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Flexural Strengthening of RC Beams Using Ferrocement Laminates with Partial Replacement of Fine Aggregate by Steel Slag

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ABSTRACT

World wide a great deal of research is currently being focused on the use of correct material for repair and strengthening of existing reinforced concrete structure and the research is also concern about the effective utilization of fine aggregate in construction industries due to scarcity of natural resources. Some of the special performance requirements of repair and strengthening material are strength, durability, effectiveness of bonding of new material to the existing structure etc. Ferro cement is one of the versatile materials for strengthening of structures and is identified as a novel construction that meets one or more of the above mentioned performance requirements. If Ferro cement, having special performance requirements, is used for strengthening, repair and construction of building elements, then the benefits achieved will be more. For instance, the use of Ferro cement in the construction of earthquake resistant structures, precast roof elements, and other marine uses will result in the design of smaller sections.

Key Words: Ferro cement, Durability, Resistant structures.

1. INTRODUCTION

Natural disasters such as earthquakes, tornadoes and tsunamis threaten the integrity of civil infrastructures and safety of their uses. A large number of existing reinforced concrete buildings and other structures typically have not sufficient capacity to resist the forces during such catastrophes. In order to guarantee the safety of the people, the older and existing structures need to be repaired and strengthened to prevent their collapse. Efficient methods are needed to be developed for structures repair and strengthening. The ageing of the nation's infrastructure in a tight economic environment has necessitated the search for innovative and cost effective solutions. In recent years, the use of Ferro cement laminate has become a subject of great interest in structural community. Several studies had been focused on the use of externally bonded Ferro cement laminates to reinforce existing structures in need of strengthening.

2. METHODOLOGY

The first step in this study was optimization of Ferro cement laminate with correct mix proportion of mortar matrix containing cement, sand, steel slag and volume fraction of mesh reinforcement. So an analytical investigation was carried out as a conformation study for experimental results obtained by Sridhar et.al. From the analytical investigation, appropriate Ferro cement laminate was chosen for flexural strengthening of RC beams. For experimental investigation totally five RC beams of size 1220mm x 100mm x 150mm and four Ferro cement laminates of size 1220mm x 150mm x 25mm were cast. Of which two beams were strengthened with three and four layers of galvanised square weld mesh and mortar mix of cement sand ratio 1:2 with 0% replacement of steel slag for fine aggregate and other two beams were strengthened with three and four layers of galvanised square weld mesh with mortar mix of 1:2 and 30% replacement fine aggregate by steel slag.

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After 28 days of curing both laminates and beams taken out and allowed to dry in air for two days. Then the surface of beam was prepared to attach Ferro cement laminates.

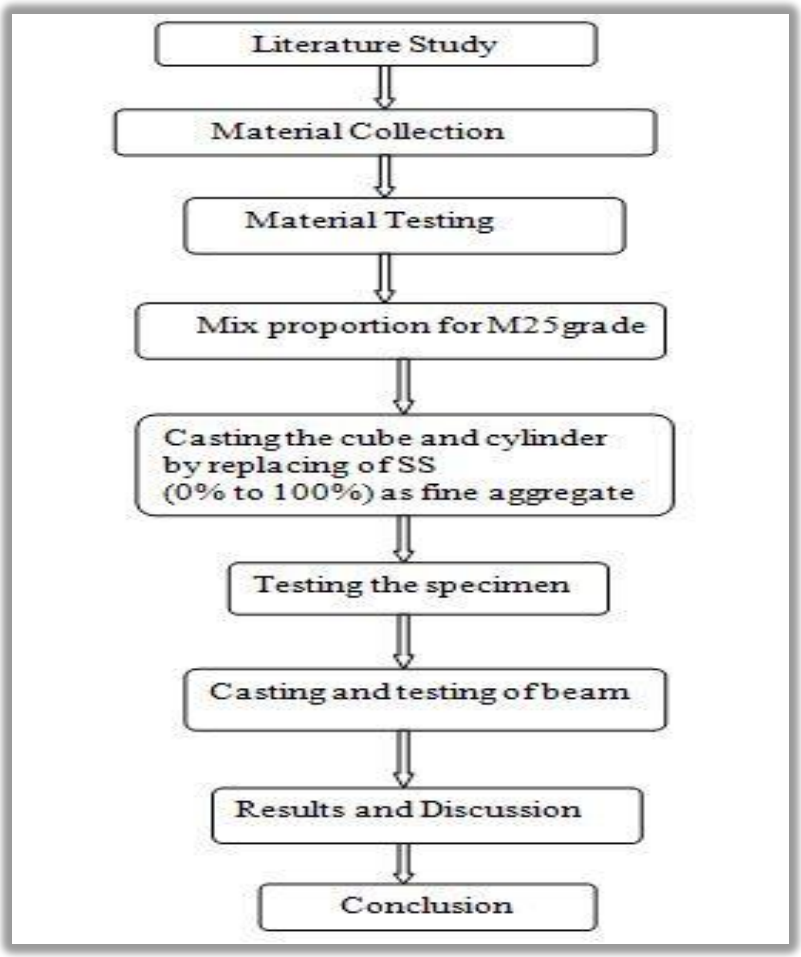

Figure 1: Methodology

3. RC BEAM DESIGN

Five reinforced concrete beams with simply supported span lengths of 1.22 m,and a cross-section of 150 mm x 100 mm were cast and tested under two point loading.

- Construction facilities – casting, curing and storage of specimens;
- Testing facilities – loading capacity of the testing machine;
- Handling facilities – lifting and moving the specimen

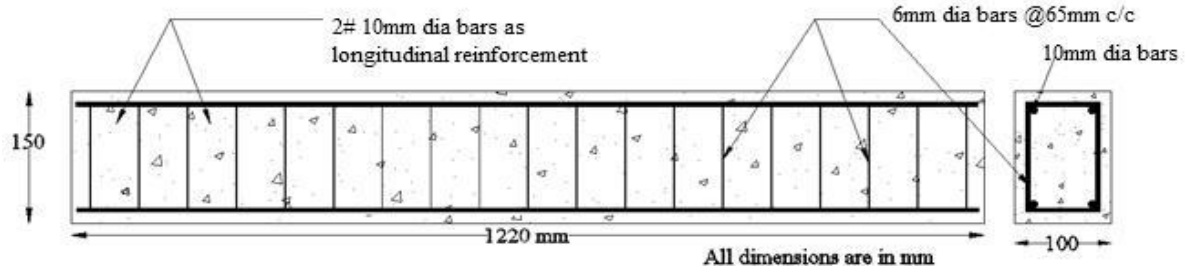

Figure 2: RC Beam Design

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Concrete is a construction material composed of Ordinary Portland cement and water combined with sand, gravel and crushed stone or other inert material such as expanded slag or vermiculite. Nominal concrete mix of 1:1:2 by weight was used to achieve the strength of 25 N/mm^2. The water cement ratio of 0.5 is used. Three cube specimens were cast and tested at the age 28 days to determine the compressive strength of concrete. The average compressive strength was found to be 31 N/mm^2.

Figure 3: Application of epoxy resin on RC beam, laminate and Strengthened RC beam

4. TESTING OF STRENGTHENED RC BEAMS

Table 1: Experimental results of RC beams under two point loading

Beam designation	First Crack		Ultimate Load (kN)	Maximum Deflection (mm)	Ductility Factor	Energy Absorption (kN-mm)
	Load(kN)	Deflection (mm)				
CON	24.5	5.15	73	10.49	1.83	282.5
FB01	31.1	3.19	81	7.92	2.42	335
FB02	31.5	2.70	84.2	7.8	2.89	345
FB03	34.1	2.47	88.5	6.9	2.79	340
FB04	45	1.92	97.8	5.62	2.93	350

Five concrete beams were tested under two point monotonically increasing load to failure for this research. One was control beam, which was used for comparison for the remaining four. The remaining beams were externally reinforced with Ferro cement laminate mounted to the bottom. After 7 days of air curing the control beam and

strengthened beams were subject to flexural test under two point loading with flexural span of 366.70mm in Universal Testing Machine of 1000ton capacity. All the beams were simply supported with an effective span of 1100mm. Hydraulic jack with 100ton capacity was used to apply load. The load cell having a capacity of 5 ton was used to measure the applied load. The load was applied in increments of 2 kN and at each stage mid span deflection was noted using a dial gauge having a least count of 0.01mm. The initializations of flexural crack were carefully observed and corresponding load and deflection were noted. The ultimate load and the mode of failure of the specimen were noted.

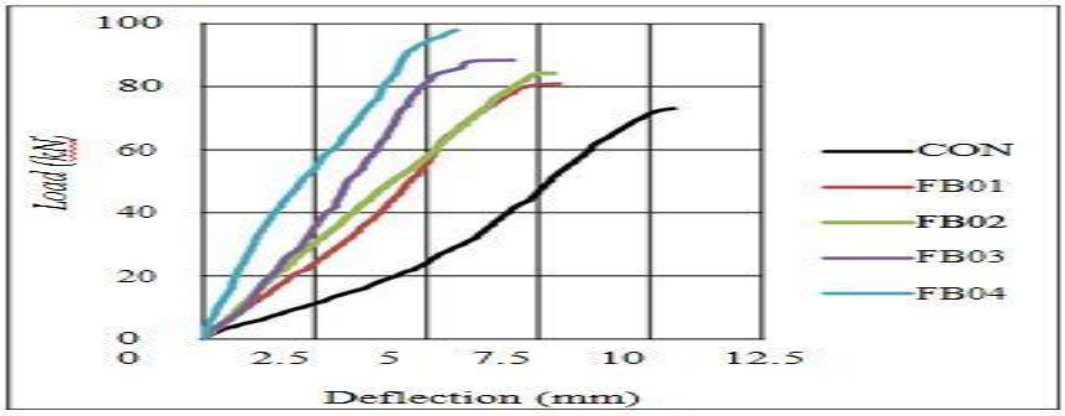

Fig.4: Load Vs deflection curve for strengthened RC beams

5. CONCULSION

Finally, it is concluded that use of steel slag as replacement material for fine aggregate in Ferro cement laminate have a considerable impact on its performance as a strengthening material due to its higher specific gravity and higher surface area. Therefore, the steel slag not only act as a fine aggregate it also act as a filler material for cement.

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