Fresh concrete properties of light weight concrete using EPS and LECA as a replacement of normal aggregates

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***Abstract* - Lightweight Expanded clay aggregate (LECA) and Expanded Polystyrene Beads (EPS) are those materials which are useful for making lightweight concrete. Lightweight expanded clay is made from clay and expanded polystyrene beads are collected from packing waste. We are trying to produce concrete with lowest density and maximum possible strength. We take different proportions of EPS and LECA. Different tests on fresh concrete and hardened concrete. This paper contents compaction factor test and slump cone test result analysis performed on different concrete mixes having different proportions of EPS and LECA.**

***Index Terms* - EPS, LECA, slump, compaction factor, cement, aggregate**

I. INTRODUCTION

LECA:

Lightweight expanded clay aggregate is an amazing material made from clay. Sometimes it is necessary to remove black cotton soil from foundation to make stable foundation. Removal of this clay is big problem. Now a days research works are going on to solve this problem. As a result lightweight expanded clay aggregate are invented. Light expanded clay aggregate is producing in more than 20 countries like Italy, Denmark, Switzerland, Norvey, Germany, Finland, Portugal, U.K, and Iran etc. LECA is an environment-friendly, entirely natural product incorporating the same benefits as tile in brick form LECA is indestructible, non-combustible, and impervious to attack by dry-rot, wet-rot and insects. LECA is a natural material and a LECA building is a healthy building, so that is Leca has been used in competition projects for allergy-friendly, healthy homes.[1]

EPS:

With construction of structures expanding over the seas and a new found focus towards sustainability. This wonderful material known as Expanded Polystyrene Concrete is known for its low density and environment friendly properties apart from having various other advantages like better heat and sound insulation, ease of construction and affordability. The success of this concrete is evident from its increasing usage in green buildings and sea structures all over the world. The freedom to tinker with the properties of the concrete by altering the making process and components gives greater flexibility to creative minds while emphasizing the fundamentals of concrete design. Aluminum is a forming agent the reaction with water produces hydrogen gas which makes air pockets in concrete which result in to lowering of density and makes it porous.[2]

II. MATERIALS

The materials used in the present investigation are Ordinary Portland cement of 53 grade having a specific gravity of 3.15 with initial and final setting times of 34 minutes and 489 minutes respectively. Artificial LECA aggregate and EPS (expanded polystyrene). EPS beads and LECA used as lightweight aggregate to produce lightweight concrete with density varying from 400 to 2000 kg/m³. The bulk density of LECA was 530 kg/m³ and of EPS beads was 7 to 10 kg/m³. Normal sand was used. There were no additional admixtures used. The properties of EPS (Physical and Mechanical), Properties of LECA (Physical and Mechanical), Chemical composition of Cement, Properties of Fine aggregate, Properties of Water, Sieve analysis and Sieve analysis of LECA are given in table respectively 1, 2, 3, 4, 5 and 6. Mix design of concrete using EPS as a replacement of Normal Aggregate and Mix design of concrete using LECA as a replacement of normal aggregate as shown in Table 7-A and 7-B respectively.

Table – 1 Physical and mechanical Properties of EPS:

Property	Average value
Density	8.5 kg/m³
Compressive strength	0.09Mpa
Flexure strength	0.23Mpa
Water Vapor permeability	1.43 Perm-cm
Water absorption	3.00% by vol.

Table – 2 Physical and mechanical Properties of LECA:

Property	Average value
Bulk Density	530kg/m³
Crushing strength	2.26Mpa
pH	8.05
Water absorption	18%
Clay lump	0.1%

Table – 3 Chemical composition of Cement:

1) Surface Area (cm^2 / gm)	3040 > 2250	
2) Initial Setting Time	107 min > 30 min	
3) Final Setting Time	223 min < 600 min	
4) Specific Gravity (Confirm IS-2269)	3.15	
3 Days	28.5 > 27.0	3 Days
7 Days	39.2 > 37.0	7 Days

Table – 4 Fine Aggregate properties

1) Sand (confirming to IS-383-1970)	Zone -II
2) Specific Gravity (IS-2386-Pt-3-1963)	2.65
3) Water absorption (IS-2386-Pt-3-1963)	1.65
4) Silt content (IS-2386-Pt-1-1963)	0.15
5) Bulk Loose Density (Kg / m^3)	1545

Table – 5 Water Properties

Name of Test	Result Obtained (as per IS3025-1986)	Permissible Limit (as per IS-4562000)
PH -Value	7.10	Not less than 6
Chloride Content (as CL)	240.00	Max.-2000.00 P.P.M. for P.C.C. Max.-500.00 P.P.M. for R.C.C.
Organic Content	140.00	Max.-200.00 P.P.M.
Inorganic Content	1350.00	Max.-3000.00 P.P.M.
Alkali	12.00	Max.-25.00 ml
Sulphates (as SO4)	135.00	Max.-400.00 P.P.M.
Suspended Matter	650.00	Max.-2000 P.P.M.
T.D.S.	840.00	Max.-1200 P.P.M.

Table – 6 Sieve Analysis of Sand

Sieve Analysis of Sand	
IS Sieve Size (mm)	**% of Passing**
10	100.00
4.75	100.00
2.36	91.40
1.18	64.20
0.600	46.90
0.300	14.50
0.150	1.10

Table – 6 Sieve Analysis of LECA

IS Sieve Size (mm)	% of Passing
19	100.00
17	93.5
10	26.01
6.3	1.45
4.75	0.5

III. MIX DESIGN

Table – 7A Mix design of concrete with EPS

Group	Cement (Kg/m3)	Water (Kg/m3)	F.A. (Kg/m3)	C.A.20 mm (Kg/m3)	C.A.10 mm (Kg/m3)	EPS (Kg/m3)
A1	572.5	296.29	578.17	0.00	0.00	7.3501
A2	572.5	296.29	361.35	0.00	0.00	8.6864
A3	572.5	296.29	144.54	0.00	0.00	9.7304

Table – 7B Mix design of concrete with LECA

Group	Cement (Kg/ m3)	Water (Kg/m3)	F.A. (Kg/m3)	LWCA 20 mm (Kg/m3)	LWCA10 mm (Kg/m3)
B1	572.5	270	578.17	359.96	0.00
B2	572.5	270	361.35	163.62	245.43
B3	572.5	270	144.54	0.00	458.15

IV. EXPERIMENTAL PROGRAM

Slump Test

Fig. – 1 Slump Test

To determine the workability of concrete mix by slump test conducted by as per IS 1199-1959. The internal surface of the mould thoroughly cleaned and freed from superfluous moisture than mould placed on a smooth, horizontal, rigid and nonabsorbent surface. The mould was filled in four layers, each approximately one-quarter of the height of the mould. Each layer was tamped with twenty-five strokes of the rounded end of the tamping rod. The bottom layer tamped throughout its depth. After the top layer has been rodded, the concrete was struck off level with a trowel or the tamping rod, so that the mould is exactly filled. The mould removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested. Test results of slump test given in table no-8.

Compaction Factor Test

The concrete was placed gently in upper hopper, using the hand scoop. The hopper was filled level with its brim and trap -door was opened so concrete falls in to lower hopper. Than the trap door of second hopper was opened and concrete was allowed to fall in cylinder. The excess concrete above the top of cylinder was removed by towel. The weight of concrete was measured and compare that with the weight of concrete was fully compacted in same cylinder. And the ratio of both known.

V. RESULTS

Table – 8 workability Test Results

Gr. No.	Slump type	Slump (mm)	Compaction Factor
A1	collapse	160	0.97
A2	collapse	157	0.96
A3	collapse	155	0.96
B1	collapse	25	0.96
B2	collapse	23	0.96
B3	collapse	22	0.95

VI. CONCLUSION

Increase in replacement of normal aggregates with Lightweight Expanded clay aggregate (LECA) and Expanded Polystyrene Beads (EPS) decreases the workability of concrete. Using of Lightweight Expanded clay aggregate as an replacement of normal aggregate having less workability compare to use of Expanded Polystyrene Beads as a replacement of normal aggregate.

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