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Mineralogical Assessment Regarding the Sustainability of Mortars Exposed to Sodium Sulfate Attack

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Abstract

The paper presents the mineralogical analysis in XRD and thin sections of three types of mortars, before and after immersion in a salty solution of sodium sulphate decahydrate (Na2SO4•10H2O). The proposal of the study it was to identify the chemical transformation of minerals, and the degree of mortars decay after 15 cycles of immersion in salty solution. These studies highlights the role of mineralogical analysis in conservation of building materials in order to avoid their deterioration when are exposed in aggressive environment.

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Keywords: XRD analysis; thin section; salt attack; minerals.

1. Introduction

Crystalissation of soluble salts in the pores of building materials with low density, can affect their sustainability and durability during constructions' lifecycle [1-8]. The scientific researcher's shows [9-12] that the chlorides effect can be less disruptive and produce lower disintegration of materials in respect to that reported in case of sulphates.

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The sulfate attack can be observed in numerous buildings (especially made of masonry works), directly as efflorescence on materials surfaces (rendering or masonry units), sub-efflorescence under the finishing (rendering) or as crypto efflorescence inside the pores of component materials (mortars and masonry units) [3-7].

At material level, chemical reactions can take place due to hydration product (calcium hydroxide, portlandite and alumina) which in the presence of water reacts with sodium and magnesium sulfate to form calcium sulfate (gypsum), delaying ettringite and thenardite [12-16].

The mineralogical content and chemical compound highlights the minerals transformation [15, 16], and their interaction with salt crystals.

The objectives of the study, it was to develop a new mortar recipe with improved physico-mechanical characteristics to resist to salt attack and to be used as an alternative to classical materials. In order to determine the sulfate attack on building materials have been realized 3 type of mortars recipe: sample 1 – mortar based on natural pozzolanic materials as substitute of cement in 50%, samples 2 and 3 - mortars based on natural pozzolanic materials as substitute of cement in 50%, with additives like plasticizer respectively air-entraining.

2. Materials and Methods

The study was performed on cubic samples of mortars, with dimension of 4x4x4cm. The test consisted in total immersion of samples for 2hours in a saturated solution of Na_2SO_4, 14% decahydrate (14g $Na_2SO_4 \cdot 10H_2O$ to 86g of deionized water). After immersion the samples were dried to constant weight in a ventilated oven at a temperature of 105ºC.

All samples were analyzed from mineralogical and petrographical point of view. The mineralogical content, the transformations and alteration processes were examined under transmitted light microscope in thin sections prepared according to STAS 6200/3-81 [17].

The X –ray diffraction (XRD) were recorded on BRUKER D8 Advance X-ray diffractometer, working at 45kV and 45mA. The $Cu_{K\alpha}$ radiation, Ni filtered was collimated with Soller slits. A germanium monochromator was used. The data of the X-ray diffraction patterns were collected in a step-scanning mode with steps of $\Delta 2\theta = 0.01°$. Pure alumina powder (standard sample) was used to correct the data for instrumental broadening.

3. Results and discussion

A partial disintegration of the samples at the corners was observed since the 5th wet-drying cycle. On the surface and in the pores began a progressive accumulation of salts from one cycle to another, consequently resulting an increases of mass for dry samples.

The X-ray diffraction patterns performed on samples are presented in figures 1-3.

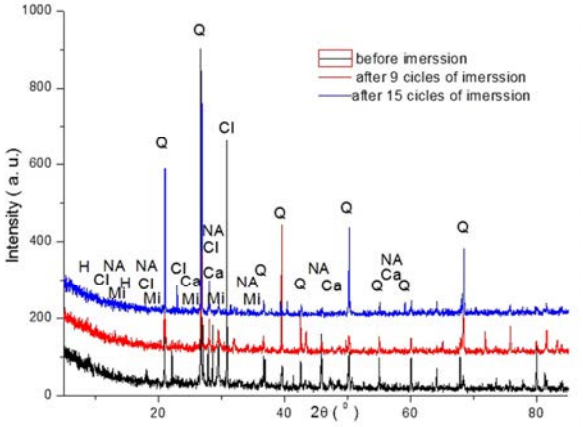

Fig. 1. The XRD pattern of sample 1