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GREEN KERBSTONE PRODUCTION USING CRUSHED OIL PALM SHELL ANDBLENDED CORN COB ASPARTIAL REPLACEMENT FOR QUARRY DUST

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ABSTRACT

This research was aimed at investigating the suitability of oil palm shell and corn cob as partial replacements for quarry dust in the production of kerbstone. The paucity of building materials and the large disposal of agricultural wastes in developing countries has been a serious problem in building and agricultural industries. Thus, the reuse of these agro-waste materials as alternatives for construction materials appears to be a viable solution to help minimize the use of construction material to avoid scarcity and the high cost of the building materials. Quarry dust was partially replaced with oil palm shell at 50% only and for corn cob at 5%, 10%, 15%, 20%, 30% respectively. A 50% replacement was done using corn cob which failed as result of the inability of the mix to dry up after a week which was due to the large amount of corn cob contained in the mix and its high-water absorption property. The kerbs were cured by water for 7 days, 14 days and 28 days. A total of 81 kerbstones were produced for testing for compressive strength and water absorption. A decrease in the slump value was noticed as the amount of corn cob increased which was as a result of the presence of silica compound in the corn cob while an increase in the workability was noticed for kerbs containing 50% of oil palm shell and it gave a medium degree of workability. The compressive strength of the samples increased as the age increased but decreased as the percentage of replacement increased. Samples of 0% replacement had a greater compressive strength at each age compared to samples of 5%, 10%, 15%, 20% and 30%. The results obtained showed that quarry dust can be replaced partially with corn cob up to 5% and oil palm shell up to 50%. In the use of oil palm shell and corn cob together, it was observed from the result obtained that corn cob has more effect on the properties of the kerbstones than the oil palm shell.

Keywords: Kerbstones, Compressive Strength, Workability, Water absorption, Slump Test, Oil Palm Shell, Corn Cob, Quarry Dust.

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1. INTRODUCTION

Kerbstones which are used in paving for walkways and to separate the footway from the carriageway are gotten from the mixture of engineering materials (quarry dust and cement). The problem of depletion of resources and increase in pollution has caused for researchers and engineers to seek and develop new materials relying on the agro-waste materials. [1-3] stated that the volume of concrete is composed of about 70 - 80% of coarse aggregate, which is to connote that the percentage is of considerable importance. A high demand has been placed on building material in the industry in the last decade and as a result of the increase in population which causes a chronic shortage of engineering materials. In order to meet the high demand, engineers and researchers have developed various means of minimizing the building material usage by partial or full replacement with agro-waste materials. Disposal of solid waste generated from agricultural and industrial production process is another serious problem in developing countries like Nigeria which has created opportunities for the re-use of agro-waste in the construction industry. Various agricultural waste materials are already used in concrete as replacement alternatives for cement, fine aggregate, coarse aggregate and reinforcing materials.

The wastes gotten from agricultural sources are, rice husk, sugarcane bagasse, corn cub, palm kernel etc. Reuse of these solid wastes as a sustainable construction material appears to be a feasible solution to the problem of pollution, and also the problem of cost. Corn cob is an agro-waste gotten from corn, it is the part of the ear on which the kernel grows. It is a solid agro-waste gotten from the consumption of corn which is produced in large quantities in farms. This natural and organic material may be used in the building industry in the production of building materials [4-6]. Palm kernel shells are the fraction of shell left after the nut has been removed after the crushing in Palm Oil mill. Kernel shells are a fibrous material and can be used as a replacement for quarry dust in the production of concrete waste. Various researches have been carried out for the replacement of these material in the construction using various additives gotten from agro-wastes and other sources. According to [7-9], corn cob has shown to be a suitable material for replacement of quarry dust as a result of it's good compressive strength property when used for contruction purposes.[10-14] studied the mechanical properties of self-compacting concrete produced from the use of quarry dust powder, silica fume plus quarry dust powder and only fly ash. In the research, the compressive strength of quarry dust was evaluated with an increase in the strength up to 28 days. It was noted that the concrete produced from the use of only quarry dust powder had the highest compressive strength with a maximum compressive strength of 70.1 while other specimens containing quarry dust plus silica fume and also using fly ash only had a compressive strength of 64.4 and 52.1MPa respectively. After 90 days, there was an increase in the strength to additional 0.85% of the 28 days curing for quarry dust only while 5.99% and 7.13% for use of both quarry dust plus silica and fly ash only respectively. From the results gotten in the research, it shows that it takes lesser time for quarry dust to achieve a high compressive strength and when used with other materials it can help improve the properties of the materials.

[15-19] also did a research on the effect of replacement of sand with fly ash and quarry dust mix on the strength property of grade M40 concrete. In their research, where used quarry dusty to replace the sand from 0-75% and replacing of sand with 0-75% quarry dust plus fly ash to replace cement with 0-20% of fly ash. From the table, above, the compressive strength of 39.32MPa was achieved for quarry dust replacement of 75% after 28 days which is close to the 40MPa grade required which makes it suitable as a good replacement for the sand in other to help save cost. They concluded that a maximum replacement of 15% with quarry dust is advisable to achieve a greater compressive strength. Another research was done on replacing sand with quarry dust in which an increase was noticed in the compressive strength as the percentage of replacement was increased. For 20%, 23.25MPa was reported after 28 days curing and 31.45MPa was reported for 40% which concludes that the addition of quarry dust in concrete helps improve its compressive strength property. [20-25] studied the flexural strength of quarry dust concrete by casting a (70 x 15 x 15) cm beam and testing at the age of 28 days by applying a load to it until failure was noticed. A value of 8.71MPa was the average modulus of rupture recorded for 40% replacement of sand with quarry dust in concrete specimen and an average of 8.31MPa when replaced with 20% of quarry dust. Results showed that the highest flexural strength was achieved for 15% replacement after which a decrease was noticed. The maximum replacement of sand with quarry dust in concrete is 15% to achieve a high resistance to deformation. [26-29]. In this research, the properties of corn cob and palm kernel waste as replacement for quarry dust in the production of kerbstones was examined. The strength and durability of the waste material is also discussed

2. MATERIALS AND METHOD

In order to achieve the stated objectives of this research, the following materials were used in the production of the Kerbstones in a specific mix proportion: Cement, Mineral aggregates (Quarry dust), Corn cob, Oil palm shell, and Water.

2.1. Cement

The cement used in the Kerbstone production was Dangote ordinary Portland cement which consist of iron ore, lime, alumina and silica which is ground up and fired in a kiln machine to produce a binding material. It is a 42.5R grade Rapid Hardening Cement with an initial setting time of 30 minutes and a final setting time of 600 minutes which is expected to give a high compressive strength of 48MPa minimum and 58MPa maximum after 28 days of curing as observed by various researchers. The cement powder when mixed with water forms a paste and acts like a glue in bonding of the aggregates. The amount of cement to be used would be determined by the mix ratio and volume of Kerbstone being produced.

2.2. Mineral aggregates (Quarry Dust)

Quarry dust is a mineral aggregate gotten from the crushing of limestone granites. They were also sieved and made free from any form of contaminants. The quarry dust used was gotten from OmuAran, Kwara State region of Nigeria. The amount of quarry dust used was determined by the mix proportion and the volume of the Kerbstone produced.

2.3. Corn cob

This is gotten from corn. It is the inner part of the corn which is only visible after consumption of the corn grains. The corn cob used was gotten from Landmark University Teaching and Research Farm Omu-Aran, Kwara State. The corn cob was grinded into smaller sizes ranging from 8-12mm in diameter with a grinding machine gotten from Landmark

University Commercial Farm. The amount of corn cob to be used was determined by the mix proportion, the percentage of replacement and the volume of Kerbstone being produced.

2.4. Oil palm shell

This is another material which was used in the replacement of quarry dust this research work. It was gotten from the extraction of oil from the oil palm kernel which is covered with a hard endocarp known as the oil palm shell. The oil palm shell to be used was gotten from Oyo state region of Nigeria which was washed and made free from contaminants. It air dried to prevent any form of moisture content. The amount of oil palm shell used was determined by the mix proportion, the percentage of replacement and the volume of the Kerbstone to be produced.

2.5. Water

Water was mixed with the cement powder to form a paste which held the aggregates together like glue. It must be clean, fresh and free from any dirt, unwanted chemicals or rubbish that may affect the mixture. Many concrete plants now use potable water. The water used was gotten from Landmark University, OmuAran, Kwara state and its suitability would be checked. The amount of water used was determined by the mixture proportion and the volume of Kerbstone to be produced.

2.6. MIX DESIGN

A mixture containing the materials listedabove was used in the production of the kerbstones. The mix ratio used for the materials was 1:4. A control mix of 0% replacement was cast followed by the various replacement. It should be noted that all mixtures were carried out manually with head pans used for measurement. That is, 1 head pan of cement to 4 head pans of quarry dust. It should also be noted that

1 head pan of cement = 25kg; 1 head pan of stone dust = 34kg and Volume of mould = 450 x 300 x 100 = 13.5×10^6 mm^3

2.6.1. Constituent of 0% replacement mix

The control mix contained cement, quarry dust only using the mix ratio of 1:4 and a water cement ratio of 0.45. That is, it contains 1 head pan of cement to 4 head pans of quarry dust only. Its measurement was done in kilogram using the head pan. The mixture produced kerbstones for 7, 14, 28 days curing ages of 3 each giving a total of nine kerbstones.

2.6.2. Constituent of 5%, 10%, 15%, 20%, 30%, 50% replacement mix with blended corn cob

This mix contains cement, corn cob and quarry dust using the mix ratio of 1:2:2, 1:0.2:3.8, 1:0.4:3.6, 1:0.6:3.4, 1:0.8:3.2, 1:1.2:2.8 and a water cement ratio of 0.45. The quarry dust was replaced by 5%, 10%, 15%, 20%, 30%, 50%percentage of corn cob only. The mixture produced kerbstones for 7, 14, 28 days curing age of three each giving a total of 54 kerbstones.

2.6.3. Constituent of 50% replacement mix with crushed oil palm shell

This mix contains cement, oil palm shell and quarry dust using the mix ratio of 1:2:2 and a water cement ratio of 0.45. The quarry dust was replaced by 50 percentage of crushed oil palm shell only. That is, it contains 1 head pan of cement to 2 head pans of crushed oil palm shell and 2 head pans quarry dust. The mixture produced kerbstones for 7, 14, 28 days curing age of three each giving a total of nine kerbstones.

2.6.4. Constituent of 25% replacement mix with blended corn cob and crushed oil palm shell

This mix contains cement, corn cob, oil palm shell and quarry dust using the mix ratio of 1:1:1:2 and a water cement ratio of 0.45. The quarry dust was replaced by 50 percentage of corn cob and oil palm shell. That is, it contains 1 head pan of cement to 1 head pan of blended corn cob ash, 1 head pan of oil palm shell and 2 head pans quarry dust. The mixture produced kerbstones for 7, 14, 28 days curing age of three each giving a total of nine kerbstones.

2.7. TESTING METHOD

The samples of kerbstone produced from the mix design were subjected to the following tests;

2.7.1. Compressive strength: determination of compressive strength would be done in accordance with BS 1881 Part 120/ BS EN. 12504 Part: 2000. Compressive strength resists compression due to loads tending to reduce its size. The compressive strength of the Kerbstone depends on various factors such as, water-cement ratio, quality of Kerbstone materials, quality control during production (theconstructor.org). The Kerbstone was casted and cured for 7, 14 and 28days. After each curing days has been completed, the compressive test was carried out on the Kerbstone using a compression testing machine which would crush the kerbs after each curing age. The kerbs were placed in the compressive test machine with a load vertically applied until failure occurs. The compressive strength was then calculated as below.

Compressive strength = $\frac{\text{Load x 1000}}{\text{Area}}$ and it is measured in N/mm^2.

Figure 2 Sample before crushing and after crushing respectively

Water absorption test: The Kerbstone samples was dried for 72 hours in a suitably open space. On removal from its exposure to sun, they were cooled for 24 hours in a desiccator or in a small dry airtight vessel. They shall then be immersed in water again for each curing days. At the end of this period they were removed, shaken to remove the bulk of the water, and then dried with a cloth as rapidly as possible until all the free water is removed from the surface, and again weighed. Water absorption is expressed in grams. It is the percentage of increase in weight of the kerb over the original or initial weight. Improper curing would lead to insufficient moisture and this has been found to produce cracks and compromise strength of kerbstones.

Water content (%) = $\frac{w_2 - w_1}{w_2} \times 100$

where: $\mathbf{w_1}$ = weight of Kerbstone before immersion $\mathbf{w_2}$ = weight of Kerbstone after immersion.

Figure 3 Water curing of samples

2.7.1. Slump Test: After producing a fresh mix for the Kerbstone, the mixture was poured into a Slump Cone which is placed on a flat surface large enough to accommodate the foot lugs. The cone was then filled to one-third with the mix and a 600mm long x 16mm diameter rod distributed evenly over the cross section of the sample. The cone was then filled up to two-third of its height and a rod used to compact it as above by stamping it evenly across the cross section of the sample 25 times. It was then filled up till it overflows and stamped with 25 blows with a rod as above. All excess mix around it was removed. The cone was then lifted up vertically with a very slow motion and a tape place on the slumped mixture to take its height to the slump cone.

Figure 4 Slump test for samples

Figure 5: Slump test measurement of samples

2.8. Quantity Estimation

The following are the estimation of the materials required in carrying out the laboratory tests in this research work. The various materials used for the production of the kerbstones in various given proportions are shown on Tables 1, 2, 3 and 4.

Table 1 Table showing the amount of kerbstones to be produced for each mix

Curing Age	1:4 (quality control mix)	1:2:2 (corn cob mix)	1:2:2 (oil palm shell mix)	1:2:1:1 (corn cob and oil palm shell mix)
7	3	3	3	3
14	3	3	3	3
28	3	3	3	3
Total	9	9	9	9

Table 2 Table showing the amounts of kerbstones for each curing days

Curing Age	1:0.2:3.8 (corn cob mix)	1:0.4:3.6 (corn cob mix)	1:0.6:3.4 (corn cob mix)	1:0.8:3.2 (corn cob mix)	1:1.2:2.8 (corn cob mix)
7	3	3	3	3	3
14	3	3	3	3	3
28	3	3	3	3	3
Total	9	9	9	9	9

Therefore, the total amount of Kerbstone produced for this research is 9 mix x 9kerbs each = 81 kerbstones.

Table 3 Table showing the quantity estimation for 1 kerbstone per mix ratio measured in kilogram

Mix ratio	Cement	Quarry dust	Oil palm shell	Corn cob
1:4	3.405	15.890	-	-
1:2:2	3.405	7.945	3.5	-
1:2:2	3.405	7.945	-	1.797
1:2:1:1	3.405	7.945	1.75	0.899
1:0.2:3.8	3.405	15.1	-	0.1797
1:0.4:3.6	3.405	14.3	-	0.359
1:0.6:3.4	3.405	13.507	-	0.539
1:0.8:3.2	3.405	12.71	-	0.719
1:1.2:2.8	3.405	11.123	-	1.078

Table 4 Table showing the quantity estimation for 9 kerbstones per mix ratio measured in kilogram

Mix ratio	Cement	Quarry dust	Oil palm shell	Corn cob
1:4	30.645	149.364	-	-
1:2:2	30.654	71.505	31.5	-
1:2:2	30.645	71.505	-	16.173
1:2:1:1	30.645	71.505	15.75	8.091
1:0.2:3.8	30.645	135.9	-	1.6173
1:0.4:3.6	30.645	128.7	-	3.231
1:0.6:3.4	30.645	121.563	-	4.851
1:0.8:3.2	30.645	114.39	-	6.471
1:1.2:2.8	30.645	100.107	-	9.702
Total	275.805	964.539	47.25	50.1363

3. RESULTS AND DISCUSSION

3.1. Slump Test

Table 5 Slump values for various replacements with corn cob

Percentage replacement (%)	Mix ratio	Slump value (mm)			Avg. Slump value (mm)
		1	2	3	
0	1:4	60	70	75	68.33
5	1:0.2:3.8	70	60	64	64.66
10	1:0.4:3.6	62	66	65	64.33
15	1:0.6:3.4	50	50	47	49.00
20	1:0.8:3.2	60	50	55	55.00
25	1:1:1:2	50	20	30	33.33
30	1:1.2:2.8	50	65	55	56.66
50	1:2:2	60	45	40	48.33

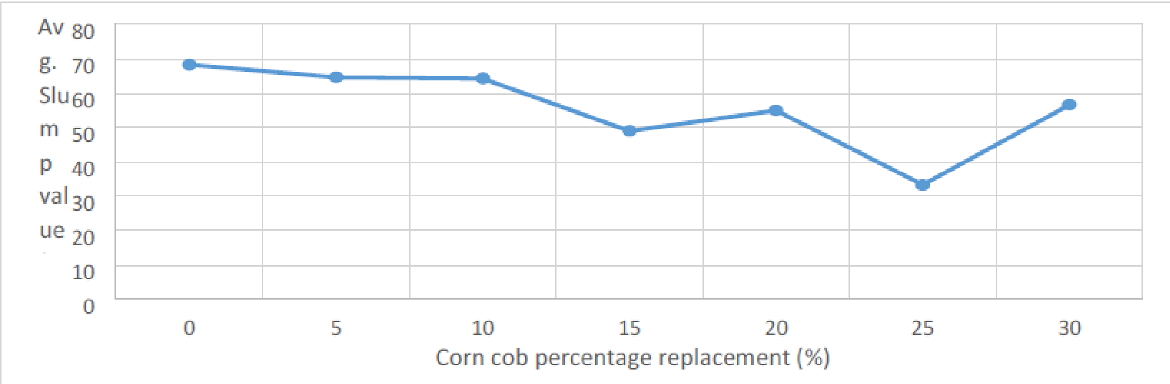

Figure 6 Line graph of Slump value for Curbstone containing corn cob

Table 6 Table showing the slump value for 50% replacement with oil palm shell

Percentage replacement (%)	Mix ratio	Slump value (	mm)		Avg. Slump value (mm)
		1	2	3	
0	1:4	60	70	75	68.33
50	1:2:2	80	70	60	70.00

Table 7 Table showing the slump value for 25% replacement with oil palm shell and corn cob each

Percentage replacement (%)	Mix ratio	Slump value (	mm)		Avg. Slump value (mm)
		1	2	3	
0	1:04	60	70	75	68.33
25	1:2:1:1	50	20	30	33.33

From the table 5, it was noticed that the oil palm shell mix of 50 percent replacement showed a medium degree workability when compared with the control mix which is as a result of the size of oil palm shell used in the research (grinded oil palm shell passing through sieve number 4.75mm). According to the workability test of Teo et al. (2007) it could be seen the slump was 50-70-mm which showed a medium workability and it is within the range of a workable mix. From the table 4.2 below, at 50 percent replacement, the mix gives a range of 60-80mm which give either a medium degree workability with a small size particle of below 4.75mm. From the above discussion, oil palm shell Kerbstone mix showed a better workability than the control mix of a Kerbstone and are found to satisfy the minimum range of the value for structural light weight concrete.

3.2. Water Absorption Test

In order to figure out the water absorption capacity of kerbstones containing corn cob and oil palm shell and comparing with the control mix of Kerbstone containing 0 percent replacement, an experimental test was performed by immersing the kerbstones in water for 7, 14 and 28 days respectively and comparing the weight of the kerbstones before and after immersion in water and removed after the following respective days. The test carried out was able to determine the water absorption rate of the samples between 7 to 28 days. The results gotten from the test are shown in the tables below.

3.2.1. Summary on the Water Absorption rate for Kerbstone containing corn cob

From the results obtained above, it can be noticed that as the percentage of replacement of corn cob increases, the water absorption rate increases which indicates that kerbstones containing corn cob are highly permeable and have high water absorption rate. Although it helps in covering of pores in concrete, its high absorption characteristics as a material affects the Kerbstone characteristics.

Table 8 Table showing the water content for various replacement with corn cob

Water Content For 0%, 5%, 10%, 15%, 20%, 30% Replacement with Corn Cob

Curing Age	0%	5%	10%	15%	20%	30%
7 days	5.0	4.7	5.5	8.5	14.4	15.2
14 days	4.0	4.8	5.9	14.0	14.5	15.6
28 days	3.9	5.2	6.3	14.8	15.0	15.9

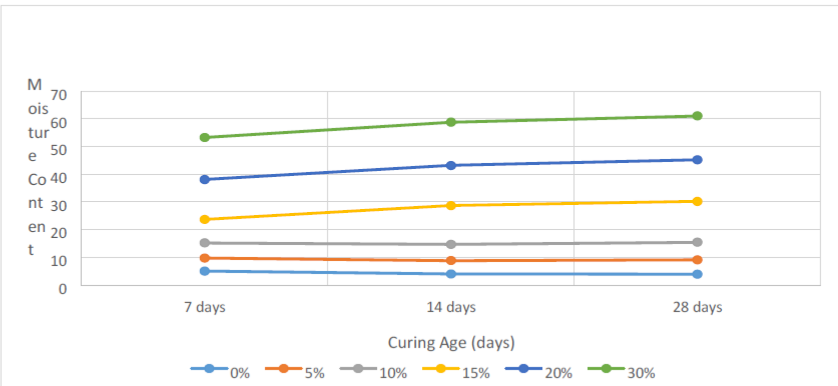

Figure 9 Graph showing Water Content for 0%, 5%, 10%, 15%, 20%, 30% Replacements With Corn Cob

3.2.2. Water Absorption for Kerbstone containing oil palm shell

From the table 9, it can be observed that there is an increase in the water absorption rate from the 7th day to the 14th day. At the 7th day, the rate was observed as 2.3% and increased by 0.2% at the 14th day. There was also an increase in the rate after 28days to 3.1% which is 0.8% greater than that of 7 days and 0.6% greater than that of 14days. From the observations and comparing to the water absorption rate for the control mix, it can be noticed that there is a decrease in the absorption rate of the Kerbstone which is as a result of the size of crushed oil palm shell used. The size of oil palm shell has a great effect on the absorption rate of the Kerbstone as the reduction in size of the shell helps in reducing the presence of pores in the kerbstone because of the ability of the shells to cover up the pores. For larger size oil palm shells, it would give a higher absorption rate because of its inability to seal up the tiny pores present in the kerbstone.

Table 9 Water Content For 50% Replacement Samples with Oil Palm Shell

Curing Age	Mean Dry weight of Kerb (kg)	Mean Wet weight of Kerb (kg)	Water (%)	absorption
7 days	15.919	16.294	2.3	
14 days	15.520	15.909	2.5	
28 days	15.592	16.086	3.1	

3.2.3. Water Absorption for Kerbstone containing oil palm shell and corn cob

From table 10, it can be observed that there is an increase in the water absorption rate from the 7th day to the 14th day. At the 7th day, the rate was observed as 9.9% and increased by 0.6% at the 14th day. There was also an increase in the rate after 28days to 10.8% which is 0.9% greater than that of 7 days and 0.3% greater than that of 14days.The results obtained in table 4.2.9 contains both oil palm shell and corn cob. The results obtained in section 4.2.2 and 4.2.3 containing corn cob only and oil palm shell only respectively can now be compared to the observation in this section. It can be observed that corn cob gave a high-water absorption rate and oil palm shell gave a low rate, but in using both in one specimen, a high-water absorption rate was observed with is as a result of the amount of corn cob present in the specimen which is greater than that of the oil palm shell and the physical property of high absorption rate of corn cob as a material. It can be noticed also that the properties of corn cob in Kerbstone production is more effective than that of oil palm shell on the water absorption property of the Kerbstone.

Table 10 Water Content For 25% Replacement Samples with Oil Palm Shell and Corn Cob Each

Curing Age	Mean Dry weight of Kerb (kg)	Mean Wet weight of Kerb (kg)	Water (%)	absorption
7 days	15.34	17.03	9.90	
14 days	14.06	15.70	10.5	
28 days	14.73	16.52	10.8	

3.3. Compressive Strength Tests

The variation of compressive strength of the control specimen and the other specimens containing oil palm shell and corn cob are shown in the sub sections below.

3.3.1. Summary on the Water Absorption rate for Kerbstone containing corn cob

From the results obtained for various percentage replacements with corn cob only in Kerbstone production shown in the table 4.19 as the summary of section 4.2.2.1 – 4.2.2.5, it can be observed that as the percentage of replacement increases, the values of compressive strength reduces. This proves that the increase in the amount of corn cob material in Kerbstone mix affects the strength and its use as a building material. A value of 7.6 N/mm^2 was achieved for the control specimen and a decrease in the value was noticed as the content of corn cob increased. These observations were also noticed for both 14 and 28 days' compressive strength values for the various percentage replacement as it increases. It can also be observed that the compressive strength value increases as the curing days increase, this shows the importance of curing in concrete. It would take a longer period for the corn cob mix to achieve a compressive strength of the control mix for only 5% since it has the closest value of compressive strength to control specimen.

Table 11 Compressive strength for various replacements with corn cob

Compressive Strength For 0%, 5%, 10%, 15%, 20%, 30% Replacement with Corn Cob

Curing Age	0%	5%	10%	15%	20%	30%
7 days	7.6	3.7	3.2	2.3	0.5	0.4
14 days	9.0	4.1	3.7	2.6	0.6	0.7
28 days	9.2	4.4	3.8	3.1	0.8	0.8

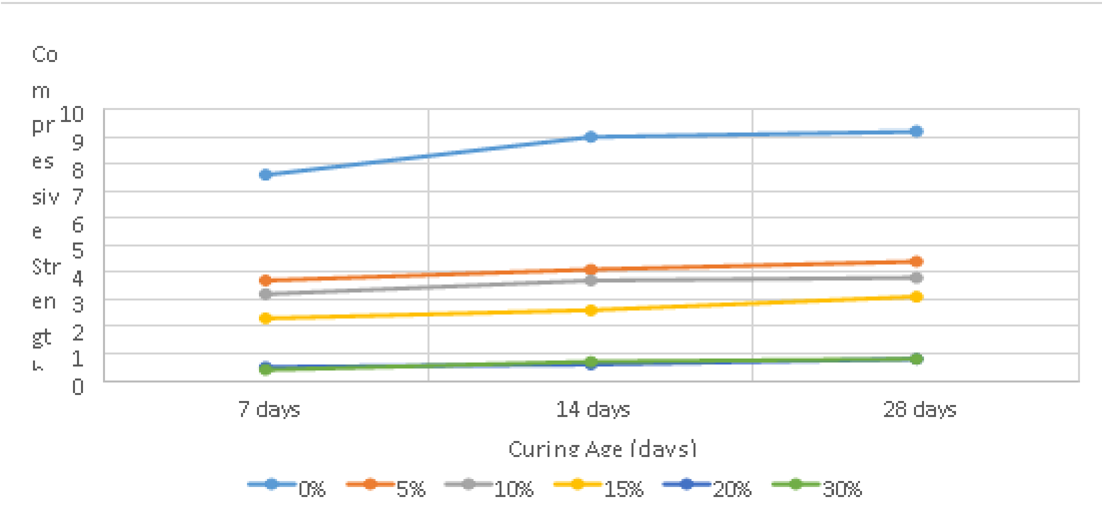

Fig. 10. Graph showing Compressive Strength For 0%, 5%, 10%, 15%, 20% and 30% replacements with corncob

3.3.3 Compressive Strength for Kerbstone containing 50% oil palm shell

Oil palm shell is an agro-waste material known to be hard and have a strong physical bond with cement paste. The size of the oil palm shell affects the compressive strength of the building materials it is used for. The medium and large size oil palm shell produce a higher compressive strength than the small size oil palm shell. From the table 4.20 below, a crushing value of 413.8kN was obtained after 7 days and a compressive strength of 6.6 N/mm$^{2.}$ There was an increase in the compressive strength and crushing value after 14 days to 7.3 N/mm^2 and 462.7 kN respectively. There was also a further increase to 568.7kN and 9.3 N/mm^2 after 28days curing. It was observed that there is an increase in the compressive strength after 28 days curing more than that of the control mix by 0.1N/mm^2 replacement which shows that oil palm shell has a great effect in increasing the strength when used for replacement of quarry dust in kerbstone production

Table 12 Table showing the compressive strength of 50% replacement with oil pam shell

Duration	Mean Crushing Value (kN)	Compressive Strength (N/mm^2)
7 days	413.8	6.6
14 days	462.7	7.3
28 days 568.7 9.3		

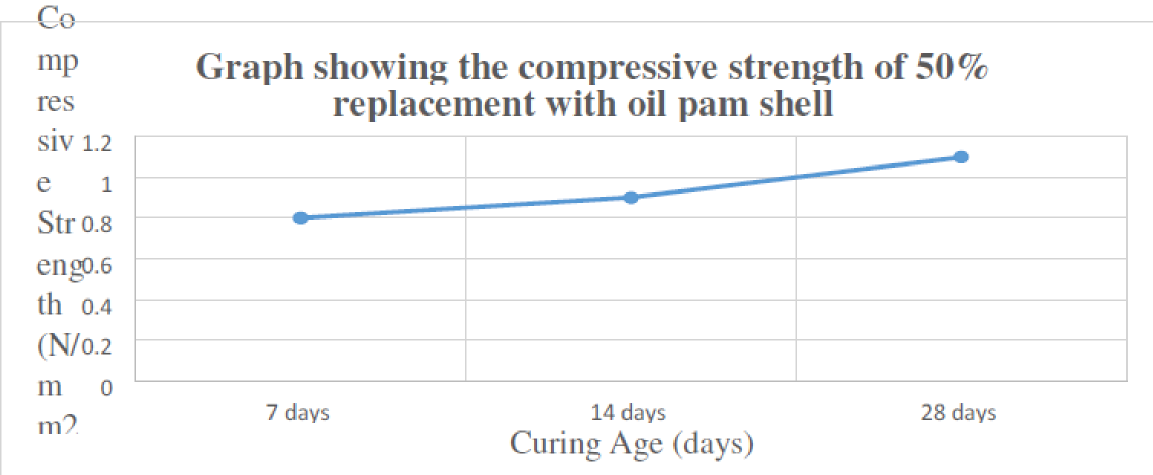

Figure 11 Bar chart showing the compressive strength of 50% replacement with oil pam shell

3.3.4. Compressive Strength for Kerbstone containing oil palm shell and corn cob

From the table 4.21 below, the compressive strength observed for the specimen containing both oil palm shell and corn cob after 7 days is 41kN and 0.8 N/mm^2 and an increase to 46.2kN and 0.9N/mm^2 after 14 days. The optimum compressive strength and crushing value was attained after 28 days as 48.5kN and 1.1 N/mm^2. From the results obtained, it can be observed that corn cob has more effect in reducing the compressive strength of the specimen when combined with oil palm shell which is as a result of the of the amount of corn cob contained in the mix and its negative property as use for strength on building materials.

Table 13 Table showing the compressive strength of 25% replacement with oil pam shell and corn cob each

Duration	Mean Crushing Value (kN)	Compressive Strength (N/mm^2)
7 days	41.0	0.8
14 days	46.2	0.9
28 days	48.5	1.1

Figure 12 Bar chart showing the compressive strength of 25% replacement with oil pam shell and corn cob each

4. CONCLUSION

This project was set to investigate the suitability of using oil palm shell and corn cob for partial replacement of quarry dust in kerbstones. It has been shown that it is possible to replace quarry dust with corn cob and oil palm shell at 5% and 50% respectively and still obtained reasonable physical properties. Results obtained showed that the slump value decreases as the corn cob content increases which is as a result of the presence of silica compound while the slump value increase as the oil palm shell increases to produce a medium degree of workability. From the results obtained for the compressive strength, the strength increases as the curing age increases but it decreases as the percentage of replacement with the agro-waste increases. The replacement with corn cob also gave a very high water absorption and a low absorption with oil palm shell replacement. Replacing corn cob at 5% and 10% gave a good water absorption rate of 5.2% and 6.3% while for 50% replacement, a rate of 3.1% was achieved after 28 days. This study has shown that oil palm shell and corn cob as agro-waste at 50% and 5% replacement respectively can serve as a suitable replacement for quarry dust in the production of kerbs. The use of superplasticizer can help improve the characteristics of this materials.

The following recommendations were drawn from the findings of this research:

- To improve the mechanical properties of kerbs produced using corn cob at 50% and oil palm shell at 5%, it is recommended the further investigation be done on the use of super plasticizer on the materials be done to see its effect on the mechanical properties of the kerb.
- An alternative agro-waste material should be tested for to see if it gives a better characteristic than that of oil palm shell and corn cob.
- Further investigation should be done on possibility of using a higher amount of oil palm shell for replacing the quarry dust in kerb production.
- Further investigation should be done in identifying the agro-waste material which can be used for total replacement of the granites in the production of kerbs.

REFERENCES

[1] Falade, F., Ikponmwosa, E. E., &Ojediran, N. I. (2010). Behaviour of lightweight concrete containing periwinkle shell at elevated temperature. *Journal of Engineering Science and Technology*, *5*(4), 379-390.

[2] Atoyebi, O. D., Modupe, A. E., Aladegboye, O. J., &Odeyemi, S. V. (2018). Dataset of the Density, Water Absorption and Compressive Strength of Lateritic Earth Moist Concrete. *Data in Brief.* https://doi.org/10.1016/j. dib.2018.07.032i

[3] ACI Committee 213, Guide for structural lightweight aggregate concrete. (1987) (ACI 213R-87). Farmington Hills (MI): American Concrete Institute.

[4] ACI116R. (2000) Cement and concrete terminology.

[5] Alengaram UJ, Jumaat MZ, Mahmud H, Fayyadh MM (2011) Shear behaviour ofreinforced palm kernel shell concrete beams. Construction Building Material; 25:2918– pp. 27.

[6] Alengaram UJ, Jumaat MZ, Mahmud H. (2008) Ductility behaviour of reinforced palm kernel shell concrete beams. Europe Junior Science Research.;23(3):406– pp. 20.

[7] Alengaram UJ, Jumaat MZ, Mahmud H. (2008) Influence of cementitious materials and aggregates content on compressive strength of palm kernel shell concrete. International Junior Physical Science ;8(18):3207–pp. 13.

[8] Alengaram UJ, Mahmud H, Jumaat MZ, Shirazi SM. (2010) Effect of aggregate size and proportion on strength properties of palm kernel shell concrete. International Junior Physical Science;5(12):1848– pp. 56.

[9] Alengaram UJ, Mahmud H, Jumaat MZ. (2010) Comparison of mechanical and bond properties of oil palm kernel shell concrete with normal weight concrete. International Junior Physical Science;5(8):1231– pp. 9.

[10] Alengaram UJ, Mahmud H, Jumaat MZ. (2010) Development of lightweight concrete using industrial waste material, palm kernel shell as lightweight aggregate and its properties. In: 2nd International conference on chemical, biological and environmental engineering. 277–pp. 81.

[11] Alengaram UJ, Mahmud H, Jumaat MZ. (2011) Enhancement and prediction of modulus of elasticity of palm kernel shell concrete. Material Design;32(4):2143–pp. 8.

[12] Ali AAA. (1984) Basic strength properties of lightweight concrete using agricultural wastes as aggregates in low-cost housing for developing countries. India: Roorkee.

[13] Babu KG, Babu SD. (2003) Behaviour of lightweight expanded polystyrene concrete containing silica fume. Cement Concrete Research;33(5):755–pp. 62.

[14] Basri HB, Mannan MA, Zain MFM. (1999) Concrete using waste oil palm shells as aggregate. Cement Concrete Research;29(4):619– pp. 22.

[15] Chia KS, Zhang M-H. (2002) Water permeability and chloride penetrability of high strength lightweight aggregate concrete. Cement Concrete Research ;32(4):639–pp. 45

[16] Committee ACI. 213 Guide for structural lightweight aggregate concrete.

[17] Gunasekaran K, Kumar PS, Lakshmipathy M. (2011) Mechanical and bond properties of coconut shell concrete. Construction Building Material;25(1):92–pp. 8.

[18] Hemmings RT, Cornelius BJ, Yuran P, Wu M. (2009) Comparative study of lightweight aggregates. In: 2009 world of coal ash (WOCA) conference. Lexington, KY, USA.

[19] L. Marhall. (1972) The Thermal Properties of Concrete. Building Science. (7): 167-174.

[20] Lightweight concrete made from crushed oil palm shell: Tensile strength and effect of initial curing on compressive strength. Construction and Building Materials. (27): 252–258.

[21] M.A. Mannan., J. A., C. Ganapathy., D.C.L. Teo. (2006) Quality improvement of oil palm shell (OPS) as coarse aggregate in lightweight concrete. Building and Environment. (41): 1239–1242.

[22] Mahmud H, Jumaat MZ, Alengaram UJ. (2009) Influence of sand/cement ratio on mechanical property of palm kernel shell concrete. Junior Applied Science;9(9):1764–pp. 9.

[23] Mannan MA, Alexander J, Ganapathy C, Teo DCL. (2006) Quality improvement of oil palm shell (OPS) as coarse aggregate in lightweight concrete. Building Environment.;41(9):1239– pp. 42.

[24] Mannan MA, Ganapathy C. (2001) Long-term strengths of concrete with oil palm shell as coarse aggregate. Cement Concrete Research;31(9):1319– pp. 21.

[25] Mannan MA, Ganapathy C. (2001) Mix design for oil palm shell concrete. Cement Concrete Research;31(9):1323– pp. 5.

[26] Mannan MA, Ganapathy C. (2002) Engineering properties of concrete with oil palm shell as coarse aggregate. Construction Building Materials;16(1): pp. 29–34

[27] Mannan MA, Ganapathy C. (2004) Concrete from an agricultural waste-oil palm shell(OPS). Building Environment; 39:441– pp.8.

[28] N. Abullah, F. Sulaiman, H. Gerhouser, A. Shariff. (2011) An outlook of Malaysian energy, oil palm industry and its utilization of waste as useful resources. Biomass and Bio energy. (35): 3775-3786.

[29] Ndoke PN. (2006) Performance of palm kernel shells as a partial replacement for coarse aggregate in asphalt concrete. Leonardo El J Practical Technology;5(9):145–pp. 52. 34 Pantzaris TP, Ahmad MJ. (2001) Properties and utilization of palm kernel oil. MPOB