Investigation on Properties of Concrete by Replacing of Fine Aggregate with Bottom Fly Ash

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***Abstract*- This paper presents the results of an experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate (sand) was partially replaced with bottom fly ash. Concrete- a material synonymous with strength and longevity has emerged as the dominant construction material for the infrastructure needs for the Twenty first century. In order to make use of coal ash popular in masonry mortar and structural concrete, research is going on worldwide. In India, research is also going on to utilize huge stocks coal ash in the different zones of the country. The prime objective of the study was to evaluate the structural properties and potential of concrete containing bottom ash vis-à-vis that of concrete containing no bottom ash of corresponding mix proportions and strength. The cubes were tested for the compressive strength and beams specimens were tested for flexural strength. Splitting tensile strength tests were conducted on cylinder specimens. The total numbers of 60 cubes, 40 beams specimens and 40 numbers of cylinders were tested for compressive strength, flexural strength and splitting tensile strength respectively at different ages to study the following aspect. The effect on unit weight of concrete after incorporating varying proportions of bottom ash. The effect of bottom ash on workability (C.F) of fresh concrete. The effect on compressive, flexural and splitting tensile strength using bottom ash in varying percentages as a partial replacement of fine aggregates.**

I. INTRODUCTION

A. GENERAL

Concrete is a material synonymous with strength and longevity has emerged as the dominant construction material for the infrastructure needs for 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. The challenge for the civil engineering community in the near future will be 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.

II. GENERATION OF FLY ASH AND BOTTOM ASH

Fly ash is a finely divided residue resulting from the combustion of pulverized coal in boilers. It is transported from the boilers by flue gases and collected by means of electric precipitators and mechanical collectors. It is a pozzolanic material and consists of small spheres of glassy surface of complex chemical composition together with small quantities of quartz, mullica, haematite, magnetite and unburnt carbon. It is finer than Portland cement and varies in color from light grey to dark, depending on carbon content. The greater the carbon content darker is the colour.

A. Disposal of Coal Ash

All this coal ash ejected out of the thermal power stations has to be disposed off to an open area available near the plant. In the wet disposal, which is at present being followed by most of the Thermal Power Stations, both the fly ash and bottom ash are grounded, mixed with water and are pumped into artificial lagoon or dumping yard. This is known as lagoon ash. Sometimes, coal ash mixed with water is conveyed to ponds or to nearby water courses. Disposal of coal ash in such a way no longer remains the answer. Such a huge collection of coal ash tomorrow will be more complex than the ones at present.

III. STRENGTH CHARACTERISTICS OF CONCRETE

It is the most important property of hardened concrete, which represents the ability of concrete to resist forces, in other words, strength of concrete is its resistance to rupture. It is important than other properties of concrete (secondary properties) e.g. durability, density, permeability, dimensional stability, appearance, behaviour of concrete under stresses and creep of concrete etc. Strength or some measure of it, is relatively easy to evaluate, as it is roughly indicative of the quality of concrete in other directions- strength increases, density, permeability, durability etc. generally improves. The present study compression, flexural strength and splitting tensile strength are considered for investigation. splitting .

A. Compressive Strength

It is the strength of concrete against crushing due to the direct compressive load. It is considered as most important property and often taken as the index of overall quality of concrete. Concrete has high compressive stress and it is normally required to resist compressive stresses. Compressive strength at 28 days after casting is taken as the criteria for specifying the quality of concrete. IS: 456-2000 stipulates the gain of strength beyond 28 days.

B. Tensile Strength

Concrete as we know is relatively strong in compression and weak in tension. In reinforced concrete members, little dependence is placed on the tensile strength of concrete since steel reinforcing bars are provide to resist all tensile forces.

IV. NEED FOR THE PRESENT STUDY

The continuous reduction of natural resources and the environmental hazards posed by the disposal of coal ash has reached an alarming proportion. The use of coal ash in normal strength concrete is a new dimension in concrete mix design and if applied on large scale would revolutionize the construction industry, by economizing the construction cost and decreasing the ash content.

V. OBJECTIVE OF THE STUDY

- To design the reference concrete mix of grade M25 using OPC 43 grade cement.
- To investigate the effect of replacing fine aggregate with bottom ash in varying percentages (20-50%) on compressive strength, flexural tensile strength and splitting tensile strength at the moist curing of 7,28, 56 and 90 days.
- To investigate the effect of bottom ash on workability of freshly mixed concrete.
- To investigate the effect the effect the bottom ash on unit weight of concrete.

VI. EXPERIMENTAL PROGRAM

A. GENERAL

The prime objective of the study was to evaluate the structural properties and potential of concrete containing bottom ash vis-à-vis that of concrete containing no bottom ash of corresponding mix proportions and strength.

Since it is an established fact that hydration of pozzolanic material is a delayed process compared to hydration of plain cement concrete, the main emphasis was to compare the relative structural properties of two types of the concrete at later ages. Moreover bottom ash used in this study was obtained from 'Tau Devi Lal Thermal Power Plant, Panipat'.

To investigate the strength considerations the following tests were conducted:

- Compressive strength test
- Flexural strength test
- Split tensile strength test

Along with this test for workability was also conducted. The compression test was carried out on 150mm X 150mm X 150mm cubes, flexural strength tests was carried on 100mm X 100mm X 500mm prisms and split tensile strength test was carried out on 150mm X 300 mm cylinders.

TABLE III
SPECIFICATIONS OF SUPERPLASTICIZER

Basis	**Aqueous solution of modified polycarboxylate**
Appearance	Brown liquid
Density	Approx. 1.10
Ph	Approx. 5.0

VII. MATERIAL TESTING

The following materials were used in the experimental work.

- Cement
- Fine aggregates
- Coarse aggregates
- Bottom ash
- Super plastisizer

A. Cement

In the present investigation ordinary Portland cement 43 grade with brand name 'Jaypee Cement' conforming to IS:8112-1989 was used. The cement was tested in accordance with the test methods specified in IS:4031-1988 and results obtained.

B. Fine Aggregates

TABLE I

Specific gravity	2.65

The sand used conforms to zone III. Sieve analysis for the sand was performed and result were obtained.

C. Coarse Aggregates

TABLE II

Maximum size of aggregates	20mm
Specific Gravity	2.6
Fineness modulus	6.9
Bottom Ash	
Specific Gravity	1.68

D. Water

Portable water available in the laboratory extracted from the ground was used for casting and curing.

E. Super Plasticizer

Super plastisizer of the make 'SIKA VISCOCRETE-10 (H1)' was used for the concrete.

VIII. CONCRETE MIX DESIGN

In the present investigation the existing method as per IS: 10262 (1982)[8] has been used for selecting the referenced mix (M25), however new information given in IS:456

(2000) have been incorporated. In order to get the final mix proportions for the reference mix design three trails had been prepared earlier and tested at 7 days and 28 days.

IX. CASTING OF SPECIMENS

The moulds were filled in three equal layers of concrete. Bottom layer was compacted with a 16mm dia. temping rod with bullet nose to provide a proper formation of corners and base. Then second and third layers were placed and temped. After this the moulds were placed on the table vibrator for the compaction. Proper compaction is attained when the slurry of cement appears on the surface. The vibrator was stopped and some amount of concrete was poured to fill it. The mould was again vibrated and top surface was finished with a trowel. Casting for specimens was done for each test of plain cement concrete and bottom ash concrete. The specimens were kept in a clean water tank just after removal from the mould and kept continuously moist till the time of testing.

X. PROPERTIES OF CONCRETE TO BE TESTED

- Properties Of Fresh Concrete
- Properties Of Hardend Concrete

A. Properties of Fresh Concrete

The diver's requirements mixibility, stability, transportability,

placability, modility, compactability and finishability of fresh concrete collectively refer to as workability.

1) *Measurement Of Workability:*A number of different tests are available for the measuring the workability of fresh concrete, but none of them is wholly satisfactory. Each test measures only particular aspect of it.

The different tests used for measuring workability are:

- The slump test
- The compaction factor test
- The Vee Bee consistency test
- The flow

B. Properties Of Hardend Concrete

1) *Compressive Strength Test:* Compressive strength tests were carried on 150mm*150mm*150mmm cubes with compression testing machine of 1000KN capacity. The compressive strength was found after 7, 28, 56 and 90 days in order to compare the strength of different concrete mixes.

2) *Flexural Strength Test:*Although the concrete is not normally designed to resist tension, the knowledge of tensile strength is of value in estimating the load under which crack will develop.. In the present study, the flexural test was conducted on 100mm*100mm*500mm specimens under two point loading pattern. The supports were placed at 400mm apart and loading was placed at 133mm apart.

3) *Splitting Tensile Strength:* Part from flexural test, the other method used to determine the tensile strength of concrete is splitting tensile strength test. In this test, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses induced in the specimen.The splitting tensile strength was found at 7, 28, 56, and 90 days after casting of specimens.

XI. RESULTS AND DISCUSSION

A. GENERAL

The results of the tests conducted on plain and bottom ash concrete. The cubes were tested for the compressive strength and beams specimens were tested for flexural strength. Splitting tensile strength tests were conducted on cylinder specimens. The total numbers of 60 cubes, 40 beams specimens and 40 numbers of cylinders were tested for compressive strength, flexural strength and splitting tensile strength respectively at different ages to study the following aspects:

1) The effect on unit weight of concrete after incorporating varying proportions of bottom ash.
2) The effect of bottom ash on workability (C.F) of fresh concrete.
3) The effect on compressive, flexural and splitting tensile strength using bottom ash in varying percentages as a partial replacement of fine aggregates.

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