



Monitor Optics Systems

Optical Sensing Solutions for Structural Monitoring

www.monitoroptics.com

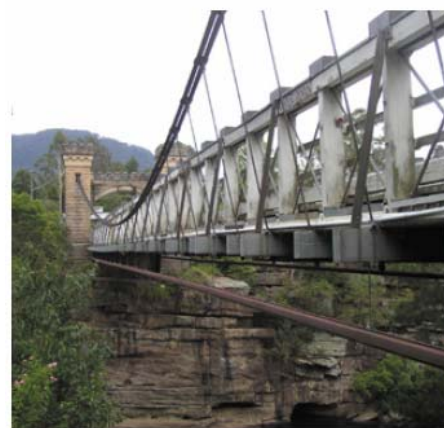
Fibre Bragg Based Structural Monitoring System for Historic Bridge

The Hampden Bridge over the Kangaroo River is the sole surviving suspension bridge from New South Wales' colonial period.

Opened in 1898, the bridge was an outstanding engineering achievement for its time. Over one hundred years on however, the bridge is being subject to far greater traffic loading than that for which it was originally designed.

Monitor Optics installed a fibre optics based, long term structural monitoring system on the bridge in December, 2004. The monitoring system was commissioned by the Road and Traffic Authority, NSW to be used as a decision support tool in the development and implementation of bridge asset management plan.

The system employed Fibre Bragg Gratings (FBG) as strain and temperature sensors, surface mounted onto key structural members. Traffic induced dynamic strain data measured by the sensors was automatically acquired, classified and transmitted web-based database for management and visualisation.



Sensors Network

Sensors were initially mounted on two of the steel rods connecting the bridge deck to the main suspension cables, and four of the tie-rods in the reinforcing trusses. Each sensor comprised 2 FBGs, one used for strain measurement and one for temperature compensation, both embedded into a carbon fibre composite strip, with the temperature compensation FBG enclosed in a polymeric tubing to isolate it from the strain field. The strips containing the FBGs were glued to the rods using strain gauge-grade glue in order to guarantee a correct strain transfer. The optical signals were carried from the sensors to the demodulation unit using standard telecom fibre cables.

Monitor Optics expanded the network after one year to measure strain on a further 4 suspension rods. The network expansion did not require new interrogation equipment thanks to the modularity of the monitoring systems designed by Monitor Optics.



Data Acquisition and Processing

Demodulation of the FBG signal was provided by a Micron Optics Si425 interrogator controlled by custom designed software. Data was acquired at 25 Hz frequency whenever a vehicle drove over the bridge (traffic event).

Monitor Optics included in the control software the capability of performing the classification of the traffic events depending on the strain profiles induced on the bridge components by each vehicle. This strategy allowed the customer to determine the typology and weight class of each vehicle.

Data was transmitted daily to a remote web server hosting DaMins, Monitor Optics proprietary web based structural data information management system, DaMins provided the customer with instant access to all the measurements and a number of additional information, as number of traffic events, number of events per each class of vehicle, statistics on bridge access and maximum-minimum strain values.

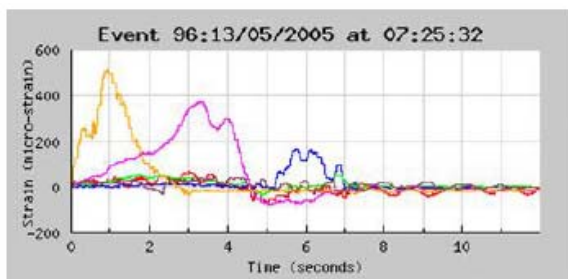


Results

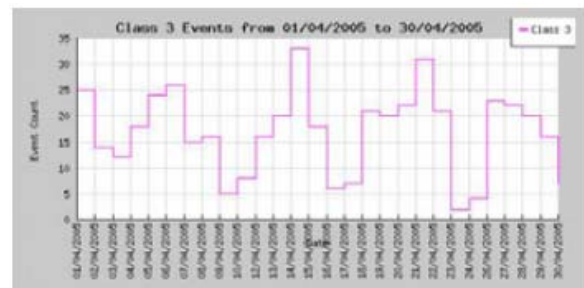
The Monitoring system provided the customer with useful information not only on the structural behaviour of the bridge, but also on the traffic patterns. Through the use of Monitor Optics on-line data management system DaMins, it was possible to verify the number of heavy vehicles engaging the bridge and confirm the suspect that overweight trucks were routinely using the bridge despite the weight limitations in place.

The FBG-based sensors exhibited linear behaviour and no hysteresis, providing reliable data throughout the operational life of the system. The system provided reliable measurements over the full range of traffic loads, from motorcycles to semi-trailers.

The system was tested during a ridge structural assessment campaign that saw the use of standard electric strain gages. The tests showed that the FBG sensors could provide the same data of the electric strain gages without any of the limitations. While some strain gages amplifiers failed during the 2 days of tests, all of the FBG sensors installed in 2004 were still operational 5 years later.



Traffic event strain data



Monthly statistics for heavy vehicles