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Effects of compaction on lateritic soil stabilized with low dosage of cement and fly ash

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Abstract
This paper examines the compaction behaviours of cement-fly ash stabilized lateritic soil. This is to know the effects of low dosage of fly ash and cement when added to laterite as stabilizing agents. The lateritic soil was taken from a borrow pit at Ona-Egbo, Ilaro, Ogun State, Nigeria. The fly ash material was obtained from Ewekoro cement factory along Papa-Itori road, Ewekoro, Ogun State and cement used is elephant Portland cement. Fly ash at 2%, 4%, 6%, 8%, and 10% were used to replace lateritic soil at percentage water ratio ranging from 2% to 14%. The tests conducted in line with BS 1377 (1990) are the moisture content and compaction. With close similarities in the results of cement and fly ash at the investigated dosage, fly ash could be substituted with cement for engineering purposes similar to that of cement. Therefore, in areas where there is availability of fly ash, demand for cement would be greatly reduced.

Keywords: Fly ash, cement, laterite, stabilization, compaction, density

1. Introduction

1.1 Background Study

Lateritic soils are one of the important soils that are widespread in tropical areas and subtropical climates. They are the most highly weathered soils in the classification system. The significant features of the lateritic soils are their poor fertility, unique color, lower cat ion exchange capacity and high clay content. The two self hardening properties that some lateritic materials possess are probably too difficult to reliably ascertain and use for most engineering purposes. Embankment constructions like dams and roads are the major construction activities that require large quantities of lateritic soils. Therefore construction of these infrastructures by using the tropical available soils especially the laterite is more beneficial in relation to their characteristics as an engineered earth fill. In the construction of infrastructures mentioned above, these tropical fill materials are placed and compacted, in most of the cases, without the addition of binding agent. However, controlling the compacting mechanical effort not to break much of the cementation of the soils is essential. Lateritic soils have great advantage because of the cementation due to the presence of cementing agents. This binding nature reduces the permeability of embankments, increases the strength of soils and hence the stability of embankments as well as increase in cut slopes (Kong and Sanjayan, 2008) [2]. In order to cope with rapid increasing demand of power throughout the world, the production of fly ash is increasing. Today, it has become a global concern and major challenges to dispose and reuse the fly ash safely, not only for environment but for construction and geotechnical engineers. This is because disposal of enormous amount of fly ash involves consumption of large expanse of land and it generates the problem of leaching and dusting in wet and dry conditions respectively. Therefore, the best way of disposing fly ash is to utilize it with some additives and converting it into a non-hazardous material and apply them in a way that is friendly to the eco-system (Mustard and Maclnnis, 1959) [3]. This study is aimed at determining the compaction properties of lateritic soils mixed with low dosage of fly ash and cement. This is with a view to determining the usage in construction and geotechnical industries.

2. Methodology

The lateritic soil was taken from a borrow pit at Ona-Egbo, Ilaro, Ogun State, Nigeria. Fly ash material was obtained from Ewekoro cement factory (*Lafarge Group Nigeria Ltd*) along Papa-Itori road, Ewekoro, Ogun State. Cement used is elephant Portland cement. Fly ash at 2%, 4%, 6%, 8%, and 10% were used to replace lateritic soil at percentage water ratio ranging from 2% to 14%. The tests conducted, in line with BS 1377 (1990) [1], are the moisture content determination and compaction.

3. Results and Discussion

The results of bulk density of fly ash and cement against percentage water ratio are presented in Figures 1 to 5 while the results of dry density of fly ash and cement against percentage water ratio are also presented in Figures 6 to 10. The results of moisture content of fly ash and cement against percentage water ratio are presented in Figures 11 to 15. From the results, at 2% and 4% fly ash and cement substitutions (Figures 1 and 2), the bulk densities of cement and fly ash are lower than that of control experiment (0%) but that of cement is the least. The density of fly ash is close to that of the control experiment. In addition to this, at 6% and 8% fly ash and cement substitutions (Figures 3 and 4), above 10% water ratio, the bulk densities of fly ash and control are similar while that of cement remain the least. Furthermore, at up to 10% fly ash and cement substitutions (Figure 5), the bulk density of fly ash is higher than that of control while that of cement remain the least and almost similar to that of the control experiment (0%). At 4% and 6% fly ash and cement substitutions (Figures 7 and 8), above 5% water ratio, the dry density of fly ash is higher than that of control (0%) and cement, while that of cement remain the least. At 8% and 10% fly ash and cement substitutions (Figures 9 and 10), above 7% water ratio, the dry density of fly ash is higher than that of cement and control experiment (0%) while that of control remain the lowest. The dry density of cement is higher than that of control experiment (0%). Apart from 2% substitution (Figure 11), from 4% to 8% fly ash and cement (Figures 12, 13 and 14), the moisture content of cement is least in all the cases investigated. This is due to the fact that much of the water has been used during hydration process. In addition, the moisture content of the control experiment is the highest, since no additive was added, only the particles of the lateritic soil were involved in the reaction and no chemical reaction took place during the process. The moisture content of fly ash additive is lower than that of the control but higher than that of cement additive. At 10% fly ash and cement substitution (Figure 15), there are similarities in the moisture content of fly ash and cement additive and both are lower than that of control experiment (0%).

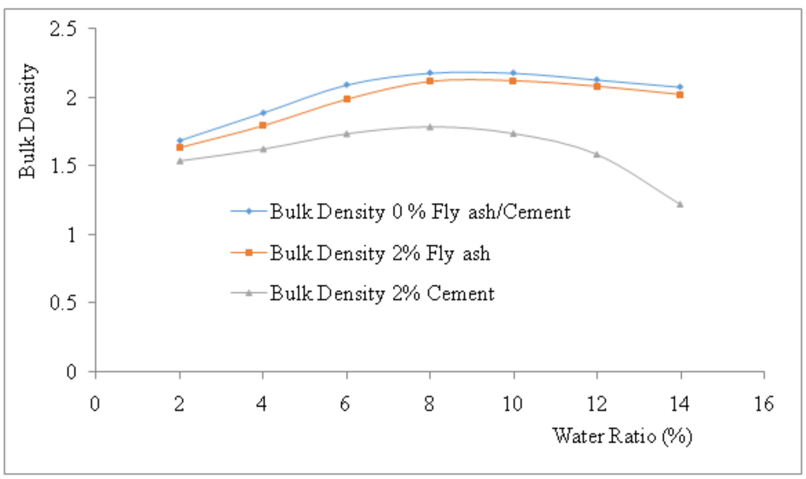

Fig 1: Results of bulk density of fly ash and cement against water ratio

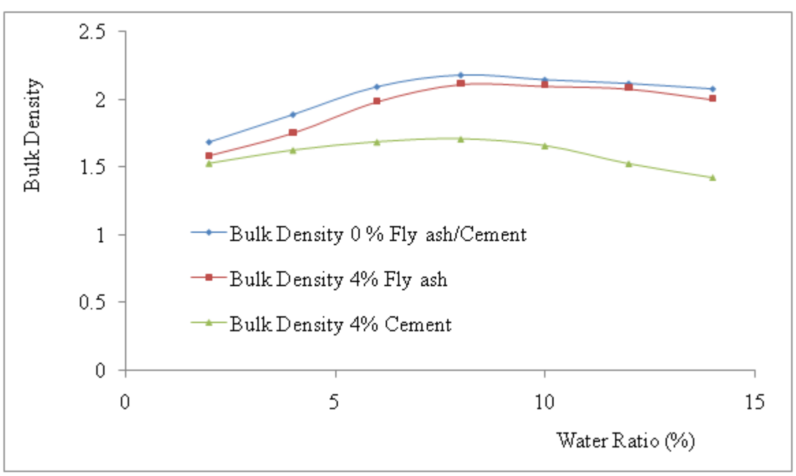

Fig 2: Results of bulk density of fly ash and cement against water ratio

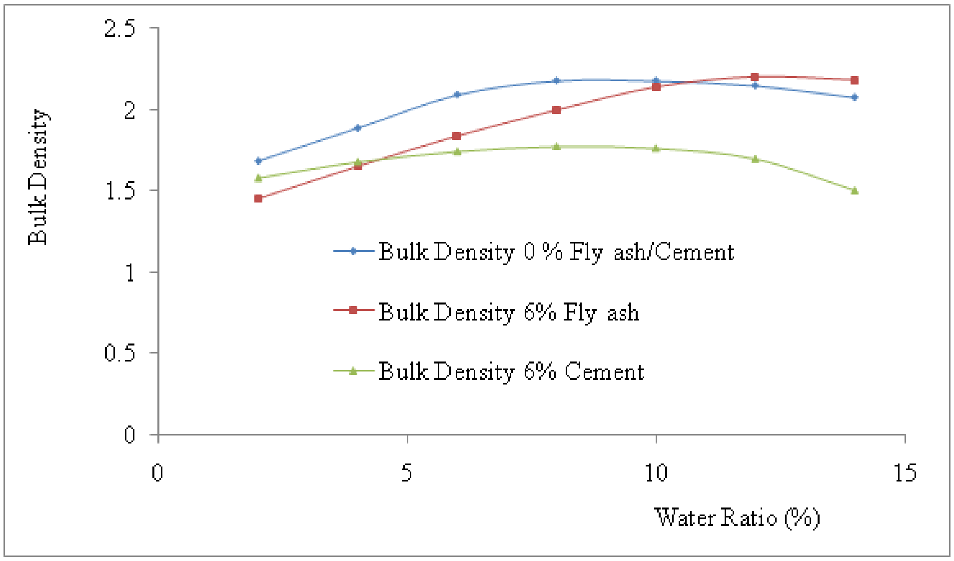

Fig 3: Results of bulk density of fly ash and cement against water ratio

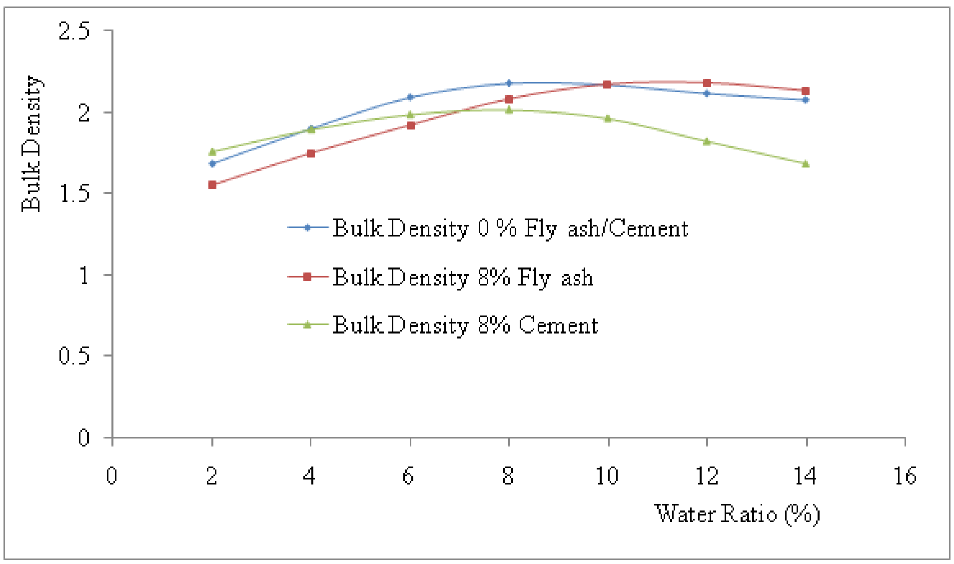

Fig 4: Results of bulk density of fly ash and cement against water ratio

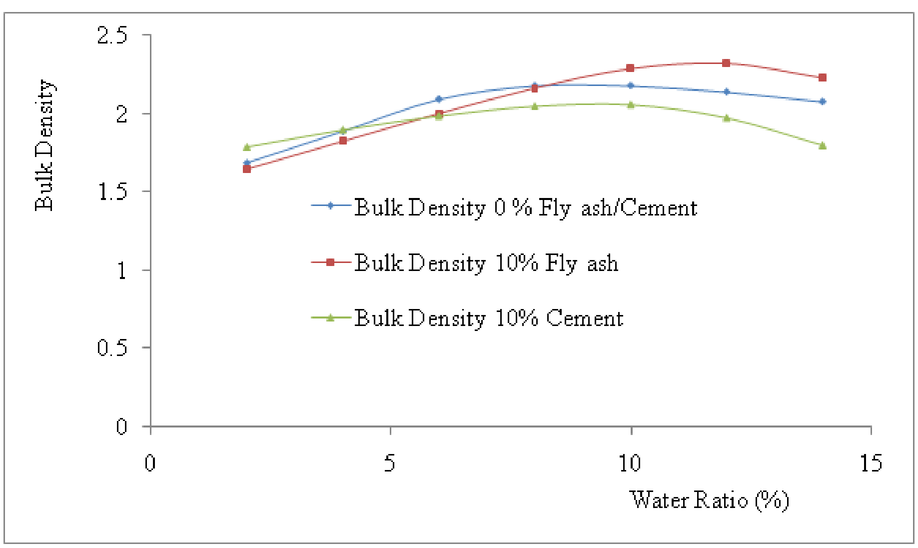

Fig 5: Results of bulk density of fly ash and cement against water ratio

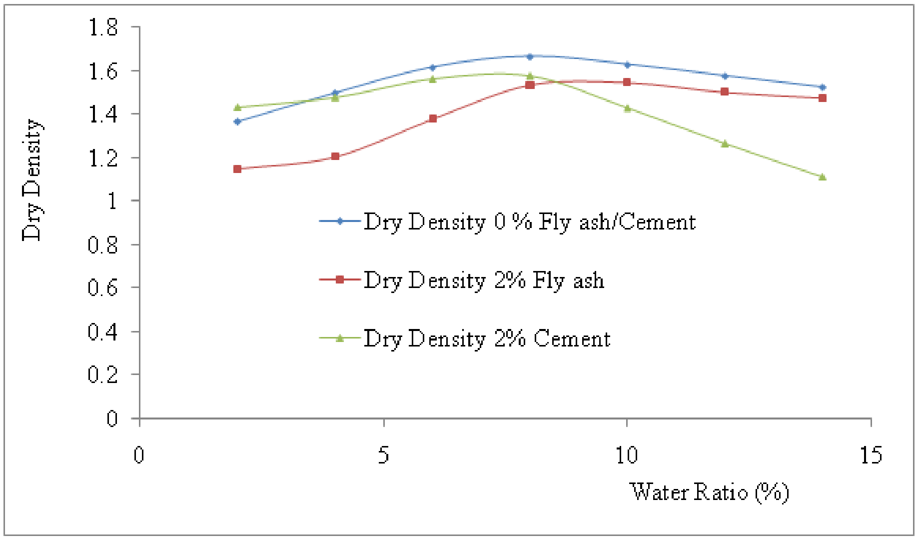

Fig 6: Results of dry density of fly ash and cement against water ratio

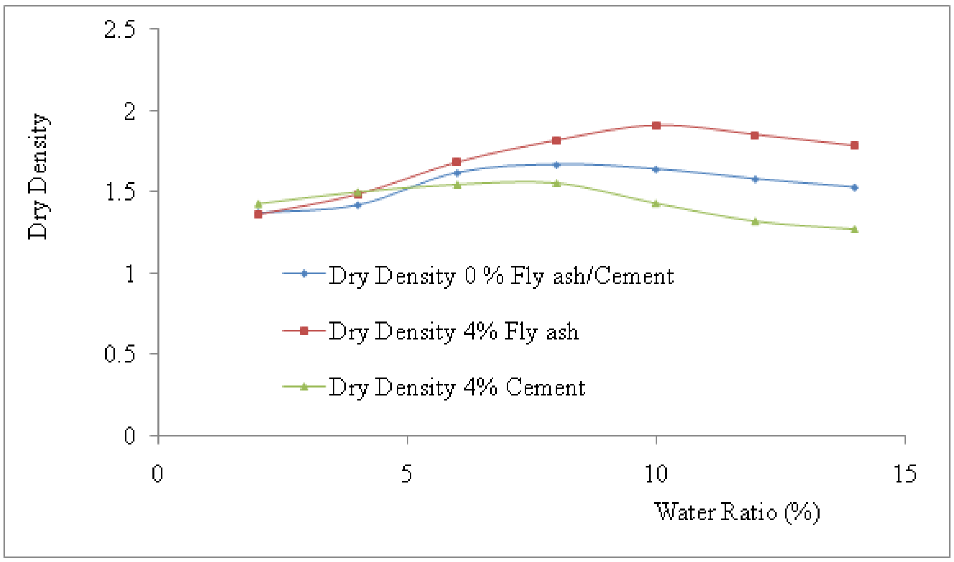

Fig 7: Results of dry density of fly ash and cement against water ratio

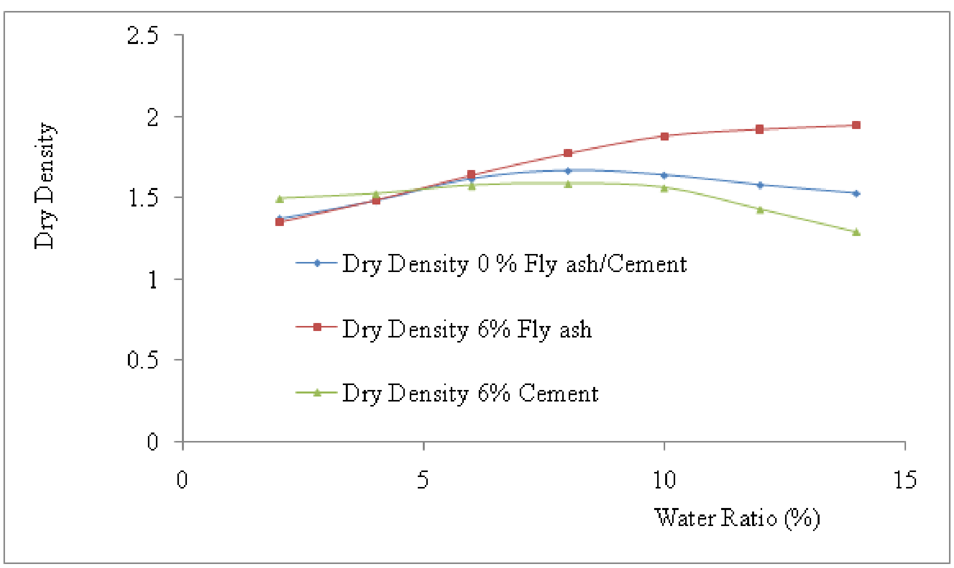

Fig 8: Results of dry density of fly ash and cement against water ratio

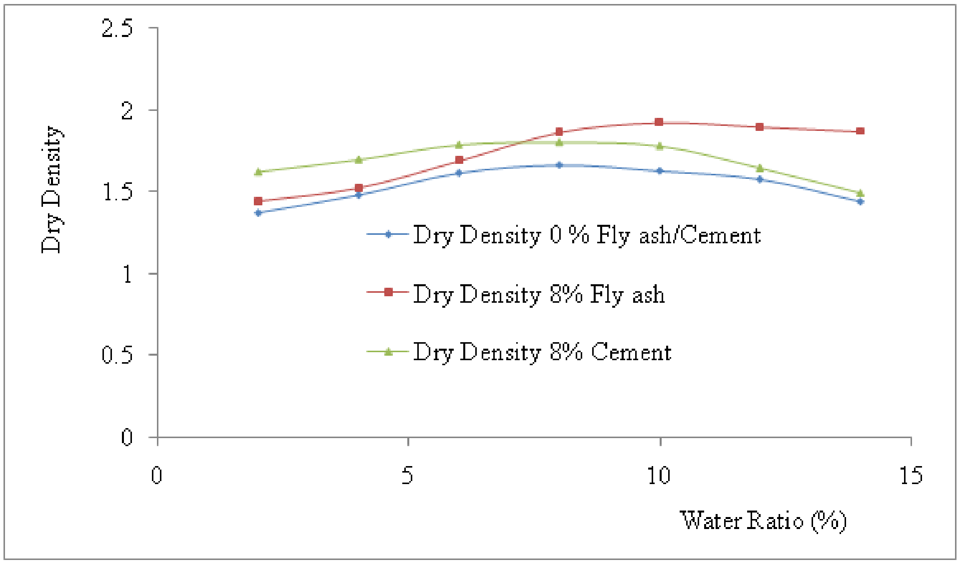

Fig 9: Results of dry density of fly ash and cement against water ratio

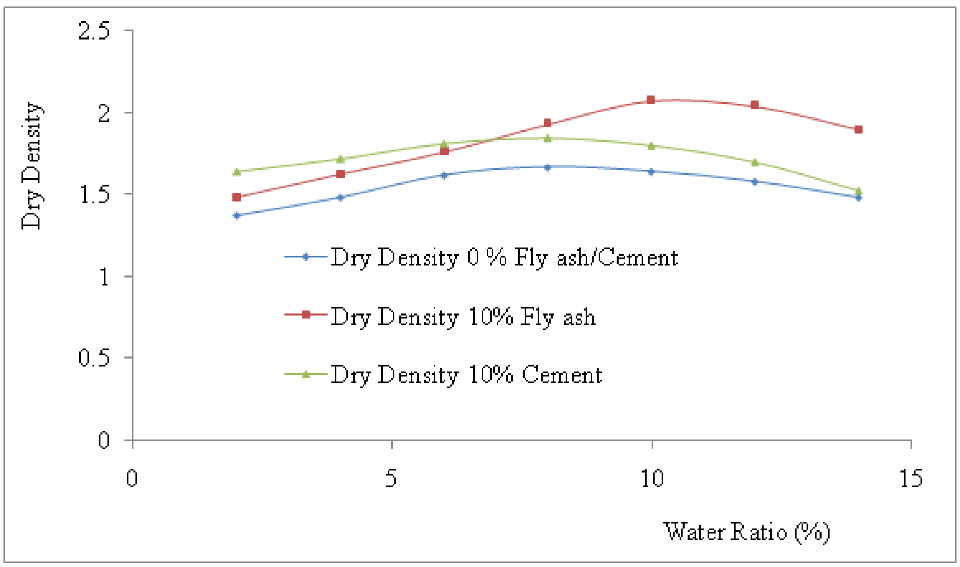

Fig 10: Results of dry density of fly ash and cement against water ratio

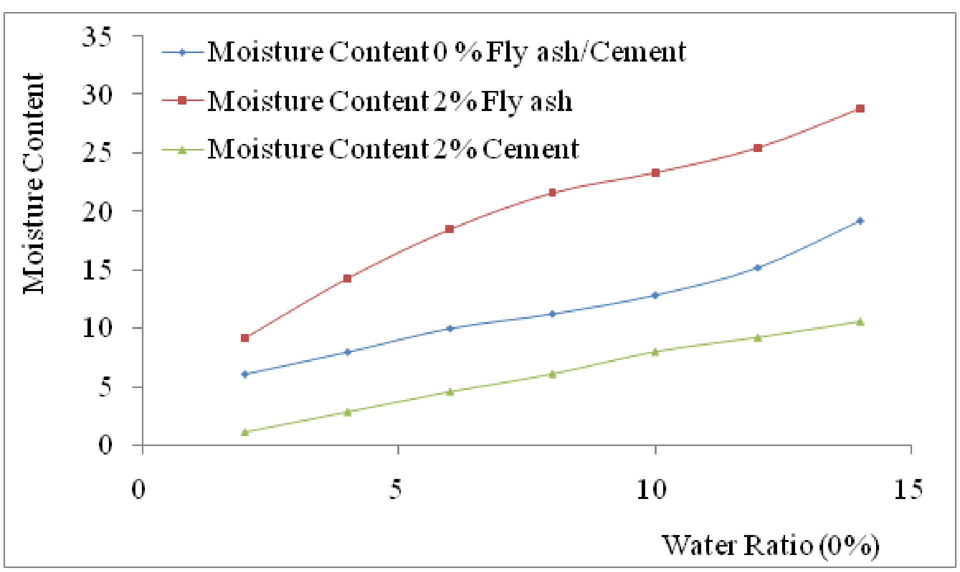

Fig 11: Results of moisture content of fly ash and cement against water ratio

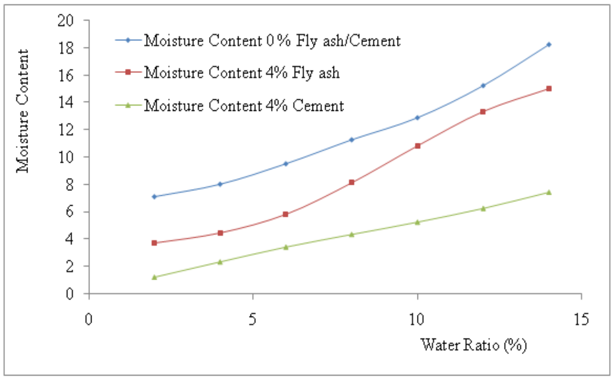

Fig 12: Results of moisture content of fly ash and cement against water ratio

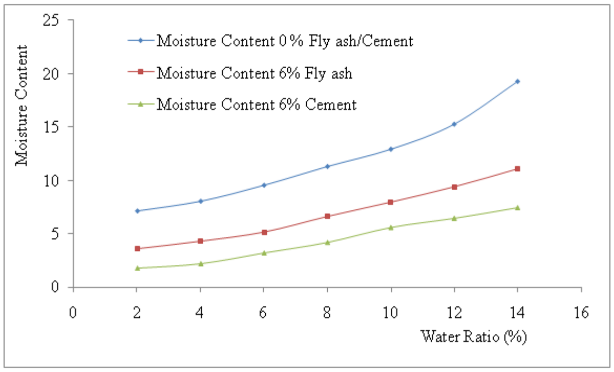

Fig 13: Results of moisture content of fly ash and cement against water ratio

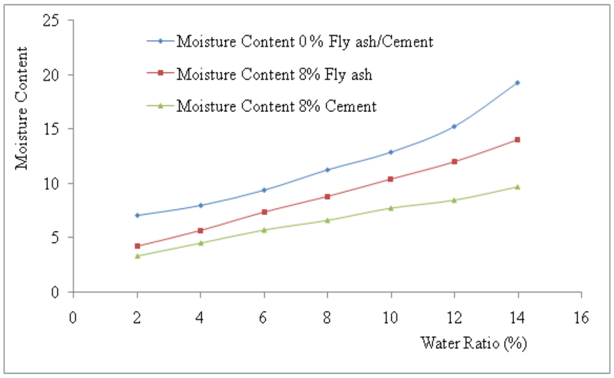

Fig 14: Results of moisture content of fly ash and cement against water ratio

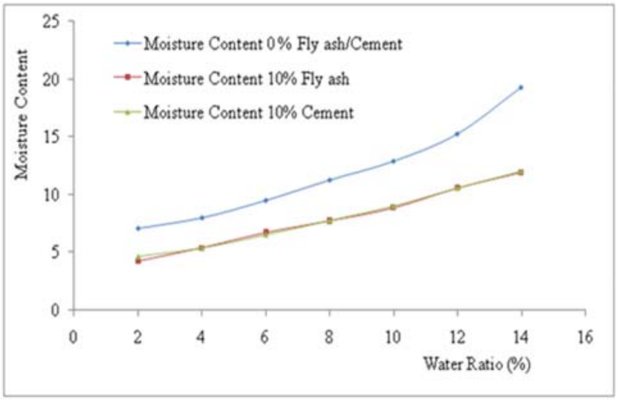

Fig 15: Results of moisture content of fly ash and cement against water ratio

4. Conclusions
This paper has examined the compaction behaviours of lateritic soil stabilized with dosage of fly ash and cement at 2%, 4%, 6%, 8%, and 10%. The similarities in the characteristics in terms of dry density, bulk density and moisture content have been discussed. The effect heat of hydration has equally been highlighted.

5. Acknowledgement
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