



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

Rifas Mohammed

ABSTRACT

Concrete is the most extensively used construction material which consumes natural materials leading to environmental concerns in terms of utilization of raw materials and also emissions of CO₂. The increase in cost of cement and scarcity in river sand also adds to the need of sustainable material which is also cost effective. Industrial wastes, such as blast furnace slag, rice husk ash, fly ash and silica fume are being used as supplementary cement replacement materials. Currently, it has been tried to utilize the large amount of bagasse ash, a fibrous residue obtained from sugar cane during extraction of sugar juice at sugarcane mills in concrete. Sugarcane bagasse ash is a waste product of the sugar refining industry which is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Coir is strong in tension, hence it can be used a fiber reinforced material. Hardened concrete tests like compressive strength and split-tensile strength were undertaken showing a remarkable increase in strength of concrete as a percentage of bagasse ash replacement and addition of coir fiber as fibre reinforcement. This report presents the results of an experimental investigation on the mechanical properties of concrete incorporating sugarcane bagasse as hand coir fiber. This study is aimed to evaluate the strength of concrete by performing tests like compressive strength, split tensile strength and flexural strength of concrete

1 Introduction

Construction industry is one of the rapidly growing industries in the world. In this industry, concrete plays an inherent role and is the most widely used man made construction material. Concrete consumes large quantities of natural resources. As per the present scenario, it is known that natural resources are depleting worldwide while at the same time the generated wastes from the Industry are increasing substantially. So for the Sustainable development of construction industry, Methods like use of non-conventional innovative materials, and recycling of waste materials should be adopted. Eco-friendly cement may be obtained by partial replacement of cement with certain low cost waste materials. Bagasse is a byproduct of the sugar industry. Juice is extracted from sugar cane then ash produced by burning bagasse is in controlled condition and at very high temperature. The disposal of this material is already causing serious environmental impacts. The recycling of bagasse ash as a partial cement replacement in concrete provides a satisfactory solution to environmental concerns associated with waste management. Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is approximately just one tenth of its compressive strength. The introduction of fibers is brought in as a solution to develop concrete with enhanced flexural and tensile strength, which is a new form of binder that could combine Portland cement in bonding with cement matrices. Fiber-reinforced



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

polymer composites have played a dominant role for a longtime in a variety of applications for their high specific strength and modulus. The fiber which serves as a reinforcement in reinforced plastics may be synthetic or natural. Past studies show that natural fibers can provide desired strength. Although glass and other synthetic fiber-reinforced plastics possess high specific strength, their fields of application are very limited because of their inherent higher cost of production. In this connection, an investigation has been carried out to make use of coir, a natural fiber abundantly available in India. Natural fibers are not only strong and lightweight but also relatively very cheap. The present work describes the development and characterization of a new set of natural fiber based composites consisting of coconut coir as reinforcement. Fibers are most generally discontinuous, randomly distributed throughout the cement matrices.

2 Literature review

Evi Aprianti, Payan Shafingh, Syamsul Bahri, Javad Nodeh (2015): conducted a study on the Supplementary cementitious Materials origin from agricultural wastes for the stream of construction and building material. Investigations proved that use of bagasse ash produce great result in the physical and mechanical properties of concrete. In 2007, Ganesh ET. Al used bagasse ash proportion in 50% and 30% OPC replacement in dry conditions. The studies used the mill fried bagasse ash burned under controlled conditions at 650 co. for 1 hour.

Fernando C.R. Almeida, Amir Sales, Juliana P. Moretti, Paulo C.D. Mendes (May 2015): conducted a study on Sugarcane bagasse ash sand (SBAS): Brazilian agro industrial by-product for use in mortar. The present study fills the gap in knowledge on the durability of mortars using different levels of SBAS ash. The substitution of natural sand by SBAS, especially with content of 30%, can lead to maintenance of mechanical properties, microspore clogging and improvement of the durability of mortars, in comparison with a reference mixture.

Aditya Sharma, Sourabh Singh Bhadoria, Bhagwati Sharma April 2015 conducted a Review on Coir Fiber Treated with natural rubber Latex as Concrete Reinforcement Material in cement Based Composites in the International Journal for Research in Applied Science & Engineering Technology (IJRASET). There are many types of natural fiber are available such as Sugarcane, Rice husk and Coir and they are easily available. These composites have high impact strength and they can be regarded as an environment friendly material.

Piyanut Muangtong et al., had investigated on “Effects of Fine Bagasse Ash on the Workability and Compressive Strength of Mortars” They are currently exploited as pozzolanic materials and supplements to improve the compressive strength in terms of microstructures of cement by partly replacement of cement with them. One of their advantages is to decrease CO₂ gas emission from decreasing consumption of cement in either mortar or concrete production. Appropriate ratio of replacing clinker by fine (<45 micron) SCBA and w/c ratio as well as effects of SCBA on properties of cement are being studied in this research. Initially, clinker and SCBA proportion were designed by replacing clinker with the amount of SCBA at 0, 20 and 40%, respectively, whereas gypsum was constant added. Specimens were casted as cement



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

mortars and pastes and, finally, analyzed for compressive strength, flow ability, chemical composition and microstructure according to curing ages of 3, 7 and 28 days. Their properties were carried out and compared with the results of commercial type I Portland cement. These test results indicated that replacing clinker with 20% SCBA was appropriate for production in laboratory scale and w/c ratio of 0.735 is suitable on workability of the resultant cement. The results of this research indicated that the appropriate proportion of clinker replaced by fine bagasse ash was 20% SCBA (C80B20). It presented the highest compressive strength comparing to all ratios (0-40% SCBA) of resultant cements and near that of commercial cement. The appropriate w/c ratio of C80B20 was 0.735:1 for good mortar flow (110±5%) and workability of cement mortar. It was ensured that increasing amount of SCBA influenced the increase of w/c ratio. Moreover, this cement procedure was possible for cement preparation in laboratory and would lead to industrial production in the future

Khansaheb A. P. Of MIT College of Management, Pune, Maharashtra, India (2015) studied on Experimental Investigation on Properties of Concrete Using Human Hair & Sugarcane Bagasse Ash published by International Journal of Innovative and Emerging Research in Engineering. Their main objective is Use of waste in useful manner. The paper concluded that 1% human hair and 5% bagasse ash by replacing cement by 1% is compared with plane cement concrete, it is found that the compressive strength increases to 122.31% and tensile strength increases to 161.43% at the end of 7 days. 1% human hair and 5% bagasse ash by replacing cement by 1% is compared with plane cement concrete, it is found that the compressive strength increases to 122.31% and tensile strength increases to 161.43% at the end of 7 days.

J. Sahaya Ruben et al Int.January 2014 presented papers on Experimental Study of Coir Fiber as Concrete Reinforcement Material in cement Based Composites published by Journal of Engineering Research and Applications. Among the various natural fibers sisal fibers, bamboo fibers, coir fibers and jute fibers are of particular interest. These composites have high impact strength besides having moderate tensile and flexural properties and it can be regarded as an environment friendly material. In this experimental study of 28 days the compressive strength and split tensile strength are carried out using different coir fiber length of 20mm, 25mm and 30mm respectively of different percentage as 0.5%, 0.75% and 1%. Using coir fiber in civil construction reduces environmental pollution factors and may also bring several improvements in concrete characteristics. Coir fiber used in cement improves the resistance of concrete from sulphate attack. Compressive strength is also improved up to certain percentage. Addition of coir fiber also arrests the micro cracks present in the concrete.

Kawee Montakarntiwong, Nuntachai Chusilp, Weerachart Tangchirapat, Chai Jaturapitakkul Materials & Design, Volume 49, August 2013 studied about the Strength and heat evolution of concretes containing bagasse ash from thermal power plants in sugar industry. In the study Ordinary Portland cement was replaced by bagasse ash at the levels of 20%, 30%, and 40% by weight of binder. The results revealed that the compressive strength of concrete containing unground bagasse ash was much lower than that of control concrete (CON). Finally, the



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

temperature of bagasse ash concretes could be reduced by 13–37% relative to CON concrete, depending on the level of cement replacement by ground bagasse ash with low loss on ignition Sumrerng Rukzon and Prinya Chindaprasirt (february 2012) conducted investigations on utilization of bagasse ash in high strength concrete. In this investigation the concrete mix in part are replaced with 10%, 20% and 30% of bagasse ash respectively. The compressive strength, the porosity, the coefficient of water absorption, the rapid chloride penetration and the chloride diffusion of concrete are determined. The test results indicate that the incorporation of bagasse ash up to 30% replacement increases the resistance to chloride penetration. Besides the use of 10% bagasse ash produce concrete with good strength and low porosity. Reasonably the substitution of 30% bagasse ash is acceptable for producing high strength concrete

Mr. G. Siva Kumar et al., (2013) had studied on “Preparation of Bio-cement using Sugarcane bagasse ash and its Hydration behavior”. In this study they had used as partial Replacement in ordinary Portland Cement (OPC) by 10% weight. Compressive strength of the sample was carried out and reported that the compendious material in sugar cane bagasse ash is responsible for early hydration. The pozzolanic activity of bagasse ash results in formation of more amount of C-S-H gel which results in enhances the strength, and hence bagasse ash is a potential replacement material for cement.

Mr. H.S. Otiose et al., had investigated on “Characterization of Sugar Cane Bagasse ash and ordinary Portland Cement blends in Concrete”, The SCBA is obtained by burning Sugar cane Bagasse at between 600-700 degrees Celsius, since the sum of SiO_2 , Al_2O_3 and Fe_2O_3 is 74.44%, For strength test, mix ratio of 1:2:4 was used and OPC was partially replaced with 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40% by weight in concrete. Compressive strength values of hardened concrete were obtained at the ages of 7, 14, 21, 28 days. Based on the test conducted, it can be concluded that SCBA is 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 blends with OPC could be used for reinforced concrete with dense aggregate. Higher blends of 15% and up to 35% of SCBA with OPC are acceptable for plane or mass concrete. The value fell short of meeting requirements for reinforced concrete with dense aggregate because of excessive fines from increasing SCBA and reducing Strength of bonding.

Mr. Lavanya M.R et al., had studied on “A Experimental Study on the Compressive Strength of Concrete by Partial replacement of Cement with Sugar cane bagasse ash”. The Feasibility of using sugar cane bagasse ash, a finely grounded waste product from the sugarcane industry, as partial replacement for cement in conventional concrete is examined. The test were conducted as per Bureau of Indian Standard (BIS) codes to evaluate the stability of SCBA for partial replacement up to 30% of cement with varying water cement (W/C) ratio. They showed that addition of SCBA results in improvement of strength in all cases and according to the results obtained, it can be concluded that Bagasse ash can increase the overall strength of concrete when used up to a 15% cement replacement level with W/C ratio of 0.35, bagasse ash



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

is a valuable pozzolanic material and it can potentially be used as a partial replacement for cement.

Mr. U. R. Karate et al., had studied on “Effect of use of Bagasse ash on Strength of Concrete” they had Chemically and Physically Characterized and partial replaced in the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight of cement in concrete. The results show that the SCBA concrete had significantly higher compressive strength compared to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%. Although the optimal level of SCBA content was achieved with 15% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete, therefore use of Super Plasticizer is not essential.

Asma Abd Elhameed Hussein et al., had studied on “Compressive Strength and Microstructure of Sugar Cane Bagasse Ash Concrete”. This study presents the results of an experimental research study on the effectiveness of Sugar Cane Bagasse Ash (SCBA) as a cement replacement material in concrete production. The ordinary Portland cement was replaced with 0, 5, 10, 15, 20, 25 and 30%, respectively bagasse ash, the effect of Sugar cane Bagasse Ash on workability, compressive strength and microstructure of Interfacial Transition Zone (ITZ) of concrete was examined. The results showed that inclusion of Sugar cane Bagasse Ash in concrete up to 20% level significantly enhanced the compressive strength of concrete at all ages; the highest compressive strength was obtained at 5% SCBA replacement level. The ITZ thickness was greatly reduced with increasing the bagasse ash replacement level up to 15%, beyond that the ITZ thickness was slightly increased, however the thickness was still narrower than the normal concrete, it was observed that at 15% bagasse ash replacement level, the interfacial transition zone was homogeneous and there was no gap between the coarse aggregate and the paste matrix. From this study they had observed that linearly increase the workability of concrete. Up to 20% replacement enhanced both the compressive strength at all ages. Highest 28-day compressive strength was obtained using 5% SCBA replacement which was about 48% higher than the reference mix-up to 20% SCBA in concrete is considered as the optimum replacement level. Twenty five and thirty percent SCBA improved the compressive strength after 28 days. Inclusion of SCBA in concrete up to 30% significantly improved the microstructure of concrete by reducing the ITZ thickness which indicates better refinement of pore structure and dense matrix compared to the reference mix. At 15% SCBA level the microstructure of ITZ was totally homogeneous without the presence of wall effect between the aggregate and the paste matrix. The micro structural properties are strongly related to the compressive strength of concrete. Further studies on microstructure of ITZ for SCBA concrete are needed as there is no available literature and it is first introduced in this study.

Kanchana lata Singh and S.M Ali Jawaid, had studied on “utilization of sugarcane Bagasse ash (SCBA) as Pozzolanic Material in concrete”. Agricultural and industrial by-products are commonly used in concrete production as cement replacement materials CRMs or as admixtures to enhance both fresh and hardened properties of concrete as well as to save the



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

environment from the negative effects caused by their disposal. Approximately 1500 Million tons of sugarcane is annually produced over all the world which leave about 40-45 % bagasse after juice crushing for sugar industry giving an average annual production of 675 Million tons of bagasse as a waste material. This paper examined the potential of bagasse ash for development as pozzolanic materials in concrete. The bagasse ash is a by-product from the combustion of bagasse as a fuel in thermal power plants and sugar cane industries. This paper presents a review on the uses of sugarcane bagasse ash in concrete. From review it may be concluded that Sugarcane Bagasse ash can be used as a pozzolanic material in concrete due to its high silica content. The results of this research indicated (10% sugarcane bagasse ash) in blended concrete had significantly higher compressive strength, as compare to 20% sugarcane bagasse ash. Sugarcane bagasse ash is pozzolanic material which may be utilized in the production of pozzolanic cement concrete which leads to reduction in cost.

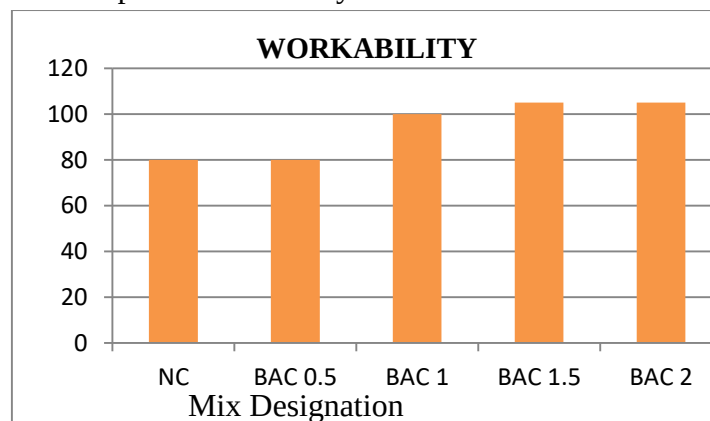
3 Experimental methodology

The aim of the present investigation is to study the effect of SCBA and Coir fiber on the strength and workability characteristics of concrete. In this work, SCBA is used as a partial replacement for the Cement in concrete. Five different mixes of concrete with varying proportions of Coir fiber ranging from 0% (control concrete), 0.5%, 1.0%, 1.5% and 2.0% of volume of cement were used. The strength and workability properties admixed concrete were compared with that of conventional concrete. The strength parameters considered for the proposed study were the cube compressive strength, cylinder compressive strength, flexural strength, split tensile strength, modulus of elasticity. The obtained result was compared with those values obtained for conventional concrete.

4 Resultant discussion

4.1 Work Ability

The workability of fresh concrete depends mainly on the material, mix proportion and environmental conditions. Generally workability of concrete decreases on addition of SBA and increases on addition of Coir fiber. The workability of concrete is measured using slump test. The results show that compared to the normal concrete, all investigated coir fiber mixtures had high slump values and acceptable workability.

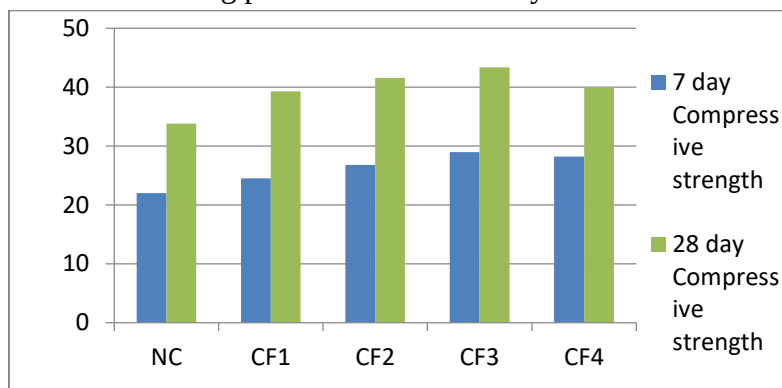




Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

4.2 Compressive Strength

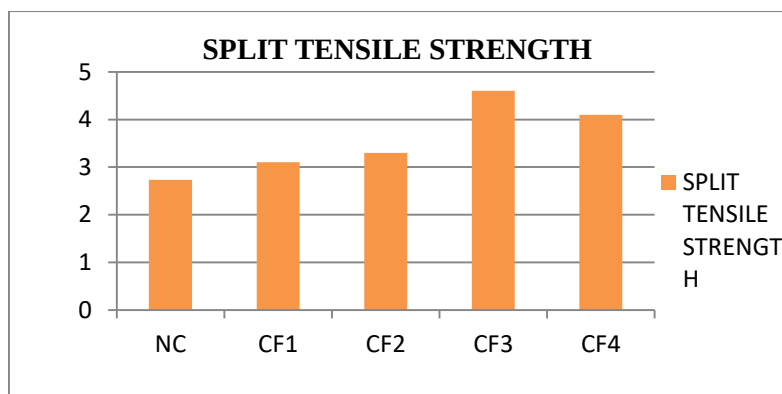
The compressive strength tests were conducted on concrete cube specimens of size 150mm. The cubes were tested after curing periods of 7 and 28 days



The silica content of pozzolans reacts with free lime released during the hydration of cement and forms additional calcium silicate hydrate (CSH) as new hydration products, which improved the compressive strength of concrete. When quantity of coir fiber and SCBA in mix is higher than the amount required to combine with the liberated lime during the process of hydration, leading to excess silica leaching out, causes a reduction in strength as it replaces part of the cementitious material but does not contribute to strength.

4.3 Cylinder Split Tensile Strength

The split tensile strength was conducted on the compression testing machine using cylinders of 300 mm height and 150 mm diameter.



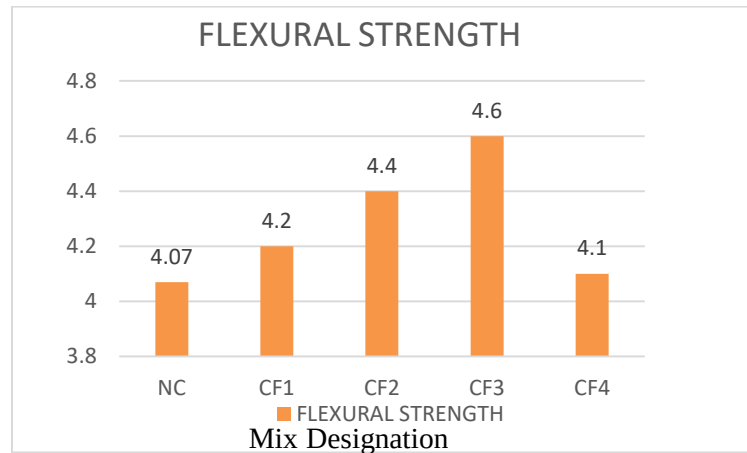
The variation in flexural strength is similar to that observed in case of compressive strength. At 28 days, flexural strength increases as % of fiber content increases up to coir 0.3%. Further increment of fiber content the strength reduces.

4.4 Flexural Strength

The flexural strength was conducted on the universal testing machine using beams of 100mm x 100mm x 500mm.



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre



Flexural strength increased up to the addition of 1.5% coir and further increment of fiber content the strength reduces.

5 Conclusion

The workability of the modified concrete increases with increase in coir fiber, when SCBA percentage is kept constant. Compared to the normal concrete, all coir fiber mixtures have high slump values and acceptable workability. It has been noticed that for 10% SCBA and 1.5% coir fiber, the Compressive Strength increases to 131.81% at the end of 7days and increases to 128.40% at the end of 28 days. For the modified concrete with 10% SCBA and 1.5% coir fiber it is found that the splitting tensile strength increases to 168.49% and the flexural strength increases to 113.02% compared to normal concrete.

Reference

1. Bagasse Fiber; Composites-A Review D Verma¹; P.C.Gope²; M.K. Maheshwari¹; R.K. Sharma, Year: 2012, J. Mater. Environ. Sic, Vol: 3, no: 6, pp. 1079-1092.
2. Evaluation of sugarcane bagasse ash as a replacement for cement in concrete works [ACTA VII 2014]
3. U. R. Kawade; Mr. V. R. Rathi; Miss Vishal; D Girge, Year: 2013, "Effect of use of Bagasse Ash on Strength of Concrete," Vol: 2, no: 7.
4. IS: 10262-1982 Indian standard recommended guidelines for concrete mix design
5. "Experimental Study of Coir Fiber as Concrete Reinforcement Material increment Based Composites", Year: 2014, Vol: 4, no: 1.
6. Year: 2012, "Improvement In The Strength Of Concrete By Using Industrial And Agricultural Waste," IOSR Journal of Engineering, Vol: 2,no: 4, pp. 755-759.
7. M. Vijaya Sekhar Reddy; I.V. Ramana Reddy, Year: 2012, "Studies on durability characteristics of high performance concrete International journal of advanced scientific and technical research", Vol: 6, no: 2, pp. 2249-9954.
8. Dr. P. Srinivasan Rao et al., "Durability studies on steel fiber reinforced met kaolin blended concrete".



Article Title: Mechanical Properties of Concrete Using Sugarcane Bagasse Ash and Coir Fibre

9. V. S Ramachandran et al., "Concrete Admixture Hand Book".
10. G. Siva Kumar et al., "Preparation of Bio-Cement using SCBH and its Hydration Behaviour".
11. H.S Otuoze et al, "Characterization of SCBH and ordinary Portland cement blends in concrete".
12. Mr. Lavanya M. R et al., "An Experimental study on the compressive strength of concrete by partial replacement of cement with SCBA".
13. R. Srinivasan et al, "Experimental study on bagasse ash in concrete".
14. U. R. Kawade et al, Year: 2013, "Effect of use of bagasse ash on strength of concrete International journal of innovative research in science Engineering and technology".
15. Lourdes M.S Souza et al, "Hydration study of SCBA and Calcium Hydroxide pastes of various initial C/S ratios".
16. Abdolkarim Abbasi; Amin Zargar;" Using Bagasse Ash in Concrete as Pozzolana".
17. Piyanut Muangtong et al, "Effect of Fine Bagasse Ash on Workability and Compressive Strength of Mortars".
18. Asma Abd Elhameed Hussein et al, "Compressive Strength and Microstructure of Sugar Cane Bagasse Ash Concrete".
19. Kanchanalata Sing; S.M Ali Jawaaid, Year: 2013, "Utilization of sugarcane bagasse ash (SCBA) as pozzolanic material in concrete".
20. R. Paul Lohlia; Ramesh C. Joshi, "Concrete Admixture Hand Book".