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Flexural Behaviour of Sugarecane Bagasse Ash Modified Fibre Reinforced Concrete

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ABSTRACT

Cement is the major component in concrete. The cement industry is creating environmental problem by emission of CO_2 during manufacturing of cement. There are various environmental impacts of cement on our ecology. Today researchers are more focusing towards the environment issue globally. Aim of the study is to utilize the waste product produced by agricultural industry and enhancement of concrete strength by using steel fibre. Sugarcane bagasse ash (SCBA) is a left-over industrial by-product 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. Sugar cane bagasse ash generated in sugar mill creating environment issue as most of the part is used as a land fill. One of the important properties of steel fibre reinforced concrete (SFRC) is its superior resistance to cracking and crack propagation. As a result of this ability to arrest cracks, fibres are able to hold the matrix together even after extensive cracking. To find the optimum volumetric percentage of steel fibre required to increase the tensile strength of concrete with laboratory experiments. The partial replacement of cement at the ratio of 10%, 20%, 30% of sugar cane bagasse ash and steel fibres of different volumetric percentages 0.5%, 1%, 2% respectively by absolute weight of concrete. Steel fibres with aspect ratio (l/d) of 50mm length and 1mm diameter crimpled were used in this study. The effect of partial replacement of cement with SCBA and addition of steel fibres in concrete obtained on flexural strength of the beams. The results shows percentage increase in 7, 14 and 28 days.

Keywords – Bagasse ash, Cement, Flexural strength, superplasticizer, Steel fiber

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I. INTRODUCTION

Concrete is the one of the most widely used construction material. The Portland cement production is a major contributor to CO_2 emission. Many efforts and researches are being made in order to reduce the use of Portland cement in concrete making by replacing of cement with various pozzolonic materials like flyash, sugarcane bagasse ash(SCBA), ground granulated blast furnace slag(GGBS) and silicafume, etc., to improve quality and reduce the cost of construction materials.

II. LITERATURE REVIEW

M.Inbasekar, P.Hariprasath, D.Senthil kumar presented study on potential utilization of sugarcane bagasse ash in steel fiber reinforced concrete, In his study 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 and crimped type steel fiber is added 0, 0.5%, 1% and 1.5% by the volume fraction of concrete were estimated. The optimum value of SCBA content was found to be 10%. For that concrete, optimum volume fraction of crimped steel fiber was founded as 1.0%. 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.

srinivasanan and sathiya presented the "Experimental Study On Bagasse Ash In Concrete" investigation carried on bagasse ash and has been chemically and physically characterized, and practically replaced in the ratio of 0%, 10%, 20%, 30% by weight of the cement in concrete. Fresh concrete test like compaction factor test and slump cone test was undertaken as well as hardened concrete test like compressive strength, spilt tensile strength, modulus of elasticity at the age of 7, 14 and 28 days was obtained and also durability aspects of bagasse concrete for marine, sulphite and chlorides attack was tested. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased

Sagar W. Dhengare, Dr.S.P.Raut, N.V.Bandwal, AnandKhangan Studied on, "Investigation into Utilization of Sugarcane Bagasse Ash as Supplementary Cementations Material in Concrete". This paper presents the use of sugarcane bagasse ash (SCBA) as a pozzolanic material for producing high-strength concrete. The utilization of industrial and agricultural waste produced by industrial processes has been the focus on waste reduction. Ordinary Portland cement (OPC) is partially replaced with finely sugarcane bagasse ash. The concrete mixtures, in part, are replaced with 0%, 10%, 15%, 20%, 25% and 30% of SCBA respectively. In addition, the compressive strength, the flexural strength, the split tensile tests were determined. The bagasse ash was sieved through No. 600 sieve. The mix design used for making the concrete specimens was based on previous research work from literature. The water cement ratios varied from 0.44 to 0.63. The tests were performed at 7, 28, 56 and 90 days of age in order to evaluate the effects of the addition SCBA on the concrete. The test result indicate that the strength of concrete increase up to 15% SCBA replacement with cement.

Lavanya M.R, suumaran.B, Pradeep.T 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 o 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 is a valuable pozzolanic material and it can potentially be used as a partial replacement for cement.

K.Ganesan, K.Rajagopal,K.Thangavel presented the . "Evaluation of Bagasse Ash as Supplementary Cementitious Material" From the investigation,Up to 20% of ordinary Portland cement can be optimally replaced with well-burnt bagasse ash without any adverse effect on the desirable properties of concrete and observed that it develops the high early strength, reduces the water permeability and it improves appreciable resistance to chloride permeation and diffusion

III. EXPERIMENTAL INVESTIGATION

The mix design (procedure) of concrete was done according to Indian Standard guidelines for M40grade. A series of laboratory tests was conducted on fibre-reinforced sugarcane bagasse ash modified concrete. Significant engineering properties such as compressive strength, spilt tensile strength and flexural strength of concrete were determined on fibre-reinforced bagasse ash modified concrete. The sugarcane bagasse ash content was varied 0%, 10%, 20% and 30% by the weight of cement and the fibre content was varied as 0%, 0.5%, 1.0% and 2.0% by the volume of concrete. The super plasticizer is also used. 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 vibratory table. The top surface was finished by means of a trowel. The specimens were removed from the mould after 24hours and then cured under water for a period of 7, 14, and 28 days. The tests were conducted as per the relevant Indian Standard specifications.

III. TEST MATERIALS

(a) Cement

Ordinary Portland 53 grade cement (Raasi gold) was used for making the concrete specimens. The specific gravity of the cement was found to be 3.15. The initial and final setting times were found to be 90 minutes and 162 minutes respectively. The Standard consistency of cement was found to be 31.5%

(b) Sugarcane Bagasse Ash

The SCBA used for this investigation was obtained from KCP Sugar factory, Vuyurru, located in Krishna district, Andhra Pradesh. SCBA contains approximately 25% of hemi-cellulose, 25% of lignin and 50% of cellulose. Each ton of sugarcane generates approximately 26% of bagasse (at 50% moisture content) and 0.62% of residual ash. The residue after combustion gives a chemical composition dominated by silicon dioxide. The specific gravity of SCBA was found to be 2.49.

Fig.1 Sugarcane Bagasse Ash

(c) Coarse Aggregate

Aggregate of size ranging from 20 mm to 12.5 mm were used in the mix. It was free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate was also tested for its various properties like Specific gravity, water absorption and fineness modulus as per IS 2386-1963 and the values for coarse aggregate were found to be 2.8, 0.5% and 7.26 respectively.

(d) Fine Aggregate

Regionally available river sand used and it confirming zone II as per Indian standards 383-1970. The sand used in this investigation is free from clay, silt and organic impurities. The fine aggregate was also tested for its various properties like specific gravity, water absorption and fineness modulus as per IS 2386-1963 and the values for fine aggregate were found to be 2.6, 1% and 2.99 respectively. Fractions from 4.75mm to 150µ are termed as fine aggregate. The fine aggregate confirms to standard specifications.

(e) Steel fiber

Discrete steel fibres confirming to ASTM A 820/A 820M-04 were used. They were type 1 cold drawn wire grooved. The steel fibres used in this project had a length of 50mm and a diameter 1mm. Hence, their aspect ratio(l/d) was 50.

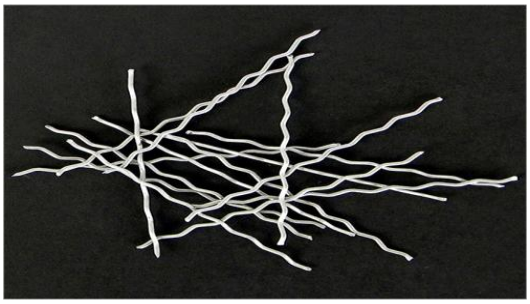


Fig.2 CRIMPLED STEEL FIBRES

(f) water

The water free from organic matter and was used in mixing the concrete. Water required quantities were measured by graduation jar and added to concrete. The rest of the materials for preparation of concrete mix were taken by weigh batching.

(g) Superplasticizer

Conplast SP430(superplasticizer) is based on sulphonated naphthalene polymers and supplied as a brown liquid instantly dispersible in water. It has been specially formulated to give high water reductions upto 25% without loss of workability or to produce high quality concrete of reduced permeability. Conplast SP430 complies with IS:9103:1999 and BS:5075 Part 3 and ASTM--C-494 Type 'A' and Type 'G' depending on the dosage of high range water reducing admixture and Type G at high dosage.

IV. MIX PROPORTION

Table - 1 Material requirement 1m^3

	Cement	Fine aggregate	Coarse aggregate	water
Kg/m^3	380	828.675	1157.670	148
Proportion	1	2.180	3.046	0.389

V. CURING OF THE SPECIMEN

The specimens are left in the moulds undisturbed for about 24 hours after casting at room temperature. The specimens are then removed from the moulds and immediately transferred to the curing tanks.

Fig.3 SPECIMENS CURED IN WATER

VI. FLEXURAL STRENGTH TEST

Flexural strength of the concrete prisms specimens are 500 mm × 100 mm × 100 mm. As already mentioned, flexural strength was determined for the curing periods of 7days, 14 days and 28 days. Preparation of the surfaces was not required, but thebearing surfaces of the supporting and loading rollers were wiped clean. The specimen was then placed in the machine in such a manner that the load was applied to the uppermost surface as cast in the mould, along two lines spaced 200 mm or 133 mm apart. The axis of the specimen was carefully aligned with the axis of the loading device. The load was applied without any shock or vibration and was increased continuously at such a rate that the extreme fibre stress increased at 0.7 N/mm^2/min. The load was increased until the specimen failed, and the failure load was recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure were noted.

The flexural strength of the specimen was determined from the expression

$f_b = \frac{Pl}{bd^2}$

Where, f_b= modulus of rupture,
b= measured width in mm of the specimen,
d= measured depth in mm of the specimen at the point of failure,
l= length in mm of the span on which the specimen was supported, and
P= maximum load in N applied to the specimen.

VII. FLEXURAL STRENGTH OF CONCRETE SPECIMENS

Beam specimens of size 100mm × 100mm × 500mm were casted and cured for 7, 14 and 28 days were tested for maximum load. Flexural strength of concrete prism specimens containing various amount of bagasse ash and steel fibres were determined.

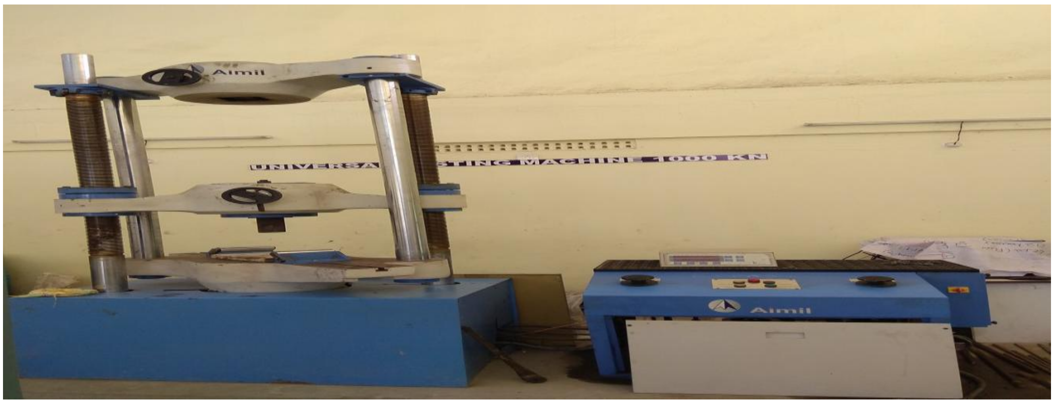


Fig.4 UNIVERSAL TESTING MACHINE

VIII. TEST RESULTS

Table - 2 Flexural Strength Test results of beam specimens on % replacement of cement with SCBA

S. No.	SCBA (%)	7 Days Strength (MPa)	14 Days Strength (MPa)	28 Days Strength (MPa)
1	0	4.34	4.64	5.26

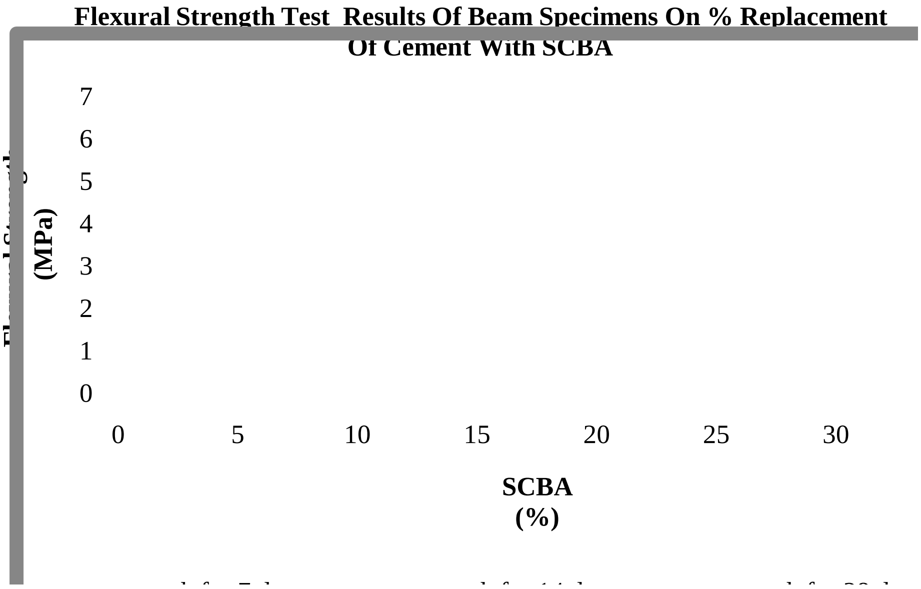
2	10	3.61	3.82	4.03
3	20	3.80	5.00	6.10
4	30	3.67	4.58	5.47

Table - 3 Flexural Strength Test Results Of Beam Specimens On % Addition Of Steel Fiber

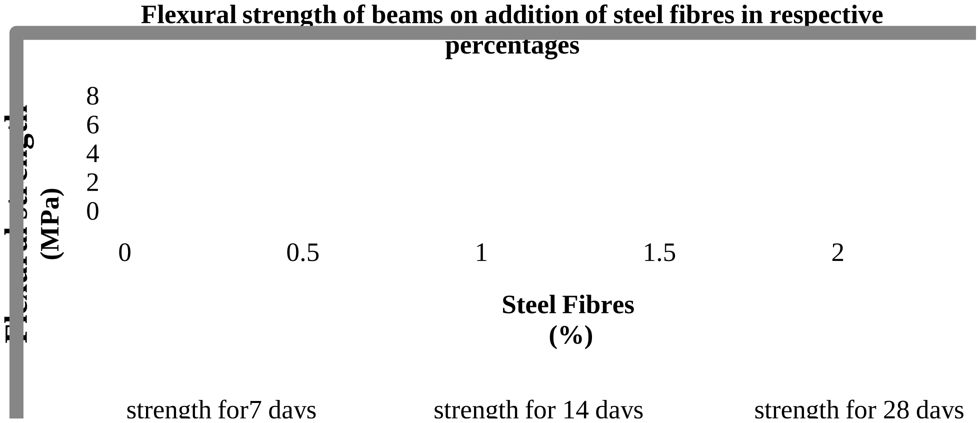
S. No.	SCBA (%)	7 Days Strength (MPa)	14 Days Strength (MPa)	28 Days Strength (MPa)
1	0	4.34	4.64	5.26
2	0.5	4.18	4.72	5.73
3	1.0	4.50	5.08	6.06
4	2.0	4.54	5.12	6.13

Table - 4 Flexural Strength Test results of beam specimens for 20% SCBA & 1.0% Steel Fiber

S. No.	7 Days Strength (MPa)	14 Days Strength (MPa)	28 Days Strength (MPa)
1	4.28	4.60	5.44



GRAPH – 1 Flexural Strength Test results of beam specimens on % replacement of cement with SCBA



GRAPH – 2 Flexural Strength Test Results Of Beam Specimens On % Addition Of Steel Fiber

Fig.4 UNIVERSAL TESTING MACHINE WITH BEAM SPECIMEN

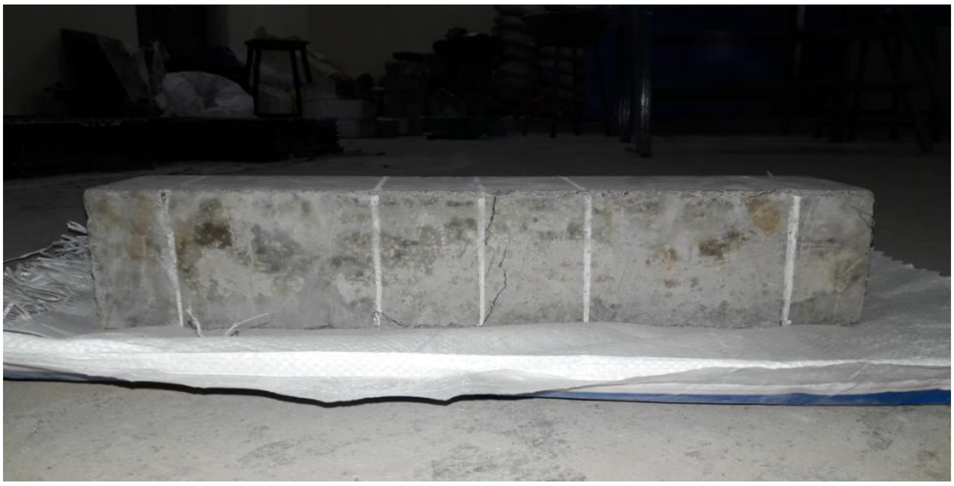
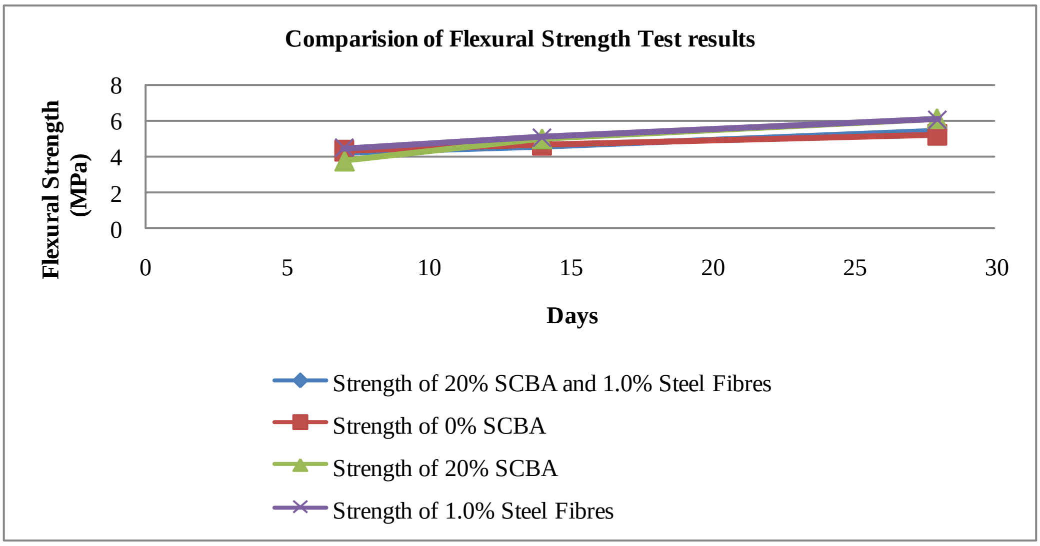


Fig.4 FAILURE AFTER FLEXURAL TEST



GRAPH – 3 Comparative Flexural Strength Test results of beam specimens for 20% SCBA & 1.0% Steel Fiber

IX. CONCLUSION

- The Specific surface area of SCBA is 420 m^2/Kg greater than 330 m^2/Kg of cement. The workability of SCBA concretes have decreased in compared with ordinary concrete. It is inferred that reduction in workability is due to large surface area of SCBA.
- The optimum value of SCBA content was found to be 20%. For that concrete, optimum volume fraction of crimped steel fiber was founded as 1%.
- 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.
- When compared to conventional concrete flexural strength increases by 15.97% on 20% SCBA.
- When compared to conventional concrete flexural strength increases by 15.21% on 1.0% Steel Fiber.
- When compared to conventional concrete flexural strength increases by 3.43% on steel fiber reinforced concrete with SCBA.

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