Scour for Bridge Rehabilitations and Policy Updates

Bridges
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Agenda

- Policy Background and Timeline for Scour
- Rehab Scour Policy Updates / Current Policy Review
Why is scour analysis required for REHAB Projects?

- This Bridge Rehab doesn’t include any work in the channel, so why does it need to be analyzed?
- There are no piers on this bridge, so why do we need to look at scour?
- It looks fine to me, why do we need it?
Because The Federal Highway Administration said so.

Approximately 60% of all bridge failures are from hydraulic or stream instability problems.
Late 1980’s: Scour becomes a nationwide concern after two bridge failures.

NY State Thruway (I-90) over Schoharie Creek Bridge Failure, New York, 1987

NTSB Faulted the NY State Thruway Authority
US 51 over The Hatchie River

April 1989: Hatchie River
NTSB Faulted Tennessee
for not fixing the bridge
before the collapse
Background

- 1988: FHWA requires all bridges to be rated on scour vulnerability under NBI.

- 1991: INDOT begins designing all new bridges to resist scour.

- 1997: INDOT Scour Committee divides all bridges into High, Medium, and Low Risk Categories.

1998: Standard Drawings for scour protection at three/four sided structures developed.
Background

- 1999: INDOT & FHWA agreement requires all bridges to be evaluated for scour when rehabbed.
- 1999: Hydraulics & Bridge Rehab send out two design memoranda detailing need for scour design during rehab.
- 1999-Present: This memo is still in effect.
- More information available on scour history available in HEC-18 (free download)
Since Scour Analysis is required

- Includes:

  Interstate, US, State and LPA Bridges
What’s the goal of Scour Analysis?

- Determine if the structure is **Scour Critical** and state that in the report.
- Determine Scour Countermeasures (whether they are required or not)
## IDM Figures for Scour

### Riprap Scour Protection

<table>
<thead>
<tr>
<th>Type</th>
<th>Minimum Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abutment</td>
</tr>
<tr>
<td>Revetment</td>
<td>1.5 ft</td>
</tr>
<tr>
<td>Class 1</td>
<td>2.0 ft</td>
</tr>
<tr>
<td>Class 2</td>
<td>2.5 ft</td>
</tr>
</tbody>
</table>

### Riprap-Lay Thickness

Note: The thickness is measured such that the top is at the ground elevation.

<table>
<thead>
<tr>
<th>Substructure Type</th>
<th>Lay Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sloping Abutment</td>
<td>The cone is covered top to toe, a square toe trench is placed below the riprap, based on lay thickness.</td>
</tr>
<tr>
<td>Vertical Abutment</td>
<td>2 times the water depth or a minimum of 10 ft</td>
</tr>
<tr>
<td>Pier</td>
<td>2 times the pier width or a minimum of 6 ft. The lay width is from the outside wall of the pier, all the way around.</td>
</tr>
</tbody>
</table>

### Riprap-Lay Width

Note: For an oversized-box or three-sided structure, see the INDOT Standard Drawings.
What is “Scour Critical”

- A bridge-rehabilitation project requires only the 1% annual EP to be evaluated.
- If analyzing an existing bridge, the foundation of the bridge should be checked against the low-scour elevation to determine if the bridge is scour critical.
“Scour Critical” - Continued

- If Low Scour depth is within 10 feet of any of the interior Pier or Bent pile tips, then it’s considered scour critical*
- Provide documentation of existing foundation depth
- If an existing bridge foundation is unknown, the bridge is automatically considered scour critical
What about piers over waterways, but not in the channel?

- Stream channels are known to migrate both horizontally and vertically
- All piers should be checked for scour critical
Check Bridge Inspection Report

The channel is moving to the east.

The channel is sand over sandstone.

The 1967 Flow Line elv. = 349.80'
The 2003 Flow Line elv. = 339.10' UW Report
The 2008 Flow Line elv. = 337.70' UW Report
The Q-100 Flow Line elv. = 363.14'
The Q-100 Scour Depth elv. = 344.39'

Read the inspection reports carefully
Floodplain Scour

White Lick Creek near SR 67 and Mooresville. Source: USGS
Floodplain Scour

Source: USGS-Recent Channel Migration Rates of Selected Streams in Indiana
“Scour Critical” - Continued

- What about countermeasures for scour at the abutments
  - Are there any existing scour countermeasures, and if so, what is the condition of the existing scour countermeasures?
  - Are the countermeasures adequate?
    - Riprap size
    - Signs of failing (bridge inspection report)
Are there exceptions/exemptions??

- Preventative maintenance doesn’t require Scour Analysis

- EXCEPT….
  - 1. Scour Mitigation
  - 2. Bridge-Length Culvert Liners
  - 3. Rigid Bridge Deck overlays
From Figure 412-2C

- Terminology includes:
  - Rigid, LMC, Dense Overlay, Silica Fume Overlay
What about flexible overlays???

- No

Thin Deck Overlays do not require scour analysis.

AKA: Polymeric Overlay
     Polycarb Overlay
     Polymetric Overlay
Any other Exceptions/Exemptions??

- Foundations embedded in scour resistant rock may not require analysis for those elements. Documentation and pre-coordination with the Office of Hydraulics is required.

- Coordination with INDOT Geotech may be required.
Scour Pictures
Any other Exceptions/Exemptions??

- If Stream Migration is unlikely based on historical evidence (aerial photos). This may eliminate the need for scour countermeasures on piers outside the Q100 elevation
  - Historical and current aerial photography
Any other Exceptions/Exemptions??

Source: Beam, Longest, and Neff
If constructability issues arise for larger riprap (i.e. low clearance structures), we have considered partially grouting a reduced class of riprap. Coordinate with the office of Hydraulics.
Unpublished Policies re: Hydraulics

- If Low Scour depth is within 10 feet of any of the interior Pier or Bent pile tips, then it’s considered scour critical*

- * - Designers have the option to show by computations that the structure is structurally adequate with less than 10’ of pile embedment below the low scour depth.

- Coordination with INDOT Structures and Geotech likely required.
Scour Standard Drawing Possible Update

>10'-0"??

INDIANA DEPARTMENT OF TRANSPORTATION

THREE-SIDED CONCRETE STRUCTURE SCOUR PROTECTION DESIGN, SPAN WIDTH H ≥ 20'-0"

SEPTEMBER 2011

STANDARD DRAWING NO. E 723-CCSP-04

/\ Richard L. Metcalf 09/01/11
DESIGN STANDARDS ENGINEER DATE

/\ Mark A. Miller 09/01/11
CHIEF HIGHWAY ENGINEER DATE
Photo 8

Photo showing scour hole at north face of pier # 2.
Photo 16

Photo showing scour hole at north face of pier # 3.
SR 46 Over Killion Ditch
Scour Pictures

31-03-06062A
5.34
Little Sand Creek
07/21/98
Scour Pictures
Contact

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