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Study and Experimentation of Autoclaved Aerated Concrete by using Fly Ash

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Abstract:- Light weight concrete can be defined as a type of concrete which includes and expanding agent in that it increases the volume of the mixture while giving additional qualities such as inability and lessened the dead weight. The usage of Autoclaved Aerated Concrete blocks gives a prospective solution to building construction industry along with environmental preservation.

Autoclaved Aerated Concrete (AAC) is versatile light weight concrete and they are generally used as blocks. The study of AAC replacing natural sand by fly ash is investigated. Design AAC mix having mix proportion 1:3 with water cement ratio of 0.6 in these specimens using with lime, the sand is constantly used in the specimens. The aluminum powder is used at the range of0.25, 0.5, 0.75, and 1gms of total weight of concrete. The properties of the mortar such as density, water absorption and compression strength for 24 hrs stream curing were determined.

AAC is produced out of a mix of pulverized fly ash (PFA), lime, cement, gypsum, water and aluminum and is hardened by steam curing in autoclaves. As a result of its excellent properties, AAC is used in many building constructions, for example in residential homes, commercial and industrial buildings, schools, hospitals, hotels and many other applications. The construction material AAC contains 60% to 85% air by volume.

I. INTRODUCTION

The aerated concrete is a one types of lightweight concrete. Aerated concrete is also well-known as a cellular concrete. it can be divided into two main types according to the method of production. The AAC is produced by adding in a predetermined amount of aluminum powder and other additives into slurry of Ground high silica sand, cement or lime and water. The background of foamed concrete began much later than lightweight aggregate concrete. Foamed concrete is not a particularly new material, it is first recorded used ate backtotheearly1920s.The application of foamed concrete for construction works was not recognized until the late 1970s. Beside the AAC began approximately 100 years ago. In 1914, the Swedes first discovered a mixture of cement, lime, water and sand that was expanded by the adding aluminum powder to generate hydrogen gas in the cement slurry. Prior to that, inventive minds had tried beaten egg whites, yeast and other unusual methods of adding air to the concrete. It was reported that foamed concrete was developedin Europeover 60 year sagoand has since then beenon the in ternational market form or ethan 20 years. Foamed concrete have high flow ability, low self-weight, minimum consumption of aggregate, controlled low strength, and excellent thermal insulation properties. The density of foamed concrete has wide range (1600-400kg/m3), with appropriate control in the dosage of the foam, can be obtained for application to structural, partition, insulation, and filling grades.

II. SCOPE

Autoclaved Aerated Concrete (AAC) is a non combustible, lime based, cementations building material that is expanding into new worldwide markets. now a days Use Of AAC block significantly increase due to low cost and easy structure. Builder and developer set up their own AAC block Plant instead of buying.

III. ENVIRONMENTAL PERFORMANCE

A. Resources

AAC is made from naturally occurring materials that are found in abundance –lime, fine sand, other siliceous materials, water and a small amount of aluminum powder(manufactured from a by-product of aluminum). Furthermore the production of AACdemands relatively small amounts of raw materials per m of product, and up to a fifth asmuch as other construction products.

B. Environmental impact during production

No raw materials are wasted in the production process and all production off cuts is fed back into the production circuit. The manufacture of AAC requires less energy than for all other masonry products, thereby reducing use of fossil fuels and associated emissions of carbon dioxide (CO_2). Industrial-quality water is used and neither water nor steam is released into the environment. No toxic gases are created in the production process.

C. Environmental impact during use

AAC's excellent thermal efficiency makes a major contribution to environmental protection by sharply reducing the need for space heating and cooling in buildings. In addition, AAC's easy workability allows accurate cutting that minimizes the generation of solid waste during use. The fact that AAC is up to five times lighter than concrete leads to significant reductions in CO2 emissions during transportation.

D. Reuse, recovery and disposal

Throughout the life cycle of AAC, potential waste is reused or recycled wherever possible to minimize final disposal in landfill. Where AAC waste is sent to landfill, its environmental impact is minor since it contains no toxic substances.

IV. MATERIAL USED

A. Fly Ash or Sand

Key ingredient for manufacturing AAC blocks is silica rich material like fly ash or sand. Most of the AAC companies in India use fly ash to manufacture AAC blocks. 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 Aluminum powder in quantities consistent with the recipe. Alternately sand can also be used to manufacture AAC blocks. A 'wet' ball mill finely grinds sand with water converting it into sand slurry. Sand slurry is mixed with other ingredients just like fly ash slurry.

B. Lime Powder

Lime powder required for AAC production is obtained either by crushing limestone to fine powder at AAC factory or by directly purchasing it in powder form. Although purchasing lime powder might be little costly, many manufacturers opt for it rather than investing in lime crushing equipment like ball mill, jaw crusher, bucket elevators, etc. Lime powder is stored in silos fabricated from mild steel (MS) or built using brick and mortar depending of individual preferences.

C. Cement

53-grade Ordinary Portland Cement (OPC) from reputed manufacturer is required for manufacturing AAC blocks. Cement supplied by 'mini plants' is not recommended due to drastic variations in quality over different batches. Some AAC factories might plan their captive cement processing units as such an unit can produce cement as wells process lime. Such factories can opt for 'major plant' clinker and manufacture their own cement for AACproduction. Cement is usually stored in silos.

D. Gypsum

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

E. Aluminium Powder/Paste

Aluminium powder/paste is easily available from vario us manufacturers. As very small quantity of Aluminiumpowder/pa ste is required to be added to the mixture, it is usually weighed manually and added to the mixing unit.

V. PHYSICAL PROPERTIES

A. Drying shrinkage

Foam concrete possesses high drying shrinkage due to the absence of aggregates, i.e., up to 10 times greater than those observed on normal weight concrete. Autoclaving is reported to reduce the drying shrinkage significantly by 12–50% of that of moist-cured concrete due to a change in mineralogical compositions. The shrinkage of foam concrete reduces with density which is attributed to the lower paste content affecting the shrinkage in low density mixes.

B. Low Density and High Strength

Due to its low density, foam concrete imposes little vertical stress on the substructure - a particularly important attribute in areas sensitive to settlement. Heavier density (1000 kg/m3 +) foam concrete is mainly used for applications where water ingress would be an issue - infilling cellars, or in the construction of roof slabs for example.

C. Compressive strength

The compressive strength decreases exponentially with a reduction in density of foam concrete. The parameters affecting the strength of foam concrete are cement–sand and water–cement ratios, curing regime, type and particle size distribution of sand and type of foaming agent used. For dry density of foam concrete between 500 and 1000 kg/m3, the compressive strength decreases with an increase in void diameter. For densities higher than 1000 kg/m3, as the air-voids are far apart to have an influence on the compressive strength, the composition of the paste determines the compressive strength.

D. Flexural and tensile strengths

Splitting tensile strengths of foam concrete are lower than those of equivalent normal weight and lightweight aggregate concrete with higher values observed for mixes with sand than those with fly ash .Use of Polypropylene fibres has been reported to enhance the performance with respect to tensile and flexural strength of foam concrete.

VI. EXPERIMENTAL TEST

A. Mix proportion of Raw Materials tabulated given below

S NO.	CEMENT	FINE AGGREGATE	FLY ASH	LIME	AL(gm)	GYPSUM (gm)
1	1	3	0	0	1	1
2	0.9	2.25	0.75	0.1	2	2
3	0.8	1.50	1.5	0.2	3	3
4	0.7	0.75	2.25	0.3	4	4
5	0.6	0	3	0.4	5	5

Table 1. Experimental Test

B. Compressive Strength

It is the capacity of a material or structure to withstand loads tending to reduce size as opposite tensile strength which withstands loads tending to elongate. The specimens are tested by compression testing machine after 24 hours stream curing.

Compressive strength = load / area

S.NO	SIZE (mm)	WEIGHT	COMPRESSION LOAD (N
1	150X150X15	648	34.8
2	150X150X15	640	34.3
3	150X150X15	599	31.6
4	150X150X15	584	24.9
5	150X150X15	479	20.8

Table-2 : Tabulation for with lime compressive strength

B. Water absorption test

It is the capacity of a material to absorb and retain water and the dry material is fully immersed in water and then water absorption is workout either as % of weight or % of volume of dry material.

% of water absorption = $((W_2 – W_1) / W_1)$ X 100

C. Dry Density Test

It is the mass of unit volume of homogenous material. Density of a material greatly influences its physical material. Density = mass / volume

VII. RESULTS

% of Foam	Compressive Strength (Mpa)	Density (Kg/m3)	Porosity (%)	Water Absorption (%)
25%	17.27	1831	11.48	10.23
50%	11.87	1645	13.67	13.05
75%	7.12	1329	17.89	16.87
100%	2.52	1013	27.46	21.34

Table 3. Results on performance of bricks based on foaming

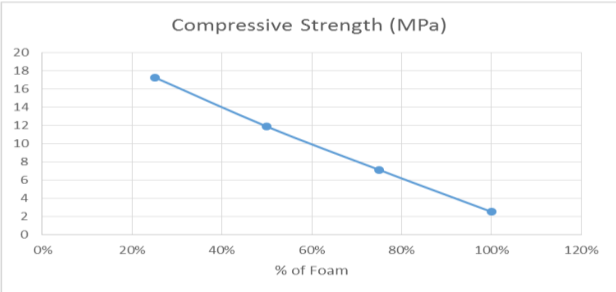

Fig 1:- Compressive Strength Test for AAC blocks

The Compressive strength results of the Autoclave aerated blocks shows the sharp decline in the strength characteristic as the foaming pressure has been increased. This is due to the excess void generated during the foaming reducing the matrix for bonding. The results shows the value of 17.27 MPa at 25% of foaming. At 100% foaming the Compressive strength is almost upto the 2.52 MPa. The same results are also available for commercially available autoclave aerated bricks (2-4 MPa).

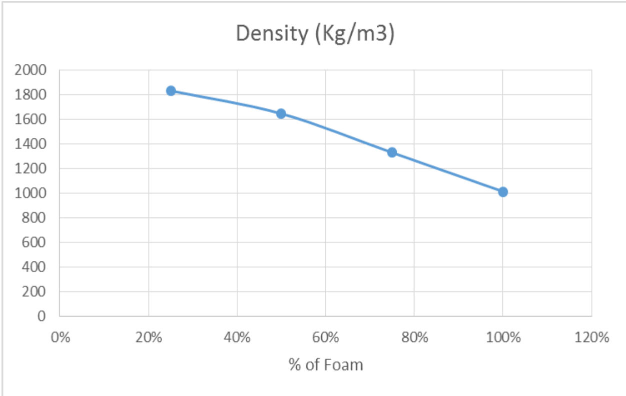

Fig 2:- Density Test for AAC Blocks

The Density of materials depends on the composition and the void proportion in the materials. As the autoclave aerated bricks has huge voids, there would be less dense matrix. Due to this reason, the density of AAC blocks is low. Figure 6.2 suggest decrease in density as the foaming increases. Foaming creates the voids hence the density is less. The density at 25% foaming is around 1831 Kg/m^3. However, the density sharply declines as the foaming pressure increased at 100% with the value of 1013 Kg/m^3.

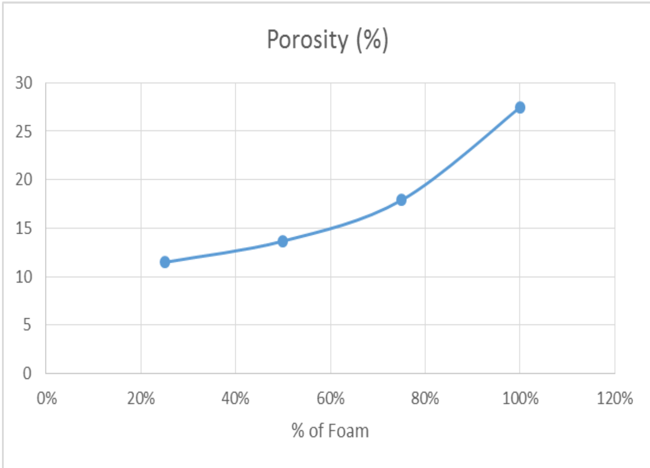

Fig 3:- Porosity test for AAC Blocks

Similar to density porosity is due to the generation of voids. More the voids, more will be the porosity. The foaming will generate more voids hence porosity will greatly increase in material. At 25% foaming pressure, the porosity was 10%.

The increse in porosity by 170% was observed as the foaming pressure increased upto 100%. At 100% foaming the porosity was obsereved at 27%.

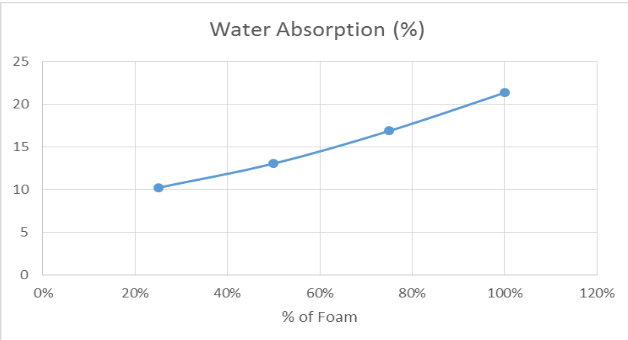

Fig 4:- Water Absorption (%) Test for AAC Blocks

The rate of water absorbed by any material depends upon the percentage of voids. Open pores will store absorb the water and store it. The water absorption increased due to the foaming. This is one of area of concern for autoclave aerated bricks.

Fig 5:- cube and block mould

Fig 6:- compressive strength test

VIII. CONCLUSION

Based on the above experiment sand samples made, following has been concluded:

- The Aerated concrete is a much lighter concrete and can float on water. It does not contain coarse aggregates. It is composed of cement, sand, high water-cement ratio and aluminium powder. Just as we mix the aluminium powder in the cement-
- sand slurry, the expansion in the.
- volume can be observed. Within 5 minutes it expands by 30%. It consists of many pores and thus is not structurally strong. It is a good insulator of heat and sound and thus can be used in place of conventional bricks or at the places which does not bear any load.
- The lightweight concrete manufactured using fly ash as in a powder form and it is heavily used in manufacturing of AAC blocks. In this the normal coarse aggregates are replaced by fly ash having size less than 4.75 mm. Its surface is flat and smooth and showing a good finish. Although it cannot be used as a structural concrete but its cube test results show considerable strength and can be used as an architectural concrete. It is a good insulator of heat and sound and thus has the same uses as of the above aerated concrete.
- The initial findings have shown that the lightweight concrete has a desirable strength to an alternative construction material for the industrialized building system.
- The strength of aerated lightweight concrete are low for lower density mixture. This resulted in the increment of voids throughout the sample caused by the foam. Thus the decrease in the compressive strength of the concrete.
- The foamed lightweight concrete is not suitable to be used as non-load bearing wall as the compressive strength is 27% less than recommended. Nevertheless the compressive strength is accepted to be produced as non-load bearing structure.

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