# Experimental Study on a Light Weight Concrete with Partial Replacement of Pumice Stone in Aggregates

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**Abstract-Concrete is the commonly used manufactured building material in the world, owing to its usefulness and relatively low cost. One of the disadvantages of conventional concrete is its high self-weight. This heavy self-weight of concrete will result in uneconomical structural material. To decrease the self-weight of concrete, the coarse aggregate is replaced partially by lightweight aggregate. This is known as lightweight concrete having low density, reduction of dead load and to increase thermal insulation. There are two types of lightweight aggregate - natural lightweight aggregate and artificial lightweight aggregate. One of the most commonly available natural lightweight aggregate called pumice aggregate is used as a replacement for coarse aggregate. Pumice aggregate is used because of its low density than conventional coarse aggregate, and it is easily available. Lightweight concrete is prepared by partially replacing the coarse aggregate with pumice aggregate by 50%, 70% & 100%. The conventional concrete and pumice lightweight aggregate concrete is made by using mix M25 with SLES (sodium lauryl ether sulphate) admixture. The mechanical properties of conventional concrete and pumice lightweight aggregate concrete are compared by conducting various destructive and non-destructive tests and favorable replacement is found.**

**Keywords: Pumice stone, lightweight concrete, Non-destructive test, low density, SLES.**

## 1.INTRODUCTION

The present day world is witnessing construction of very challenging and difficult civil engineering structures. Researchers all over the world are attempting to develop low density or lightweight concrete by using different admixtures in concrete up to certain proportions. This study deals with the development of Floating concrete by using light weight aggregate (Pumice stone) and SLES as an air entraining agent. Floating concrete is made by introducing air or gas into concrete slurry, so that when the mix sets and hardens, uniform cellular structure is formed. Thus it is a mixture of water, cement and finely crushed sand. We mix fine powder of Aluminum to the slurry and it reacts with the calcium hydroxide present in it thus producing hydrogen gas. This hydrogen gas when contained in the slurry mix gives the cellular structure and thus makes the concrete lighter than the conventional concrete. Pumice stone is a lightweight aggregate of low specific gravity. It is a highly porous material with a high water absorption percentage. In this we do not use the conventional aggregate and replace it by the pumicestone. Pumice is the specimen of highly Porous rocks having density approximately 800-2000 Kg/m3 . Pumice is produced when super-heated, highly pressurized rock is violently ejected from volcano

## 2.REVIEW OF LITERATURES:

1) Malik Mehran Manzoor et al. (2018) used pumice and aluminium powder as air entraining agents to investigate this development in floating concrete. They had been working on combining the types previously mentioned in the survey. Comparison this study was carried out between simple cement concrete and lightweight concrete with different proportions of aggregates and a fixed amount of aluminium content (2% by weight) of cement. It was made with satisfactory strength using five Light concrete mixes and different proportions of pumice stone. The result of the survey showed that the size of the aggregate and the proportion affects the compressive strength and unit weight of concrete. In addition, the result showed that when using pumice as in addition, it is possible to generate a float with a satisfactory force. This concrete

does not correspond to the supporting structure Component strength requirement.

2) Rayees Ahmad Ganie (2017) studied the production of floating concrete with pumice, foaming agent and thermocol. He It also examined the influence of aggregate types and amounts on the compressive strength of concrete. It was also produced strength which was determined by using five lightweight concrete mixes and different proportions of pumice stones. The result of the investigation was showed. This proportion and the size of the aggregate influenced the compressive strength of the concrete and the unit weight. It also showed the result that you can make satisfied foam concrete using foam and pumice aggregates. Strength requirements for the structural components that carry the load do not match this concrete for the construction of structures such as barges, slabs, buildings, etc. Floating concrete can be used effectively as the highest part of the country is covered in water; the land is used for construction work.

3)Nikhil S. Chavan et al. (2018) studied the mechanical properties of floating concrete using exhausted polystyrene such as Aggregate exchange. The pressure test, the split tensile test and the density test were performed on concrete and completed. It was possible to float the concrete into the concrete using EPS beads to replace the aggregate. Use EPS Floating concrete provides pearls with standard workability and can be easily compacted and finished. Compressive strength of Floating concrete was inferior to conventional concrete. The density of the floating concrete for each mixing project was less than 1000 kg /m2. There is leakage and honeycomb problems, the leakage problem can be controlled using a sealing solution. T was also possible to build a boat out of concrete, e.g. H. With floating concrete, which offers more advantages, such as cost savings, reduces the use of wood for the rescue operation.

PROPERTIES OF MATERIALS

Concrete mix constituents:

Concrete is a composite material, made by mixing Coarse aggregate (CA) & Fine aggregate(FA), Cement & Water. In this the study on normal concrete with partial replacement of cement by marble powder, the properties of the materials used are experimentally studied and described below.

Materials Used:

Following materials are generally used for the preparation of concrete specimen.

- Cement
- Fine aggregate
- Coarse aggregate (pumice stone)
- Pumice powder
- Water
- Air entering agent

Cement:

Ordinary Portland Cement (OPC) of 53 Grade conforming to the specifications of Indian Standard was used throughout the course of the investigation. It was fresh and without any lumps. Cement is by far the primary element of concrete, in that it presents the binding material for the discrete elements. The various tests were conducted and the results obtained were reported in table.

Physical properties of cement

Fine Aggregat

M-sand

The fine aggregate used is M - sand which is the substitute of river sand for the preparation of concrete specimen. Manufacturing sand is produced from hard granite stones by crushing. In this investigation locally available M-sand conforming to Indian standard passing through 4.75mm sievewas used throughout the study.

Physical properties of Fine aggregate

| S.No | Test Performed | Results |
|---|---|---|
| 1. | Fineness modulus | 2.91 |
| 2. | Specific Gravity | 2.85 |
| 3. | Grading zone | II |

4.2.2.2 Pumice powder

Pumice has an average porosity of 90% and initially floats on water. Pumice varies in density according to the thickness of the solid material between the bubbles; many samples float in water. It is formed by volcanic eruptions when molten lava is shot in the air with many bubbles of gas in it.The purpose of using 50 % of pumice powder is to reduce the density and weight of concrete.

Coarse Aggregate:

The coarse aggregates can be classified into six groups of shapes namely cubically and angular for high quality aggregates while irregular, flaky and elongated are classified as low qualityaggregate. Crushed angular aggregate of size 10mm to 20mm are used in this experimental study and the aggregates are free from dust before used in the preparation of concrete specimen .It is non-reactive and available in local quarry.

Physical properties of Coarse aggregate

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 15 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.

Physical properties of Fine aggregate for pumice powder

| S.No | Test Performed | Results |
|---|---|---|
| 1. | Fineness modulus | 2.2 |
| 2. | Specific Gravity | 1.01 |
| 3. | Grading zone | II |

Water

Water is an important ingredient of concrete as it plays an important role in mixing, laying, and compaction, setting and hardening of concrete. It influences the strength development and durability of concrete. The quantity and quality of water is required to be looked into very carefully. Fresh potable water confirming IS-456-2000 was used for the preparation of the concrete.

Air entraining agent

Air-entraining admixtures facilitate the development of a system of microscopic air bubbles within concrete during mixing. They increase the freeze-thaw durability of concrete, increase resistance to scaling caused by deicing chemicals, and improve workability. SLES( sodiuym lauryl either sulphate ) is used as a air entraining agent.It makes foam when it mix with water.pH value is 3-7.

MIX PROPOTION

Stipulations for proportioning:

a) Grade designation — M25
b) Maximum nominal size of aggregate — 20mm
c) Type of cement — OPC 53 grade
d) Water cement ratio — 0.45
e) Exposure condition — Mild
f) Degree of supervision — Good
g) Type of aggregate — Crushed angular aggregate

Test Data for Materials:

- Specific gravity of cement — 3.15
- Specific gravity of coarse aggregate — 2.70
- Specific gravity of fine aggregate — 2.85
- Specific gravity of pumice powder — 1.05

Mix ratio:

For conventional cube

| Cement: | Fine aggregate | : Coarse aggregate |
|---|---|---|
| 375: | 632 | :1234 |
| 1: | 1.68 | : 3.29 |

For cube using pumice aggregate

Specific gravity of pumice stone = 1.05

| Cement | :Fine aggregate | : Coarse aggregate | : W/C |
|---|---|---|---|
| 1 | :1 | : 2 | : 0.45 |

| MIX ID | CEMENT(g) | F.A(g) | | C.A(g) | PUMICE AGGREGATE(g) |
|---|---|---|---|---|---|
| | | M SAND | PUMICE POWDER | | |
| $P_{0\%}$ | 700 | 350 | 350 | 1400 | 0 |
| $P_{50\%}$ | 700 | 350 | 350 | 700 | 700 |
| $P_{70\%}$ | 700 | 350 | 350 | 420 | 980 |
| $P_{100\%}$ | 700 | 350 | 350 | 0 | 1400 |

Mix proportion

EXPERIMENTAL INVESTIGATION

COMPRESSIVE STRENGTH TEST:

Compressive strength test is done as Per IS 516-1959. The test is conducted on Compression testing machine as shown in the figure. It is done by testing concrete cube of size 150mmX150mmX150mm . Mechanical behavior of concrete was studied for M25 grade concrete.

After the required period of curing , the cube specimen are taken from the curing tank and cleanedto wipe off the surface water. Then clean the bearing surface of the compression testing machine. The axis of the specimen was carefully aligned with the centre of thrust of the plate. The load was then gradually applies. The maximum load at which the specimen breaks and the pointer starts moving back is noted. The compressive strength was calculated in N/mm2.

Compressive strength of concrete is tested on cube at different percentage of waste marble powder content in concrete. The strength of concrete has been tested on cube at 7 days,14 days and 28days and the results obtained. The result is the average of three standard cube specimen .

Compressive strength=Load/Area =P / A

Where , P is the Ultimate load in N,

A is the cross sectional area in m

Experimental setup for compressive test

Analysis of test results (compressive strength) of concrete

| SI. NO | PERCENTAGE REPLACEMENT OF PUMICE STONE | AVERAGE COMPRESSIVE STRENGTH ($N/mm^2$) | |
|---|---|---|---|
| | | 7 days | 28days |
| 1. | 0 % | 21.5 | 27.7 |
| 2. | 50% | 15.5 | 18.6 |
| 3. | 70% | 6.2 | 10.2 |
| 4. | 100% | 4.7 | 8.86 |

REBOUND HAMMER TEST

Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring controlled mass that slides on a plunger within a tubular housing. The operation of rebound hammer is shown in the fig.1. When the plunger of rebound hammer is pressed against the surface of concrete, a spring controlled mass with a constant energy is made to hit concrete surface to rebound back. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This measured value is designated as Rebound Number (rebound index). A concrete with low strength and low stiffness will absorb more energy to yield in a lower rebound value.

Rebound hammer test

Analysis of test result of rebound hammer test

| specimen | Average rebound hammer number | Compressive strength | Quality of concrete |
|---|---|---|---|
| Normal concrete | 33.2 | 24.5 | Good layer |
| PLWAC 50% | 27.4 | 14.2 | Fair |
| PLWAC 70% | 24.9 | 12.4 | Fair |
| PLWAC 100% | 21.5 | 8.1 | Fair |

DENSITY CALCULATION:

DENSITY = MASS / VOLUME

Size of cube = 150mm x 150mm x 150mm.

Density of 100% replaced cube = 3.065/ 0.15 x 0.15 x 0.15 =817.33

| S.no | percentage | Weight of cube(kg) | Density( kg/ $m^3$) |
|---|---|---|---|
| 1. | 0% | 8.180 | 2181.3 |
| 2. | 50% | 5.400 | 1440 |
| 3. | 70% | 3.650 | 973.3 |
| 4. | 100% | 3.065 | 817.33 |

fig 8.1 rebound hammer test

8.2.4 ULTRASONIC PULSE VELOCITY:

| S.NO | METHOD | PATH LENGTH (L) in cm | TIME (T) in seconds | Velocity (v) in km/s | Quality of concrete |
|---|---|---|---|---|---|
| 0% (normal concrete) | DIRECT | 15 | $31.6 \times 10^{-6}$ | 4.74 | Very good to excellent |
| | SEMI DIRECT | 10.6 | $18.9 \times 10^{-6}$ | 5.60 | Very good to excellent |
| 50% | DIRECT | 15 | $41.3 \times 10^{-6}$ | 3.63 | Good |
| | SEMI DIRECT | 10.6 | $28.6 \times 10^{-6}$ | 3.70 | Good |
| 70% | DIRECT | 15 | $46.7 \times 10^{-6}$ | 3.21 | Satisfactory |
| | SEMI DIRECT | 10.6 | $32.3 \times 10^{-6}$ | 3.20 | Satisfactory |
| 100% | DIRECT | 15 | $50.1 \times 10^{-6}$ | 2.99 | Poor |
| | SEMI DIRECT | 10.6 | $38.4 \times 10^{-6}$ | 2.76 | Poor |

Fig no 8.2 ultrasonic pulse velocity test

## CONCLUSION

From the comparison of the test results, the following conclusions are made:

1. Compressive strength value is compared to normal concrete and replacement of Coarse aggregate by Pumice from different percentages (50%, 70%, 100%).
2. It shows that increasing percentages of pumice aggregate will decrease the density of the concrete which results in light-weight aggregate concrete. Pumice aggregate can be replaced for natural aggregate to decrease the self-weight of concrete.
3. Maximum value of strength is obtained in 50% replacement of Pumice with coarse aggregate.
4. Pumice aggregate absorbs more water as compared to normal coarse aggregate because pumice aggregate contains more pores hence strength will be reduced.
5. It shows that increasing percentages of pumice aggregate decreases the strength of concrete
6. 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 sunshades and partition walls.
7. From ultra sonic test 50% and 70% replaced lightweight concrete is good concrete.

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