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Sustainable use of coco pith in cement-sand mortar for masonry block production: Mechanical characteristics, durability and environmental benefit

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ABSTRACT

The present study performs a comprehensive analysis that includes the assessment of mechanical and durability characteristics of cement blocks, cost-effectiveness and eco-benefit analysis of incorporating coco pith in the production of cement blocks. As coco pith is often considered waste material and dumped in landfills, the usage of coco pith in cement blocks is encouraged to promote sustainable construction practices. In this study, a total of 504 cubes (100 mm × 100 mm × 100 mm) and 24 blocks (200 mm × 100 mm × 60 mm) were prepared. The samples were tested with mortar containing 0, 4, 6 and 8% of coconut coir as a fraction of cement weight. Experimental programs conducted on fresh and hardened mortar included determining workability and setting time; physical parameters such as densities at different moisture conditions and water absorption rates; mechanical characteristics including compressive strength at different moisture conditions and flexural tensile strength; durability aspects such as sorption, evaporation rate, resistance against wet-dry cycle, and resistance against the severe environmental condition. In addition, to evaluate the cost-benefit and sustainability of coco pith incorporation in cement-sand blocks, the material consumption, embodied energy and CO2 emission for mortar mixes production was calculated. Results showed that the inclusion of 4% coco pith in the mortar increased air-dried compressive strength by 8% compared to that of the control mortar. However, further increase in coco pith content decreased compressive strength. For 6% and 8% coco pith content, the decrease in compressive strength was 3% and 25%, respectively. A similar trend was observed for the flexural strength of mortar blocks. However, even for mortar with 8% coco pith content, the flexural tensile strength was higher than that of the control mortar. Higher coco pith content in mortar tended to increase water absorption and sorption by capillary action. Still, for cement mortar with 4% coco pith content, both water absorption rate and sorpitivity were within the allowable limit. When cost per unit volume per strength was considered, mortar with 4% coco pith was more beneficial as it was 11.7% lesser than that of the control mortar. When energy consumption and carbon emission per unit volume per strength were considered, mortar with 4% coco pith was more effective as it was 11.6% and 11.5% lesser than that of the control mortar, respectively. So, it is recommended to use coco pith up to 4%, which provides better mechanical characteristics and sustainable production without compromising important durability properties.

1. Introduction

A significant proportion of the world population lives in housings made of masonry because of its low cost and construction easiness, especially in developing countries. In addition, masonry structures depict a long-lasting architectural appearance. Cement and river sand combination is generally used for masonry block production (Poorveekan et al., 2021). Published literature exhibit that there are several supplementary cementitious materials such as fly ash (Jiang et al., 2020b), waste glass powder (Jiang et al., 2020a, 2022), rice husk ash (Jittin et al., 2020), metakaolin (Raheem et al., 2021) and lime (Sathiparan, 2021) that have been used for sustainable production of construction materials. Meanwhile, recent infrastructure development that takes place in many countries has increased the demand for river

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