International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.8, pp 98-109, 2017

Experimental Study On Light Weight Concrete Using Leca

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Abstract : This report presents experimental study on effect of partial replacement of coarse aggregate (Jelly) by Light weight coarse 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 strength cylinders and flexural strength of light weight concrete against conventional concrete by partially replacing natural aggregates by LECA by 20%, 40%, 60%, 80% and 100%. 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, Compressive strength, Tensile strength, Flexural strength.

1.0 Introduction

Light Weight Concrete is produced using light weight aggregates. For the most part light weight concrete is not as strong as concrete made with typical aggregates. It is in this way typically utilized when the lightness of the concrete is useful and when high quality is not needed. Because of high self weight of traditional concrete with ordinary aggregates, a few endeavours have been made in the past to decrease the self weight of concrete called light weight concrete which is lighter than the conventional concrete made with typical weight aggregates[3,6]. There are numerous favourable circumstances of light weight concrete over the typical concrete, one of them being its low density of concrete aides in decrease of dead load. As officially clarified it is more obliged where lightness is more imperative than the strength, for instance for developing elevated structures. It might likewise be utilized as a part of concrete curve spans, where the dead weight of the concrete makes a noteworthy commitment to the loads thus the strength/weight proportion is imperative instead of without a doubt the concrete strength. Another element for utilizing light weight concrete may be its low warm conductivity, which comes about because of its high void substance. Since the strength is affected fundamentally by the coarse aggregates while the workability depends basically on the fine aggregates, concrete is some of the time made with ordinary weight fine aggregates and light weight coarse aggregates. Usually light weight aggregates must be wetted for 24 hours prior to utilize.

Air entrainment is frequently utilized as a part of light weight concrete to reduce the density, to enhance workability, to enhance imperviousness to frost and to lessen warm conductivity[7,8]. Especially if ordinary weight aggregates is utilized for the fine aggregates, air entrainment likewise serves to balance the densities of the cement/fine aggregates glue and of the coarse aggregates thus lessens the tendency of the coarse aggregates to float to the top point of concrete.

It is extremely hard to deliver steady light weight concrete. One specific issue is that numerous light weight aggregates absorb water quickly. It is undesirable to utilize aggregates in the immersed, surface-dry condition subsequent to the water substance of the aggregates should be minimized with a specific end goal to keep the concrete density low[1.4]. For the most part dry aggregates are utilized. Furthermore, the amount of water consumed by the aggregates in the time in the middle of blending and setting of the concrete, which will differ generally as indicated by conditions, must be assessed.

Light weight concrete has turned out to be more famous in the late years attributable to the tremendous points of interest it offers over the normal concrete. Advanced innovation and a superior comprehension of concrete have likewise helped much in advancement and utilization of light weight concrete. Uncommon sort of light weight concrete, however in the meantime sufficiently strong to be utilized for the structural purposes. This sort of concrete has extraordinary future in the years to come.

The main objective of this project is to study the different strength parameters like compressive, tensile, flexural strength, Comparing Density of conventional concrete with light weight concrete for M20 grade of concrete and also study the workability characteristics of concrete.

2.0 Materials and its Properties

2.1 LECA :

The abbreviation of LECA is Light weight expandable clay aggregate. LECA is produced of clay with poor lime content, which is dried and fired in rotary kilns. The kilns shape the clay into pellets and at a temperature of 1.150 ºC gas is formed. The gas expands the pellets resulting in high porosity and low weight properties. The porosity is caved in by a matrix of solid bricklike ceramic material with high compressive strength. The porosity is partly open and allows water to penetrate into the LWA. The LWA particles absorbs about 5-10% water after one hour and the long time absorption is 50-100% water by weight measured as increase of bulk density when immerged in water.

When absorbing water contained air is evacuated from the porosity of the LWA. The water absorption for LWA in LWAC is somewhat lower than the values presented above. As a general guide 90% of one hour LWA absorption in water may be used as the total absorption in fresh state LWAC. Exact water absorption characteristics are declared by the manufacturer for each product.

The advantages by using clay as a source material instead of shale and other raw materials are the ability for the manufacturer to decide the density of the LWA. maxit Group is today manufacturing LWA at 10 plants in Europe. The standard LWA has a bulk density at 250350 kg/m3 and a corresponding particle density at 450-550 kg/m3.

Some factories can produce higher density material with considerably higher particle strength with bulk density up to 800 kg/m3. In general, the particle strength is dependent by the particle density. A high density LECA has a considerably higher strength than a low density material when manufactured at the same site and with the same raw materials. The LWA surface is rough and porous and fresh cement paste bonds very well to the surface resulting in excellent surface interaction properties.

Table 1-Physical properties of LECA

Sl.no	Property	Value
1	Specific gravity	0.56
2	Water absorption	18%
3	Impact value	49.68%

2.2 Cement :

Cement is a binder, a substance that sets and hardens and can bind other materials together. Though all cement conforming to various IS code are suitable, selection of cement should be based on their compressive strength, fineness and compatibility with other ingredients. Cements of various strength are available. The strength of cement decides the target strength of concrete. Fineness or particle size of Portland cement affects rate of hydration, which is responsible for the rate of strength gain. Approximately 95% of cement particles are smaller than 45 micron with the average particle size about 15 microns. Here OPC 53 grade cement is used.

Table 2 -Physical properties of cement

Sl.no	Property	Value
1	Specific gravity	2.45
2	Water absorption	0.97%
3	Fineness modulus	3.44
4	Crushing value	12.40%
5	Impact value	12.50%
6	Abrasion value	14.5%
7	Flakiness index	35.85%
8	Elongation index	45.45%

Sl.no	Property	Value
1	Normal consistency	36%
2	Initial setting time	30 minutes
3	Final setting time	8 hours
4	Specific gravity	3.30
5	Fineness of cement	3%

2.3 Fine aggregate

Sand is an extremely needful material for the construction but this important material must be purchased with all care and vigilance. Sand which is used in the construction purpose must be clean, free from waste stones and impurities. An examination should be made on the fineness of the available sands and depending on its fineness, it should then be planned to be used for the different purpose of the construction.

Table 3 -Physical properties of Fine Aggregate

Sl.no	Property	Value
1	Specific gravity	2.21
2	Water absorption	0.75%
3	Bulking of sand	11.9%
4	Fineness modulus	2.57

Table 5- Mix design and Mix proportion for conventional M30 grade concrete

Water	Cement	Fine Aggregate	Coarse Aggregate
186litres	413.33 Kg/m^3	593.85 Kg/m^3	1029.71 Kg/m^3
0.45	1	1.43	2.49
Mix Design for M30 Grade Concrete 1 : 1.43 : 2.49			

2.4 Coarse aggregate

Coarse aggregate are used for making concrete. They may be in the form of irregular broken stone or naturally occurring gravel. Material which are large to be retained on 4.75mm sieve size are called coarse aggregates. Its maximum size can be up to 63mm.

2.5 Water

Water is an important ingredient of concrete as it actively participates in chemical reaction with cement. This is the least expensive but most important ingredient of concrete. Clean potable water conforming to IS: 456-2000 was used; the water used in the preparation of mortar should not need to be distilled water, but must be free of all acids and other dissolved salts. A lower water-to-cement ratio yields a stronger, more durable concrete, whereas more water gives a freer-flowing concrete with a higher slump.

3.0 Concrete Mix Design

In this study M30 concrete was used, the concrete mix design for standard conventional concrete is done by using IS 10262:2009 and that for light weight concrete using LECA by ACI 211.2-98 as mix design is not available light weight concrete for higher grade concrete.

Table 6 - Mix design and Mix proportion for light weight concrete using LECA

Water	Cement	Fine Aggregate	LECA aggregate
340 liters	708.33 lb/yd^3	883.48 lb/yd^3	758.19 lb/yd^3
340 liters	420.25 Kg/m^3	524.16 Kg/m^3	449.83 Kg/m^3
0.45	1	1.24	0.63
Mix Design for light weight M30 Grade Concrete = 1 : 1.24 : 0.63			

4.0 Results and Discussions

Cubes and cylindrical specimens were tested for compressive strength in the Compression testing machine of capacity 2000KN.The cylindrical specimens also were tested to determine split tensile strength. The prism specimens were tested in Universal testing machine of capacity 2000KN.An average of three specimens was tested for each strength tests.

4.1 Compressive strength test

Tests Results of Cube compressive strength are listed in table.

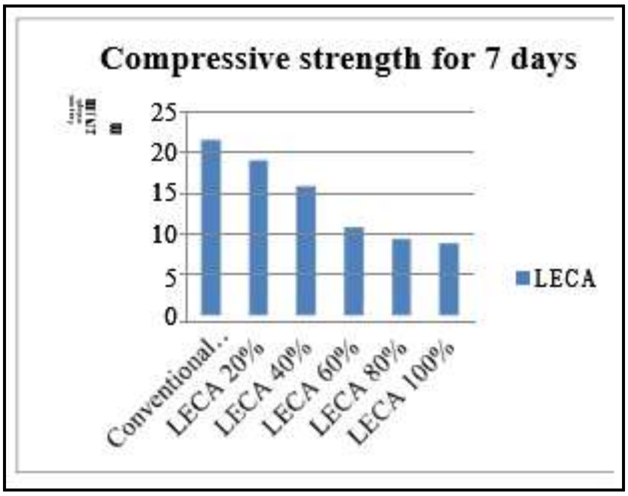
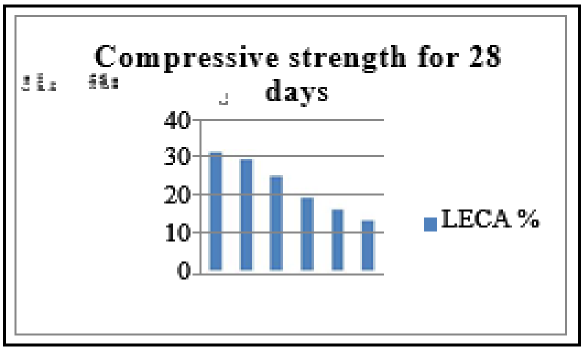


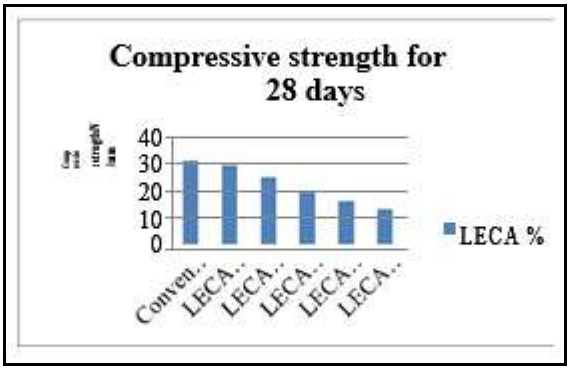
Table 7- Compressive strength of cubes in N/mm^2 at 7 days

S.No.	Type of concrete	Compressive strength in N/mm^2	Weight of cube in Kg
1.	Conventional concrete	21.47	8.3
2.	Concrete with 20% LECA	19.03	7.5
3.	Concrete with 40% LECA	15.86	7
4.	Concrete with 60% LECA	10.75	6.4
5.	Concrete with 80% LECA	9.42	5.8
6.	Concrete with 100% LECA	8.77	5.1

Table 8 - Compressive strength of cubes in N/mm^2 at 28 days

S.No.	Type of concrete	Compressive strength in N/mm^2	Weight of cube in Kg
1.	Conventional concrete	31.58	8.4
2.	Concrete with 20% LECA	29.85	7.1
3.	Concrete with 40% LECA	25.40	6.9
4.	Concrete with 60% LECA	19.64	6.5
5.	Concrete with 80% LECA	16.28	5.2
6.	Concrete with 100% LECA	13.37	5





4.2 Split tensile test :

Tests Results of Split tensile strength are shown in table

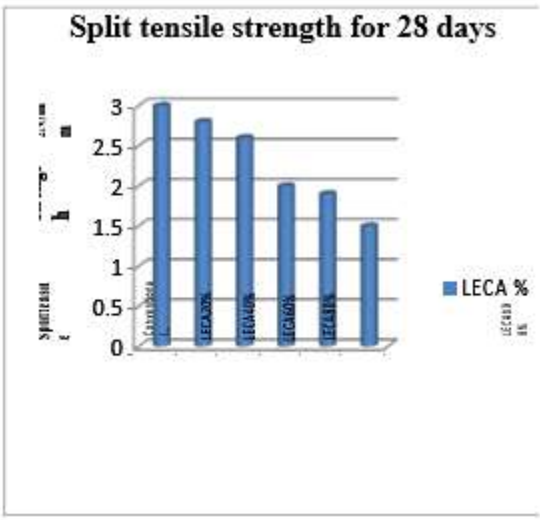
Table 8 -Split tensile strength at 7 days in N/mm^2

S.No.	Type of concrete	Split tensile strength in N/mm^2
1.	Conventional concrete	2.7
2.	Concrete with 20% LECA	2.5
3.	Concrete with 40% LECA	2.2
4.	Concrete with 60% LECA	1.8
5.	Concrete with 80% LECA	1.5
6.	Concrete with 100% LECA	1.2

Split tensile Strength Results at 7 days

Table 9-Split tensile strength at 28 days in N/mm^2

S.No.	Type of concrete	Split tensile strength in N/mm^2
1.	Conventional concrete	3.0
2.	Concrete with 20% LECA	2.8
3.	Concrete with 40% LECA	2.6
4.	Concrete with 60% LECA	2.0
5.	Concrete with 80% LECA	1.9
6.	Concrete with 100% LECA	1.7



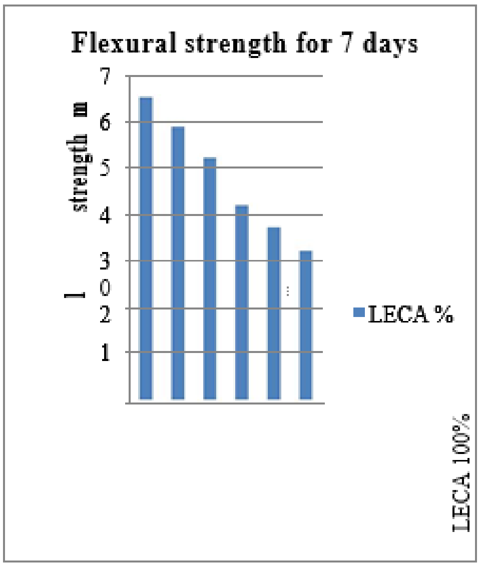
Split tensile Strength Results at 28 days

4.3 Flexural strength

Tests Results of Flexural strength are shown in table

Table 10 - Flexural strength at 7 days in N/mm^2

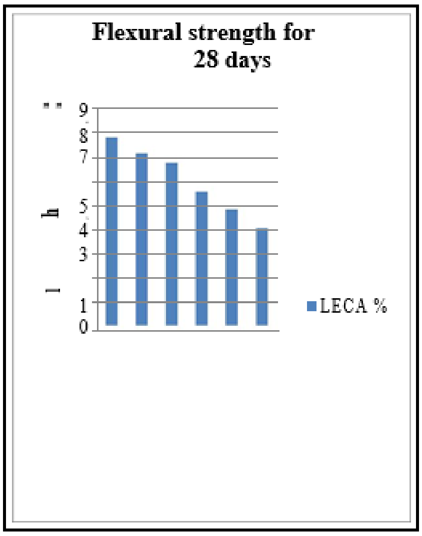
S.No.	Type of concrete	Flexural strength in N/mm^2
1.	Conventional concrete	6.58
2.	Concrete with 20% LECA	5.94
3.	Concrete with 40% LECA	5.26
4.	Concrete with 60% LECA	4.23
5.	Concrete with 80% LECA	3.75
6.	Concrete with 100% LECA	3.24



Flexural Strength Results for 7 days

Table 11 - Flexural strength at 28 days in N/mm^2

S.No.	Type of concrete	Flexural strength in N/mm^2
1.	Conventional concrete	7.83
2.	Concrete with 20% LECA	7.14
3.	Concrete with 40% LECA	6.76
4.	Concrete with 60% LECA	5.55
5.	Concrete with 80% LECA	4.81
6.	Concrete with 100% LECA	4.04



Flexural Strength Results for 28 days

5.0 Conclusion:

The main aim of the project is to reduce the weight of the concrete. from the above report we can achieve a compressive strength of 29.85 N/mm^2 at 20% LECA replaced and also achieve 25.40 N/mm^2 at 40% LECA replaced to normal coarse aggregate when cured at 28 days and also we can see a mere improvement in compressive strength if cured like 60 days and more with which we can manage the compressive strength. By reducing the weight of concrete we can reduce the dead weight of concrete and reduce the construction cost by reducing the cost spend on foundation. There is reduction in density of light weight aggregate concrete using LECA as compared to conventional concrete.

The Workability of LWAC gets considerably increased when LECA is used as coarse aggregate.

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