Essentials of Slide-in Bridge Construction: A Guide for Bridge Designers

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Agenda

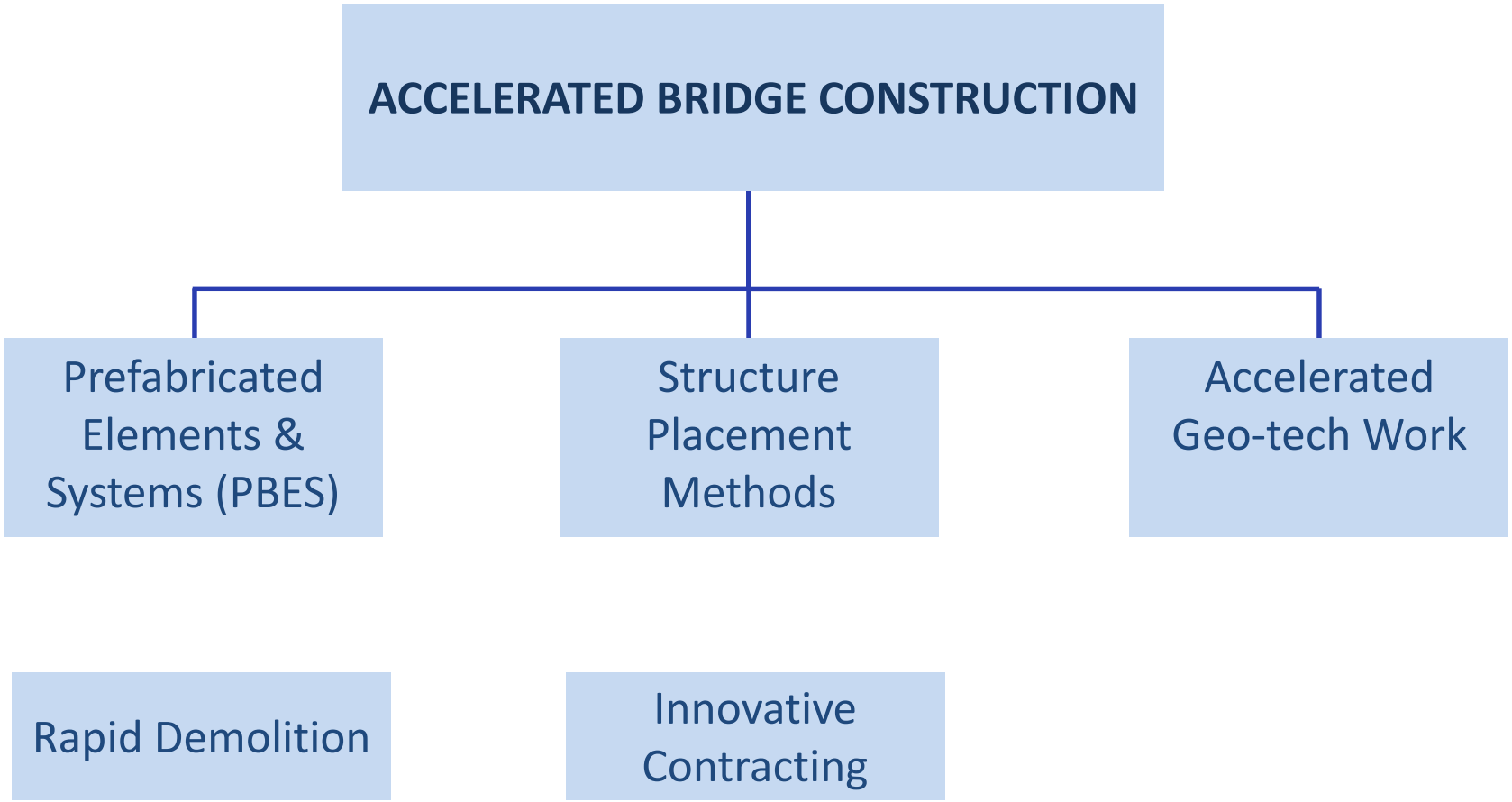
- ❑ Introduction to ABC
- ❑ Introduction to Slide-In Bridge Construction (SIBC)
- ❑ Slide shoes
- ❑ Movement systems
- ❑ Components of SIBC design
  - Permanent Bridge Design
  - Temporary Support System
  - Push / Pull System
  - Sliding Bearings
  - Sliding Forces
- ❑ SIBC Case Study

What is ABC ?

Accelerated Bridge Construction (ABC)

ABC is bridge construction that uses innovative planning, design and construction methods to reduce *mobility impacts* when replacing / rehabilitating existing bridges.

ABC Elements and Methods



Benefits of ABC

Reduces disruption to operations/ service

Safer; reduces exposure of workers and public to construction activities

Better quality control due to prefabricated elements

Reduced environmental impacts

Time Metrics for ABC – Mobility Impact Time

Mobility Impacts Within:

Tier 1: Overnight or < 24 hours

Tier 2: Weekend or < 3 days

Tier 3: Up to 2 weeks

ABC Time

1. On-site construction time
2. Mobility impact time (ABC closure period)

ABC can minimize both

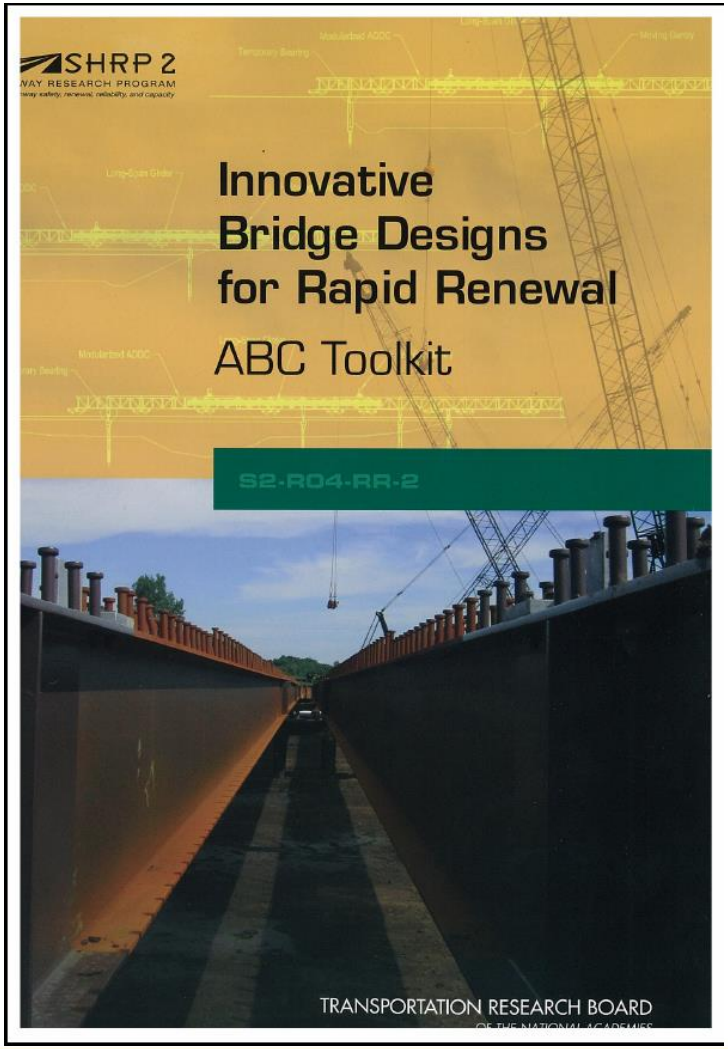
Project R04

Innovative Bridge Designs for Rapid Renewal

2007 – 2013

HNTB – Prime

SHRP 2 ABC Toolkit



- SHRP 2 *ABC Toolkit*
- Published 2012
  - Prefabricated elements
  - Slide-In Bridge Construction (SIBC)

www.trb.org

Prefabricated Elements & Systems (PBES)

Self-Propelled Modular Transporter (SPMT)

- Multi-axle platform
- Each axle moves independently
- Moves on uneven terrain

Lake Champlain Bridge, NY – Float-In

Slide in Replacement

What is Slide In Bridge Construction (SIBC)

- A method of accelerated bridge construction also known as horizontal or lateral sliding.
- New superstructure is built parallel to existing bridge on temporary supports.
- Old bridge is then demolished, new substructure constructed, and then new bridge is slid into place.
- In some instances the new substructure is constructed below the existing structure, this reduces the overall traffic disruption time.

Slide-In Bridge Construction (SIBC)

- Sliding technique allows the new superstructure to be built alongside the exiting reducing traffic impacts.
- Requires availability of ROW / space.

Alternate Approach to SIBC

- In other instances, the existing bridge is first slid off of the existing alignment and then used as a temporary bypass bridge while the new bridge is constructed on the old (existing) alignment.
- In this case, the temporary substructure system must not only provide support for the bridge, but also live load and other transient loads.

Impediments to Using SIBC

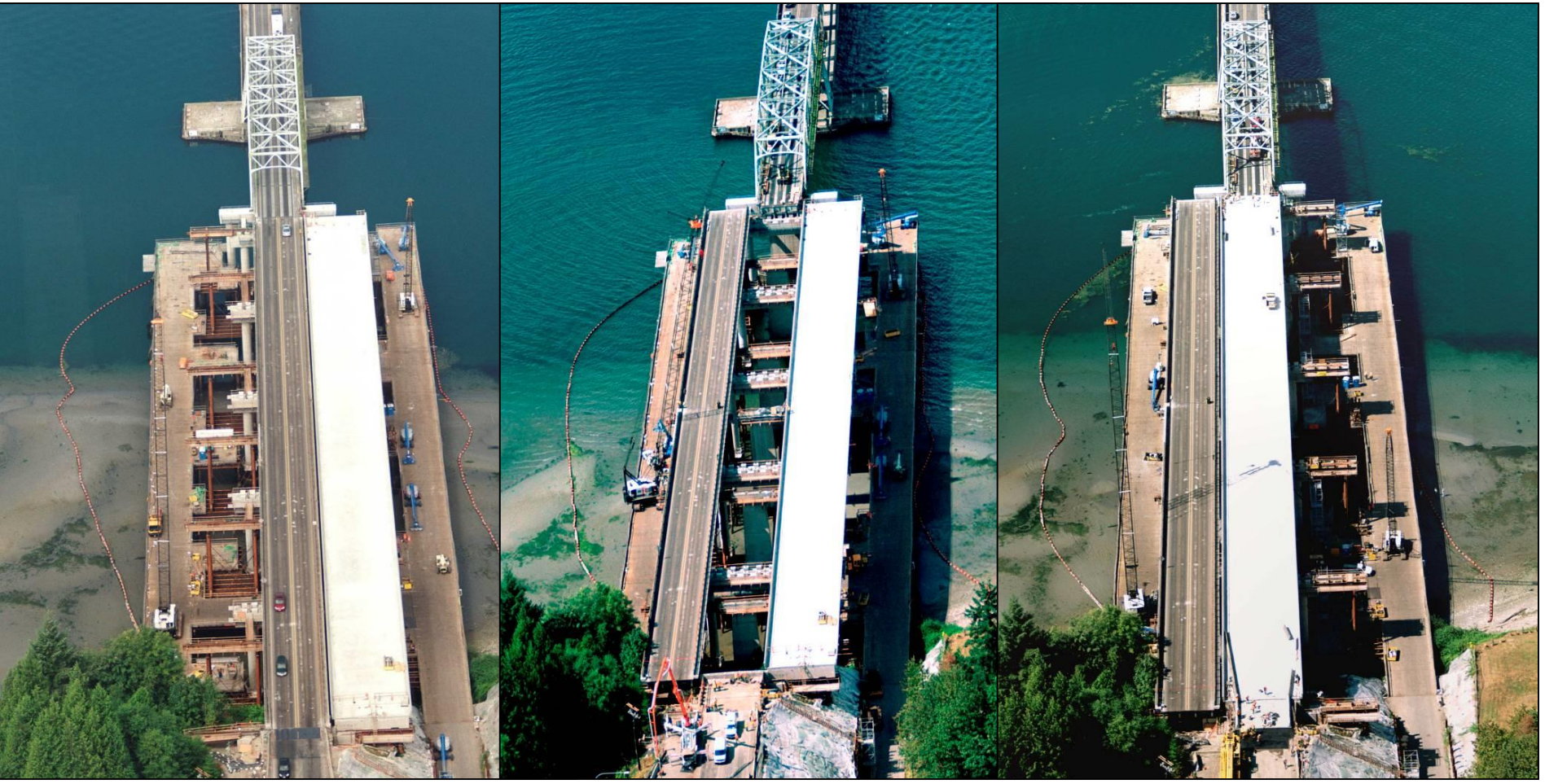
- Impediments to SIBC
  - Limited ROW
  - Terrain around existing bridge is rugged
  - Geotechnical conditions cannot adequately support temporary works
  - Alignment restrictions

When to Use SIBC

- Bridges on high ADT routes over low ADT routes
- Bridges over waterways
- Railroad bridges
- Ideal conditions for SIBC
  - Wide, flat area(s) adjacent to original structure

NJ Transit Hogback Bridge – Gladstone Line Weekend Slide in Replacement 2004

Roll-Out Roll-In
Hood Canal Bridge WSDOT



Before During After

Roll-Out Roll-In
New York City 2005

- Bridge over I-678 – Van Wyck Expressway
- NYSDOT

Slide Bearings

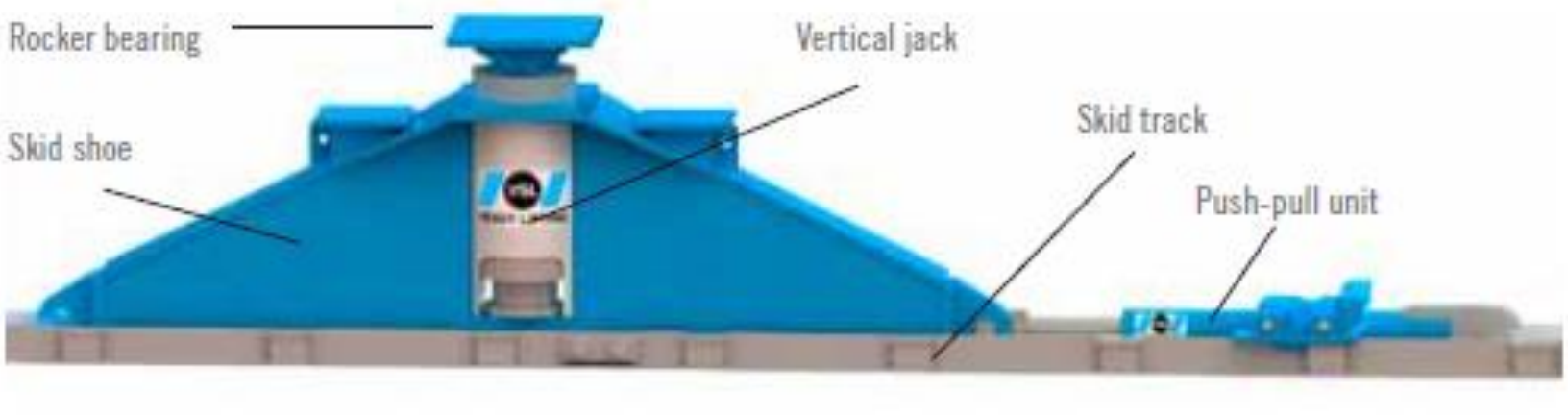
- Rollers
- Teflon Pads

Skid Shoes

Skidding System

Sliding System Main Components: skid shoes, push-pull units, skid tracks, hydraulic pumps and a monitoring and control system.

VSL Skidding System

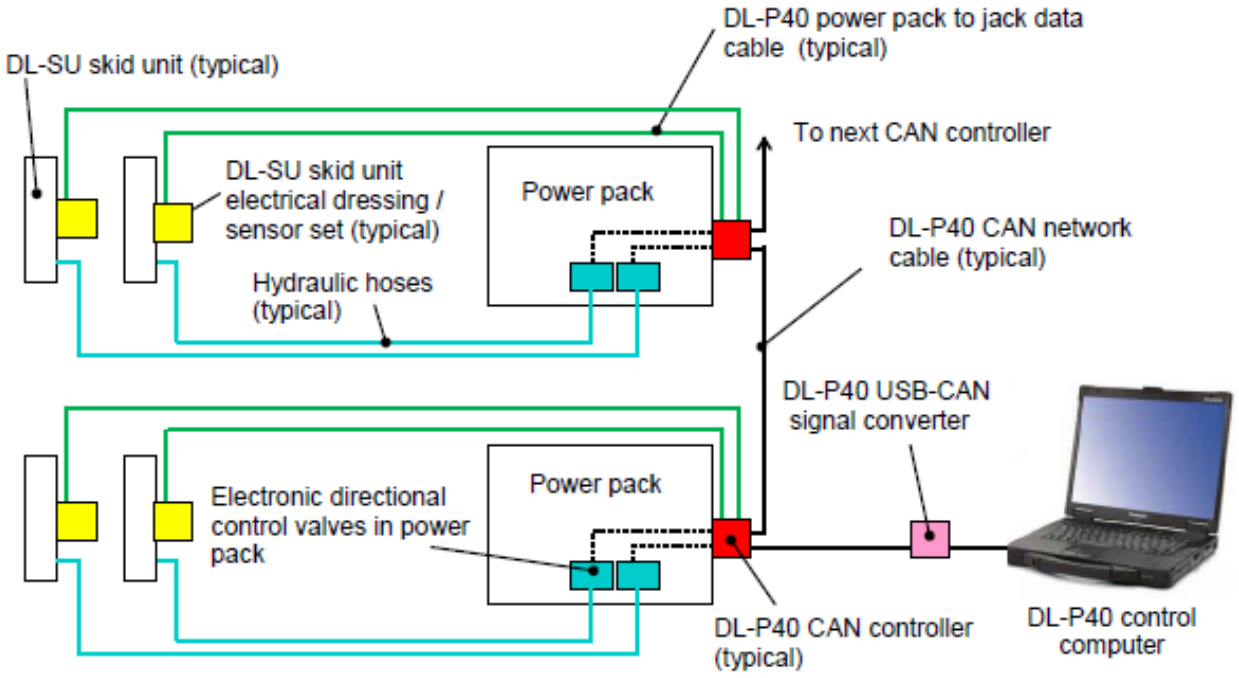


Series of Teflon pads are mounted on the skid track

Skidding System

- Special skid tracks are available for use when moving loads along curves.
- A simplified version called a **skid beam** can be used if the load does not need to be raised in the vertical direction
- Capacity up to 250 tons per shoe

Synchronous Jacking and Skidding Systems

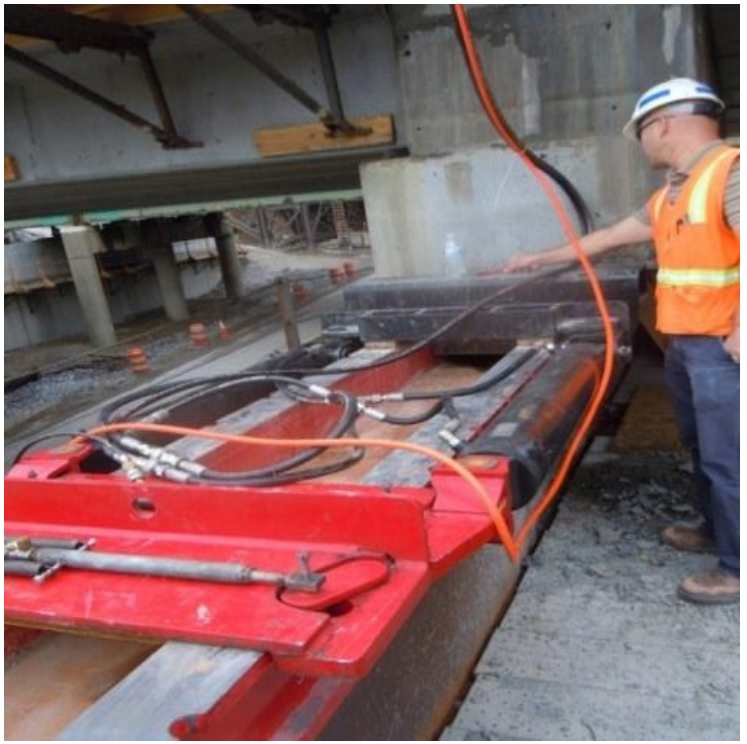


Control System

Load, stroke in the skidding jacks is monitored on the control computer

Hydraulic Power Pack

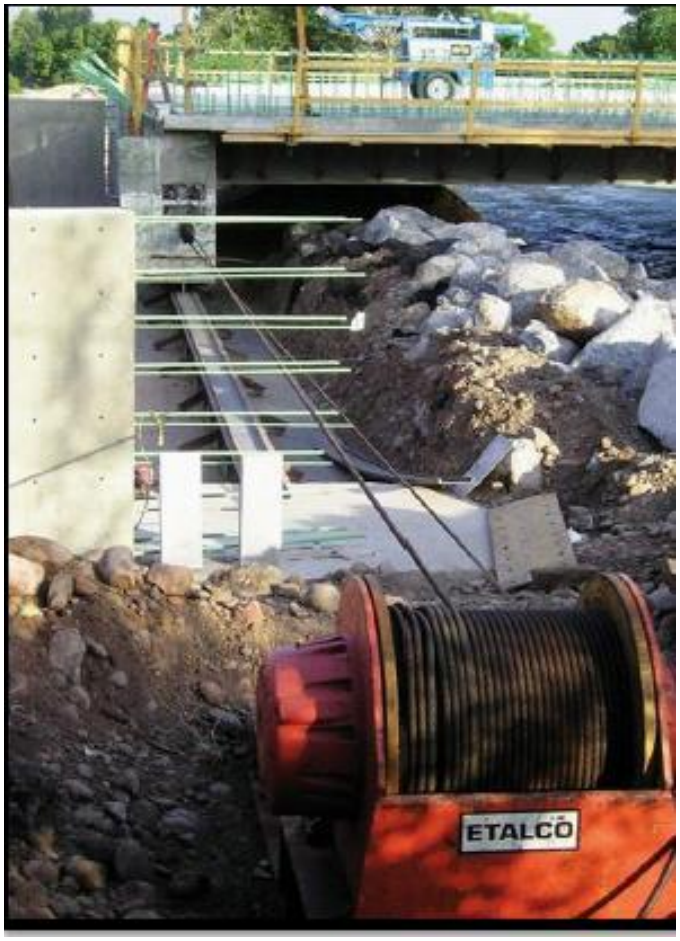
Movement Systems



Push/Pull hydraulic jacks

Movement Systems

Pulling with
strand jacks / Power winch



Movement Systems

NJ TRANSIT,
Hogback Bridge
Come-Along cable puller

Components of Slide-In Construction Design

1. Permanent Bridge Design
2. Temporary Support System
3. Push / Pull System
4. Sliding Bearings
5. Sliding Forces

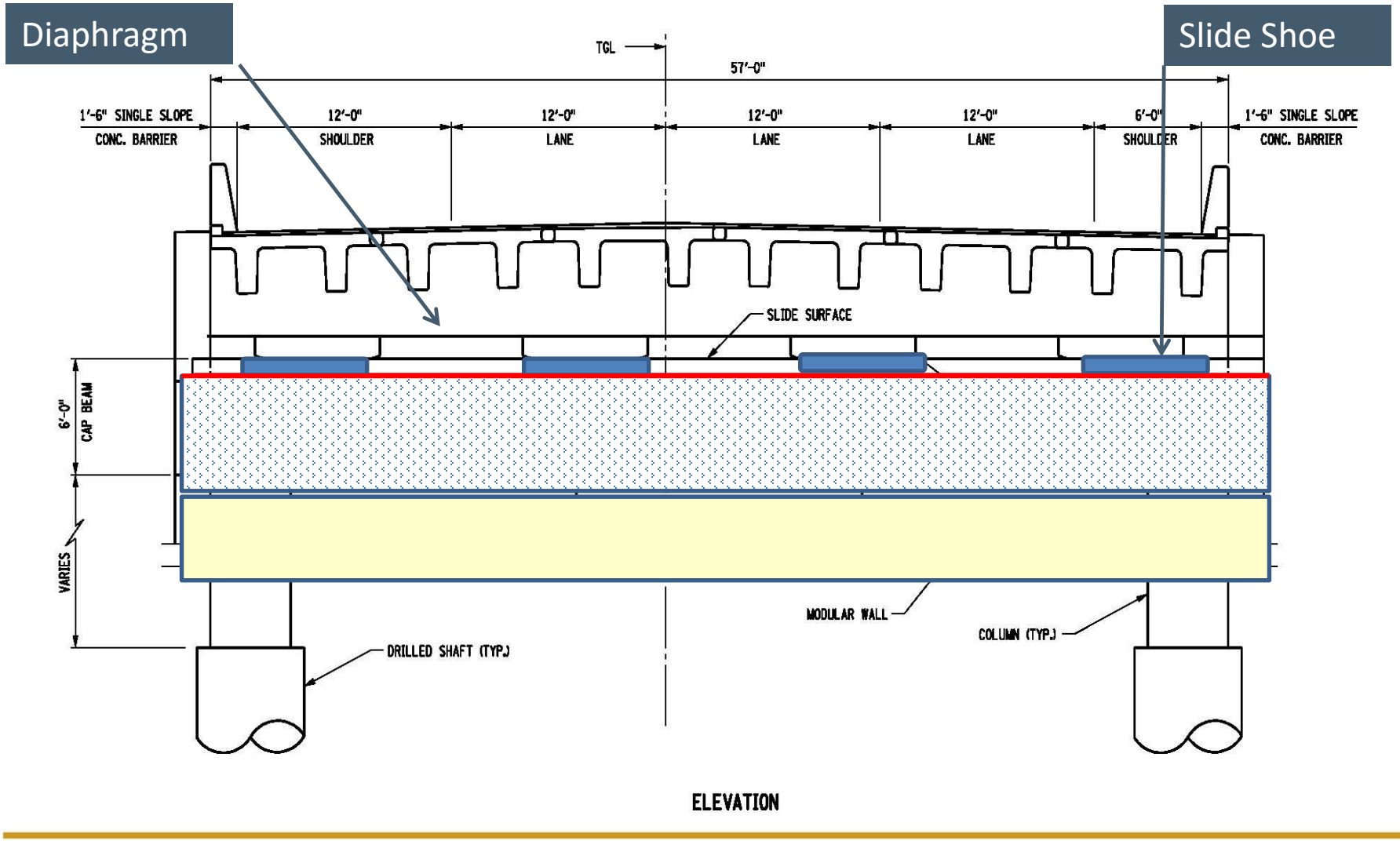
1. Permanent Bridge Design

- The design of the permanent bridge must consider anticipated construction activities.
- Consideration of the how the new bridge will be slid into place.
- Strengthening or modifying components of the superstructure and the substructure
  - Local areas where the push/pull system will be attached,
  - Where the sliding plates and/or rollers will support the structure, and
  - Where the sliding track will be installed.

- **End diaphragms and end diaphragm connections which support the bridge during the lateral slide**
- **Flexural, shear effects on capbeam from moving vertical load**

Slide Support at Abutment

I-84 NY Bridge Slide



End Diaphragm & Slide Shoes

2. Temp Support System (falsework)

- Design must consider all applicable load effects including environmental loads as well as the anticipated load effects applied by the sliding system. (Contractor designed)
- Relative stiffness of permanent support structures (likely relatively stiff) versus stiffness of temporary support structures (likely relatively flexible).
- Anticipated deflection / settlement of the temporary system.
- Provisions for vertical adjustment of track girder
- Attach the temp support to the permanent structure for lateral restraint

2. Temp Support System (falsework)

Design of Temp Support System (falsework)

- Temporary works usually lies within the contractor's responsibilities.
- Must be conducted by a competent, registered professional engineer.
- Geotechnical work must be the responsibility of the engineer of record.
- Additionally geotechnical borings and report may be required to ensure that the temporary foundation system operates as desired/needed.

3. Push / Pull System

- Adequate force application to overcome frictional forces
- Hydraulic jacks offer the opportunity to either push or pull the system. Strand jacks and winches are used for “pull only”
- Pairs of opposing strand jacks and winches can be used to develop a push/pull system
- System controls to ensure all components of the push/pull system work together
- Displacement control during the slide to ensure that the ends of the superstructure move at the same rate and thus avoid any racking or binding.
- Contingency planning in the event of equipment failure

4. Sliding Bearings

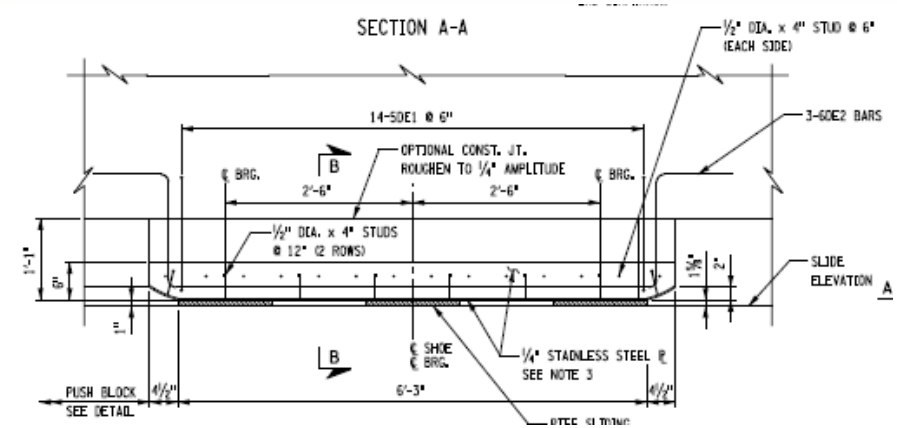
- Steel rollers, slide plates or PTFE sliding bearings can be used as sliding elements.
- Rollers have higher load capacity
- Rollers and slide plates require removal whereas a slide bearings could be designed to remain as part of the permanent structure.
- Eliminates vertical jacking requirements at the conclusion of the slide, saving money and time
- Rollers are more costly than pads and are often used on bridge projects with larger load requirements.

4. Sliding Bearings

- Pads also allow the use of an unguided system that will not bind if ends of the bridge move at different rates.
- Continuous lubrication of the pads is critical during the slide.
- Normally, the sliding surface of the shoe consists of polished stainless steel.
- Often, slide pads are reused in a slide as the bridge slides over them. For the final move into the bridge's permanent position, new pads are placed and left in place.
- Monitoring is especially important on bridges moved without guides.

Slide Shoes & Slide Bearings

PTFE Bonded to Elastomeric Pad

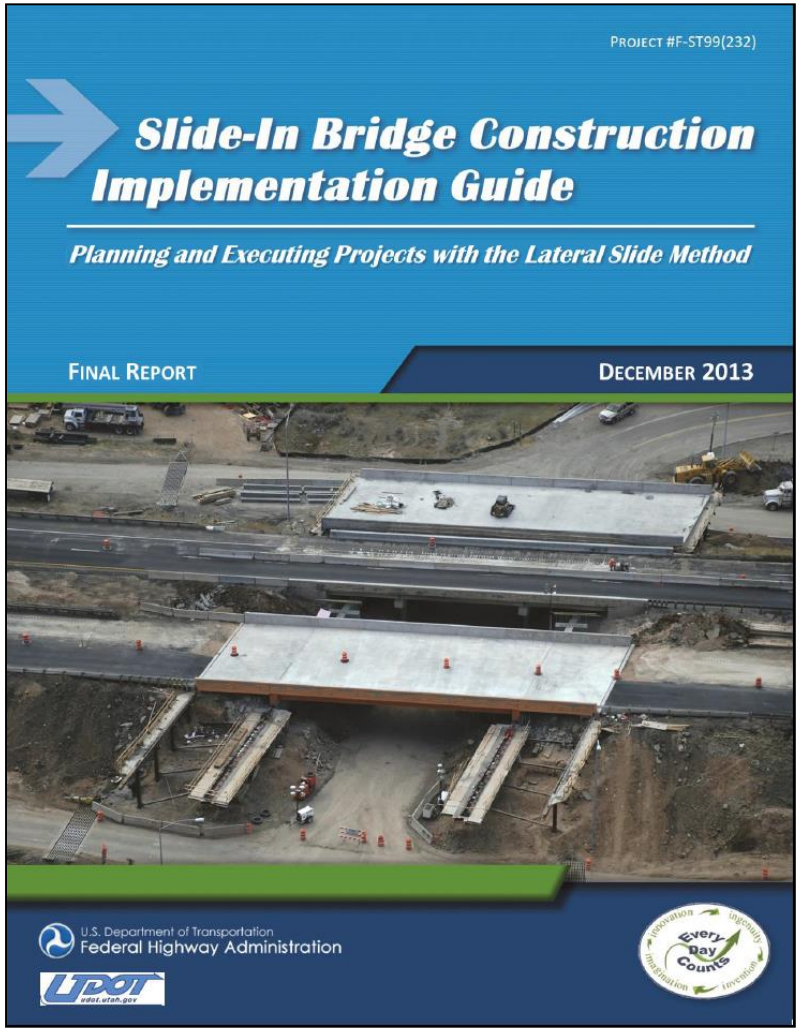


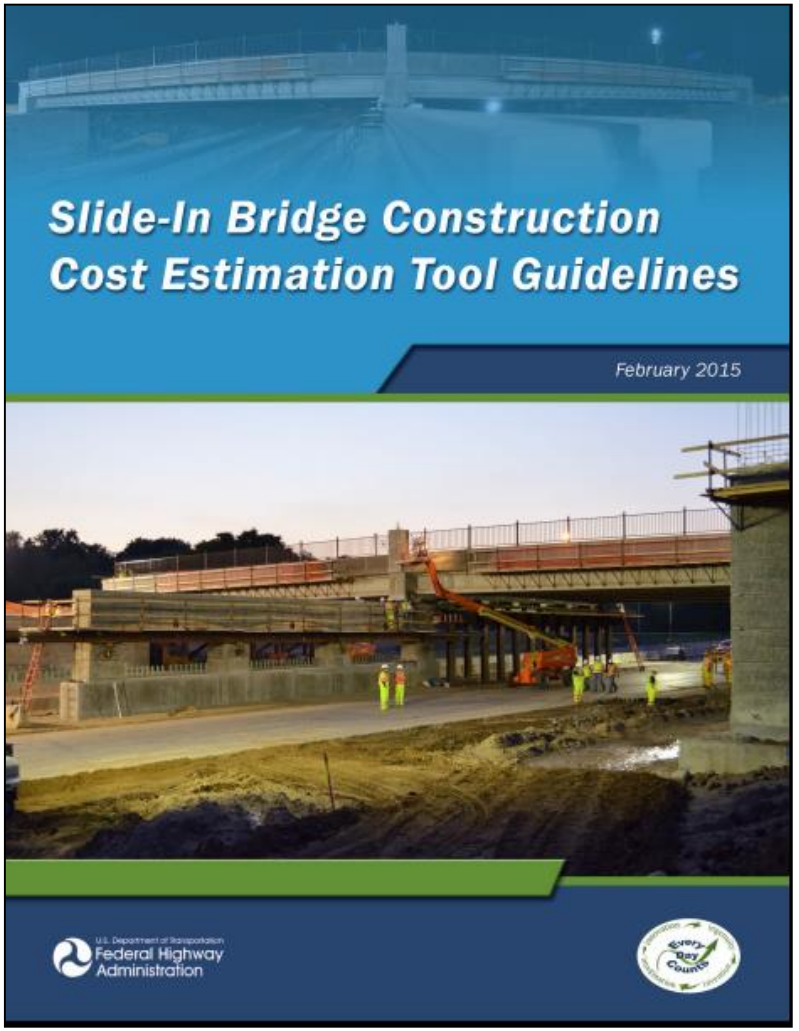
5. Sliding Forces

- Coefficients of friction for PTFE (Teflon) bearings are given in the *AASHTO LRFD Specifications*.
- Static coefficients in the range of 0.09 to 0.12 and dynamic coefficients in the range of 0.05 to 0.06 . Rollers have lower friction values
- Use a **trial slide** to verify friction values
- Pushing or pulling mechanisms should have a capacity in excess of the calculated pushing or pulling force in anticipation of higher frictional effects.

Slide Mechanism	Coefficient of Friction
Teflon coated neoprene bearing pads	10% of Vertical Load
Hillman Rollers	5% of Vertical Load

FHWA SIBC Implementation Guides





Slide In Bridge Construction:

Case Study

SHRP2 Demonstration Project

Slide-In Bridge Construction
Weekend Replacement of NY I-84 Twin Bridges

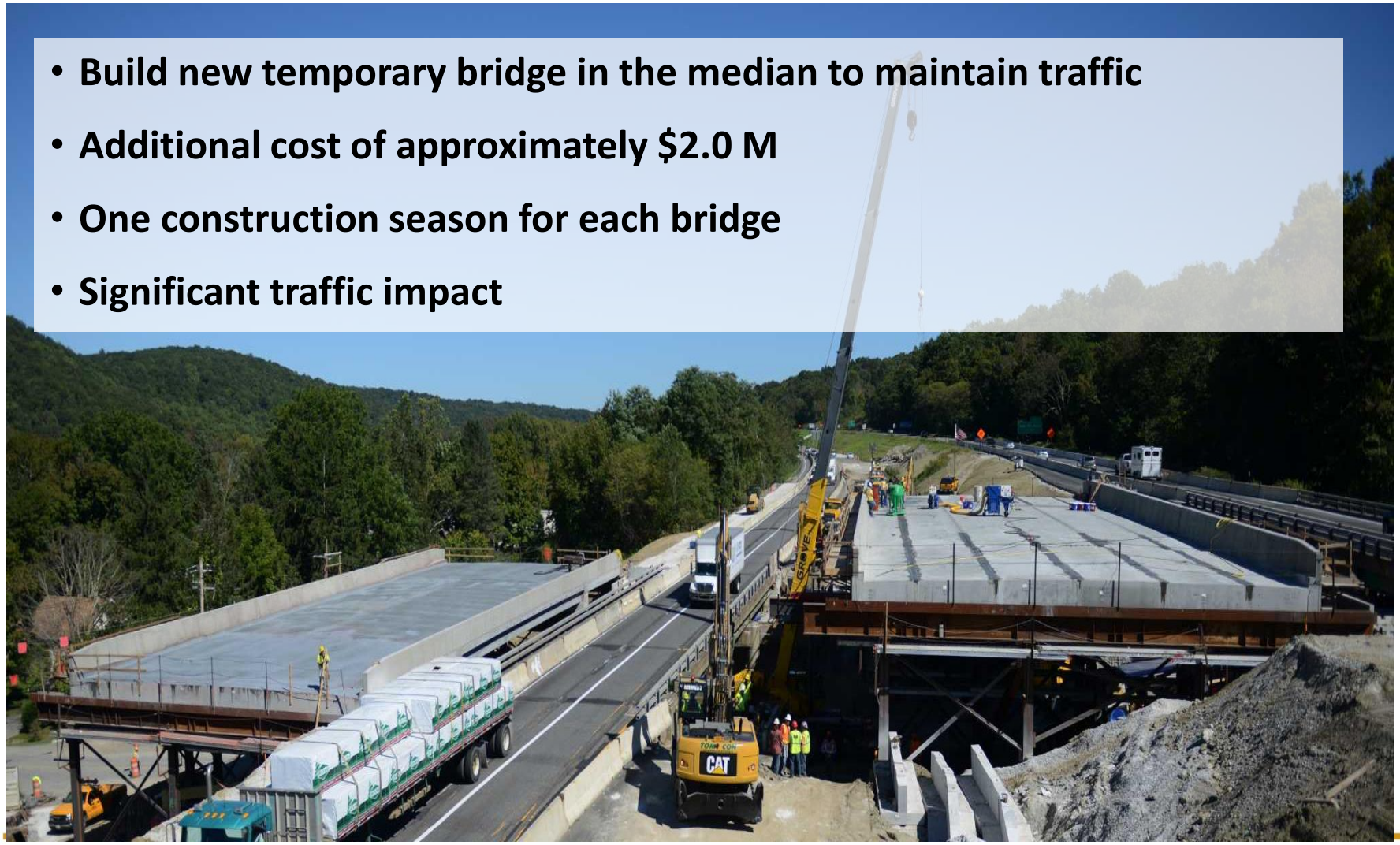
- 20 Hr closure
- Two weekend nights
- Sept 21, 2013
- Oct 19, 2013

Weekend Replacement of NY I-84 Twin Bridges

- Over 75,000 ADT
- 16% trucks
- Existing bridges are too narrow for cross-overs
- Elevation differences between EB & WB roadways
- Underpassing road at 16% grade

Original Plan

- Build new temporary bridge in the median to maintain traffic
- Additional cost of approximately $2.0 M
- One construction season for each bridge
- Significant traffic impact



ABC Design: Slide-In Replacement

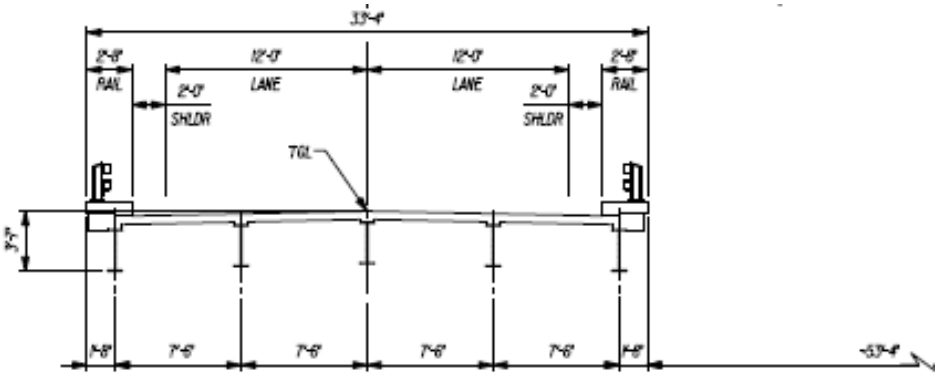
- Slide-In replacement over two weekend nights
- Traffic disruption on I-84 reduced from two years to two Saturday nights (20 hr closures).
- Incentive/disincentive clause: $10,000 per hour for early or late completion ($50 K max incentive)
- Eliminates need for a temporary bridge & cross-overs – over; $2 M savings.
- Both slides completed within 10 months after NTP
- Traffic detoured onto state Route 6 for 20 hrs.

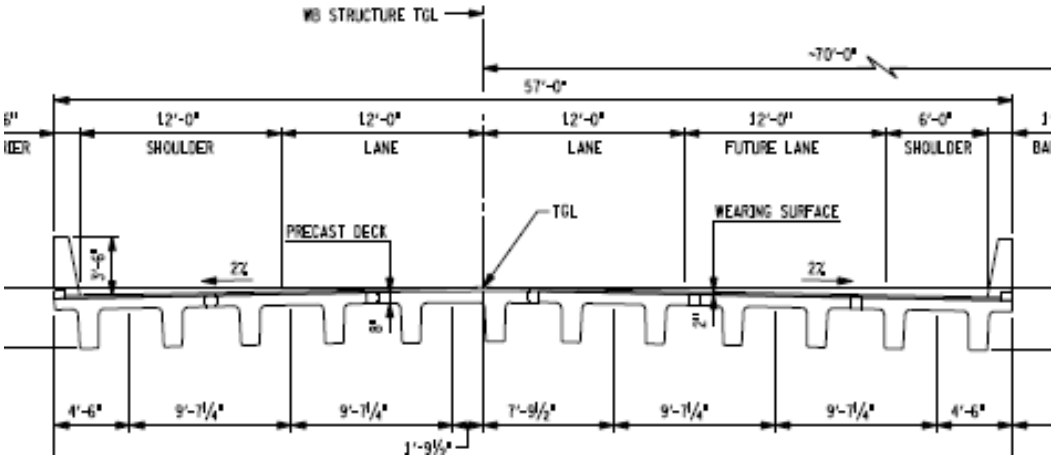
ABC Approach

Rapid Demolition – 4 Hrs

- Chop and Drop
- Local road below closed

Superstructure Sections





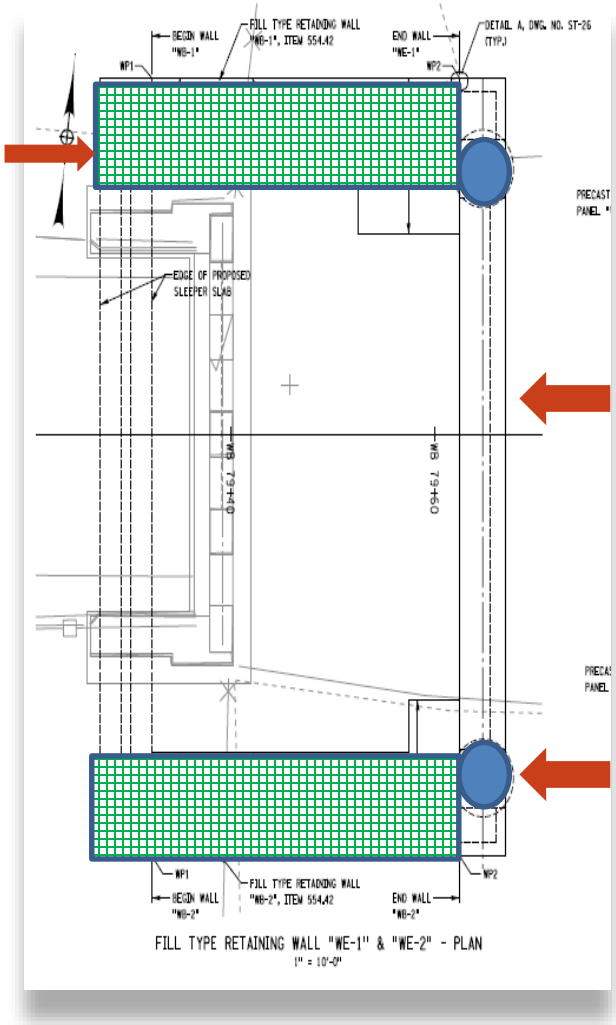
- Double T beams (NEXT)
- Precast approach slabs
- UHPC closure pour

ABC Design - New Bridges

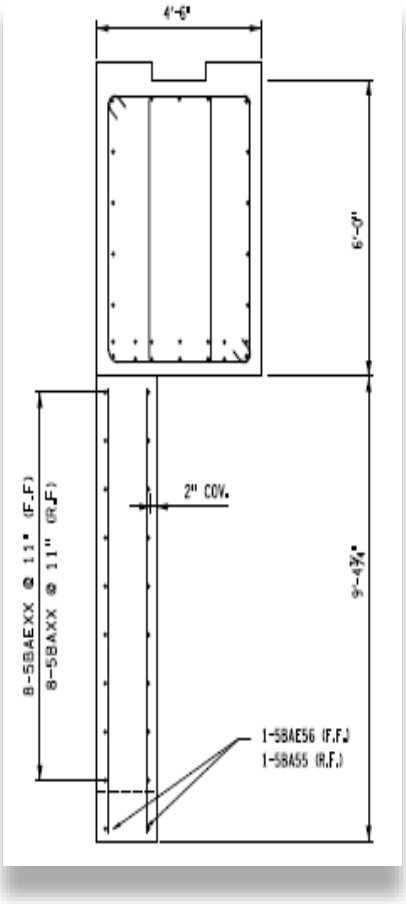
- Single span 80’; three lanes at 12’
- Left shoulder 6’, right shoulder 12’
- Bridge width 33’-4” ⇨ 57’-0”
- Use of asphalt wearing surface eliminates grinding
- Under passing Dingle Ridge Road on 16% grade
- New bridges are two feet higher than the existing to provide 14’-6” under-clearance.
- Minimize structure depth using double Tee sections

Abutment Design

T-Wall



Cap Beam

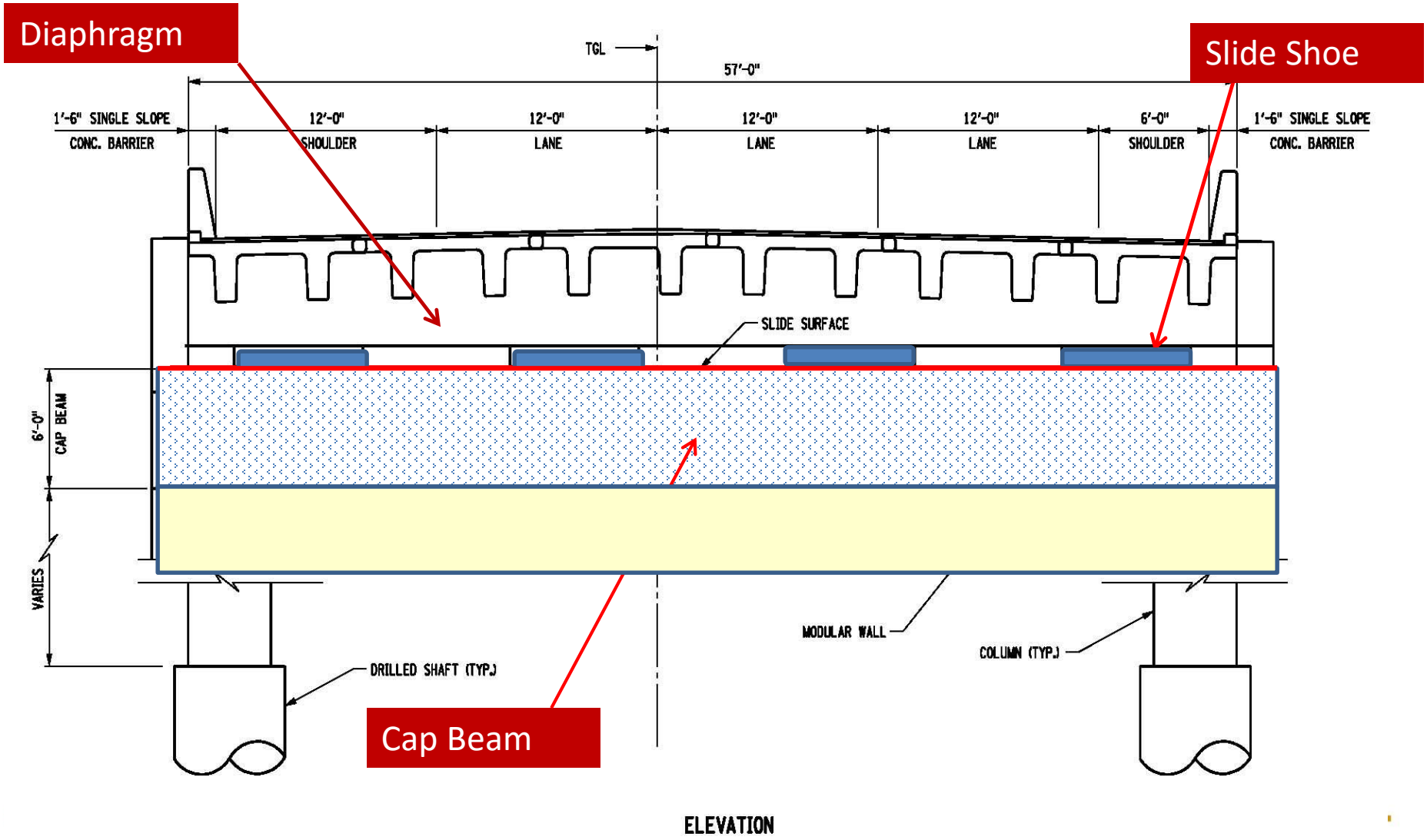


Drilled shafts supporting cap beam

Drilled Shafts Outside Existing Footprint

New Abutment

Straddle Bent Abutment



Falsework

Temporary Bents on H piles
Contractor designed

Slide Bearings

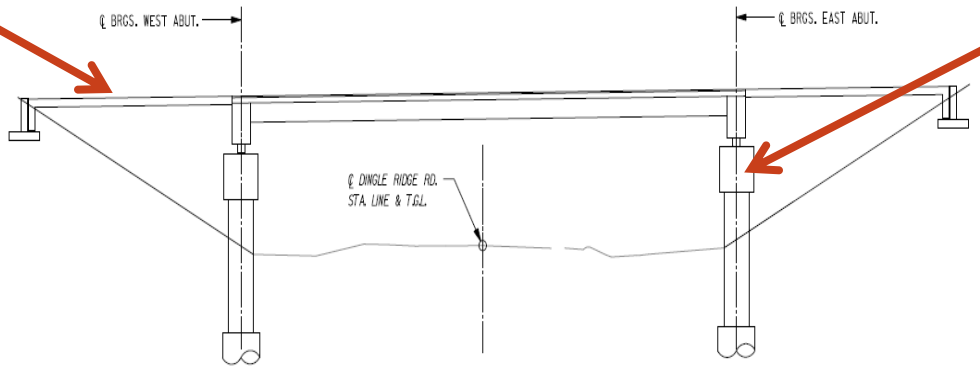
Stainless Steel on Elastomeric Bearings w/PTFE

PTFE bonded to Elastomeric Bearing

Slide-In Replacement Concept

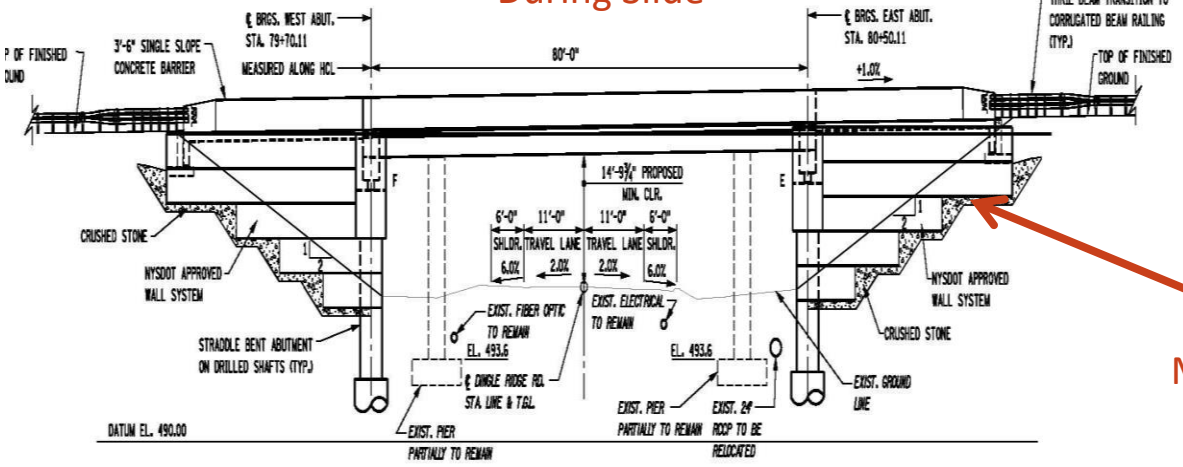
Temporary end span

Slide Surface



ELEVATION

During Slide

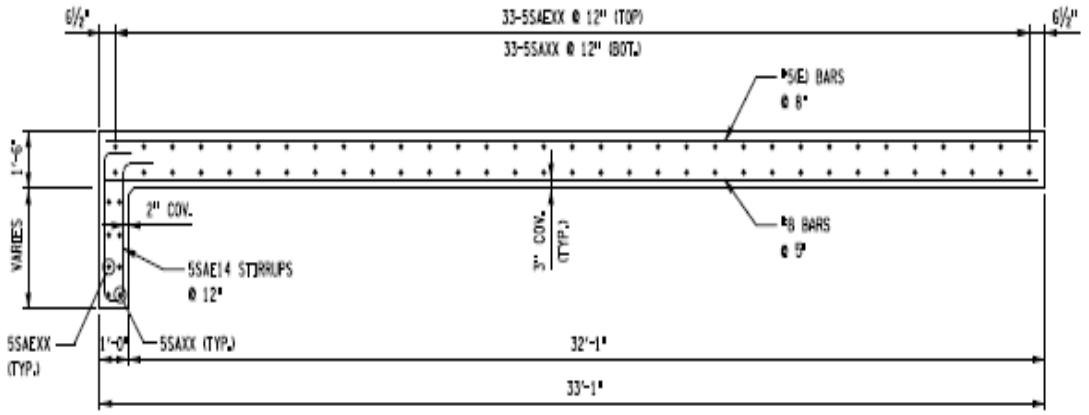


ELEVATION A-A

Modular walls

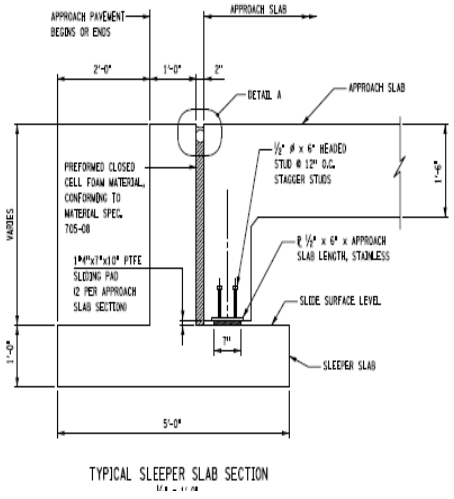
Precast Approach Slabs

Temporary End Spans Carrying Traffic



APPROACH SLAB UNIT ELEVATION

3/8" = 1'-0"



TYPICAL SLEEPER SLAB SECTION

Inverted T Sleeper Slabs

Lateral Slide -- Oct 21 2013

7 hours to demolish bridge and slide-in new bridge

Raising The Approaches

- Takes time: Critical path for closure period

Bridge Slides Completed 10 Months After NTP


OCTOBER 7, 2013 ■ A SUPPLEMENT TO ENGINEERING NEWS-RECORD
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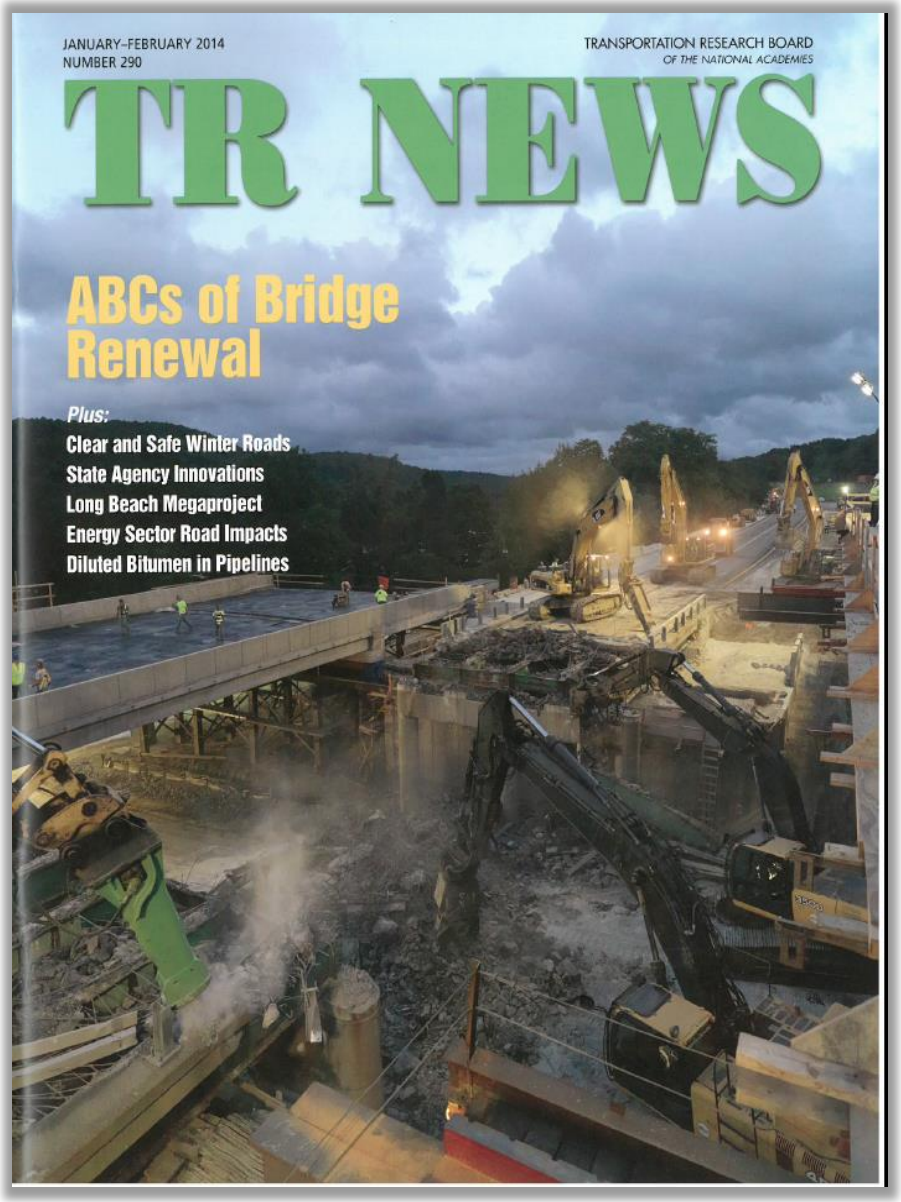
Crews Lay Pipe In Occupied Multifamily Housing Complex
DEERE
DEERE
McGRAW HILL CONSTRUCTION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ABC Benefits

- **Road Closure** will be significantly reduced from two construction seasons to two weekends.
- **Safety** within the work zone will be improved.
- **Reduced Costs** primarily by not building the crossovers and temporary bridge in the median ($2.0 M savings)
- **Impacts to the New York City watershed** will be substantially reduced; at least 5 acres of land will not have to be disturbed using ABC.

ABC is the clear choice

Thank You for Attending

Questions ?