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Fresh and mechanical properties of concrete containing recycled fine aggregate as partial sand replacement

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ABSTRACT

Concrete is one of the world's oldest established construction materials, having been employed in the creation of various structures throughout history. Due to increased demand, the materials used in concrete buildings, particularly granite aggregates and natural sand, are rapidly decreasing. Continuous use of these natural resources has a detrimental effect on the ecosystem. Simultaneously, concrete waste from construction and demolition waste (CDW) created landfills and environmental damage. Therefore, recycled fine aggregate (RFA) was utilized in this research to replace natural sand. This experiment used a total of five mixtures. Mixes with RFA replacement amounts of 0%, 10%, 20%, 30%, and 40% were cast and subjected to water curing. The slump test, compressive test, and water absorption test were done for concrete containing various percentages of RFA. Incorporation of RFA up to 20% enhances the concrete strength. Generally, concrete produced using RFA up to 40% exhibits water absorption not exceeding 10% enabling it to be categorized as good quality concrete. The approach of channeling concrete waste to be utilized as recycled fine aggregate would decrease waste dumping at landfill and mining of sand from local rivers.

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1. Introduction

Concrete is commonly employed in the construction of most buildings, bridges, and other structures across the globe. Globally, this building material is the second most consumed material after water [1]. In addition to its numerous benefits, concrete has several well-known drawbacks, one of which is its excessive aggregate consumption. Up to 80% of the volume of concrete is made up of aggregates. The raw materials used in concrete include water, fine aggregate, and coarse aggregate. Fine aggregate, sometimes referred to as river sand, is produced by rivers. Sand and gravel, which are essential raw building materials, have been extracted in vast amounts from riverbeds as a result of rapid growth, urbanisation, and industrialisation [2]. In contrast, as previously demonstrated in considerable studies [3] unlawful and indiscriminate sand mining can cause major problems in local habitats and aquatic ecosystems. Today's building sectors are on the lookout for alternative materials that will help them save construction costs. Various forms of waste material may be replaced as a possible building material and utilized in a variety of construction projects after processing and treatment [4]. However, not all waste materials can be reused as construction materials or even processed. Thus, study and experimentation are necessary to determine the efficacy and potential of waste reuse in the building business.

As the world's population continues to rise, the need for adequate housing, sanitation, and healthcare is critical to its well-being [5]. Concrete is the preferred building material to meet this requirement, but its production results in the unsustainable removal of natural resources like sand and gravel, which causes environmental disasters in the areas where they are used [6]. Concrete waste may be found all over the world, especially in locations where the built environment is growing rapidly and where concerted assaults, earthquakes, or extreme weather events have occurred. The EPA estimated that the United States produced about 136 million tonnes of construction debris related to buildings in 1996 [7]. Approximately one-third of landfill waste in the United States is made up of construction and demolition (C&D) debris

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