

DIGITAL INCLINOMETER



INTRODUCTION

DATA DIGGER Inclinometer is one of the most advanced MEMS digital inclinometer system being produced anywhere. It utilizes the capability of high computational power and large high resolution colour display of today's Android OS based mobile phones as a readout and data storage unit.

FEATURES

- Advanced, light weight, shock resistant digital MEMS bi-axial inclinometer system.
- Uses easily available Android OS based GSM/GPRS capable mobile phones as hand held readout unit.
- Phone provides high resolution vivid color display of readings and graphs.
- Wireless Bluetooth connection eliminates cable between rotating reel and mobile phone readout.
- Mobile phone memory capacity allows local storage of more than 1 million data points.
- Data can be compared instantly after logging with previously logged data using different graph types.
- Data can be sent instantly to central server over GSM/GPRS connection.

APPLICATION

- Determination of lateral movement and deformation of earth works or structure.
- Measurement of magnitude of inclination or tilt and its variation with time in structures like retaining/diaphragm walls, piles etc.



The mobile phone uses wireless Bluetooth connection to communicate with the inclinometer reel unit. Gone are the days of frayed cable and unreliable slip ring connection between the reel and the hand held readout units.

The Inclinometer system is much lighter in weight and is very much liked by field personnel who have to carry the system from borehole to borehole for logging.

OVERVIEW

The digital inclinometer system consists of a traversing type digital tilt sensing probe that is connected to a reel unit kept at borehole top. The reel unit consists of a winding reel that holds the cable and a wireless Bluetooth relay unit that sends the digital probe data to the mobile phone. A rechargeable battery in the reel unit supplies power to the whole system.

DESCRIPTION

The digital inclinometer probe has a measuring range of ± 30 degrees with a resolution of ± 10 arc seconds. The probe uses a 24 bit ADC that measures the MEMS sensor output with a resolution of over 1 million counts. An embedded processor in the probe provides a digital output that gives the horizontal displacement value directly in desired engineering units.

The probe data is transferred to the reel over a thin high strength two core cable with a central high strength Kevlar core that makes the cable essentially stretch proof even with intensive use. The twin core cable carries both data and power supply to the probe from the reel unit. Transmitting data digitally to the reel allows any length of cable to be used without affecting the accuracy of the measurement.

A standard commercially available Android OS based mobile phone is used as a hand held unit. Digital Inclinometer application is loaded on the mobile phone to enable it to configure and collect data from the digital inclinometer system.

The mobile phone communicates with the reel unit of the Inclinometer system through its in-built Bluetooth wireless interface. The wireless link eliminates the traditional slip ring and cable connection between the reel unit and the handheld readout that often became unreliable due to frayed cable and slip ring problem.

Android Digital Inclinometer application exploits the huge computational and image processing power of today's mobile phone to display the logged borehole data as tables or various types of graphs commonly used at back end computers to visualize the data. This allows the operator to verify the logged data and investigate any anomaly immediately at site.

The current memory capacity available in mobile phones allows storage of borehole data of all the boreholes in a site for a number of months.

Use of an off the shelf available mobile phone allows a faulty hand held readout to be serviced or replaced with another unit locally very easily eliminating delays associated with servicing a custom readout unit or a proprietary palm top computer.

The mobile phone can also be loaded with application software for other types of sensor and data loggers equipped with Bluetooth interface that are being made available by select manufacturers now a days. This will free the field operator from carrying different readout units for different types of sensors/data loggers.

A choice of mobile phones can also provide the functions of camera to record photos or video clips of site conditions, view tutorial videos on site, or fix its geographic location using the inbuilt GPS receiver besides all the functions available in a mobile phone.



OPTIONAL SETTLEMENT MEASUREMENT

If settlement monitoring is also desired, annular magnetic targets can be fixed to the inclinometer casing at different depths and a magnetic sensor probe can be used to plot the change in depth of the magnetic targets over time.

SYSTEM COMPONENTS

DATA DIGGER Inclinometer system basically consists of four components:

- Access tube and fittings
- Digital tilt sensing probe
- Interconnecting cable on a portable reel
- Mobile phone as a readout/datalogger unit



ACCESS TUBE AND FITTINGS

ABS access tubes have longitudinal keyways, specially produced to close tolerances. Wheels of tilt sensing probe can run smoothly inside these keyways.

Access tubes are 3 m (~9.85 ft) in length. Different kinds of couplings are available to rapidly join access tubes. Telescopic couplings are available in case settlement is expected to take place.

Design of these couplings ensure that correct alignment of keyways is maintained throughout depth of gage well.

Self-aligning access tube

Self aligning ABS tubing, 70 mm o.d. (~ 2.75 in), 58 mm i.d., 3 m length.

ABS fixed coupling (70 mm)

ABS fixed coupling for 70 mm o.d. access tube; 77 mm o.d. x 160 mm length.

ABS telescopic coupling (70 mm)

ABS telescopic coupling for 70 mm o.d. access tube; 77 mm o.d. x 300 mm length, displacement up to 150 mm.

End cap for ABS tubing (70 mm)

ABS end cap for 70 mm o.d. access tube to fit at top or bottom.

Top cap for ABS tubing (70 mm)

ABS lockable top cap for 70 mm o.d. access tube.

Pop rivets for ABS tubing

Pop rivets packets of 100 numbers for fixed coupling.

Self tapping screws for ABS tubing

Self tapping screws packets of 100 numbers for telescopic coupling.

Pop rivet gun

Hand held manually operated.

Power drill

230 V 50 Hz operation power drill with two 3.2 mm dia drill bits.

Mastic tape

50 mm width x 10 m long mastic tape.

ABS casing sealing accessories

BOPP tape 50 mm width x 30 m long.

Protective cover

Note: ABS casing with 85 mm o.d. (~ 3.35 in), 77 mm i.d., available on request.



DIGITAL TILT SENSING PROBE

Inclinometer probe

Digital probe of stainless steel construction is fitted with two pairs of pivoted sprung wheels which can rotate freely. Standard gage length between the wheels is 500 mm. An option of 2 ft gage length (Imperial unit) is also available. The spring loaded wheel arms help to position the probe centrally inside the access casing at any required depth.

The probe is designed for use in all standard inclinometer access tubing with o.d. 70 mm (~ 2.75 in) and with o.d. 85 mm (~ 3.35 in)

Probe consists of two precision MEMS accelerometers. One accelerometer has its axis in the plane of the wheels and other at 90° to it. The probe senses horizontal deviation between the probe axis and the vertical plane, simultaneously in both the orthogonal axis. A four pin connector is provided for connection to the cable.

Dummy probe

It has the same dimension as the actual probe. It is used for checking the gage well. Cord length is same as cable length in the actual probe.

Calibration check jig

It enables verification of calibration of the inclinometer probe at known angles of tilt.



INTERCONNECTING CABLE

Operating cable and cable reel

Two core abrasion resistant polyurethane sheathed, weather proof signal cable with high tensile straining member, graduated at every 0.5 m (or 2 ft Imperial). This is available in different lengths.

A four pin connector is provided for connecting to the probe. The cable reel comprises of a plastic winding reel on suitable frame to hold the specified length of the cable.

Cable suspension bracket

It can be directly placed on the ABS tubing at the top of gage well. It has a slot to hold the cable at the graduated marks for convenience in taking the readings.



MOBILE PHONE

Any GSM/GPRS mobile phone running Android 2.1 (or later) Operating System with at least 480 x 800 pixel bright color display, at least 1 GB memory and Bluetooth connection can be used as a hand held readout/datalogger unit. Mobile phone should be compatible with local cellular standards. Internet connectivity is required if data is to be transferred to remote server. A local cellular connection (SIM) is required for operation.



DATA DIGGER Digital Inclinometer application software for Android needs to be installed in the phone.

Application software is supplied free to owners of Digital Inclinometer System.

A suitable mobile phone installed with Digital Inclinometer application software is generally supplied with the Digital Inclinometer System. However, obtaining local cellular connection with internet connectivity is in user scope.

