



Durability of concretes containing ground granulated blast furnace GGBS against sulfate attack

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ABSTRACT

Ground granulated blast furnace GGBS (GGBS), a by-product of the steel manufacturing industry, being used as an effective partial cement replacement material, has already been proven to improve several performance characteristics of concrete. The reactivity of GGBS has been found to depend on the properties of GGBS, which varies with the source of GGBS, type of raw material used, method and the rate of cooling. In this paper cement replacement levels of 35%, 42.5% and 50% were selected to study the effects of GGBS on compressive strength and sulfate resistance in concretes. Two tests were used to determine the resistance of GGBS concrete to sulfate attack. These tests involved immersion in 5% sodium sulfate solutions. Furthermore, compressive strength of concrete mixtures that keep in water and sodium sulfate were determined at ages up to 180 and 270 days respectively. Also mass change of concrete mixtures were determined. The experimental results show that at later ages GGBS concrete that keeps in water got closer compressive strength to control concrete. After 270 days of exposure to the sodium sulfate solutions, in mixtures containing 50% GGBS replacement by Portland cement had rather growth compare to 35% GGBS replacement by Ordinary Portland Cement (OPC).

Key word. Ground granulated blast furnace GGBS, mechanical properties, durability, sulfate attack

1. INTRODUCTION

It is a well-known fact that the causes of damage in concrete are freezing, water penetration, chemical degradation and erosion. Therefore, it is important that durability of concrete be enhanced. This can be accomplished by some additives which improve the properties of both freshly mixed concrete and hardened concrete by pozzolanic reaction. Benefits of using additional binder materials on the durability of concrete are well established. High-performance concrete may contain materials such as fly ash, silica fume, ground granulated GGBS, natural pozzolana, fibers, chemical admixtures and other materials, individually or in various combinations. These materials can enhance the strength and durability of concrete, simultaneously, rendering them recommendable for use in concrete industry. Also It is an efficient procedure for the cement industry in order to decrease CO₂ emissions, which represents about 5% of the total anthropic emissions in the world [1]. In addition, it can contribute to save natural resources, recycle by-products and preserve the environment. Ground granulate blast furnace GGBS (GGBS) is a by-product from the iron industry; it is one of the most commonly used additions in the cement industry. According to the manufacturing process, GGBS is a quite variable material due to the variability of its chemical composition. Offering latent hydraulic properties when mixed with clinker cement, hydration of GGBS is directly related to its hydraulicity: the dissolution of GGBS glass fraction is ensured by hydroxyl ions (OH⁻) resulting from the hydrolysis of Portlandite Ca(OH)₂ produced by the hydration of clinker [2,3]. The hydration products formed in the cement matrix are mainly additional hydrated calcium silicates and aluminates (CSH, CAH). The resulting hydrated cementitious matrix presents good chemical resistance and a more refined pores structure [4,5]. Therefore the mechanical performance and durability of concrete are improved.