6 Non-destructive Inspection of Rebar Corrosion in Concrete

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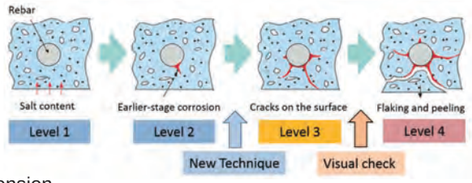
R&D Objectives and Subjects

Objectives — Creation of an Inspection Technique for Promoting Preventive Maintenance

Target: Roadway infrastructure (particularly bridges)

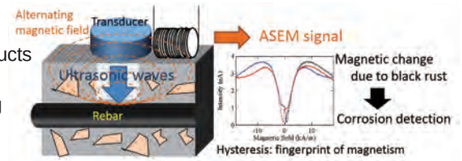
Conventional maintenance :
◆Visual check : Observation of cracks on the surface of concrete.
Strength performance of RC structures has already been reduced.
=> Massive renovation and reinforcement are required.

Ideal maintenance :
◆Non-destructive detection of earlier-stage rebar corrosion
=> Small-scale maintenance => Cost reduction and life extension



Subjects — Corrosion Detection by Using Acoustically Stimulated Electromagnetic (ASEM) Techniques

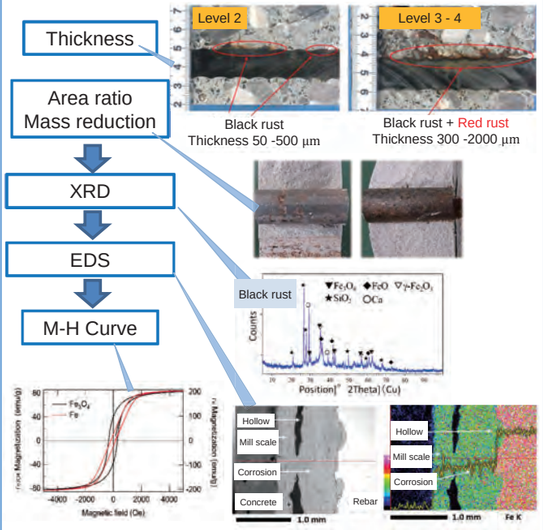
ASEM method Detection of alternating magnetic fields excited by ultrasonic waves
=> Sensing of magnetic hysteresis behavior (Fingerprint of magnetism)
=> Identification of black rust formed on rebar



Development item
- Clarifying magnetic properties of corrosion products
- Developing dedicated instruments
- Determining the index parameters for identifying the corrosion stage
- Performing on-site verification

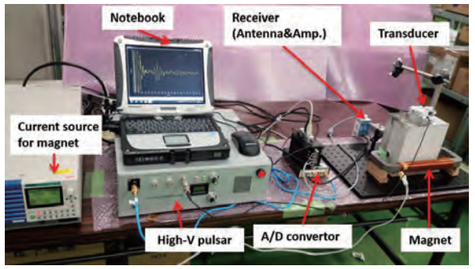
Current Accomplishments (1/2)

■ Analysis of Corrosion products



【Our measurement target】
- Thickness ~100 μm, Area ~100%, Mass reduction~ 3%
- The content rate of the target material, Fe_3O_4 is estimated to be 40 – 60 % in corrosion products.

■ Instrument



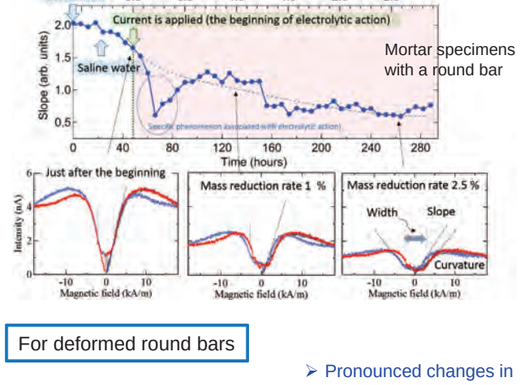
System
- High voltage pulsar (1000 V) Reverb suppression due to an FET shunt circuit.
- Fast waveform processing units
- Current source for the electromagnet

Probe Head
- Ultrasonic transducer 200 kHz composite type. Double EM shield
- Receiving antenna Resonant circuit & low noise amplifier
- Acoustic delay line Acrylic or Teflon type Water type
- Specified electromagnet B = 0.47 T in steel bar. Weight < 2 kg.

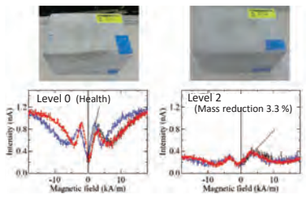
Current Accomplishments (2/2)

■ Index parameters for the corrosion stage

Monitoring of corrosion produced by electrolytic action



For deformed round bars



- Pronounced changes in magnetic curves around 3%-mass reduction.
- Index parameter => Curvature, width, slope in the magnetic curve
- This similar behavior is confirmed for a deformed round bar.

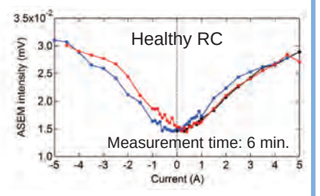
■ On-site verification

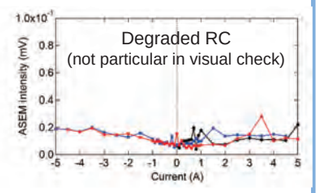
Corrosion extraction

Magnetic measurements
⇒ Fe_3O_4 content ~ 30%.
(typically 40 – 60% for corrosion produced in concrete)

➢ This suggests that Fe_3O_4 content is reduced with time.

On-site investigation





➢ Disclose the degraded conditions in concrete structures.

Goals

Target and reaching objective in SIP

Main Target	Reaching objective
Bridge Floor Covering depth: 30 mm - 50 mm	✓ Completion of the prototype instrument ✓ Index parameters for the corrosion stage ✓ Accumulation of on-site investigations

Toward social implementation of this technology

① Induction of routine checks
Application of routine checks for bridges (once every five years).
--- Promoting a paradigm shift from visual checks to non-destructive evaluations with scientific evidence ---

② Device rental & sales
The enhancement of its visibility and reputation to consultants and inspection companies through rental services.
=> The establishment of the position as the representative tool that can detect rebar corrosion.

③ Technical training
Penetration in the association.
(The Japanese Society for Non-Destructive Inspection etc.)

④ Technological assistance and sales overseas
Cooperation and spread of activities with American bridge maintenance companies.

Bridge floor