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Optimisation for the Use of Rice Husk Ash and Sawdust As Alternative Binder For Concrete

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----------ABSTRACT----------
The disposal of saw dust and rice husk has always been by incineration or open air burning, this has hazardous effect on the air and environment at large. They can be recycled for use in construction industry without producing any harm to human and environment. Research has shown that they can be used as a binder replacement.This paper highlights the optimal material that can be added to concrete for optimum strength. Sawdust and Rice husk mixed with bone powder was added to replace cement in relative percentage of 5, 10, 15 and 20%.The result shows that rice husk and sawdust are alternative binder that can replace cement to some extent but there is reduction in strength as well. 18 concrete cubes were casted using mix ratio 1:2:4, the control experiment without sawdust or rice husk has strength of 8.9N/mm^2. With 5% Rice husk ash, the strength dropped to 7.6 N/mm^2, but using 5% saw dust, the strength dropped to 7.71 N/mm^2. Further addition of both materials to give 15% addition produced strength of 6.2 N/mm^2 and 4.4 N/mm^2 for rice husk and saw dust respectively. Both materials can be added to produce a lightweight structure but the amount replacement for saw dust must not exceed 10% while rice husk must not exceed 15% in order to produce safe and durable structure.

KEYWORDS: *Binder, Concrete, Sawdust, RiceHusk*

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I. INTRODUCTION

Concrete is a composite material composed of coarse granular material (the aggregate of filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together. (Zongjin, 2011)

Concrete = Filler + Binder

Concrete is a mass of sand, gravel, crushed rock, or other aggregate bonded together by a hardened paste of hydraulic cement and water. When properly proportioned, mixed, and consolidated, these ingredients form a workable mass which can be placed into a form of desired size and shape. The water present reacts with the cement to convert the concrete to a hard and durable product. (Kamran 2013) The minimum expected concrete strength is 20N/mm^2 at 28 days for a normal concrete mix of ratio 1:2:4. (Yusuf 2011)The cost of building materials nowadays is so high in some parts of the world; particularly developing countries like Nigeria, that only the government, industries, business cooperation and few individual can afford it. This high and still rising cost can however be reduced to a minimum by use of alternative building materials that are cheap, locally available and bring about a reduction in the overall dead weight of the building. Some industrial and agricultural products that would otherwise litter the environment as waste or at best be put into only limited use could gainfully be employed as building material. This study examined the use of saw dust ash or rice husk ash mixed with bone ash as partial replacement for ordinary Portland cement in concrete. It involves the determination of the chemical composition of the ash and evaluation of the workability, and compressive strength of the concrete

II. MATERIALS AND METHODS

Cement: Cement can be described as a material with adhesive and cohesive properties which make it capable of bonding mineral fragment into a compact whole and solid in the presence of water. For constructional purposes, the term cement is restricted to the bonding material used with aggregates, bricks, building blocks etc. This type of cement is usually principally constituted of compounds of lime, clay and magnesium, building in civil engineering is concerned with calcareous cement. It is made by heating limestone and clay or other suitable raw materials together to form a clinker rich in calcium sulphate which regulates the rate of setting when the cement is mixed with the water.

Aggregates: Aggregates are hard inert filler materials mixed with a binding material like cement lime or mud in the preparation of mortar or concrete. Aggregates occupy 70 – 75% of the total volume of a mass of concrete and therefore, the properties of concrete are to a large extent dependent on the properties of the aggregates in them. The aggregate used are local aggregates (Gravel and pit sand for coarse and fine aggregate respectively).

Sawdust: Sawdust is an organic waste resulting from the mechanical milling or processing of timber (wood) into various shapes and sizes. The dust is usually used as domestic fuel. The resulting ash known as saw-dust ash (SDA) is a form of pozzolana.
Dry sawdust concrete weighs only 30% as much as normal weight concrete and its insulating properties approximate those of wood. With proper cement to sawdust ratios, it is not flammable. (Marthong, 2012)

Rice Husk Ash: Rice husk is an agro-waste material which is produced in about 100 million of tons. Approximately, 20 Kg of rice husk are obtained for 100 Kg of rice. Rice husks contain organic substances and 20% of inorganic material. Rice husk ash (RHA) is obtained by the combustion of rice husk. The most important property of RHA that determines pozzolanic activity is the amorphous phase content. (Mauro, 2012)
Rice-Husk Ash can either substitute for some of the cement in a mortar or it can be mixed with quicklime to make a hydraulic, cement-free mortar. RHA may be used as a substitute for expensive cement to provide mortars possessing a range of strengths. (Allen)
Rice chaff is realized during the process of threshing and shelling operations, which is aimed at removing the grains from the protecting casting. These operations can be carried out by hand or by use of threshing machine. The threshing of rice by hand (manually) entails the beating of small bunches by hand, 6 to 8 times against a hard-surface (stones, metal drum,). If the cereals have been harvested when sufficiently ripe and the grain is dry, it detaches itself easily with a little fraction scattered around.

Bone Powder: Bone Powder is a complex chemical made from calcium, phosphate and hydroxyl ions, but which may also contain small amount of cationic, magnesium and strontium replacing calcium and bicarbonate and fluoride, replacing the hydroxyl anions. Bone is a strong, hard, fibrous material in mammalian body (endo- skeleton) which gives shape and supports to the body.The bone ash in this condition can be easily reduced to a fine powder. It crumble when it passes through sieve, the ash was whitish in colour. The mix design is to select the optimum proportion of cement, water and aggregates to produce a concrete that satisfies the requirements of strength, workability, durability and economy. The control cube been made with pure cement and the remaining five (5) having different percentage substitution of cement for rice chaff and bone powder, i.e. 5%, 10% 15% and 20% respectively. Mix ratio of 1:2:4 was used and the water-cement ratio was 0.5. The sizes of sand used are mainly percentage passing 5.00mm with B.S sieve. The granite used is also clean and the sizes are mainly percentage passing 20.00mm B.S sieve. The rice chaff used was obtained from "Ekimogun Mills" at Odo-Ado, Ado-Ekiti, Ekiti State. The bone was obtained from Rufus Giwa Polytechnic, Owo abattoir opposite cooperative building. The bone was dried, washed and ready again before being set ablaze to obtain the required ash.

Research Methodology

The concrete was mixed according to BS 1881. The proportion mix ratio of 1:2:4 of coarse aggregate, sand and replacement binder (sawdust ash or rice-husk ash mixture) were thoroughly mixed in clean surface using a shovel until a homogenous or suitable consistency was reached. The ash from rice husk was obtained from rice grinding machine operator and after burning, the residue was taken to the laboratory for sieving. The cubes were cast and cured at room temperature with water for 28 days. Saw Dust Ash was used to replace ordinary Port-land cement at 5%, 10%, 15% and 20% by weight of cement. Concrete with no SDA present serves as the control experiment. The mix ratio used was 1:2:4 (binder, sand and granite) with water to binder ratio of 0.5. Rice Husk Ash mixed with bone ash was used for another mix with pure cement without RHA for the control and the remaining four (4) having different percentage substitution of cement for rice chaff and bone powder, i.e. 5%, 10% 15% and 20% respectively. Mix ratio of 1:2:4 was used and the water-cement ratio was 0.5.Slump and compacting factor tests were carried out to check the effect of SDA and Rice Husk Ash on the workability of fresh concrete. The tests were carried out in accordance with the requirements of BS 1881: Part 102 (1983) for slump test and BS 1881: Part 103 (1983) for compacting factor test. Specimen preparation for compressive strength test was performed using 150mm cube steel moulds. The specimens were cast in three layers, each layer being tamped with 25 strokes of the tamping rod spread uniformly over the cross section of the mould.

The top of each mould was smoothened and leveled and the outside surfaces cleaned. The moulds and their contents were kept in the curing room at temperature and relative humidity 90% for 24hours.
De-moulding of the cubes took place after 24hours and the specimens were transferred into water bath in the curing room. Compressive strength was determined at curing age 28 days. The compressive strength was determined using compression machine.

III. RESULTS AND DISCUSSIONS

Mixture of rice husk ash and sawdust can be used in the production of normal weight concrete. Figure 1 Shows the Effect of percentage variation of each material (Rice Husk Ash and Sawdust) on the compressive strength.

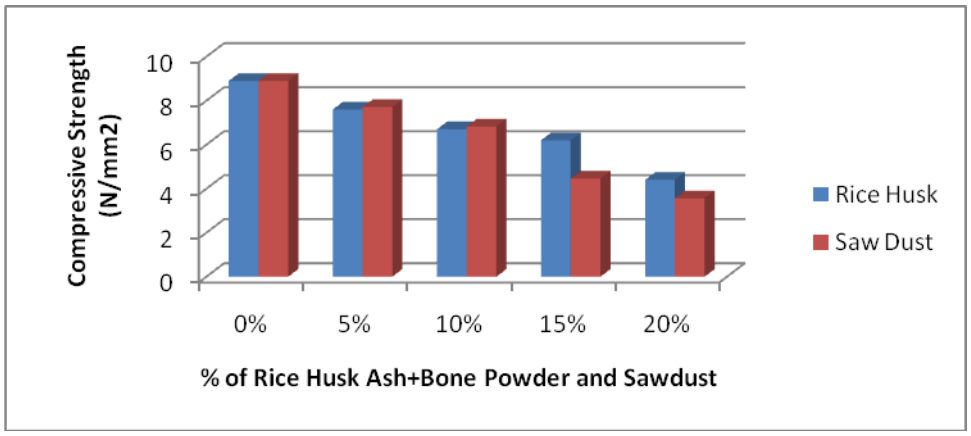

Figure 1: Bar Chart showing the effect of each binder replacement percentage with corresponding compressive strength of the concrete

From the result, sawdust replacement has better performance when the added percentage is not more than 10%. On the other hand, with 15% rice husk, the strength is still permissible for light structure.Figure 2 shows the effect of rice husk ash and sawdust on the density of concrete. The change in density is minimal with addition of rice husk ash but there is much difference when sawdust is used.

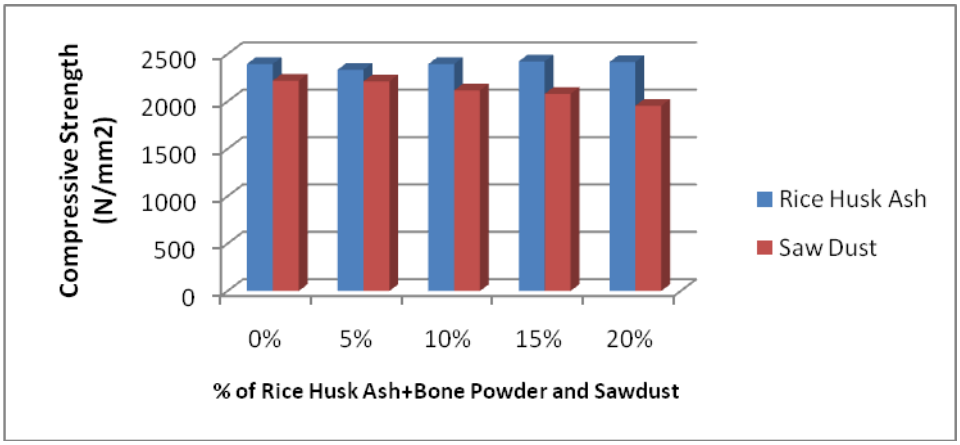

Figure 2: Bar Chart showing the effect of each binder replacement percentage with corresponding density of concrete

IV. CONCLUSION

Rice husk ash and sawdust are good materials that can supplement cement to some extent but the percentage of sawdust recommended should not be more than 10 percent while the rice husk ash is permissible to 15% of cement. This mixture is permitted for lightweight structures.

All materials used for the practical are local materials and they are readily available and they can also reduce the cost of producing concrete when implemented.There has been no issue of hazardous emission generated from this materials when used for construction . The mode of disposing rice husk ash and sawdust has been by open air burning which has harmful effect on the people and environment at large but with its implementation in lightweight structure, it will help in providing clean and safe environment.

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