Materialia 21 (2022) 101309

Contents lists available at ScienceDirect

Materialia

journal homepage: www.elsevier.com/locate/mtla

Mechanical performance and durability of banana fibre and coconut coir reinforced cement stabilized soil blocks

Kirupairaja Thanushan [a], Navaratnarajah Sathiparan [b,*]

[a] Department of Civil Engineering, New Mexico State University, United States
[b] Department of Civil Engineering, University Jaffna, Kilinochchi, Sri Lanka

ARTICLE INFO

Keywords:
Mortar
Recycling and reuse of materials
Fibre-reinforcement

ABSTRACT

Agricultural waste disposal is said to be amongst one of the pressing environmental problems in many countries. Finding economical usage for this waste by incorporating it in a product is the approach often used to overcome associated environmental issues. Banana fibre and coconut coir are major agricultural waste products in Sri Lanka and fewer amounts of these are converted into usable products. Manufacturing cement-stabilized soil blocks incorporating these waste materials is envisaged to reduce environmental impact. The present study focused on the post-peak behaviour and durability of banana fibre and coconut coir-strengthened cement-stabilized soil blocks. Banana fibre and coconut coir reinforced cement-stabilized soil blocks were tested for compression, flexural bending, water absorption, sorptivity, resistance against chemicals, wet-dry weathering and freeze-thaw weathering. The banana fibre showed better post-peak behaviour in compression and coconut coir showed better post-peak behaviour in flexural. Both fibre reinforcements improved durability of cement block against acid attack, alkaline attack, wet-dry weathering and freeze-thaw weathering. Moreover, the specimen reinforced with coconut coir was found to exhibit better durability compared to the specimen reinforced with banana fibres.

1. Introduction

Cement blocks are one of the major construction materials employed in housing construction. It is easy to produce with desired compressive strength. In the recent years, the construction industry has been facing challenges in producing cement blocks due to inadequate supply of river sand. River sand is a fine aggregate constituent used in the production of concrete and cement-sand blocks. In Sri Lanka, to meet the demand for river sand, there were overexploitation of sand along the river beds in the past. This has led to several harmful consequences such as the increased depth of river beds, lowered water tables and disappearance of aquatic lives from freshwater [1]. Due to that, Geological Survey and Mines Bureau (GSMB) of Sri Lanka introduced the current Mines and Minerals Act No. 33 [2], which regulates the extraction of the river sand from river beds. This regulation has further increased scarcity of river sand. The possible solution to this is to focus on environmental friendly construction materials such as compressed earth cement blocks or cement-stabilized earth blocks [3]. The widely available raw material for stabilized earth block is lateritic soil can be obtained from many places and therefore less transportation is required. However, there are major issues including brittle behaviour and durability to be addressed before employing cement-stabilized earth blocks for construction [4]. This issue may be overcome by incorporating fibres in the production process of the cement-stabilized earth blocks.

On the other hand, agricultural waste disposal is an environmental problem in several countries. Incorporating this waste into a product is one approach that has been commonly used to overcome pertaining environmental issues. One of the by-products of agricultural waste is natural fibres. Natural fibres extracted from coconut, banana, sugarcane, jute, sisal, oil palm and flex have been used in cementitious material. The purpose of incorporating fibres in cementitious material is to improve ductility, toughness and flexibility. The literature indicates that both natural fibres and synthetic fibres have been incorporated in the production of cementitious material [5–11]. Even though synthetic fibres showed better performance, using natural fibres is beneficial as they are readily available, inexpensive, of low density, biodegradable, energy-efficient and eco-friendly [12].

Several research studies have been carried out with fibre-reinforced concrete. In the context of research work carried out on masonry blocks, the majority of research has been done with cement-sand blocks [13–16] and adobe [17–19]. However, investigating the suitability of fibre-reinforced and cement-stabilized soil blocks are scarce. Of this, most of the works have focused on determination of its strength capacity and only a few works have reported on the post-peak behaviour of cement-stabilized soil blocks [20].

* Corresponding author.
E-mail address: sakthi@eng.jfn.ac.lk (N. Sathiparan).

https://doi.org/10.1016/j.mtla.2021.101309
Received 17 June 2021; Accepted 22 December 2021
Available online 29 December 2021
2589-1529/© 2021 Acta Materialia Inc. Published by Elsevier B.V. All rights reserved.