Promat

EXPERT SUMMARY

Chloride penetration resistance of fire protection boards from Promat

04/090/2

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CONTENT

General

For reasons of traffic safety, de-icing agents (de-icing salt) are often sprinkled on the streets in the winter months. Melted water contaminated with de-icing salt is transported to the surfaces of engineering structures (bridges and tunnels) in the form of spray water and spray mist. These de-icing salts have a damaging effect on the exposed surfaces, and given a respective concentration they can cause reinforcement corrosion. The result is corrosion-related cracking and concrete spalling. In 2001, around €0.4 billion was spent on maintaining the engineering structures in the federal road network alone, half of which was for repairs caused by corrosion, [I], [2].

The Promat GmbH, Ratingen, and the engineering office Prof. Schiessl, Munich, has reviewed protective systems with the PROMATECT-T and PROMATECT-H tunneling boards for chloride resistance on concrete and evaluated the resistance for a stress period of around 50 years, cf. DIN 1045:2001, [3] the usual service life of reinforced concrete structures.

Resistance Studies

According to the regulations currently in force, proof of sufficient durability must be provided either by following prescriptive standard requirements, confer DIN 1045:2001, or by means of an explicit performance record. Within the scope of this performance record, it is checked whether the measured material resistances, which usually is described by the characteristics of penetration resistance (diffusion coefficient) and concrete coverage , offers an adequate resistance to the expected damaging environmental impact, confer DIN Technical Report 100, [4].

The explicit proof of sufficient performance can be carried out via a fully probabilistic reliability analysis (confer also [5]). The reliability is characterized by the so-called reliability index β, which is linked to certain probabilities of occurrence p_f. A reliability index β = 0 is linked to a probability of occurrence of p_f= 50%, a reliability index β = 1.28 is linked to a probability of occurrence of p_f = 10%. For service conditions, such as in normal buildings, a reliability of β = 1.5 is usually required, which corresponds to a probability of failure of p_f = 7%. confer [6].

The engineering office Prof. Schiessl conducted the examination of the resistance to chloride-induced corrosion on the PROMATECT tunnel construction boards and carried out a durability calculation for this.

Scope of Application

The area of application was examined in which the PROMATECT tunnel construction boards are in direct contact with the concrete. When lining the tunnel, the boards are to be fixed to the concrete with sufficiently corrosion-resistant fasteners, dowels or screws, or placed directly in the formwork and concreted over.

Exposure to spray mist was assumed (exposure class XD 1 according to [3]).

Evaluation of the resistance to chloride-induced corrosion when placing the PROMATECT Tunnels Boards directly on the reinforced concrete

The evaluation included Portland cement concrete with cement CEM I and blastfurnace concrete with cement CEM III/B, both clad and unclad with PROMATECT tunnel boards.

In the probable first case it is assumed that the concentration of chloride on the surface of the reinforced concrete is halved by the PROMATECT tunnel boards fixed to the concrete. Compared to unclad concrete, halving the chloride surface concentration leads to a significant increase in the reliability index β - for concrete with CEM I, β is calculated after 50 years as 2.7 (from the original β = 1.8) and for concrete with CEM III/B at 3.9 (from the original β = 3.0).

In the other, improbable second case, the unfavorably chloride surface concentration is assumed to be twice as high compared to the unclad variant. This is linked to a reduction in the reliability index. After 50 years, the reliability index β for concrete with CEM I β = 1.4 (originally β = 1.8). In the case of a concrete with CEM III/B, this expected reduction cannot be demonstrated mathematically, β = 3.0 (from the original β = 3.0). I.e., also taking into account extremely unfavorable assumptioned,improbable circumstances, the reliability of the cladded structure against chloride-induced reinforcement corrosion is not significantly reduced.

Summary

If PROMATECT tunnel boards are attached directly to the concrete surface, it can be assumed that the covered reinforced concrete components will be subject to almost diffusion-controlled conditions over the entire concrete cover area, which is completely different to unprotected reinforced concrete components, where the wet-dry cycles can cause capillary suction transport.

From the test results in connection with the spray mist exposure, it can be deduced that direct cladding of the PROMATECT tunnel construction boards to the reinforced concrete structure is possible, since even under unfavorable assumptions the doubling of the chloride surface concentration compared to unclad components, the reliability of the cladded components is hardly below the reliability required in [6]
If the assumption is favorable, the chloride surface concentration on the concrete surface could be halved due to the cladding. This would be accompanied by a considerable increase in reliability. In the case of concrete with a high chloride resistance, the calculated reliability for PROMATECT tunnel boards fixed directly to the concrete is far above the normatively required reliability.

Under the assumptions made above, structures covered with PROMATECT tunneling boards exposed to spray mist have a sufficiently high durability against chloride-induced reinforcement corrosion. Compared to unclad structures, it is to be expected that the service life of cladded structures against the effects of chloride is to some extent significantly prolonged.

Literature

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