

# NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering  
Materials Laboratory Division  
Washington, D.C. 20594



April 28, 2008

MATERIALS LABORATORY FACTUAL REPORT

Report No. 08-031

## A. ACCIDENT

Place : Minneapolis, Minnesota  
Date : August 1, 2007  
Vehicle : I35W Highway Bridge  
NTSB No. : HWY07MH024  
Investigator : Mark Bagnard

## B. COMPONENTS EXAMINED

Pieces from nodes L11 East and West from the deck truss portion of the bridge

## C. DETAILS OF THE EXAMINATION

This report contains information and documentation on nodes L11 East and West of the deck truss portion of the bridge. This report primarily focuses on the damage patterns associated with the diagonals of the nodes, and this report is supplemental to Structural Investigation Group Chairman Factual Report No. 08-015. Some of the photographs in the figures in this report (08-031) were taken after the node L11 pieces were transported to the NTSB Training Center in Ashburn, Virginia.

### L11 East

As presented in the Structural Investigation Group Chairman Factual Report, node L11 East was recovered in five pieces:

The node was recovered from the river bottom in three main sections and two small pieces before torch cutting: (1) the lower chord L10/L11E to L11/L12E (although damaged, the chord was connected through both side plates), (2) the U10/L11E diagonal connected to node U10 East, and (3) the L11/U12E diagonal connected at node U12 East with the lower end of vertical U11/L11E connected by means of the west side gusset plate. Recovered separately was (4) a 12-foot piece of the east side plate of U11/L11E vertical starting above the first internal diaphragm. Also recovered was (5) a 6-foot piece of the lower chord upper cover plate and splice plate.

Both the east and west side plates of the lower chord members (L10/L11E and L11/L12E) remained attached to each other through intact portions of the gusset plates at node L11 East (see figure 1), but fractures in the gusset plates separated the diagonals (U10/L11E and L11/U12E) and the vertical (U11/L11E) from the lower chord members.

### Tension Diagonal U10/L11E

Examination of gusset plate fracture areas between the tension diagonal (U10/L11E) and the lower chord member L10/L11E at node L11 East revealed bending deformation adjacent to the fracture, consistent with fracture under compression or bending loads, and inconsistent with fracture under tensile loads.

- The west gusset plate in the area between the tension diagonal and the lower chord was fractured partially along a line of corrosion at the upper edge of the lower chord. The portion of the west gusset plate below the fracture was folded to the east over the top of the lower chord, and the portion of the plate above the fracture was folded to the west away from the west flange of the U10/L11 East diagonal (see figure 2). Figure 3 shows the line of corrosion in the west gusset plate adjacent to and just below the fracture between the tension diagonal and the lower chord.
- The east gusset plate in the area between the tension diagonal and the lower chord was fractured, with part of the fracture through the line of corrosion at the top of the lower chord. The plate above the fracture folded to the west over the lower end of the east flange of the diagonal, and the plate below the fracture was pulled to the east away from the east side plate (see figure 4). Deformation patterns associated with the gusset plates in the area between the tension diagonal U10/L11E and the lower chord member clearly indicated that the diagonal translated east relative to the lower chord before the gusset plate fractured. The east gusset plate was largely intact in the area between the tension diagonal and vertical member U11/L11E (visible on the left side of figure 2).

The Structural Investigation Group Chairman Factual Report states that “Diagonal U10/L11E folded down, and translated east relative to node L11 East, with the west flange of the diagonal impacting the upper cover plate of L10/L11E within about 14 feet of the node centerline.”

### Compression Diagonal L11/U12E

The lower (L11E) ends of both side plates of compression diagonal L11/U12E were split from each other and curled outward, away from the node. Examination of the gusset plate fractures and deformation between this compression diagonal and lower chord L11/L12E showed that the gusset plates were folded over the lower ends of the compression diagonal side plates and that there was scraping damage on the inside surfaces of the side plates. Figure 5 shows the scraping pattern on the inside of the east side plate of the compression diagonal and the gusset plate folded over the end of the side plate, consistent with the side plate passing on the outside of the node. Damage patterns on the lower end of the compression diagonal and the associated areas of the gusset plates indicated that the lower end of the diagonal split apart, with the side plates

penetrating on the outside of the remainder of the node. The west gusset plate in the area between the compression diagonal and the vertical was not fractured, as can be seen in the upper left corner of figure 1, and this gusset plate remained attached to the west side plate of the vertical.

### L11 West

As presented in the Structural Investigation Group Chairman Factual Report, node L11 West was recovered in four pieces:

The node was recovered from the river bottom in four main sections before torch cutting: (1) the lower chord L10/L11W to L11/L12W (although severely damaged, the chord was continuous through the east side plate), (2) the U10/L11W diagonal connected to node U10 West, (3) the L11/U12 diagonal connected to node U12 West, and (4) the U11/L11W vertical connected to part of floor truss 11.

Both the east and west side plates of the lower chord members (L10/L11W and L11/L12W) remained attached to each other through intact portions of the gusset plates at node L11 West (see figure 6). The west side plate of lower chord member L10/L11W was fractured near and adjacent to the west gusset plate for node L11 West. (See Materials Laboratory Report No. 08-004 for additional information on a portion of this fracture.) Fractures in the gusset plates separated the diagonals (U10/L11W and L11/U12W) and the vertical (U11/L11E) from the lower chord members.

### Tension Diagonal U10/L11W

Examination of the gusset plate fracture area between the tension diagonal (U10/L11W) and the lower chord member L10/L11W at node L11 West revealed bending deformation adjacent to the fracture, consistent with fracture under compression or bending loads, and inconsistent with fracture under tensile loads.

- The west gusset plate in the area between the tension diagonal and the lower chord was fractured just above the top row of rivets in the lower chord, consistent with a bending fracture as the west flange of the tension diagonal translated west relative to the lower chord. The fractured gusset plate was bent over the lower end of the west flange of the tension diagonal, as indicated by arrows "1" in figure 7. The west gusset plate was not fractured in the area between the tension diagonal and the vertical member U11/L11W, as shown by arrows "2" in figure 7.
- The east gusset plate in the area between the tension diagonal and the lower chord was fractured at the top of the lower chord. The fractured east gusset plate was peeled from the lower end of the east flange of the tension diagonal, as indicated by arrows "3" in figure 7.

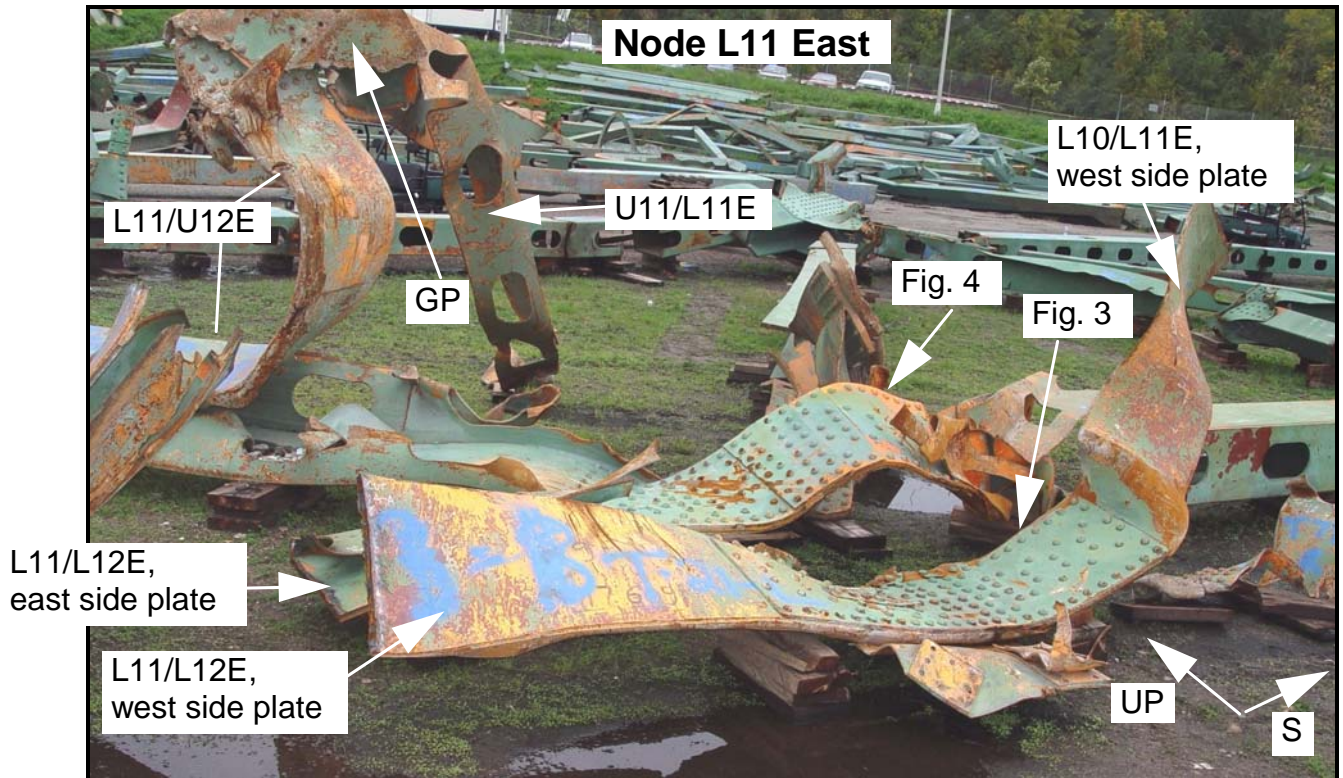
The Structural Investigation Group Chairman Factual Report states that "Diagonal U10/L11W only partially penetrated into the lower chord of the node; the diagonal rotated

CCW (looking east) relative to the node, contacting the upper surface of the lower chord and translating west relative to the node.”

#### Compression Diagonal L11/U12W

Examination of the fractured and deformed gusset plates in areas between the compression diagonal L11/U12W and the lower chord member L11/L12W and between the compression diagonal and vertical member U11/L11W indicated that the lower end of this diagonal translated west relative to the remainder of the node, with the east side plate penetrating through the node and the west side plate passing on the west side of the node. Scrape marks and damage patterns on the lower end of the compression diagonal were consistent with this motion. Figure 8 shows the scraping damage on the west side plate of compression diagonal L11/U12W.

James F. Wildey II  
Supervisory Metallurgist



ImageNo:0803A00068, Project No:2008020014

Figure 1. Overall view at Bohemian Flats showing the side plates of lower chord members L10/L11E and L11/L12E at node L11E. The diagonals and the vertical at this node are also visible. Arrow "GP" indicates a portion of the west gusset plate that was intact between the vertical U11/L11E and the compression diagonal L11/U12E.

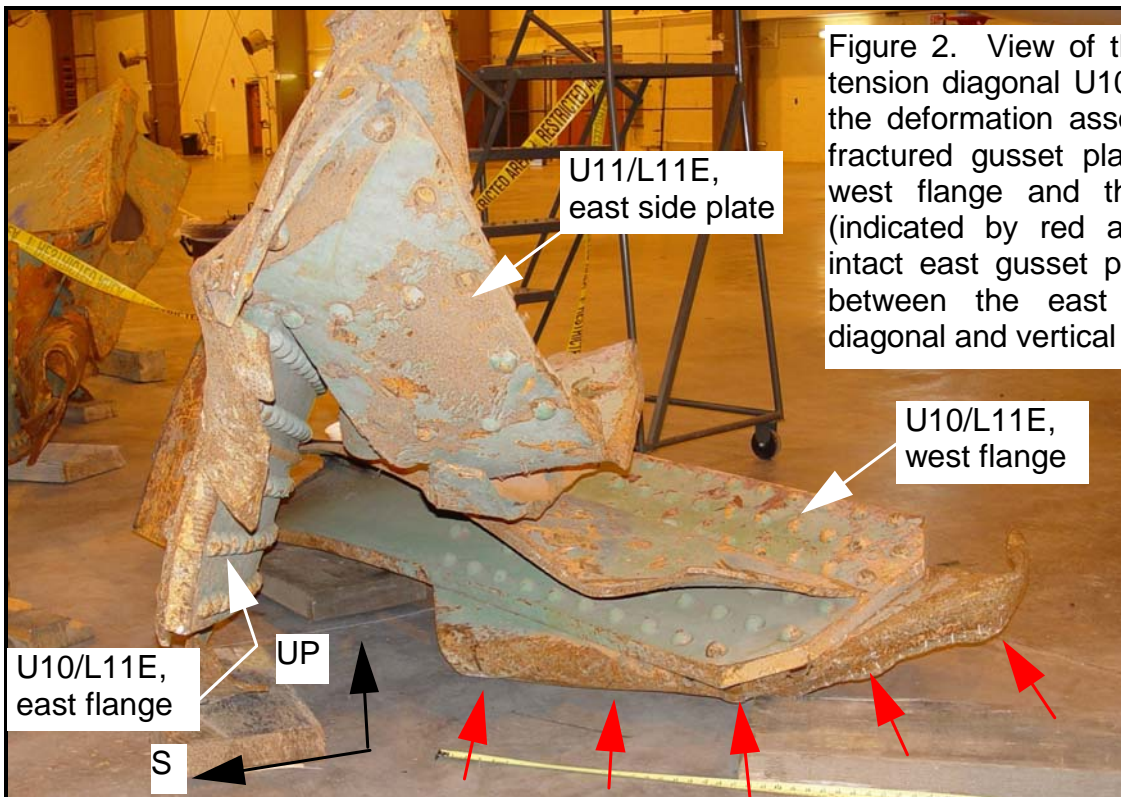
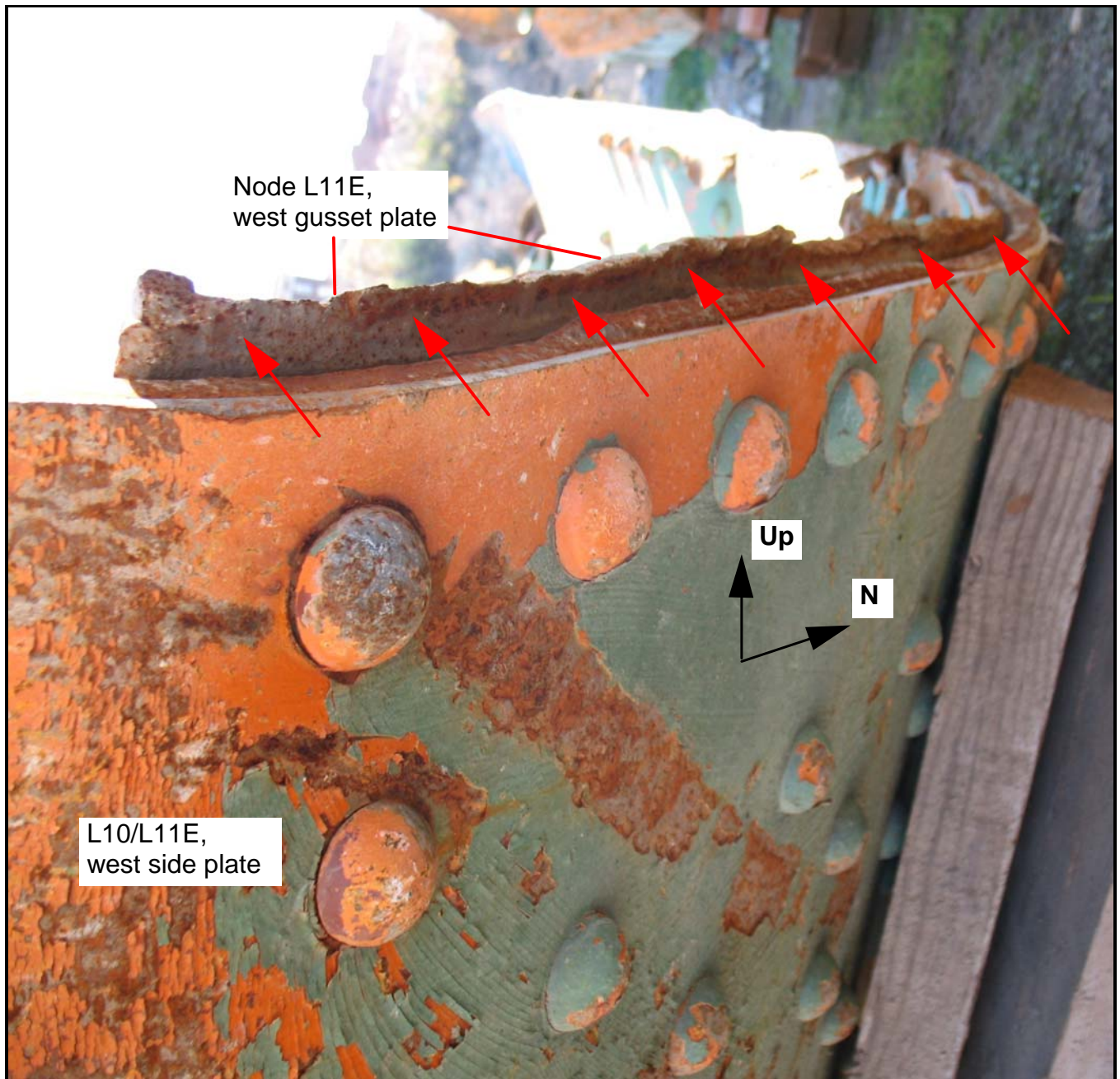


Figure 2. View of the lower end of tension diagonal U10/L11E, showing the deformation associated with the fractured gusset plate between the west flange and the lower chord (indicated by red arrows) and the intact east gusset plate in the area between the east flange of the diagonal and vertical U11/L11E.

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Figure 3. Arrows indicate a line of corrosion in the west gusset plate of node L11E, in the area between the tension diagonal U10/L11E and the lower chord L11/L11E. This area mates with the area indicated by the red arrows in figure 2, and the "Fig. 3" arrow in figure 1 indicates the area shown in this photograph.

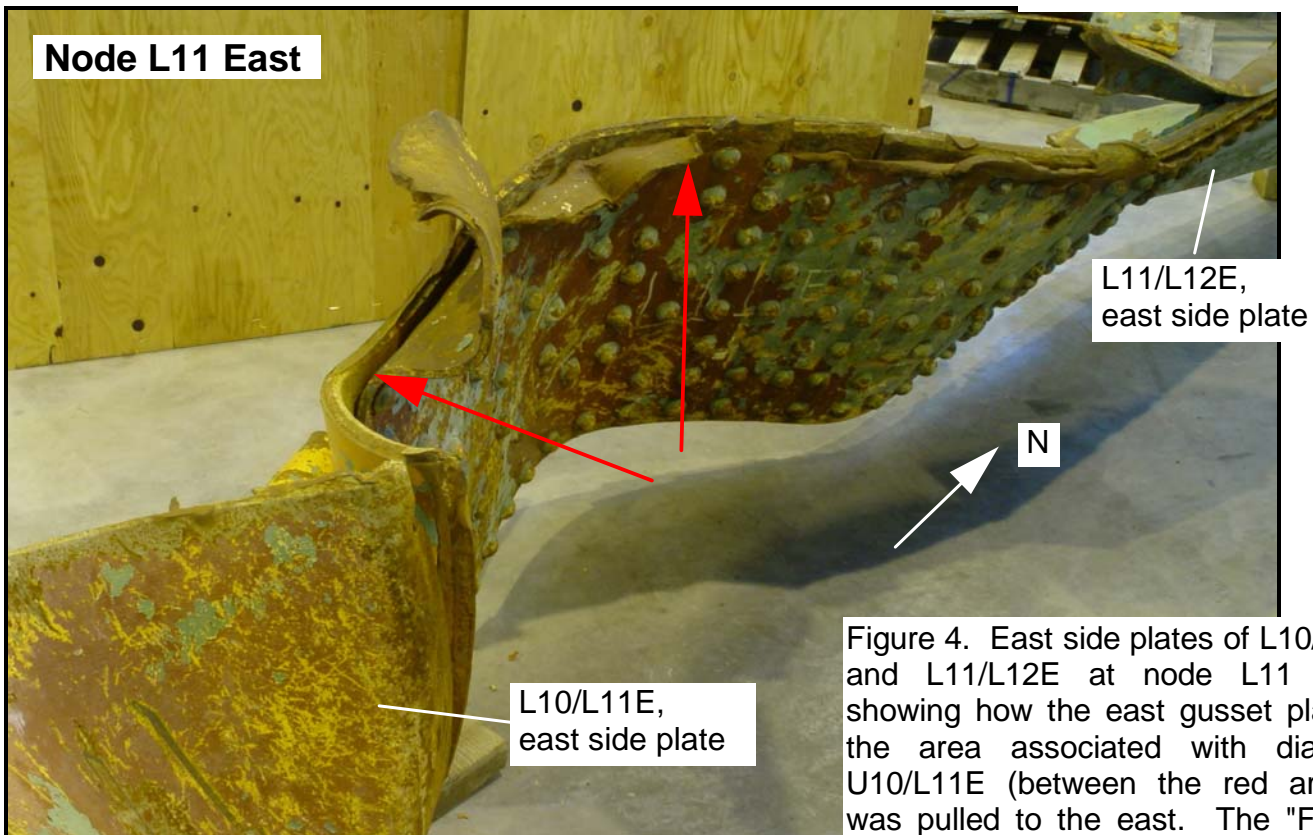


Figure 4. East side plates of L10/L11E and L11/L12E at node L11 East, showing how the east gusset plate in the area associated with diagonal U10/L11E (between the red arrows) was pulled to the east. The "Fig. 4" arrow in figure 1 indicates the direction of viewing in this photograph.

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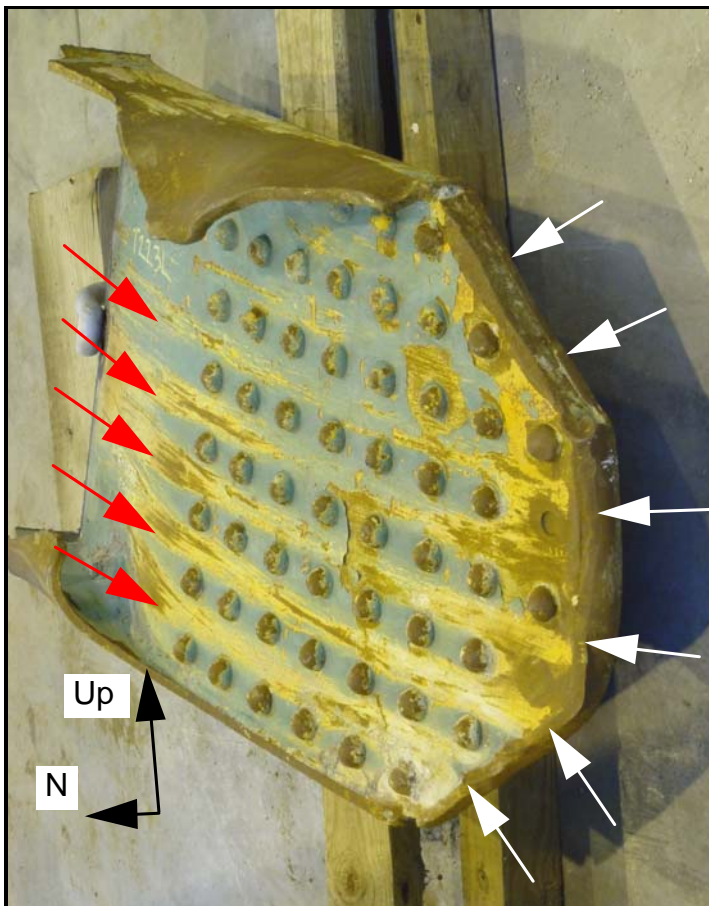


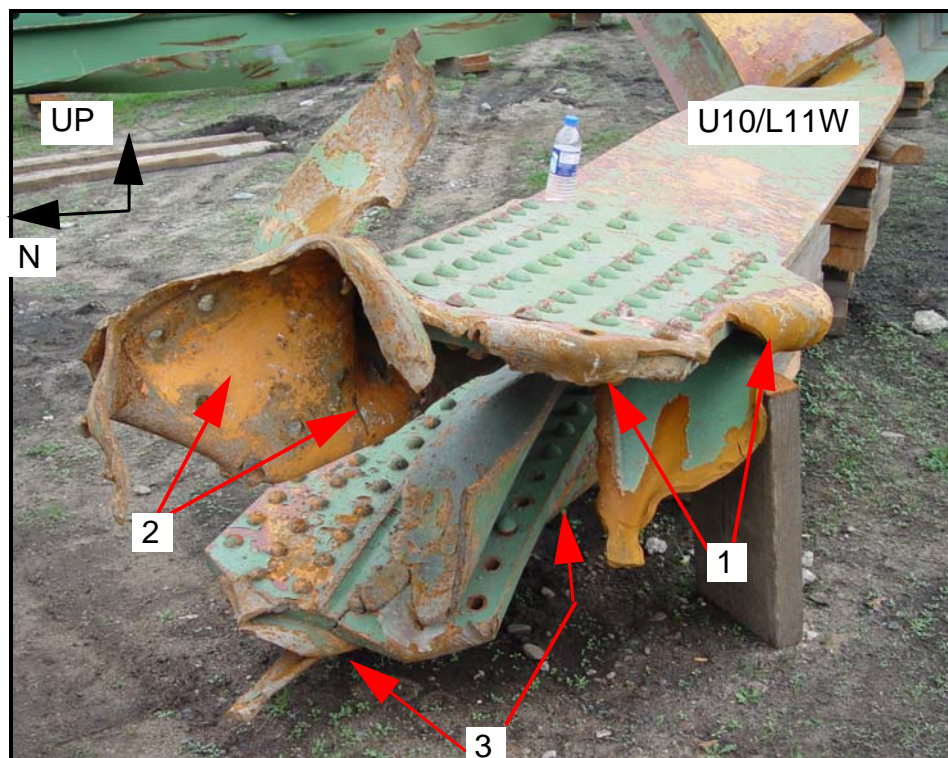
Figure 5. Inside surface of the lower (L11E) end of the east side plate of compression diagonal L11/U12E, showing scraping marks on the inside surface (red arrows) and the east gusset plate folded over the lower end of the side plate (white arrows).

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Figure 6. View of the lower chord members of node L11 West, viewed looking south, with the east gusset plate on top.



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Figure 7. Lower (L11W) end of tension diagonal U10/L11W, with the west flange of the diagonal facing up. View is looking primarily up and slightly east. The folded west gusset plate (arrows "1"), the intact portion of the west gusset plate between the diagonal and the vertical (arrows "2"), and the peeled east gusset plate (arrows "3") are visible.



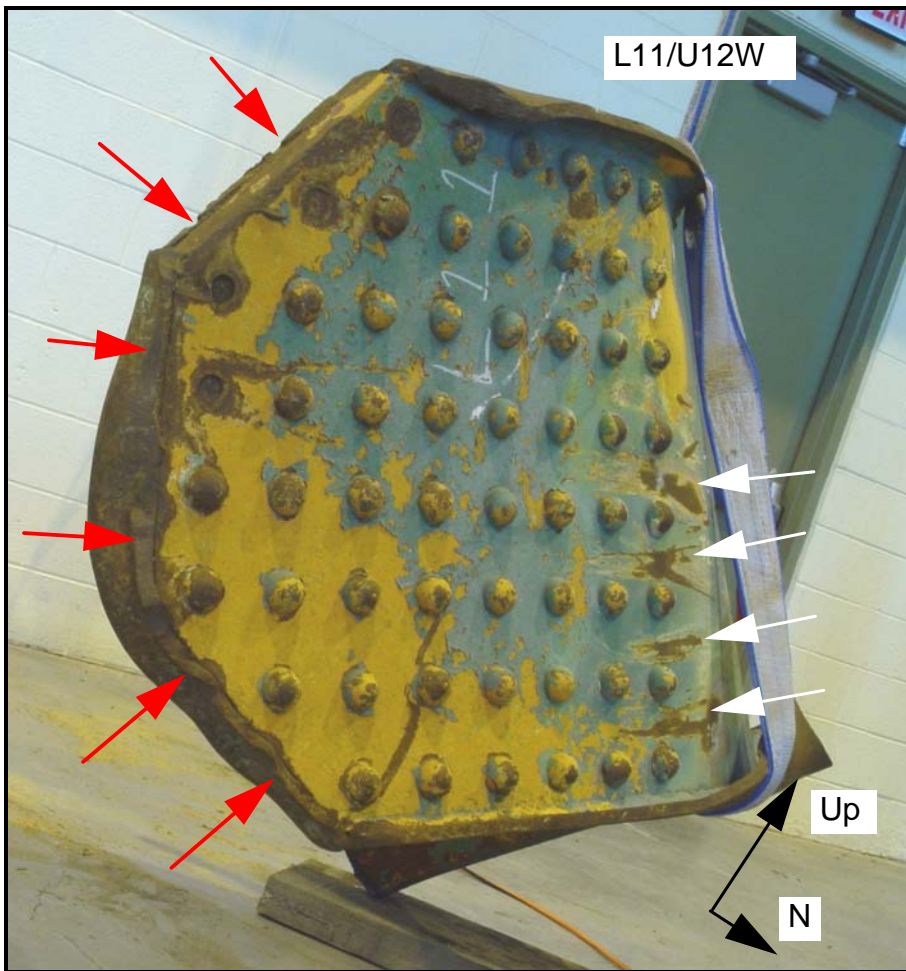


Figure 8. Inside surface of the lower (L11W) end of the west side plate of compression diagonal L11/U12W, showing scraping marks on the inside surface (white arrows) and the west gusset plate folded over the lower end of the side plate (red arrows).

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