ALL WRAPPED UP

Fully-locked cables on one of Germany's most heavily-used road bridges have been thoroughly inspected and wrapped to protect them from corrosion

The Köhlband Bridge is one of the most important road bridges in Germany, providing access to Hamburg Port for heavy traffic. The steel bridge was built between 1969 and 1974 as a cable-stayed bridge with 88 fully-locked cables of 65mm – 120mm diameter and a total length of approximately 8.4km. The cable stays were previously restored in a project in the late 1970s.

The original corrosion protection of the cables consisted of galvanisation, a red lead filling and a polyurethane coating with a total thickness of 450μm. But over the years, damage had been inflicted, and corrosion of the bridge cables was detected during regular inspections. Owner Hamburg Port Authority decided to restore the coating and to carry out an extensive cable inspection in an attempt to extend the life of the bridge.

A number of criteria were considered in the choice of the most suitable maintenance process. Disruption to traffic had to be minimised; what's more, the work had to be completed in just a few months, during the short period of good weather. The work required every cable to be inspected by a person, and photographs of the entire cable surface, an estimated 2,500m^2, to be taken to enable comparative inspections in the future.

Magneto-inductive testing had to carried out on all cables to detect wire breaks and severe internal corrosion and the entire surface of the cables had to be permanently protected from corrosion. The bridge owner preferred a system which did not require any treatment of the cables such as sand blasting, before the coating was applied. The system also had to comply with the requirements of the German standards for corrosion protection TL/TP KOR-VVS in its main characteristics and form a protective sheath in accordance with DIN EN 12068. Both the coating system and the non-destructive testing had to be obtained from a single source to eliminate organisational problems.

Based on its previous work on the Passerelle de deux Rives bridge between Kehl and Strasbourg *(Bd&e issue no 53)*, Alpin Technik & Ingenieurservice was asked to propose a concept for the maintenance of the cables in accordance with the various criteria set out above. Alpin Technik's proposal was approved by the Hamburg Port Authority and the company was contracted to carry out the work *(pictured above)*. Specialist suppliers Denso and Suspa DSI were called in to deliver the butyl rubber tape coating systems, while DMT supervised and assessed the magneto-inductive testing of the cables.

The maintenance project required a series of tasks, which were completed as follows. Firstly an inspection of all cables was carried out using a cable-access method, and any loose or raised particles of the old coating were removed. Automatic visual documentation was then carried out, with photographs of the entire cable surface being taken for future inspections.

The cables were covered with cold-fusing butyl rubber tapes, using automatic equipment, with a final polyethylene layer creating a total layer thickness of 2.6mm.

The corrosion protection process was documented by cameras at the same time. Magneto-inductive testing for wire breaks and severe internal corrosion was then carried out. Automatic visual documentation was carried out with the company's transportation unit, the basic device used for all automatic extension modules, in combination with a camera system which takes pictures of the cable surface at a high speed.

Once the photographs have been taken, special software compiles them into a single photograph at the actual size of the cable. The owner or other external offices can examine this photo and add comments for preparation of a report, which can be automatically generated using special software.

The corrosion protection system consists of butyl rubber tape, which fuses to itself by interdiffusion of the molecules in the overlapping areas and consequently creates a closed, tubular sheath. The base film, which is the actual corrosion protestion, consists of a three-layer tape. A butyl rubber coating is applied on both sides to a stabilised polyethylene carrier film. The tape thickness is 0.8mm.

The top layer is of a two-layer tape. A co-extruded inter-layer, which connects to the inner butyl rubber layer without any boundary or separating layers, is applied to a stabilised polyethylene carrier film. The tape thickness is 0.5mm.

The polyethylene carrier film can be produced in various colors, depending on the visual requirements of the bridge – at Köhlbrand Bridge grey was used. Both the base and the top layers form an additional protective sheath in accordance to regulations DIN 30672 and DIN EN 12068 and also offer robust mechanical protection from external damage. The butyl-rubber based corrosion protection system is classified as DIN 4102 – B2.

The same transportation unit is used as the basis for the taping robot, carrying the taping module at the front end. This transportation unit has three 'caterpillar' carriages and is controlled by electronics, moving along the cable automatically. The two rolls of corrosion protection tape each with a width of 50mm are fed into the taping module.

Control of the taping robot takes place from the ground via a special monitor, and the data relating to the taping procedure is stored for the client. The tapes are overlapped by 50%, creating a four-layer thickness of approximately 2.6mm over the existing coating.

Connections at the cable anchors are adapted according to the particular location and construction of the cables, but must be designed to prevent the intrusion of water. In the case of the Köhlbrand Bridge the taping was fed into the tower and sealed off on the cable using butyl rubber primer and butyl rubber filler.

Five inspection points were created once the taping was complete, which made it possible to take material samples without damaging the actual corrosion protection of the cables. For this, another base and top layer was applied to the existing tape over a length of some 500mm in these areas. To ensure it could easily be removed, a separating agent was applied to the surface of the tape before the additional coats were applied and a strip of stainless steel was inserted, along which a longitudinal cut could be made to take material samples.

After applying the corrosion protection system, the cables were inspected in cooperation with DMT, using magneto-inductive testing devices. Devices for testing cables of a diameter of up to 150mm and a weight of up to 300kg were used. No significant damage was detected.

No scaffolding, enclosure or blasting was required, and the site work was completed within 4.5 months. Corrosion protection work started on the first eight cables in June 2009; these were judged to be in the worst condition. Seven days after starting set-up, the work on these eight cables was finished and the client was convinced about the efficiency of the method.

As a result of this demonstration the client agreed for the 80 remaining cables to be treated in the same way, including the automated visual inspection and record of the surface condition and MFL testing. The second stage of the work began in May this year and was finished by the end of August, including about 15 days of interruption due to rain. Within this time all 80 cables were visually inspected within arm's reach by use of motorized rope access, they were wrapped with butyl rubber tape and the condition of the cables was checked using MFL technology. Some of the larger cables which have a greater radius of curvature along their length still have to checked by MFL; this is planned to be carried out next year with a new, larger 250mm MFL device.

The use of automated technology and a proven corrosion protection system on this project enabled significant cost and time savings