The New Svinesund Bridge - Sweden

Project Description:

The world's largest bridge with a single arch is being built across the Ide Fjord at Svinesund. The bridge will form a part of the European highway, E6, which is the main route for all road traffic between Gothenburg and Oslo. The bridge is an elegant but structurally complicated bridge as it combines a very slender construction with a special structural form. Due to the uniqueness of design and the importance of the bridge a monitoring project was initiated by the Swedish National Road Administration (Vägverket). The monitoring project, including measurements during the construction phase, the testing phase, and the first 5 years of operation, is coordinated by The Royal Institute of Technology (KTH).
For more information, see the monitoring project homepage at http://www.byv.kth.se/svinesund/

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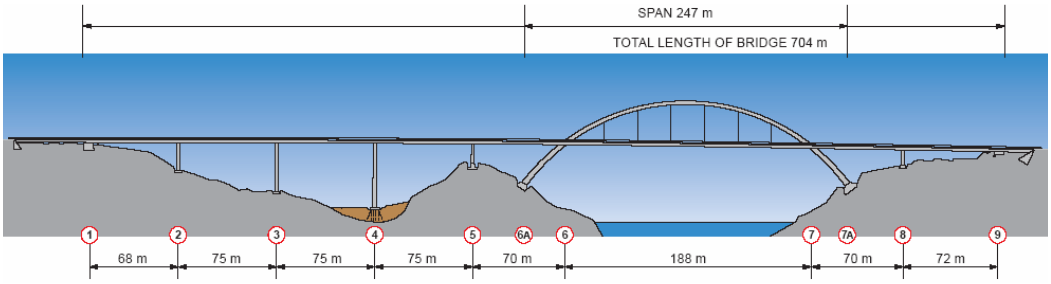
Quick Facts:

- **Name and Location:** The New Svinesund Bridge, joining Sweden and Norway
- **Owner:** The Swedish National Road Administration (Vägverket)
- **Structure category:** Arch bridge
- **Spans:** main arch span of 247 m
- **Structural system:** 2 steel box girders suspended from a single concrete arch
- **Start of SHM:** June, 2003
- **Number of sensors installed:** 58 (68 when the bridge is completed)
- **Instrumentation design by:** KTH, division of structural design and bridges, Stockholm, Sweden

Description of Structure:

The New Svinesund Bridge is a highway bridge across the Ide fjord joining Sweden and Norway. The total length of the bridge is 704 m and consists of a substructure in ordinary reinforced concrete together with a steel box-girder superstructure. The main span of the bridge between abutments is approximately 247 m and consists of a single ordinary reinforced concrete arch which carries two steel box-girder bridge decks, one on either side of the arch. The level of the top of the arch and the bridge deck are +91.7 m and +61 m, respectively. Over the part of the bridge where the arch rises above the level of the bridge decking, the two bridge decks are joined by traverse beams positioned at 25.5 m centres. The traverse beams are in turn supported by hangers to the concrete arch.



Sketch of the New Svinesund Bridge in its entirety, showing grid-line numbering and approximate dimensions.

Purpose of Inspection:

The primary objective of the monitoring programme is to check that the bridge is built as designed and to learn more about the as-built structure. This will be achieved by comparing the measured structural behaviour of the bridge with that predicted by theory.

Sensor Details*:

Type of sensors	Number	Location
Vibrating-wire strain gauges	16	4 at arch base and 4 just below the bridge deck, Norwegian and Swedish side.
Resistance strain gauges	8	2 at arch base, 2 in a segment just below bridge deck, and 4 at the crown.
Linear servo accelerometers on concrete arch	4	installed pair-wise and are moved to new arch segments as construction of the arch progresses. When the arch is completed, 2 accelerometers will be moved to the arch mid point and 2 to the arch's Swedish quarter point.
linear servo accelerometers on bridge deck	6	3 at mid point and 3 at quarter point.
Temperature gauges	28	at the same sections as the strain gauges.
outside air temperature gauge	1	at arch base on Swedish side.
3-directional ultrasonic anemometer	1	for measuring wind speed and direction at deck level close to the first support on the Swedish side.
Load cells	2	monitor the forces in the first hanger pairs on the Swedish side.
LVDT	2	monitor transverse movement of the bridge deck at the first bridge pier supports on both sides of the arch.

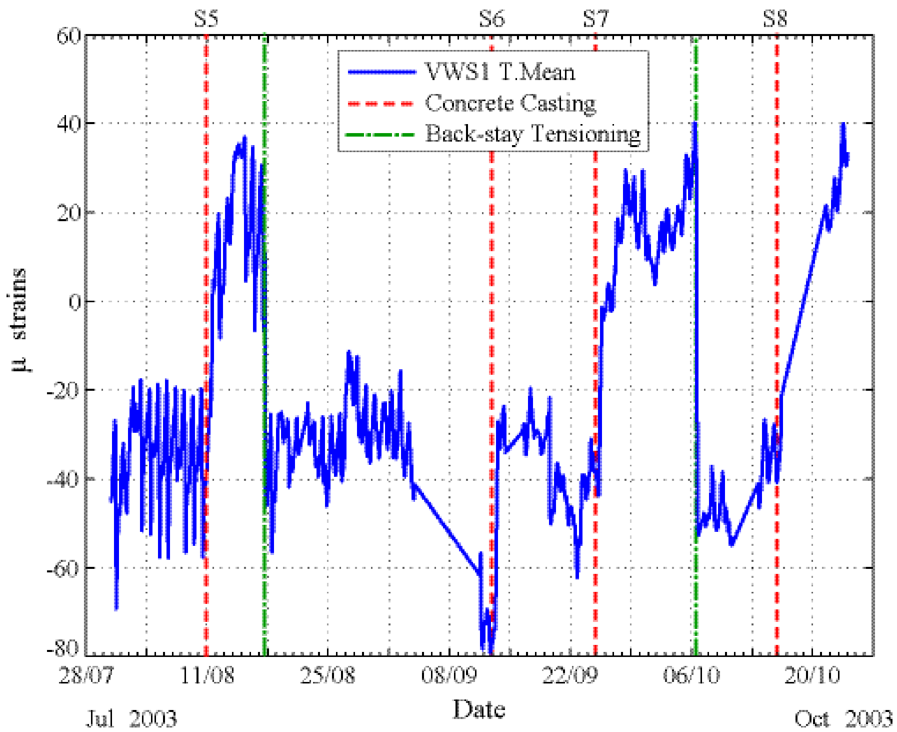
Measurement Equipment and Data Management:

The data acquisition system consists of two separate data sub-control units built up of basic MGC Digital Frontend modules from HBM (Hottinger Baldwin Messtechnik). The units are located at the base of the arch on respectively the Norwegian and Swedish side. The sub-control system on the Swedish side contains the central rack-mounted industrial computer and is connected with ISDN telephone link for data transmittal to the computer facilities at KTH for further analysis and presentation of data. The logged data on the Norwegian side is transmitted to the central computer on the Swedish side via a radio Ethernet link.

The selected logging procedure provides sampling of all sensors continuously at 50 Hz with the exception of the temperature sensors which have a sampling of once per 20 seconds or 1/20 Hz. At the end of each 10 minutes sampling period, statistical data such as mean, maximum, minimum and standard deviation are calculated for each sensor and stored in a statistical data file having a file name that identifies the date and time period when the data was recorded. Raw data, taken during a 10 minutes period, is stored in a buffer if the "trigger" value for calculated standard deviation for acceleration is exceeded.

Examples of Outcomes:

The figure below show the strains measured at the roof of a segment close to the arch base on the Swedish side. The casting of each subsequent segment causes an elongation of the reinforcement bars. This is to be expected as the arch behaves as a cantilever and the extra weight at the end of the structure caused by the newly cast arch segments will cause tension in the top of the section at the base of the arch. In a similar manner, tensioning the support cables, represented by the green dot-dashed lines, causes a contraction of the same reinforcement bars.



This figure show how the work on site is mirrored by the measured strains. The casting dates for segments are represented by dotted red lines. Segment numbers are shown at the top of the figure. The dates when tensioning of support cables occurred are shown in green.

Benefits of Using SHM Technologies in the Project:

See purpose of inspection.

References:

Gerard James and Raid Karoumi, "Monitoring of the New Svinesund Bridge, Report1: Instrumentation of the arch and preliminary results from the construction phase", TRITA-BKN. Rapport 74, Brobyggnad 2003, ISSN 1103-4289, ISRN KTH/BKN/R--74--SE, Royal Institute of Technology (KTH), Stockholm.

This report will soon be available on the monitoring project homepage at http://www.byv.kth.se/svinesund/

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