

Comparative Effect of Grinded and Ungrinded Palm Kernel Shell on the Strength of Pavers

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ABSTRACT

Paving stones are increasing, being used by corporate bodies and individual for its functionalities and aesthetic value, the production of pavers over the years have been specifically carried out using stone dust which is relatively expensive and not readily affordable to the common man. This study was carried out to determine comparative effect of grinded and ungrinded palm kernel shell on the strength of pavers. Stone dust, river sand, grinded palm kernel shell, un-grinded palm kernel shell and cement were combine in different ratio namely, T₁(4,0,0,0,1), T₂(0,2,2,0,1), T₃ (1,2,0,1,1), T₄(1,1,2,0,1), T₅(1,1,0,2,1), T₆(0,2,1,1,1) respectively to form six treatment with two replicates. The pavers were tested for weight and strength properties, T₃ has the highest value of the mean weight while T₁ has the lowest value. T₃ (stone dust (1), river sand (2), un-grinded palm kernel shell (1) and 25kg of cement (1)), T₁(stone dust (4) and 25kg of cement (1)). Also, the compressive strength results show that T₃ also has the highest value of 127Mpa (Mega pascal) while T₆ has the lowest value of 33Mpa (Mega pascal). The data collected was subjected to analysis of variance (ANOVA) to determine the difference in the strength of the pavers. The analysis of variance shows that there is no significant difference between the compressive strength of the treatments. The colour of the paver shows that the paver produced with river sand and un-grinded palm kernel shell is brighter and stronger than others, it is then recommended that T₃ can be used in the production of pavers because it is strong and can also withstand environmental stress.

Keywords-- Pavers, Stone Dust, Palm Kernel, Cement, Compressive Strength

I. INTRODUCTION

Landscape design is the act of planning, designing, construction and management of land or open space, and arrangement of natural and man-made element through application of natural and scientific knowledge which concern resource conservation and stewardship. The environment can be beautified by hard and soft landscape

which must be given proper attention with the use of paving tiles, kerbs, and ornamental. [1].

Pavers are most commonly made from cement mixed with other constituents, and tend to stimulate the effect of cobblestone pathway. This special interlocking feature enables pavers to be easily installed without use of mortar. Pavers have the advantage of being an easy self-installation for the homeowner or contractor. Landscape design deals with the proper demarcation or segmentation of the open space (environment) into various functional units to suit man's purpose of protective accessibility, connection and privacy. Hard landscape is the use of man solid substance to design the environment, it involves the use of pavers, kerbs, asphalt or brick, gravel etc. Pavers systems are so easy to install, since they do not need mortar to hold them together. They are laid on a bed of sand and joint are stabilized by the use of sand particles.

Interlocking and concrete pavement are special dry-mix pre-cast of concrete commonly used in the exterior hard landscaping pavements application, paving stones are installed over a compacted stone, sub-base and a leveling bed of sand. Concrete paving stones can be used for walkways, patois, pool deck, drive ways and airport or loading docks instead of connecting the pavers by pouring grout between the joints as one would with tiles. Sand particles are spread over pavers and tumped down. The sand stabilizes the interlocking pavers, yet allow for some flexibility. One of the major structural distresses of a concrete paver is rutting caused by traffic loading. [2] assessed the conditions of 48 concrete pavers laid on motorways in service and found that rutting accounted for 40% of all distresses. [3] proved that the vertical load distribution in pavement structures was not significantly affected by construction patterns. It was found that shape, size, and thickness of the blocks have a significant influence on the behavior of concrete pavers [4]. However, [5] found that pavement performance was influenced more by the block shape and laying pattern than the block thickness by using rutting depth as an indicator.

Based on the analysis results of finite-element model, [6] pointed that the performance of concrete paver was found to be affected more by the construction pattern. Then the viewpoint was demonstrated by the deflection basins data measured in the field test [7]. Variation of deflection among different laying patterns was significantly high compared with deflection variations of block shapes. The herringbone bond had the lowest and the stack bond showed the largest deflection. They do not easily break or buckle like asphalt or poured concrete. Its benefit is that it has high compressive strength, pleasant look, time saving, it can be easily removed and replaced. Palm kernel shells as a local materials: Palm kernel shells are the crushed outer part of palm kernel nut derived after the extraction of palm oil. Palm kernel shell (PKS) is the hard endocarp of palm kernel fruit that surround the palm seed. It is obtained as crushed pieces after threshing or crushing to remove the seed which is used in the production of palm kernel oil [8].

Palm kernel shells are not common materials in the construction industry. This is either because they are not available in very large quantities like sand, gravel or because the use for such has not been encouraged.

Therefore there is a greater call for sourcing and development of alternative, non-conventional local construction materials. The palm kernel shell is derived from the oil palm, an economical valuable tree. Palm kernel shells are mostly dumped as waste product of the oil palm industry and in some other places, they are used for cooking. The palm kernel shell has been used as aggregates in light

and dense concrete for structural and non-structural purposes. The use of palm kernel will go a long way into reducing cost of construction materials and also drastically reduce environmental pollution due to its constant burning. Therefore, this study is designed to determine the effect of incorporating grinded palm kernel shell and un-grinded palm kernel shell with stone dust and river sand as affordable materials for producing pavers having high strength and ability to withstand environmental degradation.

II. MATERIALS AND METHOD

The materials used for this study are as follows: stone dust, river sand, palm kernel shell, lubricant, cements, water and the following tools were also used: wheel barrow, shovel, plastic mould (double t), weighing balance, measuring tape, hand trowel, head pan, hand trowel.

Plastic moulds were cleaned and lubricated for easy removal of the dried pavers, then the different mixing ratio that made up the treatment combination was carried out. The different treatment materials were mixed thoroughly and equal amount of water was added. Each treatment was poured into the mould and placed in an aerated surrounding or environment.

The treatments was demoulded after 24 hours and the pavers was subjected to curing for 48 hours before taken to the laboratory for compressive test.

Treatment Table

Table 1: Mixing ratio (treatment combination) for the production

Treatments (T)	Stone dust	River sand	Grinded palm kernel shell	Ungrinded palm kernel shell	Cement
1	4	-	-	-	1(25kg)
2	-	2	2	-	1(25kg)
3	1	2	-	1	1(25kg)
4	1	1	2	-	1(25kg)
5	1	1	-	2	1(25kg)
6	-	2	1	1	1(25kg)

Table 1 shows the different proportions of the material used for the experiment to form various treatments. T₁ constitutes four head pans of stone dust and one head pan of cement, T₂ consists of two head pans of river sand, two head pans of grinded palm kernel shell and one head pan of cement, T₃ is the mixture of one head pan of stone dust, two head pans of river sand, one head pan of un-grinded palm kernel shell and one head pan of cement. T₄ is the combination of one head pan of stone dust, one head pan of river sand, two head pans of grinded palm kernel shell and one head pan of cement. T₅ consists of one head pan of stone dust, one head pan of river sand, two head pans of un-grinded of palm kernel shell and one head pan of cement. T₆ constitutes two head pans of river sand, one head pan of

grinded palm kernel shell, one head pan of un-grinded palm kernel shell and one head pan of cement. The property of materials determined is presented on table using Complete Randomized Design, (CRD). The data obtained was subjected to Analysis of Variance (ANOVA) to determine the difference on the compressive strength and the water absorption.

Procedure for Pavers Compressive Strength Property

Testing of the quality of the materials was designed and performed to ensure adequate quality of the constructed pavers. It involved laboratory test of each paver carried out at the material testing laboratory, Ministry of Works and Transport, Oyo State secretariat, Ibadan, Oyo State, Nigeria. The compressive strength property in the

laboratory was done after 28days of production to ensure for proper curing and drying. The test procedures were as follow; each replicate were separated according to their treatment after which each replicate was placed in between the flat plate one by one. The machine was switch on and the plate pushed up the pavers until it touched the metal plate at the top and compressed the treatment until it get weaken and then the meter stopped reading. The values of each treatment showed on the meter were recorded and the average was written down in Mega pascal(Mpa).

Water Absorption Test

Each treatment was subjected in water for 48hours to determine the saturated weight (M_s). It was taken out of water and the surface dried with a dry cloth to remove excess water on it and the weight was determined by recording the saturated weight on a weighing balance (M_s). The dry weight value was taken before subjecting the pavers in water as the dry weight (M_d) and the percentage water absorption, was calculated using the relation [9]:

$$A = \frac{M_s - M_d}{M_d} \times 100$$

A = Water absorption
 M_d = Dry weight
 M_s = Saturated weight

III. RESULTS AND DISCUSSION

Water Absorption

According to Egyptian standard specification of water absorption for normal duty, paving unit should not be greater than 8% with no individual unit greater than 10%. ASTM stated that the average absorption of test samples shall not be greater than 5% with no individual unit greater than 7%. It should be noted that ASTM does not categorize

paving units as does the ESS. T_3 (stone dust + river sand + ungrinded palm kernel shell + cement) recorded the highest value of 10.4 1%. The water absorption of paver containing grinded palm kernel shell+ cement (T_4) also increased with the value of 8.33%, followed by T_2 with value of 6.81%, followed by T_5 with value of 6.00%, followed by T_6 with value of 5.55% and T_1 with value of 5.46%. The result shows that there is no significant difference among the treatments combination at 5% level of significance.

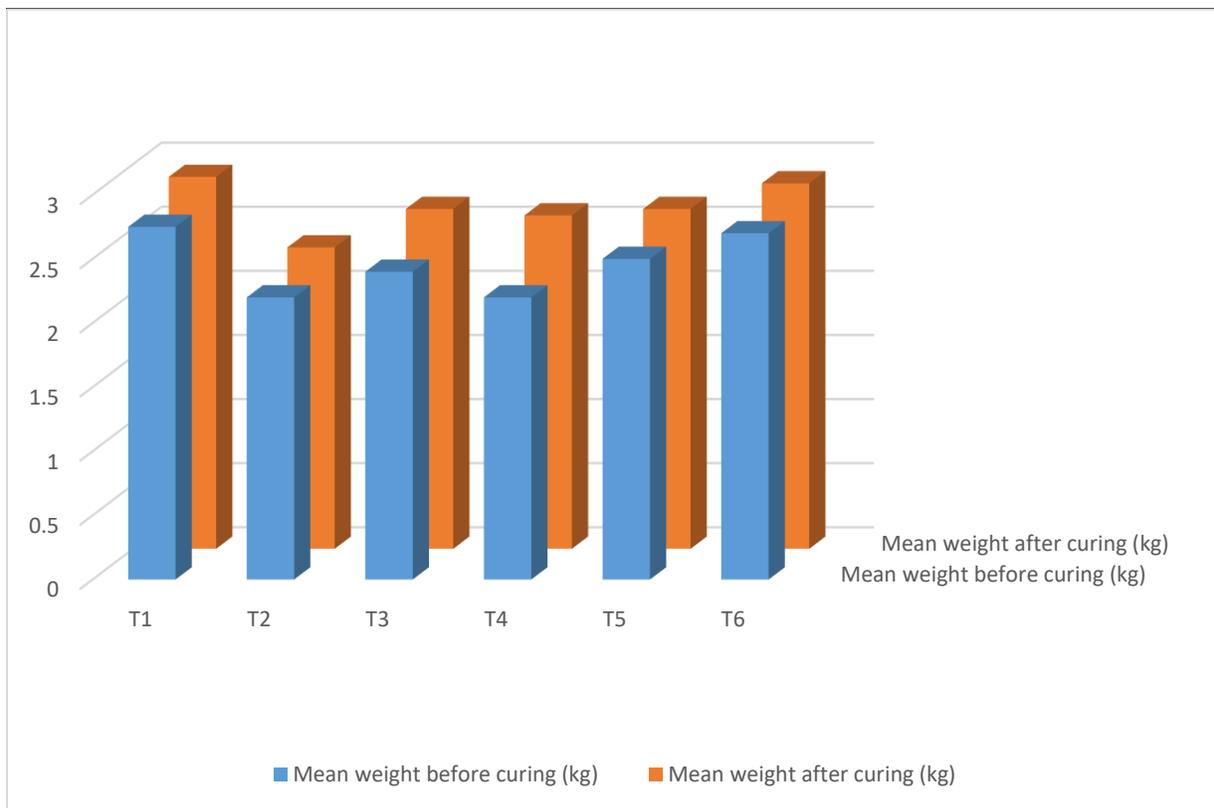


Figure 1: Mean weight (kg) of pavers before and after curing

Figure 1 contains the average weight of pavers before and after curing operation. The mean value was obtained using this formula:

Average weight of paver

$$= \frac{M_{Waf} - M_{Wbf}}{M_{Wbf}} \times 100$$

Where: M_{Waf} = mean weight after curing

M_{Wbf} = mean weight before curing

Compressive Strength

Table 2: The average compressive strength test of the pavers

Treatments	Average compressive strength
1	95 ^b
2	47 ^c
3	127 ^a
4	29 ^d
5	116 ^a
6	33 ^d
LSD	13.87

Note: Values with the same letter are not significantly different, while values with different letters are significantly different. Table 2 shows the average compressive strength of different pavers in Mega pascal (Mpa). The table shows that T₃ (Stone dust + River sand + un-grinded palm kernel shell + cement) had the highest average compressive strength with a value of 127MPa, followed by T₅ (Stone dust+ river sand+ ungrounded palm kernel shell + cement) with average compressive strength of 116MPa, followed by T₁(Stone dust + cement) with average compressive strength of 95MPa, T₂ (River sand +grinded palm kernel shell + cement) has the value of 47MPa, T₆(River sand + grinded

palm kernel shell + un-grinded palm kernel shell + cement) has the value of 33MPa, and T₄ (stone dust + river sand grinded palm kernel shell + cement) has 29MPa.

The result revealed that there is no significant different between T₃ and T₅. Also, there is no significant different between T₄ and T₅, While others are significantly different from one another. In addition, it was also observed that T₁, T₃ and T₅ met the standard specification of minimum of 55 MPa stated by Egyptian standard specification [10], While T₂,T₄ and T₆ deviated from the standard specification of [10].

Physical Appearance

Table 3: The physical appearance of pavers produced using different treatments

Treatment physical appearance	Observation
T ₁	Bright
T ₂	Dull
T ₃	Very bright
T ₄	Dull
T ₅	Very bright
T ₆	Dull

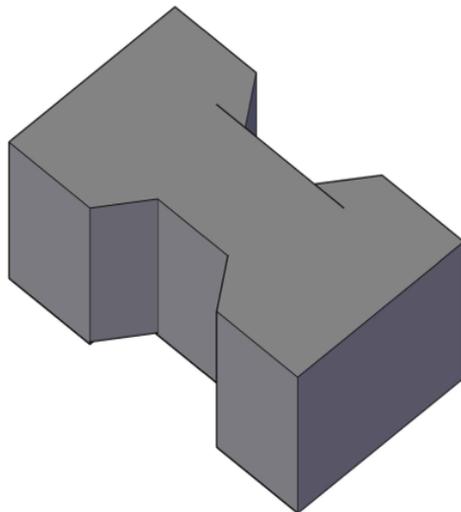
Table 3 showed that T₃ (stone dust + river sand +un-grinded palm kernel shell +cement) and T₅ (Stone dust + river sand + un-grinded palm kernel shell + cement) recorded the brighter colour, and it also enhances the beauty of pavers. T₁ (stone dust + cement) which is the control also has a bright colour but not as bright as T₃ and T₅ while T₂ (river sand + grinded palm kernel shell + cement), T₄ (stone dust + grinded palm kernel shell + cement) and T₆ (river sand + grinded palm kernel shell + ungrounded palm kernel shell + cement) recorded dull colours. Therefore, for aesthetic purpose which is one of the aims of landscaping,

the paving stone produce from T₃ and T₅ appear to be the brightest, the dull ones might be due to the grinded palm kernel shell.

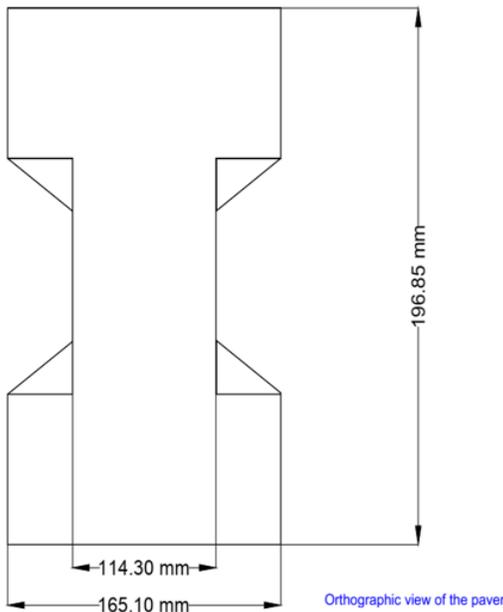
IV. CONCLUSION AND RECOMMENDATION

This study revealed that it is possible to produce pavers from river sand, un-grinded palm kernel shell and cement at a much cheaper cost. It also shows that water absorption of pavers increases in river sand, un-grinded

palm kernel shell and cement which is T_3 , indicating characteristics of durability. There is need to create awareness concerning the possibility of replacing stone dust with river sand and un-grinded palm kernel shell in the production of pavers. Un-grinded palm kernel shell and river sand offer important economic advantages in regions where the availability of quarry is scarce for the production of stone dust. Palm kernel shell can effectively be used to replace stone dust and reduce the negative impact this cause



Isometric drawing of the paver



Orthographic view of the paver

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