



CASE STUDY: SMART Retaining Wall

THE CHALLENGE

The service life of key infrastructure is increasingly being extended well beyond its original design life. There are many cases of retaining structures constructed in the 1970's with 30 year design lives, still being in service today. Structural health monitoring is required to make informed asset management and risk decisions regarding interventions to prolong service life, repair or replacement.

Anchored sheet pile walls are a specific case where corrosion of either the anchors or the sheet piles could lead to progressive failure and catastrophic collapse, with significant safety consequences for the areas above and below the wall.

Viotel recently provided real-time monitoring for a 350m long 8.5m high anchored sheet pile wall retaining an embankment beneath an access road to a port. The wall was constructed in 1982 with a 30 year design life. The Viotel Tilt nodes that were installed to provide real-time monitoring movement of the walers along the sheet pile. The Viotel dashboard was set up with movement thresholds triggering email alerts to relevant asset managers / risk owners.

THE SOLUTION Retaining Wall Monitoring

The number of instruments is a function of the height and length of the wall, the age of the wall, the type of wall, and the risk to life and property damage associated with excessive movement and/or failure of the wall.

For this wall, the permanent stressed anchors are likely to be approaching the end of their original design life. Typically anchors of this type are subjected to long term monitoring through load cells, and/or lift off tests. The British Standard for Anchors (BS EN 1537) recommends a minimum of 1% of anchors are selected for long term monitoring. For this wall, it would be around 12 anchors.

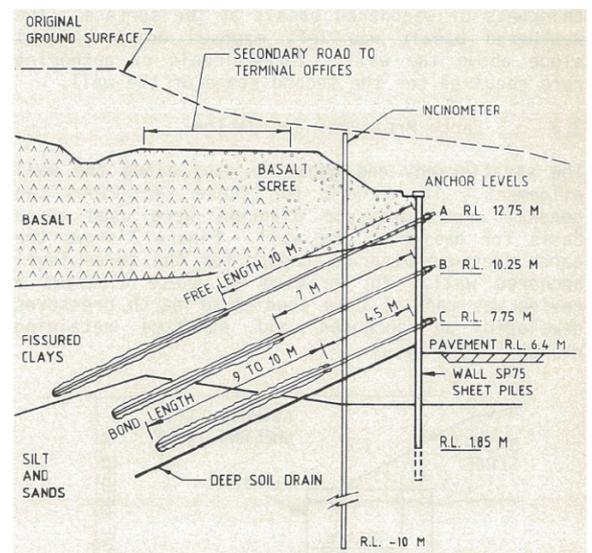
The total wall length is around 350m and monitoring instruments on retaining walls for road authorities, such as bridge abutments and embankment walls is typically two instruments per wall.

AT A GLANCE

How Viotel Tilt Nodes played a key role in monitoring the stability of an Anchored Sheet Pile Wall while allowing road access activity below.

KEY POINTS:

- Viotel developed a comprehensive monitoring program for the existing retaining wall including vibration monitors and tilt nodes.
- All data is available on Viotel's data management platform, myViotel



Geotechnical aspects of the Anchored Sheet Pile Retaining Wall constructed in 1982



Viotel Triaxial Tilt Node installed

THE SOLUTION

Retaining Wall Monitoring

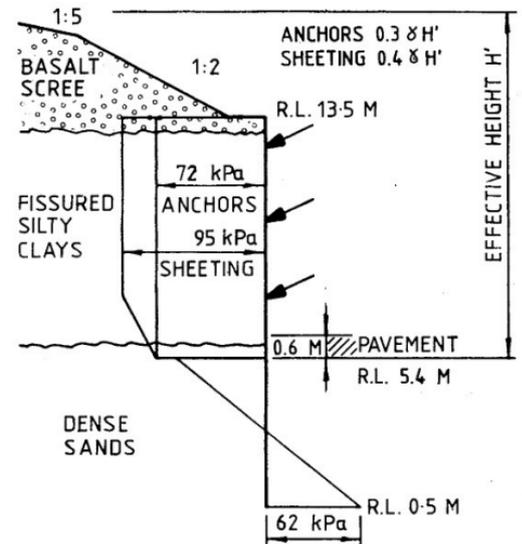
The Hong Kong Guide to Retaining Wall Design (Geo guide 1) recommends one monitoring point per 25m of wall.

As the anchors are approaching the end of its original design life an increase in the original monitoring regime is warranted. 5 Tilt nodes were installed on the retaining wall in stage 1 with another 7 Tilt nodes to be installed in stage 2. The stage 1 Tilt nodes were installed within 1 day.

Viotel triaxial Tilt nodes were mounted on weld on brackets fixed to the retaining structure walers between the ground anchors. The Viotel Tilt nodes provide a feed of real-time monitoring data to the Viotel AWS Cloud database which is interpreted via a dedicated project dashboard.

ALERTS & ALARMS

Viotel liaised with consulting engineers **pitt&sherry** who established trigger thresholds for the wall movements and alerts, which are set via the **myViotel** web based platform.



Earth pressure diagram for 3 level anchored wall

Trigger	Criteria	Response
Alert	80% of allowable rotation of wall or horizontal movement	Continue monitoring as per agreed plan and continue routine maintenance and inspections
Action	> 80% but less than 100% of allowable movement	Undertake engineering site inspection and assessment, undertake point cloud survey and compare with previous survey, prepare Trigger Action Response Plan
Alarm	> 100%	Implementation of Trigger Action Response Plan. Consideration of suspension of traffic movement above wall, and activities at base of wall depending on engineering assessment

RESULTS

The wall monitoring has been in place for over 18 months. The Viotel Tilt nodes are sensitive enough to detect slight seasonal variation as the steel heats up and expands in summer then contracts in winter. The monitoring has established a stable baseline for the wall with no false alerts.

VIOTEL WIRELESS TRIAXIAL TILTMETER

The Viotel Wireless Triaxial Tiltmeter features a high accuracy triaxial tilt sensor and is self-contained with internal battery (solar panel optional), GPS and cellular (CatM1) modem.

The tiltmeter is shipped pre-programmed and integrated. Simply mount the sensor in the desired location and power on for **reliable, continuous, real-time monitoring**.

The **Viotel** units are safe, self-contained IoT sensor packs which are discrete, simple to install and calibrate, powered with mains/battery &/or solar power and with analysis power via on-board microprocessors. The **myViotel** app, accessing internet-based data, transforms a sensor from a disconnected unintelligent asset to a networked live data device.



FEATURES & BENEFITS

- WIRELESS OPERATION
- EVENT DETECTION MODE
- CONTINUOUS MONITORING
- EASY INSTALLATION
- ANY ORIENTATION
- CAT-M1 COMMUNICATIONS
- ALARM CAPABILITY WHEN TILT EXCEEDS PRE-SET LIMITS
- INTERNAL TEMPERATURE SENSOR
- INTERNAL GPS FOR POSITIONING
- MADE IN AUSTRALIA



Integrated data path from source to decision

Specifications

Number of components	3 - Triaxial
Resolution	0.0003°
Accuracy	0.001°
Operating Tilt Range	-180° to +180°
Sampling Rate	From every 5 minutes to daily
Upload Rate	From every 5 minutes to daily (max 24 data per upload)
Dimensions	110mm x 150mm x 60mm (WxLxD)
Weight	0.6kg
Operating Temperature	-35 to +75°C
Internal Battery Life	Hourly recorded readings, daily upload: > 4.2 years (includes continuous event detection)
Enclosure Features	ABS plastic, UV stabilised, IP67

Viotel SMART Structural Health Monitoring Systems are applied to monitor the structural health of bridges, towers, wharfs, buildings, and dams.