Preservation of historical structures

The repair of two historically important sites in Croatia has been carried out with differing construction chemical solutions.

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Zagreb Cathedral.

The famous Zagreb Cathedral is the tallest and one of the most beautiful buildings in Croatia, which attracts thousands of tourists worldwide. As the most impressive gothic-style sacral building south-east of the Alps, it is characterised by great architectural and historical value. Its construction dates back to 1093 with continued enrichment of the cathedral by famous architects during the following centuries.

Reconstruction of the cathedral in the late 1800s was led by Hermann Bollé, who brought the building to its most recent architectural form in which it stood until the earthquake of 22 March 2020 damaged the cathedral's southern spire. Over the past 30 years, extensive restoration work has been undertaken on the cathedral, with ongoing repairs to this day.

During reconstruction work on the south tower in 2012, damaged steel joints were found surrounding the tower 100mm below the surface at approximately every 3m. Most of the joints were only partially exposed in order to replace the surface layer of stone on the belltower, while the back of the joints remained embedded in stone and lime mortar. The joints were covered with a layer of rust and, in drainage areas, corroded all the way through the cross-section.

In order to define the optimal solution for maintaining or improving the mechanical resistance and structural stability of the tower, the Faculty of Mechanical Engineering and Naval Architecture of Zagreb was called in to examine the joints. At its laboratory, it performed experiments on steel joints removed from the cathedral. It recommended the following course of action:

- remove corrosion from accessible joint connections
- apply corrosion protection to accessible joint connections
- strengthen the joint connections where damage had occurred.

It was suggested to use a minimal range of intrusion to keep the mechanical resistance and stability of the tower structure at their existing levels, while keeping costs at a minimum. Cortec's CorrVerter MCI Rust Primer was recommended for corrosion protection. The rust primer is a water-based product that quickly converts rust into a protective layer and is capable of penetrating into corroded surfaces. It contains a chemical chelating agent that modifies surface rust into a hydrophobic passive layer.

A metal brush was used to remove loose rust from the joints. Then, two layers of the rust primer coating were applied directly onto the metal. A brush was used for

Zagreb Cathedral – damaged steel joints on south tower.

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application on smaller metal joint surfaces, while spray application was used for larger areas. The first coat was applied at a thickness of 100 microns (4 mils). A second coat was applied at a thickness of 75 microns (3 mils). During application, the coating temperature was 13°C (55°F). The joints were then reinforced with steel fishplates that were welded onto the joints and also protected with CorrVerter. The final step was to replace the stones around the joints. With the help of a skilled team and good project management, the entire project was completed successfully with minimal cost and intrusion, as specified. The coating penetrated into the metal and stopped further advancement of the corrosion process.

Renovation of medieval city walls

The town of Ilok, Croatia, is a place of rich history and cultural heritage. The medieval long fortress and royal castle of Ilok are protected historical and cultural treasures of the highest degree, enabling visitors to step into ages long past.

The tower walls have a square floor plan and rest on foundations made of broken stone. These walls are exposed to damaging atmospheric influences and the binding material between the bricks has washed away, leading to brick deterioration. Renovation work on 'tower three' includes strengthening of the foundations, restoration of collapsed parts and injection of cracks.

The project involves the use of corrosion inhibitors to prolong the life of the structure. Cortec's corrosion inhibitor MCI-2005 is added into concrete being used to reinforce the foundation. This amine-carboxylate-based

corrosion inhibitor admixture to protect embedded metallic reinforcement from corrosion in order to extend the lifetime of the walls. MCI-2005 is a water-based, organic corrosion-inhibiting admixture with set-retarding effects. When incorporated into concrete, it migrates towards reinforcement to form a molecular layer that inhibits the corrosion reaction on both anodic and cathodic components of the corrosion cell. In new construction, this protection is quantified by subsequent reduction in corrosion rates when corrosion does initiate. When used with repair mortars and grouts, MCI-2005 not only protects reinforcement within the patch, but also can help protect embedded reinforcement already in place in undisturbed concrete adjacent to the repair. ■

Top: CorrVerter MCI Rust Primer is applied to the joint; the coating has converted the corrosion into a protective layer. Middle: Protection offered with MCI-2005 corrosion inhibitor. Below: Reinforcement of the foundation of medieval city walls with MCI technology.