Thermal Integrity Profiler (TIP)

Assesses the quality of cast in place concrete foundations

Pile Dynamics, Inc.

Foundation & Geotechnical Engineering

The Thermal Integrity Profiler (TIP) uses the heat generated by curing cement (hydration energy) to assess the quality of cast in place concrete foundations such as drilled shafts, bored, augered cast-in-place (ACIP), continuous flight auger (CFA) and drilled displacement piles.

TIP results in brief:

Regions that are	Indicate
Colder than normal	Necks or Inclusions or poor concrete quality
Warmer than normal	Bulges

The expected temperature at any location is dependent on the shaft diameter, mix design, time of measurement and distance to the center of the shaft.

TIP measurements may be used to locate areas of concern, estimate the shape of the shaft, evaluate the degree of eccentricity of the reinforcing cage, and determine the concrete cover.

The Thermal Integrity Profiler evaluates the concrete quality of the entire cross-section, including outside the reinforcing cage, and along the entire length, without maximum length limitations.

Thermal Wire® cable attached to rebar cage

Data Collection

TIP data is collected by either the Thermal Wire® cables system or by the Thermal Probe system:

The TIP Thermal Wire Cable System[i] includes cables fitted with digital thermal sensors spaced at every 305 mm and Thermal Acquisition Ports (TAP). The Thermal Wire cables are attached to the reinforcing cage prior to concreting. In general one cable is installed per each 305 mm (one foot) of diameter. A TAP is connected to each Thermal Wire cable, and automatically samples data from that cable at user selected time intervals, typically every 15 minutes. Temperatures obtained throughout the concrete curing process are saved in each TAP, and may be viewed at any time after data collection begins. The temperature versus time history prior to the peak temperature is inspected to confirm uniform quality or spot potential anomalies. A single Thermal Wire cable may be attached to a center rebar for small diameter augered cast-in-place or continuous flight auger piles.

The TIP Probe System[ii] includes a thermal probe with four orthogonal infrared sensors and a Thermal Acquisition Port for Probes (TAPP). Data is collected by inserting the probe in standard (40 to 50 mm) plastic or steel access tubes (TIP results are insensitive to tube de-bonding; access tubes must be empty of water during testing) previously built into the shaft. The probe is lowered into the tube (a depth measurement unit registers its location) and measures the internal temperature which is recorded by the TAPP. TIP Probe testing is typically performed within 12 to 48 hours of casting. TIP displays temperatures versus depth in real time during the test.

Thermal Integrity Profiler (Probe System)

Quality Assurance for Deep Foundations

Specification Highlights

*Visit **www.pile.com/tip** for complete specifications.*

The **Thermal Integrity Profiler** and the **Thermal Acquisition Port for Probes** are powered by an internal battery with an 8 hour duration. The battery of the **Thermal Acquisition Ports for Thermal Wire®** cables lasts 28 days.

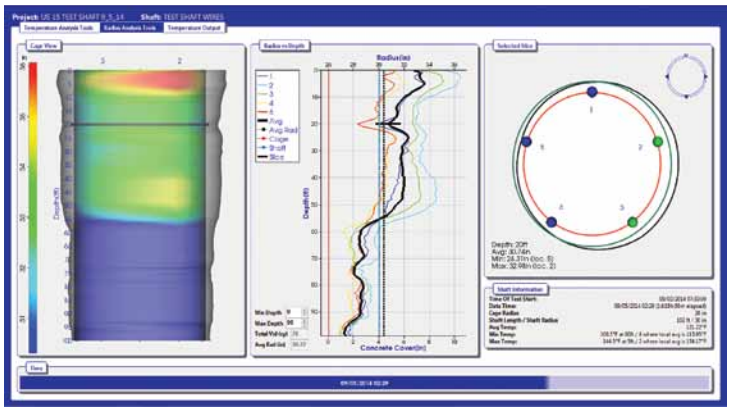
A **Depth Measurement Unit** (Rotary Encoder with 2.5 mm resolution) is provided with the probe system.

Thermal Wire cables are furnished in rolls of lengths starting at 6 m (20 ft) with length increments of 1.5 m (5 ft).

Thermal Integrity Profiling is usually completed within 48 hours of shaft installation - earlier than any other integrity evaluation of cast-in-place concrete foundations.

Clockwise from bottom left:
Thermal Acquisition Port for Probes, Thermal Probe, Thermal Acquisition Port for Thermal Wire cable and close up of Digital Thermal Sensor

*The **Thermal Integrity Profiler** meets or exceeds the requirements of **ASTM D7949** - Standard Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations.*



Software

The TIP Reporter Software displays measured temperatures versus depth and mapped on cross sections of the shaft. This helps identify areas of concern such as potential over-pour bulges, necking, or cage alignment irregularities.

TIP Reporter also estimates the concrete cover along the entire length of the shaft. In addition to TIP temperature measurements, this analysis requires the total concrete volume as an additional input. The estimated effective shaft radius, reinforcement cage location and the concrete cover of the reinforcement bars can then be determined.

The Thermal Integrity Profiler received:

- **2012 MAGNET/NASA Manufacturing Innovation Project Award**
- **2013 NOVA Award from the Construction Innovation Forum**
- **2013 Deep Foundations Institute C. William Bermingham Award for Innovation**
- **2015 American Society of Civil Engineers Charles Pankow Award for Innovation**

[i] *Cotton, D., Ference, M., Piscsalko, G., and Rausche, F., (2010) "Pile Sensing Device and Method of Making and Using the Same" US Patent 8,382,369*

[ii] *Mullins, A. G. and Kranc, S. C., (2004), "Method for Testing the Integrity of Concrete Shafts," US Patent 6,783,273*

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