Enhancement The Strength Characteristics of Concrete Using Different Ratio of Superplasticizer In The Mix

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Abstract- *In last few years, considerable attention has been given to the use of superplasticizer as a chemical admixture in cement concrete mixture. However, the use of chemical admixtures in cement concrete is a very common solution to achieve high performance concrete. The past researchers have been underlined the use of chemical admixtures imparts the desirable properties to the cement concrete in both fresh and hardened state.*

This thesis work has been made an attempt to study the influence of the superplasticizer dose of 0.5, 1, 1.5, 2 and 2.5 percentage on the performance of the cement concrete, by using superplasticizer we can reduce the water demand of concrete mix. This study utilizes the Conplast sp430 which is a superplasticizer; it is used in the concrete mix with variable quantity i.e. 500 ml – 2,500 ml per 100 kg of cement. The use of superplasticizer helps in reducing the utilization of water and it also increases the strength of the concrete. The use of superplasticizer also helps in preservation of the environment by saving the water. The main objective of this research is to determine that what percentage the superplasticizer can be used in the concrete mix to achieve its target mean strength. The experimental tests for fresh and hardened properties of concrete for M25 grade are studied and the results are compared with normal concrete. In this ongoing research work it is concentrated on the use of superplasticizer for reducing the water demand in the mix. A series of tests were carried out to determine the slump value, compressive strength and flexural strength with and without addition of superplasticizer, the result shows that the increase of superplasticizer dose in the cement concrete mixture leads to gain of good ability in addition to slump. Additionally, there is also slightly increase in the compressive strength as well as flexural strength than that of normal concrete.

The Strength of cement concrete is a very important characteristic. This thesis investigated prior studies on the compressive strength and flexural strength of cement concrete as it relates to water-cement ratio, aggregate-cement ratio, aggregate size, quantity of admixture and compaction and compares those results with results obtained in laboratory experiments conducted on samples of cement concrete cube casted for this purpose.

During the development of new generation product like concrete made with superplasticizer, it is essential to investigate the properties of fresh and hardened concrete to encourage and escalate its application in the civil engineering construction industry. This research investigates the properties of fresh and hardened concrete made with different quantity utilized of superplasticizer in concrete mix

I. INTRODUCTION

1.1 General

Construction developments are on their peak level in the 21st century round the globe. There are number of skyscrapers, roads, dams, bridges, underground tunnels and under water structures all over the world. The old days when it was very difficult to talk about the advantages of using admixtures have passed. It is now fairly clear that admixtures can both solve technical problems and save substantial cost also by increasing the strength of concrete and reducing the water demand. However, they also have the potential to generate technical problems if not correctly selected or used. According to **(Neville A.M., 1994)**, several benefits are obtainable through the use of admixtures, such as improved quality, retardation or acceleration of setting time, coloring, improved concrete strength, increased flowability for the same water/cement ratio, better frost and sulfate resistance, improved fire resistance, improved workability, cracking control and superior finishability. The specific effects of an admixture usually vary with the type of cement, mix proportion, special conditions (particularly temperature) and dosage **(Irving Kett)**.

In the construction industry a lot of admixtures are used for different purposes to improve different desirable properties of cement concrete. Generally, admixtures are classified in to two groups:-

1. Mineral
2. Chemical admixtures.

Water reducing admixture is one type of chemical admixture which provide a wide range of benefits for concrete in the fresh and hardened sates. Different water reducing admixtures can be easily available in the market; from those admixtures high range water reducing admixture also known as superplasticizer, type F is the main type of admixture which provide a lot of improvement in the properties of the for concrete properties. This admixture is produced in our country as the name mega flow SP1 and SP4, which has a capacity to improve the workability, compressive strength and permeability of concrete. Though, in our country researches and investigation are not yet done on admixtures. Consequently, this research has investigated some benefits which are obtained by the use of superplasticizing admixture as an additional construction material. In order to show the effects of superplasticizing admixture on the concrete properties, such as: workability, strength and permeability, laboratory experimentations were performed by adding dosages of 0%, 0.5%, 1% and 1.5% superplasticizing admixture in the concrete mixes prepared by used and virgin aggregate with four stages and results are determined. Then, based on the experimental results the conclusions are drawn and recommendations have been forwarded.

Large numbers of structures have been demolished due to their limit of life span, unsuitable position in continuous growing city, and damaged condition caused by natural disaster and hazards. The demolition of the structures is generating concrete rubbles and causing the environmental problems due to unplanned disposal and lacking of the landfill sites. A large portion of the potentially useful demolition waste is disposed off in the landfill sites. The transportation and disposal of these wastes are economically and environmentally not sustainable. To overcome from these problems, nowadays alternative aggregate are drawing more interest in the construction industry **(Md. Safiuddin, Ubagaram Johnson Alengaram, June, 2011)**.

In the whole world, approximately 90 to 95 % of the construction materials market for both the structural and non-structural applications is made of cement concrete compared with other materials used for similar properties and functions. Cement Concrete, generally, is a product made from cement, water and aggregates and an additional material known as an admixture, is sometimes added to modify the certain properties of cement concrete. Cement is the chemically active component of concrete mix but it’s reactivity is only brought into the effect upon mixing with the water. The aggregate participate not important roles in the chemical reaction but its effectiveness arises because it is an economical filler material or hard composite material with fine resistance to the volume changes which take place with-in the cement concrete after mixing, further improving the durability of cement concrete. In hardened state, cement concrete is a rock like hard material with a property of high compressive strength. In its plastic state, cement concrete may be moulded into any desired shapes, it may be used to advantages architecturally or exclusively for decorative purposes.

Cement concrete has low tensile strength, and hence, this is the main reason why it is used with steel bar (reinforcement) to resist any tensile forces in the Reinforced Cement Concrete (RCC). On the other hand, cement concrete is usually used in building construction for foundation work, columns, beams and slabs construction, in shell structures, bridges, sewerage treatment plants (STP), roads, electric polls, cooling towers, railway sleepers and so on. In precast concrete industry, cement concrete is broadly used as concrete blocks, shell panels, pipes, piles and electric lamp posts **(Jackson, N.; and Dhir R.K. (Eds.). 1996)**.

At the present time, more than 70 percent of in-situ cement concrete in the world is produced by the ready mixed concrete (RMC) industry. The ready mixed concrete (RMC) producers are using a superplasticizer (SP) admixture which is easily available from various manufacturers. Superplasticizer (SP) is used to increase the workability without changing the water/cement (W/C) ratio. Or, it can be used to increase the ultimate strength of the cement concrete by reducing the water content while maintaining the sufficient workability.

Superplasticizer is a type of water reducing admixture; however, the difference between the superplasticizer and water reducer is that superplasticizer will significantly reduce the water required for cement concrete mixing **(Neville A.M, 2005)**. Normally, there are 4 main categories of superplasticizers, those are as follows:

A. Sulfonated melamineformaldehyde condensates
B. Sulfonated naphthaleneformaldehyde condensaes
C. Modified lignosulfonates and
D. Others such as sulfonic- acid esters and carbohydrate esters.

Effects of superplasticizer are very obvious, i.e. to produce cement concrete with a very high workability or cement concrete with a very high strength. Mechanism of superplasticizer is all the way through giving the cement particles highly negative charge so that they can repel each other due to the same electrostatic charge. By deflocculating the cement particles, more water is provided for cement concrete mixing **(Neville A.M, 2005)**. For common usage, dosage of superplasticizer is used in the range between 1 to 3 l/m3. Though, the dosage can be increased to as high as 5 to 20 l/m3. Since concentration of superplasticizer is different, any comparison of performance should be made on the basis of the amount of solids, and not on the total mass of the mix. Usefulness of a given dosage of superplasticizer depends on the W / C ratio. Effectiveness increases when water/cement ratio decreases. Compatibility with actual binding material i.e. cement is one of the most significant parameters that required to be into consideration, and it's not recommended that the cement and superplasticizer conform the standard independently **(Neville A.M, 2005)**. There are several advantages obtained when superplasticizer is used those are as follows:

1- It produces high workability cement concrete with constant cement content and strength, with objective for easy placing and compaction activity.
2- It produces cement concrete with normal workability, but lower water requirement.
3- It produces cement concrete with combination of high workability and low water content in the mix and designing a normal strength and workable concrete with less cement content.

Usage of superplasticizer becomes very popular these days since it possesses advantages for both fresh state concrete and hardened state concrete. The utilization of superplasticizer will have positive effects on the properties of cement concrete, both in the fresh and hardened states **(Yamakawa C., Kishitani K., Fukushi I. and Kuroha K., 1990)**. In the fresh state concrete, utilization of the superplasticizer will in general reduces the tendency to the bleeding due to the reduction in water/cement ratio or water content of the cement concrete mix. On the other hand, if W/C ratio is maintained, there is tendency that superplasticizer will extend the time of set of concrete mix as more water is available to lubricate the mixture. In case of the hardened concrete the use of superplasticizer will increase the compressive strength by enhancing the effectiveness of the compaction of the mix to produce denser concrete. Risk of drying shrinkage will be reduced by maintaining the cement concrete in liquid state for longer period of time. In addition, the rate of carbonation becomes the slower when water/cement ratio is decreased with the presence of superplasticizer in the mix **(Yamakawa C., Kishitani K., Fukushi I. and Kuroha K., 1990)**. Different types of superplasticizer will normally have the different effects on the properties and performance of the cement concrete mix **(Borsai A., 1994)** carried out an investigation to study the effect of two different types of superplasticizers-acrylic polymer (AP) and sulfonated naphthalene (SN) on the cement concrete containing high volume of fly ash. From the investigation, they concluded that AP- based superplasticizer performs significantly better than the SN- based superplasticizer, where it provides higher value of slump and lower slump loss and higher water reduction. In addition, the cement concrete containing AP- based superplasticizer gives the higher compressive strength and durability performance (in terms of CO2 and chloride penetration). Hence, addition of AP- based superplasticizer not only improves the slump loss problem of the cement concrete, but also it doesn't cause any reduction in the early strength development of the hardened concrete. However, the influence of a superplasticizer by the name of **(Mighty 2000)** in addition, they confirmed that slump of the fresh concrete can be optionally controlled in all mix-designs if reactive polymer is added. Since the workability of low W/C ratio cement concrete is hard to control, addition of the reactive polymer can usefully maintain the initial slump of RMC. In addition, they stated that superplasticizer can really produce a good quality cement concrete by increasing the density of cement concrete, in the course of significant reduction in the water requirement and the slump loss. The reason for extensive usage of admixtures is that these admixtures are capable to contribute considerable physical and economic benefits with respect to the cement concrete. On the other hand, usage of admixture is not treatment for poor quality of cement concrete mix due to the use of the inaccurate mixture proportion, poor work-manship in the cement concrete mixing and the troubles caused by low quality raw materials selection.

1.2 Objective of this work

The foremost objective of this work is to develop a sustainable and eco friendly solution for producing ready mix concrete by using superplasticizer i.e. conplast sp430. This study is targeted to produce a durable concrete that is acceptable in its all fresh and hardened properties. This research work is conducted to achieve the following objectives:

1- Comparative study of the fresh and hardened properties of the cement concrete with different percentage of superplasticizer i.e. conplast sp430 in the cement concrete mix.
2- Investigate the potential of superplasticizer i.e. a water reducing admixture in the cement concrete mix.
3- Investigate the various properties of new concrete mix like workability, compressive strength and flexural strength.

4- Determination of the best suitable mix for the higher desirable properties.

1.3 Superplasticizer

Superplasticizing admixture is a type of high range water reducing chemical admixture, which have a capacity of reducing the mixing water up to 35%. This type of admixture will provide high quality development or improvement for concrete in both fresh and hardened states. Generally, superplasticizing admixtures improve the workability, compressive strength, flexural strength and permeability of the concrete **(28) (Steven Kosmatka H., 2003)**.

Therefore, the main discussion of this chapter focus on reviewing the admixtures, particularly on superplasticizing admixture used to produce a quality concrete.

Several chemical admixtures can be applied to pervious concrete to obtain special properties, including retarders, hydration-stabilizing admixture, water-reducing admixture and air-entraining admixture. These admixtures are also used for the same reasons in conventional concrete. For example, retarders are used to stabilise and control cement hydration, and an air-entraining admixture is used for freeze–thaw durability. ACI recommended that accelerators should be used for cold weather, and a retarding admixture should be used for hot weather.

II. LITERATURE REVIEW

2.0 Introduction

In this chapter, we discussed previous researches regarding Cement concrete prepared with superplasticizer (water reducing admixture) characteristics and the influences of these materials on properties of fresh as well as hardened concrete.

Cement concrete prepared with admixture has in recent times become very attractive to the civil engineers and material scientists. As it demonstrates higher workability, better mechanical properties and improved durability, these concrete mixes has been gradually more applied in the civil engineering constructions such as tall building, off-shore structures and bridges **(Aitcin, P. C. and B. Miao, 1992)**. One most important chemical admixture in preparing the High Performance Concrete is superplasticizer. The most significant improvement in the concrete technology during the past 30 years has been the use of superplasticizers. However, the reason that superplasticizers are much more important than any other chemical admixture is the number of improvements, which can be achieve by its use. However, the reason for widespread usage of admixtures is that admixtures are able to impart considerable physical and economic benefits with respect to concrete. However, usage of admixture is not remedy for poor quality of concrete due to the use of incorrect mix proportion, poor workmanship in concrete mixing and the problems caused by low quality raw materials selection. According to **(Fukuda K., Mizunuma T., Izumi T., Iizuka M., Hisaka M.M., 1990, Tanaka M., Matsuo S., Ohta A. and Veda M., 1996)**, advances in superplasticizers, containing alternative water soluble synthetic products, have been proposed in the been proposed in the last decade to reduce the slump-loss drawback which can partly or completely cancel the initial technical advantage associated with the use of superplasticizers (low *w/c* ratio or high slump level).

An admixture, according to the ASTM C-125-97a standards, is a material other than water, aggregates or hydraulic cement that is used as an ingredient of concrete or mortar, and is added to the batch immediately before or during mixing. A material such as a grinding aid added to cement during its manufacture is termed an additive **(Ramachandran, C. K., Hignite, C. E., Gray, S. L. & Melnykovych, 1981).**

According to Yamakawa, the utilization of superplasticizer will have positive effects on properties of concrete, both in the fresh and hardened states. In the fresh state, utilization of superplasticizer will normally reduce tendency to bleeding due to the reduction in water/ cement ratio or water content of concrete. However, if water/ cement ratio is maintained, there is tendency that superplasticizer will prolong the time of set of concrete as more water is available to lubricate the mix. In the case of hardened concrete, **(Yamakawa C., Kishitani K., Fukushi I. and Kuroha K., 1990)** highlighted that the use of superplasticizer will increase compressive strength by enhancing the effectiveness of compaction to produce denser concrete. Risk of drying shrinkage will be reduced by retaining the concrete in liquid state for longer period of time. In addition, rate of carbonation become slower when water/ cement ratio is decreased with the presence of superplasticizer.

2.1 Admixtures

Historically, the admixtures are almost as older as concrete itself. They have been recognized as significant components of concrete used to enhance its performance. The original use of admixtures in cementitious mixtures as an additional material is not well documented. It would be a logical development to use such materials, which imparted desired qualities to the surface, as an integral part of the mixture. It is known that the Romans used milk, animal fat and blood to improve their concrete properties. Although these were added to improve the workability of concrete, blood is a very effective air entraining agent and might well have improved the durability of Roman concrete; eggs during the middle ages in European country; polished gluey rice paste, gloss, tung oil, blackstrap molasses and extracts from elm soaked in the water and boiled bananas by the Chinese; and in Mesoamerica and Peru, cactus juice and latex from rubber plants **(Edward G.N, 2008).**

At the present time, admixtures are very important and necessary components for the modern concrete technology. The concrete properties both in fresh and hardened states can be modified or improved by the addition of admixtures. Currently, admixtures are obtained as mineral and chemical admixtures which used to improve the short term and long term properties of the concrete **(ACI Manual of concrete practice, 2009).**

The effect of size of Recycled Aggregate on compressive strength described by the researchers. The 100% of RA used in concrete mix to replace the natural coarse aggregate in concrete with 100 x 100 x 100 cube mm were cast with target compressive strength is 25 MPa. The 28-day compressive strength was crushed at 3, 14, 28 days are reported found that the size of 10 mm and 14 mm of RA in RAC is quite similar performance with 10 mm and 14 mm size of Natural Aggregate (NA) in natural aggregate concrete (NAC) **(Ismail Abdul Rahman et al., 2009)**.

The recycled aggregate that are obtained from site-tested concrete specimen makes good quality concrete. The compressive strength of used aggregate concrete (UAC) is found to be higher than the compressive strength of normal concrete. Used aggregate concrete is in close proximity to normal concrete in terms of split tensile strength, flexural strength and wet density. The slump of used aggregate concrete is low and that can be improved by using saturated surface dry (SSD) coarse aggregate **(Yong, P.C et al., 2009)**.

2.2 Aggregate used in our cement concrete mix:-

Aggregates which uses in plain cement concrete are appropriate for our concrete which is prepared with using superplasticizer, as these aggregates were categories in two types:

1. Fine aggregates (sand)
2. Coarse aggregates

Fine aggregates are required in both mortar and cement concrete. As the types of fine aggregate been manufactured and used were based on maximum grain size and particle size distribution. The fine aggregates available in the used of concrete can be natural, crushed or manufactured fine aggregate (sand).

Coarse aggregates used can be of normal-weight, lightweight or heavyweight type. The usage of heavyweight aggregate is restricted to the specific construction conditions. As known that these aggregates contains in cement concrete were successfully used in the field applications such as pavements and in concrete slab, where the strength of these structure were improve by the used of fibres in the concrete mix. Aggregates used in the cement concrete have a major effect on the properties of cement concrete. Such properties of the aggregates that may influence the concrete are density, particle shape, grading, porosity, cleanliness and alkali reactivity of the aggregates. The details of the coarse aggregates were shown in Table-2.1.

Table-2.1 Type of Coarse Aggregate, Source And Their Density

Type of Coarse Aggregate	Source	Density (Kg/m^3)
Normal Weight	Natural Gravel Or Crushed Stone	2240
Light Weight	Expanded Clay Or Blast Furnace Slag	1440-1760
Heavy Weight	Quarried	2300-2400

2.3 Binding Material/Cement

The cement in the mixture commonly consists of Portland cement. However, in some cases, the binding material can be manufacture by non-Portland cement materials. The cement paste or mortars normally used for cladding or shelling, which generally applied in thin sheet components, such as asbestos cement.

The most commonly used cement in any cement concrete mixing purpose is called Ordinary Portland Cement (OPC). Other available cement types are as follows:

1- High strength cement
2- Portland pozzolana cement
3- Low heat cement
4- Sulphate resisting cement
5- Shrinkage resisting cement.

All these type of cement can be used in to produce our cement concrete mixture. However, the hardened cement paste contains various sizes of air voids in their structure. This shows that the microstructure exhibits the volume changes in the hardened cement concrete paste were from the effects of creep and shrinkage at the movement of water in the cement matrix. Additionally, the hydration of the cement paste creates a highly alkaline environment with pH value ranges from 12 to 12.5.

2.4 Water used in cement concrete

The quality of water is very important as it can influence the setting time of fresh concrete and the strength of hardened concrete. In addition, it causes the risk of corrosion of the reinforcement, especially to steel reinforcement. On the other hand, water is required for the heat of hydration process of cement and moulding and placing of cement concrete in the required shape and location. **(Balaguru and Shah, 1992)** stated that the adequate water for the heat of hydration process requires a minimum water/cement ratio of 0.28. Water that is fit for drinking is appropriate for cement concrete used. If there is a high concentration of sodium, high suspended solids or potassium salts contain in the water, the water can't be used for cement concrete mixing. Concern on the water must be taken to avoid pollution of water, such as split admixtures.

III. MIX DESIGNING AND SAMPLE PREPARATION

3.1 General

This chapter number four of our thesis deals with the method of mix design (IS Code) and also various tests performed on the test samples prepared by these mixes. The various tests like workability by slump cone test, compressive strength test and flexural strength of the concrete mix containing partial replacement of PPC by lime stone powder and marble dust will be conducted in this chapter.

3.2 Method of Concrete Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, workability and durability as economical as possible, is termed as the concrete mix design. In our study mix design was done by BIS mix design method which is based on Bureau of Indian Standards BIS: 10262-2009.

3.2.1 BIS Mix Design Method

The basic steps involved in the concrete mix design process can be summarized as follows:

i. Based on the level of quality control the target mean strength is estimated from the specified characteristic strength.
ii. The water/cement ratio is selected for the target mean strength and checked for the requirements of durability.
iii. The water content for the required workability is determined by slump cone test.
iv. The cement content can be determined from the water/cement ratio determined by slump cone test and water content obtained in step (ii) and (iii) respectively and is checked for the water requirements.
v. The relative proportion of fine aggregate and coarse aggregates are selected from the characteristic of coarse and fine aggregates.
vi. The trial mix proportions are determined.
vii. The trial mixes are tested for verifying the compressive strength and suitable adjustments are made to get there the final mix composition.

3.3 Mix Calculations

The mix calculations per unit volume of concrete according to IS code shall be as follows:

1. Volume of concrete = 1 m^3 eq. **1**
2. Volume of cement = $\frac{\text{Mass of cement}}{\text{Specific gravity of cement}} \text{ X } \frac{1}{1000}$

   $= \frac{372}{3.15} x \frac{1}{1000} = 0.118 \text{ m}^3$ eq. **2**
3. Volume of water = $\frac{186}{1} x \frac{1}{1000} = 0.186 \text{ m}^3$ eq. **3**
4. Volume of all aggregate= [eq. 1 – ({eq. 2 + eq. 3})] = 0.696 m^3 eq. **4**
5. Mass of coarse aggregate = (eq. 4) x Volume of coarse aggregate x Specific gravity of coarse aggregate x 1000 = 0.696 x 0.62 x 2.65 x1000 = 1143.528 kg
6. Mass of fine aggregate = (eq. 4) x Volume of fine aggregate x Specific gravity of fine aggregate x 1000
   = 0.696 x 0.38 x 2.72 x1000
   = 719.39 kg

Table-3.1 Proportion of Different Materials In Our Mix

Cement	Fine aggregate	Coarse aggregate	Water
372	719.39 kg	1143.528 kg	186 litre
1	1.93	3.074	0.50

3.4 Preparation of Trial Mixes

Based on the concrete mix design by Bureau of Indian Standard (BIS) method, four trials mixes were prepared. Two trials mixes were prepared with W/C ratio of 0.50 and other two mixes were prepared with W/C ratio of 0.55. The 6 cubes were casted for each mix and were tested at 7 and 28 days. The mix proportions for various constituents have been summarized in Table-4.6.

Table-3.2 Quantities Per Cubic Meter For Trial Mixes (M-25)

Mix No.	W/C ratio	Slump (mm)	Water (l/m^3)	Cement Kg/m3	Sand Kg/m^3	Coarse Aggregate Kg/m^3	Average cube strength at 7 days (MPa)	Average cube strength at 28 days (MPa)
Mix-A	**0.50**	**50**	**186**	**372**	**719.39**	**1143.52**	**21.31**	**31.8**
Mix-B	0.50	100	208	416	633.18	1162.58	19.93	30.2
Mix-C	0.55	50	186	338.18	724.32	1126.62	20.53	31.1
Mix-D	0.55	100	208	378.18	712.33	1139.52	20.95	30.8

The Mix-A was selected as the design mix because its average cube strength is very close to the target mean strength of the concrete with appropriate content of cement among all the trial mixes.

3.5 Prepared Mixes For Testing of The Compressive Strength

We prepared the various mixes of cement concrete for the preparation of cube to testing of the compressive strength with the variable percentage of superplasticizer in the range 5 ml/kg, 10 ml/kg and 15 ml/kg as per Indian Standard code (For high strength concrete mix, the range of superplasticizer used is 0.7 to 2.0 liters/100 kg of binding material).

Table-3.3 Prepared Mixes For Tests of Compressive Strength of Concrete

Mix No.	W/C ratio	Slump (mm)	Superplasticizer (Conplast SP430) by weight of cement	Water (l/m^3)	Cement Kg/m^3	Sand Kg/m^3	Coarse Aggregate Kg/m^3
Mix-I	0.50	50	0%	186	372	719.39	1143.52
Mix-II	0.50	50	0.5%	186	353.4	719.39	1143.52
Mix-III	0.50	50	1.0%	186	334.5	719.39	1143.52
Mix-IV	0.50	50	1.5%	186	316.2	719.39	1143.52

IV. ANALYSIS OF RESULTS

4.1 General

Series of the tests were carried out on the prepared samples with various mixes i.e. variable percentage (0.5%, 1.0% and 1.5%)of superplasticizer i. e. Conplast SP430 in the cement concrete mixtures. The tests conducted were compressive strength, split tensile strength and flexural strength of concrete mixes. The obtain results are given in the Table below.

4.2 Compressive Strength Test Results

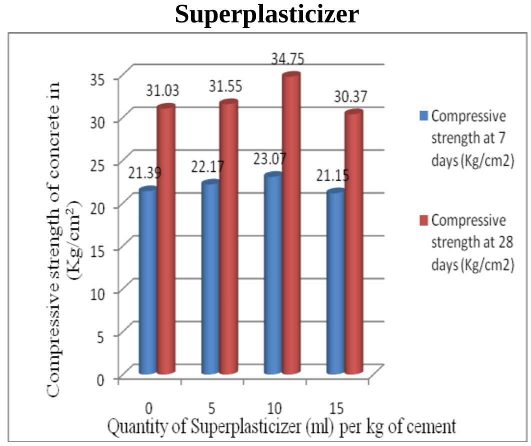
The laboratory test results are presented below in the tabular form for different mixes with variable percentage of superplasticizer in the mixture.

Table-4.1 Test Results of Compressive Strength of All The Mixes (Prepared With Superplasticizer)

S. No.	Quantity of Superplasticizer in the mix (%)	Compressive strength at 7 days (Kg/cm^2)	Compressive strength at 28 days (Kg/cm^2)
1	0	21.39	31.03
2	5	22.17	31.55
3	10	23.07	34.75
4	15	21.15	30.37

After comparing all these test results we found that when we add 0 % Superplasticizer in the mix the results of compressive strength at 7 days shows approximately 8 % increment in compressive strength and at 28 days shows 12 % increment in compressive strength.

Graph-4.1 Test Results of Compressive Strength of All The Mixes Prepared With Variable Quantity of Superplasticizer



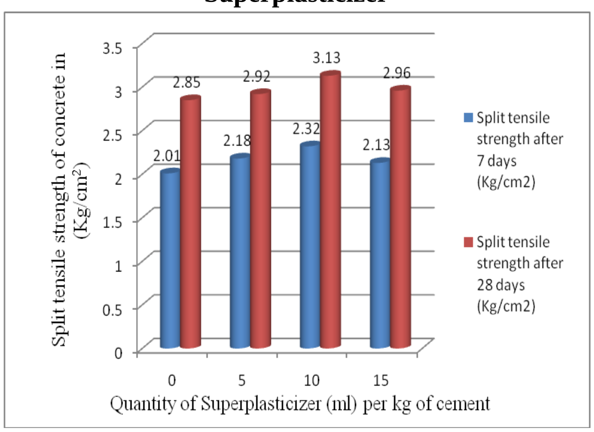
4.3 Split Tensile Strength Test Results

The laboratory test results are presented below in the tabular form for different mixes with variable percentage of Superplasticizer in the mix.

Table-4.2 Test Results of Split Tensile Strength of All The Mixes Prepared With Variable % of Superplasticizer

S. No.	Quantity of Superplasticizer in the mix (%)	Split tensile strength after 7 days (Kg/cm²)	Split tensile strength after 28 days (Kg/cm²)
1	0	2.01	2.85
2	0.5	2.18	2.92
3	1.0	2.32	3.13
4	1.5	2.13	2.96

Graph-4.2 Test Results of Split Tensile Strength of All The Mixes Prepared With Variable Quantity of Superplasticizer



After comparing all these results we can say that Superplasticizer increases the Split Tensile Strength of a concrete mix up to 15.4 % at 7 days curing and approximately 10 % at 28 days curing a certain limit but after that range it starts reducing its strength.

V. CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH

5.1 Conclusion

The prime objective of this thesis research work was to understand the effect of addition of Superplasticizer (Conplast SP430) in the cement concrete mixtures. In this experimental study we determine the best composition of the cement concrete mix prepared with appropriate quantity of Superplasticizer (Conplast SP430). For determination of compressive strength, split tensile strength and flexural strength of the various mix prepared with variable percentage of Superplasticizer (Conplast SP430). These are the following conclusions of this research.

1. By this experimental research we found that the compressive strength of cement concrete can be increase up to 8 % at 7 days curing and 12 % at 28 days curing with use of 1.0 % Superplasticizer (Conplast SP430) in the concrete mixture.
2. By this experimental research work we found that the split tensile strength of cement concrete can be increase up to 15 % and 10 % at 7 days and 28 days respectively by adding 1.0 % Superplasticizer (Conplast SP430) in the concrete mixture.
3. The results for flexural strength test are 16.23 % and 16.86 % increment respectively for 7 days and 28 days curing by adding 1.0 % Superplasticizer (Conplast SP430) in the concrete mixture.

By these test results we can say that addition of Superplasticizer i.e. Conplast SP430 in the cement concrete mixture can be a useful material in civil engineering construction work.

5.2 Recommendation For Future Research

Theses are some recommendation for future work in this field.

1. In future experimental work one should also check the other different superplasticizers available in the market in the cement concrete mixture.
2. In future experimental work one should also check the effects of using other different types of admixtures in the cement concrete mixture.
3. In future research work some additional materials like glass powder, granite dust and other stone’s powder with these materials could be tested for all types of strength.
4. The effect of using stone dust and marble powder in these mixes can be tested in future study.
5. The long term properties of the various types structures made by these mixes could be study for detailed information on these materials.

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