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# EFFECT OF MOISTURE CONTENT ON CALIFONIA BEARING RATIO (CBR) OF LATERITIC SOIL

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## ABSTRACT

*This research investigates the effect of moisture content on California bearing ratio (CBR) of lateritic soil using optimum moisture content and varying moisture content method of conducting CBR test. The evaluation includes index properties of soil, compaction and California bearing ratio test. The lateritic soil was classified as A-7-6 according to*

## Introduction

As viewed by engineers, soil includes earth materials, which can be organic and inorganic extending over the rock crust. (Murthy,2009). Laterites are very rich in iron (Fe) and aluminum (Al), they are found in tropical and subtropical region where climate is wet. They develop as a result of long-lasting weathering of parent rock. Nearly all occurring laterites are rusty red in colour because of iron oxide minerals goethite, $HFeO_2$; lepidocrocite, FeO(OH); and hematite, $Fe_2O_3$(Aleva, 1994). The relationship between density, moisture content, and compaction energy can be predicted from the compaction curve results. When the water content is increased their will be a relative change in the structure of the soil with respect to compaction process, and a corresponding increase in dry density with compaction efforts.

*AASHTO classification. The compaction characteristics were carried out using British standard light, (BSL), West African standard (WAS), and Modified (ASSHTO) compactive efforts to determine the optimum moisture content (OMC) and maximum dry density (MDD) of the lateritic soil samples which was then use to obtain the corresponding CBR value based on optimum moisture content method. From the study, useful data were obtained showing that the CBR characteristic of each method varies with moisture content, with the OMC method exhibiting lower CBR value of 26% while that of varying moisture content with a value of 86% indicating an increase of 60% in CBR value.*

Keywords— California bearing ratio, compaction, lateritic soil, Optimum moisture content, Soil

(Arifin *et a,* 2018). Laboratory experiments conducted on three different Soil samples in Shanxi province to study the CBR characteristic, reviled that the moisture content has great effect on the CBR value. (Wu Xirong, 2014)

## Materials and Methods

### Materials

### Soil

The soil sample used in performing the laboratory test was lateritic soil, which was obtained from Mai-kunkele borrow pit, along minna-kunkele road, geographical coordinate are latitude 9°37' and longitude 6°33' east, central Nigeria. The soil sample collected in this zone was brownish and reddish in colour.

### Water

The water used for this research study was obtained directly from Gidan Kwano campus of Federal University of Technology Minna borehole.

### METHOD

The lateritic soil samples moulded at varying moisture content and at optimum moisture content to its practor density was tested for its California bearing ratio (CBR) strength. The process constitutes the determination of the practor density and OMC for each of the prepared

sample. The laboratory tests carried out were in accordance with British Standard institute (1990a) and Nigeria General specification (1997).

## Results and Discussion

### Index property of soil

The geotechnical index properties of the laterite are shown in table 1. The lateritic soil is classified as A-7-6 according to AASHTO [11] soil classification system.

Table 1 index property of natural lateritic soil

| Properties | Quantities |
|---|---|
| **Natural moisture content (%)** | Soil sample completely dried |
| **Percent passing B.S sieve NO. 200** | 52 |
| **Liquid limit (%)** | 48 |
| **Plastic limit (%)** | 24 |
| **Plasticity index (%)** | 24 |
| **Group index** | A-7-6 (9) |
| **AASHTO classification** | A-7-6 |
| **Specific gravity** | 2.61 |
| **colour** | Reddish-Brownish |

### Compaction characteristics

Three different methods are used to carry out the compaction of the laterite namely: standard light (BSL), west African standard (WAS) and modified (AASHTO). With each done three times and the average optimum moisture content and maximum dry density determined.

### British standard light (BSL) Method

The compaction test results based on BSL is shown in table 2 below. The optimum moisture content (OMC) ranges from 20.0% - 20.10% and maximum dry density (MDD) ranges from 1.70g/cm$^3$. Therefore, average OMC is calculated to be 20% and average MDD calculated to be 1.70g/cm$^3$.

Table 2 summary of MDD and OMC

| Numbers of trials | MDD (g/cm$^3$) | OMC (%) |
|---|---|---|
| **1** | 1.70 | 20.1 |
| **2** | 1.71 | 20.0 |
| **3** | 1.71 | 20.0 |
| **Average** | 1.70 | 20.0 |

**West African standard (WAS) method**

The compaction test result are shown in table 3 below. The optimum moisture content (OMC) ranges from 18.0% - 19.0% and maximum dry density (MDD) ranges from 1.81g/cm$^3$ – 1.83g/cm$^3$. Therefore, average OMC is calculated to be 19.0% and average MDD calculated to be 1.82g/cm$^3$.

Table 3 summary of MDD and OMC

| Number of trials | MDD(g/cm$^3$) | OMC (%) |
|---|---|---|
| **1** | 1.83 | 18.0 |
| **2** | 1.83 | 19.0 |
| **3** | 1.81 | 19.0 |
| **Average** | 1.82 | 19.0 |

**Modified (ASSHTO) method**

The compaction test result are shown in table 4 below. The optimum moisture content (OMC) ranges from 17.0% - 18.0% and maximum dry density (MDD) ranges from 1.82g/cm$^3$ – 1.87g/cm$^3$. Therefore, average OMC is calculated to be 18.0% and average MDD calculated to be 1.87g/cm$^3$.

Table 4 summary of MDD and OMC

| Number of trials | MDD(g/cm$^3$) | OMC (%) |
|---|---|---|
| **1** | 1.87 | 17.0 |
| **2** | 1.88 | 17.0 |
| **3** | 1.86 | 19.0 |
| **Average** | 1.87 | 19.8 |

**California bearing ratio test (CBR)**

The CBR test conducted was of two basic methods; in the first method the lateritic soil is compacted using three different compactive efforts based on British standard (BS), West African standard (WAS) and Modified AASHTO to obtain the CBR value of the soil sample which is based strictly on the average OMC from the compaction test conducted. The second method is based on varying of the water content without considering the OMC from the compaction test conducted. From these five (5) CBR values are calculated with their corresponding moisture content.

**California Bearing Ratio (CBR) based on OMC**

Table 5 below shows the CBR values of three different compactive efforts with relation to their average OMC from the compaction test conducted.

Table 5 summary of calculated CBR values

| | BSL | | WAS | | AASHTO | |
|---|---|---|---|---|---|---|
| **Penetration** | TOP | BOTTOM | TOP | BOTTOM | TOP | BOTTOM |
| **CBR at 2.5mm** | 20 | 24 | 8 | 12 | 19 | 23 |
| **CBR at 5mm** | 24 | 26 | 11 | 13 | 22 | 24 |
| **CBR (%)** | 26 | | 13 | | 24 | |

**CBR based on varying moisture content**

The result of the CBR test conducted is shown on table 6 below, while the graph of OMC against CBR is shown on figure 1. Table 6 shows the CBR value of the lateritic soil with varying moisture content based on BS method. From the graph the maximum CBR is 86% with moisture content 10.0%.

Table 6 summary of calculated CBR values

| Penetration | TOP | BOTTOM | TOP | BOTTOM | TOP | BOTTOM | TOP | BOTTOM | TOP | BOTTOM |
|---|---|---|---|---|---|---|---|---|---|---|
| CBR at 2.5mm | 21 | 24 | 56 | 77 | 76 | 23 | 30 | 72 | 7 | 7 |
| CBR at 5mm | 31 | 19 | 61 | 84 | 61 | 24 | 42 | 63 | 9 | 7 |
| CBR (%) | 31 | | 61 | | 84 | | 72 | | 9 | |
| MC (%) | 6.35 | | 8.29 | | 9.92 | | 12.08 | | 15.54 | |

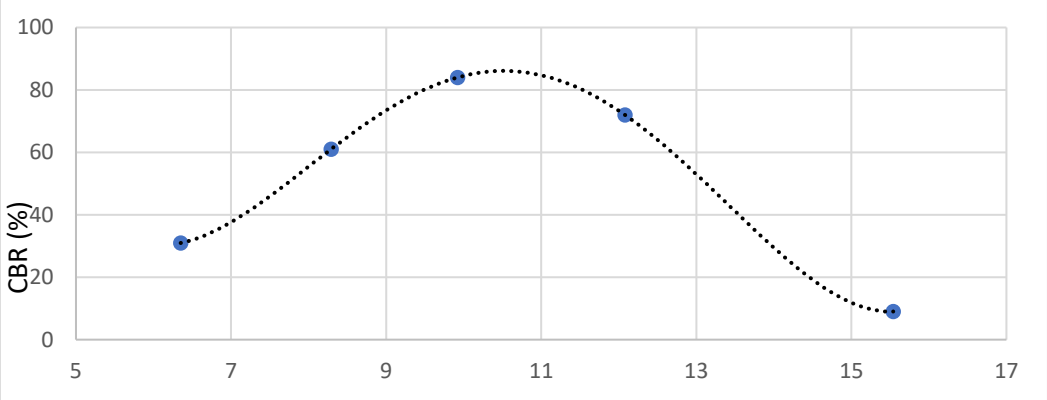


Figure 1 Graph of MC against CBR

**Conclusion**

The lateritic soil is classified as A-7-6 according to AASHTO soil classification system, from the result of the index properties.



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The result of the CBR test conducted based on BSL method carried out on the lateritic soil with respect to its average optimum moisture content was determined to be 26% while that based on varying of moisture content was determined to be 86%. This result shows that varying of the moisture content and conducting CBR test directly yields a higher CBR value than when carrying out compaction to determine the OMC before conducting CBR test, a 60% increase of CBR value was obtained when varying moisture content method is used.

The result also shows that the moisture content that gives the highest CBR value of 86% is 10% based on varying moisture content while OMC of 20% average is used to achieve CBR value of 26%, this result shows that moisture content below the optimum moisture gives a higher CBR value.

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