

Investigating and Experimentation on High Performance Concrete Using Super Plasticizer and Silica Fume

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ABSTRACT: Optimum production of High Performance Concrete (HPC) can be accomplished by suitable selecting, proportioning, controlling of all the ingredients. HPC can be used largely in the fields of constructional purposes worldwide. This paper presents the mix design for the development of high strength concrete using silica fume and super plasticizer. strength and durability properties of the concrete mainly depends on the usage of admixtures. Using 43Grade ordinary Portland cement, locally available river sand and aggregates on the basis of ASTM C 127 for determining relative quantities for the grade of concrete M60. For the mix design ACI 211.4R-93 were followed. To find out optimum use of admixtures compressive strength can be made at the levels of (0,5,10,15,20,25% of silica fume at 7 days and 28 days curing). After obtaining average of the strength at 7th and 28th days gives the proper mix for HPC using silica fume and super plasticizer.

KEYWORDS: Compressive strength, ACI mix design, Silica fume, Super plasticizer, High performance concrete.

I. INTRODUCTION

Though there are many definitions for the High Performance Concrete (HPC), but the satisfactory accepted one is given by the American Concrete Institute(ACI). Without determining the performance requirements one cannot possible to give a suitable definition for HPC of the intended use of the concrete. As it acquires lower water cement ratio of 0.2 to 0.45. For the concrete to be workable and fluid, super plasticizer is well in sake. Hence HPC gains almost higher strength than normal concrete mixes.

Since there are many methods for mix design for HPC, among that ACI[1], Aitcin[2] are some methods to be adopted for mix design purposes. As it attributes for an optimise combination of structural properties like stiffness, toughness, durability, energy absorption capacity and corrosion resistance. In general HPC is meant to differentiate between structural materials from the conventional once, for the fulfilment of the final application in civil engineering. It was found that metakaolin was successful in producing mix designs with similar properties as Silica fume modified concrete. Required strength was achieved through increasing the fly ash and lowering the silica fume contents, although chloride ion permeability was negatively affected. The removal of silica fume and the inclusion of Calcite decreased the concrete's resistance to chloride ion permeability and produced concrete that failed to attain the required 28-day ultimate compressive strength of 65Mpa.

II. RELATED WORK

Swati choudhary, Rishab bajaj(2014): This paper includes the detailed study on the recent developments in High Performance Concrete, stressing more on the earthquake prone areas. It highlights the advantages and importance of

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High Performance concrete over conventional concrete and also includes effect of Mineral and Chemical Admixtures used to improve performance of concrete.

Sudarsan Rao Hunchate, venkata reddy.T.C(2014): High Performance Concrete (HPC) now a days used widely in the construction industry world-wide. To produce HPC with normal ingredients we use mineral admixtures like Silica fume, fly ash and metakoline and workable agents Super plasticizers are also used. The usage of mineral admixtures in the concrete not only enhances its strength properties but also durability. The compressive strength are investigating finding the optimum use of mineral admixture (Silica fume of levels 0, 5, 10,15, 20 and 25% at 7 days and 28 days of curing). The present investigation aims to give design mix for HPC by using silica fume and super plasticizers.

III. RESEARCH SIGNIFICANCE

By varying the percentage of silica fumes(0-25%) and at the constant dosage of super plasticizers and other ingredients. Experiments were carried out on HPC for M60 grade concrete using the literature available on HPC and ACI code methods. The main objective of the present investigation is to develop a mix design procedure to obtain good workability and achieve strength properties and to find the optimum percentage of silica fume. So the present investigation emphasis is given to study strength characteristics of HPC using silica fume and super plasticizers.

IV. EXPERIMENTAL PROGRAM

A. Materials used.

Ordinary Portland cement of 43 grade, confirming to IS 8112:1989, and locally available river sand as fine aggregate(zone-II) confirming to IS-383-1970, and coarse aggregates(10 mm 30%, and 20 mm 70% by weight) were used in present investigation. Super plasticizer(Chemical admixture FOSROC CONPLAST SP430 confirming to BIS 9103-1999 is used as workable agent Silica fume(Mineral admixture) Corniche SF (Micro silica) obtained from ELKEM INDIA (P) LTD, confirming to ASTM C-1240 is used. Table 1 and 2 respectively represents the properties of fine aggregate and coarse aggregate. Table 3 shows the properties of cement.

Table 1 Properties of Fine Aggregate.

Sieve size	Weight retained (in gms)	% wt retained	% cumulative wt retained	% wt passing
10mm	-	-	-	100
4.75mm	60	6.0	6.0	94.5
2.36mm	85	8.5	14.5	85.5
2.00mm	140	14.0	28.8	71.2
1.18mm	207	20.7	49.2	50.8
600microns	300	30.0	80.4	19.6
150microns	192	19.2	98.2	1.8
Pan	18	1.8	100	0

Table 2 Properties of Coarse Aggregate

Coarse aggregate	Specific gravity	Bulk density(kg/m ³)	Water absorption(%)
CA	2.67	1495	0.19

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Table 3 Properties of Cement

Property	Result
Normal Consistency	32%
Setting Time	
Initial	40min
Final	480min
Specific Gravity	3.16
Fineness of Cement (By 90micron sieve)	2% retained
Compressive strength	
7 days	34 N/mm ²
28 days	56 N/mm ²

V. METHODOLOGY

B. Preparation of Test Specimen.

Casting of six concrete mixes with replacement of 0, 5, 10, 15, 20 and 25% silica fume with cement, keeping w/b ratio as 0.29%. For all the mixes ratio of cementenous matrix to coarse aggregate and fine aggregate was maintained at 1:1.5:2. The casted cubes and cylinders are cured in curing pond. Compressive strength of cubes and cylinders are tested at 7 days and 28 days and the results are shown in Table 4 and Table 5.

Table 4: Average value of cube strength and cylindrical strength of concrete (MPa).

Nomenclature	Cube Compressive Strength (fcu) 7 days	Cylinder Compressive Strength (fc) 7 days
HPC 0%	54.2	11.3
HPC 5%	54.8	12.0
HPC 10%	57.1	12.9
HPC 15%	60.2	13.7
HPC 20%	58.3	13.0
HPC 25%	55.7	12.1

Table 5: Average value of cube strength and cylindrical strength of concrete (MPa)

Nomenclature	Cube Compressive Strength (fcu) 28 days	Cylinder Compressive Strength (fc) 28 days
HPC 0%	60.3	12.8
HPC 5%	62.5	13.5
HPC 10%	64.1	13.8
HPC 15%	71.2	14.8
HPC 20%	68.7	13.7
HPC 25%	64.6	12.6

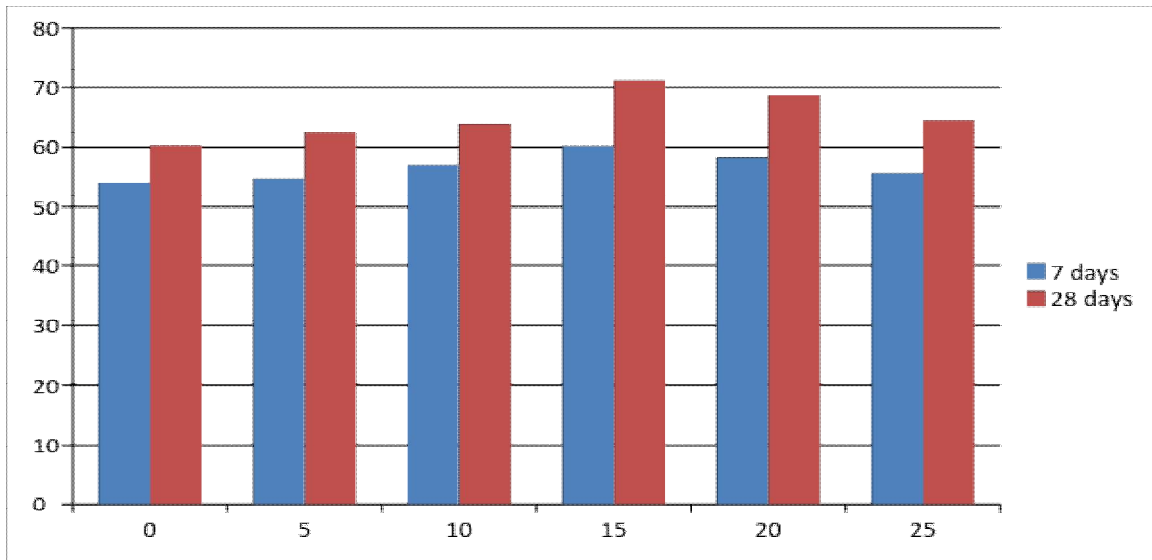
Graphical representation of variation of strengths of cubes and cylinders at 7days and 28days under the gradual replacement of percentage of silica fume(0-25%).

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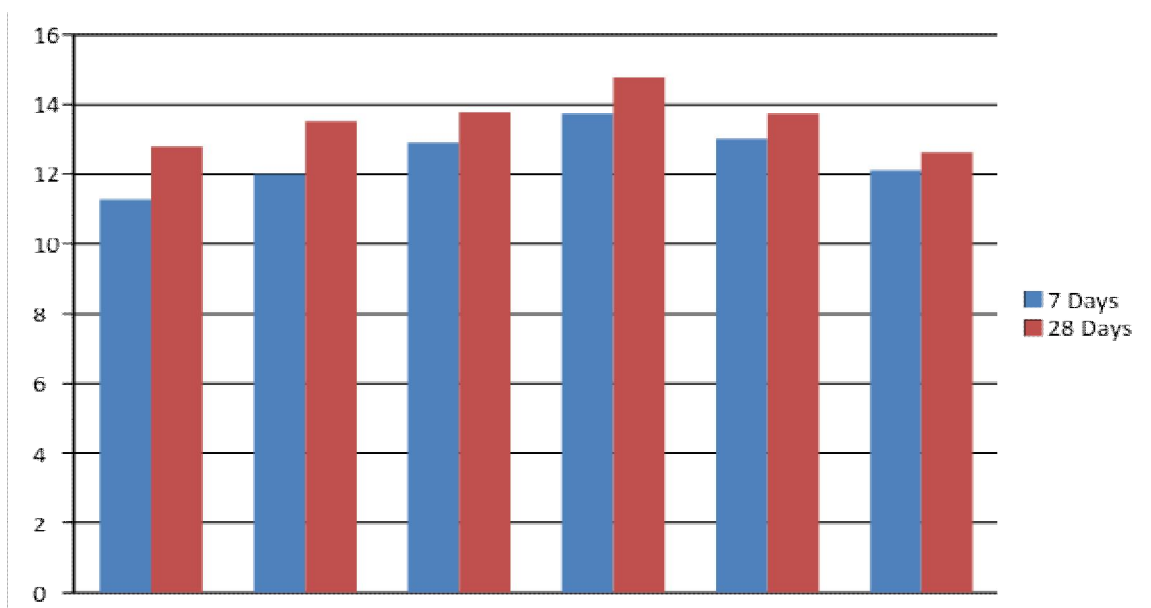
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Percentage of silica fume

Fig.1 Percentage of silica fume replacement with cement Vs compressive strength

Maximum value of the cube compressive strength at the replacement of silica fume by 15% is 71.2Mpa for M60 grade of concrete at a period of 28days curing.



Percentage of silica fume

Fig.2 Percentage of silica fume replacement with cement Vs compressive strength

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Maximum value of the cylinder compressive strength at the replacement of silica fume by 15% is 14.8Mpa for M60 grade of concrete at a period of 28days curing.

V. DISCUSSION OF TEST RESULTS

By the application of gradual replacement of cement by silica fume increases the compressive strength at 15%. Use of super plasticizer decreases the water content ratio and hence increases workability of concrete.

VI. CONCLUSION

1. Use of silica fume in the mix increases the compressive strength of concrete upto 15% with the average of increase of 2-3% for every mix and then decreases.
2. Therefore the maximum replacement of silica fume in the present investigation is 15% .
3. Average compressive strengths of cubes and cylinders at 7days and 28days are 50-72Mpa and 35-50Mpa.
4. Use of super plasticizer decreases the water content and increases the workability of concrete.

REFERENCES

- [1] ACI, 234R-96, "guide for the use of silica fume in concrete," Reported by ACI, Committee, 234, pp.1-51, 1996.
- [2] Aitcin. P.C. "High performance concrete, E & FN Spon, London, 1998.
- [3] A. Islam Laskar and S. Talukdar. "A New Mix Design Method For High Performance Concrete," Asian Journal of Civil Engineering (Building and Housing) Vol.9, No.1,pp.15-23, 2008.
- [4] P.Vinayagam,"Experimental Investigation on high performance concrete Using Silica Fume and Superplasticizer", International journal of Computer and Communication Engineering, Vol.1, No.2, pp. 168-171, 2012.
- [5] Hooton R.D. "Influence of silica fume replacement of cement on physical properties and resistance to Sulphate attack, Freezing and Thawing, and alkali-silica reactivity, ACI Material Journal, No.2, pp.143-151, 1993.
- [6] V. Yogendran, B.W.Langan, M.N. Haque, M.A. Ward, "Silica fume in high strength concrete", ACI Mater. J.84 (2) pp. 124-129, 1982.
- [7] A. Annadurai and A. Ravichandran, "Development of mix design for high strength concrete with Admixtures", IOSR Journal of Mechanical and Civil Engineering", vol.10, issues-5, pp.22-27, 2014.
- [8] Patil Shreekedar.A and Kumbhar .P.D "Study on effect of mineral admixtures in mix proportioning of HPC", International Journal of Research in Advent Technology", Vol.1, Issue.5,pp.499-504, 2013.
- [9] IS 8112:1989. Indian Standard Specification for 43 Grade Ordinary Portland Cement, Indian Standard Institution, New Delhi.
- [10] IS 383-1970. Specification for Coarse and Fine Aggregates from Natural Sources for Concrete (Second Revision).