INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY

Molybdenum preserving Venice

For centuries Venice has been fighting nature to keep itself from drowning. It is under attack from rising water, sinking ground, high tides, wind, salt water and, more recently, erosion caused by the wake of hundreds of motorboats. In the last ten to fifteen years the maintenance team of the city has used moly-grade stainless steels extensively to strengthen its defense. In this battle, stainless steel often works behind the scenes, embedded in stone or brick. But in some cases it is in plain sight and blends in beautifully with the old building materials.

Venice is one of the most beautiful cities in the world. With its maze of canals, cobweb of bridges, grand palazzos and scenic squares, it brings to mind romantic notions: wealthy citizens leading a noble life, visiting each other by gondola, or strolling along a canal in the fog – a time before cars were ubiquitous. Its fragile position exposed to water from all sides adds to the wonderment. Venice comprises over one hundred islands. It is located in the Venetian Lagoon, a body of salt water at the North end of the Adriatic Sea.

The city of Venice was founded by refugees from surrounding Roman mainland cities like Padua and Aquileia around the fourth and fifth century AD. The people were forced to retreat to the marshy lands by several waves of invaders from the North seeking to destroy the Roman Empire. After losing the mainland cities in the North, Rome moved the main administrative and religious entities of the region to Venice before the fall of the empire. ›

The Grand Canal in Venice: stainless steel plays an important role in the background. © iStockphoto/prestongeorge

Due to its strategic location, Venice became a flourishing trading center between Western Europe and the rest of the world. By the 15th century, huge convoys of ships full of goods left the lagoon several times a year. The stunning palaces on the Grand Canal still reflect the wealth of one of the most powerful and prosperous nations in history.

However, Venice's position and marshy ground imposed massive limitations on construction. To keep buildings from sinking into the swamps, millions of wooden piles had to be driven into the bottomless marches. The Rialto Bridge alone required 12,000 piles to support its weight when built in 1588.

Over the centuries, the maintenance of infrastructure, monuments and works of art was always of vital importance. The Great Council constantly gave orders to dredge the canals, preserve the waters of the lagoon from contamination, adopt precautions at times of plague, preserve the state of cemeteries, and to conduct many other activities. In short, Venice has a long tradition of being "high maintenance."

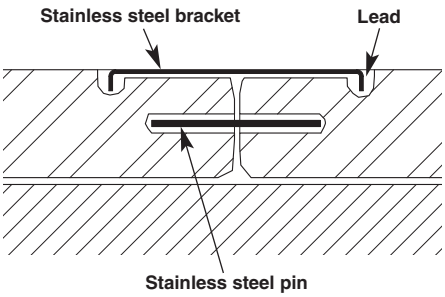
Maintaining the unmaintainable

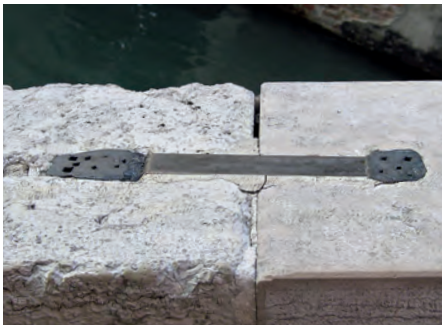
Today, the municipal agency Insula is in charge of planning and organizing the maintenance and repair of public spaces and services of Venice. The agency employs almost 100 people, half of which are engineers, architects and other technical professionals. Dr. Ivano Turlon, who leads the Insula team stated: "Because Venice is such a unique city with such unique problems, the agency can often not use standard repair and maintenance practices which work in other cities but has to develop unique, custom-made solutions."

Type 316 moly-grade stainless steel is one of the tools that the agency uses successfully in its battle with sea water, wind, erosion, high tides, rising waters, sagging ground, polluting industries on the mainland, and the effects of millions of tourists. Molybdenum gives the stainless steel the good corrosion resistance needed, particularly in coastal areas where chlorides (salts) are present.

Stainless steels stabilize walls

Along many canals low walls separate the walkways from the water. These brick walls are capped with heavy slabs of white Istrian stone. Traditionally, the tops of the slabs were connected with iron or copper brackets. In recent years, Insula systematically replaced them with Type 316L stainless steel brackets whenever walls had to be repaired or rebuilt. Unlike copper and iron, stainless steel is able to resist the corrosive environment here. Modern masons use the same ancient method for cementing the brackets into the stone. They fill the holes where the two ends of the bracket grip the stones with liquid lead and then strengthen the connection between the stone and the steel by hammering a pointed tool repeatedly into the soft lead, compressing it. Additionally, the stone caps are connected internally with Type 316L pins, which are cemented in place with epoxy. ›





The white stone caps of the brick walls are secured with metal brackets. The original copper or iron brackets (left) are now being replaced with Type 316L stainless steel (right).

Traditional handrails in Venice are wrought iron, protected with black paint. As the paint thins and chips it has to be reapplied. Even then, wrought iron does corrode and has to be replaced every so often. Stainless steel handrails need much less maintenance and are therefore the most cost effective solution for Insula. The agency installs Type 316 stainless steel wherever old handrails have to be replaced and where new handrails are fitted. Because the population of Venice is aging and its citizens have to walk so much to get around, additional handrails are continually being added.

Invisible molybdenum in and under bridges

Even such an ancient and romantic city as Venice has to provide modern services to its inhabitants. Early builders had not made any provisions for power services, let alone high speed Internet. Adding gas, water, telephone and electricity to the homes of Venice meant tearing up walkways to install underground piping. To cross a canal, the first engineers to install the pipes hid them within the original cross section of the old stone bridges. To fit the pipes into the bridge, they removed several layers of bricks from the substructure of the bridges and put the pipes into the channels they so created. As it turned out much later, the channels cut into the bridges weakened the structure causing longitudinal cracks to form.

Installation of a flat stainless steel duct for water and gas services on the San Boldo bridge. © Daniele Resini for Insula spa, municipal agency for the urban maintenance of Venice.

Insula restored many of these bridges during the “grande intervento”, the big push between 1996 and 2005 to catch up with maintenance and repairs that had been neglected for decades. They removed the water and gas carrying cast iron pipes from about 140 stone bridges and reinstalled the bricks to fill the channels and stabilize the structure.

Then the agency replaced the cast iron gas and water pipes with Type 316 stainless steel ducts, which were only 10 cm high. The cross section of the ducts was wide and flat instead of round. The flat ducts could fit between the newly repaired supporting structure and the top layer of the bridge.

Insula selected stainless steel for this application because maintenance of buried pipes would be very costly and difficult, and because they wanted a long-lasting solution. This same idea of using flat stainless steel rectangular ducts to transport fluids and gas across canals is also used on old cast iron bridges. These bridges are light and consist only of a frame and steps, all in cast iron. There is no place to bury the duct, so the stainless steel duct with its low profile is nestled directly under the bridge. It is hidden a bit by the face of the bridge and painted black to blend with the color of the bridge. In this way utility services can cross the bridge without being noticed.

Some of the cast iron bridges, which were built in the 1850s to 1880s, are starting to show structural deterioration and have to be restored. In the case of the Ponte della Donna Onesta (picture below), the engineers reinforced the bridge from the inside with a Type 316 stainless steel plate. ›

Stainless steel reinforcing plates were welded to the inside faces in a workshop (below). From the outside, the restored bridge looks like the original, the repairs are invisible. © (below) Insula spa, municipal agency for the urban maintenance of Venice.

In a similar case Insula tried a different technology, using fiber reinforced plastic (FRP) strips for strengthening. This solution is simpler because the FRP can be applied in place. However, reinforcing with a stainless steel plate is the preferred solution for low bridges. These bridges are occasionally hit by boats, which can crack the FRP. Stainless steel is resistant to small collisions.

A leading role for stainless steel

With their expanding experience using stainless steel in maintenance applications, engineers at Insula are now convinced of the suitability of stainless steel as a building material for new installations in Venice's demanding environment. Proving the point, they have recently built some larger structures entirely from stainless steel: two footbridges and a terminal for the vaporetto, the famous waterbus.

Ponte delle Capuccine (shown on the photo below) is a new bridge located on Burano. This modern structure is made entirely of Type 316L stainless steel, painted black to blend with the historic environment. The other new bridge,

The structure of Ponte dei Lavraneri is made of 2205 duplex stainless steel. It is the longest bridge in Venice.

Ponte dei Lavraneri, (shown above) is the longest bridge in Venice and connects La Giudecca with Sacca Fisola, the small island in the west. This bridge replaces an old wooden bridge which had to be demolished. The structure of the bridge is made entirely of 2205 duplex stainless steel. However, from the outside it looks like a wood bridge because it has been clad with wood panels to resemble the old structure and to fit the context of Venice. There is also a new waterbus terminal on Burano. It is built of stainless steel structural shapes and glass. Here the stainless steel remains in plain sight and is not hidden or concealed – a glimpse into the future?

Ponte delle Capuccine on Burano is built from Type 316L and painted black to blend with the historic environment.

Stainless steel behind the scenes

The corrosion resistance, strength and toughness of stainless steel make it an ideal building material for demanding environments where longevity is a prime concern. Stainless steel makes Insula's work easier because, once installed, it guarantees a long, low maintenance life for new and repaired structures. This means the engineers can focus on more than just keeping up with painting and replacing the most obviously deteriorated structures. They can improve their coverage of maintenance and can plan further ahead. This will guarantee the survival of this fragile jewel in the Venetian Lagoon for many more centuries.