Creative Approaches to Truss Analysis Using BrR

2016 AASHTO RADBUG Meeting

August 2-3, 2016

Chicago, IL

George Huang, PhD, PE

California Department of Transportation

Introduction

- In California, permit trucks were always rated with the adjacent lane of HS20 load for truss bridges. We only started to use BrR regularly for truss bridge three years ago after this function was added.
- In BrR, only axial load members can be used for the truss model.
- The truss spans and non truss spans are modeled separately.
- Relation between different truss points can be connected only with truss member.

Introduction (Cont.)

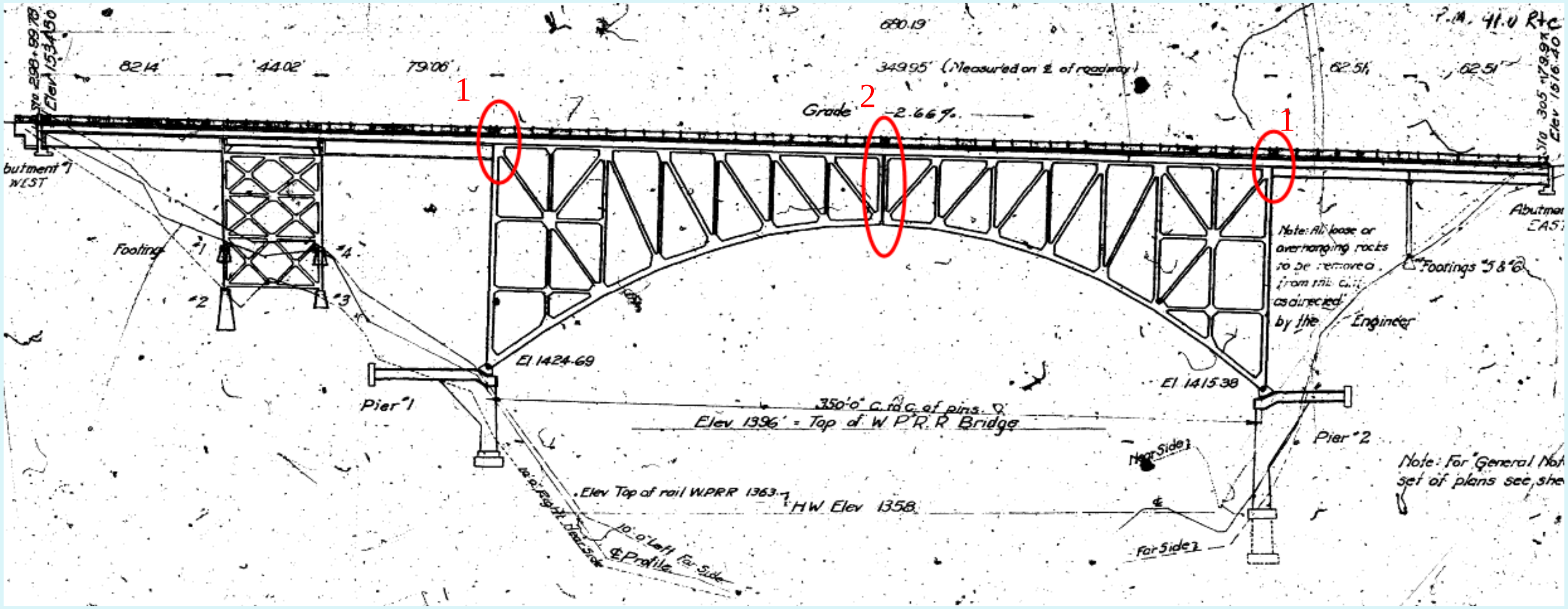
- Features from some truss bridges may seem beyond the application limits of BrR:
  - (1) Girders of non-truss span rested on members of truss span.
  - (2) Two vertical members connected at one joint.
  - (3) Members connected with pins and hanger.
  - (4) Members taking shear load.
- This presentation will show examples of how to handle these special features with BrR.

Case 1: North Feather River Bridge

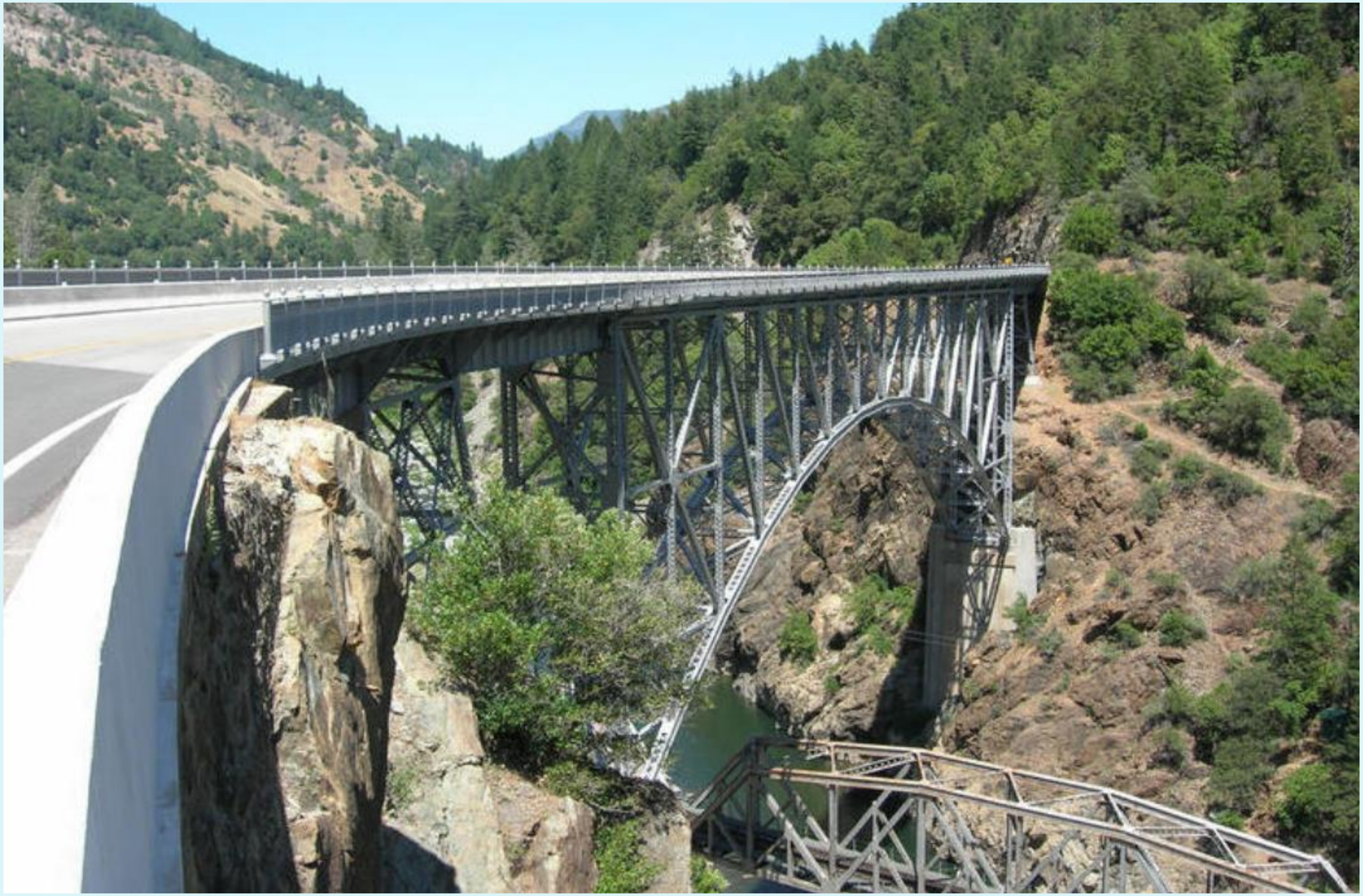
(Br. No.12 0038)

- Built in 1932 and strengthened in 2006.
- One deck truss span (350 ft) with concrete deck on stringers and floor beams.
- Five simple approach spans (44 to 82 ft) with concrete deck on floor beams and two main girders.
- Girders of the approach spans are directly connected to the truss members.
- There is an open expansion joint at the middle of truss span.

Case 1: North Feather River Bridge



Case 1: North Feather River Bridge



Case 1: North Feather River Bridge

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Truss Span: open joint at middle span

Case 1: North Feather River Bridge

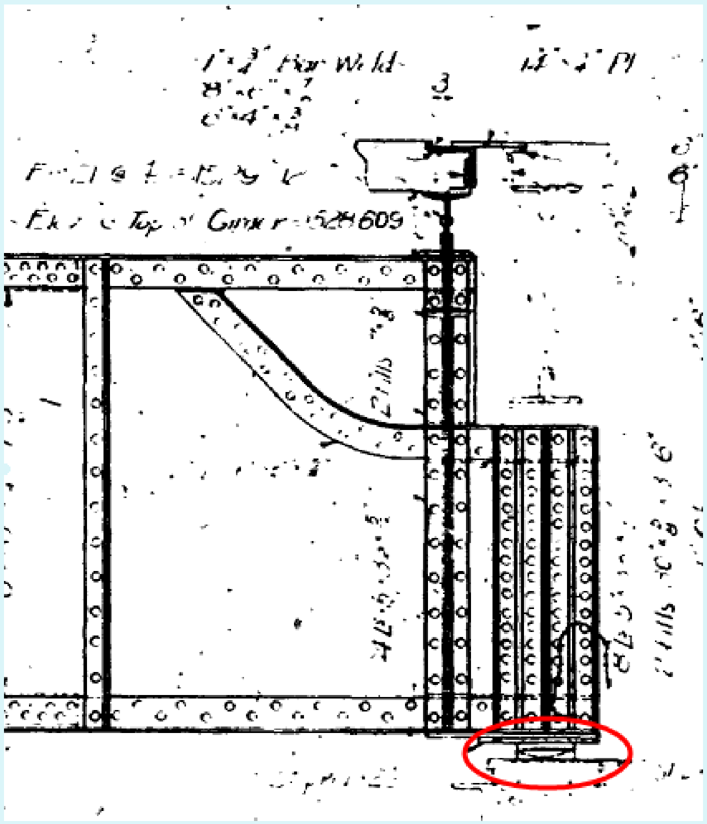
Approach span rested on truss span

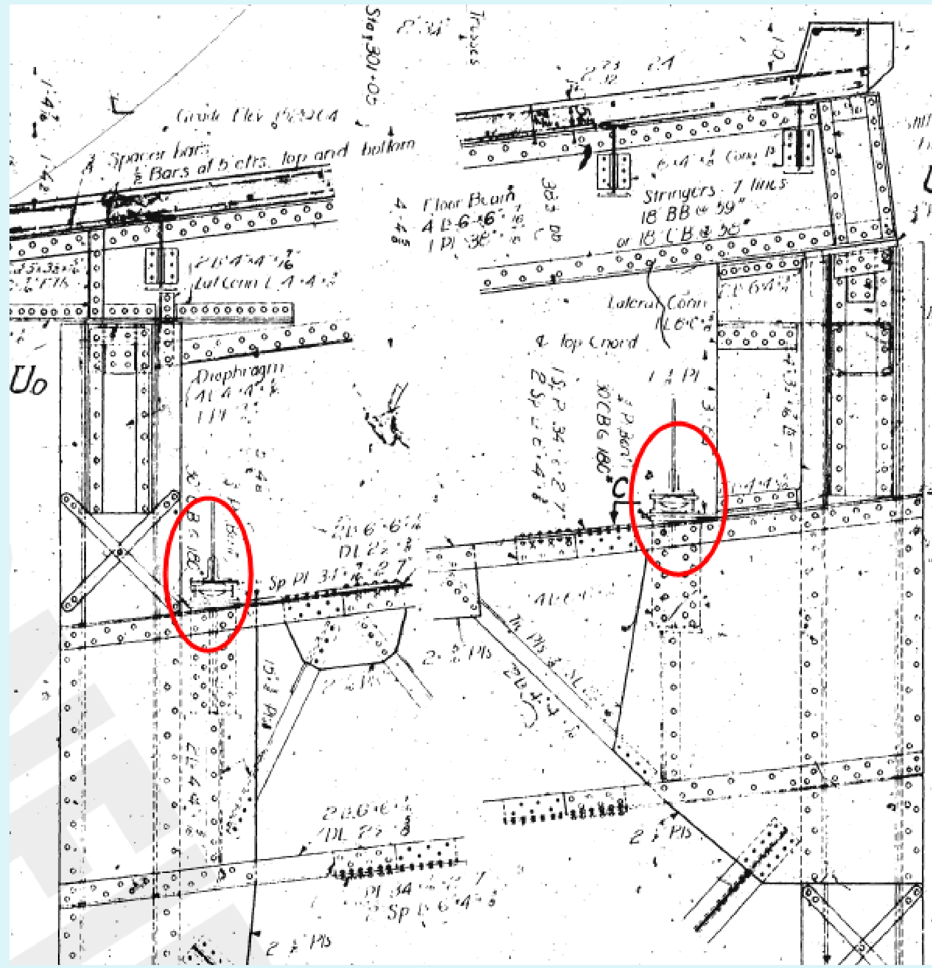
Case 1: North Feather River Bridge

Approach span

Case 1: North Feather River Bridge

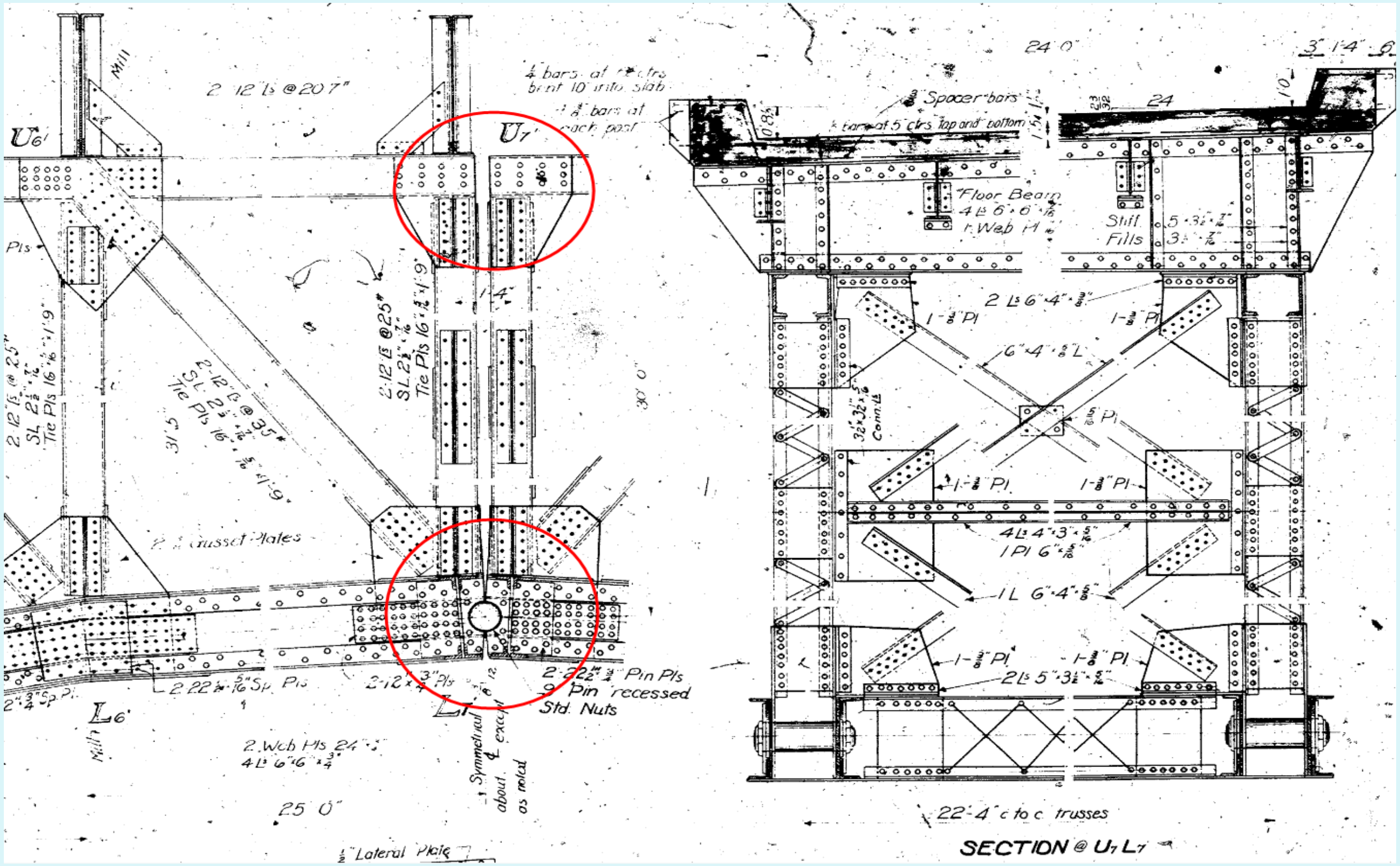
Approach span girders rested on the truss span





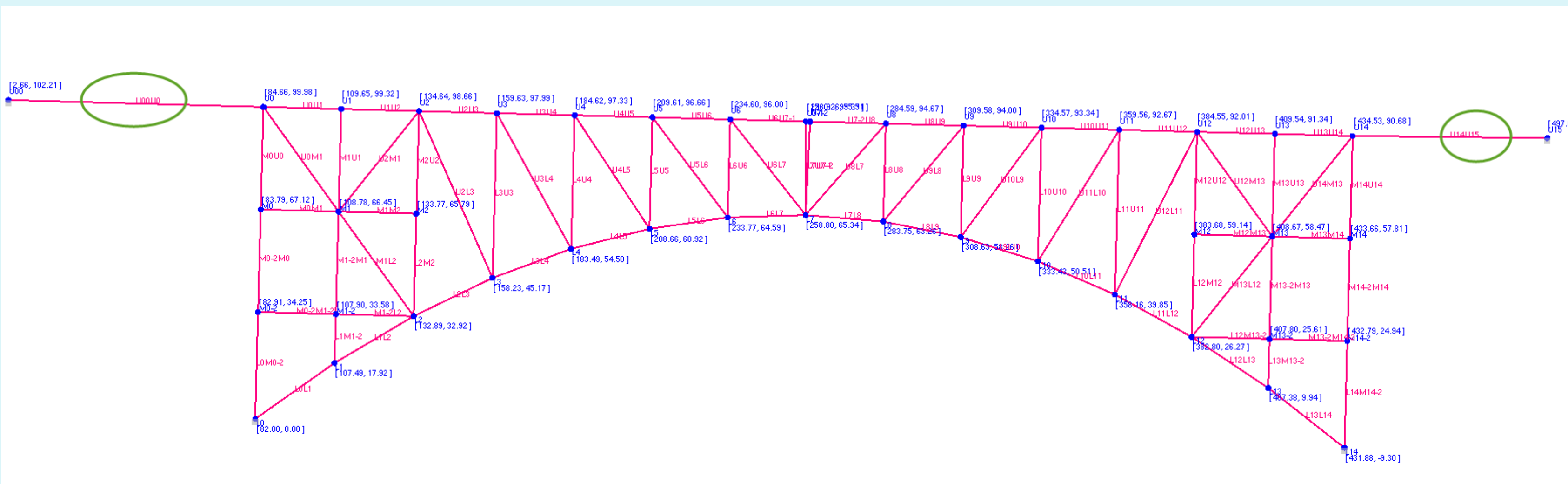
Case 1: North Feather River Bridge

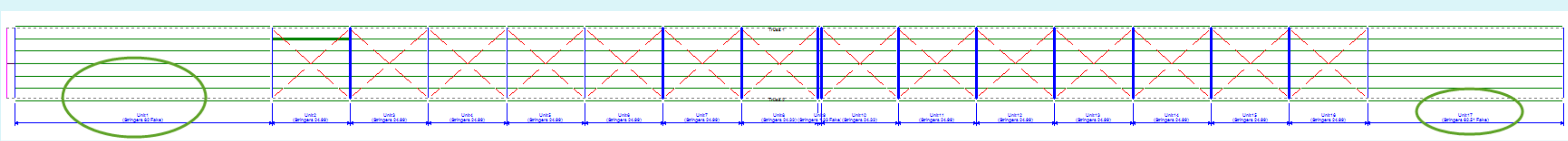
Two vertical members at the middle joint



Case 1: North Feather River Bridge

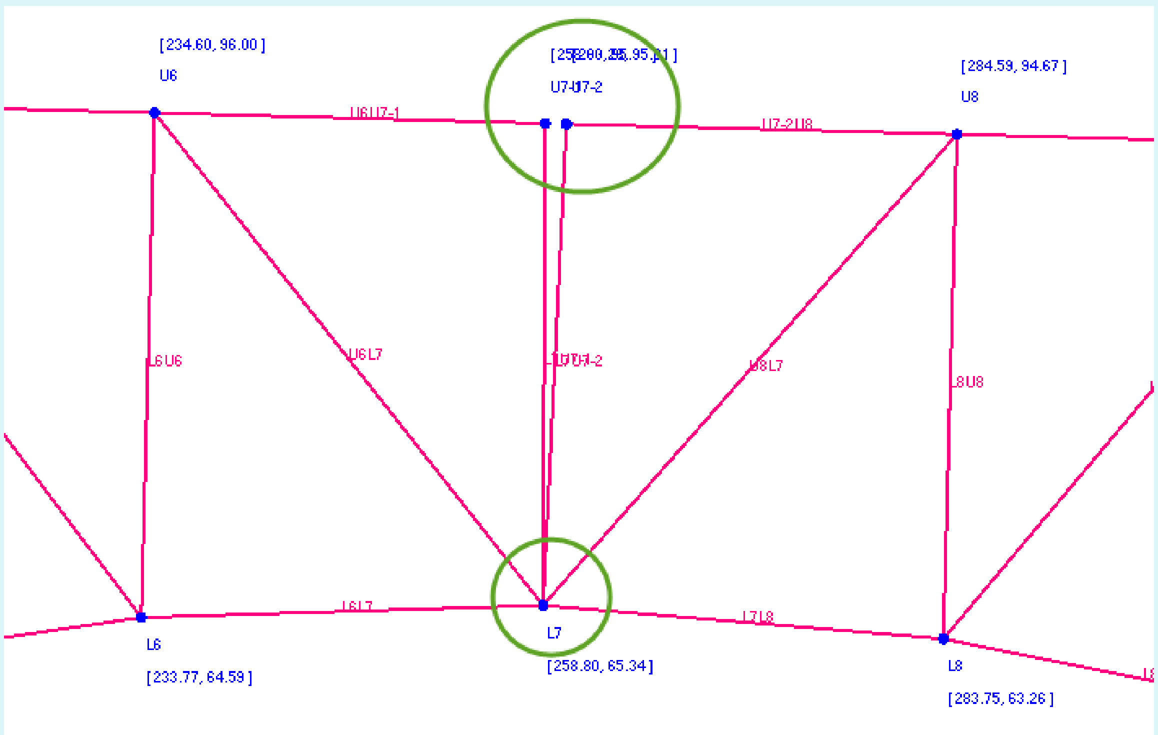
- Fake truss for the approach span connection details





Case 1: North Feather River Bridge

- Use one bottom chord joint for both vertical members at middle joint



Case 1: North Feather River Bridge

- Fake approach truss spans used to get the correct dead and live loads on truss span.
- The dead load from the fake approach span should match the actual span weight.
- Different in-plane and out-of-plane supporting lengths used considering the transverse bracing members.

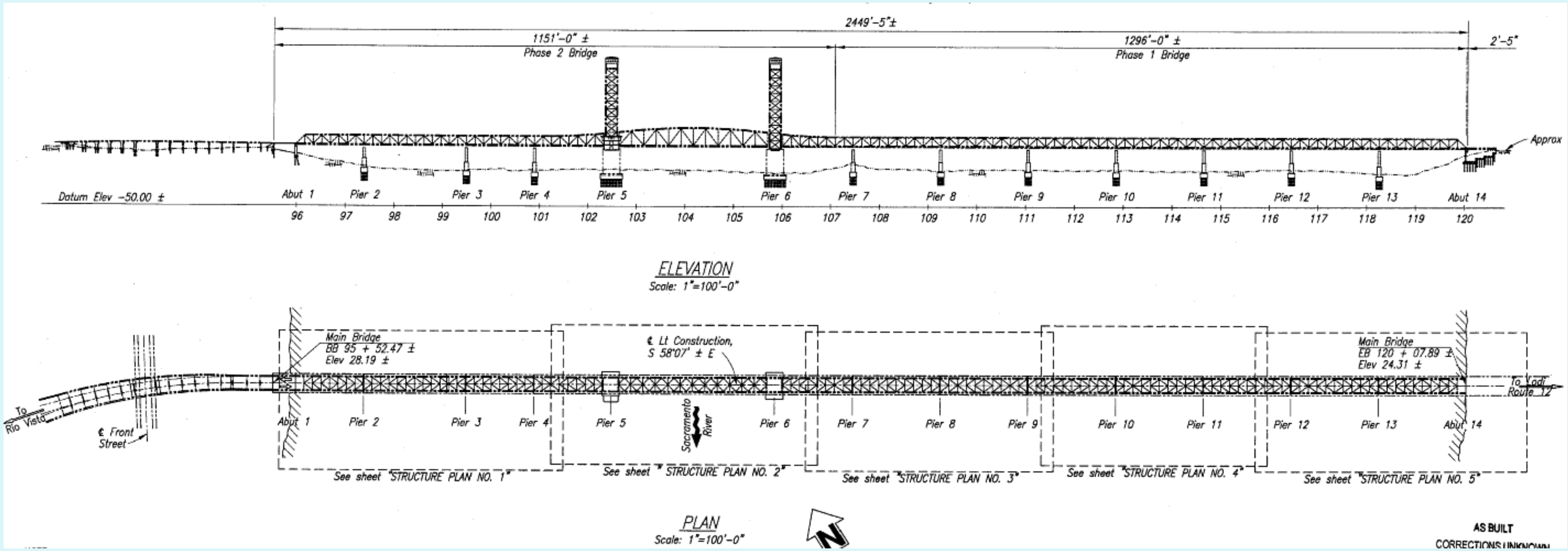
Case 2: Sacramento River Bridge

(at Rio Vista, Br. No.23 0024)

- Built in 1944 and partially replaced and extended in 1958.
- 17 RC slab approach spans (20 to 45 ft).
- Continuous through truss for Span 1 to 4 and 6 to 13 (140 to 210 ft)
- Through truss of lift span for Span 5 (306 ft),
- Expansion joints with hangers used for the continuous truss spans.

Case 2: Sacramento River Bridge

Bridge Layout



Case 2: Sacramento River Bridge

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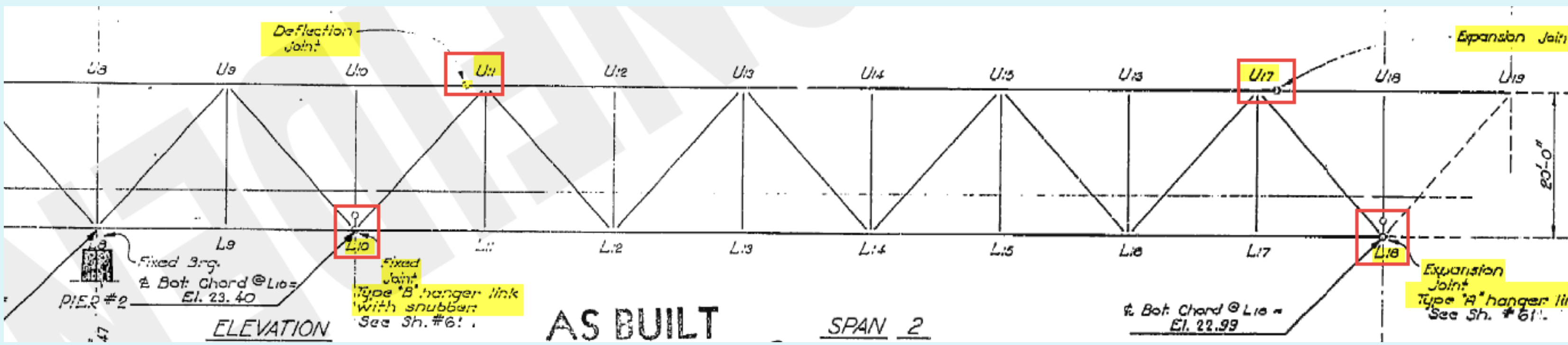
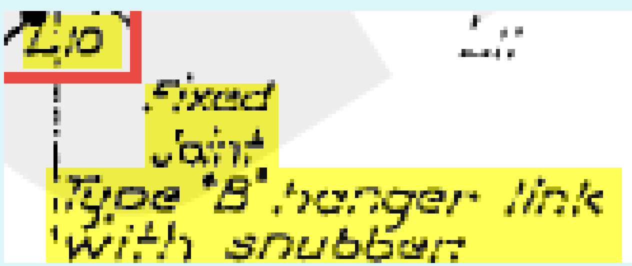
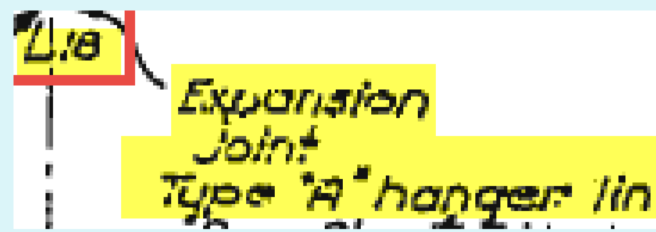
Special Joints at Truss Span2

Deflection Joint

Expansion Joint

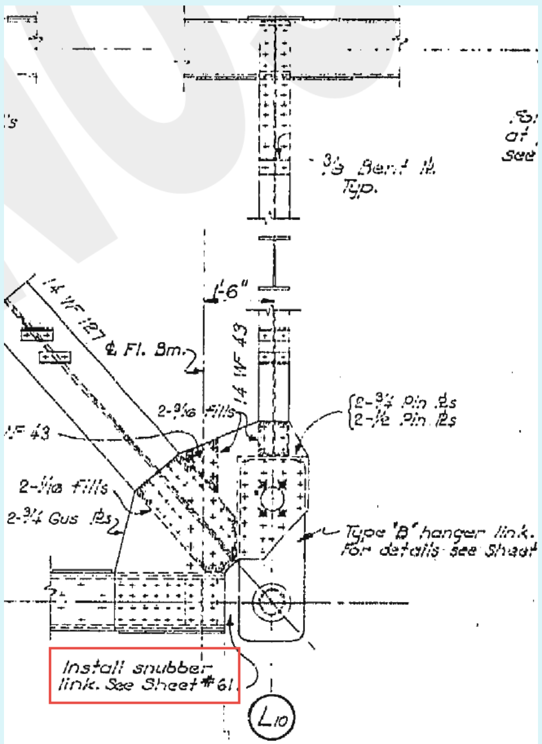


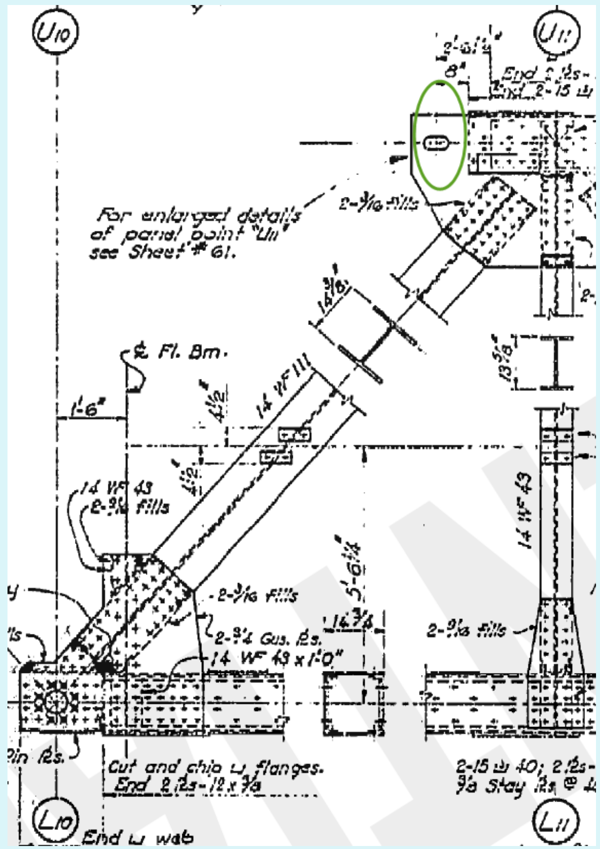


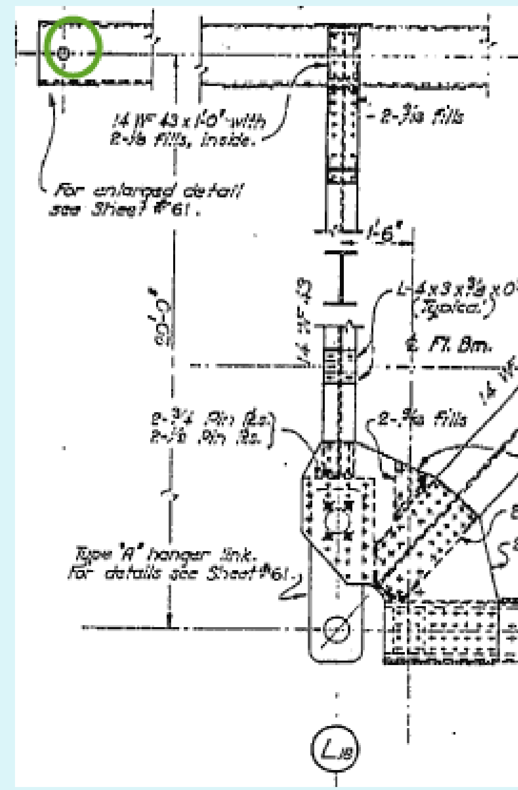


Case 2: Sacramento River Bridge

Joint Details at L10, U11, L18 and U17

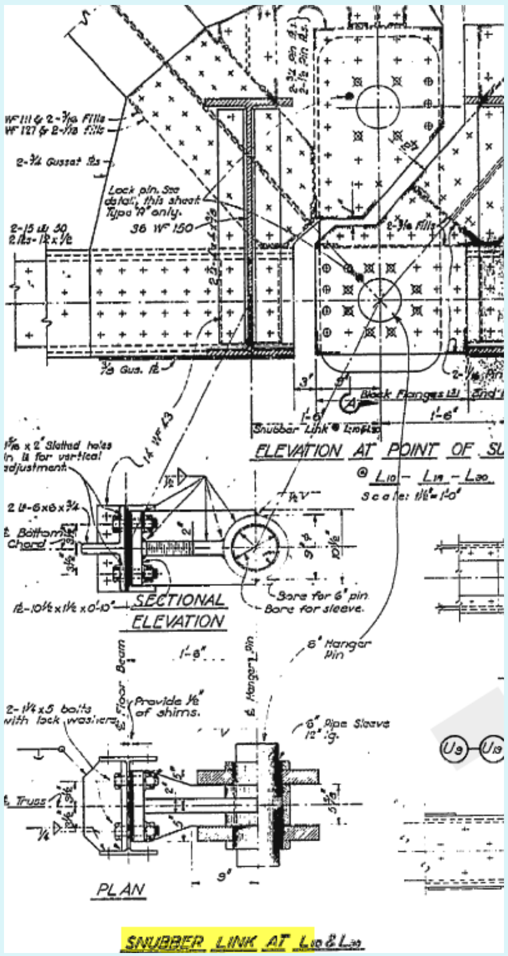




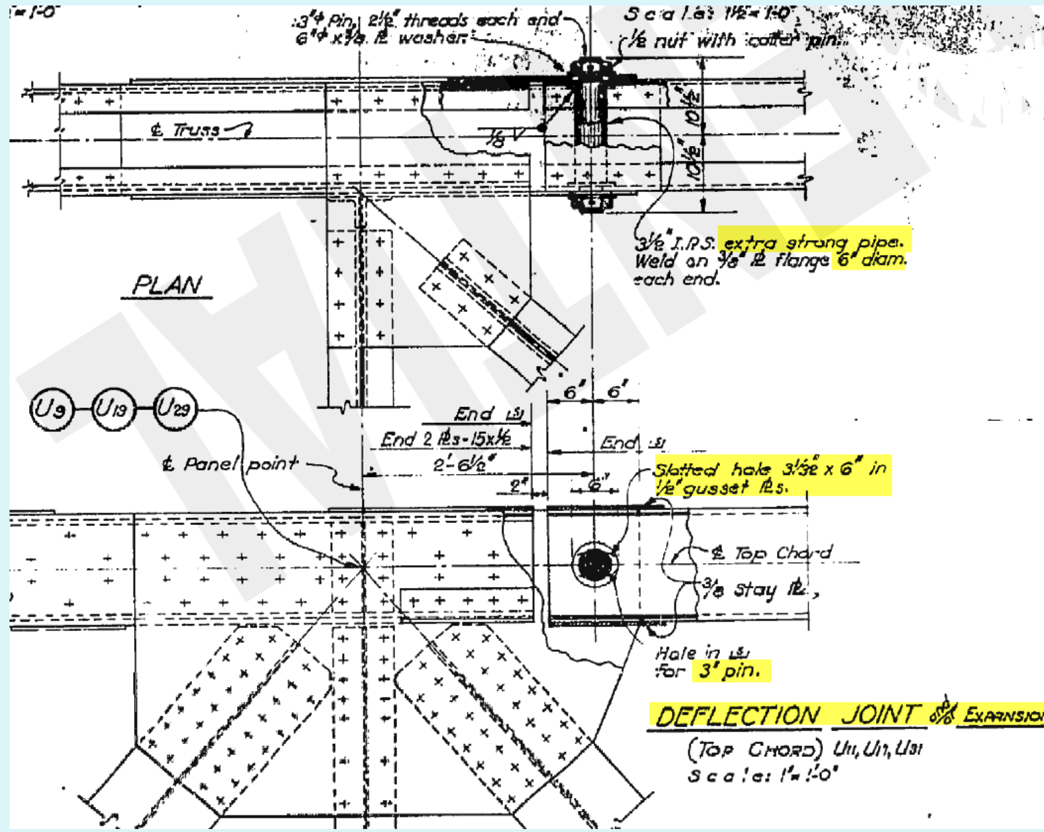


Case 2: Sacramento River Bridge

Joint Details at L10



Joint Details at U11 and U17

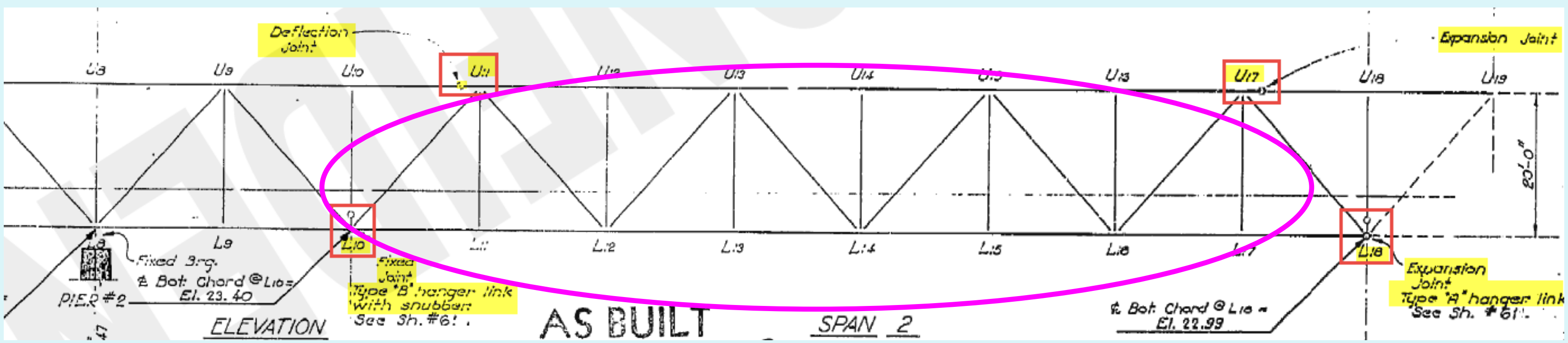


Case 2: Sacramento River Bridge

Expansion Joint at U11

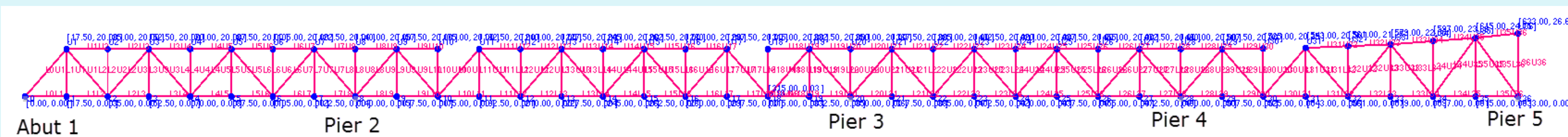
Case 2: Sacramento River Bridge

Truss L10, U11 to U17, L18 seems like a dropped span during the construction, with pinned support at L10 and roller support at L18.

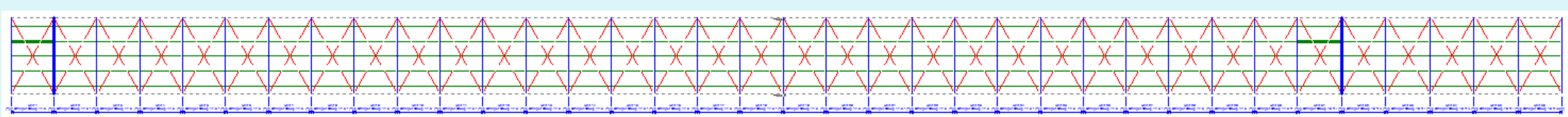


Case 2: Sacramento River Bridge

BrR Model for Truss Approach



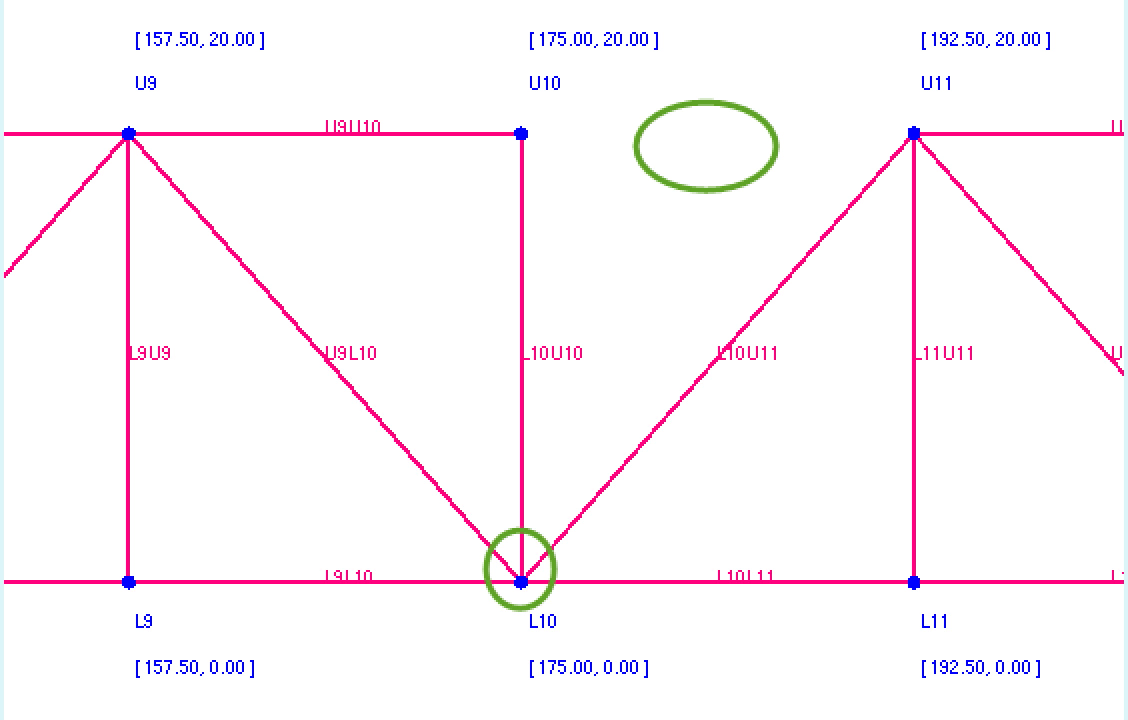
Truss Layout



Framing Plan

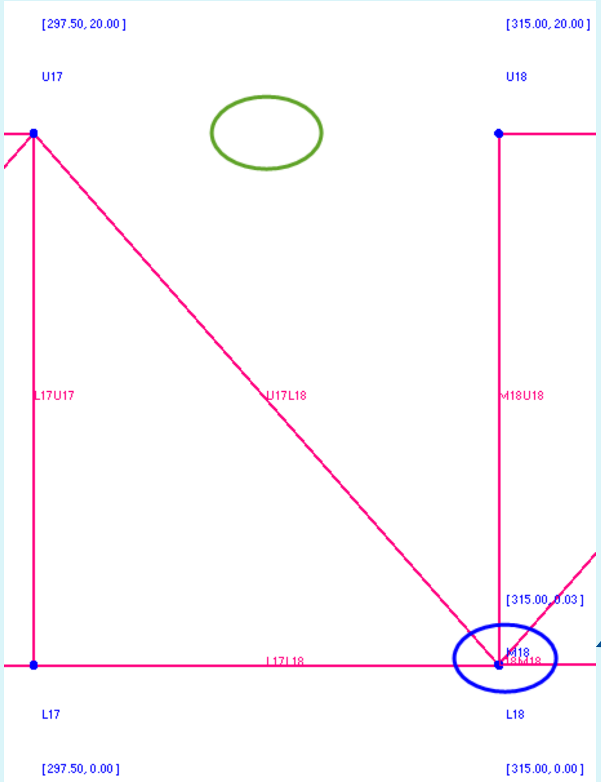
Case 2: Sacramento River Bridge

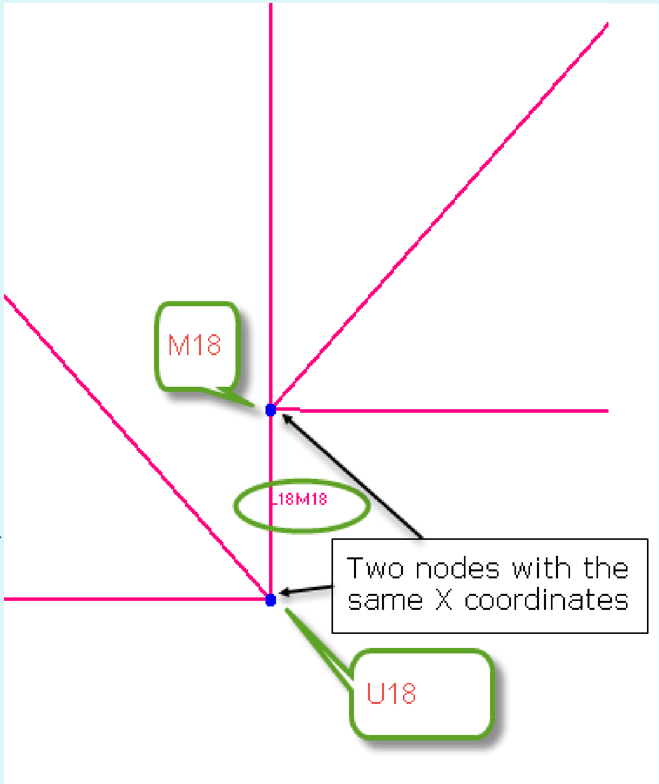
- For join at L10, using single node.
- For the expansion joint near U10, remove top chord U10U11.



Case 2: Sacramento River Bridge

- For joint at U18, add a new node M18 and the vertical member L18M18 (0.03 ft)





Case 2: Sacramento River Bridge

- The results from this BrR model were compared with those from a detailed FEM model with CSiBridge. It was found that the results from both models were very close to each other.

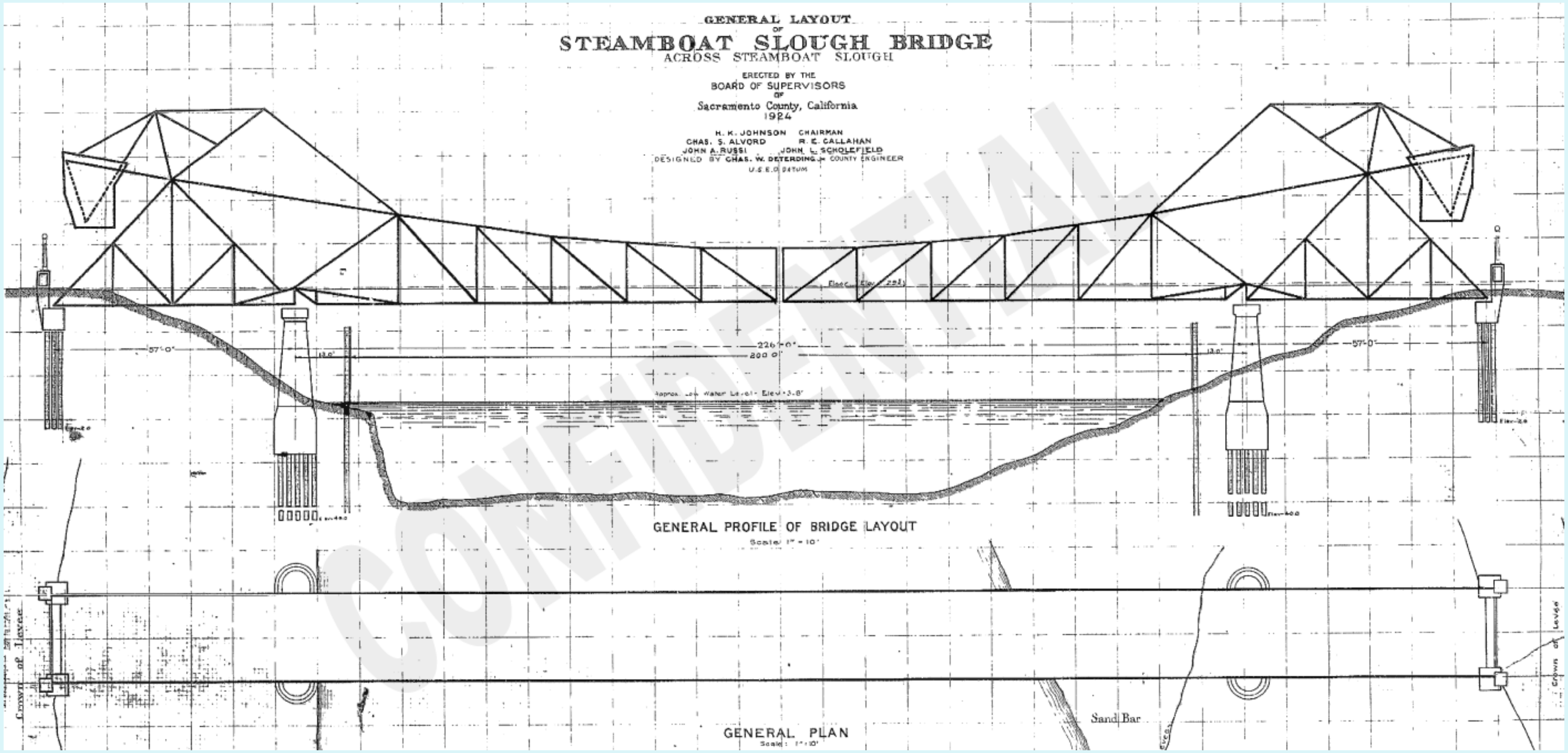
Case 3:Steamboat Slough Bridge

(Br. No. 24 0052)

- Riveted double leaf Strauss bascule steel truss built in 1924
- Span lengths of 57 ft , 226 ft and 57 ft.
- RC deck in Span 1 and 3, and open steel grid deck in Span 2, all on steel stringers and floor beams
- Two leaves connected with shear locks for equal live load deflection.

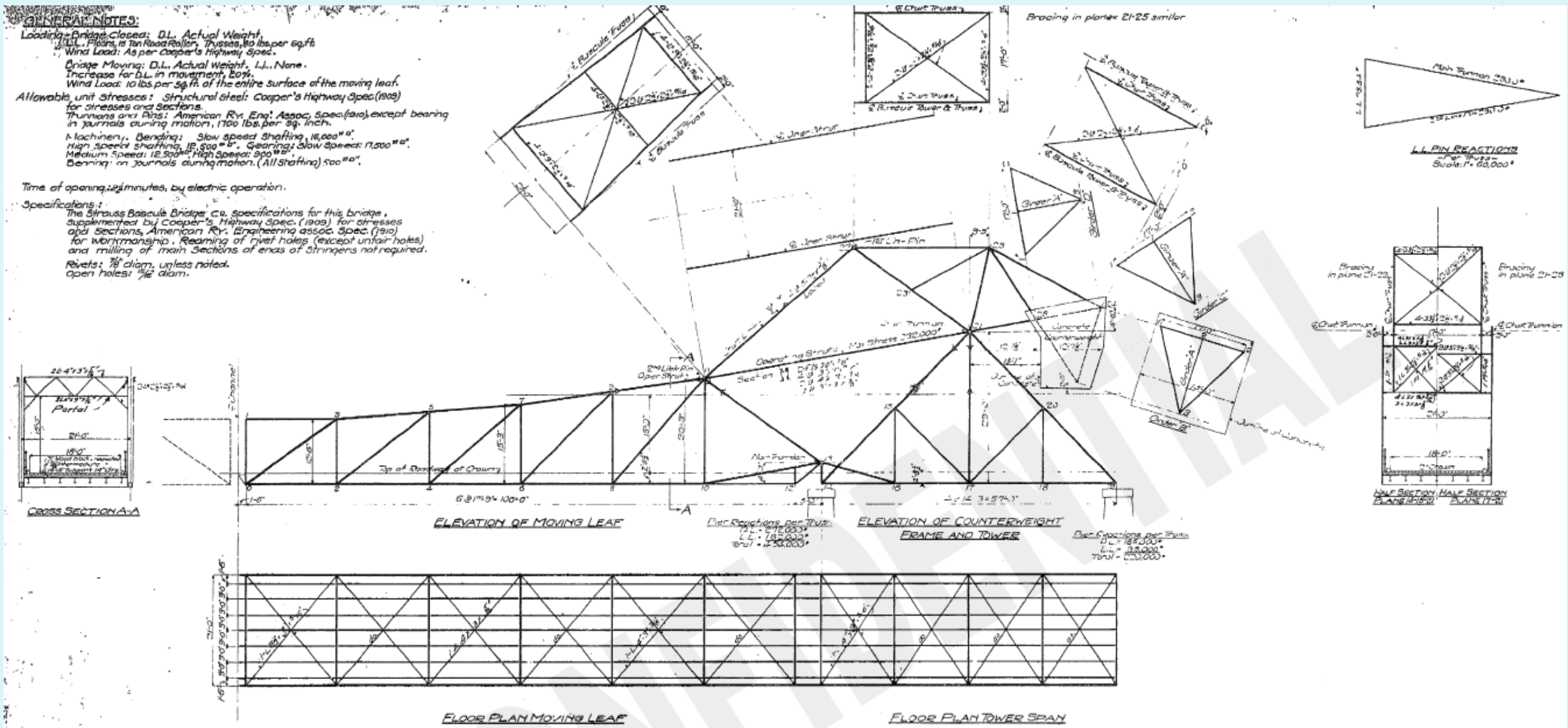
Case 3:Steamboat Slough Bridge

- General Plan



Case 3:Steamboat Slough Bridge

- Structure Layout



Case 3: Steamboat Slough Bridge

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The same type bridge in the opening stage

Case 3: Steamboat Slough Bridge

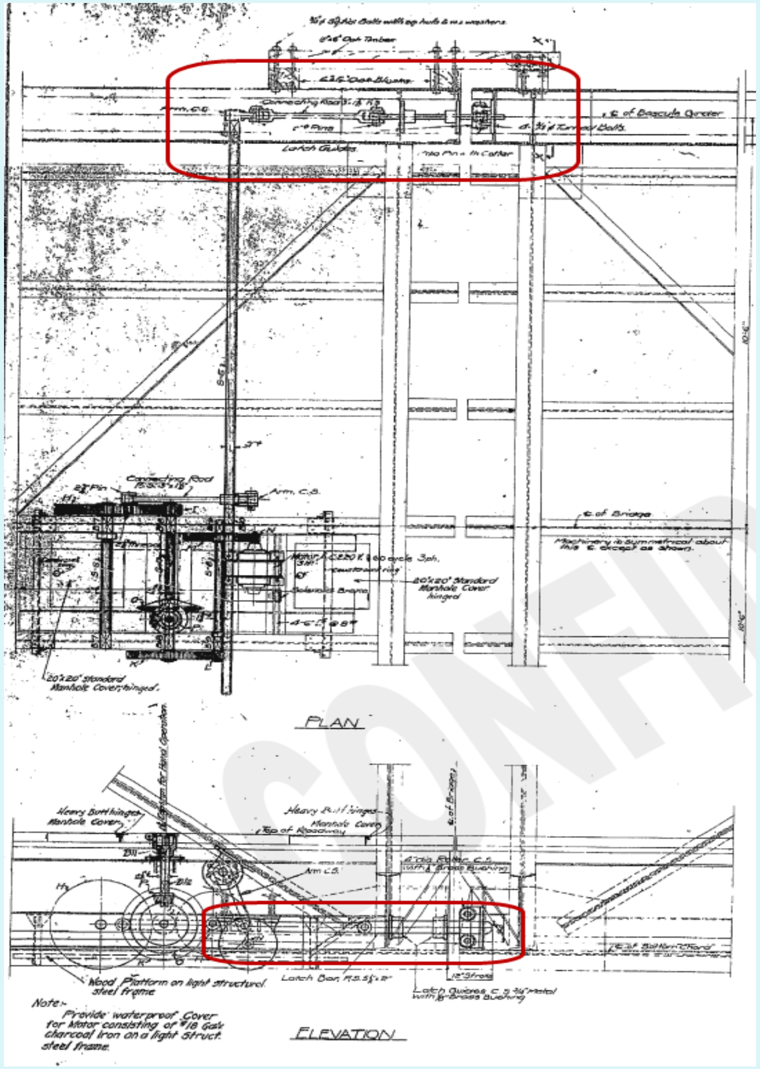
Counterweight Detail

Case 3: Steamboat Slough Bridge

Deck, stringer and floor beam

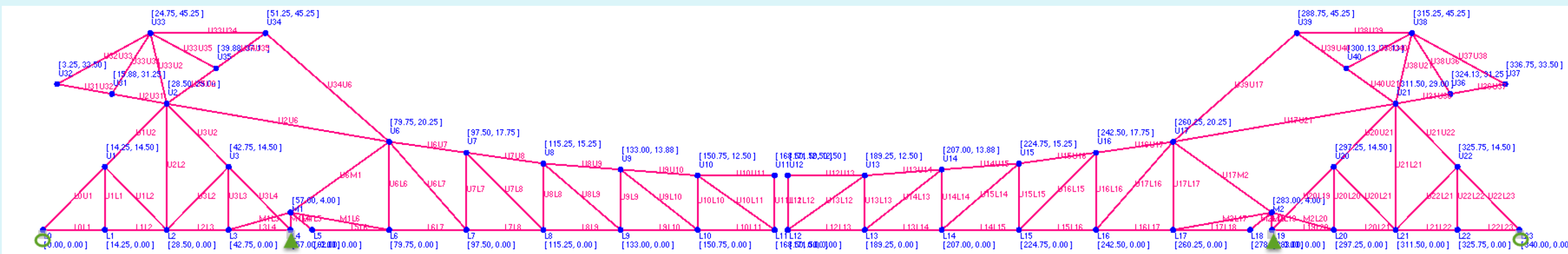
Case 3:Steamboat Slough Bridge

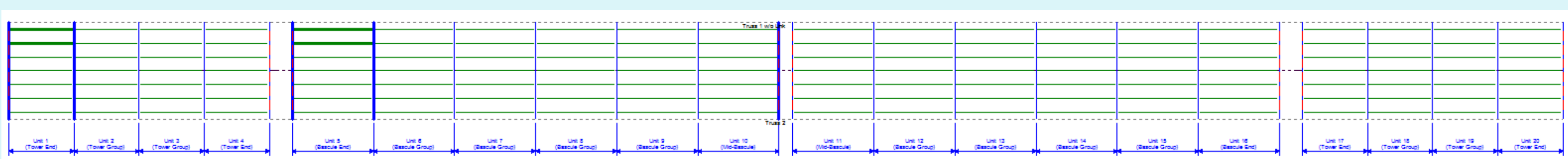
Shear lock: 5.5”x2” latch bar



Case 3: Steamboat Slough Bridge

Model A with two separate leaves without shear lock

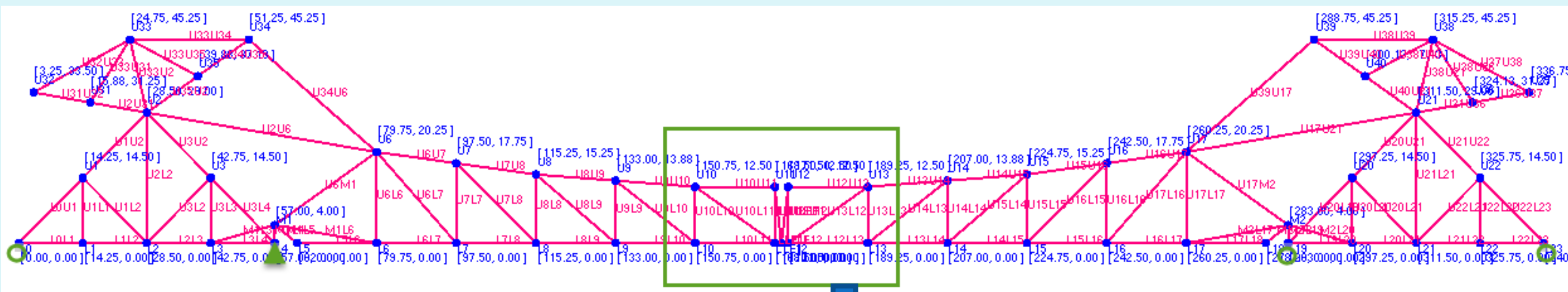


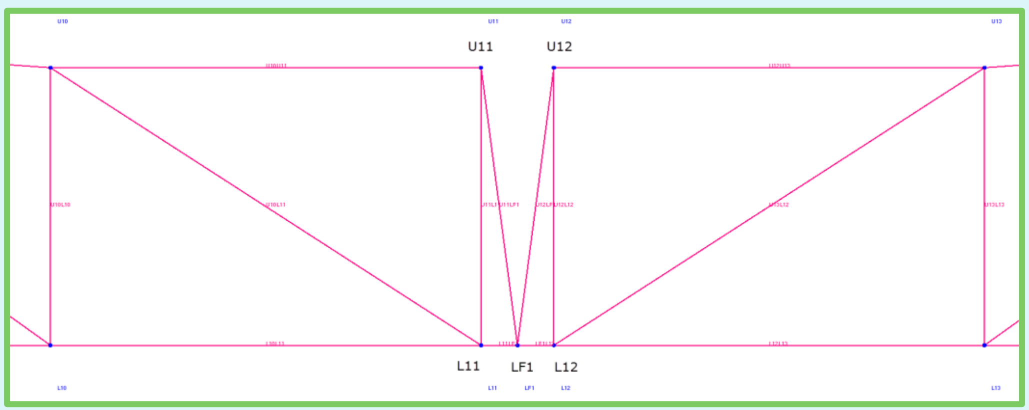


- Correct for dead load but not for live load
- How to model the shear locks with truss member?

Case 3: Steamboat Slough Bridge

Model B with shear locks





Case 3: Steamboat Slough Bridge

In Model B,

- Add an extra lower chord node between two leaves;
- Create four fake truss members, two bottom chord and two inclined, with large stiffness;
- Use only one pinned support with other roller supports for the model.
- The axial force in the end vertical member (U11L11 or U12L12) is the shear force from the shear lock.

The member forces due to dead loads from Model B are very close to those from Model A.

Conclusion

- BrR truss analysis engines have some modeling limitations, but with some “work around”, they can be used for truss structures with many special details.
- There are still some analysis limitations, for example, for swing bridges, where span end bearings are raised or jacked, at the close position. Adding “support displacement” load function, which is available for girder type structures, can solve this limitation.

Questions?