Activities to Improve Reliability of and Streamline Periodic Inspection of Road Tunnels, Bridges, etc.

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1. Introduction

Obligation of periodic inspection once in five years was stipulated by law in 2014 with respect to about 10,000 tunnels, 700,000 bridges, etc. all over the country. In fiscal 2019, the second cycle of this periodic inspection started. The Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") updated the technical advice (periodic inspection procedure) and notified road administrators across the country in March 2019 in order to improve the reliability of periodic inspection and contribute to streamlining of inspection operations etc. using new technologies etc. Accordingly, NILIM analyzed the results of past periodic inspections etc. and the draft of revised version with the Road Bureau. This paper introduces an example of the study conducted by NILIM to improve the reliability of periodic inspections and streamline the inspection operations.

2. Study for improvement of reliability

In periodic inspection of tunnels and road bridges under national control, detailed conditions are recorded in addition to the data required by law in order to use inspection results for quality improvement and streamlining of the maintenance of road structures in the country. NILIM has been conducting various analyses using this record.

Fig. 1 shows the result of probability calculation as to what extent of damage occurs due to aging to the members of which condition was altered in repair / reinforcement and to the members standing since the beginning. In each year, red (e) represents the probability of damage being serious, and blue (a) represents the probability of damage remaining minor. Fig. 1 also shows increase in the probability of leading to serious damage according to the elapsed years. It is also found that there is a probability of serious damage even if the number of elapsed ears is relatively small. For the members repaired / reinforced, distribution of the degree of damage is inclined to blue (a) or red (e), unlike the members remaining since the beginning, which suggests the trend of being vulnerable to damage.

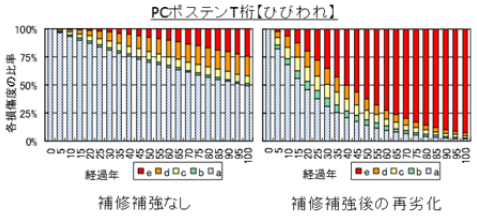

Fig. 1: Example of re-deterioration of the repaired / reinforced member

Fig. 2 shows results of the organization as to what extent of damage is caused to the member in next periodic inspection (5 years after) that had no or minor damage in the previous periodic inspection. It is found from this that even a sound member may have damage to some extent.

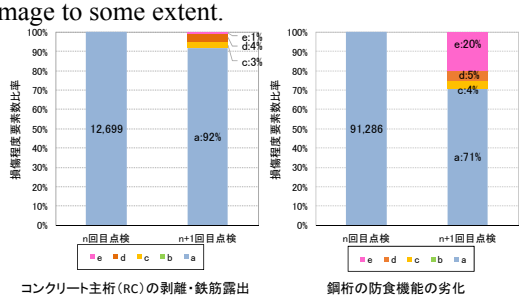

Fig. 2: Example of change in the element with "a" after five years

We conducted various analyses on other structures. For example, as a result of analyzing the spots of floating / peeling / exfoliation of concrete, which were confirmed in the tunnel periodic inspection, they were concentrated on the joint part at 65% and damaged part and repaired part at 34%, as shown in Fig. 3.

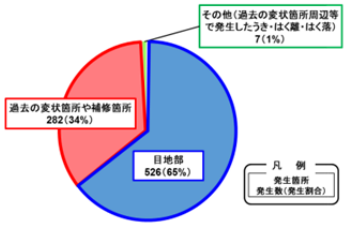

Fig. 3: Occurrence trend of floating / peeling / exfoliation

As known from the above, it was confirmed anew that periodic condition check is important to detect abnormality and carry out timely actions, without depending on the elapsed years or condition confirmed in the previous inspection. Further, including the above-mentioned results and the results of analyzing other various damages, technical considerations in grasping damages to tunnels, road bridges, etc. were improved. For example, from a viewpoint of preventing peeled concrete from falling onto road users etc. and causing injury, examples of the structure / part that requires focused inspection or that allows for labor saving, according to structural characteristics were improved.

3. Study for streamlining

It was also suggested from the aforementioned analysis of periodic inspection results that nondestructive inspection etc. are desirable in addition to short-range visual observation for some parts or damages and other method could be taken in some cases. It was also found from the examination of actual periodic inspection records by each road administrators that many road administrators have detailed record of conditions such as crack drawings and photos by typically classifying types and sizes of damages and are quantitatively recording their occurrence range etc. Accordingly, it is also important to maximize the effect of data accumulation by each administrator through streamlining of their work and utilization of their data.

Hence, it was decided in accordance with the scheduled renewal of technical advice to support the grasp of detailed condition and disseminate reference information for utilization of equipment etc. contributing to laborsaving in recording work. For example, in selecting equipment etc. on the site, it is desirable that the specifications and capability of various equipment etc. are indicated in a unified manner and can be compared and that errors etc. should be clarified for interpretation of results. Then, technical data providing the specifications and characteristics of machines in a unified manner was prepared for the equipment etc. that have been tried by the government. NILIM has conducted joint studies and proposed as findings the methods of grasping and indicating capabilities in using equipment etc. that support conditin detection at narrow part, etc. (See Fig. 4). These proposals were referred to in indicating the specifications and capability of equipment etc.

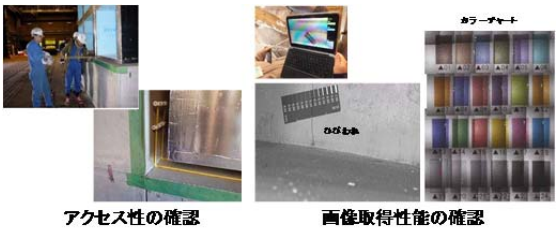

Fig. 4: Verification items for using supporting equipment

It was also found that local governments often keep records, as symbols, of not only soundness diagnosis results but damages to each part of road bridge following the "Basic data collection procedure," which is one of the detailed damage recording methods. Then, NILIM has published deterioration curves (see Fig. 5) created from the data accumulated on national roads under control according to the types of members and damages for comparison with average aging of the road bridges under national control when the condition is recorded following the procedure above. These deterioration curves are expected to serve as reference when studying the priority of actions for a lot of structures that need preventive maintenance, e.g. by comparing the average trend of aging with the condition of the target structure.

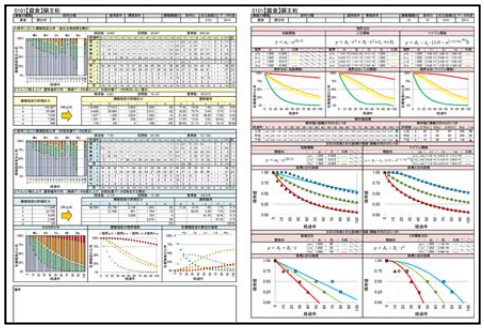

Fig. 5: Example of deterioration curves (corrosion of main girder)

4. Conclusion

The issues in repair / reinforcement design were also clarified from the results of periodic inspection. For repair / reinforcement, we intend to improve technical standards in turn since improvement thereof is urgently required.

☞See the following for details.

1) Material for the 10th meeting of the Road Technology Subcommittee, 2) Technical Note of NILIM, No. 1030, 3) Technical Note of NILIM, No. 381, 4) 2018 NILIM Report "Analysis of deterioration characteristics of road bridges based on road bridge periodic inspection data", 5) 2019 NILIM Report "Development and Implementation of the Performance Evaluation Method of Nondestructive Testing Techniques"