A Study on High performance Concrete

Shruti Jawade[1], Siddharth Pastariya [2]

[1] P.G. Student, Department of Civil Engineering, Sri Aurobindo Institute of Technology Indore, India
2 Assistant Professor, Department of Civil Engineering, Sri Aurobindo Institute of Technology Indore, India

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Abstract - High Performance Concrete can be considered as a logical development of cement concrete in which the ingredients are proportioned and selected to contribute efficiently to the various properties of cement concrete in fresh as well as in hardened states. Higher strength is one of the features of High Performance Concrete which provides significant structural advantages. The three major components contributing to the cost of a structural member are concrete, steel reinforcement and formwork .

This paper aims at comparing these major components when concrete of higher grade is used in the design and to establish that High strength concrete provides the most economical way for designing the load bearing members and to carry a vertical load to the building foundation through columns. The mix design variables affecting the concrete strength which are the most critical in the strength development of concrete includes water-cementitious material ratio, total cementitious material, cement-admixture ratio, amount of super plasticizer dose .These factors are to be analyzed in order to obtain a mix for concrete of higher grade

***Key Words*:** High-Performance Concrete, Mineral admixture, chemical admixture, cementitious material, GGBS, Silica fumes

1.INTRODUCTION

Concrete is the maximum broadly used creation material in India with annual intake exceeding a hundred million cubic meters. Also, the current earthquakes in distinctive components of the arena have over again discovered the significance of layout of systems with excessive ductility. The strength and ductility of systems in particular relies upon on right detailing of reinforcement in beam- column joints. Under seismic excitations, the beam-column joint vicinity is subjected to excessive horizontal & vertical forces whose magnitudes are a lot better than the ones in the adjoining beams & columns. Conventional Ordinary Portland Cement Concrete that is designed on the premise of compressive strength does now no longer meet many purposeful necessities as it's far located deficit in competitive environments, time of creation, strength absorption capacity, restore and retrofitting jobs etc. and loses its tensile resistance after the formation of a couple of cracks. So, there may be a want to layout High Performance Concrete that is a ways advanced to Conventional Concrete, because the Ingredients of High Performance Concrete make contributions maximum efficaciously to the numerous necessities.

The attribute “High Performance” implies an optimized aggregate of structural residences including strength, toughness, strength absorption capacity, stiffness, durability, a couple of cracking and corrosion resistance, considering the very last value of the material and above all, of the produce manufactured. Generally speaking, excessive overall performance is supposed to differentiate structural substances from the traditional once, in addition to to optimize a aggregate of residences in time period of very last software in civilengineering. HPC concretes are normally designed the usage of substances aside from cement on my own to obtain those necessities, including Fly Ash (from the coal burning process), Ground Blast Furnace Slag (from the metallic making process), or Silica fume (from the discount of excessive high-satisfactory quartz in an electric strengthed arc furnace). Different quantities of those substances are mixed with Portland cement in various probabilities relying at the unique HPC necessities.

Though there are numerous definitions for High Performance Concrete (HPC), the maximum broadly-commonplace one is that given via way of means of the American Concrete Institute (ACI), which states; “High Performance Concrete is concrete that meets unique overall performance and uniformity necessities that can not constantly be carried out robotically via way of means of the usage of most effective traditional substances and ordinary mixing, setting and curing practices.” It isn't always viable to offer a completely unique definition of HPC with out figuring out the overall performance necessities of the meant use of the concrete

Need of HPC

HPC is needed as a production material in systems built in very numerous environments. The systems like tunnels in sea beds, tunnels and pipes wearing sewage, offshore piers and platforms, confinements systems for stable and liquid wastes containing poisonous chemical substances and radioactive elements, jetties and ports, sea hyperlink bridges pier and superstructures and excessive upward thrust systems, chimney and towers, foundations and mounds in competitive surroundings. Concrete has executed fairly nicely withinside the beyond in favorable surroundings, if layout and built properly. Concrete strength, that's effortlessly regulated through controlling the water-cement ratio, has served nicely withinside the beyond because the main criterion for overall performance of everyday concrete.

Project Objective

In this paper two experimental investigations will be made on the High strength Concrete. In first The effect of silica fume dosage and the dose of super plasticizer on the strength of concrete have been evaluated using an experimental program aimed at achieving a High strength concrete mix. And in the second the effect of silica fume on compressive strength on high strength concrete was studied by carrying out. The silica fume was replaced by 0%, 5%, 10% and 12.5% for water-binder ratio of 0.26. Also for the constant replacement of fly ash by 10% along with the above mentioned replacement.

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2. Significance of the System

The paper mainly focuses on high performance concrete. The study of Methodology is explained in section III, section IV covers the experimental results of the study, and section V discusses the Conclusion.

3. Methodology

Experimental Programme - I

The main aim of the Experimental Programme was to achieve a mix proportion for M60 in the laboratory that we can propose for further use and can be used to calculate cost aspect for the above grade of concrete. To get the control mix Entroy and Shackalock method was used. It was designed for extremely low workability. To improve the strength and workability silica fume and super plasticizers were used in trial batches. Silica fume was replaced by 5%,10% and 15%.Toeach percentage of silica fume replacement, superplasticizers were added in dosages of 1%,1.25% and 1.5%.Coarse aggregate was divided into 3 parts one retained on 5mm sieve, second part retained on 8 mm sieve and third part retained on 10 mm sieve passing 15 mm sieve

The control mix proportion: 1 : 0.812 : 2.088 Fine aggregate /Total aggregate: 28% Water/binder ratio=0.3

In this mix 5% cement was replaced by silica fume keeping the water/binder ratio same and to this, super plasticizer dosages of 1%,1.25% and 1.5% were added and the mixes were named as Ms5/1,Ms5/2,Ms5/3 respectively. So in Ms5/1, Ms5/2, Ms5/3 except super plasticizer dose all other quantities remain the same. And similarly . Silica fume was replaced by 10% and 15%.

Table1. Details of MIX 1(Ms5)

Mix	Cement (in kg)	Silica Fume (in kg)	Fine aggregate (in kg)	Coarse aggregate (in kg)	Super plasticizer (in kg)
Ms5/1	570.4	30.02	488.8	1257.5	6.02
Ms5/2	570.4	30.02	488.8	1257.5	7.5
Ms5/3	570.4	30.02	488.8	1257.5	9.0

Table2. Details of MIX 2(Ms10)

Mix	Cement (in kg)	Silica Fume (in kg)	Fine aggregate (in kg)	Coarse aggregate (in kg)	Super plasticizer (in kg)
Ms10/1	540.4	60.04	488.8	1257.5	6.02
Ms10/2	540.4	60.04	488.8	1257.5	7.5
Ms10/3	540.4	60.04	488.8	1257.5	9

Table3. Details of MIX 3(Ms15)

Mix	Cement (in kg)	Silica Fume (in kg)	Fine aggregate (in kg)	Coarse aggregate (in kg)	Super plasticizer (in kg)
Ms15/1	510.4	90.07	488.8	1257.5	6.02
Ms15/2	510.4	90.07	488.8	1257.5	7.5
Ms15/3	510.4	90.07	488.8	1257.5	9.0

Table4. Details of MIX 4

Mix	Cement in kg	Silica fume In kg	Fine Aggregate in kg	Coarse aggregate in kg	Superplasticizer dose in kg	Water/Cementitious material Ratio
Ms10/1.25/1	568	63.11	512.6	1317.5	7.88	0.325
Ms10/1.25/2	564.74	62.75	509.7	1313.6	7.84	0.35
Ms10/1.25/3	561.3	62.37	506.7	1301.8	7.79	0.375

Experimental Programme – II

The concrete used in this study was proportioned to attain strength of 75 MPa. ACI committee recommendation has been used for M75 design The mixes MSG1, MSG2, and MSG3 were obtained by replacing 5, 7.5 and 10 percent of the mass of cement by Silica Fume. Then mix MSFG1, MSFG2 and MSFG3 were obtained by replacing the mass of cement by the above percentage of Silica Fume and with 10% of Fly Ash. The water cement ratio (w/c) is taken as 0.26. The mix design has been adopted as per ACI 211.4R-93.

Table5. Mix Proportions

Mix	% Silica Fume	% Fly Ash	% Glass Fibre	W/C Ratio
MSG1	5	0	0.3	0.26
MSG2	7.5	0	0.3	0.26
MSG3	10	0	0.3	0.26
MSG4	12.5	0	0.3	0.26
MSFG1	5	10	0.3	0.26
MSFG2	7.5	10	0.3	0.26
MSFG3	10	10	0.3	0.26
MSFG4	12.5	10	0.3	0.26
C	0	0	0	0.26

4. Experimental Results

A. Results of Experimental Analysis I

1. Workability

Table6. Slump Values in mm for different mixes

MIX	SLUMP VALUE (in mm)
Ms5/1	5
Ms5/2	10
Ms5/3	25
Ms10/1	4
Ms10/2	8
Ms10/3	15
Ms15/1	0
Ms15/2	3
Ms15/3	15

2. Compressive Strength

Table7 Compressive strengths for MIX1, MIX2, MIX3

MIX	28 days compressive strength (N/mm^2)
Ms5/1	60.1
Ms5/2	54.3
Ms5/3	51.2
Ms10/1	45.4
Ms10/2	51.1
Ms10/3	51.8
Ms15/1	47.3
Ms15/2	41.9
Ms15/3	45.2

Table8. Compressive strengths for MIX 4

Mix	W/CM ratio	28 days compressive strength in N/mm^2
Ms10/1.25/0	0.3	51
Ms10/1.25/1	0.325	38.67
Ms10/1.25/2	0.35	37.33
Ms10/1.25/3	0.375	36.74

B. Results of Experimental Analysis II

1. Compressive Strength Test Result

Table9. Compressive Strength Results

Mix	% Silica Fume	% Fly Ash	% Glass Fibre	28 Days N/mm^2
MSG1	5	0	0.3	68
MSG2	7.5	0	0.3	70
MSG3	10	0	0.3	78
MSG4	12.5	0	0.3	73
MSFG1	5	10	0.3	67
MSFG2	7.5	10	0.3	71
MSFG3	10	10	0.3	81
MSFG4	12.5	10	0.3	77
C	0	0	0	69

2. Split Tensile Strength Test Result

Table10. Split Tensile Strength Results

Mix	% Silica Fume	% Fly Ash	% Glass Fibre	28 Days N/mm^2
MSG1	5	0	0.3	5.092
MSG2	7.5	0	0.3	5.410
MSG3	**10**	0	**0.3**	**6.040**
MSG4	12.5	0	0.3	5.729
MSFG1	5	10	0.3	5.729
MSFG2	7.5	10	0.3	6.366
MSFG3	**10**	**10**	**0.3**	**6.684**
MSFG4	12.5	10	0.3	6.040
C	0	0	0	5.729

3. Flexural Strength Test Result

Table11. Flexural Strength Results

Mix	% Silica Fume	% Fly Ash	% Glass Fibre	28 Days N/mm^2
MSG1	5	0	0.3	4.551
MSG2	7.5	0	0.3	4.866
MSG3	**10**	**0**	**0.3**	**5.179**
MSG4	12.5	0	0.3	4.748
MSFG1	5	10	0.3	4.238
MSFG2	7.5	10	0.3	5.023
MSFG3	**10**	**10**	**0.3**	**5.337**
MSFG4	12.5	10	0.3	4.866
C	0	0	0	4.395

5. CONCLUSIONS

The mix design variables affecting the concrete strength which can be the maximum crucial withinside the strength improvement of concrete such as water-cementitious ratio, overall cementitious material, cement-admixture ratio quantity of exceptional plasticizer dose are to be analyzed and optimum values of the crucial mix design are to be taken for acquiring the combinationture layout for the specified High Performance Concrete.

High Performance Concrete with better compressive strength affords the maximum economical manner for designing the weight bearing individuals and to hold a vertical load to the constructing basis thru columns through a discount in the amount of metallic required and additionally concrete which make contributions specifically to the fee of the structural member. The mix design affecting the concrete strength which can be the maximum crucial withinside the strength improvement of concrete such as water-cementitious material ratio, overall cementitious material, cement-admixture ratio quantity of exceptional plasticizer dose are to be analyzed and optimum values of the crucial mix design are to be taken for acquiring the combinationture layout for the specified High Performance Concrete

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