GEO INSTRUMENTS

Monitoring Settlement

Hydrostatic Level Gauges

Horizontal Shape Array

Settlement Plates and Piezometers

Building Settlement

Settlement in buildings is typically the result of changes in the foundation soil below the building, but is monitored on the building itself, since access to the foundation soil is not is not available. Common parameters for monitoring building settlement include:

Cracks in floor slabs and walls are monitored with crackmeters.

Misalignments of incoming utilities or expansion joints can be monitored with jointmeters.

Differential settlement of floors and walls can be monitored with hydrostatic level cells.

Tilt (rotation) of structural elements can be monitored by tiltmeters.

Displacement of walls and structural elements can be monitored in three dimensions by AMTS systems.

Convergence of ceiling to floor distances can be monitored by laser extensometers.

Surface & Subsurface Settlement

Settlement or heave can result from excavation and support of excavation, tunneling and compensation grouting, dewatering, and erosion. Common parameters for monitoring include:

Water tables are monitored with observation wells and piezometers, typically installed outside excavation perimeters or along tunnel alignments.

Displacements of utilities potentially affected by excavation or tunneling can be monitored with utility monitoring points.

Vertical settlement profile along the axis of a borehole can be monitored by multipoint borehole extensometers.

Horizontal settlement profile along highway foundations, railroad track beds, and tank foundations can be monitored with horizontal shape arrays.

Surface displacements of roads and railroad tracks can be monitored by AMTS systems and road prisms.

Ground Improvement

Ground improvement techniques, such as surcharging of compressible soils also induce settlement. Settlement measurements are used to evaluate the progress of the treatment.

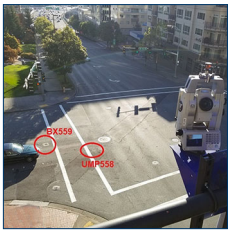
Settlement Plates provide settlement data corresponding to the load of the surcharge placed on the compressible soil.

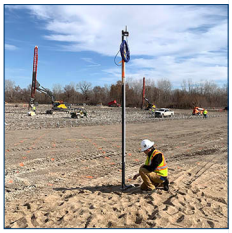
Piezometers monitor the expected changes in pore-water pressure.

Construction Control

Compensation grouting is used to replace ground loss caused by the passage of a tunnel boring machine.

A horizontal shape array, installed just above the planned path of the TBM can monitor ground loss and correction in near real time. Early detection allows grouting at lower pressure, avoiding damage to the tunnel liner and minimizing heave in the foundation soil of the structure above.





Seismic Retrofits to Bridge Piers

During seismic retrofit work, a sudden 5-inch settlement of a bridge pier forced closure of the bridge. Engineers evaluated the failure, revised construction methods, and specified continuous monitoring in a test area to confirm the efficacy of the new method.

Monitoring Requirements

The monitoring system was to provide hourly updates on the stability of piers in the test area and send alarm notifications if any settlement or tilt exceeded a specified value.

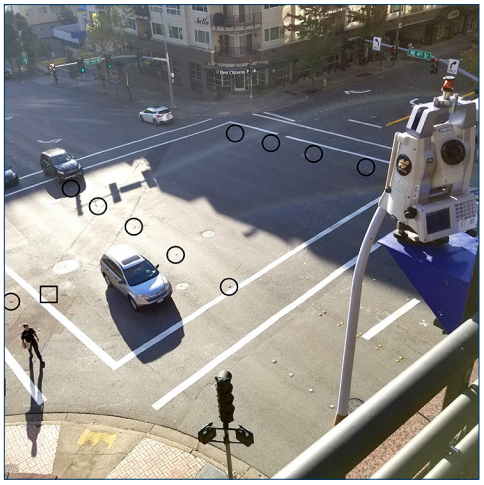
Implementation

Settlement & Tilt Measurements were obtained by four AMTS systems and 48 prisms installed on the piers. Control prisms, set outside the zone of influence, provided stable points of reference. The AMTS systems transmitted hourly readings to the internet.

Data Management: GEO's web-based servers received the measurements, applied least-squares adjustments, and posted the results on a dedicated project website.

The project website continuously updated site status, graphs, and data, sent alerts as needed, and generated daily reports.

The data proved that settlements were in the expected range and confirmed that the new construction methods were successful.



Construction of Transit Tunnel

Sound Transit's Bellevue Tunnel alignment passed directly under a busy thoroughfare with multi-story residential and commercial structures on either side.

Monitoring Requirements

Monitored parameters included lateral deformation, water levels, loading within the tunnel liner, and settlement of structures, utilities, and the road surface along the tunnel alignment. Monitoring frequency was increased as the tunnel head approached and decreased as the heading passed.

Settlement Monitoring

MPBXs and **UMPs** were installed in the roadway above the tunnel centerline. To avoid obstructing traffic, they were terminated below grade and automated with wireless loggers. No trenching was required.

AMTS systems were installed at twelve locations to monitor 350 prisms on the roads and structures along the tunnel alignment. Arrays of road prisms, circled in the photo above, were installed across the road at 50-foot intervals. Prisms were also installed on structural elements and corners of buildings to detect any movement of the buildings.

Data Management: All measurements were transmitted to GEO's web-based servers, which received and processed the measurements, checked for alarm conditions, and then posted the results on a dedicated project website.

Settlement of Storage Facility

This tilt-up constructed storage facility experienced settlement that lead to cracks and outward rotation of its walls.

Monitoring Requirement

On-going effects from the settlement had to be monitored continuously, including the rate of settlement, the progress of developing cracks, and the potential tilting of the walls.

Implementation

Settlement was monitored using ten hydrostatic level cells that wrapped around two walls of the structure. A datalogger transmitted hourly readings to the internet.

Tilting of the walls was monitored using ten battery-powered, wireless-mesh tiltmeters. The tiltmeters forwarded their measurements to a wireless internet gateway.

Cracks were monitored with three crackmeters connected to battery-powered, wireless-mesh nodes. Measurements were forwarded to the same internet gateway.

Data Management: All instrumentation was automated, allowing 24/7 monitoring. Incoming data was received and processed by GeoCloud servers. Results were automatically posted on a dedicated website that was also capable of sending alerts to by email and text message.