COMPARISON OF FLEXURAL STRENGTH VALUES OF PALM KERNEL SHELL CONCRETE MEASURED BY DIRECT AND INDIRECT METHODS

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Abstract: The research seeks to compare the difference in measurement of flexural strength of palm kernel shell (PKS) concrete, using direct and indirect methods (beam and splitting cylinder specimen).The Palm kernel shell (PKS) was subjected to various physical tests and values obtained are as follows; specific gravity of Palm kernel shell (PKS) 1.3, Aggregate impact value 10.23.The Concrete was cast using two mix ratios 1:1.5:3 and 1:2:4. The concrete cubes, cylinders, and beams were crushed at 7, 14 and 28days in other to determine the compressive strength and flexural strength of the concrete for the various mixed. The 28th day compressive strength was 12.30N/mm^2 and 20N/mm^{2,} for the two mixed ratio respectively. The 28th day flexural strength was 2.03N/mm^2 and 1.10N/mm^2 for the beam and cylinder specimen respectively. The student t-test showed that there is no significant difference between the tensile strength measured using direct and indirect methods.

Key Words: Flexural Strength, Palm Kernel Shell, Concrete, Beams, Construction Materials.

INTRODUCTION:

It has been observed over through the years that the cost of construction materials is on a high increase and has thus affected the cost of construction of structures as well. The rising cost of construction and the need to reduce environmental stresses to make construction sustainable, has necessitated research into the use of alternative materials, especially locally available ones which can replace conventional ones used in concrete production. The use of such replaceable materials should not only contribute to construction cost reduction but also make engineering construction sustainable; such materials should be cheap and available. The use of cheaper building materials without loss of performance is very crucial to the growth of developing countries, this research seek to study the flexural and compressive strength of concrete when palm kernel shells is used instead of the conventional coarse aggregate in a concrete mix. Palm kernel shell as aggregate in concrete will further make construction more affordable where it suits, this could be traced to its availability in abundance in a place like Nigeria, where palm oil trees dominate their plantation. Nigeria is among countries that are short of lightweight aggregates; therefore, if alternative is made available for these industries for power generation, then this shell can be effectively used as lightweight aggregate.

AIM :

The aim of this study is to compare flexural strength values measured by direct and indirect methods.

THE OBJECTIVES ARE:

I. To determine the direct flexural strength of palm kernel shell concrete.
ii. To determine the split-cylinder tensile strength of palm kernel shell concrete.
iii. To compare the direct and indirect method of measuring flexural strength.
IV. To determines the compressive strength of palm kernel shell concrete.
V. To determine the specify gravity of palm kernel shell.
Vi. To carry out sieve analysis of the aggregates.
Vii. To determine the appropriate mixes for palm kernel shell concrete.

LOCATION OF THE STUDY:

Makurdi town the study area is the Capital of Benue state in Nigeria, the town lies between latitude 7^0 and 8^0 Northern as well as longitude 8^0 and 9^0 eastern .it has a total area of 25 km^2 and an average relief of 120 m (Agbede and smart,2007)

JUSTIFICATION OF THE STUDY:

The increase in general building activities and civil engineering construction, particularly in the field of reinforced concrete and road building, and the consequent spectacular increase in the consumption of available reserved of materials for these activities, led to some competition and shortages of natural aggregates suitable for concrete construction in some areas or regions of the world which Nigeria is not an exemption. An attempt to provide alternative material for reinforcement by using Palm Kernel Shell (PKS) which is in abundance, would reduce environmental hazards and as well drastically reduce the cost of construction.

SCOPE AND LIMITATION:

The research is restricted to only concrete production from palm kernel shell as coarse aggregate, the mix ratio used for the studies are 1:1½:3, 1:2: 4.and water cement ratio used is 0.5 respectively. The tests performed on the Palm Kernel Shell (PKS) coarse material and fine aggregate includes; specify gravity, Particle size analysis, water absorption, aggregate impact test and tests performed in the Palm Kernel Shell concrete (PKSC) concrete includes; compressive test, flexural strength, split tensile strength, density test, and slump test. Materials such as river sand, Cement, Admixtures, Water, palm kernel shells etc. were used in this work.

MATERIALS AND METHODS:

The method employed in carrying out this research includes preliminary tests (sieve analysis, Aggregate impact test, water Absorption test and specify gravity), sample preparation and testing (casting of Beams and cylinders, curing, flexural strength test, split tensile strength test, slump test and density test).

RESULTS AND ANALYSIS:

Presented below are results obtained from all the tests conducted in this research work. The results of the following tests have been discussed in this section of the work; sieve analysis, Aggregate impact test, water Absorption test and specify gravity, curing, flexural strength test, split tensile strength test, slump test and density test.

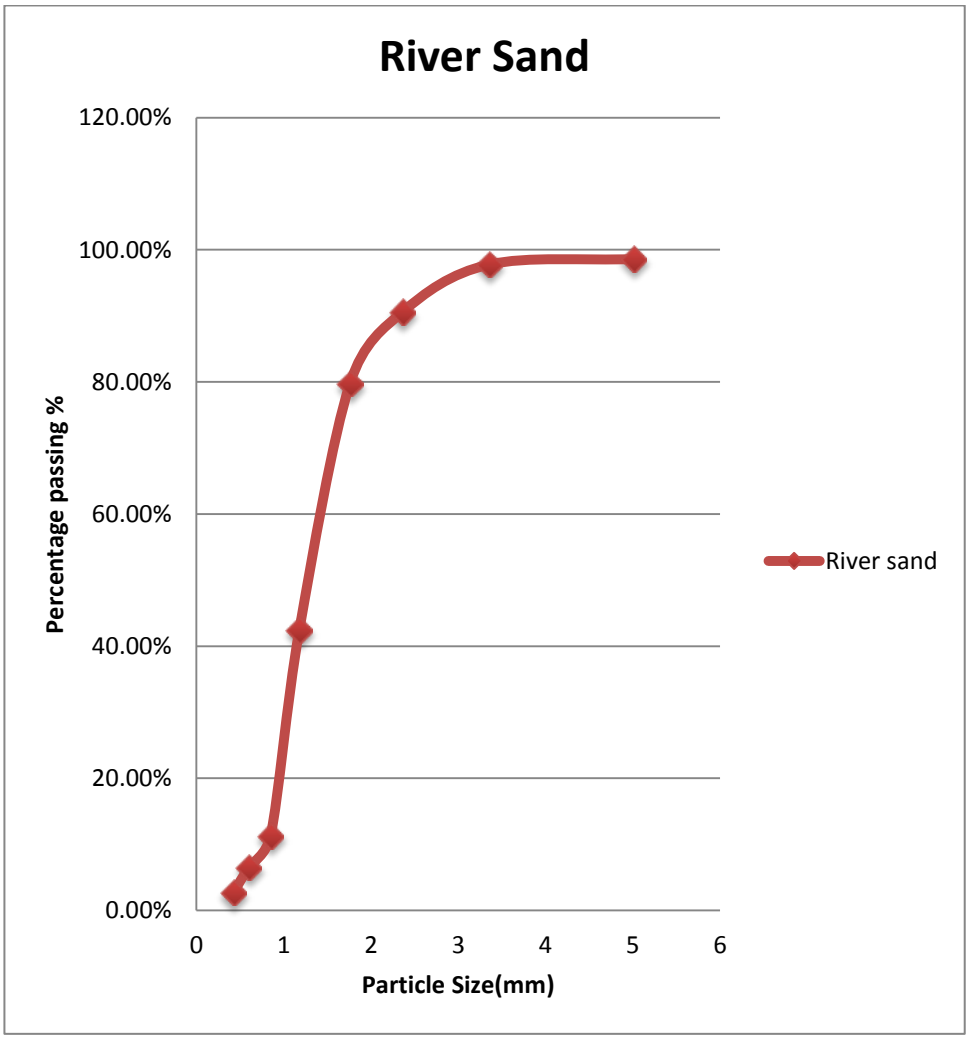

Figure 1: Particle size distribution curve for fine aggregate (River Sand)

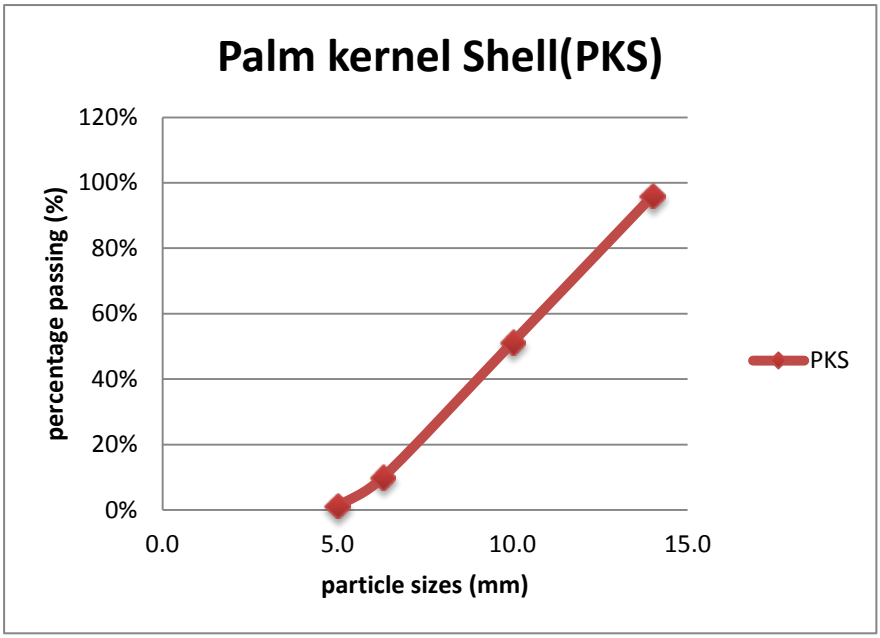

Figure 2. Particle size distribution curves for coarse aggregate (Palm Kernel Shell).

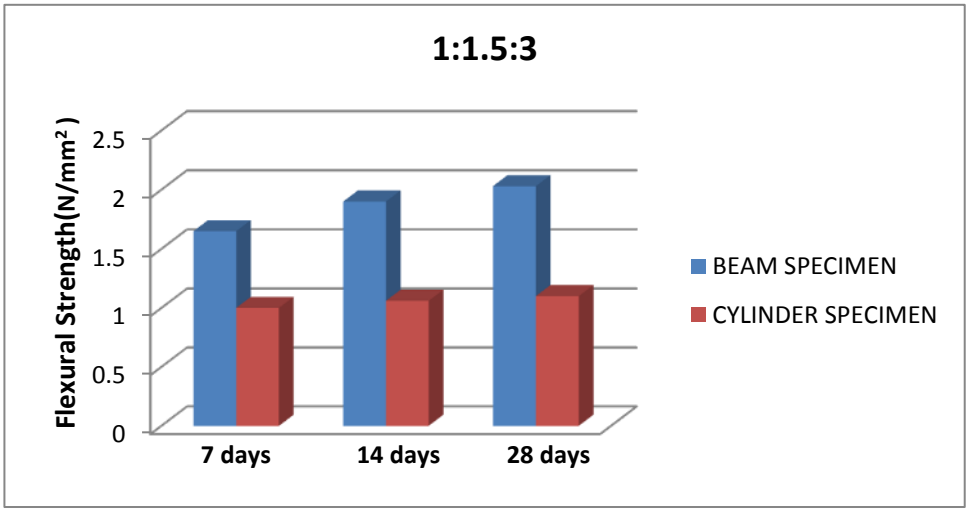

Figure 3 Shows the Average flexural strength of (beam and cylinders) and curing duration for ratio 1:1.5:3.

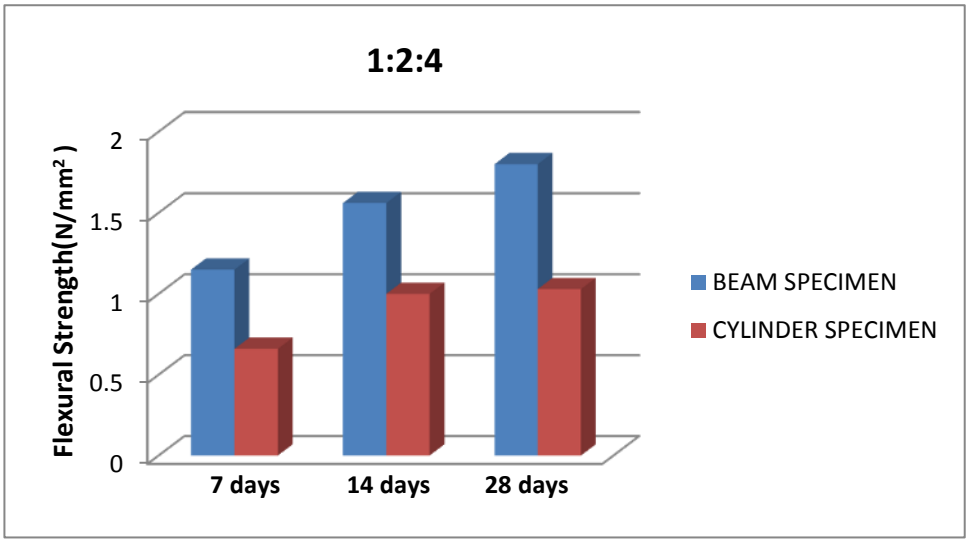

Figure 4 Shows the Average flexural strength of (beam and cylinders) with curing duration for ratio 1:2:4.

Comparison of the flexural strength (direct and indirect method) was done using student T- table method. A T-test is any statistical hypothesis test used in determining if two set of data are significantly different from each other e.g. if the null hypothesis is supported, it was introduced by William Sealy Gosset in 1908.
This was done for 28days strength of the two mix ratios in reference.
Equations used for computation of t-test are as follows:

Mean values $\bar{X} = \frac{\sum \bar{X}_1}{n}, where\ N = 5$

$\bar{X}_1, \bar{X}_2\ are\ the\ beams\ and\ cylinder\ specimen$

Variance $S^2 = \frac{\sum(x-\bar{x})^2}{n}$

Degree of freedom $\sqrt{}$ =N+N-2

Standard deviation $\delta = \sqrt{\frac{N_1S^2+N_2S^2}{(N_1+N_2)-2}}$

T-test equation $[t] = \frac{\bar{x}_1-\bar{x}_2}{\delta\sqrt{\frac{1}{N_1}+\frac{1}{N_2}}}$

Table 1. Comparison of direct and indirect method (ratios 1:1.5:3)

Number	Sample A= X1 (beam specimen)	Sample B=X2 (cylinder specimen)
1	2.00	1.08
2	2.03	1.10
3	1.99	1.10
4	1.94	1.08
5	1.88	1.06
∑	9.84	5.42
$\bar{X}$	2.0	1.08

Table 2. Variance of sample (ratio 1:1.5:3) 28th days strength

NUMBER	SAMPLE A(N1)	$(X-X)^2$	SAMPLE B(N2)	$(9X-X)^2$
1	2.00	9	1.08	15.40
2	2.03	8.8	1.10	15.21
3	1.99	9.06	1.10	15.21
4	1.94	9.40	1.08	15.40
5	1.88	9.70	1.06	15.60
6	∑	45.96	∑	76.72

$s^2_1 = \frac{45.96}{5} = 9.2$

$S^2 2 = \frac{76.72}{5} = 15.3$

Standard deviation $\delta = \sqrt{\frac{5X9.2+5\times15.3}{(5+5)-2}}$ =3.9

Degree of freedom $\sqrt{}$ = 5+5-2 = 8

T-test equation $[t] = \frac{2.0-1.08}{3.9\sqrt{\frac{1}{5}+\frac{1}{5}}} = 0.37$

Using a two tailed test at 0.05 significant level, from student t-table for statistician vol.1, third edition, edited by E.S. Pearson and H.O. Hartley, 1966, p.146
t= -2.306 < t < 2.303, but calculated t = 0.37, hence, Ho is accepted. There is no significant different between sample A and B.

Table 3. Comparison of direct and indirect method (ratios 1:2:4)

Number	Sample A= X1(beam specimen)	Sample B=X2 (cylinder specimen)
1	1.70	1.04
2	1.87	1.02
3	1.80	1.02
4	1.74	1.06
5	1.90	1.00
∑	9.01	6.40
Average $\bar{X}$	1.80	1.03

Table 4. Variance of sample (1:2:4)28th days strength

Number	Sample A(N1)	$X-X^2$	Sample B(N2)	$X-X^2$
1	1.70	10.9	1.04	15.70
2	1.87	9.80	1.02	15.80
3	1.80	10.2	1.02	15.80
4	1.74	10.6	1.06	15.52
5	1.90	9.60	1.00	16.00
6	∑	51.10	∑	78.82

$S^2 1 = \frac{51.1}{5} = 10.22$

$S^2 2 = \frac{78.82}{5} = 15.76$

Standard deviation $\delta = \sqrt{\frac{5X10.22+5X15.76}{(5+5)-2}} = 4.03$

Degree of freedom √ =5+5-2 = 8

T-test equation $[t] = \frac{1.80-1.03}{4.03\sqrt{\frac{1}{5}+\frac{1}{5}}} = 0.30$

Using a two tailed test at 0.05 significant levels, from student t-table for statistician vol.1, third edition, edited by E.S. Pearson and H.O. Hartley, 1966, p.146

t= -2.306 < t < 2.303, but calculated t = 0.30, hence, Ho is accepted. There is no significant different between sample A and B.

ANALYSIS OF RESULT:

THE GRADATION OF PALM KERNEL SHELL (PKS):

The gradation of Palm Kernel Shell (PKS) was obtained from by sieve analysis. This was done by passing PKS through a set of standard sieves and cumulative passing percentages were obtained, the total of about 98% of the PKS used as coarse aggregate passed through sieve 14mm but was retained on 5mm. This conformed to literature, hence PKS are classified as coarse aggregate (BS 882, 2002). Grading of coarse aggregate is necessary in order to get a cohesive and light weight concrete.

THE SLUMP TEST:

The slump test is a means of assessing the consistency and cohesiveness of fresh concrete. It is used indirectly as a means of checking that the adequate amount of water has been added to the mix. The slump test results obtained from the mix designs were in range of 2 – 4 mm as shown in Figure 3 indicating that the mixed ratio of 1:1.5:3 achieved the highest workability

THE SPECIFIC GRAVITY:

The specific gravity [GS] is defined as the density of the material divided by the density of distilled water. The value of specific gravity helps in the computation of the density. The result for the specific gravity value obtained was 3.43

The GS value of palm kernel shell (PKS) value obtained from the test was 1.30, which is smaller compared to a conventional coarse and these result suggest why palm kernel shell concrete are light weight.

COMPRESSIVE STRENGTH:

The average compressive strength increases in curing age from 8.20N/mm^2 and 11.50N/mm^2 at 7th Days strength to 12.30N/mm^2 and 20N/mm^2 at 28th strength for ratio 1:2:4 and 1:1.5:3 respectively. The British code CP 110:1972 lays the minimum strength of concrete for reinforced concrete with light weight aggregate as 15MPa, with mix ratio of 1:1.5:3 is adequate and satisfied the conditions of being classified as light weight aggregate based on its density and compressive strength, while ratio 1:2:4 didn't satisfied the code but can be used for plain concrete, these result also confirms to the result of earlier researchers I.T. Yusuf and Y.A. Jimoh, (2013) who work on properties of palm kernel shell at 100% replacement as coarse aggregate at three different mixed ratio(1:1:2, 1:1.5:3,1:2:4) and their compressive strength was 21.18N/mm^2, 20.10N/mm^2, 13.10N/mm^2 respectively at 28th days.

THE FLEXURAL STRENGTH (BEAM SPECIMEN):

The flexural strength which is the ability of a material to resist deformation under bending loading was carry out in direct and indirect method (beam and cylinder specimen) table 4.31 shown the two results which follow the

trend of the compressive strength with increase in strength with curing duration and with ratio 1:1.5:3 with the highest flexural strength, the result are 1.65N/mm^2 and 1.15 N/mm^2 for 7Days and 2.03N/mm^2 and 1.80N/mm at 28th days for ratio (1:1.5:3and 1:2:4) respectively for the Beam specimen

THE FLEXURAL STRENGTH (CYCLINDER SPECIMEN):

The result of the cylinder specimen (splitting tensile strength) are as followed 1.00N/mm^2 and 0.66N/mm^2 at 7days to 1.10N/mm^2 and 1.03N/mm^2 at 28th days for ratio (1:1.5:3 and 1:2:4) respectively. The result obtained is lower than that of (Oyejobi et al, 2012) when they reported on the flexural strength of palm kernel as coarse aggregate at 100% replacement which was 2.40N/mm^2 and 2.00N/mm^2 at 28th day strength for same mixed reference.

THE COMPARISON OF DIRECT AND INDERCT METHOD OF TESTING FLEXURAL STRENGTH (BEAM AND CYLINDER):

The result obtain from student t-test table at 0.05% level of significant differences shows that at ratio 1:1.5:3 the sample calculated t = 0.37 < 2.306 from t-test tables value and ratio 1:2:4 follows same trends t = 0.3 < 2.306 therefore the Ho is accepted, there is no significant difference between beam and cylinder method in testing flexural strength of concrete.

CONCULSION:

From the table of results the flexural strength for the beam and cylinder specimens at 28 days was 2.03N/mm^2 and 1.80N/mm^2 for the beam specimen and 1.10N/mm^2 and 1.03N/mm^2 for cylinder specimen for mixed 1:1.5:3 and 1:2 :4 respectively. The average compressive strength in table 4.16 showed that the strength increases with curing duration from 8.20N/mm^2 and 11.50N/mm^2 at 7 Days strength to 12.30N/mm^2 and 20N/mm^2 at 28 days' strength for ratio 1:2:4 and 1:1.5:3 respectively. The British code CP 110:1972 lays the minimum strength of concrete for reinforced concrete with light weight aggregate as 15MPa, with mixed ratio 1:1.5:3 being adequate, The PKS specific gravity is 1.3 and impact value 10.13 and the specific gravity of sand used is 2.64, the slump value of the concrete varies between 2mm-4mm for the two mixed ratio. The result obtain from student t-test table at 0.05% level of significant differences shows that at ratio 1:1.5:3 the sample calculated t = 0.37 < 2.306 from t-test tables value and ratio 1:2:4 follows same trends t = 0.3 < 2.306 therefore the Ho is accepted, there is no significant difference between beam and cylinder method in testing flexural strength of concrete

RECOMMENATIONS:

Based on the results obtained in this study from student t-test table at 0.05% level of significant differences it was discovered that the Ho is accepted, there is no significant difference between beam and cylinder method in testing flexural strength of concrete

1. The indirect method can be used in place of the direct method in testing flexural strength of concrete

2. Further work can be done using conventional concrete to ascertain the differences.

3. Further work can be done using different method of testing apart from student t-test.

4. It is recommended that a precise economic analyses is conducted to determine the exact comparative economic advantages and disadvantages of Palm Kernel Shell (PKS) against conventional materials.

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