Aged Deterioration Inspection Results of Suspender Ropes by Main Flux Method

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Summary

Two types of suspender ropes, Center Fit Rope Core (CFRC) ropes and Parallel Wire Strand (PWS) ropes are used in the Honshu-Shikoku suspension bridges. CFRC ropes are painted and supposed to be replaced periodically. Since conventional visual inspection cannot catch the internal corrosion state, Honshu-Shikoku Bridge Expressway Co., Ltd. (HSBE) developed a non-destructive inspection system using an electromagnetic method (main flux method) in order to know the internal corrosion state accurately. The corroded CFRC ropes of the Innoshima Bridge and the Ohshima Bridge, inspected in the past, were inspected again. It has been nine years and five years since the last inspection of the Innoshima Bridge and the Ohshima Bridge respectively. As a result, it was found that the sectional area reduction rates of the ropes are at most about 2.3% and at most about 1.0% respectively.

Keywords: main flux method, suspender ropes, CFRC, inspection, aged deterioration, suspension bridge, corrosion rate, electromagnetic method.

1. Introduction

Inspection of suspender ropes was conducted visually in the past. It is very difficult to know the internal corrosion state by visual inspection. A non-destructive inspection using the electromagnetic method (main flux method) was developed by Honshu-Shikoku Bridge Expressway Co., Ltd. (HSBE).

2. Outline of Inspection by Main Flux Method

When a wire rope is magnetized in axial direction strongly, magnetic force lines are made. The number of magnetic force lines per unit sectional area is defined as a flux. Inspection by the main flux method is a measuring method of a sectional area of an electromagnetic material using the linear relation between a main flux and a sectional area. Fig. 1 shows the principle of the main flux method.

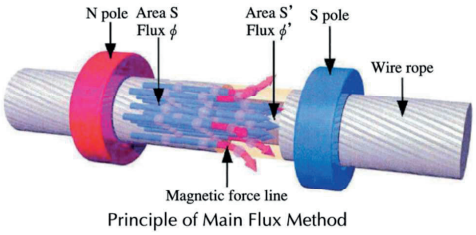

Fig.1: Principle of Main Flux Method

There are two types of measurement by the main flux method, a continuous measurement and a fixed point measurement. A continuous measurement is to measure the main flux continuously along the rope axis. A fixed point measurement is to measure the main flux at a fixed point on a rope.

3. Inspection Accuracy

Accuracy of the continuous measurement by the main flux method is evaluated by laboratory test in 2002. The defect finding ability is more than 0.5% of the sectional area reduction rate and more

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than10mm of defect length. As the accuracy of the fixed point measurement is influenced by magnetic field near the point, the error of the measurement is confirmed to be about 1%.

4. Inspection Results

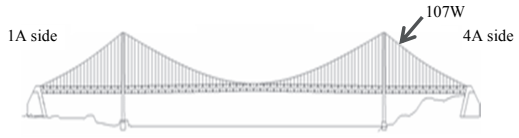

Fig. 2: Measuring Point (Innoshima Bridge in 2011)

4.1 Innoshima Bridge

In order to compare the test result in 2002 and 2011, measurement of four suspender ropes was conducted at the panel number 107W (Fig. 2). Corrosions were detected at the point 5-8m below the clamp (Fig. 3) and at the centre (25-40m from the clamp) of the rope.

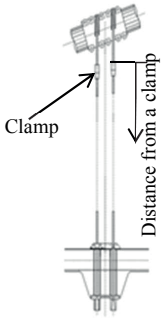

Fig. 3: Clamp and Distance

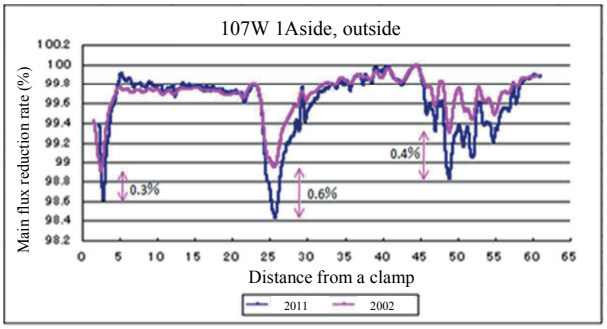

Fig. 4: Measurement Results in 2011 and 2002

The test results in 2011 compared to the results in 2002 is shown in Fig. 4; the curves of the main flux are almost same, it was found that there is no additional corrosion point. The fixed point measurement was conducted at 13 points including some 5 points conducted in 2002.

Some results in 2011 are larger than those in 2002, although, the reason of the difference is supposed to be influence of the measurement error (about 1%). Corroded points are just at the clamp and at the centre of the rope. Sectional area reduction rate of the most heavily corroded point is 1.3%. Maximum corrosion rate par year is 1.1%/9years.

4.2 Ohshima Bridge

Eight suspender ropes at four panel numbers including the ropes measured in 2006 were measured.

Slight corrosion was found on four ropes. There has been no new corroded point since 2006. Slight corrosion was found just at the clamp, and there is no major corrosion. It means the suspender ropes are in good condition.

5. Conclusions

A maximum corrosion rate of 1.3% was measured in the Innoshima Bridge. When a measurement error of 1.0% is considered, the maximum corrosion rate is about 2.3%. Repainting of suspender ropes has been conducted in the bridge; the suspender ropes can be expected to have enough remaining sectional area at the end of the repainting work period.

It was found that suspender ropes of the Ohshima Bridge are still in good condition.

6. References

[1] SAKAI K., KUSUHARA S., MORIYAMA A., and OGIHARA K., *"Maintenance Optimization of Suspender Ropes of Suspension Bridges"*, IABMAS 2012 Italy.