Introduction to Bridge Scour

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Bridge Scour Can Be Serious:
Abutment Failure in Iowa

Pier Failure in Taiwan
Failure by Contraction Scour

- For some bridges the width of the river has been narrowed to reduce span length.
- This smaller flow cross-sectional area leads to higher velocity \( V = Q/A \)
- If increased velocity is high enough, then the sediment will start to erode.

Contraction Scour Schematic

- Original riverbanks
- Reduced flow area
- Bridge Abutments

Riverbed Degradation

- Some rivers have beds that are naturally degrading due to conditions upstream or downstream.
- Any bridge piers or abutments built will need to have a deeper foundation.
Riverbed Aggradation

- Some rivers have beds that are naturally aggrading due to conditions upstream or downstream.
- Higher riverbed leads to increased flow depth and bridge over-topping.

Vortices Around Abutments

- Wake Vortex
- Normal Level
- Floodplain
- Abutment
- Toe Vortex
- Downward Flow/Front Vortex
- Return Flow
- Main Channel

Scour Around Abutment with Floodplain Flow
Vortices Around Pier

- PLAN
- SECTION A-A

A Wake Vortex
Horseshoe Vortex

A Downward Roller

Scour Design Method Summary

- HEC 18, "Evaluating Scour at Bridges" FHA, Publ # FHWA HI-96-031
- 1: Determine scour analysis variables
- 2: Analyze long-term bed elevation change
- 3: Evaluate scour analysis method
- 4: Compute contraction scour magnitude
- 5: Compute local pier scour magnitude
- 6: Compute local abutment scour magnitude
- 7: Plot and evaluate total scour

Potential Pitfalls With the Design Method

- From lab studies of constant flow for many days
- Tends to over-estimate scour depth
- No analysis of scour hole filling in when the flood is receding
Scour Countermeasures

- Bank-Hardening (riprap, cable-tied blocks, geobags)
- Flow-Altering (spur dikes, guidebanks)

Riprap and Cable-Tied Blocks

- Large mattresses of blocks tied together with cable

Cable-Tied Blocks
Geobags

- Pervious Bags Filled with Gravel
- PLAN

- SECTION
  - Vertical water seepage
  - No winnowing of fines

Spur Dikes at Abutment
(Rock walls perpendicular to flow to divert flow away from abutment)

Guidebanks

- Guide flow smoothly through bridge opening
Parallel Walls

- Rock walls parallel to flow to guide flow and stop return flow

NCHRP 24-18A: Abutment Scour Countermeasures

- Project sponsored by National Academy of Sciences,
- Transportation Research Board,
- National Cooperative Highway Research Project

Goals and Outcomes

- To produce design guidelines for abutment scour countermeasures
- First study to do this for compound channel flow with flow on floodplain
- Final Report finished by July 2006
More questions?

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