How CRAs now support the Statue of Liberty

Built in 1886, the copper-clad Statue of Liberty has required quite some maintenance and renovation to keep it in pristine condition. In 1986, for example, engineers decided to replace rusty iron components with advanced materials such as Ferralium and 316L.

By David Sear

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A gift of friendship from the people of France to the United States, "The Statue of Liberty Enlightening the World" is recognized the world over as a universal symbol of freedom and democracy. Since its dedication in 1886 it has become an iconic structure instantly recognised by people from all continents.

When first built the Statue of Liberty was the world's tallest structure (some 46 metres high) and naturally made use of the most modern materials and construction techniques available at the time. Moreover, one of the architects behind the Statue of Liberty was none other than Alexandre-Gustav Eiffel, the French bridge engineer famed for building the Eiffel Tower in Paris, France. He is widely acknowledged as having designed the internal framework that keeps the Statue of Liberty standing.

As visitors to the Statue of Liberty will testify, it is in fact nothing more than a hollow shell, formed by 310 skillfully contoured copper plates riveted together at the edges. Eifel realised that this copper shell, weighing more than 80 tonnes, would be unable to support its own weight, much less withstand the buffeting winds of New York!

Eifel therefore developed a new construction method which would both support the copper plates and facilitate movement, allowing the metal to expand and contract during the hot summers and cold winters. This technique would later become known as the 'curtain-wall' technique.

Image: Wikimedia Commons

Standing 46 metres high, the Statue of Liberty was the world's tallest structure when first built

At the heart of the Statue of Liberty Eiffel therefore placed a sturdy iron tower, comprising four legs. This tower is surrounded by a secondary array of supporting iron beams and bars. These connect the central tower to so-called ribs, flat strips of iron which have been bent into shape to follow the exact curvature of each and every copper plate. Finally, the ribs are connected to the plates by saddles – U-shaped copper profiles which were connected to the plates using rivets.

Galvanic corrosion

As Eiffel was aware, combining dissimilar metals in such a fashion can lead to galvanic corrosion. He therefore specified that asbestos cloth coated with shellac be used to isolate the copper saddles from the iron bars. This method was initially successful yet over time the shellac dried out, allowing the asbestos to become dry and porous causing it to absorb moisture. So the cloth which was designed to prevent corrosion actually promoted it! As the iron bars corroded they swelled and distorted, in some cases to such an extent that the copper rivets pulled though the copper sheets.

This problem had already been recognised by the early twentieth century, and indeed during the course of the years various coatings were applied to try and stop corrosion whilst iron bars which became more severely corroded were replaced. However, by the late 1970s a decision was taken to give the Statue of Liberty a more extensive restoration. Indeed, the condition and subsequent refurbishment of the statue became a national cause in the USA and also France, with many companies donating both materials and services to the project.

Engineers tasked with working out how best to repair the Statue of Liberty decided that the 'puddled iron' in the internal superstructure needed replacing. For the rigid flat bars they chose Ferralium® 255, which at the time was being made by Cabot Haynes. Investigation had shown that this alloy, when used for the flat bar structure and associated bolting, exhibited minimal reaction with the copper cladding. It offered thermal expansion and elasticity similar to that of the wrought iron, but was far stronger.

However, at the time it was deemed that Ferralium® 255 would have been too difficult to form into more complex parts needed elsewhere, so Alloy 316L stainless steel was selected for shaped elements such as the ribs. 316L was said to exhibit minimal reactivity with the copper, and have a modulus of elasticity similar to the wrought iron.

The refurbishment was successfully completed in time for the grand reopening of the Statue of Liberty, timed to mark its centenary in 1986. Ten years later, an inspection report indicated that the corrosion problems had been corrected and that the installation had remained corrosion-resistant.

References

- Copper Development Association Inc.
- Wikipedia
- The New York Times
- The Washington Post

Insider Tip:

SSWN extends our thanks to Rodney Rice for bringing this unusual yet telling application of stainless steels to our attention. Would you like to share your favourite case history? Then simply contact David on d.sear@kci-world.com, or +31 575 585 528.