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Corrosion Protection of Locked Coil Ropes at Road Bridges

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Abstract

1. Introduction – Rope Bridges in Germany

In the course of federal motorways, major roads and some city roads in Germany there are about 40 big road bridges which have high strength cables. All but one bridges have locked coil ropes, one bridge has parallel wire strands. Most bridges are cable stayed bridges, some bridges are suspension bridges, at two bridges there are under-guyings. Closely packed bundled single ropes are called as cables.

2. Locked Coil Ropes

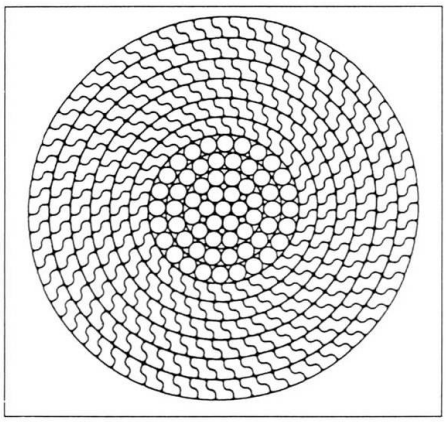

Fig. 1:
Locked coil rope – cross section

Locked coil ropes inside consist of round wires and outside of several layers of Z-wires which tighten the inner structure by their shape and order, see Fig. 1. They have the advantage that a wire takes load after two lay lengths if it is broken. This behaviour is got by pressing this wire into the structure of the rope through contraction of the rope caused by the spiral structure. At parallel wire strands a broken wire is lost for the strength over the whole length of the cable. Furthermore locked coil ropes have the advantage that they can be designed in a more slender way than parallel wire strands and that by the locked type the inner structure of the rope is mechanically tightened and therefore much better protected against corrosion attack. But it seems that they have the disadvantage that they are more expensive than parallel wire strands having the same strength. Regarding the rope mechanics it has to be considered that they have a lower modulus of elasticity than parallel wire strands by reasons of the spiral structure.

In the beginning (about 1959 – 1965) the single wires were not galvanized. Later on only the outer wires were galvanized, and since the end of the seventies all wires are galvanized. The galvanizing alone is not a sufficient corrosion protection. Therefore an outer corrosion protection is necessary in the form of a coating, consisting of several coats.
Beside some exceptions red lead was and is used as blocking agent which is filled in the inner of the rope during the fabrication of the single layers. The aim is that by the blocking agent an easy gliding is possible between the single wires (lubricating) and that the single wires are protected against corrosion. As these characteristics must be available over the whole life time the blocking agent has to fulfil high requirements of the lubricating, the corrosion protection and the durability. The anchoring of a rope is normally done by the embedding of the wires in a cast corpus consisting of a zinc alloy and by wedging the wires against each other in the socket.

3. Rules

Standards were drafted and introduced in the responsibility of the German Ministry of Transport to avoid mistakes at this member sensitive and important for safety and to have a basis for the invitation to bid for rope works. By this a high level of quality at the fabrication of the rope and the capability for inspection under traffic is to be ensured. The maintenance is also dealt with in detail. Additional to the regulations in the standards requirements to the rope or cable (rope bundle) and to the corrosion protection are formulated to fulfil the expectations to the life time: It is counted on that the existing bridges reach 80 to 100 years supposed that the heaviness of the traffic does not grow strongly and that no other life time diminishing influences occur which are not determined by the structure itself. For the structure itself a regular test of the stability is necessary in any case. The rope is not understood as a working part, but modern structures allow the changing of single ropes in an emergency case.

4. Maintenance of the ropes

At the construction works in the responsibility of the road administration in Germany the German standard DIN 1076 is used. A main inspection has to be done every 6 years and between after 3 years a simple inspection. For the main inspection at bridges with ropes and cables in Germany a Bridge rope inspection machine was developed. It is a kind of cable railway with whom a driving of the ropes and cables is possible without loading the tensile elements themselves. For the inspection of ropes for wire fractures the magnetic inductive test is used.

5. Investigations of Ropes

By the BASt investigations were carried out with the aim to get information about the mechanical situation for bridges ropes in the structure. Beside that investigations were done about the climatic effects by exposure tests. At a chemical laboratory the chemistry of the blocking agent itself was investigated. In particular the water absorption was important. Temperature measures were also carried out at ropes where the temperatures were measured on and under the corrosion protection coating.

6. Conclusion

The locked coil rope in bridge structures presents itself as a robust, durable and easy-care member if the requirements of the above mentioned regulations are fulfilled which can be inspected easily, too. Single wire breaks of the outer layer possibly appearing are not critical and can be seen at the surface.