International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.06, June 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

GRENNER CONCRETE USING AGRO-INDUSTRIAL WASTE AS A PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economic, environmental and technical reasons. Sugar- cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapor. 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 Portland cement were prepared with water-cement ratio of 0.42 and cement content of 378 kg/m^3 for the control mix. Wet concrete tests like slump cone test, as well as hardened concrete test like compressive strength, split tensile strength and flexural strength at the age of 7days, 28 days and 90 days were carried out. The test results indicated that up to 10% replacement of cement by bagasse ash results in better or similar concrete properties and further environmental and economic advantages can also be exploited by using bagasse ash as a partial cement replacement material.

INTRODUCTION

Concrete is the world's most consumed man-made material. To produce 1 ton of Portland cement, 1.5 tons of raw materials are needed. These materials include good quality limestone and clay. Therefore, to manufacture 1.5 billion tons of cement annually, at least 2.3 billion tons of raw materials are needed. Over 5-million BTU of energy is needed to produce one tone of cement. In the year 1914, India Cement Company Ltd started cement production in Porbandar with an output of 10,000 tons and a production of 1000 installed capacity. At the time of independence 1947, the installed capacity of cement plants in India was approximately 4.5 million tons and actual production around 3.2 million tons per year. The partial deep control in 1982 prompted various industrial houses to set a setup new cement plants in the country, capacity was nearly 30 million tons, which has now, increase to nearly 120 million tons during a period of 20 years. The full decontrol on cement industry in 1988 further provided momentum for the growth.

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MATERIALS USED

In this chapter, materials properties and concrete mix design calculations for M25 grade concrete in detail was presented. Mix design summary for M25 under study are covered in this chapter.

Materials and their properties:

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

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

Table 3.1 Physical properties of cement

S. No	Property	Test results
1	Normal consistency	29%
2	Specific gravity	3.10
3	Initial setting time	92 minutes
4	Final setting time	195 minutes

MIX DESIGN

Design of M25 grade concrete:

Stipulations for proportioning:

a) Grade designation : M30
b) Type of cement : OPC 53grade confirming IS: 12269
c) Minimum Cement content : 300 kg/m³
d) Maximum nominal size of aggregate : 20 mm
e) Maximum water – cement ratio : 0.5
f) Workability : 100 mm (slump)
g) Exposure condition : Moderate
h) Method of concrete placing : Non Pumpable
i) Degree of supervision : Good
j) Type of aggregate : Crushed angular aggregate
k) Test data for materials:
l) Cement used : OPC 53 grade confirming IS: 12269
m) Specific gravity of cement : 3.10
n) Mineral admixture : ----------
o) Specific gravity of
1) Coarse aggregate : 2.69

2) Fine aggregate : 3.08

3) Bagasse Ash : 2.3

p) Water absorption

1) Coarse aggregate : 0.5%s

2) Fine aggregate : 1.0%

q) Free (Surface) moisture

1) Coarse aggregate : NIL

2) Fine aggregate : NIL

r) Sieve analysis

Fine aggregate : Confirming to grading Zone II of Table 4 of IS: 383

EXPERIMENTAL WORK

Objective of testing:

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.

Table 5.1 No. of specimens prepared for determining hardened properties.

Specimens	No. of specimen cured in water					
	RMAL MIX	CBA 5%	CBA 10%	CBA 15%	CBA 20%	CBA 25%
Cubes	9	9	9	9	9	9
Cylinders	9	9	9	9	9	9
Beams	9	9	9	9	9	9

Hardened properties of concrete:

Compression test:

Compression test was conducted on 150mm×150mm×150mm cubes. Concrete specimens were removed from curing tank and cleaned. In the testing machine, the cube is placed with the cast faces at right angles to that of compressive faces, then load is applied at a constant rate of 1.4 kg/cm^2/minute up to failure and the ultimate load is noted. The load is increased until the specimen fails and the maximum load is recorded. The compression tests were carried out at 7 days, 28 days and 90 days. For strength computation, the average load of three specimens is considered for each mix. The average of three specimens was reported as the cube compressive of strength.

Split tensile strength test:

The cylinder specimen is of the size 150 mm diameters and 300mm length. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of compression testing machine and the load is applied until failure of cylinder, along its longitudinal direction. The cylinder specimens are tested at 7 days, 28 days and 90 days.

Figure 5.5: Split tensile strength Test of Cylinder

Flexural strength test:

In the flexural strength test theoretical maximum tensile stress reached at the bottom fibres of the test beam is known as the modulus of rupture. When concrete is subjected to bending stress, compressive as well as tensile stresses are developed at top and bottom fibres respectively. The strength shown by the concrete against bending is known as flexural strength. The standard size of specimen is 100mm×100mm×500m with a span of 600mm.

Figure 5.6: Flexural strength test of beam

TEST RESULTS

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 7 days, 28 days and 90 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

Table 6.2 Compressive strength test results

S.No	Mix id	Compressive Strength (N/mm^2)		
		7 Days	28 Days	90 Days
1	NORMAL MIX	29.13	36.18	37.93
2	SCBA 5%	28.15	36.89	38.67
3	SCBA 10%	27.26	37.52	39.85
4	SCBA 15%	24.44	33.93	35.41
5	SCBA 20%	21.93	30.07	31.56
6	SCBA 25%	19.26	24.85	26.52

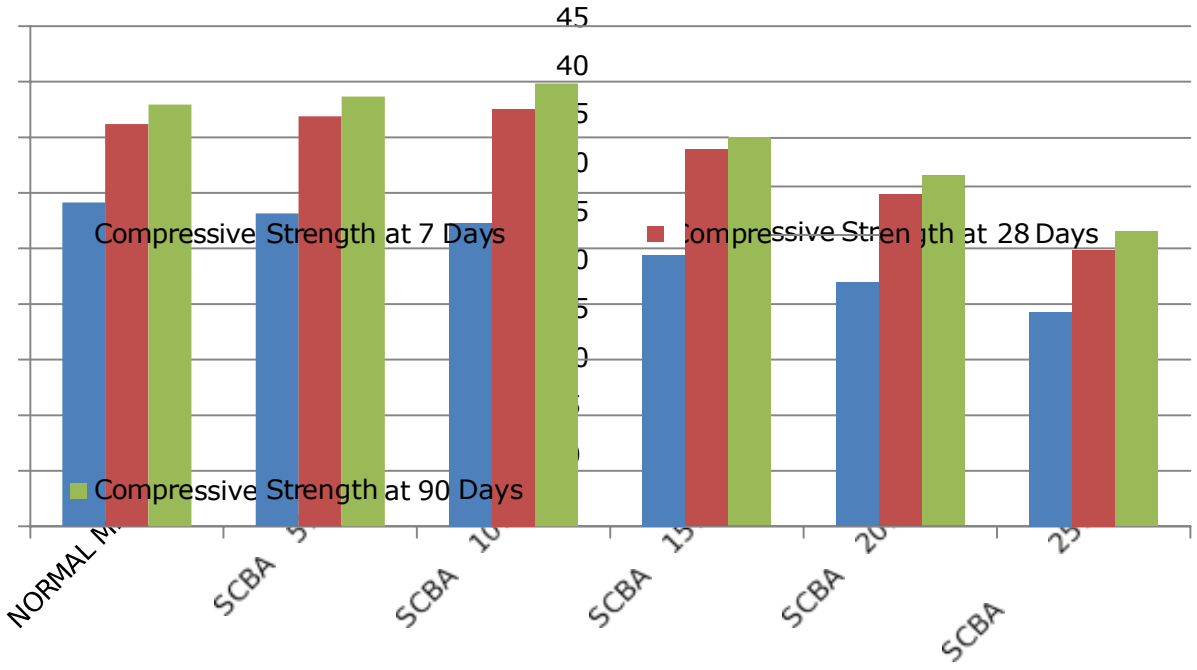

Figure 6.2 Compressive Strength vs age

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 6.3 Split tensile strength test results

S.No	Mix id	Split Tensile Strength (N/mm^2)		
		7 Days	28 Days	90 Days
1	NORMAL MIX	1.89	2.55	2.64
2	SCBA 5%	1.63	2.59	2.72
3	SCBA 10%	1.60	2.75	2.83
4	SCBA 15%	1.42	2.25	2.31
5	SCBA 20%	1.17	1.92	2.03
6	SCBA 25%	1.06	1.76	1.83

Figure 6.3 Split Tensile Strength graph vs age

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 7days, 28 days and 90 days.

Table 6.4 Flexural strength test results

S.No	Mix id	Flexural Strength (N/mm^2)		
		7 Days	28 Days	90 Days
1	NORMAL MIX	4.67	5.87	6.25
2	SCBA 5%	4.53	6.13	6.52
3	SCBA 10%	4.53	6.4	6.92
4	SCBA 15%	3.33	5.7	5.85
5	SCBA 20%	3.20	4.9	5.22
6	SCBA 25%	3.07	4.1	4.66

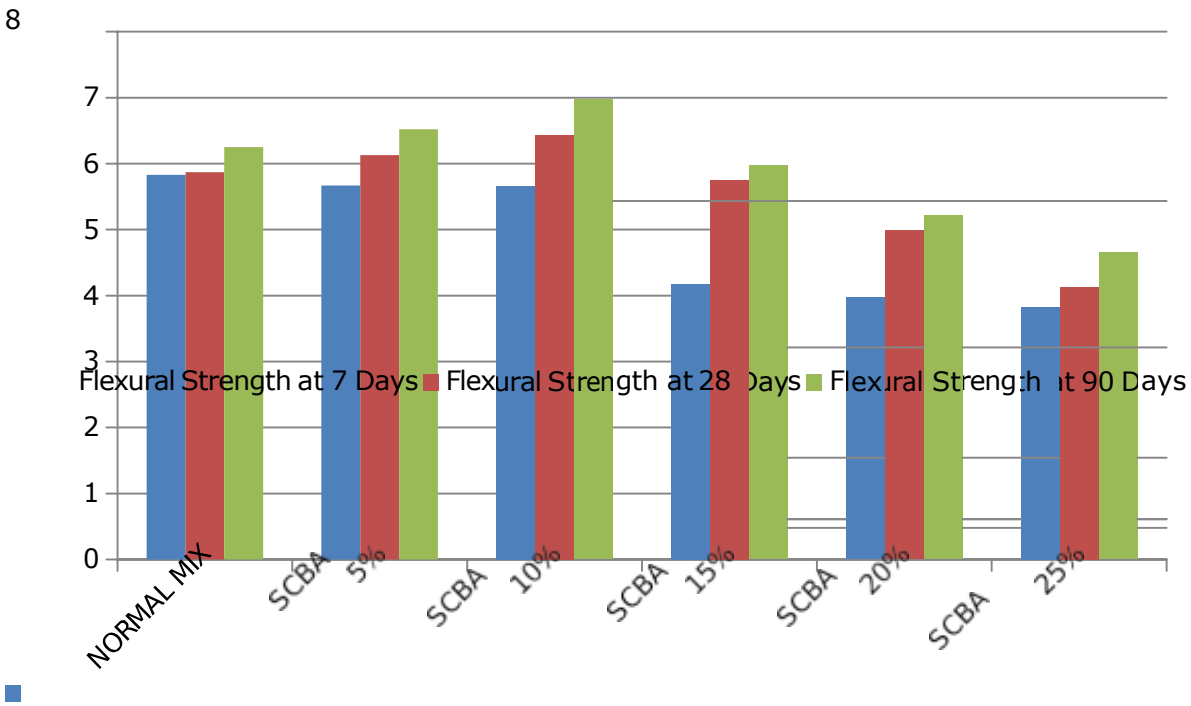

Figure 6.4 Flexural Strength graphvs Age

CONCLUSIONS

Based on the study, following conclusions can draw.

i. There is a change in slump for SCBA 5% has decreased 3.5% when compared with normal mix.

ii. 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.

iii. The compressive strengths of SCBA mixes at the age of 7 days was gradually decreases its strength when compared with normal mix.

iv. 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.

v. 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.

vi. 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.

vii. 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.

viii. 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.

ix. Cement can be replaced with bagasse ash up to 10% without much loss in compressive strength.

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