Horizontal inclinometer system
Model TES-AN-25H
System description & method statement for installing ABS casing (Model TES-AN-25H horizontal inclinometer system) in a raft or a base slab

1. General description & specifications

The horizontal inclinometer system is used for measurement of settlement profile of a structure e.g. a raft or a base slab during the testing stage in particular and during its entire operating life, if required.

The horizontal inclinometer system mainly comprises of the following:

1.1 Casing model TES-AN-25/1.1

Self aligning ABS inclinometer casing with four internal keyways at 90° to each other, 70 mm o.d., 58 mm i.d. and length 3 m each.

1.2 Fixed coupling TES-AN-25/1.2

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

1.3 Protective cap model TES-AN-25H/1.4

End cap for inclinometer cable reel end. The protective end cap incorporates a fixed pin.

1.4 Protective cap model TES-AN-25H/1.5

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

1.5 Inclinometer probe model TES-AN-25H/2.1

It is of stainless steel construction designed to take measurements within horizontally installed inclinometer casing. It is biaxial and is fitted with two pairs of pivoted sprung wheels which can freely rotate on individual bearings. The rear end of probe has provision to fix an eye bolt used to connect the pull cable when taking readings. The standard gage length between the wheels is 500 mm. A six pin connector is provided for connection to the cable.

1.6 Inclinometer datalogger model TES-DI-53 INS

The data logger is compatible with the inclinometer probe. It is battery operated with an easy to read display. It is housed in a rugged and weather proof enclosure. The data logger has built-in data storage.
facility and is capable of analyzing the stored data. It is supplied complete with software to transfer the
data to a PC for further processing or for archive purposes.

1.7 Dummy probe model TES-AN-25H/2.2

1.8 Calibration check jig model TES-AN-25H/2.3

1.9 Operating cable and cable reel Model TES-AN-25H/3.1
Polyurethane sheathed six core 30/0.2 ATC cable with central high tensile straining member, graduated
at every 0.5 m. Length as specified by the customer. A six pin connector is provided for connecting to the
probe. The cable reel comprises of a plastic winding reel to hold the specified length of cable.

1.10 Pulling cable with reel Model TES-AN-25H/3.2
It is used to pull inclinometer probe from the other end. This cable is always left inside the casing,
stretched throughout the length, hooked to the end caps.

1.11 Installation accessories
- Model TES-AN-25/1.6 pop rivets for ABS tubing
- Model TES-AN-25/1.7 pop rivet gun
- Model TES-AN-25/1.8 power drill machine with 3.2 mm φ drill bit
- Model TES-AN-25/1.9 sealing accessories - mastic tape
- Model TES-AN-25/1.10 Sealing accessories - BOPP tape

2. Installation procedure

2.1. Accurately mark the alignment with the help of surveying equipment over the base slab
reinforcement cage where the inclinometer access casing has to be laid. This alignment has to
be a straight line passing through the centre point of the tank and close to horizontal. Make
necessary arrangement (use of wooden packing etc.) to make the alignment horizontal wherever
required.

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. 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 a gap is there 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.

2.5. Join the coupling with casing using pop rivets and pop rivet gun supplied with installation
accessories (refer to figure 2). 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.

2.6. Put a rivet through 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.

2.7. Seal joints between fixed coupling and casing with mastic waterproof tape. 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.

![Figure 2 – rivet at two diametrically opposite points](image)

2.8. Put at least two rounds of BOPP (refer to figure 3) tape firmly over the applied mastic tape. This will further ensure that the joint remains waterproof.

2.9. Repeat the above procedure for jointing further lengths casing. Pass dummy probe to check correctness of casing jointing after assembling 3 casings of 3 m each. 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.

2.10. Secure the jointed casings on the marked alignment either using a tie wire or nylon cable ties to the base slab reinforcement. 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 base slab. This would ensure that the principal 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 principal 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 should 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.
2.11. 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.

2.12. 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.

2.13. Keep at least 50 mm lengths of casing protruding outside the sidewall of the raft or the base slab. 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.

2.14. Mark inclinometer identifications and direction of principal groove set where the probe shall be inserted near the casing end at the sidewall. Use paint or permanent marker for this purpose.

3. Pictorial description

3.1 Carrying case and dummy probe

The Inclinometer probe is shipped in a protective carrying case. Remove the end cap retaining pin by unscrewing the thumb screw as shown in figure 4 (above) and figure 5 (next page).
Figure 5

Take out the retaining pin and remove the end cap and protective filler foam. Draw out the inclinometer probe carefully outwards taking care that the probe is not subjected to any shock.

Figure 6

Figure 6 shows the inclinometer probe taken out of its carrying case. The dummy sensor (probe) is also laid out in the foreground. Notice the inclinometer probe has two screw-on protective caps with integral eye bolts for protecting the probe connector at each end. The eye bolts are used to fix the pull cable when taking readings. These protective caps have to be removed for connecting the inclinometer cable connector to the probe.

3.2 Inclinometer casing accessories and pull cable.

Figure 7
Figure 7 shows a set of two inclinometer protective caps for the installed inclinometer casing that are used in place of the standard caps when pull cables are used. The stainless steel pull cables have to be left inside the inclinometer casing, stretched throughout the casing length. The end caps have pins that are 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.

![Figure 8](image)

**Figure 8**

One end of the pull cable has a standard hook for fixing to the dummy or inclinometer probe. The other end is provided with a loop for fixing to the protective cap (or to the pull cable reel). See figure 8 for details. An adjustable clamp is provided for forming the loop. If required, after installation, the length of the pull cable can be shortened to the desired length by loosening the set screws and drawing out the free end of the pull cable through the adjustable clamp. The excess free cable length protruding out of the clamp can be cut off with a steel wire cutter. Do not forget to tighten the set screws after adjusting the cable length.

![Figure 9](image)

**Figure 9**

Figure 9 shows the how loop of the pull cable at the reel end is fixed to the protective cap. The removable pin of the protective cap is removed by unscrewing. 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. This pull cable loop has to be removed from the protective cap and fixed to the pull cable reel for reeling when taking readings.
3.3 System Components

Figure 11 shows the horizontal inclinometer system components laid out prior to taking readings. The inclinometer casing shown on the left would generally be installed in foundations etc. The hook of the pull cable is shown fixed to one end of the inclinometer probe. The safety cap at the other end of the inclinometer probe has been removed and the probe connector at the end of the probe cable reel is shown fixed to the inclinometer probe. The readout connector of the cable reel is plugged in to the readout and the system is ready for taking readings.

3.4 Calibration check jig

The calibration check jig is used to ensure that the original factory calibration is unchanged. Any drift in the calibration of the inclinometer probe at a later date will be detected by the calibration check jig. The calibration check jig should be fixed to a vertical wall so that at 0° position the calibration check 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 check jig and probe readings for 0° and + and - 15° positions noted down. If any drift is detected in probe readings at a later date, it indicates that probe needs calibration. It should be noted that the 0° and ± 15° positions are approximate and should not be taken as calibration points.
Figure 12 shows the calibration check jig components. The mounting brackets should be attached to the fixed plate of the calibration check jig (as shown in figure) using the supplied set of fasteners. The calibration check 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 is lengthwise aligned as much horizontal as possible.

Figure 13 shows the index pin and three reference holes as seen from back of the calibration check jig. After installation this side of jig faces the wall. The index pin is attached to calibration check jig by a length of chain. During calibration check, inclinometer guide assembly is rotated till index pin goes through any one of the three holes seen in the figure and locating hole provided in the guide assembly.

The middle hole corresponds to 0° position and the two holes at either side correspond to + and – 15° 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 14 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 15](image1)

Figure 15 shows the retainer cap 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 16](image2)

Figure 16 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 17](image3)
After the inclinometer probe is fully pushed inside the guide casing of the calibration jig, the anchoring screw (S) is fixed to the retainer cap on the inclinometer probe. This prevents the inclinometer probe from sliding out of the guide casing during calibration.

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 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.