PUTTING RESEARCH TO WORK

BRIEF

An Alternative Foundation System for Post-and-Panel Retaining Walls

To accommodate necessary abrupt ground surface changes, engineers use structures called retaining walls. These vertical walls help support earth slopes by resisting lateral soil pressure, which would otherwise cause the soil to fail and move, potentially having large safety/cost/liability implications. WisDOT designs and constructs many retaining walls every year.

One common type of retaining structure is the post-and-panel wall system. Construction of this wall type typically involves drilling a line of 2 to 4 feet diameter holes vertically into the ground, placing steel posts (H-sections) in these holes, and then filling the holes with concrete to a certain depth. Above this concrete foundation, and between the posts, horizontal members (wood or precast concrete panel) are placed to retain the earth behind them. The design of these walls involves determining the post spacing, length and diameter that will produce a system of sufficient strength to resist the predicted loads.

What's the Problem?

Contractors have approached WisDOT with an alternative post-and-panel retaining wall design that replaces the typical below-ground concrete column foundations with steel plates of the same width and length. These plates are welded to the steel H-sections and then driven into the ground, rather than being placed into a bored hole, as with the standard system. Because this plate system doesn't require boring a hole and filling it with concrete, it can be less expensive than the traditional method, involving less construction time and material costs. Before WisDOT could use these systems, research was needed to determine whether they were strong enough to resist the lateral pressures of the retained soil. Other concerns include the potential damage to the plate during driving, control and accuracy of post alignment, long-term durability due to steel corrosion and the potential horizontal wall movement (deflection) over time.

Research Objectives and Methodology

The objective of this research project was to assess the feasibility of an alternative foundation system for post-and-panel retaining walls that replaces bored-in concrete columns (piers) with driven H-sections with attached steel plates.

Researchers began by conducting a literature review of conventional and alternative post-and-panel systems to determine whether others have used steel plates to replace concrete columns. They then used 3-D finite element mathematical modeling to a) determine whether the proposed plate system was theoretically sound and b) develop criteria for engineers to design the systems and determine such parameters as strength, thickness, attachment requirements for plates, predicted movement—or lateral deflection—of the combined post and plate, and predicted overall bending of the wall.

Researchers used the results of this modeling to design and conduct full-scale field testing of both a plate system and a conventional system that used posts founded in concrete columns. During construction, each system was instrumented with inclinometers and potentiometers to determine lateral deflection, as well as gauges to determine strain distribution. After construction, researchers used a hydraulic jack to apply a lateral load to each system and gradually increase this load to the point of system failure. Strain and deflection measurements were taken for each increment of loading.

Results

Results showed that the plate system is a feasible alternative foundation to concrete column foundations for post-and-panel retaining walls in certain applications. While the concrete pier system is stronger than the plate system—failing at 150,000 as opposed to 100,000 pounds—it is strong enough for most applications. And while the plate system deflects more than concrete columns in response to

Investigator

"In some cases it's not possible to drill and place piles for a post-and-panel retaining wall system; this project showed an alternative plate system to be both a promising and cost-effective alternative."

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While traditional post-and-panel retaining wall systems require labor-intensive drilling and placement of concrete piers (left), the plate system can be driven directly into the ground in a matter of minutes (right).

Project Manager

"This system has the potential for application on certain project sites and offers designers another possible type of post-and-panel wall foundation."

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lateral loads, its entire embedded length contributes to its strength. In concrete piers these forces are concentrated in the upper half of the embedded length. It was noted that the plate system deflected significantly more than the concrete column system, which will limit its application at some sites.

Results also showed that the plate system was easier to construct, reduced construction time, and because it does not require excavation and concrete mixing, was far more cost-effective than the traditional concrete pier foundation system. The fabrication of the plate system involved simple welding, and the installation was accurate and rapid at the test site. It took only five minutes to align the plate system, and about three minutes to drive it 17.5 feet into relatively dense granular soil, with no apparent damage to the plate during driving.

Benefits, Implementation and Further Research

This system has the potential to speed construction and lower construction costs in certain applications, which benefits WisDOT, contractors and the public. WisDOT is considering its inclusion in the Bridge Design Manual.

Researchers recommend further field testing in difficult soils, such as dense gravelly soils, to verify that installation is as rapid and easy in a variety of subsurface soil conditions. They also recommend further field tests to verify design recommendations developed during mathematical modeling.

This brief summarizes Project 0092-07-06, "Development and Full Scale Testing of an Alternate Foundation System for Post and Panel Retaining Walls," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.

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