Experimental Study on Concrete with Pumice Stone and Leca Aggregate as a Partial Replacement of Coarse Aggregate

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Abstract— Structural light weight aggregate concrete is an important and versatile material in modern construction. The main objective of using LWAC is normally to reduce cost by reducing the dead load of structures. In this study an attempt has been made to study the mechanical properties of concrete M30 using the light weight aggregate pumice stone and leca aggregate as a partial replacement to coarse aggregate. For this purpose concrete is made by partial replacement of coarse aggregate with different ratio of pumice and leca aggregate with different percentage and thereby achieving the target strength with low density of concrete. The properties such as compressive strength, tensile strength and flexural strength and density are studied by casting cube specimens of size 150mmx150mmx150mm and beam 150mmx150mmx700mm.The results are compared with conventional M30 grade concrete.

Key words: Leca, Pumice, Compressive Strength, Flexural Strength, Density

I. Introduction

In Design of concrete structures, light weight concrete plays a prominent role in reducing the density and to increase the thermal insulation [4]. These may relate of both structural integrity &serviceability [1]. More environmental and economic benefits can be achieved if waste material can be used to replace the fine light weight aggregate. The new sources of Structural aggregate which is produced from environmental waste is Natural aggregates, synthetic light weight aggregate The use of structural grade light weight concrete reduces the self-weight and helps to construct larger precast units[3]. In this study, an attempt has been made to study the Mechanical Properties of a structural grade light weight concrete M30 using the light weight aggregate pumice stone and Leca aggregate as a partial replacement to coarse aggregate. Most of the normal weight aggregate of normal concretes is natural stone such as limestone and granite. The use of light weight concrete permits greater design flexibility and substantial cost savings, reduced dead load, improved cyclic loading, structural response, longer spans, better fire ratings, thinner sections, smaller size structural members, less reinforcing steel and lower foundations costs. Light Weight Aggregate is a relatively new material. For the same crushing strength, the density of concrete made with such an aggregate can is as much as 35 percent lower than the normal weight concrete. In addition to the reduced dead weight, the lower modulus of elasticity and adequate ductility of light weight concrete may be advantageous in the seismic design of structures. Other inherent advantages of the material are its greater fire resistance, low thermal conductivity, low coefficient of thermal expansion and lower erection and transport costs for prefabricated members. The LWC has been widely used across other countries such as US, UK and Sweden [2].

II. Literature Survey

Anil Kumar R, Dr. P Prakash-[5]have presented experimental investigation on concrete by replacing coarse aggregate by cinder and leca.M30 grade light weight concrete with 60%cinder and 40%Leca had an average compressive strength 36.52MPa and split tensile strength 2.5 MPa.

Rajeshwari S,Dr.Sunilaa George [6]–In this study attempt have been made to compare conventional concrete and light weight concrete using mix M25.partial replacement of coarse aggregate by pumice aggregate by 60% the compressive strength is comparable with normal concrete M25.

Nagashree B, Dr. S. Vijaya [7]-In this study the analysis of light weight aggregate concrete using leca and cinder as coarse aggregates. The mix design is carried out for both M20 and M30 grade concrete mixes; the coarse aggregate proportion is fully replaced by blended aggregates (leca and cinder) in various percentages by volume. The experimental results shows that the full replacement of coarse aggregate proportion with 40% of leca and 60% of cinder aggregates have given the better results with high strength, less weight and low density.

III. Materials

A. Cement

Portland pozzolana (ultratech) cement is used in the investigation. The cement used has been tested for various proportions as per IS:4031-1998 and found to be confirming to various specifications of IS:12269-1987.

B. Coarse aggregate

Crushed stone coarse aggregate confirming to IS-383-1987 was used. Maximum size of aggregate was 12mm.Specific gravity of coarse aggregate was 2.68.

C. Fine aggregate

Manjara river bed sand was used as fine aggregate. Specific gravity of fine aggregate is 2.63.

D. Water

Clean potable water is used.

E. Pumice Aggregate

Pumice called pumicite in its powdered or dust form, is a volcanic rock that consists of highly vesicular rough textured volcanic glass, which may or may not contain crystals. Pumice is formed during the volcanic eruption of viscous magma, mostly siliceous and rich in dissolved volatile constituents, especially water vapor .Their treatment is only via mechanical handling, crushing and screening. Specific gravity of Pumice aggregate is 0.8.

F. Leca aggregate

It is abbreviated as LIGHT EXPANDED CLAY AGGREGATES. It is the special type of aggregate which are formed by pyroclastic process in rotary kiln at very high temperature. Since it is exposed to high temperature, the organic compounds burn, as a result the pellets expand & form a honeycombed structure. Whereas the outside surface of each granule melts and is sintered. The resulting ceramic pellets are lightweight, porous and have a high crushing resistance. . Specific gravity of Leca aggregate is 0.50.Water absorption was 15%.fineness modulus was 6.5.

Fig. 1: Leca and Pumice

IV. METHODOLOGY

A. Workability

The workability tests were performed using standard sizes of slump moulds as per IS-1199-1999 and compaction factor apparatus which was developed in UK. Value 90 mm and 0.9 respectively.

B. Compressive Strength

Casted 150x150x150mm cubes and allowed for curing in curing tank for 7days and 28 days. And tested in 200 tones compression testing machine.

C. Flexural strength

Casting beam 150x150x700 mm and allowed for curing in curing tank for 7days and 28 days and tested in flexural testing machine.

D. Tensile strength

Casted 150x150x150mm cubes and allowed for curing in curing tank for 7days and 28 days. And tested in 200 tones compression testing machine

water	cement	FA	CA
200	500	644	985
0.4	1	1.28	1.97
20	50	64	98

Table 1: Mix Proportion M30

V. RESULTS

Test results of compressive test as shown in table 2.

Sr.no	Mix designation			Average compressive strength MPa	
	CA %	LECA %	PUMICE	7 days	28 days
1	100	0	0	24.09	33.23
2	60	20	20	13.43	18.65
3	70	15	15	21.35	25.05
4	80	10	10	22.83	30.75

Table 2: Compressive strength

Test results of Flexural test as shown in table 3

Sr.no	Mix designation			Average flexural strength MPa	
	CA %	LECA %	PUMICE %	7 days	28 days
1	100	0	0	6.77	7.11
2	60	20	20	2.96	3.72
3	70	15	15	3.31	4.28
4	80	10	10	4.9	6.42

Table 3: Flexural strength

Test results of Tensile test as shown in table 4.

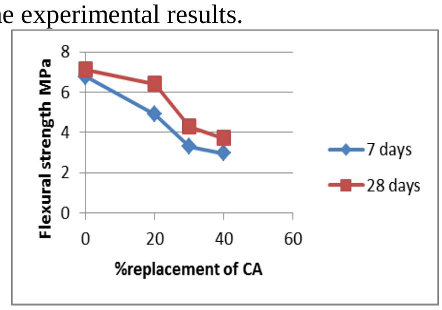
Sr.no	Mix designation			Average Tensile strength MPa	
	CA %	LECA %	PUMICE %	7 days	28 days
1	100	0	0	15.48	21.20
2	60	20	20	8.62	11.74
3	70	15	15	12.85	16.07
4	80	10	10	14.65	19.7

Table 4: Tensile strength

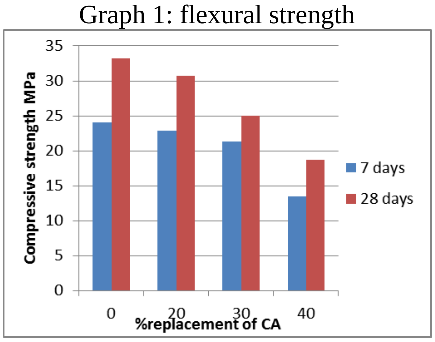
The comparison of experimental results and analyzing were done in graphical way.

The compressive strength, flexural strength and tensile strength of various proportions of M30 for different curing periods such as 7 days and 28 days are analyzed.

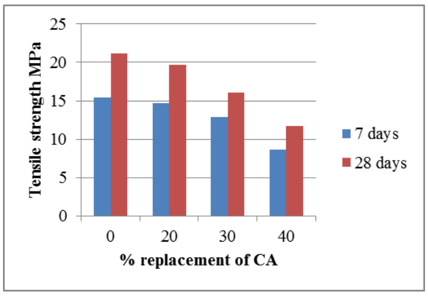
Partial replacement of CA by 10% pumice and 10% leca found to be optimum design mix which can be seen in the experimental results.



Graph 1: flexural strength



Graph 2: compressive strength



Graph 3: Tensile strength

VI. CONCLUSIONS

CA can be replaced partially by using pumice and Leca aggregate. As the % of pumice and Leca increases the cubes weight decreases from 8.2Kg to 6.5Kg but simultaneously there was decrease in the strength. By partially replacing 10% Leca and 10% pumice by CA gave a good low weight structural concrete.By replacing 10% Leca and 10%pumice the average compressive strength was 30.75Mpa which was nearer to the compressive strength of normal aggregate concrete i.e33.23Mpa. the flexural strength was 6.42 MPa which was nearer to design mix concrete i.e. 7.11Mpa.the light weight aggregate is no way inferior to natural coarse aggregate and it can be used for construction purpose.

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