PARTIAL REPLACEMENT OFCEMENT WITH SUGAR CANE BAGASSE ASH AND HYBRID FIBERS

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Abstract

Concrete is the world's second most widely used material. Concrete can gain strength over time and is not affected by temperature, but the cost of cement in concrete is very high and is not environmentally friendly because it emits a large amount of carbon -di-oxide, so to overcome this problem, we will partially replace the cement with sugar cane bagasse ash. SCBA has a chemical composition similar to cement. The use age of SCBA 20% in concrete revealed very little strength. To improve the properties of our project, we will add more cementitious materials and hybrid fibres, and we will investigate the properties of SCBA concrete in the fresh and hardened states.

Keywords: Surgane bagasse, Fibers, Glass fibers, OPC cement, Admixtures, Workability, Strength

Introduction

Different waste materials as well as by-products are used as pozzolanic materials in concrete. Utilization of different supplementary cementitious' materials (SCM) for the production of blended cements contributes to achieving durable and sustainable concrete . Enormous quantities of sugarcane bagasse ash (SCBA) are obtained as by-product from cogeneration combustion boilers in sugar industries; this material has been described to be a suitable supplementary cementitious material for use in concrete in previous research studies . India is the second largest producer of sugarcane and large quantity of bagasse ash (67,000 tonnes/day) is directly disposed to nearest land which causes severe environmental problems . Rapid implementation of bagasse based new cogeneration plants (that are mandated by the government) is expected to substantially increase bagasse ash generation. The utilization of bagasse ash as a supplementary cementing material through systematic processing and characterization offers a profitable and environment-friendly alternative to its disposal.

Pozzolanic materials such as sugarcane bagasse ash and rice husk ash are agricultural by-products and cannot be directly used as a mineral admixture in concrete due to the presence of unburnt particles . Sugar cane is a kind of tropical and subtropical crop and is the mainsugar crop worldwide. Global sugar crop acreage is approximately 31.3 million hectares, among which sugar cane accounts for approximately 70%. The world's top three sugar-producing countries are Brazil, India, and China, which accounted for 20.57%, 16.91%, and 6.31% of the global production in 2016, respectively. Recently, sugar cane acreage reached approximately 1.23million hectares in China, and production was approximately 100 million tons in 2017/2018.Apart from that SCBA is rich in amorphous silica that leads to good pozzolanic properties.

Introduction to Sugar Cane Bagasse Ash

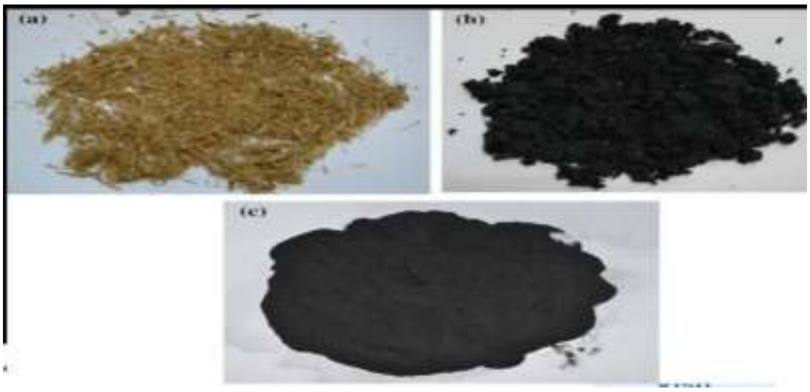


Fig 1Sugar cane bagasse ash

Sugarcane today plays a major role in the worldwide economy, and Brazil is the leading producer of sugar and alcohol, which are important international commodities. 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 (SBA), 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 moreÂ Â» inert materials. The present study used ash collected from four sugar mills in the region of Sao Carlos, SP, Brazil, which is one of the world's largest producers of sugarcane. The ash samples were subjected to chemical characterization, sieve analysis, determination of specific gravity, X-ray diffraction, scanning electron microscopy, and solubilization and leaching tests. Mortars and concretes with SBA as sand replacement were produced and tests were carried out: compressive strength, tensile strength and elastic modulus. The results indicated that the SBA samples presented physical properties similar to those of natural sand. Several heavy metals were found in the SBA samples, indicating the need to restrict its use as a fertilizer. The mortars produced with SBA in place of sand showed better mechanical results than the reference samples. SBA can be used as a partial substitute of sand in concretes made with cement slag-modified Portland cement.

Process of making sugar cane bagasse ash

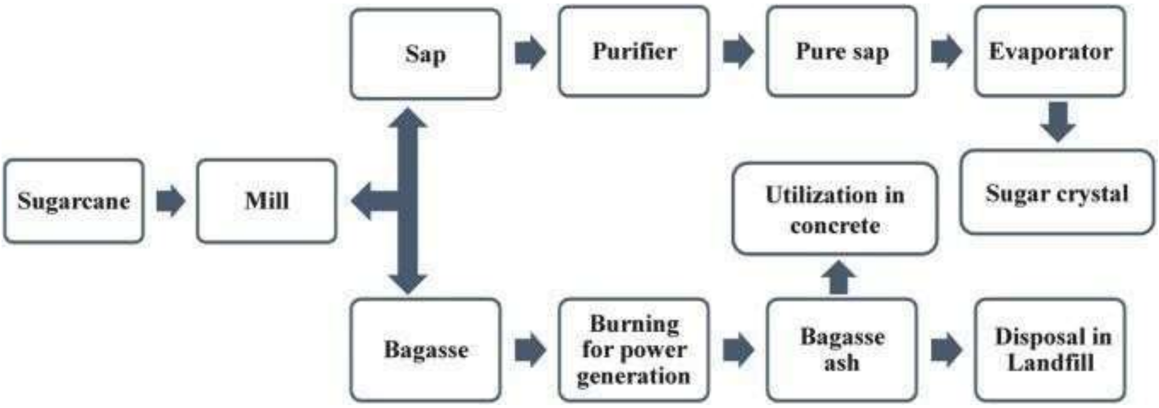


Fig 2 Process of making sugar cane bassae ash

Advantages Of Sugar Cane Bagasse Ash:

Apart from helping us to reduce plastic waste in our home, area, country, and the planet, the biodegradable food packaging made from sugarcane pulp also has other benefits too.

1. Heat Tolerant

Made from a natural resource, this sugarcane pulp based eco-friendly packaging can tolerate heatup to 200°F, which makes it safe to use inside oven or microwave. Yes! You can store and reheat your food in it, without worrying about its endurance to heat.

2. Biodegradable

This is the foremost reason why it has become an instant hit with every green enthusiast. It is completely natural and biodegradable. It can break down easily into the soil within a few weeks, unlike its plastic counterparts that take millions of years.

3. Fertilizer

Ever bought entrance tickets for a show, where the entire amount you have paid is entirely redeemable at the food counter? The same is the case with using Sugarcane-pulp based packaging. You buy it, use it, dispose of it in a composting bin, and you get fertilizer out of it. After degrading into the soil, it produces fertilizer that nurtures the soil rather than harming it.

4. Renewable Resource

This eco-friendly compostable packaging from Ecoware is produced from Bagasse, an agricultural waste. Farmers get paid for it and it is renewable. This means that no pollution from crop burning and no non-renewable resource gets exploited to produce it. A win-win situation, right?

5. Eco-friendly

The problem with plastic packaging is that it is composed of chemicals such as BPA bisphenol A,and is not biodegradable. Instead, it stays dumped in landfills for millions of years, because we haven`t figured out prospective solutions yet to deal with plastic pollution. Sugarcane-based packaging, on the other hand, is made from plant-based fiber, which makes it fully biodegradable.

6. Hybrid Fibers:

In our project we add hybrid fibers like steel fibers, polypropylene and glass to the sugar cane bagasse ash and know its properties

Literature Review

Bahurudeen, Deepak kanraj, v.Gokul dev,Manu santhanam.Concrete with bagasse ash replacement showed equal or marginally better strength perfomence compared to control concrete even at 3 days according gto the journal.The total heat as well as the peak heat rate of SCBA blend concrete was found to be lesser than controlmix.Durability performance of concrete with SCBA based cements was observed. Drying shrinkage behavior ofSCBA replaced concretes was similar to that of OPC concrete.

Gopinath Athira,The geographical distribution of the sugarcane bagasse ash on the network analysis is studied.The researches say that the SCBA is easily accessible to the RMC plants compared toother SCM. Profiling ofRMC plants are mentioned in the journal.

Authors:S.n minnu,A.bahurudeen,G.Athira According to the journal the specific gravity ofSCBAis less compared to fly ash and slag. Thecontrolled calcination enchances the reactivity of SCBA where as fly ash &slag donot need calcination.The carbonation depths are high for fly ash& slag compared to SCBA. Therefore SCBA is aperfect substitute for SCM.

Author:Bahurudeen.A,Manu santhanam The no of mills located in india has been discussed and found that large amount of sugarcanebagasse is dissposedwhich is not environment friendly. To stop this the potentialof SCBA as SCMis known.According to research the compressive strength of SCBA is more compared to normal concrete & rich in amorphous silica which is a good evidence.

Materials Used

Cement Properties

1) Fineness of Cement

The size of the particles of the cement is its fineness. The required fineness of good cement is achieved through grinding the clinker in the last step of cement production process. As hydrationrate of cement is directly related to the cement particle size, fineness of cement is very important.

2) Soundness of Cement

Soundness refers to the ability of cement to not shrink upon hardening. Good quality cement retainsits volume after setting without delayed expansion, which is caused by excessive free lime and magnesia.

3) Consistency of Cement

The ability of cement paste to flow is consistency.It is measured by Vicat Test.In Vicat Test Cement paste of normal consistency is taken in the Vicat Apparatus. The plunger of the apparatusis brought down to touch the top surface of the cement. The plunger will penetrate the cement up to a certain depth depending on the consistency. A cement is said to have a normal consistency when the plunger penetrates 10¡À1 mm.

4) Strength of Cement

Three types of strength of cement are measured compressive, tensile and flexural. Various factors affect the strength such as water-cement ratio, cement-fine aggregate ratio, curing conditions, sizeand shape of a specimen, the manner of molding and mixing, loading conditions and age.

Compressive Strength: It is the most common strength test. A test specimen (50mm) is taken and subjected to a compressive load until failure. The loading sequence must be within 20 seconds and80 seconds.

Tensile strength: Though this test used to be common during the early years of cement production, now it does not offer any useful information about the properties of cement.Flexural strength: This is actually a measure of tensile strength in bending. The test is performed in a 40 x40 x 160 mm cement mortar beam, which is loaded at its center point until failure

5) Setting Time of Cement

Cement sets and hardens when water is added. This setting time can vary depending on multiple factors, such as fineness of cement, cement-water ratio, chemical content, and admixtures. Cement used in construction should have an initial setting time that is not too low and a final setting time not too high. Hence, two setting times are measured:

Initial set: When the paste begins to stiffen noticeably (typically occurs within 30-45 minutes)Final set: When the cement hardens, being able to sustain some load (occurs below 10 hours)

6) Heat of Hydration

When water is added to cement, the reaction that takes place is called hydration. Hydration generates heat, which can affect the quality of the cement and also be beneficial in maintaining curing temperature during cold weather.On the other hand, when heat generation is high, especiallyin large structures, it may cause undesired stress.

The heat of hydration is affected most by C3S and C3A present in cement, and also by water-cement ratio, fineness and curing temperature.

The heat of hydration of Portland cement is calculated by determining the difference between thedry and the partially hydrated cement (obtained by comparing these at 7th and 28th days).

7) Bulk density

When cement is mixed with water, the water replaces areas where there would normally be air. Because of that, the bulk density of cement is not very important. Cement has a varying range of density depending on the cement composition percentage. The density of cement may be anywhere from 62 to 78 pounds per cubic foot.

8) Specific Gravity (Relative Density)

Specific gravity is generally used in mixture proportioning calculations. Portland cement has a specific gravity of 3.15, but other types of cement (for example, portland-blast-furnace-slag and portland-pozzolan cement) may have specific gravities of about 2.90

Fig :3 Cement COARSE AGGREGATE(Properties):

1. Composition

Aggregate consisting of such materials that can chemically react with alkalis in cement and cause excessive expansion, cracking, and deterioration of concrete mix should never be used.

Therefore it is necessary to test aggregates to ensure whether there is the presence of any such constituents in aggregate or not.

2. Size and Shape

The size and shape of the aggregate particles greatly influence the quantity of cement required in concrete mix and hence ultimately the economy of concrete. IS: 456 recommended the below choose the maximum size of coarse aggregate to be used in PCC and RCC mix.

The maximum size of coarse aggregate in concrete making should be less than, 1/4th of the minimum dimension of the RCC member. 1/5th of the minimum dimension of the RCC member.

3. Surface Texture

The development of hard bond strength between coarse aggregate and cement paste depends uponthe surface roughness, surface texture, and porosity of coarse aggregate.

In case the surface is but porous, the maximum bond strength will develop in concrete. In poroussurface aggregates, the bond strength of aggregate increase as cement paste start setting.

4. Specific gravity

The ratio of the weight of oven-dried aggregate which is kept for 24 hours at a temperature of 100to 100°C, to the weight of an equal volume of water displaced by saturated dry surface aggregate is called the specific gravity of aggregates.

Specific gravity is mainly oh two types:
Apparent specific gravityBulk specific gravity
The specific gravity of major aggregates falls within the range of 2.6 to 2.9.

5. Bulk Density

Bulk density of aggregate can be defined as the weight of coarse aggregate required to fill the unit volume of the container. It is generally expressed in kg/liter.

Bulk density of aggregates particles depends upon the following 3 factors which are:Degree of compaction Grading of aggregates The shape of aggregate particles

6. Voids

The empty spaces left between coarse aggregate particles are known as voids. The volume of voids equals the difference between the total volume of the aggregate mass & the volume occupied by the particles alone.

7. Porosity and Absorption

The holes produced in the rocks at the time of the solidification of the molten magma, due to air bubbles, are known as pores.

Water absorption may be defined as the difference between the weight of very dry aggregates andthe weight of the saturate aggregates with the surface dry condition.

8. Bulking of Sand

It can be defined as an increase in the bulk volume of the quantity of sand in a moist condition over the volume of the same quantity of dry or completely saturated sand.
The proportion/ratio of the volume of moist sand due to the volume of sand when dry is called a bulking of sand.

9. Fineness Modulus

Fineness modulus is commonly utilized to get an idea of how coarse or fine the aggregate is. More fineness modulus value indicates that the aggregate is a coarse sand small value of fineness modulus indicated that the aggregate is finer.

Fineness modulus is a factor obtained by adding the cumulative percentages of aggregate retainedon each of the sieves ranging from 80 mm to 150 mm micron and dividing this by 100.

10. Specific Surface Area of Aggregate

The total surface area of aggregate particles per unit weight of the material is called specific surface. This is an indirect measure of the aggregate grading. The specific surface rises with the reduction in the size of aggregate particles. The specific surface area of the fine aggregate is very much lesser than that of the coarse aggregate.

Fig 4:Coarse Aggregate

Fine Aggregate(Properties):

Specific Gravity**:**

To the density of water, it is the ratio of the density of aggregate.Moisture Content**:**

Weight of water absorbed to the weight of dry aggregate and measured in percentage.

Bulking:

Bulking means an increase in the volume of sand due to surface moisture.

1. Surface texture
2. Soundness
3. Durability
4. Silt content.

Size:

The size should be equal to or less than 4.75mm.

Shape:

To completely round grained sand, the sand of irregular nodular shape is preferable and in coarse aggregates shape of aggregate plays an important role.

Fig :5 fine aggregate SUGAR CANE BAGASSE ASH(properties)

In order to validate the results of muffle fire loss obtained, thermo gravimetric tests were employed. The analyses were conducted on STA 449 F3 JUPITER NETZSCH simultaneous analysis equipment. The experimental conditions used were as follows: inert atmosphere (N2), maximum flow of 100 ml/min and heating range of 30°C to 1000°C, with a heating rate of 10°C/min, with sample port (alumina crucible), and mass approximately around 20 mg ± 0.5 and purge of 50°C/min. For the chemical analysis of precursor materials, the technique and semiquantitative analysis by X-ray fluorescence (XRF) spectrometry were employed. In this sense, the chemical characterization of the precursor materials was obtained using Shimadzu equipment, model XRF 1800.

Fig:6 Sugar cane bagasse ash

RECRON FIBER(Properties):

Recron fiber has high durability,resistance to cracking ,high tensile strength,specific gravity is 1.36It is acid resistant

Fig :7 Steel fiber

Fig :8 P olypropolene

Fig :9 G lass fiber

Methodology:

To find the hardened concrete properties with hardened testHardened test:

Compressive strength

Remove the samples from the water after curing time specified and excess water from the surfaceshould be wiped. The dimension of the samples to the nearest 0.2m taken The bearing surface of the testing machine should be cleaned Place the sample in the machine so that the load is applied to the opposite sides of the cube cast. Align the centre of the sample with the machine's base plate. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Gently rotate the movable part by hand so that it touches the upper surface of the sample. Apply load gradually at a rate of 140 kg / cm2 per minute until the samples fail. The maximum load recorded and any unusual features in the type of failure noted.

Fig :10 Compressive strength test apparatus

Split Tensile strength :

After curing, wipe out water from the surface of specimen Using a marker, draw diametrical lines on the two ends of the specimen to verify that they areon the same axial place. Measure the dimensions of the specimen. Keep the plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over thebottom plate. Place the other plywood strip above the specimen and bring down the upper plate to touch the plywood strip. Apply the load continuously without shock at a rate of approximately 14-21 kg/cm2/minute (Which corresponds to a total load of 9.9 ton/minute to 14.85 ton/minute) *Write the breaking load (P)

Fig: 11Split tensile strength test apparatus

Flexural Strength

Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross section of the beam mould and throughout the depth of each layer. Clean the bearing surfaces of the supporting and loading rollers , and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers. Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers shall be at least10 mm more than the width of the test specimen. A total of four rollers shall be used, three out ofwhich shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be **3d** and the distance between the inner rollers shall be **d**. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at arate of 180 kg/min for the 10.0 cm specimens

Fig:12 Flexural strength test apparatus

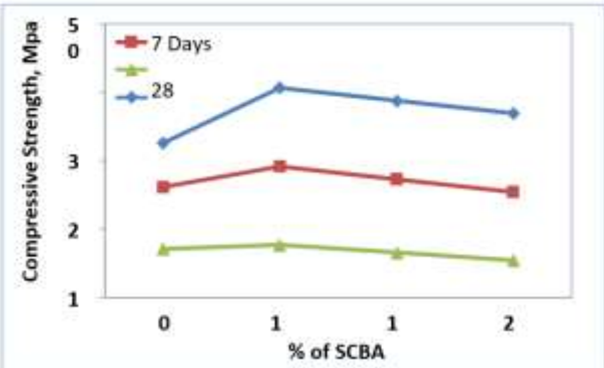
Result and Discussion

Following Mechanical Properties Of Concrete Like Conventional and Sugar Cane Bagasse ash And Hybrid Fibers based concrete specimens and performed test like compressive strength,flexural and load Vs deflection etc..

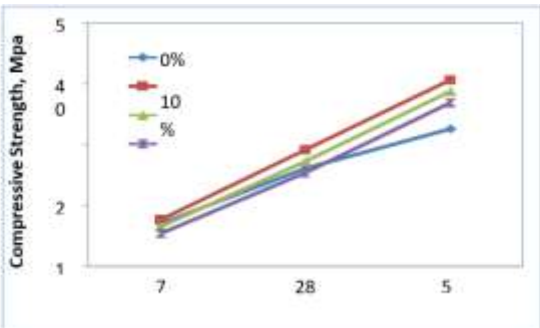
Table 1&2 Compressive strength of Convention Concrete and SCBA

NORMAL CEMENT	7 DAYS	28 DAYS	56 DAYS
COMPRESSIVE STRENGTH	17.04	26.12	35.2

NO. OF DAYS	7 DAYS	28 DAYS	56 DAYS
NORMAL CONCRETE	17.04	26.12	35.2
10% SCBA	17.68	29.17	40.65
15% SCBA	16.54	27.29	38.77
20% SCBA	15.4	25.41	36.89



GRAPH :.1 COMPRESSIVE STRENGTH vs PERCENTAGE OF SCBA(Normal concrete+SCBA)



GRAPH 2 COMPRESSIVE STRENGTH VS NO OF DAYS (normal concrete +SCBA)

According to table no 3 the maximum compressive strength is achieved when we add 10% of sugar cane bagasse ash .The strength of the 10% added SCBA is more than the normal concrete but the strength is decreasing the percentage of SCBA

Table:3 SCBA and 2% of glass fiber

NO. OF DAYS	7 DAYS	28 DAYS	56 DAYS
NORMAL CONCRETE	17.04	26.12	35.2
10% SCBA+GF	19.44	32.09	44.74
15% SCBA+GF	18.19	30.83	43.47
20% SCBA+GF	16.94	28.71	40.48

Table 4:Flexural Strength

S.no	Material used	% Of additives	Compressive Strength
1	Sugar cane bagasse ash	**10**	4.004N/mm^2
2	15%Sugar cane bagasse Ash:	**15**	3.89N/mm^2
2	20%Sugar cane bagasse Ash :	**20**	3.76N/mm2

Conclusions

- Workability of concrete used SCBA and GF mixed with normal concrete is produce good Standard consistency values.
- The maximum strength of concrete is attained at 10%, the strength of the cube Is decreasing by increasing the percentage of sugar cane bagasse ash.
- The Compressive strength of the concrete cube is increased by 10Percentage by adding glass fiber and decreased 2.5 Percentage by addingpolypropylene fiber.
- Conclude from our work replacement 10% in cement is produce enough strength and good fineness of cement and produce early setting of concrete.

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