Performance Evaluation Of Cement Mortar By Partial Replacement Of Fine Aggregate As Aac Block Owder And Baggase Fibers

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ABSTRACT

Autoclaved aerated concrete (AAC) blocks are widely employed in contemporary construction due to their outstanding thermal insulation properties and lightweight nature. Their composition includes lime, Portland cement, water, aluminum powder, calcined gypsum, and quartz sand. These blocks are versatile and can be easily shaped or cut to accommodate specific requirements, making them suitable for various applications.

This research explores strategies to encourage the reuse or recycling of surplus AAC blocks, aiming to maximize their usage in construction. Specifically, the study examines different approaches for incorporating AAC block waste as an alternative to sand in mortar mixtures at varying substitution levels of 0%, 25%, 50%, and 75%. The prepared samples were subjected to compressive strength testing to evaluate their mechanical properties.

KEYWORDS: AAC WASTE,BAGGASE FIBER,CEMENT MORTAR,SAND REPLACEMENT

INTRODUCTION

Materials and methods play a vital role in enhancing the strength, workability, and sustainability of construction projects. With growing emphasis on eco-friendly development and resource optimization, the construction industry is shifting towards the adoption of

sustainable materials. One major concern is the excessive generation of waste during construction activities, including materials such as broken bricks, demolished concrete, waste AAC block pieces, and agricultural residues. These wastes, if not utilized properly, contribute to pollution, landfill overload, and depletion of natural resources.

PROBLEM STATEMENT

In this study, we aim to investigate the potential of integrating recycled and agricultural waste materials— specifically recycled AAC block powder and natural bagasse fibers—into cement mortar to address sustainability challenges in the construction sector. The increasing shortage and rising cost of natural fine aggregates like river sand call for the exploration of alternative materials that are both eco-friendly and locally available. Waste AAC block powder,

Additionally, bagasse fiber, a by-product from sugarcane processing, is widely available in agricultural regions but remains underutilized in structural applications. Its natural fibrous structure offers potential benefits in improving mortar flexibility and crack resistance. By examining their physical and mechanical performance

LITERATURE REVIEW

The main purpose of literature Review is to idea about the research work conducted in the world. this forms the basis on which one can carry out the work techniques that can be used for conducting experiments .The following literature elaborates the research studies made on different construction waste as a Replacement of fine aggregate.

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) **Mechanical Performance of Mortar Reinforced with Sugarcane Bagasse Fibers S. Rajan, P. Karthik, International Journal of Sustainable Construction Engineering and Technology, 2023** – This study used bagasse fibers in cement mortar at varying contents of 0%, 0.5%, 1%, and 1.5% by weight of cement. The results showed improved flexural strength and reduced shrinkage cracks at 1% fiber addition. Beyond 1%, the fibers negatively affected workability. The paper concluded that natural bagasse fibers enhance ductility and cracking resistance in mortar and serve as a cost-effective sustainable material.

MATERIALS

Materials play a vital role in preparing any kind of concrete and mortar. Because the ultimate properties of mortar or concrete mainly depend on the properties of the materials used to prepare them. Materials used for the current work were natural sand, waste AAC block fine aggregate, bagasse fibers, and cement, which are

common materials for the preparation of any kind of mortar in general, except waste AAC fine aggregate and bagasse fibers. The following materials were used in this project:

4.1 Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to materials to bind them together. The cement used in this study is ordinary portland cement (OPC) produced by 'Ultratech Company'. The various properties of cement are also studied before using it, and these properties are mentioned in the following chapter.

4.2 Fine Aggregate / Natural Sand

Natural river sand was used as the fine aggregate in this experimental investigation. It conforms to IS: 383 – 2016 specifications and served as the control material for comparison with mixes partially replaced with AAC block powder and bagasse fibers.

Properties of Fine Aggregate Used:

Type: Natural River Sand

Zone: II (as per IS: 383)

Fineness Modulus: 2.6 – 2.9

Specific Gravity: 2.60 – 2.65

Bulk Density: 1450 – 1600 kg/m³

Water Absorption: < 2%

Cleanliness: Free from clay, silt, and organic impurities

The fine aggregate was sieved through a 4.75 mm IS sieve and retained on a 150 µm sieve to ensure proper gradation. The sand was oven-dried prior to mixing to avoid moisture-related inconsistencies in the mix.

4.3 Fine Aggregate (Waste AAC Block)

The preparation of fine aggregate from waste AAC blocks, which are gathered from construction sites, is the crucial task in the present work. We prepared fine aggregate by manual process. The properties of waste AAC block fine aggregate are determined and mentioned in the following section. It is white in color, lightweight, and porous in nature, which helps improve thermal insulation properties of mortar.

4.4Bagasse Fibers: Bagasse fibers are natural fibers obtained from sugarcane waste after juice extraction in sugar mills. These fibers were sun-dried, cleaned, and cut into small lengths of about 20–25 mm before being added to the mortar. The use of natural fibers helps in increasing the crack resistance, tensile strength, and ductility of mortar. The bagasse used in this work is unprocessed chemically and represents an eco-friendly reinforcement material.

4.5 Water

The mixing water should be fresh, clean, and potable. It should be free from organic matter, silt, oil, sugar, chlorides, and acidic materials. The value of pH should be close to 7.0.

5.EXPERIMENTAL WORK , RESULTS AND DISCUSSION

The experimental work in this study focuses on evaluating the performance of mortar by partially replacing natural fine aggregate with recycled AAC (Autoclaved Aerated Concrete) block powder at different percentages (0%, 25%, 50%, and 75%) and by incorporating natural bagasse fibers at varying contents (0%, 0.5%, 1%, and 1.5%). The aim is to determine the mechanical and physical properties of the mortar, such as workability, compressive strength, and flexural strength. This helps in identifying an optimal mix that offers a sustainable alternative to conventional mortar without compromising performance.

5.1 Testing of Materials

recycled AAC block powder, and bagasse fibers. These materials were examined for their physical The materials tested in this study include Ordinary Portland Cement (OPC), natural sand, properties to ensure compatibility, quality, and suitability for mortar production.

5.1.1 Cement

The cement used was OPC of 43 Grade conforming to IS: 8112. It was tested for fineness, standard consistency, and compressive strength. The results of these tests are shown in Table 1.

Table 1: Physical properties of cement

PROPERTY	RESULTS
Fineness	5%
Consistency Strength	30%
Compressive strength	N/mm²
3 days	30 N/mm²
7 days	45N/mm²

5.1.2 Fine Aggregate

Two types of fine aggregates were used: natural river sand and recycled AAC block powder. Tests such as fineness modulus, water absorption, and bulk density were performed in accordance with IS 383:1970. The results are presented in Table 2.

Table 2 : Physical properties of Fine aggregate

PROPERTY	**RESULTS** (Crushed sand)	**RESULTS** (Recycled AAC Block Fine Aggregate)
Fineness modulus	3	2.7
Water Absorption	2.5%	15%
Bulk Density	1.65kg/lit	1.1kg/lit

5.1.3 Bagasse Fibers

Bagasse fibers were obtained from sugarcane waste. The fibers were cleaned, dried, and cut into lengths of 20– 25 mm. They were used in mortar at 0%, 0.5%, 1%, and 1.5% by weight of cement. The bagasse fibers were not chemically treated and their physical characteristics were as follows:

Fiber Length: 30mm Color: Light brown

Moisture Content: Below 10% Density: Approx. 1.25 g/cm³

5.2 Testing of Specimens :

Testing of specimens was a crucial part of this research to evaluate the mechanical performance of mortar prepared with varying percentages of waste AAC block fine aggregate and bagasse fibers. The specimens were cast and cured under controlled conditions to assess their compressive strength accurately. For this purpose, a total of eight cubes of size 70.7 mm were prepared — two cubes for each replacement percentage. These specimens were tested at three different curing ages: 3 days, 7 days, and 28 days to observe the development of strength over time. The compressive strength test was conducted as per IS: 516-1959 using a compression testing machine. The test values from the cube specimens were recorded and averaged to ensure consistency and reduce error.

5.2.1 Compressive Strength of Cement Mortar

5.2.1.1 Proportioning of Cement Mortar

The mix design was based on a 1:3 ratio of cement to fine aggregate. For all mixes, the water-cement ratio was kept constant at 0.60. However, due to the higher water absorption capacity of waste AAC block powder, an additional 30% of water by weight of fine aggregate (FA) was added in the mixes containing AAC powder to compensate for water loss and ensure consistency in workability and strength development.

The prepared mixes varied in AAC content: 0%, 25%, 50%, and 75%. The mixes were designated as M1, M2, M3, and M4 respectively. Each mix had two specimens for compressive testing.

Table 3 : Properties of Cement mortar Mix

PROPERTY	CEMENT MORTAR (Crushed sand)	CEMENT MORTAR (Recycled AAC block fine aggregate)
Mix proportion	1.3	1.3
Water cement Ratio	0.50	0.50

A total 4 different mix combinations were prepared using:

Recycled AAC block powder at 0%, 25%, 50%, 75% replacement of fine aggregate

Natural baggase fibers at 0%, 0.5%, 1.0%, 1.5% addition by weight of cement

For each combination, 2 mortar cube specimens were castandtestedat3, 7, and 28days to ensure accuracy and consistency of results.

5.2.1.2 Preparation and Testing of Cement Mortar Specimens

The mortar was mixed manually to ensure uniform distribution of cement, sand, AAC powder, and water. Cube molds of size 70.7 mm × 70.7 mm × 70.7 mm were cleaned, oiled, and filled with the freshly prepared mortar. The specimens were demolded after 24 hours and cured in water until the day of testing. The compressive strength test was conducted using a compression testing machine at 3, 7, and 28 days.

There were four different kinds of specimens prepared, and their compressive strength was examined for a period of 3, 7 days and 28 days in the current project work. Table No. 4 lists the type

of specimen, its designation, and the testing age of the specimen.

Table 4 :Compressive strength of Test Specimens

MIX ID	AAC(%)	FIBER (%)	COMPRESSIVE STRENGTH(N/mm²)
M1	0%	0%	11.26 N/mm²
M2	25%	0.5%	7.66 N/mm²
M3	50%	1%	5.86 N/mm²
M4	75%	1.5%	4.95 N/mm²

6. CONCLUSION

The present study was undertaken to evaluate the feasibility of using waste AAC block powder as a partial replacement of fine aggregate in mortar, along with the addition of natural bagasse fibers. From the experimental results, it is observed that the inclusion of AAC block fine aggregate led to a reduction in compressive strength as the replacement percentage increased. This is due to the higher water absorption and lower density of AAC powder, which affects the overall strength development.

These findings indicate that waste AAC block powder and natural bagasse fibers can be used effectively in mortar for non-structural applications, such as plastering, masonry, or eco-friendly construction blocks. Further studies with optimized curing, fiber treatment, and admixtures can enhance the performance for broader structural applications.

Overall, the study highlights the importance of reusing construction and agricultural waste to promote sustainable construction practices, reduce environmental impact, and manage material shortages.

REFERENCES

1.Utilization of Recycled AAC Block Powder in Mortar by S. Kumar et al., published in Journal of Cleaner Production in 2022. This study explores the effects of using recycled AAC block powder as a partial replacement for fine aggregate in mortar.

2.Mechanical Properties of Mortar with Natural Fibers by A. Singh et al., published in Construction and Building Materials in 2023. This research examines the mechanical properties of mortar reinforced with natural fibers, including bagasse fibers.

3.Experimental Investigation on Mortar with Recycled Fine Aggregate by V. Kanna et al., published in International Journal of Engineering and Technology in 2022. This study investigates the effects of using recycled fine aggregate in mortar.

4.Sustainability of AAC Blocks in Construction by R. Sharma et al., published in Journal of Sustainable Construction in 2022. This research discusses the sustainability benefits of using AAC blocks in construction.

5.Bagasse Fiber-Reinforced Composites by J. Li et al., published in Journal of Composite Materials in 2023. This study explores the properties of composites reinforced with bagasse fibers.

9.Recycled AAC Block Powder in Concrete by E. Erdog'anOzbay et al., published in Journal of Cleaner Production in 2022. This study explores the use of recycled AAC block powder in concrete.

12.Mechanical Properties of Bagasse Fiber-Reinforced Mortar by R. Suram et al., published in Journal of Materials in Civil Engineering in 2023. This research examines the mechanical properties of mortar reinforced with bagasse fibers.

13.Sustainability Benefits of Using Recycled Materials in Construction by S. Singh et al., published in Journal of Sustainable Construction in 2023. This study discusses the sustainability benefits of using recycled materials, including AAC block powder, in construction.