Outline of “Non-Destructive Inspection Device for Inspection of Stay Cables”

「斜材点検用非破壊検査装置」の概要

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1. Introduction

Cable-stayed bridges and extradosed bridges are composed of main girders, towers, and stay cables. The stay cables are an important component, and therefore it is extremely important to properly maintain them in order to ensure the high durability and safety of these bridges.

The Japan Prestressed Concrete Institute (JPCI) has established “Guidelines for Maintenance and Management of PC Cable-stayed Bridges and Extradosed Bridges” describing maintenance methods for cable-stayed bridges and extradosed bridges [1]. The guidelines stipulate that the protection pipe of the stay cable should be visually inspected in regular inspections.

However, as shown in **Fig. 1**, there are many areas where visual inspection is difficult to conduct, such as stay cables running from tall main towers to girders. To conduct visual inspection in these areas, rope access technology (**Fig. 2**) or a mobile elevated working platform required. In addition, although the prestressing steel cables inside the protection pipe are protected from the cable rupture, there is a risk that these cables may break due to damages caused by weather conditions, corrosion, materials or fatigue caused by stress fluctuations. Therefore, it is necessary to investigate the deformation of the prestressing steel cables as well. For this reason, a self-propelled stay-cable inspection device was developed as a non-destructive inspection device for investigating the deformation of protection pipes and prestressing steel cables inside protection pipes by remote operation from the ground level, without working in high places [2].

2. Outline of the Technology

The self-propelled stay-cable inspection device is shown in **Fig. 3**. It consists of a main unit and an inspection sensor unit. The main unit consists of a driving unit and image sensor (video camera) that inspects deformation of the protection pipe. The inspection sensor unit inspects the deformation of the prestressing steel cables inside protection pipes. These units can be moved upward/downward, and stopped by self-propulsion via remote control from a personal computer from other locations.

Fig. 1 Cable-stayed bridge (Tomei Ashigara Bridge)

Fig. 2 Inspection with rope access technology

Fig. 3 Self-propelled stay-cable inspection device

(1) Main Unit (Driving Unit and Image Sensor)

The driving unit consists of rollers, drive motors, and electromagnetic brakes. The traveling speed of the inspection device is 7.0 to 10.0 m/min.

Four video cameras are installed on the image sensor to inspect the deformation of the protection pipe, and the entire circumference (360°) of the protection pipe can be inspected simultaneously. Cracks of 0.1 mm or larger can be detected while traveling, and the camera's zoom function can be used to check deformations in detail. Lighting allows for nighttime inspections.

In demonstration test, comparison was made between inspection with the self-propelled stay-cable inspection device and close visual inspection by human inspectors. It was confirmed that the accuracy of the device was just as good or even better than that of close visual inspection by the inspectors. The deformation state of the protection pipe photographed by the device is shown in **Fig. 4**.

Fig. 4 Image of a protection pipe taken by the device

(2) Inspection Sensor Unit

The inspection sensor unit consists of an inspection sensor for eddy current testing and an eddy current flaw detector. The sensor is moved at intervals of 10 mm over an inspection area of 300 mm, and 30 inspections are performed. The flaw detection results are determined based on the detected waveform, and the waveform exhibits a disturbed state in damaged areas. To make the inspection results easier to read on the screen, the display magnification can be adjusted and the line waveform can be converted to a circular waveform (**Fig. 5**).

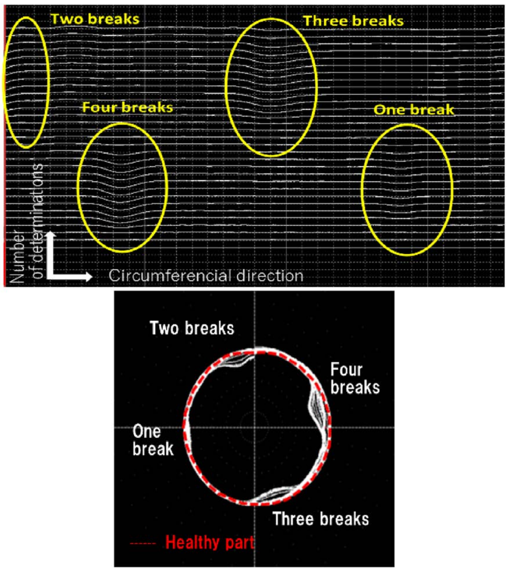

Fig. 5 Line and circular waveform detected by eddy current test

3. Inspection Procedure

The inspection procedure using the self-propelled stay-cable inspection device consists of preparation, setting, lifting, lowering, and removal of the device. If deformation is detected in a protection pipe, the inspection sensor is attached to the main unit and an eddy current flaw detection test is performed. The device can be used to inspect six to eight stay-cables per day which is equivalent to the speed of close visual inspection.

4. Conclusion

For the inspection of cable-stayed bridges and extradosed bridges, the following effects were obtained by using the self-propelled stay-cable inspection device, which is an innovative inspection device that contributes to the higher durability and safety of cable-stayed bridges and extradosed bridges.

- The device can efficiently inspect the deformation of protection pipes with the same accuracy as close visual inspection by human inspectors.
- Previously, the only way to inspect protection pipes located in high places was to use rope access technology or mobile elevated working platform. However, this device enables safe inspection in high places by remote control from the ground level.
- If there is any deformation in a protection pipe, the presence or absence deformation of the prestressing steel cables inside the protection pipe can also be easily inspected by using the device.

References

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