



AUTOCLAVED AERATED CONCRETE USING ALUMINIUM POWDER

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Abstract

Blocks and other masonry components are made using Autoclaved Aerated Concrete (AAC), a lightweight precast building material. Made from cement, lime, fly ash, and a gas-forming agent, it has a cellular structure with lots of air gaps, which lowers density in comparison to regular concrete. Properties including porosity, water absorption, and compressive and tensile strength are all impacted by the addition of aluminum powder. By assessing their mechanical and physical characteristics—such as density, water absorption, initial rate of absorption, compressive strength, stress–strain behavior, and flexural strength—and contrasting them with more traditional materials, this study investigates the possibility of using AAC blocks as an alternative to traditional masonry units.

1. Introduction

Lightweight concrete made of quartz sand, calcined gypsum, lime, cement, water, and aluminum powder is known as autoclaved

aerated concrete, or AAC. A Slurry consisting of finely crushed siliceous materials and either Portland cement or lime is created by adding air or gas. A cellular structure that is evenly dispersed is created as the mixture solidifies. An autoclave is used to cure AAC goods under high pressure and temperature. For both exterior and interior construction, AAC is frequently utilized due to its superior thermal insulation qualities. Apart from its capacity to insulate, AAC has the benefit of being quick and simple to install since it can be cut, sanded, or routed to the desired size on-site using common power equipment that include carbon steel blades. High-rise buildings and constructions subjected to large temperature fluctuations are especially well suited for AAC. Because of its reduced density, high-rise structures require less concrete and steel for their structural elements. Because AAC blocks have fewer joints, less mortar is needed to install them, and because of their precise dimensions, less rendering material is needed. Because AAC's exceptional thermal efficiency eliminates the need for separate insulation and building materials, it speeds up construction

and lowers total costs, making it perfect for areas with severe temperatures.

While traditional cement mortar can be utilized in masonry, most AAC constructions prefer thin-bed mortar, approximately 1/8 inch thick, in accordance with national building regulations. To shield AAC surfaces from environmental factors, they may be finished with stucco or plaster, or covered with materials like brick or vinyl siding. This study aims to investigate how various gradings of aluminum powder—particle sizes of up to 125 μm , 53.5–44 μm , and 44–37 μm —functioning as a foaming agent at 0.25% in the creation of aerated concrete, influence the final product. The specimens, cured underwater for 28 days, were assessed for density, compressive strength, tensile strength, water absorption, and porosity, and the findings were compared.

Aluminum dust, a by-product of the aluminum dross recycling industry, is typically treated to remove or stabilize metallic aluminum before landfill disposal. Instead, this study proposes an innovative approach of utilizing aluminum dust as a foaming agent to partially replace expensive aluminum powder in the manufacture of autoclaved aerated concrete (AAC).

2. OBJECTIVE

To investigate the practicality of incorporating aluminum powder in Autoclaved Aerated Concrete. To examine the compressive strength and additional mechanical characteristics of AAC blocks that utilize aluminum powder and contrast them with traditional red bricks and cement blocks.

3. MATERIALS AND METHOD

Raw materials like Ordinary Portland Cement Grade 53 (IS 269:1989 and IS 383:1970), Fly ash (Class C), Lime stone, Aluminum Powder

and Gypsum with equivalent water and other additives are used.

Compound	Chemical composition (%)
CaO	57.84
SiO₂	20.33
Fe₂O₃	4.68
Al₂O₃	3.40
MgO	1.51
TiO₂	0.09
K₂O	0.72
Na₂O	0.51
SO₃	7.26
Loss of Ignition	3.42
Insoluble residue	1.23

Table 1: Chief constituents of ordinary Portland cement

The final product's quality is determined by the dosage and mixing process. keeping the proportions of all the materials at 4.4: 0.66: 0.26: 0.1 for fly ash, lime, cement, and gypsum Water content = 180 liters; aluminum makes up approximately 0.084% of the mix's total dry elements. It takes 5.5 minutes to complete the mixing and pouring cycle. A container is pumped with fly ash. Pumping stops when the required weight is added. Likewise, gypsum, cement, and lime powder are poured into separate containers by means of conveyors. All ingredients are released into the mixing drum by the control system once the necessary quantity of each ingredient has been placed into its designated container. Attached to the mixing unit is a smaller bowl-shaped device that is used to feed aluminum powder. A dosing unit can be used to pour the mixture into moulds after it has been churned for a

predetermined amount of time. This mixture is released into moulds in predetermined amounts by the dosing unit.

After the raw material mix is ready, it is poured into molds that have been greased (usually 1 m³). It doesn't stick because of the oil coating. Aluminum reacts with water and calcium hydroxide in the mold to produce hydrogen gas, which creates tiny air bubbles (2–5 mm). This results in the slurry expanding up to three times its initial volume, giving AAC blocks their insulating and lightweight structure. Approximately four hours are needed for the rising and pre-curing process, depending on the mix and weather. The semi-hardened mass is wire-cut after pre-curing, and it is then steam-cured in an autoclave at 800–1200 kPa pressure and 180°C. After pre-curing, the hardened mixture is demoulded using a crane and sent to the cutting line, where it is cut into required sizes.



Fig 1: flow chart of preparation of AAC Blocks

4. EXPERIMENTAL WORKS



Fig 2: Mixing of ingredients in mixed

1. WATER ABSORPTION TEST:

We have fabricated and prepared autoclaved aerated concrete blocks in different sizes. For this experiment, we selected three blocks

weighing 11.780kg, 11.800kg, and 12kg, which we then submerged in water. After a duration of 24 hours, we removed them, finding their weights to be 13kg, 13.5kg, and 13.820kg. The percentages of water absorption were calculated to be 10.36, 14.41, and 15.17.



Fig 3: Curing in water for water Absorption test

2. SHRINKAGE TEST DRYING:

Drying shrinkage is the contraction that occurs when capillary water loss causes a hardened concrete mixture. This shrinkage causes tensile stress before the concrete is loaded in any way, which can lead to internal warping, cracking, and outward deflection. After soaking three samples in water for drying shrinkage, we put them aside to dry for a day. The samples had three sizes before testing: 600 x 200 x 100 mm, 600 x 200 x 100 mm, and 600 x 200 x 100 mm. The following are the sample sizes following testing: 599 cm x 199 mm x 99 cm, 598 mm x 198.5 cm x 98 mm, and 598 mm x 198 mm x 98.75 mm. The drying shrinkage percentages are around 0.04%.

3. COMPRESSIVE STRENGTH TEST:

To assess the structural performance of concrete masonry blocks, their compressive strength is measured. Eight blocks that are 28 days old are chosen for the test and analyzed in the lab within three days of being collected. Two steel bearing blocks, one stationary and one moving, make up the compressive strength testing apparatus. The movable block is used to apply load while the masonry unit is

positioned on the fixed block. First, half of the anticipated maximum load is delivered steadily, and then the remaining load is applied gradually over a minimum of two minutes. It is noted what load the block fails at. The highest failure load is divided by the block's gross cross-sectional area to determine the compressive strength. The same procedure is repeated for all eight blocks, and the average of their results is reported as the final compressive strength.

S.NO	AREA OF BLOCK (mm ²)	MAXIMUM LOAD (KN)	MAXIMUM COMPRESSIVE STRENGTH (N/mm ²)
1	150 X 100	65.3	4.3
2	150 X 100	68.3	4.5
3	150 X 100	65.3	4.4
4	150 X 100	73.5	4.9
5	150 X 100	67.1	4.5
6	150 X 100	65.5	4.4
7	150 X 100	64.9	4.3
8	150 X 100	63	4.2

Table 2: Compressive strength of individual blocks.



Fig 4: Checking compressive strength under UTM

5. RESULTS

DENSITY:

Density plays a major role in determining the strength of Autoclaved Aerated concrete. Density of these AAC lightweight blocks usually lesser than other type of blocks.

S. NO	SPECIFICATION	SIZE OF SPECIMEN (in mts)	WEIGHT OF SPECIMEN (in kgs)	DENSITY OF SPECIMEN (Kg/m ³)
1	RED BRICKS	0.220X0.068X0.101	2.6200	1734.00
		0.220X0.069X0.100	2.6200	1725.96
		0.223X0.066X0.103	2.6800	1767.87
2	CEMENT	0.30X0.178X0.121	14.960	2315.29
		0.30X0.18	15.00	2258.

	BRICKS	0X0.123	0	36
		0.30X0.18	15.46	2283.
		5X0.122	0	27
3	AAC BLOCKS	0.6X0.143X0.151	11.80	910.78
		0.6X0.152X0.151	11.78	855.41
		0.6X0.153X0.148	12.00	883.23
			0	

Table 3: Comparison of density values for different type specimens

Compared to red brick, cement brick and AAC blocks, AAC blocks have less density providing the same strength as other two bricks.

WATER ABSORPTION:

The water absorption rate of a brick or block refers to the amount of water it takes in when immersed in water for a duration of 24 hours, represented as a percentage of its dry weight. The strength of a brick or block is influenced by its capacity for water absorption. The water absorption of a brick or block is attributed to the voids present within it. Porosity denotes the ability to take in and release moisture, making it a significant and valuable property of bricks and blocks.

S.NO	SPECIFICATION	WATER ABSORPTION (in %)
1	RED BRICKS	18.93
		18.25
		18.74

2	CEMENT BRICKS	21.39
		21.12
		21.96
3	AAC BLOCKS	10.36
		14.14
		15.17

Table 4: Water Absorption in different materials

Although AAC Blocks are porous material it has less water absorption value possess good quality and helps in providing good strength.

COMPRESSIVE STRENGTH:

The compressive strength test for bricks is conducted to assess their load-bearing ability under compression using a universal testing machine (UTM). Compressive strength is determined by dividing the failure load by the load application area, typically assessed after 28 days of curing.

S.N O	SPECIFICATIO N	COMPRESSIV E STRENGTH (N/mm ²)
1	RED BRICKS	2.2
		2.1
		2.4
2	CEMENT BRICKS	2.6
		2.7
		2.5
3	AAC BLOCKS	4.5
		4.9
		4.4

Table 5: Compressive strength of different materials under UTM

AAC blocks gives more compressive strength compared two other types of bricks.

6. CONCLUSIONS

Autoclaved Aerated Concrete (AAC) blocks are lightweight construction materials that improve structural stability and safety, particularly in regions prone to earthquakes, as the seismic effect correlates directly with the weight of the building. Being approximately 80% lighter than traditional red bricks, AAC blocks greatly lessen the dead load, resulting in savings on cement and steel while also reducing overall construction expenses. Even with their lightweight properties, they provide significant strength and durability. Composed of non-biodegradable substances, AAC blocks resist rotting and mold growth, ensuring cleaner and more durable interiors. Furthermore, their smooth surface and versatility make them ideal for various architectural designs.

7. SCOPE:

- To investigate the effect of various admixtures in autoclaved aerated concrete.
- To investigate the feasibility of using more foaming agents in autoclaved aerated concrete.
- To study the workability, compressive and tensile strength of autoclaved aerated concrete by using various types of admixtures in various proportions.

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