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Comparative Effects Of Selected Aggregates On The Construction Of Concrete Garden Seat

Aluko, K. A.[1], Aderemi, A.M.[2], Majekodunmi, O.A.[1], Ogunwale, O.G.[3], Adewoye, A.A[1], Oyewole, O.O.[3], Amoran, S.A.[4]

1. Horticulture and Landscape Technology Department, Federal College of Forestry, Ibadan, Nigeria.
2. Agricultural Technology Department, Federal College of Forestry, Ibadan, Nigeria.
3. Agricultural Extension and Management, Federal College of Forestry, Ibadan, Nigeria.
4. National Horticultural Research Institute of Nigeria.

Correspondence author's email – aderemi.am@frin.gov.ng
Phone no: 08035637542, 08079713340

Abstract: *Concrete is a widely used construction substance that consists of cement material, fine aggregate, coarse and required quantity of water. Fine aggregate is usually sand properties of fine aggregate which affect the durability and performance of concrete in the block industry. The most commonly used fine aggregates are natural river sand, granite, sawdust, stone dust, Palm kernel, and some agricultural waste product. A concrete garden seat is one of the hardscapes, it beautifies and provides means of relaxation in a recreation garden. The study was based on the use of different aggregate (Stone dust, River sand, Sawdust, Palm kernel, Water, and Cement) on the production of the concrete garden seat and comparing their rate of water absorption, compressive strength of each treatment and determine the best treatment for the construction of concrete garden seat that will meet up with the ASTM standard organization. Therefore, the parameters assessed were water absorption, compressive strength and cost implication of the treatments. The results showed that treatment T_0 (175 kg of stone dust and 50 kg of cement) had the highest compressive strength with an average of 3.935 MPa, this suggests its high durability and longevity. On the other hand, the production cost ₦15,150 which is more expensive when compared with the other treatments. The study further discovered that T_2 (75 kg of river sand, 50 kg of stone dust, 50 kg of palm kernel shell and 50 kg of cement) can be compared with T_0 in terms of compressive strength (3.541MPa) and water absorption rate (5). The cost of production (₦14,300) is less than that of T_0 (₦15,150) and also is environmentally friendly. The results obtained from the use of palm kernel waste (shell) for the production of garden seat has shown that it is durable, has appreciable water absorption rate, reduced use of stone dust, reduced cost of production and encouraged sustainable waste management. It is therefore, recommended that T_2 (75 kg river sand, 50 kg stone dust, 50 kg cement and 50 kg palm kernel shell) should be used in the production of horticultural garden seats.*

Keyword: Natural river sand, Granite, Sawdust, Palm kernel shell, Cement, Garden seat**.**

Introduction

The rising cost of building construction in developing countries has been a source of concern to government and private building developers. Concrete is a very good construction material made by mixing cement, coarse aggregate (gravel or crushed stones), fine aggregate (Sand) and water either in designed or prescribed proportions. It is strong in compression and is resistant to some chemical and biological attack, for example, termites attack. This account for its wide spread use in civil engineering structure such as buildings, concrete block, sculptural work, concrete garden seat, dams etc. (Smith, 2009).
The most commonly used fine aggregates is natural river sand, granite, sawdust, stone dust, and rice husk. Fine and coarse aggregate constitute about 75% of total volume of the concrete. It is therefore, important to obtain right type and good quality aggregate, because the aggregate form the main matrix of concrete (Srinivasa, *et al*.., 2015).

In some countries, concrete production is very expensive considering only the value of the ready-mix concrete sold each year. Some materials like rice husk, saw dust, river sand, gravel and granite are alternative materials which can be effectively used in a construction as partial replacement of natural sand. Stone dust is well appreciated in term of strength and economy over normal sand from medium grade concrete in making concrete product (Mahzuz *et al*., 2011). Fine and coarse aggregate constitute about 75% of total volume of the concrete. It is therefore, important to obtain right type and good quality aggregate, because the aggregate form the main matrix of concrete block production (Srinivasa, *et al*.., 2015). 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 (Catriona, 2003). 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 (Olutoge, 1995).

Materials and Methods

The experiment was carried out at Horticultural and Landscape Technology Department, Federal College of Forestry, Jericho, Ibadan, Nigeria. The materials used are: cement, diesel oil (Lubricant), palm kernel shell, river sand, saw dust, stone dust, water. The tools used are: bucket, head pan, mansory hand trowel, mold, shovel.

The aggregates mixture of each batch of the concrete garden seat samples was homogenously mixed together according to the standard proportion of each treatment combination. The inner surfaces of the sample molds was lubricated with diesel for easy demolding to avoid cracking. The mortal method which involves the preparation of cement soup was used for casting purposes. The prepared mortar (slurry) was poured into the lubricated mold and manual vibration was done immediately the aggregate mixed was pour and was continuously vibrated. The casted sample of concrete garden was left for 48 hours to set properly before demolding.

Treatment	Stone dust	River sand	Saw dust	Palm kernel	Cement
T_0	175 kg (7hp)	________	_________	________	1 bag
T_1	________	125 kg (5 hp)	50 kg (2 hp)	________	1 bag
T_2	50 kg (2 hp)	75 kg (3 hp)	________	50 kg (2 hp)	1 bag

Treatments

Parameter assessed

The following parameters were assessed:

Water absorption**:** Water absorption of each treatment was determined by weighing each sample on a weighing balance and their values was recorded as dry weight (Md). Each of the treatments was submerged in water for 24 hours, after which the treatments were taken out of the water and the surface wiped with cloth to remove excess water. The weight was determined by weighing on a weighing balance and recorded as the saturated weight (Ms). The percentage water absorbed, otherwise known as water absorption was calculated using the relation below (Adewoye, *et al*., 2011);

$A = \frac{Ms-Md}{Md} \times 100\%$.................. Eqn 1.

Where;

A = Water absorption.

Md = Dry weight (Before immersion).

Ms = Saturated weight (After immersion).

Compressive strength test (MPa)**:** The compressive strength for each treatment was determined as the quotient of the breaking force of the area of impact and is given by (Ohijeagbon, 2008):

$CS = \frac{PC}{\mathrm{AC}}$ …………………………. Eqn 2

Where;

C = Compressive strength of the treatment

PC = Load on the treatment at failure

AC = Calculated area of the bearing surface on the test treatments

Cost implication**:** The cost of producing each treatment was estimated and the best sample was selected.

Testing procedure

Two (2) samples were selected randomly from each treatment for testing. The compressive strength test of each sample (paver) was carried out by using Digital Compressive Machine. Descriptive analysis was used to analyze the data collected.

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Result and discussion

Table 1: Compressive strength of the garden seats.

Treatments	**Average compressive strength (MPa)**
T_0	3.935a
T_1	2.867c
T_2	3.541b
LSD	1.04

Note: Means with the same letter are not significantly different from each other.

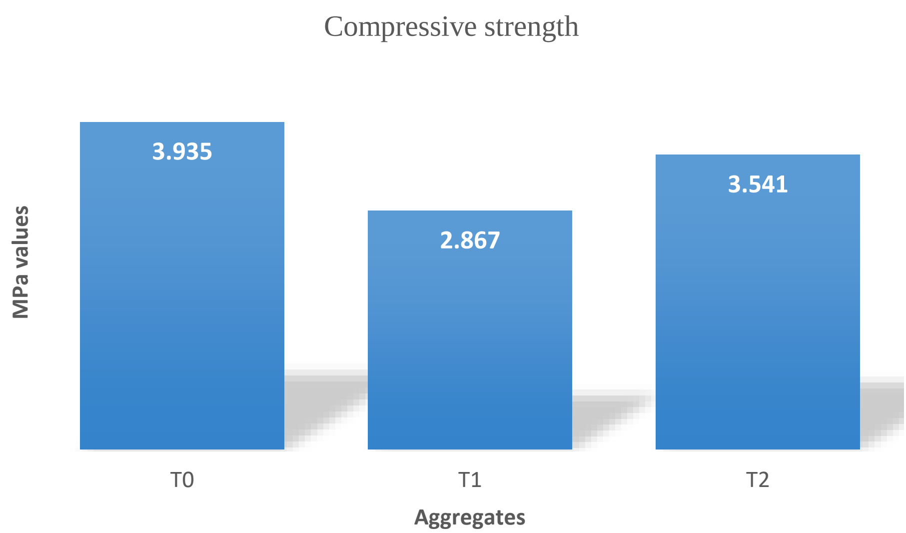

Fig 1: Compressive strength of the Garden seat Produced.

The table presented above shows the compressive strength of different aggregates used for production of garden seats. It was observed that seat made from 7 head pans and 1 bag of cement (T_0) gave the best compressive strength with an average value of 3.935 MPa. Seat made from 5 head pans of river sand, 2 head pans of saw dust, 2 head pans of palm kernel shell and 1 bag of cement (T_2) performed second best in terms of strength (3.541 MPa) while T1 (5 head pans of river sand, 2 head pans of saw dust and 1 bag of cement) had the least compressive strength with an average value of 2.867 MPa.

Table 2: Water absorption percentage of the garden seat

Treatments	**Water absorption (%)**
T0	**5**
T1	**7**
T2	**5**

Table 2 shows water absorption percentage of each of the treatment samples. Water absorption percentage was obtained by dividing weight before soaking and weight after soaking expressed in percentage. Following ASTM, 2013 which stated that average absorption percentage value should not be more 5%, T_0 and T_2 are the samples that had water absorption percentage within the range of the standard water absorption level.

Table 3: Treatments cost

Treatments	Items	Quantity (kg)	Rate (₦)	Amount (₦)
T_0	Stone dust	175 (7 head pans)	450	3,150
	Cement	50 (1 bag)	2,500	2,500
	Iron rod	1 (11.5mm)	1,500	3,000

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	Diesel	1 litre	250	250
	Black oil	1 litre	250	250
	Mould	4	1,500	6,000
				Total = 15,150
T_1	River sand	125 (5 head pans)	200	1,000
	Saw dust	50 (2 head pans)	250	500
	Cement	50 (1 bag)	2,500	2,500
	Iron rod	2 (11.5mm)	1,500	3,000
	Diesel	1 litre	250	250
	Black oil	1 litre	250	250
	Mould	4	1,500	6,000
				Total = 13,500
T_2	River sand	75 (3 head pans)	200	600
	Stone dust	50 (2 head pans)	450	900
	Palm kernel shell	50 (2 head pans)	400	800
	Cement	50 (1 bag)	2,500	2,500
	Iron rod	2 (11.5mm)	1,500	3,000
	Diesel	1 litre	250	250
	Black oil	1 litre	250	250
	Mould	4	1,500	6,000
				Total = 14,300

The table presented above highlighted the cost implication of producing garden seats with different aggregates such as stone dust, saw dust, river sand and palm kernel shell. The table shows that it is more expensive to produce garden seat from treatment T_0 (₦15,150). T1 is less expensive with a total cost of ₦13,500 while T_2 was produced with a total cost of ₦14,300.

Conclusion

The results obtained from the study showed that treatment with 175 kg of stone dust and 50 kg of cement (T_1) had the highest compressive strength with an average of 3.935 MPa which suggests its high durability and longevity. On the other hand, the production cost (₦15,150) is more expensive when compared with the other treatments. The study also found out that T_2 (75 kg of river sand, 50 kg of stone dust, 50 kg of palm kernel shell and 50 kg of cement) can compete well with T_0 in terms of compressive strength (3.541 MPa) and water absorption rate (5). The cost of production (₦14,300) is less than that of T_0 (₦15,150) and also environmentally friendly. The results obtained from the use of palm kernel waste (shell) for the production of garden seat has shown that it is durable, has appreciable water absorption rate, reduced used of stone dust, reduced cost of production and encouraged sustainable waste management. The results corroborate with the findings of Aluko, et al., (2021) which stated that palm kernel as an aggregate of a concrete is good for pavers production, which can withstand environmental stress. It is therefore, recommended that T_2 (75 kg river sand, 50 kg stone dust, 50 kg cement and 50 kg palm kernel shell) should be used in the production of horticultural garden seat.

T3 (Stone dust + river sand + un-grinded palm kernel shell + cement) are good for the production of pavers.

Fig. 1: Picture of a concrete garden seat

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