Experimental Study on Light Weight Concrete by using LECA and Fly ash

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***Abstract*— This report presents experimental study on effect of partial replacement of coarse aggregate (Jelly) by Light weightcoarse aggregate (LECA). LECA is also more or less similar to properties of Jelly. LECA is used in concrete to minimize the demand of coarse aggregate (Jelly) and also in design of concrete structures, self-weight occupies very large portion of total load coming on the structures critically in cases such as weak soils and tall structures also, impressive benefits in lessening density of concrete, thus contributing towards economy of work. The light weight concrete gives low density than conventional concrete and has better thermal insulation comparatively. Main intention of carrying out this project is to compare the weight of concrete and strength properties viz. cube compressive strength, split tensile stremgth and flexural strength of light weight concrete against conventional concrete by partially replacing natural aggregates by LECA by 25 percentage, 35 percentage and replacing cement by flyash by 20 percentage. Lightweight aggregate has been effectively utilized for well more than two millennia and use of lightweight total adds to the maintainable advancement by moderating energy. Bringing down transportation prerequisites, boosting outline and construction proficiency and expanding the service life of the item it is utilized as a part of with expanding concern over the intemperate abuse of common aggregates, lightweight aggregate delivered artificially is a feasible new resource of structural aggregate objects.**

Keywords*— *LECA, Fly ash, Compressive strength, Flexuralstrength, split tensile strength.

I. INTRODUCTION

In the recent construction industry, even though we are practicing with different composite materials concrete plays a major role in the construction sector. Concrete is a building material. consisting of the cement, fine aggregate and coarse aggregate. the ingredients of concrete, coarse aggregate imparts greater volumetric stability and durability to concrete [1].

Lightweight concrete mixture is made with a lightweight coarse aggregate and sometimes a portion or entire fine aggregates may be lightweight instead of normal aggregates. Lightweight concrete can produce in three different methods those are foam concrete, lightweight aggregate concrete, and no fine concrete [2].

Replacing LECA aggregate with coarse aggregate decreases the self-weight of the concrete and results in decreasing the self-weight of building [1].

II. OBJECTIVES

- To reduce the self-weight of the concrete.
- To develop a lightweight concrete using LECA as aggregates in addition with fly ash.
- The focus was on to develop the Light weight concrete with good strength.
- To compare compressive strength of normal concrete mix at curing period 28 days with usage of LECA and fly ash mix.
- To compare Flexural strength of normal concrete mix at curing period 28 days with usage of LECAand fly ash mix.
- Construction of eco-friendly and sustainable construction.

III. MATERIALS USED

A. Cement

Cement is a binder, a substance that sets and hardens independently, and can bind other materials together. Cement is generally graded according to a few sets ofspecifications defined IS 650:1996. For this studyLocally available Birla Ordinary Portland Cement of OPC 53 Grade was used.

B. Fine aggregate

The locally available natural river sand is procured and is found to be conformed to grading zone-II of Table of IS 383-1970. Various tests have been carried out as per the procedure given in IS 383(1970) from them it is found that.

- Specific Gravity of fine aggregate is 2.46.
- Fineness Modulus of Fine Aggregate is 2.72.

C. Coaarse aggregate

Machine Crushed granite aggregate confirming to IS 383-1970 consisting 20 mm maximum size of aggregate has been obtained from the local quarry. It has been tested for Physical Properties.

- Specific Gravity of coarse aggregate is 2.73.

- Water absorption is 4.71 percentage.

D. LECA

It is abbreviated as LIGHT WEIGHT EXPANDED CLAY AGGREGATES. It is the special type of aggregate (sp gravity-0.643) which are formed by pyroclastic process in rotary kiln at very high temperature. LECA is non- Destructible, non-combustible & impervious to attack by dry-rot, wet-rot & insects.

E. Flyash

Flyash is the by-product from the coal combustion which is composed of fine particles of burned fuel also known as pulverized fuel ash. The properties and chemical composition of flyash depends on the source and composition of coal during burning.

IV. METHODOLOGY

The raw materials are firstly cleaned such that it should be freefrom impurities and then they are subjected to the basic tests. Based on the appropriate water cement ratio the mix designs are obtained for m30 grade concrete as per the codal provisions. For the obtained mix design the conventional aggregates is partially replaced by LECA in 25 and 35 percentages. The fresh concrete, slump test is carried for each proportion. For each blended proportioned percentage the cubes, beams and cylinders are casted in order to determine hardened properties of concrete. The above specimens are keptfor curing for 28days and then the test results are determined.

A. MIX DESIGN

Concrete specimens casted using M30 grade of concrete designed as per IS 10262: 2009. Mix ratio obtained are as follows

- For conventional concrete is 1:1.617:2.35 (Cement: FA: CA).
- For light weight concrete by replacing 25 percentage of coarse aggregate by leca is 1:1.383:1.959:0.159(Cement: FA: CA: Leca).
- For light weight concrete by replacing 25 percentage of coarse aggregate by leca is 1:1.383:1.699:0.224(Cement: FA: CA: Leca).

V. RESULT AND DISCUSSION

The mechanical properties of concrete are determined byvarious tests as follows;

1) Compressive strength of concrete.
2) Split tensile strength of concrete.
3) Flexural strength of concrete.

A. Compressive strength

For each concrete mix, the compressive strength is determined on 150×150×150 mm cubes at 28 days of curing.

Following tables give the compressive strength test resultsof conventional concrete and light weight concrete with variouspercentages of Leca.

TABLE I. COMPRESSIVE STRENGTH

Mix Designation	Curing period	Compressive strength (N/mm^2)	Avg Compressive strength (N/mm^2)
M30 (conventional concrete)	28 days	32.35	31.52
		30.66	
		31.55	
M30 (adding 25% Leca)	28 days	28.88	29.58
		29.2	
		30.67	
M30 (adding 35% Leca)	28 days	24.44	24.84
		24.75	
		25.33	

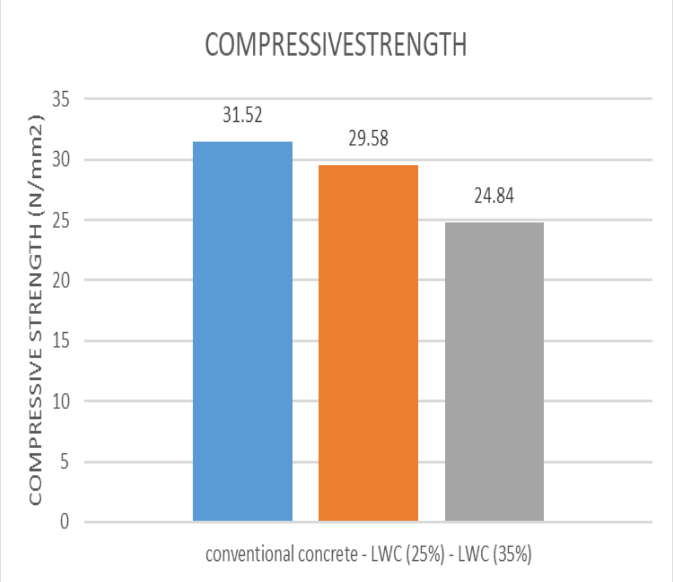

Fig. 1. Compressive strength comparison between conventional concrete and light weight concrete with 25 percentage and 35 percentage of partial replacement of coarse aggregate by leca.

The above graph indicates the bar chart of compressive strength between conventional concrete and light weight concrete with partial replacement of coarse aggregate by LECA. It can be clearly seen that compressive strength of conventional concrete is found to be 31.52 N/mm2, similarly compressive strength of light weight concrete with 25% and

35% replacement of coarse aggregate by leca is found to be 29.58 N/mm2 and 24.84 N/mm2 respectively.

Fig. 2. Compressive strength testing machine

B. Split tensile strength

Test has been conducted after 28 days of curing. Split tensile test is conducted on 150 mm diameter and 300 mm length cylinders as per IS 5816-1999.

Following tables give the Tensile strength test results of conventional concrete and light weight concrete with various percentages of Leca.

TABLE II. SPLIT TENSILE STRENGTH

Mix Designation	Curing period	Compressive strength (N/mm^2)	Avg Compressive strength (N/mm^2)
M30 (conventional concrete)	28 days	32.35	31.52
		30.66	
		31.55	
M30 (adding 25% Leca)	28 days	28.88	29.58
		29.2	
		30.67	
M30 (adding 35% Leca)	28 days	24.44	24.84
		24.75	
		25.33	

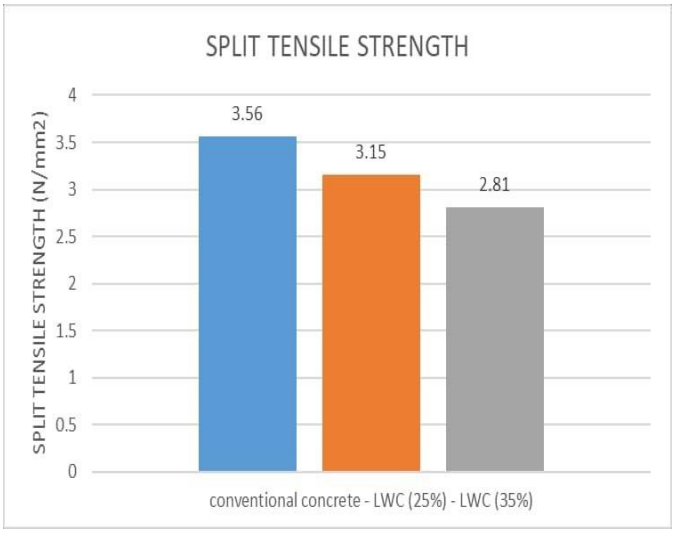

Fig. 3. Split tensile strength Comparison between conventional concrete and light weight concrete with 25 percentage and 35 percentage of partial replacement of coarse aggregate by leca.

The above figures indicates the bar chart of split tensile strength between conventional concrete and light weight concrete with partial replacement of coarse aggregate by LECA. It can be clearly seen that split tensile strength ofconventional concrete is found to be 3.56 N/mm2, similarly compressive strength of light weight concrete with 25% and 35% replacement of coarse aggregate by leca is found to be 3.15 N/mm2 and 2.81 N/mm2 respectively.

Fig. 4. Split tensile strength testing

C. Flexural strength

Test has been conducted after 28 days of curing. Split tensile is conducted on 500×100×100mm specimens at 7days of curing.

Following tables give the Tensile strength test results of conventional concrete and light weight concrete with various percentages of Leca.

TABLE III. FLEXURAL STRENGTH

Mix Designation	Curing period	Flexural strength (N/mm^2)	Avg Flexural strength (N/mm^2)
M30 (conventional concrete)	28 days	8.2	7.69
		7.6	
		7.29	
M30 (adding 25% Leca)	28 days	5.45	5.53
		5.77	
		5.38	
M30 (adding 35% Leca)	28 days	5.77	4.93
		4.18	
		4.86	

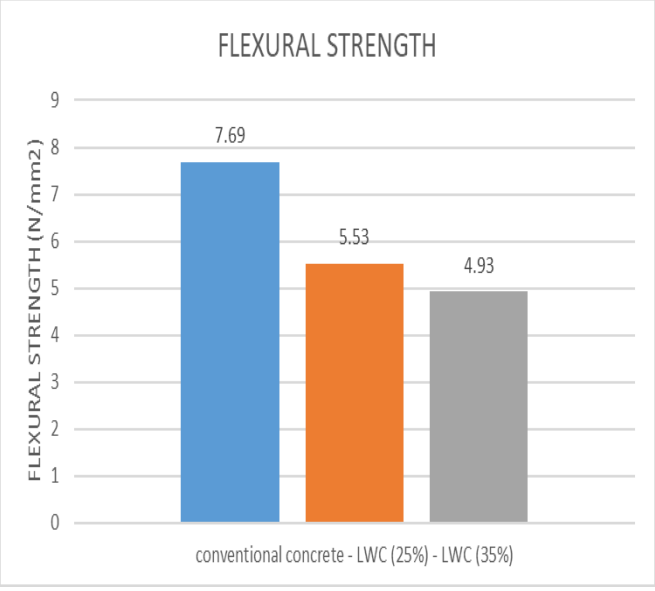

Fig. 5. Flexural strength Comparison between conventional concrete and light weight concrete with 25 percentage and 35 percentage of partial replacement of coarse aggregate by leca.

The above figures indicates the bar chart of flexural strength between conventional concrete and light weight concrete with partial replacement of coarse aggregate by LECA. It can be clearly seen that flexural strength of conventional concrete is found to be 7.69 N/mm2, similarly compressive strength of light weight concrete with 25% and 35% replacement of coarse aggregate by leca is found to be
5.53 N/mm2 and 4.93 N/mm2 respectively.

Fig. 6. Flexural strength testing

A.TESTS ANALYSIS

- The compressive strength of conventional concrete after 28 days of curing is found to be 31.52 N/mm2.
- Similarly the compressive strength of light weightconcrete (LECA25%) and (LECA35%) is found to be
  29.58 N/mm2 and 24.84 N/mm2 respectively.
- The compressive strength of conventional concrete, light weight concrete (LECA25%) and light weight concrete (LECA35%) is found to be 31.52 N/mm2,
  29.58 N/mm2 and 24.84 N/mm2 respectively.
- The split tensile strength of conventional concreteafter 28 days of curing is found to be 3.56 N/mm2.
- Similarly the split tensile strength of light weight concrete (LECA25%) and (LECA35%) is found to be
  3.15 N/mm2 and 2.81 N/mm2 respectively.
- The split tensile strength of conventional concrete, light weight concrete (LECA25%) and light weight concrete (LECA35%) is found to be 3.56 N/mm2,
  3.15 N/mm2 and 2.81 N/mm2 respectively.
- The flexural strength of conventional concrete after 28 days of curing is found to be 7.69 N/mm2.
- Similarly the flexural strength of light weight concrete (LECA25%) and (LECA35%) is found to be 5.53 N/mm2 and 4.93 N/mm2 respectively.
- The flexural strength of conventional

concrete, light weight concrete (LECA25%) and light weight concrete (LECA35%) is found to be 7.69 N/mm2,
5.53 N/mm2 and 4.93 N/mm2 respectively.

- The mechanical properties of light weight concrete is gradually decreasing as we increase the percentage of replacement of coarse aggregate because the light weight aggregate have low specific gravity than conventional aggregates.

VI. CONCLUSION

- Leca can be used as a light weight aggregate in replacement of normal conventional aggregate.
- By using 25% of LECA as a partial replacement to normal convential aggregate compressive strength is promising.
- The density of concrete is found to decrease with the increase in percentage replacement of normal aggregate by leca.
- The light weight aggregate is having good interlocking bonds between the particles so therefore it is structurally sound.
- Increasing the percentage of light weight aggregate decreases the overall mass of the structure.
- The structural lightweight concrete is a sustainable material as the aggregate used is economical when compared to coarse aggregate and it is extensively used in agriculture usage.

VII. SCOPE OF THE FUTURE WORK

- In the present study M30 grade concrete was considered. The present work can be extended to higher grades.
- In the present study we have replaced 25% and 35% percent of normal coarse aggregate by light weight expanded clay.
- The use of light weight aggregate is not highlighted in the construction industry; hence the use of LECA canbe a solution.
- The low-density concrete would be used only for filling the areas in the construction industry, but a more in detail study and tests performed can lead to a new Invention to the present trend.
- The use of different light weight aggregates in the production of light weight concrete can be an effective measure to the construction industry and to Concrete Technology.

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