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# A Research Paper on "Experimental Investigation on Autoclaved Aerated Concrete (AAC) Using Blast Furnace Slag and Plastic Fiber"

Ashwini A. Hingankar[1], Mr. M. M. Lohe[2]

*[1]PG Student, Civil Engineering Department, Bapurao Deshmukh College of Engineering, Sevagram,Wardha – 442 102 (M.S.)*
*[2]Assistant Professor, Civil Engineering Department, Bapurao Deshmukh College of Engineering,Sevagram, Wardha – 442 102 (M.S.)*
*Email: [1]ashwini.hingankar016@gmail.com*

***Abstract:*** ***The developments of new and innovative materials are contributing significantly to the large scale such as automotive industry. Smart materials are highly efficient materials and their performance comes at high costs associated with the high level of Research & Development involved. The main aim of this paper is to study in detail about AAC concrete blocks, its performance, advantages and compared AAC blocks with red clay bricks hence recommendation given for using AAC blocks.***
***Main ingredients include fly ash, water, quicklime, cement, aluminum powder and gypsum. The block hardness is being achieved by cement strength, and instant curing mechanism by autoclaving. Gypsum acts as a long term strength gainer. The chemical reaction due to the aluminum paste provides AAC its distinct porous structure, lightness, and insulation properties, completely different compared to other lightweight concrete materials. The finished product is a 2.5 times lighter Block compared to conventional Bricks, while providing the similar strengths. The specific gravity stays around 0.6 to 0.65. This is one single most USP of the AAC blocks, because by using these blocks in structural buildings, the builder saves around 30 to 35 % of structural steel, and concrete, as these blocks reduce the dead load on the building signific.***

***Keywords: Aac Blocks, Autoclaved Aerated Concrete, Comparison of Aac Blocks, Aac Block Strength, Block Analysis.***

## 1. INTRODUCTION

The traditional bricks are the main building materials that are used extensively in the construction and building industries in India. Due to the rapid urbanization and expanding interest for development materials, block furnaces have quickly developed which have legitimately or in a roundabout way caused a progression of ecological and medical issues. At a worldwide level, ecological contamination from block making activities adds to the wonders of an Earth-wide temperature boost and environmental change. The different kinds of blocks can be utilized as an option in contrast to the red blocks, to diminish natural contamination and Global warming. AAC blocks might be one of the answers for block substitution. Like froth concrete, Autoclaved Aerated Concrete (AAC) is one of the

confirmed green structure materials, which can be utilized for business, modern and private development. It has the basic properties required for use as a structured segment. Because of the lightweight and high solidarity to weight proportion of circulated air through solid items, their utilization brings about an obvious economy in the auxiliary individuals, and along these lines spare concrete and steel support.

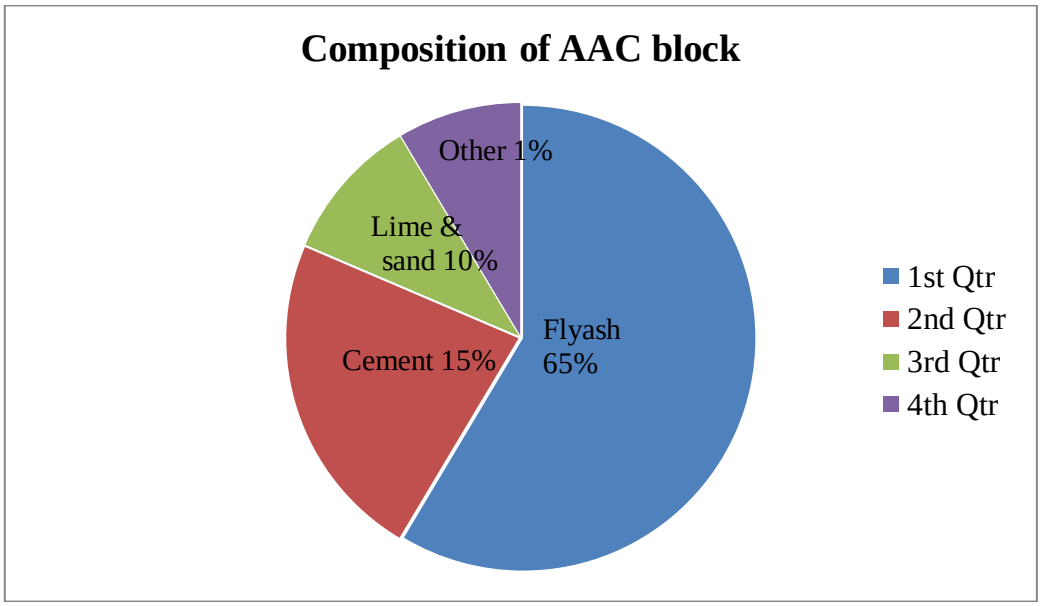
The Autoclaved Aerated Concrete (AAC) is an eco-friendly material that has many environmental benefits. The weight of the AAC block is around one-fourth to one-fifth that of concrete based on volume. The manufacturing of AAC blocks has the same greenhouse gas environmental impact and has the same embodied energy as that of concrete block. The AAC blocks or panels have lower embodied energy per square meter than a concrete alternative building material. The AAC block and panels have more insulation value and thus it has low energy usage for heating and cooling loads requirement. The total energy used in manufacturing the ACC blocks is around 50% less than that of manufacturing other prefabricated building components and products. As compared to regular cement concrete building products, AAC reduces around one-third of the environmental waste. The Autoclaved Aerated Concrete (AAC) blocks and panels have proven to be more durable, provide thermal insulation and structural requirements, and also have major economic and environmental benefits as compared to other traditional building components and products. Thus Autoclaved aerated concrete can be said to a suitable and potential eco-friendly building material, which is beneficial for the environment, which fulfills the requirement for the construction of sustainable architecture and construction (Andrews, 2019).

## 2. TYPICAL COMPOSITION OF AAC

Block is a similar term referring to a rectangular building block composed of similar materials, but is usually larger than a brick. Lightweight bricks (also called lightweight block Or AAC blocks) are made from expanded clay aggregate or concrete. AAC was perfected in the mid-1920s by the Swedish architect and inventor Dr. Johan Axel Eriksson, working with Professor Henrik Kreüger at the Royal Institute of Technology[3]. Size of AAC blocks as per Indian Standard are 600mm*200mm*100/150/200 mm.

| Materials | Percentage by volume of block | Weight |
|---|---|---|
| Cement | 15% | 1.026kg |

| | | |
|---|---|---|
| Fly ash | 65% | 4.446 |
| Lime | 10% | 0.684 |
| Sand | 10% | 0.684 |
| Aluminium powder | 0.2% | 13.68 gm |
| Gypsum | 0.2% | 13.68 gm |
| Water | 0.65 | 2 litre |




## 3. STRUCTURAL PROPERTY OF AAC BLOCKS

Aerated concrete is relatively homogeneous when compared to normal concrete, as it does not contain coarse aggregate phase, yet shows vast variation in its properties. The properties of aerated concrete depend on its microstructure and composition which are influenced by the binder used. In order to study the behavior of lightweight concrete, normal concrete testing was done to determine the material and structural properties of each type of lightweight concrete and how will these properties differ according to a different type of mixture and its composition. Once concrete has hardened it can be subjected to a wide range of tests to prove its ability to perform as planned or to discover its characteristics. For new concrete, this usually involves casting specimens from fresh concrete and testing them for various properties as the concrete matures. The structural properties are as follows –

### 3.1. Density

The density of AAC ranges from 250 to 1,800 kg/m3, as compared to 2400-2600 kg/m3 for conventional concrete. Therefore, the weight of a structure built with foam concrete would undoubtedly be reduced significantly, leading to tremendous savings in the use of reinforcement steel in the foundations and structural members. AAC blocks are ideal for the entire building structure and Possess high structural integrity. The product is light weight and easy work ability means that it is very quick to install on site, thereby saving in steel, cement, and mortar and plastering costs.

### 3.2. Compressive strength

Compressive strength may be defined as the measured maximum resistance of a concrete specimen to axial loading. An average compressive strength of 2.86 MPa has been achieved on 650 kg/cum density AAC cubes following 28 days of the standard water-curing. A compressive strength of more than 20 MPa is obtainable with the addition of silica fumes, polypropylene fibers and steel mesh reinforcements, for special applications in which more compressive strength is required. Since blocks made from AAC are 1/3 to ½ the weight of normal concrete blocks. For the purpose of bearing the self-load of the AAC block-wall, blocks of compressive strength 0.21–0.31 MPa are used, as compared to conventional blocks of 0.42-0.56 MPa.

### 3.3. Thermal conductivity and fire resistance

It is a measure of the material conductivity as tested in a laboratory procedure that measures the heat flow through building material under steady and constant climatic conditions. It is important to remember that these laboratory conditions do not reflect the normal climatic cycles. Based on the above definition, it is obvious that the lower the K value the higher the insulating value.

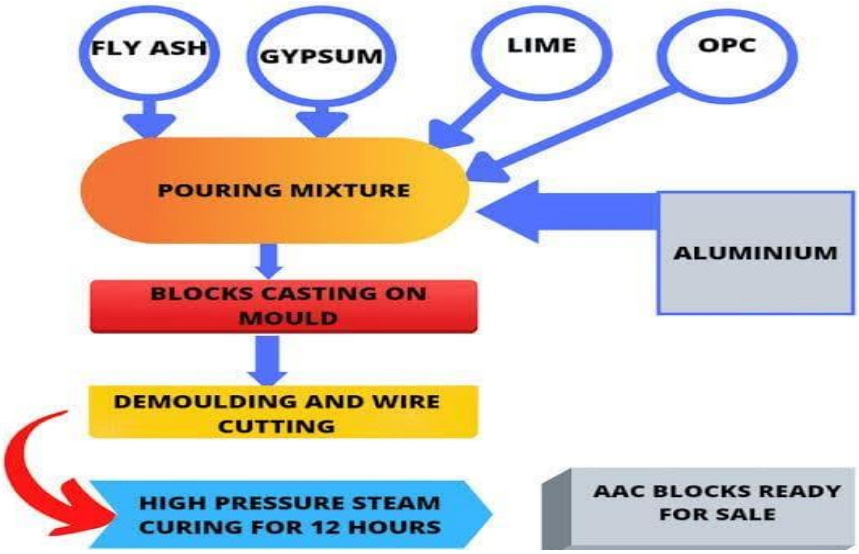
### 3.4. Drying shrinkage and water absorption

These properties are particularly important in concrete, as well as being important for durability. It can be used to predict concrete durability to resist corrosion. Absorption capacity is a measure of the porosity of an aggregates. It is also used as a correlation factor in determination of free moisture by oven-drying method. The absorption capacity is determined by finding the weight of surface-dry sample after it has been soaked for 24 hr and again finding the weight after the sample has been dried in an oven; the difference in weight, expressed as a percentage of the dry sample weight, is the absorption capacity.

## 4. OBJECTIVES OF STUDY

To make the autoclaved aerated concrete block (AAC) using blast furnances slag and plastic fiber as an alternative material for partial replacement of FLY ASH.
The main objective of this project to reuse industrial waste material in construction and to reduce the environmental pollution. 2. To check the workability of AAC BLOCK.
3. To check the suitability to be used for the construction low cost housing.
4. To analyses the cost of autoclaved aerated concrete block using blast furnces slag and plastic fiber
5. To reduces the weight as 3-4 t imes lighter than traditional bricks and therefore, easier and cheaper to transport. 6. To reduces construction time by 20%. As these blocks are lighter, it make construction easier and faster.

## 5. PROCESS FLOW CHART OF MANUFACTURING OF AAC BLOCK




## 6. MIX PROPORTIONS

### 6.1 Mix Proportions I

| Materials | Percentage by volume of | Weight |
|---|---|---|
| Cement | 15% | 1.026kg |
| Fly ash | 65%,60%,55%,50%,45% | 4.446kg,4.104,3kg.762,kg3.078kg |
| Lime | 10% | 0.684kg |
| Sand | 10% | 0.684kg |
| Aluminium powder | 0.2% | 13.68gm |
| Blast furnace slag | 0%,5%,10%,15%,20% | 0.342.0.684,1.026,1.368 |
| Gypsum | 0.2% | 13.68gm |
| Water | 0.65 | 2 litre |

### 6.2 Mix Proportions Ii

| Materials | Percentage by volume of block | Weight |
|---|---|---|
| Cement | 15% | 1.026kg |
| Fly ash | 65%,60%,55%,50%,45% | 4.446kg,4.104,3kg.762,kg3.078kg |
| Lime | 10% | 0.684kg |
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| Aluminium powder | 0.2% | 13.68gm |
| Plastic fiber | 0%,5%,10%,15%,20% | 0.342.0.684,1.026,1.368 |
| Gypsum | 0.2% | 13.68gm |
| Water | 0.65 | 2 litre |

### 6.3 Mix Proportions Iii

| Materials | Percentage by volume of block | Weight |
|---|---|---|
| Cement | 15% | 1.026kg |
| Fly ash | 65%,60%,55%,50%,45% | 4.446kg,4.104,3kg.762,kg3.078kg |

| | | |
|---|---|---|
| Lime | 10% | 0.684kg |
| Sand | 10% | 0.684kg |
| Aluminium powder | 0.2% | 13.68gm |
| Plastic fiber + blast furnance slag | 0%,5%,10%,15%,20% | 0.342.0.684,1.026,1.368 |
| Gypsum | 0.2% | 13.68gm |
| Water | 0.65 | 2 litre |

## 7. RAW MATERIAL PREPARATION

Fly ash is mixed with water to form fly ash slurry. Lime powder required for AC production is obtained either by crushing limestone to fine powder. 53-grade Ordinary Portland Cement from reputed manufacturer is required for manufacturing AC blocks. Gypsum is easily available in the market and is used in powder form Aluminium powder/paste is easily available from various manufacturers.

7.1 Dosing and Mixing:
After raw material preparation, next step of AC blocks manufacturing process is dosing and mixing. Process of dosing and mixing defines the quality of final products. Maintaining ratio of all ingredients as per the selected recipe is critical to ensure consistent quality of production. The fly ash and cement is mixed in dry state thoroughly after that recipe material is mixed the lime is mixed with slurry and then aluminium powder is mixed with water and then slurry is prepared and moulded.

**7.2 Casting:**
AAC blocks manufacturing process involves casting, rising and pre-curing. Before casting, moulds are coated with a thin layer of oil. This is done in order to ensure that green cake does not stick to moulds. While slurry is mixed and poured into greased moulds, Aluminium reacts with Calcium Hydroxide and water to form Hydrogen. Millions of tiny Hydrogen bubbles are released due to this reaction. This leads to formation of tiny unconnected cells causing slurry mix to expand. Such expansion may be twice its original volume. This process is very similar to rising of idli or dhokla dough. It must be noted that bubbles generated during AC blocks

manufacturing process are unconnected. Bubble size is usually 2 5mm. These cells are the reason behind light weight and insulating properties of AC blocks. Once rising process is over, green-cake is allowed to settle and cure for some time. This ensures cutting strength required for wire cutting.

**7.3 Demoulding:**

In earlier casting we have seen how slurry is cast in moulds and allowed to rise and gain strength during pre curing. Once green cake has achieved strength, it is ready to be demoulded. In industries they generally use machines to separate the mould or invert the mould upside down to remove the block from the mould.

## 8. RESULT

### a. Compressive Strength of Blocks For 3 Days

| Sr.No. | Types of block | Compressive strength of blocks(N/mm$^2$) |
|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| | | **BLOCK 1** | **BLOCK 2** | **BLOCK 3** | **Average** |
| 1 | MIX PROPORTIONS I | 3.2 | 3.0 | 3.4 | 3.2 |
| 2 | MIX PROPORTIONS II | 3.0 | 3.4 | 3.6 | 3.3 |
| 3 | MIX PROPORTIONS III | 2.8 | 3.0 | 3.2 | 3 |

**b. Compressive Strength of Blocks For 7 Days**

| **Sr.No.** | **Types of block** | **Compressive strength of blocks(N/mm$^2$)** | | | |
|---|---|---|---|---|---|
| | | **BLOCK 1** | **BLOCK 2** | **BLOCK 3** | **Average** |
| 1 | MIX PROPORTIONS I | 3.4 | 3.0 | 3.6 | 3.3 |
| 2 | MIX PROPORTIONS II | 2.8 | 3.2 | 3.4 | 3.1 |
| 3 | MIX PROPORTIONS III | 2.6 | 3.0 | 3.4 | 3 |

## 9. CONCLUSION

From above results and discussion, following conclusions are drawn regarding comparison of AAC block and brunt clay brick for building construction;

i) From the experimental results carried out in this study, it is observed that density of mix proportion of AAC block is comparatively more than conventional AAC block. Therefore AAC block is best option for earthquake resistance structure.

i) From the experimental results carried out in this study, it is observed that water absorption of mix proportion of AAC block is comparatively slightly more than AAC block. Therefore mix proportion of AAC block is slightly better than AAC block.

iii) From the experimental results carried out in this study, it is observed that compressive strength of AAC block is comparatively more than convetional AAC block. Therefore AAC block is better for load transfer.

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