Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: Improved Calculation of Scour Potential in Cohesive Soils and Scour-Susceptible Rock

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Revised bridge scour calculations help MDOT better allocate finite resources

The Michigan Department of Transportation (MDOT) calculates how flowing water and floods are likely to erode the soil surrounding bridge foundations over time (a process called scour), and then designs and maintains bridges accordingly. Because MDOT's formulas for predicting bridge scour were developed by the federal government for multiple states to use, they offer a one-size-fits-all solution and sometimes call for costly designs and countermeasures that may not be needed. Researchers developed guidance for Michigan-specific rock types, which over time will allow MDOT to more precisely predict scour and better allocate the agency's resources.

PROBLEM

Fast-moving water can wash sediment away or erode rock from underwater bridge piers and abutments, especially during floods or other high-flow events. This process, known as scour, can eventually lead to instability; scour is the leading cause of bridge failures around the world. To anticipate and reduce the risk, MDOT has traditionally relied on federal scour-prediction standards to guide its bridge design, construction and maintenance efforts.

Because these standards were written to apply generally to all states, they take a worst-case-scenario approach and provide calculations for a bridge built on

Scour occurs much more gradually in limestone bedrock – shown in this core sample taken near the US-2 bridge over the Escanaba River – than in sandy soil. To account for this variation, MDOT is developing a more precise approach to scour design customized to Michigan's surface geology.

(continued)

"MDOT's risk-based process helps us identify what we should do to take care of a bridge. If we're using overly conservative assumptions for scour, we're not necessarily getting the most efficient use of our resources."

Rebecca Curtis, P.E.
Project Manager

the most challenging sandy terrain. In such a highly erodible environment, a bridge would require deep drilled shaft foundations and other structural precautions that can add significant costs to a project. Across Michigan, the surface geology contains sand, but it also contains clay and sedimentary rock – materials that are less likely to wash away or which erode at a significantly slower rate than sand. In these instances, the standard calculations call for more expensive bridge designs than the environment warrants.

To design and maintain bridges that consider Michigan's unique geology and make better use of state resources, MDOT sought to develop scour prediction calculations specific to Michigan.

RESEARCH

Through a literature search and interviews with other state departments of transportation (DOTs), researchers identified three tried-and-tested methods that could be used and adjusted to calculate scour in the types of rock and clay that are common in Michigan. They then selected four representative Michigan bridges – two founded on bedrock and two on clay-type soils – to serve as case studies for testing the different methods.

Using site-specific geotechnical reports and other available data, researchers applied the three scour calculation methods to each bridge to gain a better understanding of what data are needed, how the data can be collected and where Michigan-specific modifications should be made. The team then analyzed the results and compared them to the methods MDOT currently uses.

RESULTS

Researchers found that each calculation method is best suited for a specific type of geology and provided guidance for which to choose based on the results of the case studies. The team also offered direction for more challenging scenarios, such as sites with layers of earth that erode at different rates.

Additionally, researchers identified gaps between the available data and the information needed for optimal calculations. Since some of the desired data can only be gathered through tests that are not commonly conducted, researchers provided MDOT with recommended testing procedures, offered ways to collect some missing information during the course of other work and suggested viable work-arounds for situations when data cannot be obtained. Researchers also developed a three-tiered rock classification system to help guide scour analysis for bridges founded on rocks. These tools would make future scour analysis efforts easier.

While the research indicates that the three new calculation methods will provide MDOT with more accurate and cost-effective options for predicting scour in non-sandy soils, these approaches will need to be compared with real-world data collected in the field.

VALUE

Through surveying other states, this project revealed that most DOTs continue to calculate scour using a form of the federal standards, making modifications as needed. This research effort – investigating more accurate scour calculation methods for use in clay and rock – is still in its early stages, and it highlights MDOT's place at the forefront of this new line of inquiry. Additional related research, currently being conducted through a collaboration that includes MDOT, the Federal Highway Administration and other state DOTs, will continue these efforts to develop cutting-edge soil and erosion testing methods.

By designing and building bridges that account for the environment around them, MDOT will have the ability to more accurately predict scour and allocate resources where they are needed. As the scour calculations identified in this research are validated and calibrated against real measurements taken over time, MDOT will be better positioned to quantify just how much has been saved.

Research Administration

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