



INSTRUCTION MANUAL

RETRIEVABLE BOREHOLE EXTENSOMETER

Model BOF-EX

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E1004C-080918

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1 INTRODUCTION

The model BOF-EX multiple position borehole extensometer has been developed by ROCTEST primarily as an answer to requests from the industry for high precision measurements.

The sensitivity of the BOF-EX allows it to be used for determining in situ rock properties in conjunction with plate load tests, for the critical control of underground nuclear waste repository sites and for pile load tests. It is also used for monitoring cracks in concrete dams.

The BOF-EX can also be combined with a coaxial packer assembly to form a tool capable of monitoring the coupled hydraulic/mechanical response of natural fractures. This configuration is called the PAC-EX.

The design is modular making it very versatile and also very easy to install. The instrument can be supplied pre-assembled, with elements specified by the user to meet particular applications.

The electronic sensor can be selected from a variety of displacement and transducers according to user requirement, interfacing with standard readout and data logging equipment.

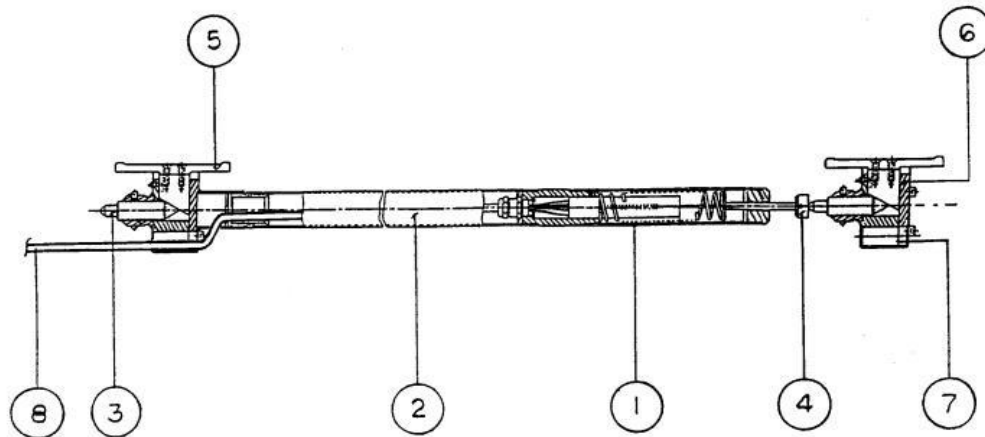
The BOF-EX is set entirely inside the borehole and measures discrete, preselected sections. The results are not affected by disturbing surface factors such as rock fragmentation around the collar or environmental conditions such as temperature or excavation activities. The problem of rod friction or striction encountered with surface transducers and multiple rods are eliminated.

The anchors are mechanical. The whole instrument can be removed from the borehole without affecting any parts. It can be reinstalled with modules modified according to revised requirements or can be reused at other locations.

The standard model is submersible, built to resist pressures up to 100 meters of water.

2 DESCRIPTION

The model BOF-EX borehole extensometer system is modular in design and comprises the following basic elements: mechanical anchor, transducer module, extension tube, centralizers, setting tool and rods.



LEGEND

- 1- TRANSDUCER MODULE.
- 2- EXTENSION TUBE.
- 3- HEXAGONAL SCREW.
- 4- DISK TYPE ANVIL & SPINDLE.
- 5- ANCHOR PAD.
- 6- ANCHOR.
- 7- CABLE PASSAGEWAY.
- 8- CABLE.

FIGURE 1 : Assemblage du BOF-EX

2.1 MECHANICAL ANCHOR

The standard anchor is designed to fit boreholes with a nominal diameter of 76 mm such as NQ diamond drill standard. All anchors, including the bottom, are similar and can be easily retrieved. The standard anchor is composed of a disk supporting three pads spaced at 120° and a central cylinder housing a jacking screw.

- One pad can extend outwards 8.4 mm by the action of a screw jack, fitting undersize and oversize standard holes varying from 72 mm to 80.4 mm.
- The disk has openings, 15 mm in diameter, allowing up to fifteen cables to pass.
- One end of the anchor is terminated with a bayonet connector and a screw with a hexagonal head. The anchor is expanded in the hole using a string of concentric setting rods. The inner rod with the hexagonal head and is turned clockwise to expend the pads.
- The other end of the anchor has a short threaded cylinder to attach the extension tube(s) or a

transducer module.

2.2 TRANSDUCER MODULE

The standard transducer module is composed of a sealed cylinder, and the displacement transducer. The transducer is either a LVDT, a linear potentiometer or a vibrating wire transducer.

A spring loaded stem slides axially out of the housing. The stem is terminated by a flat disk that butts against the screw end of an anchor. When first installed, the displacement transducer is fully extended and the adjustment is made when the unit is set in the borehole. The transducer module can either be screwed to an extension tube or directly to one side of an anchor.

2.3 EXTENSION TUBE

Normally, the transducer module is attached to one or more extension tubes that screws together in order to span the required distance between anchors.

Extension tubes are available in standard 1.5 meters lengths as well as in shorter custom lengths required to set the desired anchor spacing.

2.4 CENTRALIZER

The centralizer is used to center and support the transducer modules and extension rods. Centralizers are mounted on each transducer module or to support extension rod spans that exceed 1.5 meters.

2.5 ELECTRICAL CABLE

Consult the calibration sheet provided with the transducer for the color code.

2.6 READOUT UNITS

The readout unit depends on the transducer used. A LVDT or potentiometer transducer can be read with a Acculog unit, and a vibrating wire transducer can be read with a MB-6T(L). Refer to the Reading section and to respective readout units manual.

3 SPECIFICATIONS

3.1 MECHANICAL ANCHOR

| | |
|--|-------------------------------------|
| Nominal outside diameter : | 76.2 mm |
| Minimum diameter (pads retracted) : | 72 mm |
| Maximum diameter (pads extended) : | 80.4 mm |
| Material : | Aluminium, stainless steel or invar |

3.2 TRANSDUCER MODULE

| | |
|--------------------------------|---|
| Type : | LVDT, linear potentiometer or vibrating wire transducer |
| Accuracy : | +/- 0.1% to +/- 0.5% F.S. depending on transducer |
| Resolution : | 0.01mm (LVDT, Lin. Pot.) / 0.02% F.S. (Vibrating wire) |
| Measuring scale : | +/- 2.5 to +/- 25 mm |
| Operating temperature : | -55°C to +125°C (LVDT) / -55°C to +60°C (Lin. Pot.) / -27°C to +65°C (Vibrating wire) |
| Outside diameter : | 31.8 mm |
| Cable standard : | 2 twisted pairs 22 AWG, shielded, Ø ext. 6.2 mm |

3.3 EXTENSION TUBES

| | |
|---------------------------|-------------------------------------|
| Outside diameter : | 31.8 mm |
| Length : | 1.5 m maximum or shorter |
| Material : | Aluminium, stainless steel or invar |

4 INSTALLATION

The BOF-EX extensometer components are installed sequentially in the borehole beginning with the deepest anchor and proceeding outwards the collar.

4.1 DOWNSTREAM ANCHOR

- Determine the depth of the deepest anchor.
- Connect the bayonet head on the installing tool to the anchor. The engraved red line on the tool should line up with the mobile anchor pad.
- Connect the first 1.5 m length of outer installing tube to the anchor installation tool. Again, make sure that the engraved red lines are aligned.
- Insert the anchor into the borehole. The mobile pads on all anchors inserted into the hole must all point in the same direction. Continue to add outer installing tubes to push the anchor to its setting depth. Make sure that as tubes are added, the red index lines remain aligned.
- When the anchor reaches the required depth, the inner rods used to expand the anchor are inserted. Begin by inserting the anchor setting rod fitted with a 3/8 hex socket which mates with the hexagon screw on the anchor.
- Apply a layer of grease to the male rod coupling before joining rods together so the threads will not get stuck and the BOF-EX will still be retrievable. Advance the socket head set screw located on the rod coupling pin until the set screw is flush with the outside of the rod.
- Continue to insert rods until the hex socket engages the screw on the anchor.
- Hold the outer rods fixed and rotate the inner rod string clockwise to expand and set the anchor.
- Once the pad contacts the borehole walls, continue to torque the inner rod firmly using a pair of vice grips. Make sure sufficient torque is applied.

- Release the outer setting rod string by pushing in on the rods and then rotating the rod string counterclockwise.
- Pull the outer rod string back 25 to 50 mm.
- Pull out the inner rod string breaking it into convenient lengths.
- Pull out the outer rod string assembly.
- Assemble the deepest transducer module with the required number of extension rods.

4.2 OTHER MODULES

- Assemble the transducer with the extension rods to an anchor.
- Thread the transducer cable through the appropriate marked hole in the anchor.
- Install the centralizer on the measuring module or on the extension tube. A centralizer must be installed at 2 meters intervals along the extension tubes.
- Insert all in the borehole using the installation tools.
- When the contact is made with the previously installed downstream anchor, the measuring module is connected to its readout box. The extensometer tube is pushed forward until the initial position desired is reached (half way, extension or compression). In this final position, the anchor is fixed as described in the previous procedure.
- Continue to assemble and install the next and subsequent modules, extension tubes and anchors with the same installation sequence.
- Use the procedure described above making sure that the cables leading from already installed modules are aligned and during insertion, guided by the disc mounted on the installing tool.

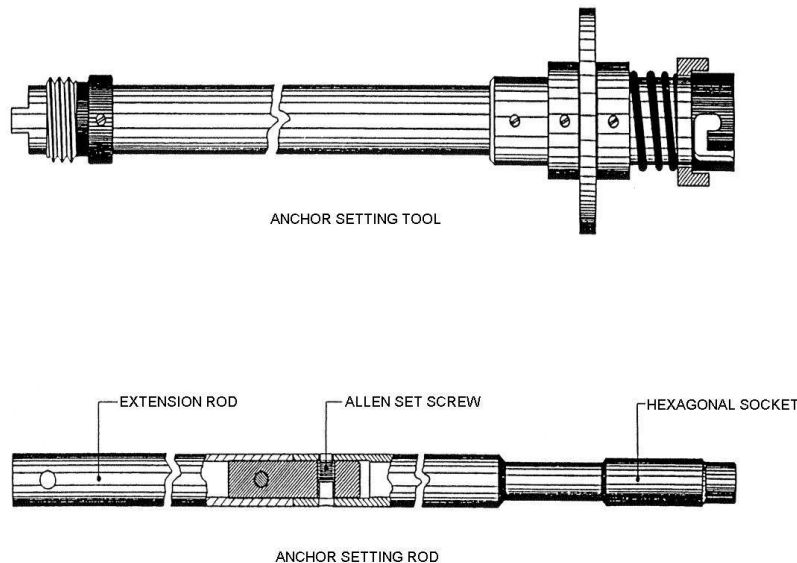


FIGURE 2 : Anchor setting tool and rod

5 READINGS

Before the installation of the BOF-EX, readings must be taken to be sure that the transducers are operational.

During the installation, readings should also be taken to set the initial position of the sensor with the anticipated displacement. In example, if a fissure is expected, the transducer will be set in compression.

5.1 LINEAR POTENTIOMETER OR LVDT TRANSDUCER

Please, refer to the manual of the Acculog unit.

5.2 VIBRATING WIRE TRANSDUCER

Please, refer to the manual of the MB-6T(L) unit. You may also refer to the calibration sheet furnished for each transducer. It will indicate the conversion equation of the readings units to engineering units and the conversion factors for each transducer as determined to the calibration. Finally, this calibration sheet will give you the value read on the reading unit corresponding to the initial position desired of the transducer (half way, compression, extension).

The reading unit has a cable with 4 alligator clips to it end. Join the clips following this table.

| Cable | Connections | | | | |
|-----------|--------------|----------------|-----------------|--------------------------|--------|
| | WIRE HI(RED) | WIRE LO(BLACK) | THERM HI(WHITE) | THERM LO /SHIELD (GREEN) | |
| IRC - 41A | RED | BLACK | WHITE | GREEN | SHIELD |

TABLE 1 : Wiring Code for Electrical Cables

To obtain a reading, move the MB-6T GAGE selector to position 2 (JM) and the THERMISTOR selector to position :

| <u>THERMISTOR</u> | <u>Position</u> |
|-------------------------|-----------------|
| 2 k Ω | A |
| 3 k Ω (standard) | B |
| 10 k Ω | C |