Volume: 1 Issue: 1 08-Jun-2013,ISSN_NO: 2320-7256

BOTTOM ASH CONCRETE

K. Nataraj1, S.M. Midun1, K. Mura Hari1, Dr. G. Mohan Ganesh2 and Dr. A. S. Santhi3

1 – M.Tech. Student, 2 – Professor & PM, 3 - Professor & Director

School of Mechanical and Building Science, VIT University, Vellore - 632014, TamilNadu, India

Raj_678@yahoo.com; +91-8106302343

Abstract

This paper about the experimental investigations on the study of bottom ash concrete by replacing river sand with lignite based bottom ash. Bottom ash is a coarser material, which falls into furnace bottom in modern large thermal power plants and constitute about 20% of total ash content of the coal fed in the boilers. Bottom ash, which is rarely used in concrete due to its inactive pozzolanic reaction, improved its quality of concrete. Since fine collection is completely replaced with bottom ash. The effect of mechanical properties on bottom ash has to be studied. This project will give a clear idea of sustainable effect of bottom ash concrete. The strength development for various percentages (0- 40%) replacement of cement with fly ash has to be studied at various stages.

Key words: Bottom ash, fly ash, Pozzolanic reaction.

Introduction

In India, over 70% of electricity is generated by combustion of fossil fuels, out of which nearly 61% is produced by coal- fired plants [1]. This results in the production of roughly 200 million ton of ash. Most of the ash has to be disposed of either dry or wet to an open area available near the plant or by grounding both the fly ash and bottom ash and mixing it with water and pumping into non-natural lagoon or dumping yards. This causes environmental pollution and loss of productive land.

Fly ash is one of the residues generated in combustion, and comprises of fine particles that rise with the flue gases. Ash which settles is termed bottom ash. Two classes of fly ash are defined by ASTM C 618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash[2,3]. Class F fly ash contains less than 10% lime (CaO). Class C fly ash contains more than 10% lime (CaO). Bottom ash is the coarser material, which falls into furnace bottom in modern large thermal power plants and constitute about 20% of total ash content of the coal fed in the boilers. Bottom ash, which was rarely used in concrete due to its inactive pozzolanic reaction, improved its quality of concrete.

Present study

The structural properties of both bottom ash concrete as well as replacement of cement with fly ash in concrete are well known, and their individual behavior is also fully understood. In the present study, an effort is made to combine the structural properties of bottom as concrete replacement of cement with fly ash in the concrete.

Mix design for Bottom Ash Concrete

The mix proportions were arrived based on IS 10262:2009. Same mix design was used for all the mix proportions.

Table 1: Mix design proportions for Bottom ash concrete

S.no	Mixture no.	M1	M2	M3	M4
1.	Cement	100%	80%	70%	60%
2	Fly Ash	0%	20%	30%	40%
3	Fine aggregate	Replacing with 100% Bottom Ash			
4	Coarse aggregate	12mm aggregates 40% & 20mm aggregates 60%			
5	Water	0.4% binder ratio			

Materials Used

Cement: Ordinary Portland cement 53 grade conforming to IS: 12269- 1987 was used. The specific gravity of cement is 3.2. Initial setting time is 160 minutes and Final setting time is 270 minutes.

Fly Ash & Bottom Ash: Bottom ash and Fly ash is obtained from thermal power plant at Neyveli ,NLC (NEYVELI LIGNITE CORPORATION) in India was used in the investigation. The specific gravity of bottom ash was 2.38. Bottom ash passing through 600 micron sieve is used for the investigation. The specific gravity of fly ash was 2.28. Class C fly ash is used in the investigation.

Coarse Aggregate: Coarse aggregates were used with 20 mm & 12mm nominal size. The specific gravity of coarse aggregates is 2.7. Super plasticizer: A commercially available super plasticizer, Aqueous Solution of modified water reduced accelerators (polycarboxylate) was used in the study.

Experimental Procedure

The experimental work consisted of tests on standard size control specimens of bottom ash concrete & bottom ash with replacement of cement with fly ash in the concrete. The tests were conducted to find the compressive strength on cubes of 100mm X 100mm X 100mm size and the tensile strength on cylinders of 100mm diameter and depth 200mm size. The test specimens were divided into four categories depending upon the percentage of fly ash from 0% to increments of 40% replacement of cement with fly ash.

Mixing and Casting the Specimens

A nominal mix of the proportions of M30 mix design is used as per IS: 10262: 2009 (1.0: 2.26: 3.873) (Cement: Fine aggregate: Coarse aggregate) by weight, with a water- cement ratio of 0.4 was maintained throughout the study. All the required materials for preparing the concrete were weighed as per the required proportions. The cement and bottom ash were thoroughly mixed in the dry state. The mixture was again thoroughly mixed and gently placed over the coarse aggregate. Super plasticizers was mixed with water and finally added to the dry mixture. The mixing of concrete was carried out in a tilting mixer to obtain a uniform concrete. Similarly same mixing procedure was followed for all mix proportions of concrete. Concreting was done in the moulds while they were on a table vibrator. Vibrations were continued for three minutes to ensure uniform compaction.

Figure 1. Casting cubes of 100 X 100 X 100mm size.

Figure 2. Casting cylinders of 100mm diameter, depth 200mm size.

Curing of Specimens

The specimens were demoulded after 48 hours of casting and placed in a curing tank for 28 days. After the curing period, the specimens were removed from the curing tank and whitewashed for better visibility of cracks.

Testing of the Specimens

Cubes and cylinders were tested on 300T compression testing machine. Loading was conducted as per the Indian Standard specifications. Compressive Strengths are calculated for 1day, 7days & 28days. Tensile strength is calculated for 28 days. Appling load intensity of 1.0 KN/sec.

Figure 3. Testing of cube in compression testing machine after 28days curing.

Figure 4. Testing of cylinder in compression testing machine after 28days curing.

Test Results

Results obtained from tentative investigations to study the compressive strength as well as the tensile strength of bottom ash concrete are presented here for discussion.

Table 2: Compressive strength of Bottom ash concrete for 1day, 7 days and 28 days

% of Fly ash	Compressive Strength (N/mm^2)		
	1 Day	7 Days	28 Days
0%	20.13	37.83	47.8
20%	11.1	16.93	28.43
30%	11.86	21.33	NA
40%	5.46	17.1	NA

Table 3: Tensile strength of Bottom ash concrete for 28 days

% of Fly ash	Tensile Strength (N/mm^2)
	28 Days
0%	1.251
20%	1.543
30%	NA
40%	NA

Compressive Strength

Cube specimens were tested for compression and the average ultimate compressive stress was determined from the failure compressive load. The values of average compressive strength are given in Table 2. Chart is plotted for the average compressive strength against percentage fly ash added to concrete and is given in Fig.5. Table 2 show the percentage increase in the compressive strength of bottom ash concrete over the compressive strength of concrete with replacement of cement with fly ash.

Calculation of compressive strength is given by

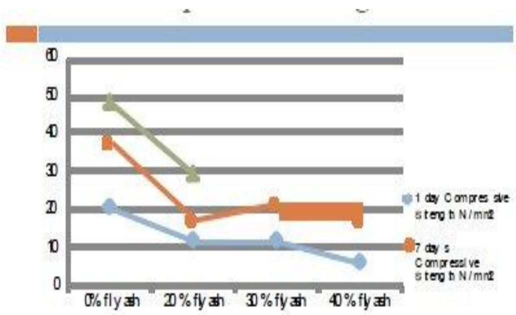

Figure 5. Chart of compressive strength against percentage of replacement of cement with fly ash The maximum increase in the compressive strength is found in the specimens as given the above chart.

Tensile Strength

Cylinder specimens were tested for compression and the average ultimate tensile stress was determined from the failure compressive load. The values of average tensile strength are given in Table 3. Charts are plotted as average tensile strength against percentage fly ash added to concrete is given in Figs.6. Table 3 show the percentage increase in the tensile strength of bottom ash concrete over the compressive strength of concrete with replacement of cement with fly ash. We find tensile strength using cylinder splitting tension test. The splitting strength gives 5 to 12% higher value then the direct tensile strength.

Calculation of tensile strength is given by

$C= P/\pi LD$.

Where P is compressive load on cylinder, L is length of cylinder and D is the diameter of cylinder.

Tensile Strength

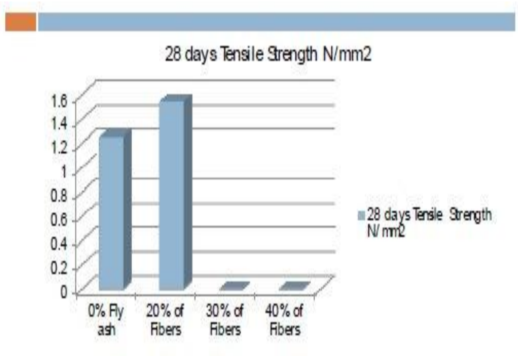

Figure 6. Chart of tensile strength against percentage of replacement of cement with fly ash The maximum increase in the tensile strength is found in the specimens are given above.

Conclusions

From the experimental study conducted on bottom ash concrete and bottom ash and replacement of cement with fly ash in the concrete, the following conclusions can be drawn:

1. When the bottom ash is used in the concrete, the workability of existing is decreased due to the water demand. This problem is solved by increasing the content of Superplasticizer.

2. When the bottom ash and fly ash content increased in the concrete, the density of concrete decreased due to the low specific gravity of bottom ash and fly ash as compared to fine aggregates and cement.

3. Finally, the use of bottom ash in concrete is recommended as an alternative to fine aggregates in concrete.

4. The percentage of fly ash from 0% to increments of 40% replacement of cement with 0.4 w/c ratios is more effective in resisting tensile stresses as well as compressive stresses. Hence, the optimum percentage of replacement of cement with fly ash in bottom ash concrete is 30%.

Finally, the use of Bottom ash concrete with 30% replacement of cement with fly ash is recommended which enables the large utilization of waste product.

References

- Concrete Technology by M.S. Shetty.
- P. Aggarwal* , Y. Aggarwal, S.M. Gupta: Effect of bottom ash as replacement of fine aggregates in concrete, Asian journal of civil
- Rafat Siddique*: Effect of fine aggregate replacement with Class F fly ash on the mechanical properties of concrete, Department of Civil Engineering, Thapar Institut

Engineering and Technology, Deemed University, Patiala 147004, India Received 28 February 2002; accepted 16 September 2002.

 Sivasundram,V. and Malhotra, V.M., High performance high volume fly ash concrete, Indian Concrete Journal, Nov (2004) 13- 2.

 Naik, T.R. and Ramme, B.W., High strength concrete containing large quantities of fly ash, ACI Materials Journal, March- April (1989) 111- 116.

 IS:12269- 1987.Specifications for 53 grade Portland cement, Bureau of Indian Standards, New Delhi, India.

 IS: 10262-2009. Recommended guidelines for concrete mix design, Bureau of Indian Standards, New Delhi, India.