Enhancement of Technical Information Associated with the Revision of the Regular Inspection Procedure for Road Bridges

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1. Introduction

Triggered by the ceiling plate collapse accident in the Sasago Tunnel on the Chuo Expressway in December 2012, relevant laws and regulations were amended in 2013, and regular inspection are now required by law. The ten years after the regular inspection became legally mandate, the national bridge inspection standards referred to as the ministerial technical advice were revised in March 2024 based on a thorough technical review and analysis by Bridge and Structures Division, NILIM, on the quality of inspection records and lessons learned after the mandate bridge inspection took effect.

The regular bridge inspection is an essential part of bridge management, and revisions to the standards influence the day-to-day practices of every road owner. With the technical excellence of NILIM and the rich experience in MLIT's highway offices, the hands-on experience sessions and revised training courses were smoothly prepared and delivered to the road owners. This article summarizes efforts to enhance technical information on bridge inspection for road owners and engineers.

2. Details of the revision of the regular inspection procedure

In the revision, the requirement to record the bridge inspection results was made more stringent to ensure accountability for the inspection results. Plus, the standard part and recommendation part of the bridge inspection record were clarified. The law requires bridge owners to declare the maintenance policy for individual bridges, known as the bridge integrity classification. The revised standards now require that the load-carrying performance evaluation for vehicle traffic, earthquakes, torrential rains, and floods, etc., which are rarely expected at the time of the next regular inspection, be recorded. In addition, durability performance should be considered, and distress that may significantly affect life-cycle costs should be recorded. These technical evaluations should have been essential for bridge owners to decide the bridge integrity classification, but were not always shown in the bridge inspection record. To strengthen technical accountability for bridge inspection results for bridge users and avoid poor decisions due to the lack of relevant technical backgrounds, the standard record items were revised.

Although it was not mandatory, bridge owners sometimes recorded detailed damage distributions using their own protocols. However, such recording work was often cumbersome and labor-intensive. Still, it was understandable that the owners would want to record as much information as possible for future use in asset management. Accordingly, in addition to the national bridge inspection standards, MLIT has now provided a recommended objective data recording protocol from the owner's asset management perspective. As a merit, using the recommended protocol, the recorded data can be statistically comparable to deterioration curves obtained by NILIM from earlier damage records collected with an equivalent but more detailed data-recording protocol from more than 20,000 bridges operated by MLIT across Japan.

3. Hands-on experience sessions

The MLIT Headquarters, Regional Bureaus, and NILIM held hands-on experience sessions in every region across Japan within three months after the revision, such that bridge owners could attend and ensure the aim of the revision. A total of 8000 officers from bridge owners participated. The sessions were held at bridge sites. NILIM especially provided practical, hands-on guidance on conducting the bridge performance evaluation based on on-site observations of the bridge structure and condition. Observing the bridge together with the participants helped them experience the technical aspects of the performance evaluation for individual bridges during inspection, as well as the relationship between these evaluations and the owner's decision for the bridge maintenance policy.

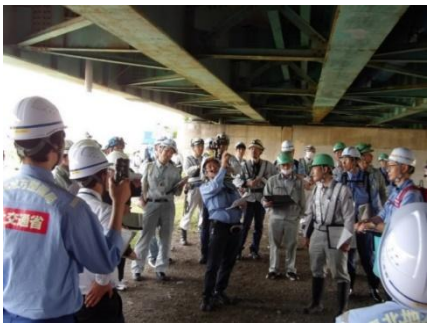

Photo-1 Hands-on experience session on a bridge site

4. Support for acquiring knowledge and skills in the implementation of regular inspection

MLIT Regional Development Bureaus regularly provide road owners with the official training course for the mandated regular inspection, since the inspection became mandated. NILIM, in addition to its ordinary mission of research, plays a nodal agency role in providing the course curriculum, lecture materials,

follow-up documents, and the exam system, which are published as the official text and as a NILIM report. In line with the revision of the national inspection standards, NILIM has revised the lecture materials, on-site training materials, and exam structures.

The training course is designed to understand the legal aspects of regular and other inspections, and to efficiently and systematically acquire the essential technical knowledge and skills to observe the structural load-carrying system and distress of bridges, examine the causes and states of damage and the bridge performance conditions, and report these findings and technical reviews. The training course includes lectures, on-site training, and an achievement exam. In the exam, participants observe a bridge at a hands-on distance and describe their observations and technical views of its performance.

Table-1 Bridge Inspection Training Curriculum

Category	Curriculum
Laws, regulations, and standards	Code structures – Laws, regulations, and standards in mandated road structure inspection
	Art of bridge observation, bridge performance evaluations, and reporting
Performance evaluations for structural elements and components	Basics to bridge structures, roles of components and elements, loads, limit states, and structural mechanics
	Damage mechanism of steel members and its influence on resistance and durability
	Damage mechanism of concrete members and its influence on resistance and durability
	Damage mechanism of substructures and its influence on resistance and durability
	Damage mechanism of bearings and accessories, and its influence on resistance and durability
On-site exercise	On-site exercise for hands-on observations and technical evaluations for bridge performance
Related structures and facilities	Inspection for pedestrian bridges and overhead sign structures and supports
	Basics of the structural system of sheds and large-scale culverts
	Damage mechanism and technical evaluation for rock/snow sheds and large-scale culverts
Achievement examination	Practical and background knowledge of laws, requirements, and technical evaluations for mandated inspection (Select type test)
	Principle and practice of the bridge observation and technical evaluation examination (Written test)
Updates	Latest damage cases and takeaways

The course is not intended to teach the classification of damage types and their extents. The key is to learn the relationship between load paths and the roles of structural elements in bridges, the influence of distress on bridge load-carrying performance depending on the damage type and location, its cause and source, and to apply this knowledge to review bridge performance in bridge inspection reports. In addition, without an understanding of the legal and overall picture of bridge inspection administration, inspectors and related officials cannot provide a relevant technical review of the need for, or no need for, maintenance actions for individual bridges.

Table-1 shows the curriculum. The course starts with an understanding of the relevant regulations and standards, technical backgrounds, notable bridge damage events, and earlier struggles in bridge management in Japan. Then it covers the load-carrying mechanisms and the roles of the elements of bridges, with a brief catch-up on fundamental knowledge of structural mechanics, materials, loads and load effects, and bridge engineering. After that, through chosen case studies, participants study the mechanisms and progression of damage in steel and concrete members, foundations, bearings, and related components, with detailed characteristics of typical damage distributions and locations. Finally, by combining basic knowledge of bridge structure and condition with the causes, evolution mechanisms, and types of distress, the participants understand the principles and how to observe bridges and evaluate their load-carrying and durability performance individually. Then, participants train in the art of an articulate, technically sufficient description of bridge performance conditions through on-site exercise using an existing bridge. As shown in Photo-2, in the on-site exercise, participants conduct a hands-on observation of the bridge, record the damage and irregularities, estimate the cause and condition of the observed damage, and evaluate the bridge's performance. The achievement exam includes general technical knowledge and skills necessary for inspection. In particular, the written test covers the art of describing the technical considerations of the present bridge performance, its reasons, and supporting evidence for the bridge used in the on-site training.

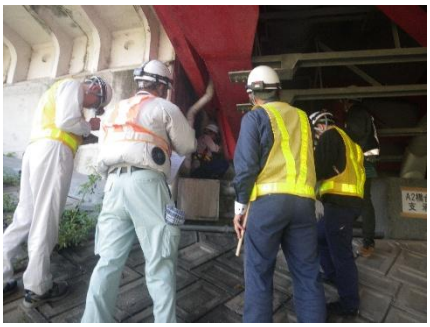

Photo-2 Trainees conducting a hands-on observation on a bridge in the MLIT bridge inspection course

NILIM is the national institute for the research and development of technical policy and standards for bridges and structures, and it has a wide range of knowledge and experience in bridge performance evaluation. Accordingly, NILIM owned the update of the lecture materials, such as adding case studies and more comprehensive photo examples of bridge damage, and also has developed a new systematic learning process and guidance for the performance evaluation system of existing road bridges. NILIM also directly delivered lectures on related laws, regulations, and standards, on the observation and evaluation of bridge performance, and on the technical writing of inspection results.

5. Remarks

The introductory material, the official textbook, and other supplemental references for the training course are available on the website[1)-3)]. The Bridge and Structures Division will continue pursuing the mission of developing technical standards for bridge design, inspection, repair, retrofit, and rehabilitation.

☞For more detailed information, visit:

1) Website of the MLIT https://www.mlit.go.jp/road/sisaku/yobohozen/tenken/yobo7_17.pdf
2) Technical Note of NILIM No. 1307 (https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1307.htm)
3) Website of the Bridge and Structures Division, NILIM https://www.nilim.go.jp/lab/ubg/index.htm