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Experimental Study on Partial Replacement of Cement by SCBA for M30 Concrete – A Review

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I. Introduction

Cement is one the most used construction material. It is the conventional building material that actually is responsible for about 5% - 8% of global CO2 (a greenhouse gas) and with the ever increasing demand it could significantly contribute to environmental pollution imposing detrimental effects. Researchers all over the world today are focusing on ways of utilizing industrial or agricultural waste, as a source of raw materials for many industries. Utilization of such wastes as cement replacement materials may reduce the cost of concrete production and also minimize the negative environmental effects with disposal of these wastes. Sugarcane is main food crop in tropical and subtropical countries. It is the major resource for the sugar production. India is the second largest producer of sugarcane in the world with 361,037,000 Metric Tonnes of production in a year. The processing of it in sugar-mill generates about 10 million tonnes of SCBA as a waste material. One tonne of sugarcane can generate approximate 26% of bagasse and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide. Sugarcane bagasse (SCB) is the waste created after juice extraction from sugarcane. The Sugarcane bagasse ash (SCBA) is acquired through the control burning of sugarcane bagasse. The SCB creates the environmental nuisance due to direct disposal on the open lands and forms garbage heaps in that area. Besides SCBA, rice husk ash, palm kernel husk ash, fly ash, ground blast-furnace slag and silica fume have pozollanic properties that can be used in partial replacement of cement. The quality of concrete produced from SCBA beyond an optimum quantity of SCBA will leaches out silicate which does not contribute to the strength of concrete. Recently sugarcane bagasse ash, has been tested in some parts of the world for its pozzolanic property and also improves the properties of mortar and concrete like compressive strength and water tightness in certain percentage of replacement and fineness. The silicate content of sugarcane bagasse ash is the reason behind its pozzolanic property. Depending on the burning and other properties of the raw materials like the soil on which soil is grown, the silicate content in the ash may vary from ash to ash.

II. MATERIAL USED IN CONCRETE

Materials used in Concrete The materials used in the projects for making concrete mixture are cement, Fine aggregate, coarse aggregate, SCBA, are detailed describe below:

Cement: Cement is by far the most important constituent of concrete, in that it forms the binding medium for the discrete ingredients. Made out of naturally occurring raw materials and sometimes blended or underground with industrial wastes. The cement used in this study was OPC 53 grades Ordinary Portland cement (OPC) conforming to IS12269-1987.

Fine aggregate: Aggregates which occupy nearly 70 to 75 percent volume of concrete are sometimes viewed as inert ingredients in more than one sense. However, it is now well recognized that physical, chemical and thermal properties of aggregates substantially influence the properties and performance of concrete. The fine aggregate (sand) used was clean dry sand was sieved in 4.75 mm sieve to remove all pebbles.

Course aggregate: Coarse aggregate is used for making concrete. They may be in the form of irregular broken stone or naturally occurring gravel. Material which is large to be retained on 4.75mm sieve size is called coarse aggregates. Its maximum size can be up to 40 mm.

Water: water plays an important role in the formation of concrete as it participates in a chemical reaction with cement. Due to the presence of water, the gel is formed which helps in increase of strength of concrete. Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel. Portable water is generally considered satisfactory for mixing. The pH value of water shall not be less than the following concentrations represent the maximum permissible values.

The physical and chemical properties of groundwater shall be tested along with soil investigation and if the water is not found conforming to the requirements of IS 456 – 2000, the tender documents shall clearly specify that the contractor has to arrange good quality water construction indicating the source.

SCBA- Bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. The burning of bagasse leaves bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. It has been known that the worldwide total production of sugarcane is over 1500 million tons. Sugarcane consists about 30% bagasse whereas the sugar recovered is about 10%, and the bagasse leaves about 8% bagasse ash (this figure depend on the quality and type of the boiler, modern boiler release lower amount of bagasse ash) as a waste, this disposal of bagasse ash will be of serious concern. Sugarcane bagasse ash has recently been tested in some parts of the world for its use as a cement replacement material. This attack is related to the expansive character of the ettringite formation by reaction of internal (in the concrete) or external (from the environment) sulphate with the hydrated calcium aluminate of the hardened cement matrix. Not necessarily the ettringite formation produces a damaging effect. When it occurs *homogeneously* and *immediately* (within hours or days) in a mixture or in a deformable concrete – early ettringite formation (EEF) - the related expansion does not cause any significant localized disruptive action.

III. Literature Survey

[1], K. Kiran et. Al.

In this paper an overview is given of new developments results obtained we can see that with an increase in age, strength is also increased when cement is replaced up to 15%. It can be also noticed that the maximum strength is obtained when cement is replaced by 5% when compared with 0%. From the experimental study following conclusions are made

• The results show that Sugarcane Bagasse Ash can be utilized for partial replacement of cement up to 15% by weight of cement without any major loss of strength.

• The results showed that the concrete with 5% of SCBA after 28 days of curing had higher strength when compared to concrete with other replacement percentages.

• Greenhouse gasses emissions can be reduced by replacement of cement with OPC.

• Mechanical properties of concrete are developed in later ages due to slow pozzolanic reactions

[2], Sabir Ali et. al.

In this research paper the experimental results of cement partially replaced with SCBA in conventional concrete, the following points were concluded.

• SCBA blended concrete showed great improvement in compressive strength. Maximum compressive strength of 34.9N/mm2 was achieved at 10% SCBA. All the SCBA made concrete mixes showed increase in compressive strength of concrete.

• However, all mix proportions showed a value of- SAI greater than 75%. Maximum SAI value was calculated at 10% SCBA which is 115.67%. The maximum SAI of 108.45% was achieved at 15% replacement of cement with SCBA.

• The optimum percentage of SCBA is concluded to be at 10% replacement of cement with SCBA.

• SCBA blended concrete at all replacement percentages gave more water absorption than the control mix. The increase in the water absorption is due to the high water demand of SBCA.

[3], Arshee Khan et. al,

In this research paper after performing the tests on M30 concrete with partial replacement of cement (0%, 3%, 6%, 9%, and 12%) with SBCA, it has been observed that the compressive strength, flexural strength and split tensile increases with increase in percentage of SBCA and it is maximum for 6% and then starts decreasing.

[4], Pragalbha Khare et. al.,

In this research paper the various methodologies for design and development of SCBA mortar and concrete have been reviewed. Various physico-mechanical and chemical properties of the SCBA are studied in accordance with the revived literature and the Standards. SCBA was a good replacement for cement in concrete as well as mortar. It can be easily replaced up to 20%. The maximum compressive strength was found at 15% replacement level, though 15% replacement gave higher strength 20 could be used because the result from 20% replacement is near about control concrete. In case of split tensile strength 10% replacement gave higher strength. The utilization of bagasse ash in concrete and mortar solves the problem of its disposal thus keeping the environment free from pollution. The improvement in compressive strength of mortar by partially replacing cement by SCBA is due to filler effect and pozzolanic reaction between reactive SiO2 from SCBA and Ca(OH)2 from cement hydration. The study in turn is useful for various resource persons involved in using SCBA material to develop sustainable construction material.

[5], Bangar. Siyali S et. al.,

In this experimental research result shows that the strength of concrete is increase with the help of Sugar Cane Bagasse Ash (SCBA).Therefore, with the use of Sugarcane Baggage Ash (SCBA) in partially replacement of cement in concrete, we can increase the strength of concrete with reducing the consumption of cement. Also it is best use of Sugar Cane Bagasse Ash (SCBA) instead of land filling and make environment clean. This was due to the combined effect of relative fineness and the Pozzolonic activity of Sugarcane Bagasse Ash (SCBA) & also may be due to the existing of crystalline silica

(SiO2). According to Bui strengthening capability of a mineral admixture not only depends on the Pozzolonic reactivity, but also on the relative fineness of the filler material. At 90.00 days stage compressive strength for S4 10% replacement was shown clear developing strength about 0.960% of Ordinary Portland Cement (OPC) while the other samples (S2 & S3) were shown 85% strength development than Ordinary Portland Cement (OPC). Decrease in compressive strength values with increase in the substitution ratio indicated that filler effect was predominant only up to 10% ash substitution. The increase in compressive strength values in the S4 is due to the combined effect of physical and chemical processes. Physical action was caused by the high specific surface area of Sugarcane Bagasse Ash (SCBA) & chemical action was the Pozzolonic reaction between calcium hydroxide (CH) and silica (SiO2). Also the hydration of silica (SiO2) itself in the alkaline environment may have been responsible for increase in compressive strength. But hydration reaction in S2 and S3 specimen was slow; possible because of low reactivity of silica (SiO2) and also, the reduction in CaO contents may have caused the reduction in ultimate strength development.

IV. Problem Identification

As per the research papers in literature review many researchers have mixed SCBA at different percentage but none of the above has mixed SCBA for 5%, 10%, 15%, 20% & 25% without adding admixture. Also there were none researchers to test the sugarcane bagasse mix concrete on durability. Hence in the present study, it is aimed at concrete mix with partial replacement of cement by SCBA granules (5%, 10%, 15%, 20% & 25%). This mix in the form of cubes and cylinders were subjected to compression and split tension to ascertain the behavior and strength parameter.

V. Objective

This dissertation is about the studies on strength of cement mortar with partial replacement of Ordinary Portland cement by Sugarcane Bagasse Ash (SBCA). In many research paper cement mortar paste were prepared with various percent of SCBA as partial replacement of OPC in range 0% to 25 % by weight of cement. The compressive strength test, flexural strength test & split tensile strength test was carried out as per relevant Indian standard codes. The test results were compared and a conclusion was made.

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