Gusset Plate Retrofit in Illinois

Jayme F. Schiff, P.E., S.E.
Repair Plans Unit Chief
Illinois Department of Transportation

October, 2010

Illinois DOT's *"Guidelines for Rating Gusset Plates by the Load Factor Method"*

- Maximum envelope live load forces may be used to determine the ratings. Where ratings are found to be deficient, they should be recalculated with concurrent live load forces. (Concurrent forces available with Virtis software.)
- Typically an effective length factor, K, of 1.2 shall be used.
- A shear reduction factor, omega (Ω), of 0.74 shall be used.
- Developed splice plates may carry a portion of the forces at a joint.

IDOT's Guidelines (cont'd):

- If there is any recorded corrosion, raters should account for the greater of:
  - the actual section loss based on inspection data
  - 10% assumed section loss.
- The Load Factor capacity need not be reduced by 10% to increase the margin of safety on non-redundant structures.

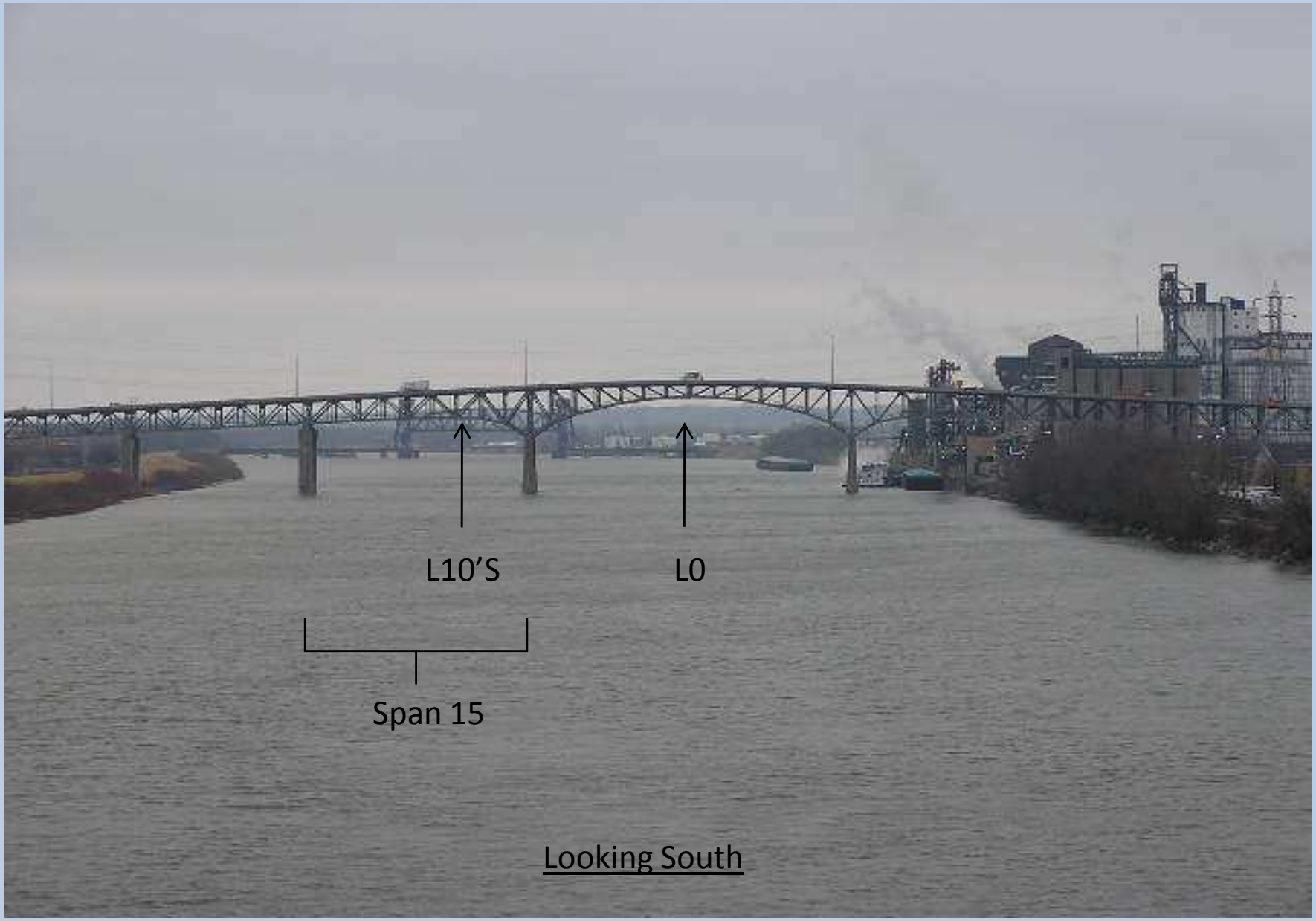
IDOT's Guidelines (cont'd):

- Generally, half the loads shall be distributed to the inside gusset plate and half to the outside gusset plate. Where the resulting ratings at a node are deficient, loads may be proportionally distributed between the inside and outside gussets based on the remaining thickness of each original plate. IDOT recommends that no more than 30% of the load on one side be redistributed to the other side. This would result in a maximum of 65% of the total load going to one gusset and the remaining 35% of the total load going to the other gusset.
- This limit does not apply to an asymmetric retrofit.

Current Gusset Plate Retrofit Project:

- Cedar Street Truss Bridge in Peoria, Illinois. Built in 1932. Carries four lanes of traffic.
- 7 simple span deck truss units and one 3 span haunched cantilever deck truss unit.
- Structure was inspected in 2009 and gusset plate deterioration was found.
- Bridge has been posted for 15 tons due to the significant deterioration at two nodes. The current project will strengthen the gussets at the two nodes (and one floorbeam) so the posting can be removed. A much larger project is expected to follow, to strengthen many more gusset plates.

Cedar Street Truss Bridge (Built in 1932):



Field Inspection Photos at one node - Span 15 L10'S:

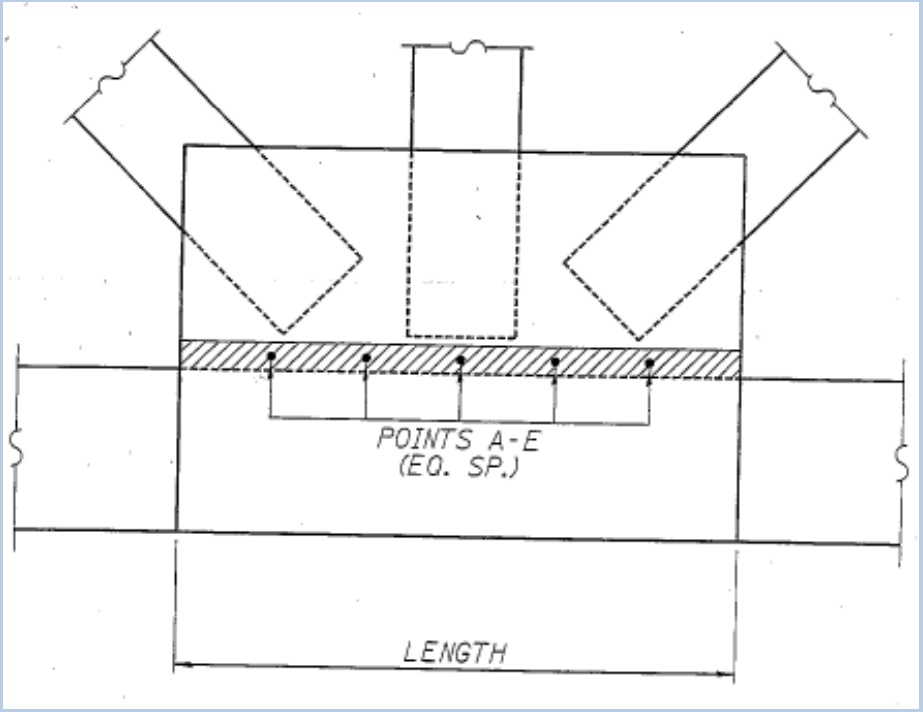
(on bottom chord of anchor span)

Outside Gusset Plate

Inside Gusset Plate

Field Inspection Data at Span 15 L10'S:

Plate	Gusset Nominal (in)	Plate Length (in)	Thickness Remaining A (in)	B (in)	C (in)	D (in)	E (in)	Average Thickness (in)	Average Sec. Loss (%)	Area Remaining (in^2)
SP 15 - L10'S (OP)	0.625	86.00	0.48	0.40	0.58	0.39	0.43	0.46	27.04%	39.22
SP 15 - L10'S (IP)	0.625	86.00	0.45	0.50	0.31	0.30	0.47	0.41	35.04%	34.92



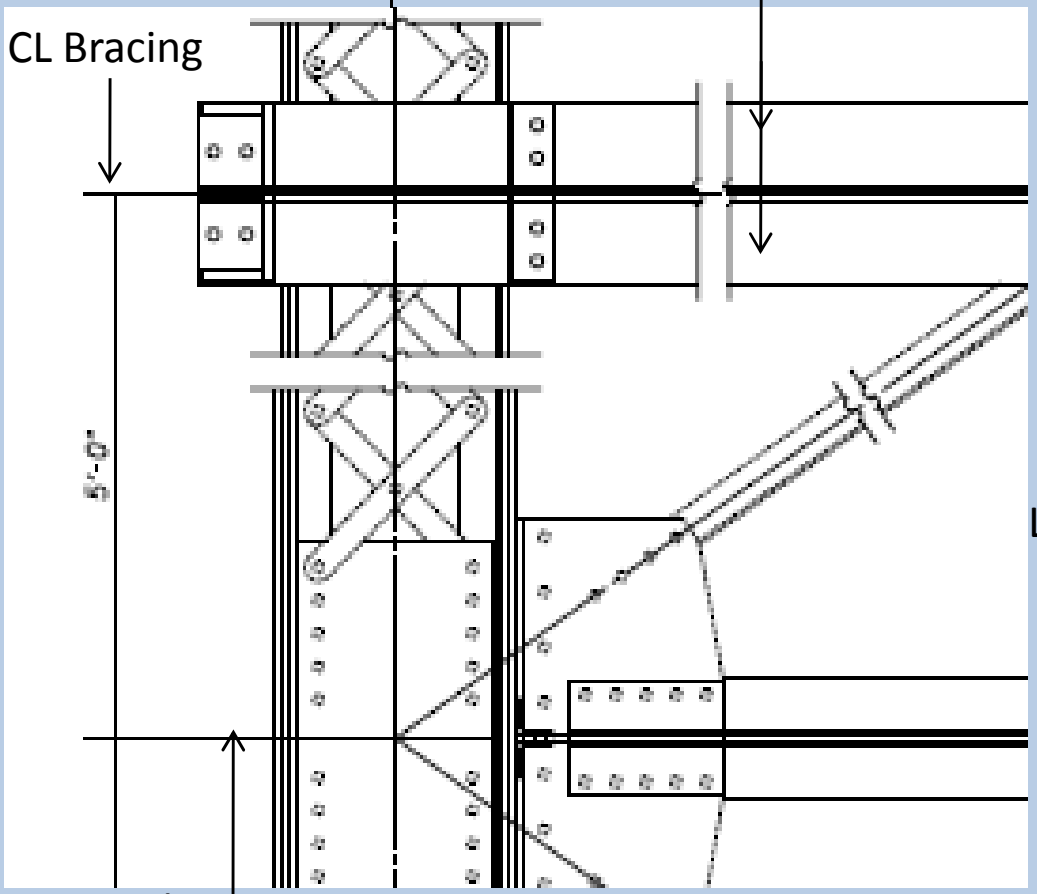
SECTION LOSS

Gusset Plate Elevation

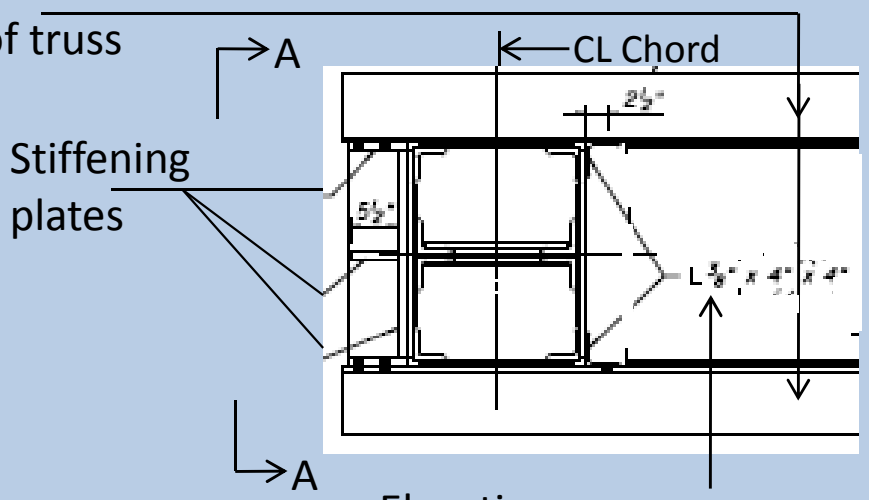
Evaluation:

- Raters used the 2009 FHWA Guidance and IDOT's Guidelines along with the field inspection data to determine the remaining capacity of the gusset plates according to the Load Factor method.
- Gusset plates with deficient ratings needed to be retrofitted.
- Retrofit method chosen: Add new gusset plates and keep the existing gusset plates.
- Plans were developed by WHKS & Co. (Scott Sanford and Chad Hodel).
- Technical support from Dr. John Fisher, Dr. Karl Frank, and Dr. Rob Connor.

Temporary Lateral Bracing System at Span 15 L10'S:

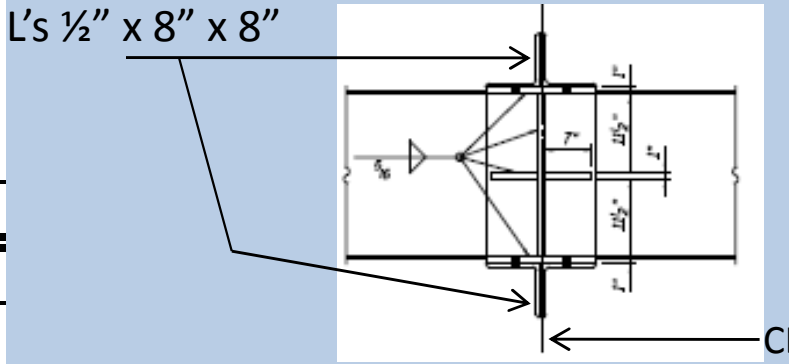


Plan



Elevation

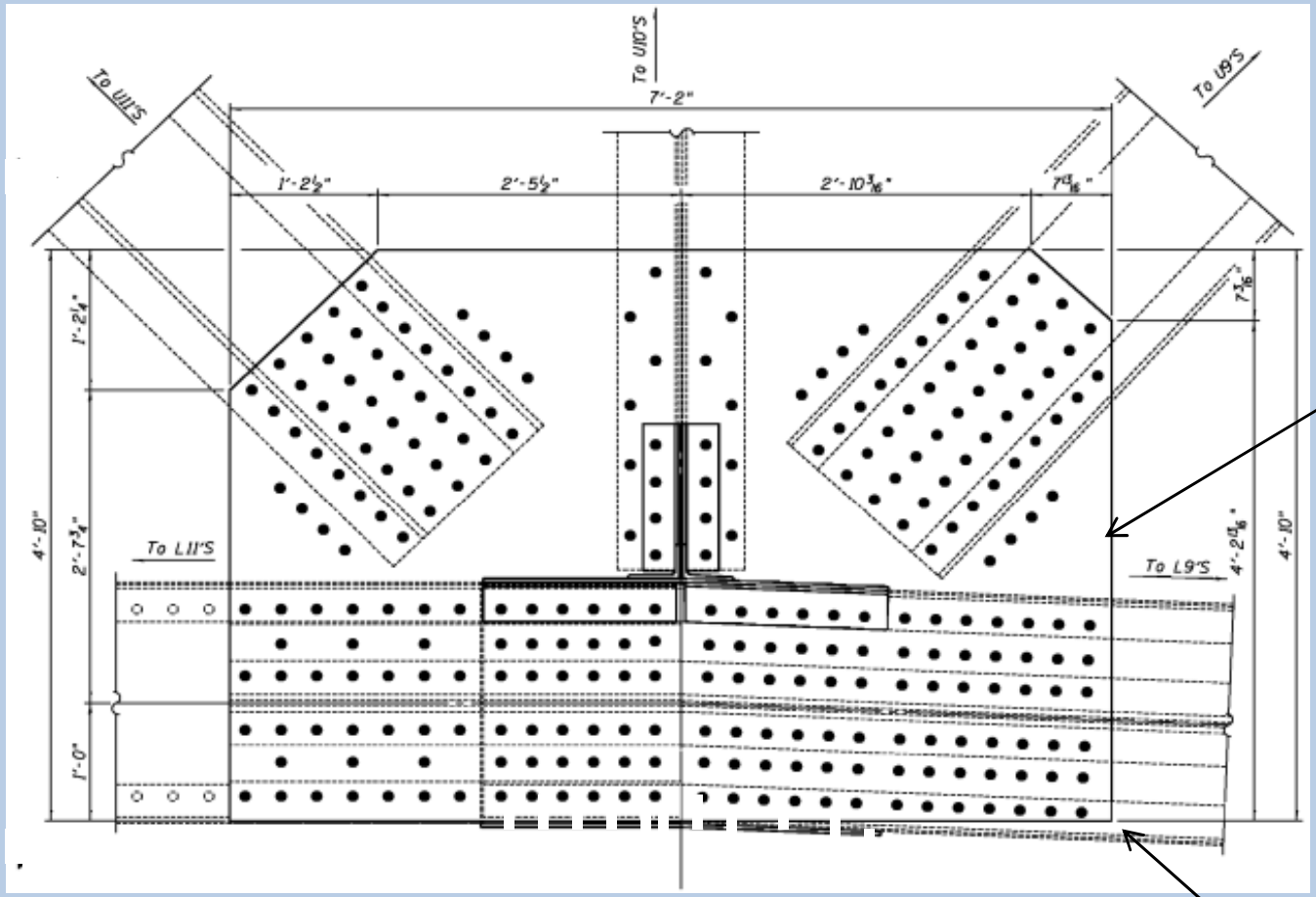
Stiffening L's



Section A-A

Note: Full system for this node includes two sets of lateral bracing – one on each side of the node. Each set runs from out-to-out of the truss. Also strengthened a diagonal brace. The dead load force in the bottom chord is 975 k.

Proposed Retrofit at Span 15 L10'S:



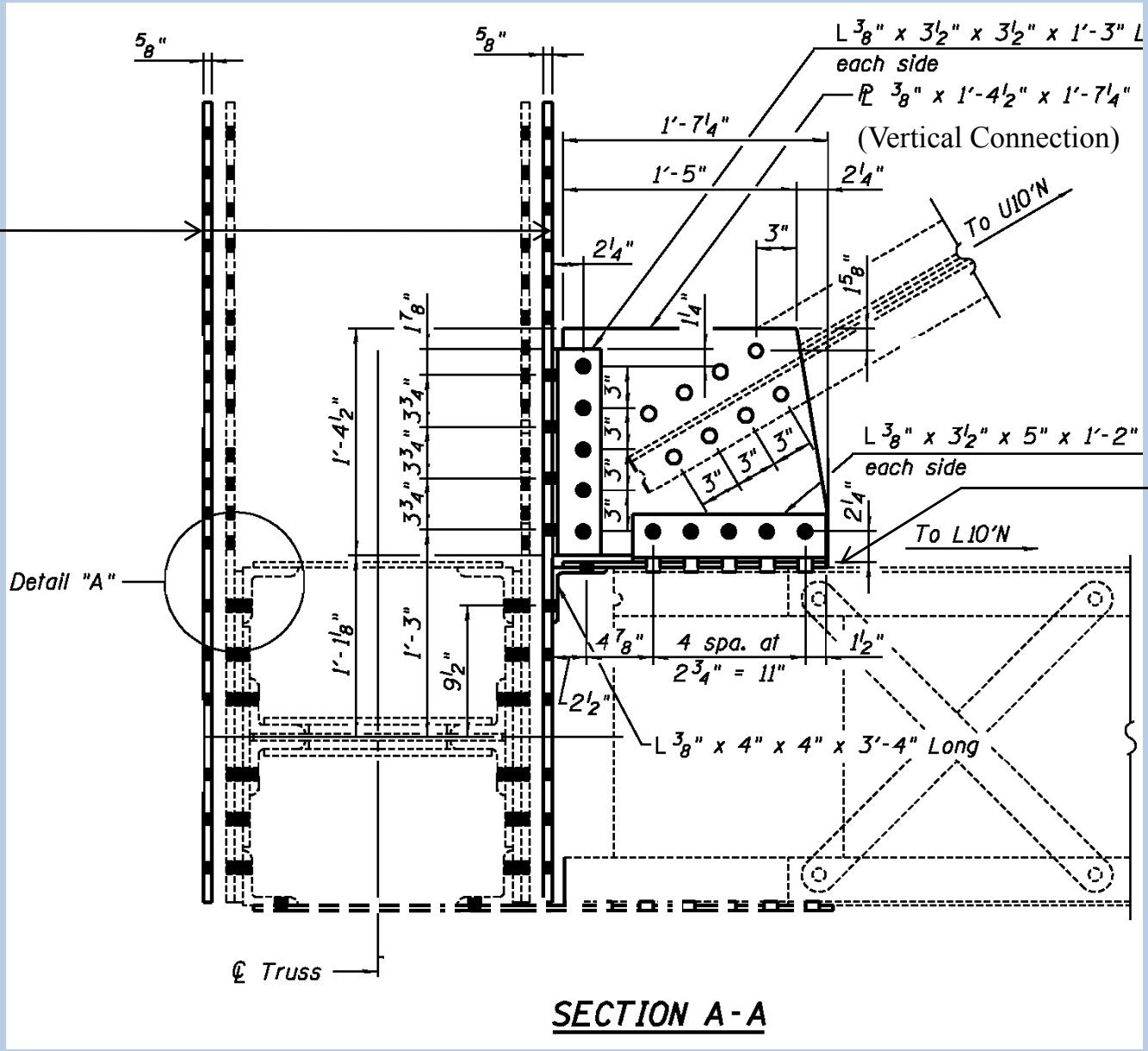
New Vertical Gusset PL 5/8" x 4' - 10" x 7' – 2" (FCM) (Weight = 884 lbs)

Bottom chord (in compression for dead load)

Inside Gusset Plate Elevation (Outside Gusset Plate – similar)

Proposed Retrofit at Span 15 L10'S (cont'd):

New Outside and Inside Vertical Gusset PLs 5/8"
x 4' - 10"
x 7' – 2"
(FCM)



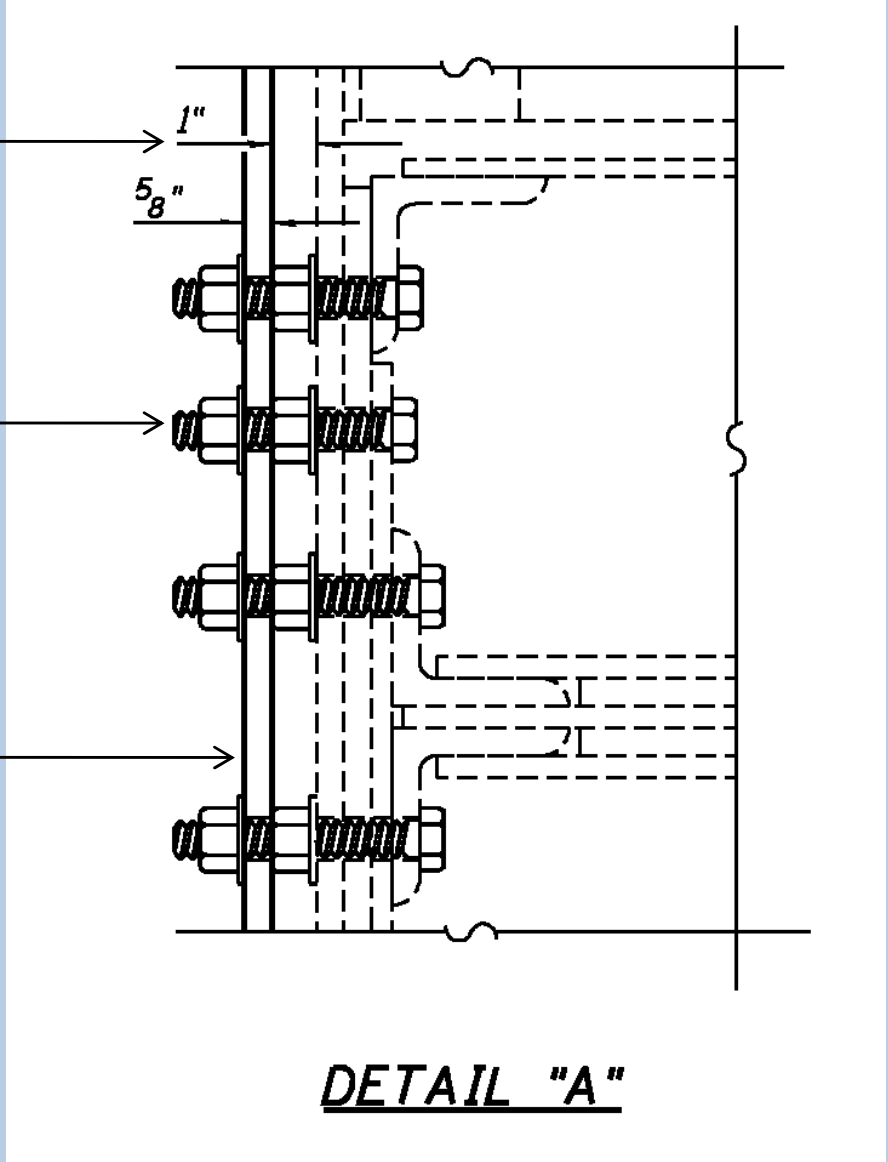
Horizontal Connection
PL 3/8" x 3' - 4"
x 1'- 4 1/4"

Proposed Retrofit at Span 15 L10'S (cont'd):

1" Gap between existing and new gusset plates for one washer and one nut.

15/16" Ø Hole for New 7/8" Ø H.S. Bolt with two washers and two nuts fully tightened.

New 5/8" Gusset Plate (FCM)



Construction Sequence:

- No live load allowed on bridge during retrofit work.
- Strengthen an existing diagonal brace and install Temporary Lateral Bracing System.
- Adjacent to the deteriorated inside gusset plates, remove the connection plates and angles for the existing lateral bracing system. Cut back the existing lateral bracing members that will interfere with the retrofit work.
- Remove the existing gusset plate rivets and replace with bolts. Install first washer and nut on each new gusset plate bolt and fully tighten.

Construction Sequence (cont'd):

- Place new gusset plates, connection plates and connection angles.
- Install second washer and nut on each new gusset plate bolt and fully tighten.
- Reconnect the lateral bracing members.
- Remove the Temporary Lateral Bracing System.
- Since two nuts will be tightened on each bolt, there was concern about which bolt length to use for determining the required amount of rotation for each nut based on the Turn-of-Nut method. The appropriate bolt lengths to use for each nut are provided in the contract plans.

Questions?

IDOT's Guidelines were issued in a memo to all bridge designers (ABD 10.2). Copies may be downloaded at:

http://www.dot.il.gov/bridges/ABD102.pdf