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Assessment of an Analysis of Use of Superplasticizer in Concrete & Mortar

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ABSTRACT: This investigation deals with the effects of use of super-plasticizers in mortar and concrete. Studies were carried out on a cement paste, mortar and on 5 types of different mixes, with and without the use of super plasticizers. Four types of indigenous super plasticizers were taken from the different supply sources. The super plasticizers are CMC-Superplast, sikament-600, plastiment-BV/40 and CICO-Superplast. The effects of different doses levels 0.5, 1.0, 1.5 and 2.0 % of the super plasticizers were studied for the water reduction and 7-day, 28-day compressive strength of the mortar and for each type of concrete mixes. The studies were also carried out for standard consistency and setting time of cement paste for each type of super plasticizers for the doses levels 0.5, 1.0, 1.5 and 2.0 %. Results based on this study indicate that the addition of a normal dose of the super plasticizers results in water reduction with a slight retardation in its setting time without affecting other properties of fresh mortar and concrete. The compressive strength of the mortar and concrete mixes gets increased when the water reduction takes place due to the addition of the super plasticizers.

I. INTRODUCTION

The workability is a very important property of concrete in its green state. A high workability is required in ferro-cement work, pumping of concrete etc. cement mortar of high workability has the advantage of quick and easy placement and form a void free and low permeable composition and hence reinforcement can protected against corrosion. But achieving the above mentioned advantages one has to use a high cement content maintaining water-cement ratio of high water content maintaining the cement content. Both these methods may lead to segregation, excessive shrinkage, and undesirable heat development and may also cause long term detrimental effects. To overcome these snags and admixtures may be called for, which may impart a high workability to concrete and mortar without increasing water-cement ratio, and also may reduce water content without losing workability so that high strength of cement composition can be achieved. Such admixtures are designated and super plasticizers. Super plasticizers, a water reducing admixture is a chemical or a mixture of chemicals that when added to normal concrete, imparts extreme workability of a flowing consistency (200mm-250mm of slump) and allows a larger water reduction ranging from 20-30%. The introduction of super plasticizers opened up new possibilities for the use of different cement composition in construction in INDIA. It is believed that development of super plasticizers is a major break through which will have very significant effect on the production and the use of cement composition in future. In tropical like India both the increase temperature and addition of super plasticizers cause the slump loss at the increased rate. This can be avoided and at the same time the advantages of super plasticized concrete can be obtained in tropical countries by the use of some modified super plasticizers. Some retards may be added with super plasticizers to make it suitable for tropical countries.The super plasticizers are also being used in the cement mortars, grouts, coatings, adhesives, fiber reinforced concrete, ferro-cement etc.

II. MATERIAL AND METHODS

Most widely used super-plasticizers are liquid water reducing admixtures. These usually consists of either naphthalene or melamine suphonate condensed in the presence of formaldehyde. The super-plasticizer or high range water reducing admixtures which are available these days can be broadly classified in the following categories according to their composition:

Category A – Sulphonated Melamine formaldehyde condensate (SMF)

Category B – Sulphonate Naphthalene formaldehyde condensate (SNF)
Category C – Modified lignosulphate (MLF)
Category D – Other organic compounds such as sulphuric acid esters and other carbohydrates esters.
Within each category variation do occur, for instance chemically similar materials may have different molecular weights, so alter their effectiveness. Moreover, other chemical may be added, which also change the performance to some extent. A particular information should be sought from the admixtures supplier when selecting a product.

Cement: used was ordinary Portland cement with properties shown in table .Same type of cement was used throughout the work. The cement was stored properly and used within 6 months

Table 1: Physical Properties of Cement.

S No.	Name of Test	Test Results	IS269-1976 Requirement
1	Color of the cement	Moderate Grey	
2	Standard Consistency	25%	
3	Specific Gravity	3.1	
4	Setting Time		
	(i) Initial Setting Time	69 Minutes	> 30 Minutes
	(ii) Final Setting Time	185 Minutes	< 600 Minutes
5	Compressive Strength on 1:3 cement sand mortar cubes using standard mortar		
	(i) 3 - day compressive Strength	25 Mpa	16 Mpa
	(ii)7 - day compressive Strength	30 Mpa	22 Mpa
6	Fineness (By Sieve analysis on IS 90 micron sieve)	8.50%	< 10
7	Soundness	2	< 10

Aggregate: Good quality river sand was used as a fine aggregate. The fineness modulus, specific gravity bulk density and water absorption are 2.36, 800 kg/m3 and 0.80%. Coarse aggregate passing through 20mm and retained 10mm sieve was used. Its specific gravity and water absorption was 2.65 and 0.33%.

Water: Tap water, used for drinking purpose available in the laboratory was found for mixing purposes.

Superplasticizers: Four super plasticizers were collected from different supply sources. Their commercial names and sources are listed in Table 2.

Table 2: List of Superplasticizers.

CODE DESIGNATION	Commercial Name	COLOR	STATE	SPECIFIC GRAVITY	Recommended Dose (Percentage by weight of cement)	Supply Source
A	CMC Superplast	Dark Amber	Liquid	1.14	1 to 2	Constrction Material Corporation, Roorkee
B	Sikament - 600	Dark Brown	Liquid	1.22	0.5 to 3.0	Sika-Qualcrete Pvt. Ltd. Culcutta.
C	Plastiment BV/40	Brown	Liquid	1.21	0.5 to 2.0	Sika-Qualcrete Pvt. Ltd. Culcutta.
D	CICO – Superplast	Brown	Liquid	1.17	0.4 to 2.0	The structural Water – proofing co. Pvt. Ltd., Culcutta

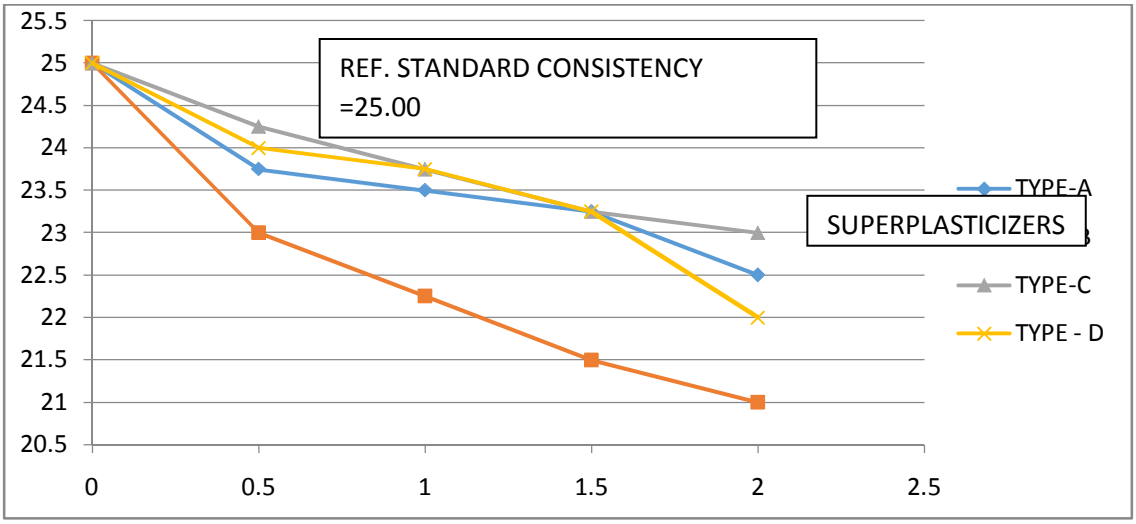
III. EXPERIMENTAL PROGRAM

The aim of present investigation was to, study the water-reducing property of the super-plasticizers which are locally available in India.Mixture Proportions:- Five mixes M_1, M_2, M_3, M_4 AND M_5 with water – cement ratios of 0.35, 0.40, 0.45, 0.50 and 0.55 and with aggregate – cement ratios 2.8, 4.0, 4.5, 5.0 and 6.0, respectively were designed for a compacting factor of 0.80 ± 0.05 as per Indian Specifications (5,6). The tests specimen were 150 mm size cube which were tested for 7 – day and 28-day compressive strength. The tests were carried out as per relevant Indian Standard Specifications (7).

IV. EXPERIMENTAL METHODOLOGY

Table 3: Standard Consistency, Setting Time of Cement Paste with Different Superplasticizers.

Types of Superplasticizers	Dose (% by weight of cement)	Standard Concsistency in Percent	% Reduction of water - content	Setting Time	
				Iniatial (Min)	Final (Min)
CMC Super - Plast (A)	0.0	25.00	0	69	185
	0.5	23.75	5	121	215
	1.0	23.50	6	110	276
	1.5	23.25	7	124	281
	2.0	22.50	10	121	270
Sikament - 600 (B)	0.0	25.00	0	69	185
	0.5	23.00	8	265	300
	1.0	22.25	11	321	378
	1.5	21.50	14	278	More Than 10 hours
	2.0	21.00	16	320	More Than 10 hours
Plastiment BV/40 (C)	0.0	25.00	0	69	185
	0.5	24.25	3	228	289
	1.0	23.75	5	245	285
	1.5	23.25	7	235	304
	2.0	23.00	8	243	348
CICO – Superplast	0.0	25.00	0	69	185
	0.5	24.00	4	70	200
	1.0	23.75	5	216	286
	1.5	23.25	7	227	353
	2.0	22.00	12	172	335

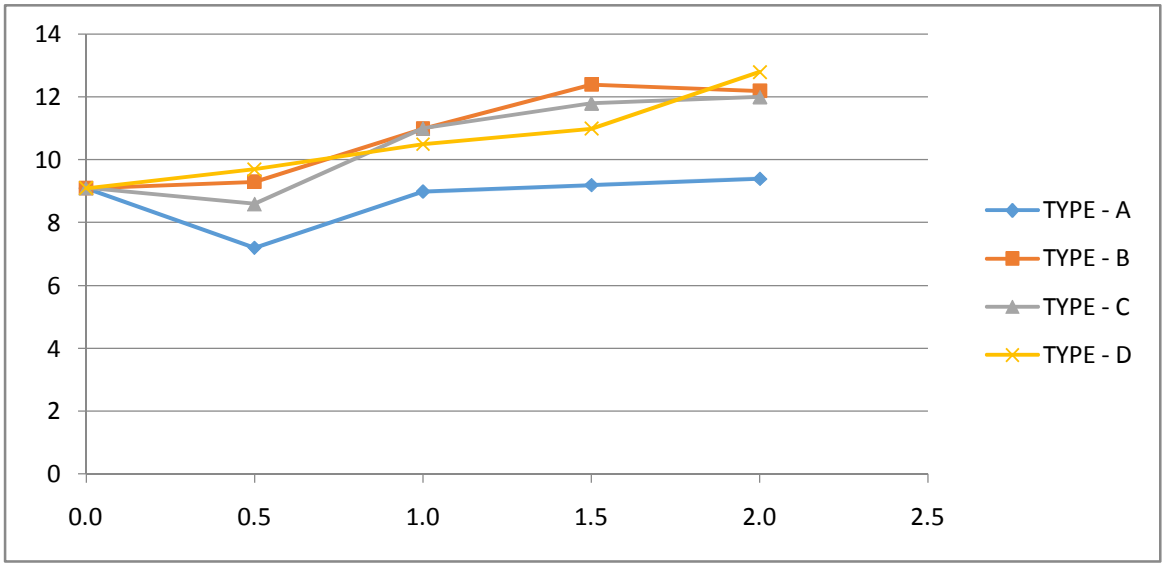


Variation of Standard Consistency with Dosage Rate
(X – axis :superplasticizer dosage(% BY wt. of cement), Y- axis standard consistency)

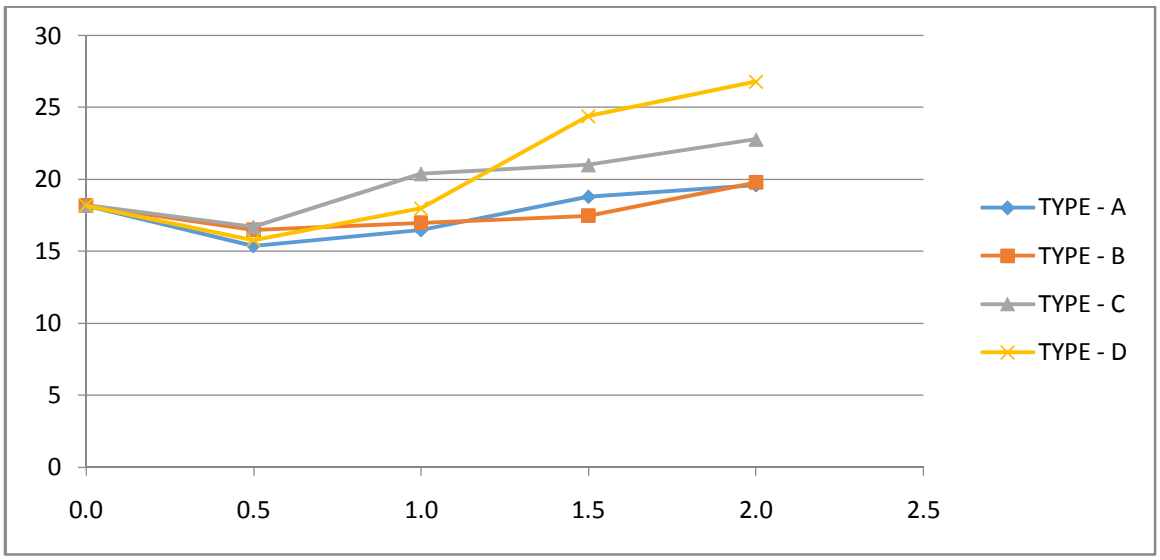
Table 5: Concrete – Water-Cement Ratio And Compressive Strength.

Types of Superplasticizers	Dose (% by weight of cement)	Water - Cement Ratio	Compressive Strength M Pa			
			7 - Day	7 - Day Avg.	28 - Day	28 - Day Avg.
CMC Super - Plast (A)	0	0.35	25.3	22	36.4	35.3
			20.9		33.8	
			23.1		34.7	
	1	0.33	22.2	21.8	24	38.4
			22.7		28.4	
			21.3		28.4	
	2	0.3	23.6	24.7	30.2	39.2
			25.8		30.2	
			18.2		27.6	
Sikament - 600 (B)	1	0.33	24.9	11	14.8	17
			24		17	
			24.9		17	
	2	0.3	No Setting After 24 hours		No Setting After 24 hours	
Plastiment BV/40 (C)	1	0.33	22.7	22.3	33.2	35.7
			22.2		32.8	
			22.2		32	
	2	0.31	24	22.8	39.6	38.5
			22.2		38	
			22.2		37.6	
CICO – Superplast	1	0.31	22.7	22.6	34.7	34.8
			22.7		34.7	
			25.8		35.1	
	2	30	25.8	24.9	37.2	37.1
			24.4		33.2	
			24.4		36.8	

Mix – M_1, Cement Content – 620 Kg/m^3, Aggregate / Cement = 2.8,
Constant Compaction Factor – 0.80 ± 0.05
Cube Specimen Size = 150 mm × 150 mm × 150 mm



Effect of Dosage on 7 – Day Compressive Strength



Effect of Dosage on 28 – Day Compressive Strength

V. CONCLUSION

Based on the observed results and previous work done on the related topic, the following conclusions are drawn tentatively for the mortar and concrete mixes studied in the present report.All the four indigenous super-plasticizers which were used in the present work, are capable of reducing the water content in the range of 20-30% when used in the range of 1.0 – 2.0% by weight of cement. In general for the same dosage levels of the super-plasticizers the water reduction is more in lean mixes than in rich mixes.The relationship between dosage level of the super-plasticizers and the percentage of water reduction is almost linear in the range of 0.5 – 2.0% of dosage levels.

In general it is noticed that excessive dosage of the super-plasticizers causes segregation of concrete. For sikament – 600 the dosage levels higher than 1.0 percent are not suitable because at the higher dosage the setting gets retarded.For the mortar studied with and without the use of the super-plasticizers in present work, the rate of water – reduction is maximum in case of sikament – 600 and it is minimum for CMC – SUPERPLAST. The rate of water reduction is maximum for the concrete mix M_4 among all the different mixes when they were studied with the use of super-plasticizers.It can be concluded that for the same workability, all the super-plasticizers may be used as water reducer in cement mortar and concrete. In turn, it will cause an increase in the early strength as well as the 28 – days strength value.For the mortar the results of 7-day and 28-day compressive strength are most favorable in case of CICO – SUPERPLAST and least favorable in case of CMC – SUPERPLAST.Super-plasticizers which are studied in present work, affect the initial setting time and final setting time of cement and this effect should be taken note of in concrete mixes.In general, the 7 – day and 28 –day compressive strength of all the concrete mixes studied in this work, increases with the increase in dosage levels of the super-plasticizers.The results are almost consistent with the experimental errors, even though the usage of super-plasticizers may be resorted to after careful evaluation.

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