Technologies and Initiatives for Quality Road Infrastructure development in Japan

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The G20 Principles for Quality Infrastructure Investment

- Endorsed in the 2019 Osaka Summit.
- “Quality growth" requires not only "quantity" but also "quality" of infrastructure investment, even under enormous investment demands..

Principle 2: Raising Economic Efficiency in View of Life-Cycle Cost

Principle 1: Maximizing the Positive Impact of Infrastructure to Achieve Sustainable Growth and Development

Principle 3: Integrating Environmental Considerations in Infrastructure Investments

Principle 4: Building Resilience against Natural Disasters and Other Risks

Principle 6: Strengthening Infrastructure Governance

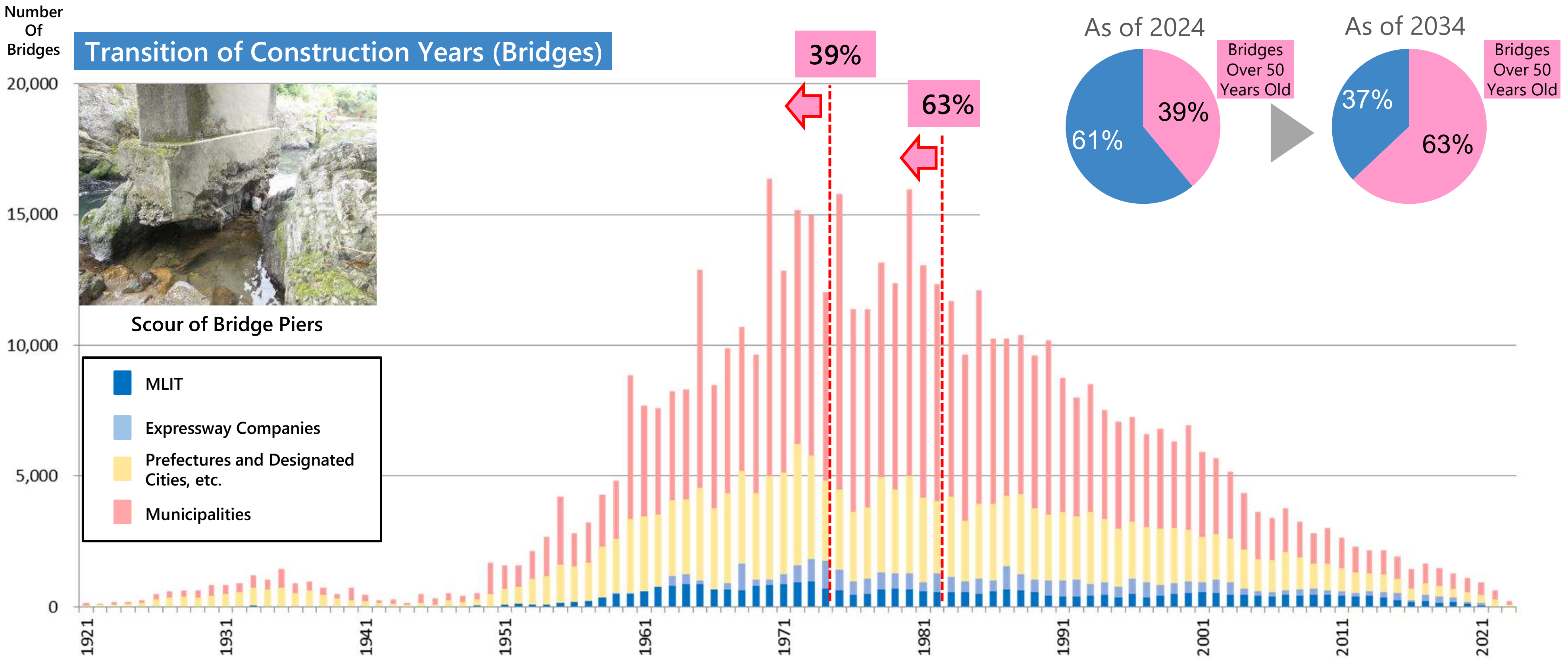
Principle 5: Integrating Social Considerations in Infrastructure Investment

Source: G20 PRINCIPLES FOR QUALITY INFRASTRUCTURE INVESTMENT https://www.mofa.go.jp/mofaj/gaiko/g20/osaka19/pdf/documents/en/annex_01.pdf

Reducing Life Cycle Cost

Life Cycle Cost (LCC): Aging and Deterioration of Road Infrastructure

- In Japan, 39% of the bridges are more than 50 years old as of 2024.
- In the next 10 years, by 2034, it will rise to 63%.

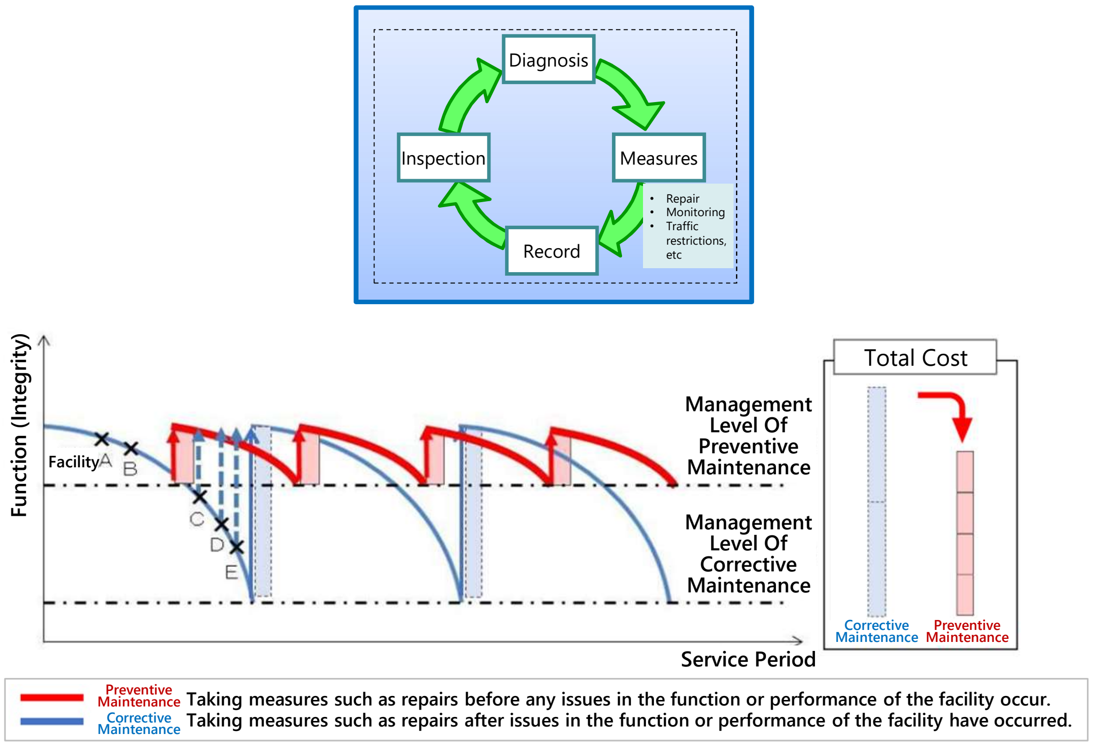


*Additionally, there are approximately 195,000 bridges with unknown construction years, such as old bridges for which records cannot be found.

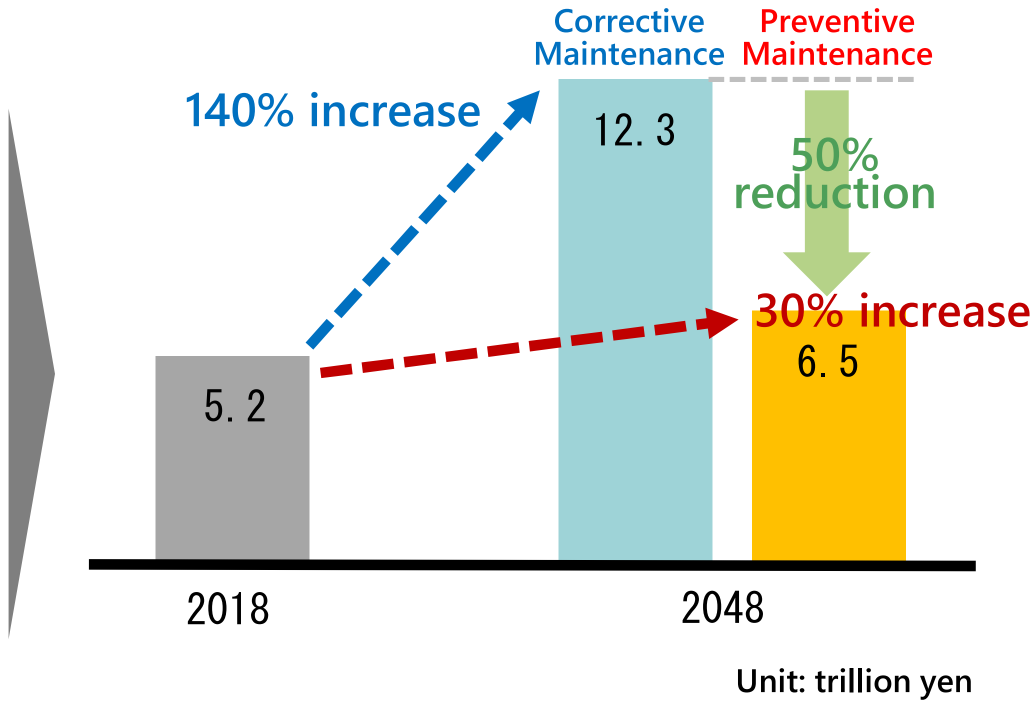
LCC : Preventive maintenance

- Maintenance costs will increase by approx. 140% in 30 years through "corrective maintenance"
- By introducing "preventive maintenance," the increase will be limited to approx. 30%. The annual cost will be reduced by approx. 50% compared to "corrective maintenance."

Concept and Scheme of Preventive Maintenance



Effect of Preventive Maintenance



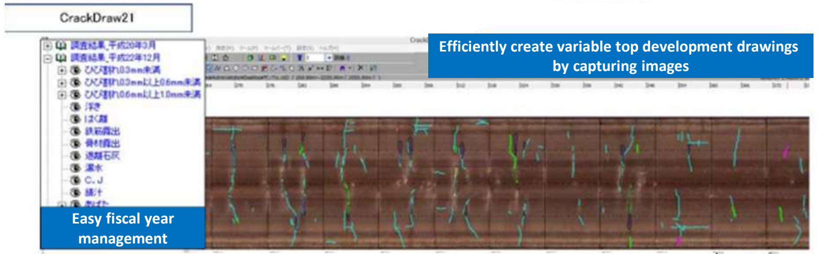
- Certified cutting-edge inspection technologies are successively added to the Inspection Support Technology Performance Catalog. (As of April 2024, 321 technologies)
- Government set the requirement for the performance values.
- Introduction to regular inspections by national and local governments are highly recommended.

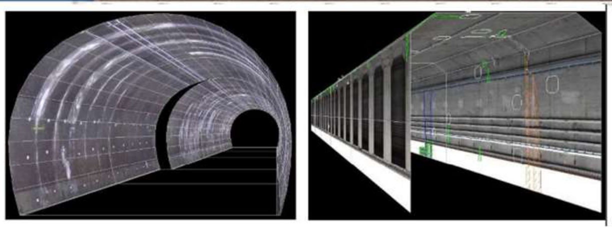
Examples of image measurement/analysis technology

☐ Drive-through tunnel imaging system


Road Tunnel Imaging Situation

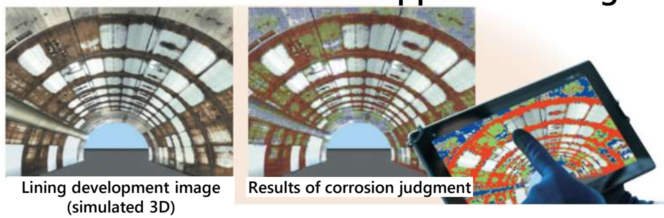
Example of Camera Equipment Placement





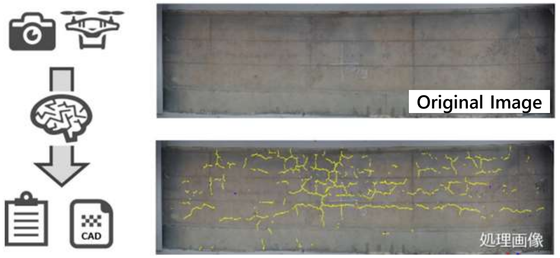
A system that uses multiple digital video cameras and lighting to capture images of structures while driving, enabling high-precision detection of cracks, water leakage, and other abnormalities by visualizing the condition of the concrete surface.

☐ Corrosion assessment app "Color Judge"


Lining development image (simulated 3D)
Results of corrosion judgment

Determine the degree of corrosion of main structures and accessories using color codes.

☐ Bridge inspection support system by non-GNSS environment UAV.



Processed Image

In bridge inspection work, a technology that uses the non-GNSS environment UAV "Skydio 2/X2" to obtain the necessary images for inspection.

☐ Ropeway scanning system

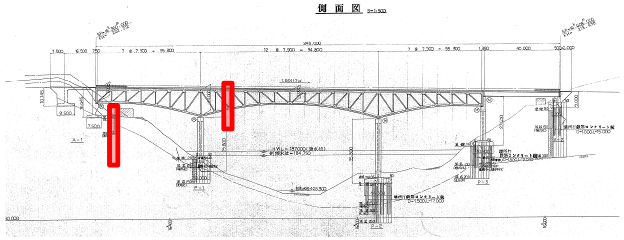
A device that moves along ropes installed between girders to assess damage conditions.

[New Technology] Bridge Pier Inspection by Drone

- Drones replace conventional rope access with traffic control.
- Costs reduced by approximately 50%.

Bridge Overview

- Bridge name: Keiryu Bridge (National Road 452)
- Bridge length: 248.00 m
- Bridge type: 3-span continuous truss + simple composite sheet girder bridge
- Targeted sections/components: Piers
- Type of deformation: Cracks



Conventional Checks

Inspection with Rope Access Technology

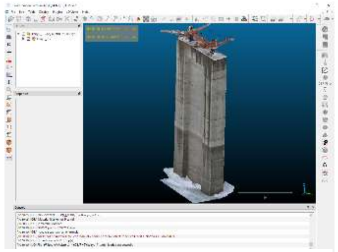
Rope access inspection status

Traffic control is necessary

- Road traffic control is required during ascent and descent due to the narrow width of the road
- Requires a qualified rope access surveyor
- Transcribe the damage diagram sketched during the inspection on the desk

New Technology Utilization Inspection

Status of drone photography



Modeling of photographed images

R5 Principle Items:
3D photographic recordings using inspection support technology

Performance Catalog	Technology
NETIS	Small drone technology with omni-directional collision avoidance sensors 【BR010009-V0323】
Other	

- Inspection costs for high bridge legs can be **reduced by 51% of inspection time for rope access**
- Safety costs related to traffic control are also unnecessary
- After the inspection, the damage can be confirmed on the desk by 3D modeling.

[New Technology] Bridge Pier Inspection by Unmanned Sonar Equipped Boat

MLIT Ministry of Land, Infrastructure, Transport and Tourism

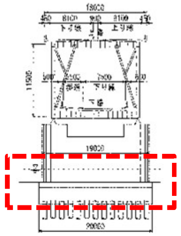
- Remote-controlled boats equipped with multibeam sonar replace conventional underwater pier inspections by divers.

Bridge Overview

- Bridge name: Shin-Asahi Bridge (Route 2)
- Bridge length: 284.64 m
- Bridge type: Steel 3-span continuous double-deck truss bridge
- Targeted area/component: Foundation
- Type of deformation to be addressed: scour

Panoramic photo

Site conditions (pier foundations)



Scope of Application of New Technology

Conventional Checks

(Proximity visual inspection and measurement by divers)

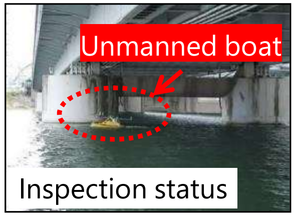
Inspection status

- Underwater sections are inspected by divers through close-up visual inspection.
- Underwater work must be performed by qualified personnel.

New Technology Utilization Inspection

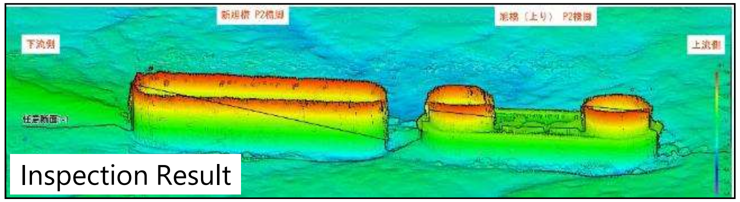
R5 Principle Items:
Measurement of underwater locations of riverbeds, foundations, revetments, etc.

Unmanned boat



Inspection status

Performance Catalog	Technology
NETIS	Depth and depth surveying by unmanned boat equipped with multibeam depth finder 【KTK-210020-A】
Other	



Inspection Result

This technology uses an unmanned remote-controlled boat equipped with a multibeam sonar to measure the riverbed in planar view and record and display the results in three dimensions.

[New Technology] Tunnel Inspection by Radar Equipped Vehicle

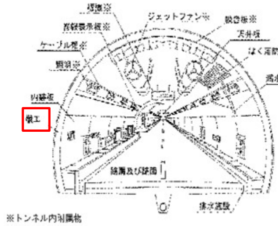
- Radar-equipped vehicles replace visual and sound inspections with traffic control.

Tunnel Overview

- Tunnel name: Asakawa Tunnel (National Highway No. 20 BP)
- Extension: 1845 m (upstream) 1839 m (downstream)
- Tunnel Classification: Overland tunneling method
- Targeted area/component: Lining
- Type of deformation: Cracks, etc.

Mine entrance
at the starting point (upstream)

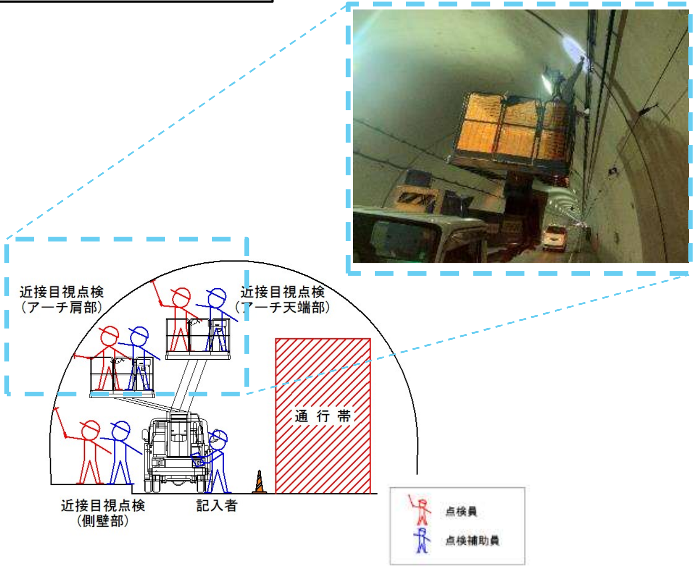
Mine entrance
at the origin (downstream)



□ : Area of application

Conventional Checks

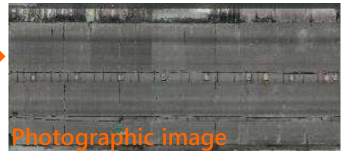
Proximity visual + sound inspection



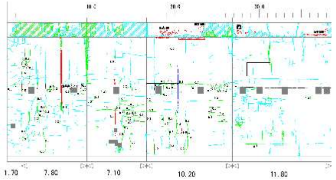
New Technology Utilization Inspection

Tunnel Master

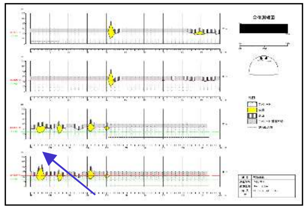
MIMM-R/MIMM



Auto Create



Deformation development



Detection of voids
→ Extraction of percussion inspection points

R5 Principle Items:
Measurement and recording of deformations (cracks, swell, separation, etc.) of the inner lining of tunnels by means of images, etc.

Performance Catalog	Technology
NETIS	High-Speed 3D Tunnel Inspection System MIMM-R (MIMM-R)-Radar Inspection Technology 【KK-130026-V】、【TN020006-V0323】
Other	Road Tunnel Disaster Prevention Vehicle "Tunnel Master" 【TN020007-V0223】

LCC : Long-life Pavement Technology

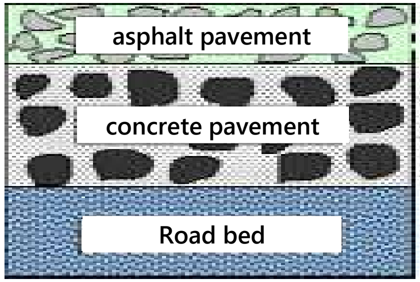
- Long-life pavement technologies contribute to reduction of GHG emission by reducing maintenance frequency and traffic congestion due to maintenance works.

Long-life Pavement Technology

Pavement Composition

Outline

●Pavement using asphalt mixture for the surface/base course and cement-based plates for the layer below



Features

●Structural durability of cement-based pavement enables longer life than ordinary asphalt pavement
●Lower lifecycle costs
●Asphalt pavement for surface/base course provide good runnability and easy maintenance

Source:http://www.dohkenkyo.net/pavement/meisyo/

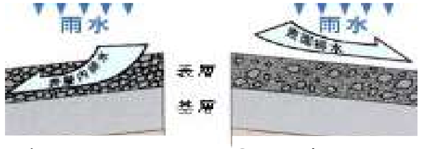
Asphalt Mixtures

Highly durable asphalt mixture

●Advantage in fluidity, water resistance, oil resistance, torsion resistance, drainage, etc., and durability

Long-life porous asphalt mixture

●Asphalt mixed with special additives to extend life of multi function pavement



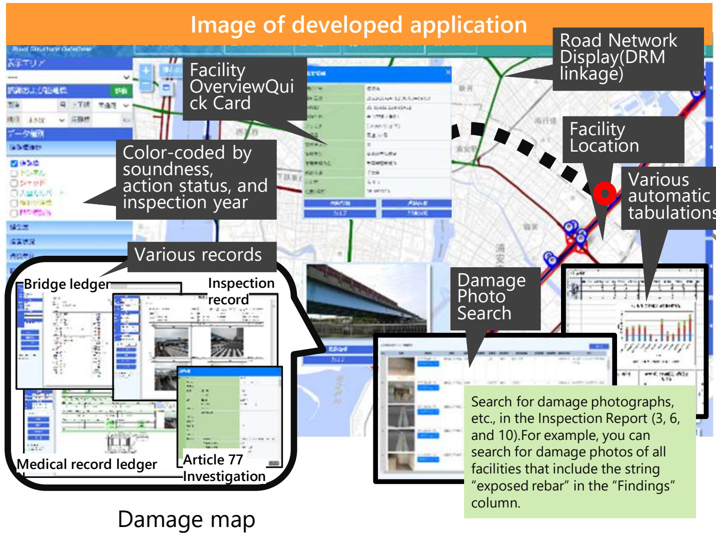
Drainage pavement General pavement

Source:http://www.dohkenkyo.net/pavement/meisyo/

Reduce GHG emission by reducing maintenace frequency

National Road Asset Inspection Database

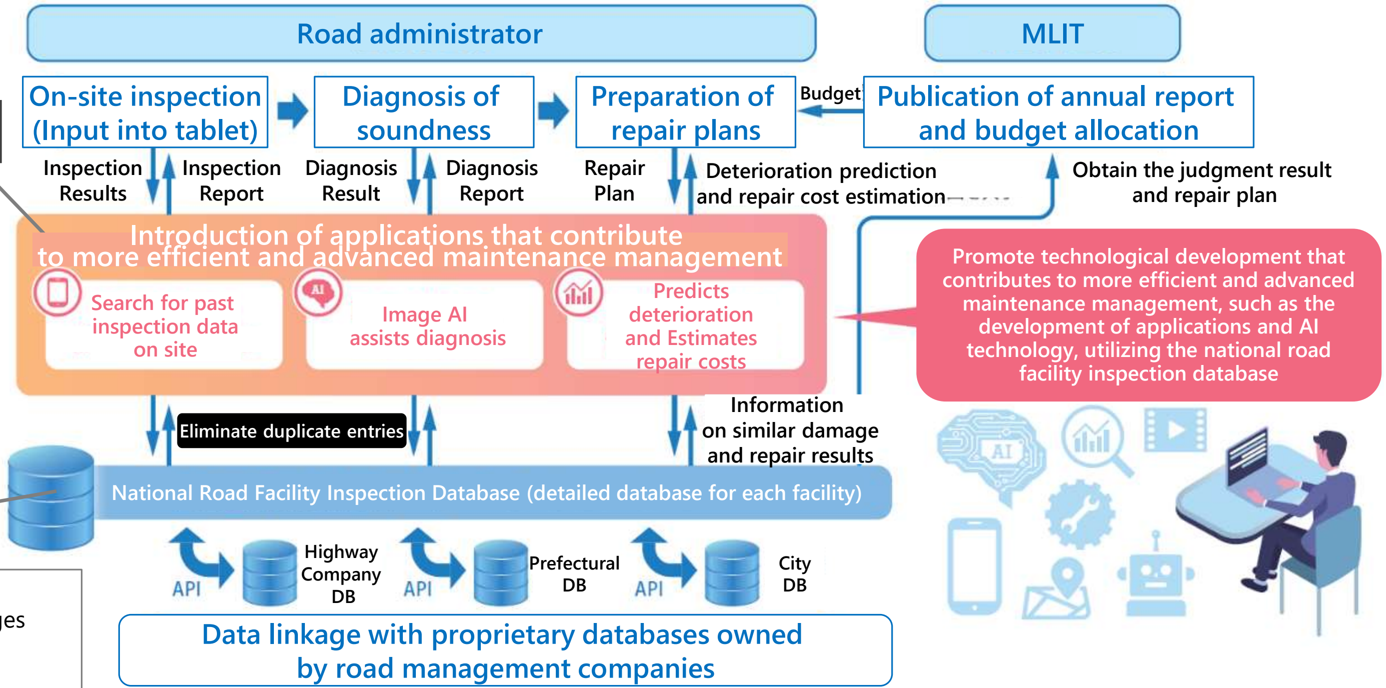
- The National Road Asset Inspection Database consists of a basic DB and a group of individual DBs of detailed data for each type of structures e.g. bridges, tunnels and pavements.
- App to view comprehensive information on a map is under development.



Damage map

Browsable data

Bridges : Approx. 720,000 bridges
Tunnels ：approx. 11,000
Sheds : approx. 3,000
Culverts ：approx. 9,000
Pedestrian bridges: approx. 11,000
Gantry-type signs, etc.: approx. 17,000
Pavement ：approx. 880 km



Reducing impact on Climate Change and Biodiversity

Asphalt Recycling Technology

- Asphalt pavement recycling is widespread all over Japan after the enactment of the Construction Material Recycling Act in 2000 . Recycling rate is 99.5%.
- Estimated CO_2 emissions from production of reclaimed asphalt mixture is 16% lower compared to all new mixtures.

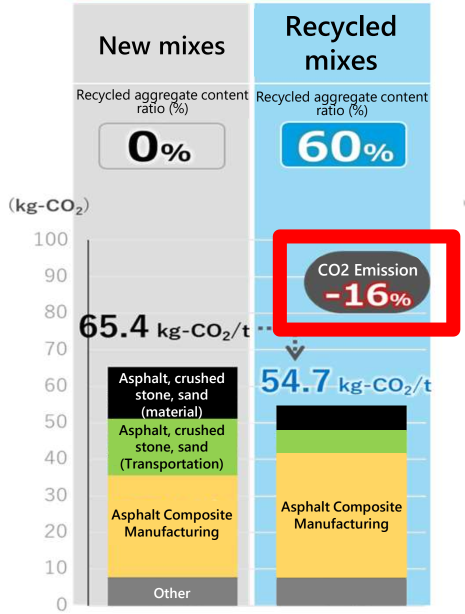
Asphalt Recycling Technology

Created based on the source:
"PWRI: Aiming to establish permanent pavement recycling technology"

Three expected effects

① GHG reduction

Comparison of CO_2 emissions
per ton of asphalt mix produced in Japan

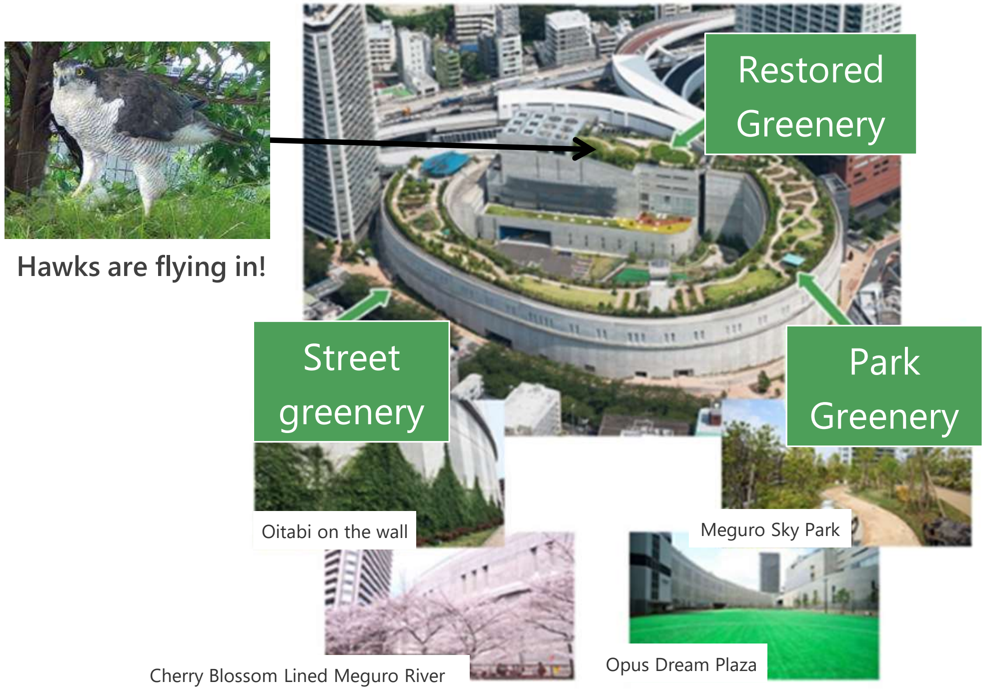


②Resource recycling
③Maintenance cost reduction

Aiming Nature Positive

- We aim to contribute to the prevention of global warming as well as to the preservation of biodiversity through developing green and eco-friendly road.

Ohashi "Green" Junction (Metropolitan Expressway)



Wildlife Bridge

Mobara Animal Bridge Ken-O Expressway

Improving Resilience against Natural Disaster

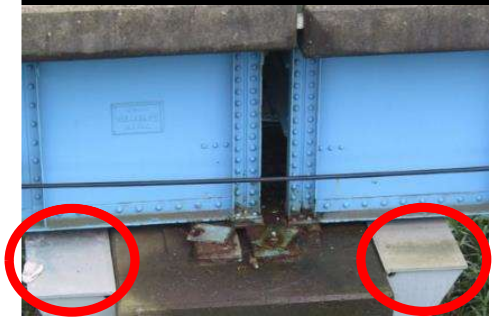
Seismic Design and Devices/Attachments

- After experiencing Hyogo-ken Nanbu Earthquake in 1995, seismic design guideline for road bridges were revised and seismic reinforcements were installed to existing bridges.
- Bridges under current design standard or with reinforcement would suffer only minor damage at the same magnitude as the Hyogo-ken Nanbu Earthquake, and would be able to recover their function promptly.

Damage from
Hyogo-ken Nanbu Earthquake

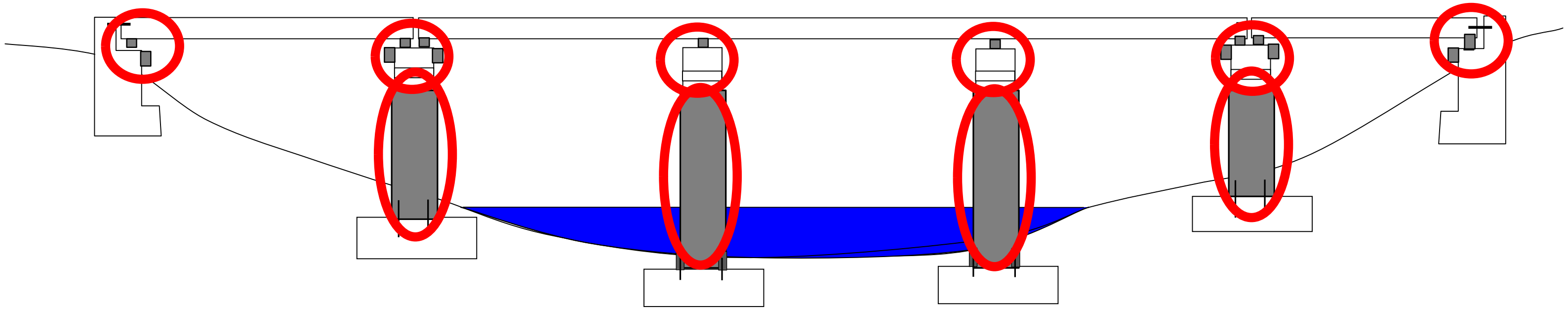
After countermeasures

Unseating Prevention Device



Edge spreading

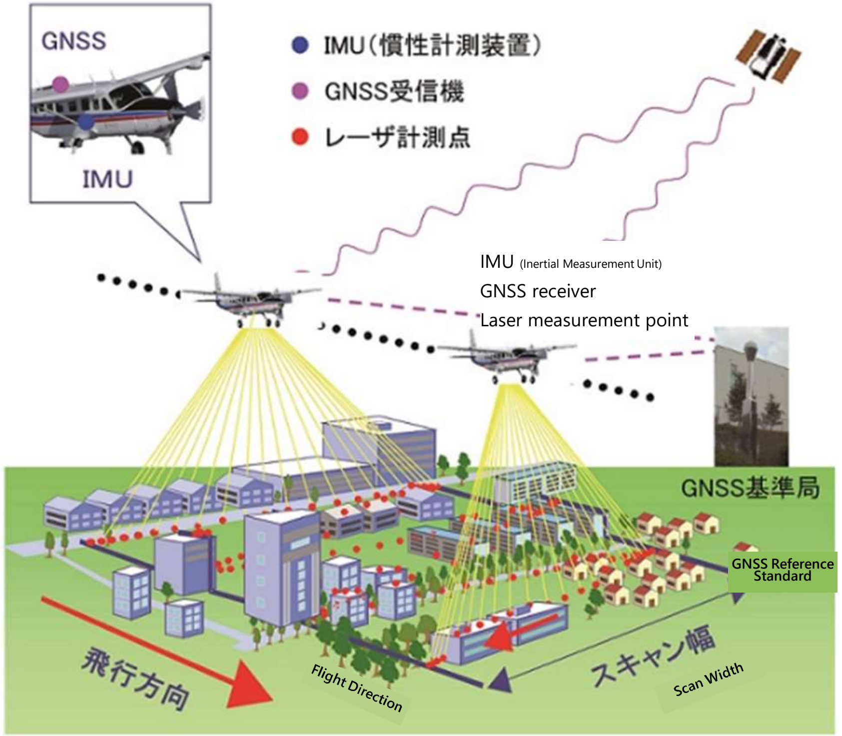
Bearing reinforcement



Assessing Slope Risk using 3D Point Cloud Data

- 3D point cloud data provide stable and high precision topographic map to enable disaster risk assessment without omission.

Aerial Laser Surveying



Source: Geographical Survey Institute:
https://www.gsi.go.jp/kankyochiri/Laser_index.html
https://www.gsi.go.jp/kankyochiri/Laser_senmon.html

Effects of using aerial laser surveying

Conventional Survey

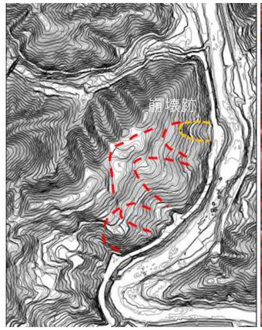
Experts decipher and assess manually

Topographic map

Aerial photographs

Laser Survey

Less inconsistency through high precision



Laser topographic surveying

Microtopography

Slope Management

- Disaster prevention works are implemented reflecting the slope assessment result.
- Annual inspections are conducted based on the Slope Management Database at the sites that need prevention works and monitoring.

《 Disaster Prevention Works》


Crib Work + Anchor


Crib Work

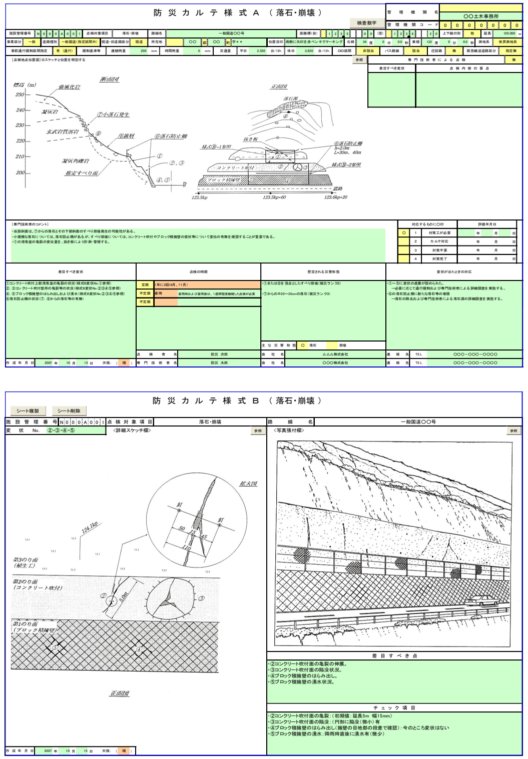

Rockfall protection netting


Wire rope hanger


Rockfall protection fence


Rock shed

《 Slope Management Database 》



Slope management database


Inspection of boulder condition


Inspection of unstable rock mass


Inspection of existing prevention works

Support System for Early Recovery from Disaster (TEC-FORCE)

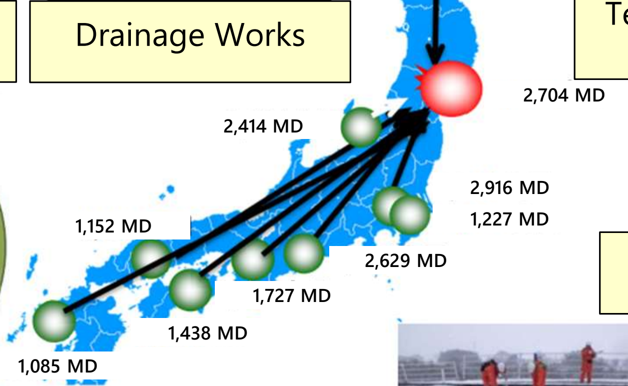
- TEC-FORCE (Emergency Disaster Response Team) was established in 2018 to provide prompt support to disaster-affected areas, consisting of staff members from MLIT's regional development bureaus nationwide.
- TEC-FORCE provides technical support on "assessing the damage" "preventing the spread" "early recovery" etc. (as of April 2024, approx. 17,000 members).

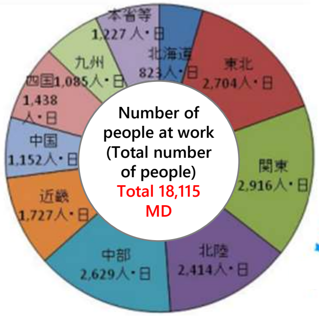
Dispatch of TEC-FORCE to the Great East Japan Earthquake in 2011

Information Gathering

Drainage Works

Technical Support to the Local Government





Provide satellite communication

- TEC-FORCE: Total 18,115 persons/day (3/11-11/21)
- Disaster response machinery (drainage pump vehicles, satellite communication vehicles, etc.)
  ：5,760 vehicles/day dispatched during the first month

Assessment of embankment damage

Assessment of road damage

Lessons learned from TEC-FORCE activities in Noto Peninsula Earthquake 2024

- TEC-FORCE Drone Survey Team needs organizational enhancement.
- ITS spots, portable roadside ITS unit, AI web cameras, satellite data and private-sector car navigation information to be more effectively utilized to monitor traffic condition.
- In case of communication disruptions in public communications networks, government communications network to be strengthened by increasing number of satellite communications equipment.

Damage survey by drone team

Acquisition of 3D point cloud data

Trike (three-wheeled motorcycle) (TBD)

▲Satellite Transmission Equipment

Video streaming by satellite communication vehicle

Traffic monitoring by ETC2.0 portable roadside units

Before deployment of portable roadside ITS unit (January 4)

After deployment of portable roadside ITS units (February 3)

Thank you for your kind attention

For further information:
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