



Standard Test Method for Monitoring Ground Movement Using Probe-Type Inclinometers¹

This standard is issued under the fixed designation D 6230; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the use of inclinometers to monitor the internal movement of ground. The test method covers types of instruments, installation procedures, operating procedures and maintenance requirements. It also provides formulae for data reduction.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids²
- D 4622 Test Method for Rock Mass Monitoring Using Inclinometers³

3. Significance and Use

3.1 An inclinometer is a device for measuring deformation normal to the axis of a pipe by passing a probe along the pipe and measuring the inclination of the probe with respect to the line of gravity. Measurements are converted to distances using trigonometric functions. Distances are summed to find the position of the pipe. Successive measurements give differences in position of the pipe and indicate deformation normal to the axis of the pipe. In most cases the pipe is installed in a near-vertical hole. Measurements indicate subsurface horizontal deformation. In some cases the pipe is installed horizontally and the measurements indicate vertical deformation.

3.2 Inclinometers are also called slope inclinometers or slope indicators. Typical applications include measuring the rate of landslide movement and locating the zone of shearing, monitoring the magnitude and rate of horizontal movements

for embankments and excavations, monitoring the settlement and lateral spread beneath tanks and embankments, and monitoring the deflection of bulkheads, piles or structural walls.

4. Apparatus

4.1 The probe type inclinometer uses sensors inside a probe to indicate the orientation of the probe relative to the pull of gravity. The complete system consists of:

4.1.1 A permanently installed pipe, called casing, with test method grooves. The casing is made of plastic, aluminum alloy, or fiberglass.

4.1.2 *The Probe*—Most probes use force balance accelerometers which give a voltage output that is proportional to inclination of the probe. Biaxial probes contain two sensors oriented 90 ° apart to permit readings in orthogonal directions at the same time.

4.1.3 A portable readout unit with power supply for the sensors and display to indicate probe inclination. The readout unit may have internal memory to record data.

4.1.4 An electrical cable connecting the probe and readout unit with distance markings. Fig. 1 shows a typical set of components.

5. Procedure

5.1 Installation of Casing in a Borehole:

5.1.1 Select casing materials that are compatible with the environmental conditions at the installation. Select casing size consistent with the specific measurement requirements and conditions for the job. Store casing materials in a safe, secure place to prevent damage. Sunlight may damage plastic casing. High and low pH may damage metal casing. Note that a special probe may be required for non-vertical boreholes.

5.1.2 Assemble all components required for the casing, including casing, joints, connectors, and end cap. Examine each component for defects. Do not use defective components since they may later cause problems with readings that are difficult to diagnose and impossible to correct. Keep all components clean and free of foreign matter during assembly. Follow the manufacturer's instructions for assembly of the casing. If required, use sealing mastic and tape to seal all couplings to prevent later flow of soil particles into the casing. This is especially important when using grout to seal the casing in the hole. Exercise care to keep the casing grooves free of obstructions. When assembling couplings, use procedures to

¹ This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.23 on Field Instrumentation.

Current edition approved Feb. 10, 1998. Published January 1999.

² Annual Book of ASTM Standards, Vol 04.08.

³ Annual Book of ASTM Standards, Vol 04.09