Wisconsin Department of Transportation
Wisconsin Highway Research Program

Request for Proposal

Monitoring Lateral Earth Pressure and Movements of Cut Retaining Walls

Questions submitted to research@dot.wi.gov regarding the content of this RFP are due no later than 4:30 PM (CST) on December 12, 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 December 19, 2016

Proposers must submit a PDF version of their proposal by 4:30 PM (CST) on January 20, 2017 to: research@dot.wi.gov

Researchers will be notified of the proposal review decision by May 1, 2017

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
Geotech Technical Oversight Committee

Monitoring Lateral Earth Pressure and Movements of Cut Retaining Walls

I. Background and Problem Statement

Problem Statement:

Retaining walls constructed from top-down ('cut' walls) such as cantilevered and anchored soldier pile and lagging walls, sheet pile walls and tangent/secant pile walls are utilized on numerous transportation projects. Design of these walls involves estimation of lateral earth pressure distribution to evaluate safety against soil failure at the strength limit state, as well as movement and stability at the service limit state. The wall design must also consider the effects of lateral wall movement and settlement behind the wall to ensure adequate wall durability as well as to prevent adverse effects to adjacent facilities.

Retaining wall design including estimation of lateral earth pressure and wall movement is a complex soil-structure interaction problem. Various methods to estimate the magnitude and distribution of earth pressures above grade, as well as the passive resistance of foundation soils, are currently used to predict the loads acting on the wall elements as well as to estimate wall movement. These methods can produce varied results. Furthermore, there is little documentation regarding actual versus predicted lateral earth pressures or wall movements for cut walls, particularly for those built in Wisconsin. Better estimation of earth pressures developed along the height of the wall along with wall deflection and settlement of soil behind the wall will provide calibration of commonly used design procedures and perhaps a reduction in retaining wall cost and improvement in performance.

Background:

Cut retaining walls such as soldier pile and lagging walls, sheet pile walls and tangent/secant pile walls are commonly utilized on transportation-related projects, particularly where protection of right-of-way, utilities, roads, and structures are required. Numerous design methods are used to predict the lateral earth pressure acting on the wall as well as the estimated lateral wall movements and the vertical movement of the soil retained behind the wall.

The over prediction of lateral earth pressure and wall movement result in conservative design which may correlate to unnecessarily high retaining wall cost. On the contrary, underestimation of lateral earth pressure and wall movement may result in wall failure or excessive wall deflection and/or settlement behind the wall. Excessive wall movement can lead to long-term maintenance problems as well as a reduced service life for retaining structures. Also, potential user delays and increased costs can occur if these movements impact existing flow of traffic either to repair damaged retaining walls or to close roadways in locations where retaining wall movements have

become problematic. Excessive wall movements can also have a negative impact on adjacent roadways, buried utilities, and structures.

II. Objectives

The intended outcome of this study is to meet the following objectives:

- Investigate the short-term and long-term performance of cut retaining walls, namely soldier pile and lagging walls since they are most commonly built by WisDOT.
- Measure the top-of-wall lateral deflection of cut retaining walls over time.
- Measure the magnitude and distribution of lateral earth pressure along the height of the wall over time.
- Measure vertical ground settlement at various points behind the wall over time.
- Compare measured lateral earth pressure and retaining wall movement versus estimated wall movements generated from commonly used methods and computer programs.
- Determine if modifications to existing design methodologies can be made based on findings of research.

III. Scope of Work

Task 1 – Literature Review

Conduct an extensive literature review to determine what design methodologies are most successfully used to predict lateral earth pressures and estimate horizontal and vertical movements of cut retaining walls. Also, assess the design methodologies used for predicting lateral earth pressures and retaining wall movements. The literature review will also document both the current state of practice and the ideal material characterization procedure for the proper implementation of design methodologies.

Task 2 – Instrumentation

Develop a monitoring strategy and instrument two cut retaining walls (one cantilevered wall and one anchored wall) chosen by WisDOT officials and WHRP TOC to monitor both short and long term lateral earth pressures and horizontal and vertical movements.

Task 3 – Survey

Use LIDAR to take measurements along the surface of cut retaining walls at regular intervals during the duration of the research project to get a highly detailed account of horizontal movement of the walls.

WisDOT will make available the use of its RIEGL VZ-400 LIDAR equipment in order to survey the constructed walls over the duration of the research project. The RIEGL VZ-400 has a survey grade accuracy of 0.04 feet.

Task 4 – Data Analysis

Based on the data collected in previous tasks conduct a detailed analysis of cut retaining wall design methodologies as it relates to predicting lateral earth pressure and wall movement.

Task 5 – 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

- Expected level by staff/TOC members: Maximum of 40 hours over the duration of the project. WisDOT officials and POC members will select the project sites.
- WisDOT will make available the use of its LIDAR equipment in order to survey the constructed walls over the duration of the research project.
- The research team will not assume the availability of other WisDOT staff or additional equipment in the proposal. If WisDOT or another entity donates additional equipment, a letter of commitment must be included in the proposal.
- If field work on or around in-service facilities is required by the research, the proposal will need to discuss the nature and extent of needed traffic control and support assistance that will be requested from the WisDOT. The TOC will provide contact information for the relevant WisDOT regional personnel and possibly the county personnel such that the researcher will be able to closely coordinate where project fieldwork is being conducted. For WisDOT planning purposes, the Principal Investigator shall specify in his or her proposal, as practical, what specific traffic control will be required for this project, such as traffic flagging, signage, barricades, etc., as well as the duration needed (hours/day/location).

V. Budget and Time Frame

A. Project Duration
   i. The total duration of the project is **30 months** with an anticipated start date around **October 1, 2017**.
   ii. The draft final report shall be submitted at least three months prior to the end date of the contract.
   iii. Contract is considered closed upon submission of electronic and hard copies of the final report.
B. Project Budget

i. The project budget shall not exceed **$150,000** and shall include any costs associated with field monitoring, analyzing data, and preparing the draft and final reports.

C. 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.

D. Matching funds will not be considered in the proposal evaluation process.

VI. Implementation

Successful implementation of this research will be achieved through the development of the following items:

- Development of WisDOT guidance on the prediction of horizontal and vertical movement of cut retaining walls.
- Calibration of specific design methodologies based on research results.
- Development of threshold tolerance parameters that can be used for inspecting walls after construction to determine the level of wall performance.
- Creation of a course to assist in the training of WisDOT staff in implementation of best practices for cut wall designing tools/methodology.