Porosity Model Evaluation Pressured by Void Ratio on Homogenous Compression of Fine Sand Formation in Obioakpor, Port Hacourt

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Abstract— *This study develop model that will evaluates the influences of soil compression in natural condition or in an impose loads determined by the rate of soil porosity. Porosity evaluation in homogeneous fines sand formation were to monitor the homogeneous setting effect from the rate of low void ratio and permeability observed to pressure compression of fine sand, the expression has proven different dimensions that will always generate homogeneous setting in the deltaic formation, to predict this types of porosity, mathematical modelling approach were applied, the developed system generated governing equation that were derived to produced predictive model for porosity evaluation in fine sand formation. Soil and highway engineers can apply these techniques during design of roads and foundation as a parameter that is highly significant to check the rate of porosity on soil compression.*

Keywords—permeability coefficient, void ratio, compressibility and fine sand.

I. INTRODUCTION

The development of roads that generate compaction of traffic has been identified as a major process that affects the production and the environment by changing the soil structure. It has been observed in physical properties of soils (Anh et al 2011). More so it has also experienced changes in mechanical strength, further more water and gas transports and thus affects the root and shoot growth. It changes also express soil nitrogen and carbon cycles observed to cause increases in soil erosion due to water flow (Soane and van Ouwerkerk, 1994). Enumerating soil damage by compaction is consequently significance when establishing strategies for unindustrialized and forest management on a local scale and for ecological fortification measures on a larger scale. The assessment of the soil compaction effects on soil physical properties is normally based on the contemplation of the changes in soil mechanical strength, aeration and hydraulic properties (Horn et al., 1995; Kozlowski, 1999; Lipiec and Hatano, 2003; Schäfer- Landefeld et al., 2004; Hemmat and Adamchuk, 2008; Anh et al 2011). Different concept have been projected to evaluate soil degradation due to compaction using relatives between soil compaction parameters and soil capacity parameters such as air-filled porosity, degree of saturation, water content, etc: (i) Håkansson (1990) there should be thorough description on soil compactness in terms of relative soil porosity variations; (ii) Koolen and Kuipers (1989) observe the soil understanding thought about compaction and proposed various compaction criteria in terms of variations of soil strength parameters such as the pre-compression pressure; (iii) Horn et al. (2007) and Mosaddeghi et al. (2007) investigated the relationships between applied stress and soil air permeability; (iv) Håkansson and Lipiec (2000) analysed soil compaction using relations between soil capacity parameters and air permeability. Note that after Horn and Kutilek (2009), a capacity parameter defines a general status, while an intensity parameter includes dynamic aspects over time and space. Goss and Ehlers (2010) presented their disagreement about these definitions, arguing that both intensity and capacity properties can vary in both space and time. In the present work, the term "capacity parameter" is adopted and it defines a general status, i.e., the composition of a given volume but not the internal structure and function (as proposed by Horn and Kutilek, 2009); at the same time, it is admitted that the capacity parameters can vary with time (following Goss and Ehlers, 2010). Laboratory studies on air permeability have shown its dependency on various soil parameters related to the capacity parameters, such as the degree of saturation

(Seyfried and Murdock, 1997; Juca and Maciel, 2006), the water content (Sanchez-Giron et al., 1998) and the air-filled porosity (Olson et al., 2001; Moldrup et al., 2003). In general, the air permeability is lower at a higher degree of saturation with a lower air-filled porosity. Based on the experimental data of compacted silty soil, Delage et al. (1998) concluded that airfilled porosity is the unique parameter affecting the air permeability. Moon et al. (2008) found that the air permeability of compacted soils depends on the compaction energy as well as the moisture content at moulding; the lowest value of air permeability being at the optimum moisture content (maximum dry unit weight). Studies on undisturbed and repacked soils have shown significant effects of the soil structure and pore-space characteristics on the air permeability (O'Sullivan et al., 1999; Moldrup et al., 2001; Tuli et al. 2005; Dörner and Horn, 2006).

II. THEORETICAL BACKGROUND

Soil is one of the most significant engineering materials. Nevertheless, different abundant materials of apparently are equally significance, its properties cannot be predestined for it is naturally occurring material. The Engineer is consequently burden with the liability to either make his design outfit for construction purpose or carry out process intended at improving its properties to the desired or an acceptable condition through the applications of soil stabilizing agents or designed stable load or stable soil for construction, The solidity of soil is of utmost significance to the field of construction/soil Engineering. The solidity of structures observed on soil depends on the shear strength of fundamental soil which is influenced by the movement of water within soil matrix. It has also express the way it is governed by the quantity of pores distribution setting present in the soil, these condition centre on the porosity deposit expressed in the study, thus under evaluation for soil compression in roads and foundation designed (i.e., the soil porosity), the consequences has generated several results of which makes the soil to either be of high or low permeability. Soil permeability is fundamentally a measure that will definitely ease water that can flow through a soil (Donald, 2001). Permeability depends on porosity – the higher the porosity the higher the permeability. It is one of the most important higway and geotechnical parameters that determine the behaviour of soil under load (Verruijt, 2010). Some soil types in the tropics (e.g. black cotton soil) absorb large amount of water during the raining seasons and do not allow easy passage of such water – they are of low permeability (Alhassan, 2008 Gbenga and Oluwatobi,2013).

III. GOVERNING EQUATION

$$K\frac{\partial \phi_{(x)}}{\partial t} = Dv_{(x)}\frac{\partial \phi}{\partial x} + V_{(x)}\frac{\partial \phi}{\partial x} \quad \text{......................} \quad (1)$$

The developed equation express the system on the rate of porosity evaluation, the system are developed through this generated governing equation derived by expressing various way the variables has displayed their functions to generate the model that can predict porosity of in terms of its compression rate, the developed equation will definitely express the model base on the behaviour of structural macropoles of the soil through the derived solution expressed bellow.

Nomenclature

K	=	Permeability	[LT^{-1}]
ϕ	=	Porosity [-]	
D	=	Dispersion in number	[-]
V(x)	=	Velocity	[LT]
T	=	Time	[T]
X	=	Depth	[L]

Let $K = X\,T$ from equation (2), we have

$$KT^1Z = D_v TX^1 + V_{(x)} TX^1 \quad \text{.......................} \quad (2)$$

$$K\frac{T^1}{T} = D_v\frac{X^1}{X} + V_{(x)}\frac{X^1}{X} \quad \text{...........................} \quad (3)$$

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

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

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

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

$$\left[D_v + V_{(x)}\right]\frac{X^1}{X} = \tau^2 \quad \text{..............................} \quad (8)$$

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

i.e. $$K\frac{\partial T}{dT} = \tau^2 \quad \text{..............................} \quad (9)$$

$$\int\frac{dT}{T} = \frac{\tau^2}{K}\int dt \quad \text{..............................} \quad (10)$$

$$Ln\,T = \frac{\tau^2}{K}t + c_1 \quad \text{.............................} \quad (11)$$

$$LnZ = \frac{\tau^2}{K} + c_1 \quad \text{...........................} \quad (12)$$

$$T = A\ell^{\frac{\tau^2}{K}} \qquad \text{..............................} \qquad (13)$$

In generally concept of these disintegration of the grain size to various particles are express in different condition base on the structured strata in deltaic formation. the period were considered in the system base on fluid porosity evaluation as a results of low degree of permeability and void rate developing variation of soil compression for imposed load in roads or foundation designs on soil, the express model has shows the rate of soil compression at various period .

From (7)

$$\left[D_v + V_{(x)}\right]\frac{X^1}{X} = \tau^2 dx \text{..............................} \qquad (14)$$

$$\int \frac{dx}{x} = \frac{\tau^2}{D_v + V_{(x)}}\int dx \text{..............................} \qquad (15)$$

$$Ln\ x = \frac{\tau^2}{D_v + V_{(x)}} X + c_1 \text{.........................} \qquad (16)$$

$$Z = \exp\left[\frac{\tau^2}{D_v + V_{(x)}} X + c_1\right] \text{....................} \qquad (17)$$

$$X = B\exp\frac{\tau^2}{D_v + V_{(x)}} x \text{..............................} \qquad (18)$$

Combining (17) and (18), we have

$$C, TX = TX$$

$$Ae\frac{\tau^2}{K} Z\ B\left[\exp\frac{\tau^2}{D_v + V_{(x)}}\right] \text{..............................} \qquad (19)$$

$$C\ X, T = AB\exp\left[\frac{t}{K} + \frac{X}{D_v + V_{(x)}}\right]\tau^2 \text{..........} \ (20)$$

The behaviour of porosity in soil engineering properties has various variation base on several pressures from formation characteristics, the parameters depend on the rate of predominance's in any deposition, this may affect the degree of porosity on the rate of compression, and this condition will definitely determine the rate of soil porosity either low or high in the deltaic formation. The study were able to developed predictive model that will monitor porosity deposition on the rate of variation of soil compression in design of roads and foundation, the express model consider several rate of soil compression base of geological setting and manmade activities in the study area.

IV. CONCLUSION

The rate of Porosity depends on void through the disintegration of deposited rocks formation, the lower the porosity the lower the void ratio and permeability. These expression are base on the relationship that both parameters has as a characteristics in soil formation, It is one of the most significant geotechnical parameters that determines the behaviour of soil under load. The stability of structures depends on the amount and nature of moisture in the underneath soil. This hinges on the soil porosity and void ratio, it also determined the rate of water movement on soil. The Engineer is therefore burden with the accountability to either make his design suit the soil or carry out procedures aimed at improving its properties to the desired or an acceptable state through the introduction of soil stabilizing agents or designing the type of foundation that suites the soil for such construction purpose, The stability of soil is of utmost importance to the field of construction /soil Engineering. These conditions monitored the rate of porosity in terms formation variation in design of foundation and roads.

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