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MODEL STUDIES TO MONITOR STIFF AND FIRM CLAY DEPOSITION SETTLEMENT FROM COMPRESSIVE INDEX IN SWAMPY ENVIRONMENT OF NIGER DELTA

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ABSTRACT

Several experts has been monitoring the behaviuor of various soil through experimental set up, these concept has produced reliable results for compression index, the development of modeling and simulation expression of two different soil including monitoring there rate of compression and comparative level has not been carried out. Base on these conditions the behaviour of both parameters in terms of expressing compression rate in such deltaic environment become signification goal to achieved in this study, such condition were monitored through modeling techniques in the study area, simulation from derived solution were carried out to be compared between both parameters, the simulation values through graphical representation express the behavior of both soil compression index, linear deposition were observed to be predominant in all the figures at the optimum level recorded at [4.4M]. Comparative analysis of both parameters has expressed their rate of fitness thus the relationship of both soil formations on compression index.

KEYWORDS: mode studies, stiff, clay firm clay and compression index

1. INTRODUCTION

Experts deal with Design and construction of embankments and structures, this are done on soft clay deposits these are one of the important challenges of Geotechnical engineering. For construction of deformation- sensitive structures, such as a power plant, the magnitude of deformations and control of these characteristics are extremely important for the serviceability of structures and equipment. Too much deformation under sensitive structures may result to cracking, fractures structure or equipment failures. Soft clay deposits usually have a low bearing capacity, lower permeability, and high compressibility. It is predictable that the soft clay deposits have to be treated before the positioning of structures Consolidation of compressible soils involving elimination of pore water from the soil. This can be done by applying a surcharge load to squeeze the water out. To accelerate the dewatering and consolidation process, wick drains can be installed to provide conduits for water flow and to shorten the flow path of the water in the low-permeability soil (Eluozo and Ode 2015a, 2015b, 2015c). More so Drained compressibility parameters for cohesive soils are valuable when carrying out long term settlement examination, by providing input parameters for analysis and design of ground improvement the drained compressibility parameters include the compression and recompression indices, overconsolidation ratio and coefficient of consolidation. These parameters can be influenced with variable degrees by quality of samples used in the tests. (Jamiolkowski et al., 1985 and Terzaghi et al., 1996). Empirical correlations to estimate these parameters or equivalent in other forms, from insitu tests such as piezocone are available in the literature (e.g. Jamiolkowski et al, 1985, Lunne et al., 1997 and Mayne, 2009). However, estimating drained parameters from undrained piezocone test results could be complicated and sometimes may have various degrees of uncertainties (Lunne etl. 1997 Hamza M Shahien, 2013). Comprehensive geotechnical investigation campaigns were carried out in seven sites of major projects along the north coast and within the Delta of the Nile River of Egypt. Three of these sites were reported in Hight et al. (2000), Hamza et al. (2002), (2003) and (2005). The seven sites were used by Hamza and Shahien (2009) to investigate the correlations of estimating the efective stress friction angle from piezocone data. The statification of the sites consists of silty sand top layer over very soft to medium stiff clay layer over sand over stiff to hard clay. The thickness of the soft clay layer tends to thicken as moving from west to east of the Delta (Hamza et al., 2005).oedometer tests as suggested by Andresen and Kolstad (1979)

2. GOVERNING EQUATION

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

Nomenclature

λ = Plastic Index
β = plastic Limit
Vo = Void Ratio
ϕ = porosity
Z = Depth

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

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

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

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

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

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

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

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

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

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

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

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

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)

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

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

$$a_1 = \frac{H\frac{\lambda}{\beta}}{V_0 - \Phi} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

Substitute (10) into equation (11)

$$a_1 = -a_0$$

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

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. RESULTS AND DISCUSSION

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

Table:1 Predictive Values for stiff and firm clay at Different Depth

Depth [M]	Predictive of Stiff Clay Cc	Predictive of firm Clay Cc
0.2	0.0048	0.00287
0.4	0.0096	0.0056
0.6	0.014	0.0084
0.8	0.0196	0.011
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	0.0287
2.2	0.0528	0.0308
2.4	0.0576	0.0336
2.6	0.0624	0.0364
2.8	0.0672	0.0372
3	0.072	0.042
3.2	0.0768	0.0448
3.4	0.0816	0.0476
3.6	0.0864	0.0504
3.8	0.0912	0.0532
4	0.096	0.056
4.2	0.1008	0.0588
4.4	0.10564	0.0616

Table:2 Predictive Values for stiff and firm at Different Depth

Depth [M]	Predictive of Firm Clay Cc	Predictive of Stiff Clay Cc
0.2	0.00639	0.00287
0.4	0.012	0.0056
0.6	0.018	0.0084
0.8	0.024	0.011
1	0.03	0.014
1.2	0.036	0.0168
1.4	0.04	0.0196
1.6	0.048	0.0224
1.8	0.054	0.0252
2	0.06	0.0287
2.2	0.066	0.0308
2.4	0.072	0.0336
2.6	0.078	0.0364
2.8	0.084	0.0372
3	0.09	0.042
3.2	0.096	0.0448
3.4	0.102	0.0476
3.6	0.108	0.0504
3.8	0.114	0.0532
4	0.12	0.056
4.2	0.126	0.0588
4.4	0.132	0.0616

Table: 3 Predictive Values for stiff and firm at Different Depth

Depth [M]	Predictive of Stiff Clay Cc	Predictive of firm Clay Cc
0.2	0.004	0.00287
0.4	0.008	0.0056
0.6	0.012	0.0084
0.8	0.016	0.011
1	0.02	0.014
1.2	0.024	0.0168
1.4	0.028	0.0196
1.6	0.032	0.0224
1.8	0.036	0.0252
2	0.04	0.0287
2.2	0.044	0.0308
2.4	0.048	0.0336
2.6	0.052	0.0364

2.8	**0.056**	**0.0372**
3	**0.06**	**0.042**
3.2	**0.064**	**0.0448**
3.4	**0.068**	**0.0476**
3.6	**0.072**	**0.0504**
3.8	**0.076**	**0.0532**
4	**0.08**	**0.056**
4.2	**0.084**	**0.0588**
4.4	**0.088**	**0.0616**

Table: 4 Predictive Values for stiff and firm at Different Depth

Depth [M]	Predictive of Firm Clay Cc	Predictive of Stiff Clay Cc
0.2	**0.004**	**0.00639**
0.4	**0.0084**	**0.012**
0.6	**0.0126**	**0.018**
0.8	**0.0168**	**0.024**
1	**0.021**	**0.03**
1.2	**0.0252**	**0.036**
1.4	**0.0294**	**0.04**
1.6	**0.0356**	**0.048**
1.8	**0.0378**	**0.054**
2	**0.042**	**0.06**
2.2	**0.0462**	**0.066**
2.4	**0.0504**	**0.072**
2.6	**0.0546**	**0.078**
2.8	**0.0588**	**0.084**
3	**0.06**	**0.09**

Table: 5 Predictive Values for stiff and firm at Different Depth

Depth [M]	Predictive of firm Clay Cc	Predictive of Stiff Clay Cc
0.2	**0.0031**	**0.004**
0.4	**0.006**	**0.008**
0.6	**0.009**	**0.012**
0.8	**0.015**	**0.016**
1	**0.017**	**0.02**
1.2	**0.018**	**0.024**

1.4	**0.021**	**0.028**
1.6	**0.024**	**0.032**
1.8	**0.027**	**0.036**
2	**0.03**	**0.04**
2.2	**0.033**	**0.044**
2.4	**0.036**	**0.048**
2.6	**0.039**	**0.052**
2.8	**0.042**	**0.056**
3	**0.045**	**0.06**
3.2	**0.048**	**0.064**
3.4	**0.051**	**0.068**
3.6	**0.054**	**0.072**
3.8	**0.056**	**0.076**
4	**0.06**	**0.08**

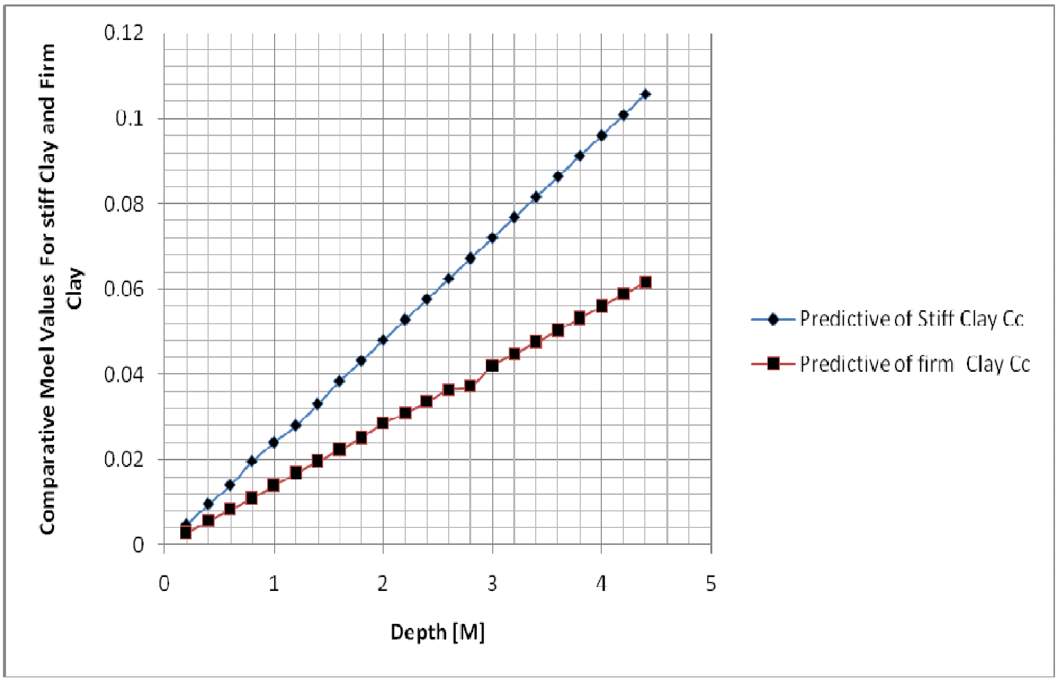

Figure: 1 Predictive Values for stiff and firm at Different Depth

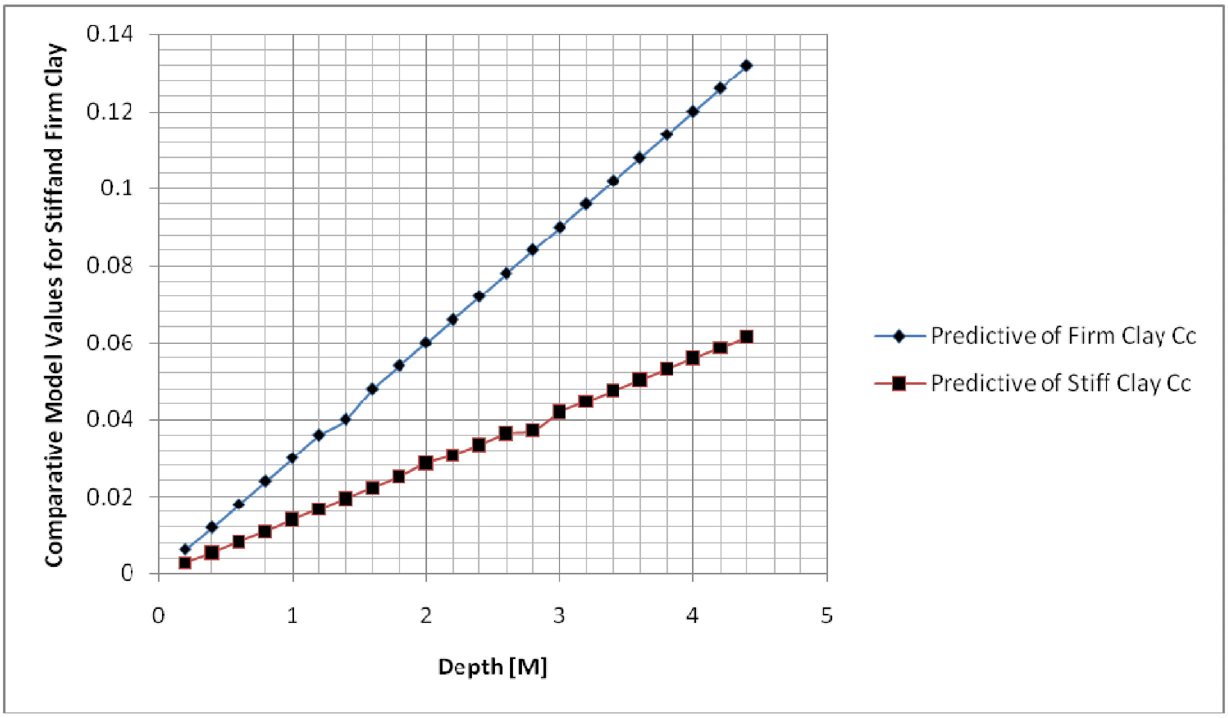

Figure: 2 Predictive Values for stiff and firm at Different Depth

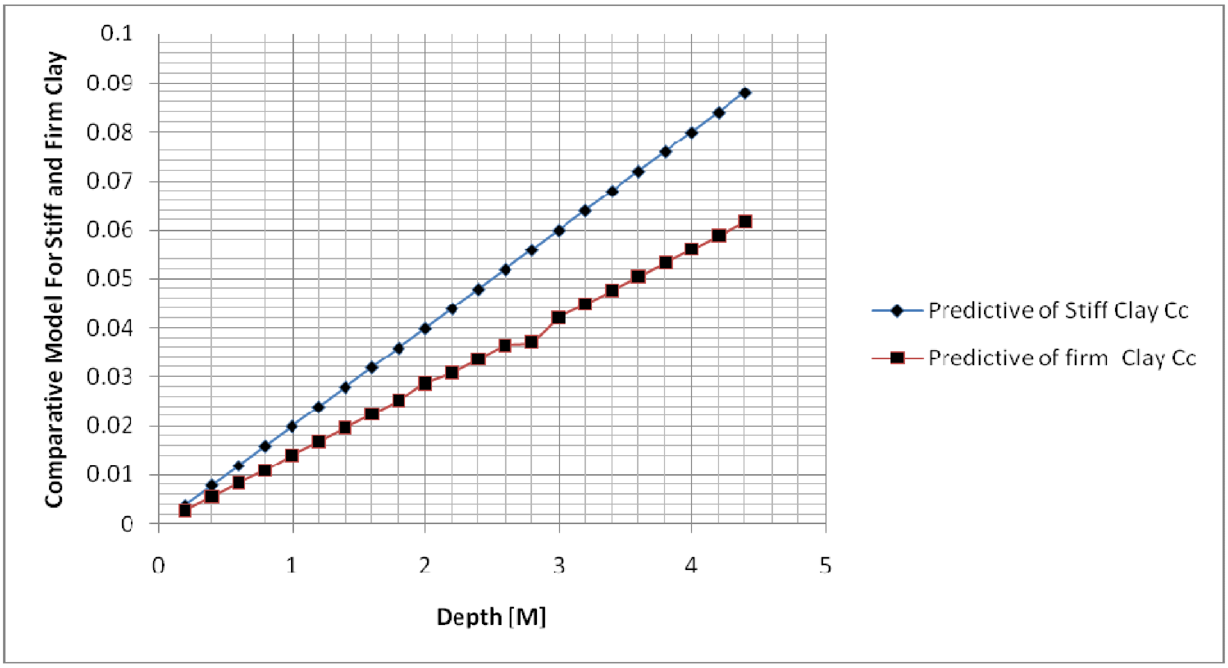

Figure: 3 Predictive Values for stiff and firm at Different Depth

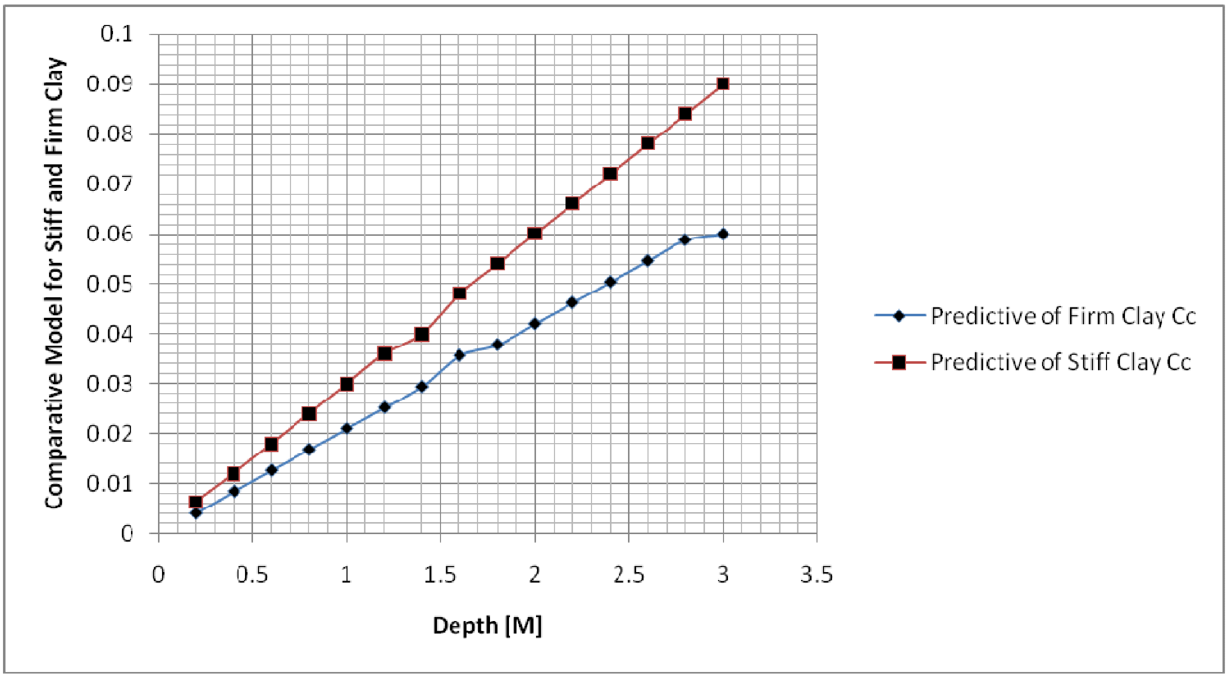

Figure: 4 Predictive Values for stiff and firm at Different Depth

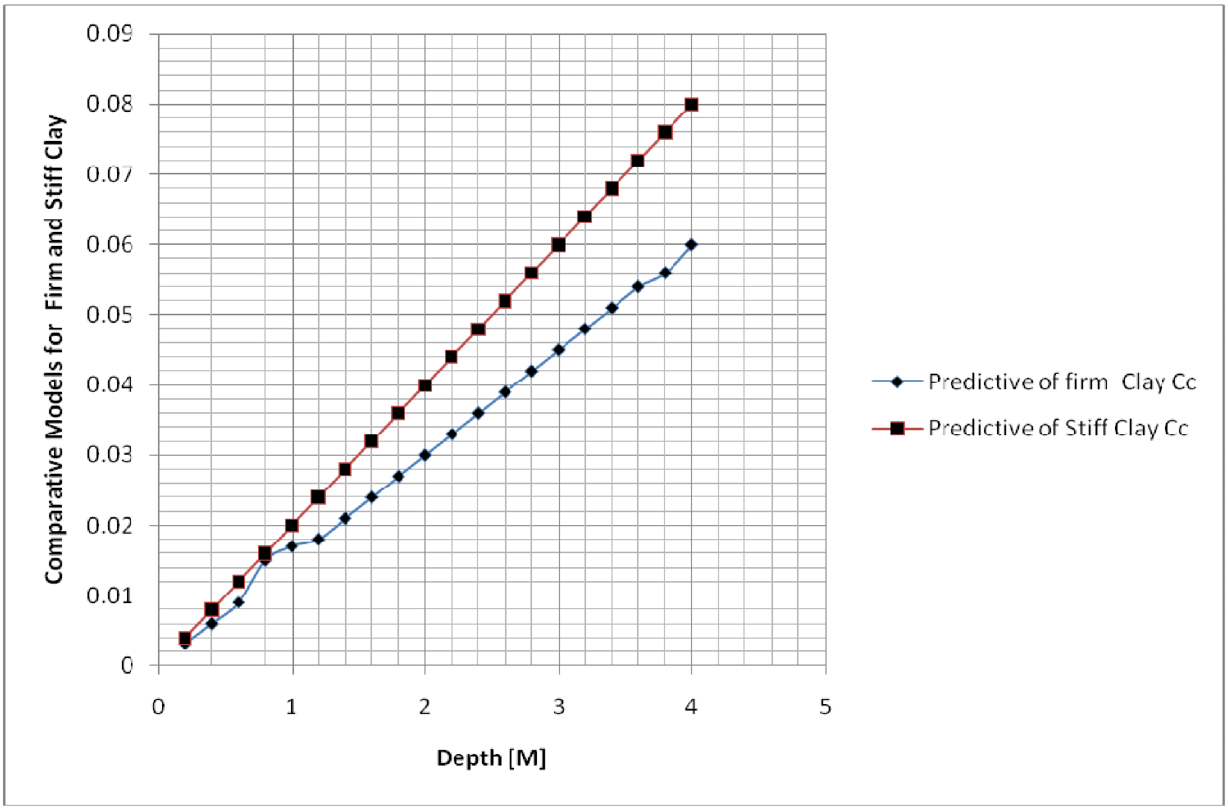

Figure: 5 Predictive Values for stiff and firm at Different Depth

The expression here detailed the behaviour of these two clay formation at various depth, the deposition of these two parameters are in linear level, the firm clay expressing more compression more but at exponential phase, these expression implies that there comparative rate has definitely establish relationship between both parameters stated above. While figure two maintained similar condition but firm clay expressing more compressibility base on the graphical representation, but the stiff clay formation express slight fluctuation in some depth, but maintained linear state to the optimum values recorded at [4.4M], Figure three express similar condition were exponential state of compression were observed between both parameters, but stiff clay experienced more linear than firm clay, slight vacillation were observed thus to the optimum values recorded at [4.4 M], figure four experienced slight vacillation but definitely developed linear deposition between both parameters to the optimum level, but the firm clay experienced more compression than that stiff clay formation, figure five observed firm clay formation generated exponential deposition at different depth to the optimum values recorded at [4.4M], while that stiff clay express fluctuation thus developed linear to the optimum values at the same depth.

4. CONCLUSION

The developments of these two formations are predominant in deltaic environment, the study has express the behaviour of clay formation, these type of compressibility in deltaic areas are observed to be predominant, these condition were monitored through the development of these concept to model and simulate two parameters establishing their relationship. The depositions of both parameters express their various level compressions under the influences of formation characteristics in soil relation to compression index. The generated predictive values from both parameters were compared to determined there relationship in terms of compression index in deltaic environment, linear deposition of both soil formation were observed, it also experiences slight variation including fluctuation in some depth, while compression also observed similar condition, the study has express the behaviour of these two soil compression index by establishing the rates of their fits thus relationship through comparative expression.

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