International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June 2018 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON POZZOLOANIC ACTIVITY OF SUGARCANE BAGASSE ASH IN CONCRETE

Arjun T[1], Sandeep Kumar D S[2],Yashwanth M K[3]

[1]P G student, PES College of Engineering, Mandya, Karnataka, India
[2]Assistant professor, PES College of Engineering, Mandya, Karnataka, India
[3] Associate professor, Maharaja Institute of technology Mysore, Mandya, Karnataka, 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 waste, such as blast furnace slag, fly ash silica fume are being used as supplementary cementing materials. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from the 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 fiber waste product of the sugar refining industry, along with ethanol vapor. Bagasse ash mainly contains aluminium ion and silica. The present study is aimed at utilizing sugarcane bagasse ash in concrete, with partial replacement of cement. The replacement is at various percentages 0%, 10%, 15% and 20% and its effect on property of concrete was investigated. Fresh and hardened property was exercised with various replacement levels. The study indicated that sugarcane bagasse ash can effectively be used as cement replacement (up to 10%). Concrete of grade M25 was considered and control mix is designed using IS 10262-2009. Slump cone test result were considered to know the workability of the fresh concrete and mechanical strength properties at the age of 7 and 28days for hardened concrete was considered for the study and compared, with control mix. Along with compressive strength split tensile strength test was also carried out for 28 days .The results are quite promising to use bagasse ash as partial replacement to cement.*

Key Words: **Portland cement, bagasse ash, concrete, compressive strength, split tensile test, slump, water cement ratio, LOI(Loss on ignition)**

1. INTRODUCTION

Cement is the third most energy intensive material after steel and aluminum produced in tones. Cement industry consumes raw materials rich in silica, alumina, iron and calcium. Therefore this industry has been actively involved in finding ways to use waste products in the manufacturing of cement both as secondary fuel and raw material. Sugar manufacturing is the

Major agro industry in India. Initiatives are emerging worldwide to control and regulate the management of sub-products, residuals, and industrial waste in order to preserve the environment from the point of view of environmental contamination as well as the preservation and care of natural areas. Recently the use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation. The most conspicuous of these is sugarcane bagasse ash, a finely ground waste product from the sugarcane industry. In this study, sugarcane bagasse ash (SBA) was replaced for cement in various proportions of 0%, 10%,15%, 20%, and for water cement ratio such 0.45 and its compressive strength and tensile strength were studied.

2. OBJECTIVES OF STUDY

- To characterize the pozzolanic activity of bagasse ash to be used as partial replacement for cement in concrete.
- To ascertain the effect of Bagasse Ash as alternative cementitious material with variable percentages by weight of cement in fresh properties of bagasse ash based concrete to be compared with controlled (normal) concrete.
- To ascertain the effect of Bagasse Ash as alternative cementitious material with variable percentages by weight of cement in hardened properties like compressive strength and tensile strength of bagasse ash based concrete to be compared with controlled (normal) concrete.

3. TEST PROCEDURE.

- The mix design is done for M25 grade concrete as per IS 10262:2009.
- Materials required for casting 12 cubes, 18 cylinders is calculated.
- The ingredients are mixed as per IS 516:1959 in the order of one half of coarse aggregate, fine aggregate, cement or cementitious material and

finally remaining coarse aggregate and then water for not less than 2 minutes using pan mixer in order to obtain homogeneity.

- After mixing, slump test is carried out
- Concrete is poured in to slump cone in 4 layers and each layer is tamped for about 25 times.
- Concrete is poured in to cube moulds in 2 layers and each layer is tamped for about 35 times.
- Concrete is poured in to cylindrical moulds in 4 layers and each layer is tamped for about 35 times.
- The controlled concrete and bagasse ash based concrete cubes, cylinders are allowed to harden before demoulding it.
- The cubes, cylinders are then immersed in water for the process of curing.
- The cubes and cylinders are removed from water and then allowed to dry in air for half an hour then air dried densities are calculated prior to the test.
- The cubes are tested for 7days and 28days compression test.
- The cylinders are tested for 28days split tensile strength test.

5. TESTS ON CEMENT

Table 1 Chemical properties of ordinary cement

Chemical Composition	OPC
SiO_2	18.4
Al_2O_3	5.6
Fe_2O_3	3.00
CaO	66.8
MgO	1.4
SO_3	2.8
K_2O	0.5
LOI	2

Table 2 Physical Properties of ordinary Portland cement

Sl no.	Tests	Results	Requirements as per IS: 12269-2013	Test code
1.	Normal Consistency	28%		IS: 4031(Part 4)-1988
2.	Setting time Initial setting time Final setting time	 35min 520min	 Min 30 mins Max 600 mins	IS: 4031(Part 5)-1988
3.	Soundness	1mm	10mm	IS: 4031(Part 3)-1988
4.	Specific gravity	3.15	3 to 4	IS: 4031
5.	Fineness of cement (by sieve analysis)	2%	10%	IS: 4031
6.	Compressive Strength Test on cement 7days 28days	 33 Mpa 43.2 Mpa	 Min 37 Mpa Min43 Mpa	

6. TESTS ON BAGASSE ASH

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. The ash, therefore, becomes an industrial waste and poses disposal problems. The sample of sugarcane bagasse ash was found to have completely burnt silica-rich fine particles and two different types of carbon-rich fibrous unburnt particles named coarse fibrous particles and fine fibrous particles as shown in fig 1.Therefore, it becomes necessary to recondition the sample for use as pozzolanic material by grinding to a fineness of less than 90 microns and the resulting ash was chemically analyzed and physically characterized.

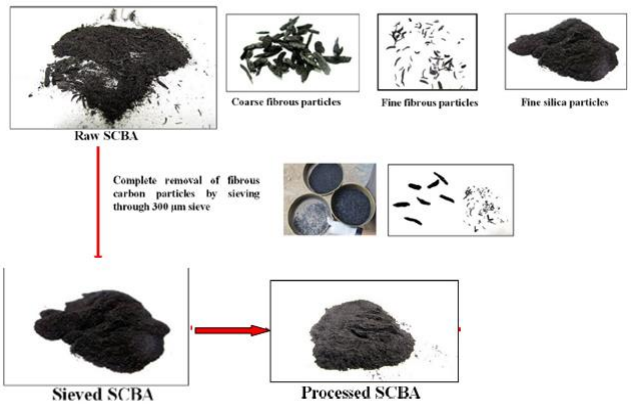

Fig 1: Production of Sugarcane bagasse ash (SCBA)

Table 3 Chemical properties of bagasse ash

Chemical Composition	SiO_2%	Al_2O_3 %	Fe_2O_3%	CaO %	LOI %
Bagasse Ash	59.93	0.22	3.88	2.13	26.93

Table 4 Physical Composition of bagasse ash

Sl no	**Tests**	**Results**	**Recommended Values**
1.	Specific Gravity	2.08	
2.	Bulk Density Kg/m3 Loose Compacted	396.5 462.32	
3	SiO_2+ Al_2O_3+Fe_2O_3	64.03	< 70% or < 60%
4	Loss on Ignition (LOI)	26.93	< 7%

7. TESTS ON FINE AGGREGATE

Table 5 Physical Properties of Fine Aggregates

TESTS	**RESULTS**	**REQUIREMENTS AS PER IS: 383- 1970**	**IS CODE**
Specific gravity	2.68	2.3 to 3	IS: 2386(Part 3)
Fineness modulus	3.01	2.3 – 3.5	IS: 2386(Part 1)
Silt content	1%	<3%	IS: 2386
Water Absorption	4%	<3%	IS: 2386(Part 3)
Bulk Density	1612.9 kg/m3		
Passing 75 micron	1.6%	<3%	

Fig 2 Mixing of Concrete ingredients using Pan Mixer

8. TESTS ON COARSE AGGREGATE

Table 6 Physical Properties of Coarse Aggregate

Sl No.	**Tests**	**Results**	**Requirements as per IS: 383-1970**	**Test IS code**
1.	Specific gravity	2.7	2.5 to 3	IS: 2386(Part 3)-1963
2.	Water absorption	0.502%		IS: 2386(Part 3)-1963
4.	Shape test Flakiness Index Elongation Index	21.65% 19.56%	< 30%	IS: 2386(Part 4)-1963
5.	Crushing value	20.9%	< 45%	IS: 2386(Part 4)-1963

Table 7 Results of slump values for mix proportions

	SLUMP in mm	**CHEMICAL ADMIXTURE**	**TIME**
NC	100	0.5	5
GSBAC 10	140	0.5	4
GSBAC 15	140	1.9	5
GSBAC 20	140	2.2	4

Table 8 Compressive strength of cubes

CYLINDERS	7 Days (MPa)	28 Days (MPa)
NC	23.59	37.11
GSBAC 10	26.84	48.23
GSBAC 15	21.11	32.38
GSBAC 20	18.23	30.23

Table 9 Split Tensile strength of cylinders

CYLINDERS	28 Days (MPa)
NC	2.840
GSBAC 10	2.898
GSBAC 15	2.224
GSBAC 20	2.090

9. RESULTS AND DISCUSSION

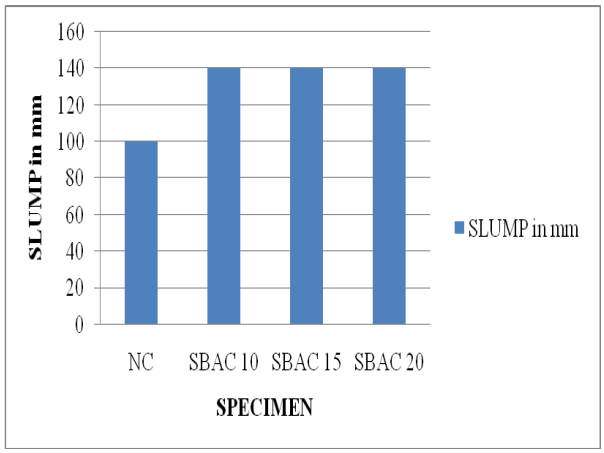

Chart 3 Graph shows the variation of slump with replacement of bagasse ash

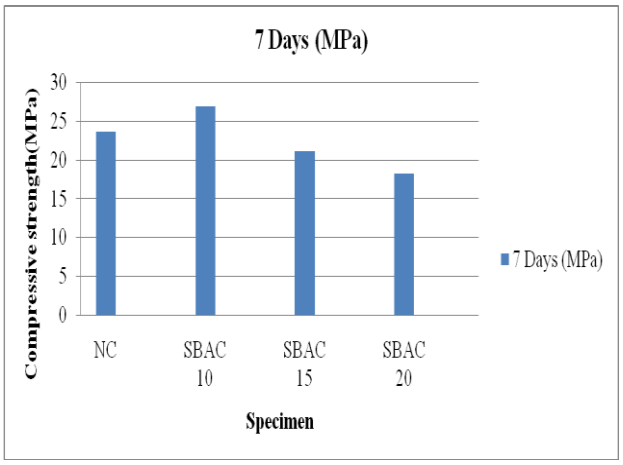

Chart 4 compressive strength of cubes at 7 Days

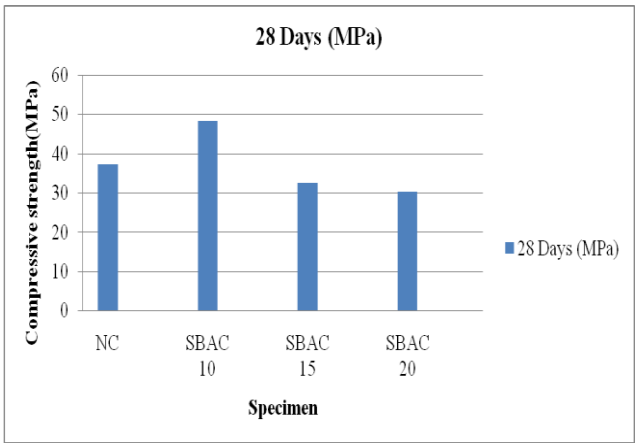

Chart 5 compressive strength of cubes at 28 Days

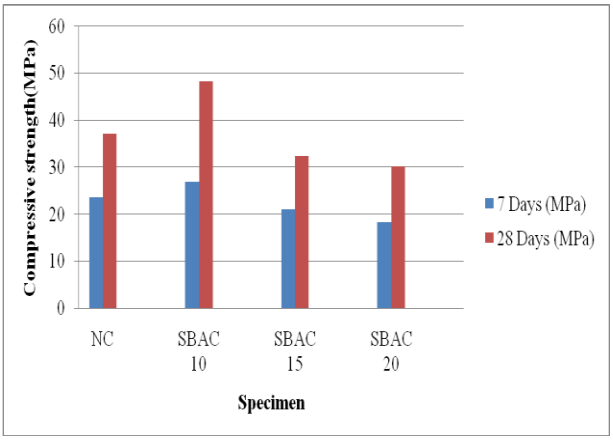

Chart 6 Compressive strength of cubes

From the above graph, it indicates that increase in bagasse ash content there will be increase in compressive strength at 7 days as compared to controlled concrete but after 28 days there will be increase in compressive strength value at 10% as compared controlled concrete beyond that there is a reduction in compressive strength value. There is no gain in

strength at 7 days because since it is a low heat of hydration cement the pozzolonic activity will begin at 28 days and also LOI content is more than the recommended value made concrete decrease in strength.
Decrease in compressive strength values with increase in the substitution ratio indicated that filler effect is predominant only up to 10% ash substitution.

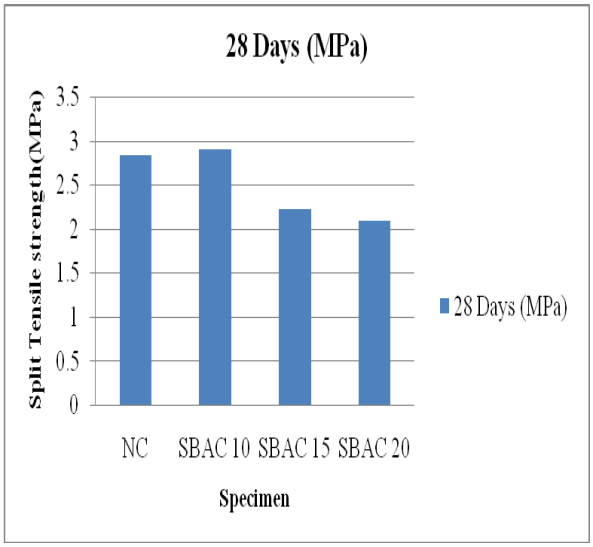

Chart 7 Split tensile strength at 28 Days

From the above graph, it indicates that increase in bagasse ash content up to 10% there is a greater tensile strength value of concrete when compared to controlled concrete, beyond that there is a reduction in split tensile strength

10. CONCLUSION

- Bagasse ash up to 10% is found to be better substitute for cement for improving workability of concrete.
- From the compressive strength results of cubes, it is found that on 10% of bagasse ash replacement with cement will yield better compressive strength as compared to controlled concrete.
- From the split tensile strength results, it is found that on 10% of bagasse ash replacement with cement will yield better tensile strength as compared to controlled concrete.
- Thus, we can conclude that addition of up to 10% of bagasse ash as substitute for cement to produce concrete which can be used for practical structural applications.

ACKNOWLEDGEMENT

I express my deepest gratitude to my project guide Mr. D S Sandeep Kumar and our HOD Dr. R. M. Mahalingegowda whose encouragement, guidance and support from the initial level to the final level enabled me to develop an understanding of the subject.

REFERENCES

Text Books

1. Neville, A.M., Properties of concrete, Pitman Publishing Ltd, London, 1995, pp.8-17.
2. M.S.Shetty., Concrete Technology, S.Chand Publishers, 2011. Pp.466-473, 510-514
3. P.Kumar Mehta and Paul J.M. Monterio., Microstructure, properties, and materials, Tata Mc graw hill third edition 2010, pp.26-32, 258.
4. Sathish Chandra and Leif Berntsson., Lightweight Aggregate Concrete, Science technology and applications, 2010.,pp.25-27, 91-104,
5. Indian standard code for Specification for Coarse and Fine Aggregates from Natural Sources for Concrete, IS 383: 1970,
6. Indian standard code of practice plain and reinforced concrete (fourth revision), IS 456 2000, Bureau of Indian Standards, New Delhi.
7. Indian standard code for Method of Tests for Strength of Concrete, IS 516: 1959, Bureau of Indian Standards, New Delhi.
8. Indian standard code for Methods of sampling and analysis of concrete, IS 1199: 1959, Bureau of Indian Standards, New Delhi.
9. Indian standard code for Methods of test for pozzolanic materials, IS 1727:1967, Bureau of Indian Standards, New Delhi.
10. Indian standard code for Methods of test for aggregates for concrete, IS 2386 (PART III): 1984, Bureau of Indian Standards, New Delhi.
11. Indian standard code for Specification for pulverized fuel Ash for use as pozzolona in cement, cement mortar and concrete, IS 3812 (part-1): 2013, Bureau of Indian Standards, New Delhi.
12. Indian standard code for Specification for pulverized fuel Ash for use as admixture in cement mortar and

concrete, IS 3812 (part-2): 2013, Bureau of Indian Standards, New Delhi.

13. Indian standard code for Methods of physical tests for hydraulic cement, IS 4031 (Part IV)-1988, Bureau of Indian Standards, New Delhi.

14. Indian standard code for Methods of physical tests for hydraulic cement, IS 4031 (Part V)-1988, Bureau of Indian Standards, New Delhi.

15. Indian Standard code for Ordinary Portland cement - 43 grade specification, IS 8112-2013, Bureau of Indian Standards, New Delhi.

16. Indian Standard code for Concrete mix Proportioning Guidelines, IS 10262-2009, Bureau of Indian Standards, New Delhi.

17. Indian Standard code for ordinary Portland cement- 53 grade specification, IS 12269-2013, Bureau of Indian Standards, New Delhi.

18. EduardoM.R,Fairbairn,BrancaB,Americano,GuilhermeC.Cordeiro,RomildoD.ToledoFilho and Marcos M. Silvoso., Replacement of cement by sugarcane bagasse ash: CO2 emissions reduction and potential for carbon credits, Journal of Environmental Management, Elsevier 91(2010), PP.1864-1871.

19. Eltayeb A Ellatif Ahmed Habib, et al, The usage of the Sugarcane Bagasse Ash in Sudanese Sugar Company as Pozzolanic-Cement Binder., IOSR Journal of Engineering (IOSRJEN**),** April. 2014, ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 04, Issue 04, ||V3|| PP 54-60.

20. G.Sireesha, M. Kanta Rao and P. Kanta Rao., An Experimental Study on Strength Properties of Concrete When Cement Is Partially Replaced With Sugar-Cane Bagasse Ash, IOSR journal of Mechanical and civil Engineering, Sep. - Oct. 2013, e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 9, Issue 3 PP 35-38.

21. G. C. Cordeiro, R. D. Toledo filho and E. M. R. Fairbairn.,Ultrafine sugar cane bagasse ash: high potential pozzolanic material for tropical countries, Ibracon structures and materials journal, Number 1 (Marc2010) ,Volume 3, pp. 50 - 67 • ISSN 1983-4195.

22. Lavanya M.R, Sugumaran.B and Pradeep.T., An Experimental study on the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash, International journal of engineering inventions, December2012, ISSN: 2278-7461, ISBN: 2319-6491, Volume 1, Issue 11 PP: 01-04.

23. Mohamed Eljack Suliman and Samah M. Fudl Almolastudied., The use of sugarcane bagasse ash as an alternative local pozzolanic material: study of chemical composition, A scientific journal of COMSATS – SCIENCE VISION**,** January 2010 to December 2011, Vol.16 and Vol. 17, pp 65-69.

24. M.Shivakumar and Dr.N.Mahendran., Experimental studies of strength and cost analysis of concrete using bagasse ash, International journal of engineering research and technology, April-2013, ISSN: 227-0181,Vol 2-Issue 4.

25. Mrs.U.R.Kawade, Mr.V.R.Rathi and Miss Vaishali D. Girge**.,** Effect of use of Bagasse Ash on Strength of Concrete, International Journal of Innovative Research in Science, Engineering and Technology , July 2013, Vol. 2, Issue 7, pp 2997-3000.

26. Nuntachai Chusilp, Chai Jaturapitakkul and Kraiwood Kiattikomol., Utilization of bagasse ash as a pozzolanic material in concrete, Construction and Building Materials, 23 (2009) pp: 3352–3358.

27. R.Srinivasan, K.Sathiya., Experimental Study on Bagasse Ash in Concrete, International Journal for Service Learning in Engineering, Fall 2010 ,Vol. 5, No. 2, ISSN 1555-9033, pp. 60-66,

28. S. Suvimol and C. Daungruedee., Bagasse ash: effect of pozollona activity and application in cement use aspect, 2008, The 3rd ACF International conference-ACF/VCA.

29. Sirirat Janjaturaphan and SupapornWansom., pozzolanic activity of industrial sugar cane bagasse ash, Suranaree J. Sci. Technology, October – December 2010, vol.17, No.4, pp:349-357.

30. T. Shafana, r. and venkatasubramani ., A study on the mechanical properties of concrete with partial replacement of fine aggregate with sugarcane bagasse ash, international journal of advanced structures and geotechnical engineering, january 2014. ISSN 2319-5347, vol. 03, No. 01, pp 34-39.

BIOGRAPHIES

Arjun T
M.Tech (CADS)
PES College of Engineering
Mandya, Karnataka

Sandeep Kumar D S
Assistant Professor,
PES College of Engineering
Mandya, Karnataka

Yashwanth M K
Associate Professor
Maharaja Institute of Technology
Mysore, Mandya, Karnataka