International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 743-755 www.ijaem.net ISSN: 2395-5252

Partial Replacement of Coarse Aggregate with Palm Kernel Shell in Concrete and the Effect on Strenght

[1]Adebobola T. Olanrewaju, [1]Omoniyi Olaoluwa & [2]Adeniseun Olaoluwa

Department of Civil Engineering, Federal Polytechnic, Ile-oluji, Nigeria

Date of Submission: 05-04-2023 Date of Acceptance: 15-04-2023

ABSTRACT

The cost of concrete materials in building project has been a concern to the society. These and other things led to the research on biological local materials that are dumped as waste in our environment, causing pollution and congestion as substitute materials. Therefore, this research work was carried out in respect to that, in order to determine the use of palm kernel shell as a partial replacement for coarse aggregate in concrete, taken into consideration the compressive strength and water absorption capacity. Preliminary investigation was conducted to ascertain the suitability of using the aggregate for construction work. The tests conducted were the water absorption and compressive test. Mixture ratio of 1:2:4 for cement, sand and coarse aggregate was adopted for this work respectively. The replacement percentage of the coarse aggregate were 50%, 75% and 100%, the mix composition was calculated using the absolute weight method. For each replacement of palm kernel percentage, 32cubes of 150mm×150mm were cast to allow the compressive strength to be monitored at 7, 14, 21 and 28days. The test result shows that concrete proved to have the highest compressive strength at 50% replacement followed by 75% and then 100% replacement. The work also observed that concrete made with 0% replacement was stronger with average compressive strength of 24.02 N/mm^2 on curing for 28days compared to 50% 7.80 N/mm^2, 75% 2.82 N/mm^2 and 100% 1.84 N/mm^{2}haven cured for the same number of days.

Keywords: Effect, palm kernel shell, partial replacement and coarse aggregate.

I. INTRODUCTION

Many aspects of our daily life depend directly or indirectly on concrete. Concrete is prepared by mixing various constituents like cement, sand, aggregates, water, which are economically available (Saravanan et al. 2015).The aggregates typically account about 75% of the concrete volume and play a substantial role in different concrete properties such as workability, strength, dimensional stability and durability. Conventional concrete consists of sand as fine aggregate and gravel, limestone or granite in various sizes and shapes as coarse aggregate. There is a growing interest in using waste materials as alternative aggregate materials and significant research is made on the use of many different materials as aggregate substitutes. Industrial waste materials such as coal ash, blast furnace slag and steel slag and agricultural waste materials such as coconut shell, palm kernel shells etc. have been use by many researchers in replacement of aggregate in concrete for the purpose of recycling industrial and agricultural waste materials. However, palm kernel shells (agricultural waste) were used in this research to produce concrete in a quest for reducing environmental pollution.

Palm kernel shells (PKS) or oil palm shells (OPS) are organic waste materials obtained from crude palm oil producing factories in Asia and Africa (Alengaram et al., 2010). The oil palm industry is important in many countries such as Malaysia, Indonesia and Nigeria. Malaysia is one of the world leaders in the production and export of palm oil and contributes about 57.6% of the total supply of palm oil in the world. Oil palm shells are produced in large quantities by the oil mills. For instance, in Malaysia and Nigeria it was estimated that over 4 million tonnes and 1.5 million tonnes respectively of oil palm shell (OPS) solid waste is produced annually and only a fraction is used for fuel (traditionally used as solid fuels for steam boilers at palm oil mills) and other applications (Shafigh et al., 2011). The main palm oil producing states in Nigeria includesOgun, Osun,Ondo, Oyo, Edo, Cross River, Anambra, Enugu, Imo, Abia, Ekiti, Akwa-Ibom, Delta, Rivers etc.

1.2 Aim and Objectives

The aim of the study is to analyze the strength of concrete made from replacement of coarse aggregate with palm kernel shell.

The objectives of the work are to:

- Examine the concrete with percentage of oil palm shells replacement on wet properties.
- Determine the relationship between densities of concrete and percentage of oil palm shellsreplacement.
- Investigate the relationship between compressive strength of concrete and percentage of oil palm shells replacement.

II. LITERATURE REVIEW

Concrete is a major component of most of our infrastructural facilities today in the 21st century because of its versatility in use. Concrete is used more than any other man made material in the world. Theimportant of concrete in modern society cannot be underestimated according to NBRRI (2009), building failure occur far more frequently during the construction period than in service. Unfortunately,this is the practice in Nigeria even though the construction industry had produced quite some reasonable quantity of trained and experienced professionals specialized in this area of training. The reasons these professional are not being maximally utilized still remain a paradox.

Concrete being a major construction material commonly and regularly used in virtually any type of construction work constitute at least about 40% of the total work. Therefore, it's important and a proper study of its regular production and utilization cannot be over emphasized especially now that its utilization in construction actually is increasingly rising. (Nawy, et al 2008), opined that merely choosing the appropriate constituent material for a particular concrete is necessary but not a sufficient condition for the production of high-quality concrete. Remarking that, the materials must be proportionally correct and the concrete must be mixed, placed and cured properly.

2.1 ConcreteConstituents

Concrete may be defined as a solid mass made by use of cementing medium, generally the ingredients compose of cement, fine aggregate coarse aggregate and water. Concrete has been in use as a building material for more than a hundred and fifty years. Concrete is remarkably strongin compression but it's equally weak in tension. The use of plain concrete as a structural material is limited to situation where significant tensile stresses and strains do not develop among the research of concrete Omar M. et al (2012), all conducted an experimental study to investigate the influence of partial replacement of sand with limestone waste (LSW), as well as marble powder (MP) as an additive on the concrete properties.The replacement proportion of sand with limestone dust was practiced in the concrete mixed with 25%, 50% 75%. Besides proportion of 5%, 10% and 15%, marble powder were practiced in the concrete mixture. The mechanical properties of the concrete were measured at age 28 days for direct tensile, flexural strength, static modulus of elasticity test and permeability test. As for compression strength, it was measured at 7, 28 and 90 days. The study concluded that the workability of the concrete was not affected by the addition of limestone dust to the concrete mixed while the compressive strength increased by 12% after 28 days when using limestone dust up to 50% of sand replacement . The basic constituent of concrete is cement, water and aggregate.

2.1.1 Aggregate

In a concrete the major component in terms of volume is aggregate. In essence concrete is like an artificial rock consist of Aggregate Material bound together by hydrated cement. In any concrete aggregate (fine sand and coarse) usually occupy about 70-75% of the total volume of the concrete mass (Gupta et al. 2004). The aggregate has to be graded so the whole mass of concrete act as a relative solid homogeneous dense combination with the smallest particle acting as inert filler for the voids that exist between the larger particles (Nawy et al, 2008). This therefore suggests that the selection and proportional of aggregate should be given due attention as it not only affect the strength but also the durability of the structural performance of the concrete.

2.1.2 Cement

Cement is any material that hardens and become something adhesive after application in plastic form. Cement is the main constituent of concrete it is a basic ingredient of concrete mortar and plaster. Cement that resists high temperature are called refractory cement.Microsoft Encarta, 2009). This cement has the property of settling and hardening under water by virtue of a chemical reaction with it. Cement consists of aluminate and silicate of lime, it's can be classified into two groups; Natural cement and Portland cement. The

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 743-755 www.ijaem.net ISSN: 2395-5252

natural cement, is a type of cement obtained by burning limestone containing 20-40% clay and crushing its powder, it is brown in nature and set very quickly when mixed with water. Portland cement (PC), this is classified and presented as Portland cement and special cement. The Portland cement is further divided into ordinary PC, rapid hardening and low heat cement. Types of special cement are; quick setting high alumina blast furnace cement among others. Cements when mixed with water wall form a paste that hardens into a strong rigid material. It isthese pastes that fills the voids between aggregate particles and bind them together to formconcrete.

2.1.3 Water

Water in mixing of concrete is the quantity of water that comes in contact with cement, impact slums of concrete and it is used to determine the water to cement ratio (10 per cm) of the concrete mixture strength and durability of concrete is controlled to a large content by its water/cement

2.1.4 Admixtures

They are material mainly liquid that are added to the concrete at the batching stage and modified the property, they are usually added in small concentration. There are number of different type of admixture that is water reducing plasticizing accelerator gas generation water proofing (Shepard and Kenton, 2016).

III. MATERIALS AND METHOD

3.1 Materials

Palm kernel shell used for this research had a maximum size of 15mm and a minimum size of 3mm; the thicknesses of the palm kernel shells (PKS) used vary from 1.5 - 4mm. The medium size particles rangingfrom 5-10mm (consisting of 70% of the total PKS) was used in this study. The PKS was obtained locally from Mr. Akin farm at Idanre in Idanre Local Government Area of Ondo State, Nigeria. The shells were flushed with hot water to remove dust and other impurities that could be detrimental to concrete. They were sun-dried and oven dried at a temperature of 400^0C, crushed and sieved with sieve No 200. Packed in plastic sheets to prevent contact with water. Filler and coarse aggregate were obtained from Civil Engineering Department workshop FEDPOLEL.

Natural river sand free from deleterious materials was obtained from a river line area in Ile-OlujiTown, Ondo State. Ordinary Portland cement manufactured by Dangote Cement Factory conforming to BS 12(1996) was used in the concrete production.

Water used in mixing the materials was from the Federal Polytechnic Ile-oluji borehole. The water looked clean and was free from any visible impurities. It conformed to the requirements of BS 1348 (1980).

Plate 1: Cement


Plate 2: Coarse Aggregate (20mm)


Plate 3: Palm kernel shell Aggregate


Plate 4: Fine Aggregate

3.1.1 Apparatus:

The equipment used for this study were; 150mm x 150mm x 150mm steel moulds; wooden cube that was provide to make enough cube at a time, Compressive Strength Machine (Model 42070,Chandler Eng. USA) which meets the requirement of BS 1881-115; sensitive weighing balance, trowel, curing tank and steel rod.


Plate 5: Sieve


Plate 6: Weighing Balance


Plate 7: Compressive Machine


Plate 8: Cube (150mm X 150mm)

3.2 Method

Specified proportions of each material such as 4% filler of size 0.075mm, 35% quarry stone dust of maximum size 5mm and 6% river sand of maximum size 5mm. The mixture was compacted with 25 blows cube samples for the compressive test, Palm kernel shells were partially replaced at 0%, 50%, 75% and 100% by weight of total coarse aggregate in the mixture. A total of 32 number of 150mm cubes were cast and observed for 7, 14, 21, and 28 curing days. The cubes were weighed and crushed using the Technotest KB 1500kN capacity crushing machine in the Civil Engineering Laboratory of Federal Polytechnic of Ile-Oluji. Each compressive strength is the mean strength of the two (2) cubes. The green concrete was systematically tampered in the steel mould and identification codes were marked on the mouldsfor ease of recognition of the concretes made with similar mixing proportion. The concrete cubes were demoded after 24hours and the ponding technique of curing was adopted. In each case, the cubes were submerged in the curing tank in the entire curing period. The thermal stresses that could lead to

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 743-755 www.ijaem.net ISSN: 2395-5252

cracking was avoided by keeping the curing water at a laboratory temperature of about 28 degree (James, et al.
2011).

3.2.1 Compressive Strength Test

The apparatus for this test consists of cubes (150mm x 150mm), the bullet-nosed rod (600x16mm) and the steel plate and float. The samples are collected and filled in a clean concrete cube. When the cube is half-filled, the concrete is compacted by tapping with a rod 25times. This was also repeated when the cube is filled. After compacting, the cube is put in a cool dry place to sit for at least 24 hours. The concrete cube is then sent to the laboratory where it is cured and crushed to test the compressive strength. Samples were tested at 7, 14, 21 and 28 days.

3.2.2 Experimental Design

This study compressive strength tests on concrete specimen using palm kernel shell replace coarse aggregate and fine aggregate. This partial replacement was done using 0%, 50%, 75% and 100% for both experiments. A constant mix proportion of 1:2:4 and water cement (w/c) ratio of 0.6 was employed for all concrete mixtures used in this research study.

3.2.3 Concrete Batching

Mixing and curing the concrete components (coarse aggregate, fine aggregate, palm kernel shell, and cement) were thoroughly mixed together using 1:2:4 design mix, after which water at 0.6 water-cement ratio was added. The aggregates were prepared in accordance with the requirements of BS 1017. The concrete specimens produced from both methods were cured in a curing tank and subjected to two tests; workability and compressive strength at 7, 14, 21 and 28 days.

IV. RESULTS AND DISCUSSION

4.1 RESULTS

The compressive strength recorded for each of the cube, the result was presented in table1 and a chart is used to represent the percentage of each of the cube

Compressive strength of concrete (N/mm^2) is given by dividing Area of cube by Maximum load at failure get when crushing.

Compressive Strength of concrete (N/mm^3) = $\frac{\text{maximum load at failure P (N)}}{\text{Area of cube (mm)}}$

Area of cube = 150mm X 150mm = 22,500mm^2

Volume =150mm X 150mm X 150mm = 3,375,000mm^3

Table 1 below, shows the mixing proportion of 1:2:4 of Cement, Coarse Aggregate and Fine Aggregate respectively, showing the volume of the constituents used for mixing.

Table1: Mix proportion for 1:2:4 concrete mix

Mix design (%)	Concrete Volume (m^3)	Cement (kg)	Water (kg)	FA (kg)	CA (kg)	PKSA (kg)
0	0.003475	17.4842	9.24	40.25	82.10	0.00
50	0.003475	17.4842	9.24	40.25	41.05	41.05
75	0.003475	17.4842	9.24	40.25	20.53	20.53
100	0.003475	17.4842	9.24	40.25	0.00	82.10

Table 2 shows the result of water absorption for 7days in which the full aggregate (0%) gives 3.48, 50% gives 3.56, 75% gives 4.84 while 100% gives 4.88, the result indicate that concrete absorb high water the more the replacement proportion.

Table 2: Water absorption capacity of the casted concrete at different percentage replacement after 7days curing

Cube no.	% Replacement of Coarse aggregate	weight before immersion (kg)	weight after immersion (kg)	absorption gain (kg)	% gain in moisture	average % gain in moisture
$G7_1$	0%	7.2	7.5	0.3	4.17	3.48
$G7_2$		7.2	7.4	0.2	2.78	
$P7_1$	50%	5.7	5.9	0.2	3.51	3.56
$P7_2$		5.6	5.8	0.2	3.60	
$B7_1$	75%	5.1	5.3	0.2	3.90	4.84
$B7_2$		5.2	5.5	0.3	5.78	
$S7_1$	100%	4.2	4.4	0.2	4.88	4.88
$S7_2$		4.2	4.4	0.2	4.88	

Table 3 shows the result of water absorption for 14days in which the full aggregate (0%) gives 3.85, 50% gives 5.09, 75% gives 3.71 while 100% gives 3.39, the result indicate that concrete absorb high water at 50% of proportion.

Table 3 Water absorption capacity of the casted concrete at different percentage replacement after 14days curing

Cube no.	% Replacement of Coarse aggregate	weight before immersion (kg)	weight after immersiongain (kg)	absorption (kg)	% gain in moisture	average % gain in moisture
$G14_1$	0%	7.5	7.8	0.3	4.00	3.85
$G14_2$		7.4	7.6	0.2	2.70	
$P14_1$	50%	5.8	6.1	0.3	5.17	5.09
$P14_2$		6.0	6.3	0.3	5.00	
$B14_1$	75%	5.5	5.7	0.2	3.64	3.71
$B14_2$		5.3	5.5	0.2	3.77	
$S14_1$	100%	4.4	4.6	0.2	4.55	3.39
$S14_2$		4.5	4.6	0.1	2.22	

Table 4, shows the result of water absorption for 21days in which the full aggregate (0%) gives 3.25, 50% gives 4.12, 75% gives 3.57 while 100% gives 3.57, the result indicate that concrete absorb high water the more the replacement proportion

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 743-755 www.ijaem.net ISSN: 2395-5252

Table 4. Water absorption capacity of the casted replacement after 21days curing

Cube no.	% Replacement of Coarse aggregate	weight before immersion (kg)	weight after immersion (kg)	absorption gain (kg)	% gain in moisture	average % gain in moisture
$G21_1$	0%	7.7	7.9	0.2	2.59	3.25
$G21_2$		7.7	8.0	0.3	3.90	
$P21_1$	50%	6.0	6.3	0.3	5.00	4.12
$P21_2$		6.2	6.4	0.2	3.23	
$B21_1$	75%	5.6	5.8	0.2	3.57	3.57
$B21_2$		5.6	5.8	0.2	3.57	
$S21_1$	100%	4.5	4.7	0.2	4.44	5.55
$S21_2$		4.5	4.8	0.3	6.66	

Table 5, shows the result of water absorption for 21days in which the full aggregate (0%) gives 3.15, 50% gives 4.69, 75% gives 3.42 while 100% gives 3.04, the result indicate that concrete absorb high water the more the replacement proportion.

Table 5: Water absorption capacity of the casted replacement after 28days curing

Cube no.	% Replacement of Coarse aggregate	weight before immersion (kg)	weight after immersion (kg)	absorption gain (kg)	% gain in moisture	average % gain in moisture
$G28_1$	0%	7.9	8.2	0.3	3.79	3.15
$G28_2$		8.0	8.2	0.2	2.50	
$P28_1$	50%	6.4	6.6	0.3	4.69	4.69
$P28_2$		6.4	6.6	0.3	4.69	
$B28_1$	75%	5.8	6.0	0.2	3.45	3.42
$B28_2$		5.9	6.1	0.2	3.39	
$S28_1$	100%	5.0	5.2	0.2	4.00	3.04
$S28_2$		4.8	5.3	0.1	2.08	

Table 6: Compressive strength test for 7days (0% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	7.5	3,375,000	2.2×10^{-6}	22,500	342,000	15.20	15.36
2.	7.4	3,375,000	2.19×10^{-6}	22,500	368,100	16.36	

Table 7: Compressive strength test for 7days (50% replacements)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	5.9	3,375,000	1.7×10^{-6}	22,500	102,600	4.56	4.56
2.	5.8	3,375,000	1.7×10^{-6}	22,500	102,600	4.56	

Table 8: Compressive strength test for 7days (75 % replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	5.3	3,375,000	1.6×10^{-6}	22,500	32,625	1.45	1.50
2.	5.5	3,375,000	1.6×10^{-6}	22,500	34,875	1.55	

Table 9: Compressive strength test for 7days (100% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	4.4	3,375,000	1.3×10^{-6}	22,500	20,250	0.90	0.95
2.	4.4	3,375,000	1.3×10^{-6}	22,500	22,500	1.00	

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 743-755 www.ijaem.net ISSN: 2395-5252

Table 10: Compressive strength test for 14days (0% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	7.8	3,375,000	2.3×10^{-6}	22,500	399,600	17.76	17.50
2.	7.6	3,375,000	2.2×10^{-6}	22,500	387,900	17.24	

Table 11: Compressive strength test for 14days (50% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	6.1	3,375,000	1.8×10^{-6}	22,500	138,380	6.15	6.15
2.	6.3	3,375,000	1.9 x 10-6	22,500	138,380	6.15	

Table 12: Compressive strength test for 14days (75% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	5.7	3,375,000	1.7×10^{-6}	22,500	41,625	1.85	1.87
2.	5.5	3,375,000	1.6×10^{-6}	22,500	42,525	1.89	

Table 13: Compressive strength test for 14days (100% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	4.6	3,375,000	1.4×10^{-6}	22,500	22,950	1.02	1.02
2.	4.6	3,375,000	1.4×10^{-6}	22,500	22,950	1.02	

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 743-755 www.ijaem.net ISSN: 2395-5252

Table 14: Compressive strength test for 21days (0% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	7.9	3,375,000	2.3×10^{-6}	22,500	450,000	20	20.05
2.	8.0	3,375,000	2.4 x 10-6	22,500	472,500	21	

Table 15: Compressive strength test for 21days (50% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	6.3	3,375,000	1.9×10^{-6}	22,500	161,780	7.19	7.19
2.	6.4	3,375,000	1.9×10^{-6}	22,500	161,780	7.19	

Table 16: Compressive strength test for 14days (75% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	5.8	3,375,000	1.7×10^{-6}	22,500	40,500	1.88	1.87
2.	5.8	3,375,000	1.7 x 10-6	22,500	41,850	1.86	

Table 17: Compressive strength test for 21days (100% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	4.7	3,375,000	1.4×10^{-6}	22,500	28,800	1.28	1.34
2.	4.8	3,375,000	1.4×10^{-6}	22,500	31,500	1.40	

Table 18: Compressive strength test for 28days (0% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	8.2	3,375,000	1.8×10^{-6}	22,500	540,450	24.02	24.02
2.	8.2	3,375,000	1.8×10^{-6}	22,500	540,450	24.02	

Table 19: Compressive strength test for 28days (50% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	6.6	3,375,000	2.0×10^{-6}	22,500	177,750	7.90	7.80
2.	6.6	3,375,000	2.0×10^{-6}	22,500	182,250	8.10	

Table 20: Compressive strength test for 28days (75% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	6.0	3,375,000	1.8×10^{-6}	22,500	63,000	2.80	2.82
2.	6.0	3,375,000	1.8×10^{-6}	22,500	63,900	2.84	

Table 21: Compressive strength test for 28days (100% replacement)

S/N	Mass (kg)	Volume (m^3)	Density (Kg/mm^3)	Area of cube (mm^2)	Load (N)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1.	4.2	3,375,000	1.2×10^{-6}	22,500	41,400	1.84	1.84
2.	5.3	3,375,000	1.6 x 10-6	22,500	41,400	1.84	

4.2 DISCUSSION

4.2.1 Compressive strength

Compression cube test is used to determine the mechanical strength of concrete to sustain the axial force applied on the surface of concrete. Compressive strength is the major parameter which influences other properties of concrete such as flexural strength, splitting tensile strength and modulus of elasticity. To evaluate the effect of replacement of palm kernel shell as coarse aggregates on the compressive strength of concrete plain control concrete is compared with five concrete batch mixes containing different percentage of palm kernel shell aggregates (PKSA). The average compression strength for all batches was summarized in Table 22. The data was plotted and shown in Figures below.

Table 22: Compressive Strength Result

Age at testing (days)	Palm kernel shell replacement (%)			
	0	50	75	100
7	15.78	4.56	1.50	0.95
14	17.50	6.15	1.87	1.02
21	20.05	7.19	2.29	1.34
28	24.02	7.80	2.82	1.84

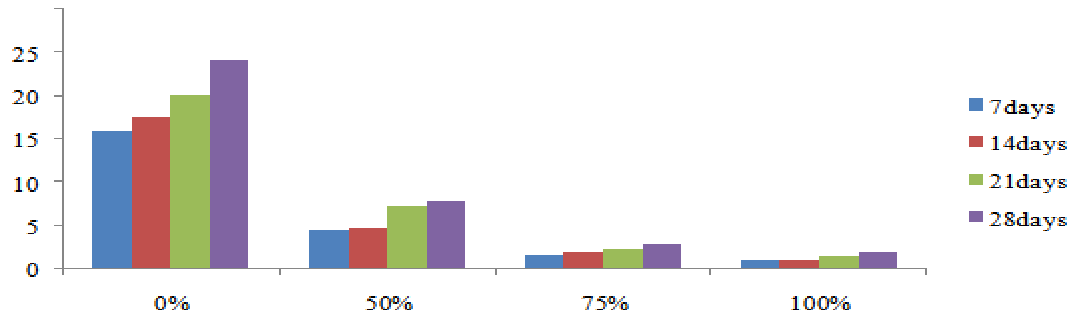

Figure 4.1: Compressive strength of 7day, 14days, 21days and 28days

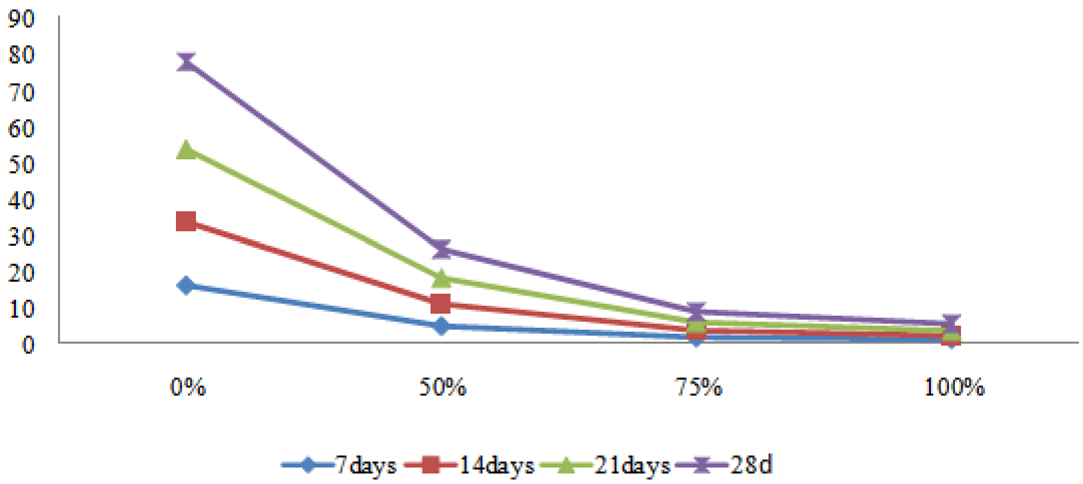

Figure 4.2: Compressive strength of 7day, 14days, 21days and 28days.

In general, the compressive strength of all mixes increases steadily with respect to curing age. At 28days, compressive strength of concrete specimen with natural fine and coarse aggregate (control specimen) was 24.02 N/mm^2. On the other hand, the compressive strength test how an increment in the compressive strength of the cube as the day's increases with 28 days recording, the highest value The progressive increase in compressive strength shows that the palm kernel shell aggregate doesn't undergo deterioration once the shells have been imbedded in concrete.

V. CONCLUSION

Judging by the results obtained from the tests conducted, it can be concluded that Palm kernel shells can be used as partial replacement for coarse aggregate up to 50% for light concrete works, mostly in areas where the soil is well stable. This will go a long way into reducing construction and maintenance costs of these building and will also reduce the depletion of scarce coarse aggregate.The use of palm kernel shells as a building construction material will encourage the rural dwellers to plant more palm trees, thereby empowering them economically.

REFERENCES

[1]. Alengaram U. J., Hilmi M. &Zamin J.(2010).Comparison of mechanical and bond properties of oil palm kernelshell concrete with normal weight concrete. Int J PhysSci; 5(8):1231–9.

[2]. Chudley R, Greeno R (2008).Building Construction Handbook. Sixth Edition Butterworth-Heinemann

[3]. Gupta, Neville and Brooks (2004).Materials for various construction purpose".

[4]. Microsoft Encarta, (2009). Chemistry Microsoft Encarta 2009 (DVD). Redmond WA: Microsoft Corporation, U.S.A. 2008

[5]. Nawy G.E. (2008).Fundamentals of high performance concrete. J. Wiley & Sons. NY 214; NBRRI (2009). Nigeria Building and Road Research institute

[6]. Omar M., AbdElhameed&Sherif HBRC.(2012).Experiment investigation on the effect of partial replacement of sand byPalmKernel Shell as Coarse Aggregate, Journal of Building and Environment 41(3):297-301;Publications, 30, Corporate Drive

[7]. SaravananT., Balamonica C., Bharathi P., Gopalakrishnan N. & Murthy S. (2015). Embedded piezoelectric transducers based early-age hydration monitoring of cement concrete added with accelerator/retarder admixtures. Journal of Intelligent Material Systems and Structures; Volume 32, Issue 8

[8]. ShafighP., Jumaat MZ & Mahmud H. (2011). Palm kernel shell as a lightweight aggregate in concrete. Building and 2005quarry dust in plain cement concrete for different mix proportion "page 812 – 817.Replacement on Densities and compressive strength of concrete

[9]. Shepard and Kenton (2016).Comparison of Mechanical and Bond Properties of Palm KernelShell:Technology;101(July (13):4834–41