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Effect of granite dust on the performance charactristics of kernelrazzo floor finish

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Abstract

This study is part of an on-going research on the durability performance of kernelrazzo, a type of terrazzo floor finish. It investigated the effect of partial replacement of the coarse aggregate with granite dust on the compressive strength, water absorption capacity and density of kernelrazzo. Two mix ratios (1:3 and 1:4), varying aggregate replacements of marble chipping with burnt palm kernel shells amounting to 0%, 25%, 50%, 75% and 100%, varying percentage replacements of all coarse aggregates with granite dust amounting to 0%, 10%, 30% and 50% were used. Cost comparisons were also made. Test results showed that the compressive strength of kernelrazzo increases up to a maximum of 30% coarse aggregate replacement by granite dust for both mixes for 0–50% replacement of marble chippings with palm kernel shells. For 75–100% marble chippings replacement, the compressive strength increases with increasing amount of granite dust. The water absorption capacity and density (upto 30% of granite dust) decrease and increase, respectively, with increase in percentage of granite dust. The cost of kernelrazo decreases with increase in the percentage of replacement of coarse aggregates with granite dust, except for 100% marble chipping replacement. It was recommended that to produce a good kernelrazzo floor finish in terms of strength, durability, density, water absorption capacity and cost, the overall coarse aggregate should not contain more than 50% of palm kernel shells for 1:4 and 1:3 mix ratios with a maximum of 30% aggregate replacement with granite dust.

Keywords: Compressive strength; Palmkernel shells; Kernelrazzo; Terrazzo; Granite dust; Water absorption

1. Introduction

The quest for affordable housing in Nigeria brought out the need for this study. Since materials cost accounted for two-third of the building production cost, it is necessary to look for a way of cutting down conventional material costs. One of the suggestions in the forefront has been the sourcing, development and use of readily available local materials suitable for the production of any component of a building. One of such local materials which previous studies [1] have indicated would be suitable for floor finish construction is palm kernels. When palm kernel replaces either partially or wholly the marble chippings in terrazzo, the resulting product is termed KERNELRAZZO. Palm kernel shell is a waste product in the agricultural sector and is available in large quantities in Nigeria. A first study on the use of palm kernels as an aggregate in floor finish reveals that the surface appearance of the Precast and in situ kernelrazzo tiles and floor, started fading out after two years of exposure.

From the slump test, it was discovered that the mix with 100% palm kernel shell has no slump and indicates a loose and cohesionless mix. Durability is a function of the force of cohesion between particles; it follows that the floor finish produced from this mix may not possess long-term durability.

To solve these problems, granite dust was chosen as a fine aggregate to be added to the mix to act further as a binding agent and ultimately improve the strength and durability properties of kernelrazzo. Granite dust was chosen because

1. The grain size analysis of granite dust showed that it is well distributed with grain size of 0.075–2.36 mm with more dusty particles which implies more cohesion than when sand is used.

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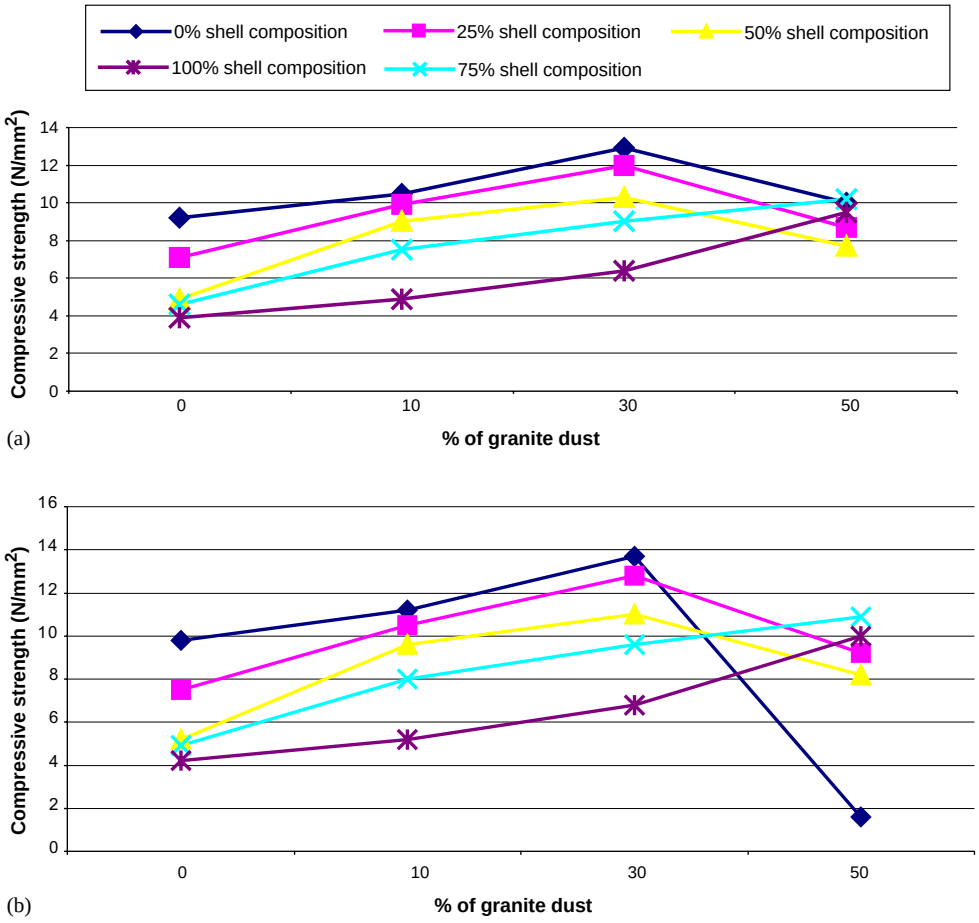


Fig. 1. (a) Graph of 7 days compressive strength (1:4); (b) graph of 7 days compressive strength (1:3).

2. The parent material of granite dust, that is, granite has similar properties with marble chippings, which are used for terrazzo flooring.
3. The use of granite dust in the Nigerian Construction Industry is limited to few construction works. Hence if proved adequate, it's use in production kernelrazzo would provide another avenue for economical use of granite dust.

Hence, this study forms part of an on-going research on the durability performance of kernelrazzo. It investigated the effect of partial replacement of the coarse aggregate with granite dust on the compressive strength, water absorption capacity and density of kernelrazzo.

2. Experimental programme

The palm kernel shells were obtained from a local palm mill in Ajebandele, Ile-Ife in Ife Central Local Government Area of Osun State of Nigeria. It was obtained in the already cracked and oil-extracted form, fibrous outer parts of the nut already removed. It was kept indoors in sacks for two months. It was washed and graded in accordance with [2] for lightweight aggregates and as stated in [3]. The sieve analysis of the shell was carried out in accordance with the provision of [4] and the sample corresponds to the requirements of the nominal size of graded aggregate of 14–15 mm. Terrazzo chippings were obtained from a nearby city (Ibadan) and transported to the laboratory in barley bags. The cement used as the binding agent was the Ordinary Portland Cement (OPC) and the water was a portable drinking water. Granite dust was obtained from a nearby quarry.

Open air burnt palm kernel shells were used throughout the experiment. Details of the physical characteristics of palm kernel shells and the preparation of the precast kernelrazzo tiles can be obtained from the first report in Ref. [1].

Two mix ratios (1:3 and 1:4), varying aggregate replacements of marble chippings with burnt palm kernel shells amounting to 0%, 25%, 50%, 75% and 100%, varying percentage replacement of all coarse aggregates with granite dust amounting to 0%, 10%, 30% and 50% were used. The kernelrazzo mixes and cubes were prepared in accordance with the provisions of Ref. [5, Part 108]. However, $100 \times 100 \times 100$ mm steel moulds were used in this test.

A minimum of three cubes were cast for strength and density tests and another three cubes were used in water absorption test of each variable tested.

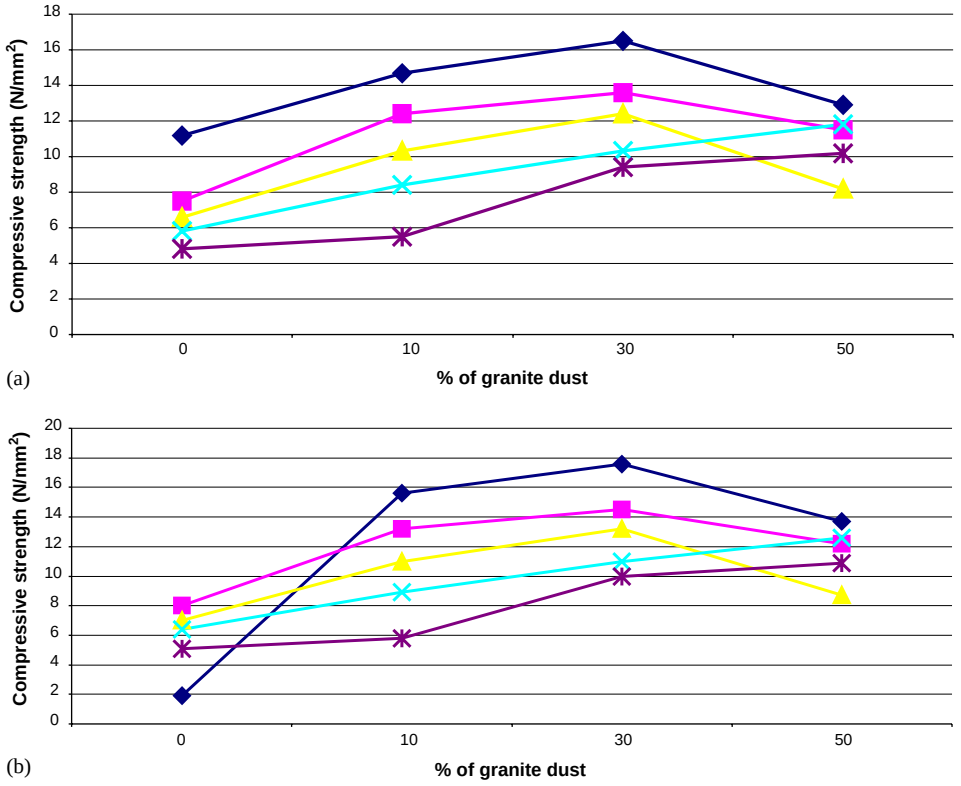


Fig. 2. (a) Graph of 14 days compressive strength (1:4); (b) graph of 14 days compressive strength (1:3).

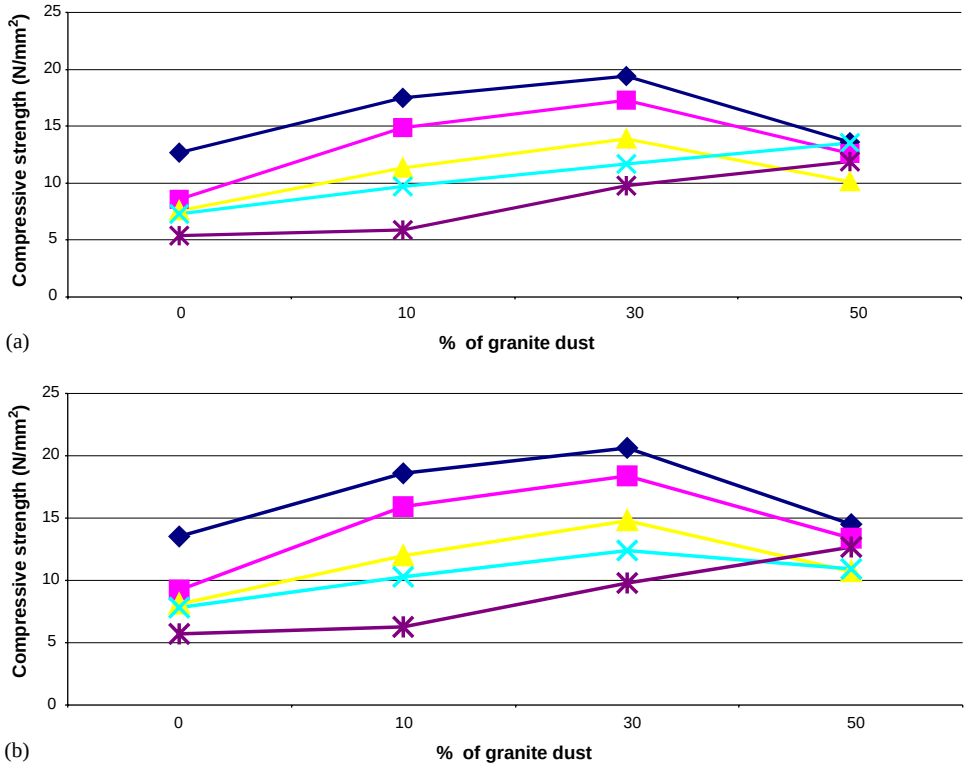
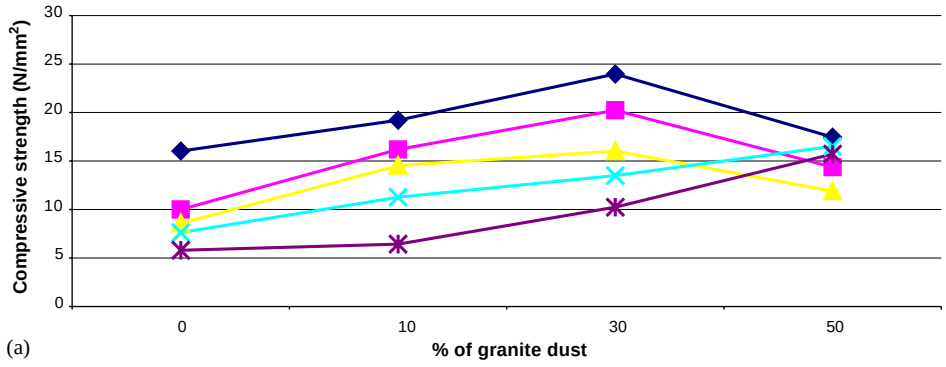
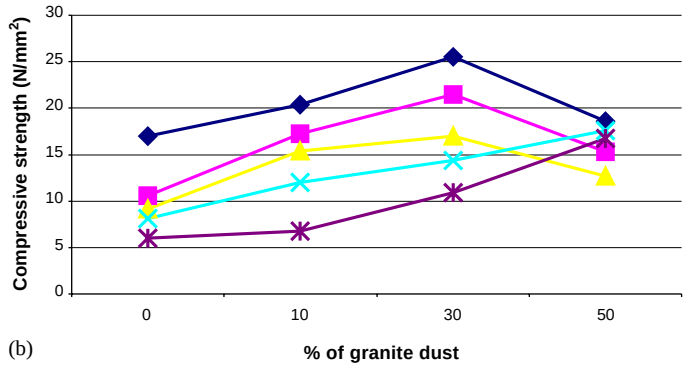


Fig. 3. (a) Graph of 21 days compressive strength (1:4); (b) graph of 21 days compressive strength (1:3).

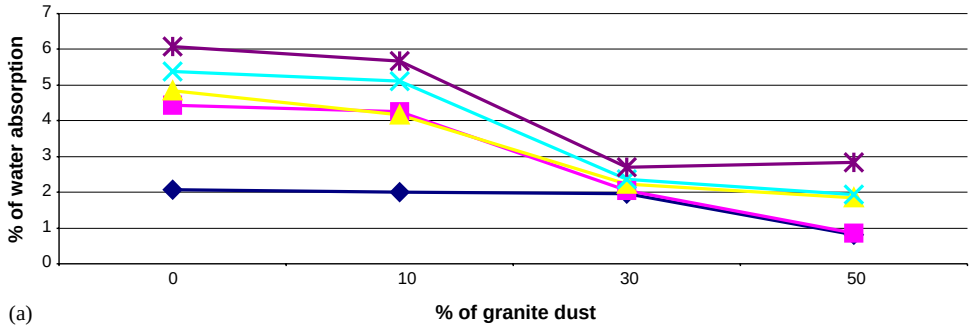


(a)

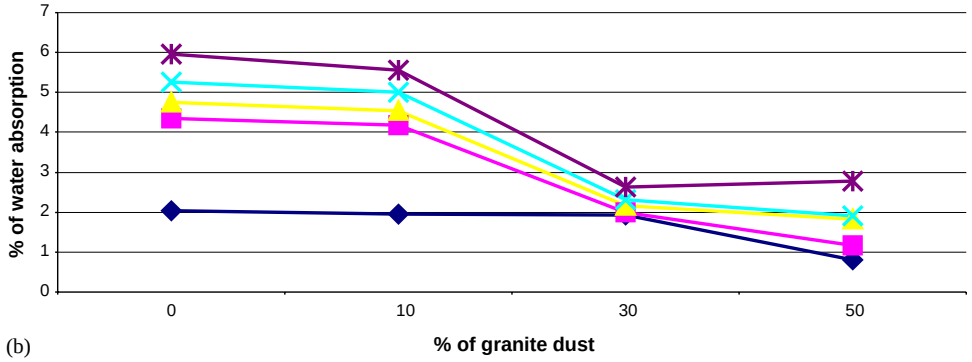


(b)

Fig. 4. (a) Graph of 28 days compressive strength (1:4); (b) graph of 28 days compressive strength (1:3).



(a)



(b)

Fig. 5. (a) Graph of %water absorption (1:4); (b) graph of %water absorption (1:3).

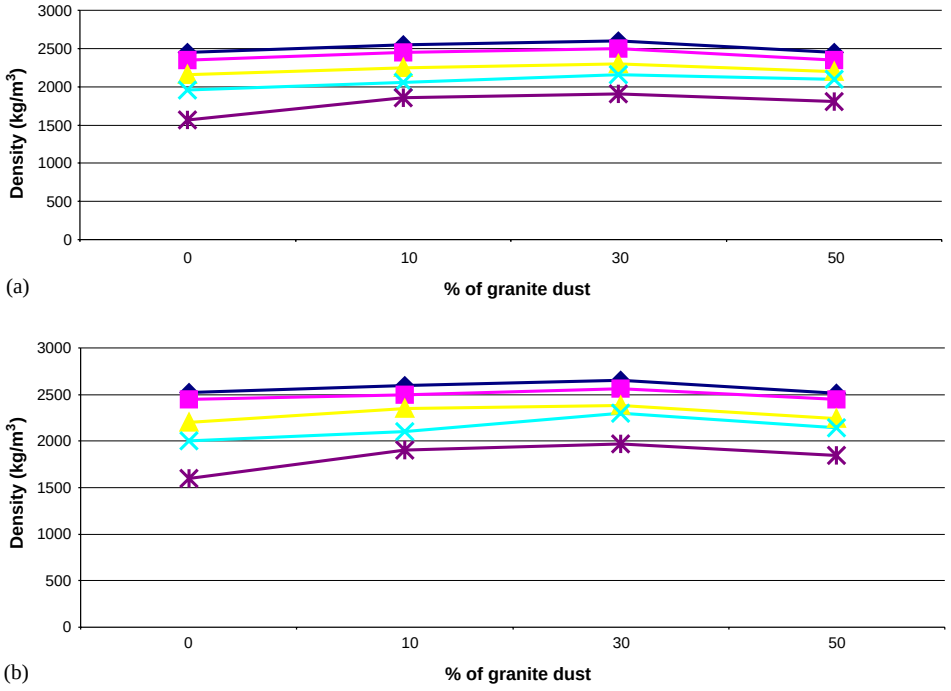


Fig. 6. (a) Graph of density cubes (1:4); (b) graph of density cubes (1:3).

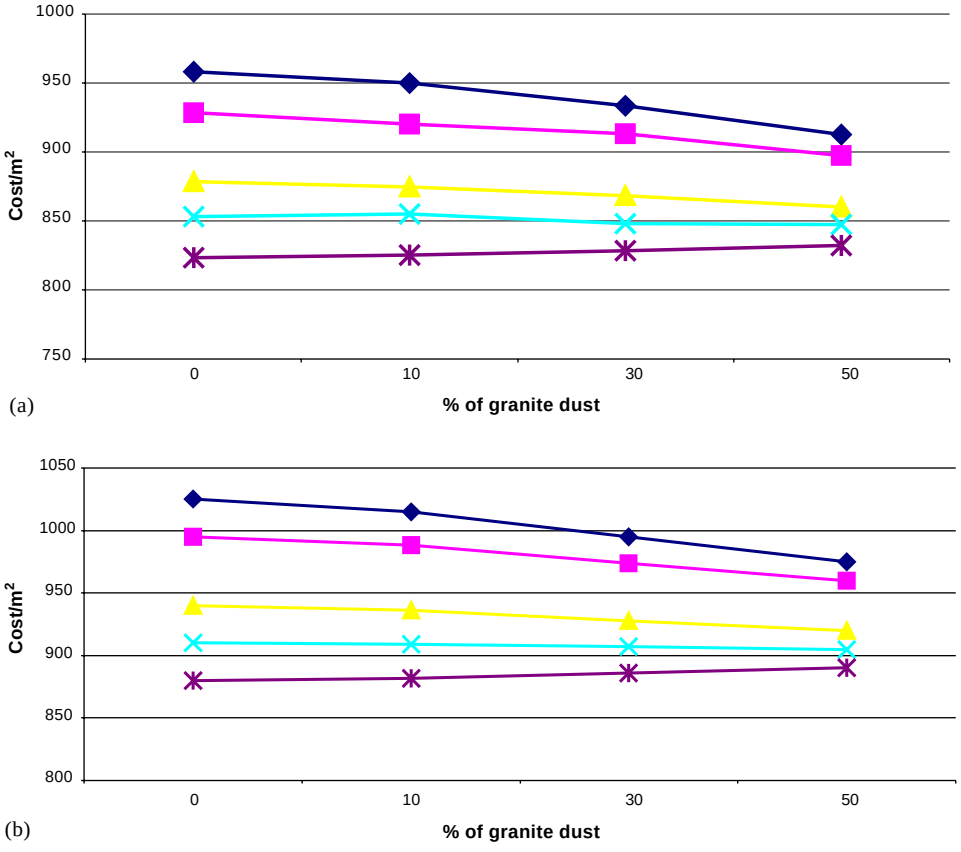


Fig. 7. (a) Graph of cost comparison (1:4); (b) graph of cost comparison (1:3).

3. Tests results and discussion

Compressive strength. The results showed that the compressive strength of the cubes increases with increase in the percentage substitution of granite dust up to 30% and decreases afterward for both mixes (Figs. 1–4). For the 75% and 100% palm kernel shell composition, the compressive strength increases with the increase in amount of granite dust. This is probably because the shell, being a lightweight aggregate, and in largest proportion in this mix, has not much strength and still relies on the cohesion caused by the introduction of granite dust.

Water absorption capacity. The water absorption tests showed that the percentage water absorption decreases with increase in the percentage substitution of granite dust (Fig. 5). Unlike in kernelrazzo without granite dust, the introduction of the granite dust, being a fine aggregate, causes the interstitial spaces to be filled. A compact cohesive structure able to resist water penetration is created.

Density. Fig. 6 shows the variation of density of cubes with the percentage composition of granite dust. The density of the cubes increases with the percentage increment of granite dust. However, it appears that beyond 30% granite dust composition, the density decreases. The implication of this proportionate increase of density with percentage composition of granite dust is that more weight will be exerted on the floor and on the building as a whole. This is because the design and construction load on the building increases with a consequential increase in the cost of building.

However, the weight of 50%, 75% and 100% palm kerned shell is lower compared to the 0% and 25% palm kernel shell replacement. This means that a level between 50% and 100% palm kernel shell composition and the corresponding granite dust replacement can still be used to minimise the total load on the building. Nevertheless, balance should be struck between density and the other deciding factors.

Cost analysis. Interestingly, the cost of the kernelrazzo decreases as the percentage addition of granite dust increases (Fig. 7).

Aesthetic. The Precast tiles were quite appealing aesthetically. The marble chippings were used to create a contrast with the black palm kernel shell and the result was an aesthetically excellent floor finish.

4. Conclusion and recommendations

The compressive strength of kernelrazzo increases till coarse aggregate replacement by granite dust reaches a maximum of 30% for both mixes and it increase till 0–50% replacement with marble chippings with palm kernel shells. For 75–100% marble chippings replacement, the compressive strength increases with increase in the amount of granite dust. The inclusion of the granite dust also results in reduction in water absorption capacity of kernelrazzo and an improvement in its durability. Except for 100% marble chipping replacement, the unit cost of kernelrazzo decreases with increase in the percentage composition of granite dust. There is thus an advantage as strength is gained while cost is reduced. Similarly, aesthetics was not adversely affected by inclusion of granite dust. Hence, it would not be out of place to recommend that to produce a good kernelrazzo floor finish in terms of strength, durability, density, water absorption capacity and cost, the overall coarse aggregate should not contain more than 50% of palm kernel shells for 1:4 and 1:3 mix ratios with a maximum of 30% aggregate replacement with granite dust. Expecting studies on the long-term exposure performance resistance to chemical attack and thermal conductivity characteristics of kernelrazzo containing granite dust to yield satisfactory results, it will no doubt be widely acceptable as a floor finish and will in provide affordable housing for the low and medium income earners in Nigeria.

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