

INFLUENCE OF OPTIMIZED SUPER PLASTICIZER EFFECT ON HIGH STRENGTH CONCRETE

Abstract

Chemical admixtures are a valuable choice in concrete production for achieving better performance and desired properties. Among them, Super plasticizer, one of the common admixtures which are used to reduce water content in the concrete mix and influences the behavior of fresh concrete. In order to determine the optimum dosage of admixture, Marsh Cone Test was performed and additionally the effect of higher dosage has been studied together. 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

Authors

Dr. Valikala Giridhar

Professor

Department of Civil Engineering

KSRM College of Engineering

Kadapa, Andhra Pradesh, India

drgiridhar@ksrmce.ac.in

Mr. Mahankali Sreenath

PhD Research Scholar,

Department of Civil Engineering

Jawaharlal Nehru Technological University

Anathapuramu, Andhra Pradesh, India

mahankalisreenath.m@gmail.com

I. INTRODUCTION

In the current civil construction industry admixtures of chemicals and minerals are playing a major role for strengthen and enhancement of concrete. Among the both, Chemical admixtures are having the have the potential to improve both workability of concrete and also strength at a time [1,2]. The advantages of chemical admixture can be identified when the outcome is concrete with high workability and 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 case of chemical admixture, we can find many uses and have positive effects on the properties of fresh and hardened 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.

1. 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: The reasons for incompatibility of concrete are as follows:

- 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.
- In case if $SO_4/C3A$ ratio is considerably low causes C3A hydration which result in early stiffening (flash set). The high ration of calcium sulphates to a gypsum (false set) provides a high ratio of $SO_4/C3A$
- Another element that affects compatibility is temperature. Limited temperatures result in low fluidity while hot weather conditions boost admixture adsorption, leading to fluidity.
- Higher alkali cements react more quickly, which increases the stiffening rate and the slump loss.

- 2. 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 Entainers
 - Super plasticizers
 - Set Retarders
 - Specialty Admixtures
 - Water Reducers
- 3. 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 are

- Naphthalenesulfonate based Super plasticizers (SNF)
- Melamine-sulfonate based Super plasticizers (SMF)
- Lignosulfonate based Super plasticizers (MLS), and
- 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
 - Suitability: Low temperature areas
 - Dosage: 0.5 - 3% by weight of cement
- Sulphonated naphthalene formaldehyde condensates
 - Suitability: Hightemperature areas
 - Dosage: 0.5 - 3% by weight of cement
- Modified Lignosulphates
 - Suitability: Temperaturevariation is high
 - Dosage: Below 0.25% by weight of cement
- Carboxylated admixture
 - Suitability: 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].

- 4. 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 impermeability of concrete or mortar.

5. Polycarboxylic ether: Next generation concrete accelerator made of polycarboxylates is a ready-to-use liquid admixture with excellent performance and no chloride. When using specific polycarboxylate concrete admixtures instead of normal mortar and concrete, the initial setting time of the concrete is one to three times faster. It expedites the hydration process and improves the workability and strength of cement. By lowering the amount of time needed for the concrete to cure, it facilitates the placement of the mix and expedites construction. Labor costs and time will be saved since forms and alternative protection will be removed earlier and finishing will start.

- **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 low 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 creting uses greater dosages.

II. 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.

III. LITERATURE REVIEW

- 1. 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].

Super plasticizers (SMF, SNF, MLS, and other organic admixtures) have an impact on a variety of the physico-chemical characteristics of cement and concrete. Chemical properties include, among others, adsorption behaviour, conductivity changes, zeta potential changes, heat of hydration, chlorine penetration, and sulphate attack. Physical properties include theology, morphology, microstructure, compressive strengths, pore size distributions, and workability.

According to slump and compaction factor trials, concrete containing fly ash and super plasticizer has good workability, marginally speeds self-compaction, and boosts compressive strength.[16].

IV. 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.

1. **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.
2. **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)
 - To a maximum water content of 207 kg/m³ (w/c of 0.45)
3. **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.

4. 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.

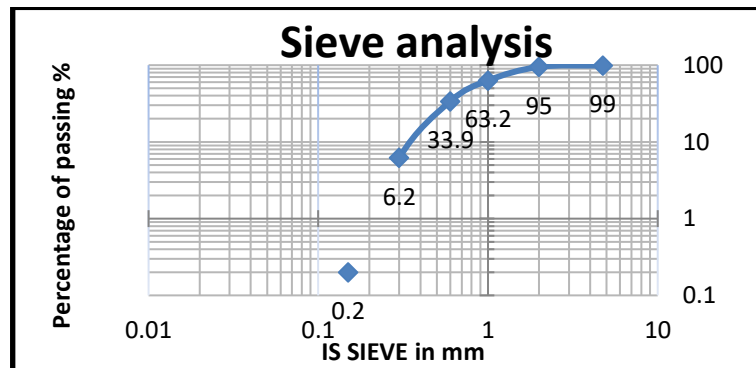
Table 2: Properties of Coarse Aggregate

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

Sl.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	Nil
pH (23 ± 2 °C)	8 ± 1

- **Sulfonated melamine formaldehyde:** 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@ 20°C	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 linked 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.

V. METHODOLOGY

Observations for 1 minute retention period are taken.

1. 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.
2. 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.

3. 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.
4. 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.
5. 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.
6. Repeat the test for each dosage level of the super plasticizer SMF.
7. 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	Cemet (kg)	Fine Aggregate	Coarse Aggregate	Super plasticizer	W:C
			(kg)	(kg)	(ml)	
1m ³	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.

VI. 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 Marsh Cone Test was used in the study to determine the best amount of chemical admixture to add to each batch in order to compare how well OPC cement worked with the two types of SP. For a specific water to cement ratio of 0.35, super plasticizers PCE and SMF are used. A predetermined volume of paste was fed through the funnel one time, and that time was recorded. According to EN 445 and ASTM 939 94a test procedures, the test was conducted.

Marsh Cone Time was recorded during the experimental work, as indicated in Table 7 and Table 8 in Figure 2, The Marsh Cone Time in Seconds is plotted on the Y axis, and the Super Plasticizer dosage percentage is plotted on the X axis using the determined optimum dose. This point is known as "Saturation Point". The results of the Marsh Cone Test are shown in Figure 2. A predetermined amount of paste is poured into a metal cone during the test, and the time needed is timed using a stopwatch. The test was conducted using PCE with a constant w/c ratio of 0.35 and OPC-53 grade cement.

The lowest Marsh Cone Time (MCT1), according to Table 7, is 32 seconds at 1% Super plasticizer dose. As shown in Figure 2, 1.0% is the ideal dosage for a 0.35 water cement ratio. As indicated in Table 7 and Figure 2, the ideal poly carboxylic ether (PCE) dose for a water cement ratio of 0.35 is 1.0%. Given that they are considering about the optimum amount of cement and superplasticizer for the chosen 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

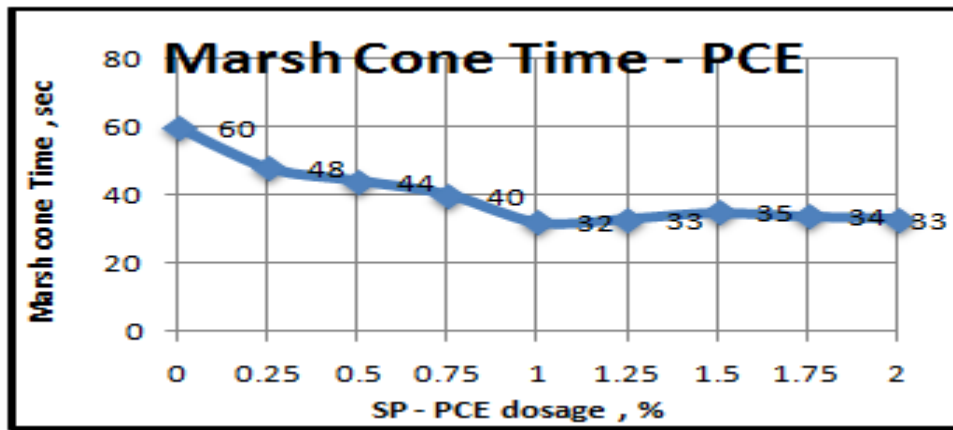


Figure 2: Analysis of Marsh Cone Test results using PCE

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

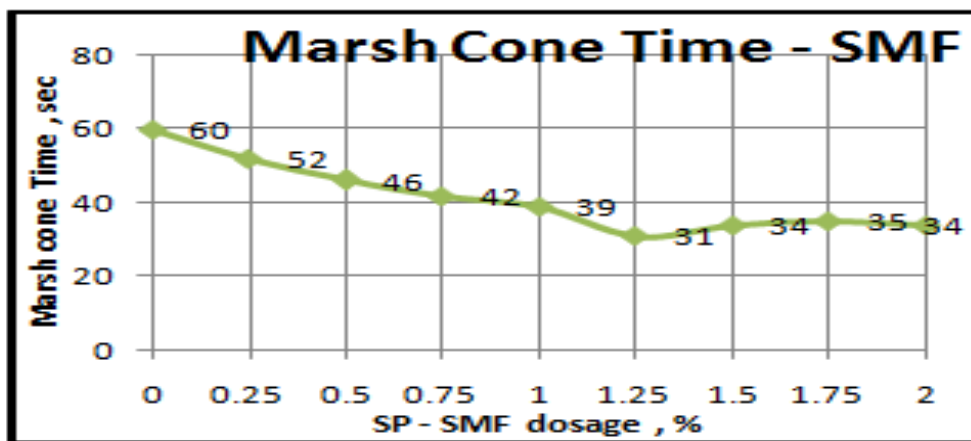


Table 9: Summary of Cement Super plasticizer Compatibility Study

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:** Additionally, slump cone tests were performed on freshly mixed concrete materials using both super plasticizers and those without at a water to cement ratio of 0.35 and varying water amount decrease. As a result, the slump test was carried out in line with the table 10 requirements of the IS standards. For Super Plasticizer with or without values, various slump values measured (in mm) are obtained.

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. Slump value, SP quantity, and SP percentage were noted. Figure 4 demonstrates it. The slump height (mm) is on the Y axis, while the super plasticizer % is on the X axis. 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.

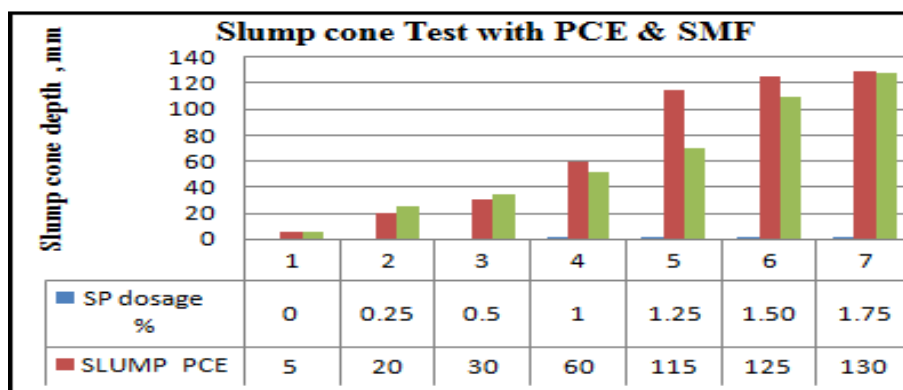


Figure 4: Effect of SP of PCE & SMF in Slump Cone

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.

3. **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 carried out over the period of 7 and 28 days. Table 11 and Figure 7 show the values of the SP dosage and the compressive and splitting tensile strengths at various particular Super plasticizer dosages.

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

POLYCARBOXIL ITE ETHER		Compressive strength N/mm ²		Split tensile strength N/mm ²		Slump Cone Test , mm
S.NO	Mix Code	7 days	28 days	7 days	28 days	
1	PCE-0 %	26.4	43.1	3.25	4.16	5
2	PCE-0.25%	31.4	44.2	3.65	4.52	20
3	PCE-0.5%	33.2	45	3.91	4.64	30
4	PCE-0.75%	34.4	46.1	4.21	4.75	60
5	PCE-1.00%	38.6	49.2	4.52	4.94	115
6	PCE-1.25%	36.2	47.8	4.42	4.85	125
7	PCE-1.5%	35.7	47.2	4.39	4.82	130

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

SULFONATED MELAMINE FORMALDIHIDE		Compressive strength N/mm ²		Split tensile strength N/mm ²		Slump Cone Test , mm
S.NO	Mix Code	7 days	28 days	7 days	28 days	
1	SMF-0 %	26.4	42.1	3.12	4.12	5
2	SMF-0.25 %	28.3	43.2	3.35	4.42	25
3	SMF-0.5%	30.2	44.5	3.62	4.56	34
4	SMF-0.75%	31.4	45.8	3.93	4.78	51
5	SMF-1.00%	33.2	46.2	4.36	4.95	70
6	SMF-1.25%	37	48.2	4.59	5.1	110
7	SMF-1.5%	34.2	47.8	4.42	4.95	128

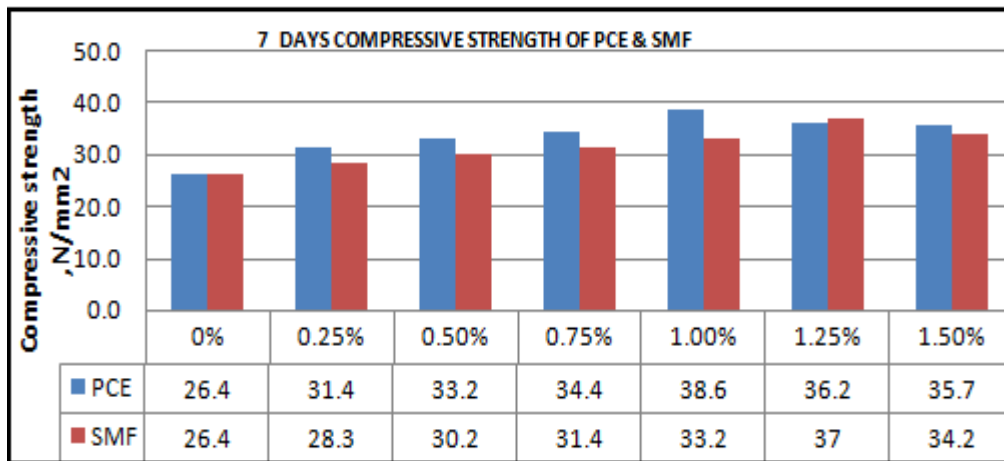


Figure 5: Effect of SP of PCE & SMF on 7 days Compressive strength of concrete with comparison of 0 % of super plasticizer

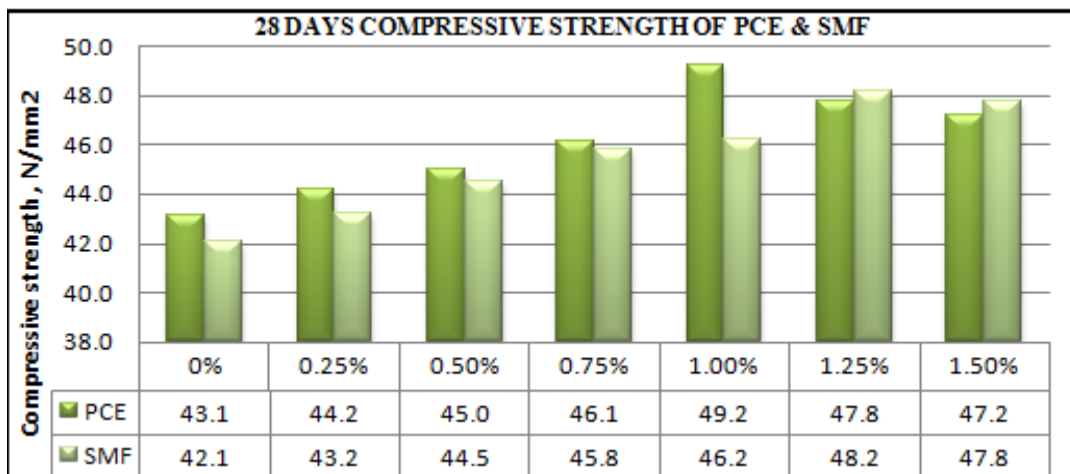


Figure 6: Effect of SP of PCE & SMF on 28 days Compressive strength of concrete with comparison of 0 % of super plasticizer

- 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 versus 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:** To perform tensile strength test on concrete, it may not be conducted on it just like Tensile strength test on steel. It is due to the gripping problem at the end of concrete cubes or cylinders. So, split tensile strength and flexural strength, some of the indirect methods to find out Tensile strength of concrete. In the present chapter, the tensile strength of concrete is predicted by split tensile test. For this, Cylinders of dimensions 150mm dia. x 300mm high were cast from concrete mixes and kept on moisture condition in laboratory.

VII. 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. Collepari, L. Coppola, R. Troli, and M. Collepari, "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.ijserd.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.