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Experimental Study on Durability of Concrete by Partial Replacement of Cement with Sugarcane Bagasse Ash

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***Abstract*: India is the second largest producer of sugarcane in the world. In India sugarcane is used to produce Jaggery, Sugar etc. During making of these products a large quantity of wastes is generated. These are considered as agricultural wastes. These wastes should be effectively managed otherwise will cause pollution problems around the sugar industries. On the other hand, there is an increase in construction activities around the world which has caused shortage of concrete making materials, especially cement. Therefore, replacement for cement are being experimented all around the world with materials having similar properties like cement. Samples of sugarcane bagasse ash was taken from sugar industry in Mandya, Karnataka. Sugarcane bagasse ash was obtained by burning sugarcane bagasse at 600 degrees centigrade and the ash was ground until particle passing 53 micrometer sieve. When it was characterized it had chemical composition of 70% Silica with ethanol vapor. This paper experiments by using sugarcane bagasse ash as partial replacement of ordinary Portland cement of 43 grade by weight. Six different concrete mix with bagasse ash replacement of 0%, 5%, 10%, 15%, 20%, 25% to OPC were prepared for M20 grade concrete with water to cement ratio of 0.4. 150*150*150mm concrete cubes were casted and tested for compressive strength at curing period of 7 and 28 days. The properties of the mixes were assessed both at fresh and hardened state and the compressive strength results shows that 10% replacement gives maximum strength when compared with nominal concrete without any replacements.**

***Keywords*: Sugarcane bagasse ash (SCBA), Concrete, Ordinary Portland Cement, Curing.**

1. Introduction

Sugarcane Bagasse ash is a byproduct of sugar factories found after burning sugarcane Bagasse, which itself is found after the extraction of all economical sugar from sugarcane. Sugarcane production in India is over 300 million tons/year that cause about 10 million tons of SCBA as un-utilized and waste material. SCB used in this study was obtained from Mandya district (Karnataka). The suitable burning condition was determined as 600ºC for 5 hours after trial burnings were made at 400°, 500°, 600°, 700°, and 800°C temperature and for 3, 5, 6 and 8 hours. Ashes then obtained were grinded and sieved through 53μm sieve in order to increase the specific surface area.

The Sugarcane Bagasse ash utilization would not only be economical, but may also result in foreign exchange earnings 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 Mandya district in Karnataka. This paper analyzes the effect of SCBA in concrete by partial replacement of cement at the ratio of 0%, 5%, 10% 15%, 20% and 25% by weight. The main ingredients consist of Ordinary Portland cement, Sugarcane Bagasse ash, Manufacture sand, coarse aggregate and water. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water for 28 days and tested for compression test at 7 and 28 days.

A. Objective of the study

The main objective of the study is to find out how we can effectively utilize the materials that are coming from factory outlets as waste materials which are causing disposal problems and to control pollution by reducing cement production which is major cause of pollution. With the ever increasing need of development in infrastructure has led researchers and scientists to search for locally available alternative binders that can replace cement partially and are eco – friendly and contribute towards waste management. India being second most sugarcane

producing country in the world, also produces substantial amount of Sugar cane bagasse ash which is a fibrous waste product of sugar industry and can be used as an alternate binding material in concrete. This would not only help in waste management but also result in saving in cement production equivalent to alternative binding material used in concrete decreasing the amount of harmful greenhouse gases produced in the process of cement production. With the ever increasing demand and consumption of cement and in the backdrop of waste management, scientists and researchers all over the world are always in quest for developing alternate binders that are environment friendly and contribute towards sustainable management. Sugarcane Bagasse (SCB) which is a voluminous by-product in the sugar mills when juice is extracted from the cane. It is, however, generally used as a fuel to fire furnaces in the same sugar mill that yields about 8-10% ashes containing high amounts of un-burnt matter, silicon, aluminum, iron and calcium oxides. But the ashes obtained directly from the mill are not reactive because of these are burnt under uncontrolled conditions and at very high temperatures. The ash, therefore, becomes an industrial waste and poses disposal problems.

2. Materials used and Basic Test Conducted

The present work, the test was conducted in JSSATE Bengaluru. Therefore, here in this chapter we have discussed about fundamental test conducted on the test material and properties of the materials. The materials used in this study are mentioned below:

A. Ordinary Portland Cement (43 grade)

Cement used for this study was ACC cement of 43 grade.

Table 1
Physical properties of cement

S. No.	Physical properties	Value
1	Specific gravity	2.12
2	Fineness (m^2/kg)	300
3	Moisture content (%)	45
4	Density (kg/m^2)	575
5	Colour	Black

B. Sugarcane Bagasse Ash

Sugarcane Bagasse ash used for this study was taken from a sugar factory near Mandya, Karnataka.

Table 2
Physical properties of Sugarcane Bagasse ash

S. No.	Physical properties	Values
1	Specific gravity	3.156
2	Fineness (m^2/Kg)	310
3	Standard Consistency (%)	35
4	Initial setting time (Min)	40
5	Final setting time (Min)	310
6	Compressive strength (Mpa)	3 days = 25
		7 days = 37
		28 days = 50

C. Manufacture sand

M sand used for this study was supplied by an enterprise in Bengaluru.

Table 3
Physical properties of Manufacture sand

S. No.	Physical properties	Value
1	Specific gravity	2.63
2	Fineness Modulus	3.05
3	Bulk density (Kg/l)	1.397

D. Coarse aggregate

Coarse aggregate used for this study was collected by a quarry near Ramanagara, Karnataka.

Table 4
Physical properties of Coarse aggregate

S. No.	Physical properties	Value
1	Specific gravity	2.70
2	Flakiness index (%)	24
3	Elongation index (%)	33.9
4	Impact value (%)	18.6
5	Bulk density (Kg/l)	1.32

E. Water

Different requirements for suitability of water for concrete based construction are given in code book IS 456 - 2000.

3. Methodology

Material used for this experimental work was evaluated and checked whether it is confirming the IS code and then was adopted in mix design, casting, curing and testing of the specimen were conducted and then came to the conclusion with the interpretation of the result. In this experimental work, 24 numbers of concrete blocks of $15cm^3$ sizes are prepared, and mix design of concrete was done according to Indian standard guidelines for M_{20} grade and the water cement ratio is kept 0.4. Based upon the quantities of ingredient of the mixes, the quantities of sugar cane Bagasse ash for 0%, 5%,10%,15%, 20%, 25% replacement to cement respectively by weight were estimated and it is cured in water for a period of 7 and 28 days. The tests for compressive strength were conducted at 7 and 28 days. These tests were conducted as per the relevant Indian standard specification.

4. Results and Discussions

After Conduction of the compression test, the load at which the concrete specimens broke was taken as its compression strength and was noted down in a tabular column. The tabular column contains percentage replacement of cement and the compression strength obtained by that corresponding mix at 7 days of curing and 28 days of curing respectively. Also a graphical representation is done for the test results.

Table 5
Compressive strength results of 7 days cured specimens

Sample no.	% of SCBA	7 Days (Mpa)
1	0	19.11
2	5	19.72
3	10	21.24
4	15	14.74
5	20	13.95
6	25	13.62

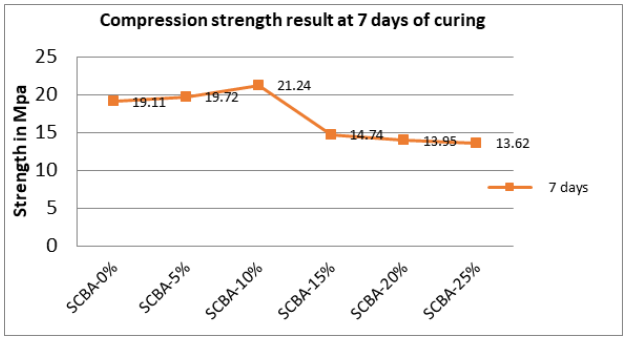

Fig. 1. Compression strength at 7 days

Table 6
Compressive strength results o

Sample no.	% of SCBA	28 Days (Mpa)
1	0	31.85
2	5	32.88
3	10	35.40
4	15	24.58
5	20	23.25
6	25	22.70

f 28 days cured specimens

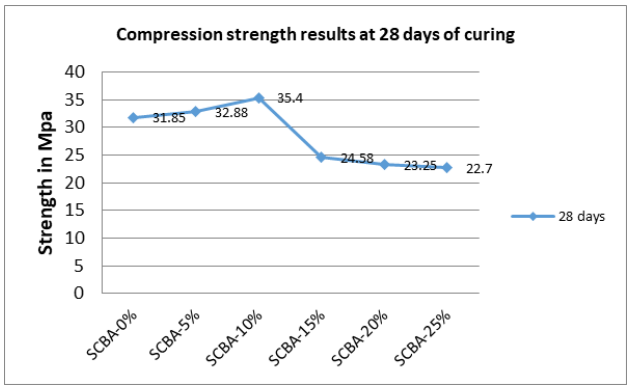

Fig. 2. Compression strength at 28 days

5. Conclusion

In this project, conclusion is done based on the compression test conducted for 0%,5%,10%,15%,20%,25% replacements of SCBA by weight to the cement in concrete for 7 and 28 days of curing.

The conclusions obtained after conduction of this experiment are listed below:

- Since Bagasse ash is a by-product material, its use as a cement replacing material reduces the levels of Co_2 emission by the cement industry. In addition, its use resolves the disposal problems associated with is in the sugar industries.
- The compressive strength results of the concrete have revealed that the concrete with 10% cement replacement by Bagasse ash have shown a 5% compressive strength improvement at 28days over the control concrete with 100% ordinary Portland cement.
- The 15% and 20% replacements shown 3.45% and 12.2% reduction in strength at 28 days over the control concrete.
- Therefore, up to 10% we can say that there is no strength reduction.
- The workability of concrete containing Bagasse ash decreases slightly as the Bagasse ash content increases which is due to the higher water demand of Bagasse ash.

A. Scope for further studies

The main purpose of this part is to make the readers aware of the findings emerging from the study, and shortcomings. The shortcomings for future researchers on a domain that they must consider to save time and avoid repetitive outcomes. Further, this chapter also gives guidelines to researchers on other dimensions and critical estimation from which the topic can be explored. And also the future changes that can be made on this project will also be provided in this chapter.

- Here only compressive strength of the concrete is studied, other properties like split tensile strength, heat resistance, shear, pullout test can be studied.
- This can also be studied in self compaction concrete.
- We can replace fly ash in the place of Sugarcane Bagasse ash for utilization of concrete.
- Can vary mix proportions of the concrete by changing the grade of concrete.
- Can vary the curing period of the concrete and its strength can be checked out.

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