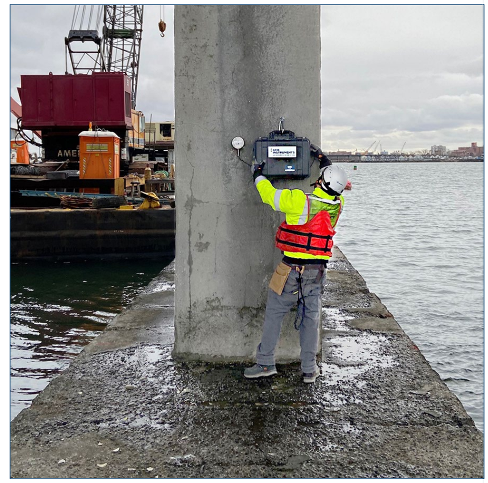
GEO INSTRUMENTS

Monitoring Bridges

AMTS System

Laser-Tilt Sensors



Vibration Monitor and Geophone

Piers & Abutments

Piers and abutments transfer loads from the superstructure to the foundation. Abutments also retain the approach embankments. Monitoring parameters include:

Displacement: Vertical and lateral movement of piers can be monitored with AMTS systems. GNNS sensors can provide backup if fog interrupts sight-lines.

Tilt: Changes in tilt can be monitored with tiltmeters installed on pier faces. Laser-tilt sensors can monitor relative changes in distance between two piers, indicating displacement or rotation.

Vibration: Vibrations from construction activities can be monitored for exceedances with vibration monitors. Geophones are installed directly onto the piers.

Deformation: Cracks in concrete piers or movement at joints in stone piers and abutments can be monitored with crackmeters.

Approach Embankments

Approach embankments provide the transition from the bridge deck to the adjacent roadway or railway. Monitoring parameters include:

Settlement: During construction of the embankment, settlement of foundation soil can be monitored with settlement plates or settlement cells.

Settlement of tracks or roads supported by finished embankments can be monitored with AMTS and rail prisms or road prisms. In critical applications, long horizontal shape arrays can also be deployed along the tracks or under the road surface.

Lateral deformation: Lateral deformation can be monitored with inclinometers or shape arrays. Both of these instruments require vertical boreholes. Lateral deformation of retaining walls that support the embankment can be monitored by AMTS or tiltmeters.

Wireless Data Acquisition

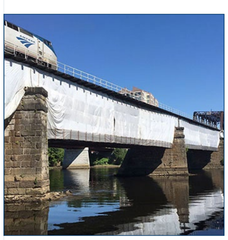
Self-powered loggers transmit measurements from AMTS systems, vibration monitors, shape arrays, tiltmeters, and other sensors to the internet.

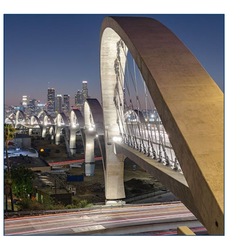
Web-Based Data Management

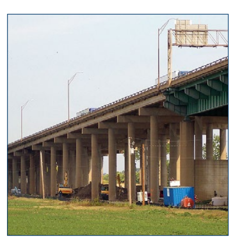
Secure GeoCloud servers on the internet process incoming measurements, check for alarms, update project databases, and automatically update status views, plots, and reports. Alerts are sent to users by text message or emails.

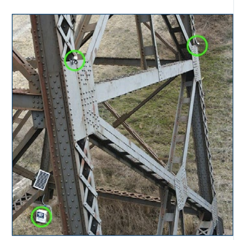
GeoCloud Project Websites

GeoCloud project websites provide easy access to data. Status views show sensors, current readings, and alarm status on CAD drawings, photos, or satellite images. Graph types include trend plots, inclinometer plots of cumulative change, dedicated vibration monitor plots, and more.









Cross Bay Bridge Upgrade

The upgrade project for this six-lane highway bridge involved replacement of fender systems and scour protection for the piers.

Monitoring Requirements

The project required vibration monitoring and stability monitoring. One aspect was monitoring for movement when heavy stone mattresses were placed at the base of the piers.

Implementation

Displacements were monitored by three AMTS systems. These systems were installed on brackets mounted to the piers. They were powered by solar-charged batteries and transmitted measurements by cellular modem at sheduled intervals.

Vibrations were monitored by eight vibration monitors that were installed directly onto the piers. All the monitors were supplied with cellular modems and capable of reporting waveforms of exceedances as well as standard histograms.

Tilt was monitored by laser-tilt sensors. These dual-function sensors were capable of reporting both relative displacements between bridge elements as well as tilt.

Data Management: The project website continuously updated site status, graphs, and data for all three systems, sent alerts as needed, and generated weekly reports.

Spokane River Bridge

The project involved construction of a new rail bridge adjacent to the existing bridge, which had to be monitored.

Monitoring Requirements

The project required monitoring of the existing piers and abutments for potential impacts from the construction.

Implementation

Displacements, including settlement, were monitored at 12 points by a single AMTS system mounted on a 16 foot tower. At maximum distances of 500-feet, the AMTS system accuracy was about ±1 mm.

Vibrations levels were measured by six automated vibration monitors placed on abutments, steel bents, and concrete piers. Geophones were installed on the sides closest to the contractor's activities.

Tilt was monitored by wireless tiltmeters, two on each of the steel bents, one on each of the concrete piers, and one on each of the steel supports founded on the concrete piers. The tiltmeters were co-located with the AMTS prisms.

Baselines: Baselines were established by a week of monitoring with the AMTS, vibration monitors, and tiltmeters.

Data Management: The project website continuously updated site status, graphs, and data for all three systems, sent alerts as needed, and generated weekly reports.

Merrimack River Bridge

The rehabilitation project for the Merrimack River Bridge involved strengthening the superstructure and mitigating scour.

Monitoring Requirements

The project required monitoring stability of the piers during installation of sheet piles and other work. Monitoring for background tidal effects was also required .

Implementation

Displacements were monitored by an AMTS that was located on a pier of the neighboring Comeau bridge, which offered excellent sightlines to prisms on the Merrimack piers.

Vibrations were monitored by vibration monitors and geophones placed on the piers.

Deformations were monitored by crackmeters placed on each pier.

Other monitoring: Hydrophones were placed to monitor underwater pressure changes that could affect fish. Water level monitors were placed to record tides.

Data Management: The project website continuously updated site status, graphs, and data for all three systems, sent alerts as needed, and generated weekly reports.