Use of In-Place Inclinometers During Lateral Load Testing

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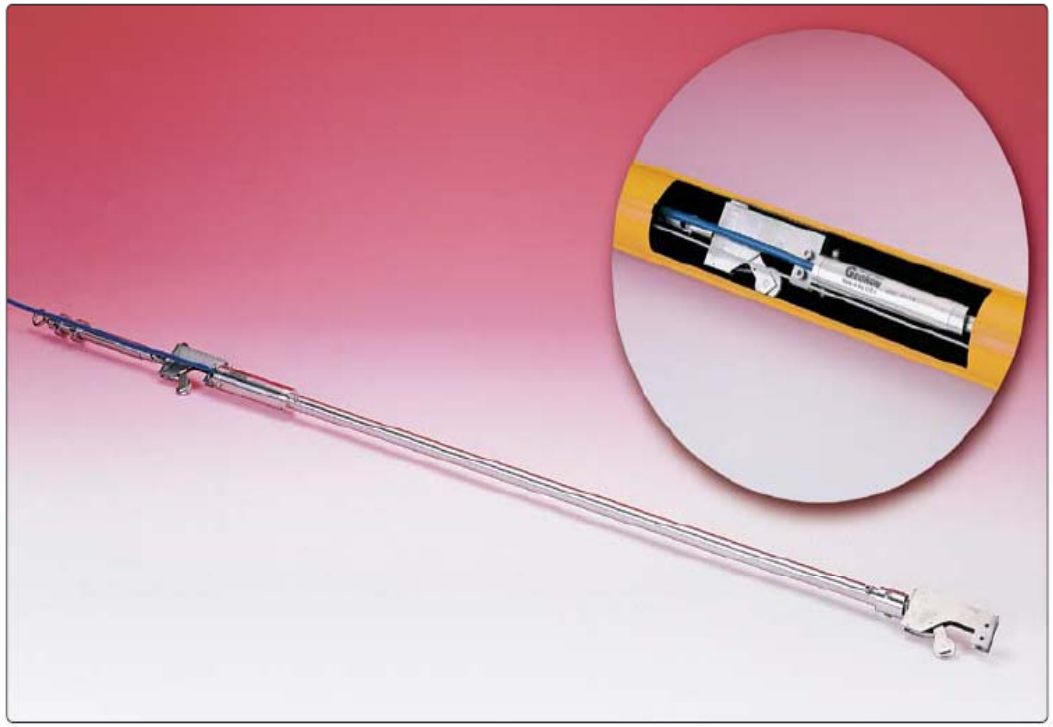
In-Place Inclinometers for Lateral Load Testing

- **Discussion Outline**
  - Project Background
  - Predicting Pile Performance
  - Verifying Pile Performance
  - Test Setup
  - Test Procedure
  - Results
  - Project Conclusions



Project Background

- **Micropiles Installed to Support Sensitive Structure at Reclaimed Mine Site**
- **Design Loadings Cyclic**
- **Unique Ground Conditions**
- **Thorough Testing Program Specified**

Project Background

- **Meeting Design Demands**
  - Lateral Load Test Information Valuable
  - Pile Deflected Shape Required to Verify Design
  - In-Place Inclinometers (IPI's) Decided Upon to Record Lateral Movements Along Length of Pile

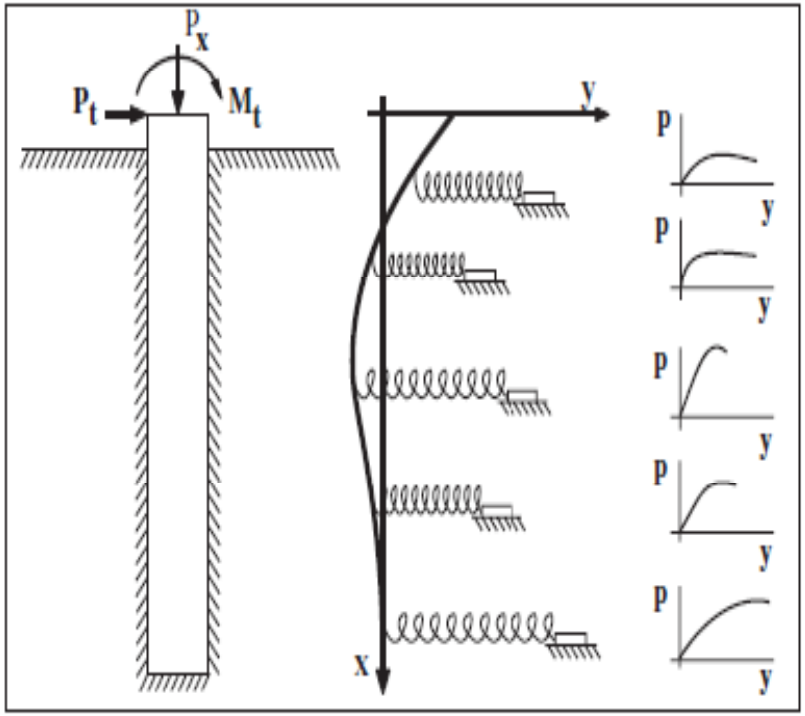
Project Background Information

- **In Place Inclinometers:**
  - Geokon Model 6150 MEMS (Micro-Electrical Mechanical Sensors)
    - Use Standard Inclinometer Casing
    - Uniaxial
    - Individually wired
    - Installed in a single ‘string’ connected by universal joints

- **But why not just a simple load test?**

Predicting Pile Performance

- **Why are Lateral Loads Different from Axial Loads?**
  - Soils provide non-linear resistance
  - Lateral Load performance is very sensitive to the soil type



Predicting Pile Performance

- **Navfac Methods:**

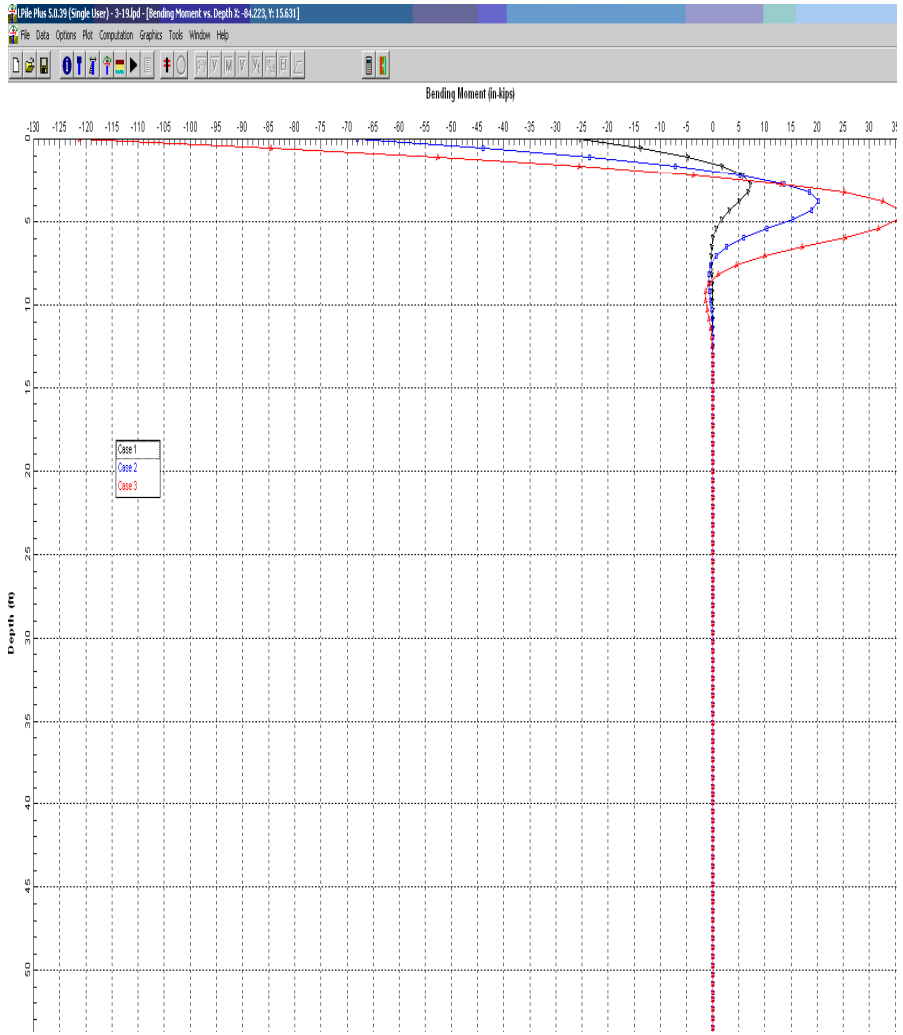
$$P = \left[\frac{\delta_p}{F_\delta}\right] \times \frac{EI}{\left[(EI/f)^{1/5}\right]^3}$$

- **Mathematical Models:**

$$EI\frac{d^4y}{dx^4} + P_x\frac{d^2y}{dx^2} - p - w = 0$$

Predicting Pile Performance

- **Software Analysis: LPILE, GROUP**
- **Soil Properties; Friction Angle, Unit Weight, Water Table**
- **Pile Properties**



Verifying Pile Performance: Test Set up

Verifying Pile Performance

- **Lateral Load Test: Two Test Piles**

- **Pile 1: Two Inclinometer Casings**
  - One IPI string, One Standard Inclinometer

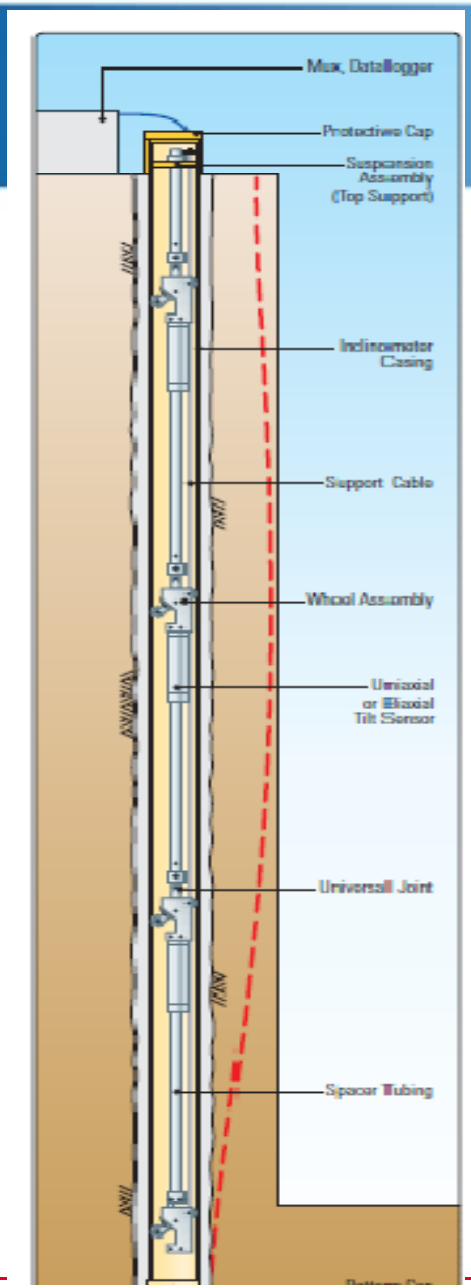
- **Pile 2: One Inclinometer Casing**
  - Standard Inclinometer

In-Place Inclinometers: Quantity & Location

- **9 IPI's spaced at 2.5' were chosen**
- **Based on:**
  - Depth of Lateral Displacement
  - Relative Change in Displacement Along the Pile
- **Depth of lowest IPI at 20 ft from load application**

IPI Installation

IPI Installation (2)

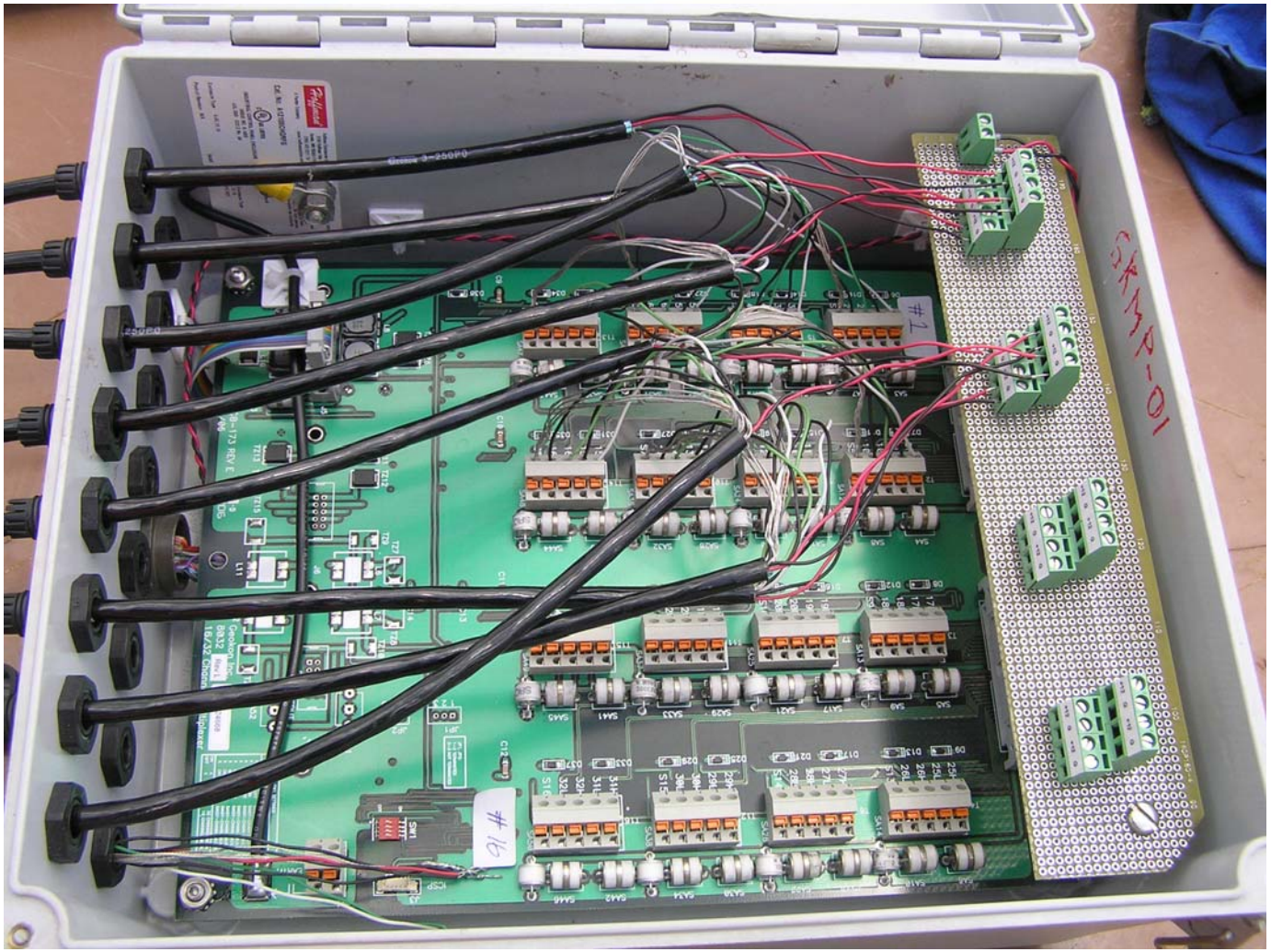


IPI Installation (3)

IPI Installation: Wiring

Inclinometer Installation: Pile 1

IPI Wiring



Inclinometer Installation: Pile 2

Casing Installation

Verifying Pile Performance

- **Standard ASTM D3966 Lateral Test Set Up**

Verifying Pile Performance

- **Standard Dial Gage Arrangements**

Dial Gage Placement

In-Place Inclinometer System

Test Procedure: Components

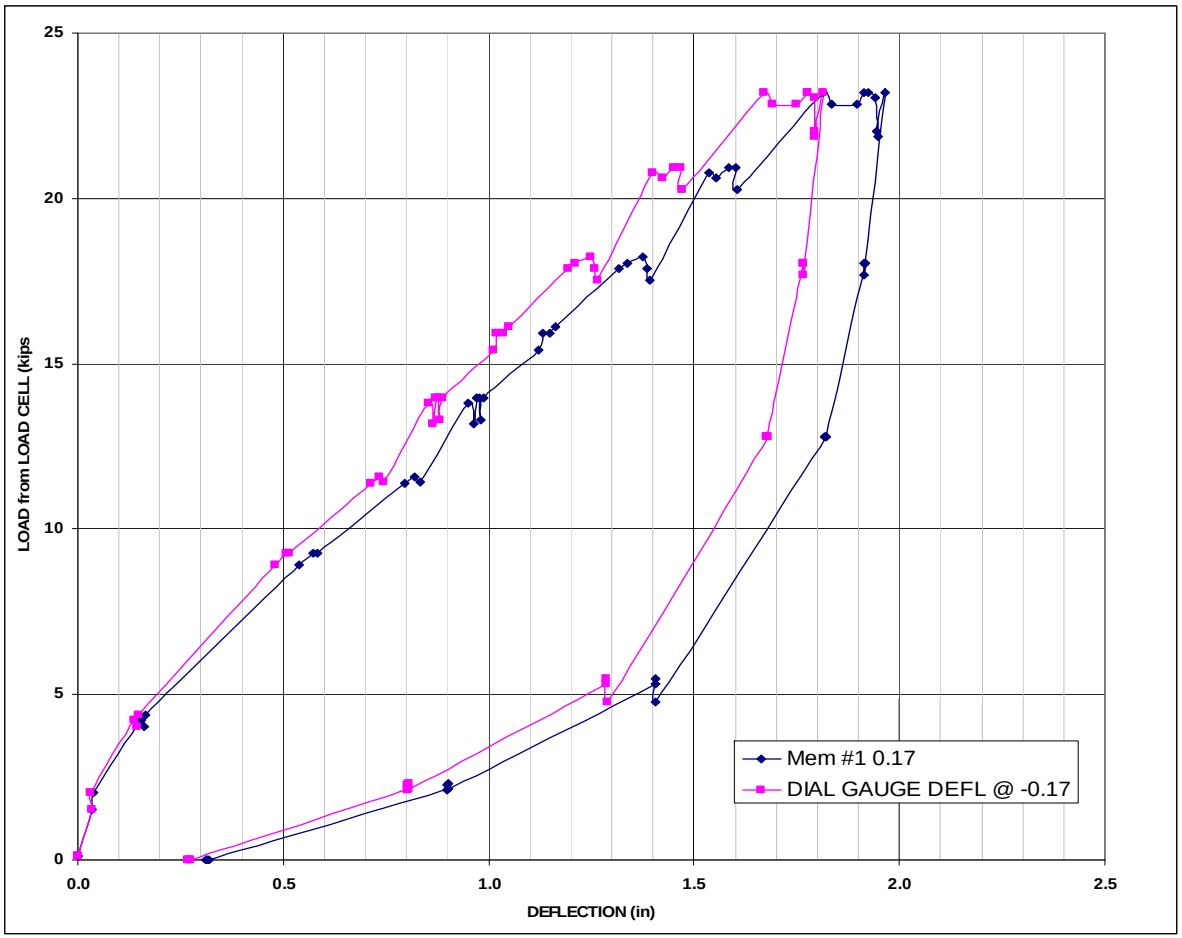
- 6 Dial Gages
- 9 In-place Inclinometers
- Standard Inclinometer
- Wires, Mirrors & Scales
- Load Cell
- Hand Pumped 20T Jack

Test Procedure (2)

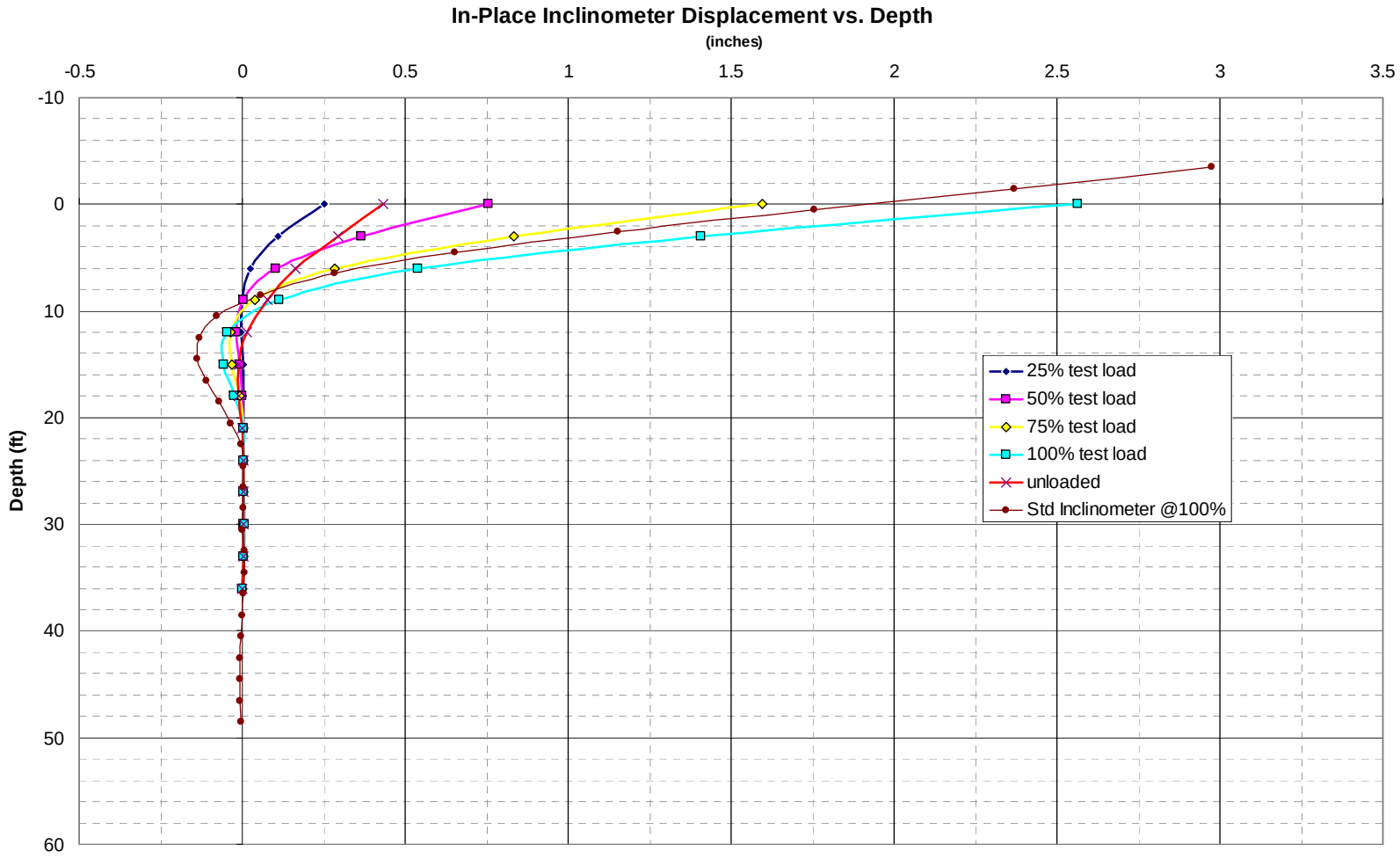
- **Synchronize Readings of IPI's with Dial Gage Readings**
- **Included Auto Recording of Load Cell**
- **Instant view of Pile Deflections**

Test Results Load vs. Deflection

- **Comparing Dial Gage at Loading Point to IPI #1**



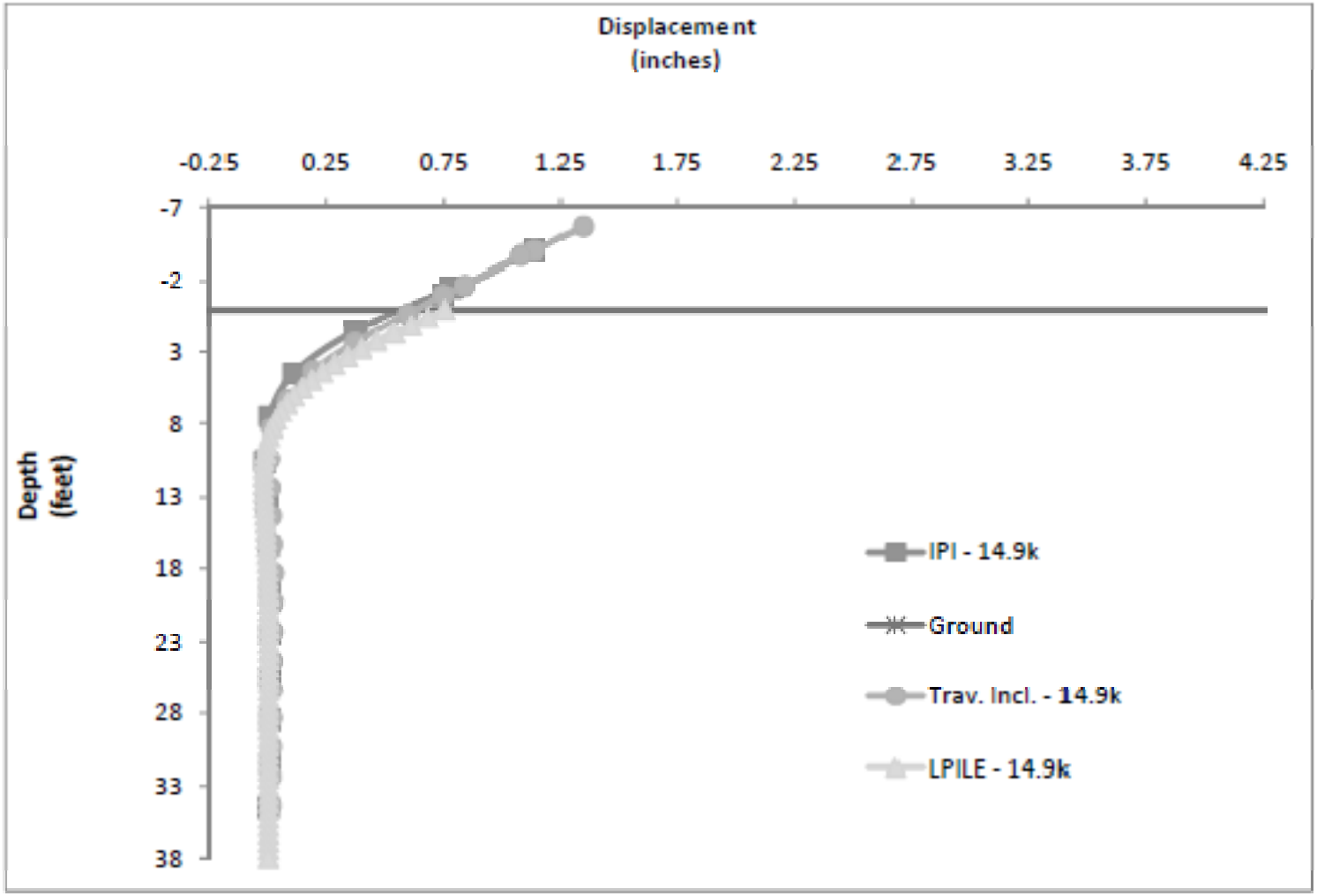
Test Results: Deflection vs. Depth



Test Results

- **Compare to Initial Design Model Assumptions**
- **Adjust and Iterate Soil Parameters to Refine Model**
- **Input Site Specific P-Y curve into LPILE**

Test Results: Predicted vs. Measured



Project Conclusions

- **In-Place Inclinometers Provide Accurate Measurement of Lateral Displacement**
- **Coordination of Measuring Devices is Key**
- **End Results can Allow for Refined Designs and Cost Savings**

Questions?

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