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COMPARATIVE STUDY ON WITH AND WITHOUT REPLACEMENT OF CEMENT WITH SUGAR CANE BAGASSE ASH

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ABSTRACT
This Project has shown that every one ton of cement manufacture releases half ton of carbon dioxide, so there is an immediate need to control the usage of cement. On the hand materials wastes such as Sugar Cane Bagasse Ash (SCBA) is difficult to dispose which in return is environmental Hazard. The Bagasse ash imparts high early strength to concrete. The Silica present in the Bagasse ash reacts with components of cement during hydration and imparts additional properties such as chloride resistance, corrosion resistance etc. Therefore, the use of Bagasse ash in concrete not only reduces the environmental pollution but also enhances the properties of concrete and also reduces the cost. This project mainly deals with the replacement of cement with Bagasse ash in fixed proportions and analysing the effect SCBA blended concrete. The concrete M60 mix designed by varying the proportions of Bagasse ash for 0%, 5%, 7.5%, 10% & 12.5% the cubes were casted and cured in normal water for ages of 7, 14 and 28 days, the properties like slump cone test for fresh concrete and compressive strength for hardened concrete were verified and results was analysed.
Keywords: Sugar Cane Bagasse Ash (SCBA), M60 mix, compressive strength, slump cone test.

1. INTRODUCTION

1.1 General

In ancient period, the structures are made from naturally occurring gaps formed between mountains and hills generally known as caves. As the time passes, with increasing population the number of caves occupied is increased. So as to protect the nature, construction of structures has been started. Initially buildings are constructed with the available local materials such as the stones, mud and lime. Later, as the technology improved stones were used in the foundation and the superstructure was constructed with the bricks made of lime and concrete.

Concrete usage around the world is second only to water. Concrete manufacturing involves consumptions of ingredients like cement, fine aggregates, coarse aggregates, water and admixtures. The utilization of concrete is increasing manifold due to developments and subsequent demand for infrastructure and construction activities. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcination of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced.

Now a days, Agricultural and industrial by-products are used in concrete production as cement replacement materials or as admixtures to enhance both fresh and hardened properties of concrete as well as to save the environment from the negative effects caused by their disposal. 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 Sugarcane is one of the major crops grown in over 110 countries and its total production is over 1500 million tons. In India sugarcane production is over 300 million tons/year that cause around 10 million tons of sugarcane bagasse ash as an un-utilized and waste material. After the extraction of all economical sugar from sugarcane, about 40-45 percent fibrous residue is obtained, this is reused in the same industry as fuel in boilers for heat or power generation leaving behind 8-10 percent ash as waste, known as sugarcane bagasse ash (SCBA).

The bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness. The higher silica content in the bagasse ash was suggested to be the main cause for these improvements. Although, the silicate content may vary from ash to ash depending on the burning conditions.

Bagasse ash, which is considered as an industrial waste, if utilized to its maximum capacity in the construction industry, provides the benefits of reducing the Conventional cement generated CO2 as well as saving precious land from becoming a landfill site. Hence, Bagasse ash-based concretes have been gaining popularity as an eco-friendly construction material and studies are being conducted on its suitability as an alternative to the much popular Portland cement concrete.

In this study, sugarcane bagasse ash (SCBA) was replaced for cement in various proportions of 0%, 5%, 7%, 10% & 12% in Concrete and its compressive strength was studied.

2. LITERATURE REVIEW

Sugarcane today plays a major role in the worldwide economy and Brazil is the leading producer. The production process generates bagasse as a waste, which is used as fuel to stoke boilers that produce steam for electricity cogeneration. The final product of this burning is residual sugarcane bagasse ash (SCBA), which is normally used as fertilizer in sugarcane plantations. Ash stands out among agro-industrial wastes because it results from energy generating processes. Many types of ash do not have hydraulic or pozzolanic reactivity, but can be used in civil construction as inert materials. Mortars and concretes with SCBA as cement replacement were produced and tests were carried out: compressive strength, tensile strength and elastic modulus. The results indicated that the SCBA samples presented physical properties similar to those of cement. Several heavy metals were found in the SCBA samples, indicating the need to restrict its use as a fertilizer. The mortars produced with SCBA in place of cement showed better mechanical results than the reference samples. SCBA can be used as a partial substitute of cement.

A briefing on few of the literature reviews are given below:

- **R.Srinivasan**, Senior Lecturer, Department of Civil Engineering, Tamilnadu College of Engineering and **K.Sathiya,** Lecturer, Department of Civil Engineering, Avinashilingam University for Women in 2010 made experimental study on Bagasse ash in concrete. In this paper, Bagasse ash has been chemically and physically characterized and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of 7 and 28 days was obtained. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased. From the observations, it is clear that the addition of SCBA in plain concrete increases its strength under compression, tension, young's modulus and flexure up to 10% of replacement after that strength results was decreases.

- In the study conducted by **A.D.V.S. Siva Kumar, K.V.G.D. Balaji, T. Santhosh Kumar,** Assistant Professors of Civil Engineering in GITAM University, Andhra Pradesh in 2014, bagasse ash is used as partial replacement of cement because it is one of the by product which can be used as mineral admixture due to its high content in silica (SiO2), it is also a waste product produced from Sugar manufacturing industry. In this study, sugarcane Bagasse ash is partially replaced in the ratio of 0%, 5%,10%,15% and 25% by weight of cement in concrete and exposed to different elevated temperature (i.e., 2000, 4000, 6000, 8000) C for 1 hour and immediately cooled with water. The result shows that the strength of concrete specimens increased at 2000C than room temperature for all percentage of replacement of cement with SCBA

3. OBJECTIVE AND METHODOLOGY

3.1 Objective of the study

The present study deals with the partial replacement of Sugarcane Bagasse ash for M 30 grade of concrete.

i) To study the effect of adding different percentages (0%, 5%, 7.5%, 10% & 12.5%) of sugarcane bagasse ash by the weight of cement in the preparation of concrete mix.
ii) To determine the workability of freshly prepared concrete by Slump test.
iii) To determine the compressive strength of cubes at 7, 14, 28 days curing

3.2 Methodology

1. Collect the Sugar cane waste, by burning process the sugarcane bagasse ash (SCBA) was obtained.
2. Sieve the SCBA with 75microns IS sieve, passed SCBA used for cement replacement.
3. Find out the fineness modulus and specific gravity tests for SCBA.
4. Find out the physical properties of Coarse aggregate, Fine aggregate, cement.

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5. Design mix design of M60 grade concrete. And calculate the mix proportions for individual mix.
6. Partial replacement of cement with SCBA with varying percentages (0%, 5%, 7.5%, 10%, 12.5% and 15%) in the preparation of concrete.
7. Perform the workability, compressive strength tests on conventional and SCBA based concrete. Compare the values and find out the optimum percentage of SCBA replacing by cement.
8. Conclusions.

4. MATERIALS AND MIX DESIGN

4.1 Materials Used

Concrete is a homogeneous mixture of cement, fine aggregates and coarse aggregates derives its strength in the presence of water through hydration. The bonding strength of concrete mainly depends on the cement used and the compressive strength of concrete is derived from the coarse and fine aggregates used.

Table. 1: Experimental sieve analysis for zone determination (fine aggregate).

Designation of IS Sieve	Weight Retained(gm) W1	Individual Weight Retained(gm)	Total% Retained	Total% Passing	Specimen% Passing
10mm	0	-	-	100	100
4.75mm	13	1.3	1.3	98.5	95-100
2mm	24	2.4	3.7	96.3	95-100
1mm	246	24.6	28.3	71.7	55-90
600microns	328	32.8	61.1	38.9	35-59
300microns	318	31.8	92.9	7.1	8-30
150microns	70	7	99.7	0.3	0-10
Pan	1	-	-	-	-

Table. 2: Specific gravity of the materials.

Materials	Specific Gravity
Cement	3.14
Sugarcane Bagasse Ash	2.2
Fine Aggregate	2.68
Coarse Aggregate	2.83

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4.2 Mix Design

Grade of concrete used-M60.

Table. 3: Designed values of materials.

S. No	Item name	As per mixed design(kg/m3)
1	Cement	492.9
3	Fine aggregates	611.43
4	Coarse aggregates	1098.74
5	water	197.16

4.3 Sugarcane Bagasse Ash Concrete Mix Design:

The mix design chosen for the present experimental work is as given below. The mix for Sugarcane Bagasse Ash concrete of M60 was chosen as cement: fine aggregate: coarse aggregate of 1: 1.526: 2.818 with w/c ratio of 0.45. The individual weight of materials listed in the below table.

In this research work 15 Standard cubic specimens of size 150mm (9 sample for each percentage partial replacement of cement with coal bagasse ash and aggregates, water was kept constant) were casted for the compressive strength of concrete and it was kept under curing for 7, 14 days & 28 days of age. Total cubes for compressive strength testing were 54 (9 cubes * 6 proportions).

Table. 4: Material weight for cubes preparation.

SCBA % (%)	CEMENT (Kg)	SCBA (Kg)	FA (Kg)	CA (Kg)	Water (Lit)
0	1.829	0	2.269	4.079	0.731
5	1.737	0.091			
7.5	1.691	0.137			
10	1.646	0.182			
12.5	1.600	0.228			
15	1.554	0.274			

5. EXPERIMENTAL INVESTIGATION

5.1 Sugarcane Bagasse Ash Concrete Production:

Sugarcane Bagasse Ash concrete production is done using the same equipment as that of conventional cement concrete. The detailed process is as given below

Mixing: The dry components (cement, Bagasse ash, sand and coarse aggregate) are introduced into the pan mixer and mixed thoroughly for 4 minutes initially. Later Water is introduced for proper mixing. Wet mixing is continued for another 2 minutes for uniform mixing of concrete ingredients. Concrete can now be tested for workability.

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Placing and Compaction: Placing the concrete in cube, beam moulds and compaction by manual. Delay in placing and compaction causes evaporation of water which should be avoided.

Concrete was cast in pre-oiled cast cube iron moulds in 3 layers by tamping each layer with greater than 35 blows and beam iron moulds in 2 layers by tamping each layer with 35 blows. Then the tamped moulds were placed on the vibrator for compaction and surface finished neat.

Fig. 1: Fresh SCBA concrete.

Fig. 2: SCBA concrete placed in cube moulds.

Curing: Sugarcane Bagasse Ash concrete attained strength and hardened due to curing for 28days. 1. After the casting of cubes, they are left for 24 hours to dry and then demoulded the casted cubes. They are cured in a curing tank for 7, 14, 28 days.

2.After the casting of beams, they are left for 24 hours to dry and then demoulded the casted cubes. They are cured in a curing tank for 28 days.

Fig. 3: SCBA Concrete cubes before drying.

5.2 Tests on Fresh Concrete

The slump value is a measure indicating the consistency or workability of cement concrete. It gives an idea of water content needed for concrete to be used for different works. A concrete is said to be workable if it can be easily mixed, placed, compacted and finished. A workable concrete should not show any segregation or bleeding. Segregation is said to occur when coarse aggregate at one place occurs. This results in large voids, less durability and strength. Bleeding of concrete is said to occur when excess water comes up at the surface of concrete. This causes small pores through the mass of concrete and is undesirable. By this test we can determine the water content to get specified slump value.

Fig. 4: Slump test on concrete.

5.3 Tests on Hardened Concrete

5.3.1 Compressive strength

Concrete cubes of sizes 150mm x 150mm x 150mm are casted by following the Mix design recommendations for both Cement concrete and sugarcane bagasse ash concrete, cured in

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their respective conditions, and was tested for their 7days, 14days, and 28days compressive strength by using the Compression Testing Machine. This test determines the peak load value that a specimen can withstand before failing. All tests were performed as per guidelines prescribed under IS: 516 -1959.

6. RESULTS AND DISCUSSIONS

6.1 General

The results of the strength and workability tests that were carried out on the five trial mixes of M60 grade concrete to evaluate their workability, strength related properties were presented in this chapter. The effects of SCBA on the properties of the concrete mixtures were discussed separately in this chapter.

6.2 Experimental outputs

6.2.1 Workability of concrete (Slump cone test)

The test is conducted by mixing the quantities according to the mix proportions obtained from the mix design and adding water in required quantities for different percentages of bagasse ash.

The results that are obtained by conducting workability test are mentioned in the following table.

Table. 5: Result of slump test.

S. No	% Of SCBA	Slump (mm)
1	0	120
2	5	110
3	7.5	100
4	10	90
5	12.5	75
6	15	50

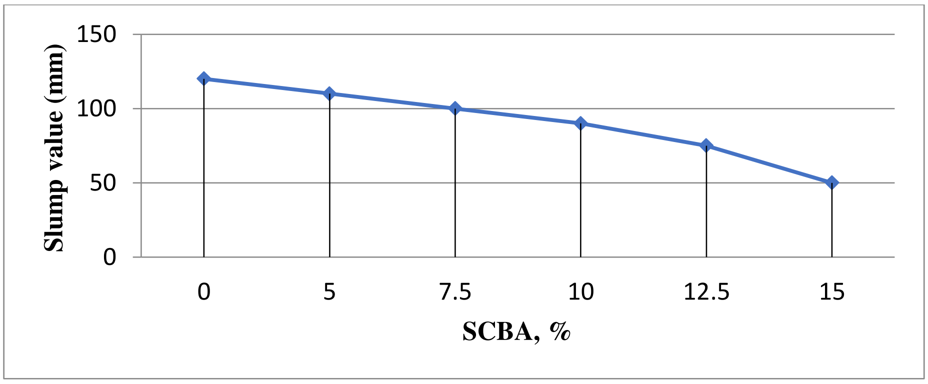

Fig. 5: Slump test results.

The above figure shows the slump results. It was observed that, the slumps decreases as the SCBA content were increased in the mix.

6.2.2 Compressive Strength of Concrete (in N/mm^2)

The 7, 14, 28 days compressive strength was studied and the values of 3 samples studied are shown in the tabular form. Table 6.2 shows the data of 7, 14, 28 days compressive strength

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obtained. Below tables gives the 7, 14, 28 days compressive strength of concrete with maximum nominal size of aggregates 20mm. The 7, 14, 28 days compressive strength was also plotted Fig 6.2 by taking the average of these three values overall an increase in the compressive strength was observed with addition of SCBA as compare to conventional concrete.

Table. 6: Compressive strength of concrete.

% Of SCBA	Avg Compressive strength (N/mm^2)		
	7days	14days	28days
0	34.02	51.10	57.05
5	36.05	54.09	60.20
7.5	37.34	56.05	62.40
10	37.80	56.73	63.08
12.5	36.10	54.42	60.50
15	33.56	50.50	56.12

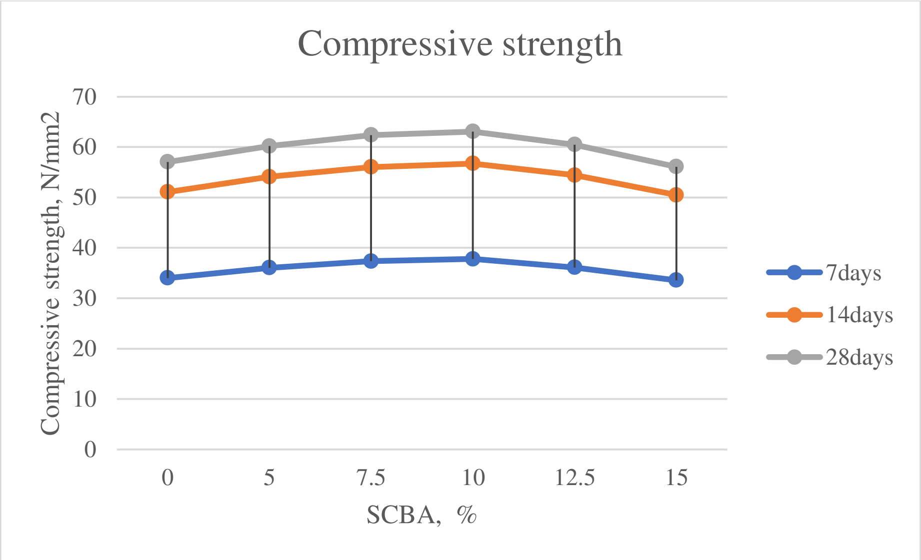

Fig. 6: Effect of ESP on 7, 14 and 28days compressive strength.

6.3 Discussion

From the results obtained by conducting compressive strength tests and comparing them we can observe that, when 10% of sugarcane bagasse ash is replaced by cement gives more strength than at other percentages. It is also observed that at 12.5% replacement the strength is decreasing. So, the percentage of ash that should be replaced will be restricted to the particular percentage which would be advantageous.

In the present study, from the taken percentages we can conclude 10% as the range that could be replaced.

7. CONCLUSION

Result shows that the Sugarcane Bagasse ash in concrete has significantly higher compressive strength compared to the normal concrete without Sugarcane Bagasse ash.

1. In this project, cement is replaced with Sugarcane Bagasse ash with optimum limit of 10%.
2. Results show that maximum strength of concrete was achieved with 10% replacement of cement with Sugarcane Bagasse ash. After that there was decrease in the strength of concrete with increase in the content of Sugarcane Bagasse ash in concrete.
3. This replacement is economical compared to other conventional concrete.
4. Thus, cheaper concrete can be made with industrial waste products for an equivalent strength.
5. Utilization of Bagasse ash in concrete solves the problem of its disposal thus keeping the environment free from the pollution.

REFERENCES

[1] **R. Srinivasan**, Senior Lecturer, Department of Civil Engineering, Tamilnadu College of Engineering and **K.Sathiya**, Lecturer, Department of Civil Engineering, Avinashilingam College of Women, Coimbatore published International Journal for Service Learning in Engineering Vol. 5, No. 2, pp. 60-66, Fall 2010 ISSN 1555-9033 on "Experimental Study on Sugarcane Bagasse Ash in Concrete".

[2] **A.D.V.S. Siva Kumar**, **K.V.G.D. Balaji** and **T. Santhosh Kumar**, M-tech (SE&NDM), Professor and Assistant Professor, Civil Engineering Department, GITAM University, Andhra Pradesh, (India) in July 2014 made study on " Behaviour of Sugarcane Bagasse ash concrete exposed to elevated temperature."

[3] **Jayminkumar A. Patel,** M.Tech student and **Dr. D. B. Raijiwala,** Assistant Professor of SVNIT, Surat published a research article on "Experimental study on compressive strength of concrete by partially replacement of cement with sugar cane bagasse ash" in the year 2015.

[4] Mini **Vishwakarma, R.K. Grover**, Student M.E. Structural Engineering, Associate Professor, Civil Engineering Department, Jabalpur Engineering College made study on Strength and cost analysis of concrete with sugarcane bagasse ash in the year 2015.

[5] Aigbodion.V.S, Hassan. S.B, Olajide.S,O, Agunsoye.O.J, Abdul Rahaman.A.S.Oka for.G.E, The use of sugarcane bagasse ash as an aggregate for foundry sand production in Nigeria, Proceedings of the Nigerian Metallurgical Society (NMS), (2008) Annual Conference & Annual General Meeting, pp 16-22.

[6] Ganesan, K.Rajagopal& Thangavel 2007.Evaluation of bagasse ash supplementary cementitious material. Cement and Concrete Composites, 29, 515-524.

[7] Committee Board of sugar cane and sugar (2004). 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 Bangkok Thailand (in Thai).

[8] Baguant.K Properties of concrete with bagasse ash as fine aggregate, In Proc 5th CANMET/ACI Intl. conf. on fly ash, silica fume, slag and natural pozzolans in concrete, Ed by Malhotra VM, USA, ACI SP, (1995)153(18), 315-337.

[9] Payá,Jet. al.,Sugarcane bagasse ash (SCBA): studies on its properties for reusing in concrete production, Journal of Chemical technology and Biotechnology, (2002)77, 321-325.
[10] IS 383 -1970 "Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete", Bureau of Indian Standards, New Delhi.
[11] IS 10262 -1981 "IS Method of Mix Design", Bureau of Indian Standards, New Delhi.
[12] IS 516 -1959 "Methods of Tests for strength of concrete", Bureau of Indian Standards, NewDelhi.
[13] IS 456 -2000 "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.
[14] P. Aggarwal, Y. Aggarwal, and S.M. Gupta, "Effect of Bottom Ash as replacement of Fine Aggregates in Concrete," Asian Journal of Civil Engineering (Building and Housing), vol. 8, No.1, 2007, pp.49-62.
[15] V. S. Aigbodion, S. B. Hassan, T. Ause and G.B. Nyior, "Potential Utilization of Solid Waste (Bagasse Ash)," Journal of Minerals & Materials Characterization & Engineering, vol. 9, No.1, 2010, pp.67-77.
[16] Ajay Goyal, Hattori Kunio, Ogata Hidehiko and Ashraf Muhammad "Processing of Sugarcane Bagasse Ash and reactivity of Ash- Blended Cement Mortar," Trans. of JSIDRE, vol. 77, Issue 3, 2010, pp.243-251.
[17] J. de. Brito, and N. Saikia, "Recycled Aggregate in Concrete," Green Energy and Technology, Springer-Verlag London, 2013, pp.23-80.
[18] D. Brindha, and S. Nagan "Utilization of Copper Slag as a Partial Replacement of Fine Aggregate in Concrete," International Journal of Earth Sciences and Engineering, vol. 3, No.4, 2010, pp.579-585.
[19] Chandana Sukesh, Katakam Bala Krishna, P. Sri Lakshmi Sai Teja and S. Kanakambara Rao, "Partial Replacement of Sand with Quarry Dust in Concrete," International Journal of Innovative Technology and Exploring Engineering, vol. 2, Issue 6, 2013, pp.254-258.
[20] Mrs.U.R.Kawade, Mr.V.R.Rathi, Miss Vaishali and D. Girge, Effect of use of Bagasse Ash on Strength of Concrete, *International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7, July 2013.*
[21] R.Srinivasan and K.Sathiya, Experimental Study on Bagasse Ash in Concrete, *International Journal for Service Learning in Engineering Vol. 5, No. 2, Fall 2010 ISSN 1555-9033.*
[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 ISSN: 2278-7461, ISBN: 2319-6491 Volume 1, Issue 11 (December2012).*
[23] T. Shafana and R.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 ISSN 2319-5347, Vol. 03, No. 01, January 2014.

[24] IS456-2000, Plain and Reinforced Concrete- Code of Practice. [6] IS2386-1963, Methods of test for aggregates for concrete.

[25] IS383-1970, Specification for Coarse and Fine Aggregates from Natural Source for Concrete.

[26] Caldarone, M. A., Gruber, K. A., and Burg, R. G. (1994). "*High reactivity metakaolin: A new generation mineral admixture*." Concrete Institute, 16(11), 37–40.

[27] Wild S. Khatib, J. M and Jones, A. (1996)"*Relative strength, pozzolanic activity and cement hydration in superplasticizer metakaolin concrete*." *Cement and Concrete Research, 26*, 1537–1544.

[28] Ismat.A, "*Biomass: An ideal fuel for sugar mills for steam/power generation*." (2004). *Fuel Research Centre, Pakistan Council of Scientific and Industrial Research (PCSIR)*.