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Comparative Analysis of Strength and Physical Properties of Concrete Made from Three Different Coarse Aggregate (Granite, Gravel and Palm Kernel)

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Abstract
The study is aimed at examining the comparative analysis of the strength and physical properties of concrete made from three different coarse aggregates. The research present the result and findings of an experimental research of the strength and physical properties of concrete made from different aggregates such as sharp sand, granite, gravel, palm kernel shell. In this research, sieve analysis and compressive test were carried out using a 150mm×150mm×150mm mould and a mix ratio of 1:2:4 by weight of concrete and water cement ratio of 0.5 was adopted, 36 cubes were produced and all the samples were cured in fresh water. The concrete cubes were tested for compressive strength at 7, 14, 21 and 28 days. The result obtained from the compressive strength shows that the different coarse aggregate used, possess different compressive strength value. The mean strength in N/mm^2 of concrete cubes cast with palm kernel at 7, 14,21and 28days gave $3.64N/mm^2$, $3.82N/mm^2$ $4.00N/mm^2$and $4.22N/mm^2$respectively while concrete made of gravel gave strength of 12.53 N/mm^2, 12.98 N/mm^2, 13.33 N/mm^2, 16.67 N/mm^2, For concrete made of granite, the strength are 14.53 N/mm^2, 15.56 N/mm^2, 18.67 N/mm^2 and 20.44 N/mm^2respectively. This concludes from the above listed result that, the compressive strength of concrete made from granite gave higher compressive strength value of 20.44 N/mm^2, at 28days as compared to the compressive strength of concrete made of gravel and palm kernel shell which gave a compressive strength value of 16.67 N/mm^2 and $4.0N/mm^2$respectively.Specifications of the intended works pre-determines materials which are suitable for construction, it is therefore evident to ascertain the strength of these material before execution of intended project.
Keywords: Composite Material, Aggregate, Compressive Strength, Curing

1.0 Introduction

A composite material consists essentially of a binding medium, such as a mixture of Portland cement and water, within which are embedded particles or fragments of aggregate, usually a combination of fine and coarse aggregate. Concrete is by far the most versatile and most widely used construction material worldwide (Jagannadha and Rao, 2009). It can be engineered to satisfy a wide range of performance specifications, unlike other building materials, such as natural stone or steel, which generally have to be used as they are. Because the tensile strength of concrete is much lower than its compressive strength, it is typically reinforced with steel bars, in which case it is known as reinforced concrete (Newton, 2003). Composite materials are made up of various constituents. The properties and characteristics of the composite are functions of the constituent materials, properties, as well as the various mix proportions. When concrete is freshly mixed, the aggregates are suspended in cement, water, air bubble paste. Selection of types and size gradation of the aggregate depends upon the nature of the aggregate employed, a fairly precise balance between the amount of fine and coarse aggregate size fraction may have to be maintained to achieve the desire mobility, plasticity and freedom from segregation (Olajide, 2013).

Presence of aggregate provides an enormous contact area for intimate bond between the paste and the aggregate surfaces. Rigidity of aggregate greatly restrains volume change of the whole mass. Aggregate can be classified by their mineral, chemical, and physical properties, aggregate physical properties and direct result of its mineral and chemical properties, significantly improve the workability of the fresh concrete which are contributed by proper choice of aggregate, this improvement is important in the properties of hardened concrete. Three quarters of the volume of concrete is occupied by aggregate so its quality should be of important consideration. Aggregate that does not contain any harmful substances are very useful for the production of concrete to suite its properties. Good sand gravel should not contain any harmful material such as pyrites, coal, ignite, laminated materials, clay, alkali, soft fragments and organic impurities in such quality as to affect the strength durability of the concrete (Neville, 1987).

2.0 Materials and Methods

The materials used in this research include; cement, water, aggregates (sand, granite, gravel and palm-kernel shell), cube formwork 150mmx150mmx150mm. In order to examine the proportion of mix design for aggregate used. Series of test were carried out on the aggregate (sieve analysis, compaction test and crushing test). These

tests were carried out at both the geotechnical and concrete laboratory of civil engineering department of the polytechnic Ibadan. Fine aggregate and coarse aggregate were obtained from different locations around Ilorin, kwara state, Nigeria. Cube with ratio 1:2:4 were prepared for compressive strength test, after specific curing day.

Quantity of Material needed for a Concrete Cube using GRAVEL, SHARP SAND AND CEMENT.

The normal mix ratio of 1:2:4

Water/cement ratio = 0.5

Mass of cement = 3.16kg

CUBES|DAYS	7days	14days	21days	28days	Total
Granite	3	3	3	3	12
Gravel	3	3	3	3	12
Perm kernel	3	3	3	3	12
Total					36

0.15 X 0.15 X 0.15 = 0.003375 X12 = 0. 0405m^3

0.003375 X 36 = 0.1215m^3

Table 3.1. Volume of materials used

Specimen type	Cement (ltrs)	Fine.a (ltrs)	Coarse.A (ltrs)	No of cubes
Granite	8.505	17.01	34.02	12
Gravel	8.505	17.01	34.02	12
Perm kernel	8.505	17.01	34.02	12
TOTAL	25.515	51.03	102.06	36

3.0 Result and Discussion

The results of the investigation show variation in the comparative strength and physical properties of concrete made from various aggregate of fine aggregate (sharp sand) and coarse aggregate (granite, gravel, palm kernel shell). The indicates that the different coarse aggregate used possesses varying compressive strength values. The compressive strength increases with the age of curing of concrete. This is shown in the tables and figures below.

Table 1 Particle Size Analysis for Granite

Sieve sizes(mm)	Mass retained(g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage finer (%)
75.0	100	2.61	2.61	99.99
50.0	100	2.61	5.22	94.77
37.5	150	3.92	9.14	90.77
31.5	390	10.18	19.32	90.85
19.0	350	65.27	84.59	80.67
13.2	300	7.83	92.42	15.40
10.0	200	5.22	97.64	7.57
9.5	90	2.35	99.99	2.35
4.75	0	0	99.99	0
0	0	0	99.99	0

Table 2 Particle Size Analysis for Gravel

Sieve sizes(mm)	Mass retained(g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage finer (%)
26.5	420	9.62	9.62	100
20.0	565	12.71	22.33	77.7
14.0	365	8.36	30.65	69.34
10.0	435	9.96	40.65	56.38
8.0	545	12.48	43.13	56.9
6.0	400	9.16	62.29	37.74
4.7	465	10.65	72.94	27.09
2.0	460	10.53	83.47	16.56
1.8	265	6.07	89.54	10.49
0.6	458	10.49	100	0

Table 3 Particle Size Analysis for Palm-kernel

Sieve sizes(mm)	Mass retained(g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage finer (%)
75.0	0	0	0	100
50.0	100	3.70	3.70	96.30
37.0	700	25.93	29.63	70.40
31.5	800	29.63	59.26	40.73
19.0	850	31.48	90.74	9.30
13.2	50	1.85	92.59	7.40
10.0	50	1.85	94.44	5.55
9.5	100	3.70	98.14	0.85
4.75	50	1.85	99.99	0
0	0	0	99.99	0

Table 4 Particle Size Analysis for Sharp Sand

Sieve sizes(mm)	Mass retained(g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage finer (%)
4.75	3	0.91	0.91	99.09
3.18	2	0.61	1.52	98.48
2.40	3	0.91	2.43	97.57
1.68	6	1.82	4.25	95.75
1.18	24	7.27	11.52	88.48
0.60	91	27.58	39.1	60.9
0.295	94	28.48	67.58	32.42
0.15	76	23.03	90.61	9.39
0.075	19	5.76	96.37	3.63
Pan	8	2.42	98.79	1.21
Total	326	98.79		

Table 5: Average Compressive Strength Values

Ratio	Sample	Age of cubes	Date manufacture	Date of test	Average compressive strength (N/MM^2)
1 : 2 : 4	Sharp Sand, Palm Kernel Shell	7 days	18/8/2017	26/1/2018	3.64
		14days	18/8/2017	01/2/2018	3.82
		21days	18/8/2017	07/2/2018	4.00
		28days	18/8/2017	13/2/2018	4.22
1 : 2 : 4	SharpSand,Gravel	7 days	18/8/2017	26/1/2018	12.53
		14days	18/8/2017	01/2/2018	12.98
		21days	18/8/2017	07/2/2018	13.33
		28days	18/8/2017	13/2/2018	16.67
1 : 2 : 4	Sharp Sand, Granite,	7 days	17/8/2017	26/1/2018	14.53
		14days	17/8/2017	01/2/2018	14.56
		21days	17/8/2017	07/2/2018	18.67
		28days	17/8/2017	13/2/2018	20.44

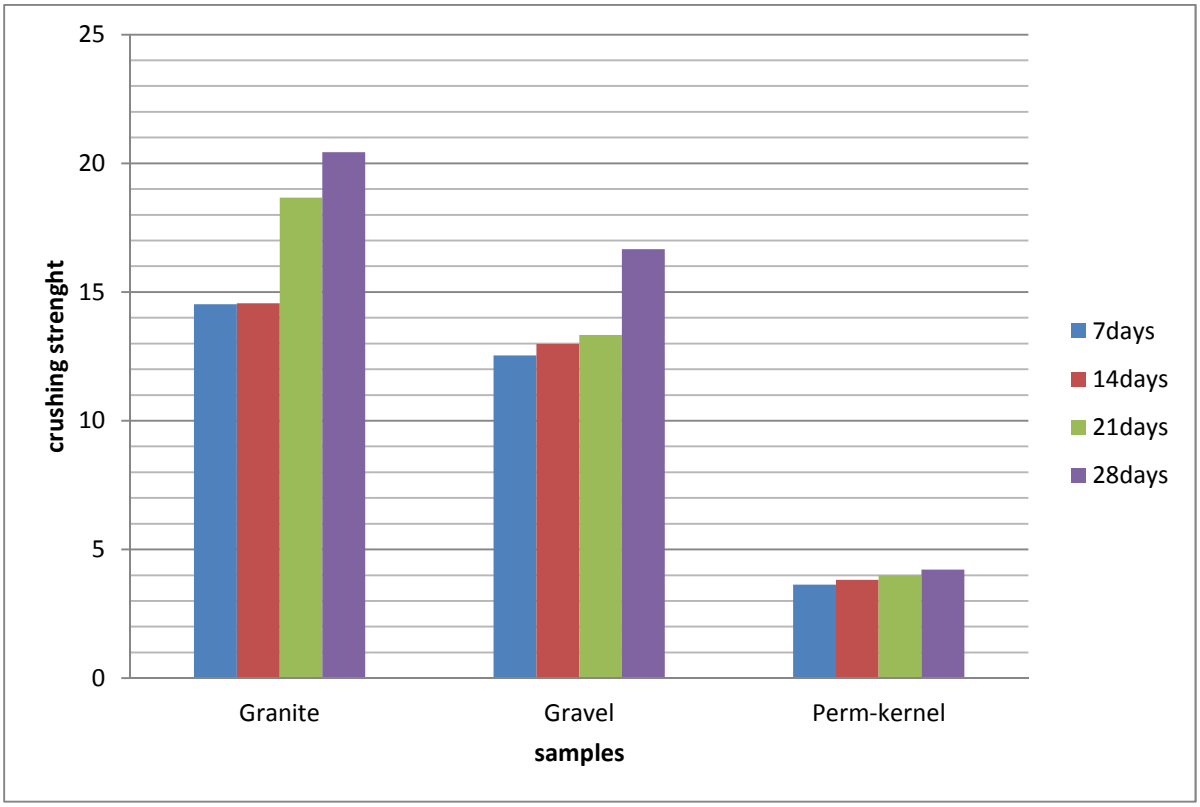

Fig 1. Average crushing strength chart of samples compared

4.0 Conclusion and Recommendation

The study investigated the comparative strength and physical properties of concrete made from various aggregate of fine aggregate (sharp sand) and coarse aggregate (granite, gravel, palm kernel shell). It can be observed from the result of the test carried out that the curing ages, has different effect in the strength of concrete of the same aggregate and mix ratio. The mean strength of concrete cured at 7days , 14days, 21days, and 28days For concrete made of palm kernel shell, gravel and granite respectively are (3.64N/mm^2, 3.82 N/mm^2, 4.0N/mm^2& 4.22 N/mm^2), (12.53 N/mm^2,12.98 N/mm^2,13.33 N/mm^2&16.67 N/mm^2), (14.53 N/mm^2, 15.56 N/mm^2, 18.67 N/mm^2 &20.44 N/mm^2) respectively. It can be concluded that concrete made from granite performs best at 28 days as this gives the best increase in strength of the concrete as compared to palm- kernel shell and gravel. Palm- kernel and gravel could also be used as a substitute for coarse aggregate this depends on the specification and strength required. It can also be concluded from the experiments that granite is suitable as a means of reinforcement for adverse effects on concrete strength posed by increased moisture content.

References

BS 812-110(1990): testing concrete methods for determination of aggregate.

Jagannadha Rao K and Ahmed Khan T (2009). "Suitability of glass fibers in high strength recycled aggregate concrete-an experimental investigation". *Asian Journal of Civil Engineering (Building and Housing)*, vol. 10, issue 6 pp 251-257.

Neville B.L. (1987), Factors Effecting Test on Hardened Concrete, 4thEdition, Pitman Publishing Ltd, London.

Newton, M. O (2003), "structural detailing for building and civil engineering" Macmillan press Limited.

Olajide, O. (2013) properties of palm kernel shells and fibre as a aggregates for making concrete. Exlevier publisher.