EFFECT OF DIFFERENT WATER REDUCERS ON THE COMPRESSIVE STRENGTH OF M50 CONCRETE

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Abstract

In this Technical paper the experimented results obtained on the Compressive Strength of M50 grade of concrete with the addition of chemical admixtures is discussed. It is a known fact that we need high strength for concrete as we build structures to withstand heavy loads. Various chemical admixtures are available and their property to advance the compressive strength of concrete is not much known. In this direction ten water reducing Chemical admixtures were selected (four plasticizers and six super plasticizers) and they were added to M50 grade of concrete. As per ACI Method of mix design M50 grade of concrete was designed using OPC 43 grade of cement. To this M50 grade of concrete water reducing chemical admixtures are added in three different dosages. Cubes of standard size of 150mm x 150mm x 150mm were cast with three different water cement ratio and with three different dosage of the concerned chemical admixture. The cast cubes were tested for their 3days, 7days and 28 days strength and conclusions were drawn. It is found in the study that addition of chemical admixtures do considerably improve the compressive strength of concrete in cubes. Necessary tabulations and graphs are drawn and the performances of these chemical admixtures are studied and conclusion arrived.

Keywords: Compressive strength, concrete, Plasticizers, Super Plasticizers

I. INTRODUCTION

The strength of concrete depends on a large extent on the water cement ratio. The compressive strength of concrete increases with decrease in water/cement ratio. To help reduce the water cement ratio chemical admixtures are helpful. These chemical admixtures help to increase the workability of concrete and in turn help to reduce the water content. The expectation of the contractors is to keep the workability of concrete at a desirable level and at the same time to increase the compressive strength of concrete. Many companies which manufacture different chemical admixtures such as water reducers claim that by using their water reducers the compressive strength of concrete could be enhanced considerably. Hence in this study different water reducers are selected and added to concrete in different dosage and their performance to increase the compressive strength of concrete is studied.

II. MATERIALS USED

Ordinary Portland cement of grade 43 from the same batch got from ACC, Madukarai was used to make all the concrete cubes. Fine River sand which was dust free was used as fine aggregate. Dry coarse aggregate of size less than 20mm was used throughout the study.

The physical properties of the materials used for this investigation is shown in Table 1.

Table 1. Physical properties of Materials Used

S. No.	Material	Physical Property	Value
1.	Cement	Specific Gravity	3.15
2.	Fine Aggregate	Specific Gravity	2.62
		Fineness Modulus	2.44
3.	Coarse Aggregate	Specific Gravity	2.81
		Dry Rodded Bulk Density	1748kg/m^3

The ACI Method of concrete mix design was used to design the M50 grade of concrete and the amount of the constituents of concrete was calculated using the physical properties of the materials.

The amount of materials used is shown in Table 2.

Table 2. Weight of Materials in kg used to make 1m^3 of M50 grade of concrete

Material	Cement	Fine Aggregate	Coarse Aggregate	Water
Wt. in kg	514	582	1154	185
Ratio	1	1.13	2.25	0.36

III. CHEMICALS USED

From the most commonly available chemical water reducing agents available in the market ten were selected.

The six super plasticizers that are used in this study are

a) Organic Polymers - OP

b) Sulphonate Naphthalene Polymers - SNP

c) Melamine Formaldehyde- MF

d) Sulphonate Formaldehyde- SF

e) Naphthalene Sulphonate- NS and

f) Naphthalene Formaldehyde- NF

The four plasticizers that are used in this investigation are

a) Modified lignosulphonate- ML

b) Refined lingosulphonate- RL

c) Condensed lignosulphonate- CL

d) Processed lignosulphonate- PL

The claims made by the manufactures of the above chemical water reducers are studied in depth and they are found as follows:

a) Eliminates the need of compaction

b) Workability of similar concrete could be produced with 20% to 30% of less water content

c) Increase compressive, tensile and flexural strength

d) High early strength is achieved enabling mould utilization in precast concreting

e) Enables in making close textured concrete with reduced porosity and hence more durable

f) Higher cohesion resulting in less bleeding and segregation.

Though the claims made by them are tall and good the extent to which these claims are true and real is not known to the Engineers and contractors. At the field the water reducers such as plasticizers and super plasticizers are roughly used to just get a workable concrete. The persons in the field are not aware of the parameters by which the strengths of concrete are improved or affected. In this investigation the effect of the above ten water reducing agents on the compressive strength of concrete is studied in detail.

IV. EXPERIMENTAL PROGRAMME

A detailed experimental programme was launched with the M50 grade of concrete selected designed and made with the help of the materials described above.

V. WITHOUT CHEMICAL ADMIXTURE.

Cubes were cast without the chemical water reducers. These average values are entered in table 3 and the readings are used to plot the graph shown in figure 1.

Table 3. Compressive Strength of cubes without Admixture in N/mm^2

Days	W/C Radio 0.36			W/C Radio 0.3			W/C Radio 0.25		
	Dosage 0.75	Dosage 1.0	Dosage 1.25	Dosage 0.75	Dosage 1.0	Dosage 1.25	Dosage 0.75	Dosage 1.0	Dosage 1.25
28 Days	53	49	44	55	51	46	42	38	33
7 Days	40	35	31	42	40	37	34	27	23
3 Days	27	23	21	30	27	23	24	20	18

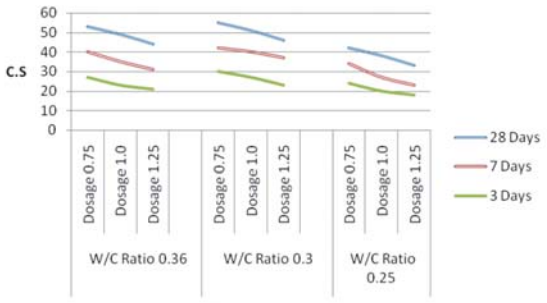

Fig.1. Compressive Strength of Cubes Without Admixtures in N/mm^2

The concrete moulds were cleared from all dust and wiped thoroughly and the sides were coated with oil for the smooth formation of the concrete cubes. The ingredients such as cement, sand and aggregate were measured by weight with the help of a weigh balance and thoroughly mixed. After that the water with the admixture was added to the concrete mixture and thoroughly mixed.

The mixed concrete was then placed in the cube mould and was well compacted with the help of a vibrator. The concrete moulds are kept for 24hours and then the concrete cubes are removed from the mould and placed inside water for curing to take place. The cubes were taken

and tested for its compressive strength with the help of a compression testing machine and the readings were entered in a table 4 and table 5.The above experimental procedure was conducted by keeping the water cement ratio at 0.36, 0.3 and 0.25. The Dosage of the water reducers added was kept at 0.75%, 1.0% and 1. 25% by weight of cement.

Three such cubes were made for each parameter and the cubes were tested for its compressive strength for 3days, 7days and 28days and the compressive strength in N/mm^2 was found. The average value of the three cubes was considered for plotting the graphs. The graphs were show from figure 2 to figure11.

Table 4. Compressive Strength of Cubes of M50 Concrete with Plasticizers in N/mm^2

		W/C Ratio 0.36			W/C Ratio 0.3			W/C Ratio 0.25		
28 Days Strength		Dosage 0.75	Dosage 1.0	Dosage 1.25	Dosage 0.75	Dosage 1.0	Dosage 1.25	Dosage 0.75	Dosage 1.0	Dosage 1.25
	ML	59	56	49	56	52	48	48	40	35
	RL	60	48	42	66	50	40	51	35	28
	CL	62	48	45	56	51	40	46	35	25
	PL	62	56	48	59	52	42	47	38	35
	7 Days Strength									
	ML	41	36	33	42	39	31	32	28	22
	RL	35	29	25	38	32	24	28	25	19
	CL	42	35	29	38	31	25	29	27	17
	PL	46	39	36	41	36	27	30	24	18
	3 Days Strength									
	ML	31	29	27	34	28	25	25	23	20
	RL	30	25	22	32	29	21	24	21	17
	CL	34	28	25	29	25	20	20	18	15
	PL	31	28	26	32	30	25	23	20	17

Table 5. Compressive Strength of Cubes of M50 Concrete with Super Plasticizers in N/mm^2

		W/C Ratio 0.36			W/C Ratio 0.3			W/C Ratio 0.25		
28 Days Strength		Dosage 0.75	Dosage 1.0	Dosage 1.25	Dosage 0.75	Dosage 1.0	Dosage 1.25	Dosage 0.75	Dosage 1.0	Dosage 1.25
	OP	56	51	38	66	56	34	42	32	29
	SNP	76	70	66	79	66	56	55	48	49
	MF	76	61	56	77	64	52	64	48	42
	SF	70	64	60	73	62	55	51	39	35
	NS	56	51	46	59	55	43	47	41	31
	NF	63	59	52	74	62	47	47	44	35
	7 Days Strength									
	OP	41	38	32	40	35	28	32	23	21
	SNP	46	42	35	45	41	39	34	29	27
	MF	45	41	34	49	43	31	36	32	25
	SF	42	33	29	46	31	24	36	25	20
	NS	43	35	32	49	39	29	28	25	20
	NF	42	36	29	45	38	27	30	27	22
	3 Days Strength									
	OP	28	30	26	35	29	25	28	22	19
	SNP	37	32	28	38	33	28	29	25	21
	MF	32	28	24	37	26	22	28	22	19
	SF	32	28	23	35	25	21	24	21	18
	NS	30	25	22	37	28	20	24	19	16
	NF	31	28	26	38	25	24	21	20	17

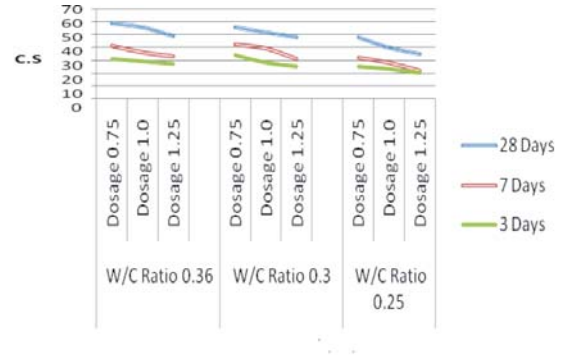

Fig. 2. Compressive Strength of Cubes With ML in N/mm^2

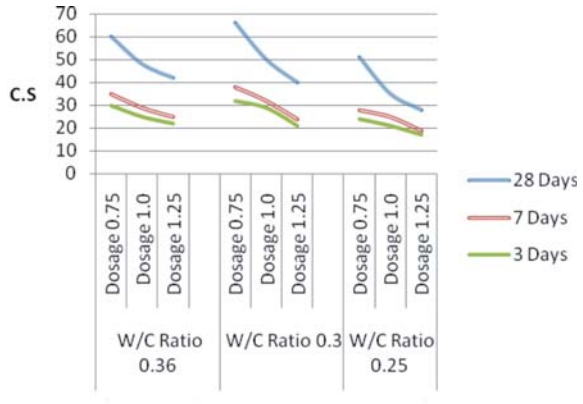

Fig. 3. Compressive Strength of Cubes With RL in N/mm^2

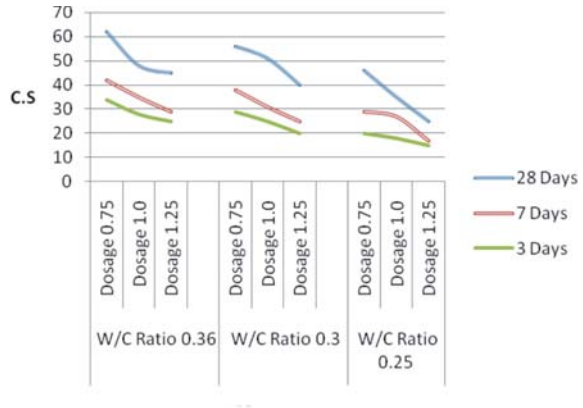

Fig. 4. Compressive Strength of Cubes With CL in N/mm^2

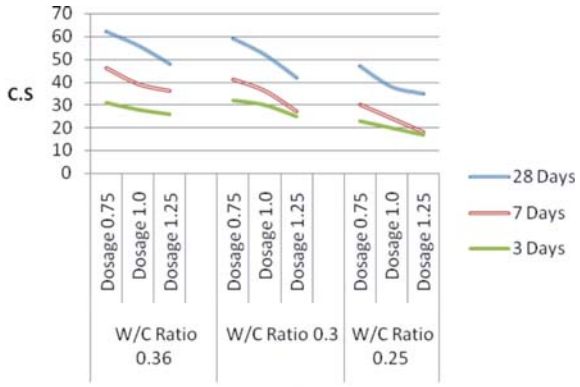

Fig. 5. Compressive Strength of Cubes With PL in N/mm^2

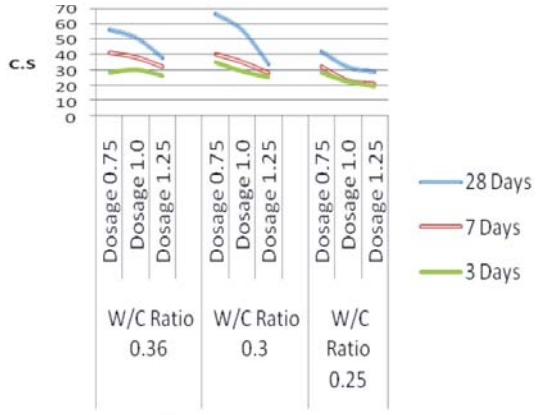

Fig. 6. Compressive Strength of Cubes With OP in N/mm^2

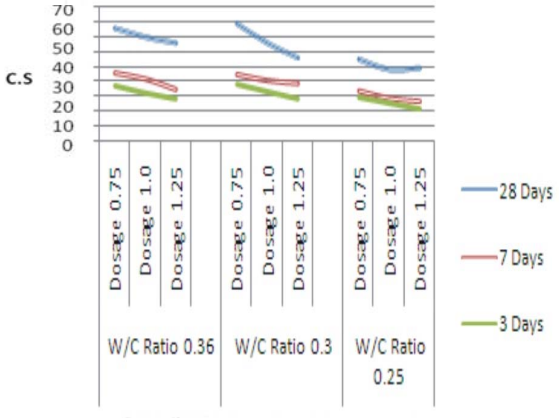

Fig. 7. Compressive Strength of Cubes With SNP in N/mm^2

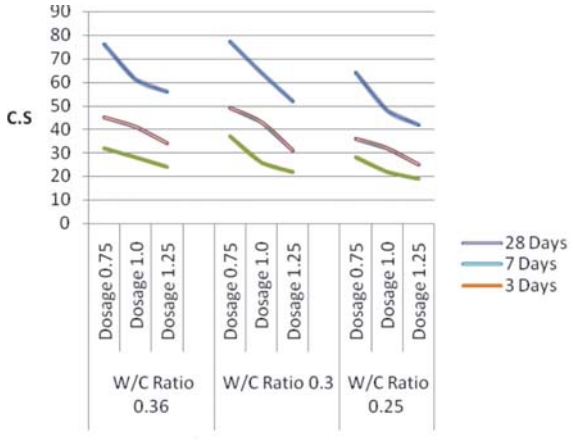

Fig. 8. Compressive Strength of Cubes With MF in N/mm^2

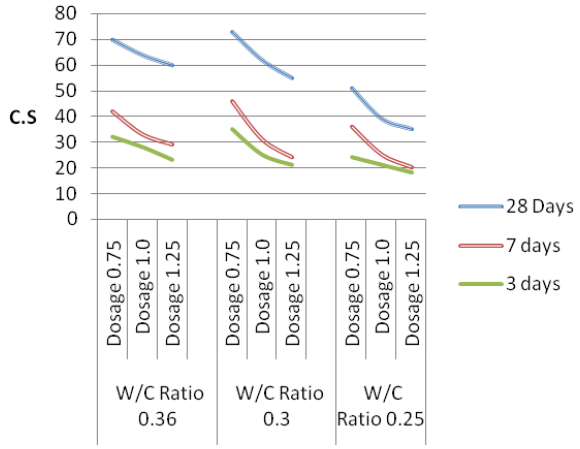

Fig. 9.Compressive Strength of Cubes With SF in N/mm^2

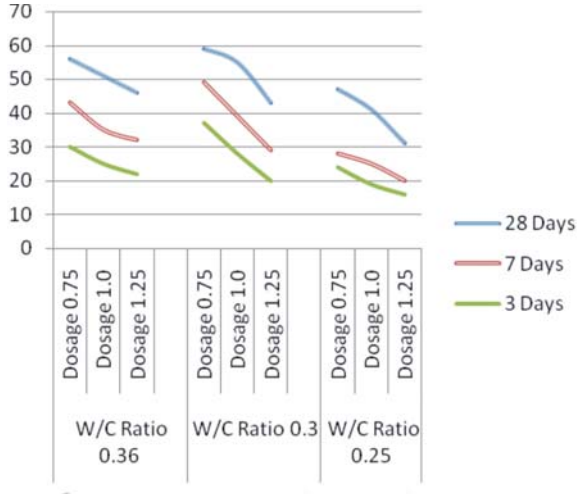

Fig. 10.Compressive Strength of Cubes With NS in N/mm^2

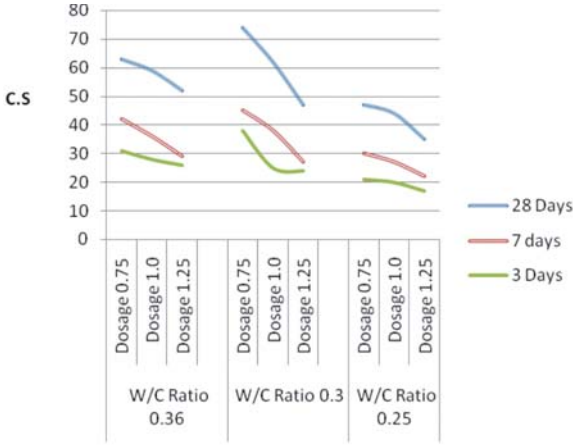

Fig. 11. Compressive Strength of Cubes With NF in N/mm^2

VI. TEST RESULTS AND DISCUSSIONS

It is clearly evident from the graph that there is marked improvement in the compressive strength of the cubes when the water reducing admixtures are added. But the increase in compressive strength is only about 10% to 20% more than the reference mix. Some companies have claimed that the increase in strength will be more than 40%.

By comparing figure 1 and figure 2 it was found for modified lignosulphonate the maximum increase in compressive strength was found as.5%

By comparing figure 1 and figure 3 it was found for Refined lignosulphonate the maximum increase in compressive strength was found as. 20%

On comparing figure 1 and figure 4 it was found for condensed lignosulphonate the maximum increase in compressive strength was found as 17%

It was found by comparing figure 1 and figure 5 for processed lignosulphonate the maximum increase in compressive strength was found as 17%

By comparing figure 1 and figure 6 it was found for organic polymer the maximum increase in compressive strength was found as 20%

It was found by comparing figure 1 and figure 7 for sulphonate naphthalene polymer the maximum increase in compressive strength was found as 44%

By comparing figure 1 and figure 8 for melamine formaldehyde the increase in maximum compressive strength was found as 40%.

By comparing figure 1 and figure 9 for sulphonate formaldehyde the increase in maximum compressive strength was found as 32%

By comparing figure 1 and figure 10 for Naphthalene Sulphonate the increase in maximum compressive strength was found as 7%.

By comparing figure 1 and figure 11 for Naphthalene Formaldehyde the increase in maximum compressive strength was found as 35%.

VII. CONCLUSION

Results of the experimental investigation on the compressive strength of concrete cubes when added with different water reducing admixtures is reported in this paper. The experiments conducted in this study used M50 grade of concrete made of OPC43 grade of cement for the entire study.

1) The compressive strength of concrete cubes increased by 15% with the addition of Plasticizers and by 30% with the addition of Super Plasticizers.

2) The compressive strength increased considerably when the water cement ratio was kept at 0.3.

3) The compressive strength got very much reduced when the water cement ratio was further reduced to 0.25.

4) The optimum compressive strength in general was got when the dosage of the chemical added is kept at 0.75% by weight of cement, rather then when added by 1% or 1.25%. More addition of the chemical did not result in the increase of compressive strength of concrete.

5) Among the water reducers used sulphonate Naphthalene Polymers gave the best results when compared with others.

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