INFLUENCE OF OPTIMIZED SUPER PLASTICIZER EFFECT ON HIGH STRENGTH CONCRETE

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ABSTRACT

Chemical admixtures are a valuable choice in concrete production for achieving better performance and desired properties. Super plasticizers are commonly known as excessive Range Water Reducers because it permits low water cement ratio and it influencing the fresh concrete behavior. To determine the optimum dosage of admixture, an experimental investigation was performed and also the effect of higher dosage into the experimentation together studied. The present paper emphasizes on determining optimum Super plasticizer dosage of desired workability using Marsh Cone Test at pre-determined water cement ratio of 0.35 for M40 grade concrete. This was studied with the two different types of Super plasticizers of Polycarboxylate Ether (PCE) and Sulphonated melamine formaldehyde (SMF) with dosage of 0 to 2 % with the interval of 0.25% on fresh and hardened concrete properties. Experimentation was conducted and conclusions were drawn. A comparative study has been done in this chapter between both the Super Plasticizers.

Keywords—Super Plasticizer, Dosage, Marsh Cone Test,Cement,Concrete Strength, RMC

#  INTRODUCTION

 In the current civil construction industry admixtures of chemicals and miners are playing a major role for strengthen and enhancement of concrete. Chemical admixtures have the capability to significantly improve the workability of concrete and also impart a significant improvement in concrete strength.[1,2]. The advantages will be found when chemical admixtures produce high workable concretes objectives are kept with a primary objective for imparting the strength. In our admixture less cement content and low water requirement are used for new chemical admixture in providing fresh and hardened stages of concrete. In chemical admixture we have various uses and have positive effects on the fresh and hardened properties of the concrete. In the fresh stage, use of chemical admixture will generally reduce the bleeding effects due to the decrease in water content [3]. High compressive strength could only be achieved when low water to cement ratio (w/c) is ensured in the mix design , while maintaining adequate workability of the fresh mixture[4]. In the current market so many types of branded brands of chemical admixtures are various types and brands available with various properties. Hence the behavior with particular admixtures which uses certain materials will be also having some changes. Our experimental study providing compatibility between cement and admixture is necessary before its application in field[5]. Therefore, our primary concern of application is to provide a better selection of cement and admixture.

## **Compatibility of Admixtures and Cementitious Materials**

 Concrete faces compatibility problems like cement- admixture incompatibility and incompatibility between admixtures when they are added. The admixture materials used may show a incompatibility for various cementing materials and mixtures without any supplementary methods. The following are the incompatibility problems:

* Loss of Slump
* Low strength gain rate
* Stiffening of concrete in the early age
* Segregation of concrete
* Increased water demand

### Origins of Incompatibility

 Some of the causes of incompatibility problems like early stiffening, retardation etc. are listed below.

* In cement, admixtures or combination of both materials will be a Incompatibility of cement and admixtures due to the chemical composition of materials used to some extent may be not suitable or incompatibility.
* If SO4/C3A ratio is too low uncontrolled C3A hydration occurs which result in early stiffening (flash set). The high ration of calcium sulphates to a gypsum (false set) provides a high ratio of SO4/C3A
* Temperature is another factor affecting compatibility. Hot weather conditions lead to increased admixture adsorption thereby leads to fluidity whereas low temperature results in low fluidity.
* Higher alkali cements react faster and leads to higher rate of stiffening and higher slump loss.

## **Chemical Admixtures**

Chemical and mineral admixtures are the two main categories of concrete additives. Chemical admixtures are added to concrete to control features such as heat of hydration, speed up or slow down the setting period, increase workability, aid in water savings, disperse/deflocculates cement particles, resource in entrain air, and eventually improve impermeability and durability traits. Fundamentally, they are chemical substances. These ranges and dosages will vary from 0.2% to 2% by weight of cement[6].

### Types of Admixtures

Chemical admixtures can be classified into the following types:

* Set Accelerators
* Air Entertainers
* Super plasticizers
* Set Retarders
* Specialty Admixtures
* Water Reducers

## **Super Plasticizers**

When describing about the chemical admixture super plasticizers which is also called as high range water reducer in admixture. This chemical admixture was developed in the years 1960 and 1979 by Germany and Japan respectively. This is a different when we compared with normal plasticizers with various dose levels of super plasticizers having higher conventional water reducer ratio of (0.5 to 3.0%) and lesser undesirable properties of concrete with (0.18 to 0.47). This admixture concrete provides 30% reduction of water producing very effective results on the workability i.e. without reduction in the workability of concrete[7]. The basic advantages of super-plasticizers are

* This admixture provides a very easy placement with higher strength providing a high workability of concrete
* Uses Lower water content with a higher strength concrete
* Provides a Use of less cement concrete mix having more strength and workability

The admixture is a homogenous cohesive concrete without any bleeding, segregation for provided tendency. Additionally, it creates flowing concrete when very quick placement is required, whether it is on a floor, pavement slab, or in an accessible position. The creation of extremely strong concrete utilizing regular workability but a very low water/cement ratio is a second application for Super Plasticizer. [8].

### Types of Super Plasticizers

Overall, four different Super plasticizer categories can be defined [9]:

1. Naphthalenesulfonate based Super plasticizers (SNF)
2. Melamine-sulfonate based Super plasticizers (SMF)
3. Lignosulfonate based Super plasticizers (MLS), and
4. Polycarboxylates ether-based Super plasticizers

In the described categories of Naphthalenesulfonate based Super plasticizers (SNF), Melamine-sulfonate based Super plasticizers (SMF). and Lignosulfonate based Super plasticizers (MLS) which were very widely used as a types of super plasticizers for the past decade and they are also named as 1st,2nd generation admixture super plasticizers. But in the provided Category of D which as used in 90’s called as 3rd generate category which is currently used in cement industry. The older generations of Super plasticizer have shown an improved dispersion of cement material particles with electro steric repulsions. These categories are generally used for cement concrete as given below:

* Sulphonated melamine formaldehyde condensates – It is suitable in low temperature areas – dosage: 0.5 - 3% by weight of cement
* Sulphonated naphthalene formaldehyde condensates – It is more suitable in high temperature areas – dosage: 0.5 - 3% by weight of cement
* Modified Lignosulphates – It is suitable for conditions where temperature variation is high – dosage not more than 0.25% by weight of cement
* Carboxylated admixture – It is suitable where workability is required to be retained for large duration. The Super plasticizer is adsorbed onto the cement particles, thereby lowering inter-particle attraction and producing a more uniform dispersion of cement grains as with a normal water-reducer[10].

The way that Super Plasticizer works is by giving cement particles a strong electrical charge that causes them to reject one another. More water is made available for mixing concrete by deflocculating the cement granules. Super plasticizer dose for common use ranges from 1 to 3 L per m3. The dosage can be raised to between 5 and 20 l/m3, though. The water to cement ratio affects how well a specific dosage of Super plasticizer works. Whenever w/c falls, it rises. One of the most crucial factors that had to be taken into account was compatibility with actual cement; it is not advised that cement and Super plasticizer adhere to the standard independently [11].

### Sulphonated Melamine Formaldehyde(SMF)

Sulfonated melamine formaldehyde (SMF) is a polymer used in cement and plaster-based formulations to decrease the amount of water while enhancing the fluidity and workability of the mixture. Lower porosity is achieved in concretes by adding SMF to an appropriate mix design. better resistance to hostile conditions and increased mechanical strength. In self leveling flooring materials and grout for the base of casing equipment.

* In high strength gypsum and gypsum products
* In ready mixed concrete , pumping concrete , flowing concrete , high strength and high performance concrete , self compacted concrete and high strength cement mortar
* One of major components of water proofing materials for improving impermiability of concrete or mortar.

### Polycarboxylic Ether

Polycarboxylate concrete admixtures next generation concrete accelerator is a ready-to-use liquid admixture with outstanding performance and no chloride. Initial concrete setting time is one to three times faster with special polycarboxylate concrete admixtures than with regular mortar and concrete. It enhances the workability and strength of cement while also speeding up the hydration process. It makes it easier to place the mix and speeds up construction by reducing the time it takes for the concrete to set. Because forms and alternative protection will be removed early and finishing will begin, labour costs and time will be saved.

### Applications

* For reducing setting time of Cement, in self compacting concrete and mortars.
* Cement Poles, Pavers Block, Cement-Pipes, Brick.
* Concrete pavements, High-rise and large scale building construction.
* Swimming pool construction.
* For setting mortars & concrete in law temperature climate.

### Dosage

Practical trials should be used to establish the best dosage. The dosage is determined by the temperature, kind of cement, needed strength, and type of acceleration. A dose range of 0.5 to 2.0% by weight of cement is usually advised as a guideline. Precast elements, on the other hand, utilize lower dosages, whereas shot cresting uses greater dosages.

## **Objectives of the Study**

The main objective of the study is to determine the Optimum dosage of two different super plasticizers PCE & SMF for M40 grade concrete and its influence on fresh and hardened properties of concrete.

## **Step by Step procedure**

* To determine the Optimum dosage of two different S.P of PCE & SMF using ‘Marsh Cone Test’.
* Work is carried out in comparing the compressive strengths and Split tensile strength of conventional concrete with the dosage of 0 %, 0.25%, 0.5%, 0.75%, 1.0%, 1.5%, 1.75% and 2.0% of PCE and SMF separately. With the same time fresh concrete properties of Slump cone and compaction factor test were observed in terms of workability of same dosages.
* As per the replacements, cubes and cylinders are casted using OPC 53 grade cement for M40 grade concrete.
* The cubes and Cylinders were cured for 7 and 28 days and the compressive strength and split tensile strength of the concrete is determined.
* Later the analysis of test results is done to draw conclusions.

# LITERATURE REVIEW

## **Effect of Super Plasticizers on Properties of Concrete**

 At a water cement ratio of 0.4 to 0.55 and a super plasticizer level of 0%, the compressive strength ranged from 11.38 to 18.04 N/mm2 at 7 days of curing, but at the same level of super plasticizer and water-cement ratio at 14 days of curing, it ranged from 12.78 to 18.80 N/mm2. At a water cement ratio of 0.4 to 0.55 and a super plasticizer level of 0-3.5%, the compressive strengths varied from 14.00 to 21.90 N/mm2 and 15.00 to 23.10 N/mm2 for curing times of 21 and 28 days, respectively. The slump test varied from 10-90mm at a super plasticizer level of 0–3.5% at a water-cement ratio of 0.4–0.55.[10]. Effect of Super plasticizing Admixture on Concrete Properties was the topic of a research study presented. The goals of this study were to identify the optimum dosage of concrete super plasticizer for normal concrete and to evaluate the influence of super plasticizer on concrete parameters, with a focus on 30 N/mm2 characteristic strength at 28 days. Ordinary Portland cement, 20 mm granite coarse aggregate, and sea sand were used to make one control mix. Finally, the study found that super plasticizer had a considerable impact on both fresh and hardened concrete properties [8]. SP concrete's compressive strengths are often higher than the comparable strengths of reference mixes. A water reducer of up to 32-33 percent c is used when SP is employed can be accomplished SP concrete's compressive strength increases as a result of this phenomenon. New generations of SP have recently been created to produce extremely high strength concrete with compressive strengths of 15000 psi and higher, as well as very high early strength at 2 to 4 hours. There is no unnecessary segregation or bleeding of concrete in water-reduced SP concrete since the water content is lower [13]. The slump and compaction factor experiments revealed that concrete containing fly ash and super plasticizer produces good workability and marginally accelerates and increases the compressive strength of self-compacting concrete[10]. Plasticizers also increased workability at constant water-cement ratios while increasing compressive strength at lower water-cement ratios. To avoid bleeding and segregation, the cement content was reduced while the sand content was increased [9]. The study demonstrated the effect of re-dosing super plasticizer to regain slump on concrete with the goal of determining the variance of super plasticizer contribution and its effect on the compressive strength of concrete owing to re-dosing. Ordinary Portland cement was used to make one control mix. M-sand with a fineness modulus of 2.96 and crushed stone that has been sieved at 20mm. The results obtained showed that:

* Those blends with a higher initial dose of super plasticizer had less slump loss in the period allotted.
* The qualities of hardened concrete, such as compressive strength, were found to be higher in super plasticized concrete than in control mix, indicating that super plasticizers improved the strength of concrete by improving its workability, resulting in a denser and less porous structure[14].

The non destructive testing values were also found to be in good agreement with the strength behaviour of super plasticized concrete for destructive testing, and the compatibility of Sulphonated Naphthalene Formaldehyde and Lignosulphonates based superplasticizers with Portland slag cements was investigated. Even when the coarse and fine aggregates, water, chemical additive family, and concrete mix design procedure were all maintained same, different brands of cement performed differently [15].

Many physico-chemical properties of cement and concrete are affected by superplasticizers (SMF, SNF, MLS, and other organic admixtures). Physical properties include theology, morphology, microstructure, compressive strengths, pore size distributions, workability, and so on; chemical properties include adsorption behaviour, conductivity changes, zeta potential changes, heat of hydration, chlorine penetration, and sulphate attack, among others. The slump and compaction factor experiments revealed that concrete containing fly ash and super plasticizer produces good workability and marginally accelerates and increases the compressive strength of self-compacting concrete[16].

# MATERIALS AND METHODS

 Cement, sand as a fine aggregate, crushed rock as coarse aggregate, water, and additives make up the building material known as concrete. Therefore, before conducting any actual experiments, it is crucial to perform physical characteristic testing on the materials employed for the inquiry.

## **Project Design**

 The purpose of these experimental design were determining optimized dosage of super plasticizer using OPC 53 grade cement and Two different types of Super plasticizers PCE and SMF with pre-determining of water to cement ratio of 0.35 (constant) , to observe the effects of Super plasticizer on workability of fresh concrete and concrete strength.

## **Variable Parameters**

The following have been chosen as the study's variable parameters. The types of cement used, the Super plasticizer dose, and the amount of water used were chosen as variables to examine how these factors affected the behavior of the concrete as a whole.

* As per IS 10262-2009 & IS 456-2000 recommends the following components with the specified content to achieve good Concrete
* For slumps 25 to 100mm,
* A minimum cement content of 8 bags per m3 of concrete
* Nominal maximum sizes of aggregates (20mm)
* A maximum water content of 207 kg/m3 (w/c of 0.45)

### Variables were selected as follows

* Super plasticizer - from 0%, to 2.5% for Marsh Cone Test
* Water to Cement ratio – 0.35
* Super plasticizer - 0%, 0.5%, 0.75%, 1.0%, 1.25%, and 1.5% for Slump Test & strength tests of concrete.
* Marsh Cone Time and Slump values were recorded.

## **Materials**

### Cement

IS Mark OPC-53 grade cement become used for all concrete mixes. The cement used become fresh and with none lumps. Testing of cement changed into executed as in step with IS: 8112-1989. The various assessments outcomes conducted at the cement are mentioned in Table 1 and selected cement properties are within limits and is suitable for experimentation.

**Table 1: Properties of cement**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No.** | **Description** | **Test Results** | **IS Code Limits** |
| 1. | Specific Gravity | 3.14 | 3.10-3.15 |
| 2. | Fineness Modulus | 4.16 | <10% |
| 3. | Normal Consistency | 29% | >26% |
| 4. | Initial Setting Time | 68 Minutes | >30 Minutes |
| 5. | Final Setting Time | 169 Minutes | <3 Hours |

### Coarse Aggregate

In our present work we have used coarse aggregates having 10mm and 20mm sizes which are available local market, and the testing coarse aggregates were done as per IS: 383-1970 and their results are shown in Table 2. The 20mm aggregates were initially sieved via a 20mm sieve, while the 10mm aggregates were sieved first through a 10mm sieve, followed by a 4.75 mm sieve.

**Table 2: Properties of Coarse Aggregate**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Characteristics** | **Value** |
| 1. | Type | Crushed |
| 2. | Maximum Size | 20 mm |
| 3. | Specific Gravity (10mm) | 2.704 |
| 4. | Specific Gravity (20mm) | 2.825 |
| 5. | Total Water Absorption (10mm) | 1.6432% |
| 6. | Total Water Absorption (20mm) | 3.645% |
| 7. | Moisture Content (10mm) | 0.806% |
| 8. | Moisture Content (20mm) | 0.7049% |
| 9. | Fineness Modulus (10mm) | 6.46 |
| 10. | Fineness Modulus (20mm) | 7.68 |

### Fine Aggregate

The majority of aggregates that pass through a 4.75 mm IS sieve are referred to be fine aggregates. Table 3 displays the outcomes of this experimental program using fine aggregate that was locally sourced and in compliance with Indian Standard Specifications IS: 383-1970. Any particles larger than 4.75 mm and in compliance with grading zone I were removed from the sand by sieving it using a 4.75 mm sieve.

**Table 3: Properties of Coarse Aggregates**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Characteristics** | **Value** |
| 1. | Type | Uncrushed (Natural) |
| 2. | Specific Gravity | 2.566 |
| 3. | Total Water Absorption | 1.02% |
| 4. | Moisture Content | 1% |
| 5. | Net Water Absorption | 0.86% |
| 6. | Fineness Modulus | 4.02 |
| 7. | Bulk Density | 1.3 |
| 8. | Grading Zone  | I |

**Graph 1: Sieve Analysis of Fine Aggregate**

### Super Plasticizers

In this project we are using two types of super plasticizers

#### Polycarboxilite Ether

In the experiment, a chemical admixture called polycarboxilite ether was used. It is made by the New Delhi-based Sri Krishna Overseas firm and sold online. It is a highly effective concrete admixture that is especially well suited for the creation of free-flowing concrete and concrete with high strengths. Its chemical foundations are either, and the tests and standards meet EN 934-2 requirements. It is typically advised to use a dosage range of 0.5 to 2.0 percent by weight of cement. Table 4 summarizes the properties.

**Table 4: Typical properties of PCE Super plasticizer up to 25°C**

|  |  |
| --- | --- |
| **Properties** | **Value** |
| Form | Liquid |
| Appearance/Color | Dark Brown Liquid |
| Density | 1.2 ± 0.02kg/l |
| Chloride content | Nill |
| pH (23 ± 2 ºC) | 8 ± 1 |

#### Sulfonated Melamine Formaldihide

SMF is a liquid super plasticizer for high performance concrete that is melamine based. SMF's great workability with concrete mixes allows it to transform stiff concrete into flow-able concrete. The concrete performs well in both the plastic and hardening states because to its good slump and retention capabilities without affecting the setting time and the ability to significantly reduce water content. It is made by the New Delhi-based Sri Krishna Overseas Company and sold online. Table 5 summarizes the properties.

**Table 5: Typical properties of SMF Super plasticizer up to 25°C**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Chemical and Physical Properties** | **SMF Liquid** |
| 1. | Appearance | White to off white powder |
| 2. | Moisture, max % | 4 |
| 3. | Bulk Density, g/cc | 55 to 85 |
| 4. | pH value of 20% aqueous solutions@ 200C | 7.0 to 10.0 |
| 5. | Particle Size, >200mm, % | 5 to 25 |
| 6. | Particle Size, <100mm, % | 15 to 40 |
| 7. | Free formaldehyde, max % | 0.1 |
| 8. | Chloride, Max %  | 0.05 |
| 9. | Sodium % | 9 to 11 |

## **Marsh Cone Test**

To test the workability for various specifications and quality control of cement pastes the marsh cone was implemented In our experiential results. Though the test standards are varying from country to country result the principle output is same. In the marsh cone test various amount of materials, their flow out, time are recorded for measuring the flow time which is l inked with the fluidity of the tested material. As longer the flow time we have observed lower the fluidity. As the proposed approach Marsh cone test is very simple to observe the data readings about cement pastes behavior. In our used cement based materials, mix design order to define the saturation point, i.e. the dosage beyond which the flow time does not decrease appreciably. As Marsh Cone test is tested with filled fluid material with nozzle kept closed and also measured the quantity of fluid with nozzle opened for freely flow activity. Used Marsh cone time for measuring time, quantity of materials to record the flow out activity. The saturation point is defined as the chemical admixture dosage beyond which the flow time dose not decrease appreciably. The dosage at which the Marsh cone time is lowest is called the saturation point. The dosage is the optimum dosage for that brand of cement and admixture (plasticizer or super plasticizer) for that w/c ratio. The apparatus of Marsh Cone is shown in Figure 1.

### Methodology

Observations for 1 minute retention period are taken.

* In our first test, water cement ratio is kept as 0.35 and PCE dosage of 0, 0.5, 0.75, 1, 1.25 and 1.5 % is administered. Temperature is noted down.
* In a mechanical mixer, fully mix the 2 kg of OPC cement, water, and PCE super plasticizer to make 1 litre of cement paste. Place the water in the mixing bowl first, and then add the 2 kg of cement. After stirring for a minute, add the necessary amount of PCE Super Plasticizer, and continue stirring for an additional minute. So, slurry is created.
* Pour one liter of the slurry (measured in a 1000-ml jar) into the marsh cone while properly sealing the opening at the bottom with a finger.
* Set the stopwatch to start while removing the finger. Take note of how long it took to empty the Marsh Cone. "Marsh Cone Time" is the name given to this period.
* Conduct the test again using the same retention period, the same mixture, and the appropriate recording of Marsh Cone time. Throughout the test, the cement and additive mixture should be mixed.
* Repeat the test for each dosage level of the super plasticizer SMF.
* The ideal dosage is determined by drawing a typical graph of Marsh Cone Time in Seconds vs. Admixture/Cement dosage in percentage. This point is known as “Saturation Point”

 

**Figure 1: Cement, PCE, SMF, Marshcone Setup**

## **Moulds**

For preparation of concrete specimens of various dosages we have used size 150mm x 150mm Cubical moulds to provide two super plasticizers to the determination of compressive strength Care was taken in using proper compaction through casting and vibrator was used for proper compaction. For determination of split tensile strength we have used cylindrical mould of size 150 mm x 300 mm with concrete specimens and also followed and prepared in accordance with Indian Standard Specifications IS: 516-1959.

**Table 6: Quantity of materials in kg for 1m3, M40 grade concrete grade production**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Target Mean Strength = 48.25 MPa** | **Water in Liters** | **Cement (kg)** | **Fine Aggregate** | **Coarse Aggregate** | **Super Plasticizer** | **W:C** |
| **(kg)** | **(kg)** | **(ml)** |
| 1m3 | 146 | 417 | 797 | 1211 | 4170 | 0.35 |

### Preparation and Casting of Specimens

Proper preparation and casting of concrete specimens are essential parts of testing process in this section, we will show the sum of figs which are represented as preparation and casting of specimens. All the specimens were cast having mix proportions as given in Tables 6. For these mix proportions, required quantities of materials were weighed.

# RESULTS AND DISCUSSION

 The test has performed by considering 0.35 water-cement ratio based varying percentage of super plasticizer. Additionally, the test was carried out on hardened concrete utilizing testing equipment to determine the concrete's compressive and split tensile strengths after curing for 7 and 28 days while employing various Super plasticizer dosages in the concrete mixtures.

## **Determination of Optimum Dosage of Super plasticizer on Marsh Cone Test**

The study was performed Marsh Cone Test to decide the optimum dosage of chemical admixture for each batch to observe compatibility of OPC cement with two different type of SP. Super plasticizers PCE and SMF, for particular water to cement ratio of 0.35. The time needed for a fixed volume of paste pass through the funnel was recorded. The test was carried out according to EN 445 and ASTM 939 94a test procedure.

When carrying out the experimental works, Marsh Cone Time was recorded as shown in Table 7 and Table 8 in Figure 2, Y axis is the Marsh Cone Time in Seconds and X axis is Super plasticizer percentage of dosage was drawn through optimum dose ascertained. This point is known as “Saturation Point”. Figure 2 is demonstrated Marsh Cone Test experimental outputs. During performing the test, predetermined volume of paste poured into metal cone and the time required is measured using stopwatch. The test was carried out using OPC – 53 grade cement with PCE for constant w/c ratio of 0.35.

From Table 4.1 the lowest the Marsh Cone Time (MCT1) is 32 sec at 1% Super plasticizer dosage. Therefore, 1.0% is an optimum dosage for 0.35 water cement ratio, as indicted in Figure 2. The optimum dosage of Poly carboxylic Ether (PCE) for water cement ratio of 0.35 is 1.0% for OPC cement type as shown in Table 7 and Figure 2. Since, those are considering optimum dose of cement and super plasticizer for selected water cement ratio.

**Table 7: Mix Proportions for Cement Paste in Marsh Cone Test using PCE super plasticizer with constant w/c of 0.3**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Mix No.** | **W/C ratio** | **Cement (gm)** | **Water ml** | **PCE dosage , %** | **PCE in (ml)** | **Marsh Cone Time (sec)** |
| T1 | 0.35 | 2000 | 700 | 0 | 0 | 60 |
| T2 | 2000 | 700 | 0.25 | 5 | 48 |
| T3 | 2000 | 700 | 0.5 | 10 | 44 |
| T4 | 2000 | 700 | 0.75 | 15 | 40 |
| T5 | 2000 | 700 | 1 | 20 | 32 |
| T6 | 2000 | 700 | 1.25 | 25 | 33 |
| T7 | 2000 | 700 | 1.5 | 30 | 35 |
| T8 | 2000 | 700 | 1.75 | 35 | 34 |
| T9 | 2000 | 700 | 2 | 40 | 33 |
|  |  |  |  |  |  |

**Figure 2: Analysis of Marsh Cone Test results using PCE**

**Table 8: Mix Proportions for Cement Paste in Marsh Cone Test using SMF super plasticizer with constant w/c of 0.35**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Mix No.** | **W/C ratio** | **Cement (gm)** | **Water ml** | **SMF dosage, %** | **SMF in (ml)** | **Marsh Cone Time (sec)** |
| T1 | 0.35 | 2000 | 700 | 0 | 0 | 60 |
| T2 | 2000 | 700 | 0.25 | 5 | 52 |
| T3 | 2000 | 700 | 0.5 | 10 | 46 |
| T4 | 2000 | 700 | 0.75 | 15 | 42 |
| T5 | 2000 | 700 | 1 | 20 | 39 |
| T6 | 2000 | 700 | 1.25 | **25** | **31** |
| T7 | 2000 | 700 | 1.5 | 30 | 34 |
| T8 | 2000 | 700 | 1.75 | 35 | 35 |
| T9 | 2000 | 700 | 2 | 40 | 34 |

**Figure 3: Analysis of Marsh Cone Test results using SMF**

**Table 9: Summary of Cement Super plasticizer Compatibility Study**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Cement Type** | **Chemical Admixture Type** | **Water cement ratio** | **Optimum Dosage of** |
| 1 | OPC -53 | PCE | 0.35 | **1%** |
| 2 | SMF | **1.25%** |

The optimum dosage given a water cement ratio of 0.35 is 1.25% using of Sulphonated Melamine Formaldehyde (SMF) for OPC cement type as shown in Table 8 and Figure 3. Since, those are considering optimum dose of super plasticizer and cement for selected water cement ratio.

## **Effects of Super plasticizer Dosage on Slump Test**

Also, slump cone was carried out on fresh concrete materials without and with super plasticizers at water to cement ratio 0.35 and variable water amount reduction. Hence, the slump test were performed in accordance with the requirements of IS codes, shown in table 10. Various slump values which are measured (in mm) are resulted for Super plasticizer for with or without values.

**Table 10: Slump Test with & without Super plasticizer – PCE & SMF**

|  |  |  |
| --- | --- | --- |
| **S.No** | **SP dosage %** | **Slump Cone test , mm** |
| **PCE** | **SMF** |
| 1 | 0 | 5 | 5 |
| 2 | 0.25 | 20 | 25 |
| 3 | 0.5 | 30 | 34 |
| 4 | 1 | 60 | 51 |
| 5 | 1.25 | 115 | 70 |
| 6 | 1.5 | 125 | 110 |
| 7 | 1.75 | 130 | 128 |

Slump values results of super plasticizer are been described in Table 10 and Fig 4 for PCE & SMF super plasticizers respectively. Percentage of SP, SP amount and slump value were recorded. It is demonstrated in Figure 4 Y-axis is the slump height (mm) and X-axis is Super plasticizer in percentage. It was clear the required slump 60 mm and 70 mm was achieved at both super plasticizers optimum dosage of 1 % & 1.25 % and without SP slump value close to ‘0’ because of lesser water cement ratio.

**Figure 4: Effect of SP of PCE & SMF in Slump Cone**

Hence, the SP dosage increased on the concrete mix with the two types of SP of PCE and SMF has distinct results as shown in Figure 4. However, water cement ratios are not altered through super plasticizing through admixtures which has increase the workability. Based on the required slump value of specific construction of structure the dosage of both the Super plasticizers were increased.

## **Effect of Super plasticizer on Properties of Hardened Concrete Strength**

The intense effect of Super plasticizer (SP) on properties of hardened concrete has also providing a enhanced compressive strength which are using the properties of concrete using the tensile strength. These tests were performed on 7 days and 28 days. The values of SP dosage and Compressive and Splitting Tensile strength at different specific dosage of Super plasticizer also demonstrated in Table 11 and Figure 7 consequently.

**Table 11: Compressive and split tensile Strength of concrete of super plastered Concrete using PCE super plasticizer**

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**Table 12: Compressive and split tensile Strength of concrete of super plastered Concrete using SMF super plasticizer**



**Figure 5: Effect of SP of PCE & SMF on 7 days Compressive strength of concrete with comparison of 0 % of super plasticizer**

**Figure 6: Effect of SP of PCE & SMF on 28 days Compressive strength of concrete with comparison of 0 % of super plasticizer**

### Compressive Strength

It is clear from Figures 5 and 6 that the strength increases steadily when the dosage of Super Plasticizer is increased. Additionally, it was discovered that the Super Plasticizer's dosage values, which correspond to compressive strength, are lowest and greatest. Continuous Super Plasticizer Agent addition may not be able to increase the compressive strength of concrete continuously; rather, excessive dose significantly lowers the electricity It is accurate to say that when dosage rises, compressive strength does as well. However, overdosing on SP disrupted the hydration process because it adds additional water to the concrete during the mixing phase. Overdosing causes cement particles to deflocculated more quickly.

Figure 5 demonstrate strength verses dosage of Super plasticizer using PCE & SMF in concrete mixture. It is observed the compressive strength of concrete is maximum at 1 and 1.25 % Super plasticizer dosage and obtained as 49.2 N/mm2 and 48.2 N/mm2 respectively of PCE and SMF for 28 days.

Hence, it can be concluded that the optimum dosage of Super plasticizer for strength criteria is obtained for PCE and SMF super plasticizers with respect to 0 % of super plasticizers; along this competitively PCE super plasticizer gives good compatibility it means cohesiveness PCE with OPC is well as uniformity of the concrete. With OPC cement with lesser dosage value of 1 % instead of SMF. With the acceptance of the statement of PCE was better than SMF for higher strength development of concrete same time SMF also very much better other than 0 % SP usage in development of higher strength concrete development

### Split Tensile Strength

In this concrete it is very difficult to measure directly to determine by tension method because of the problem associated gripping test specimens. For this reasons, the indirect tests such as splitting tensile test and the flexural are used. The indirect tension test is also called the Brazilian test, splitting test. The determination of tensile strength of concrete was carried out by splitting tensile test. Cylinders of 150mm dia. x 300mm high were cast from concrete mixes and kept on moisture condition in laboratory.

# CONCLUSIONS

From our experiential results we concluded and provide outlined Information:

* From the investigation, Optimum Dosage of super plasticizer of PCE and SMF are 1.0% and 1.25% in the respect of OPC 53 grade Cement for a selected water cement ratio of 0.35 of M-40 grade concrete.
* It observed that the top of the line dosages derived from the above tests fall inside the range encouraged via manufactures and it can be point out the two SPs are compatible with the cement used for decided on water cement ratio
* The super plasticizer admixture doses as shown a effective and useful optimization with marsh cone test results.
* According to test results, adding Super Plasticizers to admixtures enhances workability without raising water consumption. The addition of 0.5% Super Plasticizer Admixture to the concrete mix did not significantly improve the workability of cement concrete mix, as required by IS 10262 - 2009 and IS 456-200 standard. However, adding 1%, 1.5%, and 2% of SPs to the concrete mix significantly alters the cement's ability to be worked. Additionally, the additions of 0.5%, 1.0%, and 1.5% of SPs in the trial mix with OPC cement have demonstrated an increase in the degree of workability. However, impacts of bleeding and segregation of concrete mix occur over 1.5% SP.
* Through our performed experimental results and observations the admixture Super plasticizer as shown a very impressive Compressive strength of concrete mix. It is observed the compressive strength of concrete is maximum at 1 % and 1.25 % Super plasticizer dosage and obtained as 49.2 N/mm2 and 48.2 N/mm2 respectively of PCE and SMF for 28 days.
* It is observed the split tensile strength of concrete is maximum at 1 and 1.25 % Super plasticizer dosage and obtained as 4.94 N/mm2 and 5.1 N/mm2 respectively of PCE and SMF for 28 days.
* It also observed that amount of water can be reduced by 24.5 % using these types of high water reducer Sp of PCE and SMF; It was did while designing the mix design of M40 grade concrete, the actual requirement of water is 196 liters for 1 m3 with the usage of these type of SP designed water quantity are 146 liters.
* Additionally, it was shown that at 7 and 28 days, the super plasticized concrete specimens provided greater strength in splitting tensile strength and compressive than the control specimens. As a result, when admixtures are applied to fresh concrete, the compressive and cracking tensile strengths are increased.

##### REFERENCES

1. A. R. B. H, V. B. D. L, and S. R. Shashikumara, “Compatibility study of slag cement with PCE based admixtures,” pp. 801–805, 2016.
2. A. Borsoi, S. Collepardi, L. Coppola, R. Troli, and M. Collepardi, “Strength and durability of concretes with slag-fly ash- Portland cement.”
3. D. Sathyan, K. B. Anand, K. M. Mini, and S. Aparna, “Optimization of superplasticizer in portland pozzolana cement mortar and concrete,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 310, no. 1, 2018, doi: 10.1088/1757-899X/310/1/012036.
4. Antoni, J. G. Halim, O. C. Kusuma, and D. Hardjito, “Optimizing Polycarboxylate Based Superplasticizer Dosage with Different Cement Type,” *Procedia Eng.*, vol. 171, pp. 752–759, 2017, doi: 10.1016/j.proeng.2017.01.442.
5. Tiji K James and Liji Anna Mathew, “Compatibility Study of an Admixture with Different Cement Brands of Varying Chemical Composition for SCC,” *Int. J. Eng. Res.*, vol. V5, no. 09, pp. 503–506, 2016, doi: 10.17577/ijertv5is090279.
6. A. K. Shrivastava and M. Kumar, “Compatibility issues of cement with water reducing admixture in concrete,” *Perspect. Sci.*, vol. 8, pp. 290–292, 2016, doi: 10.1016/j.pisc.2016.04.055.
7. L. E. Zapata Orduz, G. Portela, O. M. Suárez, and A. D. Cáceres, “Compatibility analysis between Portland cement type I and micro/nano-SiO2 in the presence of polycarboxylate-type superplasticizers,” *Cogent Eng.*, vol. 3, no. 1, 2016, doi: 10.1080/23311916.2016.1260952.
8. A. M. Kashyap, E. T. Chakrapani, L. Narasimha Murthy, and S. Suryanarayana Raju, “Influence of dosage of super plasticizer on the mechanical properties of binary blended concrete,” *Int. J. Recent Technol. Eng.*, vol. 8, no. 2 Special Issue 3, pp. 707–711, 2019, doi: 10.35940/ijrte.B1131.0782S319.
9. M. S. Mohammed, S. A. Mohamed, and M. A. Megat Johari, “Influence of Superplasticizer Compatibility on the Setting Time, Strength and Stiffening Characteristics of Concrete,” *Adv. Appl. Sci.*, vol. 1, no. 2, pp. 30–36, 2016, doi: 10.11648/j.aas.20160102.12.
10. A. Mardani-Aghabaglou, M. Tuyan, G. Yilmaz, Ö. Ariöz, and K. Ramyar, “Effect of different types of superplasticizer on fresh, rheological and strength properties of self-consolidating concrete,” *Constr. Build. Mater.*, vol. 47, pp. 1020–1025, 2013, doi: 10.1016/j.conbuildmat.2013.05.105.
11. V. B. Pathak and R. A. Shah, “A Compatibility Study on Different Types of Cement and Plasticizer,” vol. 1, no. 9, pp. 52–54, 2013, [Online]. Available: www.ijsrd.com.
12. D. Arpitha, C. Rajasekaran, and N. Puttaswamy, “Investigations on compatibility of cement-superplasticizer interaction and its influence on mortar workability incorporating copper slag as fine aggregate,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 431, no. 8, 2018, doi: 10.1088/1757-899X/431/8/082009.
13. S. Nagaraj and D. Jeyakumar, “Behaviour of normal concrete using superplasticizer under different curing regimes,” *Int. J. Civ. Eng. Technol.*, vol. 9, no. 4, pp. 865–870, 2018.
14. S. Shrihari, M. V. Seshagiri Rao, V. S. Reddy, and A. Manasa, “Compatibility Assessment of Commercial Cements with superplasticizers,” *E3S Web Conf.*, vol. 184, no. June 2017, 2020, doi: 10.1051/e3sconf/202018401079.
15. P. R. Kannan Rajkumar, P. T. Ravichandran, J. K. Ravi, and L. Krishnaraj, “Investigation on the Compatibility of Cement Paste with SNF and PCE based Superplasticizers,” *Indian J. Sci. Technol.*, vol. 9, no. 34, 2016, doi: 10.17485/ijst/2016/v9i3 4/95865.
16. D. Jadhav, “Compatibility of Chemical Admixture With Cement: Marsh Cone Test,” *Int. J. Adv. Mech. Civ. Eng.*, no. 3, pp. 2394–2827, 2016.