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Morphological and microstructural analysis of macropores in cement-based composites.

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Resumo: Air-entraining admixtures (AEA) introduce small air bubbles homogeneously dispersed in cement-based composites. This effect promotes several morphological changes that affect their physical and mechanical properties. Therefore, the present work presents and evaluates the morphological and microstructural aspects of the use of a biodegradable anionic surfactant, the Linear Alkylbenzene Sodium Sulfonate (LAS), as an AEA. To this end, mortars (1:3:0.48) comprising increasing dosages of LAS-based AEA were produced, and their pore system was evaluated. Mortars with no admixtures were also produced, for comparison purposes. To obtain images of the pore systems, we used High Resolution Scanner, Optical Microscopy and Scanning Electron Microscopy. The morphological analysis was associated with physical and rheological properties. Results show the pore system and the effects of low, medium and high concentrations of AEA on the matrix. Therefore, this work contributes to a better understanding of the physical effects of the addition of AEA to cement-based composites.

Palavras-Chave: *Air Entraining Admixtures; Cement-Based Composites; Morphological Analysis; Pore System*.

INTRODUÇÃO

Air-entraining admixtures (AEA) introduce small air bubbles homogeneously dispersed in cement-based composites. In the fresh state, they improve workability and cohesion; reduce the w/c ratio, segregation and bleeding. In the hardened state, the voids reduce water capillarity and the specific gravity, while increasing thermoacoustic insulation and resistance to freezing [1,2]. Most AEAs are surfactant molecules, formed by a hydrophilic group and a simple hydrophobic branching. At the interface between the cement particles and the air, they promote the formation of bubbles and avoid the tendency of bubbles already formed to coalesce or to undo [3].

In the hardened concrete there are 3 classes of pores: gel pores (< 10 nm), capillary pores (5 nm - 5 μm) and air-entrained voids (> 5 μm). Not only the size of pores, but also the porosity of the hydration shell immediately surrounding them are important parameters [4]. It is believed that this shell prevents the diffusion of gas into the surrounding fluid when voids are formed. The diffusion would lead to a decrease in the number of small voids and increase in formation of larger voids, harming the mechanical properties of the composite. Therefore, the present work evaluates the morphological and microstructural aspects of different AEA concentrations in mortars.

MATERIAIS E MÉTODOS

To determine the influence of AEA, mortars (1:3:0.48) were produced according to NBR 7215. The materials used were: Portland cement CP-II-F-32; Fractions of regional river sand; Potable water; and LAS-based AEA. The AEA dosages varied from 0.0005% to 0.8% over the mass of cement (wt%). The analysis of the void system was performed by a High Resolution Scanner and a Scanning Electron Microscopy (SEM). After polishing, samples were scanned into an HP Scanjet G4050 scanner (2400 dpi). Analysis of the pore size distribution was aided by a computational tool. SEM images were obtained by means of secondary electrons with a VEGA3 Tescan equipment. The SEM was performed at Nanolab, UFOP.

RESULTADOS E DISCUSSÕES

Figures 1 and 2 show that, for mortars with low AEA content (< 0.02%), the matrix is mostly intact, with a small amount of relatively small, disperse pores (above 90% less than 100 μm). Intermediate values of AEA (up to 0.2%) present a greater number of pores, with varied and well distributed sizes. Finally, mortars with high AEA content (above 0.2%) exhibit voids of all sizes; and in such proportion, that almost no fragment of dense structure is observed.

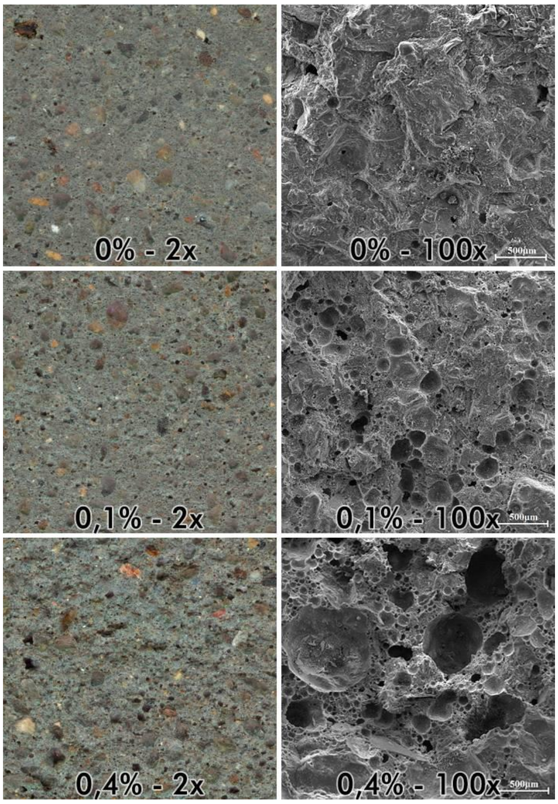

Figure 1. Scanner and SEM Images of mortars

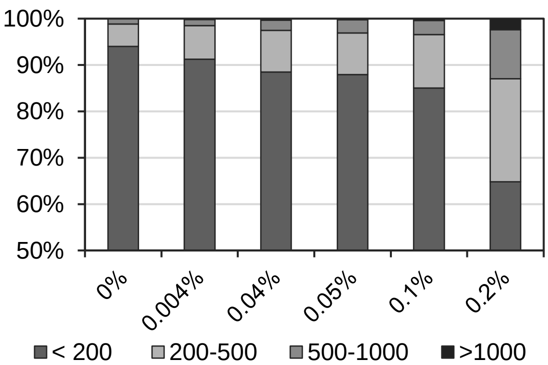

Figure 2. Proportion of pore radii, in μm

The pores of mortars with high AEA content also presented a great volume of cement hydration products in their interior (Figure 3). This was probably due to the increased permeability of the hydration shell. This factor possibly contributed to the increase of the larger pores in the matrices with high content of AEA and could compromise the mechanical strength and durability.

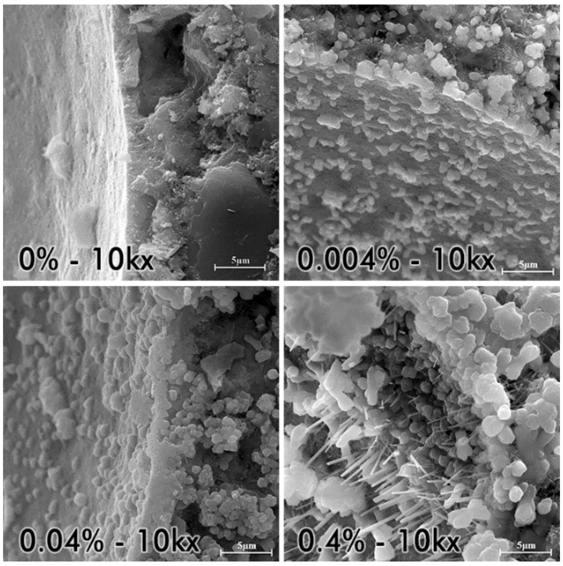

Figure 3. SEM images of mortars – 10.000x

CONCLUSÕES

As conclusion, with the increase in AEA content, there is an increase in the pore volume and their average size. The ideal pore system would be equivalent to an intermediate content. Thus, this work emphasizes the importance of adequate dosing and handling of AEAs for concretes and mortars.

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REFERÊNCIAS

[1] Ramachandran, V. S. Concrete Admixtures Handbook. 2a. ed. New Jersey: Noyes Publications, 1995

[2] Mendes, J. C. et al. Mechanical, rheological and morphological analysis of cement-based composites with a new LAS-based Air Entraining Agent. *Construction and Building Materials* 145, 648–661, 2017

[3] Du, L.; Folliard, K. J. Mechanisms of air entrainment in concrete. *Cement and Concrete Research*, 35, 1463–1471, 2005.

[4] Ley, M. T. et al. The physical and chemical characteristics of the shell of air-entrained bubbles in the cement paste. *Cement and Concrete Research*, v. 39, p. 417-425, 2009