Experimental Investigation On Flexural Properties Of Lightweight Concrete Using Steel Scraps

P.Pavithra Lakshmi[1] , A.Karthika[2] ,
[1 2,] UG Student,
Civil Engineering Department,
P.S.R Engineering College,
Sivakasi, Tamil Nadu, India

K.Mahendran M.E.,MBA.,[3]
[3,] Associate professor,
S.Vijaya Baskar M.E., [4]
[4]Assistant Professor,
Civil Engineering Department,
P.S.R Engineering College,
Sivakasi, Tamil Nadu, India

ABSTRACT *— This paper investigates the mechanical properties of light weight concrete produced by replacing of normal coarse aggregate using light expanded clay aggregate (LECA). It reduces the self weight of the building thereby reducing destruction during earthquake or any environmental impact. The main specialists of lightweight concrete are its low density and thermal conductivity. Steel scrap is admixture which used along with lightweight concrete for purpose of giving strength to concrete The mix Design is made for M30 grade using sufficient water-cement ratio. After curing for 7 and 28 days, the compressive strength, split tensile strength in the concrete cubes and cylinder is measured and compared with conventional concrete.*

KEYWORDS — Expanded clay aggregate, compressive strength, flexural strength, water absorption, bulk density.

1. INTRODUCTION

Concrete is a composite element consisting of cement, sand, water, coarse and fine aggregate. Lightweight concrete is a versatile material which consists primarily of a cement based mortar mixed with at least 20% of volume air. The material is now being used in an ever increasing number of applications, ranging from one step house casting to low density void fills. Light weight concrete has a surprisingly long history and was first patented in 1923, mainly for use as an insulation material. Although there is evidence that the Romans used air entertainers to decrease density, this was not really a true Light weight concrete. Significant improvements over the past 20 years in production equipment and better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale. Lightweight and free flowing, it is a material suitable for a wide range of purposes such as, but not limited to panels and block production, floor and roof screeds, wall casting, complete house casting, sound barrier walls, floating homes, void infill, slope protection, outdoor furniture and many more applications The generally higher unit cost of lightweight structural concrete is offset by reduced dead loads and lower foundation costs. There may be a special advantage when existing structures are being altered or expanded.

LIGHT WEIGHT CONCRETE AND ITS NATURE

Lightweight aggregates can fill many roles that will make human activity more environmentally responsible. The green house gas emission associated with both the processing of the raw material and from the fuel burned to produce the expansion of the raw material pales in comparison to the environmental rewards derived from its use. The raw material being mostly composed of silica releases low amounts of green house gases upon heating unlike the ingredients used to make cement. The emissions from manufacturing cement are about one tonne of CO2 per tonne of cement and for expanding shale; clay and slate are never above about 0.3 tonnes of CO per tonne of aggregates produced. With the rotary kiln used to make both cement and lightweight aggregates, the fuel consumption is cement and 3.0 gigajoules per tonne for expanding shale, clay or slate.

STEEL SCRAP

By using of steel scraps in light weight concrete mixers it gives flexural strength to concrete and attains its strength in concrete

Fig 1 Steel Scraps

LECA

Light expanded clay aggregate consists of small, lightweight, bloated particles of burnt clay to a temperature to about 1200 C. The thousands of air small, air-filled cavities give LECA its strength and thermal insulation properties.

Fig 2. Light Expanded Clay Aggregate

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FIRE ENDURANCE AND THERMAL PROPERTIES

In addition to advantages based on their lightness, structural lightweight concretes resist fire better than ordinary concretes because of their lower thermal conductivity, lower coefficient of thermal expansion, and the inherent fire stability of aggregates already burned to over 2000 degrees F. For concretes exposed to the elements, structural lightweight has some advantages over normal weight concrete. The lower conductivity lengthens the time required for exposed members to reach a steady state temperature, and this resistance reduces interior temperature changes under transient conditions. Such a time lag moderates solar buildup and nightly cooling effects. In tall buildings, the lower coefficient of thermal expansion for exposed lightweight columns means a reduction in volume changes and the stresses associated with them

CHEMICAL STABILITY

Stability of all kind of concrete, light or ordinary, against chemical substances depends on nature and quality of cement. In aggressive environment, choosing right kind of cement and neutral aggregates is very important. When used aggregates consist of interconnected pores, resistance for absorption and penetration of aggressive material into the concrete decreases. Generally, resistance of both kind of concrete, ordinary and LECA, against aggressive material is nearly equivalent

FIRE RESISTANCE

Generally, fire resistance of concrete depends on the following factors:

1- Structural details
2- Heat conduction
3- Heat capacity
4- Concrete resistance to heat

Coefficient of thermal conductivity of lightweight concrete is less than that of ordinary concrete and shows better protection against increasing high temperature; therefore, for heat protection, less thickness of lightweight concrete on reinforcement is required. Experiments about

fire resistance of concrete hold in England and Sweden shows that Leca concrete does not crack and peel while ordinary concrete made of quartz aggregates severely

cracks and peels (25). Until how new, a reasonable explanation about this different resistance is not given. With strong supposition, peeling concrete from heat depends on the percent of moisture present in the concrete.

ADVANTAGE OF LIGHT WEIGHT CONCRETE

- Reduces seismic forces.
- Improves structural efficiency.
- Improve hydration due to internal curing.
- Formwork is controlled.

DISADVANTAGE OF LIGHT WEIGHT CONCRETE

- Reinforcement should be provided to avoid occurrence of Corrosion which occur twice than normal concrete.

APPLICATION OF LIGHT WEIGHT CONCRETE

- Used as covering for architectural purposes...
- Fire and corrosion protection.
- In framed structures used as a construction of partition and panel wall.

2. TESTING OF MATERIALS

Table 1.Test For Cement, fine Aggregate and Coarse Aggregate:

PROPERTIES	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
SPECIFIC GRAVITY (G)	3.14	2.65	2.43
FINENESS MODULUS	–	2.86	5.03

3. LIGHTWEIGHT CONCRETE MIX DEIGN

Mix preparation is particularly important when using lightweight aggregates. Like conventional concrete mix design, this lightweight concrete mix design is prepared by replacing coarse aggregate by LECA by 45%,50%,60%

and 70%. The mix deign is prepared for M30 grade concrete using IS10262-2009 and IS 456-2000. IS code is used for mix design, mix proportion obtained for M30 grade of conventional concrete and light weight concrete mix ratio was 1:1.8:2.4 and 1:1.8:0.94.

Table 2. Mix Proportion For LWC (Light Weight Concrete):

Water	**Cement**	**Fine aggregate**	**LECA**
160	380	711	359
0.42	1	1.8	0.94

4. RESULT AND DISCUSSION

The result will be based on focus of the performance of Lightweight expanded clay aggregate. The results Presented on regarding the split tensile strength and Flexural strength. The performance of concrete is influenced by proper and good practice of mixing which can lead to better performance and quality of the concrete. In the present study, M30 grade of concrete cylinders of size 150×300mm and size of prism 500×100×100mm were cast for determining the split tensile strength and flexural strength. The cast specimens were remolded at the end of 24 hours,7 days and cured for 28days.

SPLITTING TENSILE TEST

A Cylindrical specimen (150x300) was prepared for the splitting tensile test. The test was performed by a digital automatic testing machine with the load rate. The splitting tensile strength of the specimens was calculated as follows:

$$T=2P/3.14LD$$

Where:

T = Splitting tensile strength (Mpa)

P=Maximum applied load indicated by the testing machine,

L=length in (mm),

D=Diameter in (mm

FLEXURAL TEST

The flexural test was conducted by dimensions of (500x100x100) mm. The loading and midpoint displacement of specimens was recorded during the experiment. Two specifications named ‘initial’ and ‘ultimate’ failures which testify the impact resistance of the specimens were evaluated. Initial failure is the number of blows required to cause the first visible crack in specimen, and ultimate failure is the number of blows after which the disc specimen fails and comes in contact with three of the four steel lugs of the test equipment.

Table 3.Tensile strengths of various percentage of LECA (7 DAYS)

MIXTURES	CYLINDER WEIGHT(kg)	SPLIT TENSILE STRENGTH (N/mm^2)
Conventional concrete	12.5	2.27
45% of LECA	10.8	2.12
50% of LECA	10.3	2.02
60% of LECA	9.7	1.83
70% of LECA	9.3	1.71

Fig 3. Cylinder specimen

Table 5 Tensile strengths of various percentage of LECA (28 DAYS):

Table 6 Flexural strengths of various percentage of LECA(28 DAYS):

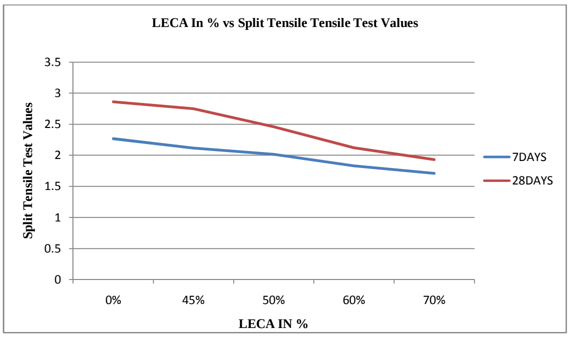
Mixtures	Prism Weight (Kg)	Flexural Strength (N/)
Conventional concrete	10.3	3.37
45% of LECA	9.3	3.10
50% of LECA	8.5	3.02
60% of LECA	7.9	2.86
70% of LECA	7.6	2.73

Fig 4.Testing Of Cylinder

Fig 5. Testing Of Beam

MIXTURES	CYLINDER WEIGHT(kg)	SPLIT TENSILE STRENGTH (N/mm^2)
Conventional concrete	12.5	2.86
45% of LECA	10.8	2.75
50% of LECA	10.3	2.46
60% of LECA	9.7	2.12
70% of LECA	9.3	1.93

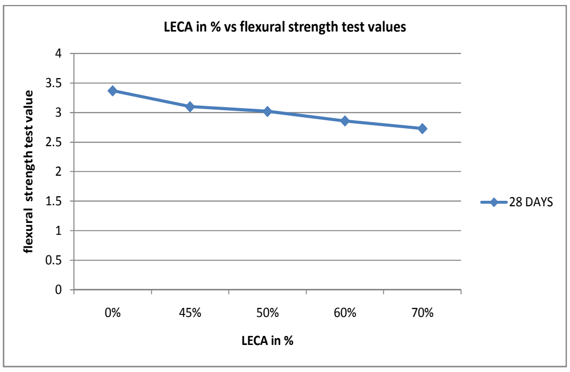
SPLIT TENSILE TEST FOR LIGHTWEIGHT CONCRETE



REPLACEMENT OF LECA FOR COARSE AGGREGATE IN %

Fig 6.Graph for split tensile test

FLEXTURE TEST FOR LIGHTWEIGHT CONCRETE



REPLACEMENT OF LECA FOR COARSE AGGREGATE IN %

\Fig 7.Graph for Flexure Strength

5. CONCLUSION

In this study, the Flexural properties of lightweight concrete using LECA (Lightweight Expanded Clay Aggregate) and Steel scraps are used and the Replacement of Coarse aggregate by 45%,50%,60%,70% LECA were investigated. The Flexural properties of Lightweight concrete give lightweight strength to structure. In the 45% Replacement of LECA found to have high Split Tensile Strength (2.75 N/mm2) than the normal weight concrete at age of 28 days. The Split tensile & flexural Strength for 45%, 50%,60% are seems to be good but 70% is lower when compared to others. Thus, Lightweight concrete increase ground stability and reduces land deformation and settlement. It has good sound insulation and fire resistance property.

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