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Comparison of glass powder and pulverized fuel ash for improving the water resistance of magnesium oxychloride cement

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Abstract: The water resistance of magnesium oxychloride cement (MOC) incorporating glass powder (GP) and pulverized fuel ash (PFA) with and without CO_2 curing was investigated in terms of the strength retention coefficient and the volume stability. The microstructure was studied using quantitative X-ray diffraction (QXRD), thermogravimetry (TG), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The results show that the effect of incorporating GP on the water resistance is much lower than that of PFA due to the lower pozzolanic activity of GP generating a lower amount of magnesium silica hydrate gel (M-S-H gel). The MOC incorporated with GP or PFA showed high water resistance after CO_2 curing due to the higher quantity of amorphous gel that formed a much denser interlocking network.

Keywords: Magnesium oxychloride cement (MOC); CO_2 curing; microstructure; gel formation; water resistance

1. Introduction

Magnesium oxychloride cement (MOC) is formed by mixing magnesium oxide with an aqueous solution of magnesium chloride. This is a potential cementitious material used for fire protection[1], grinding wheels[2, 3] and industrial flooring[4] due to its better performance over conventional Portland based cements, such as good fire resistance[5], good resistance to abrasion[6] and low thermal conductivity[7]. Besides, it does not need wet curing and provides a high early strength[8].

However, its application is mainly limited by the instability of MOC in water[9, 10]. It was reported that the residual compressive strength of MOC paste cured for 15 days in a dry environment was reduced by about 90% after additional 28 days of immersion in water[9]. The reason is that the main hydration products in MOC, Phase 5 ($5Mg(OH)_2•MgCl_2•8H_2O$) and Phase 3 ($3Mg(OH)_2•MgCl_2•8H_2O$), are unstable in water and progressively decompose to $Mg(OH)_2$ and other soluble ions, thus leading to the significant decrease of compressive strength[11]. Adding water-soluble phosphate was considered to be a simple and efficient method to improve the water resistance. The compressive strength of MOC paste hardened in air for 28 days decreased only by 15.5% after 3 months of water immersion after the addition of 0.5% H_3PO_4 and 5% K_3PO_4 (by weight of mixture of additives and magnesia)[12]. However, adding additives increases the cost of MOC based products. On the contrary, the