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Full Length Research Paper

Model Prediction to Monitor Pore Distribution Impact on Bearing Pressure in Silty Formation Influenced by Velocity in Coastal Area of Abonnema

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The deposition on pore distribution of silty soil are confirmed to generate lots of impact on highly impose loads, the soil experiences lots of stress from imposed loads, variation on pore distribution in silty formation were generated to monitor the effect on bearing pressures base on its level of deposition in various depths. Predicting pore distribution percentage in silty formations were to monitor the rate of increase in their various deposition, such condition should also determine some level of impact when the soil is carrying an imposed load, the establishment of mathematical model were carried out to predict the deposition rate of pore distribution of silty formation reflecting impact on bearing pressure of the soil, these also reflect on the condition of settlement under the influences of preconsolidation and consolidation of soil. The developed model where able to predict this level of pore distribution to seventy metres, comparing the predicted values with experimental results, it developed the best fit validating model. Experts will definitely apply these concept model as a useful tool in predicting pore distribution of silty formation in the study area.

Keywords: Model prediction, pore distribution, deep foundation, silty, velocity.

INTRODUCTION

Numerous customary geotechnical troubles are connected with the relations between soil and water. However, knowledge of groundwater systems (together with pressure levels and flows) between geotechnical engineers might be enhanced. Knowledge of surface water is substantial along with hydrologists and knowledge of groundwater is substantial along with hydrogeologists. If knowledge in these conventionally separate fields can be applied, it may enhance considerably our knowledge of the contact between soil and water in geotechnical problems. An appropriate forename for such exploitation could be hydrogeotechnics. Geotechnical challenges related to groundwater mostly concern settlement and stability. Lowered groundwater levels could cause settlement, while stability troubles are normally related to high water levels or intense precipitation. This study deals primarily with stability challenges related to elevated pore pressure and groundwater level in deep layers due to the long-term effects of infiltrated precipitation. Other sort of water-induced gradient stability trouble can be attributed to heavy rain causing increased pore pressures in shallow layers, loading effects from superficially stored rain and surface or inner erosion (piping). Furthermore, the circulation of water connecting rivers, lakes, oceans, the atmosphere and the ground is usually referred to as the hydrologic cycle. The dynamic device in this movement is radiation from the sun. This radiation causes water disappearance and plant transpiration, which jointly are called

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evapotranspiration. But in most European nations, at high elevation, the evapotranspiration is cooled down and condenses into water droplets, which ultimately causes rainfall. When rain falls as snow, water is stored in the snowpack and the circulation is delayed until snowmelt. Precipitation falling as rain, or melting snow, causes runoff into streams, lakes and oceans as well as recharge into groundwater reservoirs. On average over a large area, the infiltration is caused by precipitation minus evapotranspiration and is called the effective precipitation. Looking at the infiltrating water and the groundwater reservoirs in detail, a more correct name for the hydrologic cycle could be the hydrogeological (or geohydrological) cycle (Håkan, 2008).

A geologic deposit that has sufficient hydraulic conductivity for considerable quantities of water to be stored and withdrawn from wells is called an aquifer. An aquitard, on the other hand, is a geologic deposit that is not permeable enough to transmit a significant amount of water. The suggested techniques for predicting utmost pore pressures have been developed principally for clay areas, but for silty formation, it has not been developed. However, the procedures that cause steadiness challenges due to elevated pore pressures change considerably between sandy or silty slopes and clay areas. In most part of Nigeria wet lands deposit clay formation. Moreover, this study considers natural areas as opposed to areas with dense construction work and deep foundations. Pore pressures in silty and also silty clay are governed by hydrogeological boundary conditions. If the water pressures below and above the clay are known, the pore pressures within the silty and silt sand including silt clay can be calculated. Several literatures have expressed the water pressure in confined aquifers. In order to improve our understanding of groundwater systems in clay areas, groundwater level fluctuations in confined aquifers have been analysed and simulated.

Furthermore, an attempt has been made to identify typical examples of these fluctuations, based on objective criteria such as local topography, geology and position within an aquifer. Apart from analyses and simulations of groundwater fluctuations, the recommended method for maximum pore pressure predictions has also been analysed and tested. Consequently, extended studies of the superficial groundwater systems is a remaining and important part of future research (Håkan, 2008). A soil that is subjected to shear deformations will normally experience a volume change, which for a water-saturated soil results in a change in pore pressure. In a highly permeable soil, a change in pore pressure can be neutralised through water drainage. In a soil with low permeability, such as clay, the drainage process is slow and shear deformations and failures can therefore often be regarded as occurring under undrained conditions (Sällfors, 2001). These deformations are often too large to be acceptable and normally cause pore pressure generation, which in turn can also cause undrained failures (Sällfors, 1986).

A settlement condition is depending on the consolidation coefficient and thus the hydraulic conductivity and the modulus of the soil. The hydraulic conductivity of a certain soil is reduced by consolidation of the soil and the modulus can also be strongly dependent on the effective soil stresses. This is the case for clay soils, in which the structure is reconfigured for effective stresses greater than the pre-consolidation pressure in the soil. The reconfiguration causes a softer soil, and when the effective stresses exceed the pre-consolidation pressure, the modulus for the clay decreases significantly. Exceeding pre-consolidation pressure is typically caused by external loading or a decrease in the groundwater level. Finding exact values for the modulus is difficult, but they can be assumed to be in the same order of magnitude as the unloading modulus (Berntsson, 1983). From lab tests, these unloading modulus have been found to vary in the range 200-1000• 'c s for Swedish west coast clay (Persson, 2007).

Year past in 1950's, laboratory studies of echo velocity in aquatic sediments began at Cambridge [Laughton, 1954, 1957], at the Navy Electronics Laboratory [Hamilton, 1956; Hamilton et al., 1956; Shumway, 1960], and at the Lamont Geological Observatory [Sutton et al., 1957; Na[e and Drake, 1957]. Na[e and Drake [1963] have summarized this field through about 1960. Since 1960 laboratory measurements of velocity in sea-floor samples have been. Published by Parasnis[1 960],Hamilton [1963, 1965], Ryan et al. [1965], Hot** et al. [1968], and Schreiber [1968a]. Apparently the first in situ measurements (other than those of seismology) made by Wood and his colleagues in the tidal mud flats during World War II (referred to in Wood and Weston [1964]).

The advent of scuba techniques followed measurements to be made in the sea floor to water depths of about 45 meters [Hamilton et al. 1956] measurements to about 1200 meters [Hamilton, 1963]; A very important source of information on compressional and shear waves, and on elastic and other properties of saturated sediment is in the literature of soil mechanics; a source often overlooked by geologists and geophysicists. Papers by Hardin and Richart [1963], and by Richart and Whitman [1967] contain discussions and comprehensive bibliographies. During the period 1964 to 1968, the writer made laboratory and in situ measurement so the velocity of compressional waves and the density, porosity, and other mass physical properties of marine sediments from several major sedimentary environments in the North Pacific and adjacent areas [Edwin,1970].

Developed Governing Equation

$$K\phi \frac{\partial e_{(x)}}{\partial t} = \Delta V_{(x)} \frac{\partial e}{\partial x} + V_{(t)} \frac{\partial c}{\partial x} \qquad \text{................} \qquad (1)$$

Nomenclature

e = pore distribution [-]
K = Permeability $[LT^{-1}]$
ϕ = Porosity [-]
D = Dispersion in number [-]
V(t) = Velocity $[LT^{-1}]$
C = Concentration $[ML^{-3}]$
T = Time [T]
X = Depth [L]

Let $C = XT$ from equation (2), we have

$$K\phi\, T^1 Z \;=\; D_v TX^1 \;+\; V_{(t)}\, TX^1 \quad .... \quad (2)$$

$$K\phi \frac{T^1}{T} = D_v \frac{X^1}{X} + V_{(t)} \frac{X^1}{X} = \tau^2 \quad .... \quad (3)$$

$$K\phi \frac{T^1}{T} = \tau^2 \quad .... \quad (4)$$

$$D_v \frac{X^1}{X} = \tau^2 \quad .... \quad (5)$$

$$V_{(x)} \frac{X^1}{X} = \tau^2 \quad .... \quad (6)$$

This implies that equations (4), (5), and (6) can be written as:

$$\left[D_v + V_{(x)}\right]\frac{X^1}{X} = \tau^2 \quad .... \quad (7)$$

From (4) $K\phi \frac{T^1}{T} = \tau^2$

i.e. $K\phi \frac{\partial T}{dT} = \tau^2$ .... (8)

$$\int \frac{dT}{T} = \frac{\tau^2}{K\phi}\int dt \quad .... \quad (9)$$

$$Ln\, T = \frac{\tau^2}{K\phi} t + c_1 \quad .... \quad (10)$$

$$\frac{\tau^2}{K\phi} + c_1 \quad .... \quad (11)$$

$$\boxed{T = A\ell^{\frac{\tau^2}{K\phi}}} \quad .... \quad (12)$$

From (7)

$$\left[D_v + V_{(x)}\right]\frac{X^1}{X} = \tau^2\, dx \quad .... \quad (13)$$

$$\int \frac{dx}{dx} = \frac{\tau^2}{D_v + V_{(x)}}\int dx \quad .... \quad (14)$$

$$Ln\, x = \frac{\tau^2}{D_v + V_{(x)} - K_d} + c_1 \quad .... \quad (15)$$

$$Z = \exp\left[\frac{\tau^2}{D_v + V_{(x)}} + c_1\right] \quad .... \quad (16)$$

$$X = B\exp\frac{\tau^2}{D_v + V_{(x)}}x \quad .... \quad (17)$$

Combining (17) and (18), we have

$$C, TX = TX$$

$$A\ell^{K\phi} B\left[\exp\frac{\tau^2}{D_v + V_{(x)}}\right] \quad .... \quad (18)$$

$$C\; X, T = AB\exp\left[\frac{t}{K\phi} + \frac{X}{D_v + V_{(x)}}\right]\tau^2 \quad .... \quad (19)$$

MATERIALS AND METHODS

Standard laboratory experiment where performed to determine pore distribution of silty formation using the standard method for the experiment at different formation, the soil deposition of the strata were collected in sequences based on the structural deposition at different locations, these samples collected at different locations generated variations at different depths producing pore distribution values. The experimental results were compared with the theoretical values for the validation of the model.

RESULTS AND DISCUSSION

Results and discussion are presented in tables including graphical representation void ratios in lateritic and peat soil formations.

Table 1: Deposition of Pore Distribution at Different Depths

Depths[M]	Pore Distribution
3	0.22
6	0.26
9	0.3
12	0.36
15	0.42
18	0.49
21	0.58
24	0.67
27	0.79
30	0.92
33	1.07
36	1.26

Tables 2: Comparisons Between Predicted and Experimental Values of pore Distribution at Different Depths

Depths[M]	Predicted values	Experimental values
3	0.22	0.21
6	0.26	0.25
9	0.3	0.3
12	0.36	0.34
15	0.42	0.4
18	0.49	0.46
21	0.58	0.54
24	0.67	0.62
27	0.79	0.72
30	0.92	0.82
33	1.07	0.95
36	1.26	1.09

Table 3: Deposition of Pore Distribution at Different Depths

Depths[M]	Pore Distribution
3	0.5
6	0.53
9	0.57
12	0.6
15	0.65
18	0.69
21	0.74
24	0.78
27	0.84
30	0.89
33	0.95
36	1.09

Table 4: Comparisons Between Predicted and Experimental Values of Pore Distribution at Different Depths

Depths[M]	Predicted values	Experimental values
3	0.5	0.48
6	0.53	0.49
9	0.57	0.52
12	0.6	0.57
15	0.65	0.62
18	0.69	0.64
21	0.74	0.71
24	0.78	0.74
27	0.84	0.81
30	0.89	0.84
33	0.95	0.91
36	1.09	1.01

Table 5: Deposition of Pore Distribution at Different Depths

Depths[M]	Pore Distribution
3	0.06
6	0.07
9	0.081
12	0.089
15	0.097
18	0.107
21	0.118
24	0.12
27	0.14
30	0.15
33	0.17
36	0.18
39	0.2
42	0.22
45	0.25
49	0.28
52	0.31
55	0.34
58	0.37
61	0.41
64	0.45
67	0.5
70	0.55

Table 6: Comparisons Between Predicted and Experimental Values of Pore Distribution at Different Depths

Depths[M]	Predicted	Experimental Values
3	0.06	0.05
6	0.07	0.05
9	0.081	0.075
12	0.089	0.083
15	0.097	0.094
18	0.107	0.102
21	0.118	0.113
24	0.12	0.11
27	0.14	0.11
30	0.15	0.12
33	0.17	0.13
36	0.18	0.15
39	0.2	0.17
42	0.22	0.19
45	0.25	0.21
49	0.28	0.25
52	0.31	0.29
55	0.34	0.31
58	0.37	0.33
61	0.41	0.38
64	0.45	0.42
67	0.5	0.49
70	0.55	0.52

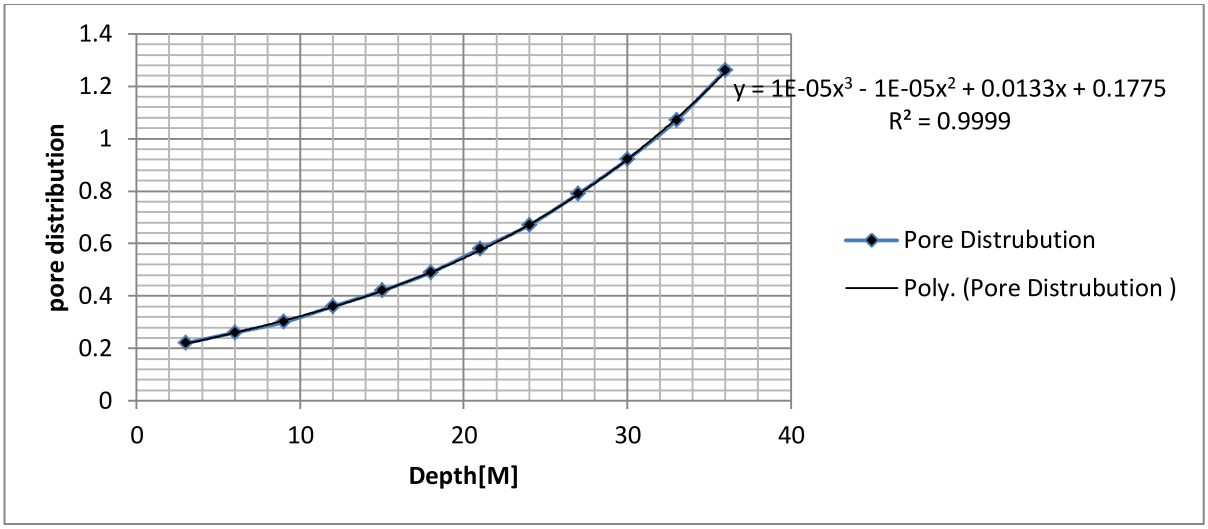


Figure 1: Deposition of Pore Distribution at Different Depths

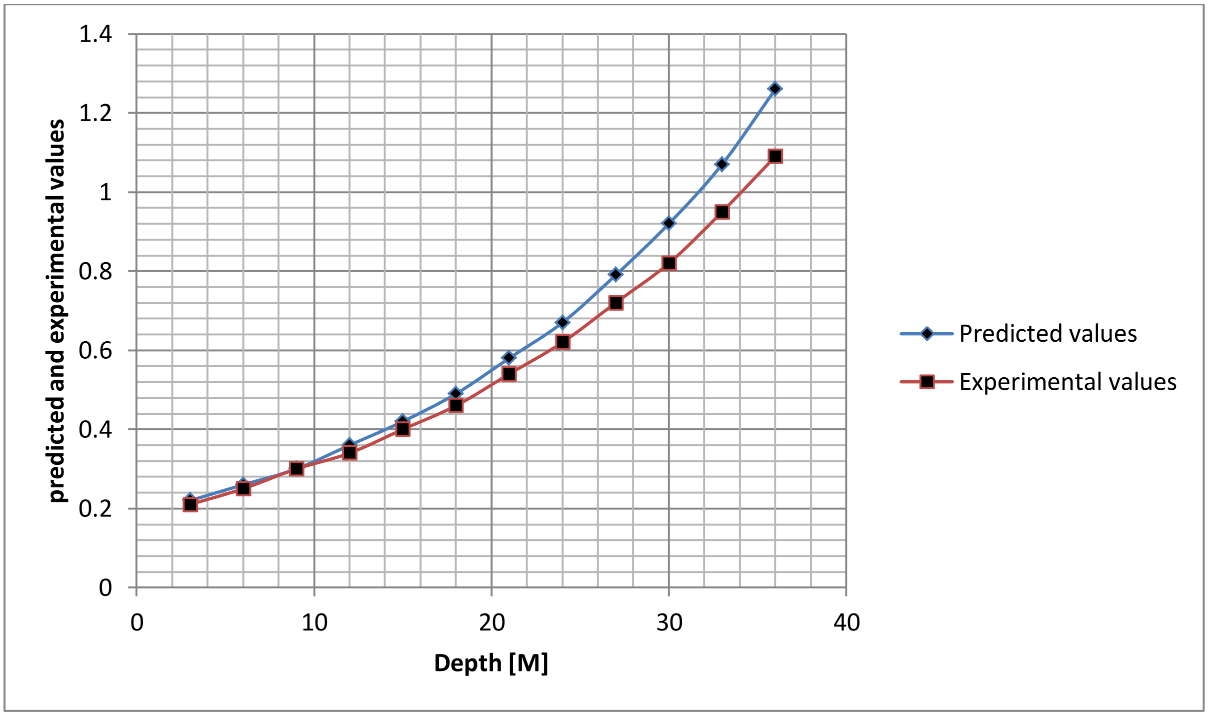


Figure 2: Comparisons between Predicted and Experimental Values of Pore Distribution at Different Depths

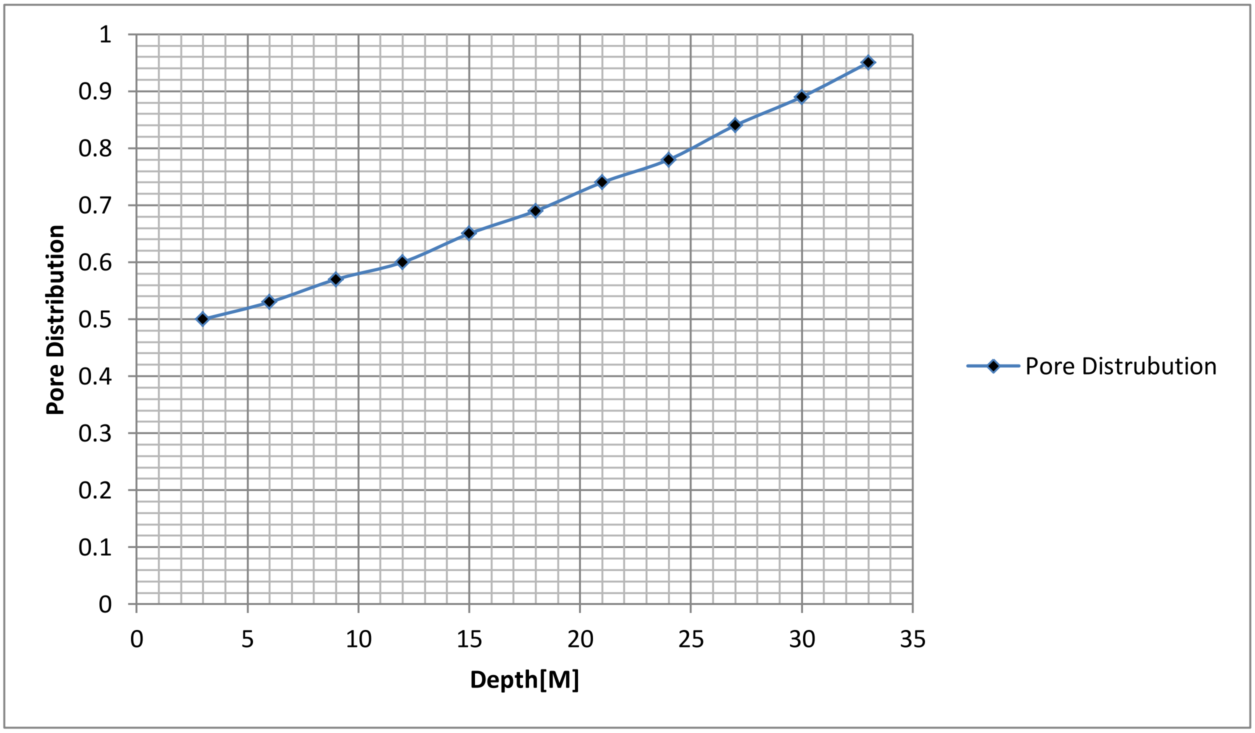
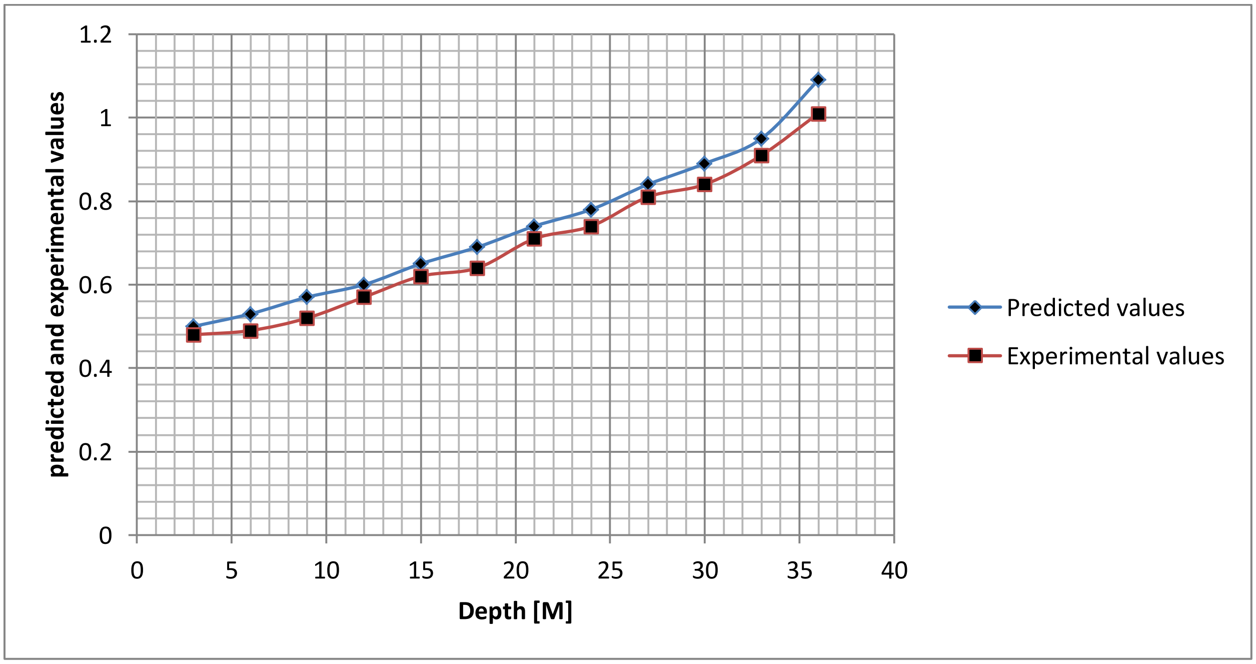


Figure 3: Deposition of Pore Distribution at Different Depths



Tables 4: Comparisons between predicted and experimental values of pore distribution at different depths

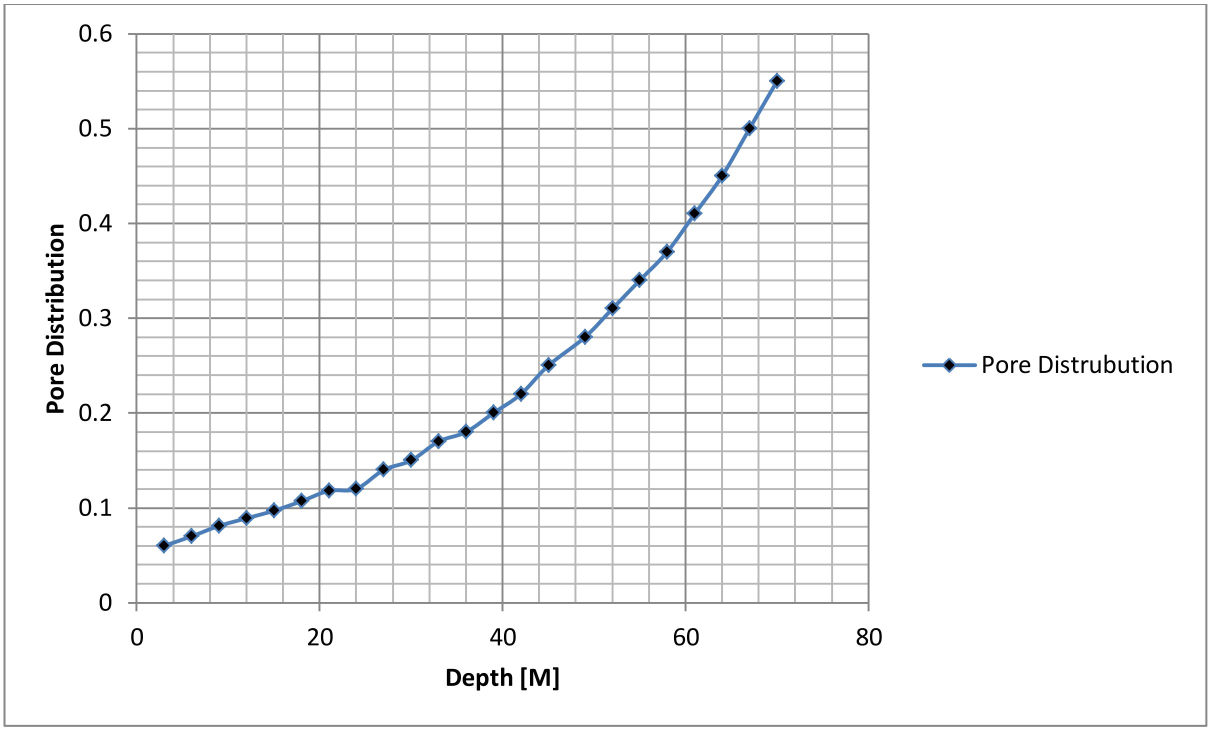


Figure 5: Deposition of Pore Distribution at Different Depths

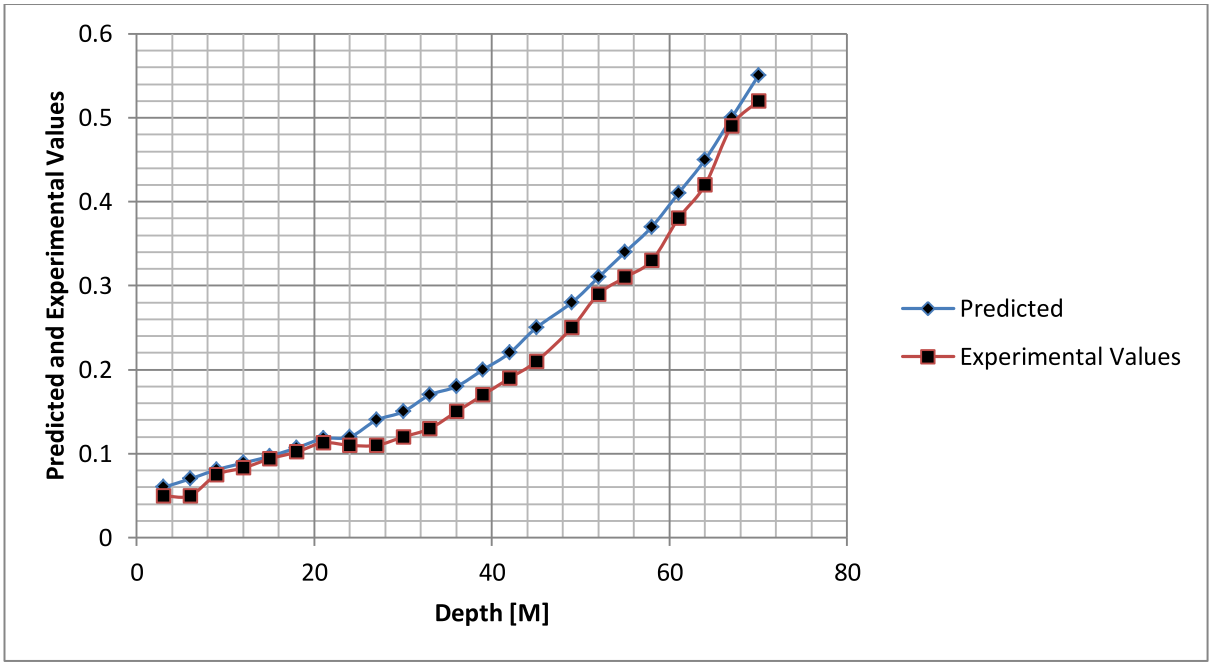


Figure 6: Comparisons between Predicted and Experimental Values of Pore Distribution at Different Depths

The figures presented express various deposition of pore distribution system under the influence of formation variation through its characteristics from its geological setting. There is a strong relationship between this and the geotechnical characteristics, therefore the study base on the developmental model is monitoring the deposition of these parameters under the influence of geotechnical characteristics from geological deposition of the formation. Figure one and two observed a gradual increase in void percentage deposition to the optimum level, the deposition expresses linearized setting influenced by alluvium stratification of the formation. Similar conditions were observed in figure two as the predicted were compared with experimental values. The expressed parameter developed best figures. While figure three and four developed higher pore distribution than figures one and two. From the graphical representation, it observed linear increase, but with slight fluctuation between thirty three and thirty six metres.

Comparing it with experimental values, it developed correlated fits but with more fluctuation between the trends, while figures five and six predicted the deposition of pore distribution of the soil to deeper level, there is the tendency that lots of geotechnical characteristics may have influenced the pore distribution of the strata at those deeper level, the figures experienced gradual increase with slight variations to the point where the optimum level at seventy metres were recorded, the deposition of the formation are affected by geological setting including geotechnical characteristics of the soil, more so the hydraulic conductivity is constant during the consolidation process, the change in pore pressure is equal to the change in effective stress (but with an opposite sign), consolidation is one-dimensional and the strain is only dependent on the change in effective stress (i.e. where creep settlement is not considered).

CONCLUSION

There lots of challenges in handling geotechnical problems related to changes in groundwater levels, these concepts are found in the present today's methods, the notion of effective stress is a precondition. These expressions are observed; if the groundwater levels in an area are lowered below the normal levels, the effective stress level in the soil will be enhanced, generating compaction (or settlement) of the soil. An important lowering of the water level can be generated by pumping, including irrigation, for example, or it may also be due to leakage into a deeper tunnel. On the other hand, when the groundwater level rises, the effective stress decreases and thus also the interparticle forces. The depositions of pore distribution are also influenced by several geotechnical characteristics just like effective stress in soil under influences of variation experiences on imposed loading. A soil that is subject to shear deformations will normally experience a volume change, which for a water-saturated soil results change in pore pressure. In a highly permeable soil a change in pore pressure can be neutralised through water drainage. In a soil with low permeability, such as clay, where the drainage process is slow and shear deformations and failures can therefore often be regarded as occurring under undrained conditions

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