# PARTIAL REPLACEMENT OF PERLITE POWDER WITH CEMENT IN CONCRETE

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**Abstract -** *For structural application of lightweight concrete, the density is more important than the strength. A low density for the same strength level reduces the self-weight, foundation size and construction cost. Structural lightweight aggregate concrete was designed with natural perlite aggregate that will provide an advantage of reducing dead weight of the structure also compared the strength of normal concrete with perlite concrete by partially replacing of perlite with sand as a percentage of 5%, 10%, and 15% in normal concrete mix. Perlite is an amorphous volcanic glass that has a relatively high water content, typically formed by the hydration of obsidian. It is an industrial mineral and a commercial product useful for its low density after processing. Small quantities of perlite are also used in foundries, cryogenic insulation, and in ceramics as a clay additive. It is also used by the explosives industry. Due to thermal and mechanical stability, non-toxicity, and high resistance against microbial attacks and organic solvents, perlite is widely used in biotechnological applications. Perlite was found to be an excellent support for immobilization of biocatalysts such as enzymes for bioremediation and sensing applications.*

***Key words*: Perlite powder, Compressive Strength, Split tensile strength.**

## 1. INTRODUCTION

Perlite is an amorphous volcanic glass that has a relatively high water content, typically formed by the hydration of obsidian. It occurs naturally and has the unusual property of greatly expanding when heated sufficiently. It is an industrial mineral and a commercial product useful for its low density after processing. Perlite softens when it reaches temperatures of 850– 900 °C (1,560–1,650 °F). Water trapped in the structure of the material vaporises and escapes, and this causes the expansion of the material to 7–16 times its original volume. The expanded material is a brilliant white, due to the reflectivity of the trapped bubbles. Unexpanded ("raw") perlite has a bulk density around 1100 kg/m$^3$ (1.1 g/cm$^3$), while typical expanded perlite has a bulk density of about 30–150 kg/m$^3$ (0.03–0.150 g/cm$^3$)Small quantities of perlite are also used in foundries, cryogenic insulation, and in ceramics as a clay additive. It is also used by the explosives industry. Due to thermal and mechanical stability, non-toxicity, and high resistance against microbial attacks and organic solvents, perlite is widely used in biotechnological applications. Perlite was found to be an excellent support for immobilization of biocatalysts such as enzymes for bioremediation and sensing applications. The investigation are to be carried out using serveral tests which include compressive test, split tensile test.

## 2. MATERIAL USED

### 2.1 Cement

The cement used in this study was OPC 53 grade from Ramco Cement Company which is widely used in the construction industries. The chemical properties of cement are shown in Table. Which is given by the supplier. The physical properties of cement was determined by testing the cement as per IS 12269:1987 (reaffirmed 2004).

### 2.2 Perlite powder

Perlite is an amorphous volcanic glass that has a relatively high water content, typically formed by the hydration of obsidian. It occurs naturally and has the unusual property of greatly expanding when heated sufficiently. It is an industrial mineral and a commercial product useful for its low density after processing .Perlite softens when it reaches temperatures of 850–900 °C (1,560–1,650 °F). Water trapped in the structure of the material vaporises and escapes, and this causes the expansion of the material to 7–16 times its original volume. The expanded material is a brilliant white, due to the reflectivity of the trapped bubbles.

**Fig 2.1 perlite powder**

**2.3 Fine Aggregate**

Fine aggregate shall consist of natural sand or manufactured sand or a combination. Fine aggregates should be selected so as to reduce the water demand hence rounded particles are thus preferred to crush rock fines where possible. The finest fractions of fine aggregate are helpful to prevent segregation. The river sand conforming to zone II as per IS 383-1987 was used. It passes through 2.36mm IS sieve.

**2.4 Coarse aggregate**

Hard granite broken stone was used as coarse aggregate. The coarse aggregate is sieved in 20mm sieve and the aggregate passing through the seive is used as coarse aggregate

**2.4 Water**

Water is an important ingredient in cement paste, as it chemically participates in the reactions with cement to form the hydration product, C-S-H gel. The strength of cement mortar depends mainly from the binding action of the hydrated cement paste C-S-H gel. For high performance concrete it is important to have the compatibility between the given cement and the chemical and mineral admixtures along with water used for mixing. Water is a chemical substance with the chemical formula H2O. Its molecule contains one oxygen and two hydrogen atoms connected by covalent bonds.

**3. PROPERTIES OF MATERIALS**

**Table-1:Properties of cement**

| S.NO | Property | Result |
|---|---|---|
| 1 | Initial setting time | 45 minutes |
| 2 | final setting time | 466 minutes |
| 3 | Consistency | 30% |
| 4 | Specific gravity | 3.15 |
| 5 | Fineness | 8.5% |

**Table-2:properties of perlite**

| S.NO | Property | Result |
|---|---|---|
| 1 | Specific gravity | 2.2 |
| 2 | Physical state | Micronized powder |
| 3 | Colour | White |
| 4 | Water absorption | 1.5% |

**Table-3: Properties of sand**

| S.NO | Property | Result |
|---|---|---|
| 1 | Fineness modulus | 2.58 |
| 2 | Specific gravity | 2.44 |
| 3 | Grading zone | II |
| 4 | Water absorption | 1.0% |

**Table-4: properties of coarse aggregate**

| S.NO | Property | Result |
|---|---|---|
| 1 | Fineness modulus | 3.44 |
| 2 | Specific gravity | 2.98 |
| 3 | Water absorption | 0.5% |

## 4. RESULTS AND DISCUSSION

### 4.1 Slump Cone Test

The slump test is perhaps the most widely used, primarily because of the simplicity of the apparatus required and the test procedure. The internal surface of the mould was thoroughly cleaned and free from superfluous moisture and any set concrete before commencing the test. The mould was placed on a metal pan which was smooth, horizontal, rigid and non-absorbent. The mould was carefully filled in four layers, each approximately one quarter of the height of the mould. Each layer was stamped with the tamping rod. The strokes were distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers penetrated into the under lying layer. The bottom layer was tamped throughout the depth. After the top layer was rotted, the concrete was struck off level with a trowel such that the mould was exactly filled. The mortar which has leaked out between the mould and base plate was cleaned away. The mould was removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allowed the slump to subside and the slump was measured immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested. The slump measured was recorded in terms of mm of subsidence of the specimen during the test.

Slump = 5.3 cm = 53 mm

### 4.2 Compaction Factor Test

The apparatus consists of 2 hopper vessels A and B provided with hinged doors at their bottom. A cylindrical vessel B is opened so that the concrete falls into the vessel B. after this; hinged door of the vessel B is opened so that the concrete will fall into the cylinder C. The surplus concrete from this cylinder is struck off with steel floats. The contents of the cylinder are again filled with the sample in 5 cm layers. The concrete is being compacted by ramming and vibrating and then weighed to find compaction factor.

**Table 4.1 Compaction factor Test Result**

| S.NO | Description | Compaction factor value |
|---|---|---|
| 1 | Cement + perlite powder (5%) | 0.87 |
| 2 | Cement + perlite powder (10%) | 0.86 |
| 3 | Cement + perlite powder (15%) | 0.85 |
| 4 | Cement + perlite powder (20%) | 0.84 |

### 4.3 Compressive Strength Test for Cube

As per IS 516:1959 Compression test was carried out on the three samples in each proportion were tested and the strength was obtained as an average. The individual variation of specimens was not more than ± 15 percent of the average. The specimens stored in water were tested immediately on the removal from grid were wiped off the specimens and any projecting pins removed. The dimensions of the specimens were recorded before testing.

$fc = P/A\ N/mm^2$

Where,
P = Load at which the specimen fails in N.
A = Area over which the load is applied in mm².
f = compressive stress in N/mm².

**Compressive Strength of Cube:**

**Replacement:** Ceramic 5%, 10%, 15%,20%
**Size of cube:** 150x150x150 mm.

**Compressive Strength Tests**

The compressive strength of the concrete cubes with Bagasse ash of various proportions is found at the 7 and 28th day from the day of curing. The below Figure 4.1 shows the Failure of concrete during compressive test on concrete.

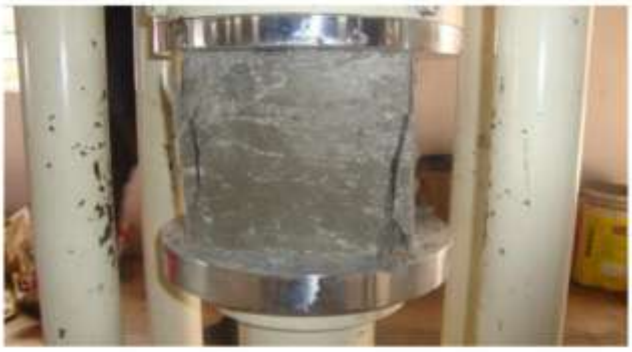

**Figure 4.1: Compressive Test on Concrete Cube**

**Table 4.2: For perlite Powder (5%) Replacement of Cement**

| Description | Day | Load (KN) | Strength (N/mm²) | Strength Mean value (N/mm²) |
|---|---|---|---|---|
| Cement+perlite powder(10%) | 7 | 1090 | 48.4 | 45.3 |
| | 7 | 980 | 43.5 | |
| | 7 | 990 | 44 | |
| | 28 | 1230 | 54.94 | 50.45 |
| | 28 | 1020 | 45.33 | |
| | 28 | 1150 | 51.1 | |

**Table 4.3: For perlite Powder (10%) Replacemen of Cement**

| Description | Day | Load (KN) | Strength (N/mm²) | Strength mean alue(N/mm²) |
|---|---|---|---|---|
| Cement+perlite Powder(5%) | 7 | 920 | 40.96 | 41.36 |
| | 7 | 940 | 41.79 | |
| | 7 | 930 | 41.34 | |
| | 28 | 960 | 42.68 | 43.41 |
| | 28 | 980 | 43.56 | |
| | 28 | 990 | 44 | |

**Table 4.4 for perlite powder 15%replacement of cement**

| Description | Day | Load (KN) | Strength (N/mm²) | Strength mean value (N/mm²) |
|---|---|---|---|---|
| Cement+perlite powder(15%) | 7 | 1030 | 46.1 | 49.84 |
| | 7 | 1210 | 52.34 | |
| | 7 | 1150 | 51.1 | |
| | 28 | 1240 | 55.71 | 56.35 |
| | 28 | 1290 | 56.16 | |
| | 28 | 1310 | 57.2 | |

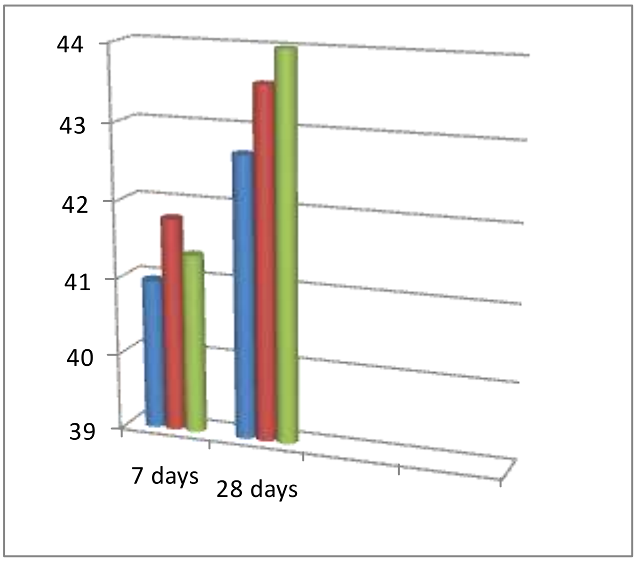


**Figure 4.2: perlite powder (5%) Compressive Strength (N/mm²)**

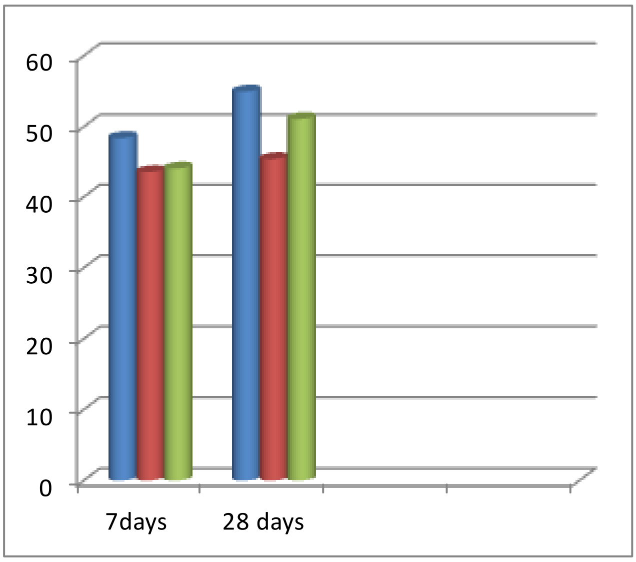


**Figure 4.3: perlite powder (10%) Compressive Strength (N/mm²)**

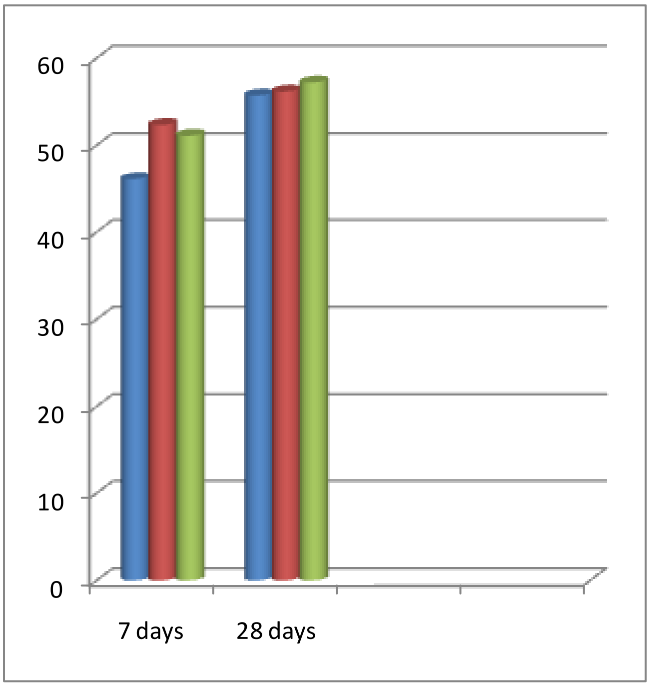


**Figure 4.4: perlite powder (15%) Compressive Strength (N/mm$^2$)**

**Comparison of 7 and 28 Days Compressive strength result**

**Table 4.5: Comparison of 7 Days Compressive Strength**

| S.NO | Replacement | Strength of mean value (N/mm$^2$) |
|---|---|---|
| 1 | Perlite powder (5%) | 41.36 |
| 2 | Perlite powder(10%) | 45.3 |
| 3 | Perlite powder(15%) | 49.84 |

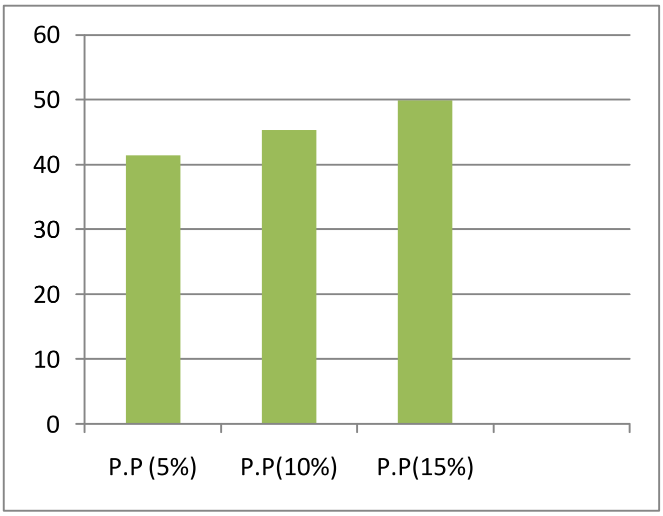


**Figure 4.5: Comparison of 7 Days Compressive Strength**

**Table 4.6: Comparison of 28 Days Compressive Strength**

| S.NO | Replacement | Strength of mean value(N/mm$^2$) |
|---|---|---|
| 1 | Perlite powder (5%) | 56.35 |
| 2 | Perlite powder (10%) | 50.45 |
| 3 | Perlite powder(15%) | 43.41 |

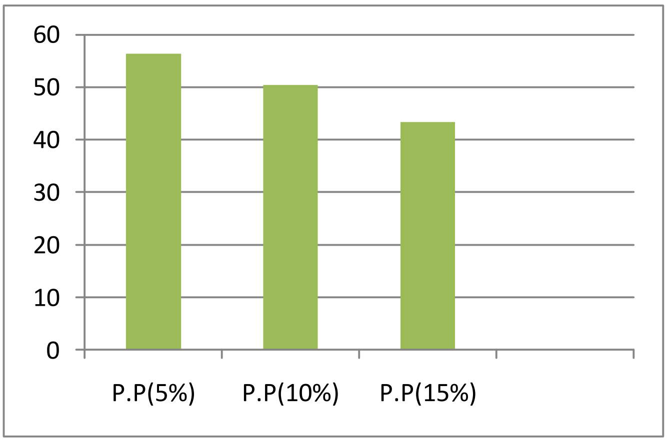


**Figure 4.6: Comparison of 28 Days Compressive Strength**

**CONCLUSIONS**

1. From this project maximum strength was achieved at a perlite powder(5%), perlite powder (10%), perlite powder (15%) replacement of concrete materials.
2. Replacement of perlite powder (5%) concrete cube attained the maximum strength of 56.35 N/mm$^2$ at 28 Days.
3. Replacement of perlite powder (10%) concrete cube attained the maximum strength of 50.45 N/mm$^2$ at 28 Days
4. Replacement of perlite powder (15%) concrete cube attained the maximum strength of 43.41 N/mm$^2$ at 28 Days.
5. In this experiment the replacement of perlite powder 10% gives optimum result.
6. Finally, this experiment when the replacement of the strength and the replacement of perlite powder increases the strength while increases the replacement of materials.

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