Experimental investigation on strength characteristics of autoclave aerated concrete block using natural pozzolanas

Thangamani kothapally[1*], *Ushadevi* Patil[2], *Chigullapally* Mounika[3] and *Gandi* Mounika Naidu[1], *Geetha* Kumari B[4], *Evgeny* Vladimirovich Kotov[5]

[1]Department of Civil Engineering, KG Reddy College of Engineering and Technology, Telangana, India-501504
[2]Department of Civil Engineering, GS Moze College of Engineering, Pune, Maharashtra, India.
[3]Department of Civil Engineering, Vignana Bharati Institute of Technology, Telangana, India
[4]Department of CSE, GRIET, Hyderabad, Telangana, India
[5]Lovely Professional University, Phagwara, Punjab, India.

Abstract. In this present study we have studied about the strength enhancement of autoclaved aerated block by using natural pozzolanas. Fly ash has been partially replaced with GGBS. GGBS has been used in place of fly ash at percentages of 6%, 12%, and 18% of the total amount of fly ash plus super plasticizer. GGBS improves resistance to damage from alkali silica reaction. It also reduces the thermal cracking. The role of super plasticizer is to reduce the water content in block.we have used 1% of super plastizer to the 1 litre of water. Each block's compressive strength is measured and computed for varying fly ash and GGBS ratios. It has been observed that replacing GGBS with 12% yields higher compressive strength than replacing it with 6% or 18%.

Keywords. Sustainable, GGBS, super plasticizers, aluminum powder.

1 Introduction

A resilient, load-bearing, lightweight, and substantially insulating building material, autoclaved aerated concrete comes in a wide variety of sizes and strengths. With in terms of weight, AAC blocks are three times lighter than red bricks. it is now among the most often utilized building components. AAC is made of limestone, flash, cement, water, and a tiny bit of rising agent. AAC Blocks are 600 x 200 x (75 - 250) mm in size. AAC blocks are large, weigh much less, lowering labor costs. AAC environmentally friendly than traditional structural building materials like concrete.

The autoclaved aerated concrete's mechanical qualities may be efficiently improved and its water absorption can be decreased by adding pozzolanic ingredients The specimens with zeolite, silica fume, and granulated blast-furnace slag were added to the AAC to increase its

* Corresponding author: ktm@kgr.ac.in

compressive strength. [1]. Agricultural by products and industrial waste when used in light weight concrete reduces the dead weight of structures because of low density, low thermal conductivity and high compressive strength. But if we use them at larger proportions surface errors and hardening will be affected [2]. Utilising BA in autoclaved aerated concrete (AAC) compositions results in unit weight drop in the AAC. BA in concrete has a positive influence on AAC strength growth. As the BA replacement ratio increase, the thermal conductivity values decrease [3]. AAC added with basalt fiber will be having more thermal conductivity and AAC added with carbon fiber will have more compressive and flexural strength [4]. The use of wood fiber in AAC will give Fluidity, and porosity will reduce as wood fiber content increase, but volume density and heat conductivity increases. Wood fiber improves mechanical properties like flexural strength [5]. Addition of industrial waste in AAC is made of cement, gypsum, silica fume, and lime aluminium powder. Due to their strong thermal resistance and sound insulation, raw materials have advantages such as light weight, energy efficiency, and environmental friendliness [6].

WGD incorporation in AAC concrete shows environmental benefits, such as reduced granite industry waste and beneficial effects on the physio-mechanical properties [7]. Usage of red gypsum as the replacement of fly ash will result in reduction of gas foaming rate and increase relative strength of AAC block [8]. We can save reinforced steel if we replace traditional bricks with aac block. The light weight will allow greater deformability. It tends to less the inertia forces caused by seismic motion on building [9]. IBA can also be used as a silica source to partially replace silica and as an aerating agent to replace pricey aluminium powder in the manufacturing of autoclaved aerated concrete. Using IBA as an aerating agent. Because IBA-AAC creates a more uniform pore structure with smaller pore sizes than AAC, it has a higher compressive strength than AAC for a given density. [10]. In aerated concrete, the effect of utilising crushed clay brick as an alternative aggregate. To explore the physical and mechanical characteristics of AAC. Natural sand was replaced with crushed clay brick aggregate in each series.

The unit weight, thermal conductivity, all decrease, whereas porosity will rise. There will be increase in the compressive strength of autoclave aerated concrete [11]. The most often utilized building material in the building and construction sectors is conventional brick. AAC blocks are among the building materials that have gained popularity recently. Aerated concrete (autoclaved) is made of fly ash, lime, cement, water, and an aerating agent. The most common forms of AAC production are prefabricated panels and cuboidal blocks. One kind of concrete that is intended to have a lot of closed air spaces is autoclaved aerated concrete. AAC blocks are lightweight, durable, low density, and energy-efficient. It is created by adding a foaming agent to concrete and then pouring the mixture into different-sized moulds.[12].

2 Materials Used:

1. Fly ash
2. Gypsum
3. GGBS
4. Lime
5. Cement
6. Aluminum powder
7. Super plasticizer

2.1 Mix Proportion:

Table 1. Mix Proportion

Flyash %	GGBS %	Lime %	Cement %	Gypsum %	Aluminum Powder (gms)
58	6	14	20	2	23
52	12	14	20	2	23
46	18	14	20	2	23

3 Procedure:

All the materials are collected and stored at room temperature. Materials are tested.[1] Test blocks are prepared by proper bolting and applying nonstick material i,e oil [2]. Materials are taken and weighed according to the ratios mentioned in the mix proportion [3]. Dry weight of all the samples are taken and noted. For the total dry weight of the sample 23 grams of aluminium powder is added [4]. All the samples are mixed thoroughly. Water is added to the sample. Volume of water taken as 0.6 % percent of total dry weight [5]. For the total volume of water 1% of super plasticizer is added [6]. Mixing is done until the sample becomes slurry. When the required slurry is obtained the sample is poured into the mould[7] . Reaction starts in the sample and bulging will take place because of addition of aluminium powder [8]. Mould is kept at a room temperature for 24 hours and after 24 hours remove the sample from the mould [9]. The block is kept for steam curing for a time period of 6 hours. After curing period, the block is taken out and tested for compressive strength [10]. Same procedure is carried out for remaining two mix proportions. All the three samples are tested and compared to compressive strength to the standard blocks.

4 Results and Discussions:

4.1 Compressive Strength:

Compressive strength is defined as the maximum load that a member can withstand without breaking under applied load. The standard Compressive strength (CS) of AAC block is taken as 4.65 N/mm^2.

Table 2. AAC Block Compressive strength with using GGBS

S No	% of Replacement of GGBS	Compressive strength(N/mm2)
1	0%	2.05
2	6%	1.36
3	12%	2.95
4	18%	1.47

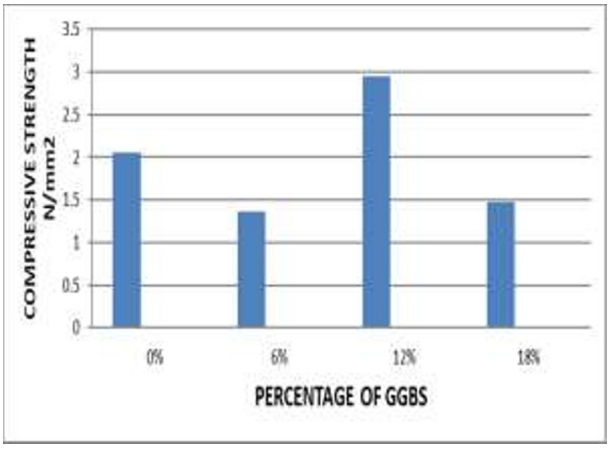

Fig. 1. Compressive strength variation with using GGBS

From the above chart we can see that the difference between the compressive strength of AAC block with change in proportion of GGBS content. When 0% percent of GGBS is replaced, the compressive strength is 2.05N/mm2. When 6% percent of GGBS is replaced, the compressive strength is 1.36N/mm2. When 12% percent of GGBS is replaced, the compressive strength is 2.95N/mm2. When 18% percent of GGBS is replaced, the compressive strength is 1.47N/mm2. From this we can observe that there is an increase in compressive strength of AAC block when 12% of GGBS is replaced when compared to 6% and 18%.

4 Conclusions

From this experimental study we observed that there is an increase in compressive strength of AAC block when fly ash is partially replaced with 12% of GGBS along with using super plasticizer when compared to 6% and 18%. So, it is suitable to use 12% of GGBS along with super plasticizer to get good compressive strength and it is also sustainable. It also reduces the cost and proves to be economical. These blocks will be having less thermal cracking because of GGBS properties and can be used for partition walls. So, it is optimum to use 12% of GGBS as replacement of fly ash and further more studies can give more details about enhancement of AAC blocks strength.

References

1. [1] Thangamani, K. "Effect of magnetic water and neem leaves ash on strength properties." Materials Today: Proceedings 79 (2023): 406-410.
2. [2] Gholhaki, Majid, Mohammadkazem Sharbatdar, and Ghasem Pachideh. "An experimental investigation into the mechanical performance and microstructure of cementitious mortars containing recycled waste materials subjected to various environments." Journal of Building Engineering 61 (2022): 105275.
3. [3] Thangamani, K., N. Naveen Kumar, and T. S. Babu. "Experimental study on partial replacement of cement with using marble powder and coarse aggregate with demolished waste." AIP Conference Proceedings. Vol. 2648. No. 1. AIP Publishing, 2022.

4. [4] Chinnu, S. N., et al. "Reuse of industrial and agricultural by-products as pozzolan and aggregates in lightweight concrete." Construction and Building Materials 302 (2021): 124172.
5. [5] Yew, Ming Kun, et al. "Effects of pre-treated on dura shell and tenera shell for high strength lightweight concrete." Journal of Building Engineering 42 (2021): 102493.
6. [6] Cai, Qiang, et al. "Utilization of waste red gypsum in autoclaved aerated concrete preparation." Construction and Building Materials 291 (2021): 123376.
7. [7] Poongodi, K., et al. "Durability properties of self-compacting concrete made with recycled aggregate." Silicon 13.8 (2021): 2727-2735.
8. [8] Kalpana, M., and S. Mohith. "A study on compressive behavior of AAC added with industrial waste." Materials Today: Proceedings 22 (2020): 1043-1046.
9. [9] Zafar, Muhammad Saeed, et al. "Sustainable incorporation of waste granite dust as partial replacement of sand in autoclave aerated concrete." Construction and Building Materials 250 (2020): 118878.
10. [10] Raj, Amit, Arun Ch Borsaikia, and Uday S. Dixit. "Evaluation of mechanical properties of autoclaved aerated concrete (AAC) block and its masonry." Journal of The Institution of Engineers (India): Series A 101 (2020): 315-325.
11. [11] Xu, Rongsheng, et al. "Utilizing wood fiber produced with wood waste to reinforce autoclaved aerated concrete." Construction and Building Materials 208 (2019): 242-249.
12. [12] Aliabdo, Ali A., Abd-Elmoaty M. Abd-Elmoaty, and Hani H. Hassan. "Utilization of crushed clay brick in cellular concrete production." Alexandria Engineering Journal 53.1 (2014): 119-130.
13. [13] Kurama, H., I. B. Topcu, and C. Karakurt. "Properties of the autoclaved aerated concrete produced from coal bottom ash." Journal of materials processing technology 209.2 (2009): 767-773.
14. [14] Pachideh, Ghasem, and Majid Gholhaki. "Effect of pozzolanic materials on mechanical properties and water absorption of autoclaved aerated concrete." Journal of Building Engineering 26 (2019): 100856.
15. [15] Kurama, H., I. B. Topcu, and C. Karakurt. "Properties of the autoclaved aerated concrete produced from coal bottom ash." Journal of materials processing technology 209.2 (2009): 767-773.
16. [16] Hauser, André, Urs Eggenberger, and Thomas Mumenthaler. "Fly ash from cellulose industry as secondary raw material in autoclaved aerated concrete." Cement and Concrete Research 29.3 (1999): 297-302.