Materialia 21 (2022) 101324

Contents lists available at ScienceDirect

Materialia

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

Quarry dust as river sand replacement in cement masonry blocks: Effect on mechanical and durability characteristics

Kosalya Sundaralingam, Arvinthan Peiris, Arulanantham Anburuvel, Navaratnarajah Sathiparan*

Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Sri Lanka

ARTICLE INFO

Keywords:
Cement blocks
River sand
Quarry dust
Strength
Durability

ABSTRACT

Natural sand or river sand constitutes as major fine aggregate in cementitious construction. Especially, masonry block production requires 70–90% sand as raw material. While the demand for river sand increases rapidly, the supply of good quality river sand is limited due to the restrictions in sand mining in river beds. Because excessive extraction of river sand to cater the increasing demand has brought undesirable environment-related consequences. The persisting issues encouraged the researchers to find a sustainable alternative for river sand. Quarry dust is one of the alternatives as it has some advantages over river sand such as better contribution to the strength of the cementitious material, better workability, lesser cement consumption and eco-friendly. The present study explored the feasibility of using quarry dust as fine aggregate in manufacturing cement blocks. Cement blocks with four different quarry dust composition levels 0, 33.3%, 66.7 and 100%, were prepared and tested. The testing included determination of mechanical characteristics (compressive and flexural strength) and durability aspects (sorption, evaporation, wet and dry cycle, resistance against salt, alkaline and acid solution). The test results exhibited that mechanical characteristics and resistance against wet and dry cycles improved when quarry dust completely replaced river sand as fine aggregate. When quarry dust content increased, the cubes subjected to severe environmental conditions exhibited higher strength reduction rates compared to that of normal environmental condition. The final strength, however was higher than the corresponding cubes with river sand. In addition to strength improvement, quarry dust replacement yielded lesser cost and sustainable benefits, which would promote the deployment of quarry dust in cement-sand block production.

1. Introduction

Cement-sand mix is primarily used as a construction material for house construction around the world. Typically, river sand is widely deployed in the mix as fine aggregate which constitutes from 70 to 90% by weight of the total cement-sand mix. With the escalating construction activities, the demand for river sand steadily increases, in contrast, the supply of good quality river sand becomes scarce due to the heightened controls by the authorities to prevent overexploitation of river sand. Uncontrolled extraction of sand from river beds has led to various environmental consequences [1]. Thus, the persisting issues in inadequate supply of river sand stimulated researchers to find an appropriate substitution for river sand.

Generally, in masonry blocks, sand is being partially substituted with wastes such as industrial waste, agricultural waste, and sand from resources other than river beds. There are several industrial wastes used as sand replacement in masonry block production such as construction and demolition waste, bottom ash, fly ash, copper slag, glass powder, waste marble powder, granulated blast furnace slag, granite sawing waste, quarry dust, cotton waste, paper mill waste, and crumb rubber [2–15]. Findings from the published literature show that masonry blocks incorporating these industrial wastes as partial replacement for sand satisfied the standard requirements pertaining to compressive strength and water absorption. However, the process of converting the said materials into fine aggregates is a costly process, involves great energy. Also, supply of these industrial waste materials is limited, which is inadequate to meet the demand for fine aggregates.

In another context, several studies have focused on the utilization of agricultural wastes as sand replacement in the production of masonry blocks. Agricultural wastes such as straw, rice husk, sawdust, peanut shell, coconut shell and processed tea waste were considered as potential replacements in these studies [16–22]. The findings from these studies revealed that masonry blocks prepared with agricultural waste as partial replacement for sand, fulfilled the minimum strength requirements stipulated in standards [23]. However, durability of these blocks under extreme environmental conditions is of great concern, especially the high water absorption rate and limited resistance against chemicals prevent such blocks being used in wall construction [21]. Despite the pertaining issues pointed out, masonry blocks with industrial waste and

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

https://doi.org/10.1016/j.mtla.2022.101324
Received 22 September 2021; Accepted 9 January 2022
Available online 10 January 2022