

USE OF GEOFIBRES IN THE RECONSTRUCTION OF ROAD

Ms. Ms.S. V. Niwane , Ms. Apeksha G. Choudhry

PG Student, G. H. Raisoni University Amravati Maharashtra, India

Abstract- The study was undertaken to evaluate the effect of geofibres in the reconstruction of Road. Samples of sub- grade soil were collected within the failed section of Road. Geofibres was added to the soil in an increasing order of 5% , 10% , 15% and 20% by weight of the soil in a single and double layered system. The sub- grade soil samples and sample stabilized with geofibres was subjected to laboratory testing. The test conducted were sieve analysis test, specific gravity test, atterberg limit test, compaction test and CBR test. Results obtained from sieve analysis test classified the samples as A-7-6 according to AASHTO Soil Classification System and CH (clay of high plasticity) according to Unified Soil Classification System, the specific gravity of the sub- grade soil was 2.66, the liquid limit, plastic limit and plasticity index of the sub- grade soil was 34.8% , 21.5% and 13.3% , the maximum dry unit weight of the sub- grade soil increased from 20.7kN/m³ to 22.67kN/m³, for the single layered disposition of geofibres while for the double layered disposition of geofibres, the maximum dry unit weight of the sub- grade soil increased from 20.7kN/m³ to 23.2kN/m³. The CBR of the sub- grade soil increased from 25.8% to 32.6% for the single layered system, 27.4% to 34.8% for the double layered. The study therefore recommends the use of geofibres in road construction as improvement in the strength properties of the sub- grade soil was observed.

Keywords- Geofibres, Soil

I. INTRODUCTION

Road is a one- lane single carriage way located at the outskirts of Nnamdi Azikiwe University Awka Anambra State Nigeria. The road passes through places such as Yahoo Junction, Miracle Junction, Commissioner Quarters, First and Second Markets and terminates at a stepped terrain in Aroma. These road majorly used by student and lecturers of Nnamdi Azikiwe University is characterized by severe pavement distresses ranging from large potholes, alligator cracking, collapse and clogging of drainage channels evident in regions especially at Miracle and Yahoo junction respectively. Occurrence of this distresses have been largely attributed to poor geotechnical properties of the sub- grade soil, therefore it is highly pertinent from civil engineering

Flexible pavements are multi- layered system consisting sub- grade (pavement foundation), sub- base, base course and wearing course (asphalt concrete). Performance of a flexible pavement during service is significantly influenced by the strength and stiffness of the sub- grade layer as it serves as foundation for the pavement (Kadeyali, 1997). Sub- grade is natural compacted earth composed soils ranging from laterite, clays and there are cases where the sub- grade may contain expansive soils that its strength as strength cannot be guaranteed under applied loads (Osinubi, 2013). In such scenario stabilization of the sub- grade soil become necessary. Soil stabilization involves the placement of a material in a given soil layer where the presence of the material causes a redistribution of stresses and strains in the soil favorable to the purpose at hand (Palmeira, 2014). Currently, soil stabilization is most commonly performed with geosynthetics, leading to an increase in the strength and a decrease in the compressibility of the composite material. In other words, the addition of geosynthetic reinforcement in regions of tensile strain helps to inhibit the stresses in the soil, thereby increasing the shearing characteristics of the composite material (Jewell, 2012).

1.1 Scope of Study

The study is focused basically on promoting the use of geofibres as an additive for strength enhancement of sub- grade soils along road. The geofibre will be added to the sub- grade soils in increasing percentages of 5% in a two layered system by weight of the sub- grade soils Samples of sub- grade soils and geofibres will be collected and subjected to laboratory testing. The laboratory testing includes: Sieve analysis test, Specific gravity test, Atterberg limit (Liquid and Plastic limit) test, Compaction test and California Bearing Ratio test. The California Bearing Ratio test will be used as index to evaluate the strength of the sub- grade soil. During the experimental investigation for determination of California Bearing Ratio (CBR) value of the sub- grade soils modified geofibre, single layer and double layer of geofibre will be placed horizontally at varying depth so as to certain the strength of the modified sub- grade soils. Recommendations will be made based on key findings obtained from California Bearing Ratio test.

1.2 Aim and Objectives of Study

The aim of the study is to evaluate the use of geofiber as a material for strength improvement of sub- grade soil in road construction while the objectives are:

1. Ascertain the feasibility and efficacy of using geofibers as an additive for strength enhancement of sub- grade soils along Road.
2. Evaluate the index properties of geofibers and sub- grade soils collected along Road.
3. Study the effect of geofibres on strength properties of sub- grade soils collected along Road.
4. Determine the maximum amount of geofibers needed for optimum improvement in strength of sub- grade soils.
5. Draw conclusion and make relevant recommendation in the light of the findings obtained from the study.

II. RESULTS AND DISCUSSION

This section presents experimental results valuable in assessing the use of geofibres in road construction. These results are presented in Table 4.0 – 4.1 below:

2.1 Results

Table 2.0: Index Properties of the Sub- grade Soil Samples

Properties	Soil Sample
Specific Gravity	2.66
Liquid Limit (%)	34.8
Plastic Limit (%)	21.5
Plasticity Index (%)	13.3
Plasticity Rating	Medium Plasticity
Percentage Passing Sieve No 200 (0.075mm)	43.7
AASHTO Soil Classification System	A- 7- 6
Unified Soil Classification System	CH

Table 2.1: Compaction and CBR Characteristics of Soil Stabilized with Geofibres

Percentage Replacement/ Properties	0% G F	5% GF	10% GF	15% GF	20% GF
Maximum Dry Unit Weight (kN/m ³) (single layered system)	20.7	21.7	22.2	22.2	22.67
Optimum Moisture Content (%) (single layered system)	11.8	13.8	10.8	12.21	10.68
Maximum Dry Unit Weight (kN/m ³) (single layered system)	20.7	21.73	22.64	23.1	23.2
Optimum Moisture Content (%) (single layered system)	11.8	14.97	7.85	7.3	15.1
CBR Values (single layered system)	25.8	27.3	29.5	30.3	32.6
CBR Values (double layered system)	25.8	28.8	31.6	32.5	34.8

2.2 Evaluation of the Index Properties of the Soil Sample

Figure 4.0 is a semi- logarithmic plot of the particle size distribution of the natural clayey soils. The percentage passing sieve No 200 (0.075mm) was 43.7 and as a result, the soil sample was classified as CH (clay of high plasticity) according to Unified Soil Classification System and A- 7- 6 according to AASHTO Soil Classification System. The shape parameter (D₁₀) cannot be determined from the particle size distribution chart and as a result, the gradation of the clayey samples could not be ascertained.

Atterberg limit test of the soil sample revealed that the liquid limit, plastic limit and plasticity index of the samples were 34.8% , 21.5% and 13.3% respectively. The results meet the requirement given by Federal Ministry of Works and Housing, (1999) which state that the liquid limit and plasticity index of sub- grade soil samples must not exceed 80% and 55% respectively.

The specific gravity of the sample was 2.66; this value obtained satisfied the specification given by Federal Ministry of Works and Housing, (1999) which state that the specific gravity of sub- grade soils must lie within the range of 2.5 to 2.75. The specific gravity value obtained (2.66) also

suggest the presence of clay or silt which is advantageous at the sub- grade level of road construction.

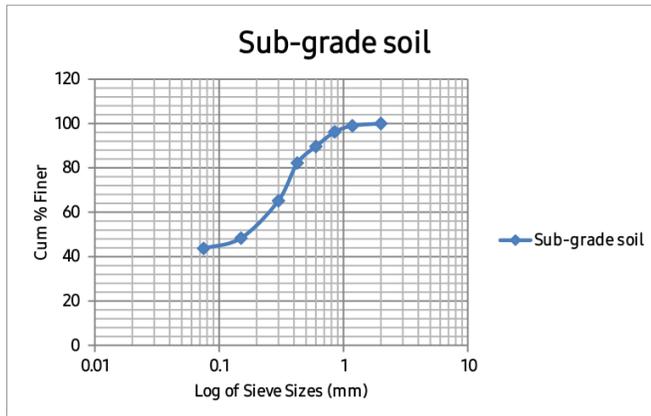


Table 2.3 Economic Analysis Pavement Reconstructed with Geofiber and Non Geofibre Reinforced Sub- grade Soil along Road.

Bill No	Description	Geofibre Reinforced Sub-grade Soils Amount (#)	Non-Geofibre Reinforced Sub-grade Soils Amount (#)
1	Earth work	5,125,000.00	9,989,200.00
2	Road work	50,840,000.00	54,899,000.00
	Sub Total	55,840,000.00	64,888,200.00
	Add 5% Contingency	2,798,250.00	3,244,410.00
	Sub Total	58,763,250.00	68,136,610.00
	Add 5% VAT	2,938,162.50	3,406,663.50
	Grand Total	61,701,412.50	71,539,240.00

2.2.5 Economic Assessment of Geofibre and Non Geofibre Constructed Pavement Structure

Table 2.3 depicts the economic assessment of the pavement constructed with sub- grade reinforced with geofibre and non geofibre reinforced sub- grade soils. From the findings obtained, it is very obvious that the cost of pavement constructed with sub- grade reinforced with geofibre was relatively lesser compared to that constructed without the use of geofibre. The discrepancy in cost is due to the relative cheapness of geofibre and ease of replacement of expensive materials used for strength enhancement of the sub- grade soils. It is therefore pertinent to incorporate the use of geofibre as a material for road construction as this will not only enhance the bearing strength of the sub- grade soil but also foster cost effectiveness in both pavement construction and reconstruction process.

Figure 2.0: Particle Size Distribution Curve for the Soil Sample

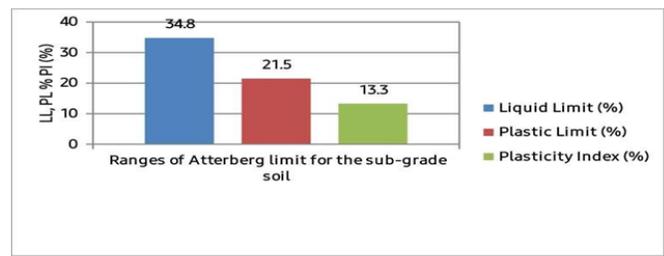


Figure 2.1: Liquid, Plastic and Plasticity Index of the soil Sample

2.3 Evaluation of the Compaction and CBR Characteristics of the Sub- grade Soil Stabilized with Geofibres

Figure 2.1- 2.3 shows the results of maximum dry unit weight and optimum moisture content obtained at varying percentages of geofibres for both single and double layered system. Results obtained revealed that the maximum dry unit weight of the soil increased on consistent addition of geofibres to the soil from 5% to 20% for the single layered disposition of geofibres. Although, a slight deviation was observed at 15% geofibre content, this could be attributed to lapses in the experimentation process. While for the doubled layered disposition of geofibres, a trend of decrease and increase in maximum dry unit weight of the sub- grade soil was observed. The peak maximum dry unit weight was recorded at 15% geofibre content. The optimum moisture content on the other hand, was found to decrease with increasing percentages of geofibres. Comparative assessment of the effect of single and double layered disposition of geofibres on the compaction characteristics of the soil shows that the increase in the maximum dry unit weight of the sub- grade soil was consistent for the single layered disposition of geofibres than that of the double layer. However, the peak maximum dry unit weight for the double layered disposition of geofibres was higher than that of the single layer. Works indicative of these findings are the works of (Nangia et al. 2015), (Krishna and Rao, 2017) and (Dayakar, et al. 2018).

Table 2.2 depicts the CBR characteristics of the soil samples stabilized with geofibres for both single and double layered arrangements. Results obtained for the single layered system shows that addition of geofibres to the soil improved the CBR characteristics of the soil from its natural value of 25.8% to 32.6% while for the double layered disposition, the CBR characteristics of the soil increased from 27.4% to 34.8% . The addition of geofibres enhanced the CBR of the soil making them suitable for use as both sub- base type 2 and sub- base type 1 material as recommended by Federal Ministry of Works and Housing, (1999).

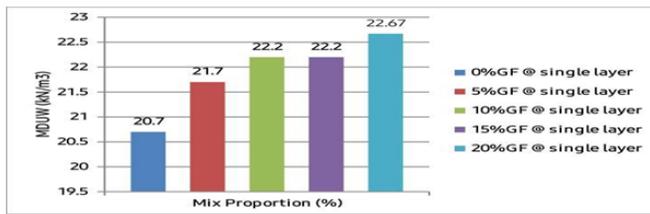


Figure 2.2: Maximum Dry Unit Weight for Single layer Disposition of Geofibres

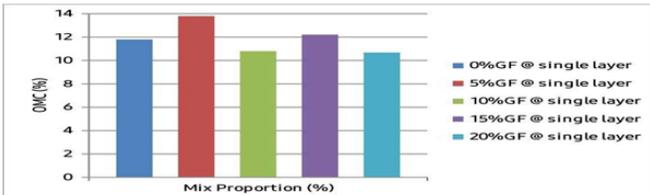


Figure 2.3: Optimum Moisture Content for Single layer Disposition of Geofibres

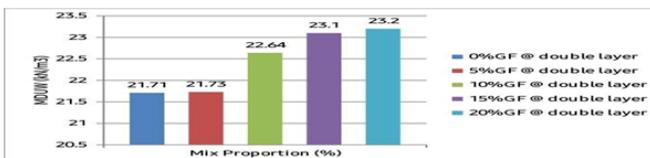


Figure 2.4: Maximum Dry Unit Weight for Double layer Disposition of Geofibres

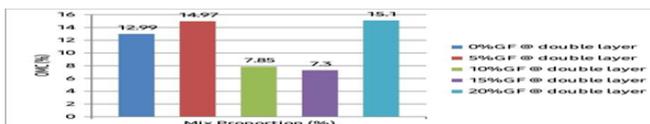
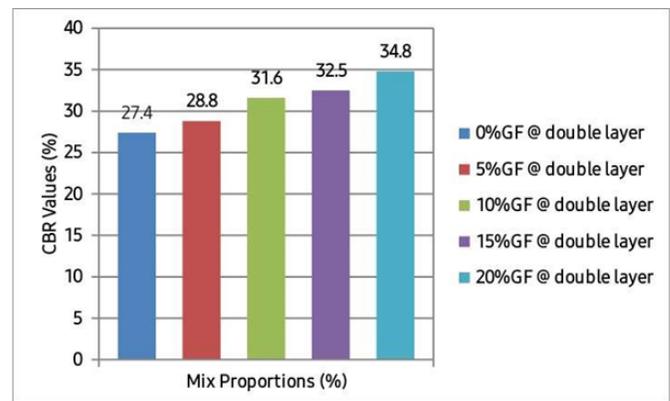
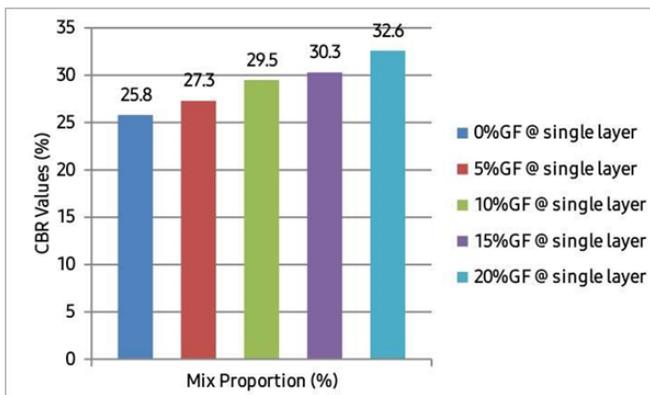


Figure 2.5: Optimum Moisture Content for Double layer Disposition of Geofibres



0% GF @ double layer

III. CONCLUSIONS

- From the findings obtained on the assessment of the effect of geofibres as a material for road construction, the following conclusion can be drawn:
 - Evaluation of the particle size distribution of clay shows that the percentage passing sieve No 200 (0.075mm) was 43.7 and as a results, the clay sample was classified as CH (clay of high plasticity) according to Unified Soil Classification System and A- 7- 6 according to AASHTO Soil Classification System.
 - The specific gravity, liquid limit, plastic limit and plasticity index of the soil sample were 2.66, 34.8% , 21.5% and 13.3% .
- The maximum dry unit weight of the soil sample was found to increase on consistent addition of geofibres from 5% to 20% for the single layered disposition of geofibre while for the double layered disposition of geofibre, a range of fluctuating values was obtained.

REFERENCES

- Atkinson, J. (2002). Particle Size Analysis, University of the West England, John City University.
- Badejo, B., “Transportation in Nigerian cities: findings, expectations and future outlook”, In K. M. Yari,
- Ndirimbula, A. G., Nwosu, E. C. G. & Badejo, B. A. (Eds), Transportation challenges in Nigerian cities: A synopsis, pp.123- 141, Nigerian Institute of Town Planners & Town Planners Registration Council of Nigeria, Abuja, 2017.
- Badejo, B.A., (2014). Transportation: Removing the clogs to Nigeria’s development”, Anchorage Press & Publishers, Lagos.
- Berg, R.R., Christopher, B.R. and Perkins, S.W. (2000), “Geosynthetic reinforcement of the aggregate base/sub-base courses of flexible pavement structures- GMA white

- paper II”, Geosynthetic Materials Association, Roseville, MN, USA, 176p.
- [6] Bogale, B.D., (2016). “Socioeconomic impacts of road development in Ethiopia: case studies of Gendewuha-Gelago, Mile–Weldiya and Ginchi- Kachisi Roads”, (Doctoral Thesis), Department of Geography, University of South Africa.
- [7] Bos, D. (2014). “Regulation: Theory and concepts”, In D. Parker & Saal, D. (Eds), International Handbook in Privatisation, pp. 447- 497, Edward Edgar Publishing Model, Cheltenham,.
- [8] Braja, M. (2002). Soil Mechanics Laboratory Manual 6th Edition, New York, Oxford University Press.
- [9] Braja, M. (2006) “Specific Gravity” In Principle of Geotechnical Engineering, 7th Edition, Cengage Learning (Pp.34).
- [10] Britannica Encyclopedia (2012), Roads and Highways, available online at <http://www.britannica.com/EBchecked/topic/505109/roads-and-highways>, accessed on 22 July.