STUDY ON FIBRE REINFORCED AUTOCLAVED AERATED CONCRETE USING FABRICS OF WOVEN GLASS FIBRES

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ABSTRACT

Fibre Reinforced Autoclaved Aerated Concrete (FRAAC) 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. FRAAC 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. FRAAC 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. FRAAC 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.

Keywords: *AAC blocks, FRAAC blocks, fabrics of woven glass fibres*

I. INTRODUCTION

AAC blocks possess a cellular structure created during manufacturing process. Millions of tiny air cells impart AAC blocks very light weight structure. Density of these light weight blocks is range from 600-800 kg/m3. FRAAC blocks are made of inorganic materials, which do not allow the growth of pests, termites and ants. As they do not nest in AAC blocks, FRAAC blocks are very easy to handle. These blocks come with larger size and fewer joint which helps to easy and fast installation causes saving in time. The porous structure of the FRAAC blocks results into absorption of sound. It reduces the

rate transmission of sound, so these are ideal for construction of schools, colleges, hospitals and cinema theatre etc. AAC is non-toxic product which does not pollute the air, land or water. During the manufacturing process, waste from the cutting process is recycled back with raw material and used again. At the joints cement and sand is not required so, it reduced the cost of sand and cement. Also, for installation it requires less time so, labour charges also reduce and ultimately it effects on the cost of construction of building. FRAAC blocks weighs almost around 80% less as compared to the conventional clay brick ultimately resulting into great reduction of dead load on building. Further the dead load is reduced which results into reduction of use of cement and steel which helps to reduce the construction cost of building. Because of addition of Glass Fibres based on 100% Virgin high tenacity glass straight fibres and fibrillated mesh fibre in graded lengths, with Chemical Surface Treatment for uniform dispersion in wet concrete. The strength achieves more than regular AAC block.

II. Materials used

a. Fly Ash

Ash produced from combustion of coal. It is also known as pulverized fuel ash, composed of particulates that are driven out of coal-fired boiler together with fuel gases.

Table1: Properties of fly ash

Sr. No.	Properties	Value
1.	Specific gravity	2.51

b. Cement (53 Grade): Portland cement of 53 grade is used. The physical properties of cement as obtained from various tests.

Table 2: Properties of cement

Sr. No.	Properties	Value
1.	Standard consistency	30 %
2.	Initial setting time	45 min.
3.	Final setting time	290 min.
4.	Specific gravity	3.17

c. Lime: The lime obtained from calcinations process of lime stone is used. It is also known as burnt lime or quick lime.

Table 3: Properties of lime

Sr. No.	Properties	Value
1.	Specific gravity	2.71
2.	Lime slacking test	Temp in 10min 30-40°c
3.	Sieve test through 160µ	Min. 80

d. Gypsum: Gypsum is a rock mineral usually found in earth's crust. It acts as a

hardening retarder in Portland cement

Table 4: Properties of gypsum

Sr. No.	Properties	Value
1.	Specific gravity	2.24
2.	Sieve test through 160μ	Min. 80 %

e. Alumina: It is a finely divided aluminum. It is used as a foaming agent, added to create hydrogen bubbles in the mix which increases the volume of the block.

f. Mapcure Asw: It is a liquid substance that is added as a surface coating on freshly installed blocks. It is used to reduce the loss of water or heat in order to create ideal condition.

g. Glass fibre: Fabrics of woven glass fibres are useful for thermal insulators because of their high ratio of surface area to weight

Table 5: Properties of glass fibre

Sr. No.	Properties	Value
1.	Tensile strength	4892Mpa
2.	Density	2.46 g/Cu.m
3.	Thermal expansion	5 μm/m.□
4.	Softening temperature	1057 □

h. Density:Density = Mass / Volume

Density of AAC block (without fibre):=2.358/(0.15X0.15X0.15m)=698.67 kg/m3
Density of AAC Block (with fibre):=2.71/(0.15X0.15X0.15m)=803 kg/m3

III. Manufacturing process

a. 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. Add fibre into the container in required proportion. All these processes take place in a huge container.

b. Addition of expansion agent

After mixing process, expansion agent is added to the mixture 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 which forms microscopic air bubbles which results in increasing of pastes volume.

$$2Al + 3Ca(OH)_2 + 6H_2O \; 3\,CaO.\,AL_2O_3 + 3H_2$$

Aliminium powder + Hydrated lime Tricalcium hydrate + Hydrogen

c. 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. After the curing process cutting will take place. 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.

d. Curing process by autoclave

Autoclave is defined as a strong, pressurized and steam-heated vessel. 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. Temperature inside autoclave should be 190°C 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. 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.

IV. Tests on AAC and FRAAC

a. Water absorption test:

Water absorption test on bricks are conducted to determine durability property of bricks such as degree of burning, quality and behavior of bricks weathering. A brick with water absorption of less then 7% provides better resistance to damage by freezing. The test is carried out by the block is kept in water for 24 hours. After 24 hours the weight of the block is noted as (W1). Then the block is kept in the oven for 24 hours with constant temperature 110□. After 24 hours the oven dried weight of block is taken as (W2), then the water absorption is calculated by the formula,

Water Absorption= W_2/W_1 x 100

Where, W_1= Wet weight of block, W_2= Oven dried weight of block

b. For AAC block :-

Dry weight of AAC block = 2.175 kg,Wet weight of AAC block (after 24 hours) = 2.71 kg

Weight of moisture content = 0.525, % of water absorption = (0.513/2.175)x100 =

24.15%

c. FORFRAAC :-

Dry weight of AAC block = 2.100 kg, Wet weight of AAC block (after 24 hours) = 2.575 kg;
Weight of moisture content = 0.475, % of water absorption = (0.475/2.100)x100 = 22.61%

d. Compressive strength test:

The specimens of size 150x150x150mm was tested in 400KN capacity of Universal Testing Machine (UTM) and the compressive strength is calculated by using the formula, Compressive Strength=P/A
Where, Compressive Strength is in C P = Maximum Load in KN A = Cross sectional area in mm²

e. Test on AAC block

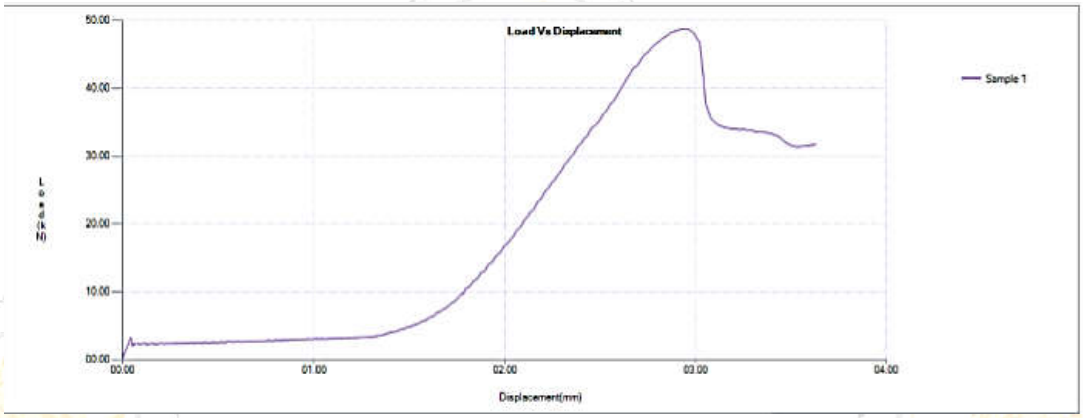

Fig.1: Test result for AAC

Results: Max. Force (Fm) = 48.75KN, Displacement at Fm = 2.94 mm, Maximum Displacement = 3.62 mm, Compressive Strength = 2.1 N/mm²

f. Test on FRAAC block

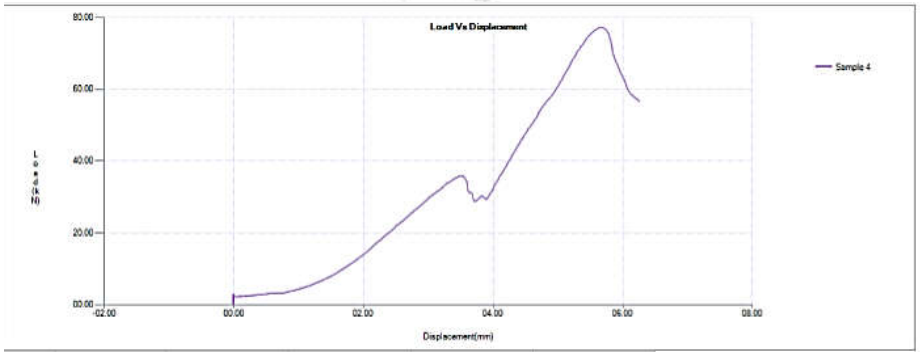

Fig. 2: Test result for FAAC

Results: Max. Force (Fm) = 77.19 KN, Displacement at Fm = 5.65 mm, Maximum Displacement = 6.25mm, Compressive Strength = 3 N/mm^2

V. Adhesive used for Construction

AAC block adhesive is a fast, clean, accurate system for construction using autoclaved aerated concrete blocks of close dimensional tolerance with 2mm-3mm mortar joints.

a. Areas of application:

1) laying and joining of fly ash bricks, cement blocks, hollow blocks, AAC blocks etc.
2) Joining of pre-stressed concrete blocks
3) Constructing parapet wall
4) Joining of cement window and floor frames
5) Constructing garden and boundary wall

b. Technical specification

Table 6: Technical specification of adhesive

Sr. No	Points	Description
1.	Appearance	Free Flowing Powder
2.	Color	Gray
3.	Water Demand	28 to 30%
4.	Initial Setting Time	60 Min.
5.	Final Setting Time	10 Hours
6.	Self Curing	Yes

VI. Conclusion

1. We increase the strength of the block by reducing the size of block as compare to the AAC block.
2. Because of using air entering reagents the total dead load of building decreases.
3. As the size of block decreases the utilization of space is more so that we can use more space for different purpose can be used.
4. The cost of FRAAC block is less than the regular AAC block so that we can use for the any type of construction.
5. The bricks required for the construction is less as compare to clay bricks

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