

Activities for maintenance and construction of road structures

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1. Introduction

The aging of the road structures, which were intensively constructed during and after the high economic growth period, is becoming a serious problem nationwide, and it is necessary to properly maintain these road structures without excessive cost, in preparation for the coming depopulation. To properly maintain road structures, we have to follow a maintenance cycle that includes an inspection, diagnosis, treatment, and recording. Periodical inspections based on the laws for bridges and tunnels started in July 2014. From now on, it is important to take measures based on the inspection and diagnosis results and effectively follow the maintenance cycle. In addition, to ensure stability for people and an active local economy, it is necessary to more effectively and efficiently construct highly durable road structures on a limited budget. The utilization of new construction forms and materials is one of the methods for that purpose. Ensuring the security and durability of the constructed structures is necessary for the accurate utilization of these new technologies.

In order to maintain the road structures and support their effective construction from a technical perspective, in cooperation with the Ministry of Land, Infrastructure, Transport and Tourism and related agencies, the Road Structures Department prepares drafts of technical standards for bridges, tunnels, earthwork structures, pavements, etc.; investigates and researches matters required for the preparation of these technical standards; gives technical instructions and advice on problems in the actual field; and develops engineers with specialized experience.

2. Operation of reliable and effective maintenance cycle

For the reliable and effective operation of the maintenance cycle, reliable inspection and diagnosis systems and a reduction in the burden and costs of field works are necessary. In addition, the development of technologies to support the inspection and diagnosis systems, and measures such as for repair and reinforcement, are required. Therefore, the Road Structures Department is mainly conducting the following research:

1) Inspection

An evaluation on the adaptability of non-destructive test technologies using electromagnetic waves, X-rays, and infrared rays to check for damage not found by an appearance check such as corrosion inside concrete and underground foundations

Rationalization measures for inspections based on the analysis of the periodical check data of bridges and tunnels (inspection items, frequency, procedures, etc.)

2) Diagnosis

Procedures to determine the integrity of damaged bridges based on an analysis method with damage condition data and the actual material strength, and procedures to evaluate the condition of rusted weatherproof steel materials using binocular vision photos of rust

3) Repair and reinforcement

A design method for the repair and reinforcement of existing bridges (Photo 1), using a partial coefficients design that applies the variation in existing members and

additional members, and the actual material strengths and loads corresponding to a scheduled service period

Performance requirements and management items for the hot-work technology used for reinforcing steel bridges



Photo 1: Reinforcement of bridge with external cables

A method for evaluating the durability of fall prevention works used as tunnel repair measures, and a selection method based on an abnormal condition

The damage condition and repair and reinforcement effects of underground structures such as sheds and culverts, based on the analyzed inspection data

Regarding pavements that are not subject to periodic inspections, we are promoting research on appropriate maintenance methods based on the pavement condition by type (concrete pavement or asphalt pavement), and the life elongation effects of maintenance construction methods such as patching. In earthwork construction, for banking and cutting, which are not subject to periodic inspections, we are promoting research on maintenance methods that incorporate the viewpoints of road functions and risk management. Furthermore, we are promoting research on ways to create and utilize a plan for a longer-operating life, in order to establish a management method to maintain and upgrade road structures on a budget.

3. Construction of reliable road structures

To construct reliable, safe, and durable structures with new structural forms and materials, it is necessary to

clarify the performance requirements of the structures, and set-up a design method for reasonably evaluating the characteristics of the structural forms and performance of the materials. In addition, to reduce the future maintenance burden, it is important to adopt a design that considers durability and easy maintenance, and to ensure quality at the time of construction. Therefore, the Road Structures Department is mainly promoting the following research:

- 1) Design method with appropriate performance evaluation

A partial coefficients design method, which can be used to individually consider the working loads and safety margins of materials, and appropriately evaluate the performances of bridges with various new forms, and a design method for bridges with complicated stress conditions, along with structural analysis methods such as constant shear flow panels and cubic lattice models

A method for setting the design load when designing a the covering structure of a tunnel to which no standard support pattern is applied (because of little earth covering, weak soil, etc.), along with an analytical method, and a performance requirements and performance verification method

A method for setting the design load to ensure the performance required for a large-scale earthwork structure, and also an earthwork structure with a new form, as shown in Photo 2, and a performance requirements and performance verification method



Photo 2: Example of earthwork structure with new form (abutment back approach part with reinforcing clay wall)

2) Design and construction method, allowing reduction of maintenance burden

Improved durability, structural details, and specifications allowing a reduction in the burden for inspection and repairs, and a quality management method for the construction phase, designed by integrating the knowledge acquired from analysis on inspection results

Application of concrete pavements with high durability, for pavement lifecycle cost reduction

In addition, regarding members other than these major structures, we evaluate the third-party damage risks quantitatively with the goal of preventing third-party damage, and promote research on design methods for effective prevention and measures procedures.

4. Human development, and technical instruction and consultation

To develop engineers with specialized experience, we prepare training textbooks and send lecturers to lectures and training, which contribute to the development of engineers and the improvement of their technical skills, targeting not only the staffs of the Regional Development Bureaus of the Ministry of Land, Infrastructure, Transport and Tourism, who are charged with the actual maintenance work for road structures, but also the staffs of local authorities and private engineers. In addition, we provide technical consultations regarding technology audits and evaluations, which require professional knowledge about disasters, serious accidents, failures,

and advanced details of the standards, instruct the field staffs. We also participate in committee meetings to support them, and also send our staff to the "Direct Diagnosis" conducted by the "Road maintenance technology group," which consists of the Regional Development Bureau staff, as a support activity for the local authorities (two bridges and one shed in FY2016). Numerous lessons that we learned through technical consultations are introduced in the Civil Engineering journal, which is collaboratively edited by the NILIM and the Public Works Research Institute, under the title "Maintenance we can learn in field works (in Japanese)."