Deformation refers to changes in the shape or position of natural formations, such as slopes, or man-made structures, such as underground openings, embankments, and retaining walls. Deformation monitoring is used to assess risk, control for potential damage, and evaluate remediation measures.

Typical instrumentation includes automated total stations (AMTS), inclinometers, extensometers, piezometers, tiltmeters, and crackmeters.

**Green Line Metro**
Construction of a 2.5 mile test track next to the busy Green Line posed potential safety issues. To monitor for possible deformation of the Green Line track bed, GEO deployed an array of fifteen automated total stations (AMTS) and 900 target prisms. Although the automated total stations were 800 feet apart, GEO was able to create a strong geometric network through the use of shared target prisms and 60 control prisms. Measurements were transmitted hourly to GEO’s server, where they were processed with least-squares software, checked for alarms, converted to site coordinates, and posted on a dedicated website.

**Rosslyn Metro Station**
Demolition, blasting, and excavation at a site adjacent to the Rosslyn metro station posed a risk to the station vault, ventilation shafts, escalator, and elevators. GEO monitored the full length of the vault with four AMTS and arrays of prisms installed every 25 feet, supplemented by convergence gauges set between the vault ceiling and the station ceiling. Tiltmeters were placed in the escalator vault and the ventilation shafts to detect possible deformation and changes in alignment. Antennas from the radio modems in the vaults were brought out discretely to public areas so that measurements could be transmitted off site for processing.

**I-90 at Snoqualmie Pass**
Snow avalanches and rockfalls at Snoqualmie Pass have caused frequent closures of I-90, so transportation authorities designed a multi-year project to stabilize the slopes, realign and widen lanes, and construct flyover bridges in avalanche zones. To monitor deformation of the steep slopes at this remote location, GEO deployed automated total stations, piezometers, instrumented rock dowels, data loggers, and communications equipment, all powered by solar panels and batteries. Point-to-point radios transmit measurements to base stations at higher elevations where cellular links can relay them to the internet and Washington DOT offices.

**Castle Village Retaining Wall**
When a large retaining wall failed, 41,000 cubic yards of rock, soil, and trees slumped onto a major urban highway, closing it and endangering nearby apartment buildings. To help manage risk during reconstruction of the wall, GEO installed more than 100 sensors to monitor settlements, lateral displacements, and rotation. Readings were obtained every 15 minutes, checked against alarm thresholds, and displayed on a dedicated website. The system earned the praise of the design and construction engineers for giving them tremendous peace of mind during a very difficult project.

**Sound Transit I-5 Undercrossing**
Sound Transit’s U-Link project extends the light-rail system from downtown Seattle to the University District. GEO-Instruments monitored a high risk section of the project, where twin tunnels would cross under I-5 and through the foundations of the 40-foot high, 400-foot long retaining walls on either side of the highway. GEO deployed multiple technologies to monitor the walls for deformation, including two AMTS, a laser scanner, tiltmeters, crackmeters, inclinometers, six data loggers, and mixed-mode communications. The complex system was commissioned in just four weeks.

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About GEO-Instruments

GEO-Instruments provides automated solutions for monitoring the safety and stability of buildings, excavations, bridges, railways, roads, tunnels, dams, embankments, and slopes.

We help clients manage risk by installing advanced monitoring systems and automating the collection, processing, and delivery of alarms, data, and reports.

We work as part of the design and construction team or as independent consultants. Our highest priorities are delivering practical, cost-effective solutions and maintaining good communications with our clients.

Established in 2003, we have acquired a reputation for getting results and providing excellent customer service. We now operate from offices in Rhode Island, New York, District of Columbia, California, and Washington.

Advanced Technologies

The GEO-Instruments team has extensive experience in instrumentation, civil engineering, information technology, and construction. We can integrate and deploy a wide range of technologies to meet project requirements.

Efficient Field Services

GEO-Instruments can mobilize field services quickly. Our technicians are trained and cross-trained to ensure that field services are performed efficiently and that systems are installed and commissioned correctly.

Wireless Communications

GEO-Instruments can implement wireless systems in nearly any environment. Our systems provide reliable data collection, eliminate the costs of installing and protecting cables, and reduce the need for site visits.

Web Access to Data & Reports

GEO-Instruments creates a website for each project. The website automatically updates data, graphs, and reports, freeing engineers for other work. Reports can be emailed to all stakeholders, and site status can be reviewed in real time at meetings.

Tank Foundations

Plant engineers at an oil storage facility requested a monitoring system to provide early detection of differential settlements while retired storage tanks were returned to service. GEO installed four high-resolution tiltmeters in sparkproof enclosures on the foundation rings of each tank. Readings were collected by data loggers located outside the hazard zone. GEO’s server retrieved the data, checked for alarms, and then posted updated readings on a dedicated website. The system provided confidence in the performance of the tank foundations and helped the facility increase capacity at low cost. See Monitoring Settlement

Salesforce Tower

Salesforce tower will be the tallest building in San Francisco and the centerpiece of the Transbay Redevelopment project. To monitor the support system, GEO-Instruments has deployed 138 prisms and four automated total stations (AMTS), two mounted on walers and two mounted on buildings. This configuration not only provides complete coverage of the support system, but also allows the four AMTS to share some common points of measure, creating a strong geometric network for least-squares processing and delivery of accurate measurements. The system provides updates every two hours. See Monitoring Support of Excavation

Portland Pier

Nearby dredging posed a potential risk to the support structure of this container ship pier. To monitor the structure, GEO-Instruments was asked to provide hourly readings of underwater load cells. GEO supplied weldments for the cells, which were installed by divers, and a battery-powered logging system for data collection. The logging system, fitted with a cellular modem and GEO’s Lid-Link® antenna, was installed flush with the pavement of the pier to avoid interfering with operations. GEO’s server retrieved data 24/7 and posted processed readings on a dedicated website for convenient and immediate access. See Monitoring Structures.