AN EXPERIMENTAL STUDY ON STRENGTH PROPERTIES OF VERMICULITE CONCRETE USING FLYASH AS PARTIALLY REPLACEMENT OF CEMENT AND SILICA FUME AS MINERAL ADMIXTURE

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Abstract - *Concrete is the single most widely used building material throughout the world. Concrete is used in large amounts because it is only and extremely good building material. In many places of the world the temperature is rising day by day. These days due to constant sand mining the natural sand is depleting at an alarming rate. In this case fine aggregate is partially replacement of vermiculite. Use of vermiculite in concrete it will enhance the shrinkage and crack resistance, fire resistance and reduces environmental impact and also reduce the cost. In this present study, an attempt has been made to study the mechanical properties of M35 grade concrete with different percentages at a range of 5%, 10%, 15%, 20%, 25% and 30% as partially replacement with vermiculite to the total weight of fine aggregate along with mineral admixtures like Fly ash (FA) is replace with cement by various percentages i.e., 10%, 15% and 20% and silica fume (SF) as adding of 5%, 7.5%, 10% and 12.5% 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 15% fly ash is replacement by weight of cement and optimum percentage of split tensile strength i.e. 10% silica fume is addition and 10% fly ash is replacement by weight of cement. Water cement ratio is 0.42.Water cement ratio is put constant for all trail mixtures.*

Key Words: **Exfoliated Vermiculite, Silica Fume, Fly ash, Compressive Strength, Split Tensile Strength, Flexural Strength, Cement, Fine Aggregate**

1. INTRODUCTION

Vermicular is an Italian word for worm from which it has consequent its name as vermiculite. Some establishment quotes the Latin word vermicular from which the name vermiculite might be implemented. Vermiculite is a hydrous phyllosilicate mineral group and is micaceous in environment. Vermiculite is formed by weathering or hydrothermal alteration of biotite or phlogopite. Exfoliated vermiculite is obtainable in five different grades, which are based upon weight rather than particle size.

Figure -1: Vermiculite passing through 4.75 mm sieve

1.1. OBJECTIVES

The objectives of this study are:

- To study the strength properties with increasing the percentage values of vermiculite.
- To study the increasing in strength properties by adding mineral admixtures.
- To study the optimum percentage varying at different percentage values of mineral admixtures like silica fume and fly ash.
- To study the bulk density and cubes weight at various replacement levels of vermiculite.

2. LITERATURE REVIEW

M.R.Divya et al., (2016) have study on M30 grade concrete using vermiculite as partial replacement with 40%, 50% and 60% to the total weight of fine aggregate. The aim of their project is to study the strength parameters such as compressive strength, split tensile & flexural strength of concrete. They study result shows the optimum strength in compare the strengths for different vermiculite percentage was observed to be 50%.

S Syed Abdul Rahman and Gijo K Babu (2016) In their study, structural light weight aggregate concrete was designed with the use of natural vermiculite aggregate that will provide an advantage of reducing dead weight of structure and to obtain a more reasonable structural light weight concrete by the use of vermiculite power as a partial replacement of fine aggregate. Three mixes were created

with the cement content of 479kg/m^3 in M30 grade and water cement ratio is 0.40. The proportion of 0%, 5% and 10%, as vermiculite replacement to fine aggregate. And lastly they concluded that the 10% replacement of vermiculite to fine aggregate well compared to control mix.

S.Sharmila and L.Vijayan (2016) Have study replacement of the fine aggregate with the material called vermiculite. It belongs to the family of light weight aggregates. The exfoliated vermiculite is used as a replacement of fine aggregate. This project is mostly related in places where the ecological temperature is very high. The Replacements were done in 5, 10 and 15% of fine aggregate. And finally conclude that the Vermiculite replaced concrete shows insignificant decrease in density up to 15% when compared to normal concrete. In spit tensile test no much variation in split tensile strength when compare to normal concrete.

B. Krishna Kumari Bai, M. KantaRao (2015) Have their study high performance concrete with mineral admixtures, low water cement ratio and super plasticizers are use. Fly ash (FA) is replaced with cement by different percentages i.e., 5%, 10%, 15%, 20%, 25% and silica fume (SF) as addition of 10% by total weight of cement. It has been observed that the workability and required strengths are achieve at optimum percentage i.e. 10% silica fume is addition and 15% fly ash is replacement by weight of cement. Water cement ratio is 0.32. They concluded that the compressive strength is increased by 11% for replacement of cement by 15% fly ash and silica fume 10% was addition of cement. The flexural strength test value for 28 days was found to be 8.5 N/mm^2. The split tensile strength test value for 28 days was fund to be 4.2N/mm^2.

3. MATERIALS USED

The materials properties used in the concrete are given below:

Cement
Ordinary Portland Cement of KCP brand of 53 grade confirming to IS 4031-1988 was used throughout the study. The specific gravity of cement is taken as 3.15.

Fine Aggregate
The Natural River sand locally available confirming to IS 383-1987 was used of grading zone II. The specific gravity, fineness modulus and water absorption of fine aggregate is 2.62, 2.36 and 1.8%.

Coarse Aggregate
Locally available coarse aggregate passing through 20 mm sieve and retained on 10 mm sieve is used throughout the project. The specific gravity, fineness modulus and water absorption of coarse aggregate is 2.75, 6.08 and 1.58%.

Vermiculite Aggregate
The Vermiculite is used as a filler material and it is obtainable in golden brown, can also be white, colorless or yellow. The specific gravity of vermiculite is 2.06.

Silica Fume
Silica fume is a by product of producing silicon metal or ferrosilicon alloys. One of the most favorable uses for silica fume is in concrete. The specific gravity of silica fume is 2.63.

Fly Ash
Fly ash is a thermal waste by product which is available in various places. The specific gravity of fly ash is 2.11.

Water
For curing purpose portable water is used during the project.

4. EXPERIMENTAL INVESTIGATION

In this experimental investigation the mechanical properties of vermiculite concrete for different partially replacement percentages of vermiculite and various replacements and addition of mineral admixtures to the whole weight cement are determined.

4.1 Mix proportions

By using recommended guidelines of concrete mix design using Indian standard code (IS: 10262-2009) the mix proportions of concrete were prepared for **M35** grade concrete is **1:1.45:2.66** with a water-cement ratio of **0.42**.

Cement (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	W/C (lit)
442.85	642.78	1178.82	186
1	1.45	2.66	0.42

Table 1: Mix proportion of vermiculite concrete

4.2 Mechanical properties vermiculite concrete

In order to calculate the Compressive strength tests were conducted at 7, 28 days of cube (150x 150 x150 mm) specimens. For each set, three cubes are tested.
In order to calculate the Split tensile strength tests were conducted at 7, 28 days of cylinders (150x 300 mm) specimens. For each set, three cylinders are tested.

5. TEST RESULTS AND DISCUSSIONS

Effect of Vermiculite under Cubes for partially replacement of fine aggregate

Table-2: Compressive strength of vermiculite concrete

S.no	Percentage Replacement of Vermiculite (%)	Compressive Strength (N/mm²)	
		7Days	28Days
1.	0	30.5	43.92
2.	5	29.62	42.45
3.	10	27.43	40.92
4.	15	25.87	37.48
5.	20	23.62	36.50
6.	25	21.45	35.67
7.	30	19.15	30.12

Effect of Vermiculite under cylinders for partially replacement of fine aggregate

Table-3: Split Tensile strength of vermiculite concrete

S.no	Percentage Replacement of Vermiculite (%)	Tensile Strength (N/mm²)	
		7 Days	28Days
1.	0	2.71	4.18
2.	5	2.67	4.12
3.	10	2.61	4.02
4.	15	2.56	3.94
5.	20	2.48	3.82
6.	25	2.4	3.7
7.	30	2.33	3.59

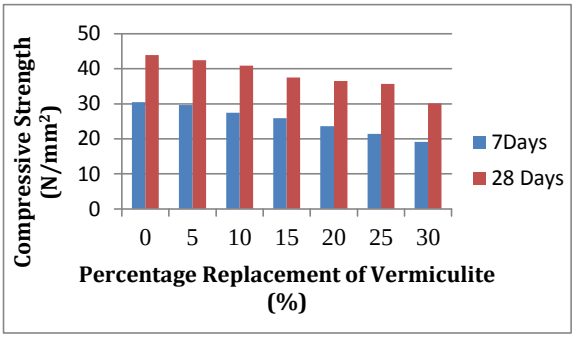

Fig-2: Graph shows the Compressive strengths for various Percentage Replacement of Vermiculite

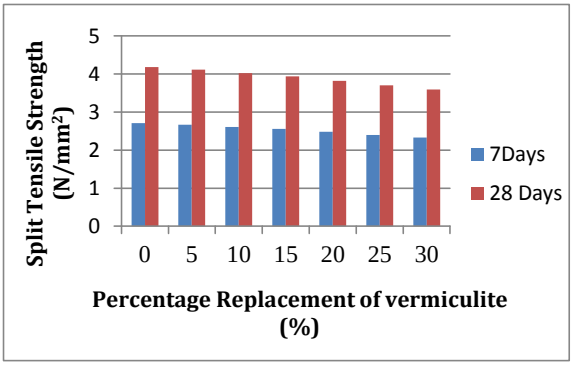

Fig-3: Graph shows the Split Tensile strengths for various Percentage Replacement of Vermiculite

Effect of Cubes weights due to Replacement of Vermiculite with fine aggregate

S.no	Percentage Replacement of Vermiculite (%)	Weight of the Cube Specimens(Kgs)
1.	0	9.02
2.	5	8.71
3.	10	8.46
4.	15	8.15
5.	20	7.86
6.	25	7.66
7.	30	7.50

Table-4: weight of the cube specimens

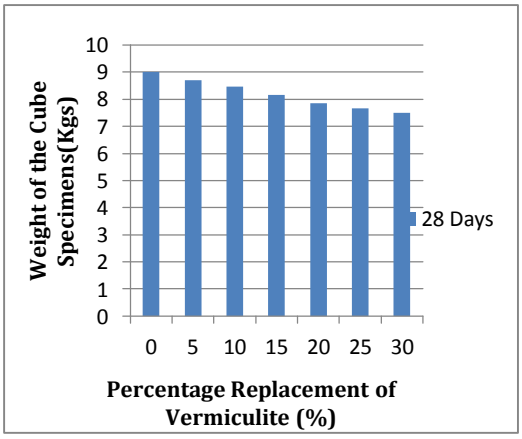

Fig-4: Graph shows the weight of cube specimens

% Replacement of Vermiculite	Density of concrete Kg/m³
0%	2672.59
5%	2580.74
10%	2506.66
15%	2414.81
20%	2328.88
25%	2269.62
30%	2222.22

Table-5: Density of concrete with different % replacement of vermiculite

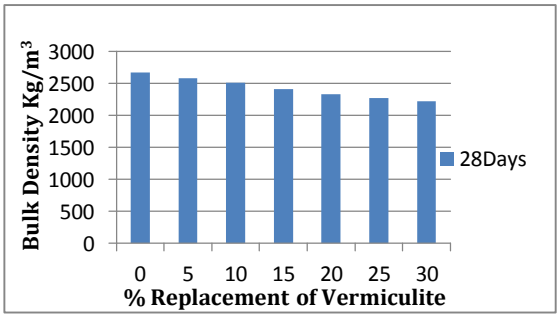

Table-6: To calculate the optimum percentage of Cubes with varying proportions of Mineral Admixtures is given below.

Mix Designation		Compressive Strength (N/mm²)	
% of Silica Fume added + % Replacement of Fly ash		7Days	28Days
5	10	31.92	44.10
	15	33.62	44.55
	20	30.23	43.9
7.5	10	35.67	46.13
	15	34.40	47.16
	20	33.63	45.12
10	10	36.50	47.75
	15	**37.48**	**49.05**
	20	36.71	46.71
12.5	10	35.41	45.31

Table-7: To calculate the optimum percentage of Cylinders with varying proportions of Mineral Admixtures is given below.

Mix Designation		Split Tensile Strength (N/mm²)	
% of Silica Fume added + % Replacement of Fly ash		7Days	28 Days
5	10	2.79	4.3
	15	2.85	4.39
	20	2.78	4.28
7.5	10	2.87	4.42
	15	2.96	4.56
	20	2.89	4.45
10	**10**	**3.04**	**4.68**
	15	2.83	4.36
	20	2.6	4
12.5	10	2.54	3.92

Table-8: For optimum percentage of mineral admixtures fine aggregate is partially replaced with vermiculite i.e., (10%S.F+15%F.A)

S.no	Percentage Replacement of Vermiculite (%)	Compressive Strength (N/mm²)	
		7Days	28Days
1.	0	37.48	49.05
2.	5	36.42	48.65
3.	10	35.67	46.98
4.	15	34.40	45.14
5.	20	32.12	43.29
6.	25	29.15	37.12
7.	30	25.62	33.42

Table-9: For optimum percentage of mineral admixtures fine aggregate is partially replaced with vermiculite i.e., (10%S.F+10%F.A)

S.no	Percentage Replacement of Vermiculite (%)	Split Tensile Strength (N/mm²)	
		7Days	28Days
1.	0	3.04	4.68
2.	5	3.0	4.62
3.	10	2.94	4.53
4.	15	2.85	4.39
5.	20	2.76	4.25
6.	25	2.61	4.02
7.	30	2.5	3.86

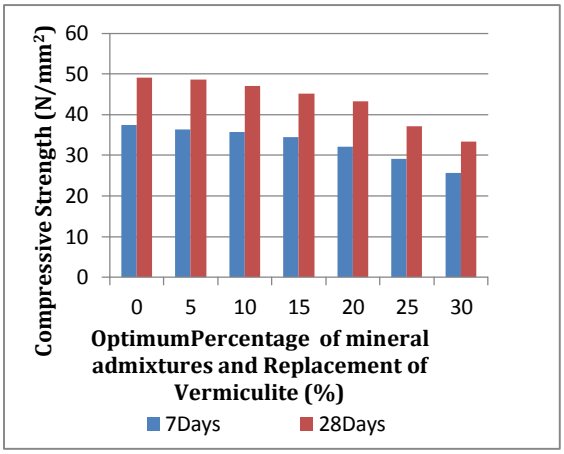

Fig-8: Graph shows the Compressive strengths for Replacement of fine aggregate with vermiculite to the Optimum percentage of mineral admixtures for cubes i.e., (10%S.F+15%F.A)

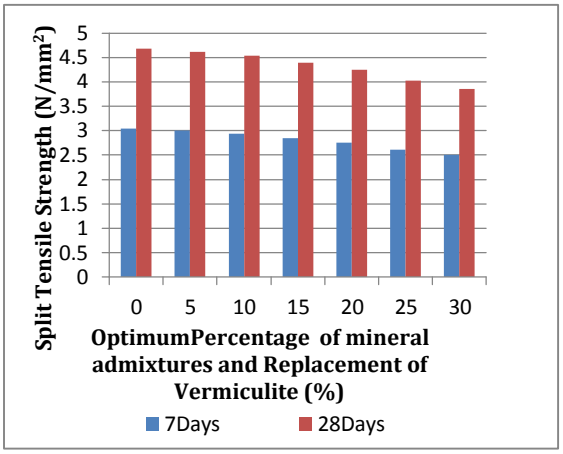

Fig-9: Graph shows the strengths for Replacement of fine aggregate with vermiculite to the Optimum percentage of mineral admixtures for cylinders i.e., (10%S.F+10%F.A)

6. CONCLUSIONS

Based on the experimental investigations conducted on the casted cubes and cylinders the following conclusions were drawn.

1. The compressive strength is increased 11.68% for replacement of cement by 15% fly ash and addition of 10% silica fume when compared with the nominal mix and it is considered as the optimum mix.

2. The Split tensile strength is increased 11.96% for replacement of cement by 10% fly ash and addition

of 10% silica fume when compared with the nominal mix and it is considered as the optimum mix

3. Though the compressive strength of concrete decreases with increase of percentage of vermiculite, but with the replacement of fly ash at 15% and addition of silica fume at 10% to cement with replacement of vermiculite to fine aggregate up to 20% may be accepted as it is giving required target mean strength.

4. Though the Split Tensile strength of concrete decreases with increase of percentage of vermiculite, but with the replacement of fly ash at 10% and addition of silica fume at 10% to cement with replacement of vermiculite to fine aggregate up to 20% may be accepted as it is giving required target mean strength.

5. vermiculite concrete can be used for crack and shrinkage resistance and it can be used in fire resisting structure.

7. REFERENCES

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8. S.Sharmila and L.Vijayan (2016) Have study replacement of the fine aggregate with the material called vermiculite. It belongs to the family of light weight aggregates. The exfoliated vermiculite is used as a replacement of fine aggregate. This project is mainly applicable in places where the environmental temperature is very high. The Replacements were done in 5, 10 and 15% of fine aggregate

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