"Experimental Study of M 25 concrete with Sugarcane Bagasse and sisal fibre"

Sharad Nigam, Tarun Kumar Rajak, Rajan Kumar Singh
Department of Civil Engineering SSIPMT Raipur, India
sharadnigam1910@gmail.com

Department of Civil Engineering SSIPMT Raipur, India
t.rajak@ssipmt.com

Department of Civil Engineering SSIPMT Raipur, India
rajankumar.singh@ssipmt.com

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Abstract—*Since concrete is used more than any other material in the world, its use cannot be avoided. However, given the current shortage of natural resources, there is also a greater need for concrete. Because it helps to conserve natural resources, the use of industrial waste byproduct in structural concrete has been advocated. When compared to conventional concrete (without SBCA and Sisal fibre), the research studies showed that sisal fibre concretes were significantly improved in their flexural properties with strength gains for different mixes due to the inclusion of fibre up to 2% and also exhibited synergistic interaction effects due to SBCA combinations. The presence of sisal fibres in concrete showed in ductile failure with multiple splitting and bridging the crack formation, when reached an ultimate failure load.*

When reinforced structures use only Portland cement in their concrete and the rebar is not tightly interlocked, the structural building concrete corrosions are continually exposed to higher levels of deterioration. Additionally, corrosions may be brought on by the offered cover concrete's insufficient depth. In these conditions, mineral admixtures are crucial to the construction industry. The use of pozzolanic activity of residue like sugarcane bagasse ash (SCBA) has exceptional strength, more stiffness, and remarkable durability; the average particle less than 45 microns replaced (0-20%), sisal fibres (2.0%), steel slag (0- 60%), along with 1.5% of super plasticizers by weight of binder content for various mixes of M25 grade of concrete was experimentally studied. This research work is focused on, how to increase the corrosion resistance and enhancing the matrix densification by using the accelerated corrosion technique by Florida method. The potential corrosion of steel rebar with SCBA shows the tremendous resistance impact towards the corrosion initiation period of cracks. It was clearly observed that 20% of SCBA with 40% of steel slag along with 2.0% of sisal fibres shows extensive performance effects on the RCPT for 7, 14 28 and 56 days of curing.

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I. INTRODUCTION

Ordinary Portland Cement (OPC) is the important component used for the manufacture of cement and has no choice in the common development sector except steel structures that are not intelligent. Be that as it may, discharge of a lot of carbon dioxide gas into the climate is a key issue for a dangerous atmospheric deviation, turns into a significant burden. Henceforth it is unavoidable either to scan for an elective material or mostly supplant it by some other material, which is practical.

It has been evaluated that roughly 250 to 300 million lots of mechanical squanders are being created each year through substance and rural process in India. Sugarcane bagasse debris, the sinewy buildup subsequent to pulverizing and squeeze removal of sugarcane, was a large present day waste object from the sugar business. Contingent upon the burning conditions, the subsequent Sugarcane Bagasse Ash (SCBA) might include great ranges of SiO2 and Al2O3, empowering this one utilization as a treasured cementitious material in combined bond frameworks. It is located that bagasse particles is excessive in silica and is discovered to have pozzolanic property so it very appropriate can additionally be utilized as alternative to enchantment material. Sisal fibre is a kinds of Agave.

Utilization of sisal fibre builds the flexural quality of cement. The expansion of polymeric strands improves the strengthening productivity of the network and builds the ductile presentation. Also, the nearness of sisal fibre gives ostensible functionality on the crisp solid properties even at higher water to fastener proportion. Among different common strands, sisal filaments are generally accessible and modest in setting to the monetary state of India..

Sousa, L.N.; Figueiredo, P.F.; França et al (2022) [1] Studies on Effect of Non-Calcined Sugarcane Bagasse Ash as an Alternative Precursor on the Properties of Alkali-Activated Pastes. The pastes were produced by mixing the precursors with the activator, composed of a mixture of sodium hydroxide 8 mol/L and sodium silicate. Aiming to study the incorporation of SCBA, all samples have a precursor/activator ratio and a BFS/(BFS + MK) ratio constant of 0.6. The compressive strength analysis, FTIR, XRD, TGA, SEM and isothermal calorimetry analyses pointed out the occurrence of alkaline activation in all proposed samples for curing times of 7, 28 and 91 days. The sample GM0.6-BA0 (15% SCBA) achieved the highest compressive strength among the samples proposed (117.7 MPa, at 91 days), along with a good development of strength throughout the curing days. Thus, this work presents the properties of alkaline-activated pastes using SCBA as a sustainable and alternative precursor, seeking to encourage the use of raw materials and alternative waste in civil construction.

Sewwandi, M.N et al (2021) [2] Optimizing pre liming ph for efficient juice clarification process in Sri Lankan sugar factories. This study was conducted treating with Milk of Lime to reach different pH levels (T1- with Initial pH, T2, T3 and T4 with 6.5, 7.5 and 8.5 of pH respectively) to determine the optimum pre-liming pH which could result in best cane juice clarification in Sri Lankan sugar industries. It is expected to obtain high turbidity and higher mud volume with low sugar inversion at optimum pH. Therefore, the results suggest optimum pH range lie around pH 7.5 to 8.5. Conducting similar experiment by using mixed juice extracted from sugar factory mills with pH range around 7.0 to 8.4 at 0.2 increments is suggested to validate the optimum pH.

Mr. Vishat Trivedi et al (2020) [3] This paper introduces the concept on high performance of concrete of cement using sugarcane bagasse ash (SCBA) in replace of cement with different percentage value. Sugarcane bagasse ash, fly ash, glass used as mineral intermixtures in

Portland cement to improve the tensile strength, compressive strength, flexural strength of concrete by replacing of cement. As we noticed, use of Portland cement is very common in all type of construction, if construction increases the availability of Portland cement also increases, so we are consuming the natural materials to replace it by cement. It can also cause environmental advantages like minimizing in energy consumption or in greenhouse gas emissions and decrease of waste emissions. We also reduce carbon dioxide (CO2) emissions with these admixtures. Consequently, sugarcane bagasse powder (SCBA) can be utilized as mineral admixture because of high silica (SiO2) content. In this experimental study, we reduced cement ratio and used sugarcane bagasse ash (SCBA) with 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%. The indicates that the SCBA had highly flexural strength, compressive strength and split tensile strength as compare to normal concrete. The outcomes demonstrate that Sugarcane Bagasse gives increment in the workability of concrete when contrasted with conventional cement. The outcomes show that SBA can be utilized 15% substitution as compared to normal concrete.

Patil, C et al (2018) [4] In the study, micro structural observations and elemental analysis of Portland cement (OPC) and sugarcane bagasse ashes collected from four different sugar factories are carried out. Out of these four factories, three are located in the region of north Karnataka state (Chikodi, Vijayapur, M.K.Hubli) and one in Maharashtra state (Ichalakaranji) are studied. These ashes are represented as BA-C (Chikodi), BA-V (Vijayapur), BA-M (M.K.Hubli) and BA-I (Ichalakaranji). The microstructural observations were made using Scanning Electron Microscope (SEM) and elemental compositions were analyzed by Energy dispersive spectroscopy (EDS). As indicated by SEM results, the OPC and all the sugarcane bagasse ashes presents different microstructure. On the other hand EDS map shows calcium as predominate element in OPC and silicium in all the bagasse ashes.

Bangar Sayali et al. (2017) [5] this was because of the consolidated impact of relative fineness and the Pozzolonic movement of Sugarcane Baggage Ash (SCBA) and might be because of the current of crystalline silica (SiO2). As indicated by Bui fortifying ability of a mineral admixture relies upon the Pozzolanic reactivity, yet also on the general fineness of the filler material. A multi-day organize compressive quality for S4 10% substitution was indicated clear creating quality about 0.960% of OPC while different examples (S2 and S3) were demonstrated 85% quality improvement than OPC. Lessening in compressive quality qualities with increment in the substitution proportion demonstrated that filler impact was prevalent just up to 10% cinder substitution. The expansion in compressive quality qualities in the S4 is because of the consolidated impact of physical and concoction forms. Physical activity was brought about by the high explicit surface zone of Sugarcane Baggage Ash (SCBA) and concoction activity was the Pozzolonic response between calcium hydroxide (CH) and silica (SiO2). Additionally, the hydration of silica (SiO2) itself in the soluble condition may have been in charge of increment in compressive quality. In any case, hydration response in S2 and S3 example was moderate; conceivable due to low reactivity of silica (SiO2) and the decrease in CaO substance may have caused the decrease in extreme quality advancement.

II. EXPERIMENTAL PROGRAM -

GENERAL

Sugarcane Bagasse Ash is a pozzolanic product and it consists of specific features. It is used in different forms of application with high qualities. SCBA is a good additive for concrete and or cement application. Generally, cement partially replaced by SCBA in concrete with exhibits favorable engineering properties. For the preliminary investigation of Ordinary Portland Cement, Sugarcane Bagasse ash (SCBA), Steel Slag (SS), Sisal Fibre (SF), Crushed Granite Aggregates (CGA) & River sand was subjected to properties analyses to determine for compare with standard use. The specimen was cast with M25 grade of concrete with different replacement levels of Sugarcane Bagasse ash and Steel Slag. This research is to study the development of sugarcane bagasse ash (SCBA), sisal fibre and steel slag in concrete of M25 grade concrete.

MATERIALS USED

Cement

Conventional Portland bond affirming to IS: 12269-2013 (Specification for 53 grade normal Portland concrete), fine aggregates, coarse aggregates, and consumable H2O have been utilized for the manage Ordinary Portland concrete examples. River sand to be had in Vellore was used as fine aggregates and tested as per IS: 2386-1963 (Methods of Test for Aggregates for Concrete). In this exam, locally reachable blue rock squashed stone totals of greatest size 20mm was utilized and portrayal exam has been accomplished in keeping with Maybe IS: 2386-1963 (Methods of Test for Aggregates for Concrete).

Table 1 Physical and Mechanical Properties of Cement

Characteristics	**Result**
Specific Gravity	3.18
Normal Consistency	30 %
Initial Setting Time	46 min
Final Setting Time	320 min
Normal Consistency	34%
Soundness Le-Chatelier Method	5 mm

Aggregate

Aggregate characteristics such as precise gravity, bulk density and particle size distribution and moisture content material changed into vital previous to proportioning of mixtures. Shape and surface assumed a good sized activity in influencing the rheological properties of cement, these qualities might also likewise be considered whilst proportioning. The molecule shape to need to otherwise be dimensional, i.e., now not stretched or flaky. Total have to be fee of level free of level and extended molecule. Smooth and rounded aggregates required much less of cement paste to flowing concrete.

Table 2 Physical Properties of Fine Aggregate

Physical Properties	Result
Specific Gravity	2.6
Fineness Modulus	2.69
Water Absorption	2%
Bulk Density	1.709 g/cc
Grading	Zone 1

Table 3 Physical Properties of Coarse Aggregate

Physical Properties	Result
Specific Gravity	2.6
Fineness Modulus	2.69
Water Absorption	2%
Bulk Density	1.709 g/cc
Grading	Zone 1

Sugarcane Bagasse Ash (SCBA)

Bagasse is the stringy build-up of sugar stick in the wake of pulverizing and extraction of juice. Sugar stick bagasse debris is the waste made of the burning of bagasse for quality in sugar manufacturing plants. Sugarcane bagasse debris is discarded in landfills and is presently turning into a natural weight. Here bagasse debris has replaced in the proportion of 0%, 5%, 10%, 15%, 20% and 25%.

Table 4 Physical and chemical properties of SCBA

Physical Properties	Result
Specific Gravity	3.3
Fineness Modulus	2.70
Water Absorption	1.8%

Sisal Fiber Sisal

Fiber is gotten from the leaves of the plant. It is normally gotten by way of gadget decortications in which the leaf is squashed among rollers and afterward while exactly scratched. Sisal fibre is really coarse and inflexible. It is esteemed for cordage use due to its satisfactory, durability, capacity to extend, partiality for unique dyestuffs and safety from disintegration in saltwater.

Table 5 Physical Properties of Coarse Aggregate

Physical Properties	Result
Length	2.88 mm
Width	22.6 µm
Elongation	3.02%
Moisture Regain	18%

Steel Slag

Steel slag is glass-like side-effect left over after an ideal metal has been isolated from its crude mineral. Slag is normally a blend of steel oxides and silicon dioxide. In any case, slags can incorporate metallic sulfides and primary metals. While slags are commonly used to evacuate squander in metal purifying, they can likewise fill different needs, for example, aiding the temperature control of the refining and limiting any re-oxidation of the last fluid metal item before the liquid metal is expelled from the heater and used to make strong metal.

Design Mix of Concrete

Initially, an excessive strength concrete with goal strength of M25 grade concrete became followed for different proportions from the experimental outcomes shows the 20% of sugarcane bagasse ash is more appropriate and changed in Portland cement.

Further testing is carried out using the optimum value of 20% SCBA (as constant) with addition of 2% sisal fibre and replacing various percentage of steel slag with coarse aggregate such as 0%, 10%, 20%, 30%, 40%, 50% in this study are given in Table 6 and mix proportion of the concrete was explained in Table 7.

Table 6 Concrete mixture proportions (for all mixtures)

Sample Name	Cement	Sugarcane Bagash	Fine Aggregate	Coarse Aggregate	Steel Slag	Sisal Fibre
CC	375	0	651.63	1293.58	0	0
SB1	300	75	651.63	1164.22	129.358	2
SB2	300	75	651.63	1034.86	258.716	2
SB3	300	75	651.63	905.506	388.074	2
SB4	300	75	651.63	776.148	517.432	2
SB5	300	75	651.63	646.79	646.79	2

Table 7 Mix Proportion of the Concrete

Sample	Cement	Sugarcane Bagash	Fine Aggregate	Coarse Aggregate	Steel Slag	Sisal Fiber
CC	1	0	1.73	3.45	0	0
SB1	0.8	0.2	1.73	3.104	0.344	0.02
SB2	0.8	0.2	1.73	2.759	0.689	0.02
SB3	0.8	0.2	1.73	2.414	1.034	0.02
SB4	0.8	0.2	1.73	2.069	1.379	0.02
SB5	0.8	0.2	1.73	1.724	1.724	0.02

III. RESULTS AND DISCUSSION –

3.1 Compressive Strength of Concrete

It can be seen that maximum 56-day strength of 30.70 MPa has been achieved for plain concrete with a w / c ratio of 0.44. While the cement mixes replaced with SCBA ash reported a maximum resistance of 28 days of 30.40 MPa for a replacement of SCBA ash of 20%. However, the target grade M25 was not achieved with the effect of the particle size. The compressive strength compared to control specimen with various percentages results are presented in Table 8 and Table 9.

Table 8 Compressive Strength Test without Steel Slag

S.No.	**Designation**	**Compressive Strength (MPa)**			
		7 Days	**14 Days**	**28 Days**	**56 Days**
1	CC	17.4	25.12	28.30	28.65
2	SB1	18.45	25.48	28.60	29.20
3	SB2	18.65	25.75	29.58	29.85
4	SB3	18.82	26.20	29.75	30.35
5	SB4	19.20	26.45	30.40	30.70

Table 9 Compressive Strength Test with Steel Slag

S.No.	Designation	Compressive Strength (MPa)			
		7 Days	14 Days	28 Days	56 Days
1	CC	18.2	25.20	28.00	29.40
2	SB1	19.1	26.10	28.70	30.30
3	SB2	19.4	26.40	29.20	30.60
4	SB3	19.9	26.90	29.70	31.10
5	SB4	20.30	27.30	31.30	31.50

3.2 Splitting tensile strength of concrete

The splitting tensile strength of the concrete sample used to be measured in the same machine used for the compressive strength, but in this case, the cylindrical sample was once positioned axially and the load used to be applied alongside the curved surface. In the case of sisal fibres, it was once found that the expand in tensile strength depended on the fibre doseand it was additionally found that the sisal fibres produced an extend in tensile strength which it was once exceptionally higher than that of steel fibres as shown in Fig 4.4. The splitting tensile strength compared to control specimen with various percentages results are presented in Table 10 and Table 11. The addition of 2.0% sisal fibres to M25 graded concrete confirmed a tensile strength of 3.20 MPa at 28 days compared to plain concrete.

Table 10 Split tensile strength without Steel Slag

S.No.	**Designation**	***Splitting tensile* (MPa)**			
		7 Days	**14 Days**	**28 Days**	**56 Days**
1	CC	1.6	2.1	2.71	3.34
2	SB1	1.71	2.34	2.84	3.38
3	SB2	1.75	2.37	2.90	3.85
4	SB3	1.8	2.47	3.15	3.20
5	SB4	1.75	2.52	3.20	3.42

Table 11 Splitting tensile strength with Steel Slag

S.No.	**Designation**	***Splitting tensile* (MPa)**			
		7 Days	**14 Days**	**28 Days**	**56 Days**
1	CC	1.75	2.52	3.24	3.60
2	SB1	1.8	2.63	3.34	3.77
3	SB2	1.92	2.72	3.42	3.81
4	SB3	1.96	2.81	3.51	3.83
5	SB4	1.99	2.93	3.59	4.10

3.3 Flexural Strength Test –

Flexural bending properties evaluated from the standard test as per IS: 516-2018. A maximum flexural strength 28-days of 4.91 MPa was obtained for sisal fibre substituted plain cement concrete mixes as shown in Table 12 and Table 13 that the flexural test results for various mixture proportions of SCBA, steel slag, along with sisal fibres concrete. A maximum flexural strength for 28-days is 5.31 MPa was achieved for concrete.

Table 12 Flexural strength without Steel Slag

S.No.	Designation	Flexural Strength (MPa)		
		14 Days	28 Days	56 Days
1	CC	2.88	3.45	3.78
2	SB1	3.70	4.68	4.75
3	SB2	4.25	4.75	4.91
4	SB3	3.85	4.88	4.91
5	SB4	4.15	4.91	5.2

Table 12 Flexural strength with Steel Slag

S.No.	Designation	Flexural Strength (MPa)		
		14 Days	28 Days	56 Days
1	CC	3.85	4.91	5.2
2	SB1	4.12	5.10	5.32
3	SB2	4.45	5.26	5.37
4	SB3	4.35	5.29	5.44
5	SB4	4.55	5.31	5.49

3.4 ACID ATTACK TEST

From the test results for SCBA with and without blended in Portland cement based concrete cured the specimens in 3% HCL, 3%H2SO4 and 3% NaOH as shown in Table 3.4.

Table 3.4 Acid Attack Compressive Strength

Designation	HCL 3%	H2SO4 3%	NaoH 3%
CC	35.3	34.9	35.1
SB1	26.5	36.9	35.6
SB2	34.1	23..3	28.9
SB3	36.7	38.8	28.4
SB4	34.8	39.6	30.7

IV CONCLUSIONS

The following conclusions are drawn based on the performance in experimental test results and the discussion on the mechanical and durability studies, corrosion resistance, permeability, sulfate acid attack, and rapid chloride permeability test on with sugarcane bagasse ash-based sisal fibre reinforced concrete.

The very prominent conclusions drawn from the present work are as follows.

1. The replacement of Portland cement with 20% of SCBA decreases the fresh concrete workability. Therefore, it is essentially required up to 1.5 % of the binder content of the super-plasticizer. The use of chemical admixture in concrete is valuable for better workability and strength it reduces the water content up to 60%.
2. SBCA substituted concretes showed favorable improvements on the concrete hardened properties. This necessarily shows improved compressive strength of sisal fibre concrete (SS5) up to 34.3 MPa and this increase was significant for a higher dosage of 2% Vf of concrete Cement concrete for various mixes can be made economical by partially replacing the Cement with Sugar Cane Bagasse Ash.
3. It is noted that they produce green, sustainable, and eco-friendly cement concrete by partially replacing Cement with Sugar Cane Bagasse Ash With the above study, the mean target strength of M25 grade cement concrete is achieved with partial replacement of Cement by Sugar Cane Bagasse Ash with the addition of sisal fibres up to 2% by volume of fraction Also, SBCA addition in sisal fibre concrete mix at 20% showed a marginal increase in strength up to 10% in the case of reference concrete.
4. A maximum splitting tensile stress at 28 days as (3.59 MPa) of sisal fibre reinforced concrete was observed in the case of 2% fibre substituted concrete mixes.
5. Flexural strength of sisal fibre, SBCA, steel slag concrete shows a significant increase in strength up to 5.49 MPa at 56 days when compared to plain concrete 5.20 MPa. Its increased fibre addition does provide an anticipated increase in flexural strength and also improves the bending stress.
6. The replacement of Portland cement with 20% of SCBA decreases the fresh concrete workability. Therefore, it is essentially required up to 1.5 % of the binder content of the super-plasticizer. The use of chemical admixture in concrete is valuable for better workability and strength it reduces the water content up to 60%.

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