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Geotehnical Properties of Plastic Stabilized Lateritic Soil

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ABSTRACT: *Stabilization is the combination of soils and additives to change its properties and remain in its stable compacted state without undergoing any change under effect of exposure to weather and traffic. Soil stabilization through the reinforced soil construction is an efficient and reliable technique for improving the strength and stability of soils. The lateritic soil used in this study was taken along Papa-Ilaro road Ajegunle at Abalabi, Ogun State, Nigeria and the solid plastic wastes were taken from different locations in Ilaro. The plastics were grounded into pellets and substituted with laterite at 10%, 15%, 20%, 25% and 30% for compaction test and at 5%, 10%, 15%, 20%, 25% and 30% for California bearing ration (CBR) test. The tests conducted in line with BS 1377 (1990) are the specific gravity, compaction and CBR. From the results, it was also observed that plastic pellets reduce the bulk densities and dry densities in the same proportion as the percentage water content increases. From the results, it is hereby suggested that plastic pellets could be mixed with lateritic material around underground pipes to mitigate the effects of accidental explosions. Consequently, environmental risk and hazards caused by plastic wastes and accidental explosions could be greatly reduced.*

Keywords: *Plastic, Laterite, Stabilization, Cement, Strength, Compaction, Explosions*

I. BACKGROUND STUDY

Over the last three decades there has been increasing global concern over the public health impacts attributed to environmental pollution, in particular, the global burden of diseases (Kimani, 2007). The world Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occurs due to prolong exposure to environmental pollution. Most of these environmental-related diseases are however not easily detected and may be acquired during childhood and manifested later in the adulthood. Improper management of solid waste is one of the main causes of environmental pollution and degradation in many cities, especially in developing countries. Many of these cities lack solid waste regulation and proper disposal facilities, including harmful waste which may be infectious, toxic or radioactive. Municipal waste dumping sites are designated places set aside for waste disposal. Depending on a level of waste generated, such waste may be dumped in an uncontrolled manner or simply burnt. Plastics are inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties. The diversity of polymers and the versatility of their properties are used to make a vast array of products that brings medical and technological advances, energy savings and other numerous societal benefits. As a consequence, the production of plastics has increased substantially over 60 years from around 0.5 million tons in 1950 to over 260 million tons today. In Europe alone, according to European Public Health Alliance, (2009) the plastics industry has a turnover in excess of 300 million Euros and employs 1.6 million people (Plastics Europe, 2009). Out of all the plastic waste generated around the world, only 5 per cent is recycled while the remaining 95 per cent ends up in landfills, worse, as litter or in the oceans according to Carter, (1985). In line with the basic environmental edicts; reduce, reuse and recycle which is the main focus of this study. The specific objectives are to determine the moisture content of lateritic soil and plastic pellets, to determine the specific gravity of laterite and laterite mixed with plastic pellets, to determine the optimum moisture content and maximum dry density laterite and laterite stabilized with varying degrees of plastic pellets, to determine the bearing capacity of lateritic soil stabilized with plastic pellet using the California Bearing Ratio (CBR).

Stabilization is the combination of soils and additives in such a way the, when it is compacted under specified conditions and to specified extent, would undergo material change in its properties and would remain in its stable compacted state without undergoing any change under effect of exposure to weather and traffic. Stabilization could be mechanical, bituminous, chemical (cement, lime etc.) or a combination of two or more of these materials depending on the nature of deficiency observed in a particular lateritic soil. Soil stabilization involves the use of stabilizing agents (binder materials) in weak soils to improve its geotechnical properties such as compressibility, strength, permeability and durability (Olarewaju, 2013).

II. METHODOLOGY

The lateritic soil was taken along Papa-Ilaro road Ajegunle at Abalabi, Ogun State and the solid plastic wastes were taken from different locations in Ilaro. The plastics wastes (Figure 1a and b) were grounded into pellets and substituted with laterite at 10%, 15%, 20%, 25% and 30% for compaction test and 5%, 10%, 15%, 20%, 25% and 30% for California bearing ration (CBR) test. The tests were conducted in line with BS 1377 (1990) to determine the moisture content, specific gravity, compaction and CBR.

(a)

(b)

Figure 1: (a) Plastic Waste **(b)** Plastic Pellets

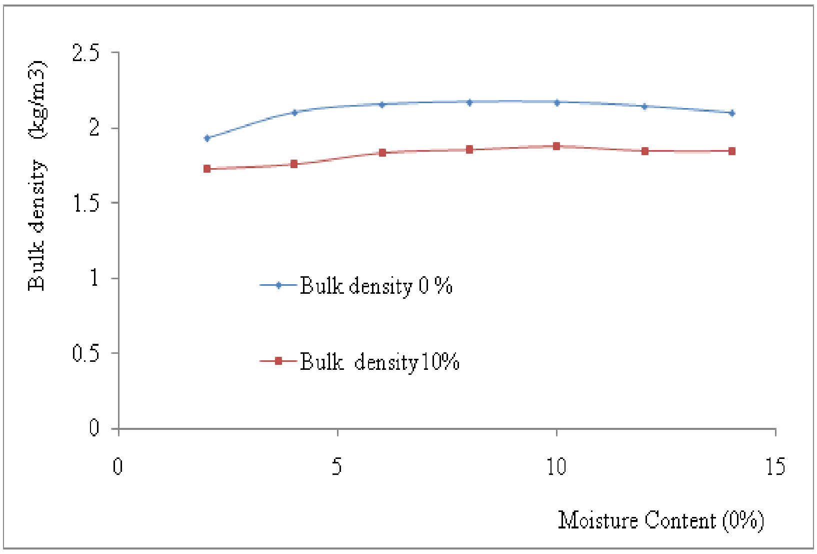
III. RESULTS AND DISCUSSION

The results of specific gravity for laterite and mixture of lateritic soil and plastic (0% to 10% and 100%) are presented in Table 1. In addition to this, the results of bulk density and dry density at varying percentage of plastic substitutions (10%, 15%, 20%, 25% and 30%) against percentage moisture content are graphically presented in Figures 2 to 6 (a and b) respectively. Finally, the results of highest CBR value of plastic against percentage water ratio are graphically presented in Figures 7. From the results shown in Figures 2 to 6 (a and b), increasing the amount of plastic pellets in the laterite reduces the bulk and dry densities. This could be attributed to the specific gravity of plastic pellets (Table 1) which is lower than that of laterite. Therefore, mixture of laterite and plastic pellets could be thought of as a material with low density whether loose or dense. In the works by Olarewaju et al. (2012), Olarewaju (2013) and (2015), in other to mitigate the effects of accidental explosions on underground structures (whether surface, underground or open trench accidental explosion) loose materials of low relative density such as tire-chips could be used. In the said works, loose sand and dense sand were tested by simulation. From the results of Humphrey et al. (1993), the compacted density of tire-chips ranges from 0.618 Mg/m^3 to 0.642 Mg/m^3 while Young's modulus of tire-chips ranges from 770 kPa to 1130 kPa. With the characteristics exhibited by lateritic soil mixed with 10% and above, especially at 30% plastic pellets mixed with lateritic soil could serve the same purpose of loose sand to cover underground structures like pipes as suggested by Olarewaju et al. (2012), Olarewaju (2013) and (2015). From the results of the highest CBR test (Figure 7), at a particular water ratio, the higher the dosage of plastic pellets, the higher the

CBR values. In addition to this, irrespective of the dosage of plastic pellets used, the higher the percentage water ratio used, the lower the CBR values. In other words, increasing the water reduces the strength of the laterite-plastic mixture. This is due to the fact that water acts as lubricant between the particles of laterite and plastic pellets.

Table 1: Results of specific gravity of plastic pellets mix with lateritic soil

% Plastic	Specific Gravity
0	2.64
1	2.14
2	1.99
3	1.96
4	1.93
5	1.86
6	1.78
7	1.61
8	1.49
9	1.42
10	1.38
100	0.99



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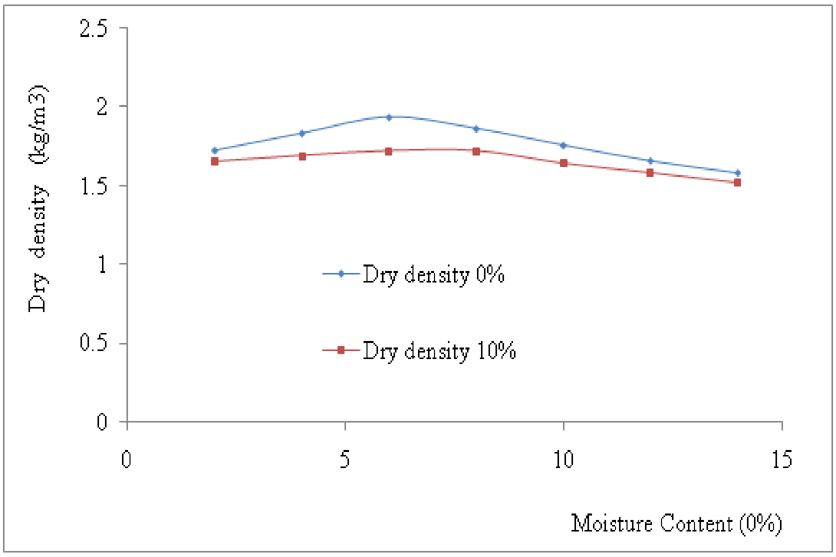
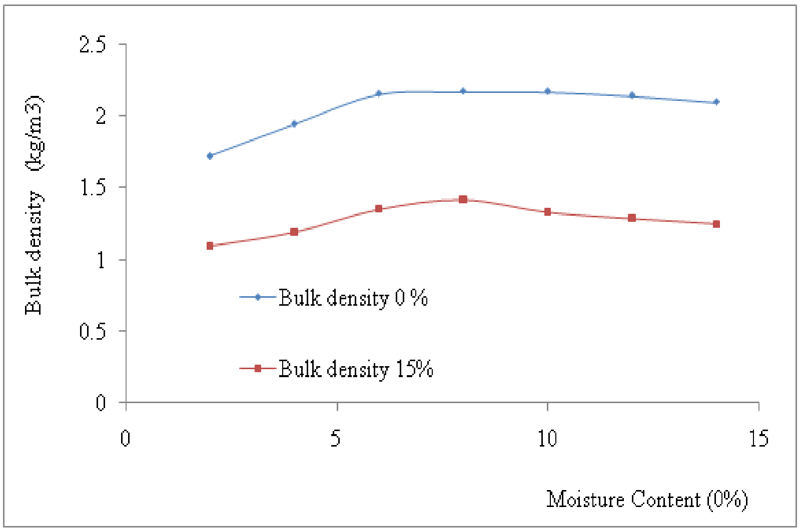


(b)

Figure 2: Results of **(a)** bulk density and **(b)** dry against moisture content (10%)



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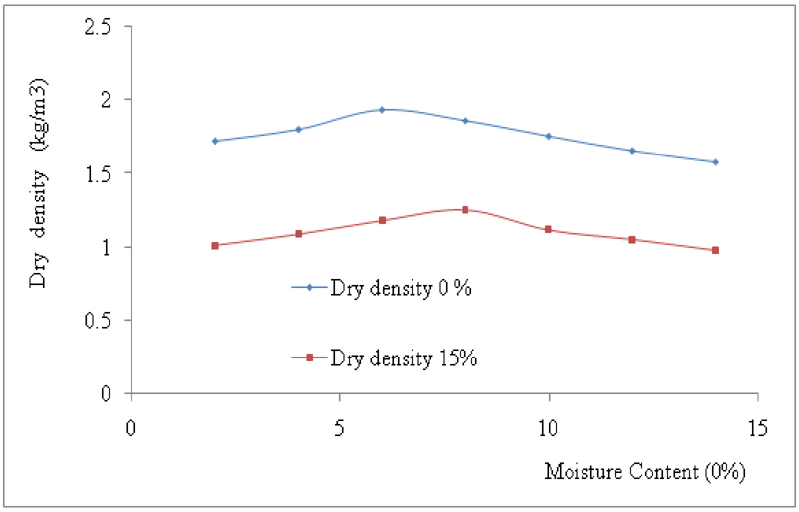

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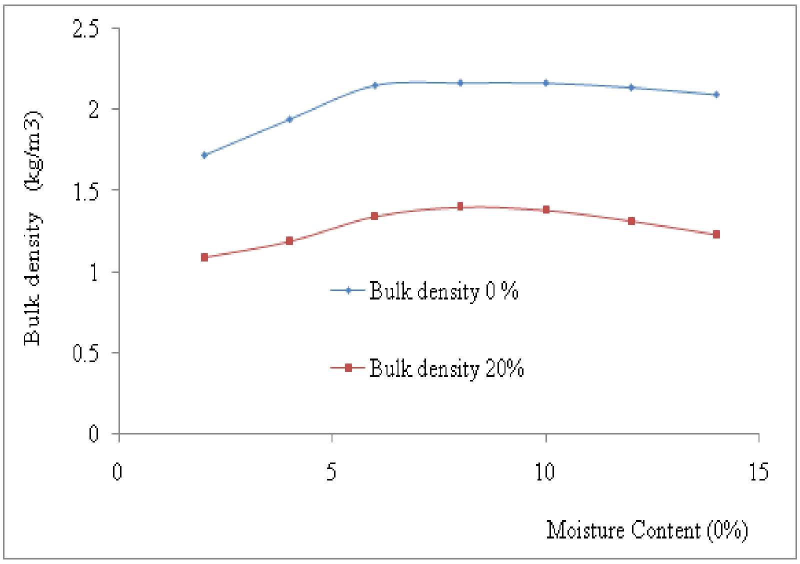
Figure 3: Results of **(a)** bulk density and **(b)** dry density against moisture content (15%)



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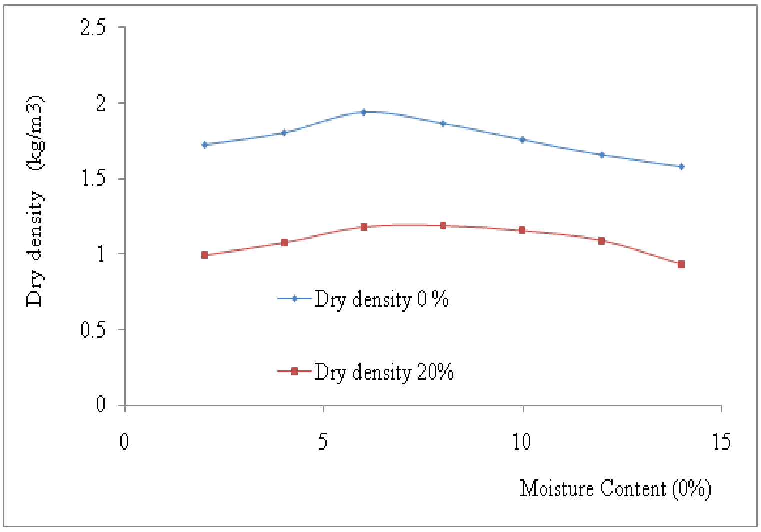
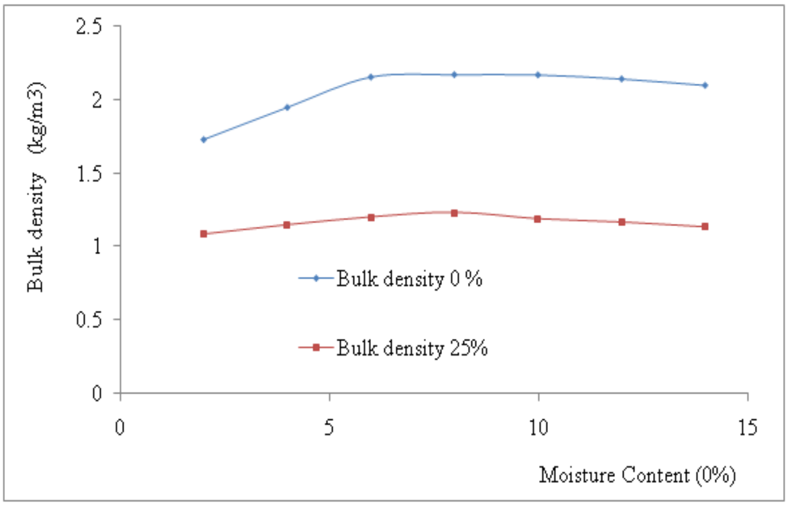


(b)

Figure 4: Results of **(a)** bulk density and **(b)** dry density against moisture content (20%)



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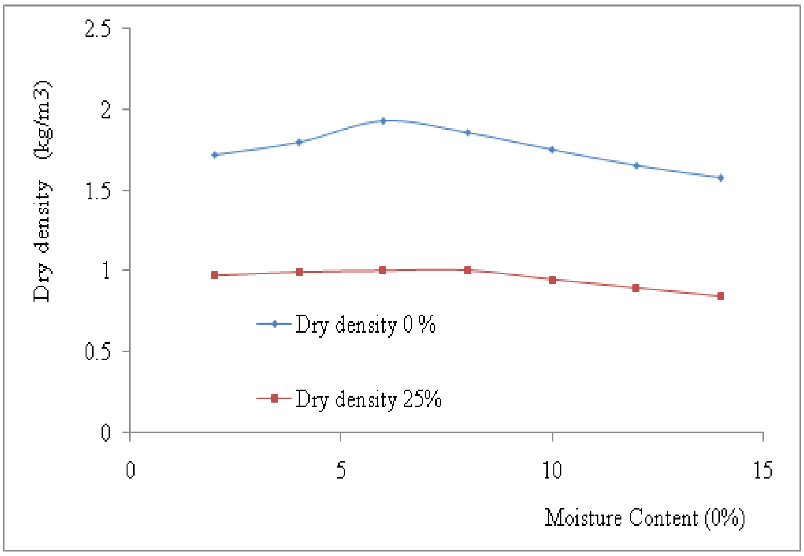
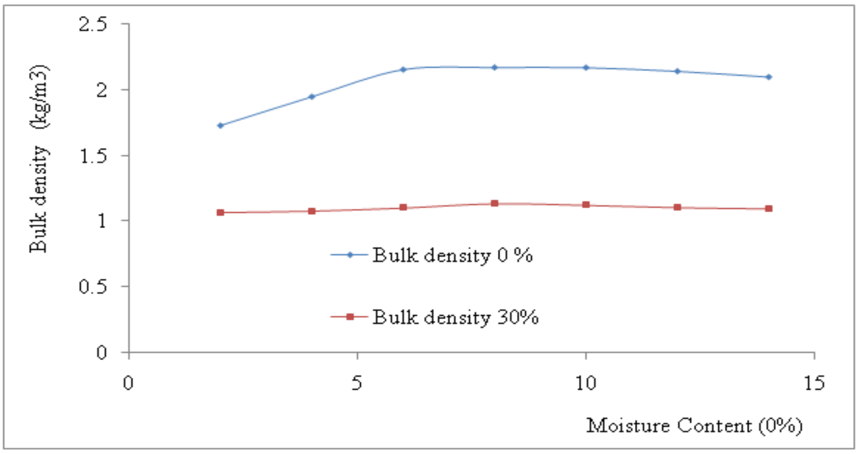


(b)

Figure 5: Results of **(a)** bulk density and **(b)** dry density against moisture content (25%)



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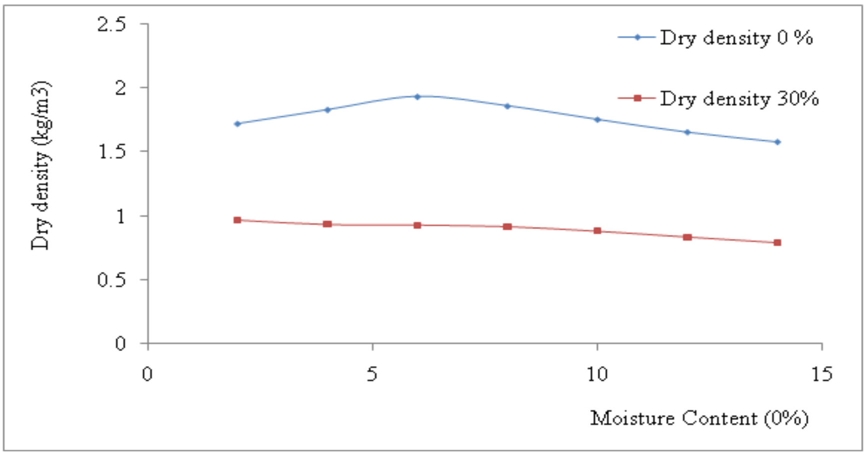

(b)

Figure 6: Results of **(a)** bulk density and **(b)** dry density against moisture content (30%)

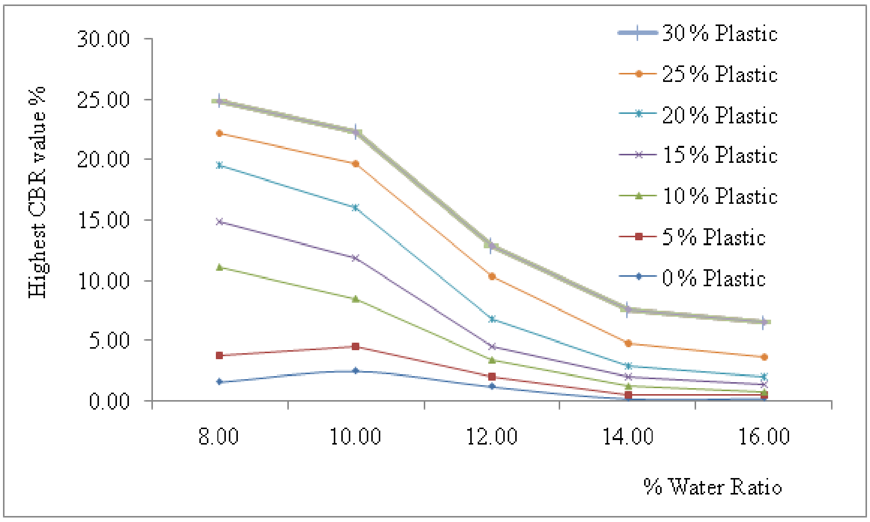

Figure 7: Results of CBR of laterite and laterite mixed with plastic pellets

IV. CONCLUSIONS

This paper has explained the characteristics (in terms of dry density, bulk density and CBR) of lateritic soil mixed with plastic pellets in relative high dosage. The behavious has equally translated into the usage of such composite material to mitigate the effects of accidental explosions on underground structures/pipes. This will assist the construction industries to look into a new construction material round the underground tanks storing volatile and inflammable material (e.g. propane, premium motor spirit, etc) as well as road construction.

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