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EXPERIMENTAL STUDY ON HIGH PERFORMANCE CONCRETE USING SILICA FUME, FLY ASH AND POLYCARBOXYLATE ETHER

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Abstract — High performance concrete (HPC) is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. HPC works out to be economical. HPC in construction enhances the service life of the structure. High performance concrete almost always has a higher strength than normal concrete. The experiment has been carried out on M_{40} grade of concrete, using silica fume in different percentage 0%, 5%, 10%, 15% to the weight of cement. The attempt has been made to compare, the 7 days and 28 days compressive strength, splitting tensile strength and flexural strength of concrete by silica fume, fly ash and super plasticizer with the normal concrete of M_{40} grade with maintaining the required water cement ratio.

Keywords — High strength, Silica fume, Fly ash, Super plasticizer, M_{40}.

I. INTRODUCTION

High performance concrete is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The term 'high performance' is somewhat pretentious because the essential feature of this concrete is that it's ingredients and proportions are specifically chosen so as to have particularly appropriate properties for the expected use of the structure such as high strength and low permeability.

High Performance Concrete can be designed to give optimized performance characteristics for a given set of load, usage and exposure conditions consistent with the requirements of cost, service life and durability. The high performance concrete does not require special ingredients or special equipments except careful design and production. High performance concrete has several advantages like improved durability characteristics and much lesser micro cracking than normal strength concrete.

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II. OBJECTIVE

1. To determine the mix proportion for M_{40} mixes using river sand, coarse aggregate, silica fume.
2. To carry out strength test (compression, flexural and slit tensile) on concrete replaced with various proportions of silica fume and polycarboxcylate ether for various curing periods of 7, 14 and 28 days.
3. To evaluate the cost reduction and management of materials without compensating the strength properties of concrete.

III. EXPERIMENTAL PROGRAMME

Thirty six specimens were casted and tested in laboratory. Silica fume is used in concrete by various proportions such as 0%, 10%, 15%, 20% to the weight of cement and studied the 7, 14, 28 days compressive strength, flexural strength and tensile strength.

Test materials are given below:

A. Cement

Ordinary Portland cement (53 grade) whose specific gravity is 3.1, initial setting time is 45 minutes, final setting time is 200 minutes is used.

B. Fine aggregate

In this study zone II sand is used whose specific gravity is 2.86, fineness modulus is 2.1, bulk density is 33% is used.

C. Coarse aggregate

Coarse aggregate of size 20mm is used which has specific gravity 2.8, fineness modulus 4.76 as per IS 383.

D. Water

Portable water free from harmful oils, alkalis, sugar, organic impurities are used for proportioning and curing of concrete.

E. Super plasticizer

Polycarboxylate ether complies with IS:9103 1999 and BS:5075. This Super Plasticizer show extremely high water reduction in concrete with improved workability and increase in strength by almost 20-30% depending on use.

F. Silica fume

Silica fume, also known as micro silica, is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production.

G. Mix design

The following mix design is arrived:

Samples	Silica fume(%)	Fly ash(%)
S1(conventional)	0%	0%
S2	10%	10%
S3	15%	20%
S4	20%	30%

Table 1 Mix Proportions Of Concrete

IV. RESULTS AND DISSCUSSION

Workability of fresh concrete is determined by using slump test given below

Samples	Slump Value(mm)
S1	85
S2	76
S3	72
S4	69

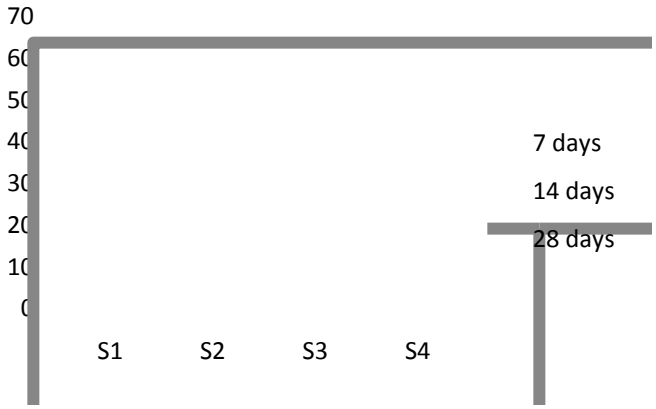
Table 2 Workability Of Concrete

A. Compressive strength

The test was carried out for compressive strength of M_{40} grade of concrete. The compressive strength of high performance concrete with silica fume, fly ash and super plasticizer is given below:

Samples	Compressive strength(N/mm^2)		
	7 days	14 days	28 days
S1	30.45	39.19	44.93
S2	35.06	41.38	53.93
S3	42.96	51.21	65.48
S4	41.32	48.41	62.58

Table 3 Compressive Strength Of Concrete



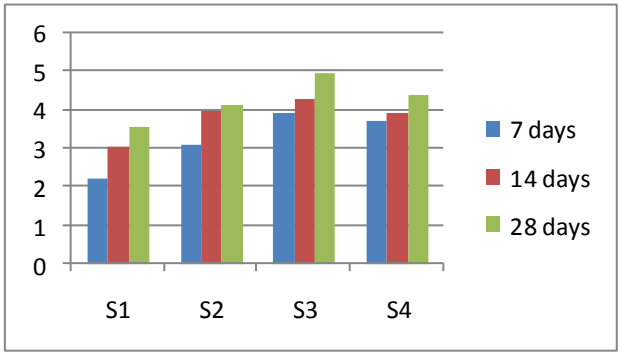
Graph 1 Compressive Strength Of Concrete

B. Split tensile strength

The test was carried out according to IS 5816:1999 to obtain split tensile strength of M_{40} concrete the test results were given in the table 4

Samples	Tensile strength(N/mm^2)		
	7 days	14 days	28 days
S1	2.21	3.04	3.56
S2	3.12	3.97	4.12
S3	3.95	4.29	4.98
S4	3.71	3.95	4.38

Table 4 split tensile strength of concrete



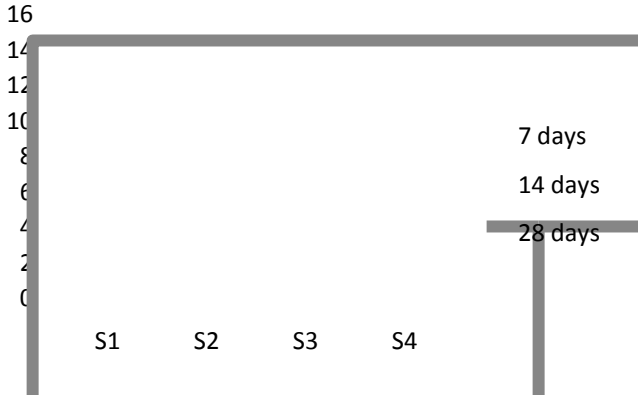
Graph 2 Split Tensile Strength Of Concrete

C. Flexural strength

The test was carried on beam specimens, the test results are given below:

Samples	Flexural strength(N/mm^2)		
	7 days	14 days	28 days
S1	7.15	8.61	9.66
S2	7.32	9.49	13.72
S3	8.25	9.91	13.86
S4	7.12	8.89	12.54

Table 5 Flexural Strength Of Concrete



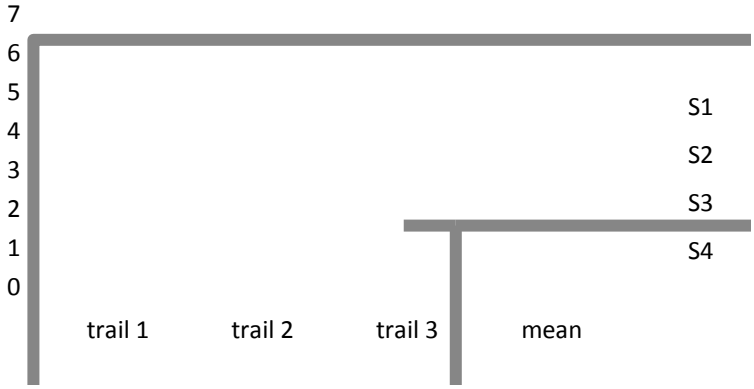
Graph 3 Flexural Strength Of Concrete

D. Permeability test

The test was conducted as per IS 3085-1965. The results of permeability test on conventional high performance concrete are depicted in table 5. The coefficient of permeability is less when silica fume percentage is increased. It was found to be respectively 4.75 for 20% replacement of silica fume.

S. No	Coefficient of permeability			
	Trail 1	Trail 2	Trail 3	Mean
S1(Conventional)	6.02	5.97	6.08	6.02
S2	5.73	6.01	5.85	5.86
S3	5.06	5.15	4.98	5.07
S4	4.74	4.83	4.70	4.75

Table 6 Coefficient of permeability



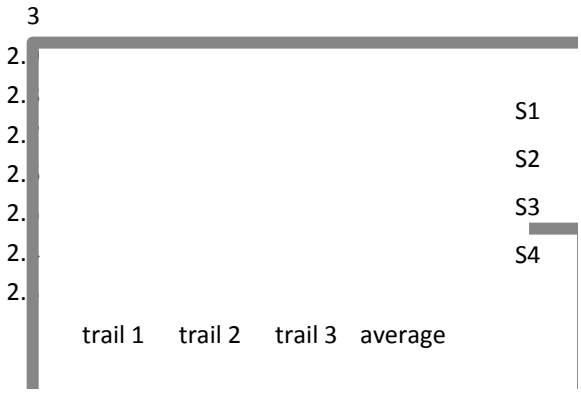
Graph 4 Coefficient of permeability

E. Sulphate resistant test

The specimens for sulphuric acid attack were kept immersed in 3% sulphuric acid solution 28 days. They were tested after 28 days loss in weight. Test results are depicted in table 6 and graphically represented in graph 5.

S. NO	% loss in weight after 28 days			
	Trail 1	Trail 2	Trail 3	Average
S1(conventional)	2.84	2.92	2.87	2.87
S2	2.72	2.75	2.78	2.75
S3	2.68	2.70	2.71	2.69
S4	2.56	2.61	2.61	2.60

Table 7 Sulphate resistant test



Graph 5 Sulphate resistant test

V. CONCLUSION

Based on the experiments done the following result is achieved.

- Compressive, flexural, split tensile test were conducted and results are found to be high for S3 proportion of concrete. i.e.15% silica fume and 20% fly ash.
- Permeability test is conducted and the reduction in coefficient of permeability is found in increase in the silica fume content.
- Sulphate attack test is conducted, the influence of sulphate in concrete is less for those having high silica fume content.
- By this study silica fume and fly ash were found to be an effective construction material.

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