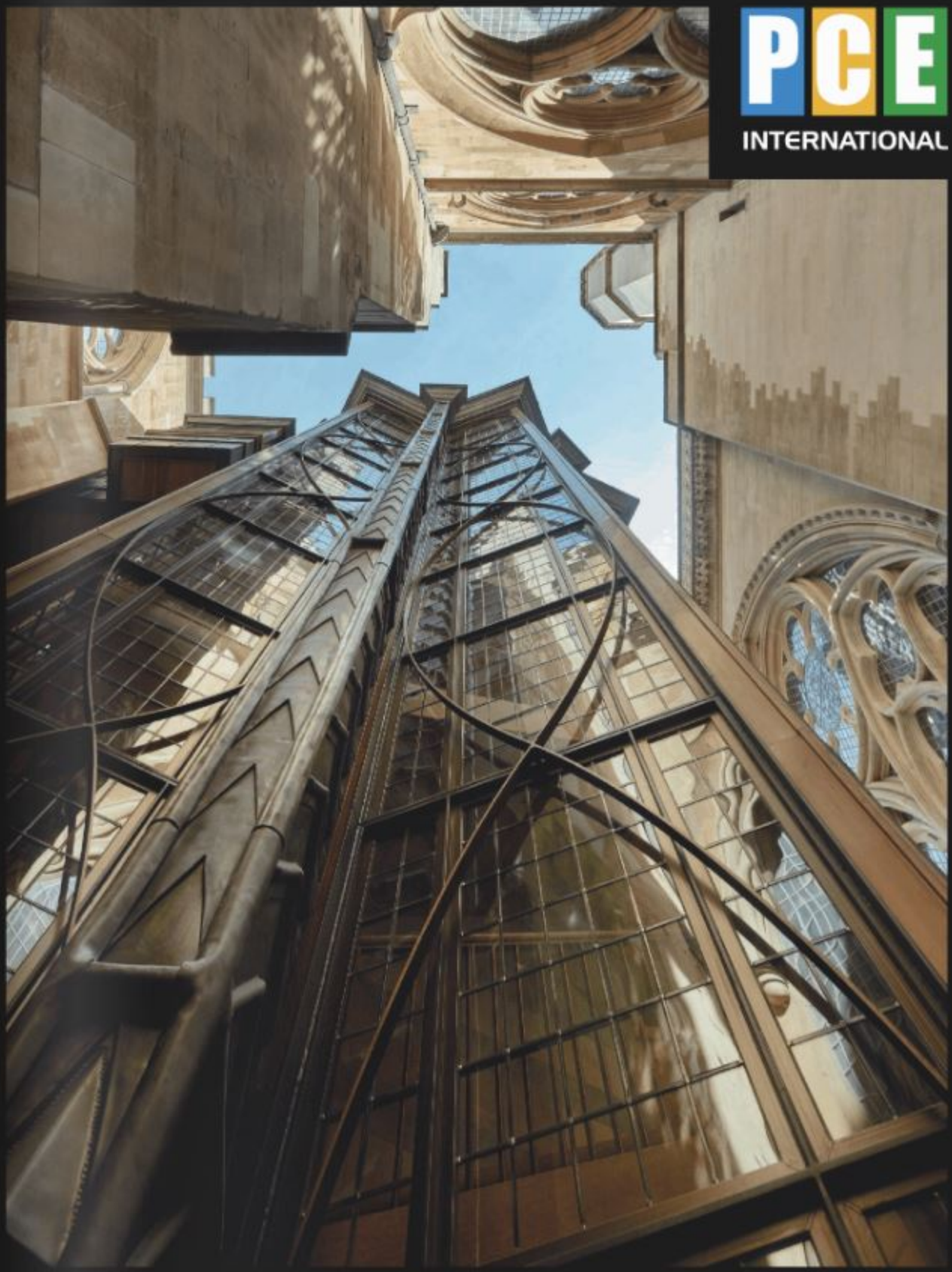

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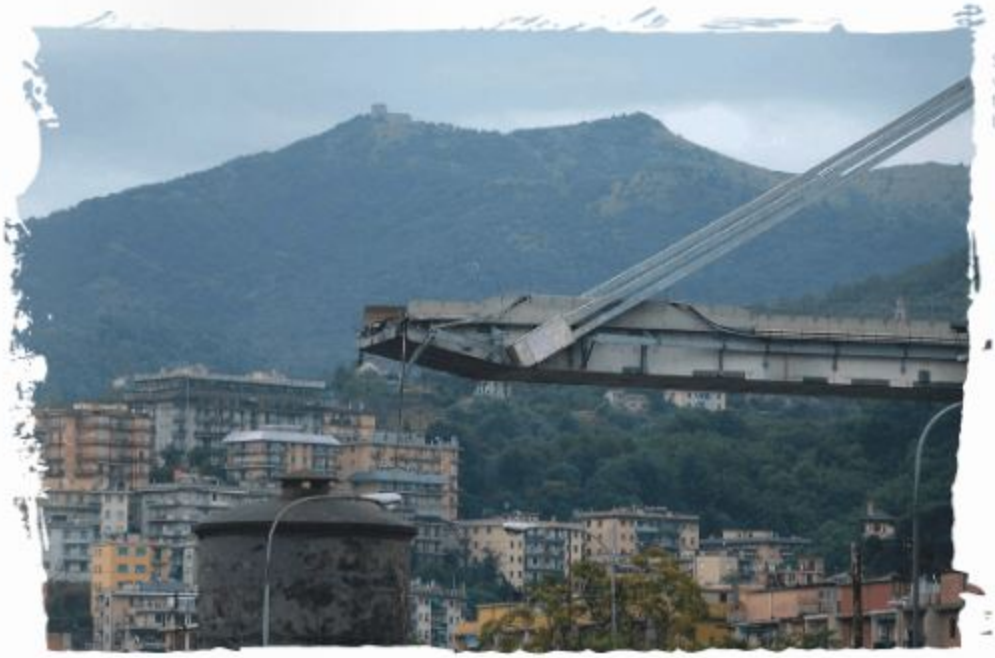


Something went very wrong with the Morandi bridge in Genoa

ACHIEVING SUSTAINABILITY

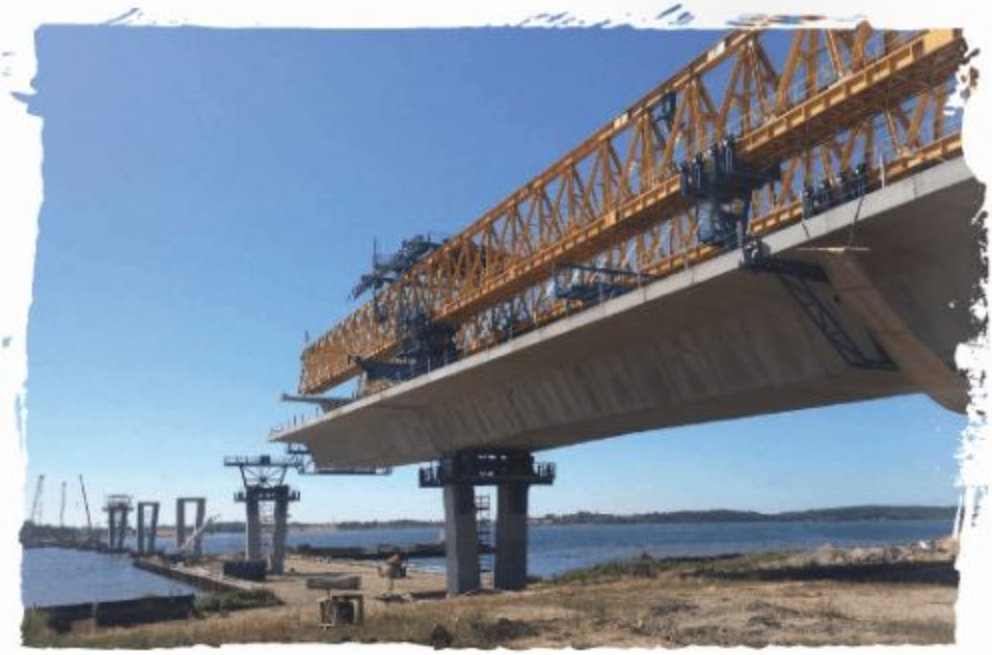
Preventing tragic events, such as structural collapse, by the use of Migratory Corrosion Inhibitor technology

According to engineering regulations, the durability and design lifetime of a structure is around 50 years. Its lifetime can be extended by regular maintenance, otherwise it should be demolished and rebuilt. By using MCI technology in severely corrosive environments, structures will have improved corrosion resistance and therefore longer durability. Increased durability means fewer repairs, enhanced structural integrity and a longer service life, all leading to greater sustainability.

Corrosion is natural force that can be life threatening. Corrosion is huge problem for engineers, as metal products are frequently used in the structures they design, and these corrosion problems can be a safety hazard. Sadly, the recent bridge collapse in Italy demonstrated how neglecting this powerful force can have tragic consequences. Something went very wrong with the Morandi bridge in Genoa, which was completed in 1967.

Engineers had expressed numerous concerns about its unusual concrete-encased common steel cables. The designer of the Genoa bridge warned four decades ago that it would require constant maintenance to remove rust, given the effects of corrosion from sea air and pollution on the concrete. Also, the problem of the fatigue corrosion of metal elements, which is particularly insidious in steels of high mechanical strength such as strands, is still a little-known subject. Morandi Bridge is the fourth bridge that has collapsed over the last few years, and this should be an urgent warning.

"As this reinforced and pre-stressed concrete bridge has been there for more than 35 years, it is very possible that corrosion of tendons or reinforcement is a contributory factor," said Ivana Liposcak, Cortec's MCI Technical Support Manager for Europe. "The long-term sustainability and behaviour of viaducts subjected to heavy traffic and situated in



There are many current cases of using migrating inhibitor technology in projects around the word, such as erecting the new Frederikssund bridge in Denmark

aggressive environments were not known and considered at the time of planning.

Due to the vibration in the concrete, microcracks can occur, through which the moisture ingress can lead to oxidation and corrosion of the steel. In that way the structure loses its strength due to corrosion," explains Liposcak.

CRUMBLING WORLDWIDE INFRASTRUCTURE

In North Carolina in the spring of 2000, a concrete and steel walkway snapped in half as people were making their way back to the parking lot across a bridge.

After an inspection, it was determined that all 11 steel cables that were holding the bridge together were corroded, and the bridge had buckled under the weight. The corrosion was caused by too much calcium chloride, an inorganic salt compound that's highly corrosive to steel, mixed into the grout that cemented the bridge's steel cables in place. Nearly 50 lawsuits were filed against the speedway and the construction company with settlements of millions of dollars.

A report from the American Road & Transportation Builders Association states that more than 15% of that country's bridges are 'structurally deficient'. The difficulty is that concrete, or rather the steel that is used to reinforce it, can fail in a number of ways. Salt, ice and the pounding of weather can cause fractures in the concrete's surface. Once the water reaches the steel reinforcing or tendons, it corrodes them. This enlarges the cracks, which can cause the concrete to fall apart.

"Other factors also compound the deterioration of bridges, such as constant traffic," says Liposcak. "This is a problem for bridges designed 50 years ago, when traffic volumes were lower, cars were smaller and lorries much lighter." Harsh weather conditions, such as heat, cold, floods and high winds buffeting all contribute to corrosion of bridges, which is why regular inspections and maintenance are essential.

BUILDING SUSTAINABLE AND DURABLE STRUCTURES

During last two decades there have been huge advances in technology which should extend the lifespan of structures, thus avoiding such tragedies. One of the most efficient uses of migrating corrosion inhibitors (MCI) are when they are applied directly during the construction phase, as well as when used as part of the maintenance repair system in existing structures. In pre-stressed structures for bridges, MCI's, such as Cortec's MCI 309, are recommended for the protection of the pre-stressed cables before grouting.

Sustainable construction has become a goal for owners across the globe. An often overlooked aspect is the durability and service life of the final structure. However, this is undoubtedly one of the main factors influencing structural sustainability. MCI inhibitors are made

from a renewable raw material, enabling users to earn certain LEED credits.

There are many current cases of using migrating inhibitor technology in projects around the world, such as in the erection of the new Frederikssund Bridge in Denmark. The aim is to replace the old bridge built in 1935, by providing an alternative to the only currently active bridge over the fjord. The project includes the design and construction of an 8km long dual carriageway highway, and a 1.4km bridge over the Roskilde Fjord. MCI 309 is being used for corrosion protection of PT concrete segments.

MCIs are based on amine technology. They are classified as mixed inhibitors, meaning they affect both anodic and cathodic portions of a corrosion cell. MCI is applied in many forms including as a concrete admixture or a topical treatment. It moves as a liquid through the concrete matrix via capillary action and migrates in a vapour phase throughout the concrete pore structure. When MCI comes in contact with embedded metals, it has an ionic attraction to it and forms a protective molecular layer. This film prevents corrosive elements from further reacting with the reinforcement and also reduces existing corrosion rates, greatly extending concrete service life.

MASLENICA BRIDGE

The Maslenica Bridge in Croatia is one of the largest bridges of its type with a 200m diameter arc. Because of the aggressive environment of changing temperatures, constantly fluctuating humidity, and strong wind containing salt from seawater, the reinforcing steel had started to corrode, causing concrete spalling. To restore the bridge and prevent future corrosion from happening, all spalling concrete was water-blasted off, along with dirt and corrosion on the rebar. CorrVerter MCI Rust Primer was brushed on exposed rebar to passivate the metal from further corrosion, and MCI-2020 was applied to the entire concrete structure using an airless sprayer to prevent any potential corrosion that was not apparent.

If the world was made of Lego bricks, building of bridges would be perfected and perhaps they would never collapse. In the real world, every project is different. Geology, weather conditions, volume of traffic, and available construction materials all affect design and construction. Today, we are lucky enough to have huge advances in corrosion protection that can be applied in construction industry. However, we need to utilise them properly for the benefit of all of us. ■