wjert, 2018, Vol. 4, Issue 2, 236-243. *Original Article* ISSN 2454-695X

World Journal of Engineering Research and Technology
WJERT
www.wjert.org SJIF Impact Factor: 5.218

ASSESSMENT OF GEOTECHNICAL PROPERTIES OF A-6 SOIL STABILIZED WITH GLASS POWDER AS PARTIAL REPLACEMENT OF CEMENT

Adekanmi Jonathan Segun*[1] and Popoola Oluniyi Oyedeji[2]

Civil Engineering Department, The Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

Article Received on 29/12/2017 Article Revised on 19/01/2018 Article Accepted on 09/02/2018

***Corresponding Author**
Adekanmi Jonathan Segun
Civil Engineering Department, The Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

ABSTRACT

This research looked into the effect of glass powder as partial replacement of cement on the geotechnical properties of silty soil. The waste glass was grinded to powder and choose as a partial replacement of cement with a view to obtaining suitable percentage of the glass powder that can partially replace cement and still provide the soil with the adequate engineering properties required to make it useful in the construction industry. The soil sample used was collected from the Federal Polytechnic Ado-Ekiti and was subjected to laboratory tests in other to classify the soil. The soil sample was stabilized with 10% additive(s) by weight of the soil sample. Since the goal is to partially replace cement with glass powder, the quantity of cement used was been reduced in steps of 2% and replaced by glass powder to give the total sum of 10% additives. The effects of this alteration were monitored on the consistency limits and compaction tests. The consistency limits results revealed that 8% replacement of cement by glass powder increases the plasticity of the soil as the Plasticity Index moves from 18.03% in 10% cement to 21.69%. The compaction results showed that 6% replacement of cement by glass powder increases the soil's Maximum Dry Density and Optimum Moisture Content from 1509Kg/m^3 to 1748Kg/m^3 and 12.8% to 17.4% respectively as compare to 10% cement. The results proved glass powder to be suitable as replacing material for cement in stabilization of soil.

KEYWORDS: Glass powder, partial replacement, A-6 soil, cement, plasticity index.

INTRODUCTION

Building construction industries are faced with different numbers of challenges as regards the availability of suitable material for construction and the cost of the available material used. The materials used on daily basis in the construction industries among others are cement, sand and laterite. Lateritic soils are used as road pavement materials and for filling of foundation in Civil Engineering. The quest for standard job and profit had limit engineers and contractors to making use of the available soil materials closer to their site. The available materials are not totally fitted for the available job in so many cases, this instances led to looking inward to solving the problem by stabilizing the available soil material or replacing it with suitable soil material or additives. In years past, cement had been the only option available for stabilizing inadequate soil, the cost of acquiring a bag of cement in a retail shop is not affordable any longer by a common man and the level of pollution generated in its production had started shifting the attention of Engineers and contractors from its use as stabilizing materials. Hence, there arose different research from the wealth of ideas of researchers to the possible alternative.

Many locally available and less costly materials like saw dust, cassava peel, palm kernel shell, maize cobs, cocoa pods, and the likes, converted to ash have been used by researchers (Adetoro et al, 2015, Moses et al, 2013, and Owolabi et al, 2012) and they were proved to be positive as stabilizing and replacing agent. The effects of waste glass powder was monitored on different soils from different locations by (Jinu et al, 2017, Subash et al, 2016, Ikara et al, 2016, & Olufowobi et al, 2014) and it was verified that its presence as replacement or stabilisation material increases the strength of soil at an average percentage of 6 to the weight of dry soil sample.

The soil sample used for this research work was classified by AASHTO method of soil classification as “fair to poor” if to be used as subgrade material. Therefore, the need to check the effects of glass powder as partial replacement of cement, pegged at 10%.

Table 1: Details of sample treatment.

Sample Code	Description
L_{100}	Untreated soil sample
LC_{10}	100% Soil sample + 10% cement
LC_8G	100% Soil sample + 8% cement + 2% glass powder
LC_6G	100% Soil sample + 6% cement + 4% glass powder
LC_4G	100% Soil sample + 4% cement + 6% glass powder
LC_2G	100% Soil sample + 2% cement + 8% glass powder
LG_{10}	100% Soil sample + 10% glass powder

MATERIALS AND METHODS

Materials

The materials used for this study are lateritic soil, glass powder, cement and water. The soil sample was collected in its disturbed state at a depth of 1.2m below ground level behind central store of the Federal polytechnic, Ado Ekiti along centre for enterpreneurship and development vocational skill of the institution. Soil sample used was air dried under a shed for an average of ten days, and was pulverized in other to remove deleterious materials from the sample. Waste louvre blades were collected in Ado-Ekiti and grinded to powder and were sieve through 600µm aperture. Dangote Portland limestone cement, grade 42.5R used was procured in a store at Ado Ekiti and was properly stored to avoid weakness in its strength. The water used was ensured to be fit for drinking purpose.

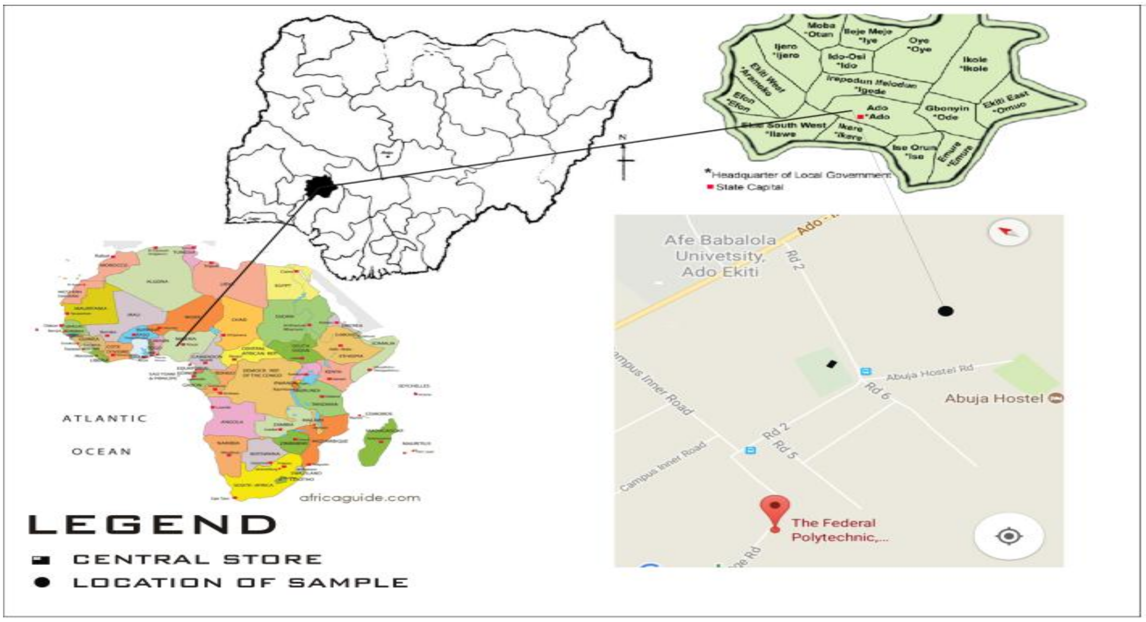

Fig. 1: Location of the study area [Google Earth, 2010].

Methods

The soil sample was subjected to different laboratory tests as explained below:

Particle Size Distribution and Hydrometer Test: The soil sample was soaked for 24hours and washed through 75µm sieve. The retained sample on the sieve was dried, poured on the arranged set of sieves in accordance with British standard (BS 1377; 1990) in other to classify the soil according to its particle in accordance with AASHTO. The filtrate was subjected to hydrometer test in other to ascertain the percentage of silts and clay that is present in the soil.

Specific Gravity: Specific gravity of a soil sample can be defined as the weight in air of a given volume of soil particles to the weight in air of an equal volume of distilled water at the same temperature (4^0C). The test was performed in accordance with part 2 of British Standard (BS 1377) on oven-dried soil sample at 105^0C by using pycnometer. The specific gravity of soil was determined as it affects the density, void ratio and degree of saturation of the soil.

Atterberg Limits Test: Atterberg limits are measures of determining relationship of fine grained soil with water. Soil transits from one phase to the other due to the water contents present. The moisture content, in percent, at which the transition from solid to semisolid phase takes place, is defined as the shrinkage limit. The moisture content at the point of transition from semi-solid to plastic phase is the plastic limit, and from plastic to liquid phase is the liquid limit (Das, 2010). 200g of soil sample passing through 0.425mm sieve was placed on non-porous glass plate and soaked for 24 hours. The water contents at which a thread of soil sample crumble at 3mm was determine to give the plastic limit while the water content at 20mm penetration of cone penetrometer method of the liquid limit test gives the value of the liquid limit. Glass powder was used as partial replacement to give total percent of additives as 10.

Compaction: Compaction test was conducted in other to monitor the water-density relationship of the soil. The soil sample was compacted in accordance with part 4 of British Standard (BS 1377; 1990). The soil sample was stabilized with cement and glass powder at a total percent of 10 by weight of the soil. The percentage of cement was reduced in steps of 2% by glass powder, until it is totally replaced by glass powder. The Standard Proctor (SP) method of compaction was adopted for this study which involves the use of 2.5Kg rammer falling through a height of 300mm in a 1000cm^3 mould. The soil was compacted in three layers, with each layer receiving 27 blows of the rammer.

Table 2: Summary of Untreated Soil Sample.

CONSISTENCY LIMITS (%)				PARTICLE SIZE DISTRIBUTION [Percentage Passing]					COMPACTION		REMARK (AASHTO)	USCS
LL	PL	PI	LS	2.36mm	0.6mm	0.075mm	0.06mm	0.002mm	MDD (Kg/m^3)	OMC (%)	A-6(4)	CL
29.14	16.07	13.07	5.01	99.45	94.18	54.49	36.08	2.00	1840	16.4		

RESULTS AND DISCUSSION

Particle Size Distribution: From the particle size distribution result shown in Table 3 and the graph shown in Fig. 2, it was observed that more than 50% of the whole soil sample by weight passes through sieve number #200 which make it to be fine grained soil as describe by USCS and silt-clay materials by AASHTO. Further classification describes the soil as Sandy lean CLAY.

Table 3: Particle Size Distribution Result.

SIEVE SIZE (mm)	WEIGHT RETAINED (gm)	% WEIGHT RETAINED	% WEIGHT PASSING
9.50	0.00	0.00	100.00
4.75	0.00	0.00	100.00
2.36	2.75	0.55	99.45
1.18	8.03	1.61	97.84
0.60	18.30	3.66	94.18
0.425	14.20	2.84	91.34
0.30	20.20	4.04	87.30
0.15	83.18	16.64	70.66
0.075	80.85	16.17	54.49

Specific Gravity: The specific gravity result of 2.42 is an indication of organic material in the soil sample used.

Atterberg limits: The result of the untreated soil sample shows that the soil is of low plasticity (LL<50%). The soil was classified according to AASHTO as A-6(4), while using Casangrade chart for classification of fine grained soil, it was classified as CL according to USCS. Alteration in the soil sample by the additives does not have any effect on the classification of the soil as it remains as CL soil. Although, the PL, LL, PI and linear shrinkage(SL) values of the soil sample does not remain constant, the result as indicated in Table 4 shows that the treatment of the soil sample at the combination of 2% cement and 8% glass powder, gave maximum values for PI and SL.

From the result as shown in Table 4, it was established that the higher in quantity of cement used, the lower the shrinkage experienced by the soil.

Table 4: Summary of the tests results for the treated soil samples.

Sample Code	PL (%)	LL (%)	PI (%)	SL (%)	MDD (Kg/m^3)	OMC (%)
L_{100}	16.07	29.14	13.07	5.71	1840	16.4
LC_{10}	18.77	36.80	18.03	4.29	1509	12.8
LC_8G	21.77	36.64	14.87	6.43	1582	13.0
LC_6G	20.83	35.82	14.99	6.43	1744	15.7
LC_4G	18.26	35.96	17.70	7.14	1748	17.4
LC_2G	14.83	36.52	21.69	8.57	1430	15.4
LG_{10}	13.63	35.20	21.57	6.43	1606	13.8

Compaction: The results of the compaction test as shown in Table 4 and the graph shown in Fig. 3 revealed that the presence of the additives reduces the maximum dry density of the soil and improving the soil's OMC. The soil sample is most reactive at the combination of 4% cement and 6% glass powder as its maximum dry density is far better than the value gotten from the mixture of the soil sample with 10% cement.

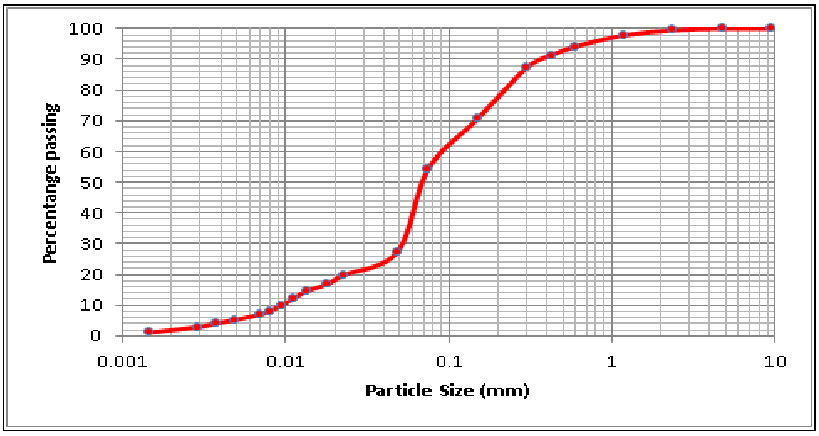

Fig. 2: Particle Size Distribution Graph.

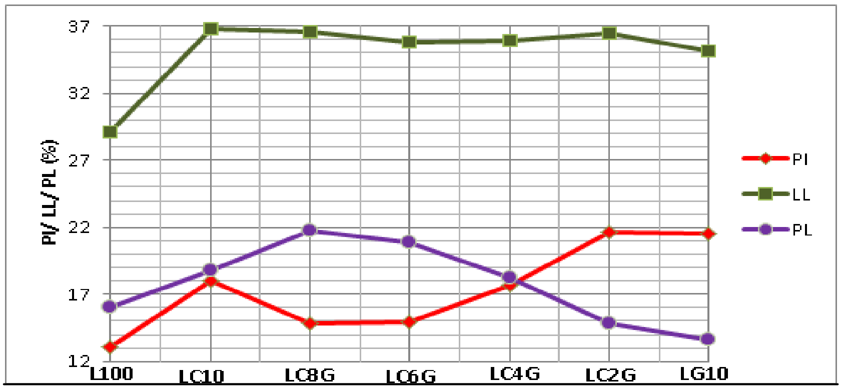

Fig. 3: Atterberg Indexes Graph of the Treated Soil.

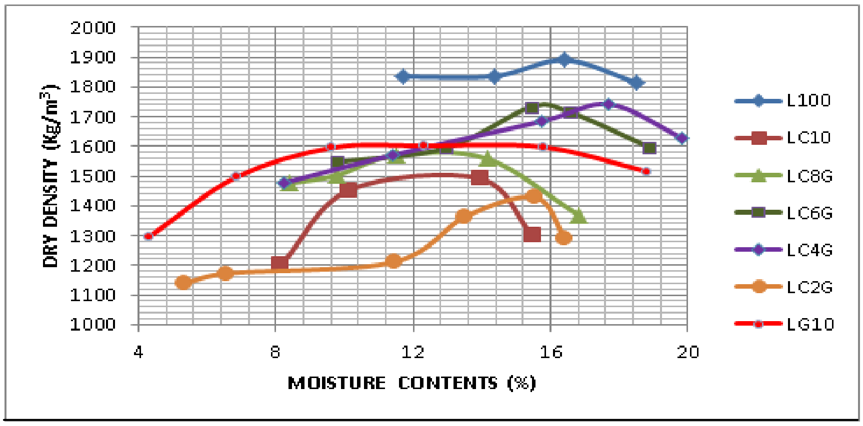

Fig. 4: Compaction Graph of the Treated Soil.

CONCLUSION AND RECOMMENDATION

From the study, it was revealed that glass powder proved to be suitable for improving the engineering properties of poor soil. This shows that much demand placed on cement in other to improve the strength of poor soil can be reduced by shifting to the use of glass in its place. It was therefore recommended that much attention be put on the use of waste glass in building and highway industry.

The government can look into processing the waste glass into powdery form and encourage its use, especially in the tropical region of the world. Further research to the use of glass powder is advised.

REFERENCES

1. Adarsh M., and Veena U. D. Soil Stabilization of Alluvial Soil by Using Marble, International Journal of Civil Engineering and Technology (IJCIET), 2016; 7(5): 87–92.
2. Adetoro E.A., and Adekanmi J.S. Evaluation of Presence of Sawdust and Palm Kernel Shell Ashes on Geotechnical Properties of Ekiti State Soil, Journal of Multidisciplinary Engineering Science and Technology (JMEST), 2015; 2(11): 3184-3188.
3. Adetoro E. A. and Adam J. O. Analysis of Influences of Locally Available Additives on Geotechnical Properties of Ekiti State Soil, Southwestern, Nigeria, International Journal of Innovative, Research in Science, Engineering and Technology (IJIRSET), 2015; 4(8): 7093 -7099.
4. American Association of State Highway and Transportation Officials (AASHTO), Standard Specification for Transportation Materials and Methods of Sampling and Testing (14th ed.), USA: Washington DC, AASHTO, 1986.

5. British Standard Methods of Test for Soils for Civil Engineering Purposes (BS 1377), UK: London, British Standards Institution, 1990.
6. Das B. M. Principles of Geotechnical Engineering, 7th Edition, Stamford, USA: Cengage Learning (Engineering), 2010.
7. Europa Technologies, Google Earth 2010. Available: http://earth.google.com/, 2017.
8. Ikara I. A., Kundiri A. M., and Mohammed I. Influence of Standard and Modified Proctor Compactive Efforts on Cement Stabilized Black Cotton Soil (BCS) with Waste Glass (WG) Admixture, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 2016; 13(3): 07-16.
9. Jinu R. B., Joseph J. K., Juny M. S., and Mariya T. Effect of Glass Powder on Engineering Properties of Clayey Soil, International Journal of Engineering Research & Technology (IJERT), 2017; 6(5): 228-231.
10. Moses G., and Osinubi K. J. Influence of Compactive Efforts on Cement-Bagasse Ash Treatment of Expansive Black Cotton Soil, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, 2013; 7(7): 566-573.
11. Olufowobi J., Ogundoju A., Micheal B., and Aderinlewo O. Clay Soil Stabilisation Using Powdered Glass, Journal of Engineering Science and Technology, 2014; 9(5); 541 – 558.
12. Owolabi A.O. and Dada M.O. Cocoa Pod and Palm Kernel Shell Ashes as Partial Replacement of Portland Cement in Stabilizing Laterite for a Road Construction, Journal of Applied Science and Technology, 2012; 17(1/2): 53.
13. Subash K., Sreerag R., Deeraj A. D., Sukesh S., Dilna S. V., and Jino J. Stabilization of Black Cotton Soil using Glass and Plastic Granules, International Journal of Engineering Research & Technology (IJERT), 2016; 5(4): 480-483.
14. Vijayakumar G., Vishaliny H., and Govindarajulu D. Studies on Glass Powder as Partial Replacement of Cement in Concrete Production, International Journal of Emerging Technology and Advanced Engineering, 2013; 3(2): 153-157.