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Chemical Shrinkage of Pastes Made with Shrinkage Reducing Admixtures

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Abstract. Shrinkage Reducing Admixtures (SRA) are being used more often in concrete structures in order to better control shrinkage cracks. High-performance concrete, nowadays with large application, has more proneness to crack at very early age due to the lower W/C. In this type of concrete, autogenous shrinkage is usually more important than drying shrinkage. Autogenous shrinkage is due to the volume decrease inherent to binder hydration reactions. The rate of these reactions is influenced not only by the type of binder but also by the presence of chemical admixtures. It is recognized that SRA delay the hydration, being a secondary effect of this type of admixtures. In this work changes on the degree of hydration of cement pastes with SRA and different binders are presented, using the chemical shrinkage test.

Introduction

Shrinkage Reducing Admixtures (SRA) are being used more often in concrete structures in order to better control shrinkage cracks. These products are easily available and are effective in decreasing shrinkage [1-5]. According the literature, the main mechanism of these products for decreasing shrinkage is the decrease of surface tension on the interstitial liquid present in the concrete pores. Indeed, SRA decrease the surface tension when mixed with water. According Laplace's law, Eq. (1), for the same capillary pore radium r, and perfect wetting $\theta=0^o$, lowering the surface tension σ, decreases the liquid pressure p_l, and, consequently, the stresses in the solid body also decreases (p_g is the gas pressure).

$$p_g - p_l = \frac{2\sigma}{r}\cos\theta\,. \tag{1}$$

This equation applies for pore capillary partially filled, when the balance is achieved in interfaces solid-liquid-gas [6]. Assuming this mechanism as the main cause of shrinkage for pores with high relative humidity, say, 80 %, SRA are very useful to control shrinkage in high-performance concrete (HPC).

Nowadays this type of concrete has large application, and has more proneness to crack at very early age due to the lower W/C. For HPC, autogenous shrinkage is usually more important than drying shrinkage since the drying is reduced due to lower water content and the more closed pore system. Autogenous shrinkage is high at early age, precisely when the concrete strength is low.

Autogenous shrinkage is due to the volume decrease, inherent to binder hydration reactions. This volume decrease in the solid state is mainly due to water consumption by hydration, which, for low W/C, originates desiccation. So, the autogenous shrinkage depends on rate of hydration and on the