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Utilization of Sugarcane Bagasse Ash as a Partial Replacement by Cement with Normal Concrete

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Abstract: ***This paper presents a detailed investigation of the utilization of refined sugarcane bagasse ash (SCBA) as partial replacement for cement on the properties of fresh and hardened concrete. The study verified that SCBA shows promising results of its use as a cement replacement material (CRM). The potential of SCBA as a CRM was found because of its chemical composition, fineness and well-controlled incineration process. The availability of bagasse is also a positive indicator for the sustainable supply of SCBA as CRM. In the world, approximately 1500 Mt of sugarcane is annually produced, which yields approximately 40–45% bagasse after juice extraction in sugar mills. In this study, SCBA content was varied from 5 to 20% as partial replacement of cement. The effects of SCBA on the workability, compressive strength and splitting tensile strength of concrete were investigated. The results showed that the replacement of SCBA (5–50% content) increased the slump value of fresh concrete. The mechanical properties (compressive strength and splitting tensile strength) of concrete made of 5% SCBA showed a reasonable enhancement in the results in comparison with the 100% cement concrete***
Keywords: Sugarcane Bagasse Ash (SCBA), compressive and splitting tensile strength. Cement replacement material (CRM).

I. INTRODUCTION

Concrete is the most commonly used construction material in the world. It is basically composed of two components: paste and aggregate. The paste contains cement and water and sometimes other Cementitious and chemical admixtures, whereas the aggregate contains sand and gravel or crushed stone. The paste binds the aggregates together. The aggregates are relatively inert filler materials which occupy 70% to 80% of the concrete and can therefore be expected to have influence on its properties. Ordinary 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 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. The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from sugar factory in kukwada near davangere.

II. LITRATURE REVIEW

The following are past literature review for Sugarcane Bagasse ash replaced by normal concrete.

1) *Pradeep. T:* In this paper, sugarcane bagasse ash was partially replaced for cement in various proportions of 0%, 10%, 15%, 20%, 25%, 30% for various water content ratio such as 0.35, 0.4 & 0.45. For each water cement ratio and replacements 3 cubes were caste.
2) *V.R. Ramkumar et.al:* Made an attempt that the influence of addition of bottom ash has a partial replacement of fine aggregate with various percentage viz. 0%, 10%, 20%, 30% & 40% respectively. Experimental investigation was done using M_{20} mix.
3) *Srinivasan:* Reported by Sugar Cane Bagasse ash. This Bagasse ash mainly containing aluminium and silica. It has been partially replaced in the ratio of 0%,5%,15% and 25% by weight of cement in concrete.
4) *Lavanya M.R et.al:* The tests were conducted as per Bureau of Indian Standards (BIS) codes to evaluate the suitability of SBA for partial replacements up to 30% of cement with varying water cement (w/c) ratio.

III. MATERIALS AND METHODS

Present experimental program methodology adopted has been divided into two phases, the 1st phase deals with to study the physical properties of basic materials and development of normal concrete mixes by using industrial by product such as Sugarcane Bagasse Ash (SCBA) with partial replacement to the mass of cement of ranging from (5%, 10%, 15% & 20%) and the 2nd phase covers the study of fresh and hardened properties. Initially basic materials test such as fine aggregates coarse aggregates, cement, SCBA to achieve fresh properties of normal concrete by trial and error method for different dosage of water reducers .For hardened properties compressive strength and split tensile strength at the age of 7 and 28 days of developed mixes in the laboratory.

A. *Cement:* The cement used for the investigation was Ordinary Portland Cement (OPC-43grade). It confirmed to the requirements of Indian Standard Specification.
B. *Fine Aggregate:* Locally available free of debris and nearly river bed sand is used as fine aggregate. Particles are angular in shape passing 4.75mm and retaining on 150 micron standard sieve. Confirming to IS 383-1970 (part 1).
C. *Coarse aggregates:* The maximum size of aggregate is generally limited to 20mm. Confirming to IS 383-1970 (part 3).
D. *Mixing water:* Water available in the college campus conforming to the requirements of water for concreting and curing as per IS: 456-2000.
E. *Sugarcane Bagasse Ash:* The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemi-cellulose 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. In this sugarcane bagasse ash was collected during the cleaning operation of a boiler operating in the Sugar Factory.

IV. MIX DESIGN

The method of mix design for BCSC proposed and used in this study is based on a code IS 10262-2009.

A. *Procedure For Concrete Mix Design Requires Following Step By Step Process*
1) Calculation of target strength of concrete
2) Selection of water-cement ratio
3) Determination of aggregate air content
4) Selection of water content for concrete
5) Selection of cement content for concrete
6) Calculation of aggregate ratio
7) Calculation of aggregate content for concrete
8) Trial mixes for testing concrete mix design strength

Final quantities for 5%
Cement = 345.00 kg/m^3
Bagasse ash = 38.40 kg/m^3
Fine aggregate =662.25kg/m^3.
Coarse aggregate = 1120.00 kg/m^3
Water content = 209.35kg/m^3
Water-cement ratio = 0.54
Final mix proportion =1: 1.74: 2.92

V. RESULTS AND DISCUSSIONS

The basic materials used in the present work are tested in the laboratory in order to ascertain the properties of different materials to satisfy the codal provisions. Further, tested the cement, fine aggregate and coarse aggregates used in the investigation and the properties of those materials evaluated in the laboratory are tabulated in **Tables 4.1** and **4.2** respectively.

Table I
Test results of cement and Bagasse ash

Sl. No	Material	Test	Result
1	Cement	Specific gravity	3.10
		Initial setting time (min)	35
		Final setting time (min)	295
		Fineness (%)	7.6
2	Bagasse ash	Specific gravity	2.06

Table II
Test results of Fine and coarse aggregate

Sl. No	Material	Test	Result
1	Fine Aggregate	Specific gravity	2.60
		Water absorption (%)	1.35
		Fineness Modulus	3.0
2	Coarse Aggregate	Specific Gravity	2.65
		Water absorption (%)	0.8

The test results of cement, Bagasse ash, fine aggregate and coarse aggregates obtained in the laboratory satisfies as per BIS Code requirements.

1) *Test on Fresh Concrete:* To determine the slump for the given concrete mix in the laboratory. One of the best method to determine the workability of IS code Provision. the following are the slump test trails as below.

Table III
Slump test

W/C Ratio	Initial Reading(mm)	Final Reading (mm)	Type of slump	Slump value(mm)
0.45	300	300	True slump	0
0.50	300	270	-	30
0.55	300	231	Shear slump	69
0.60	300	206	Collapse	94

2) *Hardened Properties*: The important hardened properties are compressive and splitting tensile strengths. However in the present investigation they are evaluated by replacing cement by Bagasse ash. The compressive strength results of concrete, when cement is partially replaced by Bagasse ash for different ages are reported in Table 4.3 and conforming to IS 516 1959.

Table IV
Compressive strength results of concrete for various replacement levels of SCBA concrete with different ages.

Specifications	7-days (MPa)	28- days (MPa)
SCBC 0%	18.55	26.04
SCBC 05%	20.22	27.47
SCBC 10%	18.60	26.51
SCBC 15%	15.80	24.10
SCBC 20%	13.94	21.02

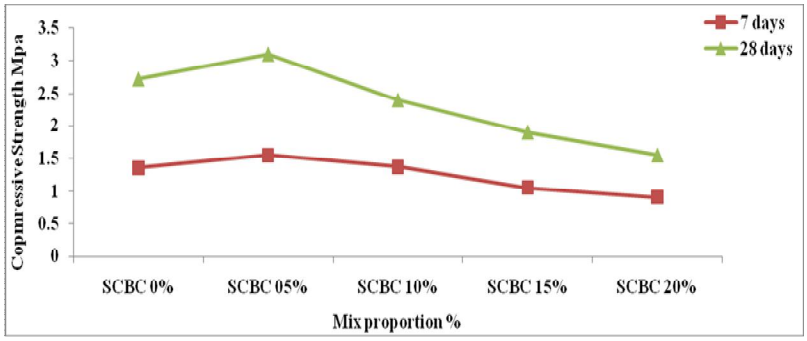

Fig.4.1: Comparison between compressive strength for 7 days and 28 days SCBA concrete.

a) Observation: The above graph 4.1 indicates that the comparison between Normal concrete and SCBA concrete. It observed that utmost compressive strength for 7 days and 28 days is 5% replacement of Bagasse ash and strength decreases gradually with the increase in percentage of Bagasse ash.

Table V. Splitting tensile strength results of concrete, cement is partially replaced by SCBS for different ages

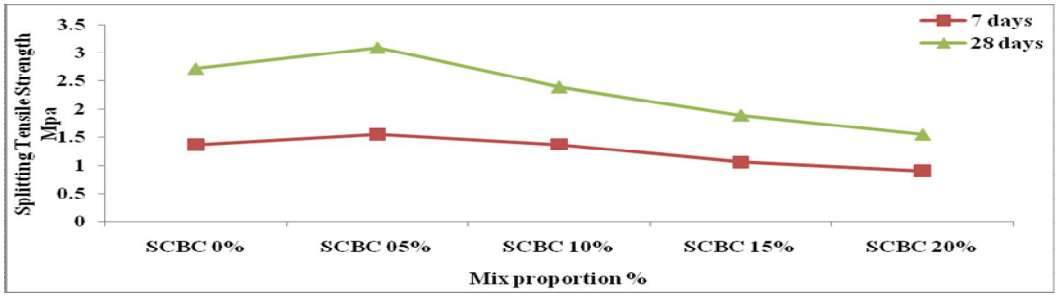

Fig.4.2: Graph of splitting tensile strength of SCBA concrete at 7 and 28 days

b) Observation: The above graph 4.2 indicates that the comparison between Normal concrete and SCBA concrete. It observed that maximum splitting tensile strength for 7 days and 28 days is 5% replacement of Bagasse ash and strength decreases gradually with the increase in percentage of Bagasse ash.

VI. CONCLUSIONS

This research was successfully carried out, to the establishment of SCBA as an alternative cement replacement material in concrete. After the detailed investigation the following conclusions have been drawn:

A. SCBA in concrete gives the higher compressive strength as compared to the normal strength concrete, hence optimal results were found at the 5% replacement of cement with SCBA.
B. SCBA in concrete gives the maximum splitting tensile strength as compared to the normal strength concrete, hence optimal results were found at the 5% replacement of cement with SCBA.
C. The usage of SCBA in concrete is not only a waste-minimizing technique; also it saves the amount of cement.
D. The replacement of cement with SCBA increases the workability of fresh concrete; therefore, use of super-plasticizer is not essential.
E. It is recommended that future research should be performed to assess the use of SCBA in concrete for several properties of concrete for example modulus of elasticity, flexure test, drying shrinkage etc.

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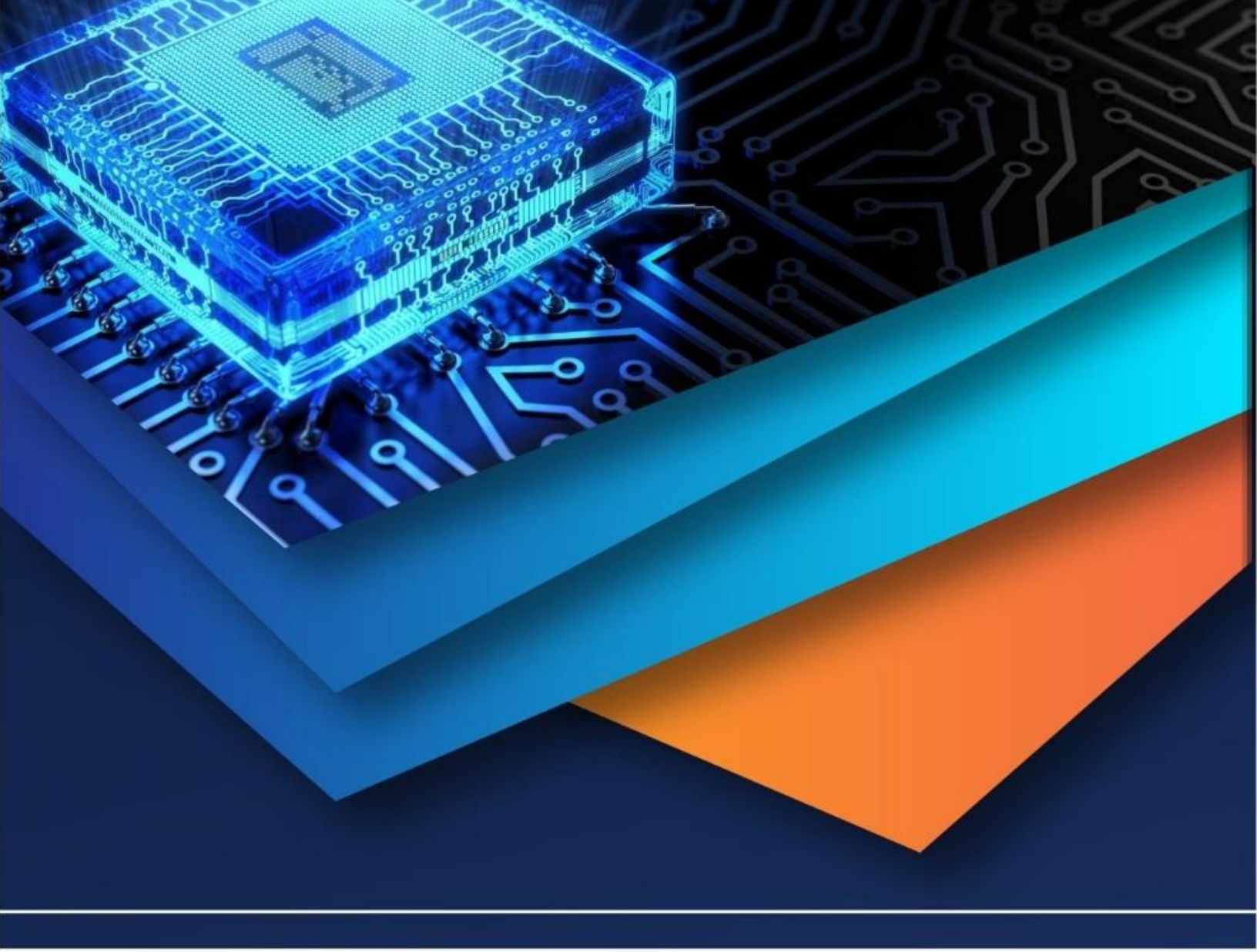

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