

## **Non-Destructive Testing Inspection Report**

**B-27-0053**

**Castle Mound Road over IH-94 near Black River Falls, WI**



**January 8<sup>th</sup>, 2021**

**For: HNTB Corporation**

**By: Fickett Structural Solutions, Inc.**

## Table of Contents

<b>1</b>	<b>Introduction .....</b>	<b>3</b>
<b>2</b>	<b>Location Map.....</b>	<b>4</b>
<b>3</b>	<b>Traffic Control.....</b>	<b>4</b>
<b>4</b>	<b>Inspection Findings .....</b>	<b>5</b>
4.1	Girder 4.....	5
4.2	Girder 3.....	5
4.3	Girder 2.....	6
4.4	Girder 1.....	6
4.5	Girder Keepers.....	6
<b>5</b>	<b>Inspection Findings, Conclusions, and Recommendations.....</b>	<b>7</b>
<b>6</b>	<b>Appendix A: Defect Schematics .....</b>	<b>8</b>
<b>7</b>	<b>Appendix B: Photographs .....</b>	<b>10</b>

## 1 INTRODUCTION

On January 8<sup>th</sup>, 2021, representatives of Fickett Structural Solutions, Inc. (Fickett) performed a damage inspection of B-27-0053 for HNTB. The purpose of the inspection was to further investigate the impact damage from a backhoe, which struck the bridge on 7/24/2020. Visual and Magnetic Particle (MT) testing was performed on connections within the observed damage limits.

A damage inspection performed by Gregory Haig (WisDOT) on 7/24/2020 noted the following:

*On 7/24/2020 approximately 50 ft. of girder 1 over the west bound lanes was struck by a backhoe and bent out plane by over 2 ft. the 3rd diaphragm in completely broke out and punched a 2 ft. hole in the girder. 10 ft. of the bottom cover plate also broke away from the bottom flange. In addition after looking at the top flange "hands on", 20 ft. of the top flange of G1 has broke loose from the deck and is no longer acting as a composite member. Girder 2 sustained less damage but still bent out of plane by approximately 6 in. Girder 4 has about 1 ft. of the girder "peeled" down but does not appear to be affecting the capacity.*

The following team members performed the damage inspection services:

- Fickett Structural Solutions, Inc.
  - Team Leader: Ryan A. Sievers, PE, CWI, NDT Limited Level II
  - Team Member: Traa T. Haase, EIT, CWI, NDT Limited Level II

The following tasks were performed by the inspection engineers from Fickett:

- Nondestructive Testing (NDT) on welded diaphragm connection stiffeners on distorted girders using MT along the fillet weld terminations at the top and bottom of the stiffeners. The remainder of the welds were visually inspected for signs of cracking.
- NDT on areas of impact damage including the cover plate to bottom flange longitudinal weld.
- NDT and visual inspection of Span 2 field splices for distortion and damage.

## 2 LOCATION MAP

B-27-0053 carries Castle Mound Road over IH-94. Refer to the below location map.

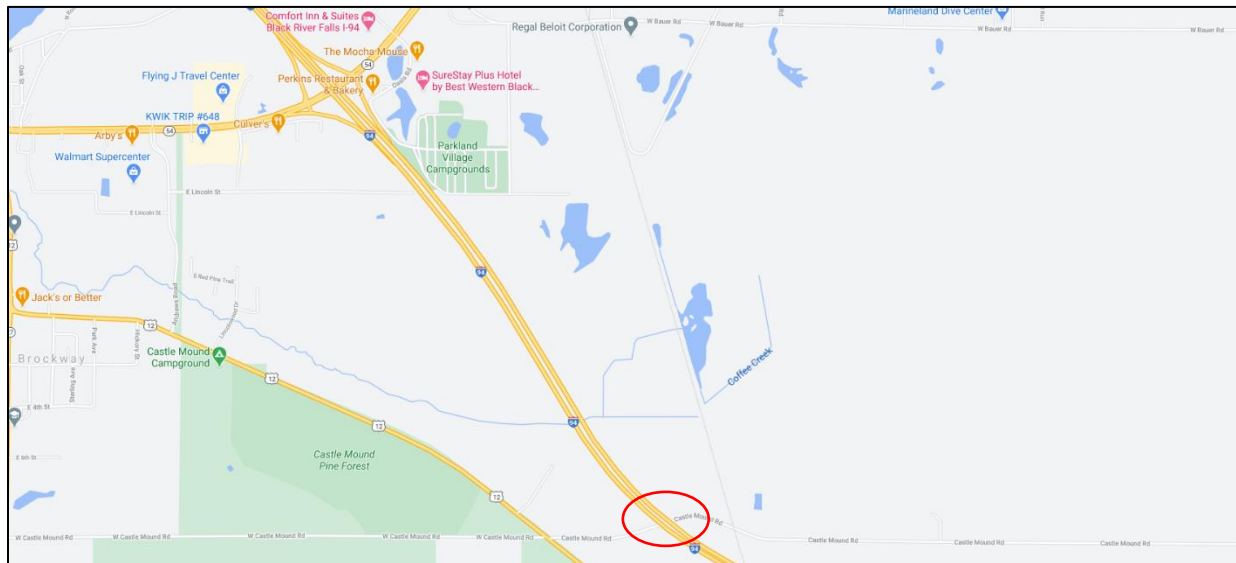


Figure 1: Location Map of B-27-0053

## 3 TRAFFIC CONTROL

IH-94 WB was closed under the bridge utilizing two stages of traffic control. Stage 1 of the traffic control was a single lane closure of Lane 2 and the right shoulder. Stage 2 of the traffic control was a single lane closure of Lane 1 and left shoulder. Mega Rentals, Inc. performed traffic control for the inspection. A bucket truck was used to access the underside of the bridge during inspection activities.

## 4 INSPECTION FINDINGS

The following sections outline the conditions for each of the areas inspected. All defects were located in Span 2. All crack tips were marked in the field by the inspectors, although low temperatures and frost on the girders made it difficult to mark. All crack tips were photographed and measured in case our markings wear off prior to repairs.

### 4.1 GIRDER 4

Girder 4 from the field splice to the East Abutment will be replaced as part of the repair contract and did not require an in-depth inspection. The deck above Girder 4 was called out in the July 24<sup>th</sup>, 2020 inspection as being delaminated from the Girder 4 top flange for 20 ft. and was no longer acting compositely. In the area called out as being delaminated, the deck along the edges of the top flange had spalled with up to 1.5 in. of penetration, exposing the top edge of the top flange in isolated locations (**Photo 6**).

The Span 2 field splice was not displaced or rotated, and the splice plates had no distortion or damage (**Photo 8**). Moderate corrosion with negligible pack rust buildup was found in the faying surfaces of the field plates on all four girder field splice plates.

### 4.2 GIRDER 3

Girder 3 had an area of impact damage located 4 in. west of Bay 3, Diaphragm 11 (the diaphragm was broken out due to impact to Girder 4). The cover plate to bottom flange weld was cracked and the flange was bent up to 1 in. upwards over a 20 in. length in the area of impact damage (**Photo 11/Photo 12**). The web to the east of this impact damage, was distorted up to 2 in. out-of-plane with no indication of cracking in the girder web (**Photo 13**).

The girder bottom flange was deflected up to 4 in. to the north with the web rotated up to 12 degrees at the point of impact. Outside of this area of impact damage the girder bottom flange was deflected up to 1.25 in. to the north with the web rotated up to 1 degree before going back to vertical at Diaphragms 9 and 13.

The following girder web to diaphragm welds were cracked:

- Span 2, Girder 3, Bay 3, Diaphragm 10 (**Photo 9**)
- Span 2, Girder 3, Bay 2, Diaphragm 11 (**Photo 10**)
- Span 2, Girder 3, Bay 2, Diaphragm 12 (**Photo 14**)
- Span 2, Girder 3, Bay 3, Diaphragm 12 (**Photo 15**)

#### **4.3 GIRDER 2**

Girder 2 had one cracked web to diaphragm weld on Span 2, Girder 2, Bay 2, Diaphragm 11 (**Photo 16**). The girder bottom flange was deflected up to 1 in. to the north with the web rotated up to 1.5 degrees from Diaphragm 11 to the East Abutment.

#### **4.4 GIRDER 1**

Girder 1 had an area of impact damage starting 8 ft. east of Diaphragm 10 and was 4 ft. long with a 1 ft. long area of torn steel up to 1/4 in. thick (**Photo 18**). Both Diaphragm 10 (**Photo 17**) and Diaphragm 11 (**Photo 19**) web to diaphragm welds were cracked. The girder bottom flange was deflected up to 1 in. to the north with the web rotated up to 3 degrees between Diaphragms 10 and 11 in the area of impact.

#### **4.5 GIRDER KEEPERS**

The previous reports indicated broken off and cracked girder keepers, as well as shifted girders. Pack rust was present between the girder bottom flanges and girder keepers. The following defects were noted on the girder keepers on the East Abutment:

- Girder 1 – Both girder keepers were cracked approximately half length.
- Girder 2 – The north girder keeper was cracked approximately half length.
- Girder 3 – The north girder keeper was cracked approximately half length and the girder had shifted 1/4 in. to the north.
- Girder 4 – The north girder keeper was broken off and the girder had shifted 5/8 in. to the north.

## 5 INSPECTION FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

HNTB determined that the portion of Girder 4 east of the field splice in Span 2 will be replaced along with Bay 3, Diaphragm 11 which was broken out due to impact damage.

It is recommended that the areas of impact damage on Girders 1 and 3 be heat straightened and the 20 in. section of cracked cover plate to bottom flange weld on Girder 3 be ground out and a bolted retrofit be installed after heat straightening. The seven cracked diaphragm to web welds should have crack arrest holes drilled to capture the crack tips after all heat straightening is performed.

Should there be any questions, please do not hesitate to contact me at (608) 831-3238. We appreciate the opportunity to work with you on this project and look forward to working with you on future projects.

Respectfully Submitted,  
**Fickett Structural Solutions, Inc.**



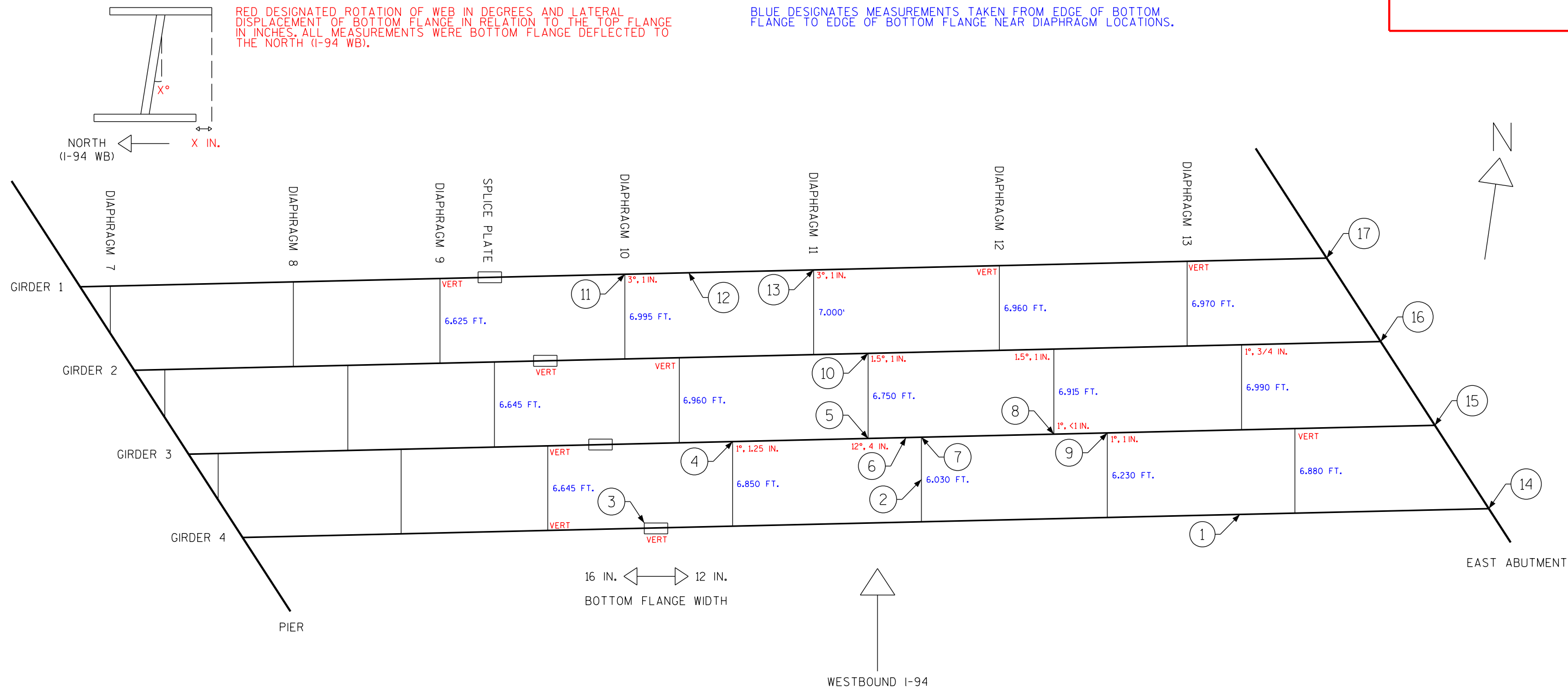
Ryan A. Sievers, PE, CWI, NDT Level II  
Team Leader



Traa T. Haase, EIT, CWI, NDT Level II  
Team Member

## **6 APPENDIX A: DEFECT SCHEMATICS**





## PHOTO NOTES:

- 6 1. GIRDER 4 FROM FIELD SPLICE TO EAST ABUTMENT WILL BE REPLACED AS PART OF REPAIR CONTRACT AND DOES NOT REQUIRE IN-DEPTH INSPECTION. THE DECK ABOVE THE GIRDER WAS SPALLED WITH UP TO 1.5 IN. OF PENETRATION AND THE TOP EDGE OF THE TOP FLANGE EXPOSED IN ISOLATED AREAS. THE DECK DID NOT APPEAR TO BE DELAMINATED FROM GIRDER AS STATED IN PREVIOUS DAMAGE REPORT.
- 7 2. DIAPHRAGM 11 WAS BROKEN OUT AND HAD PUNCHED AN APPROXIMATELY 2 FT. HOLE IN GIRDER 4.
- 8 3. THE SPLICE PLATES WERE ALL VERTICAL WITH NO DISTORTION. CORROSION AND MINOR PACK RUST WAS NOTED AT ALL FIELD SPLICES.
- 9 4. THE DIAPHRAGM TO WEB WELD HAD A 1.75 IN. CRACK STARTING AT THE BOTTOM EDGE.
- 10 5. THE DIAPHRAGM TO WEB WELD HAD A 1.75 IN. CRACK STARTING AT THE BOTTOM EDGE. THE DIAPHRAGM HAD BEEN PUSHED 1.5 IN. EAST AND THE WEB WAS DISTORTED UP TO 2 IN. TO THE SOUTH WITH NO CRACKING TO THE WEB NOTED. THE DIAPHRAGM STIFFENER TO DIAPHRAGM WELD WAS CRACKED THROUGH.
- 11, 12 6. IMPACT DAMAGE TO BOTTOM FLANGE STARTING 4 IN. WEST OF DIAPHRAGM 11 WELD FOR 20 IN. THE COVER PLATE TO BOTTOM FLANGE WELD WAS CRACKED AND THE FLANGE WAS BENT UPWARDS UP TO 1 IN.
- 13 7. THE WEB AT THE TOP OF THE DIAPHRAGM WELD WAS UP TO 2 IN. OUT-OF-PLANE TO THE NORTH WITH NO CRACKING NOTED.
- 14 8. THE DIAPHRAGM TO WEB WELD HAD A 6.25 IN. CRACK STARTING AT THE BOTTOM EDGE WITH UP TO 1/2 IN. SEPARATION BETWEEN DIAPHRAGM AND WEB AT BOTTOM EDGE.

## PHOTO NOTES (CONTINUED):

- 15 9. THE DIAPHRAGM TO WEB WELD HAD A 10 IN. CRACK STARTING AT THE BOTTOM EDGE AND A 3 IN. CRACK STARTING AT THE TOP EDGE WITH UP TO 1/4 IN. SEPARATION BETWEEN DIAPHRAGM AND WEB AT BOTTOM EDGE.
- 16 10. THE DIAPHRAGM TO WEB WELD HAD A 1.25 IN. CRACK STARTING AT THE TOP EDGE.
- 17 11. THE DIAPHRAGM TO WEB WELD HAD A 11.75 IN. CRACK STARTING AT THE BOTTOM EDGE WITH UP TO 3/8 IN. SEPARATION BETWEEN DIAPHRAGM AND WEB AT BOTTOM EDGE.
- 18 12. THE SOUTH BOTTOM FLANGE HAD 4 FT. OF IMPACT DAMAGE STARTING 8 FT. EAST OF DIAPHRAGM 10. THE BOTTOM FLANGE HAD A 1 FT. LONG AREA OF TORN STEEL UP TO 1/4 IN. THICK.
- 19 13. THE DIAPHRAGM TO WEB WELD HAD A 17 IN. CRACK STARTING AT THE BOTTOM EDGE WITH UP TO 3/8 IN. SEPARATION BETWEEN DIAPHRAGM AND WEB AT BOTTOM EDGE.
- 20 14. THE NORTH GIRDER KEEPER WAS BROKEN OFF AND THE GIRDER HAD SHIFTED 5/8 IN. TO THE NORTH.
- 21 15. THE NORTH GIRDER KEEPER WAS CRACKED APPROXIMATELY HALF LENGTH AND THE GIRDER HAD SHIFTED 1/4 IN. TO THE NORTH.
- 22 16. THE NORTH GIRDER KEEPER WAS CRACKED APPROXIMATELY HALF LENGTH.
- 23 17. BOTH GIRDER KEEPER WERE CRACKED APPROXIMATELY HALF LENGTH.

PREVIOUS REPORT INDICATED BROKEN OFF AND CRACKED GIRDER KEEPERS AS WELL AS SHIFTED GIRDERS. PACK RUST WAS PRESENT BETWEEN THE GIRDER BOTTOM FLANGES AND GIRDER KEEPERS.

NO.	DATE	REVISION	BY
STATE OF WISCONSIN DEPARTMENT OF TRANSPORTATION			
STRUCTURE B-27-0053			
DRAWN BY		RAS	PLANS TD
INSPECTION NOTES		SHEET	
		01/08/2021	

## 7 APPENDIX B: PHOTOGRAPHS



**Photo 1** : South Elevation looking northwest.



**Photo 2** : Looking west along Span 2, Girder 4 from East Abutment.





**Photo 3** : Looking west along Span 2, Girder 3 from East Abutment.



**Photo 4** : Looking west along Span 2, Girder 2 from East Abutment.



**Photo 5** : Looking west along Span 2, Girder 1 from East Abutment.

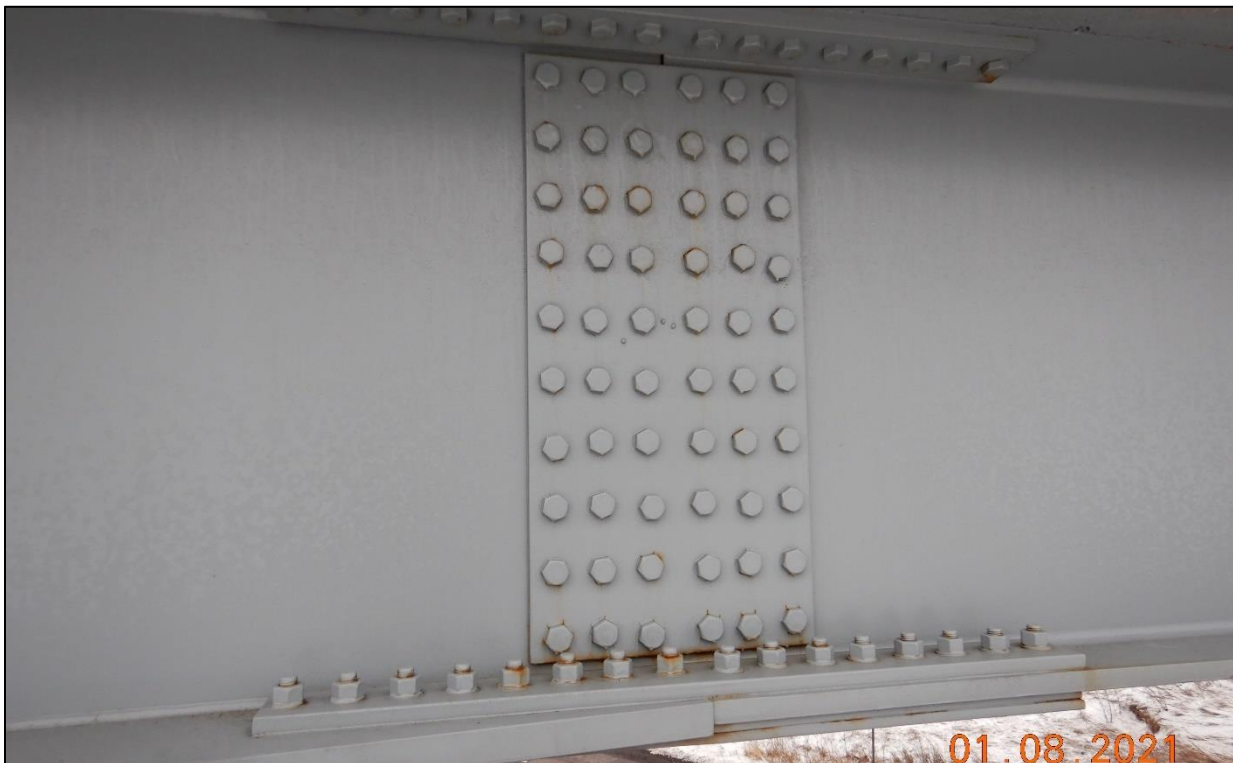


**Photo 6** : Looking west along Span 2, Girder 4 at top flange to deck interface with spalling up to 1.5 in. deep.





**Photo 7** : Looking northeast at Span 2, Girder 4 at area of impact. Note tear in web at missing Diaphragm 11 Location.



**Photo 8** : Looking north at Span 2, Girder 4 Splice Connection.



**Photo 9** : Looking northeast at Span 2, Girder 3, Diaphragm 10 to web weld with 1.75 in. crack starting at the bottom edge.



**Photo 10** : Looking southeast at Span 2, Girder 3, Diaphragm 11 to web weld with 1.75 in. crack starting at the bottom edge. The diaphragm had been pushed 1.5 in. east and the web was distorted up to 2 in. to the south with no cracking noted. The diaphragm stiffener to diaphragm weld was cracked through.





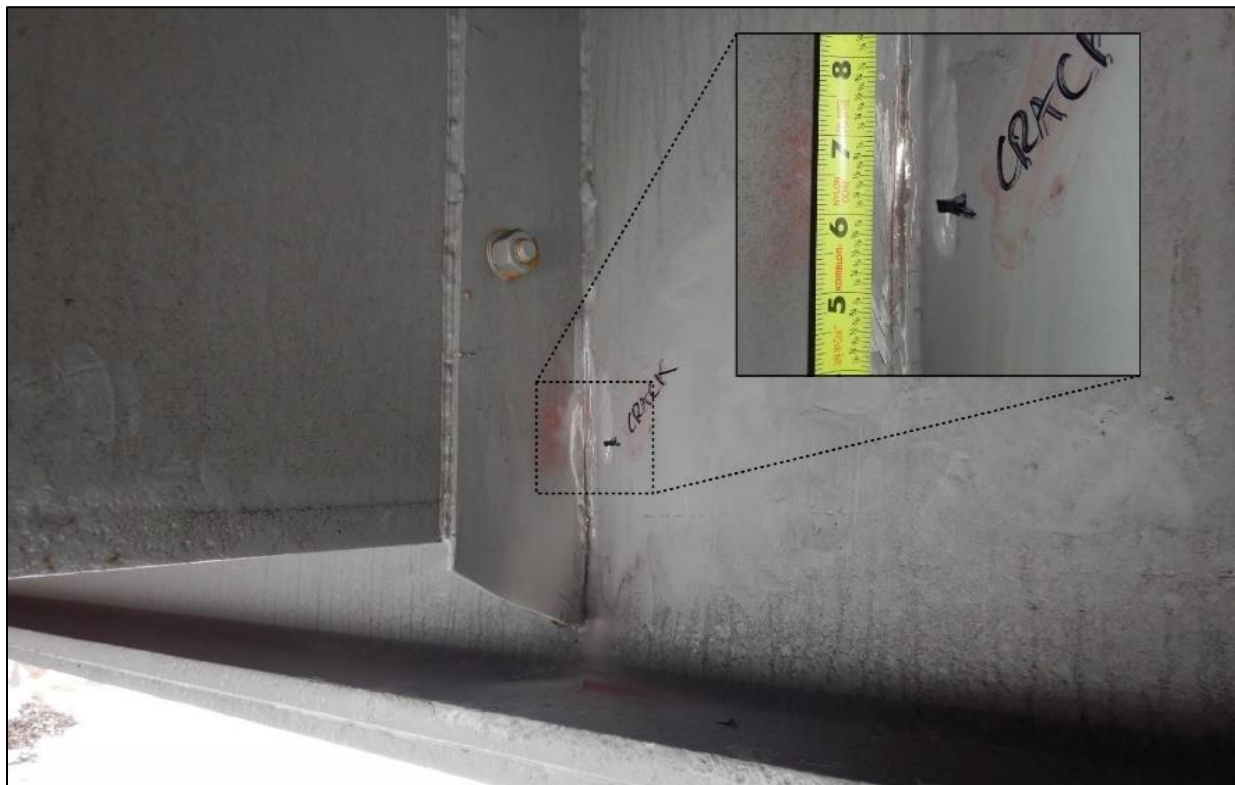
**Photo 11** : Looking north at Girder 3 impact damage to bottom flange starting 4 in. west of Diaphragm 11 weld for 20 in. with the cover plate to bottom flange weld cracked and flange was bent upwards 1 in.



**Photo 12** : Looking northwest at Girder 3 impact damage overview.

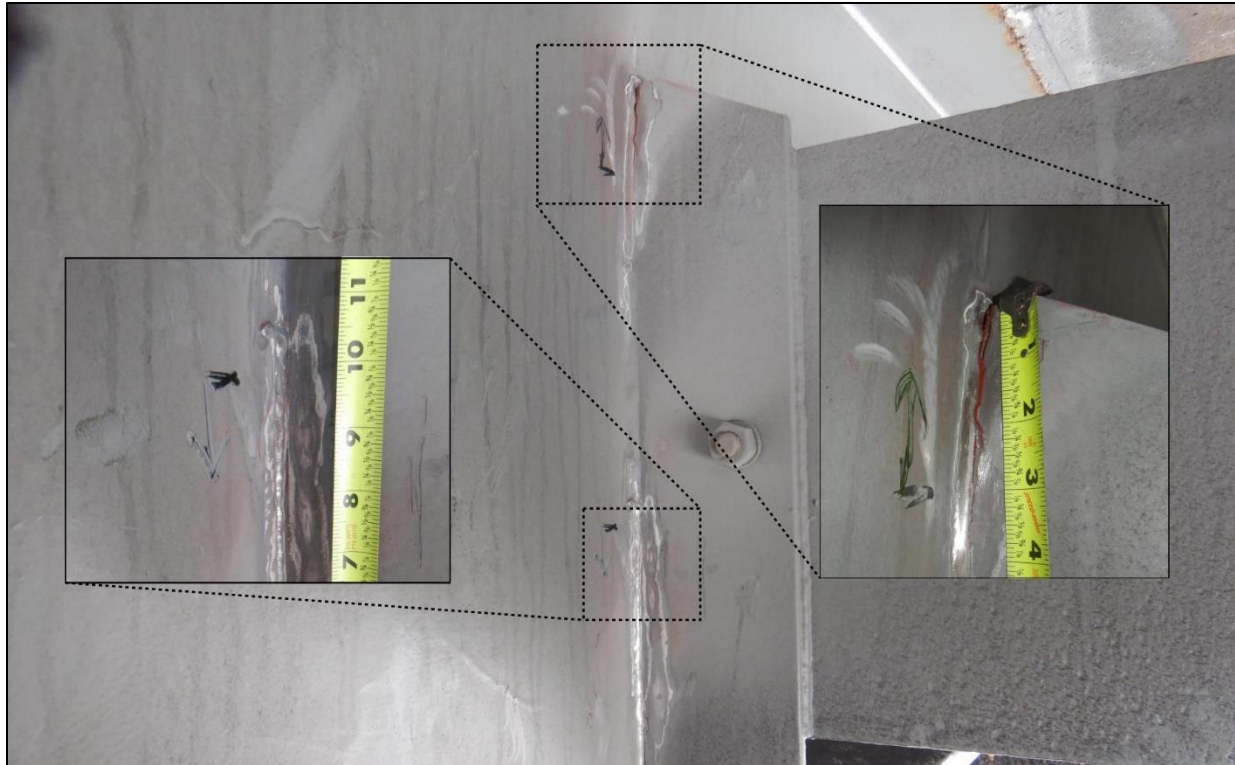


**Photo 13** : Looking east along Girder 3 at Diaphragm 11 with the web distorted up to 2 in. out-of-plane.



**Photo 14** : Looking southeast at Span 2, Girder 3, Diaphragm 12 to web weld with 6.25 in. long crack starting at the bottom edge with up to 1/2 in. of separation between diaphragm and web at bottom edge.





**Photo 15** : Looking southeast at Span 2, Girder 3, Diaphragm 12 to web weld with 10 in. long crack starting at the bottom edge and 3 in. long crack starting at the top edge with up to 1/4 in. of separation between diaphragm and web at bottom edge.



**Photo 16** : Looking northeast at Span 2, Girder 2, Diaphragm 11 to web weld with 1.25 in. long crack starting at the top edge.



**Photo 17** : Looking northeast at Span 2, Girder 1, Diaphragm 10 to web weld with 11.75 in. long crack starting at the bottom edge with up to 3/8 in. of separation between diaphragm and web at bottom edge.



**Photo 18** : Looking east along Span 2, Girder 1 south, bottom flange with 4 ft. of impact damage starting 8 ft. east of Diaphragm 10. The bottom flange had a 1 ft. long area of torn steel up to 1/4 in. thick.





**Photo 19** : Looking northeast at Span 2, Girder 1, Diaphragm 11 to web weld with 17 in. long crack starting at the bottom edge with up to 3/8 in. of separation between diaphragm and web at bottom edge.



**Photo 20** : Looking east at East Abutment, Girder 4 Bearing with the north keeper broken off and the girder shifted 5/8 in. to the north.





**Photo 21** : Looking east at East Abutment, Girder 3 Bearing with the north keeper cracked and the girder shifted 1/4 in. to the north.



**Photo 22** : Looking east at East Abutment, Girder 2 Bearing with the north keeper cracked.



**Photo 23** : Looking east at East Abutment, Girder 2 Bearing with both girder keepers cracked.