Replacement of Sand By Construction And Demolition Waste In Autoclaved Aerated Concrete

Vallabhy. S[1], Ranjani. A[2], Pushpalatha. T[3], Ramya. T. V[4]
[1] H.O.D., Dept of Civil Engineering
[2, 3, 4]Dept. of Civil Engineering
[1, 2, 3, 4] Prathyusha Engineering College, Tamil Nadu

Abstract- *The concrete is the second most consumed material in the world after water. In this age of rapid urbanization there is a dire need to recycle the waste produced from the construction industry. This construction & demolition waste unlike other wastes is bulk and takes a major proportion of the landfill. These wastes take years of time to decompose. This project deals with Replacement of sand by Construction & Demolition waste (CDW) in Autoclaved Aerated Concrete blocks. So, in order to maintain a sustainable environment this project deals with incorporating the Construction & Demolition waste into the AAC blocks as a replacement for silica sand without compromising the strength and durability parameters in quantities starting from 5% and increasing the percentage of CDW by 5 % in the order 10%, 15%, 20%, 25%, 30%, 35%, 40% and decreasing the quantity of silica sand used in the order 50%, 45%, 40%, 35%, 30%, 25%, 20% and 15%. Aluminium powder is added as aerating agent. The resulting aerated cube is subjected to the Autoclaving process at 190°C & 12 atmospheric pressure for 12 hours. The AAC blocks are then subjected to compressive strength test, water absorption test and block density test.*

Keywords- AAC blocks, Aluminium powder, Construction & demolition waste (CDW), Silica sand, Autoclaving process.

I. INTRODUCTION

AAC stands for Autoclaved Aerated Concrete. It was invented in the early 1920s by a Swedish architect named J A Eriksson. His purpose for designing AAC was to reduce consumption of timber and provide a cheaper and sustainable building solution. Autoclaved Aerated Concrete is a Lightweight, Load-bearing, High-insulating, Durable building product, which is produced in a wide range of sizes and strengths. The density of Autoclaved Aerated Concrete blocks ranges from 550 kg/m3 to 650 kg/m3 which is lesser than the conventional red bricks and concrete. AAC is produced from the materials lime, silica sand, gypsum, cement and water, and a small amount of aerating agent.

AAC is manufactured by a process that involves slurry preparation, foaming, cutting, and steam curing (Autoclaving).

II. LITERATURE REVIEW

[1] Lam N N (2020)-This paper aims to research, use and compare the use of recycled AAC waste and fly ash to replace natural sand in AAC concrete brick production factories. The new developed AAC was conducted by replacing sand with recycled AAC and fly ash in ratio of 0%, 5%, 10%, 15%, 20%, 30%, 40% and 60%, 80% and 100%. Mechanical tests such as density, compressive strength have been carried out. Research results show that it is possible to take advantage of recycled AAC waste products with a maximum content of 5% and fly ash with a content of up to 100% to replace the natural sand in the manufacture of AAC bricks.

[2] AR Rafiza, HY Chan, A Thongtha, W Jettipattaranat and KL Lim (2019) - In this study, To reduce the construction waste, an innovative AAC block has been developed by using recycled AAC in powder form to replace sands in the manufacturing process. The new developed AAC was conducted by replacing sand with recycled AAC in ratio of 0%, 15%, 20%, 25%, 30%, 45%, 40% and 45%. Mechanical tests such as density, compressive strength have been carried out.

[3] Zuhair Nadeem, Qunshan Wei And Felix Mcyotto (2020) - In this study, 40% waste will be utilized, Construction waste(5%,10%,15%....40%) and Fly ash (35%,30%,25….0%)respectively, keeping the aerating agent constant at 0.06% that is aluminum powder. The compressive strength of the material will be checked after autoclaving at 2000 temperature and 1Mpa Pressure for 6 hours. The study aims to design an autoclave aerated concrete material and to recycle the waste generated by various industries mainly from the construction sector.

[4] Patrícia Favaretto , Gelsa Edith Navarro Hidalgo, Carlos Hoffmann Sampaio, Rodrigo de Almeida Silva and Richard Thomas Lermen (2017) - The main objective of this study was to evaluate the use of construction and demolition waste (CDW) from the Passo Fundo region of Rio Grande do Sul (RS), Brazil, in the development of aerated foamed concrete. CDW was processed (sieved only), characterized, and used as an aggregate, completely substituting natural sand. The influence of CDW granulometry and the amount of foam upon compressive strength, wet and dry bulk density, water absorption, and the air voids of concrete blocks were determined.

[5] **Kashif Ali Panhwar, Zuhair Nadeem, Qunshan Wei, Kai Zhang, Bilal, Zhemin Shen (2020)** - In this study, the possibility of utilizing construction and demolition waste, fly ash waste for the manufacturing of lightweight non-autoclaved aerated concrete has been represented.In this study, 40% waste utilized, Construction and demolition waste (5%,10%,15%,20%....……40%) and Fly ash (35%,30%,25%,20%........0%) accordingly, while expansion agent maintained constant at 0.06%. The compressive strength of the final material was checked after (7,14,21 and 28 days) respectively, obtaining maximum strength after 28 days.

III. METHODOLOGY

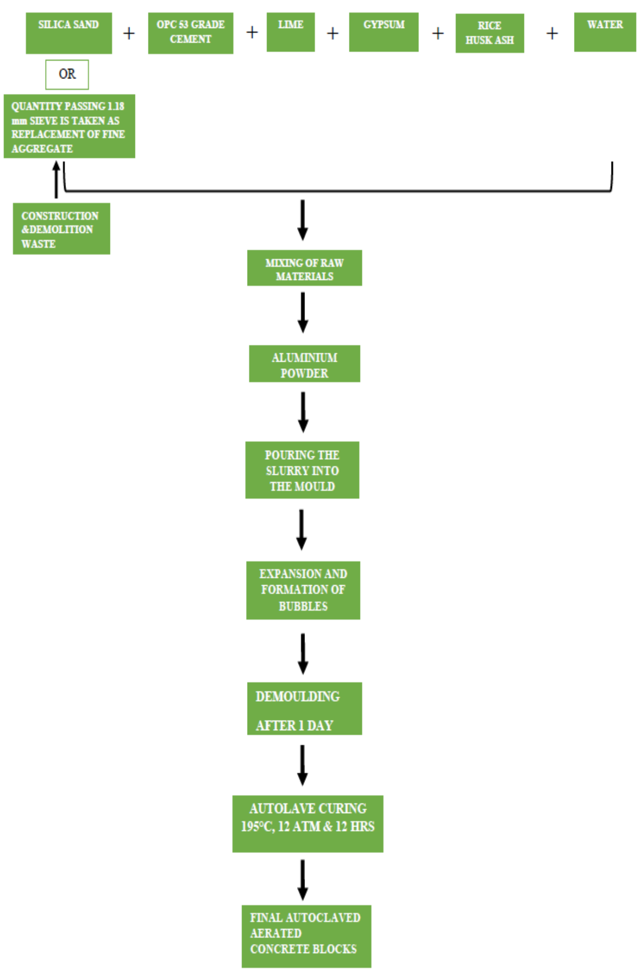

Fig. 1 Methodology

IV. MATERIALS

Construction & Demolition Waste - The CDW was collected from a nearby construction site in Arani, Periyapalayam. The collected CDW was then sieved and the quantity passing 1.18 mm sieve was taken as replacement for the fine aggregate (silica sand).

Cement (OPC 53 grade) - Cement is a binding material, used for binding the ingredients. Initial and final setting time of the cement is checked. The initial setting was 3o minutes and the final setting time was 165 minutes. Specific gravity of cement was found to be 3.15.

Silica Sand - The silica content in the silica sand was found to 94.3% and the moisture content was found to be 0.3%.

Rice Husk Ash - It was used to increase the strength of the AAC block since construction & demolition waste is added.

Aluminium powder - Aluminum powder is used at a rate of 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 escapes into the atmosphere and is replaced by air.

Lime - Lime powder required for the AAC production is obtained by crushing limestone to fine powder. The purpose of adding lime is to make a binding between materials. The CaO content was found to be 85.96%.

Gypsum - Gypsum is a very soft mineral composed of calcium sulfate dihydrate. It is colorless to white, may be yellow, blue.

Water - The mixing water was found to have a pH of 6.

V. EXPERIMENTAL PROCEDURE

This involved the provision of mix proportion and the required amount of cement, silica sand, CDW, lime, gypsum, rice husk ash and aerating agent (aluminium powder). The fine aggregates (CDW and silica sand) are mixed with cement. Then RHA, Lime and Gypsum are added to this mix. Then water will be added to this mix and hydration starts with cement forming bond between fine aggregates and cement paste.After the mixing process, an expansion agent (Aluminium powder) is added to the mix for increasing its volume. The mixture is stirred well for 3 minutes and transferred to the cube mould of size 150 mm.

Samples	Cement	C&D Waste	Silica sand	Lime	RHA	Gypsum	Aluminium powder	W/R
AAC-1	20%	5%	50%	15%	8%	2%	0.075%	0.65%
AAC-2	20%	10%	45%	15%	8%	2%	0.075%	0.65%
AAC-3	20%	15%	40%	15%	8%	2%	0.075%	0.65%
AAC-4	20%	20%	35%	15%	8%	2%	0.075%	0.65%
AAC-5	20%	25%	30%	15%	8%	2%	0.075%	0.65%
AAC-6	20%	30%	25%	15%	8%	2%	0.075%	0.65%
AAC-7	20%	35%	20%	15%	8%	2%	0.075%	0.65%
AAC-8	20%	40%	15%	15%	8%	2%	0.075%	0.65%

R = Final dry mix

Further, the aluminium powder reacts with calcium hydroxide which is the product of reaction between cement and water. This reaction between aluminum powder and calcium hydroxide causes formation of microscopic air bubbles which results in an increase of pastes volume as shown in the figure.

Fig. 2 a) Casted Aerated Concrete b) Pores present in casted AAC blocks

Fig. 3 Casted aerated blocks before and after autoclaving process

The slurry after pouring in the mould is stored in a room at a temperature of 20-25°C for 1 day, then the sample is demoulded and transferred to an Autoclave with a temperature of 190°C and a pressure of 14 atm for 12 hours. After the autoclaving process the blocks are cooled to room temperature and the blocks are taken for testing compressive strength, water absorption and density.

VI. RESULTS AND DISCUSSION

1. Compressive strength

The first two samples AAC 1 and AAC 2 gave approximately similar results. Although the first 4 samples exhibit high value of compressive strength, sample AAC 5 with 25 % CDW and 30 % Silica sand can be used as a substitute for conventional block. The compressive strength of sample AAC 6 can be increased by increasing the amount of rice husk ash in the sample. On the other hand, sample AAC 8 containing 40% CDW and 15% silica sand gave the lowest compressive strength and highest density.

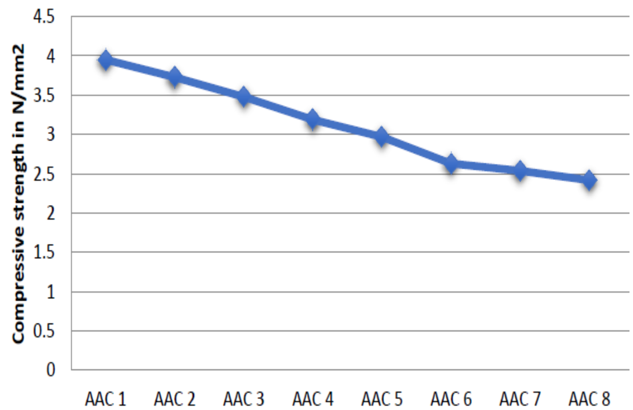

Fig. 4 Graphical representation of compressive strength

2. Block Density

The density of AAC blocks decreases with the increase in the content of Construction & Demolition waste (CDW) as density is directly proportional to compressive strength. The density is given in kg/m^3.

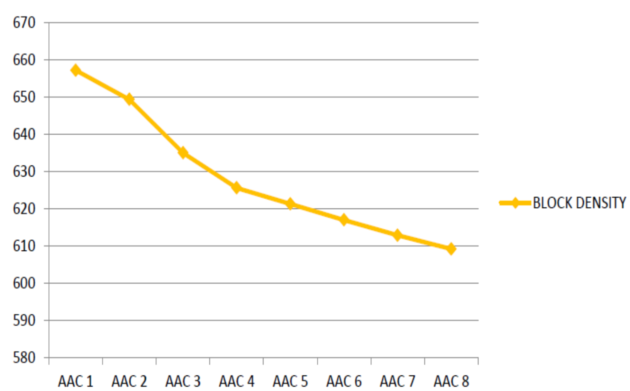

Fig. 5 Graphical representation of block density

3. Water absorption

The samples AAC 7 and AAC 8 have high water absorption values 25.80% and 26.37%. This is due to the fact that these samples were too porous as compared to other samples.

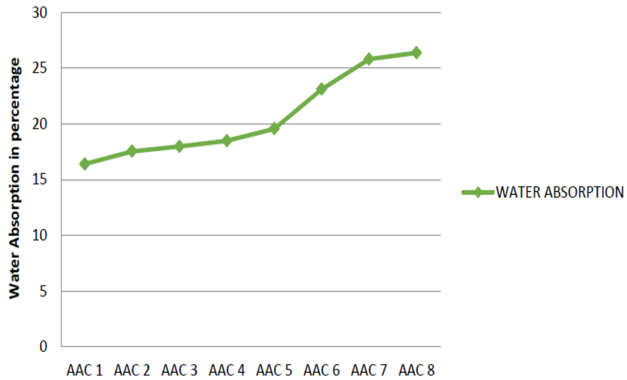

Fig. 6 Graphical representation of block density

VII. CONCLUSION

In this study, the feasibility of utilizing construction & demolition waste for the production of lightweight Autoclaved aerated concrete blocks has been illustrated. Based on the work, the following conclusions may be undertaken.

Although the first 4 samples exhibit high value of compressive strength, sample AAC 5 with 25 % CDW and 30 % Silica sand can be used as a substitute for conventional block along with satisfactory density and water absorption. It was also observed that the increase in the CDW caused a decrease in the compressive strength and density, showing that compressive strength is directly proportional to density of the block. An increase in the content of construction & demolition waste and a corresponding decrease in the content of silica sand leads to a deterioration of all studied features of AAC, especially for sample AAC 8 with 15 % silica sand. Based on the obtained results, the specimen samples AAC 1 to AAC 4 can be used as a replacement for the conventional AAC blocks.

The specimen AAC 5 with CDW 25 % and 30 % silica sand can be used for simple applications such as partitions, roofing and floor filling. It can be concluded that the use of construction waste along with waste of other industries in concrete production can help us maintain a sustainable and green environment.

REFERENCES

[1] N N Lam 2020 Influence of Fly Ash and Recycled AAC Waste for Replacement of Natural Sand in Manufacture of Autoclaved Aerated Concrete IOP Conf. Ser.: Earth Environ. Sci. 505 012001

[2] AR Rafiza, HY Chan, A Thongtha, W Jettipattaranat and KL Lim. An Innovative Autoclaved Aerated Concrete (AAC) with Recycled AAC Powder for Low Carbon Construction IOP Conf. Ser.: Earth Environ. Sci. 268 (2019) 012050

[3] Zuhair Nadeem, Qunshan Wei, Felix Mcyotto (2020). Utilization of construction and Demolition waste, fly ash waste in autoclaved aerated concrete. Advance in Environmental waste management & Recycling.

[4] Severin Seifert, Anna-Lena Liesch, Volker Thome Sebastian Dittrich, and Daniela Wolfram 2018 Application of recycled waste material for the production of autoclaved aerated concrete. Ce papers. 2018;2:495-502

[5] Rayees Ali Khan (2020) Preparation of Autoclaved Aerated Concrete (AAC) Block by using Aluminum Powder as Foaming Agent International Journal Of Innovative Science And Research Technology (IRJET) ISSN 2395 – 0056

[6] S. Gopalakrishnan, N. Sowndhararajan (2017) Study on Material and Mechanical Properties of Autoclaved Aerated Concrete. South Asian Journal of Engineering and Technology 22-38

[7] Nguyen Ngoc Lam (2020) Recycling of AAC Waste in The Manufacture of Autoclaved Aerated Concrete in Vietnam. International Journal Of GEOMATE.

[8] Dingyi Yang, Miao Liu, Zhiming Ma 2020 Properties of the foam concrete containing waste brick powder derived from construction and demolition waste, Journal of Building Engineering-101509

[9] Patrícia Favaretto , Gelsa Edith Navarro Hidalgo, Carlos Hoffmann Sampaio, Rodrigo de Almeida Silva and Richard Thomas Lermen (2017) Characterization and Use of Construction and Demolition Waste from South of Brazil in the Production of Foamed Concrete Blocks Appl. Sci.7 1090

[10] Kashif Ali Panhwar, Zuhair Nadeem, Qunshan Wei, Kai Zhang, Bilal, Zhemin Shen (2020) Utilization of Construction and Demolition Waste Along with Fly Ash waste in Preparing Non-Autoclaved Aerated Concrete. Journal of Earth Sciences & Environmental Studies 5(3):103-109

[11] Z M Jaini, R H M Rum and K H Boon 2017 Strength and fracture energy of foamed concrete incorporating rice husk ash and polypropylene mega-mesh 55 IOP Conf. Ser.: Mater. Sci. Eng. 248 1200542

[12] J. Srinu Naik, V. Chandana, K. Mahesh Kumar, G. Nagaraju, P. Sai Ram Kishore, Mr. Anand Kumar (2018) Study and Experimentation of Autoclaved Aerated Concrete by using Fly Ash International Journal Of Innovative Science And Research Technology(IRJET) ISSN 2456 - 2165

[13] Amit Raj, Arun Ch. Borsaikia, Uday S. Dixit (2020) Evaluation of Mechanical Properties of Autoclaved Aerated Concrete (AAC) Block and its Masonry. Springer 020-00437-5

[14] Sanjay Kumar Vishwakarma, Vinay Ajeet Saxena, Dr. Ajay Pratap Singh 2019 Utilization of Construction and Demolition waste in Civil Industry: A Review. International Journal of Scientific Research In Civil Engineering ISSN 2456- 6667

[15] Athira M, Indu Susan Raj, Dr. Elson John (2020) Study on aerated concrete blocks International Journal Of Innovative Science And Research Technology (IRJET) ISSN 2395-0056 16.Abhishek, Dr. Om Prakash Netula (2016) Construction and Demolition Waste Management in Civil Engineering Projects. International Journal of Multidisciplinary Allied Research Review and practices ISSN 2455-1570

[16] Ali J. Hamad 2014 Materials, Production, Properties and Application of Aerated Lightweight Concrete: Review. International journal of material science and Engineering

[17] R.A. Rahman, A. Fazlizan, N. Asim and A. Thongtha (2019) Utilization of waste material for aerated autoclaved concrete production: A preliminary review. IOP Conf. Ser.: Earth Environ. Sci. 463 012035

[18] Nishanthi Perumalsamy, Angammal Sankar, Sharru Preethi RC, Naufal Rizwan PS, Jansi Sheela S, Puthiya Sekar C and Gayathri Arumaikkani (2018) Effective Review on Utilization of Wastes in Aerated Cellular Concrete Journal Of Chemical And Pharmaceutical Research (JCPR) ISSN 0975 -7384

[19] C. Ulsen, H. Kahn, G. Hawlitschek, E.A. Masini, S.C Angulo, V.M. John Production of recycled sand from construction and demolition waste. Constr Build Mater 2013; 1168 – 1173

[20] R.V. Silva, J. de Brito, R. K Dhir Properties and composition of recycled aggregates from construction and demolition waste suitable for concrete production. Constr Build Mater 2014; 201- 217