Analysis on Use of Superplasticizer Content on Mix Design of High Strength Concrete (M100)

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Abstract- *Research paper includes the variation of superplasticizer on the strength on M100 grade concrete whose compressive strength at 28 days will be111.8 N⁄mm2 according to IS 456:2000. The proportion of fine to coarse aggregate gives maximum weight of combined aggregate can be obtained by trial. The compressive strength of concrete is its useful and important properties. Master glenium superplasticizer is used as super plasticizer in this research. High strength concrete can be made by using low water to cement ratio but water to binder ratio will give more strength .*

KEYWORDS-silica fume, super plasticizer, compressive strength.

I. INTRODUCTION

Superpalsticizer is a high range water reducer and retarding admixture. Superplasticizers are soluble macromolecules, which are hundreds of times larger than of water molecule.

PC (polycarboxylate ether) or naphthalene based super plasticizers are used because they will reduce more than 30% of mixing water than the normal super plasticizers.

Mechanism of the superplasticizers is known as adsorption by C3A(tricalcium aluminate), which breaks the agglomeration by repulsion of same charges and releases entrapped water. The adsorption mechanism is partially different from the Water Reducing Admixture. The difference relates to compatibility between Portland Cement and superplasticizers. It is necessary to ensure that the superplasticizers do not become fixed with tricalcium aluminate in cement particle, which will cause reduction in concrete workability concrete on the hardened concrete and the complicated inter-relationship between the variables.

High-strength concrete (HSC) has a compressive strength greater than 55MPa having water cement ratio (w/c) ranging from of 0.35 to 0.30 or even less. Due to low w/c ratio it requires super plasticizer to achieve required workability.

For high strength concrete (M 60 and above) mixes, generally OPC 53-grade, a PC based super plasticizer (which can reduce

30% of the mixing water) and 5-10% silica fume will be required.

II. LITERATURE REVIEW

There are various research reports available on the various properties of concrete.

1.Hafiz A. Alaka	According to them excess dosage of superplasticizer helps to achieve increased workability, causes a decrease in abrasion resistance and has no decisive effect (good or bad) on the compressive, flexural and tensile splitting strengths of HVFA concrete mixes. An increase in fly ash content in the HVFA concrete mixes resulted in reduced overall flexural strength, tensile splitting strength and abrasion resistance. Not using a very low w/b ratio, which can be achieved by using an excess dose of super plasticizer, results in HVFA concrete mixes struggling to meet the minimum required compressive, flexural and tensile splitting strengths of various standards. According to them they concluded that although HVFA concrete, which is normally prepared with a high dosage of superplasticizer, is highly sustainable, it is not the best for applications such as industrial floors, where wear and abrasion resistance is of vital importance.

III MATERIALS USED

The ingredients of high strength concrete are: Cement, Fine aggregate, Coarse aggregate and water. Admixtures may be used to enhance some properties of the concrete.

A.Cement

Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together.In this research OPC 53 grade cement is used because it imparts in greature strength. The colour of the cement is grey. Specific gravity of the cement is 3.15.

B. Fine aggregate

Fine Aggregate (sand):. Fine aggregate includes the particles that all passes through. 4.75 mm sieve and retain on 0.075 mm sieve. River sand is used as fine aggregate. Specific gravity of the fine aggregate is 2.16.Water absorption by fine aggregate is 1%. From sieve analysis fine aggregate is of zone II and fineness modulus of fine aggregate is 2.319.

C. Coarse aggregate

Coarse aggregate" means which is breaked from rocks using explosives & crushed into pieces using machines & coarse aggregate sizes 6mm,12mm,20mm,40mm,60mm are divided using big sieves in machines & coarse aggregate like 6,12,20mm is used to mix in concrete for construction purposes & 40mm is used for railroads. Specific gravity of the fine aggregate is 2.74. Water absorption by them is 0.5% .Size of coarse aggregate is taken as 40% of 4mm to 10mm size aggregate and 60% of 10mm to 20mm.

D. Water

The role of water cement ratio is of utmost importance for the compressive strength of concrete and other desirable properties such as durability etc . In concrete mix design, the ratio of the amount of water to the amount of cement used (both by weight) is called the water to cement ratio (w/c) and water are responsible for binding everything together in concrete.

In concrete, the single most significant influence on most or all of the properties is the amount of water used in the mix. Water used in the preparation of concrete should be free from dirt and organic matters.

E. Admixture

It is a by product of producing silicon metal or ferrosilicon alloys and they are used to enhance some properties like strength, durability, workability, to increase or decrease setting times etc. Here, silica fume is used as an admixture. It is grey in colour.

F. Super plasticizer

The new generation of this kind of admixtures represented by polycarboxylate ether-based super plasticizers. With a relatively low dosage (0.15–0.3% by cement weight) they allow a water reduction up to 40%, due to their chemical structure which enables good particle dispersion. In this research (*MASTER GLENIUM SKY 8765*) is used.

IV. MIX DESIGN

Mix Design is a process of selecting suitable ingredient materials of concrete and determining their relative proportions as economically as possible that would satisfy the desired properties of fresh and hardened concrete as well. For mix design purpose, the complete knowledge of the various properties of the ingredient materials and the conditions at the site should be known beforehand. In India, generally IS Codes are followed for designing a concrete mix.

A. Data used

The basic data required for design of concrete mix of grade M100 are given in the table below.

Data	Value
Degree of workability desired	**Good**
Standard deviation	**6**
Statistic, depending upon the accepted proportion of low results(t)	**1.65**
Target mean strength	**111.98 MPa**
Maximum size of aggregate Used	**20 mm**

B.Water content

The role of water cement ratio is of utmost importance for the compressive strength of concrete and other desirable properties such as durability etc .According to IS-10262:2009, for 20 mm size aggregate, water content and sand as percent of total aggregate by absolute volume is taken as 186 kg per cubic meter of concrete. We have used

140 liters water and with super plasticizer 1 % of binder and expected that super plasticizer, silica fume will have high workability of 120 mm slump.

C. Air content estimation

We have taken 1% amount of entrapped air from IS-10262:1982,as approximate amount of entrapped air to be expected in normal concrete is taken as 1%.

D. Casting of samples for mix design

The size of the cube Specimen is (150x150x150) mm. A total of 5 trials for mix design were casted. In each trial 6 cubes are casted. A total of 30 cubes are casted for the mix design of high strength concrete.

E. Curing of samples

3cubes - from each trial are taken out in 7 day and 28 day respectively for compression test. Accelerated steam curing also done on the trial no 5 in which predicted 28 days compressive strength = R28 = (8.09 + 1.64 Ra), where Ra is accelerated compressive strength and R28 is predicted compressive strength at 28 days.

.F.Mix proportions

Table A: Mix Proportions

Trial mix no	Water to binder ratio	Cement: Fine aggregate: Coarse aggregate	super plasticizer
1	0.33	1:1.27:2.11	1.4% of cement
2	0.30	1:1.46:2.26	1% of cement
3	0.28	1:1.27:2.26	1% of cement
4	**0.27**	**1:1.458:2.3**	**1% of binder**
5	**0.25**	**1:1.35:2.14**	**1% of binder**

V. RESULTS

A. (Trial 1) results

When superplasticizer 1.4% of cement is used then 7-day and 28-day compressive test result of Trial-1 are given in the following table.

Table B: *(Trial 1) results*

Age in days		7	28
No of Cubes		3	3
Cube Strength in MPa	Cube 1	35	59
	Cube 2	37	62.5
	Cube 3	35	62
Average Compressive Strength in Mpa		35.66	61.1

B. (Trial 2) results

When superplasticizer 1% of cement is used then the 7-day and 28-day compressive test result of Trial-2 are given in the following table.

Table C: *(Trial 2) results*

Age in days		7	28
No of Cubes		3	3
Cube Strength in MPa	Cube 1	34.4	63.55
	Cube 2	38	64.44
	Cube 3	36	66.62
Average Compressive Strength in N/mm 2		35.66	61.1

3. (Trial 3) results

When superplasticizer 1% of cement is used then the 7-day and 28-day compressive test result of Trial-3 are given in the following table.

Table D: ***(Trial 3) results***

Age in days		7	28
No of Cubes		3	3
Cube Strength in MPa	Cube 1	37	66.34
	Cube 2	38	67.23
	Cube 3	36.50	68
Average Compressive Strength in N/mm2		37.16	67.19

4. (Trial 4) results

When super plasticizer 1% of binder is used then the 7-day and 28-day compressive test result of Trial-4 are given in the following table.

Table E: ***(Trial 4) results***

Age in days		7	28
No of Cubes		3	3
Cube Strength in MPa	Cube 1	48.89	78.20
	Cube 2	51.11	80.3
	Cube 3	50.12	77.64
Average Compressive Strength in N/mm2		50.04	78.71

5. (Trial 5) results

The specimens are cured in accelerated steam curing. Accelerated Curing Method is used to get early high compressive strength in concrete within 28 hours. This method is also used to find out 28 days compressive strength of concrete in 28 hours.Predicted 28 days compressive strength = R28 = (8.09 + 1.64 Rac), where Ra is accelerated compressive strength and R28 is predicted compressive strength at 28 days. When superplasticizer 1% of binder is used then the 7-day and 28-day compressive test result of Trial-3 are given in the following table.

Table F: ***Trial 5(compressive test results)***

Age in hours		28	
No of Cubes		3	
Cube Strength in MPa	Cube 1	Rac=66.2	R28=116.65
	Cube 2	Rac=62.4	R28=110.33
	Cube 3	Rac=61.2	R28=108.5
Average Compressive Strength in N/mm2		111.8	

VI. CONCLUSION

The trial mix-5 having ingredients (cement: sand: coarse aggregate) and having ratio {1: 1.35: 2.14} with super-plasticizer (Polycarboxylate ether based) **1% of binder**, 10% silica fume of cement and water-binder ratio 0.25 gives satisfactory result. This proportion gives predicted compressive strength of 111.8 MPa at 28days using accelerating curing method. This proportion can be used to produce concrete of grade M100. A slump of 120 mm is obtained. So the amount of super-plasticizer used should be between 0.8% to 1% of the quantity of binder (cement + silica fume).

VII.REFERENCES

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