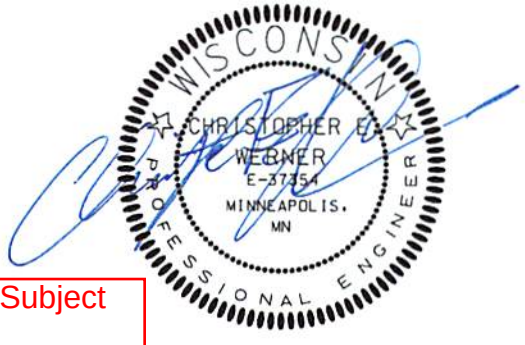
July 2010

Engineering Study for Bridge Rehabilitation
Structure No. B-47-45

Prepared for:
Pierce County Highway Department



Prepared By:
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Concur with Recommendations Subject to Comments on page 2/15
APL
WisDOT Bureau of Structures
7-29-2013

Comments 07-29-13

B-47-45

By APL

We concur with recommended **Alternative: Superstructure Replacement** subject to the following comments:

During project development request the Bureau of Structures look for pile driving records. They may exist which will help confirm pile capacities under LRFD criteria.

The report does not address meeting the requirements of Trans 75 for the accommodation of bicycles within bridge roadway width (or sidewalk). Given the rural area and 2009 year ADT<400 the proposed bridge width should be able to meet requirements of Trans 75, but BOS will defer to the Region Contact for acceptability.

The report does not contain any construction cost estimates, but we assume the application does. For this particular bridge it is clear the recommended alternative will be cost effective.

The DNR has this tributary labeled as Plum Creek. During project development the project name should be confirmed with owner.

If the West abutment slope protection is not repaired it should be included in the scope of the funded project.

INTRODUCTION

HDR was retained by the Pierce County Highway Department to inspect structure B-47-45, which carries CTH U over a tributary of the Plum River in Maiden Rock, Wisconsin, and evaluate the feasibility of rehabilitating the bridge by replacing the superstructure and reusing the existing abutments. This Engineering Study summarizes the results of our inspection and analysis and will be submitted with the application for rehabilitation funds from the Wisconsin Department of Transportation Local Bridge Program.

FIELD INSPECTION

HDR, in cooperation with Pierce County staff, completed the field inspection of the existing structure on June 30, 2010. The following is a summary of the inspection findings:

- *Deck*: Several repairs are located in the eastbound lane of the structure. The repaired areas are sound, but there are several areas of delaminated concrete on adjacent areas when sounded with a hammer. There are also several delaminated areas of concrete along the longitudinal reflective cracks in this same area of deck (see Appendix for Photo 6115).

- *Superstructure*: The precast channel beam on the south fascia is in poor condition. There is a large spall in the outside channel leg measuring 4 feet long by 8 inches tall at the midspan of the bridge with exposed strands and up to four broken wires in the bottom strand (see Appendix for Photo 6116). The north fascia precast beam is showing longitudinal cracking along the bottom of the outside channel leg with rust staining, but there is no spalling at this time.

- *Substructure*: The substructure is in good condition. The abutments and wingwalls have no cracks, delaminations, or spalls noted. The concrete slope protection along the West Abutment has pulled away approximately 3 inches along the length. This concrete was placed at a later date than the rip rap from the original construction in an effort to reinforce this bank. Some undermining was noted along this abutment, which varied up to 14 inches deep primarily on the south half of the abutment. There is no evidence of material being lost from under the approach roadway. The piles could not be inspected.

- *Channel and Channel Protection*: The stream enters the structure at an approximately 30-degree skew from perpendicular. This is causing the slope protection to degrade along the West Abutment. The channel is well vegetated both upstream and downstream of the structure.

ENGINEERING ANALYSIS

In addition to the field inspection, HDR evaluated superstructure replacement alternatives for the bridge. Because no pile driving records exist, the capacity of the existing timber piles for Load and Resistance Factor Design (LRFD) was determined by converting the Allowable Stress Design (ASD) value based on the required driven capacity shown in the 1976 plans and conservatively assuming a factor of safety of 2.0. We calculated the dead load of the abutment, a future wearing surface load of 20 pounds per square foot, and the HL-93 live load. These loads were combined in the Strength I load combination and compared to the estimated LRFD pile capacity to determine the reserve capacity available for superstructure dead load. We found that the Strength I value exceeded the factored resistance of the existing piles as determined by conservatively converting the 1976 plan information to LRFD.

We then checked the piles using ASD with a new, rolled steel girder superstructure and HL-93 live load, and we found that they would support a new superstructure based on our conceptual calculations. Several other superstructure alternatives were considered initially, including prestressed concrete girders and a haunched concrete slab; but given the capacity of the existing piles, the replacement superstructure needs to be as lightweight as possible. For this reason, the most viable superstructure alternative appears to be a 9" concrete deck on four 27-inch rolled steel girders. Based on preliminary bearing design and haunch assumptions, this superstructure alternative may require the profile grade to be raised by approximately 4 inches.

Based on the functional classification and ADT of CTH U, matching the existing clear roadway width of 33 feet will be adequate. Therefore, no widening of the existing substructure will be required. As noted above, the existing abutment and piles would need to be evaluated using ASD in order to accommodate a new superstructure. However, the replacement superstructure would be designed using LRFD and the entire structure would be evaluated for HL-93 live load. This design methodology will need to be approved by the Wisconsin Department of Transportation (WisDOT).

SUMMARY

The deficiencies noted in our inspection were found in the existing deck and superstructure. Replacing the existing superstructure with a new, rolled steel girder superstructure will correct these deficiencies and would extend the life of this bridge for more than 10 years. In addition to the superstructure replacement, HDR recommends that the County take action to repair the slope protection at the West Abutment in order to minimize further undermining. Replacement of the superstructure of this bridge is approximately half the cost of a complete replacement. Using a new steel superstructure and an ASD design approach for the existing abutments, we believe this is a cost effective way to extend the useful life of this structure and increase the sufficiency rating to a value greater than 80.

APPENDIX – Inspection Photos

PHOTO LOG

Photo Number	Item	Description
IMG_6090	Upstream Channel(North)	Looking north showing well vegetated channel. Note: Stream enters the bridge at approximately a 30 degree skew from perpendicular.
IMG_6091	Downstream Channel (South)	Looking south showing well vegetated channel
IMG_6092	South Fascia Beam	Showing exposed strands; three exposed strands with heavy corrosion and some broken wires
IMG_6093	South Fascia Beam	Showing exposed strands; three exposed strands with heavy corrosion and some broken wires
IMG_6094	North Fascia Beam	Showing longitudinal cracking on bottom of leg with rust staining
IMG_6095	North Fascia Beam	Showing longitudinal cracking on bottom of leg with rust staining
IMG_6096	West Abutment	Looking at Elevation View of West Abutment
IMG_6097	East Abutment	Looking NE at East Abutment (No cracks)
IMG_6098	East Abutment	Looking NE at south end of East Abutment showing exposed cable in South Fascia Beam
IMG_6099	SE Wingwall	Looking NE at SE wingwall (No cracks)
IMG_6100	NE Wingwall	Looking NE at NE wingwall (No cracks)
IMG_6101	NE Corner of Deck	Showing 40" +/- superstructure depth
IMG_6102	South Fascia Beam	East end of South Fascia beam showing broken wire on bottom strand and 6"H x 3" deep x 3'L Spall
IMG_6103	East Abutment	Looking NE at East Abutment (No cracks)
IMG_6104	West Abutment	Looking NW at West Abutment (No cracks)
IMG_6105	SW Wingwall	Looking SW at SW Wingwall (No cracks)
IMG_6106	West Abutment	Looking south along West Abutment showing concrete slope protection pulled away from abutment
IMG_6107	NW Wingwall	Looking NW at NW Wingwall (No Cracks)
IMG_6108	West Abutment	Showing undermining of West Abutment; Varies to 14" primarily on south half of abutment
IMG_6109	West Abutment	Looking north along abutment showing concrete slope protection pulled away 3" +/-
IMG_6110	South Fascia Beam	Looking north at 4' long by 8" tall full leg width spall with exposed strands near midspan
IMG_6111	Channel	Looking upstream at bend in channel just upstream from bridge
IMG_6112	Channel	Looking downstream through structure opening
IMG_6013	Channel	Looking upstream through structure opening
IMG_6114	Rail	Looking east along bridge rail
IMG_6115	Deck	Looking west at repairs in EB Lane
IMG_6116	South Fascia Beam	Looking at spall in leg with exposed strands and up to 4 broken wires
IMG_6117	South Fascia Beam	Looking at spall in leg with exposed strands and up to 4 broken wires
IMG_6118	Approach Roadway	Looking east at approach roadway
IMG_6119	Approach Roadway	Looking west at approach roadway
IMG_6120	North Elevation	Looking SW at North Elevation of Bridge
IMG_6121	South Elevation	Looking NW at South Elevation of Bridge
IMG_6122	North Elevation	Looking SE at North Elevation of Bridge

County: Pierce

Bridge Inspection Photographs

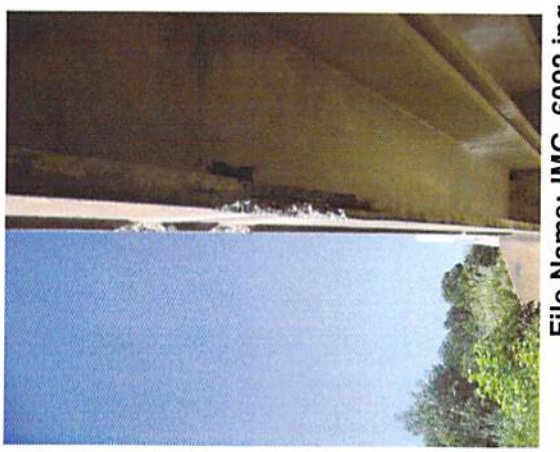
WisDOT Bridge #: B-47-45

Date Photos Taken: 6/30/10

File Name: IMG_6091.jpg

File Name: IMG_6093.jpg

File Name: IMG_6090.jpg



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WisDOT Bridge #: B-47-45

County: Pierce

Bridge Inspection Photographs

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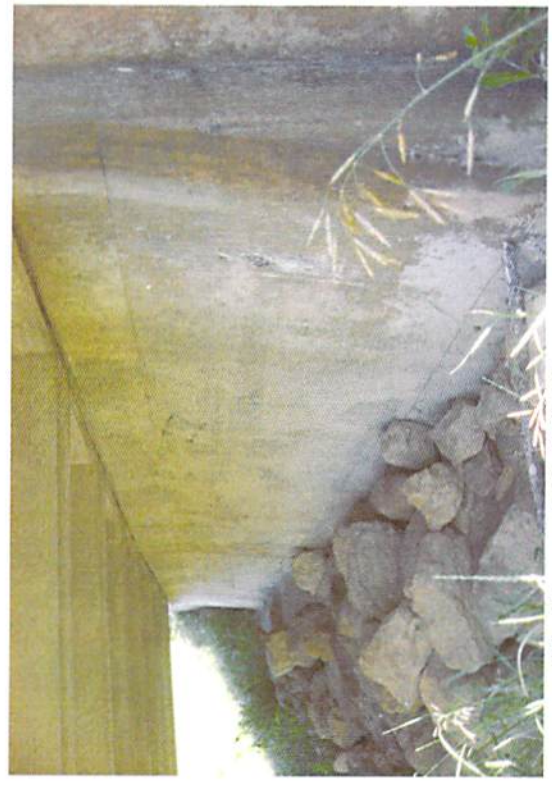

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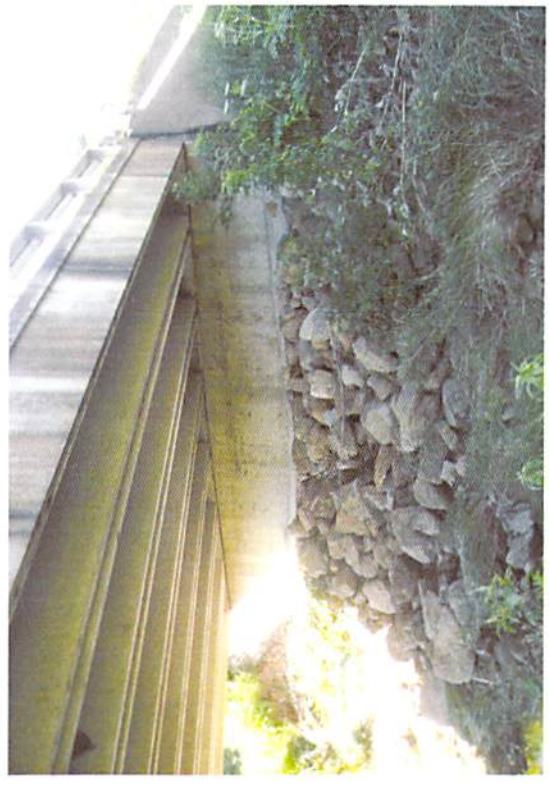

File Name: IMG_6096.jpg

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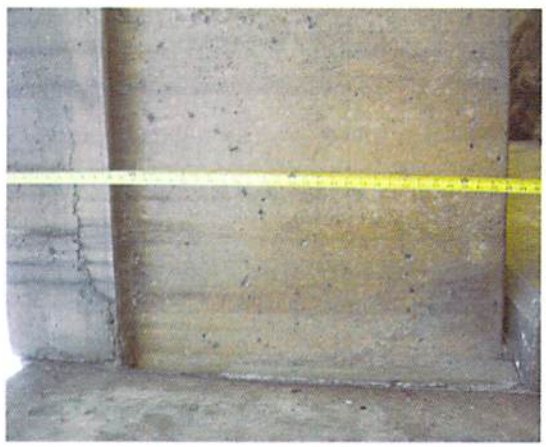
File Name: IMG_6099.jpg



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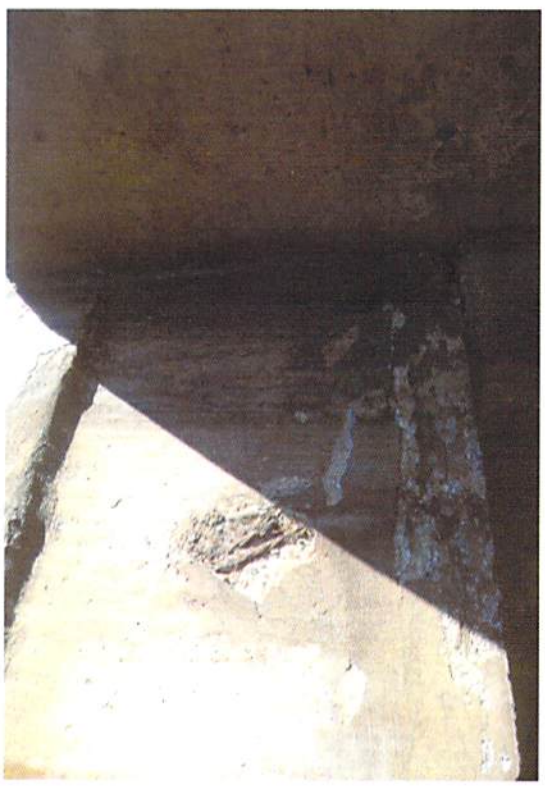

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File Name: IMG_6100.jpg

County: Pierce

Bridge Inspection Photographs

WisDOT Bridge #: B-47-45

Date Photos Taken: 6/30/10

File Name: IMG_6103.jpg

File Name: IMG_6105.jpg

File Name: IMG_6102.jpg

File Name: IMG_6104.jpg

County: Pierce

Bridge Inspection Photographs

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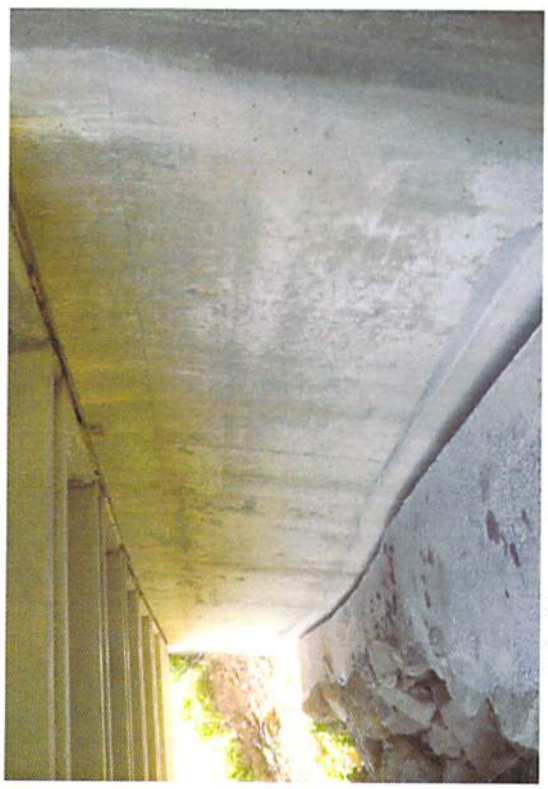
Date Photos Taken: 6/30/10

File Name: IMG_6107.jpg

File Name: IMG_6109.jpg



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File Name: IMG_6108.jpg

County: Pierce

Bridge Inspection Photographs

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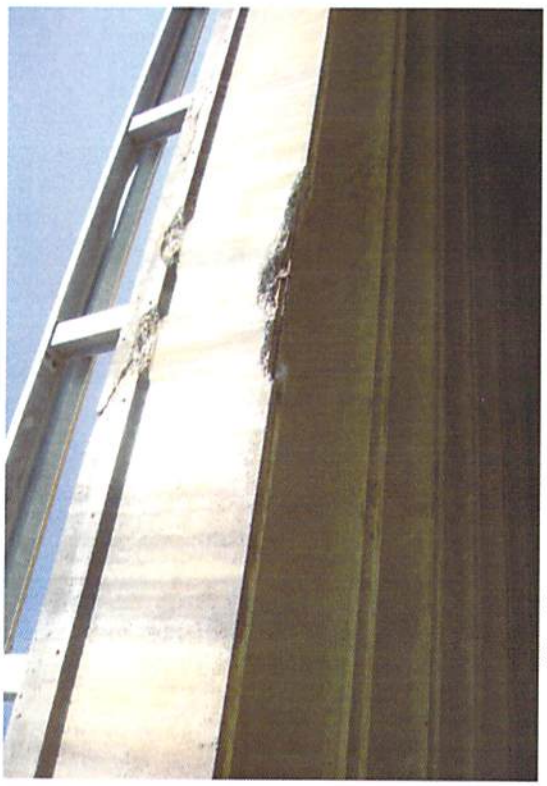

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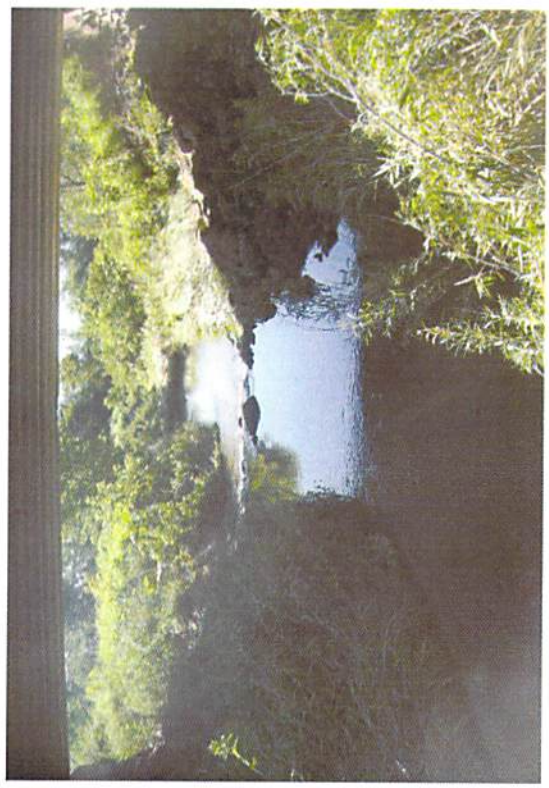

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County: Pierce

Bridge Inspection Photographs

WisDOT Bridge #: B-47-45

Date Photos Taken: 6/30/10

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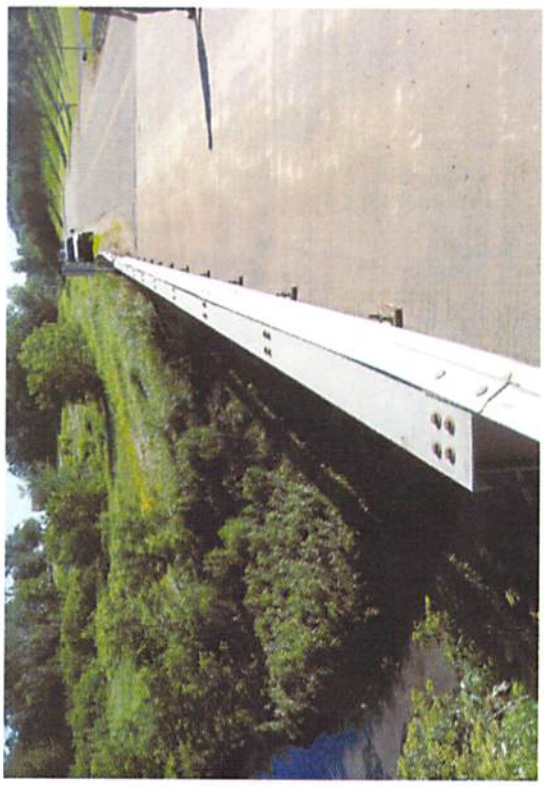
File Name: IMG_6117.jpg



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File Name: IMG_6116.jpg

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Bridge Inspection Photographs

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File Name: IMG_6119.jpg

File Name: IMG_6121.jpg

File Name: IMG_6118.jpg

File Name: IMG_6120.jpg

County: Pierce

Bridge Inspection Photographs

WisDOT Bridge #: B-47-45

Date Photos Taken: 6/30/10

File Name: IMG_6122.jpg