

A Study on Performance of Bottom Ash in Concrete

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ABSTRACT: Concrete is the most important engineering material and the addition of some other materials may change the properties of concrete. Studies have been carried out to investigate the possibility of utilizing a broad range of materials as partial replacement materials for cement and aggregate in the production of concrete. The present experimental study was conceived following the general purpose of testing new sustainable building processes and modern production systems, aims not only at saving natural raw materials and reducing energy consumption, but also to recycle industrial by-products. The objectives of this study was to investigate the effect of use of coal bottom ash as partial replacement of fine aggregates in two percentages (5 and 10%), on concrete properties such as compressive strength, splitting tensile strength test, flexural strength. The test results of this research work indicates that at fixed water cement ratio, workability decreased with the use of coal bottom ash as a replacement of fine aggregate in concrete. Compressive strength of bottom ash concrete at the curing age of 28 days was increased compared to control concrete. Splitting tensile strength of concrete improved at percentages of replacement of bottom ash.

KEYWORDS: Cement, Fine aggregate, Coarse Aggregate, Bottom Ash.

I.INTRODUCTION

Concrete is a composite material containing hydraulic cement, water, coarse aggregate and fine aggregate. The resulting material is a stone like structure which is formed by the chemical reaction of the cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks. The formation of cracks in the concrete may also occur due to the drying shrinkage. These cracks are basically micro cracks. These cracks increase in size and magnitude as the time elapses and the finally makes the concrete to fail. Concrete is the most vital material for the construction of high rise buildings and various infrastructures. Infrastructure development in such areas particularly in developing countries like India is more. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water and river sand is the main raw material used as fine aggregate in the production of concrete. The natural sources of river sand are getting depleted gradually. The demand for the protection of the natural environment and the ban on mining in some areas is further aggravating the problem of availability of river sand. At present, the construction industry is plagued with the scarcity of this essential constituent material of concrete. Therefore, in the present circumstances of scant sources of river sand and boom in infrastructure development, it becomes essential and more significant to find out its substitute material in concrete. Coal bottom ash is a coarse granular and incombustible byproduct from coal burning furnaces. It is composed of mainly silica, alumina and iron with small amounts of calcium, magnesium sulfate, etc. The appearance and particle size distribution of coal bottom ash is similar to that of river sand. These properties of coal bottom ash make it attractive to be used as fine aggregate in the production of concrete.

1.1 HISTORY OF BOTTOM ASH:

Coal bottom ash and boiler slag are the coarse, granular, incombustible by-products that are collected from the bottom of furnaces that burn coal for the generation of steam, the production of electric power, or both. The majority of these coal by-products are produced at coal-fired electric utility generating stations, although considerable bottom ash and/or boiler slag are also produced from many smaller industrial or institutional coal-fired boilers and from coal-burning

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independent power production facilities. The type of by-product (i.e., bottom ash or boiler slag) produced depends on the type of furnace used to burn the coal.

II. MATERIALS AND TESTS

2.1 CEMENT:

Cement acts as a binding agent for materials. Cement as applied in Civil Engineering Industry is produced by calcining at high temperature. It is a mixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. Cement is the most expensive materials in concrete and it is available in different forms. When cement is mixed with water, a chemical reaction takes place as a result of which the cement paste sets and hardens to a stone mass. Depending upon the chemical compositions, setting and hardening properties.

2.1.1 TESTS ON CEMENT

2.1.2 STANDARD CONSISTENCY TEST:

Standard consistency of cement is defined as that water content at which the needle of the apparatus fails to penetrate the specimen by 5mm from bottom of the mould.

WATER CONTENT (%)	DEPTH OF PENETRATION FROM BOTTOM (mm)
28	36
30	29
32	5

2.2 FINE AGGREGATES:

The material we have used as fine aggregate in this project is river sand is an ideal substitute to river sand. It is manufactured just the way nature has done for millions of years. Sand is created by a rock-hit – rockcrushing technique using state of the art plant and machinery with world class technology. Created from specific natural rock, it is crushed by a three stage configuration consisting of a Jaw crusher followed by a Cone crusher and finally a Vertical Shaft Impactor (VSI) to obtain sand that is consistent in its cubical particle shapes and gradation. River sand is the environmental friendly solution that serves as a perfect substitute for the fast depleting and excessively. Mined river sand. River sand 0–4.75 mm is suitable for all concrete preparations and is used across all segments such as independent houses, builders RMC Plants, Concrete Batching Plants and Infrastructure Concrete works.

2.2.1 TESTS ON FINE AGGREGATE

Properties of fine aggregate:

Sl. No	Property	Test results
1	Specific Gravity	2.39
2	Size	4.75mm

2.3 COARSE AGGREGATES:

The material whose particles are of size as are retained on I.S Sieve No.480 (4.75mm) is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of work. The coarse aggregate used in this experimental investigation are of 20mm, 10mm and 6mm sizes, crushed angular in shape. The aggregates are free from dust before used in the concrete.

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2.3.1 TESTS ON COARSE AGGREGATE

Properties of coarse aggregate:

Sl. No	Property	Test results
1	Specific Gravity	2.39
2	Size	>4.75mm

2.4 BOTTOM ASH:

In this project we use bottom ash as a replacement of fine aggregates. Bottom ash is part of the non-combustible residue of combustion in a furnace or incinerator. In an industrial context, it usually refers to coal combustion and comprises traces of combustibles embedded in forming clinkers and sticking to hot side walls of a coal-burning furnace during its operation. The portion of the ash that escapes up the chimney or stack is, however, referred to as fly ash. The clinkers fall by themselves into the bottom hopper of a coal-burning furnace and are cooled. The above portion of the ash is referred to as bottom ash too.

III. TESTS ON FRESH CONCRETE

3.1 Slump test:

Slump test is the most commonly used method for measuring consistency of concrete which can be employed either in laboratory or at site of work. It is note suitable method for very wet or very dry concrete. It is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch.

PERCENTAGE OF BOTTOM ASH ADDED	SLUMP VALUE (in mm)
0%	120
5%	85
10%	67

3.2 Compaction factor test:

Amount of work done by allowing the concrete to fall through a standard height. The degree of compaction called the compaction factor is measured by the ratio of density of actually achieved in the test to the density of the same concrete fully compacted.

Compaction factor = weight of partially compacted concrete / weight of fully compacted concrete.

PERCENTAGE OF BOTTOM ASH ADDED	COMPACTION FACTOR
0%	0.883
5%	0.80
10%	0.76

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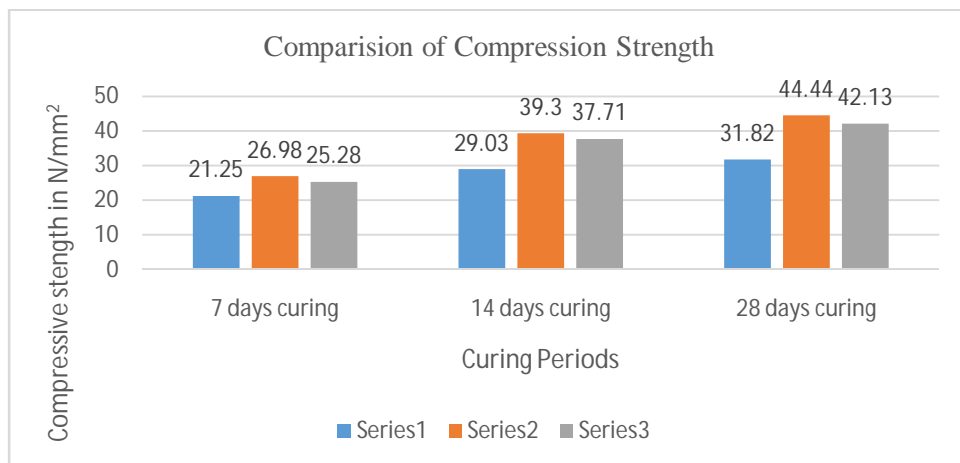
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IV. TEST ON HARDENED CONCRETE

4.1 COMPRESSION TEST VALUES OF M30 GRADE OF BOTTOM ASH CONCRETE

Sl.no	Percentage of bottom ash replaced by fine aggregate	Compression strength(N/mm ²)		
		7 days curing	14 days curing	28 days curing
1	0%	21.25	29.03	31.82
2	5%	26.98	39.30	44.44
3	10%	25.28	37.71	42.13



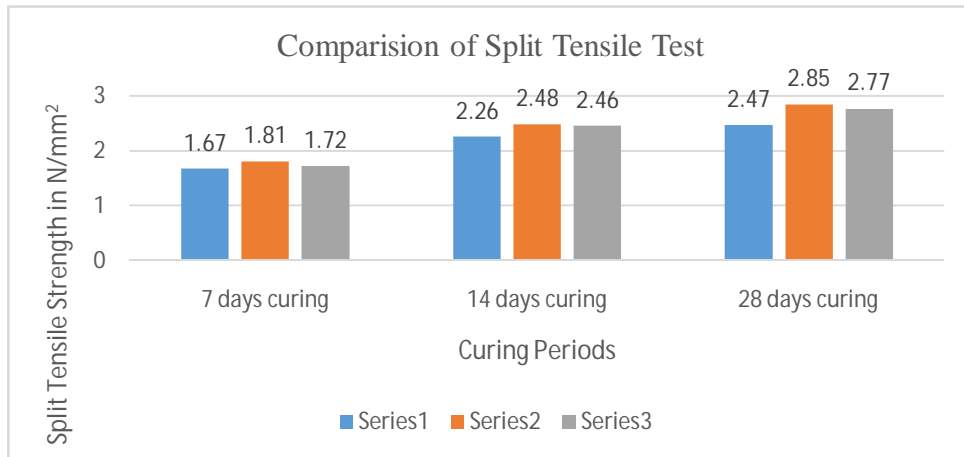
4.2 SPLIT TENSILE TEST VALUES OF M30 GRADE OF BOTTOM ASH CONCRETE

Sl.no	Percentage of bottom ash replaced	Spilt tensile strength(N/mm ²)		
		7 days curing	14 days curing	28 days curing
1	0%	1.67	2.26	2.47
2	5%	1.81	2.48	2.85
3	10%	1.72	2.46	2.77

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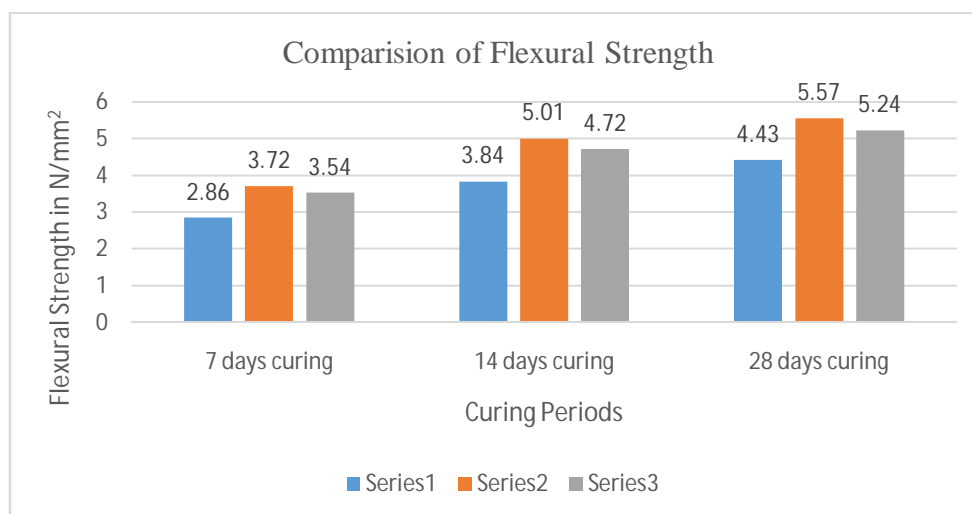
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4.3 FLEXURAL TEST VALUES OF M30 GRADE OF BOTTOM ASH CONCRETE

Sl.no	Percentage of bottom ash replaced	Flexural strength		
		7 days curing	14 days curing	28 days curing
1	0%	2.86	3.84	4.43
2	5%	3.72	5.01	5.57
3	10%	3.54	4.72	5.24



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V.CONCLUSION

The following conclusions could be arrived at from the study:

- The workability of concrete decreased with the increase in bottom ash content due to the increase in water demand.
- The density of concrete decreased with the increase in bottom ash content due to the low specific gravity of bottom ash as compared to fine aggregates.
- Compressive strength, splitting tensile strength and Flexural strength of fine aggregates replaced bottom ash concrete specimens were higher than control concrete specimen.
- Compressive strength, splitting tensile strength and Flexural strength of fine aggregate replaced bottom ash concrete continue to increase with age for all the bottom ash contents.
- Compressive strength of concrete containing 5% of bottom ash attaining more strength than the control concrete specimen.

Bottom ash used as fine aggregates replacement enables the large utilization of waste product.

REFERENCES

1. Malkit Singh et al. "Strength properties and micro-structural properties of concrete containing coal bottom ash as partial replacement of fine aggregate", Construction and Building Materials 50; 246–256.
2. Bumjoo Kim et al. "Geotechnical Properties of Fly and Bottom Ash Mixtures for Use in Highway Embankments" Journal of Geotechnical and Geoenvironmental Engineering © asce/july 2005.
3. P. Aggarwal, Y. Aggarwal, S. M. "Effect of bottom ash as replacement of fine aggregates in concrete" .Asian Journal of Civil Engineering (building and housing) vol. 8, no. 1 (2007).
4. Abdulhameed et al. "Properties of concrete using tanjung bin power plant coal bottom ash and fly ash", International Journal of Sustainable Construction Engineering & Technology (ISSN: 2180-3242) Vol 3, Issue 2, 2012.
5. M. P. Kadam et al. "Effect of coal bottom ash as sand replacement on the properties of concrete with different w/c ratio" International Journal of Advanced Technology in Civil Engineering, ISSN: 2231–5721, Volume-2, Issue-1, 2013.
6. P. Tang et al. "The application of MSWI bottom ash fines in high performance concrete", 1st International Conference on the Chemistry of Construction Materials (2012).
7. Yogesh Aggarwal, Rafat Siddique, "Microstructure and properties of concrete using bottom ash and waste foundry sand as partial replacement of fine aggregates", Construction and Building Materials 54 (2014) 210–223.
8. C. Mathiraja, "A Study on Concrete Using Bottom Ash, Manufacturing Sand and Hybrid Steel and Coir Fibres", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) Volume 10, Issue 1 (Nov. - Dec. 2013), PP 55-57.