GEOKON warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by GEOKON, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY IS VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of GEOKON’s control. Components that wear or are damaged by misuse are not warranted. This includes fuses and batteries.

GEOKON manufactures scientific instruments whose misuse is potentially dangerous. The instruments are intended to be installed and used only by qualified personnel. There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. GEOKON is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential which the purchaser may experience as a result of the installation or use of the product. The buyer’s sole remedy for any breach of this agreement by GEOKON or any breach of any warranty by GEOKON shall not exceed the purchase price paid by the purchaser to GEOKON for the unit or units, or equipment directly affected by such breach. Under no circumstances will GEOKON reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

Every precaution for accuracy has been taken in the preparation of manuals and/or software, however, GEOKON neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages or losses that result from the use of the products in accordance with the information contained in the manual or software.
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1. INTRODUCTION

The Model 6600 Inclinometer Casing is intended for use with all commercially available inclinometer probes to monitor the stability of embankments, slopes, rock cuts, foundation and excavation walls, piles, etc. The casing sections are designed to be assembled quickly and easily, using self-aligning couplings which incorporate a Quick-Lock connection. It is suitable for installation in boreholes and piles, set into concrete, or attached to structures.

FIGURE 1: Model 6600-1-10 Quick-Lock ABS Inclinometer Casing

The casing and couplings have grooves spaced at ninety-degree intervals, which fit the wheels of the inclinometer probe thus maintaining the orientation of the probe as it is traversed up and down the casing. The probe accurately measures the change in the angle of tilt, from the vertical, at spacings along the casing. These incremental changes are added together to give a profile of the casing. Changes in the profile become a measure of the stability of the body or structure in which it is installed. The casing can also be used with in-place inclinometers, which are particularly well suited for real-time automatic monitoring.

FIGURE 2: Ninety Degree Spaced Grooves

FIGURE 3: Quick-Lock Connection System
1.1 CASING STORAGE
Inspect casing lengths to insure that none were damaged in transit. Ensure that the casing is not warped, and that the inside of the casing is clean. Keep the joint and casing interior clean by removing the protective end caps only when you install the casing.

Store casing horizontally and supported evenly so it does not warp or bend. Prolonged exposure to direct sunlight can deform the casing, so store it in shade whenever possible.

Note: Do not assemble the casing prior to insertion in the borehole.

1.2 BOREHOLE DRILLING
Drill the borehole as vertical as possible, preferably within one degree of vertical. Flush the borehole clear of debris, and verify that the borehole is fully open to the bottom. Check the depth of the borehole before installing the casing. Also, consider that using a casing anchor or external weights will require a deeper borehole.
2. INSTALLATION

2.1 GROOVE ALIGNMENT
It is important to have one set of grooves oriented down slope, in the direction of expected movement. If the direction cannot be determined, orient North/South. **Alignment must be maintained throughout the installation, to avoid introducing torsion to the casing, thereby causing spiraling of the grooves.** Never push the casing from the top or twist the casing during installation.

![Groove Alignment](image)

**FIGURE 4: Groove Alignment**

2.2 OVERVIEW
Insert the casing into the borehole one tube section at a time, using clamps to keep the sections positioned at the top of the borehole while you connect the sections. Use the provided Model 6600-2 Quick-Lock coupling wires to join the casing tube sections together. In dry boreholes, or in situations where down-hole problems seem likely, rig a safety line to provide extra security and a way to retrieve the casing if necessary.

2.3 INITIAL CASING SECTION
1. Number each casing section to confirm correct depth placement and to assist with placement of any external instruments (such as vibrating wire piezometers).

2. There are two options for sealing the bottom of the casing:
   - Model 6600-1B Bottom Cap
   - Model 6600-2A Casing Anchor Kit (sold separately)

   If you plan on using the Model 6600-1B Bottom Cap, either:
   - Apply ABS cement to the inside of the cap and install it onto the tube, or
   - Use self-tapping screws following the procedure outlined in Appendix B, steps 6 and 7.

   **Note:** ABS cement must be supplied locally.

   If you plan on using the Model 6600-2A Casing Anchor, refer to the instructions in Appendix B.
3. Attach a clamp to the tube near the coupling.
4. Lower the tube into the borehole, capped/anchored-end first, until the clamp rests on the borehole collar.

### 2.4 NEXT CASING SECTION

To maintain orientation of the casing sections, install the sections with one groove aligned toward anticipated direction of maximum movement (downslope or toward excavation).

1. Insert another casing tube section into the tube coupling.
2. Rotate the tube inside the coupling while pushing downward. The notch at the end of the tube should slide onto the tab inside the coupling as shown:

   ![Figure 6: Connecting the Casing Sections](image)

   **FIGURE 6: Connecting the Casing Sections**

3. Insert a Quick-Lock coupling wire into the hole in the tube coupling. Keep threading the wire into the hole until you meet significant resistance.

   **Note:** Keep the wire clean and wire hole free of debris to avoid clogging.

   ![Figure 5: Coupling Tab](image)

   **FIGURE 5: Coupling Tab**

4. If desired, pull upward gently on the coupling to verify it is secure.

   **Note:** For additional protection, wrap caulking tape around the top of the coupler to seal the joint. Then wrap electrical tape around the caulking tape and then around the end of the wire to secure it to the coupler.
5. Attach another clamp to the tube near the free end, or as high as you can reach.

6. Remove the first clamp and lower the assembled section into the borehole, until the second clamp rests on the borehole collar.

7. If necessary, repeat steps 5-6 as needed until the free end of the tube is at an accessible height.

2.5 SUBSEQUENT CASING SECTIONS
Repeat the steps in the Section 2.4 for the rest of the casing sections until you reach the desired depth.

If possible, verify the alignment of the grooves by running a dummy probe to the bottom of the hole. If the probe will not pass, jumps track, or returns in another set of grooves, pull the casing and check each tube section for proper alignment.

2.6 CASING BUOYANCY
If the borehole is filled with water or drilling mud, filling the casing with clean water can neutralize the casing’s buoyancy, making it easier to submerge.

Additional weight may be necessary for boreholes with drilling mud, as the weight of the casing and the water may not be enough to overcome the buoyancy. Steel water pipe or clean chain can be carefully added into the casing (in such a way as to be retrievable) to provide additional down force.

Note: Be careful not to damage the bottom cap or sealed joint when lowering objects into the casing.

Caution: The differential pressure introduced by the head of water may cause the casing to fail if it exceeds the 15 bar (217 psi) burst capacity of the casing.

BUOYANCY DURING GROUTING
Casing also becomes buoyant during the process of grouting the borehole.

Use one of the following methods to prevent the casing from floating out of the borehole during grouting:

- Insert steel water pipe or clean chain inside the casing. Be careful not to damage the bottom cap or sealed joint when lowering solid objects down inside the casing.

- Grout the casing in stages:
  - Secure the bottom of the casing with an initial batch of grout, letting it set up overnight.
  - Grout the next section of casing, up to ground surface (if remainder of casing section can accommodate the pressure of the fluid grout).

- The Model 6600-2A Casing Anchor can resolve buoyancy issues, but it renders the installation permanent once deployed.

CAUTION: Applying a down force to the top of the casing will likely distort the casing profile. Never use the drill rig as a reaction force, or wedge into the collar of the borehole. Doing so can cause the casing to shift or “snake” within the borehole, which can affect the accuracy and precision of the inclinometer system.
2.7 GROUTING
Properly mixed grout must be thin enough to pump, but thick enough to set in a reasonable amount of time, and should be designed for the application. Very stiff grouts should not be used in a very soft soil formation, and similarly, a very soft grout mix should not be used for stiff soils or shoring wall systems.

Ensure that the grout is free of lumps. If the mixture is too watery, it will shrink excessively, leaving the upper portion of the borehole un-grouted. Avoid the use of grouts that cure at high temperature since these may damage the casing.

Use a tremie system to deliver the grout as directed by the engineer. Grouting, via a high shear filtered grouting machine is recommended to avoid problems with lumps obstructing the tremie tube.

The surface level of the water in the casing can indicate casing collapse or grout ingress. Grout ingress into the casing is likely to cause the water level to rise.

**Note:** Ensure that differential pressures are kept to a minimum, as the casing will collapse at 217 PSI differential.

Deeper boreholes will likely require a staged grouting procedure, with appropriate stages dependent on borehole water level, grout density, grout pump type, etc.

**Note:** Proper grouting of inclinometer casing is crucial to a successful inclinometer installation. The installer should have experience with grouting, and be able to work with the drill crew to determine the proper grout mixture. Grout consistency is very important to ensure proper curing, and to avoid separation of the solids and water. Grout with the proper viscosity is easier to pump.

**Note:** Site conditions can vary, making each inclinometer installation unique. Good judgment, by on-site personnel, and previous experience are the keys to success. GEOKON can provide suggestions on grout mixes based on the soil or rock type where the inclinometer application is to be installed.

2.8 INSTALLING THE MODEL 6501-6-4 PROTECTIVE HOUSING
The Model 6501-6-4 Protective Housing is grouted in place around the inclinometer casing where it protrudes from the ground. It consists of a 0.91 m (3’) × 100 mm (4”) diameter galvanized steel pipe with lockable cap which threads onto the top of the steel pipe to protect the casing from vandalism.

![FIGURE 8: Model 6501-6-4 Protective Housing with Lockable Cap](image)

2.9 CASING EXTENSION
When using the Model 6501-6-4 Protective Housing it will be necessary to extend the top of the casing above the top of the cap such that the pulley assembly can be attached.
APPENDIX A. SPECIFICATIONS

<table>
<thead>
<tr>
<th>Casing ID</th>
<th>58 mm (2.28&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casing OD</td>
<td>70 mm (2.75&quot;)</td>
</tr>
<tr>
<td>Casing Length</td>
<td>3 m (10')</td>
</tr>
<tr>
<td>Coupling OD</td>
<td>75 mm (2.95&quot;)</td>
</tr>
<tr>
<td>Bottom Plug OD</td>
<td>72 mm (2.83&quot;)</td>
</tr>
<tr>
<td>Material</td>
<td>ABS plastic</td>
</tr>
<tr>
<td>Collapsing Pressure</td>
<td>15 bar (217 psi)</td>
</tr>
<tr>
<td>Groove Spiral</td>
<td>&lt;0.2 degrees/m (0.06 degrees/ft)</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>−20 to 80 °C (−4 to 176 °F)</td>
</tr>
<tr>
<td>Weight</td>
<td>1.06 kg/m (0.71 lbs/ft)</td>
</tr>
</tbody>
</table>

**TABLE 1: Casing Specifications**

<table>
<thead>
<tr>
<th>Telescopic Section OD</th>
<th>85 mm (3.35&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed Length</td>
<td>3 m (10')</td>
</tr>
<tr>
<td>Extended Length</td>
<td>3.2 m (10.5')</td>
</tr>
<tr>
<td>Range</td>
<td>152 mm (6&quot;)</td>
</tr>
<tr>
<td>Weight</td>
<td>4.35 kg (9.6 lbs)</td>
</tr>
</tbody>
</table>

**TABLE 2: Telescopic Casing Specifications**
APPENDIX B.  MODEL 6600-2A CASING ANCHOR

B.1 CASING ANCHOR COMPONENTS
GEOKON provides the following parts:

- Casing anchor
- O-ring
- Four self-tapping screws
- Caulking tape
- Electrical Tape

In addition, you will need the following parts:

- ABS cement (locally-sourced)
- Release cord of desired length, rated for 250 kg (500 lb).
  Alternatively, GEOKON can provide part number 07-062G, galvanized aircraft cable 1.59 mm (1/16”) diameter for this purpose.

B.2 CASING ANCHOR INSTALLATION
1. Use one hand to press the two anchor legs closed against the shaft of the anchor.
2. Slip the O-ring over the top of one leg. Be careful to avoid the sharp edge.
3. Stretch the O-ring around the pipe and loop it over the top of the other leg.
4. Apply ABS cement to the top of the anchor.
5. Insert the anchor into the open end of the tube.
6. Use the self-tapping screws to secure the tube to the anchor.

**FIGURE 14: Install the Self-Tapping Screws**

7. To prevent the entry of grout, use caulking tape and electrical tape to completely cover the screw heads and the seam where the bottom of the casing joins the top of the anchor.

**FIGURE 15: Installed Anchor with Tape for Grout Protection**
8. Fasten the release cord onto O-ring, as indicated in the figure below.

![Release Cord](image)

**FIGURE 16: Release Cord, made using GEOKON part number 07-062G**

9. Lower the casing into the borehole. Feed the release cord with the casing as you lower it.

For detailed instructions on installing the casing into the borehole, see Section 2.

**B.3 DEPLOYING THE ANCHOR**

Do the following when the casing reaches the desired depth:

1. Pull the release cord to dislodge the O-ring from the anchor legs, which then expand into the surrounding earth, holding the anchor in place.

2. Remove the entire length of release cord from the borehole.

3. Backfill the borehole with grout as necessary.
APPENDIX C. TELESCOPING CASING SECTIONS

The Model 6600-1TS is a telescoping tube section for applications that are expected to experience settlement or heave of the ground.

The telescoping section can accommodate up to 152 mm (6 inches) of movement. The most common application is for conditions where settlement is expected. For this application, the telescoping section should be installed in the fully extended position.

![Diagram of telescoping section](image)

**FIGURE 17: Model 6600-1TS Telescoping Tube Section**

**INSTALLATION METHODOLOGY**

Where settlement is expected, the telescoping casing sections are extended after the bottom of the casing has been secured using a casing anchor, grout, or by adding sufficient weight in the interior of the casing.

Once secure, extend the telescoping casing section(s). Make note of the original height of the top of casing, and then, based on the number of telescoping section, calculate the height of the casing after pulling it up.

For installations where heave is expected, or where the bottom of the casing may sink (e.g., tunnel passages), then the telescoping sections should remain compressed during installation. A wrap of duct tape, applied to the joint of the telescoping section, will help keep it compressed during installation.
APPENDIX D. CASING REPAIR

If an inclinometer casing becomes damaged, it can be repaired. The following items are required:

- Model 6600-1C Replacing Coupler
- Model 6600-2 Quick-Lock Coupling Wire
- Model 6600-2RT Reconnect Alignment Tool
- Model 6600-1-10 Section of Inclinometer Casing
- Model SUP-806 Duct Tape
- ABS cement (supplied locally)

Typically, the damaged section of a casing is in the upper few feet of the installation, where the casing is most vulnerable.

The procedure to replace a damaged section of casing is as follows:

1. Determine the length of replacement casing needed for the process.
   **Note:** Be sure to include the length of the replacing coupler when making your determination.

2. Cut the existing casing below the damaged section according to the measurements completed in Step 1. Make the cut as perpendicular as possible to the axis of the casing.

3. Cut the replacement casing to the appropriate length.

4. Debur the edges of both cut casing sections and clear any debris from the portion that will be coupled.

5. Apply ABS cement to the outside of the top of the existing casing.

6. Slip the replacing coupler onto the bottom of the alignment tool, to the point where the tab inside the coupler slides into the notch in the tool.

7. Grasp the tool by the handle and slide the coupler onto the top of the existing casing.

8. Twist the tool until the silver spring plungers on the tool slip into the grooves on the inside of the existing casing.

9. Press the tool downward until you meet solid resistance.

10. Press down on the coupler to keep it in place while you pull upward to separate the tool from the coupler.

11. Allow the cement to cure.
APPENDIX E. PARTS LIST

The following table lists components of the Model 6600 Inclinometer Casing.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6600-1-10</td>
<td>Quick-Lock ABS inclinometer casing, 70 mm (2.75’), 3 m (10’) length</td>
</tr>
<tr>
<td>6600-1B</td>
<td>Bottom Cap for Quick-Lock inclinometer casing. <strong>Note:</strong> Requires ABS cement, local supply</td>
</tr>
<tr>
<td>6600-1C</td>
<td>Replacing Coupler for Quick-Lock inclinometer casing. <strong>Note:</strong> Requires ABS cement, local supply</td>
</tr>
<tr>
<td>6600-1T</td>
<td>Top Cap for Quick-Lock inclinometer casing</td>
</tr>
<tr>
<td>6600-1TS</td>
<td>Telescoping Section for Quick-Lock inclinometer casing, 3 m (10’) length x 152 mm (6”) range</td>
</tr>
<tr>
<td>6600-2</td>
<td>Quick-Lock coupling wire, 400 mm (16”) length. One required per coupling.</td>
</tr>
<tr>
<td>6600-2A</td>
<td>Casing Anchor Kit</td>
</tr>
<tr>
<td>6600-2RT</td>
<td>Reconnect Alignment Tool</td>
</tr>
<tr>
<td>6501-5</td>
<td>Inclinometer casing coupling waterproof tapes (enough for 24 couplings)</td>
</tr>
<tr>
<td>ADH-116</td>
<td>Putty Tape</td>
</tr>
<tr>
<td>SUP-802</td>
<td>Electrical Tape</td>
</tr>
<tr>
<td>SUP-806</td>
<td>Duct Tape</td>
</tr>
<tr>
<td>6501-6-4</td>
<td>Inclinometer casing protective housing, 0.91 m (3’) x 100 mm (4”) galvanized steel pipe with lockable cap. For use with 70 mm (2.75”) casing.</td>
</tr>
<tr>
<td>6000-20</td>
<td>Pulley for 0.25” cables</td>
</tr>
<tr>
<td>6000-20A</td>
<td>Pulley for 0.3125” cables</td>
</tr>
<tr>
<td>07-062G</td>
<td>Galvanized aircraft cable, 1.59 mm (1/16”)</td>
</tr>
</tbody>
</table>

**Note:** ABS cement must be supplied locally.

*TABLE 3: Model 6600 Available Accessories*

*FIGURE 20: Model 6600 Accessories*