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Experimental Study of Light Weight Concrete by Partial Replacement of Coarse Aggregate Using Pumice Aggregate

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Abstract: ***Light weight concrete has many applications in concrete and construction industry now a days. In this Study an attempt has been made to compare the conventional concrete and light weight aggregate concrete using mix M25. Light weight concrete is made by Partial replacement of Coarse Aggregate with different ratios of Pumice ranging from 50%, 60% and 70%. This study is focused to determine the strength parameters of light weight aggregate concrete to find the favorable replacement with the above mentioned replacements. The results are compared with conventional concrete.***

Keywords: Light Weight Concrete, Pumice, Strength

1. Introduction

Structural lightweight aggregate concrete is an important and versatile material in modern construction [1]. It has many advantages of dead load reduction, high thermal insulation; increase the progress of building and lowers haulage and handling cost [3]. If floors and walls are made up of light weight concrete, it leads to economy of structure. It also lowers power consumption for extreme climatic condition due to possessing property of low thermal conductivity.

Nowadays lightweight concrete are commonly used in precast and prestressed components. Light weight concrete offers design flexibility and substantial cost savings by providing less dead load, improves seismic structural response, better fire rating, decreased storey height, smaller size structural members, lower foundation cost, and less reinforcing steel [1].

The highly porous microstructure of light weight aggregate gives it low density and better insulation and make that the concrete made with light weight concrete exhibit lower thermal conductivity than that of normal weight concrete [2]. Therefore light weight concrete provide more efficient fire protection than dense aggregate as it is less liable to spalling and has a higher thermal insulation[2]

The LWC has been widely across other countries such as USA, UK and Sweden [3]**.** Light weight concrete plays an important role in structural engineering and its use is steadily increasing. It is defined as a type of concrete which includes an Expanding agent in that it increases the volume of mixture [3]. It is lighter than conventional concrete with dry density of 300kg/m^3 upto 1840kg/m^3 [3]. The reduction in weight by use of light weight concrete will be advantageous, especially for building structures.

Pumice:

Pumice stone is a natural lightweight aggregate which is formed by the sudden cooling of molten volcanic matter. Pumice is formed during the volcanic eruption of viscous magma, mostly siliceous and rich in dissolved volatile constituents, especially water vapour .Their treatment is only via mechanical handling, crushing and screening.

Figure 1: Pumice Aggregate

Larger volume of concrete can be handled by lighter Equipment with less wear and tear on the equipment. Light Weight Pumice concrete also reduces the live load of formwork and false work.

Pumice Concrete delivers a high fire – rating the standard concrete and will not spall under contact with direct flame. Thermal conductivity is low in Pumice Concrete. Acoustical ratings are higher for pumice Concrete as well. It has Superior resistance to harsh Weather conditions like freezing and thawing.

The superior Water absorption/desorption Characteristics of Pumice that the moisture held in the interior of the Pumice Aggregate is not immediately available for chemical interaction with cement so it extremely beneficial in maintaining longer period of curing resulting better strength and reduced Permeability in the final concrete.

The mixing is difficult in Pumice Aggregate compared to normal concrete. Pumice Aggregate should be uniformly pre wet to reach total saturation, then to be allowed to sit while excess water drain out. This will fill the internal voids of the Pumice with water. Pre wetting the mix will

prevent drying of aggregate at site and reduce shrinkage cracks. Avoid over vibrating or over finishing in Pumice concrete. When using normal concrete, segregation and over finishing causes the paste to come to the top. With pumice Concrete it's the Coarse Pumice particle that floats to the top. Curing is similar as normal concrete. Form removal should be delayed for an additional 24 hours for Pumice concrete as compared to normal concrete.

2. Materials and Methods

2.1. Materials

2.1.1Cement:

Ordinary Portland Cement (53 Grade) with 29% normal consistency conforming to IS: 8112-1989 [3] was used. The specific gravity and fineness modulus of cement are 3.14 and 5% respectively.

2.1.2 Coarse Aggregate:

Crushed stone coarse aggregate conforming to IS 383 – 1987 was used. The values of loose and compacted bulk density values of coarse aggregates were 4.417 kg and 4.905kg, respectively & physical properties are also determined.

2.1.3 Fine aggregate:

River sand was used throughout the investigation as the fine aggregate conforming to grading zone III. The properties of sand by conducting tests according with IS 2386(part -1) -1963. The Specific gravity, fineness modulus and moisture content were determined.

2.1.4 Pumice Aggregate

Pumice aggregate 20 mm sizes were used. Specific gravity of Pumice aggregate used is 0.82.

2.1.5 Water

Water is an important ingredient of concrete as it actively participates in chemical reactions with cement. Clean potable water conforming to IS 456 – 2000 was used for the preparation of concrete mixture.

2.2 Concrete Mix Design:

In the present study, M25 grade with nominal mix as per IS 456-2000 was used. Concrete mix proportion by weight for $1m^3$ and water cement ratio of 0.5.Table 1. Gives the mix used for study.

Table 1: Mix proportions

S. No	Cement	Water	Fine aggregate	Coarse Aggregate
Normal concrete	1	0.5	1.56	3.12
LWC	1	0.5	2.86	1.27

2.3 Casting and Testing

Pumice was added in concrete in step of (50%, 60%, 70%).The percentage of replacement are arrived with trial study using Pumice. For each percent of Pumice replacement as coarse aggregate, cubes & cylinders were cast. Final strength of cube & cylinder are tested for 7 days, 14 days & 28 days curing. The average compressive strength and tensile strength are then determined for each mix proportions and are discussed in the result and discussion.

3. Results and Discussions

3.1 Test results of Compressive test

The cube specimens are tested for compressive strength at the end of 7days, 14days, and 28days.

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

The results of the compressive strength tests on concrete cubes are shown in Table 2(a) and Figure1

Table 2(a): Test result of Compression Strength

SI.NO	Percentage replacement of Pumice	Average Compressive Strength N/mm^2		
		7 Days	14 Days	28 Days
1	0%	21.78	24.2	25.5
2	50%	9.33	10.36	13.32
3	60%	15.5	17.22	22.14
4	70%	6.2	6.89	8.85

Comparison of Compressive strength results

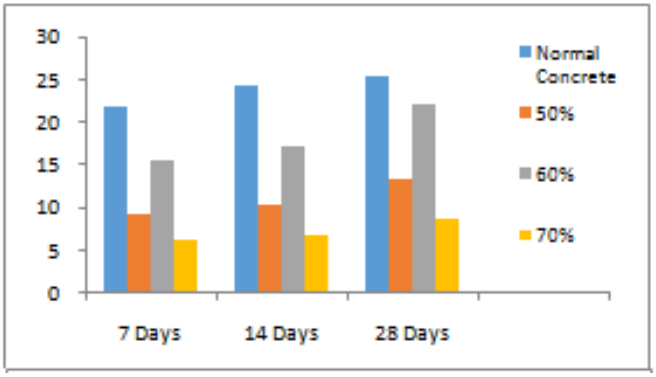


Figure 2: Compression Test on Cubes

3.1 Test results of tensile test:

The cylinder specimens were tested for tensile strength at the end of 7days, 14days, and 28days.
The Tensile strength of the specimen was calculated by using the formula
Tensile strength = $2P/\pi LD$
The results of the tensile strength tests on concrete cubes are shown in Table 2(a), (b) and Figure 2

Figure 3: Split tensile Test on cylinders

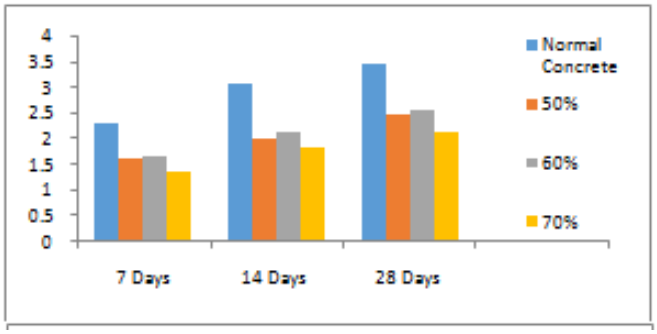
Table 2(a): Test Result of Split Tensile Strength

Normal Concrete	Average Compressive Strength N/mm^2		
	7 Days	14 Days	28 Days
M_{25}	2.312	3.06	3.43

Table 2(b): Test Result for Split Tensile Strength

SI. NO	Percentage replacement of Pumice	Average Compressive Strength N/mm^2		
		7 Days	14 Days	28 Days
1	0%	2.312	3.06	3.43
2	50%	1.62	1.98	2.48
3	60%	1.65	2.123	2.54
4	70%	1.38	1.84	2.123

Comparison of tensile strength results



4. Conclusions

Based on the experimental investigations concerning the compressive strength and split tensile strength of concrete, the observations and the following conclusions are drawn from the present study.

- Compression strength value is compared to normal concrete and replacement of Coarse aggregate by Pumice from different percentages (50%, 60%, 70%).
- Maximum value of strength is obtained in 60% replacement of Pumice with coarse aggregate.
- Concrete with 60% replacement of pumice the compressive strength is comparable with normal concrete.
- This type of concrete can be utilized in wall panels of non load bearing type for use in precast buildings.

5. Scope for Further Study

Seeing the advantages of light weight concrete, further investigation will be carried out with this aggregate in casting of wall panels and their behavior can be studied for non load bearing walls under different load conditions.

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