BUREAU OF STRUCTURES

WisDOT Structural Engineers Symposium

Program Agenda
May 23, 2024

8:00 a.m. Registration

8:30 a.m. BOS Director's Perspective – *Josh Dietsche*

8:40 a.m. Bridge Inspection and Maintenance Update – *Jason Lahm*

9:10 a.m. BOS Initiatives/Policy & Standards Updates – *James Luebke*

9:25 a.m. Local Bridge Program & Asset Management Updates – *Laura Shadewald*

9:45 p.m. Best Practices for Constructability – *Carolyn Brugman*

10:00 a.m. Break/Networking (Beverages and Snacks)

10:20 a.m. Welcome & Secretary's Office Remarks – *WisDOT Deputy Secretary Christina Boardman*

10:25 a.m. Structures Cost Estimating – *Fred Schunke*

10:45 a.m. South Bridge Connector Update/ InfraWorks Overview – *Mark Maday, Trey Horbinski (Jacobs)*

11:20 a.m. Small Group/Table Discussion – *All*

11:40 a.m. Geotechnical Updates (WBM preboring updates, drilled shaft projects, needs for borings, etc.) – *Dave Staab*

12:00 p.m. Lunch/Networking

1:00 p.m. Consultant Review Updates – *Najoua Ksontini*

1:15 p.m. Federal Highway Updates – *Derek Soden*

2:00 p.m. Small Group/Table Discussion – *All*

2:20 p.m. WisDOT's 1st Design-Build Project from a Structures Perspective – *Bill Dreher (SRF), Vinod Patel (EXP), Brent Freeman (Kraemer)*

2:55 p.m. Break/Networking (Beverages and Snacks)

3:15 p.m. Wisconsin Highway Research Program – *James Luebke*

3:30 p.m. Ratings and Mega Loads – *Alex Pence*

3:45 p.m. Interactive Survey & Q/A

4:00 p.m. Adjourn

Conference Location: University of Wisconsin-Madison Union South
1308 West Dayton Street
Madison, WI 53715

For today's presentations, agenda, and proof of attendance, please visit:

http://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/research.aspx

Partnerships | People | Process

WisDOT Maintenance Unit

Jason Lahm
BOS Structures and Repair Unit Supervisor/ UAS Pilot
2024 WisDOT Structural Engineers Symposium
Madison, WI
May 23, 2024

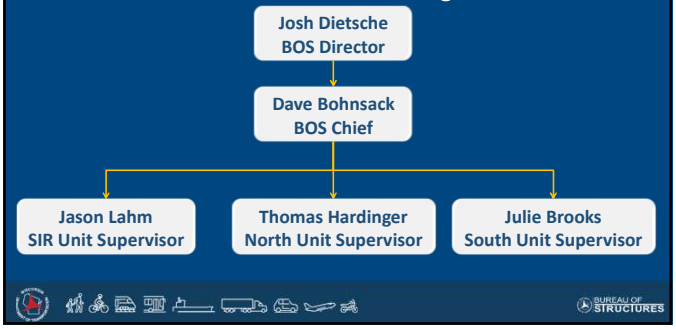
1

Maintenance Unit Topics

- BOS Maintenance Section Organization
- Structures Inspection and Repair (SIR) Unit Organization
- Lift Bridge Unit
- UAS (Drone) Unit

2

BOS Maintenance Unit Organization



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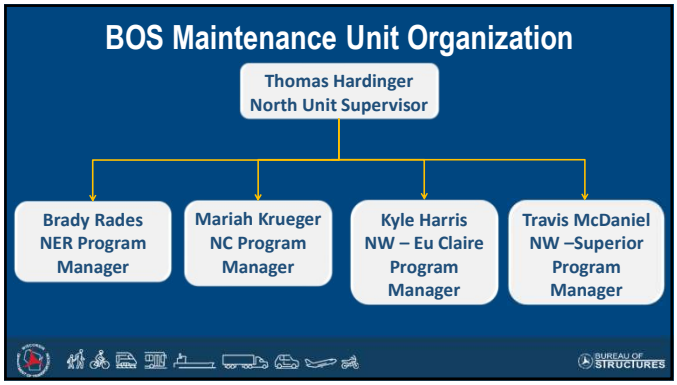
BOS Maintenance Unit Organization
Thomas Hardinger
North Unit Supervisor
Brady Rades
NER Program Manager
Mariah Krueger
NC Program Manager
Kyle Harris
NW – Eu Claire Program Manager
Travis McDaniel
NW –Superior Program Manager
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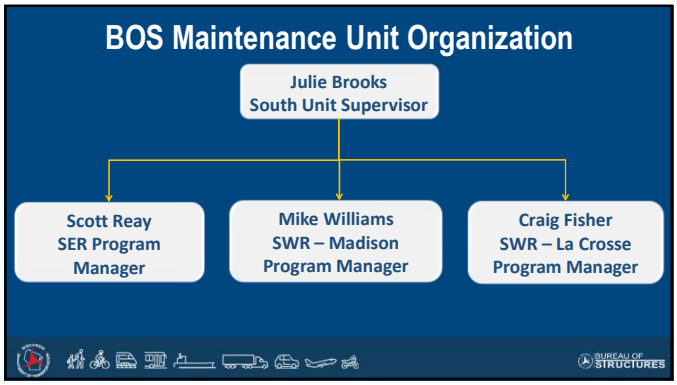
BOS Maintenance Unit Organization
Julie Brooks
South Unit Supervisor
Scott Reay
SER Program Manager
Mike Williams
SWR – Madison Program Manager
Craig Fisher
SWR – La Crosse Program Manager
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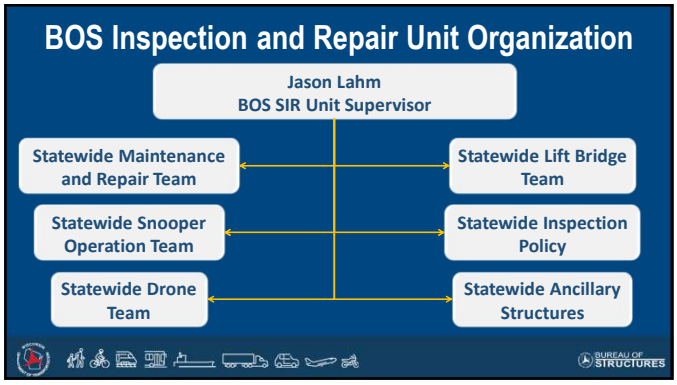
BOS Inspection and Repair Unit Organization
Jason Lahm
BOS SIR Unit Supervisor
Statewide Maintenance and Repair Team
Statewide Lift Bridge Team
Statewide Snooper Operation Team
Statewide Inspection Policy
Statewide Drone Team
Statewide Ancillary Structures
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Lift Bridge Team

- Jason Lahm, Lift Bridge Team Supervisor
- Jim McDowell, PM Lift Bridge Team
- Lift Bridge Team Members: Emerson H, Mark R, Joel Mass, Max K, Andrew Smith

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Why a Lift Bridge Team?

- Build Expertise
- Improved QC/QA Process
- More Efficient Use of State Funds
- Statewide Resource
- Communication Between Owners

8

UAS (Drone) Team

- Jason Lahm, Drone Team Supervisor (UAS Pilot)
- Steve Doocy, Lead Drone Pilot (UAS Pilot)
- Anthony Stakston, Lead EMILY Boat Captain (UAS Pilot)
- Currently WisDOT has 10 Additional Bridge Inspectors/ UAS Pilots.

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Why UAS (Drone) Team?

- Structure Inspection
- Modeling
- Ancillary Structure Inspections
- Mapping
- Public Relations
- Quantity Calculations

10

Policies

- Personnel
  - 2-person team – Pilot and Inspection TL
  - Pre-flight meeting and form
- All drones use tracked in Aloft
  - Land and Water Based Included
- Drones are used as to supplement the inspection

11

Unmanned (Drone) Vehicles

12

Use Cases

- Structure Inspections
  - Saving Time and Tax dollars
  - No Traffic Disruptions
  - Keeping Employees safe
  - Video and picture records
  - View areas hard to reach
- Modeling
  - Accurate material storage amounts
  - 3D bridge Models

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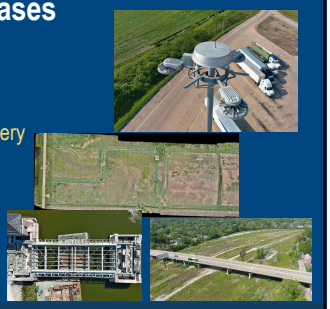
Use Cases

- High Mast Lighting Inspections
  - Very difficult to inspect
  - Inspector needs to climb or rent very expensive equipment
  - Complete a safe inspection
- Mapping
  - Wetland Mitigation Monitoring
- Public Relations
  - Present and Past Project Photos



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Use Cases

- Quantity Calculations
  - Deck Cracking
  - Slat Shed Quantity
  - Stockpile Quantities
- Flooding Monitoring
  - Waterway Movement
  - Slope Failures

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Use Cases
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Structure Inspection
Sample Inspections
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Structure Inspection
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Structure Inspection

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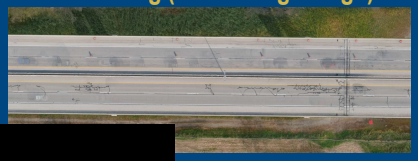
Structure Inspection

Top of Deck Cracking (8000' Long Bridge)



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Deck Thermal Imaging

Identifying Concrete Delaminations

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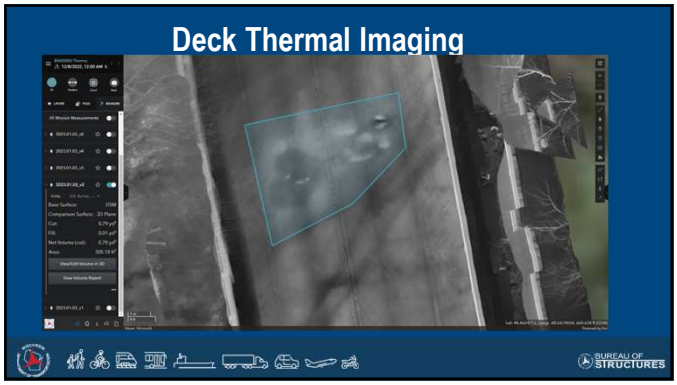
Deck Thermal Imaging
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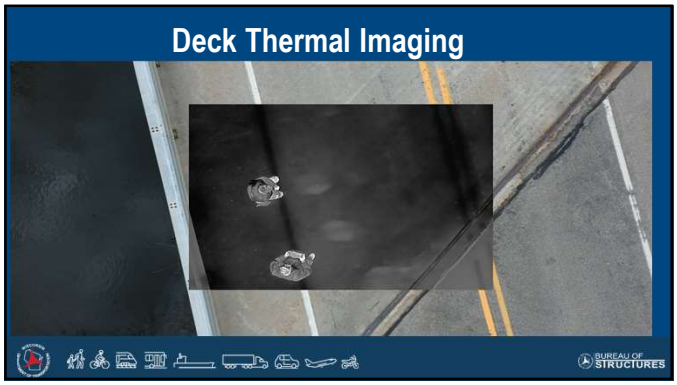
22


Deck Thermal Imaging
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Retaining Wall Inspection
Retaining Wall Movement
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EMILY Boat
Sonar
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25


EMILY Boat
Sonar
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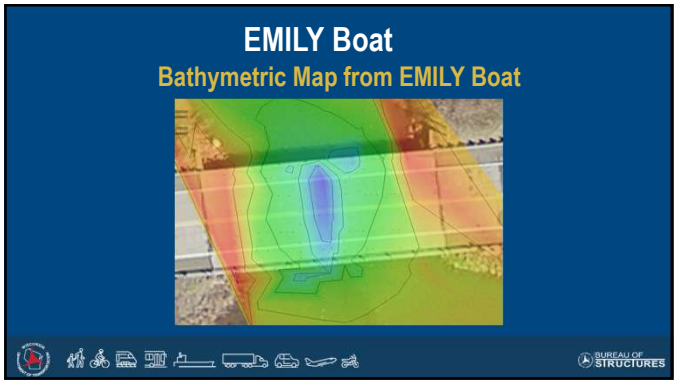
EMILY Boat
Bathymetric Map from EMILY Boat
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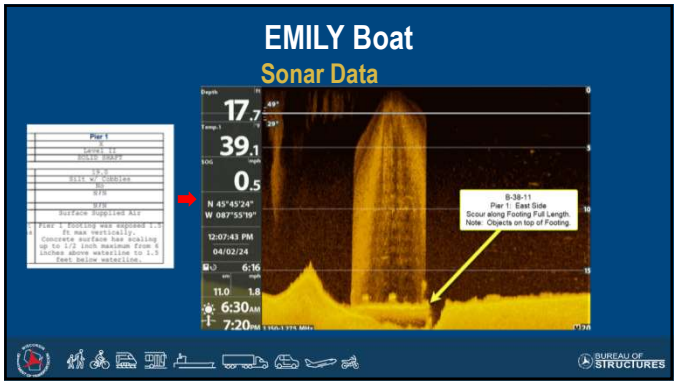
EMILY Boat
Sonar Data
17.7
39.1
0.5
N 45°45'24"
W 087°55'19"
12:07:43 PM
04/02/24
6:30AM
7:20PM
B-38-11
Pier 1: East Side
Scour along Footing Full Length.
Note: Objects on top of Footing.
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Underwater Verification - ROV
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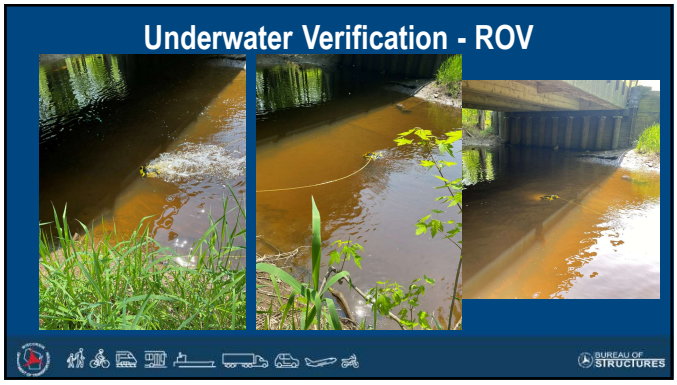
Underwater Verification - ROV
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Underwater Verification - ROV
Assessment of Mysterious Sonar Data

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Underwater Verification - ROV

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Data

- Raw Photos & Video
- Sonar
  - Point cloud
  - Sonar images
- Processed Data
  - Orthomosaic Images
  - Photogrammetry Images
  - Point Clouds & CADD models
  - Sonar Bathymetry
  - Testing the creation of Digital Twins

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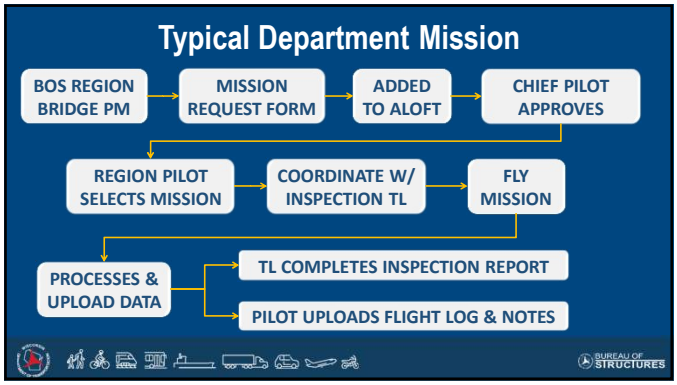
Typical Department Mission
BOS REGION BRIDGE PM
MISSION REQUEST FORM
ADDED TO ALOFT
CHIEF PILOT APPROVES
REGION PILOT SELECTS MISSION
COORDINATE W/ INSPECTION TL
FLY MISSION
PROCESSES & UPLOAD DATA
TL COMPLETES INSPECTION REPORT
PILOT UPLOADS FLIGHT LOG & NOTES
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BOS Initiatives/Policy & Standards

James Luebke P.E.
Policy and Standards Engineer

WisDOT Structural Engineers Symposium
University of Wisconsin-Madison Union South, Madison WI

May 23, 2024

1

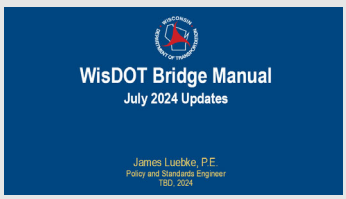
Overview

- Bridge Manual Update Webinars
- Concrete Box Culverts
- Other Updates
- What is Next?

2

Bridge Manual Update Webinars

- Next Update: August 2024

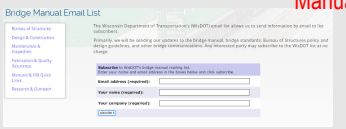


Questions: James.Luebke@dot.wi.gov

3

Bridge Manual Update Webinars

- To be added to email distribution list ➔ Search "WisDOT Bridge Manual Email List"



- To be removed from email distribution list:
  - Send an email to James.Luebke@dot.wi.gov

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Concrete Box Culverts

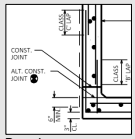
Overview:

- Details
- Precast Allowances
- ASTM C1577
- Items Under Development

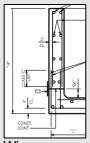
5

Construction Joints

- Horizontal
  - Barrel (RMW not required)
  - Wing (RMW required)*



Barrel



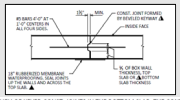
Wing

*epoxy coated bars and no alt jt.

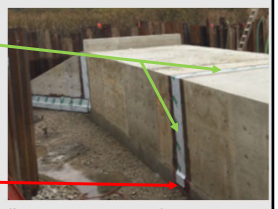
6

Construction Joints

- Vertical
  - Barrel (Top and Sides)
  - Barrel (Bottom)*



⚠ IN LIEU OF KEYED CONST. JOINTS IN THE BOTTOM SLAB, THE CONTRACTOR MAY USE 2" DEEP SAW CUTS WITHIN 12 HOURS AFTER POURING. #5 BARS 4'-0" AT 1'-0" CENTERS REQUIRED FOR KEYED CONST. JOINTS AND SAW CUT JOINTS.



Std. 36.03 **(Draft July 2024)**

*#5 bars required (formed jt. and saw cut jt.)

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Sheet Waterproofing Membrane

- Sheet Membrane Waterproofing for Asphalt Overlays (516.0600.S)
  - Asphalt Overlays (PMA Overlay Alternative)
- Sheet Membrane Waterproofing for Buried Structures (516.0610.S)
  - Buried Bridge Structures (epoxy bars in top slab)
  - CIP Pedestrian Underpasses
  - *Buried Culvert Structures with low-fills (under development)*

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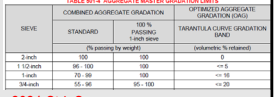
Coarse Aggregates

Breaker Run Substitution:

- Coarse Aggregate #1
  - ➔ AASHTO No. 67
- Coarse Aggregate #2
  - ➔ AASHTO No. 4
- APS 6 Gradations (Std. Spec. 310 & 604)

2023 Std. Spec.



2024 Std. Spec.

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Precast Allowances

- Historically, Contract plans with CIP design and details with precast allowance
- The designer shall determine if a noted precast allowance is appropriate on a project-by-project basis. This includes the barrel and wingwalls.
- Precast Design:
  - Barrel➔ ASTM C1577, Standards, and STSP
  - Wingwalls ➔ Standards and STSP

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Precast Allowances

- Several conditions where a noted allowance for precast may not be suitable for a project:
  - Openings not covered by ASTM C1577 (>12 ft spans or twin cell)
  - Depth of cover is less than 2 ft while supporting traffic loads
  - Pedestrian underpasses
  - Unique hydraulic conditions or other factors

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Precast Box Culverts

- ASTM C1577 Includes:
  - Single-cell precast box culverts
  - Standard Openings (3-ft by 2-ft to 12-ft by 12-ft)
  - Design fills (20 ft to 30 feet)
  - Provides wall and slab thicknesses and reinforcing areas

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Precast Box Culverts

- ASTM C1577 Includes:
  - Design Criteria (Appendix X1)
    - Span: 12-ft maximum standard opening
    - Load: HL-93 live load without the lane load
    - Materials: f'c=5 ksi, fy=65 ksi
    - Arrangement: A slab thickness of 1/12 the span (or greater)

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Precast Box Culverts

- ASTM C1577 Special Design *(under development)*:
  - Design Criteria (Appendix X1)
    - Span: Maximum WisDOT allowance
    - Load: HL-93 live load with the lane load (for L>12ft)
    - Materials: Higher strengths (f'c=6 ksi, fy=80 ksi)
    - Arrangement: Crack and deflection control limits

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Precast Box Culvert *(Under development)*

- Standards
- Special Provision
- Bridge Manual

Items:
- Fills less than 2-ft
- Construction details (e.g. joint ties)
- Maximum permissible joint opening
- Undercut and backfill notes
- Precast walls

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What is Next?

- Bridge Manual Release – End of July 2024
- Bridge Manual Release Webinar – August 2024
- AASHTO LRFD 10th Edition – End of 2024?
- WHRP Implementation

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Questions

James Luebke, PE
James.luebke@dot.wi.gov
(608) 266-5098

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Local Structures Topics & Updates

Laura Shadewald
Structures Development Chief

WisDOT Structural Engineers Symposium
UW-Madison Union South, Madison, WI

May 23, 2024

1

Local Structures Topics and Updates

- Trans 212/213 Updates
- Local Structures 6-20 Feet
- Open Railings vs. Parapets

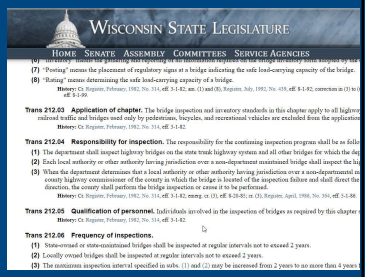
2

Trans 212/213 Updates

3

Trans 212/213 Updates

- First Adopted in 1982
- Revised 2-3 times
- Remained static since 1999


WISCONSIN STATE LEGISLATURE

HOME SENATE ASSEMBLY COMMITTEES SERVICE AGENCIES

(7) "Posting" means the placement of regulatory signs at a bridge indicating the safe load-carrying capacity of the bridge.

(8) "Rating" means determining the safe load-carrying capacity of a bridge.

History: Cr. Register, February, 1982, No. 314, eff. 3-1-82; am. (1) and (8), Register, July, 1992, No. 438, eff. 8-1-92; correction in (3) to (6) eff. 8-1-92.

Trans 212.03 Application of chapter. The bridge inspection and inventory standards in this chapter apply to all highway railroad traffic and bridges used only by pedestrians, bicycles, and recreational vehicles are excluded from the application

History: Cr. Register, February, 1982, No. 314, eff. 3-1-82.

Trans 212.04 Responsibility for inspection. The responsibility for the continuing inspection program shall be as follo

(1) The department shall inspect highway bridges on the state trunk highway system and all other bridges for which the de

(2) Each local authority or other authority having jurisdiction over a non-department maintained bridge shall inspect the hi

(3) When the department determines that a local authority or other authority having jurisdiction over a non-departmental m county highway commissioner of the county in which the bridge is located of the inspection failure and shall direct the direction, the county shall perform the bridge inspection or cause it to be performed.

History: Cr. Register, February, 1982, No. 314, eff. 3-1-82; emerg. cr. (3), eff. 8-20-85; cr. (3), Register, April, 1986, No. 364, eff. 5-1-86.

Trans 212.05 Qualification of personnel. Individuals involved in the inspection of bridges as required by this chapter

History: Cr. Register, February, 1982, No. 314, eff. 3-1-82.

Trans 212.06 Frequency of inspections.

(1) State-owned or state-maintained bridges shall be inspected at regular intervals not to exceed 2 years.

(2) Locally owned bridges shall be inspected at regular intervals not to exceed 2 years.

(3) The maximum inspection interval specified in subs. (1) and (2) may be increased from 2 years to no more than 4 years

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Trans 212/213 Updates

- Trans 212: Standards for the Inspection of Bridges in WI
  - Propose Update to:
    - Consistent with current inspection standards & procedures
    - Update obsolete language & terminology
    - Ensure compliance with 23 CFR Part 650 Subpart C Final Rule on National Bridge Inspection Standards, effective 2022

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Trans 212/213 Updates

- Trans 213: Local Bridge Program
  - Broaden eligibility for funding of local bridges
    - "Sufficiency Rating" – outdated, no longer used nationally
  - Appropriately identify timely bridge improvement work
    - Preserve and extend the life of bridges

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Trans 212/213 Updates

- Draft language is almost complete
- Next Steps:
  - Rule Drafting, Analysis and Fiscal Estimate
    - Prehearing materials that are reviewed and approved by DOT
  - Stakeholder outreach
  - Clearinghouse Rules, Public Hearing, Legislative Review
  - Final Rule Published
- Draft rule will be in effect for the next local program cycle Spring 2025

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Local Structures 6 – 20ft Program Overview

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Overview of the Issue

- Structures (local system) under 20ft long…
  - …have no inventory requirements.
  - …have no inspection requirements.
  - …have no load rating requirements.
  - …are **NOT** eligible for federal bridge rehabilitation and replacement funding.

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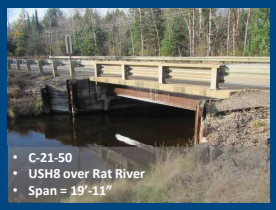
Overview of the Issue

- Bridges and "not bridges" can look and act very similar



- C-21-50
- USH8 over Rat River
- Span = 19'-11"

NOT A BRIDGE

- B-12-818
- STH131 over Branch of Kickapoo River
- Span = 24'-0"

BRIDGE

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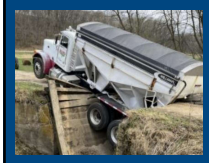
Overview of the Issue

- Small structures can still present issues…



- …and require funding to repair or replace.

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Wisconsin 2023 – 25 State Budget

- Budget Language
  - *Provides $12,500,000 SEG to JCF's supplemental appropriation in FY24 for assessment of local bridges and culverts and create a biennial DOT SEG appropriation that could receive the funds. Directs the Department to develop a program for counties to assess local bridges and culverts that are less than 20 feet, but greater than six feet in length.*
- State Statute 85.64
  - *The department shall administer a program for counties to inventory and assess the condition of local bridges and culverts that are 20 feet or less in length but greater than 6 feet in length.*

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Wisconsin 2023 – 25 State Budget

- Collaborative effort to "develop a program"
  - Wisconsin DOT
  - Wisconsin Towns Association
  - League of Wisconsin Municipalities
  - Wisconsin Counties Association
  - Wisconsin County Highway Association

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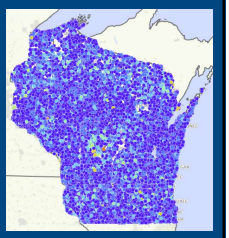
Size of the Local Inventory

- Approximately 25,000 structures that meet criteria
  - WisDOT GIS mapping
  - Extrapolation from state-owned data
  - Local owner survey
- WisDOT provided information on possible locations



BUREAU OF STRUCTURES

14

Phased Approach

- Working with local owner representatives on a phased approach:
  - Inventory
  - Inspection
    - Load rating - as needed and pending available funds

BUREAU OF STRUCTURES

15

Phase 1: Inventory Information

- No qualifications for person collecting this information
- WisDOT Bureau of Structures provided direction/training
- Data uploaded to the Highway Structures Information System (HSIS)
  - Name of person collecting information
  - Date of inventory
  - Owner
  - County
  - Municipality
  - Feature on (roadway name/number)
  - Number of lanes on structure
  - Feature under (if known)
  - Location (Latitude / Longitude)
  - Location description (distance from an intersection)
  - Total structure length
  - Structure type (pipe culvert, box culvert, girder bridge, etc.)
  - Structure material (concrete, steel, etc.)
  - Weight limit (if posted)
  - Concerns identified

BUREAU OF STRUCTURES

16

Phase 2: Inspection

- Inspections performed by Wisconsin certified bridge inspectors (about 300 in the state)
- Based on National Bridge Inspection (NBI) rating scale (0 – 9)
  - 0 – 2: Severe condition
  - 3 – 4: Poor condition
  - 5 – 6: Fair condition
  - 7 – 9: Good condition
- WisDOT Bureau of Structures provided direction/training

BUREAU OF STRUCTURES

17

Load Rating

- As deemed necessary and pending availability of funds, perform load ratings to ensure safety
  - Determining if the structure can safely carry legal-weight vehicles
  - Load post as necessary
- Performed by structural engineers
- Contracting and reimbursement mechanism pending availability of funds

BUREAU OF STRUCTURES

18

Looking Ahead

- Information is being gathered for two reasons:
  - Ensure these structures are safe for the travelling public
  - Support future budget proposals for rehabilitation & replacement funding
- Future funding is not guaranteed, but collecting information on the size, nature, and condition of the small structure inventory is a necessary first step.



BUREAU OF STRUCTURES

19

Open Railings vs. Parapets

BUREAU OF STRUCTURES

20

Open Railing vs. Parapet

- Parapets preferred/required on state system
- Open railing used more frequently on local structures
- Lots of issues when open railing is used

BUREAU OF STRUCTURES

21

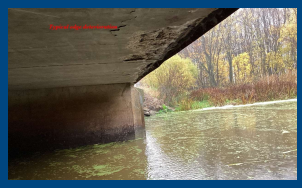
Open Railing vs. Parapet

- Initial Cost
  - Open Railing: $300-$400/LF
  - Parapet:
    - 32SS: $150/LF
    - 42SS: $185/LF

22

Open Railing vs. Parapet

- Minimum grade 0.5%
  - 30' Long Structure = 1.8"
  - 50' Long Structure = 3"

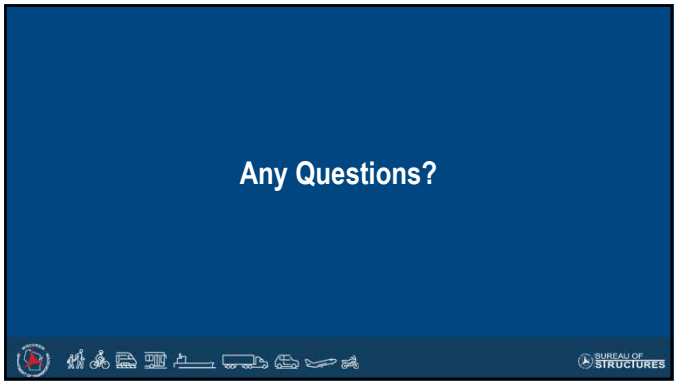


23

Open Railing vs. Parapet

- What are we asking?
  - Consider all the options, including parapets
  - Educate the local owners – initial and long-term costs
  - Help us build more sustainable bridges!

24



25

Best Practices for Constructability

Carolyn Brugman, PE
Structures Construction Program Manager

2024 WisDOT Structural Engineers Symposium
UW-Madison Union South, Madison, WI

May 23, 2024

1

Outline

- Considerations during design to help construction go smoothly
- Construction questions and issues we see that can be addressed during design

2

Removing Structure over Waterway

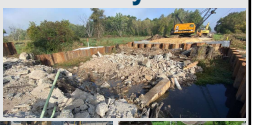
Issue

- Selection of the incorrect bid item - Remove Debris, Minimal Debris, or Debris Capture
  - Following DNR initial recommendation without coordination

3

Removing Structure over Waterway
Solutions

- Select bid item based on structure type - WBM
  - CMM 645.6 contain example removal plans for each item
- Coordinate with DNR and Regional Environmental Coordinator
- Coordinate with BOS on unique structures/situations

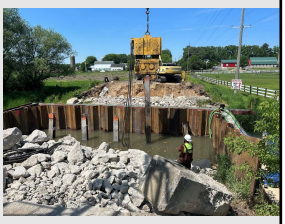


BUREAU OF STRUCTURES

4

Pile Conflicts and Removing Piling
Considerations

- Verify locations of existing piling vs. proposed
  - Offset proposed substructures from existing
  - Space new piling to avoid existing
  - If neither is possible, include removing existing piling SPV



BUREAU OF STRUCTURES

5

Rebar Congestion
Issue

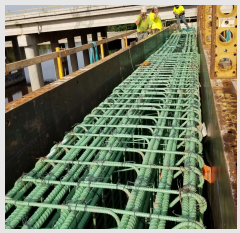
- Tight rebar spacing makes consolidation around rebar difficult
  - Leave enough space for vibrator


BUREAU OF STRUCTURES

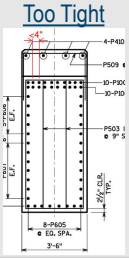
6

Rebar Congestion
Solutions

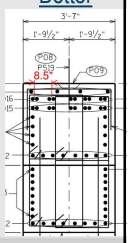
- Stagger lap splices
- Bundle bars
- Multiple rows of rebar
- Upsize members



Too Tight



Better



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7

Small (or Large) Haunches
Include Plan Note

- When haunches less than 1 ¼" or greater than 8" are expected
  - Draws attention to contractor that alternate forming methods may be required

GIRDER HAUNCHES ARE EXPECTED TO BE LESS THAN 1.25" IN SOME AREAS, TRADITIONAL DECK FORMING SYSTEMS MAY NOT BE SUITABLE.

GIRDER HAUNCHES ARE EXPECTED TO BE GREATER THAN 8" IN SOME AREAS, TRADITIONAL DECK FORMING SYSTEMS MAY NOT BE SUITABLE.

BUREAU OF STRUCTURES

8

Complex Geometry
Considerations

- Tapers
  - Material cost vs. labor cost
- Superelevation Transitions
  - Difficult to get right with finishing machine

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9

Existing Conditions for Rehabs

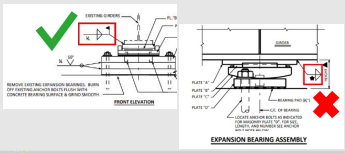
- Verify Scope of Work
  - Review inspection reports/scoping notes
  - Secondary maintenance items
- Check most recent inspection reports
- Field verify bearing heights for bearing replacements

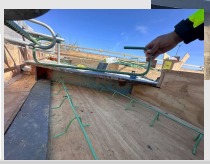
BUREAU OF STRUCTURES

10

Existing Conditions for Rehabs

- Pay attention to existing expansion end diaphragm height for joint replacements
- Field Welding Details for Bearing Replacements





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11

Roadway Design Coordination
Transition from Road to Bridge

- Scope of bridge rehab work (and how this impacts approach road)
  - Replacement of concrete approach needed for redeck/overlay?
  - Pavement replacement directly behind the paving block
- Transition between road and bridge
  - Parapet transitions
  - Curb/sidewalk locations and transitions
  - Grading in Vicinity of Structure

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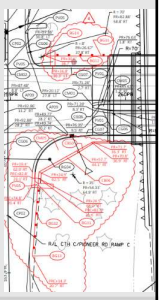
12

Roadway Design Coordination (cont.)

- Get updated files from roadway designer frequently
  - Profile
  - Alignments
  - Typical Section/X-Slopes/Transitions
  - Utility (Name & Work Plan)
  - Bridge Layout

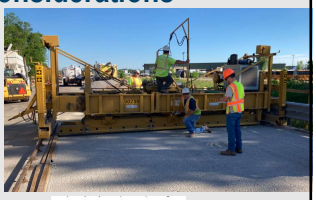


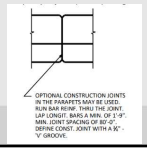
BUREAU OF STRUCTURES

13

Miscellaneous Considerations

- Concrete Overlay Staging
  - Construction joints at crown/grade break
- Temporary Support SPV
  - Calculations to determine necessity
- Parapet Optional Joints
  - Remove optional construction joint if bridge is less than 80' long





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14

Miscellaneous Considerations (cont.)

- Soldier Pile Walls
  - Piles and tiebacks are considered primary members but soldier pile fabricators can be from "Fabricated Bridge Components" or "Primary Members" APL
  - Add note to plans that all welding needs to conform to AWS D1.5
- Box Culverts
  - Consider if inclusion of precast box substitution note is appropriate per WBM

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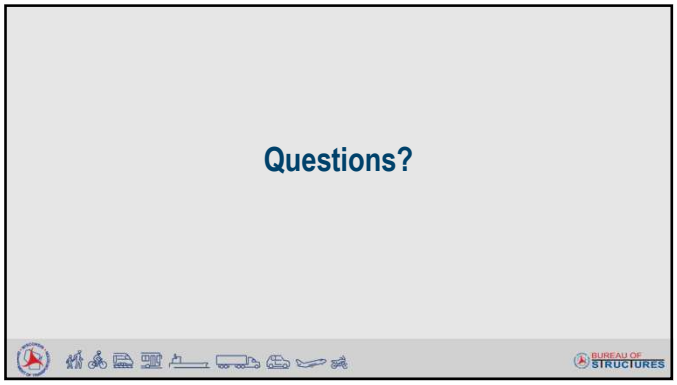
15



16

Structures Cost Estimating

Fred Schunke
NCR Design QA Engineer

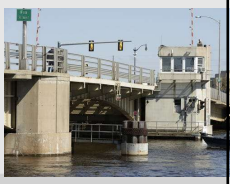
WisDOT Structural Engineers Symposium

May 23, 2024

1

Lesson Objectives

- Share where structure estimating guidance is in the FDM
- Review commodity trends and share how to adjust historic prices.
- Share some guidance to develop final estimates including updates to the Similar Projects Tool, Bid Express User Guide and plan locations.



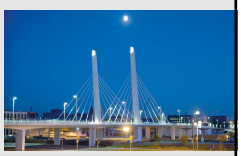
BUREAU OF STRUCTURES

2

FDM 19-5 Estimates

Sections Relevant for Today

- FDM 19-5-5 noted in the Bridge Manual 5.3
- Google WisDOT FDM
- WisDOT Webpages
  - Doing Business > Engineers and consultants > Structure and road resources
  - Listed under Standards and manuals



BUREAU OF STRUCTURES

3

FDM 19-5 Estimates

Sections Relevant for Today

- FDM 19-5-5.5 Tools and Resources (pg. 13-17)
  - Bid Express
  - Similar Projects Tool
  - Other Tools and Resources
    - Plans, Proposals, Addenda and As-builts

BUREAU OF STRUCTURES

4

FDM 19-5 Estimates

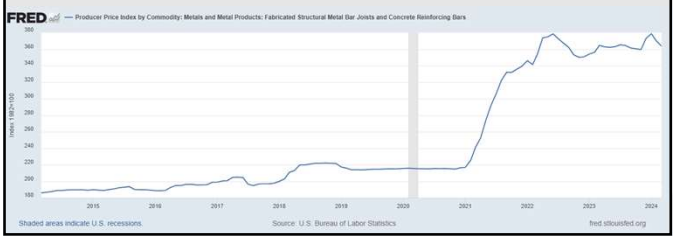
Sections Relevant for Today

- FDM 19-5-5.6.3 Bid Item Estimating Guidance (pg. 20-21)
  - Concrete Masonry Bridges
  - Concrete Masonry Overlay Decks
- FDM 19-5-5.6.4 Unit Price Guidance (pg. 22)
  - Adjusting Unit Prices
    - WisDOT Chained Fisher Construction Cost Index

5

Producer Price Index Commodities

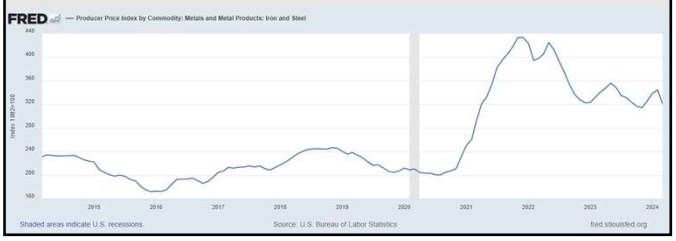
Nationwide Concrete Reinforcing Bars (10 years)



6

Producer Price Index Commodities

Nationwide Iron and Steel (10 years)



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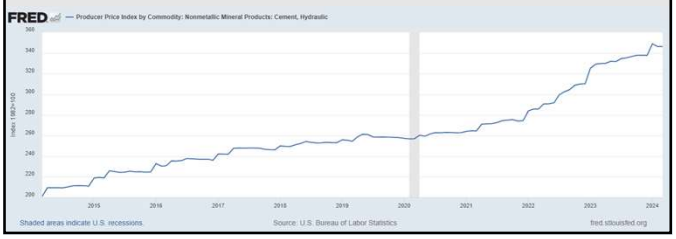
Producer Price Index Commodities

Nationwide Cement (10 years)



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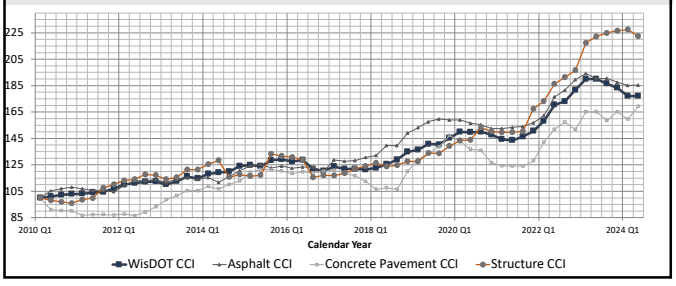
WisDOT Chained Fisher Construction Cost Index



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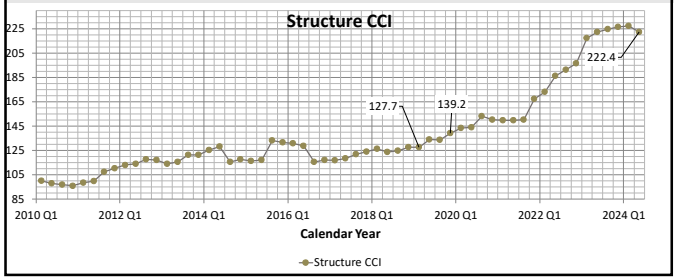
10

WisDOT Construction Cost Index



11

WisDOT Construction Cost Index

Adjusting Unit Prices

- Guidance in FDM 19-5-5.6.4 (page 21)
- **Do not forecast prices past the current date**
- Used to convert past prices into current dollars without recent bid history
- Adjusting prices using the WisDOT CCI is approximate
  - But will provide a better estimate
- Recent price trends for bid items will always be more reliable

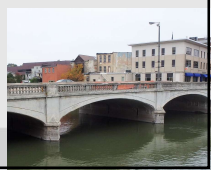
BUREAU OF STRUCTURES

12

WisDOT Construction Cost Index

Adjusting Unit Prices

- Use a ratio from past and current index values to convert past prices into current dollars
- $\frac{Current\ Index\ Value}{Past\ Index\ Value} \times Past\ Bid\ Price = Current\ Bid\ Price$
- Example:
  - Jan. to Dec. 2019 price = $166 Total SF Cost
  - Past Index Values = 127.7 to 139.2, using 137
  - Current Index Value = 222.4
  - $\frac{222.4}{137} \times \$166 = \$269\ or\ \$270\ rounded$



13

WisDOT Construction Cost Index

Adjusting Unit Prices

- Estimator Prices do not need to be adjusted

14

Concrete Masonry Bridges

FDM 19-5-5.6.3 Bid Item Estimating Guidance

- Regression prices should not be used
  - Prices vary for slab-spans, girder and rehabilitated bridges
  - Concrete Masonry Bridges, Removing Structure and Excavation for Structures should be estimated at the **same time** with the same bid data and contractor
    - Each contractor will bid these items differently
    - May need to look at losing bid prices

BUREAU OF STRUCTURES

15

PS&E Estimates

- Finding similar bridges in the HSI
  - No recent bridges
  - Easy to find similar bridges
- Bid Express, Similar Projects Tool and Let Plans
  - All recent and historic bridges
  - More effort required

BUREAU OF STRUCTURES

16

Removing Structure Over Waterway

"Average" Price Differences

	Removing Structure Over Waterway Remove Debris	Removing Structure Over Waterway Minimal Debris	Removing Structure Over Waterway Debris Capture
No. of Structures	28	116	11
Minimum	$6,039	$4,289	$41,100
Maximum	$737,500	$2,443,750	$378,461

BUREAU OF STRUCTURES

17

Removing Structure Over Waterway

"Average" Price Differences

	Removing Structure Over Waterway Remove Debris	Difference	Removing Structure Over Waterway Minimal Debris	Difference	Removing Structure Over Waterway Debris Capture
25th Percentile	$18,738	$25,236	$43,974	$39,231	$83,205
Median	$57,261	$16,071	$73,332	$53,321	$126,653
75th Percentile	$83,607	$40,624	$124,230	$62,470	$186,700

BUREAU OF STRUCTURES

18

Removing Structure Over Waterway

"Average" Price Differences

	Removing Structure Over Waterway Remove Debris	Difference	Removing Structure Over Waterway Minimal Debris	Difference	Removing Structure Over Waterway Debris Capture
Typical Ranges	$19,000 to $84,000	$16,000 to $41,000	$44,000 to $124,000	$39,000 to $62,000	$83,000 to $187,000
Below Typical	<$19,000	increase 100% decrease 50%	<$44,000	increase 100% decrease 50%	<$83,000
Above Typical	>$84,000	increase 50% decrease 33%	>$124,000	increase 50% decrease 33%	>$187,000

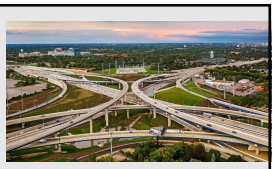
19

Bid Express User Guide

- Linked in FDM 19-5-5.5.1 Primary Tools pg. 13-14
  - Linked in the Estimating Tools Pages
- Introduction – pg. 2-3
  - Start up
  - Bid Express Overview
- **Looking up bid history and bid tabulations – pg. 4-7**
  - Guidance for what to enter in bid history fields
  - Steps to review and obtain results

20

Bid Express User Guide



- Tips and Tricks – pg. 8-24
  - Step-by-step guides with screen captures
  - Finding proposal, project or bid information with any project or structure ID
  - Finding structure information
  - Filter and graph Bid Tab Analysis results in Excel
- Appendices – pg. 25-29
  - County and region map
  - County and region codes

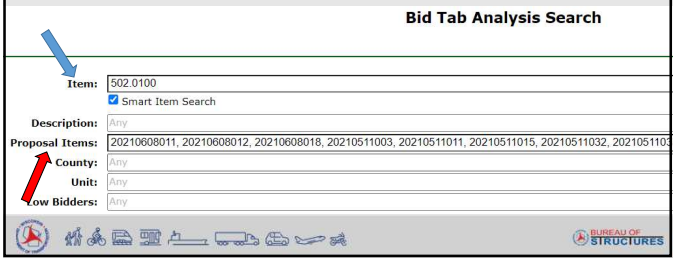
21

Similar Project Tool Updates

- Copy Proposal IDs for BidX Button has been added
- Proposal IDs may be filtered
  - Bridge Replacement or Rehabilitations for structure items
  - Reconstruction or resurfacing/pavement replacements for sidewalk, earthwork and aggregates
  - Broad filters recommended

22

Similar Project Tool Updates



23

Plans, Proposals, Addenda and As-builts

FDM 19-5-5.5.2 Other Tools and Resources

- Let plans and proposals October 2021 and earlier
  - Plans and Proposals FTP Site
- All addenda and let plans and proposals
  - HCCI Pages
  - Let plans and proposals after October 2021 are in HCCI Pages
- As-builts on DOTView GIS Application in Geoportal
  - WisDOT staff only

24

Contact Information

Rielly O'Donnell
- Proposal Management Chief DTSD-BPD
- Rielly.ODonnell@dot.wi.gov
- (608) 266-3721

Fred Schunke
- Design QA Engineer NCR
- fred.schunke@dot.wi.gov
- (715) 421-8079

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25

SOUTH BRIDGE CONNECTOR

Mark Maday / Jacobs
Trey Horbinski / Jacobs

WisDOT Structural Engineers Symposium
University of Wisconsin-Madison Union South
Madison, WI
May 23, 2024

BUREAU OF STRUCTURES

Jacobs

1

SOUTH BRIDGE CONNECTOR

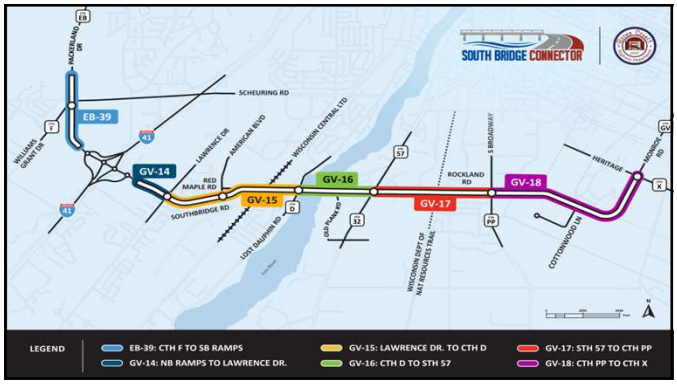
Presentation Outline

- Project Overview
- History / Project Status
- Segment GV-16
- Bridge Alternatives
- Schedule
- Infraworks Demo

BUREAU OF STRUCTURES

Jacobs

2

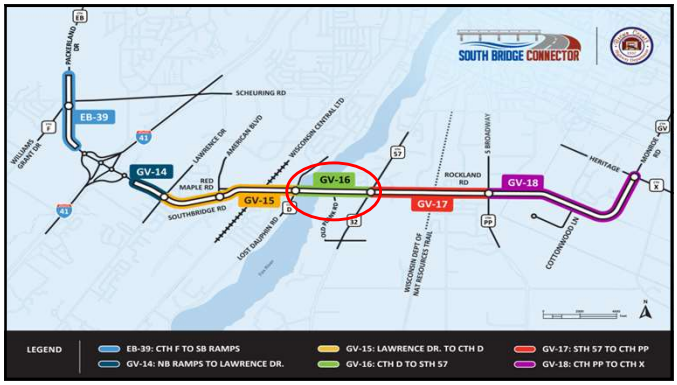


3

SOUTH BRIDGE CONNECTOR

- Tier 1 EIS – ROD Obtained October, 2020
  - https://www.browncountywi.gov/departments/planning-and-land-services/planning/south-bridge-connector/
  - WisDOT Committed Construction of the I-41 / CTH GV Interchange
- $5M Federal Funding For Design / Construction, April 2022
- WisDOT Local Program Committed $50M For Construction
  - Brown County and City of DePere Local Cost Share
- Brown County Project Website:
  - https://www.browncountywi.gov/departments/highway/general-information/south-bridge-connector/

4



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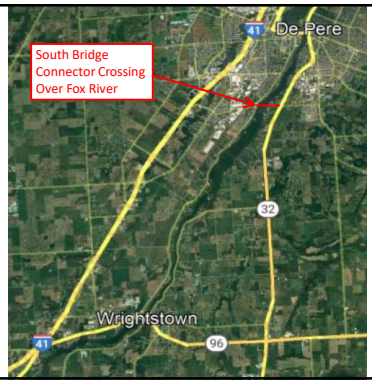

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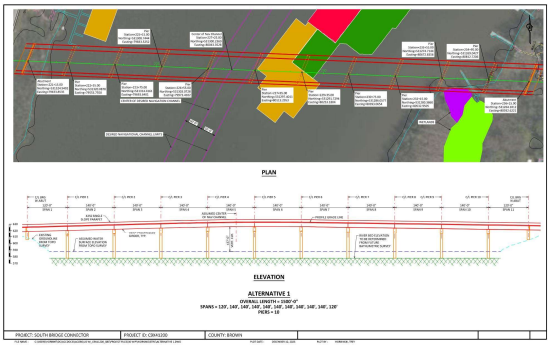
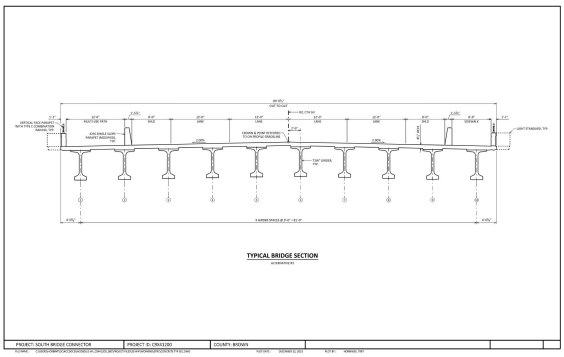
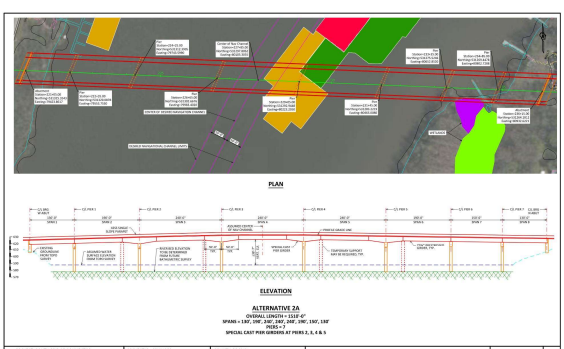

PLAN
ELEVATION
ALTERNATIVE 1
OVERALL LENGTH = 1080'-0"
SPANS = 120', 140', 140', 140', 140', 140', 140', 140', 140', 120'
PIERS = 10
PROJECT: SOUTH BRIDGE CONNECTOR
PROJECT ID: CBX3100
COUNTY: BROWN

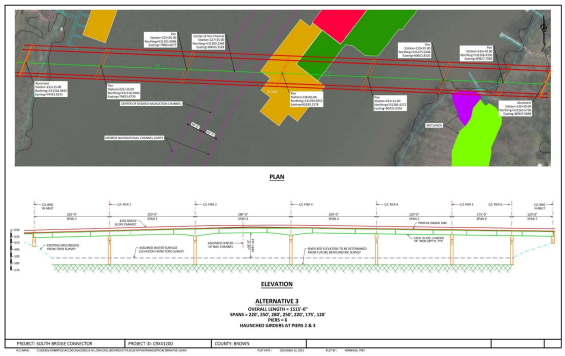
7


TYPICAL BRIDGE SECTION
PROJECT: SOUTH BRIDGE CONNECTOR
PROJECT ID: CBX3100
COUNTY: BROWN

8


PLAN
ELEVATION
ALTERNATIVE 2A
OVERALL LENGTH = 1110'-0"
SPANS = 130', 170', 240', 240', 240', 170', 130'
PIERS = 7
SPECIAL CAST PCBS GIRDERS AT PIERS 2, 3, 4 & 5
PROJECT: SOUTH BRIDGE CONNECTOR
PROJECT ID: CBX3100
COUNTY: BROWN

9



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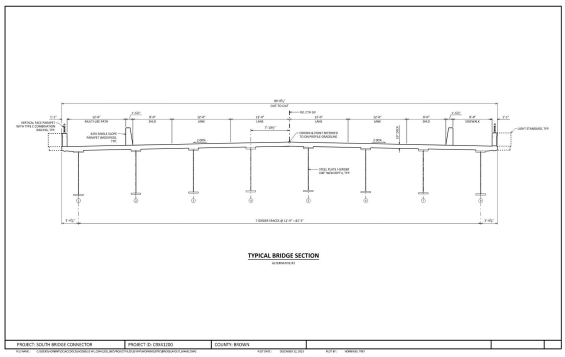


11

SOUTH BRIDGE CONNECTOR

Segment GV-16 Project Schedule:

- Preliminary Engineering: 2024
- Final Design: 2025 - 2026
- Construction: 2027 - 2028

BUREAU OF STRUCTURES

Jacobs

12

Autodesk Infraworks
Conceptual Infrastructure Modeling

AUTODESK InfraWorks Jacobs

13

Presentation Roadmap

- Software Overview
- Site Modeling
- Bridge Modeling
- Model Enhancements
- Sharing the Model
- Live Demo

14

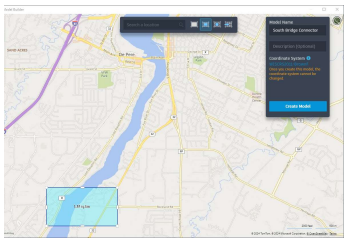
Software Overview

3D Civil Infrastructure	• Conceptual design of roads, structures, drainage
Purchase Options	• Standalone subscription • Bundled – part of Autodesk AEC bundle
Seamless integration with other Autodesk products	• Civil 3D • Revit
Usable "Out-of-the-box"	• Common road and bridge elements preloaded

15

Creating an Existing Site Model

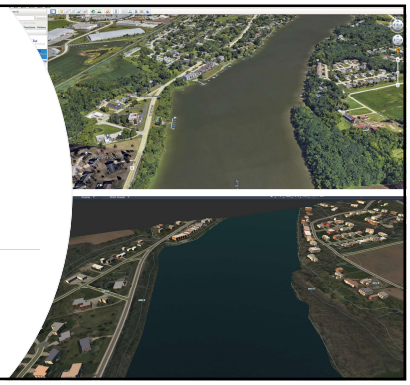
1. Model builder tool
   - Model up to 200 sq km
2. Minimize model size
   - Improves performance
3. Create Model
   - Email when created
   - Available in project library



Infraworks Model Builder Tool

16

Model Builder Result

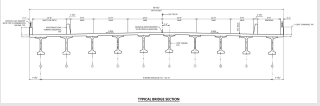


17

Model the Roadway

Create	Bridge alignment and profile in C3D
Import	Alignment and profile into Infraworks
Model	Typical section as road

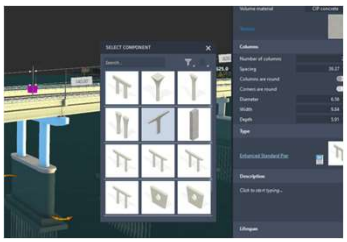
Infraworks Typical Roadway Section



18

Model the Bridge

1. Create new "Proposal"
2. Layout bridge geometry
3. Customize bridge components
   - Girders
   - Piers
   - Foundations



Customizing a Bridge Pier with Default Shapes

19

Realistic water

Foliage

Moving vehicles*

Sun and Sky

Buildings

Model Enhancements

*with Autodesk 3DS Max

20

Sharing the Model

Screenshots

Drive-thru Videos

Interactive Presentation

Export as 3D Model

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Infraworks Demo

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Geotechnical Engineering Update

David Staab, PE
Geotechnical Engineering Unit Supervisor

Structural Engineers Symposium
UW Madison – Union South

May 23, 2024

1

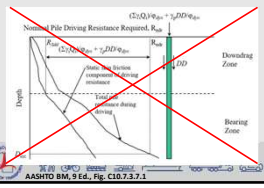
Geotechnical Engineering Unit – Staff Updates

2022	2024
Bob Arndorfer (Retired June 2022)	Dave Staab, Supervisor
Jeff Horsfall (Retired April 2023)	Paulo Florio, Geotech. Eng.
Crystal Goffard	Crystal Goffard, Geotech. Eng.
Dave Staab	Tri Tran, Geotech. Eng.
Dan Reid	Dan Reid, Geologist (Retiring February 2025)

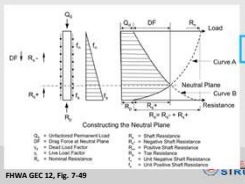
2

Downdrag Update

- AASHTO Bridge Manual updates to replace “Explicit Method” (3.11.8 and 10.7.1.6.2) with Neutral Plane Method.
- AASHTO Bridge Manual updates expected later in 2024



AASHTO BM, 9 Ed., Fig. C10.7.3.7.1



FHWA GEC 12, Fig. 7-49

3

Downdrag Update

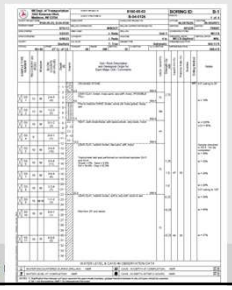
- WisDOT Bridge Manual updates to follow AASHTO BM updates.
- Neutral Plane Method has/can be used on WisDOT projects now.
- FHWA GEC 12, Section 7.3.6
- Contact BOS/BTS for assistance.

4

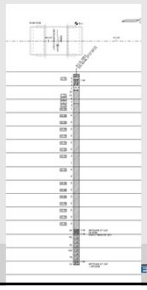
Geotechnical Data Management

gINT sunsetting in 2026

gINT boring log



gINT fence log



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Geotechnical Data Management

gINT replacement

- 4 programs evaluated
- BoreDM selected

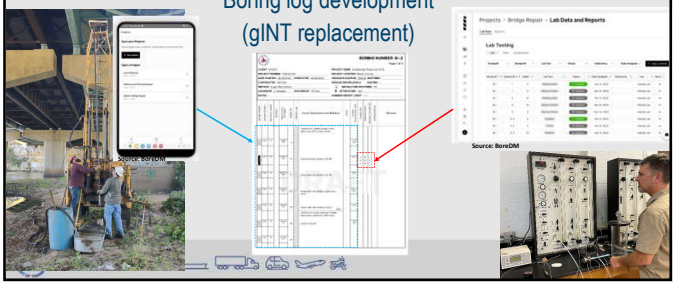
6

BoreDM for WisDOT

Field data collection

Boring log development (gINT replacement)

Geotechnical lab data



7

BoreDM for WisDOT

- Centralized storage for all geotechnical information
- Import existing WisDOT gINT files
- Import existing WisDOT PDF logs
- Reduce manual data entry/re-entry points (human error)
- Updated soil boring log heading and format

8

BoreDM for WisDOT

Designers may appreciate

- DXF export for CAD software (fence diagrams)
- Civil 3D API Connection (in development)

9

Geotechnical Data Management

- Geo-Institute (ASCE) - DiGGS
- DiGGS for geodata is analogous to HTML for transmitting website data
- gINT replacement programs working towards DiGGS compatibility

Source: ASCE Geo-Institute

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Geotechnical Data Management

Standard Practice for

Digital Interchange of Geotechnical Data

AASHTO Designation: PP 102-20 (2022)[1]

First Published: 2020 Reviewed but Not Updated: 2022

Technical Subcommittee: 1b, Geotechnical Exploration, Instrumentation, Stabilization, and Field Testing

4.2. Complete records of all data identified to be recorded and reported by geotechnical standard test procedures, or as specified by the Agency and conducted by the Agency or on the Agency's behalf by contracted geotechnical service providers, shall be transferred to the Agency and by the Agency in a format consistent with the DIGGS schema.

11

Geotechnical Data Management

Bachus, et al., Deep Foundations, May/June 2020

12

WisDOT Geotechnical Data Management

- Data vs. Information
- WisDOT data will be stored and transferred using DiGGS.
- WisDOT consultant geotechnical data?
  - Expect DiGGS requirements
  - Timeframe TBD
  - Coordination, communication & education

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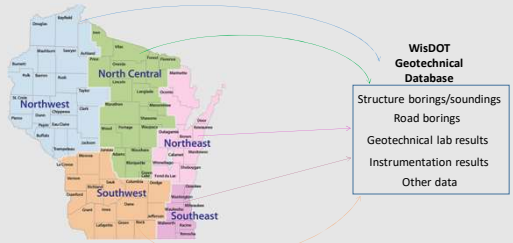
WisDOT Geotechnical Data Management



WisDOT Geotechnical Database

Structure borings/soundings
Road borings
Geotechnical lab results
Instrumentation results
Other data

14

Geotechnical Data Management

15

Questions?

David Staab, PE
david.staab@dot.wi.gov
608-246-7952

BUREAU OF STRUCTURES

16

CONSULTANT REVIEW

Najoua Ksontini, P.E.
Consultant Review and Hydraulics Supervisor

2024 WisDOT Structural Engineers Symposium

1

Consultant Review CONTACTS

Supervisor
Najoua Ksontini

Preliminary Review
Ruth Coisman

Records Coordinator
Sarah Wright

Final Review
Steve Revello
Emily Kuehne
Max Kulick

2

Quality Assurance/Quality Control

QA/QC

All consultant firms providing structural design services to the Department must have a QA/QC plan on file with BOS.

The QA/QC plan should be specific to the consultant firm and should document procedures that the firm utilizes to ensure plan quality.

Refer to WisDOT BM 6.5 for items to be included in the QA/QC plan.

When to resubmit QA/QC Plan?

FALL 2024	PROCEDURE CHANGES	STAFF CHANGES

MORE INFORMATION TO COME

3

Preliminary Plan REVIEW

HYDROLOGY REPORT
E-submit 60 days prior to preliminary plan submittal [WisDOT BM Chapter 6.5]

NON-STANDARD DESIGNS
contact Ruth ahead of submittal

- not following abutment tables
- 3-sided structures
- <0.5% grade [state system]
- high skew
- lack of freeboard
- shallow foundations
- open railing [state system]
- high level aesthetics
- doing something weird

PRIORITIZING
let Najoua know ahead of time, but we can't accommodate everyone's schedule

DNR INITIAL CONCURRENCE LETTER
include with preliminary plan submittal

SIZING REPORT
include scour calculations [WisDOT BM Chapter 8 Appendix A]

4

Final Plan REVIEW

ON-TIME SUBMITTAL IMPROVEMENT FORM
when final plans submitted <2 months prior to PS&E

GEOTECH REPORT
include with final plan submittal, make sure it is latest and greatest

PRELIMINARY PLAN
include responses to preliminary plan comments

RATING SPREADSHEET
no longer required

LOAD RATING SUMMARY FORM
complete FAST Act Emergency Vehicles when:
[WisDOT BM Chapter 45]
HL-93 INVENTORY < 0.9
HS-20 INVENTORY < 20

5

UPDATES

- Final Consultant Performance Evaluation Report ★★☆
  BOS no longer completing

REMINDERS

- don't count on BOS to be your QA/QC
  include plan initials for both preliminary and final plans
- preliminary plan review status
  contact Ruth and Najoua, not consultant reviewers
- Removing Structure bid items
  [WisDOT BM 6.3.3.8]

6

Thank You!

Questions?

7

U.S. Department of Transportation
Federal Highway Administration

FHWA Updates

WisDOT Structural Engineers Symposium
Derek Soden, Principal Structural Engineer
May 23, 2024

1

Disclaimer

U.S. Department of Transportation
Federal Highway Administration

Except for the statutes and regulations cited, the contents of this presentation do not have the force and effect of law and are not meant to bind the States or the public in any way. This presentation is intended only to provide information regarding existing requirements under the law or agency policies.

Unless otherwise noted, FHWA is the source for all images in this presentation.

2

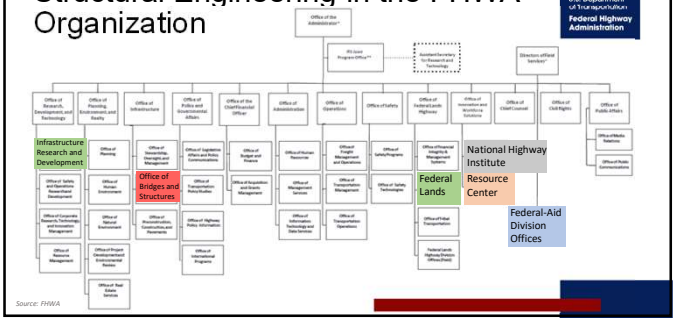
U.S. Department of Transportation
Federal Highway Administration

Agenda

- FHWA Structural Engineering Organization
- Bridge and Tunnel Safety and Funding Programs
- Recent Bridge Issues
  - Fern Hollow Bridge, NTSB Final Report

3

Structural Engineering in the FHWA Organization



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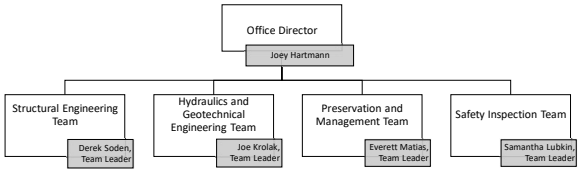
FHWA Office of Bridges and Structures



5

Bridge and Tunnel Safety and Funding Programs

- National Bridge Inspection Standards – 2022 Final Rulemaking
- Bridge Formula Program
- Bridge Investment Program

6

2022 NBIS Rulemaking

- Published in the Federal Register May 6, 2022 (87 FR 27396)
- Became effective June 6, 2022
  - Load rating provisions effective as of that date
- Incorporation of the Specifications for the National Bridge Inventory (SNBI)
  - Replaces the 1995 "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges"
  - Full implementation by 2028[1]

[1] See FHWA's May 25, 2022 Memorandum "Implementation of the Specifications for the National Bridge Inventory" for more information

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BFP: Bridge Formula Program

Purpose	Bridge replacement, rehabilitation, preservation, protection, and construction
Funding	$27.5 B (FY 22-26), apportioned to the States, $5.5 B per Fiscal Year

Eligible projects	• Highway bridge projects on public roads including:
	  • Replacement, Rehabilitation, Preservation, Protection, or Construction
	• BFP funding may be used on:
	  • Any highway bridge that is listed in the National Bridge Inventory (NBI), or
	  • Any new highway bridge that upon the completion of construction would meet the definition of a highway bridge and would be required to be reported to the NBI

Ineligible Projects	• NBIS bridge inspections • Load rating and posting of bridges • Non-highway bridge projects
Other Key Provisions	• 100 percent Federal share for costs reimbursed with BFP funds under this program for an off-system highway bridge owned by a county, town, township, city, municipality or other local agency, or federally-recognized Tribe

See FHWA's Jan. 14, 2022, BFP Implementation Guidance for additional information.

8

8

BIP: Bridge Investment Program (discretionary grants)

Purpose	Improve bridge (and culvert) condition, safety, efficiency, and reliability
Funding	$12.5 B (FY 22-26), including— • $3.3 B (FY 22-26) in Contract Authority from the Highway Trust Fund (HTF); and • $9.2 B (FY 22-26) in advance appropriations from the General Fund (GF)
Eligible entities	• State, MPO (w/ pop. >200K), Local government, Special purpose district/public authority with a transportation function, Federal land management agency, or Tribal government
Eligible projects	• Project to replace, rehabilitate, preserve or protect one or more bridges on the NBI • Project to replace or rehabilitate culverts to improve flood control and improve habitat connectivity for aquatic species
Other key provisions	• Large Bridge Projects (>$100M) are eligible for up to 50% of project costs and have the option for multi-year funding agreements • Bridge Projects (≤$100M) are eligible for up to 80% of project costs • Sets aside of $20M per FY for Planning grants • Sets aside of $40M per FY for Tribal transportation bridges

9

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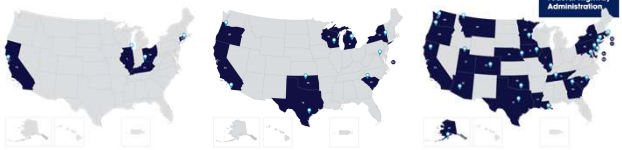
FY 2022 Bridge Investment Program



Large Bridge Projects
- $2.1 billion
- 4 Projects in 5 States
  - Brent Spence Bridge (KY, OH)
  - Golden Gate Bridge (CA)
  - Gold Star Mem. Bridge (CT)
  - Calumet River Bridges (IL)

Bridge Projects
- $296 million
- 9 Projects in 9 States

Planning Grants
- $20 million (statutory set-aside)
- 24 Projects in 24 States, including:
  - Interstate Replacement Bridge (OR)
  - Cape Cod Bridges (MA)
  - East River Bridges (NY)

10

Review and Selection Process

- Application Intake and Eligibility Review – Large Bridge Projects
  - Applications submitted before the applicable application deadline will be considered for the current review cycle
    - November 27, 2023, for FY23/24 Funding Cycle
    - August 1, 2024, for FY25 Funding Cycle
    - August 1, 2025, for FY 26 Funding Cycle
- Application Intake and Eligibility Review – Bridge Projects
  - Applications submitted before the applicable application deadline will be considered for the current review cycle
    - March 19, 2024, for FY23/24 Funding Cycle
    - November 1, 2024, for FY25 Funding Cycle
    - November 1, 2025, for FY 26 Funding Cycle

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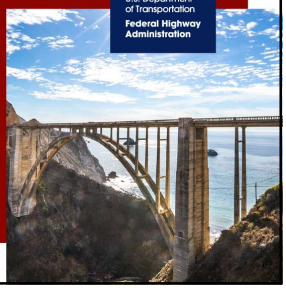
Recent Bridge Issues

- Hernando DeSoto Bridge (2021)
- Fern Hollow Bridge (2022)
- Washington Bridge (2023)
- Francis Scott Key Bridge (2024)



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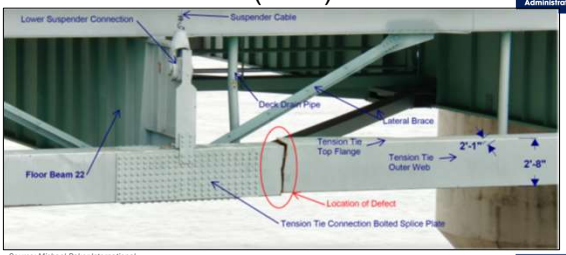
Hernando de Soto Bridge – Tie Girder Fracture (2021)

U.S. Department of Transportation
Federal Highway Administration



Source: Michael Baker International

13

13

December 13, 2021 FHWA Memo

U.S. Department of Transportation
Federal Highway Administration

- Non-Destructive Testing of Fracture Critical Members Fabricated from AASHTO M244 Grade 100 (ASTM A514/A517) Steel
- *Requires* that State DOTs:
  - Identify bridges with fracture critical members fabricated from T-1 steel without requirements to meet the provisions of the AASHTO/AWS FCP and document them in the FCM inspection procedures[1]
  - Supplement hands-on inspection of T-1 FCMs with Non-Destructive Evaluation verifying the soundness of butt welds in tension[2]
    - Unless previous verification has been documented
    - Previous verification needs have been performed a minimum of 48 hours after original welding (≤ 2" thick, 72 hours for > 2" thick)
    - Complete testing by March 31, 2024
  - Classify rejectable indications (using AASHTO/AWS criteria) as critical findings[3]
  - By March 31, 2022, Report an inventory of bridges with T-1 FCMs and actions taken to perform verification and follow up on findings[4]
    - Update reporting data at six-month intervals

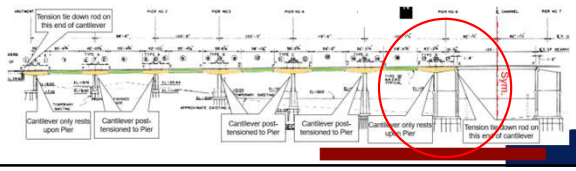
[1] 23 CFR 1.36, 23 CFR 650.313 [2] 23 CFR 1.36, 23 CFR 650.313 [3] 23 CFR 1.36, 23 CFR 650.313 [4] 23 CFR 1.36, 23 CFR 650.315

14

Washington Bridge Closure (2023)

U.S. Department of Transportation
Federal Highway Administration

- Carries I-195 over the Seekonk River in Providence, Rhode Island
- Emergency closure, December 2023
- Bridge Details
  - 13 spans, 1,904' total length
  - Prestressed concrete cantilever and drop-in spans, with one steel span



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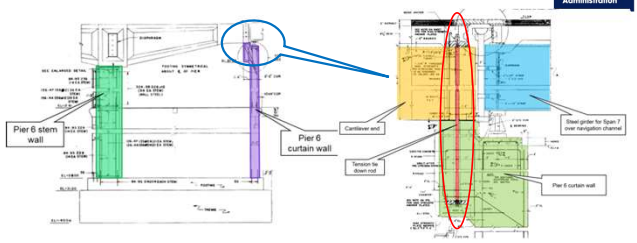
Washington Bridge Details

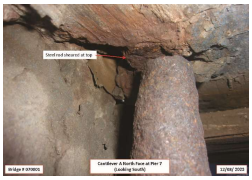
U.S. Department of Transportation
Federal Highway Administration



16

Tie Rod Conditions, December 2023

U.S. Department of Transportation
Federal Highway Administration



17

Fern Hollow Bridge Collapse

U.S. Department of Transportation
Federal Highway Administration

- January 28, 2022
- Pittsburgh, Pennsylvania
  - Forbes Avenue over Nine Mile Run in Frick Park
- 6 injuries (2 serious)
- 3-span rigid (K) frame 442'-8" in length
  - Constructed 1972-1973
- Fracture Critical (NSTM) Bridge
- Poor Condition (annual inspections)
- Posted at 26 tons

18

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NTSB Report and Docket

The main accident page and link to final report is at:
https://www.ntsb.gov/investigations/Pages/HWY22MH003.aspx

The docket is at:
https://data.ntsb.gov/Docket/?NTSBNumber=HWY22MH003

- "Forbes Avenue over Fern Hollow Bridge Collapse Investigation – Assessment of Bridge Inspection and Load Rating"
- "Materials Laboratory Factual Report 23-036," Appendix A and Appendix B

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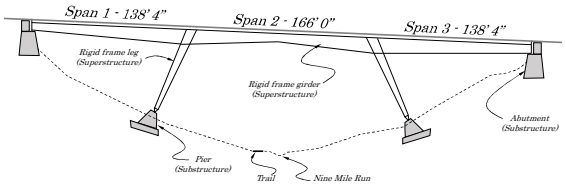
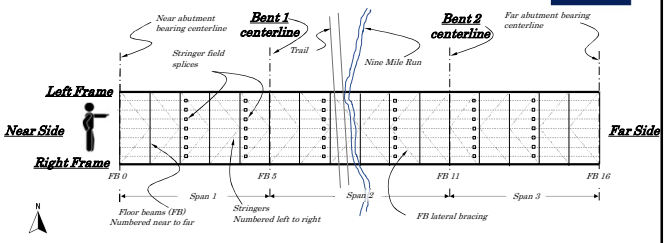
Bridge Description



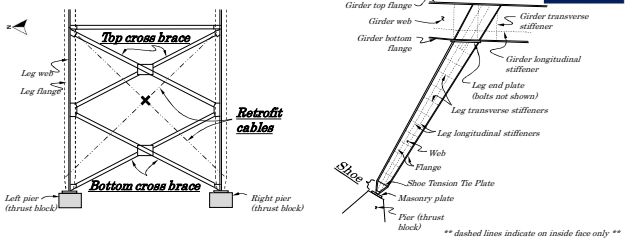
20

Bridge Description



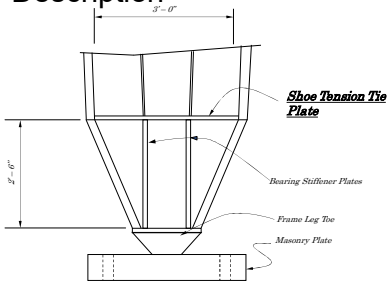
21

Bridge Description



22

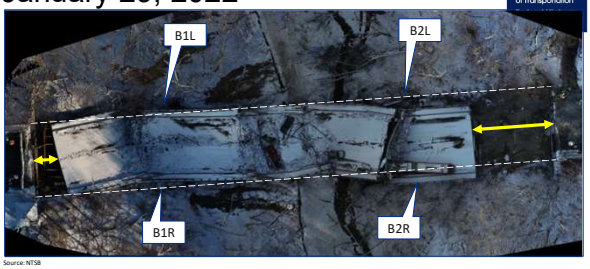
Bridge Description



23

23

January 29, 2022



Source: NTSB

24

Leg B1R

Outside bridge

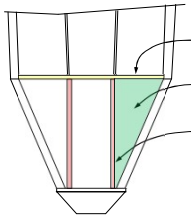
~20 ft of downhill flange was missing, wasn't recovered until rest of super was removed

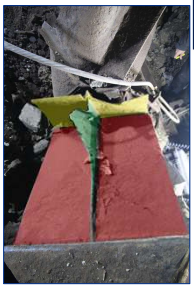
U.S. Department of Transportation
Federal Highway Administration

All images source: NTSB

25

Leg B1R



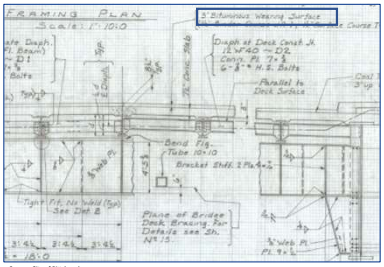


U.S. Department of Transportation
Federal Highway Administration

All images source: NTSB

26

Wearing Surface



Source: City of Pittsburgh

U.S. Department of Transportation
Federal Highway Administration

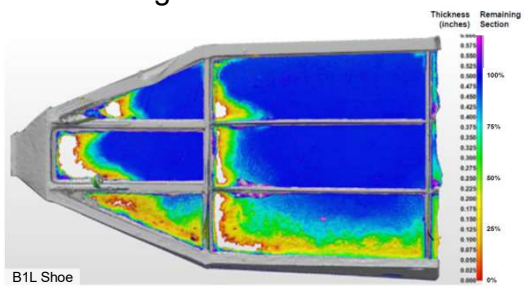
27

Wearing Surface

All images source: NTSB

28

Remaining Section Measurements



B1L Shoe

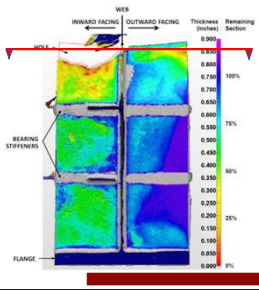
Image Source: NTSB

29

29

Remaining Section Measurements

B1R Tension Tie Plate



$2.2 in^2$ remaining effective area in the tie plate

Images Source: NTSB

30

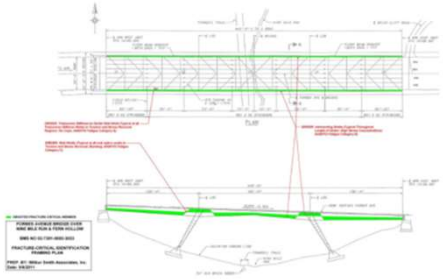
30

Inspection Investigations

- Reviewed all inspection reports going back to 2005.
- Assessed inspection procedures and quality. Significant findings included issues related to:
  - Fracture Critical Member (FCM) inspection procedures,
  - Section loss measurements and documentation, and
  - Condition assessment.
- Assessed inspector recommendations. Significant findings included issues related to:
  - Load re-rating, and
  - Maintenance prioritization.

31

FCM Inspection Procedures- Identification

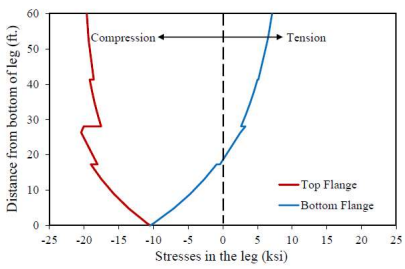


- Girders highlighted to indicate zones of tension.
- No portion of the legs are highlighted.

Source: PennDOT and City of Pittsburgh

32

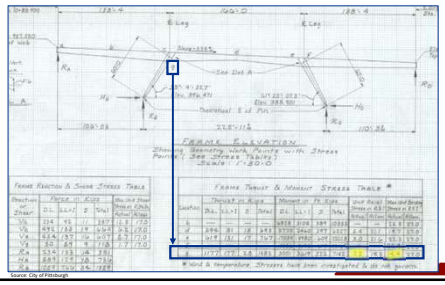
FCM Inspection Procedures- Identification



- FHWA independent analysis.
- Analysis shows the upper $^2/_3$ of the leg is partially in tension.

33

FCM Inspection Procedures- Identification

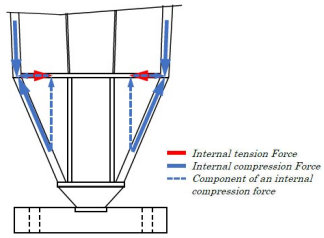


Design plans show 14.4 ksi bending stress exceeds 7.3 ksi axial stress at top of leg. This implies tension.

Source: City of Pittsburgh

34

FCM Inspection Procedures- Identification



- Change in flange angle results in balancing tension force.
- The base of the leg is globally in compression, but the tie plate element is in axial tension.

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Section Loss - History

- As far back as 2005, the leg stiffeners/webs, and cross braces had documented section loss including areas of 100% section loss.
- Cross brace connections deteriorated rapidly from 2005-2021, including the failure of the connections for Bent 1 bottom brace in 2018.

All images sources: PennDOT and City of Pittsburgh

36

Section Loss- Measurement and Documentation

- Documentation focused on the growing areas of 100% section loss.
- No indication that cleaning of the steel had been performed based on photos.
- No reviewed report included measurement of tie plate section loss.
- Unclear whether all areas of section loss were accessed and measured on the legs.
- Loss, when reported, was primarily estimate of depth or percent.

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Section Loss- Measurement and Documentation

AASHTO MBE Article 4.8.1.2- Cleaning.

"*Metal structures with heavy plate corrosion will require chipping with a hammer or other means to remove corrosion down to the base metal in order to measure the remaining section.*"

AASHTO MBE Article 4.8.3.1- Steel Beams, Girders, and Box Sections.

"*Structural steel members should be inspected for loss of section due to corrosion. Where a build-up of rust scale is present, a visual observation is usually not sufficient to evaluate section loss. Hand scrape areas of rust scale to base metal and measure the remaining section using calipers, ultrasonic thickness meters, or other appropriate method. Sufficient measurements should be taken to allow the evaluation of the effect of the losses on member capacity…*

Inspect uncoated weathering steel structures for details or conditions that promote continuous wetting of uncoated steel; bridge geometrics that result in salt spray reaching the uncoated steel; pitting of the surface of the steel indicating unacceptable degradation of the steel."

AASHTO Manual for Bridge Evaluation, 3rd Edition [23 CFR 650.317(o)]

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Section Loss- Measurement and Documentation

All images sources: PennDOT and City of Pittsburgh

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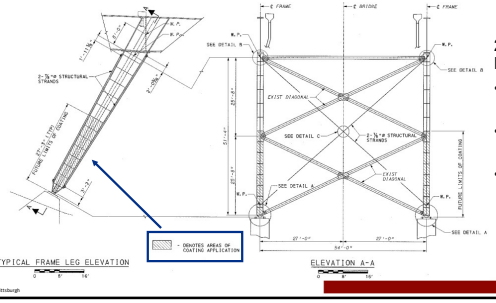
Section Loss- Measurement and Documentation

Web hole above B1R tie plate, 2013 vs 2021

All images sources: PennDOT and City of Pittsburgh

40

Maintenance and Rehabilitation History



2009 Rehabilitation

- Install cable braces.
- Install PVC downspouts.
- Zone paint legs.

Source: City of Pittsburgh

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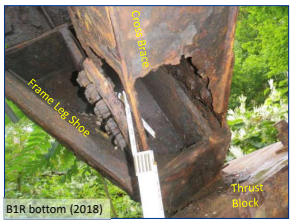
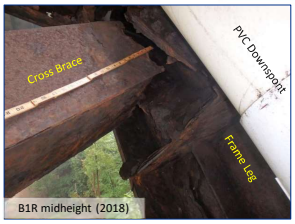
Maintenance and Rehabilitation





All images sources: PennDOT and City of Pittsburgh

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Maintenance and Rehabilitation

- Lower cross brace was removed in December 2018/January 2019.
- Load rating analysis assumptions indicated that the rating assumed full loss of cross braces.

Comments/Assumptions*: Ratings assume full loss of the original column cross frames and 1/16" loss in the stringer flange as well as to the near half

Sources: PennDOT and City of Pittsburgh

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Maintenance Recommendations

- PennDOT includes maintenance recommendations in inspection reports.
- Inspectors recommend maintenance actions and assign a priority to them based on PennDOT Publication 100A.

Coding:

	Short Definition	Action Timeframe
0	**CRITICAL**	Immediate response required ..... (within 7 days)
1	**HIGH PRIORITY**	As soon as work can be scheduled ..... (within 6 months)
2	**PRIORITY**	Review work plan and re-prioritize schedule. ..... (routine inspection interval)
3	**SCHEDULE**	Add to scheduled work. ..... (Add to schedule)
4	**PROGRAM**	Add to programmed work ..... (when funds are available)
5	**ROUTINE**	As per existing maintenance schedule. ..... (within the next work cycle)

Notes:

1) The District Bridge Engineer (and owner for non-PennDOT bridges) must be advised of conditions that warrant a Priority code 0 or 1 Flexaction work candidate, and must accept this coding before Item 1A07, Inspection Status, is changed to Approved. See Publication 238 Sections 2.13 and 2.14 for specific guidance and required actions for Priority Codes 0 and 1.

Source: PennDOT Publication 100A

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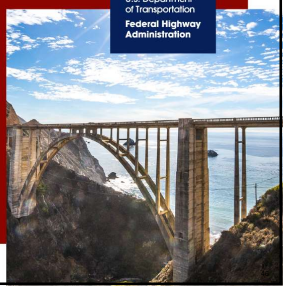
Fern Hollow Bridge Maintenance Recommendations

Recommended Maintenance Item Description	Priority	First Year Identified	Additional Years Identified	Documented Completion
Repair/replace stiffeners and web on frame legs	2	2007	2009-2021	
Repair cross bracing on both frame legs	2	2005	2007-2021	
Re-tension cables on legs	2	2009	2011-2014	7/25/2014
Extend PVC "weepholes" in deck to drain below superstructure	2	2005	2007-2021	
Paint superstructure areas exposed to leakage, primarily the frame legs[a]	2	2007	2014-2021	
Drill crack arrest holes in FB girder connection plate cracks	2	2015	2016-2021	
Clean and flush deck scuppers (drains)[b]	2	2017	2018-2021	
Repair/replace lower cross frame at Bent 1 which is nearly severed at connections.	1	2017	3/2018	1/4/2019 cross frame was removed.
Remove or replace defective light pole on deck.	0	2009		By 2011 inspection, all light poles were replaced.
Repair/replace lower cross frame at Bent 1 which has become severed. (priority raised to 0)	0	9/2018		1/4/2019 cross frame was removed
Add "bridge" placards to all postings	0	2015		Before 2016 inspection
Add "distance ahead" placards to all postings	0	2020		9/11/2020

45

Load Rating Investigations

- Review of historical load rating records
- Evaluation of load rating analyses
- Independent FHWA analyses



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Historical Load Rating Records

- June 2000 – Evaluated floor beams and stringers
  - Did not evaluate rigid frame girders or legs
  - AASHTO H-20 and HS-20 and PennDOT ML80 live loads
- September 2003 – Supplemental live load analysis
  - PennDOT TK527 live load
- October 2013 – Most recent load rating
  - Evaluated floor beams, stringers and rigid frame girders and legs
  - Based on inspection recommendation to: *perform an analysis of the stability of the structure assuming that the cross braces are nonfunctional*

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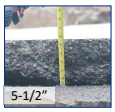
2014 Load Rating

- Load Factor Rating (LFR) method
- Considered section losses noted in inspection reports
  - Equivalent sections (i.e., "smeared" losses)
- Excluded the contribution of the leg cross braces
  - Weak axis unbraced length = full height of leg
- Included weight of 3" wearing surface



All images source: NTSB

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Equivalent Section Loss

- Based on worst-case observation, an 11” wide hole
- Applied as a generalized 11” wide void along entire plate length
- Based on average plate width of 3’-0”, section thickness was reduced proportionately:

$$\frac{0.5"}{36"} = \frac{t_{eff}}{36" - 11"} \rightarrow t_{eff} = \frac{25"}{36"}(0.5") = 0.347"$$

- Flange losses similarly modeled
- Appropriate for global analyses, not for consideration of local effects

Sources: PennDOT and City of Pittsburgh

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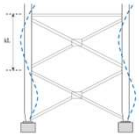
Effective Length Factor

- Euler Buckling Load:

$$P_{cr} = \frac{\pi^2 EI}{(kL)^2}$$

- As designed, assumed, buckled shape in the weak-axis direction:



Sources: PennDOT and City of Pittsburgh

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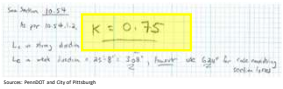
Effective Length Factor

- From the Load Rating calculations



Sources: PennDOT and City of Pittsburgh

- From AASHTO Standard Specifications for Highway Bridges*

10.54.1.2 Effective Length

The effective length factor K shall be determined as follows

(a) For members having lateral support in both directions at its ends

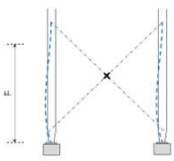
K = 0.75 for riveted, bolted, or welded end connections.

K = 0.875 for pinned ends.

(b) For members having ends not fully supported laterally by diagonal bracing or an attachment to an adjacent structure, the effective length factor shall be determined by a rational procedure.**

** AASHTO Manual for Bridge Evaluation, 3rd Edition, Article 6B.1.1 [23 CFR 650.317(a)]*

- Assumes translation- and rotational restraint that the cable bracing could not provide:



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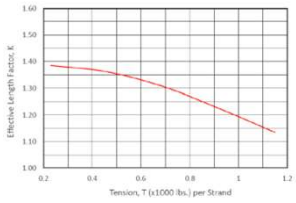
Effective Length Factor

U.S. Department of Transportation
Federal Highway Administration

- Relationship between cable tension and k factor:



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Summary of Leg Ratings (Sectional Analysis)

U.S. Department of Transportation
Federal Highway Administration

Scenario	HS-20 Operating Rating Factor (per MBE LFR)	HS-20 Operating Rating (tons) (per MBE LFR)
As-Designed Assumes both cross braces effective between legs (k=1.0) and 3-inch wearing surface	2.89[2]	104
Modified As-Designed Assumes both cross braces effective between legs (k=1.0) and 5.6-inch wearing surface	2.62[2]	94
2014 Load Rating Assumes cross braces ineffective, cable braces effective (k=0.75), 3-inch wearing surface, section loss distributed evenly across frame leg.	0.92	33[3]
Existing Condition at Collapse 1 Assumes cross braces ineffective, cable braces tightened to approximately 1000 lbf tension (k=1.2), 5.6-inch wearing surface and section loss distributed evenly across frame leg.	0.17	6
Existing Condition at Collapse 2 Assumes cross bracing ineffective, cable braces tightened to approximately 200 lbf tension (k=1.4), 5.6-inch wearing surface and section loss distributed evenly across frame leg.	-0.66[6]	N/A

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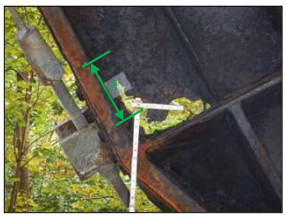
Local Effects – Flange Buckling

U.S. Department of Transportation
Federal Highway Administration

- Analysis to determine unbraced length of the flange plate that results in plate buckling controlling over global buckling.
- f_{cr} for global buckling of the leg, using the upper bound value of k was 11.5ksi
- For flange buckling to control, l_b would need to be at least 96”
- Result: flange buckling was not a controlling limit state



Sources: PennDOT and City of Pittsburgh

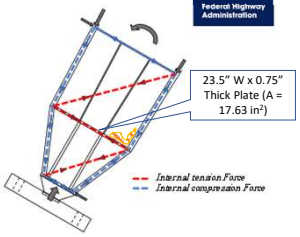
54

Local Effects: Tension Tie Plate Tension

- Strut-and-tie model of the lowest panel of the leg and the shoe
- Demonstrates that the geometry of the shoe puts the plate into tension
  - Region of the web with corrosion holes is largely in a compression stress field
- FHWA analysis established remaining section required to control rating:

Asphalt	k factor	Operating R.F.	Equiv. $A_{remaining}$
5.6"	0.75	0.92	$6.97in^2$
5.6"	1.2	0.17	$6.71in^2$
5.6"	1.4	-0.66	N/A
5.6	1.2	0.08 (3 Tons)	$6.59in^2$

- Measured remaining area: as little as $2.2in^2$



55

NTSB Recommendations

56

56

NTSB Finding of Probable Cause

"…was the failure of the transverse tie plate on the southwest leg of the bridge, a fracture-critical member (nonredundant steel tension member), due to corrosion and section loss resulting from the City of Pittsburgh's failure to act on repeated maintenance and repair recommendations from inspection reports. Contributing to the collapse were the poor quality of inspections, the incomplete identification of the bridge's fracture-critical members (nonredundant steel tension members), and the incorrect load rating calculations for the bridge. Also contributing to the collapse was insufficient oversight by the Pennsylvania Department of Transportation of the City of Pittsburgh's bridge inspection program."

NTSB February 21, 2024, Highway Investigation Report 24-02, pg. 103.

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NTSB Recommendations for FHWA

1. Require one time review of NSTM inspection procedures for steel frames to ensure that all fracture critical members are identified and inspected.
2. Update the BIRM to address the identification of localized tension zones in members partially or fully in tension.
3. Update the BIRM to include information on the selection, frequency of use, and application of NDE approaches to measuring asphalt wearing surface thickness.

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NTSB Recommendations for FHWA

4. Establish a process for targeted reviews of safety issues identified in this investigation, including
   a) Bridge owners' determinations that a new load rating is required
   b) Appropriateness of assumptions used in the load rating of deteriorated structures
5. Incorporate the findings of this investigation into bridge inspection training courses and use the Fern Hollow Bridge as a case study.

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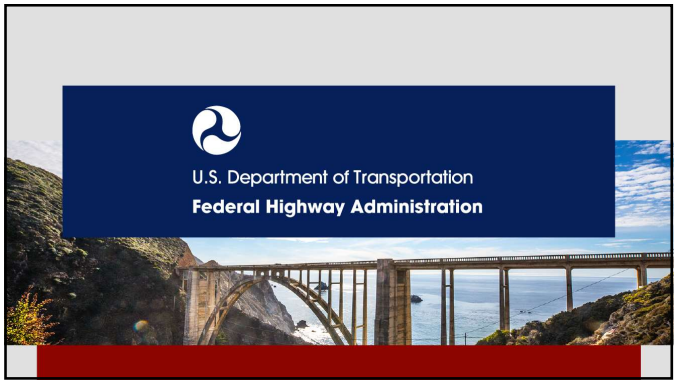

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WISDOT'S 1ST DESIGN-BUILD PROJECT

WIS-130 Bridges over the Wisconsin River

May 23, 2024

1

Introductions

Laura Shadewald, PE
Structures Development Chief

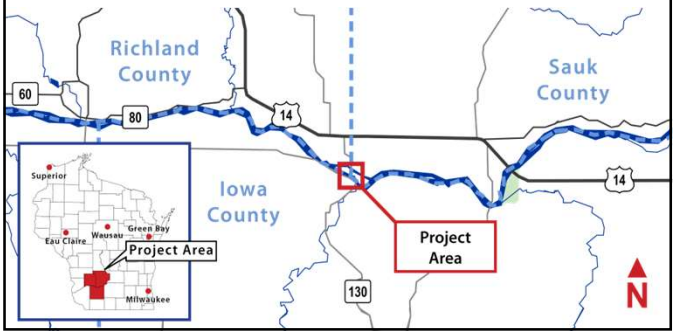
Brent Freeman, PE
DB Project Manager

Bill Dreher, PE
DB Bridge Design Engineer

Vinod Patel, PE, SE
DB Lead Bridge Design Engineer

2

Project Location



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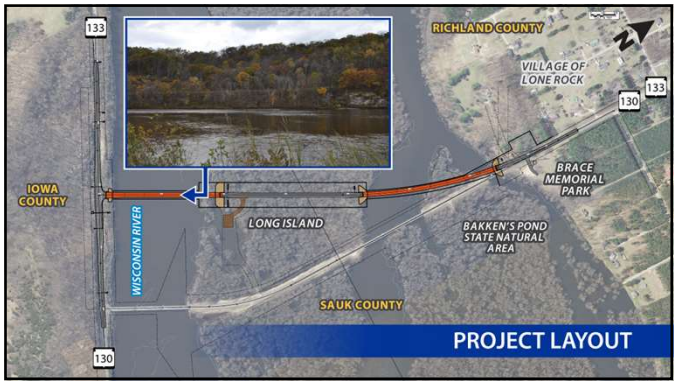


4

Project Need

Existing Truss Bridges

- Built in early 1930s / 1940s
- End of design life
- Structurally deficient
- Functionally obsolete
- Bridges get struck by large trucks
- Poor intersection geometry


Photo by SRF

Photo by SRF

5

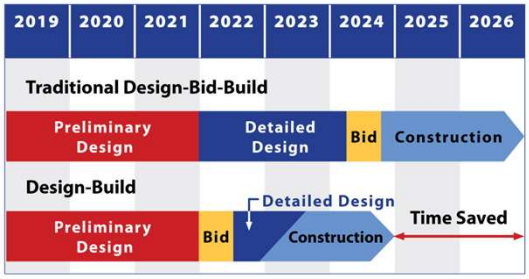
Why Design-Build Delivery was Chosen

- Environmental document & preliminary design complete
- Desire for an accelerated schedule to address pressing needs through accelerated procurement
- Well-defined scope, yet flexible enough to allow for efficiencies and innovation
- Appropriate size and complexity
- Minimal utility conflicts
- Minimal real estate
- No concern with contractor interest or lack of proposers

6

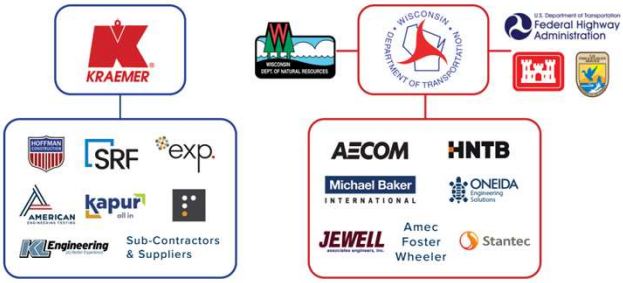
Time Saved with Design-Build

Traffic on New Bridges Two Years Early!



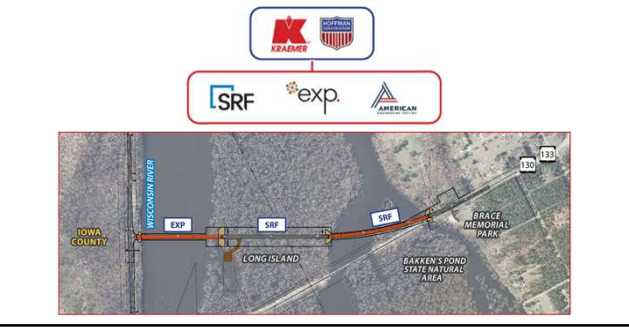
7

Project Team



8

D-B Team



9

Creating the D-B Team

- Teaming
  - SRF Internal discussions in 2019
  - KNA and SRF contact in late 2020
    - WisDOT industry review workshops
  - WisDOT D-B projects announced to industry in summer 2021
    - SRF and KNA immediately teamed
      - Desired major river crossing and WisDOT experience – added EXP
    - Request for Qualifications issued November 2021, Statements of Qualifications due January 2022
    - Request for Proposals issued February 2022, Technical and Price Proposals due May 2022

10

Request for Qualifications (RFQ)

- Statement of Qualifications (SOQ)
  - Know & Understand the Project Goals
  - Select the Right Team
  - Experience
    - Scope of work –and– as teammates
  - KNA and SRF – long history as DB teammates
  - EXP major river crossings design experience
  - AET added for geotechnical and environmental
  - Added Hoffman as a major contractor partner – grading/earthwork subcontractor

11

Request for Proposals (RFP)

- Process
  - Pursuit Schedule – 3 months to develop technical and price proposals
  - Instructions to Proposers (ITP) , RFP Books 1 to 3, and RID review
  - DB Team Meetings
  - Requests for Clarifications, Q&A
  - One-on-One Meetings with DOT
  - SOQ Modifications (if necessary)
  - Alternate Technical Concepts (ATC) development and review, and finalizing
  - Design Concepts development and review, and finalizing
  - Estimating
    - Subcontractors and Suppliers outreach and coaching, including all our DBEs
  - Technical Proposal development, review, finalize
  - Final Price Proposal

12

Alternate Technical Concept (ATC)

Objective: Benefit from DB's Innovative Solutions and Construction Means & Methods

Reduce Cost & Construction Duration	Reduce Impacts	Improve Constructability	Maintain Quality & Safety
↓	↓	↑	↕

Other Considerations:

- Durability
- Life-cycle Maintenance
- Aesthetics
- Construction Safety

ATC
D-B Mechanism to get DOT's Pre-approval

13

ATC's

- Summary of ATC's

Kraemer North America Resubmitted Final ATC Responses			- From 4/8/22 Submittal Deadline	Incorporated in Design-Builder's Proposal	
#	Subject	Date Received	Response - WisDOT		Notes
ATC 2	Longer Continuous Span	3/16/2022	The submitted ATC is Approved.	YES	Used at South bridge
ATC 3	Reinforced Soil Slopes	3/16/2022	The submitted ATC is Approved.	NO	
ATC 5	Alternate Pier Types	3/17/2022	The submitted ATC is Approved.	YES	
ATC 6	Shorter South Bridge, Optimize Pier Location	3/19/2022	The submitted ATC is Conditionally Approved. Condition: The required permits for the Project are obtained based on the associated natural resource impacts of this ATC.	YES	
ATC 7	South Bridge-Alternate Span Configuration	3/19/2022	The submitted ATC is Approved.	NO	
ATC 8	North Bridge-Alternate Span Configuration	3/19/2022	The submitted ATC is Approved.	YES	
ATC 13	MSE Walls	3/25/2022	The submitted ATC is Approved.	YES	

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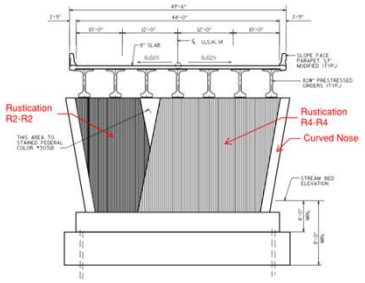
ATC – Bridge Piers and Girders

- North Bridge
  - Three piers eliminated with increase to 72W girders from 45Ws
    - Required roadway profile grade raise
  - Savings per pier estimated at $217k (before design optimization)
  - Pier type change to hammerhead style from reverse trapezoid – estimated at $100k per pier (before final rebar detailing) and one week saved on schedule per pier
- South Bridge
  - One pier eliminated with shorter bridge, alternate span configuration and girder design modifications - $217k saved
  - Pier type change to hammerhead design at $100k per pier (before final rebar detailing) and one week saved on schedule per pier
- Overall savings from changes to piers amounted to over $2,000,000 and 12 weeks construction schedule savings

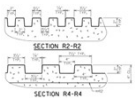
15

Bridge Piers - RFP



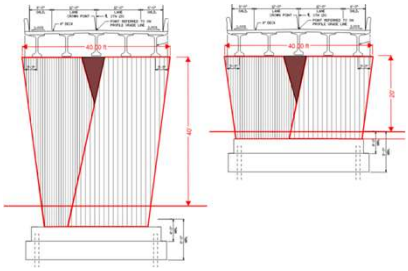
RFP Requirements

- Trapezoidal Piers similar as the US 14 Bridge
- Vertical Rustication on both faces
- Slanted Curved Noses with Rustication



16

Bridge Piers - RFP



Visual Disparity

- US 14
  - All piers same height – 24'
  - Uniform width @ water level
- WIS-130
  - Pier height varies from 40' to 20'
  - Width @ water level varies from 26' to 33'

Potential for Improvements

- Reduce Materials / Visual Mass
- Reduce cost
- Reduce construction time
- Reduce footprint / wetland impacts
- Reduce scour potential

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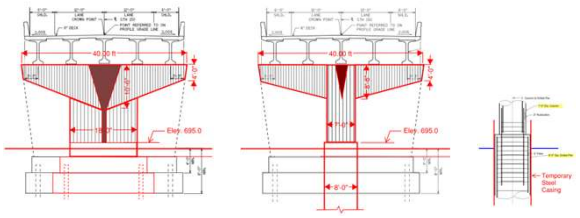
Bridge Piers – ATC #5



ATC #5A

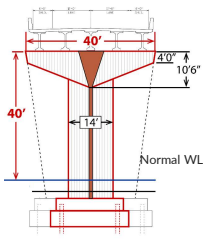
- Hammerhead Pier w/Oblong Shaft
- Pile supported footing
- Construct with Cofferdam

ATC #5B

- Hammerhead Pier w/Round Shaft
- Single Drilled Shaft Foundation
- Shaft transition above Design Water Level
- Construct with Temporary Casing

18

Bridge Piers – Final ATC



Benefits
- Compact size
- Smaller footprint / cofferdam & seal
- Less impacts to sensitive wetlands
- Less cost
- Less time to construct
- Better visual quality
- More openness for river users – greater visibility of surrounding natural beauty
- Structural benefits –
  - Lesser scour depth
  - Less ice force

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Bridge Piers – Renderings / Photo

RFP Base Case

ATC

Photo of As-Built Pier

20

Technical Proposal

- Executive Summary
- Narratives
  - Design Features
  - Environmental Compliance Plan
  - Mobility with the Project Corridor
  - Conceptual Designs
- Appendices
  - Organizational Chart
  - ATCs Documentation
  - Progress Schedule
  - Roll Plot of Conceptual Design of Project
  - Proposer Information, Certifications, and Documents (the legal stuff)

21

Price Proposal

- Bid Certification
- Bid Bond
- Bid Form
  - Standard Form with Lump Sum Prices for each of the five bid items
    - one for each structure and one for the roadway/all other work
- DBE certifications and commitments
- Above is what actually gets submitted. The effort to get to that point requires many more bullet points!

22

Design Refinements/Challenges

- South Bridge
  - South abutment design
  - Pier 1 foundation design
  - Bridge configuration
  - Retaining walls

- North Bridge
  - Drop girder line
  - South abutment design

23

Design Refinements/Challenges

- South Bridge: South Abutment (background)
  - Underlying bedrock slopes down from South to North and West to East
  - Located mid slope of steep slope between river and two-lane STH 133.
  - Tall abutment body
  - Permanent tieback and deadman system required
  - Curved wingwalls
  - Retaining walls tied into wing walls
  - Tough Access
  - Complex temporary shoring required
  - Construction completed during full closure of STH 133

24

Design Refinements/Challenges

- South Bridge: South Abutment Design – Contractor Considerations
  - Schedule constraints
    - Completion tied in with STH 133 roadway improvements, which were completed under full closure of STH 133 in 120 calendar days
  - No access from existing STH 133 prior to our improvements, when road was open to traffic
  - Access from river to begin work early
  - Complex, multi-staged and tied back temporary shoring system
    - Required for construction sequencing
  - Pre-bored and driven piles into rock
    - Tried to limit pre-boring where possible
  - Wingwalls completed as soon as possible after body constructed
    - MSE Walls tied in to wing walls
  - Parapets tied into roadway barrier that sit on moment slabs over MSE walls

25

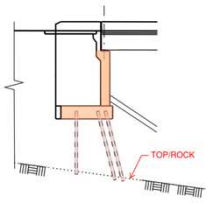
Design Refinements/Challenges

- South Bridge: South Abutment Design – Contractor Considerations
  - Complex, multi-stage temporary shoring – required temporary tiebacks for

26

Design Refinements/Challenges

South Bridge – South Abutment
Bid Proposal Design

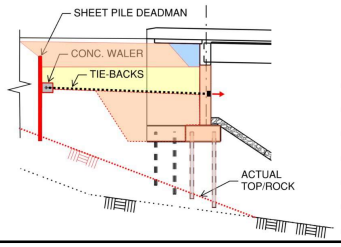


- Rock profile – mild slope
- Conventional semi-retaining abutment
- ± 33 ft. height
- Battered piles

27

Design Refinements/Challenges

South Bridge – South Abutment
Final Design



- Additional borings
- Rock profile – steep slope
- Concerns with driving battered piles
- Issues with Global Stability
- Semi-retaining abutment with tie-backs
- All vertical piles
- Sheet pile deadman with concrete waler

28

Design Refinements/Challenges

South Bridge – South Abutment
As-built Abutment

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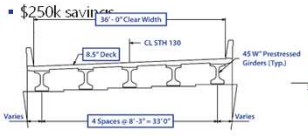
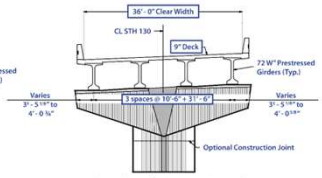
Design Refinements/Challenges

North Bridge - Reduce Number of Girder Lines

- Debond strands (2 of 46) vs. increased concrete strength (8.5 ksi)
- Fabrication, transport, setting girders
- Less deck forming (# of bays)
- More strands, thicker deck
- $250k savings



RFP Cross Section



Revised Cross Section

30

Field Design Changes

- South Bridge
  - Pier 1 Foundation Re-design & South Abutment NCR Changes
  - Pier 2 Seal Revision
- North Bridge
  - Pier Spread Footing Seal & Rock Excavation Revisions
  - Pier Cap Rebar Detail Modification
  - Pier Cap Rebar Bar# 613 Revision
  - Girder #5 Stirrups Revised Bottom Leg
  - Deck Modular Joint Blockout and Deck Rebar Mods

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Field Design Changes

- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions
  - Spread footings on concrete seals
  - 500-year scour will expose the sandstone bedrock.
  - Long-term degradation of the bedrock = 0.75 feet
  - Seals embedded 1' minimum into sound rock

32

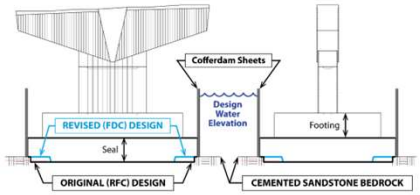
Field Design Changes

- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions – Contractor Considerations
  - Make all cofferdams same size with thickness as needed
  - Subsurface information from WisDOT
  - Boring locations did not line up with the revised pier layout
  - No new borings
  - Rock excavation limited to 4.5' from edge of seal resulting in reduced seal bearing area

33

Field Design Changes

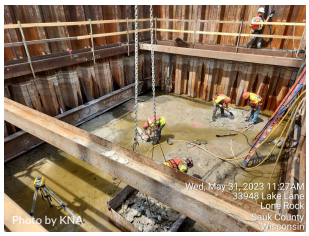
- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions – Designer Considerations



34

Field Design Changes

- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions



35

Field Design Changes

- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions
  - Nominal bearing resistance increased from 10 ksf to 30 ksf
  - Rock elevations estimated during design
  - Excavation provided accurate rock elevations (higher than estimated)
  - Hydrostatic Pressure
    - Higher rock led to thinner seals
    - Keep top of footing below 'normal water'
    - Footing elevation changes would affect thermal model and pier design
  - Epoxy anchors
  - Reduced design water elevation

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Field Design Changes

- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions
  - Hydrostatic Pressure
    - Hydraulic conductivity of sandstone
    - Any significant seepage through bedrock would be through joints or fractures
    - Uplift force would be hydrostatic pressure acting over the area of the fractures within the seal footprint
    - Assume 50% of seal footprint subjected to full hydrostatic pressure

37

Field Design Changes

- North Bridge: Pier Spread Footing Seal & Rock Excavation Revisions
  - Hydrostatic Pressure
    - Excavation inspected by diver to ensure no significant joints or fractures
    - Buoyancy forces develop shortly after dewatering. Wait at least 24 hours to confirm no seal uplift
    - No bu[illegible]ncrete

38

DB – Owner's Perspective

- A learning process!
- Preferences vs. Contractual Requirements
- Submittal & Review Processes
- Different contract documents
- Teamwork!

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Thank You!

40

Wisconsin Highway Research Program

James Luebke P.E.
Policy and Standards Engineer

WisDOT Structural Engineers Symposium
University of Wisconsin-Madison Union South, Madison WI

May 23, 2024

1

Overview

- WHRP
- Recently Completed Projects
- Active Projects

WHRP

2

Wisconsin Highway Research Program (WHRP) Overview

- Established in 1998
- Collaboration with the University of Wisconsin - Madison
- Four research areas
  - Flexible Pavements
  - Rigid Pavements
  - Geotechnics
  - Structures
- GOAL: Practical research ⇨ implementable results

3

WHRP

- Better Ways to Design, Build and Reconstruct
- Selected and overseen by WisDOT, Academia, Industry, Consulting Engineers, and the FHWA.
- Structures Area – 1 to 2 projects/Year

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WHRP Funding

- WHRP project funding is approximately $1 million annually
- Projects are funded by:
  - 80% FHWA federal funds (SPR, Part B Research), and
  - 20% WisDOT state funds

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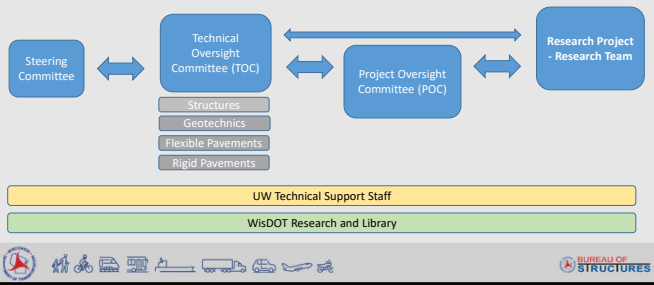
5

WHRP Organization



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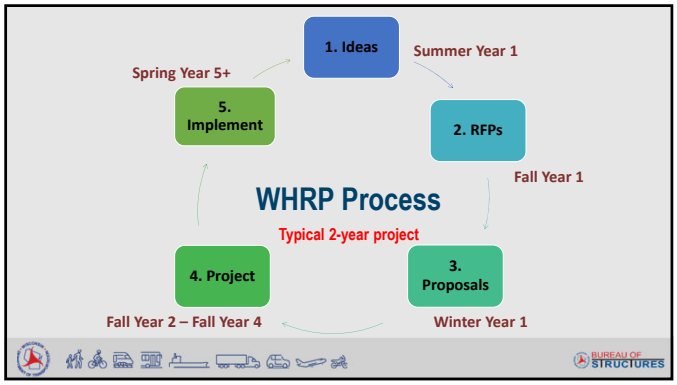
1. Ideas
Summer Year 1
2. RFPs
Fall Year 1
3. Proposals
Winter Year 1
4. Project
Fall Year 2 – Fall Year 4
5. Implement
Spring Year 5+
WHRP Process
Typical 2-year project
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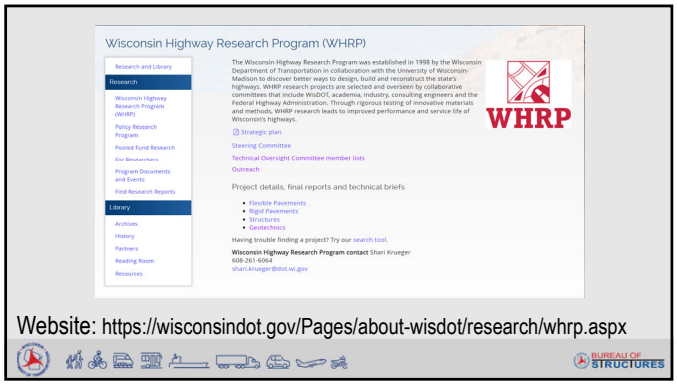
Wisconsin Highway Research Program (WHRP)
WHRP
Website: https://wisconsindot.gov/Pages/about-wisdot/research/whrp.aspx
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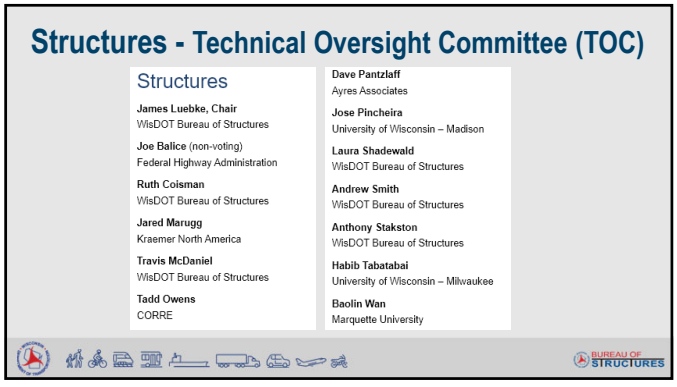
8


Structures - Technical Oversight Committee (TOC)
Structures
James Luebke, Chair
WisDOT Bureau of Structures
Joe Balice (non-voting)
Federal Highway Administration
Ruth Coisman
WisDOT Bureau of Structures
Jared Marugg
Kraemer North America
Travis McDaniel
WisDOT Bureau of Structures
Tadd Owens
CORRE
Dave Pantzlaff
Ayres Associates
Jose Pincheira
University of Wisconsin – Madison
Laura Shadewald
WisDOT Bureau of Structures
Andrew Smith
WisDOT Bureau of Structures
Anthony Stakston
WisDOT Bureau of Structures
Habib Tabatabai
University of Wisconsin – Milwaukee
Baolin Wan
Marquette University
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9

Recently Completed Projects

- Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges
- Optimizing Bridge Abutment Slope Protection at Stream Crossings
- Improving Bridge Concrete Overlay Performance

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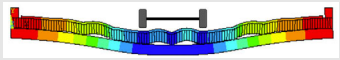
10

Timber Slab Bridges

- Objective: Develop a more accurate and reliable determination of wheel load distribution
- Research Benefit: Avoided new or lower weight postings (70+/-)



0092-20-01 Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges (12/21)

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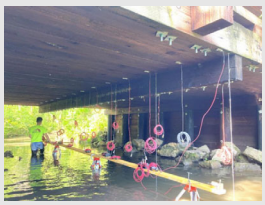
11

Timber Slab Bridges

- Field Tested 10 Bridges
- Developed 3D FE models
- Parametric Study
- Validated New Equation - Equivalent Strip Width



0092-20-01 Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges (12/21)

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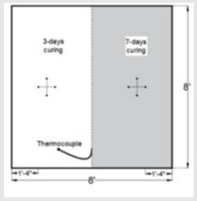
12

Improving Bridge Concrete Overlay Performance

- Experimental Work – Slab Tests:
  - (2) cure durations (3 and 7 day)
  - (7) different overlay mixes



0092-22-01 Improving Bridge Concrete Overlay Performance (9/23)

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Improving Bridge Concrete Overlay Performance

Mixture	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7
Designation	E.E.	FRC	CR-15	FRC-15	FA	LMC	E-I
Description	Grade E	Grade E, PVA Fibers	Grade E Reduced Cement	Grade E Reduced Cement PVA Fiber	Grade E 15%-Fly Ash	Latex Modified Mix	Grade E
Cement Type	IL	IL	IL	IL	IL	IL	I
Sand, dry (lbs)	1405	1405	1405	1405	1405	1405	1405
Gravel, dry (lbs)	1405	1405	1405	1405	1405	1405	1405
Cement	823	823	700	700	700	659	823
Water-Cement Ratio	0.324	0.324	0.324	0.324	0.324	0.324	0.324
Water reducer (oz)	To meet slump requirement						
Air Entrainment (oz)	To meet air content requirement						
PVA fiber (lbs)		1.5		1.5			
Fly Ash (lbs)					123		
Latex (lbs.)						139	

0092-22-01 Improving Bridge Concrete Overlay Performance (9/23)

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Improving Bridge Concrete Overlay Performance

- Summary and Conclusions
  - Heat-of-hydration (calorimetry) tests indicated that Type IL cement can generate higher peaks of heat flow compared Type I.
  - Reduction of cement content resulted in reduced heat flow for both IL and OPC.
  - Replacing cement with fly ash (0, 10%, 15%, and 20% replacement) resulted in progressively smaller heat flow peaks.

0092-22-01 Improving Bridge Concrete Overlay Performance (9/23)

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15

Improving Bridge Concrete Overlay Performance

- Recommendations:
  - Modifications to the Mix Design
  - Increase Concrete Cure
  - Perform Deck Repairs Before Placing the Overlay

0092-22-01 Improving Bridge Concrete Overlay Performance (9/23)

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16

Optimizing Bridge Abutment Slope Protection at Stream Crossings

- Develop guidance for identifying performance issues associated with slope protection.
- Develop guidance with life-cycle cost considerations.

0092-21-02 Optimizing Bridge Abutment Slope Protection at Stream Crossings (12/22)

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17

Active Projects

- Bridge Deck Thermography Verification and Policy
- Vertical and Overhead Concrete Patches
- State of Practice for Specifying and Repairing MSE Walls
- Investigation of MSE Wall Corrosion in Wisconsin (Geotech)
- Investigation of Removing Existing Abutment Exp. Joints (Pre-Contract)

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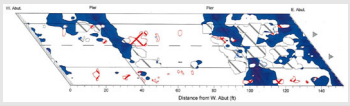
Bridge Deck Thermography

- Specifications IRT data collection.
- State-wide policies on using IRT
- Guidelines on the IRT's accuracy



PI: AECOM
PM: Philip Meinel
Completion: 10/2024

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Vertical and Overhead Concrete Patches

- Investigate and provide material selection guidance and repair strategies for concrete surface repairs.
- Develop patch-repair material installation specifications, installation inspection requirements, and acceptance criteria.
- Investigate the performance of minor to intermediate patch repairs

PI: WJE
PM: Andrew Smith
Completion: 10/2025

20

Investigation of MSE Wall Corrosion in WI

Figure: FHWA-HIF-24-002

PI: Geocomp, Inc
PM: Steven Doocy
Completion: 10/2025

21

State of Practice for Specifying and Repairing MSE Walls

- Identify best practices for MSE wall usage
- Recommendations to maximize MSE wall service life
- Prepare recommendations for specific retrofit solutions.

PI: Applied Research Associates, Inc.
PM: Ruth Coisman
Completion: 2/2026

22

Investigation of Removing Existing Abutment Expansion Joints

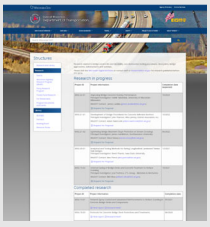
- Examine WisDOT's practice of removing existing expansion joints at substructures.
- Define practical limits of substructure conversions.
- Prepare recommendations for converting substructures.

PI: TBA
PM: Laura Shadewald
Completion: 10/2026

23

WHRP Reports:

- https://wisconsindot.gov/Pages/about-wisdot/research/structures.aspx



24


Questions
WHRP
James Luebke, PE
James.luebke@dot.wi.gov
(608) 266-5098
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25

Load Ratings & Mega-Loads

Alex Pence
Supervisor – Automation & Load Ratings

BOS Symposium
May 23, 2024

1

Topic 1: Load Rating FAQs

- Emergency & Posting Vehicle Evaluations
- Where to Find Recent Load Ratings
- Low Load Ratings on Good Bridges
- Wis-SPV Ratings
- Prestressed Girder Shear
- Culvert Ratings

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Emergency & Posting Vehicle Evaluations

When do posting / emergency vehicles need to be analyzed?

Vehicles	Inventory Rating	Operating Rating
Emergency Vehicles	HS20 RF < 1.0 HL93 RF < 0.9	---
SHVs	---	HS20 RF < 1.3 HL93 RF < 1.0
Other Posting Vehicles	---	HS20 RF < 1.0 HL93 RF < 1.0

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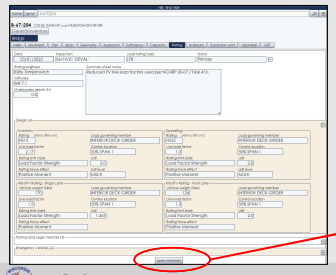
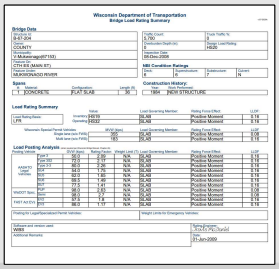
3

Where to Find Recent Load Ratings?

HSIS Rating Tab





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Low Load Ratings on Good Bridges

- Impacts
  - Legal Weight Limit Restrictions
  - OSOW Freight Restrictions
  - Reduced Service Life
  - Inspection Frequency (Inv RF < 1.0)
- Design Phase
  - Consider cost/benefit of refined analysis, alternate methods, or strengthening
  - Reach out to BOS Rating Unit to discuss

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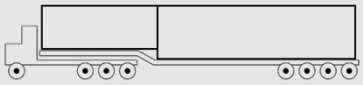
5

Wis-SPV Ratings

- Wisconsin Bridge Manual Section 45.12
  - Target MVW > 190 kips w/ Single-Lane Loading
    - Plus FWS for new designs
  - Report ratings w/o FWS on plans and load rating summary sheet
  - Consider Interior Girders or Slab Strips only
  - For rehab or in-service bridge ratings, contact BOS if MVW < 190 kips
    - Below 170 kips can restrict annual permits



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6

Prestressed Girder Shear

45.6.1 Prestressed Concrete

For bridges designed to be continuous over interior supports, the negative capacity shall come from the reinforcing steel in the concrete deck. Conservatively, only the top mat of steel deck reinforcing steel should be considered when rating for negative moment. If this assumption results in abnormally low ratings for negative moment, contact the Bureau of Structures Rating Unit for consultation.

Elastic gains in prestressed concrete elements shall be neglected for a conservative approach.

Shear design equations for prestressed concrete bridges have evolved through various revisions of the AASHTO design code. Because of this, prestressed concrete bridges designed during the 1960s and 1970s may not meet current shear capacity requirements. Shear capacity should be calculated based on the most current AASHTO code, either LFR or LRFR. Shear should be considered when determining the controlling ratings for a structure. If shear capacities are determined to be insufficient, the load rating engineer of record should contact the Bureau of Structures Rating Unit for consultation. If an existing bridge was designed using the Simplified Procedure for shear, the Simplified Procedure **LRFD [5.8.3.4.3]** (7th Edition - 2014) may be considered for shear ratings.

BUREAU OF STRUCTURES

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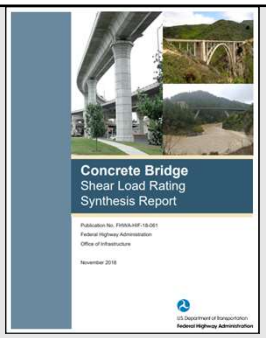
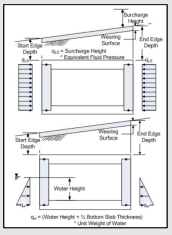


BUREAU OF STRUCTURES

8

Culvert Load Ratings

- Bridge Manual Ch. 45 Update (July 2023)
- 3 Methods
  - Calculated
    - Ideal method; required for most concrete boxes
  - Assigned
    - Requires stamped plans/calcs with design load & fill depth
    - Must meet minimum original design standards
  - Field Evaluation & Engineering Judgment
    - Use when Calculated or Assigned cannot be used
    - Bridge Manual has recommended ratings and postings based on condition



BUREAU OF STRUCTURES

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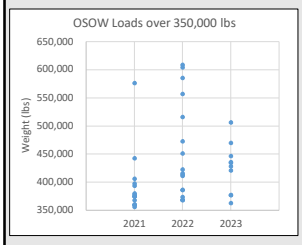
Topic 2: Mega-Loads in Wisconsin



BUREAU OF STRUCTURES

10

1.4M-Lb Mega-Load: Xcel Energy Generator

- 658,000-lb generator
- Converts natural gas turbine output into electricity
- Green Energy initiative
- Destination: Eau Claire, WI (Xcel Energy)
  - Originally could not get rail clearance
  - Planned to travel by barge
- Schedule: Summer 2024

BUREAU OF STRUCTURES

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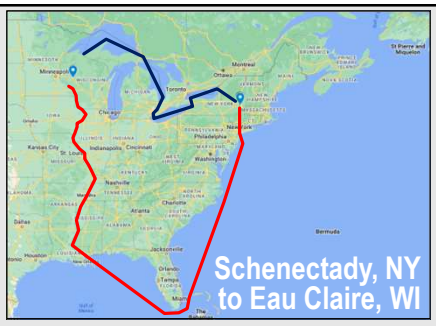
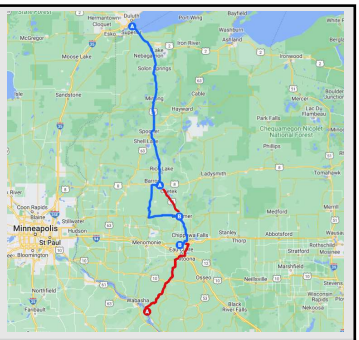


BUREAU OF STRUCTURES

12

Routes through Wisconsin

- From Alma (Mississippi)
- From Superior (Great Lakes)
  - First Attempt
  - Detour for Denied Bridges



BUREAU OF STRUCTURES

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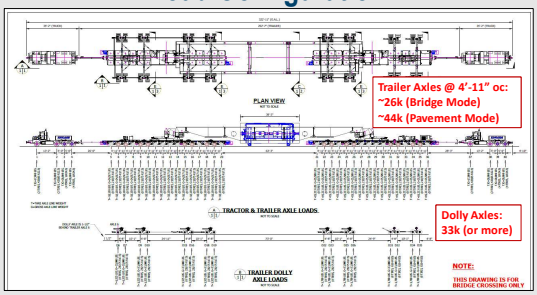
Load Configuration



BUREAU OF STRUCTURES

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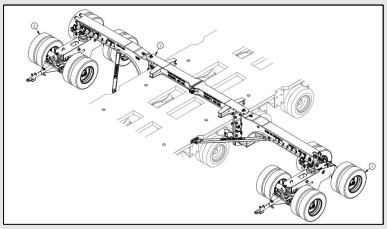
Load Configuration

- 1,482,422 lbs
- 40 axles
- 2 trailers
- 2 trucks
- 322'-11" length
- 9'-10" wide "pavement mode"
- 31'-2" wide "bridge mode"



BUREAU OF STRUCTURES

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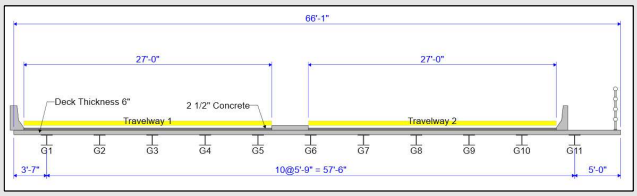
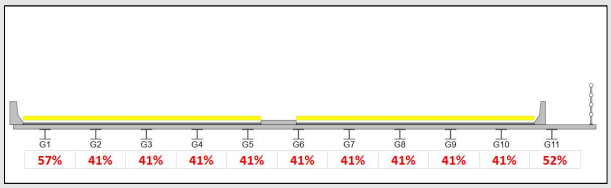
Example Bridge w/ Non-Standard Gage (NSG) Vehicle Analysis



16

AASHTO Std Spec (LFD/LFR)

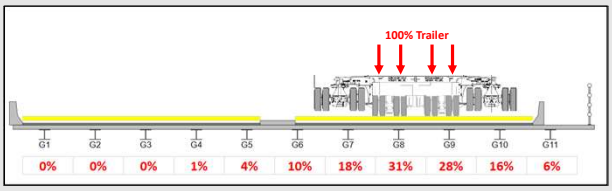
Standard Truck Axle Live Load Distribution



17

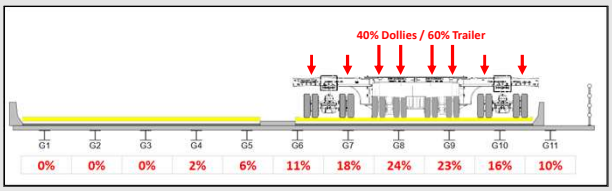
NSG + Vehicle Path Distribution Factors

Roadway Configuration (Dollies Lifted)



18

NSG + Vehicle Path Distribution Factors
Balanced Load on Dollies, Minimum Width



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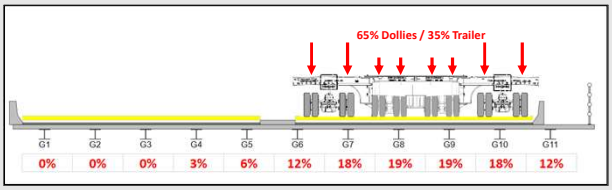
19

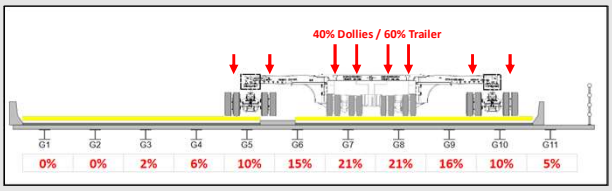
NSG + Vehicle Path Distribution Factors
Maximum Load on Dollies, Minimum Width



BUREAU OF STRUCTURES

20

NSG + Vehicle Path Distribution Factors
Balanced Load on Dollies, Maximum Width



BUREAU OF STRUCTURES

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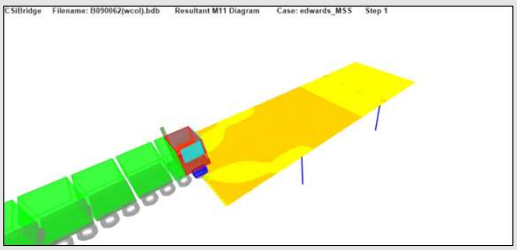
3D Analysis for Slabs



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Analysis Refinement Options

- Steel Girder – Positive Moment
  - Elastic vs. Plastic
- Prestressed Girder – Shear
  - LFR vs. LRFR, General vs. Simplified, Ignore
- Deck Reinforcement – Negative Moment
  - Top Mat only vs. Top & Bottom
- Moment Redistribution
  - Decrease Negative Moment, Increase Positive Moment
- LRFR instead of LFR
  - Usually better for PS girder shear
  - Allows lower LL factor for escorted permit loads

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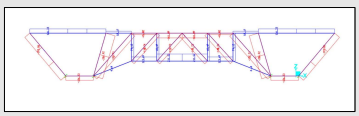
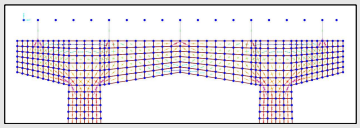
Other Rating Checks

- Inspection Report Review
- Culverts
- Pier Caps
  - Traditional Beam Analysis
  - FEA / Strut-and-Tie





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Permit Fees

- Bridge Review
  - $10 per hour → $10 flat fee?
  - Unchanged since 1983
- Other Special Investigation
  - Opened Project ID
  - Tracking Actual Costs
  - BOS + Consultant Resources

Trans 250.05 Special investigation fees.

(1) The department shall charge the following special investigation fees:

(a) For each single trip permit for a width exceeding 16 feet, a region review fee of $10 for each region through which the load is routed to cover the costs incurred by the region office in reviewing the adequacy of the route for the proposed move.

(b) For each single trip permit for a gross weight exceeding 150,000 pounds, a bridge review fee of $10 per hour for each employee-hour or fraction thereof required to review the adequacy of the bridges to support the proposed load to cover the costs incurred by the department for this review.

(c) For any other special investigation deemed necessary by the department because of the size or weight of the load or of the route to be travelled, the actual cost incurred by the department in making the investigation.

(2) The fees under sub. (1) shall be charged regardless of whether the special investigation is conducted before or after a permit application is received and regardless of whether a permit is issued or denied.

History: Cr. Register, September, 1983, No. 333, eff. 10-1-83; correction in (1) (a) made under s. 13.92 (4) (b) 6., Stats., Register February 2013 No. 686.

BUREAU OF STRUCTURES

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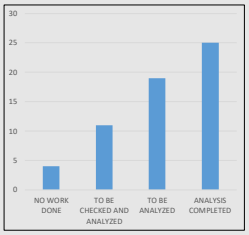
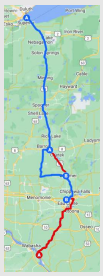
Progress





- Alma – Eau Claire (27)
  - 7 approved
  - 1 denied
  - 19 incomplete
- Superior – Eau Claire (49)
  - 24 approved
  - 2 denied
  - 23 incomplete
    - 7 removed from route
- Superior – Eau Claire Detour (14)
  - 14 incomplete
- **Most Recent Route (50)**
  - **Evaluation ~85% complete**

BUREAU OF STRUCTURES

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Hold Up!

Letter to WisDOT

"Notification to terminate the Superior to Eau Claire permitting efforts. There was a design change made to this specific generator that enabled it to fit within the needed rail clearance envelope."

"We look forward to partnering with the State of Wisconsin as the rail siding to the project site will still require road transit, in a much smaller-scope (under 10 miles)."

BUREAU OF STRUCTURES

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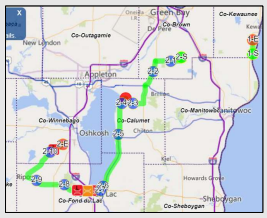
Another Mega-Load!

- Kewaunee Power Station
  - Traveling to Oshkosh, then via rail to Utah
    - October 2024
  - 780,200 lbs
    - Not over a million, but still…
  - 22 axles
  - 219'-6" length
  - 16'-0" width
  - 14 bridges
    - Not 50, but still…



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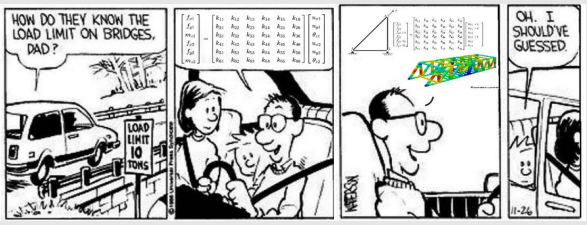

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