Vibrating Wire Deformeter

User Manual

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Installation and use of Vibrating Wire Deformeter

1 General Information

Thank you for choosing the Vibrating Wire, Wire Deformeter.

This manual has been written to provide you with relevant information and to guide you in best practice when using a Wire Deformeter in order for you to gain the most from our product.

Please read this manual thoroughly before use to help avoid any problems and keep it handy when using a Wire Deformeter.

Wire Deformeter

The Wire Deformeter provides accurate measurement of displacement for structural or geotechnical monitoring.

The sensor is made from high quality Stainless Steel, incorporates 'O' ring seals to allow for underwater use and is designed for long-term, reliable monitoring.

Fitted across two anchor points, the sensor monitors displacement by detecting a change in tension in the Vibrating Wire inside the sensor.

The Wire Deformeter provides accurate, repeatable readings over long cable lengths combined with a long working life and long-term stability and reliability.

2 Components and Tools

The components for the VW Deformeter and the tools required for installation are listed and shown below.

<u>Deformeter</u>

Transducer base plate

Base plate anchors X 2

Vibrating Wire Displacement Transducer

Universal anchor point

Transducer wire clamp

Transducer anti rotation block

0.5mm stainless steel wire

Tools

17mm AF spanner X 2

Small adjustable spanner

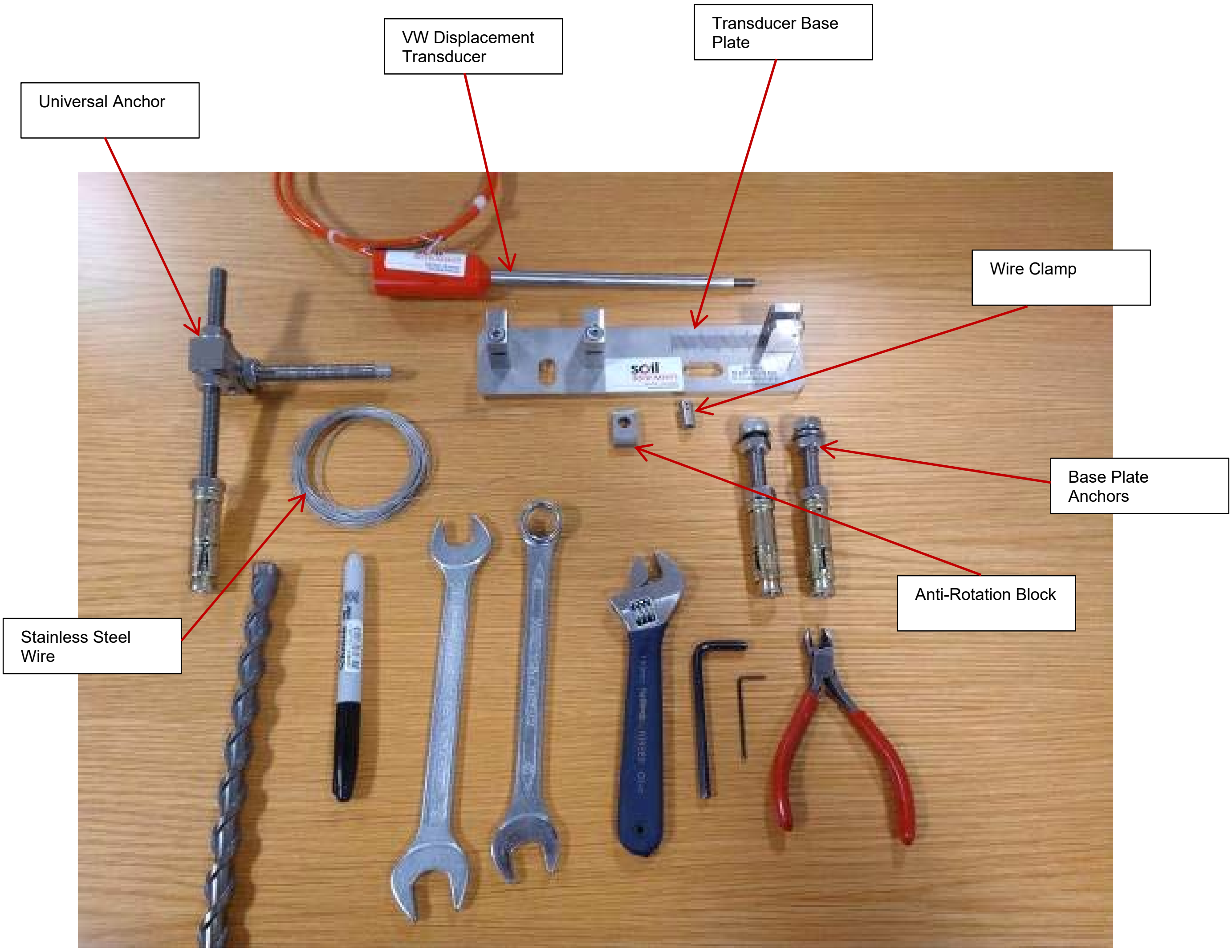
Wire cutters

Marker pen

16mm diameter masonry drill

1.5mm AF socket set key

5mm AF socket set key



3 Installing the base plate

Position the base plate against the structure in the required orientation.

Mark the fixing hole positions using the marker pen

Drill to the depth of the anchors using the 16mm diameter masonry drill in the centre of the marks.

Insert the anchor into the hole and tighten to secure the anchor to the structure.

Arrange the nuts and washers as shown below.

Position the base plate over the anchors.

Tighten the nuts to secure the base plate to the anchors.

4 Installing the transducer to the base plate

Release the transducer clamp screws on the transducer mounting blocks and insert the transducer.

Slide the anti-rotation block over the shaft of the transducer up to the end of the body tube.

Attach the transducer wire clamp to the end of the transducer shaft and tighten using the adjustable spanner, do not over tighten.

Thread the stainless steel wire under the wire pulley.

Using the graduated scale apply a mark approximately 15mm from the end of the wire.

Loosen the socket set screws in the wire clamp and insert the wire, the mark should be level with the end of the clamp.

Tighten the four socket set screws evenly so that the wire is securely clamped.

The face of the wire clamp should be positioned at a distance from the face of the pulley block at the range of the transducer plus 6mm.

E.g. if the transducer is a 30mm range transducer then position the face at the 36mm mark as show below.

If the transducer is a 50mm range transducer then position the face at the 56mm mark.

The mm graduations assist with this positioning.

The positioning prevents the transducer being over extended should the wire be accidentally pulled beyond the range or the transducer.

With the transducer positioned correctly the transducer clamp block screws can now be tightened to secure the transducer in position, do not over tighten the screws.

Only tighten sufficiently so that the transducer cannot be moved by hand.

The anti-rotation block can now be secured to the transducer shaft by tightening its socket set screw.

5 Installing the universal anchor

The universal anchor has been designed to provide flexible installation of the anchor in relation to the base plate.

Allowing installation on surfaces in line with or adjacent to the surface upon which the base plate is mounted.

The wire can exit the base plate at any angle from 0 to 90 degrees.

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Mark and drill the hole for the universal anchor.

Insert the anchor into the drilled hole.

Tighten the anchor securing nut to secure the anchor to the structure.

Adjust the anchor to the desired position and orientation and then lock in position by tightening the two securing nuts.

6 Fixing and tensioning the wire

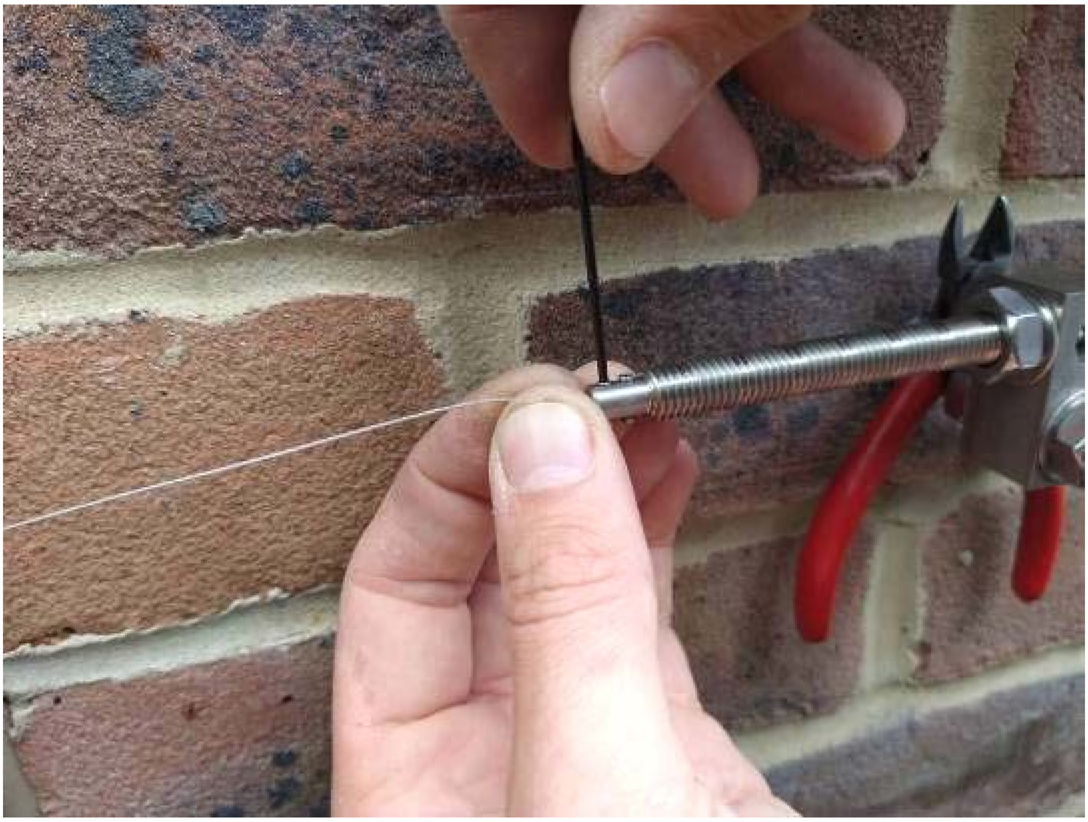
Adjust the wire tension stud so that the stud is fully extended towards the base plate.

Cut the wire 15mm past the end of the wire tension stud.

Loosen the 4 clamp screws.

Mark the wire 10mm from the cut end and insert into the end of the tension stud.

Tighten the four screws evenly to clamp the wire.



Adjust the tension stud by adjusting the two nuts without rotating the tension stud.

Using the graduated scale and the face of the wire clamp adjust the transducer to its preferred staring position.

Lock the tensioning screw once the start position has been set by tightening the two nuts.

The universal anchor is designed to accommodate multiple orientations.

7 Setting start position

The VW Deformeter can measure convergence or extension of the distance between the two anchor points.

If the direction of change is known then the start position can be set to maximise the range of movement in that direction.

I.e. if convergence is the only direction of anticipated movement then the start position can be set to the 1mm mark between the face of the wire clamp and the pulley block, this allows 30mm of convergence and 1mm of extension.

Set the start position at the 31mm mark between the face of the wire clamp and the pulley block if extension is the only anticipated direction of movement.

If the direction of movement is unknown then set the start position at mid-point, at the 16mm mark between the face of the wire clamp and the pulley block.

8 Reading and data conversion

The four wires from the VW Deformeter are identified in the table below:

Wire Colour	Identification
Red	Deformeter sensor +
Black	Deformeter sensor -
Green	Thermistor +
White	Thermistor -
Shield	Shield

Connect the transducer cable to the Vibrating Wire readout unit and record the installed start position frequency and temperature reading.

Record the readings and the serial number of the transducer; these will be required to convert all future readings into engineering units.

Calculation of Engineering units from frequency-based units.

The mathematical relationship between the frequency of vibration of a tensioned wire and the force applying the tension is an approximate straight line relationship between the square of the measured frequency and the applied force.

Engineering units of measurement maybe derived from the frequency-based units measured by vibrating wire readouts, in 2 traditional ways:-

From ‘Period’ units (t x 10^7) and from ‘Linear’(f^2/1000) units using two methods: a simple Linear equation or a Polynomial equation.

Use Linear units unless you have an readout unit that only reads in Period.

Calculation using ‘Period’ units

This method of calculation is only used by the obsolete Soil Instruments Vibrating Wire loggers’ (models RO-1-VW-1 or 2 and with serial numbers starting VL or TVL) internal processors’, for calculating and displaying directly on the loggers’ LCD screen, the required Engineering based units.

The following formula is used for readings in ‘Period’ units.

E = K (10^7/P0^2 – 10^7/P1^2)

Where,

E is the Pressure in resultant Engineering units,

K is the Period Gauge Factor for units of calibration (from the calibration sheet)

P0 is the installation Period ‘base’ or ‘zero’ reading

P1 is the current Period reading.

The loggers’ require ‘Period’ base or zero reading units for entering into their channel tables, to calculate and display correctly the required engineering units.

If an Engineering-based unit is required other than the units of calibration, then the correct K factor will have to be calculated using the standard relationship between Engineering units.

For example, if the units of engineering required were in inches and the calibration units were mm, we can find out that 1mm is equal to 0.03937 inches, so we would derive the K factor for inches by multiplying the K factor for mm by 0.03937.

Calculation using Linear units.

The following formula is used for readings in ‘Linear’ units. E = G (R0 – R1)

Where,

E is the resultant Engineering unit,

G the linear Gauge factor for the units of calibration (from the calibration sheet)

R0 is the installation Linear ‘base’ or ‘zero’ reading

R1 is the current Linear reading.

Again the Linear gauge factor for units other than the units of calibration would need to be calculated using the same principles as stated in the last paragraph of the 'Period unit' section.

Linear unit calculation using a Polynomial equation.

Linear units may be applied to the following polynomial equation, for calculation of Engineering units to a higher order of accuracy.

$E = AR1^2 + BR1 + C$

Where,

E is the resultant Engineering unit

A, B and C the Polynomial Gauge factors A, B and C, from the instrument's calibration sheet and R1 is the current Linear reading.

The value C is an offset value and relates to the zero value experienced by the transducer at the time of calibration. This value should be re-calculated at the installation time as follows:

$C = -(AR0^2 + BR0)$

Where,

A and B are as above

R0 is the installation Linear 'base' or 'zero' reading.

Please note that the sign of the re-calculated value of C, should be the same as the original value of C, so if the original is negative then the recalculated value should also be negative.

Conversion to engineering units other than the units of calibration, would best be done after conversion, using a factor calculated using the same principles as stated in the last paragraph of the 'Period unit' section.

NOTE: **A negative sign represents a decrease in length across the Deformeter anchor points.**

Temperature Correction

The Deformeter working elements are made primarily of steel and stainless steel and are affected by changing temperature to a certain predictable degree.

In case of large temperature changes application of temperature correction will improve the accuracy of the measurements.

The approximate temperature effect on the gauge is -0.02mm per degree Celsius.

Hence for a temperature increase of 10°C a Deformeter will indicate (-0.02 x 10) -0.2mm to the result indicated by the Deformeter reading.

A fall in temperature will result in a positive change in linear measurement which can be corrected accordingly.

Physical dimensional changes due to temperature in the Deformeter and the structure on which it is mounted are of the order of 10^{-6}mm/m/°C and can be neglected.

Barometric pressure changes do not affect the Deformeter reading.

Environmental Factors

Since the purpose of the Deformeter installation is to monitor site conditions, factors which may affect these conditions should always be observed and recorded.

Seemingly minor effects may have a real influence on the behaviour of the structure being monitored and may give an early indication of potential problems.

Such factors include but are not limited to: blasting, rainfall, tidal levels, excavation and fill levels and sequences, site traffic, temperature and barometric changes, changes in personnel reading the instruments, nearby construction activities, seasonal changes, etc.

9 Trouble shooting

Before any of the steps below are followed, a Vibrating Wire readout unit should be used to verify the stability of the reading.

Wildly fluctuating readings from the sensor (or an unsteady audio signal) are both indications of possible problems with the instrument or related electrical cables.

If the readout is giving faulty readings or audio signals from all of the Wire Deformeters, a faulty readout unit and/or lead must be suspected.

Another lead/readout unit should be used to check the readings.

If there is a fault with the readout unit, please contact Soil Instruments support team for assistance.