Effect of Super plasticizer for Improvement of Concrete Strength: A Review

Prabhat Mishra[1], R.C. Singh[2]

[12]*Department of Civil Engineering, RSR Rungta College of Engineering and Technology, Bhilai*

ABSTRACT

High performance concrete is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The use of some mineral and chemical admixtures like super plasticizer enhance the strength, durability and workability qualities to a very high extent. Use of High Performance concrete in construction enhances the service life of the structure and the structure suffers less damage which would reduce overall costs. In this paper will focused about the mixing of super plasticizer for improve the performance of concrete compressive strength.

Keyword*s: Concrete, Super Plasticizer, Compressive strength.*

I. INTRODUCTION

Concrete is a composite material in which a binding material mixed in water on solidification binds the inert particles of well graded fine and coarse aggregates. Cement and lime are generally used as binding materials, whereas sand cinder is used as fine aggregates and crushed stones, gravel, broken bricks, clinkers are used as coarse aggregates.

Fig 1. Cement Concrete

The superplasticizers (SP) are referred to as high range water reducing admixture by ASTMC494, which mainly disperses the water in concrete matrix. This property is some time called as dispersion-fluidification property of concrete admixture.

II. LITERATURE REVIEW

In this chapter, some of the literature on super plasticizer mixed concrete.

Gołaszewski and Szwabowski (2004), Through the investigation with rotational rheometer, it is possible to precisely determine the influence of superplasticizers on the rheological properties of mortars. On the ground of

this, it is possible to choose compatible cement–superplasticizer system and optimise the composition of mortar and concrete from workability point of view.

The results clearly show that the AP and PC type superplasticizers are more effective than SNF superplasticizers. Used in the same dosage, these superplasticizers make it possible to obtain mortars with considerably reduced g value and low workability loss. The characteristic of mortars with AP and PC superplasticizers is high h value, which is an advantage from the segregation point of view (e.g., the stability of SSC depends on high h value), but can cause some practical problems (e.g., with slip forming or equipment cleaning). Using PC and AP superplasticizers, especially good results can be expected for low W/C ratio mortars or concretes. For plain concrete, with normal or high W/C ratio, the effectiveness of these superplasticizer is similar to SNF superplasticizers, and thus for economic reasons, their application is not beneficial.

Ahmad et. al. (2005), It has long been a concrete technologist's dream to discover method of making concrete at the lowest possible water/cement ratio while maintaining a high workability. To a considerable extent this dream has been fulfilled with the advent of superplasticizers. Have indeed added a new dimension to the application of admixtures with regards to production of high strength and flowing concretes. It is now possible to produce concrete with compressive strength of the order of 13000 psi (90 Mpa). In addition, these are also suitable for use with other cementations materials like fly ash and blast furnace slag.

In the wake of energy conservation policy and diminishing supplies of high quality raw materials, there is a need to use marginal quality cements and aggregates for the production of concrete. In such instances the use of superplasticizers permits the production of concrete at low water/ cement ratios. Thus, many waste materials of today become the useful by products of tomorrow. It is the particular role of superplasticizers, which is very importance for us here in Pakistan, because of our poor economy and less developed industrial base. Besides, the addition of superplasticizers to produces concrete with less cement but normal strength and workability is another application, which has received more attention.

Sakai et. al. (2006), This paper describes the influence of various types of superplasticizers such as naphthalene type (β-NS), refined lignin sulfonate type (LS) and polycarboxylate types (P34, S34) on the hydration of cement and the pore structure of hardened cement. Other superplasticizers except β-NS delayed the initial hydration of cement. In any case, it hardly influences the hydration reaction at late stage of cement. The retardation by the addition of superplasticizers is not observed after 28 days of curing. Large pores of 0.1 μm or more for hardened cement with LS or β-NS are larger than those of hardened samples with P34 or S34 cured for 28, 56 and 91 days. This is related to the coagulated structures of fresh cement pastes with various types of superplasticizers. It was presumed that the size of the cluster of aggregated particles became small when S34 or P34 that has a high dispersing ability was added compared to LS or β-NS that has a lower dispersing ability.

Srinivasan et. al. (2010), The Zeta potential of cement suspensions were measured in diluted suspensions in the past. Various researchers tried to establish a relationship between zeta potential values and interaction of superplasticisers in cement suspensions. The electroacoustic method, however, allows to measure the zeta potential of cement suspensions at high concentrations up to 60 v/v% of solids. Based on the zeta potential observations of ordinary Portland cement (OPC) and Portland pozzolanic cement (PPC) pastes at a water–cement ratio of 0.50 with different bases of superplasticisers, the following conclusions are derived:

- The zeta potential of control (admixture free) pastes of PPC is higher when compared with OPC pastes. This indicate that, in general, the electrostatic repulsion and particle dispersion is greater in PPC pastes.
- The dispersion behaviour of OPC and PPC pastes varies with different bases of superplasticisers.
- The zeta potential values of PPC pastes at different dosages of SMF based superplasticiser are significantly greater than those of OPC pastes.
- The zeta potential values of PPC pastes at different dosages of LS and SNF based superplasticiser are marginally greater than those of OPC pastes.
- SNF based superplasticisers resulted in the most effective increase of the zeta potential of cement pastes both in the case of OPC and PPC.

Tamrakar and Mishra (2013), This paper was conducted to study the effect of superplasticizer on properties of concrete with characteristic strength of 20 and 40 N/mm². The properties investigated were workability (Slump), and compressive strength. On the basis of observation on test result it can be stated that properties of concrete in fresh and hardened stages have been improved with the addition of three types of superplasticizer for all nominal mixes of concrete, the Glenium 140 have shown however more pronounced in terms of increase in the compressive strength, workability, water reduction, cement saving requirements of concretes. From the results of the study the workability of concrete can be increased by addition of superplasticizer. However, very high

dosages of SP tend to impair the cohesiveness of concrete. Slump loss can be reduced by using the chemical admixtures. However, effectiveness is higher for superplasticizer concrete.

Singh (2014), As civil engineer's maintaining our duty to discover method of making concrete at lowest water cement ratio while maintain a required workability. It is now possible with the advent of super plasticizers. Today new applications of admixture have been brought into the market for production of high strength and flowing concretes. These super plasticizers were also suitable for use with other cement material like FLY ASH and PPC. The effects of super plasticizer on fresh and hardened concrete were investigated. The experiment program included test on workability, slump loss and compressive strength. In this experimental works we are comparing the properties of super plasticizer-based concrete with that of without super plasticizer added concrete. Super plasticizer permitted a significant water reduction while maintain the same workability.

In these research program three different families of super plasticizers has been used.

Rheobuild 1125(Sulphonated naphthalene polymer based)

Glenium 140 (Polycarboxylic ether polymers)

Pozzolith 225 (Modified lignosulphate)

Two design ratios of M20 and M40 grade were used for mix proportioning of concrete constitute by weight. The water cement ratio was maintained as 0.55, 0.40, to study the effect of these super plasticizer on various properties of concrete. The dosages of super plasticizer were adopted as 0.25% by weight of cement. To study the effect of super plasticizer the experiment has been divided into four series namely workability series, water reduction series and cement saving series, compressive strength.

Kong et. al. (2016), The molecular structure of PCEs such as the densities of carboxylate groups, the functional group contents, the molecular weight and the side chain polymerization degrees can affect the hydration behavior of Portland cement. As the number of carboxylic groups in PCEs increased, the first hydration temperature peak declined. Moreover, the appearance of the main hydration peak and maximum elevated temperature was delayed. The hydration age needed to reach the main hydration peak and maximum elevated temperature was not delayed when the molar ratio of AA and TPEG2400 exceeded 4.5, but the peak values decreased to levels lower than those of the blank sample. The hydration reactions between cement and water can be controlled by the PCEs absorbed on the surface of cement particles. With the increase in carboxylate groups, the absorption capability of PCE on the surface of cement particles strengthened, and the delay effect of PCEs became prominent. PCEs with large molecular weights required longer hydration age to reach maximum elevated temperature, and the shape of the main hydration peak was broadened.

When the molar ratio of polyoxyethylene ether monomer remained unchanged, the molecular weight of PCEs increased with the decrease of MAS. This phenomenon caused main chain extension. The absorption capacity of PCEs with long main chain was relatively low. However, as regard to the samples with different molecular weight, how much they adsorbed was not the key factor on delaying the hydration process. The PCEs with long main chains can be adsorbed on the surface of cement particles simultaneously, which resulted in agglomerate of the cement particles and, thereby, the hinderance of the process of hydration.

Piekarczyk et. al. (2017), Within the scope of the research and examined admixtures, it was found that in order to increase the degree of fluidity of previously aerated concrete, made with the participation of innovative air-entraining CEM II/B-V, should be:

- For each air-entraining cement the choice of amount and type of plasticizer or superplasticizer, due to the required aeration and consistency of mixture, can be successfully carried out only on the basis of experimental comparison. The condition of compatibility of entraining and super plasticizing admixtures with cement should be verified, taking into account their mutual influence of both the consistency and the content of the air in the mixture. It is important to verify their interactions and possible consequences for air-entrainment and mortar consistency, as well as concrete.
- The recommended admixtures in the case of the air-entraining CEM II B-V are traditional plasticizers based on the naphthalene and melamine. In case of a significant increase in the degree of liquidity of concrete mixture, first new generation superplasticizers based on modified naphthalene, and then modified phosphoramidate should be used. The new generation superplasticizers based on polycarboxylate, polycarboxylic ether and acrylate cause a significant increase in the air-content of the air-entrained mortars. In certain cases of cement mortars and less dosage of SP, almost three times.
- The third-generation SPs based on modified naphthalenes provide a good workability of the mortar, no worse than SPs based on a polycarboxylate, polycarboxylate ether, acrylate, or a phosphoramidate.

Antoni et. al. (2017), the uses of polycarboxylate ether (PCE) as superplasticizer (SP) in the manufacture of high strength concrete is increasingly common. Each brand of SP available on the market has different compositions, causing differences in dosage requirement and the resulting characteristics. Beside SP type,

cement type and composition also affect the fresh and hardened concrete properties. In this study, the optimum dosages of several brands of PCE superplasticizer in making mortar were investigated. Two different cement types were used. The effect of SP on flowability, setting time, and resulting compressive strength were evaluated. The results show that with the increase of SP dosage in mortar mixture, the flowability increased. However, there is an optimum value for each brand and for each water cement ratio. The increase of flowability is accompanied by an increase in compressive strength until it reaches the optimum level. Nevertheless, excessive use of SP could lead to bleeding and segregation, and reduce the compressive strength. It was found that ordinary Portland cement (OPC) requires higher SP dosage than Portland Pozzolan cement (PPC) for the same flowability. Longer setting time was observed for all mixtures employing SP, at different degrees of extension. It correlates with the slump retention time. Simple method to determine the optimum dosage is suggested in this paper.

III. CONCLUSION

The concrete mixture which possesses high durability and high strength when compared to conventional concrete. As per ACI is that concrete which meets special performance and uniformity requirements that cannot always be achieved by using only conventional material, placing and curing practices. In this paper we will study the experimental work that conducted compressive strength test for super plasticizer mix concrete and the performance of the concrete will increase a material widely utilized in heavy structural construction.

REFERENCES

[1] J. Gołaszewski, J. Szwabowski Influence of superplasticizers on rheological behaviour of fresh cement mortars Cem. & Con. Res., 34 (2004), pp. 235-248, 2004.
[2] Saeed Ahmad, Muhammad Nawaz, Ayub El, “Effect of Superplasticizers on Workability and Strength of Concrete”, 30th Conference on Our World In Concrete & Structures, pp 23–24, 2005.
[3] Etsuo Sakai, Takayuki Kasuga, Tomomi Sugiyama, Kiyoshi Asaga, Masaki Daimon, “Influence of superplasticizers on the hydration of cement and the pore structure of hardened cement”, Cement and Concrete Research, 36, 2049–2053, 2006.
[4] S. Srinivasan, S.A. Barbhuiya, D. Charan, S.P. Pandey, “Characterising cement-superplasticiser interaction using zeta potential measurements”, Const. & Build. Mat., Vol. 24, Issue 12, pp. 2517-2521, 2010.
[5] Roshan Tamrakar, Mr. S.P.Mishra, “Experimental Studies on Property of Concrete due to Different Ingredient based Super Plasticizer”, International Journal of Science, Engineering and Technology Research, Vol. 2, Issue 5, pp 1036-1040, 2013.
[6] Sishminder Pal Singh, “Influence Of Superplastisizer On Flow And Strength Characteristics Of Concrete”, International Journal of Advancements in Research & Technology, Vol. 3, Issue 12, pp 72-76, 2014.
[7] E. Tkaczewska, “Effect of the superplasticizer type on the properties of the fly ash blended cement” Const. & Build. Mat., Vol. 70, pp. 388-393, 2014.
[8] F. Kong, L. Pan, C. Wang, D. Zhang, N. Xu, “Effects of polycarboxylate superplasticizers with different molecular structure on the hydration behavior of cement paste” Construction and Building Materials, Vol. 105, pp. 545-553, 2016.
[9] Beata Łaźniewska-Piekarczyk, Patrycja Miera, Janusz Szwabowski, “Plasticizer and Superplasticizer Compatibility with Cement with Synthetic and Natural Air-Entraining Admixtures”, IOP Conf. Series: Materials Science and Engineering, Vol. 245, pp 1-8, 2017.
[10] Antoni, James Gabriel Halim, Owen Chandra Kusuma, Djwantoro Hardjito, “Optimizing Polycarboxylate Based Superplasticizer Dosage with Different Cement Type”, Procedia Engineering, Vol. 171, pp 752-759, 2017.