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***Journal of Scientific and Engineering Research*, 2020, 7(5):48-52**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Strength Properties of Concrete Made with Wood Waste Ash as a Partial Replacement for Cement

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Abstract This research work is to determine a reliable percentage of Wood Waste Ash (WWA) as a partial replacement of cement in concrete production. Construction works is increasing at daily basic with substantial consumption of cement in large proportion hence the need for partial replacement of cement in concrete. The researcher has shown that every tone of cement manufacture releases half ton of carbon dioxide, thus there is an instantaneous got to management the usage of cement. Wood waste ash is a waste material of combustion in wood fire power plants and also pollutants for environment, they can be used as Cement Replacement Materials (CRM) to decrease the pollution with the cost of cement in concrete production. The compressive strength of cubes size 150mm x 150mm x 150mm and split tensile strength 100mm diameter and 200mm height cylinders were determined at curing of 7,14 and 28 days. The wood waste ashes were used to replace 5%, 10% 15% and 20% by weight of the cement in concrete. The mix ratio was 1:2:4 with water/cement ratio at 0.45 including control specimens as the conventional concrete. The objective of the study is to determine the suitability of wood waste ash as a partial replacement of cement in concrete production. It was discovered of the test carried out on hardened concrete that the mechanical properties of concrete mixture decreased slightly with increasing in WWA replacement in concrete. The result showed that WWA added with cement gives good strength for use in structural concrete.

Keywords Compressive strength, split tensile strength, cement, wood waste ash, pollution

Introduction

Concrete is a versatile construction material that is widely employed in nearly all structural works. It's a stuff comprising cement, aggregates, water and admixtures. Concrete's skillfulness and economy have created the world's most helpful construction material and must continue developing to meet increasing demands [1]. Portland cement could be a comparatively expansive ingredient in concrete, and contains of 10% to 20% of concrete weight. Cement is the most widely consumable material in the infrastructure development works and its production emit extensive amounts of CO_2 [2]. It is considered as a durable material of construction. That is, the increase in demand of cement can lead to scarcity of the product, which will lead to high increase in the price of cement. It is believed that some part of the world does not have raw material for the production of cement. Thus, there is ought to explore for different materials to cement within the construction. The employment of material as a cement replacement has become a lot of common in recent decade .It is time to raise the use of cement replacement materials in the concrete production. Utilization of wood waste ash as a replacement of cement in concrete production will reduce the cost of concrete production. Wood waste as his about to be considered as a good replacement of cement because it has pozzolanic property that would

potentially be used as a cement replacement [3]. However, it contributes the most important portion of embodied energy and gas in atmosphere. Continuous generation of wastes arising from industrial by-products and agricultural residue, produce acute environmental issues each in terms of their treatment and disposal. In the recent years, growing consciousness concerning world's environment and increasing energy security has led to increasing demand for renewable energy resources and to diversify current ways of energy production. The wastes generated from the biomass industries like wood, woodchips, wood bark, and laborious chips is used as fuel supply a higher approach for their safe and economical disposal. These wood ash wastes is obtained in abundance from industries that need wood as their fuel for in operation their boiler units. Moreover, the employment of wood ash as a soil supplementary material is obtaining more and more restrictive to considerably high metal content in ashes, particularly wood ash, which can cause hazards just in case of groundwater contamination and sterility of agricultural fertile land increase and strength behavior [4]. Researchers have conducted tests that showed promising results that wood waste ash is befittingly to replace cement part in concrete production. Hence, incorporating the usage of wood waste ash as replacement for cement in integrated cement is helpful for the environmental purpose of reckon well as manufacturing low value construction entity so resulting in a property relationship.

Methodology

Materials

Ordinary Portland Cement (OPC): The Dangote cement was taking up and use in this study, which were gotten from Fadeyi, Somolu local government, Lagos State. It conforms to [5].

Coarse Aggregate: Crushed stone aggregates of nominal size 20mm were used throughout the study and was gotten from Fadeyi, Somolu local government area, Lagos state. The aggregates were washed to remove dust, dirt and were dried to surface dry condition and conforming to [6].

Fine Aggregate: The natural sand used for this study was gotten from Fadeyi, Somolu local government area, Lagos state and was transported to the laboratory. The sand conforming to [6].

Water: In this study clean potable water was used for both mixing and curing of concrete. It was free from organic matter, silt, oil, chloride and acidic material. The water was obtained from Yaba College of Technology, Lagos state. It conforms to [7].

Wood Waste Ash: Wood waste ash used in carrying out this study was gotten from bakery bread in Ereko Fadeyi, Mushin local government area of Lagos state. It conforms to [8].

Mix Designs: Compressive strength of dimension 150mm x150 mm x l50mrn was used in casting the total of 45 cubes. The cast concrete was placed in the water tank, filled with potable water in the laboratory. For each trial mix 3 cubes, 9 cubes were tested at different ages of concrete to obtain the compressive strength at the age of 7days, 14days, and 28days. Compressive strength was tested according to [9]. Split tensile strength test was also carried out according to [10] and conducted on 30 cylindrical moulds of size100mm diameter X 200mm height with partial replacement of cement at 5%, 10 %, 15% and 20% of wood waste ash in concrete. The specimens was tested for 7, 14 and 28 days curing. After hardening stage, the specimens was place between two platens with two pieces of 3mm thick and measure up to 25mm wide plywood strips on the top and bottom of the cylindrical specimens. The workability was determined using the slump test according to [11].

Results and Discussion

Chemical Composition of Wood Waste Ash

Table 1: Chemical Composition of Wood Waste Ash

Chemical Constituents	Percentage Composition (%)
Silicon dioxide (SiO*R*2*R*) %	62.19
Aluminum oxide (Al*R*2*R*O*R*3*R*)%	7.38
Iron oxide (Fe*R*2*R*O*R*3*R*) %	3.23
Calcium oxide (CaO) %	12.60
Magnesium oxide (MgO) %	2.45
Potassium Oxide (K*R*2*R*O) %	1.57
Loss of Ignition (1000*P*0c)	34.30

Moisture content %	1.60
Alkalis %	0.89
Total $SiO_2 + Al_2O_3 + Fe_2O_3$	**72.8**

Table 2: Physical properties of fine and coarse aggregate

S/ No.	Physical Properties	Fine Aggregate	Coarse Aggregate
1.	Specific gravity	2.14g	2.73g
2.	Water absorption	1.5%	0.9%

Slump Test

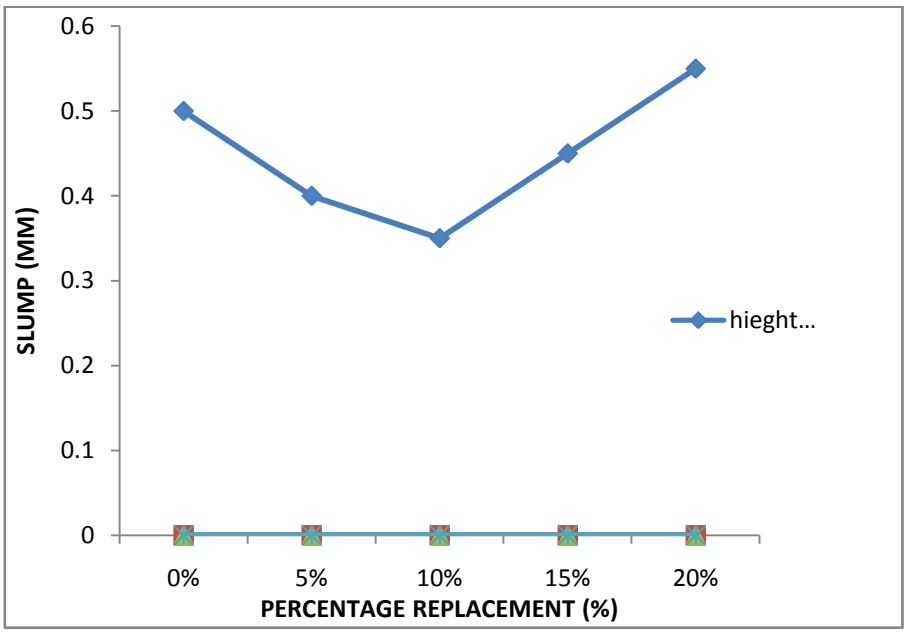

Figure 1: Variation of slump with percentage replacement

The figure shows that for constant water cement ratio, the slump first decreases for up to 10% wood ash replacement, and then increases with increasing wood ash content. These results indicate that concrete containing wood ash farther 10% replacement level becomes more workable as the wood ash content increases which means that less water is needed to make the concrete workable. The lower water demand can be characterized to the finer ash particles with replacement role in concrete production.

Compressive Strength

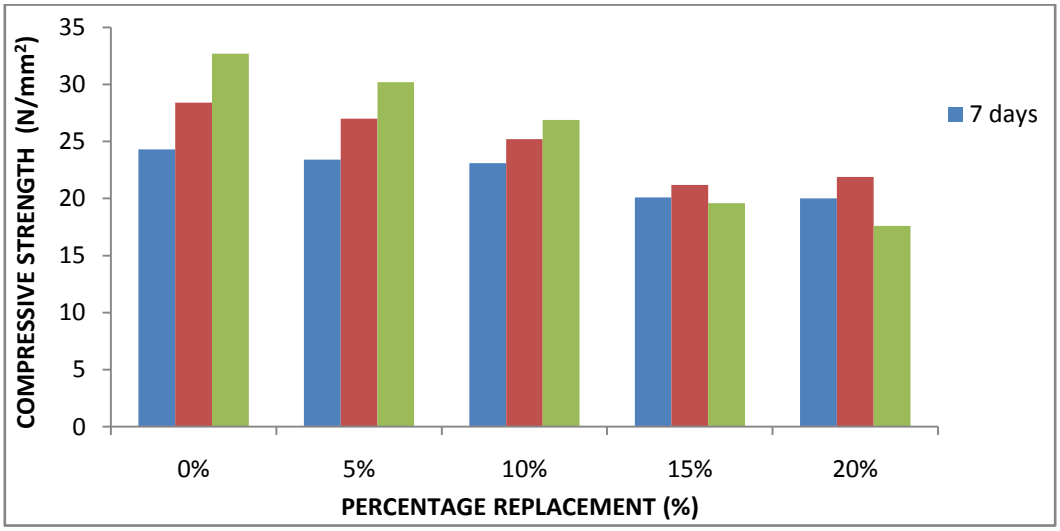

Figure 2: Variation of compressive strength with percentage replacement

The figure shows that compressive strength generally increases with curing period and reduces in strength with the increasing wood ash materials. The result at 7days showed that the compressive strength of concrete with 0% and 5% wood ash replacement is the highest at this level. Similarly, both 5% and 10% wood ash concrete have lower strength than the control at 7 days. It can be rightly said that all specimen cured in good water condition of different days acquired a high rate of increment of strength based on days of curing, that the task of curing operation on the cubes improves its compressive strength, this shows that, the longer the cube in a good quality of curing water, the higher the compressive strength attained by the cube.

The Split Tensile Strength

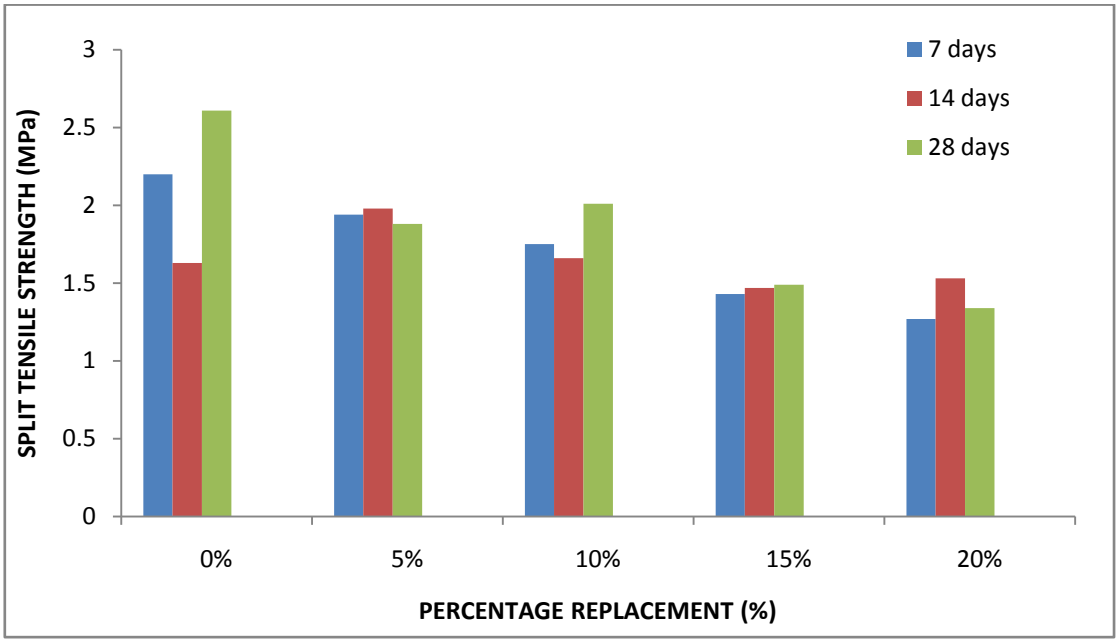

Figure 3: variation of split tensile strength with percentage replacement

The figure shows that split tensile strength generally increase with curing period and reduce in strength with the increasing replacement which is wood ash materials. The result at 7 days showed that the tensile strength of concrete with 0% and 5% wood ash replacement has highest strength. Similarly, 10%, 15% and 20% wood ash concrete cylinder have lower strength than the control at 7 days that is 0%. It can be rightly said that the specimen of all percentage replacement cured in good water condition of different days acquired a high rate of increment of strength based on days of curing.

Conclusion

In this study, the strength properties of concrete was investigated with the following conclusion:

i. Suitability of wood ash as cementitous material was effective because wood ash contain pozzolanic elements that are similar to OPC.

ii. The strength of concrete decreases upon increasing the quantity of wood ash in the concrete, when compared to control specimen. Also the strength increases with age due to pozzolanic reaction.

iii. Use of wood ash in concrete helps to convert Wood ash from being an environmental threat to a useful resource as cementitous material.

iv. Split tensile strength of wood ash concrete has reliable strength at 5% replacement by weight of OPC, but will became unreliable when it exceed 5% replacement.

v. Wood ash increases workability of fresh concrete.

vi. Water absorption increases with increasing wood ash percentage.

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