RAMA IX Bridge - Thailand

Project Description:

The RAMA IX Bridge in Bangkok, Thailand was opened in 1987. The bridge is part of Metropolitan Bangkok's Expressway. The bridge represents a crucial connection between Bangkok and Thonburi, across the Chao Phraya River. As part of a regular 15 years inspection, all 68 stay cables of the bridge were subjected to Non Destructive Evaluation in order to assess their conditions.

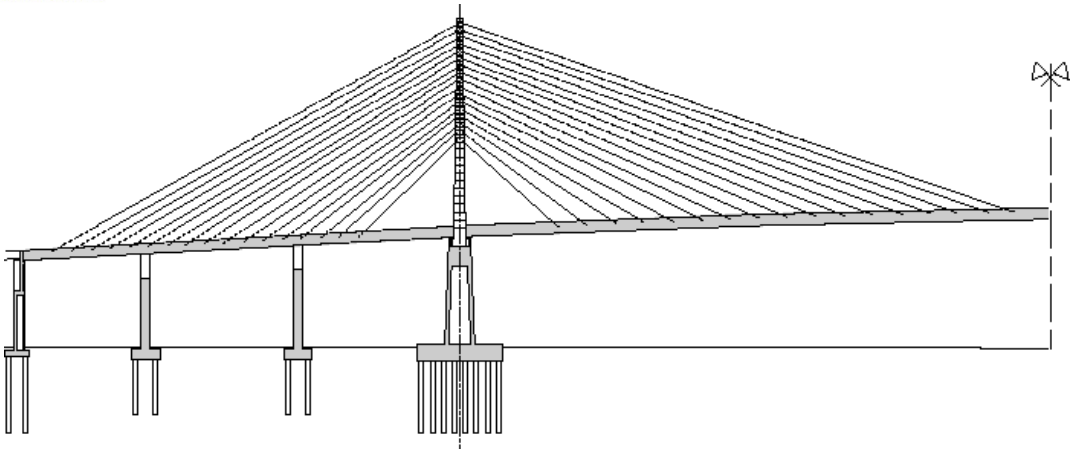
RAMA IX Bridge, Bangkok, Thailand (Photo by Katrin Janberg, www.structurae.net)

Quick Facts:

- **Name and Location:** RAMA IX Bridge - Bangkok, Thailand
- **Owner:** Expressway and Rapid Transit Authority of Thailand (ETA), Bangkok, Thailand
- **Structure category:** Medium span (cable stayed bridge)
- **Spans:** Main span: 450 m Back spans: 61.20 m - 57.60 m - 46.80 m
- **Structural system:** Steel box girder with orthotropic deck and steel pylons, supported on concrete piers and pile foundations.
- **Start of SHM:** July, 2001
- **Number of sensors installed:** N/A
- **Instrumentation design by:** EMPA, Structural Engineering Research Laboratory, Switzerland

Description of Structure:

The Rama IX is a single plane cable stayed bridge with steel box girder and orthotropic deck and steel pylons. It is comprised of a main span (450 m) and two back spans (61.2m+57.6m+46.8m). The bridge carries 6 lanes of traffic. A total of 68 locked coil cables (121mm≤Ø≤168mm) are divided in 4 groups of 17 (1 group on each back span and 2 groups on the main span of the bridge).



Longitudinal-section of the RAMA IX Bridge

Purpose of Inspection:

The purpose of the inspection of the RAMA IX Stay cables was to assess their condition with respect to the presence of fractured wires and possibly of corrosion in the cross-section of the free length of the cables. The inspection was performed using the magnetic flux leakage (MFL) method. The MFL method is non-destructive inspection method.

Due to the importance of the link for the city's traffic system, the inspection had to be carried out without interrupting the service of the bridge. This condition together with practical considerations ruled out the use of radiation based methods for the inspection.

Sensor Details*:

Type	Number	Location
Global MFL sensor circumference of the cable Circumference resolved MFL Sensors the circumference of the cable	1	In the MFL device, on the ≤26

Measurement Equipment and Data Management:

Type of system	Data Management	CMS
PC based measurement system	▪ data pre-view (overview of unfiltered signal) on site ▪ main analysis, graphical presentation and documentation in office ▪ data backed up on CDs on site	N/A

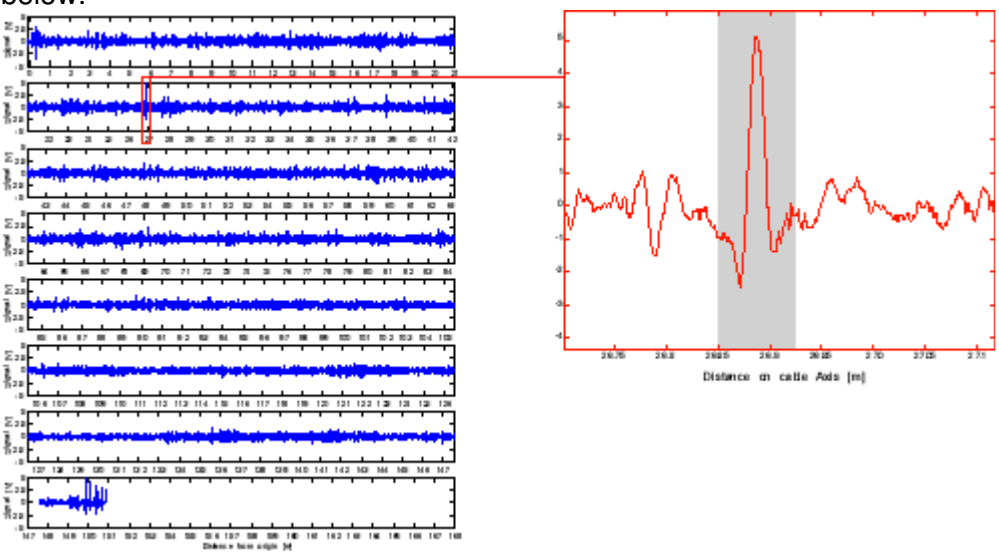
Data Analysis Procedures:

Type of analysis	Software	Additional features
Data post-processing (filtering of speed related effects) Flaw recognition and localization	Software developed in-house	New developments after RAMA IX: • 3D localization of the flaws for multi-strand cables • ANN based recognition of flaws

Examples of Outcomes:

100% of the free length of the cables was inspected. The output from the global MFL sensor yielded overall information about the presence of fractures within the cable

cross-section as a function of the distance along the cable axis, as shown in figure below:



In the case of locked coil cables, such as the ones installed on RAMA IX Bridge, and parallel wire bundles, the information obtained from the circumference resolved MFL sensors, is not used to localize the position of flaws within the cross-section of the cable but as a second set of sensors for backup measurement. For multi-strand systems, the mapping of the magnetic flux leakage maps on the surface of the cable can be used to localize the position of flaws within the cross-section of a cable. The identification of signals indicating the presence of flaws has now been automated to a large extent.

Benefits of Using SHM Technologies in the Project:

The application of the MFL technique was at the time of its deployment the only commercially viable solution for the inspection of the cables installed on the bridge for a total length of approximately 8.5 km.

To present no alternatives to the application of magnetic methods to the inspection of large diameter steel cables has been found.

In addition to making use of a nondestructive method, the inspection procedure used on RAMA IX did not require any interruption of the traffic on the bridge.

References:

R. K. Stanley, "Simple explanation of the theory of the total magnetic-flux method for the measurement of ferromagnetic cross-sections", Materials Evaluation, **53** (1), 72-75 (1995)

A. Bergamini, "Nondestructive Testing of Stay Cables - Field Experience in South East Asia", Proc. 3WCSC, Como, Italy, Wiley, 2002 (in print)

A. Bergamini, R. Christen "A Simple Approach to the Localization of Flaws in Large Diameter Steel Cables" SPIE's 8th Annual international Symposium on NDE for Health Monitoring and Diagnostics, 2003, to be published

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