Green River Gorge Bridge Seismic Retrofit

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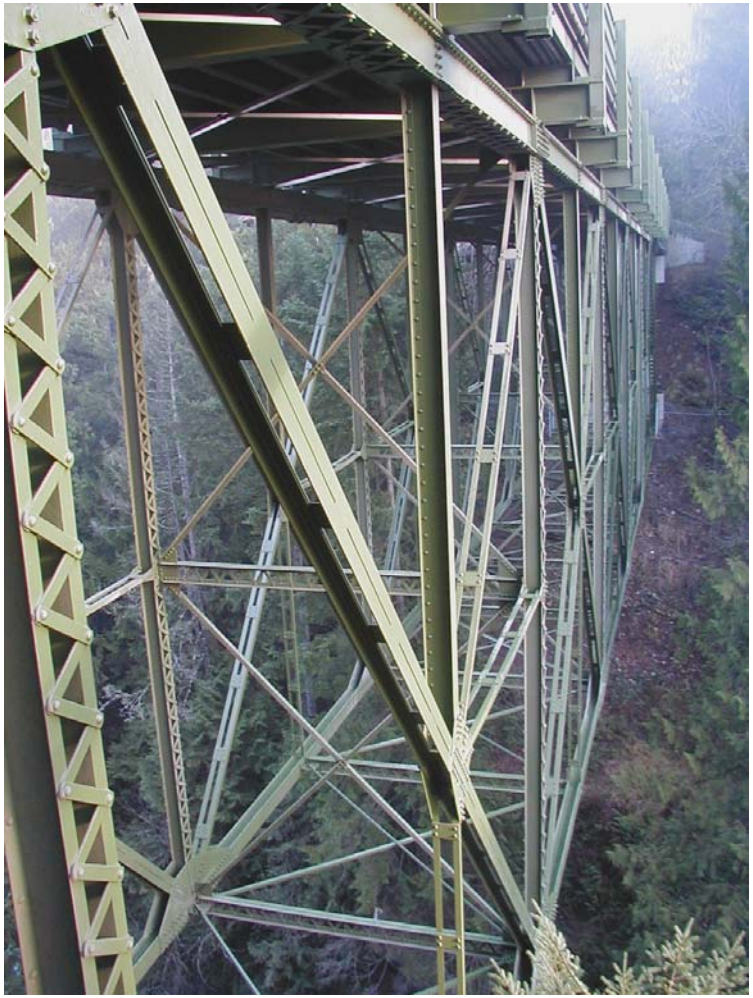
Introduction

Main span truss of the bridge



Bridge Deck and Railing

Seismic Consideration

- As per AASHTO-LRFD 3rd Edition, 2004
  - 4.7.4 Analysis for Earthquake Loads
    - 4.7.4.2 Single-span bridges
      - No seismic analysis required for single-span bridges
      - Only support connection is considered
- Green River Gorge Bridge
  - King County Landmark
  - The bridge built in 1915, no seismic load in original design
  - Tall truss with narrow width (40'x20')
  - Over 160' deep gorge

Seismic Analysis

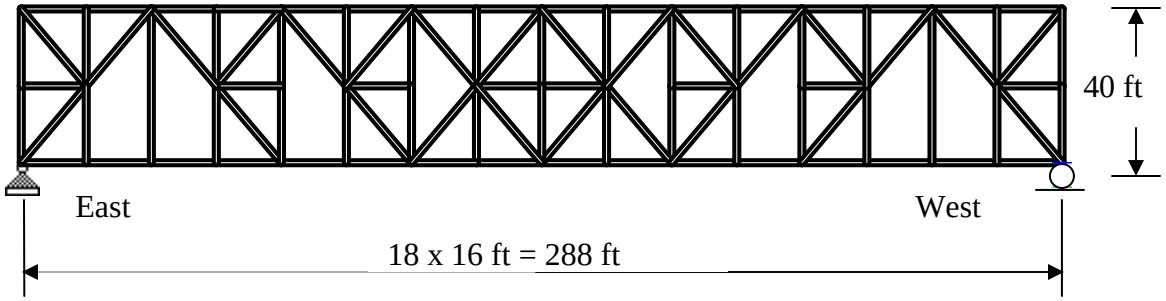
- Acceleration Coefficient: A= 0.30
- Importance Classification: II
- Site Coefficient: S = 1.2
- Seismic Zone: 4
- Seismic Performance Category: C
- Horizontal EQ force=S*A*W for connection between superstructure and abutment
- Uniform load elastic method for superstructures
- Horizontal EQ force=C_{sm}*W for superstructures

Existing Bearing Support Conditions

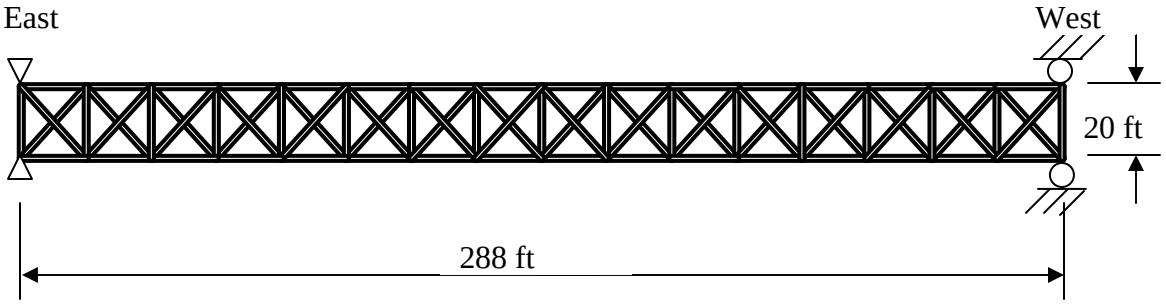
Hinged Bearing Support
at East End of Bridge

Sliding bearing support
at West End of Bridge

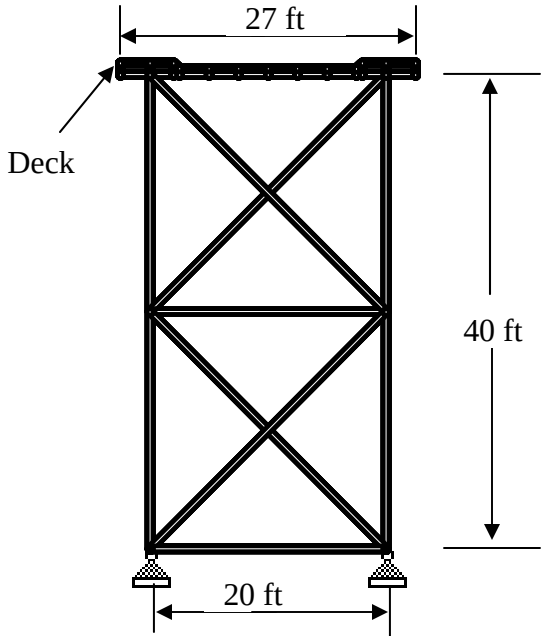
FE Model of Main Span Truss



Elevation of the truss



Plan View of the Bottom Chord and support condition

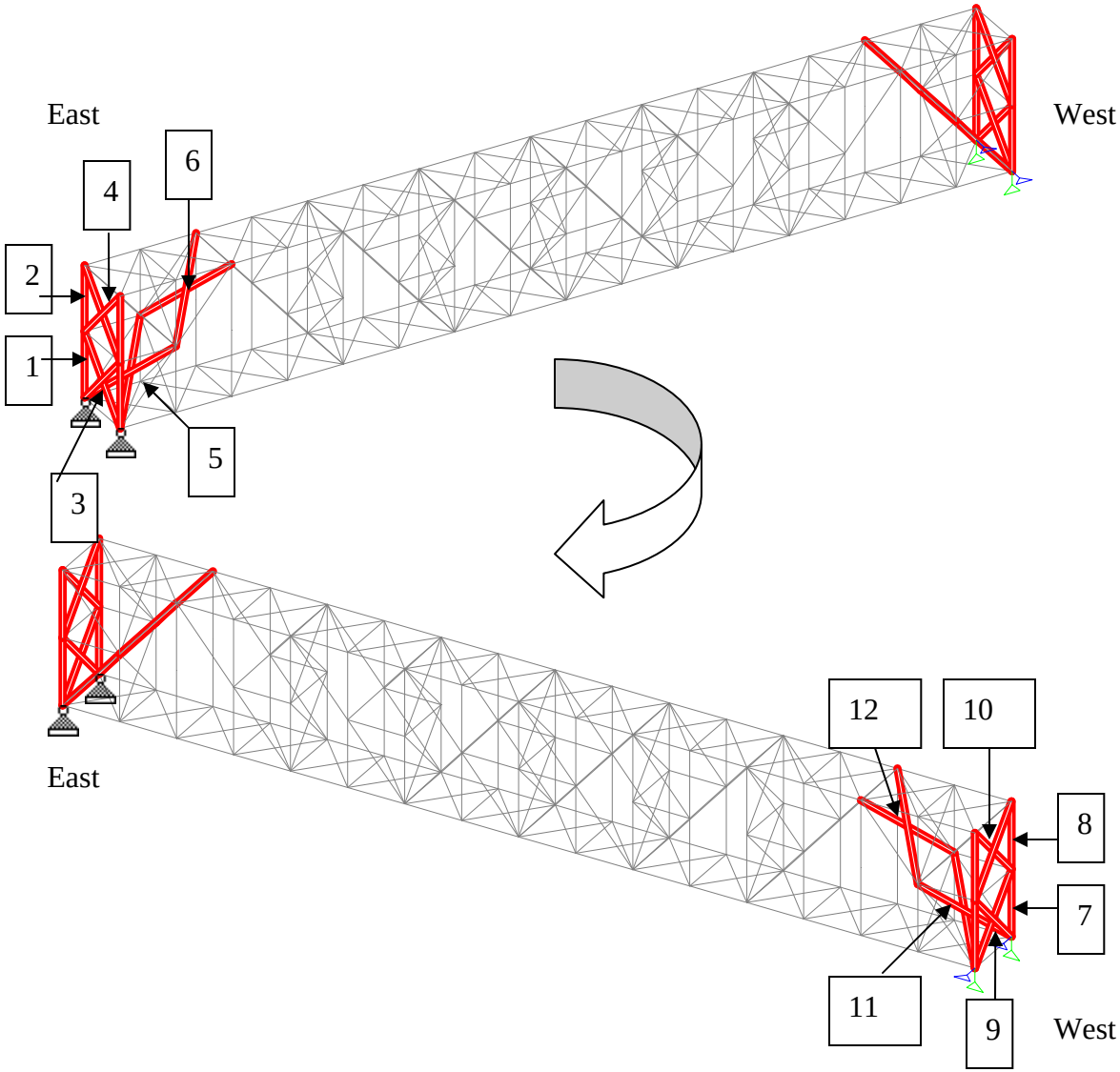


Cross section of the bridge main span

Seismic Vulnerability Findings

1. Deficient anchor bolts at east end hinged bearing supports
2. 4 deficient braces and 2 deficient vertical columns at each end of the truss
3. Deficient connection plates corresponding to the deficient braces

Deficient components of the truss



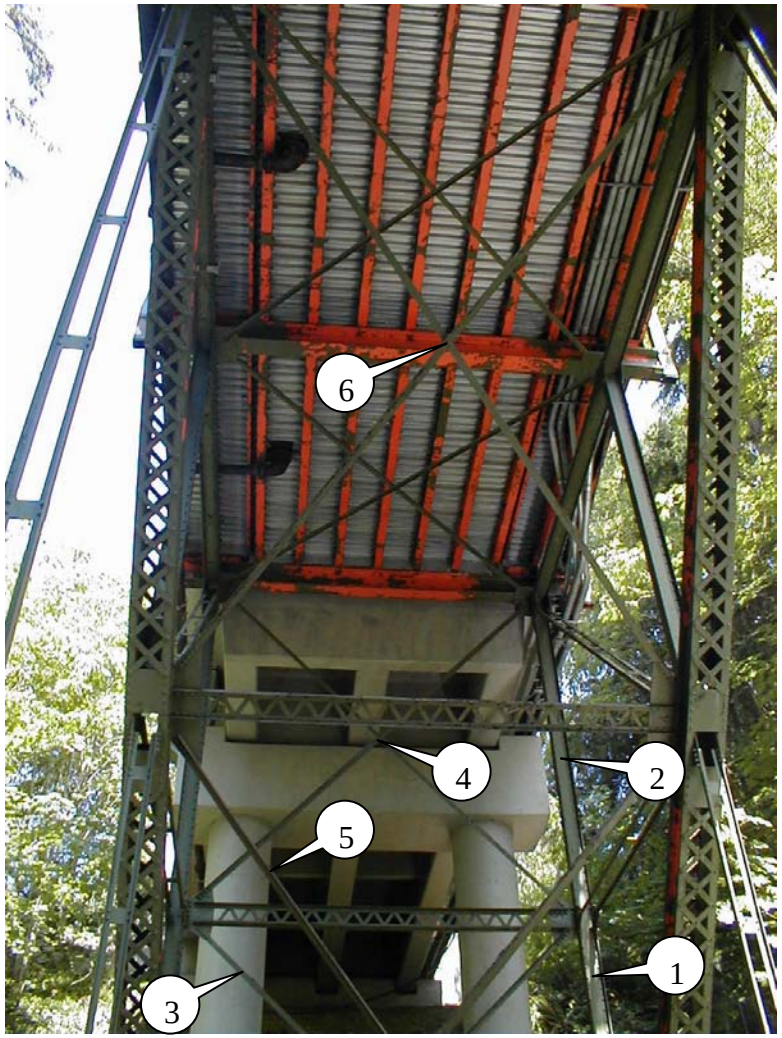
Capacity/Demand Ratio of the deficient components of existing truss

Component	Demand (kip)	Capacity (kip)	C/D
1	-200	-92	0.46
2	-125	-92	0.74
3	+104	+55	0.53
4	+103	+55	0.53
5	+134	+60	0.45
6	+81	+60	0.74

Capacity/Demand Ratio of the deficient components of existing truss (cont')

Component	Demand (kip)	Capacity (kip)	C/D
7	-220	-92	0.42
8	-124	-92	0.74
9	+106	+55	0.52
10	+104	+55	0.52
11	+102	+60	0.59
12	+61	+60	0.98

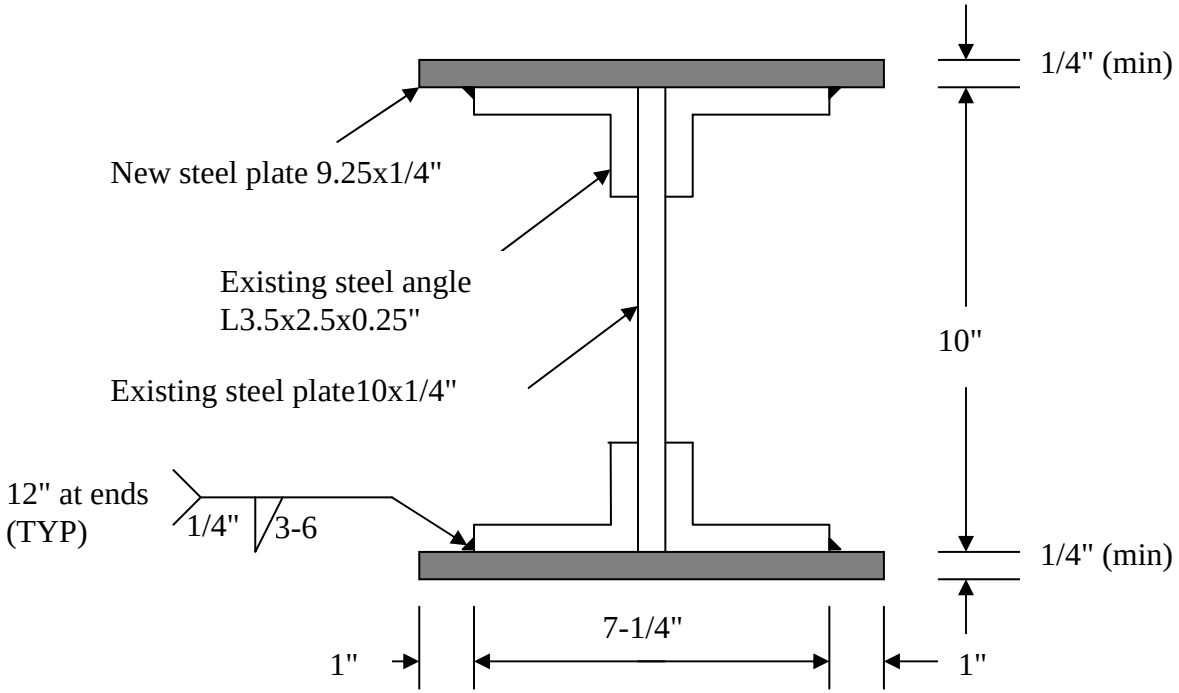
Deficient Components of the Truss



Proposed Seismic Retrofit Methods

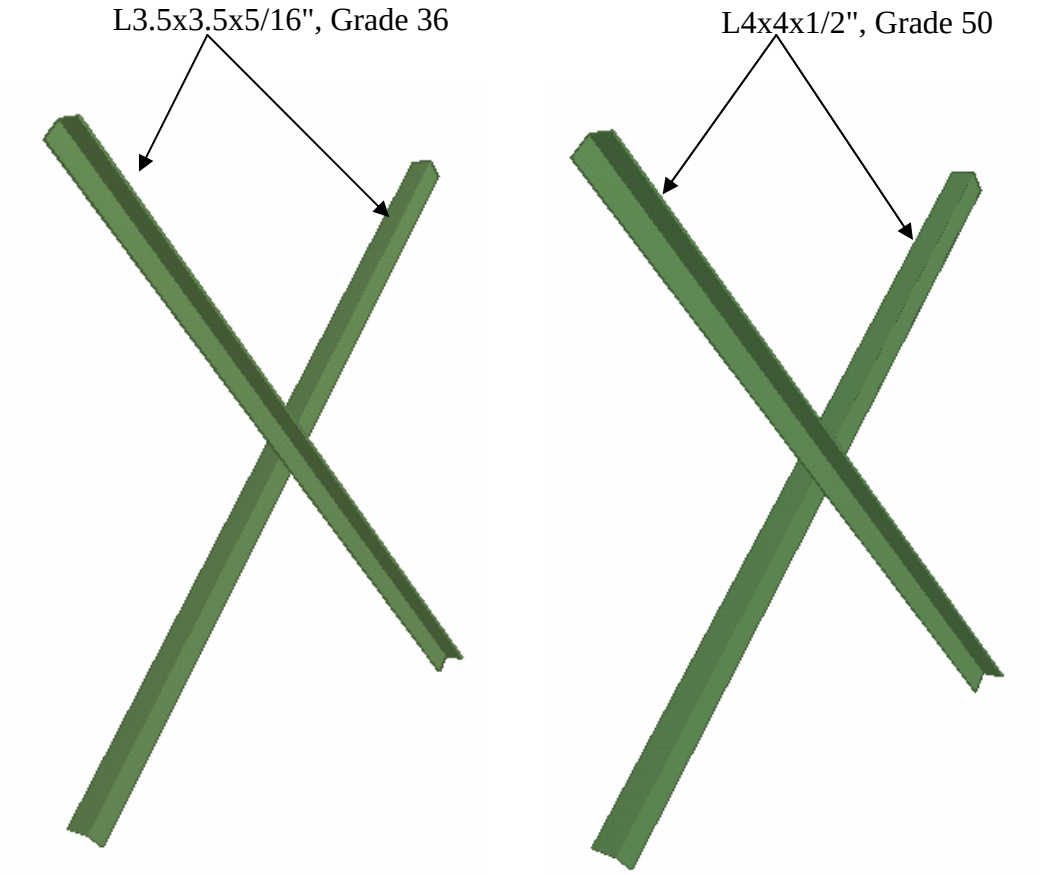
- Strengthening/replacing deficient truss members
  - Replacing deficient braces by larger section and higher strength steel angle
  - Welding steel plate on the vertical columns
- Strengthening deficient connections
  - Thicker and higher strength steel plates
  - Stronger bolts
  - Weld connection
- Reinforcing bearing anchor connection at east bridge abutment

Cross section of retrofitted vertical members



Steel Plate Welded on Vertical Column

Replacement of deficient braces



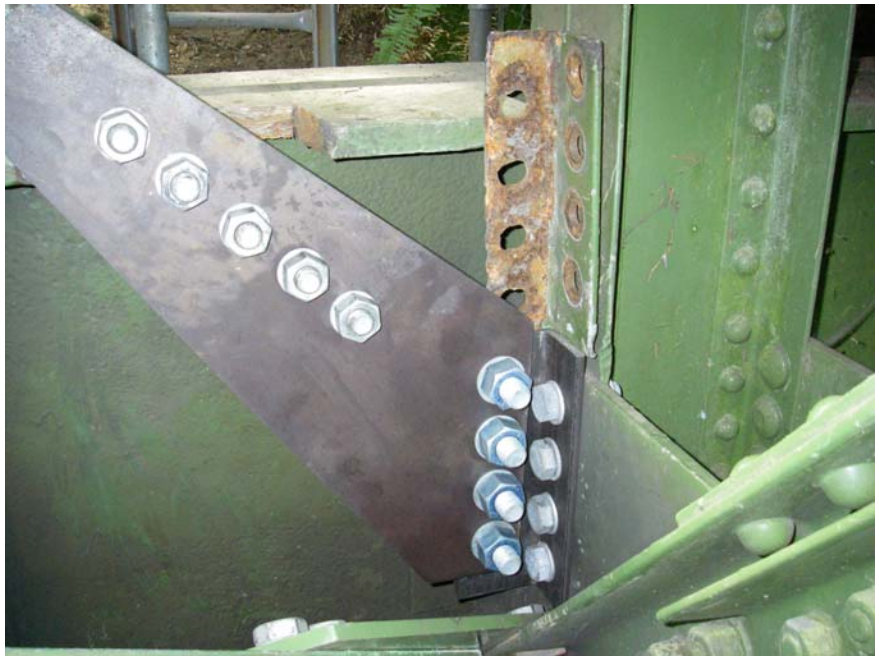
(a). The existing diagonal braces

(b) The new diagonal braces

New braces and vertical members

Connection Retrofit

Existing Connection
Plate: t=3/8”, Grade 36
Bolt: 4-3/4”Φ, A304
2L3.5x3x1/4, Grade 36



New Connection (before painting)
Plate: t=1/2”, Grade 50
Bolt: 5-7/8” Φ, or 4-1” Φ, A325
2L4x3x3/8, Grade 50

Bearing Support Retrofit

16 - #8 dowel bars

Scaffolding

Summary

- Construction completed in Sept. of 2008
- Construction Cost: $350,000
- Bridge appearance unchanged (King County Landmark)
- Last one of 117 seismic retrofitted bridges in King County after 14 years of effort

Acknowledgement

Mr. Stephen Jiang

Mr. Mark Anderson

The End