


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Slide In Bridge Construction (SIBC)

National Perspective and Lessons Learned

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Federal Highway Administration

Atlanta, GA, November, 2015

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

What is SIBC?

And

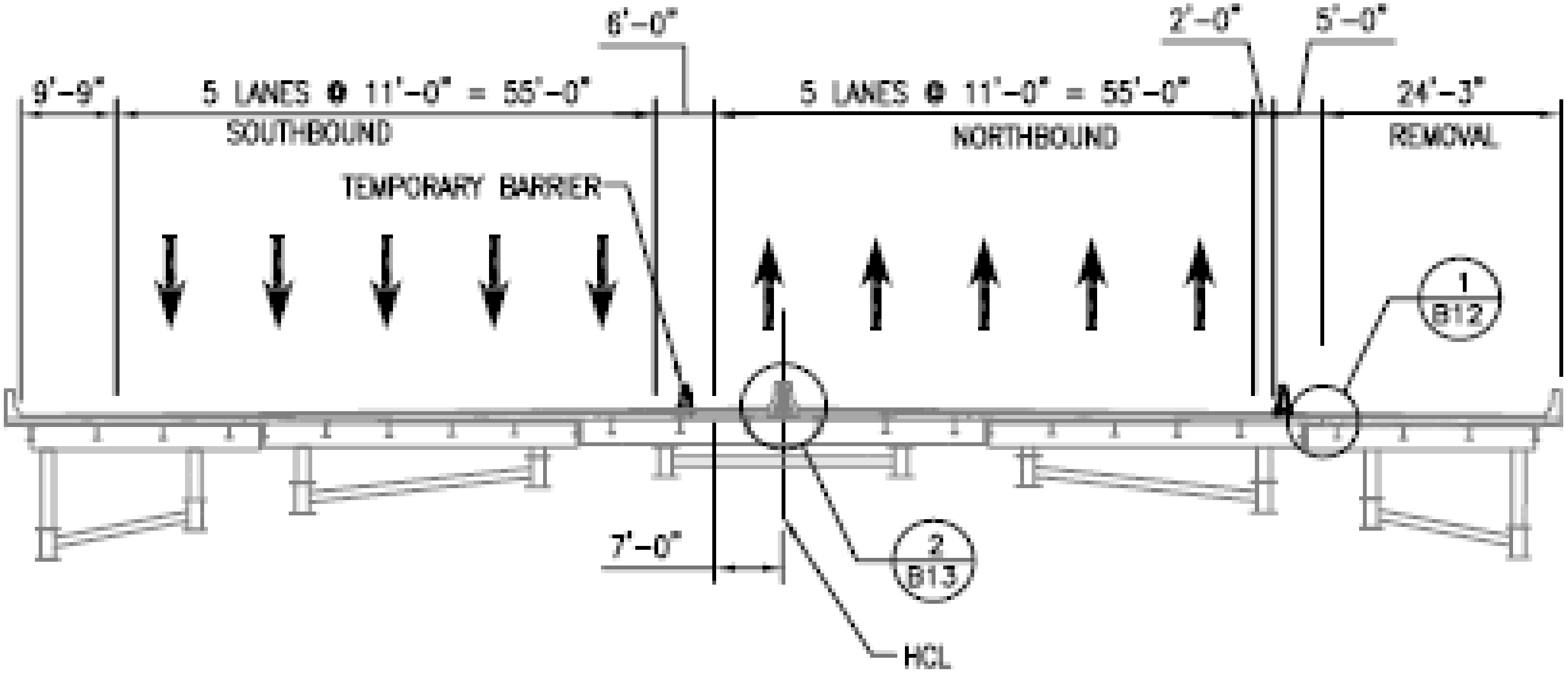
Why SIBC?

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



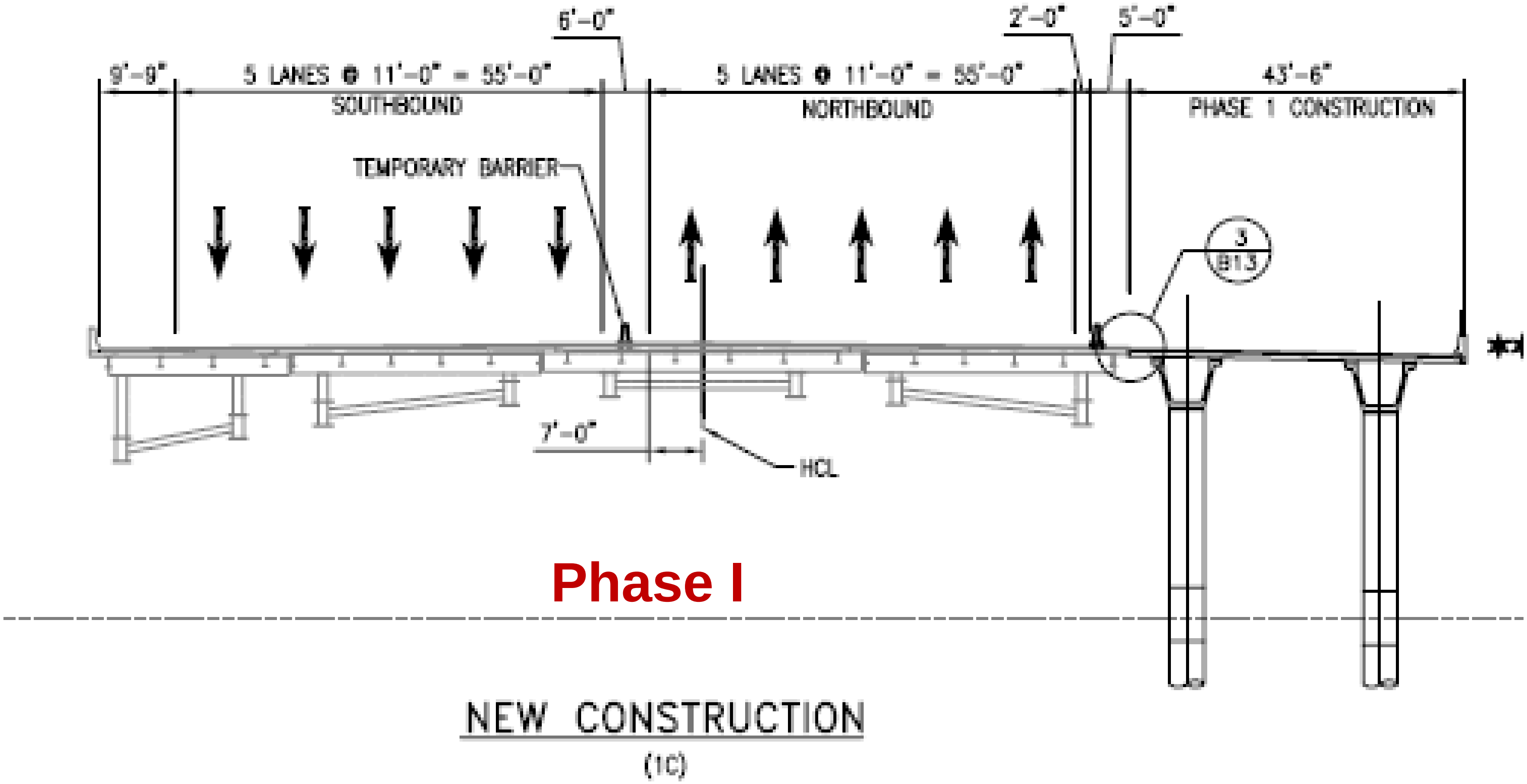
Phase I

REMOVAL

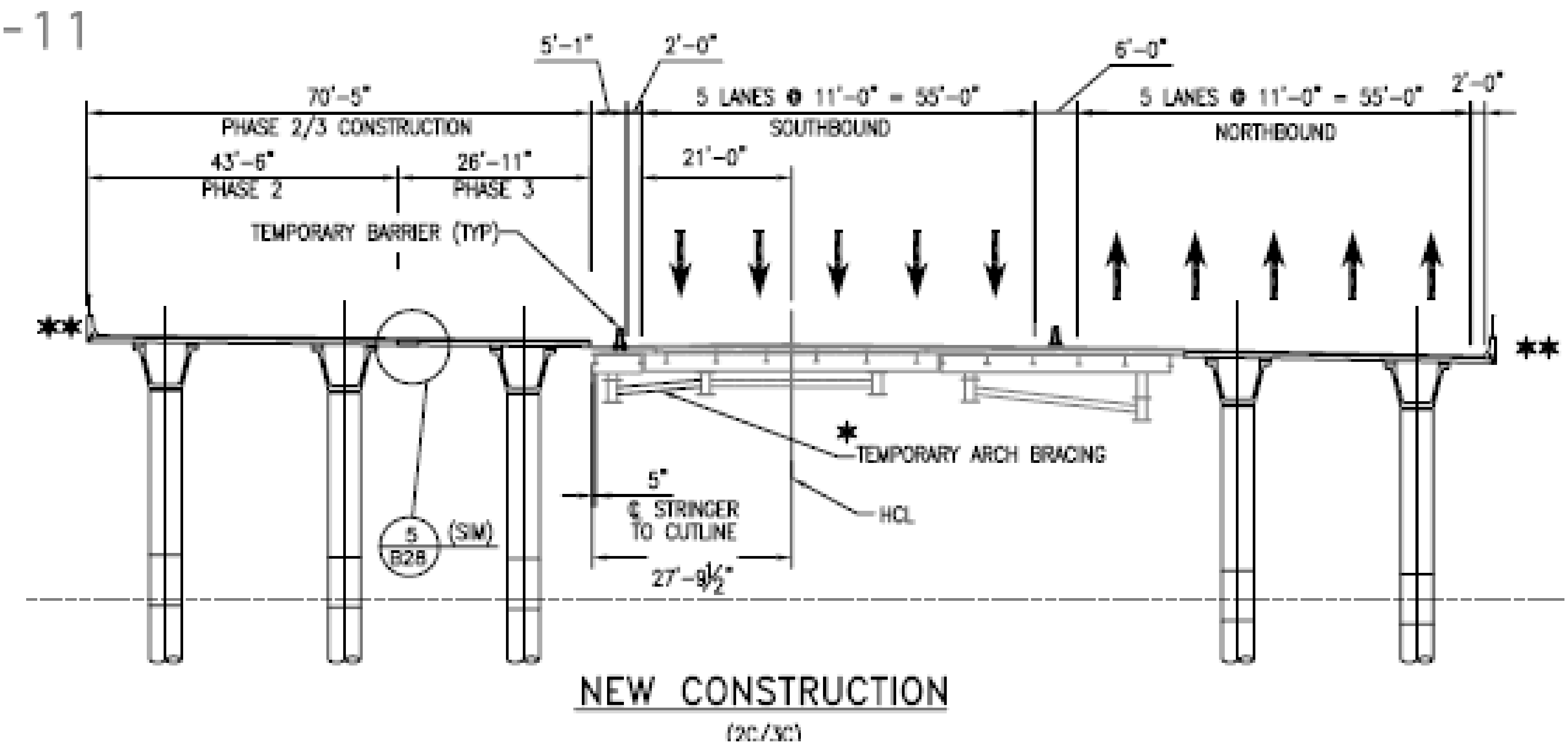
(1A & 1B)

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

Conventional Bridge Construction

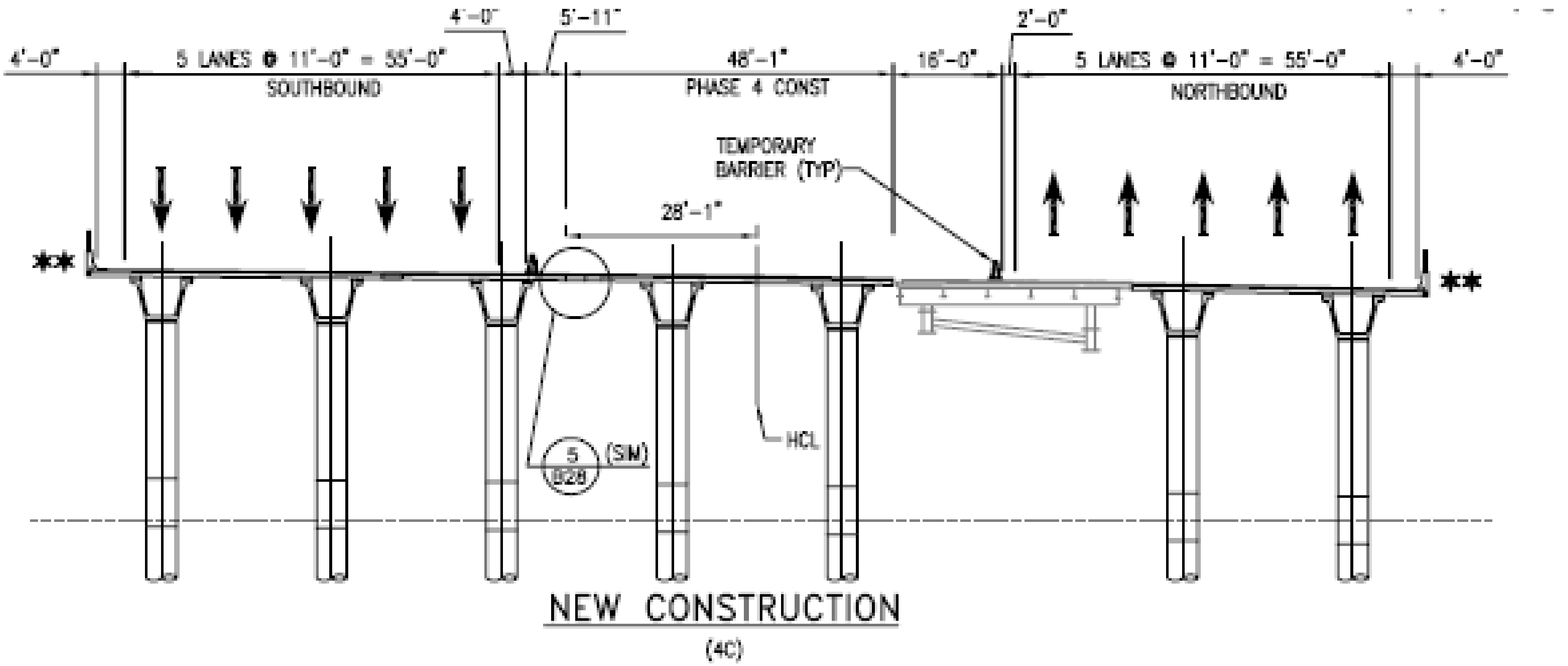


Conventional Bridge Construction



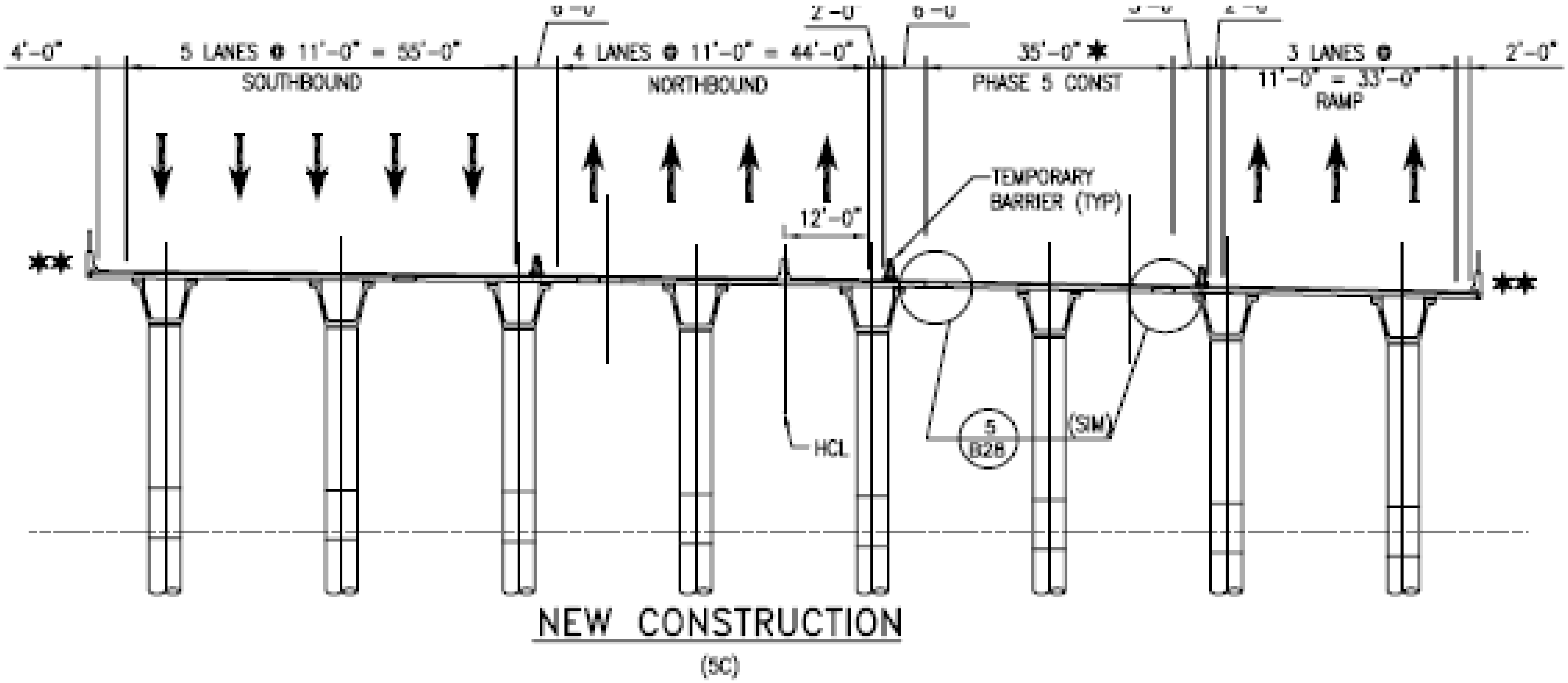
Phase 2 & 3

Conventional Bridge Construction



Phase 4

Conventional Bridge Construction

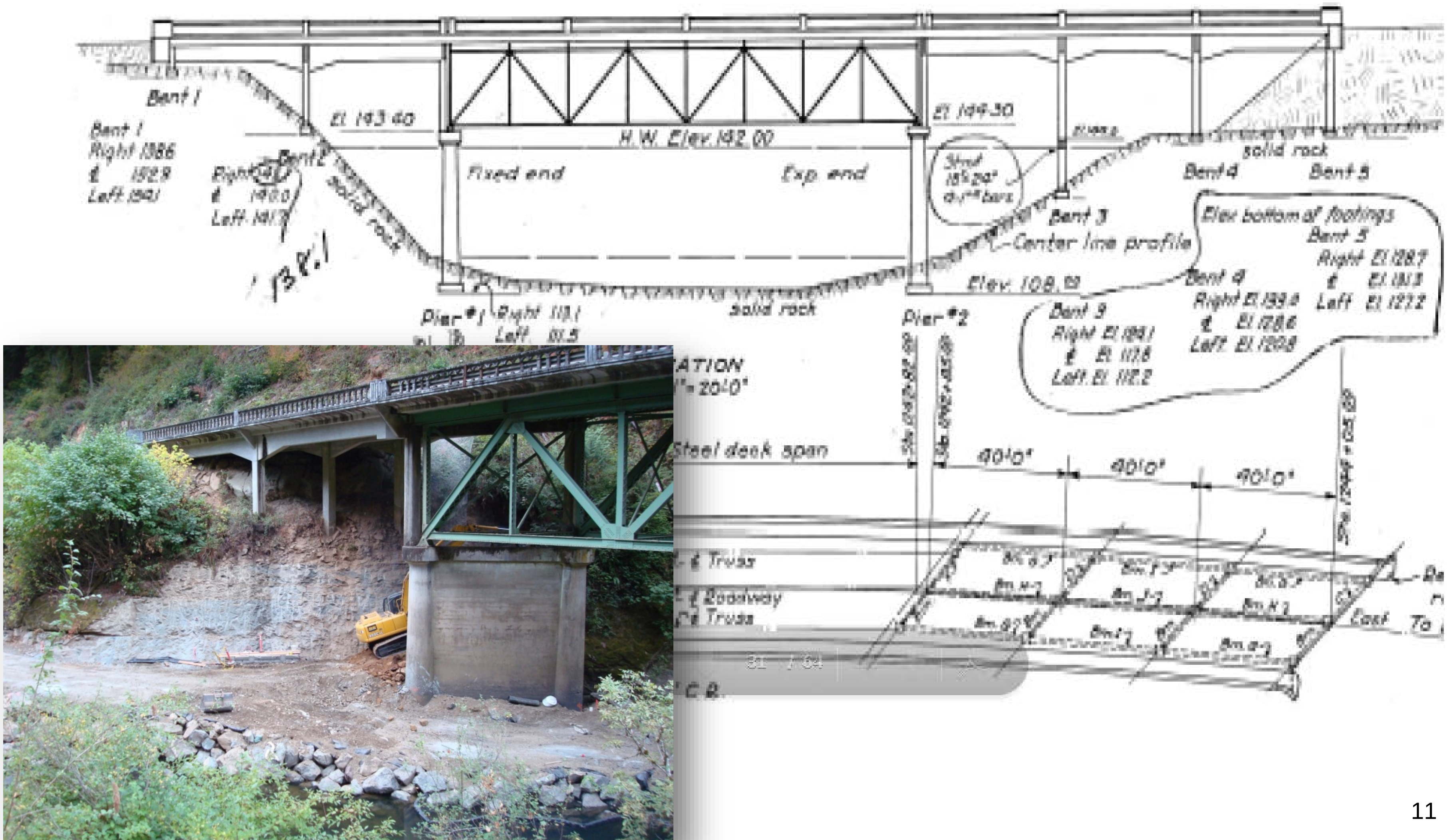


Phase 5

Prefabricated Bridge Elements

Slide In Bridge Construction (SIBC)

Slide In Bridge Construction (SIBC)



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)

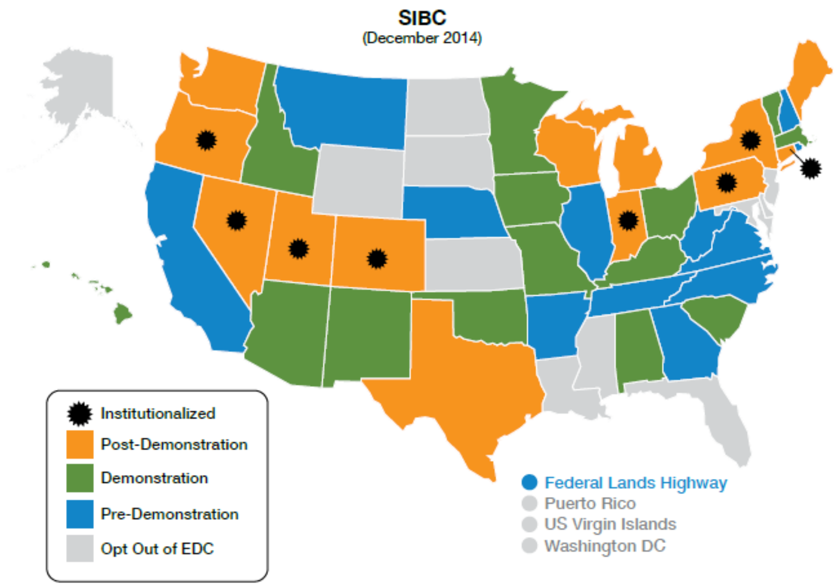
Slide In Bridge Construction (SIBC)

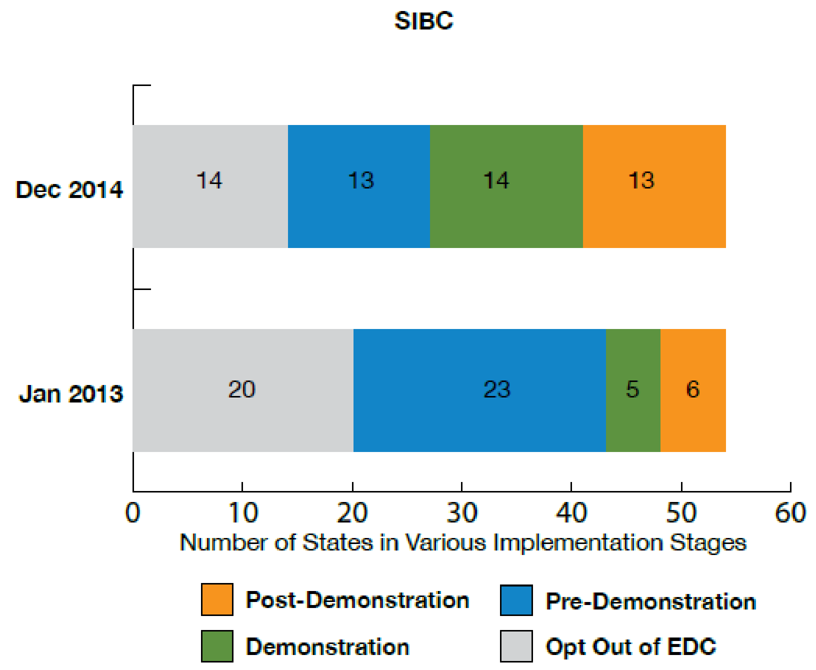
Why SIBC?

SIBC VS. Conventional Construction

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

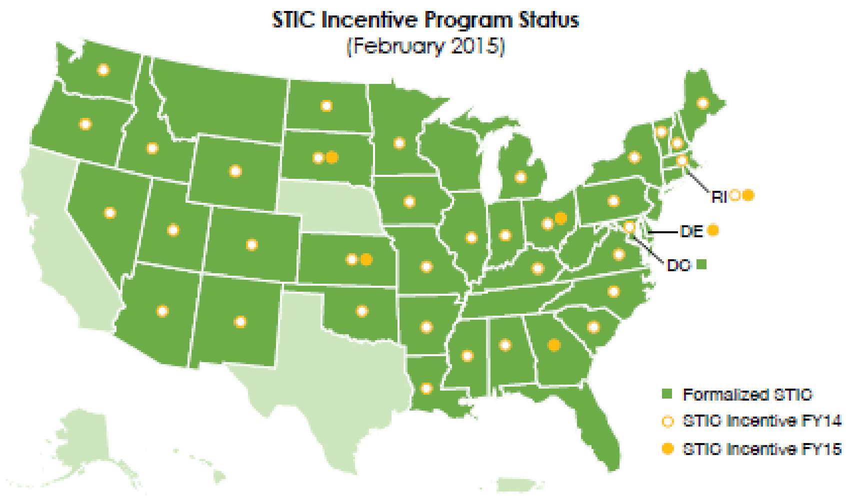
SIBC Implementation





Resources for Innovation Implementation

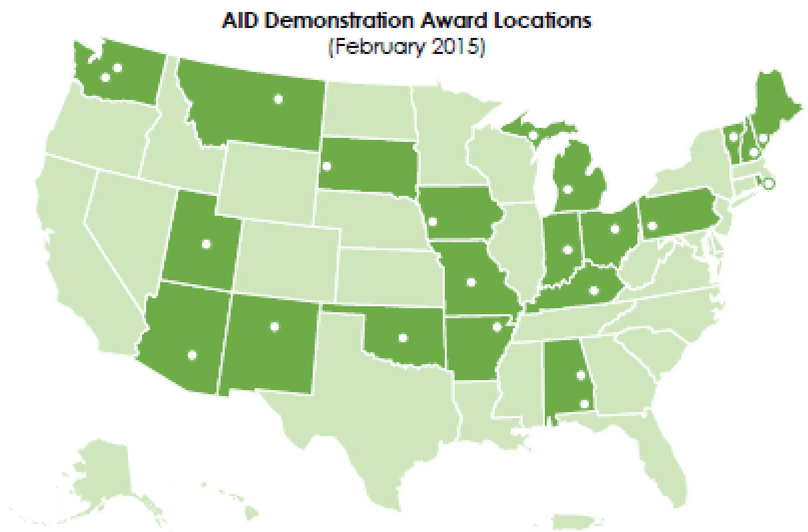
State Transportation Innovation Council Incentive Program



$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

Resources for Innovation Implementation

- MAP-21 Section 1304 –
- Innovative Project Delivery

- *Increase Federal Share payable to a project by 5% for innovation (Faster, Better, and Smarter)*

Lessons Learned

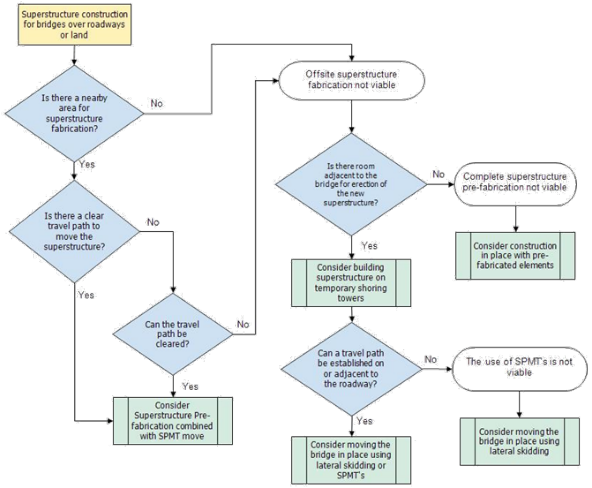
- Owner Perspective
- Engineer/ Designer Perspective
- Contractor Perspective

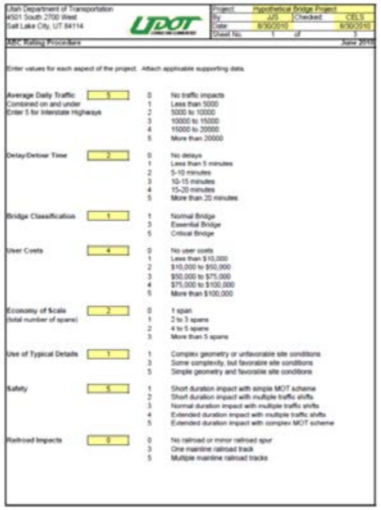
Lessons Learned

- Owner Perspective

Decision Making

- Tools exist to help owners when to use ABC
  - Flowcharts
  - Weighted scoring method
  - Matrix
  - Narratives to describe the situation
  - Analytical Hierarchy Process (AHP)





Utah Department of Transportation
4501 South 2700 West
Salt Lake City, UT 84114

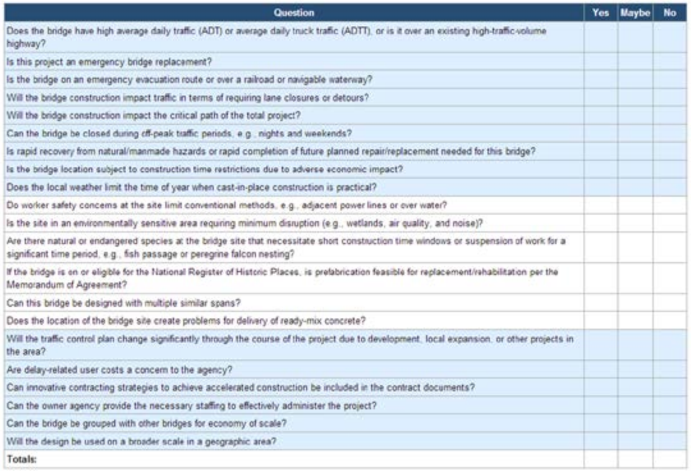
UDOT

Project	Hypothetical Bridge Project		
By	JJS	Checked	CELS
Date	8/30/2010		8/30/2010
Sheet No.	1	of	3

ABC Rating Procedure — June 2010

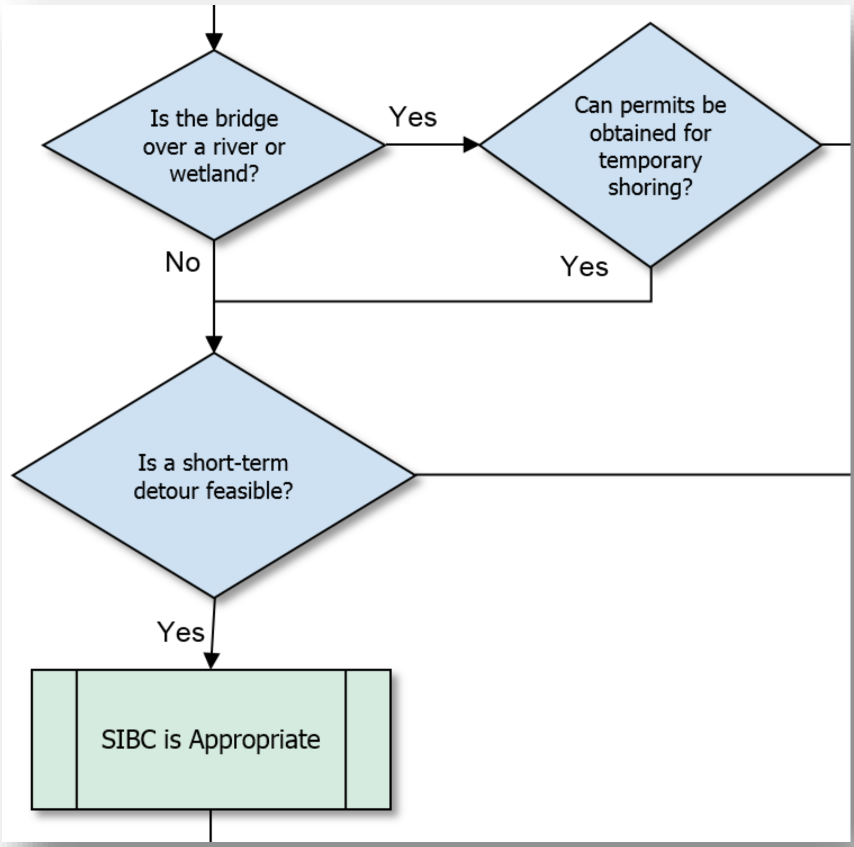
Enter values for each aspect of the project. Attach applicable supporting data.

Aspect	Value	Score	Description
Average Daily Traffic Combined on and under Enter 5 for Interstate Highways	5	0	No traffic impacts
		1	Less than 5000
		2	5000 to 10000
		3	10000 to 15000
		4	15000 to 20000
		5	More than 20000
Delay/Detour Time	2	0	No delays
		1	Less than 5 minutes
		2	5-10 minutes
		3	10-15 minutes
		4	15-20 minutes
		5	More than 20 minutes
Bridge Classification	1	1	Normal Bridge
		3	Essential Bridge
		5	Critical Bridge
User Costs	4	0	No user costs
		1	Less than $10,000
		2	$10,000 to $50,000
		3	$50,000 to $75,000
		4	$75,000 to $100,000
		5	More than $100,000
Economy of Scale (total number of spans)	2	0	1 span
		1	2 to 3 spans
		2	4 to 5 spans
		3	More than 5 spans
Use of Typical Details	1	1	Complex geometry or unfavorable site conditions
		3	Some complexity, but favorable site conditions
		5	Simple geometry and favorable site conditions
Safety	5	1	Short duration impact with simple MOT scheme
		2	Short duration impact with multiple traffic shifts
		3	Normal duration impact with multiple traffic shifts
		4	Extended duration impact with multiple traffic shifts
		5	Extended duration impact with complex MOT scheme
Railroad Impacts	0	0	No railroad or minor railroad spur
		3	One mainline railroad track
		5	Multiple mainline railroad tracks



Question	Yes	Maybe	No
Does the bridge have high average daily traffic (ADT) or average daily truck traffic (ADTT), or is it over an existing high-traffic-volume highway?			
Is this project an emergency bridge replacement?			
Is the bridge on an emergency evacuation route or over a railroad or navigable waterway?			
Will the bridge construction impact traffic in terms of requiring lane closures or detours?			
Will the bridge construction impact the critical path of the total project?			
Can the bridge be closed during off-peak traffic periods, e.g., nights and weekends?			
Is rapid recovery from natural/manmade hazards or rapid completion of future planned repair/replacement needed for this bridge?			
Is the bridge location subject to construction time restrictions due to adverse economic impact?			
Does the local weather limit the time of year when cast-in-place construction is practical?			
Do worker safety concerns at the site limit conventional methods, e.g., adjacent power lines or over water?			
Is the site in an environmentally sensitive area requiring minimum disruption (e.g., wetlands, air quality, and noise)?			
Are there natural or endangered species at the bridge site that necessitate short construction time windows or suspension of work for a significant time period, e.g., fish passage or peregrine falcon nesting?			
If the bridge is on or eligible for the National Register of Historic Places, is prefabrication feasible for replacement/rehabilitation per the Memorandum of Agreement?			
Can this bridge be designed with multiple similar spans?			
Does the location of the bridge site create problems for delivery of ready-mix concrete?			
Will the traffic control plan change significantly through the course of the project due to development, local expansion, or other projects in the area?			
Are delay-related user costs a concern to the agency?			
Can innovative contracting strategies to achieve accelerated construction be included in the contract documents?			
Can the owner agency provide the necessary staffing to effectively administer the project?			
Can the bridge be grouped with other bridges for economy of scale?			
Will the design be used on a broader scale in a geographic area?			
Totals:			

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

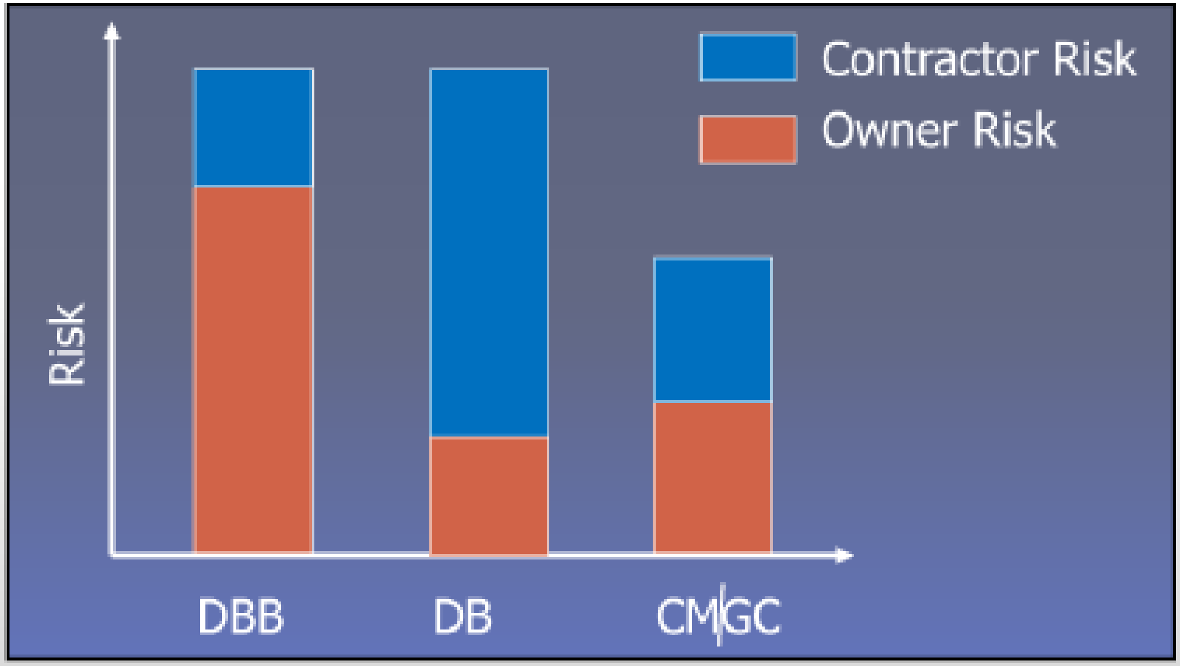
- Construction Manager/General Contractor (CM/GC)

- A+B contracting

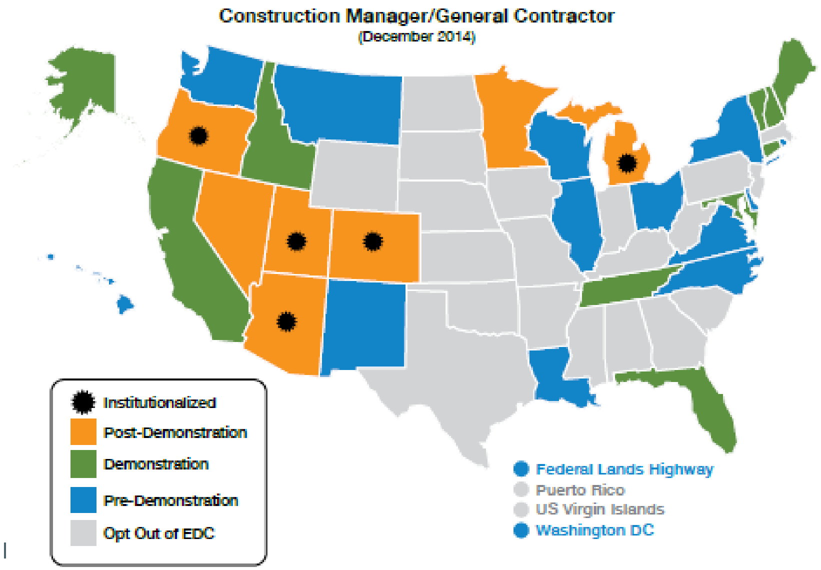
CM/GC Basics

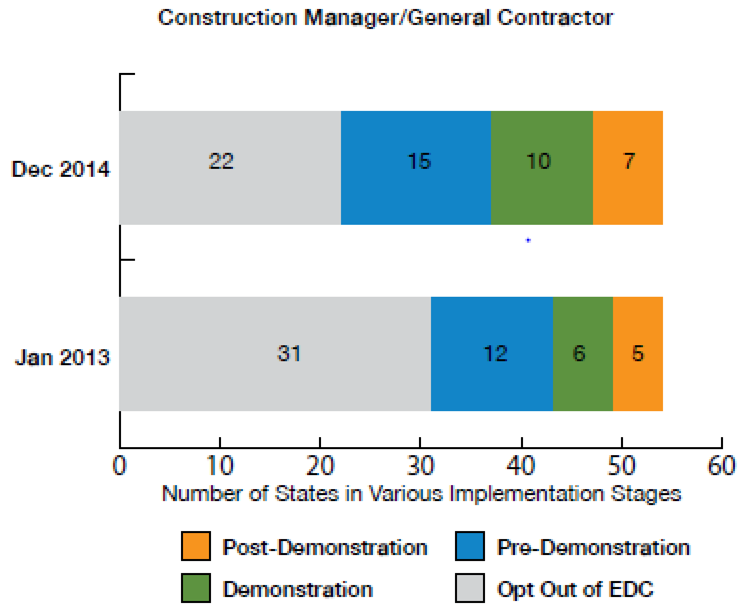
Risk = $$$

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

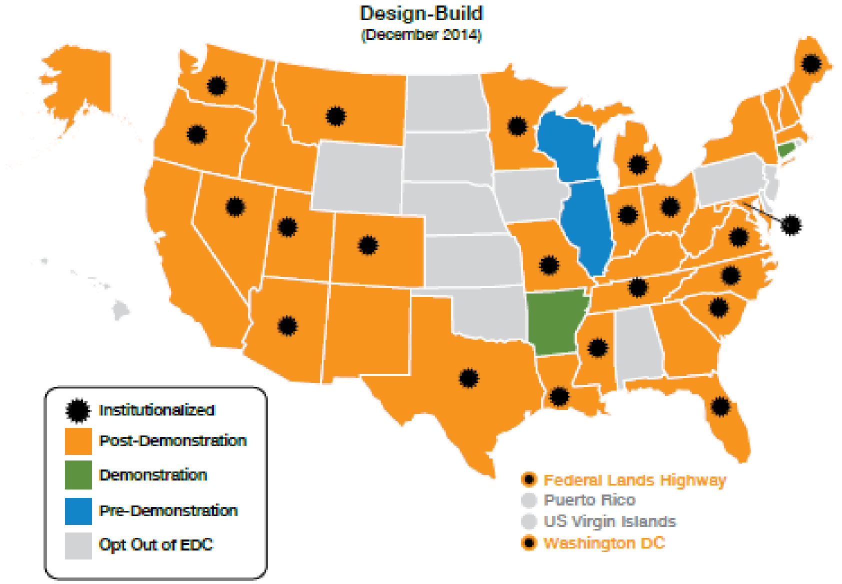


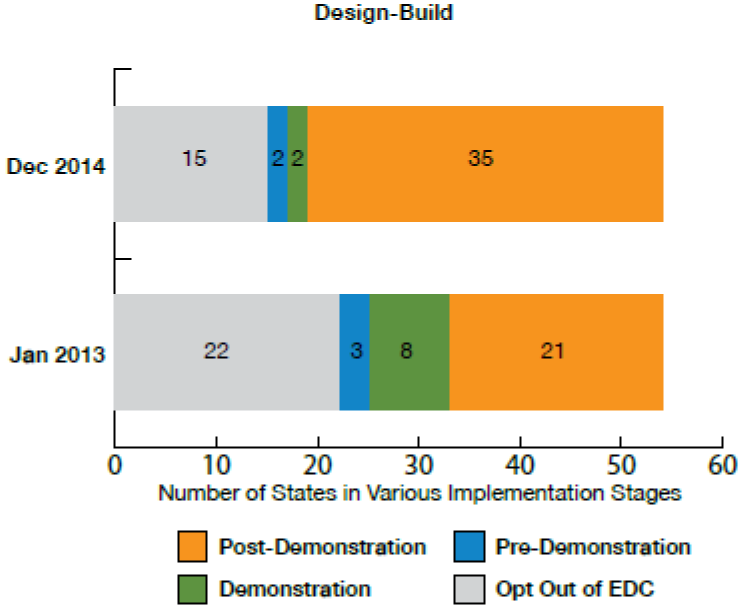
CMGC Implementation





Design-Build



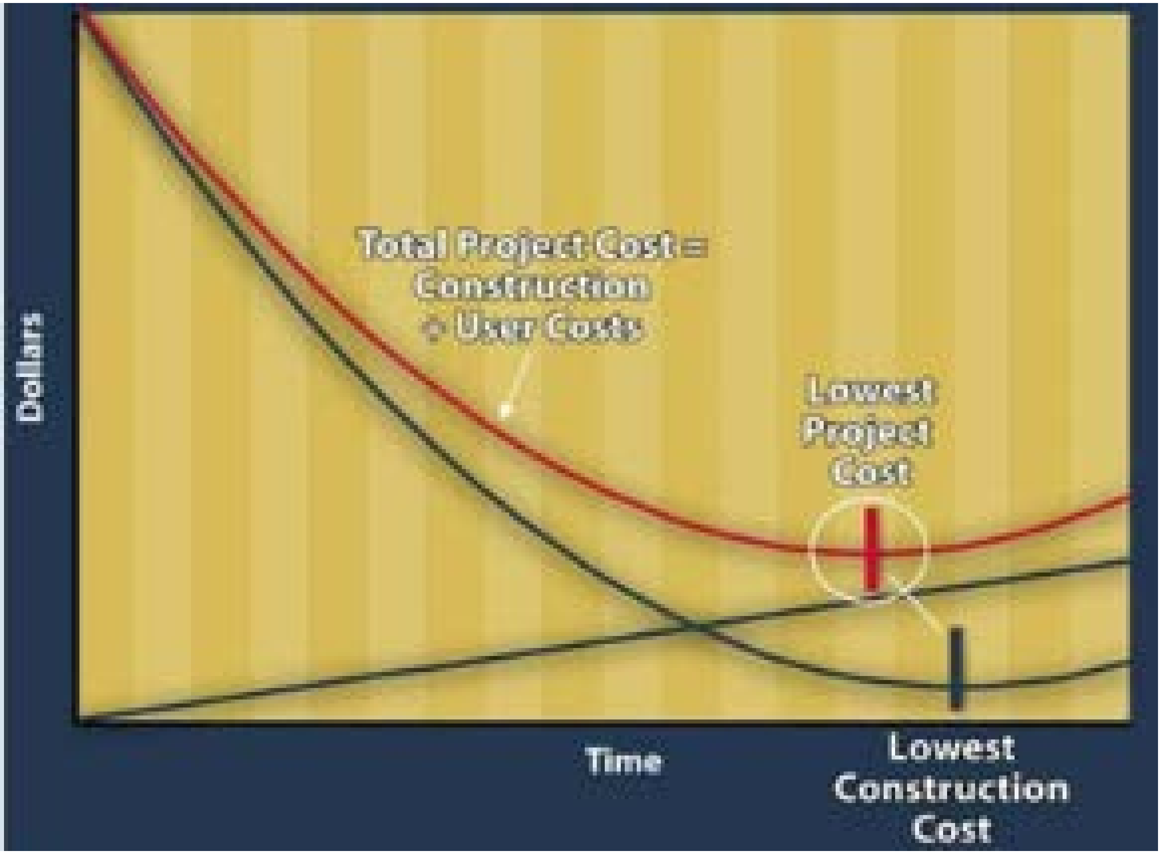


Cost Consideration

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)

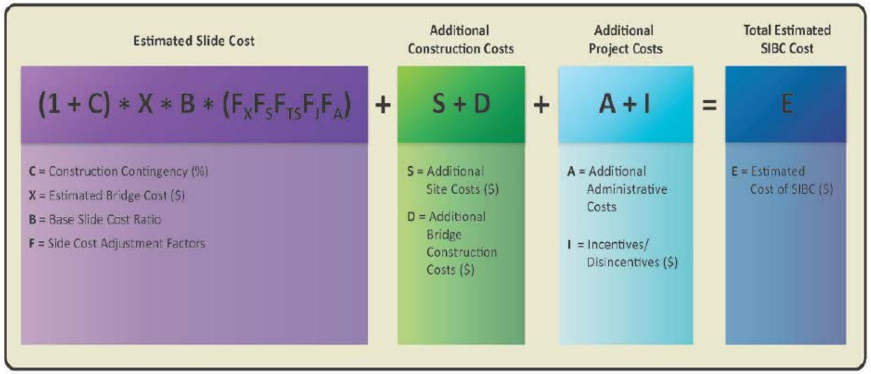
+

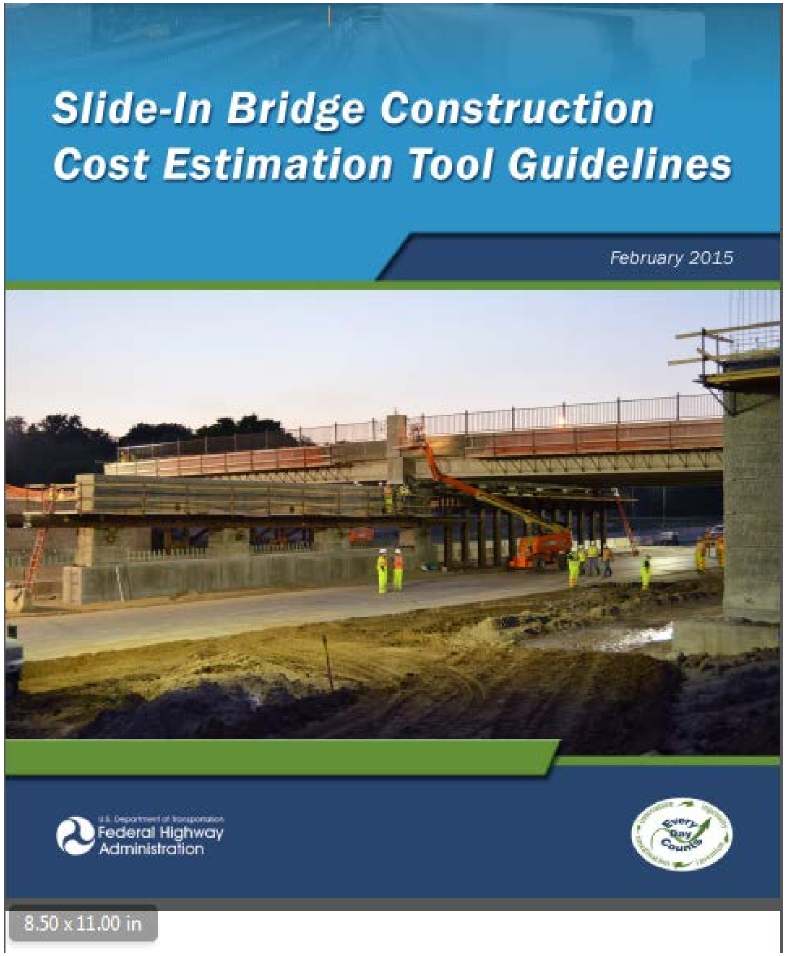
Delay Costs

+

Crash and Safety Costs

SIBC Cost Estimation Tool Guidelines



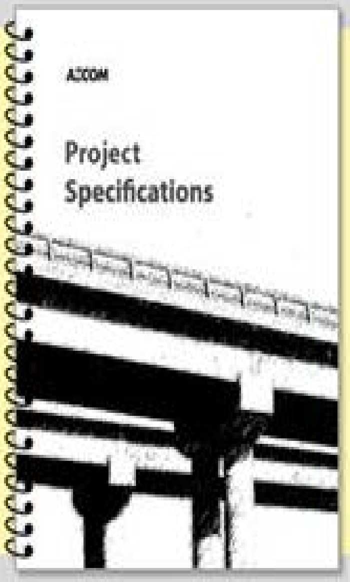


Slide Cost = 20% x Bridge Cost
FX, Experience Factor
FS, Site Complexity Factor
FTS, Temporary Shoring Factor
FJ, Vertical Jacking Factor
FA, AADT/Undercrossing Factor
S, Additional Site Costs
D, Additional Bridge Construction Costs
A, Additional Administration Costs
I, Additional Incentives/Disincentives

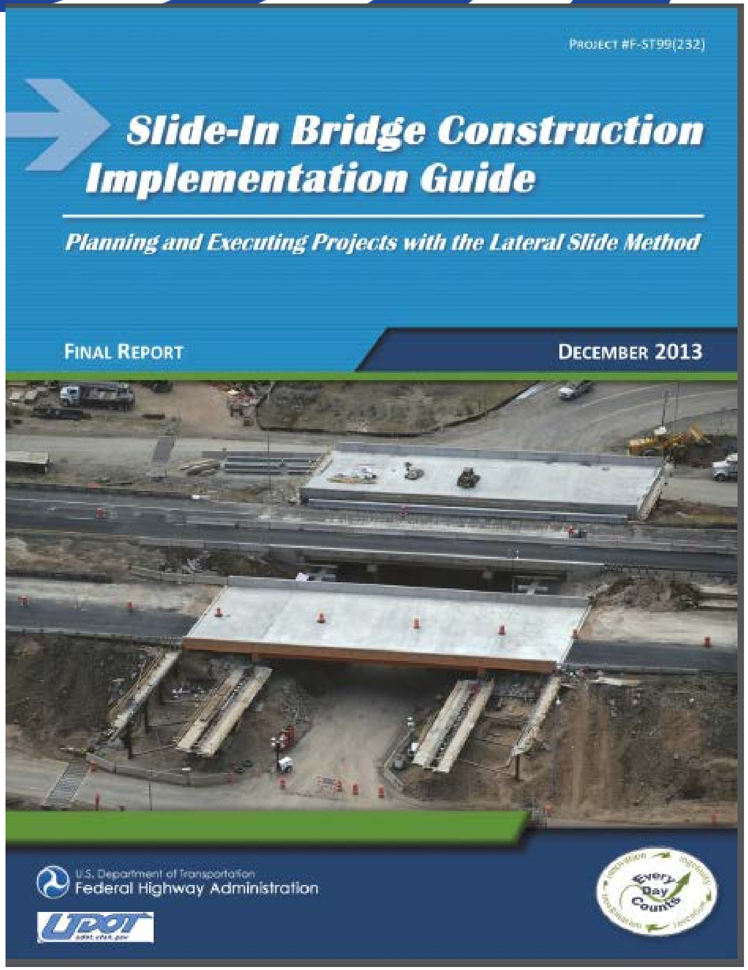
Specifications

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

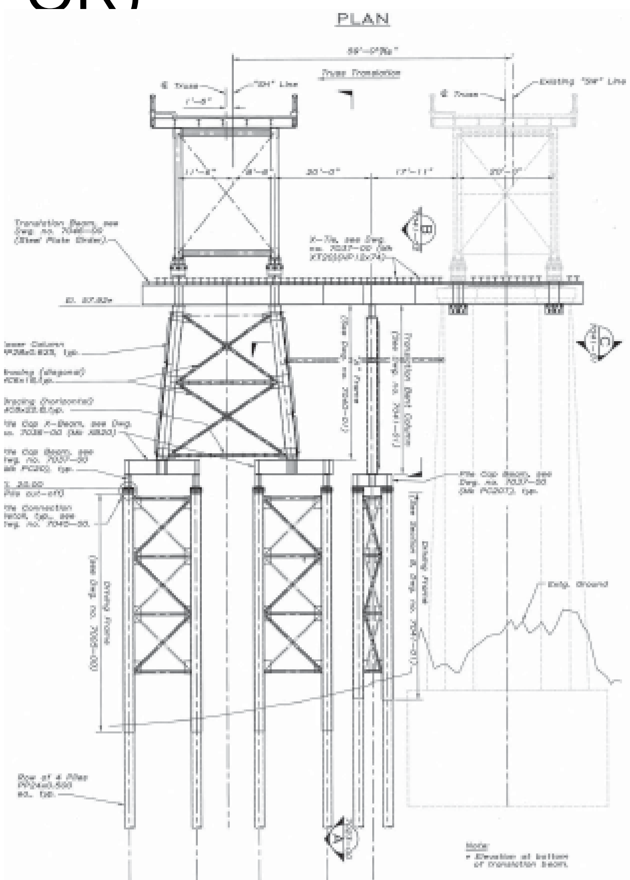


Lessons Learned

- 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

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

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) Jack**s**

- 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

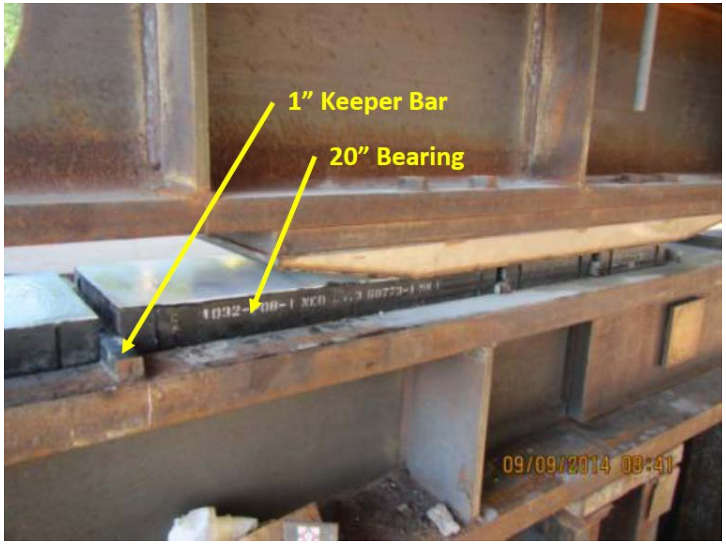
Temporary Teflon pads

- 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

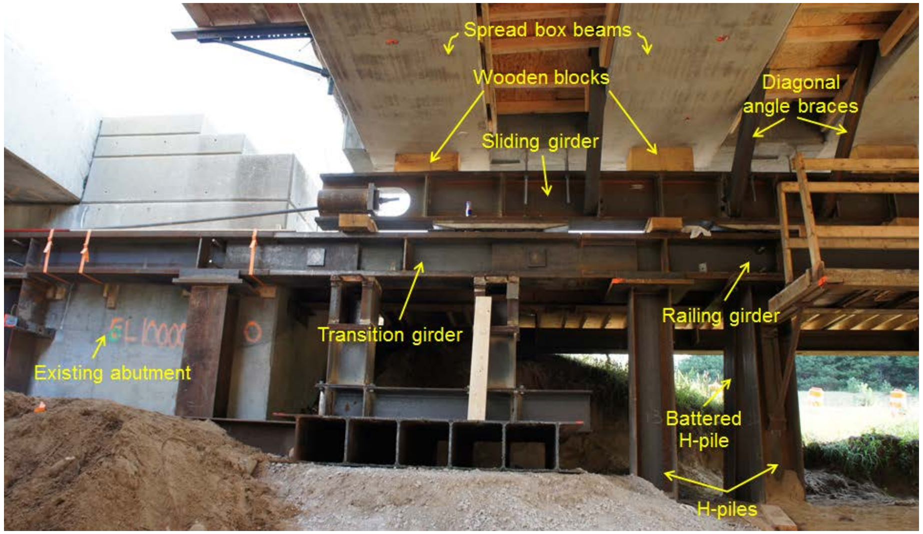
- Industrial Rollers are readily available
- Need tracks to keep movement aligned, and tracks must be parallel
- Roller path must be clean of debris
- Binding and Jamming might occur
- Need mechanism to stop for final position

Temporary Works

- Temporary Bents on H-piles
- Slide system

- Contractor designed
- Always connect temporary bents to the abutment

Temporary Works



- Transition girder support

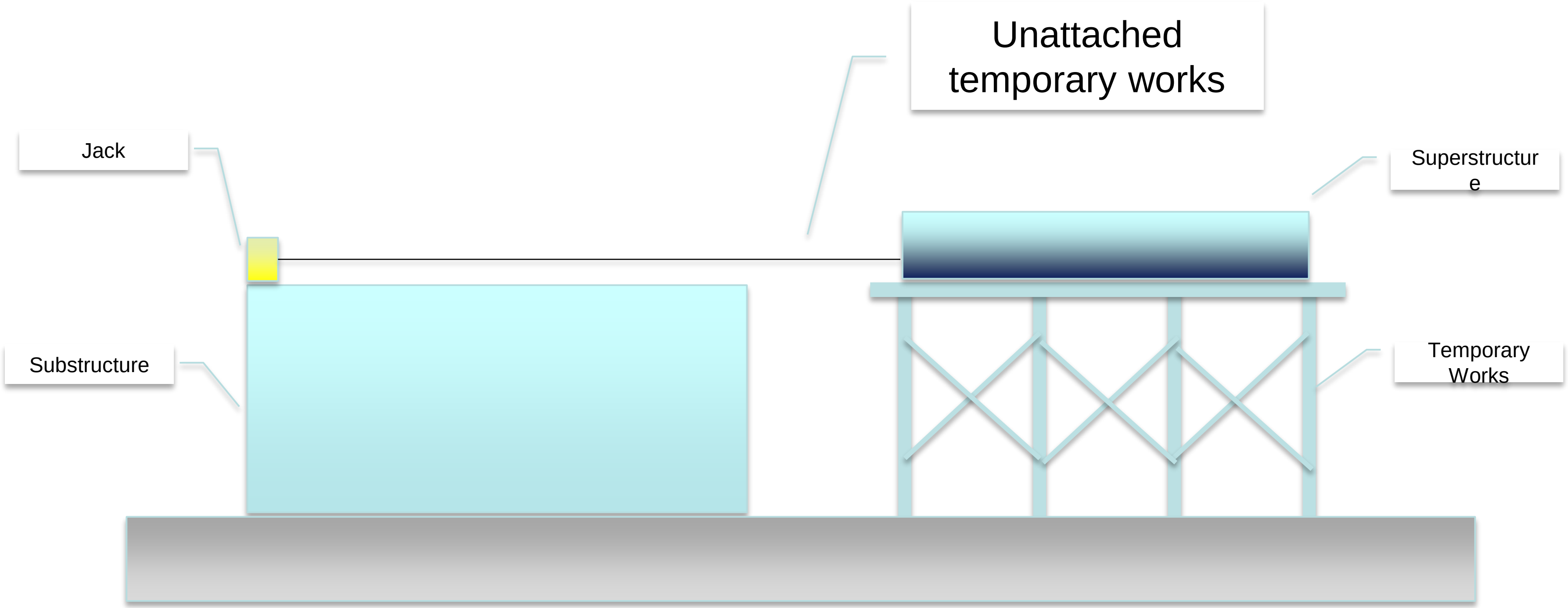
- Sliding method dictates the temporary work design
- Verifying field and fabrication tolerances is required
- Account for driven piles installation tolerances
- Account for differential settlement between abutment and temporary support

Lessons Learned

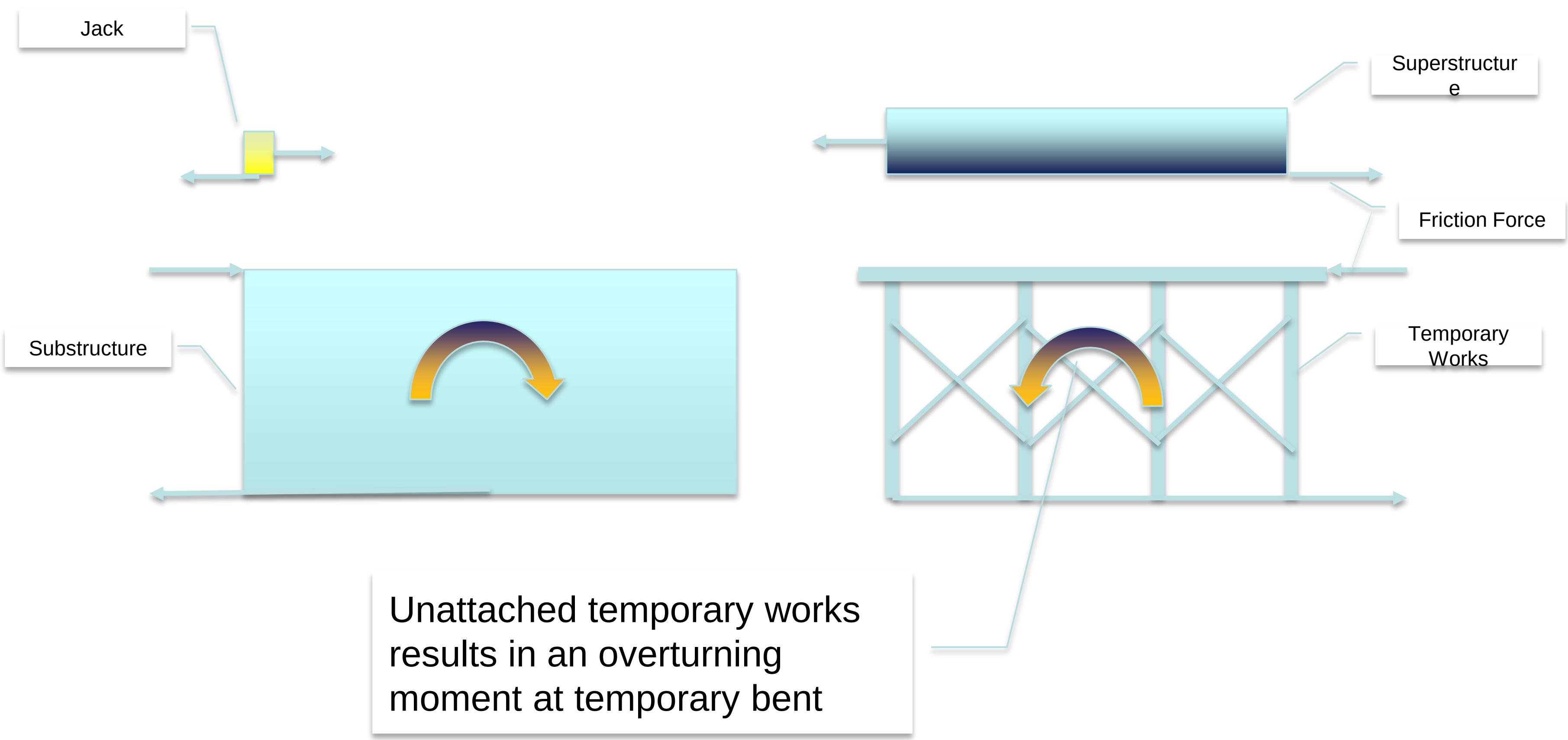
Engineer/ Designer

Perspective

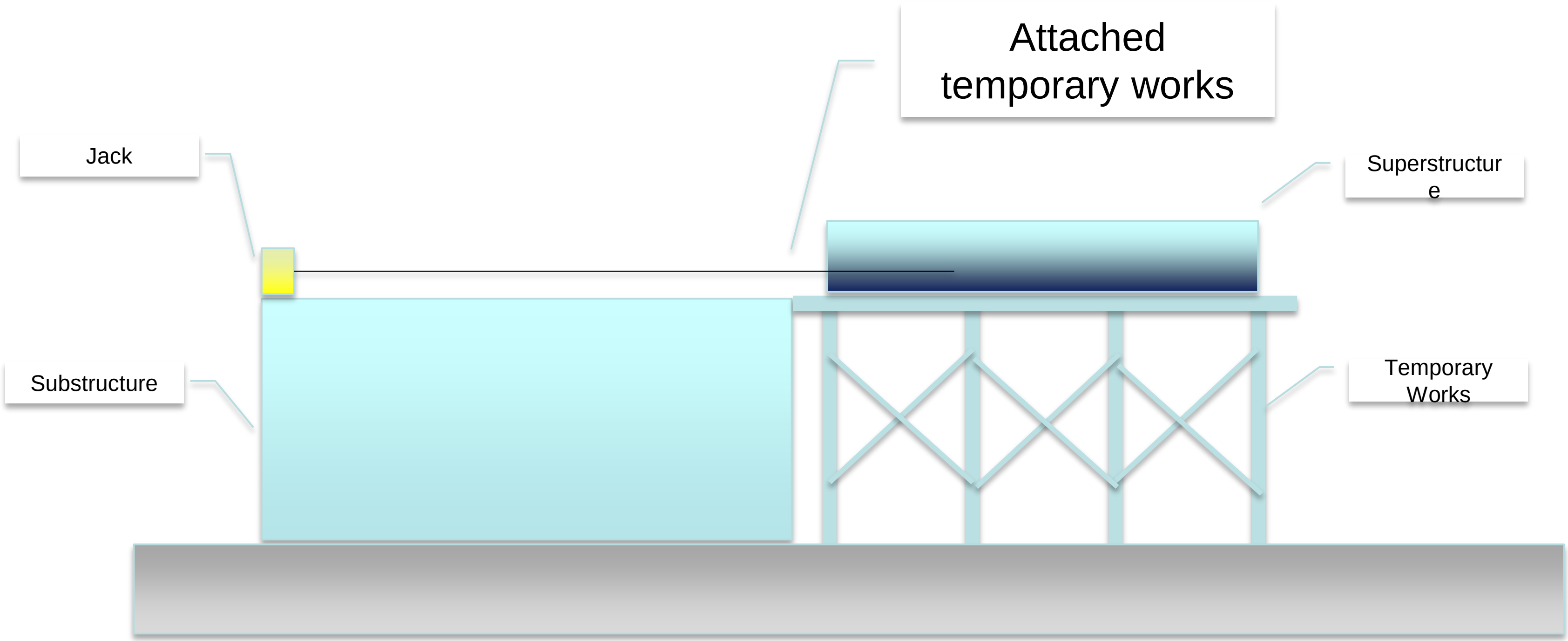
Force Diagram



Force Diagram



Force Diagram



Design of Temporary Works

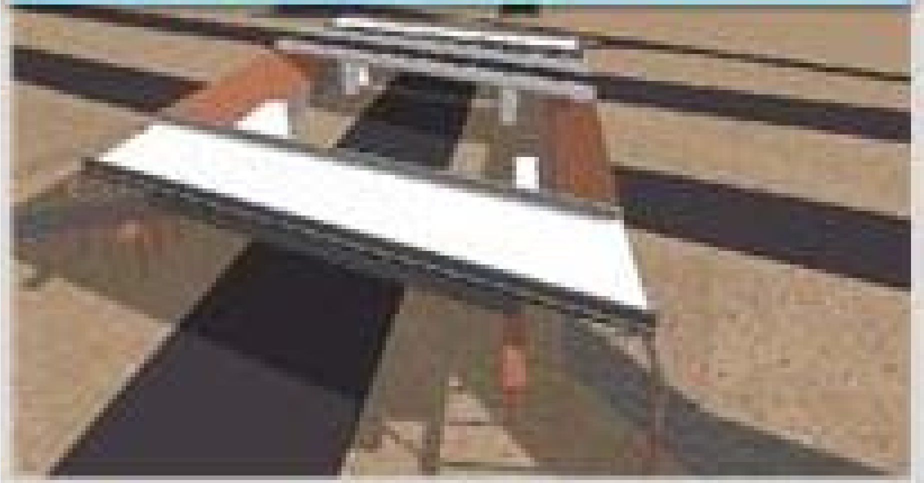
- The engineer must make a very good estimation of the coefficient of friction (static and kinetic) expected during the slide and then verify during rehearsal slide.

Slide Mechanism	Estimated Lateral Force Required*
PTFE coated neoprene bearing pads	10% of Vertical Load
Heavy Duty Rollers	5% of Vertical Load**

* 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

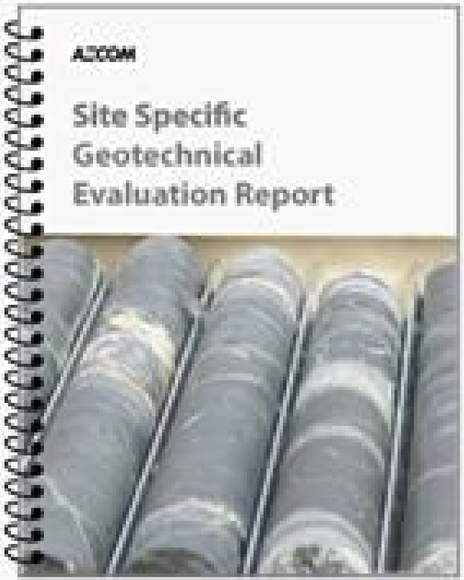
During the slide the coefficient of friction can be as low as 1% to 2%

Up to 20% has been used due sliding variables (debris, binding, overstressed PTFE)

Geotechnical Investigation

Temporary Works - Geotechnical Considerations

Temporary support foundations are designed to suit existing soil conditions.



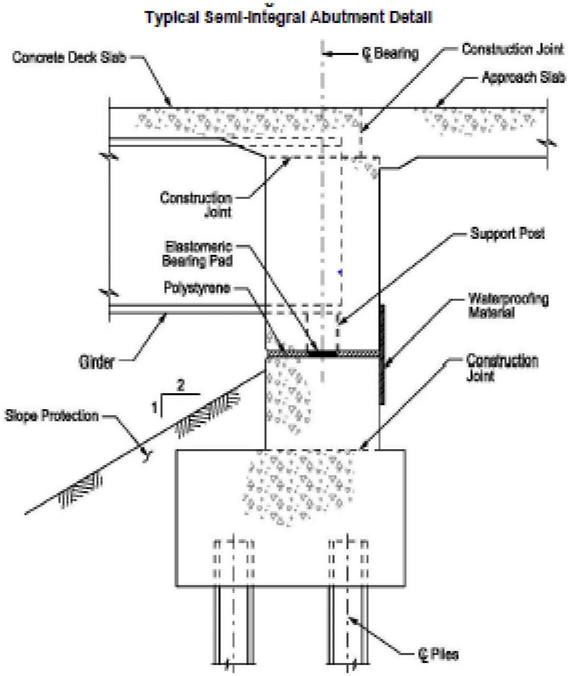
- Owners should provide geotechnical borings to assist the contractor in bidding the temporary supports
- Expected settlement and deflection of the system when the full bridge load is applied should be taken into account when setting elevations for temporary structures

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

Abutment Details

GRS Abutment

- Use new bridge as Detour
- Build GRS Abutment
- Use precast beam seat for sliding new bridge

Pier Construction Challenges

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

Straddle Beam -SH 51, OK

Approach Slab Options

- 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.

Project Costs

Restrictive, unrealistic requirements drive up the project costs

Project Quality

Loosely defined tolerances may result in substandard quality

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