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Densification characteristics of lateritic soil stabilized with plastic pellets

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Abstract
Wastes generation has increased year by year and the disposal becomes a serious problem. It is therefore necessary to utilize the wastes effectively with technical development in relevant field. Soil stabilization through the reinforced soil construction is an efficient and reliable technique for improving the strength and stability of soils either for road construction or to mitigate the effects of loads from accidental explosions. In this study, lateritic soil was taken from a borrow pit located along Papa-Ilaro road Ajegunle at Abalabi, via Ilaro, Ogun State, Nigeria and the solid plastic was taken from different waste locations in Ilaro. The plastic was grounded into pellets and were sieved to determine the particle size distribution. For laterite mix, plastic pellets were substituted in the lateritic soil at 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8% and 9% with 0% serving as control. The tests conducted in line with BS 1377 (1990) are the moisture content, specific gravity and compaction. From the soil classification, it was observed that the lateritic soil sample is sandy-clay-loam. It was also observed that plastic pellets slightly increases the bulk densities and dry densities in the same proportion at 1% to 9% plastic as the percentage water content increases. From the results, plastic pellets could be used as stabilizing material for road construction. This will reduce the environmental risk and hazard caused by plastic waste/

Keywords: Plastic, pellets, laterite, stabilization, cement, strength, compaction

1. Introduction
1.1 Background Study
Plastics are considered as one of the important invention which has remarkably assisted in different aspect of life whether in the scientific field or others. It is a fact that we can recycle the plastic and make it usable for number of times so that its wastage will be reduced remarkably. Plastic-waste materials are produced plentifully, such as polyethylene terephthalate plastic bottles, polypropylene (PP) of plastic sack, and polypropylene (PP) of carpet. But such materials have been used little for engineering purposes. Only 5 per cent of the world's plastic waste is recycled and the remaining 95 per cent ends up in landfills, litter or in the oceans Huppert (2006) [2]. Plastic constitutes approximately 90 per cent of all trash floating on the ocean's surface, with 46,000 pieces of plastic per square mile Kimani (2007) [4]. The plastic wastes in the form of granules could be mixed with soil and the behaviour of mixture is similar to fibre reinforced soil. Plastic fibres/granules are distributed throughout a soil mass. Hence uses of plastic waste for improving the engineering properties of soil are taken up in the present study. Preliminary experiments showed that addition of plastic waste pieces lead to an improvement in strength response and there is a need to do detailed studies in this direction. On the other hand, they are otherwise considered unsuitable and if found effective can also reduce the problem of disposal of this non biodegradable waste. In recent times, with the increase in the demand for infrastructure and raw materials, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement. Pavement designers have always been searching for technical and economical solutions for roadway applications. Soil stabilization technique, which is normally used for the improvement of local soil is considered an economical solution in places where granular materials are not available Jefferson *et al*. (2009) [3].

This study is aimed at determining the densification properties of lateritic soil mixed with solid plastic pellets. Using lateritic soil as the control the specific objectives are to determination the moisture content of lateritic soil and plastic pellets, to determine the bulk density and dry density of lateritic and plastic pellets; to determine the specific gravity of lateritic soil and plastic pellets and finally to determine the optimum moisture content and maximum dry density of laterite and laterite stabilized with plastic pellets. Although different types of material have been used for soil stabilization in the past but solid plastic pellet has never been used for replacement. If found to be useful as replacement, then, environmental risks and hazards caused by plastic wastes will be greatly reduced.

2. Methodology

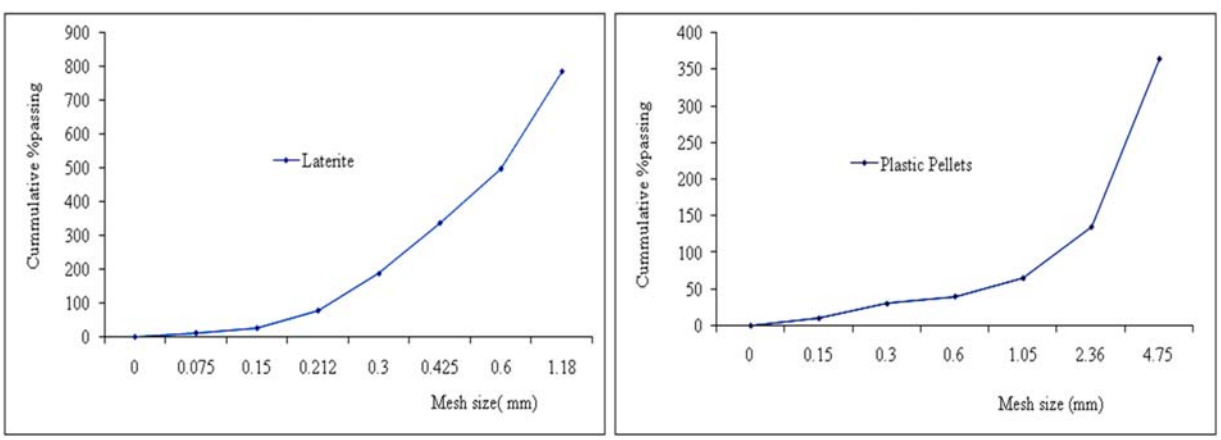
The lateritic soil was obtained from a borrow pit located along Papa-Ilaro road Ajegunle at Abalabi, via Ilaro, Ogun State, Nigeria and the solid plastic were taken taken from different location in Ilaro. The plastic wastes (Figure 1a) were grounded into pellets (Figure 1b) and sieved to determine the particle size distribution. Laterite-pellets mixture were substituted thus: 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8% and 9% with 0% serving as control. The tests were conducted in line with BS 1377 (1990) [1] to determine the moisture content, specific gravity and compaction.

A B

Fig 1: (A) Plastic Waste (B) Plastic Pellets

3. Results and Discussions

The results of grain size analysis for lateritic soil and plastic pellets are graphically presented in Figures 2 a and b respectively. In addition, the results of dry and bulk densities for 0% and 1% plastic mixed against moisture content up to 0 % and 9 % are graphically presented in Figures 3 to 11 while the results of specific gravity against percentage plastic mixed are graphically presented in Figure 12. From the results (Figures 3 to 11 respectively), the maximum dry densities are 1.94, 1.98, 1.89, 1.814, 1.952, 1.913, 1.945, 1.87, 2.045 and 1.573 for 0% to 9% plastic mix respectively. There is little difference in the dry and bulk densities results at 1% to 8% compared to the control which is 100% laterite (0% plastic). Remarkable difference was observed at 9% plastic substitution lower in densities than 0% plastic (100% laterite). From the results (Figure 12), the specific gravity of lateritic soil and plastic pellets are 2.21 and 0.993 (approximately 1.0) respectively. From the result, the specific gravity of laterite is similar to that of granite which is in the range of 2.19 and 2.28 and the specific gravity of plastic pellets is similar to that of coal and bitumen which is in the range of 0.92 and 1.18. For the percentage investigated, from the results shown in Figure 12, increasing the percentage plastic pellets substitution reduces the specific gravity.



A B

Fig 2: Grain size analysis - (A) lateritic soil and (B) plastic pellets

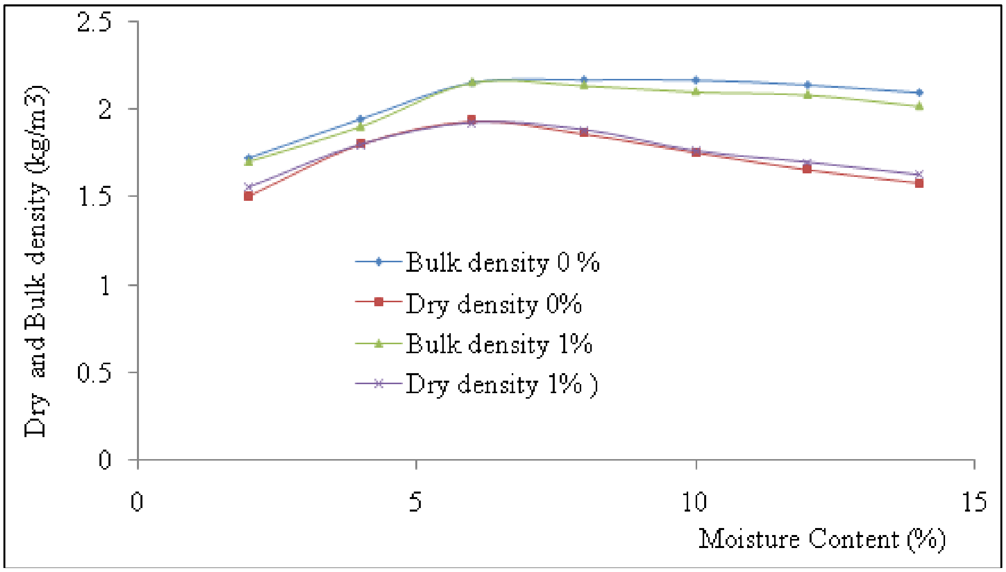


Fig 3: Results of dry and bulk density for 0% and 1% plastic against moisture content.

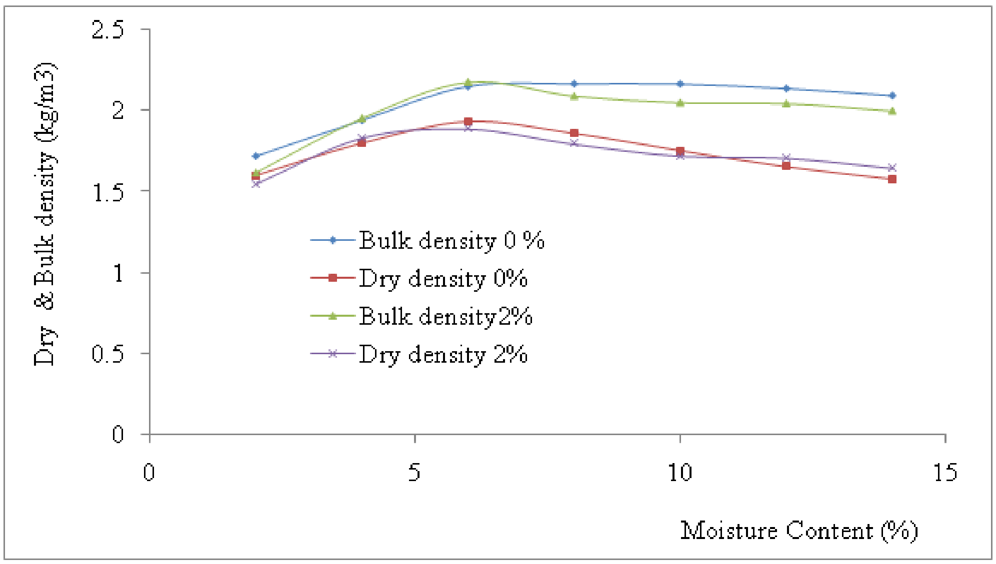


Fig 4: Results of dry and bulk density for 0% and 2% plastic against moisture content.

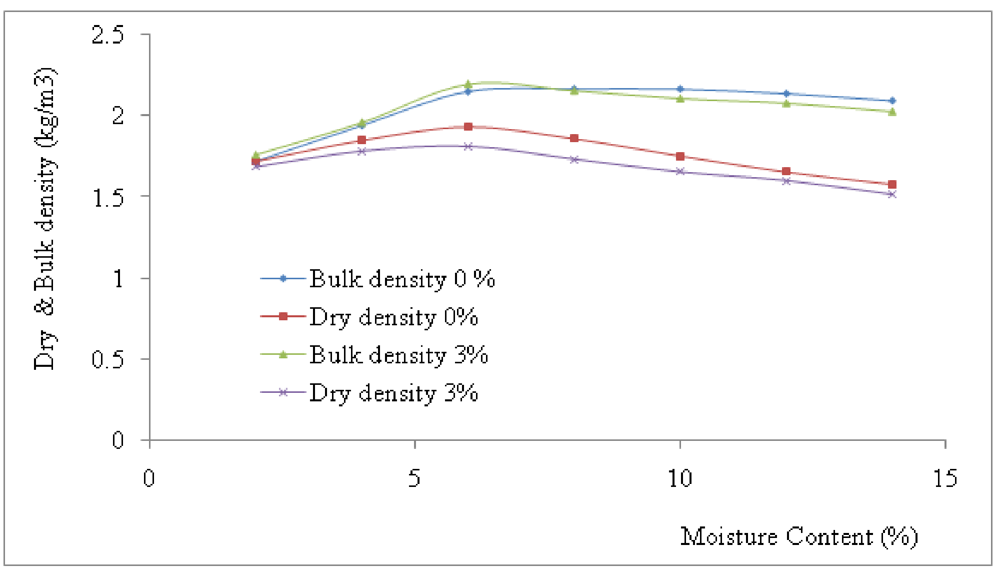


Fig 5: Results of dry and bulk density mixed with 0% and 3% plastic against moisture content.

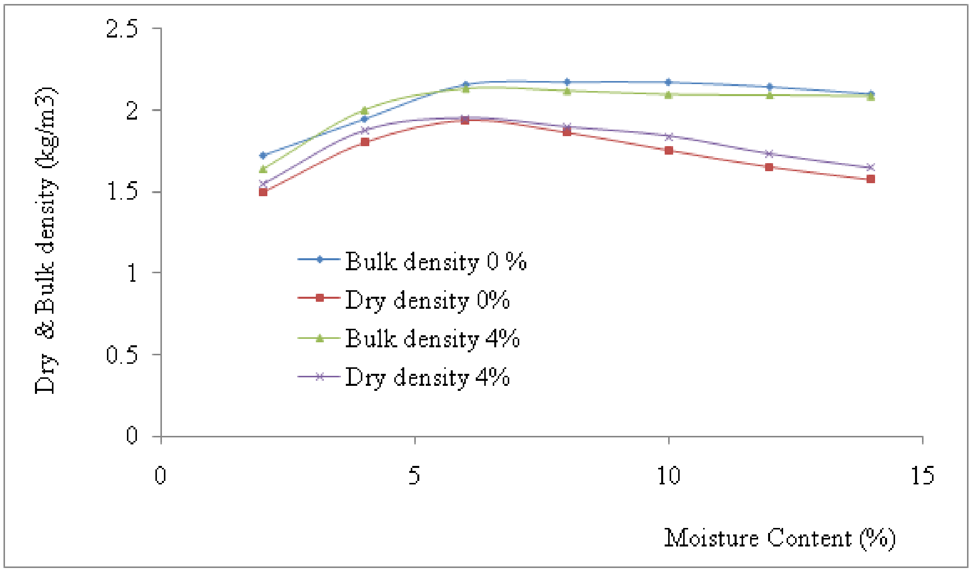


Fig 6: Results of dry and bulk density mixed with 0% and 4% plastic against moisture content.

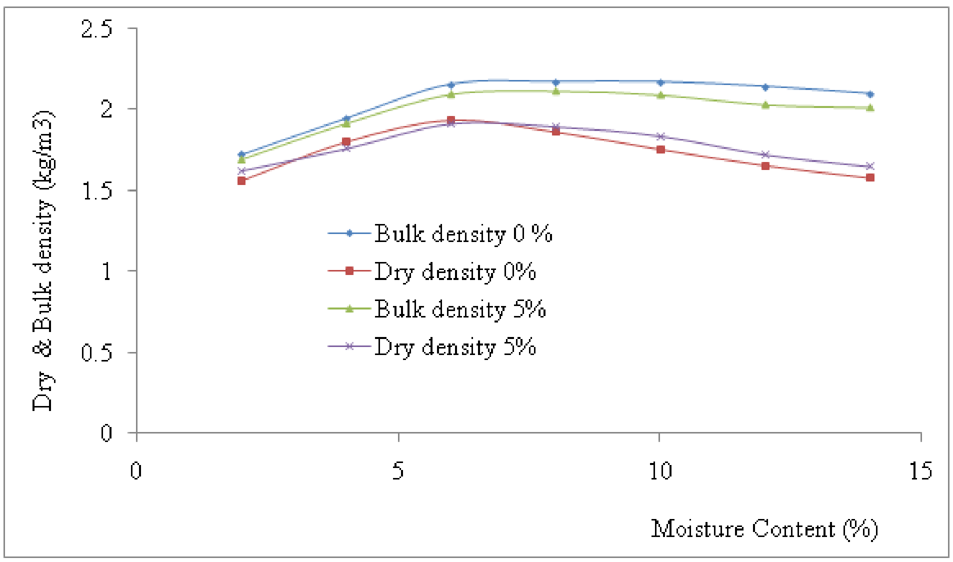


Fig 7: Results of dry and bulk density mixed with 0% and 5% plastic against moisture content.

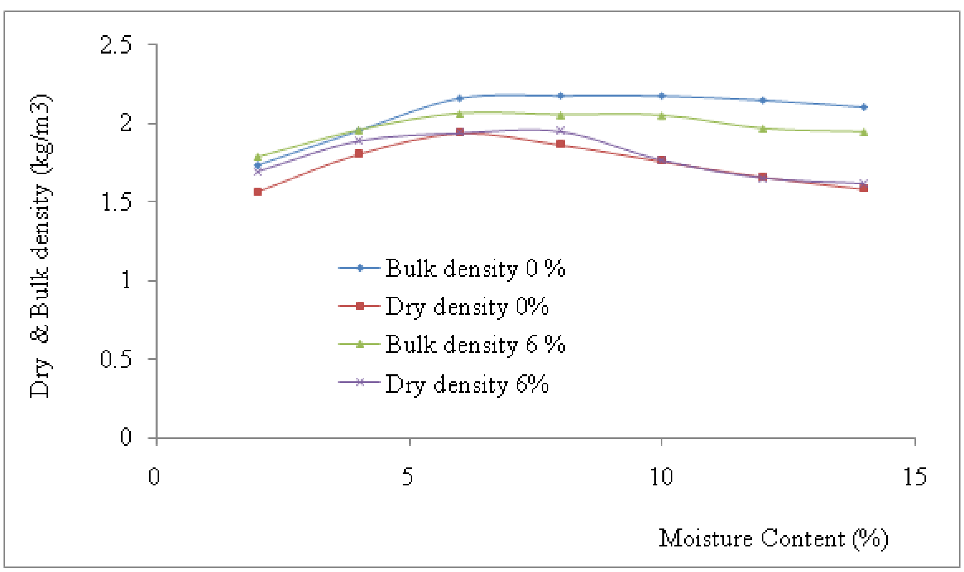


Fig 8: Results of dry and bulk density mixed with 0% and 6% plastic against moisture content.

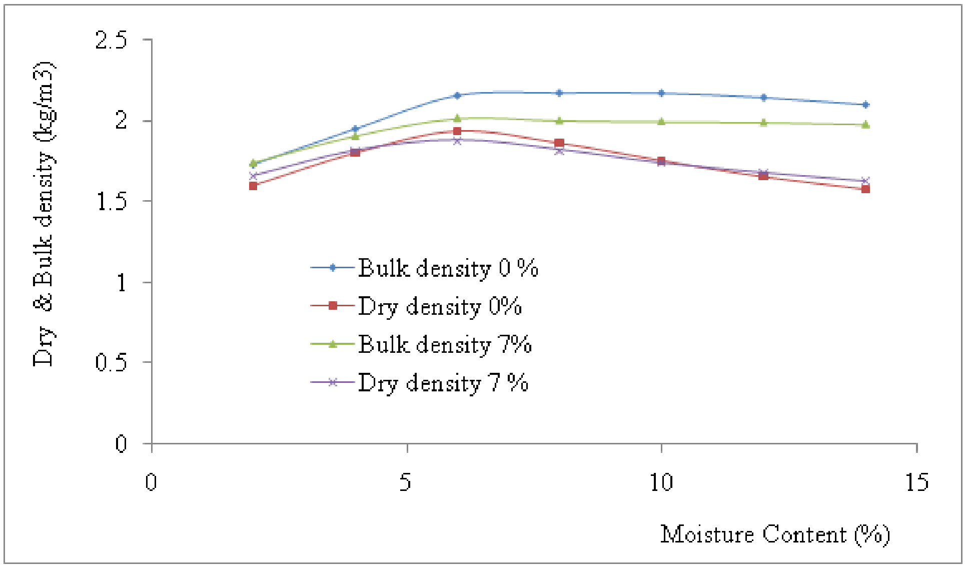


Fig 9: Results of dry and bulk density mixed with 0% and 7% plastic against moisture content.

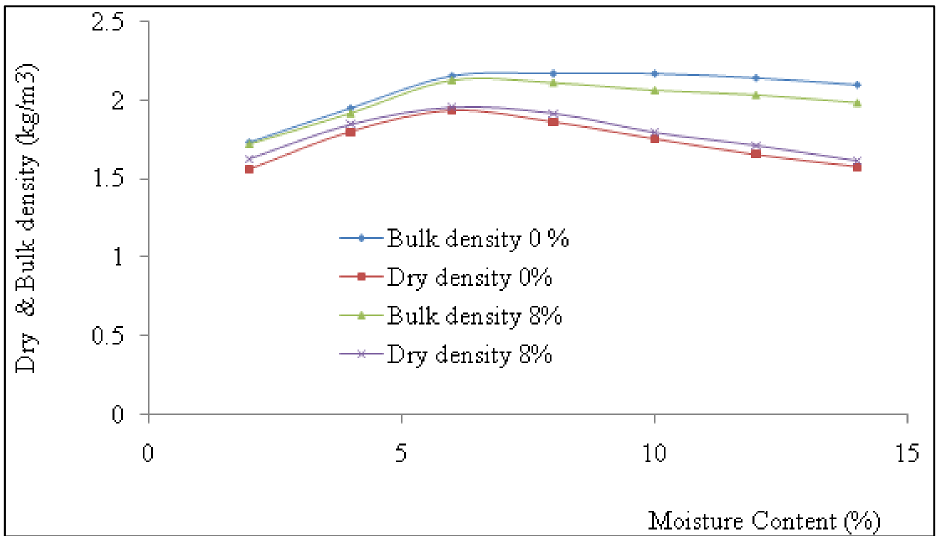


Fig 10: Results of dry and bulk density mixed with 0% and 8% plastic against moisture content.

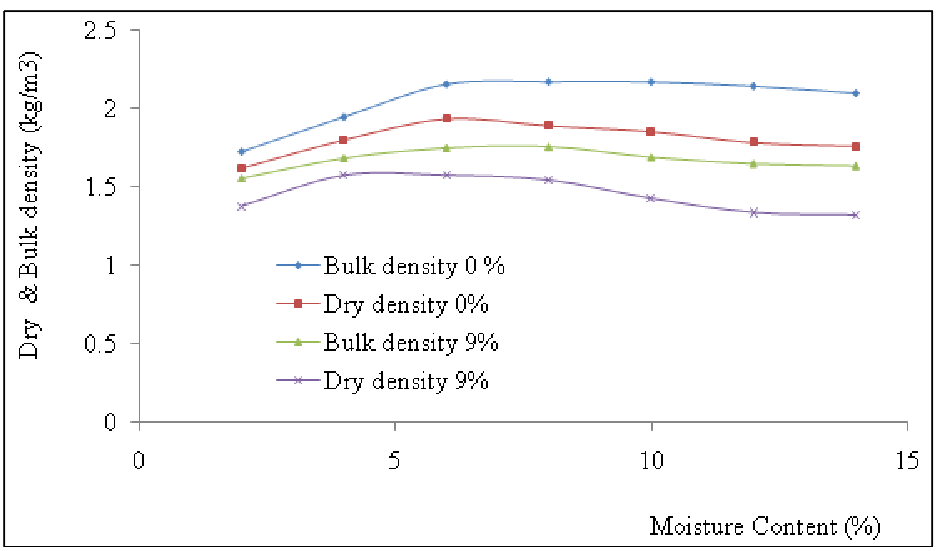


Fig 11: Results of dry and bulk density mixed with 0% and 9% plastic against moisture content.

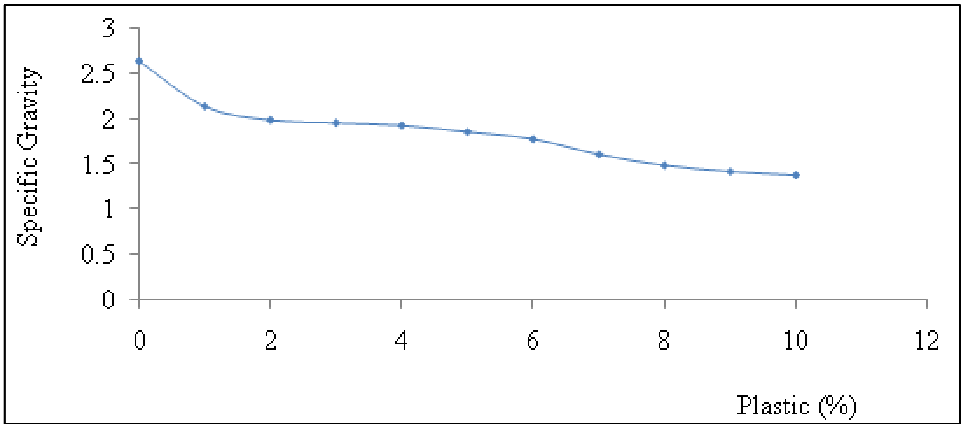


Fig 12: Results of specific gravity against percentage plastic mixed

4. Conclusions

The specific gravity of laterite and the specific gravity of plastic pellets are similar to the specific gravity of coal and bitumen respectively. From the compaction test, the behaviours of laterite and lateritic soil mixed with varying degrees of plastic from 1% to 9% (in terms of bulk and dry densities) followed the same trend but tends to reduce when the substitution increases from 10% and above. From the results of this study, it is hereby suggested that plastic pellets of up to 9% could be used as stabilizing agent for lateritic soil for road construction.

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