INSTRUCTION MANUAL

BOREHOLE EXTENSOMETER

Model E-2

Tel. : 1.450.465.1113 • 1.877.ROCTEST (Canada, USA) • 33 (1) 64.06.40.80 (Europe) • www.roctest.com • www.telemac.com

E1085B-990428

TABLE OF CONTENTS

1 INTRODUCTION

The type E-2 double-point borehole extensometer has been designed to permit on-site measurement of the position of two expansion shell anchors in boreholes either 1 1/2 or 1 3/4 inch in diameter and to depths of 50 feet. The extensometer is designed to be read by a dial gage or depth micrometer.

The extensometer, which is set inside a borehole using setting tubes, consists essentially of three expandable shell type anchors. A stainless steel rod from the deepest anchor and a galvanized tube from the intermediate anchor extend to a surface anchor located at the mouth of the borehole. Axial rock movements along the borehole cause the ends (tips) of the rod and/or tube to move in relation to the surface anchor. These movements are measured using a depth gage either of the dial or micrometer type.

The extensometer is designed primarily for use in percussively drilled holes and can be set in any orientation. While there is no natural limit on setting depths, it is expected that most installations will be set in holes of approximately 20 feet. The usual reason for installing double-point extensometers is to distinguish deep seated rock movements from superficial spalling information, for example, to assess the efficiency of rock bolting systems.

The E-2 extensometer is a simple and straightforward device. The choice of materials inhibits corrosion effects, and the extensometer can be expected to function for many years.

2 EQUIPMENT DESCRIPTION

2.1 MECHANICAL DESCRIPTION

Figure 1 is a schematic of the type E-2 extensometer.

The borehole anchors usually supplied with the E-2 extensometer are conventional roof bolt anchors set by rotating a bolt to pull a wedge through an expanding shell component. To prevent the shell from rotating during setting, it must be in contact with the borehole walls to provide the necessary friction. The anchors should be no more difficult to set than conventional roof bolts.

Where problems are experienced using this type of anchor, alternative double expansion shell anchors can be supplied with a bow spring to prevent the shell section from rotating during setting.

The surface anchor is a double wedge expansion shell anchor set by rotating a nut over a length of threaded tube passing through the anchor. When the mouth of the borehole is oversize, additional curved shoes can be provided to take up the additional clearance. A special blind nut having two holes to locate the dial or depth gage plunger is mounted at the end of the threaded tube section of the anchor.

When the extensometer is set after a shotcrete or a concrete lining has been applied at the borehole surface, then a standpipe must be grouted into the borehole and the surface anchor set inside the pipe. To provide room for the standpipe, the mount of the borehole must be at least 1 3/4 inch diameter.

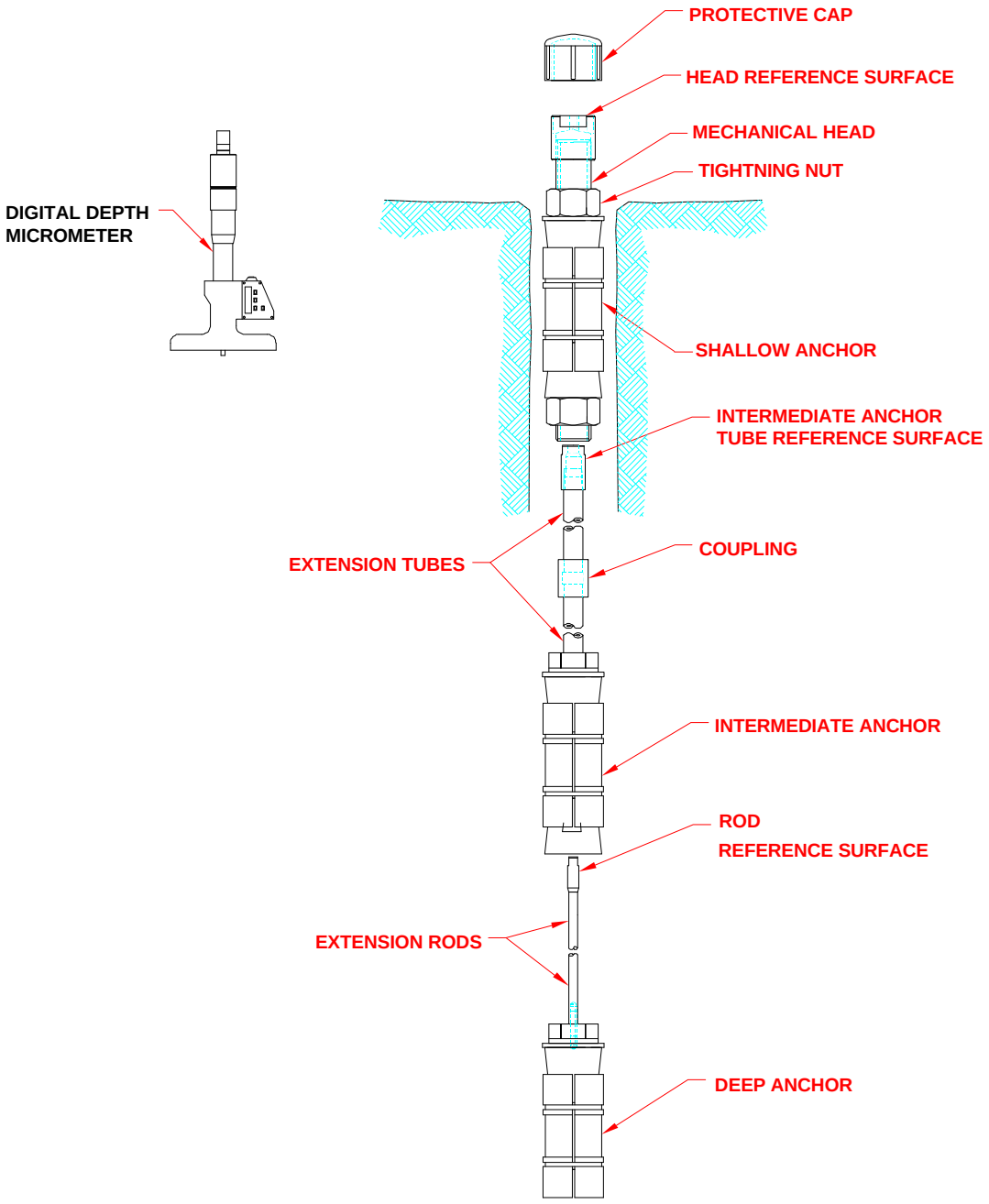

Figure 1. Model E-2 Double-Point Rod Extensometer

showing Dial Gage Readout

A short standpipe and cap are also available to protect the measurement surface of the surface anchor when shotcreting or a concrete lining is not provided. The anchor is set 3 or 4 inches inside the mouth of the borehole and the short pipe grouted in over the anchor.

The connecting rods to the deepest position anchor are standard 1.5 m or 3 m lengths of 7/32 inch or 1/4 inch diameter stainless steel rod coupled by set screws. Shorter lengths are provided to make up connecting rods to exact anchor spacing. The connections to the intermediate anchor is 1/8 inch or 1/4 inch I.P.S. schedule 40 galvanized pipe, supplied in 1.5 m or 3 m lengths and coupled by conventional pipe couplers. Both the rod to the deepest anchor and the tube to the intermediate anchor are terminated by machined tips to form a reference surface against which the dial or depth gage plunger rests when making measurements.

The setting depth of the deep anchor (the distance from the surface anchor midpoint to the deep anchor midpoint) is nominally equal to the length of the connecting rod. Similarly, the setting depth of the intermediate anchor is nominally equal to the length of the connecting tubes (measured from surface anchor midpoint to the intermediate anchor midpoint).

2.2 READOUT

The E-2 extensometer is read using either a dial gage or depth micrometer. The plunger of the instrument is inserted through the appropriate hole in the measuring surface of the surface anchor in order to contact and rest against either the end of the rod to the deepest anchor or the end of the tube to the intermediate anchor. The main body of the gage is then pushed against the surface anchor measuring surface to enable the distance to the rod or tube to be measured. A friction brake dial gage can be provided to enable the gage to be removed from the anchor with the required reading locked in place.

3 INSTALLATION PROCEDURES

3.1 BOREHOLE REQUIREMENTS AND ANCHOR SPACING

The extensometer is designed for either 1 1/2 inch or 1 3/4 inch diameter boreholes. The diameter of boreholes must be specified when ordering equipment. Where the borehole is to be extended through a shotcrete lining, at least the first 1 foot must be drilled 1 3/4 inch and a standpipe grouted in place. The borehole should be at least 6 inches deeper than the deepest anchor position.

Borehole anchor spacing are usually determined by geological factors and the size and geometry of the rock mass being monitored. When available, drill cores should be inspected to reveal zones and planes of weakness which may suggest appropriate anchor locations. The anchor positions must be specified when ordering equipment.

3.2 INSTALLATION PROCEDURE

The following instructions should be read through several times and the equipment checked prior to attempting an installation. It is advisable to lay out the various components on a clean level surface and to connect the various sections together, checking threads, clearances, lengths, etc... to become thoroughly familiar with the extensometer. Setting tubes, pipe wrenches and vice grip wrenches are required to set the extensometer. The ancillary equipment has been kept as simple as possible; in particular, the setting tubes consist of lengths of steel pipe terminated by a pipe coupling at one end and a threaded section at the other. A short, 3 foot setting tube length is also supplied.

Specific setting instructions are as follows:

1) Measure the length of the borehole using the setting tubes and a tape measure.

   Select the correct number and length of connecting rods and tubes for the deep and intermediate anchor positions. Where necessary, to adjust the depth of the deepest anchor, cut the length of the stainless steel rod to the appropriate length, retap the cut extremity and mount it at the end of one of the 1/4 inch rods. This will be the last rod to be installed and will receive the reference surface.

2) Ensure that the shell section of the deep anchor spins freely on the threaded bolt; if necessary, oil the thread. Screw the anchor bolt to the first of the 1/4 inch connecting rods using quick setting Loctite cement and the vice grip wrenches to ensure a permanent joint. Assemble the anchor and attached rod inside the first of the setting tubes (this rod has a socket at one end); the hex head on the deep anchor should nest inside the socket. The first setting tube is 5 feet long , so the rod will be sticking out of the end of the tube. Expand the shell section of the deep anchor slightly and then push the anchor rods and setting tube into the borehole.

3) Continue to add connecting rods and setting tubes, tightening the connecting rod joints until the anchor setting position is approached. Mount the last rod holding the threaded rod section (if required) and the measuring tip. Couple on the final setting tube (usually the short 3 foot length), first marking the position of the rod tip on the outside of the tube. Push the anchor to its final setting position, typically with the rod tip 2 inches inside the borehole mouth, as determined by the mark on the setting tube.

4) The anchor is expanded and set by turning the setting tubes. Occasionally, the anchor may have a tendency to spin without expanding. (This can be avoided, as described earlier, by ensuring that the shell is free to turn on the bolt and also by slightly expanding the shell). If the shell section of the anchor still turns and this cannot be rectified by bearing down on the setting tubes, then the anchor must be withdrawn and replaced or freed. Alternative double expansion shell anchors fitting with an anti-rotation spring are available if anchor setting is a recurrent problem. Securely tighten the anchor using pipe wrenches to turn the setting tubes. Remove the setting tubes.

5) Repeat the above operations for the intermediate anchor, but this time using connecting tubes. Tighten and cement the couplers on the connecting tubes. Set the anchor with the tube rod tip approximately 1 1/2 inch inside the borehole mouth (or any

pre-determined distance). Do not tighten the tube rod tip if the extensometer is to be extended later through shotcrete.

6) If the extensometer is later to be extended through shotcrete or a cast concrete lining, a short length of standpipe should now be grouted into the mouth of the borehole. The part of the pipe sticking out of the borehole is threaded for an extension that will be applied later. Grout the pipe in position with quick setting cement.

7) Install the surface anchor either in the mouth of the borehole or standpipe using the special socket wrench provided. Adjust the position of the anchor prior to setting so that the measuring surface on the end of the threaded tube section of the anchor lies approximately 1 inch inside the borehole or standpipe.

   When the extensometer is not to be extended, a short length of pipe fitted with an end cap should now be grouted in place up against the anchor to protect the measuring surfaces.

   The extensometer is now installed.

8) Take initial readings using a dial gage indicator or micrometer depth gage as described in Section 4.

9) To extend the extensometer through shotcrete (or a cast concrete lining) after the extensometer has been set, remove the surface anchor assembly from the standpipe. Remove the intermediate anchor connecting tube rod tip using the tool supplied or a pair of pliers. The rod tip connected to the deep anchor will also be removed. Add the required length of stainless steel rod to the deep anchor connecting rod and the proper length tube to the intermediate anchor. Mount the rod tip to the deep anchor connecting rod and replace the intermediate anchor connecting tube rod tip. Extend the standpipe using a pipe coupler and re-install the anchor. Shotcreting can now take place and the extensometer is again ready for use.

4 READING PROCEDURE

4.1 READING TECHNIQUES

The E-2 extensometer is read either by a dial gage indicator or depth micrometer referencing between the rod tips on the connecting rod (to the deep anchor) and the connecting tube (to the intermediate anchor) and the measurement surface on the surface anchor. With reference to Figure 1, the inner or central hole in the surface anchor measurement surface connects to the deep anchor and the outer hole to the intermediate anchor.

To take readings, insert the plunger of the dial indicator or depth micrometer into each of the holes in the surface anchor measurement surface. Hold the collar or base of the instrument firmly against the surface anchor measurement surface. When using the dial

gage, note the reading; when using the depth micrometer, rotate the drum micrometer to bring the plunger in contact with the rod tip, remove the instrument and note the reading.

In certain installations where it is difficult to read the dial gage face with a gage mounted on the surface anchor, a special dial gage can be supplied with a brake. With this gage, the plung does not return to the zero position automatically, so the readings can be taken after the gage has been removed from the reference surface. Measurements are taken by tightening the adjustable friction brake at the rear of the gage, pushing the rear plunger into the dial gage body through the brake, inserting it into the appropriate hole in the anchor measurement surface and then pushing the gage reference surface against the anchor. The rod tip drives the plunger back through the brake, retaining the reading on the dial face. Before removing the gage, the adjustable brake can be tightened still further to fully immobilize the plunger, but this is not essential.

When using either of the dial gage readouts, it is essential to ensure that the dial scale has not moved between readings. A calibration block is provided to verify the score position. Measure the depth of the hole in the reference block and then use this as the basic reference reading.

Readings should be repeated several times until the operator is confident that the true reading has been obtained. With care, reproducibility of ±0.001 inch can be achieved.

5 GENERAL COMMENTS

Frequency of readings should be suitable to the purpose for which readings are being made. When the extensometer is adjacent to active excavation areas, or where ground movements are seen to be occurring, then readings should be made at least once per shift or once per day. As movements cease, then readings can be reduced to once every second or third day or even once a week.

All readings should be recorded in a field book. The observer should compare the current readings with the previous readings. Any sudden changes of reading should be immediately confirmed by a duplicate reading on the spot. This procedure will serve to minimize gross reading errors which can occur. All raw data should be plotted without delay on a chart against time. These plots should be kept up to date daily. They will reveal zones of ground which are undergoing movements; they are essential if safety measures are to be implemented in a timely manner. Failure to plot the data on this regular basis negates the purpose of the monitoring program.

The raw data can be treated in various ways to reveal the actual zones along the borehole at which movement is occurring. Inspection of the raw data curve will immediately show whether movements are accelerating, decelerating, are constant, or have stopped. They will immediately revel the efficiency of any remedial efforts to improve stability.