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ADVANCED CORROSION PROTECTION OF STRUCTURAL TENSION MEMBERS

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Summary

Locked coil strands can be used in all types of rope supported bridges where long-term corrosion protection is a primary requirement. This paper reports advances of corrosion protection of locked coil strands with galvanically protective coatings and high density polyethylene (HDPE) sheathing.

Keywords: wires; ropes; cables; corrosion protection; cost effective; Galfan; Bezinal 3000; HDPE

1. Advanced Coatings for Dynamic and Static Cable Applications

Corrosion as a process costs 3 % of GDP per year worldwide in material degradation. For metals, highly industrial polluted and marine areas are responsible for high corrosion rates. A primary protection of steel against corrosion is often provided by a metallic coating. Historically Zinc was the first coating to be applied for this purpose. Zinc corrodes about 10 times slower compared to steel and it provides also cathodic protection to the steel in places where the product is damaged.

However, due to the high demands on working life of bridge applications alternative and innovative solutions to further improve the corrosion resistance of steel ropes are recommended including use of advanced metallic coatings, blocking compounds and additional plastic coatings.

Galfan® was developed in 1980 and became the first advanced metallic coating available on wire. The coating consists of Zinc-5 % Aluminum added with low quantities of rare earth metals. Bekaert provides this Zn-5%Al coating under the trademark Bezinal®. At the turn of the century the sheet industry started to introduce the first ZnAlMg alloy coatings and these showed superior corrosion performance compared to Zinc. Bezinal 3000 of Bekaert is now the first of such a ZnAlMg coatings to be available on high strength steel wires. Bezinal 3000 shows superior corrosion performance in the Neutral Salt Spray test. Like the other ZnAlMg coatings available on sheet, Bezinal 3000 coated wires provide superior performance in cathodic protection. This was demonstrated by comparing after 3 years the rust at the cut edges in a real atmosphere.

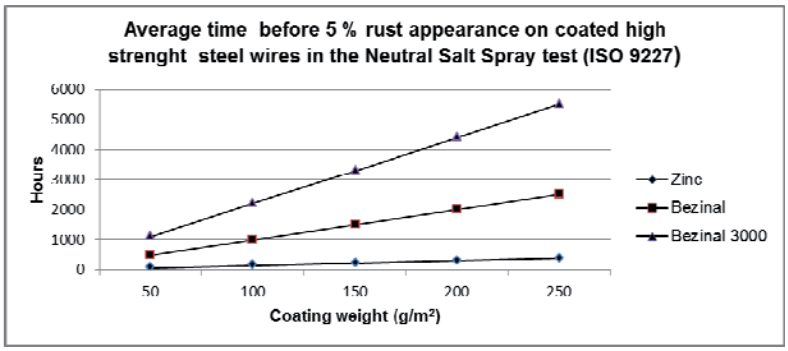

Fig. 1. Corrosion performance of Zinc, Bezinal and Bezinal 3000 in the Neutral Salt Spray test.

2. HDPE-sheathed Locked Coil Assemblies

Locked coil assemblies are the most common tension members for pedestrian bridges and major road bridges since more than 85 years. They consist of a core of round wire and several layers of Z-shaped wires. Each layer of round and Z-shaped layers will be helically spun usually in opposite direction to minimize the residual torque.

The major cause of deterioration of bridge cables is steel corrosion. Locked coil strands have multiple corrosion barriers; (a) Galvanizing of all wires, (b) Filling the inter wire gaps with a corrosion inhibitor blocking compound which also prevents the intrusion of corrosive media into the rope in service, and (c) an additional painting of the cables with specially approved paint systems can be used for very aggressive atmospheres. In locked coil strands the Z-shaped wires themselves provide an additional effective surface barrier against the penetration of corrosive media because of the interlocking of the Z-shaped wires.

The construction industry has a demand for a long-term corrosion protection. Bridon, the former company of Bridon-Bekaert react to the requirement and took the experience of sheathed open spiral strand in the offshore industry into the development of sheathed locked coil assemblies for bridge applications

The advantages of plastic sheathing of ropes for structural applications are many fold. Unlike paint systems the sheathing is applied in the factory. The time, cost and weather dependency associated with applying a paint system are eliminated. Like paint systems sheathed ropes can be made in different colours to suit the architectural design. The plastic sheathing is designed for the full design life of the rope and does not need any further maintenance whereas paint systems need to be re-applied from time to time.

Pressure grade high density polyethylene (HDPE) optimized with colour is used by Bridon-Bekaert in sheathing because it offers a cost-effective solution with a good combination of physical and mechanical properties. A compatible UV stabiliser is added to the plastic during the sheathing operation to provide good colour stability and prevent or slow down the degradation of plastic caused by in-service exposure to UV radiation and temperature.

The provision of double layers of HDPE may offer more corrosion protection and increase the longevity of the structural ropes. Sheathing with two different colors also offers a visual aid to indicate areas of damage more effectively than a single sheathed product of similar thickness.

Furthermore, it is known that strake profiles in plastic sheathing suppress Vortex Induced Vibrations (VIV) in the cables. Such cladded systems are however expensive. Extrusion of continuous helical strakes integral to the sheathing was recently demonstrated and this method would offer a more cost-effective solution.

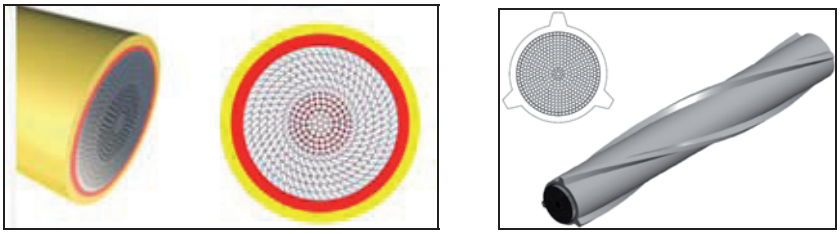

Fig. 2. Double sheathed locked coil strands and spiral strands with helical strakes

3. Conclusions

The paper reports the enhancement of corrosion protection on wires and on locked coil assemblies. Advanced metallic coatings can be used to improve the corrosion protection of the wires. HDPE Sheathed locked coil assemblies have the advantage to reduce the overall costs, because the cost- and time consuming application of the outer corrosion protection can be done in a factory under controlled environmental and quality aspects.

These HDPE Sheathed locked coil offers new opportunities for the design of bridges.