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# Study of Performance of Prefabricated Ferro cement In-filled and Hollow Beams

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***Abstract:*** Ferro cement is an alternative material for RCC with high performance and cost effectiveness. Prefabrication method saves engineering time in the construction. The use of prefabricated Ferro cement components for construction could possibly reduce the cost of construction and time for completion. In this study beams with size 0.4 x 0.25 x 1m at 5cm thickness along single wire mesh were cast and tested in laboratory and their break load capacity are studied. Ferro cement Hollow beams, Ferro cement Hollow beams in-filled with PCC, Ferro cement hollow beams in-filled with RCC, and normal RCC beams are tested and results were compared. The Ferro cement Hollow beams are preferable in low cost housing and have needful load carrying capacity.

*Index Terms* - **Ferro cement, Prefabrication, In filled beams, Hollow beams, wire-mesh, Breaking load capacity**

## I. INTRODUCTION

Now a day we are facing the housing shortages and low standards of living. The main reason is cost for building materials is increasing day by day and the constructional system. So the material should be structurally efficient, light weight, cost effective and at the same time an effective constructional method is to be used. Ferro cement is a material that has the qualities mentioned with high performance and also cost effective. Moreover, Prefabrication is a method that saves engineering time on the construction. The use of prefabricated Ferro cement components could possibly reduce the cost of construction and time for completion. This study deals with the study on prefabricated in filled and hollow beams by using Ferro cement, and their applicability in current environment of construction.

- ***Ferro cement***

Ferro cement is a building material composed of a relatively thin layer of concrete covering a steel reinforcing material such as wire mesh. Since these materials are widely available and are relatively low in cost, and since the building techniques are simple enough to be done by unskilled labour, Ferro cement is an attractive type of construction for many developing countries. The cost of reinforcement can be kept to a minimum in Ferro cement. There is no need for complicated formwork as in reinforced concrete construction, or welding which is done in steel construction. Ferro cement can be shaped into any form.

- ***Prefabrication***

Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site, and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. The term is used to distinguish this process from the more conventional construction practice of transporting the basic materials to the construction site where all assembly is carried out. Shorter construction time- less than half of conventional cast in situ construction

## II. EXPERIMENTAL STUDY

- ***Materials used***

Ferro cement consists of cement mortar and wire mesh. The cement mortar imparts the compressive strength to the Ferro cement structure. . The ratio of cement to fine aggregate was 1:3 and the water/cement ratio was taken as 0.45. Welded steel wire mesh of aperture size 20mm and thickness 1mm was used for the specimen casting. Here wire mesh act as layer of reinforcement to the Ferro cement.

- ***Details of specimens.***

The beams cast were of size 250mm x 400mm and 1m long. A Ferro cement hollow beam, Ferro cement hollow beam in filled with PCC, Ferro cement hollow beam infilled with RCC and normal RCC beam were cast to compare the strength obtained. The mould for casting box beams was made out of timber. The mould consisted of two sections mainly; the outer and the inner sections. The inner section was placed in a channel on a plywood board with 5cm projecting outside. The outer section then will be placed outside of the plywood board, giving 5cm thickness for the hollow section. For the ease of casting the Outer section is made as two parts; the lower and upper parts.

After placing the outer section of the mould, the steel mesh was placed in between the two sections. Then the cement mortar was placed in between the sections. The cement mortar was compacted manually using steel rod and by using a hammer, thus the hollow beams were cast. The hollow sections are then filled with PCC. Another RCC specimen was made with 10mm and 8mm dia bars as main reinforcement and shear reinforcement respectively inside the hollow Ferro cement beam. These specimens are compared with a normal RCC beam with 10mm main bars and 8 mm stirrups. The following figures show the different processes

Figure 1.Reinforcement cage

Figure 2.Form work

Figure 3 cast specimen

Figure 4. Hollow beam with PCC

- ***Tests of specimens.***

The specimens cast were tested for their breaking load capacity. The specimens were placed on the loading frame in simply supported condition. The load was applied at a constant rate without shocks and increased continuously.

For testing of beams, they were placed on I-sections with c/c distance of 90cm and an I- section was placed above the beam at center for applying the load uniformly at center of the beam. For testing of Ferro cement hollow beam, hydraulic jack of 50T

capacity was used. For testing of beams with infill concrete and normal RCC beam, hydraulic jack of 100T capacity was used. The load applied was measured using a dial gauge with 0.1T accuracy.

- ***Results***

Figure 5.Test setup for Ferrocement Hollow beam

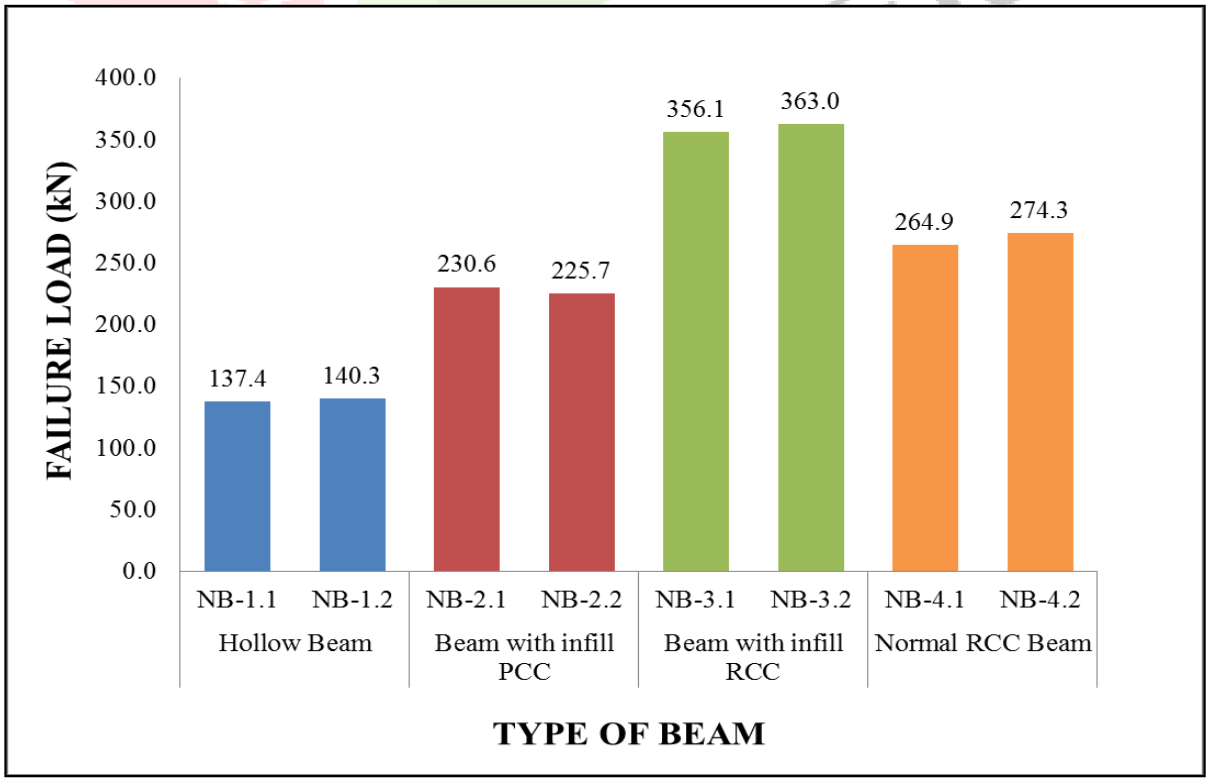
Figure 6.Test setup for infill beams & normal RCC Beam

TABLE.1 TEST RESULTS OF BEAMS

| TYPE | FORCEMENT DETAILS | Sp No. | First Crack Load | | | Failure Load | | |
|---|---|---|---|---|---|---|---|---|
| | | | T | kN | Avg | T | kN | Avg |
| **Hollow Beam** | Wire mesh | NB1.1 | 13.0 | 127.6 | **128.6** | 14.0 | 137.4 | **138.9** |
| | | NB1.2 | 13.2 | 129.5 | | 14.3 | 140.3 | |
| **Beam with infill PCC** | Wire mesh in outer ferrocement section | NB2.1 | 23.3 | 225.7 | **225.2** | 23.5 | 230.6 | **228.1** |
| | | NB2.2 | 22.9 | 224.6 | | 23.3 | 225.7 | |
| **Beam with infill RCC** | Wire mesh in outer ferrocement section & 10mm dia. bars as main reinforcement and 8mm dia. bars as shear reinforcement | NB3.1 | 33.8 | 331.6 | **332.6** | 36.3 | 356.1 | **359.6** |
| | | NB3.2 | 34.2 | 333.6 | | 37.0 | 363.0 | |
| **Normal RCC Beam** | 10mm dia. bars as main reinforcement and 8mm dia. bars as shear reinforcement | NB4.1 | 24.0 | 235.4 | **236.9** | 27.0 | 264.9 | **269.6** |
| | | NB4.2 | 24.3 | 238.4 | | 28.0 | 274.3 | |

During the testing of specimens, the failure of beams was sudden with increase of load after the occurrence of first crack in the case of Ferro cement hollow beam and Ferro cement beam in filled with PCC.

From the results we can observe that the test results of Ferro cement hollow beam in filled with PCC is comparable to that of normal RCC beam. However, based on results obtained we can use Ferro cement hollow beams where load to be carried is less, i.e. for low rise buildings, particularly up to 2 storied buildings. Since our aim is to provide low cost housing, it is preferable to use Ferro cement hollow beam.



- ***Cost comparison*.**

| Description | Reinforcement Details | Material Cost (Rs.) |
|---|---|---|
| **Hollow Beam** | Wire mesh | 506.50 |
| **Beam with infill PCC** | Wire mesh in outer Ferro cement section | 880.87 |
| **Beam with infill RCC** | Wire mesh in outer Ferro cement section & 4 # 12mm dia. bars as main reinforcement and 8mm dia. bars as shear reinforcement | 1297.87 |
| **Normal RCC Beam** | 12mm dia. bars as main reinforcement and 8mm dia. bars as shear reinforcement | 989.50 |

**Conclusion**

Shelter is a fundamental need which provides protection for human being from other elements such as weather. With increase in population around world, there has been increase in demand of shelters with speedy construction. Ferrocement used for construction of shelter solves the problem of cost while prefabrication solves the problem of speedy construction. Combined together prefabricated Ferro cement is an amble solution for both the problems. In this thesis work, effort has been made to study the suitability of prefabricated Ferro cement beams for the construction of low cost housing.

For the study, model specimens were cast and tested in a loading frame with a capacity of 100T. A cost comparison based on material cost was done to get a mere idea on the costs of ferrocement elements with RCC elements. From experimental study it was observed that, failure load of Ferro cement hollow beam infilled with PCC is comparable to that of normal RCC beam.

Based on results obtained from the study, it can be concluded that the prefabricated ferrocement hollow beams maybe used for the construction of low cost housing and it is also cheaper compared to RCC elements of similar size. With use of ferrocement elements the dead load can be reduced for a building, and hence the section size for compression member can be reduced.

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