GEODAQ

Automated Monitoring, Reusable

INC500 Series In-Place Inclinometer

Features

- **Provides continuous monitoring for automated early warning notification**
- **Easy installation into Standard Inclinometer Casing (2.75 inch / 70 mm Diameter)**
- **Fully integrated sensors, signal conditioning, and digital communication electronics**
- **No programming or complicated instrumentation setup required**
- **Long term reliability with improved MEMS sensor technology**
- **Lead Free Product**

COMPLETE WEB-BASED MONITORING SYSTEM

General Description

The INC500 Series is a complete in-place inclinometer system which includes all signal conditioning and data acquisition electronics within a low-profile, watertight, continuous assembly suitable for installation in standard inclinometer casing. The INC500 system integrates an entire network of digital tilt measurements over a single cable connected to a GCM controller. Complete displacement profiles are delivered to any web-browser using password protection and secure-shell data transfer. The INC500 offers many distinct features that make it an attractive alternative or replacement for traditional borehole inclinometer type systems. The INC500 greatly simplifies field installation, reduces field data collection costs, can be installed in existing or new inclinometer casing, and provides continuous monitoring capabilities with early warning notification.

Applications

- **Web-Based Monitoring**
- **Dams and Levees**
- **Landslide and Slope Monitoring**
- **Early Warning Systems**
- **Earth Retaining Structures**
- **Shaft and Tunnel Monitoring**

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4755 J Street, Sacramento, CA 95819
www.geodaq.com
916-930-9800

DETAILED DESCRIPTION

Introduction

The INC500 series in-place inclinometer consists of a series of self-contained instrumentation modules. Each module contains a series of precisely spaced MEMS-based accelerometer sensors with signal conditioning circuitry designed specifically for tilt measurements in two orthogonal directions. Tilt readings at known locations along the length of the INC can be evaluated using numerical integration techniques to produce displacement profiles. The accuracy of a displacement profile measurement is related to the number of tilt sensors integrated into the INC500 module. More tilt sensors results in greater displacement measurement accuracy and better definition in regions where deformations are expected to occur.

The standard INC500 inclinometer configuration includes biaxial sensors mounted at a spacing of 12-inches. Figure 1 illustrates a sample INC500 inclinometer system consisting of five INC500 series modules connected to a Geodaq GCM controller. The INC500 modules can be installed inside a standard 2.75-inch diameter inclinometer casing using centralizers mounted to the module housing. Each centralizer has four stainless steel wheel assemblies that track all internal grooves of the inclinometer casing. Adjacent modules are joined by an underwater connector and a coupler assembly shown in Figure 2. Inclinometer readings are collected by the GCM module and communicated to a web server computer via a wireless modem. Complete inclinometer displacement profile results are viewable from any standard web browser using a password. Because displacement profiles are calculated in real-time, threshold levels can be established for early notification applications.

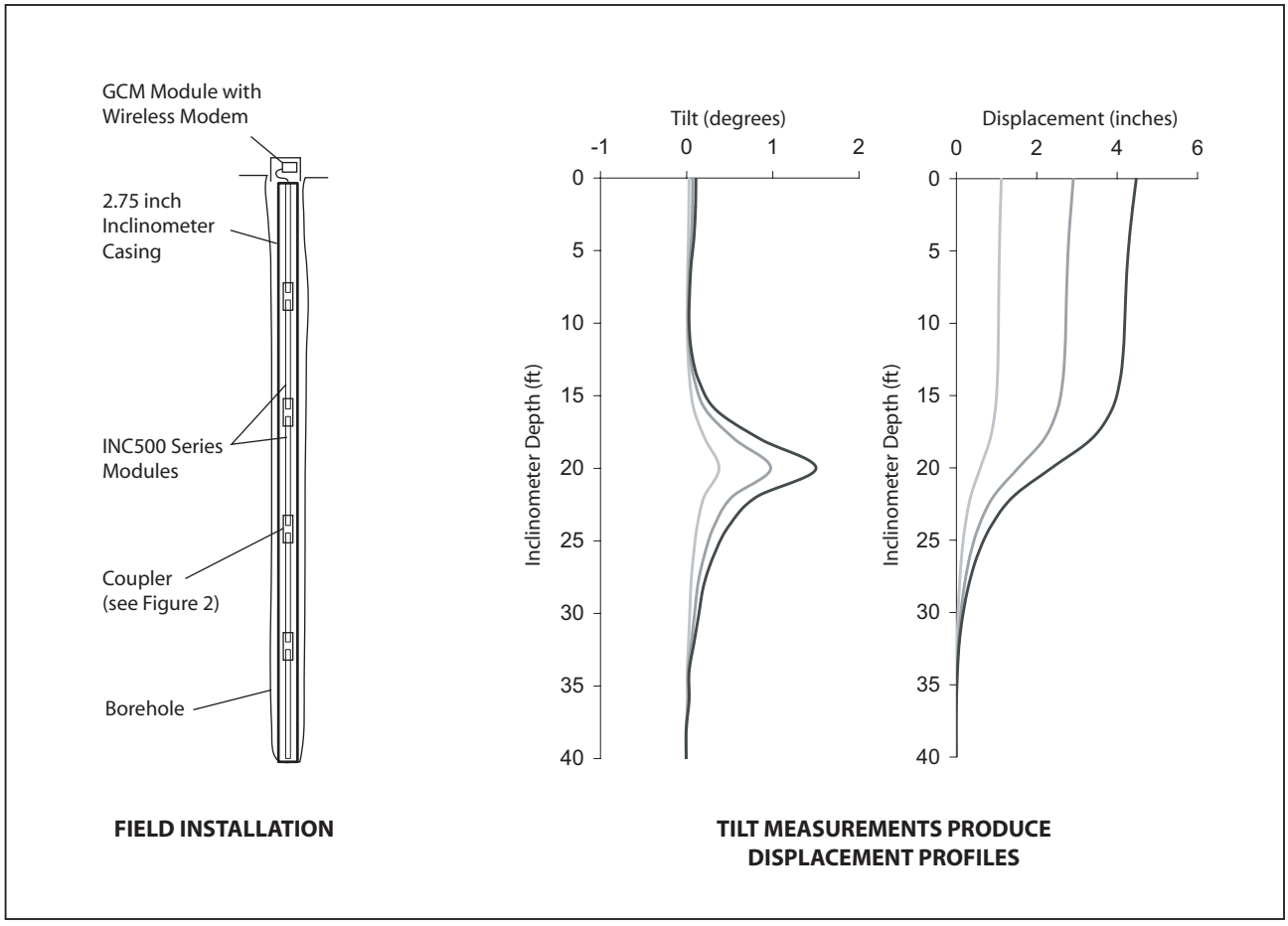

Figure 1. Sample In-Place Inclinometer System with Five INC500 Series Modules

Physical

The INC500 Series inclinometer is shipped as a complete system with all the components needed for installation. Multiple INC500 modules are connected end-to-end using underwater electrical connectors. The total length of the INC500 Series inclinometer can vary from 8 feet to several hundred feet depending on the number of modules ordered for each inclinometer. The outer housing consists of ABS plastic, and the sensors and electronics are encapsulated in a marine grade water sealant forming a corrosion resistant, durable, and watertight housing.

The INC500 in-place inclinometer can be installed into standard 2.75-inch diameter (70 mm) inclinometer casing using the newly developed C70 centralizer shown in Figure 2. The C70 centralizer provides accurate sensor alignment with the internal grooves of the inclinometer casing, and four stainless steel wheels are mounted to spring element fingers creating stability in all directions. Typically, four or more C70 centralizers are mounted along the length of each INC500 module. Adjacent INC500 modules are joined together with an underwater electrical connector and the CSC coupler creating a continuous in-place inclinometer system with uniform bending stiffness characteristics over its entire length. The CSC coupler consists of two parts (CSC1 and CSC2) and is assembled in two basic steps as shown in Figure 3. Assembly details for the CSC coupler system is shown in Figure 4 and includes the location of front and back CSC1 and CSC2 parts.

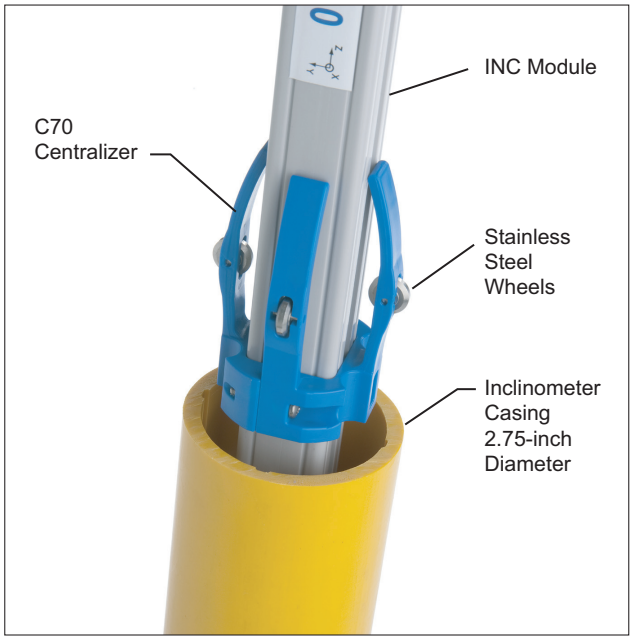

Figure 2. C70 Centralizer

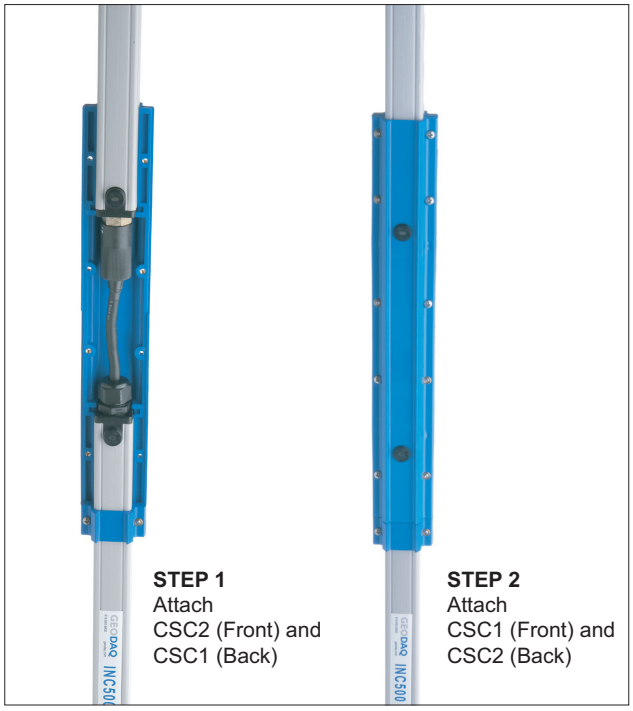

Figure 3. CSC Coupler - Two Step Installation

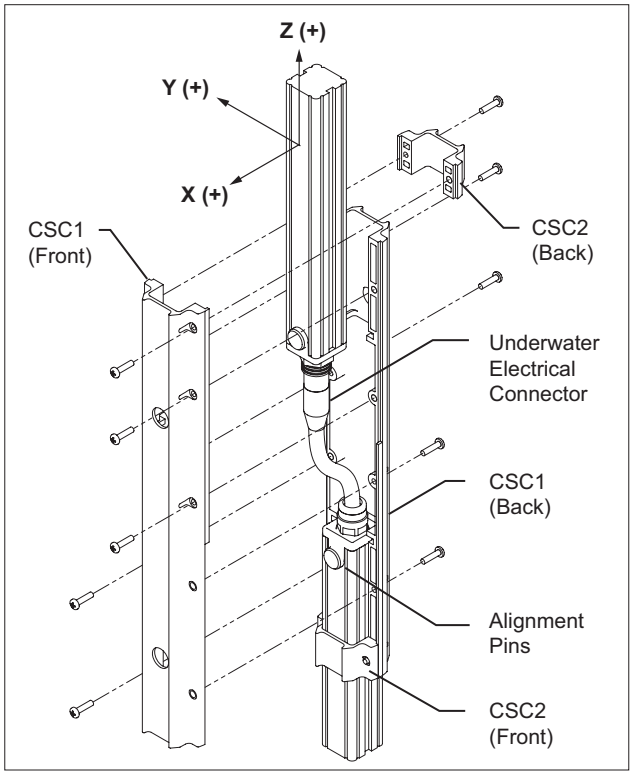

Figure 4. CSC Coupler Assembly Detail

SPECIFICATIONS

Parameter	Condition/Notes	Min	Typ	Max	Units
Sensor Type	MEMS accelerometer CMOS Temperature Sensor				
Measurement Range					
Acceleration	Accuracy decreases with increasing tilt angles	±1.0			g
Tilt	Accuracy decreases with temperature changes		±15	±90	arc degrees
Temperature		- 40		266	°F
Accuracy/Resolution	Based on ±3 degree tilt range at constant temperature				
INC500 Module Accuracy	Displacement accuracy for 8-foot module (rms)		0.04		inches
INC500 Module Resolution	Displacement resolution for 8-foot module (rms)		0.01		inches
Tilt Sensor Resolution	Evaluation over 1 month at constant temperature (rms)		0.015		arc degrees
System Accuracy	module accuracy x $\sqrt{\text{number of modules}}$ (rms)				
Temperature			±3		°F
Minimum Curvature Radius	X-axis direction, long-term performance not evaluated		8		feet
Power Supply					
Operating Voltage Range	Multiple inclinometer modules		11.5	18	V (DC)
Current Consumption	Current consumption per module		100	130	mA
Temperature Range					
Operating Range	Larger temperature ranges available with special order	0		150	°F
Storage Range		0		150	°F
Electrical Connector	Underwater molded connector (4-pin)				
INC Module Material					
Body	ABS plastic				
End Cap	ABS plastic				
Coupler	ABS plastic				
Physical Dimensions					
Module Length			8		feet
Module Width			1.12		inches
Module Height			1.15		inches
Coupler Height			1.60		inches
Coupler Width			1.92		inches
Module Weight			5		lbs.

We believe all information contained herein to be correct as of the time of printing. Geodaq reserves the right, however, to change any specification without notice, and will not be held resposible for any errors.

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