxy adhesive.

FIRAS AL-MAHMOUD (2009) The aim of the experimental programme developed in this work was to investigate the possibility of using Carbon Fibre-Reinforced Polymer (CFRP) rods to strengthen concrete structural members with the near-surface mounted reinforcement (NSM) technique. The global behaviour of reinforced concrete beams strengthened by NSM and subjected to flexure was investigated.

YASMEEN TALEB OBAIDAT (2010) The ABAQUS program was used to develop finite element models for simulation of the behaviour of beams. From the analyses the load-deflection relationships until failure, failure modes and crack patterns were obtained and compared to the experimental results. The models were then used to study how different parameters affect retrofitted beam behaviour and investigate how CFRP should be applied in order to get maximum increase of load capaci.

Concrete is the most widely used man made materials in the construction world. It contains following materials,
Cement Fine aggregate Coarse aggregate Water PVC pipe Reinforcement

4.1 CEMENT

OPC53 Grade conforming IS12269:1987, Minimum cement
content: 320 kg/m3 (IS456:2000), Specific gravity of Cement: 3.09

TABLE 4.1 PHYSICAL PROPERTIES OF CEMENT

	TEST FOR CEMENT RESULT	**RESULT**
1	Standard Consistent Test	30%
2	Initial setting time	35min
3	Final setting time	580min
4	Specific gravity	2.83

.1.2 FINE AGGREGATE

The fine aggregate passes through 4.75mm and retained on 75 micron sieve are used. The purpose of the fine aggregate is fill the voids in the coarse aggregate and to act as a workability agent, in this work zone III grade sand used is used Table 4.2 shows the properties of fine aggregate.

FIG.4.2 FINE AGGREGATE

4.1.3 COARSE AGGREGATE

The coarse aggregate is used in the form of broken crushed stone which of size re through 40mm sieve and retained through 20mm sieve. It is well graded different particle size and angular in shape. Table shows the properties of coarse aggregate.

4.1.4 WATER
The water used for mixing and curing the concrete is the portable

Water available for in the campus.

5.1 EXPERIMENTAL SETUP FOR COMPRESSION TEST

5.1.1 Compression test
The specimen is placed at the centre of the pads located at the top and bottom portion of compression testing machine.
5.1.2 Compression test procedure
After placing specimen in the testing machine. The test load is applied gradually, increasing at a constant rate. The ultimate load is which the cube fails was noted and the compressive strength was calculated.
Compressive strength = (P/A) (N/mm^2)
Where,
P = Applied load
A = Area of the specimen
Cube size = 150x150x150mm

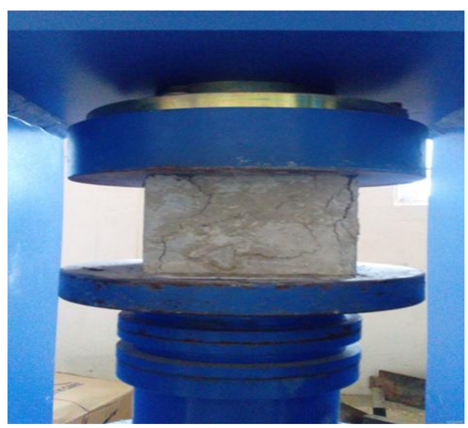


FIG 5.1 COMPRESSIVE STRENGTH OF CUBE

5.2 EXPERIMENTAL SETUP FOR SPLIT TENSILETEST

5.2.1 Split tensile strength procedure

After placing the specimen in the testing machine, the test load is applied gradually, increasing at a constant rate. Magnitude of this stress acting in a direction perpendicular to the line of these line actions of applied compressive force is given.

Spilt tensile strength = (2xp) / (πxDxL) (N/mm²)

Where,

P = Applied load

D = Diameter of the cylinder (mm)

L = length of cylinder

FIG 5.2 SPILT TENSILE STRENGTH

5.3 FLEXURAL STRENGTH TEST

5.3.1 CASTING OF SPECIMENS

Slab specimens were prepared for finding the flexural behavior of slab.

The slab moulds of 200 mm x 250 mm in cross section and 1200 mm long was

STEEL REINFORCEMENT:

AT TOP: 10mm DIA BARS (2NO'S)

AT BOTTOM: 12mm DIA BARS (2NO'S)

STIRRUPS: 8mm DIA BARS @ 150mm MIN. SPACING (12 NO'S)

FIG.5.3 SCHEMATIC DIAGRAM FOR TESTING ARRANGEMENT

5.4 CASTING OF HOLLOW CORE SLAB

There are various methods of precast concrete flooring construction to give the most economic solution to various types of loadings having long spans. These floors give maximum structural performance with minimum weight and can be used with or without structural toppings and non-structural finishes, size is 1200x450x150 mm

FIG 5.4 HOLLOW CORE SLAB BEFORE CASTING

FIG 5.4 HOLLOW CORE SLAB AFTER CASTING

5.5 FLEXURAL STRENGTH TEST

Flexural strength, also known as modulus of rupture, bending
strength or fracture strength a mechanical parameter for brittle material.
The transverse bending test is most frequently employed, using a three point
flexural test technique. Prepared one slab of conventional and another breams
are hollow-core slab and hollow with filling by low grade materials.Flexural
strength test was conducted after 28 days the concrete Slabs and UTM was used
for this test.

5.6 BEHAVIOR OF RC SLAB

The Ultimate load carrying capacity of the RC slab is determined experimentally.

The Load Vs deflection curves are drawn.

The failure modes of the RC slab is studied experimentally.

5.7 LOADING FRAME TEST

5.7.1 LOADING FRAME TEST PROCEDURE

The slab is gradually loaded by increasing the load level by increment of 2.0 KN, up to failure. The Deflection readings measured at the mid span of the slab recorded.

The beam is subjected to load up to failure of the beam. As the load level is increased further, the crack is developed. The concrete was crushed and spalling down.

ADING FRAME SETUP

FIG 5.5 SET UP FOR LOADING FRAME

FLEXURAL STRENGTH OF RC SOLID SLAB CONCRETE (at mid span)

Conventional slab

FIG 5.6 CRACKS ON CONVENTIONAL SLAB

Hollow slab

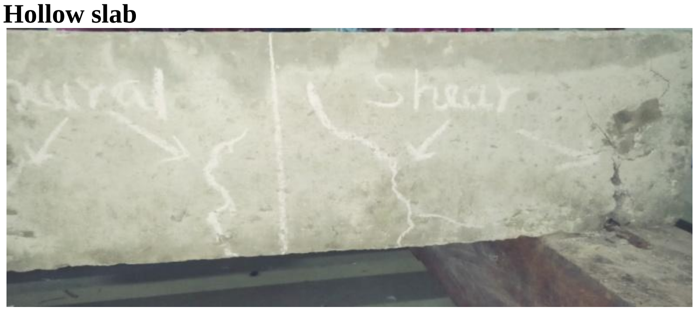


FIG 5.7 CRACKS ON HOLLOW-CORE SLAB

6.RESULT AND DISCUSSION

6.1 GENERAL

Due to several advantages in reduction in self weight of hollow-core slab concrete beam used for structural construction has becoming popular. This paper makes a comparative study between the load carrying capacity of an Reinforced solid slab and Hollow core slab. An experimental study will carried out the study the change in the structural behavior of R.C.C slab, to enhance the flexural and Shear capacity of the slabs

6.2 COMPRESSIVE STRENGTH

Compressive strength is most important property of the hardened concrete. The concrete cubes were casted, cured and tested accordance with the IS standard and 7 days and 28 days. Compressive strength results of concrete are listed in table. The highest compressive strength value which is obtained at 28 days for M35 grade concrete.

TABLE 6.1-COMPRESSIVE STRENGTH TEST IN MPA

Mix Design	Cubes 28days (N/mm^2)	Average strength (N/mm^2)
M_1	36.26	37.28
M_2	37.84	
M_3	37.76	

6.2 SPLIT TENSILE STRENGTH

After curing of cylinder specimens150mm diameter and 300mm height they are placed in testing machine. The load is applied on the cylinder specimens. The cylinder specimen is failed at ultimate load which is noted from the dial gauge reading.

TABLE NO 6.2 SPLIT TENSILE STRENGTH

Mix Design	Cylinder 28days (N/mm^2)	Average strength (N/mm^2)
M_1	4.2	4.07
M_2	4.6	

M_3	3.4	

6.3 FLEXURE STRENGTH TEST

Flexural strength test was conducted after 28 days the concrete slabs were fabricated and Loading frame was used for this test. Prepared one beam of convetional and another is hollow core beam and graually applied load values are noted and also drawn a graph

6.4.FLEXURAL STRENGTH OF RC SOLID SLAB CONCRETE
(At mid span)

S.NO	LOAD(KN)	DEFLECTION(mm)
1	0	0
2	2	0.66
3	4	1.61
4	6	2.73
5	8	4.37
6	10	5.58
7	12	6.98
8	14	7.08
9	16	6.80
10	18	6.74

TABLE NO 6.3 DEFLECTION OF SOLID SLAB

6.5.FLEXURAL STRENGTH OF RC HOLLOW SLAB CONCRETE
(At mid span)

TABLE

NO 6.4 DEFLECTION OF HOLLOW SLAB

6.5.1 FLAEXURAL COMPARISION OF SOLID AND HOLLOW CORE SLAB IN(MID SPAN)

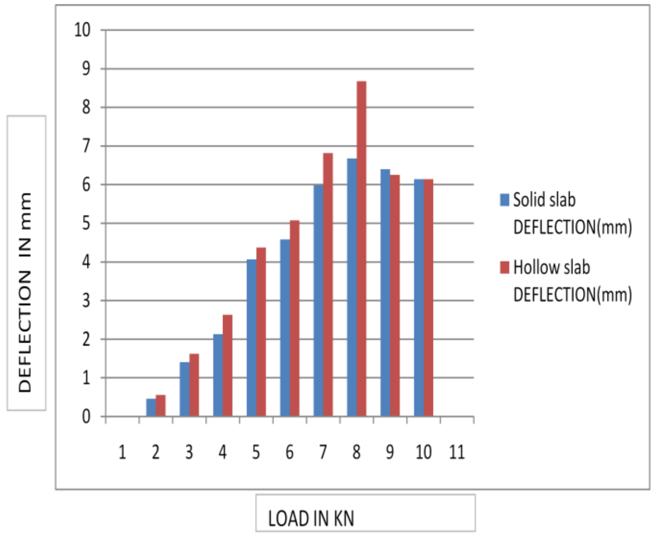
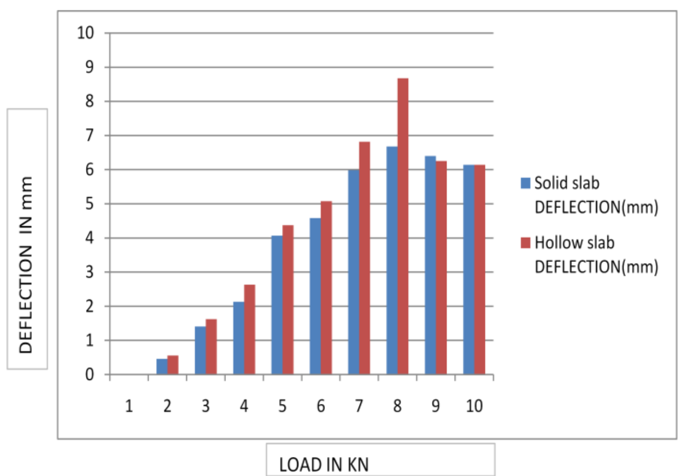


FIG NO 6.1 GRAPH SHOWING OF SOLID AND HOLLOW CORE SLAB

6.6.FLEXURAL STRENGTH OF RC SOLID SLAB CONCRETE
(At L/3 span

6.7.1 FLAEXURAL COMPARISION OF SOLID AND HOLLOW CORE SLAB IN L/3



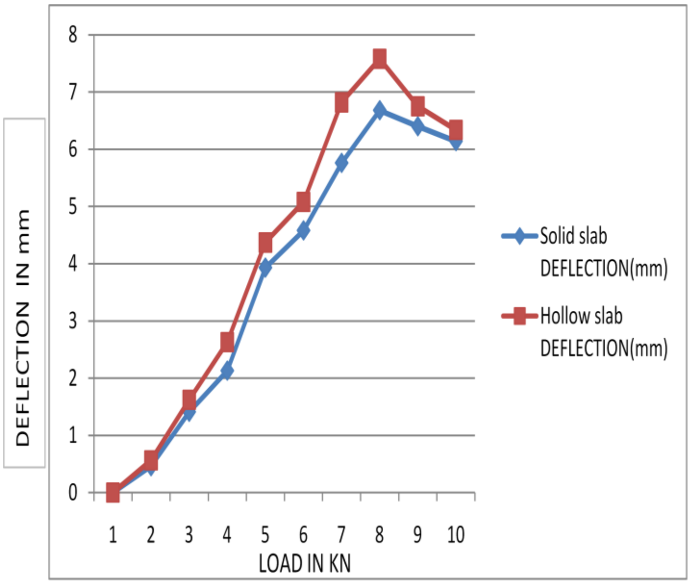


FIG NO 6.3 GRAPH SHOWING OF SOLID AND HOLLOW CORE SLAB L/3

7.CONCLUSION

As the main objective of this project is to investigate the advantages of the use of hollow core slab elements with the solid slab constructions, this section deals with cost comparison of the two systems Hollow core slabs are most widely known for providing economical, efficient floor and roof systems . The top surface can be prepared for the installation of a floor covering by feathering the joints with latex cement, installing non-structural fill concretes ranging from 15 to 50mm thick depending on the material used, or by casting a composite structural concrete topping. The underside can be used as a finished ceiling as installed, by painting, by applying an acoustical spray. When properly coordinated for alignment, the voids in a hollow core slabmaybe used for electrical or mechanical runs. For example, routing of a lighting circuit through the cores can allow fixtures in an exposed slab ceiling without unsightly surface mounted conduit. A hollow core slab provides the efficiency of a precast member for load capacity, span range, and deflection control

REFERENCES

1. Arthur H. Nilson 1987. Design of prestressed concrete, 2nd edition. Canada: John Wiley and Sons.
2. Ben C. Gerwick,Jr 1971.Construction of prestressed concrete structures. New York: Wily inter-science.
3. Biruh Habtu 2005, Precast prestressed hollow core concrete floor slabs. MSc. thesis: school of graduate studies, Addis Ababa University of technology faculty.
4. British standard (BS) 8110 1997.Structural use of concrete, part1, code of practice for design and construction. London: British standards institution.
5. Chudley R.1996. Construction technology, 2nd edition. England : Longman group limited.
6. Dharris J. and Smith I.C. 1963.Basic design and construction in prestressed
7. London: Chatto and Windus
8. Donald R. Buettner and Roger J. Becker 1998. Prestrssed hollow core concrete slab design manual, 2nd edition. U.S.A. Precast prestressed concrete institute, Chicago.
9. Fredrick S. Merritt, M.Kent Loftin. and Jonathan T. Ricketts 1996.Standared hand book for civil engineers ,4th edition. New York: McGraw-Hill
10. Gilbert, R.I. & N.C. 1990.Design of prestressed concrete. London: Academic Division of Unwin Hyman Ltd.
11. Kenneth Leet 1991. Reinforced concrete design, 2nd edition. U.S.A.
12. Kent Preston H. and Norman J. Sollenberger. 1967. Modern prestressed concrete. New York :McGraw-Hill
13. Kim S. Elliott 2002. Precast concrete structures construction.Oxford,Boston: Butterworth-Heinemann.
14. Libby James R.1971.Modern prestressed concrete design principles and construction methods. New York: Van Nostrand Reinhold co.
15. Lin,T.Y and Ned H.Burns. 1982. Design of prestressed concrete structures, 3rd edition. Canada: John Wiley and Sons
16. Mallick and Rangasami 1977. The mechanics of prestressed concrete,
17. 3rd edition. Delhi: Khanna Publishers.
18. Michael Chi and Frank A.Bibestein1963. Theory of prestressed concrete. Englewood Cliffs, New Jersey: Prentice-hall inc.
19. Ramaswamy G.S.1978. Modern prestressed concrete design. London: Pitman publishing limited.
20. Robert A.Hartland 1975.Design of precast concrete: an introduction to practical design.London: Survey university press:

International text book Co.

21. Tihamer Koncz Dr.Ing.1968. Manual of precast concrete construction. Germany: Bauverlag Gmb H. Wiesbaden and Berlin.
22. Bison. Hollow core floors for multiple occupancy housing, UK: Bison concrete products limited.2007 from:
23. <e-mail: concrete@ bison.co.uk,web site: www.bison.co.uk.>
24. Concrete Manufacturers Association 1996. Precast concrete floor slabs design manual, Randburg:The association < e-mail: cma@cis.co.za, website: www. cma.org.za>
25. Old castle precast building systems division. 2007, from:
26. <http://www.oldcastlesystems.com>
27. Precast prestressed hollow core slab hand book 2006, PNK Enterprise Co.,Ltd. Retrieved 2007.