STUDY OF PROPERTIES OF FOAM CONCRETE WITH FLY ASH AND QUARRY DUST

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Abstract

Foam Concrete is a versatile fabric which is built up of cement, fly ash and protein based foam. Fundamentally it is a raw material which is currently utilized in India for walling purpose. Foam Concrete gives better sound insulation, thermal insulation, durable, lightweight, uniform size & shape, reduce permeability. It is non-load bearing structural element which causes a lower intensity than conventional concrete. Cellular concrete is popular because of its light weight, which reduces self-weight of the construction. In this dissertation Foam Concrete blocks are cast with 65% of fly ash and 35% of cement with foam content 1.5% of total weight and to increase its strength sand and quarry dust is added in its composition which replace fly ash up to 30% at an interval of 5%.

To check properties of these cellular lightweight concrete (FC) block test like compressive strength, density and water absorption is performed in the lab.

Keywords: Cement, Quarry Dust, Fly ash, Foam Concrete

I.INTRODUCTION

Lightweight concrete has been wide utilised in several structural applications and its consumption grows each year on a worldwide base. The cause for this is often that mix treatment of light-weight concrete has several benefits. These include: a discount within the loading of the structure, that minimizes the size of structural members; the assembly of lighter and smaller pre-cast parts with cheap casting, handling and shipping operations; the look of extra space as a result of the diminution in size of the structural members; a decrease within the peril of earthquake damage; and enlarged thermal insulation and flame resistance.

In India, among the multiple construction applications, masonry structures type the best proportion of the uses of typical burnt clay bricks, ash bricks, hollow concrete block, that have several drawbacks (like an excellent weight, non-uniform form and size, low thermal insulation and fireplace resistance etc.), which will be improved by mixed treatment of light-weight concrete. the employment light-weight concrete, provides improved thermal insulation and flame resistance, thereby it's thought of a good approach not solely in fireplace protection however conjointly in reducing the U-values (it's the live of warmth passing through a structural element) of structures.

Lightweight concrete is created during a sensible vary of densities between three hundred and 2000 kg/m3 using method of mixed treatment, 3 strategies. The primary method is supposed to have no quarry fines, wherever the fine portion (sand particles) of the whole concrete combination is omitted. The second methodology is by introducing stable air bubbles in the intervals in the concrete body through mechanical foaming and chemical mixture. This character of concrete is understood as aerated, cellular or gas concrete. The tertiary and latest methodology is by mix treatment of light-weight combination. This might occur from either a natural or a synthetic origin

II.FOAM CONCRETE

Cellular lightweight concrete is a material of new generation, its properties makes it versatile material which is ready to give the new foundation to the today's construction industries. Cellular lightweight concrete is highly workable,

self-compacting and self-levelling in nature. It is also light in weight and provides excellent thermal and acoustic insulation which is needed by the good construction material. It is widely used construction material in different structural applications and its consumption grows day by day on a global basis. The reason behind that is low self-weight by which reduction in the dead load of the structure and also minimize section of the structural elements; reduction in the risk of earthquake damage; and its porosity makes an excellent thermal and sound insulator which intern saves the energy consumption. Concrete containing intentionally entrained air voids in the hardened cement paste or mortar matrix to form a cellular structure of low density are known as cellular concrete or cellular lightweight concrete.

Cellular lightweight concrete is made by introducing the gas or air bubbles into a slurry or plastic mortar mix of cement and siliceous filler in order to produce a material with a uniform cellular structure, containing voids between 0.1 to 1 mm in size after getting set, similar to a sponge rubber. The 'skin' of the air voids or cells must be able to withstand mixing and compaction. The final resulting product is known as cellular concrete which is not a concrete in real sense of the word as no coarse aggregate is present. Cellular concrete is also referred as aerated concrete, gas concrete, or foam concrete.

There are two ways of aeration in concrete and appropriate name being given to each end product.

1. Foamed concrete is produced by using two principal methods. Either the pre-foaming method or the mixed foaming method. In the pre-foaming method, cement based slurry or base mix and stable preformed aqueous foam produce separately and then thoroughly blending the foam into the base mix. While in the mixed foaming method, the surface active agent is mixed along with the ingredients of base mix. The agent introduces and stabilizes air bubbles during mixing at high speed by beating action, and foam is produced resulting in a cellular structure in the concrete. In both the methods the foam must be stable during mixing, transporting and placing. Based on these criteria, foamed concrete is defined as concrete weighing from 200 to 1600 kg/m^3, having homogeneous void or cell structure.

2. Gas concrete, which is obtained by a chemical reaction generating a gas or air bubbles in the slurry or plastic mortar, so that when it sets it contains a large number of gas bubbles. The consistency of the mortar must be good so that the gas can expand the mortar without getting escape. Therefore the speed of gas evolution, consistency of mortar and its setting time must be matched. Most commonly used chemical is aluminium powder, and its proportion being of the order of 0.2 per cent of the mass of the cement. The reaction of the aluminium powder with calcium hydroxide {$Ca(OH)_2$} or the alkalis during the mixing liberates hydrogen bubbles and makes the cellular structure in the concrete. Sometimes powdered zinc or aluminium alloy can also be used and hydrogen peroxide is employed to introduce oxygen bubbles into the concrete.

Figure 1: Classification of Aerated Concrete

A. Production of foam

Foam is produced by using the hydrolyzed protein agent or protein based foaming agent. There are two methods used to produce foam for Foam Concrete.

Mixed foaming method

Pre-foaming method

Air entrainment is the process in which many small size air bubbles are introduced into concrete and become part of the matrix that binds the aggregate together into the hardened concrete. The air bubbles are discrete throughout the cement paste but are not part of it.

The small air bubbles in concrete can improve not only freeze-thaw resistance in concrete but also the workability of concrete, consistency of plastic concrete and reduces its bleeding and

segregation. And reduced shrinkage and creep as well as reduced permeability.

B. Mechanism of air entrainment

Air bubbles in the concrete are not actually formed by air entraining agents but stabilized by them. However air bubbles formation and stability in the fresh concrete are considered as two different processes that are equally important for the air void system. One is air entrainment in fresh concrete which is done by the mixing process. Another is the stabilization of the air which is achieved by adding air entraining agents, which form a protective film or layer around the air bubbles.

C. Types of air-entraining agents

The air-entraining agents classified in small group of surfactants [50].

1. Salts of wood resins.
2. Synthetic detergents.
3. Salts of sulfonated lignin.
4. Salts of petroleum acids.
5. Salts of proteinaceous materials.
6. Fatty and resinous acids and their salts.
7. Organic salts of sulfonated hydrocarbons.

III. MATERIALS USED

A. Cement

Cement is defined as a material with cohesive and adhesive properties that make it capable of bonding the aggregate (mineral fragments) into the compact whole, which imparts the strength and durability to the hardened mass called concrete. The cement used for constructing the concrete is called the hydraulic cement because they react chemically with water in an exothermic process called hydration that results in water resisting product. Cement is a generic term that can apply to all binders. Thither are a broad mixture of cements that are used to some extent in the building and building industries, or to resolve particular problems. The chemical makeup of these cements can be rather diverse, but by far the greatest quantity of concrete used today is made with Portland cements.

Portland cement is the type of hydraulic cement which is applied to manufacture of concrete.

In this project, for the production of Foam Concrete, Ordinary Portland Cement 53 grades are used. The cement which is used in this project is tested in the lab and their result is rendered in the table.

Table 1: Properties of Portland Cement

S. No.	Property	53 Grade OPC	Value
1	Fineness	225(min.)	
2	Initial Setting Time	30(min.)	35 min
3	Final Setting Time	600(max.)	178 min
4	Soundness	10mm (max.)	2mm
5	Compressive Strength	7 Days – 37 MPa (min.)	7 Days – 38.49 MPa
		28 Days – 53 MPa (min.)	28 Days – 54.76 MPa

B. Fly Ash

Fly ash is a fairly divided residue which results from the burning of ground or powdered bituminous coal or sub-bituminous coal like lignite and transported by the flue gases of boilers fired by pulverized coal or lignite. Fly ash is a by-product of many thermal power plants or other plants using pulverized coal or lignite as a origin of heat for boilers.

C. Quarry Dust

Quarry dust is collected from nearest crusher plant. Quarry Dust which is used in this project is tested in the lab for their properties and their solutions is presented in the table.

Table 2: Properties of Fine Aggregates

S. No.	Property	Value
1.	Specific Gravity	2.62
2.	Bulking	30.21%
3.	Water Absorption	0.92%

D. Water

Water is an indispensable element in the fabrication of concrete. It takes an important role in the making of concrete- in the mixing of fresh

concrete and in curing while hardening the concrete. In edict to secure the proper strength development and strength, it is necessary that the water applied, should be free from impurities like oils, acids, bases, salts, sugar and organic materials, for mixing and curing.

E. Foam agent

Protein based standard foaming agents or hydrolyzed protein agents are induced by protein hydrolysis of animal proteins such as keratin (horn meal and hoof), cattle hooves and fish plates, blood and saponin, and casein of cows, pigs and other remnants of animal carcasses. This contributes not only to occasional variations in quality, due to the differing raw materials employed in different batches, but also to the very intense stench of such foaming agents. Their self-life is roughly 1 year under sealed conditions. Properties of Foaming agent are presented below in the table.

Table 3: Properties of hydrolyzed protein agent

Appearance	Black-Brown liquid
Density	1.12 to 1.18 g/cm³
PH value	6.5 to 7.5
Solubility	Solubility in water at any ratio
Sediment content	Below 1%
Storage temperature	21-25ºc
Specific gravity	1.22

IV.METHODOLOGY

In the experimental program; three basic tests, for evaluating the properties of Foam Concrete, were conducted i.e. tests for compressive strength, water absorption and dry density. The compressive strength of concrete was tested at the ages of 7 days and 28 days. The compressive strength was tested on concrete cubes of 150 x 150 x 150 mm after water curing for 7 days and 28 days. Besides the strength test of the concrete, the water absorption tests and dry density tests of concrete were also conducted.

A. Compressive strength test

The compression test was taken as per IS 516–1959. The specimens were retained in water for curing for 7 days and 28 days and for removal were tested in dry condition and grit present on the airfoil. The load was used without shock and increased continuously at a pace of about 140 kg/sq. Cm/min until the resistor of the specimen to the increasing load breaks down and no greater load can be maintained. The maximum load applied to the specimen was then read. Experimental set up for compressive strength testing is presented in image 4.16.

$$Compressive\ strength\ in\ MPa = \frac{Maximum\ load\ at\ failure\ (N)}{Average\ area\ of\ the\ bed\ faces\ (mm^2)}$$

B. Water absorption test

The water absorption test was led as per (IS: 3495- 1992 Part-2). The water absorption test was done by 24-hour immersion, cold water test, in which the dry specimen of Foam Concrete cube was held open in a ventilated oven at a temperature of 105 to 115oC till it attains substantially constant mass. Cool the specimen at room temperature and obtained its weight (M1). Than immersed completely dried specimen in clean water at a temperature of 27 $\pm$ 2ºC for 24 hours. Removed the specimen and wiped out the water with a damp cloth at its surfaces and weigh the specimen (M2).

Water absorption, percent by mass, after 24-hour immersion in cold water was broken by the convention:

$$Water\ absorption\ (\%) = \frac{M2 - M1}{M1} \times 100$$

C. Dry density

Dry density (weighted density) can be taken by adopting two methods

1. By evaluating the mass using the water displacement method
2. By measuring the physical dimension of a cube

Dry density of Foam Concrete was measured according to following equation

$$\rho_d = \frac{W_d}{V} \quad (2)$$

$$V = \frac{W_d - W_w}{\rho_w} \quad (3)$$

Where;

ρ_d = Dry density of Foam Concrete in kg/m³.

W_d = Weight of oven dry cube of Foam Concrete in kg.

V = Volume of Foam Concrete cube in m³.

W_w = Weight of cube under water in kg.

ρ_w = Density of water in kg/m³.

Dry density of Foam Concrete can also be measured by taking the physical dimension of the cube.

$$\rho_d = \frac{W_{dc}}{Vc}$$

Where:

$\rho_d =$ Dry density of Foam Concrete in kg/m^3.

$W_{dc} =$ Weight of oven dry cube of Foam Concrete cube in kg.

$Vc =$ Volume of Foam Concrete cube in m^3.

$$Vc = (0.15 \times 0.15 \times 0.15)\ \text{m}^3$$

$$Vc = 0.003375\ \text{m}^3$$

In present study, the dry density is obtained for three cubes of each mix. The dry density of mix is the average value of these three cubes.

V.CONCLUSIONS

The current survey is study of the properties of Foam Concrete and to check suitability of quarry dust in FOAM CONCRETE composition

To study the properties of foam concrete using fly ash, quarry dust and foaming agents mixed proportions of these materials are used in varying quantities and hence the results are computed on experimental basis.

VI.REFERENCES

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