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Analysis of bulk density on heterogeneous sandy and silty clay deposition in deltaic environment

Abstract

This paper monitors the variation of bulk density in predominant sandy and silty clay soil in deltaic environment. The behavior of this geotechnical property expresses the degree of soil compaction at different depth of these two formation, monitoring and evaluation was carried through experimental investigations at different location at 5m deep, the results generated values that express fluctuation from graphical representation, these were between shallow depth of five meters deep, the fluctuation of these values from these ten location show the refection of soil heterogeneity in the deltaic environment. The application of these results can be applied in geotechnical or highway design and construction of flexible pavement.

Keywords: analysis, bulk density, heterogeneous sand, silty clay

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Introduction

The accuracy of soil water content measurement using time-domain reflectometry (TDR) depends on:

a. The accuracy of time delay measurement.

b. The calibration used to convert measured time delay to volumetric soil water content.

Many techniques have been developed to improve the accuracy of time delay measurement. For example, the switching diode technique has been employed to obtain an unambiguous time mark in the Moisture Point TDR soil moisture instrument.[1–6] Meanwhile, several calibration equations have been developed to explore the relationship between time delay and volumetric soil water[7–13] developed a well-known 'Universal' empirical calibration equation between apparent dielectric permittivity Ka and volumetric water content v. This universal calibration has been validated by numerous reports for two decades, when it is applied to general soil conditions. However, with the increase of resolution and accuracy of time delay measurement a discrepancy between[7–9] universal calibration and experimental results has been reported when the universal relationship of Kaversus was applied to soil with high clay content and salinity.[14–18] The apparent dielectric constant Ka of a material is determined by measuring the propagating time (time delay) of an electromagnetic (EM) wave in that material.[19–24] In practice, an EM wave is sent through the material of interest along a transmission line (probe) buried in it (Table 1), and the EM wave is reflected back at the end of the transmission line. The round-trip time T is then measured. According to Maxwell's equation (Table 2), the velocity v of an EM wave propagating in a material medium with apparent dielectric permittivity Ka can be calculated.[25–29]

Table 1 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000kg/m³
0.2	2.54
0.4	2.52
0.8	2.54
1	2.58
1.2	2.61
1.4	2.61
1.6	2.61
1.8	2.62
2	2.64
2.5	2.66
3	2.7
4	2.68
5	2.68

Table 2 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000kg/m³
0.2	2.5
0.4	2.53
0.8	2.54
1	2.56
1.2	2.57
1.4	2.62
1.6	2.65
1.8	2.68
2	2.74
2.5	2.67
3	2.72
4	2.62
5	2.63

Materials and method

Natural sample of sandy and silty clay was obtained manually from various locations at a depth of about 1-5m (Table 3). The collected and manufactured soil was subjected to laboratory tests in order to determine its base on of the geotechnical properties (Table 4). The test conducted was bulk density, the standard application of determining bulk density was carried out. These tests were conducted based on B.S 1377-1990 (Table 5).

Table 3 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000kg/m³
0.2	2.52
0.4	2.53
0.8	2.53
1	2.55
1.2	2.56
1.4	2.57
1.6	2.59
1.8	2.6
2	2.6
2.5	2.61
3	2.62
4	2.63
5	2.64

Table 4 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000kg/m³
0.2	2.71
0.4	2.7
0.8	2.68
1	2.66
1.2	2.57
1.4	2.58
1.6	2.1
1.8	2.11
2	2.11
2.5	2.62
3	2.63
4	2.64
5	2.65

Table 5 Bulk density of the soil at different depth

Table Continued..

Depth meter (mm)	Bulk density 1000kg/m³
0.2	2.51
0.4	2.5
0.8	2.52
1	2.52
1.2	2.53
1.4	2.55
1.6	2.56
1.8	2.57
2	2.54
2.5	2.54
3	2.54
4	2.63
5	2.64

Results and discussion

Results and discussion are presented in tables including graphical representation for bulk Density stated below (Table 6). The study has express thoroughly the behavior of soil in terms of bulk density;[30–32] such characteristic was investigated to determine various (Table 7) degree of soil compaction at different lithology, Figure 1 developed vacillation from 1-5m were the optimum bulk density were observed at 3m and constantly maintain linear bulk density between 4-5m. Figure 2 developed oscillation but the optimum values was recorded at 2.5m and suddenly observed slight decrease in fluctuation form between 3-5m. (Figure 3) developed fluctuations between 1.1.5m thus experiences sudden increase between 2 and 3m and gradually increase to the optimum level at 5m. Figure 4 experienced sudden decrease (Table 8) and finally maintained linear increase between 3-5m. Figure 5 express vacillation between 1-5m, but developed optimum values recorded at 5m. Figure 6 in similar condition developed fluctuation where the optimum values were recorded at 3.5m and suddenly vacillate again between 4-5m. (Figure 7) maintained similar condition by fluctuation from 1-5m (Table 9) where the optimum values were recorded at 5m. (Figure 8) experienced slight vacillation between 1-2m and suddenly increase to optimum level recorded at 5m. (Figure 9) observed sudden increase between 1-1.5m (Table 10) and suddenly decrease with increase in depth, the developed gradual increase between 3-5m. (Figure 10) developed fluctuation from 1-5m and experience the optimum values recorded at 5m.

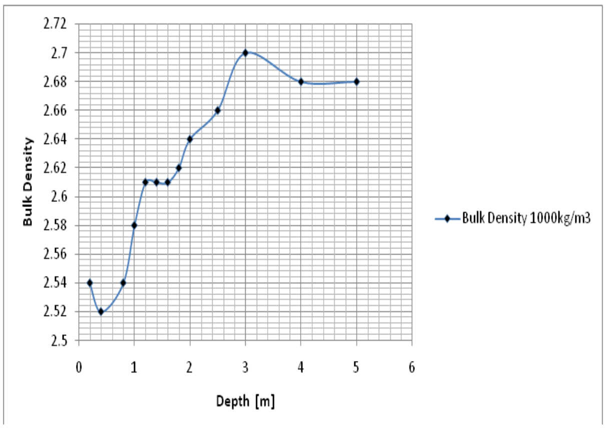

Figure 1 Bulk density of the soil at different depth.

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Table 6 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000Kg/m^3
0.2	2.54
0.4	2.52
0.8	2.54
1	2.58
1.2	2.61
1.4	2.61
1.6	2.61
1.8	2.62
2	2.64
2.5	2.66
3	2.73
4	2.68
5	2.68

Table 7 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000Kg/m^3
0.2	2.5
0.4	2.51
0.8	2.54
1	2.56
1.2	2.57
1.4	2.61
1.6	2.57
1.8	2.55
2	2.61
2.5	2.67
3	2.69
4	2.65
5	2.71

Table 8 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000Kg/m^3
0.2	2.52
0.4	2.53
0.8	2.53
1	2.55
1.2	2.56
1.4	2.57
1.6	2.59
1.8	2.6
2	2.6
2.5	2.61
3	2.62
4	2.63
5	2.64

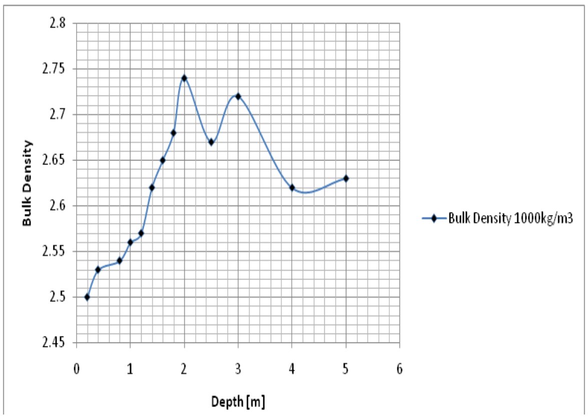

Figure 2 Bulk density of the soil at different depth.

Table 9 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000Kg/m^3
0.2	2.71
0.4	2.7
0.8	2.68
1	2.66
1.2	2.61
1.4	2.58
1.6	2.6
1.8	2.61
2	2.61
2.5	2.62
3	2.63
4	2.64
5	2.65

Table 10 Bulk density of the soil at different depth

Depth meter (mm)	Bulk density 1000Kg/m^3
0.2	2.51
0.4	2.5
0.8	2.52
1	2.52
1.2	2.53
1.4	2.55
1.6	2.55
1.8	2.56
2	2.57

Table Continued..

Depth meter (mm)	Bulk density 1000Kg/m³
2.5	2.54
3	2.54
4	2.54
5	2.58

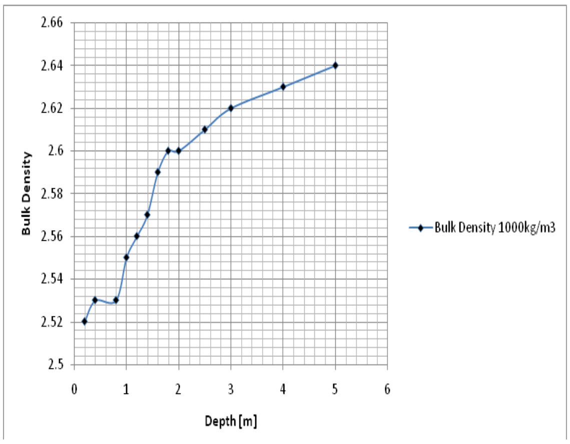

Figure 3 Bulk density of the soil at different depth.

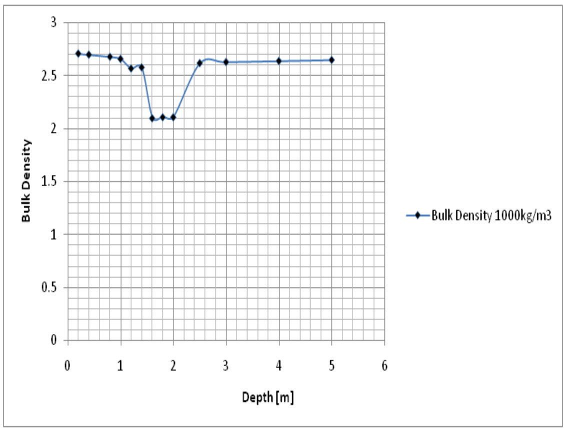

Figure 4 Bulk density of the soil at different depth.

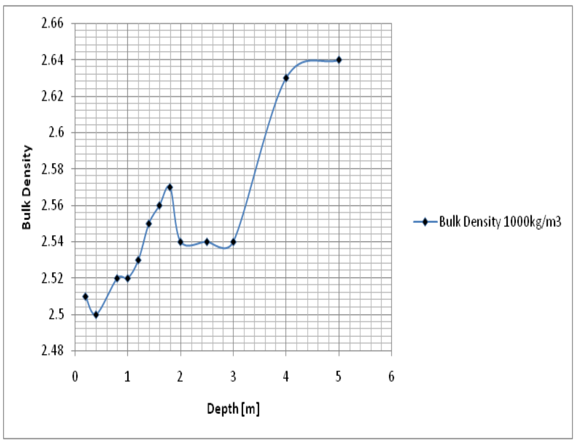

Figure 5 Bulk density of the soil at different depth.

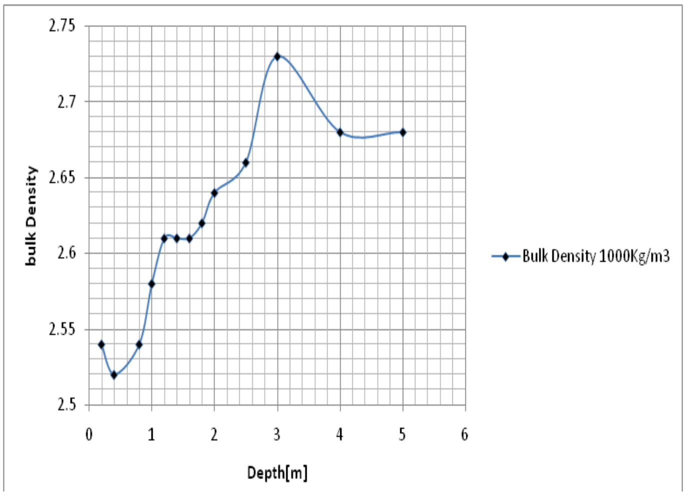

Figure 6 Bulk density of the soil at different depth.

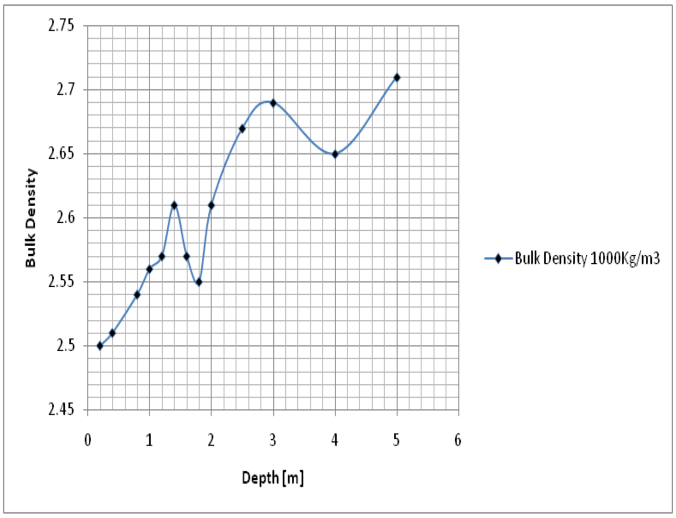

Figure 7 Bulk density of the soil at different depth.

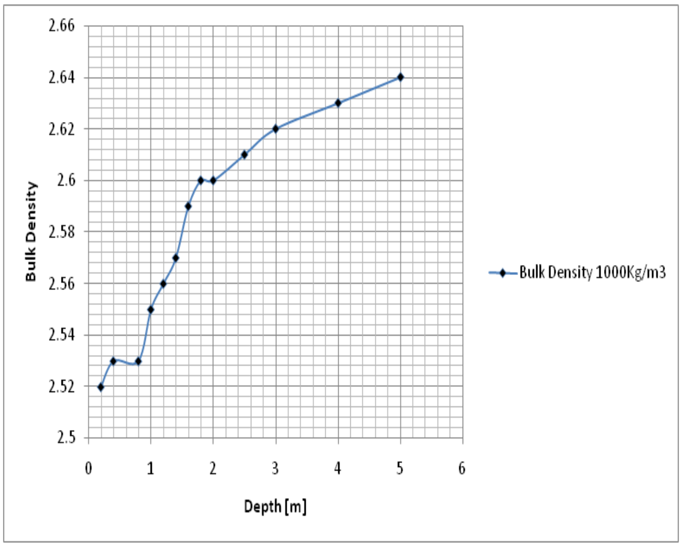

Figure 8 Bulk density of the soil at different depth.

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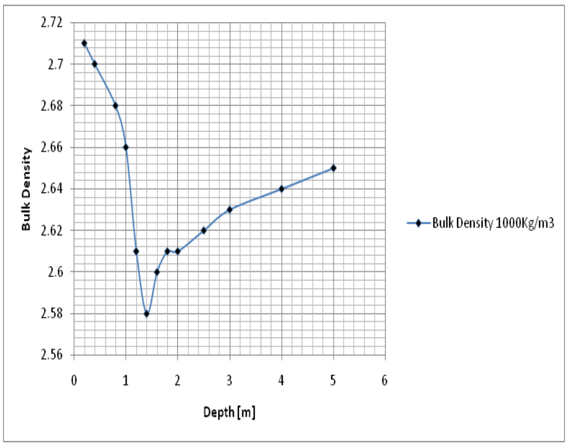

Figure 9 Bulk density of the soil at different depth.

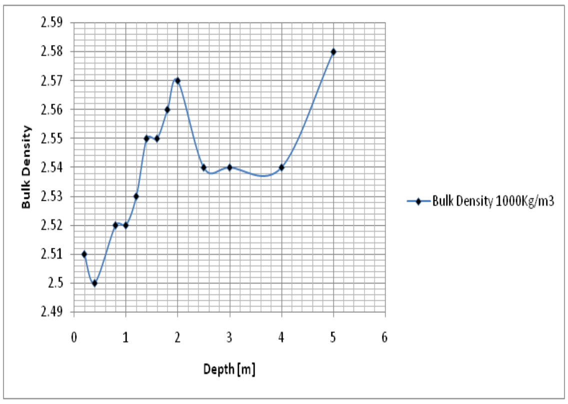

Figure 10 Bulk density of the soil at different depth.

Conclusion

The study has thorough express the variation in the formation at the deltaic environment, the predominance of deltaic deposition developed heterogeneity on bulk density of the soil, the deposition of the soil are predominantly influenced by the rate of density at different depth, this was done to determine bulk density of sandy and silty clay, it normally done for thorough geotechnical or high way purpose, base on these geotechnical properties of compaction, bulk density are thoroughly analyzed, monitoring the degree of compaction, is imperative for these two purpose due to the variation of bulk density within these predominant formation in deltaic environment. It also including its rate of compaction that has been expressed, the results will be applied for thorough engineering design and construction for geotechnical and high way road design.

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None.

Conflict of interest

The author declares no conflict of interest.

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