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COMPACTION BEHAVIOUR OF LATERITIC SOILS TREATED WITH SAW DUST ASH AND CEMENT

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ABSTRACT : *Recently the world is facing the challenge of utilizing Industrialized/Agricultural waste and also on how to minimize the negative effect of carbon dioxide to the ozone layer. Sawdust ash being among the waste product generated industrially, need to be utilize due to how it appears in open areas or landfills which is environmental unfriendly. This study have looked at the effect of sawdust ash on compaction behaviour of soil by mixing it with cement. The compaction test carried out was in compliance with the British standard, adopting British Standard Light and British Standard Heavy. From the compaction test conducted it was observe that upon addition of sawdust ash content to soil/cement mixture at different percentage, 0, 3, 6, and 9% for cement and 0, 2, 4, 6, 8, and 10% for sawdust ash, the Maximum dry density MDD increases from 1.42Mg/m 3 and 1.53 Mg/m 3 for the natural soil to 1.54Mg/m 3 and 1.64Mg/m 3 at 6% cement / 6% sawdust ash content while the Optimum moisture content OMC decreases from 26% and 23% for the natural soil to 16% and 14% at 6% cement / sawdust ash content. However, the trend can be of advantage in construction involving wet soil, since there is less need for soil to be dry prior to compaction.*

KEYWORDS *Sawdust ash, British Standard Light, British Standard Heavy, Maximum dry density and Optimum Moisture Content*

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I. INTRODUCTION

Lateritic soil is the most abundant soil encountered during any engineering construction work, sometimes this soil tends to be more troublesome or problematic during construction process, as such may require treatment with any of the industrialize stabilizing agent depending on the type of construction work (Asger Bhojiya Et al, 2022)

The worldwide production of cement is excessively high because of its more utilization in concrete. More than 5 billion tones cement is created every year (Ahmed et al., 2018), (Dauda Et al 2022.) . Be that as it may, the manufacturing of cement is lessening the limestone caves on the earth and furthermore requires an incredible utilization of vitality. There is a requirement for moderate structure materials in giving satisfactory outcomes. In this manner, there is the need to look for nearby materials as options for the development of useful however minimal effort structures in both the rustic and urban zones (Malik et al., 2015). The consistent wastage from industries and residue from farming work makes intensive issues on environmental conditions (Kashyap et al., 2005). When these materials have properties of pozzolana, this will be the advantage of resulting by partial replacement with cement in concrete production (Ganesah 2004). In India the scientist and researchers are still processing with find out the best affordable solution, so different attempts are done on small replacement with fly ash, rice husk ash and sawdust ash.

The waste from sawing and milling of wood results as sawdust, the sawmills eventually located in every town of the country, the sawing is a continue daily based process which produce a lot of wastage, after burning this material the residue called as sawdust ash. The utilization of wood-fuel for generating energy is the ultimate solution for problems connected to wood waste. However, the thermal combustion generally reduces the mass and the volume of the wood waste but it yields an inheritance problem that is formation wood ash (Sawdust ash)(Cheah and Ramli, 2011a). In the USA alone, about 3 million tons of wood ash are produced annually (Cheah and Ramli, 2013). Usually, timber industries have its own small-scale boiler units which employ generated wood waste in the unit itself as fuel for heat energy production regarding other processes like drying the finished products(Cheah and Ramli, 201b). Moreover, it was detected that wood ash produced by timber manufacturing industries is not handled properly, which may cause serious environmental and health problems(Cheah and Ramli, 2011b).

Due to lack of efficient disposal systems, saw dust waste presently constitutes environmental problems. Fapohunda et al. (2018) did a comprehensive review on SDA and other wood products, highlighting their properties and application potentials for construction purposes in built environment. Particularly, the review showed that the sum of SiO 2 + Al 2 O 3 + Fe 2 O 3 of SDA in the review was above 50%, indicating a cementitious pozzolanic traits of Classes C and N, and thus, a potential material for cement replacement.

II. MATERIALS AND METHODS

A. MATERIALS

The materials used for this research are lateritic soil, Ordinary Portland Cement, and Sawdust Ash (SDA)

a. Natural soil

Lateritic soil samples were collected from a burrow pit located along Bauchi-Gombe Road in (Inkil town), Bauchi Local Government Area of Bauchi state, Nigeria, through the disturbed method of sampling. It was collected at a depth between 0.5-1.0m. the collected samples were then sealed in large to medium-sized bags and thereafter transported to the laboratory.

b. Sawdust ash

The Saw dust was collected from local Saw mill in Industrial area, Gwamaja Yan Katako Dala, Kano State as shown in plate 1. After collection, clean saw dust not having much bark and so not much organic content was air dried and burnt in a muffler furnace at a temperature of 500 ^{0} C, as shown in plate 2 and 3. Then, it was stored in an air tight container to prevent moisture loss and any form of contamination.The chemical composition of sawdust ashes (SDA), differs with various types of wood, but they predominantly comprise silica, alumina and lime (Chodhury et al., 2015. The chemical composition of sawdust used is mainly silica, alumina, and lime besides other oxides with less proportions.

Plate 1: Dried Sawdust

Plate 2: Burning of Sawdust in Muffler Furnace

Plate 3: Sawdust Ash

c. Cement

The ordinary Portland cement (OPC) used for the study was purchased from an open market at Sharada, Kano State.

B. METHODS

The specimens were compacted using the compactive effort adopting British standard light and British standard heavy (BSL and BSH Compactive energy effort), as shown in plate 4. The BSL compactive effort was deduced from a rammer of size 2.5kg, released from a height of about 300mm, on to 3 layers in a 1000cm 3 British mould were each individual layer received 27blows. Whilst, the BSH effort was deduced from 4.5kg rammer released from a height of about 450mm on to 5layers in a 1000cm 3 British cylindrical mould, were each individual layer received 27blows.

Plate 4: Compaction Test

III. RESULTS AND DISCUSSION

A. COMPACTION CHARACTERISTICS

a. Maximum dry density

The variation of maximum dry densities (MDD) of soil-cement mixtures with sawdust ash content for the two compactive efforts adopted for the research; BSL and BSH respectively, are presented in Figs.4.1a-b.

It was observed that MDD increased with higher cement and sawdust ash contents for the two energy levels considered. Maximum dry density values increased from 1.42 and 1.53 Mg/m 3 for the natural soil compacted with BSL and BSH energies, respectively, to 1.54 and 1.64 Mg/m 3 , respectively, at 6% cement/6% sawdust ash content. Similar results were reported by Phanikumar et al. (2004), Jadhao and Nagarnaik (2008) as well as Kumar and Puri (2013) and Muhammad et al., (2020).

The observed increase in MDD could be due to cement and sawdust ash that occupied the void within the soil matrix and in addition, the flocculation and agglomeration of the clay particle due to exchange of ions. This is in agreement with the findings reported by Osinubi, (1999; 2000), Moses (2008), Oriola and Moses (2010; 2011), as well as Osinubi and Oyelakin (2012). The increase in MDD could also be attributed to high specific gravity of the additives replacing the soil particles with lower specific gravity.

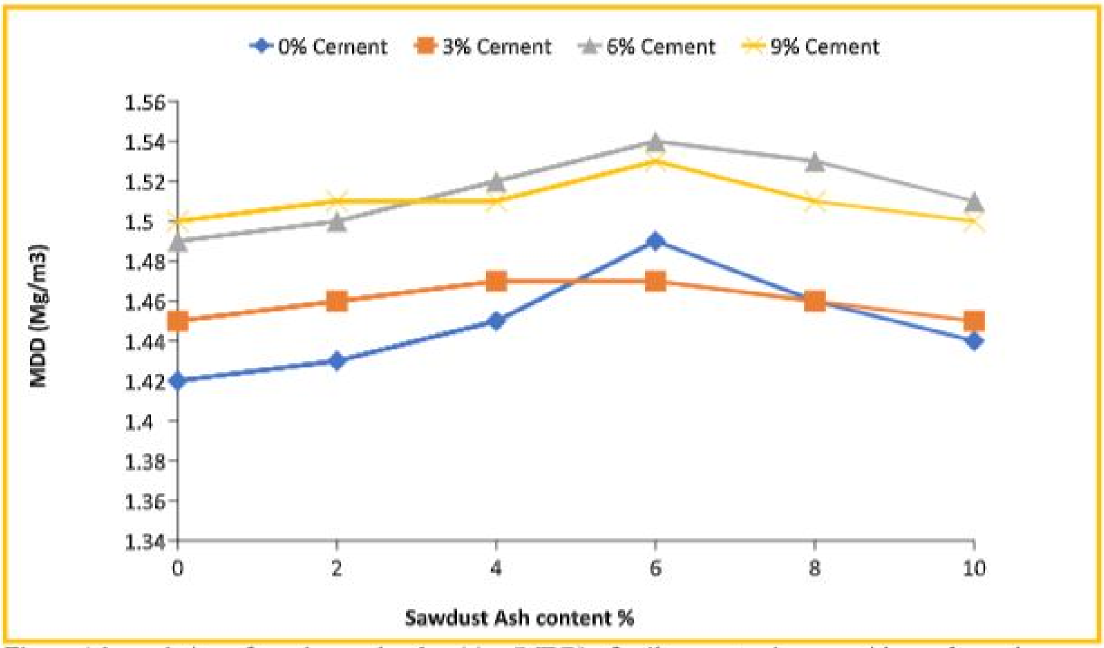

Fig. 4.1a: Variation of maximum dry densities (MDD) of soil-cement mixtures with sawdust ash content (BSL Compactive effort)

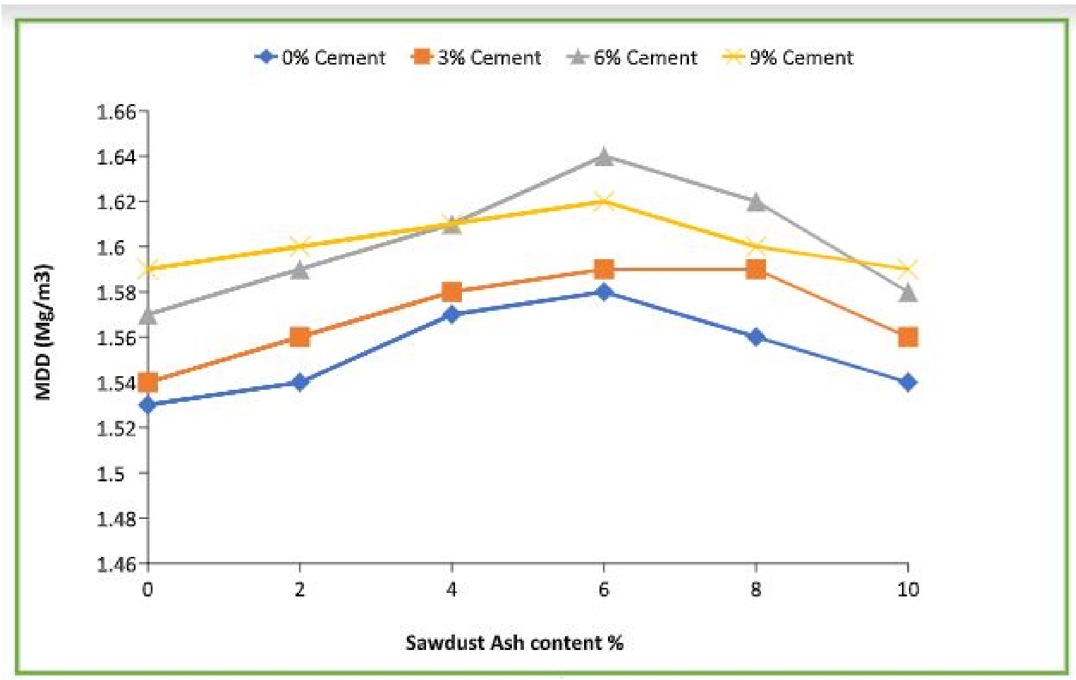

Fig. 4.1b: Variation of maximum dry densities (MDD) of soil-cement mixtures with sawdust ash content (BSH Compactive effort)

b. Optimum moisture content

The variation of optimum moisture content (OMC) of soil-cement mixture with SDA for BSL, and BSH compactions is shown in Figure. 4.2a-b. Optimum moisture content (OMC) values decreased from 26 and 23%

for the natural soil compacted with BSL and BSH energies, respectively, to a minimum value of 16 and 14% at 6% cement / 6 % sawdust ash contents, respectively.

It was observed that the OMC decreased with higher cement and sawdust ash contents for all the compactive efforts considered at 6% cement /6% sawdust ash content. This was probably due to self -desiccation of the mixture during which all the water was used, resulting in low hydration. When no water movement to or from soil-sawdust ash-cement matrix is permitted, the water is used up in the hydration until too little is left to saturate the solid surfaces and hence the relative humidity within the paste decreases (Osinubi, 2001; Moses et.al. 2012). The process described above might have affected the reaction mechanism of cement-sawdust ash stabilized lateritic soil. This is in conformity with the findings of Osinubi and Stephen (2007), Moses (2006), Oriola and Moses (2010; 2011) as well as Kumar and Puri(2013) and Muhammad et al., (2020).

The decreased in OMC was attributed to the absorption capacity of the additives due to their porous properties. The subsequent increase was as a result of the pozzolanic action of the additives and soil, which needs more water (Sarkar et al, 2012). An explanation that was offered for these trends is that there was increasing desire for water which commensurate with the higher amount of the additives because more water was required for the dissociation of admixtures with Ca 2+ and OH – ions to supply more Ca 2+ for the cation exchange reaction. Another reason could be due to the increasing surface area caused by the higher amount of the additives, which required more water for the lubrication of the entire matrix.

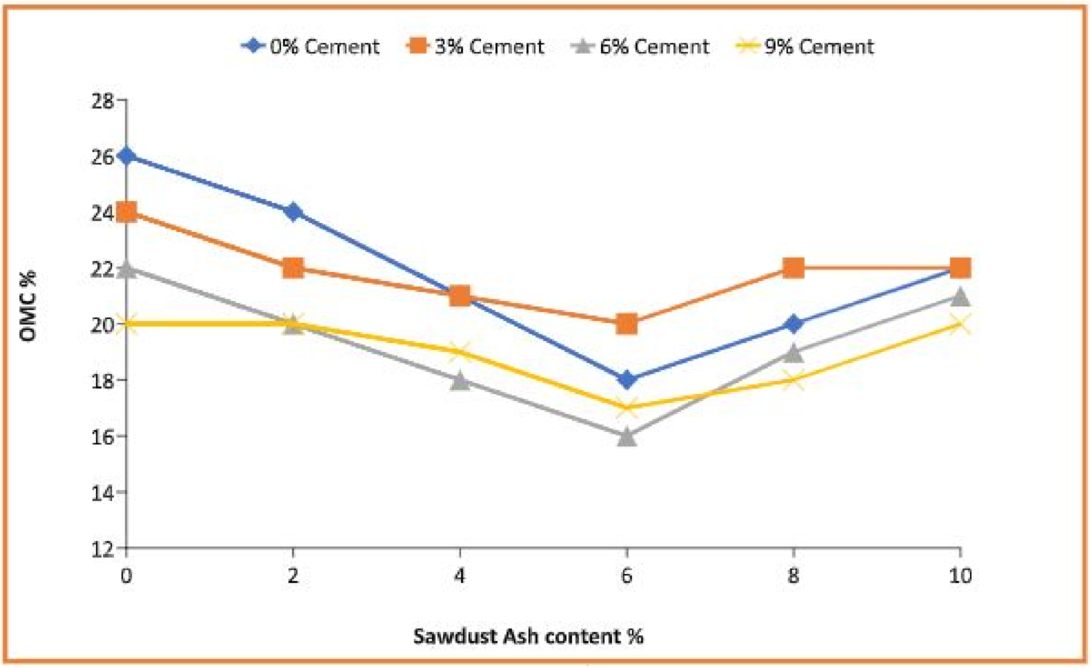

Fig. 4.2a: variation of optimum moisture content (OMC) of soil-cement mixture with SDA content (BSL Compactive effort)

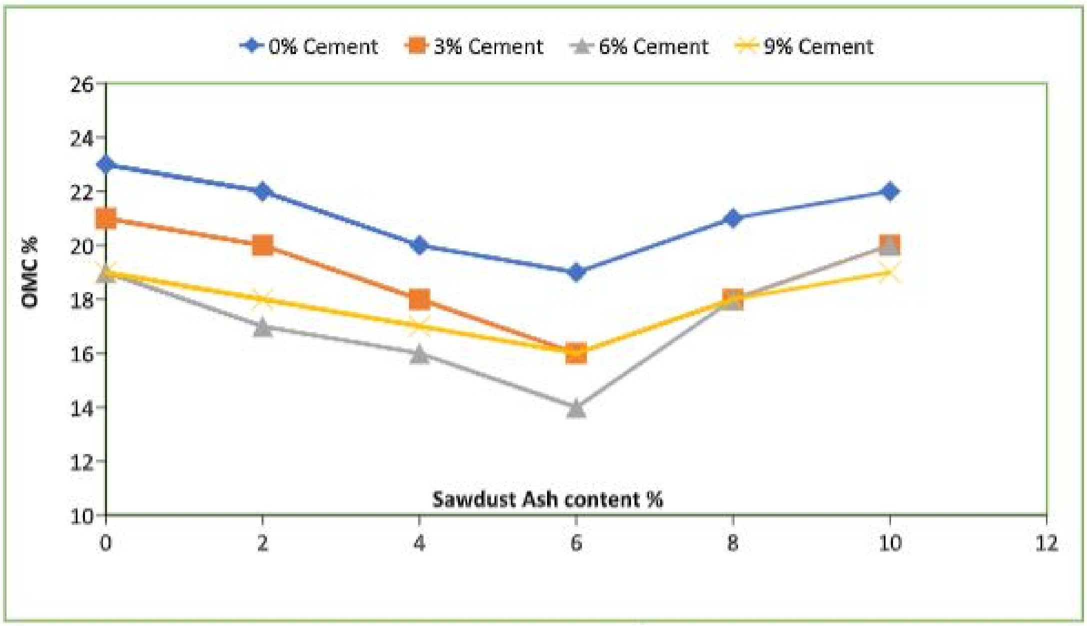

Fig. 4.2b: variation of optimum moisture content (OMC) of soil-cement mixture with SDA content (BSH Compactive effort)

IV. CONCLUSION

The compaction characteristics of the treated samples generally showed trends of increase in MDD and decrease in OMC, respectively, with higher sawdust ash content. The trend can be of advantage in construction involving wet soils, since there is less need for the soil to be dry prior to compaction. Despite the improvement in compaction behaviour for the treated soil, thus cannot be used as final judgement for soil stabilization. However, there is a need for other strength properties.

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