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Effects of Industrial and Agricultural Recycled Waste Enhanced with Lime Utilisation in Stabilising Kaolinitic Soil

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Abstract: Soft kaolin clay is a problematic soils encountered in various construction projects that lead to the implementation of soil stabilisation. On the other side, the massive production of industrial and agricultural waste currently presents a critical problem for the environment. However, the utilisation of industrial and agricultural wastes in altering the characteristics of kaolinitic soil can be considered as an ideal solution to enhance the characterisation of problematic soils in the field of construction. Therefore, this study examines the alterations of the engineering properties of soft kaolin clay by utilising silica fume as the industrial by-product and eggshell ash as the agricultural by-product enhanced with lime use. To assess the impact of silica fume, eggshell ash, and lime on the various characteristics of kaolinitic soil, a series of laboratory experiments containing Atterberg limits, specific gravity, compaction test, unconfined compression test, X-ray fluorescence, X-ray diffraction, sieve analysis, and field emission scanning electron microscope is carried out. In this study, 2%, 4% and 6% of silica fume, 3%, 6% and 9% of eggshell ash and lime and the optimal combination of SF, ESA with 3%, 6% and 9% of lime are used and were cured for 1, 7, 14 and 30 days. The results present that the optimal utilization of silica fume, eggshell ash, and lime can alter the engineering characteristics of the soft kaolin clay by reducing the specific gravity, consistency limits, linear shrinkage, and maximum dry density, while increasing the value of shrinkage limit, and optimum moisture content. In terms of strength improvement, the highest unconfined compression strength was recorded when soft kaolin clay was treated with 6% silica fume, 6% eggshell ash and 9% of lime for four (4) different days of curing with a strength improvement of 81.03%, 82.46%, 88.49% and 88.74%. Therefore, this study concludes that optimal use of silica fume, eggshell ash, and lime can persistently alter the characteristics of kaolinitic soil and open the way to economical and sustainable materials in improving the problem soil.

Keywords: Eggshell ash, lime, silica fume, soft kaolin clay, soil improvement

1. Introduction

Kaolinitic soil is among the complex soils faced in construction projects (Ishak & Zaini, 2018) and recognized for its problematic characteristics due to the volumetric alterations corresponding to the modifications in the dampness regime (Goh et al., 2020). Some of the main engineering characteristics and resistance problems associated with these soil forms include severe settlement, low welding resistance, insufficient plasticity, greater compressibility, dispersion, expansion, erosion, and resistance to climate variables (Hasan et al., 2021a). Furthermore, the consequent calamities and estimated expenses of recovery and reconstruction of structures based on the problematic soils are a national concern (Zolkepli et al., 2019). Kaolin among the most common types of clay minerals (Zolkepli et al., 2018). Kaolin are the most sensitively distributed high-resistance clays between each other (Zaini et al., 2023). Hence, unstable soils,

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