



ENCARDIO RITE

ONE STOP MONITORING SOLUTIONS | HYDROLOGY | GEOTECHNICAL | STRUCTURAL | GEODETIC
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USERS' MANUAL

VERTICAL INCLINOMETER CUM MAGNETIC SETTLEMENT SYSTEM

MODEL EDS-91



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1 GENERAL DESCRIPTION & SPECIFICATIONS

The inclinometer cum magnetic settlement system is specially designed for measurement of lateral movement and settlement/heave. A near vertical gage well is made by installing the casing in a borehole or embedding in an earth/rock fill.

The inclinometer probe is then passed through the entire length of the gage well from bottom to top, taking readings at fixed predetermined intervals. The probe senses the inclination of the access tube in two planes at right angles to each other.

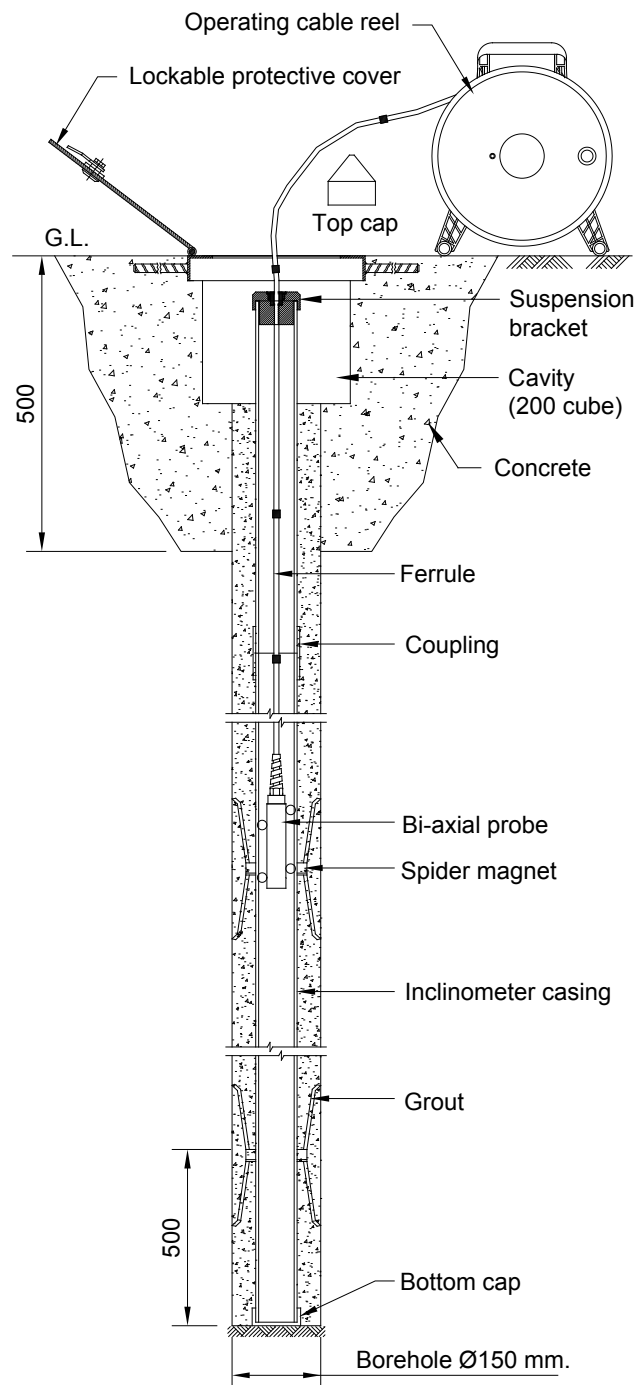
A set of initial base readings taken within the gage well form the reference datum. All subsequent readings are taken over a period of time at identical depths, thereby indicating rate, magnitude, and direction of lateral deformation. This inclination is displayed in terms of horizontal displacement on the datalogger at the ground level with the operator.

Provided one end of access tubing is known to be fixed, complete profile of gage well may be obtained by taking a succession of readings. By comparing the profiles, horizontal displacement of gage well at different depths over a period of time is determined.

The settlement/heave is measured by model EDS-91/2.1 magnetic settlement device. Spider magnets positioned outside the casing grip the surrounding soil at locations where displacement is to be monitored. The probe is lowered within the access tube to sense the position of magnets. The reed switch closes on entering a magnetic field and activates a buzzer in the signal receiving instrument (EDS-91/2.1)

Ancillary equipment

- Access tubing with couplings
- Installation accessories
- Dummy inclinometer probe
- Inclinometer probe calibration check frame
- Pull cord (2-3 mm nylon cord)



2 INSTALLATION PROCEDURE

2.1 Preparation

- 1 Fix leaf spring to the magnets with self tapping screw (provided) if they are supplied separately.
- 2 Fix the datum magnet assembly firmly to the access tubing with the screws provided, 0.5 m above the bottom plug. Since in most cases the bottom of inclinometer access tubing is located in solid ground (fixed), the datum magnet becomes a benchmark. This tubing will be used as bottom most tubing. All the other magnet assembly readings are referred to this datum magnet to get their respective absolute settlement relative to the benchmark.
- 3 Position spider magnets on access tubing with waterproof sealing tape (picture 1) as per picture on the bottom most access tubing and all other tubing. The leaf spring legs can be made close by release wire link around them after compressing, for easier assembly. (picture 2 & 3)



Picture 1

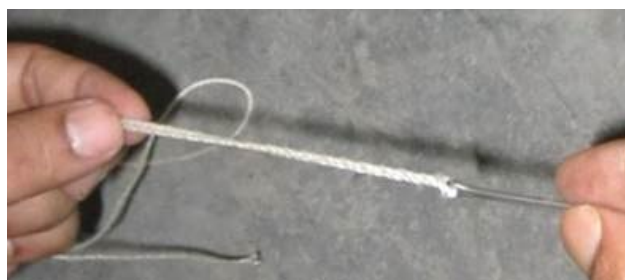
NOTE: Ensure that all spider magnets are fixed in similar fashion on access tube. For example at least one spider leaf is aligned on the groove of the tubing. This make releasing the spider leaf easier and pushing the grout pipe safely.

The spider magnets are provided with two holes on the magnet housing. Ensure that at least one of the holes of the magnet housing is aligned with the hole of other magnets fixed on different casings. This will ensure that all release pin are aligned with each other and can be pulled out from the release wire link easily.

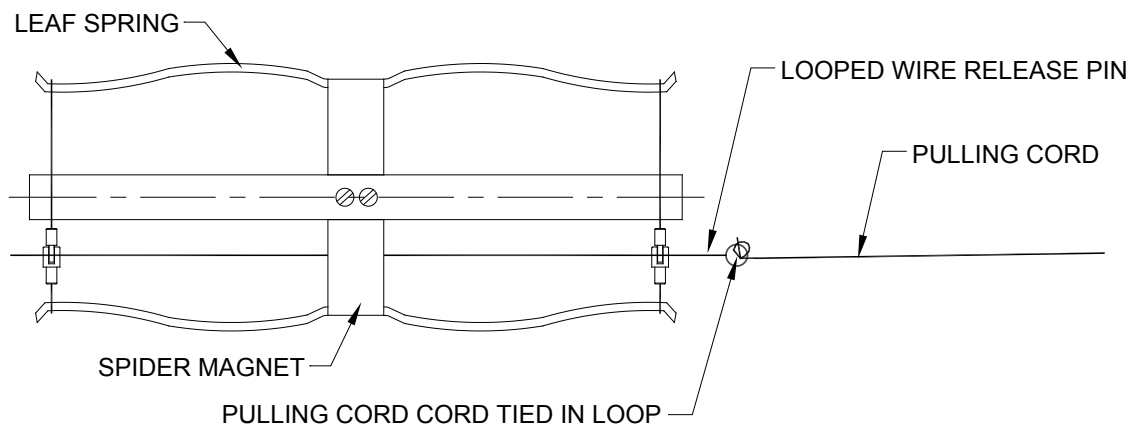
2.2 Installation

- 1 Drill a 150 mm diameter hole, preferably within 1° to the vertical, up to a depth of around 1 m below the planned elevation of the borehole. If necessary use steel casing to prevent the sidewall of the borehole from collapsing. Wash the hole clean to the bottom.
- 2 Single looped wire release pin is used to hold the leaf springs of spider magnet in closed position
- 3 With this method individual pulling cord, tied in the loop of release pin are taken to the top. The cords are marked individually taking the bottom most magnet (magnet which is just above the datum magnet) as #1. The cords are pulled one by one starting from bottom most magnet.

This loop wire release pin is inserted into release pin as shown in figure below Picture 2 & 3.



Picture 2



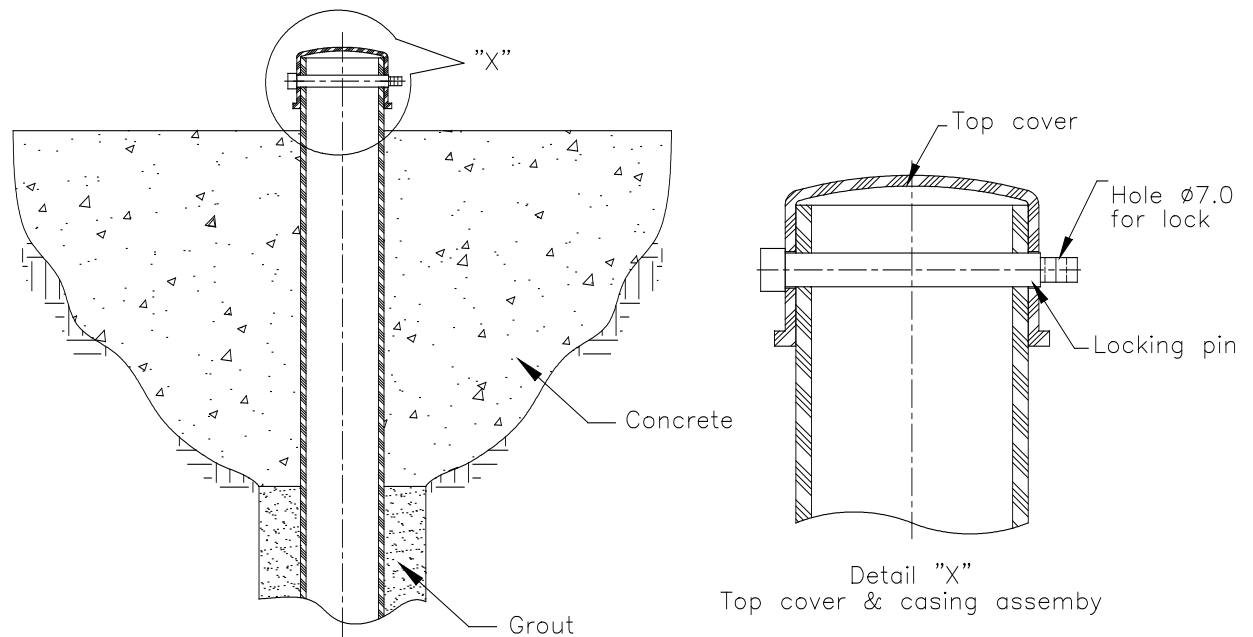
Picture 3

Fixed coupling and add another tubing. Hold the tubing with clamp fixing it below the spider magnet. Continue the method mentioned at step 3,4 and 5 to fixed the magnet assembly with release wire and release pin.

- 4 The grout tube can be fixed to bottom cap. Tape it around 20 cm below the top with a safety clamp such that it does not accidentally fall into borehole or it can be lowered after lowering down the access tubing.
- 5 To counteract buoyancy, if required fill casing with water to lower it into the borehole.
- 6 Grout casing as directed by the project authorities. If no instructions are available, suggested grout mixes are as follows:
 - Hard and medium soils

Cement	50 kg
Bentonite	15 kg
Water	125 litre
 - Soft soil

Cement	50 kg
Bentonite	20 kg
Water	325 litre
- 7 Flush inside of casing with water after grouting. This is to prevent any leaked in grout from sticking in the casing and impairing the movement of the torpedo
- 8 Expand hole near top of casing and make a concrete platform as shown in figure 1 & 3.
- 9 The top of the upper most casing should be around 100 mm above the concrete platform. Fix the protective top plug and lock it. When not taking readings, the gage well should be protected with the top plug and locked.

**Figure 1**

- 10 If necessary, top cap may be kept flush with the concrete platform. If this is done, make sure during concreting that the lock and the pin can be replaced with ease.
- 11 If steel casing is used to prevent side walls of the boreholes from collapsing, it will have to be gradually withdrawn as grout is pumped into the borehole.

3 TAKING READINGS:

3.1 Inclinator readings (for details please refer to user manual)

- Before taking the first reading make sure that the grout filled in the annular space between guide pipe and access casing is sufficiently set. It is recommended taking the first reading at least one week after the grouting.
- Keep the inclinometer probe inside the pipe for 10 min. before starting first reading every time .
- Place cable holder plate on the top of casing. Lower inclinometer probe to bottom of gage well with uppermost torpedo wheel pointing in direction marked 'A'. Raise probe along entire length of gage well from bottom to top, taking readings at intervals of 0.5 m.
- Again lower probe to bottom of gage well with uppermost torpedo wheel pointing in direction 'B'. Raise probe along entire length of gage well from bottom to top, taking readings at intervals of 0.5 m.
- A set of initial readings taken within the gage well. The base reading is formed after taking at least three sets of initial readings. Choose the most repeatable reading set and make it the base. All subsequent readings are compared with this base reading thereby indicating rate, magnitude, and direction of lateral deformation. This inclination is displayed in terms of horizontal displacement on the datalogger at the ground level with the operator.
- Provided one end of access tubing is known to be fixed, complete profile of gage well may be obtained by taking a succession of readings. By comparing profiles, horizontal displacement of gage well at different depths over a period of time is determined

NOTE: Base readings should also be taken by spare system as precaution. At the time of maintenance this system can be used.

Provided one end of the casing is known to be fixed, complete profile of gage well may be obtained by taking a succession of readings. By comparing the profiles, horizontal displacement of gage well at different depths over a period of time is determined.

NOTE: It is recommended practice to determine initial X, Y and Z positions of casing top by surveying after casing is set. This reference reading may be required for verification of deflection at a later date. The point which may be fixed for determining the initial and subsequent X, Y and Z positions, is the pipe top surface near groove A. Top of inclinometer will be surveyed weekly.

NOTE: Cable length will be checked weekly with calibrated measuring tape.

3.2 Settlement readings

- Settlement is measured by model EDS-91/2.1 magnetic settlement device. Switch in the device. Fix the centering bush (if required) on the magnetic probe. The centering bush is used to align the magnetic probe at the center of the inclinometer pipe.
- Lower probe into the well below the datum magnet mounted at the lowest level.
- Raise the probe gradually by pulling the flat tape. Hold the flat cable against the reference and read the depth from the cable marking at the point where the buzzer first gives a sound. Verify this reading as correct by slightly lowering the probe and again gradually raising it. The top of the well is usually taken as the reference for taking readings.
- Raise the probe below the next spider magnet and take the reading as described in above paragraph. Repeat the procedure for all the spider magnets installed in the well. During the process keep winding the flat cable on the cable reel.
- Initial readings are important for reference. User is recommended to take three sets of initial readings from separate passes through casing. Average the readings for each magnet.

4 ESSENTIAL REQUIREMENT FOR INSTALLATION AND MONITORING PERSONNEL

Personnel involved in installation and monitoring must have a background of good installation and monitoring practices and knowledge of the fundamentals of geotechnics. They must be professionally trained. Persons with no prior experience may find it difficult to carry on with this work. The intricacies involved are such that even if a single essential but apparently minor requirement is ignored or overlooked, the most reliable of instruments and data obtained from them will be rendered useless.

This method statement does not provide for each and every condition in the field that may affect the performance of the instrument. Also, blindly following the method statement will not guarantee success. Sometimes, depending upon field conditions, the personnel will have to consciously depart from the written text and use their knowledge and common sense to find the solution to a particular problem.

Users must ensure that their installation and monitoring personnel have prior training and experience in all operations laid down in this method statement before taking up this installation and monitoring work.