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Compaction characteristics of lateritic soil mixed with cement and fly ash each at 10%, 12% and 14%

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Abstract

This paper explains the compaction behaviours relatively high dosage of cement and fly ash stabilized lateritic soil. This is to know the effects of fly ash and cement when added to laterite as stabilizing agents. The lateritic soil was taken from a borrow pit at Ona-Egbo, located along Ilaro Express road, Ilaro, Ogun State, Nigeria and the Fly ash material was taken from Ewekoro cement factory along Papa-Itori road, Ewekoro, Ogun State. Cement used is elephant Portland cement. Fly ash and cement each at 10%, 12% and 14% were used to replace lateritic soil at water ratio ranging from 2% to 14%. The tests conducted in line with BS 1377 (1990) are moisture content and compaction. From the results, at the percentages of fly ash and cement investigated, the dry densities of both fly ash and cement are higher than that of control (0%) while that of fly ash is higher than that of cement due to the heat of hydration in cement. In the case of moisture content, at 10% fly ash and cement, the moisture content of cement is similar to that of fly ash with both lower than control (0%). At 12% and 14% fly ash and cement, the moisture contents of both the fly ash and cement are lower than that of control. Finally the moisture content increased as the water ratio increases in the same proportion. 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. 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

The production of Portland cement consumes considerable energy and at the same time contributes a large volume of carbon dioxide to the atmosphere. As a result of this, the climate change due to global warming has become a major concern globally. Several efforts have been put in progress to supplement the use of Portland cement in concrete in order to address the global warming issues. These efforts include the utilization of supplementary cementing materials such as granulated blast furnace slag, rice-husk ash, fly ash, silica fume, etc as well as the development of alternative binders to Portland cement. One of the alternatives is fly ash. The composition of fly ash and other essential properties have been given in grater details in Olarewaju (2016) [9]. Fly ash, commonly used as pozzolan in the construction industry, is an extremely fine powder consisting of spherical particles less than 50 microns in size. The most common use of fly ash is as a partial replacement for Portland cement used in producing concrete. Replacement rates normally run in between 20% to 30% but can be higher. Fly ash reacts as a pozzolan with the lime in cement as it hydrates, creating more of the durable binder that holds concrete together. As a result, concrete made with fly ash may be stronger and more durable than normal concrete made exclusively with Portland cement. Fly ash particle are spherical and also in the same size range as Portland cement. With this size, a reduction in the amount of water need for mixing and concrete can be obtained. In precast concrete, this can be translated into better workability, resulting in shape and distinctive corners and edges with a better surface appearance. These also make it easy to fill intricate shapes and patterns. Strength in concrete greatly depends on many factors. The most important of this is the ratio of water to cement. Those that contain a good quality of fly ash will generally improve workability. Concrete is used in large quantities almost everywhere mankind needs infrastructures. Concrete has wide applications such as pavements, bridges,, architectural structures, foundations, brick, block walls, highways, runways, parking structures, dams, swimming pools, reservoirs, pipes, footings, foundations, fences and poles, etc. The amount of concrete used worldwide, ton for ton, is twice that of wood, steel, plastics and aluminum combined. Therefore there is need to look for alternatives to binding materials like cement. This is with a view to reducing the demand for cement and other natural resources such as limestone, etc.

2. Methodology

The lateritic soil was taken from a borrow pit at Ona-Egbo, located along Ilaro Express road, Ilaro, Ogun State, Nigeria and the Fly ash material (Figure 1a) was taken from Ewekoro cement factory (*Lafarge Group Nigeria Ltd*) along Papa-Itori road, Ewekoro, Ogun State. Cement used is elephant Portland cement (Figure 1b). Fly ash and cement each at 10%, 12% and 14% were used to replace lateritic soil at water ratio ranging from 2% to 14%. The tests conducted in line with BS 1377 (1990) are the moisture content determination and compaction.

a

b

Fig 1: (a) Fly ash: (b) Cement

3. Results and Discussions

The results of bulk and dry densities density against water percentage ratio for 10%, 12% and 14% substitutions are graphically presented in Figures 2 to 4 and 5 to 7 respectively while the results of moisture content against water ration for 10%, 12% and 14% are graphically presented in Figures 8 and 10 respectively. From the results, at 10% fly ash and cement (Figure 2), at above 7% water ratio, the bulk density of cement is lower than that of control (0%) while that of fly ash is equally higher than that of control. In addition to this, at 12% fly ash and cement (Figure 3), above 4% water ratio, bulk density of cement is lower than control while that of fly ash is equally lower than control. At 14% fly ash and cement (Figure 4), the behaviour at above 8% is similar to that of 12% substitution. In the case of dry density, at 10%, 12% and 14% fly ash and cement (Figure 5 to 7), the dry densities of both fly ash and cement are higher than that of control (0%) while that of fly ash is higher than that of cement due to the heat of hydration in cement. According to Mustard (1959), the reduction in the rate of the heat produced and hence the internal temperature rise of the concrete has long been an incentive for using fly ash in mass concrete construction.

According to Langley (1992), in massive concrete pours where the rate of heat loss is small, the maximum temperature rise in fly ash concrete will primarily be a function of the amount and composition of the Portland cement and fly ash used, together with the temperature of the concrete at the time of placing. According to Bremner (2004), replacing Portland cement with fly ash can reduce the exothermic reaction between cement and water. Joshi (1997) [4] also opined that because of the slower Pozzolanic reaction, partial replacement of Portland cement with fly ash results in a release of heat over a longer period of time. Therefore, the concrete temperature remains lower because heat is dissipated as it is produced. Berry (1986) [1] also estimated that the contribution of fly ash to early age heat generation ranges from 15-30% of that of an equivalent mass of Portland cement. In general, the rate of heat evolution parallels the rate of strength development. Some high calcium ashes react very rapidly with water, generating excessive heat rather than reducing the heat of hydration (Berry, 1986) [1]. In addition to this, in the case of moisture content, at 10% fly ash and cement (Figure 8), the moisture content of cement is similar to that of fly ash with both lower than control. Furthermore, at 12% and 14% fly ash and cement (Figures 9 and 10), the moisture contents of both the fly ash and cement are lower than that of control. In all, the moisture content increased as the water ratio increases in the same proportion.

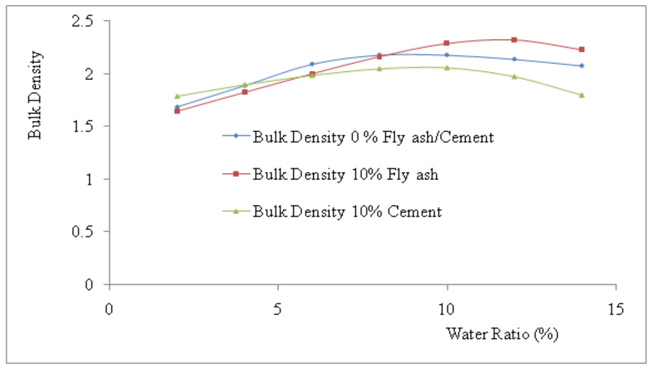

Fig 2: Bulk density against water ratio

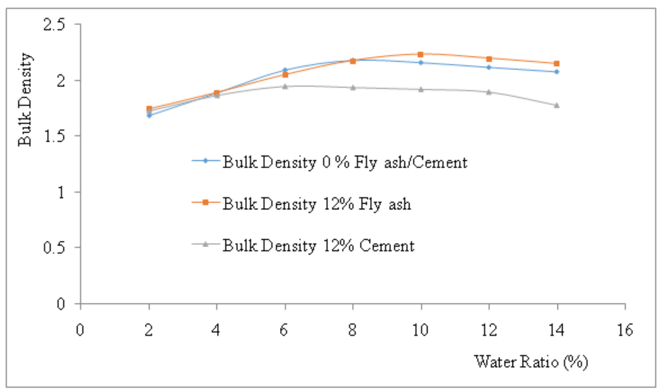

Fig 3: Bulk density against water ratio

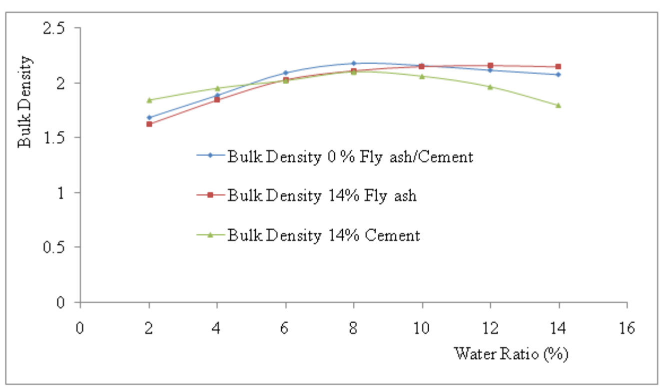

Fig 4: Bulk density against water ratio

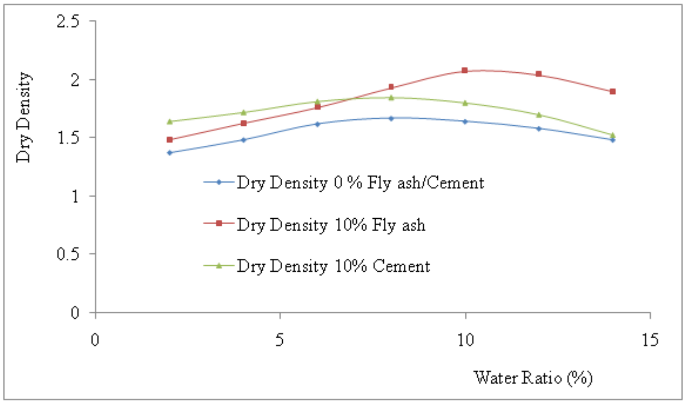

Fig 5: Dry density against water ratio

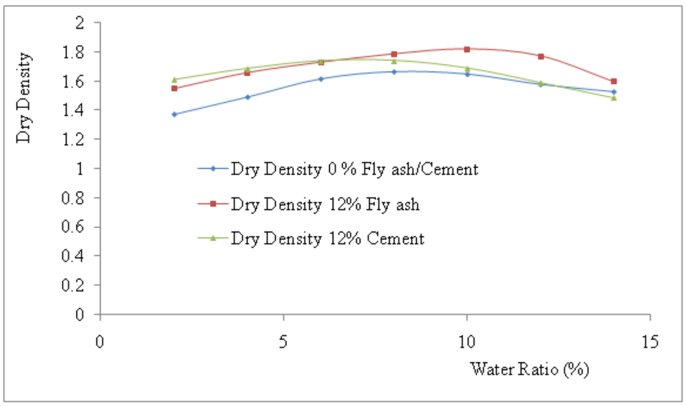

Fig 6: Dry density against water ratio

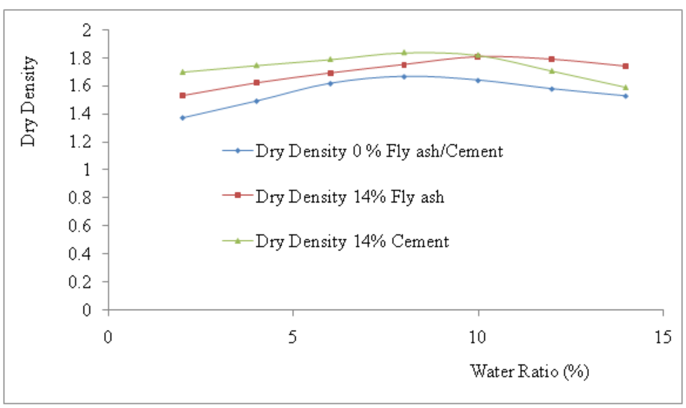

Fig 7: Dry density against water ratio

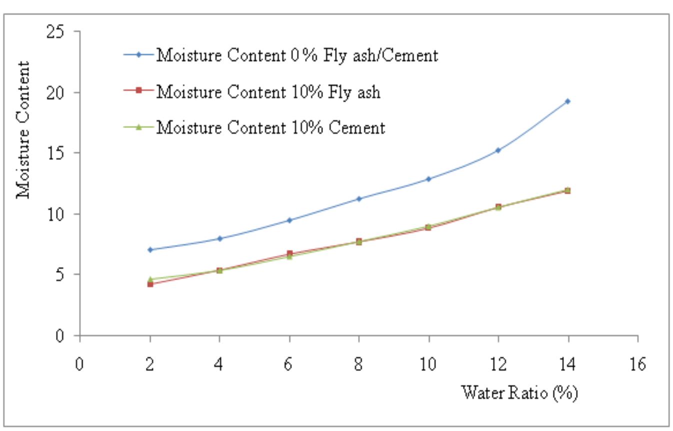

Fig 8: Moisture content against water ratio

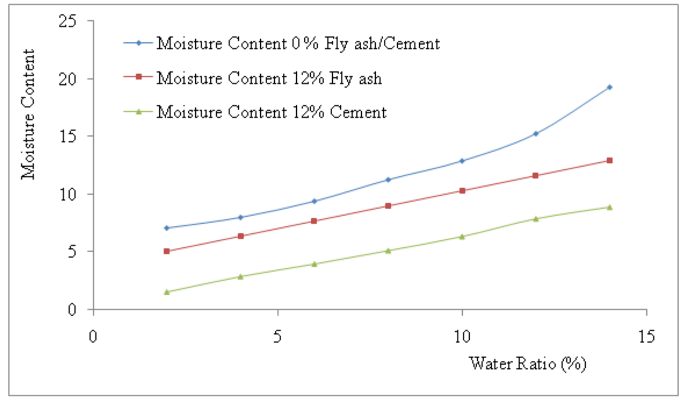

Fig 9: Moisture content against water ratio

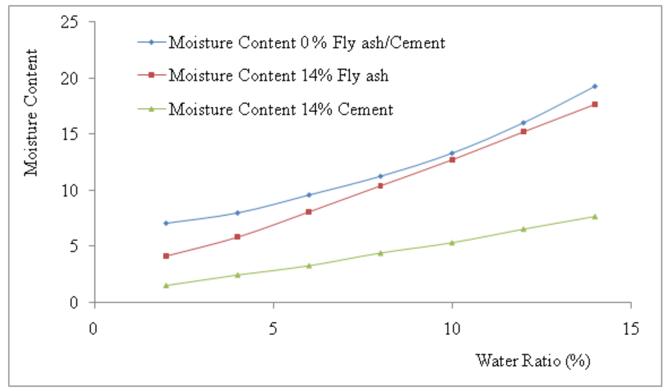

Fig 10: Moisture content against water ratio

4. Conclusions

This paper has examined the compaction behaviours of lateritic soil stabilized with dosage of fly ash and cement at 10%, 12% and 14%. The similarities in the characteristics in terms of dry density, bulk density and moisture content have been highlighted. The effects of heat of hydration have equally been discussed.

5. Acknowledgement

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6. References

1. Berry EE, Malhotra VM. Fly Ash in Concrete. Energy, Mines and Resources, 1986.
2. Canada, CANMET, ACI Committee, Canada, 2011; 10(2):420-431.
3. BS, 1970-1971, Methods of Testing Concrete for Strength, British Standard Institution. 1881; 6:1-4.
4. Joshi RC, Lohtia RP. Fly Ash in Concrete – Production, Properties and Uses, 1997.
5. Advances in Concrete Technology. Gordon and Breach Science Publishers, India, 2:1-47.
6. Kong DLY, Sanjayan JG. Damage behavior of geopolymer composites exposed to elevated temperatures, Journal article on Cement and Concrete Composites. 2008; 30(10):986-991.

7. Malhotra VM. Sustainable Development and Concrete Technology, ACI Concrete International USA. 2002; 24:7-22.
8. Mustard JN, MacInnis C. The Use of Fly Ash in Concrete by Ontario Hydro, Engineering Journal. 1959, 74-79.
9. Olarewaju AJ. Engineering Properties of Concrete Mixed with Varying Proportions of Fly Ash, American Journal of Engineering Research (AJER), Accepted (In print), 2016.