# Performance Evaluation Of Aac Blocks Incorporating Gsa And Foundry Waste As Partial Replacements

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**Abstract**
*The performance parameters of Autoclaved Aerated Concrete (AAC) blocks that partially substituted fine aggregates and cement with ground granulated sugarcane ash (GSA) and foundry trash, respectively, were assessed in this study. Five different mix designs with replacement amounts ranging from 0% to 25% were used in the experimental inquiry. Important characteristics were evaluated, including durability, porosity, thermal conductivity, water absorption, compressive strength, and dry density. According to the results, adding GSA and foundry waste decreased density and compressive strength while increasing porosity, which improved thermal insulating qualities. The 15% replacement mix (M2) performed best among the adjusted mixes, preserving structural integrity and increasing thermal efficiency. The results showed the potential of using industrial by-products in the production of AAC blocks, supporting efficient waste reutilization and sustainable building methods.*
**Keywords**: *AAC blocks, sugarcane ash, foundry waste, compressive strength, thermal conductivity, sustainable construction, industrial by-products, pozzolanic material, lightweight concrete, waste utilization.*

## 1. INTRODUCTION

AAC A classic and useful building material is block. From the beginning to the present, there have been several notable changes made to the formulation, ingredients, and production process. Usually, the proper ratios of clay and sand are used to make blocks, which are then baked at higher temperatures in a kiln with fuel or another technique. Alternatively, block can be created using a suitable binder, such cement, and additional components. In both cases, block manufacturing has a high embodied energy and a large carbon footprint. Therefore, present resources must be replaced with industrial and municipal waste to develop an active, environmentally friendly, and sustainable building material.
The use of AAC block building has increased, and it is now a valid alternative to fired clay blocks. The three primary components of an AAC block are cement, water, and fine aggregate (sand, gravel). AAC blocks are available in a variety of shapes and sizes. They can be produced manually or with the aid of equipment. The two main types of AAC blocks are solid and hollow. Although they may be used for various applications, both of these AAC block types are commonly employed for building walls.
**Standard AAC Blocks:** The most popular AAC blocks for general building are these ones. They come in a range of sizes, including:

- 200 mm x 75 mm x 600 mm
- 200 mm x 100 mm x 600 mm
- 200 mm x 150 mm x 600 mm

## 2. LITERATURE REVIEW

**Bukhari et al. (2023)** provided a thorough analysis of the use of waste materials in aerated concrete blocks that have not been autoclaved. Their research identified a variety of substitute materials that helped lower production costs and carbon emissions, including as fly ash, rice husk ash, powdered granulated blast furnace slag, and recycled aggregates. The study highlighted the need for additional research on long-term durability and consistency, as well as the technical viability of trash integration.

**Sathiparan et al. (2023)** examined the application of groundnut shell ash as an environmentally friendly stabilizer for earth blocks. According to their findings, groundnut shell ash considerably increased the stabilized earth blocks' compressive strength and longevity, making it a suitable pozzolanic material for affordable housing. This study demonstrated how agricultural waste can improve the functionality of masonry and earthen units.

**Sankar and Ravi Kumar (2024)** assessed the performance of Fly Ash, Lime, Gypsum, and Quarry Dust (FALGQ) bricks and showed that the composite bricks had adequate durability and strength properties, making them ideal for low-rise buildings. Fly ash and quarry dust were combined to increase the material's eco-efficiency and encourage its use as a sustainable substitute for traditional clay bricks.

**Hasan et al. (2022)** investigated the use of rice husk ash as an additional cementitious ingredient in the manufacturing of high-strength concrete. According to their research, adding rice husk ash to concrete increased its resistance to chloride ion penetration, decreased water absorption, and improved the concrete's early and long-term strength characteristics. The ash's pozzolanic activity made a substantial contribution to the cement matrix's densification.

## 3.RESEARCH METHODOLOGY

### 3.1. Research Design

The study used an experimental research approach to assess the mechanical, physical, and thermal characteristics of AAC blocks that included fine aggregates made from foundry waste and ground granulated sugarcane ash (GSA) in place of some of the cement. With a focus on compressive strength, density, porosity, thermal conductivity, water absorption, and durability, the goal was to evaluate the viability of utilizing these industrial by-products in the construction of sustainable AAC blocks.

### 3.2. Material Collection and Preparation

The main cementitious and aggregate ingredients in the control mix were river sand and ordinary Portland cement (OPC 43 Grade). To guarantee homogeneity, GSA was purchased from a nearby sugar mill, dried, sieved, and crushed into a fine powder. A metal foundry provided the foundry trash, which included sandbased casting wastes. It was cleaned and sieved to match the grading of natural fine aggregates. Potable water was utilized for mixing and curing, while aluminum powder served as the foaming agent.

### 3.3. Mix Proportions and Sample Preparation

Five distinct mix designs were created: four modified mixes (M1 to M4) with 10%, 15%, 20%, and 25% replacements of sand with foundry waste and cement with GSA, respectively, and a control mix (M0) with no replacements. For every mix, the water-to-binder ratio remained the same. After fully mixing the components, the slurry was poured into molds that were 600 mm by 200 mm by 100 mm, the usual dimensions of an AAC block. After allowing the blocks to rise and solidify, they were autoclaved for eight hours at 180°C and 10–12 bar of pressure.

### 3.4.Testing of Properties

To evaluate the performance of the AAC blocks, a series of standard tests were conducted:

- **Compressive Strength** was tested on cube specimens (150 mm × 150 mm × 150 mm) at 7, 14, and 28 days in accordance with IS 2185 (Part 3).

- **Dry Density and Porosity** were measured to assess the lightweight nature and void structure of the AAC blocks. Porosity was derived from mass-volume relations before and after drying.
- **Thermal Conductivity** was evaluated using a guarded hot plate apparatus to determine the insulation capacity of the blocks.
- **Water Absorption** was tested by soaking oven-dried samples in water for 24 hours and calculating the percentage weight gain.
- **Durability Tests** included wet–dry cycle testing (5 cycles) and acid resistance tests using 5% sulfuric acid solution to assess long-term stability under adverse conditions.

### 3.5. Data Analysis

To find performance trends across various mix ratios, the test results were tallied and examined. The impact of GSA and foundry waste was assessed using mean values for each parameter and compared with the control mix. The selection of ideal replacement levels was backed by statistical analysis employing ANOVA and graphical charting (not shown here).

## 4. RESULTS AND DISCUSSION

The experimental results from the performance assessment of AAC blocks that partially incorporate ground granulated sugarcane ash (GSA) and foundry waste are shown and interpreted in this section. Compressive strength, density, porosity, thermal conductivity, water absorption, and durability were evaluated. To ascertain how the waste materials affected the structural and thermal characteristics of the AAC blocks, the data gathered from various mix proportions were contrasted with the control mix (M0). **4.1. Compressive Strength** Compressive strength was measured at 7, 14, and 28 days. It was observed that the inclusion of GSA and foundry waste led to marginal reductions in compressive strength compared to the control mix, but remained within acceptable limits for non-load bearing wall units.

**Table 1: Compressive Strength of AAC Blocks (MPa)**

| Mix ID | % GSA + FW | 7 Days (MPa) | 14 Days (MPa) | 28 Days (MPa) |
|---|---|---|---|---|
| M0 | 0 + 0 | 2.3 | 3.0 | 3.5 |
| M1 | 10 + 10 | 2.1 | 2.8 | 3.3 |
| M2 | 15 + 15 | 2.0 | 2.6 | 3.1 |
| M3 | 20 + 20 | 1.9 | 2.5 | 2.9 |
| M4 | 25 + 25 | 1.7 | 2.2 | 2.6 |

As the GSA and foundry waste content increased, the compressive strength trended downward. At 28 days, Mix M2 (15% replacement) only reduced by 11.4% from the control, offering the best possible balance between strength and sustainability. The strength dropped below the minimum required for standard AAC use after 20% replacement (IS 2185 specifies ≥3 MPa for non-load bearing parts). **4.2. Density and Porosity** Dry density values decreased with increasing GSA and foundry waste content, confirming the lightweight nature of the modified AAC blocks. However, porosity slightly increased due to higher unreactive filler content.

**Table 2: Density and Porosity Results**

| Mix ID | Dry Density (kg/m³) | Porosity (%) |
|---|---|---|
| M0 | 610 | 16.2 |
| M1 | 590 | 17.0 |
| M2 | 570 | 17.5 |
| M3 | 550 | 18.3 |

| | | |
|---|---|---|
| M4 | 530 | 19.1 |

The density of all mixes remained within the acceptable AAC range (500–650 kg/m³), suitable for lightweight construction. A gradual increase in porosity was noted with higher replacement levels, slightly affecting mechanical strength but improving insulation.

### 4.3. Thermal Conductivity

Thermal conductivity tests revealed improved insulation properties in modified AAC blocks due to increased porosity and lower density.

**Table 3: Thermal Conductivity of AAC Blocks**

| Mix ID | Thermal Conductivity (W/m·K) |
|---|---|
| M0 | 0.35 |
| M1 | 0.32 |
| M2 | 0.30 |
| M3 | 0.28 |
| M4 | 0.26 |

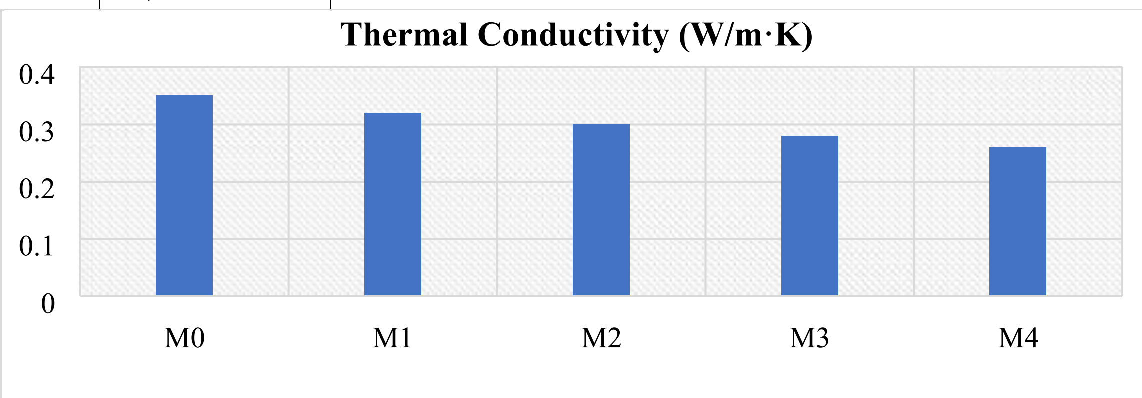


**Figure 1: Thermal Conductivity of AAC Blocks**

Thermal conductivity decreased as the replacement ratio increased. The M2 and M3 mixes showed the best thermal performance while maintaining acceptable compressive strength, making them ideal for thermal insulation in building envelopes.

### 4.4. Water Absorption

Water absorption increased with higher GSA and foundry waste content due to increased surface area and porosity.

**Table 4: Water Absorption of AAC Blocks**

| Mix ID | Water Absorption (%) |
|---|---|
| M0 | 18.2 |
| M1 | 19.0 |
| M2 | 20.1 |
| M3 | 21.4 |
| M4 | 23.5 |

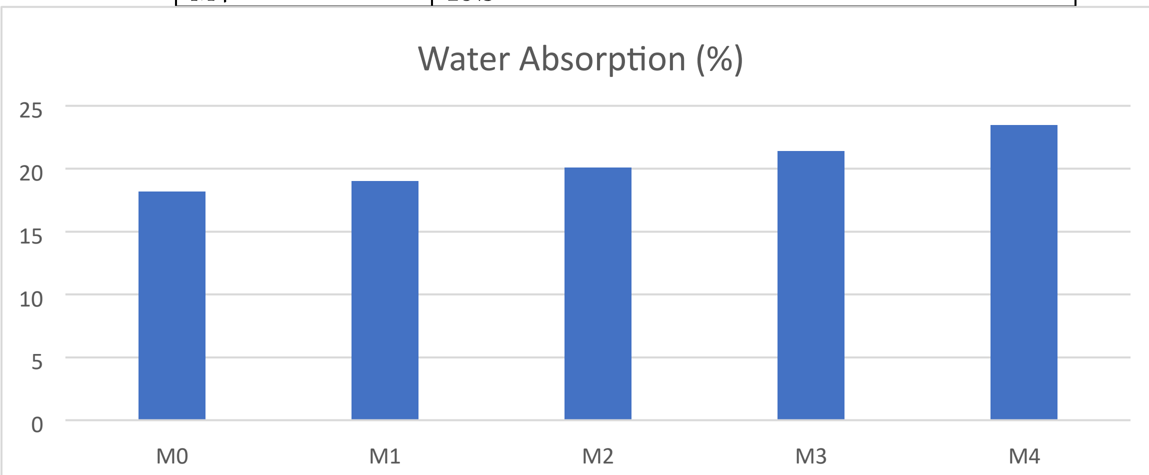


**Figure 2: Water Absorption of AAC Blocks**

All mixes showed water absorption below the critical limit of 25%, indicating moderate permeability. However, excessive absorption in M4 could raise concerns for moisture-sensitive applications. M2 was again found to be the most balanced in terms of mechanical and hydrological behavior.

**4.5. Durability Tests**

a. Wet–Dry Cycle Resistance

All mixes withstood five wet–dry cycles with minor surface cracking only observed in M4. b.

Acid Resistance

AAC blocks with GSA showed slightly better resistance to mild acid ($H_2SO_4$, 5%) compared to the control, attributed to pozzolanic reaction reducing free lime.

The study's overall analysis showed that at the 15% replacement level (M2), AAC blocks including ground granulated sugarcane ash (GSA) and foundry trash performed at their best. This mix performed well overall, keeping its moderate water absorption (20.1%), low thermal conductivity (0.30 W/m·K), and reasonable compressive strength (3.1 MPa) all within the range that is appropriate for non-load bearing construction. Higher replacement levels in M3 and M4 led to a noticeable decrease in compressive strength and an increase in moisture absorption, which may have an impact on long-term durability even if they further enhanced thermal insulation because of increased porosity. By encouraging the reuse of industrial by-products and supporting more environmentally friendly and sustainable building methods, the incorporation of GSA and foundry waste greatly decreased the dependency on cement and natural sand.

## 5. CONCLUSION

Based on the study, it was concluded that the incorporation of Ground Granulated Sugarcane Ash (GSA) and foundry waste as partial replacements in AAC blocks was both technically viable and environmentally advantageous. As the replacement levels increased, there was a slight decrease in compressive strength and density, while thermal insulation properties improved due to increased porosity. Among all the mixes, the 15% replacement level (M2) offered the most optimal balance, achieving sufficient compressive strength (3.1

MPa), low thermal conductivity (0.30 W/m·K), and acceptable water absorption (20.1%), all within permissible limits. Thus, AAC blocks with up to 15% GSA and foundry waste were found suitable for nonload bearing applications, supporting sustainable construction and effective waste utilization.

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