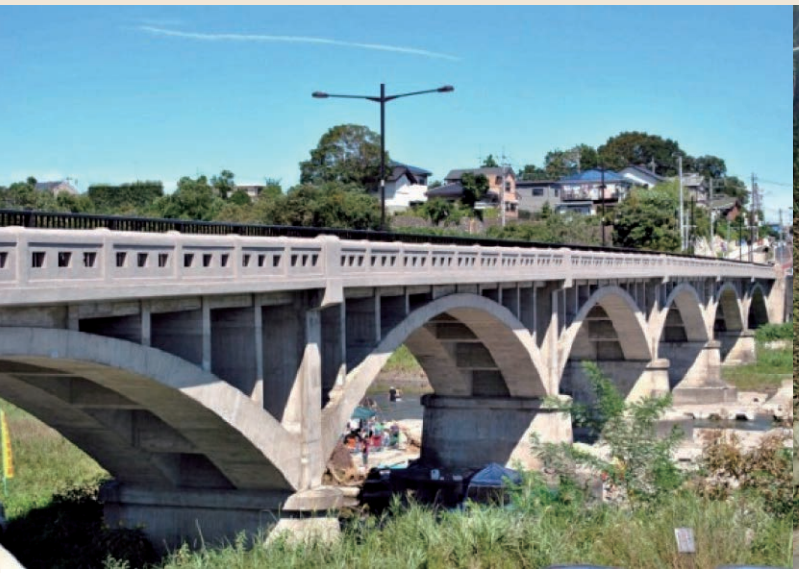
Infrastructure Health Report

Road Sector Trial Version

May 2016



Higashi Akiru Bridge, Tokyo
Selected as the JSCE Civil Engineering Heritage, 2015

Seiso Railway No. 2 Tunnel, Chiba
Selected as the JSCE Civil Engineering Heritage, 2014

JSCE 公益社団法人 土木學會
JAPAN SOCIETY OF CIVIL ENGINEERS

Message from the President of JSCE

Noriaki Hirose
(103rd JSCE President)

Infrastructure has contributed greatly to the rapid economy growth and improvement in quality of life. However, the aging of such infrastructures is now a major social issue. Thus far, focus has been placed on assigning a budget and engineers to new construction projects. In the future, it will become necessary to shift these resources to the maintenance and updating of aging infrastructure. Infrastructure is closely related to the lives and economic activities of all people. In order for us in the present and subsequent generations to enjoy lives that are safe, secure and full of vitality, it is essential to adequately maintain and update infrastructure.

Due to the importance of infrastructure development and management, current assessment of overall infrastructure by civil engineers' societies is being conducted in the United States and the United Kingdom, and the results thereof are becoming widely recognized. Based on the deterioration state and management system of the infrastructure in Japan, JSCE, as a third party institution, has also decided to assess the soundness of the current infrastructure. The target of the assessment shall be the overall infrastructure, and the results will be summarized in the "Infrastructure Health Report" which is scheduled to be released. This year, preceding other infrastructure, a trial health report has been prepared with roads as the target, including bridges and tunnels for which there is already a systematic implementation of inspection and diagnosis.

Through the widespread understanding of the current status of the infrastructure as well as the recognition of the importance and future tasks for the maintenance and updating of the infrastructure by the Japanese citizens, we hope that you will take action and cooperate with us in seeking the solution to the issues.

Results of the Health Assessment in the Road Sector

Bridges	**D** ↗	- Currently, deterioration in many bridges is obvious. There is a need for urgent maintenance and repair and to stop the progression of the deterioration process. - Deterioration is obvious in many tunnels and maintenance and repairs on the deteriorating sites are urgently needed.
Tunnels	**D** →	- There are always certain sections on road surfaces (pavement) which deteriorate quickly, and early repairs in accordance with the maintenance evaluation level are required. - Regarding the management system, since the revision of the Road Act in 2014, the system for the maintenance of bridges and tunnels has improved. However, there are differences in efforts regarding the formulation of tunnel maintenance plans according to the administrator. Regarding the road surface, there are some administrators who have not yet formulated a maintenance plan. Thus, the formulation of a plan and the enhancement of a system for implementing the plan are desired.
Road Surface (Pavement)	**C** ↘	

Health Assessment Index

Health assessment is carried out by means of a method developed independently by JSCE, that of collecting released published data and surveys of inspection results and maintenance system information of the facilities. By assessing data provided by each administrator, the national average is expressed as an index.

Health Assessment Index of the Facilities

A Sound	B Satisfactory	C Caution	D Warning	E Critical
No deterioration is seen in most facilities	Deterioration is seen in some facilities	Deterioration is progressing in quite a few facilities, requiring early repairs	Deterioration is obvious in many facilities, requiring repairs and reinforcements	Deterioration is serious overall, requiring urgent measures

Management System of the Facilities

↗	→	↘
The state in which, if the present management system continues, the health condition will likely progress toward improvement.	The state in which, if the present management system continues, the current health condition will continue.	The state in which, unless there is an improvement in the present management system, there is a possibility that the health condition will deteriorate.

Road sector

Bridges D →

There are approximately 720,000 bridges (2m or longer) in Japan. The majority of them were constructed during the period of rapid economic growth, in other words, their in-service period has exceeded 30~50 years. In 10 years, 40% of all bridges will have exceeded the in-service period of 50 years. Of that number, there are approximately 230,000 old bridges which have no record of the construction year.

It can be assessed regarding the current health condition of bridges is that deterioration is obvious in many bridges. It is expected that deterioration over time due will continue. Therefore, many bridges require repairs and continuous implementation of adequate management is essential. The level of health varies according to the administrator as indicated in Table 1. The ratio of bridges managed by the prefecture and government-ordinance designated cities is approximately 25% of all bridges nationwide, those managed by municipalities constitute approximately 65%, totalling approximately 90% of all bridges. Therefore, measures are required to ensure that some bridges do not fall under the dangerous category.

Although many bridges are obviously deteriorating, a long-term management plan has been established by various administrators and regular inspections held once every 5 years have become compulsory, indicating that measures are being carried out with recognition for the importance of management. If the present maintenance system continues and is implemented effectively, it is anticipated that the health condition of bridges will improve. However, the number of engineers engaged in the maintenance of bridges cannot be said to be sufficient, requiring the improvement both in the quality and quantity of engineers.

Table 1 Health Status by Administrator

Nationally-managed roads	Roads managed by the prefectures and government ordinance-designated cities	Roads managed by municipalities	Intracity roads managed by Expressway Companies	Intercity roads managed by Expressway Companies
C	D	D	C	C

Road Sector

Tunnels D →

There are approximately 10,000 road tunnels in Japan. As with bridges, the majority of them were constructed during the period of rapid economic growth, in other words, tunnels reaching 30~50 in-service years are increasing.

Regarding the number of tunnels by administrator (Table 2), approximately 30% are managed nationally or by Expressway Companies, approximately 50% are managed by the prefectures or government ordinance-designated cities and approximately 20% are managed by municipalities.

As for the health condition, tunnels managed nationally, those managed by Expressway Companies, those managed by the prefectures or government ordinance-designated cities, those managed by municipalities were in good health condition, in that order. Although they are not in a serious condition, it is thought that there are a great deal of tunnels requiring early repairs. However, this is the first year that a systematic inspection was carried out, and there is a possibility that some administrators may have started inspecting tunnels with a prior knowledge of an inferior health condition.

Regarding the system of managing the health of tunnels, from the perspective of the storage of facility register management, inspection records and repair records, tunnels managed by the Expressway Companies were good and those managed by the prefecture were basically good. However, tunnels managed by municipalities require future effort. Each administrator has proposed a long-term inspection plan and therefore, improvements in the health condition of tunnels are anticipated, although planning and improvements in the securing of the number of inspection engineers and certification of skills are necessary.

Table 2 Health Status by Administrator

Nationally-managed roads	Roads managed by the prefectures and government ordinance-designated cities	Roads managed by municipalities	Intracity roads managed by Expressway Companies	Intercity roads managed by Expressway Companies
C	D	D	C	C

Road Sector

Road Surface (Pavement) C →

The total length of paved roads in Japan is approximately 1 million km, with a surface area of approximately 5,300km^2 (roadway) and the length thereof is equal to 25 times the circumference of the earth, with the area approximately 2.4 times the size of Tokyo Metropolis. A paved road surface is connected to running safety and is a structure with a prerequisite of renewal after a set period of time. Damages to such road surface have a direct and major effect on the safety and comfort of the users.

The health condition of the surveyed road surface (pavement), excluding that of municipalities, was relatively satisfactory. However, there were some areas in which the deteriorated road surface was not adequately renewed. The degree of health differs according to the administrator, as shown in Table 3. The control value differs according to road use, such as expressways requiring a road surface with a greater level of soundness due to high-speed travel. However, there are arterial roads which do not satisfy the control values suitable for roads managed nationally and by prefectures or government ordinance-designated cities. Such roads require further improvements in their health condition.

Concerning the maintenance system, there are slight differences according to the administrator, and although expressways have a fixed assessment system, the majority of administrator overseeing general roads have such problems as the postponement of necessary repairs, increase in complaints, and increase in cases of management flaws, etc. It is of great concern that the maintenance of the current health condition of roads is becoming more and more difficult each year. Furthermore, there are administrators who have not yet formulated a pavement maintenance plan, and so it is hoped that plans will be formulated in order for effective maintenance to take place.

Table 3 Health Status by Administrator

Nationally-managed roads	Roads managed by the prefecture and government ordinance-designated cities	Intracity roads managed by Expressway Companies	Intercity roads managed by Expressway Companies
C	C	B	B

Note) Roads managed by municipalities were not surveyed in this report; therefore, they are not the target of assessment.

In preparing this health report:

The purpose of the infrastructure health assessment is designed not only to assess the infrastructure but also to gain the understanding of the Japanese citizens and to indicate the necessity of formulating a policy for improvement. The assessment results of bridges, tunnels and road surface (pavement) in the road sector all have different assessment items and standards; thus, the results thereof are not intended to be compared. Regarding the road surface (pavement), there is no inspection manual designated by the state and therefore is an assessment based on questionnaire surveys by JSCE. In addition, due to municipalities not being the target of this survey, we will continue to seek methods of carrying out surveys in this area.

The focus of the report and evaluation was the level of soundness (damage level) attributed to aging. However, it is necessary to evaluate the intended function and physical capacity of the infrastructure as it is done in the U.S. and U.K. (i.e. road capacity and safety, safety of river flood control and water utilization, etc.) in the future.

In order to effectively maintain the vast infrastructure scale, it is anticipated that with the deepening of understanding of the citizens regarding the health report results, the administrators in turn, will further improve their maintenance based on the above results.

Kotaro Hashimoto,
Chairman, Special
Committee on
Health Assessment of
Infrastructure
(101st JSCE President)

Maintenance and Updating Issues and Solutions

Extending the life of infrastructure and adding new functions thereto by means of updating contribute to alleviating the cost burden to the next generation as well. Maintenance of infrastructure consists of 3 factors, namely, **(1) a system to carry out maintenance, adequate inspections, diagnosis and measures to implement it, (2) development of an effective and efficient maintenance technique, and (3) budgetary provisions**. If there were deficiencies in any of the above factors, maintenance cannot be adequately carried out.

Regarding an adequate system and implementation, administrators must acknowledge that strict demands will be placed on their managerial responsibilities and capable engineers must be assigned who can adequately determine the deterioration state of the infrastructure and the countermeasures thereof. Additionally, there is a need to establish an arrangement for maintenance engineers to achieve technical advancements and to utilize such advancements. A certification system by private sectors has been adopted, and through clinical practice and examinations, cultivating manpower with practical skills and utilizing such personnel are essential.

As to maintenance technology, new techniques need to be adequately evaluated and an arrangement and contract system to promote their use are required. Advancements in nondestructive inspections are remarkable; therefore, it is indispensable to promote the streamlining of standards and systems based on latest technologies and inspection data.

Concerning budgetary provisions, it is necessary to have the basic understanding that deterioration of infrastructure leads to social insecurity and economic stagnation. Maintenance entails an accumulation of daily effort, and administrators need to secure a long-term, stable budget. A system design in which there is a sound growth in maintenance businesses is essential.

In addition, there are many facilities, although sound, do not have the basic physical capacity due to underestimation at the design stage. However, in view of the intensification of effects such as the frequent occurrence of earthquakes and the increase in torrential rainfall in recent times, this situation is far from ideal. Examinations of physical capacity and urgent improvements thereto are indispensable.

Future Plans

Health assessment will be carried out for overall infrastructure.

In 2016, we plan to release the health report for rivers and sewage systems. In addition, there will be a follow-up in the road sector.

From 2017 onward, health reports for various infrastructure, beginning with ports, will be released in stages. Additionally, health reports for various infrastructure are scheduled to be released every 5 years henceforth.