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RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

A typical Multi-Point Borehole Extensometer shown with the 3 main components: Head, Rods and Anchors

PRODUCT CATEGORY:
EXTENSOMETERS

Multi-Point 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.

> 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

✓ **Increase Safety**	✓ **High Accuracy**
✓ **Increase Productivity**	✓ **High Reliability**

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

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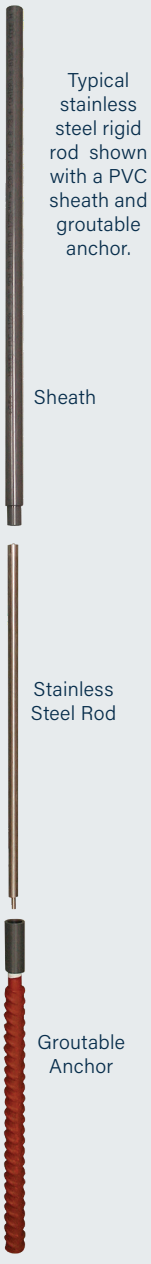
Rigid Rod:

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). Please contact RST for more info.

STAINLESS STEEL (1/4"):

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



> 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:

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 rods may be accommodated in a 90 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.

> INSTALLATION

The flexible rod 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.

RST's DT Series and RSTAR Affinity Data Loggers or flexDAQ Data Loggers can be used to monitor the Multi-Point Borehole Extensometer.

RSTAR Affinity Data Logger

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PRODUCT CATEGORY:
EXTENSOMETERS

Head/Sensor Types:

COMBINATION HEAD (electrical VW sensors with manual override):

Used in applications where automation of data is desired by connecting electric sensors to a datalogger. RST offers vibrating wire displacement sensors 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.

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 50, 100, 150, and 200.

Top view of Combination Head with protective cap removed.

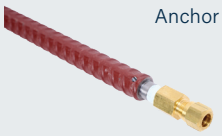
MECHANICAL HEAD (for manual readings with depth micrometer):

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

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. The double acting borros prong type is available. Up to six can be placed in a single 3 in. (NX) borehole.

Borros Anchor

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

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.

Bladder Type Hydraulic Anchor

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EXTENSOMETERS

SPECIFICATIONS + ORDERING

Contact RST Instruments for available custom options.

FLEXIBLE ROD

ORDERING METHOD:
1) Select Above Grade or Below Grade Installation
2) Select Manual or Combination Head
3) Select type and range of sensors
4) Select type and length of rods
5) Select type of anchors

RIGID ROD

ITEM	PART #	
HEADS		
Combination Heads	MPBX	
Mechanical Heads	EXMPBXMA1 (1 point) EXMPBXMA2 (2 points) EXMPBXMA3 (3 points) EXMPBXMA4 (4 points) EXMPBXMA5 (5 points) EXMPBXMA6 (6 points)	
RODS		
1/4 in. Standard, Stainless Steel Individual PVC Sheath	EXRO2502 (0.25 m) EXRO2505 (0.5 m) EXRO2510 (1.0 m) EXRO2515 (1.5 m) EXRO2520 (2.0 m) EXRO2530 (3.0 m)	EXRO2535 (3 ft.) EXRO2550 (5 ft.) EXRO2600 (10 ft.)
ANCHORS		
Groutable	EXMP11000M (metric) EXMP11000 (imperial)	
Hydraulic Borros	EXHY13000 (double acting)	
Groutable with Spring Legs	EXMP12000M (metric) EXMP12000 (imperial)	
Bladder Anchor	EXIL14000 (customer specifies borehole diameter)	

SPECIFICATIONS

Sensor Range	50, 100, 150, 200 mm
Accuracy	+/- 0.25% FSR
Resolution	0.025% FSR
Linearity	0.5% FSR
Operating Temperature	-20°C to 80°C
Thermal Zero Shift	<0.05% FSR/°C
Number of Anchors	1 to 6
Borehole Diameter Recommendation	Minimum 4" (101 mm)

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 EXHYDPUMP-LARGE-3/16" (up to 55 in^3 oil capacity) EXHYDPUMP-SMALL-3/16" (up to 20 in^3 oil capacity)
Grout and/or bleed tubes.	Contact RST for details.
Portable readouts.	
Terminal stations.	
Dataloggers.	
Setting tools.	
Rod spacers.	

CABLES

ITEM	PART #
1-3 Point Extensometer Cable	EL360008
4-6 Points Extensometer Cable	EL38007P