CGEO INTERNATIONAL LIMITED

Model CGEO-IC

Inclinometer casing

Installation Manual

（REV A）

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1. Application

Monitoring of lateral earth movement in landslide zone or road construction.

Detecting the shear planes in hydraulic structures.

Measuring of stability during construction.

Deflection of retaining walls and piles under loads.

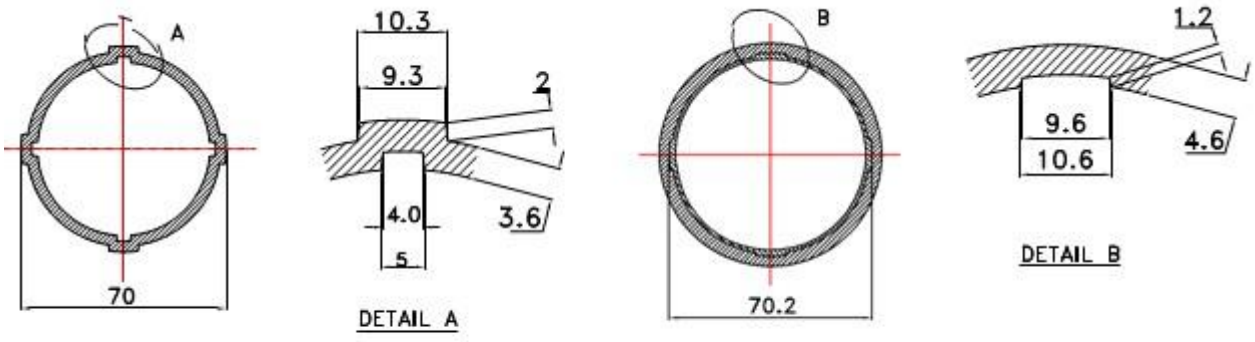
2. Feature

Suitable for long term project because of Non-corrosive 100% fresh ABS (Acrylonitrile Butadiene Styrene) resin used.

React to much bending radius which is flexible material and light weight than Steel, Aluminum or PVC material inclinometer casing.

Keep endurance against high impact strength.

Offer solution with long length couplings and telescopic couplings for soft ground monitoring or ground improvement works.

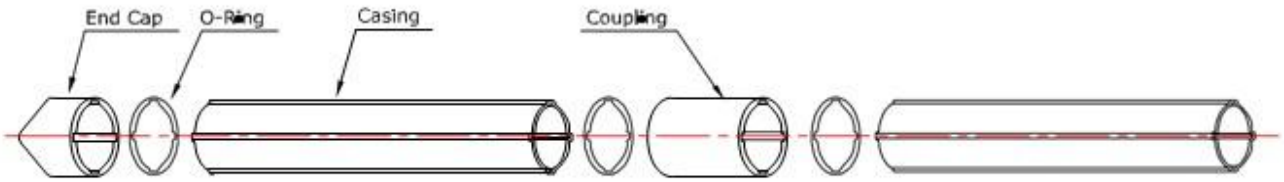


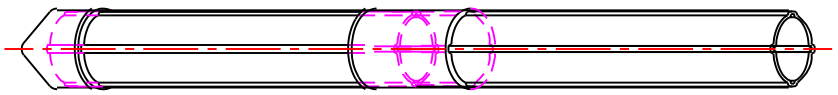
Inclinometer Casing Cross Section

Coupling Cross Section

2.1 ABS resin material properties by ASTM test procedures

Typical values at 23°C for uncoloured products		Test method		Unit	Value	
		ISO	ASTM		ISO	ASTM
Mechanical properties						
Tensile stress at yield / at break*		527	D 638	MPa	43	
Strain at yield		527	D 638	%	2.9	
Strain at break		527	D 638	%		
Young's modulus		527	D 638	MPa	2400	
Flexural strength		178		MPa	65	
Flexural modulus		178	D 790-1	MPa	2000	
Shear modulus		6721-2		MPa		
Charpy impact strength	23°C / -30°C	179/1eU		KJ/m^2	N.B.	
Charpy notched impact strength	23°C / -30°C	179/1eA		KJ/m^2	33/14	
Izod notched impact strength	23°C / -30°C	180/1A		Kg cm/cm	34/14	
Izod notched impact strength	23°C / -30°C		D 256-A	Kg cm/cm		45/18
Ball indentation hardness ,	H 358/30*	2039-1		Mpa	97	
Rockwell hardness, scale		2039-2		-		
Thermal properties						
Vicat softening temperature, VST/A/50 / VST/B/50		306		°C	107 /100	
Deflection temp., 1.8Mpa(HDT A)/0.45Mpa(HDT B)		75-2		°C	101 / 103	
Max. service temperature		-		°C	80	
Thermal coefficient of linear expansion		DIN53752		$10^{-4}/K$	0.8 – 1.1	
Thermal conductivity		DIN 52612		W/(m·K)	0.17	
Processing						
Melt volume rate MVR 220/10		1133		ml/10 min	5	
Melt temperature range (extrusion)				°C	230-250	
Mold temperature				°C		
Mold shrinkage				%	0.4-0.7	
Electrical properties						
Dielectric constant at 100 Hz / 1MHz		IEC 250		-		
Dissipation factor at 100 Hz / 1 MHz		IEC 250		10^{-4}		
Volume resistivity		IEC 93		Ω cm	$>10^{13}$	
Surface resistivity		IEC 93		Ω		
CTI, solution A		IEC 112		-		
Flammability						
UL 94	(1.6 mm)			Class	94HB	
UL 94	(3.2 mm)			Class	94HB	
Automotive materials (thickness d ≥ 1 mm)		FMVSS 302			+	
Miscellaneous properties						
Density		1183		g/cm^3	1.03	
Water absorption		62		%	0.95	
Moisture absorption (23°C/50% r.h.)		62		%	0.21	

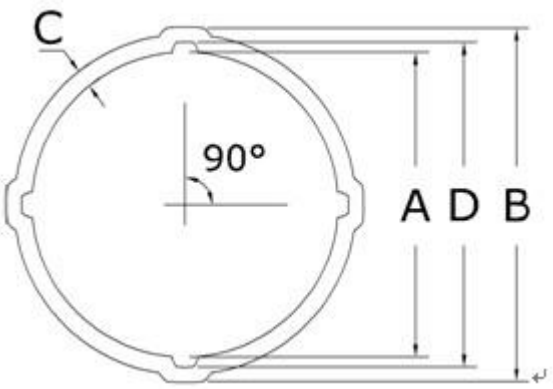




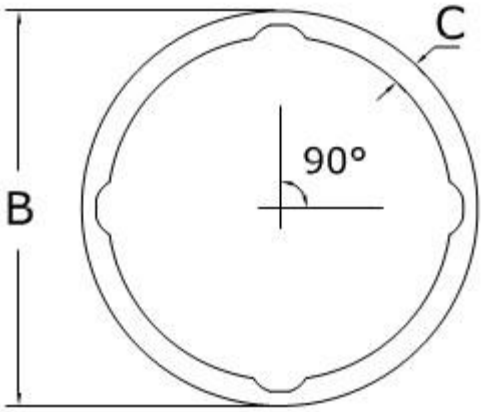
CGEO-IC Inclinometer casing & coupling's cross-section view

and dimension

ABS inclinometric Casing section



ABS Coupling section



Unit mm kg	60mm			70mm			85mm		
	Casing	Coupling	Cap	Casing	Coupling	Cap	Casing	Coupling	Cap
O D	60	66	66	70	77	77	85	94	94
Length	3M	200		3M	160		3M	200	
		N/A			400			380	
Weight	2 1	0 18	0 06	2 6	0 2	0 07	3 2	0 3	0 09

The specification and physical dimension can be changed without prior notice.

2.2 Casing materials

CGEO-IC inclinometer casing is adopted ABS: Very excellent material for inclinometer casing so far. If ground PH is greater than about 10 or if stray ground currents are suspected, ABS casing should be recommend.

2.3 Casing storage

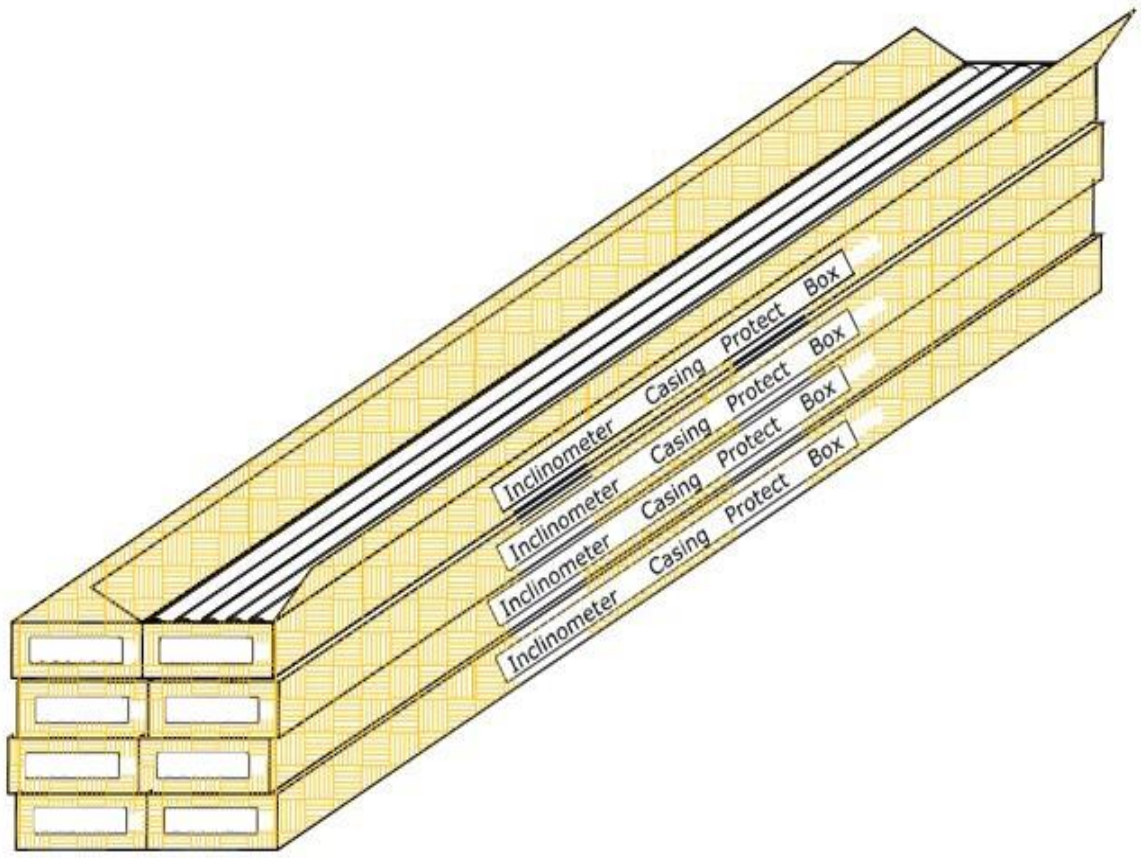
Avoid direct sunlight to inclinometer casing.

Exposure of direct heat sunlight causes casing itself poor condition.

Do not five much load or force to inclinometer casing.

Keep all inclinometer casing under the shade of cool house if possible.

Do not warp or bend during storage.

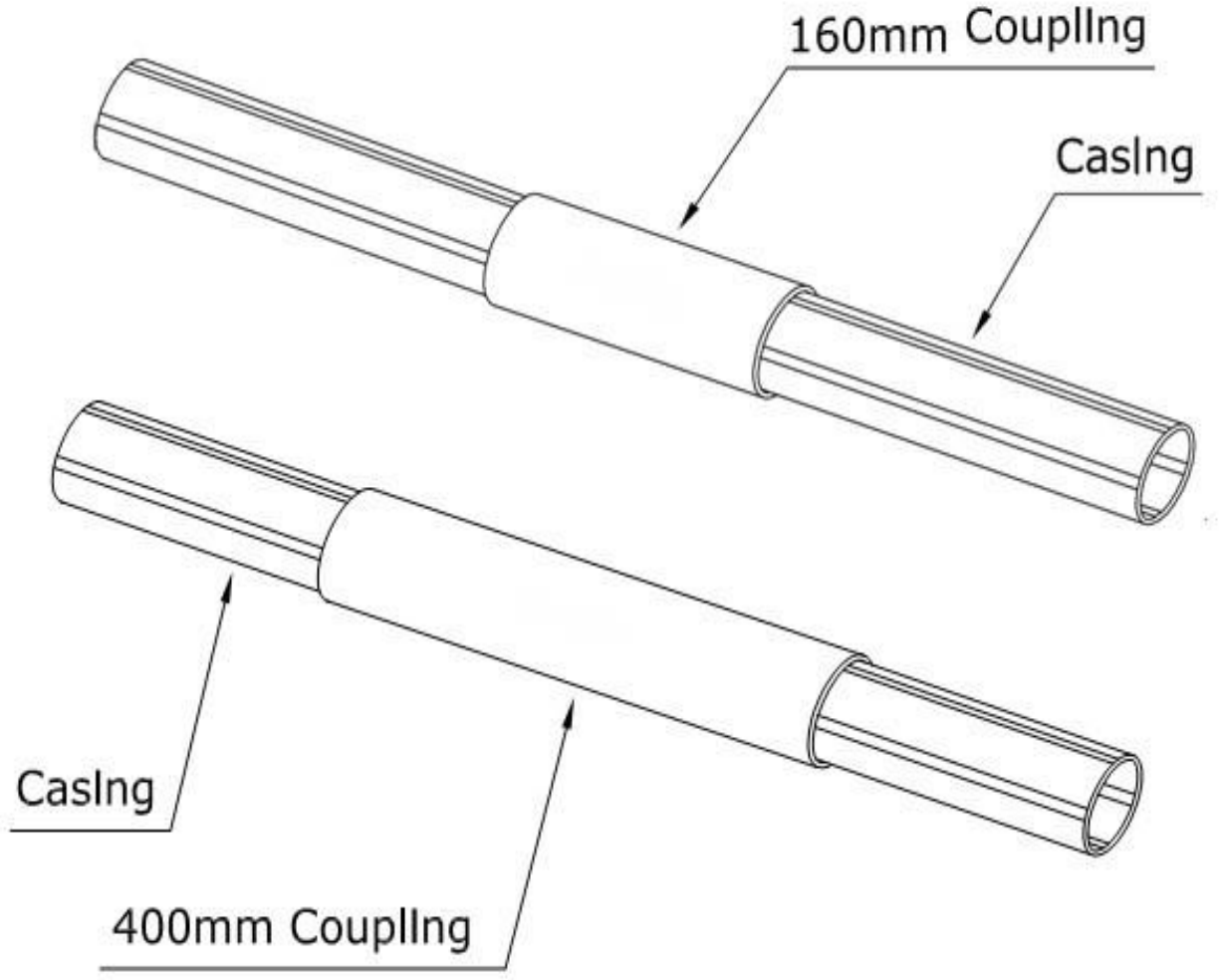


3. Coupling and telescopic coupling

In case of much displacement occurred in a short apse of time, the coupling section would be laid very weak status so it come about unforeseen problems like broken joints, a probe wheels hooked and so forth.

However CGEO-IC long length coupling and telescopic coupling clear this kinds of troubles till a project done.

Depending on geological map, an engineer must consider joint area deeply.



Telescopic coupling is made of long length coupling with calculated slot range and range fix screws.

Accessories are for assembling parts, screws and bitumen tapes.

A telescopic coupling's average range is 150mm to absorb vertical displacement.

It can be allowable monitored 30% settlement of total inclinometer casing depth.

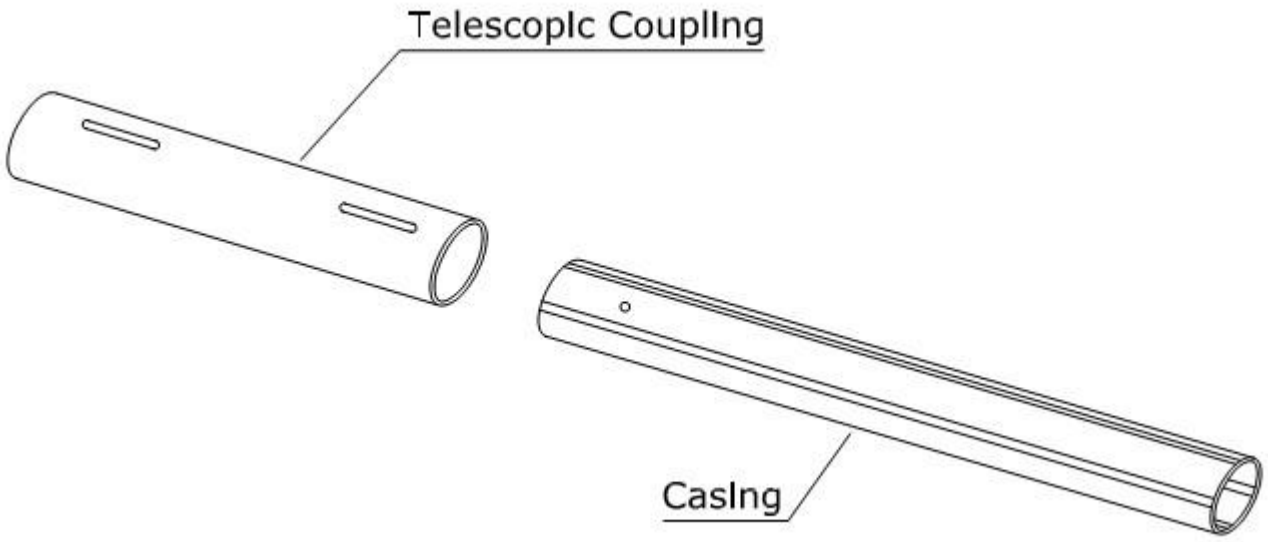
Positions and quantities of telescopic couplings should be calculated by geological earth condition.

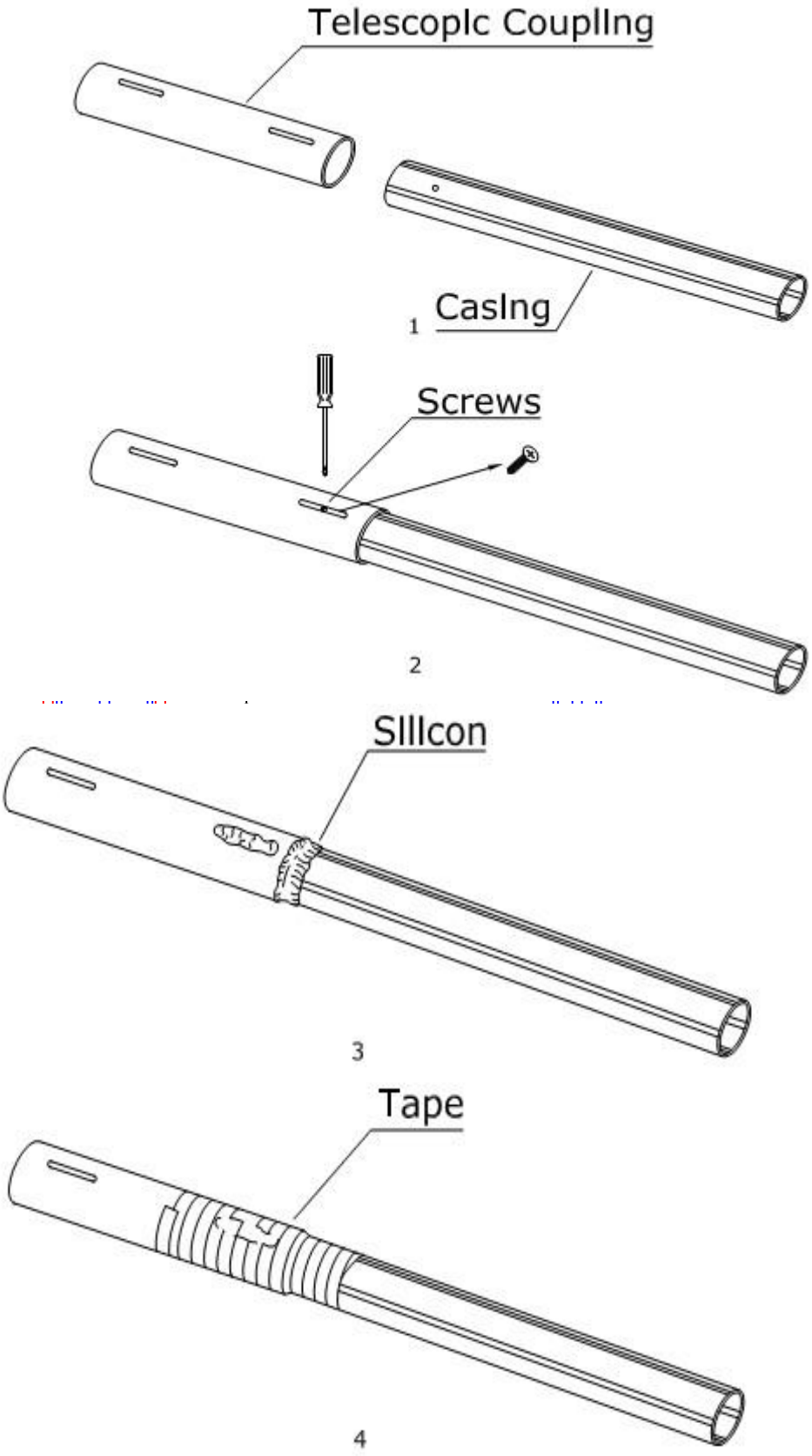
1) Prepare for appropriate setting materials, tools and equipments for inclinometer casing assembly. Adjust position of coupling for an appropriate length of travel.

2) Fix position of coupling with screws. Don not over-tighten screw.

3) Seal joint with silicon or bitumen tapes.

4) Wrap vinyl tape over entire joint section.




Telescoplc Couplling
Caslng
1
Screws
2
Slllcon
3
Tape
4

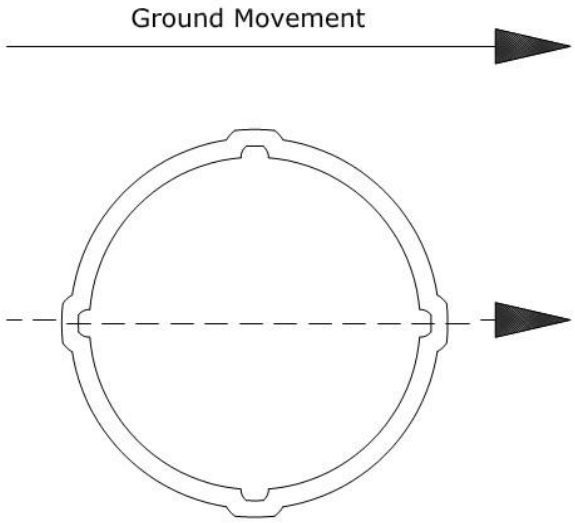
4. Casing installation

Check Borehole Depth

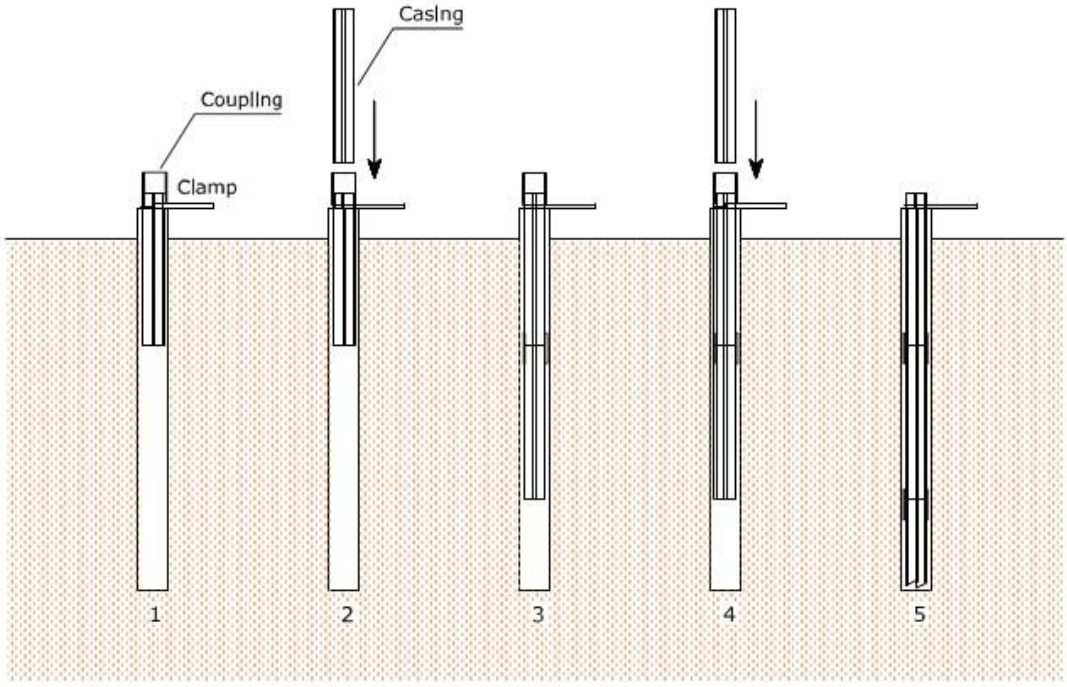
Check borehole depth before casing installation.

Align keyways toward ground movement direction

It is important to align one set of casing groove to site direction of foreseeable ground movement. It is helpful to set up direction easily with CGEO-IC inclinometer casing's external groove lines by touch feelings.



The casing clamp is a tool used during the installation of the casing in vertical borehole. The main purpose of the casing clamp is to hold the casings while you add the next section of casing.



Casing buoyancy of groundwater

Casing will float in groundwater-filled boreholes. So an engineer should pour it with water to remove buoyance. As pumping grout into the borehole, the water-filled inclinometer casing does buoyant again since the grout is more denser than water. To counter this buoyance, recommend to use a casing anchor or suspend a non-retrievable weight from the bottom of the casing before casings inserted into a BH or lower small diameter PVC pipe to the bottom of the casing.

Down force applied at the top of the casing is likely to distort the casing profile.

Therefore don't park a drill rig over the casing.

Grouting

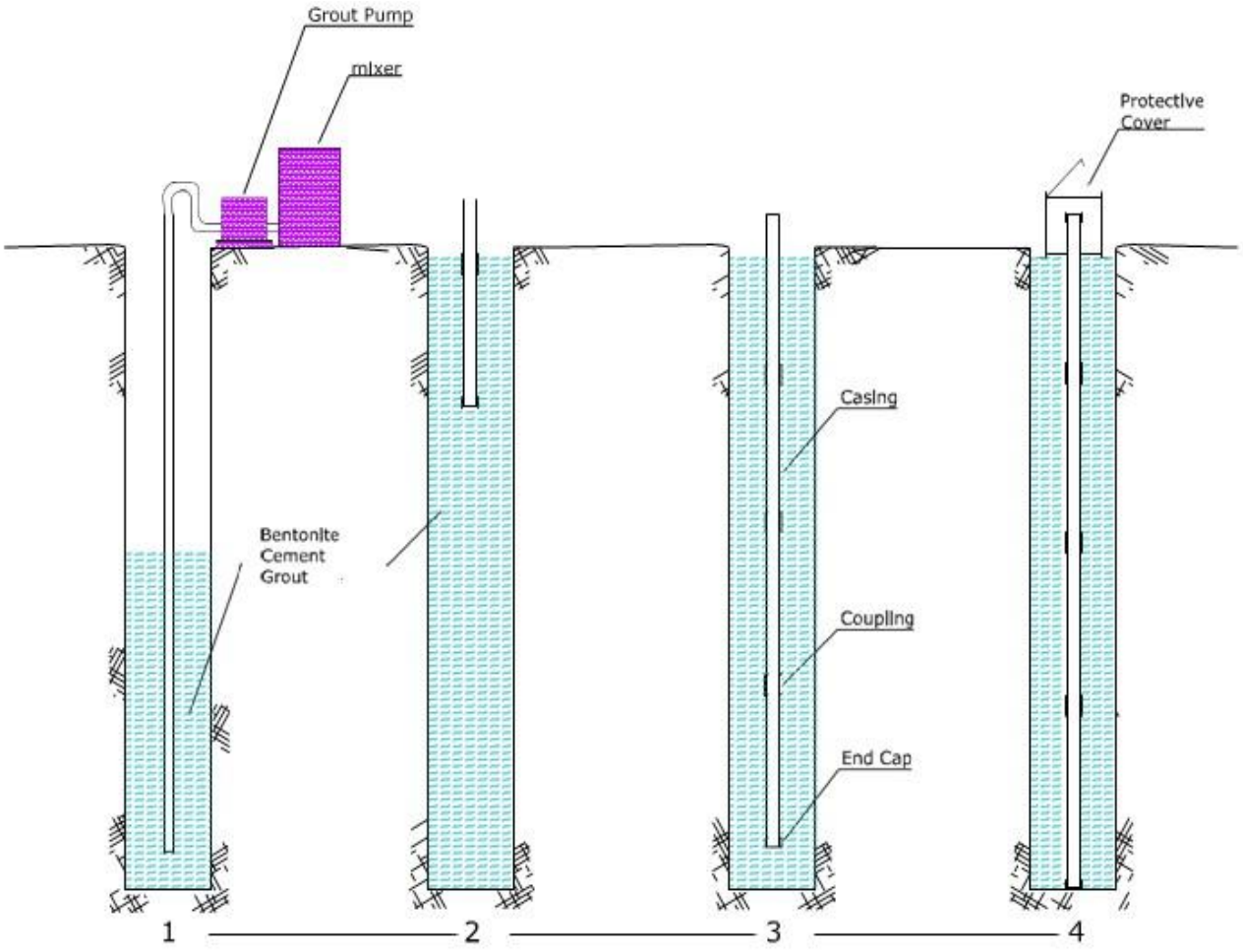
1) Do not mix the grout by hand.
2) Do not use a water pump to place the grout.
3) We recommend that a mixer, a grout pump, and a pipe for proper grout.
4) If grout is too watery, it will shrink excessively. Besides the upper portion of the borehole would be not grouted.
5) Avoid the use of grout admixtures because of curdling at high temperature may give damage the casing.
   Ideally, the grout should be mixed to match the strength and deformation properties of the ground surrounding the borehole.
   In practice, the main consideration is to use a grout that allows the casing to move surrounding soil together.

Bentonlte Cement Grout		
Materlal	Welght	Percent
Cement	40Kg (1 Bag)	13%
Bentonite	16Kg	5%
Water	260L	82%

Note: Volume of bentonite and water can be dicided at site of ground condition.
Mix cement with water first and then pour in the bentonite.
If the grout is thin or thick, mixture grout will separate or hard to pump.

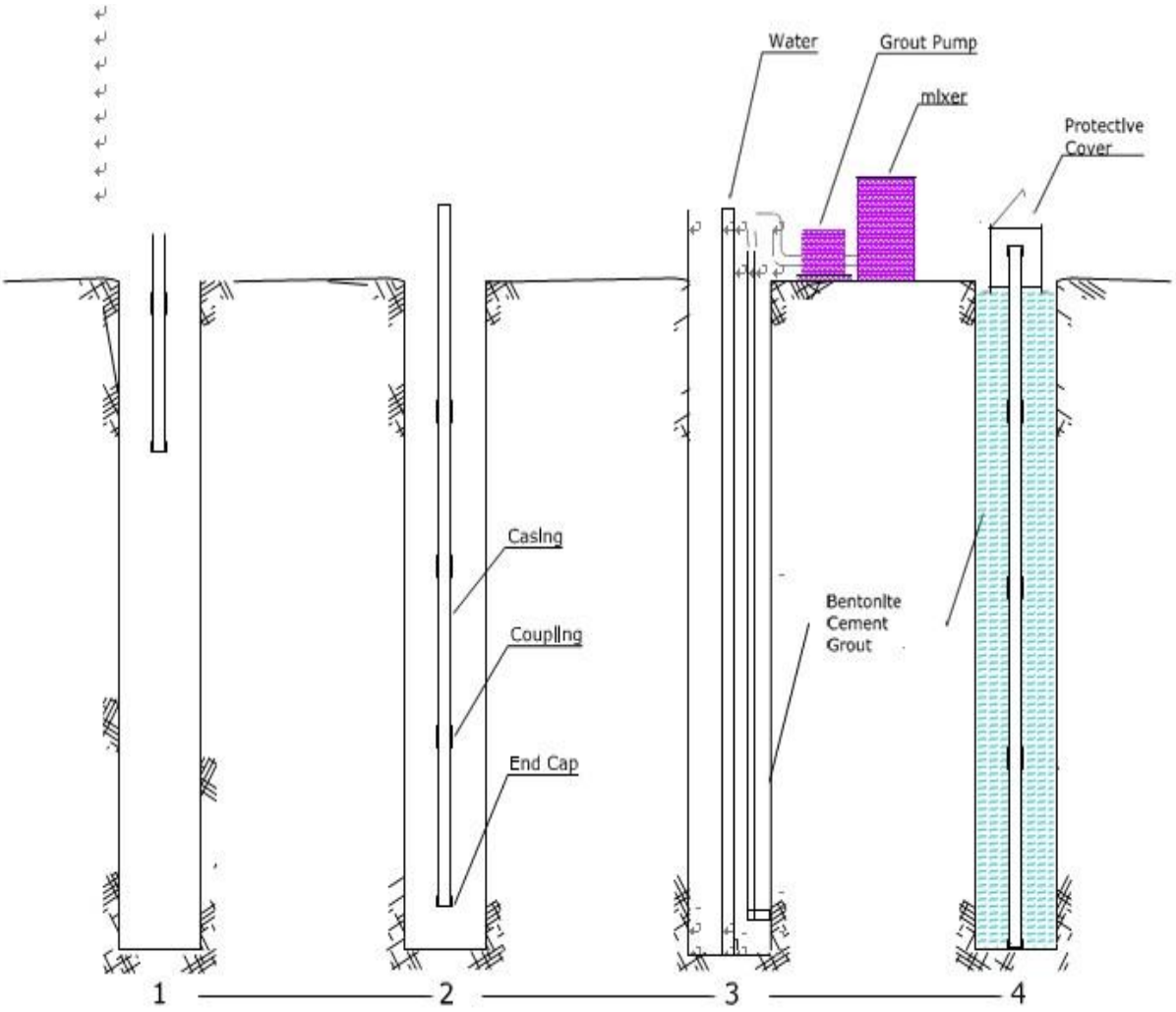
Pre-Grouting the borehole

1) Clear the borehole drilling slime. Check the borehole depth.
   Lower the grout pipe to the bottom of the borehole.
   Pump in the grout and then retrieve the grout pipe.
2) Install inclinometer casing to the specified depth.
3) Keep inclinometer casing filled with water to counteract buoyancy.
4) Allow the grout to set. Saw off inclinometer casing above ground surface.



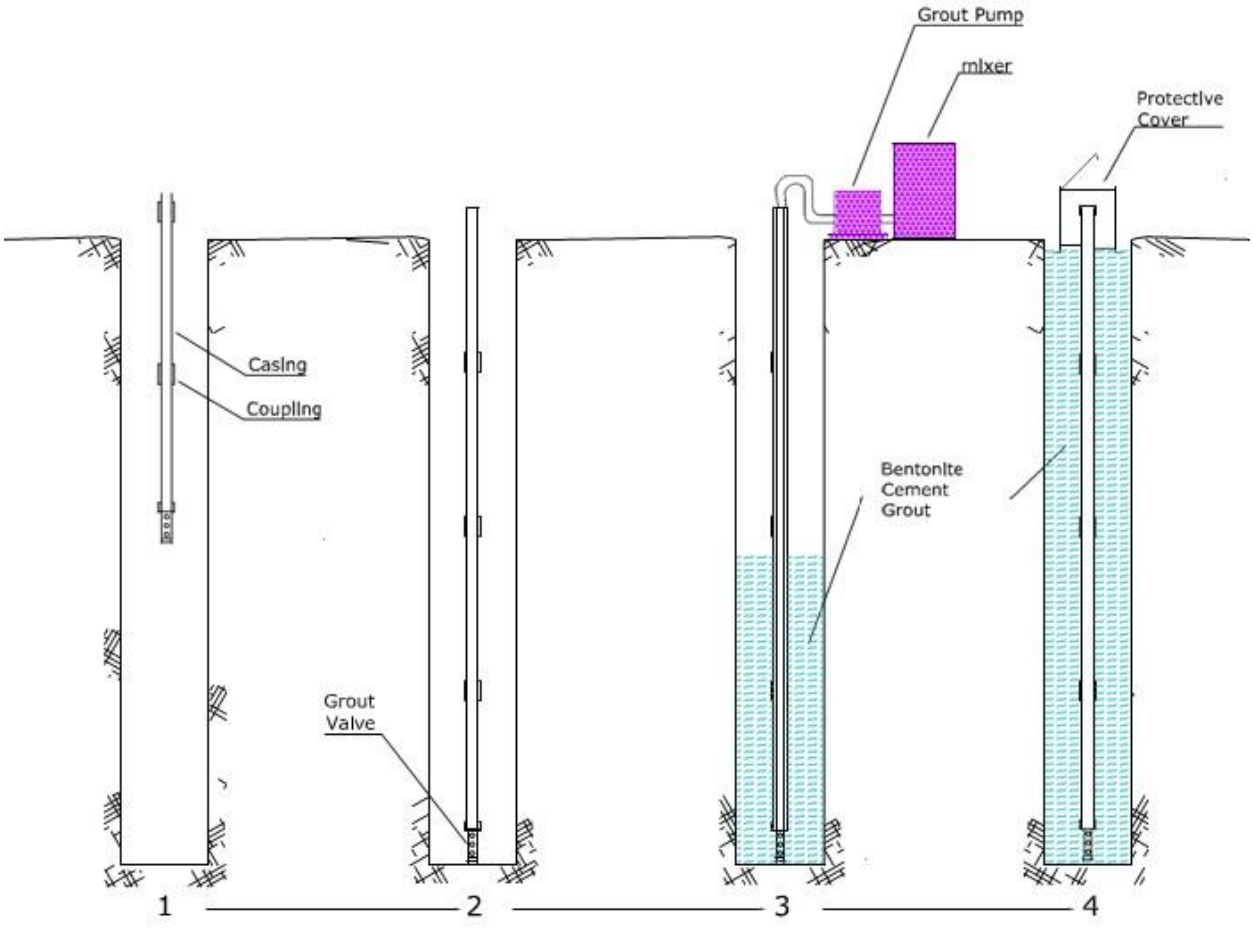
Using an external grout pipe

1) Clear the borehole drilling slime. Check the borehole depth.
2) Install casing to the specific depth.
   Lower pipe to the bottom of the casing to counteract buoyancy.
3) Cap the inclinometer casing to prevent entry of grout.
   Lower the grout pipe to the bottom of the borehole and pump in grout. Pump in grout and retrieve the grout pipe.
4) Install a protective cover.



Using a grout valve

Grout valves are used when casing is installed in small diameter boreholes that do not allow use of an external grout pipe. The grout valve is a one-way valve installed in the bottom cap of the casing. A grout pipe is lowered through the inclinometer casing to mate with the grout valve and deliver grout. Snap off the removable grouting valve. Pump clear water to bottom of the casing until clear water flows back to the ground.
Please note that grout valves add about 60cm to the effective length of the casing.



Stage grouting

In stage grouting, grout backfill is placed in stages, so that the grout pressure never exceeds the collapse strength of the casing.
Generally considering stage grouting as the depth of the borehole exceeds 60m.
Stage grouting needs at least two or more grout hoses
The first hose should lower to the bottom. The second hose should extend to bottom of the net stage and so forth.

Stage grouting with hoses

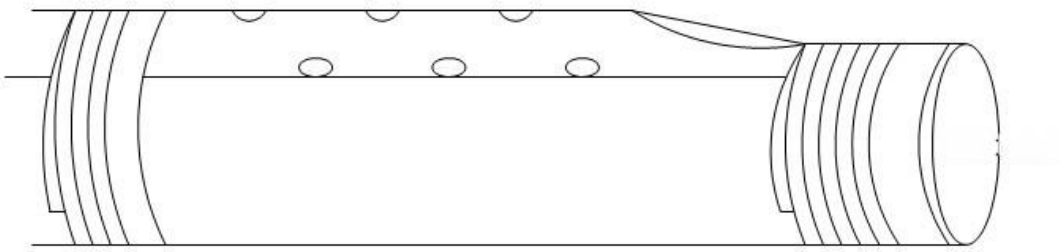
Hoses are fixed to the casing as shown in the picture.

In stage 1, calculate the volume of gout needed to backfill the borehole above the end of the Stage 2 grout hose.

Pump in that volume of grout plus approx. 30%. Leave the Stage 1 grout hose in place.

Pump water through the Stage 2 grout hose. The bottom of the Stage 2 hose should be below the surface of the grout, and pumping in water should flush grout from the borehole. If no grout appears, pump more grout through the Stage 1 hose and then test again. Continue pumping water through the Stage 2 hose until clear water flushes from the borehole.

When the Stage 1 grout has set, grout Stage 2. Because the bottom of the casing is now grouted in place, buoyancy will no longer be a trouble.



Termination

1) Protect top of inclinometer casing BH with steel cover.
2) Wait enough me to become the grout hardened.
3) Lower dummy probe to the bottom to verify internal casing condition.
4) Record initial data.