Scientific Journal of Impact Factor(SJIF): 3.134

e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 2,Issue 4, April -2015

AAC Block - A New Eco-friendly Material for Construction

Shweta O. Rathi[1], P.V. Khandve[2]

[1](Department of Civil Engineering, Prof Ram Meghe College of Engineering and Management, Badnera, Amravati, M.S., India

[2] (Department of Civil Engineering, Prof Ram Meghe College of Engineering and Management, Badnera, Amravati, M.S., India

Abstract: *Brick is the most commonly used building material for construction. The CO_2 emissions in the brick manufacturing process affects the green environment. Therefore, focus should be now more on seeking eco – friendly solutions for greener environment. Analysis of conventional and non – conventional material on cost, energy consumption and carbon emission parameters helps in highlighting suitable options for sustainable construction. AAC block, an eco – friendly material, gives a prospective solution to building construction. In this paper, attempt has been made to replace the red bricks with eco – friendly AAC blocks. The usage of AAC block reduces the cost of construction upto 20% as reduction of dead load of wall on beam makes it a comparatively lighter members. The use of AAC block also reduces the requirement of materials such as cement and sand upto 50%.*

Keywords *– AAC, bricks, light-weight, building, material*

I. INTRODUCTION

Bricks remain one of the most important building materials in the country. Brick making is a traditional industry in India, generally confined to rural areas. In recent years, with expanding urbanization and increasing demand for construction materials, brick kilns have to grow to meet the demand. It has directly or indirectly caused a series of environmental and health problems. At a local level, in the vicinity of a brick kiln, environmental pollution from brick-making operations is injurious to human health, animals and plant life. At a global level, environmental pollution from brick-making operations contributes to the phenomena of global warming and climate change. Extreme weather may cause degradation of the brick surface due to frost damage. Global warming and environmental pollution is now a global concern. Various types of blocks can be used as an alternative to the red bricks, to reduce environmental pollution and global warming. AAC blocks may be one of the solutions for brick replacement.

Autoclaved Aerated Concrete (AAC) is one of the eco – friendly and certified green building materials. AAC is porous, non-toxic, reusable, renewable and recyclable. Autoclaved Aerated Concrete, also known as aircrete, is a lightweight, load-bearing, high insulating, durable building product, which is produced in a wide range of sizes and strengths. AAC offers incredible opportunities to increase building quality and at the same time reduce costs at the construction site. The Autoclaved Aerated Concrete material was invented by a Sweden Architect, Johan Axel Eriksson in 1924. It has become one of the most used building materials in Europe and is rapidly growing in many other countries around the world. AAC is produced out of a mix of quartz sand or pulverized fly ash, lime, cement, gypsum/anhydrite, water and aluminium and is hardened by steam-curing in autoclaves. Due its excellent properties, AAC is used in many building constructions, such as in residential homes, commercial and industrial buildings, schools, hospitals, hotels and many other applications. AAC replaces clay bricks which are environmentally unsustainable. Being aerated, it contains 50 - 60 % of air, leading to light weight and low thermal conductivity. The characteristic of AAC is helpful in green housings and saves fertile lands and a solution for fly ash disposal.

II. COMPARISON OF AAC BLOCKS WITH CLAY BRICKS

The comparison between AAC blocks and bricks is shown in table no. 1

Table 1. Comparison of AAC blocks with clay bricks

Sr. no.	Parameters	AAC Blocks	Clay Bricks
1	Soil consumption	Uses fly ash which is a thermal power plant waste product & thus no consumption of top soil	One sq ft of carpet area with clay brick walling will consume 25.5 kg of top soil
2	Fuel consumption	One sq ft of carpet area with AAC blocks will consume 1 kg of coal	One sq ft of carpet area with clay bricks will consume 8 kg of coal
3	Co_2 emission	One sq ft of carpet area will emit 1.5 kg of CO_2	One sq ft of carpet area will emit 12kg of CO_2
4	Sizes	600x200x75,100,125,150,175,200,225 mm	190x90x90/40mm(modular),

			230x110x70/30mm(non-modular).
5	Compressive strength	Not less than 3 N/mm^2	Not less than 3 N/mm^2
6	Dry density	551-600 kg/m^3	1920 Kg/m^3
7	Consumption of cement mortar	0.77 bags of cement / Cu.m	1.44 bags of cement/ Cu.m
8	Energy saving	Approximately 30% for heating and cooling because of low thermal conductivity value	None
9	Cost benefits	Reduction in dead weight leading to savings in steel and concrete	None

III. RAW MATERIALS USED IN THE MANUFACTURE OF AAC BLOCKS

The following raw materials are used in the manufacturing process of AAC blocks -

3.1. Cement : Portland cement is generally preferred.

3.2. Water : Potable water should be used which should conform with the general requirements of the concrete.

3.3. Fly Ash : A by-product of thermal power plants and is an important raw material in the manufacture of AAC .

3.4. Quick Lime: Lime powder is obtained either by crushing limestone to fine powder at AAC factory or by directly purchasing it from the market.

3.5. Gypsum: Gypsum is easily available in the market and is used in powder form. It is stored in silos.

3.6. Aluminium Powder

IV. THE MANUFACTURING PROCESS

Manufacturing process of AAC contains five main steps which are as following -

i. Mixing of raw materials.
ii. Addition of expansion agent.
iii. Pre curing, cutting.
iv. Curing process with autoclave.
v. Packing and transporting.

4.1. Mixing of raw materials

In this part of manufacturing aggregates like silica sand or quartz sand and process, fine lime are mixed with cement. Then water will be added to this mix and hydration starts with cement forming bond between fine aggregates and cement paste. All these processes take place in a huge container as shown in figure 1.

4.2. Addition of expansion agent

After mixing process, expansion agent is added to the mixture as shown in figure 1 for increasing its volume and this increase can be from 2 to 5 times more than original volume of the paste. Expansion agent which is used for this process is aluminum powder; this material reacts with calcium hydroxide which is the product of reaction between cement and water. This reaction between aluminum powder and calcium hydroxide causes forming of microscopic air bubbles which results in increasing of pastes volume. These microscopic air bubbles will increase the insulation capacity of AAC.

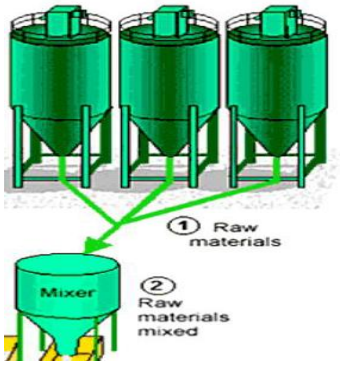

Figure 1. Mixing of Raw Materials and addition of expansion agent

This reaction is shown in following equation-

$2Al + 3Ca(OH)_2 + 6H_2O \rightarrow 3\,CaO\,.\,Al_2O_3 + 3H_2$
Aliminium powder + Hydrated lime → Tricalcium hydrate + Hydrogen

4.3. Pre-curing and cutting

Pre curing process starts after concrete mix is poured into metal moulds with dimensions of 6000 mm × 1200 mm × 600 mm as shown in figure 2 . 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 as shown in figure 3.22 below. Cutting will be done with wire cutter to avoid deformation of concrete during process. Aerated concrete blocks are available in different dimensions and various thicknesses. Dimensions for these blocks which are commonly used are: 600×250×100 mm, 600×250×150mm, and 600×250×200.

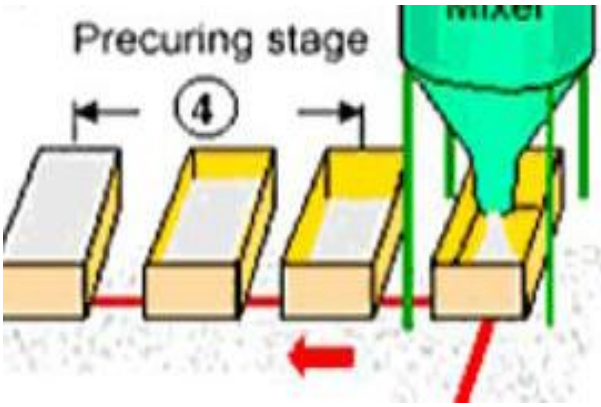

Figure2. Pre curing

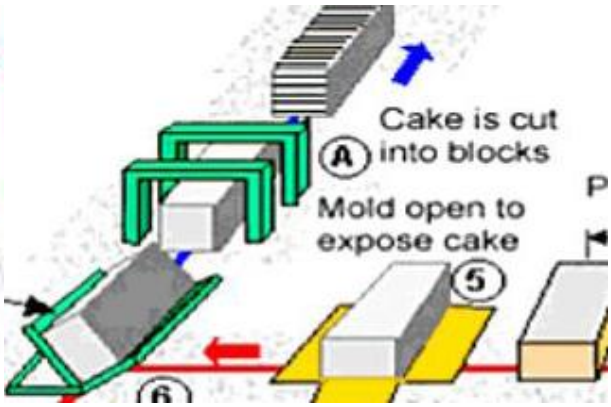

Figure3. Cutting

4.4. Curing process by autoclave

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, Domingo states, 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 190^0C 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.

4.5. Packing and transporting

After completion of mentioned processes, autoclaved aerated concrete is ready for packing and transportation, but the important factor that shall be carefully considered for this process is that; material should be cooled the cut blocks are then loaded into the autoclave. It takes a couple of hours for the autoclave to reach maximum temperature and pressure, which is held for perhaps 8-10 hours, or longer for high density/high strength aircrete.

V. 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 –

5.1. Density

The density of AAC ranges from 250 to 1,800 kg/m3, as compared to 2400-2600 kg/m^3 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.

5.2. 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.

5.3. 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.

5.4. 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. The salient features of AAC block are mainly depends on

i. Pore formation and method of curing plays an important role in microstructure property
ii. Property depends on density and along with the moisture contain.
iii. The chemical composition varies with the method of curing tobermorite get being formed for moist curing autoclaving.
iv. Strength of AAC is significantly higher due above reason.
v. Strength porosity relation has been developing for aerated concrete based on various ratios.

The shrinkage drying property of AAC material also varies with climatic condition aerated concrete exhibits good functional performance characteristics.

VI. Advantages of Autoclaved Aerated Concrete

The advantages of autoclaved aerated concrete are as follows –

6.1. Eco - friendly: AAC helps to reduce at least 30% of environmental waste as compared to traditional concrete. There is a decrease of 50% of greenhouse gas emissions.

6.2. Lightweight: It is 3-4 times lighter than traditional bricks and therefore, easier and cheaper to transport.

6.3.Energy Saver: It has an excellent property that makes it an excellent insulator.

6.4. Great Acoustics: AAC has excellent acoustic performance. It is able to be used as a very effective sound barrier.

6.5. Fire Resistant: Just like the regular concrete, ACC is fire resistant. This material is completely inorganic and not combustible.

6.6. Low Maintenance: AAC reduces the operating cost by 30% to 40%. It also reduces overall construction cost by 2.5% as it requires less jointing and reduces the quantity of cement and steel.

6.7. Faster Construction: It reduces construction time by 20%. As these blocks are lighter, it make construction easier and faster.

VII. CONCLUSION

Compressive strength of AAC blocks is comparatively more than traditional clay brick. These are suitable for walls in RCC framed building. Utilization of fly ash leads to the reduction in the cement consumption in the product which results in reduction of green house gases. Density of AAC block is 1/3 that of traditional clay brick and there is no more change in wet condition. It helps in reducing dead load of structure. Cost of construction reduces by maximum up to 20 % as reduction of dead load of wall on beam makes comparatively lighter members. 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. AAC is manufactured from common and abundant natural raw materials, therefore it is extremely resource-efficient and eco - friendly. The energy consumed in the production process emits no pollutants and creates no byproducts or toxic waste products. The work ability of AAC helps to eliminate waste on the jobsite.

REFERENCES

[1] Robert, I. "Cost - Estimating Principles." The Journal of Construction Engineering and Management,Vol. 115, ©ASCE, ISSN 0733-9364/89/0004 0545/$1.00+ $.15 per page. Paper No. 24107, December, 1989.
[2] Choi, K.C., William Ibbs, C., "Costs and Benefits of Computerization in Design and Construction." The Journal of Computing in Civil Engineering, Vol. 4, ©ASCE, ISSN 0887-3801/90/0001-0091/$1.00 + $.15 per page.Paper No. 24285, 1, January.
[3] Sawhney, A., Mund , A., Syal, M. , "Energy-Efficiency Strategies for Construction of Five Star Plus Homes." The Practice Periodical on Structural Design and Construction, Vol. 7, 1, 2002. ©ASCE, ISSN 1084-0680/2002/4-174 – 181/$8.00₴$.50 per page, 4, November.
[4] Hassan, R. "Viability of autoclaved aerated concrete walls for the residential sector in the United Arab Emirates." 0378-7788/$ – see front matter © 2011 Elsevier B.V. All rights reserved. doi:10.1016/j.enbuild, April, 2011.
[5] Vivian, W. Y. , "Cost Effectiveness of using Low Cost Housing Technologies in Construction." 1877–7058 © 2011 Published by Elsevier Ltd.doi:10.1016/j.proeng, July, 2011.
[6] Prakash, T.M., Dr.Naresh kumar, B.G., Dr. Karisiddappa. , "Strength and Elastic Properties of Aerated Concrete Blocks (ACBs)." International Journal of Chemical, Environmental & Biological Sciences (IJCEBS) Volume 1, Issue 2 (2013) ISSN 2320 –4087 (Online), 2013.
[7] Otim, G., Nakacwa, F., Kyakula, M. , "Cost Control Techniques Used On Building Construction Sites in Uganda Second International Conference on Advances in Engineering and Technology, 2002.
[8] Hebel, M.C., "Using modern methods of construction to build homes more quickly and efficiently on Autoclaved Aerated Concrete." Technical Sheet and Installation Guide, 2009.

