EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH SUGARCENE BAGGASE ASH

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ABSTRACT

The study of SCBA as a partial replacement for cement in concrete. Pozzolana Portland cement is recognized as a major construction material throughout the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also result in foreign exchange earning and environmental pollution control. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement materials. The sugarcane bagasse was burnt at 700ºc to change the sugarcane bagasse ash . The sugarcane bagasse ash is used to partially replaced by Pozzolana portlant cement by weight in ratio of 10%, 20% and 30%. In this concrete is made on the water cement ratio of 0.35 without solutions. The same replacement percentages of concrete is pouring by adding the water with solutions of NaOH and Na2Sio3. These methods of concrete is cured at 7, 14 and 28 days. Then comparing the results of mechanical and durability properties.

Keywords:- Concrete, Pozzolana cement, Sugarcane bagasse ash, NaOH, Na2Sio3.

1. INTRODUCTION

Pozzolana Portland cement is recognized as a major construction material throughout the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also result in foreign exchange earning and environmental pollution control. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement materials. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. A few studies have been carried out on the ashes obtained directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement. Therefore it is possible to use sugarcane bagasse ash (SCBA) as cement replacement material to improve quality and reduce the cost of construction materials such as mortar, concrete pavers, concrete roof tiles and soil cement interlocking block.

The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from the Tamilnadu province in India. Sugarcane production in India is over 300 million tons/year leaving about 10 million tons of as unutilized and, hence, wastes material. This paper analyzes the Comparision of SCBA in concrete by partial replacement of cement at the ratio of 10%, 20% and 30% by weight. In this concrete is made on the water cement ratio of 0.35 without solutions.The same replacement percentages of concrete is pouring by adding the water with solutions of NaOH and Na_2Sio_3.

The experimental study examines the mechanical properties such as compressive strength, split tensile strength and flexural strength. Durability properties such as water absorption test and abrasion test. The main ingredients consist of PozzolanaPortland cement, SCBA, river sand, coarse aggregate, water, NaOH and Na_2Sio_3. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water at 7, 14 and 28 Days.

2. MATERIAL AND METHODLOGY

2.1. CEMENT

Cement is a finely ground material having adhesive and cohesive properties which provide a binding medium for the discrete ingredients it is obtained by burning together, in a definite proportion. A mixture of naturally occurring argillaceous (containing alumina) and calcareous containing calcium carbonate or lime material to a partial fusion at high temperature about 1450 C chemical composition of cement.

PozzolanaPortland cement is a higher strength cement to meet the needs of the consumer for the higher strength concrete. For certain specialized works such as prestressed concrete and certain items of precast concrete requiring consistently high strength concrete, the concrete industry quite often needs a special type of pozzolanaPortland cement having the compressive strength much higher than the minimum compressive strength limits.

2.2. AGGREGATE

Aggregate are inert material which give body to the concrete reduce shrinkage and effect economy.General certain volume of concrete is occupied by aggregate. The aggregate limits the strength of concrete but the aggregate properties greatly affect the durability and structural performance of concrete. If the concrete is to be workable, strong, durable and economical the aggregate must be of proper shape,clean,strong,durable and economical.

2.3. FINE AGGREGATE

It is the aggregate most of which passes through a 4.75mm IS sieve and contains only so much coarser material as is permitted by the specification. According to the size, the fine aggregate may be described as coarse, medium and fine sands. Depending upon the practical size distribution IS 383-1970 has divided the fine aggregate into four Grading Zone.

2.4. COURSE AGGREGATE

The aggregate most of which are retained on the 4.75mm IS sieve and contain only so much of the material as permitted by the specification are termed as coarse aggregate is described by the nominal size, i.e., 40mm, 20mm, 16mm, 12.5mm and 10mm.

2.5. SUGARCANE BAGASSE ASH

The SCBA used in this present study was taken from Sugar factory which is located in Gopalapuram, Dharmapuri district of Tamilnadu State, India. It was not possible to measure the temperature in the furnace while taking the bagasse ash, because the measuring instrument was not long enough to go through the furnace. Even though it was not possible to measure the temperature, most furnaces have a temperature above that is required for complete combustion which is around 800°C. But it was suggested that at a temperature around 650°C the crystallization of minerals occurs. This reduces the pozzolanic activity of the bagasse ash. For this study, fresh SCBA taken from the furnace was used. It was cooled in air by applying a small quantity of water.

2.6. WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. The quantity and quality of water is required to be watched into carefully so that it can from the strength given durable concrete. Portable water is used for making mortar. The P_H value of water lies between 6 and 8 that indicate the water is free from organic matters.

2.7METHODOLOGY

From the literature reviewed it is clear that paucity of information exists in the sugarcane bagasse ash concrete literature. Hence an attempt has been made to study the properties of Sugarcane bagasse ash concrete. Methodology used here is briefly explained in Figure – 5.

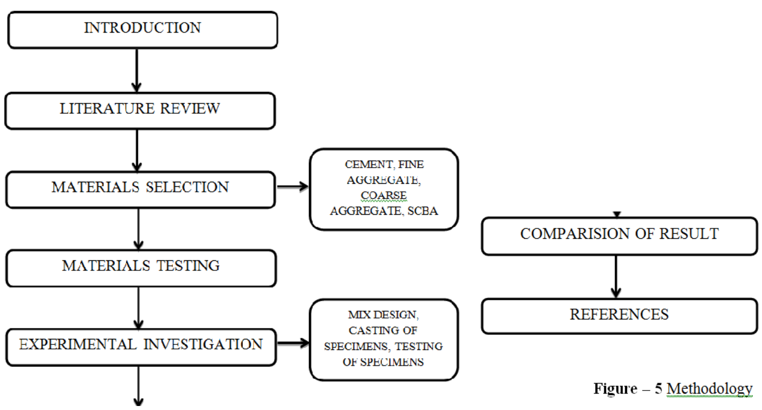

Figure – 5 Methodology

3. TESTS FOR MATERIALS

Some of the tests are done in order to find the properties of materials, they are as follows,

1. Specific gravity test
2. Sieve analysis
3. Standard consistency test

3.1. SPECIFIC GRAVITY

Specific gravity of sand is defined as the ratio of mass of given volume of solid to the mass of on equal volume of water at specific gravity of sand is an important parameter for the determination of voids and particle size. The sand specific gravity is smaller value indicating the coarse sand. The sand specific gravity is smaller value indicating the coarse sand. Specific gravity of aggregate is made use of in calculations if concrete mixes, and calculating the compaction factor in connection with the workability measurements.

Procedure

1. Specific gravity of the aggregate is determined by pycnometer method. Pycnometer is a glass jar of about 1 liter capacity and fitted with brass conical cap.
2. At first pycnometer is weighed and taken the reading accurately. Then the over dry sand is filled at one-third height of bottle and weighed.
3. Then distilled water is added until the bottle is half full and stirred with a glass rod removing entrapped air.
4. Then more water is added to the bottle to make it full and conical cap is inserted and filled water again up to the hole of conical cap and weighed. After that, pycnometer is completely washed with water.
5. Then the pycnometer is filled with water flush with the top hole of brass conical cap and weighed precisely.
6. The specific gravity of the given sample of aggregate find out by using the given formula.

$$\text{Specific gravity} = \frac{W2 \quad W1}{(W2 \quad (W4 \quad W1) \quad (W3 \quad W2))}$$

Where,
W1= Weight of pycnometer (gm)
W2=Weight of pycnometer + sand(gm)
W3=Weight of pycnometer + sand + water (gm)
W4=Weight of pycnometer filled with water (gm)

3.2. DETERMINATION OF SIEVE ANALYSIS

Apparatus

A set of IS Sieves of sizes – 4.75mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm.
Balance with an accuracy to measure 0.1 percent of the weight of the test sample.

Procedure

- The weight of sample available should not be less than the weight given below
- The sample for sieving should be prepared from the larger sample either by quartering or by means of a sample driver.
- The sample shall be brought to an air-dry condition before
- Weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100C to 110C
- The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.
- Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any for a period of not less than two minutes.
- The shaking shall be done with a varied motion, backwards and forwards, left to right, circular clockwise and anti-clockwise and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions.
- Material shall not be forced through the sieve by hand pressure, but on sieves coarser than 20 mm, placing of particles is permitted.
- Lumps of fine material, if present, may be broken by gentle pressure with fingers against the side of the sieve. Light brushing with a soft brush on the underside of the sieve may be used to clear the sieve openings.
- On completion of sieving, the material retained on each, together with any material cleaned from the mesh, shall be weighed.
- The percentage passing in each sieve is calculated and is checked against the limits given in IS: 383 – 1970.

3.3. STANDARD CONSISTENCY TEST

To determine the quantity of water required to produce a cement paste of standard consistency.

Apparatus

Vicat apparatus confirming to IS : 5513 -1969
Mould balance
10mm dia. Plunger
Weight base
Stop watch

Theory

The standard consistency of cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom of the mould.

Procedure

Prepared a weighed quantity of cement with a weighed quantity of water, taking care that the fine of gauging is not less than 3-mins, nor more than 5mins and the gauging shall be completed before any sign of setting occur.

The gauging time will be counted from the time of adding water to dry cement will commencing to fill the mould. Fill the vicatmould with the paste, the mould resting on a non-porous plate. Place the test bag in the mould, together with the non-porous resting plate, under the rod having plunger, lower the plunger gently to touch the surface of the test block and quickly release allowing it to sink into the paste. Prepare the trial paste with varying pressure of water and test as described above the until. The amount of water necessary for making up the standard consistency.

4. EXPERIMENTAL INVESTIGATION

4.1. CASTING PROCESS

4.1.1 MATERIAL PREPARATION

The selection of aggregate, sand and cement were in proportion accordance with the mix design and current practice used in making PPC concrete.

4.1.2. MIXING, PLACING AND COMPACTION

For casting, all the modulus were cleaned and oiled properly. These were securely tightened to correct dimensions before casting. Care was taken that here is no gaps left from where there is any possibility of leakage out of slurry. Careful procedure was adopted in the batching, mixing and casting operations. The concrete mixture was prepared by hand mixing. The cement and aggregates were mixed dry by manual for about three minutes. Then water was added carefully so that no water was lost during mixing and mixing continued for another four minutes.

For Cube (150mm x 150mm x 150mm), cylinder (150mm x 300mm) and Prism (500mm x 50mm x 50mm) the mixture was cast in three layers. Each layer received 25 manual strokes. SCBA was added to the mixture in dry condition during the mixture of cement and fine aggregate. While solutionswas add after the mixing of mixture with water. The specimens were allowed to remain in their respective moulduntill the next day. Then the concrete was demoulded and placed in the curing tanks for the purpose of curing.

4.2. TESTING OF SPECIMENS

4.2.1. COMPRESSION STRENGTH TEST

Apparatus

Cube moulds of size 150*150*150 mm for concrete
Tamping rod of 16mm diameter and 600 long with rounded end
Trowel
UTM

Procedure

- The bearing surfaces of the testing machine are wiped clean.
- The specimen is placed in the machine in such a manner that the load is applied to opposite sides of the cubes as cast.
- No packing is used between the faces of the test specimen and the steel plate of the testing machine.
- The load is applied without shock and increase continuously at a rate of approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load be sustained.
- The maximum load applied to the specimen is recorded and the appearance of the concrete and any unusual features in this type of failure are noted.

$$Compressive\ Strengt \ = \frac{Load\ Applied}{Area\ of\ t\ \ e\ Specimen.}$$

4.2.2. SPLIT TENSILE STRENGTH TEST

Apparatus

Cylinder moulds of size 150 mm diameter and 300 mm length for concrete
Tamping rod of 16mm diameter and 600 long with rounded end
Trowel
UTM

Procedure

The bearing surfaces of the testing machine are wiped clean.
The specimen is placed in the machine in such a manner that the load is applied to opposite sides of the cylinder as cast.
No packing is used between the faces of the test specimen and the steel plate of the testing machine.
The load is applied without shock and increase continuously at a rate of approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load be sustained.
The maximum load applied to the specimen is recorded and the appearance of the concrete and any unusual features in this type of failure are noted.

$$split\ tensile\ Strengt \ = \frac{2P}{\pi LD}$$

4.2.3. FLEXURAL STRENGTH TEST

Apparatus

Prism (small beams) moulds of size 500*100*100 mm for concrete

Tamping rod of 16mm diameter and 600 long with rounded end

Trowel

UTM

Procedure

The bearing surfaces of the testing machine are wiped clean.

The specimen is placed in the machine in such a manner that the load is applied to opposite sides of the prism as cast.

No packing is used between the faces of the test specimen and the steel plate of the testing machine.

The load is applied without shock and increase continuously at a rate of approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load be sustained.

The maximum load applied to the specimen is recorded and the appearance of the concrete and any unusual features in this type of failure are noted.

$$split\ tensile\ Strengt \ = \frac{PL}{bd\mathbf{2}}$$

5. RESULT OF SPECIMENS

5.1COMPARISION OF COMPRESSIVE STRENGTH TEST RESULTS

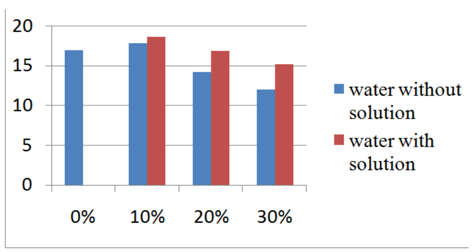

Figure 8 -Comparision of sugarcane bagasse ash Replacement Strength at 7 days without and with solution concrete

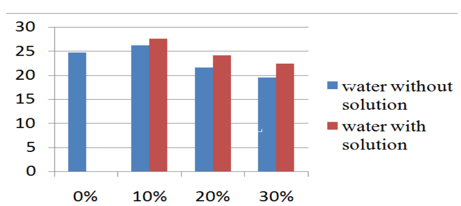

Figure 9-Comparision of sugarcane bagasse ash Replacement Strength at 14 Days without and with solution concrete

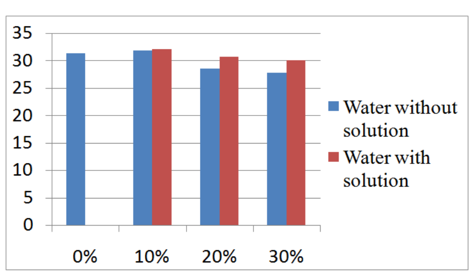

Figure 10-Comparision of sugarcane bagasse ash Replacement Strength at 28 Days without and with solution concrete

5.2. SPLIT TENSILE TEST RESULTS:

COMPARISION OF SPLIT TENSILE STRENGTH TEST RESULT

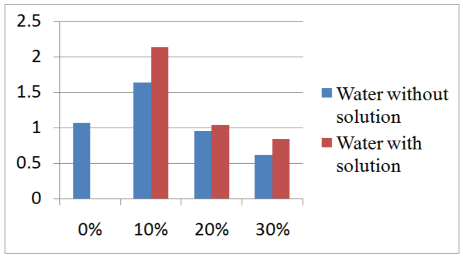

Figure 11-Comparision of sugarcane bagasse ash Replacement Strength at 7 Days without and with solution CYLINDER

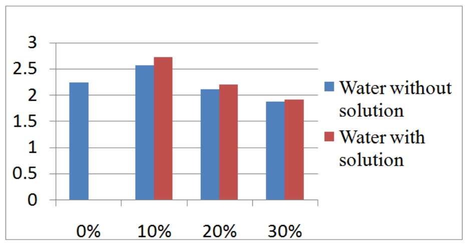

Figure 12- Comparision of sugarcane bagasse ash Replacement Strength at 14 Days without and with solution CYLINDER

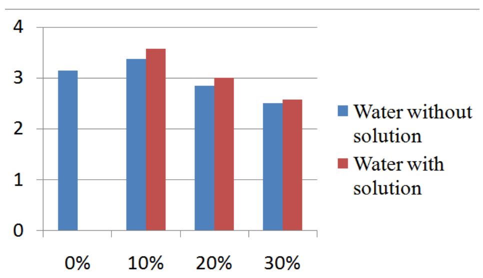

Figure 13- Comparision of sugarcane bagasse ash Replacement Strength at 28 Days without and with solution CYLINDER

5.3. FLEXURAL STRENGTH TEST RESULTS:

COMPARISION OF FLEXURAL STRENGTH TEST RESULT

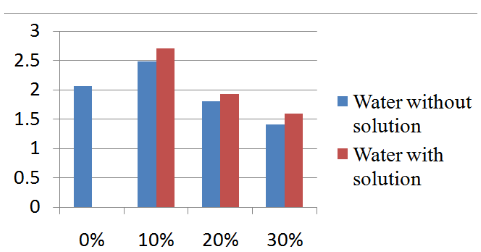

Figure 14-Comparision on flexural strength of concrete for 7 dayswith and without solution prism

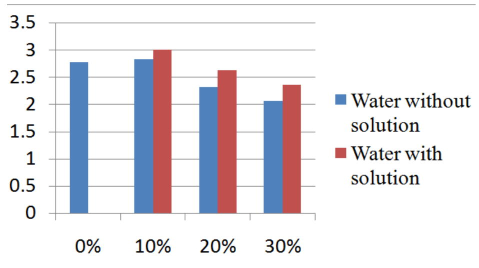

Figure 15-Comparision on flexural strength of concrete for 14 dayswith and without solution prism

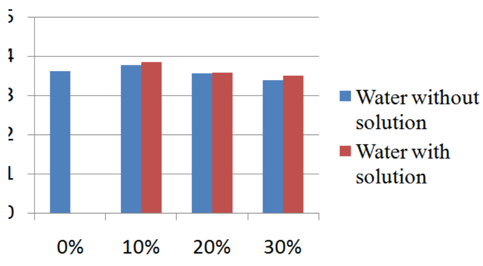

Figure 16-Comparision on flexural strength of concrete for 28 dayswith and without solution prism

6. CONCLUSION

Based on the conducted experiment and according to the results obtained, it can be concluded that: Bagasse ash can increase the overall strength of the concrete when used up to 10% cement replacement level with w/c ratio of 0.35 without any solutions. And also the Bagasse ash can slightly increase the overall strength of the concrete when it is used up to a 20% cement replacement level with w/c ratio of 0.35 with solution.From this project recommended to use of bagasse ash is partially replacement on cement up to 10% is suitable for concreting, more than 10% of bagasse ash will decrease the strength of concrete slightly. By adding the solutions of NAOH and $NA_2SiO_3$is gives the more strength while comparing with Bagasse ash concrete without solution.

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Table 2 - The Specific Gravity of Coarse Aggregate Grains (G_{CA})6.2.

RESULT AND DISCUSSION

- Use of baggase ash in concrete as upto 30% cement replacement causes slump increase and delayed in initial and final setting time.
- The mechanical properties such as compressive strength, split tensile and flexural strength of replaced without solution concrete is increasing upto 10% and decreased above 10% replacement.
- The mechanical properties such as compressive strength, split tensile and flexural strength of replaced with solution concrete is increasing slightly upto20% of replacement and decreasing above 20% of replacement.
- The solution used concrete is slightly increasing the strengths to compares the solution used concrete.
- Finally the 10% replacement is increasing the mechanical properties of concrete.