# IMPROVEMENT OF MUD FOUND IN NIGER DELTA NIGERIA COASTAL REGION USING APROMUD G300 ADMIXTURE.

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**Abstract** - The structural stability of any structure depends on the ability of the soil to withstand the applied loads from the structure to the foundation without failure. In some cases, the soil maybe weak or unstable and cannot satisfy this important condition, therefore soil improvement becomes absolutely necessary to enhance the bearing capacity of the soil. Several soil improvement techniques have been conducted with the sole aim of improving the engineering suitability of such weak soils. In this study, 0.0%, 0.15%, 0.2%, 0.3%, 0.4%, 0.5%, 0.7%, 0.8%, 1.0%, 1.2%, 1.3%, 1.5% percentages of Apromud G300 were added (% by weight) to the Mud (Soil formation) found within the Ijaw-Aiyetoro coastal region of Ondo State, Nigeria. The specimens were mixed thoroughly and experiments conducted on the various mixtures, to investigate the resultant effects on the soil bearing capacity and other geotechnical properties. The results have shown that the addition of Apromud G300 has improved the bearing capacity of the soil by more than 150 kN/m$^2$ (compared to the 50 kN/m$^2$ for the natural soil).

**Keywords** - Mud, Apromud G300, Bearing Capacity, Soil Improvement.

## I. INTRODUCTION

The most important aspect of any developing nation is infrastructural development. The daily increase in infrastructural development and the constant quest for an affordable and descent housing for the citizenry in the urban cities and its vicinity led to the scarcity of suitable sites for development. Some sites are termed "problematic soil", such sites have poor soils that shrink or subside when wet but are strong during dry season. A case in hand is the brownish mud deposits found along the coastal region of Niger Delta within the Ijaw-Aiyetoro axis in Ondo State, Nigeria.

Structures built on weak and soft soils are prone to shear failure, excessive displacements or differential settlements. The options left now for engineers and researchers all over the world is to make such soils suitable for the expected structural loading by improving the engineering properties or adopting the expensive deep foundation option as recommended by the code of practice for building or infrastructural developments on such soils. For the multi-storey high-rise buildings or structures on such soils, the expensive pile foundation is recommended. However, for structures of one or two storeys residential buildings, office buildings, churches and school buildings that can undergo settlements and displacements due to the foundation resting on the soil, adoption of the expensive deep foundation is obviously not an economically viable solution. For cost effectiveness of building on such weak soil, engineers and researchers have resorted to improving the engineering properties of the soil and therefore upgrading the bearing capacity of the soil as the best and economical option. This study therefore is to investigate the effects of the addition of the Apromud G300 Admixture on the mud as an enhancer in improving the bearing capacity of the mud.

## II. LITERATURE REVIEW

Structures constructed on weak and unstable engineering soil can be very problematic to infrastructural development. A large formation of such soils has led to a considerable reduction in suitable construction site for infrastructural development. It becomes crucial to find ways of improving the engineering properties of such problematic soils to enhance the stability and thereby making it suitable for construction activities and so respond to the demand of lack of suitable soils for construction works. (Sherwood, 1993). This process of improving the engineering properties of a weak and unstable soil involves the use of different stabilizing techniques to modify or stabilize the soil in-situ. The main objectives of soil improvement of the weak and unstable soil were to increase the shear strength, improve its resistance to failure and increase the soil bearing capacity to sustain the applied loads without excessive deformation or differential (excessive) settlement. There are different fundamental techniques adopted by different researchers (Chethan et al, (2016); Puppala et al, (2007); Otoko, (2014); Chong & Kassim, (2014); Sherwood, (1993); etc. to improve the engineering properties of unsuitable soils.

## III. MATERIALS AND METHODS

**The materials used for this experiment are mud and Apromud G300.**

**Soil Structure**

The soil sample for this experimental study was obtained from the soil formation within the Ijaw - Aiyetoro coastal region of Ondo State, Nigeria. It is a typical soft marine clay soil found in Niger Delta area of Nigeria otherwise called the Chikoko Mud. It is brownish and sometimes contains organic matters.

This soil is very hard when dry and very soft on wetting which makes it problematic for construction activities.

**Apromud G300 Admixture properties**

The Apromud G300 is a white powdered product of a French Company called Aprotek. It has a particle size of less than 1mm with an active substance of 98%, bulk density 0f 0.8g/cm$^3$ and insoluble in water. The Apromud G300 products are composed of polymers made from Sodium Polyacrylate and is completely harmless against the environment, human and animals. When applied in the right dosage, it helps in the reduction of the moisture content and solidifies the sludge, the basis on which the experimental study was conducted.

**Experimental Procedures**

The various experiments performed in this study according to standards and procedures are:

1. Moisture contents
2. Atterberg's Limits
3. Triaxial Test
4. Unconfined Compression Test

The ultimate bearing capacity Calculated based on parameters obtained from the Triaxial Test Results using the Terzaghi Ultimate Bearing Capacity Theory

$$[Q_u] = 1.3\ c\ N_c + \gamma\ D\ N_q + 0.4\ \gamma\ B\ N_\gamma \quad (kN/m^2) \qquad (1)$$

## IV. RESULTS AND DISCUSSION

The results from the experiments are presented in tables and figures below.

Moisture Content

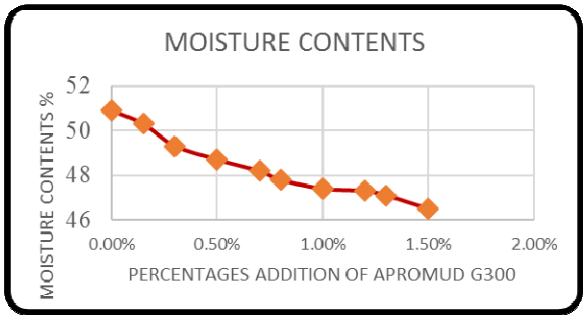



**Figure 1. Moisture Content and Percentage Addition of Apromud G300**

**Table 1. Atterberg Limits**

| Percentages of Apromud G300 | Liquid Limits (LL) % | Plastic Limit (PL) % | Plasticity Index % (PI) |
|---|---|---|---|
| 0.00 | 64.12 | 30.97 | 33.15 |
| 0.15 | 63.07 | 29.68 | 33.39 |
| 0.30 | 61.791 | 28.26 | 33.531 |
| 0.50 | 60.97 | 24.86 | 36.110 |
| 0.70 | 58.973 | 21.08 | 37.893 |
| 0.80 | 56.246 | 18.11 | 38.136 |

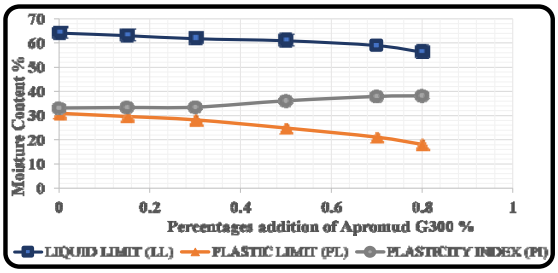



**Figure 2. Atterberg Limits**

From Figure 2 above, it was observed that increasing the percentages addition of the Apromud G300 led to a corresponding decrease in the liquid limit and plastic limits of the clay sample. However, the plasticity Index increases correspondingly too.

**Unconfined Compression Test**

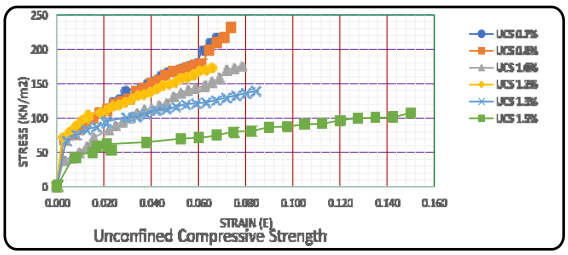



**Figure 3. Unconfined Compression Test**

**Table 2. Results of Shear stress from Triaxial Test, Unconfined Compression Test and**

Allowable Bearing Capacity

| S/No | % Addition of Apromud G300 | Cohesion (C)(kN/m²) | Angle of internal friction (ϕ) in ° | Shear Stress (τ) (kN/m2) | Stress at failure unconfined compression test Qu kN/m2 | Shear Strength unconfined compression test Qu/2 kn/m2 | Qu (kN/m²) = 1.3*c*nc + γdnq + 0.4γbnγ |
|---|---|---|---|---|---|---|---|
| 1 | 0.00% | 4.20 | 12° | 59.1 | 140.1 | 70.1 | 150.5 |
| 2 | 0.15% | 27.91 | 14° | 101.8 | 149.4 | 74.7 | 552.6 |
| 3 | 0.20% | 48.11 | 15° | 138.3 | 194.0 | 97.0 | 932.4 |
| 4 | 0.30% | 75.22 | 8° | 120.0 | 211.6 | 105.8 | 900.4 |
| 5 | 0.40% | 76.42 | 13° | 157.6 | 205.6 | 102.8 | 1239.1 |
| 6 | 0.50% | 98.47 | 4° | 121.1 | 204.7 | 102.4 | 931.7 |
| 7 | 0.70% | 97.94 | 8° | 143.5 | 203.9 | 102.0 | 1155.4 |
| 8 | 0.80% | 102.86 | 2° | 113.9 | 231.3 | 115.7 | 871.1 |
| 9 | 1.00% | 74.51 | 8° | 118.8 | 175.6 | 87.8 | 894.5 |
| 10 | 1.20% | 72.86 | 8° | 117.0 | 174.0 | 87.0 | 876.0 |
| 11 | 1.30% | 72.47 | 7° | 110.9 | 139.6 | 69.8 | 822.7 |
| 12 | 1.50% | 24.82 | 7° | 62.9 | 107.9 | 54.0 | 312.5 |

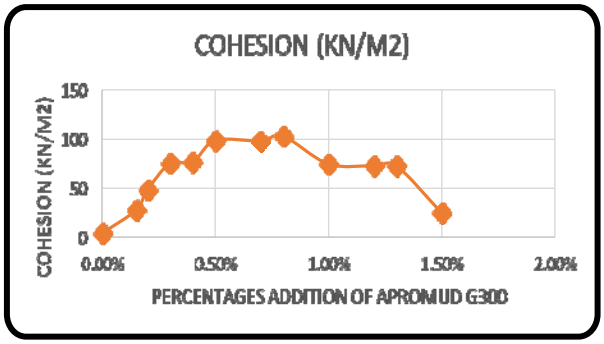



**Figure 4. Cohesion versus Percentages Addition of Apromud G300**

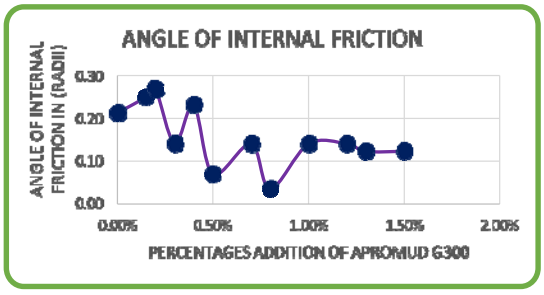



**Figure 5. Angle of Internal Friction versus Percentages Addition of Apromud**

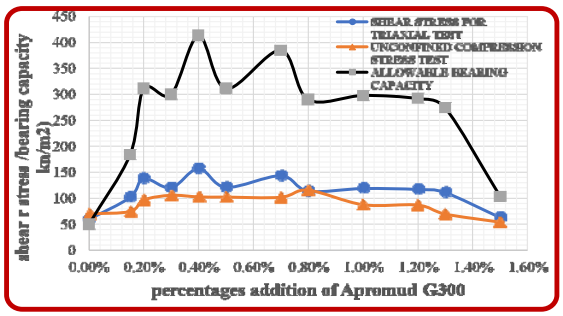



**Figure 6. Shear Strength, Bearing Capacity versus Percentages addition of Apromud G300**

From figure 6 above, shows that the percentages addition of Apromud G300 has improved the bearing capacity of the soil formation by over 200% compared to the bearing capacity of the natural Soil that is 50 kN/m$^2$. The shear strength for Triaxial test results is 102 kN/m$^2$ and unconfined compression test 115 kN/m$^2$ for the improved soil compared to the Shear Strength of 59 kN/m$^2$ and 70 kN/m$^2$ respectively for the natural or 0.0% addition of the Apromud G300 which shows a considerable improvement in the engineering properties of the soil.

## CONCLUSIONS

From the experimental results and discussions, the following inferences can be drawn:

- The high natural moisture content decreased with the percentage addition of the Apromud G300 admixture which led to a decrease in the final void ratio which makes the soil stiffer and hence enhancing the Engineering properties of the soil.
- Increasing the percentages of the Apromud G300 leads to a corresponding decrease in the liquid limit and plastic limits of the clay sample and thereby leads to a corresponding increase of the plasticity Index.
- The use of the Apromud G300 admixture has significantly enhanced the improvement of the soil bearing capacity by over 200% of the natural soil bearing capacity (50KN/m$^2$).
- The soil found within the Ijaw-Aiyetoro coastal region of Ondo state, Nigeria, was improved by the addition of 0.3% to 0.8% percentages of Apromud G300 admixture.
- The allowable bearing capacity of the soil in this study, improved by more than 150kN/m$^2$ with the percentage's addition of Apromud G300.

## RECOMMENDATION

Based on the results of this study, Apromud G300 admixture is thereby recommended for improving the bearing capacity of soft soils in proportion not exceeding 0.8%.

## REFERENCES

[1] BS 1377 (1990). Methods of Test for Soil for Civil Engineering Purposes. British Standard Institute, London

[2] Chethan, M., Shweta, P., Anand, N., Basavaraj, P., & Dayanand, H. (2016). Experimental study on soil stabilization using admixtures. IJIRST –International Journal for Innovative Research in Science & Technology. 2(12), 2349-6010.

[3] Chong, S.Y. & Kassim, K.A. (2014). Consolidation characteristics of lime column and Geotextile - Electron. J. Geotech. Eng. A, 1, 1-10.

[4] Otoko, G. R. (2014). A review of stabilization of problematic soils. International Journal of Engineering and Technology Research. 2.(5), 1-6.

[5] Puppala, A.J., Pokala, S., Intharasombat, N. & Williammee, R., (2007). Effects of Organic Matter on Physical, Strength and Volume Change Properties of Compost Amended Expansive Clay. ASCE, Journal of Geotechnical and Geo-environmental Engineering, 133, 11, 1449-1461.

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