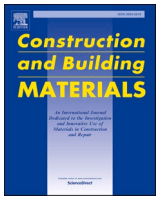
Construction and Building Materials 393 (2023) 132058

Contents lists available at ScienceDirect

Construction and Building Materials

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



Potential use of groundnut shell ash in sustainable stabilized earth blocks

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ARTICLE INFO

Keywords:
Masonry
Stabilized earth block
Cement
Groundnut shell ash
Sustainability

ABSTRACT

Cement is generally used as a stabilizer for the production of stabilized earth blocks, which has become more popular due to its cost-effectiveness and eco-friendliness. However, cement is infamous for being environmentally unfriendly because of higher energy use during its production and significant emissions of CO_2 cum other greenhouse gases. Cement alternatives have so attracted a lot of interest in recent years. Groundnut shell ash (GSA) is one of the potential waste materials to be used for cement replacement. This article includes an experimental investigation on the properties of stabilized earth blocks using GSA as a cement substitute. The percentage by mass of the total binder in the stabilized earth block that has replaced with GSA content is 0%, 10%, 20%, 30%, and 40%. The experiments on stabilized earth blocks investigate the physical, mechanical, durability properties and thermal performance as well as cost-effectiveness and eco-benefit analysis. Results show that, even though the strength of stabilized earth blocks decreases with GSA content, it improves the thermal performance, lowers the production cost and reduces the CO_2 emission and embodied energy. The conclusions of the study suggest that stabilized earth blocks based on GSA have some promise for significantly reducing the amount of cement needed in the building sector.

1. Introduction

Masonry is one of the oldest construction materials, still extensively used in house unit construction. Fired clay brick and concrete blocks are generally used for masonry because of their favourable characteristics such as being manufactured locally, being produced with desirable strength, exhibiting excellent resistance against fire, having a pleasing aesthetic appearance and having a minimal need for maintenance [1,2]. But, on the other side, both fired clay bricks and concrete blocks are neither cost-effective nor eco-friendly [3]. The usage of agricultural soils and high emissions from combustion are problems pertained to the manufacturing of fired clay bricks. River sand cum cement were needed to cast cement sand blocks. However, extreme scarcity of river sand, and the energy-intensive and high CO_2 emission involved in cement manufacturing process are the major issues in concrete block production [4]. Lately, there is a lot of focus on earth-based masonry units for house construction such as rammed earth walls, compressed earth blocks and cement-stabilized earth blocks.

Earth construction is considerably inexpensive than conventional building methods. This is because the materials are easily accessible and require minimal processing. Also, it is highly sustainable as the materials used are natural and biodegradable and it is a great insulator and helps to keep the interior of the building cool in summer and warm in winter [5]. Soil, which is a blend of gravel, sand, silt, and clay, is the major component of rammed earth. Before being rammed in-situ between formwork, this mixture is wetted until it has the correct moisture level. Rammed soil becomes substantially stronger over time as it dries out [6]. Bui and Morel [7] demonstrated that raw earth elements are fully recyclable without any loss along the value chain and precisely align with the concepts of the circular economy. However, a few unfavorable characteristics exist, including poor dimensional stability, a loss of strength when saturated with water, and erosion from wind or driving rain. By adding a chemical substance or bio-stabilizers to the soil, these problems can be considerably reduced [8-10]. Lime and cement are widely used as chemical stabilizers for earthen construction [11,12].

However, the production of lime and cement is an energy-intensive process, and hence the use of lime and cement raises the embodied energy of the stabilized earth materials [13]. Due to the chemical processes that change earth construction into cementitious material, it also has issues with recycling. Additionally, several investigations confirm that lime and cement-based stabilization can change the material's hygrothermal characteristics by lowering its vapor permeability and moisture

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https://doi.org/10.1016/j.conbuildmat.2023.132058
Received 29 November 2022; Received in revised form 24 April 2023; Accepted 2 June 2023