Mechanical Properties of Concrete using Bottom Ash as Partial Replacement for Fine Aggregate

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Abstract— This investigation in concrete is about the feasibility and usage of washed bottom ash (WBA). It can be used as a replacement for fine aggregate. In order to study the mechanical properties of concrete, M25 grade was fixed .Cubes, cylinders and prisms were casted and cured for 28 days. Cubes are tested for compressive strength, cylinders for splitting tensile strength and prisms for flexural strength. The usage of WBA is definitely better than control concrete and hence it is highly advisable. All tests and discussions are explained better.

Key words: Washed bottom ash, compression, split tensile, flexure

I. INTRODUCTION

Shelter is one of the basic amenities of human being. Structures form the important need for all areas of development. Concrete is the most important primary material used for construction due to its properties such as strength, durability, resistance to fire, and so on. Aggregates are the major constituent of concrete. As in most cases, River sand is used as fine aggregate, which will obviously increase its demand too. Lots of research works are going on regarding a replacement for sand to meet its demand. Washed Bottom Ash is an industrial waste which is obtained from thermal electric power plants as a result of burning coal. It is well known that 65% of India's electricity comes from power plants. As a result, tons of bottom ash is obtained as a waste material at the bottom of the boiler/ furnace. Disposal of them would be a problem as conventional method of landfilling is limited in a developing country like ours. This will reduce cost of disposal, reduce the area of landfills and hence reduces its effect on environmental pollution.

II. LITERATURE REVIEWS

Bottom ash (BA) was used as a part of fine aggregate in self- compacting concrete technique. Since it is little expensive compared to conventional concrete, reducing sand costs can be matched with them. Bottom ash was replaced 10%, 20% and 30% by weights of sand and various tests were conducted. By various tests results, it was found that replacement of 10% was found to be optimum. Also bottom ash has this water absorbing nature. Therefore by increased addition of the above will have demand for water. Hence, use of admixtures is highly advisable. Even investigations are being done to use bottom ash as a replacement material for cement because of its resemblance in properties.

III. EXPERIMENTAL PROGRAM

Ordinary Portland cement conforming to IS: 12269-1987 has been used as binding material. River sand conforming to IS: 383-1970 which has specific gravity of 2.54 and fineness modulus of 2.87 has been used. Crushed angular granite of size 12.5mm was used as coarse aggregate with specific gravity of 2.69 and fineness modulus of 6.20. Potable water as per IS: 456-2000 was used. M25 grade of concrete was used.

A. Cement:

Ordinary Portland cement of grade 53 conforming to IS: 1269-1987 was used as binder material. Their physical and chemical properties are mentioned in the table below:

Requirements of IS : 12269-1987			
Physical properties		**Chemical properties**	
1. Fineness	225 (min)	lime saturation factor	0.8-1.02
2. Setting Time		Alumina modulus	0.66 (min)
Initial (min)	30 minutes	Insoluble residue %	4 (max)
Final (max)	600minutes	Magnesia %	6 (max)
		Sulphuric anhydride %	3 (max)
		Loss on ignition %	4 (max)
		chloride %	0.1 (max)

B. Washed Bottom Ash (WBA):

Washed bottom ash, collected as a by- product from Ennore Thermal power plant, CHENNAI is used since it is one of the large producers of WBA. The properties of the above are mentioned in the table:

Physical properties		**Chemical properties %**	
color	Whitish grey to blackish grey	Silica (SiO_2)	41-80
Bulk density	1140 kg/m^3	Alumina (Al_2O_3)	23-34
Specific gravity	2.10 – 2.45	Ferric oxide (Fe_2O_3)	0.60 - 4.0
Fineness modulus	2.95 – 3.55	Calcium oxide (CaO)	2.80 – 18.0
		Magnesia (MgO)	1.50 - 5.0
		Loss of ignition	1.0 – 3.50

C. Fine Aggregate:

Locally available river sand was used as fine aggregate. Sieve analysis was done under the guidelines of IS: 383-1970 and sand was categorized under Zone – II. The table below shows the requirements as per the codes:

Sieve sizes	**Percentage passing**
10 mm	100
4.75 mm	90 – 100
2.36 mm	75 -100

1.18 mm	55- 90
600 microns	35 – 59
300 microns	10 – 30
150 microns	0 - 10

D. Coarse Aggregate:

Crushed angular granite of size 10 – 20mm as per IS: 383 - 1970 was used.

E. Casting details:

The required materials mentioned above were taken in proper proportions for making concrete. The materials were mixed in dry state and water along with admixture were added and mixed thoroughly. Cubes(150 x 150 mm), cylinders (150 x 300 mm)and prisms(100 x 100 x 500 mm) were casted and they were removed from the moulds after 24 hours of casting. Specimens were kept under water curing for 28 days and were taken for testing. Specimens were prepared as per IS: 516 -1999 for cubes and IS: 5816 - 1999 for cylinders.

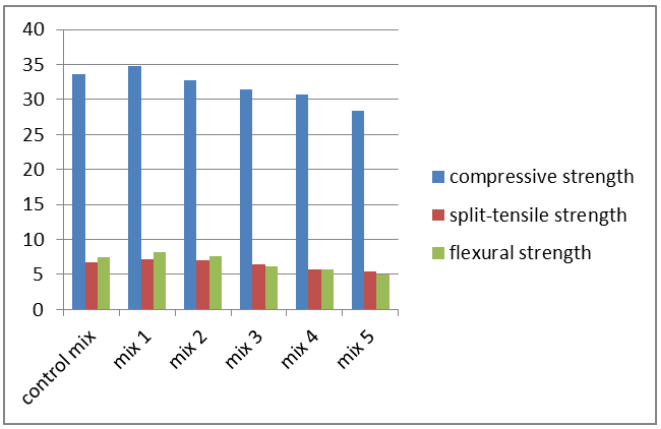
Mix ratio	**Cement (Kg/m^3)**	**Fine aggregate (Kg/m^3)**	**Washed Bottom ash(Kg/m^3)**	**Coarse aggregate(Kg/m^3)**	**Water + admixture(litre)**
Control mix	440	755.55	0	963.40	200
Mix 1	440	679.995	75.55	963.40	200
Mix 2	440	604.44	151.11	963.40	200
Mix 3	440	528.90	226.65	963.40	200
Mix 4	440	453.33	302.22	963.40	200
Mix 5	440	377.75	377,75	963.40	200

Mix 1: 10% WBA; Mix 2- 20% WBA; Mix 3- 30% WBA; Mix 4 – 40% WBA; Mix 5 – 50% WBA

F. Testing:

Specimens were tested for compressive strength, splitting tensile strength and flexural strength and values were recorded based on 3 trials. Compression testing Machine for testing cubes and cylinders were adopted. Two- point loading simply supported edge conditions were adopted for flexural strength. Testing were done for specimens cured for 28 days.

Mix ratio	Compressive strength (N/mm^2)	Split – tensile strength (N/mm^2)	Flexural strength(N/mm^2)
Control mix	33.56	6.73	7.45
Mix 1	34.78	7.17	8.12
Mix 2	32.68	6.98	7.67
Mix 3	31.45	6.45	6.12
Mix 4	30.67	5.78	5.76
Mix 5	28.34	5.39	5.04



IV. Results and Conclusion

From various tests carried out, it can be found that washed bottom ash added as a partial replacement for fine aggregate will have both positive and negative impact on concrete. More addition of washed bottom ash eventually reduces its strength while at early stages addition of 10 -15 % has showed good improvement in compressive strength.

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