Scour Technology Transfer

MDOT Overview

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## Performance Measures

<table>
<thead>
<tr>
<th>Region</th>
<th>Scour Critical Interstate Bridges</th>
<th>2018-2022 Year Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>North</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Grand</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Bay</td>
<td>13</td>
<td>3-4</td>
</tr>
<tr>
<td>Southwest</td>
<td>13</td>
<td>3-4</td>
</tr>
<tr>
<td>University</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Metro</td>
<td>6</td>
<td>1-2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>
Performance Measures

Scour Critical Bridges - Interstate

Number of Bridges

Year

2012 2014 2016 2018 2020

Goal  Actual  Predicted

MDOT Michigan Department of Transportation
BRIDGE DEVELOPMENT
This scan was conducted as a part of NCHRP Project 20-68A, the U.S. Domestic Scan program.

The program was requested by the American Association of State Highway and Transportation Officials (AASHTO), with funding provided through the National Cooperative Highway Research Program (NCHRP).
“The scan team will focus on practices for inspection, monitoring, countermeasure selection and placement, and risk management for scour-critical and scour-susceptible bridges individually and in networks of varying sizes.”
NCHRP Panel’s Anticipated Outcomes

“By documenting and sharing successful practices the scan team will produce a valuable resource for use by bridge owners, state and local bridge inspectors, bridge designers and bridge management staff in reducing the risk to the travelling public due to flooding and scour.”
Scan Team

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Wisconsin DOT

Stephanie Cavalier, P.E.
Bridge Scour Manager
Louisiana Department of Transportation and Development (LADOTD)

AASHTO / NCHRP
U.S. Domestic Scan Program
Team’s Approach

Desk Scan, Literature Search, Identify Agencies and prepare questions.

Is the evaluation team multidisciplined?

- Yes
- No

Combine Responses

Host Workshop

AASHTO / NCHRP
U.S. Domestic Scan Program
Scan Recommendations

- General Procedures and Risk Analysis
- Scour Modeling and Analysis
- Monitoring and Field Inspection
- Design, Construction and Sustainability of Countermeasures
- Scour Plans of Action
Scan Recommendations

- Final Report will be available on the web at [www.domesticscan.org](http://www.domesticscan.org) later this summer
General MDOT Overview

Purpose

The purpose of this policy is to identify MDOT and local agencies’ responsibilities for the management of bridges vulnerable to scour. MDOT’s goals for management of scour susceptible bridges are:

- Ensure the safety of individual bridges and bridge approaches crossing waterways.
  - Perform Scour Evaluations following procedures listed in HEC-18.
  - Develop and implement Plan of Actions (POA).
  - Address critical findings by initiating follow up actions such as scour monitoring, mitigation, or replacement.
- Reduce the network wide risk of bridge scour and minimize future flood damage to bridges.
  - Utilize data driven, risk-based asset management. See MDOT Scour Risk Assessment, or Local Agency Scour Risk Assessment documents.
  - Prioritize scour mitigation and countermeasures given fiscal resources and constraints.
  - Design and place countermeasures to reduce the risk of bridges that are scour critical.
  - Consider bridge replacement as an option for mitigation if one of the following conditions are met:
    - The structure is a replacement candidate due to condition.
    - The structure is ranked both highly critical and highly vulnerable during the risk assessment and countermeasures will not reduce the risk to acceptable levels.
    - Countermeasures are not feasible due to cost, constructability, environmental constraints or backwater concerns.
Risk Management

- Vulnerability Categories
  - Skew
  - Channel Protection
  - Footing Type
  - Number of Substructure Units
  - Scour Rating (NBI 113)
  - Soil Type
  - Scour Remediation
  - Presence of scour during inspection
  - Waterway Adequacy
Risk Management

- Criticality Categories
  - Highway Classification
  - Traffic Volume
  - Detour Length
  - Deck Area
  - Economic Importance (Truck Traffic and Marine Navigation)
Risk Management
MDOT – Hydraulic Unit
Scour Process

• Original process developed through the Scour Committee in the 1990’s.
• Level I analysis conducted for all structures with spans greater than 20 feet.
• Level II analysis conducted for all structures not coded 8 for item 113.
• Majority of original analysis done by Consultant contract in the 1990’s.
• Scour analysis/rating often re-reviewed with any associated bridge rehabilitation and/or CPM work.
• New Item 113 coding guidance document developed by the Scour Committee in 2014.
Level I forms originally developed with guidance from FHWA’s HEC-18 and HEC-20 manuals.

Approved through the MDOT Scour committee in the 1990’s.

Overall scour and stream stability through site visit, aerial photographs, construction records, etc.

Many single span structures rated 8 off original Level I analysis through engineering judgement, which we often re-review at project level.

Construction records often required to verify pile length or if piles were even constructed.
• Most of the older analysis were done with HEC-2 or WSPRO.

• Many of the analysis were performed prior to DEQ providing discharge information.

• Countermeasure design and recommendations provided with the Level II analysis.
• Unit often consulted with items noted in routine bridge inspection through RFA process.

• We may re-evaluated Item 113 rating, if applicable.
MDOT – Hydraulic Unit
Scour Process – Bridge Rehabilitation/CPM

• In-house PM’s generally ask unit to review for countermeasure placement with any rehab/CPM work.

• We may re-evaluated Item 113 rating, if applicable.

• Perform site visit to verify if countermeasures are in place and assess overall stream stability. Will make countermeasure recommendations, as necessary.
With new Item 113 coding guidelines, there has been a stronger push to place more robust countermeasures to adjust ratings to either 7 or 8 for scour critical structures.

Articulating Concrete Block (ACB) has been used at multiple single span structure locations to change rating to at least a 7.
• Noticed problems with rock riprap dissolution, specifically with pure limestone riprap.
• Sulfate durability testing adding to our SP in 2016.
• Noticed issues with ACB installations.
• ACB has very tight construction and failure tolerances.
Level II scour evaluation done for all new bridge construction.

Hydraulic analysis performed in 1D HEC-RAS.

Scour calculations typically done in Microsoft Excel spreadsheets or MathCAD.

Countermeasure design and recommendations done for all new structures, however, foundation depths do not rely on countermeasures.

Scour memo provided to Bridge PM and Geotechnical Unit Supervisor.

Structure re-coded (if applicable) at post-construction inspection.
MDOT – Geotechnical Services Section

• Request for geotechnical investigation/engineering is initiated from Bridge Design

• What is the scope of work?
  • Scour protection retrofit of existing structure?
  • Replacement?

• Evaluate the existing information
  • Is it available?
  • If so, is it adequate or is more field investigation needed?

• Need to get the preliminary scour depths/elevations from the Hydraulics Unit
MDOT – Geotechnical Services Section Field Investigation

- Where are the existing substructures?
- Where are the proposed substructures?
- Where can we drill?
  - Lane restrictions
- How deep are the footings?
- What type of foundation is anticipated?
  - Deep foundation typically needed for scour critical structures (piles, drilled shafts, micropiles)
- If pile supported, what is the preliminary factored resistance needed for the replacement bridge?
MDOT – Geotechnical Services Section
Field Investigation
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Field Investigation
MDOT – Geotechnical Services Section

• Laboratory Testing
  • Grain size analysis, with hydrometer
  • Results sent to the Hydraulic Unit
• The Hydraulic Unit then reanalyzes their scour analysis
• If necessary, the scour analysis results are then discussed in an interdisciplinary meeting with Hydraulics, Bridge Design and Geotechnical
MDOT – Geotechnical Services Section

• The scour results are then used in the geotechnical analysis for the foundation
  • Geotechnical analysis at design flood (100 year event) and check flood (500 year event)
  • Evaluate lateral pile capacity, buckling, nominal pile driving resistance and minimum pile penetration elevation for piles first.
  • If piles aren’t an option then look to drilled shafts or micropiles, depending on site conditions.

• Constructability aspects of scour countermeasures are also evaluated.
  • If a scour retro fit, will the installation of the countermeasures affect/compromise the existing structure
  • How will the countermeasures be constructed? Is it feasible?