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Research article

MODELLING PORE DISTRIBUTION OF GRAVEL FORMATION THROUGH COMPRESSIBILITY OF SOIL IN PORT METROPOLIS

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Abstract

Modelling pore distribution of gravel formation influenced by compressibility of soil has been thoroughly expressed. The developed model were to monitor various deposition of pore distribution rates pressured by compressibility of soil on gravel formation, the focus of the study is to monitor the rate of compressibility impact on pore distribution through disintegration of these formation from porous rocks. these were express through mathematical modelling techniques, the derived model were generated from the system to produced the governing equation for the study, the expressed equation were resolved considering several conditions in geotechnical properties of soil, the model generated other situations that may have been insignificant but are part of the influences on soil compressibility that pressure pore distribution rate in gravel formation. Experts will definitely apply this concept as another useful tool in determining compressibility in on pore distribution of gravel formation in the study area.

Keywords: modelling, pore distribution, compressibility, soli consolidation and gravel formation

1. Introduction

The depositions of Natural clays normally have a compression curve (in conditions of void ratio *e* versus effective vertical stress $\sigma v'$ in the semi-logarithmic plane) lying above that of reconstituted clays owing to the effect of soil composition (e.g. Leroueil et al., 1979; Leroueil et al., 1985; Locat & Lefebvre, 1986; Leroueil & Vaughan, 1990; Schmertmann, 1991; Cotecchia & Chandler, 1997; Hong & Tsuchida 1999 Zhen-Shun et al 2012). It is familiar perform to refer to reconstituted clays when evaluating the consequence of soil formation on the mechanical behaviour of natural sedimentary clays (e.g. Skempton & Northey, 1953; Houston & Mitchell, 1969; Nagaraj & Srinivasa Murthy, 1986; Hight et al., 1987; Burland, 1990; Liu & Carter, 1999; Hong & Tsuchida, 1999; Chandler, 2000; Cotecchia & Chandler, 2000; Liu & Carter, 2000). It has been recognized that the soil formation restrains the deformation of natural clays under efficient vertical stress up to the consolidation yield stress, as a result generating low compressibility of clays pending when the stress level go beyond the consolidation yield stress (e.g. Butterfield, 1979; Holtz et al., 1986; Burland, 1990). The dissimilarity of void ratio between natural clays and reconstituted clays at the same stress level frequently increases with increasing consolidation stress up to the consolidation yield stress, but reduces when there is an application of stress level that is larger than the consolidation yield stress (e.g. Liu & Carter, 1999; Hong & Tsuchida, 1999; Liu & Carter, 2000). Leroueil et al. (1985) there are classified compressive behaviour of natural clays into two states: the intact state as it occurs in natural deposits; and the destructured state referring to the breakdown of the original clay structure when submitted to volumetric or shear deformations. The previous is interrelated to elastic deformation while the latter is connected to elasto-plastic deformation (Shun et al 2012). The main parameters affecting the compressibility of natural clays in the destructured state are not well understood. It should be well-known that the void ratio or the water content at the consolidation yield stress for natural clays is different from that of reconstituted clays. Consequently, the dissimilarity in compressive behaviour between destructured natural clays and the reconstituted clays may not be directly attributed to soil formation lacking considered effect of the starting state on compressibility. As a result, several question arise: 1) what is the basic instrument accountable for the compressive behaviour of natural clays at the destructured state defined by Leroueil et al. (1985), i.e., when the stress level is greater than the consolidation yield stress? 2) How does the soil structure of natural clays degrade with increasing stress when the stress level reaches and exceeds the consolidation yield stress? 3) What is the fundamental mechanism which causes the difference in compressibility between natural clays and reconstituted clays? With these questions in mind, changes in compressibility are first discussed in this paper based on oedometer test data for reconstituted clays having different initial water contents and different liquid limits, in an attempt to clarify the fundamental mechanism responsible for the compressive behaviour of reconstituted clays (Shun et al 2012).

2. Theoretical background

Assessment formation on compressibility parameter for undisturbed soil applying soil properties such as water content, liquid limit and void ratio is possible to be done. This relationship can also be useful for examination of quality control which it requirements is easy and faster in its ways. Compressibility index of gravel soil from field and then to be tested at laboratory will be compared with developed model equations generated. The ability of soils to withstand loading are at variance depend on the soil types. Normally, fine-grained soils have a comparatively smaller capability in comportment of load than the coarser grained soil. Hence, fine grained soils therefore have a greater degree of compressibility. Principal compressibility result of the soil can be assessed by laboratories examinations from samples, it has been observed there are time consuming and costly. Assessment of the Compression Index applying the physical properties of the soil is fast and easy. Some researchers present a linear correlation between Cc value and physical soil properties in such water content, including liquid limit and void ratio. In this concept mathematical modelling method is used to compare with the physical properties of gravel soil to obtain void ratio rate from compressibility influences. Such comparative of both predictive and experimental values are influenced by compressibility of gravel formation, more so it can also be attributed to dependent variable in water content, liquid limit respectively which were not considered as an independent variables is presented in the study. Analytical model solutions through mathematical equations were developed to monitor the rate of compressibility influences on pore distribution in gravel formations (Slamet and Abdelazim 2012).

3 Governing equation

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

The expression in equation [1] is the governing equation that should model degree of void ratio through soil compressibility, there are lots of geotechnical properties that are normally considered in the deposition, but most significant parameters were integrated into the system to generate the governing equation for the study, variations of void percentage in gravel formation may not have been thoroughly express, but the developed concept will definitely predict the rate of void percentage in gravel formation under the influences of soil compressibility.

Nomenclature

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

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

$$K\phi\, T^1 Z = D_v\, TX^1 + V_{(x)}\, TX^1 \qquad \text{.................................} \qquad (2)$$

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

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

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

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

This implies that equations (4), (5), (6) and (7) can be written as:

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

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

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

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

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

$$\frac{\tau^2}{K\phi} + c_1 \qquad \text{................................} \qquad (12)$$

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

Due to fluid deposition between the pore distribution of the soil, there are the tendency of fluid velocity with respect to time considered, therefore the parameter time were part of the system that formulated the governing equation, the flow of fluid will definitely related with permeability and porosity of the soil formation, the development of pore distribution in gravel formation with respect to time in fluid deposition were found significant as it expressed in the generated model for time.

From (8)

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

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

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

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

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

Combining (17) and (18), we have

$$C, TX = TX$$

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

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

The behaviour of void in compressibility of soil has been thorough express through these applications, the derived solution were able to express significant variable in the system that develop compressibility of soil influences on void ratio in gravel formation, the express derived solution were able to considered several phase of soil deposition under geotechnical properties for the study, these concept will definitely predict the degrees of void ratio in any construction activities under any influences.

4. Conclusion

The behaviour of the system has definitely express the level of influences compressibility can pressure the deposition of void percentage in the study area, such dimension were thoroughly expressed in various conditions on the derived solution to develop the model. The derived model were able to integrate time of fluid since the intercedes of the formation will always express fluid in the soil, experts in soil engineering are conversant with experimental values from previous derived formulas, but this approach will definitely predict void similar to experimental values in any deltaic location, the study is imperative because experts will use this concept as another easier tools in generating pore distribution percentage for soil engineering practise

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