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Utilization of Construction and Demolition Waste Along with Fly Ash waste in Preparing Non-Autoclaved Aerated Concrete

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Research

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ABSTRACT

China's construction industries are rapidly increasing, and with that generation of Construction and Demolition waste is also growing, and another side industrial waste such as fly ash produced by a thermal power plant, Associated environmental issues, it is essential to utilize in any form; Studies by concrete experts have indicated the feasibility of suitably handling and recycling such waste in new concrete, mainly for basic-level applications. Non-autoclaved aerated concrete is a lightweight substance that could be used as substitute building materials; it is generally made up of raw materials such as Cement, quicklime, gypsum, sand, and expansion agent like an aluminum powder; 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 checked after (7,14,21 and 28 days) respectively, obtained maximum strength after 28 days; this study goals to design a low cost, Non-autoclaved aerated concrete material and to reuse the waste produced from different sectors, mainly from the construction sector

Keywords: Non-Autoclaved concrete, Lightweight concrete, Eco-friendly, Construction and Demolition waste, Fly ash

1. INTRODUCTION

Construction & demolition (C&D) waste it becomes a serious challenge not only for China but all over the world, China annually million tons (C&D) waste generated about 5% reused remaining waste dumped in landfill area become a source of environmental pollution[1–3]. Earlier studies show in the past few years, up to 55 % universally expansion in urbanization, around 60% Population of China & 82% USA living in urban areas, the future prediction from 2015-2035 about 1.5 billion new citizens will add in urban population areas, which will cause new groundwork & housing challenges[4–6].C&D waste contain harmful matter such as heavy metal, Organic compound, asbestos will harm the environment such as damage of soil, damage of agriculture land & air pollution[7,8] Generally, Construction& Demolition waste is divided into seven different groups according to their class, such as construction concrete, steel, glass, wood, gypsum, plastic, bricks, clay & asphalt concrete[9,10]. "Previous studies reported in (2019) that USA about 580 million tons C&D waste produced about 70% waste recycled, another side European union annually 530 million tons C&D waste produced and estimate 46% reused, while China around 2 billion tons C&D waste generated only 5% waste recycled in China, the elementary cause behind it a smaller amount of national schemes utilization recycled Construction & Demolition waste"[11–13].C&D waste holding a vital section of complete solid waste in the globe, which generally utilization in landfill area, scholar recommended this waste utilized in construction industries designed an innovative concrete [2,14,15]. A severe challenge for all the countries, How to deal with construction & demolition waste along with economically & ecologically friendly properties; this problem might be overcome utilization C&D waste in construction area produce such as blocks, bricks & concrete[16,17].In(2017)" studied reported that China generated the world the enormous amount of C&D waste, one of china's most advanced state Shenzhen around 85% of C&D waste was landfilled, caused severe damage to the environment" [18].In order to the reused vast amount of C&D waste in Metropolis, China C&D waste Reutilizing industries are still in preliminary Position[19]. Construction & Demolition waste management must follow" 3R" rules-reduce, recycled and reused; it is the minimal rate in china, while other developed countries such as Japan, Singapore, Germany, USA, Denmark, South Korea, it touches up to 70% to 95% [17,20,21]. China's administration waste management strategies are being advanced at the municipal and regional levels to boost Reused & Recycled construction & Demolition waste[5,22]. Awareness and urgent steps required to Controlled Construction and demolition waste or to utilize in another form[23].

Non-Autoclaved aerated concrete (NAAC) is lightweight concrete, porous materials contain a vast amount of air-voids; due to its Lightweight, it widely used as a porous building material such as the partition of the wall, roof installation, wall of the lower floor, as well as low load-bearing wall structure[24–26].NAAC blocks contain about 70% to 80% of air voids; it can be easily drilled, nailed, cut & save even better than timber[27,28]. On the other hand, the NAAC does not contain any coarse aggerate resultant very light in weight, easily transport from one unit to other units[29,30]. NAAC a low density and low strength material, generally it is made by a mixture of cement, quick lime, quartz sand, water & expansion agents such as Aluminum powder[31,32]. NAAC has several beneficial possessions such as low thermal conductivity, fire resistance, good sound insulator & water absorption[33]. Generally, the difference between Autoclave aerated concrete and non-Autoclave aerated concrete based on their curing method[28,34]. as compared with Autoclaved aerated concrete Non-autoclaved aerated concrete efficiently manufactured it does not need high pressure & steam for curing; it can quickly cure under 80C-100C for 2 to 6 hours, resultant less energy consumption saves the massive cost of production & This study also beneficial for those countries which have energy crisis issues, This aims of the study is utilization construction demolition waste & Fly ash waste in the manufacturing of Non-autoclave aerated concrete which widely available vast quantity in china, while fly ash is a substitute of siliceous materials, e.g., quartz sand.

However, making more economically cheap and environmentally friendly reducing the consumption of leading siliceous raw materials sand throughout the processing, while the other hand decreased the percentage of Cement up to 23% and utilized disposal waste, allows to save the cost of production & making beneficial ecological state of the environment.

2. MATERIALS AND METHODS

2.1. Preparation OF Raw Materials

Raw Materials used in preparing non-Autoclave aerated concrete such as Cement, quicklime, gypsum, fly ash, and aluminum powder provided by National Dredging Company Shanghai, China, while Construction and Demolition waste debris collected from a construction site which nearby the Environmental Engineering department Donghua University shanghai China shows in Fig 1.

Fig 1: Flow chart All raw materials used in preparing Non-Autoclaved aerated Concrete

First, separate such as timber, harden, plastic from construction and demolition waste; after that, concrete waste crushed with the help of an industrial crusher, it changed into a reduced size, then minor size concrete placed into an industrial grinder becomes converted into fine aggregates, finally to obtained fine fraction from 0.5mm to 1 mm using sieves.

2.2. Experimental Procedure

The Arrangement of mixed designed samples shows in Table 1. In this experiment's series, the Percentage of Cement, Quicklime, Gypsum, Aluminum Powder kept constant while Construction & Demolition waste and Fly ash waste ratio changeable. All experiments were performed at room temperature.

W/R: water ratio was used 0.60 throughout all experiments

Table1: The composition of mixed samples

Samples No.	Portland Cement	Quick Lime	C & D Waste	Fly Ash	Gypsum	AL-Powder
NAC-1	23%	35%	5%	35%	2%	0.06%
NAC-2	23%	35%	10%	30%	2%	0.06%
NAC-3	23%	35%	15%	25%	2%	0.06%
NAC-4	23%	35%	20%	20%	2%	0.06%
NAC-5	23%	35%	25%	15%	2%	0.06%
NAC-6	23%	35%	30%	10%	2%	0.06%
NAC-7	23%	35%	35%	5%	2%	0.06%
NAC-8	23%	35%	40%	0%	2%	0.06%

First, the raw materials such as cement, Construction & Demolition waste, quick lime, fly ash, gypsum weighted with an accuracy ±1g, while Aluminum powder weighted with an accuracy±0. 01g.after that weighted dry materials add in a bucket thoroughly mixed proper, then warm water about ±60 C added in a mixture start stirring for 2 minutes, then added aluminum powder again stirring for 3 minutes till becoming a homogenous paste, then final paste poured into the moulds with the size of 60mm*60mm*60mm, before poured final paste in moulds lubricating done with the help of hand brush.

The samples kept in the oven at 60C-70C for 1-2 hours then take out the sample from the oven; after that demould processed done, finally samples kept at room temperature for 28 days to obtained maximum strength, the overall experimental process diagram shown in Fig 2.

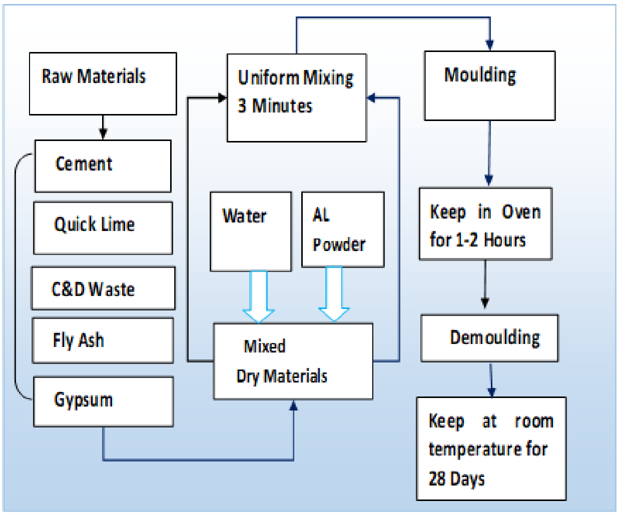

Fig 2: Flow Diagram of Experimental process

2.3. Density Control and Analysis

The expansion agent- aluminum- reacts with calcium hydroxide during the chemical reaction (contact between water and Portland cement). As a result, tricalcium hydrate and hydrogen gas created. A large volume of hydrogen produced causes pore creation and expansion of concrete (Figure 3A). The reaction equation represented as follows [35,36].

2Al + 3Ca (OH)2 + 6H2O → 3CaO.Al2O3.6H2O + 3H2 eq (1)

The density of porous materials was measured according to Chinese standards of JG/T266-2011. The figure 3B Shows the final porous lightweight concrete, while figure 3C shows the controlled sample having a density range between 860 to 915kg/cm.^{3}

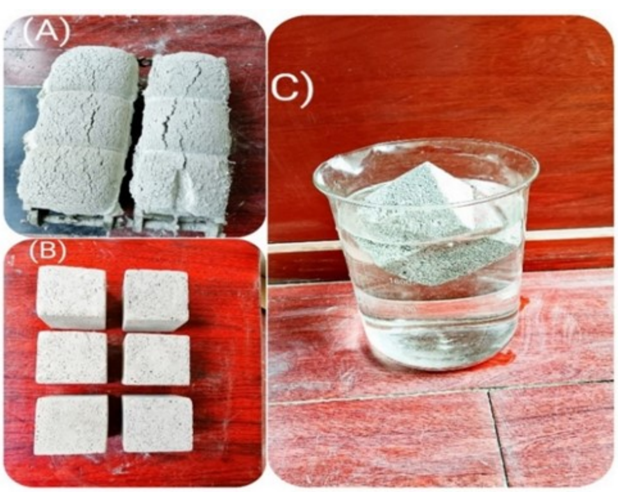

Fig 3: Expanded Concrete (A), Final Porous Concrete (B), Controlled Samples©

3. RESULTS AND DISCUSSION

3.1. Mechanical properties

The compression strength of final porous materials was checked according to Chinese standard JG/T266-2011 and JGJ/T341-2014, after(7,14,21 and 28 days) respectively, as results show obtained maximum compressive strength after 28 days, the last two sample NAC-7 and NAC-8 almost similar result, while samples NAC-6 containing 30% C&D waste and 10% Fly ash waste show the maximum compressive Strength 2 MPa, On the other side, sample NAC-2 containing 10% C&D waste and 30% fly ash which gave the minimum compressive Strength (1Mpa) and lowest density (860.24kg/cm^3) Table 2, figure 4.

Table 2: The Characteristics of the tested samples

Samples No.	Cross-sectional area	7Days (Mpa)	14Days (Mpa)	21Days (Mpa)	28Days (Mpa)	Density (Kg/m^3)
NAC-1	3600	0.5	0.8	0.9	1.1	870.76
NAC-2	3600	0.5	0.8	0.7	1	860.24
NAC-3	3600	0.7	0.9	1	1.1	874.98
NAC-4	3600	0.9	1	1.2	1.4	892.53
NAC-5	3600	1.2	1.5	1.6	1.9	911.38
NAC-6	3600	1.5	1.6	1.8	2	915.35
NAC-7	3600	0.9	1	1.1	1.3	890.92
NAC-8	3600	0.6	0.8	1	1.2	880.79

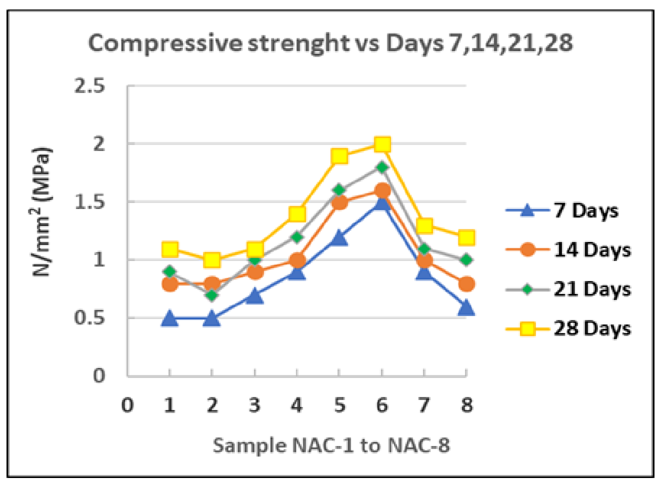

Fig 4: Compression Strength (MPa) Samples

3.2. Effect of compressive strength on density

As the results show compressive strength is directly proportional to density, sample NAC-6 shows maximums compressive strength and highest density, while on the other hand, sample NAC-2 shows minimum compressive strength and lowest density Figure 5.

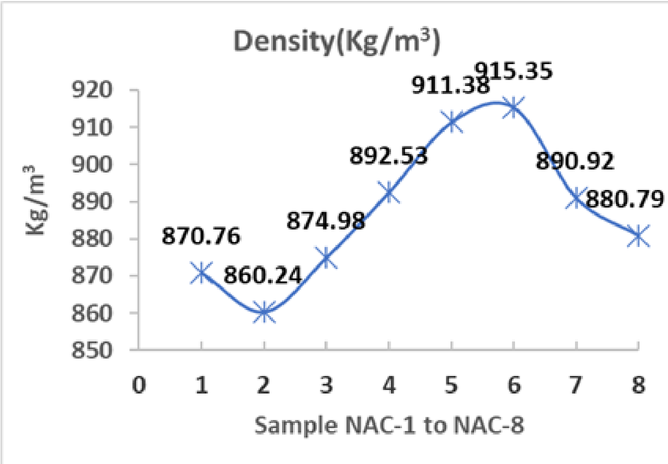

Fig 5. Density vs Compression strength relationships

3.3. Water Absorption

Water absorption final porous materials checked according to Chinese standard, JG/T266-2011. The value of water absorption shows in Fig 6, the samples NAC-1 and NAC-2 comparatively high-Water absorption value,25.2-26.5%, because of these relatively low densities and containing a vast amount of air - voids as compared to other samples.

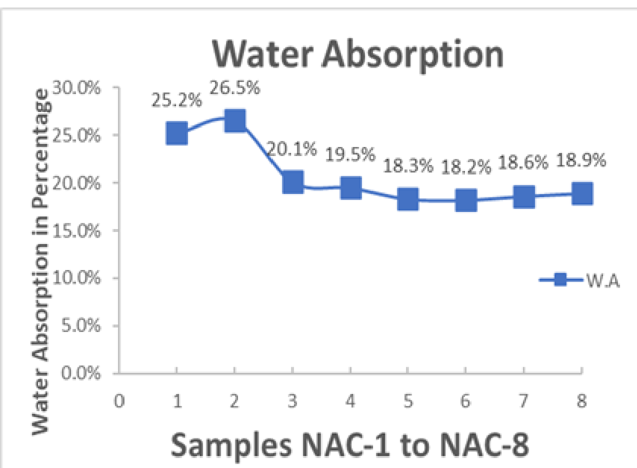

Figure 6: Water Absorption of samples

4. CONCLUSION

In this study, the possibility of utilizing construction and demolition waste, fly ash waste for the manufacturing of lightweight non-autoclave aerated concrete has been represented; based on research, the following hypotheses can be drawn. Comparison to standard Autoclaved aerated concrete (AAC), Non-autoclaved concrete (NAC) has significant advantages in encouraging and reducing the production procedure the cost of goods. Throughout the NAC manufacturing, steam curing required less than 80C for 2 to 4 hours after being cut. Hence NAC has the characteristic less energy consumption compared to (AAC).

Based on the finding, Sample NAC-6 containing 30% C & D waste and 10% Fly ash waste showed the maximum compressive strength and acceptable density and low water absorption value, which could be used for basic roofing applications, floor lining, partition, and probably for masonry.

Consequently, even this product cannot meet with the strength criteria needed for load-bearing structures. Ultimately, it can be concluded that usage of construction waste together with waste from another sector in Aerated concrete development, could be a hopeful step onwards in saving energy and enhancement of the environment.

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