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Affordable housing issue: Experimental investigation on properties of eco-friendly lightweight concrete produced from incorporating periwinkle and palm kernel shells

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A R T I C L E I N F O

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A B S T R A C T

In recent times, sustainable production of concrete is now considered a major issue due to continuous depletion of raw resources. Thus, this current study investigates the physical and strength performance of eco-friendly concrete produced with the combination of periwinkle (PWS) and palm kernel shells (PKS) used as an alternative for granite. Two mix ratios of 1:2:4 and 1:1.5:3 (cement: sand: granite) were considered with a 28-day target strength of 20 N/mm^2 and 25 N/mm^2, respectively. A total number of 144 cubes were produced with PWS and PKS was used as partial replacement for granite in the concrete mixes considered. Physical properties of the materials were determined, while the hardened concrete samples were tested for their density and compressive strength. Obtained results showed that both PWS and PKS are lightweight materials compare to granite, thus significantly influence the concrete density. The results revealed a decreasing trend in the strength development for the mixes. The compressive strength decreases as the combined content of PWS and PKS increases in the concrete mixes. However, concrete containing PWS and PKS produced from mix-ratio of 1:1.5:3 exhibited some comparable strength compare to the control. The results showed that PWS and PKS can be combined equally and used in the production of lightweight concrete at an optimum of 5%. This implies that low-cost lightweight concrete can be produced using a combination of palm kernel and periwinkle shells, thus helping to provide affordable housing and also preserving raw materials.

1. Introduction

Concrete is known to be one of the most used construction components [1], because it aid the rapid growth of infrastructural facilities due to its strength and ability to be made in different forms, shapes, and sizes Ogundipe et al. [2]. It is a composite material made from cement, water, fine and coarse aggregates [3]. Meanwhile, researchers has always focus on means of improving the properties of concrete to meet the construction demands as well as conserve the raw resources [4]. Aggregates are known to be one of the major constitute that contribute to strength performance of concrete in resisting compression forces in structures (Unnikrishna and [5]. As such, concrete is known to be the preferred choice of construction materials [6]. As also noted in the study of Bhavya and Sanjeev [7] that aggregates account for up to 75% of the total volume of concrete. Though they are classified into two groups: fine and coarse aggregates. River sand and stone dust are the most used material for fine aggregate in concrete production, while granite and gravel constitute the best choice of coarse aggregates available for concrete production in the construction industry [8,9].

However, the high cost of producing concrete as a result of the cost of conventional materials has always been an issue of concern, thereby hindering the effort of many low-income earners towards affordable housing provisions [2]. According to Ezeigwe [10]; one of the main challenges of housing in Nigeria is affordability. Ghaffar et al. [11] noted that affordable housing and energy conservation are among the current issues in the construction industry. Notably, the money spent on

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procuring materials which are always on increase figure. Thus, the possibility of affordable housing will required that paradigm shift from total dependence on the use of conventional materials to non-conventional materials. Similarly, the additional advantage of this shift will be the possible conservation of the natural resources [8]. It was opined by Sankh et al. [12] that the time is now to begin seeking for alternative materials that could be used in place of traditional materials to avert the potential of geological harm posed by long term blasting of rocks and dredging of seas.

In light of these stated backgrounds, attention of many researchers have been drawn to multiple wastes that could be used in an eco-friendly manner for sustainable housing production. A study by Atoyebi et al. [3]; noted that Nigeria generated large volume of wastes from different sources, thus the need for improve strategy and awareness for an effective waste management practices. This will eradicate the indiscriminate dumping of wastes on roadways, motor parks, trailer parks, uncompleted buildings or abandoned industrial, commercial, or residential buildings [13,14]. As stated by Imam et al. [15] that the traditional means of disposing of solid waste in most part of the country is either by buried or left to pile in heaps. Thus researchers like Stein [16]; Sudan [17], and Sonia [18], suggested the option of recycling of these wastes into new products or raw materials as a means of reducing its environmental impact and resources depletion.

Some of these wastes can be recycled as alternative building materials. In recent times, attention of several researchers have been drawn to some of these agricultural wastes (such as palm kernel and coconut shells) and marine waste (such as periwinkle and oyster shells) that can be developed as component materials for the conventional building materials [19,20]. For example, periwinkle snail is an edible sea-food that is available in some coastal countries including Nigeria (Dauda et al., 2018). The shells appear in "V" like spiral shape, though it is brittle but very strong in texture. After the consumption of the edible snail, the shells becomes a waste product that is mostly discarded becoming environmental concern. Many research efforts has been noted on the best alternative ways the shells could be reuse for different construction and engineering purposes. Studies by Agbede and Manasseh [21]; Otunyo et al. [22] and Soneye et al. [23] assessed the beneficial reuse of periwinkle shells as substitute material in place of fine and coarse aggregates in concrete and sandcrete block production, while Dauda et al. [24] in their study explored the pozzolanic potential of the periwinkle shells as stabilizing agent for lateritic soil. Soneye et al. [23] maintained that 30% replacement of coarse and fine aggregate with PWS gave an adequate compressive strength. A recent study by Odeyemi et al. [19] combined both the sawdust and periwinkle shells to produced particle boards of quality strength. Ogundipe et al. [25] also noted that periwinkle shells could be combined with other agro-wastes; such as palm kernel or coconut shells in concrete production.

In the same vein, palm kernel shells (PKS) are an agro-waste material obtained after the extraction of palm oil by crushing of the nut in the oil mill [26,27]. PKS is the hard-core shell (endocarp) portion left-over as residues. The palm trees are grown mainly in tropical regions of African and Asian countries such as Ghana, Nigeria, Malaysia, Brazil and so on, and large quantities of these palm kernel shells are mostly generated in areas where the processing of palm oil are available [28]. Ikubanni et al. [20] mentioned that PKS constitutes a significant portion of solid waste from oil palm processing. Most African homes used palm kernel shell residue mostly with firewood for domestic cooking, while to some others the shells are piled up as waste products adding to environmental pollution [29]. Various studies have investigated the beneficial utilization of PKS in the areas of biomass and bio-fertilizer applications, water purification, energy storage, concrete reinforcing additives, supercapacitor electrode, advance materials development, and so on [20,30–33].

A study by Prusty et al. [34]; reported on the beneficial reuse of agro-waste materials as sustainable replacement for conventional aggregates in concrete; or deployed as a stabilizing materials for soil [35,36] in the provision of sustainable infrastructures. Studies by Olanipekun et al. [28] and Osei and Jackson [37] observed that when palm kernel shells are used as partial replacement for coarse aggregate in concrete production, the strength of such concrete gradually increases as the age of concrete progresses. Furthermore, Olusola and Babafemi [38] reported a value of 18.13 MPa for lightweight concrete produced at optimum 50% PKS replacement for coarse aggregate. Also, a study by Olusola and Babafemi [38] suggested that a suitable lightweight concretes could be achieved at 25% replacement of coarse aggregate with PKS. Recently, Salawu et al. [30] examined the performance of pulverized organic carbon PKS and egg shell on the strength properties of grey cast iron material, while Ikubanni et al. [20] in their study highlights the presence of strengthening oxides like the silicon compound in PKS residue. Meanwhile, in the realization of the goals 9 and 11 of the Sustainable Development Goals (SDGs), researchers like Joshua et al. [39] recommended the use of 10% palm kernel nut ash (PKNA) as partial replacement for Portland cement in concrete. Abinaya and Prasanna [40], studied the structural performance of self-compacting concrete containing different percentages of oyster shell powder as cement replacement and concluded that 5% replacement of cement with oyster shell powder gave the optimum performances. Soneye et al. [23] noted in their study of the need to embrace the use of sustainable building materials that are locally available and affordable for housing production. These according to Soneye et al. [23] will go a long way in addressing housing deficits been experienced in some low-income countries due to the high cost of production. It will also be in line with the goal 9 and 11 of the SDGs, which encourage the use of non-conventional building materials in ensuring affordable housing for all and protecting the climate.

The use of Agro and marine wastes such as PWS and PKS have the potential of lowering the cost of housing production; thus providing a useful relief to the authorities towards producing mass and affordable housing units. This current study investigated the physical and mechanical properties of lightweight concrete, by incorporating palm kernel and periwinkle shells at equal percentage as partial replacement for granite up to 50%. With a view of providing mass and sustainable buildings as indicated in SDGs 9 and 11 goals, which borders the provision of sustainable infrastructure and development. Reducing the dead weight is very important in the construction industry, thus the industry has a huge preference for efficient lightweight concrete. Some of the advantages of lightweight concrete include good thermal insulation, cost saving and time reduction in terms of production and handling [41].

2. Materials and method

2.1. Materials

The sample of granite (Ge) and river sand (RS) shown in Fig. 1(a) and (b) used for this research was procured from the quarry site in Abeokuta, Ogun State, and the materials complied with BS EN 1997:1 [42]. Also, palm kernel and periwinkle shells shown in Fig. 2(a) and (b) used for the study came from Badagry, Lagos State, Nigeria. Dangote Ordinary Portland Cement (OPC) brand of grade 42.5 N was procured from vendor shop at Ota town, in Ogun State also meet [43] standard. However, this study used portable water from Covenant University, Ota, which met the requirement of BS EN 100 [44]. The chemical compositions of the cement, PKS and PWS materials used in this study was determined using the non-destructive X-ray fluorescence (XRF) analyser (TEFA ORTEC automatic X-ray F).

2.2. Methods

The study adopted 150 mm^3 concrete mould, and the design mix of 1: 1½: 3 for (M25) concrete and 1: 2: 4 for (M20) concrete BS5328-2 [45]. It was batched by volume and the equivalent weight in kg/m^3 was calculated because both the periwinkle shells (PWS), and palm kernel shells weigh lesser than granite (Ge). 0.5, 0.55 and 0.60 water/cement ratio

Fig. 1. (a) Granite (coarse aggregate; (b) River sand (fine aggregate).

Fig. 2. (a) Periwinkle shells; (b) Palm kernel shells.

was adopted for the experiment according to percentage replacement of PKS and PWS see Table 1. This research used 25% palm kernel (PKS), and 25% periwinkle shells (PWS) as coarse aggregate with 50% of granite (Ge) to determine the strength parameters in the concrete production. Before the start of the experimental process, palm kernel and periwinkle shells were washed with warm water to filter out particles from the palm

Table 1
Proportion of concrete mixtures.

Concrete mixtures		Cement (Kg/m^3)	River sand RS (Kg/m^3)	Coarse Aggregate (Kg/m^3)			Water (Kg/m^3)	Water/Cement ratio
				PWS	PKS	Granite (Ge)		
Control	1:2:4	15.46	38.33	0	0	62.22	7.73	0.50
5% PKS, 5%PWS, 90% G	1:2:4	15.46	38.33	3.11	3.11	56.00	7.73	0.50
10% PKS, 10%PWS, 80%Ge	1:2:4	15.46	38.33	6.22	6.22	49.78	7.73	0.50
15%PKS, 15%PWS, 70%Ge	1:2:4	15.46	38.33	9.33	9.33	43.52	7.73	0.50
20% PKS, 20%PWS, 60%Ge	1:2:4	15.46	38.33	12.44	12.44	37.33	9.28	0.60
25%PKS, 25%PWS, 50%Ge	1:2:4	15.46	38.33	15.56	15.56	31.11	9.28	0.60
Control	1:1.5:3	15.46	30.66	0	0	46.61	7.73	0.50
5%PKS, 5%PWS, 90%Ge	1:1.5:3	15.46	30.66	2.33	2.33	41.96	7.73	0.50
10%PKS, 10%PWS, 80%Ge	1:1.5:3	15.46	30.66	4.66	4.66	37.29	7.73	0.50
15%PKS, 15%PWS, 70%Ge	1:1.5:3	15.46	30.66	6.99	6.99	32.63	7.73	0.50
20%PKS, 20%PWS, 60%Ge	1:1.5:3	15.46	30.66	9.32	9.32	27.97	8.50	0.55
25%PKS, 25%PWS, 50% Ge	1:1.5:3	15.46	30.66	11.65	11.65	23.31	8.50	0.55

Fig. 3. Compression testing machine.

kernel shells and periwinkle snail from the shells. Both shells were later dried in the sun before being batched manually and mixed for concrete production. The concrete materials were manually batched, mixed, and produced. The concrete cubes were cured by complete emersion in water throughout the crushing age.

Grain size distributions test was in accordance with [46]; water absorption complied with BS EN ISO 10545 [47]; loose and rodding bulk density were carried out to determine the physical properties' of the samples. 144 numbers of 150 mm^3 concrete cubes were cast in three layers, and each layer was mechanically vibrated in order to eliminate the pore spaces within the concrete cubes. Subsequently, the compressive strength test were conducted at age 7, 14, 21, and 28 days. The water absorption tests was carried out on the samples at age 28 days. The experimental process also takes into consideration the precautions noted in Refs. [48,49]. The study ensures that aggregate used for the research is well-graded and useful for concrete production. However, Soneye et al. [23], established the fact that though PKS and PWS are not uniformly graded that doesn't make them un-useable for concrete production. The apparatus and tools used for the experiments include digital sieve shaker, digital weighing balance, Thermostical oven, and digital compression testing machine Model YES-2000, 2000 KN Max. Capacity, manufactured in the year 2010 (Fig. 3), 150 mm^3 steel mould, wheelbarrow, head pan, shovel, vibrating table, and curing tank.

3. Results and discussion

3.1. Physical properties and chemical composition

The results in the Table 2 below showed values obtained for the specific gravity (SG) and water absorption (WA) tests for the river sand (2.62; 3.65%), periwinkle shells (1.38; 5.67%), palm kernel shells (1.51; 8.7%) and granite (2.66; 3.83%) respectively (see Table 1). The water absorption figures indicate the percentage of porosity in the aggregates, and also help to design the best water-cement ratio for the concrete design mix using these materials. The results of the specific gravity of granite (2.66) and river sand (2.62) falls within the specified standard of 2.5–3.0 [47]. Also, the (SG) obtained for periwinkle shells (1.38), and palm kernel shells (1.38) are lesser than the specified standard 2.5–3.0 [47]. As noted in Olanipekun et al. [28] and Olusola, and Babafemi [38]; both PKS and PWS could be considered as a lightweight aggregate for concrete production.

Table 2
Specific gravity and water absorption.

Physical properties	Granite	Palm kernel shells	Periwinkle shells	Sand
Aggregate Size (mm)	20	20	20	4.75
Specific Gravity (SG)	2.66	1.51	1.38	2.62
Water absorption	3.83	8.7	5.67	3.65

Table 3
Properties of fine aggregate.

Aggregate properties	Unit	Fine aggregate
Particle size	Mm	4.75
Specific gravity values		2.62
Loose bulk density	kg/m^3	1.398
Rodded bulk density	kg/m^3	1.582
%Void in aggregate (G_S-R/R*100%);	%	46.64

There is an average of 1.398 kg/ltr loose bulk density in the river sand, and average of 1.582 kg/ltr rodded bulk density as shown in Table 3. The rodded bulk density received 25 strokes of tapping rod at three different layers, and it was distributed evenly on the river sand filled into the measurement bucket. Therefore, the bulk density of the river sand increased by 11.635% after rodded. The result fall within the 1520–1680 kg/ltr, expected for fine aggregate used in concrete production as stated in Ref. [50]. The result tabulate in Table 3 showed that the river sand used for this experimental study has 46.64% of the void. This showed that the river sand used for this research work satisfied the required standard. Because the percentage of void present in the of river sand fall within the expected void of 45%–50% for normal well-grade class of fine aggregate as recommended by Ref. [50].

Fig. 4 depicts the oxides compound presence in the PKS and PWS materials compare to the ordinary Portland cement (OPC). The PKS contain SiO2 (45.7%), Fe2O3 (33.9%), Al2O3 (8.3%), MgO (0.55%), and CaO (3.07%), while the PWS SiO2 (31.1%), Fe2O3 (4.21%), Al2O3 (8.3%), MgO (0.76%), and CaO (53.1%). The findings suggest that both PKS and PWS contains relative high content of silica compare to cement, while the calcium oxide content in cement and PWS are relatively high compare to PKS. The chemical compositions of the material did not reveal the presence of any toxic elements. Meanwhile, a related study by Ohimain et al. [51] reported that palm kernel shells does not leach to produce toxic substances into the environment once the shells are bound in the cement matrix. It is expected that both PKS and PWS can be used as granite replacement in concrete without leaching any harmful substances into the environment [52].

3.2. Particle size distribution (PSD)

The grain size distributions indicated in Table 4 and Fig. 4 from the

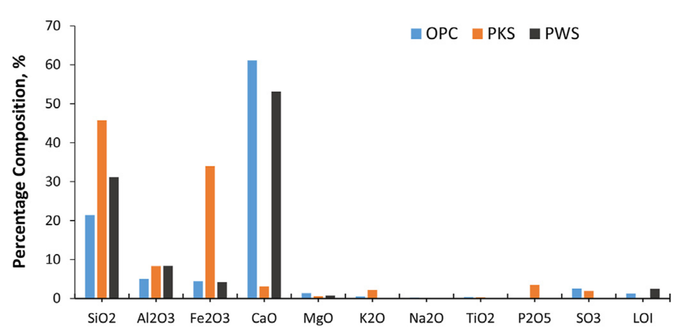

Fig. 4. Chemical content (%) of the OPC, PKS and PWS.

Table 4
Particle size distribution of aggregate samples.

Specimens	D_{10}	D_{30}	D_{60}	C_u	C_c	USCS classification	
						Group symbol	Group name
River Sand	0.16	0.49	2.75	17.18	0.58	SW	Well graded
Granite	3.02	6.05	13.05	4.32	0.93	GW	Well graded
PKS	9.85	10.51	15.35	1.56	0.73	GP	Poorly graded
PWS	9.95	10.59	15.45	1.55	0.73	GP	Poorly graded

Cu = D60/D10, while Cc = (D30)2/D10*D60.

experimental procedures revealed the following. 0.58 coefficients of curvature (C_C) and 17.18 coefficients of uniformity (C_U) for river sand; 0.93 C_C and 4.32 C_U for the granite; Periwinkle has 0.73 C_C and 1.55 C_U, while Palm kernel has 0.73 (C_C) and 1.56 (C_U). Therefore, both the granite and river sand used for this study are well graded because the coefficients of curvature recorded are 0.58 and 0.93 C_C, respectively. These indicate a good grains distribution of aggregate recommended for concrete works in Vandevelde [53]; Ogunbayo et al. [54]; and Ogunbayo et al., [55]. The result of the particle size distributions analysis based on Fig. 5 and Table 4 further proves the suitability of both the fine and coarse aggregates used for this study. Moreover, as shown in Table 4, the river sand according to the unified soil classification system (USCS) as postulated in ASTM Standard [46] is uniformly graded and can be classified as a well-graded sand (SW) since the C_U (17.18) which is $\geq$ 6 and Cc (0.58) is less than 1$\leq$ or $\leq$ 3. Also, based on the USCS as postulated in ASTM Standard [46]; the granite used for the study could be adjudged as a well and uniformly grade gravel since Cu (4.32) is $\geq$ 4 and Cc (0.93) is less than 1$\leq$ or $\leq$ 3.

However, both the C_U and C_C for periwinkle and palm kernel shells showed that these two materials are poorly graded. The changes noticed in the grain size distribution, influenced the properties of concrete. PKS and PWS shows average co-efficient of curvature which could probably help in producing homogeneity concrete at hardened stage. This supported the outcome of Soneye et al. [23] study that poorly graded status of PKS and PWS does not make them un-useable in concrete production.

3.3. Density

The results of the concrete density presented in Figs. 6 and 7 revealed how the concrete density increases as the age of the concrete progress.

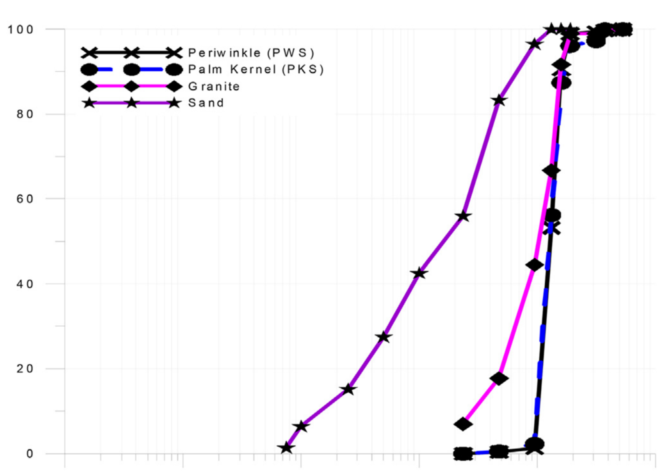

Fig. 5. Particle size distributions for the River Sand (RD) granite (Ge), periwinkle shells (PWS), and palm kernel shells (PWS).

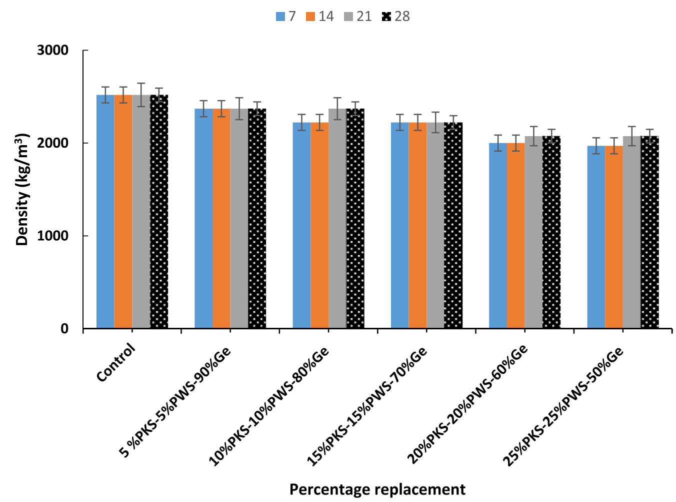

Fig. 6. Density of concrete produced with granite, PKS and PWS for mix 1:2:4.

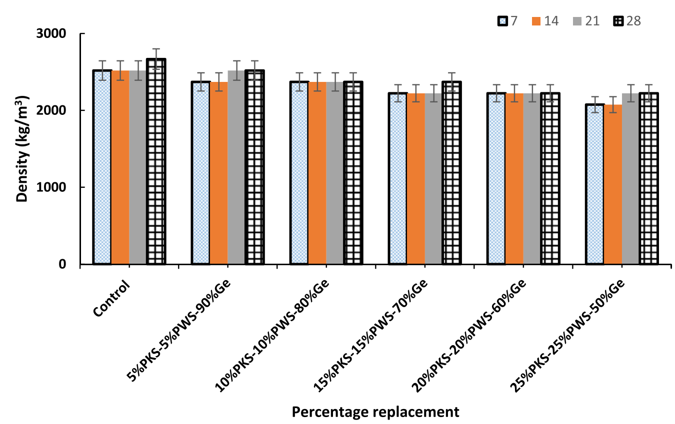

Fig. 7. Density of concrete produced with granite, PKS and PWS for mix 1:1.5:3.

However, the control cubes for the design mix of 1:2:4 maintained the same average density of 2516 kg/m^3 from 7 to 28 days. The design mix of 1:1.5:3 maintained an average density of 2516 kg/m^3 from 7 to 21 days, and on the 28 days, the density increase to 2666 kg/m^3 of the concrete. Also, slight decreases were noted in the density of concrete as the percentage replacement of Ge with PWS and PKS changes. Also, an average density of 2370 kg/m^3 was attained at age 28 days for 5%PKS, and 5% PWS replacement, however this dropped to 2074 kg/m^3 for the 25%PKS, and 25%PWS produced with mix design of 1: 2: 4. Also, the average density of 2518 kg/m^3 at age 28 days for 5% PKS, and 5% PWS replacement decreased to 2022 kg/m^3 for the 25%PKS, and 25%PWS produced with mix design of 1: 1.5: 3. Invariably, the average density obtained for the tested ages of the concretes is within the required standard both for normal concrete (2400 kg/m^3) and lightweight concrete (1750 kg/m^3) as stipulated in Refs. [56,57]. It is also worthy to note that the cubes produced for this study were vibrated on a mechanical operated vibrating table in order to ensure that pore spaces in the cubes were eliminated.

3.4. Mechanical property

3.4.1. Compressive strength

The study adopted two design mix 1:1.5:3 and 1:2:4 to determine the mechanical property of the concrete via the compressive strength test. Each of the design mix was replaced with 5%PKS, and 5%PWS; 10%PKS, and 10%PWS; 15%PKS, and 15%PWS; 20%PKS, and 20%PWS; 25%PKS, and 25%PWS respectively. The strength of the cubes was tested at the age

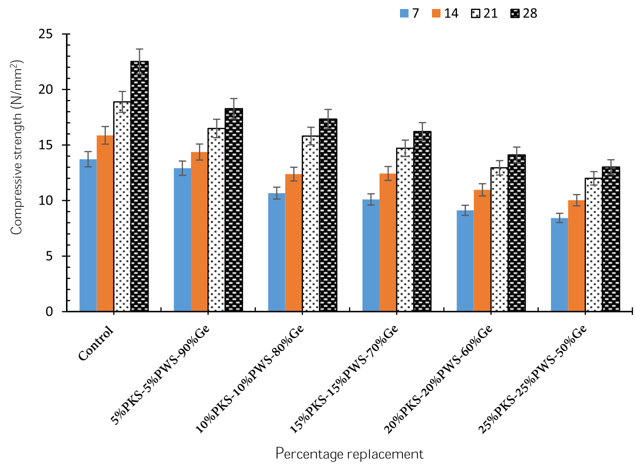

Fig. 8. Compressive strength of produced with granite, PKS and PWS for mix 1:2:4.

of 7, 14, 21, and 28 days BS 8110 [57]. On each day of testing, three cubes was tested and the average strength of the three cubes were calculated and used for plotting of the graph. Figs. 8 and 9 represented the development of concrete strengths as the testing ages of the concrete increases. The mechanical properties for the control mix of 1:2:4 moved from 13.72 N/mm^2 at age 7 days to 22.52 N/mm^2 at age 28 days bringing about 39% increase from the strength attained on the 7th day. Also, the strength of the concrete control mix of 1:1.5:3 moved from 18.71 N/mm^2 at age 7 days to 28.65 N/mm^2 at age 28 days bringing about 35% increase in strength attained on the 7th day. It was further observed that 15%PKS, and 15%PWS replacement using design mix 1: 2: 4 (M20) gave a satisfactory strength of 16.21 N/mm^2 at age 28 days. Meanwhile, 15% PKS, and 15%PWS replacement with the design mix 1: 1.5: 3 (M20) attained a compressive strength of 20.93 N/mm^2 at age 28 days. However, 25%PKS, and 25%PWS replacement at 1:2:4 (M20) design mix strength of 13.02 N/mm^2 failed to match the M20 strength targeted whereas, 1: 1.5: 3 (M25) design mix maintained a compressive strength of 16.33 N/mm^2.

The result of this experimental study corroborates the findings of [23, 28,37,38]. The result showed an increase in the mechanical property of concrete, as the age of concrete progresses. However, the 5%, 10% and 15% replacement of granite with PWS and PKS are considered satisfactory in producing eco-friendly lightweight concrete with good

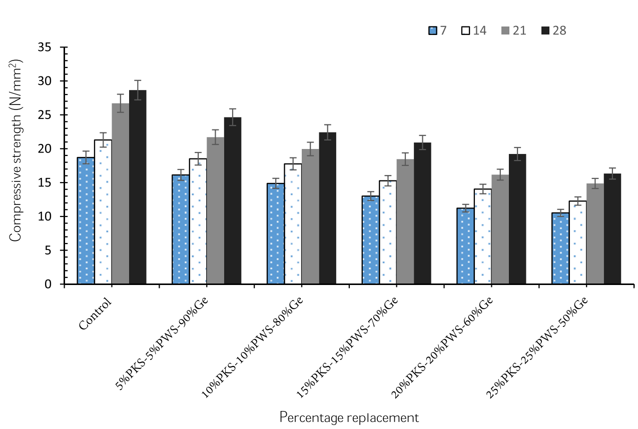

Fig. 9. Compressive strength of produced with granite, PKS and PWS for mix 1:1.5:3.

compressive strength. However, the strength of the concrete dropped as the percentage replacement of PWS and PKS goes beyond 15%, because the volume of the coarse aggregate increase due to the fact that PWS and PKS weight lesser than granite [58]. Secondly, the PWS has an elongated V shape that could create pure-space within the concrete [24].

This experimental study investigated the strength parameter of concrete produced with 25% Palm kernel shells, 25% of Periwinkle shells, and 50% of granite as a means of providing mass and sustainable infrastructure as indicated in SDG goals 9 and 11. The results of concrete strength obtained from this study is an improvement on the findings of Olanipekun et al. [28]; Osei and Jackson [37]; Olusola and Babafemi [38]; and Soneye et al. [23]. These authors conducted studies using agro and marine wastes, their study either combined the granite with palm kernel shells or gravel with palm kernel shells. However, with a focus on goals 9 and 11 of SDG, the 28 days strength (16.33 N/mm^2) of concrete produced with 25% PKS, and 25% PWS replacement at 1:1.5:3 design mix is almost the same with the 15% PKS, and 15% PWS at 1:2:4 (M20) design mix.

4. Conclusion

From this study, the physical characterization of the PKS and PWS indicated the material has lower density compared to granite material, while the particle size distributions of PKS and PWS, shows average coefficient of curvature which could possibly help in producing homogeneity concrete at hardened stage. The density of the concrete decreased slightly as the percentage replacement of both PKS and PWS increases, but the average density obtained at age 28-day for the two mix ratios are still within the range for lightweight normal concrete. The outcome of the results from compressive strength indicated that both PKS and PWS are suitable replacement for coarse aggregate in lightweight concrete production. As such, 5%PKS and 5%PWS will give a satisfactory M20 grade of lightweight concrete using a 1:1.5:3 design mix. However, adopting 10% and 15% replacement of granite with PWS and PKS are considered to be most suited for non-load bearing structural works while the 5% replacement of granite with PWS and PKS should be considered for possible load bearing structural lightweight concrete works.

Credit author statement

Ogundipe, K. E: Conceptualization, Methodology, Data curation, Experiment, Writing – original draft. Writing- Reviewing and Editing, Ogunbayo, B. F: Conceptualization, Data curation, Experiment, Validation, Olofinnade, O. M: Methodology, Data curation, Reviewing and Editing, Amusan, L. M: Conceptualization, Supervision, Validation, Aigbavboa, C. O: Validation, Supervision, Reviewing and Editing,

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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