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Mechanical Properties On High Performance Concrete By Replacing The Cement By Flyash, Silica Fume And Metakaolin

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Abstract

Concrete is probably the most extensively used construction material in the world. The addition of mineral admixture in cement has dramatically increased along with the development of concrete industry, due to the consideration of cost saving, energy saving, environmental protection and conservation of resources. High Performance Concrete (HPC) is the latest development in concrete. It has become more popular these days and is being used in many prestigious projects. The utilization of calcined clay, in the form of high reactivity metakaolin and silica in concrete has received considerable attention in recent years. The present paper deals with the study of compressive strength of M60 grade HPC mixes incorporating different percentages of high reactivity metakaolin and silica fume by weight of cement along with some suitable super plasticizer. The results of the study indicate that the strength study of HPC mixes improved by incorporating metakoalin and silica fume up to a desirable content of 15% and 5% respectively by weight of cement.

Keywords: Compressive strength, High Performance Concrete, High reactivity metakaolin, Silica Fume and Mineral Admixtures.

INTRODUCTION

American Concrete Institute defines High Performance Concrete as “A concrete which meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials and normal mixing, placing and curing practices”. In general HPC mixes possess high durability and high strength when compared to that of the normal conventional concrete. For producing HPC, it is well recognised that the use of supplementary cementitious materials such as silica fume(SF), fly ash(FA) are necessary. When these materials are used as mineral admixtures, they improve the strength and durability properties of the concrete.

High performance concrete works out to be economical, even though its initial cost is higher than that of conventional concrete because the use of High Performance Concrete in construction enhances the service life of the structure and the structure suffers less damage which would reduce overall costs.

P. Kumar Mehta (2004) proved that it is possible to produce sustainable, high performance concrete mixtures that show high workability, high ultimate strength and high durability. Due to the lower Portland cement content, HVFA concrete mixtures may take one to two hours longer to set. High volume fly ash concrete has easier flow ability, pump ability and compatibility. Since high volume of fly ash is used, the setting time is slower compared to normal concrete. Tarun. R et al., (2004) investigated Long-term tests for compressive strength, resistance to chloride-ion penetration, and density. Test results revealed that both Class C and Class F fly ash contributed to high long-term compressive strength. Generally, the concrete mixtures containing Class F fly ash exhibited higher resistance to chloride ion penetration relative to mixtures containing Class C fly ash. Eva Vejmelkova et al., (2012) studied that the compressive and bending strength of MC after 28 days were slightly worse but it could be anticipated that there would be improvement in the later strength gain in the long term view. The durability properties of MC were excellent. Its frost resistance was better compared to PC.

I. EXPERIMENTAL WORK

The materials used for making High performance concrete specimens are low calcium fly ash as the source material, River sand, coarse aggregate as the filler, and water & super plasticizer as workability measure. IS mark 53 grade cement (Brand- DALMIA cement) was used for all concrete mixes. The cement which was used, was fresh and without any lumps in it. In this investigation, class F type of fly ash is obtained from Metur power plant with fineness modulus and specific gravity were 7.86 and 2.21 respectively. The fineness modulus and specific gravity of river sand were 3.12 and 2.64.

Metakaolin is compatible with most concrete admixtures, such as superplasticizers, retarders, accelerators, etc. Based on previous experience, replacing 10-15% of the cement with Metakaolin gives us an optimal performance.BB Sabir (2001)

Silica Fume is a very reactive and effective pozzolanic material due to its fine particle size and high purity of SiO2 (99.5%) content. It enhances the mechanical properties, durability and constructability in concrete. It is used in the production of High strength & High performance concrete. The recommended dosage is 7-10% of the cement weight added to the concrete. Silica fume is the most commonly used mineral admixture in high strength concrete. It is used in the construction of high performance concrete structures like bridges where the strength and durability properties of the concrete is required.

The superplasticizer used in this study is CONPLAST SP430. To produce high workability concrete without loss of strength and to promote high early and ultimate strengths by taking advantage of water reduction whilst maintaining workability. It produces high quality concrete of improved durability and impermeability.

II. PREPARATION OF HIGH PERFORMANCE CONCRETE

A. In this project, a number of supplementary cementitious materials are being used. A total of 6 cases are present. For each case, a total of 12 cubes were cast. The cubes are tested for 7 days, 14 days, 28 days, and 56 days. For each day test, 3 cubes were cast .The cement is kept constant at 30 % for the third, fourth, fifth and sixth cases respectively. Fly ash is kept constant for all the cases. 50 % fly ash is used. The term high volume fly ash can be used only when optimum fly ash content is 50 % shown in table I.

B. Casting of Test Specimen The test moulds were all set and oil is applied inside, before mixing. The ingredients for SCGC were weigh batched. The concrete mixing were done using mixer machine. The concrete is taken in buckets and then poured into the moulds without any tamping or compaction. The top surface is kept smooth.

Table I Mix Proportions for fresh HPC

Case	No. of cubes	REQUIRED MATERIAL IN kg/m^3					Metakaolin (MK)
		Cement (CE)	Sand	Aggregate	Fly ash (FA)	Silica fume (SF)	
Case 1 (100% CE, 0%FA,0%SF,0%MK)	12	20.420	27.67	44.879	0	0	0
Case 2 (30% CE, 50%FA,0%SF,20%MK)	12	6.126	27.67	44.879	10.21	0	4.084
Case 3 (30% CE, 50%FA,5%SF,15%MK)	12	6.126	27.67	44.879	10.21	1.021	3.063
Case 4 (30% CE,50%FA,10%SF,10%MK)	12	6.126	27.67	44.879	10.21	2.3483	2.3483
Case 5 (30% CE,50%FA,15%SF,5%MK)	12	6.126	27.67	44.879	10.21	3.063	1.021
Case 6 (30% CE,50%FA,20%SF, 0%MK)	12	6.126	27.67	44.879	10.21	4.084	0

III. STRENGTH STUDY ON SCGC

A. Compression Test

Compression test is the most common test conducted on hardened concrete, because it is an easy test to perform and most desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compression test is carried out on specimen in cubical or in cylindrical shape. Table II shows the compressive strength for various mixes.

Table II compressive strength for various mixes

Standard	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)	56 Days(N/mm^2)
Case 1	44.29	53.82	63.33	65.86
Case 2	25.480	33.39	38.66	45.69
Case 3	18.45	25.92	42.34	48.93
Case 4	23.26	29.37	47.15	55.80
Case 5	21.79	27.03	50.22	61.75
Case 6	20.41	27.53	44.32	56.49

IV. RESULTS AND DISCUSSIONS

As per above results, the normal conventional concrete for M60 mix is achieved according to standards. But, the concrete containing admixtures explicit slower strength gain at 7 days, when compared to M60 concrete with 100% cement mix.

Fig. 1 represents that at 28 days, the mix containing 15%SF, 5% MK, 50%FA, 30 % C showed a better strength gain compared to the other mixes containing admixtures. At 56 days, the mix containing 15 % SF, 5% MK, 50% FA, 30%CE has attained the desired grade proving that there is an increase in the later strength gain in the concrete containing admixtures [9]. Case 2 and case 3 shows very less strength gain at 56 days due to the inherent properties of the concrete mix itself.

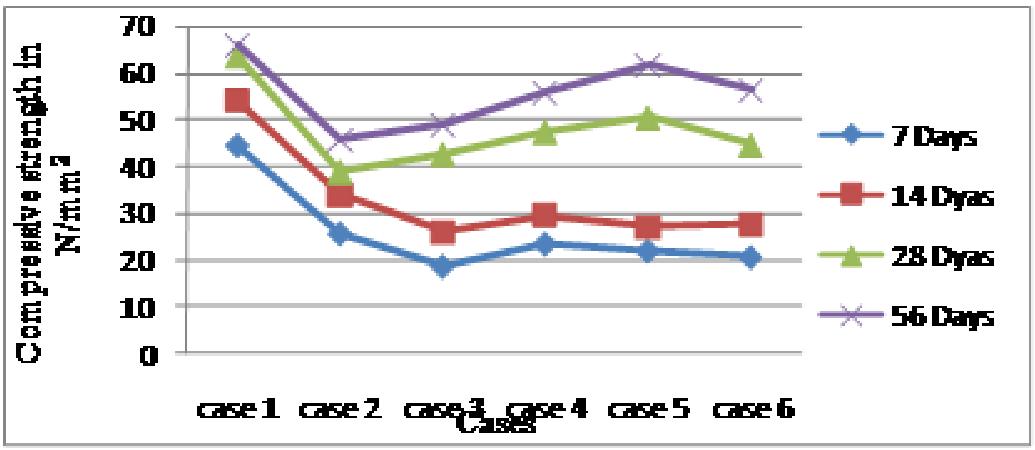

Fig 1. Variation in compressive strength of different cases

V. CONCLUSIONS

- In normal conventional concrete, the desired strength was achieved in 28 days by the use of a super plasticizer.
- The concrete mixes containing supplementary cementitious materials did not achieve the desired strength in 28 days. This may be due to the high volume of fly ash being used.
- Since high volume of fly ash is being used, the strength gain can be seen only at later ages i.e. 56 days.
- The concrete mix containing 15%SF, 5%MK,50%FA, 30%C has shown best results when compared to other concrete mixes containing admixtures. This shows that this can be used in real time applications in places where high strength is required but at later ages is sufficient.

- Since fly ash is readily available and it is an industrial by product, the use of high volume of fly ash can reduce the overall cost of concrete.
- Also, when fly ash is used , the heat is limited when compared to that of 100% cement concrete .

REFERENCES

1. A. Bilodeau, V. M.Malhotra 2000, "High- Volume Fly Ash System: Concrete Solution for Sustainable Development", ACI Material Journal, vol. 97, pp. 41-48.
2. A. Elahi, P.A.M. Basheer, S.V. Nanukuttan, Q.U.Z. Khan 2010, “Mechanical and durability properties of high performance concretes containing supplementary cementitious materials”, Construction and Building Materials, pp. 292-299.
3. B.B. Sabir, S. Wild, J. Bai 2001, "Metakaolin and Calcined Clay as Pozzolans for Concrete: A Review", Cement Concrete Composites, vol. 16, pp. 441-454.
4. C.S. Poon, L. Lam and Y.L. Wong 2000 , “A study on high strength concrete with large volumes of low calcium fly ash cement and concrete”, Cement and Concrete Research 30, , pp. 447-455.
5. C.S. Poon, S.C. Kou, L. Lam, 2006 “Compressive strength, chloride diffusivity and pore structure of high performance metakaolin and silica fume concrete”, Construction and Building Materials, pp. 858-865.