



# ENCARDIO RITE

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USERS' MANUAL

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## SINGLE POINT MECHANICAL BOREHOLE EXTENSOMETER

MODEL EDS-64UD



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## Contents

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Applications	1
1.2	Measurement method	1
1.3	Conventions used in this manual	1
1.4	How to use this manual	1
<b>2</b>	<b>BOREHOLE EXTENSOMETER</b>	<b>3</b>
2.1	Introduction	3
2.2	General description	4
2.2.1	Reference head assembly	4
2.2.2	Stainless steel/Fiber glass rod assembly	4
2.2.3	Anchor	5
<b>3</b>	<b>INSTALLATION PROCEDURE</b>	<b>6</b>
3.1	Site preparation before installation	6
3.2	Procedure	6
3.3	Tools & accessories required for installation	8

## 1 INTRODUCTION

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Encardio-rite borehole extensometer is a precision instrument designed to help civil engineers and geologists in measurement of deformation of rock mass and adjacent or surrounding soil. Together with anchor bolt load cell and tape extensometer, borehole extensometer is an essential piece of equipment for investigation and monitoring of foundations, slopes & embankments and for studying the behavior of rock around underground cavities, tunnels and mines. Model EDS-64UD borehole extensometer can be used for upward or downward sloping hole using stainless steel or fiberglass connecting rods.

In model EDS-64U/D system offered by Encardio-rite, single point extensometer can be installed in a borehole of  $\phi$  50 mm with diameter at mouth of borehole increased to 62 mm up to a depth of 200 mm.

**NOTE:** This instruction manual gives procedure for mounting single point extensometer in a downward hole. For mounting in vertically upward to horizontal borehole modify procedure suitably.

### 1.1 Applications

- To determine how roof or wall of mine, underground cavity or tunnel behaves during excavation.
- To study effectiveness of roof/wall support system of a mine, underground cavity or tunnel.
- To measure and monitor movements in slopes and foundations due to excavation of underground cavities or due to construction of heavy structures like concrete, rock-fill, masonry or earth dams over the foundation.

### 1.2 Measurement method

Displacement is measured by using a micrometer depth gage, selectable ranges are 50, 100 and 150 mm.

### 1.3 Conventions used in this manual

**WARNING!** Warning messages calls attention to a procedure or practice that if not properly followed could possibly cause personal injury.

**CAUTION:** Caution messages calls attention to a procedure or practice that if not properly followed may result in loss of data or damage to equipment.

**NOTE:** Note contains important information and is set off from regular text to draw the users' attention.

### 1.4 How to use this manual

The users' manual is intended to provide sufficient information for making optimum use of the single position mechanical extensometer in different applications.

To make the manual more useful we invite valuable comments and suggestions regarding any additions or enhancements. We also request to please let us know of any errors that are found while going through the manual.

**NOTE:** Installation personnel must have a background of good installation practices and knowledge of fundamentals of geotechnics. Novices may find it very difficult to carry on installation work. The intricacies involved in installation are such that even if a single essential but apparently minor requirement is ignored or overlooked, the most reliable of instruments will be rendered useless.

A lot of effort has been made in preparing this instruction manual. However best of instruction manuals cannot provide for each and every condition in field that may affect performance of the sensor. Also, blindly following the instruction manual will not guarantee success. Sometimes, depending upon field conditions, installation personnel will have to consciously

depart from written text and use their knowledge and common sense to find solution to a particular problem.

Installation and measurements using borehole extensometer requires expertise. It is recommended that potential users themselves practice all operations laid down in this manual by repeated installations.

*For description of borehole extensometer manufactured by Encardio-rite: See § 2.1 "Introduction" and § 2.2 "General Description".*

*For installation of single point position borehole extensometers: See § 3 "Installation".*

*For tools & accessories required for installation: See § 3.3 "Tools & accessories required for installation".*

## 2 BOREHOLE EXTENSOMETER

### 2.1 Introduction

Borehole extensometer measures displacement taking place in a borehole with reference to time. Extensometer helps to accurately measure change in distance between anchor (1 figure 2.1) with respect to reference plate (5.8 in figure 2.2) and monitor their relative displacement with passage of time. It is usually assumed that the anchor is in stable ground and so any change in anchor spacing is interpreted as sag of roof bed, movement of side wall or slope, settlement of foundation etc.

Sl. #	Description
1	Anchor
2	Connecting rod
3	Air vent tube (Not required in Downward sloping borehole)
4	Grout pipe
5	Reference/flanged head Assembly
6	Reference button
7	Expandable Anchor M12x145 with washer & nut
8	Setting screw (Ch. Head) M6x100 (refer Figure 2.5)
9	Hex. Nut M6 (refer Figure 2.5)

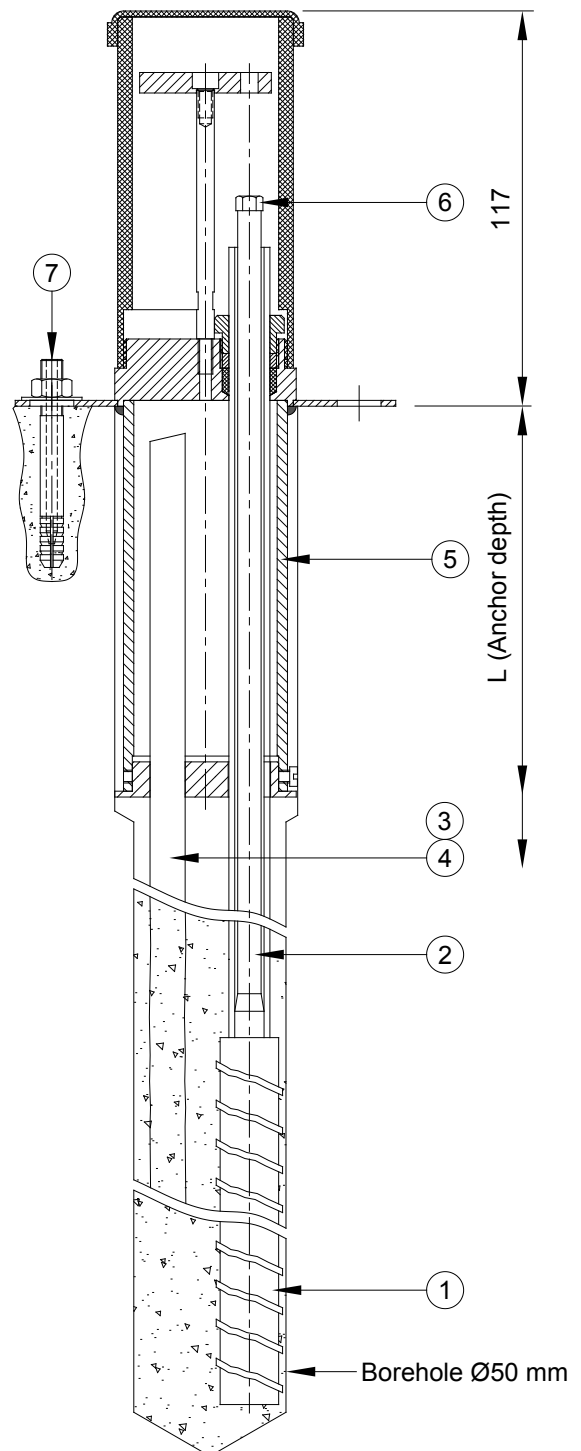
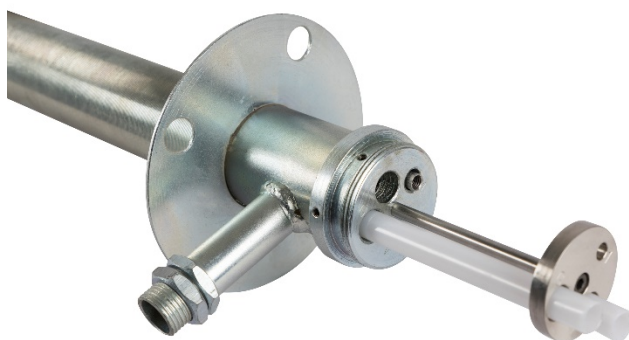


Figure 2.1

## 2.2 General description

EDS-64U/D essentially is a system in which single anchor is mounted in a borehole and its relative displacement is monitored with time with respect to a reference plate. At locations where access to mouth of borehole is easily available, mechanical measurement of displacement by EDS-64U/D is economical and reliable. Displacement reading is taken by a micrometer depth gage by measuring depth of reference button at near end of connecting rod from a reference plate.

Borehole extensometer basically comprises of three major components:

- Reference head assembly
- Stainless steel/Fiberglass assembly
- Anchor

### 2.2.1 Reference head assembly

Refer to figure 2.2 and part list below it for details. Reference head assembly for single point extensometer is installed in a borehole of  $\phi$  50 mm. The diameter at mouth of borehole is increased to 62 mm up to a depth of 200 mm. The flange has four 15 mm diameter mounting holes at a PCD of 105 mm.

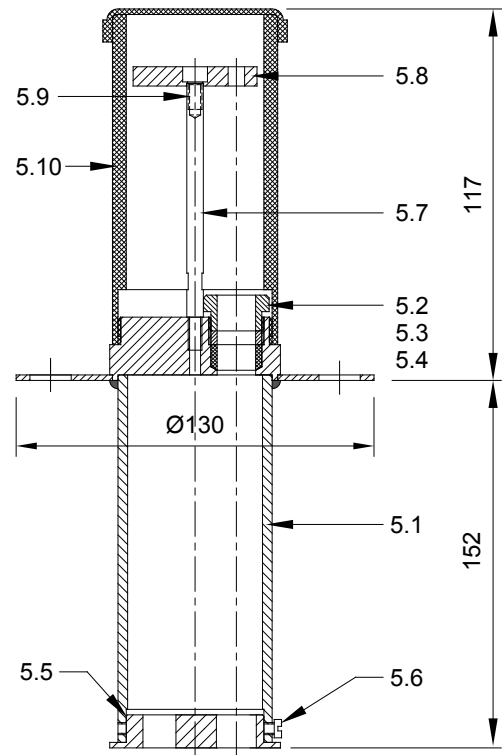
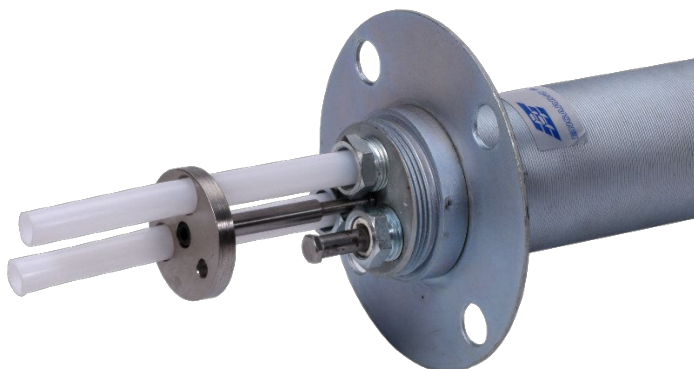


Figure 2.2

Sl. #	Description
5.1	Reference Housing
5.2	Rubber bush
5.3	Washer
5.4	Hollow bolt
5.5	Guide plate
5.6	Ch. Head screw M5x8
5.7	Center pillar
5.8	Reference plate
5.9	Allen head bolt M5x10
5.10	Cover assembly

### 2.2.2 Stainless steel/Fiber glass rod assembly

It comprises of a stainless steel/fiberglass rod of specified length protected inside an outer PVC tubing/continuous nylon tube. The rod has two end connectors. One end connector has a male thread and fits into the anchor. The other end connector with a female thread is for the reference button. The anchor end of PVC/nylon tube is firmly sealed with the anchor to prevent any grout from leaking in. The other end of the PVC/nylon tube is firmly sealed in the reference head assembly (refer 5.2 – 5.4 in figure 2.2). Proper sealing in the reference head assembly is especially necessary for upwards to horizontally slanting holes for preventing any grout for leaking into the reference head assembly during grouting.

The outer tube allows free movement to stainless steel/fiberglass rod and reference button even after borehole is grouted.

**NOTE:** Fiberglass rods are generally more suitable for vertically upward holes as compared to downward holes. This is because in vertically upward holes the rod is in tension; whereas in downward holes it is in compression, resulting in sagging or buckling. Longer the extensometer, greater may be the sagging or buckling.

Shorter the extensometer, better is accuracy of measurement of relative displacement between anchors. In deeper boreholes, use of stainless steel connecting rods is recommended, as they are more rigid.

Design Engineer should carefully consider what type of connecting rod to use taking into consideration field conditions and accuracy of measurement required. Actual performance of rods is determined by site conditions and it is recommended to conduct some field tests to arrive at a proper conclusion.

### 2.2.3 Anchor

Following type of anchor are available from Encardio-rite:

- Encardio-rite groutable anchor  $\phi$  20 mm x 500 mm long usually used for hard rocks. Anchor is lowered down or pushed in borehole along with connecting rod of appropriate length and fixed in position by cement grout. The connecting rod is protected from cement grout by enclosing in PVC/nylon tubing, thus allowing for its free movement. Groutable anchor may be installed in vertical boreholes or holes inclined upwards. Installation of groutable anchor in holes inclined upwards needs special precautions to retain grout and prevent it from flowing out of the borehole.

Reinforced bar groutable anchor of diameter 20 mm x 500 mm long is typically used in rock.

In case groutable anchor is installed in deep borehole, grouting in stages may be necessary and this may require some modification in the design. In such a case consult factory at Lucknow

**NOTE:** Encardio-rite uses the convention that depth of anchor is calculated as distance from mouth of hole to near end of anchor.



**Figure 2.3 – Fiberglass rod assembly**



**Figure 2.4 – Groutable Anchor**

### 3 INSTALLATION PROCEDURE

**NOTE:** Procedure described below is for installing borehole extensometer for single point in a downward/downward sloping hole using groutable anchor. For installation in an upward to horizontally sloping borehole, modify procedure suitably.

#### 3.1 Site preparation before installation

3.1.1 Drill hole of 62 mm diameter to the depth of 0.3 m more than length of anchor.

**NOTE:** In case borehole extensometer is to be mounted horizontally and design permits, it is desirable to provide a downward slope of 5° or more to the borehole. This facilitates grouting of anchor as grout can easily flow in.

3.1.2 At mouth of hole, increase diameter of drilled hole to 62 mm up to a depth of 200 mm for wrapping outside of housing with rags or jute cloth strips soaked in cement.

3.1.3 Insert reference head assembly centralised in the 62 mm borehole. Taking holes on flange as reference, drill four holes 15 mm diameter x 125 mm deep for fastening flange to borehole. Remove reference head assembly from borehole.

3.1.4 Wash hole clean upto bottom by pumping in freshwater.

#### 3.2 Procedure

3.2.1 Apply Loctite 415 or equivalent on machined portion of groutable anchor. Screw male end connector of stainless steel rod/fibreglass rod assembly to groutable anchor using Loctite 290 or equivalent as a thread sealant. In the process, the PVC protective pipe/nylon tubing will also get firmly gripped to groutable anchor.

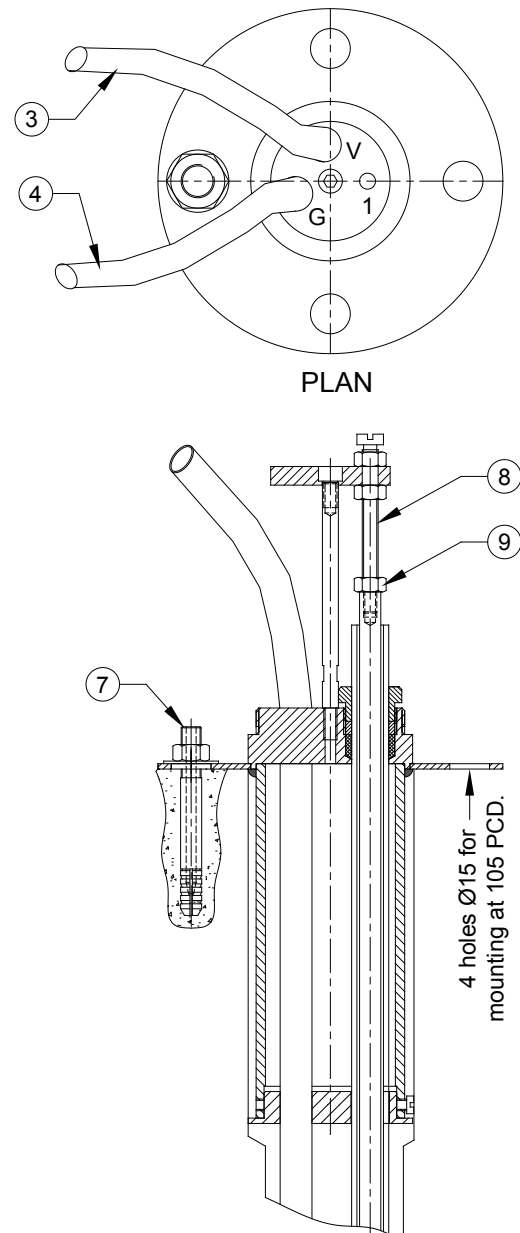
3.2.2 Refer to figure 2-2. Remove cover (5.10) from flanged housing (5.1) and place latter flat on the ground. Loosen all hollow bolts (5.4) slightly.

3.2.3 Insert groutable anchor into borehole till other end of stainless steel/fibreglass rod is around 1-1.5 m outside face of borehole. Trim PVC protective pipe/nylon sleeve such that female connector on stainless steel/fibreglass rod is exposed by around 150 mm/10 mm from connector end.

**NOTE:** The stainless steel rods are supplied in standard lengths of 1, 2, and 3 m with protective PVC tubing for the connecting rod.

**WARNING!** The fiberglass rod is supplied in coil form using cable ties. It is very stiff material and must be carefully handled when unwinding as the end may snap back and cause personal injury.

3.2.4 The end of stainless steel rod to pass through the guide plate (5.5 of figure 2.2) to emerge through hole marked '1' on reference/flanged housing top (5.1 of figure 2.2). In case of Fiberglass rod,



**Figure 2.5 – EDS-64UD Assembly**



guide end of fiberglass rod through corresponding hole in guide plate (5.5 of figure 2.2) to emerge through hole marked '1' on reference/flanged housing top (5.1 of figure 2.2). Fiberglass rod will have to be bent to achieve this. Locate setting screw (8 of figure 2.5) between reference plate (5.8 of figure 2.2) and female connector end of stainless steel/fiberglass rod. Insert setting screw (8 of figure 2.5) through reference plate hole and screw through setting spacer into female connector end. When tightened, reference button will be at a depth of around 25 mm from top of reference plate. In case this distance is to be maintained different, use different length setting spacer (8 of figure 2.5).

- 3.2.5 In case hole in reference plate is not aligned with hole marked '1' in flanged housing, loosen Allen head bolt (5.9 of figure 2.2) and retighten after aligning.

**NOTE:** On side wall and roof where extension is generally expected, it may be desirable to use a 5-10 mm setting spacer (8 of figure 2.5). Similarly, in a vertically down borehole where settlement is generally expected, it may be desirable to use a setting spacer of 40-45 mm.

- 3.2.6 Tighten hollow bolt (5.4 of figure 2.2) with spanner size 20 mm to firmly grip PVC/nylon tube but not to squeeze or hinder free movement of female end connector inside the PVC/nylon tube.

**NOTE:** In upward to horizontally sloping borehole, be particularly careful in tightening the hollow bolts (5.4 of figure 2.2) properly as grout may leak through into the reference head assembly during the grouting process.

**NOTE:** Always assemble and mount anchor first. This is a good convention to follow to avoid any confusion at a later date in identification. Holes on top of flanged housing are marked clockwise with identification numbers 1, G and V respectively.

**NOTE:** Take care that extensometer assembly does not drop into borehole accidentally. It is advisable to secure it properly by attaching a safety rope to the anchor.

- 3.2.7 Install grout tube in same manner as described in § 3.2.2 - 3.2.5. Generally, lower end of grout tube is kept at a level higher than the anchor. While inserting the anchor in borehole, lowest end of grout tube is tied with a cable tie to stainless steel/fiberglass connecting rod. To determine length of grout tube ensure that around 1.5 m is outside the flanged housing (5.1 of figure 2.2) for ease in attaching it to grout pump.

**NOTE:** In upward to horizontally sloping borehole, grout tube should be about 1.5 m longer than depth of anchor and taped around 300 mm below far end of anchor. Tape grout tube every 2 m with an insulation tape to the PVC/nylon tube to prevent it from swinging loose.

**NOTE:** In downward sloping borehole, air vent tube is not required.

**NOTE:** In upward to horizontally sloping borehole, air vent tube should be about 0.5 m longer than depth of anchor and taped around 50 mm above far end of anchor. Tape air vent tube every 2 m with an insulation tape to the PVC/nylon tube to prevent it from swinging loose.

**CAUTION:** In upward to horizontally sloping borehole, care should be taken that air vent tube is taped around 50 mm beyond rear of the anchor and should not get detached. This is very necessary for the grout to fill in up to end of the anchor.

- 3.2.8 Wrap rags or jute cloth strips soaked in quick setting cement water mix outside flanged housing (5.1 of figure 2.2) to build up approximately 5 mm thick layer. Lift and insert housing in borehole using a to and fro screwing motion sealing the annular space between housing and borehole. Fix wedge anchors ('7' in figure 2.5) in holes drilled earlier for securing flanged housing. Give enough time to let flanged housing set in borehole.

- 3.2.9 Connect grout pipe to grouting machine and pump grout till the entire cavity is filled up to tip of air vent pipe. Let grout set in for 8-12 hours.

**NOTE:** Check Engineer for cement water proportion to be used in grout. Composition of grout to be used depends upon site conditions.

**NOTE:** Grout should cover the anchor or be around 1 m from the face of the borehole whichever distance is less.

**CAUTION:** Please ensure that no grout overflows into the flanged housing. In case it overflows, it may get into the protective PVC/nylon tubing and may also jam the setting rods.

3.2.10 Again pump grout into the system after the 8-12 hours setting period is over to ensure that the anchor is properly grouted. During setting, the heavier grout has a tendency to settle down leaving water at the top with a possibility that grouting is not proper near the face of the borehole. Rule this possibility out by pumping grout again and ensuring that any such water at the top is pumped out through the air vent tube and replaced by grout.

**CAUTION:** To get correct displacement readings, ensure that the anchor is properly grouted.

3.2.11 Remove screws (9 of figure 2.5) and setting spacers (8 of figure 2.5). Cut the grout and vent tubes from the root and remove them. Clean reference head assembly properly.

3.2.12 Fix reference buttons to top of stainless steel/fiberglass rods.

3.2.13 Take initial readings with the help of depth micrometer. It is recommended to note date, time and temperature while taking the initial reading. Subsequent readings will determine relative displacement between anchor and reference plate.

### 3.3 Tools & accessories required for installation

The following tools and accessories are required for proper installation of the single position borehole extensometer:

- Loctite 290 and Loctite 415 or equivalent
- Acetone (commercial)
- Spanner size 6/7, 10/11, 20/22
- Screw driver ( tip size 6 x 0.4 mm)
- Allen key 5 mm
- Hacksaw with 150 mm blade
- Tube cutter
- SS connecting rod holding clamps-02 no.
- Application brush 25 mm
- SS top connecting rod (0.055 m)-1 no.
- Micrometer depth gage 100 mm range