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Instruction Manual

Model 1900

Magnetic Extensometer

(Doc Rev G, 7/14)

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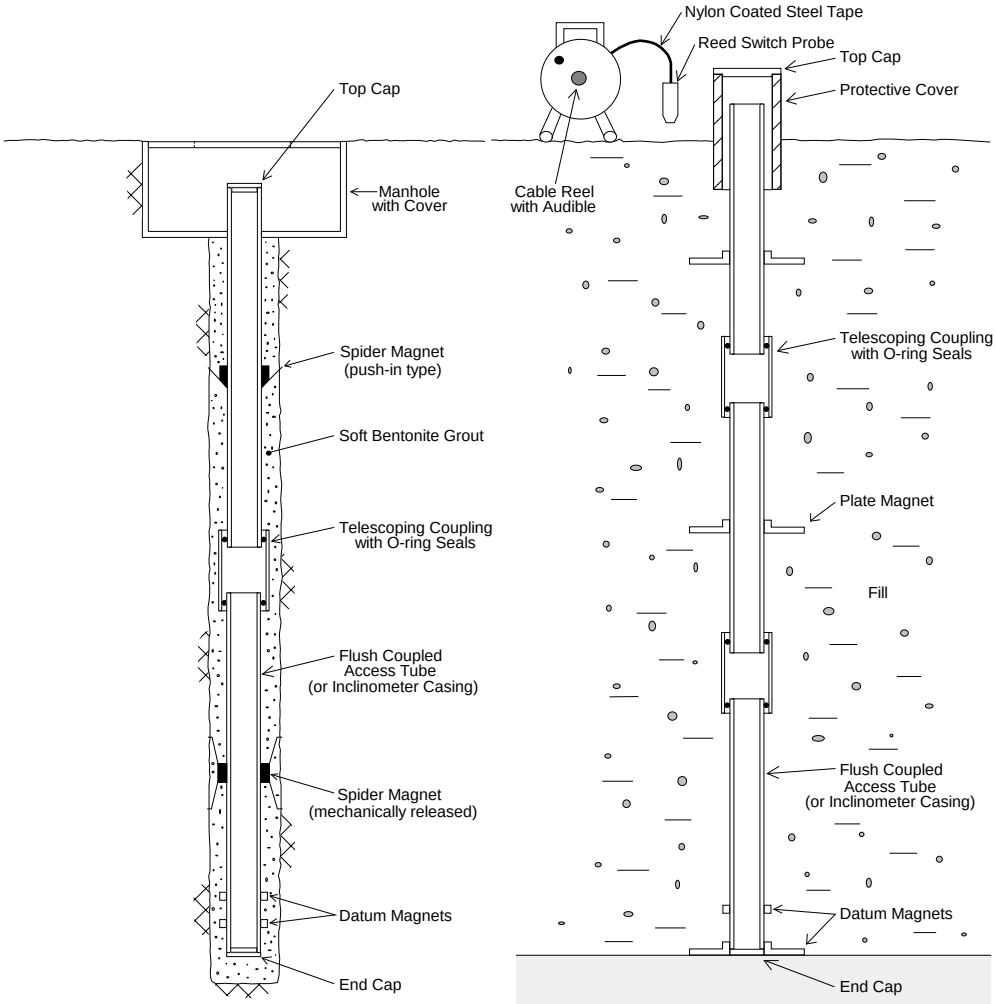
1. INTRODUCTION

The Model 1900 Magnetic Extensometer is designed to measure movement between magnetic targets anchored in the ground. Its primary use is the measurement of vertical compression in embankments, foundations and fills and the movement of settlements in soft ground due to the placement of fills and embankments. It may also be used to measure heave

1.1. Theory of Operation

Figure 1- shows the basic arrangement of the Magnetic Extensometer.



Anchor points with permanent magnets are anchored in the ground with a continuous access tube passing through their center. A reed switch probe is lowered inside the access tube on the end of a graduated measurement tape which also contains two electrical conductors. As the probe passes each anchor, the magnets in the anchor cause the reed switch to close which sounds a buzzer, at the surface, on the tape reel.

When the buzzer sounds the depth of the anchor is measured by reading the graduated tape opposite the top of the access tube.

In most cases the bottom of the access tube is deep enough to be located in solid ground. A datum magnet anchored to the bottom of the access tube provides a stable benchmark datum to which all the other anchor measurements are referred to in order to calculate the absolute settlement of each anchor point relative to the benchmark.

If the bottom of the access tube cannot be located in the solid ground then it will be necessary to reference the position of each anchor to the top of the access tube and to transfer this elevation to an external benchmark by normal level surveying techniques.

2. INSTALLATION

Installations are either in boreholes or directly in a fill as it is placed. A list of suggested tools is given in Appendix B

2.1. Installation in Boreholes

Boreholes may be either open, cased, grouted or not grouted. In the case of cased boreholes it will be necessary to pull the casings after the string of access tubes and anchors have been installed inside it. In holes which are to be grouted using a soft bentonite grout there are two options; a) to pre-grout the borehole or b) to grout the borehole through a tremie pipe after the extensometer string has been lowered into position.

2.1.1. Preparing the Access Tube Anchor String

It is advisable to prepare the entire access tube string on a stretch of clean, level ground prior to installing it. In this way there will be a minimum of delay during the actual installation since everything will be ready. Do not screw the sections together just arrange them in their correct order with the anchors attached.

1. Begin by cementing the end cap onto the bottom section of the access tubing using PVC cement (not supplied by Geokon).

2. Using the three set screws tighten the datum magnet onto the bottom section of the access tube about one meter above the bottom end cap. (Don't put the datum magnet too close to the bottom in case the access tube silts up.)

3. Select further sections of access tube and/or telescoping couplings. Position the spider anchors along the sections of access tubing in their desired locations. The spider anchors are attached to the access tube as shown in Figure 2.

Figure 2 - Anchor Assembly - Securing the Leaf Springs

Use the chains supplied to restrain the ends of the leaf springs). The pull-pin passes though the links of the chain holding the leaf springs snug against the access tube. Use ¾ inch electricians tape (2 turns) around the pull pin above and below the anchor, (see Figure 2). This holds the anchor pull-pin in place and makes it more difficult to pull the pin out, thus reducing the risk of prematurely tripping the anchor during installation.) It also holds the spider anchor in place preventing it from sliding up the access tube during installation.

4. Leave the pull cable coiled up but connect the loop on the end of the pull cable to the anchor pull-pin by clipping the hook through the eye of the pull cable.
   Wrap a single layer of masking tape around the cable about 30cm above the hook. This also will make it more difficult for the pull-pin to be pulled prematurely.

5. Tape identification tags onto each end of the pull cables. Use "#1" for the top anchor, "#2" for the anchor next to the top, etc.

2.1.2. Installing the Access Tube Anchor String

1. Begin assembling the access tube string and pushing it down inside the borehole. If the hole is to be grouted after the string is placed then the tremie pipe should be taped to the end of the access tube. Tape heavily enough to prevent the Tremie pipe from coming loose as it is pushed into the hole but not so heavy that it cannot be pulled loose deliberately at the start of grouting.

   If the borehole is already filled with grout or water it will be necessary to fill the access tube with water to overcome the buoyancy forces.

2. When sections with spider anchors are added to the string the pull-cables should be uncoiled and placed in the charge of one or more persons with strict instructions that **the pull cables must be fed smoothly into the borehole along with the access tubing and that on no account must any of the pull-cables be snagged, tangled or pulled on which could cause premature triggering of the anchors.** It may be advisable to have more than one person in charge of the pull-cables and tremie pipe.

3. When the access tube has been lowered to the bottom of the borehole it will be necessary to make sure that all the telescoping couplings are fully extended so as to be able to

accommodate the anticipated settlements. (If heave is being measured the couplings can be left closed or nearly closed)

This is best done by means of a long push-rod (not supplied by Geokon) made from any easily available water pipe with threaded connectors. The push-rod assembly when joined should be sufficient length to reach the bottom of the access tube. To open the telescopic couplings push down on the push-rod assembly and pull up on the access tubes.

4. Now use the reed switch probe to verify the position of the anchors before they have been tripped. If the anchors have slipped it is still possible to remove the access tube and reposition them.

5. If the hole is to be grouted now is the time to do it.

   Bentonite grout is required, one which will remain soft and not impede the settlement of the ground, i.e. which will allow the anchor to follow the movement of the ground. (A typical grout is 43 kgm cement, 2 kgm bentonite and 40 kgm water, or enough water to make the mix pumpable.)

6. If the hole is cased the casing can now be removed. Make sure that the access tubing does not pull upwards during this process.

7. The magnetic spider anchors can now be released beginning at the top anchor. Select pull-cable #1 and give it a quick hard pull in the same manner as already practiced.

   Remove the pull-cable and anchor pull-pin completely from the borehole before tripping anchor #2. Repeat this process for all the anchors.

2.2. Installation in Fills

Plate shaped magnetic anchors are used in fills. As the fill is placed the access tube is extended upwards by screwing on more sections along with telescoping couplings (make sure these are fully extended when installed). The plate anchors are simply laid on top of the fill surface as soon as it reaches the desired anchor elevation. They are then buried as more fill is placed.

As each new section of access tube is added this will alter the reed switch probe readings. But the data reduction will still follow the method outlined in section 4.

3. TAKING READINGS

Before taking readings check the battery voltage by depressing the "TEST" button on the side of the tape storage reel. If no beep is heard then replace the 9 volt alkaline battery. Access to the battery holder is made by removing the three small screws around the periphery of the tape reel on the side which holds the test button and buzzer.

Readings are taken by lowering the reed switch probe down the access tube until an audible beep is heard from the buzzer in the tape reel. A reading of the graduated measurement tape is taken opposite the top of the access tube when the buzzer just starts to sound.

For greater accuracy, a second reading can be obtained at the same anchor by lowering the probe until the buzzer just stays beeping. Again take a measurement on the tape, as before, and average the two readings to get the position of the anchor.

Repeat this process for all the anchors and the datum anchor at the bottom of the hole.

4. DATA REDUCTION

The distance from the datum magnet to the top of the access tube can be designated D_t meters .

The distance from the top of the access tube to any intermediate anchor can be designated D_1, D_2, D_3, etc.

If the datum magnet is located in solid ground (i.e. no settlement) then the true settlement of any intermediate anchor is given by $D_t - D_n$ meters.

For instance, assume that initially D_t = 29.214 meters and the measured distance to the top anchor D_1 is 3.632 meters.

Then (D_t-D_1) at time T_0 is 25.582 meters. One day later at time T_1, D_t=28.943 meters and D_1=3.595 meters. So (D_t-D_1) at time T_1 is 25.348 meters hence anchor D_1 has settled (25.582-25.348)=0.234 meters. Similarly, the top of the access tube has settled a distance of (29.214-28.943)=0.271 meters and the compression of the ground between the top of the access tube and anchor D_1 is (0.271-0.234)=0.037 meters.

If, on the other hand, it is required that all measurements be referred to the top of the access tube, then the actual elevation of the borehole anchors can be computed simply by subtracting the measured distances D_1, D_2, D_3, etc. from the surveyed elevation of the top of the access tube. The settlement of each anchor is then the observed difference of elevation from one survey to the next.

APPENDIX A - SPECIFICATIONS

A.1. Model 1900 Magnetic Extensometer Specifications

Available Ranges:[1]	unlimited (cable lengths 30m, 100m, 100 ft., 500 ft.)
Borehole Size:[2]	4-6" (100-150 mm) standard
Tube Size:	PVC 1" sch. 80
Telescoping Section:	range of movement, 12 inches or 300 mm
Repeatability:	±3 mm, ±0.01 ft.
Resolution:	±1 mm, ±0.005 ft.
Temperature Range:	–30 to +80° C -30 to 110° F
Power:	9V Alkaline Battery
Probe Construction:	Stainless Steel and Delrin

Table A-1 Model 1900 Specifications

Notes:
[1] Other ranges available.
[2] Other sizes available.

APPENDIX B – LIST OF TOOLS

- black electrical tape (anchors, packing aircraft cables, to protect loops)
- masking tape to hold aircraft cables during installation
- small cutting tool (to cut cable ties)
- measuring tape (to place the anchors on the access tube at correct depth)
- color pen (not black) to identify anchor location on access tube
- working gloves (to hold anchor legs closed when working with the chain and the access tube)
- PVC glue (for top cap)
- steel saw (to cut access tubing)
- pipe wrench
- set of Allen wrenches
- long push-rod (extensible to reach the bottom of the hole, (typically 1’4 inch water pipe).

Tool list for 1900 extensometer installation:

color tapes to identify anchors (or ID numbers)
- black electrical tape (anchors, packing aircraft cables, to protect loops)
- duct tape for cable reel and bottom cap
- masking tape to hold aircraft cables during installation
- small and medium plastic cable ties or cable clamps or cable grips (for making loops with the cable)

- medium cutting tool (to cut aircraft cable)
- small cutting tool (to cut cable ties)
- measuring tape (to place the anchors on the access tube at correct depth)
- 300ft tape (to measure aircraft cable length)
- color pen (not black) to identify anchor location on access tube
- working gloves (to hold anchor legs closed when working with the chain and the access tube)
- grease for telescopic sections (and possibly for anchors)
- clear water (to clean threads)
- tarpaulin to protect black access tubing from direct sunlight (too hot to manipulate without protection)
- PVC glue (for top cap)
- steel saw (to cut access tubing)
- big pliers (to screw bottom cap)

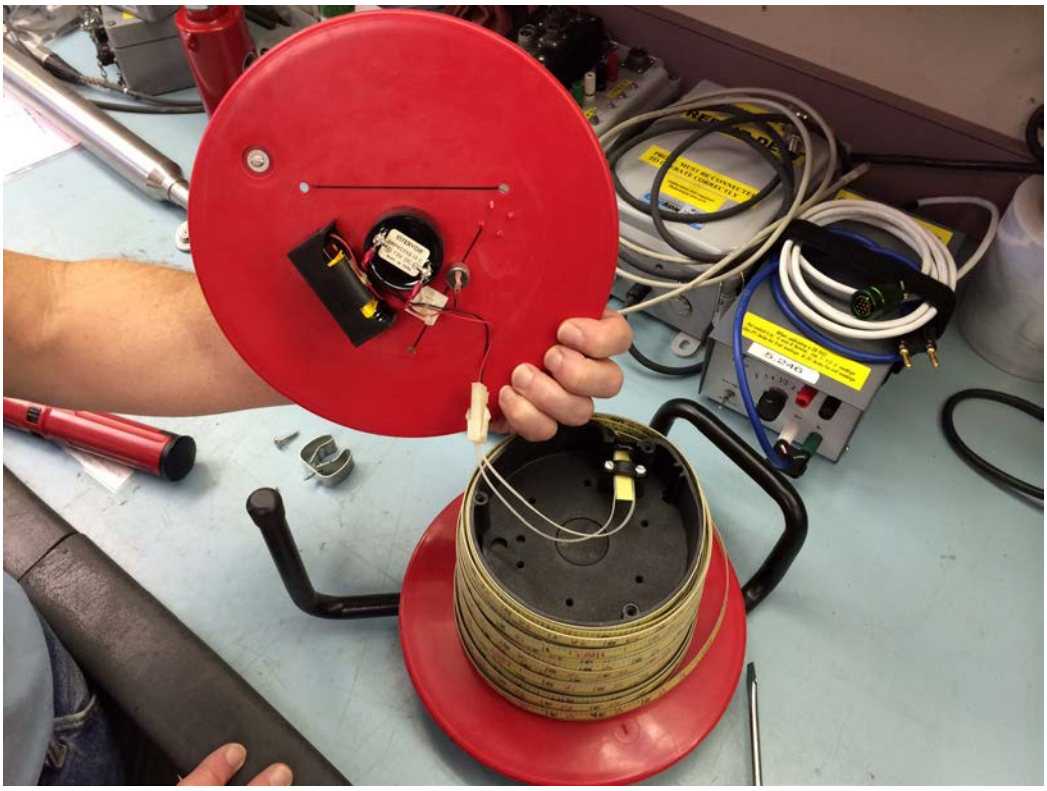
- spare o-rings for access tubing
- 1 additional link to the 10in chain used to hold anchor legs closed on tubing

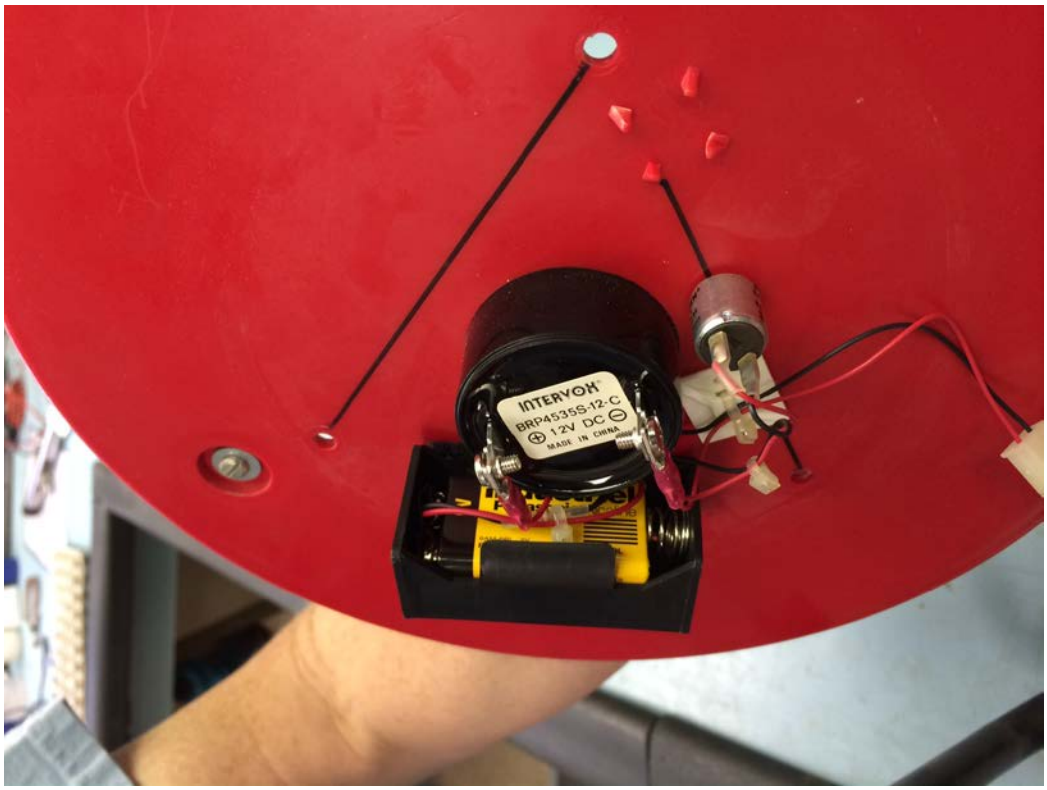
Tool list for 1900 extensometer installation around an inclinometer tubing:

- color tapes to identify anchors (or ID numbers)
- black electrical tape (anchors, packing aircraft cables, to protect loops)
- duct tape for cable reel and bottom cap
- masking tape to hold aircraft cables during installation
- small and medium plastic cable ties or cable clamps or cable grips (for making loops with the cable)
- medium cutting tool (to cut aircraft cable)
- small cutting tool (to cut cable ties)
- measuring tape (to place the anchors on the access tube at correct depth)
- 300ft tape (to measure aircraft cable length)
- marker to identify anchor location on inclinometer tubing
- working gloves (to hold anchor legs closed when working with the chain and the access tube)
- grease for telescopic sections (and possibly for anchors)
- PVC glue (for top cap)
- steel saw (to cut inclinometer tubing)

APPENDIX C – BATTERY REPLACEMENT

The battery is a standard 9V battery. Simply remove the 3 screws holding the buzzer side flange of the reel together, being careful the tape does not fall off the reel. There they will see where the battery is installed . See photographs on next page.

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