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A Review Paper on Potential use of Agro-Waste as Supplementary Material for Cement to make Sustainable Concrete

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ABSTRACT: In recent days, the remarkable contribution of using waste materials in place of cement has gained significant attention to researchers and scientist in making sustainable concrete which are eco-friendly and contribute towards waste management. Sugar Cane Bagasse Ash is one such agricultural waste material found in many countries around the globe including India and India is the second largest in major sugar producing countries in the world. Due to that there is increase in bagasse day by day as a by-product from the sugar mill. This will result in saving in cement production equivalent to the alternative binding material used in concrete. Bagasse is the fibrous residue of sugar cane after crushing and extraction of juice. Sugar cane bagasse ash is the waste product of the combustion of bagasse for energy in sugar factories. Sugar cane bagasse ash is disposed of in landfills and is now becoming an environmental burden. This paper is a guide for beginners to identify the major thrust area of research.

KEYWORDS: Bagasse Ash, mineral admixture, Workability, & Compressive Strength

I. INTRODUCTION

Sustainability is a critical one to the prosperity of our planet, preceded with development of a society and human. Concrete is one of the most generally used materials in the globe. However, the manufacturing of one ton Portland cement prompts the discharges of convincing quantity of CO_2. Along Cement Industries concrete manufacturing industries were also generally observed as one of the significant contributors of global warming, because of their high energy and their production causing high carbon dioxide (CO_2) impression [1]. It is practically difficult to make concrete as a carbon-impartial material because of the huge volume of cement utilized in its preparation. A way to deal with diminish the dependence on cement in preparation of concrete is by offering locally available by-products as Supplementary Cementitious Material (SCM) and other materials tracking low carbon in the production of cement and concrete.

The utilization of industrial and agricultural waste products in the industry has been the focus of the research for economic, environmental, and technical reasons. Currently, Agricultural wastes like wheat straw ash, rice husk ash, hazel nutshell and Sugar Cane Bagasse Ash (SCBA) contribute for the development of concrete by acting as pozzolanic materials in addition to industrial waste [2]. Among the agriculture waste, SCBA is a fibrous waste-product obtained from sugar refining industry. Bagasse ash has become a difficult concern for sugar industries towards disposal as it is causing environmental pollution. Hence these wastes have to be managed urgently by effective ways towards getting wealth from waste [3]. Reducing the cement content in concrete is carried out by partial inclusion of SCBA waste with cement, help to curtail the usage of natural resources thereby aids to maintain the environmental sustainability.

It is estimated that 44,220 tonnes/day of sugarcane bagasse ash (SCBA) in India is disposed directly in the lands of rural regions which cause the severe pollution. The problem of waste accumulation exists worldwide, specifically in the densely populated areas. Most of these materials are left as stockpiles, landfill material or illegally dumped in selected areas. Large quantities of this waste cannot be eliminated[4]. However, the environmental impact can be reduced by making more sustainable use of this waste.

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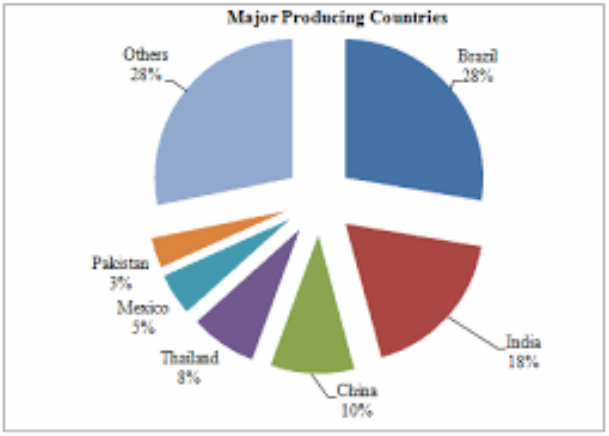
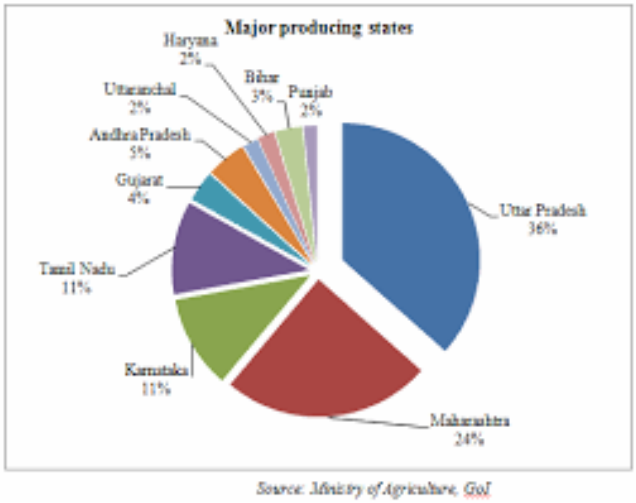
II. PRODUCTION OF SUGAR CANE

Approximately 1500 millions tons of sugarcane is annually produced over all the world which leave about 40-45% bagasse after juice crushing for sugar industry giving an average annual production of 675 million tons of bagasse as a waste material. India is being one of the largest producers of sugarcane in the world (2nd), produces nearly 300 million tons per year which is given in Fig.1and large quantity of bagasse is available from sugar mills[5]. Tamil Nadu secures 3rd position in India in the production of sugarcane which s shown in Fig.2.The resulting bagasse ash represents approximately 0.62% of the sugarcane weight. ThesugarcaneBagasseashcomposedofapproximately50%cellulose, 25% hemicelluloses and 25% lignin [6].



Source: USDA

Fig. 1 Sugarcane production in the world



Source: Ministry of Agriculture, GoI

Fig. 2 Sugarcane production in India

During extraction of juice from the sugarcane stalk, the solid waste material is burned at high temperature to produce amorphous silica on bagasse ash which has pozzolanic properties. Residual ash collected as waste on burning of bagasse ash is disposed in the nearest landfill. The raw SCBA consists of SiO_2, Al_2O_3, FeO_3 and CaO. SiO_2 being the major component of bagasse ash containing chemical composition mainly silica (60–75%) [7]. Therefore, bagasse ash is used as possible cement replacement material. For this experimental study, bagasse ash has been collected from Dharani sugar mills, Vasudevanallur, Tamil Nadu.

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III. LITERATURE REVIEW

Locally available Agro waste ash (BA) was used to replace cement in proportions 5%, 10%, 15%, 20% and 25% by weight of cement respectively in concrete. From the experimental results it is observed that replacement of Cement in concrete with BA and Silica fume has shown decreased values of drying shrinkage of Ternary Bagasse Ash Silica Fume concrete [8]. The effect of bagasse ash in concrete by replacement of ordinary Portland cement by weight in ratio of 0%, 10%, 20% and 30% was studied. The results showed a decrease in concrete density with increase in % replacement of sugarcane bagasse ash and 20% can be used as partial replacement of cement in concrete. Up to 10% of ordinary Portland cement can be optimally replaced with bagasse ash without any adverse effect on the desirable properties of concrete [9]. The specific advantages of such replacements are reduction in water permeability of concrete, increases the corrosion resistance of rebar embedded in concrete.

The untreated bagasse ash has been partially replaced in the ratio of 0%, 10%, 20%, 30% and 40% by volume of fine aggregate in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken along with hardened concrete tests like compressive strength, split tensile strength and sorptivity. The results revealed that bagasse ash can be a suitable replacement to fine aggregate [3]. The use of 10% of sugarcane bagasse ash produced concretes with good strength and low porosity. The incorporation of sugarcane bagasse ash up to 30% replacement level increases the resistance to chloride penetration and it is acceptable for producing high-strength concrete [10].

The target mean strength has been increased for the partial replacement of up to 10% by weight [11]. The compressive strengths at 15 and 20 % replacement of RHA and SCBA are lower. Due to slow pozzolanic reaction the Sugar Cane Bagasse Ash (SCBA) concrete achieves significant improvement in its mechanical properties at later ages. In concretes can be replaced with 20% SCBA without sacrificing strength at later ages. Both RHA and SCBA concrete is resistant against sulphate attack up to 3%, but further increase up to 5% of $MgSO_4$ the decrease in compressive strengths can be observed [12].

Evaluating the usage of bagasse ash as viscosity modifying agent in self-compacting concrete and the relative costs of the materials used in self-compacting concrete was studied. The result revealed that the compressive strength developed by the self-compacting concrete mixes with bagasse ash at 28 days were comparable to the control concrete. The cost analysis showed that the cost of ingredients of specific self-compacting concrete mix is 35.63% less than that of control concrete [11]. In general, the concrete with light-weight aggregate has lower stiffness than that of normal concrete at the same compressive strength.

IV. IMPORTANT FINDINGS

All literature review showed that sugarcane bagasse ash can be used as pozzolanic material. The Bagasse ash is a good Pozzolanic material as the total ofalumina, silica, and ferric oxide content is more than 70 %. Theresidueaftercombustionpresentsachemicalcompositiondominatesby silicon dioxide(SiO_2). The ash can be undergone a heat treatment process undercontrolled temperature at 600 – 800°C for one hour to obtain an amorphoussilica and also to remove the moisture & carbon in the ash. Ashes then obtained were grinded and sieved in order to increase the specific surface area [13].

Due to the amount of unburnt carbon particles in Sugarcane Bagasse ash, it has very high Loss of ignition. The specific gravity of bagasse ash is also found to be low. These properties may affect the pozzolanic activity and hence some treatment like grinding can be done to bagasse ash before it is used in Concrete [14]. Many researchers have also studied the effect of grinding on SCBA and found improvement in the properties but yet more research is needed to enhance the pozzolanic properties of bagasse ash.

While using SCBA, decrease in workability of fresh concrete is observed as its surface area is more. The replacement of bagasse up to 25% does not alter much the compressive strength in comparison to conventional concrete but it has been seen by researchers that the durability parameters improve by use of BA [15]. Yet the durability parameters are not yet fully analysed.

V. SUMMARY

From the review study following major conclusions is drawn:

- SCBA need to have heat treatment method, grinding and sieving before using in concrete as this would affect the properties of concrete.
- Sugarcane Bagasse ash has the potential for replacing cement upto 20% to 25%.
- Use of bagasse ash in mortar has much scope of doing research as few studies are available.
- Durability properties of concrete can be enhanced by use of SCBA in concrete.

- To improve workability of concrete certain admixtures can be added while preparing concrete.
- Use of bagasse ash in concrete will keep the environment safe.

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