

Vibrating Wire Settlement Systems

Applications

Settlement Systems are designed to measure the settlement of...

- Dams
- Fills and embankments
- Foundations
- Roadways
- Storage tanks
- Surcharges

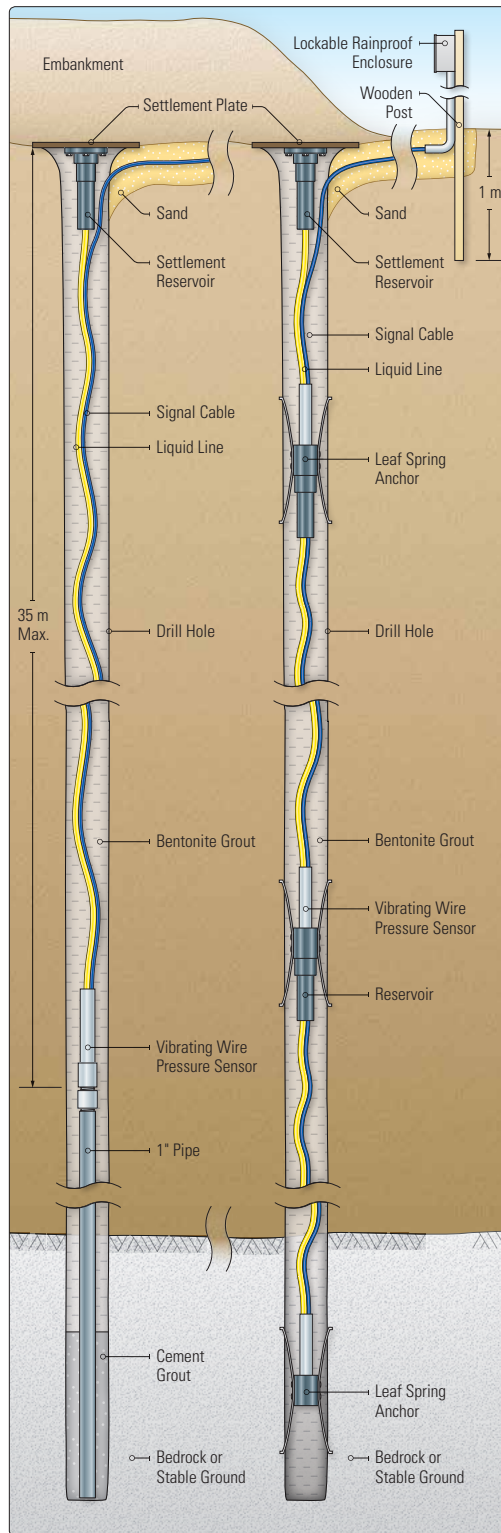


• Model 4600 Vibrating Wire Settlement System.



• Model 4600M Vibrating Wire Settlement Sensor with leaf spring anchor.

Model 4600 Settlement System



• Typical Model 4600 (left) and 4600M (right) installations.

Operating Principle

The Model 4600 is designed for use where there is bedrock or stable ground, accessible by drilling a borehole, which can be used as a stable benchmark immediately beneath the point of settlement. A vibrating wire pressure sensor, anchored on a pipe grouted into solid ground or bedrock at the bottom of the borehole, is connected by a liquid-filled tube to a reservoir attached to a settlement plate located at the ground surface. As the fill is placed, the reservoir settles and the liquid pressure on the sensor diminishes. An electrical cable runs from the sensor to a remote readout location.

Where it is important to know in which subsurface zone settlement is occurring, a special version, the Model 4600M, can be used. It comprises of several 4600 systems, installed one above the other, in a single borehole. Intermediate combinations of reservoir and sensor are held in place in the borehole by leaf spring or hydraulic anchors.

Typical applications for the Model 4600 are: the measurement of sea-floor settlement beneath the construction of a sand-island, and the measurement of settlement beneath a surcharge in a swampy area.

Advantages and Limitations

A closed loop vent line between transducer and reservoir prevents temperature and barometric pressure fluctuations from affecting the readings. The use of long horizontal liquid-filled tubes, which could be susceptible to air bubble formation, is not required. However, the proximity of stable ground beneath the settlement point and the drilling of a borehole are required. Systems are supplied fully sealed and assembled, ready for installation.

Technical Specifications

Standard Ranges ¹	7, 17, 35 m
Resolution	0.025% F.S.
Sensor Accuracy ²	±0.1% F.S.
Temperature Range ¹	-20°C to +80°C
Length × Diameter	(reservoir) 305 × 60 mm (sensor) 191 × 35 mm

¹Other ranges available on request.

²Laboratory accuracy. Total system accuracy is subject to site-specific variables.

Model 4660 Settlement System



● Model 4660 Settlement System (protective cover cutaway shows vibrating wire sensor).

Applications

The Model 4660 is designed for remote measurement of the settlement of a point in or below fills, surcharges, embankments, etc. Systems with tube lengths of up to 300 m have been used successfully to measure settlements in earth dam embankments.

Operating Principle

A vibrating wire pressure sensor is attached to a settlement plate located at the point of settlement. The sensor is connected via two liquid-filled tubes, extending laterally, to a reservoir located on stable ground. The sensor measures the hydraulic head

of liquid between the sensor and reservoir locations.

Advantages and Limitations

A vented cable runs from the sensor to the remote readout location and connects to the reservoir so that barometric pressure fluctuations do not affect the readings.

The liquid-filled tubes can be flushed to remove any air bubbles that might form.

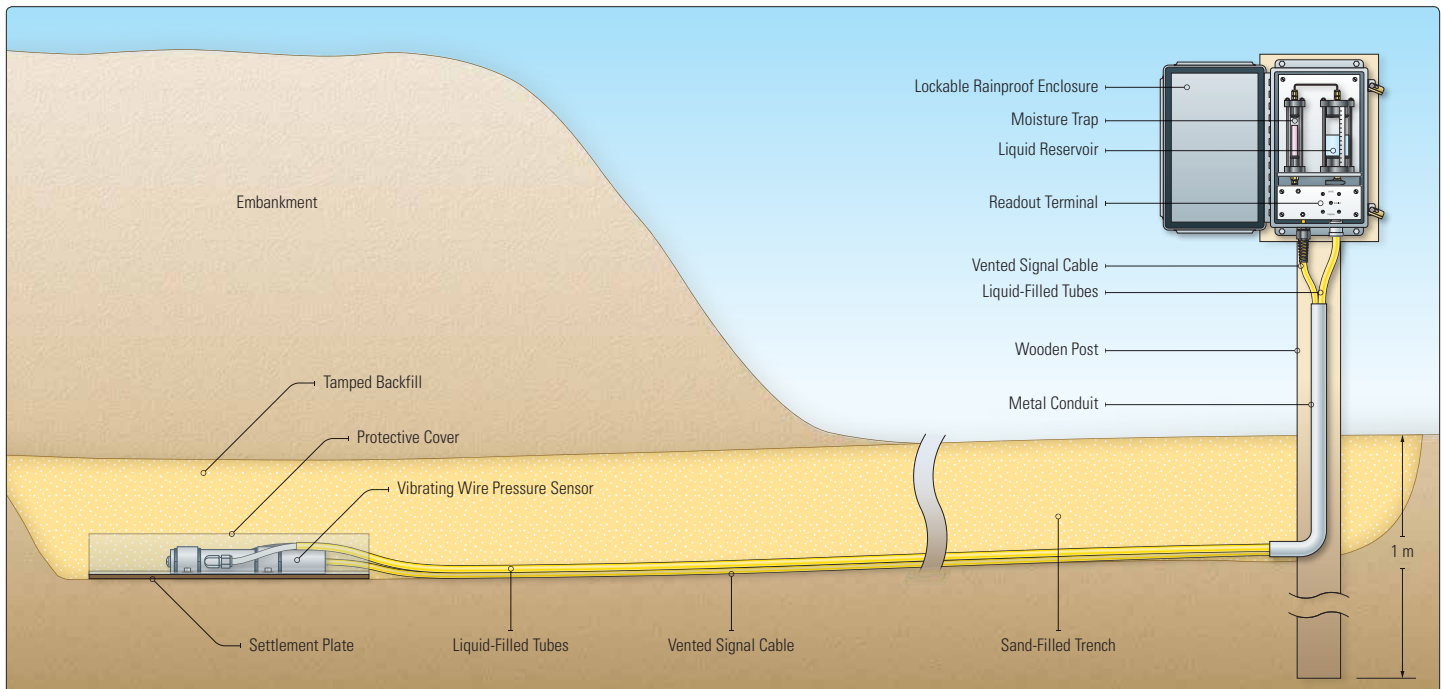
It is possible to perform in-situ checks at any time on both the calibration and zero stability.

Technical Specifications

Standard Ranges ¹	7, 17 m
Resolution	0.025% F.S.
Sensor Accuracy ²	±0.1% F.S.
Temperature Range ¹	-20°C to +80°C
Length × Diameter	(reservoir) 152 × 51 mm, (sensor) 168 × 25 mm
Length × Width × Height	(plate) 305 × 305 × 6 mm, (cover) 305 × 127 × 45 mm

¹Other ranges available on request.

²Laboratory accuracy. Total system accuracy is subject to site-specific variables.



● Model 4660 installation for the remote measurement of subsurface settlement beneath a large embankment.

Model 4651 Settlement Profiler



● Model 4651 Settlement Profiler.

Applications

The Model 4651 Settlement Profiler is a portable device designed to measure profiles of heave and settlement beneath fills, embankments, roadways, storage tanks, structures, etc. It can be used to measure differential settlements at discrete points on structures such as building columns, etc., and also to monitor surface settlement above tunneling activities.

Operating Principle

A sensitive Vibrating Wire Pressure Sensor is located inside a torpedo that can be pulled through a buried pipe, or carried from point to point. The Sensor is connected, via a liquid-filled tube, to a reservoir located on stable

ground. The tubing is stored on a reel, which is mounted horizontally at the reservoir location, and is free to turn as the torpedo is pulled into the hole, or, is positioned at different locations. The sensor measures the hydraulic head between the reservoir and the sensor locations.

Advantages and Limitations

Independent measurements of settlement can be made at closely spaced intervals providing a detailed profile of differential settlements over a wide area.

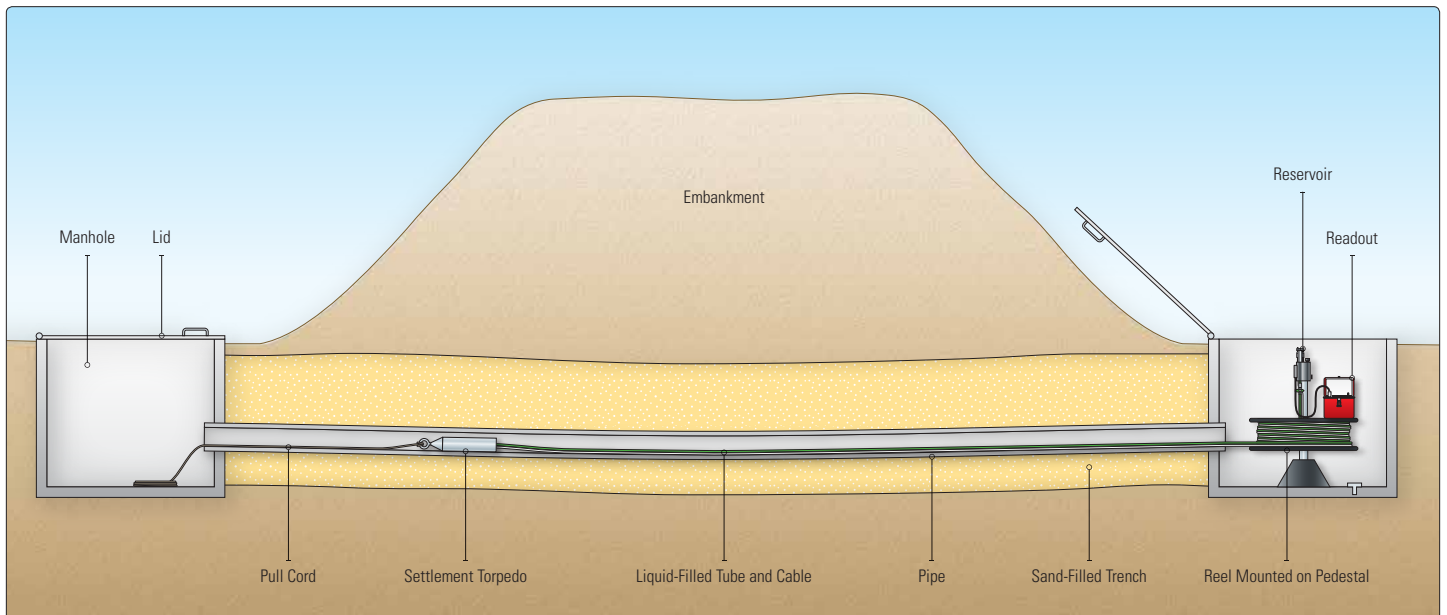
The Sensor is vented so that barometric pressure fluctuations have no effect on the readings.

Technical Specifications

Standard Range ¹	7 m
Resolution	0.025% F.S.
Sensor Accuracy ²	±0.1% F.S.
Temperature Range ¹	-20°C to +80°C (using antifreeze solutions)
Reel Capacity	(4651-1) up to 130 m; (4651-2) up to 330 m
Length × Diameter	(probe) 203 × 35 mm, (reel) 178 × 610 mm

¹Other ranges available on request.

²Laboratory accuracy. Total system accuracy is subject to site-specific variables.



● Model 4651 installation used to measure and monitor embankment settlement. As an alternative installation, the empty manhole (shown above at left) and open-ended pipe may be replaced by a capped pipe with a pulley and return cable to pull and position the torpedo from the reel end of the pipe (shown above at right).

Model 4675 High Sensitivity Settlement System



● Model 4675 High Sensitivity Settlement System.

Applications

The Model 4675 is designed to detect and measure very small changes of elevation at discrete locations. It has been used to measure differential settlements along tunnels, deflections of bridges and bridge piers, the settlement of building columns and floor slabs, etc. (i.e. situations in which high sensitivity is essential).

Operating Principle

A series of vessels are interconnected by a liquid-filled tube. One reference vessel is located on stable ground and the other vessels are located at the points of settlement. Each vessel contains a cylindrical weight suspended from a vibrating wire transducer. The common liquid level inside each vessel partially submerges the hanging weights; settlement of a vessel causes an apparent rise of the water level in that vessel leading to a greater buoyancy force on the weight and a reduction in the tension and frequency of the vibrating wire.

Advantages and Limitations

Very high resolution, of the order of 0.07 mm, can be attained. A vent line connected to each of the vessels prevents the readings from being affected by ambient air currents and barometric fluctuations. The readings are not significantly affected by temperature changes.

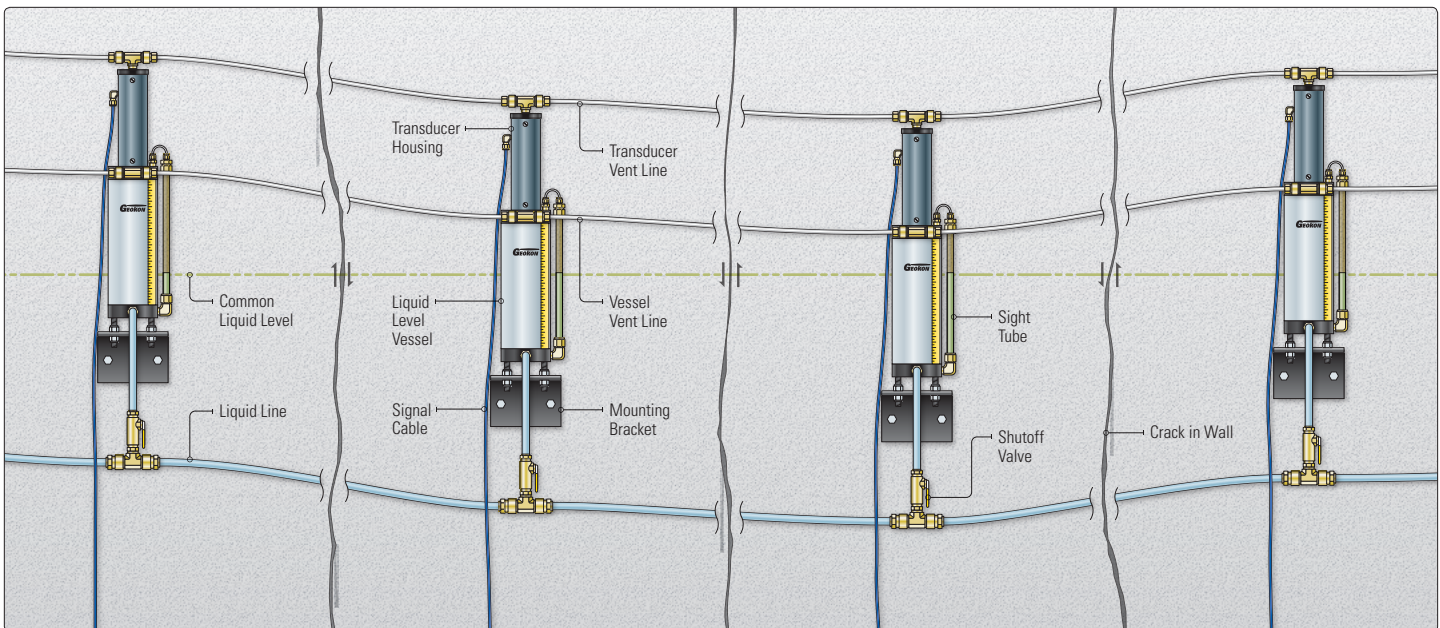
The vessels must be installed at the same elevation and the connecting liquid-filled tubing must remain below the vessels at all points.

Technical Specifications

Standard Ranges ¹	100, 150, 300, 600 mm
Resolution	0.025% F.S.
Sensor Accuracy ²	±0.1% F.S.
Temperature Range ¹	-20°C to +80°C (using antifreeze solutions)
Dimensions	depends on range

¹Other ranges available on request.

²Laboratory accuracy. Total system accuracy is subject to site-specific variables.



● Installation of the Model 4675 on a concrete wall with exaggerated settlement to illustrate change in elevation.