International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Structural Behaviour of Lightweight concrete with Conventional Concrete

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Accepted 14 April 2016, Available online 16 April 2016, **Vol.6, No.2 (April 2016)**

Abstract

The main objective of this project is to study and analysis of light weight concrete with conventional concrete. The lightweight concrete is produced by mixing air entraining agent Kemilite-pr in conventional concrete in 0%, 10%, 20%, 30% and 20% cement is replaced by fly ash to make it cost effective. The analysis programme focuses on tests such as Compressive test, Flexural test, Split tensile test, Water absorption test, and Density test, Pull out test & Rebound Hammer test (NDT) only. The results obtained are useful to compare the results with that of conventional concrete. The main forte of this concrete is to low density and thermal conductivity. Ultimately there is reduction of dead load, faster building rate in construction and lessen haulage and handling costs

Keywords: *Lightweight concrete, Destructive and Non-destructive test, Compressive test, Water absorption test, Flexural test, Kemilite-PR*

1. Introduction

Since Roman times, Lightweight Concrete and foaming agents have been employed to reduce the weight of concrete. However, unlike these foamed true aerated concrete relies on the alkaline binder (lime & cement) reacting with an acid to release gases, which remain entrained in the material. The first attempt to produce aerated concrete was a method patented by a Czechoslovakian, Mr. E. Hoffman, in 1889 (E. Hoffman, 1889).The first documented attempt at autoclaving aerated concrete was in 1923 in Sweden. The discovery was almost accidental. An architectural science lecturer, Dr. Johan Axel Eriksson, then assistant professor for Building Techniques at the Royal Institute of Technology in Stockholm, was working on a variety of aerated concrete samples.

Eriksson patented his 'gas concrete', known locally as 'porenbetong', in 1924. It took a few years for him to find a manufacturer prepared to invest in a plant and in November 1929, Y-TONG was first licensed and manufactured by building product producer, Karl August Carlen, in the town of Yxhult, Sweden. Y-Tong is an abbreviation of the town's name and the Swedish word for concrete- 'betong'. This plant was operational until the late 1960's. The development of an autoclaved aerated concrete industry, using local raw materials, began producing what were known as 'warm stones' due to the thermal resistivity provided by the aerated material Lightweight concrete can be defined as a type of concrete which includes an expanding agent (Here Kemilite-PR) in that it increases the volume of the mixture while giving additional qualities such as lessened the dead weight. It is lighter than the conventional concrete.

The use of lightweight concrete has been widely spread across countries such as USA, United Kingdom and Sweden. The main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages are that there is a reduction of dead load, faster building construction and lower haulage and handling costs. Therefore, this fundamental research report is prepared to show activities and progress of the lightweight concrete. Focused were on the performance of lightweight concrete such as compressive strength tests, water absorption and density and supplementary tests and comparisons made with other types of lightweight concrete.

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 Categories as

i) No-fines concrete
ii) Lightweight aggregate concrete
iii) Aerated/Foamed concrete

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2. Literature Review

1) Dipanjan Mukherjee, Low cost light weight concrete making by using waste materials, Global Journal of Engineering Science and Research Management [Mukherjee, 1(6): October, 2014] ISSN: 2349-45065518

This paper discusses about a very simple lab experiment of light weight concrete making. A concrete cube is prepared by using sand, cement, water, over burnt brick bats & fly ash. Fly ash is used as a cement replacement and over burnt brick bat is used as a coarse aggregate. Both fly ash & over burnt brick bats are considered as waste materials of thermal power plant & construction sites. Mix design is done for M20 grade of concrete As per IS 10262-2009. Finally it was seen that 16.67% reduction of weight without increase the cost. It was also seen that for M20 grade of concrete it provides 94.9% strength at 28 days compression test. This is quite significant & this ordinary mix design also gives satisfactory performance of lightweight concrete cube making.

2) Properties of Aerated (Foamed) Concrete Blocks by (Prakash T M Naresh kumar B G Karisiddappa Raghunath S) from International Journal of Scientific & Engineering Research Volume 4, Issue 1, January-2013, ISSN 2229-5518

The quest for finding a light weight material as a re-placement for conventional masonry units has been there since nearly three decades. In India, over the past two decades a significant time has been utilized for making at- tempts to promote Aerated Concrete Blocks (ACB) as an alter-native to the conventional masonry units. Alongside with this growth of development of manufacture of Aerated concrete blocks, concrete industry has seen a small but significant growth in usage of Aerated (foamed) concrete blocks. Simultaneously, there has been a very significant change in the replacement of burnt clay bricks by concrete masonry units. It appears that the usage of Aerated concrete block masonry may become more common in the coming years. Many structures, not only in urban and semi-urban regions, but also in rural regions of India have started using concrete masonry units in place of the traditional bricks. The use of Aerated concrete blocks as a load-bearing masonry unit, at present, is very much limited, in the Indian context. Only recently in a very few reinforced concrete framed buildings, Aerated concrete block masonry is used in place of conventional masonry in-fill.

3) Cellular Light-Weight Concrete Blocks as a Replacement of Burnt Clay Bricks by K.Krishna Bhavani Siram ; International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-2, December 2012

Global warming and Environmental pollution is now a global concern. Cellular Light Weight Technology blocks can be used as an alternative to the red bricks, to reduce Environmental pollution and Global warming. CLC blocks are environment friendly. The energy consumed in the production of CLC blocks is only a fraction compared to the production of red bricks and emits no pollutants and creates no toxic products or by products. It is produced by initially making slurry of Cement + Fly Ash + Water, which is further mixed with the addition of pre-formed stable foam in an ordinary concrete mixer under ambient conditions.

Concluding Remark

From literature work, the structural performance of Light weight concrete with respect to conventional concrete has not studied, so I have decided to study structural behaviour of Light weight concrete with replacement of cementatition material as Fly ash with respect to cement & Foam.

3. Outline of Proposed Work

Materials Used

Light weight concrete is produced by the combination of Portland cement, coarse aggregate, sand, fly ash, potable water and appropriate aerating agent (Kemilite-PR-Protein Based Foaming Agent).

For preparation of light weight concrete M30 mix is used. In this mix 20% fly ash used to replace cement and is decided by referring research paper and variable % of Kemilite that is 0%, 10%, 20%, 30% mix in concrete to produce a light weight concrete.

Testing Program of Lightweight Concrete

In order to study the behaviour of lightweight concrete, normal concrete testing will be done to determine the material and structural properties of each type 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.

4. Test

1) Destructive Test- Compressive Strength, Water Absorption, Density
2) Non-Destructive Test- Pull out Test, Rebound Hammer Test

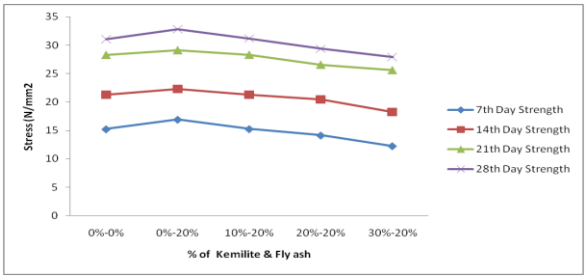
5. Test Results

The project is going to focus on performance of Lightweight Concrete in relation to compressive strength, density and water absorption at this stage for

different mixes of Kemilite in Light Weight Concrete. In future flexural strength and split tensile test will perform on beams and cylinders. The result obtained is as following

1) Compressive strength test

For compressive strength test three blocks for each percentage from 7 to 28 days and tested on compression testing machine and result obtained by average of three blocks. They are shown in following graph



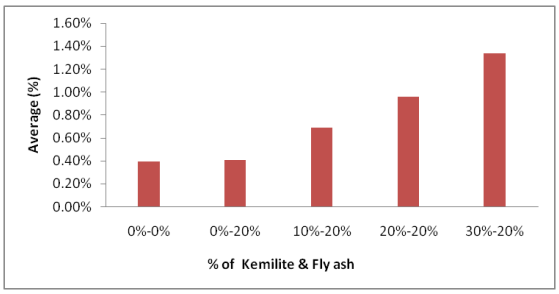
Graph 1: Compression Test Result

2) Water absorption test

Water absorption test is taken on last three blocks of 28th days and average percentage finds out to calculate result of water absorption test.

Table 2: % of water absorption for different % of Foam

% of Kemilite & Fly ash	Average (%)
0%-0%	0.40 %
0%-20%	0.41 %
10%-20%	0.69 %
20%-20%	0.96 %
30%-20%	1.34 %

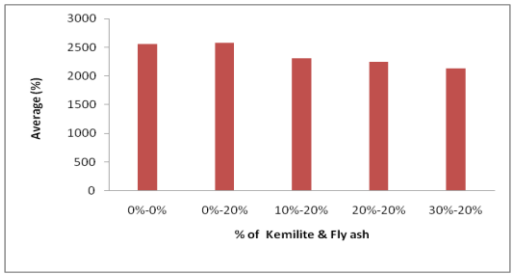


Graph 2: Water Absorption Test Result

3) Density

Table 3: Density obtained for different % of Foam

% of Kemilite	0%-0%	0%-20%	10%-20%	20%-20%	30%-20%
Density (Kg/m3)	2560	2571	2302	2240	2136



Graph 3: Density Test Result

4) Non Distructive Test of Concerte

Non-destructive tests are the representation of relation between the property of structure which is being tested and the strength of test specimen. These tests are usually done in case of disputes between the parties which are involved in construction of any type of structure. Clients usually ask to conduct the test of strength of concrete which is being used in the structure.

The most common tests which are usually conducted are:

I) Pull out Test-This test measures the strength of specimen by means of special tension jacks that are usually used to be inserted in test specimen.

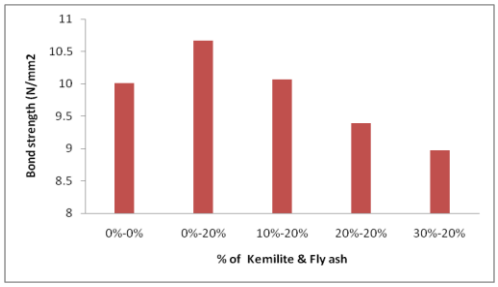
II) Rebound Hammer Test-It is one of the oldest non-destructive tests. This test is widely used because of its economical procedure

I) Pull out Test

This Indian Standard (Part I) was adopted by the Indian Standards Institution on 20 November 1967, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council. This part deals with the method for comparison of the bond resistance of different types of reinforcing bars with concrete by pull-out test.

Table 4: Result of Pull out test of concrete after 28th days

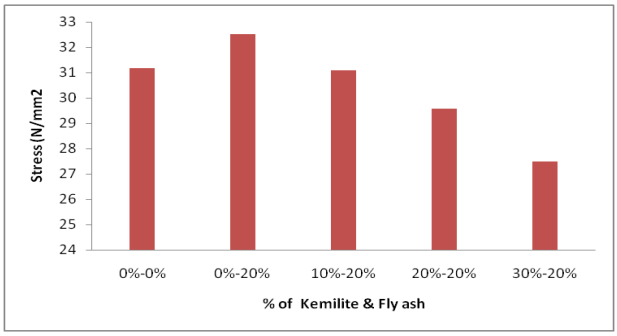
% of Kemilite & Fly ash	0%-0%	0%-20%	10%-20%	20%-20%	30%-20%
Bond strength(N/mm2)	10.01	10.67	10.07	9.39	8.97



Graph 4: Result of Pull out test of concrete

II) Rebound Hammer Test

Rebound hammer test is done to find out the compressive strength of concrete by using rebound hammer as per IS: 13311 (Part 2) – 1992. The rebound of an elastic mass depends on the hardness of the surface against which its mass strikes. When the plunger of the rebound hammer is pressed against the surface of the concrete, the Spring-controlled mass rebounds and the extent of such a rebound depends upon the surface hardness of the concrete. The surface hardness and therefore the rebound are taken to be related to the compressive strength of the concrete. The rebound value is read from a graduated scale and is designated as the rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.



Graph 5: Result of Rebound Hammer Test

Conclusion

According to results we conclude that we can economize the cost of construction without compromising with quality of concrete by replacing 20% cement with fly ash.

Total cost saving for 1 $m^3$of Lightweight concrete is reduced with compared to conventional concrete. This should lead to increased utilization of lightweight concrete for reduction of dead load, faster building rate in construction and lessen haulage and handling costs.

Light weight concrete sample of 10% kimlite-20%fly having density 2302kg/m^3 which is 258 kg/m^3 less than conventional concrete and showing comparatively equal strength to the conventional concrete.

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IS: 383-1970, Specification for coarse and fine Aggregate from Natural Sources.

IS: 10086-1982, Specification for moulds for use in tests of cement and concrete.

IS: 456-2000, plain and reinforced concrete - code of practice.

IS: 6042-1969, Code of practice for construction of Lightweight concrete blocks masonry

IS: 5816-1999, splitting tensile strength of concrete method.