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Study of Concrete as Partially Replacement of Cement with Coal Bottom Ash (CBA)

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ABSTRACT

The coal-fired thermal power plants are the main source of coal bottom ash. Coal Bottom Ash is used as a replacement of both sand and cement depending on the size of bottom ash. The present study will provide a better understanding of mechanical and durability properties of concrete in which cement is partially replaced with bottom ash. The present thesis would contribute to the efforts being made in the field of concrete technology towards the development of concretes possessing good strength and durability properties along with economic and ecological advantage. Based on the study, valuable advice will be given to concrete structures. In the present experimental study, the various strength properties like the compressive strength of cement mortar and concrete and also durability properties like Acid attack and water absorption test on both ordinary concrete and coal bottom ash Concrete, best coal bottom ash concrete mix is carried out and compared with an ordinary concrete mix for economic and ecological study. In this study different percentage of ordinary and grinded coal bottom ash is used. It was found that with an increase in the amount of coal bottom ash, standard consistency, initial and final setting time increases at the same time workability of concrete decreases. It was also found that initial day's strength is less for bottom ash concrete compare to control mix, but as the age increases, they show good improvement in strength due to pozzalanic reaction. Optimum dosage is observed to be 5% GBA which shows more strength compared to control mix at 56 days. It was found that with an increase of the amount of bottom ash resistance to acid attack increases. GBA shows more resistance to acid attack compared to OBA. With the increase in the amount of bottom ash water absorption capacity of concrete increases, also as the age increases for all the mix water absorption capacity decreases.

It was also found that at optimum dosage i.e at 5% replacement of cement with GBA it is also economical and also the amount of CO2 Emitted is also decreased that means it is also environmentally friendly compared to control mix.

Keywords: *Bottom Coal Ash, Workability, Compressive Strength, Water Absorption, Economic Study.*

1. INTRODUCTION

Management of coal combustion products has created a challenge for utilities and regulators. In many countries coal combustion products are classified as hazardous substances and usage of them is limited. From the other hand, the coal combustion products have chemical and physical properties that make them suitable for engineering and construction works. Coal combustion products are mainly utilized in the building materials industry, in civil engineering, in road construction, for construction works in underground coal mining as well as for re-cultivation and restoration purposes in open caste mining. They are used as a replacement for natural resources. Their utilization helps to save natural resources and to reduce the energy demand and greenhouse gas emissions to the atmosphere caused by mining and generation of products which are replaced by coal combustion products. Coal combustion products include fly ash, bottom ash, boiler slag and flue gas desulfurization material.

2. MATERIALS USED

2.1 Cement

Ordinary Portland cement (OPC) from a single lot was used throughout the course of the investigation. The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 1489-1991(Part-1). All the tests were carried out as per recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with

the moisture. The fineness of cement is obtained as 3%. Standard consistency is obtained to be 31%. Initial setting time is 65 minutes and final setting time is 315 minutes

2.2 Fine Aggregate

River sand was used as fine aggregate. The specific gravity and fineness modulus was 2.55 and 2.94 respectively and it belongs to zone II of grading.

2.3 Course aggregate

Crushed angular granite from a local source was used as coarse aggregate. The specific gravity was 2.67, flakiness index of 4.58 percent and elongation index of 3.96.

2.4 Bottom ash

Bottom ash from nearby cement factories is used in this study. In this study, we used two types of bottom ash.

3. MIX PROPORTIONS

Table 3.1 Mix details

MIX	OPC (%)	OBA (%)	GBA (%)
M1	100	0	0
M2	95	5	0
M3	90	10	0
M4	85	15	0
M5	95	0	5
M6	90	0	10
M7	85	0	15

4. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

4.1 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure given in chapter 3. w/c ratio was kept constant 0.45 for all the concrete mixes. The workability results of different concrete mixes were shown in Table 4.1

Table 4.1 Workability values for different concrete mixes

Mix No	Description	Slump (mm)
1	100%OPC+0%OBA+0%GBA	107
2	95%OPC+5%OBA+0%GBA	101
3	90%OPC+10%OBA+0%GBA	96
4	85%OPC+15%OBA+0%GBA	91
5	95%OPC+0%OBA+5%GBA	99
6	90%OPC+0%OBA+10%GBA	93
7	85%OPC+0%OBA+15%GBA	88

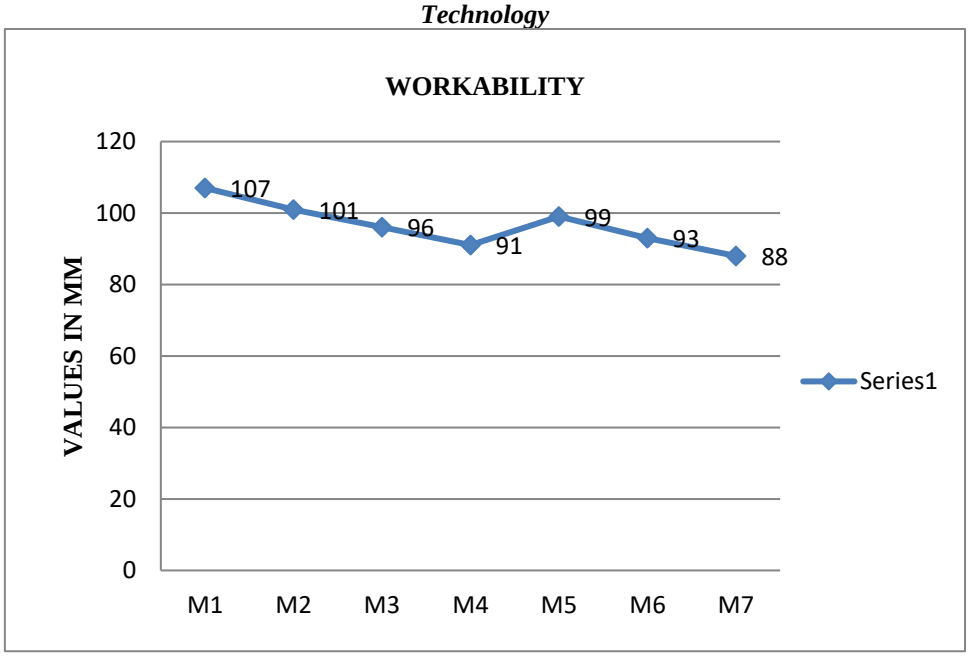

Fig. 4.1 workability of concrete different mixes

Table 4.1 shows that as the replacement of cement with bottom ash increases, the workability of concrete mix decreases as compared to control mix. And it also shows that the addition of GBA decreases the workability more compared to OBA. Workability of concrete is reduced because bottom ash absorbs the water.

4.2 Compressive Strength

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, 28, 56 and 90 days. The compressive strength test results of all the mixes at different curing ages are shown in Table 4.2. Variation of compressive strength of all the mixes cured at 7,14,28,56 and 90 days are also shown in Fig. 4.3. Fig. 5.4 shows the variation of the compressive strength of concrete mixes w.r.t control mix after 7,14,28,56 and 90 days respectively.

Table 4.2 Compressive strength (MPa) results of concrete at different curing ages

Mix name	Mix description	7 Days	28 days	56 days	90 days
M1	100%OPC+0%OBA+0%GBA	23	35.025	38.45	38.9
M2	95%OPC+5%OBA+0%GBA	20.61	27.675	35.9	37.55
M3	90%OPC+10%OBA+0%GBA	20.095	23.8	30	33.25
M4	85%OPC+15%OBA+0%GBA	15.325	19.545	27.85	29.3
M5	95%OPC+0%OBA+5%GBA	20.63	31.34	43	43.6
M6	90%OPC+0%OBA+10%GBA	20.23	25.4	35.8	38.1
M7	85%OPC+0%OBA+15%GBA	16.821	25.7	33.5	36.7

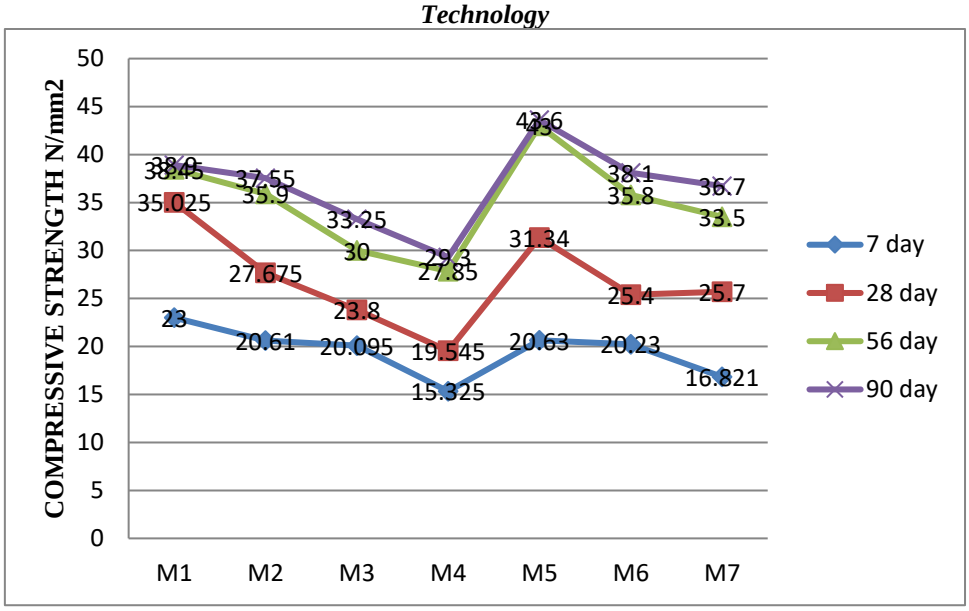

Fig. 4.2 compressive strength of concrete different curing age

4.3 Water Absorption Test

The results of the water absorption tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The cube that is cured for different days are taken and weight is measured and that cube is placed in an oven and after every 24hrs weight is measured this process is carried out until we get constant weight. The test results are shown in Table 4.3

Table 4.3 Water absorption of concrete

Mix Type	% of bottom ash	Water Absorption of concrete (%)		
		28 days immersion period	56 days immersion period	90 days immersion period
M1	0.0%	6.13	5.55	4.6
M2	5% OBA	6.53	5.63	4.97
M3	10% OBA	6.31	6.27	4.55
M4	15% OBA	6.99	6.99	4.24
M5	5% GBA	6.48	5.88	4.97
M6	10% GBA	6.26	5.84	4.76
M7	15% GBA	6.47	6.19	4.73

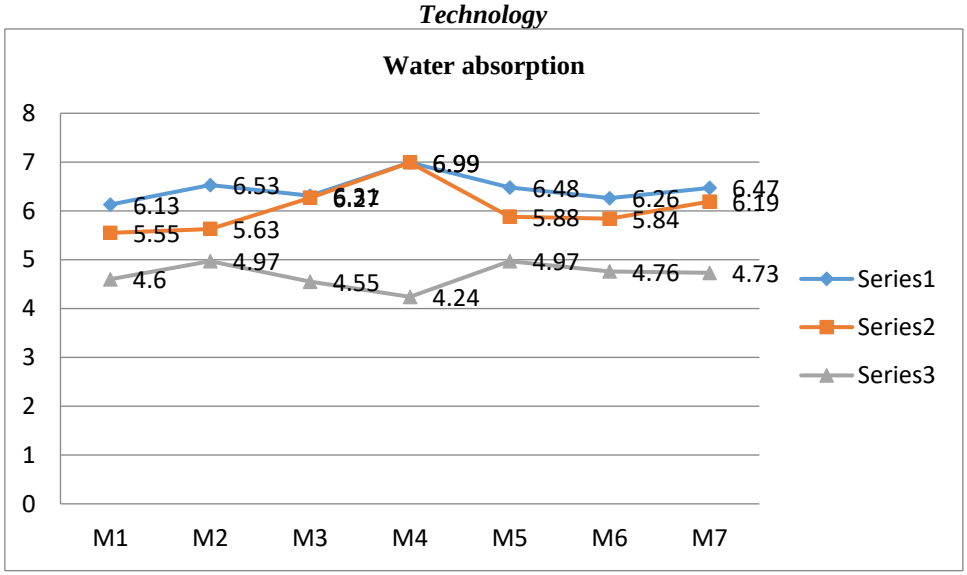

Fig.4.3 water absorption value in 28, 56, 90 days

From Table 4.10 it was observed that as the bottom ash content increases the water absorption capacity of concrete is increased initially. At 90Days it was observed that bottom ash concrete is absorbing less water than 28Days.

4.4 Economic study

From the above compressive strength test results shown in Table 5.9, comparing the results of bottom ash concrete with control mix it was observed that 5% replacement of cement with GBA is showing good results so it has been taken as sample to check whether it is economical or not. In this study we compare cost of making 5% GBA concrete with control mix. In this mix's amount of coarse aggregate, fine aggregate and water remains same so there is no effect of them on change in cost of concrete. Cost is affected only by change in cement content. Assuming the cost of transportation is same for both cement and bottom ash transportation the below calculations are done.

5. CONCLUSIONS

5.1 Introduction

In the current investigation, bottom ash concrete was used to examine the strength, water absorption, economic study. The experimental data obtained has been analysed and discussed in Chapter-4, to fulfil to the best of ability, the objectives set forth for the present investigation. This chapter gives the broad conclusions that may be drawn from the investigation.

5.2 Conclusions

a. The results show that as the cement replacement with bottom ash increases standard consistency increases. Addition of GBA increases the standard consistency more compared to OBA. As the cement replacement with bottom ash increases initial and final setting is increased. It is observed that GBA and OBA show nearly same effect.

b. It was found that as the bottom ash content increases in the concrete workability decreases. For the same amount of bottom ash in GBA workability decreases more compared to OBA.

c. It was observed that addition of bottom ash reduces strength initially but later age strength was found to be more compared to control mix. Addition of GBA gives more strength compared to OBA concrete at all the ages. Addition of 5% GBA shows more strength compared to control mix at 56 days and 90 days.

d. The durability of concrete from the aspect of resistance to acid attack on concrete increases by replacing the cement with bottom ash. It was observed that replacement of cement with GBA gives more resistance to acid attack as compared to OBA.

e. Concrete containing bottom ash was found to absorb more water compare to ordinary concrete. As the curing age progress water absorption capacity of concrete before and after replacement with bottom ash decreases.

f. It was observed that at optimum dosage i.e at 5% replacement of cement with GBA concrete is economical and CO2 emission also decreased that means it is environment friendly compare to control mix

6. REFERENCES

[1] Aggarwal Yogesh and Siddique Rafat., 2014.Microstructure and properties of concrete using bottom ash and waste foundry sand as partial replacement of fine aggregates, Construction and Building Materials, vol 54, pp 210–223.
[2] Almusallam A.A, Maslehuddin M, Abdul-Waris M, and Khan M.M., 1998. Effect of mix proportions on plastic shrinkage cracking of concrete in hot environments, Construction and Building Materials, vol 12, pp 353-358.

[3] Andrade L.B, Rocha J.C, and Cheriaf M., 2007. Aspects of moisture kinetics of coal bottom ash in concrete, Cement and Concrete Research, vol 37, pp 231–241.
[4] Andrade L.B, Rocha J.C, and Cheriaf M., 2009. Influence of coal bottom ash as fine aggregate on fresh properties of concrete, Construction and Building Materials, Vol.23, pp 609-614.
[5] Bai J and Wild S., 2002. Investigation of the temperature change and heat evolution of mortar incorporating PFA and metakaolin, Cement & Concrete Composites, vol 24, pp 201–209.
[6] Bai Y, Darcy F, and Basheer P.A.M., 2005. Strength and drying shrinkage properties of concrete containing furnace bottom ash as fine aggregate, Construction and Building Materials, vol 19, pp 691-697.
[7] Bajarea Diana , Bumanisb Girts and Upeniece Liga., 2013. Coal Combustion Bottom Ash as Microfiller with Pozzolanic Properties for Traditional Concrete, Procedia Engineering, vol 57, pp 149 – 158.
[8] Barbare Nikhil, Shukla Arun and Bose Arijit., 2003. Uptake and loss of water in a cenosphere–concrete composite material, Cement and Concrete Research, vol 33, pp 1681–1686.
[9] Bilir Turhan., 2012. Effects of non-ground slag and bottom ash as fine aggregate on concrete permeability properties, Construction and Building Materials, vol 26, pp 730–734.
[10] Cheriaf M, Cavalcante Rocha M, and Pera J., 1999. Pozzolanic properties of pulverized coal combustion bottom ash, Cement and Concrete Research, vol 29, pp 1387–1391.
[11] Holt E and Leivo M., 2004. Cracking risks associated with early age shrinkage, Cement & Concrete Composites, vol 26, pp 521–530.
[12] Isaia G.C, Gastaldini A.L.G and Moraes R., 2003 Physical and pozzolanic action of mineral additions on the mechanical strength of high-performance concrete, Cement & Concrete Composites, vol 25, pp 69–76.
[13] Kasemchaisiri R, and Tangtermsirikul S., 2007. A method to determine water retainability of porous fine aggregate for design and quality control of fresh concrete, Construction and Building Materials, vol 21, pp 1322–1334.
[14] Kim H.K, Jang J.G, Choi Y.C and Lee H.K., 2014. Improved chloride resistance of high-strength concrete amended with coal bottom ash for internal curing, Construction and Building Materials, vol 71, pp 334–343.
[15] Kim H.K, Lee H.K., 2011. Use of power plant bottom ash as fine and coarse aggregates in high-strength concrete, Construction and Building Materials, vol 25, pp 1115-1122.

