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SUITABILITY OF SUGARCANE BAGASSE ASH AND ALKALINE ACTIVATED RICE HUSK ASH AS PARTIAL REPLACEMENT FOR CEMENT IN CONCRETE

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ABSTRACT

In this study, the suitability of Sugarcane bagasse ash and alkaline activated rice husk ash as Cementious materials in partial replacement for cement in concrete was investigated. The Sugarcane bagasse ash and activated rice husk ash were used to partially replace cement by percentage of 5%, 10%, 15% and 20% in concrete cube samples. 60 number of grade 20 concrete cubes and 60 numbers of grade 25 concrete cubes were cast in laboratory and cured for 7, 14, 21, and 28 days in accordance to BS1881: part 116: 1983. Water/cement ratio of 0.55 was used in the work; the study is aimed towards managing the of Sugarcane bagasse and rice husks through reuse so as to reduce there accumulation which constitute nuisance on the environment and could cause environmental health hazards. The Sugarcane bagasse was incinerated, sieved after incineration using sieve size of 150μm and was later mixed with the activated rice husk ash in the laboratory at equal percentage. However despite the observed loss in compressive strengths of the concrete, it can still be used for various application requiring medium and low strength in accordance to concrete grade 5, a strength which is achieved with these replacement of Sugarcane bagasse ash and activated rice husk ash in concrete: such as non-load bearing concrete wall, sidewalks, road barrier, concrete block, kerbs. The amount of concrete produce worldwide for this application could ensure the viability of this study.

Keywords: *Sugarcane Bagasse Ash, Rice Husk Ash, Cementious Material, Environmental Health Hazard, Compressive Strength.*

INTRODUCTION

Rice husk ash is an agro waste material. Rice husk ash (RHA) is obtained by burning of rice husk in a controlled manner. When properly burnt, it has high silica content and can be used as an admixture in mortar and concrete. India produces about 122 million tons of paddy every year. About 20-22% rice husk is generated from paddy and 20- 25% of the total husk becomes as “RICE HUSK ASH” after burning. Each ton of paddy produces about 40 Kg of rice husk ash. Therefore it is a good potential to make the use of rice husk ash as pozzolanic material for making mortar and concrete. (Sumit Bansal, 2014).

Rice husk is an agricultural residue widely available in major rice processing countries. The husk surrounds the paddy grain. During milling process the paddy grains about 78% of weight is obtained as husk. This husk is used as fuel in the various mills to generate steam for the parboiling process. This husk contains about 75% organic volatile matter and the rest 25% of the weight of this husk is converted into ash during the firing process. This ash is known as rice husk ash. This RHA contains around 85% -90% amorphous silica. Rice husk is generated from the rice processing industries as a major agricultural by product in many parts of the world especially in developing countries. About 500 million tons of paddies are produced in the world annually after incineration only about 20% of rice husk is transformed to RHA.The introduction of pozzolan as cement replacement materials inrecent years seems to be successful. The use of pozzolan has proven to be an effective solution in enhancing the properties of concrete in terms of strength and durability. The current pozzolan in use are such as fly ash, silica fume and slag. Development and investigation of other sources of pozzolan such as kaolin will be able to provide more alternatives for the engineer to select the most suitable cement replacement material for different environments.

Sugarcane Bagasse Ash (SCBA) which is a byproduct of sugar factories found after burning sugarcane bagasse is being produced from sugar manufacturing units as a waste material which will be grinded to the fineness less than cement for obtaining good bonding between cement and SCBA. Recently, sugarcane bagasse ash, has been tested in some parts of the world for its pozzolanic property and has been found to improve some of the properties of the concrete like compressive strength and water tightness in certain replacement percentages and fineness, Ranjith A. and Sanjith J. (2015). The use of sugarcane bagasse ash (SCBA) as cement replacement material is to improve quality and reduce the cost of construction material such as mortar and concrete pavers. Hence, several research groups, and even the Portland cement industry, are investigating alternatives to produce green binding materials. Moreover, these binding materials can reduce up to 80% of CO2 emissions when compared to that of Portland cement production. The release of dust, gases, noise and vibration when operating machinery and during blasting in quarries and consumption of large quantities of fuel during manufacture is a form of airborne pollution. Therefore, there is the need to search for local materials as alternatives for the construction of functional but low cost buildings in both the rural and urban areas. The important of this research is to help reduce the cost of cement and reduce the volume of solid waste generated from sugarcane. This will economize the usage of Portland cement in construction works, Lourdes Soriano (2013). Nowadays, several studies have been performed in order to re-use industrial and/or agricultural wastes abundantly generated in society: this approach is in agreement with sustainable development principles.

MATERIAL AND METHOD

Bagasse Ash and Rice Husk Ash

Bagasse is a cellulose fiber remaining after the extraction of the sugar-bearing juice from sugarcane. Bagasse ash is one of the biomass sources and valuable byproducts in sugar milling that often uses bagasse as a primary fuel source to supply all the needs of energy to move the plants. The bagasse ash is about 8-10% of the bagasse and contains unburned matter, silica and alumina. Kanchan L. (2013). Bagasse ash has been a problem to the environment due to its disposal. The most significant pollutant emitted from the boilers being a particulate matter, caused by the turbulent movement of combustion gases with respect to the burning bagasse and resulting ash. Sometimes some auxiliary fuels typically fuel or natural gas may be used during startup of the boiler or when the moisture content of the bagasse is too high to support combustion, in such cases the emissions of SO_2 and NOX will increase. Ghazali M.J (2008). Rice husk ash is the ash that is obtained by the process carbonizing unit it get reduced by 25%. The rice husk for the research was obtained locally. These ashes were deliberated until fine ash is being produced. These ashes were sieved by the 600micron where further impurities are being minimized. After the process of sieving, the rice husk ash was activated so as to increase it reactivity properties before been used.

Materials

The Rice Husk under investigation was subjected to activation process. The method of activation was compounded from various methods described by Bradley & Grim (1951), Grim &Kulbicki (1961) and Joshi et al (1961).

For activation, 50kg of Rice Husk Ash powder (12xx, BS 410) was digested with 250cm of concentrated sulphuric acid for 3hour in a mixer apparatus. After cooling, the solid washed with distilled water several times until the washings were neutral (pH 7.0). The washing water was decanted and the solids dried at 100°C for 1hour and then heated between 350 - 500°C in an aching furnace for about 2hour. The solids obtained after heat activation were sieved to obtain particle size passing through mesh size 250um used for subsequent work. The Two by-products was then mix together in equal proportion before then used to replace cement in partially in determined percentages.

The Bagasse ash used was obtained locally from the burning of Sugarcane husks. The husks were completely burnt under atmospheric condition, sealed in plastic bags and transported to the laboratory. The ash was then passed through British Standard No 200 sieve, with 0.75mm aperture, and kept to be mixed with the cement in the pre-determined percentages.

Compressive Strength Test

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. For cube test, casting was done using 150mm X 150mm X 150mm concrete mould. The concrete is poured in the mould and tempered 35 times in three (3) layers properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen is made even and smooth. These specimens are tested by compression testing machine (digital display) after 7 days 14 days 21 days and 28 days curing. Load are applied gradually until the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

RESULTS AND DISCUSSION

Table 1: Compressive Strength of Control, 5%, 10%, 15% and 20% (Grade 20)

Age (Days)	Crushing strength (N/mm²)				
	Control	5% Repl.	10% Repl.	15% Repl.	20% Repl.
7	14.82	13.36	12.48	10.25	8.44
14	16.55	16.04	14.22	12.18	10.33
21	20.11	19.44	17.56	14.81	13.36
28	24.89	24.36	20.24	17.31	16.21

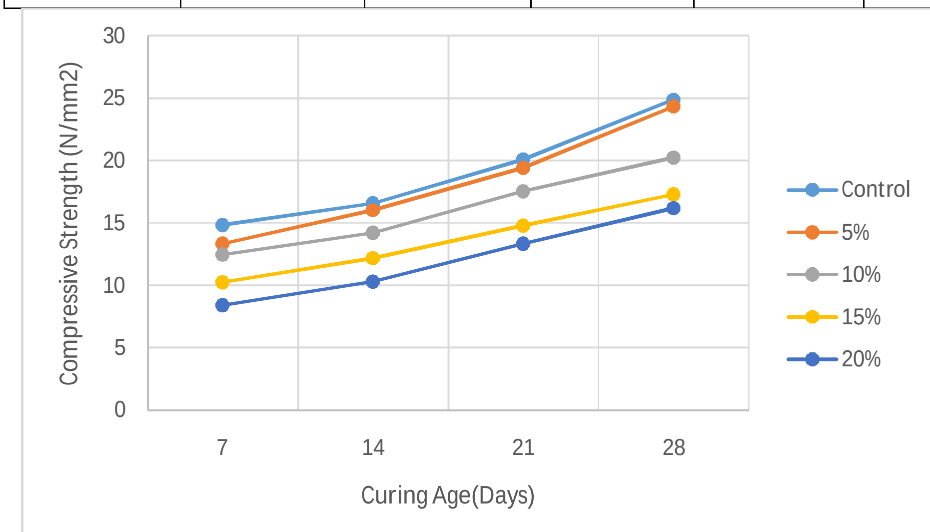

Fig. 1: A graph of compressive strength (N/mm²) against Age (Days) for Grade 20

Table 2: Compressive Strength of Control, 5%, 10%, 15%, and 20% (Grade 25)

Age (Days)	Crushing strength (N/mm²)				
	Control	5% Repl.	10% Repl.	15% Repl.	20% Repl.
7	19.44	18.71	17.22	16.18	15.24
14	21.71	20.48	18.44	17.48	16.11
21	24.61	23.81	22.56	18.19	17.22
28	27.84	25.89	25.22	23.11	19.65

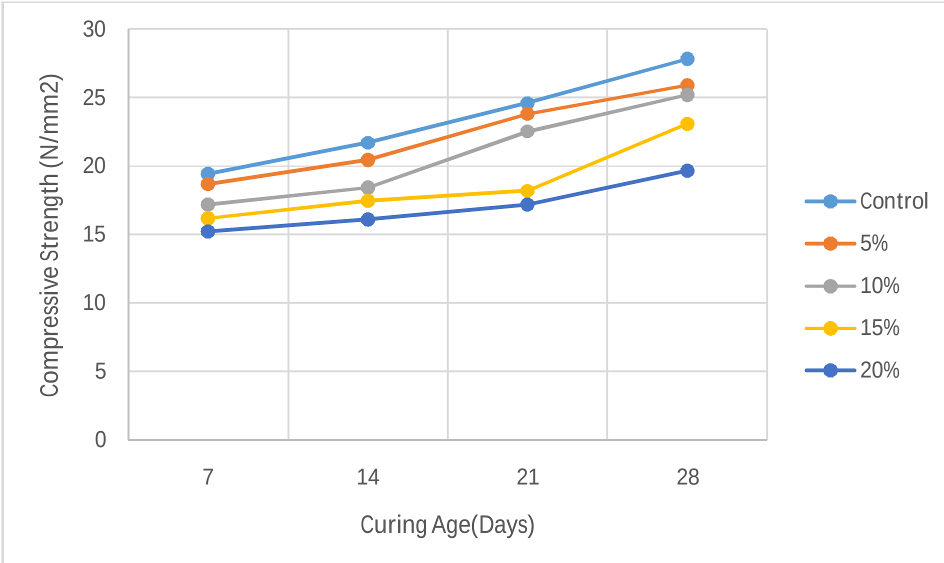

Fig. 2: A graph of compressive strength (N/mm²) against Age (Days) for Grade 25

Discussion of Result

The result obtained from the entire test carried out on the sample of concrete is as follows:

The compressive strength for grade 20 and 25 at 0%, 5%, 10%, 15% and 20% were obtained as follows: Concrete grade 20 7 days = 14.82 N/mm², 13.36 N/mm², 12.48 N/mm², 10.25 N/mm², and 8.44 N/mm², 14days = 16.55 N/mm², 16.04 N/mm², 14.22 N/mm², 12.18 N/mm², and 10.33 N/mm², 21days = 20.11N/mm², 19.44 N/mm², 17.56 N/mm², 14.81 N/mm², and 13.36 N/mm², 28days = 24.89 N/mm², 24.36 N/mm², 20.24 N/mm², 17.31 N/mm², and 16.21 N/mm², Concrete grade 25 7 days = 19.44 N/mm², 18.71 N/mm², 17.22 N/mm², 16.18 N/mm², and 15.24 N/mm², 14days = 21.71 N/mm², 20.48 N/mm², 18.44 N/mm², 17.48 N/mm², and 16.11 N/mm², 21days = 24.61 N/mm², 23.81 N/mm², 22.56 N/mm², 18.19 N/mm², and 17.22 N/mm², 28days = 27.84 N/mm², 25.89 N/mm², 25.22 N/mm², 23.11 N/mm², and 19.65 N/mm² respectively.

Therefore, the result above shows that increase in percentage of replacement decreases the strength of concrete for both grade 20 and 25 and increases in strength with increase in curing days.

The results of this trend may be due to a drop in workability with increase SCBA and RHA. Test to assess the workability of fresh concrete indicates that incorporation of SCBAand RHA in concrete leads to a decrease in slump value, which depends on the replacement content. This reduction in slump was due to the absorption of some quantity of mixing water by SCBA and RHA particles. Because of the large surface area of SCBA and RHA, more water molecules were attracted towards the surface of these particles. Thus, the quantity of the free water available for the concrete mix which helps in improving the fluidity of the mixture was decreased and there was an increase in the viscosity of the concrete mix. This in turn reduces the workability of the concrete and the effect was the same for other two tests also. If density were to be considered according to BS877, the concrete mixture would have been considered a light-weight concrete.

CONCLUSION

From the result obtained in this study, it can be concluded that Sugarcane Bagasse ash and rice husk ash can be used as a potential material for replacing cement. There is an increase in strength with increase in curing age, an decrease in strength with an increase in percentage replacement up to 20% of the locust beans waste and rice husk ash.

RECOMMENDATIONS

Although, the results of this research study have shown a considerable reduction in the compressive strength of concrete with high replacement content percentage than normal concrete, it could be recommended to use in low strengths requirements structures such as non-load bearing walls, road kerb, precast units for partition walls, some cases of slabs on soil, culverts, sidewalks, concrete blocks for architectural applications and concrete blocks. Although, these research works was carried out within a specific time frame and considering the financial challenges, further study can be carried out on activated sugarcane bagasse ash and activated rice husk ash concrete by the additive of admixture such as silica fume of different percentage or by the use of different cement type in order to overcome the significant reduction of the concrete strength due to the replacement.

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