Effectiveness of Repair Methods of Corroded Bridge Cables

Shunichi NAKAMURA
Professor, Tokai University
snakamu@keyaki.cc.u-tokai.ac.jp

Shunichi Nakamura, born 1950, received his BEng and MEng from Kyoto University, and PhD from Imperial College of Science and Technology, UK.

Keita SUZUMURA
Manager, Nippon Steel Engineering
suzumura.keita@eng.nsc.co.jp

Keita Suzumura, born 1965, received his BSc and MSc from Hokkaido University, and DEng. from Tokai University, Japan.

Summary

It is important to repair the corroded bridge cables by proper methods so that corrosion does not progress further. Six repair methods were proposed and applied to cable specimens. Then, the specimens were exposed to the severe corrosion environments and the effectiveness of the proposed repair methods was compared. Two different types of test cables were used in this study: parallel wire strands and spiral strands. The parallel wire strand cables consist of 19 non-galvanized steel wires. This aimed at the main cables of suspension bridges. Six repair methods were applied to these cable specimens: coating with zinc or epoxy resin paint or zinc powder paste, filling with epoxy resin or oil, and dehumidification method. Then the specimens were wrapped with wet gauze and kept at 40^{o}C for 15 months to accelerate corrosion. By investigating mass loss due to corrosion and appearance during this period, effectiveness of six repair methods was compared. As for the surface wires, the dehumidification method was the most effective followed by the epoxy resin paint and filling, the zinc powder paste, and the zinc and epoxy resin paint on the surface. The oil filling was not very effective compared with other repair methods. The corrosion of the inside wires was much less than those of the surface wires. The spiral strand cables consist of seven galvanized steel wires. This test aimed at hangers of suspension bridges and stays of cable-stayed bridges. By investigating mass loss due to corrosion and appearance of both inside and surface wires during the 16 month period, the proposed six repair methods were all very effective compared with those of un-repaired strands. This study proves that, even if a cable is corroded, proper repair works are effective in preventing further corrosion.

Keywords: bridge wires; corrosion; galvanized steel wires; parallel wire strands; spiral strands; repair; zinc paste; epoxy resin paint; dehumidification.

1. Repair methods for corroded parallel wire strands

It is an important subject how to repair corroded wires. Seven cases were compared in evaluating effectiveness of different repair methods: (1) taking no repair measure, (2) coating only the surface wires with epoxy resin paint with a thickness of 80μm, (3) coating only the surface wires with zinc rich paint with a thickness of 50μm, (4) coating and filling the surface and inside wires with oil containing inhibitor with a thickness of 1.0mm, (5) coating and filling the surface and inside wires with epoxy resin paint, (6) coating the surface layer with thick paste containing zinc powders with a thickness of 1.0 mm, and (7) dehumidifying the inside of a cable at 45% RH.

Fig.1 shows the mass loss due to corrosion of the surface wires repaired by six repair methods. It is found from Fig.1 that the mass loss of the repaired wires is much less than that of non-repaired wires. Among the repair methods the dehumidification method (case 7) was the most effective followed by epoxy resin paint and filling (case 5), zinc powder paste (case 6), and zinc rich and epoxy resin paint (case 2 and case 3). The oil filling (case 4) was not very effective compared with other repair methods. It was thought that it was because that the oil became solid. It was also found that the mass loss of most of the repaired wires for 15 months was between 40 to 70 g/m^2 which was much less than those of the surface wires (450 g/m^2). In particular, the dehumidification and

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epoxy resin paint and filling of surface and inside wires seem to be very effective.

2. Repair methods for corroded spiral strands

Next six repair methods for spiral strands wires are investigated. Seven cases were compared, same as the first test group, in evaluating effectiveness of six different repair methods of corroded wires: (1) taking no measure, (2) coating only the surface wires with epoxy resin paint, (3) coating only the surface wires with zinc rich paint, (4) coating and filling the surface and inside wires with oil containing inhibitor, (5) coating and filling the surface and inside wires entire wires with epoxy resin paint, (6) coating the surface layer with thick paste containing zinc powders, and (7) dehumidifying the inside of a cable at 40% RH.

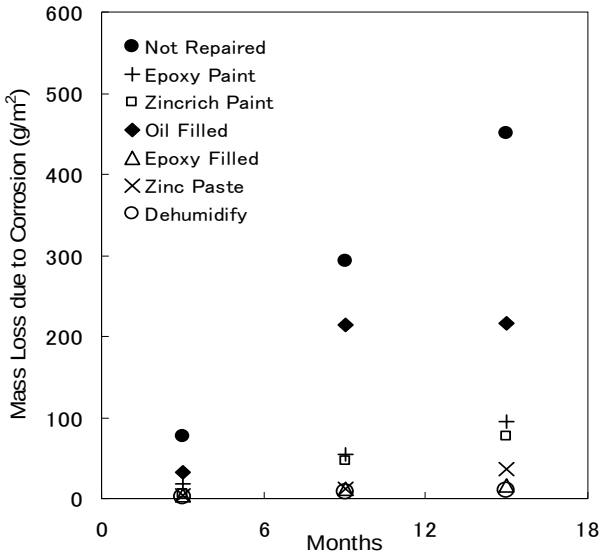

Fig. 1: Mass loss of surface wires of PWS

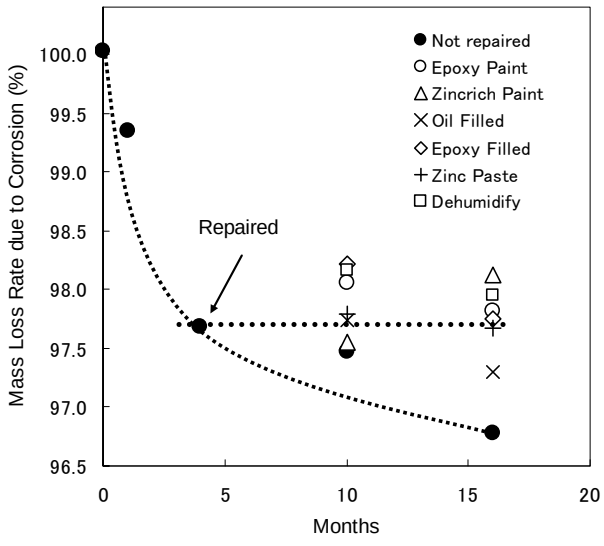

Fig. 2: Mass loss rate of spiral strands

A test cable is a spiral strand consisting of 7 galvanized steel wires. It was wrapped with wet gauze and kept in a chamber at a temperature of 40°C for 4 months to accelerate corrosion. After this period the corroded strands were applied by six repair measures explained above. Then the corrosion acceleration continued for further 12 months. The appearance and corrosion conditions of the surface and inside wires, the mass loss of these specimens were checked in 4 months, 10 months and 16 months after the initiation.

Fig.2 shows the mass loss rate due to corrosion of the spiral strands with six repair methods. The mass loss rate of the strands due to corrosion decreases sharply with time for the first four months. At this time, the corroded strands were repaired. After the initial four months, the spiral strand without repair continues to corrode. On the other hands, the corrosion does not progress further for the spiral strands which were repaired by all of the six methods. This proves that, even if a spiral strand is corroded, appropriate repair is effective in preventing further corrosion.

This proves that, even if a spiral strand is corroded, proper repair works are effective in preventing further corrosion.

3. Conclusion

Six repair methods were applied to the cables. For parallel wire strand cables, as for the surface wires the dehumidification method was the most effective followed by the epoxy resin paint of surface and inside wires, the zinc powder paste, and the zinc and epoxy resin paint of surface wires. For spiral strand cables consisting of seven galvanized steel wires, the proposed six repair methods were all very effective compared with no repair strands.

References

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