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Long-term Measurements on Chloride Ingress in Water Repellent Treated Concrete in a Road Tunnel Environment

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Abstract

A heavily trafficked tunnel in the Swedish capital Stockholm (The Eugenia tunnel), that is exposed to de-icing salts during at least four months a year, is used as a field exposure site for a project aiming to evaluate the performance of a water repellent treatment over time. Chloride profiles are being measured once a year and data for three years have been obtained so far. Monitoring of humidity and temperature inside as well as outside the concrete samples is considered for a later stage of the project. Figure 1 shows photos from the tunnel and the samples placed inside.

Figure 1: The picture on the left side shows a web camera photo of the traffic going into the Eugenia tunnel. The photo on the right side shows water repellent treated (light) and untreated (dark) samples before they were placed at the field exposure site in the tunnel.

The cubic samples, of 75 mm side length, were cut from 150 mm concrete cubes with a water-cement ratio of 0.45. Five sides of the cubes were sealed with neoprene film in order to ensure uni-dimensional chloride ingress, while the exposed surface was treated with isooctyltriethoxysilane in liquid form. The effective penetration depth of the water repellent agent was 2-3 mm which is the minimum penetration depth required by the Swedish road administration. The samples were then placed inside the tunnel in November 2004 at a field exposure site located some 50 m from the entrance. One treated and one untreated sample is analysed every year. The measurement of the chloride content was carried out with an ion-selective-technique. In order to relate the content of chloride to the amount of cement gel, the results are expressed as percentage of cement weight. The mass of cement was calculated after a Ca-titration with EDTA. Figure 2 shows the penetration profiles after one and three year exposure.

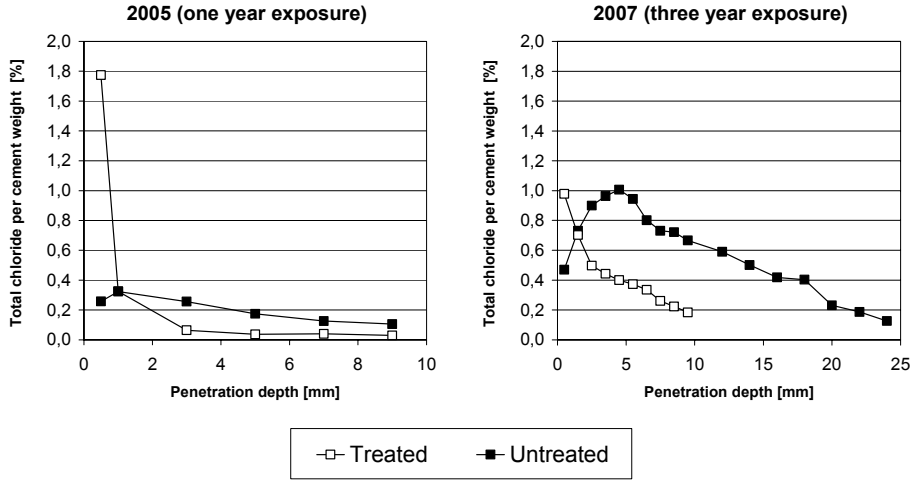

Figure 2: Chloride penetration profiles after one and three year exposure in the tunnel.

The water repellent treatment reduces the chloride ingress significantly. It can also be seen that the so called “wash out”-effect, normally caused by rain but inside this tunnel caused by splashing water from the cars, has no apparent effect on the treated samples. The chloride concentration reaches its maximum closest to the surface for the treated samples while the peak for the untreated is shifted some five millimetres inside.

From the results obtained so far, it is clear that the chloride ingress is reduced by the water repellent treatment but longer exposures are needed before any conclusions can be drawn about the service life of the water repellent treatment.

Keywords: chloride ingress, de-icing salt, durability, water repellent treatment, silane