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Cellulose ethers influence on water retention and consistency in cement-based mortars

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ABSTRACT

Cellulose ethers (CE) are commonly used as additives to improve the quality of cement-based materials. As admixtures, they improve the properties of mortars such as water retention, workability, and open time. Also, polysaccharides such as starch derivatives are used to improve the consistency of the fresh material.
The properties of cement-based mortars at fresh state were investigated. The effect of CE and their physico-chemical parameters (molecular weight, substitution degrees, etc.) on both water retention and rheological properties of mortars were studied. Moreover, some starch derivatives were also examined in order to better understand the water retention mechanisms.
Rheological measurements showed that CE have a thickening effect for a content of 0.27 wt.%. Besides, a fundamental effect of CE molecular weight on mortar consistency and its water retention capability was highlighted. Finally, the comparison with starch ethers proved that, for those admixtures, water retention is not directly linked to mortar's viscosity.

1. Introduction

Factory-made mortars have been mostly implemented as masonry renderings, fixing tiles, self-levelling floors and so on. When mortar is applied on substrate, water may be absorbed by the substrate. This phenomenon can induce insufficient hydration of cement, and thus decrease mechanical properties of the mortar. Water retention capacity of a mortar is thus a key element when choosing an appropriate formulation as a function of the substrate, climatic conditions, and industrial applications of the mortar, etc.

A wide variety of chemical admixtures are present in industrial mortars currently used in construction. They are classified according to the function they perform, e.g. air entrainment, water retention, set retardation or acceleration, etc. [1] Among the organic admixtures widely used in mortar and concrete, polysaccharides are polymers that can be classified as water reducer, set retarder, anti-washout and water retention agent [1,2]. Many authors demonstrated that mortar and concrete properties can significantly be modified at both the fresh and hardened states by the addition of polysaccharides [3–6]. Among all polysaccharides, cellulose ethers are commonly introduced into industrial mortar formulations in order to provide some required properties to the mortar, from the fresh paste to the hardened material [7]. These cellulose derivatives are suitable molecules to improve water retention and workability of the fresh material, together with adhesion to the substrate [3]. However, the major drawback of these macromolecules in mortar formulation is the cement hydration delay [2,6,8]. Pourchez et al. highlighted various delays on cement hydration induced by cellulose ethers (from 10 min up to several hours) [9,10]. This delay seemed to mainly depend on the chemical structure of the molecule and, in particular, on the degree of substitution.

When the support material absorbs water, this can induce insufficient hydration of the cement and therefore provoke a loss in mechanical performances. Water retention is a mortar property that prevents the rapid loss of water to the substrate by suction. This property avoids bleeding or “water loss” when the mortar is in contact with relatively permeable surfaces. Water retention is a fundamental property, which affects workability and bonds between mortar and masonry. Water-retaining agents, also known as thickening or viscosity enhancing additives, are essential components in mortar formulation because they also reduce segregation and improve workability. However, they can slightly reduce compressive strength

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