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Case study

Subgrade Stabilization using Rice Husk Ash-based Geopolymer (GRHA) and Cement Kiln Dust (CKD)

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ABSTRACT

This study explores the use of two wastes (rice husk ash (RHA) and cement kiln dust (CKD)) for improving the mechanical strength of a subgrade soil obtained from a failed road section in Nigeria. It presents an experimental insight on the stabilization of the soil with CKD and CKD + RHA-based geopolymer. In the RHA-based geopolymer, CKD was included as supplementary material for activator reduction. The stabilizers were mixed with the soil in varying proportions ranging from 7.5 to 15% for CKD stabilization. Thereafter, the optimum percentage of CKD was mixed with RHA (4–10%) and activated with sodium hydroxide (NaOH). Pavement design was also performed using PaveXpress considering heavy traffic loading conditions. Cost analyses were conducted on the resulting asphaltic pavement thickness for each subgrade. The results show improved mechanical with both stabilizers. However, the stabilization done with CKD at 10 % and geopolymer 3 (8 % RHA and 10 % CKD) were the optimum. Generally, CKD stabilization performed better than geopolymer stabilization. Also, the results showed that the pavement with the lowest thickness corresponds to the optimum and had the highest cost reduction. This research showed that $60,000 can be saved irrespective of stabilizer used which is in tandem with sustainable development goals (SDGs 9, 11 and 12).

1. Introduction

Problems associated with construction on collapsible, expansive or compressible soils have been well documented [1,2]. In response, different mitigation methods have been developed over the years. One such widely used and studied method is chemical stabilization [3]. Cement and lime are the commonly used stabilizers for soil improvement and are widely referred to as traditional stabilizers [4]. Improvements in the geotechnical and mechanical properties of soils using traditional stabilizers are brought about by hydration and pozzolanic reactions [5–7]. However, irrespective of the impressive soil improvement performance of traditional stabilizers, there are environmental concerns such as the emission of greenhouse gases (GHG) and the huge consumption of energy and raw materials during production [8]. Furthermore, the increase in waste generation globally has necessitated the use of certain waste as unconventional or alternative stabilizers [9]. These wastes can be industrial, agricultural and sometimes, municipal solid waste.

Irrespective of the waste source, the chemical composition (high percentage of SiO_2, Al_2O_3 and CaO), pozzolanic potential and the amount generated annually has necessitated different studies. These waste include sugarcane bagasse ash [10,11],

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