IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 6 Ver. VI (Nov. - Dec. 2015), PP 12-16
www.iosrjournals.org

Utilization Of Sugarcane Bagasse Ash (SCBA) In Concrete By Partial Replacement Of Cement

Dr.M.Vijaya Sekhar Reddy[1], K.Ashalatha[2], M.Madhuri[2], P.Sumalatha[2]

[1] *Head and Assistant Professor , Department of Civil Engineering , Srikalahasteeswara Institute of Technology, Srikalahasti, Andhra Pradesh, India.*

[2] *Lecturer, Department of Civil Engineering, Srikalahasteeswara Institute of Technology, Srikalahasti, AndhraPradesh, India.*

***Abstract*:** *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 as industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cementing materials (SCMs). Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from sugar industry and the bagasse-biomass fuel in electric generation industry. The utilization of industrial and agricultural waste produced by industrial process has been the focus of waste reduction research for economical, environmental, and technical reasons. Sugarcane Bagasse Ash is a fibrous waste product of the sugar refining industry, along with ethanol vapour. Bagasse ash mainly contains aluminum ion and silica. The present study is aimed at utilizing sugarcane bagasse ash concrete, with partial replacement of cement. The replacement is done at various percentages like 0%, 5%, 10%, 15% and 20% and its effect on properties of concrete was investigated.. Fresh and hardened properties were exercised with various replacement levels. The study indicated that sugarcane bagasse ash can effectively be used as cement replacement (up to 10%) without substantial change in strength.*

Keywords: *Compressive Strength, Concrete, Sugarcane Bagasse Ash and Workability.*

I. Introduction

Ordinary Portland cement is recognized as a major construction material throughout the world. Portland cement is the conventional building material that actually is responsible for about 5% to 8% of global CO_2 emissions. This environmental problem will most likely be increased due to exponential demand of Portland cement. 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. Several researchers and even the Portland cement industry are investigating alternatives to produce green building materials [1].

Sugarcane is major crop grown in over 110 countries and its total production is over 1500 million tons. Sugarcane production in India is over 300 million tonnes per year. The processing of it in sugar-mill generates about 10 million tones of SCBA as a waste material. One tonne of sugarcane can generate approximate 26% of bagasse and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide [2-3].

Sugarcane is a member of the grass family. Sugarcane is a tree-free renewable resource and one of the most important agricultural plants that grown in hot regions. Sugarcane is “carbon neutral” (i.e. emissions are equal to energy generated) and is the product of choice in the manufacture of bio-fuels due to its high energy conversion rate. Bagasse is lateral production of sugarcane that after treatment of sugarcane in the form of light yellow particles is produced. The chemical composition of this product are cellulose fiber, water and some soil soluble material such as cube sugar, by passing time cube sugar is converted alcohol and also the evaporation of bagasse fibre produce the methane gas which can cause fire in some circumstances [4].

II. Literature Review

Ganesan et al., studied the effects of SCBA content as partial replacement of cement (0-30%) on physical and mechanical properties of hardened concrete. The properties of concrete were investigated include compressive strength, splitting tensile strength, water absorption, permeability characteristics, chloride diffusion and resistance to chloride ion penetration. All tests carried out in accordance with Indian Standards. The test results indicated that SCBA is an effective mineral admixture up to 20% replacement was advantageous. The increase in strength may be partially due to the pozzolanic reaction [5].

Nunta chai et al., examined the importance of bagasse ash for development as pozzolanic materials in concrete. The physical properties of concrete containing ground bagasse ash (BA) including compressive strength, water permeability, and heat evolution were investigated and all tests were done in accordance with American Standards. When bagasse ash is ground up into small particles, the compressive strength of concrete containing this ground bagasse ash improves significantly. The low water permeability values of concretes containing ground bagasse ash at 90 days were mostly caused by the pozzolanic reaction. The higher the replacement fraction of Portland cement by ground bagasse ash, the longer the delay time to obtain the highest temperature rise. Concrete containing up to 30% ground bagasse ash had a higher compressive strength and a lower water permeability than the control concrete, both at ages of 28 and 90 days [6].

Kawade et al. studied the effect of use of SCBA on strength of concrete by partial replacement of cement at the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight for compressive strength. If some of raw material having similar composition can be replaced by weight of cement in concrete then cost could be reduced without affecting its quality. It was found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%. Partial replacement of cement by SCBA increases workability of fresh concrete; therefore use of super plasticizer is not essential. Tests were done in accordance with American Standards [7].

Srinivasan et al., studied chemical and physical characterization of SCBA, and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of 7 and 28 days was obtained as per Indian Standards. It was found that the cement could be advantageously replaced with SCBA up to a maximum limit of 10%. 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 concrete [8].

Somna et al.. studied the utilization of a pozzolanic material to improve the mechanical properties and durability of recycled aggregate concrete. Ground bagasse ash (GBA) was used to replace Portland cement at the percentages of 20, 35, and 50 by weight of binder. SCBA used to replace natural coarse aggregate not more than 25% by weight. When GBA was used to partially replace cement in recycled aggregate concrete, the chloride penetration decreased and was lower than those of control concrete at the same immersed time. Compressive strength, modulus of elasticity, water permeability, and chloride penetration depth of the concretes were determined as per American Standards. Recycled aggregate concrete by incorporating SCBA has the modulus of elasticity, lower than that of the conventional concrete by approximately 25–26% [9].

Otuoze et al. concluded that SCBA was a good pozzolana for concrete cementation and partial blends of it with OPC could give good strength development and other engineering properties in concrete. An optimum of 10% SCBA with OPC could be used for reinforced concrete with dense aggregate. The replacement of cement by SCBA was 0-30% and in accordance with American and Brazilian Standards all tests were carried out [10].

Lavanya et al.. examined the partial replacement for cement in conventional concrete. The tests were conducted as per Bureau of Indian Standards (BIS), IS 516-1959 codes to evaluate the suitability of SCBA for partial replacements up to 30% of cement with varying water cement (w/c) ratio .The physical properties of SCBA were studied. Compressive strengths (7, 14 and 28 days) were determined in accordance with Indian Standards. The results showed that the addition of sugarcane bagasse ash improves the strengths in all cases. The maximum strength increase happens at 15% with 0.35 w/c ratio [11].

III. Materials Used In The Present Study

1. Cement

Ordinary Portland cement Zuari-53 grade conforming to IS: 12269-1987 [12] was used in concrete.
The physical properties of the cement are listed in Table 1.

Table 1: Physical Properties of Zuari-53 Grade Cement.

S No	1	2	3	4	5		
Properties	**Specific gravity**	**Normal consistency**	**Initial setting time**	**Final setting time**	**Compressive strength (Mpa)**		
Values	3.15	32%	60 min	320 min	3 days	7 days	28 days
					29.4	44.8	56.5

2. Aggregates

A crushed granite rock with a maximum size of 20mm with specific gravity of 2.74 was used as a coarse aggregate. Natural sand from Swarnamukhi River in Srikalahasthi with specific gravity of 2.60 was used as fine aggregate conforming to zone- II of IS 383-1970 [13]. The fineness modulus of fine and coarse aggregates is 3.16 and 7.19.The individual aggregates were blended to get the desired combined grading.

3. Water

Potable water was used for mixing and curing of concrete cubes.

4. Bagasse Ash

Bagasse Ash was burnt for approximately 72 hours in air in an uncontrolled burning process. The temperature was in the range of 700- 6000 ^{0}C.The ash collected was sieved through BS standard sieve size 75 µm and its colour was black. It was then measured by volume to replace the cement at 5%, 10%,15%and 20%. Bagasse ash is taken from the nearing rice mill factory. Specific gravity given by the manufacturer is about 1.84. Sugarcane Bagasse Ash was collected during the cleaning operation of a boiler operating in the Sakthi Sugar Factory, located in the city of Sathyamangalam, Tamilnadu.The chemical composition of bagasse ash is listed in Table 2.

Table 2: Chemical Composition of the Bagasse Ash.

Composition (% by mass)/property	Bagasse Ash
SiO_2	78.34
Al_2O_3	8.55
Fe_2O_3	3.61
CaO	2.15
Na_2O	0.12
K_2O	3.46
MnO	0.13
TiO_2	0.50
P_2O_5	1.07
Loss on ignition	0.42

IV. Mix Proportioning

In the present work, proportions for concrete mix design of M20 were carried out according to IS: 10262-2009 [14] recommendations. For making the mixes containing sugarcane bagasse ash, the amount of powder is calculated by using the weight of powder, in place of the weight of cement. The resultant mix proportions of all the mixes are tabulated in Table 3.

Table 3: Mix Proportions for M20 Concrete.

Parameters	Percentage Replacement of Bagasse Ash				
	CONTROL MIX	MIX 1 (5%)	MIX 2 (10%)	MIX 3 (15%)	MIX 3 (20%)
W/C Ratio	0.5	0.5	0.5	0.5	0.5
Water kg/cu.m	191.6	191.6	191.6	191.6	191.6
Cement kg/cu.m	383	363.85	344.70	325.55	306.4
Fine aggregates kg/cu.m	727	727	727	727	727
Coarseaggregates kg/cu.m	1103	1103	1103	1103	1103
Bagasse Ash kg/cu.m	0	19.15	38.30	57.45	76.60

V. Results And Discussions

1. Workability Test (Slump Cone Test)

The workability results are presented in Table.4 and Fig 1.

Table 4: Workability Test (Slump Cone Test)

Replacement of Bagasse Ash with Cement (%)	Workability(slump in cm)
Control Mix	23
Mix 1	24
Mix 2	28
Mix 3	25
Mix 4	22

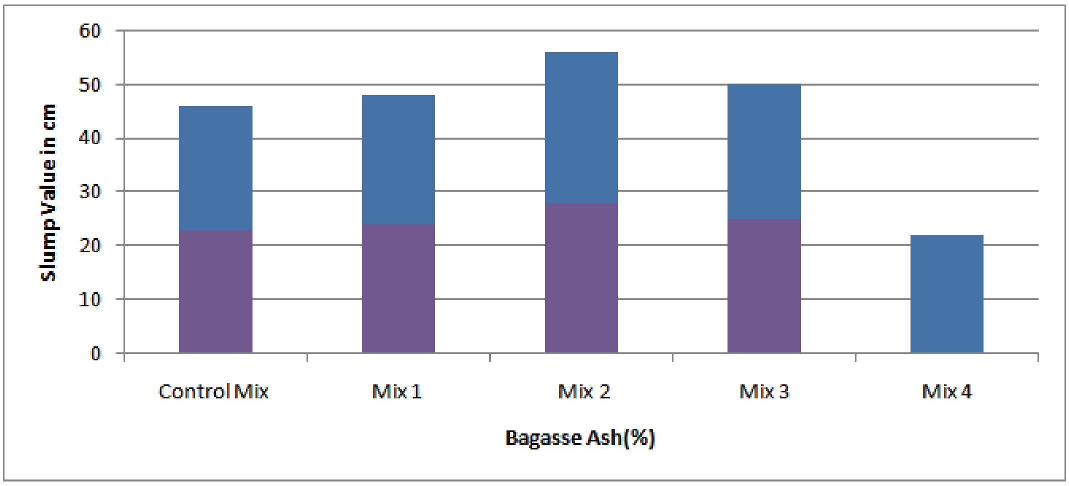

Fig.1 Variation of slump value for different trail mixes

2. Compressive Strength

The tests were carried out as per IS: 516-1959 [15]. The 150mm size cubes of various concrete mixtures were cast to test compressive strength. The cubes specimens after de-moulding were stored in curing tanks and on removal of cubes from water the compressive strength were conducted at 7days, 28days and the results are represented in Table 5 and Fig 2. The test results were compared with controlled concrete.

Table 5. Compressive Strength for Different Trail Mixes

Percentage Replacement of Bagasse ash	Compressive Strength N/mm^2	
	7 Days	28 Days
Control mix	14.12	23.43
Mix 1	18.73	29.75
Mix 2	17.93	30.57
Mix 3	15.22	27.22
Mix 4	13.81	23.13

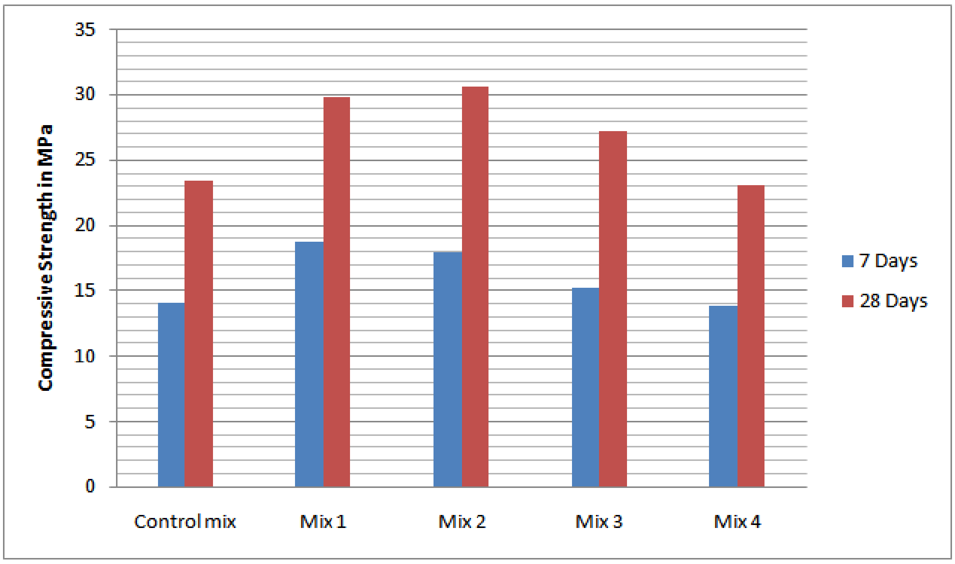

Fig. 2. Variation of Compressive Strength for Different Trail Mixes

VI. Conclusions

The experimental results show that the maximum compressive strengths for seven and 28 days curing period achieved are 17.93 and 30.57 N/mm^2 respectively with 10% replacement of cement by bagasse ash.

The results show that the SCBA in blended concrete had significantly higher compressive strength compare to that of the controlled concrete.

It reveals that the cement could be advantageously replaced with SCBA up to maximum limit of 10%.

Partial replacement of cement by SCBA increases workability of fresh concrete; therefore use of superplasticizer is not substantial.

References

[1]. Aigbodion.V.S, Hassan.S.B, Olajide.S,O, Agunsoye.O.J, AbdulRahaman.A.S. and Okafor.G.E,"The use of rice husk ash as an aggregate for foundry sand production in Nigeria", Proceedings of The Nigerian Metallurgical Society (NMS), Annual *Conference & Annual General Meeting*, 2008 pp 16-22.

[2]. Mrs.U.R.Kawade, Mr.V.R.Rathi, Miss Vaishali and D. Girge, "Effect of use of Bagasse Ash on Strength of Concrete", ISSN: 2319-8753 Vol. 2, Issue 7, 4. Abdolkarim Abbasi and Amin Zargar," Using Baggase Ash in Concrete as Pozzolan", *Middle-East Journal of Scientific Research 13 (6)*:2013 pp716-719.

[3]. Committee Board of sugar cane and sugar Summary of sugar cane and sugar industry in Thailand in 2003/2004, Division of sugar cane and sugar industry Policy,Ministry of Industry,Vol.2 (2004). Bangkok Thailand (in Thai). 4

[4]. Abdolkarim Abbasi and Amin Zargar, "Using bagasse ash in concrete as pozzolan," *Middle-East Journal of Scientific Research,vol.13(6)*, 2013. pp.716-719.

[5]. Ganesan, K., Rajagopal, K., and Thangavel, K. "Evaluation of bagasse ash as supplementary cementitious material" *Cement and Concrete Composites*,2007.

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

[7]. Mrs.U.R.Kawade, Mr.V.R.Rathi, Miss Vaishali and D. Girge, "Effect of use of Bagasse Ash on Strength of Concrete", ISSN: 2319-8753 *Vol. 2, Issue 7*, 2013.

[8]. R.Srinivasan, and K.Sathiya, "Experimental Study on Bagasse Ash in Concrete", *International Journal for Service Learning in Engineering ,Vol. 5, No. 2*, 2010,pp. 60-66.

[9]. Rattapon Somna , Chai Jaturapitakkul ,Pokpong Rattanachu, and Wichian Chalee," Effect of ground bagasse ash on mechanical and durability properties of recycled aggregate concrete", *Materials and Design 36* (2012) 597–603.

[10]. H. S. Otuoze, y. D. Amartey, b. H. Sada, h. A. Ahmed, m. I. Sanni and m. A. Suleiman," Characterization of sugar cane bagasse ash and ordinary portland cement blends in concrete" *procs 4th West Africa Built Environment Research (WABER) conference*, 2012,pp 24-26.

[11]. Lavanya M.R, Sugumaran.B, Pradeep.T, "An Experimental study on the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash", *ISSN: 2278-7461, ISBN: 2319-6491 Volume 1, Issue 11* ,2012, PP01-04.

[12]. IS: 12269-1987, Bureau of Indian standards, New Delhi, India, 53grade Ordinary Portland Cement-specification.

[13]. IS: 383-1970. Specification for coarse and fine Aggregates from natural sources for concrete. Bureau of Indian standards, New Delhi.

[14]. IS: 10262-2009 and SP 23:1982. Recommended Guidelines for concrete Mix. Bureau of Indian Standards, New Delhi.

[15]. IS: 516-1959. Indian Standard Methods of Test for Strength of concrete. Bureau of Indian Standards, New Delhi.