Research of Bio-Waste Influence on Bio-Composite CO_2 Emission

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Abstract

The increasing focus on sustainable development has driven significant research into reducing the carbon footprint of construction materials. Traditional building materials like concrete are major contributors to CO_2 emissions, prompting the exploration of bio-composites as greener alternatives. Bio-composites, incorporating bio-waste, offer a potential pathway to sequester carbon and reduce reliance on conventional materials. Studies have investigated the use of wood waste [1, 2], bamboo [3], and biochar [4] in bio-concrete and cement-based composites to improve their environmental performance. The integration of these materials aims to not only reduce CO_2 emissions but also contribute to a circular economy by utilizing waste streams [1]. Life cycle assessment (LCA) plays a crucial role in evaluating the true environmental impact of these bio-composites [2, 5]. Understanding the CO_2 emission profiles of bio-waste-incorporated composites is essential for their wider adoption and contribution to climate change mitigation. This research delves into the influence of different bio-waste materials on the CO_2 emission of bio-composites, providing valuable insights for sustainable construction practices.

This research investigates the potential of pressed bio-composites made from wood sawdust, aiming for sustainable construction materials. It explores varying compositions using cement, lime, sand, and shale ash to achieve optimal mechanical properties and reduce CO_2 emissions. The study comprehensively examines the effect of chemical solutions (water, aluminum sulphate, calcium hydroxide, calcium chloride) on sawdust treatment and the use of cement, lime, sand content and shale ash replacement, followed by evaluations of air-drying, CO_2 chamber conditioning, and ambient curing processes. The results highlight the importance of a strategic mix design that balances mechanical strength and environmental impact.

The research demonstrates that wood sawdust, treated with water, proved superior as an aggregate, where the mixture significantly improved compressive strength (44%) and density (14%) by adding 20% of 0.4 mm sand to the cement-water mixture. Partially replacing cement with shale ash, wood sawdust and sand significantly improved the material; this resulted in a 55% higher compressive strength and 7% greater density, while offering cost savings and reducing environmental impact.

Carbonization, in conjunction with specific curing processes (air drying, CO_2 chamber conditioning and ambient curing) showed enhanced mechanical properties and durability, with an increase of compressive strength of 12% and the density increased 2%, due to the improved bio-composites (that are both dry and submerged). Despite the fact that 30% of portland cement was replaced with shale ash, it was possible to achieve a compressive strength of the bio-composite of up to 9.60 MPa. because it is not normal, that the down reduction of strongest binder like portland cement could increase the strength so much.

Overall, the study underscores the viability of producing environmentally friendly and durable construction materials by combining wood waste with locally available resources. The outcomes contribute valuable insights into sustainable building practices, showcasing the potential for bio-composites as an alternative to conventional materials. Determination of CO_2 emission have showed that with sawdust and shale ash is possible to achieve about zero carbon emission level.

Keywords

Bio-composite, wood sawdust, shale ash, blocks, eco-friendly materials, CO_2 emission.