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Preliminary Study of Development of Light Weight Concrete Blocks using Rice Husk Ash

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Abstract: ***The most widely utilised building material is brick. Analyzing the cost, energy consumption, and carbon emission factors of traditional and non-conventional materials aids in identifying viable solutions for sustainable construction. Autoclaved Aerated Concrete (AAC) block, an eco–friendly material, gives a prospective solution to building construction. It can be as light as a quarter of the weight of traditional building pieces. Sand, cement, lime, fly ash, gypsum, aluminium powder, and water make up AAC, which is made up of readily available basic ingredients. By decreasing the dead load of walls/partitions on structural elements, the use of AAC blocks decreases construction costs by up to 20%. In this study, an attempt will be made to develop AAC blocks first using conventional materials, i. e. cement, calcined lime, gypsum, fly ash, and aluminum powder, and then replacing cement and calcined lime with suitable industrial waste in various proportions to achieve a similar strength as that of the conventional AAC blocks. Also, efforts will also be made to determine the best curing methodology and the curing time and temperatures. Tests such as compressive strength, density, water absorption, soundness, fire resistance, will also be conducted to determine the effect of the various material proportions or combinations on these properties.***

Keywords: AAC blocks; compressive strength; density; industrial wastes; curing time

1. Introduction

Bricks making and manufacturing has become a real tradition in our country. It has been the most used building material in many of the construction projects. Environmental pollution from brick manufacturing processes is harmful to human health, plant life, and animal life on a local level in the neighbourhood of a brick kiln. It can also be said like brick making is one of the factors for the cause of global warming and climate change, thus there is a definite need to overcome these effects on environment and finding out the best replacement for the brick manufacturing. Henceforth there came up an innovative idea i. e. Environmentally friendly autoclaved aerated concrete blocks Dr. Johan Axel Eriksson, a Swedish architect, developed autoclaved aerated concrete blocks in the mid-twentieth century. AAC (autoclaved aerated concrete) is a lightweight concrete that is made by employing an expansion agent (aluminium powder) and curing it under high pressure steam to create air spaces in the concrete. In general, AAC manufacturing involves in the utilization of Industrial waste, but only in limited proportions. We, find many issues like increase in dead weight, less flexural strength, no qualitative testing facilities, absorption of water with standard burnt clay bricks. Hence, AAC manufacturing was initiated by the architects as it was found that AAC provides more advantages than the standard burnt clay bricks. Fly ash, one of the most generated waste products from thermal power plant remains the main component of AAC.

Autoclaveds Aerated Concrete

Raw substances which might be appropriate for autoclaved aerated concrete are first-rate graded substances. Fly ash, cement, gypsum, lime, aluminum powder are the most important uncooked substances for generating AAC. Fly ash is blended up with water to shape slurry, later finely graded substances cement, lime, gypsum, and aluminum powder are brought to the slurry to shape a paste. The addition of aluminum powder reasons enlargement in quantity up to two to five instances the authentic quantity. When this expansion agent combines with calcium hydroxide, small air bubbles form, causing hydrogen to accumulate within the spaces. The hydrogen that forms inside the system bubbles up and is altered by air. The quantity boom specially relies upon on the quantity of aluminum powder brought and reacted with calcium hydroxide.

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

After the reaction, a solid but still soft cake is formed. Following that, it's sliced into the appropriate block sizes and autoclaved for 12 hours. During the steam pressure hardening process, which occurs when the temperature reaches 190 degree Celsius and the pressure reaches 8 to 12 bar, the AAC blocks develop their high strength and unique properties. After the autoclaving procedure, the material is available to use on the construction site right away.

2. Literature Review

Effect of fine Aluminum containing waste in Autoclaved aerated concrete incorporating Rice husk ash. This investigation was focused on the physical and mechanical properties, as well as the microstructure of autoclaved aerated concrete (AAC) incorporating both rice-husk ash (RHA) and aluminum (Al)-containing waste (AW) as a partial aggregate and expansive agent replacement. The AW was used to substitute metallic aluminum powder at levels of 5, 10, 15 and 20% by weigh (Kittipong et al., 2015a) experimental studies were carried out on different AAC samples made from U. S. electric utility fly ash as silica content along with conventional building material

specimens, were tested for thermal properties. Three primary issues which were studied in these experimental studies, were To develop and compare AAC thermal inertia to conventional building materials, To find out major differences in thermal inertia characteristics of the AAC blocks produced by various utilities To determine periodic heat flow of the material (Lawrence & D, 1999a) Experimental investigation into fracture of autoclaved aerated concrete (AAC) is carried out. In terms of fracture mechanisms, there exists a similarity between AAC and structural concrete, the fracture process was described by fictitious crack model used for concrete. The fracture properties of AAC at room temperature are not affected by moisture content. AAC was found to be having unique thermal abilities. It has superior thermal inertia compared with most conventional materials. The only conventional building material having same approximate thermal inertia ability as AAC was solid wood (Eugen et al., 1990)

3. Proposed work

AAC manufacturing mainly involves in the usage of costliest and non-eco-friendly materials like cement, aluminum powder and calcined lime. Change in proportions of the materials will be carried out and replacement of materials with suitable quantities of Industrial wastes. In addition to these materials, we induce another waste namely Rice husk ash which is rich in silica content as a replacement of portions of cement and also increase fly ash content accordingly. An attempt will be made for testing out the standard proportioned specimens at 100^0 Celsius steam curing. Attempt will be made in casting out specimens of different sizes 230*100*100 mm Casted specimens are put to the test in a series of tests that include steam curing at 100 degrees Celsius for 6 and 12 hours. . . Soluble oil is used so that separation of particles takes place in the mixture which results in stain free blocks, and it is used in smaller quantities

Table 1: Standard proportion of AAC block For one specimen of size 230*100*100 mm

Components	Quantity
Fly ash	0.990 kg
Water	0.524 liters
Cement	0.220 kg
Lime	0.093 kg
Gypsum	0.013 kg
Aluminum powder	0.81gms

Tests that will be carried out on the specimens
1) Compressive strength test
2) Water absorption test

Moulds made out of steel were prepared using L-angle steel sections. The dimension of mould is 800*100*100 mm Wooden plates were used for separation in order to cut the specimen into the dimension of standard brick i. e 230*100*100 mm. But further detailed investigations are to be done to report the exact variation in strengths with replacement mixes. Rice husk ash was the major replacement that we wanted to incorporate into the mix as it is rich in silica content

Replacement: Replaced Cement & Lime with Rice husk ash

Table 2: Replaced Cement & Lime by weight with Rice husk ash

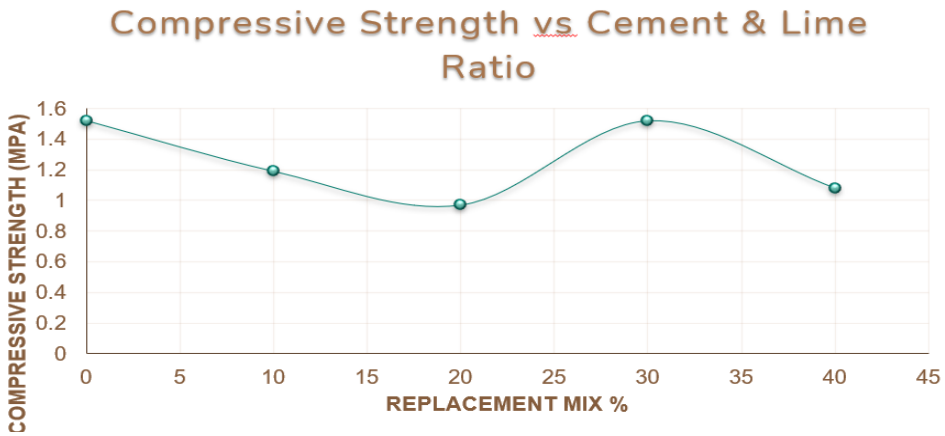
Components	10%	20%	30%	40%
Fly ash	3.44 kg	3.44 kg	3.44 kg	3.44 kg
Water	1.82 litre	1.82 litres	2.0 litres	1.82 litres
Cement	649.8 gms	608 gms	532 gms	646 gms
Lime	288 gms	256 gms	224 gms	272 gms
Gypsum	40 gms	40 gms	40 gms	40 gms
Aluminum powder	3gms	4 gms	5 gms	4 gms
Rice husk ash	104.2gms	216 gms	324 gms	232 gms

The replacement mix-1, 2, 3, 4 specimens were demoulded and left in the open air for 24 hours without being disturbed. varying. An attempt will be made for testing out the proportioned specimens at 100^0 Celsius steam curing. Then all Casted specimens of dimension 230*100*100 mm are tested by conducting tests subjected to steam curing[at]100^0 Celsius for 6 and12 hours.

Compressive Strength

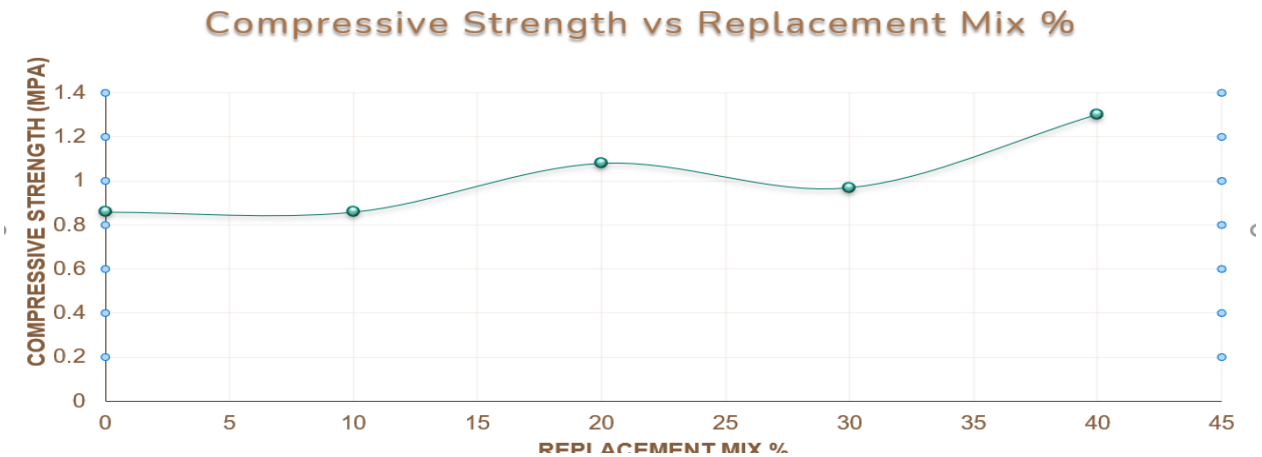
Table 3: Compressive Strength for various Mix Proportions (Steam Curing at 100 °C)

S. No.	Replacement Mix (%)	Compressive Strength (Mpa)
		6 hours 12 hours
1	0	1.52 0.86
2	10	1.19 0.86
3	20	0.97 1.08
4	30	1.52 0.97
5	40	1.08 1.30



Graph 1: Compressive Strength at 100°C Steam Curing for 6 hours vs Replacement mix %

From the Graph1.6 hours steam curing, it is clear that as the rice husk ash level rises to 20%, the compressive strength decreases. And there after compressive strength increased at 30% replacement mix. The excessive rice husk ash content made the mix less workable and which resulted in setting of the mix soon after placing it in the mould and this could be the reason why with the increase in the rice husk ash content the compressive strength is continuously changing. It can also be observed that, maximum amount of strength has been attained with 30% replacement mix for 6 hours.



Graph 2: Compressive Strength at 100°C Steam Curing for 12 hours vs Replacement mix

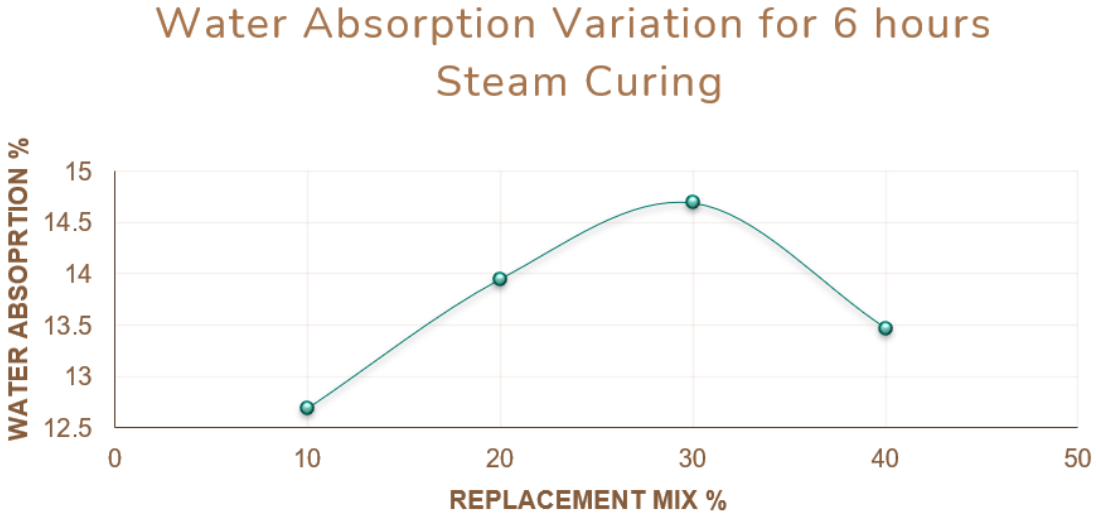
From the Graph2.12 hours steam curing, it can be seen that as the rice husk ash content rises, the compressive strength rises as well. The excessive rice husk ash content made the mix less workable and which resulted in setting of the mix soon after placing it in the mould and this could be the reason why with the increase in the rice husk ash content the compressive strength is continuously changing Weight of the block after immersing it into the water bath for 24 hours. It can also be observed that, maximum amount of strength has been attained with 40% replacement mix for 12 hours.

Water Absorption Test

Table 4: Water absorption for various Mix Proportions (Steam Curing at 100 °C)

S. No.	Replacement mix (%)	Water absorption (%) after 24 hours
		6 hours 12 hours
1	10	12.69 25.71
2	20	13.95 14.65
3	30	14.69 13.80
4	40	13.47 12.65

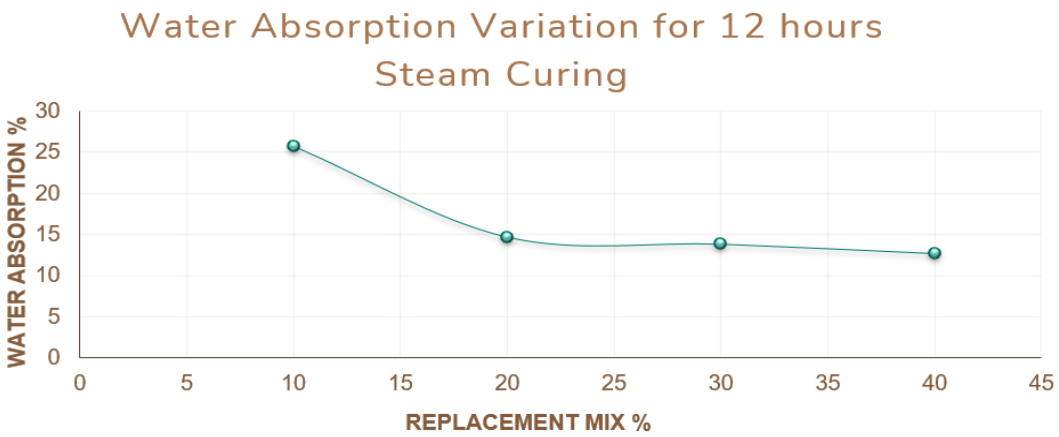
Water absorption= (W2-W1) /W1*100
Where W1= Weight of the block before immersing it into the water bath
W2= The weight of the block after it has been immersed in water for 24 hours.



Graph 3: Water absorption % vs Replacement mix % (for 6hours Steam Curing)

From the Graph 3. During the first 6 hours of steam curing, water absorption improves with an increase in rice husk ash content, but thereafter reduces by 40%. The excessive rice husk ash content made the mix less workable and which resulted in setting of the mix soon after placing it in the mould. This makes the conclusion regarding water absorption a difficult task at 6 hours Steam Curing. Further

investigations are to be carried out to report the exact variation.



Graph 4: Water absorption % vs Replacement mix % (for 12hrs Steam Curing)

From the Graph 4. Water absorption decreases with increasing rice husk ash concentration after 12 hours of steam curing. The increased rice husk ash content rendered the mix less workable, causing it to set up quickly after being placed in the mould. With an increase in rice husk ash content, less water was absorbed.

4. Conclusion

Here we can clearly see that there is a change in compressive strength of brick strength of brick at 30 % and 40 %mix replacement at different curing conditions. so with ideal conditions continuous steam curing good lab conditions the strength can be achieved by replacement mix. rice husk ash based light weight blocks have almost equal compressive strength properties compared to original autoclaved aerated concrete. the variation in compressive strength at different curing conditions cannot be concluded because strength depends on duration of mix and how exactly the materials get mixed uniformly. . as fly ash and rice husk ash are cheap compared to ordinary Portland cement, lime and hence it is economical as well as eco-friendly

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