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Air Cured Lightweight Concrete

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Abstract—The increasing environmental concerns have created need innovations in concrete, such as lightweight concrete that can be cured without water. This project aims at sustainable use of material in improving infrastructure, sustainable cities and communities. Concrete is prepared by replacing a certain amount of cement with pozzolanic material,fly ash in 0-30% by weight in different mixes. Foaming agent is added to reduce the dead weight of the concrete. Sulphonatednaphthalene formaldehyde is added as a water reducing agent, this reduces the required water content without compromising on its workability. blocks are casted and cured in atmospheric air. Then the blocks are tested, the compressive strength as well as the water absorption results are obtained and compared.

Index Terms—Lightweight concrete, sustainability, air curing, pozzolanic material, compressive strength, water absorption.

I. INTRODUCTION

Lightweight blocks are a perfect alternative to conventional bricks as they help to reduce the dead load of the buildings. This inclined substitution is accomplished with fly ash of cement that reduces emission of carbon due to cement production. The usage of fly ash is also an effective method of waste disposal, solid waste management. Thus, we can say that ACC blocks are environment friendly. These include, reduction of dead load of the building, this also increases fire resistance of the structure. The production of air cured concrete blocks includes making slurry of cement, fine aggregate, sulphonated naphthalene formaldehyde and a protein based foaming agent. Various tests are performed on cement and fly ash to use the cement and concrete with the most desired properties. The foam is added to the concrete mixture to fill the tiny pores, provides strength and prevents failure due to shrinkage. Foamed concrete is known for its high workability, low cement content, no coarse aggregate, low water content and excellent thermal insulation. It is widely used for plastering and fabrication works, since it has good compressive strength and water absorption. The concrete is formed by pre formed foam method. Cubes of four different proportions are casted such as the first one with zero fly ash content, second one with 10% fly ash, 3rd one with 20% fly
ash and the fourth one with 30% fly ash content. The blocks are tested to check for better compressive strength and water absorption and the results are discussed.

II. MATERIAL STUDY

A. Cement

Cement is the universally used binding material, but its production emits enormous amounts of greenhouse gases such as carbon dioxide. They must satisfy certain specifications to attain the compressive strength. The properties of the cement such as standard consistency, setting time and specific gravity were

tested in accordance with IS: 4031-1988 and the results are tabulated accordingly. The table1.1 shows the property of the sand which is to be used to prepare the concrete.

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Table 1.1 Cement's Physical properties (OPC 53 Grade):

S.No	Test Properties	Results
1.	Specific gravity	3.13
2.	Initial setting time	60 minutes
3	Final setting time	600 minutes
4.	Consistency	29.5%

B. Fine aggregate

Those aggregates that pass through 4.75mm sieve are termed as fine aggregates. They occupy the voids in the coarse aggregate mixture. The aggregate's strength is mainly dependent on the type and amount of aggregates used for making the concrete. Below table specific the details of properties of fine aggregates.

Table 1.2 fine aggregate's Physical properties

S.No	Test properties	Results	Indian standards
1.	Specific gravity	2.53	IS 2386 (part III) 1963
2.	Fineness modulus	2.68	IS: 383-1970
3.	Bulk density	1838	IS 2386 (part III) 1963
4.	Water absorption	3	IS 2386 (part III) 1963

C. Fly Ash

Fly ash is the product from the combustion of pulverized coal . They are inorganic substances and are very difficult to dispose of. They are substituted in the place of cement. There are two available classes of fly ash, Class C and Class F. Table 1.3 shows the detail properties of fly ash.

Table 1.3 Physical properties of fly ash:

1.	Specific Gravity	3.13
2.	Initial setting time	60 minutes
3.	Final setting time	600 minutes
4.	Fly Ash	29.5%

D. Water

Ordinary clean portable water is available in Sri Sai Ram institute of technology, premises. It is free from suspended particles and used for mixing as well as curing. Water abiding specifications given in IS: 3025 was used.

E. Foaming Agent

Foaming agent is used to fill in the micropores in the concrete to not let the concrete compromise in strength due to its less weight and also to avoid failure or cracks due to shrinkage. They are of generally two types 1. Protein based foaming agent, 2. Synthetic foaming agent.

F. Sulphonated Naphthalene Formaldehyde

It is an excellent dispersing agent. It acts as a water reducer. It is compatible with a greater number of additives used in admixtures. It reduces the water content used without reducing the workability of this air cured lightweight concrete.

G. Aluminum Powder

Aluminum powder is uniform in shape. They are used in lightweight concrete as it provides additional strength by improving the density which is also an important property of light weight concrete.

III. MIX DESIGN

It is the trial and error process of obtaining the desired quantity of a material to obtain or satisfy a set of properties. A set of 30 cubes were casted in all and their compressive strength and water absorption properties were obtained and compared and hence the most desirable mic is obtained. Five different mix proportions were obtained.

A. Mix A

Table 1.4 shows the details of the mix ratio of the various materials which is to be used to prepare as a trial without foam but included the fly ash.

Table 1.4 Mix A is prepared without foam and fly ash.

1.	Cement	360Kg
2.	Fine Aggregate	1200Kg
3.	Water	180Kg

B. Mix B

Table 1.5 shows the details of mix B with 10% fly ash by weight of cement and foam are used in the mix, replacing cement.

Table 1.5 Mix B is prepared with foam and 10%fly ash.

S.No	Test Properties	Results
1.	Cement	324Kg
2.	Fly Ash	36Kg
3.	Fine Aggregate	1200Kg
4.	Water	180Kg

C. Mix C

Table 1.6 shows the details of the mix B 20% of cement content by weight is now being replaced with foaming agents and fly ash. In addition to these 0.1% aluminum powder is added.

Table 1.6 Mix C is prepared witH foam and 20 % fly ash.

S.No	Test Properties	Results
1.	Cement	288Kg
2.	Fly Ash	72Kg
3.	Aluminum Powder	0.288Kg
4.	Fine Aggregate	1200Kg
5.	Water	180Kg

D. Mix D

30% of cement content by weight is replaced by fly ash, foaming agent, 0.2%Sulphonated Naphthalene Formaldehyde and 0.2% aluminum powder are added. All details are given in the below table1.7.

Table 1.7 Mix D is prepared without foam ,30% fly ash ,0.2 percent of sulphonate formaldehyde and aluminum powder.

S.No	Test Properties	Results
1.	Cement	252Kg
2.	Fly Ash	72Kg
3.	Aluminum Powder	0.576Kg
4.	S.N.F	0.576Kg
5.	Fine Aggregate	1200Kg
6.	Water	180Kg

E. Mix E

It is the final mix, it contains fly ash replacing 30%of cement by weight. Additional to it we add 0.2% of Sulphonated Naphthalene Formaldehyde and 0.25% aluminum powder. details of the mix in kilogram is given in the table 1.8.The percentage of the various ingredients in the mix is increased in order to get better strength of the concrete. Also to cast a light weight concrete. The table 1.8 shows the mix proposition of mix design

Table 1.8 Mix D is prepared without foam ,30% fly ash ,0.2 percent sulphonate formaldehyde and0.2.5 % aluminum powder.

S.No	Test Properties	Results
1.	Cement	252Kg
2.	Fly Ash	72Kg
3.	Aluminum Powder	0.630Kg
4.	S.N.F	0.576Kg
5.	Fine Aggregate	1200Kg

6.	Water	180Kg

IV. PREPARATION OF CONCRETE BLOCKS

Firstly, 30 concrete blocks with dimension 400 mm X 100 mm X200 mm have been produced. Standard steel mold according to IS specifications were used.

A. Mixing

Different concrete mixes according to different mix proportions specified were made. Mixing can either be done manually or mechanically.

B. Sampling

1. The mounds were cleaned and then oil was applied completely.
2. Then the concrete was filled in three layers in the mold, each layer being approximately 5cm thick Each layer was tamped 25 times, to escape air voids.
3. The top surface must be smoothened using a trowel.

C. Curing

Moist air curing is performed. After storing the specimens in moist air for 24 hours completely, the specimens are marked for identification, unmolded from their respective molds and cured at room temperature until taken for testing. Normal curing is done for 28 days by immersing the cube in the water to get at least 70% of desired strength.

V. RESULTS AND COMPARISON

A. Compressive strength of concrete

For any concrete two test results very important one is the compressive strength and another is the flexural strength of the concrete. If these results are obtained as per the design strength then the concrete is said to be very good. Test to find the performance on the Air Cured Lightweight concrete block of size 400mm*200mm*100mm the compressive strength was obtained by curing it for 28 days. The test was performed in the Compression Testing machine.

The compressive strength of the air cured blocks is given in table 1.8 the block is air cured one. The results are as expected though better than the blocks which are cured normally. These blocks cannot be used as load bearing structure.

Table 1.9 Results for compression test on blocks of various mix proportion:

MIX	**Mix A**	**Mix B**	**Mix C**	**Mix D**	**Mix E**
Average Compressive Strength(N/mm^2)	16.8	4.7	6.8	8.9	7.6

Comparison of compressive strength test result on samples with different mix proportions: below figure shows the details about the mixes.

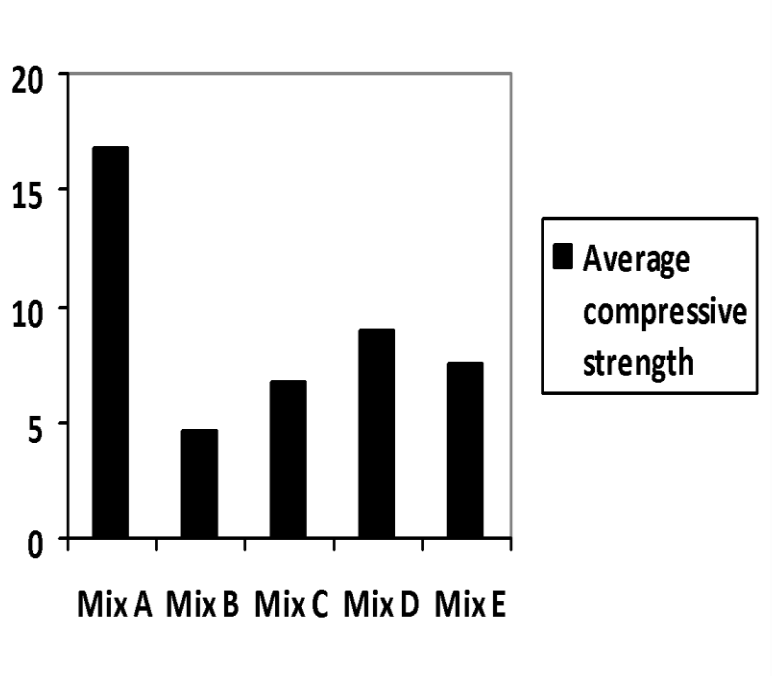

Fig 1.1 Graphical representation of compression strength of different mixes

B. Water absorption of concrete

Concrete blocks are taken oven dried and then weighted. Then the specimen is immersed in water for 24 hours and then weighted. the difference is calculated and then the percentage increase in weight is accordingly found out.Table no 2.0 gives the results of water absorptions.

Table 2.0 Results for water absorption test:

MIX	Mix A	Mix B	Mix C	Mix D	Mix E
Water absorption percentage	10%	9%	8.5%	8%	8%

Comparison of water absorption test on various specimens with different mix proportions:

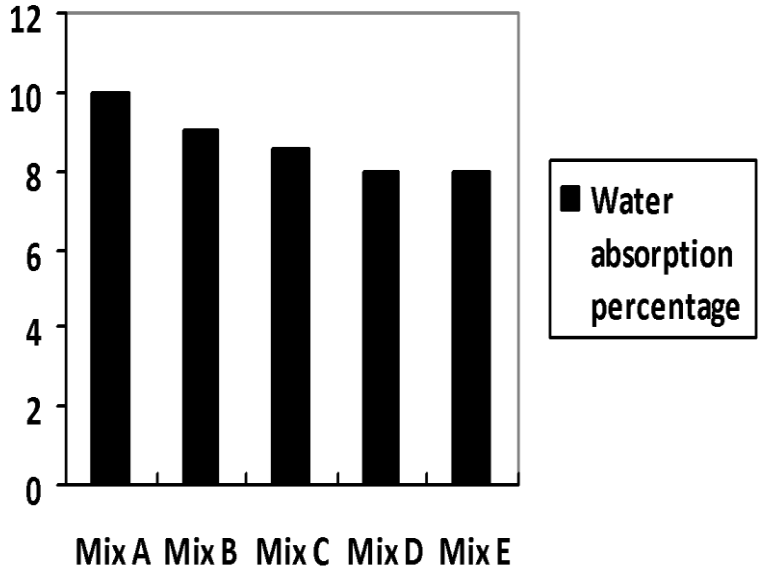

Fig1.2 Graphical representation of Water absorption percentage of different mixes

VI. CONCLUSION

Therefore, it is concluded that Mix D is the best among all other designed mixes. It is capable of resisting compressive strength up to 8.9kN/mm^2 and water absorption is only 8% of its weight. As we cure in air it minimizes the water requirement of this type of concrete. Such concrete can be used for the plastering free concrete since the finish of the surface is very smooth.

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