PERFORMANCE OF PUMICE STONE AND VERMICULITE IN LIGHT WEIGHT CONCRETE

Ms.Jayashree A[1], MS. Anitha A[2], Ms. Sofia G[3]
[1,2,3]Assistant professor, Department of Civil Engineering,
Mount Zion College of Engineering And Technology, Pudukkottai.

Abstract - This paper is an experiment to study the behavior and performance of concrete, when incorporating vermiculite and pumice stone in concrete. Vermiculite was a full replacement of fine aggregate and pumice stone partial amount of course aggregate replaced by pumice stone. All required test on potential materials were done as per is specification. This test results were compared with conventional material and the optimum levels of replacement also been studied to prepare a proper concrete. For this project M30 (i.e. 1:1:1.4) grade concrete mix with 0.4 water/cement ratio was adopted. To find the correct replacement percentage of pumice stone concrete cubes were casted with of various percentages of pumice stone added from 0% to 20% with the interval of 2%. Sample compressive test was done on this cubes and along vermiculite fatherly preceded with the maximum strength given interval mixes. Maximum compressive strength attained at 16% replacement and Maximum split tensile strength attained at 16% replacement. All the tests were conducted as per IS specifications.

***Key Words*: Compressive strength, Split tensile strength, Pumice stone and vermiculite.**

1. INTRODUCTION

Concrete is world's most consumed material due to it's excellent mechanical and sturdiness properties. at the present , concrete industry is stuck with the scarcity of the aggregates and environment pollution from cement production. The cement industry features a significant contribution in heating because combustion of fuel within the cement kiln and therefore the electricity used for grinding the clinker, emit great deal of CO2. A statistics says that production of 1 ton of cement produce one tone of CO2. Taking altogether stages of production, concrete is claimed to be liable for 4-8% of the world's CO2. Half of concrete's CO2 emissions are created during the manufacture of clinker, the most-energy intensive a part of the cement-making process. Cement industry is liable for about 5% of worldwide CO2 emissions.

Worldwide, the production of cement increases every year. Different countries of the world has different rate of producing cement (at 2017), for instance

1. China produces 2.4 billion metric tons of cement per year
2. India produces 280 million tons of cement per year.
3. United States produces 86.3 million metric tons of cement per year.

These numbers increases with the increase of construction development

Furthermore, the world is changing faster than ever before. The whole of construction industry is shaken up by the increasing population of 200,000 people per day; all of them need affordable housing as well as social, transportation and utility infrastructure. To face such challenges, the industry is almost under pressure to transform. Transformation will have effects within the society, by reducing construction costs on the environment, by improving the utilization of scarce materials and over the economy by narrowing the worldwide infrastructure gap and improving economic development in general gradually.

Pumice stone - Typically light colored igneous rock that consists of highly vesicular rough textured volcanic rock like formed when super-heated, highly pressurized rock is violently ejected from a volcano is named as pumice. The foamy nature of pumice happens due to simultaneous rapid cooling and rapid depressurization where depressurization creates bubbles like structure giving pumice stone a foamy structure.

Vermiculite - Significant expansion of a hydrous phyllosilicate mineral when heated is Vermiculite. In industry Exfoliation method is used to form vermiculite, where the mineral is heated sufficiently in commercial furnaces to routinely produce this effect. Formation of Vermiculite is by the weathering or hydrothermal alteration of biotite or phlogopite. Vermiculite is used spray-applied fireproofing materials.

1.1 Research significance

- An alternative way to use pumice stone in construction by incorporating them into concrete.
- It is the aim of this experiment is to introduce an environmental friendly technology, which can benefit the society and the nation. Volcanic material in concrete construction is a best technology for disposal problems

1.2 Potential materials for concrete

The following materials are used in concrete:

a) Cement - 53 grade Ordinary Portland Cement with 3.12 specific gravity was used.
b) Fine aggregate - Zone II river sand with specific gravity of 2.64 was used. Size not greater than 4.75.
c) Coarse aggregate - Specific gravity of 2.75 was used.
d) Pumice stone – Pumice stone is a highly porous volcanic rock, Specific gravity of pumice stone is 1.67.

e) Vermiculite – vermiculite is a mineral hydrous phyllosilicate Specific gravity of vermiculite is 2.51.

2. M30 MIX PROPORTION

Mix design of M30 grade concrete mix was designed As per IS 10262:1982

Table - 1 Concrete Proportion

Cement	Fine aggregate	Coarse aggregate	Water
329 kg/m^3	329 kg/m^3	461 kg/m^3	107 liters
1	1	1.4	0.4

3.TEST ON CONCRETE

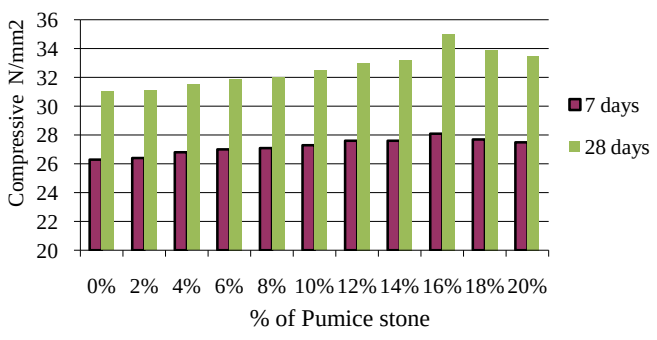
3.1 Sample compression strength test

Sample compression test was conducted to obtain the optimum dosage values of pumice stone. Average compressive strength obtained at 7th and 28th day by taking average of specimens for each day are compiled below. Cube size – 150 x 150 x 150mm.

Table - 2 Sample compressive strength at 7 and 28 days

S.No	% of replacement	Compression value (N/mm^2)	
		7th day	28th day
1	0 %	26.3	31
2	2 %	26.4	31.1
3	4 %	26.8	31.5
4	6 %	27	31.9
5	8 %	27.1	32
6	10 %	27.3	32.5
7	12 %	27.6	33
8	14 %	27.6	33.2
9	16 %	**28.1**	**35**
10	18 %	27.7	33.9
11	20 %	27.5	33.5

Figure - 1 Sample compressive test



By this sample test high strength obtained at 16% replacement of pumice stone. So followed by the test result 15%, 16% and 17% were recommended for further compressive and split tensile test along with vermiculite.

VTPS A - 100% Vermiculite (fine) + 15% Pumice (course)
VTPS B - 100% Vermiculite (fine) + 16% Pumice (course)
VTPS C - 100% Vermiculite (fine) + 17% Pumice (course)

3.2 Workability test

Slump test: Generally slump test is used to determine the workability of concrete. Here 0%, 15%, 16%, and 17% pumice stone fresh concrete used. The test was followed as per IS 1199-1959.

Figure - 2 Slump test

Table- 3 Slump test

S.NO	Type of concrete	Sample value (cm)
1.	CC	2
2.	VTPC 1	3
3.	VTPC 2	2
4.	VTPC 3	4

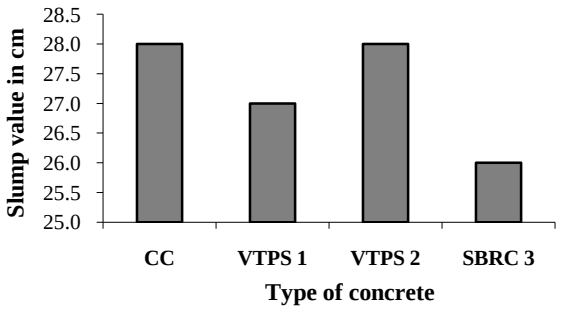


Figure - 3 Slump test graphical representation

3.3 Compression Test

Compressive value at 7th and 28th days were obtained by taking average test values of specimens for each day are compiled below.

3.4 Split Tensile Test

Based on IS 516-1959 split tensile test was conducted, size of cylinder specimen is 150mm height and 300mm diameter.

Figure - 4 Compressive strength test

Table-4 Compressive and spilt tensile strength at 7 and 28 days

S.No	Mix type	Compressive strength (N/mm^2)	
		7 days	28 days
1.	CC	26.1	31
2.	VTPS 1	27.5	33.9
3.	VTPS 2	**28.5**	**35**
4.	VTPS 3	27.2	33.5
S.No	**Mix type**	**Spilt tensile strength (N/mm^2)**	
		7 days	**28 days**
1.	CC	3.6	4.49
2.	VTPS 1	4.87	5.18
3.	VTPS 2	**4.76**	**5.63**
4.	VTPS 3	4.1	5.36

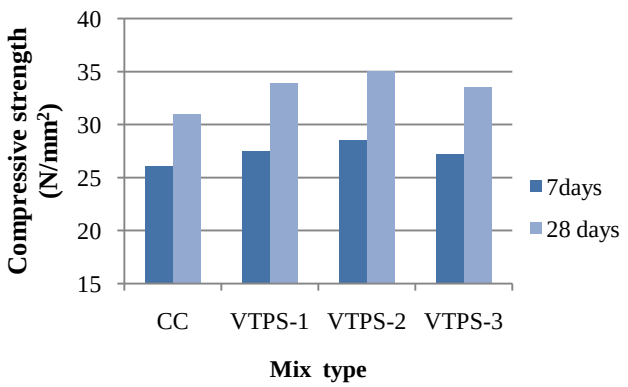


Figure - 5 Compression values at 7th and 28th day

Figure - 6 Split tensile test

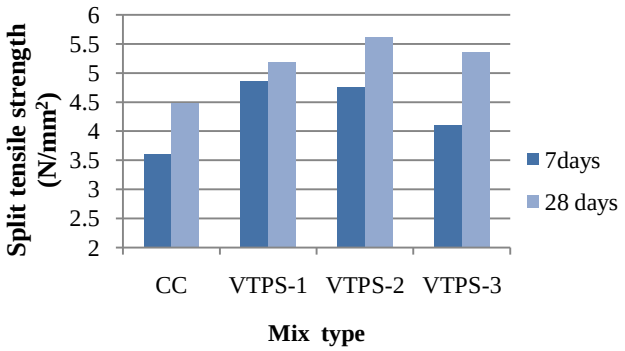


Figure - 7 Split tensile values at 7th and 28th day

3.5 Weight reduction test

VTPS 3 mix gives high weight reduction compared with other dosages. Which shows the increase of pumice stone decrease the weight of concrete but after some point strength also decrease.

Table-5 Weight Reduction

S.NO	Type of concrete	Weight Reduction (g)
1.	CC	8505
2.	VTPS 1	7959
3.	VTPS 2	7840
4.	VTPS 3	7750

4. CONCLUSION

The main aim of this investigation is study and evaluate the performance of pumice stone and vermiculite replaced concrete.

Tests for all potential materials were carried out. Properties cement, pumice stone, vermiculite And other material was found by various tests.

Mix design was prepared as per the IS 10262:1982 for M30 grade concrete.

Cubes, cylinders and beams with different proportion of pumice stone and vermiculite were casted by proper sequence.

Then obtained compressive and tensile strength values are compared with conventional concrete.

Cube size for compressive strength is 150*150*150mm .

7th day compressive strength test results, conventional concrete has strength of 26.1 N/mm² and VTPS B has 28.5N/mm² which was 5% higher than conventional concrete and higher than the other dosages.

28th day compressive strength test results, conventional concrete has strength of 31N/mm² and VTPS B have 35N/mm² which was higher than conventional concrete and higher than the other dosages.

Cylinder size is 150mm diameter and 300mm height for split tensile strength

7th day split tensile test results, it was observed that conventional concrete has attained a tensile strength of 3.6 N/mm^2 and VTPS B has 4.76 N/mm² which was higher than conventional concrete and other dosages.

28th day split tensile test results, it was observed that conventional concrete has attained a tensile strength of 4.49 N/mm^2 and VTPS B has 5.63 N/mm² which was higher than conventional concrete.