

Technological Development of Earth Building Materials with Enhanced Performance Using Biomaterials



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ABSTRACT

In the discourse of sustainable architecture, earth building materials are re-attributed strategic importance due to their low embodied energy potential, recyclability, and hygroscopic properties that regulate indoor air quality. However, the sensitivity of raw earth to water, its low mechanical strength, and the risk of shrinkage-induced deformation limit the standardization of the material on an industrial scale. This article aims to examine current technological developments in which the physical, mechanical, and durability performance of earth materials are improved through biopolymer additives, natural fiber integration, and hybrid stabilization techniques.

Within the scope of the study, the roles of biopolymers such as xanthan gum, chitosan, chitin, and alginate in soil stabilization, as well as gypsum and lime-based hybrid stabilization (Alker) technologies, were evaluated through literature review and experimental data analysis. Analyses reveal that biopolymers strengthen soil cohesion through hydrogen bonds formed with clay particles and hydrogel formations filling the pores; reducing material permeability by up to 30 times while increasing shear strength by 10-15%. It has been observed that vegetable and animal fibers integrated into the matrix reduce thermal conductivity by lowering density and minimize crack formation by preventing drying shrinkage. Furthermore, it was determined that Alker technology increases earthquake energy damping capacity by imparting ductility to the material, while "self-healing" smart earth composites working on the principle of microbial induced calcite precipitation (MICP) can autonomously repair micro-cracks.

In conclusion, this study validates the potential of earth material as a high-performance, ecological alternative compatible with modern building codes and suitable for industrial production, within the axis of upcycling excavation soil and strengthening it with biotechnological methods.

KEY WORDS:

Earth building materials, biopolymer, soil stabilization, Alker technology, self-healing, sustainable architecture.