

Soil Strainmeter

51705699

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Introduction

Overview

The **Soil Strainmeter** is a horizontal extensometer that monitors soil movement over the distance between two anchors. Strainmeters can be linked to monitor deformation over long spans.

A strainmeter consists of a sensor, a rod, and two anchors. The sensor and rod are housed in telescoping PVC pipe. The anchors are attached along the pipe.

The entire assembly is then buried in an embankment, and an initial reading is taken. Subsequent readings will indicate a change in length if deformation of the ground occurs.

Applications

- Monitoring horizontal strains in earthen embankment dams.
- Monitoring tension cracks in earth structures.

Components

Single-Sensor Soil Strainmeter

The single-sensor soil strainmeter has one potentiometer and comes assembled in a waterproof housing (with signal cable attached) with a stainless steel all-thread rod, a centralizer, telescoping PVC pipe, an end plug, a termination cap, and two anchors. The single-sensor strainmeter is generally used as the odd numbered strainmeter in an odd numbered string.

Double-Sensor Soil Strainmeter

The double-sensor soil strainmeter has two potentiometers and comes assembled in a waterproof housing (with signal cable attached) with two stainless steel all-thread rods, two centralizers, telescoping PVC pipe, end plugs, termination caps, and three anchors. The double-sensor soil strainmeter is used in most cases due to the cable cost savings derived from combining two sensors.

Extensions

Extensions consist of a stainless steel all-thread rod, one or two centralizers (depending on extension length), telescoping PVC pipe, and an anchor.

General Concerns

Trial Assembly

In a suitable location (preferably off-site), lay out the strainmeter components and assemble them without using cement or tightening the nuts or set screws. Check that the cable lengths, individual gauge lengths, and overall length of linked strainmeters agree with specifications.

Identify Cables

Mark cables for positive identification later. Attach identifying marks with a durable, waterproof tape. At a minimum, mark the end of the cable three times at 1-meter intervals, then mark the remaining cable at 2 or 3-meter intervals. If the end of the cable is cut or spliced, mark the end three times as described above.

Identify Strainmeters

Once the trial assembly is completed, make a record of the intended position of each strainmeter. Paint identifying marks on each unit.

Pre-Assembly

Partial pre-assembly can speed installation. Strainmeters up to 3 meters long can be carried easily.

Tools Required

- 30-meter tape measure (100 feet)
- 2 adjustable wrenches
- 1 hacksaw
- PVC/ABS cement
- 1/8-inch allen wrench

When connecting to dataloggers or terminal boxes:

- Small screwdriver
- Wire strippers
- Wire cutters

Assembly

Assembly Options

1. Assembling a Strainmeter
2. Adding an Extension
3. Shortening a Rod
4. Linking Strainmeters
5. Terminating Strainmeters
6. Installing the Anchors

Assembling a Strainmeter

Follow the procedures outlined below for both single and double-sensor strainmeters. See figure 1 in the appendix for an illustration. To shorten any rods, refer to the section titled *Shortening a Rod*.

1. Identify the soil strainmeter sensor.
2. Extend and retract the telescoping joint several times to “exercise” the joint so it will be easier to adjust later.
3. Gently shake the soil strainmeter sensor until the sensor rod slides out of the end of the coupling.
4. Locate the all-thread rod. Slide a centralizer with set screw to the center of the all-thread rod and tighten the set screw using a 1/8-inch allen wrench. Screw the jam nut onto the rod.
5. Holding the sensor rod with one hand, thread on the rod, and tighten the jam nut. Push the sensor rod into closed (retracted) position.
6. Slide the PVC pipe onto the all-thread rod. Apply PVC cement liberally to the end of the pipe and push it firmly into the coupling.
7. Do not attach the termination cap yet.

Adding an Extension

Each extension kit consists of a stainless steel all-thread rod provided with a coupling nut and two jam nuts; one or two centralizers (depending on extension length); a length of PVC pipe; and a telescoping coupling. See figure 2 in the appendix for an illustration.

1. Slide a centralizer with set screw to the center of the all-thread rod and tighten the set screw using a 1/8-inch allen wrench. Install a centralizer every 1.5 meters for PVC pipe support.
2. Thread the jam nut and coupling nut onto the end of the all-thread rod extension.
3. Join the extension rod to the strainmeter rod using the coupling nut. Then tighten the jam nuts.
4. Locate the telescoping coupling. Exercise the coupling for easier adjustment later.
5. Orient the outer sleeve of the telescoping coupling toward the strainmeter sensor. Slide it onto the rod and cement it to the pipe.
6. Slide the PVC extension pipe over the all-thread rod.
7. Cement the PVC extension pipe to the telescoping coupling.
8. Close the extension as noted in the section titled *Assembling a Strainmeter*.

Shortening a Rod

An all-thread rod can be shortened in the field to meet site requirements.

1. During the trial assembly, determine if there is excess all-thread rod.
2. Mark the excess rod that must be removed to attain the required length.
3. Thread a nut onto the rod just past the cut zone.
4. Cut the all-thread rod at the marked area. Use the nut to clean up the thread.
5. Mark the amount of PVC pipe that must be removed and cut it off.
6. Check that the desired length is obtained.

Linking Strainmeters

Strainmeters can be linked together as follows:

1. Orient the strainmeter sensor so the cable gland is horizontal. All cable glands should ultimately be oriented horizontally in the same direction.
2. Slide an end plug onto the all-thread rod and tighten the set screw using a 1/8-inch allen wrench.
3. Slide a slip coupling over the end plug and cement the coupling to the end of the PVC pipe.
4. Cement a 4-inch section of PVC pipe into the slip coupling.
5. Following steps 2 and 3, attach an end plug and slip coupling to the next strainmeter in the string. Cement the slip coupling to the 4-inch section.
6. Repeat steps 2-5 as necessary until all the strainmeters are joined into the string.

Terminating Strainmeters

Termination caps are attached to each end of the string of strainmeters as follows (see figure 3 in the appendix for an illustration):

1. Ensure that the sensor rod and telescoping coupling are both fully closed (retracted) by pushing them toward the strainmeter sensor.
2. Slide the end plug onto the all-thread rod and tighten the set screw using a 1/8-inch allen wrench.
3. Slide the slip coupling over the end plug and cement the coupling to the end of the PVC pipe.
4. Cement a 4-inch section of PVC pipe into the slip coupling.
5. Cement the termination cap onto the end of the 4-inch section of PVC pipe.

Installing the Anchors

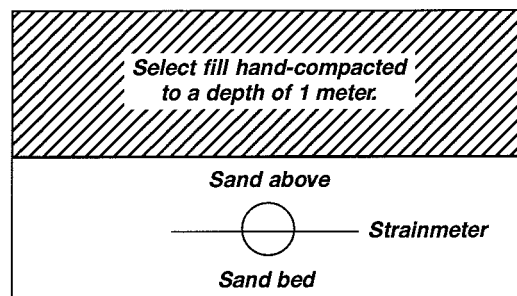
The final step is to attach anchors to the strainmeter sensor housings and to the end of each strainmeter. An anchor consists of an angle iron with two thread holes, two plastic clamp halves, and two stainless steel bolts.

1. Unscrew the bolts from the anchor clamp (see figure 4 in the appendix).
2. Separate the clamp halves.
3. Position the anchor clamp near the "T" of the strainmeter or in the center of the 4-inch section of PVC pipe at the end of the strainmeter. Note: If two strainmeters are linked at the 4-inch section of PVC pipe, install only one anchor. In a string of strainmeters, extra anchors will result.
4. Position the anchor on the anchor clamp, reassemble the clamp halves, and tighten the bolts.

Installation

Installation

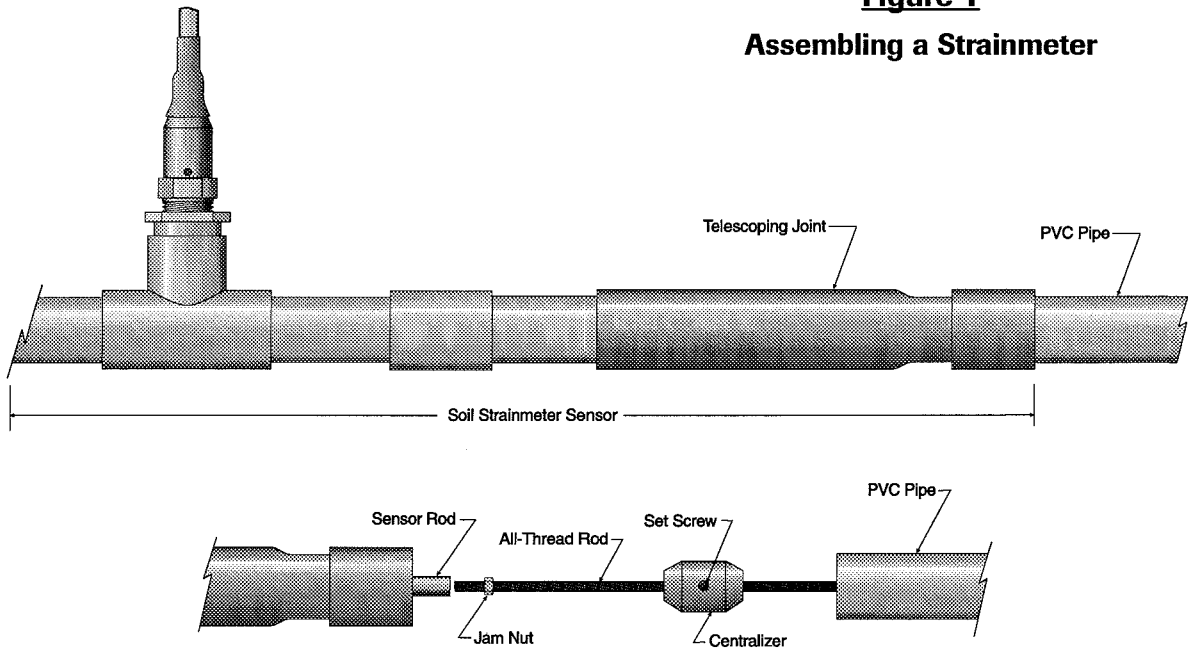
1. Prepare a flat, level area for the strainmeter(s). Stake out the intended positions of the anchors. Perform an optical survey to record the location of the anchor stakes.
2. Lay out the strainmeters. Double-check that the cable lengths are correct.
3. Adjust the length of each strainmeter.
4. Adjust the strainmeter measurement range. When telescoping couplings are fully closed, the strainmeter can accommodate six inches of extension. If you anticipate compression, open the telescoping coupling to provide adequate range for compression
5. Starting from the end of the string and working toward the beginning, link the strainmeters using the instructions outlined previously.
5. Measure and record the gauge length (anchor to anchor) of each strainmeter, the overall length of the string of strainmeters, and the location of each anchor.
6. Connect a manual readout or multimeter (depending on your application) to each strainmeter to check the initial settings.
7. Lay out the signal cables for each sensor. The cables should be oriented as specified. See the section on *General Concerns* for cable marking suggestions.
8. Backfill over the complete string by carefully hand-placing graded sand to a thickness of at least 150 millimeters (6 inches). The backfill must be hand-compacted over the length of the string of strainmeters.



9. Build up the sand over the installation using selected fill material until there is at least 1 meter (3 feet) of cover.
10. Begin normal placement of fill.

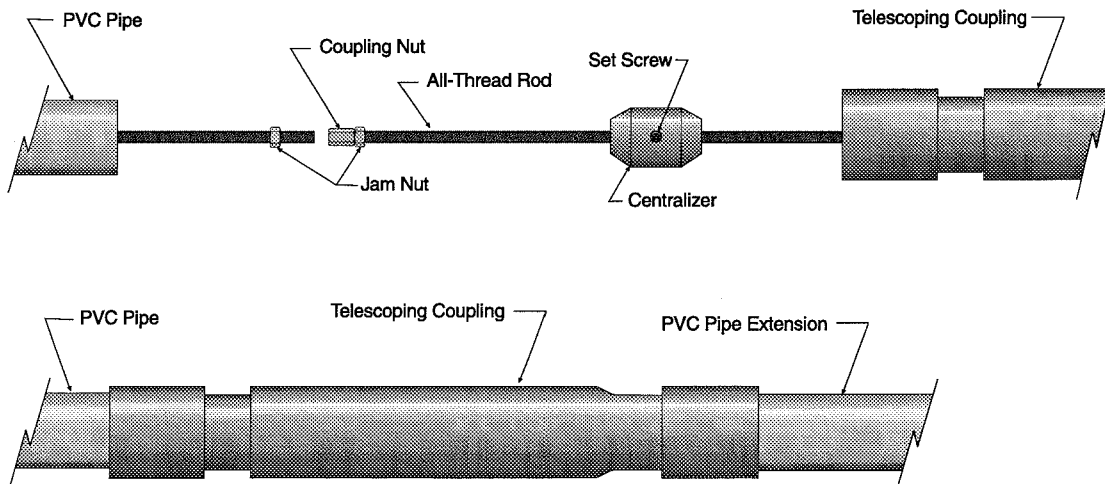
Appendix

Figure 1
Assembling a Strainmeter



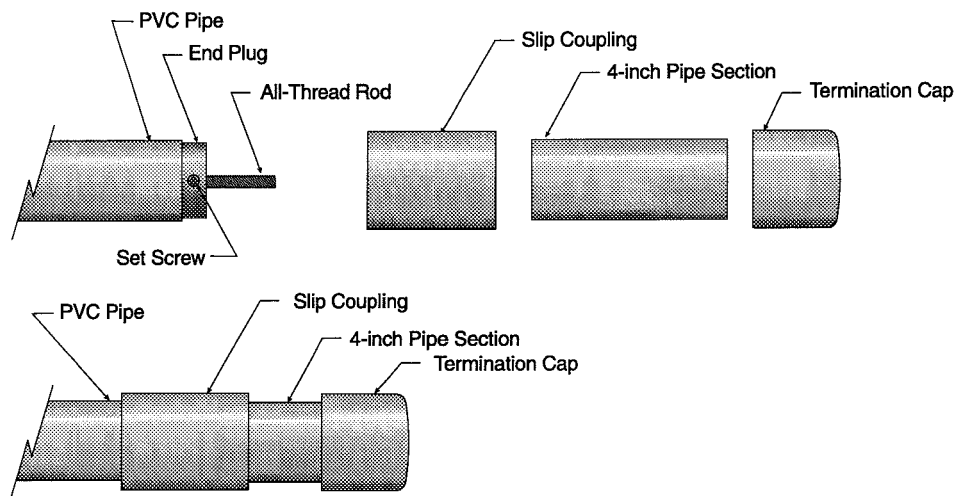
STMTR-01

Figure 2
Adding an Extension



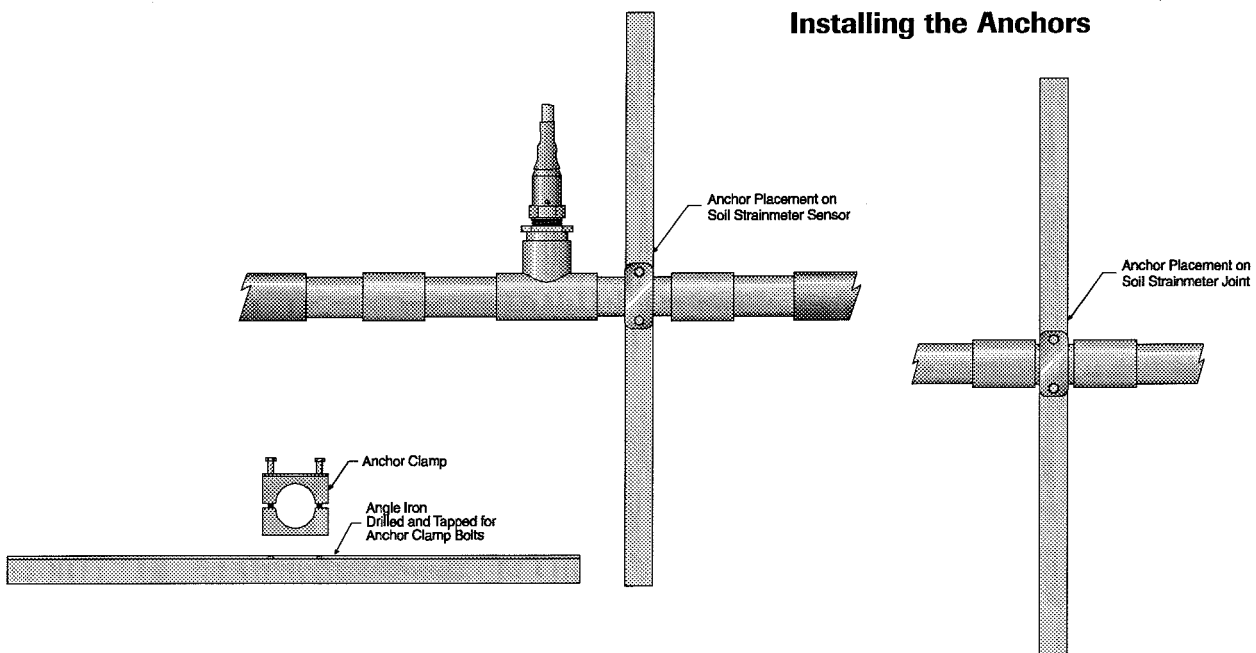
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Figure 3
Terminating Strainmeters

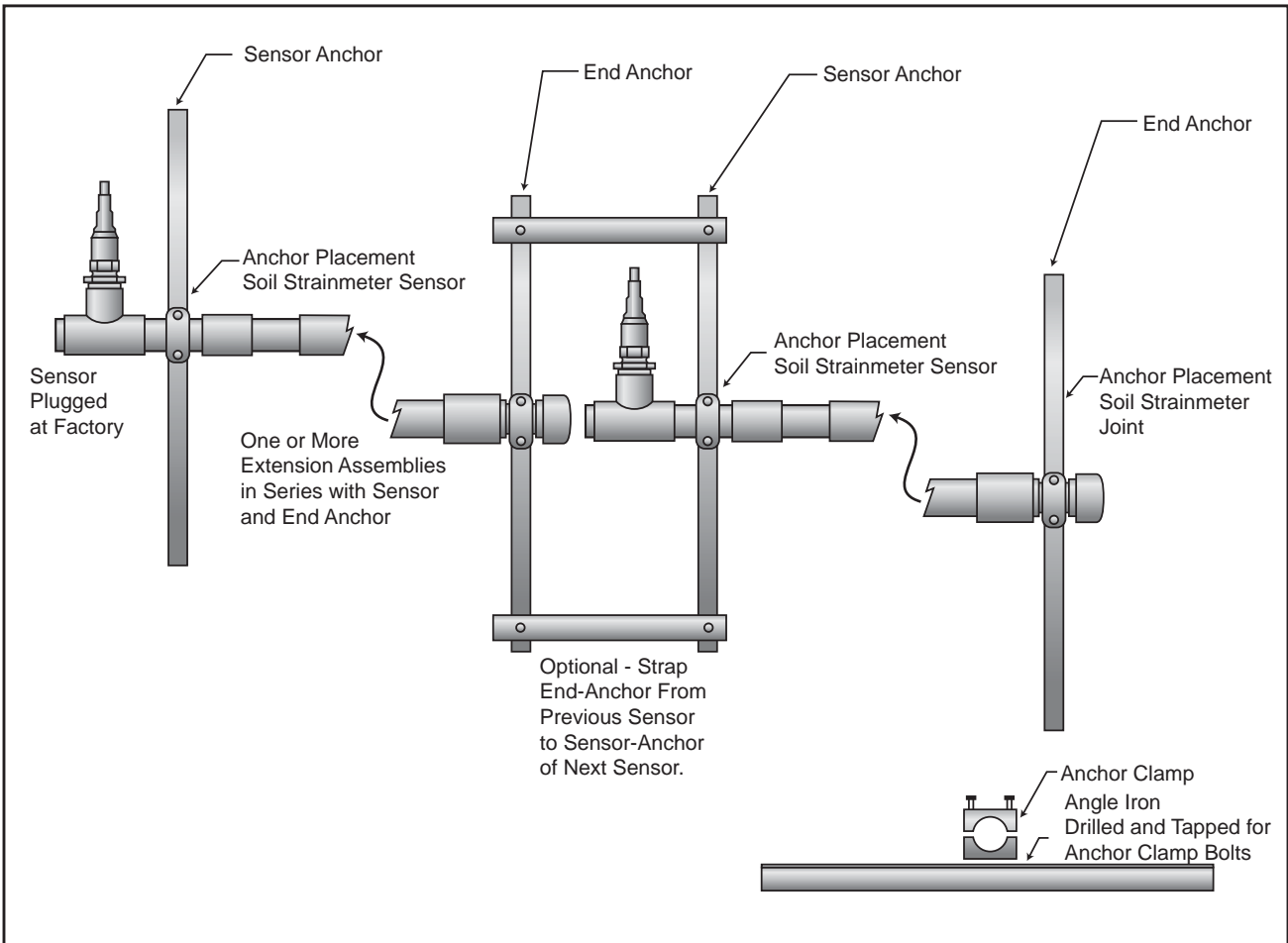
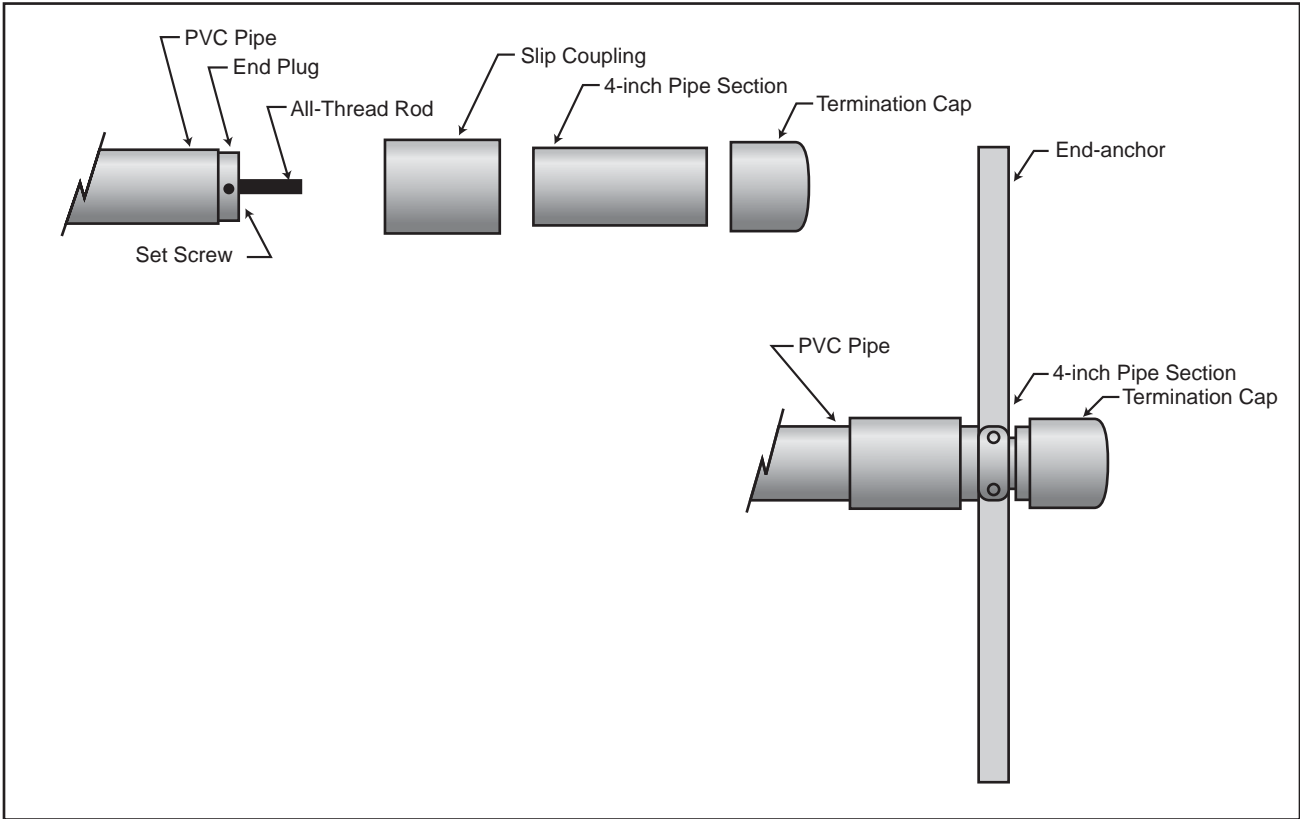


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Figure 4
Installing the Anchors

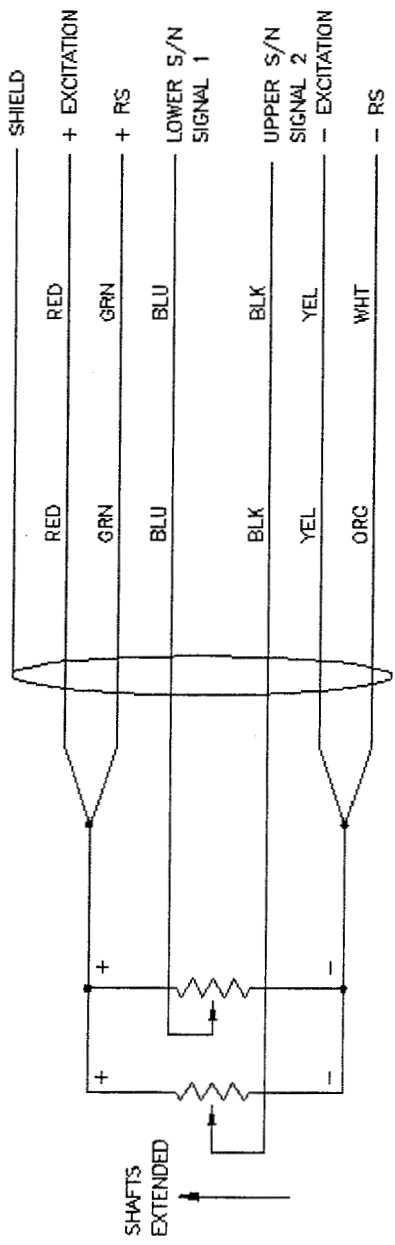


STMTR-04.cdr



ECL ZONE		REVISIONS	
A	A1	DESCRIPTION	DATE
		FIRST DRAWN	6/28/96
		CABLE CHANGED	6/30/97
		SHOW +/- RS	3/12/98

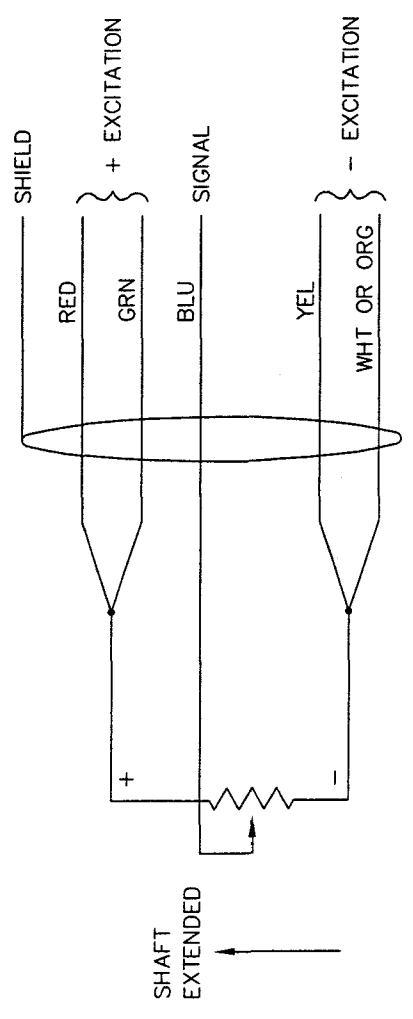
SENSOR CABLE
50613527 56400800



UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCES ARE		SLOPE INDICATOR	
DECIMALS FRACTIONS ANGLES		TITLE	
X ± .010 ± .005 ± .005		WIRING DIAGRAM	
XXX ± .005		DUAL STRAIN METER, 6" (150 mm) RANGE	
NATIONAL		SIZE	DWG NUMBER
FIG 81		B	51705620
	DATE	SCALE	ECL
	3/12/98	DO NOT SCALE	A1
			DRAWING OF 1

REVISIONS		
ECL	DESCRIPTION	DATE
A	FIRST DRAWN	6/30/97

SENSOR CABLE # 50613527
OR 56400800



UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCES ARE: DECIMALS FRACTIONS ANGLES .X ± .02 ± .030 ± .5° .XX ± .010 .XXX ± .005		SLOPE INDICATOR	
TITLE WIRING DIAGRAM SINGLE STRAIN METER, 6" (150 mm) RANGE		SIZE B	ECL A
DRAWN BY 6/30/97		DATE	INITIALS
SCALE DO NOT SCALE DRAWING		SHEET 1 OF 1	

Soil Strainmeter Connection Detail

The connections below are used with the DMMP and Bare Wire Adapter (BWA) to read potentiometers used in soil strainmeters. The wire colors are Slope Indicator's standard colors for cable 50613527 (PU, 22ga.)

BWA	Color	Function
1	Blue	Sensor 1
2	Black	Sensor 2
3		
4		
5	Red	Excitation +
6	Green	Rem. Sense +
7	Yellow	Excitation -
8	Orange	Rem. Sense -
9		
10	Shield	Shield