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Utilization of agro-waste groundnut shell and its derivatives in sustainable construction and building materials – A review

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ABSTRACT

In recent years, there have been extensive focus on using agricultural waste in construction and building materials as substitution alternatives for cement, fine aggregate and coarse aggregate. One such agro-waste is groundnut shell, a by-product of groundnut (peanut). Even though some amount of groundnut shell is converted into value-added products, a fraction of it is still being disposed as waste. The present review investigates the published work pertaining to the use of groundnut shell and its derivatives in construction and building as substitution for cement in concrete and cement mortar; stabilizer for soil, pavement and bricks; precursor for alkali-activated binder; fine aggregate in concrete and masonry blocks. In addition, the article discusses the potential use of groundnut shell and its derivatives, physical properties and chemical composition of groundnut shell ash, and eco-benefits of using groundnut shell and its derivatives as cement and aggregate substitution. It is obvious that certain areas such as microstructural and mineralogical investigation of the groundnut shell ash blended construction materials and the usage of groundnut shell ash in other construction and building materials such as fired-clay bricks, stabilized earth blocks, tile, alkali-activated composites and pavement blocks remain least explored. The comprehensive knowledge provided in this article is anticipated to assist in the selection of appropriate manufacturing aspects, which will improve the agro-waste usage in construction materials on an industrial scale. The connected academics and professionals involved in the building, waste management, sustainable development, resource conservation, and recycling industries will gain from it. Moreover, this review would assist the development of code of practices pertaining to the use of agro-wastes, and thus persuade the concerned personnel to switch to sustainable construction practices.

1. Introduction

Cement production is one of the major contributors to carbon dioxide (CO_2) emissions. It is responsible for 8% of the global artificial CO_2 emission. More than 4 billion metric tons of cement are produced [1]. China and India are the major cement producers, covering almost two-thirds of cement production worldwide. Fig. 1 illustrates the annual cement production during the last 25 years and country-wise cement production in 2021 [2]. For the fabrication of every ton of cement, around 900 kg of CO_2 is emitted [3].

The high level of CO_2 emission happens when burning fossil fuels to generate heat to initiate the cement manufacturing process and thermal decomposition of calcium carbonate in the progression of manufacturing cement clinker. During this process, 30–40% is derived from burning fuels and 60–70% result from decarbonation [4–7]. Although cement production contributes to a significant

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