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STUDY ON POTENTIAL UTILIZATION OF SUGARCANE BAGASSE ASH IN STEEL FIBER REINFORCED CONCRETE

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ABSTRACT
Aim of the project is to utilize the waste product produced by agricultural industry and enhancement of concrete strength by using steel fiber. Sugarcane bagasse ash (SCBA) is a left-over industrial byproduct which is used as a replacement of cement. SCBA has high content in silica. Using of SCBA in concrete is a remarkable possibility for economy and conservation of natural resources. One of the important properties of steel fiber reinforced concrete (SFRC) is its superior resistance to cracking and crack propagation. As a result of this ability to arrest cracks, fibers are able to hold the matrix together even after extensive cracking. In this project SCBA has been partially replaced with cement in the ratio of 0%, 5%, 10%, 15% and 20% by the weight of cement in M30 Grade concrete. From the test results optimum percentage of SCBA has achieved on steel fiber reinforced concrete.

KEYWORDS: Bagasse Ash, concrete, Crimped steel fiber, partial replacement, Compressive strength, flexural strength.

INTRODUCTION
Innovations are developing worldwide to control and regulate the management of sub-products, residuals and industrial wastes in order to preserve the environment from contamination. A good solution to the problem of recycling of agro industrial residue would be by burning them in a controlled environment and use the ashes (waste) for more noble means. Utilization of such wastes as cement replacement materials may reduce the cost of concrete production and also minimize the negative environmental effects with disposal of these wastes.

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, large fibrous residue is obtained. When bagasse is burnt in the boiler of cogeneration plant under controlled conditions, reactive amorphous silica is formed due to the combustion process and is present in the residual ashes known as Sugarcane Bagasse Ash. This amorphous silica content makes bagasse ash a useful cement replacement material in concrete. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO_2). In this study the bagasse ash is planned to use as the partial replacement for cement in order to utilize the wastages and to protect the environment from the hazards. Sugarcane bagasse ash is normally used as fertilizer in sugarcane plantation.

Concrete is characterized by brittle failure, the nearly complete loss of loading capacity, once failure is initiated. This can be overcome by the inclusion of a small amount of short randomly distributed fibers (steel, glass, synthetic and natural). Steel fiber reinforced concrete has the ability of excellent tensile strength, flexural strength, shock resistance, fatigue resistance, ductility and crack arrest. Therefore, it has been applied abroad in various professional fields of construction, irrigation works and architecture. There are currently 300,000 metric tons of fibers used for concrete reinforcement. Steel fiber remains the most used fiber of all (50% of total tonnage used).

NEED AND ADVANTAGES

Need of Sugarcane Bagasse Ash (SCBA) Usage

1. Each ton of cement produces approximately about one ton of CO_2 and cement.
2. Brings positive effect to the environment.
3. When used as replacement for cement in concrete, it reduces the problem associated with their disposal.
4. Decrease in the emission of greenhouse gases. Construction industry is responsible for the emission of about 5% of CO_2 worldwide.

Need of steel fiber

Steel fibers will enhance hardened state properties of structural concrete. Additionally, they are often used to replace or supplement structural reinforcement. Essentially, fibers act as crack arrester restricting the development of cracks and thus transforming an integrally brittle matrix, i.e. cement concrete with its low tensile and impact resistances, into a strong composite with superior crack resistance, improved ductility and distinctive post-cracking behavior prior to failure.

Advantages

1. The ash disposal problem from sugar industry is reduced since it is usually disposed of in open land area.
2. Due to partial replacement of cement in concrete results, overall price involved in the construction is reduced.
3. Steel fibers are employed as an additive to the concrete in order to increase the energy absorption capacity and to control the crack development. It is advantageous in seismic resistant structures.

EXPERIMENTAL INVESTIGATION

In this experimental work, a total of 96 numbers of concrete samples were casted. The typical size of cube 150mm×150mm×150mm is used. The mix design (procedure) of concrete was done according to Indian Standard guidelines for M30 grade. To achieve optimum value of SCBA on steel fiber reinforced concrete tests were divided into two parts. In first part optimum value of SCBA was founded from normal concrete. For that, concrete specimens were casted with partial replacement of sugarcane bagasse ash as 0%, 5%, 10%, 15% and 20% by the weight of cement. In second part optimum percent of steel fiber was founded from SCBA concrete. In that optimum value of SCBA replacement kept as fixed and crimped type steel fiber is added 0, 0.5%, 1% and 1.5% by the volume fraction of concrete were estimated. The ingredients of concrete were thoroughly mixed in mixer machine till uniform consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the cast iron mould. Concrete was poured into the mould and compacted carefully using table vibrator. The top surface was over by means of a trowel. The specimens were removed from the mould after 24hours and then cured under water for a period of 7 and 28 days. The samples were taken out from the curing tank just prior to the test. The compressive test was conducted using a 1000kN capacity compression testing machine. This test was lead as per the relevant Indian Standard specifications.

MATERIAL PROPERTIES

Cement

The cement used in this study was OPC 53 grade from Dalmia Cement Company which is widely used in the construction industries and it conforming as per IS 12269-1987.

Table 1: Physical properties of cement

PROPERTY	VALUE
Specific Gravity	3.15
Standard consistency	32.5%
Setting time	`
(i) Initial setting time	45 minutes
(ii) Final setting time	330 minutes

Table 2: Chemical composition of cement

COMPONENT	%
SiO_2	21.8
Al_2O_3	4.8
Fe_2O_3	3.8
CaO	63.3
SO_3	2.2
MgO_3	0.9
Na_2O	0.21
K_2O	0.46
Cl	0.04
P_2O_5	<0.04
Loss of ignition	2
Insoluble residue	0.4

Fine Aggregate

Aggregates for the concrete were obtained from approved suppliers conforming to the specifications of IS 383 - 1970 and were chemically inactive (inert), spotless and robust. The fine aggregate was tested as per the limits which is specified in IS: 2386 (Part- 3):1963. In this study, fine aggregate having a fineness modulus of 2.46 which is carried out by using sieve analysis and it confirming to zone 3.

Table 3 : Physical properties of Fine aggregate

PROPERTY	VALUE
Specific gravity	2.65
Fineness modulus	2.46
Type of sand	River sand
Sand confirming zone	Zone III (Medium sand)

Coarse Aggregate

Coarse aggregates will be machine-crushed one of black trap or equivalent black tough stone and shall be stiff, robust, dense, durable, spotless or procured from quarries approved by the consultant. In this study, crushed aggregate of size 20 mm in angular shape is used and it conforming to IS 383-1970.

Table 4 : Properties of Coarse Aggregate

PROPERTY	VALUE
Specific gravity	2.67
Fineness modulus	7.682
Impact value	22.12%
Crushing value	24.44%

Sugarcane Bagasse Ash

It comprises high volume of sio_2. Therefore, it is classified as a good pozzolanic material. SCBA can be used as an add-on for cementitious material due to its pozzolanic property.

Table 5 : Physical properties of Sugarcane Bagasse Ash

PROPERTY	VALUE
Fineness modulus	2.12
Specific gravity	1.78

Table 6 : Chemical composition of Sugarcane Bagasse Ash

OXIDES	SCBA MASS %
Silica (SiO_2)	68
Alumina (Al_2O_3)	3.05
Ferric Oxide (Fe_2O_3)	3.72
Calcium Oxide (CaO)	5.1
Magnesium Oxide (MgO)	1.15
Sulfur Tri Oxide (SO_3)	0.67
Loss of Ignition	4.5

Water

Good potable water available in the site is used for the construction purpose which conforming to the requirements of water for concreting and curing as per IS: 456-2009.

Steel fiber

Steel fiber used in this study was crimped type steel fiber. Photograph of this fiber is shown in Fig.1. Properties of fiber are shown in Table 6. Fibers were placed randomly oriented into the concrete.

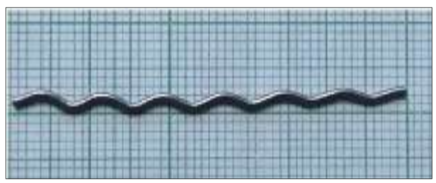

Fig.1 Crimped type steel fiber

Table 7 : Properties of steel fiber

PROPERTY	VALUE
Length	50mm
Cross sectional diameter	1mm
Undulation width	2mm
Aspect ratio	50

RESULTS AND DISCUSSION

Slump Test

A high-quality concrete is one which has appropriate workability (around 65 mm slump height) in the fresh condition. Basically, the greater the measured height of slump, the improved the workability will be, indicating that the concrete flows easily but at the same time is free from segregation. The slump achieved at the rate of 65 mm to 80 mm for the different mixes of SCBA. The workability is achieved by adding the super plasticizers.

Compressive strength test

Compressive strength was done for the cube samples of size 150 mm x 150 mm x 150 mm. During first part of test concrete cubes were casted with partial replacement of cement with sugarcane bagasse ash as 0%, 5%, 10%, 15% and 20% and it was verified at the age of 7 and 28 days. The test results are plotted in the graph as shown in the Fig.2.

Compressive strength constantly increases as the curing period goes on increasing. Maximum compressive strength achieved on 10% replacement of SCBA. In which compressive strength increases by 7.69% in SCBA concrete when compared to conventional concrete.

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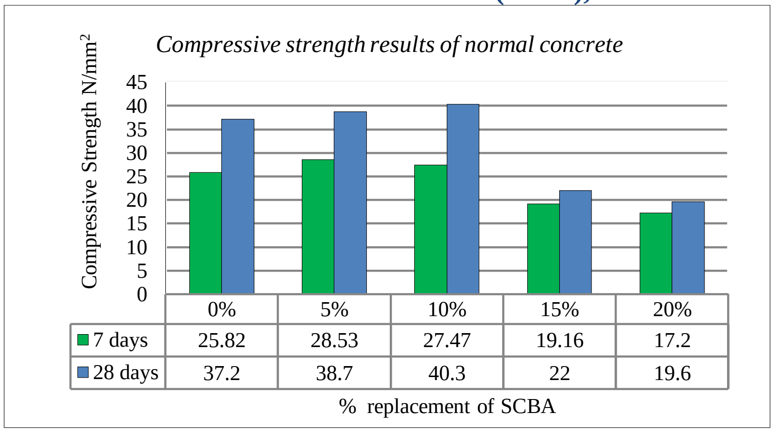

Fig.2 Compressive strength results of normal concrete for different % of SCBA

At second of part test concrete cubes were casted with optimum value of 10% replacement SCBA kept as constant and crimped type steel fiber is added 0, 0.5%, 1% and 1.5% by the volume fraction of concrete. It was verified at the age of 7 and 28 days. The test results are plotted in the graph as shown in the Fig.3.

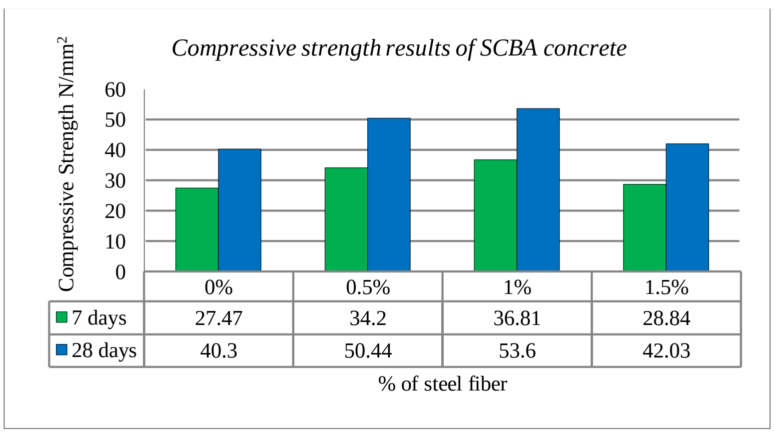

Fig.3 Compressive strength results of SCBA concrete for different % of steel fiber

From the test results maximum compressive strength was achieved on 1% addition of steel fiber. In which compressive strength increases by 24.81% on SCBA concrete with Steel fiber when compared to SCBA concrete without steel fiber.

Split tensile strength test

Split tensile test was done on cylinder specimens of size 150 mm in diameter and 300 mm in length. The cylinder specimen with partial replacement was done which carried out as same as the compressive strength and it is verified at the age of 28 days. The spilt tensile strength test results of normal concrete for different % of SCBA are shown in Fig.4.

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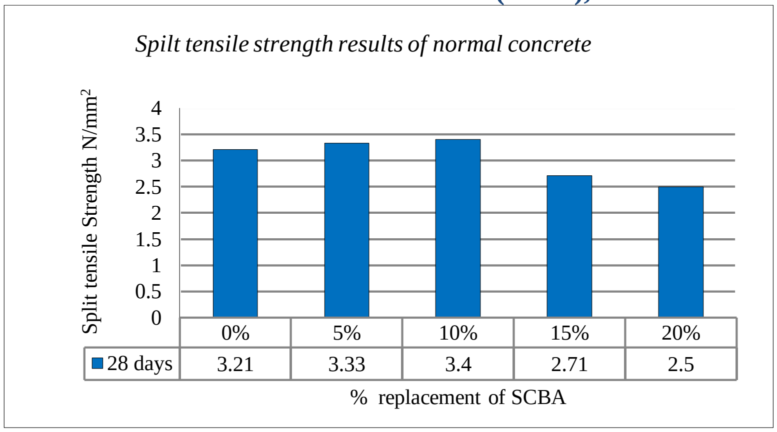

Fig.4 Split tensile strength results of normal concrete for different % of SCBA

Spilt tensile strength of concrete goes on increasing by increase in SCBA up to the optimum value. The optimum value of SCBA content was found to be 10%. Due to SCBA replacement spilt tensile strength increases by 5.58% when compared to conventional concrete.

The spilt tensile strength test results of SCBA concrete for different % of steel fiber are shown in Fig.5.

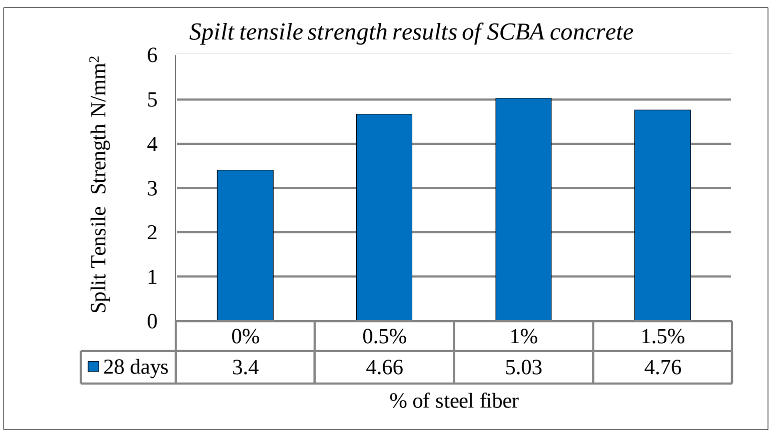

Fig.5 Split tensile strength results of SCBA concrete for different % of steel fiber

From the test results maximum spilt tensile strength was achieved on 1% addition of steel fiber. In which spilt tensile strength increases by 32.40% on SCBA concrete with Steel fiber when compared to SCBA concrete without steel fiber.

Flexural strength test

Flexural strength test was done on beam specimens of size 100 mm X 100 mm X 500 mm. The beam specimen with partial replacement was done which carried out as same as the compressive strength and it is verified at the age of 28 days. The flexural strength test results of normal concrete for different % of SCBA are shown in Fig.6.

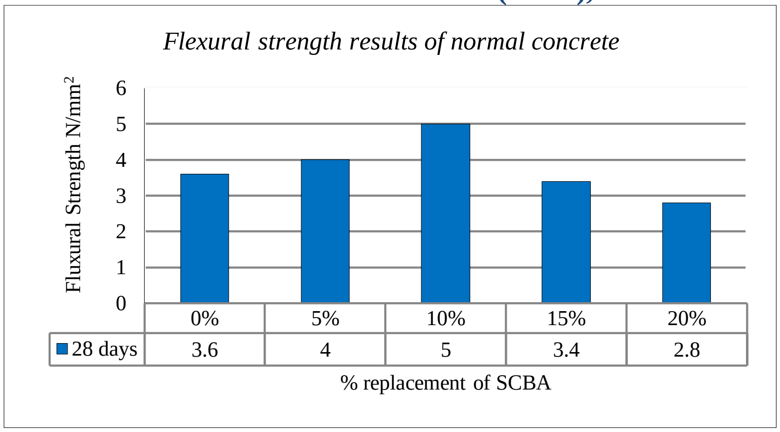

Fig.6 Flexural strength results of normal concrete for different % of SCBA

It was founded that, at the age of 28 days, maximum flexural strength was obtained at 10% replacement of SCBA. Beyond 10% of SCBA, the spilt tensile strength decreases gradually. In which flexural strength increases by 28% in SCBA concrete when compared to conventional concrete.

The flexural strength test results of SCBA concrete for different % of steel fiber are shown in Fig.7.

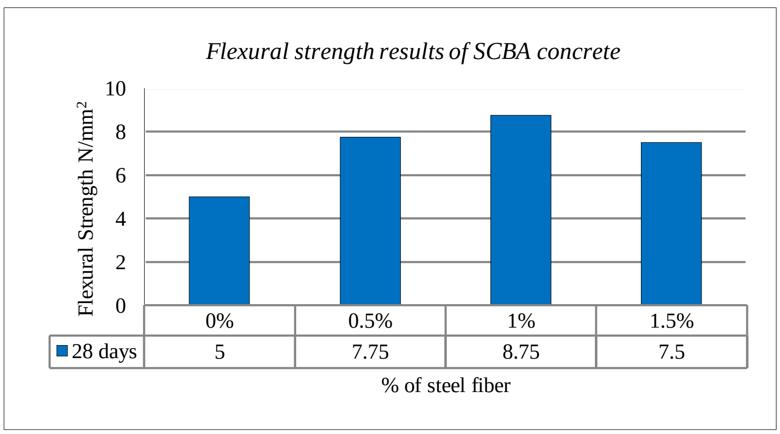

Fig.7 Flexural strength results of SCBA concrete for different % of steel fiber

From the test results maximum flexural strength was achieved on 1% addition of steel fiber. In which flexural strength increases by 42.86% on SCBA concrete with Steel fiber when compared to SCBA concrete without steel fiber.

CONCLUSION

From this experiments and research work the following facts are drawn

- It is observed that the workability of concrete gets increased as the percentage of SCBA increases. This may be due to the increasing in the surface area of sugarcane ash, after adding SCBA that needs less water to wetting the cement particle.
- Compressive strength, Spilt tensile strength and Flexural strength value of concrete goes on increasing by increase in SCBA up to the optimum value. The optimum value of SCBA content was found to be 10%. For that concrete, optimum volume fraction of crimped steel fiber was founded as 1%.
- When compared to conventional concrete compressive strength increases by 30.6% on steel fiber reinforced concrete with SCBA.
- When compared to conventional concrete spilt tensile strength increases by 36.2% on steel fiber reinforced concrete with SCBA.

- When compared to conventional concrete flexural strength increases by 58.9% on steel fiber reinforced concrete with SCBA.
- While testing the specimens, the normal cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two piece geometry. But due to addition of steel fibers in concrete, cracks gets ceased which results into the ductile behavior of Steel Fiber Reinforced concrete.

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REFERENCES

[1] Ahsana Fathima K M & Shibi Varghese ‘Behavioural Study of Steel Fiber and Polypropylene Fiber Reinforced Concrete’, Impact Journals, Vol. 2, Issue 10, PP. 17-24.
[2] A.M. Shende, A.M. Pande, M. Gulfam Pathan (2012) ‘Experimental Study on Steel Fiber Reinforced Concrete for M-40 Grade’, IRJES Journal, Volume 1, Issue 1,PP. 043-048.
[3] Falah A. Almottiri (2011) ‘Physical Properties of Steel Fiber Reinforced Cement Composites Made with Fly Ash’, Jordan Journal of Civil Engineering, Volume 5, No. 2, PP.278-286.
[4] IS 456 - 2000, ‘Plain and Reinforced Concrete-Code of Practice’, Bureau of Indian Standards, New Delhi
[5] IS 10262 - 2009, ‘Indian Standard Concrete Mix Proportioning-Guidelines’, Bureau of Indian Standards, New Delhi.
[6] IS 516 - 1959 ‘Indian Standard for Methods of Test for Strength of Concrete’, Bureau of Indian Standards, New Delhi.
[7] IS 12269 - 1987, ‘Specification for 53 Grade Ordinary Portland Cement’, Bureau of Indian Standards, New Delhi.
[8] IS 2386 - 1963, ‘Methods of test for aggregates for concrete’, Bureau of Indian Standards, New Delhi.
[9] IS 383-1979 (Reaffirmed 1997), ‘Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete’, Bureau of Indian Standards, New Delhi.
[10] Lavanya M.R, Sugumaran.B, Pradeep.T (2012) ‘An Experimental study on the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash’, IJEI journal, Volume 1, Issue 11, PP: 01-04.
[11] Milind V. Mohod (2014) ‘Performance of Steel Fiber Reinforced Concrete’, RESEARCH INVENTY Journal, Vol. 1, Issue 12 (December 2012), PP 01-04.
[12] R.Srinivasan, K.Sathiya (2010) ‘Experimental Study on Bagasse Ash in Concrete’, International Journal for Service Learning in Engineering, Vol. 5, No.2, pp.60-66.
[13] T. S. Abdulkadir,. D. O. Oyejobi, A. A. Lawal (2014) ‘Evaluation Of Sugarcane Bagasse Ash As A Replacementfor Cement In Concrete Works’, ACTA TEHNICA CORVINIENSIS – Bulletin of Engineering Fascicule 3 [July – September] Tome VII .
[14] U.R.Kawade, Mr.V.R.Rathi, Miss Vaishali D. Girge (2013) ‘Effect of use of Bagasse Ash on Strength of Concrete’, International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7, pp. 2997-3000.
[15] Vikrant S. Vairagade, Kavita S. Kene (2012) ‘Introduction to Steel Fiber Reinforced Concrete on Engineering Performance of Concrete’, IJSTR Journal, Volume 1, Issue 4, pp: 139-141.
[16] Yashwanth.M.K, Dr.B.G.Nareshkumar (2014) ‘An Experimental Study on Bagasse ash as Replacement for Cement in Lightweight Concrete’, IJLTET Journal, Vol. 3, Issue 3, pp:253-260.