Accelerated Bridge Construction

- “ABC”
- Innovative construction methods
- Reduce on-site construction time
- Reduce traffic impacts
Accelerated Bridge Construction

- **ABC Improves**
  - Site constructability
  - Total project delivery time
  - Work-zone safety

- **ABC Reduces**
  - Traffic impacts
  - Onsite construction time
  - Weather-related delays
ABC in Railway Bridges

- In rail industry, ABC is SOP
- Standard Operating Procedure for 30+ years
- Minimize disruption to rail traffic
- Maximize revenues
Challenges with Railway Bridges

- Defined rail network infrastructure
- Detours often involve competitor’s track
- Remote access
- Slow orders can affect entire system
- AMTRAK on many routes
- Minimal ROW for bypass (shoo-fly)
- Environmental permitting
Project Discussion

- Bridge replacements under live rail traffic
- Lateral slide techniques
- Float-out / float-in replacements
- Special case railway projects
- Newer methods of railway construction
Definitions

- Track window – defined time between scheduled trains
- Track closure – defined shut down
- Class 1 RRs (7) – Operating Revenues > $475.75M (2014)
- Class 2 (Regionals)  Class III (Short lines)  < $37.4M (2013)
Definitions

- AREMA (Chapters 7, 8, 9, 10, 15)
- Cooper E-80 loading

*Figure 8-2-1. Cooper E 80 (EM 360) Axle Load Diagram*
Stage Constructed - Foundations Under Live Rail Traffic, then Closure

- Wellsville, KS (30 Hr.)
- El Dorado, KS (36 Hr.)
- P&L RR over KY Hwy 282 (Weekend)
- Burlington, IA (30 and 36 Hr. Closures)
- Barstow, IL (16 Hr. Closure)
El Dorado, Kansas

36 Hour Changeout
El Dorado, Kansas
Elevation View – Replace Trestle

245’-4” New

Exist. Timber Spans at 14’ Spa.
New P/C Dbl-Cell Boxes at 42’
Bridge Deck Removal
New Pier

Exist. Timber Bent

Pile Splice

Detail A

HP14x117

30” Casing Pipe

24” Drilled Socket

Pile Clamp on Excavator

Pile Splice
New Cap Welded to Piles
Setting Cap and Steel Bent at Pier
At Existing Pier

New Dbl.Cell Box

Exist. DPG

Frame Bent
Setting Dbl-Cell Box Beam
Setting Dbl-Cell Box Beam
Typical Section

HP14x102
Jointed Track Panels
P&L RR over KY-282
Lateral Slide
P&L RR over KY-282
Removing Ballast
TPG Adjacent to Existing
Precast Abutments
Piling Installed Prior to Closure
Lateral Slide
Pulled With Winches
Lateral Slide
In Final Position with Ballast
In Final Position
BNSF 204.66 Mississippi River Bridge

Approach Span Float-Ins
BNSF 204.66 Mississippi River Bridge, Burlington, IA  Approach Span Float-Ins

- 250’ Approach Spans
Columbia River Bridge
Waddell & Harrington, Circa 1915
► Looking East to Illinois, 1920
Main Coal & Amtrak Route

Approximately 40 trains per day including 2 Amtrak
Construct Super-Caps

- Foundation elements outside bridge footprint
- Install large pier cap(s) below existing bridge
- Construct under traffic prior to changeout
- Considered mass concrete pours
Installation of 12’ Diameter Pier Caisson
12’ Diameter Pier Caisson
Installation of Oscillator Platform – 48” Diameter
• Drilled shafts – 12’ dia
• Installed in 60-80’ sections, then welded together
• 125’ to 175’ in length
Completed 12’ Diameter Pier Caisson Installation
Drilling 11’ Diameter Rock Socket w/ Kelly-bar

- Rock sockets – 11’ dia
- 35’ to 45’ in length
Cages range from 160’ to 210’ in length to anchor into solid rock.
Pier 2 Drilled Shafts Complete w/ Cages in Place
Drilled Shaft Complete w/ Cages in Place

- Up to 850 yd$^3$ concrete was used for each shaft
- 9000 yd$^3$ total for drilled shafts
Floating Soffit Forms for Pier Caps Being Installed
Reinforcement Installation - Pier Caps

- Rebar Weight in Each Cap: 106,000 lbs
Pier Cap Forms Complete and Ready for Pour

Pier Cap Dimensions:
10’x14’x68’
Pier Cap Finishing and Elevation Verification
Completed Pier Cap
Replace Approach Spans

► Replace Whipple truss spans with 6- 250’ trusses
► Replace W. appr. DPG w/ 132’ and 92’ DPG’s, & 28’ conc.
► BNSF Railway funding: $68.7M
► Total bridge length = 2,146 ft.
► Total weight = 16,771,830 lbs (8386 tons)
Key Dates and Scheduling

► Project: May 2010 - July 2012

► Phase 2: Spans 1 & 2 Oct. 2011 (36 hr. track closure)
► Phase 3: Spans 3 & 4 Feb. 2012 (30 hr. track closure)
► Phase 4: Spans 5 & 6 Mar. 2012 (36 hr. track closure)
Various Truss Components at Green Bay Bottoms (17 miles downstream of Burlington)
Truss Erection Yard Green Bay Bottoms

- 17 Miles downstream from Burlington
Runway Platform over Levee
Spans 2, 3 & 4 (17 miles downstream)
Existing Spans 1 & 2, Float-out Barges in Place
Truss Span 1 Float under VLS
Truss Span 1 Float under VLS
Truss Span Transporting Upstream
Aerial View – Phase 2 Complete
Spans 3 & 4 Moored Downstream
Spans 3 & 4 Awaiting Float-In
Float-In Complete of Spans 3 & 4
Temporary DPG, Truss Span 5 and Jump Span 3
Phase 4 Window – 36 Hrs. to Install Spans 5 & 6
Phase 4 Window – 36 Hrs. to Install Spans 5 & 6
New Span 5 Floated Into Position
Final Alignment After Ballast Placement
All 6 Truss Spans Installed
Falsework with Transfer to Barges

P&L RR Tennessee River Bridge near Kentucky Lake, KY
500’ Main Span
BNSF 43.41, Barstow, Illinois
BNSF 43.41, Barstow, IL – Before
Subcaps Installed
Bridge Removed – Caps Installed
Typical Section
New Bridge Installation
Final Product
BNSF Bridge
Spanish Lake, Missouri
Railroad over Roadway
Roadway Span with On-track Equipment
Elevation and Cross Section

Steps to track level
Belgrove Ave.
Watkins Creek

Elevation

Cross Section

Open deck replaced with precast concrete ballasted deck
Existing 5'-4" Girders
New 5'-0" Truss

18'-6"
12'-8"
Multiple Spans
Ballast Pans Delivered
Setting Ballast Pan
Setting Ballast Pan
Ballast Pan and Track
HCB – Hybrid Composite Beam®
(Hillman Composite Bridge)
Testing at TTCI - Pueblo, CO

- HCB 42’ Span
- 244 MGT

- Strategy:
  - w/2 - 25T cranes
  - 45’ vs. 30’ spans
Testing at TTCI - Pueblo, CO
Schematic

Free Body Force Diagram

Hybrid-Composite Beam (HCB®) Design and Maintenance Manual
CP Railway, BC

HCB-8-hour track window
33’ Span
Piece weight  6000 lbs.
Fully assembled 42,000 lbs.
BNSF Railway, CO

HCB-8-hour track window
42’ Span
Piece Weight 7600 lbs
Fully assembled 53,000 lbs.
Bridge Raising

Spirit of St. Louis over I-64 - Missouri
Spirit of St. Louis over I-64 - Missouri

Existing Bridge
Spirit of St. Louis over I-64 - Missouri
Raise Bridge 2 Feet
Provide Required Vertical Clearance
Spirit of St. Louis over I-64 - Missouri
Raise Bridge 2 Feet
Provide Required Vertical Clearance
Spirit of St. Louis over I-64 - Missouri
Raise Bridge 2 Feet
Provide Required Vertical Clearance
Spirit of St. Louis over I-64 - Missouri
Raise Bridge 2 Feet
Provide Required Vertical Clearance
Spirit of St. Louis over I-64 - Missouri

Before

After
Lessons Learned

► Revenue generation is paramount
► Economics drives use of accelerated construction (SOP)
► Bridge type?? – economics (again) & constructability
► Ongoing maintenance necessary
► Consider - equate private revenue to user cost
► Higher cost justifies minimizing traffic disruption
Thank you.