Experimental Study on Strength of M25 Grade of concrete by Using Bagasse Ash as A Partial Replacement of Cement

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Abstract— This project work is an experimental investigation on Sugarcane Bagasses Ash as a partial replacement of cement. Cement Concrete occupies an important role in the fields of civil engineering. The strength of the concrete is known to vary with some factors such as cement content, type of aggregate, water cement ratio, mixed proportion etc.., efforts have been made and continued to replace these components especially cement with the aim to reduce cost without adverse effect on strength characteristics of concrete. Sugarcane 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 used as a cement replacement material. It Develops industrial waste management system by making the best use of industrial waste. The strength characteristics such as compressive strength, split tensile strength and flexural strength of concrete mix are tested for 7days, 28days and 56days of curing period and Results are analyzed by comparing with conventional concrete mix. Test for grade as per specified procedure of IS codes. Hence, it is an environmental friendly methods of construction to establish strategies, to find economical means of construction by using Bagasse Ash.

Key words: Concrete mix, Bagasse ash, Compressive Strength, Spilt tensile Strength and Flexural Strength

I. INTRODUCTION

The industrial and economic growth witnessed in recent decades has brought with it an increase in the generation of different types of waste (urban, industrial, construction etc.) despite the waste management policies which have been adopted nationally and internationally the practice of dumping and/or the inadequate management of waste from the various manufacturing sectors have had a notable impact on the receiving environment. At the same time, these practices represent an economic cost. However if waste is managed correctly it can be converted into a resource which contributes to savings in raw materials, conservation of natural resources and the climate, and promotes sustainable development.

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. Despite variety use of bagasse, for production of wood, papers, animal food, compost and thermal insulation, statistics show that about one million tone extra of bagasse ash remains in the country

Sugarcane consists about 30% bagasse whereas the sugar recovered is about 10%, and the bagasse leaves about 8% bagasse ash (this figure depend on the quality and type of the boiler, modern boiler release lower amount of bagasse ash) as a waste. As the sugar production is increased, the quantity of bagasse ash produced will also be large and the disposal will be a problem.

Sugarcane bagasse ash has recently been tested in some parts of the world for its use as a cement replacement material. 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.

The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from the E.I.D Parry (India) Limited near Sankili village, Palakonda in Srikakulam district,AP. 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 7 days, 28 days and 56 days.

II. MATERIALS AND THEIR PROPERTIES

Raw materials required for the concrete use in the present work are

- Cement
- Fine aggregate
- Coarse aggregate
- Bagasse ash
- Water

A. *Cement:*

Cement may be defined as the adhesive substance capable of uniting fragments or masses of solid matter to a lumped whole Lea et al. (1970). Various types of cements can be used in the concrete production. It should be fresh, free from foreign matters and of uniform consistency.

B. Fine Aggregate:

The most common fine aggregate used in the concrete is river sand. River sand is a vital ingredient in making the two most normally used construction material viz. cement concrete and mortar. The sand should be clean, hard, strong and free from the organic impurities and deleterious substances. It should be capable of producing a sufficiently workable mix with minimum water-cement ratio.

C. Coarse Aggregate:

The aggregates are formed due to natural designation of rocks or by artificial crushing of the rock or gravel. Specific gravity and fineness modulus of aggregate is 2.65 and 6.98 respectively.

D. 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 and relatively small amounts of soluble solids. Nearly all bagasse produced in India is burnt for energy needed for sugar processing. The surplus energy is convened into electricity. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO2).

E. Water:

Mixing water should be clean, fresh and potable. Water should be free from impurities like clay, loam, soluble salts which leads to deterioration in properties of concrete. Potable water is fit for mixing and curing of concrete.

S. No	Property	Test results
1	Normal consistency	28%
2	Specific gravity	3.10
3	Initial setting time	92 minutes
4	Final setting time	195 minutes

Table 1: Cement

S. No	Property	Value
1	Specific gravity	3.08
2	Fineness modulus	2.28
3	Bulk density: Loose Compacted	 14kN/m^3 15kN/m^3
4	Grading	Zone-II

Table 2: Fine Aggregate

Sieve size	Retained	% retained	Cumulative % retained	%passed
4.75	-----	----	-----	100
2.36	6.5	0.65	0.65	99.3
1.18	80.5	8.05	8.7	91.3
600	149	14.9	23.6	76.4
300	733	73.3	96.9	3.1
150	15	1.5	98.4	1.6
Pan	16	1.6	100	0

Fineness Modulus =2.2

Table 3: Sieve analysis

S. No	Property	Value
1	Specific gravity	2.69
2	Fineness modulus	6.02
3	Bulk density Loose Compacted	 14 kN/m^3 16 kN/m^3
4	Nominal maximum size	20 mm

Table 4: Coarse Aggregate:

Components	Mass %
Silica as SiO_2	70.5
Calcium as CaO	4.7
Potassium as k_2O	12.16
Iron as Fe_2O_3	1.89
Sodium as Na_2O	3.82
Aluminum as Al_2O_3	1.36
Magnesium as MgO	4.68
Titanium as TiO_2	< 0.06
Loss of ignition	0.78

Table 5: Chemical Composition of Bagasse Ash

Properties	Values
Specific Gravity	2.20
Colour	Black
Density (gm/cm^3)	1.20
Moisture content	6.28%
Surface area	1150 m^2/kg
Fineness Modulus	2.32

Table 6: Physical Properties of Bagasse Ash

Fig. 1: of Sugarcane Bagasse Ash:

III. MIX DESIGN

All the mixes prepared are corresponds to M-25 grade. For the design of mix IS: 10262-2009 recommendations are adopted. Design mix proportions of M-25 grade Concrete are given in the following.

Cement = 378 kg/ m^3

Water = 159litre

Fine aggregate: = 797kg

Coarse aggregate = 1238kg

Water Cement ratio = 0.42

Water	Cement	Fine aggregate	Coarse aggregate
0.42	1	2.1	3.2

Table 7:

A. Workability of concrete :

S.No	Mix Id	Slump (mm)
1	NORMAL MIX	86
2	SCBA 5%	83
3	SCBA 10%	82
4	SCBA 15%	79
5	SCBA 20%	74
6	SCBA 25%	70

Table 8:

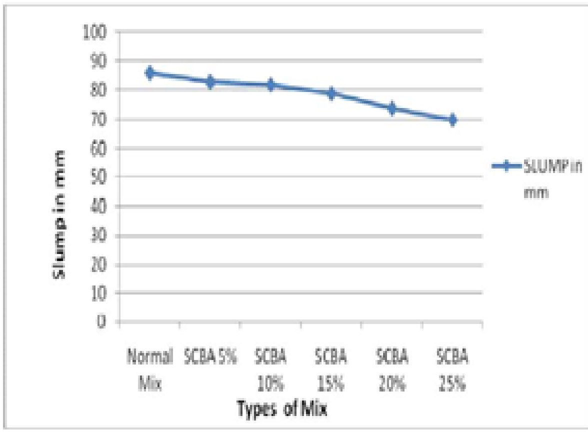

Fig. 2:

B. Preparation of Specimens

Specimens	No. of specimen cured in water					
	NORMAL MIX	SCBA 5%	SCBA 10%	SCBA 15%	SCBA 20%	SCBA 25%
Cubes	9	9	9	9	9	9
Cylinders	9	9	9	9	9	9
Beams	9	9	9	9	9	9
Total	27	27	27	27	27	27

Table 9:

IV. TEST RESULTS

A. Compressive strength:

The compressive strength of a material is that value of uni-axial compressive stress reached when the material fails completely. The compressive strengths of concrete has been evaluated by testing cubes of size 15cm*15cm*15cm.

The compressive strength is determined by the ratio of failure load to the cross sectional area of the specimen.

S.No	Mix id	Compressive Strength (N/mm²)		
		7 Days	28 Days	56 Days
1	NORMAL MIX	29.13	36.18	37.11
2	SCBA 5%	28.15	36.89	37.85
3	SCBA 10%	27.26	37.52	38.03
4	SCBA 15%	24.44	33.93	34.59
5	SCBA 20%	21.93	30.07	30.74
6	SCBA 25%	19.26	24.85	25.70

Table 10:

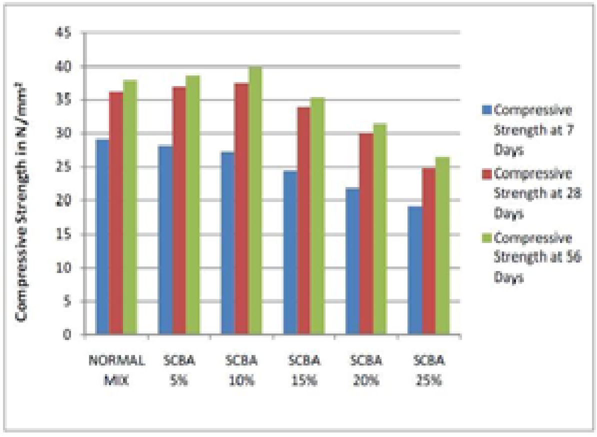

Fig. 3:

B. *Split tensile strength:*

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and is continued until failure of the specimen occurs.

Splitting Tensile Strength shall be calculated by using the formula. Fct = 2p/pld

S.No	Mix id	Split Tensile Strength (N/mm²)		
		7 Days	28 Days	56 Days
1	NORMAL MIX	1.89	2.55	2.59
2	SCBA 5%	1.63	2.59	2.65
3	SCBA 10%	1.60	2.75	2.80
4	SCBA 15%	1.42	2.25	2.29
5	SCBA 20%	1.17	1.92	1.98
6	SCBA 25%	1.06	1.76	1.80

Table 11:

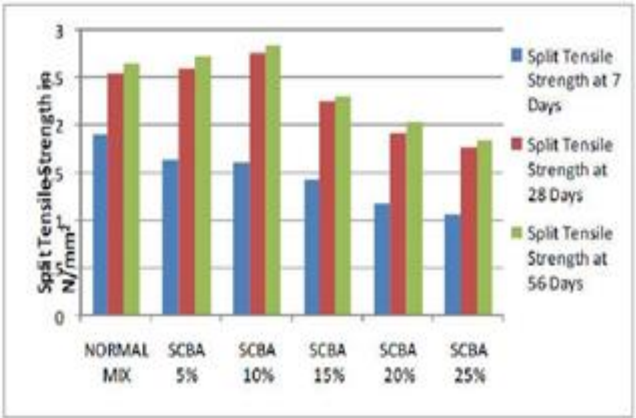

Fig. 4:

C. *Flexural strength*

The flexural strength may be expressed as the modulus of rupture fb,

fb = pl/bd2

When "a" is greater than 20.0 cm for 15 cm specimen, or greater than 13.3 cm for a 10.0 cm specimen

fb = 3p*a/bd2

When a is less than 20.0 cm but greater than 17.0cm for a 15.0 cm specimen, or less than 13.3 cm but greater than 11.0cm for a 10.0cm specimen .

S.No	Mix id	Flexural Strength (N/mm²)		
		7 Days	28 Days	56 Days
1	NORMAL MIX	4.67	5.87	6.10
2	SCBA 5%	4.53	6.13	6.46
3	SCBA 10%	4.53	6.43	6.65
4	SCBA 15%	3.33	5.75	5.83
5	SCBA 20%	3.20	4.93	5.02
6	SCBA 25%	3.07	4.13	4.58

Table 12:

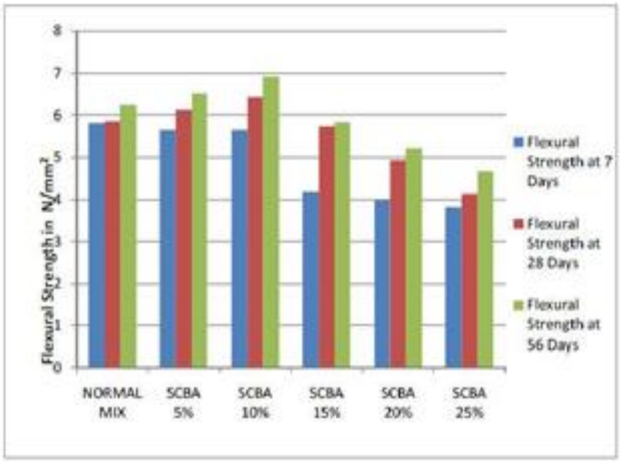

Fig. 5:

V. CONCLUSION

- There is a change in slump for SCBA 5% has decreased 3.5% when compared with normal mix.
- The slump for SCBA 10%, SCBA 15%, SCBA 20% and SCBA 25% has reduced by 4.7%, 8.2%, 14% and 18.7% respectively when compared with the normal mix.
- To get the required slump use the admixtures.
- The compressive strengths of SCBA mixes at the age of 7 days was gradually decreases its strength when compared with normal mix due to pozzolanic activity .
- 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.
- 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.
- 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.

- 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.
- 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.
- The flexural strength of SCBA 15%, SCBA 20% and SCBA 25% at the age of 28 days has decreases it strength by 2.4%, 16.1% and 26.5% when compared with normal mix.
- The strengths of SCBA 5% and SCBA 10% at the age of 56 days increases its compressive, split tensile and flexural strengths when compared with normal mix.
- Similarly the strengths of SCBA 15%, SCBA 20% and SCBA 25% at the age of 56 days decreases its compressive, split tensile and flexural strengths when compared with normal mix.
- Finally concluded that cement can be replaced with bagasse ash up to 10% without much loss its compressive strength.
- Considerable decrease in compressive strength was observed from 15% 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.
- Concerned stakeholder, such as sugar industries, cement industries and relevant government institutions, should be made aware about this potential cement replacement material and promote its standardized production and usage.
- To improve the strengths of SCBA 15%, SCBA 20% using chemical admixtures like micro silica and super plasticizers for improving the strength.

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