THE MAGAZINE OF THE CONCRETE SOCIETY

CONCRETE

Volume 58, Issue 8 October 2024

HOW LOW CAN YOU GO?

The latest technologies, projects and opinions in the drive towards low-carbon construction.

CELEBRATING 200 YEARS

The invention of Portland cement and Joseph Aspdin's 1824 patent

SPRAYED CONCRETE

Lowering the carbon impact of tunnel linings

(Photo: Rizzani de Eccher.)

Mitigating corrosion of post-tensioning tendons before grouting

Ash Hasania, **Ivana Liposcak** and **Julie Holmquist** of **Cortec Corporation** look at the application of migrating corrosion-inhibiting powder as a solution to protecting PT tendons, especially in winter months.

Corrosion in construction is a global problem that impacts the structural integrity, material durability and profitability of a project. Various types of corrosion that may lead to failures include, but are not limited to, steel reinforcement corrosion, structural steel corrosion, corrosion of metallic anchors and supports, and corrosion of post-tensioning (PT) tendons. The last issue may start right after manufacturing if PT tendons are not stored properly. Corrosion may also occur during shipping and transit if tendons are not properly packed and corrosives sealed out. Finally, PT tendons for bonded systems may corrode after installation if water and salts intrude into the ducts. This happens more prominently in winter months when grouting is delayed due to freezing temperatures, creating a window of time in which it is easier for corrosives to get in contact with PT stands and initiate the corrosion process. Since these tendons are under tension, metal loss due to corrosion could make it easier for them to snap and fail.

WHY DOES PT PROTECTION MATTER?

PT tendons are critical components of the structural system in bridges, parking garages, buildings and more. Their concrete compression offers a variety of advantages such as increasing load-bearing capacity, reducing the number of supports and size of spans needed, allowing for thinner slabs, decreasing cracking and increasing durability. A corrosion failure in a PT tendon can lead to a sudden loss of load-bearing capacity with significant or catastrophic consequences if the remaining tendons are not able to compensate for the lost structural capacity. This may result in significant costs and downtime for repairs, if not complete structural failure.

MAIN IMAGE:
Figure 1 – sections of the Roskilde Fjord Bridge were built off-site and assembled on-site. A grouting delay prompted the application of migrating corrosion inhibitors for PT corrosion protection.

INSET ABOVE:
Figure 2 – Skulte overpass under construction.
(Photo: Cortec Case History 758.)

PT PROTECTION STRATEGIES

Traditionally, emulsifiable oils have been applied for corrosion protection of PT tendons until grouting. While they may provide corrosion protection, these oils cause increased tendon slippage, typically requiring them to be flushed out before grouting. Unfortunately, the introduction of water can cause grout voids, water disposal challenges and tendon corrosion (see Lüthi *et al*[1]).

Migrating corrosion-inhibiting

(Photos: Cortec Case History 758.)

ABOVE:
Figure 3 – Skulte overpass.

ABOVE RIGHT:
Figure 4 – preparing to apply MCI-309 to PT ducts after freezing temperatures delayed grouting.

powder, developed by Cortec, is a solution that protects PT tendons after installation and prior to grouting. This powder can be easily fogged into the PT ducts from one end using a low-pressure air tool. Unlike conventional messy oil injections, application of migrating corrosion-inhibiting powder is completely dry, eliminating the need for water flushing prior to grouting. Once the prescribed amount is applied (500g/m^3 for MCI-309), the vents and ends of the duct can be capped or sealed. After the powder is trapped inside the duct, it begins to vaporise and migrate throughout the void, adsorbing onto ferrous and aluminium metals as a protective molecular layer. Removal is not necessary prior to grouting, as the technology does not detrimentally affect the adhesion between the grout and the tendons, making this method easy and cost-effective.

TESTING AND VALIDATION

Long-term corrosion testing was conducted by the Pennsylvania State University Grouting Laboratory on PT strand specimens to confirm the efficacy of migrating corrosion-inhibiting powder. After one year of exposure, they saw a significant reduction in the amount of corrosion occurring in the treated tubes – one an environmental chamber with a constant temperature of 26°C (78°F) and 95% relative humidity, the other containing salt water (see Schokker and Musselman[2]).

GLOBAL USE

Migrating corrosion-inhibiting powder for PT strands and voids has been, and continues to be, used in many projects globally:

- Roskilde Fjord Bridge, Frederikssund, Denmark, was built to provide an additional route over the Roskilde Fjord, where the only other bridge dates from 1935. Post-tension bridge sections for the 8km (5 mile) dual-carriageway bridge were cast in Poland before transporting them to Denmark for installation. Migrating corrosion-inhibiting powder was applied to the tendon casings to protect PT tendons that were installed but not yet grouted. Since grouting was not performed until 30 days after the segments had been delivered to the construction site, this was an important step toward promoting the integrity of a significant structure.
- The Skulte Overpass, Riga, Latvia – OK Building Materials and Tensa provided and installed a post-tensioned reinforcement system totalling 200 tonnes for the Skulte Overpass. With such a large project, contractors did not expect to complete tendon stressing and grouting in a single construction season but almost reached this goal before freezing winter temperatures set in, forcing them to delay grouting for two to three months. What was appealing about using migrating corrosion inhibitors in this project was that they offered protection but did not require flushing. The powder was applied using conventional compressors.

CONCLUDING REMARKS

Many elements can lead to PT tendon corrosion and migrating corrosion-inhibiting powder represents a powerful line of defence to safeguard post-tensioning tendons. Its formulation, ease of use, versatility and proven efficacy make it a preferred choice for users seeking a reliable solution to mitigate the risks associated with PT corrosion. By incorporating migrating corrosion-inhibiting powder into PT protection practices during construction, contractors can promote safer and more durable structures. C

References:

1. LÜTHI, T., DIEPHUIS, J., ICAZA, J.J., BREEN, J.E. and KREGER, M.E. *Factors Affecting Bond and Friction Losses in Multi-Strand Post-Tensioning Tendons Including the Effect of Emulsifiable Oils*. CTR Research Report, Ferguson Structural Engineering Lab, The University of Texas at Austin, June 2005, available at: *https://tinyurl.com/y47zh78h*.
2. SCHOKKER, A.J. and MUSSELMAN, E. *CORTEC Product Testing: Bond and Corrosion Testing, Final Report*. The Pennsylvania State University Grouting Laboratory, June 2008.