International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

High Strength Concrete without using Cementitious Admixtures

Poornima Patil,
Assistant Professor,
Department of Civil Engineering
SDM College of Engineering & Technology, Dharwad – 580002

Kushal Kapali A
Assistant Professor,
Department of Civil Engineering
SDM College of Engineering & Technology, Dharwad – 580002

***Abstract*— There is a growing demand for special concrete mixes, high performance concrete, high strength, low permeability concrete, for use in bridges, marine environment, nuclear power plants etc. To achieve this, a partial replacement of cement with silica fume, metakoline, rice husk etc is a common practice. This market is currently filled by silica fume or micro silica, being imported from Norway, China and also from Burma. Due to limited supply of silica fumes in India and the demand being high the price of silica fume has risen as much as Rs. 28.50 per kg. The project will present the extensive study and trial mix conducted for academic interest to produce concrete of maximum compressive strength using maximum cement content specified in IRS Concrete Bridge Code-1997 without use of any special cementitious additive material such as GGBS, silica fume, metakoline, rice husk etc.**

At present, a third generation superplasticizer viz. polycarboxylate base has been developed. By using this type of superplasticizer, the w/c ratio in concrete mix can be reduced to 0.23. It has been estimated that on an average, 23% of water by weight of cement is required for chemical reaction with Portland cement compound, and is called Bond water and another 15 % of water by weight of cement is required to fill up the gel pores. Due to use of superplasticizer this gel pore water (15%) can be reduced upto 0 as superplasticizer takes care to fill gel pores.

Keywords*— *Special Concrete; Cementitious; Super-Plasticizer; Water; Gel Pores.

1. INTRODUCTION

Cement is main ingredient of concrete or mortar. The excess cement content in concrete leads to risk of cracking due to drying shrinkage or early age thermal cracking and increased risk of damage due to alkali silica reaction. Considering the harmful effect in concrete due to use of excessive cement, various standard specification specified the limits of the use of cement content. Indian standard specification IS456:2000 specified maximum cement as 450kg/m^3; Indian Railway Specification IRS Concrete Bridge Code specified the maximum cement content as 500kg/m^3 and MORT&H specification specified the maximum cement as 540kg/m^3. Cement content alone has no significant influence on compressive strength; w/c ratio appears to be the main parameter for strength. w/c ratio for a given set of conditions appears to be the dominant parameter affecting the durability of concrete.

At present, a third generation superplasticizer viz. Polycarboxylate base has been developed. By using this type of super plasticizer, w/c ratio in concrete mix can be lowered to 0.23. It has been estimated that on an average, 23% of water by weight of cement is required for chemical reaction with Portland cement compound, and is called Bond Water and another 15% of water by weight of cement is required to fill up the gel-pores. Due to use of superplasticizer this gel pore water (15%) can be reduced upto zero as superplasticizer takes care to fill gel-pores.

2. OBJECTIVES

1) To study the possibility of using superplasticizer to prepare a high strength concrete.
2) To conduct a detailed experimental study on workability & Compressive strength at age of 7 & 28 days and to compare the cost for both concrete mix using super plasticizer and silica fume.

3. MATERIALS AND METHODOLOGY

3.1 Materials

1. Ordinary Portland cement of 53 grade
2. Fine aggregate
3. Coarse aggregate
4. Water
5. Steel slag

3.2 Superplasticizer

The superplasticizer used in the project is PERMA PLAST PC-302.It is based on polycarboxylic ether and

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

synthetic polymer. It is light brown liquid with specific gravity 1.15. It may be dispensed at dosages varying between 0.6%-2% by weight of cement depending upon type of concrete required.

By using this superplasticizer, w/c ratio in concrete mix can be lowered to 0.23.

3.2 Mixing and casting

The procedure adopted for the preparation of concrete specimens in the form of cubes for strength tests is discussed below:

1. For concrete mix containing silica fume, the materials cement, silica fume, fine aggregates and coarse aggregates were weighed and placed on a large mixing tray which is clean and free from impurities.
The ingredients were mixed properly until the uniform mix was obtained ,after which the mix was poured with required amount of water and mixed well for about 5 minutes.
2. For concrete mix without silica fume and using superplasticizer, the materials cement, fine aggregates and coarse aggregates were weighed and placed on a large mixing tray which is clean and free from impurities.
The ingredients were mixed properly until the uniform mix was obtained ,after which the mix was poured with required amount of water and superplasticizer and were mixed well for about 5 minutes
3. The concrete cube mould of size (150 mm x 150 mm x 150mm) are prepared with concrete mix, placing of concrete mix is done in three successive layer with 25 blows for each layer with the help of a tamping rod , the top surface is then smoothened.
4. The varying percentage of concrete mixes replaced with (10%, 15%, 20%) silica fume as a cementitious admixture were casted into cubes for subsequent tests.
5. The three different concrete mixes using (0.6%, 0.8%, 1%) superplasticizer were casted into cubes for subsequent tests.
6. The concrete moulds are removed after 24 hours of placing in a safe location and the concrete cubes were placed in a curing tank for a specified period of time. The procedure for casting of concrete specimen is shown in below figure

3.3 Concrete Mix Design

3.3.1 Mix design of concrete M55 grade by replacing 10% cement by silica fume.
3.3.2 Mix design of concrete M55 grade by replacing 15% cement by silica fume.
3.3.3 Mix design of concrete M55 grade by replacing 20% cement by silica fume.
3.3.4 Mix design of concrete M55 grade using 0.6% super plasticizer
3.3.5 Mix design of concrete M55 grade using 0.8% super plasticizer
3.3.6 Mix design of concrete M55 grade using 1.0% super plasticizer

	Silica Fume			Superplasticizer		
	Trial I 10%	Trial II 15%	Trial III 20%	Trial I 0.6%	Trial II 0.8%	Trial III 1.0 %
Cement (Kg)	371.1	351.	330	450	450	450
Silica Fume (Kg)	41.3	61.9	82.6	…..	…..	…..
Coarse aggregate (Kg)	1076	1.69	1061	1192	1200	1267
Fine aggregate (Kg)	767	762	757	777	782.5	826
Water (Kg)	206	206	206	157.5	135	112
Superplas tizer (ltr.)	…..	…..	…..	2.35	3.13	3.91

4. RESULTS AND DISCUSSIONS

Compressive strength of concrete mixes of M55 grade of concrete made by 10%,15% and 20% replacement of cement by silica fume and using 0.6%,0.8% and 1.0% superplasticizer by weight of water was tested after 7, and 28 days of curing for different w/c ratio. Slump test was also done for all the mixes just after preparation of mixes.

4.1 Slump Values for Concrete Specimens:

Slump test for different mixes was done just after mixing of the different mixes. Slump values are tabulated in Table 4.1

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

Mix	Slump (mm)
10% Silica Fume	73
15% Silica Fume	60
20% Silica Fume	47
0.6% Superplasticizer	73
0.8% Superplasticizer	70
1.0% Superplasticizer	71

Table 4.1

4.2 Compressive Strength Values for Concrete Specimens The results of compressive strength of various mix proportions Using Silica Fume after curing period of 7 days and 28 days is given in Table 4.2.1 and Fig. 4.2.1

Mix Description	10% Silica Fume	15% Silica Fume	20%Silica Fume
7Days	38.50	40.68	35.45
28 Days	58.40	61.30	57.90

Table 4.2.1

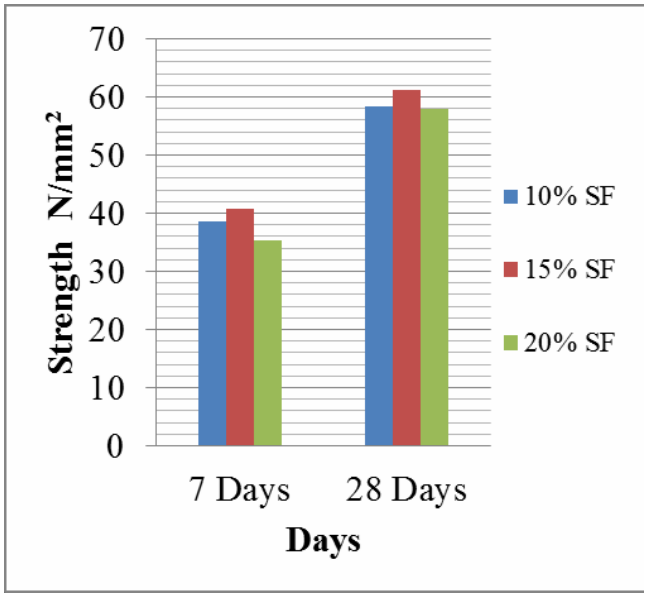

Fig. 4.2.1

- The compressive strength is minimum when 10% cement by weight is replaced with silica fume.
- The compressive strength increases by approx 6.0% when silica content is increased by 5%.
- Further addition ie. 20% replacement of cement by silica fume reduces the strength.
- The strength is maximum when 15% cement by weight is replaced by silica fume.
- The strength is minimum when 20% cement by weight is replaced by silica fume.

The results of compressive strength of various mix proportions Using Superplasticizer after curing period of 7 days and 28 days is given in Table 4.2.2 and Fig. 4.2.2

Mix Description	0.6% Super plasticizer	0.8% Super plasticizer	1.0% Super plasticizer
7 Days	42.50	46.20	49.30
28 Days	58.60	62.40	65.52

Table 4.2.2

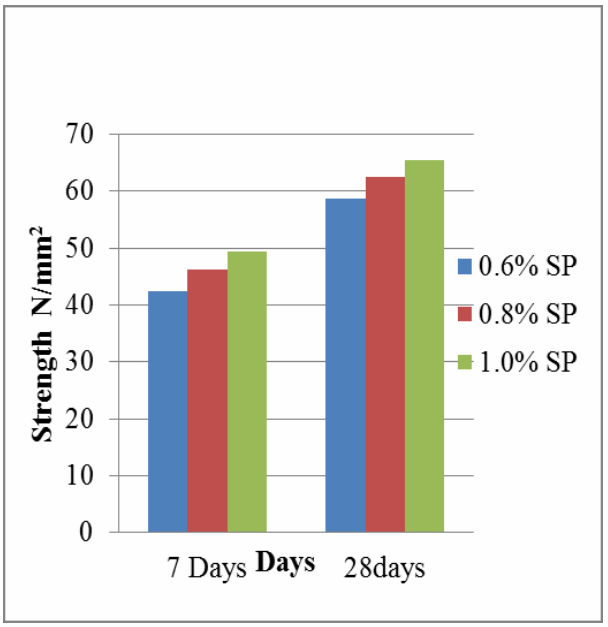

Fig. 4.2.2

From the above result it can be clearly seen that as the water-cement ratio decreses, the compressive strength increases.

Decrease in water-cement ratio of 0.05 increases the compressive strength by 6.5%.

The maximum strength that we are getting is 65.52 MPa when the water-cement ratio is 0.25.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

5. CONCLUSIONS

This work relates the use of Superplasticizer as water reducer to prepare high strength concrete of grade M55 with conventional production method using cementitious admixture i.e. Silica Fume.

- The compressive strength is minimum when 10% cement by weight is replaced with silica fume.
- The 28 days compressive strength increases by approx 6.0% when silica content is increased by 5%.
- Further addition ie. 20% replacement of cement by silica fume reduces the strength.
- The strength is maximum when 15% cement by weight is replaced by silica fume.
- The strength is minimum when 20% cement by weight is replaced by silica fume.
- Decrease in water-cement ratio of 0.05 increases the compressive strength by 6.5%.
- The maximum strength that we are getting is 65.52 MPa when the water-cement ratio is 0.25.
- The compressive strength results show that concrete of M55 grade can be produced with cement content of 450KG/m3 without using any cementitious admixtures like Silica Fume.
- The cost comparison results show that it is economical as compared to other concrete produced by using cementitious admixtures like Siica Fume.
- By using a third generation superplasticizer, water cement ratio of concrete can be minimized upto bond water (23%). Low water cement ratio insures both high strength and low permeability or high durability.
- Concrete of high compressive strength, low permeability and excellent workability can be produced by using maximum cement content as per IS 456:2000

6. REFERENCES

[1] Surajit Choudhury, " High strength concrete without using cementitious additives", The Indian Concrete Journal, October 2015.

[2] Mohammad Abdur Rashida And Mohammad Abul Mansurb, "Considerations in producing high strength concrete", Journal of Civil Engineering (JEB), 37(1) (2009) 53-63.

[3] Dr. R. B. KHADIRANAIKAR, "High performance concrete", Professor BEC, Bagalkot.

[4] Verma Ajay, Chandak Rajeev and Yadav R. K., " Effect of micro silica on the strength of concrete with ordinary Portland cement", Research journal of engineering sciencers, vol 1(3), 1-4, September 2012.

[5] IS 456:2000, "Plain and reinforced concrete", code of practice (Fourth Revision).

[6] IS 10262:2009, " Concrete mix proportioning", (First Revision).

[7] IS 383:1970, " Specification for coarse and fine aggregate from natural sources for concrete", ninth reprint

September 1993.

[8] Dr. A. K. Mullick, " High performance concrete for bridges and highway pavement".

[9] P.Kumar Mehta, " Advancement in concrete technology".

[10] I B Muthi, " Dosage Limit Determination Of Superplasticizing Admixture And Effect Evaluation On Properties Of Concrete", International Journal of Scientific & Engineering Research Volume 4, Issue3, March-2013 1 ISSN 2229-5518it.