

A SYSTEMATIC REVIEW OF LIFE CYCLE ASSESSMENTS FOR LOW-CARBON CONSTRUCTION MATERIALS

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Abstract:

The global construction industry is a predominant contributor to climate change and resource consumption; this is mainly because it uses a lot of carbon-heavy materials like concrete and steel. To systematically evaluate the true sustainability claims of alternatives, this study conducts a systematic review of Life Cycle Assessment (LCA) studies to examine the environmental and health impacts of low-carbon construction materials like cross-laminated timber (CLT), hempcrete, geopolymers, and recycled aggregates. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a literature search across major databases identified nine peer-reviewed publications (2010–2025) meeting strict inclusion criteria. The analysis consolidated evidence on carbon dioxide (CO₂) reduction potential, health implications, and implementation challenges. Results indicate that low-carbon materials can significantly lower emissions. CLT emits approximately 9% less CO₂ than conventional concrete, geopolymers reduce emissions by 9–60%, and bio-based materials like hempcrete enable carbon sequestration. Health co-benefits include improved indoor air quality (e.g., 30% fewer volatile organic compounds) and enhanced occupational safety. However, barriers such as cost, regulatory gaps, and industry resistance hinder widespread adoption. The findings affirm that low-carbon materials can reduce both a building's Global Warming Potential (GWP) and its health hazards. Key recommendations include policy improvements (e.g., carbon pricing and subsidies), standardization of LCA methods, and the integration of health metrics into green building certifications. Future research should focus on quantifying health co-benefits and developing scalable strategies adaptable to diverse economic context.

Keywords: Low Carbon Construction Materials, Life Cycle Assessment, CO₂ Emissions, Sustainable Building, Indoor Air Quality, Circular Economy

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