Current State of Infrastructure Maintenance and Monitoring in Japan

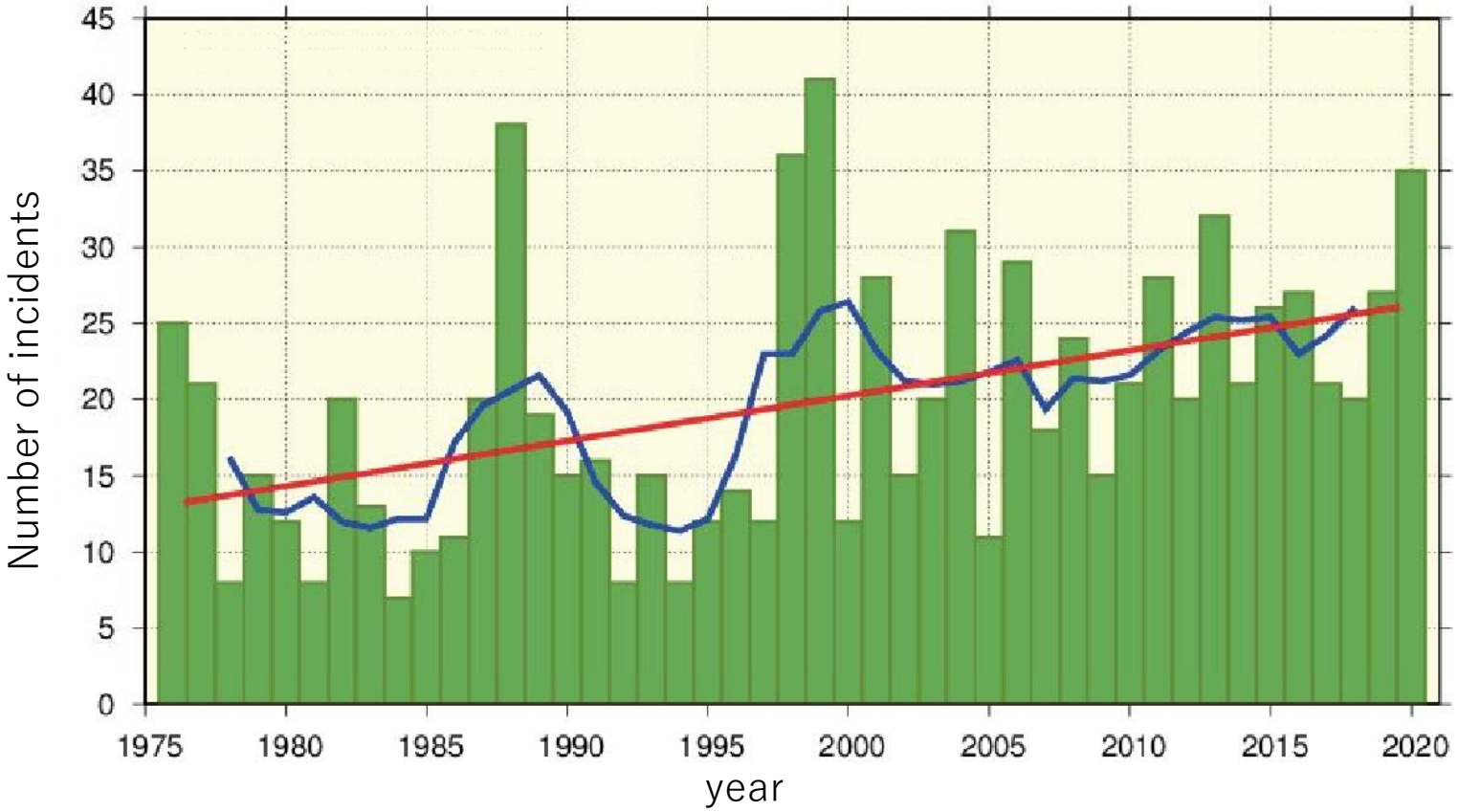
(ACECC TC-28, CECAR9, 22nd of Sep 2022)

For a Better Quality of Life

http://www.acecc-world.org/

Frequent terrible heavy rain disasters

Secular variation of the number of hourly precipitation exceeding 80mm per year (1976-2020)



Source: Climate Change Monitoring Report 2020(Japan Meteorological Agency, April 2021)

Frequent terrible heavy rain disasters(Road bridge)

2018（typhoon）
Inclination of piers

2019（terrible heavy rain）
Inclination of piers

2021（terrible heavy rain）
Subsidence of piers

2022（typhoon）
Outflow of piers

Source:Recent research prospects for bridge foundation scour damage and preventive maintenance (Public Works Research Institute, Japan)

Frequent terrible heavy rain disasters(Railway bridge)

【第1三篠川橋梁（JR西日本 芸備線）】

直近20年間に被災したJRの橋梁

合計47橋梁

【第六久慈川橋梁（JR東日本 水郡線）】

【球磨川（くまがわ）第1橋梁（JR九州 肥薩線）】

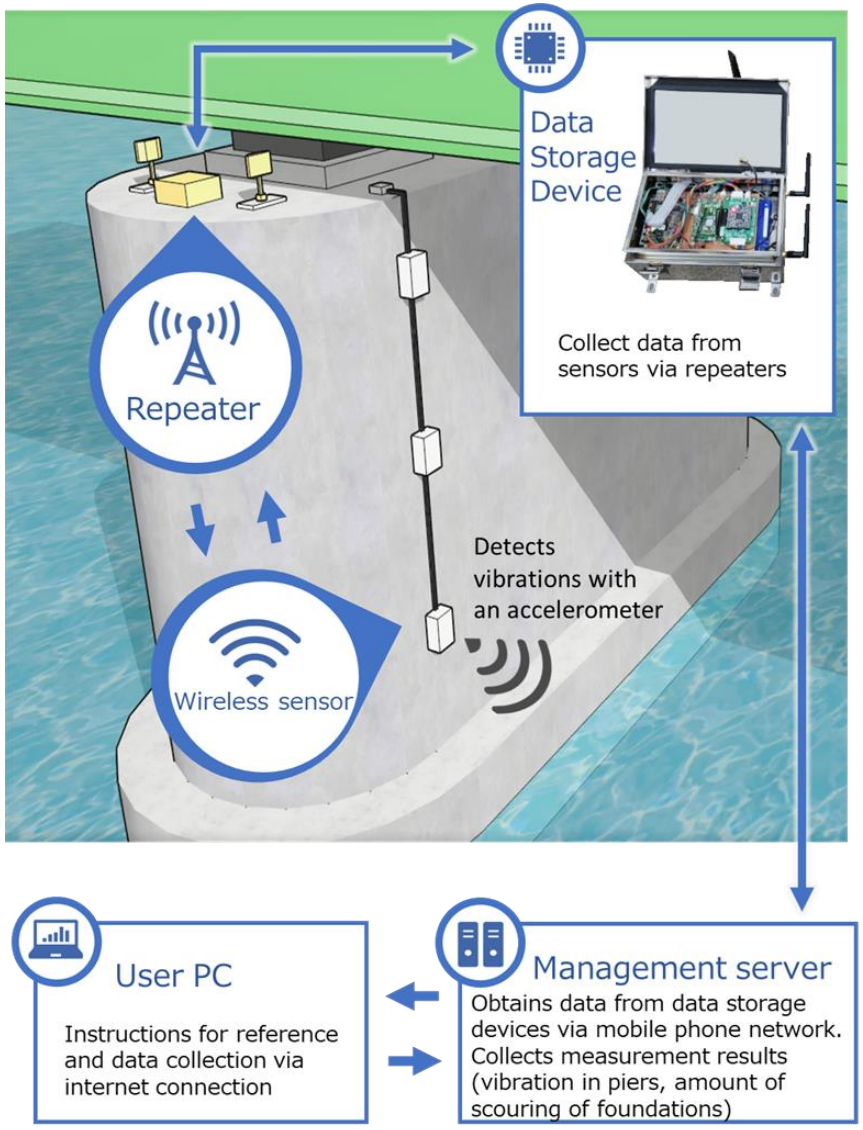
【第二球磨川（くまがわ）橋梁（JR九州 肥薩線）】

Source:Damage to Japan Railway river bridges (Railway Bureau, Ministry of Land, Infrastructure, Transport and Tourism, September 28, 2021)

Monitoring system for bridge foundation scouring

Overview

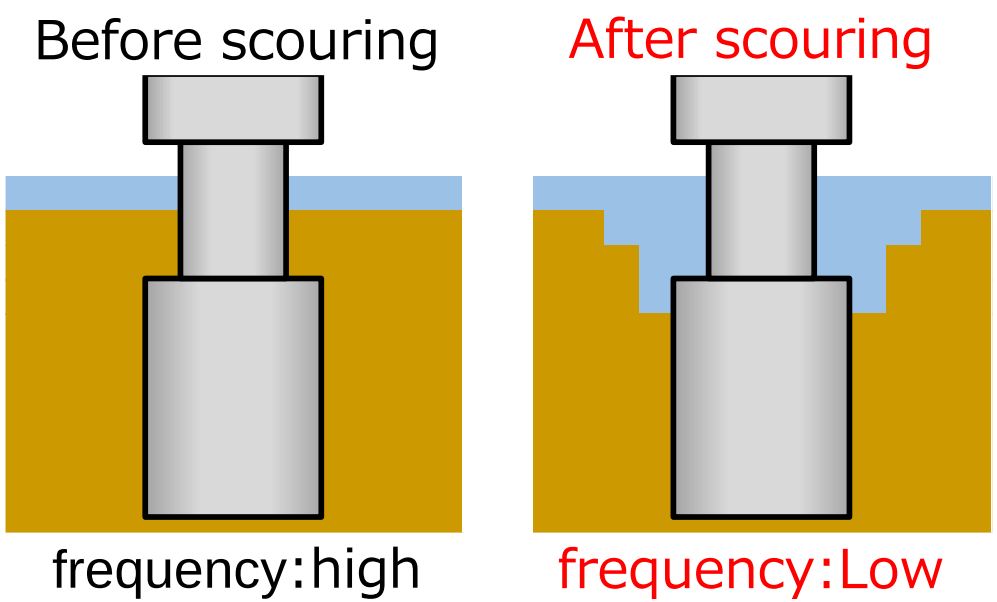
- This system remotely monitors the scouring of the foundations of bridge substructures located in rivers.
- By using the communication line of the mobile phone, it is possible to measure data and check the soundness without going to the site
- Quickly determine if a vehicle can pass in the event of a flood and notify the administrator by email

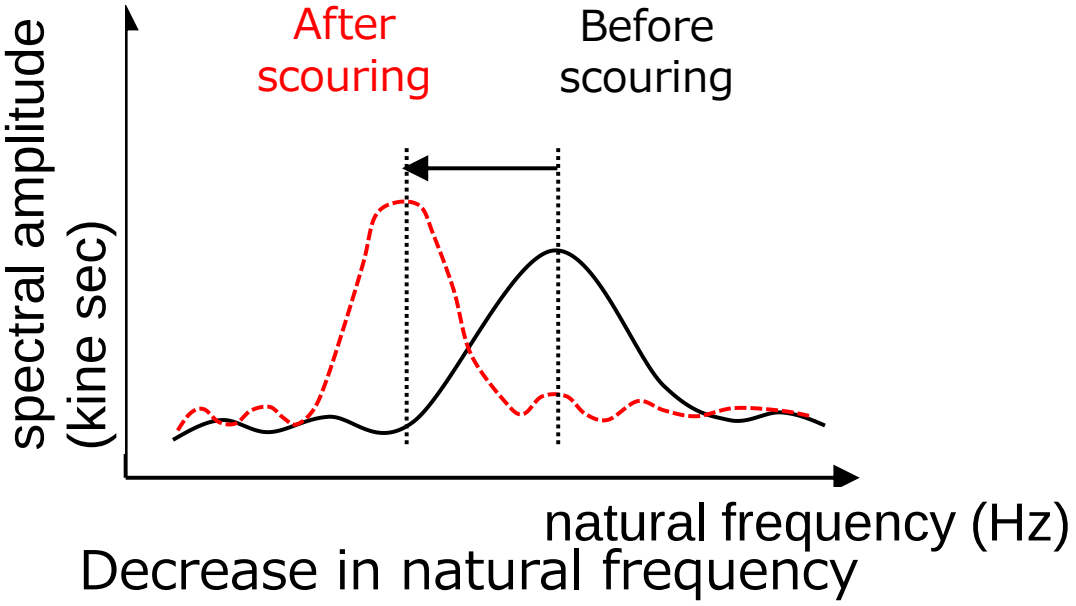


Monitoring system for bridge foundation scouring

Principle of Measurement

- ◆Focusing on the fact that the natural frequency of bridge piers decreases when the soil and sand around the foundation is scoured.
- ◆This system quantitatively identifies the amount of scour by measuring the change in natural frequency.





Monitoring system for bridge foundation scouring

Effectiveness

◆Quickly grasp the situation

Real-time measurements are enabled remotely without going to the site by using an Internet connection.

◆Ensure safety

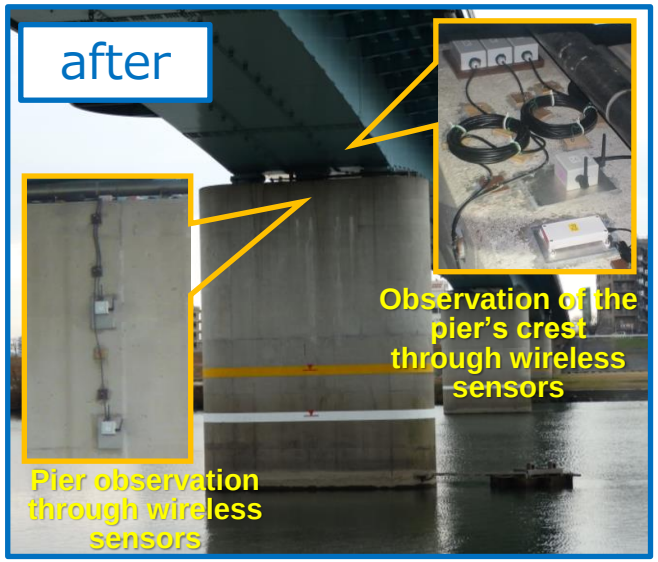
No need to enter the river even during floods.

◆Eliminate hard-to-access areas

Based on changes in the frequency of vibration, the amount of scouring can be quantitatively determined even under water where close visual inspection is difficult.

◆Support for initial response in the event of a disaster

By setting the limit amount of scour for foundation stability as a threshold, the administrator can be notified of abnormalities by e-mail.



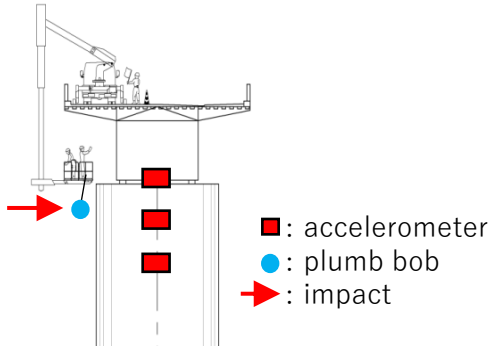
Monitoring system for bridge foundation scouring

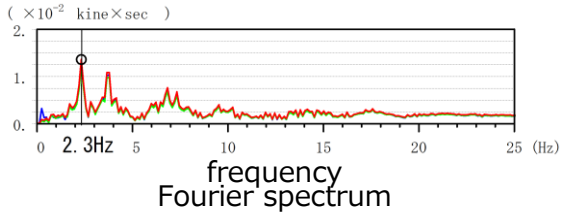
Installation of monitoring equipment

Sensors for piers and data recording equipment are connected through wireless connections.

Vibration testing of piers

Determining the natural frequency of the piers.

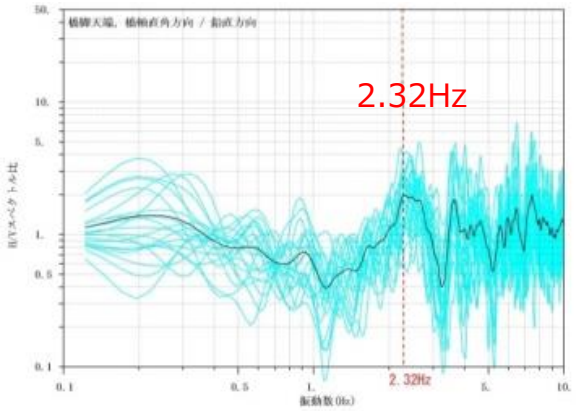




frequency
Fourier spectrum

Long-term measurement of changes in natural frequency

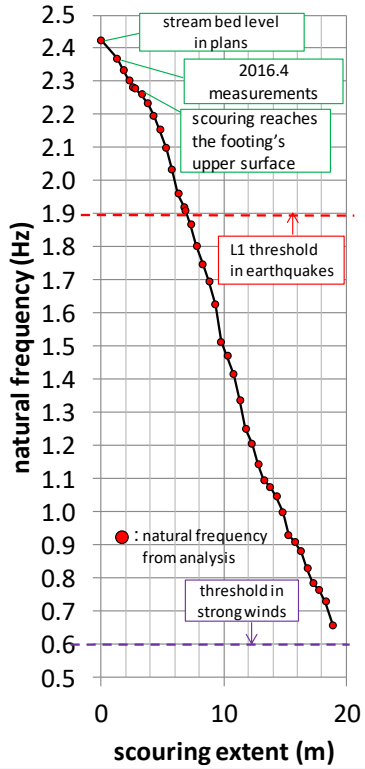
Ambient vibration measurements from traffic passing through bridges were used.



observed waveforms(20times)
mean

Assessment of scouring and safety conditions

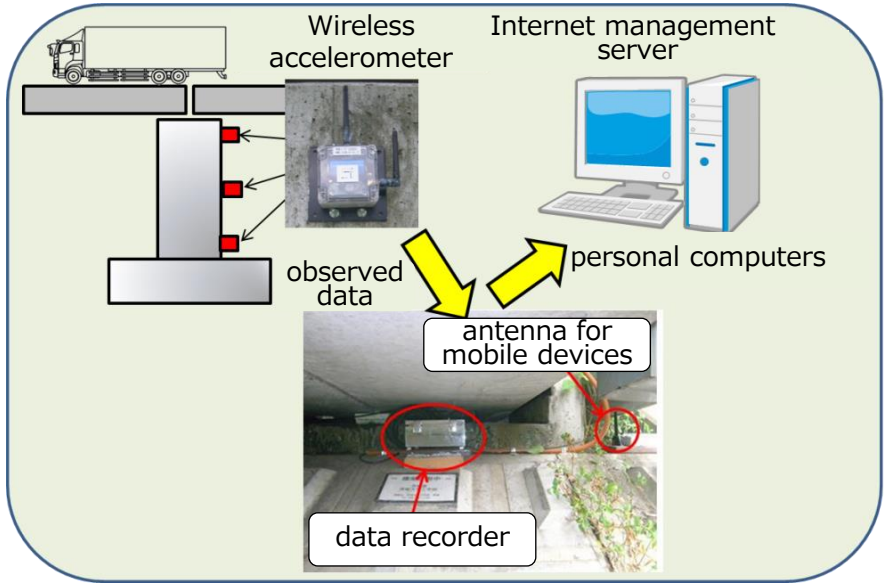
Identification of stream bed levels that ensure the foundation's safety and their relationship with the natural frequency of the pier.



Monitoring system for bridge foundation scouring

How to make use of the product

- Determine the extent of scouring from the pier's natural frequency
- Remotely monitor the foundation's safety conditions during natural disaster occurrences



Services provided

【Regular use】

Install accelerometer to pier.

Measures the pier's vibration such as ambient vibration and the passing of large vehicles.

Determines scouring extent from the pier's natural frequency.

【During disaster occurrences】

Scourings and changes in stream bed levels occur due to floods.

Compares measurements to the foundation's safety thresholds.
If values fall below threshold, alarms are sent to road administrators.

【Following disasters】

Scourings and changes in stream bed levels have occurred after floods.

Determine the degree to which natural frequency has increased, from emergency measures taken on the pier.
While ensuring safety, evaluate whether the bridge can return to service.

Case study of Monitoring

- Bridges managed by the MLIT
- Simple steel deck box girder + 4 span continuous steel deck box girder + simple steel deck I-girder (L=402m)
- Pile foundation

- Municipally managed bridges
- PC 2 span continuous pre-tensioned hollow deck bridge (L=33m)
- Spread foundation

※MLIT（Ministry of Land, Infrastructure, Transport and Tourism）

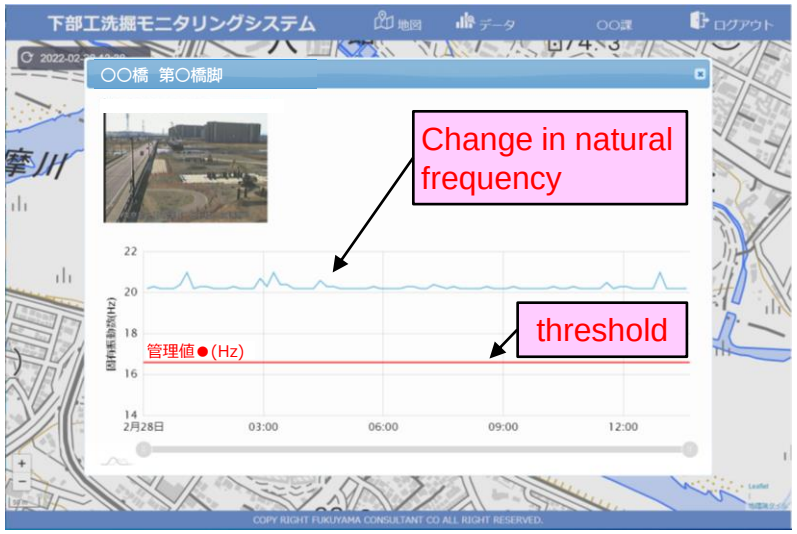
Monitoring system screen

Top page (Location map)

- Log in to the system by entering the login ID and password given to the user in advance.
- The location map of the target bridge is displayed on the top page.

Monitoring results(vibration frequency)

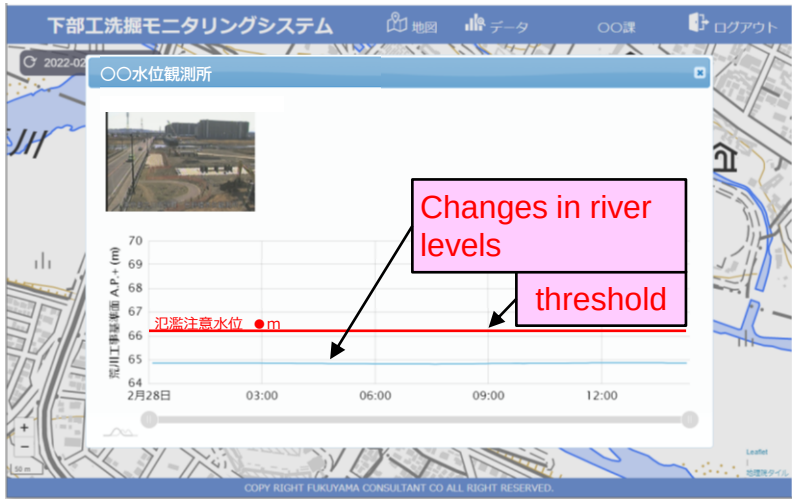
- Click on a flag on the target bridge to display the monitoring results (vibration frequency).
- Multiple control values can be set.
- If the value falls below the control value, an alert is issued to a predetermined address.



Monitoring system screen

Linked with other information (river water level)

- Possible to link with water level data of rivers, webcams, and other monitoring results
- For example, water level data published by the Ministry of Land, Infrastructure, Transport and Tourism(MLIT) can be automatically imported, graphs can be displayed, and alerts can be issued.



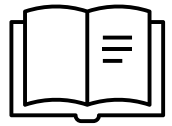
Data output

- In addition to displaying past monitoring results, data output and printing are available.
- Data output format：csv, xlsx, pdf, etc.
- Graph output format：jpg, pdf, etc.

Achievements of this technology

More than 30 record

Patented



Published in the catalog by MLIT

- Applied to many road and railroad bridges
- Demonstrated results in the Cross-ministerial **S**trategic **I**nnovation Promotion **P**rogram, an initiative of the Cabinet Office

SIP 戦略的イノベーション創造プログラム
Cross-ministerial Strategic Innovation Promotion Program

- Evaluation Method for Soundness of Foundation Structures
（Patent No. 4863813）

A method to accurately evaluate the soundness of a foundation structure based on vibration data from the excitation of the superstructure and the characteristics of the ground.

- Listed in the MLIT's Performance Catalog for Supporting Inspection Technology

Reference for publication of this technology

【Reference for publication
in guidelines of Japanese civil engineering agencies】

PUBLIC WORKS RESEARCH INSTITUTE

Guidelines for the use of monitoring systems for civil engineering structures (2020.12)

Japan Society of Civil Engineers

Guidelines for the use of monitoring technologies (2022.6)

MLIT Ministry of Land, Infrastructure, Transport and Tourism

Performance catalog of inspection support technology (2022.9)

Trends in the use of new technologies in Japan

- In Japan, local governments are required to consider the use of new technology as a condition for receiving subsidies for expenses related to inspection, repair design, and construction of road structures.（2020～）

- In order to improve the sophistication and efficiency of periodic inspections and to promote the development of new technologies, the use of inspection support technology has become a principle for periodic inspections of bridges and tunnels managed by the Ministry of Land, Infrastructure, Transport and Tourism（MLIT）.（2022～）