International Journal of Civil Engineering Research.
ISSN 2278-3652 Volume 5, Number 1 (2014), pp. 43-48

http://www.ripublication.com/ijcer.htm

Study of the Admixture-cement Compatibility for the Economic Production of Special Concretes

Anshuman Dogra[1] and Richa Bhardwaj[2]

[1]B.E. Civil Engineering, Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India.
[2] B. Tech. Civil Engineering, National Institute of Technology, Hamirpur, Himachal Pradesh, India.

Abstract

The addition of superplasticizers with mineral admixtures like fly ash, alccofine etc. to concrete imparts a high strength and workability to it, even at very small water cement ratios. But to get the maximum benefit from this amalgamation of concrete and admixtures, the incompatibility issues between these two need to be studied. In the present work, the aim is to find the optimum dosage for different superplasticizers, for a particular grade of cement, using Marsh Cone test. The results of these rheological tests conducted on the cement slurry are analyzed graphically to find the optimum dosage of a superplasticizer and its compatibility with the concrete. It has been found that Polycarboxylate Ether (PCE) based superplasticizers show greater compatibility and economical dosage as compared to Sulphonated Napthalene Formaldehyde (SNF) based superplasticizers. A cost analysis is further done to assess the overall practical utility of the admixtures.

Keywords: Marsh Cone Test, Saturation Point, Optimum Dosage Of Superplasticizers, Workability, Glenium B233, Rheobuild 522 (ND), Master Glenium Ace 30, Master Glenium ACE 30 IT.

1. Introduction

Over the course of time, the concrete industry has to cope with the day to day challenges and the use of mineral and chemical admixtures has been a magic wand for the same. To achieve the desired properties in a high quality concrete, these admixtures, particularly superplasticizers, are added to the cement. Superplasticizers are the high range water reducers used for the proper dispersion of the cement particles in a concrete suspension [Ramachandran (1995)]. The addition of the superplasticizers can reduce the water-cement ratio of the concrete to the range of 0.25–0.30, without affecting its strength and workability. This also increases the durability of the concrete. Thus, we get a homogeneous workable concrete at low water cement ratios, which is less susceptible to bleeding and segregation. The addition of superplasticizers not only improves the rheological properties of the concrete but imparts it more compactness and strength in the hardened state.

These days, due to the availability of different types of admixtures and cement in the market, there is flexibility in choosing the right composition of the concrete according to the desired parameters, keeping in mind the overall economy and environmental safety. Admixtures, especially new superplasticizers are being developed regularly, which dramatically change the properties of the concrete. But if there is incompatibility between the cement and the admixture, it may cause rapid loss of workability, excessive quickening/retardation of setting and low rates of strength gain, in addition to the economic loss.

2. Superplasticizers

2.1 Types of Superplasticizers

Superplasticizers can be classified into following four groups:

a) Sulfonated melamine–formaldehyde condensates (SMF)
b) Sulfonated naphthalene-formaldehyde condensates (SNF)
c) Modified lignosulfonates (MLS)
d) Polycarboxylate Derivatives (PCE based)

2.2 Dispersion–Fluidification property of superplasticizers

Superplasticizers are the dispersants, having a polar hydrophilic group attached to a non-polar hydrophobic organic chain with some polar groups, which prevent the flocculation of fine particles of cement. The polar groups in the chain get adsorbed on the surface of the cement grains, and the hydrophobic end with the polar hydrophilic groups at the tip point outwards from the cement grain. The hydrophilic tip is able to reduce the surface tension of water, and the adsorbed polymer keeps the cement particles apart due to electrostatic repulsions. Thus the fluidic property of the concrete increases and the concrete is workable even at lower water–cement ratios. [**The Concrete Portal (2013)**]

2.3 Properties of the superplasticizers used in this study

Following table shows the name and the performance test data for all the four BASF superplasticizers used in this study. [BASF The Chemical Company’s Website]

S. No.	Name	Relative Density	pH	Chloride Ion Content
1.	Glenium B233	1.08 ± 0.01 at 25°C	≥6	≤0.2%
2.	Rheobuild 522 (ND)	1.20±0.02 at 25°C	≥6	≤0.2%
3.	Master Glenium ACE 30	1.06±0.01 at 25°C	≥6	≤0.2%
4.	Master Glenium ACE 30 IT	1.11±0.01 at 25°C	≥6	≤0.2%

3. Marsh Cone Test

Marsh cone test is reliable and simple method to study the rheological properties of cements and mortars. Flow time of cement/mortar through marsh cone is indicator of viscosity, which depends upon cement superplasticizer compatibility. It is widely used to study cement superplasticizer compatibility and to determine optimum superplasticizer dosage of a specific cement-superplasticizer combination.

3.1 Apparatus

Apparatus consist of a conical brass vessel held on a wooden stand with an orifice of 8mm or 10mm at its bottom. A stop watch is needed to measure the time taken by 1 liter of cement or mortar to pass through the vessel. A mortar mixer is also needed to prepare the cement paste with desired w/c ratio. [Pamnani et. al. (2013)]

3.2 Materials Used

PPC cement, BASF superplasticizers- Master Glenium B233, Master Glenium ACE 30, Master Glenium ACE 30 IT, Master Rheobuild 522 ND

3.3 Methodology

In the present study, 1L of cement paste is prepared in mortar mixer using 2 kg of cement and w/c ratio of 0.32-0.35.High strength Concrete designs typically have w/c ratios less than 0.35. Water is added in two steps- 70% of water is added in beginning of mixing and rest 30% of water is mixed with superplasticizer, and added afterwards. Cement slurry is prepared with the w/c ratio of 0.32 and admixture dosage of 0.5 %. 1 liter of cement slurry is made to flow through marsh cone after 5 min and 60 min of mixing and time in seconds is measured using a stopwatch. The procedure is repeated gradually increasing the S.P. Dosage in steps of 0.2%. Similar tests are conducted for rest of superplasticizers and graphs are plotted with time as Y axis and S.P. dosage as X-axis.

4. Analysis of the Results

4.1 Results of the marsh cone test

The results of the Marsh Cone Test for the cement slurry containing different superplasticizers are tabulated below (Table 1). The same results are shown graphically to compare the test results for different superplasticizers (Figure 3, Figure 4, Figure 5 and Figure 6)

Table 3: Cost Analysis for PCE based superplasticizers (Note–The rates of different superplasticizers are indicative only)

6. Conclusion

Four admixtures were taken in this study keeping the brand and grade of cement constant throughout. The saturation points was obtained using Marsh cone test. Difference between 5 min and 60 min flow time was least for PCE based Master Glenium ACE 30 and greatest for SNF base Master Rheobuild 522 ND. However least admixture dosage at low w/c ratio was obtained for PCE based Master Glenium ACE 30 IT. This concludes the superiority of PCE based superplasticizers on SNF based superplasticizers. Concrete cubes were prepared using optimum dosage of Master Glenium ACE 30 IT in mix design for High strength concrete and indicative strength of 70 MPa was achieved. Hence, for designing of HSC, optimum dosage from Marsh flow cone experiment can be used as starting point and later, by hit and trials, mix design for HSC can be fixed as per strength and workability requirements. Also a cost analysis is done within the PCE based Superplasticizers. However, a cost analysis is only beneficial when project site requirements are not very specific. For specific and critical requirements of any project, it is recommended to use specially recommended admixtures at recommended dosages for given mix design.

References

[1] Ramachandran, V.S. (1995) Concrete Admixtures Handbook–Properties, Science, and Technology, 2nd Edition, William Andrew Publishing, ISBN 0-8155-1373-9 p. 121

[2] The Concrete Portal, http://www.theconcreteportal.com/admix_chem.html (2013)

[3] BASF The Chemical Company’s Website, http://www.basf-cc.co.in/en/products/admixtures_for_concrete/ (2013)

[4] Pamnani N., Patel P., Pitroda J., Verma (2013), Comparison and Optimization of Dosage of Different Super-Plasticizers for Self Compacted Concrete Using Marsh Cone, *IJEIT 2 (8) 79 - 80.*