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EXPERIMENTAL INVESTIGATION ON CONCRETE USING BOTTOM ASH AS A PARTIAL REPLACEMENT OF FINE AGGREGATE IN ADDITION WITH PPF

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ABSTRACT

Bottom ash is a hazardous by-product from coal based thermal power plants. In this study fine aggregate in concrete mix has been replaced with bottom ash and Polypropylene fiber is additionally used to enhance the strength characteristics of concrete. The concrete mix design is done for M25 grade concrete. The mix is prepared for different combinations of 0%, 10%, 20% and 30% of replacement of sand by bottom ash with 0.5% of polypropylene fiber by total weight of the Cube. The mechanical properties were compared with control mix and it was found that the optimal combination as 30percantage bottom ash and 1.0 percentage polypropylene fiber. Flexural strength was compared by testing beams of size 1.5 x 0.25 x 0.15m under two point loading. Results showed that was no degradation of strength for beams as replacement of fine aggregate with bottom ash.

Keywords—Bottom ash, Polypropylene fiber, Fine aggregate, Flexural strength.

I.INTRODUCTION

1.1 General

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. The concrete is prepared and fabricated from component and it is used in all types of structural systems. 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. Concrete is an widely used material for most of the civil engineering projects. It is produced with cost effective material. Concrete is used to support, to enclose, to surface and to fill. Thus from the consideration of energy and resource conservation and sustainability of the environment, concrete is the most preferred material. Concrete industry is drawing upon enormous natural resources. One day these natural resources will become extinct which compels for replacement of these materials with alternate materials. The material to replace sand in

concrete become very need in the light of the world facing serious problem due to the decreased availability of river sand.

1.2 NEED FOR THE USE OF COAL ASH IN CONSTRUCTION

Energy is the main backbone of modern civilization of the world over, and the electric power from thermal power stations is a dominant source of energy, in the order of electricity. In India, over 70% of electricity generated is by burning of fossil fuels, out of 61% is artificial by coal-fired plants. This results in the origination of around 100 ton of ash. The natural resources and the environmental exposed by the disposal of coal ash. It has proportion such that the use of coal ash in manufacturing of concrete is imperative than a desire.

1.3 BOTTOM ASH

Bottom ash is the coarser material, which drops into the bottom of the furnace in latest large thermal power plants and constitute about 20% of gross ash content of the coal fed in the boilers. It consists of non-combustible materials, and is the residual part from the incineration of household and similar waste. Underdone bottom ash is a mix of materials such as sand, stone, glass, porcelain, metals and ash from burning materials. This paper presents the review of various experimental investigations carried out by many researchers to study the effect of use of bottom ash as a replacement for sand, since the investigation on the use of bottom ash has been very limited. Bottom ash is the non-burning substance formed after the firing of lignite or coal in the furnace at a temperature of 1300 degree Celsius.

The fly ash produced is used as pozzolonic material in cement, fly ash bricks etc. the bottom ash is being deposited in piles which is becoming hazardous to the environment. Bottom ash has particle size similar to sand.

1.3.1 Use of bottom ash

In comparison to sand, an elementary raw material, the black sandy material obtained is a subsidiary raw material. Using this material is more tolerbleable and environmentally amicable and eludes the use of natural resources such as sand and gravel. Bottom ash is used in following activities.

- Road construction
- Foundation material
- Noise barriers
- Aggregate
- Art Supplies

1.3.2 Characteristics of Bottom ash:

Bottom ash is a byproduct of coal and lignite combustion. The bottom ash power plants, which firing a very high volume of coal and lignite annually to generate electricity. Bottom ash is a coarse material having grains similar to or slightly bigger than that of sand. Bottom ash obtained after burning of Lignite with calorific value of 2500 kcal/kg. Table-1 illustrates the constituents of bottom ash used in this work. The bottom ash is almost similar to that of fine aggregate. It has a Co-efficient of curvature of 2 and Co-efficient of uniformity 1.125. Fineness modulus of bottom ash is to be 2.967. The continuous reduction

of natural resources and the environmental hazards posed by the disposal of coal ash has reached alarming proportion such that the use of coal ash in concrete manufacture is a necessity than a desire.

1.4 FIBERS

In addition, fibres are intended to improve tensile strength, flexural strength, toughness and impact strength to improve the post cracking ductility and to control cracking. Several fibre materials in various size and shape have been developed. Polypropylene fibres are smooth- monofilament and have triangular shape. It has some unique properties. The term fiber based concrete is containing fibrous material which increases its structural integrity.

II.LITERATURE REVIEW

2.1 GENERAL

Satish sharma et al., (2012) study of usage of bottom ash as part replacement of sand for making concrete blocks ,This author investigated, the laboratory studies have been carried out at NCB laboratory to utilize bottom ash as part replacement of sand in concrete. This study covers manufacturing of concrete blocks without flyash & with bottom ash for making solid blocks as per specification laid down in IS: 2185 using vibro compaction machine available in NCB. Three different types of bottom ash were used in concrete mix each at 30%, 40% & 50% replacement by weight of sand for making concrete blocks. Comparative study of compressive strength of concrete at different age of curing, wet density, drying shrinkage is reported in this study. Wet density is find to be lower in blocks containing bottom ash & dry shrinkage values are find well within the limits of specifications. Concrete Blocks having bottom ash @ 30% by weight of sand are found suitable for use in the manufacture of concrete blocks.

M.P.Kadam et al., (2013) effect of coal bottom ash as sand replacement on the properties of concrete with different w/c ratio,author The compressive strength for 7, 28, 56 and 112 days was increased up to 20% replacement and after that compressive strengths were decreased from 30% to 100% replacement. The split tensile strength was increased at 7, 28, 56 and 112 days for 10% to 30% replacement and after that it was decreased for remaining replacement. The densities of hardened concrete linearly decreased as the replacement ratio of bottom ash was increased from 10% to 100% as compared to controlled concrete. It was found that the Modulus of Elasticity decreased in accordance with an increase in replacement of natural sand by bottom ash. The moduluous of elasticity of reference concrete was 32.20 × 103 N/mm2 . The moduluous of elasticity for 10 % replacement was increased by 1.55 % to 1.24% for 10% and 20 % replacement respectively. It is found that the permeability up to 30 percentage replacement, decreased and after that permeability was increased from 60 % to 100 % replacement.

T.Subramani et al., (2015) Experimental Investigation Of Partial Replacement Of Cement With Fly Ash And Sand With Bottom Ash And Glass Used In Concrete The 7 days cube compressive strength results showed reduced strength of concrete due to slow action. The Strength of concrete containing flyash 40% and 20% of bottom ash and 30% of

glass was high compared with that of the conventional mix. The flexural strength of concrete with 40% fly ash content with 30% of glass showed improvement on the mechanical properties of concrete Cement replacement level of 40 % flyash in concrete mixes was found to be the optimum level to obtain higher value of the strength and durability at the age of 28 days. By cost analysis it is found that by 40 % replacement of flyash, cost is reduced up to 45 % on Cement. Also by using bottom ash in this concrete to reduced the fine aggregate cost. To reduce the weight of concrete making an light weight concrete because here using glass as coarse aggregate.

A Jayaraman., (2014) Fully Replacement of Natural Sand With hydro Sluiced Bottom Ash in High Performance Concrete with Nanosilica Addition of nano-Silica leads to a significance increase in the characteristic strength and durability of concrete. Replacement of cement with 0.75 percentage ofNano silica gives more strength than the bottom ash mix and also the durability has been increased compared to the bottom ash sand Mix. The self weight of the Nano mix is lighter than the bottom ash sand and the conventional mix. The workability decreases with the addition of Nano-Silica compared to the standard mix and the bottom ash sand mix.The penetration level of chlorides and acids are less in Nano concrete compared to that of conventional and fully replacement of bottom ash sand. The compressive strength of concrete containing (20% bottom ash, 75% manufacturing sand and 0.5% corrugated steel fibre and 0.5% Hooked steel fibre) in mix C5 showed better strength when compared to other mixes and all other mixes shows higher strength when compared to the reference mix C1. The tensile strength of mix C5, C6 and C4 is better strength compared to other mixes.

III.OBJECTIVE AND SCOPE

3.1 OBJECTIVE

The main objective of this project is to study the flexural behavior of concrete beam.

- To study the compressive strength of concrete cubes at 7, 28 days.
- To study the specific gravity and sieve analysis for the natural sand.
- To study the specific gravity and fineness modulus for the bottom ash.
- To study the physical and chemical properties of the natural sand.
- To study the split tensile strength of cylinders.
- To study the flexural strength of the beams.
- To study the ductility and stiffness of the beams.

3.2 SCOPE

From the previous literature it is clearly understood that Bottom ash with addition of polypropylene fibers are having good flexural strength and can be used in concrete.

It gives better workability and also achieves adequate strength.

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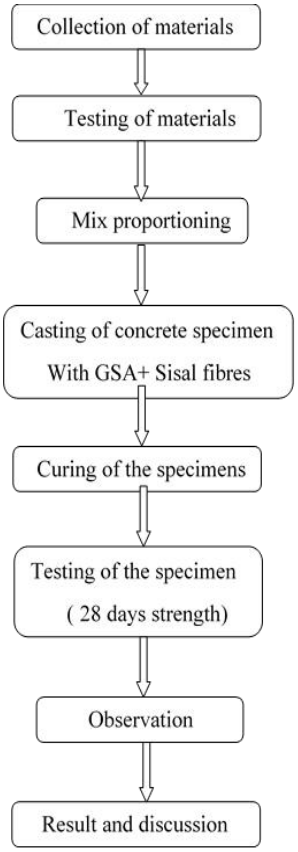
IV.METHODOLOGY

4.1 GENERAL

The chapter briefly explains the methodology adopted in this experimental work. In the first phase, the physical properties of ingredients of concrete and fresh concrete properties have been found and a mix design for M25 concrete was calculated.



4.2 EXPERIMENTAL METHOD

The following methodology has been followed in this experimental investigation,

- Mix design for M25 concrete.
- Mix proportion for concrete by using the Bottom ash and polypropylene fibre.
- Determination of compressive strength of design mixes.
- Casting of cubes with replacement of Bottom ash with addition of polypropylene in normal concrete.

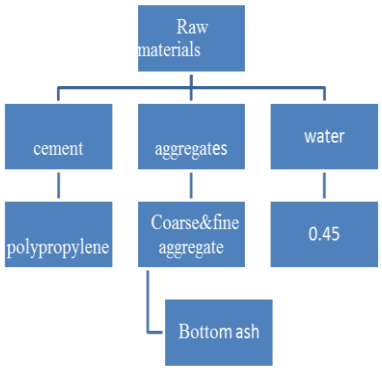


Fig4.1 Flow chart of Raw materials

V.EXPERIMENTAL INVESTIGATION

5.1 GENERAL

This chapter presents the details of materials used, mix design, details of test specimens and testing method adopted. Basic tests were conducted on fine aggregate, coarse aggregate, cement and water to check their suitability for concrete making.

5.2 PROPERTIES OF MATERIALS

5.2.1 Natural sand:

The Natural sand obtained from local resource from Cauvery river bed was used in concrete to cast test cubes and beams. The physical and chemical properties of natural sand obtained by testing the samples as per Indian Standards.

5.2.2.1 FINENESS TEST ON BOTTOM ASH

Weight of Bottom Ash Taken, W1 = 1000g

Weight of Residue (W2) = 18g

Fineness = Weight of residue/ Initial Weight *100

=18/1000*100 =1.8

Table 5.1 Specific gravity for Bottom Ash

CONTENT	TRIAL(Kg)
Wt of pycnometer(W1)	0.640
Wt of pycnometer+bottom ash(W2)	0.894
Wt of pycnometer+bottomash+water(W3)	1.662
Wt of pycnometer+water(W4)	1.520

Specific gravity of bottom ash = (W2-W1)/[(W4-W1)-(W3-W2)]

=(0.894-0.640)/[(1.520-0.640)-(1.662-0.894)]

=2.26

=2.26

5.2.4 COARSE AGGREGATE

Locally available coarse aggregates having the maximum size of 10 to 20mm was used in this present work. The results of test conducted on coarse aggregate are given in table.

Table 5.2 Properties of Coarse Aggregate

SI.NO	Characteristics	Value
1	Type	Crushed
2	Specific gravity	2.60
3	Fineness modulus	7.48.m
4	Size	max 20mm size

5.2.5 CEMENT

The cement used in this study is 43 grade OPC manufactured by chettinadu cements.

Table 5.3 Properties of cement

SI.NO	Characteristics	Value
1	Type	OPC 43 Grade
2	Specific gravity	3.15
3	Fineness modulus	3.3

5.2.6 WATER

The portable water available in the college campus has been used.

5.3 MIX PROPORTION

Concrete mix design is a process by which the proportions of various raw materials of concrete are determined with an aim to achieve a certain minimum strength and durability, as

economically as possible. The Indian standard method of mix design is used for the design of concrete mix of grade M25.

5.4 DETAILS OF TEST SPECIMENS

R1- 5% Bottom ash +0.5% PPF+ Fine aggregate + Coarse aggregate.
R1- 5% Bottom ash+1% PPF +Fine aggregate + Coarse aggregate.
R1-5% Bottom ash + 1.5% PPF + Fine aggregate + Coarse aggregate.
R2-15% Bottom ash + 0.5% PPF + Fine aggregate + Coarse aggregate.
R2-15% Bottom ash+1% PPF +Fine aggregate + Coarse aggregate.
R2-15% Bottom ash + 1.5% PPF + Fine aggregate + Coarse aggregate.
R3-25% Bottom ash + 0.5% PPF + Fine aggregate + Coarse aggregate.
R3-25% Bottom ash+1% PPF +Fine aggregate + Coarse aggregate.
R3-25% Bottom ash + 1.5% PPF + Fine aggregate + Coarse aggregate.

5.5 TESTING OF THE SPECIMEN

Laboratory tests were carried out to determine characteristic compressive strength

5.6 COMPRESSIVE STRENGTH TEST

The specimens are tested for compressive strength on compression testing machine provided with two steel bearing plates with hardened faces. The cubes are placed in the machine such a manner that the load is applied to the opposite sides of the cubes as cast. The load should be applied without shock and increased continuously at a rate of approximately 140kg/cm^2 / min. until the resistance of the specimen to the increasing load breaks down and greater load can be sustained. The measured compressive strength of
Compressive Strength = Ultimate Load / Cross sectional area of specimen

VI.RESULTS AND DISCUSSION

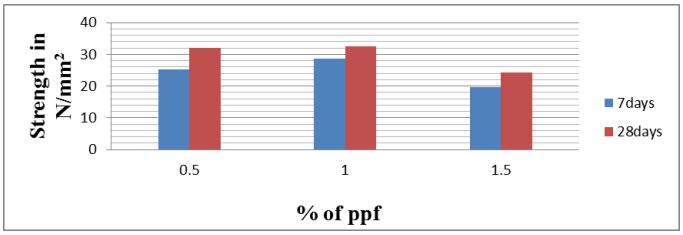
6.1 GENERAL

The results of the experimental investigation on cube specimens, The influence of light weight material on internal curing is investigated.

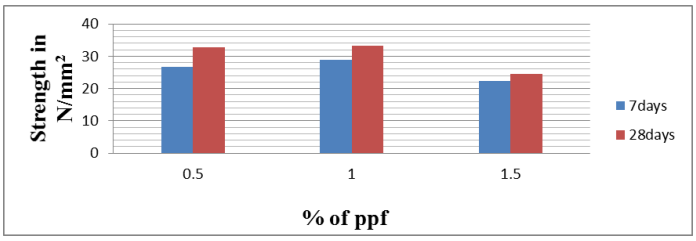
6.2 COMPRESSIVE STRENGTH OF CUBES

The Compressive Strength Results of Concrete cube Specimens for 7 and 28 days are presented in the Table 6.1 and the comparisons of the results are shown in table 6.1.The percentage increases with increase of bottom ash replacement with increase age of concrete. Strength variations between 7& 28 days of the all mixes little bit increasing of strength up to 25% replacement of bottom ash. When compare to control mix it was observed that it has good compressive strength quality. The maximum strength attained in 15% bottom ash replacement with 1% ppf and minimum strength in 25% replacement with 1.5% ppf.

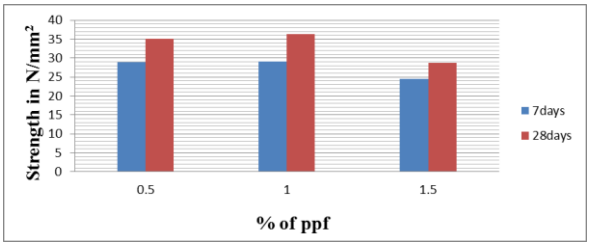
5% Bottom ash



15% Bottom ash



25% Bottom ash



6.3 SPLIT TENSILE STRENGTH OF CYLINDERS

The Split Tensile Strength Results of Concrete Cylinder Specimens for 28 days and comparisons of results are shown in Figure. The percentage increases with increase of bottom ash replacement with increase age of concrete. Strength variations between 7& 28 days of the all mixes little bit increasing of strength up to 25% replacement of bottom ash. When compare to control mix it was observed that it has good tensile strength quality. The maximum strength attained in 15% bottom ash replacement with 1% ppf and minimum strength in 25% replacement with 1.5% ppf.

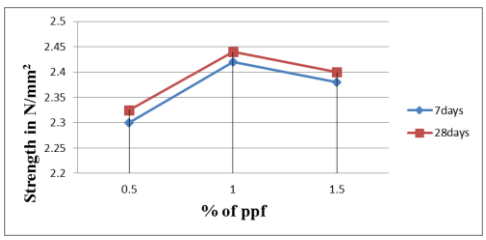
Split tensile strength in $N/mm^2 = 2P/\pi dl$

Where,

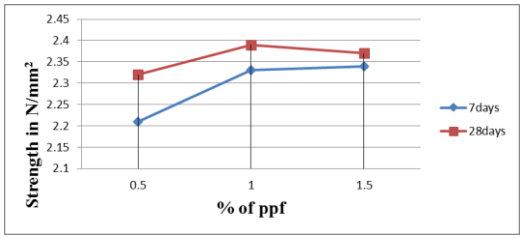
P = maximum load

πdl = surface area of the specimen

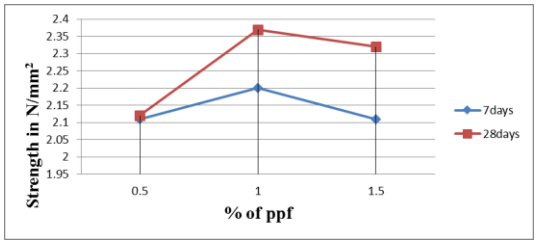
5% Bottom ash



15% Bottom ash



25% Bottom ash



6.4 DUCTILITY

Ductility is described as the ability of a structural element to sustain inelastic deformation without significant loss in resistance. If the structure possesses ductile behavior, it will be able to experience large deflections while still holding near ultimate loads and providing sample warning to the imminence of failure. In this study, the displacement ductility was investigated.

Beam Designation	First crack Load (kN)	First crack mid span deflection (mm)	Stiffness kN/mm
5%BA	12	0.48	25
15%BA	17	0.28	16.71
25%BA	30	2.05	14.63
Control	10	1.24	8.06

6.5 STIFFNESS

Stiffness may be defined as load required to cause unit deflection. The stiffness values of control specimen and other beam specimens at ultimate load and first crack load are presented in the table 6.1.

Table 6.1 Stiffness values at First crack load

Shows that the stiffness values of RC beam. Here RC beam shows stiffer than that of RC beam with replacement of materials. This shows that deflection of RC beam is less than that of other beams and the initiation of crack is also delayed in RC beam with replacement of materials.

VII.CONCLUSION

From the test results obtain the following conclusions:

The bottom ash used as fine aggregate and large utilization of waste product in addition with it increases strength in 7days and decreases gradually with age of curing of concrete. Due to the less weigth of bottom ash it reduces the transportation cost, equalize the ecological balance and the conservation of natural sources etc.Thestrength increaseswith increasing age of concrete.

From the result got from phase I, the optimum compressive strength of cubes with replacement of fine aggregate in addition ofppf, 5,15,25 % of replacement bottom ash with , 0.5,1,1.5% ppf.

From the experimental survey 15% of bottom ash is taken as a optimum for further flexural studies of beam.

Split tensile strength is maximum in 15% bottom ash replacement with varying proportion of ppf

From all the optimum result achieved from compressive, split tensile strength test the flexural members are casted and their behaviors are studied.

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