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R&D of laser directive noncontact diagnosis system for maintaining degraded infrastructures

Principal Investigator Katsumi Midorikawa (Director, RIKEN Center for Advanced Photonics)

Collaborative Research Groups QST, JAEA, ILT



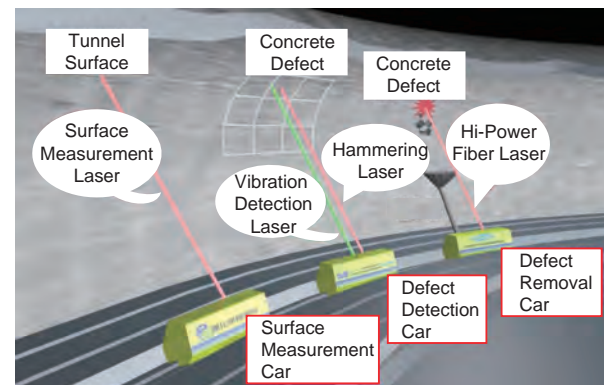
R&D Objectives and Subjects

Objectives

In Japan, large infrastructures such as tunnels and bridges constructed during the period of rapid economic growth in the 1960's will reach the end of their working lifetimes within 10 to 20 years. In order to solve this societal issue, we develop novel nondestructive inspection methods using laser technology.

Subjects

- Detection of 0.2 mm cracks by 3D remote measurement system by LIDAR and water detection by spectroscopy
- High speed inspection system by laser hammering
- Defect removal by remote drilling and cutting by QCW fiber laser
- Tunnel maintenance total system with existing technologies (a. mapping D/B b. MMS) and the above new methods



Current Accomplishments (1/2)

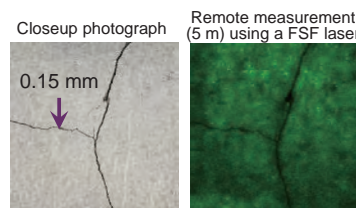
3D and spectroscopic measurement of inner wall of tunnel using frequency-shifted feedback (FSF) laser

Measurement objectives: (1) Crack of 0.2 mm width (2) 0.1 mm difference level (3) Spectroscopic detection

Measurement principle: LIDAR (Light detection and ranging)

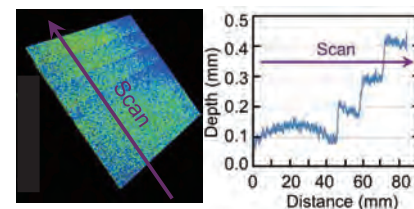
Measurement of crack of 0.15 mm width

LIDAR + measurement of light scattering



Measurement of 0.1 mm difference level

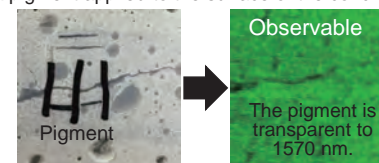
LIDAR + interferometric analysis



Spectroscopic measurement

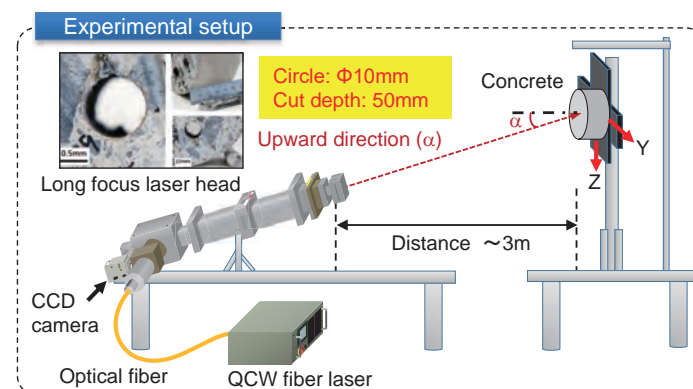
LIDAR + spectroscopic measurement

Spectroscopic measurement of crack through a pigment applied to the surface of the concrete.



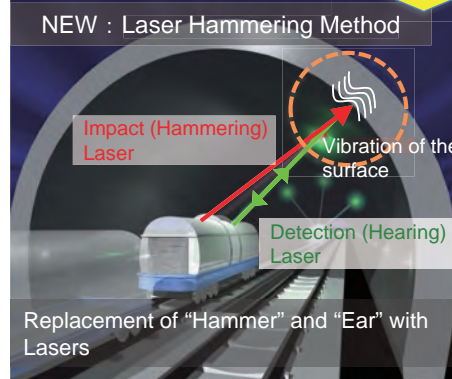
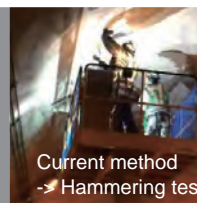
Development of laser irradiation system to remove degraded parts of tunnels
Significant features of drilling, cutting, and removal of concrete using a QCW fiber laser

1. Remote and non-contact operation of drilling and cutting of degraded parts are feasible.
2. Control of a quasi-continuous wave laser enables suppression of heat affected zones and high processing efficiency.
3. Fast drilling speed is realized with optimization of laser irradiation conditions.



Current Accomplishments (2/2)

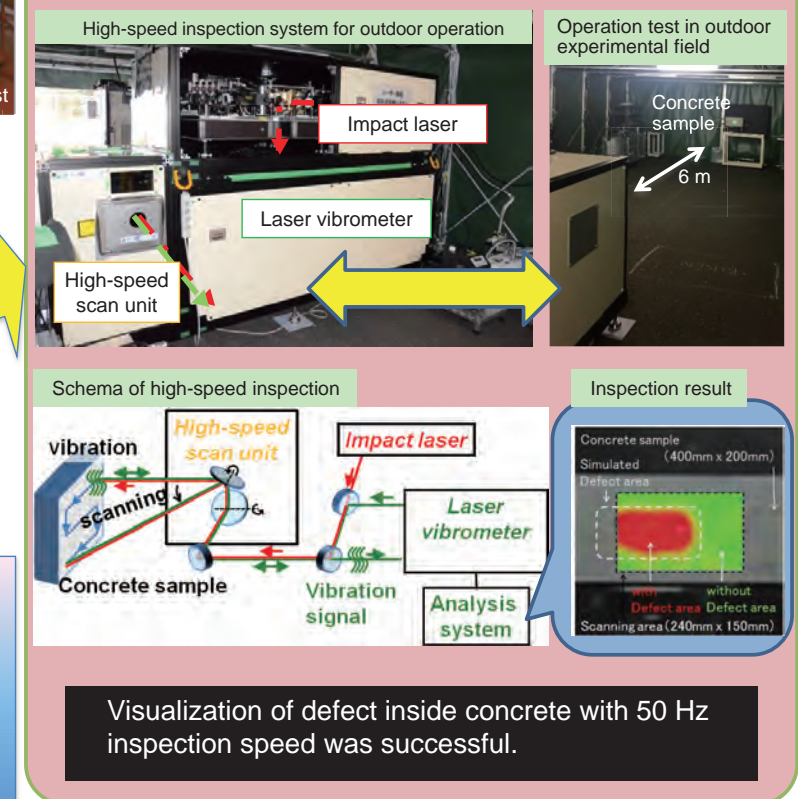
GOAL : Development of a high-speed and remote inspection method for lining concrete.



【Accomplishments】

- Development of compact, high repetition rate high power YAG laser by the improved system and unique optical layout
- 50 points/second measurement by using a lightweight, rigid, and large size scanning mirror
- Development of prototype high-speed inspection system for outdoor operation

Development of high-speed inspection system for outdoor operation



Goals

Business scheme for social implementation

The goals attained at the end of SIP research and development are as follows.

- ① Technical final numerical target of research and development
 - a. Laser Surface Measurement System : (Distance 5 m) 0.2 mm wide crack, illustration of 0.1 mm deep groove, discovery.
 - b. Laser hitting sound measurement system : (Distance 5 m) Detection of peeling / internal cavity corresponding to manual hitting sound inspection.
 - c. Removal of weak parts by laser : Construction of destruction test database of concrete.
- ② Outline of products and services
 - a. Products · Products : We created an integrated system combining R & D achievement and existing system, and commercialized measurement service.
- ③ Social Implementation
 - a. Site Users : Railway companies and local government's road conservation department
 - b. Used Places : Railway tunnels and road tunnels managed by local governments
 - c. Procurement, Manufacture, and Sale : Integrated acceptance of tunnel measurement service

