EXPERIMENTAL STUDY ON LIGHT WEIGHT CONCRETE USING LECA (LIGHT WEIGHT EXPANDED CLAY AGGREGATE)

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Abstract: *This report presents experimental study on effect of partial replacement of fine 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.*

Keywords: *LECA, Compressive strength, Tensile strength, Flexural strength.*

1. Introduction

Concrete is the most important building material used in the construction industry globally. One of the disadvantages of conventional concrete is the high self weight of concrete. Density of the normal concrete is in the order of 2200 to 2600 kg/m3. This heavy self weight results in larger dimensions of load bearing elements and foundations making it to some extent an uneconomical material. Attempts have been made in the past to reduce the self weight of concrete thereby increasing efficiency of concrete as a structural material. This resulted in evolution of light weight concrete with densities of the order of 300 to 1850 kg/m3. Light weight concrete has become more popular in recent years owing to the tremendous advantage it offers over conventional concrete. Some of the advantages of having light weight concrete are that it helps in reduction of dead load, increases the progress of building and lowers handling costs. Another most important characteristic of light weight concrete is the relatively low thermal conductivity and high sound insulation. Basically there is three different ways of achieving light weight concrete.

By replacing the usual mineral aggregate by light weight aggregate.

By introducing gas or air bubbles in mortar. This is known as 'aerated concrete.'

By omitting sand fraction from the aggregate. This is called 'no-fines' concrete. As such they are not used widely in making light weight concrete. Some of the natural light weight aggregates are pumice, diatomite, scoria, volcanic cinders, saw dust and rice husk out of which pumice is the only one which is used widely.

2. Materials and its Properties

2.1 LECA:

Bloated clay by its commercial name LECA (Lightweight Expanded Clay Aggregate) is an aggregate made by expanding clay at average temperature of 1200 C° in rotary kiln. LECA is usually produced from 0.1 mm up to 25 mm and supplied in various range sizes, which some of the commons grades are (0-4) mm, (4-10) mm, (10-25) mm and 0-25 mm which has 510, 330, 250 and 280 kg/m^3 average density. Some of the important advantages of LECA aggregate are: lightness, thermal insulation by low conductivity coefficient, soundproofing by high acoustic resistance, moisture impermeable, incompressible under

permanent pressure and gravity loads, non–decomposition against severe condition, fire resistant.

TABLE 1: Physical properties of LECA

PROPERTY	VALUE
Specific gravity	0.56
Water absorption	18%
Impact value	49.86%

2.2 Cement:

Cement is defined as the material with adhesive and cohesive properties which make it capable of bonding the constituents of concrete compact mass. Cement is obtained by grinding the raw materials (calcareous materials like limestone, chalk, marine shell and argillaceous materials containing silica, alumina and iron oxide).The mixture is then burnt in a large at a temperature of 1300°C to 1500°C.OPC53gradeconfirming IS 8112 : 1989wasused.

S.NO.	TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 8112-1989
1	Specific gravity	3.15	3.15
2	Normal consistency	32	30 to 35
3	Initial setting time (minutes)	40	>30
4	Final setting time (minutes)	590	<600

TABLE 2: Physical properties of cement

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.

2.4 Coarse aggregate

Coarse aggregate is 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.

S.NO.	TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 8112-1989
1	Specific gravity	3.15	3.15
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TABLE 3: Physical properties of aggregates

3. 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.

MIX PROPORTION

Quantity required per m³ of concrete after correction, M30

Cement = 320 kg/m³

Water = 197 liters/m³

Fine aggregate = 782kg/m³

Coarse aggregate = 1098.92kg/m³

Chemical admixture = 1.75kg/m³

Water cement ratio = 0.45

M30 mix ratio = 1: 1.92: 2.07: 0.45

3.1 Casting Specimens:

Fig 1: LECA

Fig 2: CUBES

Fig 3: CYCLINDERS

Testing machines:

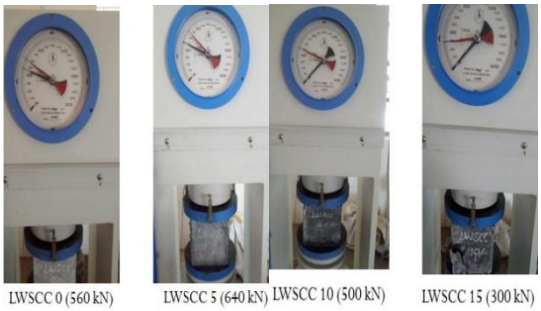


Fig 4: Compression strength

Fig: 5 Flexural tensile strength

4. TESTS:

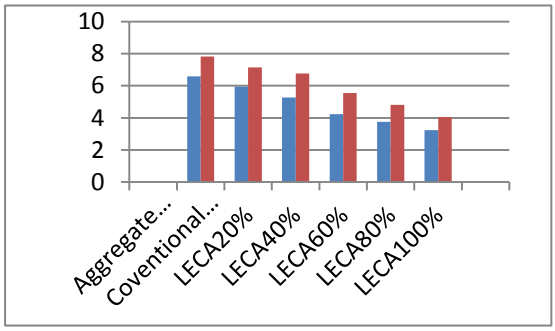
4.1 Compressive strength test:

Tests Results of Cube compressive strength are listed in table.

TABLE 4: Compressive strength of cubes in N/mm2 at 7days and 28 days

TYPES OF CONCRETE	COMPRESSIVE IN N/mm2 7 DAYS	28 DAYS
Conventional concrete	21.47	31.58
Concrete with 20% LECA	19.03	29.85
Concrete with 40% LECA	15.86	25.40
Concrete with 60% LECA	10.75	19.64
Concrete with 80% LECA	9.42	16.28
Concretewith100% LECA	8.77	13.37

Graph:1 Aggregate proportion vs Compressive strength in N/mm2



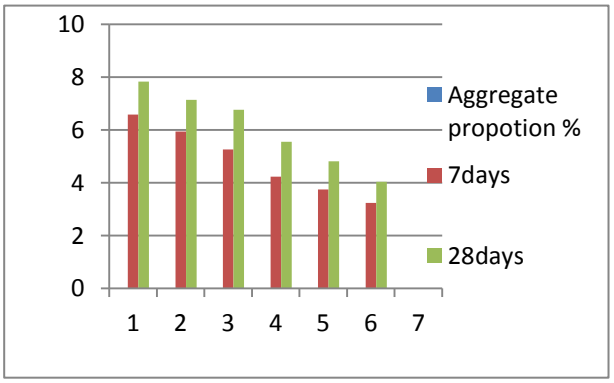
4.2 Split test:

The result of cubes split test of cubes show in table.

TABLE 5: Split test of cubes in N/mm2 at 7days & 28 days

TYPES OF CONCRETE	SPLIT STRENGTH N/mm2 7 DAYS	28 DAYS
Conventional concrete	2.7	3.0
Concrete with 20% LECA	2.5	2.8
Concrete with 40% LECA	2.2	2.6
Concrete with 60% LECA	1.8	2.0
Concrete with 80% LECA	1.5	1.9
Concrete with 100% LECA	1.2	1.7

Graph: 2 Aggregate proportion LECA% vs split test



4.3 Flexural test:

The flexural test of cubes shows in table.

TABLE 6: Flexural strength of cubes in N/mm2 at 7days & 28days

TYPES OF CONCRETE	FLEXURAL STRENGTH N/mm2	
Conventional concrete	6.58	7.83
Concrete with 20% LECA	5.94	7.14
Concrete with 40% LECA	5.26	6.76
Concrete with 60% LECA	4.23	5.55
Concrete with 80% LECA	3.75	4.81
Concrete with 100% LECA	3.24	4.04

Graph: 3 Aggregate proportion LECA % vs Compressive strength in N/mm2

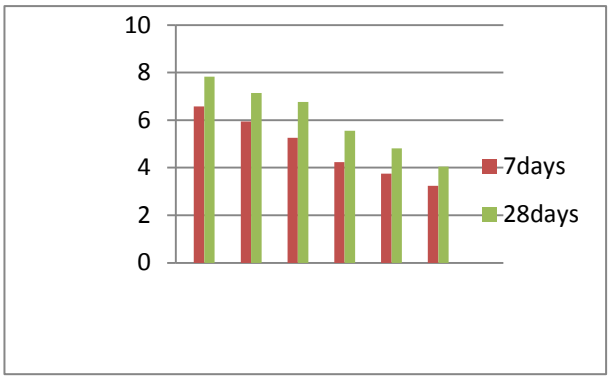


TABLE 7: Nominal strength vs light weight concrete strength.

Compressive Strength of Normal Concrete (N/mm2)		Compressive Strength of Light weight concrete (N/mm2)	
7days	28days	7days	28days
31.89	43.53	27.12	39.20

31.63	43.26	27.30	39.47
31.72	43.42	27.09	38.93

5. SUMMARY:

The primary importance of Light weight concrete (LWC) is to reduce the load acting on the structure by reducing the self weight of the members and that of Self compacting concrete (SCC) is to avoid compaction in congested reinforcement by enhancing the flow ability of concrete. In this project an attempt has been made to combine the advantages of Light Weight Concrete (LWC) and Self Compacting Concrete (SCC) leading to Light Weight Self Compacting Concrete (LWSCC). Following is the summary of the project,

A suitable methodology is arrived to achieve the objective of the project.

Properties of the materials used in concrete were found out.

Mix design is arrived such that the workability properties are within the acceptance criteria Self compacting concrete specimens in which fine aggregate is replaced by varying percentage of Light Expanded Clay Aggregate (LECA) are casted and tested for strength and self weight.

Discussions were made on the results obtained and the project was concluded.

6. CONCLUSION:

From the results arrived from the experimental study conducted on Self compacting concrete specimens with varying percentage replacement of fine aggregate by LECA,

The compressive strength of LWSCC 0 at 7 days and 28 days was 24.667 N/mm^2 and 30.074 N/mm^2 respectively and it increased gradually to 26.074 N/mm^{2}and 33.778 N/mm^2 respectively for LWSCC 5. This was due to the fact that the spherical shape of LECA aggregates contributed to better self compaction and hence higher strength.

Later the compressive strength at 7 days and 28 days decreased to 22.222 N/mm^{2}and 26.667 N/mm^2 respectively for LWSCC 10. Beyond 15 % of LECA content in fine aggregate i.e. LWSCC 15, the compressive strength reduces suddenly to 15.259 N/mm^2 and 21.037 N/mm^2 respectively, which is probable due to weaker nature and unavailability of enough water for hydration due to very pronounced water absorption characteristics of LECA

With further replacement of fine aggregate by LECA, light weight concrete with unit weight of range 300 kg/m^3 to 1850 kg/m^3 can be obtained.

From this experimental study, 5% is considered as optimum in replacing fine aggregate in self compacting concrete by Light Expanded Clay Aggregate (LECA).

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