Experimental investigation of Light weight concrete with partial replacement of coarse aggregate by Pumice Stone

Chithra S J[1], Eso Kumary Paul P M[2]
[1]*M.E(Structural Engineering), Department of Civil Engineering, Bethlahem Institute of Engineering, Karungal, Kaniyakumari, Tamil Nadu - 629157, India*
[2]*Assistant Professor (M.E), Department of Civil Engineering, Bethlahem Institute of Engineering, Karungal, Kaniyakumari, Tamil Nadu - 629157, India*

Abstract: **In the recent construction sector is to design the building with the cost-effective manner. In order to address this issue, self-weight of the structural member has to be reduced considerably, and then simultaneously the dimensions will be minimized. The objective of this project is to develop conventional concrete and simultaneously study about the light weight concrete. In the present study the natural coarse aggregate is partially replaced by light weight coarse aggregate (LWCA) such as pumice stone. This study an attempt has been made to study the mechanical property of light weight concrete M30. For this purpose, along with a control mix, the natural coarse aggregate is replaced with light weight coarse aggregate such as pumice up to 0%, 25%, 50%and 100%. The set of moulds were prepared to study the compressive strength, tensile strength, flexural strength. Trial slump test was carried out at the beginning in the fresh state. 7, 14 and 28 days compressive test, tensile and flexural strength test were performed in the harden state. The results obtained are interesting and useful compared to the results of conventional concrete.**

Keywords: Pumice Stone, Lower environmental impact, Partial replacement, Strength Properties.

I.INTRODUCTION

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement. In the past, lime based cement binders, such as lime putty, were often used but sometimes with other hydraulic cements, such as a calcium aluminate cement or with Portland cement to form Portland cement concrete (named for its visual resemblance to Portland stone).Many other non- cementitious types of concrete exist with other methods of binding aggregate together, including asphalt concrete with a bitumen binder, which is frequently used for road surfaces, and polymer concretes that use polymers as abinder.

Structural light weight concrete is a most adaptable material in present developed construction. It has several advantages such as dead load lessening and thermal insulation is more. If walls and floorings are made with light weight concrete, it leads to economy of construction. The use of light weight concrete is gaining wide acceptance in building construction. The need for the development of cheaper structures are further increased the demand for the utilization of lightweight concrete. Pumice is one among the foremost is feasible to commonly occurring natural lightweight coarse aggregates used for the assembly of concrete. Pumice lightweight aggregate is a volcanic-origin natural aggregate of very low specific gravity. The pumice is used to describe porous solids produced from the solidified magma produced during eruption of volcanoes. The voids are formed due to the release of gases in the magma. The resulting solids have a very high porous structure. Provided that pumice are often wont to produce structural grade lightweight concrete.

At the present time light weight concrete is usually used in pre-cast and restressed structures. Lightweight concrete offers the cost savings of plan adaptability and significant by giving less dead load, and improves the seismic structural response and fire rating much better, storey height is diminished, lesser foundation cost, and less reinforcing steel.

Pumice is a common rock of volcanic origin used as light weight aggregate, which occurs in many parts of the world, and returns its useful properties only when it is young and unaltered. The low density is due to their cells with cavities being formed by gases expanding with release of pressure.

II.OBJECTIVE

To determine the optimal replacement percentage of coarse aggregate with pumice stone for achieving the desired properties of lightweight concrete.

To investigate the effects of pumice stone replacement on the workability, density, and compressive strength of lightweight concrete.

To evaluate the potential benefits of using pumice stone as a sustainable aggregate in light weight concrete, including reduced weight, improved thermal insulation, and environmental benefits.

To compare the properties of lightweight concrete made with pumice stone and traditional coarse aggregate.

To develop a mix design for lightweight concrete using pumice stone as a partial replacement for coarse aggregate.

Properties	Results
Specific Gravity	3.15
Standard consistency	30%
Initial Setting time	32 min
Final Setting time	270 minutes

1. MATERIALS USED

CEMENT:

Cement is a folio material which is utilized in development activities, that ties all the Constituents together. The most important types of cement are used as a component in the preparing the mortar for the brick masonry, and of concrete which is a combination of cement and an aggregate to form a strong building material is used in the present thesis work.

Table 2 Properties of Fine Aggregate

Properties	Results
Specific Gravity	2.63
Water Absorption	3.01
Fineness	1.5%

Table 3 Properties of Coarse Aggregate

Properties	Results
Specific Gravity	2.70
Water Absorption	0.67%
Crushing Strength	24.75%

PUMICE LIGHTWEIGHT AGGREGATE:

Pumice is a natural aggregate of abundant resource around the world and it is environmental friendly. Pumice is created when super highly pressurized is violently ejected from a volcano.

The properties of pumice aggregate were tested as per IS 2386 (Part – 3 & 4)-1963 and IS 383- 1970 given in Table 4. The water absorption of pumice aggregate is more than the water absorption of coarse aggregate. Hence, before using pumice aggregate, it should be soaked in water for 24 hours.Table 1 Properties of Cement

AGGREGATE:

Fine aggregate is a small size filler material in concrete which fills the voids in between the coarse aggregate. The particle size fine aggregate ranges from 4.75mm to 75 m. M-Sand conforming to grading zone II and the requirements of IS 3831970 is used as fine aggregate. It should be clean, hard, strong and free from organic impurities and deleterious substance it should inert to other materials and of suitable types concerning strength, density, shrinkage, and durability of concrete made with it. The properties of fine aggregate were tested as per IS 2386 (Part – 3)1963 and IS 383-1970.

Fig.1 Pumice Stone

Table 4 Properties of Pumice Light Weight

Properties	Results
Specific Gravity	1.05
Water absorption	50%

CONPLAST SP430

Conplast SP430 is a superplasticizer based on selected sulphonted naphthalene polymers and it is a chloride free super plasticising admixture. It is provided as a brown solution which immediately disperses in water. It is brown in colour and has a specific gravity of 1.20 to 1.21. The dosage used is 1.5% weight of cement.

2. CONCRETE TESTS AND RESULTS

FRESH CONCRETE TESTS

SLUMP CONE TEST in M30 Grade Concrete

Table 5 Slump Cone Test

S.NO	Type of concrete	Slump (mm)
1	Normal concrete	130
2	PLWAC (50%)	40
3	PLWAC (80%)	32
4	PLWAC (100%)	30

COMPACTION FACTOR TEST in M30 Grade

Table 6 Compaction Factor Test

Type of concrete	Compaction factor value	Type of concrete
Normal concrete	0.96	Normal concrete
PLWAC (50%)	0.95	PLWAC (50%)
PLWAC (80%)	0.93	PLWAC (80%)
PLWAC (100%)	0.92	PLWAC (100%)

ULTRASONIC PULSE VELOCITY TEST

Table 7 Ultrasonic pulse velocity test

Specimen	Ultrasonic pulse velocity	
	Average travelled time (s)	Average pulse velocity(m/s)
Normal concrete	19.63	5075.33
PLWAC (50%)	29.34	5057.67
PLWAC (80%)	15.56	6736
PLWAC (100%)	19.7	6339.33

Comparison of Test Results

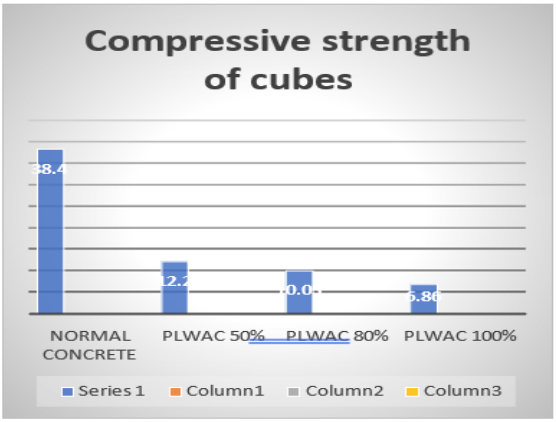

Fig 8 Comparison of compressive strength test results

HARDENED CONCRETE TEST

The individual variations of specimen were not more than ± 15 percent of the average. The specimen stored in water was tested immediately on the removal from the tank. The specimen was wiped off and the dimensions of the specimen and their weight were recorded before testing. The bearing surface of the testing machine were wiped clean the other materials, which may come in contact with the compression plates. While placing in the cube in the machine, care was taken such that the load was applied to opposite side of the cube as casted and not to the top and the bottom. The maximum load applied to the specimen was recorded and any usual appearance in the type of failure was noted.

III.CONCLUSION

From the comparison of the test results, the following conclusions are made: It shows that increasing percentages of pumice aggregate will decrease the density of the concrete which results in lightweight aggregate concrete. Pumice aggregate absorbs more water as compared to normal coarse aggregate because pumice aggregate contains more pores hence strength will be reduced. Hence superplasticizers are used. The compressive strength, split tensile strength and flexural strength of Pumice LWAC with 50%, 80% and100% replacement shows that only 50% replacement has optimum value. After 50% the compressive strength, split tensile strength and flexural strength value for 80% and 100% decreases. It shows that increasing percentages of pumice aggregate decreases the strength of concrete. This type of concrete can be used in wall panels of non-load bearing type for use in precast buildings and can be used in lintels, sunshades and partition walls. · Pumice aggregate concrete can be used in earthquake-resistant structures.

IV. ACKNOWLEGMENT

First of all, I acknowledge with heartfelt gratitude, GOD ALMIGHTY for all His blessings and guidance with which I could complete my work successfully.

With profound respect and pride, I express my sincere

thanks to our honorable Chairman, Shri. GERALD SELVARAJA for facilitating us with this opportunity. I am greatly and profoundly thankful to our Director, Er. T. ISAN, for his kind support to take up this project.

I record my sincere thanks to our Principal, Dr. S. EMMY PREMA, for expressing her keen support during this project work.

I would like to express my sincere thanks and deep sense of gratitude to our Head of the Department, Civil Engineering, Mr. S. SHIJILIN PREM SHIROLD, for his valuable guidance and suggestions paved way for the successful completion of the project work.

I extend my gratitude to my project coordinator, Mrs. P.M. ESO KUMARY PAUL, for his support and timely suggestions for the completion of project.

I also convey my immense gratitude to my project guide Mrs. P.M. ESO KUMARY PAUL, for her/his constant technical support and stupendous encouragement which enabled me to complete my project successfully.

I am also grateful to all our department faculty members, my beloved parents and my friends for their valuable suggestions in bringing out this project.

REFERENCE

[1] NagaswaramRoopa, K. Supriya and P. Rasheed Khan (March 2017), did the "experimental Study on Concrete by Partial Replacement of Coarse Aggregate with pumice".

[2] Vinod Goud, et al (2016) did the investigation of partially replacing coarse Aggregate with pumice in Concrete and its effect.

[3] Dr.G. Elangovan (2015) Studied "partial replacement of coarse aggregate by pumice" using M20 grade of concrete.

[4] R. S. Muralitharan and V. Ramasamy investigated the mechanical properties of pumice lightweight aggregate concrete. In this investigation, pumice stone are proposed to be utilized as the coarse aggregate. It is possible to develop lightweight concrete using pumice with a dry density of 1200 kg/m^3up to 1450 kg/m^3.

[5] Suba Lakshmi, S. Karthick, Gasper Helden, M. Dinesh Boopathi and V. Balaji Pandian carried out the study on lightweight concrete by using pumice aggregate.

[6] Devi Pravallika and K. Venkateswara Rao carried out an experimental study on strength and durability properties of M40 concrete by partial replacement of coarse aggregate with a natural lightweight aggregate pumice stone

[7] H. Al-Khaiat and M.N. Haque -He worked on the curing the physical properties and the early strength.

[8] T. Parhizkar et.al. - Exhibited experiments on the properties of volcanic pumice lightweight aggregates concretes

[9] P.C.Taylor- currently professor at Wuhan University of Technology has quoted various results such as mineral admixtures affect the physical and mechanical properties of High Strength Structural Light Concrete and moreover concluded that further addition of fly ashes improves the compressive strength and splitting tensile strength of HSSLC and furthermore Addition of silica fume enhances the compressive strength about 25%

[10] Khandaker M. Anwar Hossain - he carried out an investigation on volcanic pumice. Test was conducted after 0% to 25% of cement by weight and on concrete by replacing 0% to 100% of coarse aggregate by volume.