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Effect of Partially Replacement of Bottom Furnace Ash on Mechanical Properties of Ferrocement

Viraj Mukund Kadam[1*], Manisha Jamgade[2]
[1]*PG Student, Department of Civil Engineering, Pillai HOC College of Engineering, Rasayani, India*
[2]*Assistant Professor, Department of Civil Engineering, Pillai HOC College of Engineering and Technology, Rasayani, India*

***Abstract*: The essential need for financial turn of events and social advancement of a nation is subject to the energy from different source. The need of giving energy as the power to the developing business just as farming areas has brought about the setting up of countless coal based Thermal Power Stations in various pieces of the country. In these Power Stations, the consuming of a coal at high temperature produces coal debris as a waste material. The gigantic tremendous amount of debris being created over these years is probably going to cause an issue for its removal and cause natural contamination prompting wellbeing risks. The answer for this issue is to utilize or use modern results or strong squanders in creating cement like Bottom Furnace Ash (BFA), Fly Ash (FA), slag, squander glass, silica smolder, and so on Base debris is generally portrayed as heterogeneous particles comprising of attractive and paramagnetic metals, glass, manufactured and regular ceramics, minerals and unburned materials The utilization of fly debris in cement can decrease the utilization of normal assets and furthermore reduces the impact of poison in climate. The current review focuses on the examinations to assess the mechanical properties of ferrocement containing Bottom Furnace Ash supplanted with the Fine Aggregate. The different test was coordinated to track down the effects on the mechanical properties of ferrocement, for instance, Compressive Strength, Flexural Strength, Split Tensile Strength and sturdiness properties like Water ingestion test. At the point when every one of the ends were thought about it was observed that BFA is accessible inexpensively in huge amount so by supplanting it with the fine total there is decrease in cost of development. Consequently, it tends to be considered as conservative.**

***Keywords*: Bottom Furnace Ash (BFA), Ferrocement, Fine Aggregates (FA).**

1. Introduction

Ferrocement is a composite construction material generally prepared the usage of hydraulic cement mortar bolstered with layer of steel mesh member. Unlike traditional bolstered concrete, ferrocement reinforcement is assembled into its final desired shape the use of carefully space layer of continuous and relative small aperture sized cord mesh tied on small rods. Traditional cement mortar is then plasters over the reinforcement cage ether by means of hand (press filling) or through mechanized pressure method, without used of traditional formwork. Most normally, ferrocement detail are constructed by means of unskilled labour for fabricating the skeletal reinforcement cage and semi-professional labour for pressfilling cement mortar on it.

The method may be very time consuming extra effect has for the fine control for improvement of extra green approach add both ferrocement and self-compacting concrete the best of SCC is that it self-compact with the aid of its own weight and it also labour and time saving and excellent product.

A. Bottom Furnace Ash

Bottom ash is the coarse, granular, incombustible result of coal ignition that is gathered from the lower part of heaters (Shambalid Ahady et.al, 2016). Most Bottom ash is created at coal-terminated power plants. The following is a correlation of fly debris and base debris, to show the size contrast of the particles and the distinction in surface. At the point when crushed coal is singed in a bottom boiler, a large portion of the unburned material is trapped in the vent gas and caught as fly ash. Somewhere around 10-20% of this debris is bottom ash (P. Aggarwal et.al, 2007). This ash is dull dim in concealing, and is around the size of sand. This debris is gathered in a water-filled hopper at the lower part of the furnace and eliminate by high-pressure water jets. It is saved in an assortment lake and put away for removal or later use in the wake of reusing.

Along with the health and natural effects of bottom ash, one issue with it is that it exists in enormous amounts.

B. Ferrocement

Ferrocement is a composite construction material commonly prepared using hydraulic cement mortar reinforced with layer of steel mesh (K. Saundhri Rajan et.al, 2019). In this method, certain limitations like uncontrolled w/c ratio, non- uniform thickness of desired quality of mortar, less workable mortar and labour intensive construction were observed. SCM is used in retrofitting, grouting, construction repair works as will be filled easily in narrow gaps and cracks.

Application of Ferrocement:

- Residential and public buildings

*Corresponding author: virajkadam9773@gmail.com

- Agriculture Structures
- Transportation Structures
- Marine and Rural Energy.

Advantages of Ferrocement:

- Fabricated into any desired shape
- Low skilled labour
- Ease of construction
- Low construction material cost.
- Better resistance against earthquake.

2. Objectives and Methodology

A. Objectives

Objective of the work is to investigate the mechanical and durability properties of Ferrocement by partially replacing fine aggregate with the Bottom furnace ash. In order to achieve the objectives, various trial mixes of ferrocement mortar were conducted by varying the percentage the bottom furnace ash as a partial replacement of fine aggregate in mortar. Also results compared with that of the conventional type of mortar blend. The use of BFA material in ferrocement mortar have many advantages which are directly proportional to the durability of the structure, along with it the quantity of the fine aggregate used in various mix proportions was also reduced. Scope of the present study is to finalize the optimum percentage of bottom ash that can be used to replace the fine aggregate.

For Characterization of self-compacting ferrocement with partial replacement of fine aggregate by Bottom furnace ash, experimental work would be carried out to achieve following objective:

- To find the effect of BFA (Bottom Furnace Ash) on mechanical properties like compressive strength, flexural strength and split tensile strength of ferrocement.
- To study the durability properties of fresh self – compacting ferrocement with partial replacement of cement by Bottom furnace Ash.
- To compare the cost of construction between conventional ferrocement and ferrocement replaced with the BFA (Bottom Furnace Ash).

B. Materials Used

1) Cement

The Ordinary Portland cement is effectively accessible in the market. The ACC cement should be utilized for performing out the various tests throughout the research work is of the same batch. The physical properties of the cement were also compared with the IS 12269: 2013. Ordinary Portland cement of 53 grade with a specific gravity of 3.14 is used.

2) Fine Aggregate

River Sand is used as filler material. The sand will sieve and size fractions are combined in equal proportion to maintain grading complying with standard sand as per IS 650:1991. River sand is used with testing done by sieve analysis, the fine aggregates passing through 4.75mm sieve is used.

3) Water-cement ratio

Water-cement ratio was kept 0.4 in the entire research work.

4) Bottom Ash

The use of Bottom Ash as a constituent of ferocement, as a fine aggregate. Size of fine aggregate should be of 4.75mm.

C. Test Performed

Mix design was maintained as 1:2 for entire research work as per ACI 549R-97 (1997). As per requirement the effect on mechanical properties should be study by varying the proportion of BFA as 0%, 5%, 10%, 15%, and 20 % in cement mortar. The mechanical properties of ferrocement like compressive strength, split tensile strength, flexural strength were carried out and durability properties like water absorption test is also carried out. The results were taken after curing period of 7, 14, 28 days.

3. Tests and Results

A. Test for Compressive Strength

The compressive strength of concrete is one of the principle properties of concrete in by far most of it essential application.

The examination of the compressive strength trial of various substitution of 0%, 5%, 10%, 15% of BFA were noticed and recorded for relieving time of 7, 14, 28 days observed shown in fig. 1 and fig. 2.

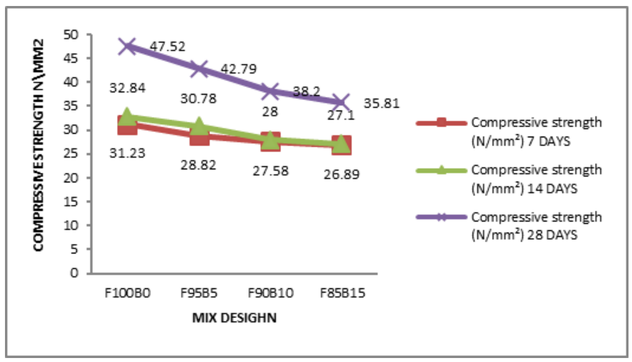

Fig. 1. Comparison between results of compressive strength (horizontal)

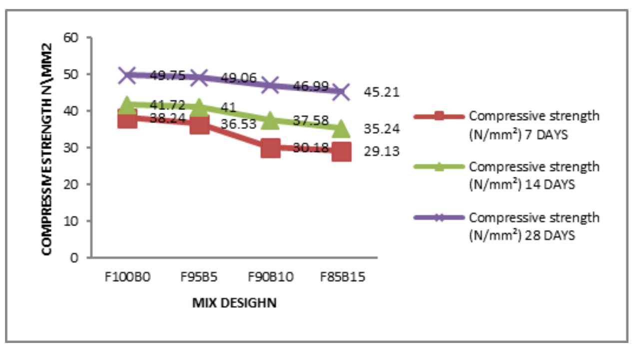

Fig. 2. Comparison between results of compressive strength (vertical)

The press-filling strategy is utilized for situation of wire mesh during the projecting system. The arrangement of wire network is set on a level plane or in an upward direction as for surface of loading.

By looking at the after effects of compressive strength of 28 days of on a horizontally aligned wire mesh or in an upward direction adjusted wire mesh, it is seen that in an upward direction adjusted wire mesh cube gives higher strength than that of horizontally adjusted wire mesh.

B. Test for Split Tensile Strength

The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder, along vertical diameter. Splitting tensile strength gives higher value than the direct tensile strength.

After water curing of self-compacting ferrocement mortar cylinder of size 150mm X 150mm X 300mm, Split Tensile strength test is done after a trial of 7, 14 and 28 days.

Examination of split tensile strength of various substitution of 5%, 10%, 15% of BFA according to trial of 7, 14 and 28 days were recorded and referenced in the fig. 3.

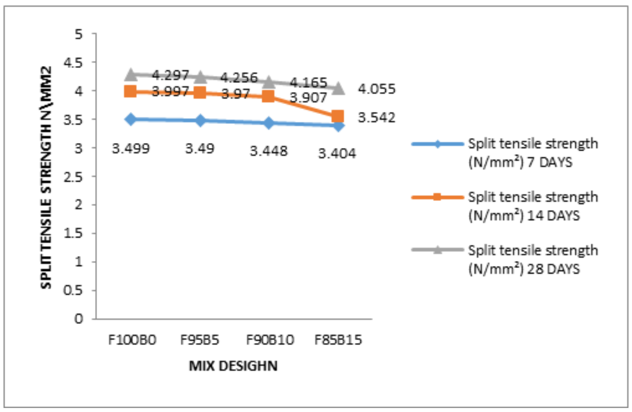

Fig. 3. Comparison between results of Split Tensile Strength

It is seen that gradually substitution of BFA shows gradually decrease in split tensile strength but there is no quikly decrease in graph.

C. Test for Flexural Strength

The standard size of beam sample was chosen according to the past examination of flexural strength of self-compacting mortar and the size of beam sample was (150 X 150 X 300) mm. Water curing was done period of 7, 14 and 28 days and after that the beam sample were tested in Universal Testing Machine under centre point loading to find out flexural strength.

From the fig. 4, it shows that the flexural strength of ferrocement with 0% replacement of BFA for 28 days is noted as 4.812 N/mm.

- With 5% substitution of BFA, flexural strength of ferrocement for curing period of 28 days is noted as 4.795 N/mm² which is slightly less than that of 0% substitution of BFA.
- With the further substitution of 10% of BFA the flexural strength for water relieving time of 28 days is recorded as 4.630 N/mm.
- With the further substitution of 15% replacement of BFA flexural strength for restoring time of 28 days was noted as 4.590 N/mm.
- It is seen that gradually replacement of BFA shows gradually decrease in flexural strength but there is no sudden decrease in graph of flexural strength.

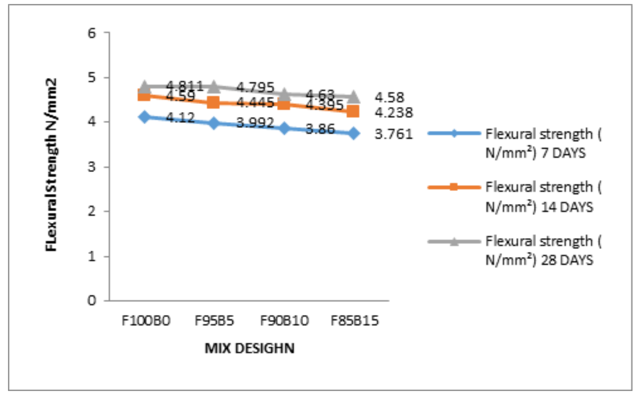

Fig. 4. Comparison between results of Flexural Strength

4. Cost Analysis

On the basic of the experimental investigation done so another objective of replacement of 5%, 10%, 15% of Fine Aggregate by the BFA, the cost analysis is carried out by concentrating only on the BFA replacement. For cost analysis, consider a small construction of ferrocement partition wall of 10 sq. m. The cost analysis is compared with the 0% replacement of BFA with mix proportion of Cement and Sand (1:2) and the replacements of 5%, 10% 15% of BFA with fine aggregate is mention in the table 1.

5. Conclusion

Based on the results of this experimental investigation, the following conclusion are drawn.

- It is found out that vertically aligned wire mesh cubes sample gives higher strength than that of horizontally aligned wire mesh.
- By taking compressive strength of vertically aligned wire mesh in consideration, the reduction of the compressive strength of ferrocement with partial replacement of 5%, 10%, 15% is decreasing gradually instead of sudden decrease.
- It is concluded that gradually substitution of BFA shows gradually decrease in split tensile strength and also in Flexural Tensile Strength but there is no sudden decrease in graph of both.

Table 1
Comparison of Cost Analysis (Amount in Rs.)

S.No.	Material	F100B0	F95B5	F90B10	F85B15
1	4 mm Skeletal Steel Mesh	2560	2560	2560	2560
2	Cement	1480	1480	1480	1480
3	Sand	1925	1828	1732	1636
4	Bottom Furnace Ash	0	9.5	19.25	28
5	Additive	500	500	500	500
	TOTAL	**6465**	**6377.5**	**6291.25**	**6204**

- It is also concluded that fine aggregate can be replaced up to 15% without any sudden change in the compressive strength, split tensile strength and flexural strength.
- It is concluded that as BFA is available cheaply in large quantity so by replacing it with the fine aggregate there is reduction in cost of construction. Thus it can be considered as economical.

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