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Autoclaved Aerated Concrete

Akshay Lad[1], Nikhil Shirode [2], Balaji Shivpuje[3] Prof. B.R.Waravte[4]

UG Student, Civil Engineering, Trinity Academy of Engineering, Pune, India[1]

UG Student, Civil Engineering, Trinity Academy of Engineering, Pune, India[2]

UG Student, Civil Engineering, Trinity Academy of Engineering, Pune, India[3]

Guide, Civil Engineering, Trinity Academy of Engineering, Pune, India3

Abstract: The most commonly used building material is Brick in the country. And, for many decades it has got the prime importance with some adverse effect on environment. The Carbon Dioxide which gets emitted from the manufacturing process of bricks affects the green environment. Hence, the present study focuses on the construction material known as Autoclaved Aerated Concrete which is eco-friendly i.e. harmless to the environment and which has many more advantages over conventional brick. And due to this, the manufacturing process of the Autoclaved Aerated Concrete Blocks is studied and it can be said that Autoclaved Aerated Concrete blocks can be used as a substitute to conventional brick which has many benefits over it like Thermal insulation, Sound Insulation, Adequate Strength and Stability, Durability, Fire Resistance etc.

Keywords: Autoclaved Aerated Concrete, Thermal Insulation, Sound Insulation, Durability.

I. INTRODUCTION

The most commonly used building material is brick in the entire country. It is the most conventional material and been used in the construction work from many decades. With the developing urbanization in the past few years in the country, demand of construction material is rising. Due to this, demand of brick kiln was of prime importance and hence, developed many problems related to health as well as environment. It has affected environment globally with problems like global warming. Hence, to reduce the adverse effects of brick on nature, Autoclaved Aerated Concrete was invented at the mid of 1920 by a Swedish architect Johan Axel Eriksson. Autoclaved aerated concrete (AAC) is made with fine aggregates, cement, and an expansion agent that causes the fresh mixture to rise like bread dough. In fact, this type of concrete contains 80 per cent air. In the factory where it is made, the material is moulded and cut into precisely dimensioned units. Autoclaved Aerated Concrete is an eco-friendly construction material with numerous advantages over conventional bricks like Thermal insulation, Sound Insulation, Adequate Strength and Stability, Durability, Fire Resistance etc.

II. INTRODUCTION OF AUTOCLAVED AERATED CONCRETE

Autoclaved aerated concrete is a lightweight, precast, foam concrete building material suitable for producing concrete masonry unit like blocks. AAC is one of the major achievements of the 20th century in the field of construction. It is a lightweight, precast building material that simultaneously provides structure, insulation, and fire resistance. AAC Blocks is a unique and excellent type of building materials due to its superb heat, fire and sound resistance. AAC block is lightweight and offers ultimate workability, flexibility and durability. AAC relatively easy to work with, and can be cut and shaped with hand tools including woodworking tools. Blocks are made to very exacting dimensions and are usually laid in thin-bed mortar that is applied with a toothed trowel, although more conventional thick-bed mortar can be used. Wall panels are storey height, reinforced and mechanically fixed. AAC can also be used in panel form for floor and roof construction. It has a long life and does not produce toxic gases after it has been put in place.

III. RAW MATERIALS USED IN THE MANUFACTURING OF AAC

a) **Cement:** Portland cement is generally preferred. Cement, known as the binder, is a substance used in the construction process that sets and hardens and is capable of binding other materials together. 14% present in AAC block this substance is available in different colours and grades.
b) **Water:** Potable water should be used which should conform with the general requirements of the concrete.
c) **Fly Ash:** A by-product of thermal power plants and is an important raw material in the manufacture of AAC. Majorly used(around 68%) in manufacturing AAC block, fly ash is a by-product of burning pulverized coal in an electric generation power plant. These are mixed with water to form a fly ash slurry which is then mixed with other ingredients to form blocks.

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d) **Quick Lime:** Lime powder is obtained either by crushing limestone to fine powder at AAC factory or by directly purchasing it from the market. Acting as a binding agent, lime is used 14% in a powder form that is either obtained from crushing the limestone at the AAC block factory or directly purchasing it from the merchants. Testing of the properties is done before using it in the manufacturing process especially calcium oxide content and temperature. The temperature should be between 55 – 60ºC and calcium oxide content should be below 80%.
e) **Gypsum:** Gypsum is easily available in the market and is used in powder form. It is stored in silos. This component of AAC block is a very soft mineral that could be colourless to white, maybe yellow, blue. It is a translucent, soft, and water-soluble component that is used 3.5% in a powder form.
f) **Aluminium Powder:** Used as an expansion agent, aluminium powder is used at a rate by volume.
Apart from these, around 0.5% of other miscellaneous products are used. After the raw material preparation, the AAC bricks are manufactured using a dosing and mixing process that means the quality of final products. The component of AAC block is used by maintaining the ratio in the process which in turn gives out a strong, light-weight block to meet all the construction needs.

IV. MANUFACTURING PROCESS OF AUTOCLAVED AERATED CONCRETE

a) Raw Material Mixing: The key ingredient to manufacture AAC blocks is fly ash. Fly ash is mixed with water to form fly ash slurry. Slurry thus formed is mixed with other ingredients like lime powder, cement, gypsum and aluminium powder in quantities consistent with the recipe.

Fig. 1 Raw Materials Dry Mix

Dosing and mixing includes the mixing of raw materials in a desired proportion so as to achieve efficient strength. Figure 2 shows the mixing unit. A dosing and mixing unit is used to form the correct mix to produce Autoclaved Aerated Concrete (AAC) blocks. Fly ash/sand slurry is pumped into a separate container. Once the desired weight is poured in, pumping is stopped. Similarly lime powder, cement and gypsum are poured into individual containers using screw conveyors. Once required amount of each ingredient is filled into their individual containers control system releases all ingredients into mixing drum.

Fig. 2 Dosing & Mixing

b) Blocks Casting on Moulds: After thorough mixing, slurry containing fly ash (or sand), lime powder, cement, gypsum and aluminium is poured in moulds. Moulds can be of various sizes depending upon installed capacity. 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.

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Fig. 3 AAC Blocks Casting Mould

After thorough mixing, slurry containing fly ash (or sand), lime powder, cement, gypsum and aluminium is poured in moulds. Moulds can be of various sizes depending upon installed capacity. 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.

c) Demoulding and Cutting:

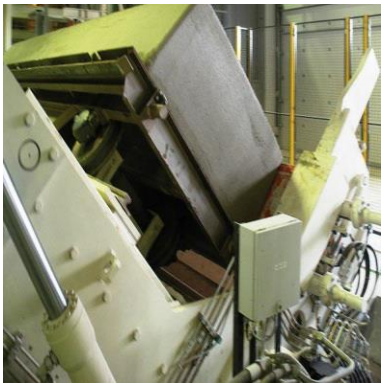

Fig. 4 Demoulding of AAC block

Demoulding and cutting are very critical processes in AAC blocks manufacturing. These two processes play a major role in defining amount of rejection as well as dimensional accuracy of the final product. Once a mould is out of pre-curing room, it is lifted by a crane or rolled on tracks for demoulding operation. Two types of cutting are carried out: horizontal and vertical cutting.

d) Curing:

Pre curing process starts after concrete mix is poured into metal moulds. In these moulds, concrete will be pre cured after it is poured into mould to reach its shape and after this pre curing process cutting will take place.

Autoclave is defined as a strong, pressurized and steam-heated vessel. Concrete mix that is categorized as autoclaved has its ultimate mechanical properties conditions. In order to reach the ultimate mechanical characteristics for AAC, Curing with autoclaving method requires three main factors which are moisture, temperature and pressure. These three factors should be applied on material all at the same time. Temperature inside autoclave should be 1900ºC and essential pressure should be about 10 to 12 atmospheres. Moisture will be controlled by autoclave and this process should be continued up to 12 hours to provide proper condition for hydration.

e) AAC Block: After going through all the above steps, finally, the formation of AAC blocks takes place and which can be used for the construction work.

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Fig. 5 Autoclaved Aerated Concrete

V. COMPARISON BETWEEN AAC BLOCKS & CONVENTIONAL BRICKS

TABLE 1: COMPARISON BETWEEN AAC BLOCKS & CONVENTIONAL BRICKS

Sr. No.	Particulars	AAC Block	Conventional Brick
1	SIZE (L x H x B)	650mm x 250mm x (75mm-300mm)	230mm x 750mm x 115mm
2	Compressive strength	3-4.0 N/mm^2 (As per IS: 2185 part III)	2.5-3 N/mm^2
3	Dry Density	550-650 kg/m^3 (Oven dry)	1800 kg/m^3
4	Fire resistance	2 to 6 hours depending on thickness	2 hours
5	Sound reduction index I (dB)	45 to 200 mm thick wall	50 for 230 mm thick wall
6	Thermal conductivity (Kw-m/C)	0.16	0.81
7	Mortar Consumption M3 with 1:6	0.5 bag of cement	1.35 bag of cement
8	Chemical Composition	Fly ash used around 70% which reacts with binders (Lime and Cement) to from AAC	Soil is used which contains many inorganic impurities like sulphates etc. resulting in Efflorescence
9	Structure Cost	Steel saving up to 15%	NO such saving
10	Quality	Uniform and consistence	Normally varies
11	Efflorescence	No such chance, which improves the durability of wall along with plaster and paint in a long run	Most chances are there
12	Storage	Readily available at any time and any reason in a short notice so no storage required	Particularly in monsoon, stock at side is compulsory which block large working space
13	Finishing	Can be directly cut or shaped/sculptured as required	Not possible
14	Cost benefit factor	Saving up to 24% in structural cost due to reduction of dead load (Subject to project design)	No cost benefit
15	Water required	Requires less in wetting and curing, hence saving electricity bills and labour cost	Need more curing resulted to higher amount of electricity bill and labour cost
16	Maintenance	Less due its due to superior properties	Comparatively high

- **ADVANTAGES OF AAC BLOCKS:**

1. Lightweight
2. Easy Workability & Design Flexibility
3. Faster Construction
4. Easy to Install
5. Sets &Hardens quickly
6. Minimum Wastages
7. Thermal Insulation
8. Energy Efficient
9. Eco-Friendly
10. Sustainable
11. Acoustic Performance
12. Fire Resistant
13. Cost Saving
14. Variation in sizes
15. Seismic Resistant
16. Accuracy
17. Termite Pest-Resistant
18. Water Saver

- **DISADVANTAGES OF AAC BLOCKS:**

1. **Installation during rainy weather:** AAC is known to crack after installation, which can be avoided by reducing the strength of the mortar and ensuring the blocks are dry during and after installation.
2. Brittle nature: they need to be handled more carefully than clay bricks to avoid breakage.

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3. **Attachments:** The brittle nature of the blocks requires longer, thinner screws when fitting cabinets and wall hangings and wood-suitable drill bits or hammering in. Special, large diameter wall plugs (anchors) are available at a higher cost than common wall plugs.
4. Insulation requirements in newer building codes of northern European countries would require very thick walls when using AAC alone. Thus many builders choose to use traditional building methods installing an extra layer of insulation around the entire building
5. The cost per unit of AAC is high, but overall, masonry cost is low because it requires less mortar for installation.

VI. CONCLUSION

AAC Block is a lightweight, load-bearing, high-insulating, and durable building product. AAC is manufactured from common and abundant natural raw materials, therefore it is extremely resource-efficient and eco - friendly. These are suitable for walls in RCC framed building. It helps in reducing dead load of structure. The workability of AAC helps to eliminate waste on the jobsite. Density of AAC block is 1/3 that of traditional clay brick Compressive strength of AAC blocks is comparatively more than traditional clay brick. Cost of construction reduces by maximum up to 20 % as reduction of dead load of wall on beam makes comparatively lighter members. Use of AAC reduces overall labour and material costs. Utilization of fly ash leads to the reduction in the cement consumption in the product which results in reduction of greenhouse gases. As both side face of AAC block wall are plane, thickness of plaster is very less, and so there is substantial reduction up to 50% in requirement of cement and sand for plaster work. The energy consumed in the production process emits no pollutants and creates no by-products or toxic waste products. Superior thermal insulation of the blocks reduces the need to turn on the air conditioner which in turn helps in saving electricity costs.

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