Raising Existing In-Service Bridges

KPFF Consulting Engineers

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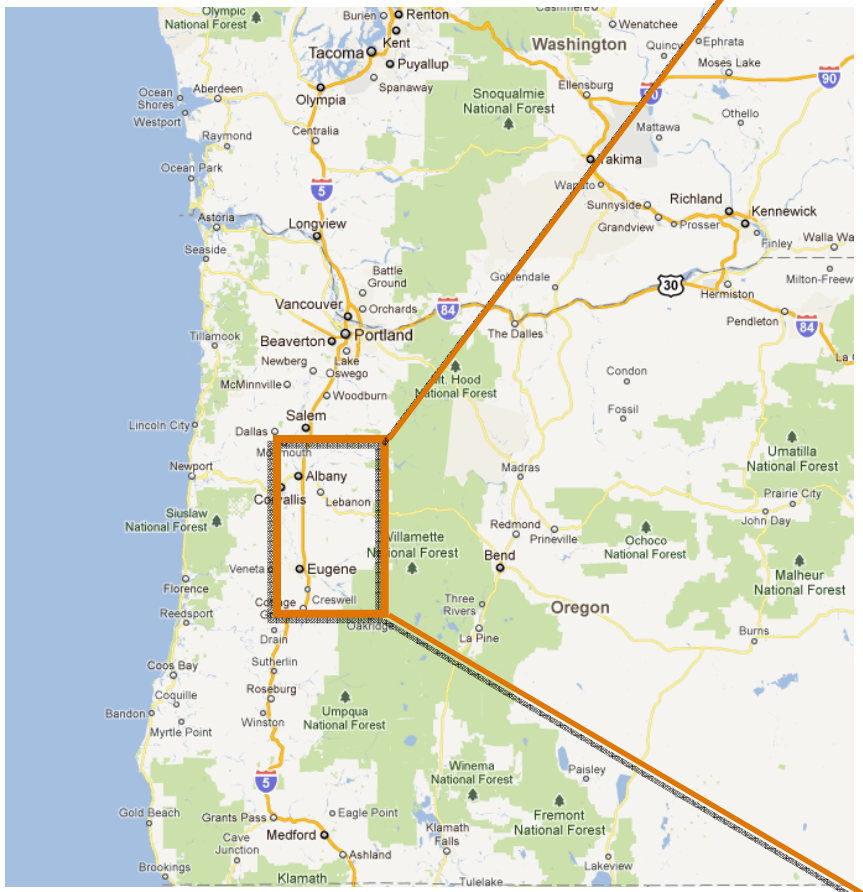
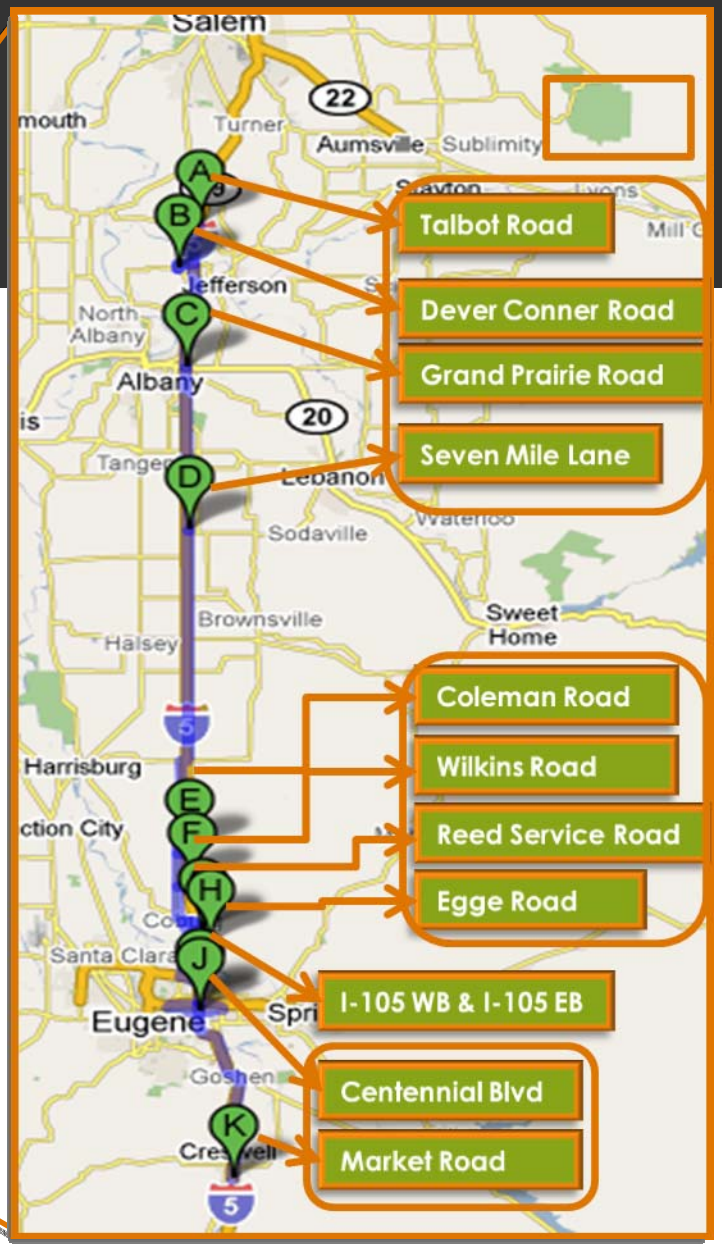
September 2011

Project name:
I-5 Vertical Clearance Improvements





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I-5 Vertical Clearance Improvements

Client: Oregon Department of Transportation

(Ken Kohl, Project Manager)

Project Objectives

- Raise 12 existing structures to provide a min. of 16’ 8” clearance over I-5
- Minimize disruptions to traffic

Typical Structures Being Raised

Structures to be raised up to 18”

Outline

- Bridge Raising 101
- Design
- Construction

Bridge Raising 101

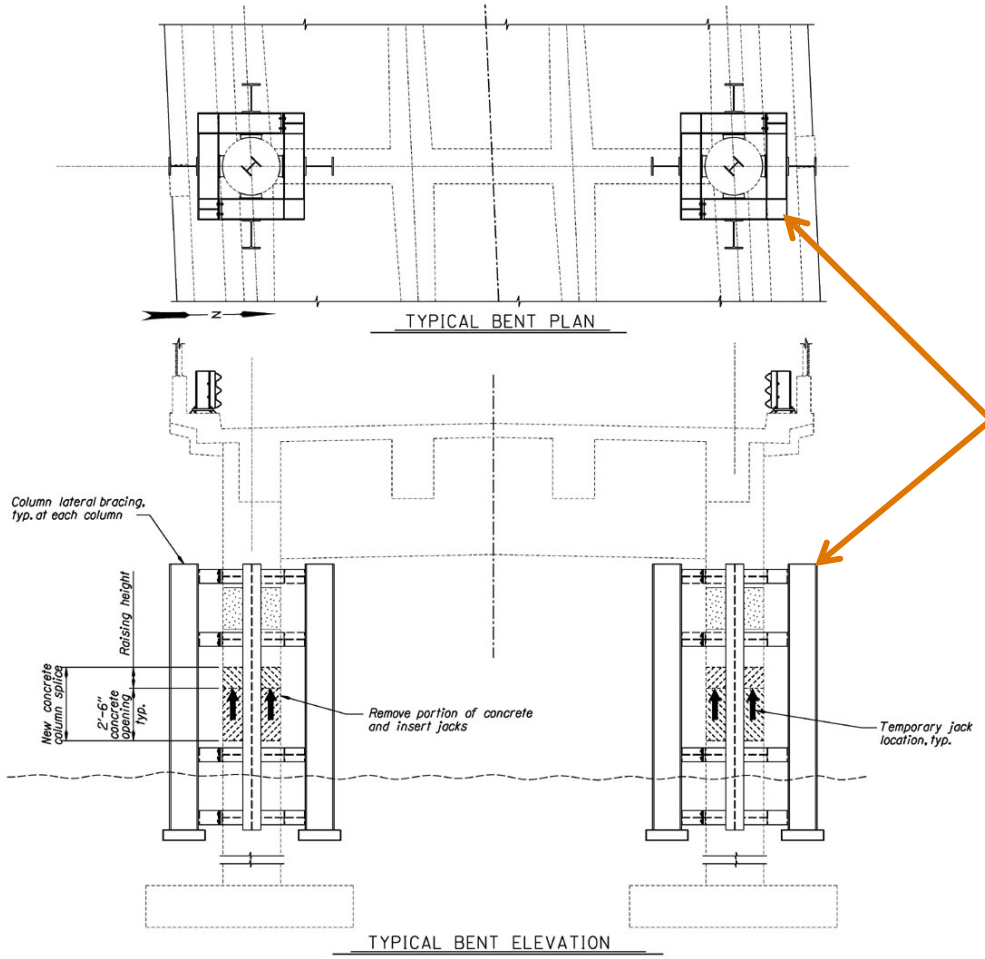
Q: How do you “raise” a bridge?

Bridge Raising 101

A: Very carefully!

General Procedure

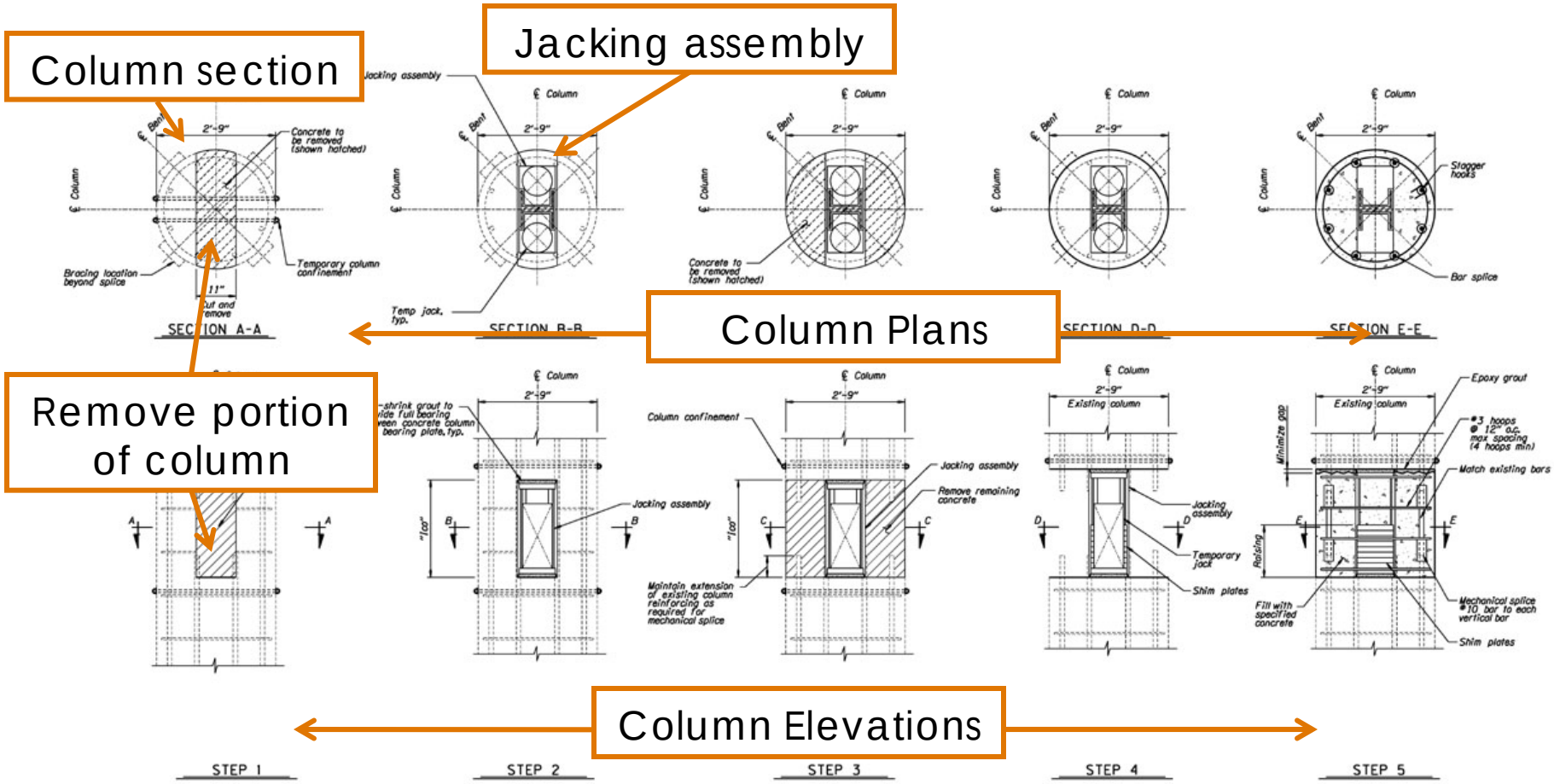
1. Provide lateral bracing for structure



Provide Temporary lateral bracing.Typ. at each column

General Procedure

2. Remove portions of existing columns and end bents



General Procedure

3. Insert jacking boxes, hydraulic jacks and backup supports

General Procedure

4. Remove remaining concrete and sever reinforcing

General Procedure

5. Raise Structure ¼" at a time.

General Procedure

6. Re-couple column reinforcing, install end bent reinforcing.

General Procedure

7. Make new concrete column and end wall splices.

General Procedure

9. Epoxy inject top of column splices. Grout top of end bents.

10. Remove falsework.

Design

Design

Design Criteria was a compilation of:

- ODOT's Bridge Design and Drafting Manual (BDDM)
- AASHTO Bridge Temporary Works
- AASHTO LRFD
- ACI

Design

Design Criteria

- ODOT BDDM
- AASHTO Bridge Temporary Works
- AASHTO LRFD
- ACI

Developed a unifying set of design criteria for project – i.e. "A Rule Book"

Design Approach

- Review previous bridge raising examples
- Develop 2 bridge raising approaches – primary and alternate
- Give bidders more options
- Provide sufficient detail to aid bidders, reduce risk of unknowns

Design Approach

- Provide preliminary, but detailed, construction sequences
- “Balancing Act”, provide key information without prescribing means and methods

Engineer of Record
(KPFF)

Contractor/Bridge Raising Engineer
(Hired by Contractor)

Design Approach

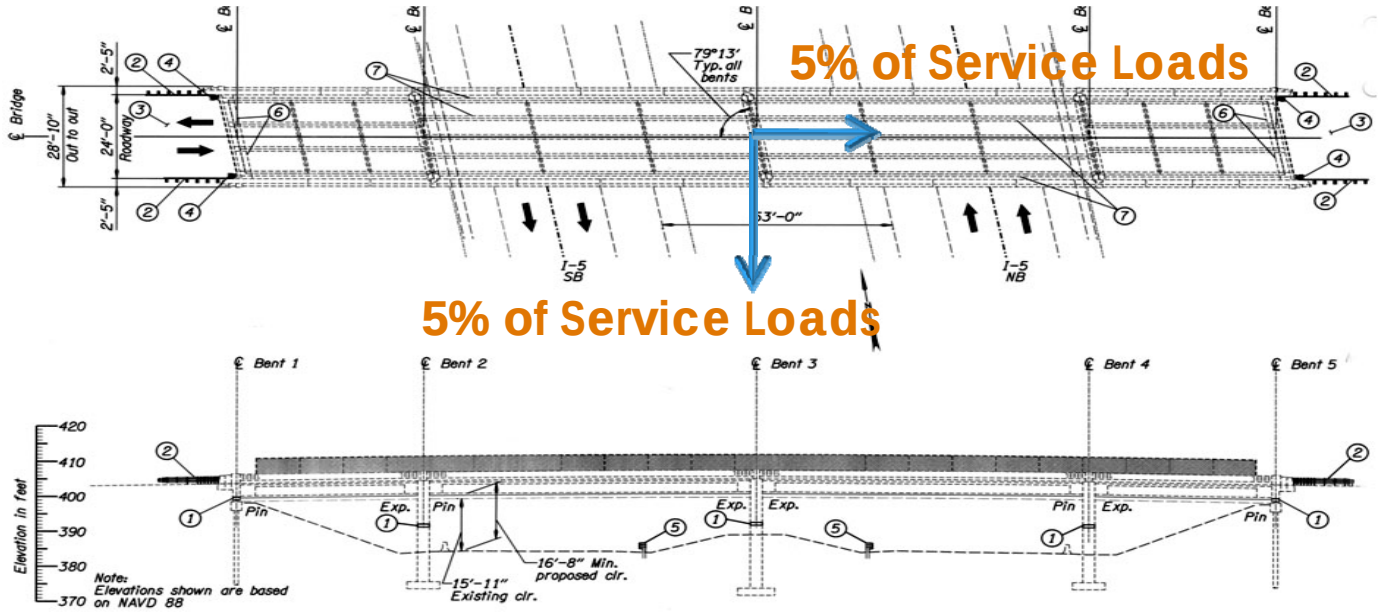
Roles and Responsibilities

- EOR scoped with developing a set of buildable/biddable contract documents
- EOR sets the rules
- EOR shows preliminary raising plans
- Contractor determines their specific means and methods
- Contractor stamps their final design
- EOR reviews contractor's final design

Design

Establish Loading Conditions

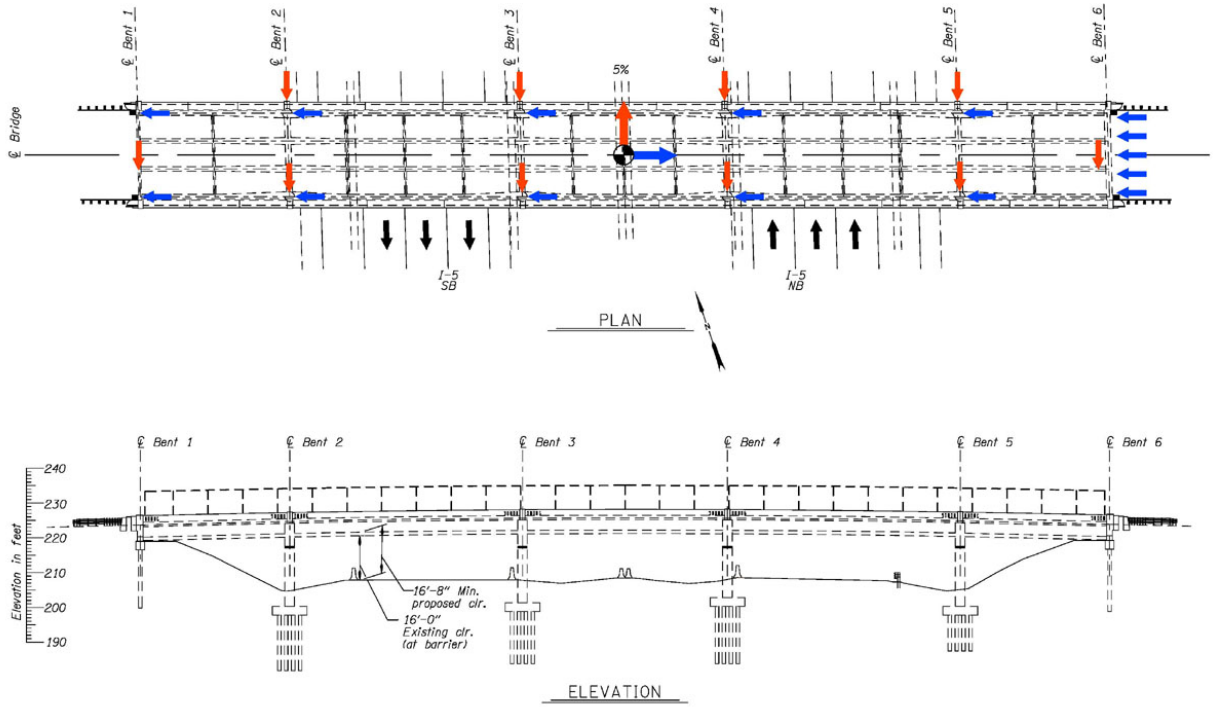
- Design Axial Loads = 1.5 x service loads
- Design Lateral Loads = 5 % of axial service loads
- Limiting Deflection = L / 240



Design

Lateral Bracing

- Column braces – transverse and longitudinal
- End bent braces – transverse
- End bent embankments – longitudinal

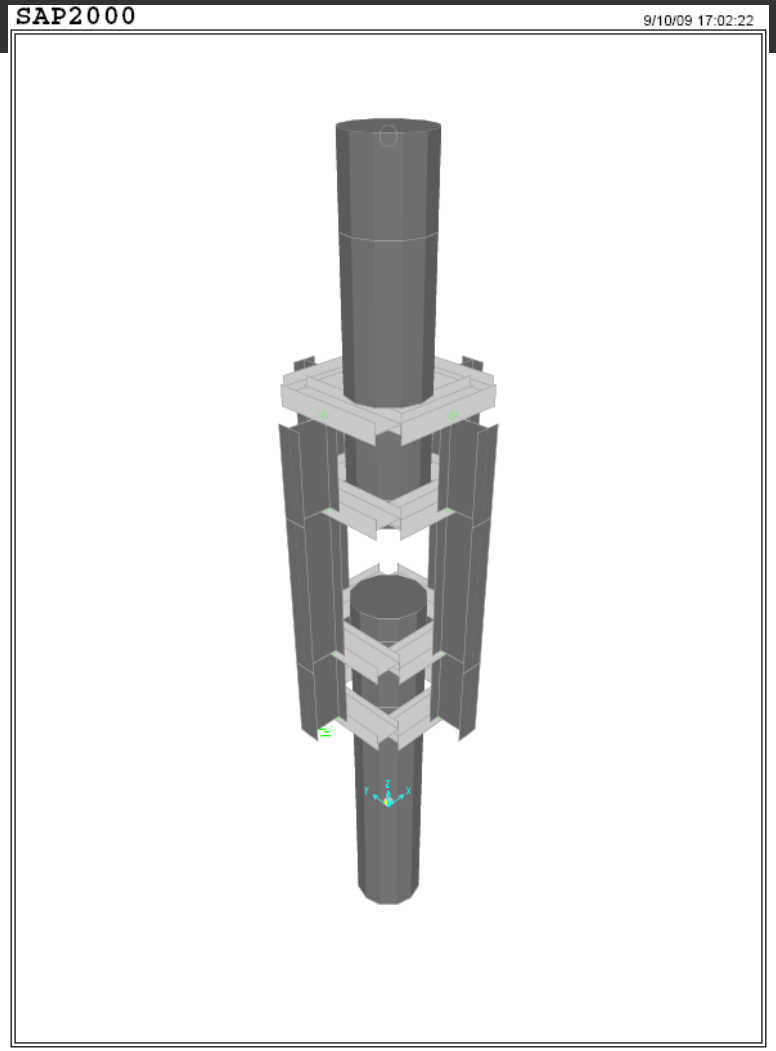


Design

Lateral Bracing

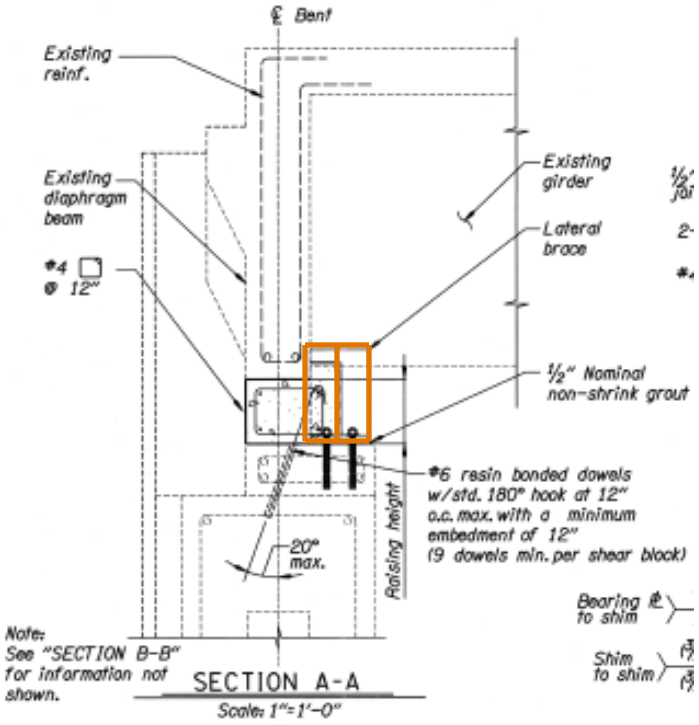
- **Brace components**
  - 4 frames around columns
  - 4 beams connecting frames
  - Bearing plates

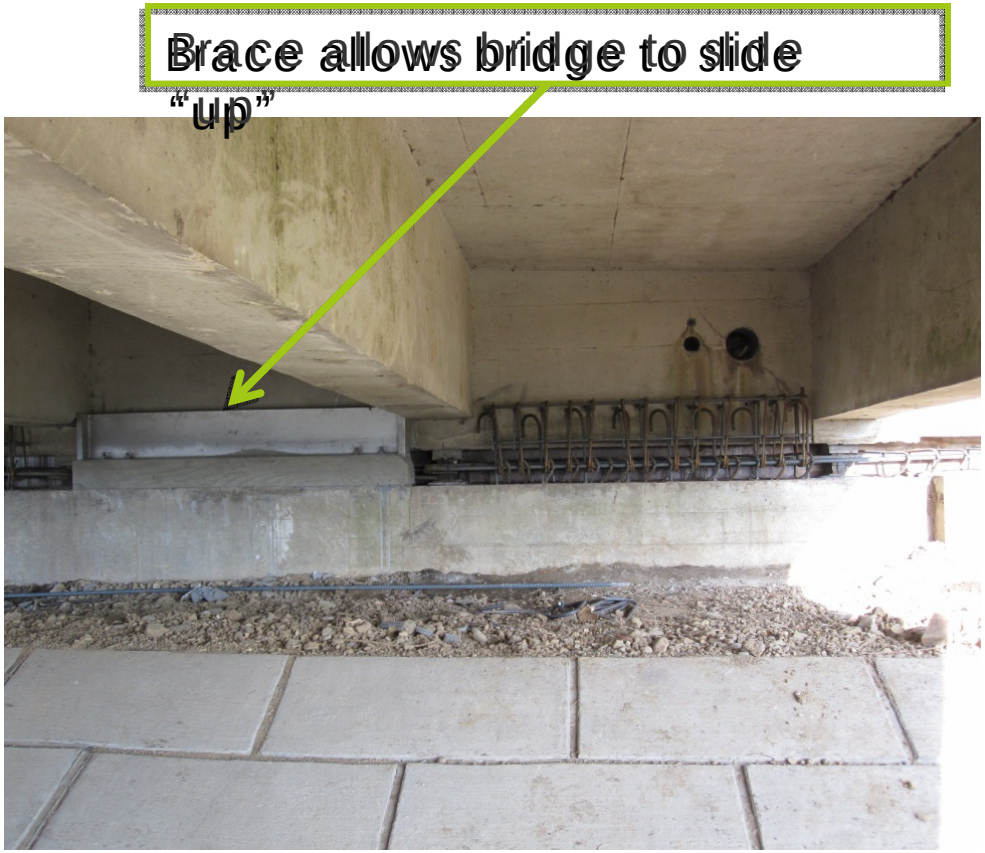
- **Transfer mechanism**
  - Propped cantilever
  - Shear
  - Moment



Design

Temporary Lateral Bracing @ End Bents

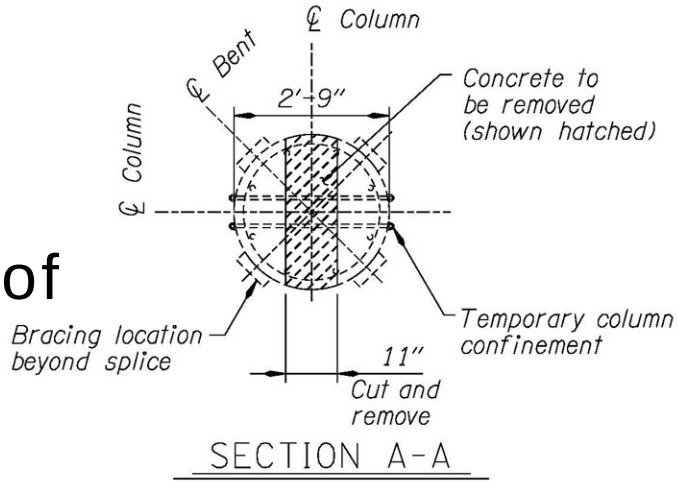




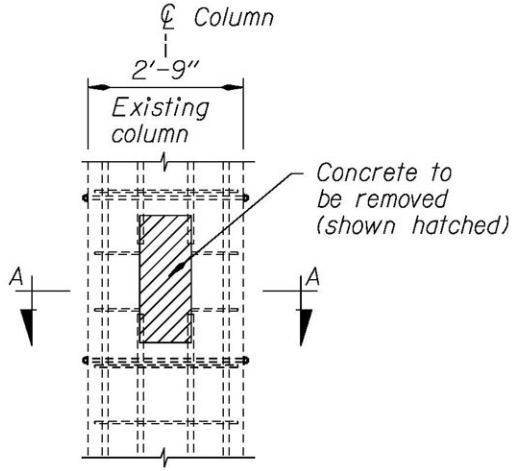
Design

Column Staging

- Step 1 – Remove portion of existing concrete column



SECTION A-A

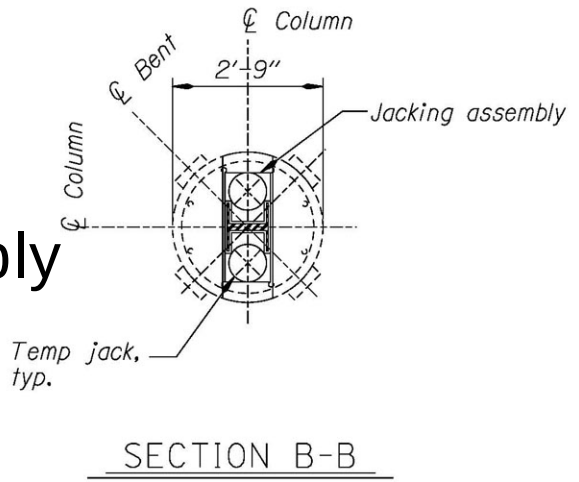


STEP 1

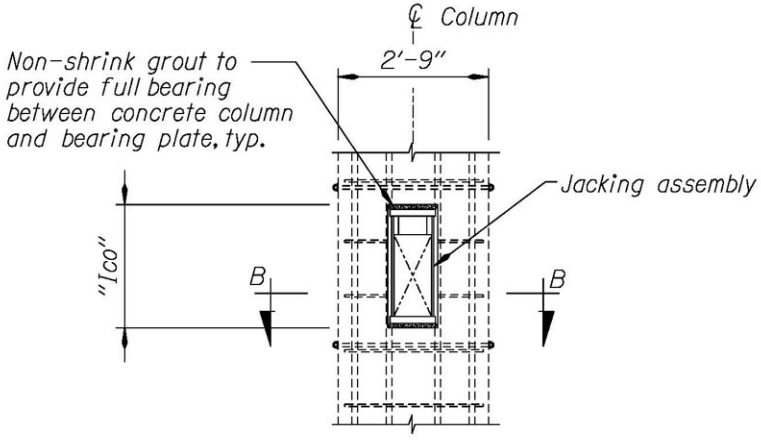
Design

Column Staging

- Step 2 - Insert jacking assembly



SECTION B-B

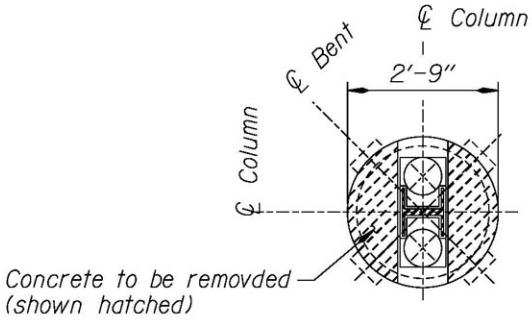


STEP 2

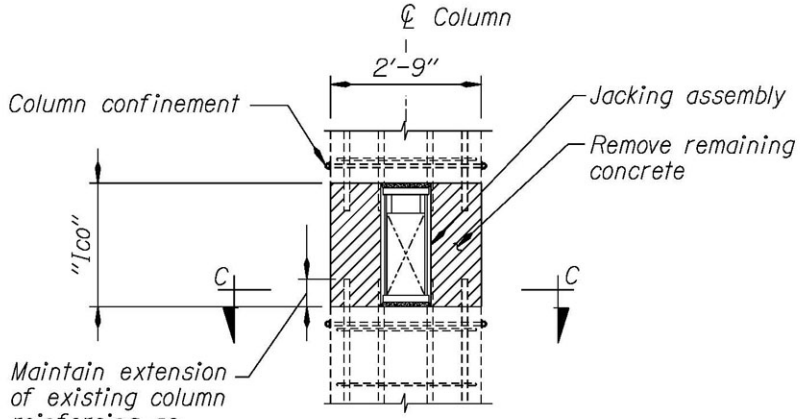
Design

Column Staging

- Step 3 – Remove remaining concrete and cut vertical reinforcing

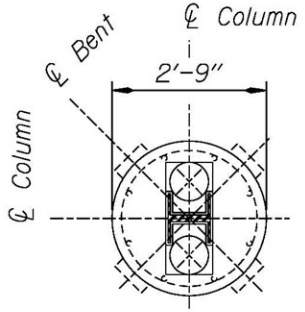


SECTION C-C



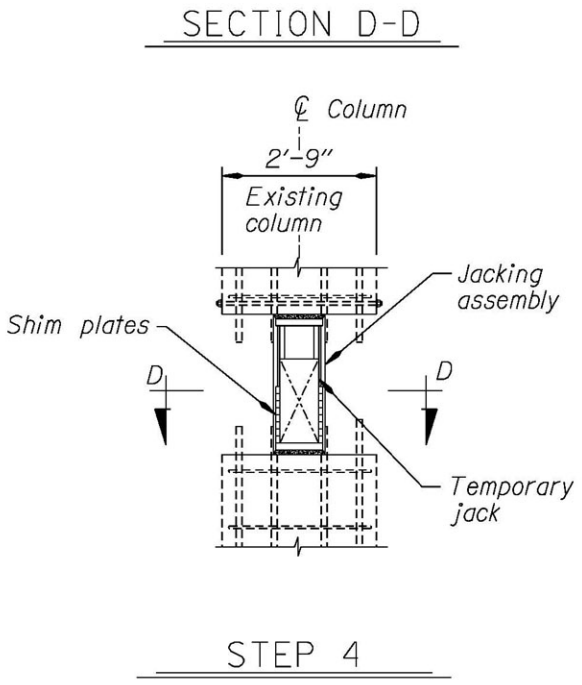
STEP 3

Design



Column Staging

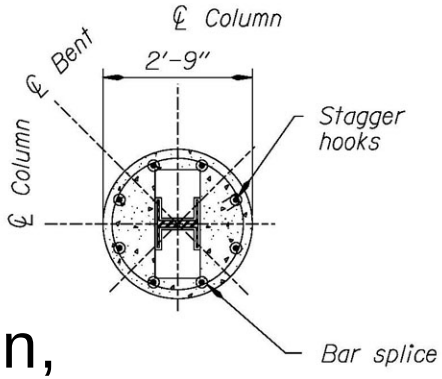
- Step 4 - Raise bridge maintain steel shims to within 1/4"



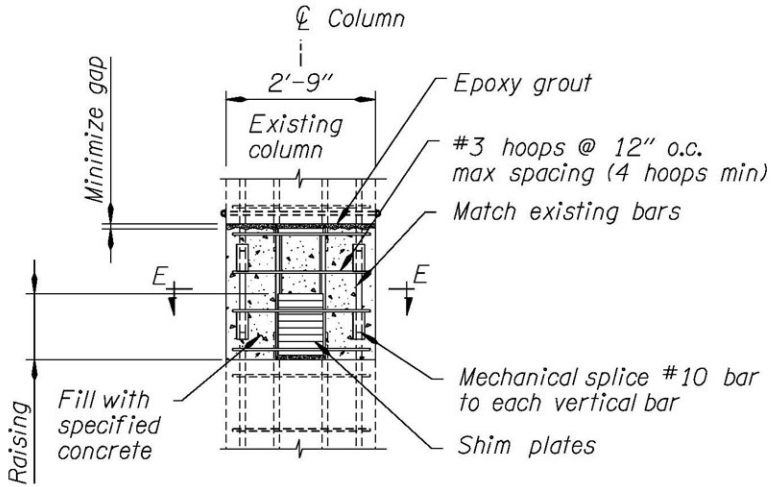
Design

Column Staging

- Step 5 - Splice Rebar, form and pour new column section, inject epoxy for full bearing



SECTION E-E



STEP 5

Design

Design Considerations

- Access

Design

Design Considerations

- Jacking equipment

Design

Design Considerations

- Good understanding of necessary construction steps

Design

Design Considerations

- Cost Implications

Design

Design Considerations

- Creative ways to lessen mobility impacts

Construction

Construction

Effective staging and safe work zone

Construction

Carefully taking a cut out of the columns

Bridge Jacking Loads (lbs)
Dead Loads ONLY

Talbot Bridge	Theoretical	Factored	Actual
Bent 1	92,000	138,000	181,000
Bent 2	417,000	625,000	517,000
Bent 3	430,000	645,000	554,000
Bent 4	430,000	645,000	566,000
Bent 5	417,000	625,000	523,000
Bent 6	92,000	138,000	197,000
Total	1,878,000	2,817,000	2,538,000

Construction

Improved high load clearance

Real proof the bridge was raised

Construction

Preparing new column splices

Acknowledgements

- **Design Lead**: KPFF (PM, Structures, Civil, Survey)
- **Design Team**:
  - GRI (Geotechical)
  - DKS (Traffic Engineer)
  - ESA Adolfson (Environmental Permitting)
  - JLA (Public Involvement)
  - ROWA (Right-of-way Acquisition)
- **Contractor**: Wildish Standard Paving

Questions?

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