

SAMPLE SPECIFICATION FOR TESTING FOUNDATIONS With the Thermal Integrity Profiling Wire Cable System

Note: This sample specification contains recommended or typical quantities in parenthesis, in the format (quantity); the Specifying Engineers can modify these quantities to their specific construction project requirements. Contractual items are minimized since each agency has its own preferences and procedures.

SPECIAL SPECIFICATION Thermal Integrity Profiler (TIP) Wire Cable Testing of Drilled Shafts

1. DESCRIPTION

Nondestructive Testing (NDT) shall be performed using the Thermal Integrity Profiler Wire Cable methodology, or equal, to provide analytical data for the entire shaft (cage and cover) radius.

The Thermal Integrity Profiler (TIP) method uses the heat generated by curing cement (hydration energy) to assess the integrity or quality of Cast-in-Place concrete foundations such as Drilled Shafts, Bored Piles, Micropiles, Augered Cast-in-Place Piles, Continuous Flight Auger Piles, and Drilled Displacement Piles, herein referred to as “Shafts”. 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 estimate the actual shape of the shaft. These estimates may be compared with concreting logs to assess the overall quality of the shaft. Because the method relies on the heat of hydration, TIP testing is general done between 8 and 48 hours of concrete placement (*note the optimum TIP testing time is dependent on shaft size and concrete mix and could range from 4 to 72 hours*). Smaller shafts are typically tested earlier. Good communication between Contractor and TIP Consultant is therefore essential. Data is acquired via the Thermal Wire Cables which are vertically zip tied to the rebar cage or center reinforcing bars prior to the concreting process.

TIP measurements that are cooler than normal indicate inclusions, necks, or poor quality concrete; while warmer than normal measurements are indicative of bulges outside of the cage diameter. Variations in temperature between diagonally opposite pairs of Thermal Wire Cables reveal cage eccentricities, such as cage misalignment.

2. EQUIPMENT, PERSONNEL & CONTRACTOR ASSISTANCE

The qualifications of the Consultant and the specifications for the equipment shall be submitted to the Engineer for approval prior to shaft installation.

2.1 Equipment

A Thermal Integrity Profiler (TIP), as manufactured by Pile Dynamics, Inc. (30725 Aurora Road, Cleveland, Ohio 44139, (216) 831-6131; www.pile.com) shall be provided.

The Equipment shall have the following minimum requirements:

(1) A computer based TIP Data Acquisition System to monitor and download temperature versus time after casting.

(2) Ability to automatically collect data at user defined time intervals (typically 15 minutes).

2.2 Qualifications of TIP Consultant

The TIP Consultant shall have a licensed professional Engineer supervising the testing and interpretation of results. The TIP Consultant shall be an independent testing agency with documented and approved experience in TIP testing.

2.3 Assistance by the Shaft Contractor to the TIP Testing Consultant.

The Contractor shall provide cooperative assistance, suitable access to the site and shafts to be tested, and labor as required to assist the TIP Consultant in performing the required tests. The Contractor shall coordinate with TIP Consultant and install the necessary TIP instrumentation prior to concreting the shaft. Thermal Wire Cable installation requirements are detailed elsewhere in this specification. Prior to TIP testing, the Contractor shall provide the shaft lengths, wire positions, the shaft construction date, shaft construction inspection record, and concrete placement details to the TIP Consultant.

2.4 Thermal Wire Cable Installation Contractor Requirements.

The Contractor responsible for installing the Thermal Wire Cable assemblies shall be required to obtain training from the Manufacturer on proper installation practices prior to actual installation.

3. TESTING PROCEDURE

Testing procedures and equipment shall conform to ASTM D7949 – “Standard Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations”.

3.1 Shaft Preparation for Thermal Wire Cables

Install (*number, typically a minimum of four*) evenly spaced Thermal Wire Cables in each (*___m, ft.*) diameter shaft.

(Note: The actual number of Thermal Wire Cables installed is typically designed as one Thermal Wire Cable for every 0.25m to 0.35m (10 inches to 14 inches) of shaft diameter, with a minimum of four Thermal Wire Cables. Shafts with different diameters at the same site may require a different number of Thermal Wire Cables.

The preferred even number of Thermal Wire Cables allows for direct comparison of temperatures on diagonally opposite cables to evaluate cage eccentricity.)

Each shaft shall be equipped with Thermal Wire Cables to permit integrity evaluation by TIP. The number of shafts to be tested by TIP is (*number*) or (*percentage of all shafts*). Since the actual cost of the Thermal Wire Cables and data collection is very low compared to cost of the shaft, installing cables and collection data for all shafts is highly recommended. The shafts to be tested shall be chosen after installation by the Engineer.

3.2 TIP Procedure

Prior to TIP testing, the Contractor shall provide the Engineer and TIP Consultant with a record of all shaft lengths with elevations of the top and bottom, field volume logs, Thermal Wire Cable serial numbers installed with corresponding location in the shaft, and the installation date and times for all shafts.

Thermal Wire Cables shall be connected to a Thermal Access Port (*TAP*) immediately following casting. Care shall be taken to record the position of each cable in the cage by serial number. Data shall be collected by the TAP at intervals of time specified by the Engineer (*typically every 15 minutes*) for a duration of time specified by the Engineer (*typically 12 to 48 hours, depending on shaft diameter; often 24 hours is sufficient to reach the peak temperature*) or as recommended by the TIP Consultant. In the event peak temperature is not reached within the specified time period, the TAP units shall remain connected to the Thermal Wire Cables for a longer duration as directed by the TIP Consultant. After completion of the data collection period, the TAP shall be connected to the main TIP data acquisition unit and the data files shall be downloaded for inspection of temperatures versus depth.

Potential local anomalies indicated by locally low temperatures relative to the average temperature at that depth, or average temperatures significantly lower than the average temperatures at other depths, shall be immediately reported to the Engineer.

(Note: In case anomalies are detected, additional TIP tests are not typically necessary. More detailed TIP analysis may be performed on the originally collected data.)

4. TIP TESTING RESULTS

4.1 Results by the TIP shall be presented in a written report within 5 working days of completion of the testing. The report shall present results of TIP tests by including:

4.2 The final analysis must include top of shaft and bottom of shaft adjustments per the manufacturer's recommendations, so that the temperature plots are adjusted for end effects.

4.3 Graphical displays of all temperature measurements versus depth.

4.4 Indication of unusual temperatures, particularly significantly cooler local deviations of the average at any depth from the overall average over the entire length.

4.5 The overall average temperature. This temperature is proportional to the average radius computed from the actual total concrete volume installed (*assuming a consistent concrete mix throughout*). Radius at any point can then be determined from the temperature at that point compared to the overall average temperature.

4.6 Variations in temperature between Thermal Wire Cables (*at each depth*) which in turn correspond to variations in cage alignment.

Where concrete volume is known the cage alignment, or offset from center, should be noted.

MEASUREMENT

This item measured by each successful test that is approved by the Engineer. Quantities of TIP testing will be shown on the plans.

BASIS OF PAYMENT

The completed TIP results and report shall be paid for at the contract bid price for "Thermal Integrity Profiling" (*for each shaft, per linear meter or foot, or per day of testing*). This shall constitute full compensation for all costs incurred and relating to the TIP testing including, but not limited to, procurement, preparation and installation, conducting the tests, and subsequent reporting of results.

(Note: Payment for Thermal Wire Cable data collection is dependent on the TIP Consultant's involvement with the process. If the TIP Consultant is on site to personally collect data, the "per day of testing" basis is considered the most equitable. If the data is sent electronically to the TIP Consultant the "per shaft tested" basis may be more equitable. If a "per shaft" basis is required for a Thermal Wire Cable project, and the project has variable shaft lengths and diameters, then multiple pay items should be created for each group of shafts with similar nominal diameters and lengths.)

TERMAL INTEGRITY PROFILER SPECIFICATIONS

Main Unit

Physical:

Size: 272 X 212 X 40 mm

Weight: 1.5 Kg

Sunlight readable VGA color display for any lighting conditions, resolution 640 x 480 pixels

Screen size: 21.3 cm (8.4")

Temperature Range: Operating: 0 to 40° C; Storage 20 to 65° C

Powered by Internal Battery (8 hours duration)

Contains 6 installed Li-Ion batteries (3.84 grams Equivalent Lithium Content (ELC))

Electronic

Microprocessor: PXA270 @ 520 MHz

Data Storage: Built in 2 GB drive

USB port for easy data retrieval

Thermal Acquisition Port for Wires (TAP)

Size: 133 X 102 X 57 mm

Weight: 766 g

Temperature Range: -20 to 65° operating; -40 to 85°C storage

Contains 1 installed Li-Ion battery. or .64 grams ELC

Internal Battery (28-day duration)

Sampling frequency: user programmable, defaulted to once every 15 minutes

Hangs from reinforcement cage; may be bolted to cage for security

Water resistant

Thermal Wire® Brand Cables

Sensor type: digital

Furnished in rolls of length starting at 6 m (20 ft.) with length increments of 1.5 m (5 ft.).

Sensor spacing: 305 mm

Sensor operating temperature: up to 105°C

Other

Soft carrying case

Full one-year warranty

Operates in English or Metric units

Technical manual included