For Strong and Resilient Roads

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Keywords: road structures, disaster prevention / mitigation, maintenance, design / construction

1. Introduction

Road structures such as bridges, tunnels, earthworks, and pavements support a safe, secure, and highly productive society by providing road functions. In order to support proper maintenance and efficient renewal of these road structures, the Road Structures Department drafts technical standards and conducts research necessary for that, provides technical consultation about on-site issues, and implements technology transfers.

In fiscal 2018, various disasters and accidents occurred and the Road Structures Department accordingly advanced its policies greatly, which included making modifications to the National Resilience Plan and revisions to periodic inspection procedures. This paper introduces the status of road structures, NILIM's activities, and future vision from the three standpoints of disaster prevention / mitigation and crisis management, infrastructure maintenance, and efficient development of road assets.

2. Disaster prevention / mitigation and crisis management

Table 1 lists the disasters that occurred in fiscal 2018. This table summarizes the data published in the website of the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") concerning disaster information. As "disaster" was chosen as the kanji (Chinese character) representing the year of 2018, many disasters occurred in 2018. In the same year, NILIM also took an emergency posture more than 10 times and conducted field surveys and technical support as described herein.

Disasters suffered in the year include liquefaction in filled wetlands, sediment disasters that seriously impacted transportation systems, and earthwork deformation. To establish a risk management method for such natural disasters, NILIM focuses on the improvement in disaster prevention performance by upgrading technical standards for new infrastructure, preventive measures for potential risk mitigation and disaster reduction for existing facilities, identifying disaster scale for securing the emergency system, and technologies for elimination of road obstacles, emergency restoration, and disaster recurrence prevention, and aims to reflect research findings successively in practice.

Particularly for liquefaction, we study risk assessment methods for box culverts, embankments, etc. and provide information on strong motion observations to facility administrators through joint research with the Public Works Research Institute, etc. We also develop facilities required for studying impact mitigation technology concerning subsidence of road structures caused by earthquakes.

3. Maintenance of infrastructure

As international standards for asset management, the ISO 55000 series requires the establishment of a hierarchical management cycle as shown in Fig.1, as well as a system to evaluate and improve implementation of the cycle. [1)] NILIM conducts R&D of various technologies that constitute the management cycle and is responsible for proposing necessary measures through analysis of inspection

Table 1: Disasters in fiscal 2018

Date	Type	Disaster	NILIM's response
Apr. 9	Earthquake	Earthquake centered in the western part of Shimane-ken	Watch
Apr. 11	Other	Sediment disaster in Nakatsu-shi, Oita	Watch
Apr. 14	Earthquake	Earthquake centered in the ocean off the south-eastern coast of the Nemuro Peninsula	Watch
Apr. 19	Volcano	Eruption of Mt. Kirishima (around the Ebino Highland)	Caution
May 12	Earthquake	Earthquake centered in the northern part of Nagano-ken	Watch
May 18	Storm / flood	Heavy rain from May 18	Watch
May 25	Earthquake	Earthquake centered in the northern part of Nagano-ken	Watch
June 17	Earthquake	Earthquake centered in the southern part of Gunma-ken	Watch
June 18	Earthquake	Earthquake centered in the northern part of Osaka-fu	Emergency
July 3	Storm / flood	July 2018 Heavy Rain (by Typhoon No. 7 and rain front)	Emergency
July 7	Earthquake	Earthquake centered in the ocean off the eastern coast of Chiba-ken	Watch
July 30	Storm / flood	Typhoon No. 12	Emergency
Aug. 5	Storm / flood	Heavy rain from Aug. 5	Emergency
Aug. 8	Storm / flood	Typhoon No. 13	Emergency
Aug. 15	Volcano	Volcanic activity on Kuchinoerabu Island	Watch
Aug. 22	Storm / flood	Typhoon Nos. 19 and 20	Emergency
Sep. 4	Storm / flood	Typhoon No. 21	Emergency
Sep. 6	Earthquake	2018 Hokkaido Eastern Iburi Earthquake	Emergency
Oct. 1	Storm / flood	Typhoon No. 24	Emergency
Oct. 9	Storm / flood	Typhoon No. 25	Emergency
Jan. 3	Earthquake	Earthquake centered in the Kumamoto Region of Kumamoto-ken	Emergency
Jan. 26	Earthquake	Earthquake centered in the Kumamoto Region of Kumamoto-ken	
Feb. 21	Earthquake	Earthquake centered in the middle-eastern part of Iburi Region, Hokkaido	Emergency

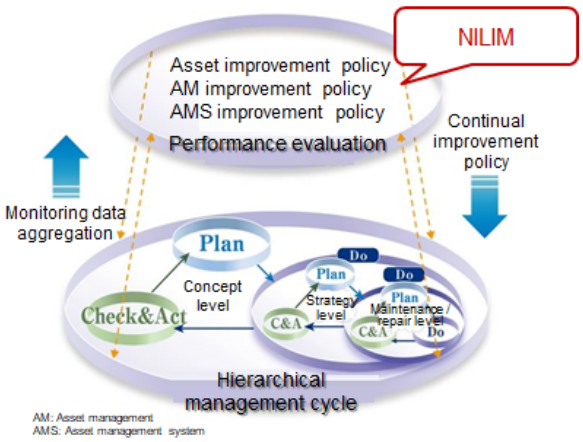

Fig. 1: Maintenance cycle

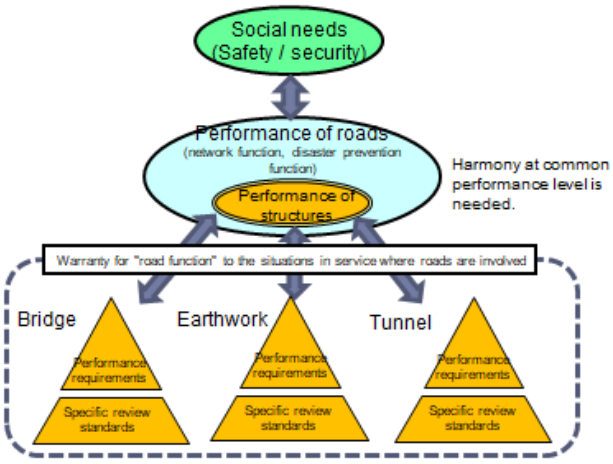

Fig. 2: Road performance and structures

results and collection of defect information.
For road structures including tunnels and bridges, visual proximity inspections are to be conducted under the act every five years as of fiscal 2014. For the second round of inspections under the act, which starts in fiscal 2019, NILIM has proposed revising the inspection procedure based on the analysis of the periodic inspection results and serious damage / accident cases. In the proposal, while specifying the spots to check according to structures to reduce hammering test / inspection by touching, spots to check and points of attention for characteristic deformation are increased. NILIM is also organizing the environment for cycle establishment, including guidelines for the utilization of inspection supporting technologies, which are being developed in each field, performance catalogs, etc. We want to improve the reliability and efficiency of inspections by continuing to use inspection results.
As inspections proceed, structures requiring repair / reinforcement are also becoming apparent. In order to streamline operations, we continue to push the introduction of the partial factor design method into repair / reinforcement design of road bridges, as well as the survey / design method for improving early deteriorated pavement sections.
We also promote the study of management methods commonly available for road structures so that efforts in asset management, which is spreading across the country, are more streamlined and effective.

4. Efficient development of road assets

For road bridges, the design technology standard was revised in July 2017 from the allowable stress design system to the partial factor design system, and the condition that "Design is possible that realizes various performances including safety reasonably and meticulously considering reliability" for various conditions of new equipment design was established. Applying this condition, we study ways to rationalize measures by utilizing new technologies such as high strength materials and an effective and reasonable repair / reinforcement methods for existing structures.
Furthermore, as shown in Fig. 2, in order to harmonize the performances of all road structures from the viewpoint of road functions, which is the ultimate purpose of road structures, we organize performance requirements systematically by design technology standards for tunnels, earthwork structures, pavement, etc. and study regulation measures that enable more specific performance design.
Furthermore, in consideration of the development of ICT technology, we also study an efficient management method using ICT technology for the process from design to maintenance of road structures.

Through the activities described above, the Road Structures Department intends to contribute to the development of strong and resilient roads and robust land.

[References]

1) KOBAYASHI Seiji, TAMURA Keiichi, FUJIKI Osamu: International Standard Asset Management Method, Kajima Institute Publishing, 2016.