

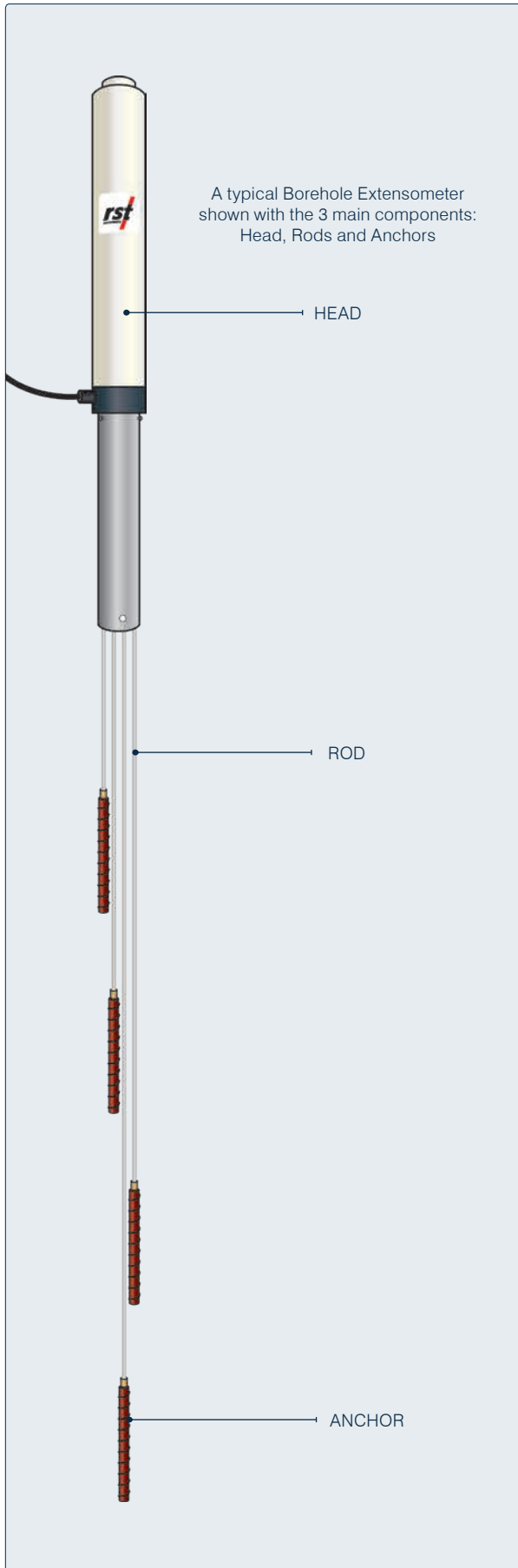
	PRODUCT CATEGORY:
	EXTENSOMETERS

# Borehole Extensometers

Stability and movement behavior of soil and rock masses can be determined by the use of borehole extensometers. A typical rod extensometer consists of a reference head, usually installed at the collar of a drill hole, and one or more in-hole anchors, each of which is fixed in place at a known depth in the borehole. As the soil or rock deforms, the distances between adjacent in-hole anchors change, as do the distances between the individual in-hole anchors and the reference head. This allows an accurate determination of distribution, magnitude, rate and acceleration of deformation in the rock or soil mass intersected by the drill hole.

The number of anchors and anchor depths should be selected based on site geology, geometry of structures in the area, and other site-specific details. The use of two, or more, anchors at various depths allows the engineer to distinguish between potentially dangerous deep seated movements and more trivial surface spalling.

For measuring compression, please see the RST Compressometer brochure.



## > APPLICATIONS

Monitoring deformation around underground excavations.	Movement behind the face of excavated slopes.
Consolidation settlement in soils.	Bottom heave in open cut excavations.
Strain in concrete structures.	Subsidence over mines, tunnels, etc.
Pile load tests.	Monitoring of mine pillar deformation.
Deformation of foundations in and under buildings.	Roof and wall stability in mines and underground workings.

## > FEATURES

Accurate and reliable.	Easily adapted to remote readout.
Anchor lengths can be varied in the field. * for Rigid Rod Extensometers only.	Rugged, easy to install, and simple to operate.


## > BENEFITS

✓ <b>Increase Safety</b>	✓ <b>High Accuracy</b>
✓ <b>Increase Productivity</b>	✓ <b>High Reliability</b>



A Borehole Extensometer, with the Electrical Head cover removed, is being installed into the ceiling of an underground opening.

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## Rigid Rod Types:

Rigid Rod Extensometers are shipped in components (rods, anchors, head) for assembly at the project site as the equipment is installed in the ground. Rigid Rods can monitor either extension or compression but can require more aerial room at site if working with 3 m rod lengths. Typically, rods have an O.D. of 6.4 mm (¼ in.), but larger diameters are available for site specific applications. Please contact RST for more info.

Another option for measuring compression is the RST Compressometer. See separate brochure.

### STEEL:

For short term, typically used with groutable anchors. Flush coupled.

### STAINLESS STEEL (1/4" or 3/8" diameter):

Most common and applicable. Come with individual sheaths and are resistant to corrosion over time. Can be used with all anchor types. Flush coupled.

### RIGID FIBERGLASS:

Light weight, allowing easy transport and installation. Non-corrosive for longevity and can be used with all anchor types. Non flush coupled.

### CARBON FIBER:

For special high temperature and changing temperature environments. The carbon-fiber has a coefficient of thermal expansion that is virtually zero (<math><0.5 \times 10^{-6}/^{\circ}\text{C}</math>), therefore eliminating any thermal effects. Non flush coupled. Can be used with all anchor types. Carbon-fiber rods are available only as special orders.

## > INSTALLATION

Rods may be sheathed in individual PVC protective pipe (nominal ¼ in. I.D.) to minimize frictional effects between different rods and between rods and the borehole wall. Protective pipe may also be filled with oil, if the borehole is inclined downward to lubricate the rods and further minimize frictional effects.

When several anchors are employed in one borehole, self-aligning installation rods are recommended to maintain anchors in correct alignment and prevent weaving of the measurement rods. Rod spacers are available to space out and support longer rods. By placing rod spacers at various places along a rods' length, "sagging" is prevented and accurate measurement is assured.



## Flexible Rod Types:



A coil of flexible fiberglass rods shown leading into a Combination Head. (Tape around groutable anchors is removed prior to installation).

Flexible Rod Extensometers are fully assembled and sealed at RST's facility prior to shipping (according to each customer's specifications), which allows for quick, easy installation at site. They are a low cost, convenient instrument for the monitoring of ground displacements and are designed to withstand severe field conditions and accommodate transverse shear. Due to their flexible nature, they are useful for applications where limited room is available (such as a small tunnel or cavern). Compact design allows installation in boreholes of minimum size; up to 6 or 10 rods may be accommodated in a 60 mm borehole. Flexible rods are recommended for extension only.

### FLEXIBLE FIBERGLASS RODS WITH INDIVIDUAL SHEATH (3/16" diameter):

Light weight, allowing easy transport and installation. Non-corrosive, for longevity. Can be used with all anchors except Snap Ring.

### FLEXIBLE STEEL RODS WITH OVERALL SHEAR TUBE (5/32" diameter):

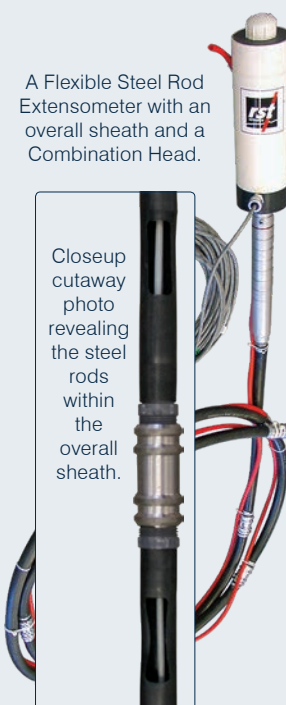
For short term applications where corrosion of the rod is not expected during the duration of the project.

### FLEXIBLE CARBON RODS WITH INDIVIDUAL SHEATH:

For special high temperature and changing temperature environments. A lighter-weight system when compared to above options. The carbon-fiber has a coefficient of thermal expansion that is virtually zero (<math><0.5 \times 10^{-6}/^{\circ}\text{C}</math>), therefore eliminating any thermal effects. Carbon-fiber rods are available only as special orders.

## > INSTALLATION

The extensometer is supplied fully assembled in a 1.2 m (4 ft) diameter coil. At the installation site, the unit is uncoiled, fitted with suitable grout tube and airbleed tube, and installed into the borehole. After grout has been injected and initial set has been reached, the protective cap is removed, the rods released, and the initial displacement recorded.



A Flexible Steel Rod Extensometer with an overall sheath and a Combination Head.

Closeup cutaway photo revealing the steel rods within the overall sheath.

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## Head/Sensor Types:

### ELECTRICAL HEAD WITH VIBRATING WIRE DISPLACEMENT SENSORS OR LINEAR POTENTIOMETERS:

Used in applications where automation of data is desired by connecting electric sensors to a datalogger. RST offers both vibrating wire displacement sensors and linear potentiometers, each available in a variety of measurement ranges. It can also be used where automated readings are not required but the extensometer head is not easily accessible – signal cable from the sensors can be used to allow for readings to be taken at a convenient location.



Top view of Combination Head with protective cap removed.

A typical Combination Head shown with a custom collar base.

### MECHANICAL HEAD (for manual readings with depth micrometer):

Used in applications where automated data is not required and the extensometer head is easily accessible to take manual readings with a depth micrometer.



Mechanical Heads

### COMBINATION HEAD (with electric sensors and manual override):

The combination head can be automated with a datalogger but also allows the user to be able to take manual readings with a depth micrometer for data redundancy.

Electrical sensors are available in ranges of 25, 50, 100, 150, 200 and 300 mm.

## Anchor Types:

### GROUTABLE ANCHOR:

Simple to install and the preferred anchor for downward directed holes. It is unaffected by blasting. It is not suitable for use in soft ground or soil as the grout column may inhibit performance. It can be used in upward directed holes with a special grouting technique. Up to six can be placed in a single 3 in. (NX) borehole.



Groutable Anchor

### HYDRAULIC ANCHOR - Borros Anchor:

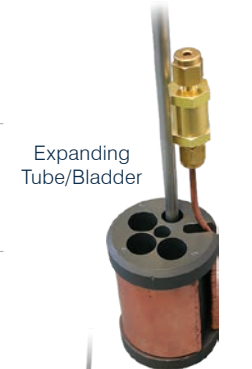
For use in soft ground and soil, especially where hole squeezing is anticipated. It is the most difficult to install. Two types are available: a single acting borros prong type, and double acting borros prong type. Up to six can be placed in a single 3 in. (NX) borehole.



Borros Anchors

### HYDRAULIC ANCHOR - Expanding Tube/Bladder:

For use in fractured rock or other applications where grouting may be difficult. Can be installed in any orientation. Hydraulic oil is used to expand the tube which allows it to grip against the borehole wall.



Expanding Tube/Bladder

### GROUTABLE ANCHOR - with Spring Legs:

For use in a groutable installation in soft ground. The mechanically activated spring legs provide extra connection to the borehole wall.



Groutable Anchor with Spring Legs

### SNAP RING ANCHOR:

For use in hard, competent rock, where smooth, uniform boreholes can be drilled. It offers the optimum in speed and simplicity of installation, and up to eight can be placed in a single 3 in. (NX) borehole. It is preferred for upward holes where grouting may be difficult. It is not likely affected by blasting. Snap ring anchors are borehole size specific and must therefore be custom sized to each hole. In small boreholes (less than 2 in.), snap ring anchors can be set using the measuring rod for restraint. In larger boreholes, the force required to set snap ring anchors requires the use of installation rods. The snap ring anchor can only be used with rigid rods.



Snap Ring Anchor

### BAYONET MODIFICATION FITTING:

A special bayonet modification fitting is available for all anchor types. This allows the measurement rod to be disconnected from the anchor and moved a known distance. With this feature the frictional effects and freedom of rod movement can be examined at any time and the reliability of readings greatly increased. Also available is an anchor tell-tale. This can be attached to the bottom of the anchor in such a way that it will project into an underground opening when the opening is excavated. This enables the extensometer to be accurately located at its lower end without resorting to expensive borehole surveying procedures.



Monitor  
with  
Confidence

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## SPECIFICATIONS + ORDERING

FLEXIBLE ROD		
ITEM	PART #	
Flexible Rod Extensometer (includes head, sensors, rods, sheaths and anchors)	EXRI0001 (1 point) EXRI0002 (2 points) EXRI0003 (3 points) EXRI0004 (4 points) EXRI0005 (5 points) EXRI0006 (6 points)	
<b>ORDERING METHOD:</b> <b>1) Select Electrical, Manual or Combination Head</b> <b>2) Select type and range of sensors</b> <b>3) Select type and length of rods</b> <b>4) Select type of anchors</b>		
RIGID ROD		
ITEM	PART #	
HEADS		
Electrical Head and Sensors	EXMPBX001 (1 point) EXMPBX002 (2 points) EXMPBX003 (3 points) EXMPBX004 (4 points) EXMPBX005 (5 points) EXMPBX006 (6 points)	
Mechanical Heads	EXMPBXMA1 (1 point) EXMPBXMA2 (2 points) EXMPBXMA3 (3 points) EXMPBXMA4 (4 points) EXMPBXMA5 (5 points)	
RODS		
1/4 in. Standard, Stainless Steel Individual PVC Sheath	EXR02502 (0.25 m) EXR02505 (0.5 m) EXR02510 (1.0 m) EXR02515 (1.5 m) EXR02520 (2.0 m) EXR02530 (3.0 m)	EXR02535 (3 ft.) EXR02550 (5 ft.) EXR02600 (10 ft.)
ANCHORS		
Groutable	EXMP11000M (metric) EXMP11000 (imperial)	
Hydraulic Borros	EXHY12000 (single acting) EXHY13000 (double acting)	
Hydraulic Expanding Tube/Bladder	EXHY14000 (customer specifies borehole diameter)	
Groutable with Spring Legs	EXMP12000M (metric) EXMP12000 (imperial)	
Snap Ring	EXSR11000 (customer specifies borehole diameter)	

ORDERING INFO CONSIDERATIONS
Rod assembly type and material.
Number of anchors, type and depths.
Reference head type -if electrical, specify sensor type, range and accuracy.
Accessories required.
Cable length.
Borehole diameter.
Environmental considerations.
Extension or compression expectations.
Drilling method, soil and/or rock types.
Orientation of borehole.
How will the extensometer head be connected to the ground at the borehole collar?

ACCESSORIES & OPTIONAL EQUIPMENT	
ITEM	PART #
Depth micrometer for Mechanical or Combination Heads.	EXDM150DT (metric, 0-150 mm range)
Hydraulic pump for hydraulic anchors.	EXHYDPUMP
Grout and/or bleed tubes.	Contact RST for details.
Portable readouts.	
Terminal stations.	
Dataloggers.	
Setting tools.	
Rod spacers.	

CABLES	
ITEM	PART #
1 Point Extensometer Cable	EL380004
2 Points Extensometer Cable	EL380006
3 Points Extensometer Cable	EL360008
4-5 Points Extensometer Cable	EL380012
6 Points Extensometer Cable	EL380013P