An Experimental Investigation On Partial Replacement Of Fine Aggregate By Bottom Ash In Cement Concrete

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Abstract- *Concrete is an irreplaceable material which is being used in infrastructural development. The cost of building construction is increasing by use of conventional materials like cement, river sand and coarse aggregates. This leads to reduction of naturally available materials. In this study, an effort is made to produce cost effective concrete by replacement of fine aggregates with bottom ash in proportions of 0%, 10%, 20%, 30%, 40% and 50%. Considering the all test results it is concluded that the optimum utilization of Bottom as his10% in concrete as replacement to the fine aggregate to obtain a considerable design mix.*

Keywords- Concrete, cement, water, fine aggregates, Bottom ash

I. INTRODUCTION

Concrete is a material synonymous with strength and longevity. It has emerged as the dominant construction material for the infrastructure needs of the twenty-first century. In addition to being durable, concrete is easily prepared and fabricated from readily available constituents and is therefore widely used in all types of structural systems. In general the fine aggregates used in the production of concrete was natural riveres and. Now a days these natural sources like river sand are exhausting gradually around the world so, their protection of environment and saving of natural resources the construction industry is look for the alternative constituent material for making concrete so, there is need for replacement of sand in India.

The fine aggregate plays a very important role for imparting better properties of concrete in its fresh and hardened state. Aggregate in concrete is structural filler. Aggregate occupies most of the volume of the concrete. It is the stuff that the cement paste coats and binds together. The composition, shape, and size of the aggregate all have significant impact on the workability, durability, strength, weight, and shrink age of the concrete.

Bottom ash

The challenge for the civil engineering community in the near future is to realize projects in harmony with the concept of sustainable development and this involves the use of high performance materials and products manufactured at reasonable cost with the lowest possible environmental impact energy is the main backbone of modern civilization of the world over, and the electric power from thermal power stations is a major source of energy, in the form of electricity. In India, over 70% of electricity generated in India, is by combustion of fossil fuels, out of which nearly 61% is produced by coal-fired plants. This results in the production of roughly 100 ton of ash. Most of the Bottom the ash has to be disposed of either dry, or wet to an open area.

Fig No. 1: Bottom Ash

Chemical Composition and Physical characteristics of Bottom Ash

Table No: 1.1 Physical properties of Bottom Ash

Sl. No	Properties	Description
1	Specific gravity	2.12
2	Bulk density (gm /cc)	0.642-0.747
3	Fines modules	6.28
4	Maximum dry density (KN/M^3)	7.20
5	Water absorption (%)	14.10
6	Sizes produced (mm)	3.47-4.75
7	Aggregate impact value (%)	18.25
8	Aggregate crushing strength (%)	19.30
9	Aggregate abrasion value (%)	30.12

Table No: 1.2 Chemical characteristics of Bottom Ash

SL.NO	Constituents	Percentage (by weight)
1	SiO_2	68.0
2	Al_2O_3	25.0
3	$Fe_2O_3 + Fe_3O_4$	2.18
4	TiO_2	1.45
5	CaO	1.66
6	MgO	0.02
7	So_4	Nil
8	Loss on igniation	1.69

II. OBJECTIVES OF THE PROJECT

The following are the objectives derived from the literature survey.

1. To determine the optimum content of bottom ash as a substitute for fine aggregate (sand) in concrete.
2. To study the fresh properties of the concrete containing Bottom Ash.
3. To evaluate the mechanical properties (compressive strength, split tensile strength, and flexural strength)of concrete containing bottom ash as a replacement to fine aggregate in concrete.

III. TESTS ON MATERIALS

A. Tests on Cement

Table No: 4.2 Physical Properties of Cement (OPC 43)

Sl. No.	Material property	Test Results Obtained	Permissible limits as per IS8112-1989
1	Fineness %	4.0	<10%
2	Normal consistency (%)	33	<34%
3	Specific gravity	3.24	-
4	Initial setting time	32	Not less than 30 minutes
5	Final setting time	567	Not more than 600 minutes
6	Compressive Strength (N/mm^2) i)7days	24	43 N/mm^2
	ii)28days	42	

B. Tests on Fine aggregate

Table No: .3 Physical properties of fine aggregate (sand)

Sl. No	Material property	Test Results obtained	Requirement as per IS 8112-2013
1	Specific gravity	2.70	Not more than 2.75
2	Fineness modulus (%)	2.90	Not more than 3.20
3	Bulk density (kg/m^3)	1600	Not more than 1760
4	Water absorption (%)	1.70	Not more than 3.2%

C. Tests on Coarse Aggregate

Table No: 4.4 Physical properties of coarse aggregate

Sl. No	Material property	Test Results obtained	Requirement as per IS 8112-2013
1	Specific gravity	2.72	Not more than 2.85
2	Fineness modulus (%)	7.60	Not more than 8
3	Bulk density (kg/m^3)	1660	Not more than 1760
4	Water absorption (%)	0.65	Not more than 8%

D. Tests on Bottom Ash

Table No: 4.5 Physical properties of Bottom ash

Sl. No	Material property	Test Results obtained
1	Specificqgravity	1.98
2	Fineness modulus (%)	2.55
3	Bulk density (kg/m^3)	1448
4	Water absorption (%)	1.52

E. Water

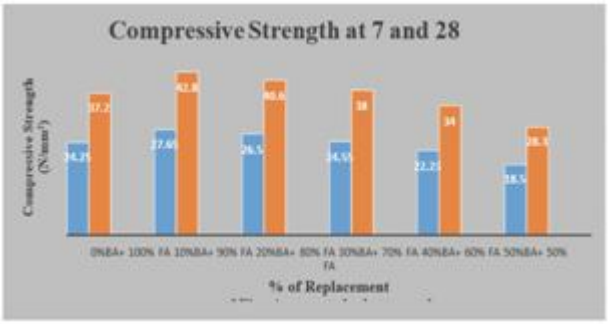
Water fit for the drinking is generally considered fit for making concrete. Water should be free from acids, oil, alkalies, vegetable or other organic Impurities. Soft water also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serve as a vehicle or lubricant in the mixture of fine aggregate and cement.

IV. RESULTS AND DISCUSSION

A. Compressive Strength Results

Table No 6.4: Overall results of Compressive Strength Test for 7 days and 28 days curing period.

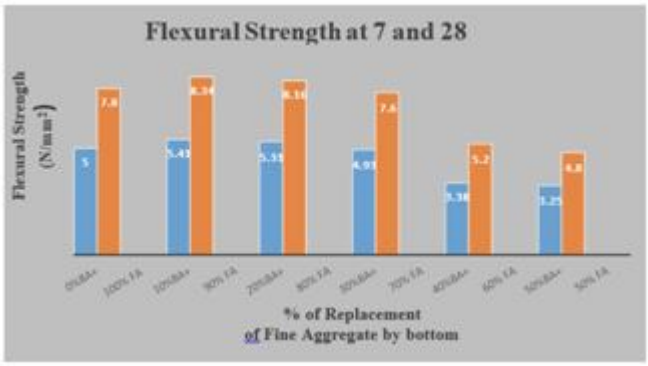
Replacement of Bottom ash	7 days		28 days	
	Compressive Strength (N/mm2)	Percentage increase or decrease in Compressive strength compared to Nominal Mix	Compressive Strength (N/mm2)	Percentage increase or decrease in Compressive strength compared to Nominal Mix
0% BA + 100% FA (Nominal Mix)	24.5	0	37.2	0
10% BA + 90% FA	27.65	14.02	42.8	15.05
20% BA + 80% FA	26.5	9.27	40.6	9.13
30% BA + 70% FA	24.55	1.23	38.0	2.15
40% BA + 60% FA	22.33	-8.32	34.0	-8.60
50% BA + 50% FA	18.5	-23.7	28.3	-23.92



B. FlexuraliStrength TestiResults

Table No. 6.10: Overall results of Flexural Strength test for 7 andi28 days curing period

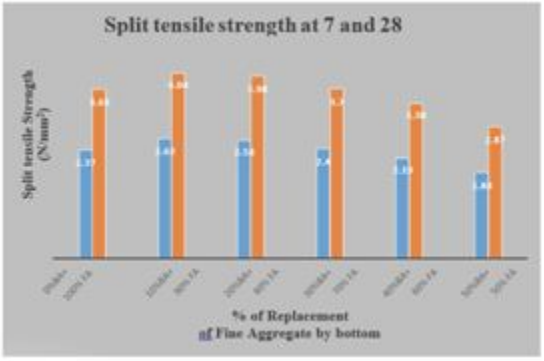
Replacement of Bottom ash	7 days		28 days	
	Split tensile Strength (N/mm^2)	Percentage increase or decrease in Split tensile strength compared to Nominal Mix	Split tensile Strength (N/mm^2)	Percentage increase or decrease in Split tensile strength compared to Nominal Mix
0% BA + 100% FA (Nominal Mix)	2.37	0	3.69	0
10% BA + 90%FA	2.62	10.5	4.04	9.4
20% BA + 80% FA	2.58	8.86	3.98	7.85
30% BA + 70% FA	2.40	1.26	3.70	0.25
40% BA + 60% FA	2.19	-7.59	3.38	-8.4
50% BA + 50% FA	1.88	-20.6	2.87	-22.2



C. Split Tensile Strength Test Results

Table No. 6.7: Overall results of Split Tensile Strength for 7 and 28 days curing period

Replacement of Bottom ash	7 days		28 days	
	Flexural Strength(N/mm^2)	Percentage increase or decrease in Flexural strength compared toNominal Mix	Flexural Strength(N/mm^2)	Percentage increase or decrease in Flexural strength compared to Nominal Mix
0% BA + 100% FA (Nominal Mix)	5.0	0	7.8	0
10% BA + 90% FA	5.41	8.2	8.34	6.92
20% BA + 80% FA	5.31	6.2	8.16	4.61
30% BA + 70% FA	4.93	-1.4	7.6	-2.56
40% BA + 60% FA	3.38	-32.4	5.2	-33.3
50% BA + 50% FA	3.25	-35	4.8	-38.5



V. CONCLUSIONS

- The specimens with bottom ash as replacement with fine aggregate was found to be better in compression which has compressive strength of 14.02% and 15.05% more than that of nominal mix concrete after 7 days andi28 days curing period respectively for 10% Bottom ash + 90% Fine aggregate.
- Better split tensile strength was achieved with the replacement to fine aggregate with Bottom ash in concrete. The split tensile strength was increased up to 10.5% and 9.4% when compared to that of the nominal mix concrete after 7 days andi28 days curing period respectively for 10% Bottom ash + 90% Fine aggregate.

- Good flexural strength was achieved with the replacement to fine aggregate with bottom ash in concrete. The flexural strength was increased up to 6.92% and 8.2% when compared to that of the nominal mix concrete after 7 days and 28idaysicuring period respectively for 10% Bottom ash + 90% Fine aggregate.

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