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From By-product To Brilliance: Transforming Adobe Brick Construction Using Meat Industry Waste-derived Glycoproteins

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Abstract : Earth is a green building material with very low embodied energy and almost zero greenhouse gas emissions. However, it lacks strength and durability in its natural state. By responsibly sourcing stabilisers, it's possible to enhance its strength. This research draws inspiration from the robustness of termite mounds, where termites incorporate glycoproteins from their saliva during construction. Biomimicry explores the potential of these termite stabilisers in producing bio-inspired adobe bricks. The meat industry generates significant waste during slaughter, including blood, skin, bones, tendons, gastrointestinal contents, and internal organs. While abundant, many meat by-products raise concerns regarding human consumption, religious orders, cultural and ethical beliefs, and also heavily contribute to environmental pollution. Extracting and utilising proteins from this waste is vital for reducing pollution and increasing profitability. Exploring the untapped potential of meat industry waste, this research investigates how glycoproteins could revolutionize adobe brick construction. Bovine serum albumin (BSA) from cows' blood and mucin from porcine stomachs were the chosen glycoproteins used as stabilisers for adobe brick production. Despite their wide usage across various fields, they have very limited utilisation in food processing. Thus, both were identified as potential stabilisers for adobe brick production in this study. Two soil types were utilised to prepare adobe bricks for testing, comparing controlled unstabilised bricks with glycoprotein-stabilised ones. All bricks underwent testing for unconfined compressive strength and erosion resistance. The primary finding of this study is the efficacy of BSA, a glycoprotein derived from cows' blood and a by-product of the beef industry, as an earth construction stabiliser. Adding 0.5% by weight of BSA resulted in a 17% and 41% increase in the unconfined compressive strength for British and Sudanese adobe bricks, respectively. Further, adding 5% by weight of BSA led to a 202% and 97% increase in the unconfined compressive strength for British and Sudanese adobe bricks, respectively. Moreover, using 0.1%, 0.2%, and 0.5% by weight of BSA resulted in erosion rate reductions of 30%, 48%, and 70% for British adobe bricks, respectively, with a 97% reduction observed for Sudanese adobe bricks at 0.5% by weight of BSA. However, mucin from the porcine stomach did not significantly improve the unconfined compressive strength of adobe bricks. Nevertheless, employing 0.1% and 0.2% by weight of mucin resulted in erosion rate reductions of 28% and 55% for British adobe bricks, respectively. These findings underscore BSA's efficiency as an earth construction stabiliser for wall construction and mucin's efficacy for wall render, showcasing their potential for sustainable and durable building practices.

Keywords : biomimicry, earth construction, industrial waste management, sustainable building materials, termite mounds.
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