Novel Fly Ash based One-part Geopolymer for Stabilization of Expansive Road Subgrade

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Expansive soils present significant challenges in road construction on account of their volumetric changes and low unconfined compressive strength (UCS). The conventional technique for soil stabilization entails the use of a chemical stabilizer like ordinary Portland cement (OPC), which is the most commonly used binder. However, the sustainability of OPC is hindered by greenhouse gas emissions. Alkali-activated geopolymers have emerged as sustainable alternatives. Geopolymers, which are formed by activating aluminosilicate precursors in an alkaline environment, come in one-part (OP-G) and two-part (TP-G) forms, with OP-Gs offering convenience and lower costs for transportation over TP-Gs. This study aims to evaluate the strength and swell characteristics of an expansive road subgrade material stabilized with OP-G. First, a comprehensive experimental program was undertaken for the mix optimization of OP-G stabilized soil based on UCS and cost. Altogether 16 UCS tests were conducted by varying binder/dry soil and solid NaOH/Fly ash (FA) ratios. Based on the findings, the optimal OP-G mix was determined at binder/dry soil = 0.2 and solid NaOH/FA = 0.1. In the second part of the study, the strength and swell characteristics of the optimum OP-G were compared with the optimum TP-G and OPC mixes. Laboratory tests, including the Atterberg limits, swell pressure, UCS, and California bearing ratio (CBR), were conducted on all three stabilized mixtures. The UCS values of the OP-G, TP-G, and OPC-treated samples were 1.23, 0.98, and 2.77 MPa, while the CBR values were 24%, 16%, and 81% respectively. All three stabilizers satisfied the ICTAD requirements for subgrade materials (UCS from 0.75 MPa to 1.5 MPa and CBR ≥ 15%). Despite the superior UCS and CBR of OPC, the OP-G can be a viable alternative, surpassing OPC in swell control and environmental impact. The outcomes reflect the effectiveness of OP-G in stabilizing expansive road subgrades.

Keywords: Expansive Soil, Fly Ash, One-Part Geopolymer, Soil Stabilization, Strength

The authors gratefully acknowledge the financial support provided by the University Research Grant No. URG/2023/15/E.