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EFFECTS OF CHEMICALS AS SUPERPLASTICIZER ON VARIOUS PROPERTIES OF THE CONCRETE

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Abstract: The second most consumed material on earth is concrete, after water. So we need to look for ways to reduce the use of water in concrete in most economic way possible. We also want concrete to gain its ultimate strength earlier to reduce the overall requirement of water. Plasticizers and Superplasticizers are used to reduce the water requirement in the concrete. The use of these admixtures not only reduces the water content of the concrete but also gives higher early strengths and higher ultimate strengths. The available Plasticizers and Superplasticizers in the market are costly and hence cannot be used for smaller project as they will make the project uneconomical. This project work is conducted to find better alternatives to these available costly Superplasticizers. This report is about the project work which includes the study of effect of chemicals as Superplasticizers on various properties of the concrete. The study of different chemicals used as Superplasticizers for concrete and their comparison with the normal concrete. There are two different chemicals taken for the project work. The chemicals are added in different proportions of 0.25%, 0.5%, 0.75% and 1% of the weight of cement. The concrete cubes of M25 grade were prepared. The normal cubes and the cubes with the chemical admixture were tested. Then the behavior of the concrete is noticed to checks how the changes made in the properties with the addition of the different proportion of the chemicals. The reduction in water content is also checked with the addition of the different proportion of the chemical admixtures. The properties like consistency, initial setting time, slump cone test, water absorption test and compressive strength tests were tested. The project work also include the study of the properties of the chemicals used for the project work .It comprises of different tests for different building material such as sand, aggregates (coarse & fine aggregates), concrete and cement used for the completion of the project. The aim of the project is to find a better substitute to the costly super plasticizers available in the market and make the each project economical.

Index Terms - concrete, superplasticizer, chemical admixtures, water reduction, early strength, workability.

I. INTRODUCTION

SUPERPLASTICIZER

Superplasticizers, also known as high range water reducers, are additives used in making high strength concrete. Plasticizers are chemical compounds that enable the production of concrete with 10% less water content. Superplasticizers allow reduction in water content by 15% or more. These additives are employed at the level of a few weight percent. Plasticizers and superplasticizer retard the curing of concrete. Super plasticizers are used where well-dispersed particle suspension is required to improve the flow characteristics (rheology) of suspensions such as in concrete applications. Their addition to concrete or mortar allows the reduction of the water to cement ratio without negatively affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete. They greatly improve the performance of the hardening fresh paste. The strength of concrete increases, as the water to cement ratio decreases. Superplasticizers are synthetic polymers. Compounds used as superplasticizer include sulfonated naphthalene formaldehyde condensate, sulfonated melamine formaldehyde condensate, acetone formaldehyde condensate and polycarboxylate ethers. Cross-linked melamine- or naphthalene- sulfonates, referred to as PMS (polymelamine sulfonate) and PNS (polynaphthalene sulfonate), respectively, are illustrative. They are prepared by cross linking of the sulfonated monomers using formaldehyde or by sulfonating the corresponding cross linked polymer.

DIFFERENCE BETWEEN PLASTICIZER AND SUPERPLASTICIZER

Plasticizers, as represented by the name, are chemical components that are added to substances to increase the plasticity of that substance. Therefore, plasticizers are additives. Increasing the plasticity is equal to softening the substance. It makes the substance flexible and durable. Superplasticizers are polymers that are used to prevent particle segregation of suspensions.

Both plasticizers and superplasticizer are known as dispersants. A dispersant is a chemical compound that is added to a suspension in order to improve the separation of particles. Both these compounds are used as additives for concrete mixtures to reduce the water requirement for the concrete mixture. Therefore, plasticizers and superplasticizer are different from each other depending on the reduction of water requirement for concrete mixtures. The main difference between Plasticizers and Superplasticizer is that plasticizers can reduce the need for water up to 10% whereas superplasticizer can reduce the need for water from 15% and more**.** Plasticizers are usually based on lignosulfonate, which is a natural polymer. The commonly used Superplasticizer are SMF, SNF, PCE. Plasticizers are added 0.1 – 0.5% by weight of cement whereas superplasticizer are added 0.5 – 3% by weight of cement.

WHY WE NEED SUPERPLASTICIZER FOR CONCRETE?

Superplasticizers are well known in market for their high range water reducing properties. They are the chemical compounds, which reduces the initial need of water for mixing the concrete mix and also reduces the curing time of the concrete. By reducing the amount of water, the cement paste will have higher density, which results in higher paste quality. An increase in paste quality will yield higher compressive and flexural strength, lower permeability, increase resistance to weathering, improve the bond of concrete and reinforcement, reduce the volume change from drying and wetting, and reduce shrinkage cracking tendencies. Another benefit of superplasticizer is concrete early strength enhancement (50 to 75%). The initial setting time may be accelerated up to an hour earlier or retarded to be an hour later according to its chemical reaction. To meet the modern demands of the world, to beat the time boundations, the superplasticizer play an important role.

OBJECTIVE OF WORK

The second most consumed material on earth is concrete, after water. So we need to look for ways to reduce the use of water in concrete in most economic way possible. We also want concrete to gain its ultimate strength earlier to reduce the overall requirement of water. The objective of work is to prepare normal concrete block and one with chemical additives and compare them on the bases of different properties of concrete. Here we take different percentage of chemical compound and test their normal consistency, compressive strength, water absorption, initial setting time of concrete block. Here we are trying to determine how concrete will behave at different percentage of chemical admixture and how much less water will be required in comparison with normal concrete. So, it is important to find ways to reduce the water-cement ratio in concrete without much affecting the workability. Superplasticizer, admixture, water-reducers are one way to achieve this.

II. RESEARCH METHODOLOGY

MATERIALS USED:

- Cement:
  - . Coromandal king (PPC)
- Aggregates:
  - . Coarse Aggregates (20mm)
  - . Fine Aggregates (4.75mm)
- Chemicals Used:
  - . Compound 1
  - . Compound 2
- Water

CHEMICALS USED

Compound 1

The first chemical used is a synthetic polymer based compound which is expected to behave as a super plasticizer. The compound does not contain any chloride compound. It has a pH ≥ 6 at 25ºC. The compound is in liquid form with dark brown color. The relative density is 1.17±0.02 at 25ºC.

COMPOUND 1 IN BOWL

Compound 2

The second chemical used is polymeric ether based compound which is also expected to behave as super plasticizer. This compound also does not contain any chloride compound. It has pH ≥ 6 at 25ºC. The compound is in liquid form with reddish brown color. The relative density is 1.05±0.02 at 25ºC.

Compound 2 in bowl

TESTS CONDUCTED

- **Consistency test**

The standard consistency of cement is determined by this test using vicat's apparatus. The standard or normal consistency is the one which permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom of the vicat mould when tested. Consistency test tells us the amount of water required for preparing a standard mix. Samples were prepared for different chemical proportion and tested.

- **Initial setting time test**

Initial setting time of concrete is the time when cement paste starts hardening. Theoretically, Initial setting time of concrete is the time period between additions of water to cement till the time at 1 mm square section needle fails to penetrate 5mm to 7mm from the bottom of the mould in the cement paste, placed in the Vicat's mould. The samples having standard consistency were used for the initial setting time test.

- **Slump cone test**

The slump test is conducted for workability check of the concrete. Workability is a term to indicate the degree of fluidity or the degree of mobility .Concrete slump value is used to find the workability, which indicates water-cement ratio. The test was conducted for each chemical proportion.

- **Water absorption test**

Water absorption test is conducted to check the amount of water absorbed by the concrete blocks in the specified number of days. Checking the amount of water absorption by the concrete is important because if the concrete absorbs more water then, its properties like strength gets degraded and it's not considered good. So water absorption check is important. The water absorption check was done for every cube.

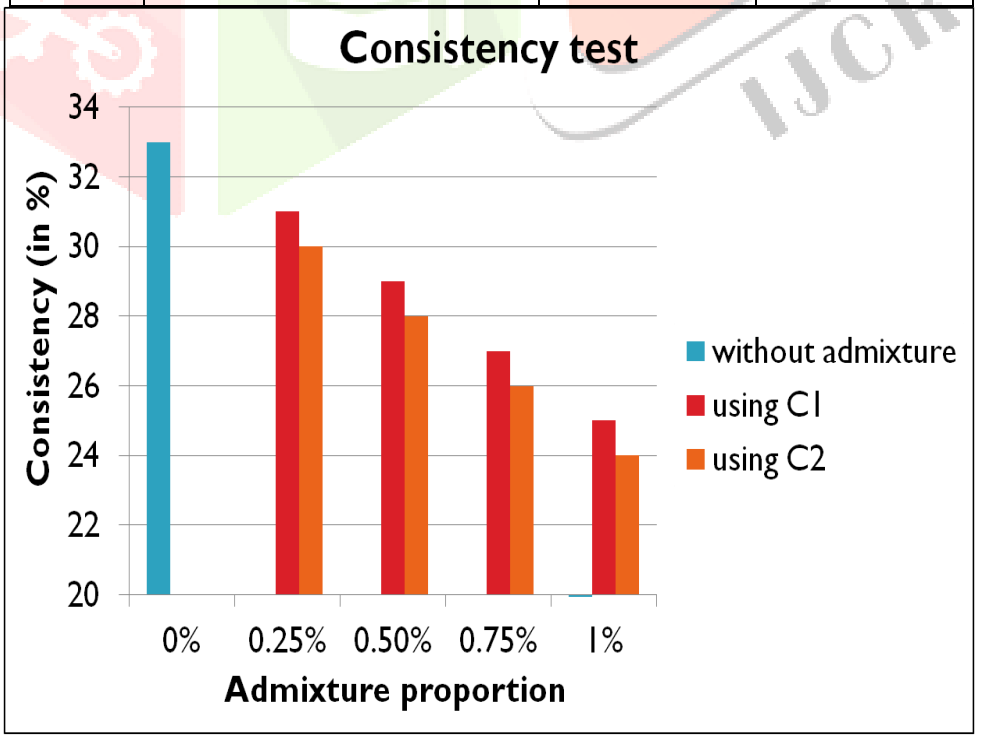
- **Compression test**

Cubes of M25 grade were casted whose strength was to be checked by the compression test. The sample cubes were casted by preparing the concrete mix and were left for 24 hours. After 24 hours the cubes were kept in a water tank for curing. The compressive strength of the cubes was then tested after 3, 7 and 14 days of curing. The average strength of 3 cubes was taken as result.

III. RESULTS

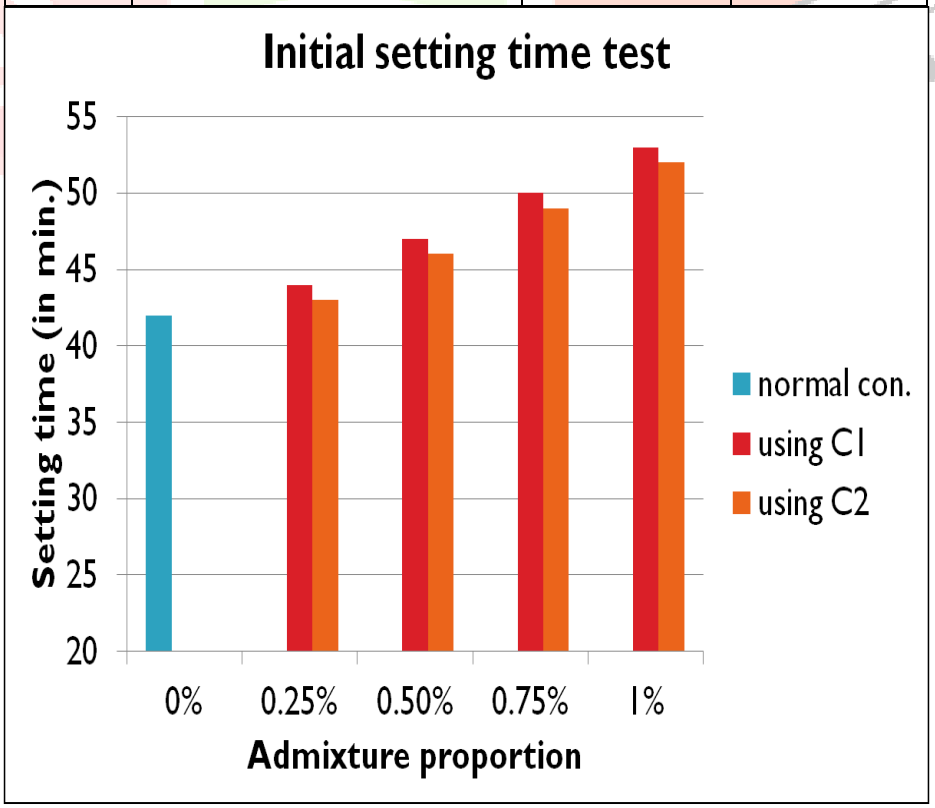
Comparative result of Consistency Test

Sr. No	Type	Proportion	Consistency
1	Only cement	0%	33%
2	Cement with compound 1	0.25%	31%
3	Cement with compound 1	0.5%	29%
4	Cement with compound 1	0.75%	27%
5	Cement with compound 1	1%	25%
6	Cement with compound 2	0.25%	30%
7	Cement with compound 2	0.5%	28%
8	Cement with compound 2	0.75%	26%
9	Cement with compound 2	1%	24%



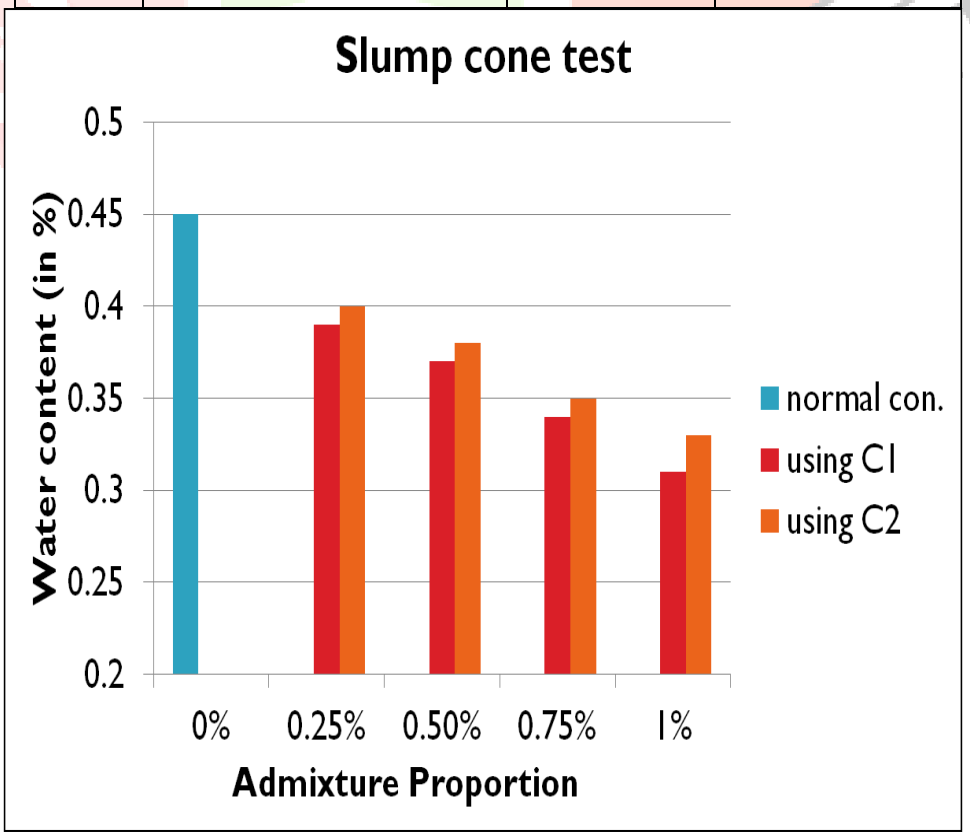
Comparative result of Initial Setting Time

Sr. No	Type	Proportion	Setting time
1	Only cement	0%	42 min.
2	Cement with compound 1	0.25%	44 min.
3	Cement with compound 1	0.5%	47 min.
4	Cement with compound 1	0.75%	50 min.
5	Cement with compound 1	1%	53 min.
6	Cement with compound 2	0.25%	43 min.
7	Cement with compound 2	0.5%	46 min.
8	Cement with compound 2	0.75%	49 min.
9	Cement with compound 2	1%	52 min.



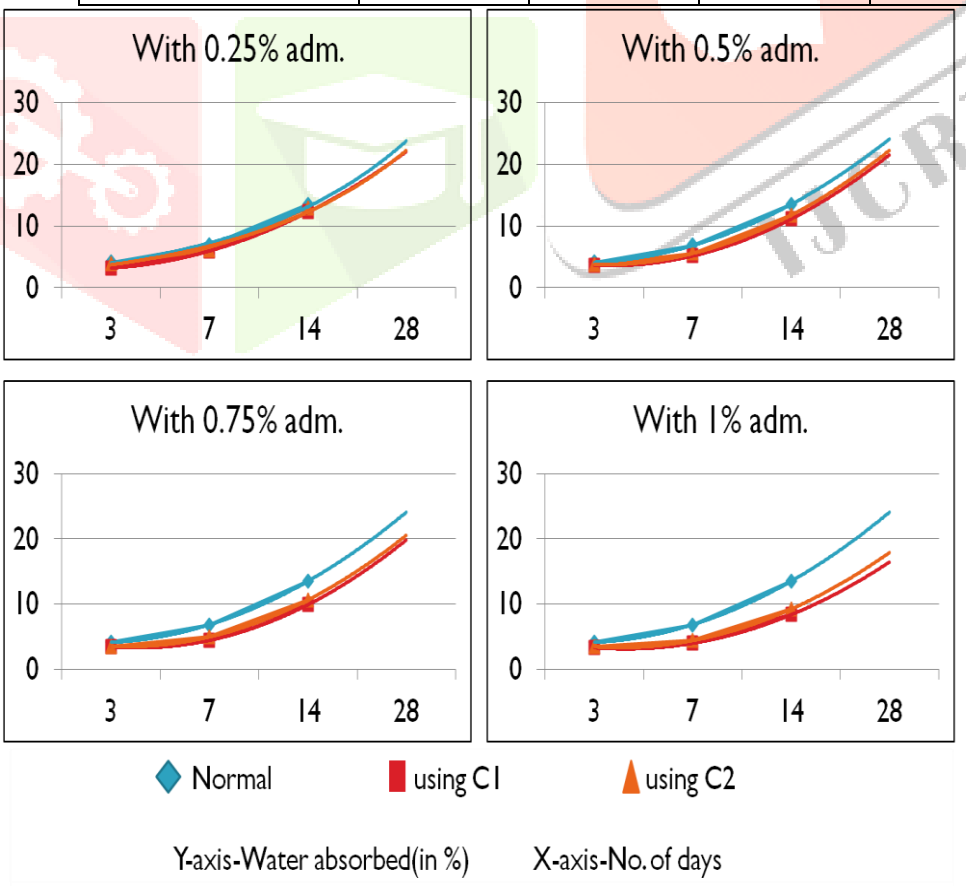
Comparative result of Slump Cone Test (for 100-120mm slump)

Sr.No	Type	Proportion	Water content
1	Only cement	0%	0.45
2	Cement with compound 1	0.25%	0.39
3	Cement with compound 1	0.5%	0.37
4	Cement with compound 1	0.75%	0.34
5	Cement with compound 1	1%	0.31
6	Cement with compound 2	0.25%	0.40
7	Cement with compound 2	0.5%	0.38
8	Cement with compound 2	0.75%	0.35
9	Cement with compound 2	1%	0.33



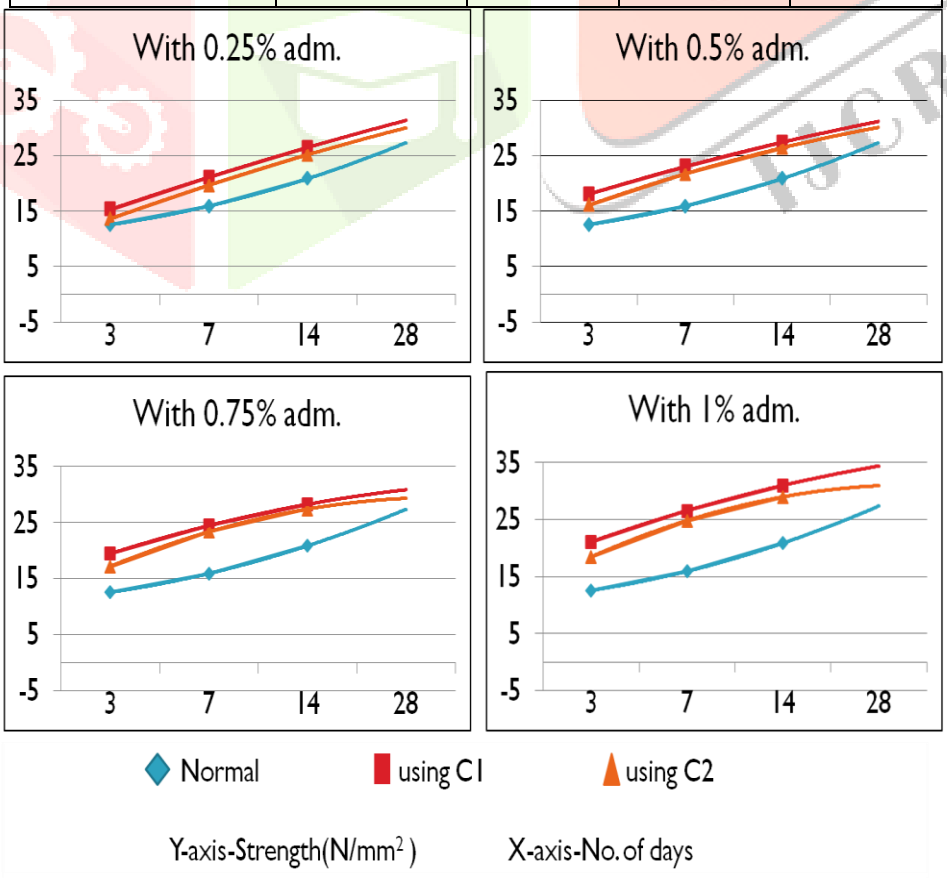
Comparative result of Water Absorption Test

Concrete type	Proportion	Percentage water absorbed		
		3 day	7 day	14 day
Normal Concrete	0%	4.12%	6.85%	13.51%
Concrete+C1	0.25%	3.18%	5.96%	12.25%
Concrete+C2	0.25%	3.91%	6.11%	12.89%
Concrete+C1	0.50%	3.62%	5.12%	11.13%
Concrete+C2	0.50%	3.71%	5.56%	11.75%
Concrete+C1	0.75%	3.47%	4.45%	9.91%
Concrete+C2	0.75%	3.52%	4.97%	10.65%
Concrete+C1	1%	3.31%	3.99%	8.37%
Concrete+C2	1%	3.45%	4.41%	9.23%



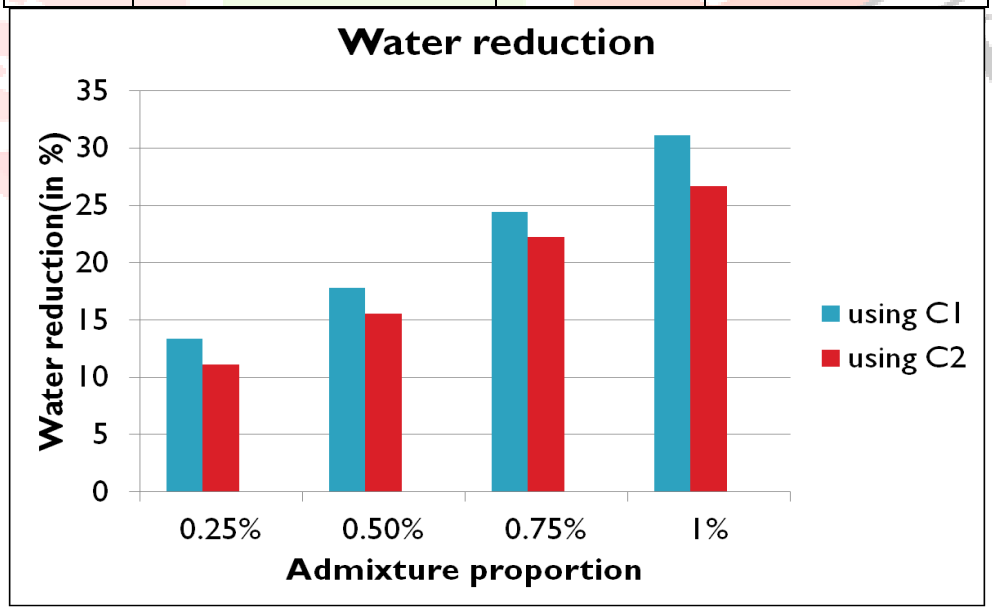
Comparative result Compressive Strength Test

Concrete type	Proportion	Average compressive strength(N/mm^2)		
		3 day	7 day	14 day
Normal Concrete	0%	12.57	15.93	20.87
Concrete+C1	0.25%	15.32	21.14	26.50
Concrete+C2	0.25%	13.62	19.71	25.19
Concrete+C1	0.50%	18.06	23.06	27.44
Concrete+C2	0.50%	16.09	21.75	26.43
Concrete+C1	0.75%	19.46	24.47	28.27
Concrete+C2	0.75%	17.21	23.37	27.41
Concrete+C1	1%	21.09	26.56	29.29
Concrete+C2	1%	18.46	24.84	28.11



Water reduction by chemical usage

Sr. No.	Type	Proportion	Water reduction
1	With compound 1	0.25%	13.33%
2	With compound 1	0.5%	17.77%
3	With compound 1	0.75%	24.44%
4	With compound 1	1%	31.11%
5	With compound 2	0.25%	11.11%
6	With compound 2	0.5%	15.55%
7	With compound 2	0.75%	22.22%
8	With compound 2	1%	26.66%



IV. CONCLUSIONS

The comparison between the normal concrete was done with the concrete prepared by the addition of the chemicals was done. The addition of the chemicals in the concrete show changes in the various properties of the concrete. The properties like workability, water absorption, compressive strength, etc were affected. Firstly, with addition of more amounts of admixtures the water requirement for the mixing is reduced. The water requirement was reduced up to more than 30%. The initial setting time of cement is also affected. The initial setting time was increased by admixtures. This is beneficial because the concrete would not set fast thus providing longer time durations to work with ease. Higher workability is achieved at lower water cement ratio using these admixtures. With higher workability

of the concrete the placement of concrete becomes easy. No extra efforts are required to placement or compaction the concrete. Thus, there is no requirement of vibrators or other such machineries. Concrete with admixture has shown increased compressive strength than normal concrete. The concrete with chemical admixtures is gaining its targeted strength in about 14 days. The ultimate strength of the concrete is expected to increase by 28-30% of its 14 days strength. The project work concludes that the ultimate strength of the concrete is higher than the targeted one. The water absorption tests also give good results. Water absorption is also low in concrete with admixture than normal concrete which means the penetration of water in concrete is low. This sounds beneficial from the waterproofing point of view. The chemicals show the properties similar to the superplasticizer. Thus they can be a better alternative to the available costly superplasticizer in the market. The changes shown by these admixtures in the various mentioned properties of the cement and concrete are good. These can be used to solve many construction problems. The chemicals used for the completion of the project showed almost similar changes in the properties of the cement and the concrete. Although the changes in the properties like water absorption, compressive strength, etc. were in similar manner, but the compound 1 shows better results than compound 2. Compound 1 showed more water reduction and the compressive strength is also higher than the other one.

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