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Short Communication

CRUSHED PALM KERNEL SHELL AS A PARTIAL REPLACEMENT OF FINE AGGREGATE IN ASPHALTIC CONCRETE

Mohammed, H[1], Afolabi, K. O[1]. and Umoru, L .E[2]

[1]Department of Civil Engineering, Obafemi Awolowo University, Ile - Ife, Nigeria,
[2]Department of Material Science and Engineering, Obafemi Awolowo University, Ile - Ife, Nigeria,

GSM No. +2348037252038
E-mail: hmesteem@yahoo.com and hmohammed@oauife.edu.ng.

Abstract

This paper presents a preliminary assessment of some properties of asphaltic concrete, with partial replacement of fine aggregate (sand) with crushed palm kernel shell. The asphaltic concrete sample of mixed proportions by weight was prepared with, fine aggregate (66%), coarse aggregate (14 % - 12 mm granite size, 14 % - 20 mm granite size), quarry dust (6 %) and bitumen (6.3 %) using standard procedure. Four samples with partial replacement of the fine aggregate with crushed palm kernel shells in proportions of 10, 30, 50 and 70 % by weight were prepared. Marshall Stability tests were thereafter carried out on the samples, and the stabilities and flows were determined. The marshal stabilities at 0, 10, 30, 50 and 70 % replacement of fine aggregate (sand) with crushed palm kernel shell were, 6.90, 6.50, 6.30, 4.75 and 3.21 kN, respectively; while the corresponding flows were 2.75, 2.45, 1.87, 295 and 4.00 mm respectively. The results showed that, the samples with 10 and 50 % partial replacement of fine aggregate (sand) with crushed palm kernel shell determined properties were within the Specifications for asphaltic concrete roads.

Keywords: : Asphaltic concrete, Fine aggregate, Crushed palm kernel shell, Marshal Stability, and General specification (Roads and Bridges).

Introduction

Palm kernel shells are not common materials in the construction industry. This is either because they are not available in very large quantities as sand or gravel, or because their use for such, has not been encouraged. For some time now, the Nigerian government has been clamouring for the use of local materials in the construction industry to limit costs of construction. There has therefore been a greater call for the sourcing and development of alternative, non conventional local construction materials. Palm kernel shells are derived from the oil palm tree (*elaeis guineensis*), an economically valuable tree, and native to western Africa and widespread throughout the tropics [1].

The oil palm (*elaeis*) is comprised of two species of the *arecaceae* or palm family. They are used in commercial agriculture in the production of palm oil. The African oil palm *elaeis guineensis* is native to West Africa, occurring between Angola and Gambia, while the American oil palm *elaeis oleifera* is native to tropical Central America and South America. The generic name is derived from the Greek word for oil, *elaion,* while the species name refers to its country of origin [2].

In Nigeria, about 1.5 million tons of palm kernel shells are produced per annum; most of which are often dumped as waste products [3]. This waste could therefore be converted to wealth, by way of its use in the production of asphaltic concrete, a major material in pavement construction.

Asphaltic concrete is derived from a mixture of coarse and fine aggregates, stone dust, mineral fillers and binder, usually bitumen. The mix is done such that the finished product does not have too much bitumen which will eventually lead to a bleeding and frictionless surface, or too much coarse aggregate to lead to ravelling of the surface. The bitumen and aggregates are usually mixed and heated at a central location. Asphaltic concrete surfaces are fairly easy to construct and repair [4].

This paper, presents a report of a preliminary assessment of some properties of asphaltic concrete, with partial replacement of fine aggregate (sand) with crushed palm kernel shell.

Materials and Method

Palm kernel shells were obtained locally and crushed. Other materials like sand, quarry dust (filler), crushed granite and bitumen were obtained from Pama & Abog Group of Company site at Ile-Ife, Osun State of Nigeria.

The grain size distributions uniformity coefficients, the specific gravities of the fine aggregate (sand) and the crushed palm kernel shells were thereafter determined.

Asphaltic concrete sample of mixed proportions by weight, fine aggregate (66%), coarse aggregate (14 % - 12 mm granite size, 14 % - 20 mm granite size), quarry dust (6 %) and bitumen were prepared using standard procedure. Furthermore, four samples with partial replacement of fine aggregate with crushed palm kernel shells in proportions of 10, 30, 50 and 70 % by weight were prepared.

Marshall Stability tests were thereafter carried out on the samples, and the stabilities and flows were determined [5].

The values were thereafter compared with those prescribed in the General Specifications (Roads and Bridges)[6], as shown on Table 1.

Results and Discussion

The specific gravities of the fine sand and crushed palm kernel shells were found to be 4.34 and 2.25, respectively. These values showed that the sand is heavier than the crushed palm kernel shells. The grain size distribution curves for the fine aggregate (sand) and crushed palm kernel shell are shown in Figures 1 and 2, respectively. The characteristic curves are typical of those of uniform sands [7] and are corroborated by their uniformity coefficients of 2.08 and 2.0 for sand and crushed palm kernel shells, respectively. The plot of the Marshall stability against the mix proportions (Figure 3) indicates that as the percentage replacement of the fine sand increases, the stability value decreases. This is expected since the replacement of the sand with crushed palm kernel shells, is expected to have an overall reducing effect on the density of the asphaltic concrete.

Also, Figure 3 depicts the variation of flow against mix proportions.

The mixes that have very low flow values and very high Marshall Stability values are considered too brittle and rigid for use in highway pavements. High flow values, however, indicate mixes that are too plastic and could deform easily under traffic loading [8]. As indicated in the Figure 3, the flow value at 30 % is too low as the mix would result in too brittle and rigid asphaltic concrete for use in flexible pavement. The samples with 10 and 50 % replacement of fine aggregate with crushed palm kernel meet the requirements for asphaltic concrete [6]. Though the flow value of the sample with 70 % partial replacement of sand with crushed palm kernel shells is within the allowable range (for flow), its stability value falls slightly below Federal Ministry of Works and Housing specification

Conclusion

In conclusion, this preliminary investigation has shown that replacement of some proportions of fine aggregate (sand) with crushed palm kernel shells is capable of imparting positively on some properties of asphaltic concrete.

In addition, the study has been able to establish that not only is uniform grain size distribution achievable from crushed palm kernel shell, the 10 and 50 % by weight replacement of fine aggregate with crushed palm kernel, satisfactorily supports the requirements for asphaltic concrete

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Table 1: Properties of Compacted Asphaltic Concrete

PROPERTY	BASE COURSE	WEARING COURSE
OPTIMUM BITUMEN CONTENT (%)	4.5- 6.5	5.0 - 8.0
STABILITY (kN)	3.5	3.5
FLOW (mm)	2– 6	2 – 4

Source: Federal Ministry of Works (1997)

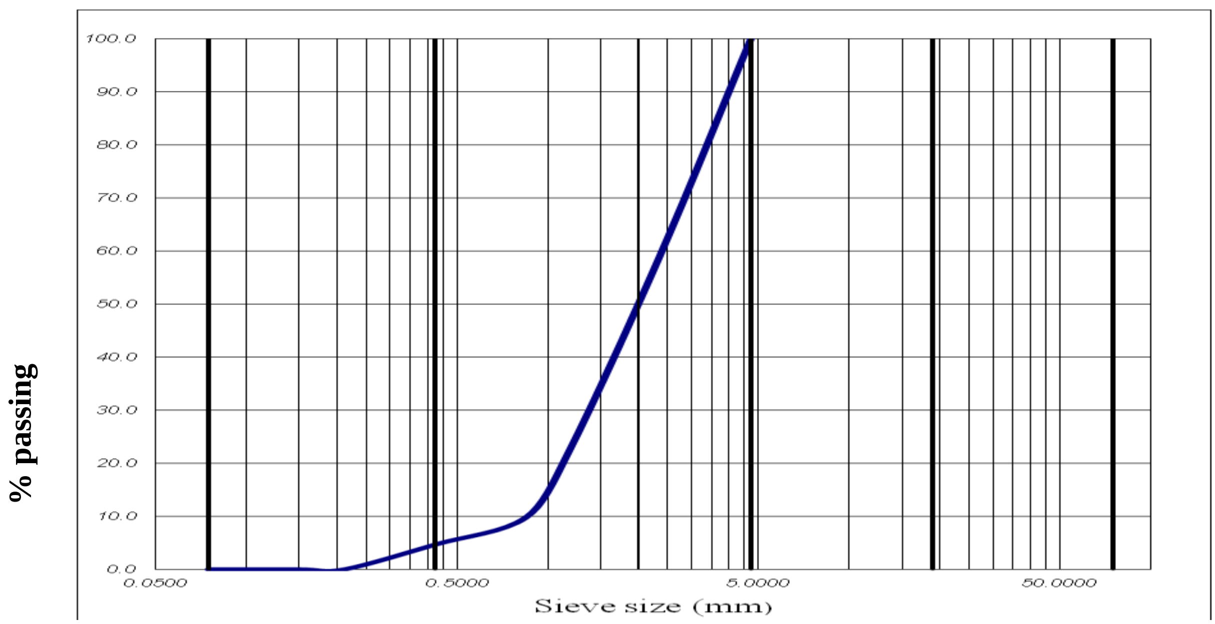

Figure 1: Grain Size Distribution Curve Fine Aggregate

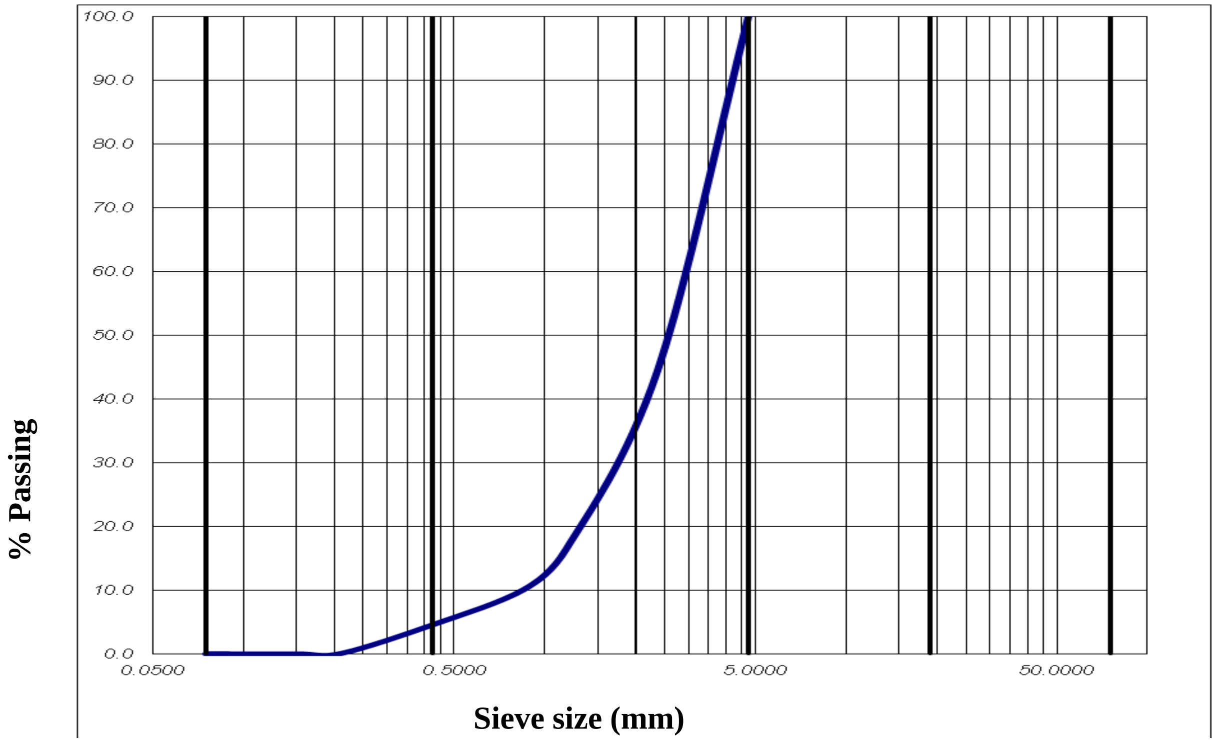

Figure 2: Grain Size Distribution Curve for Crushed Palm kernel Shell

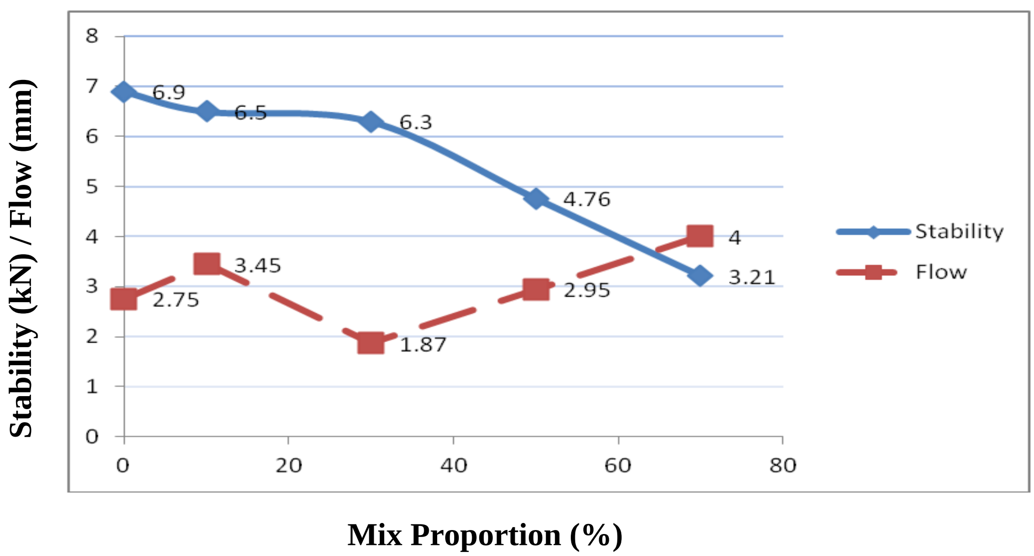

Figure 3: Marshall Stability / Flow versus Mix Proportion