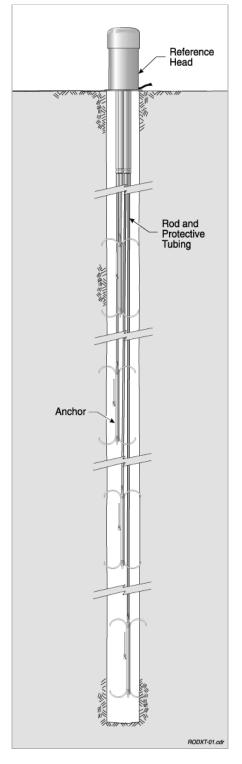
# **SLOPE INDICATOR**







# Applications

Rod extensioneters monitor settlements in foundations, subsidence above tunnels, displacements of retaining structures, and deformations in underground openings.

#### **Operation**

Components of a rod extensometer include anchors, rods, protective pipe, and a reference head.

The anchors are attached to rods and installed in the borehole. The rods span the distance from the anchors to the reference head at the surface. The protective plastic pipe prevents bonding between rods and grout backfill.

Readings are obtained at the reference head by measuring the distance between the top (near end) of the rod and a reference surface. A change in this distance indicates that movement has occurred.

Movements are referenced to a stable elevation, typically a downhole anchor. The resulting data can be used to determine the zone, rate, and acceleration of movements, and to calculate strain.

# Anchors

Groutable anchors are suitable for most applications. The hydraulic anchor is used in soft soil.

#### Rods

Rods are fiberglass or stainless steel. Fiberglass rod extensometers are assembled at the factory and shipped to the site, ready to install. The flexibility of these extensometers also makes them easier to install in confined areas, such as tunnels.

Stainless steel rod extensometers are assembled on site. However, their stiffer rods can be used for deeper anchor depths.

#### **Reference Heads**

Mechanical reference heads can be used when there is easy access to the extensometer. Measurements are obtained with a depth micrometer.

Electric reference heads are used when access to the reference head is difficult or where continuous monitoring is required. Measurements are obtained with displacement sensors and a readout or data logger.

#### W W W . S L O P E I N D I C A T O R . C O M

#### **PERFORMANCE NOTES**

**System Accuracy:** The main variables in system accuracy are site conditions and the quality of the installation. In general, the best performance is achieved when the borehole is straight and rods are held in tension to keep them straight while the grout backfill cures.

Maximum Recommended Rod Length: In general, rods in tension can be longer than rods in compression, and steel rods can be longer than fiberglass rods. In non-vertical installations, friction between rods and the protective pipe becomes a limiting factor. The table below suggests maximum lengths for rods in tension and compression.

Max Rod Lengths: Tension / Compression		
Orientation	Fiberglass	Steel
Vertical Down	20 / 15 m	40 / 30 m
Vertical Up	45 / 30m	60 / 45 m
45° Down	25 / 20 m	40 / 30 m
45° Up	35 / 25 m	55 / 40 m
Horizontal	35 / 20 m	45 / 30 m

**Number of Monitored Points:** The rod extensometer can monitor up to six points. In practice, the number of monitored points is limited by the size of the borehole, the type of anchor used, the diameter of the protective pipe, and the amount of tubing required for activating anchors and grouting. A 76 mm (3") borehole will accommodate six groutable or hydraulic anchors

# ANCHORS

#### **FIBERGLASS RODS**

Fiberglass Rod	51815855
Protective Tubing	51815860
Rod Completion Kit	51836240

Fiberglass rod has a diameter of 5 mm (3/16") and is supplied in continuous lengths. Protective polyethylene tubing is supplied in continuous lengths. Rod completion kit includes components for top and bottom of rod. Order 1 kit per anchor.

## **STAINLESS STEEL RODS**

Stainless Steel Rod	51704310
Protective Pipe	51704321
Rod Completion Kit	51836210

Stainless steel rod has a diameter of 6.4 mm (0.25") and is supplied in 10' lengths, each threaded and tapped for assembly. Protective pipe is supplied in 10' lengths and includes couplings. Requires PVC solvent cement, which can be obtained locally. Rod completion kit includes components for top and bottom of rod. Order 1 kit per anchor.

## **MECHANICAL REFERENCE HEAD**

Single-Point Head51836110	
Multi-Point Head 51836120	
Digital Depth Micrometer 51809620	)
Single-point head works with 1 rod and anchor.	
Multi-point head works with up to 6 rods and	
anchors. Readings are obtained with depth	
nicrometer. Digital depth micrometer displays	
eadings in inches and millimeters. 150 mm (6")	
ange, 0.01 mm (0.001") resolution.	

#### **ELECTRIC REFERENCE HEAD**

Single-Point Head 51836130	
Multi-Point Head 51836140	
VW Sensor, 60 mm range 52636305	
VW Sensor, 100 mm range 52636325	
Potentiometer, 60 mm range 51836152	
Potentiometer, 100 mm range 51836154	
Single-point head works with 1 rod and anchor.	
Multi-point head works with up to 6 rods and anchors. Displacement sensors are supplied with	
anchors. Displacement sensors are supplied with	
0.6 m (2') of signal cable.	

VW sensor provides resolution of 0.01% FS. Potentiometer provides resolution of 0.1% FS. Repeatability is better than  $\pm 0.5\%$  FS.

Special ranges and waterproof ratings can be quoted on request.

VW sensors are read with a VW readout or a data logger: VW minilogger for single points, Quattro logger for four points, or Campbell Scientific logger for multiple points.

Potentiometers are read with the Extensometer Indicator, a or a Campbell Scientific data logger.

# SIGNAL CABLE

Signal Cable, Multicore . . . . Contact Factory

**Universal Terminal Box**.....**57711600** For use with portable readout. Not required with data logger. Splashproof fiberglass box is 290 wide x 345 high x 135 mm deep (11.5 x 13.5 x 5.25").

## INSTALLATION ACCESSORIES

**Pipe Adapter**.....**51835170** Optional adapter for anchoring reference head to 76mm (3") diameter steel pipe installed at collar of borehole.

Optional adapter for anchoring reference head to concrete pad at borehole collar. 190 mm (7.5") plastic flange with 152 mm (6") bolt circle.

**Grout Tubing**.....**50721008** Used to deliver grout from the grout pump to the borehole. 12.7mm OD (0.5") polyethylene tubing rated for 30 bar (425 psi).

Hydraulic Tubing ......51702701 Used to activate hydraulic anchors. 6.35mm (0.25") nylon tubing filled with oil.

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Replacement hardware for connecting hydraulic tubing to anchor.

www.slopeindicator.com DGSI East 2175 West Park Court, Stone Mountain, GA USA 30087 Tel: +1-770-465-7557 solutions@slope.com DGSI West 12123 Harbour Reach Drive, Mukilteo, WA, USA 98275 Tel: +1-425-493-6200