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A Review Analysis of Microstructure, Strength and Durability of Eco Friendly Concrete Containing Sugarcane Bagasse Ash

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ABSTRACT:

We are aware that a lot of damage is done to environment in the manufacture of cement. It involves lot of carbon emission associated with other chemicals. According to studies, every tonne of cement produced emits half a tonne of carbon dioxide, hence there is an immediate need to reduce cement usage. On the hand materials wastes such as Sugar Cane Bagasse. Sugarcane bagasse ash is obtained as a by-product from cogeneration combustion boilers in sugar industries. Previous research has shown that adding sugarcane bagasse to concrete as a supplemental cementitious ingredient can improve its characteristics. The usage of ash has been limited due to a lack of understanding of the material and appropriate processing methodologies for large-scale use. Bagasse ash gives concrete a high early strength while simultaneously lowering its permeability. During hydration, the silica in the Bagasse ash combines with cement components, imparting additional qualities such as chlorine resistance, corrosion resistance, and so on. As a result, using ash in concrete not only eliminates pollution but also improves the qualities of concrete while lowering the cost. It increases the concrete's durability. The major goals of this study are to substitute cement with Bagasse ash in set proportions and to investigate the effects of HCl on SCBA mixed concrete. The concrete mix was designed by altering the amounts of ash for 0 percent, 5 percent, 10 percent, 15 percent, 20 percent, and 25% of the cubes were cast and cured in normal water and a 5% HCl solution for 7th, 28th days. The results of the tests show that when ash is replaced with cement, concrete strength increases by up to 10%.

Keywords: Microstructural, Impact resistance, HCl solution, Sugarcane Bagasse, Lightweight, Workability.

INTODUCTION:

OPC is heavily used in construction, it will continue to be so in the near future due to global demand and expansion of the construction sector. Furthermore, the concrete construction sector faces the greatest challenge in serving two essential needs of human society: environmental protection and satisfying the infrastructural needs of our rapidly rising population. Structures built in hostile surroundings are vulnerable to corrosive attack. One of the most serious issues is HCl assault on concrete structures, which results in weight loss and a decline in concrete strength, finally resulting in the structure's age being sacrificed. Sulphate attacks concrete from contaminated groundwater, seawater, and industrial effluents. Sugarcane bagasse ash, which has pozzolanic characteristics, is used as half substitution in concrete at regular intervals of 5% to 25%. SCBA is a waste material produced by sugar processing plants that will be ground to a fineness smaller than cement in order to achieve good cement-SCBA bonding. This project examines the effects of HCl exposure on concrete.

ORDINARY PORTLAND CEMENT (OPC)

Its fine powder made from a regulated blend of calcium silicates, aluminates, and ferrate, as well as gypsum and other elements. Its divided into 3 categories after 1987, based on strengthening acquired after 28^{th} days.

1. OPC 33 grade
2. OPC 43 grade
3. OPC 53 grade

The reactions b/w cement and water give Portland cement its strength. Hydration is the term for this procedure. This is a complicated process that requires first learning about composition of cement.

INTRODUCTION TO CEMENT CONCRETE

Its man-made stone made by hardening a mixture of cement, aggregates, and water with or without an appropriate additive.

Aggregates and cement water paste are combined to make cement concrete. Cement react with water and causes paste together to produce a strong rock-like structure after hardening. Fine and C.A. are two types of aggregate. Fine aggregate is sand with a particle size of less than 4.75mm, whereas coarse aggregate is gravel, crushed stone, and other materials with a practical size more than 4.75mm.

When the components are combined to make a workable concrete, its easily moulded into beams, slabs, and other shapes. After a few hours of mixing, the material undergoes a chemical reaction, which causes the mixture to solidify and harden, increasing in strength with age. The compressive strengthening of concrete is strong, while the tensile strengthening is low. There are also shrinking stresses.

LITERATURE REVIEW:

M.Vijaya Sekhar Reddy, I.V.Ramana Reddy, In 2012, researchers looked into the behaviour of High Performance Concrete (HPC), the most extensively utilised type of concrete in the construction industry. Supplementary cementing materials (SCM) and metakaolin were used instead of cement. The M60 mix design was used, and the cubes were cast and cured for 90 days in a mixture of 5% HCl (PH=2), NaOH, MgSo4, and Na2So4.They came to the conclusion that utilising supplemental cementing ingredients in concrete increased the service life of concrete structures and reduced the heat of hydration. They discovered that when concrete was substituted with fly ash, the maximum and smallest percentages of strength reduction were 12.64 percent and 1.92 percent, respectively.

Dr. P. Srinivasa Rao et al., The durability characteristics of metakaolin blended concrete were investigated using M20 concrete grade. H2So4 and HCl were used to make an attempt. Steel fibres with a 60 aspect ratio are employed at 0%, 0.50%, 1.00%, and 1.50% of the volume of concrete, respectively. They concluded that when fibre reinforced concrete and concrete containing 10% metakaolin substituted by wt. were compared to concrete, the % wt. loss was reduced and compressive strength was raised.

P. Murthi and V. Siva Kumar 2008 The resistance of ternary blended concrete to acid attack was investigated by immersing the cubes in HCL for 32 weeks. By weight of cement, binary blended concrete was created using 20% class F fly ash, while ternary blended concrete was created using 20% fly ash and 8% silica fume.

They concluded that the ternary blended concrete was performing better that the ordinary plain concrete and binary blended concrete. They discovered that M20 PCC specimens lost 19.6% and 16.1% of their mass after 28 and 90 days, respectively. It immersed in 5 percent H2So4 and 5 percent HCl solutions, it took 32 weeks to reduce 10 percent mass loss.

A.K. Al-Tamimi and M. Sonebi When immersed in acidic liquids, SCC were investigated. Workability was obtained using slump cone test, L-box and orimet for SCC mix. Cylindrical specimens of diameter 45mm and length 90mm were casted and cured for 28 days in water after they were immersed in 1% HCl and 1% H2So4 solutions by maintaining a pH of 5 regularly.

They found that when subjected to 1% SA and HCL, self-compacting concrete performed better than control concrete. They discovered that it took 18 weeks for SCC to lose 10% of its bulk and 6 weeks for CC.

B.Madhusudhana Reddy et al., The effects of HCl on blended cement (fly ash) and silica fume blended cement,concretes, were investigated. For comparison, concrete cubes were cast in deionised water with a range of dosages (100, 150, 300, 500, and 900 mg/l) implanted in water and only deionised water. The compressive strengths of silica fume blended concrete were reduced by 2 to 19 percent at 28^{th} and 90^{th} days, according to the results of the tests.

Beulah M. Asst Professor, Prahallada M. C. Professor The effect of replacing cement with metakaolin in high-performance concrete subjected to HCl attack was investigated. Cubes were casted with different water cement ratios (0.3, 0.35, 0.4 and 0.45), compressive strength was evaluated for 150×150×150 mm cubes and For 100×100×100 mm cubes, the % wt. loss was calculated. These cubes were cured in 5% hydrochloric acid for 30, 60, and 90 days.

After 30^{th} , 60^{th} , and 90^{th} days of immersion, they discovered that the residual compressive strength decreases as the water binder ratio increases. which they attribute to transition zone that leads to the development of ettringite at higher water levels.

Urooj Masood et al, investigated the behaviour of acid-exposed mixed fibre reinforced concrete. Mixed fibre reinforced concrete cubes casted and put in acids and sodium sulphate for 30, 60, 90, 120, and 180 days using a mixture of 75% glass and 25% steel fibres. Weight loss and concrete density of exposed and unexposed specimens were measured at various ages, as well as compressive strength at 180 days.

They found that when 100 percent steel fibres were utilised, the resistance to sulfuric acid attack was the highest, compared to other fibres and no fibres. Sulphuric acid resistance was higher in mixed fibre reinforced specimens than in 100 percent steel fibre reinforced specimens.

Mr. G. Siva Kumar et al., (2013) "Preparation of Bio-cement utilising Ash and Its Hydration Behavior" was the subject of his research. They employed 10% weight of OPC as half substitution in this study. The sample was tested for compressive strength, and it was discovered that the cementious substance is responsible for early hydration. Bagasse ash's pozzolanic action 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. Otuoze et al., SCBA is obtained by burning Sugar Cane Bagasse at between 600-700 degrees Celsius, because the sum of Sio2, Al2o3, and Fe2o3 is 74.44 percent, A 1:2:4 mix ratio was employed for strength tests, with OPC being partially replaced by 0 percent, 5 percent, 10 percent, 15 percent, 20 percent, 25 percent, 30 percent, 35 percent, and 40 percent by weight in concrete. At 7^{th} ,14^{th} ,21th ,28^{th} days strengthening of hardened concrete was measured. According to the results of the experiments, SCBA is a suitable pozzolana for concrete cementation, OPC may provide strengthening development in concrete. A maximum of 10% SCBA mixes with OPC may be used in reinforced concrete with thick aggregate. For plane or mass concrete, higher SCBA/OPC blends of 15 percent to 35 percent are acceptable.

Mr. Lavanya M.R et al., "A Experimental Study on the Compressive Strength of Concrete by Partial Replacement of Cement with Sugar Cane Bagasse Ash" was the subject of his research. It being investigated whether sugar cane bagasse ash, a finely ground waste product from the sugarcane industry, can be used as half substitution for cement in traditional concrete.

Mr. R. Srinivasan et al., "Experimental Study on Bagasse Ash in Concrete" was investigated. It is producing major environmental problems due to its high content of aluminium ion and silica. Chemically and physically, ash has been described, and it has been partially replaced in concrete at weight ratios of 0%, 5%, 15%, and 25% by wt. of cement. Fresh concrete tests such as compaction factor and slump cone tests, hardened concrete tests such as compressive , split tensile and flexural strengthening, and modulus of elasticity, were done at seven and 28 days. When compared to concrete without SCBA, the results reveal that SCBA in blended concrete has significantly greater strengthening. It was discovered that SCBA may be used to substitute cement up to a maximum of 10% of the time. Its partially substitute cement improves the workability of new concrete. therefore use of superplasticizer is not substantial.

Lourdes M. S. Souza et al., They researched the reactions between calcium hydroxide and ash in "Hydration of Various Initial C/S Ratio" (SCBA). Pastes with varying starting CaO/SiO2 (C/S) molar ratios were made for this purpose. Thermal studies, X-ray diffraction, scanning electron microscopy, and an energy dispersive spectrometer were used to examine the generated products. It shows main product was found to be C-S-H of not specific morphology and that could not be related to the known products C-S-H (I)/C-S-H (II).

Piyanut Muangtong et al., had investigated on "Effects of Fine Bagasse Ash on the Workability and Compressive Strength of Mortars" It used as pozzolanic materials and supplements to improve the compressive strengthening in terms of microstructures by partially replacing cement. One of their benefits is that they reduce CO2 emissions by reducing cement consumption in mortar and concrete manufacture. This study looks at the best ratio for substituting clinker with fine (45 micron) SCBA, w/c ratio and the effects of SCBA on cement characteristics. Initially, the clinker and SCBA proportions were designed by substituting clinker with 0, 20, and 40% SCBA, respectively, while gypsum was supplied at a constant rate. 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.

Asma Abd Elhameed Hussein et al., "Compressive Strengthening and Microstructure of Ash Concrete" was the subject of his research.

This report presents the findings of an experimental investigation on the efficacy of SCBA as a cement substitute material in concrete manufacturing. When OPC was replaced with 0, 5, 10, 15, 20, 25, and 30%, respectively, bagasse ash, the impact on workability, compressive strength, and microstructure of the Interfacial Transition Zone of concrete was examined. The results showed that adding up to 20% Ash to concrete boosted the concrete's compressive strength at all ages, with higher strengthening reached at a SCBA replacement level of 5%. The thickness of the ITZ was drastically lowered.

Kanchana lata Sigh and S.M Ali Jawaid, had studied on "utilization of SCBA as Pozzolanic Material in concrete"

Agricultural and industrial by-products are frequently utilised in concrete production as cement replacement materials CRMs or as admixtures to improve both freshen and hardened concrete qualities while also reducing the negative environmental effects of their disposal. Around 1500 million tonnes of ash are produced each year around the world, with roughly 40-45 percent bagasse left over after juice crushing for the sugar industry, resulting in an annual waste production of 675 million tonnes of bagasse. This paper looked ash as pozzolanic components in concrete. Bagasse ash is a byproduct of bagasse burning as a fuel in thermal power plants and the sugar cane industry. The uses of ash are discussed in this paper. Because of its high silica concentration, Sugarcane Bagasse ash can be employed as a pozzolanic ingredient in concrete, according to the review. According to the findings, blended concrete containing 10% sugarcane bagasse ash showed significantly high strengthening than blended concrete using 20% sugarcane bagasse ash. It is a pozzolanic substance that can be used to make pozzolanic cement concrete, resulting in cost savings.

(Shafiq et al., 2007; Shafiq, 2004). The cement's compressive strength improves (Janjaturaphan and Wansom, 2010).Because cement production consumes a lot of energy and accounts for 5% of global anthropogenic CO2 emissions (each tonne of cement produces about one tonne of CO2.

Fairbairn et al., 2010 Bagasse is a waste product created by sugar mills after the extraction of sugarcane juice. The vast supply of bagasse requires effective disposal. This form of bulky trash is boiler fuel in sugar mills in several countries. Due to the calorific qualities of bagasse waste, which has been utilised as the primary fuel in cogeneration plants to produce electric power throughout the last decade, rising natural gas and fuel oil costs have resulted in high electricity prices.

Frías et al., 2011; Aigbodion et al., 2010 When bagasse is burned as a fuel, it produces a large amount of ash known as ash, or SCBA. Although sugar cane bagasse ash has lately been acknowledged as a pozzolanic ingredient, research on the effects of SCBA on concrete characteristics is scarce. Lack of investigation, the majority of bagasse ash is disposed of in landfills.

Ganesan et al., 2007 Since then, sugar production has continued to rise around the world, with roughly 1500T of sugar cane produced annually, leaving about 40-45 percent bagasse after juice extraction. As a result, the average yearly production of bagasse, a bulky byproduct from the sugar industry, is projected to be 600 million tonnes.

ElHaggar, 2007 With increasing industrial activities around the world, it is imperative to search for materials that can4 replace some of the current components in commercial cement.

Chusilp et al., 2009 SCBA an agro-industrial waste of industry, has been discovered as a mineral ingredient for cement in research on the subject. As part of the sugar industry's extraction process, sugar cane stalks are pulverised to remove the juice. productive process; the fibrous waste, known as bagasse, with a net calorific value of around 8000 kJ/kg.

Batra et al., 2008 Bagasse is commonly burned in boilers at 700 and 900 degrees Celsius to provide steam and valuable energy for manufacturing processes and demands (Souza et al., 2011). Because bagasse is highly fibrous, low density, high moisture, requires fuel like coal for combustion, boiler efficiency in mills is normally 60-70 percent.

Souza et al., 2011; Faria et al., 2012 It should be noted that chemical, mineralogical and pozzolanic properties of SCBA depend on the industrial process from which it has been obtained.

EXPERIMENTAL INVESTIGAITON

Sugar cane bagasse ash was employed as half substitution of cement in concrete mixtures in the current experiment. The compressive strengthening of concrete cured in diverse conditions, such as normal water and HCL diluted solution, is tested when cement is replaced with varying weight percentages of SCBA. The following are the specifics of the experimental investigations.

MATERIALS

CEMENT

The entire project was completed with OPC of 53 grades from a single batch, which had to be stored in airtight containers to avoid being impacted by atmospheric and monsoon moisture and humidity. Physical requirements were tested in reference IS: 12269-1987, and chemical requirements were tested in line with IS: 4032-1977.

Table 3.1 Properties of cement

S.No.	Propery	Value
1.	Normal consistency	33mm
2.	Fineness of cement	7%
3.	Setting times	
	Initial (min.)	85
	Final (min.)	240
4.	Compressive strength	
	3 days	28.68 Mpa
	7 days	40.34 Mpa
	28 days	54.62 Mpa

FINE AGGREGATE

In this investigation, river sand that passed through a 4.75 mm screen and was held on a 600 micron sieve and conformed to Zone II of IS 383-1970 was employed as fine aggregate. In compliance with IS: 2386-1963, the aggregate was evaluated for physical specifications such as gradation, fineness modulus, specific gravity, and bulk modulus.

Table 3.2 Properties of F.A.

S.No.	Property	Value
1.	Specific Gravity	2.60
2.	Bulk density	1.542
3.	Fineness Modulus	2.74
4.	Zone	II

COARSE AGGREGATE

Particles of 20mm size were obtained from local crusher mills and used throughout the research. According to IS: 2386-1963 and IS: 383-1970, physical specifications such as gradation, fineness modulus, Sp. gravity, and bulk density.

Table 3.3 Properties of C.A.

S.No.	Property	Value
1.	Bulk density	1.610
2.	Specific gravity	2.74
3.	Fineness modulus	7.17
4.	Aggregate impact value	25.21
5.	Aggregate crushing value	25.22

WATER

The concrete is mixed with fresh portable water that is devoid of organic debris and oil. Water was measured and added to the concrete in the proper amounts using a graduated jar. Weigh batching was used to get the rest of the materials. The pH level should not fall below 7.

SUGARCANE BAGASSE ASH

Its composed approx. 50% cellulose and 25% hemicelluloses and ligin. Each tonne of produces about 26% ash and 0.62 percent residual ash. The chemical makeup of the residue after burning is conquered by sio2. Despite being a material that is difficult to degrade and has few nutrients, ash is utilised as a fertiliser in sugarcane harvests. During the cleaning of boiler in sugar industry Its recovered.

Table 3.4 Physical Properties of SCBA:

S.No.	Property	Value
1.	Density	575 kg/m3
2.	Specific gravity	2.2
3.	Mean particle size	0.1-0.2
4.	Min specific surface area	2500 m2/kg
5.	Particle shape	Spherical

Table 3.5 Chemical Properties of SCBA

S.No.	Component	Symbol	Percentage
1.	Silica	SiO2	63
2.	Alumina	Al2O3	31.5
3.	Ferric oxide	Fe2O3	1.79
4.	Magnese oxide	MnO	0.004
5.	Calcium oxide	CaO	0.48
6.	Magnesium oxide	MgO	0.39
7.	Loss of ignition	LOI	0.71

SUMMARY:

SCBA was successfully established as an alternate cement replacement material in concrete as a result of this research. Following a thorough study, the following results were reached:

- Because SCBA in concrete has a higher compressive strengthening than standard strength concrete, the best results were obtained by replacing 5% of the cement with SCBA.
- Using SCBA in concrete is not just a waste-reduction approach, but it also saves money

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