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AN EXAMINATION OF THE PROPERTIES OF UNPROCESSED SUGARCANE BAGASSE ASH SILICA FUME IN THE PRODUCTION OF HOLLOW CONCRETE BLOCK WITH QUARRY WASTE

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ABSTRACT

In the new millennium of sustainable building, the reuse of Sugar Cane Bagasse Ash (SCBA) as a cement substitute in the production of concrete is gaining appeal. Ash made from sugarcane bagasse is a byproduct of the sugar industry's co-generation unit. Sugarcane bagasse ash is generally dumped in landfill in and around sugar industries leading to environmental degradation. An attempt was made in the present investigation to evaluate the properties of unprocessed sugarcane bagasse ash with silica fume as additive, and quarry dust as fine aggregate in the preparation of concrete and its usage as hollow concrete block. Further, the suitability of these blocks in the construction of masonry structures was also investigated. The characteristics of ingredients such as sugarcane bagasse ash, silica fume, quarry dust, river sand, stone chips and water used in concrete, hollow block, masonry column and masonry prism were studied. The designed mixtures of concrete have been tested for its compressive strength and tensile strength. The experimental data were found to be more than 80% closer to the analytical results. The cost analysis shows that the cost of SCBA silica fume hollow concrete block is 15% higher than the control one. However, in view of sugarcane bagasse ash disposal problems, better strength, and durability than the control specimens this difference would be negligible. The SCBA silica fume concrete can be used in hollow concrete block and as masonry structures to utilize the industrial waste material in large scale, reduce the disposal problems and also improve the performance of masonry structures.

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Keywords: Unprocessed Sugarcane Bagasse, Ash Silica Fume, Hollow Concrete Block, Quarry Waste, etc.

INTRODUCTION

Bagasse is the fiberous accumulation of sugarcane after it has been crushed and the juice extracted. Although this ash is used in rural areas, its impact on the soil's maturity is disproportionately little given the disposal problems. A few environmental problems and health risks are associated with how these supplied ashes are disposed of. Additionally, the safe disposal of these ashes will be a significant challenge for the sugar industry moving forward. However, because concrete combines excellent mechanical and solidity features, it is the most expensive development material on the planet. One of the ingredients in concrete, cement, does an amazing job, but it is also the most expensive and unfriendly material. Empty squares, increased waste consumption, and the use of bagasse ash are necessary to lower the rising cost of resources, particularly cement for the manufacturing of concrete. One tonne of cement emits approximately one tonne of CO2, and the cement industry is responsible for around 5% of the global anthropogenic CO2 emissions (Ernst Worrell et al., 2001). If 20% to 30% of bagasse ash is replaced in the concrete industry, these discharges can be significantly reduced. As a result, this helps maintain the environmental conditions that are green. In the current examination research center tests were led for the examples at every level of cement replacement with bagasse ash and silica exhaust as mineral admixture. The use of bagasse ash with silica smolder (BASF) in the production of empty concrete squares was likewise contemplated. The outcomes will be contrasted all together with discover the best rate by weight of cement that has been supplanted by baggase ash with and without silica rage as admixture for improved compressive quality and split rigidity in concrete, just as to examine the effect of BASF on the compressive quality, water retention and thickness of empty concrete squares.

During the previous years, concrete and cement innovation have accomplished a ton of accomplishments. One of the accomplishments is the fuse of modern squanders as filler or added substance in cement and concrete production with specialized, monetary and environmental focal points. Such waste materials was found to have either responsive or filler effect in cement and

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concrete production. Receptive materials are named pozzolanas and have been utilized broadly worldwide where accessible. The utilization of latent fillers is likewise a typical practice around the world. Inactive fillers have been likewise utilized as total fillers in concrete production to improve molecule pressing thickness in this manner properties of concrete. Nowadays, the expanding pattern towards the utilization of filler types and sum has prompted overall innovative work in the zone.

Sugarcane Bagasse Ash-An Indian Scenario

One of India's top industries, the sugar industry is a boon to farmers. According to data from the Indian Sugar Mill Association, there are currently 538 sugar cane mills operating in the country. In India, the majority of the sugar sector has developed in various ways to become self-sufficient in this century. It is one of the companies that produces electricity and exports power to the government. In India, sugarcane is a significant Kharif crop and is produced extensively there. India is second in the world for sugar cane production. India produced between 300 and 350 million tonnes of sugar cane on average over the previous five years. Bagasse, a fibrous sugar cane residue, has a high gross calorific value when wet, averaging around 2,250 kcal/kg, and as a result, has a considerable potential for the production of power. Bagasse has been used in boilers in the past to produce steam, which is then utilised as fuel. Between 200 and 600 degrees Celsius were the boilers' working temperatures. However, there was insufficient fuel and just partial bagasse burning. As a result, in the 1980s, the cogeneration unit for sugarcane bagasse started to meet India's energy needs. As the demand for fossil fuels develops, this cogeneration unit may be a viable choice for supplying electricity to power production in the modern era. As a result, a bagasse power generating cogeneration unit is present in almost every significant sugar business. According to the Indian Ministry of New and Renewable Energy, the sucrier cogeneration units will produce about 7,000 MW of excess power over the coming years. This device was used to create residual sugar cane bagasse ash at extremely high temperatures and pressures.

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Silica Fume (SF)

Silica fume is the byproduct of the bag house filter used in the manufacturing of silicon and ferrosilicon metals. It functions well as pozzolan because of its ultra-fine texture, filler action, and high amorphous silica content. According to ASTM C 1240 (1999), silica fume increases concrete's strength, durability, abrasion resistance, and corrosion resistance in addition to lowering permeability. It is employed as a pozzolan in concrete because of its wide range of benefits and good pozzolanic behaviour. Additionally, it is used to concrete as an additive.

Quarry Dust (QD) as a Fine Aggregate

Carriage dust is a fine residue formed by a large range of stone quarrying or crushing. The nature of the parental rock, the moisture content and the process of crushing rely on the property of the quarry dust. In India around 20 million tonnes of quarry dust are generated every year and Gujarat contributes to the largest output, according to statistics data from the Central Pollution Control Board.

Pozzolans

Pozzolans are a diverse class of siliceous or siliceous and aluminous materials that have almost no cementitious value by themselves but will react artificially with calcium hydroxide at room temperature to form mixes with cementitious properties when they are finely divided and in the presence of water.

$$CH + pozzolans + Moisture\ C\text{-}S\text{-}H \longrightarrow$$

Pozzolanic reaction is the name for the reaction described above. As the hydration process progresses, cement-based mortars or concrete become more solid by consuming CH, resulting in an ever-thinner and more impermeable substance.

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Natural Pozzolans

Volcanic ashes, opalineshales and cherts, calcined diatomaceous earth, and consumed clays are all components of the distinctive pozzolan. These materials are described as Class N type pozzolans in accordance with ASTM C 618-94a. These materials are treated, which involves drying, crushing, and calcinations, to deliver pozzolan. The most common types of pozzolans used today are processed materials that are specifically heated and then properly ground to a fine powder. These materials typically include calcined clay, calcined shale, and metakacalcined clays are typically used to make concrete structures like the other pozzolans.

Artificial Pozzolan

These include agricultural wastes, industrial byproducts, fly ash, blast heater slag, metakaoline, rice husk ash, bagasse ash, and silica rage. The common pozzolans have lost favour due to convenience and the development of increasingly dynamic counterfeit pozzolans.

Sugarcane

Sugarcane is one of the significant harvests grown in watered regions of the Indus bowl. Right now, it is grown on a territory of around 2.5 million sections of land. The normal production of stick during the most recent five years is around 49 million tones, with a normal yield of 470 maunds for each section of land. The yield of sugarcane in Pakistan is practically 50% of the nations like Egypt, which is equivalent as far as agro-atmospheres. Study show that for every 10 tons of sugarcane crushed, a sugar processing plant delivers about 3 tons of wet bagasse. So on the off chance that 49 million tons crushed, at that point it produce roughly 14.7 million tones wet bagasse.

Sugarcane Bagasse

The sinewy substance that remains after sugarcane or sorghum stalks are crushed to extract their juice is known as bagasse. It is used as a biofuel, to make mash, and to make building materials. An industrial sugar plant produces around 3 tonnes of wet bagasse for every 10 tonnes of crushed sugarcane. Bagasse production varies by country according to the amount of sugarcane produced

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because it is a by-product of the pure sweetener business. Bagasse's high moisture content, which ranges from 40 to 50 percent, makes it difficult to use as fuel. After everything is said and done, bagasse is tucked away before being used again. It is stored for power production under damp conditions, and the mild exothermic process that results from the deterioration of remaining sugars slightly dries the bagasse heap. It is frequently stored wet for the creation of paper and mash to aid in the expulsion of the short substance strands that obstruct the papermaking process as well as to expel any remaining sugar.

Sugarcane Bagasse Ash (SCBA)

Customary Around the world, Portland cement is regarded as a significant building material. Researchers are focusing on ways to use municipal or industrial garbage as a source of raw materials for industry anywhere in the modern world. This waste's utilisation would not only be intelligent but may also result in remote trade income and environmental contamination reduction. As suitable cement replacement materials, industrial wastes such blast heater slag, fly ash, and silica smoulder are being used. The massive amount of bagasse ash, accumulation from the in-line sugar industry, and bagasse biomass fuel are currently being used as fuel in the electric age industry. When this garbage is burned under controlled circumstances, it also produces ash with hazy silica, which has pozzolanic qualities. Several studies have been done on the ashes that were legally purchased from industries to evaluate pozzolanic action and their suitability as fasteners, partially replacing cement. To improve quality and lower the cost of construction materials like mortar, concrete pavers, concrete roof tiles, and soil cement interlocking square, it is therefore possible to use sugarcane bagasse ash (SCBA) as a cement substitute material.

Sugar cane wastes as pozzolanic materials

Recently, experts in the construction materials sector have focused on the use of solid waste from agricultural goods known as pozzolans in the assembly of mixed mortars and concrete. Due of the ashes' pozzolanic reactivity toward lime, expanding ashes from burning agricultural solid waste into concrete is currently a common practise. Ash produced by burning sugar cane solid wastes is one of the most fascinating materials (sugar cane straw and sugar cane bagasse). Large amounts

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of solid waste are produced during the processing of considerable amounts of sugar cane. In open landfills, these wastes are sorted and decomposed, negatively harming the environment. Bagasse ashes from a heater operating in the 1000–1100 °C run showed very low pozzolanic reactivity, according to a few studies that were done to describe the sugar cane solid waste as pozzolanic material. (Villar-Cocina et al., 2008).

Chemical Composition of (SCBA)

At Pollucon labs PVT LTD, Surat, sugarcane bagasse ash that had been collected for experimental work had its chemical composition examined. Bagasse ash's chemical composition is as follows:

Table. 1 Chemical Makeup of (SCBA)

Chemical compound	Abbreviation	%
Silica	SiO2	68.42
Aluminum Oxides	Al2O3	5.812
Ferric Oxide	Fe2O3	0.218
Calcium Oxide	CaO	2.56
Phosphorous Oxide	P2O5	1.28
Magnesium Oxide	MgO	0.572
Sulphide Oxide	SO3	4.33
Loss on Ignition	LOI	15.90

Cement

As a hydraulic folio, cement is defined as a finely crushed inorganic substance that, when mixed with water, creates a glue that sets and solidifies through hydration reactions and processes, holding its quality and strength much below the surface after solidification. Both the historical background of building design and the historical background of manufacturing cement are ancient. In their ancient structures, the Egyptians, Romans, and Indians used cementing materials. The ancient Greeks and Romans used cement made from limestone they had consumed.

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LONG TERM PERFORMANCE OF BLENDED CONCRETE

The durability of concrete and reinforced concrete is given more importance. This prompted extensive research and the creation of codes to address the durability of concrete materials and structures, which were crucial to the design. Given the transportation properties of concrete, the quantitative ion diffusion process, fluid permeability, capillary absorption, and steel reinforcement depassivation, the deterioration of concrete and refurbished concrete has received a lot of attention. It has been well documented that Portland cement concrete has high mechanical properties and long-term durable features when combined with other components including fly ash, slag, silica fume, and rice husk ash. It eliminates waste management issues, conserves earth's resources, and lowers carbon dioxide emissions into the atmosphere. Published research on these mineral admixtures demonstrates that chloride ion penetration into concrete is decreased. A greater corrosion resistance of the steel reinforcement is anticipated in concrete that has been combined with cement and these admixtures.

Performance of Blended Concrete on Water Permeability

The quality criterion is based largely on compressive strength check in various concrete regulations. Applicable quality criteria, which may offer a better base for the management of concrete quality, is required to ensure the necessary durability and long-term performance of armoured concrete structures exposed to a harsh environment. The general foundation for the assessment of concrete durability are waterspace absorption, volume of permeable vacuum, water absorption coefficient, sorptiveness, water permeability, chloride permeability and diffusion. Concrete company, United Kingdom, defines concrete as excellent concrete with water absorption of 3%.

Earlier Studies on Water Permeability of Blended Concrete

Concrete setting times of 25 percent and 50 percent slag substitution rates. Their findings showed that the setting time was somewhat extended by the use of slag at low temperatures, but there was minimal effect at higher temperatures (15oC and 25oC). Mehta (1987) observed that a hydrated concrete paste penetration depth and drying dry-shrinkage of cement produced from 10, 20 and 30

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per cent Santorin earth did not differ substantially from that of pulp and cement including an OPC check.

Compressive Strength of SCBA Silica Fume Concrete

The methods outlined in IS: 516 were used to test concrete in UTM at various curing ages (1959). The initial compression strength test on the concrete involved adding unprocessed SCBA at 0%, 10%, 20%, and 30%. Each specimen was subjected to the tests, and the three findings were averaged at any replacement level for each mixing ratio. The table demonstrates that the compressive strength of the concretes has reduced for all mixing proportions at all substitution levels above the control concrete at all ages. Second, the compressive strength of unprocessed silica fume cement was assessed by adding all quantities of concrete to cement substituted with SCBA containing 0%, 10%, 20%, and 30% coupled with 10% silica fume. The results of this concrete type's strength are shown in Table 4.2. The findings demonstrate that when used as an addition, silica fume strength was improved for all amounts at any substitution level. Due to silica's pozzolanic properties, more C-S-H gel can be created, increasing its strength. Mahdi & Ramezanianpour discovered similar increases in the strength of silica fume concrete as well (2014).

Properties of Hollow Concrete Block

Dimensions: In order to achieve modular coordination in walled length and height, the nominal dimensions for the individual hollow concrete block components are essential. Length and depth actual dimensions will be 10% lower than nominal measurements because in computation of nominal dimensions the thickness of the morter joint will be considered.

Block density: the block with an average minimum density of 1500 kg/m3 is classified as Grade A whereas it is classified as grade B with an average minimum density of 1100-1500 kg/m3. In a mixed hole block, the density falls.

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Water absorption: an essential metric that demonstrates block porosity and hence block degradation and durability. For the hollow concrete block, the average water absorption should not exceed 10% by weight.

Compressive strength: the average compression strength of individual hollow concrete blocks determined in accordance with IS is: no less than 3,5 N/mm2 (2005) and no less than 2,8 N/mm2 of individual hollow concrete blocks.

Drying dehydration: wrong mixing ratio, inappropriate blend duration, high w/c ratio, high temperature, incorrect curing, and humidity loss cause to dehydration, leading to crushing of the hollow concrete block in turn. Block drying should last at least 4 weeks to minimise shrinkage. Hollow concrete blocks should not have greater than normal drying shrinkage of 0.06%.

Humidity movement: The moisture content changes both the stability and the shrinking of hollow concrete blocks. The wetness of dry blocks should not exceed 0.09 percent in submerged water.

Strength: strength and durability go together. Strength. The structural sustainability is crucial to sustainable construction and long-term performance (Mehta 1999). Adequate durability may be achieved with the appropriate use of materials and suitable proportioning.

Isolating characteristics: The thermal insulation properties are increased using hollow blocks of concrete with holes. The material characteristics of the blended cement and hollow concrete block wall thickness can, however, impact the sound transmission and thermal isolation capabilities strongly.

Fire resistance: the standard hollow concrete block is non fuel resistant to fire. But the behaviour of mixed hollow concrete blocks in a fire test is highly essential to research.

HOLLOW CONCRETE BLOCKS

As high-rise buildings, complex multiplexes and other infrastructure projects are increased, a quick and affordable construction with solid, durable and seismic resistant structural systems is urgently needed. This cleared the door for novel materials and procedures for building. One of these is the

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substitution by solid and hollow concrete blocks of typical brick building. These concrete blocks are also known as the masonry concrete unit (CMU). Block volatility promotes weight loss and improved isolation. The first hollow concrete block created and patented in 1900 by Palmer. These blocks were cast by hand with an intensive weight of 20.3 cm x 25.4 cm x 76.2 cm. Currently, highly automated block machines are available with a capacity of 1 hour to create even 2000 hollow concrete blocks. The cement, sand or quarry dust, stone chips and appropriate amount of water are hollow concrete blocks. The hollow concrete blocks are available in conventional sizes such as 400 mm x 200 mm and 400 mm x 200 mm and 150 mm x 200 mm. They may also be installed in standard dimensions. These hollow blocks of concrete may be used for all sorts of macerated constructions including exterior walls, internal walls, bearing walls with or without loading, panel walls, columns, walls for retention and compound walls. These walls might be filled in whole or in part or unfilled. In the hollow, concrete blocks, even reinforcements can be employed to enhance structural strength and performance in both vertical and horizontal areas.

CONCLUSION

The compressive strength of both hollow concrete block and cube was maximum at 10% SCBA replacement along with 10% SF as admixture compared to normal concrete. However, the compressive strength decreased with an increase in SCBA replacement. The addition of silica fume was found to increase the durability against acid, alkaline, sulphate attack. But increase in SCBA replacement decreases the durability of concrete. However with addition of silica fume the durability of SCBA concrete was found to be increased. The SCBA obtained at 1500oC was found to be suitable and durable with silica fume as admixture and 10% replacement of SCBA with 10% addition of SF was found to be optimum in strength as well as in durability characteristics compared to the normal concrete. The residual compressive strength at the end of 90 days on all exposure conditions found to be optimum at 10% SCBA replacement along with 10% SF as admixture compared to normal concrete residual strength. Thus the utilization of the waste ash reduces the consumption of cement thus reduces the possible green house emission. In addition, this would help in the reduction of disposal and health hazard problems. Therefore, by substituting solid waste for cement, such as SCBA and silica fume, we not only achieve economic savings but

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also address environmental issues related to the management of these materials' waste. However, a clearer understanding of the durability characteristics that apply to mixes and test procedures is required. To comprehend the actual conditions and relate the outcomes to laboratory values, it is also important to establish the durability of the concrete at the site.

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