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A comprehensive review on Sugarcane Bagasse Ash Granite Waste as fine Aggregate in Concrete

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Abstract: Massive infrastructure construction has generated a boom in cement consumption, and the world uses 30 billion tonnes of cement concrete year to meet it. Academics from all around the world are coming up with new carbon-neutral building solutions to recycle industrial pollution, and they are sharing their findings online. Ash from sugarcane bagasse has a high percentage of amorphous silica and may be used in the production of concrete. This study investigates the chemical and physical characteristics of ash derived from sugarcane bagasse. The effect that the processing of sugarcane bagasse ash has on the performance of concrete is investigated. In this study, the fresh and hardened properties of concrete are investigated after being treated with varying concentrations of sugarcane bagasse ash (SCBA). A more environmentally conscious era might be ushered in by recycling agricultural and industrial waste in concrete. As potential partial replacements for river sand, Sugarcane Bagasse Ash (SCBA) and Granite Waste (GW) were investigated and tested in this research. Particle packing determines % substitution. The utilisation of bagasse ash and granite waste as a partial replacement for river sand is investigated. The tests that are performed on the concrete include compression, splitting tensile, flexural, modulus of elasticity, water absorption, sorptivity, and quick chlorine penetration. According to the results of many tests, bagasse ash-granite waste concrete is much more robust than conventional concrete. Bagasse ash-granite waste concrete offers greater strength qualities and lower permeability than standard concrete, they say.

***Index Terms* - Granite waste, Permeation, Environmental Issues, Strength, Sugarcane bagasse ash.**

1.1 INTRODUCTION

Mineral admixtures in concrete, such as rice husk ash, fly ash, slag, and silica fumes, are well-known. These wastes include reactive silica, which will cause concrete to be thick and long-lasting as a result of pore and granule refinement. Non-conventional aggregates must be used in concrete because of environmental and cost-efficiency concerns. An inquiry into the probable use of these wastes in concrete manufacturing is now a significant capacity to boost waste recycling. In developing nations, the demand for river sand is significant due to the fast expansion of infrastructure. A novel idea is to use manufactured river sand to partly or completely replace natural river sand. Burning bagasse, a waste product from the sugar manufacturing process, yields unusable sugarcane bagasse ash in the boilers that generate steam for electricity cogeneration (SCBA) [1]. As a result of power generation operations, ash is unique among agro industrial wastes. The use of this ash in the manufacture of concrete will open new doors.

1.2 ENVIRONMENTAL ISSUES

Sugarcane Bagasse Ash

Bagasse makes up approximately 30 percent of sugarcane, although sugar recovery is only 10 percent , and bagasse waste disposal leaves around 8 percent bagasse ash (depending on boiler quality and type) (depending on boiler quality and type). This disposal of bagasse ash can be a major concern for the sugarcane sector. Sugarcane bagasse ash has been explored these days in numerous places of the globe for its employment as a cement alternative material. The compressive strength and water tightness of the paste, mortar, and concrete were found to be increased by the addition of bagasse ash at various replacement percentages and fineness. Improved performance was attributable largely to the greater silica concentration of bagasse ash [2]. A pozzolanic interaction between silicate and OPC hydration products has been observed, depending on fire circumstances and raw materials, notably sugarcane soil, this decreases free lime in concrete.

Granite Waste

Granite is a kind of igneous rock extensively used as a building material in a wide variety of construction applications. There is a substantial quantity of dust and debris generated throughout the granite producing process. Granite mining and crushing waste products include granite quarry muck. Approximately 45 percent of India's granite reserves are located in the state of Tamil Nadu. A considerable number of granite stone cutting and polishing firms may be found in Tamil Nadu. A frequent byproduct of these enterprises is slurry, which includes limestone, granite powder, and bone fringes. The slurry is now dry by burying it in the swamps and marshes [3]. Changes in soil fertility, groundwater pollution, and the surrounding environment are all a result of this. More than a quarter of the entire space of the industry's processing facilities is occupied by industrial trash, which is stored in open yards. To dispose of fines, land is now being filled with trash, which is creating substantial environmental damage. It will help progress concrete technology in a sustainable way while also protecting the environment if it is used in the production of concrete. The use of granite waste in building blocks and particular concrete was shown to be the most efficient method of disposing of the waste. Use of granite garbage would reduce disposal issues and the attendant environmental difficulties that go along with it. Reduce the quantity of river sand required for building with the aid of granite debris would be easy.

1.3 LITERATURE REVIEW

Saraswathy and Song, (2007) Rice husk ash mixed concrete has been studied for its mechanical properties and corrosion resistance capabilities.. At 5%, 10%, 15%, 20%, 25%, and 30%, rice husk ash was used to replace OPC in a variety of ways. In comparison to a typical Portland cement concrete mix, the outcomes were better. Researchers looked at the mechanical and corrosion-resistant properties of the material. They found that RHA up to 30% replacement level boosts the strength and corrosion resistance properties and minimises chloride penetration, reducing permeability, while reducing chloride permeability.

Praveenkumar *et al.*, (2020) we utilised a laboratory ball mill and pulverizer to produce bagasse ash with a high specific surface area and pozzolanic activity from sugarcane bagasse. Concrete paste and mortar combined with bagasse ash were analysed by us. In addition to SEM and XRD and morphological features such as FTIR, XRF, EDS, and X-Ray Fluorescence (XRF), XRF was used to evaluate the chemical composition (SEM). Addition of processed sugarcane bagasse ash to cement pastes and mortar changed the original behaviour by as much as 10%, resulting in water savings.

Mashaly *et al.*, (2018) Granite waste as a mortar paste has been examined for its durability and dimensional stability. Different superplasticizer dosages allowed us to manufacture practical mortars. Filling voids with fine GW particles improves both packing density and pore structure. – Carbonation and water resistance were unaffected by GW, however strain and rate were reduced. CSH precipitation nuclei might be made up of some of the smallest known GW particles. Cement hydration would be improved as a result.

Mohsen Tennich *et al.*, (2015) SCC may benefit from mineral additives derived from marble and tile production waste. Using a reference SCC made with limestone filler, the influence of this waste on SCC is studied and compared. Concrete LabPro2 software is used to design and modify the concrete's composition. Waste fillers from marble and tile businesses have increased SCC's compactness, which in turn increases the material's overall strength.

Vasudha D. Katare and Mangesh V. Madurwar, (2017) The curing process of mixed concrete was retarded by the use of diluted cement. The cure period of the mixed concrete paste was delayed by the use of less reactive SCBA. When concrete sets, it means that the paste may be worked for a lengthy period of time since it takes so long. For this reason, less heat is generated during the hydration development process for concrete. It is well-suited for applications such as bulk concrete manufacturing because of its low heat development characteristics.

1.4 TESTS FOR CHARACTERIZATION OF MATERIALS

Characterization is a technique used to examine and record information about a substance's structure and qualities. It is a crucial procedure in the area of materials research without which no scientific knowledge of engineering materials could be obtained. It is vital to pick the correct components, analyse the qualities, and comprehend the interaction among diverse materials for best utilisation. Cement, river sand, and fine aggregate were employed in this study [4]. The main ingredients in this mix are crushed granite aggregate and a combination of sugarcane bagasse ash and chemical admixture (a "superplasticizer").

1.4.1 Cement

Cement is a concrete element. Different cement brands have different strength development and rheological behaviour according to compound composition and fineness. One cement supplier was selected. Ordinary Portland Cement 53 grade was used (IS: 12269 - 2013).

The chosen cement was tested for its qualities.

1. Fineness test
2. Specific gravity test and
3. Setting time test

1.4.2 Sugarcane Bagasse Ash

Sugar businesses employ bagasse, a waste product of sugarcane juice extraction, to heat water in a boiler and generate steam for power plants. The combustion process produces grey-black bagasse ash. SCBA was acquired from Madras Sugar Mill in Tirukoilur, Tamil Nadu (India). The particle size and chemical content of bagasse ash were examined using Energy Dispersive X-ray (EDX) analysis with Scanning Electron Microscope (SEM).

A) **Specific Gravity**

Using a density bottle, bagasse ash was found to be SG. The empty bottle's weight is used as (W1). The bottle is half-filled with bagasse ash and weighed (W2). Then add kerosene to the whole [6]. It is properly blended to eliminate air bubbles. I weigh the bagasse ash and kerosene density bottle (W3). The density bottle is emptied and refilled with kerosene (W4). Kerosene has a Sg of 0.79..

$$\text{Specific gravity of SCBA} = \frac{W2-W1}{(W2-W1)-(W3-W4)Sg}$$

- **a)** River Sand and Granite Waste
- **b)** Local river sand met IS 383-2006 zone II requirements. This was done using the process in IS 2386 (Part-I and II) 1963.
- **c)** The crusher units produce granite waste in slurry form. A physical mechanism, granite powder disperses readily with superplasticizer and fills the spaces between river sand to form a well-packed concrete mix. Powdered granite was sized and chemically composed. The chemical composition of granite trash was evaluated using EDX and a SEM (SEM).
- **d)** Particle size distribution

1000g of river sand and granite debris was mechanically sieved through a series of sieves beginning at 4.75mm, 2.36mm, 1.18mm, 600m, 300m, 150m, 75m and pan at the bottom. The materials retained on each sieve were recorded. Fineness modulus of the sample was calculated as follows

$$\text{Fineness modulus} = \frac{\text{Sum of cumulative \% of mass retained on 4.75mm sieve to 150μm sieve}}{100}$$

e) Specific gravity and water absorption

A pycnometer measured the specific gravity of river sand and granite refuse. A 500g saturated surface dry sample was weighed (W1). The pycnometer was filled with water and the granite waste material. The pycnometer's sides were rotated to liberate trapped air. The pycnometer is weighed with water (W2). The pycnometer was emptied, refilled with water, and weighed (W3). After emptying the pycnometer, samples of river sand and granite debris were dried for 24 hours at 110oC. These were cooled to room temperature and then weighed (W4).

$$\text{Specific gravity of GW} = \frac{W4}{[W1-(W2-W3)]}$$

$$\text{Water absorption (\%)} = \frac{100\ (W3-W4)}{W4}$$

f) Bulk density

Bulk density of river sand and granite waste aggregate is done as per IS 2386 (part 3) -1963. A cylindrical metal measure of 3 litres capacity was obtained and filled approximately one-third full by aggregate samples and tamped with 25 strokes. A subsequent identical amount is filled and tamped 25 strokes. Finally, be full to bursting, tamped 25 times and excess aggregate struck off and net weight of aggregate is measured and bulk density in the compacted condition is computed.

$$\text{Bulk density (Compacted)} = \frac{\text{Net weight of the granite waste aggregate (Compacted)}}{\text{Capacity of the cylindrical measure in litres}} \times 100$$

The cylindrical measure was overflowing with granite waste aggregate, which was released from a height of 5cm above the measure's top. A straightedge levels the aggregate surface. The net weight of the aggregate is computed, as is the bulk density.

$$\text{Bulk density (Loose)} = \frac{\text{Net weight of the granite waste aggregate (Loose)}}{\text{Capacity of the cylindrical measure in litres}} \times 100$$

1.4.3 **Coarse Aggregate**

Local quarry provided crushed stone coarse aggregate. The maximum coarse aggregate size was 20mm. These parameters were obtained using IS 2386 (Part III) – 1963. Water buried 3kg coarse aggregate for 24 hours. It was then dried at room temperature until no surface moisture was visible. This sample was weighed (W1). The coarse aggregate was weighed in a water-filled basket (W2). It was taken out of the basket, dried for 24 hours at 110oC, and weighed (W3). We estimated specific gravity and water absorption.

$$\text{Specific Gravity} = \frac{W3}{(W1-W2)}$$

$$\text{Water absorption} = \frac{100(W1-W3)}{W3}$$

1.4.4 Water

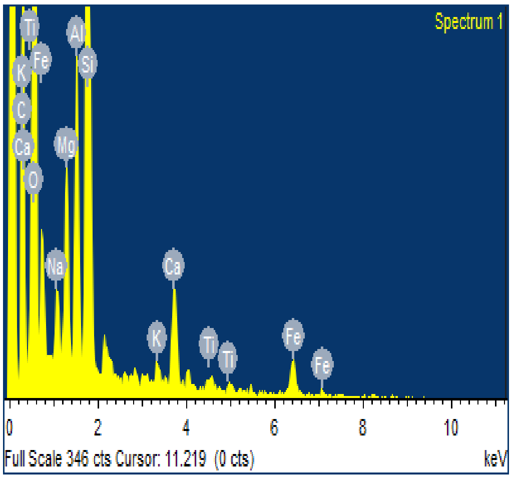
Water combines with cement and generates the binder, which binds the aggregate together. Also, it is responsible for the process to generate the hydration product, calcium-silicate- hydrate (C-S-H) gel. Concrete may be made using water that meets the specifications of IS: 456-2000. Concrete was made using water from the lab's tap for this study.

1.5 **CHEMICAL ADMIXTURE**

Superplasticizers (SP) are water reducers that were used to increase the workability of new concrete. Because finer industrial by-products are used in concrete, more water is needed to guarantee workability. Concrete with no propensity to segregate or bleed is produced using the superplasticizer. The admixture employed in this study was CONPLAST SP 430, a sulfonated naphthalene formaldehyde condensate that meets IS 9103-1999 and ASTM C494. This study employed a high-performance superplasticizer with a relative density of 1.18.

1.5.1 Properties of Granite Waste

The chemical and physical features of granite refuse. respectively. Because granite debris has a lower specific gravity than river sand, it is replaced by volume. Fig. 1.1 shows particle size distribution that meets IS 383-1970 grading zone III. Figures 1.1 and 1.2 exhibit EDS spectra and SEM pictures of granite debris, both angular in form and rough textured.



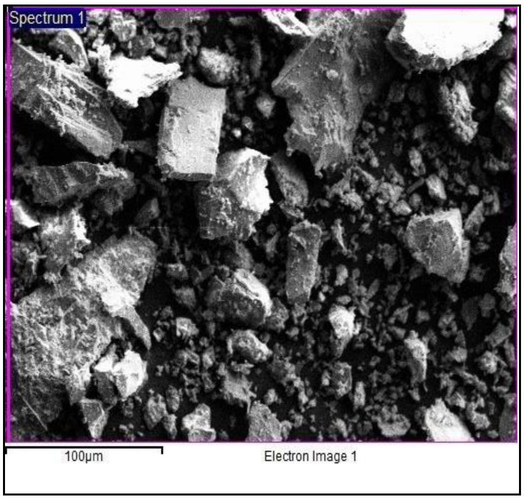


Fig1.1 EDS Spectra of Granite Waste **Fig. 1.2 SEM Image of Granite Waste**

1.5.2 Properties of River Sand

Concrete's fine aggregate is river sand. IS: 2386 (Part 3)-1963 determines the fine aggregate's Specific Gravity, Fineness Modulus, and Bulk Density. IS 383 - 1970 fine aggregate particle size distribution.

1.5.3 Properties of Coarse Aggregate

This research employed granite as coarse aggregate. Coarse aggregate absorbed 0.45% water. "Coarse aggregate was 20mm max. 6.5 fineness modulus.

1.6 CONCLUSION

Several researches have examined using industrial waste in concrete. Sugarcane bagasse ash and granite rubble are used in concrete. Sugarcane bagasse ash and granite waste were used in the investigation, which also examined the flexural behaviour of reinforced BAGW concrete beams as well as the qualities of BAGW concrete. The fundamental purpose of the concrete mix design is to discover the ideal balance of different constituents to suit the requirement for workability, strength, and durability. Because sugarcane bagasse ash and granite refuse have a lower specific gravity than natural river sand, a distinct mix proportioning procedure is presented here. The link between water-cement ratio and slump using SP, the change of compressive strength at 28days with cement-water ratio, the volume of cement content, the volume of cement-fine aggregate ratio, and the volume of cement-total aggregate ratio have been created for BAGW concrete. By applying this connection, the following principles are provided to arrive at trial mixtures. The saturated water absorption of BAGW mixes was lower when compared with that of the conventional concrete mixes. Transport mechanism in BAGW concrete due to permeation characteristics values decrease with a decrease in the water-cement ratio for both BAGW and conventional concrete. BAGW concrete shows better permeation characteristics.

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