International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Experimental Investigation on Strength Properties of Rice Husk and Silica Fume as Mineral Admixtures for Vermiculate Concrete

Dr. G. Prabhakaran[1], Chinnakotti Sasidhar[2]
[1]Professor, Department of Civil Engineering, Siddharth Group of Institutions, Puttur, Chittoor (Dist.), Andhra Pradesh, India-517 583
[2]Assistant Professor, Department of Civil Engineering, Siddharth Group of Institutions, Puttur, Chittoor (Dist.), Andhra Pradesh, India-517 583
Email address: {[1]gprabhadhana, [2]nagarajasasidhar}@gmail.com

***Abstract*—** *Concrete is quickly utilizing building material all through the world. Concrete is utilized as a part of immense sums since it is just and to a great degree great building material. In numerous spots of the world the temperature is rising step by step. Now-a-days because of steady sand mining the regular sand is draining at a disturbing rate. For this situation fine total is mostly substitution of vermiculite. Utilization of vermiculite in solid it will upgrade the shrinkage and break protection, imperviousness to fire and decreases natural effect and furthermore diminish the cost. In this present study, an attempt has been made to study the mechanical properties of M20 grade concrete with different percentages at a range of 10%, 20%, 30% and 40% as partially replacement with vermiculite to the total weight of fine aggregate along with mineral admixtures like Rice Husk Ash is replace with cement by various percentages i.e., 2%, 4% and 6% and silica fume as adding of 5%, 10% and 15% by weight of cement. It has been experiential that the required strengths are achieved at optimum percentage of compressive strength i.e. 10% silica fume is addition and 4% Rice Husk Ash replacement by weight of cement and optimum percentage of split tensile strength i.e. 10% silica fume is addition and 4% Rice Husk Ash replacement by weight of cement. Water cement ratio is 0.45.Water cement ratio is put constant for all trail mixtures.*

***Keywords*—** *Exfoliated Vermiculite, Silica Fume, Rice Husk Ash, Compressive Strength, Split Tensile Strength, Flexural Strength*.

I. INTRODUCTION

Vermicular is associate Italian word for worm from that it's ensuing its name as vermiculite. Some institution quotes the Latin word vermiculate from that the original name vermiculite may be enforced. Vermiculite may be a hydrous phyllosilicate mineral cluster and is micaceous in surroundings. Vermiculite is created by weathering or hydrothermal alteration of is in glass or is in glass. Exfoliated vermiculite is gettable in 5 totally different grades that are based mostly upon weight instead of particle size.

Generally, vermiculite can resist the temperature upto 1200^0C and it has high thermal insulation co-efficient greater than 0.046 W/m^{0}C. Because of these properties vermiculites are added in concrete by replacing aggregates by 10%, 20%, 30% and 40% by weight and their strength parameters are found.

II. OBJECTIVES OF THE STUDY

The objectives of the present study are:

- To study about the quality properties with expanding the rate estimations of vermiculite.
- To study about the expanding in quality properties by including mineral admixtures.
- To study about the ideal rate shifting at various rate estimations of mineral admixtures like silica smoke and fly fiery debris.
- To study about the mass thickness and solid shapes weight at different substitution levels of vermiculite.

III. MATERIALS & PROPERTIES

3.1 Vermiculite

Vermiculite is a hydro phyllosilicate mineral. It undergoes significant expansion when heated. Vermiculite is chosen to replace fine aggregate in concrete because of its specific properties such as light in weight, improved workability, improved fire resistance, improve resistance to cracking and shrinkage and mainly inert chemical nature. Vermiculites taken for Concrete preparation with pass through 2.36mm sieve size. The properties are listed in table 1.

TABLE 1. Proportions of vermiculite.

S.No	Properties	Values
1	Fineness modulus	2.46
2	Specific Gravity	0.65
3	Moisture content	0
4	Water absorption	2.1

3.2 Cement

Ultra-tech Ordinary Portland Cement (OPC) of 43 grade of Cement conforming to IS: 12269 - 1987has been procured and various tests have been carried out according IS: 8112-1989. The properties are listed in table 2.

TABLE 2. Proportions of cement.

S.No	Properties	Values
1	Sp. gravity	3.15
2	Normal Consistency	35 %
3	Setting Time i) Initial Setting time ii) Final setting time	 35 Min 6 hours

Dr. G. Prabhakaran and Chinnakotti Sasidhar, "Experimental investigation on strength properties of rice husk and silica fume as mineral admixtures for vermiculate concrete," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 2, pp. 312-315, 2018.

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

3.3 Fine Aggregate

The locally available natural river sand is procured and is found to be confirmed to grading zone-II as per table 4 of IS 383-1970. Various tests have been carried out as per the procedure given in IS 383(1970). The properties are listed in table 3.

TABLE 3. Fine aggregates constituents.

S.No	Properties	Value
1	Specific Gravity	2.65
2	Fineness Modulus	3.9
3	Bulk Density (Loose)	15.50 kN/m^3
4	Grading of Sand	Zone – II

The particle size distribution of sand was determined and the grading curve for upper and lower limit of zone-II sand and the fine aggregate used for Concrete preparation is drawn. The results of Sieve Analysis values are presented in fig. 1.

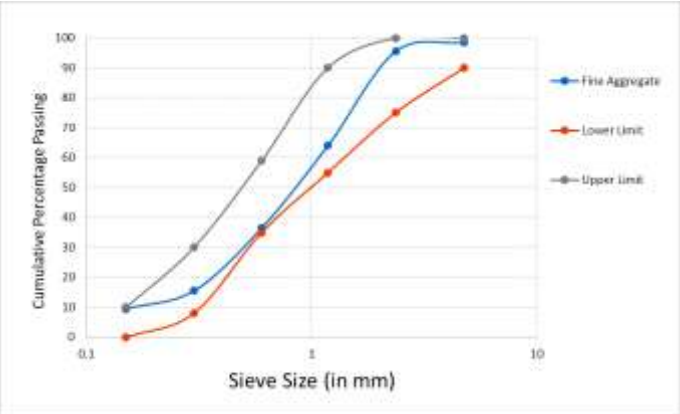

Fig. 1. Sieve analysis distribution graph.

3.4 Coarse Aggregate

As per IS 383-1970 the coarse aggregates which are crushed with machine consisting 20 mm maximum size of aggregate has been obtained from the local quarry. It has been tested for various properties and the results are given in the table 4.

TABLE 4. Coarse aggregate physical properties.

S.No	Properties	Result
1	Specific Gravity	2.65
2	Loose (Bulk Density)	14.75 kN/m^3
3	Water Absorption	0.45%
4	Fineness Modulus	7.8

3.5 Water

Local Drinking water free from impurities has been used in this experimental program for mixing and curing.

3.6 Silica-Fume

Silica-Fume is a highly pozzolanic mineral admixture, which is mainly utilized to improve concrete strength and durability of concrete. Silica-Fume reacts with calcium hydroxide formed during hydration of cement results in the increase in strength and also the Silica-Fume fills the voids between cement particles leads to increase in the durability. In this experimental program cement is replaced by 5%, 10% of Silica-Fume. The properties of Silica-Fume are given in table 5 and sample of silica fume used for concrete mix is as shown in fig. 2.

TABLE 5. Properties of silica-fume.

S.No.	Characteristics	ASTM-C-1240	Analysis Results
1	SiO_2(Min)	85%	90.20%
2	LOI (Max)	6%	2.80%
3	Moisture (Max)	3%	0.20%
4	Pozzolanic Activity Index (Min)	105%	127%
5	Specific surface Area (m^2/gm)	> 15	> 21
6	Bulk density (Kg/m^3)	550 to 700	604
7	> 45 Microns (Max)	10%	0.20%

Fig. 2. Silica fume sample.

3.7 Rice Husk Ash

Rice husk ash used in the present experimental study was obtained from Narayanavanam village, Puttur, Chittoor District, Andhra Pradesh. The Rice husk ash is amorphous in nature. Rice husk are the shells which are removed from the paddy during dehusking of paddy. Rice husk is useless from the domestic and agricultural point of view. It cannot be even used for feeding animals as its nutritional value is negligible. When burnt an ash is produced which is known as rice husk ash which has been found Pozzolanic in nature by researchers. The rice husk ash used for the mix design is as shown in fig. 3.

Fig. 3. Rice husk ash before and after burnt.

IV. MIX DESIGN

The quantities of various materials for one cum of M20 grades of concrete prepared with various combinations are presented in table 6 respectively.
For 1m^3 of concrete are:

Dr. G. Prabhakaran and Chinnakotti Sasidhar, "Experimental investigation on strength properties of rice husk and silica fume as mineral admixtures for vermiculate concrete," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 2, pp. 312-315, 2018.

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

TABLE 6. Mix proportions for $1m^3$ concrete.

Concrete	Cement (kgs)	Water (lits)	w/c	Robo Sand (kgs)	Fine Aggregate (kgs)	Coarse Aggregate (kgs)
Control	360	197	0.55	-	693	1110
20% Robo Sand	360	153	0.55	138.6	554.4	1110
40% Robo Sand	360	153	0.55	277.2	415.8	1110
60% Robo Sand	360	153	0.55	415.8	277.2	1110

V. EXPERIMENTAL PROCEDURE

5.1 Curing of Test Specimens

After the casting of cubes, cylinders and prisms, the specimens are taken from the mould after one day of casting of concrete specimens. Marking has been done on the specimens for identification. To maintain the constant moisture on the surface of the specimens, they are placed in water tank for curing. All the specimens have been cured for the desired age. Concrete cube specimens are cured for 3, 7, 28 and 56 days. M20 grade of concrete cylinder specimens and cubes were cast.

5.2 Tests on Nano-Silica and Silica-Fume Concrete

5.2.1 Compression strength test

Compression test is the most common test conducted on hardened concrete, and most of the desirable characteristic properties of concrete are predominently related to compression strength of specimen. Compression test is carried out on specimen of cubical or cylindrical in shape. Compression test is done confirming to IS: 516-1959. All the concrete specimens are tested in a 200 tones capacity of the CTM machine. And now the concrete cubes of size 150mm × 150mm × 150mm were tested for compressive strength. Compressive strength of concrete is determined by applying load at the rate of 140kg/sq.cm/minute till the specimens failed.

Fig. 4. Cube compression test.

After 3, 7, 28 and 56 days of curing, cube specimens were removed from the curing tank and cleaned to wipe off the surface water. Cubes were tested at the age of 3, 7, 28 and 56 days using compression testing machine as shown. The maximum load to failure at which the specimen fails was noted. The test was conducted for the three specimens and the average value was taken as the mean compressive strength and as shown below fig. 4.

5.2.2 Split tensile strength test

This test is conducted in a 200 tones capacity of the compression-testing machine by placing the cylindrical specimen of the concrete as shown in fig No-5, so that its axis is horizontal between the plates of the testing machine. Experimental setup for Split tension test is shown. The load was applied uniformly at a constant rate until crack occurs along the diameter in vertical takes place. Load at which the specimen failed is recorded. The following relation is used to find out the split tensile strength of the concrete

$$Ft = 2P/\pi DL$$

Where P = Compressive load on the cylinder
L = Length of the cylinder
D = Diameter of the cylinder

Fig. 5. Split tensile strength.

VI. TEST RESULTS & DISCUSSIONS

The test results and discussions of M20 grade concrete are as follows:

6.1 Investigation Results of Compressive Strength Test

Variation in the compression strength of Cube and Cylinder specimens with Silica Fume (SF) and Rice Husk ash (with Vermiculite) are tabulated below for M20 Grade of concrete specimens.

The improved test of the cube compressive strength with the age of M20 grade concrete prepared using the various proportions of Rice Husk ash and Silica Fume (with Vermiculite) are tabulated in table 7. The compressive strength can be obtained from taking average of three test results. The test results obtained shows that the compressive strength of Silica Fume (SF) and Rice Husk Ash (RH) concrete exhibits more than the control concrete and there is a

Dr. G. Prabhakaran and Chinnakotti Sasidhar, "Experimental investigation on strength properties of rice husk and silica fume as mineral admixtures for vermiculate concrete," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 2, pp. 312-315, 2018.

gradual increase up to 4% and 10% of Rice Husk Ash and Silica Fume with increasing further content the strength decreasing for the given content.

TABLE 7. Cube compressive strength of M20 grade concrete.

Concrete	Compressive Strength (MPa)		
	3 Days	7 Days	28 Days
Control Concrete	9.32	14.12	28.25
10% VC; (2%RH+5%SF)	11.03	16.72	33.45
10% VC; (4%RH+10%SF)	12.37	18.75	37.50
10% VC; (6%RH+15%SF)	11.74	17.8	35.60
20% VC; (2%RH+5%SF)	11.26	17.07	34.15
20% VC; (4%RH+10%SF)	12.95	19.62	39.25
20% VC; (6%RH+15%SF)	12.57	19.06	38.12
30% VC; (2%RH+5%SF)	11.28	17.1	34.20
30% VC; (4%RH+10%SF)	12.04	18.25	36.50
30% VC; (6%RH+15%SF)	10.60	16.07	32.15

6.2 Investigation Results of Split Tensile Strength Test (STS)

The split tensile strength of M20 grade of control concrete are presented in table 8. The Split Tensile strength can be obtained from taking average of three test results. The test results obtained shows that the tensile strength of Silica Fume (SF) and Rice Husk Ash (RH) concrete exhibits more than the control concrete and there is a gradual increase up to 4% and 10% of Rice Husk Ash and Silica Fume with increasing further content the strength decreasing for the given content.

TABLE 8. Tensile strength of M20 grade concrete.

Concrete	Tensile Strength for 28 Days (in MPa)
Control concrete	2.35
10% VC; (2%RH+5%SF)	2.79
10% VC; (4%RH+10%SF)	3.13
10% VC; (6%RH+15%SF)	2.97
20% VC; (2%RH+5%SF)	2.85
20% VC; (4%RH+10%SF)	3.27
20% VC; (6%RH+15%SF)	3.18
30% VC; (2%RH+5%SF)	2.85
30% VC; (4%RH+10%SF)	3.04
30% VC; (6%RH+15%SF)	2.68

VII. CONCLUSIONS

Using the results of the experimental investigation, it can be concluded that with the various strength characteristics of concrete are increased to maximum extent i.e., compressive strength by 39.25 kN/m^2 and split tensile strength by 3.27$kN/^2$ (20%Vermicullite, 4% Rice Husk ash and 15% Silica Fume), with further addition of proportions the various strength characteristics of concrete are decreased for various percentages of Silica Fume and rice husk ash. Along with these the CO_2 emissions are also controlled for sustainable environment.

REFERENCES

[1] Indian standard recommended guidelines for concrete mix design IS 10262-1982.
[2] Dinesh A, PadmanabanI and Maruthachalam M, "Study on low density concrete with partial replacement of coarse aggregate," *International Journal of Modern Trends in Engineering and Science*, vol. 3, issue 8, pp. 97-100, 2016.
[3] Dharma Prakash R and Dr. Sreevidya V, "Effect and strength behaviour study of concrete on using low density aggregates," *International Journal of Modern Trends in Engineering and Science*, vol. 3, issue 8, pp. 167-170, 2016.
[4] S. Sharmila and L. Vijayan, "Experimental investigation on thermo proof construction using vermiplast," *World Journal of Engineering Research and Technology*, vol. 2, issue 3, pp. 96-101, 2016.
[5] Hariharan A R, Santhi A S, and Mohan Ganesh G, "Study on strength development of high strength concrete containing fly ash and silica fume," *International Journal of Engineering Science and Technology*, vol. 3, pp. 2955-2961, 2011.
[6] B. Krishna Kumari Bai, and M. Kanta Rao, "Strength and durability properties of high performance concrete incorporating silica fume and fly ash," *International Journal of Engineering Sciences & Emerging Technologies*, vol. 8, issue 1, pp. 23-29 2015.
[7] M. R. Divya, Prof. M. Rajalingam, and Dr. Sunilaa George, "Study on concrete with replacement of fine aggregates by vermiculite," *International Journal of New Technology and Research (IJNTR)*, vol. 2, issue 5, pp. 87-89, 2016.
[8] Chandra Sekar G., Hemanth Kumar Ch, V. Manikanta, and M. Simhachalam, "Effect of fly ash on mechanical properties of light weight vermiculite concrete," *International Journal of Innovative Research in Science*, vol. 5, issue 3, pp. 4106-4112, 2016.
[9] S. Syed Abdul Rahman, and Gijo K. Babu, "An experimental investigation on light weight cement concrete using vermiculite minerals," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 5, issue 2, pp. 2389-2392, 2016.

Dr. G. Prabhakaran and Chinnakotti Sasidhar, "Experimental investigation on strength properties of rice husk and silica fume as mineral admixtures for vermiculate concrete," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 2, pp. 312-315, 2018.