ISSN: 2455 - 1597

ijergs
Open Access

International Journal of Engineering Research and Generic Science (IJERGS)
Available Online at www.ijergs.in

Volume - 5, Issue - 2, March – April - 2019, Page No. 44 - 51

Study and Experimental work on Lightweight Concrete

Anil Sharma, Arvind Singh Gaur, Mahesh Saini

Assistant Professor, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur

Abstract

Lightweight concrete can be prepared either by injecting air in its composition or it can be achieved by omitting the finer sizes of the aggregate or even replacing them by a hollow, cellular or porous aggregate. Particularly, lightweight concrete can be categorized into three groups:

i) No-Fines Concrete

ii) Light Weight Aggregate Concrete

iii) Aerated Concrete

Keywords: Thermocol Beans, Light Weight, Cement, Aggregate, Compressive Strength.

Introduction

Lightweight concrete can be defined as a type of concrete that includes a blowing agent as it increases the size of the mixture while giving additional qualities such as stability and reduces dead weight. It is lighter than conventional concrete with a dry density of 300 kg / m3 up to 1840 kg / m3; 87 to 23% lighter.

Lightweight concrete retains its large voids and does not form lease layers or cement films when placed on a wall. This research was based on the performance of light aerated concrete. However, a sufficient percentage of water cement is vital to produce adequate cohesion between cement and water. Insufficient water can cause a lack of cohesion between molecules and thus a loss of strength of concrete. Likewise, too much water can cause cement to flow to form clay layers, which subsequently weakens the resistance.

This research report was prepared to show the activities and progress made in the research project on light concrete. The performance of light cellular concrete, such as pressure resistance tests, water absorption is performed.

It was first introduced by the Romans in the second century when the "Pantheon" was built using pumice stone, which is the most used type of aggregate that year. From there, the use of lightweight concrete became widespread in other countries such as the United States, the United Kingdom, and Sweden.

Literature Review

Hemant K. Sarje: Study of Performance of Lightweight Concrete, Light Weight Concrete is becoming very popular day by day. In this project the performance of Light Weight Concrete obtained from mixing fly ash and aerating agent (Kemilite-PR-Protein Based Foaming Agent)in conventional concrete will be analysed. Finally, the results obtained are going to be published.

S. Suryani: Structural Behaviour of Precast Lightweight Foamed, The results from previous research related with sandwich panel bring a lot of benefit to others which is the usage of material, manpower and cost were decreases. This proves that this material is capable and suitable to be applied in the construction industry.

P.S.Bhandar: Cellular Lightweight Concrete Using Fly Ash, The purpose of this experiment study is to identify the performance of cellular light weight concrete in term of density and compressive strength. s a result, compressive strength also decreases with the increment of those voids. Compressive strength of 53 grade cement is slightly higher than 43 grade cement, but as strength increases its density also increases. Cellular light weight concrete is acceptable for framed structure. Cellular light weight concrete can be suitable for earthquake areas.

T. Divya Bhavana: study of light weight concrete, the compressive strength of light weight concrete is lower than the ordinary conventional concrete. Therefore this light weight concrete can be used in places where the external force acting on the structure is minimum. This light weight concrete is only capable to carry its self weight. This light weight concrete has low thermal conductivity and has an ability to absorb sound. So, it can be used for acoustic structures.

Light Weight Aggregate Concrete

Lightweight porous low density aggregate is used in this lightweight concrete instead of regular concrete. Light aggregates can be a natural aggregate such as pumice, slag and all types of volcanic origin and synthetic aggregates such as slag of expanded smelting furnaces, vermiculite and clinker aggregates. The main characteristic of this light aggregate is its high porosity which results in a low specific density.

Light aggregate concrete can be divided into two types depending on the application. One is lightweight partial compressed from concrete and the other is lightweight structural concrete. Partially compact, lightweight aggregate concrete is used for two purposes: pre-cast concrete blocks or panels, roofs and walls on site. The main condition for this type of concrete is that it must have sufficient strength and low density to obtain the best thermal insulation and low shrinkage when drying to avoid cracking.

Structurally lightweight aggregate concrete is perfectly assembled, similar to ordinary reinforced concrete in dense aggregates. It can be used with rebar to have a good bond between steel and concrete. Concrete should provide adequate protection against corrosion of steel. The overall particle shape, texture, and rough nature of fine aggregate tend to produce solid concrete mixtures. Only more dense varieties of light aggregates can be used in concrete construction.

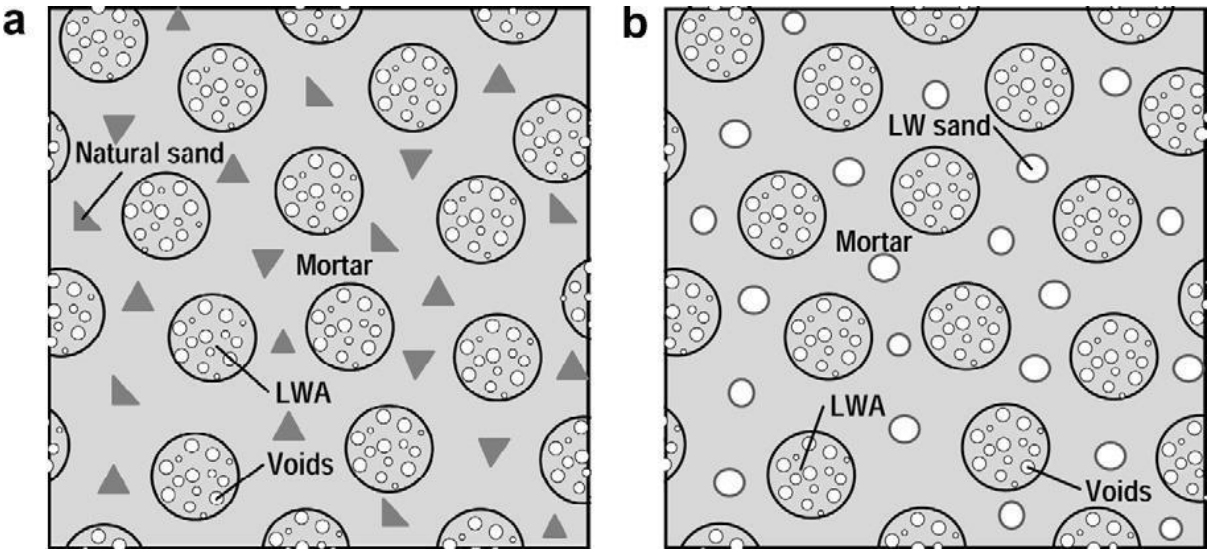


Figure1: Texture comparison of ordinary cement concrete and light weight concrete

Figure 2: Shows the feature of lightweight aggregate concrete

Aerated Concrete

Aerated concrete does not contain coarse aggregates and can be considered a mortar. Usually, aerated concrete is made by inserting air or other gas into the cement and fine sand suspension. In commercial practice, sand is replaced with powdered fuel ash or other silicic materials, and lime can be used in place of cement.

There are two ways to prepare aerated concrete. The first way is to pump the gas into the mixture while the plastic is in it through a chemical reaction. The second method is to enter the air either by mixing the stable foam or through the skin using an air-blocking agent.

The first method is generally used in precast concrete plants, where prefabricated concrete units are sterilized with reasonable strength and low drying shrinkage. The second method is mainly used for on-site concrete, suitable for roofing insulation atoms or pipe insulation. Figure 3 illustrates aerated concrete. For making aerated concrete, foam agents are generally not used, and are expensive enough for small-scale construction operations. Therefore, the method of gas injection is generally more inspiring in building practice.

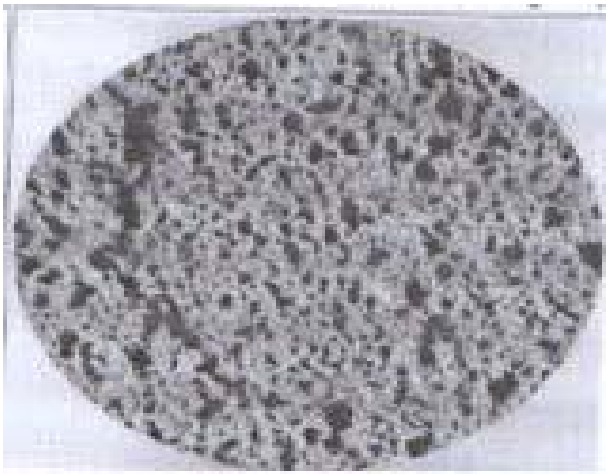


Figure 3: Aerated concrete

Advantages and Disadvantages of Lightweight Concrete :

Advantages	**Disadvantages**
i) rapid and relatively simple construction	i) Very sensitive with water content in the mixtures
ii) Economical in terms of transportation as well as reduction in manpower	ii) Difficult to place and finish because of the porosity and Angularity of the aggregate. In some mixes the cement mortar may separate the aggregate and float towards the surface
iii) Significant reduction of overall weight results in saving structural frames, footing or piles	iii) Mixing time is longer than conventional concrete to assure proper mixing
iv) Most of lightweight concrete have better nailing and sawing properties than heavier and stronger conventional concrete	

Materials & Equipments Used

For the purpose of construction of light weight concrete blocks on a small scale we used locally available materials.

1. Cement
2. Fine Sand
3. Thermocol
4. Concrete Cubical Mould
5. Trowel

Preparation of Materials

First of all the components are cleaned and separated from impurities. The thermocol beans fine aggregate is sieved through IS 4.75 sieve. Finally all the materials are volume batched.

Figure 4: Individual Materials

After all the materials are cleaned then the materials are volume batched with the proportion 1:2:4 where the cement ratio is 1, sand is in ratio 2 & thermocol in ratio 4. The concrete mould or an container can be used as an standard unit for volume batching. After proper proportioning of all the materials they are ready to be mixed.

Mixing

Individual materials are placed on metal sheet or a cleaned floor. If the construction is on a large basis then the mixing will be done in a rotary mixer. As for small scale the mixing is done in a clean area for proper mixing of materials.

Volume Batch Materials

The mixing is carried out with the help of trowels. The thermocol is placed at the bottom then the sand & finally on top cement is placed, thus forming a mountain of materials. Water cement ratio of 40 % is maintained throughout the mixing process. All the materials are thoroughly mixed as to prevent the separation of materials later. Water is added in the centre of the mountain created with materials so that all the water is properly utilized & to prevent the flow of water on the floor.

At the end of mixing the material, the trowels are properly cleaned and the mixture sticked on it is removed.

Figure 5 : Final mixture

Testing Program of Lightweight Concrete

In order to study the behaviour of lightweight concrete, normal concrete testing was done to determine the material and structural properties of lightweight concrete and how will these properties differ according to a different type of mixture and its composition.

Once concrete has hardened it can be subjected to a wide range of tests to prove its ability to perform as planned or to discover its characteristics. For new concrete this usually involves casting specimens from fresh concrete and testing them for various properties as the concrete matures.

The tests are carried out at various days of curing. Generally tests are done on 7th & 28th day of curing the specimen.

Compressive Strength

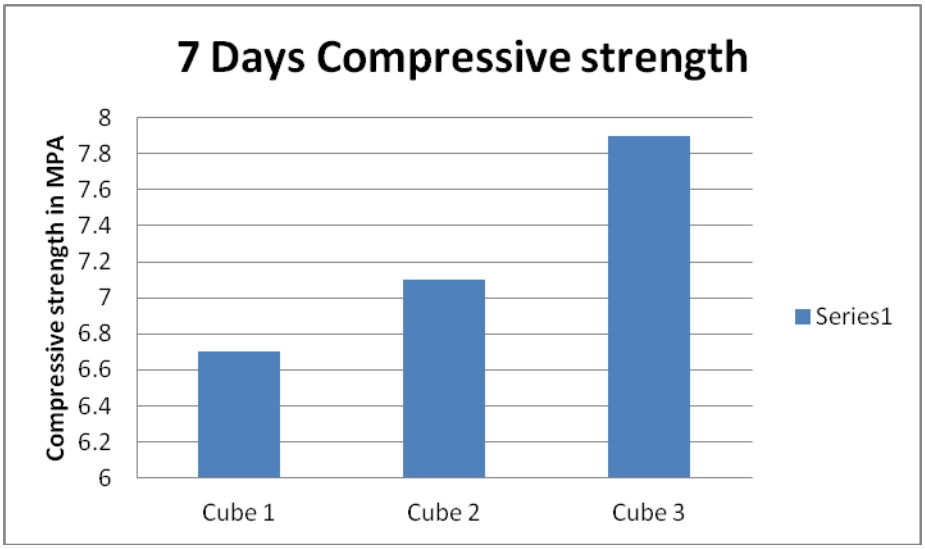
Three test mixtures were prepared during the research and from the results; the mixture with the highest compressive strength and low density will be used for further investigation.

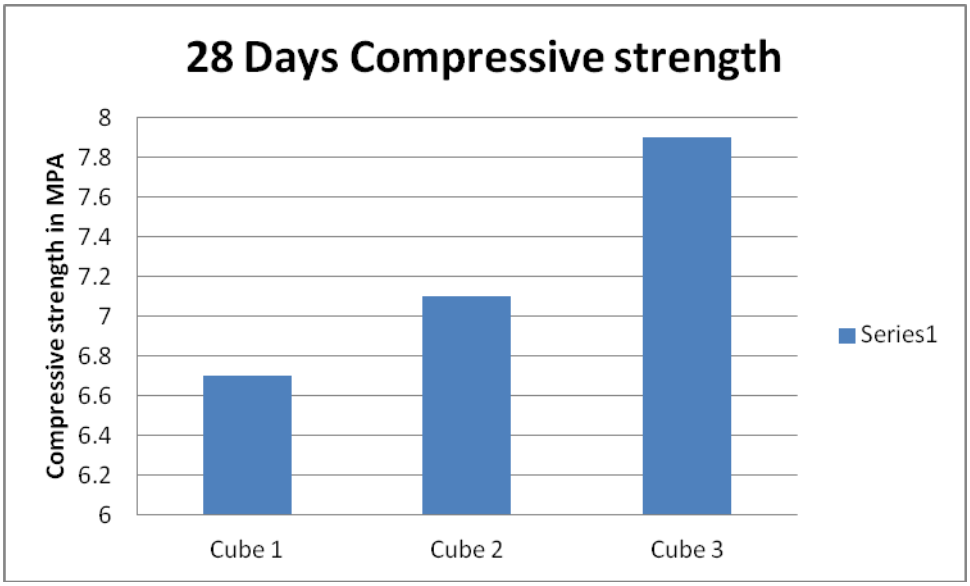
The compressive strength of a lightweight concrete from thermocol is determined within 7 and 28 days for each sample. There are 3–3 samples and the results will be taken as an average of these three. Less variables were assigned to different mixtures. This variable will be adjusted accordingly while other variables are adjusted to predict its effect on the mixture. The variable is the ratio of sandy cement. To find out the effect of the cement sand ratio on the compressive strength, we prepared three mixtures of different cement sand ratios from 1: 2, 1: 3 and 1: 4 accordingly.

Figure 6: Compression Test

Table of Results

SN.	Sample	Compressive strength (N/mm^2) 7 days	Average (N/mm^2)	Compressive strength (N/mm^2) 28 days	Average (N/mm^2)
1	Cube 1	4.3	4.33	6.7	7.2
2	Cube 2	4.1		7.1	
3	Cube 3	4.9		7.9	





Conclusions

Initial results showed that lightweight concrete prepared with thermocol beans has the desired strength as an alternative building material for the building wall.

The resistance to light aerated concrete is only slightly higher. This resulted in an increase in voids during the foam sample. Thus a decrease in the pressure strength of the concrete.

Lightweight concrete can be used as a non-bearing wall because the compressive strength is 30% less than the recommended. However, the compressive strength of its production is accepted as a non-bearing structure. Thermal insulation with lightweight concrete can reduce electricity consumption for cooling and heating. Hence a decrease in CO2 emissions.

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