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USERS' MANUAL

HORIZONTAL INCLINOMETER SYSTEM

MODEL EAN-26MH



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1 INTRODUCTION

The EAN-26MH horizontal inclinometer system is designed for long term monitoring settlement profile of structures like landfills, embankments, rafts or base slabs, storage tanks. The system is installed below the structures to study the behavioural changes particularly during the testing stage and also during its operating life, if required.

The horizontal inclinometer system provides significant quantitative data on magnitude of settlement and its variation with time. It gives information on pattern of settlement and effectiveness of construction control measures. It helps in monitoring behaviour after construction and indicates potentially dangerous conditions that may adversely affect stability of the structure, its foundation and surrounding area. It also provides basic data for design improvement that will promote safer and economical design and construction.

The EAN-26MH digital inclinometer system is an accurate instrumentation system. Its readout has built-in data storage facilities and capability of transferring stored data to a computer. The inclinometer probe operates in an ABS plastic grooved casing which may be inserted into boreholes underneath the structures. The inclinometer casing may be installed with fixed couplings as construction progresses providing opportunity for settlement measurements.

1.1 EAN-26M Digital Inclinometer Overview

The Encardio-rite model EAN-26MH Digital Inclinometer uses an Android OS based mobile phone with a Bluetooth wireless interface as a readout device. The recommended phone types have a large pixel with colour display and a capacitive touch screen that makes it easy to read the display while logging bore holes using Encardio-rite's range of horizontal borehole inclinometers.

Few functional advantages can be listed as follows:

- The readout unit can store readings from up to more than 1000 bore holes. The readings are not lost even if the power is turned off.
- Four readings are required for a uniaxial inclinometer survey for each depth level in a bore hole (as will be explained in the manual). In case of any error during logging, the probe can be inserted back to the distance with problem and logging can be continued without having to start afresh, thus saving time.
- A quick probe check mode allows verifying probe operation or calibration without having to configure a dummy borehole log as is required by most other commercially available inclinometer data loggers.
- The stored readings can be uploaded to a remote FTP server using GPRS/3G cellular network. The uploaded data is in a format that allows the data to be easily imported in spread sheet program like Microsoft Excel™.

Since readout unit is a mobile phone, most of the people are familiar with its operation. Working with a mobile phone readout unit is very easy and user friendly.

[™] (TRADEMARKS): Microsoft Excel is a trademark of Microsoft Corporation, USA.

1.2 How to use this manual

The manual is divided into a number of sections. Each section contains a specific type of information. The index tells you where to look for in this manual if you need some specific information.

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 General information

This users' manual is intended to provide you with sufficient information on operation of model EAN-26MH horizontal digital inclinometer and its mobile readout unit. The manual also contains instructions on how to set-up for inserting inclinometer probe into the ABS inclinometer casing for purpose of taking settlement readings.

NOTE: Installation personnel must have a background of good installation practices and knowledge of the fundamentals of geotechnics. Novices may find it very difficult to carry on the 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 the best of instruction manuals cannot provide for each and every condition in the field, which 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 the written text and use their knowledge and common sense to find the solution to a particular problem.

This equipment should be installed, maintained and operated by qualified personnel. Any errors or omissions in installation, data or data interpretation are not the responsibility of Encardio-rite Electronics Pvt. Ltd.

For details on how to install inclinometer casing, please refer to operating manual # WI 6002.103.

1.5 List of Abbreviations

3G	3rd Generation of wireless mobile telecommunications technology
4G	4rth Generation of wireless mobile telecommunications technology
CSV	Comma Separated Values
DI	Digital Inclinometer
EAN-26	Digital Inclinometer System
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
LED	Light Emitting Diode
PC	Personal Computer
SIM	Subscriber Identity Module
URL	Uniform Resource Locator
USB	Universal Serial Bus
WDMS	Web based Data Monitoring Service
Wi-Fi	Wireless Fidelity

2 GENERAL DESCRIPTION & SPECIFICATIONS

The horizontal inclinometer system mainly comprises of the following:

2.1 Casing model EAN-26-MH/1.1

Self-aligning ABS inclinometer casing with four internal groove at 90° to each other with 70 mm o.d. and 58 mm i.d. in 3 m length is supplied. Grooves inside the casing control the orientation of the probe and provide a fixed surface for measurements. Casing is installed with one pair of groove aligned vertically such that there is a top groove and a bottom groove.

2.2 Fixed coupling EAN-26MH/1.2

ABS, 77 mm o.d., 160 mm long fixed coupling is used for jointing two lengths of the above access casing.

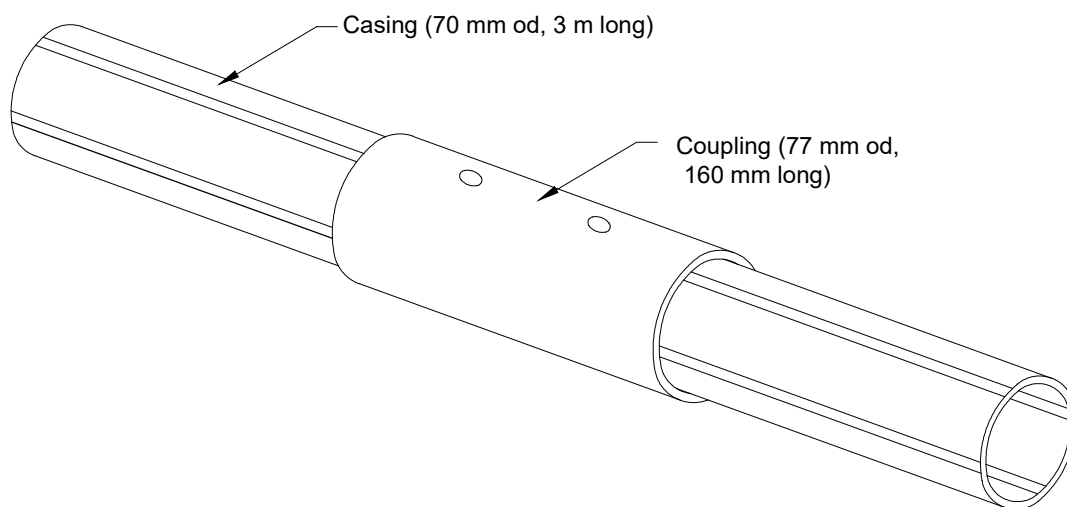


Figure 1 – Casing and Couplings

2.3 Protective cap model EAN-26MH/1.4

End cap for inclinometer cable reel end. The protective end cap incorporates a threaded adaptor.

2.4 Protective cap model EAN-26MH/1.5

End cap for pull cable reel end. The protective end cap incorporates a removable pin.

2.5 Inclinometer probe model EAN-26MH/2.1

It is of stainless steel construction designed to take measurements within horizontally installed inclinometer casing. The probe is uniaxial and is fitted with a pair of pivoted sprung wheels which can freely rotate on individual bearings and a pair of fixed wheel so as to rest on the base of the access tubing having a center distance of 500 mm i.e. gage length. Both the ends of probe have provision to fix threaded adaptor used to connect the pull cable when taking readings. A four pin connector is provided for connection to the cable. A '+' sign is marked on one side of sprung wheels. This side will be at the top

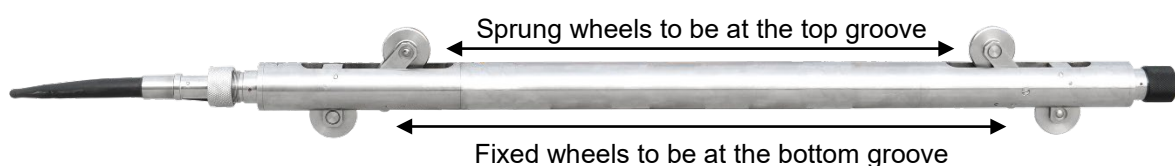


Figure 2 – Inclinometer Probe

groove for monitoring.

2.6 Mobile phone datalogger

The Digital Inclinometer system uses an Android OS based mobile phone as a hand held datalogger. Any mobile phone with minimum features (as listed below) can be used for this application. The Android operating system of phone for providing powerful platform to manage applications efficiently. It has additional useful features like phone calls, SMS, MMS, GPRS/3G, Wi-Fi, Bluetooth, USB, high resolution camera and high capacity external memory card.

The Encardio-rite inclinometer application software on the phone enables it to configure and collect data from the digital inclinometer system. The application is very friendly and has ability to show borehole logs in tabular format and create plots of borehole data instantly after borehole reading is complete. This allows the operator to verify the logged data and investigate any anomaly immediately at site.



Figure 2-3 Mobile readout unit

2.6.1 Mobile phone datalogger (minimum requirements)

A mobile phone that is intended for use as readout unit for the digital inclinometer should have the following minimum features. If a mobile phone is ordered and supplied with the system it shall have the following minimum features.

Mobile OS	Android version 2.2 or above
RAM	512MB (recommended 1 GB).
External memory	2 GB or above
Display size	480 x 800 pixels or above
Display Type	Touch screen
CPU Speed	1 GHz or above
Blue tooth	Version 3.0 with A2DP or above
Mobile Network	2G Network: GSM850/900/1800/1900 3G Network: HSDPA900/2100 (If the mobile phone readout will be used in an area covered by CDMA network services only, then a mobile phone suitable for CDMA should be used or ordered)

NOTE: Due to continuous improvements and change in availability of models no specific recommendations can be made about manufacturer and model number. Also the above features may change, if the application is upgraded. Please contact factory for latest update on minimum features requirement for mobile phone.

2.7 Dummy probe model EAN-26MH/2.2



Figure 4 Dummy Probe

2.8 Calibration check jig model EAN-26MH/2.3



Figure 5 – Calibration check jig

2.9 Operating cable and cable reel Model EAN-26MH/3.1

Two conductor stretch resistant polyurethane cable with Kevlar high tensile strength cable, graduated at every 0.5 m. Length is as specified by the customer. A four pin connector is provided for connecting to



Figure 6 –Inclinometer Cable reel

the probe. The cable reel comprises of a plastic winding reel to hold the specified length of cable.

2.10 Pulling cable with reel Model EAN-26MH/3.2

It is used to pull inclinometer probe from the other end. The pulling cable has one end with a threaded connector, which is used to connect dummy or inclinometer probe or to an end cap (which is used as a cover for ABS casing) when not in use. The other end is with an adjustable loop for anchoring hook in reel while use or to protective cap when not in use. This cable is always left inside the casing, stretched throughout the length, hooked to the end caps. For checking access tube and taking reading the threaded end adaptor (figure 14) is fixed to the dummy or inclinometer probe and the pull cable loop is fixed to the pull cable reel. The other end of the dummy/probe is fixed with operating cable.

2.11 Installation accessories

- Model EAN-26MH/1.6 pop rivets for ABS tubing
- Model EAN-26MH/1.7 pop rivet gun
- Model EAN-26MH/1.8 power drill machine with 3.2 mm ϕ drill bit
- Model EAN-26MH/1.9 sealing accessories - mastic tape
- Model EAN-26MH/1.10 Sealing accessories - BOPP tape

3 INSTALLATION PROCEDURE

- 2.1 Mark the alignment with the help of surveying equipment over the base slab reinforcement cage or where the inclinometer access casing has to be laid. This alignment has to be a straight line passing through the centre point of the structure and close to horizontal.
- 2.2 In a clean work area, collect all material to be installed along with the required accessories.
- 2.3 Make sure to clean the casing ends before inserting the same inside the fixed coupling. Also make sure that the inside surface of the casings is free of any dirt/debris while jointing.
- 2.4 Install the casing with one pair of grooves oriented vertically, such that there is a top groove and a bottom groove. Make necessary arrangement (use of wooden packing etc.) to make the alignment horizontal wherever required.
- 2.5 Mark the outside of each casing as the top groove and start assembling.
- 2.6 Pass the threaded adaptor of pull cable reel through the first access casing (pull cable end) and coupling.

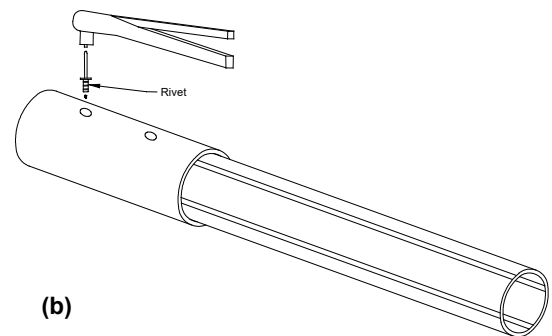
NOTE: The pull cable is to pass through all the consecutive casings and couplings to be connected.

- 2.7 Insert casing into the coupling after matching the access casing ridge to the grooves inside the fixed coupling. Insert all the way to the central collar inside the coupling. The casing will stop at the collar. Ensure not to leave any gap between the ends of the two casings inside the fixed couplings. Repeat the same procedure for the other casing also.

NOTE: If there is a gap between the two access casings inside the fixed coupling, the inclinometer probe wheels are likely to get stuck in the gap at the time of monitoring. Pulling out the probe with great force will lead to loss of calibration/damage of its sensor as these are sensitive to shock.



(a)



(b)



(c)



(d)

Figure 7

- 2.8 Join the coupling with casing using pop rivets and pop rivet gun supplied with installation accessories (refer to figure 7 (a),(b)). Riveting shall be done at two diametrically opposite points. There shall be four rivet joints per coupling. Position of these points is given in the fixed couplings as shallow holes of around 3 mm dia on its outer surface. To rivet, first drill a hole from the shallow hole with the help of power drill machine all the way through the access casing below.
- 2.9 Put a rivet through (Refer to figure 7 (b)) the drilled hole by inserting the head portion of the rivet into the hole till its collar rests over the surface of the coupling. Light hammering may be required to get the rivet firmly seated. Do not hammer at the rivet pin as it may dislodge from the cylindrical rivet head. Use a small piece of hollow casing with length slightly greater than that of the pin and having suitable diameter for hammering purpose. Make a secure riveted joint using the rivet gun.
- 2.10 Seal joints between fixed coupling and casing with mastic waterproof tape (Refer to figure 7 (c)). Surfaces where mastic tape has to be applied should be clean. Proper sealing by mastic tape is necessary to prevent intrusion of concrete sap inside the casing. One round of mastic tape with a least 10 mm of overlap should be put at each joint between the coupling and the access casing. Ensure that the mastic tape covers the rivets also. Press the applied mastic tape firmly over the joint.
- 2.11 Put at least two rounds of BOPP (Refer to figure 7 (d)) tape firmly over the applied mastic tape. This will further ensure that the joint remains waterproof.
- 2.12 Repeat the above procedure for jointing further lengths casing. Ensure the pull cable is passing through the connected access tubing.
- 2.13 Figure 8 shows a set of two inclinometer protective caps for the installed inclinometer casing that are used in place of the standard caps when pull cable are used. The stainless steel pull cable has to be left inside the inclinometer casing, stretched throughout the casing length. One end cap has pin that is used to anchor the loops at the ends of the pull cable so that the pull cable can be easily retrieved out of the casing from either end, whereas another has a threaded connector to fix the other end of the pull cable.



Figure 8 – Casing end caps

- 2.14 One end of pull cable is provided with a loop for fixing to the protective cap (or to the pull cable reel). See Figure 9 for details.

- 2.15 Form loop at the end of pull cable with the adjustable clamp. Tighten the set screws after adjusting the cable length. The excess free cable length protruding out of the clamp can be cut off with a steel wire cutter.
- 2.16 The length of the pull cable can be adjusted (shortened) to the desired length by loosening the set screws and drawing out the free end of the pull cable through the adjustable clamp.

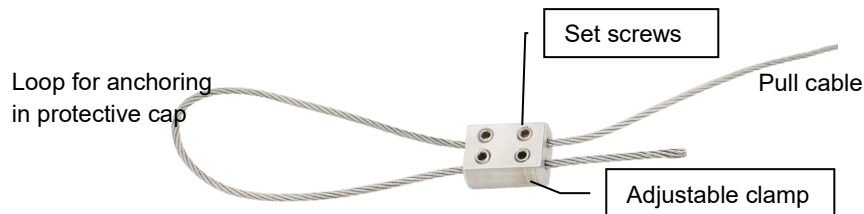


Figure 9 Loop for fixing

- 2.17 Connect the pull cable loop to protective cap (Refer to figure 10). The removable pin of the protective cap is unscrewed from one end. The loop of the pull cable is then guided over the end of the pin and the pin is screwed back to the cap to anchor the pull cable. Figure 9 shows how the loop of the pull cable at the cable reel end is fixed to the protective cap. This pull cable loop has to be removed from the protective cap and fixed to the pull cable reel for reeling when taking readings.

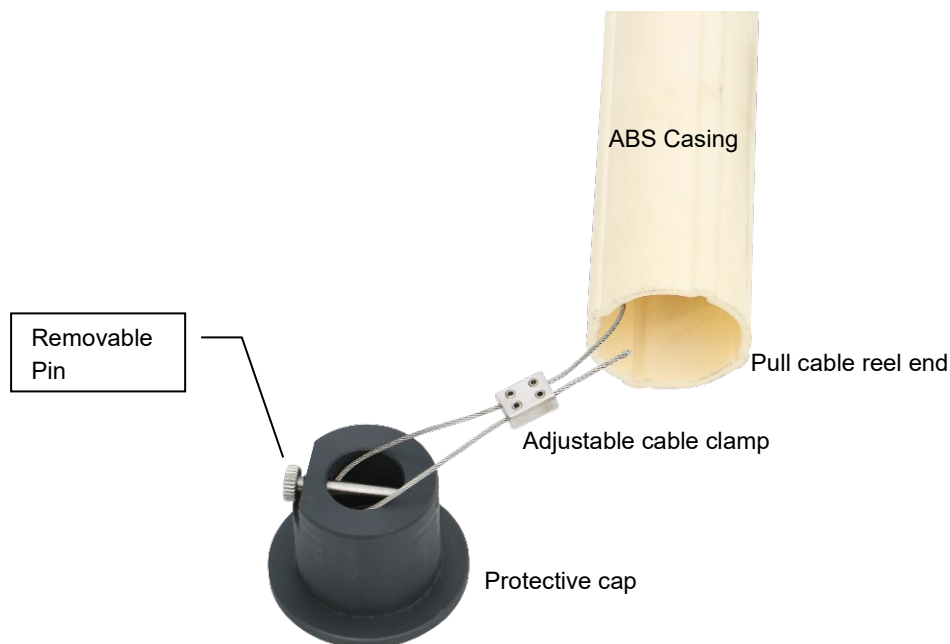


Figure 10 Pull cable at reel end fixed to the protective cap

- 2.18 The other end of the pull cable has a threaded adaptor for fixing the protective cap. The threaded adaptor should be kept engaged to the casing end cap as shown in Figure 11 when not in use.



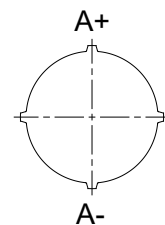
Figure 11 – Pull cable with threaded adaptor fixed to protective cap

- 2.19 Remove the protective cap from the access tube. Disengage the threaded adaptor from the casing end cap.
- 2.20 Connect and fix the dummy probe to the threaded adaptor and other end to the operating cable to pull the probe through the access casing.
- 2.21 Pass dummy probe to check the correctness of casing jointing after assembling casings of 3 m each.

NOTE: Make sure to pass the SS pulling wire through the casings while assembling the same. This wire shall remain permanently inside the access casing to facilitate pulling of dummy and main probes.

- 2.22 Secure the jointed casings on the marked alignment either using a tie wire or nylon cable ties to the reinforcement cage/horizontal borehole. This securing is essential as the casings might get shifted in any random direction during pouring of concrete.

NOTE: Maintain one pair of groove parallel to the horizontal plane/surface. This would ensure that the major set of groove, which shall be used for passing the inclinometer probe, is perpendicular to the base slab. Maintain this orientation all through the casing alignment.



CAUTION: Ensure that the orientation of major set of groove remains perpendicular to the base slab, right from the first casing laid, to the last one, at the other end of the alignment i.e. it should be maintained perpendicular all across the diameter of the base slab. This is essential to get correct data.

NOTE: Prolonged exposure of casing to direct sunlight should be avoided. During assembly, casings yet not covered under concrete shall always be kept covered with a vinyl cover to protect from direct sunlight. It should also be protected against any type of impact during the installation process.

- 2.23 Keep the ends of the casings covered by using the special protective caps provided. Cover the ends during the assembly process- if the tubing is being left unattended.

NOTE: Make sure that during pouring of concrete on the base slab, concrete is not poured directly over the access casings. This might distort or even damage the casings.

- 2.24 Flush inside of casing with clean water after concreting. This will wash away any type of dirt, debris, concrete sap, rivet heads etc.

NOTE: It is recommended to again flush the hole with water just before commencing the monitoring. Also pass a wooden 'dolly' to check for seepage of concrete sap, if any.

- 2.25 Keep at least 50 mm length of casing protruding outside the sidewall of the raft / base slab / any horizontal surface. The length shall be sufficient to put a surveying mast while determining the elevation of casing. The casing ends should be filed to give a neat finish after cutting with hacksaw up to the required length.
- 2.26 If installed in the trench, backfill the remainder of the horizontal borehole with finely graded material or select fill. Compact by hand.
- 2.27 Mark inclinometer identifications and direction of major groove set where the probe shall be inserted near the casing end at the sidewall. Use paint or permanent marker for this purpose.

After installation check

- Check installed access tubing by dummy probe before inserting inclinometer probe.
- Ensure to place end caps and protective fencing with safety sign board after installation of access tubing.

4 PREPARATION FOR AND OBTAINING READINGS

For detailed instructions, refer to section 6 & section 7 of Digital Inclinometer operation manual # WI 6002.103.

5 SIGN CONVENTION

The inclinometer datalogger uses a sign convention for casing orientation. Follow sign convention strictly. Mark casing groove orientation with a permanent ink marker pen on outside of casing and inside of lockable cover.

While inserting probe into casing, the fixed wheels of the probe are kept downward and sign '+' side is guided upwards to the top groove, connected to the operating cable reel (Refer to figure 13).

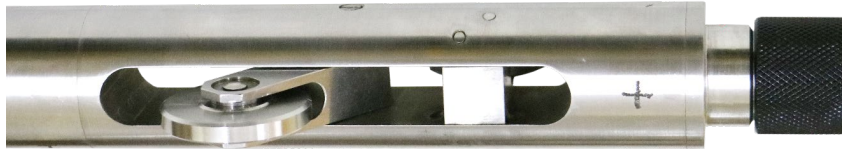


Figure 13 Sign marked on the Inclinometer probe

6 TAKING INCLINOMETER READINGS

NOTE: At least two people will be required to take horizontal inclinometer reading as one has to pull the probe using pulling cable from the farther end whereas another will monitor the readings on datalogger.

- 5.1 Take out the inclinometer probe from the carrying case carefully outwards taking care that the probe is not subjected to any shock.



Figure 14 –Inclinometer probe and dummy sensor

- 5.2 Check the installed access tubing by dummy probe before inserting inclinometer probe; the dummy sensor (probe) is also laid out in the foreground Figure 14.
- 5.3 At pulling end remove the pull cable loop from the protective cap. Unscrew the removable pin of the protective cap and take out the loop of the pull cable from the end of the pin. Screw back the pin to the cap (Refer figure 9 and 10).
- 5.4 Now fix the pull cable loop to the pull cable reel for reeling before taking readings.
- 5.5 At the monitoring end remove the protective cap from the access tube. Disengage the threaded adaptor from the casing end cap. (Refer to figure 11)
- 5.6 Figure 15 shows the horizontal inclinometer system components laid out prior to taking readings. The one end of the pull cable is shown ready to be fixed to one end of the inclinometer probe.



Figure 15 – Complete Inclinometer system

- 5.7 Remove the safety cap at the other end of the inclinometer probe.
- 5.8 Fix the inclinometer probe (side marked as '+') to the inclinometer cable reel connector and other end to the threaded adaptor of pulling cable connector (refer figure 9) to pull the probe through the casing.
- 5.9 Plug the readout connector of the cable reel to the readout unit. Connect the mobile datalogger with the cable reel.
- 5.10 Follow the inclinometer operation manual #WI 6002.103 section 7 & 8 for setting up the inclinometer probe and the borehole configuration. Also refer to the test certificate and configuration sheet for the parameters.
- 5.11 Below mentioned parameters are set:
 - Site code.
 - Borehole code.
 - RDG INT - reading Interval
 - After saving above set-up enter orientation of the probe. For example, in case orientation entered is 'A', the faces that will be logged will be 'A' and 'B', the probe being a uni-axial sensor the reading of axis B is irrelevant. Faces A, B, C, and D are here referred as A+, B+, A-, and B-.
 - On confirming 'Yes' that information is correct, the datalogger will be ready to log the data.
 - For logging borehole data, refer to the section 7 & 8 of the Inclinometer operation manual.
- 5.12 Insert the inclinometer probe in the access tube with spring loaded wheel pointing in direction marked 'A+'. Orient far end wheel of probe in direction 'A+' as marked on casing grooves and insert it into access tube up to first mark on the cable. Pull probe along the entire length of access tube with a help of pull cable reel from the other end. Keep unwinding the interconnecting cable.
- 5.13 Let probe rest at the end of the far end of access casing for approximately 5 minutes to stabilize temperatures within the probe and cable. Pull probe along the entire length of access tube with the help of cable reel, taking readings at intervals of 0.5 m. Continue logging data unless **Face AB Done** is displayed on screen. A walkie-talkie or mobile phone can be used for communication at the other end of the horizontal borehole.
- 5.14 Pullout probe from casing and remove probe from the cable connecting inclinometer probe and connect it to the other end of the probe.
- 5.15 Now insert the inclinometer probe again in the ABS Inclinometer casing and pull it to the other end of the access tubing with the spring loaded wheel pointing in direction 'A-' i.e. the farthest end of '+' at the sprung wheel side. Pull the probe along the entire length of access tubing from pull cable end to probe cable end, taking readings at intervals of 0.5 m. When all the faces are logged, borehole completed will be displayed.
- 5.16 Upon probe reaching end of casing, take out the probe.
- 5.17 Remove the threaded adaptor from the probe and fix it on the protective cap (Refer to figure 11).

- 5.18 Disconnect the mobile datalogger from the cable reel.
- 5.19 Disassemble cable from probe. Wipe clean the probe and replace protective caps on the cable and the probe. Grease the wheel, springs and axle pivots.
- 5.20 Pack probe, cable holder and datalogger in the case.
- 5.21 Rewind cable onto the cable reel, clean it and fix the connectors in place.
- 5.22 Replace the two protective end caps and plug on the ends of casing and lock it. In case any additional protection is provided, install it.

NOTE: Frequent causes of failure of the inclinometer system are like probe is not properly cleaned, associated cable, connectors and datalogger after the use. Not greasing the wheel, springs and axle pivots will invariably result in costly repairs and equipment downtime.

7 CALIBRATION CHECK JIG OF INCLINOMETER PROBE

The calibration check jig is used to ensure that the original factory calibration is unchanged. Any drift in inclinometer probe calibration at a later date will be detected by the calibration jig. The calibration jig should be fixed to a vertical wall so that at 0° position the calibration jig fixed plate is aligned as much horizontal as possible. Before using the probe for taking readings the probe should be inserted in the calibration jig and probe readings for 0° and + and - 30° positions are noted down. If any drift is detected in the probe readings at a later date, it indicates that the probe needs calibration. It should be noted that the 0° and $\pm 30^\circ$ positions are approximate and should not be taken as calibration points.

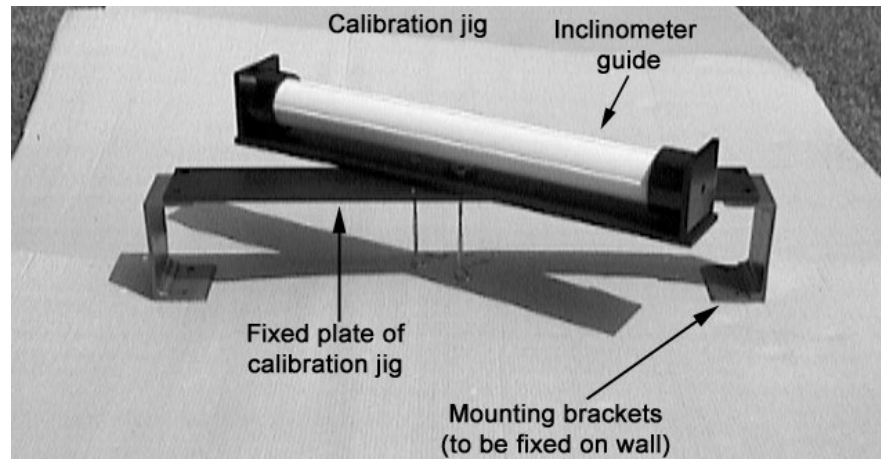


Figure 16 – Calibration jig components

Figure 16 shows the calibration jig components. The mounting brackets should be attached to the fixed plate of the calibration jig using the supplied set of fasteners. The calibration jig should be fixed to a vertical wall surface by fixing the mounting brackets to the wall using any commercially available brick/concrete fasteners with 10 mm stud diameter. While fixing ensure that the fixed plate of the calibration jig is lengthwise aligned as much horizontal as possible.

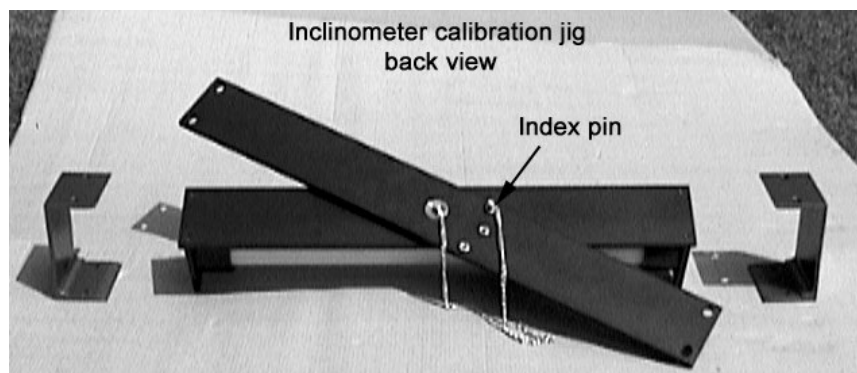


Figure 17 – Index pin and reference holes

Figure 17 shows the index pin and the three reference holes as seen from the back of the calibration jig. After installation this side of the jig faces the wall. The index pin is attached to the calibration jig by a length of chain. During calibration check the inclinometer guide assembly is rotated till the index pin goes through any one of the three holes seen in the figure and the locating hole provided in the guide assembly.

The middle hole corresponds to 0° position and the two holes at either side correspond to + and - 30° positions. It is immaterial which hole is considered +ve as only the probe readings corresponding to the three holes positions are to be noted for future reference.

Figure 18 shows the inclinometer probe being readied for calibration check. The protective end cap (B) of the inclinometer probe has been removed. A special screw-on retainer cap (A) is used for anchoring the inclinometer probe inside the guide during calibration check. This retainer cap is fixed to the calibration jig when not in use.



Figure 18 – Calibration jig & inclinometer probe with protective end cap, retainer cap and anchoring screw

The retainer cap is fixed to the inclinometer probe at one end. The anchoring screw (S), shown alongside is screwed to the retainer cap from outside the inclinometer guide to anchor the inclinometer probe inside the calibration check jig.



Figure 19 Calibration jig & inclinometer probe

Figure 19 shows the inclinometer probe with cable connected being inserted inside the calibration jig inclinometer guide casing. Note that the fixed set of wheels point downwards and the spring loaded wheels point vertically upwards.

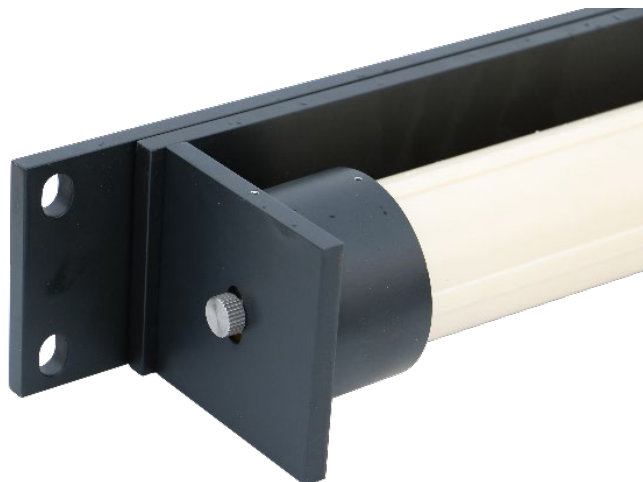


Figure 20 – Calibration jig with anchoring screw (S) fixed

After the inclinometer probe is fully pushed inside the guide casing of the calibration jig, the anchoring screw (S) (Refer to figure 20) is fixed to the retainer cap on the inclinometer probe. This prevents the inclinometer probe from sliding out of the guide casing during calibration.

7.1 Some do's and Don'ts

Do's

- If large deformations are expected to take place, use dummy probe before inserting the actual probe.
- Check if directions 'A+', and 'A-' are clearly marked on casing mouth. In case the marks are fading away, re-mark them.
- Always allow enough time for the accelerometers to "settle down" before taking any reading.
- When pulling probe during a set of readings, take extreme care in duplicating depths A+ and the A- reading runs such that errors contributed by casing irregularities are minimized.

NOTE: Keep all electrical connections clean - use alcohol or a spray cleaner suitable for electronics that will not damage the outer cable covering or panel finish.

- Replace probe wheels and axles if they become wobbly or sticky.
- Constantly check conditions of "O" ring on probe face to maintain a watertight seal.
- Keep protective plugs in place on all electric outlets to prevent physical damage or liquids spilling over them.

Don'ts:

- Hard bumps to probe can misalign and/or break the accelerometers or break internal electrical connections.
- Bending connecting cable over sharp objects or walking on it can sever internal conductors or puncture the outer waterproof coating.
- Dragging cable through the cable brake/holder on the pulley mechanism may damage or move the copper ferrules.
- The batteries should not be overcharged. Maximum recharge time is 16 hours or two times the period in operation since the last recharge. Do not attempt to recharge internal batteries or operate from an external power source when the temperature of the indicator is below 5°C.

NOTE: The inclinometer system is like other delicate equipment and its use requires common sense and reasonable care!

8 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 having no prior experience may find it difficult to carry on with this work. 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.