Performance Evaluation Of Waste Aac Block Fine Aggregate Partially Replaced In Cement Mortar And Addition Of Natural Coir Fibres

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1.*ABSTRACT:*

AAC blocks are lightweight, thermally insulating materials used in modern construction, made from lime, cement, water, aluminum powder, calcined gypsum, and quartz sand. However, significant waste is generated during construction, processing, and transport, especially leftover pieces called bats, which are often discarded. Due to their low load-bearing capacity and environmental impact, proper reuse methods are needed.This study explores recycling waste AAC blocks as a partial replacement for sand in mortar (0%, 25%, 50%, 75%) and evaluates their compressive strength. Additionally, coconut (coir) fibers—a renewable and thermally resistant material—were added in varying percentages (0%, 0.5%, 1%, 1.5%) to enhance strength and performance of cement mortar.

KEYWORDS:AAC WASTE,COCONUT COIR FIBRE,CEMENTMORTAR,,SAND REPLACEMENT.

2.INTRODUCTION

Autoclaved Aerated Concrete (AAC) blocks are widely used in modern construction due to their lightweight nature, ease of handling, and excellent thermal insulation properties. However, during construction and transportation, a considerable amount of AAC block waste is generated, especially in the form of unusable leftover pieces known as "bats." Improper disposal of this waste not only leads to resource loss but also contributes to environmental issues due to the high energy demands of AAC production. To promote sustainable construction, this study investigates the potential of reusing waste AAC blocks as a partial replacement for sand in cement mortar. Additionally, coir fiber, a natural, cost effective, and thermally resistant material, is examined for its ability to enhance the mechanical properties of mortar. The research aims to optimize material usage while improving strength and promoting eco-friendly building practices.

3.PROBLEM STATEMENT

Despite the widespread use of AAC blocks in construction, a significant portion of them is wasted during cutting, handling, and transportation. Leftover fragments, known as bats, are often discarded due to their irregular shapes and poor load-bearing capacity, leading to material wastage and environmental concerns. Additionally, the production of AAC blocks involves high energy consumption, further amplifying their environmental impact. Currently, there is no effective strategy for reusing this waste in construction. Similarly, natural fibers like coconut coir, which have beneficial properties, are underutilized in cement-based applications. Therefore, there is a pressing need to explore

innovative ways to recycle waste AAC blocks and incorporate coir fibers to improve mortar properties, reduce waste, and support sustainable construction practices.

4.LITERATURE REVIEW

A literature review helps in understanding previous global research, forming the groundwork for selecting suitable methodologies and experimental techniques for a new study. a) Experimental Study on Use of Waste AAC Block Powder as Fine Aggregate M. Ramesh, D. S. Patil, International Journal of Civil Engineering and Technology, 2022 – This study aimed at partially replacing fine aggregate in mortar using AAC block waste at 0%, 25%, 50%, and 75%. The test results showed that compressive strength increased up to 50% replacement, with slight reduction at 75% due to increased porosity.Workability remained moderate and density was reduced due to the lightweight nature of AAC. The research concluded that AAC block powder can be a viable partial replacement for sand in mortar production without compromising strength at optimal levels. b) Effect of Coconut Coir Fiber on Strength Properties of Cement Mortar – M. Ali, S. Ahmed, and R. Khan, International Journal of Engineering Research and Applications, 2019 This study investigated the use of coconut coir fibers in cement mortar at varying contents of 0%, 0.5%, 1%, and 1.5% by weight of cement, using a consistent fiber length of 30 mm. The results indicated that compressive and flexural strength increased up to 1% fiber content, after which a slight decrease was observed due to fiber clustering. Workability declined slightly with higher fiber additions. The researchers concluded that coir fiber can effectively improve mortar strength and promote eco-friendly, fiber-reinforced construction when used in optimal amounts.

5.MATERIALS

Materials play a crucial role in determining the quality and performance of mortar or concrete, as the final properties are largely influenced by the characteristics of the individual components. In this study, commonly used materials such as natural sand and cement were utilized, along with two alternative materials: waste AAC block fine aggregate and coir (coconut) fibers, which are not typically used in conventional mortar mixes. These materials were carefully selected to evaluate their combined effect on the mechanical and physical properties of mortar. The materials used in this project are listed below:

5.1 Cement. Cement acts as a binding agent in construction materials, playing a key role in setting, hardening, and holding other components together. In this study, Pozzolana Portland Cement (PPC), 53 grade, manufactured by Ultratech, was used. Prior to its application, various physical and chemical properties of the cement were assessed to ensure its suitability for the experimental work. These properties are discussed in detail in the subsequent chapter.

5.2 Fine Aggregate / Natural Sand. Natural sand is a widely accepted and traditionally used fine aggregate in both mortar and concrete applications. For this study, locally available river sand was utilized, meeting the requirements specified in IS 383. The sand was clean, well-graded, and free from impurities such as clay, silt, and organic matter. The particle size distribution ranged from 150 microns to 4.75 mm. Natural sand contributes significantly to workability, bonding, and strength in mortar, making it a reliable base material in the mix.

5.3 Fine Aggregate (Waste AAC Block). The utilization of waste AAC block material as fine aggregate is a key aspect of this study. Discarded AAC blocks, collected from construction sites,

were manually crushed and processed to obtain fine aggregate suitable for mortar preparation. The resulting material is white in color, lightweight, and highly porous, contributing to enhanced thermal insulation in the mortar mix. The physical properties of the prepared AAC fine aggregate were evaluated and are discussed in the following section

5.4 Coir Fiber. Coir fiber, extracted from the outer husk of coconuts, is a natural, renewable, and biodegradable material. In this study, coir fiber was incorporated into the mortar mix to enhance its mechanical properties, particularly crack resistance, flexural strength, and toughness. The coir fibers used were 30 mm in length with a diameter of approximately 0.45 mm, and were added in varying percentages by weight of cement (0%, 0.5%, 1%, and 1.5%). Before mixing, the fibers were cleaned and dried to ensure uniform distribution and proper bonding with the cement matrix. Their inclusion also supports sustainable construction practices by utilizing agricultural waste.

5.5 Water. Water used for mixing plays a vital role in the hydration of cement and the workability of mortar. In this study, fresh, clean, and potable water was used to ensure consistency and strength development. The water was free from impurities such as organic matter, silt, oil, sugar, chlorides, and acids, which could adversely affect the setting and durability of mortar. The pH value of the water was maintained close to 7.0, indicating a neutral and safe composition for cement-based mixes.

6.EXPERIMENTAL WORK,RESULT AND DISCUSSION.

The experimental program of this study aims to evaluate the performance of mortar by partially replacing natural sand with recycled AAC block powder at 0%, 25%, 50%, and 75%, and by incorporating coir fibers at 0%, 0.5%, 1%, and 1.5% by weight of cement. The objective is to assess key properties such as workability, compressive strength, and flexural strength, in order to identify an optimum mix that balances performance and sustainability. A series of tests were conducted on both the raw materials and the prepared mortar specimens to analyze the effect of the waste AAC powder and coir fibers on the overall behavior and strength characteristics of the mix. This research supports sustainable construction practices by reducing construction waste, promoting the reuse of industrial by-products, and integrating renewable natural fibers into conventional building materials.

6.1 Testing of Materials.To ensure the quality, compatibility, and suitability of materials for mortar production, a series of physical tests were conducted on the key components used in this study. The materials tested include Pozzolana Portland Cement (PPC), natural river sand, Waste AAC block powder, and coir fibers. Each material was evaluated for its physical properties in accordance with relevant standards to confirm its appropriateness for use in mortar mixes. These tests provided essential data for designing sustainable and performance-optimized mortar compositions.

6.1.1 Cement The Pozzolana Portland Cement (PPC) of 53 Grade, conforming to IS: 8112, was used in this study. It was tested for key physical properties including fineness, Specific gravity, Normal consistency, Initial and Final Setting time to ensure its suitability for mortar production. The results of these tests are presented in Table 1.

TABLE 1

Property	Values
Fineness modulus	2
Specific gravity	3.15
Normal consistency	28%

Initial setting time	39minutes
Final setting time	220minutes

6.1.2Fine Aggregate. This study utilized two types of fine aggregates: natural river sand and recycled AAC block powder. To assess their physical characteristics and suitability for mortar production, the aggregates were tested for fineness modulus, water absorption, and bulk density. All tests were conducted in compliance with IS 383:1970 standards. The detailed results of these tests are provided in Table 2.

Table 2

Property	**Results (Natural sand)**	**Results (Waste AAC FA)**
Fineness modulus	2.8	1.64
Water absorption	NIL	28%(by wt)
Bulk density	1.8kg/lit	0.81kg/lit

6.1.3 Coir Fiber.Natural coir fibers, extracted from coconut husk, were used in this study to enhance the mechanical performance of mortar. The fibers were manually cleaned and cut to a uniform length prior to mixing. To evaluate their suitability, key physical properties such as aspect ratio (length-to-diameter ratio) and Water Absorption were tested. These characteristics influence the bonding behavior, dispersion in the mix, and overall durability of the mortar. The test results for coir fibers are presented in Table 3.

Table 3

Property	**Result**
Fibre length	30mm
Fibre diameter	0.45mm
Aspect ratio	66.67
Colour & Texture	Brown & Rough Surface

6.2 Preparation And Testing Of Specimen The mortar was manually mixed to ensure uniform distribution of cement, natural sand, recycled AAC block powder, water, and coir fibers as per mix design. Standard cube molds of dimensions 70.7 mm × 70.7 mm × 70.7 mm were used for casting. Prior to filling, the molds were thoroughly cleaned and oiled to prevent adhesion. The fresh mortar was placed in the molds in layers and compacted properly. After casting, the specimens were demolded after 24 hours and then cured in water until the respective testing days. The compressive strength test was performed using a Compression Testing Machine (CTM) at the curing ages of 3, 7, and 28 days. Four different sets of mortar specimens were prepared, each with varying proportions of AAC powder and coir fibers. The details of the specimen types, their designations, and testing ages are provided in Table 4.

Table 4

Mix ID	AAC (%)	Fibre (%)	Compressive strength@28days(N/MM^2)
M1	0%	0%	10.36
M2	25%	0.5%	6.76
M3	50%	1%	5.86
M4	75%	1.5%	4.5

7.CONCLUSION.

This study evaluated mortar mixes with recycled AAC block powder (as partial sand replacement) and coir fibers (as natural reinforcement). Key findings include:Density slightly decreased with higher AAC content due to its lightweight nature, but remained within acceptable limits. Visual inspection revealed Property Result Fiber Length 30mm Fiber Diameter 0.45mm Aspect Ratio 66.67 Colour & Texture Brown & rough surface rougher

textures and minor surface cracks at 75% AAC replacement, indicating reduced finish quality at higher levels. Compressive strength declined moderately with increasing AAC, especially at 75%, but mixes with 25%–50% AAC maintained good strength. Flexural strength improved with coir fiber addition, enhancing crack resistance and flexibility. The optimal mix was achieved with 25%–50% AAC and 0.5% 1.0% coir fiber, offering a balanced combination of strength, density, and durability.

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