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STUDIES ON STRENGTH CHARACTERISTICS OF CONCRETE USING AGRO-WASTE

P Rajasekhar Reddy
M. Tech Student,
Department of Civil Engineering,
Usha Rama College of Engineering & Technology, Telaprolu, Krishna District,
Andhra Pradesh, India, 521109

ABSTRACT: - Sugar-cane bagasse is a fibrous waste-product of the sugar refining industry which is an agricultural product. This waste product (Sugar-cane Bagasse Ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse Ash has mainly contains silica and aluminum ion. In this project, the Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%, 10%, 15% and 25% by the weight of cement in concrete. Ordinary Portland cement was replaced by ground bagasse ash at different percentage ratios. The compressive strengths of different mortars with bagasse ash addition were also investigated. M30 concrete mixes with bagasse ash replacements of 0%, 5%, 10%, 15%, 20% and 25% of the Ordinary The test results indicated that up to 10% replacement of cement by bagasse ash results in better or similar concrete properties and hence environmental and economic advantages can be exploited by using bagasse ash as a partial cement replacement material.

Keywords: Concrete, agro-waste, partial replacement, compressive strength

1. INTRODUCTION

Sugar cane is one of the most important agricultural plants that grown in India. Bagasse is a byproduct of the sugarcane industry. The burning of bagasse leaves bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. It has been known that the worldwide total production of sugarcane is over 1500 million tons. Sugarcane consists about 30% bagasse whereas the sugar recovered is about 10%, and the bagasse leaves about 8% bagasse ash as a waste. The bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness. The higher silica content in the bagasse ash was suggested to be the main cause for these improvements. Although the silicate content may vary from ash to ash depending on the burning conditions and other properties of the raw materials including the soil on which the sugarcane is grown, it has been reported that the silicate undergoes a pozzolanic reaction with the hydration products of the cement and results in a reduction of the free lime in the concrete. Bagasse is commonly used as a substitute for wood in many tropical and subtropical countries for the production of pulp, paper and board, such as India, China, Columbia, Iran, Thailand and Argentina. The present study was carried out on sugar cane bagasse ash (SCBA) obtained by controlled combustion of sugarcane bagasse. This study analyzes the effect of SCBA in concrete by partially replacement of cement at the ratio of 0%, 5%, 10%, 15%, 20%, and 25% by weight. The experimental study examines the compressive strength, spilt tensile strength and flexural strength of concrete. The main ingredients consist of Portland cement, SCBA, river sand, coarse aggregate and water. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water at 28 days. The main objective of the work is to study the effect of partial replacement of cement with bagasse ash on the strength. In this work, we study the comparison between strength variation on normal cement concrete and bagasse ash replaced concrete. From the study we can find out how much economy can be attained on using bagasse ash as partial replacement for cement.

The major work involved is getting the appropriate mix proportions. In the present work, the concrete mixes with partial replacement of cement with bagasse ash were developed using OPC 53 grade cement. A simple mix design procedure is adopted to arrive at the mix proportions. After getting some trail mix, cubes of dimensions 150 mm *150 mm *150 mm, cylinder of dimensions 150mm*300 mm and beams of dimensions 100mm*100mm*150mm was casted and cured in the curing tank. Compressive strength, Split tensile strength and Flexural strength of concrete were conducted to know the strength properties of the mixes. Initially, a sample mix design was followed and modifications were made accordingly while arriving at the trail mixes to get optimized mix which satisfies both fresh, hardened properties and the economy.

Finally, a simple mix design is proposed. From previous experimental works, it was found that an optimal amount of 10%-15% of cement can be replaced with bagasse ash. So, to carry out further experimental studies, the cement was replaced by bagasse ash as 5%, 10%, 15%, 20%, and 25% by weight of cement. The changes in properties of concrete mix are studied.

2. MATERIALS USED

In this section, materials properties and concrete mix design calculations for M30 grade concrete in detail was presented. Raw materials required for the concrete use in the present work are Cement, Coarse Aggregates, Bagasse ash, Fine aggregate, Water.

Ordinary Portland cement:

Ordinary Portland cement is used for general constructions. The raw materials required for manufacture of Portland cement are calcareous materials, such as limestone or chalk and argillaceous materials such as shale or clay.

Sugarcane Bagasse ash

The sugarcane bagasse ash consists of approximately 50% of cellulose, 25% of hemicelluloses and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in sugarcane harvests. In this work sugarcane bagasse ash was collected during the operation of boiler operating in the KCP sugar industry located at Vuyyuru, Krisna Disrict, A.P District, Andhra Pradesh.

Sugarcane is one of the major crops grown in over 110 countries and its total production is over 1500 million tons. In India only, sugarcane production is over 400 million tons/year that cause about 10 million tons of sugarcane bagasse ash as an un-utilized and waste material. According to the world, Brazil leads the world in sugarcane production in 2011 with a 734 TMT tons harvest. India was the second largest producer with 342 TMT tons, and China the third largest producer with 115 125 TMT tons harvest. The average worldwide yield of sugarcane crops in 2011 was 70.54 tons per hectare. The most productive farms in the world were in Ethiopia with a nationwide average sugarcane crop yield of 126.93 tons per hectare.

Design of M30 grade concrete:

Mix proportions obtained for trail are given below:

Cement = 378 kg/ m³
Water = 159litre
Fine aggregate = 797kg
Coarse aggregate = 1238kg
Water Cement ratio = 0.42

3. EXPERIMENTAL WORK

It was proposed to investigate the properties of concrete, cast with partial replacement of cement with bagasse ash in the ratio of 0%, 5%, 10%, 15%, 20% and 25% proportions and cured in water.

Casting of concrete cubes, cylinders and beams:

The test moulds were kept ready before preparing the mix. Moulds were cleaned and oiled on all contacts surfaces then fixed on vibrating table firmly. The concrete is filled into moulds in three layers and then vibrated. The top surface of concrete is strucked off to level with a trowel. The number and date of casting were put on the top surface of the cubes, cylinders and beams. The test results of the cubes added with CI were compared to the test results of the controlled specimen. All the materials used in this investigation i.e. cement, fine aggregate, coarse aggregate, cast iron turnings. The cement, sand, coarse aggregate, cast iron turnings were mixed thoroughly manually. Approximately 25% of water required is added and mixed thoroughly with a view to obtain uniform mix. After that, the balance of 75% of water was added and mixed thoroughly with a view to obtain uniform mix. Care has to be taken in mixing to avoid balling effect.

4. TEST RESULTS

In this section, the experimental observations discussed are presented. The test results such as compressive strength, split tensile strength and flexural strength of hardened concrete of M30 grade replacement of cement with bagasse ash in the ratio of 0%, 5%, 10%, 15%, 20% and 25% proportions mixes at the ages of 28 days are detailed.

The slump for SCBA 5% has decreased 4.7% when compared with the Normal Mix. The slump for SCBA 10%, SCBA 15%, SCBA 20% and SCBA 25% has reduced by 6.9 %, 10.5%, 16.3% and 21% when compared with Normal mix. The slump value was gradually decreases when compared with normal mix. To improve the slumps we can use the chemical admixture like super plasticizer.

Compressive strength:

The compressive strength of the concrete was done on 150 x 150 x 150 mm cubes. A total of 54 cubes were cast for the five mixes. i.e., for each mix 9 cubes were prepared. Testing of the specimens was done at 28 days at the rate of three cubes for each mix on that particular day. The average value of the 3 specimens is reported as the strength at that particular age. The compressive strength test was conducted for all the mixes and the results are shown in the table below.

Table 1. Compressive strength test results

S.No	Mix ID	Compressive Strength (N/mm^2)
		28 Days
1	NORMAL MIX	36.18
2	SCBA 5%	36.89
3	SCBA 10%	37.52
4	SCBA 15%	33.93
5	SCBA 20%	30.07
6	SCBA 25%	24.85

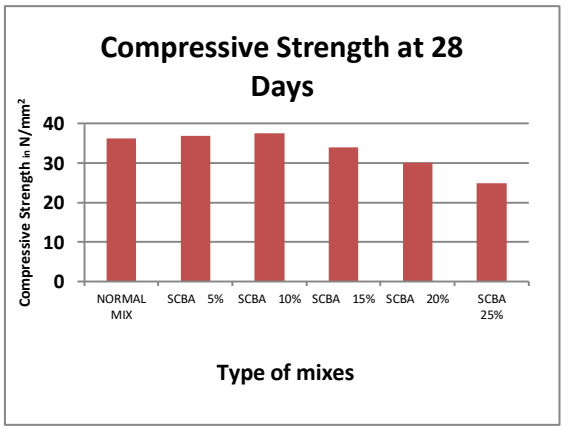

Figure 1. Compressive Strength

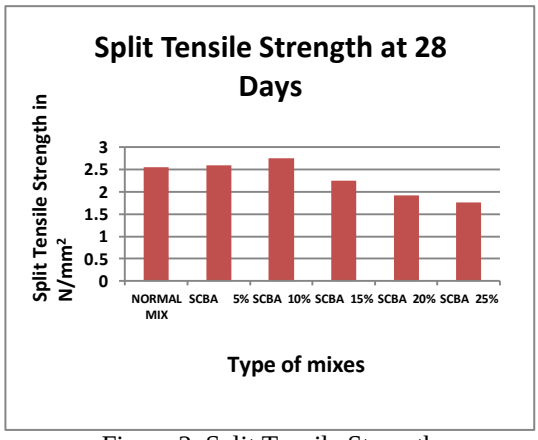

Figure 2. Split Tensile Strength

The compressive strength values obtained by testing standard cubes made with different proportions of SCBA 0%-25%. From the study of all the above percentages of replacements, it was observed that the SCBA 10% gives the optimum compressive strength.

Split tensile strength:
The indirect tensile strength was measured on 150 x 300 mm cylinders and the results were shown below. A total of 54 cylinders were cast for the five mixes. Three specimens were tested each time and the average value at the particular age was reported as the tensile strength of the concrete.

Table 2. Split tensile strength test results

S.No	Mix ID	Split Tensile Strength (N/mm^2)
		28 Days
1	NORMAL MIX	2.55
2	SCBA 5%	2.59
3	SCBA 10%	2.75
4	SCBA 15%	2.25
5	SCBA 20%	1.92
6	SCBA 25%	1.76

The tensile strength values obtained by testing standard cylinders made with different mixes with different bagasse ash proportions of 0-25%. Finally it was observed that the SCBA 10% replacement gives the highest value compared with the other replacements.

Flexural strength:
Flexural strength of the concrete was determined from modulus of rupture test on beam specimens of 100 x 100 x 500 mm size. Here also, a total of 54 specimens were cast out of which three specimens were tested for each mix at 28 days.

Table 3. Flexural strength test results

S.No	Mix ID	Flexural Strength (N/mm^2)
		28 Days
1	NORMAL MIX	5.87
2	SCBA 5%	6.13
3	SCBA 10%	6.43
4	SCBA 15%	5.75
5	SCBA 20%	4.93
6	SCBA 25%	4.13

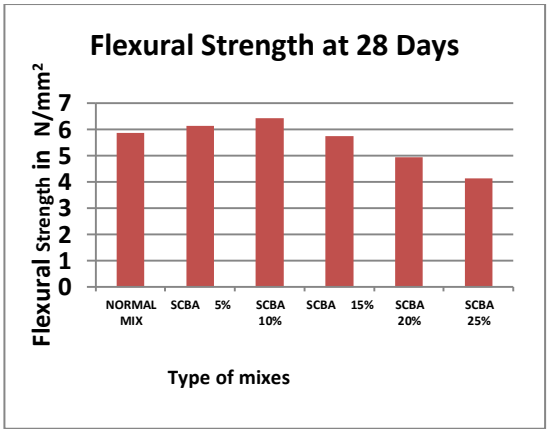

Figure 3. Flexural Strength

The flexural strength values obtained by testing standard cubes made with different SCBA mixes of 0-25%. Finally it was observed that the SCBA 10% replacement gives the highest value compared with the other replacements

5. CONCLUSIONS

Following conclusions can be drawn from the experimental investigation carried out.

1. The compressive strengths of SCBA mixes at the age of 7 days was gradually decreases its strength when compared with normal mix.
2. It was observed that the compressive strength of SCBA 5% and SCBA 10% at the age of 28 days has reached its target mean strength; however the compressive strength was increased by 2.04% and 6.55% when compared with normal mix.
3.It was observed that the compressive strength of SCBA 15%, SCBA 20% and SCBA 25% at the age of 28 days has decreases its compressive strength by 6.15%, 16.92% and34.13% respectively when compared with the normal mix.
4. The split tensile strength of mixes SCBA 5% and SCBA 10% at the age of 28 days has increases its strengths by 4.42% and 9.5% respectively when compared with the normal mix.
5. The split tensile strength of mix SCBA 15%, SCBA 20%, SCBA 25% at the age of 28 days has decreases it strengths by 11.8%, 24.8% and 32.7% when compared with the normal mix.
6. The flexural strength of SCBA 5%, SCBA 10% at the age of 28 days has increases its strength by 4.42%, 9.5% when compared with the normal mix.
7. As a final conclusion, cement can be replaced with bagasse ash up to 10% without much loss in compressive strength. Similar kind of trend was observed with split tensile strength, and flexural strength also.
8. Considerable decrease in compressive strength was observed from 15% onwards cement replacement. It has been shown in this study that 10% sugarcane bagasse ash can be used as a partial cement replacement material with technical and environmental benefits.

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