



Measuring up on all scales.

# INSTRUCTION MANUAL

## BOREHOLE EXTENSOMETER

### Model 2.5-1E

© Roctest Limited, 2000. All rights reserved.

This product should be installed and operated only by qualified personnel. Its misuse is potentially dangerous. The Company makes no warranty as to the information furnished in this manual and assumes no liability for damages resulting from the installation or use of this product. The information herein is subject to change without notification.

**ROCTEST LTD**  
665, Pine Avenue  
St-Lambert, QC J4P 2P4  
**CANADA**  
Tel. : 1-877-ROCTEST  
Tel. : (450) 465-1113  
Fax : (450) 465-1938  
E-mail : info@roctest.com  
Web Site : www.roctest.com

**ROCTEST INC.**  
P.O. Box 2907,  
Plattsburgh, NY 12901-0259  
**U.S.A.**  
Tel : 1-877-ROCTEST  
Tel : (518) 561-3300  
Fax : (518) 561-1192  
E-mail : roctest@westelcom.com  
Web Site : www.roctest.com

**ROCTEST BEIJING**  
7 DongDaMoChang Jie  
ChongWen District,  
Office Tower 508  
Beijing, China 100062  
**CHINA**  
Tel : 86.10.67.08.29.80  
Fax : 86.10.67.08.29.81  
E-mail: beijing@roctest.com  
Web Site : www.roctest.com

**TELEMAT S.A.**  
10, Eiffel Avenue  
77220 Gretz-Armainvilliers  
**FRANCE**  
Tel : 33.1.64.06.40.80  
Fax : 33.1.64.06.40.26  
E-mail: info@telemac.fr  
Web Site: www.telemac.fr

# TABLE OF CONTENTS

---

<b>1</b>	<b>PRODUCT.....</b>	<b>1-1</b>
1.1	DESCRIPTION .....	1-1
1.2	SPECIFICATIONS .....	1-2
<b>2</b>	<b>INSTALLATION.....</b>	<b>2-1</b>
2.1	BOREHOLES.....	2-1
2.2	ASSEMBLY.....	2-1
2.3	GROUTING .....	2-2
2.3.1	<i>CEMENT GROUT.....</i>	<i>2-2</i>
2.3.2	<i>POLYESTER RESIN CARTRIDGE.....</i>	<i>2-2</i>
2.3.3	<i>CEMENT MORTAR.....</i>	<i>2-3</i>
<b>3</b>	<b>READINGS .....</b>	<b>3-1</b>
3.1	ZERO READING .....	3-1
3.2	FIELD DATA.....	3-1
3.3	INTERPRETATION.....	3-2
3.3.1	<i>READINGS WITH A MECHANICAL GAGE.....</i>	<i>3-2</i>
3.3.2	<i>READINGS WITH AN ELECTRICAL TRANSDUCER.....</i>	<i>3-2</i>
	 Figure 1: Borehole Extensometer Model 2.5-1E	 <b>4-1</b>

# 1 PRODUCT

## 1.1 DESCRIPTION

The borehole model 2.5-1E extensometer is a high quality single point rod extensometer used to measure the movement of rock around tunnels, shafts and underground works. It is also used to monitor unstable slopes.

This instrument is particularly well adapted for installation in areas subject to blasting as all extensometer parts including the measuring head are installed inside the borehole.

The model 2.5-1E extensometer comprises the following parts:

### The anchor

It is made from steel reinforcing rod and is fixed to the rock by a cement grout or epoxy cartridge.

### The anchor cone

It consists of a short conical threaded coupling, which links the extension rods and protective tubing to the anchor. The anchor cone used with longer extensometers is fitted with a calibration notch to evaluate rod friction.

### The extension rods and protective tube

The standard steel rods have an OD of 17 mm and are coated to provide both protection against corrosion and a lower coefficient of friction.

The protective tube is made from high-density plastic and has an OD of 25 mm. Aluminum rods for long uphole installation are available as an option.

### The extensometer head

The stainless steel head comprises a precision reference bushing and a protective cap. It is fixed to the rock by grouting or with a layer of mortar.

The sensor bar is screwed on the upper extension rod and locked with a nut. Its length can be adjusted to reset the range of the extensometer.

Manual or remote electrical readings are made with the following readouts:

- Dial gauge

The dial gauge is supplied with a reference block and a calibration bushing.

- Electrical transducer

The electrical transducer is an LVDT mounted in a waterproof housing. It screws on to the extensometer head and can be removed to check its calibration or to make comparative readings with the dial gauge.

The readout, model REE-R, is a portable digital readout fitted with a rechargeable battery and gives a direct reading in engineering units.

## **1.2 SPECIFICATIONS**

- Maximum head diameter: 35 mm
- Maximum length: 200 m (or more under certain conditions)
- Sensitivity with manual or electrical readout: 0.01 mm
- Standard range: 10 mm (resettable - other ranges available upon request)
- Minimum hole diameter: 36 mm

## **2 INSTALLATION**

### **2.1 BOREHOLES**

The minimum diameter of the borehole is 36 mm. Diamond drilling with a coring bit is recommended in most installations. In the case of sound rock, percussion drilling may be employed.

The boreholes should be straight, of uniform diameter and drilled at least 1 meter longer than the deepest anchorage point. Drilling of horizontal boreholes should be avoided. Rather the borehole axis should be inclined sub-horizontally with a minimum dip of 2°.

In zones where the rock is strongly jointed or fractured, the boreholes should be grouted and re-drilled. Grouting pressure should be kept to the minimum to avoid deep penetration of the grout in the joints. Permeability tests prior to the rod installation are advantageous to ascertain whether subsequent grouting of the anchor will be possible.

### **2.2 ASSEMBLY**

The rods are shipped in 3.0, 2.0 or 1.0 meter lengths and the protective tube in a continuous coil.

After determining the depth of installation from the rock surface, the required lengths of rods and protective tubes are prepared. To avoid cutting the rods, it is preferable to choose a multiple of a rod length. If L is the total length of the rods, the protective tube has a length equal to  $L + 2$  cm.

To install the extensometer, proceed as follows:

- Cut the protective tube to length as specified above and check that no dirt or pieces of plastic are inside the tube.
- Screw the anchor cone onto the anchor.
- Check that the female thread on the anchor cone is clean and fix the protective tube onto the anchor cone. The anchor cone tapped slightly on a wooden block to force it into the tubing. Otherwise, heat the tubing to soften it lightly to facilitate the insertion of the anchor cone into the tubing.
- The length of overlap is 9.5 cm.
- Fix the head onto the plastic tubing and tap it slightly on a wooden block. The plastic tube should enter the head about 3 cm to be in the proper position.
- Tape one end of the grout or ventilation tube to the anchor. The grout tube goes at the bottom of downward or horizontal holes and the ventilation tube goes at the

bottom of an upward hole. The length of the grout tube must be equal to the length of the deepest extensometer plus 2 or 3 meters for connection to the grout pump.

- Screw the end connector or bayonet connector into the bottom rod and insert this rod through the extensometer head in the protective tubing. Screw the successive rods together using the 14-mm diameter studs. Fix the sensor bar on the upper thread of the uppermost rod and tighten the lock nut. Tighten all connections securely.
- Turn the end connector piece on the bottom rod into the anchor by rotating the entire rod string with the thin wall wrench supplied with the dial indicator readout unit. If a bayonet connector assembly is used, insert the bayonet connector into the locking mandrel and rotate the bayonet connector and rod string clockwise until it engages the lock mandrel.

## **2.3 GROUTING**

To fix the anchor to the rock, one of the three following methods can be used:

- Fully grouted hole with cement grout
- Anchor only fixed by a polyester resin cartridge
- Anchor only with cement mortar

The first method is recommended for installation in long boreholes and in areas subject to blasting.

### **2.3.1 CEMENT GROUT**

Pack the area between the borehole wall, the extensometer head and grout tubes with a suitable material (e.g. oakum and quick setting cement). The procedure used to grout the holes depends on the borehole inclination. For horizontal or sub-horizontal boreholes, the longest tube, which extends to the lowest anchor is used for injection and the shortest for venting. In upwardly inclined boreholes, the shortest tube is used for injection. Grouting should be done under low pressures to minimize filling of the joints.

Grouting is completed when the material injected emerges from the vent tube. After sufficient time has elapsed for curing of the grout, the extensometer head is checked to ensure that it is adequately grouted in place. Additional cement may be hand placed around the head if required.

### **2.3.2 POLYESTER RESIN CARTRIDGE**

The polyester resin cartridge system permits rapid anchoring of a single point extensometer minimizing the delay between the installation and the commencement of readings. Moreover it excludes the necessity of injection equipment.

The installation includes the following steps:

- Select the cartridge with the correct diameter and setting time;

- Insert the cartridge or cartridges into the borehole using the extensometer rod assembly;
- Rotate the extensometer rod to break the cartridge and mix its contents;
- Place quick setting mortar at the collar of the borehole and on the grooves of the extensometer head;
- Position the instrument in its final location;
- Proceed with the adjustment of the sensor bar as described below.

### **2.3.3 CEMENT MORTAR**

Cement mortar is placed in the deepest part of the borehole for fixing the anchor. To do this, fill an open end thin wall pneumatic or mechanical cylinder with mortar. Insert the cylinder into the borehole and force the cement mortar out of the cylinder to the anchor position. Place the pre-assembled extensometer in the borehole. Manually place sufficient mortar in the mouth of the borehole as well as on the grooves of the extensometer head. Carefully push the instrument to its final location. When the cement mortar has set, the zero reading may be taken.

### **3 READINGS**

The model 2.5-1E borehole extensometer is supplied with a manual reading device. It can easily be converted to remote readout by the addition of an electrical sensor model 2.5-1EE and readout unit model REE-R.

The manual readout unit consists of the instruments and tools required for the adjustment, calibration and readings. It consists of:

- a dial gauge with centering device,
- an adjustment tool for fixing and resetting the sensor bars,
- a calibration block.

The readings obtained are in mm and are measured with respect to a zero reading set at time of installation. Calibration of the dial gauge is done with the calibration block supplied.

Always check polarity of each electrical sensor prior to installation.

#### **3.1 ZERO READING**

The initial position of the sensor bar depends on the expected magnitude and direction of the movement being monitored.

Seat the dial gauge on the calibration block.

Adjust the bezelled ring on the gauge to read 5.00mm. \*Check that the rods are well connected to the anchor. Screw the sensor bar in or out as required to set it in its initial position.

This adjustment is carried out with the two thin wall socket wrenches provided.

Tighten the sensor bar lock nut and note the zero reading. Screw the protective cap onto the extensometer head to prevent entry of foreign materials in the head.

Zero measurements should be repeated frequently in the period following the installation until the readings show constant values.

#### **3.2 FIELD DATA**

Place the dial gauge on the calibration block supplied. The dial gauge should indicate 5.00 mm\*, if not, rotate the bezel to align the 0 on the outer scale with the pointer. Remove the protective cap from the extensometer head. Seat the dial gauge on the recessed bushing and record the reading to the nearest 0.01 mm on the field data form.

Take three (3) readings and compute the mean value.

### 3.3 INTERPRETATION

#### 3.3.1 READINGS WITH A MECHANICAL GAGE

Check that gage is well calibrated using a calibration block. Then remove protection cap from the extensometer's head and take a reading.

The magnitude and direction of the movement is given by the algebraic difference between current reading being taken and the initial zero reading taken at the time of installation. This difference is obtained by taking the current reading away from the zero reading, according to polarity of the gage, which depends on the type of the gage:

- Using a standard dial indicator, a reading which increases positively means that sensor rod penetrates into dial indicator i.e. that distance between surface and anchor point is diminishing, and vice versa;
- Polarity of a standard micrometer is the opposite.

#### 3.3.2 READINGS WITH AN ELECTRICAL TRANSDUCER

Check good calibration of the readout unit according to procedure supplied by manufacturer. Connect transducer to readout unit.

**NOTE:** *As explained below, polarity of the electrical transducer is the opposite depending on whether transducer has been delivered prior or not to December 1998. User should be informed about this date.*

- Polarity of an electrical transducer supplied prior to December 1998 is identical than the dial gage's one (see Section 3.3.1). Reading which increases positively indicates that sensor rod is penetrating into the transducer, i. e. that distance between surface and anchor point is diminishing.
- Polarity of an electrical transducer supplied after December 1998 is the opposite, i.e. a reading which increases positively indicates that sensor rod is emerging from the gage, i. e. that distance between surface and anchor point is increasing.

Displacement is calculated using the following formula:

$$D = C.F. \times (L - L_0) \quad (1)$$

With:

- D** = displacement (mm)
- C.F.** = calibration factor (mm/V)
- L** = current reading (VDC)
- L<sub>0</sub>** = initial reading (VDC)

Example:

When C.F. = 4.903 mm/V

L = 3.20 V

$L_0 = 0.100$  V

Then D = 4.9033 (3.2-0.1)

=15.20 mm

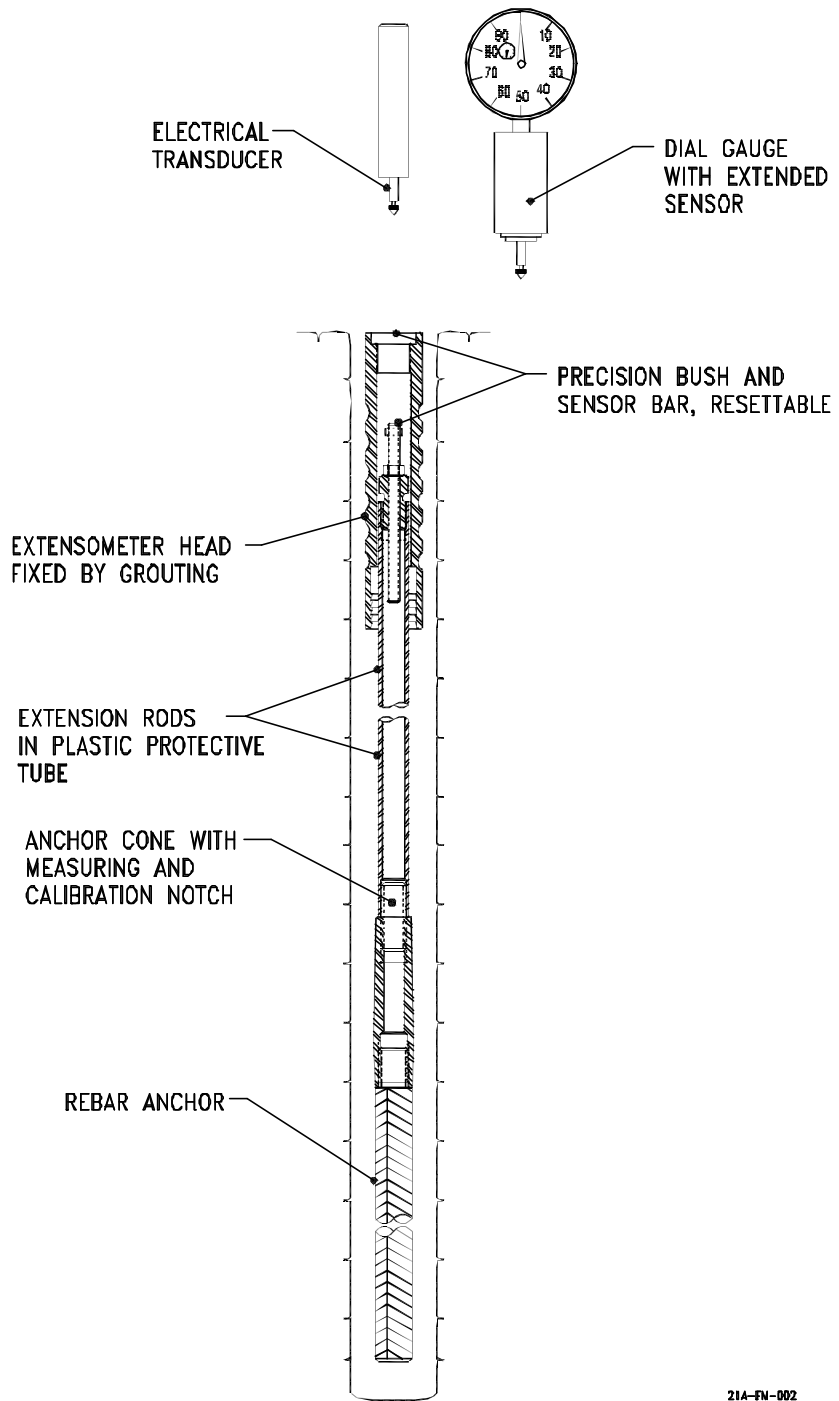


Figure 1: Borehole Extensometer Model 2.5 – 1E