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COMPATIBILITY STUDY OF SUPERPLASTICIZERS WITH CEMENT PARTIALLY REPLACED WITH BRICK POWDER

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Abstract - *Superplasticizers are chemical admixtures used where well-dispersed particle suspension is required. The complex interaction between cement and chemical admixtures in concrete mixture sometimes leads to unpredictable concrete performance in the field, which is generally defined as concrete incompatibilities. This paper is about the compatibility study of two type superplasticizers with cement and also cement partially replaced with brick powder in different water cement ratios. Experiment is conducted using Marsh cone test and the results are analyzed graphically to find the optimum dosage of a superplasticizer and its compatibility with the cement. Also the effect of superplasticizers on the consistency and initial setting time were studied in this experimental work. It has been found that Polycarboxylate Ether (PCE) based superplasticizers show greater compatibility and economical dosage as compared to Sulphonated Naphthalene Formaldehyde (SNF) based superplasticizers with all types of cements in terms of workability. Depending upon the brand and dosage rate of superplasticizer, workability is different in different water cement ratio. The retention in workability of cement paste mixed with PCE does not vary much with time, and giving a better workability for a longer time.*

Key Words: **Compatibility, Superplasticizers, Saturation dosage, workability**

1. INTRODUCTION

Chemical admixtures have become one of the essential components of concrete in recent years. Nowadays according to the needs of the users various chemical admixtures in different composition have been available in the market. The most commonly used for this purpose are those of plasticizers and superplasticizers. Among that the most important is superplasticizers, which have the ability to increase the workability of concrete considerably. Superplasticizers are usually used for the production of self leveling, self compacting high strength high performance concrete. In India superplasticizers are used in the construction of high rise building, long span bridges and ready mix concrete plant. But same superplasticizer shows different fluidity with different in same water cement ratio. So study of compatibility of cement and superplasticizer is important. According to the chemical content superplasticizers are classified into Sulfonated melamine-formaldehyde condensates (SMF), Sulfonated naphthalene-formaldehyde condensates (SNF), Modified lignosulfonates (MLS), Polycarboxylate derivatives.

2. OBJECTIVES

- To investigate the compatibility of PCE and SNF based superplasticizer on the cement partially replaced with brick powder
- To find out the optimum dosage of those superplasticizers in different w/c ratio
- Study the effect of PCE and SNF based superplasticizer on workability retention and consistency

3. METHODOLOGY

1. Prepare the cement paste by varying the percentage of SPs in various w/c ratio
2. Using Marsh cone test find out the saturation point
3. Replace the cement with 5% brick powder and find out saturation point by conducting Marsh cone test with different w/c ratios
4. Find out the most suitable pairs for both cases in different w/c ratios
5. To check the workability retention of these superplasticizers, again conduct the Marsh cone test in the obtained saturation dosage of superplasticizer and note the flow time in 15min, 30min, 1 hour and 2 hour time interval.
6. Using Vicat apparatus check whether superplasticizers have any influence on consistency and initial setting time of cement paste with and without partially replacing with brick powder.

4. MATERIALS USED FOR THE STUDY

OPC 53 grade cement, PCE and SNF based superplasticizers, Brick powder were used for the study. Properties of superplasticizers obtained from the data sheet are shows in the table1shown below. The main thing is to be note that the solid content of PCE and SNF based superplasticizers are 30% and 44.25% respectively.

Table -1: Properties of superplasticizers

Superplasticizer Type	Polycarboxylic ether polymer	Sulphonated naphthalene polymer
Name	Sika®viscocrete ®1062NS	PAC
Specific gravity	1.09	1.25
Solid content	30%	44.25%
pH at 27^{0}C	7.4	7.8
Dosage (by manufacturer)	0.2-2%	0.4-6%

5. APPARATUS USED FOR THE STUDY

Marsh cone, Stop watch, Kitchen blender for mixing, Los-Angeles abrasion machine for grinding the brick powder were used for the study.

6. MARSH CONE TEST

Marsh cone test is a simple practical method to find out the relative fluidity of cement with superplasticizer. it is based on ASTM standard of C939. Following figure shows the standard marsh cone, diameter varies from 8mm to 15cm.Its total height is 35cm. it can be made with any material such steel plastic, aluminum etc. A certain volume of cement paste is allowed to flow through the marsh con and the fluidity was measured. The flow time is varying with fluidity. In this thesis work, stainless steel marsh cone was used and w/c ratios selected are0.35, 0.40, and 0.45.

Test procedure is as follows:

First 1.6 Kg of cement is dry mix for 1 minute. After that 70% of the calculated waster was added in to the cement and continue the mixing for 1 minute. Then remaining 30% of water along with the calculated dosage of superplasticizer was added in to the cement paste and mixing was continuous for 3 minutes. The amount of water present in the superplasticizer should account in the w/c ratio. Allow the prepared mix through the marsh cone and note the time taken by the cement paste to flow through the marsh cone. Mixing was done by using kitchen blender which gives similar flow time pattern by Hobart mixer. The same procedure is repeated by varying the dosage of superplasticizer for varying w/c ratios. The flow time will reduces up to a particular dosage after that it remains constant. That particular dosage is known as optimum dosage.

7. Results and Discussions

Properties of cement and brick powder obtained from the experimental work are shown in the table 2 & 3

Table -2. Properties of cement

Specific gravity	2.87
Consistency	30%
Initial setting time	40min
Final setting time	5hrs

Table 3. Properties of cement with brick powder

Specific gravity (Brick Powder)	2.67
Consistency	31%
Initial setting time	30min
Final setting time	4hrs

The graphical representation of results obtained from the experiment for different w/c in the case of two superplasticizers in both the cases is shown below.

7.1 Effect on optimum dosage

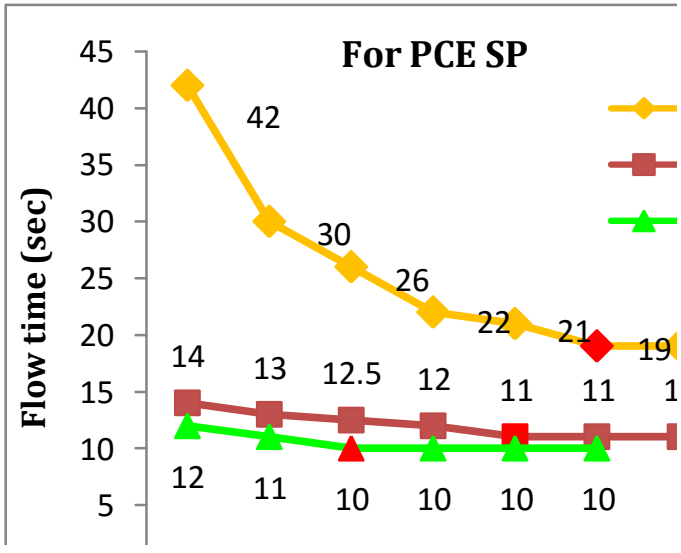


Fig.1. Flow time variation of cement paste in presents of PCE based superplasticizer in various w/c ratios

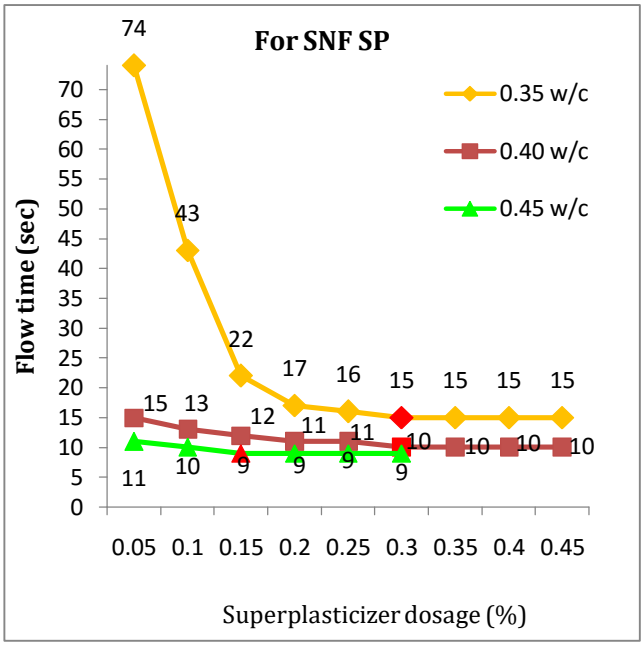


Fig.2. Flow time variation of cement paste in presents of SNF based superplasticizer in various w/c ratios

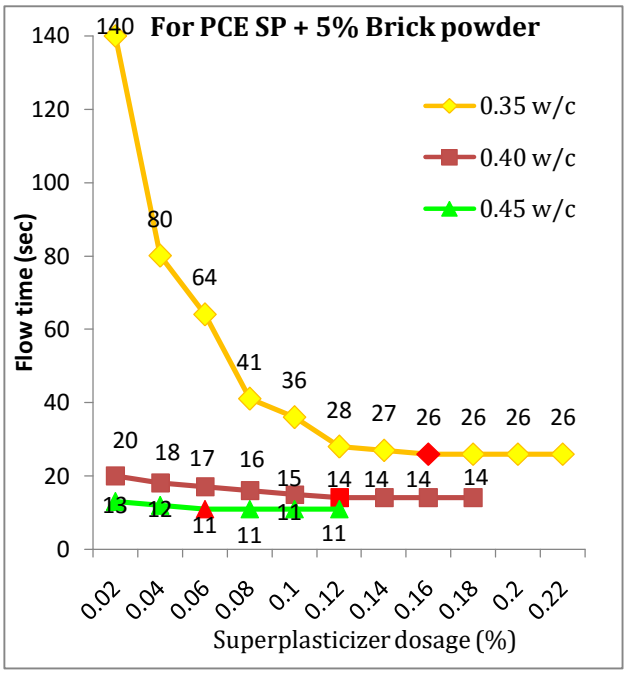


Fig.3. Flow time variation of cement paste partially replaced with brick powder in presents of PCE based superplasticizer in various w/c ratios

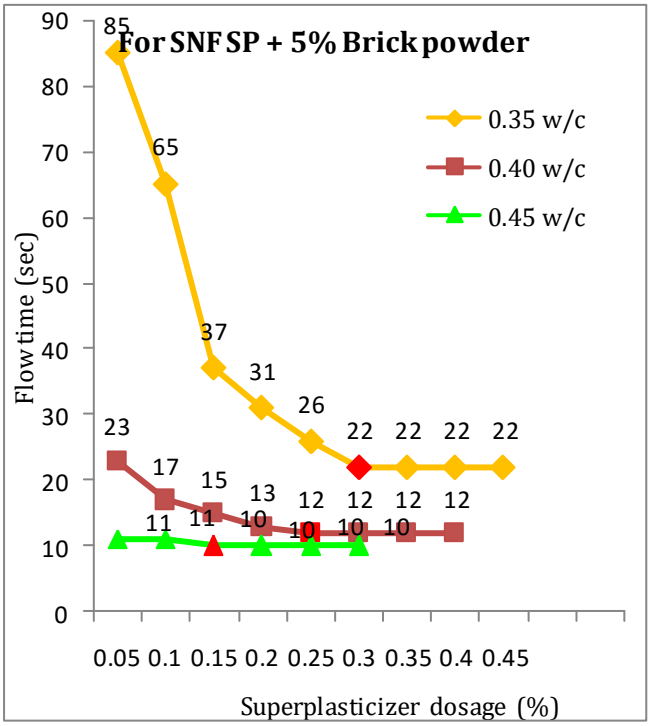
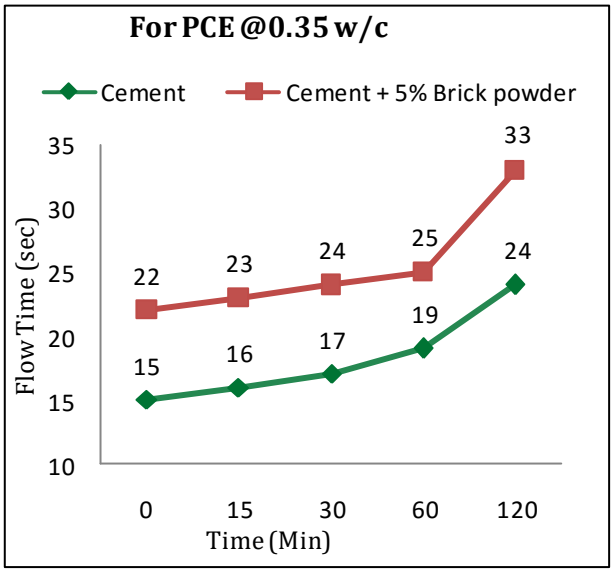


Fig.4. Flow time variation of cement paste partially replaced with brick powder in presents of SNF based superplasticizer in various w/c ratios

7.2. Effect of superplasticizers on workability retention



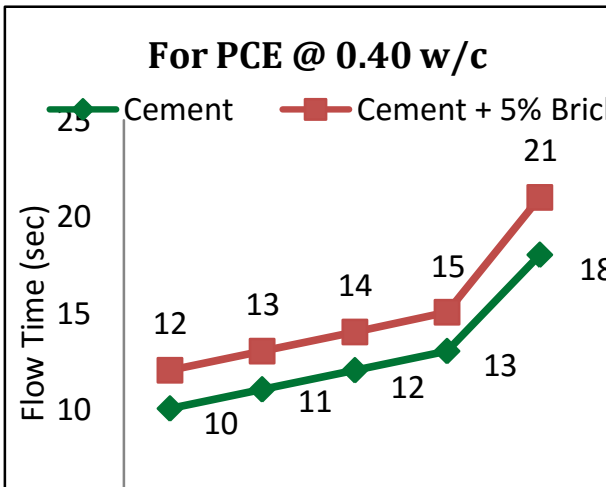
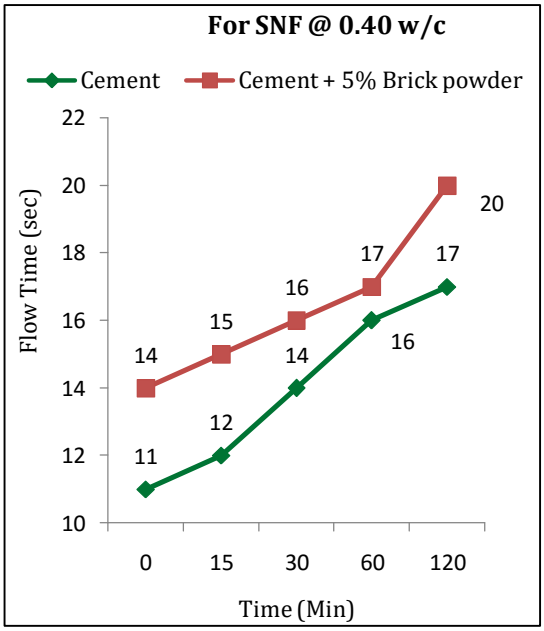
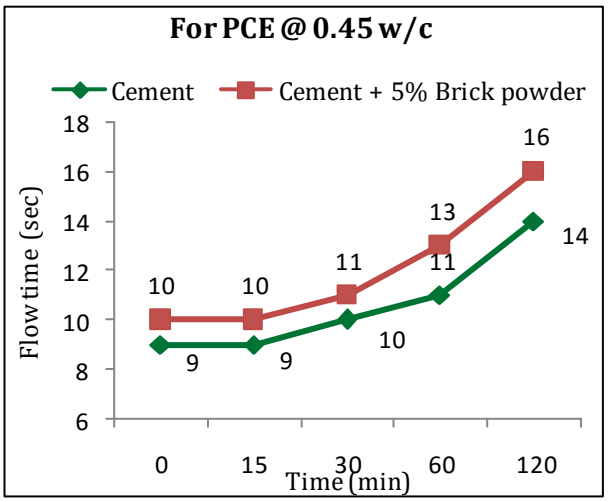


Fig.5.a & b. Effect of PCE based superplasticizer on workability retention in 0.35 and 0.40 w/c with and without replace- ment case





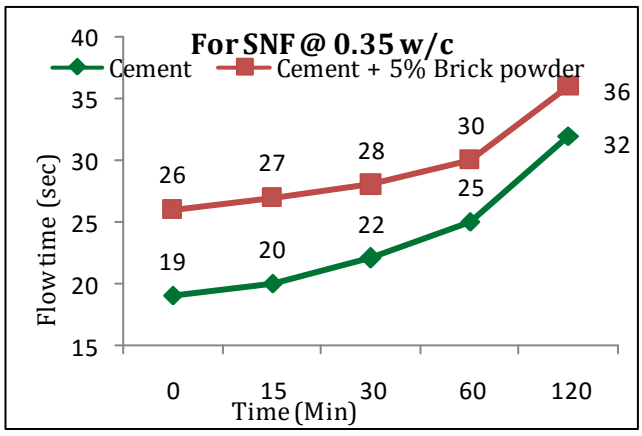


Fig.6.a, b.Effect of PCE and SNF based superplasticizer on workability retention in 0.45 and 0.35 w/c in with and without replacement case

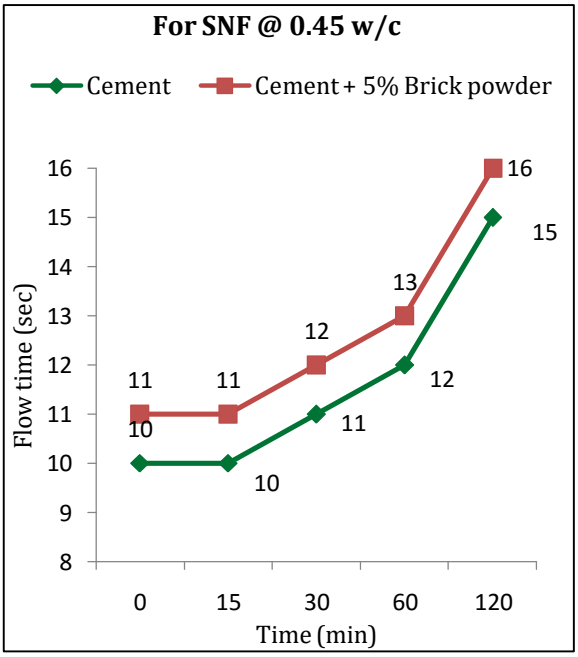
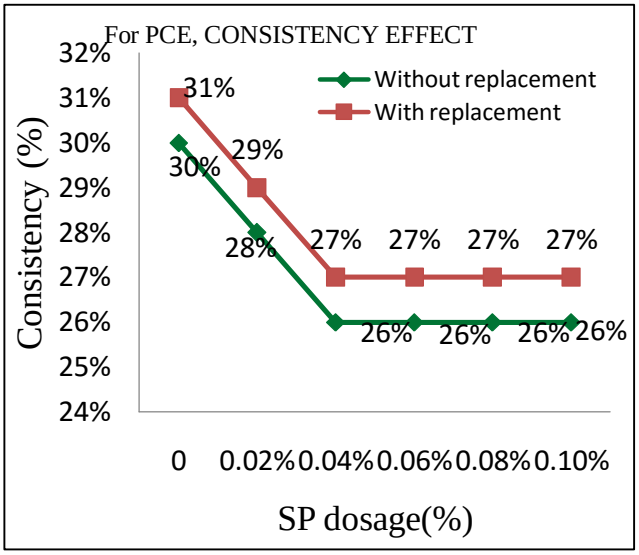


Fig.7 a & b. Effect of SNF based superplasticizer on workability retention in 0.40 and 0.45w/c in with and without replacement case

7.3. Effect of superplasticizers on Consistency and Initial setting time



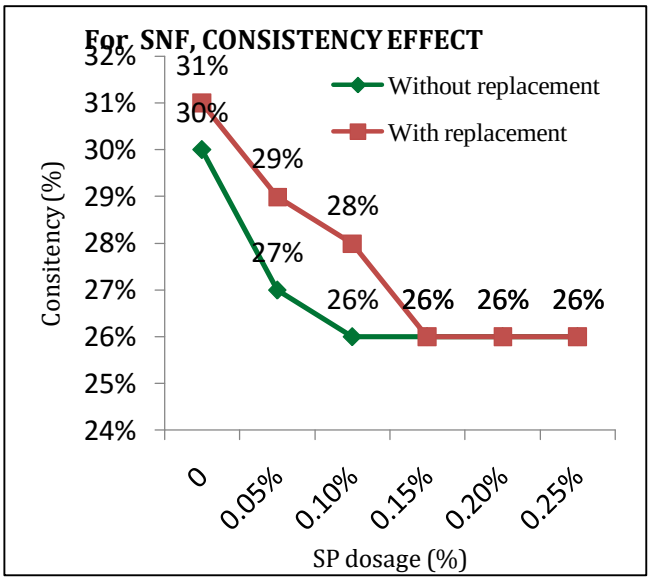


Fig.8 a & b. Effect of PCE and SNF based superplasticizer on consistency with and without replacement case

7.4. Discussions

From the figures 1,2,3,4, it can be see that the dosage of superplasticizer increases, the flow time is reduces up to a particular dosage after that it remains constant for all w/c ratios in both the case of superplasticizers. That particular dosage is known as optimum dosage. From those figures it can be also noted that as the w/c ratio decreases flow time increases. And while comparing the graphs of PCE and SNF, it can be see that as the dosage required for PCE is less than that of SNF to obtain the optimum dosage in both with and without replacement case. While replacing the cement with brick powder the flow time is increases for the same w/c ratio for the same superplasticizer. Figure 5, 6, 7 shows the effect of superplasticizers on workability retention with and without replacement case. In all cases the flow time increases as time progresses. That means for the same dosages workability retention varies from time to time. While comparing the graphs the workability retention ability increases as increasing the w/c ratios. Workability retention is reduced by the partial replacement of cement with brick powder. Figure 8 shows the effect of superplasticizer on the consistency. From the experimental results, it can be see that as the superplasticizer dosage increases the consistency reduces up to a particular dosage after that it remains constant in case of both the superplasticizer in with and without replacement case. And the consistency is increases by replacing cement partially with brick powder. For the w/c ratios workability retention is approximately same for PCE and SNF based superplasticizer in both the cases but the consistency is more for SNF than that of PCE in cases of with replacement case for the same dosage.

8. CONCLUSIONS

- As w/c ratio decreases saturation dosage increases for both SPs with and without replacement of brick powder
- Dosage required to obtain the saturation point is less for PCE in both cases
- For the same SP, dosage required is more for cement paste with partial replacement of brick powder than without replacement to obtain the saturation point
- Workability reduces by the replacement of brick powder
- Trend of workability retention is same for both cement with and without replacement with brick powder for the same w/c ratio
- For the same w/c ratio, workability retention is approximately same for both SNF & PCE based SPs
- As SP dosage increases, consistency reduces up to a particular dosage , after that remains constant
- For the same dosage of SNF & PCE, cement paste without replacing with brick powder have the same consistency
- But the consistency is more for cement paste replacing with brick powder for SNF than that of PCE for the same dosage
- PCE is more compatible than SNF based superplasticizer

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