Slide In Bridge Construction (SIBC)

National Perspective and Lessons Learned

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What is SIBC?

And

Why SIBC?
Traffic Congestion

- Average Rush-Hour Commuter spends 42 hours stuck in traffic each year
- Total 7 Billion Hours/ Year
- Cost to the economy= $160 Billion

(Urban Mobility Scorecard 2015)
Conventional Bridge Construction

Phase I

REMOVAL
(1A & 18)

EXISTING BARRIER TO BE REMOVED PRIOR TO SHIFTING THE TRAFFIC AS SHOWN, SEE DETAIL ON DWG NO. B13
Conventional Bridge Construction

Phase I

NEW CONSTRUCTION

(1C)
Conventional Bridge Construction

Phase 2 & 3
Conventional Bridge Construction

Phase 4
Conventional Bridge Construction

Phase 5
Prefabricated Bridge Elements
Slide In Bridge Construction (SIBC)
Slide In Bridge Construction (SIBC)
- Design-build, best value selection
- Winning team proposed two slide-ins to eliminate expensive detours and flagging
- Winning bid: approximately $50,000,000
- Engineers estimate: approximately $53,000,000
- Actual project duration: 32 months
- Estimated project duration: 54 months

48 Hours Closure
Slide In Bridge Construction (SIBC)
Slide In Bridge Construction (SIBC)
Why SIBC?

SIBC VS. Conventional Construction

- Reduced Traffic/ Mobility Impacts
- Shortened On-site Construction Time
- Enhanced Safety-Workers and Public
- Improved Quality & Constructability
- Reduced Environmental Impact
Resources for Innovation Implementation

State Transportation Innovation Council Incentive Program

- $100,000 standardize innovative practices
- 36 States received total of $3.5 million

Accelerated Innovation Deployment Demonstration

- Up to $1 million per project on Innovation
- 23 AID Demonstration Awards total $16 million
• MAP-21 Section 1304
• Innovative Project Delivery

• Increase Federal Share payable to a project by 5% for innovation (Faster, Better, and Smarter)
Lessons Learned

• Owner Perspective

• Engineer/ Designer Perspective

• Contractor Perspective
Lessons Learned

• Owner Perspective
Tools exist to help owners when to use ABC
- Flowcharts
- Weighted scoring method
- Matrix
- Narratives to describe the situation
- Analytical Hierarchy Process (AHP)
Flow Chart for Decision Making

Key Elements For SIBC

- Room to build the new bridge
- Road Crossing
- Temporary Work installation
- Short term road closure and detouring
Delivery Methods/Contracting

- Not all options are available in all locations – some governments prohibit certain contracting methods
  - Design-bid-build
  - Design-build
  - Construction Manager/General Contractor (CM/GC)
  - A+B contracting
Delivery Methods/Contracting

CM/GC Basics

- Risk Allocation
  - Difference Between D-B-B, D-B, and CM/GC?
  - CM/GC Shared Risk Approach

Risk = $$$
CMGC Implementation

Construction Manager/General Contractor
(December 2014)

- Institutionalized
- Post-Demonstration
- Demonstration
- Pre-Demonstration
- Opt Out of EDC

Construction Manager/General Contractor

<table>
<thead>
<tr>
<th></th>
<th>Dec 2014</th>
<th>Jan 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>States in Various Implementation Stages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-Demonstration</td>
<td>Pre-Demonstration</td>
<td>Demonstration</td>
</tr>
<tr>
<td>Dec 2014</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>Jan 2013</td>
<td>31</td>
<td>12</td>
</tr>
</tbody>
</table>

Legend:
- Federal Lands Highway
- Puerto Rico
- US Virgin Islands
- Washington DC
Design-Build

[Map of the United States showing Design-Build projects across different states, with a legend indicating institutionalized, post-demonstration, demonstration, pre-demonstration, and opt-out of EDC.]

[Bar chart showing the number of states in various implementation stages (December 2014 and January 2013).]

Federal Lands Highway
Puerto Rico
US Virgin Islands
Washington DC
Cost Consideration

SIBC Can Decrease Cost By:

- Eliminate Crossovers or Temporary Bridges
- Less Maintenance of Traffic (MOT) & Detours
- Reduced Time & Project OH Costs:
  - DOT Oversight, Administration, and CE&I
  - Contractor OH Costs
- User Costs
Total Project Cost

User Costs = Vehicle Operating Cost (VOC) + Delay Costs + Crash and Safety Costs
Slide Cost = 20% x Bridge Cost

FX, Experience Factor
FS, Site Complexity Factor
FTS, Temporary Shoring Factor
FJ, Vertical Jacking Factor
FA, AADT/Undercrossing Factor
S, Additional Site Costs
D, Additional Bridge Construction Costs
A, Additional Administration Costs
I, Additional Incentives/Disincentives
Specifications

SIBC Specifications - Intent

Project specifications communicate owner goals, project limitations, and construction requirements with respect to:

- Design
- Submittals
- Quality
- Construction Execution
- Risk
- Tolerances
- Roadway Closures
Lessons Learned

• Contractor Perspective
Contractor Method of SIBC

- Lateral Slide of Existing Bridge (Sellwood Bridge, OR)

Structure Translation

- **Equipment**
  - Pushing tugs and skids were rented, widely available
  - Teflon skidding surface lubricated with dish soap
  - Public was well informed = Good Press

- **Loads**
  - Structure was vertical loads 336 kips at ends, 900 kips interior
  - Skid force to move, estimated at less than 5%

- **Monitoring**
  - Advancement measured with marks on skid track
### Contractor Method of SIBC

**Push or Pull**
- Total Push = 13
- Total Pull = 14

**Slide or Roll**
- Total Slide = 21
- Total Roll = 8

#### Table A-4: List of SIBC Projects Considered for the Study

<table>
<thead>
<tr>
<th>State</th>
<th>Project Name</th>
<th>Year</th>
<th>Slide-in Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Push or Pull</td>
</tr>
<tr>
<td>Arizona</td>
<td>Oak Creek</td>
<td>1992</td>
<td>Push</td>
</tr>
<tr>
<td>California</td>
<td>Harcsrable Creek</td>
<td>2008</td>
<td>Push</td>
</tr>
<tr>
<td>Colorado</td>
<td>SH 71 ML over Ft Lyon Canal</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>Colorado</td>
<td>SH 266 ML over Ft Lyon Storage Canal</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>Colorado</td>
<td>SH 266 ML over Holbrook Canal</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>Colorado</td>
<td>US-34 over Republican River</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>Indiana</td>
<td>Milton Madison</td>
<td>2013</td>
<td>Pull</td>
</tr>
<tr>
<td>Maine</td>
<td>Littlefields Bridge</td>
<td>2013</td>
<td>Slide</td>
</tr>
<tr>
<td>Iowa</td>
<td>Massena Bridge</td>
<td>2013</td>
<td>Pull</td>
</tr>
<tr>
<td>Michigan</td>
<td>M-50 over I-96</td>
<td>2014</td>
<td>Push</td>
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<tr>
<td>Michigan</td>
<td>US-131 over 3 Mile Road</td>
<td>2014</td>
<td>Pull</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Larpeteau Ave Bridge</td>
<td>2014</td>
<td>Push</td>
</tr>
<tr>
<td>Missouri</td>
<td>I-44 over Gasconade River</td>
<td>2011</td>
<td>Push</td>
</tr>
<tr>
<td>Nevada</td>
<td>West Mesquite Interchange at 1-15</td>
<td>2012</td>
<td>Push</td>
</tr>
<tr>
<td>New York</td>
<td>I-84 over Dingle Ridge Road</td>
<td>2010</td>
<td>Push</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>Cotton Creek Bridge</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>Oregon</td>
<td>Depot Street</td>
<td>2006</td>
<td>Pull</td>
</tr>
<tr>
<td>Oregon</td>
<td>Elk Creek Crossing 3</td>
<td>2008</td>
<td>Pull</td>
</tr>
<tr>
<td>Oregon</td>
<td>Immaha over Little Sheep Creek</td>
<td>1997</td>
<td>Push</td>
</tr>
<tr>
<td>Oregon</td>
<td>OR-213 Jughandle</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>South Carolina</td>
<td>Ben Sawyer Bridge</td>
<td>2010</td>
<td>Pull</td>
</tr>
<tr>
<td>Texas</td>
<td>Fredericksburg Road Bridge</td>
<td>2011</td>
<td>Pull</td>
</tr>
<tr>
<td>Utah</td>
<td>I-80 at Summit Park</td>
<td>2011</td>
<td>Push</td>
</tr>
<tr>
<td>Utah</td>
<td>I-80 at Wanship</td>
<td>2012</td>
<td>Pull</td>
</tr>
<tr>
<td>Utah</td>
<td>I-80 over 2300 East</td>
<td>2009</td>
<td>Push</td>
</tr>
<tr>
<td>Utah</td>
<td>Layton Parkway</td>
<td>2010</td>
<td>Push</td>
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<tr>
<td>Washington</td>
<td>Hood Canal East Approach</td>
<td>2005</td>
<td>Pull</td>
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<tr>
<td>Washington</td>
<td>NE 8th Street</td>
<td>2003</td>
<td>Roll</td>
</tr>
<tr>
<td>Washington</td>
<td>WIS 29 EB Bridge</td>
<td>2011</td>
<td>Pull</td>
</tr>
</tbody>
</table>
Contractor method of SIBC

Pull or Push

• Early involvement of the subcontractor is critical
• Means and methods of the subcontractor dictate the bridge slide plan
• Details of the bridge to accommodate slide hardware
Types of Pull Systems

Winches

- Simple – Contractor can implement the device
- Need room to anchor the system or a crane
- Limited ability to steer the bridge into final position
- Difference between static and dynamic friction, combined with cable flexibility can cause jerky movement
- Use stops and guides on the abutment to decrease momentum and drifting.
- No ability to back up without a separate pull system
Types of Push Systems

Hydraulic jacks

- Bridge move smoothly under controlled conditions
- Jacks are anchored against side tracks or supports.
- Larger stroke lengths have helped expedite process
- Risk of slide system malfunction, hoses, pumps, motors, controls
- Some Jacks can pull the bridge with the correct anchoring
Types of Pull & Push System

Post-tensioned (PT) Jacks

• Threaded bars and PT Jacks are used
• Simple- contractor can implement the device
• Can be used to push or pull the bridge
• Synchronize the jacks to steer the move
• Design Diaphragm and Wingwall to carry jacking force
Types of Slide Systems

Temporary Teflon pads

- System is inexpensive
- Could be Elastomeric or Cotton duck
- Teflon pad allow steering the bridge both longitudinally and transverse movement to final location

- Use of guided tracks to steer slide, which constrict monitoring the performance of the pads and hinders replacement of damaged or drifted pads
Types of slide Systems

- Use keeper bar to prevent the shoving of the pads
- Excessive Lubricant application on the Teflon Pad could flow lubricate the bottom of the elastomer, which causes pad drifting
- Use rough surface to prevent pad from drifting
Types of Slide System

- Use thin elastomer to prevent pad from rolling
Sliding Surface Joints

- Construction Tolerance Control
- Recess Sliding Surface Joints
- Bridge over with steel Plate
Types of Slide Systems

• Continuous Teflon pad improves on the performance of the move
Types of Slide System

Guides could be provided to control bridge from drifting.
Types of Roller systems

- Industrial Rollers are readily available
- Need tracks to keep movement aligned, and tracks must be parallel
- Roller path must be clean of debris
- Binding and Jamming might occur
- Need mechanism to stop for final position
Temporary Works

- Contractor designed
- Always connect temporary bents to the abutment

- Temporary Bents on H-piles
- Slide system
Temporary Works

- Transition girder support

- Sliding method dictates the temporary work design
- Verifying field and fabrication tolerances is required
- Account for driven piles installation tolerances
- Account for differential settlement between abutment and temporary support
Lessons Learned

Engineer/ Designer Perspective
Force Diagram

- Jack
- Substructure
- Superstructure
- Temporary Works
- Unattached temporary works
Unattached temporary works results in an overturning moment at temporary bent
Force Diagram

- Jack
- Substructure
- Attached temporary works
- Superstructure
- Temporary Works
The engineer must make a very good estimation of the coefficient of friction (static and kinetic) expected during the slide and then verify during rehearsal slide.

<table>
<thead>
<tr>
<th>Slide Mechanism</th>
<th>Estimated Lateral Force Required*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE coated neoprene bearing pads</td>
<td>10% of Vertical Load</td>
</tr>
<tr>
<td>Heavy Duty Rollers</td>
<td>5% of Vertical Load**</td>
</tr>
</tbody>
</table>

* Recommended 5% minimum design load in any case
** Possibility of roller binding occurring increasing lateral force required
Coefficient of Friction

Static Coefficient of Friction

To start the slide the coefficient of friction can be significantly higher - in the range of 5% to 15%

Kinetic Coefficient of Friction

During the slide the coefficient of friction can be as low as 1% to 2%

Up to 20% has been used due to sliding variables (debris, binding, overstressed PTFE)
Temporary Works - Geotechnical Considerations

Temporary support foundations are designed to suit existing soil conditions.

- Owners should provide geotechnical borings to assist the contractor in bidding the temporary supports.
- Expected settlement and deflection of the system when the full bridge load is applied should be taken into account when setting elevations for temporary structures.
Abutments Design

- Common practice is to build the new abutment under the existing bridge
- Precast abutment has been used as alternate after demolition of existing bridge
Abutment Details

Overhanging Diaphragm

Semi-Integral Diaphragm
GRS Abutment

- Use new bridge as Detour
- Build GRS Abutment
- Use precast beam seat for sliding new bridge
Substructure Elements - Pier Considerations

Considerations for piers are similar in nature to those of abutments.

- Deep foundations can be installed outside the limits of existing structure utilizing long span pier caps
- Pier caps can be constructed below low chord elevation of the existing superstructure
- Piers can be offset from existing substructure elements
- Precast elements can be utilized to decrease construction period
Attention to approach slab design and construction should be a priority and not an afterthought.

Approach slabs slid with bridge (Utah method)
- Fast but expensive

Precast approach slabs placed after the slide
- Some states have problems setting slabs
- Consider the use of flowable fill under the ends of the slab

CIP approach slabs
- Can be built in two days
- Need time to cure

Buried approach slabs (MassDOT)
Tolerances

Lateral Move Loads - Tolerances

The engineer must work with the owner to define appropriate thresholds for construction tolerances to optimize project results.

Final tolerances for an SIBC project should not be more restrictive than those of a traditional construction project.