Snap Seal Inclinometer Casing Installation Instructions

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REVISION HISTORY

Rev.	Revision History	Date	Prepared By	Approved By
E	Compiled manual – initial release			

1 Intended Audience

This guide is for the personnel responsible for installing or using Snap Seal Inclinometer Casing. This manual provides steps for installing the Snap Seal Inclinometer Casing.

2 Icons and Conventions Used In This Guide

This guide uses the following icons to call attention to important information.

	**WARNING:** This icon appears when an operating procedure or practice, if not correctly followed, could result in personal injury or loss of life.
	**CAUTION**: This icon appears when an operating procedure or practice, if not strictly observed, could result in damage to or destruction of equipment.
	**NOTE**: This icon appears to highlight specific non-safety related information.

3 Safety

	**WARNING:** Always follow safety precautions and use proper personal protective equipment (PPE) including safety glasses and high-visibility clothing when working in the field with this equipment.

4 Abbreviations and Acronyms

This section lists abbreviations and acronyms used in the document.

Abbreviation or acronym	Definition
MEMS	Micro-Electro-Mechanical Systems
ABS	Acrylonitrile Butadiene Styrene
OD	Outer Diameter
ID	Inner Diameter
PSI	Pounds per Square Inch
AWJ	Aqua Water Jet

5 OVERVIEW

RST's Snap Seal Inclinometer Casing is engineered to be assembled quickly and accurately for long and short-term monitoring in the most challenging field conditions. It is suited to be installed in boreholes, embankments, piles, set into concrete or attached to structures.

The casing serves as an access tube to guide a MEMS-based inclinometer probe in the two orthogonal directions of measurement. Changes in the output of the probe caused by the deformation of the casing are proportional to the sine of the angle of inclination of the long sensor axis from vertical. These displacements are incrementally summed to provide profiles of total displacement versus depth.

The inclinometer probe uses grooves in the casing to control the azimuth of the inclinometer probe.

Snap Seal is the original O-ring sealed coupling system, which is equipped with a machined male and female end does not require glue, pop rivets, screws, or shear wires. This patented, innovative system allows casing sections to lock together while maintaining precise groove alignment and high collapse strength. The Snap Seal system is flush coupled for ease of installation in hollow stem augers and casing advancers.

The fingers on the female end of the casing lock on to the ring on the male end to provide a strength of over 1200 lbs. in tension. The O ring in the female end of the casing provides a positive seal for the joint.

RST casing is manufactured using non-recycled, virgin ABS resin, which imparts increased flexibility stability, and low temperature impact resistance.

NOTE: RST's Snap Seal Inclinometer Casing is recommended for installation depths of 50 meters or less. For greater installation depths, RST's Glue and Snap Inclinometer Casing is recommended.

5.1 APPLICATIONS

Most common applications for RST's Snap Seal Inclinometer Casing are:

- Pilings
- Subsidence control
- Embankment and dam stability
- Areas next to large excavations
- Landslides and slope stability
- Under large storage tanks
- Bridge pier, abutments deflection

5.2 FEATURES

- High precision, machined guide grooves
- Low spiral ≤ 0.005 Rad/3 m (≤ 0.3 deg./10 ft.)
- Easy assembly minimizes field installation time
- Compatible with all commercial probe types and in-place inclinometer sensors
- Integral coupling reduces assembly induced spiral by 50% over conventional separate coupling methods
- Compatible with inductance, reed switch, magnetic, or mechanical settlement monitoring devices
- Low temperature, impact, and corrosion resistant ABS plastic
- External key provides visual and tactile confirmation of proper installation

6 INSTALLATION

NOTE: These instructions are for typical field settings and may require modification to meet site-specific applications.

Please consult the site engineer(s) or RST Instruments for further details.

NOTE: The inclinometer casing must be installed, maintained, and operated by technically qualified personnel.

Any errors or omissions in the installation, data, or data interpretation, are not the responsibility of RST Instruments.

6.1 INSTALLATION PRE-REQUISITES

- Inspect casing lengths to ensure that there was no damage in transit.
- Ensure that the inside of the casing is clean.
- To ensure the joint and casing interior remains clean, only remove the protective bottom caps before installing the casing.
- Store the casing horizontally, fully supported, and away from sunlight.
- Number each length, and assemble numerically to avoid errors, and confirm correct depth.
- Drill the borehole as vertically as possible, preferably within one degree.
- Flush the borehole clean and confirm that the borehole is fully open to the bottom.

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

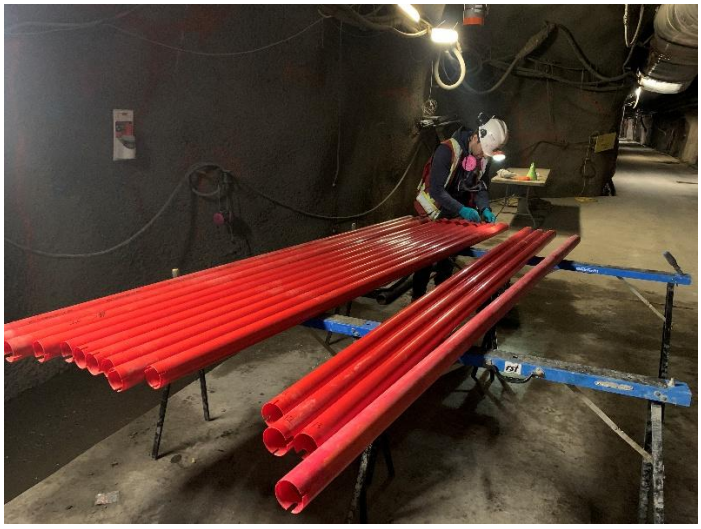


Figure 1: Visual Inspecting and Numbering of Casing Lengths According to Depth

6.2 REQUIRED TOOLS AND COMPONENTS

Before installing inclinometer casing, ensure the following parts and tools are present:

- Duct tape
- Bottom cap and top cap
- ABS 771 cement (or equivalent) and associated ABS/PVC cleaner - for use with repair couplings when required
- Pipe cutter/hand saw
- Grout tube (if required)
- Safety line (if required)
- Dummy probe (if required)
- Clean water (if required)

6.2.1 Accessories:

- Casing clamp
- Spare bottom and top caps
- Grout plug, quick-connector
- Female grout adapter
- Grout plug, gasket seal
- Well covers
- Reconnect alignment tool
- Reconnect adapter
- Spare casing lengths

6.3 INSTALLATION NOTES

- Casing should be stored horizontally and supported evenly so that it does not warp or bend. Whenever possible, casing should be stored in the shade since prolonged exposure to the heat of direct sunlight can cause deformation.

- Ensure 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.

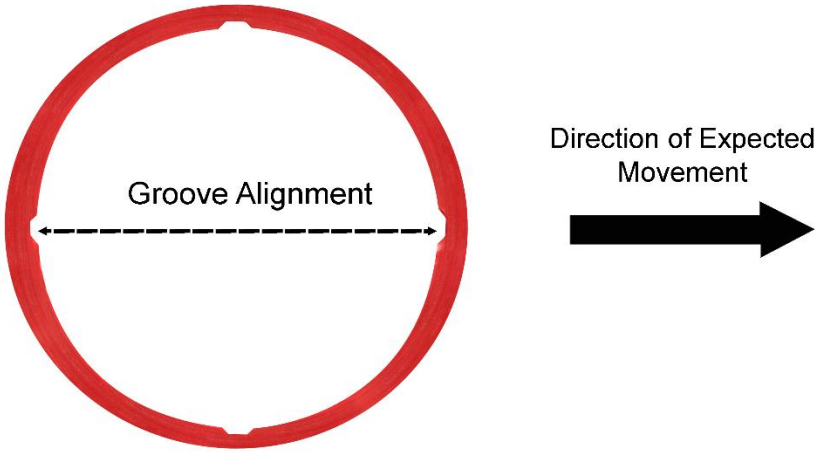


Figure 2: Ensure Proper Groove Alignment is Maintained During Installation

6.4 SNAP SEAL CASING SECTIONS

Each section of casing has a male end with an alignment key and a lock ring, and a female end with a keyway, O-ring, and lock ring (Figure 2). Casing is installed with the female end facing up. O-rings come greased from the factory, and are protected by a cap. In the field, remove the cap and ensure that the O-ring is still greased. Take care to keep the casing ends clean to ensure a proper seal. Please note the female ends of the casing have three slots in them. These are stress relief cuts which facilitate the insertion of the male end of the subsequent casing section.

Figure 3: Snap Seal Inclinometer Casing Overview

6.5 INSTALLATION PROCEDURE

6.5.1 Preparing the Borehole

Drill the borehole as vertical as possible, preferably within 1 degree. Flush the borehole clean and verify that the borehole is fully open to the bottom.

Check the depth of the borehole before the casing is assembled and installed. Also consider that grout valves or external weights may require a deeper borehole.

6.5.2 Casing Installation

Install a Bottom Cap

Before installing the first section of casing in the borehole, a bottom cap must be installed as indicated in the figure below:

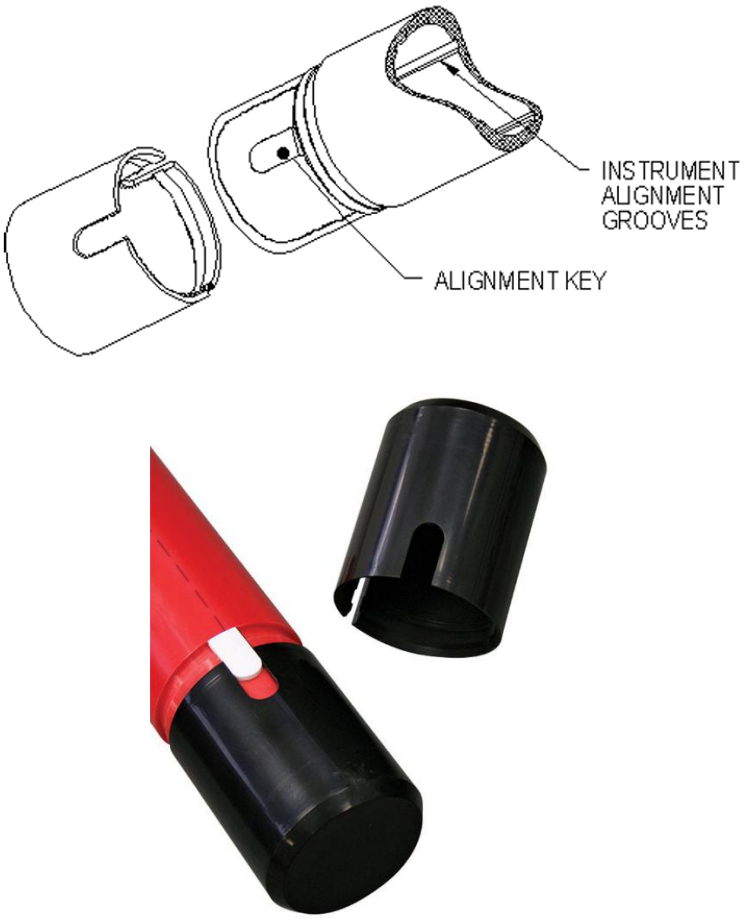


Figure 4: Bottom Cap Joint Attachment

1. Align the notch on the cap with the key-way on the casing. Slide the cap on to fully engage the notch and key. The installer will hear a “snap” as the lock ring is seated.

2. Visually ensure proper assembly.

3. Typically, a grout tube can be attached to the bottom casing. More than one grout tube can be added to the casings during installation for multistage grouting. Attach a grout tube with multiple notches cut in the grout line to ensure if one notch is blocked, the grout can flow through other notches. In some situations, a special grout cap will be required instead of the standard bottom cap. Installation is the same, except for the fact that the grout cap has a provision for a grout tube.

Figure 5: Close-Up of Grout Cap

Figure 6: Attaching a Grout Tube to the Casing

4. The casing, with the attached cap, can then be lowered into the hole. If applicable, attach a safety line (if borehole is dry), otherwise, use the drill rig clamp to hold the casings up until water is reached, but make sure it is set to the correct size so that it does not pinch or crush the casings.

5. Assemble the next casing length.

   In each case, ensure the alignment button on the casing is aligned with the notch in the female end. Use 2-inch wide waterproof duct tape on each joint to ensure the joint is stronger and the joint is sealed. A single wrap of duct tape improves the lateral strength by more than 100% and in tension by 50%.

Assembling Casing Sections

Subsequent casing sections in a borehole should be assembled in the same manner as the bottom cap (described above). Remove the protective caps and check that the O-ring and lock ring are greased. Align the key and the keyway of the two sections. Push the sections together until the joint snaps closed. In each case, the alignment button should be aligned with the notch in the female end.

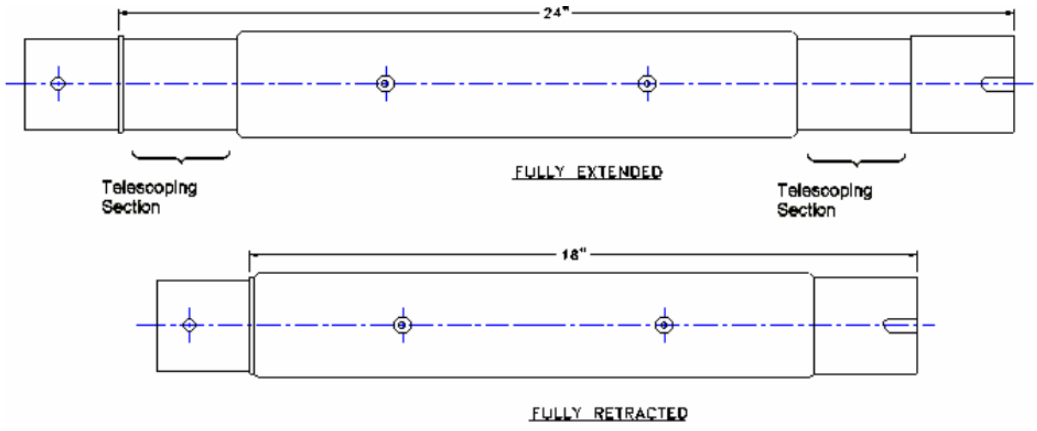
Assembling Telescopic Sections

Each telescoping section is 24” (2ft.) in length and allows for six inches of compression or extension. Settlement sections may be inserted extended or collapsed, to accommodate the expected settlement/rebound.

Typically, sections are shipped in the fully extended condition to accommodate settlement in the borehole. However, sections can be ordered in any configuration, depending on the site-specific requirements. The telescopic section is equipped with Snap Seal ends, thus allowing it to be installed similar to a standard piece of casing. If the telescoping sections are equipped with settlement rings, then lower the Reed Switch Probe into the casing after installation, and record the initial readings for each settlement ring. Contact RST Instruments Ltd for more information on Settlement Monitoring Systems. The moving joint of the section is sealed by two O-rings (one at either end). Each telescoping section contains four set-screws two on each side (Figure 4), which are individually sealed with O-rings. These screws are set in tracks which are blocked by a small web of ABS material.

When sufficient force, >200lbs, is exerted on the casing (very small in a geotechnical setting), the material will break allowing the casing to compress (or extend).

This design allows the telescopic section to bear the weight of the casing above it, and collapse under the force of ground settlement



and/or rebound. To prevent mis-tracking of the inclinometer probe as it passes through the telescoping section, the end of the grooves have a tapered “V-notch”. This notch ensures that the wheels of the probe re-establish themselves in the correct track.

Figure 7: RST Snap Seal Telescoping Section Diagram

6. Install and ballast subsequent lengths of casing or settlement sections as required. Ensure that the alignment key is oriented properly when snapping sections in place.

7. Insert settlement sections appropriately extended or collapsed to accommodate the expected settlement or rebound.

FULLY EXTENDED

FULLY RETRACTED

NOTE: If the borehole is filled with water or mud, neutralize the casing’s buoyancy by ballasting the casing with clean water. If the borehole is dry, use a combination of casing clamps and a safety line to restrain the casing during installation. Using the safety line by itself may cause spiralling due to the spiral lay of the rope.

8. Maintain one groove’s orientation down slope in the direction of the slide, or parallel to the dam axis. If the direction cannot be determined, orient North/South.

NOTE: Ensure that alignment is maintained throughout the installation to avoid introducing torsion to the casing, which can cause to grooves to spiral.

A Spiral Probe can be used to measure the amount of twist that has occurred after the installation is complete. This applies the necessary correction to the data in Inclinalysis™ to achieve a true direction and magnitude of movement. Please refer to the Digital Inclinometer Spiral Sensor product page for the installation manual and further information.

9. When at depth, confirm proper probe tracking with a dummy probe and wire reel (sold separately).

- If the probe does not pass, jumps track, or returns in another set of grooves, remove the casing, and troubleshoot.

One of the following common methods can be used to prevent the casing from floating out of the borehole during grouting:

- Use a bottom anchor (sold separately) to hold the casings in place.

Figure 8: Casing Bottom Anchor

- Insert AWJ drill rods inside the casing to weigh the casings down from the bottom. Ensure the drill rods are removed after installation is completed and the grout has set.

CAUTION: Do not use the drill rig as a reaction force to wedge the collar, as this will cause the casing to assume a large radius bend. RST does not recommend hanging a weight off the bottom cap as ballast during installation.

10. If the borehole is full of water, fill the casing with enough clean water to neutralize the buoyancy. Be careful with this technique, as in dry boreholes, the differential pressure caused by the head of water may cause casing failure. Grouting using a high shear filtered grouting machine is recommended to avoid problems with lumps obstructing the tube.

Figure 9: Filling the Casing with Clean Water to Neutralize Buoyancy

11. Begin to pump grout as directed by the engineer, usually at a rate of 10–15 liters per minute to avoid over-pressuring the casing or causing bridging and cavities.

Properly mixed grout must be thin enough to pump, but thick enough to set in a reasonable amount of time. 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. Also, avoid the use of grouts that cure at high temperature since these may damage the casing.

Figure 10: Pumping Grout though the Grout Pipe to Set the Casing Assembly in Place

12. Observe the water meniscus in the casing as an indication of casing collapse, or grout ingress.

Ensure that differential pressures are kept to a minimum, as the casing will collapse at 220 PSI differential.

NOTE: Deeper boreholes require a multistage grouting procedure with appropriate stages that depend on the borehole's water level, grout density, grout pump type, etc.

NOTE: Proper grouting of inclinometer casing is crucial to a successful inclinometer installation. The onsite engineer is required to have experience and can work with the drill crew on the proper mixture for the grout. Grout consistency is very important to ensure proper curing and to avoid separation of the solids and water. Grout must also have the proper viscosity which will enable it to be pumped easily.

13. Place a top slip cap over the last piece of casing when finished and/or not in use. **Do not cement into place**. The cap is provided as a removable protective cover.

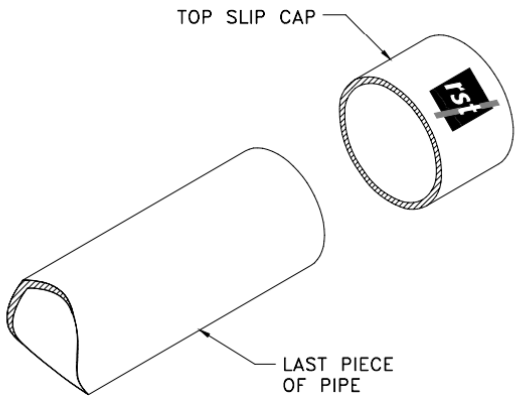


Figure 11: Top Cap Assembly

Figure 12: RST Top Caps

7 REPAIRING DAMAGED CASING

Damaged Snap Seal Casing can be repaired using RST repair couplings. Most of the time, casing becomes damaged near the top of the borehole due to movement of heavy equipment etc. In any case, the damaged portion of the casing needs to be removed.

1. Cut off the damaged portion of the casing using a hacksaw (or pipe cutter). Be sure to make this cut as square as possible. Remove all burrs.

2. Use ABS/PVC cleaner prior to applying ABS 771 cement to the inclinometer casing. The repair coupler will slide over top, and the alignment tool will be used.

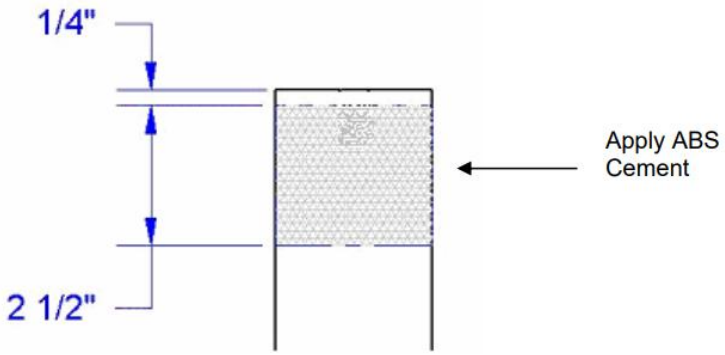


Figure 13: Casing Preparation for Repair

Figure 14: Repaired Casing Example

3. Slide the RST repair coupling onto the casing and align the grooves using the RST Casing Alignment Tool. Allow the cement to cure, according to the directions on the label.

NOTE: The RST Casing Alignment Tool is available in two different options for the two casing sizes:

- Part number “IC1002” for the 2.75” (70 mm) casing size
- Part number “IC1003” for the 3.34” (85 mm) casing size

Figure 15: Casing Alignment Tool

4. Attach subsequent casing sections as described in Section 6.5.2.

8 INSTALLING CORRUGATED SETTLEMENT SHEATH PIPE

Another alternative to using Telescopic Sections is the use of Corrugated Settlement Sheath Pipe. This allows the inclinometer casing to remain in a static position while the ground moves around it. Settlement can thus be observed at the collar of the borehole. For example, if the ground settles, the casing will be observed to extend farther out of the ground than previously.

1. Insert a weight into the bottom of the sheath with the groove side down, leaving room for the installation of the bottom cap.
2. Slide 2 band clamps over the sheath and tighten so that the clamps squeeze the sheath into the grooves locking the weight into place.
3. Install the bottom cap onto bottom of the sheath.
4. Seal with Denso tape and Duct tape.
5. Lower Corrugated Settlement Sheath Pipe into the borehole.

NOTE: Ballasting the pipe with clean water may be necessary to counter the buoyancy encountered with wet bore holes.

6. Install Inclinometer casing inside the Corrugated Settlement Sheath Pipe.
7. Eliminate any slack by pulling on it by hand (hold it in place while performing step 8).
8. Fill the void between the sheath and borehole with grout, ensuring that no grout gets into the sheath or casing.
9. If Corrugated Settlement Sheath is equipped with settlement rings, then lower the sensor into the casing and record the initial readings of each Settlement Ring. Refer to the RST Instruments Manual “Settlement Monitoring System”.

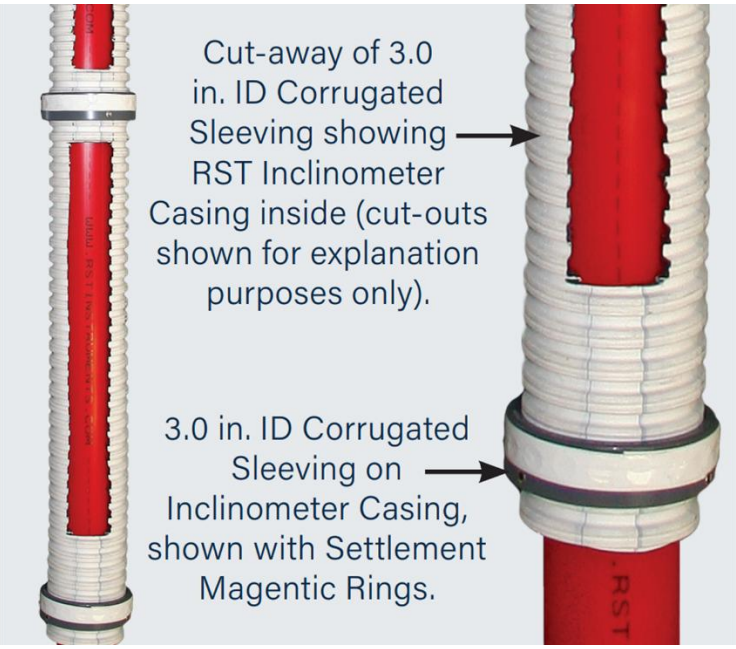


Figure 16: Inclinometer Casing Installed Inside Corrugated Sleeving with Settlement Magnetic Rings

9 PRODUCT AND TECHNICAL SPECIFICATIONS

Item	Specification	
Casing Specifications		
Description	**70 mm (2.75 in.) OD**	**85 mm (3.34 in.) OD**
Casing OD (including flush coupling)	70 mm (2.75 in.)	85 mm (3.34 in.)
Casing ID	59 mm (2.32 in.)	73 mm (2.87 in.)
Casing Length	1.5 or 3 m (5 or 10 ft.)	1.5 or 3 m (5 or 10 ft.)
Casing Weight	1.27 kg/m (0.85 lbs/ft.)	1.49 kg/m (1.0 lbs/ft.)
Material	ABS Plastic	
Groove Spiral	≤ 0.3 deg./10 ft.	

NOTE: For a complete list of specifications and ordering information, navigate to RST's Inclinometer Casing product page.

10 SERVICE, REPAIR, AND CONTACT INFORMATION

This product does not contain any user-serviceable parts. Contact RST for product services or repairs.

- For sales information: sales@rstinstruments.com
- For technical support: support@rstinstruments.com
- Support portal: https://support.rstinstruments.com/support/tickets/new
- Website: www.rstinstruments.com
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