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USE OF WOODASH IN NON-AUTOCLAVED AERATED CONCRETE

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Abstract— Non Autoclaved aerated concrete is a lightweight environmental friendly construction material. They are used as masonry units. They are made using a mixture of sand/woodash, cement, lime powder, gypsum powder, aluminium powder and water. Woodash is the residue left after burning wood and is different from flyash. Aluminium powder is mixed in small proportions by weight of the dry materials. Aluminium powder is responsible for forming gas bubbles in the mix resulting in the formation of lightweight aerated concrete. Water to dry materials ratio is taken as 0.6. Instead of rapid curing in an autoclave, conventional curing method of immersing in water was used to save energy costs. The amount of aluminium powder added to the mixture can be altered to produce samples of varying densities. But increase in aluminium powder content leads to decrease in compressive strength of samples.

Keywords— Autoclave, Aerated, Density, Compressive strength, Aluminium powder, Lightweight, Woodash.

I. INTRODUCTION

Aerated Concrete is gaining popularity nowadays due to its lightweight, environmental friendly characteristics, good insulation properties and high compressive strength. It is made up many tiny pore spaces resulting in its lightweight characteristics. But the pore spaces leads to the decrease in strength. The dry density of aerated concrete ranges from 300 -1800 kg/m^3 . The aluminium powder reacts with water and lime powder to create bubbles resulting in aerated concrete. Ordinary Portland cement provides most of the compressive strength and acts as binding agent. Water reacts with cement to increase compressive strength and reacts with lime to calcium hydroxide. Gypsum is responsible for long term strength gain. Woodash/sand acts as filler aggregate. Based on the methods curing, aerated concrete is classified into two categories, i.e. Autoclaved and non autoclaved. Curing in an autoclave leads to the formation of crystalline toberomite which has high compressive strength whereas non-autoclaving leads to the formation of toberomite gel which is weaker in compressive strength. The raw materials used for producing aerated concrete like flyash, woodash, etc. gives us an environmental friendly way of disposing waste materials.

II. NEED

Aerated Concrete is gaining popularity in the construction industry due to its lightweight, eco friendly, high strength and good insulating properties. The production process of aerated concrete does not involve any releases of harmful gases and the raw materials used like flyash, woodash ,etc. are wastes materials, thus giving us a eco friendly way of disposing our wastes. The aerated concrete blocks also reduce the dead weight of the structure considerably . This leads to better seismic performance of the structure as seismic weight of the structure plays an important role in earthquake resistance of the structure.

III. LITERATURE REVIEW

Let us take a look at the various scientific studies and researches conducted on the topic of aerated concrete.

A. Non Autoclaved Aerated Concrete Blocks: An Alternate Building Construction Material

Anshul Shrivastava et.al(2017) conducted this research on NAAC blocks to replace clay bricks in masonry. Flyash, Portland cement, lime, gypsum, aluminium powder and water was used in the mix. The aluminium percentages were varied to produce blocks of different densities. Blocks were of sizes (70.6 X 70.6 X 70.6)mm. Water ratio is 0.65 times weight of dry materials. The blocks were cured using water curing and tested for compressive strength at 7, 14 and 28 days.

i)Water absorption of NAAC blocks increases with increase in Al powder from 0.04 to 0.16%
ii)Samples S1 and S2 gives water absorption less than 40% which is acceptable for lightweight concrete
iii)NAAC blocks are lighter than clay bricks.
iv)Density of blocks decreases with increase in aluminium powder.
v)S1 and S2 have compressive strength 4.48N/mm2 and 3.75N/mm2 which is higher than strength of third class bricks.

B. Experimental Study on the Effect of Woodash on Strength of Concrete

Mehnaza Akhtar(2017) This research deals with the results on the effect of woodash on setting time and compressive strength of cement and concrete. Wood ash percentages were varied by 0%, 10%, 20%, 30%, 40% and 50% by weight of cement. The cubes were water cured for 7 and 28 days.

i)The water requirement increases as wood ash content increases.
ii)The setting times of wood ash OPC paste increases as woodash content increases. The 10 and 20% wood ash content gave satisfactory results but higher content gave negative results.

ii)The compressive strength of cement and concrete with 20% woodash increased appreciably at 28 days. Thus, optimum level of replacement is 20%.

C. Foamed Concrete

MD Jalal, Aftab Tanveer, K Jagdeesh and Furqan Ahmed(2017). Foam concrete is a vast majority of concrete containing no large aggregates, only fine sand and with extremely lightweight materials containing cement, water and foam. It can be considered relatively homogeneous when compared to normal concrete, as it does not contain coarse aggregate phase. However, the properties of foamed concrete depend on the microstructure and composition, which are influenced by the type of binder used, methods of pre-foamation and curing. The main advantage of foam concrete is its lightweight, which ensures economy of walls of the lower floors and foundations. It has several advantages and since it is porous in nature, it provides thermal insulation and considerable savings in the material. The important applications of foamed concrete include structural elements, non-structural partitions and thermal insulating materials.

i)density ranges from 300-1600 kg/cum

ii) The cells, or bubbles are discrete and range in size between 0.1 and1mm.

iii)Foam concrete is a free flowing and can be placed without compaction.

iv)The raw materials used for the production of foam concrete are, binding agent(cement, flyash), aggregates(quartz sand), foaming agent(tannic extracts of leather industry, sub soaped lye, sulfite lye) and water.

v) Cellular concrete is generally air-cured. Applying heat, steam or chemicals might accelerate curing. A curing compound prevents excessive loss of water after casting and consequently increases strength.

D. Manufacturing Process of AAC Block

Anurag Wahane(2017) produced commercial grade AAC blocks by mixing ordinary Portland cement grade 53, flyash(class C), limestone powder, gypsum, aluminium powder and water. A slurry of flyash and water is made first ,then the remaining materials are added and mix. Mix ratio used was Flyash : Lime : Cement : Gypsum = 69:20:8:3. Aluminium powder is about 0.08% of dry materials and water ratio is 0.6-0.65. Casting is done in moulds of size (4.2 X 1.2 X 0.65)m.

i)The cycle of mixing and pouring is 5.5 minutes

ii)Moulds must be oiled to prevent sticking. The mix is allowed to pre cure and rise. It usually takes around 60-240 minutes.

iii)Then the green cake which is still soft is sent to the autoclave chamber where it is steam cured at a temperature of 180-200 degree Celsius under a pressure of 800-1200 Kpa. Time taken is around 8-12 hours.

iv) After autoclaving, the blocks are ready for use.

v)The blocks are lighter and are more safer during earthquakes as the impact of earthquake is directly proportional to weight of building.

vi)AAC blocks have attractive appearance and have smooth finishes than clay bricks.

vii)AAC blocks weigh 80% lighter than clay bricks.

vii)AAC blocks are made from non-biodegradable materials and are mould free and clean.

vii)AAC blocks have higher strength than clay bricks.

E. Influence of Temperature and Curing Methods on Strength of Autoclaved Aerated Concrete

Rana Shabbar, Paul Nedwell and **Zhangjian Wu(2016)** performed this research to investigate the effects of temperature and curing methods on the properties of AAC in terms of strength and density. The specimens were cure at t (100 – 140 °C, 0-2.6 bar).density and compressive strength at 7 days were studied for a total of 9 different mixes. Compressive strength tests were then carried out after the concrete was autoclaved for 12 h and then left in air until testing. The results showed that the dry density and compressive strength of autoclaved aerated concrete increased by increasing temperature up to 120 C° and then reduced. Autoclave curing may be considered uneconomic due to considerable energy consumption while the specimens cured in the autoclave have no detrimental improvement in the strength rather than the normal aerated concrete specimens which used none.

i)The dry density and compressive strength of autoclaved aerated concrete increased by increasing the cure temperature.

ii)Highest density and compressive strength were recorded at 120^0C.

iii)With autoclave aerating process, AAC specimen exibits lower density than aerated concrete.

iv)AAC has lower compressive strength than water curing.

v)There is no significant benefit by use of the autoclave due to energy consuming issued.

F. Properties of Foamed Concrete

Amran, Farzadna and Ali(2015) This paper aims to provide insight into the suitability of foamed concrete for construction purposes and other applications.

i)Cement is used as binder, synthetic foaming agents like resin soaps, hydrolysed protein, glue resin, etc. are used.

ii)Super plasticizers are also used to improve workability and Stabilize the compatibility of foamed concrete.

iii)Synthetic fibres are also used.

iv)Fresh properties – foamed concrete is flowing and self compacting, excellent workability

v)The excessive addition of foam depletes the compressive strength

vi)Inclusion of fibres enhance the compressive strength by preventing micro cracks

vii)The difference between fresh and dry densities is limited to 100-120 kg/cum.

viii)Typical range of drying shrinkage is between 0.1%-0.35% of the total volume of hardened concrete.

ix)Drying shrinkage of foamed concrete is deemed 4-10 times higher than normal concrete due to aggregate type, high cement and water contents.

x)It was observed that thermal conductivity reacts proportionally with density and the thermal insulation characteristics deceases when the density volume increases.

G. Non-autoclaved Aerated Concrete made of modified binding composition containing supplementary cementitious materials

Oksana Poznyak and **Andryy Melnyk(2014)** investigated the impact of carbonate-containing and sulfate components, zeolite, polypropylene fibers on the properties of modified binding composition of non autoclaved aerated concrete.

The use of salt processing wastes, on one hand, has a positive ecological effect as wastes are recycled; and, on the other hand, it has economic and technical effects. Including up to 10 mass.% of carbonate-containing salt wastes into binding composition provides the increase of cement stone early strength as well as that of later terms of hardening and the use of sulfate-containing wastes causes decrease of mechanical strength at all terms of hardening. Aerated concretes containing carbonate-containing salt wastes have better ability to retain gas, the evidence of which is shortening the time of aerated concrete mix growth from 21 min. to 12-14 min. and increasing the multiplicity of swelling on 5%. The addition of reinforcing components to the composition of aerated concretes, polypropylene fiber, in particular, improves the strength characteristics of aerated concretes. The aerated concrete based on the modified binding composition containing a supplementary cementitious material, which is carbonate-containing salt waste, and reinforced with polypropylene fibers is characterized by the compressive strength of 2.7 MPa with the density of 650 kg/m3after 28 days of hardening. The thickness of partitions between pores is 0.16 – 0.21 mm, and the number of pores with the size 0.2-1.0 mm is 76.4%.

H. Structure and Properties of Aerated concrete

Ali J. Hamad(2014). This paper is attention to classification of aerated lightweight concrete into foamed concrete and autoclaved concrete. Also, it is exhibits the raw materials used in aerated concrete, types of agent, properties and applications. The production method is classified for each foamed and autoclaved concrete. The literature review of aerated lightweight properties is focuses on the porosity, permeability, compressive strength and splitting strength.

i)Aerated concrete is classified into:

- Foamed Concrete : Foam agent and non-autoclaved
- AAC : Chemical expansion and autoclaved

ii) Aerated lightweight concrete is unlike conventional concrete in some mix materials and properties. Aerated lightweight concrete does not contain coarse aggregate, and it is possess many beneficial such as low density with higher strength compared with conventional concrete, enhanced in thermal and sound insulation, reduced dead load in the could result several advantages in decrease structural elements and reduce the transferred load to the foundations and bearing capacity. Foamed concrete is different in agent of forming air-voids as compared with autoclaved aerated concrete. The air-voids in foamed concrete formed by foam agent, this operation is physical processing. Against the air-voids in autoclaved aerated concrete formed by addition aluminum powder to the other materials and reaction between them, and this operation is chemical processing. The air-voids is homogenous distribution within aerated lightweight concrete. The compressive strength of foamed concrete can be developed reach to structural strength compared with autoclaved aerated concrete. Aerated lightweight concrete is consider economy in materials and consumption of by-product and wastes materials such as fly ash.

I. High Strength Non Autoclaved Aerated Concrete

Cary Victor et.al(2014) conducted this research on NAAC in order to cut down energy cost of autoclaving. The goal was to achieve high strength-density ratio without autoclaving. Addition of titanium oxide(TiO2) and sodium alignate was done to increase compressive strength and control density respectively. The blocks were made using sand, cement, aluminium flakes, quicklime and water.

i)Autoclaving forms crystalline tobermorite which is responsible for higher strength in AAC clocks where as in NAAC blocks, tobermorite gel is formed which is weaker.

ii)Addition of TiO2 in small percentages(0.05%) increased the compressive strength of blocks

iii)sodium alignate(0.05%) proved to be a effective foam stabilizer and density controller. They provided more uniform foam structures and lower densities by trapping air.

iv)Ultimate compressive strengths of 6.61Mpa and 6.49Mpa were achieved by adding 0.05% oof TiO2 and sodium alignate each which is more than previously tested NAAC blocks.

J. Structure and Properties of Aerated Concrete

Narayanan, Ramamurthy(2000). The focus of this paper is to classify the investigations on the properties of aerated concrete in terms of physical (microstructure, density), chemical, mechanical (compressive and tensile strengths, modulus of elasticity, drying shrinkage) and functional (thermal insulation, moisture transport, durability, resistance and acoustic insulation) characteristics.

i)Types of aerated concrete based on method of pore formation:

- Air entraining method(gas concrete) – gas forming chemicals like Al powder is mixed
- Foaming method(foamed concrete) – no chemical reactions. Pores are achieved through mechanical means
- Combined pore forming – combination of the above two

ii)Based on type of binder – cement or lime binder

iii)Based on method of curing – autoclaved and non autoclaved

iv)Pore systems in aerated concrete – artificial air pore, inter-cluster pore, inter- particle pore

v)Density of aerated concrete – (300-1800)kg/cum

vi)Compressive strength of NAAC increases 30-80% between 28 days and 6 months whereas in AAC, full strength is achieved after autoclaving

vii)Drying shrinkage of aerated concrete with only cement as binder is higher than lime based .
viii)At higher degrees of saturation 20-40%, the sample becomes brittle and cracks.
ix)Thermal conductivity is independent of curing method. Finer the pores, better the insulation
x) Their low thermal conductivity and diffusivity gives an indication that aerated concrete possesses better fire-resisting properties.

IV. CONCLUSIONS

The following conclusions were drawn:

A. Aerated concrete blocks are lighter than conventional clay bricks.
B. Water absorption of aerated concrete increases with increase in aluminium powder content and should be less than 40%.
C. Density of aerated concrete decreases with increase in aluminium powder.
D. Compressive strength of aerated concrete decreases with increase in aluminium powder.
E. Thermal conductivity is independent of curing method. Finer the pores, better the insulation.
F. Their low thermal conductivity and diffusivity gives an indication that aerated concrete possesses better fire-resisting properties.
G. Autoclaving gives higher strength than non autoclaving due to formation of crystalline toberomite.
H. The water requirement increases as wood ash content increases.
I. Addition of chemical admixtures like TiO2 and sodium alignate helps improving strength and controlling density respectively.
J. Addition of polypropylene fibres also improves strength by preventing micro cracks.
K. Addition of admixtures like sulphates and carbonates can be used to modify the properties.

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