SHMEC: Crack monitoring sensor for Structural Health Monitoring

Keep a professional eye on your crack!

Sensima's SHMEC sensor 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 having been detected during an NDT inspection can be continuously monitored while the lifetime assessments and are performed. The monitoring therefore ensures a safe operation before corrective action can be performed while allowing more flexibility in the asset integrity management. In addition, it offers a continuous information on the flaw without the need of one-off physical intervention, therefore reducing the infrastructure down time and the risks of accident or unplanned outages. More advanced modes of operation are available on request, such as those providing the high frequency crack response to loads and other environmental parameters. Alternatively, the sensor can be used to monitor crack-free locations that have been identified as prone to cracking by comparison with similar components or structure calculations.

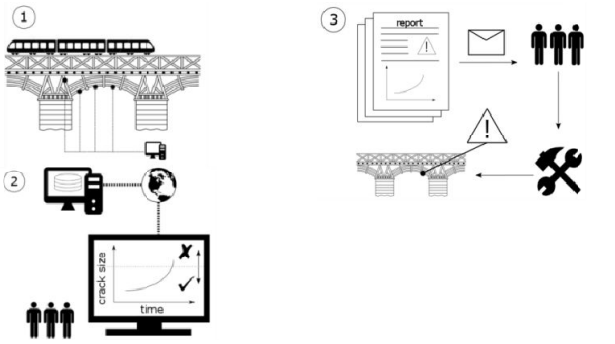

Figure 1 Scheme of potential application: (1) installation of sensors on the points of interest; (2) data analysis, storage and remote access; (3) automatic report and alarm generation.

By monitoring cracks with Sensima's SHMEC, you leave a full-fledged 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 are required and the user can directly access the information of crack extension. Application targets are large engineering metal structures such as bridges, penstocks, oil and gas platforms and pipelines as well as other metallic power generation components.

The right sensor at the right location for the right purpose

The proposed solution takes advantage of the Eddy current technique (ECT), a standard NDT technique to detect surface breaking cracks. The key advantages of ECT are that it does not require any couplant and that it can operate through most protective paints and coatings.

Sensima Inspection has developed ECT instruments for a wide range of applications from manual inspection to robotics applications, introducing new designs and radical miniaturization in ECT. Leveraging many years of NDT field experience, Sensima Inspection releases the monitoring product SHMEC, sharing the core technology of its ECT instrument line.

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

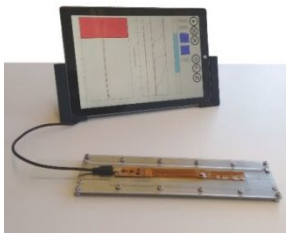

Figure 2 Example of measurement on a calibration specimen using a PC.

The main features of the SHMEC monitoring sensor are:

- Eddy Current independent flexible sensors that can be easily conformed to and installed on the inspection surface
- Crack alignments markers and stick-on-it mount facilitating sensor deployment
- Data gathering, processing and storage, alarm generations
- Correlation of crack growth to external environmental conditions (loads, temperature changes)
- Compact layout with 200x20x1 mm in 5 grams
- Conformable design for modular applications

Product description

The SHMEC 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 and the main elements of the device are depicted in Figure 3

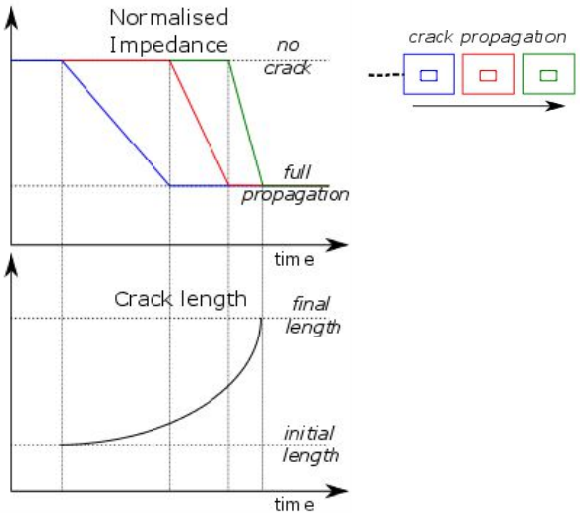

Figure 3 Main features of the structural monitoring sensor.

In its simplest configuration, the monitoring system comprises up to 10 sensors with wire connection to a compact control unit (typ. 15''x15''x10''), only requiring power supply from the bridge owner. The control unit to sensor distance can extend up to 1000 yds. The data are transmitted using GSM data connection. Periodic reports are provided to the customer. On request, we offer online data, services for the integration into an existing monitoring system, and autonomous solutions.

Laboratory tested

The SHMEC sensor has been extensively tested during laboratory fatigue tests (Figure 4) performed on different 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.

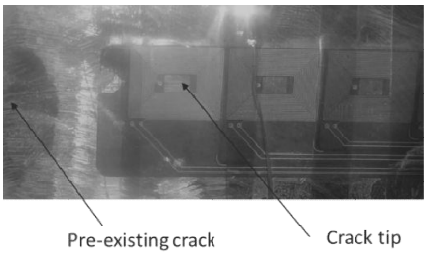

Figure 4 Sensor installation on an existing crack during fatigue testing.

Figure 5 Sensor application on different structural elements.

Field proven

The SHMEC is being used in various projects, ranging from metallic bridges to power generation applications. In 2015, the City of Bern in Switzerland appointed Sensima Inspection to deploy a monitoring system on the high profile 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: The landmark steel bridge in Bern to be instrumented with Sensima Inspection SHMEC crack monitoring technology.