



RST INSTRUMENTS LTD.

Installation Instructions for Snap Seal Inclinometer Casing

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1 Forward

Please note that these instructions are a general guideline for typical field practices, and may require modification to suit site-specific applications. This equipment should 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 Ltd.

2 Advantages of RST Snap Seal Inclinometer Casing

Traditional Inclinometer Casing installation methods dictate that screws or pop rivets must be utilized to hold the coupling in place until the ABS cement cures. The requirements for rivets are increased in deep boreholes.

Snap Seal is the *original O-ring sealed coupling system*, which does not require glue, pop rivets, screws or shear wires. This patented, innovated 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.

3 RST Snap Seal Casing Part Numbers

70 mm (2.75 inch) Casing	Part No.
1.5 m Length	ICSC-205M
3 m Length	ICSC-210M
5 ft. Length	ICSC-205
10 ft. Length	ICSC-210
Top Cap	ICC-2TC
Bottom Cap	ICSC-2BC
Grout Cap	ICSC-2CP
Telescopic Section	ICSC-2TS

85 mm (3.34 inch) Casing	Part No.
1.5 m Length	ICSC-305M
3 m Length	ICSC-310M
5 ft. Length	ICSC-305
10 ft. Length	ICSC-310
Top Cap	ICC-3TC
Bottom Cap	ICSC-3BC
Grout Cap	ICSC-3CP
Telescopic Section	ICSC-3TS

4 Pre-Installation

Before beginning the installation, ensure that all equipment, accessories and spares are available:

- Casing and caps
- Spare bottom and top caps
- Spare casing length(s)
- Grout tremie line
- Grout valved bottom cap (if employing this method); c/w spare female grout valve
- Drill rods to weigh casing
- Safety line (if required)
- Clean water supply to ballast casing
- Repair Coupling and Alignment Tool (if required)
- Hand saw
- Casing collar protection (as required)
- Chain or casing clamps

Inspect casing lengths to insure that damage during transit has not occurred. Ensure that the inside of the casing is clean. To ensure the joint and casing interior will remain clean, only remove the protective end caps prior to installing the casing. Store the casing horizontally, fully supported, and out of the sunlight. Number each length, and assemble numerically to avoid errors, and to confirm correct depth.

Do not assemble the casing prior to insertion in 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.

5 Assembly of Snap Seal Casing

5.1 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 1). 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.

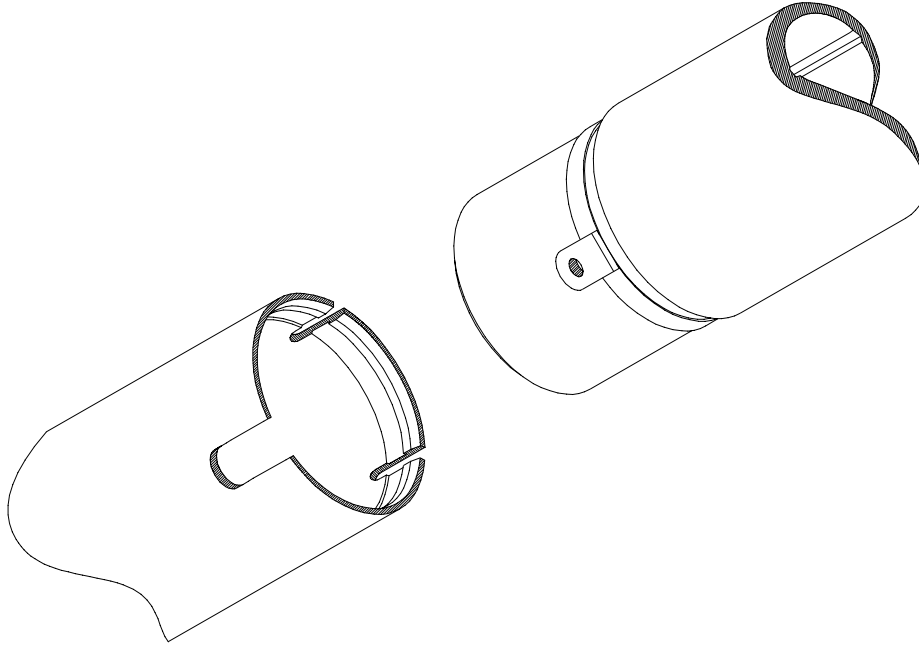


Figure 1 – RST Snap Seal Casing

5.2 Installing an End Cap

Before installing the first section of casing in the borehole, an end cap must be installed as indicated in Figure 2.

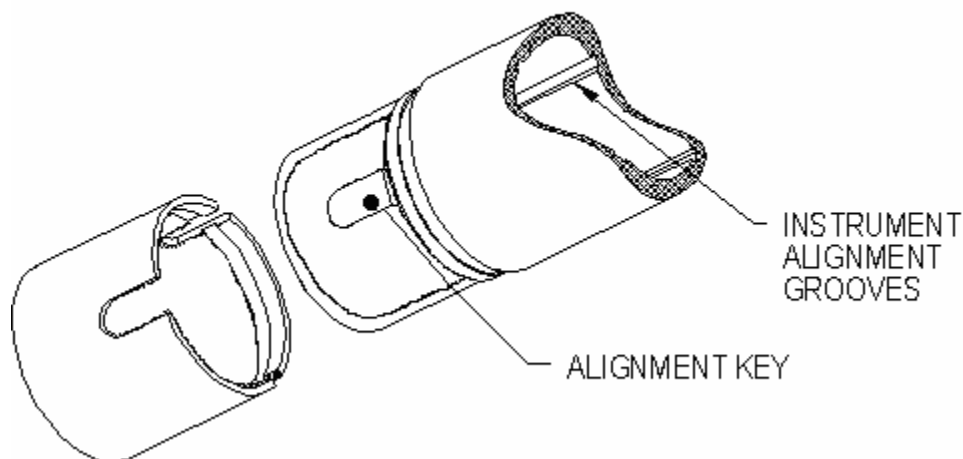


Figure 2 – End Cap Joint

Align the notch on the cap with the key on the casing. Slide the cap on to fully engage the notch and key (you will hear a “snap” as the lock ring is seated). Visually ensure proper assembly. Typically, a grout tube will be attached to the first section of casing. Additional grout tubes may be added during installation for multistage grouting. In some situations, a special grout cap will be required instead of the standard end cap. Installation is the same, except for the fact that the grout cap has a provision for a grout tube.

The casing, with attached cap, can then be lowered into the hole. If applicable, attach a safety line, and a grout tremie line.

5.3 Assembling Casing Sections

Subsequent casing sections in a borehole should be assembled in the same manner as the end 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 some cases, the user may find it easier to push the sections together using a twisting motion. In each case, the alignment button should be aligned with the notch in the female end (Figure 1).

Some practitioners use a 2-inch wide waterproof duct tape over the joint. Just a single wrap of this tape will improve the lateral strength of the joint by more than 100% and in tension by 50%.

5.4 Installing the Top Cap

After all the inclinometer sections have been installed, 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 3).

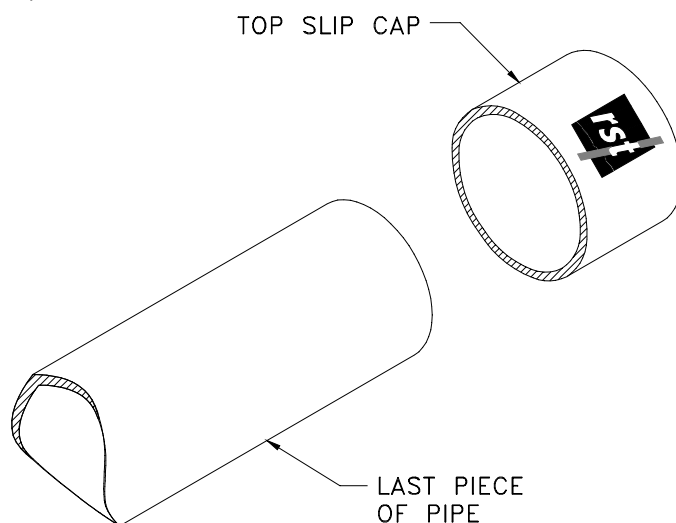


Figure 3 – Top Cap

5.5 Assembling Telescopic Sections

Each telescoping section is 2ft. (24”) in length and allows for six inches of compression or extension (Figure 4). 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 (section 5.3).

If the telescoping sections are equipped with settlement rings, then lower the sensor into the casing 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.

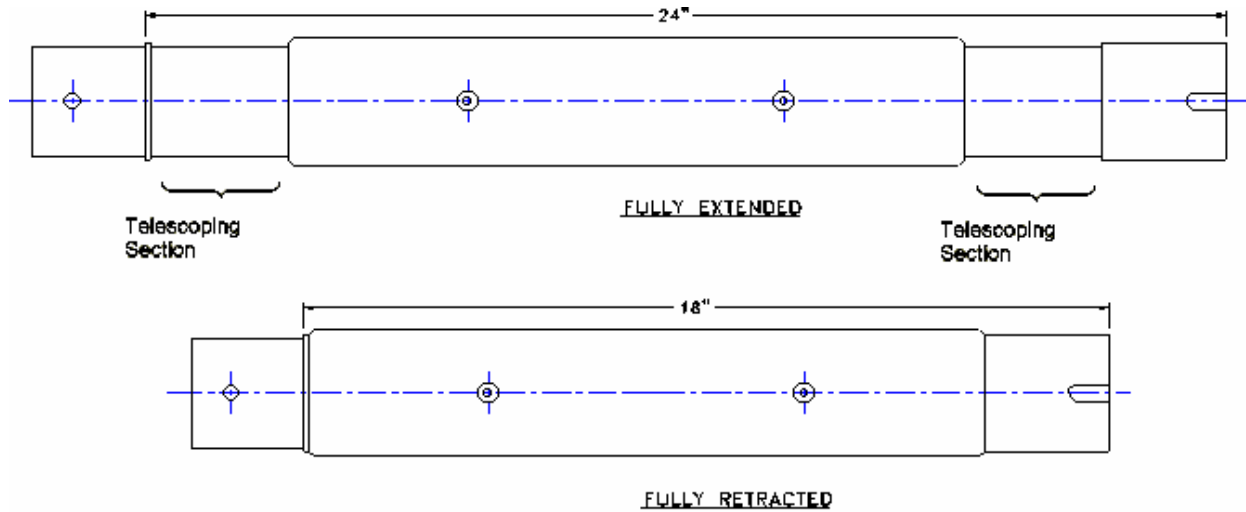


Figure 4 – RST Snap Seal Telescoping Section

6 Installing Snap Seal Casing

6.1 Installation Notes

Casing Storage

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.

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 you begin installing the casing. Also consider that grout valves or external weights may be required for deeper boreholes.

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.**

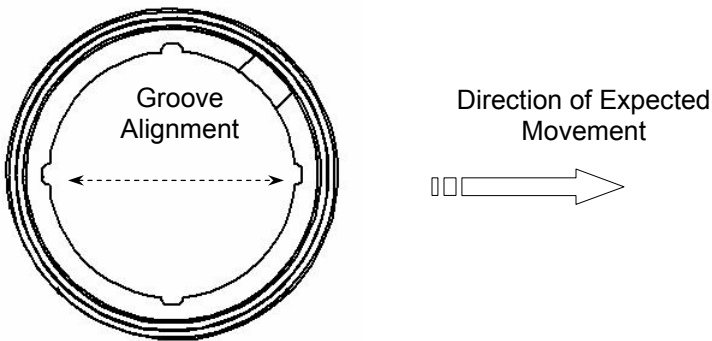


Figure 5 – Groove Alignment

6.2 Installation Methods

Pipe Clamp Method

This method involves using pipe clamps to hold the casing at the borehole collar while you add the next section of casing. Two pipe clamps are needed. 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.

- 1 Install an end cap on the first section of casing (section 5.2).
- 2 Attach one clamp to the top of the first section of casing. Lower the casing into the borehole until the clamp rests on the borehole collar.
- 3 Attach a second clamp to the top of the next section of pipe. Connect the two sections according to the instructions outlined in section 5.3. Remove the first clamp and lower the section into the borehole.

Repeat steps 2 and 3 until installation is complete. When to depth, verify the alignment of the grooves by running a dummy probe to the hole bottom. If the probe will not pass, jumps track, or returns in another set of grooves, pull the casing and rectify the problem.

In deep boreholes, it is advantageous to use a safety line to restrain the casing during installation. This can be used in conjunction with the casing clamps to lower the casing a controlled rate. Note that using the safety line *by itself* may induce spiraling due to the spiral lay of the rope, and is not recommended.

6.3 Casing Buoyancy

If the borehole is filled with water or mud, ballasting the casing with clean water can neutralize the casings' buoyancy. Exercise caution with this technique, as in dry boreholes, the differential pressure caused by the head of water may cause the casing to fail.

Casing also becomes buoyant during the process of grouting the borehole. The two following methods can be used to prevent the casing from floating out of the borehole during grouting:

- 1 Drill rods may be inserted inside the casing to hold the string from the bottom.
- 2 The bottom of the casing may be anchored in grout, then the balance of the borehole grouted.

Note

Applying a down-force to the top of the casing will likely distort the casing profile. Never use the drilling rig as a reaction force, or wedge the collar of the borehole. This will cause the casing to assume a large radius bend, making readings virtually useless.

In many cases, it is standard practice to attach a weight to the bottom of the casing to counteract the buoyancy effects of the casing. In situations where the casing is being inserted into a freshly grouted borehole, these buoyancy forces can be significantly large. RST cautions against using too large of a weight as it may fail the joint on the bottom cap or elsewhere in the casing.

6.4 Grouting

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.

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

Observe the water meniscus in the casing as an indication of casing collapse, or grout ingress (i.e. if the water in the casing rises, grout ingress can be assumed). Ensure that differential pressures are kept to a minimum, as the casing will collapse at 240 PSI differential.

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

Note

Proper grouting of inclinometer casing is crucial to a successful inclinometer installation. The on-site 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.

In summary, grouting needs to be performed by experienced personnel, site conditions vary to the extent that each inclinometer installation is unique. Good judgment by on-site personnel and previous experience is the key to a successful installation.

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. Be sure to make this cut as square as possible. Remove all burrs.
2. Apply ABS 771 Cement to the inclinometer casing (Figure 6). The repair coupler will slide over top and the alignment tool will be used.

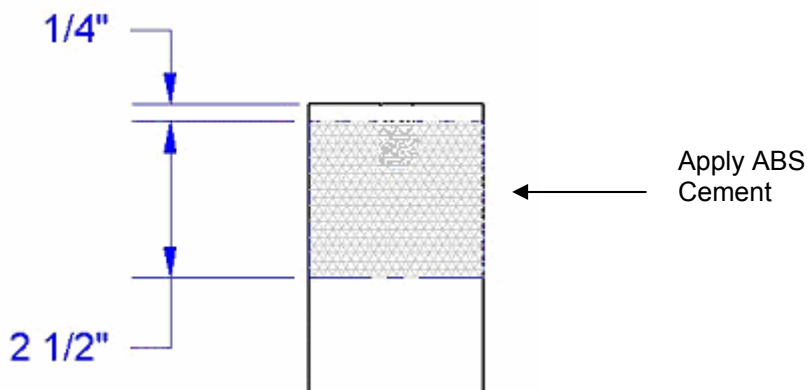


Figure 6 – Casing Preparation

3. Slide the RST repair coupling onto the casing and align the grooves using the RST Coupling Tool (Figure 7). Allow the cement to cure, according to the directions on the label.

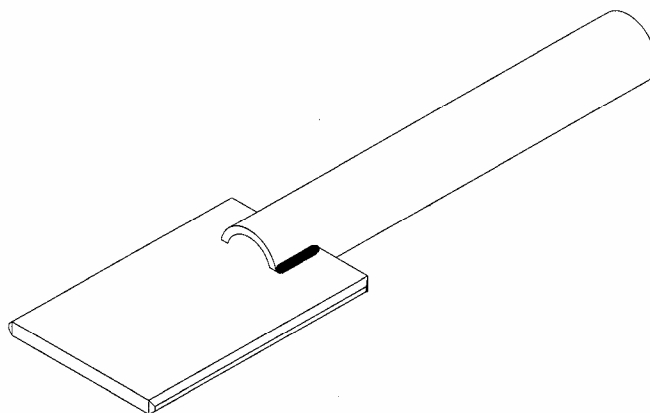


Figure 7 – RST Coupling Tool

4. Install the next section of Snap Seal casing as usual (section 5.3). Ensure that the keys and keyways are aligned.

8 Installing Corrugated Settlement Sheath Pipe

Another option 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.

Installation Method:

1. Insert a weight into the bottom of the sheath with the groove side down, leaving room for the installation of the end 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 End 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 Incliner casing inside the Corrugated Settlement Sheath Pipe.
7. Eliminate any slack by pulling on it by hand (hold 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".