International Journal of Science and Engineering and Technology (IJSE)
Maiden Edition
www.federalpolyoko.edu.ng
Volume 1; Issue 1; July 2025; Page No. 64-79.

GEOTECHNICAL PROPERTIES OF SAND DERIVED FROM AWDAW RIVER CHANNEL OKO-AMAOKPALA AREA ANAMBRA BASIN, SOUTHEASTERN NIGERIA

Ogbuagu, Fredrick Uchenna and Okoli, Ezindu Ebuka
Department of Civil Engineering Technology, Federal Polytechnic Oko, Anambra State, Nigeria
***Corresponding Author*:** uchefredrick72@gmail.com 08136966947

ABSTRACT
The alarming rate of failure and collapse of infrastructures in Nigeria is statistically notable setbacks to economic growth and constitute major causes of loss of lives and properties. Five (5) sand samples, named Oko samples 1-5, were collected from Awdaw River Channel at Oko-Amaokpala area, Anambra Basin. The samples were prepared and subjected to geotechnical tests such as Atterberg limits (liquid limits, LL, Plastic limits, PL, Plasticity index, PI, shrinkage limit); Compaction test (Optimum Moisture Content (OMC), Maximum Dry Density), Grain size distribution, Triaxial compression, Natural Moisture Content and Specific Gravity, using standard methods. The result shows that natural moisture content varies from 11.4% to 13.0%, specific gravity ranged from 2.56mg/cm^3 to 2.67mg/cm^3. The Particle size distribution revealed gravel content (0%), sand (81.7% - 89%) and fines (11.0% - 18.3%). The Atterberg limit test showed liquid limit (LL) that ranged from 27.0% to 35%. Plastic limit (PL), ranged from 11.0% to 17%. Similarly, the angle of shearing resistance, (ϕ), ranged from 26^0 to 31^0 and effective cohesion ranged from 10kN/m^2 to 16KN/m^2. The shear stress (Ʈ) values ranged from 258.81KN/m^2 to 338.00KN/m^2 with pressures of 100, 200, and 300KN/m^2. The compaction test revealed that void spaces will contain lots of air and will require good compactive effort to improve its engineering properties. The predominance of sand would guarantee high performance when used in making sandscrete blocks and in road construction works. Generally, the sand is good material for building construction, albeit, not good to be used as base course material in highway construction.

Keywords: Geotechnical, Infrastructure, Sand, Sandcrete, Oko

INTRODUCTION
Anambra Basin is commonly associated with sands, lateritic sands and laterites. Sand for civil engineering purposes is derived from quarries strewn all over the sedimentary basin. Apart from few locations where machines are used to excavate and scoop off construction materials, other quarries are in form of river and stream channels, where winning of sand is by artisanal manual labour. The entire area of Anambra State is underlain by the basin fills of Anambra Basin. The established sequence is Nkporo Shale (Enugu Shale), Mamu Formation, Ajali Sandstone, Nsukka Formation, Imo Shale, Nanka Sand (Ameki Group), Ogwashi-Asaba Formation and Benin Formation, (Nwajide and Reijers, 1996).

Infrastructures are intricately linked to all the sustainable development goals. The alarming rate of failure and collapse of infrastructures in Nigeria is statistically, notable setbacks to economic growth and constitute major causes of loss of lives and properties. In a bid to bolster up and stabilize its key challenges and stimulate development of the economy, the engineering properties of sand which is one of the major building materials, should be of utmost concern.

The geotechnical properties of sand vary at very short distances due to varying geologic, geomorphologic and anthropogenic dynamics. Hence, there is need for consideration of all the geotechnical constraints on the sustainability of civil engineering structures. This is due to the fact that, the strength and service life of infrastructures depend on the shear strength, density (degree of packing of particles), degree of compaction (mechanical stress), water absorption and adsorption capabilities, cohesiveness, water retention and plasticity (Didei and Oborie, 2018; Akaolisa et al., 2021). These engineering behaviours of sands are partly expressed in terms of the magnitude of shear strength from the triaxial compression test (shearing resistance and cohesion), and the degree of compaction (mechanical stress). The Atterberg limit values (LL, PL and P1) of sands are used extensively, either individually or together with other sand properties such as compressibility, shrinkage, and swelling character.

Highly compressible and collapsible sands due to high clay content can adversely affect the performance of infrastructure. Thus, in the wake of multiplicity of cases of professional incompetence and unethical geotechnical practices leading to failure of structures, a good geotechnical investigation report should provide basic engineering properties and their interpretations with recommendations, (Nzabakurikiza et al., 2017).

Sands have been commonly used for sandcrete block making for building construction. Index characteristics which are obtained from index tests give idea of how sand particles can behave when subjected to stress and strain. The behaviour of sand particles should also suggest the admixtures that can be used to stabilize or modify the sand. This paper investigated the geotechnical properties of sands derived from Awdaw River channel, Oko- Amaokpala area, with a view of finding out the potential the sand from this area hold for use in sandcrete block moulding for building constructions.

LITERATURE REVIEW

The behavior of soils in an undisturbed as well as in laboratory condition, is essential since they are the main building material for construction. (Nwaiwu, Alkali and Ahmed, 2006; Paige-Green, Pinard &Neiterberg, 2015). Obviously, the strength, stability, durability and sustainability of building blocks greatly depend upon a proper understanding of geotechnical properties of the soil. In their study into the geotechnical properties of lateric soil from Nimo and Nteje areas of Anambra State, Southeastern Nigeria, Ogbuagu and Okeke (2019), used Atterberg limits, Standard Proctor Compaction, California Bearing Ratio (CBR), Traxial tests and Particle Size Distribution Analysis as yardsticks. They concluded that the lateritic soil from Nteje showed higher strength and compaction properties than the soil from Nimo. Borrow pits should be investigated to determine the suitability of soils for engineering applications using Natural Moisture Content determination, Particle Size Analysis, Specific Gravity, Atterberg Limits, Compaction test, California Bearing Ratio (CBR) test and Unconfined Compression test (Aduonye, Kolapo, Olamoju and Akanbi, 2018). Employing geotechnical tests to determine the properties of soil and its suitability gained more traction from the research conducted by Sunday, Owonaro, Okeke, Onyekuru and Dozie (2019). They assessed the geotechnical properties and aggregate quality of marl deposit in Afikpo area, Southeastern Nigeria and arrived at the conclusion that the deposit has low Atterberg Limit values and favourable physico- mechanical properties and recommended that the marl deposit be used as good aggregate for high-way pavement and concrete.

Using geotechnical approach to provide explanation to severe distressed state of road along Ekwulobia-Oko - Ufuma - Umunze route, Ogbuagu and Onyemesili (2019) found out that the soil samples fall within A - 2 - 4 according to American Association of State Highway and Transport Officials (AASHTO) classification system. Moreso, the study indicated that the low CBR values of pavement materials alongside other factors, could have contributed to the latent causes of the road failure.

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

Similarly, Ademilla (2018), determined the suitability of soil samples collected from the subgrade of Arigidi/ Oke -Agbe highway. Results showed that subgrade soils below the failed locations have higher plasticity indices and are classified as A - 7 - 6 clayey soils with high water absorption capability (16.1 - 22.4%) compared to subgrade soils from the stable locations. He further averred that, low compacted density, poor CBR values indicate reduction in strength on exposure to moisture and predominance of fines in the soils are responsible for the degree of instability. He posited that, the suitability and behavior of subgrade soil is dependent on its engineering properties.

METHODOLOGY

The traditional methodology for geotechnical investigation of construction materials was adopted for this research work. The methodology comprised of three - stage study;

1. Field work (Reconnaissance): Preliminary study: This involved studying the topographic and geological maps of the study area. This was done in order to have a panoramic view of the river channel, appreciate its drainage, relief patterns and localities where it drains, its relationship with adjacent sediments within the formation and have a general idea of the nature and trend of rocks in the area.
2. Detailed field work: This involved establishment of the co-ordinates, measuring the metres above sea level, collecting soil samples for Laboratory analysis, taking pictures of the river channels.
3. Laboratory Analysis: After the samples were collected from the river channel, they were taken to the Alpha Research Laboratory, Awka, Anambra State for geotechnical analysis according to the British Standard Methods of test for soil for civil engineering purposes (BS 1377: Part 1-9, 1990) and American Society for Testing of Materials, ASTM D4318 - 17el 2017 Standard Test Methods.

GEOLOGIC SETTING

Oko-Amaokpala is an area east of the Niger. It lies in the hot and humid tropical rainforest region within Anambra Basin. Anambra Basin is a near triangular shaped embayment covering an area of about 30,000sq km (Offodile, 2014). This inland basin is an extended basin stretching underground from the area just south of the confluence of the Rivers Niger and Benue across to the areas west of the River Niger.

The basin is drained mainly by the Anambra River and its main tributaries, the Mamu and Adada rivers. Other rivers that drain this basin around the study area include; rivers Awdaw, Aghamili, Obisi etc. Anambra Basin appears to represent an inverted triangular depression with its base along the Benue River axis, and its apex pointing southwards, towards Onitsha on the main trunk of the River Niger. (Arua, 1986, Nwajide, 1979, Anyanwu & Arua 1990, Oboh-Ikuenobe et al., 2005, Nwajide, 2013).

The deposits of Anambra Basin has the following established sequence, Nkporo Shale (Enugu Shale), Mamu Formation, Ajali Sandstone, Nsukka Formation, Imo Shale, Nanka Sand (Ameki Group), Ogwashi-Asaba Lignite Formation and Benin Formation in ascending and chronological order. Nanka sand is best developed in Nanka, Oko and Agulu(Nwajide, 2013).

Soils

Soils and their characteristics are not only critical to agricultural activities but their properties influence the stability of civil engineering structures. In the study area, the soils are characteristic of humid rainforest region. There is extensive leaching and what remains is enriched in less soluble oxides and hydroxides of Aluminum (AL) and Iron (Fe), with clays in the zone of accumulation (below the zone of leaching). The soil is described as pedalfer type and is typically acidic.Lateritic soils, an extreme kind of pedalfer, are common in this area (Ezeigbo 1989; Ofomata, 1975).

Materials and Methods

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

The five representative sand samples named Oko samples 1-5 used in this research work were obtained from Awdaw river channel at 100 – 1500m intervals in Oko-Amaokpala area, Anambra Basin, Southeastern Nigeria. After the samples were collected, they were taken to Alpha Research Laboratory, Awka,Anambra State, for geotechnical analysis according to the British Standard methods of test for soil for civil engineering purposes (BS 1377: Part 1-9, 1990) and American Society for Testing of Materials,ASTM D4318 – 17 el 2017 Standard Test Methods.

Results and Discussion

Specific Gravity (SG)

Specific gravity is an index test that gives an idea of how the soil parcticles are closely packed together. It is used to calculate soil density, void ratio, saturation and other soil properties (Akaolisa et al., 2021). The specific gravity ranged from 2.57 to 2.67 fig. 1. According to Wright (1986), the standard range of values of SG for soils lies between 2.60 and 2.80.

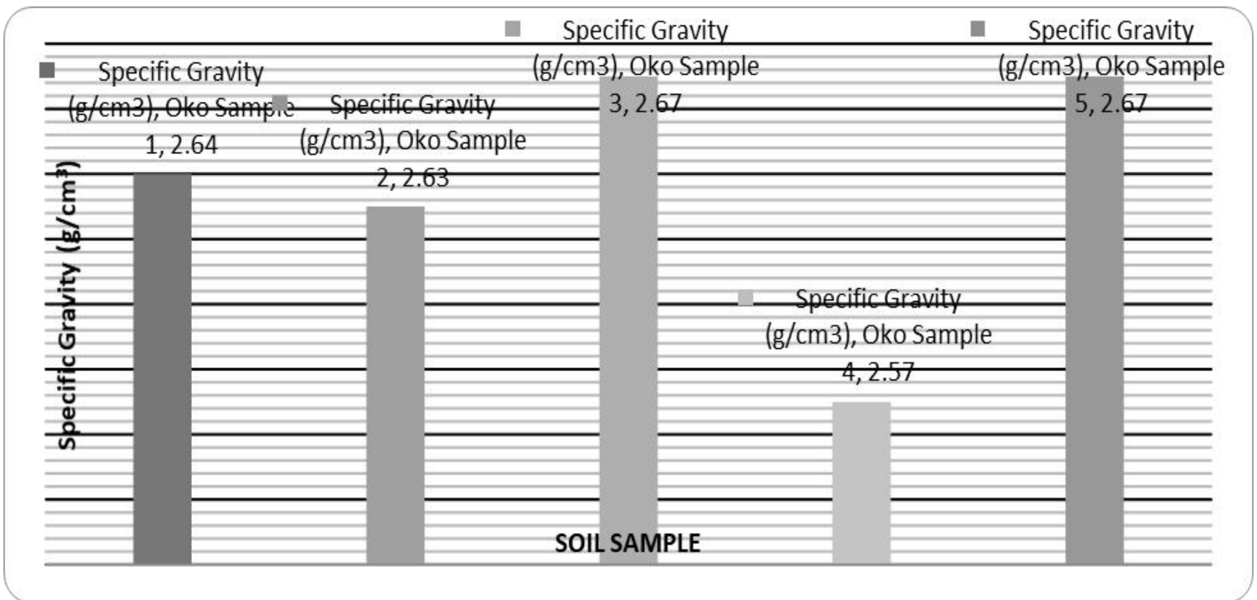

Fig 1: specific gravity of soil samples from Oko

The SG is closely linked with mineralogy and / or the chemical composition of sand (Que et al.,). Low specific gravity values indicate a coarse sand while high values indicate a fine grained sand (Wright, 1986). Consequently, Oko sample 4 is the coarsest while Oko samples 3 and 5, are the least coarse.

Grain Size Distribution

This is the determination of the size range of gravel, sand, silt, and clay present in a sand sample expressed as a percentage of the total dry weight (fig 1). The grain size distribution curves of samples across the area shows that the area has largely similar grain size distribution curves (figs. 3-7). This reveals that the area is sand heavy with no gravel sized particles and small amounts of fine sized particles. The size distribution is shown quantitatively in table... Based on the grain size distribution, it is expected that the sand samples would show some fine-grained characteristics like water retention cohesiveness, low plasticity and moderate linear shrinkage.

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

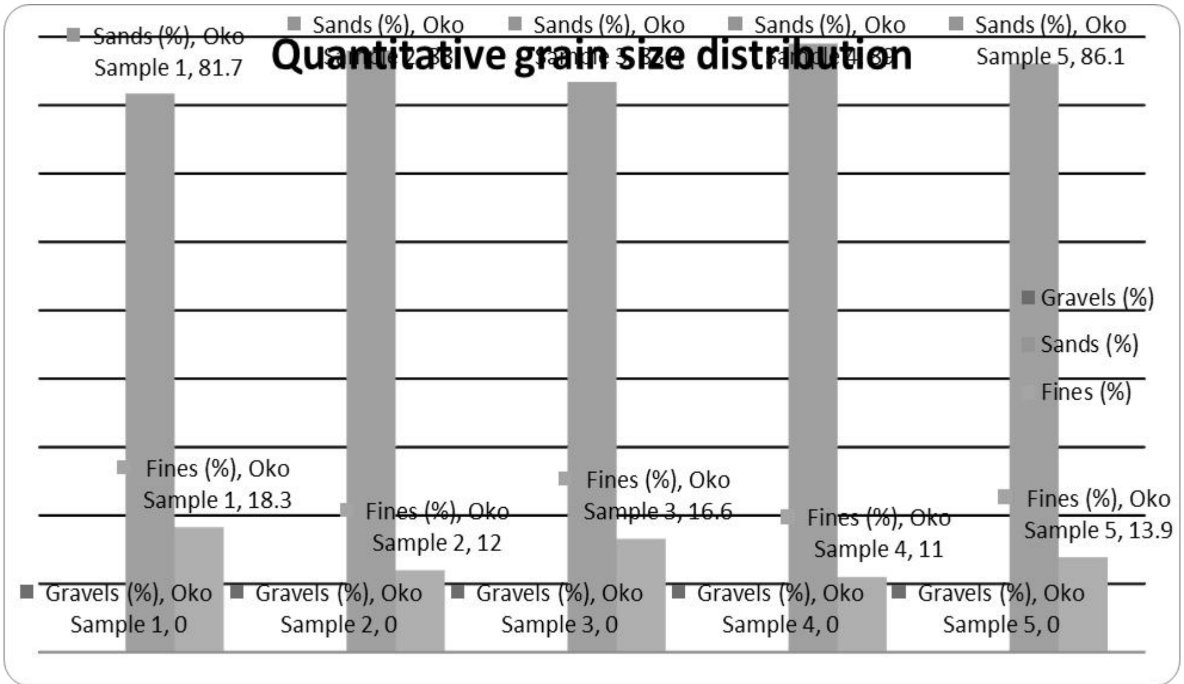

Fig 2: Particle Size Distribution of soil samples from Awdaw River Channel

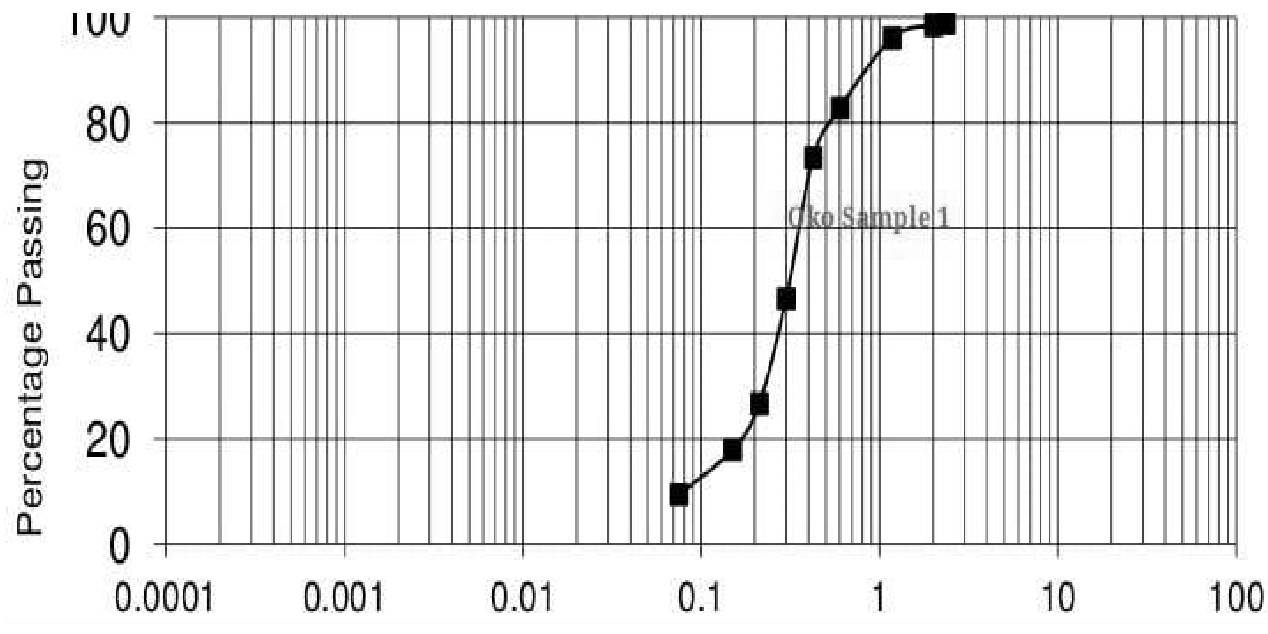

Fig 3: Graph of particle sizes against percentage passing for Oko sample 1

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

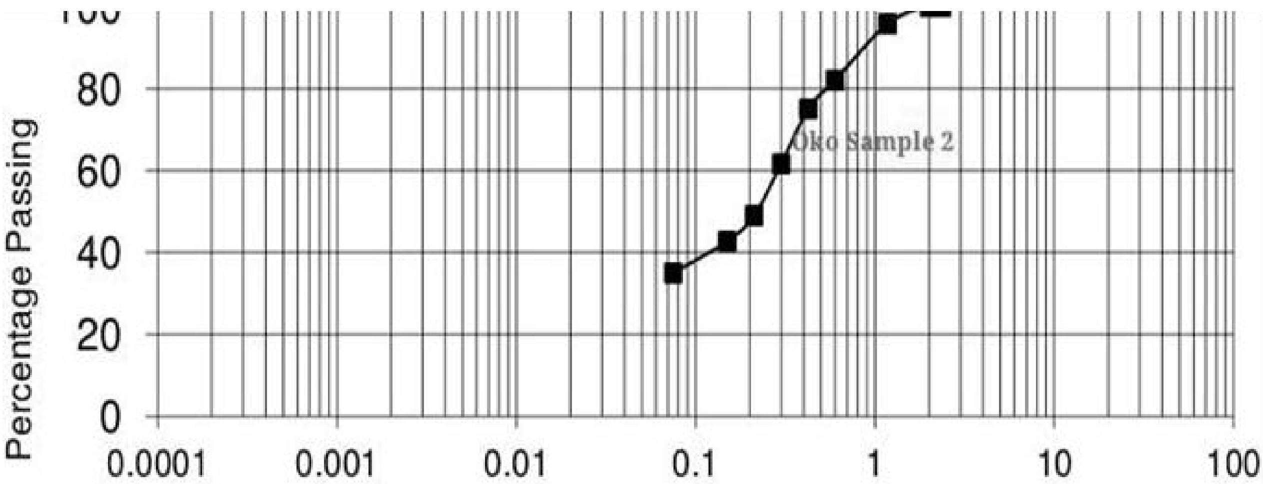

Fig 4: Graph of particle sizes against percentage passing for Oko sample 2

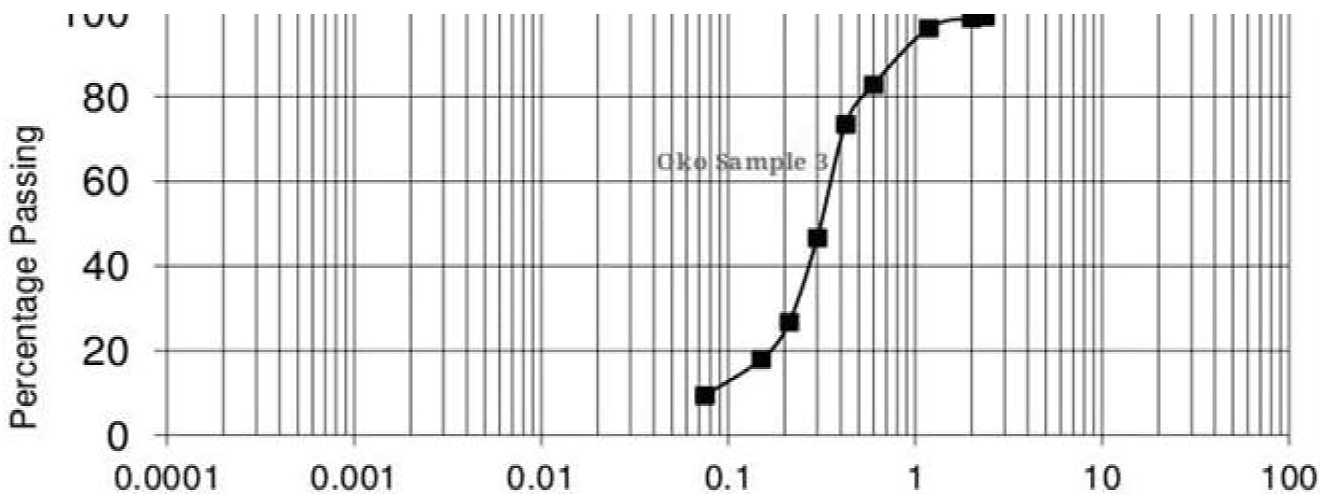

Fig 5: Graph of particle sizes against percentage passing for Oko sample 3

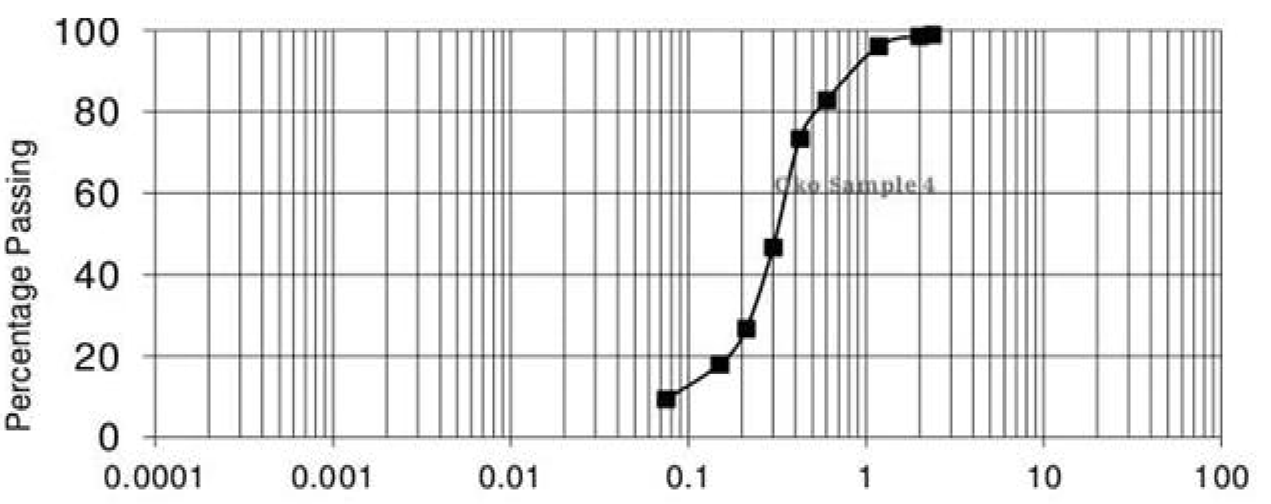

Fig 6: Graph of particle sizes against percentage passing for Oko sample 4

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

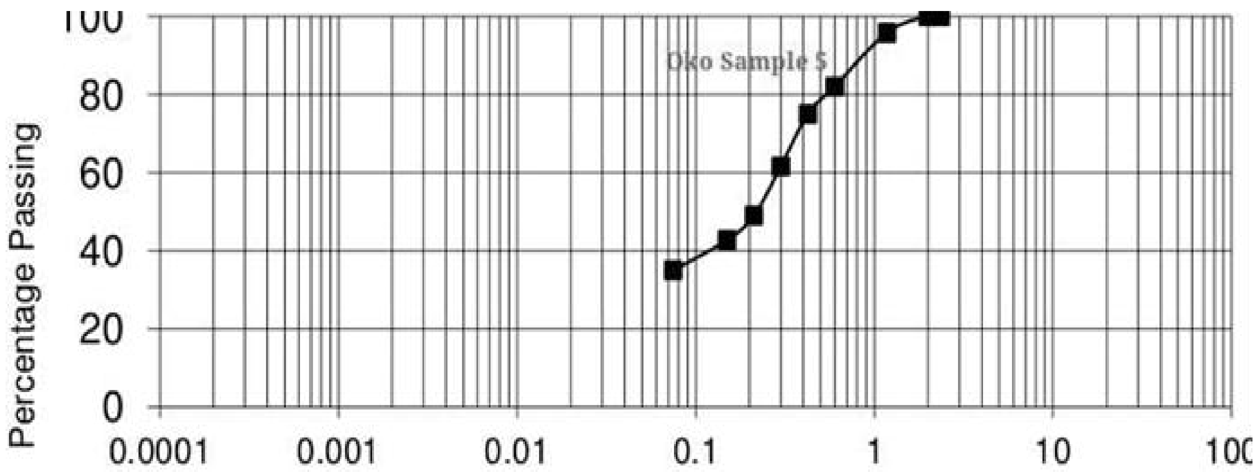

Fig 7: Graph of particle sizes against percentage passing for Oko sample 5

All the sand samples have very high percentage of sands, >80%. Therefore, the samples could be described as sandy soils of moderate compressibility. The predominance of sand will guarantee high performance when used in making sandcrete blocks and in building/constructions.

Atterberg Limits (Atterberg Consistency Test)

This test determines different states and limits of soil consistency. It is used to determine the moisture content at which a soil changes from solid, semi-solid, plastic and liquid states (Godwin et al., 2020). It is used to determine the shrinkage limit (SL), Plastic limit (PL), and Liquid Limit (LL) of sand sample. A summary of the Atterberg limit parameters is presented in Table 1.The values of LL, PL, and P1 ranged between 27% (Oko sample 3) and 35.0% (Oko sample 5); 10.0% (Oko sample 3) and 18.0% (Oko sample 5); and 11.0% (Oko sample 1) and 17.0% (Oko samples 3 and 5) respectively.

Table 1: Atterberg limits and consistency Index of soil samples from Oko

Test	**Sample Identity**				
LIQUID LIMIT (%)	**Oko Sample** 1	**Oko Sample** 2	**Oko Sample** 3	**Oko Sample** 4	**Oko Sample** 5
PLASTIC LIMIT (%)	28.0	28.0	27.0	28.0	35.0
PLASTICITY INDEX (%)	17.0	16.0	10.0	16.0	18.0
LIQUIDITY INDICES (%)	11.0	12.0	17.0	15.0	17.0
CONSISTENCY INDICES (%)	-51.1	-17.3	-16.8	-17.3	-22.6
Unified Soil Classification System	151.1	117.3	83.2	115.3	122.6
	SC	SP-SM	SP-SM	SP-SM	SC

Federal Ministry of Works and Housing specification (1997) recommends liquid limits not greater than 80% for subgrade and not greater than 35% for sub-base and base course materials; and Plasticity Index not greater than 55% for subgrade and not greater than 12% for both sub-base and base course. In terms of plasticity, the sand samples are of low plasticity (LL <35%) (Augusta, 2000). Stable materials should have low plasticity character which will not show deformation under load.

Compaction Test

This entails subjecting sand samples to mechanical stress. This test provided the basis for determining the percentage compaction and moisture content needed to achieve the required engineering properties and

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

for controlling construction to ensure that the required compaction and moisture contents are achieved (Didei and Oborie, 2018).

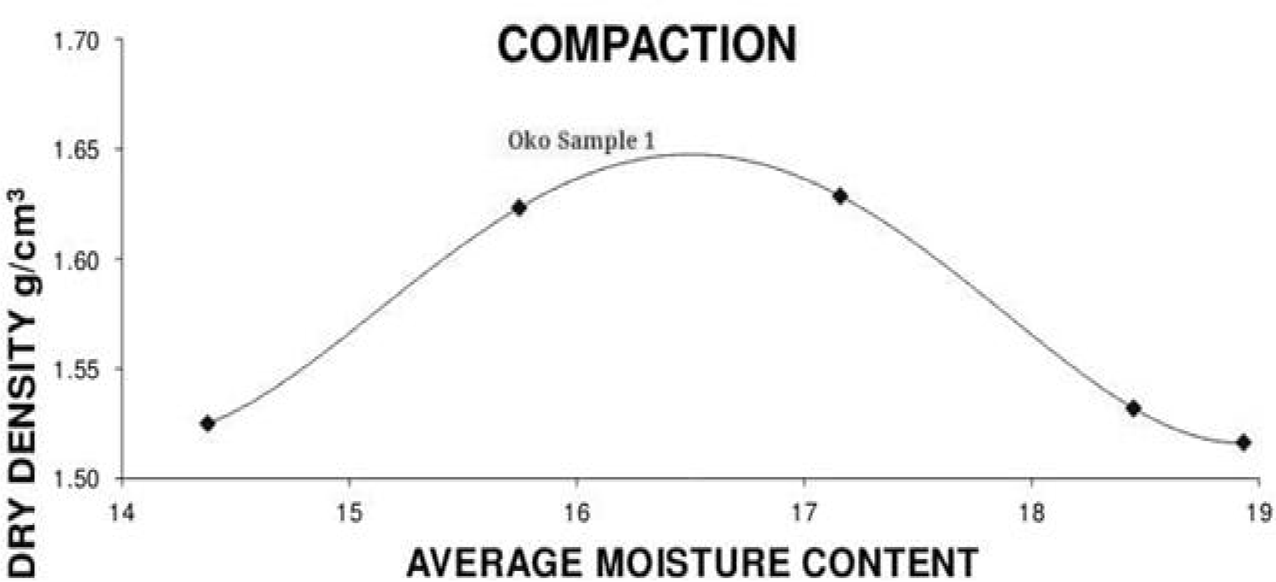

Fig 8: Graph of no of blows against moisture content for OKO sample 1

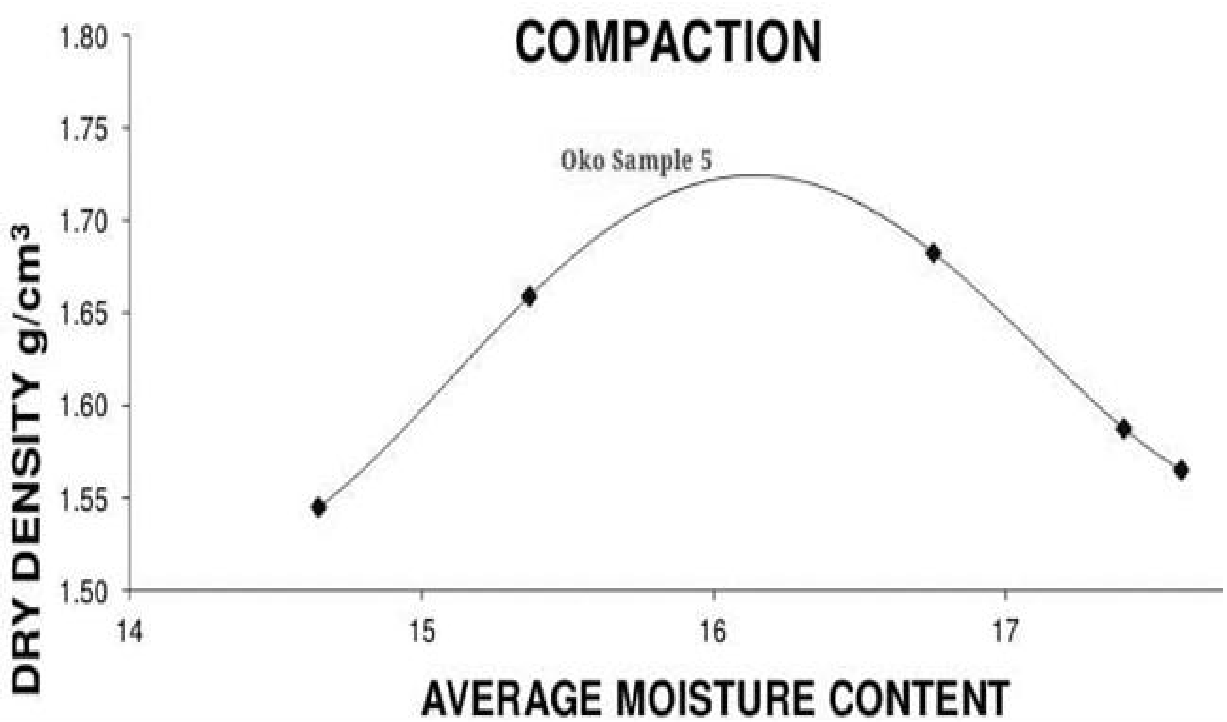

Fig 9: Graph of no of blows against moisture content for OKO sample 5

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

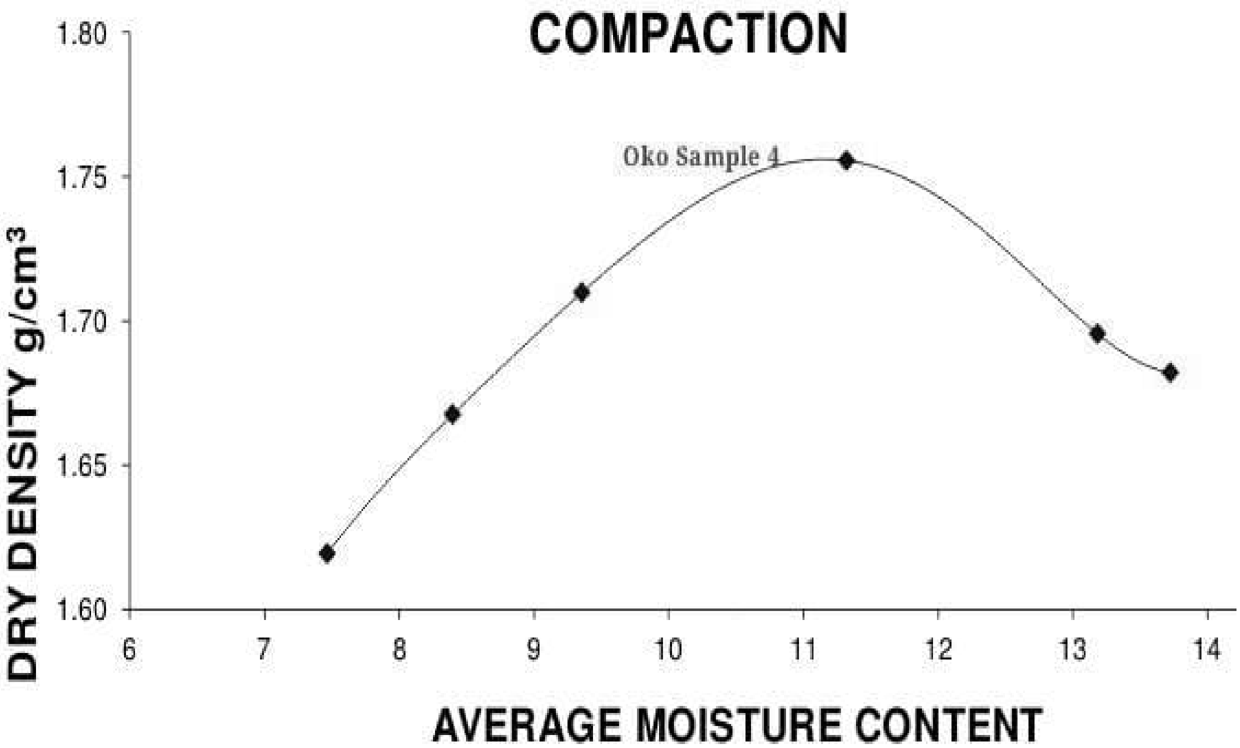

Fig 10: Graph of no of blows against moisture content for OKO sample 4

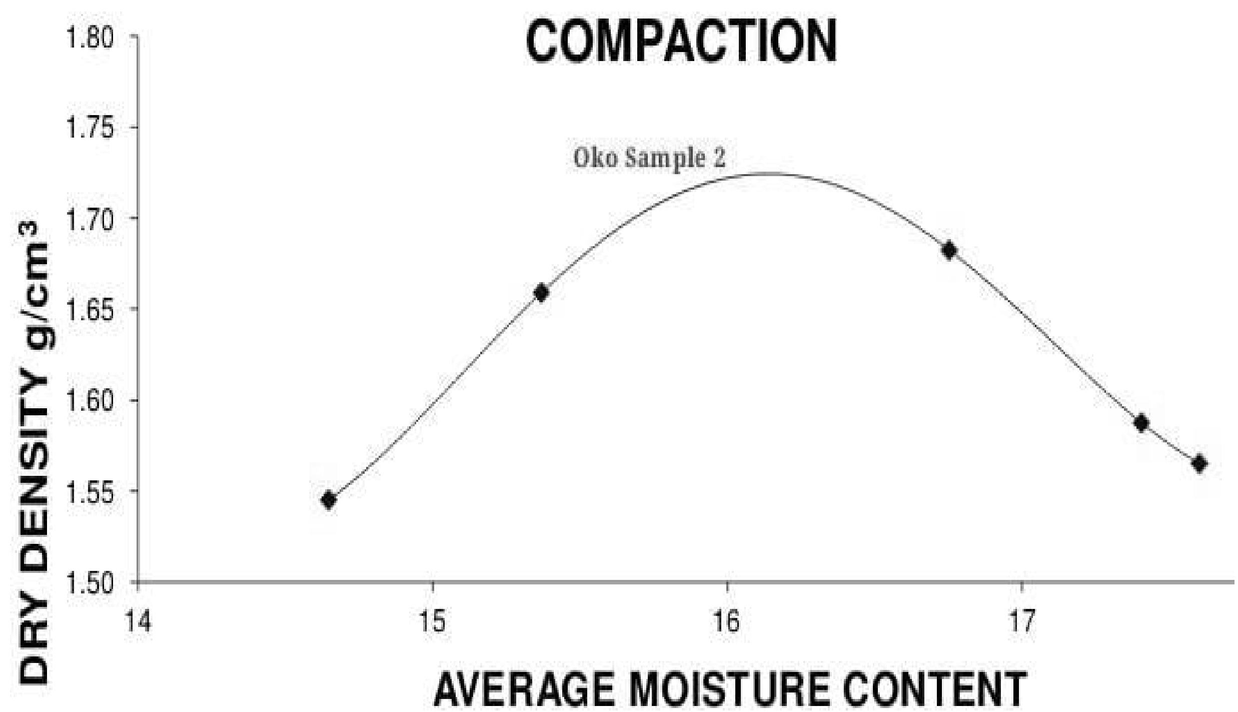

Fig 11: Graph of no of blows against moisture content for OKO sample 2

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

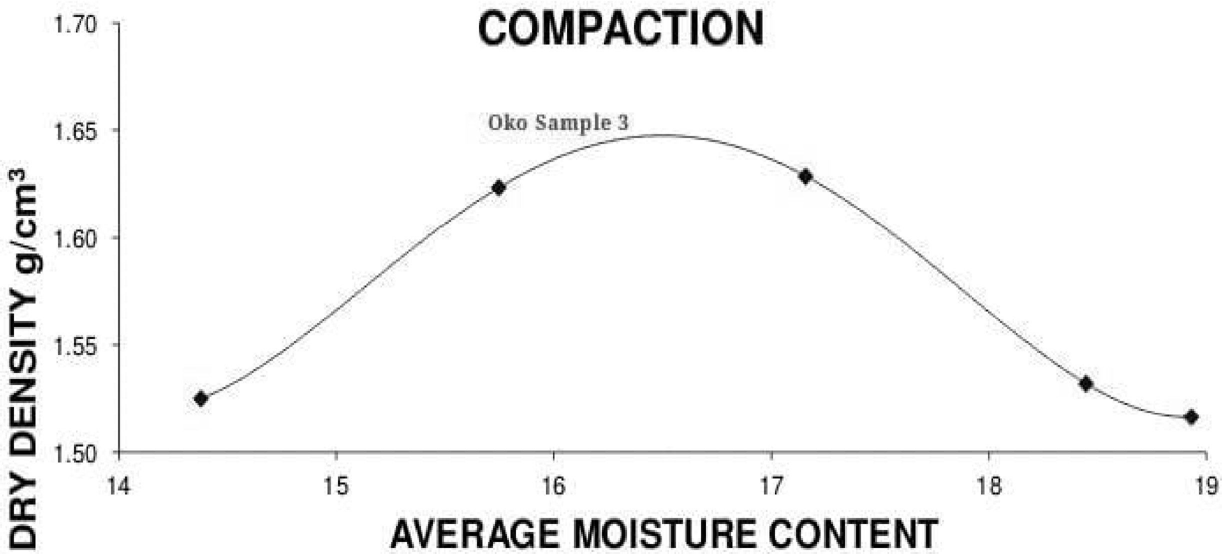

Fig 12: Graph of no of blows against moisture content for OKO sample 3

Compaction of Oko sample 1, was done with moisture content ranging from 14.4% to 18.9% and the dry density ranging from (1.52g/cm^3 to 1.65g/cm^3); Oko samples 3 (moisture content between 14.4% to 19% and dry density 1.52g/cm^3 to 1.60g/cm^3); sample 4 (7.4% to 13.8% and dry density between 1.61g/cm^3 to 1.75g/cm^3); and Oko sample 5 (moisture content between 14.6% to 18%, dry density between 1.53g/cm^3 to 1.65g/cm^3),(figs 8-12). The samples are many points from attaining maximum compaction or 100% zero-air-void. Thus, the void spaces will contain lots of air and will require good compactive effort to improve their engineering properties.

Natural Moisture Content

The values of natural moisture content of the samples are presented in fig. 13. It ranged from 11.40% to 14.20%.

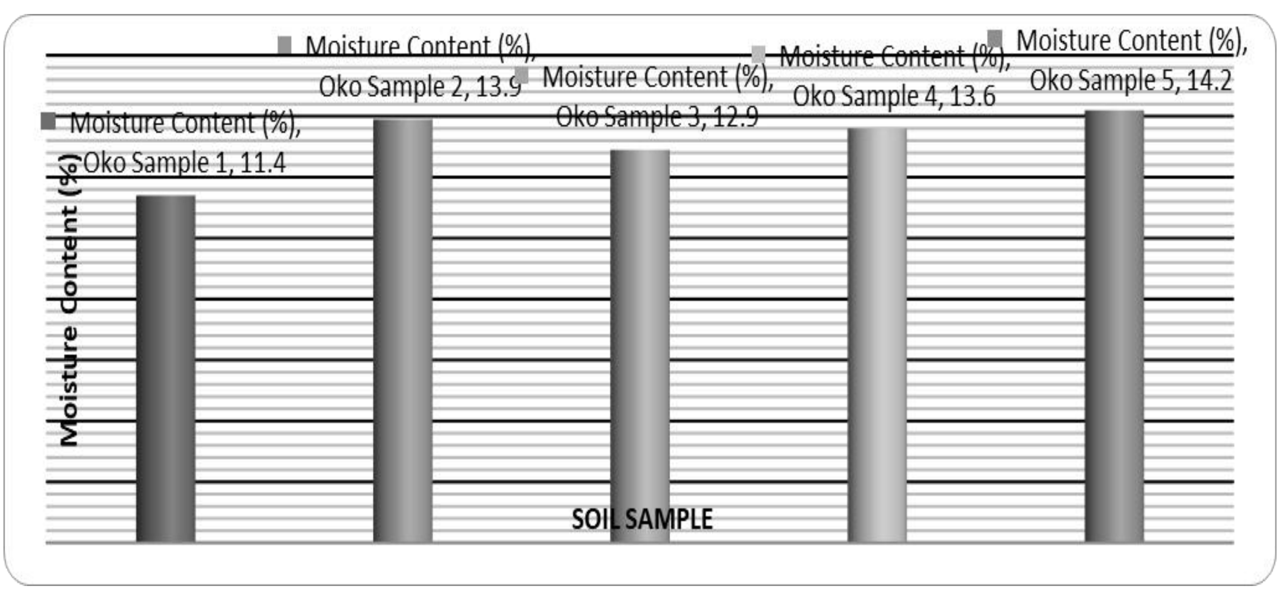

Fig 13: Natural moisture content of soil samples from Oko

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

The natural moisture content values of all the samples seem to be very high. Sand with high natural moisture content indicates high water adsorption capacity. This will further prevent development of pore water pressures.

Triaxial Strength (Consolidated Undrained Triaxial Shear Test)

The shear strength and stiffness of sand for use in geotechnical constructions are determined using this test. The primary parameters obtained include the angle of shearing resistance (angle of internal friction), φ, and cohesion (sand's inherent shear strength), C. These parameters are determined based on the effective stresses of the sand samples. Table 2, shows the results of triaxial test performed on the five samples. In addition, the results obtained from Mohr's circles for the Oko sample 1 reveals that the shear angle, φ, ranged from 26^0 to 31^0 and cohesion, C, that ranged from 10kN/m^2 to 16kN/m^2. The state of stress for the five samples is represented by Mohr's Circles which are closely related to shear strength (figs. 14-18).

Table 2: Shear strength parameter of samples

Sample ID	C (KN/m^2)	ф (0)	Ҵ (KN/m^2)
Oko Sample 1	16	30	337.13
Oko Sample 2	12	28	270.76
Oko Sample 3	14	26	258.81
Oko Sample 4	10	31	338.00
Oko Sample 5	15	28	336.20

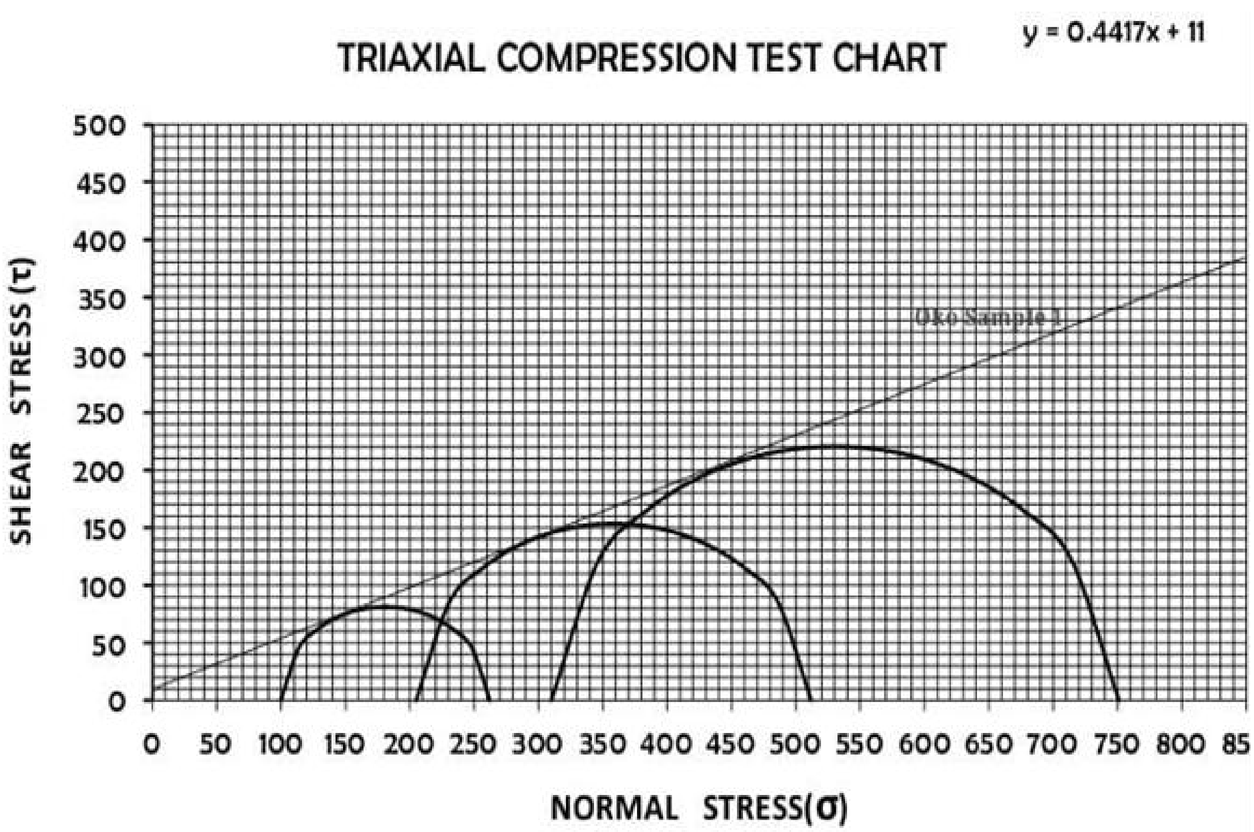

Fig 14: Graph of normal stress against shear stress for OKO sample 1

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

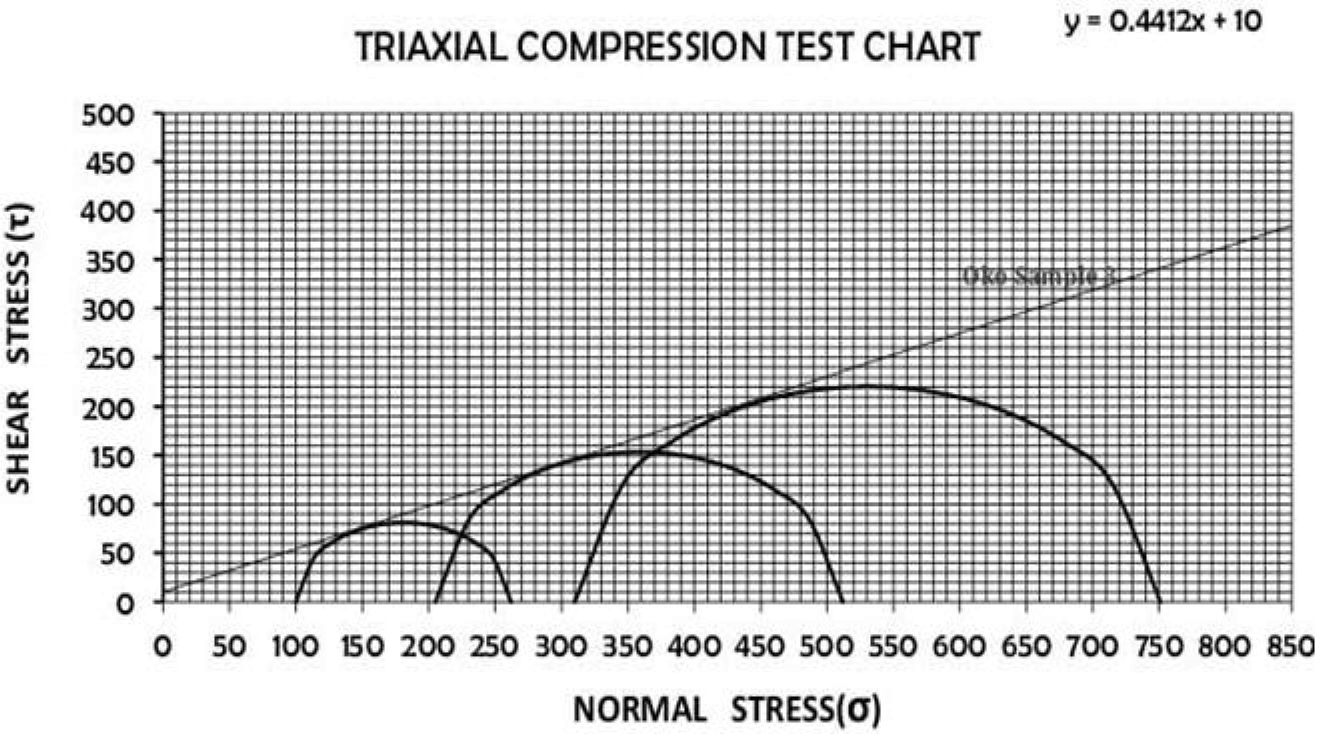

Fig 15: Graph of normal stress against shear stress for OKO sample 2

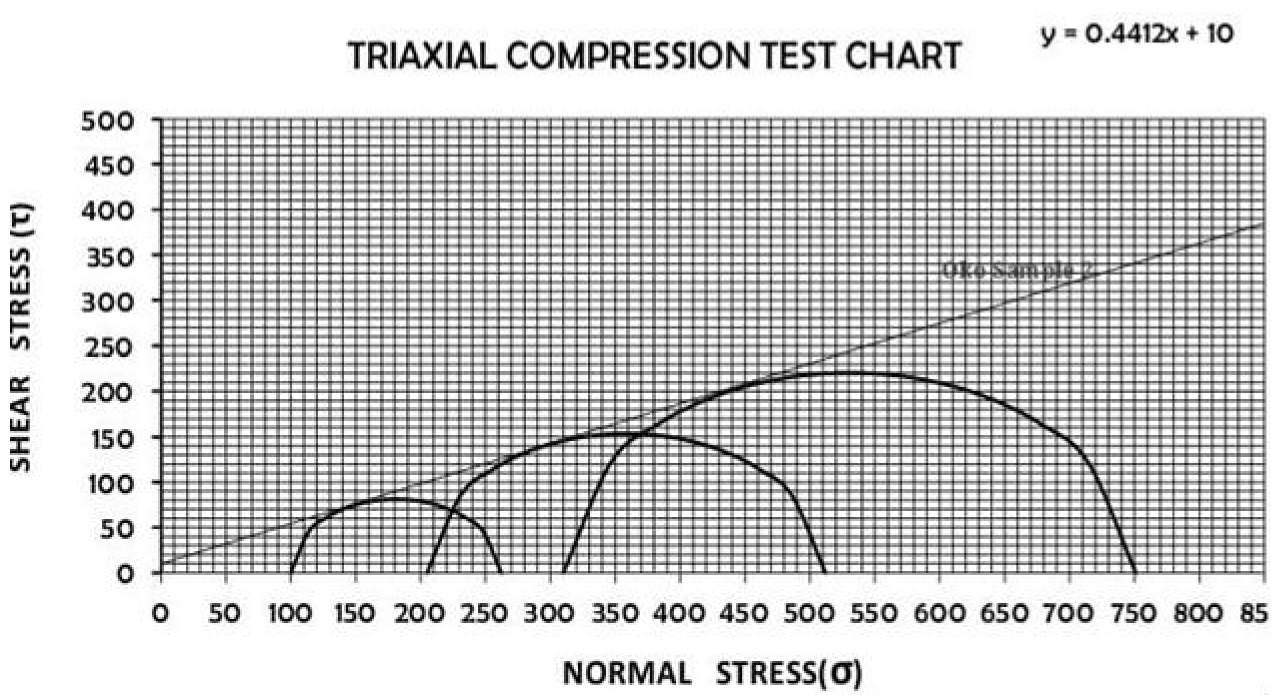

Fig 16: Graph of normal stress against shear stress for OKO sample 3

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

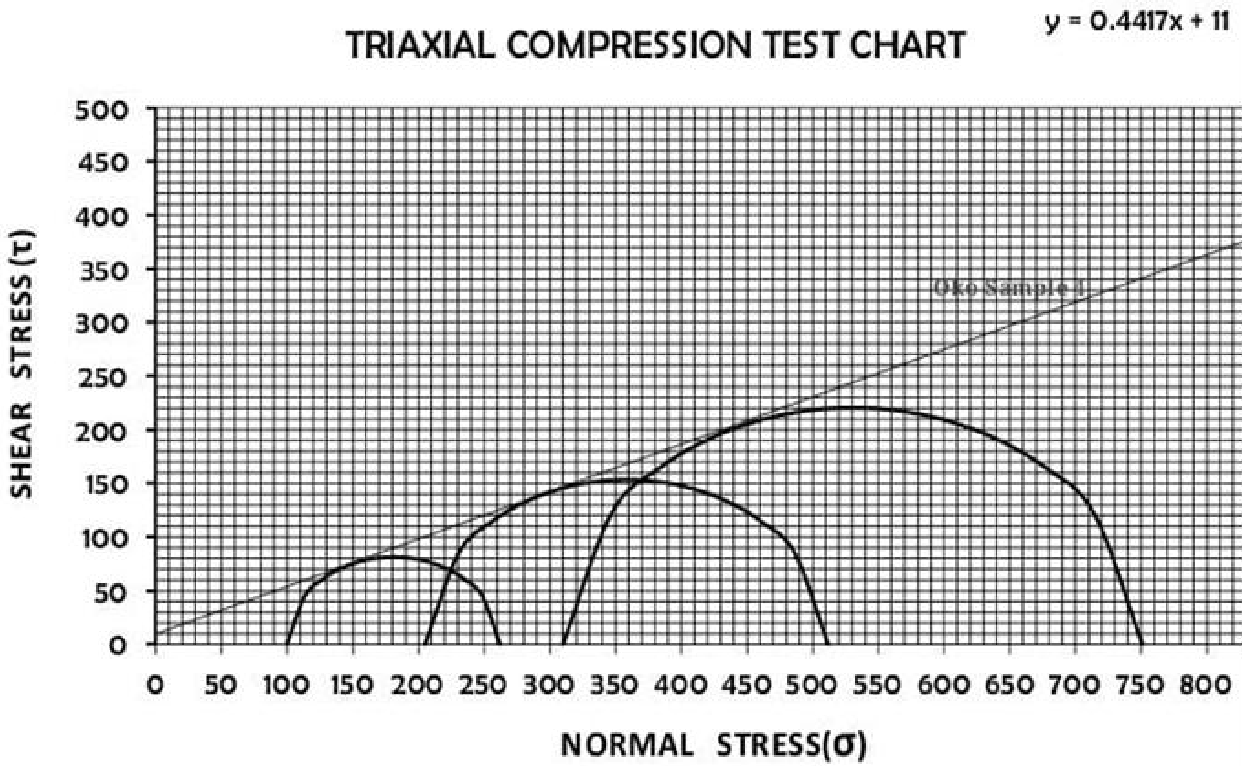

Fig 17: Graph of normal stress against shear stress for OKO sample 4

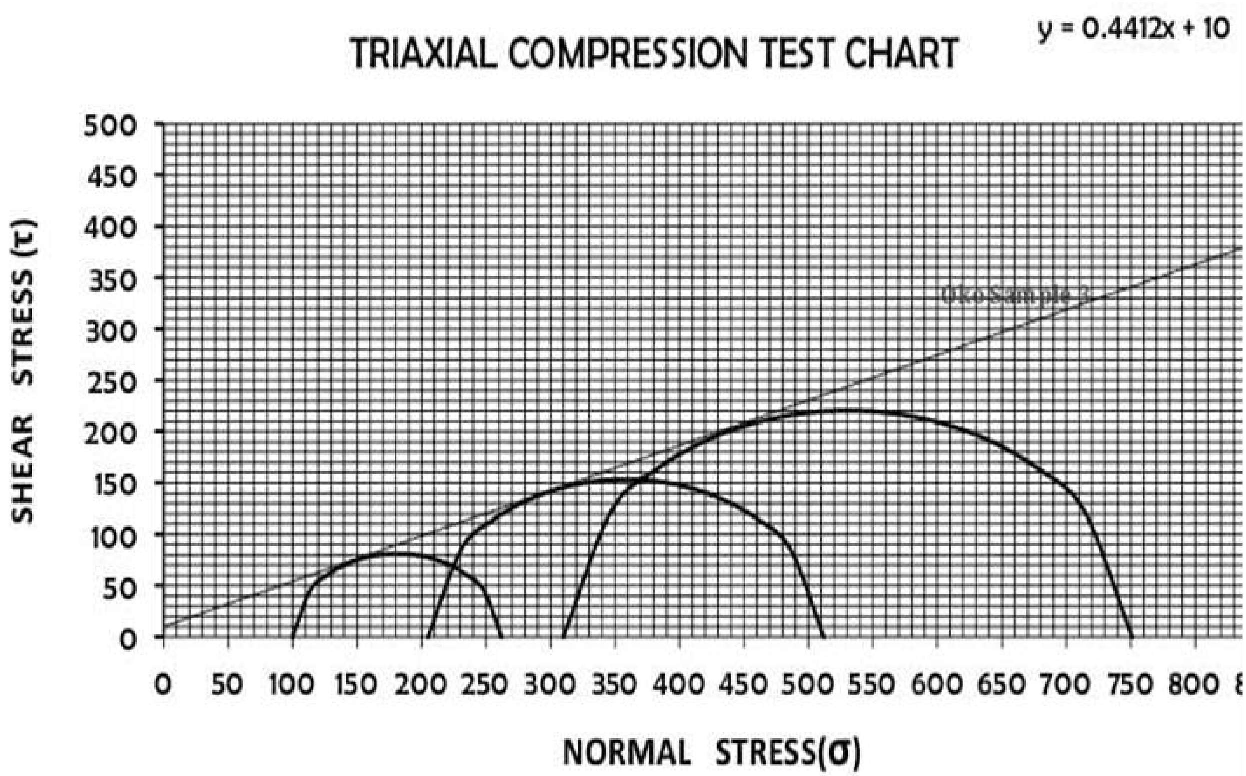

Fig 18: Graph of normal stress against shear stress for OKO sample 5

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.

The higher the values, the higher the shear strength. All the samples have higher shear strength as depicted in the high values of the two components of shear strength, the apparent cohesion and shear angle (friction). The shear strength is represented by the radius of Mohr's circle (τmax). Moreso, the shear strength is related to the sand particles' cohesion (C) and angle of internal friction (φ) . These findings corroborated earlier results from study carried out by Ogbuagu and Okeke (2019). The Mohr's Circle intersects the τ-axis at the point of maximum shear strength (τmax). Furthermore, the radius of Mohr's circle represents the shear strength and the center of Mohr's circle represents the hydrostatic stress (σm),

Conclusion and Recommendation

Table 4: Federal Min. of Works and Housing Specification for Base course material and measured soil properties

Property	Nigerian Standard required	Sample point soil property					Average	Remark
		S1	**S2**	**S3**	**S4**	**S5**		
LL (%)	≤30	28	28	27	28	35	29.20	Good
PL (%)	≤13	17	16	10	15	18	15.25	Not Good
UCS (KPa)	>103	37	40	36	31	45	37.80	Not Good
% passing No. 200 sieve	5-15	18.3	12.0	11.0	16.6	13.9	14.36	Good
General Comment							Not suitable	

The summary of the results shows that the values do not conform to the quality requirement of Federal Ministry of Works and Housing specification for Base course material (Table 5).

However, the samples showed good qualities for use as sub-base material and also excellent material for fill and embankment, Table 3.Predominance of sand will guarantee high performance when used in making sandcrete blocks and in building constructions. Since the liquid limit values generally indicated low plasticity, consequently, the sands are not likely to show deformation and instability under road.

Table 3: Nigerian specification for fill & embankment Vs measured soil properties

Property	Nigerian Standard required	Sample point soil property					Average	Remark
		S1	**S2**	**S3**	**S4**	**S5**		
MDD(g/cm^3)	>0.04	1.70	1.73	1.67	1.67	1.85	1.72	Good
OMC (%)	<18	12.05	12.01	11.99	12.12	12.11	12.06	Good
LL (%)	<40	28	28	27	28	35	29.20	Good
PL (%)	<20	17	16	10	15	18	15.25	Good
% passing No. 200 sieve	≤35	18.3	12.0	11.0	16.6	13.9	14.36	Good
General Comment							Excellent Material	

References

Ademilla, O. (2018). Geotechnical Characterization of Subgrade soils in Southwestern part of Nigeria. Proceedings of First & Second International Conferences of the Nigerian Association for Engineering Geology and the Environment (NAEGE), Lagos, Nigeria, 2016 & 2017. 1, 2018 42 - 48).

Aduonye, G.O., Kolapo, S.A., Olamoju, T.O. and Akanbi, O.T. (2018). Investigation of Geotechnical properties of lateritic soils in parts of Ife Central Local Government Area, Osun State, Southwestern Nigeria. African Journal of Environment and Natural Science Research, 1 (2), 31- 41.

Akolisa, C.C.Z., Oparah, J.C. and Agbasi, O.E. (2021). Geotechnical characteristics of Benin Formation, Owerri, Imo State Nigeria. Brillan Engineering 3 (2), 1-5.

Anyanwu, N.P.C. and Arua, I. (1990). Ichnofossils from the Imo Formation and their paleo-environmental Significance. J. Mining and Geol 26, 1-4.

Arua, I. (1986). Paleoenvironment of Eocene deposits in the Afikpo syncline, Southern Nigeria. J. of Afri Earth Sciences 5, 279 – 284.

ASTM D4318 – 17el ,(2017). Standard Test Methods for liquid limit, plastic limit, and plasticity index of soils, ASTM International, West Conshohocken, P.A. www.astm.org.

British Standards Institute. (1990). Stabilized materials for civil Engineering Purposes- Part 2: Methods of Test for Cement-stabilized and lime-stabilized materials, BS1924-2.

Augusta, E. (2000). The influence of fines content and plasticity on the strength and permeability of aggregate base class A. Thesis, master program on highway and development, Bandung Institute of Technology.

Didei, I.S. and Oborie, E. (2018). Classification and evaluation of soil compaction at shallow depth in Ogobiri and its environs, Bayelsa State, South –South Nigeria. *International Journal of Agriculture and Earth Science*, 4(1), 22-33.

Ezeigbo, H.I. (1989). Grandwater quality problems in parts of Imo State, Nigeria .J. Mining and Geol, 25, 1-9.

Federal Ministry of Works and Housing, (1997). Nigerian General specification for roads and bridges (Revesed edition) 2, 137-275.

Nwaiwu, O., Alkali, K. and Ahmed, A. (2006). Lateritic gravels in relation to gravel road pavement construction. Geotechnical and Geological Engineering, 24, 283 – 298 https: //doi.org/10.1007/510706 – 004.

Nwajide, C.S. (1979). A lithostratigraphic analysis of the Nanka Sand, Southeastern Nigeria. Nig. J. Mining and Geology, 16,103 – 109.

Nwajide, C.S. and Reijers, T.J.A. (1996). Sequence architecture in outcrops: Examples from the Anambra Basin. NAPE Bull 11, 23-32.

Nwajide, C.S. (2013). Geology of Nigeria's sedimentary basins. Lagos. CSS Press. 565p.

Nzabakurikiza, A., Onanango'oze, A., Ndziemuvindi, A. T. and Ekodeck, G.E. (2017). Geological, geotechnical and mechanical characterization of lateritic gravels from Eastern Cameroon for road construction purposes. Bull of Engrg. Geol. and the Env. 4, 201 – 210.

Oboh-Ikuenobe, F.E., Obi, G.C. and Jaramillo, C.A. (2005) Lithofacies, Palynofacies and sequence stratigraphy of paleogene strata in South Eastern Nigeria. *J. of African Science* 1, 41, 75 – 100.

Offodile, M.E. (2014). Hydrogeology: Groundwater study and development in Nigeria (3rd edition). Jos, Mecon Geology and Engineering Services Ltd. 636p.

Ofomata, G.E.K. (1975). Nsukka –Okigwe cuesta. In Ofomata, G.E.K. (ed). Nigeria in Maps Eastern States.Benin Nigeria, Ethope Publ. House. 38-45.

Ogbuagu, F.U. and Okeke, C.A.U. (2019). Geotechnical properties of lateritic soil from Nimo and Nteje areas of Anambra State, Southeastern Nigeria. IOP Conf. Series Materials Science and Engineering 640 (2019) 012078 doi: 10.1088/1757 - 899X/640/1/012078 1-10.

Ogbuagu, F.U. and Onyemesili, O.C. (2021). Evaluation of Geotechnical characteristics of pavement materials along Ekwulobia- Oko - Ufuma - Umunze road, Anambra State, Southeastern Nigeria. A paper presented at the Nigerian Mining and Geosciences Society (NMGS) 56th Annual international hybrid Conference and Exhibitions, 14 - 20 March, 2021 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Ogbuagu, F.U. and Okeke, C.U.U. (2019). Geotechnical properties of lateritic soil from Nimo and Nteje areas of Anambra State, Southeastern Nigeria. IOP conference series: Materials Science and Engineering 640 (2019) 012078 doi: 10.1088/1757-899X/640/1/012078.

Paige-Green, P., Pinard, M. and Netterberg, F. (2015). A review of specifications for lateritic materials for low volume roads transportation. Geotechnics, 5, 86 – 98 https: //doi.org/10.1016/jtrgeo. 2015 10.002.

Sunday, E.U., Owonaro, B.J., Okeke, O.C., Onyekuru, S.O. and Dozie, O.T. (2021). Geotechnical properties and aggregate quality assessment of marl deposit in Afikpo area, Southeastern Nigeria. A paper presented at the Nigerian Mining and Geosciences Society (NMGS) 56th Annual international Conference Centre, University of Ibadan, Ibadan, Nigeria.

Que, J., Wang, Q, Hen, J., Shi, B., and Meng, Q. (2008). Geotechnical properties of the soft soil in Guangzhou College City. Bull. Eng. Geol. Envron, 67, 479 – 483.

Cite this article as:
Ogbuagu, F.C. et. al. (2025). Geotechnical Properties of Sand Derived from Awdaw River Channel Oko-Amaokpala Area Anambra Basin, Southeastern Nigeria. *International Journal of Science and Engineering and Technology (IJSE), 1(1)* 64-79.