

EXPERIMENTAL STUDY ON COMPRESION AND TENSILE STRENGTH OF LIGHT WEIGHT CONCRETE USING PERLITE

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Abstract: Structural Lightweight Concrete is generally made by using artificial lightweight aggregates such as expanded clay, shale and slate. However, rapidly increasing fuel prices in recent decades and corresponding increase in the production costs of these aggregates have renewed the interest in natural lightweight aggregates such as pumice, scoria, rhyolite and perlite. This study investigates the mechanical properties and durability characteristics of lightweight concretes utilizing natural perlite aggregate in comparison to those of normal weight concrete of similar specific strength (structural efficiency). For this purpose, four concrete mixtures have been designed namely M1 (normal weight concrete with river sand as fine aggregate), M2 (normal weight concrete with M-sand or Robo sand as fine aggregate), M3 (normal weight concrete with partial replacement of cement by GGBS) and M4 (Perlite concrete by partially replacing of Perlite with sand as a percentage of 5%, 10% and 15%). 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 costs. An extensive testing program was conducted on concrete specimens to determine fresh properties such as unit weight and setting time; hardened properties such as compressive strength, split tensile strength. The results have shown that natural perlite aggregate and perlite powder can be satisfactorily utilized in the production of lightweight concrete with 28-day compressive strengths up to 50 MPa.

Key words: Perlite aggregate, Compressive strength, Split tensile strength

1. INTRODUCTION

Perlite powder is used as loose fill insulation in buildings construction, as it enhances fire levels and reduces noise transmission to buildings. There are many advantages interest in the use of lightweight fine materials, because of their association with cement paste and the compatibility among aggregates and cement paste seems not require to be carried into consideration for the design of the mix. As

composite materials, this character of concrete will head to a further homogeneous and cohesive material with a lesser of micro-cracks. In the mix design, the cement can be somewhat displaced by the natural pozzolan substances. All those materials and properties affect the properties of fresh and hardened concrete.

Fine aggregate is essential component of concrete and cement mortar. So, need for clean sand in the construction from the point of view of durability of structures. As the demand for Natural River sand is surpassing the availability, has resulted in fast depletion of natural sand sources. Robo sand is the answer for this problem especially when some states have already banned the use of river sand for construction. As per reports, Robo sand is widely used all around the world and technicians of major projects around the world insist on the compulsory use of Robo sand because of its consistent gradation and zero impurity.

2. Objectives and Scope

There are several objectives of this thesis.

- Structural lightweight concrete has low density compared to that of normal concrete. For structural application of lightweight concrete density is more important than its strength. A low density for the same strength level reduces the self weight and the construction cost. In the present study we will be comparing the strength of lightweight concrete with that of normal concrete by using Cement, GGBFS, Sand with normal and perlite aggregates. In this case we are partially replacing the aggregate with Perlite aggregate to make the structure more lighter with varying percentage. The investigations are carried out using various tests which include compressive test and split tensile test.

- First is to design a high strength lightweight concrete with natural perlite aggregate by using reasonable cement contents.
- second is to compare mechanical properties of these lightweight concretes with those of various normal weight concretes at similar specific strength.

3. MATERIALS USED

3.1 Cement

The Cement used for this experimental study is 43 grade Ordinary Portland Cement. All properties of cement are tested by referring IS 12269-1987.

3.2 Perlite

Perlite is an amorphous volcanic glass that has relatively high water content. It occurs naturally and has the property of highly expanding when heated sufficiently. It is an industrial mineral and a commercial product useful for its light weight after processing; the product expands four to twenty times its original volume. Perlite expansion is due to the presence of two to six percent combined water in the crude Perlite rock. When the crude oil is quickly heated to above 8700C (16000F), the product pops in a similar manner to popcorn.

3.3 Sand

Good quality natural river sand is used as fine aggregate. The sand is sieved in 2.36mm sieve as the sand passing through this sieve is use as fine aggregate. Zone of the fine aggregate used in this work is zone II.

3.4 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 sieve is used as coarse aggregate.

3.5 Water

Clean potable water conforming to IS 456-2000 was used in preparation of the concrete. The qualities of water samples are uniform. pH of water lies between 6 to 8 and the water is must be free of all acids, based and other dissolved salts.

4. METHODOLOGY

After selecting suitable materials, material properties were determine.

- **Batching-** weigh system should be adopted. Use of weigh system in batching, facilitates accuracy, flexibility and simplicity.
- **Mixing-** Hand mixing is practiced for small scale unimportant concrete works. As the mixing cannot be through and efficient, it is desirable to add 10% more cement to cater for the interior concrete produced by this method.
- **Placing-** For the purpose of predicting the compressive strength and split tensile strength, the concrete is placed in a steel mold of 150*150*150* mm and cylinder with 15 cm dia & 30 cm depth respectively.
- **Compaction-** Hand compaction of concrete is adopted for concrete work of small magnitude.
- **Curing-**concrete derives its strength by the hydration of cement particles. The hydration of cement is not momentary action but a process continuing for long time.

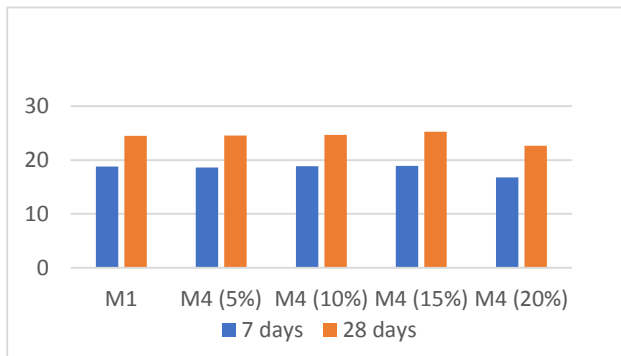
Varies tests to be carried out to know the strength of the Cube and cylinder, those are

- Compressive strength
- Split tensile strength

5. RESULTS

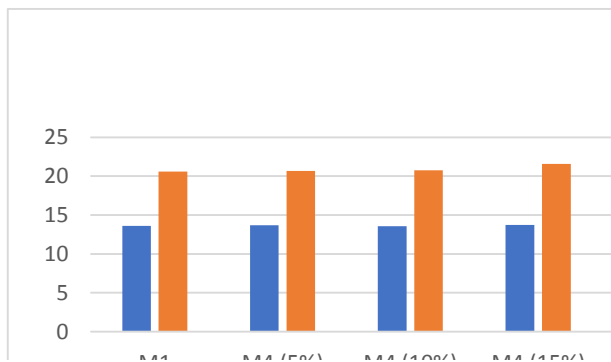
- 1) Compressive strength of cube with perlite

Mix Proportions	Compressive strength @7 days (N/mm ²)	Compressive strength @ 28 days (N/mm ²)
M1	18.81	24.52
M4 with 5% P	18.62	24.55
M4 with 10% P	18.88	24.68
M4 with 15% P	18.91	25.24
M4 with 20% P	16.78	22.65



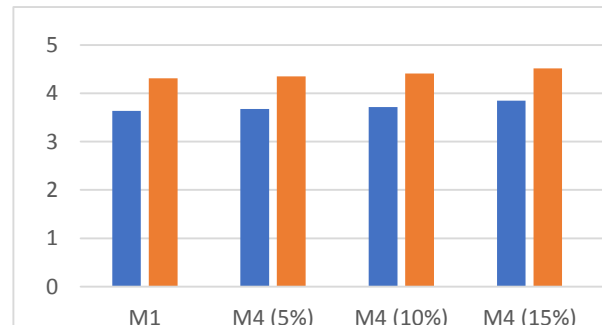
2) compressive strength of cylinder with perlite

Mix Proportions	Compressive strength @7 days	Compressive strength @ 28 days
M1	13.58	20.59
M4 with 5%P	13.68	20.68
M4 with 10%P	13.55	20.75
M4 with 15%P	13.72	21.56
M4 with 20%P	11.25	19.25



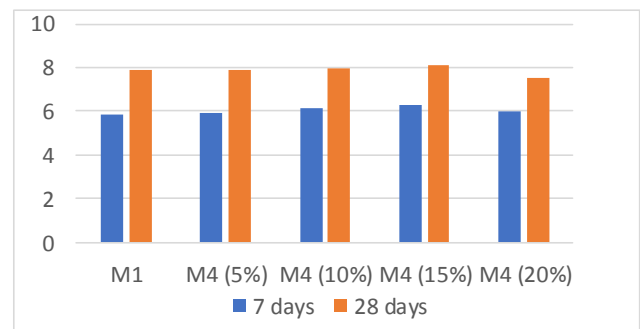
3) Split tensile strength of cube with perlite

Mix Proportions	Split tensile strength @7 days	Split tensile strength @ 28 days
M1	3.64	4.31
M4 with 5% P	3.68	4.39
M4 with 10% P	3.72	4.45
M4 with 15% P	3.85	4.73
M4 with 20% P	3.42	4.12



4) Split tensile strength of cylinder

Mix Proportions	Split tensile strength @7 days	Split tensile strength @ 28 days
M1	5.88	7.90
M4 with 5%P	5.95	7.93
M4 with 10%P	6.12	7.99
M4 with 15%P	6.26	8.08
M4 with 20%P	5.99	7.53



Weight

Weight of cube

Mix Proportions	weight in kg@7 days	Weight in kg @ 28 days
M1	8.1	8.5
M4 with 5% P	7.75	7.9
M4 with 10% P	7.6	7.6
M4 with 15% P	7.2	7
M4 with 20% P	6.9	6.7

Weight of cylinder

Mix Proportions	weight in kg@7 days	Weight in kg @ 28 days
M1	12.2	12.8
M4 with 5% P	11.9	12.1
M4 with 10% P	11.5	11.3
M4 with 15% P	10.7	10.8
M4 with 20% P	10.1	10.2

From above table, by utilizing the perlite in concrete the weight tends to decrease, which in turn makes the concrete light in weight.

6. CONCLUSIONS

The conclusions from the experimental study conducted in this thesis can be listed as below,

1. The compressive strengths of perlite aggregate increases with increasing perlite content.
2. The split tensile strengths of perlite aggregate increases with increasing perlite content.
3. Both compression and split tensile strength, 15% replacement of sand with perlite yields the highest strength
4. By utilizing the perlite in concrete the density tends to decrease, which in turn makes the concrete light in weight.
5. Natural perlite aggregate can be satisfactorily utilized in the production of high-performance lightweight concretes with 28-day by 15% replacement with sand.
6. Good-strength lightweight concretes of good workability characteristics can be produced by using natural perlite aggregate and high volume.
7. To achieve similar specific strength to that of normal weight concrete, lightweight concrete with natural perlite aggregate requires similar cement contents.

REFERENCE

1. *Bhuvaneshwari. K, Dr. Dhanalakshmi. G, Kaleeswari. G*, "EXPERIMENTAL STUDY ON LIGHTWEIGHT CONCRETE USING PERLITE", Apr -2017.
2. *Dr. Ola Adel Qasim*, "PERLITE POWDER AND STEEL FIBER EFFECTS ON PROPERTIES OF LIGHT WEIGHT CONCRET" January 2018.

3. *S.Rukmangadhara Rao, G.Himali Kumari, N.Vidya Sagar lal*, "STUDY ON STRENGTH OF CONCRETE USING ROBO SAND AS A PARTIAL REPLACEMENT OF FINE AGGREGATE", December 2015.
4. *Eser, Hasan*, "HIGH PERFORMANCE STRUCTURAL LIGHTWEIGHT CONCRETE UTILIZING NATURAL PERLITE AGGREGATE AND PERLITE POWDER", February 2014.
5. *M.Dhawal Desai, Institute of Technology Bombay*, "EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF PERLITE".
6. *Rahul & Shanil, University of Calicut*, "DEVELOPMENT OF LIGHTWEIGHT CONCRETE USING PERLITE".
7. *Hudson, B. P.*, "MANUFACTURED SAND FOR CONCRETE", May 1997.
8. *Ilangovana R, Mahendrana N and Nagamanib K* "STRENGTH AND DURABILITY PROPERTIES OF CONCRETE CONTAINING ROBO SAND AS FINE AGGREGATE", October 2008.