ISSN No. 2455-5800
Journal of Scientific Research in Allied Sciences
Original Research Article

COMPARATIVE MODELS OF LOOSE SAND AND FIRM CLAY DEPOSITION SETLEMENT FOR COMPRESSION INDEX IN DELTAIC FORMATION OF AHOADA EAST, RIVER STATES OF NIGERIA.

[1, 2] **Eluozo. S. N and** [2] **Ode .T.**
1. Subaka Nigeria Limited Port Harcourt Rivers State of Nigeria, Director and Principal Consultant Civil and Environmental Engineering, Research and Development
2. Department of Civil Engineering, faculty of Engineering, Rivers State University of Science and Technology Port Harcourt

Article history:
Submitted on: July 2016
Accepted on: August 2016
Email: info@jusres.com

ABSTRACT

compressibility of soil behaviuor are base on different formation characteristics influences, several; experts has developed some concept to monitored the behaviour of these formation, for these study it express the relationship between loose sand and firm clay compression index in the study area, there behaviour were monitored to determined there rates of compressions at various depth, these parameters were generated through the developed model that generated predictive values for firm clay and loose sand, from the simulation results it has express these parameters on linear condition to the optimum values recorded between four and five metres, such exponential deposition of compression index from both formation has explain their relationship in compressibility for impose load.

KEYWORDS: comparative models loose sand, firm clay, settlement and compression index

1. INTRODUCTION

The significant tendency of adequate and consistent geotechnical classification of sub-soils is granted. Base on these conditions, the impact of the imposed load is worsening by the thickness and consistency of the compressible layer. This, in addition to other intrinsic factors contributes to the failure of civil engineering structures (Youdeowei & Nwankwoala, 2013; Amadi *et al*, 2012). Nigeria is very attractive to foreign investors; these generate design and construction of foundation, and thus civil engineering structures in order to reduce unfavorable effects and prevention of post construction crisis. Generally, in the Niger Delta geotechnical information on the underlying soils are desired for the design of appropriate foundation for structures (Ngah & Nwankwoala, 2013; Nwankwoala & Warmate, 2014, Eluozo and Ode 2015a, 2015b, 2015c). The deposition of soil in several deltaic formation varies, such condition should be monitored to express their various behaviuor in terms of compressibility consolidation, there formation characteristics determined there deposition; there strength of soil types locations express various depositions thus generate different settlement factors that constitutes an extensive plain exposed to periodical inundation by flooding when the rivers and creeks overflow their banks. A prominent feature of the rivers and creeks is the occurrence of natural levees on both banks, behind which occur vast areas of back-swamps and lagoons/lakes where surface flow is negligible (Youdeowei and Nwankwoala, 2010). These conditions affect their deposition and their strength.

Looking from the present knowledge, the geology of the Niger Delta is derived from the works of Reyment (1965), Short and Stauble (1967), Murat (1970), Merki (1970), thus the exploration activities from oil and gas companies. It has been observed that the formation of the so-called proto-Niger Delta occurred during the second depositional cycle (Campanian-Maastrichtian) of the southern Nigerian basin. However, modern Niger Delta was formed during the third and last depositional cycle of the southern Nigerian basin which started in the Paleocene. Loose to medium dense sand was encountered immediately beneath the near surface silty clay soil. This loose to medium dense sand increases in density to becoming dense to very dense sand from about 7.0m below the existing ground level. Deeper down in the boring from about 25.0m, it is observed that the sand loosens to becoming medium dense. (Nwankwoala1et al 2015)

2. DEVELOPED GOVERNING EQUATION

$$\frac{\lambda}{\beta}\frac{d^2c}{dx^2} - V_o\frac{dc}{dx} + \Phi\frac{dc}{dx} = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (1)$$

Nomenclature

λ = Plastic Index

β = plastic Limit

V_o = Void Ratio

ϕ = porosity

Z = Depth

$$\frac{\lambda}{\beta}\frac{d^2c}{dx^2} - (V_0 - \Phi)\frac{dc}{dx} = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (2)$$

Let $C = \sum_{n=0}^{\infty} a_n x^n$

$$C^1 = \sum_{n=1}^{\infty} n a_n x^{n-1}$$

$$C^{11} = \sum_{n=2}^{\infty} n(n-1) a_n x^{n-2}$$

$$\frac{\lambda}{\beta}\sum_{n=2}^{\infty} n(n-1) a_n x^{n-2} - (V_0 - \Phi)\sum_{n=1}^{\infty} n a_n x^{n-1} = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (3)$$

Replace *n* in the 1st term by *n+2* and in the 2nd term by *n+1*, so that we have;

$$\frac{\lambda}{\beta}\sum_{n=0}^{\infty} (n+2)(n+1) a_{n+2} x^n - (V_o - \Phi)\sum_{n=0}^{\infty} (n+1) a_{n+1} x^n = 0 \qquad \ldots\ldots\ldots\ldots \qquad (4)$$

i.e. $\frac{\lambda}{\beta}(n+2)(n+1)a_{n+2} = (V_0 - \Phi)(n+1)a_{n+1}$ ……………………. (5)

$$a_{n+2} = \frac{(V_0 - \Phi)(n+1)a_{n+1}}{\frac{\lambda}{\beta}(n+2)(n+1)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (6)$$

$$a_{n+2} = \frac{(V_0 - \Phi)a_{n+1}}{\frac{\lambda}{\beta}(n+2)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (7)$$

$$\text{for } n = 0,\ a_2 = \frac{(V_0 - \Phi)a_1}{2\frac{\lambda}{\beta}} \qquad \ldots\ldots \qquad (8)$$

$$\boxed{C(x) = a_0 + a_1 \ell^{\frac{(V_0-\Phi)}{\frac{\lambda}{\beta}}x}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (9)$$

Subject equation (16) to the following boundary condition

$$C(o) = 0 \; and \; C^1(o) = H$$

$$C(x) = a_0 + a_1 \ell^{\frac{(V_0 - \Phi)}{\frac{\lambda}{\beta}} x}$$

$$C(o) = a_0 + a_1 = 0$$

i.e. $a_0 + a_1 = 0$ ………………….. (10)

$$C^1(x) = \frac{(V_0 - \Phi)}{2!\frac{\lambda}{\beta}} a_1 \ell^{\frac{(V_0 - \Phi)}{\frac{\lambda}{\beta}} x}$$

$$C^1(o) = \frac{(V_0 - \Phi)}{2!\frac{\lambda}{\beta}} a_1 = H$$

$$a_1 = \frac{H\frac{\lambda}{\beta}}{V_0 - \Phi}$$ ………………….. (11)

Substitute (10) into equation (11)

$$a_1 = -a_0$$

$$\Rightarrow \quad a_0 = \frac{-H\frac{\lambda}{\beta}}{V_0 - \Phi}$$ ………………….. (12)

Hence, the particular solution of equation (16) is of the form:

$$C(x) = -\frac{H\frac{\lambda}{\beta}}{V_0 - \Phi} + \frac{H\frac{\lambda}{\beta}}{V_0 - \Phi} \ell^{\frac{(V_0 - \Phi)}{\frac{\lambda}{\beta}} x}$$

$$\Rightarrow C(x) = \frac{H\frac{\lambda}{\beta}}{V_0 - \Phi}\left[\ell^{\frac{(V_0-\Phi)}{\frac{\beta}{\lambda}}x} - 1\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

3. RESULT AND DISCUSSION

Results comparative model for and discussion are presented in tables including graphical representation of loose sand and firm clay;

Table: 1 Predictive Values for Stiff clay and Loose Sand at Different Depth

Depth [M]	Predictive Values of Stiff Clay Cc	Predictive Values of loose sand Cc
0.2	0.004	0.002
0.4	0.008	0.004
0.6	0.012	0.0066
0.8	0.016	0.0088
1	0.02	0.011
1.2	0.024	0.0132
1.4	0.028	0.0154
1.6	0.032	0.0176
1.8	0.036	0.0198
2	0.04	0.022
2.2	0.044	0.0242
2.4	0.048	0.0264
2.6	0.052	0.0286
2.8	0.056	0.0308
3	0.06	0.033
3.2	0.064	0.0352
3.4	0.068	0.0376
3.6	0.072	0.0396
3.8	0.076	0.0418
4	0.08	0.044
4.2	0.084	0.0462
4.4	0.088	0.0484
4.6	0.092	0.0506
4.8	0.096	0.0528
5	0.1	0.055

Table: 2 Predictive Values for Stiff clay and loose sand at Different Depth

Depth [M]	Measured Values of Stiff Clay Cc	Measured Values of loose sand Cc
0.2	0.003	0.00211
0.4	0.007	0.00431
0.6	0.014	0.00651
0.8	0.018	0.00871
1	0.022	0.0109
1.2	0.028	0.0131
1.4	0.029	0.0153
1.6	0.034	0.0175
1.8	0.038	0.0197
2	0.042	0.0219
2.2	0.046	0.0241
2.4	0.049	0.0263
2.6	0.054	0.0285
2.8	0.058	0.0307
3	0.062	0.0329
3.2	0.066	0.03511
3.4	0.069	0.0373
3.6	0.074	0.03951
3.8	0.078	0.0417
4	0.084	0.0439
4.2	0.086	0.04611
4.4	0.089	0.04831
4.6	0.094	0.0505
4.8	0.098	0.05271
5	0.104	0.0549

Table: 3 Predictive Values for Stiff clay and loose Sand at Different Depth

Depth [M]	Predictive of Stiff Clay Cc	Predictive of loose sand Cc
0.2	0.0048	0.00289
0.4	0.0096	0.0056
0.6	0.014	0.0084
0.8	0.0196	0.0112
1	0.024	0.014
1.2	0.028	0.0168
1.4	0.033	0.0196
1.6	0.0384	0.0224

1.8	0.0432	0.0252
2	0.048	0.026
2.2	0.0528	0.03
2.4	0.0576	0.0336
2.6	0.0624	0.0364
2.8	0.0672	0.0392
3	0.072	0.042
3.2	0.0768	0.048
3.4	0.0816	0.0476
3.6	0.0864	0.0504
3.8	0.0912	0.0532
4	0.096	0.056

Table: 4 Average values for Loose Sand and stiff clay at Different Depth

Depth [M]	Average values for loose and stiff clay
0.2	0.003845
0.4	0.00328
0.6	0.0112
0.8	0.0154
1	0.019
1.2	0.0224
1.4	0.0263
1.6	0.0304
1.8	0.0342
2	0.037
2.2	0.0414
2.4	0.0456
2.6	0.0494
2.8	0.0532
3	0.057
3.2	0.0978
3.4	0.0788
3.6	0.0684
3.8	0.0722
4	0.152

Table: 5 Predictive Values for Stiff clay and Loose Sand at Different Depth

Depth [M]	Predictive Values for Average stiff and loose clay	Measured Values for Average Stiff and Loose Clay
0.2	0.00259	0.003745
0.4	0.005194	0.00558
0.6	0.00779	0.0112
0.8	0.01	0.0124
1	0.0129	0.0121
1.2	0.0155	0.0146
1.4	0.0182	0.0203
1.6	0.0207	0.0211
1.8	0.0233	0.0242
2	0.0259	0.026
2.2	0.0285	0.0264
2.4	0.03116	0.0306
2.6	0.0338	0.0319
2.8	0.0364	0.0352
3	0.0389	0.0411
3.2	0.0415	0.0428
3.4	0.0441	0.0448
3.6	0.0467	0.0511
3.8	0.0493	0.0522
4	0.0519	0.112

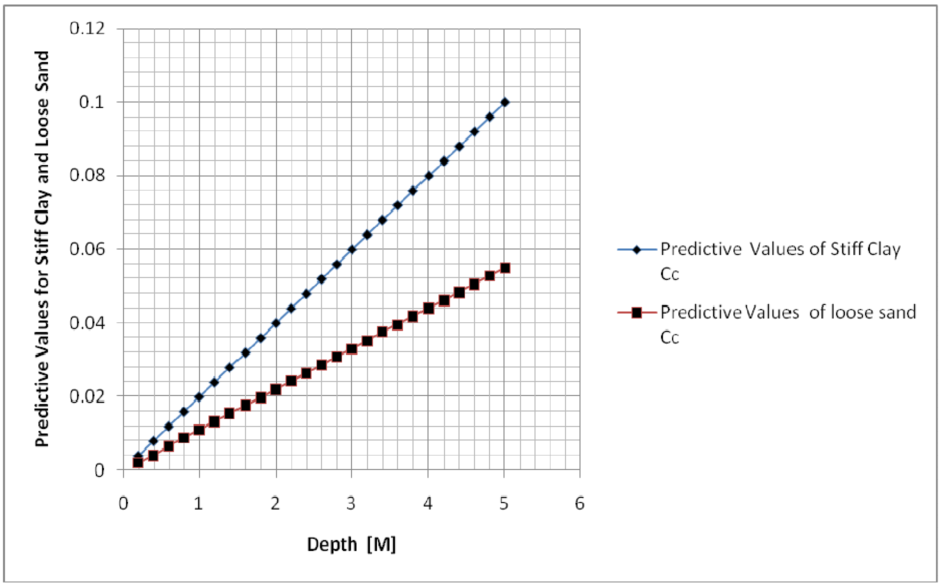

Figure: 1 Predictive Values for stiff clay and loose sand at different depth

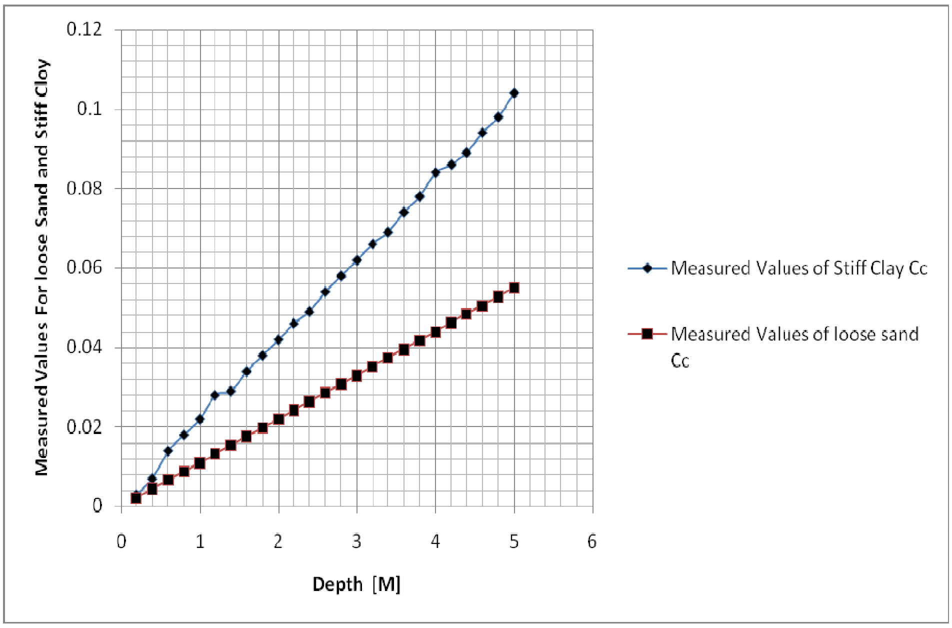

Figure: 2 Predictive Values for stiff clay and loose sand at different depth

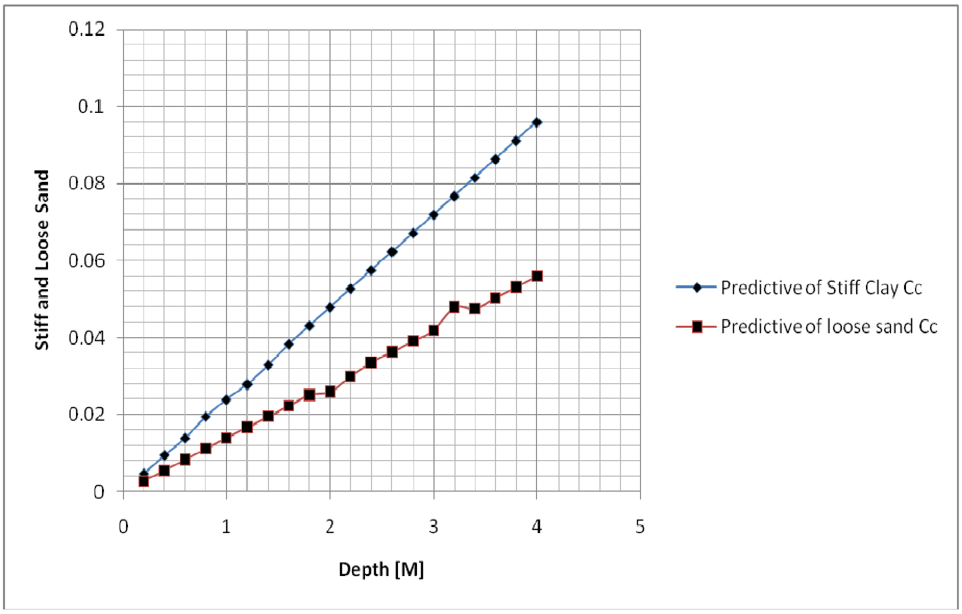

Figure: 3 Predictive Values for stiff clay and loose sand at different depth

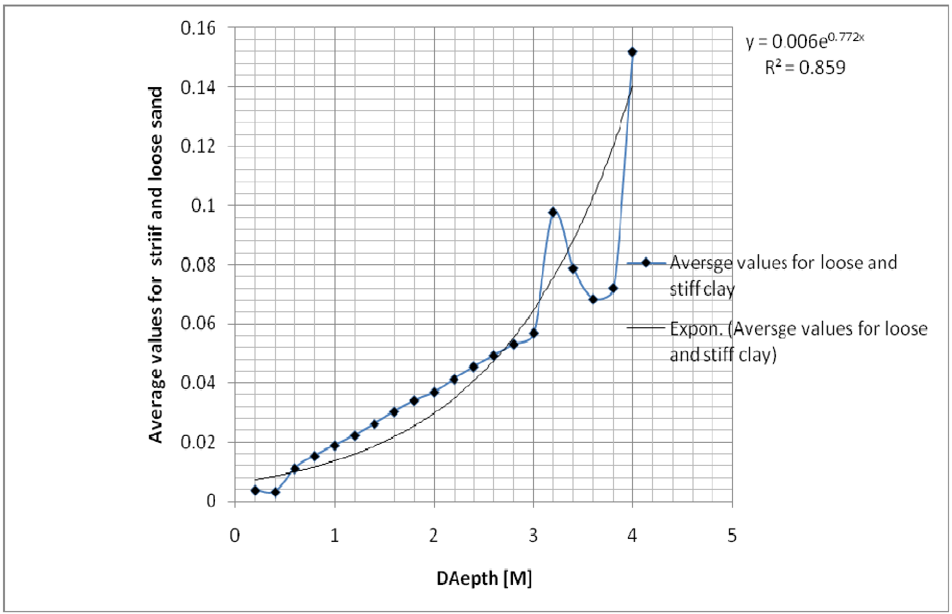

Figure: 4 Average values for loose sand and stiff clay

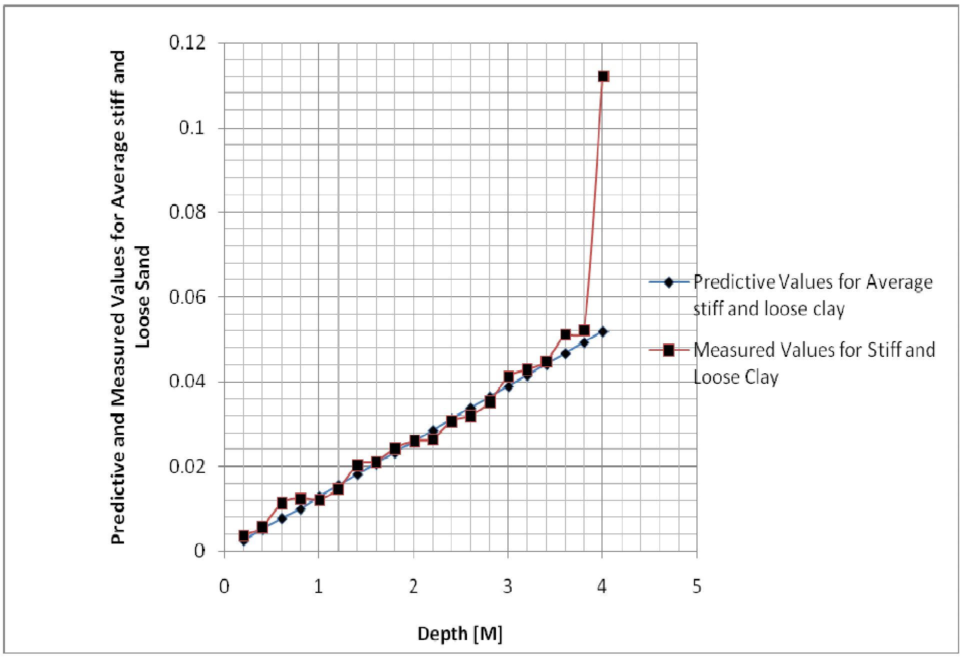

Figure: 5 Predictive and Measured values for Average loose sand and stiff clay

The figure presented express the deposition level of loose and firm clay in the deltaic formation through these graphical representations. The study express both parameters increase with respect to change in depth in homogeneous setting expressing linear increase from the graphical representation, similar condition were observed on firm clay, linear increase in compression were observed in the system there behaviour express the compression increase in linear state, but that stiff clay developed higher compression than loose sand, comparing both parameter it has faviourable fits, this can be observed from the generated parameters presented in figure one. Similar condition were observed in figure two, both parameters developed linear increase to the optimum values at five metres, the behaviour of both soil also establish best fit base on linear deposition from graphical representation, but the stiff clay maintained more compressive depositional setting comparing both parameters. Figure three expresses the behaviour of the strata in linear setting but slight vacillation were observed in loose formation, while that of firm clay maintained linear expression to the optimum values recorded at four metres, both parameters also developed faviourable fits compared in the presented figure, figure four presented an average parameters representing both soil to monitor the level relationship, the figure generating average parameter for firm soil and loose sand generated linear increase in compression index to the optimum value recorded at five metres. Figure five developed average predictive values compared with other measured values, the expression faviourable relationship, these were generated from developed model equation from average parameter of firm clay and loose sand. Linear increases were observed to the optimum values recorded at four metres.

4. CONCLUSION

The behaviour of soil in terms of compression has been thorough monitored applying this type of concept in predicting and evaluation of both parameters. These studies evaluated predicted values from simulation at different soil formation, these is express the rate of compression establishing some relationship, the developed model values from loose sand and firm clay were compared, from the graphical representation, there is an established relationship between both soil, the studies has also monitored there rate of compression in terms of soil settlement, these condition has express relationship on rate carrying an impose loads. The expression from developed model express various parameter that has relationship with other, these application has not been applied to monitored the behaviour of these two type of formation as it is monitored establishing their relationship.

5. REFERENCES

[1] H.O Nwankwoala1, A.N Amadi2, F.A Ushie3 and T. Warmate 2015 Preliminary Determination of Subsurface Soil Profiles in Akenfa Community, Bayelsa State, Nigeria civil

and environmental research Vol.7, No.8, 2015

[2] Amadi, A.N; Eze, C.J; Igwe, C.O; Okunlola, I.A and Okoye, N.O (2012). Architect's and geologist's view on the causes of building failures in Nigeria. *Modern Applied Science*, Vol.6 (6): 31 – 38.

[3] Merki, J.P.(1970). Structural Geology of the Cenozoic Niger Delta. African Geology. University of Ibadan Press.pp251-268

[4] Murat, R.C (1970). Stratigraphy and Paleogeography of the Cretaceous and Lower Tertiary in Southern Nigeria. In: Dessauvagie, T.T J and Whiteman, A.J (eds.). African Geology, University of Ibadan Press, Ibadan, Nigeria. Pp251 – 266.

[5] Ngah, S.A and Nwankwoala, H.O (2013). Evaluation of Geotechnical Properties of the Sub-soil for Shallow Foundation Design in Onne, Rivers State, Nigeria. *The Journal of Engineering and Science*, Vol. 2 (11): 08 – 16

[6] Nwankwoala, H.O and Warmate, T (2014). Geotechnical Assessment of Foundation Conditions of a Site in Ubima, Ikwerre Local Government Area, Rivers State, Nigeria. *International Journal of Engineering Research and Development (IJERD)* 9(8): 50 – 63.

[7] Reyment, R.A (1965). Aspects of the Geology of Nigeria, University of Ibadan Press, p133 Short, K. C. and Stauble, A. J. (1967). Outline of Geology of the Niger Delta. American Association of Geologists, Vol. 51, No. 5, pp. 761 – 779.

[8] Youdeowei, P.O and Nwankwoala, H.O (2010). Assessment of some geo-environmental problems associated with road construction in the Eastern Niger Delta. *Afr. J. Environ. Pollut. Health*, Vol.8 (1):1 – 7

[9] Youdeowei, P.O and Nwankwoala, H.O (2013). Suitability of soils as bearing media at a freshwater swamp terrain in the Niger Delta. *Journal of Geology and Mining Research*, Vol.5(3): 58 – 64

[10] Short, K. C. and Stauble, A. J. (1967). Outline of Geology of the Niger Delta. American Association of Geologists, Vol. 51, No. 5, pp. 761 – 779.

[11]Eluozo S. N. and Ode .T. 2015 Mathematical Model to Monitor Stiff Clay Compression index in wet land area of Degema; International Journal of Advanced Research in Engineering and Technology, **6**(12), 2015, pp. 59-72.

[12] Eluozo. S. N and Ode T, 2015 Modeling and Simulation of Compression Strength for Firm Clay in Swampy Area of Ahoada East. *International Journal of Advanced Research in Engineering and Technology*, **6**(12), pp. 73-85.

[13] Eluozo. S. N and Ode T, 2015 Mathematical Model To Predict Compression Index of Uniform Loose Sand In Coastal Area of Degema, Rivers State of Nigeria. *International Journal of Advanced Research in Engineering and Technology*, **6**(12), 2015, pp. 86-103.