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An experimental investigation on autoclave aerated concrete

D.Manikandan [1], S.Gopalakrishnan [2], K.Cheran[3]

[1] M.E Structural engineering "Builders Engineering College" kangayam , Tamilnadu, India.

[2] Head Of the Department, "Builders Engineering College", kangayam , Tamilnadu, India.

[3] Assistant Professor/CIVIL, "Vel Tech owned by RS Trust", Chennai, Tamilnadu, India.

Abstract: **Autoclaved aerated concrete (AAC) is a light weight, load bearing, high insulation and durable building product. Aerated Autoclave Concrete block is produced by mixing of cement, fly ash, water, lime, and aluminum powder.AAC block is a replacement for conventional red clay bricks, which we normally use for our building construction. The preliminary studies such as rate of water absorption, compressive strength, flexural strength, and the bond strength is studied. Bond strength between AAC and steel reinforcement is determined by performing pullout test.**

Keyword: Autoclaved aerated concrete, coarse aggregate, compressive strength, flexure, pull out test.

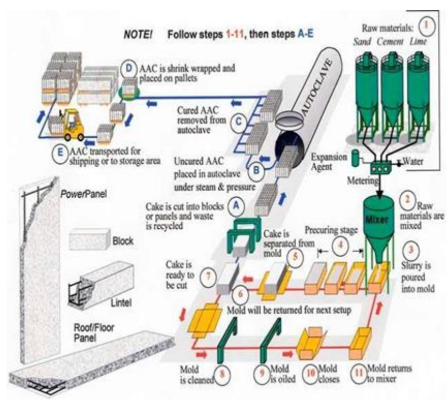
I. INTRODUCTION

AAC stands for Autoclaved Aerated Concrete. It was invented in early 1920 s by a Swedish architect named Dr. Johan Axel Eriksson. His purpose for designing AAC was to reduce consumption of timber and provide a cheaper and sustainable building solution. In addition global warming also has its own growth where construction industry remains the main reason behind the peak depletion of the sand. Rise in urbanization, deforestation, pollution etc,. Are the factors that lead to natural extinction to overcome these problems, an innovative material developed –AAC blocks.AAC has a very flexible system. It is also used as autoclaved cellular concrete (ACC).This innovation focuses on eco friendliness and directs a path to sustainable development. It also satisfies the rule of 3R‟s Reduce, Recycle and Reuse.

AAC is manufactured by a process that involves slurry preparation, foaming /rising, cutting, and steam curing (autoclaving). The raw materials of the AAC block is fly ash, cement, aluminum powder, gypsum, lime. and water.AAC blocks offer superior performance and reduced project cost due to bigger size and light weight. Bigger size leads to faster laying at site. Reduced weight translates to reduced dead-weight on structrure and higher thermal insulation.

MANUFACTURING PROCESS

The autoclaved aerated concrete production process differs slightly between individual production plants but the principles are similar. Portland cement, lime, gypsum, aluminum powder is mixed to form slurry. The slurry is poured into the moulds. Over a period of several hours, two processes occur simultaneously.



MATERIALS

The materials used for manufacturing AAC are as follows,

Cement

Ordinary Portland cement (OPC) is used for manufacturing of AAC.

Fly ash

The American society for testing and materials (ASTM) defines pozalona as "a siliceous (or) aluminous materials, which in itself possess little or no cementitious properties.

Class F flyash-It is available in the largest quantities. Class F is generally low in lime, usually under 15% contains a greater combination of silica, alumina iron (greater than 70%) than class c fly ash.

AluminumPowder

Aluminum powder is used at a rate of 0.05% - 0.08% by volume. Aluminum power reacts with calcium hydroxide and water to form hydrogen. The hydrogen gas forms and doubles the volume of raw mix creating gas bubbles up to 3 mm (1/8 inch) in diameter. At the end of the foaming process, the hydrogen escape into the atmosphere and is replaced by air.

Lime

It is made up of calcium carbonate and has the chemical formula CaCO3.lime has high PH. Composed largely of calcite and aragonite, and water soluble, hard and durable.

Gypsum

Gypsum is a very soft mineral composed of calcium sulfate dehydrate. It has the chemical formula of CaSO4.2H2O.gypsum is almost PH neutral.

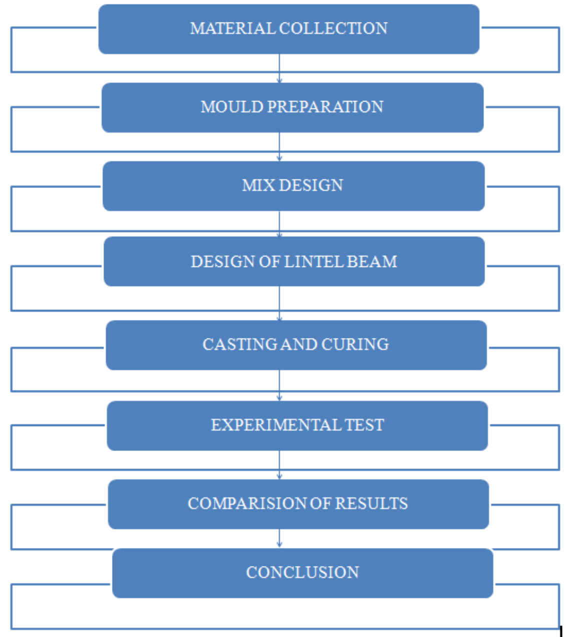
Water

These two ingredients are responsible for binding everything together. The percentage of proportion of AAC blocks is 0.6 – 0.65 %.PH of water is used for AAC block is 8.

1.4 ADVANTAGES OF AAC BLOCKS

- Porous structure allows for superior fire resistance.
- Workability allows accurate cutting, which minimizes the generation of solid waste during use.
- Resource efficiency gives it lower environmental impact in all phases of its cycle, from processing of raw material to the disposal of waste.
- Light weight saves cost &energy in transportation, labor expenses, and increases chances of survival during seismic activity.
- Greatacoustics: when you think of concrete, you do not consider it to be excellent for acoustics, however autoclaved aerated concrete has excellent acoustic performance. It is able to be used as avery effective sound barrier
- Non –toxic: there are no toxic gases or other toxic substances in autoclaved aerated concrete. It does not do not attact rodents or other pests nor can it be damaged by such.

II. METHODOLOGY



III. EXPERIMENTAL TESTS

WATER ABSORBTION TEST

Dry the specimen in a ventilated oven at a temperature of 105 to 110 degree Celsius till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (w1).specimen warm to touch shall not be used for this purpose.Immerse completely dried specimen in clean water at a room temperature 27 + -2 degree Celsius for 24 hours. Remove the specimen and wipe out any traces of water with a damp cloth and weight the specimen. Complete the weighing 3 minutes after the specimen has been removed forwater (w2).

Formula:Water absorption = ((w2-w1)/w1) X 100

Table 1 Water absorption Test for AAC blocks

S.No	Days	AAC Blocks (4") (%water absorbed)	AAC Blocks (6") (%water absorbed)
1	3	33.21	18.6
2	7	28.55	20.27
3	14	21.32	22.4
4	28	20.32	19.67

Water absorption of samples decreases and increases randomly as the number of days increases.

COMPRESSIVE STRENGTH TEST

Out of many test applied to the AAC blocks, this is the utmost important which gives an idea about all the characteristics of blocks and also concrete. By this single test one judge that whether block has been done properly or not.

Table 2 Compressive strength of AAC blocks

S.NO	Size of Specimen (mm)	Max Load (kN)	Compressive strength (N/mm2)
1	200X200	146	3.66
2	200X200	163	3.73
3	200X200	155	4
Average			3.79

Formula

Compressive strength= (load in N/Area in mm2)
=153x103/ (200x200)= 4N/mm2.

FLEXURAL STRENGTH TEST

Flexure tests are generally used to determine the flexural modulus or flexural Strength of a material .the material is laid horizontally over two points of contact and then force is applied to the top of the material through either one or two points of contact until the sample fails. The maximum recorded force is the flexural strength of that sample.

Figure 1 Flexural strength Test

Table 3 Flexural Strength for 8" Blocks

S.NO	Size of Specimen (mm)	Max Load (kN)	flexural strength (N/mm2)
1	600x200x200	65	0.72
2	600x200x200	63	0.7
3	600x200x200	59	0.65
Average			0.69

Formula

Flexural strength = (load in N/Area inmm2)
=65x103/ (600x200)
= 0.72 N/mm2.

PULLOUT TEST

As per IS 11309-1985 ,this standard lays down the method for conducting anchor pull –out test and the evaluation of bond strength between reinforcement and grout concrete. The size of bars can be used are 8mm, 12mm, and 16 Casting of Specimen.

To carry out pullout test reinforcement bars are to be fixed inside 150 mm x 150 mm x 150 mm cube filled with AACmixture. The rod is fixed at the center of the mould. Then the mixture is poured in the mould, for fixing the rod in their position.

Figure 2 Casting of Specimen for Pullout Test

Pre-Curing 0f Specimen for Pull Out Test

After the filling of mixture into the mould, it has to be cooled in room temperature, about 3 hours,as shown in fig 4.5

Figure3 Pre-Curing of Specimen for Pull out Test

Cube after curing in autoclave for 12 hours is shown in fig 4

Figure 4 Cubes After cured in Autoclave

IV. TEST RESULTS

The test results of pull out test using 8mm, 12mm and 16mm diameter bars are shown in fig 2 to 4

Table 4 Pull out Test with 8mm Dia of bar

S.No	Size of Bars	Pull out Load (kN)
1	8mm	4.5
2		4.0
3		3.5
4		4.5
5		5.0
6		4.0
7		4.5
Average		4.285

Table 5 Pull out Test with 12mm Dia of bar

S.No	Size of Bars	Pull out Load (kN)
1	12mm	6.5
2		5.5
3		5.0
4		6.0
5		5.5
6		6.5
7		6.0
Average		5.857

Table 6 Pull out Test with 16mm Dia of bar

S.No	Size of Bars	Pull out Load (kN)
1	16mm	7.0
2		4.5
3		8.5
4		5.0
5		8.5
6		4.5
7		8.0
Average		6.572

LIME TEST

The lime powder is used in AAC block for providing binding action. And the size of lime particles is residue on 90 micron. The moisture content should not be more than 2 %. The temperature should be 50 -65 degree Celsius.

PROCEDURE

1. The lime is in a state of powder which contains CaO.
2. The size of particle used for test is residue on 90 micron.
3. Then the powder is mixed with ice water.
4. For every 5 minutes the temperature is checked up to 30 minutes.
5. If the temperature is in 50 to 65 degree Celsius the lime suitable for usage.
6. In case temperature is varied means, the lime cannot be used.

Table 7 Lime Test Report (Temperature)

S.NO	TIME IN MINUTES	TEMPERATURE In℃
1	0	21
2	5	29
3	10	32
4	15	39
5	20	45
6	30	61

V. CONCLUSION

1. Aerated light weight concrete is unlike conventional concrete due to some mix materials and properties.
2. Aerated lightweight concrete does not contain coarse aggregate, and it is possess many beneficial such as low density, enhanced in thermal and sound insulation and it reduced dead load.
3. Several advantages in AAC blocks are decrease structural elements and reduce the bearing capacity.

4. Aerated lightweight concrete is considering economy in materials and consumption of by-product and waste materials such as fly ash.
5. In this study the material properties and mechanical properties of AAC blocks were investigated.
6. From the literature studies Ilearned how to increase the bond strength and flexural strength in AAC and in the feature I will use AAC as a flexural member like beams.
7. In feature study carried outthe Durability test for Autoclaved Aerated Concrete (AAC) Blocks .
8. The Experimental test is carried out for beams to examine the flexural strength of AAC beams.

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