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Effect of Mixing Rate of Plaster with Water on Properties of Gypsum Plaster

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ABSTRACT:
Gypsum plaster is a widely used building material, as it is inexpensive and mechanically strong and to make gypsum model for ceramics manufacture as modelling material. When in contact with water, calcined gypsum rehydrates through dissolution, nucleation and crystallization steps. In this work, the mixing rate of plaster with water was investigated on their effect on the properties of hardened gypsum pieces, focusing on the structure–function relationship. The mixing plaster with water was done at 120, 240, 360 and 600 rounds per minute with a constant water/ plaster ratio of 0.77. The results showed that with increasing mixing rate, the setting time decreased and the mechanical strength of the hardened piece increased. The apparent porosity, water absorption and water diffusion coefficient of the hardened piece decreased with increasing mixing rate. The microstructure of gypsum with the high mixing rate not only seems to be denser, with crystals interlaced, but also shows short crystals, which may improve the mechanical strength of the specimen. The higher mixing rate can lead to the higher rate of the nucleus formation, the smaller crystals and denser structure are formed. This material can have higher strength.

Key words: Gypsum plaster, Mixing rate, Setting time, Strength, Microstructure.

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1- Introduction

Gypsum is a calcium sulfate dehydrate mineral that occurs in several regions around the world with a wide variety of industrial applications. It can be used in its natural or dehydrated form. The hemihydrate (CaSO4.0.5H2O) is obtained by thermal dehydration from calcium sulfate dehydrate (CaSO4.2H2O) in rotary kilns [1-2]. Dehydrated calcium sulfate shows the peculiar facility to lose and recover water due to crystallization. During the calcination process, it loses 3/2 of water due to crystallization, and changes into calcium sulfate hemihydrate (CaSO4.0.5H2O), as shown in reaction (1):

$$CaSO_4.2H_2O \rightarrow CaSO_4.0.5H_2O + 3/2\ H_2O \quad (1)$$

When in contact with water, however, the hemihydrate rehydrates back to the dihydrate form as shown in reaction (2)[3]:

$$CaSO_4.0.5H_2O + 3/2H_2O \rightarrow CaSO_4.2H_2O + heat \quad (2)$$

The hemihydrate in contact with the mixing water forms a saturated solution of Ca2+ and (SO4)2− ions. During the induction period, the first nucleation points occur (forming the first dihydrate crystals). Due to the fact that dehydrate crystals are less soluble than the hemihydrate, they accumulate in the medium until reaching a critical number of crystals, starting the setting time. With continued formation of crystals, the medium becomes saturated of crystals, hardens and acquires mechanical resistance [3-4]. The water/plaster ratio is a parameter of influence on the kinetics of hydration reaction and consequently on the plaster setting time. However, other factors as water temperature, raw material and the procedure used on the plaster production as well as the