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R&D of monitoring system for bridge performance assessment based on vibration mode analysis



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Collaborative Research Groups IMV Coporation

R&D Objectives and Subjects

Objectives

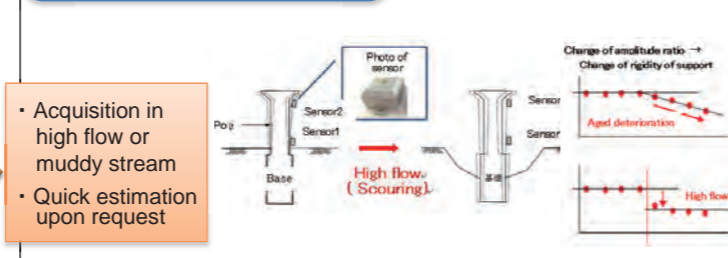
- Development of monitoring system for aged deterioration or damage of bridge based on vibration mode analysis.

Conventional inspection



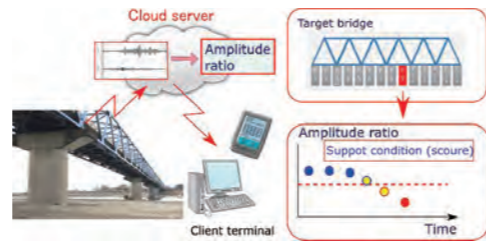
- Difficulty in high flow or muddy stream
- Requires preparation for diving

Proposed inspection



Subjects (2014-2017)

- Implementation of vibration monitoring system for bridge. → Remote system to monitor amplitude ratio of pole.
- Development of estimation method for support performance of pole. → Detection of a scoured or deteriorated pole.



Current Accomplishments (1/2)

(2014-2016)

1. Measuring system

Attachment of two sensors on upper and lower part of a scoured pole and a non-scoured pole for measurement.

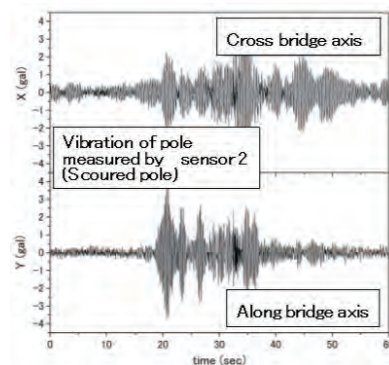
Attachment of radio gateway on upper side of pole for data transmission.



- Remote acquisition of vibration data at office via Internet connection.

2. Vibration of pole

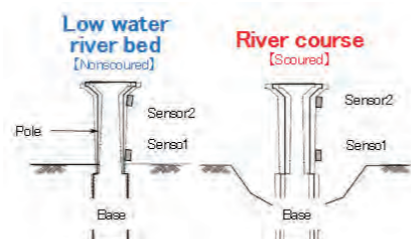
Measurement of low frequency vibration of pole with low noise using a special sensor for infrastructure.



- Estimation of amplitude ratio with low noise.
- Estimation of support rigidity of pole

3. Amplitude ratio

Verification of significant difference of 1.5 in amplitude ratio between a scoured pole and a non-scoured pole.



Type of pole	Low water river bed [Non-scoured]	River course [Scoured]
Amplitude ratio	4.31	2.80

Significant difference (about 1.5)

- Detection of scoured pole by estimating amplitude ratio.

Utilization example

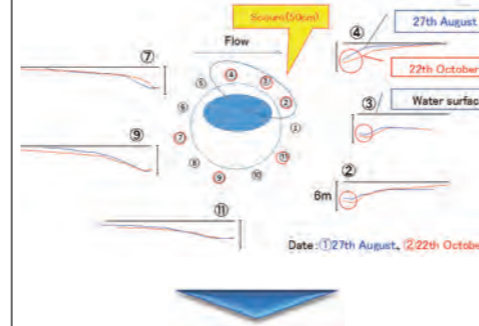
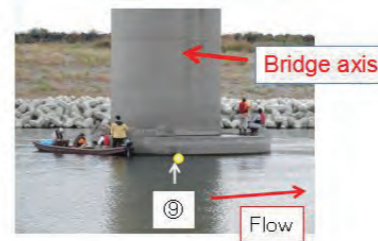
- Estimation of support rigidity of pole under the condition of high flow or muddy stream.
- Management of efficient inspection schedule.
- Quick correspondence in emergency
- Efficient management of bridge inspection

Current Accomplishments (2/2)

(2014-2016)

4. Scanning of river bed

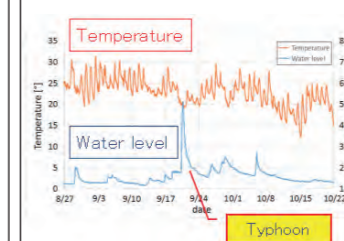
Detection of progress of scour by scanning around a pole with ultrasonic sonar before and after typhoon.



- Verification of correlation between scour and amplitude ratio for better estimation.

5. Change by high flow

Close correlation between amplitude ratio of a pole and scanning data of river bed.



Average (Error)	Bridge axis	
	Non-scour	Scour
30th August	3.90 (0.364)	3.05 (0.223)
29th September	3.67 (0.574)	2.82 (0.213)
21th October	3.84 (0.552)	2.97 (0.229)

Reduction by 10%

- Detection of scour or its progress of pole by estimating amplitude ratio.

Flow of utilization

1. Measuring system

2. Vibration of pole

3. Amplitude ratio

4. Scanning of river bed

5. Change by high flow

Quick correspondence
Efficient management of bridge

Goals

Numerical target

Management cost cut of 50% by remote monitoring and efficient inspection.

Users

Railway companies, highway companies, local governments, etc.

How to use/Places of use

Attach sensors and radio gateway on pole of bridge to monitor amplitude ratio of pole through Internet connection.

Sales method

Sale or rental of monitoring unit. Rent WEB base cloud service for inspection and management of bridge.

Services to Offer

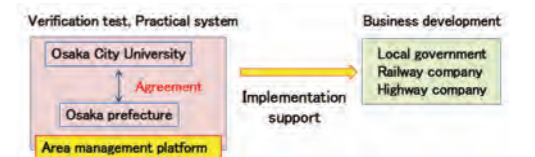
Offer useful services for quick correspondence in emergency and efficient management of bridge inspection.

Cost of typical system (20 poles)

Initial: 800,000x20=16,000,000 yen
Management (year): 20,000x20+600,000=1,000,000 yen

Detection of scoured pole and efficient inspection

→ Quick correspondence in emergency and efficient management



Pilot service in Osaka Prefecture

Reduction of traffic obstacles in emergency.
Reduction of inspection cost.

