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# SUGAR CANE BAGASSE ASH AND LOCUST BEANS WASTE ASH AS A REPLACEMENT FOR CEMENT IN CONCRETE

**ADEJOH BENJAMIN OCHOLA[1], ABUBAKAR MUHAMMAD AHMADU[2], ABDULLAHI BALARABE BALA[3].**

*Department of Civil Engineering, Kaduna Polytechnic.*

***Abstract***

*This study is aimed at investigating the compressive strength of concrete using Sugarcane Bagasse ash (SCBA) and Locust Beans Waste Ash (LBWA) as a replacement for cement in concrete using two grades of concrete; grade 20, and 30 respectively. The concrete cube cast was; control (0%) 2%, 4%, 6% and 8% respectively, the cube*

***Keywords:*** *Cementious material, Compressive strength, concrete, Sugarcane Bagasse ash, Locust Beans Waste Ash, Pozzolana*

## INTRODUCTION

Concrete is the most commonly used construction material in the world. It is basically composed of two components: paste and aggregate. The paste contains cement and water and sometimes other cementitious and chemical admixtures, whereas the aggregate contains sand and gravel or crushed stone, Lavanya materials M.R (2012). The paste binds the aggregates together, the aggregates are relatively inert filler which occupy 70% to 80% of the concrete and can therefore be expected to have influence on its properties. The proportions of these components, the paste and the aggregate is controlled by; the strength and durability of the

*was cast, cured and tested at 7days, 14days, and 28days. Although, the results of this study have shown a significant reduction in compressive strength of concrete utilizing SCBA & LBWA than normal concrete, it can be concluded that, optimum amount of sugarcane bagasse ash incorporated with Locust beans waste ash that can be replaced with cement is maximum of 6% by weight without any admixtures.*

desired concrete, the workability of the fresh concrete and the cost of the concrete. Cement which is one of the components of concrete plays a great role, but is the most expensive and environmentally unfriendly material. Ordinary Portland cement is the most extensively and for the mineral admixture and in future this demand is expected to increase even more also in this modern age, every structure has its own intended purpose and hence to meet this purpose, mused construction material in the world. Since the early 1980's, there has been an enormous demodification in traditional cement concrete has become essential. Therefore requirements for economical and more environmental-friendly cementing materials have extended interest in other cementing materials that can be used as partial replacement of the normal Portland cement, BirukHailu (2011). 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

Locust bean pod husks are ~~a~~ waste by-products of agricultural processing of the African locust bean fruit. Substantial quantities can be found across northern Nigeria during the harvest season. Across the globe, much research efforts in recent times are geared towards possible ways of recycling these wastes for reuse to keep the environment clean and safe (Adama & Jimoh, 2011). The transportation, construction, and environmental industries have the greatest potential for reuse because they use large quantities of earthen materials annually (Basha, 2003).

Locust bean pod, which is a Waste Agricultural Biomass (WAB) obtained from the fruit of the African locust bean tree (ParkiaBiglobosa), is the material resource required for the production of locust bean pod ash (LBPA). The harvested fruits are ripped open while the yellowish pulp and seeds are removed from the pods. The empty pods are the needed raw material. The pods make up 39% of the weight of the fruits while the mealy yellowish pulp and seeds make up 61% (Adama & Jimoh, 2011).

The African Locust bean tree (Family Legumianosae: Mimosodeae) with scientific name Parkiabiglobosa is a deciduous tree that grows up to 20m in height (Hausa: Dorowa). The tree grows in much of sub-sahara Africa and commonly found in Nigeria. It grows large fruit pods that contain both sweet yellow pulp and valuable black seeds. The seeds are used for food seasoning when fermented (Hausa: Dadawa, Igbo: Ogiri Yoruba: Iru). Various parts of the tree are also used for medicinal purposes. The brown Pod is usually peeled off to free the fruit and seeds and left as waste material. As an agricultural waste material it constitutes environmental nuisance hence its use as a building material has economic advantage. An investigation in the use of the pod extract as a binder showed that the extract improved the compressive strength of laterite blocks by 78.5% - (Aguwa & Okafor, 2012).

## Material and Method

### Sugar Cane Bagasse Ash and Locust Bean Waste Ash

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).

**Table.1**: Chemical Composition of Sugarcane Bagasse Ash

| S/NO | Compounds | Weights |
|---|---|---|
| **1** | SiO2 | 85.55 |
| **2** | $Al_{2}O_{3}$ | 2.29 |

| | | |
|---|---|---|
| **3** | $Fe_{2}O_{3}$ | 1.21 |
| **4** | TiO2 | 0.20 |
| **5** | $K_{2}O$ | 1.33 |
| **6** | $SO_3$ | 2.28 |
| **7** | $C_aO$ | 4.05 |
| **8** | P2O5 | 3.01 |
| **9** | $M_nO$ | 0.08 |

**Sources:** Biruk Hailu (2011)

**Table.2:** Characteristics of Sugarcane Bagasse Ash

| S/NO | Characteristics | Value |
|---|---|---|
| **1** | Colour | Black |
| **2** | Particle density (g/cm3) | 2.39 |
| **3** | Organic matter (%) | 10.32 |
| **4** | Clay (%) | 0.70 |
| **5** | Silt (%) | 11.50 |
| **6** | Sand | 87.80 |

**Sources:** Biruk Hailu (2011)

The Locust beans waste ash used was obtained locally from the burning of locust bean husks sourced from Tsauni village in Zaria L.G, Kaduna State and Shafan Koto village in Toto L.G, Nassarawa state. 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.

**Materials**

The cement used for this work was bought from a cement deport at pan taker market Tudun Wada, while the fine and coarse aggregates were obtained from kabala junction, Kaduna state. The sugarcane bagasse was collected from Kawo market, Asikolaye junction and Hayin Danmani, in Kaduna north, Kaduna state. The materials were transported to the laboratory where it was dried and kept in safe conditions. The locust bean waste used in this research were sourced from Tsauni Village in Zaria L.G, Kaduna state Nigeria. The material is usually available as a waste product of agricultural processing of the locust bean fruits during the harvest season. Locust Bean Pond Ash was produced by incineration attaining 500$^{o}$ C, after which the ash was sieved using sieve 150microns.

## Compressive strength test

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By this single test, one can judge 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. The test for compressive strength is carried out either on cube or on cylinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test. In the research, standard concrete cube of 150mm x 150mm x 150mm was used. This concrete is poured in the mould and tamped properly so as not to have any voids. After 24 hours these moulds are removed and the test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. It is done by putting cement paste and spreading smoothly on the whole area of specimen. These specimens are tested by compression testing machine after 7 days curing, 14 days and 28 days curing. Load are applied gradually until the test specimen fails in compression.

## Results and Discussion

**Table.3: Compressive Strength of Control, 2%, 4%, 6% and 8% (Grade 20)**

| Age (Days) | Crushing strength (N/mm$^2$) | | | | |
|---|---|---|---|---|---|
| | Control | 2% Repl. | 4% Repl. | 6% Repl. | 8% Repl. |
| **7** | 17.85 | 17.24 | 16.09 | 14.23 | 12.84 |
| **14** | 19.97 | 19.36 | 18.41 | 16.96 | 14.44 |
| **28** | 24.87 | 22.33 | 21.46 | 20.37 | 15.88 |

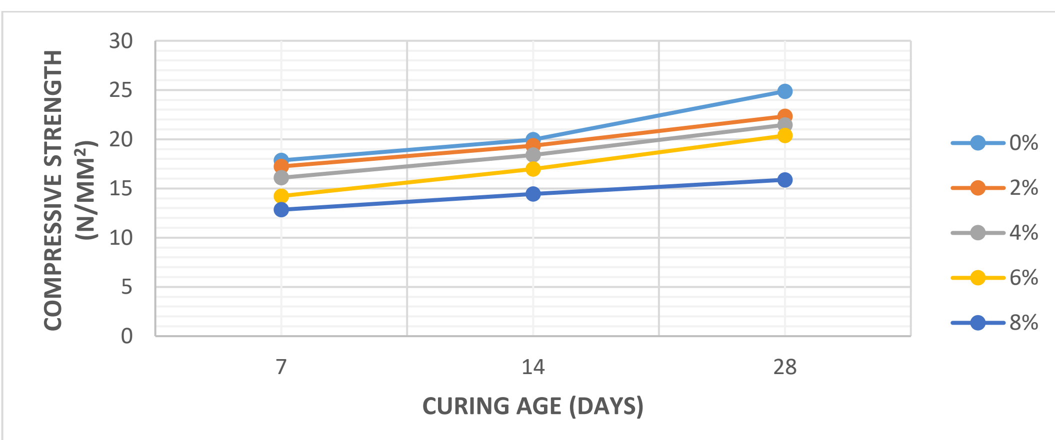


**Fig. 1: A graph of compressive strength (N/mm$^2$) against Age (Days) for Grade 20**

**Table.4: Compressive Strength of Control, 2%, 4%, 6% and 8% (Grade 30)**

| Age (Days) | Crushing strength (N/mm$^2$) | | | | |
|---|---|---|---|---|---|
| | Control | 2% Repl. | 4% Repl. | 6% Repl. | 8% Repl. |
| **7** | 21.45 | 19.06 | 15.98 | 14.22 | 12.14 |
| **14** | 27.89 | 25.96 | 24.23 | 23.21 | 21.98 |
| **28** | 34.89 | 32.21 | 31.12 | 30.05 | 27.14 |

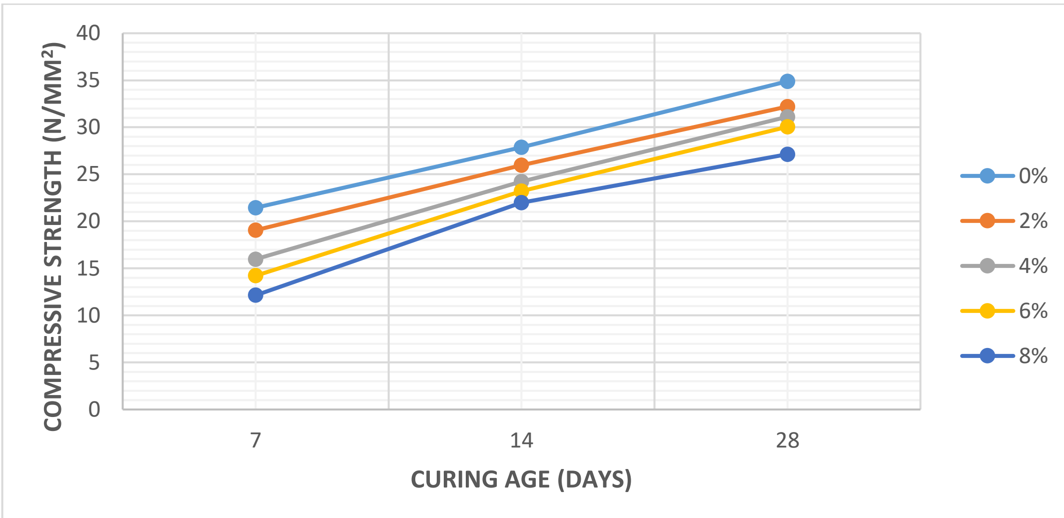


**Fig. 2: A graph of compressive strength (N/mm$^2$) against Age (Days) for Grade 30**

**Discussion of Result**

The results of Compressive Strength for 0%, 2%, 4%, 6% and 8% replacements for Grades 20 and 30 concretes are as follows: For Grade 20 at 7, 14 and 28 days, 0% mix: 17.85 N/mm$^2$, 19.97 N/mm$^2$ and 24.87N/mm2, for 2% replacement: 17.24 N/mm$^2$, 19.36 N/mm$^2$ and 22.33 N/mm2, for 4% replacement: 16.09 N/mm$^2$,18.41 N/mm$^2$ and 21.46 N/mm2, 6% replacement:14.23 N/mm$^2$, 16.96 N/mm$^2$, and 20.37 N/mm2, for 8% replacement: 12.87 N/mm$^2$,14.44 N/mm$^2$ and 15.88 N/mm2. For Grade 30 at 7, 14, and 28 days, the results are, for 0% mix: 21.05 N/mm$^2$, 27.89 N/mm$^2$, and 34.89 N/mm2, 2% replacement: 19.06 N/mm$^2$, 25.96 N/mm$^2$, and 32.21 N/mm2, 4% replacement: 15.98 N/mm$^2$, 24.23 N/mm$^2$ and 31.12 N/mm2, 6% replacement: 14.22 N/mm$^2$, 23.21 N/mm$^2$ and 30.05 N/mm2, 8% replacement: 12.18 N/mm$^2$, 21.98 N/mm$^2$ and 27.14 N/mm2 respectively.

Therefore, the results above shows that, as the percentage of replacement increases, the strength of concrete for both grades 20 and 30 decrease as well, but as the curing day increases, the strength of the concrete also increases.

The results of this trend may be due to a drop in workability with increase SCBA and LBWA. Test to assess the workability of fresh concrete indicates that incorporation of SCBA and LBWA in concrete leads to a decrease in slump value, which depends on the SCBA and LBWA content. This reduction in slump was due to the absorption of some quantity of mixing water by SCBA and LBWA particles.

Because of the large surface area of SCBA and LBWA, 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 using SCBA and LBWA would have been considered a light-weight concrete.

## Conclusion

It can be seen that there is a slight decrease in strength of concrete with increase in percentage replacement of SCBA and LBWA, though there is an increase in strength with increase in curing days. Despite the observed changes in compressive strength of the concrete due to percentage replacements, there is a large market for concrete products in which addition of SCBA and LBWA would be feasible. These can also include primary structural applications of medium to low strength requirements, benefiting from other features of this type of concrete. Therefore, the use of SCBA and LBWA can still be employed in concrete production as partial replacement for cement since the strength gained are effective according to BS 812, but this may be achieved with longer days of curing.

## Recommendations

Although, the results of this study have shown a significant reduction in compressive strength of concrete utilizing SCBA and LBWA than normal concrete, it could be recommended that SCBA and LBWA concrete should be used in road curbs, concrete blocks, non-bearing concrete walls, precast units (partition walls, concrete blocks for Architectural applications and some cases of slabs on soil, culverts, sidewalks, drive ways), foundation pads for machinery, etc. It is here by recommended that further study should be carried out under proper supervision on the SCBA and LBWA in concrete by the addition of admixtures such as silica fume and sodium hydroxide at different percentage in other to overcome the significant reduction of concrete strength due to replacement with SCBA and LBWA.

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