Alkali Activated Black Cotton Soil with Partial Replacement of Class F Fly Ash and Areca Nut Fiber Reinforcement

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Abstract Alkali activation has received great attention for improving the soil properties with suitable precursor materials. Industrial byproduct class F fly ash was suitably utilized to improve Black Cotton (BC) soil properties along with ordinary Portland cement by various researchers. However, the CO_2 emission associated with cement production has enforced the evaluation of alternative binders. Laboratory investigations were conducted on BC soil by admixing various fly ash dosages (0–50%) and reinforcing the mix with 0.5% areca nut fiber. Alkali activator solution prepared using 8 molar sodium hydroxide solution (SH) and sodium silicate solution (SS) at 1.5 SS/SH ratio showed significant improvement in Unconfined Compressive Strength (UCS) of stabilized BC soil on 7 and 28 days curing. The reinforcement was effective in improving the flexural strength of stabilized mixes. Exorbitant unsoaked California Bearing Ratio (CBR) values were observed on 28 days of curing. However, the samples could retain low soaked CBR values despite reinforcement. Scanning Electron Microscope (SEM) images showed the reduction of shrinkage cracks and strong bonding of fibers in the stabilized mix. X-Ray Diffraction (XRD) patterns evidenced the formation of various hydration products due to the alkali reaction, which resulted in the high strength gain of mixes at ambient temperature curing. The leaching of mineral constituents from the set mix lead to the failure of durability samples. Due to nondurability, the alkali activation with a selected precursor cannot suit pavement materials requirements.

Keywords Alkali solution · Black cotton soil · Strength · Durability · SEM · XRD

1 Introduction

The stable and durable foundation soils are essential for the construction of any civil engineering structure. Soil stabilization is widely used to improve desirable properties of soil with various cementitious and marginal materials. In the recent

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