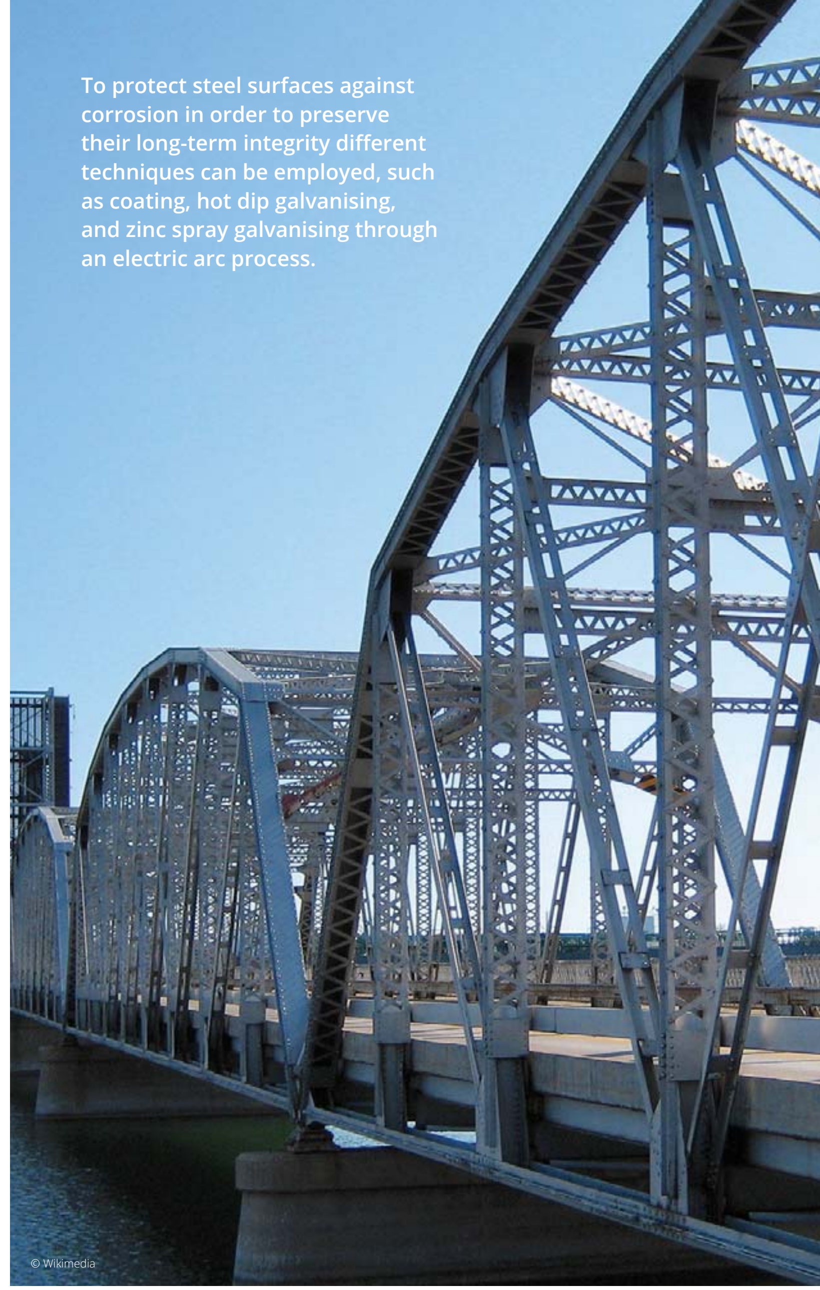
Zinc Spray Galvanising: The Preferred Choice Against The Corrosion of Steel Bridge Structures

Mario Colica
Colimet Srl, Rome - Italy colimetsrl@gmail.com



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Environmental conditions are becoming increasingly aggressive. That is why it is essential to protect steel surfaces against corrosion in order to preserve their long-term integrity. Different techniques can be employed, such as coating, hot dip galvanising and zinc spray galvanising through an electric arc process. The latter is being increasingly used in Northern Europe, the USA and Canada. In fact, zinc spray galvanising is a simple method that consists in spraying a coating, made up of millions of zinc particles obtained with a melting operation at 419.5°C in an electric arc system, on a steel surface, previously sandblasted to an SA value of 2.5 to 3. The liquid zinc solidifies in contact with steel and it creates a coating with a thickness between 20 and 300 μm, which protects the surface in two ways: passive (barrier), by insulating it from the external environment like a paint layer, and active (anodic/sacrificial), by corroding instead of steel at a 1/10 rate compared with it (**Fig. 1**). This parameter allows designers to predict the coating's lastingness before the formation of 5% rust on the structure.

Compared with hot dip galvanising, the zinc spray method has several advantages:

- unlimited thicknesses (the higher the zinc thickness, the higher the durability);
- no risk of hydrogen embrittlement because the melted particles are applied on the substrate at a temperature of 220°C;
- low environmental impact, because there are no exhausted liquids to dispose of, nor VOCs like with paints;
- possibility to treat structures in all sizes;
- possibility to work on site, because the system can be towed;
- possibility to spray zinc and/or aluminium depending on the aggressiveness of the environment;
- possibility to spray Zn/Al 85/15: a coating of 150 micron, according to AWS, U.S. Navy and DOT of New Jersey, provides 30 years of protection in most bridges exposed to wet, salt- rich environment.

In addition to corrosion protection, zinc spray galvanising (zinc metallisation) complies with the requirements of authorities Canadian Standards Association (Canadian Highway Bridge Design Code) and American Association of State Highway and Transportation Officials, relating to the sliding coefficients of bolted connections when they are subjected to impacts, vibrations, sliding and load inversion. The sliding resistance of critical connection points depends on the friction between contact surfaces when these are subjected to shear stresses. These surfaces' conditions are a crucial parameter in the assessment of their resistance when in operation. When designing critical connection points, the contact surfaces' sliding coefficient must be known in order to perform correct calculations. Coefficients are known for different types of surfaces, but the standards do not indicate any sliding coefficient for metallised surfaces.

Before metallisation, bridge designers generally mask the overlapping areas of contact surfaces where the fixing bolts are to be inserted (**Fig. 2**). This entails more work and additional costs, also because masks must be applied and then removed manually. The sliding resistance of metallic junction points is being studied with the aim of reducing construction costs, speeding up work, and protecting steel surfaces more efficiently. The Research Council of Structure Connections indicates a few methods to measure the friction coefficient. In 2012, together with the Laval University and company Canam-Bridges, they conducted a study on the sliding behaviour of metallised metal joints by adopting varying parameters, such as:

- zinc thickness from 150 to 300 µm;
- bolt thickness from 12.7 to 15.9 mm;
- presence of small burrs around the bolt holes.

The search results showed a sliding coefficient of 0.77, obtained for joints with 150 µm zinc thickness, preloaded bolts with a maximum tension of 90%, 15.9 mm sheet thickness, and no burrs, for 1,000 hours of application. The value of 0.77 is well below the coefficient required by the North American Standards, i.e. 0.50 (class B).

Some research studies carried out in 2014 by the Federal Highway Administration with a zinc thickness value of 300 µm showed an average sliding coefficient of 0.78, very similar to the results obtained by the Laval University and Canam-Bridges.

Figure 1 (left) - **The liquid zinc solidifies in contact with steel and it creates a coating with a thickness between 20 and 300 µm.**

Figure 2 (right) - **Before metallisation, bridge designers generally mask the overlapping areas of contact surfaces where the fixing bolts are to be inserted.**