

Fibre Bragg Grating Based Structural Monitoring System for the Como Cathedral

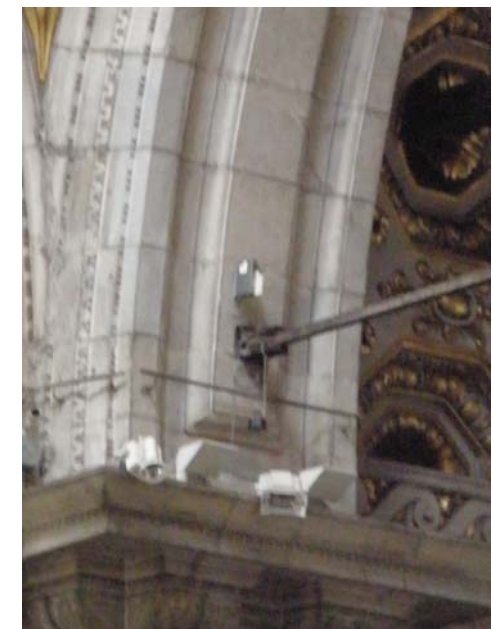
The Cathedral of Como is an important part of Northern Italy cultural heritage and has the distinction of being the last gothic cathedral built in Italy. The first documents mentioning its construction date from 1396 and the cathedral was completed in 1770.

The Cathedral is located on the shores of Lake Como and flooding phenomena often affect the area where the cathedral is located. Because of this a number of monitoring techniques had been employed on the cathedral over the years although all of these required a heavy involvement of human intervention.

The flooding phenomena and fears of an increasing risk of subsidence due to changes in the level of the lake and also that the structure was being adversely affected by traffic vibrations prompted a number of investigations on the structural health of the Cathedral. As a result of these investigations, the decision to install a long term monitoring system was taken.

A Fibre Bragg Gratings (FBG) based monitoring system was selected thanks to the number of advantages it promised.

The system today employs a number of FBG based sensors of different types to measure strains, cracks opening, temperature and relative displacement between structural components. The sensors were installed over a number of years and the system has been constantly updated.





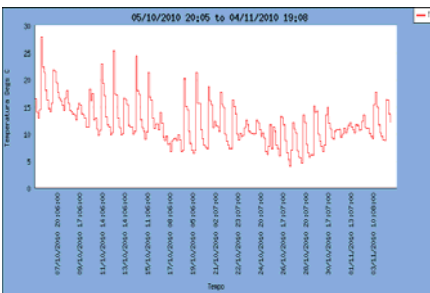
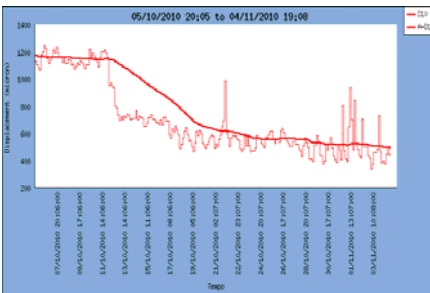
Sensors Network

The sensors were installed in the cathedral as part of several monitoring campaigns while employing the same control and interrogation unit. Different types of sensors are used. These include:

- Displacement sensors mounted over existing crack
- Displacement sensors mounted over separate structural components
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- Strain sensors on the roof concrete reinforcing members
- Long gauge displacement sensors connecting opposite pillars
- Temperature sensors

The temperature sensors are used for both the measurement of temperature inside and outside the cathedral and to compensate any temperature effect on the strain and displacement sensors

The optical signals were carried from the sensors to the demodulation unit using standard telecom fibre cables that were run in existing conduits used for the cathedral lighting system, a solution made possible by the insensitivity to EM interference typical of optical fibre sensing systems.



Data Acquisition and Processing

Demodulation of the FBG signal is provided by a Micron Optics interrogator controlled by custom designed software. Static data is acquired at 3 hour intervals. Both strain/displacement and temperature are acquired to allow the analysis of structural trends as function of temperature variations.

Data is transmitted daily to a remote web server hosting DaMins, Monitor Optics proprietary web based structural data information management system, DaMins provides the customer with instant access to all the measurements and a number of additional information including correlation analyses between temperature and strain/displacement data.

Results

The monitoring system has proved to be a valuable tool in guaranteeing the safety of this important cultural heritage building.

The Monitoring system provides the customer with real time information on the structural behaviour of the cathedral. To date data has been acquired for over 4 years and a good understanding of the actual effect of flooding phenomena on the cathedral has been achieved.

The modularity typical of FBG based sensing systems has allowed the installation of an increasing number of sensors over the years and it is expected that the system will be expanded in the near future.