

Fabrication of Green Composites from Waste Paper-Based Materials for Thermal Insulation Applications”

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Abstract

This study explores the development of sustainable bio-composite sound-absorbing panels derived from paper waste, paper mulberry (Sa) fibers, and perlite, aiming to enhance thermal insulation performance while utilizing recycled cellulose-based resources. The integration of agricultural fibers and lightweight mineral fillers provides a potential alternative to conventional synthetic insulation materials. Five formulations with a constant total mass of 600 g were prepared by varying the weight ratios of paper waste, paper mulberry fibers, and perlite from 60:20:20 to 80:10:10. Panels were produced using a hand-forming casting technique and dried at ambient conditions to achieve controlled density and porous microstructures. Thermal conductivity ranged from 0.043 to 0.058 W/m·K, which is comparable to lightweight insulating materials. Increasing paper content resulted in a gradual rise in thermal conductivity due to densification and reduced pore connectivity. Among the tested compositions, the 65:17.5:17.5 ratio demonstrated a balanced combination of thermal and mechanical properties, whereas the 70:15:15 formulation exhibited improved structural stability, indicating suitability for practical fabrication. The addition of perlite enhanced air entrapment and reduced heat transfer, while paper mulberry fibers contributed to mechanical reinforcement. Sound absorption, flexural strength, and compressive strength were further evaluated to confirm multifunctional performance. The findings highlight the feasibility of producing low-cost, sustainable insulation panels from waste-derived materials for building and acoustic applications.

Keyword: Bio-composite materials, Sound absorption, Thermal insulation, Mechanical strength, Waste paper, Mulberry fiber, Perlite, Porous structure, Sustainable materials, Acoustic panels