International Journal of Transportation Engineering and Technology
2021; 7(1): 29-32
http://www.sciencepublishinggroup.com/j/ijtet
doi: 10.11648/j.ijtet.20210701.15
ISSN: 2575-1743 (Print); ISSN: 2575-1751 (Online)

Comparative Evaluation of California Bearing Ratio (CBR) of Natural Offshore Sand and Cement Stabilized Offshore Sand as Road Subbase Material in Swampy Region

Fidelis Onyebuchi Okafor, Owo Awajigbana Tugwell

Department of Civil Engineering, University of Nigeria, Nsukka, Nigeria

Email address:
fidelis.okafor@unn.edu.ng (F. O. Okafor), awajigbana.owo.pg76722@unn.edu.ng (O. A. Tugwell)

To cite this article:
Fidelis Onyebuchi Okafor, Owo Awajigbana Tugwell. Comparative Evaluation of California Bearing Ratio (CBR) of Natural Offshore Sand and Cement Stabilized Offshore Sand as Road Subbase Material in Swampy Region. *International Journal of Transportation Engineering and Technology*. Vol. 7, No. 1, 2021, pp. 29-32. doi: 10.11648/j.ijtet.20210701.15

Received: March 13, 2021; **Accepted**: March 25, 2021; **Published**: April 1, 2021

Abstract: This investigation focused on the comparative evaluation of California Bearing Ratio values of natural offshore sand and cement stabilized offshore sand as subbase materials for road construction in swampy regions. CBR tests were carried out on the offshore sand sample to ascertain its suitability for road subbase filling. Based on the test results, the CBR of the natural offshore sand was found to be 4.05 percent. After 4% Cement stabilization, the value increased to 12 percent. At 6% cement stabilization, the CBR increased to 26 percent. At 8% cement content, the value obtained was 27 percent. At 10% cement content, the CBR results increased to 31.7 percent. After 12% cement content, the CBR values obtained became 61.4 percent. For sand to be used as subbase material, the Federal Ministry of Works and Housing, Abuja (1997) recommends that the Minimum CBR for subbase should be 30 percent. It is seen that CBR values of natural offshore sand, and at 4% - 8% cement contents did not satisfy requirement for use as subbase material. However, at 10% and 12% cement contents, CBR values of 37.9 percent and 61.4 percent obtained respectively met CBR requirement for subbase. This investigation concludes that cement can be used to stabilize offshore sand to improve the performance of its engineering properties for use as subbase material for construction of road in swampy regions.

Keywords: Cement, Offshore Sand, California Bearing Ratio (CBR)

1. Background

For many years, laterites have been used in road construction work in swampy region of Niger Delta. However, the rate of road failures in this region became alarming. As a result, sharp sand was adopted for road subbase in the swampy region. Presently, cement stabilized sand is being introduced as an economically viable alternative subbase material for road construction in the region.

Sand stabilization is the process aimed at altering the properties of sand to improve its engineering performance in terms of strength, permeability and stiffness. Over the years, cement stabilization has been widely adopted in road construction compared to other methods, due to the significant improvements it brings to properties of construction materials.

Large deposit of offshore sand from the Atlantic Ocean by Ikuru Town, Andoni Local Government Area of Rivers State was observed. In the last few decades, local builders are not using the offshore sand for building construction works stating it has high salt content in it.

Thus, there was need to investigate engineering properties of the offshore sand with the aim of using cement as a stabilizing agent to enhance its suitability for filling as a road subbase material.

The objectives of this research work include the following:

To evaluate the CBR of the offshore sand;

To use cement for the stabilization of the offshore sand;

To evaluate the CBR of the stabilized offshore sand; and

To compare the CBR values of natural and cement stabilized offshore sand for suitability as road subbase

material.

Little et al. posited that it is usually unacceptable to use soils containing more than 2% of organic material for cement stabilization [1].

Arellano et al. suggested that resilient modulus of granular soils increases as the stress intensity increases whereas that of fine grained soils decreases with increase in stress intensity [2].

It is important to use appropriate test procedures to assess the properties of cement stabilized road materials [3].

Croney et al. found that the strength of a cement stabilized road will always increase for a period of many years from the time of construction [4].

Yang in his Pavement Analysis and Design asserted that the most critical tensile stress or strain will take place at the bottom of the stabilized layer in a road structure [5].

General Specifications for Roads and Bridges by Federal Ministry of Works, Abuja in 1997 gives specifications to be followed in road construction [6].

Tingle et al. researched on sample preparation and pointed out that water content and mixing procedure affect outcome of stabilization [7].

Edincliler and Cagatay stated that the use of tire buffing improves geotechnical engineering performance of subbase materials [8].

Some Authors have noted that adding tire buffing to cohesionless soils increases CBR values [9 -11].

Yuehuan et al. worked on foamed bitumen stabilization for Australian roads [12].

Choi et al. worked on the assessment of field compaction of aggregate base materials for permeable pavements based on plate load tests to encourage these hydrologic functions of permeable pavements, their structure should contain connected pores [13].

Umashankar et al. carried out investigation on the compaction quality control of pavement layers [14].

Walubita et al. established a comprehensive data storage system for better calibration of the mechanical-empirical design and rehabilitation of flexible pavements [15].

2. Materials and Method

The sub base material used in this study was offshore sand from the Atlantic Ocean, Ikuru Town, Andoni Local Government Area of Rivers State, Nigeria. California Bearing Ratio tests were conducted on the offshore sand sample, and cement stabilization was carried out at 4%, 6%, 8%, 10%, and 12%.

California Bearing Ratio Test

California Bearing Ratio test is used for evaluating how suitable sub-grade, sub-base and base course materials can get for road construction. The test result is correlated with the thickness of flexible pavement. This test was used to assess strength of natural offshore sand and cement-stabilized offshore sand. Detailed test procedure is fully described in BS 1377-4:1990 Part 9.

3. Results

The result of CBR test carried out on the offshore sand before stabilization is plotted in figure 1.

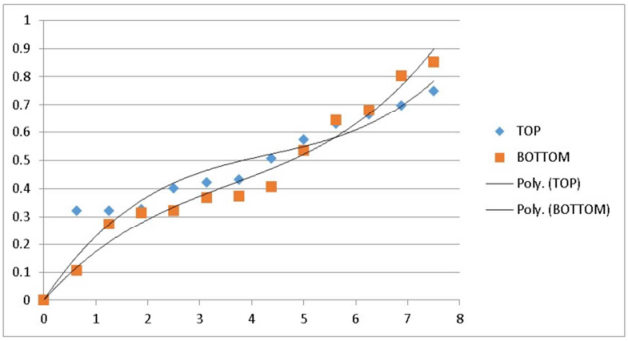

Figure 1. *CBR of offshore Sand Sample=4.05.*

The result of CBR test at 4% stabilization is plotted in figure 2.

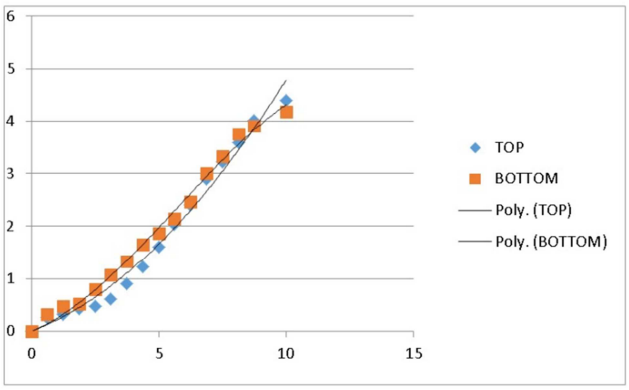

Figure 2. *CBR of offshore sand + 4% Cement Stabilization=12.*

The result of CBR test at 6% stabilization is plotted in figure 3.

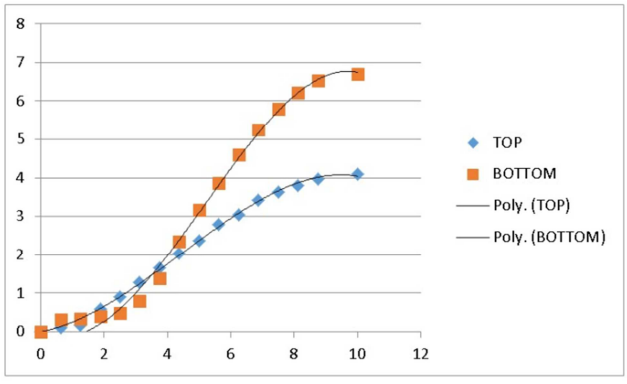

Figure 3. *CBR of offshore sand + 6% Cement Stabilization=26.*

The result of CBR test at 8% stabilization is plotted in figure 4.

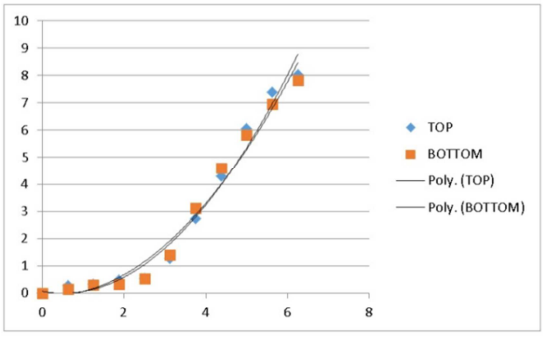

Figure 4. *CBR of offshore sand + 8% Cement Stabilization=27.0.*

The result of CBR test at 10% stabilization is plotted in figure 5.

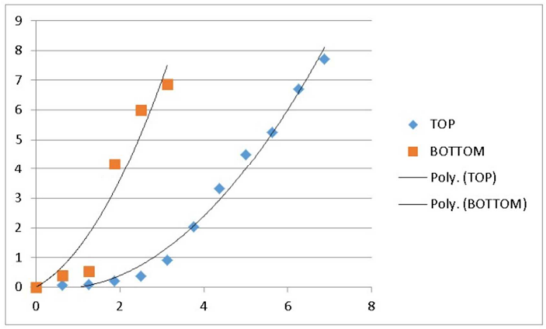

Figure 5. *CBR of offshore sand + 10% Cement Stabilization=37.9.*

The result of CBR test at 12% stabilization is plotted in figure 6.

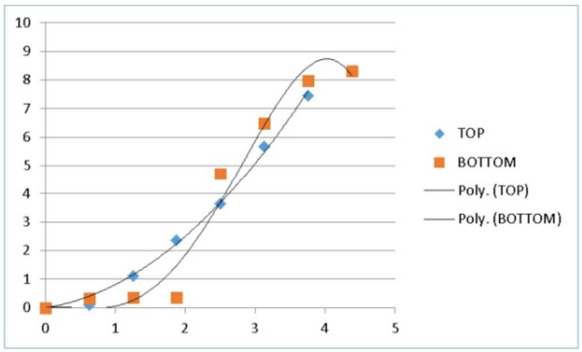

Figure 6. *CBR of offshore sand + 12% Cement Stabilization=61.4.*

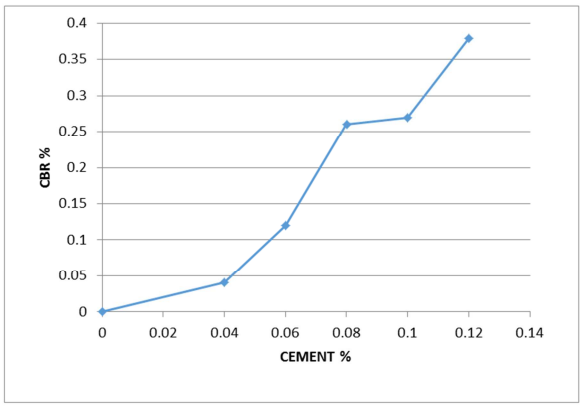

Figure 7. *Graph of CBR against Cement Content.*

4. Discussion

The results of CBR against Cement Content is summarily presented in Figure 7. CBR values of natural offshore sand, and cement contents at 4%, 6%, 8%, 10% and 12% cement contents were 4.05, 12, 26, 27, 37.9 and 61.4 percent respectively. Thus, increasing cement contents resulted in increased CBR values. It is seen that CBR values of natural offshore sand, and at 4% - 8% cement contents did not satisfy requirement for use as subbase material. However, at 10% cement content, CBR value of 37.9 percent was obtained, which met CBR requirement for subbase; while increasing cement to 12% yielded a corresponding CBR value of 61.4 percent. Hence, confirming that stabilized offshore sand is okay for road subbase filling according to Standard Specification for Construction and Maintenance of Road and Bridges, Road Development Authority.

For sand to be used as subbase material, the Federal Ministry of Works and Housing, Abuja (1997) recommends that the Minimum CBR for subbase should be 30 percent.

The results of offshore sand samples after being stabilized with cement at 10% and 12% satisfied this requirement, and hence recommended for road construction.

5. Conclusion

From this investigation, the following conclusions are drawn:

Cement can be used to stabilize offshore sand to improve the performance of its engineering properties for use as a subbase material for the construction of roads in swampy regions;

Increasing the cement contents resulted in increased CBR values. Minimum CBR specified for subbase course is 30%. It is seen that CBR values at 4% to 8% cement contents did not meet the standard. However, at 10% cement content, CBR value of 37.9% obtained satisfied the requirement for subbase while a further increment in cement content to 12% yielded a corresponding CBR of 61.4%; hence, confirming that stabilized offshore sand sample okay as subbase material to be used in road construction in the swampy regions.

6. Recommendations

From the results of this investigation, the following recommendations are made:

The use of cement to stabilize poor offshore sand subbase materials for road construction in the swampy region should be noted and adopted.

References

[1] Little, D. N. and Nair, S. (2009). Recommended Practice for Stabilization of Subgrade soils and Base materials, National Cooperative Highway Research Program (NCHRP), web only document -144, Texas A & M University, Texas.

[2] Arellano, D. and Thompson, M. R. (1998). Final report – Stabilized Base Properties (Strength, Modulus, Fatigue) for mechanistic-based airport pavement design, Technical Report of Research Department of Civil Engineering University of Illinois at Urbana-Champaign, Illinois.

[3] Standard Specification for Construction and Maintenance of Road and Bridges, Road Development Authority (RDA), 1989.

[4] Croney, D. and Croney, P. (1998). The Design and Performance of Road Pavements. 3rd Edition, Published by McGraw-Hill, U.K.

[5] Yang, H. H. "Pavement Analysis and Design' 2nd Edition, ISBN 013142473497801314247 39.

[6] General Specifications for Roads and Bridges, Federal Ministry of Works and Housing, ABUJA (1997).

[7] Tingle et al. (1999). Discrete Fibre Reinforcement of sands for Expedient Road Construction. Technical Report GL-99-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

[8] Edincliler and Catagay (2013). Weak subgrade Improvement with Rubber Fibre Inclusions, *Geosynth. Int., ICE, Vol. 20, No. 1, 2013, pp. 39-46.*

[9] Prasad, D. S. V. and Prasada Raju, G. V. R., "Performance of Waste Tyre Rubber on Model Flexible Pavement," *J. Eng. Appl. Sci., Vol. 4, 2009, pp. 89-92.*

[10] Edincliler et al. (2004) Determination of Static and Dynamic Behavior of Recycled Materials for Highways. *Resour. Conserv. Recycl., Vol. 42, No. 3, 2004, pp. 223-337.*

[11] Uchimura et al. (2007). Shaking Table Tests on Effect of Tire Chips and Sand Mixture in increasing liquefaction Resistance and Mitigating Uplift of Pipe. *Proceedings of the International Workshop on Scrap Tire Derived Geomaterials – Opportunities and Challenges, Yokosuka, Japan, March 23-24, 2007, pp. 179-186.*

[12] Yuehuan et al (2010). A preliminary study on foamed Bitumen stabilization for Western Australian pavements.

[13] Choi, Y.; Ahn, D.; Nguyen, T. H.; Ahn, J. Assessment of field compaction of aggregate base materials for permeable pavements based on plate load tests. Sustainability 2018, 10, 3817.

[14] Umashankar, B.; Hariprasad, C.; Kumar, G. T. Compaction quality control of pavement layers using LWD. J. Mater. Civ. Eng. 2016, 28, 04015111.

[15] Walubita, L. F.; Lee, S. I.; Abu-Farsakh, M.; Scullion, T.; Nazarian, S.; Abdallah, I. Texas Flexible Pavements and Overlays, Year 5 Report. Complete Data Documentation; FHWA/TX-15/0-6658-3; Texas Department of Transportation: College Station, TX, USA, 2017.