Compatibility of Cement and Water Reducers with Mineral Admixtures - A Review

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Abstract

The use of various chemical and mineral admixtures in Portland cement concrete alters the hydration process and chemical interaction and leads to unexpected concrete behaviour. Complex chemical interaction between different compositions in cements, chemical and mineral admixtures creates poor cement-admixture compatibility and leads to premature loss of workability. Cement-admixture incompatibility is a major problem in the concrete industry that affects the quality of concrete and construction schedules. A review regarding the need for studying the cement admixture compatibility is summarized in this paper.

Keywords: Compatibility, Superplasticizers, Silica fume

I. INTRODUCTION

Cement-admixture incompatibility is a major problem in the concrete industry that affects the efficiency of concrete placing, the quality of concrete, and construction schedules. This may lead to rapid loss of workability, excessive quickening / retardation of setting, and low rates of strength gain. Moreover, high performance concretes, which are in wide use today, almost always incorporate a mineral admixture or filler such as silica fume, fly ash and limestone powder. Compatibility of these mineral additions to admixtures needs to be studied.

II. LITERATURE REVIEW

Researches on the influence of supplementary cementitious materials (SCMs) on the engineering properties of high strength concrete (HSC) revealed that workability decreases at higher replacement levels of silica fume and metakaolin whereas it increases with increasing levels of fly ash and GGBS. Use of silica fume as partial replacement of OPC provides greater compressive strength than other supplementary cementitious materials[9].

Montes et al. explored the effect of limestone, fly ash and silica fume on Portland cement and the interaction of these additions with naphthalene, melamine, lignosulphonate and polycarboxylate based admixtures. The adsorption isotherms, zeta potentials and rheological behaviour of blended cements were found and compared to the non-blended cements. It was found out that the rheological behaviour of blended cements depends on the physical (specific surface) and chemical (surface charge and reactivity) characteristics of the mineral addition used and the characteristics are affected by the presence of superplasticizers[11].

Prados et al. investigated the interaction between a solid and liquid polycarboxylate superplasticizer and cement with a large amount of high porosity fly ash. Setting time, mini-slump and compressive strength tests on cement pastes showed that use of these superplasticizers improves cement behaviour and fluidity and reduces water demand of cement products. SPC performs better when compressive strength is taken into account whereas LPC provides better results when workability alone is considered[10].

John and Gettu studied the effect of temperature on fluidity, water demand, and setting time of cement paste with and without superplasticizer. Marsh cone and mini-slump test results indicate that the saturation dosage of superplasticizer increases with an increase in temperature, with the polycarboxylate based superplasticizer giving the least variation. It was also observed that the loss in fluidity of the cement paste generally increases with an increase in the ambient temperature and the setting time of cement paste decreases with increase in temperature[4].

Bayasi and Zhou investigated on the properties of silica fume concrete, including slump, air-content, compressive strength, flexural strength, permeability, and permeable void volume and the effect of the silica fume replacement ratio of cement. Results showed that increasing superplasticizer content increases the compressive strength of concrete but reduces the workability. Superplasticizer may cause an increase of silica fume concrete permeability. However, this effect of superplasticizer seems to diminish with high silica fume content[13].

Puertas et al. investigated on the effect of a polycarboxylate (PC) admixture on the mechanical, mineralogical, microstructural and rheological behaviour of Portland cement pastes. Results showed that polycarboxylate admixture retards initial cement
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Compatibility of cement and admixture with mineral admixtures must be studied in order to determine the optimum dosage of ingredients of concrete.

Silica fume provides greater compressive strength than other supplementary cementitious materials.

Increase in superplasticizer increases compressive strength but reduces workability.

Effect of superplasticizer seems to diminish with high silica fume content.

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