

WESTERN BRIDGE ENGINEERS' SEMINAR - 2007

Lake Creek Bridges Design and Construction



Presentation By:

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Presentation Outline

- Introduction
- Design Challenges (Lisa)
 - Curved Girders
 - Pier Foundations
 - Girder Shipping and Erection
- Construction Challenges (Chris)
 - Girder Erection
 - Excavation Shoring (Pier 1 Foundation)
 - Girder Shipping and Erection

Introduction

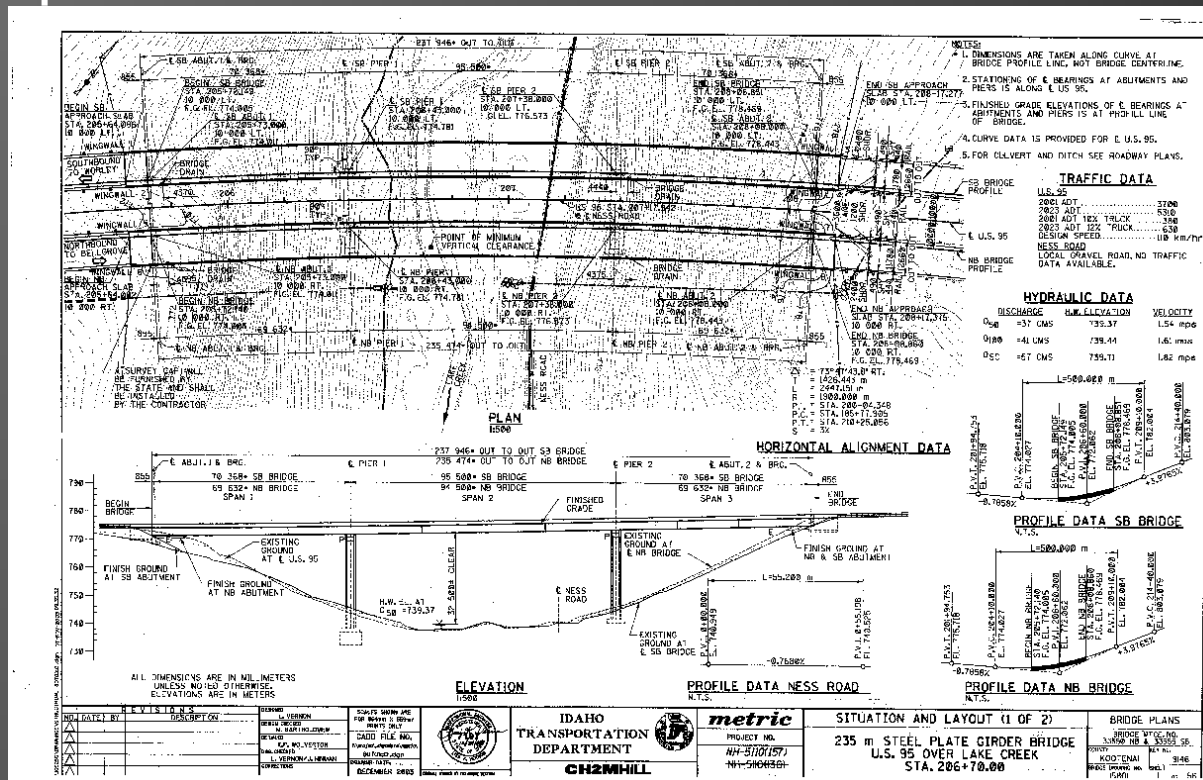
● The Lake Creek Bridges

- Design completed Fall 2003 by CH2M HILL
- Construction expected to complete October 2007
- Link between two concurrent construction phases on US 95 south of Coeur D'Alene, ID
- Bridges are two parallel twin structures
- 3 span, curved steel plate girder, over 780' long with a center span of 310'

Design Challenges – Curved Girders

Geometrics

- Each Girder has different radius
- Super elevation on a vertical curve



Design Challenges – Curved Girders

Design Code Challenges

- Central angles (radius/span length) small enough to ignore curvature per LRFD
- Reasons to consider effects of curvature
 - Variation of forces and deflections (camber) between girders
 - Cross frame members subjected to calculated forces
 - Non-uniform torsion (warping or lateral flange bending)
- Span length exceeded upper limit of live load distribution factor equations

Design Challenges – Curved Girders

Design Strategy

- Use LRFD code to analyze as a straight girder using a line girder analysis (SteelBridge)
- LFD using the Curved Girder Guide Specification and a 3-D Finite Element Analysis (BSDI)



Design Challenges – Curved Girders

Conclusion from Analysis

Even for a curvature $< 4^\circ$

- Vertical bending variation is 5-12%
- Girder deflection variation is 7-12%
- Lateral flange stress is 3% of yield
- Cross-frame forces 3 times nominal straight girder bracing design



Construction Challenges Curved Girders



Construction Challenges Curved Girders

- Difficult to “eye ball” construction layouts
- Minimal faith in construction surveyor, requiring extensive back checking



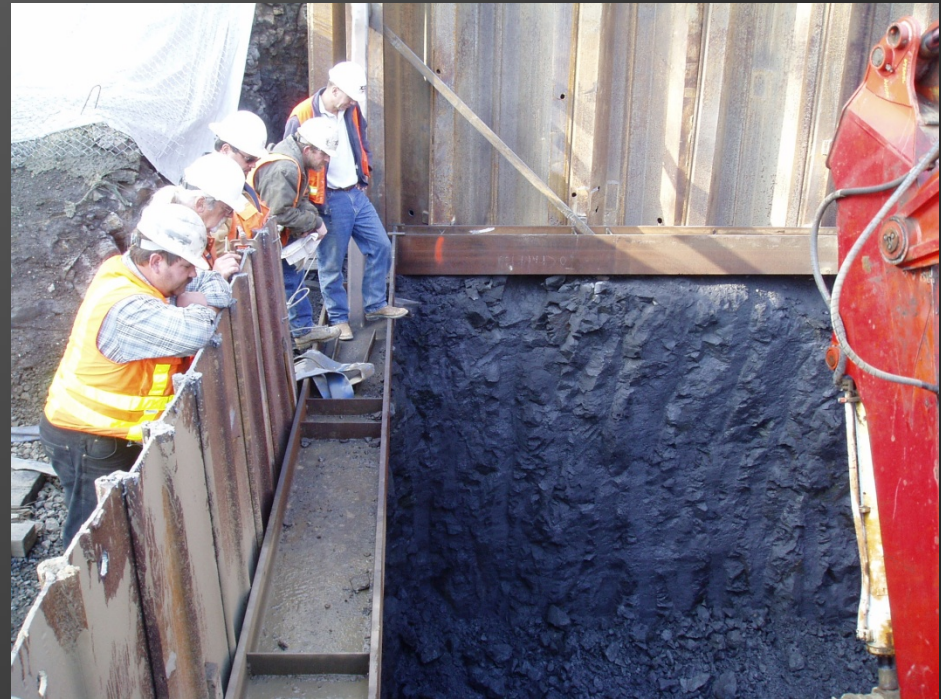
Design Challenges – Pier Foundation

Geotechnical Investigation

- 20' overburden above rock for Pier 1 Northbound
- Rock closer to surface for Pier 1 Southbound
- Ground Water

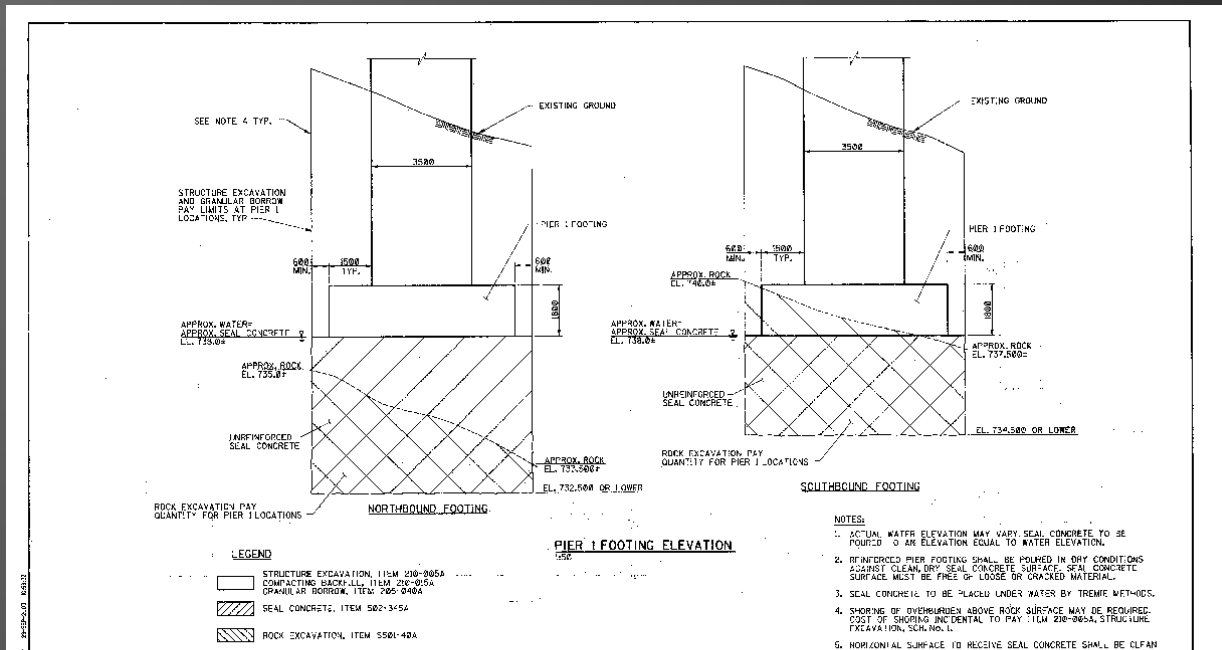
Foundation Options

- Drilled Shafts
- Micropiles
- Spread footings
- Drilled Steel Piles



Construction Challenges Pier Foundation

- Contractor was Resistant to Spread Footings
 - Proposed micro-piles



CH2MHILL

NO. 1	DESCRIPTION	GROUP	BY	DATE
1	FOOTING DETAILS	1	M. J. MOHANT	DECEMBER 2003

FOOTING DETAILS
 STEEL PLATE GIRDER BRIDGE
 OVER LAKE CREEK
 STA. 206+70.00

1-800-368-5634

1-800-368-5634

1-800-368-5634

Construction Challenges

Pier Foundation

● Conflicting Specifications

- Contractor's Notes – “It is expected that construction dewatering will be required during construction.”
- Rock Excavation – “All loose rock and soil shall be removed from the excavated rock surface with hand tools, compressed air, vacuum truck, or other suitable methods...exposed joints and open fractures shall be cleaned of soil and rock pieces...”
- Dewatering Specification – “This item consists of all the necessary items for dewatering foundation excavations for the Lake Creek Bridge construction...”
- Seal Concrete specified in construction drawings to be placed under water.

Construction Challenges Pier Foundation

- Deviation in Rock Profile



Design Challenges – Girder Shipping & Erection

○ Girder Shipping Considerations

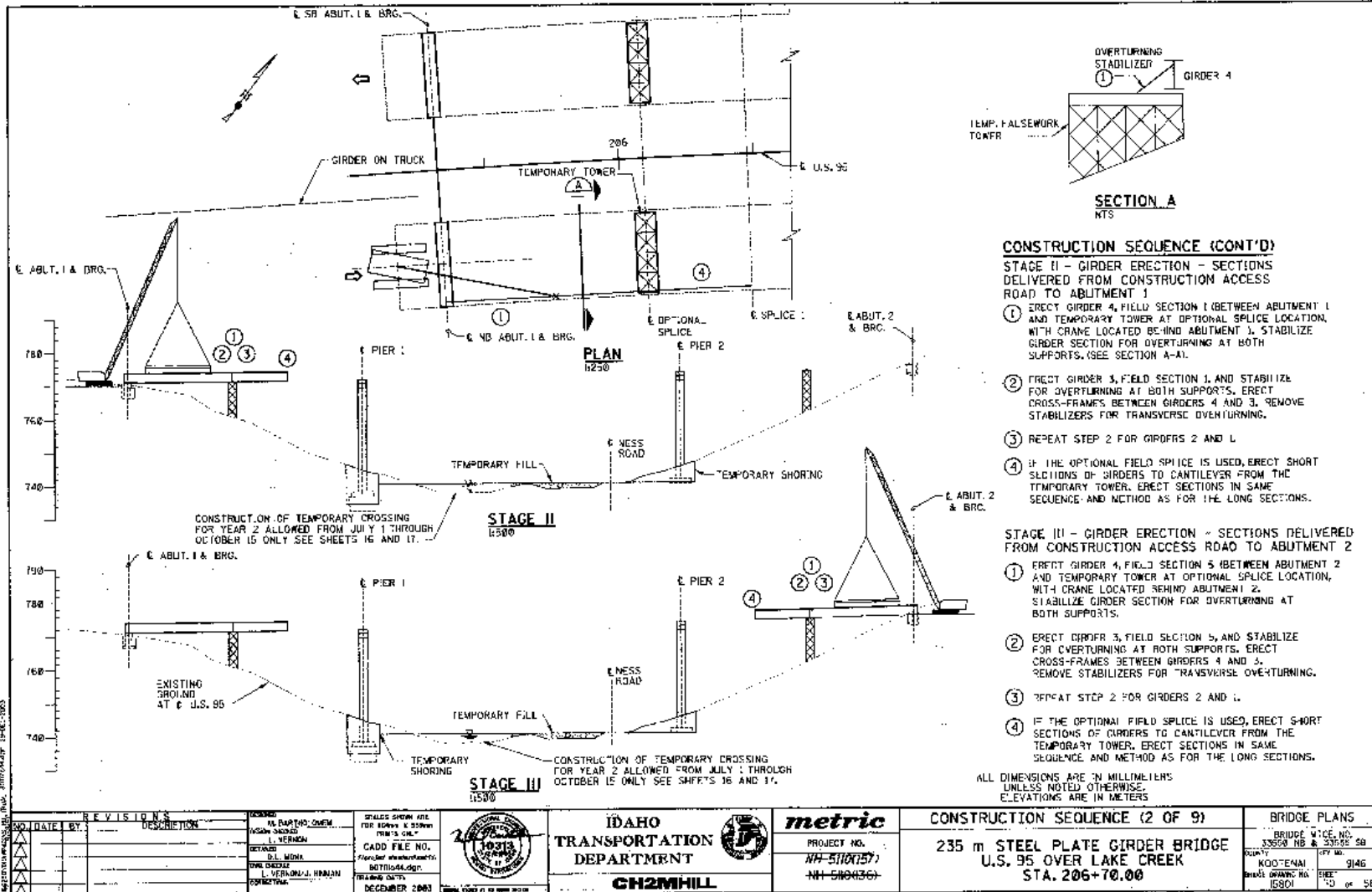
- Stresses on girders during shipping (upright or on side)
- Length of girder piece
- Shipping Options
- Staging

○ Girder Erection Considerations

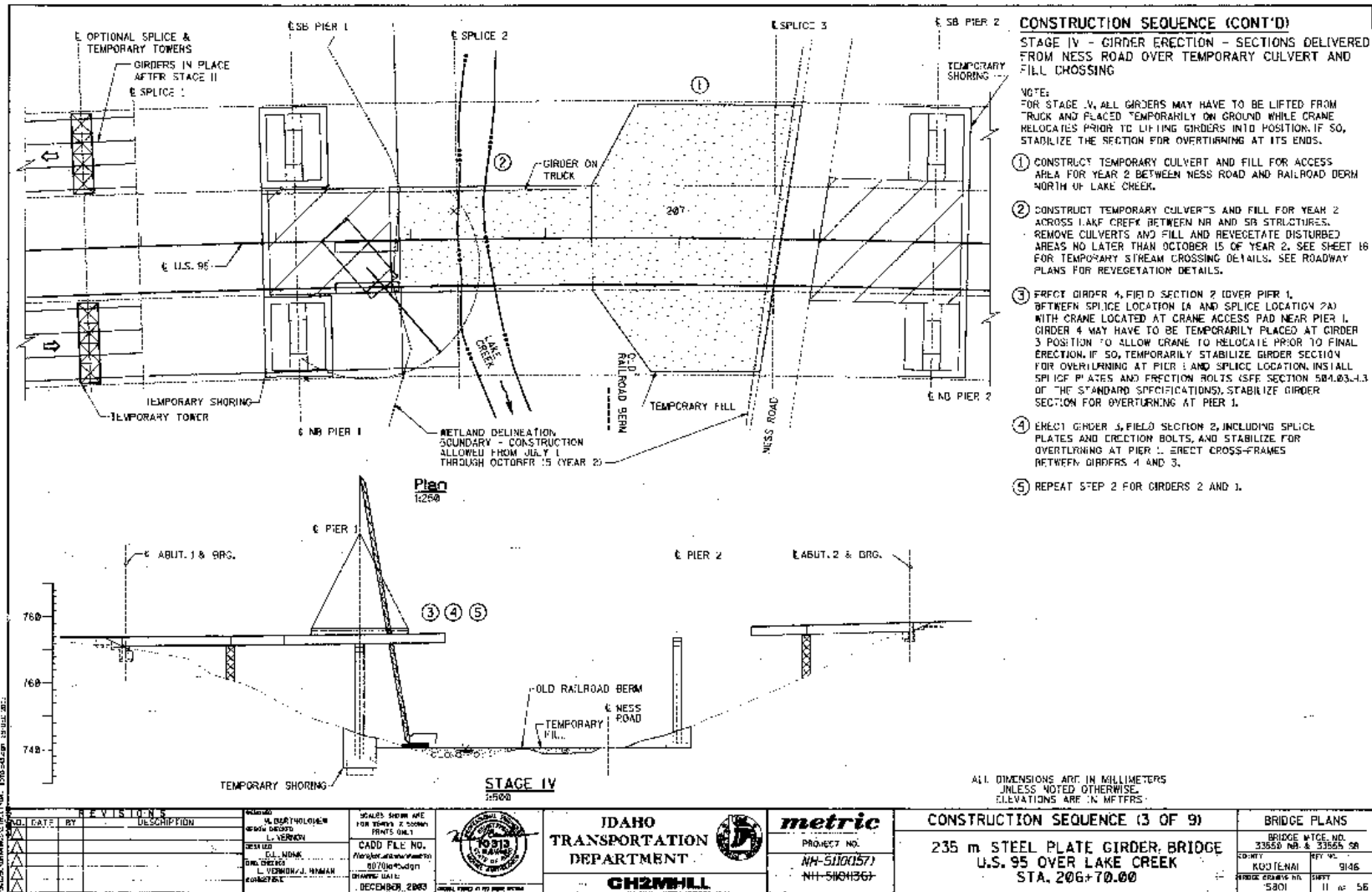
- Girder Launching vs. Crane
- Large Crane Availability
- Picking and setting
- Prepared Construction Sequence plan to illustrate that bridges were constructible



Design Challenges – Girder Shipping & Erection



Design Challenges – Girder Shipping & Erection



Constructability Review

HDR was hired by ITD to provide an independent constructability evaluation of the superstructure

Conclusions:

- Suggested adding optional field splice
- Launching is feasible (would require significant additional analysis and design)
- Suggested adding lateral bracing to decrease lateral deflection before deck is poured
- Confirmed conventional erection feasible

Construction Challenges Girder Shipping & Erection

- Bunking Requirements
 - $L_c = 43 * b^{0.25} = 8' - 3''$



Construction Challenges Girder Shipping & Erection

- Permit Restrictions
 - Time Limits
 - Over Height/Over Length



Construction Challenges Girder Shipping & Erection

- Girder Erection



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ONE COMPANY | *Many Solutions*

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Construction Challenges Girder Shipping & Erection

- Girder Erection



Questions?



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