

Inclinometer Settlement Movements Of Foundation and Embankment Materials

General Considerations- Internal measurement of settlements within an embankment and or foundation of a dam have been collected in the past by internal vertical movement devices generally. These devices have had many maintenance problems and in recent years have been replaced by measurements made within inclinometer casings. The inclinometer casings can be used to measure total or relative horizontal, vertical, or rotational movements or differential movements in any desired plane. Vertical movements, which indicate settlements of the embankment, are commonly the result of consolidation of foundation soils or embankment materials .

Description of system- The inclinometer settlement system uses the same type of casing as would be installed within drill hole installations. The major difference is at the casing joint or the connection point of the casings. Using an extended coupling, an open space is left between the two attached casing sections within the joint section (see figure 1 below). This joint separation can be made or set at a 6-inch separation or 12-inches of separation depending on the height of the embankment. At this connection joint a special settlement flange is attached to the outside of the casing to add surface area to the casing system so that when the embankment settles the inclinometer casing will settle also (see figure 2 below). These joint sections are placed every 10-feet throughout the embankment from the foundation to the top of the dam. All open casing sections are seal from the embankment materials by chalking and taping during assembly. Once the joint has been assembled the embankment materials are compacted around the casing as the dam is constructed.

The inclinometer settlement measuring point becomes the bottom of each casing section (see figure 1 below) so it is very important that during installation of casing sections, all casing sections are installed as vertical as possible and should remain that way through out embankment placement.

Taking of settlement readings- Monitoring of the inclinometer settlement is accomplished on a designated schedule by attaching a clamping or collaring device (see figure 3) to the top of the inclinometer casing. The collar device has a surveyor's tape attached to a reel that should only to wind up the survey tape to protect it from damage. **The surveyor's tape should never be used to winch the probe up the casing.** The collaring device also has an indexing mark where the depths to the casing settlement joints are measured. The settlement probe is attached to the end of the surveyor's tape along with a safety rope, both connected to the eyebolt on the top of the settlement probe. A probe constant should be determined for the probe once it has been attached to the surveyors tape. The probe constant is the distance from the top of the latches of the probe to the zero point on the surveyor's tape. This distance is added to all measurements taken using this probe. A second probe constant is the total length of the probe when it is closed for removal from the casing. This second probe constant is added to the distance measured when the probe reaches the bottom pin in the foundation and the probe closes.

The settlement probe is lowered into the casing aligning the probe with one set of inclinometer casing grooves placing the probes wheels within this groove. As the probe is lowered down the

casing, the survey tape is unwound along with the safety rope. Once the probe reaches the bottom of the first casing, the probes' measuring latches will spring open against the side walls of the casing (see figure 1 below). The operator should pull back on the survey tape and safety rope until the probe won't move up any farther. A reading to survey tape at the reference mark or zero point on the collar device should be taken. Once this is completed, the probe should be continued down the casing successively stopping at each casing joint location down the length of the casing. The probe is lowered just past the casing joint and then lifted until the latches make contact with the bottom of the casing. The depth to that point from the zero reference point on the collar device at the top of the casing is then recorded. Each casing joint is then measured in the same manner progressing downward. The probe can only be removed from the casing by lowering it to the rod that has been installed at the bottom of the pipe. The rod will cause the probe to close latching the measurement arms so that the probe can be pulled from the casing (see figure 1 below). The last reading of the settlement of the bottom of the casing should be taken now. To remove the probe, the safety rope should be used. As the safety rope is pulled the survey chain is then wound up on its reel. **Don't attempt to remove the probe by only using the survey chain crank** (see figure 4). This procedure will cause the gears on the survey reel to break. The elevation of the top of the casing must be determined from an off-dam reference benchmark. This allows for the elevation of each casing measurement point to be determined. Once the probe has been removed from the casing the pipe cap is replaced. Original elevations at the various levels of the inclinometer casing should have been obtained during the installation of each casing joint during construction. These elevations which are commonly determined to an accuracy of 0.01 foot should be compared to the elevations determined by the settlement probe for changes in the settlement at each casing joint.

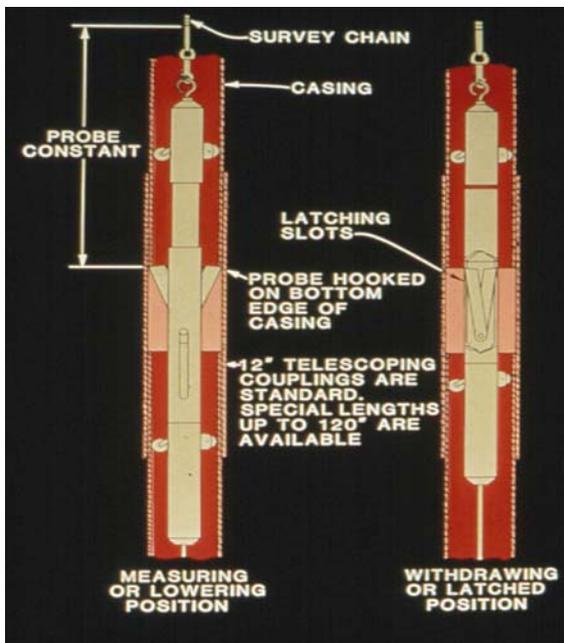


Figure 1



Figure 2



Figure 3 Collar device with guide wheels.



Figure 4 Gears of collar device.