Performance Analysis of Hollow Blocks Incorporating Bottom Ash and Geosynthetic Fibre

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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 fibre is additionally used to enhance the strength characteristics of concrete. The concrete mix design is made for concrete hollow block whose grade is B(3.5). The mechanical properties were compared with control mix and it was found that the optimal combination of polypropylene fibre as 0.5% of weight of cement, which is more sufficient to have economically strong hollow blocks. Compressive strength was compared by testing mixer block without bottom ash and polypropylene fibre of size 400 X 200 X 200 mm. Results showed that there was considerable amount of strength for blocks with bottom ash as replacement for fine aggregate.

KEYWORDS: Bottom ash, Polypropylene fibre, hollow blocks..

1. INTRODUCTION

Hollow blocks made with cement concrete possess a very low tensile strength, limited ductility and little resistance to cracking. Recent trends in concrete technology have shown improvement in workability, enhanced strength and resistance to smaller cracks in the concrete. The fibres of short length and small diameters are used in concrete to convert its brittle nature to ductile one.

The coarser material which gets collected in the furnace bottom of thermal power plants is known as bottom ash. This paper presents the experimental investigations carried out to study the effect of use of bottom ash as a replacement of fine aggregate and polypropylene fibre as admixture to the concrete mix for gaining a considerable amount of compressive strength and breaking load. The usage of fibres to improve the strength of hollow concrete block is also justified in the past studies. On different volume fractions of polypropylene fibres showed that workability of concrete decreased with the increase in bottom ash content and concluded that compressive strength, of fine aggregates replaced bottom ash concrete specimens were lower than control concrete specimens at all the ages. It was concluded that hollow concrete block containing 13-15g of polypropylene fibre is acceptable for most structural applications. The results showed increase in the ultimate load and compressive strength of concrete block.

2. MATERIALS AND METHODS

A. Cement(C)

Ordinary Portland cement of 53 grade conforming to IS 12269:1087 has been used in the casting of hollow block. It is the cementing material used in cement concrete hollow blocks. Cement is the highest priced material per unit weight of the concrete, Hence only required amount has been used while casting the specimen.

B. Bottom Ash(BA)

Bottom ash used in this study is from North chennai thermal power plant. The plant produce about 100 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 artificial lagoon or dumping yards. This causes the pollution in water bodies and loss of productive land. It is comparatively coarse material and contains higher unburnt carbon. It possesses zero or little pozzolanic property.

C. Coarse Aggregate (CA)

Stone chips whose nominal size is 20mm and specific gravity 2.67 is used as coarse aggregate. These aggregates are added 7parts that of quantity of cement and it should be free from cracks and any physical deformation.

D. Water (W)

Water fit for drinking is generally considered for making concrete. Water should be free from acids, oils, alkalis, vegetables or other organic impurities. Soft water also produces weaker concrete. Water has two functions in concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert

aggregates are held in suspension until the cement paste are hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregate and cement. Portable tap water available in the laboratory with pH value of 7.0 and conforming to the requirements of IS 456 – 2000 is used for making concrete and curing the specimen.

E. Polypropylene Fibre (PPF)

The admixture used in this project is "Polypropylene fibre" which is a geosynthetic material which controls cracking, Reduces water permeability and does reduction in rebound loss. Tensile strength of recron 3s polypropylene fibre is 4000-6000 kg/cm and has melting point 250ºC. About 13 grams of polypropylene fibre is mixed for casting 1 Hollow concrete block.

3. EXPERIMENTAL INVESTIGATION

For this experimental work hollow block cubes were casted in the laboratory. Cubes were casted using concrete mixes with fine aggregate replaced by bottom ash of 95% along with 0.5%of poly propylene fibre by weight of cement. Cubes were casted as per the standard dimension specified in IS: 2185 (Part 1) :2005 and allowed to cure for 28 days. The dimension of the casted cube was 400 x 200 x 200 mm. After curing the cubes were tested for the following tests specified by IS: 2185 (Part 1) :2005:

- Compressive strength of block
- Block density
- Water absorption

Compressive strength of blocks:

The cube specimens were tested after curing for 7, 14, 28 days and the results were compared with the control specimen. The blocks were tested on the standard compression testing machine conforming to IS 14858:2000. The testing machine shall be equipped with two steel bearing blocks, one of which is a spherically seated block that will transmit load to the upper surface of the masonry specimen, and the other a plane rigid block on which the specimen will rest. When the bearing area of the steel blocks is not sufficient to cover the bearing area of the masonry specimen, steel bearing plates meeting the requirements shall be placed between the bearing blocks and the capped specimen after the centroid of the masonry bearing surface has been aligned with the centre of thrust of the bearing blocks.

Water Absorption:

The test specimens shall be completely immersed in water at room -temperature for 24 h. The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water. They shall be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth and immediately weighed.

Subsequent to saturation, all specimens shall be dried in a ventilated oven at 100"C to 115°C for not less than 24 h and until two successive weighings at intervals of 2 h show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

Block Density:

Three blocks taken at random from the samples selected in accordance with 10, shall be dried to constant mass in a suitable oven heated to approximately 100ºC. After cooling the blocks to room temperature, the dimensions of each block shall be measured in centimetres (to the nearest millimetre) and the overall volume computed in

cubic centimetres. The block shall then be weighed in kilograms (to the nearest 10 g) and the density of each block calculated.

4. RESULTS AND DISCUSSION

Compressive strength:

The Compressive strength test results of specimens are shown in Fig.1. Replacement of Fine aggregates with 95% of bottom ash with addition of 0.5% of PPF has attained the higher compressive strength. The initial strength gain is at slower rate, since pozzolanic action of bottom ash at early age is slow which do not contribute for the strength of concrete. The test was carried out for 7, 14, 28 days.

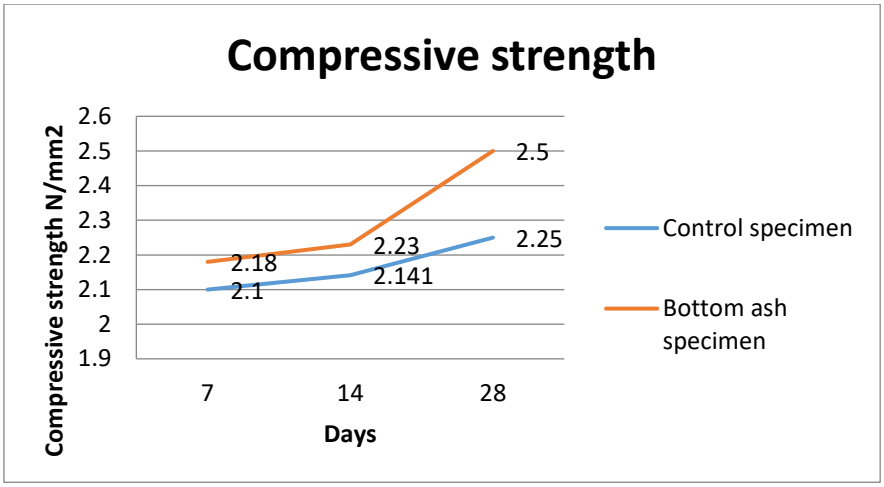

Fig.1 Compressive Strength of hollow blocks

Water Absorption

Formulae:

Water absorption, percent = $\frac{A-B}{B} X\ 100$

where,

A- Wet mass of units in kg

B – Dry mass of units in kg

Report all results separately for each unit and as the average for the three units.

Water absorption, percent for specimen 1= 4.77%

Water absorption, percent for specimen 2= 5.21%

Water absorption, percent for specimen 3= 8.52%

The average for the-three blocks shall be taken as the average water absorption and is calculated to be 6.16%.

Block Density:

Formulae:

Desnity of block = $\frac{Mass\ of\ block\ in\ kg}{VOlume\ of\ specimen\ in\ cm^3}\ \ X\ 10^6\ kg/m^3$

The average for the-three blocks shall be taken as the average density.

The Block Density of the specimen is **1414.37 kg/cm^3**

5. CONCLUSION

The study was conducted to evaluate the strength characteristics of concrete with bottom ash and polypropylene fiber. The concrete mix design was done for M25 grade concrete.

The following points were concluded from this study.

- The 7 days block compressive strength results shows reduced strength of concrete due to slow pozzolonic action.
- The strength of concrete blocks at 28 days with replacement of bottom ash along with 0.5% of polypropylene fibre shows an increase of 95% in compressive strength.
- Addition of polypropylene fibre increases the mechanical strength of the specimens.
- The addition of fibres reduces the workability of concrete which was overcome by the addition of bottom ash as replacement of fine aggregate.

Experimental result shows that Bottom ash with 0.5% PPF retained the stiffness similar to that of conventional block. Fibres in hollow concrete block made from Bottom ash with 0.5% PPF checked the development of cracks and thereby had many flexural cracks of reduced width. In this study, bottom ash collected from thermal power was used as a replacement for fine aggregate. The reduction in strength and stiffness of concrete due to bottom ash is overcome by adding polypropylene fibre to the mix.

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