IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 5 **ISSUE : 1** **Print / Issue Publication Date: 29-Jul-2020**

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2020.v05i01.133

Indexed In

Google SCHOLAR · OPEN ACCESS · doi · Crossref

WWW.IJEAST.COM

editor@ijeast.com

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 757-762
Published Online May 2020 in IJEAST (http://www.ijeast.com)

THE EFFECT OF NANO-CHEMICAL ON THE SHEAR STRENGTH PROPERTIES OF SOILS

Akolade, A.S[1], Oyekanmi, O. A[2], Aleshinloye, A. O[3], Alabi, O.T[4]
[1]Department of Civil Engineering, Lead City University, Ibadan, Nigeria.
[2]Works and Services Department, The Polytechnic Iree, Osun, Nigeria.
[3]Department of Civil Engineering, University of Ibadan, Ibadan Nigeria.
[4]Department of Civil Engineering, The Polytechnic, Ibadan, Ibadan, Nigeria

Abstract - Lateritic soils are used as a road making material and they form the sub-grade of most tropical road. For the durability of the soil material which is to be used as subgrade, there is need to improve it mechanical properties by some suitable means mostly soil stabilization.

This research studied the effect of terrasil on the geotechnical properties of subgrade material which was subjected to shear strength test. Four soil samples were collected from Eleyele area of Ido local government and labeled (A, B, C and D) at random. These samples were taken to the Laboratory for experiments to identify and determine the Grain size analysis, Atterberg, compaction and shear strength parameters at different dosages of Terrasil of 0%, 10%, 20% and 30% under the curing period of 24 hours at the laboratory, sample A,B,C & D shear strength values at 0% were (17.7 KN/m,18.55 KN/m, 14.17 KN/m & 20.74 KN/m) respectively, it was observed that the values at 10% were (14.03 KN/m, 15.09 KN/m, 15.19 KN/m & 10.84 KN/m) and the values at 20% were (8.54 KN/m, 9.85 KN/m, 8.84 KN/m & 7.21 KN/m) while the values at 30% were (6.75 KN/m, 7.80 KN/m, 8.43 KN/m and 7.74 KN/m). This result indicates that the more the additive the less the shear strength value.

The differences in the behavior of the soil under the influence of terrasil at the curing period of 24 hours shows that there is need to find out the influence of terrasil on the properties of the soil under a longer duration of about a year.

Keywords; Subgrade, Stabilization, Terrasil, Shear strength.

I. INTRODUCTION

Transportation by road is the most important facility in moving men and material. It contributes to the economic, industrial, social and cultural development of a region or state of nation. It helps primarily in linking production and consumption centers (Damodariya & Parmar, 2016).

In this tropical part of the world, lateritic soils are used as a road making material and they form the sub-grade of most tropical road. They are used as sub base and bases for low cost roads and these carry low to medium traffic (Quadri & Olafusi, 2012). In the construction of pavements, laterite is widely used as subgrade which serves as foundation for the pavement (Akolade & Olaniyan 2014), lateritic soils classified as A-3, A-2-4 and A-2-6 are adjudged suitable for sub-grade, good fill, sub-base and base materials (Amadi, & Francis, 2015)

The means of improving the soil properties is known as soil stabilization, the major forms of conventional soil stabilization are chemical and mechanical stabilization techniques; such as application of heat, lime/cement, polymer resins, geogrids, geotextile, geonet e.t.c.

New solutions are to be developed that gives all-season, pavement resistance, ensuring faster transportation and minimizing the risk of accidents. Nanotechnology is one such reformed mode which when potentially can redefine and address the rising concern of poor quality roads. Transitioning to the nano scale implies an enormous increase of the surface area with respect to the volume. Nanoparticles interact very actively with other particles and solutions such that very minute amounts may lead to considerable effects on the physico-chemical behaviour and engineering properties of soil. This research investigates into the nanoparticle known as the terrasil. Terrasil chemical is emerging as a new material for the stabilization of soil. Terrasil is nanotechnology based 100 percent organosilane, water soluble, ultraviolet and heat stable, reactive soil modifier to waterproof soil subgrade (Johnson & Rangaswamy, 2015). It reacts with water loving

silanol groups of sand, silt, clay and aggregates to convert it to highly stable water repellent alkyl Siloxane bonds and forms a breathable in-situ membrane. It resolves the critical sub-surface issues. It is water soluble, chemically reactive and non-leachable and works well with all silicate containing materials, it can be applied to almost all types of soil. Nanochemicals can be identified as environmental friendly since they conserve limiting resources like aggregates and bitumen (Johnson & Rangaswamy, 2015).

II. MATERIALS AND METHOD

In this research work, laboratory analyses were conducted to achieve the objectives. Four samples of soil were collected from a borrow pit at different points and were identified as A, B, C, and D of 20m distances apart along a river bank, with coordinate (Lat 7.418305 Long 3.868283, Lat 7.419462 Long 3.867137, Lat 7.41927 Long 3.867337 and Lat 7.419227 Long 3.867347) respectively. The following test; atterberg limit test, sieve analysis, compaction test and tri-axial text were carried out on the samples. Atterberg test was done to determine the plastic limit, liquid limits, and plastic index of the soil samples, while sieve analysis was done to determine the particle sizes that were contained in the samples, compaction test was carried out to determine the OMC and MDD of the samples by packing together of the soil particles and tri-axial to determine the shear strength parameters. Proctor compaction tests were conducted which involves the use of 4-inches-diameter mould with the compaction of three layers of soil using 27 blows by a 5.5 1b. Hammer falling 12 inches. Finally tri-axial test was conducted to determine the sample shear strength parameters with and without terrasil under 24 hours period and the engineering properties were observed.

Fig 1: Experimental operation (Compaction and Tri-axial Test)

III. RESULT AND DISCUSSION

The summary of the result of the laboratory test (grain size analysis, compaction and atterbergs limit) shown below. The engineering property test (triaxial) is presented in the tables and figures below.

a. Sieve Analysis

According to clause 6201 of Federal Ministry of Works and Housing (F.M.W & H) Specification Requirement, for a sample to be used as both subgrade/fill and base, the percentage by weight passing the No.200 sieve (75µm) shall be less than but not greater than 35%. And if the percentage passing sieve No. 200 for a Lateritic base course is greater than 35%, no need for further tests and material rejected. (Habeeb & Quadri, 2012).

Grain size analysis or gradation test was a procedure used in the experiment to assess the

particle size distribution of preliminary sample A, B, C and D of a granular material. These were shown in the tables and figures below. The percentage passing through No. 200(75 micron) sieve from the four samples ranges between 7.73% and 15.83% which indicates that the samples are coarse.

Table 1 Sieve Analysis of preliminary Results for sample A

Sieve size	Weight retained in gms	Percentage retained	Total % passing
2.36mm	39.00	13.43	86.57
425micron	36.00	12.40	45.05
75micron	44.40	15.30	14.86

Table 2 Sieve Analysis of preliminary Results for Sample B

Sieve size	Weight retained in gms	Percentage retained	Total % passing
2.36mm	30.50	12.71	87.29
425micron	29.50	12.29	47.31
75micron	38.50	16.04	15.83

Table 3 Sieve Analysis of preliminary Results for Sample C

Sieve size	Weight retained in gms	Percentage retained	Total % passing
2.36mm	60.50	18.06	81.94
425micron	42.50	12.69	41.16
75micron	61.61	18.38	8.15

Table 4 Sieve Analysis of preliminary Results for Sample D

Sieve size	Weight retained in gms	Percentage retained	Total % passing
2.36mm	52.50	17.36	82.62
425micron	44.00	14.54	37.56
75micron	32.00	10.58	7.73

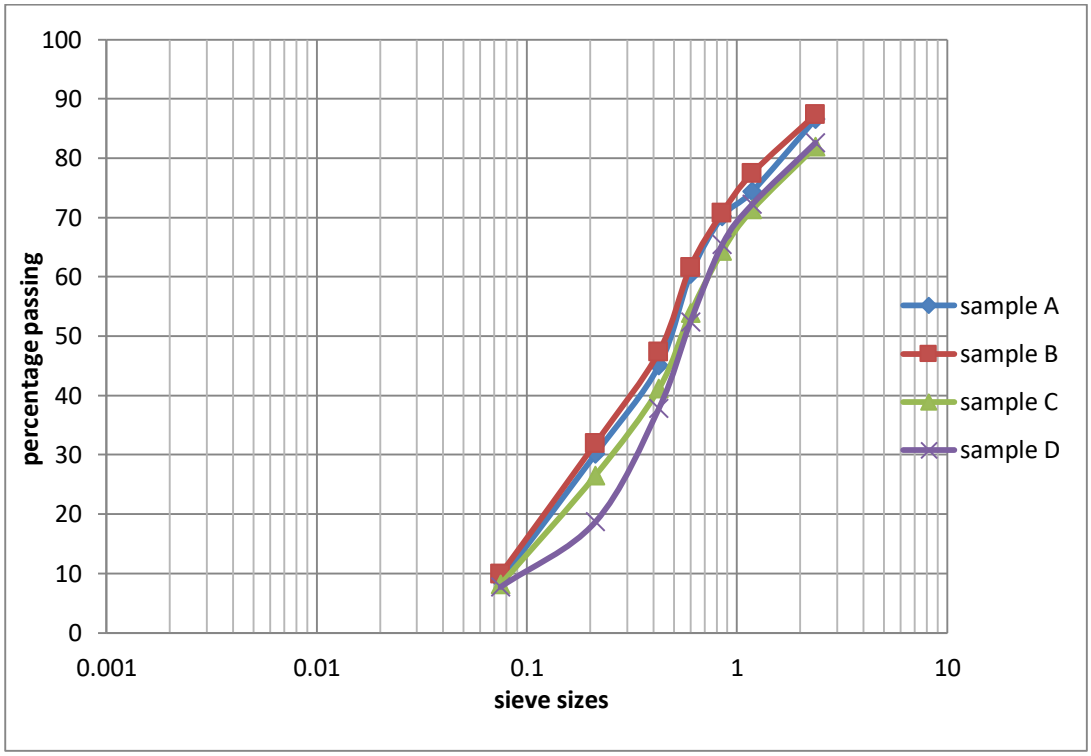

Fig 2: Graph of particle size analysis

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 757-762
Published Online May 2020 in IJEAST (http://www.ijeast.com)

b. Atterberg Limit Test

Atterberg limit test was performed to determine the soil liquid limit, plastic limit and plastic index. According to Federal Ministry of Works and Housing (F.M.W & H) Specification Requirement in clauses 6201 and 6252, material passing the 425µm sieve shall have a liquid limit of not more than 35% and a Plastic Index (P.I) of not more than 12% as determined by American Society for Testing Materials Method (Habeeb & Quadri, 2012). Sample A, B, C, D fall within the category of low plasticity since there plasticity index did not exceed 35% (UNESCO, 2008)

Table 5 Atterberg limit results

	Sample A	Sample B	Sample C	Sample D
Consistency limits (%)				
a) Liquid limit	25.20	25.00	22.50	22.50
b) Plastic limit	15.50	15.39	10.98	12.73
c)Plasticity index	9.7%	9.61%	11.52%	9.77%

c. **Compaction Test**

The compaction test was carried out in order to obtain the optimum moisture content (OMC) and the (MDD) of soil samples. Table 6 below shows the compaction test result for the soil samples while the corresponding curves of dry density against moisture content for samples were displayed in Fig 2. The OMC values obtained from the moisture-density curve were used to prepare soil samples for shear strength tests.

Table 6 Geotechnical & engineering properties of samples

	Sample A	Sample B	Sample C	Sample D
Soil classification	A-2-4	A-2-4	A-2-6	A-2-4
Engineering properties				
a) M.D.D	1.94	1.89	1.97	1.97
b) O.M.C	11.42%	10.50%	13.18%	11.55%

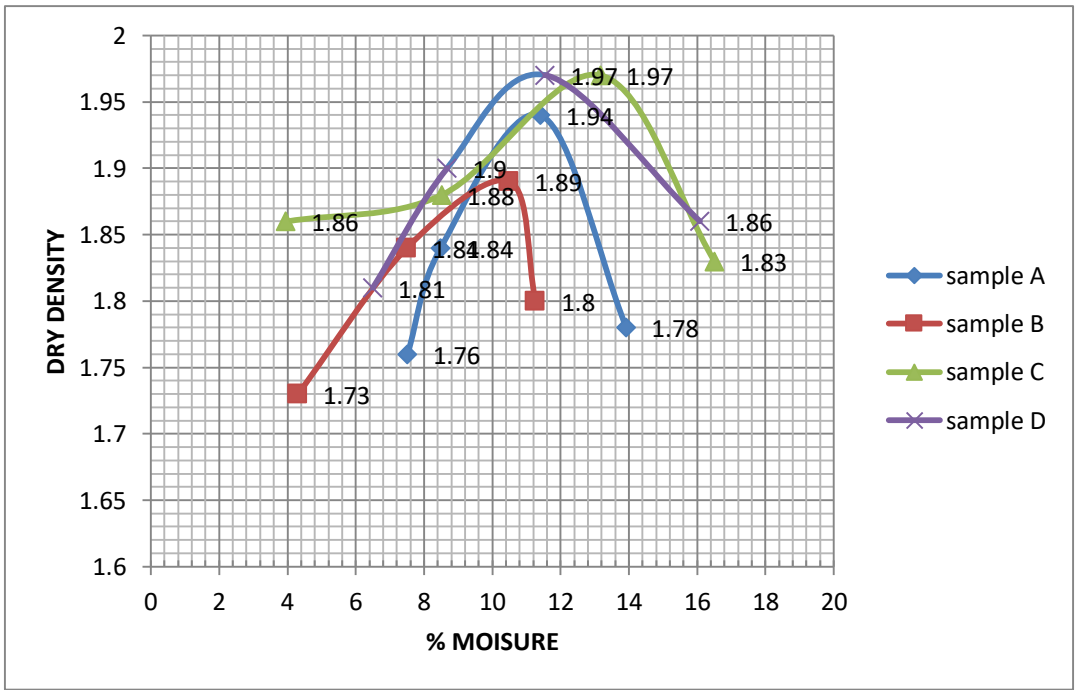

Fig 3 Graph of dry density against % moisture

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 757-762
Published Online May 2020 in IJEAST (http://www.ijeast.com)

3.3 Tri-axial Test

Tri-axial tests were conducted under the curing period of 24 hours with varying percentages of terrasil. The results are tabulated in table below. The experiment shows that with increase in dosage, there were regressions in shear strength parameters.

Table 7 shear strength results for all the soil samples

	Dosage (%)	Cohension C	Angle of friction Ø	Shear strength (KN/m)
Sample 1	0	5	11	17.7
	10	10	4	14.03
	20	3	6	8.54
	30	4	3	6.75
Sample 2	0	5	11	18.55
	10	13	2	15.09
	20	6	4	9.85
	30	5	3	7.80
Sample 3	0	9	4	14.17
	10	11	4	15.19
	20	5	4	8.84
	30	5	3	8.43
Sample 4	0	4	14	20.74
	10	10	5	10.87
	20	5	3	7.21
	30	4	4	7.74

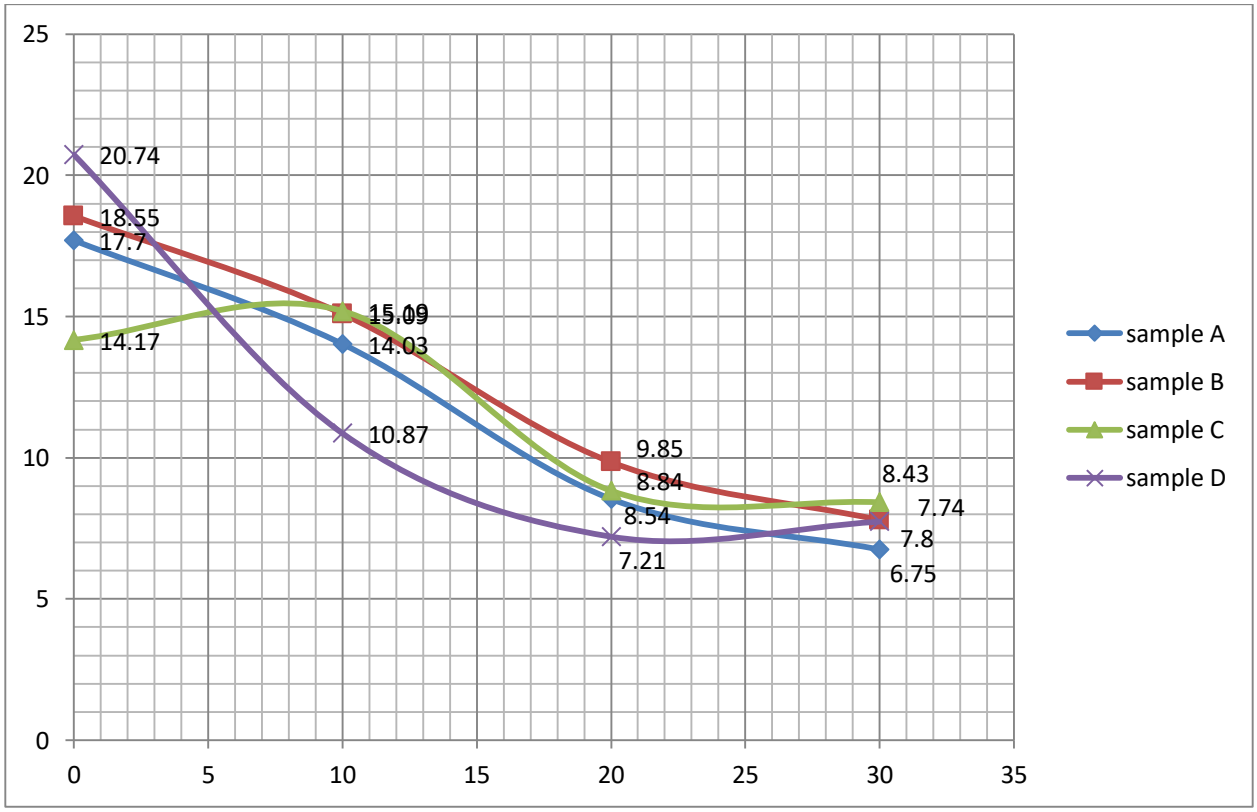

Figure 4 shows the regression of shear strength value against Percentage of terrasil dosage

IV. CONCLUSION AND RECOMMENDATION

The study investigated the effect of terrasil on the geotechnical properties of subgrade material under the curing period of 24 hours. Presence of terrasil in the four samples led to the reduction in the soil geotechnical properties such as cohesion, angle of friction, and shear strength values. However, the curing duration determines the effectiveness of terrasil on subgrade materials.

It is recommended that laboratory tests should be carried out on borrow pit materials to be used for construction so as to know their suitability for the intending purposes.

There is also a need to find out the influence of terrasil on the properties of the soil under a longer duration of about one year.

V. REFERENCE

1 Akolade, A.S and Olaniyan, O. S. (2014).Application of Geogrids on the Geotechnical Properties of Subgrade Materials under Soaked Condition *Civil and Environmental Research* www.iiste.org ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online) Vol.6, No.7, 2014. pp. 12 – 19.

2 Amadi A.N., Akande W. G., Okunlola I. A., Jimoh M.O., and Francis Deborah G.,(2015) "Assessment of the Geotechnical Properties of Lateritic Soils in Minna, North Central Nigeria for Road design and Construction." *American Journal of Mining and Metallurgy*, vol. 3, no. 1 (2015): 15-20. doi: 10.12691/ajmm-3-1-3.

3 Ayininuola, G. M, Agbede, O. A and Franklin, S.O (2009): influence of calcium sulphate on sub-soil cohesion and angle of friction. *Journal of applied sciences research. Vol. 5 No. 3,297-304.*

4 B. M. Lekha, A. U Ravi Shanar and Gouthan Sarang (2012). Fatigue and Engineering Properties of Chemically Stabilized Soil for Pavements. *Indian Geotechnical Journal*, 43[1]:96-104.

5 Damodariya S.M, Mrudul U.V, Parmar N.B.(2016) Laboratory Investigation of Soil Stabilized using Terrasil *IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 03, 2016 | ISSN (online): 2321-0613.*

6 Habeeb A. Quadri, Olabambo A. Adeyemi, Oladipupo S. Olafusi, (2012). Investigation of the Geotechnical Engineering Properties of Laterite as a Subgrade and Base Material for Road Constructions in Nigeria *Civil and Environmental Research* www.iiste.org ISSN 2222-1719(Paper) ISSN 2222-2863 (Online) Vol 2, No.8, 2012.

7 Odewumi, T.O, Alli, O. O and Akolade, A. S (2018) "Effect of Terrasil on the Hydraulic Conductivity and Strength properties of Soil". *Journal of New Trends,*Nigerian Institute of Civil Engineers (NICE).

8 Rintu Johnson, Kodi Rangaswamy, (2015). Improvement of Soil Properties as a Road Base Material using Nano chemical Solution *Indian Geotechnical Society* (IGS) 50th Indian Geotechnical Conference 17th – 19th December 2015.

9 S.V, Neehu and S. Remya (2013). Engineering Behaviour Of Nanoclay Stabilized Soil.*international journal of civil and environmental engineering 4(6).pp. 321-328.*

10 Quadri,H. A and Olafusi,O.S (2012) Investigation of the Geotechnical Engineering Properties of Laterite as a Subgrade and Base Material for Road Constructions in Nigeria. *International Institute of Science, Technology and Education.* Vol. 2, No 8 pp. 17 – 24.

11 UNESCO, Introduction of soil mechanics, version 1, December 2008

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

ABOUT IJEAST

International Journal of Engineering Applied Science and Technology (IJEAST) is a peer-reviewed, open access journal that publishes high-quality research papers in the field of Engineering, Applied Science and Technology.

IJEAST aims to provide a platform for researchers, academicians, and professionals to share their innovative ideas, research findings, and practical experiences with the global scientific community.

FOCUS AREAS

- Engineering
- Applied Science
- Technology
- Innovation & Development
- Interdisciplinary Studies

PEER REVIEWED
All submissions are rigorously peer reviewed to ensure quality.

OPEN ACCESS
Free and unrestricted access to research for all.

GLOBAL REACH
Connecting researchers and professionals worldwide.

TIMELY PUBLICATION
We ensure a swift and efficient publication process.

For more information, visit our website
www.ijeast.com

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

editor@ijeast.com
www.ijeast.com
India

2455-2143