Technical Notes - Inclinometer Casing

Material

Geosense casing is manufactured from 100% virgin ABS (Acrylonitrile butadiene styrene) the industry recommended material and has a groove spiral tolerance of <0.3 degrees/3m.

Groove geometry

The geometry of the grooves makes them compatible with most probe manufacturers and provides optimum accuracy as it allows a regular the flat surface for the probe wheels.

Selection

Type (QJ or XC)

Two types of casing are available: QJ (Quick Joint) and XC (External Coupler). The difference is the way in which they connect together.

The QJ casing features a machined flush male and female fitting on the end of each length of casing. Sealing is made with an O-ring. The main advantages of the QJ are the speed of installation which can be significant in deep installations and the fact that no rivets, rivet gun or glue are required and it can be used for combined settlement and inclinometer installation.

The XC features plain lengths of casing joined together by an external coupler which is glued and riveted to ensure a secure connection.

The main advantage of the XC is that it can be cut and easily joined with the coupler which is particularly useful in fills when the casing is built up with the embankment construction. It also has the advantage that it is a less cost option than the QJ.

Both types are available with telescopic joints where high settlement is expected.

Sizing

Casing is designed to deform with movement of the media into which it is installed i.e. ground or structure. If the casing becomes too distorted it can no longer be used and this is often demonstrated by either the probe not being able to pass down the casing or curvature forces the wheels out of the grooves.

QJ - two standard sizes are available; 70mm and 83mm outside diameter.
XC - two standard sizes are available; 70mm and 85mm outside diameter.

70mm is by far the most commonly used size with the 83/85mm generally used in applications only where large deflections are expected.

Lengths

Standard lengths are 1, 1.5m and 3m lengths. Special lengths are available on request.

Settlement

Geosense casing is designed to withstand 1-2% elongation or compression which might occur if there was settlement or heave. If you are expecting levels greater than this then it is advised to use a telescopic coupler. The telescopic coupler has a range of movement of ±75mm as standard however increased ranges can be accommodated on special request (price on application). Corrugated pipe can also be used to de-bond the casing from the surrounding ground and allow the movement to be absorbed the outer pipe.

Installation

Groove (keyway) alignment

Vertical borehole

One set of grooves should be installed in the direction of the expected movement and typically this is referred to as the A axis.

If during installation the keyways become misaligned from the direction of movement this can be rectified as long as the grout hasn't set. To realign the casing lift the casing up and down to lower the friction from the grout and carefully turn it.

NEVER TWIST THE CASING FROM THE TOP AS THIS WILL CAUSE TWISTING OF THE GROOVES.

Vertical reservation tube

Where casing is installed in diaphragm walls it is usual practice to install it inside what is often referred to as a reservation tube. This is typically a 150mm steel or plastic pipe which is first installed with the cage and then the inclinometer casing installed and grouted up. As the bottom of the inclinometer casing is usually required to be below the toe of the wall a plug is normally placed at the base of the reservation tube which can be drilled out, the borehole drilled to the required depth and the casing installed.

Horizontal

The first section is the most critical as the more accurately this is installed with the minimum amount of torsion the easier the subsequent sections will be.

Ensure that suitable mountings are provided if installed within reinforcement and ensure the sections are secured tightly to the mountings using cable ties, tie wire and duct tape. When laid in ground a good

Note 1: A pull cable is required to pull the probe to the far end and back and should be installed progressively with the casing.

Note 2: Where access is only available from one end a “dead end pulley”, together with pull through cable and access tubing will be required.

The QJ casing has one external rib over a groove which can be used to align each section and the XC has four external ribs over the grooves one of which can be marked for alignment.

Maximum depth of Installation

The maximum depth of installation is dependent on whether the borehole is dry, the groundwater level if present, density of the grout if pre-grouted and the experience of the installer. Where deep boreholes are to be installed care should be taken as regards pressures and forces that could be exerted on the casing.

- QJ – the maximum dry string length recommended is 100 metres. Placing a 50mm wide waterproof duct tape around each joint will increase the strength of the joint by approximately 50%.
- XC – the maximum dry string length recommended is 150 metres assuming the use of glue and rivets.

However we would always recommend using a rope attached to the bottom section to take the majority of the weight on installations greater than 60 metres in a dry hole. Where groundwater and/or grout exists then buoyancy (see below) would be more of an issue than the joint strength in tension.

Buoyancy

Buoyancy is often experienced during installation due to groundwater or grout if a pre-grouting technique is used. It is therefore always recommended to fill the casing with water when groundwater exists.

Grout in a borehole has a much higher density than water-filled casing. During installation, liquid grout will exert an uplift force on the bottom of the casing. This uplift force is greater than the downward force exerted by the casing even if water-filled. The net uplift can be calculated as the density of grout minus the density of water in the casing x depth of casing x area of bottom.

The options to address buoyancy are as follows:

- Fix an appropriate anchor to the bottom of the casing
- Suspend steel pipe or drill rods inside the casing
- Pre-attach a weight to the bottom of the casing
- Grout the borehole in stages

Grouting

It is standard practice to grout in inclinometer casing using a tremie method which can be done by the following:

- Tremie pipe installed alongside the casing
- Tremie pipe connected to a grout shoe on the bottom of the casing
- Tremie pipe installed to the base and the borehole pre-grouted before the casing is installed

For grout mixes please see the Grout section (hyperlink to section)

Spiral survey

Spiral surveys are generally used when:

- It is suspected that the casing has become twisted during installation
- Where deep installations occur > 50 metres
- The project specification requires it

The spiral survey only needs to be taken once at the beginning and the data can be entered into Inclinalysis to provide corrections.

Dummy probe survey

Before placing an inclinometer probe into a borehole it is recommended that a “dummy probe” which is the same construction as a normal probe except there are no sensors inside by run up and down the casing to check that there are no problems which could result in an expensive probe getting stuck in the casing.

Troubleshooting

Probe returns outside of the keyways

If the probe returns to the top of the casing no longer in the grooves this would suggest a misalignment of the keyways along the profile. The first thing to do would be to attempt another reading to eliminate the possibility of user error. If the probe still returns outside the casing then it would be worthwhile using a borehole camera to try and identify the area of misalignment. For casing misalignment there are two basic options:

- Install smaller casing inside the original casing and grout the space between
- Re-drill the hole

Joining/repairing casing after installation

In some circumstances casing can be damaged after installation especially in fill situations or needs to be extended at the top for various reasons.

- For QJ casing a special repair coupling is required but no special alignment tool is necessary as it has one external rib that can be lined up in the coupling.
- As XC has external couplers a new length of casing can simply be added together with another coupler.

Handling & Care

Protection of Ends

The QJ (Quick-Joint) casing relies on a machined male and female joint and an O-ring for sealing. It is extremely important to ensure they are not damaged and that the O-ring has not come out during transportation.

Top of borehole protection

To prevent damage and stop debris from falling or being put down the casing it is recommended that lockable protective covers are installed. Geosense provides a wide range of covers to suit individual project requirements.

Direct Sunlight

The casing should be stored out of direct sunlight at all times and we advise it to be kept in the box that it was delivered in until ready to be used.