



**Wisconsin Department of Transportation
Wisconsin Highway Research Program**

Request for Proposal

Thermal Integrity Profiling for Detecting Flaws in Drilled Shafts

Questions submitted to research@dot.wi.gov regarding the
content of this RFP are due no later than
4:30 PM (CST) on May 16, 2016

Responses to questions will be posted to the WisDOT Research and Library website
<http://wisdotresearch.wi.gov/rfps-and-proposals> by
4:30 PM (CST) on May 23, 2016

Proposers must submit a PDF version of their proposal by
4:30 PM (CST) on June 24, 2016
to: research@dot.wi.gov

Proposers will be notified by August 1, 2016

For more information regarding this RFP contact the WisDOT Research Program at:
research@dot.wi.gov. This RFP is posted to the Internet at:
<http://wisdotresearch.wi.gov/rfps-and-proposals>.



**Wisconsin Highway Research Program
Request for Proposals
Geotechnics Technical Oversight Committee**

Thermal Integrity Profiling for Detecting Flaws in Drilled Shafts

I. Background and Problem Statement

Drilled shafts are being utilized more and more for Wisconsin Department of Transportation (WisDOT) projects, particularly major projects like the Zoo Interchange in Milwaukee County. Integrity testing is performed to verify that shafts have been constructed as specified. The most common method for evaluating drilled shaft integrity is through the use of Cross-hole Sonic Logging (CSL). However, CSL testing has drawbacks. CSL testing is performed between tubes attached to the shaft's reinforcing steel cage. One limitation is that CSL testing can only measure integrity within the reinforcing cage. From a performance perspective, the concrete outside the reinforcing cage is critical since it provides the soil structure interaction through skin friction. The concrete cover outside the reinforcing cage also provides protection from corrosive environmental effects. Another limitation is the debonding of the shaft concrete from the CSL tube, which gives false anomalies (voids) in the shaft.

Thermal Integrity Profiling (TIP) testing is an emerging testing methodology that measures temperatures with respect to depth within the drilled shaft. It was introduced several years ago and is progressing from demonstration projects into more conventional use. The test is generally conducted during the heating phase as the concrete hydrates. Temperatures collected during the test are compared between different points, either vertically or horizontally, to identify and evaluate heating or cooling trends. Anomalies are detected where there are distinct temperature gradients across relatively short distances. TIP testing can be initiated immediately following concrete placement. Because of this, TIP testing results are normally available within a day or two of concrete placement. The test method has been standardized by the implementation of ASTM D7949.

TIP testing can evaluate the presence of anomalies inside as well as outside the reinforcing cage. By measuring the shaft concrete cure using temperatures, the amount of concrete cover beyond the reinforcing cage can be calculated leading to the development of a complete model of the drilled shaft with respect to depth.

Furthermore, because TIP testing relies on thermal changes, it is not as susceptible to the false anomalies in CSL testing associated with debonding. It also has the ability to evaluate reinforcing cage alignment and the adequacy of the concrete cover outside the reinforcing cage, something other test methods cannot determine.



II. Objectives

The objectives of this study are:

- Demonstrate to WisDOT the effectiveness of TIP testing.
- Validate TIP testing as a viable alternative to more traditional CSL testing.
- Evaluate the effectiveness of the technique by completing a side-by-side comparison of both test techniques within a test drilled shaft installation with known constructed flaws.
- Potentially modify WisDOT Standard Specifications to allow for TIP testing of drilled shafts.

III. Scope of Work

Task 1: Collect and analyze existing WisDOT TIP Testing Records

WisDOT has conducted TIP testing as part of the drilled shaft work that was done in the first phase of the Zoo Interchange project. TIP testing is also planned for the second phase of the Zoo Interchange project. This information would be available for the researcher to analyze.

Task 2: Field TIP Testing

Construct one drilled shaft with a built-in flaw. TIP and CSL testing would be used on the drilled shaft in order to detect the flaws constructed in the drilled shaft and identify the cause of each flaw and to compare the two techniques. TIP testing shall be done in accordance with ASTM D7949.

Task 3: Data Analysis

Based on the data collected in Tasks 1 and 2, conduct a detailed analysis of TIP testing and determine its viability as a means for quality control of drilled shaft construction.

Task 4: Final Report

Report the results of the study to the Technical Oversight Committee (TOC) in a written final report and an in-person presentation.



IV. WisDOT/TOC Contribution

- A. The research team will not assume the availability of WisDOT staff or equipment in the proposal. If WisDOT or another entity donates equipment, a letter of commitment must be included in the proposal.
- B. Any traffic control, if needed, will be the responsibility of the researcher to coordinate with existing construction contractors and WisDOT personnel.
- C. Expected level by staff/TOC members: Maximum of 40 hours.

V. Deliverables

- A. Submittal and reporting of progress as required by the WHRP and WisDOT.
- B. Reporting Requirements: Seven (7) hard copies and an electronic copy of the final report delivered to WisDOT by the contract end date.
- C. Presentation Requirements: All projects require the PI to give a closeout presentation after submittal of the draft final report.

VI. Schedule and Budget

A. **Project Duration**

- i. The total duration of the project is **24 months** starting before October 1, 2016.
- ii. Deadline for submittal of draft final report is three (3) months prior to the contract end date.
- iii. The researcher is expected to submit the draft final report with quality technical writing and proper grammar. It is acceptable to include a technical editor on the research team to ensure these requirements are met.
- iv. The contract is considered closed upon satisfactory completion of the project scope, including submission of electronic and hard copies of the final report.

B. **Project Budget**

- i. The project budget shall not exceed **\$110,000** and shall include any costs associated with performing tests, analyzing data, and preparing the draft and final reports.
- ii. Matching funds will not be considered in the proposal evaluation process.



VII. Implementation

Successful implementation of this research will be achieved by:

- Validating the TIP test method as a viable alternative to test the integrity of a drilled shaft installation.
- Developing WisDOT guidance documents that will allow for or mandate TIP testing for evaluating drilled shaft construction.
- Developing specification language for the use of TIP testing on WisDOT projects.