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Effect of Curing Methods on The Characteristic Strength of Concrete With Lateritic Sand And Periwinkle Shell

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Abstract: *This study investigates the effect of curing methods on the compressive strength of concrete with fine and coarse aggregates components fully and partly replaced with lateritic sand and periwinkle shell. A total of 45 cubes specimens of 100mm x 100mm dimensions for each percentage replacements ranging from 10% to 40% and 100% respectively were cast and cured in water and open air for 7, 14 and 28 days. The water cement ratio used is 0.65. 1:2:4 and 1:3:7 mixing ratios were adopted. The procedures for testing and crushing were carried out in accordance with B.S. 1881: Part 116: 1983. The results show that compressive strength of concrete generally increases irrespective of the percentage replacement and curing methods as the curing age increases. Compressive strength of concrete with lateritic sand and periwinkle shell as partial replacement up to 20% is the highest compared to other percentage replacements irrespective of the curing ages and curing methods.*

Keywords: *Concrete, lateritic, sand, strength, periwinkle shell.*

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I. INTRODUCTION

Shelter is one of the three basic necessities of life. The earth as one of the major building materials was used for man's shelter since time immemorial Adakole, (1992). The continuous usage of the earth as a building material for building construction leads to the increase in the cost of building production hence the need to seek alternatives or develop new materials to solve the problem of housing for ever-increasing population Apeh & Ogunbode, (2012). In developing countries like Nigeria, the high costs of procuring concrete materials for construction works have over the years constrained the users to compromise quality. This has resulted in poor performance of infrastructure; a major factor that has contributed to the increase in maintenance costs and the series of collapsed structures with attendant loss of lives and properties. Research trends globally in materials development has been that of sourcing for alternatives Adewuyi & Adegoke, (2008). The development of supplementary aggregate materials is said to be fundamental to advancing low-cost construction materials to be used in the production of low cost buildings. A number of attempts have been made to provide local alternatives to the use of river sand and granite/washed stone as fine aggregate and coarse aggregates respectively in conventional concrete. Laterite has beenidentified as a possible material for partial replacement of sand in concrete to produce what has been called laterized concrete, while studies havebeen carried out on effects of laterite incorporation in strength and serviceability properties of fresh and hardened concrete Balogun & Adepegba, (1982). Recent developments in the building construction industry have witnessed an increasing use of locally available lateritic sand generally referred to as 'sharp-sharp sand' from borrow pits for block moulding and concrete works. Some combine the sandy laterite with quarry dust. Also in the riverine areas, periwinkle shells are used as replacement for coarse aggregates in concrete. The knowledge of structural characteristics and performance of concrete made with these materials is necessary for the accurate design of structural elements in buildings and bridges. This paper is a report of part of an ongoing research on the use of lateritic sand and periwinkle shell as an alternative replacement of fine and coarse aggregate in concrete with experimental design for up to 28 days of air curing in consonance with previous works such as Neville, (2006), and Neville & Brooks (2002).The 28-day strength can also be used as a trial assessment of the compressive strength in accordance to previous research work. This work investigates the effect of weather on the incorporation of the locally available lateritic sand and periwinkle shell as full and partial replacement on strength characteristics of concrete and also the mechanical properties of these locally available materials. This study helps to achieve proper documentation of the materials to support their specification in design and construction. The introduction of lateritic sand and periwinkle shell (a seemingly waste) into concrete can be viewed as an attempt to convert an ecological waste material to a purposeful use.

II. LITERATURE REVIEW

Research trends on sourcing, development and the use of alternative, non-conventional materials have been concentrated either on partial or total replacement of sand with laterite in concrete on one hand and the replacement of granite/gravel with periwinkle shell on the other.Adoga, (2007), describes Laterite as a highly weathered material rich in secondary oxides of Iron, Aluminum or both. It is nearly devoid of base and primary silicates but may contain large amount of quarts, and Kaolinite. Laterite has been used for wall construction around the world; it is cheap, environmentally friendly and abundantly available building material in the tropical region Ayangade *et al*, (2009).

2.1 Lateritic concrete

Lateritic concrete as defined by Osadebe *et al*, (2007) is concrete in which the fine aggregate is lateritic soil. Different properties of laterized concrete have been considered at different stages with far reaching recommendations in favour of laterite as suitable for use in the construction industry.Adepegba was identified as the first to study the effect of using laterite as fine aggregate in concrete (Adepegba, 1975). This was supported by Salau, (2008) when he asserted that “Adepegba, (1975), recommended laterite with up to 40% clay content for laterized concrete”. In a further research by Adepegba, (1977), he compared resistance to high temperature, modulus of elasticity and compressive and tensile strength of laterized concrete mixes (1:2:4; 1:1.5:3 and 1:1:2 by weight) with that of normal concrete. He concluded that for high strength and workability only 25% of sand in concrete should be substituted with lateritic fine, while the mix ratio should be 1:1.5:3 (cement: sand/laterite: granite) with a water/cement ratio of 0.65.Udeoeyo, brooks, Philip & Nsan, (2010) carrid out an investigation on the early prediction of laterized concrete strength by accelerated testing. In the laboratory investigation on the efficiency of the boiling water method of accelerated strength to predict the 28-day compressive strength of laterized concrete (concrete containing laterite as full or partial replacement of sand). The result of the work showed that the accelerated strength of the concrete was between 72 and 84% of its 28 days strength. In another study by Udoeyo, *et al*., (2010) on the residual compressive strength of laterized concrete subjected to elevated temperatures and discovered that the compressive strength of laterized concrete decreased in a similar manner to that of plain concrete when subjected to elevated temperatures between 200 and 600^{0}C.

III. MATERIALS AND METHODS

Lateriwinkle concrete mixtures with five levels of lateritic sand replacements ranging from 10% to 40% and 100% and five levels of periwinkle shell replacement also ranging from 10% to 40% and 100% (i.e. a total of 45samples) were investigated. 1:2:4 mixing ratio was used. The control mixture was proportioned for a target concrete strength of 25 N/mm^2, and a water cementitious materials ratio of 0.65. The sand and granite replacement by lateritic sandand periwinkle shell respectively was thereby computed for by weight as required.
The fine aggregate used were sand and lateritic sand. The lateritic sand with a sand content ≤60% used was procured from a construction site in Anthony village, Lagos state in Nigeria. While sand used was river sand, free from deleterious substances obtained from a supplier in Lagos; the coarse aggregate used were granite and periwinkle shell obtained from a supplier in Lagos. The cement used was 42.5 grade ordinary Portland cement(OPC), Elephant product and was procured from a supplier in Yaba, Lagos. The product conforms to the requirements of BS EN 197: Part 1, 2000 for Ordinary Portland Cement.

3.1Mixing of Constituent Materials

The manual method of mixing was adopted for the mixing of the ingredients of concrete i.e. by hand mixing. The components were batched by weight.The required quantity of lateritic sand was measured on the weighing balance and placed on a flat clean surface. The required quantity of cement was measured in the same way. This mixture was mixed thoroughly until a uniform mixing was obtained. The coarse aggregate (periwinkle shell and granite) was also measured as required, poured on the mixture and mixed thoroughly as previously done. The required quantity of water was finally measured and poured into the mixture in stages for adequate mixing. The components were thoroughly and adequately mixed to prevent segregation and bleeding of the concrete. The mixture was immediately poured into formwork to avoid setting before placement in formwork. The same procedure also applied for the production of concrete with partial replacement of sand and coarse aggregate with lateritic sand and periwinkle shell respectively. The mixing and sampling of the concrete was done in accordance with BS EN 12350-1:2000.

3.2Compressive Strength Test

Compressive strength is the maximum stress sustained by the specimen, that is the maximum load registered on the testing machine divided by the cross sectional area of the specimen Udoeyo, *et al.*, (2010).The compressive strength is the most important factor which determines the overall quality of concrete. The compressive test was carried out on three cube specimens for each of the percentage replacement (10%, 20%, 30%, 40%, 100%) corresponding to the hydration period of 7, 14 and 28 days. The procedures for testing and crushing were carried out in accordance with B.S. 1881-122:2011.

The formula used for the determination of the compressive strength in N/mm^2 is

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Area}}$$

Where,

Load = load to be recorded from compressive testing machine

Area = L^2 = Surface area of cube

L = length of cube

IV. DISCUSSION OF RESULT

4.1 Workability Test Result

Table 1.0 Result of the Slump Test.

S/N	Percentage Replacement (%)	Water/cement Ratios	Slump Value for (1:2:4) (mm)	Slump Value for (1:3:7) (mm)
1	10	0.65	26	25
2	20	0.65	24	22
3	30	0.65	24	18
4	40	0.65	22	17
5	100	0.65	20	12

The workability of concrete for different types of aggregate fully and partly replaced with lateritic sand and periwinkle shell using slump test were shown in the Table 1. First, workability is inversely proportional to the aggregate concrete mix ratio. For example, workability is lower for concrete mix 1:3:7 than that of 1:2:4 for every trial. It is also obvious that workability of concrete with full lateritic sand and periwinkle shell as aggregate is lower than that of partial replacement irrespective of the mix ratios; this can be attributed to the fact that partly replaced concrete is denser than the full replacement concrete. The slump decreases as the mix ratios increases. This means that the concrete becomes less workable (stiff) with increase in the mix ratio, hence there is a high demand for water to maintain the same workability level as the control.To attain the same workability level of 10-30mm in the mixes containing lateritic sand and periwinkle aggregate as partial replacement with that of the full replacement concrete (i.e. full replacement), a higher water content was required. This is reflected in the water cementitious material ratio of 0.65 with a corresponding increase in the amount of water over control as the lateritic sand and periwinkle shell percentage increases. The higher water requirement mixes containing lateritic sand and periwinkle shell could be attributed to the high fineness of lateritic sand and periwinkle shell which meant a greater specific surface to be wetted and lubricated. This agreed with the earlier finding of the effects of water-cement ratios on workability of concrete and lateritic sand-periwinkle shell concrete mixes which depicts that workability increases as water cement ratio increases Udoeyo, *et al.*, (2010).The values of the slump range between 12 and 26mm which is within the standard required values of 10-40mm based on the mix design for concrete of low workability.

Compressive Strength Test Result

The results of the compressive strength developed within the hydration period of 7,14 and 28 days and curing in open air for the same age for all the percentage replacement are presented in the table below:

Table 2.0 Compressive Strength Corresponding to Percentage Replacement at 1:2:4 mix ratio cured in water.

Percentage Replacement	**Compressive Strength N/mm^2**

%	7 days days	14 days	28
10	11.20		17.40
20	21.20		
30	11.93		18.00
40	21.80		
100	10.80		15.00
	20.20		
	9.20		13.53
	17.80		
	4.40	6.10	7.87

Table 3.0: Compressive Strength Corresponding to Percentage Replacement at 1: 2:4 mix ratio cured in air.

Percentage Replacement %	**Compressive Strength N/mm^2**		
	7 days	14 days	28 days
10	7.60	8.87	10.60
20	8.27	9.80	11.93
30	7.00	8.93	10.60
40	6.33	8.27	9.40
100	2.87	4.07	4.93

Table 4.0: Compressive Strength Corresponding to Percentage Replacement at 1:3:7 mix ratio cured in water.

Percentage Replacement %	**Compressive Strength N/mm^2**		
	7 days	14 days	28 days
10	9.07	10.70	17.07
20	10.00	11.40	18.42
30	8.40	11.07	17.73
40	7.50	10.07	16.07
100	3.90	5.40	6.87

Table 5.0: Compressive Strength Corresponding to Percentage Replacement at 1:3:7 mix ratio cured in open air.

Percentage Replacement %	**Compressive Strength N/mm^2**		
	7 days	14 days	28 days
10	2.554.50	7.04	
20	3.00 5.40	8.12	
30	2.40 4.06	7.13	
40	2.023.07 6.02		
100	1.90 2.00 3.27		

The tables aboveshowed that the compressive strength of concrete generally increases irrespective of the percentage replacement and curing method as the curing age increases. It also showed that as the percentage replacement of sand and granite aggregate with lateritic sand and periwinkle shell increases from 7-28 days curing in open air, there was a reduction in the strength development compared to 10-20% sand and granite aggregate replacement concrete. But the strength development of the concrete specimen cured in open air is very low compared to the concrete specimens cured in water for both mix ratios. Thus, indicating that the compressive strength of concrete reduces as the percentage replacement of sand and granite aggregate increases beyond 20% and that the dehydration of concrete has a negative effect on its strength development

V. CONCLUSION

The strength of lateritic sand-periwinkle shell concrete is determined based on the properties of the lateritic sand and periwinkle shell at various percentage replacements. The workability parameter (slump test) value decreases as the percentage replacement of lateritic sand and periwinkle shell increases. This means that the concrete becomes less workable (stiff) with increase in percentage replacement content; hence there is a lesser demand for water to maintain the same workability level as the control. This again implied that both periwinkle shell and lateritic sand aggregate concrete have high moisture content and high water absorption rate. The results of the research work show that concrete containing lateritic sand and periwinkle shell as partial replacement up to 20% develop a higher compressive strength for the curing ages of 7, 14, and 28days irrespective of the mix ratios than concrete containing lateritic sand and periwinkle shell at 100% full replacement. Hence, indicating the unsuitability of lateritic-periwinkle full replacement in concrete. The compressive strength of partially replaced lateritic sand and periwinkle shell concrete is higher than that of the control which shows higher continuous strength development comparable with that of control. The optimum level of partial replacement is 20% having attained a range of 100-150% of the design strength for the entire mix ratio at 28 days. The values of compressive strength of lateritic sand-periwinkle shell concrete cured in air obtained in this work were lesser than the strength of standard moist cured concrete of corresponding age and mix ratios, implying the enhancement of hydration process and consequently the strength development through water method of strength testing.

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