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STUDIES ON MECHANICAL PROPERTIES OF CONCRETE USING SUGARCANE BAGASSE ASH (SCBA)

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ABSTRACT: *Utilization of industrial and agricultural waste in the industry has been the focus of research for economical, environmental and technical reasons. Sugarcane bagasse ash (SCBA), an industrial waste, is hazardous, if disposed off in normal environment. However, is being used as fuel in the same sugarcane mill that leaves 8-10% ash containing unburnt matter, silica and alumina. As crystallization of minerals occurs at high temperatures, these ashes are not so reactive. Hence, in order to increase the reactivity between the cement and SCBA use of activators, mineral admixtures and plasticizers is essential depending upon the required conditions. The Chemical properties of SCBA and Fly Ash are nearly same. Fly ash is already being used as replacement for cement in concrete but SCBA is not that widely used, which encouraged us to take up this topic for the project.*
This SCBA is produced in abundant quantity in places surrounding Bagalkot. So, an attempt is made to compare the results of compressive strength and split tensile strength of the specimens with and without the replacement of Sugarcane bagasse ash. Specimens are prepared for Normal Strength (less than 50MPa) and High Strength (above 50MPa) concrete. Specimens for M20, M40, M60 and M80 grade of concrete are cast and the same results are discussed further.
Keywords– *Sugarcane Bagasse Ash, Activator, Plasticizer, Fly Ash, Crystallization*

1. INTRODUCTION

Sugarcane is one of the major crops grown in over 110 countries and its total production is over 1500 million tons. After the extraction of all economical sugar from sugarcane, about 40-45% fibrous residue is obtained, which is reused in same industry as fuel in boilers for heat generation leaving behind 8-10% ash as waste, known as Sugarcane bagasse ash (SCBA). The SCBA contains high amounts of unburnt matter, silica, alumina and calcium oxides. It is very valuable pozzolona material if carbon free and amorphous ash could be obtained by further combustion. But these ashes are produced under uncontrolled and non-uniform burning conditions with temperatures rising above 1000°c resulting in a crystallization of the matter [1]. Sugarcane production in India is over 300 million ton/year leaving about 10 million tons of SCBA as un-utilized and hence waste material. Sugarcane bagasse ash is normally used as fertilizer in sugarcane plantation.

The application of pozzolanic materials has been extended to the development of high performance concretes used for construction of high specifications. The use of pozzolanas in production of concrete brings positive effects to the environment, since by substituting large quantities of cement in concrete, reduces the problem associated with their disposal [1], and the decrease in the emission of greenhouse gases (CH_4 and CO_2), the main cause of global warming. Each ton of cement produces about one tonne of CO_2 [9] and the cement industry is responsible for 5% of CO_2 emissions worldwide [9]. Some of the most commonly used pozzolanic materials in concrete, such as fly ash and silica fume are sub products of industrial processes [9]. However, there are other pozzolans that have been used on a smaller scale, such as natural pozzolans, metakaolin and agribusiness ashes such as rice husks and sugarcane bagasse ashes [9]. An option to promote the use of pozzolanic materials in developing countries is by studying waste materials that are generated in abundance in the region, and do not require too excessive treatments that make more expensive the final products [9]. One of these materials is the sugar cane bagasse ash (SCBA).

2. NEED OF SUGARCANE BAGASSE ASH (SCBA) USAGE

- ✓ Each ton of cement produces approximately about one ton of CO_2 and cement industry is responsible for the emission of about 5% of CO_2 worldwide [9]
- ✓ Brings positive effect to the environment
- ✓ When used as replacement for cement in concrete, it reduces the problem associated with their disposal
- ✓ Decrease in the emission of greenhouse gases

3. PROCESS OF EXTRACTION OF SCBA

To obtain Sugarcane Bagasse ash (SCBA), burning was carried out in two stages- open burning followed by controlled burning at 600°C for 5 hours (actual procedure), but the SCBA used for our project is collected from Bilagi Sugarcane factory where the burning temperature of SCBA was around 900-1100°C. SCBA so obtained was not fine enough to be blended with the cement; therefore to achieve fineness compared to OPC, the ash obtained after burning was grounded in a ball mill and subsequently screened through 45μ sieve.

TABLE 1 Chemical Properties of OPC and SCBA according to literature [1]

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	LOI
OPC	18.4	5.6	3.0	66.8	1.4	2.8	0.5	2.0
SCBA	62.43	4.38	6.98	11.8	2.51	1.48	3.53	4.73

3.1 Some of the uses of SCBA are as follows

- ✓ It is used as Mineral Admixture
- ✓ It is used as Replacement for Sand
- ✓ It is used as Replacement for Cement
- ✓ It is used for the Extraction of Silica
- ✓ It is used in the manufacture of Tiles in Ceramic industry
- ✓ It is used as fuel in the same sugarcane industry to stoke boilers that produce steam for electricity generation

4. EXPERIMENTAL PROGRAM

4.1General

To accomplish the objectives of the study, the experimental program was carried out on cubes and cylinders. The details of the materials used for these specimens and testing procedure incorporated in the test program are presented in the subsequent sections.

Material Property	Value
Coarse Aggregate	
Specific Gravity	2.86
Water Absorption	1.62%
Sand	
Fineness Modulus	2.63

TABLE	Specific Gravity	2.56

2 Properties of Materials

Cement	
Initial Setting time	95 mins
Final Setting time	3 hrs 5 mins
Specific Gravity	2.7
SCBA	
Specific Gravity	1.36

4.2 Materials used to cast Cubes and Cylinders

- ✓ Cement : Ordinary Portland Cement of 43grade
- ✓ Sand : Natural river sand-well graded passing through 4.75mm sieve
- ✓ Aggregates: Crushed well graded aggregates passing through 20mm and retained on 10mm sieve
- ✓ Bagasse ash: Bagasse ash passing through 45µ is used
- ✓ Gypsum: Passed under 300µ is used
- ✓ Super plasticizer: Conplast SP-430 is used

4.3 Concrete Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of required strength, durability, workability as economically as possible is termed the concrete mix design.

The proportioning of ingredients of concrete is governed by the required performance of two states namely- the plastic state and hardened state. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability therefore, becomes of vital importance.

TABLE 3 Proportioning of Materials

Materials / Grade	Cement (kg/m^3)	Sand (kg/m^3)	Coarse Aggregate (kg/m^3)	w/c	Water (kg/m^3)	Super plasticizer(%)
M20	394.00	666.68	1122.26	0.50	197	-
M40	410.80	719.00	1265.26	0.38	156	0.75
M60	578.60	630.70	1053.30	0.28	162	2.0
M80	680.00	695.50	838.80	0.25	170	2.5

5. RESULTS

5.1 General

The testing of various cubes and cylinders specimens has been carried out with respect to the Indian Standard Specifications. The compressive test was carried out with different percentage of bagasse ash.
From the literature survey it can be observed that the compressive strength of cubes and cylinders depends on the percentage replacement of the bagasse ash. Further, with the increase in the percentage replacement of bagasse ash the strength decreases. To improve the strength characteristics Gypsum was added in order to break the crystalline form of the bagasse ash.

Hence, in our present study, concrete cube and cylinder specimens, with and without using bagasse ash are prepared and tested. Different percentage of bagasse ash was replaced with cement viz. 10%, 20%, 30%.

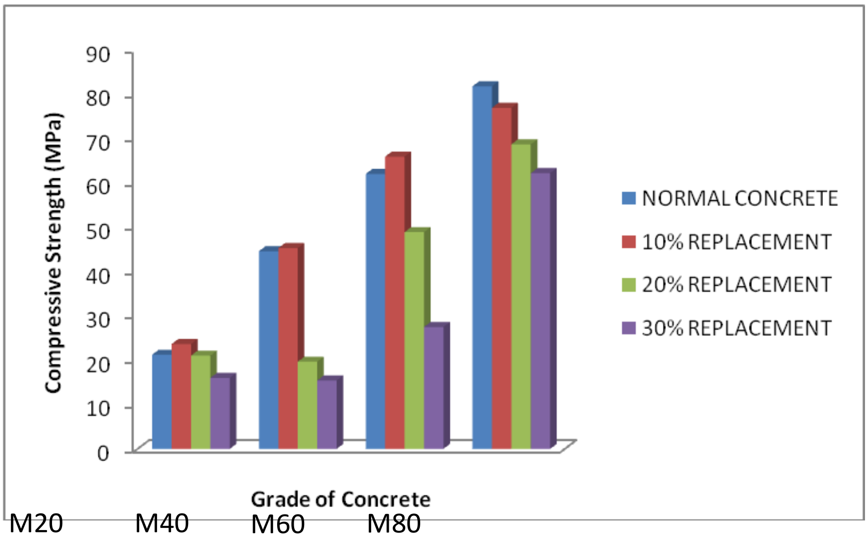

Fig 1 Comparison of Compressive Strength

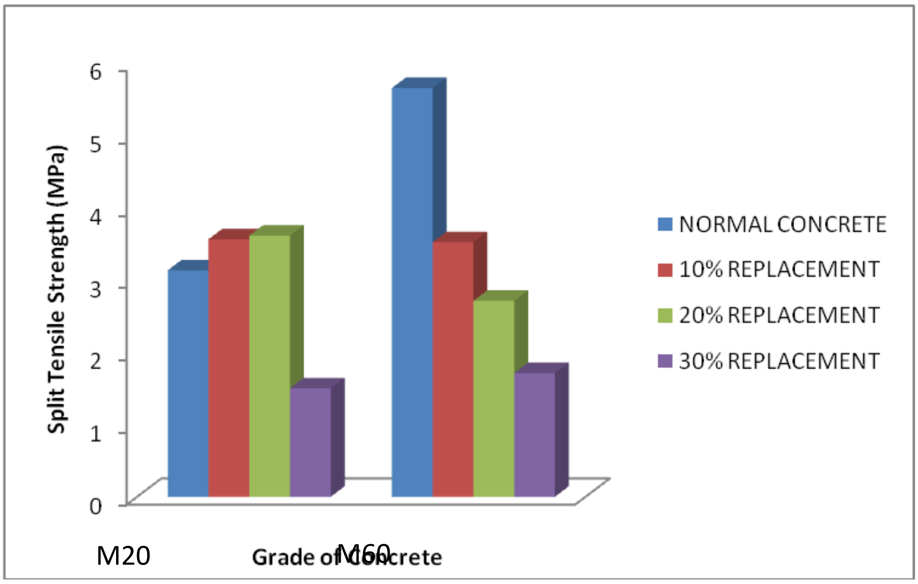

Fig 2 Comparison of Split Tensile Strength

6. CONCLUSIONS

Based on the objectives set in the present study and the experimental work carried out in the laboratory, the following conclusions are drawn.

- ✓ The burning temperature was found to be 900°c - 1100°c. There was uncontrolled burning and cooling of SCBA. According to literature particles burnt above 750°c - 800°c will have crystalline structure
- ✓ The compressive strength test results revealed that for 10%, 20% and 30% replacement of SCBA, the variation in strength for
  - M20 grade of concrete was observed to be : 11.30%, -0.94% and -24.52%
  - M40 grade of concrete was observed to be : 1.58%, -55.8% and -60.8%
  - M60 grade of concrete was observed to be : 6.4%, -21.1% and -55.7%
  - M80 grade of concrete was observed to be : -5.95%, -16.02% and -23.95% compared to normal concrete
- ✓ The results showed that for replacement of SCBA, there is no increase in strength for M80 grade of concrete in compression
- ✓ The Split tensile strength test results revealed that for 10%, 20% and 30% replacement of SCBA, the variation in strength for
  - M20 grade of concrete was observed to be : 13.7%, 15.3% and -52%
  - M60 grade of concrete was observed to be : -37.6%, -52% and -69.72% compared to normal concrete
- ✓ Binding property was inadequate. As the replacement of SCBA increased, the binding of ingredients of concrete was relatively less
- ✓ As the replacement of SCBA increased the water requirement increased, this may be because of high carbon content

REFERENCES

[1] Ajay Goyal, Anwar A.M, Hattori Kunio and Ogata Hidehiko (2007). "Properties of sugarcane bagasse ash and Its Potential as Cement-Pozzolana binder." *Department of Environmental Engineering, United Graduate School of Agricultural Sciences, Tottori University, Japan*

[2] Ganesan K, Rajagopal K, Thangavel K (2007). "Evaluation of bagasse ash as supplementary cementitious material." *Cement and Concrete Composites, Volume 29 (6), 515-524*

[3] Cordeiro G.C, Toledo Filho R.D, Tavares L.M, Fairbairn E.M.R (2008)."Pozzolanic activity and filler effect of sugar cane bagasse ash in Portland cement and lime mortars." *Cement and Concrete Composites 30, 410-418*

[4] Nuntachai Chuslip, Chai Jaturapitakkul, Kriwood Kiattikomol (2009)."Utilization of bagasse ash as a pozzolanic material in concrete." *Construction and Building Materials 23 (2009) 3352–3358*

[5] Almir Sales, Sofia Araujo Lima (2010). "Use of Brazilian sugarcane bagasse ash in concrete as sand replacement." *Construction and Building Materials, Volume 35, October 2012, Pages 829-837*

[6] Rattapon Somna, Chai Jaturapitakkul, Pokpong Rattanachu, Wichian Chalee (2011)."Effect of ground bagasse ash on mechanical and durability properties of recycled aggregate concrete." *Materials & Design, Volume 36, April 2012, Pages 597-603*

[7] Sumrerng Rukzon, Prinya Chindaprasirt (2011)."Utilization of bagasse ash in high-strength concrete." *Materials & Design, Volume 34, February 2012, Pages 45-50*

[8] Souza A.E, Teixeira S.R, Santos G.T.A, Costa F.B, Longo E (2011)."Reuse of sugarcane bagasse ash (SCBA) to produce ceramic materials." *J Environ Manage. 2011 Oct;92(10):2774-80*

[9] Maldonado-Bandala E. E, Jimenez-Quero V, Olguin-Coca F. J, Lizarraga M L. G, Baltazar-Zamora M. A, Ortiz-C A, Zambrano R P, Gaona-Tiburcio C (2011)."Electrochemical Characterization of Modified Concretes with Sugar Cane Bagasse Ash." *International Journal of Electrochemical Science;Oct2011, Vol. 6 Issue 10, p4915*