SHM-EC: Crack monitoring sensor for Structural Health Monitoring

Remote NDT Monitoring

AIMsight's SHM-EC remote inspection solution is designed to be easily positioned on the crack to be monitored and to provide direct information on the evolution of the most important parameters of the damage, namely its length and depth. In practice, it means that a crack discovered during an NDT inspection can be continuously monitored while the damage and lifetime assessments are performed. The monitoring therefore ensures a safe operation before corrective action can be undertaken. This provides more flexibility and options for the asset integrity management. In addition, the sensor system can provide useful information on the crack response to loads and other parameters, therefore contributing to the improvement of the service lifetime analysis.

Alternatively, the sensor can be used to provide reports about crack initiation in crack-free locations that have been identified as prone to cracking by comparison with similar components or structural simulation.

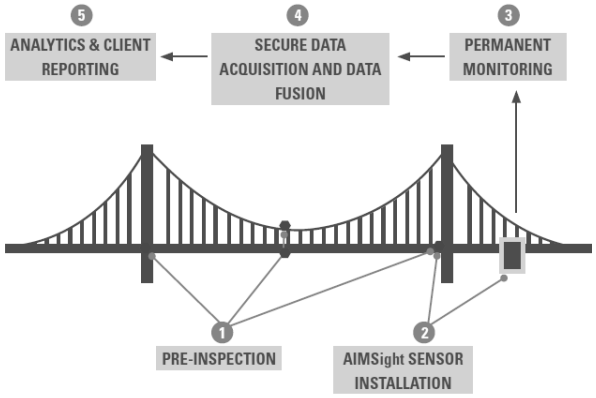

Figure 1 Typical installation process.

By subscribing to a monitoring service with AIMsight's SHM-EC, you leave an ISO 15548-compliant eddy current instrument on each flaw. Most importantly, you leverage the root cause information (crack length and depth) without the need to deploy a complex sensor network and operate a big data system. No additional and complex data processing is required, as the customer can directly access the information of crack extension. Target applications are large engineering metal structures such as bridges, penstocks, oil and gas platforms and pipelines as well as other power generation components.

The right sensor at the right location for the right purpose

The solution leverages the expertise of Sensima Inspection in the development of miniaturized eddy current (EC) solutions, a standard NDT technique to detect surface breaking cracks. The key advantages of EC are that it does not require any couplant and that it can operate through most protective paints and coatings.

The monitoring sensor is in effect a complete EC instrument, with control electronics, computer communication interface and additional sensors (temperature, acceleration, strain, displacement or others depending on needs).

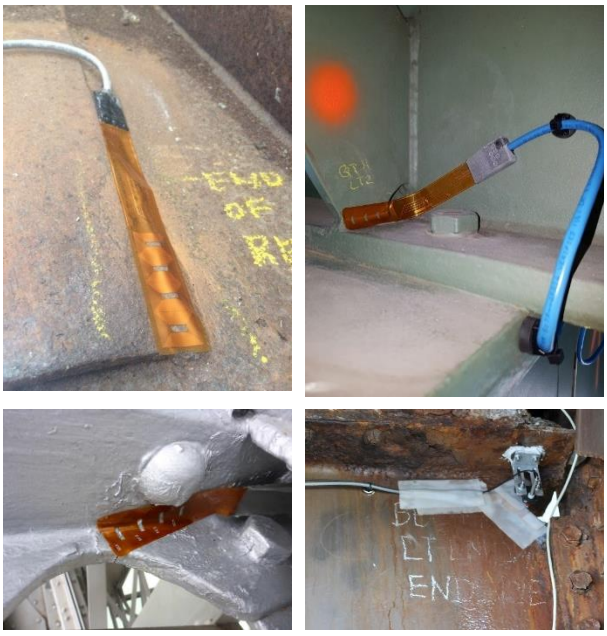

Figure 2 Sensor deployment examples on various bridges ranging in construction date from 1883 to 1971. Sensor installation is performed on top of existing coating, and can also operate in the presence of corrosion.

The main features of the SHM-EC monitoring sensor are:

- Eddy Current independent flexible sensors that can be easily conformed to and installed on the inspection surface
- No need for paint or coating removal for both the pre-inspection and the the crack growth monitoring solution!
- Crack alignments markers and adhesive tape mounting facilitating sensor deployment
- Data gathering, processing and storage, alarm generations
- Correlation of crack growth to external environmental conditions (loads, temperature changes)
- Conformable design for modular applications

Technology Description

The SHM-EC sensor is able to provide a direct measurement of the crack length. This is obtained by processing the signals of the excited coils while the defect is propagating beneath them; the principle is depicted below.

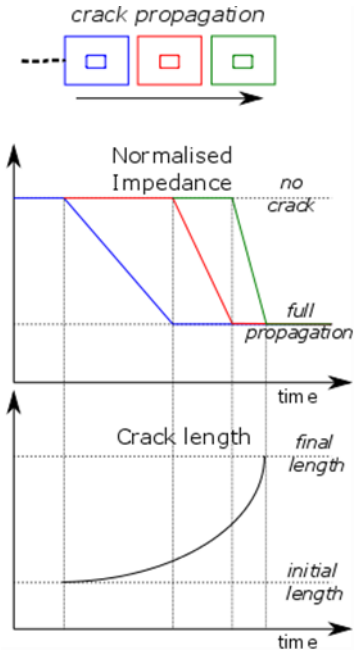

Figure 3 Crack length calculation from the eddy current signals.

In its simplest configuration, the monitoring system comprises up to 10 sensors with wire connection to a compact control unit (typ. 15''x15''x10''). The control unit to sensor distance can extend beyond 1000 yds. The data is transmitted using GSM data connection. Periodic remote inspection reports are provided to the customer.

Laboratory tested

The SHM-EC sensor has been extensively tested during laboratory fatigue tests (Figure 4) performed on diverse types of real bridge components until failure, simulating decades of operation (>10^7 cycles). Those tests have demonstrated:

- The sensor's ease of installation and operation
- Accurate defect growth measurement (submillimeter accuracy).
- The sensor's ability to detect vibrations (load cycles) as well as temperature variations in addition to the defect's geometrical parameters.

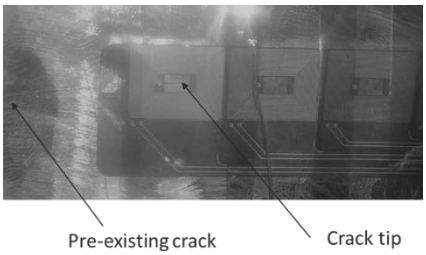

Figure 4 Sensor installation on an existing crack during fatigue testing.

Field proven

The SHM-EC is being used in various projects, ranging from metallic bridges to power generation applications. Our systems have been in operation since 2015, with the remote surveillance on behalf of the city of Bern of the Kirchenfeld bridge inaugurated in 1883. This structure is located next to the Swiss government palace and is both an important traffic node and a landmark structure.

Figure 6: Some of the structures under surveillance.