Remote handling technology - #1

An approach for remote nondestructive testing method for concrete structure using laser-generated ultrasonic

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Aging Social Infrastructure
Chlorine ion damages rebar in RC structures.

http://www.fujiprecon.co.jp/blog/archives/4325
Background & Motivation

- Integrity of Reinforcement Concrete (RC) should be monitored for safety. Aging hot labs, BWR&PWR and decommissioning 1F need it most.

- Acid rain and water is generated by CO2 in nature. Exhausted gas accelerate it. And nitric acid is generated by moisture, air and gamma-ray in hot cells.

- Nondestructive method for RC is expected very much.

[1]Asahi Newspaper digital,

http://www.nikkei.com/article/DGXLASGG21H2X_R20C17A7MM8000/
2017/7/21 22:29 日経新聞
Background and Motivation

1. Half Cell Potential Method
2. Ultrasonic / Impact Wave Method
3. Laser Hammering Method (under development)

Laser hammering method is promising but needs some basic experiments for aging RC.

Deterioration process of reinforced concrete

- Aggregate
- Rebar
- Gap appearing
- Cracking
- Water intrusion
- Rebar thinning
- Rust & crack increasing
Purpose

Our Goal:
Health monitoring for reactors RC by remote non-destructive testing

Viewpoints of the current status:
Using laser pulsing for ultrasonic generation
Laser pulsing on a rebar
Vibration detection by LDV

Concept:
Experimental Setup and Test Samples

Experimental Setup

1) Rebar (Bare Steel Rod)
2) RC sample
3) After heating the rebar
4) After Corrosion

Pulse Laser
Sample
Ultrasonic Receiver
Comparison between samples

1) Ultrasonic wave profiles of rebar and heated sample are similar.

2) All samples have strong peak at around 200[kHz]

3) The heated sample get close to rebar. It is because gap is appearing between rebar and concrete
1) With progress of corrosion, ultrasonic wave profile gets close to that of the rebar.

2) Corrosion makes the gap between rebar and concrete damaged as well as heated specimen.
Discussion about Strong peaks

1) Strong peak of 200[kHz] is derived from the condition of the diameter of the rebar.

2) The frequency shift in Corroded Sample is caused by decreasing rebar diameter.
Laser Cutting for Digging a hole

T. Yamada, et al., OPIC-LSSE2017 (Invited talk)
Demonstration of Remote Laser Cutting

T. Yamada, et al., OPIC-LSSE2017 (Invited talk)
LDV for sound velocity measurement

T. Yamada, et al., OPIC-LSSE2017 (Invited talk)
[Summary]

・Ultrasonic wave profile propagating on rebar is different, depending on the interfacial condition between rebar and outer concrete.
・Adhesive strength between rebar and concrete can be monitored.
・Thinning rebar diameter in concrete can be measured.

[Future Work]

・Development of a prototype laser processing head for remote handling/testing.
・Combination with LDV for remote nondestructive testing.
Thank you for your attentions. See you soon.
LSSE2018  April 23-27

http://opicon.jp/ja/conferences/lsse/

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Shinji Yamamoto
Yokohama National University, Japan
Hadean environment inferred from the oldest zircon of the Earth: Application of micro-analysis by laser technologies
Thank you for your attention
Experimental Method

1) The system is composed of Oscilloscope, Ultrasonic receiver, R. Concrete specimens and Nano-sec pulse laser source

2) Investigating how the different condition of the rebar has effect on ultrasonic signal profiles propagating on it.

1) Rebar (Bare Steel Rod without rib)
   - Bare Steel Rod (diameter 15mm)

2) R. Concrete Specimen (Rebar + Mortar)
   - Cylindrically Pouring Mortar

3) Heated R. Concrete Specimen
   - Gas Burner

4) Corroded R. Concrete Specimen
   - Cu Plate
   - NaCl aq.
   - Stabilized Power Supply