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MANUFACTURING PROCESS OF AAC BLOCK

Anurag Wahane[1]

Civil Department, Columbia Institute of Engineering & Technology, Raipur, (India)

ABSTRACT

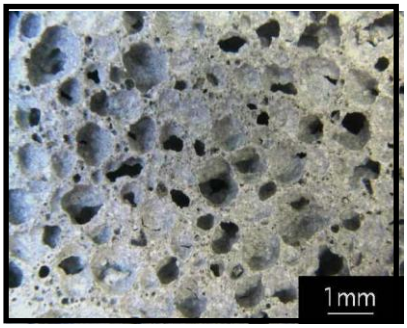
AAC blocks are light weight Aerated Autoclave Concrete Block. It is manufactured through a reaction of aluminium powder and a proportionate blend of lime, cement, and fly ash or sand. Autoclaved aerated concrete (AAC) is a lightweight cellular concrete that has been used for more than 80 years. Currently, however, no good recycling options for AAC from construction and waste exist. During this process, the hydrogen gas escapes create lots(billions) of tiny air cells, applying AAC with a strong cellular structure. The hydrogen gas or bubbles cause the concrete to expand to roughly thricetimes its original volume, further strengthened by high pressure steam curing. The product thus formed is not only light weight concrete but also has higher compressive strength. AAC is a masonry material that is lightweight, easy to construct, and economical to transport. AAC is one of the materials which can cope up with the shortage of building raw materials and can produce a light weight, energy efficient and environmentally friendly concrete. This study deals with the manufacturing process of the autoclaved aerated concrete blocks.

Keyword:-,AAC , aluminum , ,fly ash, cellular concrete, lightweight concrete

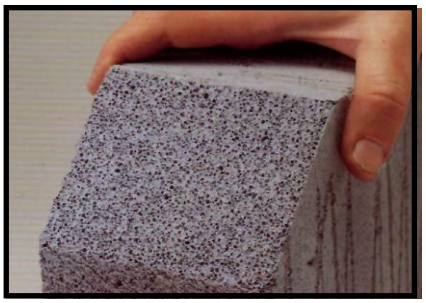
I. INTRODUCTION-

Autoclave aerated concrete blocks are also known as Auto clavedlight weight concrete(ALC) Autoclaved Aerated Concrete (AAC) is one of the eco – friendly and certified green building materials.AAC was perfected in the mid of 1920s by the Swedish architect.It has become one of the most used building materials in Europe and is rapidly growing in many other countries around the world .Basically,AAC is a mixture of cement,fly ash , sand , water, and aluminum powder. When the materials are proportionally weighed. AAC is using no aggregate larger than sand.Here, Aluminum powder reacts with calcium hydroxide and water to form H_2.The hydrogen gas foams and doubles the volume of the raw mix creating gas bubblesshown in (figure 1) At the end of the foaming process, the hydrogen escapes into the atmosphere and is replaced by air. When the air are removed from the

material, it is solid but still soft. It is then cut into blocks and placed in an cylindrical chamber for 11-.12 hours. Figure 2 shows the AAC Block.



(FIGURE -1)



(FIGURE-2)

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During this steam pressure hardening process, when the temperature reaches 190° C(374° F) and the pressure reaches to a maximum limit of 12 bar, sand reacts with calcium hydroxide to form calcium silicate hydrate, which gives AAC its high strength and light weight properties ,solid but soft in nature. After the autoclaving process, thematerial is ready for immediate use on the construction site. It has become one of the most used building materials in Europe and is rapidly growing in many other countries around the world. The characteristic of AAC is helpful in green housings and saves fertile lands and a solution for fly ash disposal.

II. MATERIAL USED

2.1 Cement :- Cement is a binder, a substanceused in construction industry that sets and hardens and can bind other materials together ,refer figure 3 The properties of OPC used in the AAC block are

(FIGURE 3-CEMENT)

- Color- White
- Density of cement -1440kg/m^3
- Type –OPC Grade 53
- Compressive strength – 53 MPa

Compound	Chemical composition (in%)
Cao	57.84
Sio_2	20.33
Fe_2O_3	4.68
Al_2O_3	3.40
Mgo	1.51
MnO	0.10
TiO_2	0.09
K_2O	0.72
Na_2O	0.51
SO_3	7.26
Loss of ignition	3.42
Insoluble residue	1.23

- Codal provision – IS 269:1989 and IS 383:1970
- Chemical compostion of cement

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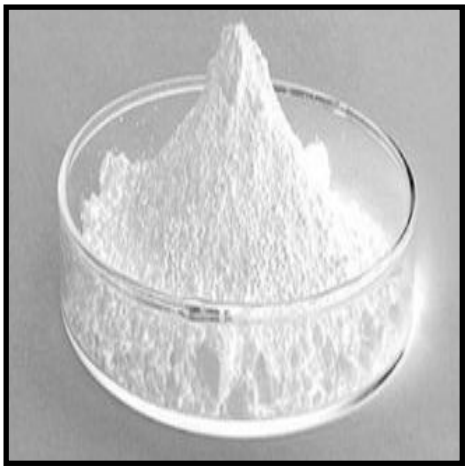
2.2 Fly ash: - Fly ash is waste industrial product used for reduction of construction cost. The density of fly ash ranges from 400-1800kg/m^3. It provides thermal insulation, fire resistance and sound absorption. The type of fly ash used is of Class C with contains 20% lime (CaO) and loss of ignition not be more than 6%,refer figure 4 for powdered fly ash .

(FIGURE 4CLASS C FLY ASH)

2.3 Sand: - Fineaggregate are basically sand consists of crushed stone with maximum particles passing through a 4.75mm sieve, refer figure 5 for fine sand. As per codal provision IS 383:1970,thesilica content shall not be less than80%.

(FIGURE 5-FINE SAND)

2.4 Limestone:-Limestone is made up of calcite aragonite referring figure 6 Limestone is obtained either by crushing to fine powder at AAC factory or by directly purchasing it in powder form from a merchant .



(FIGURE -6)

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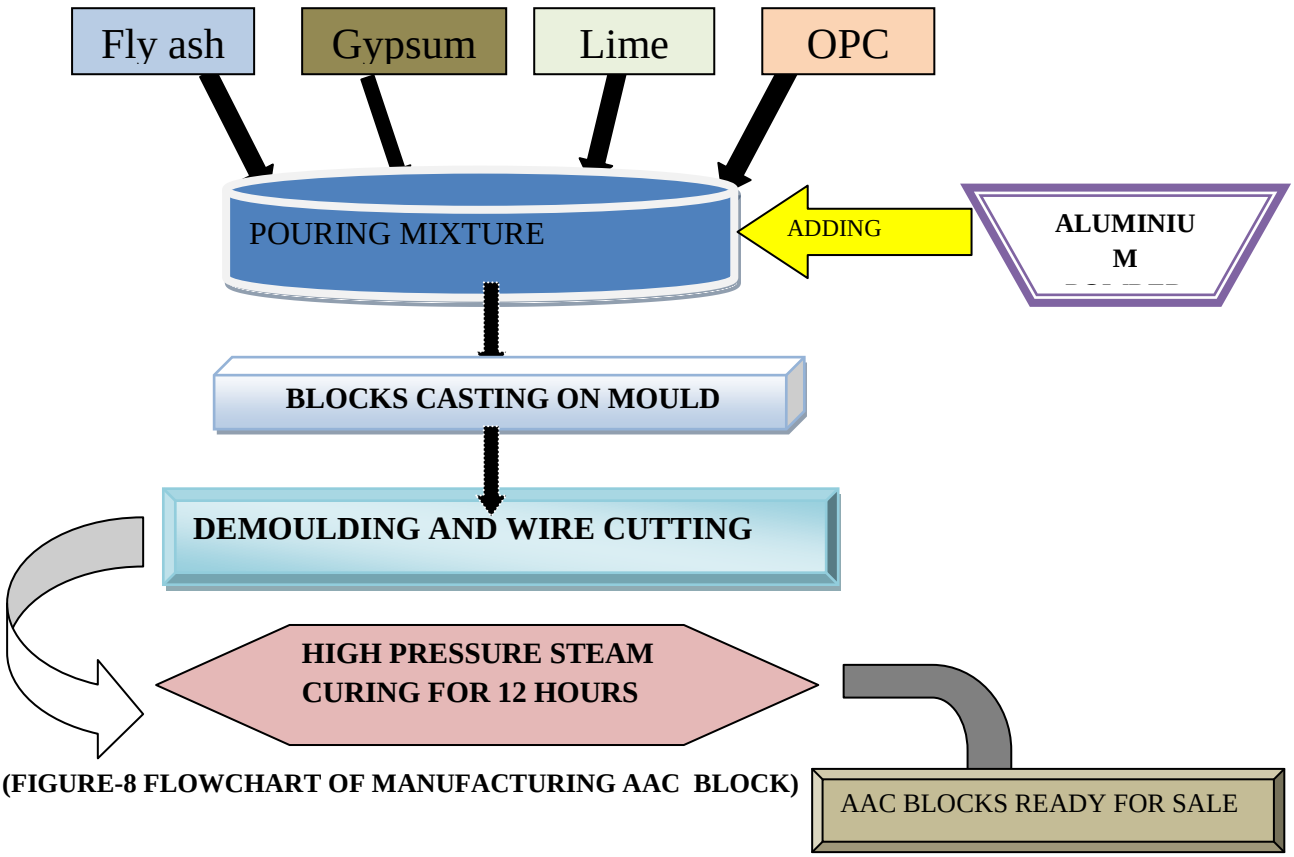
2.5 ALUMINIUM POWDER: -Aluminum is an expansion agent. When the raw material reacts with aluminum powder, air bubble introduced due to reaction between calcium hydroxide, aluminum and water and hydrogen gas is released , refer figure 7 .

$$2Al+3Ca(OH)_2 + 6H_2O \longrightarrow 3CaO.Al_2O_3.6H_2O + 3H_2$$

(FIGURE-7 ALUMINIUM POWDER)

2.6 GYPSUM :- Gypsum is easily available in the market and is used in powder form

III. MANUFACTURING PROCESS-



(FIGURE-8 FLOWCHART OF MANUFACTURING AAC BLOCK)

Step 1 – Raw Material Preparation-

AAC blocks manufacturing process starts with raw material preparation. List of raw materials and relevant details are mentioned below-

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- **Cement-** 53-grade Ordinary Portland Cement (OPC) from r manufacturer is required for manufacturing AAC blocks. Cement supplied by plants is not recommended due to variations in quality over different batches of cement.
- **Fly ash or sand –** 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 proportionate quatity to form blocks.
- **Limestone powder-** Lime powder required for AAC production is acquired by crushing limestone to fine powder at AAC factory or by directly purchasing it in powder form from a various plants.
- **Gypsum-** Gypsum is readily available in the market.

Step 2 – Dosing and Mixing-

After raw material preparation, next step of AAC blocks manufacturing process is dosing and mixing. Process of dosing and mixing means the quality of final products. Maintaining ratio of all ingredients as -

- FLY ASH OR SAND : LIME:CEMENT: GYPSUM = 69:20:8:3
- Aluminium is about 0.08% of total dry materials in the mix
- Water ratio = 0.60-0.65

The cycle of mixing and pouring is 5.5 minutes. A dosing and mixing unit is used to form the correct mix to produceAAC blocks. Fly ash is pumped into a container. Once the desired weight is poured in, pumping is stopped. Similarly lime powder, cement and gypsum are poured into individual containers using conveyors. Once required amount of each ingredient is filled into their individual containers control system releases all ingredients into mixing drum.. A smaller bowl type structure used for feeding Aluminium powder is also attached as a part of mixing unit. Once the mixture has been churned for set time, it is ready to be poured into molds using dosing unit. Dosing unit releases this mixture as per set quantities into molds. Dosing and mixing process is carried out continuously because if there is agap between charging and discharging of ingredients, residual mixture might start hardening and choke up the entire unit.For AAC blocks manufacturing, entire dosing and mixing operation is completely automated and requires minimum human intervention.

Step 3 – Casting, Rising and Curing-

Once mix of raw materials is ready, it poured is in molds. Molds can be of various sizes depending upon installed capacity like 4.2m x 1.2m x 0.65m in size.Before casting, molds are coated with a thin layer of oil in order to ensure that green-cake does not stick to molds. While slurry is mixed and poured into greased molds, Aluminum reacts with Calcium Hydroxide and water and releases hydrogen gas. This leads to formation of tiny cells causing slurry mix to expand. Such expansion may be thrice its original volume. Bubble size is about 2-5mm.Thus, this is the reason behind light weight and insulating properties of AAC block. When rising process is over, green-cake is allowed to settle &cure .

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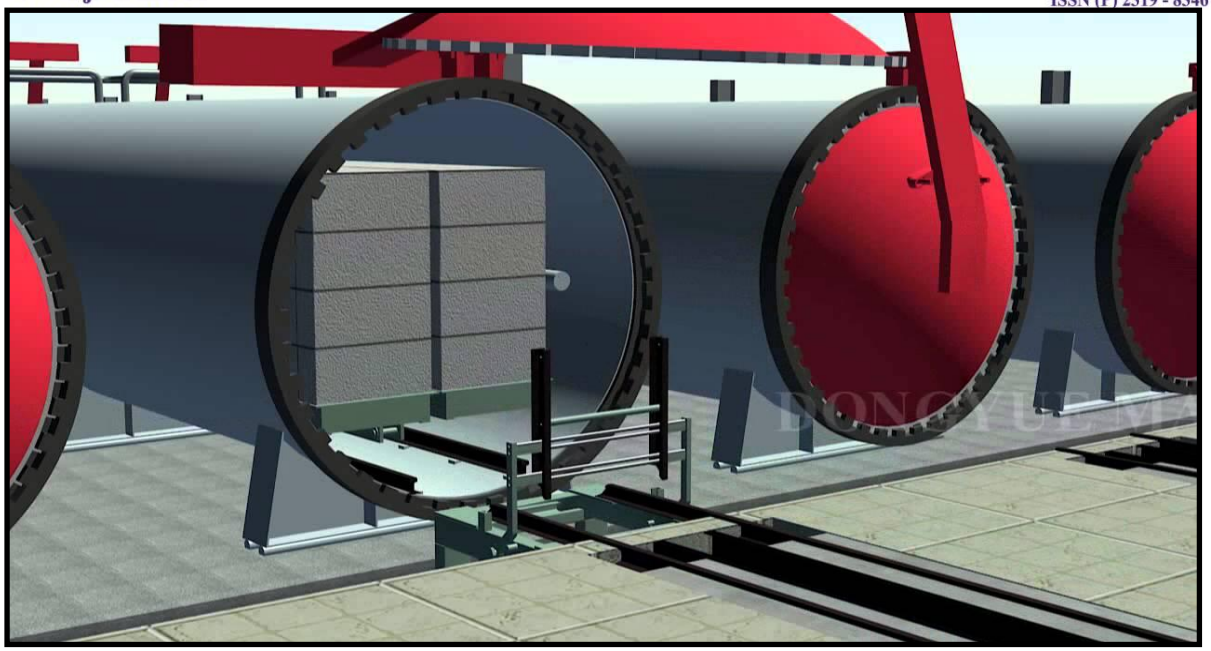

(FIGURE -9 HIGH PRESSURE TANK FOIR STEAM CURING)

Usually rising and pre-curing process takes around 60-240 minutes. Rising is dependent on raw material mix and weather conditions. Due to this, pre-curing is also referred as '*heating room pre-curing*'. At end of pre-curing process, green-cake is hard enough to be wire cut as per requirements .Autoclave Aerated concrete is cured in an autoclave – a large pressure vessel. Autoclave is normally a steel tube of 3m diameter and 45 meters long. Steam is fed into the autoclaved at high pressure, typically reaching a pressure of 800kPa to 1200 KPa and a temperature of 180°C ,refer figure 9After that blocks are taken for the DE-molding and cutting process.

Step 4 – Demoulding and Cutting –

Once green cake has achieved cutting strength, it is ready to be demoulded and cut as per requirements.Once a mold is out of pre-curing room, it is lifted by a crane for demoulding operation. While all previous processes like raw material preparation, dosing & mixing and casting are pretty much same across all technologies, demoulding and cutting process vary vastly depending on technology provider. Differences in demoulding and cutting process are also evident from different types of molds required by different technology provider.Primarily cutting process may be classified as flat-cake and tilt-cake based on how green cake is demoulded and sent to cutting line, refer figure 10

(FIGURE -10 CUTTING MACHINE)

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IV. COMPARISON-

S.NO.	DESCRIPTION	AAC BLOCK	CLAY BLOCK
1.	Structural Cost	Steel Saving Upto 15%	No Saving
2.	Breakage /Wastage	Less than 5%	Average 10 to 12 %
3.	Construction speed	Speedy construction	Comparatively slow
4.	Availability	Anytime	Shortage in monsoon
5.	Energy Saving	30% reduction	No such saving
6.	Accuracy in dimension	99%	90%
7.	Cost	30% cheaper than Red brics	-

V. CONCLUSION -

- The light weight property of the AAC blocks results into higher steadiness of the AAC blocks in the structure of the buildings. As the impact of the earthquake is directly proportional to the weight of the building, the building constructed using AAC blocks are more reliable and safer.AAC blocks are highly superior in terms of the strength.
- Higher level of strength of these blocks gives higher stability to the structure of the building. AAC is manufactured from non-biodegradable materials, which neither rot nor attract mould, keeping interiors clean and durable.
- AAC block weighs almost around 80% less as compared to the conventional red brick ultimately resulting into great reduction of deadweight. Further, the reduced deadweight results into reduction of the use of cement and steel which helps great in cost savings.
- AAC Blocks have an attractive appearance and is readily adaptable to any style of architecture. Almost any design can be achieved with AAC.

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