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Geotechnical Evaluation of Termitarium within Akure, Nigeria

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Abstract: Termites attack on building materials such as planks is highly destructive. The positive contribution of termites to the environmental soil was examined in this research. Three termitaria were selected randomly within Akure, Nigeria. Soil samples were taken at the cores of each termitarium and also 4m away from both sides. Biological characteristics of the contained termites were examined using quadrat method for identification and to study how to induce these improvements in the reworked soil. Geotechnical properties of the reworked soils were examined such as sieve analysis, specific gravity, moisture content etc. These results were compared with each other with respect to the termite specie contained in each mound to analyze which is the best specie to induce geotechnical improvements. The result revealed that termites are of different species and they use different materials to improving soil properties. It was observed that the geotechnical properties of termitaria are far better than the adjacent or surrounding soils. The improvement was traced to the activities of termites in the termitaria.
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1. Introduction

Termites are an important soil forming factor in many areas helping in soil turnover and creating small zones of better aerated and more fertile soils by bringing soil materials up from underneath to the surface (Adeyemi, Salami, 2004). Nest construction by termites range from inconspicuous below ground chambers to large above ground mounds called termitarium. The termitaria are built of soil and earth particles which are cemented together to form hard brick-like material which are very resistant to weathering and erosion as well as very difficult to chip with a sharp pick. (Olowofoyeku et al, 2016).

Termites are of the genus Macro-termes through activity of mound and subterranean gallery construction and soil particle redistribution alter mineral and organic soil composition, topography, hydrology, drainage and nutrient flow rates which can ultimately influence vegetation and regional biodiversity (Dangerfield et al. 1998). These modifications of soil properties associated with termitaria further affects tree establishment and plant species composition and richness which ultimately alter the distribution of other vertebrate and invertebrate animal species (Longair, 2004.). In civil engineering discipline, soil is very important because nearly all structures are constructed in or on the surface of the earth. Therefore, the nature of the soil at locations is very vital to Civil Engineers. The earth underneath the foundation is heterogeneous materials that are considered in design and construction of structures. Prior to foundation design, site investigation is embarked upon and the results are used in the design exercise. Since soil is heterogeneous in nature, during settingout aspect of project construction, termitaria are seen and these structures are different from the surrounding soil by physical inspection and need to be investigated (Ayininuola, 2014). There have been some studies on soil stabilization (e.g. Correia et al. 2016; Oluwatuyi et al. 2020; Puppala, 2016; Erlingsson et al. 2017; Zoriyeh et al. 2020).

The soil associated with termitaria typically has lower soil bulk density and elevated mineral carbon, nitrogen, phosphorus, magnesium, calcium, and clay content compared to the surrounding adjacent soils to the termitaria (Sileshi *et al*, 2010). (Ayininuola, 2009). Abe and Oladapo, 2014) recorded a higher organic carbon content, C/N ratio, Ca, Mg, K and P in termitaria of Macrotermes and Odontotermes spices than the surrounding soils in Nigeria. Furthermore, due to the fact that termites are bioturbators, they are responsible for the higher levels of the metals in termitaria soil since termites are known to feed on organic matter which could result in elevated levels of elements in termitaria.

Konate, *et al* (1998) discovered that there were elevated levels of the iron and titanium in termitaria soils compared to the surrounding soils in their quest in finding various means of prospecting for these two metals. They therefore concluded that termitaria sampling can be used as preliminary step in mineral prospecting since they provide an indication of the potential of the positive anomaly, and enables a judgment on the scale of the ore metal accumulation. Generally, soils are being reworked by the activities of termites. The determination of the effect of reworking by termites on the geotechnical properties of the soil and the use of these termitaria as an engineering material is a major objective of this research.

2. Materials and Methods

Three termitaria were selected randomly from three different locations which is Opposite Font Hall, along Ilesha garage, Akure Nigeria. Other samples were taken from Ilesha-Akure Expressway, Akad area, Akure, and the last sample from Behind Deeper Life Camp Ground, Along Ipinsa, Akure. Surrounding soil samples were collected from 4m away at both sides from the mounds.

At each termitarium location, three samples location were established. Each site represented as A, B and C with position 1 referring to the termitarium core while position 2 and 3 refers to the 4m surrounding soils away from the termitarium. The samples collected from each site have been then transported to soil and biology laboratory for testing its geotechnical properties and identification of termite species present in each mound respectively. The geotechnical properties that were examined are sieve analysis, specific gravity and moisture content.

Biological test was conducted on the workers of the termite specie. The worker which is the major engineer in nest building was taken from the anthill and was taken to the laboratory for testing. They were collected in a container and were preserved using a preservative (85% alcohol- 15% water) in the laboratory. Using this preservative maintains the quality of the sample for the entire duration before the expected result is achieved. This would be achieved after keeping the sample for complete 72-120 hours in 85% ethanol. There are two methods used in termite identification in the laboratory, they are transact and quadrat/conventional methods.

Quadrat method is used for this study because it is a simple method and easily available.

Fig 1. One of the termitaria prior to sampling.

3. Results and Discussions

Table 4.1 gives the result of the biological analysis of termites. The test revealed that termite mounds vary with termite species and also with location. Each species has different characteristics. Termite species look alike physically but subjecting them to biological identification dictates their differences. These differences are within their morphological and physiological structures. The characteristics of each specie dictates the type of mound formed and even how finer their soil particles are. The result of the test is specified below:

Table 4.1: Biological Analysis of Termite

Sample	Specie	Mode of Mound Formation
A	Ancistrotermes spp	Uses plant remains/ other dirts in their surroundings and the soils with their saliva for cementation
B	Macrotermes Subhyalinus	Uses their waste products and saliva to cement the reworked soils.
C	Amitermes	Uses plant remains/ other fungus remains for cementation with their saliva

Table 4.2: Specific Gravity

A1	2.66
A2	2.5
A3	2.62
B1	2.67
B2	2.39
B3	2.51
C1	2.71
C2	2.57
C3	2.41

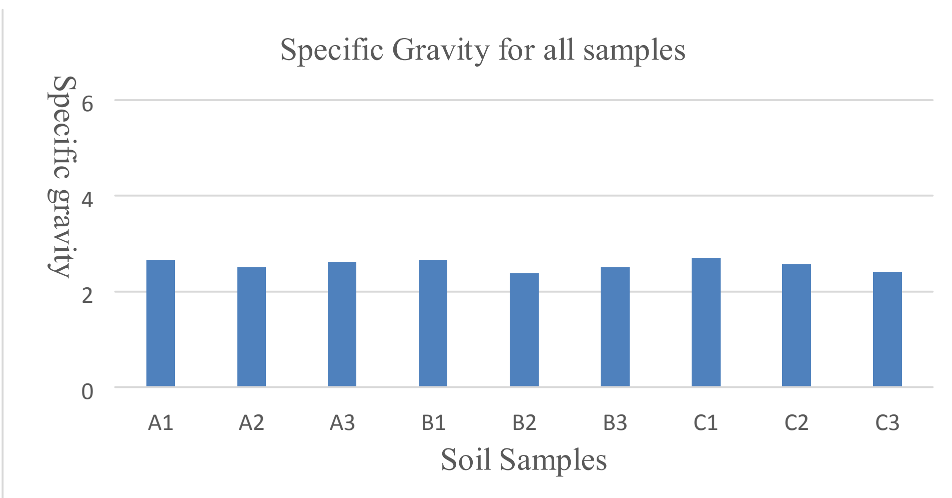

Fig 2. Specific Gravity results

The table shows that average specific gravity value is 2.56 for the surrounding soil in location 1, while the value is 2.66 in the termite reworked soils or nest from the same location. From location 2, the value is 2.67 for termite reworked soils while the value is 2.45 in the surrounding soil. From location 3, the value is 2.71 for the nest soil while the surrounding soils from both sides have an average value of 2.49. This result indicates that termite reworked soils from these locations have Specific gravity higher than the surrounding soils. This result indicates that termite reworked soils from both locations have higher Specific gravity than the surrounding soils, thus the termite reworked soils have a higher degree of laterization.

3.1 Particle Size Distribution

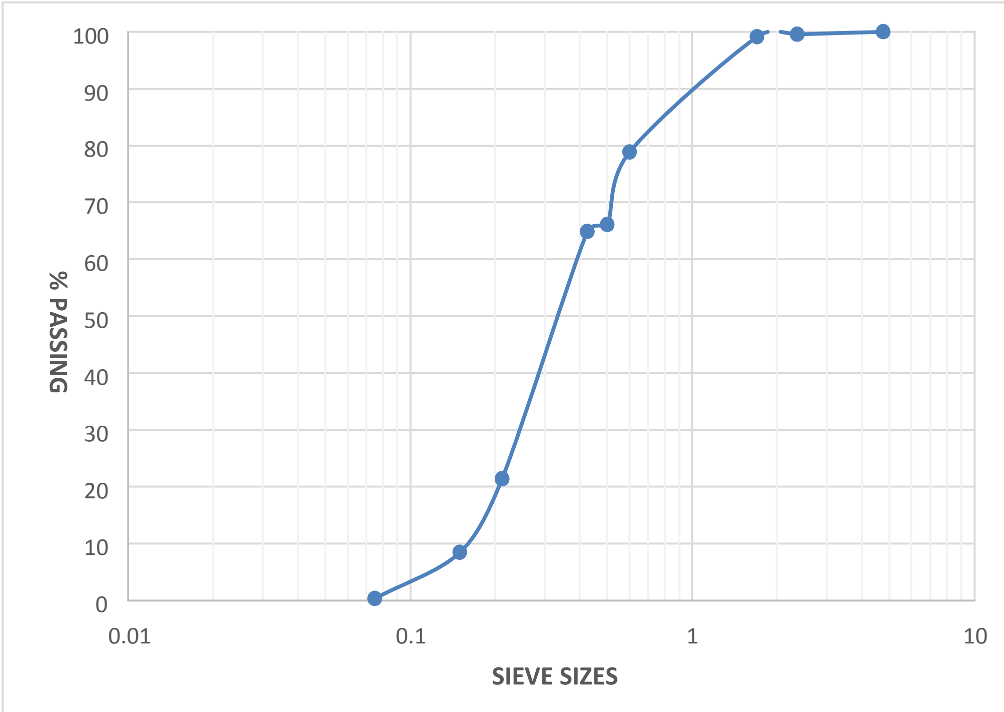

Fig 3: Particle size distribution for Sample A1

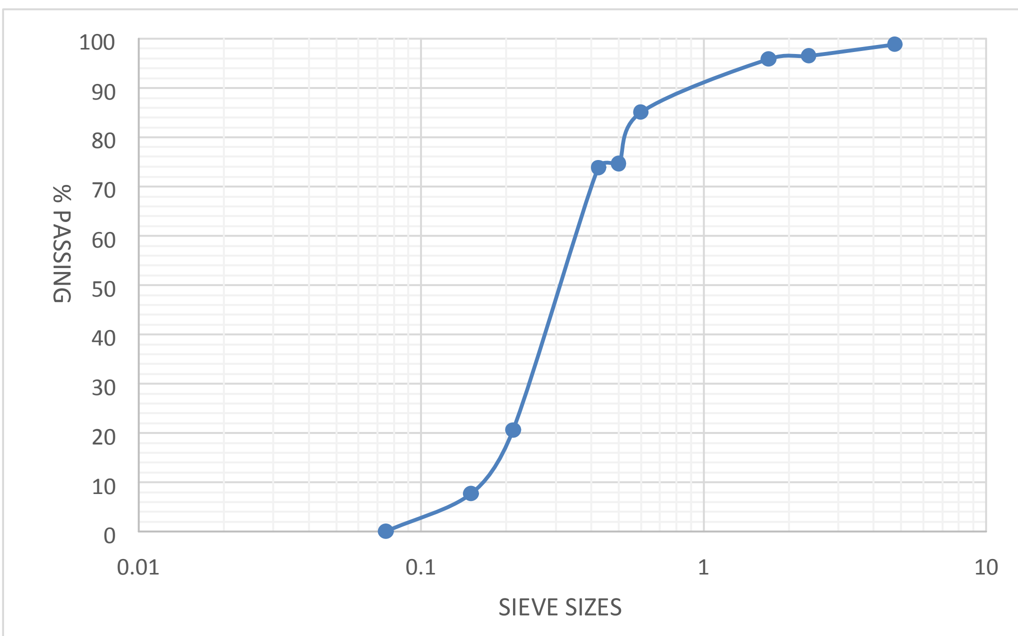

Fig 4. Particle size distribution for Sample A2

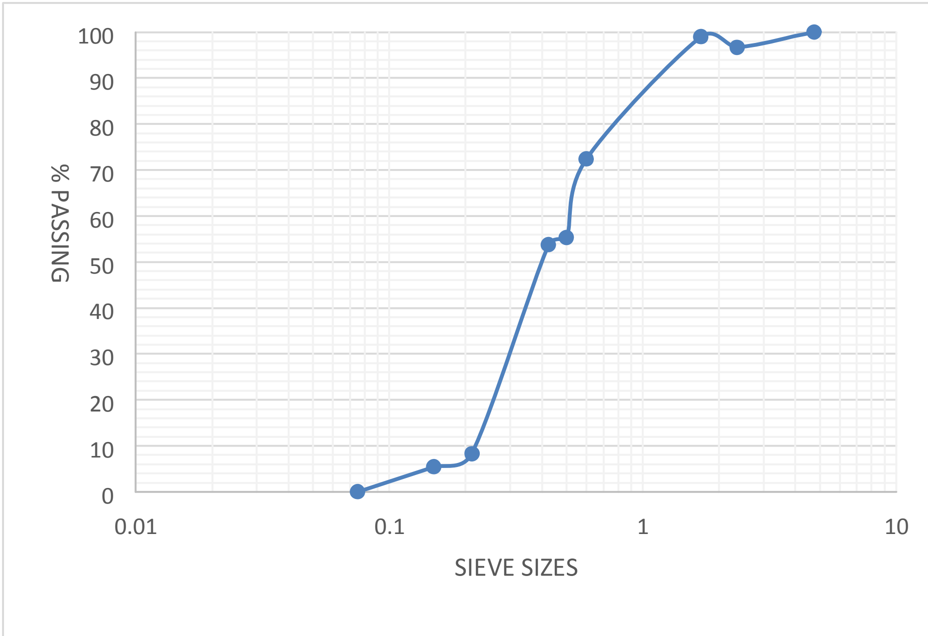

Fig 5. Particle size distribution for Sample A3

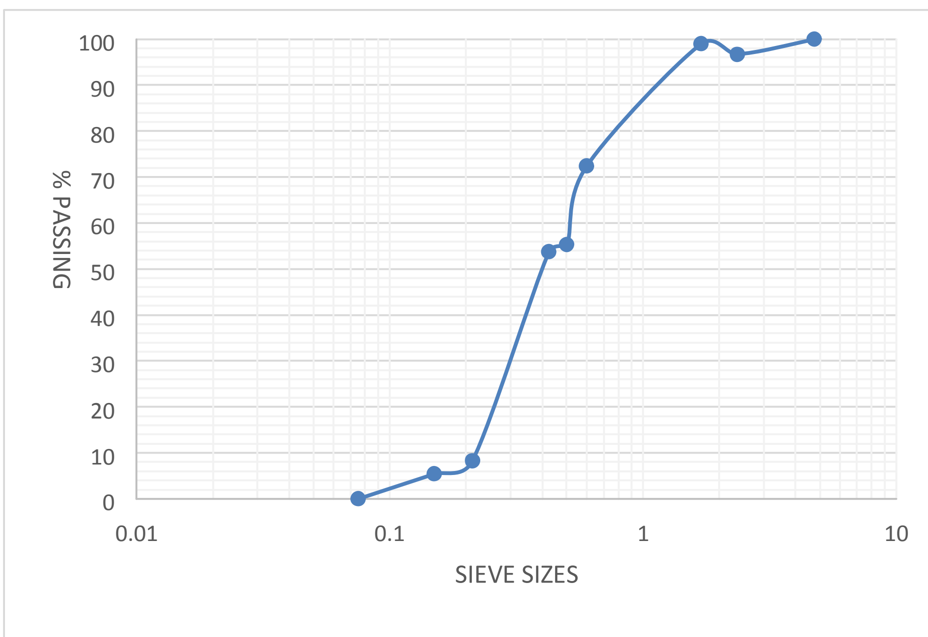

Fig 6. Particle size distribution for Sample B1

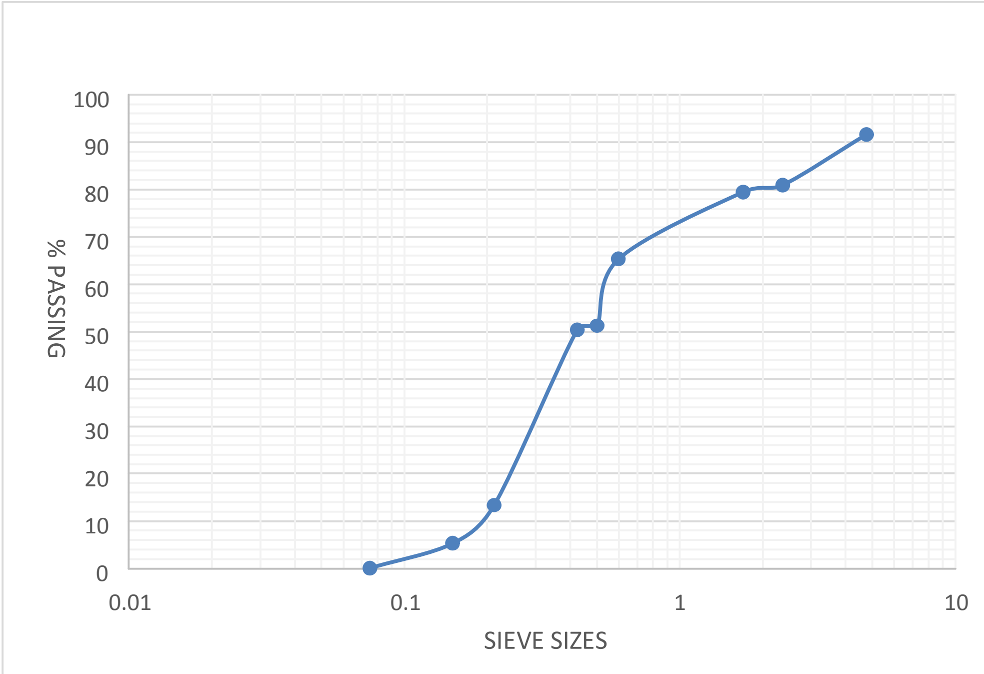

Fig 7. Particle size distribution for Sample B2

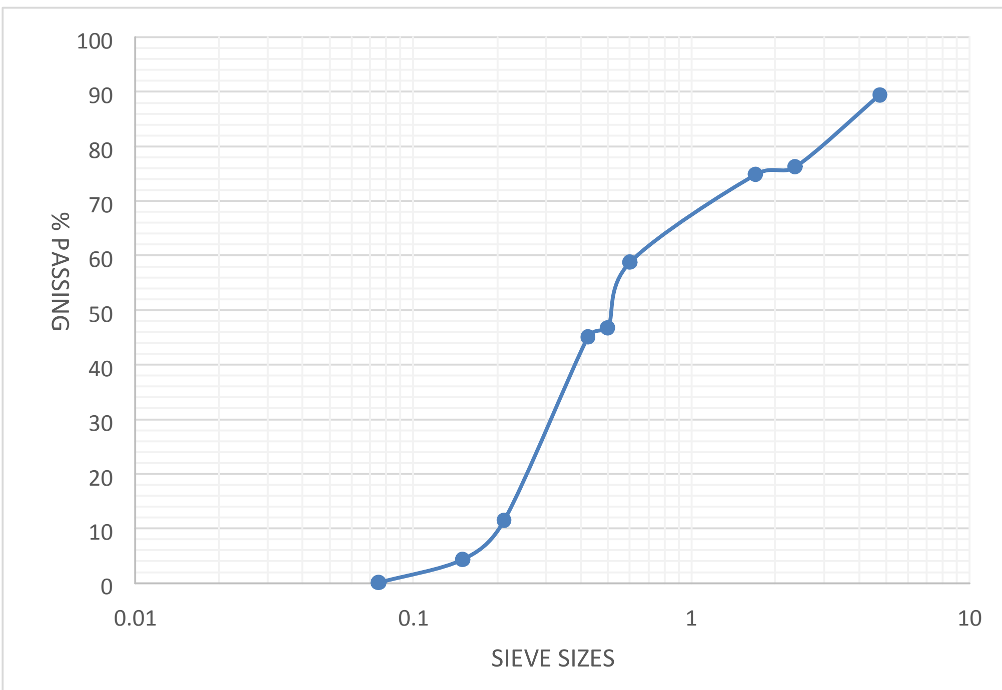

Fig 8. Particle size distribution for Sample B3

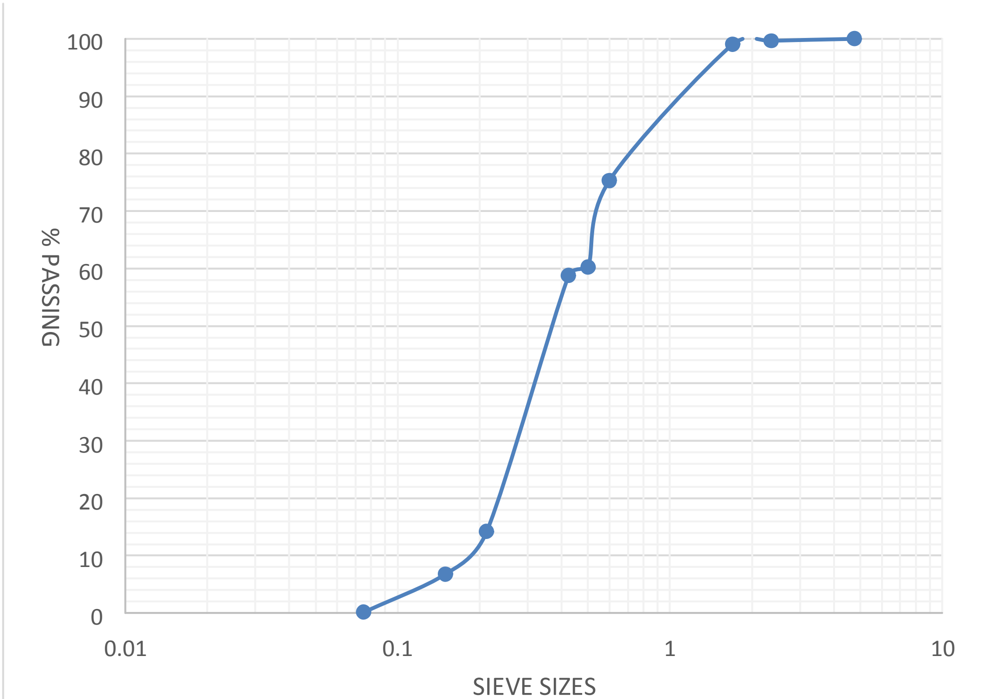

Fig 9. Particle size distribution for Sample C1

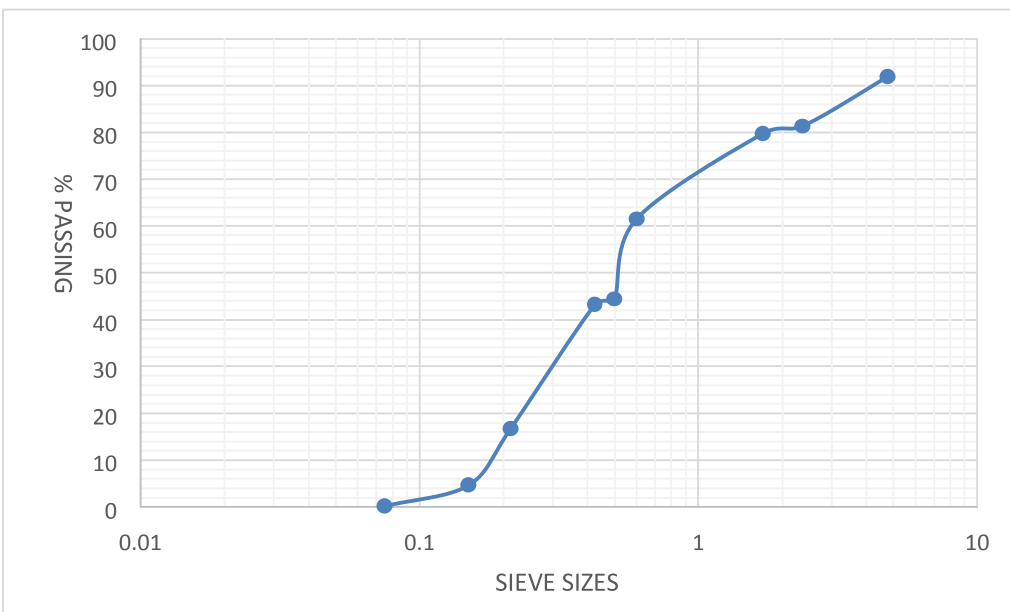

Fig 10. Particle size distribution for Sample C2

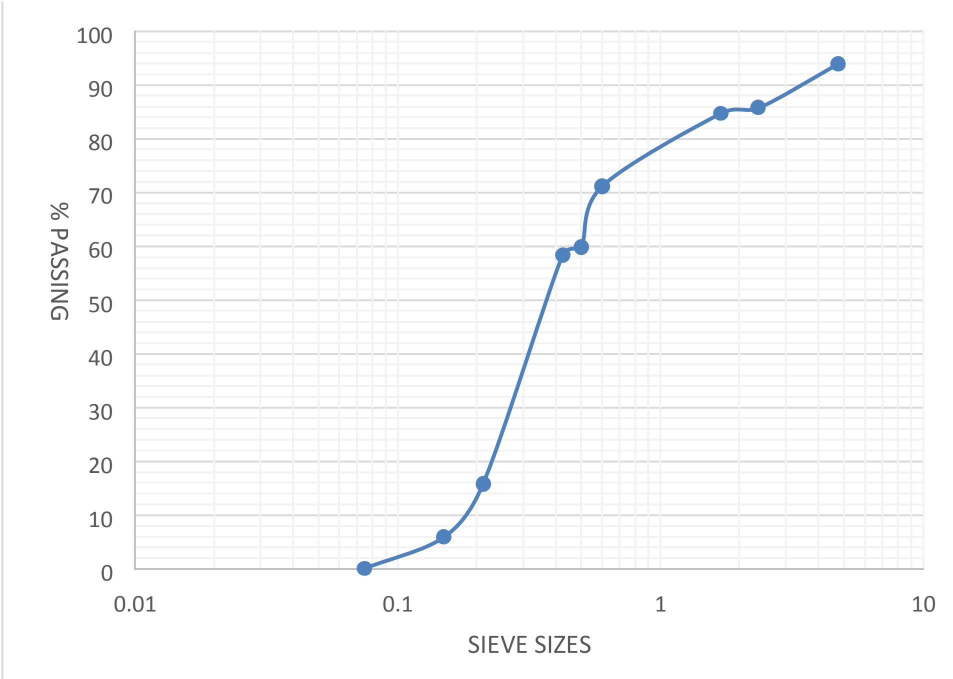

Fig 11. Particle size distribution for Sample C3

The particle size distribution results for all samples are shown above in Fig. 3-11. The particle analysis results showed that all the soil samples were well graded. The large concentration of particles is within the range of 0.075mm to 4.75mm with termitaria having higher concentration of particle size below 0.075mm than the surrounding. However, silts and clay fractions are lower in the termite reworked soils than the surrounding soils. The same trend can be observed for both soils samples in location B.

4. Conclusions

The study has shown that the geotechnical properties of the termitaria soil are better than that of the adjacent surrounding soil. It can also be deduced that these properties varies with respect to the specie of termite found in the nest because termites build their nest with different materials modes of cementation is different. These materials vary with locations.

It is therefore advised that if termitaria are encountered on construction sites, they can be used as earthwork or backfill materials rather than discard them.

Declaration of Competing Interest

The authors wish to declare that there are no known conflicts of interest associated with this publication and this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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