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Transport of Moisture and Chlorides into Sprayed Concrete

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1 Introduction

This contribution is a study of the durability and transport properties of sprayed concrete used at an actual construction site. It considers whether concrete spraying can generate different porosities as the thickness of the sprayed layer increases. This study conducted a characterization of the physical, mechanic, and durability properties of sprayed concrete with two goals in mind. The first is to determine if, when studied by layers, sprayed concrete shows different transport properties depending on its proximity or direct contact with the projected surface. The second is to study the impact of the presence of chlorides introduced by moisture via the sprayed concrete's transport mechanisms to determine potential durability issues.

2 Materials and Methodology

This study was conducted with wet-mix sprayed concrete, using a CEM I 52,5 R, water/cement ratio of 0,35, and 450 kg /m3 of cement, a superplasticizer type MASTERCLENIUM SKY 554-BASF, and the accelerating additive MasterRoc SA 172.

Figure 1. Extraction of sprayed concrete specimens (a) and division of samples into part A and part B.

The wet mix concrete was sprayed on 4 mm-thick metallic test panels located at an ongoing construction site, using 7-15 m3 air pressure per minute at a 90° angle, and maintaining a 0.5 – 1.5m distance to ensure all samples would be sprayed with similar speed, compaction, and adherence. After the spraying, the mixes were left outdoors for 28 days to simulate the environment to which they would have been exposed to at the construction site. After the initial 28 days, the next step was to extract 7.5 cm diameter cores (cylindrical specimens) from the test panels, and divide each sample into two equal parts of 5 cm each, which were called parts A and R. Part A is the first layer, which under real conditions would have been in contact with the terrain. Part R is the second layer, which is adhered to the first layer and has a surface that was used to simulate exposure to open air. The test was conducted following the standard ASTM C642. The capillary suction tests were conducted under the standards of norm ASTM C1585-04. The chloride determination test was based on the NT BUIL 443 method. Each specimen was cut through the layers of A and R, to study the penetration properties of each layer separately. The results from the chloride penetration tests are presented as the average of two A samples and two R samples at 35, 60, and 90 days. This test did not consider the troughs from which each sample originated. However, both samples A and R came from the same specimen.

3 Results

This study concludes that the samples used for the density tests show slightly different behaviors compared to the ones used at the capillary suction tests. However, these differences are not relevant. Also, the distribution of aggregates in concrete generates a difference in the mechanical properties of the different samples tested, but this difference does not show a significant impact on the moisture or chloride transport properties. On a microstructural level, there are no significant physical differences between shot concrete sample parts A and R. Both parts present a porosity network of similar characteristics. The samples of shot concrete analyzed in this study exhibited larger pore interconnectivity compared to regular concrete, which proved to increase the speed of diffusion of chlorides. This indicates that shot concrete is more vulnerable to chloride penetration than regular concrete. The high level of concordance of the results obtained from different tests indicates that A and R behave similarly under a chloride attach when completely saturated.

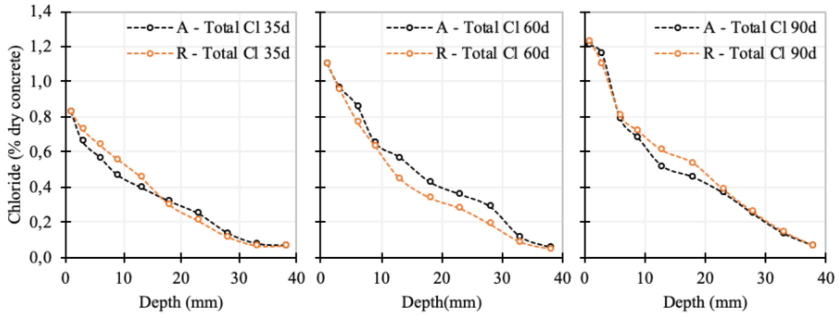

Figure 2. Chloride profiles at 35, 60, and 90 days of samples.

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