BridgeSafety

Sensory monitoring of the corrosion of steel cables in transport infrastructure

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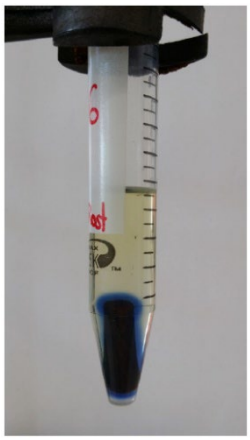
Numerous structures in our transport infrastructure are equipped with load-bearing elements made of prestressed steel cables. Due to the mechanical requirements of low-alloyed steel, these must be protected against corrosion. In modern structures, this is done with special corrosion protection gels in which the steel cables are embedded. The routine inspection of the steel cables is time-consuming and cost-intensive, as the jacket has to be partially removed in order to inspect the surface. In the present research project, the corresponding gels are to be equipped with an iron ion-sensitive indicator dye. This will enable an early and non-destructive detection of corrosion by an optical detection methods. This would result in a drastic reduction in maintenance effort, a significant increase in safety and a reduction in maintenance-related restrictions on neuralgic infrastructure.



The present project is based on an invention already filed as European Patent No. 15189545.5. The main claim of the invention application comprises a corresponding gel formulation as corrosion protection, which is mixed with an iron ion-sensitive dye. When corrosion starts, a clear colour formation occurs in the vicinity of the damaged area. After only a few weeks, a clear colour change in the gel can be observed, caused by the reaction of the dye with the iron ions.

Figure 1: Color change of the gel in the vicinity of a corroded piece of steel

Within the scope of the project, different dye systems and gels were evaluated for their suitability to detect corrosion and their long-term stability was analyzed in order to monitor this color change. Furthermore, different optical concepts were developed and set up to measure this color change with a fiber.

It was evaluated and tested how an optical fiber can be inserted into steel cables as used in prestressing technology. In principle, there are several possibilities for installation. The steel

cables usually used consist of 7 wires, one of which runs in a straight line in the center of the strand, and 6 other wires are wound around this central wire in a helical arrangement. The big challenge here is not to crush an additional optical fiber inserted between the steel strands. For this purpose, different installation positions of the fiber in the steel strands were evaluated, either along the central wire or along the helix-shaped steel strands.

Figure 2: Lead wire cable - There is a central wire in the center. Around this central wire, 6 more strands are helically wound. The optical fiber runs parallel to the central wire.

In the further course of the project, a functional model of the combination of measuring device, fiber optics and iron ion-sensitive indicator dye in gel was developed. This functional model was successfully tested in the laboratory. Figure 2 shows that even a slight color change of the indicator dye can be measured in the presence of corrosion.

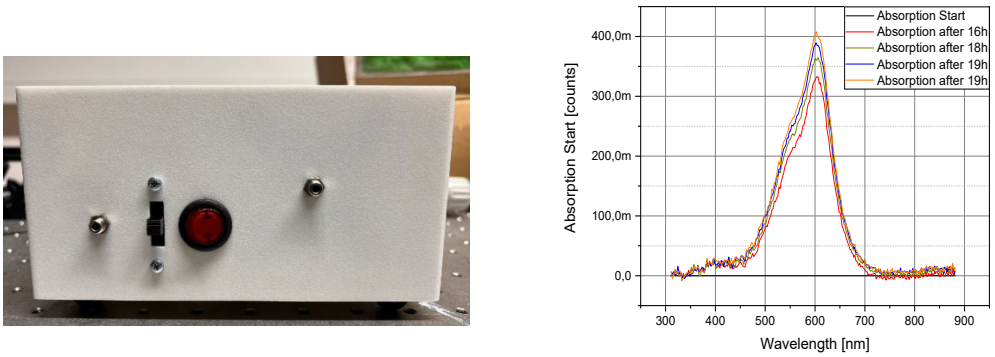


Figure 3: Shown on the left is the functional sample developed in the project. On the right, the absorption spectra of a dye in the presence of corrosion.

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