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Enhancing the Mechanical Performance of Earthen Materials by Ultrasonic Dispersion of Clay

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ABSTRACT

The study proposes an ultrasonic dispersion method to increase dispersed clay particles in soil resources used for earthen construction, examines the method's performance, and assesses whether the method enhances the mechanical performance of earthen materials. The proposed method utilizes an ultrasonic bath treatment to disperse flocculated clay aggregates and detach clay particles adhered to coarser grains. The soil-to-water ratio and mixing duration were optimized by checking the clay enrichment amount through methylene blue testing. The success of the method was verified through particle size distribution analysis, consistency limit tests, and linear shrinkage measurements, followed by compressive and flexural strength testing of earth block samples reinforced with 1% straw by weight produced from both untreated and treated soils. Three soil resources exhibiting distinct mineralogical compositions—one rich in montmorillonite, one rich in kaolinite, and one containing a mixture of montmorillonite and kaolinite—were investigated to evaluate the influence of clay type on the efficiency of ultrasonic dispersion and its contribution to mechanical behavior. Ultrasonic dispersion succeeded in raising insufficient clay content to acceptable levels in soil resources, having appropriate consistency limits, to be used for earthen construction. The treated earth block samples exhibited improvement in compressive and flexural strengths with an increase up to 91% and 148%, respectively. The ultrasonic dispersion method proved to be effective, particularly for montmorillonite-rich soils, in which the proportion of clay-sized particles below 2 μm increased to 38%. The method was found to be effective for improving the quality of soil resources used in earthen construction.

Keywords: Clay, ultrasonic treatment, methylene blue testing, consistency limits, mechanical performance.