
Standard Method of Test for

Installing, Monitoring, and Processing Data of the Traveling Type Slope Inclinometer

AASHTO Designation: T 254-80 (2004)



1. SCOPE

- 1.1. This method provides instructions for installation, monitoring, and data reduction for the *traveling type* slope inclinometer for use with guide casing. A slope inclinometer is a precision instrument that measures lateral displacement of a guide casing resulting from the movement of earth, concrete, or other masses. This type of instrument can be used to detect and monitor movements in earth- and rock-fill dams, highway embankments and foundations, excavation slopes, sheet pile bulkheads, concrete retaining walls, and other structures. Since the instrument is waterproof, it can be used on projects where normal measurements would not be feasible, such as the displacement of the lower portion of a pipe pile. The data, which are well suited for computer reduction, can be used to interpret shear zones in landslide areas and as a basis for predicting impending shear failures or structural failures based on the amount and rate of lateral deformation occurring.
- 1.2. The method is divided into the following parts:
 - 1.2.1. Part I, Method of Installing Slope Inclinometer Guide Casing;
 - 1.2.2. Part II, Method of Monitoring Slope Inclinometer Guide Casing; and
 - 1.2.3. Part III, Method of Data Computations and Analysis.
- 1.3. The values stated in SI units are to be regarded as the standard.

PART I—METHOD OF INSTALLING SLOPE INCLINOMETER GUIDE CASING

2. APPARATUS

- 2.1. *Drilling Equipment:*
 - 2.1.1. Drill rig capable of drilling a hole with diameter large enough to accommodate the particular size slope inclinometer casing used and allow for adequate backfilling. The depth of the hole needed varies with the particular installation, locale, and/or at the discretion of the engineer. Normally, a drill rig capable of drilling a 203-mm (8-in.) diameter hole approximately 61 m (200 ft) deep may be used. A smaller drill rig may be used for shallow depth installations.

2.2. *Guide Casing:*

- 2.2.1. Guide casing, usually round extruded plastic or aluminum, with four equispaced longitudinal grooves on the inside of the casing compatible with the particular torpedo sensor used. However, some casing may not be grooved because the torpedo sensor maintains proper orientation by use of locking metal orientation rods. Some inclinometers may be used in square steel casing with the torpedo sensor guide wheels tracking in opposite corners of the casing. The casing comes in assorted diameters and may come in any convenient length, such as 1.52- or 3.05-m (5- or 10-ft) sections.

2.3. *Couplings:*

- 2.3.1. The couplings may be extruded aluminum with four equispaced grooves or round plastic and usually come in 152-mm (6-in.) lengths. In cases where settlement is expected, longer couplings may be used to join the sections of casing. The resulting gap between casing sections allows the casing to telescope together as compression of the surrounding materials occurs.

2.4. *Installation Tools:*

- 2.4.1. Inclinometer guide casing installation tools specified by the manufacturer, normally consisting of a pop-rivet gun, pop rivets, casing clamps, hacksaw, hand or electric drill, drill bits, tape measure, and a device for marking casing grooves such as a felt tip marker or file. A special wheel groove alignment tool, duct or masking tape, and solvent cement may be needed for plastic casing. A vibrator may be used for backfill compaction if necessary.

2.5. *Plugs:*

- 2.5.1. Plugs compatible with the particular guide casing used for protecting the top and bottom of the casing from mud and debris. A conical plug may be used to ease insertion of the casing into a rough-sided hole.

2.6. *Protective Device (Optional):*

- 2.6.1. Hole cover or other protective device to minimize vandalism and large enough to allow the cable clamp-guide wheel assembly to be installed on the top of the casing. A metal pipe with either a threaded cap or hinged lid, with hasp and lock may be used.

3. **DRILLING AND HOLE PREPARATION**

- 3.1. The size of the drill hole should be large enough to accommodate the particular size casing used and depends on the particular installation, locale, materials encountered, the depth of the hole, available backfill materials or at the discretion of the engineer. Larger holes facilitate backfilling. Minimum diameter may be only sufficient to accommodate the casing used. This is applicable in cases where the material may close rather quickly. Normally, the drill hole may be approximately two times the outside diameter of the casing or a minimum of 127 to 152 mm (5 to 6 in.). The hole should be as vertical as possible and drilled several meters into stable material below or beyond the anticipated zone of movement. Usually, the borehole should extend at least 1.22 to 1.52 m (4 to 5 ft) into stable material.

- 3.2. The hole usually should be cleaned by flushing with water or blowing compressed air before attempting to install the inclinometer casing. Depending on the installation, sometimes it is necessary to leave drilling mud (if it is used) in the borehole to control caving and thereby allowing proper backfill.
- 3.3. Any means of accomplishing a boring is satisfactory as long as it is suitable to the engineer and conditions at the site. If the ground is firm and the hole will remain open without steel casing, then either a dry hole (drilled with a continuous flight auger) or a water-filled hole (drilled with a chopping bit or a rotary bit and using water to flush out the cuttings) is satisfactory.
- 3.3.1. Hollow stem augers may be used with success because the augers can be pulled after installation of the slope inclinometer casing. If the hole is likely to squeeze in because of soft soils or cave because of sand, drilling mud may be used and left in the hole upon completion of the boring.
- 3.3.2. If drilling mud is used, some difficulty may be encountered in making the inclinometer casing go down completely in the hole, but this may be remedied by filling the casing with water or other physical means.
- 3.4. Steel or any other type of casing may be used if justified to prevent the hole from caving. Usually, steel flush joint drill casing may be used. The steel casing should be a diameter large enough to allow backfill material to be placed in the annular space between the steel casing and outside of the slope inclinometer casing. The backfill material then can be shoveled or poured in small amounts while at the same time pulling the steel casing in small increments. Care should be taken so that the backfill material does not lock the steel casing to the slope inclinometer casing. In extremely difficult cases, steel casing may be left in place upon completion of the boring. However, steel casing tends to thicken any zones of movement. Care should be taken to maintain proper orientation of the slope inclinometer casing while backfilling.

4. INCLINOMETER CASING INSTALLATION

- 4.1. Any type of soil inclinometer casing may be used as long as it meets the slope inclinometer manufacturer's requirements and is compatible with the particular sensor torpedo used. Usually, aluminum or plastic casing is used in most installations; however, steel or other types of casing may be used under certain conditions.
- The following is a brief explanation of the installation techniques for typical aluminum and plastic casing; reference should be made to the manufacturer's instruction manual for a more detailed explanation. Refer to Figure 1.
- 4.2. *Aluminum Casing:*
- 4.2.1. Attach a plug to the bottom section of casing by normally drilling and using pop rivets. Enough pop rivets should be used to secure the plug to the casing, usually two to four rivets.
- 4.2.2. Attach an aluminum coupling onto the outer end of the casing with pop rivets. If four rivets are used they should be placed approximately 90 degrees apart. Extreme care should be used not to place a rivet in the instrument tracking grooves, or wheel paths.
- 4.2.3. Lower the first section of casing into the boring, with the plug on the lower end and the coupling attached to the top. A casing clamp should be attached approximately 0.3 to 0.6 m (1 to 2 ft) from the top of the casing.

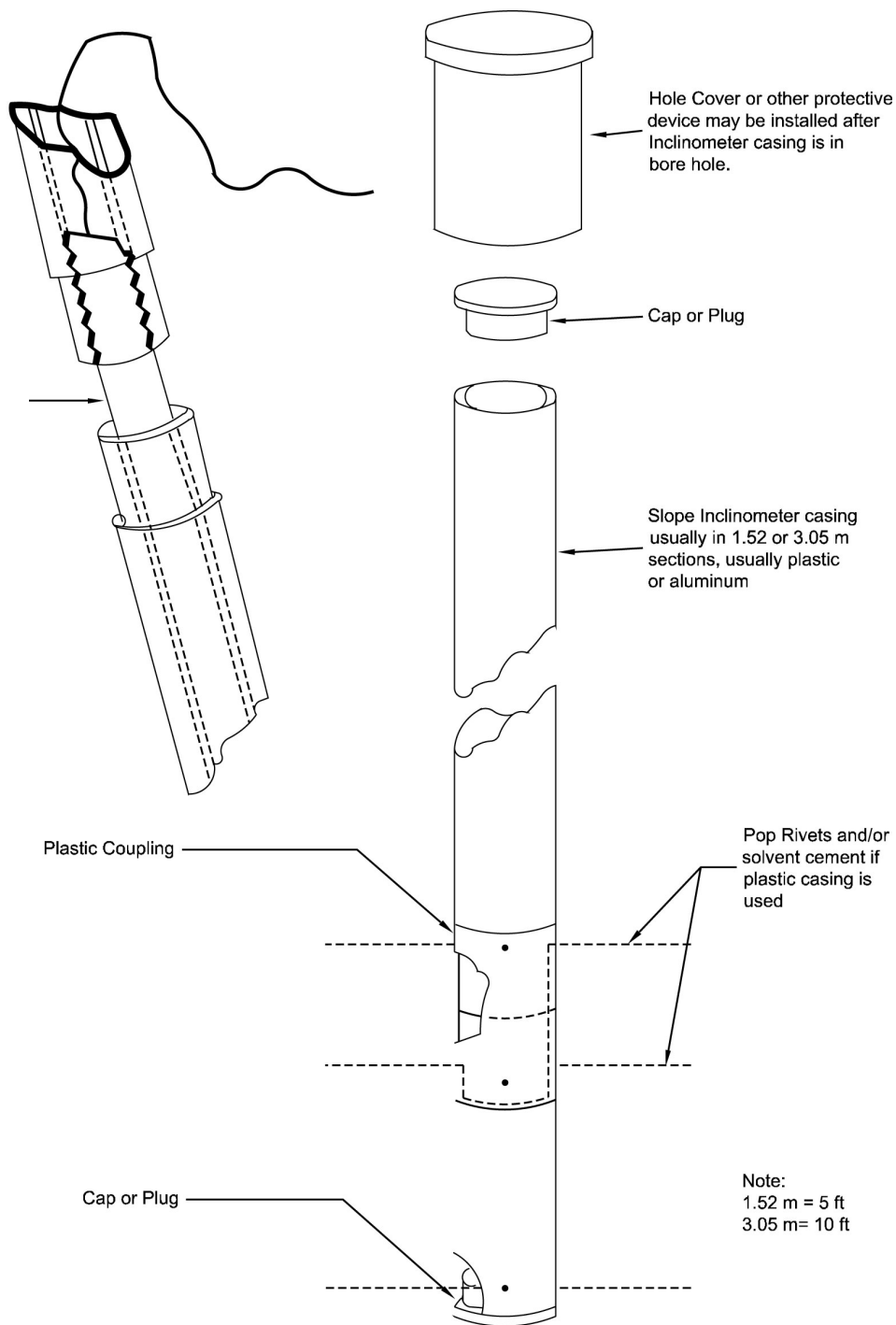


Figure 1—Typical Assembly of Slope Inclinator Casing