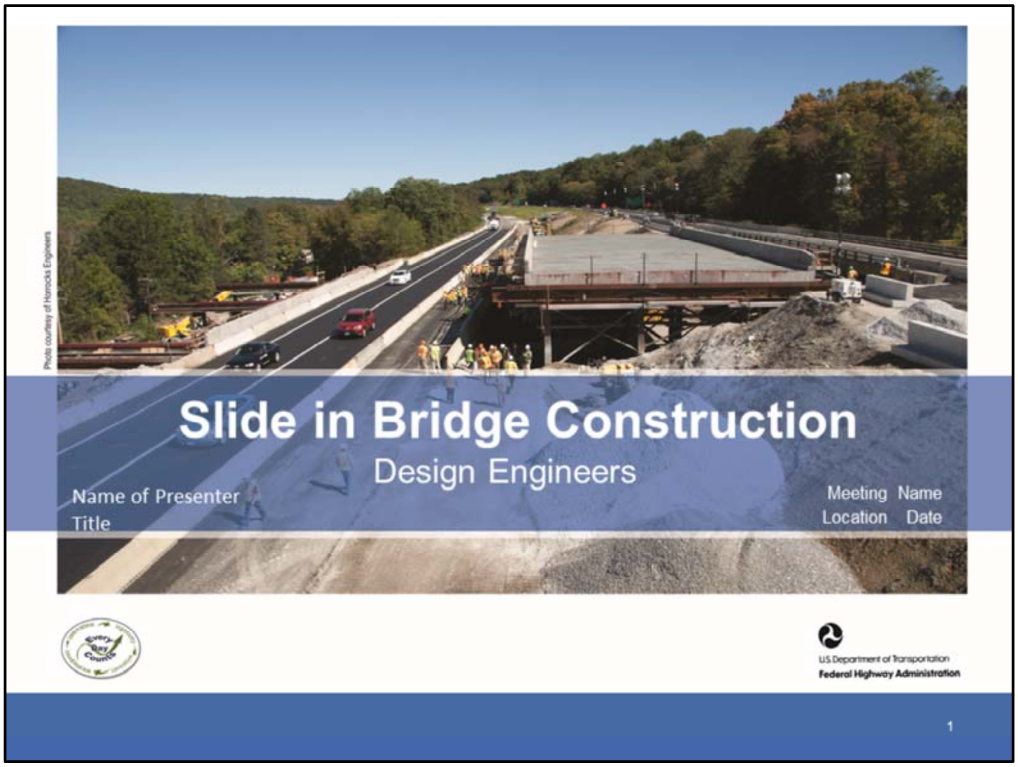
PRESENTATION HANDOUTS:

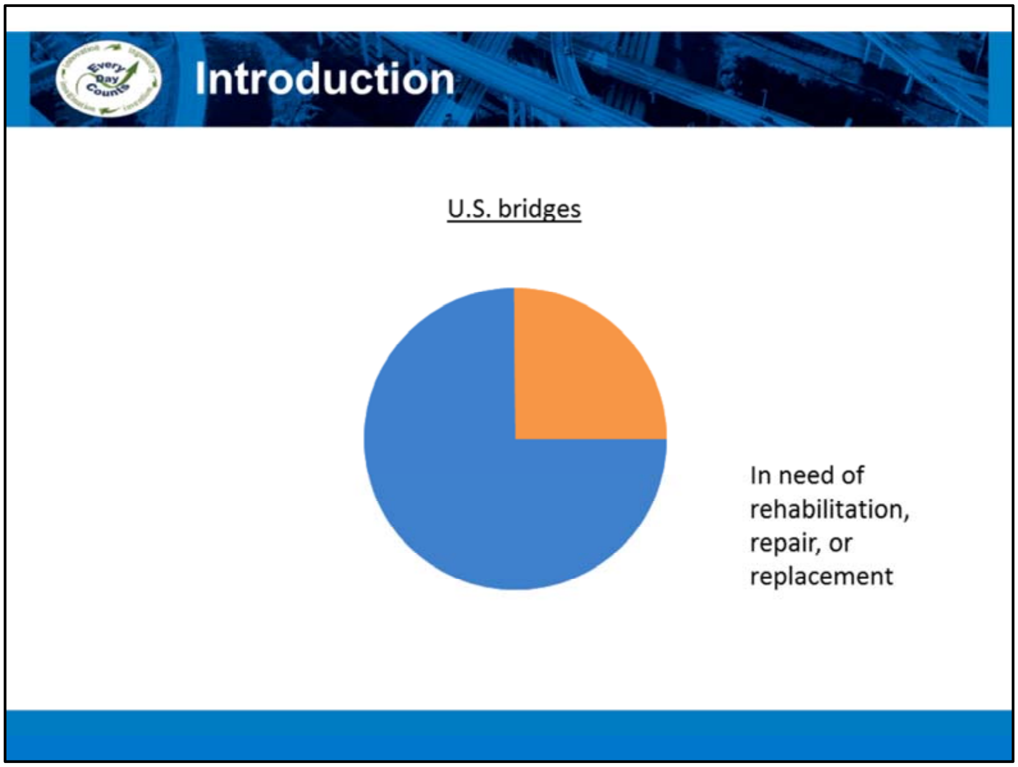
COURSE 1 SIBC OVERVIEW FOR DESIGNERS



Thank you for attending today's session on Slide in Bridge Construction.

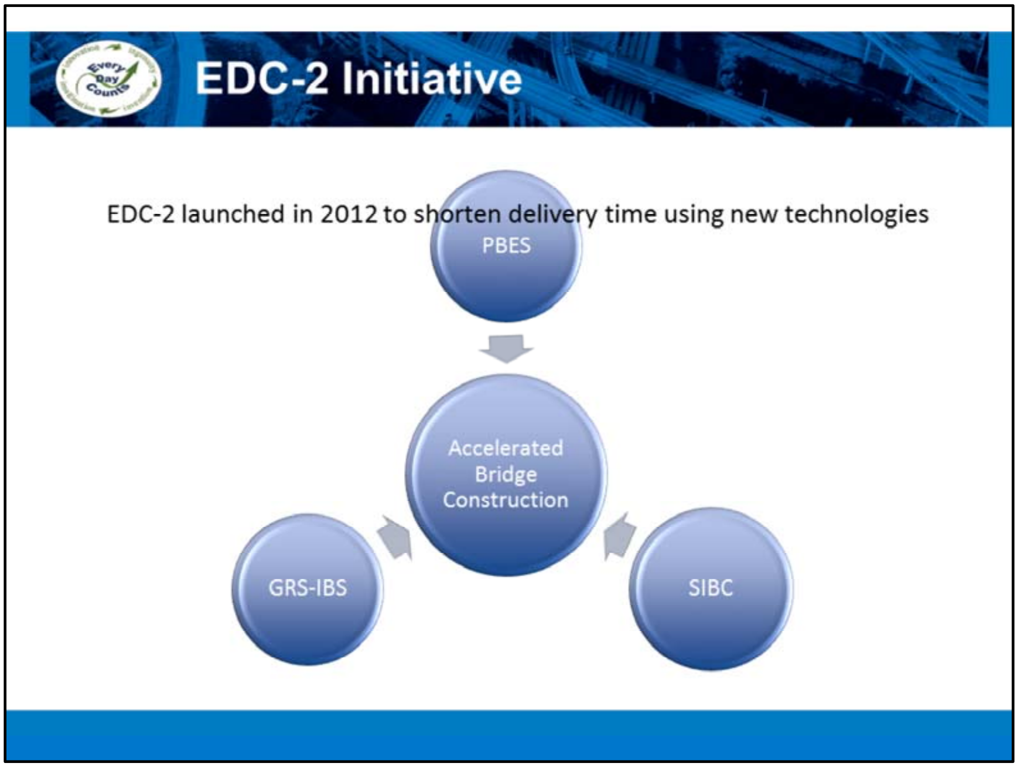
This presentation is aimed towards design engineers and developed for the FHWA as an extended effort of the Every Day Counts Initiative.

Slide-in bridge construction (SIBC) is a particular method and refinement of construction contained under the broader topic of Accelerated Bridge Construction (ABC) with the specific goal of extremely rapid bridge installation under very short term road closure.



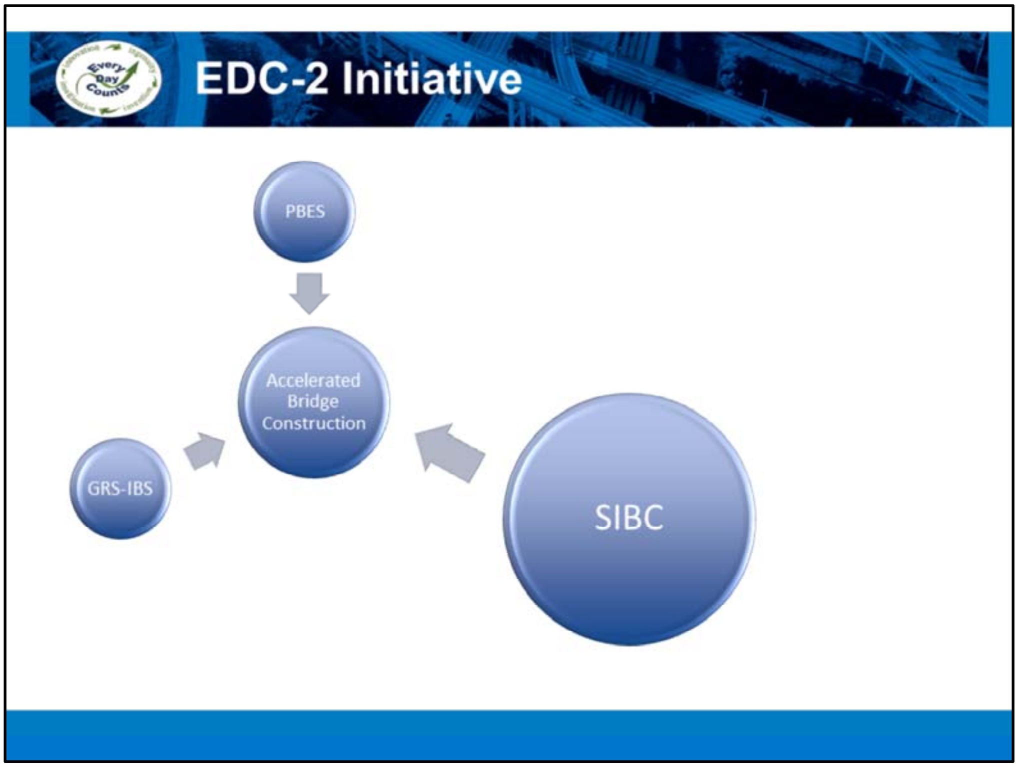
Nearly 25% of the Nation's 600,000 bridges are in need of rehabilitation, repair, or total replacement. Given this vast number, the need for bridge reconstruction methods that reduce the impacts to mobility and safety is needed. This need was one reason the Every Day Counts Initiative was launched.

Every Day Counts was first established in 2010 as a state-based initiative meant to identify and deploy innovation; specifically, to shorten project delivery, enhance safety, reduce mobility impacts, and protect the environment. The term "get in, get out, and stay out" was popularized under this program.

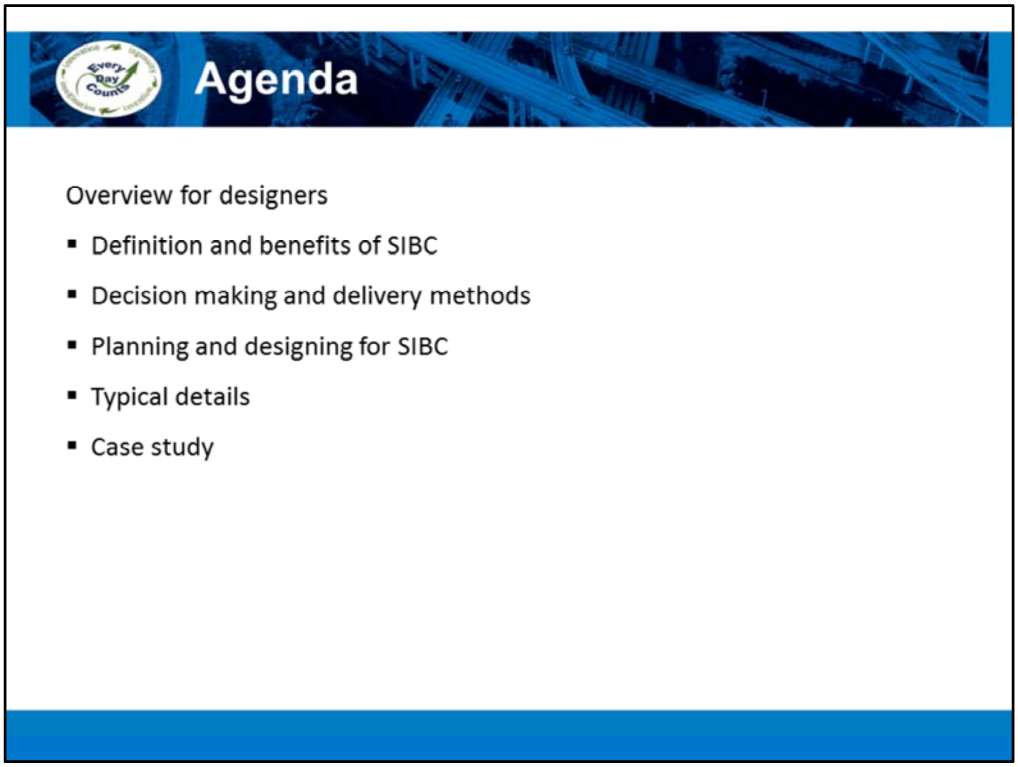


As a result of these efforts, EDC-2 was launched in 2012 with the specific focus of shortening the time needed to complete highway projects through the use of new technologies and ground-breaking processes. Within that directive, accelerated bridge construction became an area of concentration.

Three particular ABC technologies being promoted under EDC-2 are prefabricated bridge elements and systems, geosynthetic reinforced soil-integrated bridge systems, and slide-in bridge construction.



It comes as no news to anybody that our focus today will be on slide-in bridge construction.



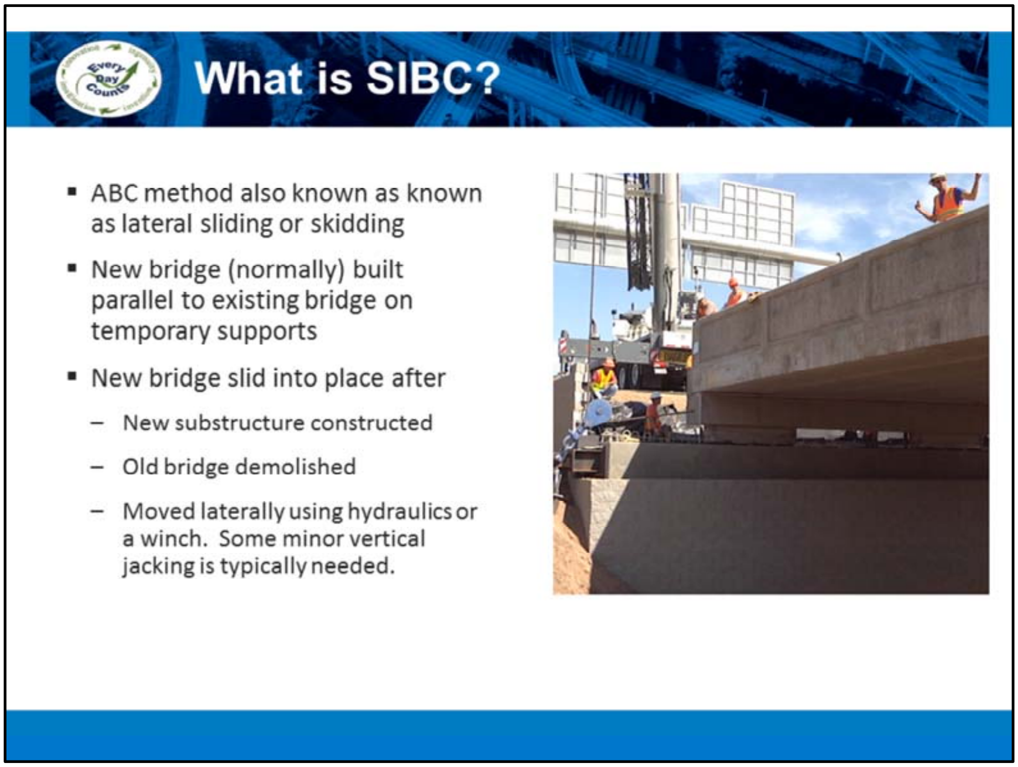
Several slide-in bridge construction topics will be covered as the day progresses. Collectively, the topics aim to provide a an overview for designers; thereby better equipping the group to pursue slide-in bridge construction or SIBC as it is now more commonly referred to.

SIBC will be defined and its benefits will be discussed.

Several ABC and SIBC decision making tools are presented along with the various delivery methods that can be employed.

Planning and designing for SIBC will be covered.

Lastly, a case study of a previous SIBC project will be presented.



So, what is slide-in bridge construction?

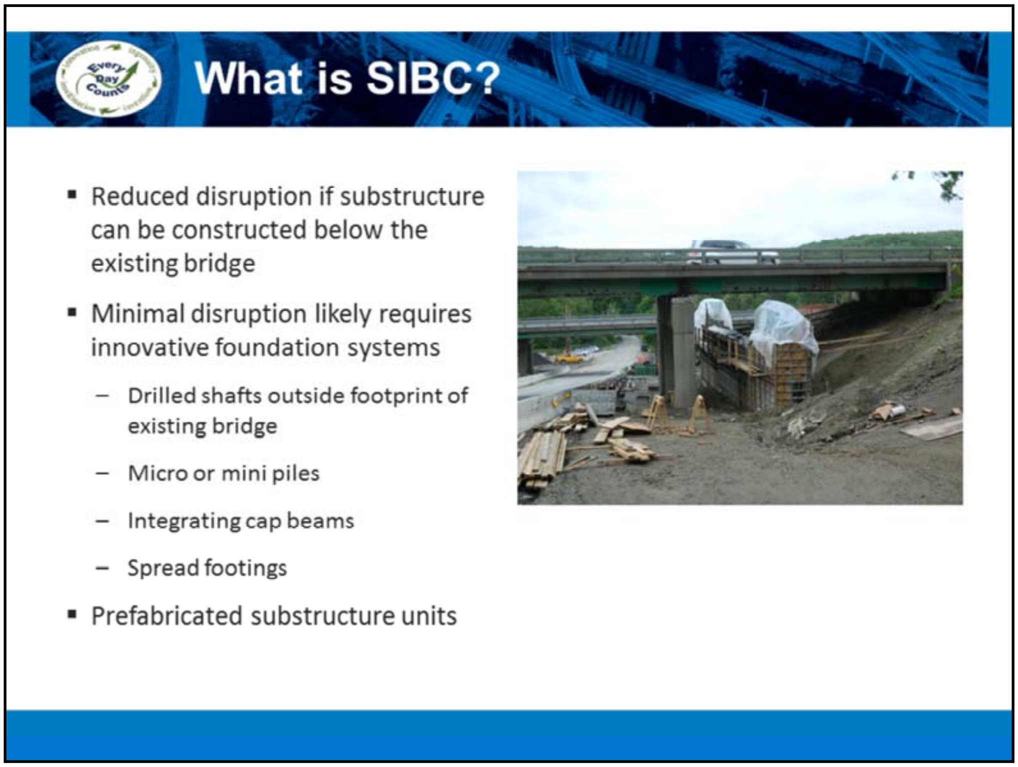
It is a method of ABC that has also been known as lateral sliding or skidding, and the variations of these techniques.

In SIBC, a new bridge is typically constructed adjacent to and parallel to the existing bridge on temporary supports.

Once complete, the old structure is demolished and the new substructure is constructed, followed by the sliding of the new superstructure on to the new substructure already in place. There have been some cases where the old substructure was reused.

The new bridge is moved laterally most commonly with hydraulic jacks, though other methods have been employed, such as a winch. Some minor vertical jacking is typically needed.

SIBC, and ABC in general, is primarily used for bridge replacement projects where the impacts to mobility are significant.



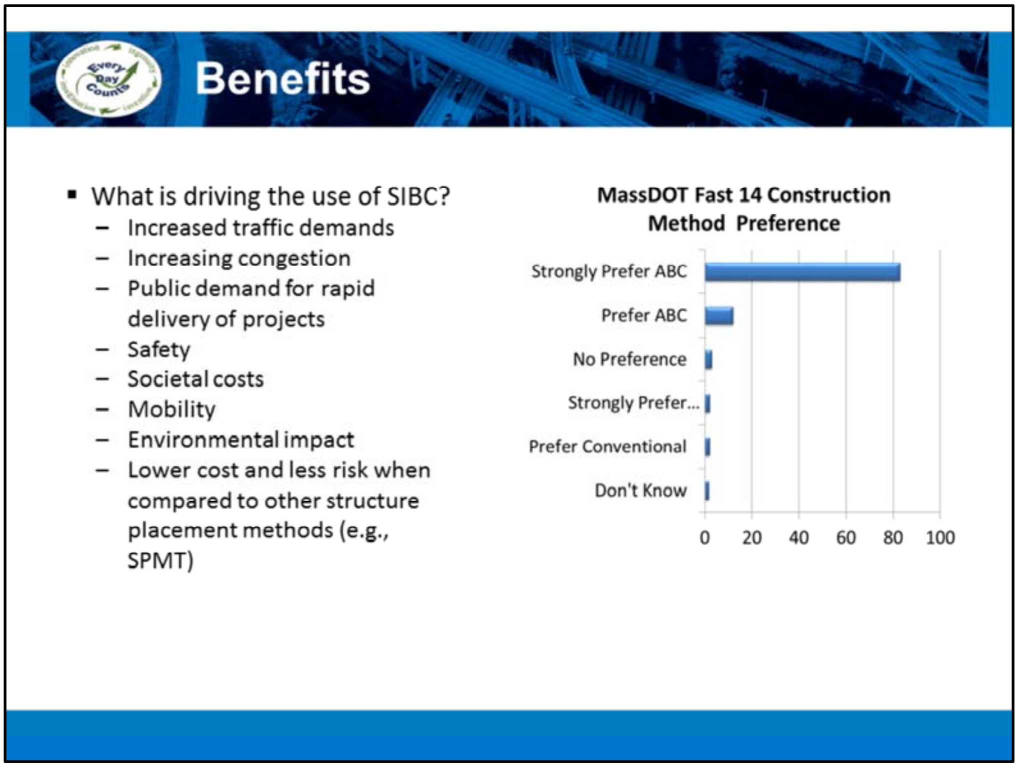
There have been many cases where the new substructure was constructed beneath the existing bridge prior to demolition. As you can predict, this expedites the process from demolition to bridge slide.

It should be pointed out, however, that constructing traditional foundation systems might not be feasible. Rather, an innovative foundation system might be required when using this method.

It is possible that prefabricated elements could play a key role in constructing the new substructure.

One might believe that bridge slides are only used for sliding a new bridge into the position of the existing. This is most commonly the case, but SIBC is not limited to only sliding new structures.

Existing structures can be slid to a new alignment to serve as a bypass bridge while a new bridge is constructed using more traditional methods. Keep in mind that in this case, the temporary substructure system will be subjected to live and other transient loads in addition to the bridge itself, typically resulting in a more robust, and hence higher cost, to such an installation.



So, what benefits can be gained by using slide-in bridge construction? Maybe the better question is 'What is driving the use of SIBC and how is it that SIBC addresses those needs?'

Traffic demands are increasing, congestion is increasing – both create an unnecessary nuisance in the lives of the traveling public. As such, the public demand for rapid delivery is increasing.

One can see in this chart the overwhelming preference for accelerated bridge construction when polled in Massachusetts prior to the MassDOT Fast 14 project.

Even more, the safety of the traveling public and bridge builders is compromised when bridge projects are long in duration. SIBC alleviates some of this risk by significantly reducing the time main-line traffic is interrupted.

Societal costs, though often difficult to fully quantify, are significantly reduced as well.

Environmental impacts can be softened.

And lastly, the costs can be lower and at less risk when compared to other rapid structure placement methods, such as self-propelled modular transporters, float in delivery, or a heavy crane pick, for example.

Benefits

- Offers non-traditional site options
- Eliminates crossovers, shoo-flies, staged construction, and long term detours
  - Can result in lower construction costs/bid price
- Reduces mobility impacts

To continue with the benefits of using SIBC: non-traditional site options can be offered, cross-overs or shoo-flies are eliminated along with staged construction and long term detours. These things can result in lower construction costs.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Mobility and environmental impacts can also be reduced and safety is nearly always enhanced for the worker and road user.

Potentially of greatest significance is that SIBC promotes user and worker safety. Safety is nearly always enhanced for the worker and road user; this can not be understated.

When compared to other ABC methods, SIBC often receives better contractor "buy-in", presumably because of the reduced risk that was previously mentioned.

Environmental impacts can also be reduced.

Benefits

- Removes bridge construction from critical path
  - May lead to better quality end product
- Involves public in reducing societal costs
  - Results in greater "buy-in" in the overall project
- Road closures better managed
  - Dates and duration are more predictable

Lastly, SIBC removes the bridge construction from the critical path which may lead to a better quality end product, it involves the public by reducing societal costs, thereby creating better "buy-in", and road closures can be better managed.

Along the way, we'll take a minute to quickly highlight a project to emphasize a couple of points. The first project highlighted is I-84 at Dingle Ridge Road in New York.

A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

Though the benefits are great, one must be aware that some potential challenges exist.

While some personnel within the DOTs embrace innovative methods, others are more resistant and tend to lean on traditional construction methods. This resistance can stall a potential SIBC project.

Finding experienced contractors and/or heavy lift engineers can be a challenge, though that challenge is being lessened as more and more SIBC projects are being completed and contractors become more familiar with the process.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

In traditional construction projects it is common that unique bridge geometry, difficult foundations, or lack of space can present a challenge. These aspects are only magnified by the nature of SIBC.

A sound traffic management plan with contingency plan included is a must.

This method of bridge construction is relatively new, and as a result, there may be some contractor limitations.

For example, significant temporary shoring and unconventional schedules are often required.

During slide operations, a 24 hour commitment from the contractor, designer, and owner is necessary.

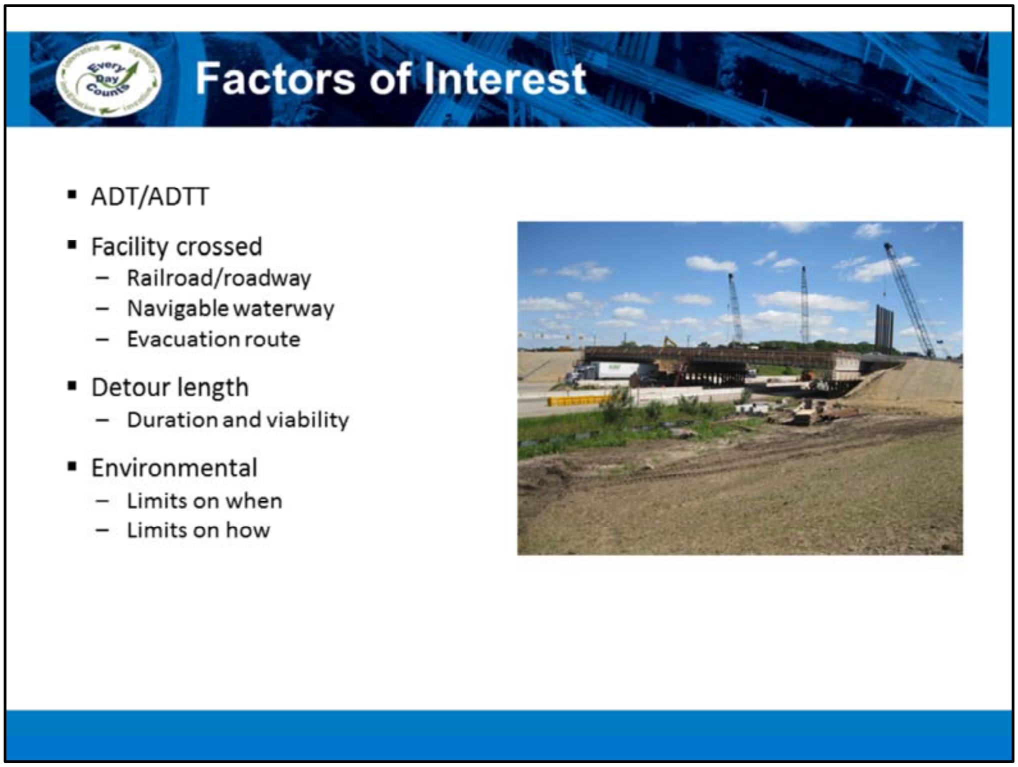
There are periods during the overall SIBC process that require extended time for the contractor, owner, and designer and, as a result, worker fatigue be an issue if not properly managed. Multiple crews can help alleviate this potential problem.

Even more, difficult foundations, equipment breakdowns, and the speed required to complete approach work can present a challenge.

Also, significant, critical time can be lost to surveying mistakes.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

To highlight another project, the Elk Creek project in Oregon was faced with numerous challenges that could be considered somewhat unique to this project. For example, the site, located in the mountains of western Oregon, did not afford ample space or flat terrain from which a new bridge could be easily constructed and slid into place. Nonetheless, the successful completion of this project using slide in construction proved that slides can be effective even in very confined locations.



Some factors of interest to consider when making an initial decision for or against SIBC include: average daily traffic, the facility that is being crossed (railroad, roadway, other?), the detour length (duration and viability), and environmental effects (limits on when and how).

Factors of Interest

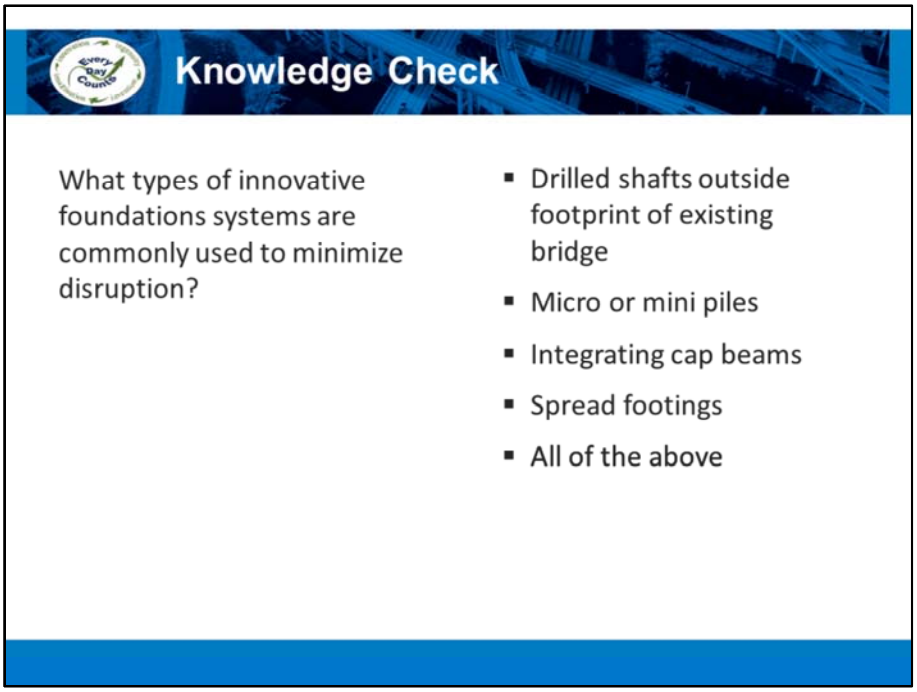
- On critical path of entire project
- Available right of way for bridge construction
- Traffic analysis
- Contractor's work area and ingress/egress ability

Is the bridge on the critical path of the entire project?, is there available right-of-way?, should traffic analysts be engaged?, where will the contractor's workspace, entrances, and exits be located?.

To this point, SIBC has been defined, some benefits and challenges have been listed, and factors of interest shown. You’ll now get an opportunity to check a bit of your knowledge.

In SIBC, the new bridge is constructed “blank” to the existing bridge on “blank” supports.

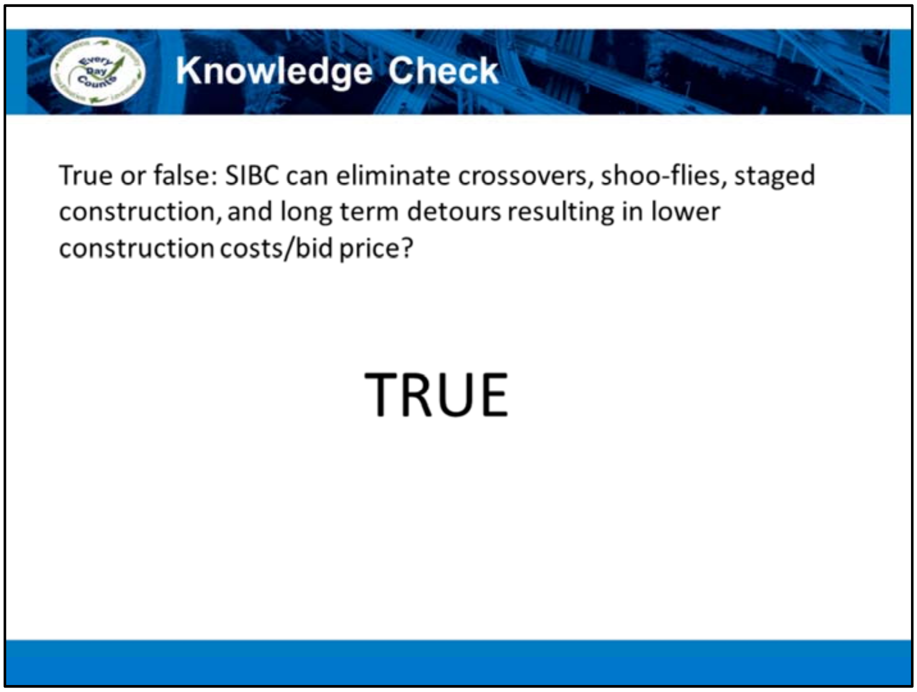
In SIBC, the new bridge is constructed “parallel” to the existing bridge on “temporary” supports.



What types of innovative foundations systems are commonly used to minimize disruption?

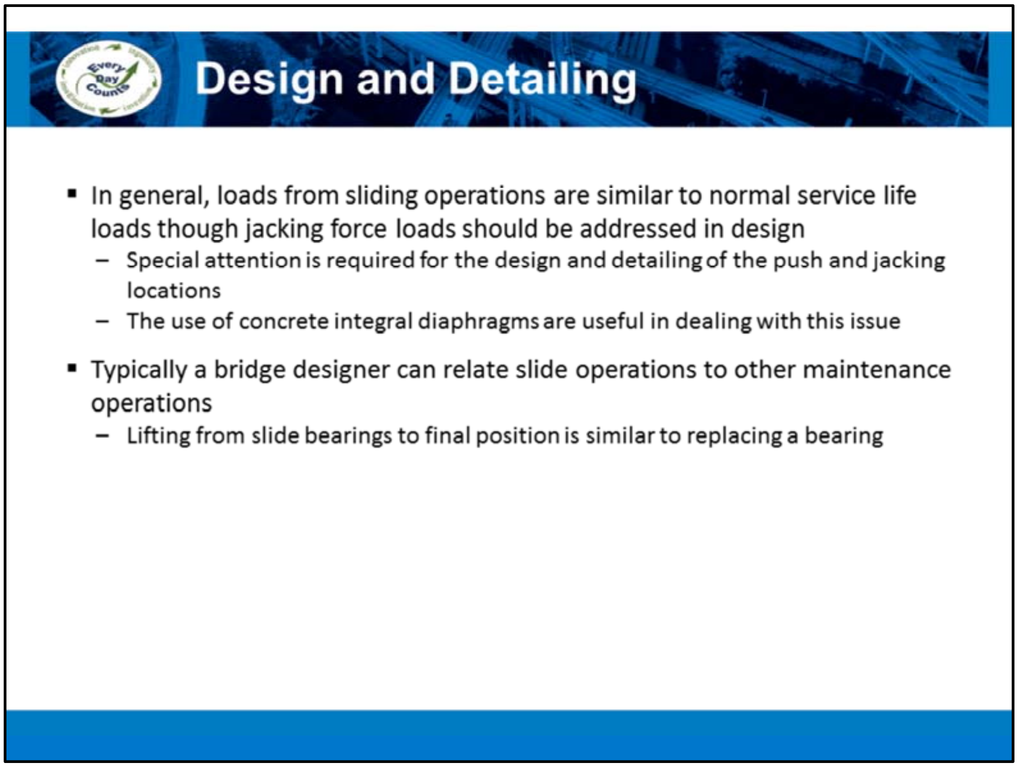
Drilled shafts outside footprint of existing bridge?
Micro or mini piles?
Integrating cap beams?
Spread footings?
Or
All of the above?

The answer: All of the above. Each of the options are commonly used to minimize disruption.



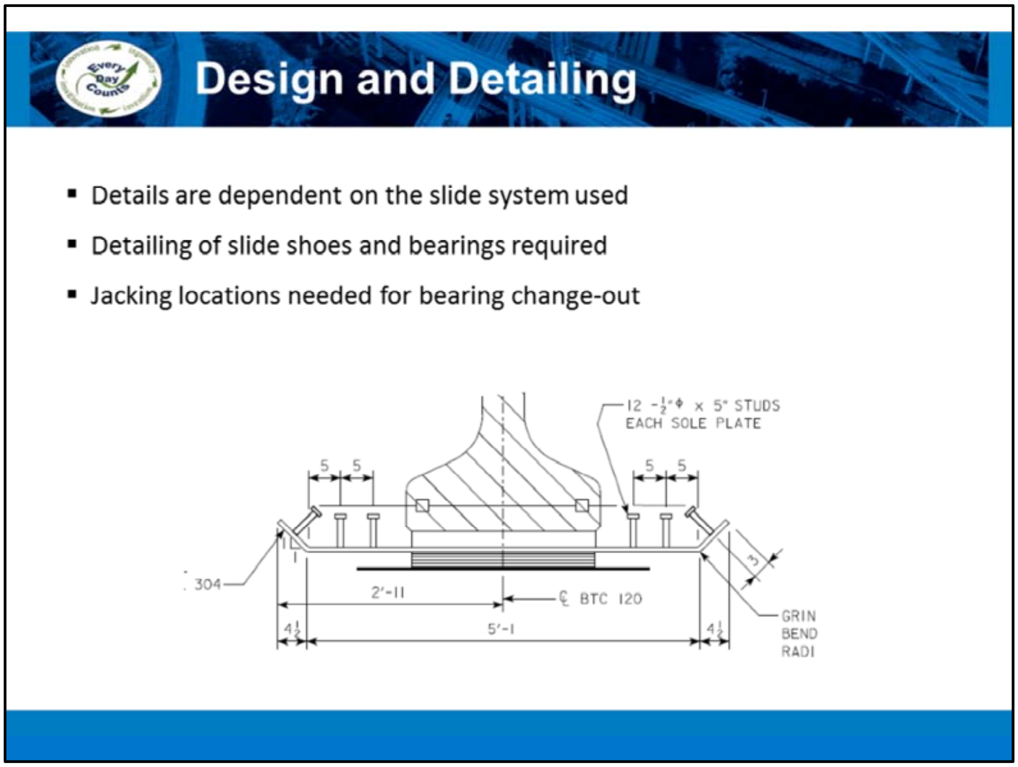
True or false: SIBC can eliminate crossovers, shoo-flies, staged construction, and long term detours resulting in lower construction costs/bid price?

True

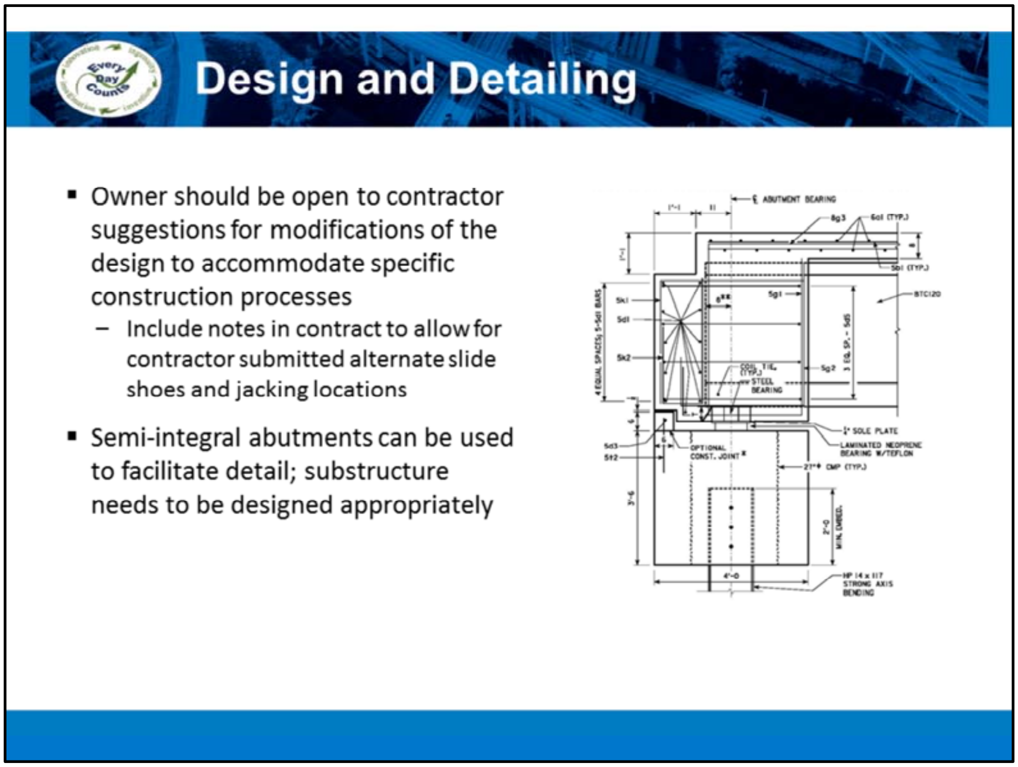


The design and detailing of a bridge slated for slide-in bridge construction is more similar than different from that of a traditionally constructed bridge. In general the loads during sliding operations are minimal and likely will not exceed loads typically seen during normal service life.

It is at the jacking locations that additional loads should be addressed. The use of concrete integral diaphragms are quite useful in dealing with this issue, an example of which is shown along with a slide plate in this detail. Forces can best be related to those seen in maintenance operations. For example, replacing a bearing.



Special attention should be paid to the detailing of slide shoes, bearings, and jacking locations if bearing change out is required.

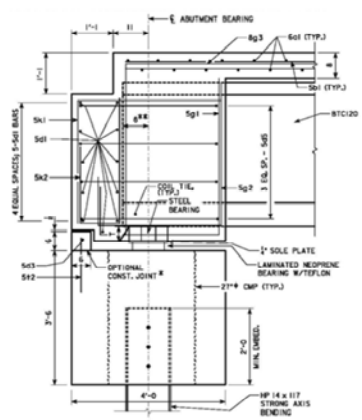


Even more, the owner should be willing to entertain a contractor's suggestions for design modifications that would enable a specific construction process to be completed with other equipment or in a different manner.

A semi-integral abutment with properly designed substructure can be used to facilitate slide details and modifications. In general, the slide surface should be level. This means that the depth of the semi-integral diaphragm will vary with roadway cross slope.

Design and Detailing

- Detail adjustability on the bearings to provide uniform loading on all bearings
- Need for slide displacement monitoring and controls
- Temporary works structure should be attached to substructure

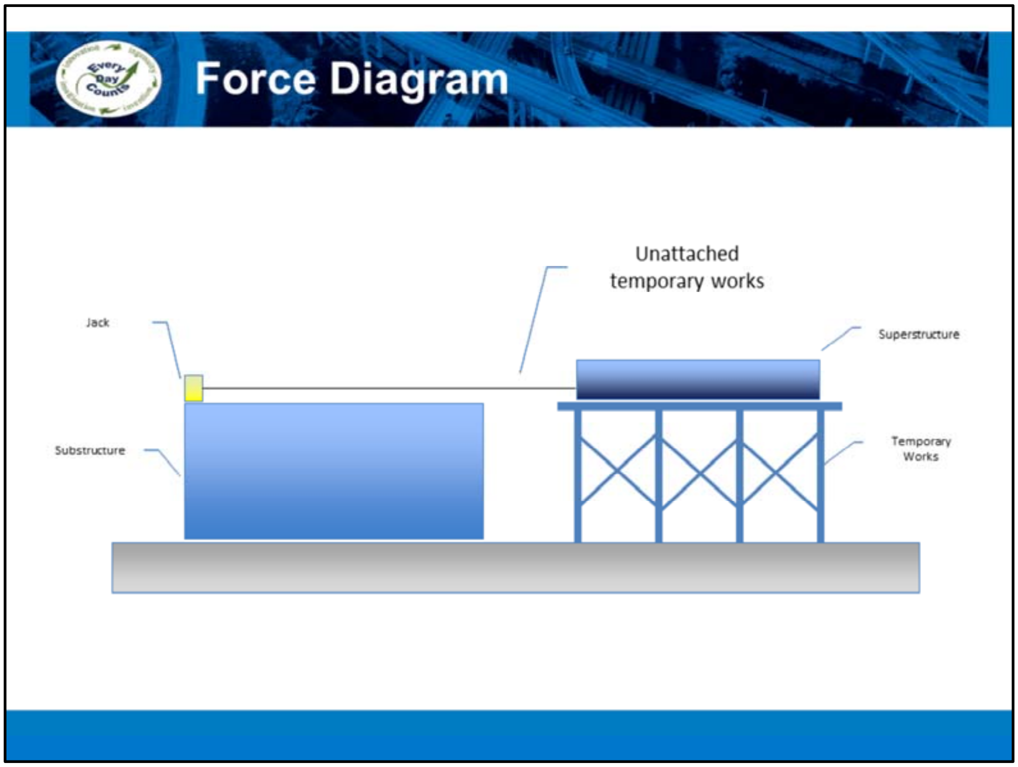


Adjustability should be provided on the bearing to ensure uniform loading on all bearings.

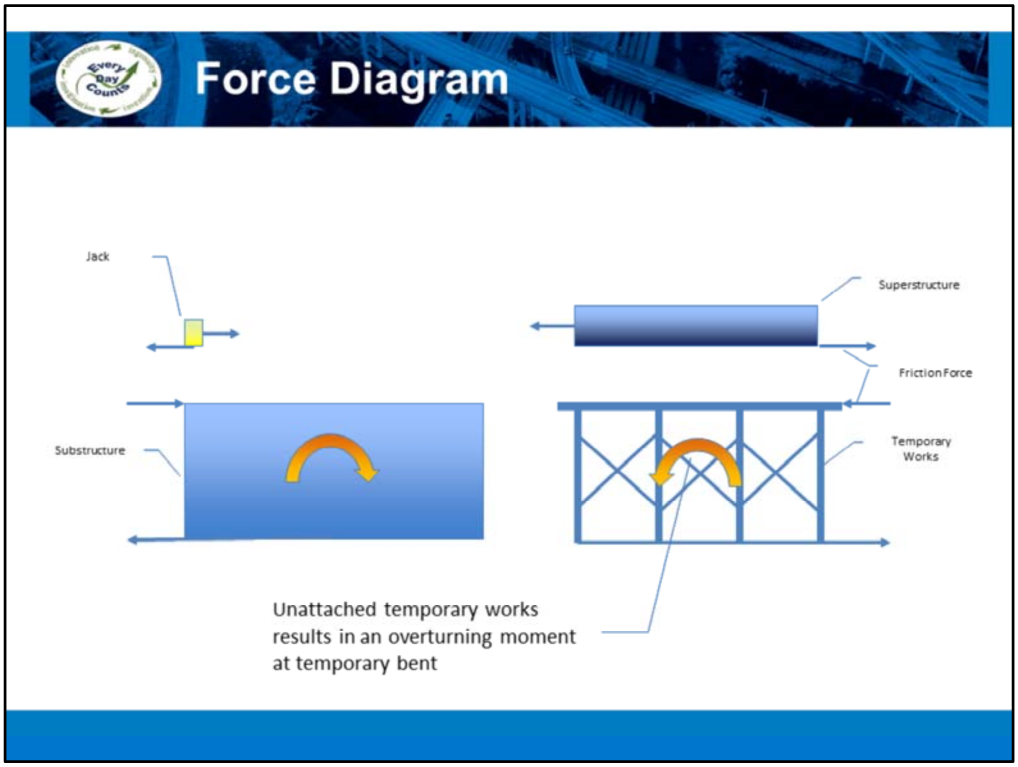
A system for monitoring displacement during the slides should be in place.

Lastly, it is greatly beneficial to the overall substructure design, both permanent and temporary, to attach the temporary works to the permanent substructure. The reason for this will be demonstrated in the following slides.

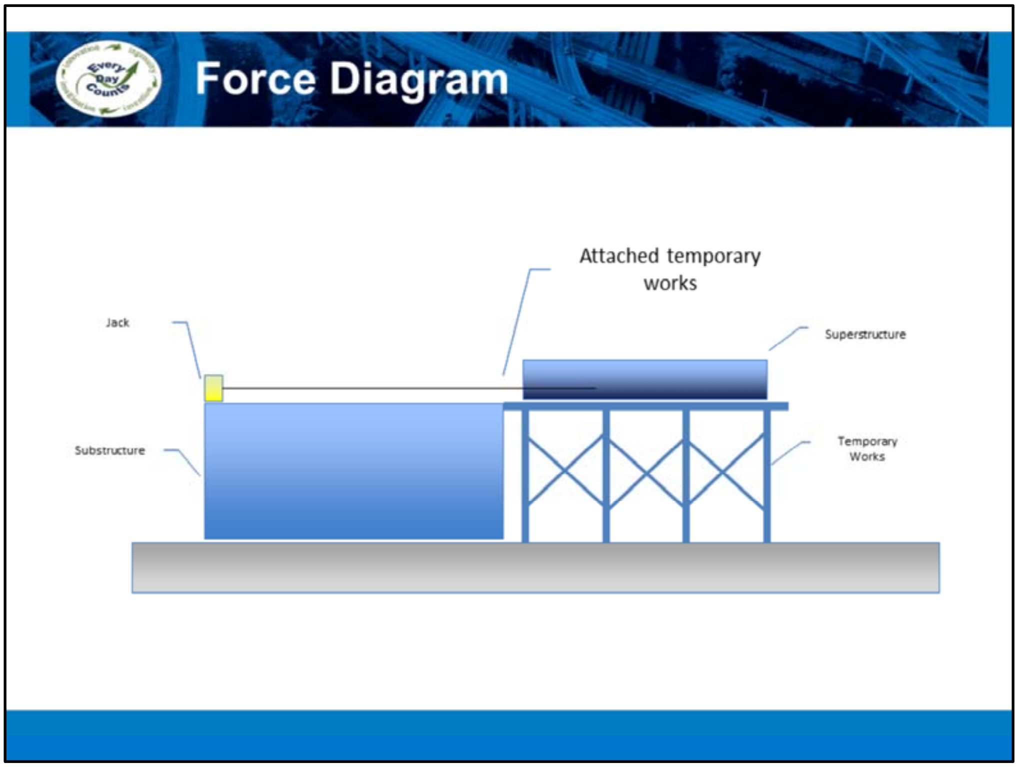
Generally the temptation is to treat the bridge as very fragile when being moved and placed, while this is appropriate, this should also be tempered with the perspective that bridges are, in fact, quite strong and durable structures.



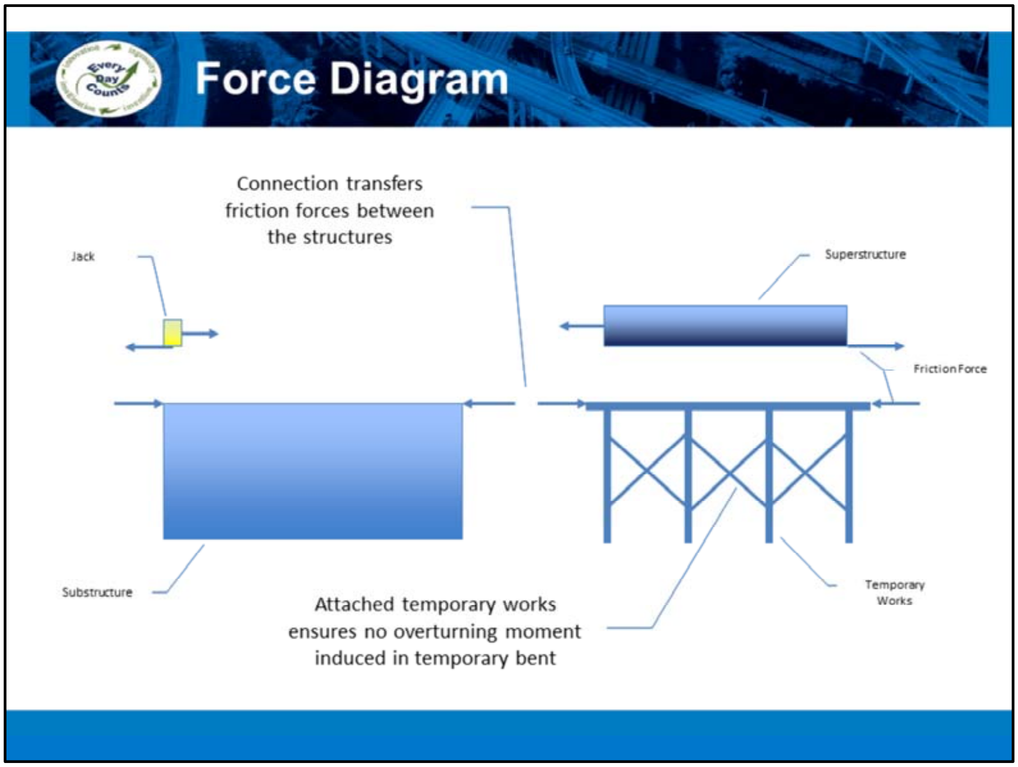
Seen in this schematic are the two substructures for the permanent and temporary works in an ‘unattached’ state. When pulling or pushing the new superstructure from one substructure to the other, significant forces are introduced to the substructures as seen in free-body-diagram on the following slide…



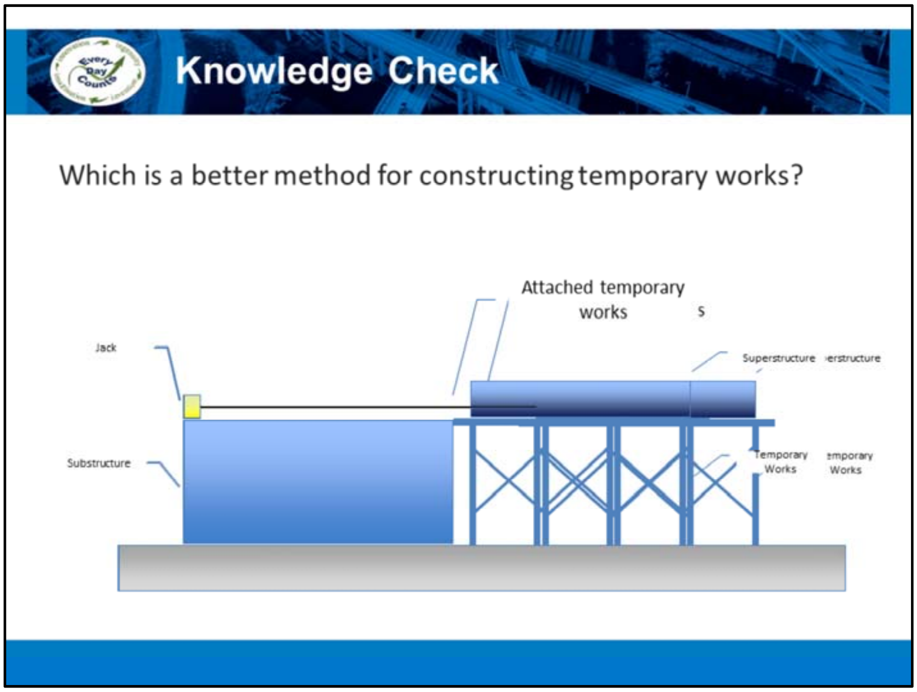
The resulting overturning moments must be accounted for in the design of the substructures, especially that of the temporary works.



Conversely, if a point of attachment is provided between the two substructures as seen in this schematic diagram, then…



… the overturning moments are eliminated, thereby greatly simplifying the design of the substructure and the temporary works.



Which method is better for constructing temporary works?

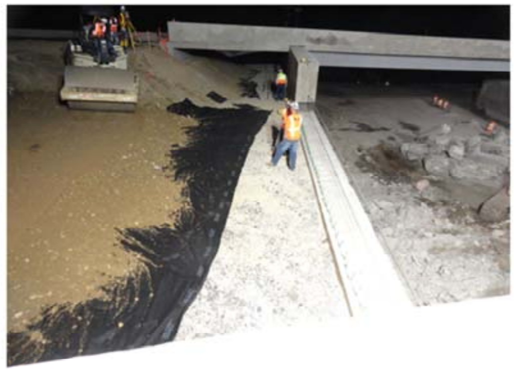
Leaving the temporary works unattached from the permanent substructure?
or
Attaching the temporary works to the permanent substructure?

Answer: Attaching the temporary works to the permanent substructure. This simplifies the demand and design of the temporary works and substructure.

As part of the Massena, Iowa bridge slide, semi-integral abutments act as the jacking locations and the temporary works were attached to the substructure. Together these details proved to be an effective means for sliding the superstructure.

Approach Slab

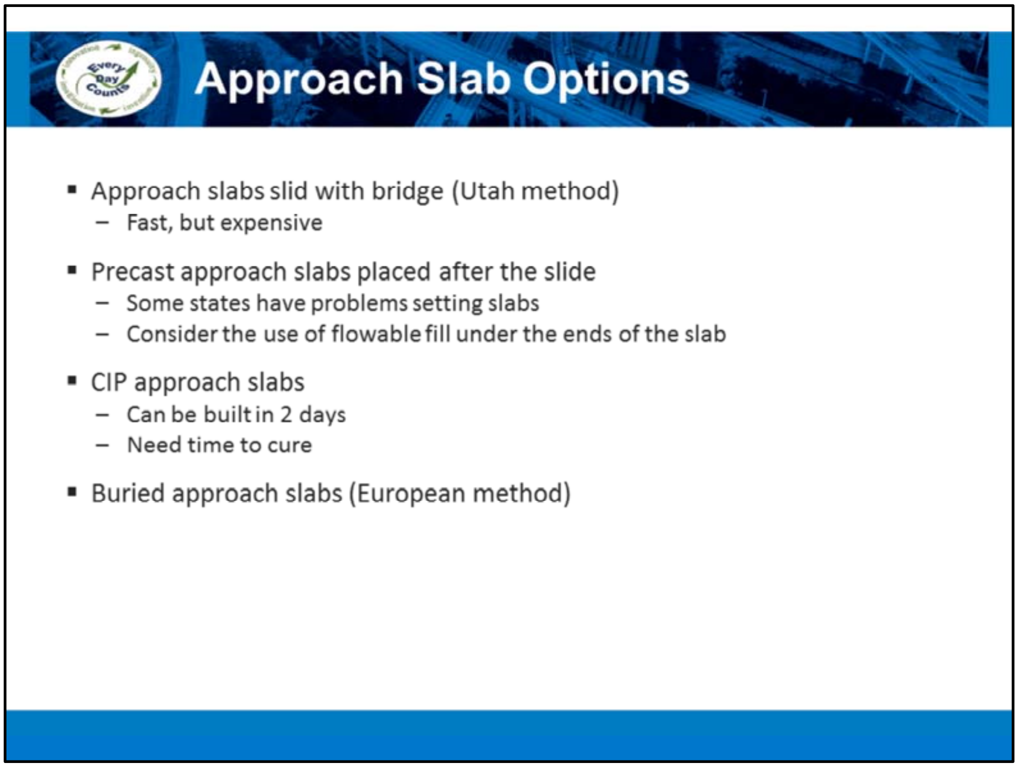
Attention to approach slab design and construction should be a priority and not an afterthought



Not to be lost with the significant focus on the constructability and slide of a new superstructure are the approach slabs. Attention to approach slab design and construction should be priority, rather than an afterthought.

Several methods have been used including the ‘Utah Method’ which involves sliding the approach slabs with the bridge, precast approach slabs placed after the slide, cast-in-place approach slabs, or even buried approach slabs commonly referred to as the ‘European Method’.

A site-specific evaluation should be completed to assess which method is best. Most DOT’s have standards for this item that are not compatible with SIBC; again perspective is key. Age-old standard details can often be placed on a pedestal resulting in resistance to otherwise reasonable alternatives.



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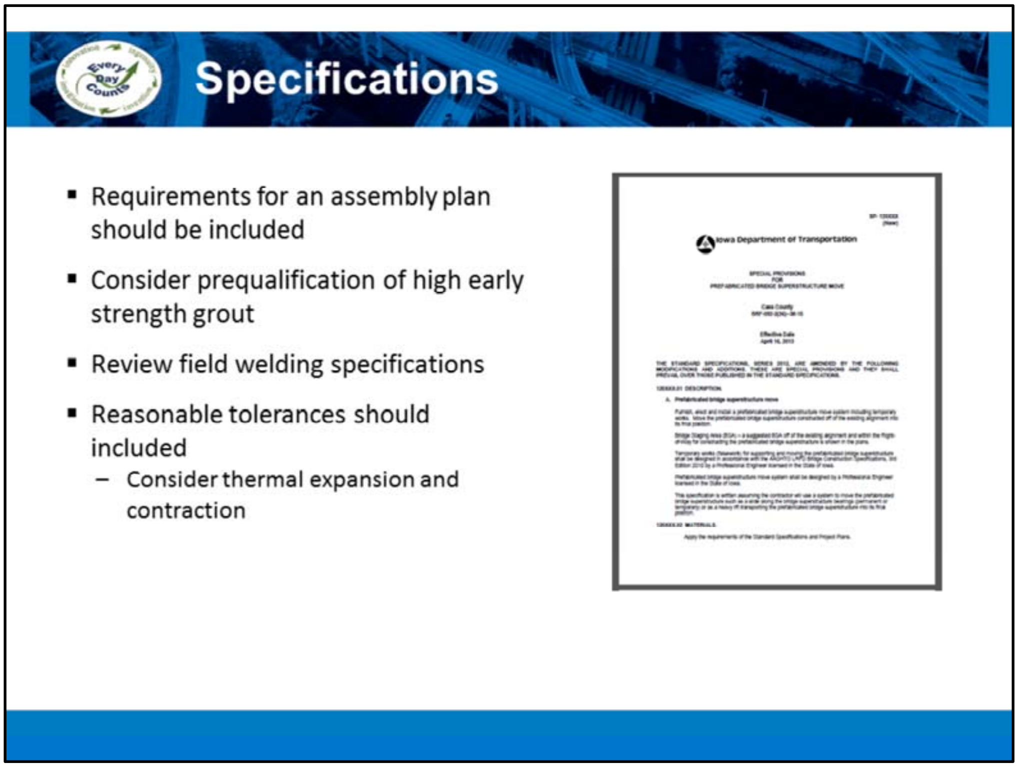
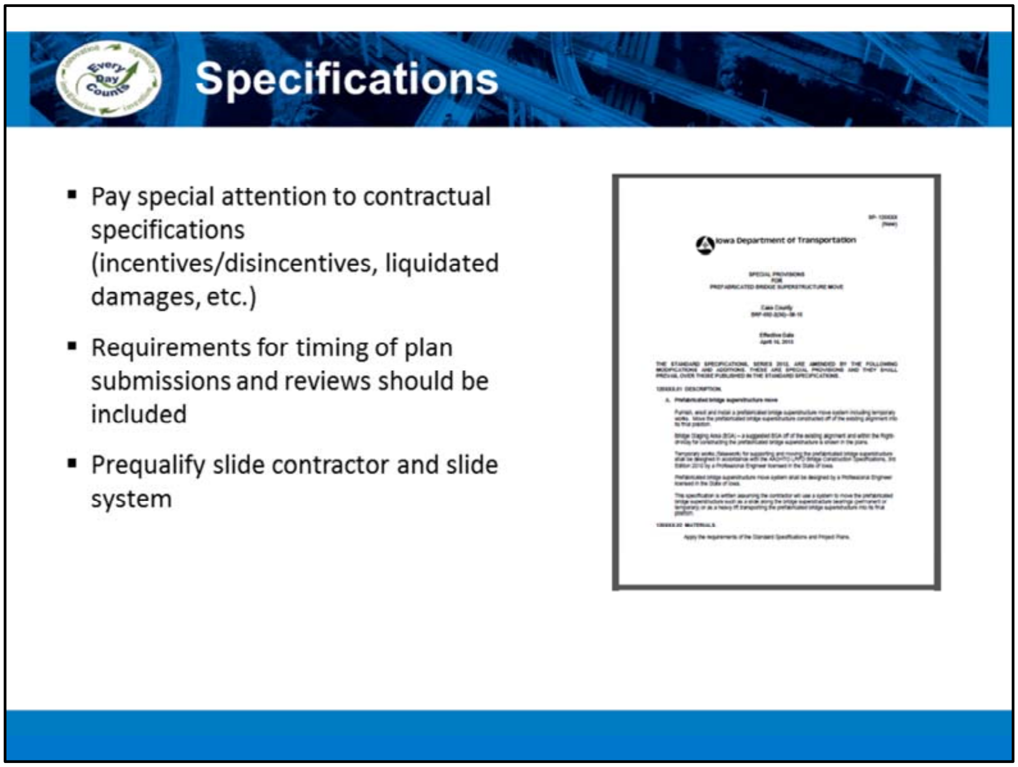


Specifications for slide-in bridge construction projects largely resemble those of a traditionally constructed bridge. However, additional specifications or modifications of existing specifications should be provided that cover the unique aspects of a slide-in project.

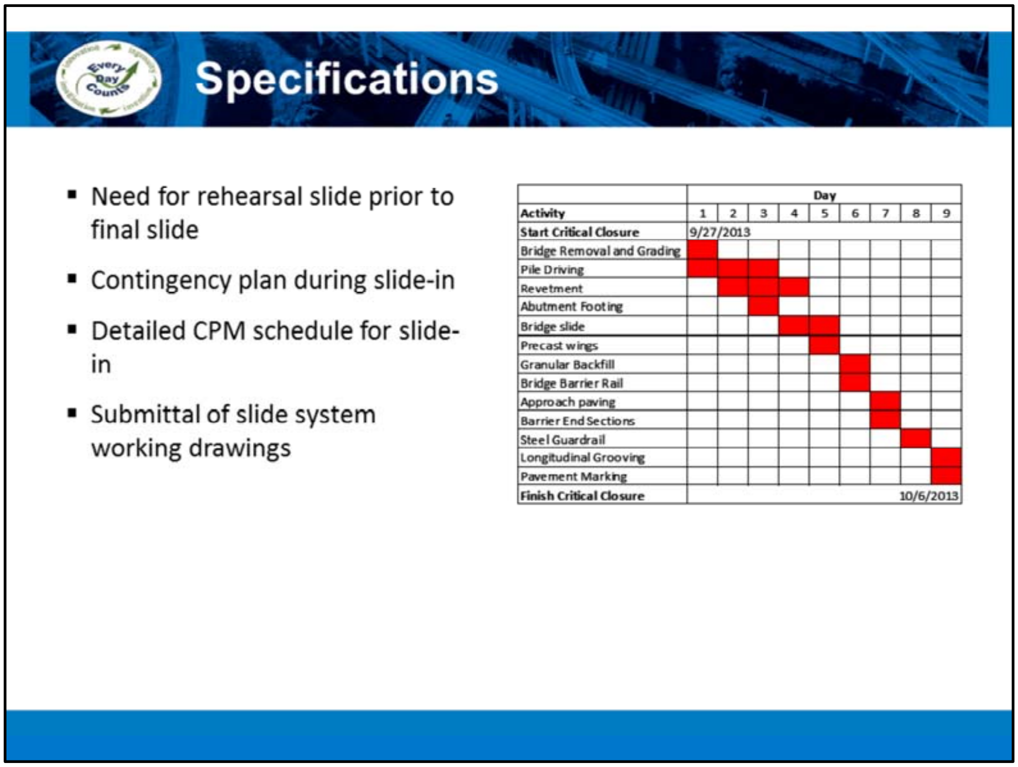
For example, requirements for an assembly plan should be included. The assembly plan is similar to an erection plan, except it includes more detail on the temporary works and equipment. It also includes a step by step plan for the completion of the work including schedule.

Prequalification of high early strength grout and review of field welding procedures should be considered. Reasonable tolerances should be included that accommodate thermal expansion and contraction, and the fact that the bridge will be moved.

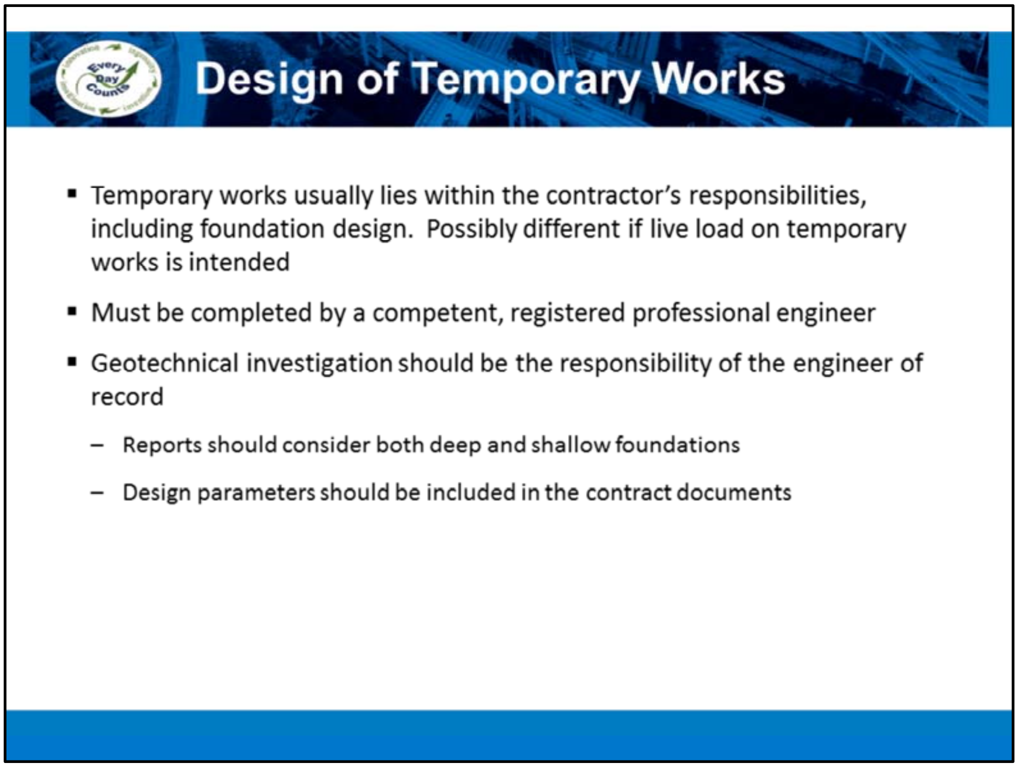


Special attention should be paid to contractual specifications such as incentives and disincentives or liquidated damages. Requirements for timing of plan submissions and reviews should be included.

Possible prequalification of the slide contractor or the project superintendent and slide system should be considered.



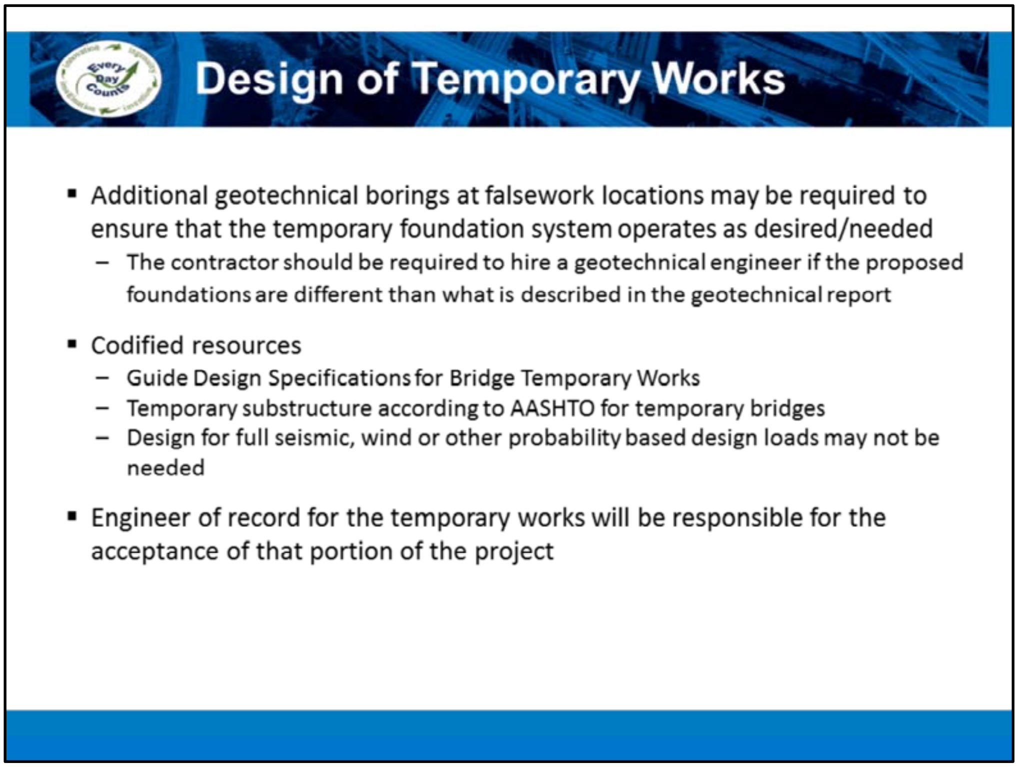
Additional specification considerations include: the need for rehearsal slide prior to final slide, a contingency plan during slide-in, a detailed CPM schedule for slide-in, and the submittal of slide system working drawings.



In most cases, the design of temporary works lies within the contractor’s responsibilities. Though if the traveling public will at least minimally travel over the temporary works, the responsibility may lie elsewhere.

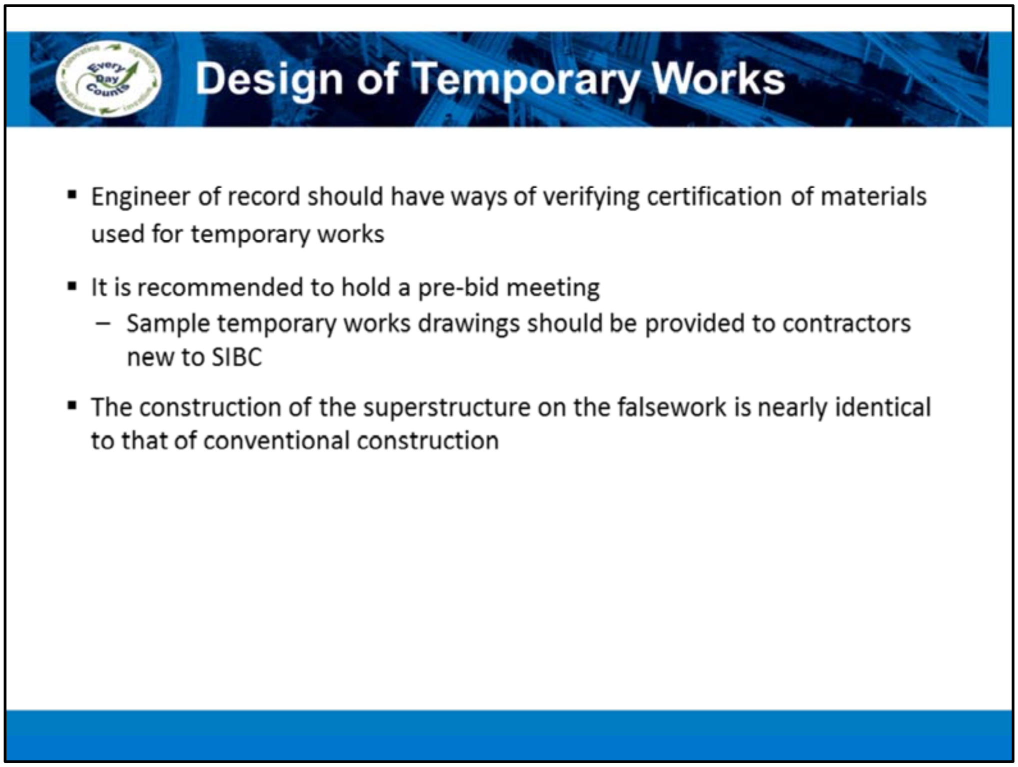
The design must be completed by a competent, registered professional engineer. The engineer of record should be responsible for the geotechnical investigation around the site including the area proposed for temporary works.

Both deep and shallow foundations should be considered and all design parameters included in the contract documents.



If temporary works foundations different than those considered are proposed by the contractor, it is required of the contractor to hire a geotechnical engineer. Several codified resources exist to guide the temporary works design including those listed here.

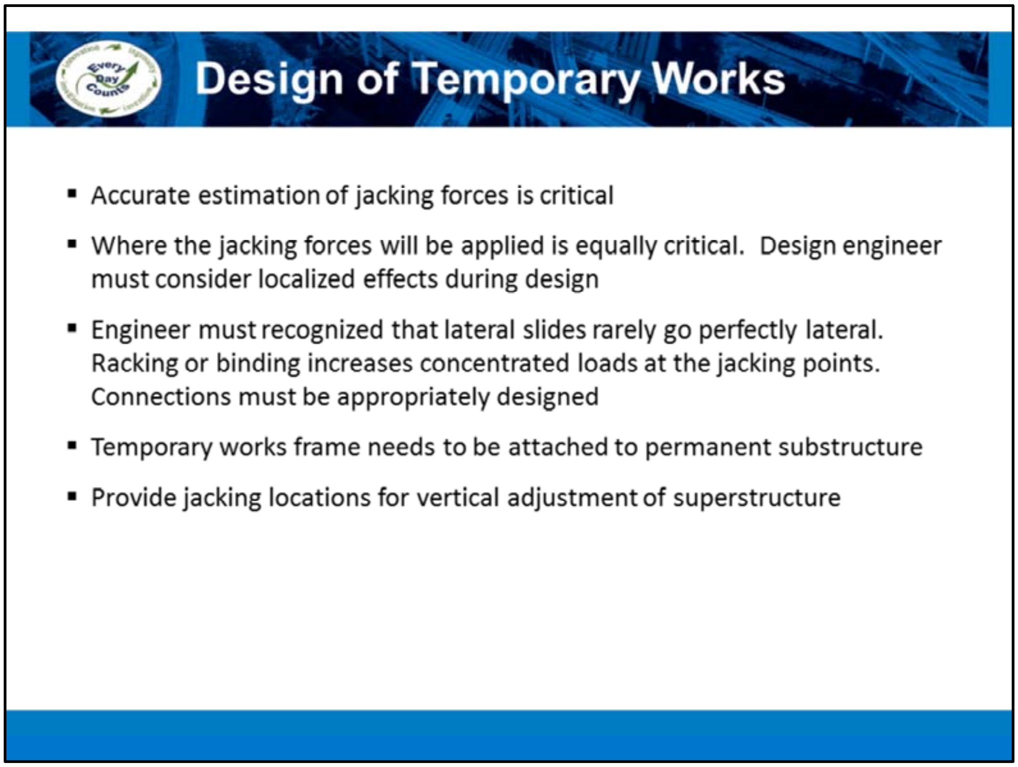
In the end, acceptance of the temporary works will be up to the engineer of record for the installation.



Further, the engineer of record should have the ability to verify materials certification.

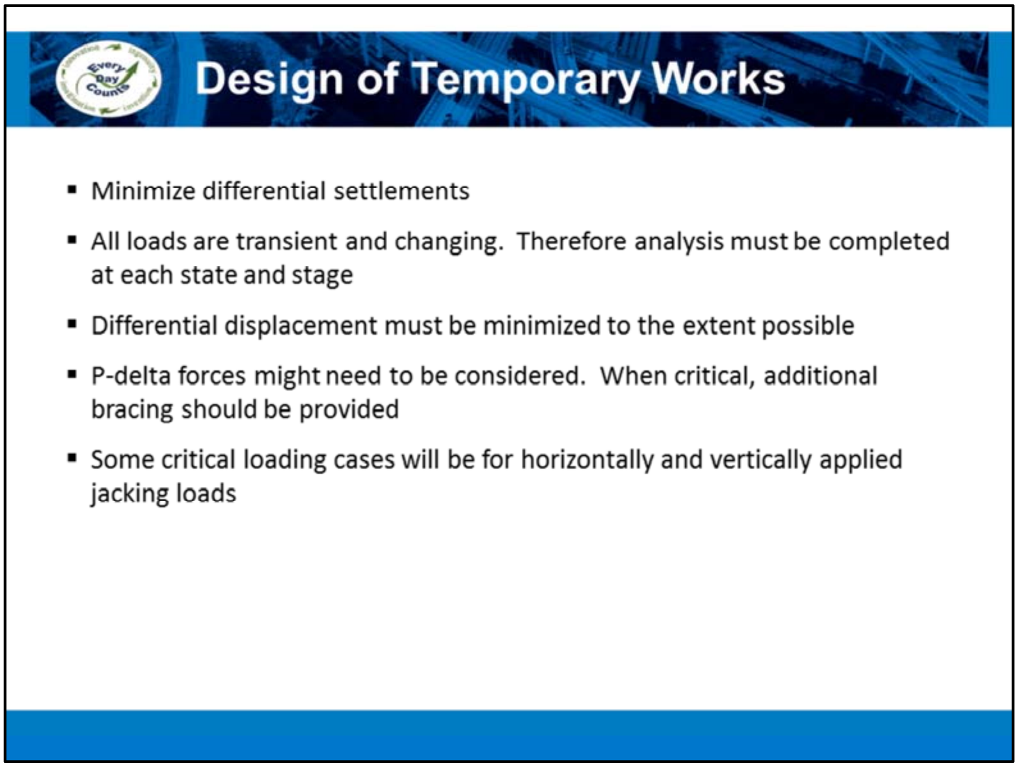
A pre-bid meeting is recommended where sample temporary works drawings can be viewed for those unfamiliar with slide-in construction.

For SIBC, the actual construction of the new superstructure upon the temporary works is very close to that of conventional construction; very few methodical changes are needed.

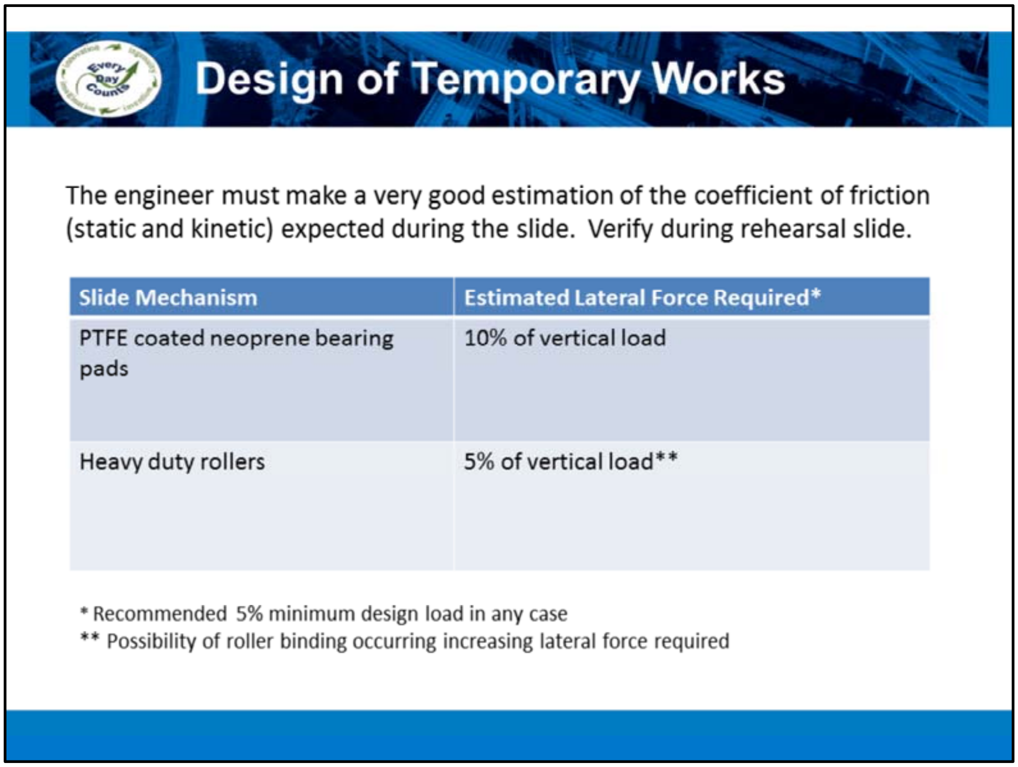


The expected jacking forces and jacking locations are key to the design of temporary works. It should be noted that possible misalignments or hang-ups during slide operations can considerably increase the jacking forces. Accordingly, connections should be appropriately designed.

For reasons discussed earlier, the temporary works should be attached to the permanent substructure. Lastly, jacking locations for vertical adjustment of the superstructure should be incorporated into the design.



Attempts to minimize the differential settlements between permanent and temporary works should be made. Note that all loads are transient and changing; therefore an analysis should be completed for stages throughout the process. Special attention should be paid to differential displacements, p-delta forces, and jacking loads.



To ensure the proper jacks will be supplied to the project, the engineer must make a good estimation of the friction forces during the slide. These forces should be verified during the rehearsal slide.

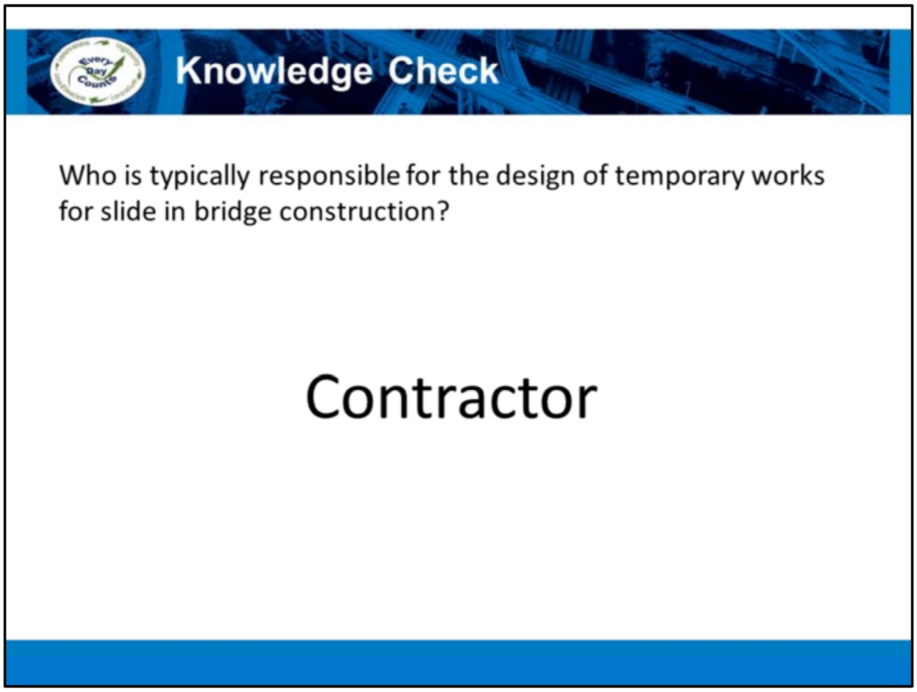
Two commonly used slide mechanisms include PTFE coated neoprene bearing pads and heavy duty rollers. The estimated lateral force required is 10% and 5% of the vertical load, respectively. Note that, in addition to the higher forces required during possible binding, a slightly higher force may be required when pushing the superstructure from a static to kinetic state.

Since the engineer of record does not know the make-up of the actual slide system, a recommended value of 10% should be used for preliminary engineering. The plans should show the recommended jacking location on the bridge and the engineer of record should verify that the structure can accommodate this force.

Design of Temporary Works

Transition from temporary support to permanent structure must be designed to accommodate the transient load and possible differential deflection.

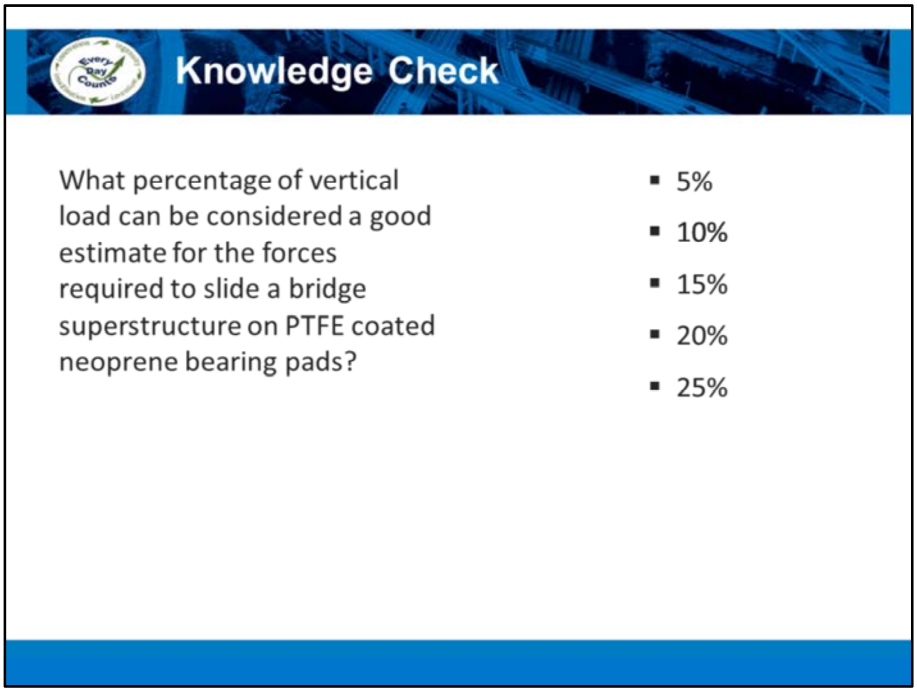
It is key that the transition from temporary supports to the permanent structure be designed to accommodate the transient load and possible differential deflection. The superstructure should experience little effect due to the changing support condition.



Who is typically responsible for the design of temporary works for slide in bridge construction?

Answer: The contractor.

Temporary works usually lies within the contractor's responsibilities, including foundation design, though this could change if live load on temporary works is intended.



What percentage of vertical load can be considered a good estimate for the forces required to slide a bridge superstructure on PTFE coated neoprene bearing pads?

5%?
10%?
15%?
20%?
Or
25%?

The answer: A good estimate on PTFE bearing pads is 10%. When using heavy duty rollers the force required is generally less, though in both circumstances the loads can increase if binding occurs or an obstruction isn't removed.

Provided in this slide are a few examples of various slide details. Shown in the two pictures to the left are PTFE coated bearing pads along with stainless steel slide shoes. Each pad is coated with dishwashing soap to further decrease the frictional forces; it is available, cheap and effective.

The top picture to the right shows jacking pockets incorporated into the semi-integral abutment used for vertical adjustment and bearing pad change-out.

The bottom picture shows the guide channel used with heavy duty rollers and also threaded rods which are connected to the jack. The slide shoe option works in conjunction with a semi-integral backwall diaphragm. The slide shoe can be just used for the move, or it can be used for the permanent bearing support. By using this method of detailing, the number of permanent bearings can be reduced by more than half. The Utah DOT has designed bridges with only 2 or 3 bearings at each support line.

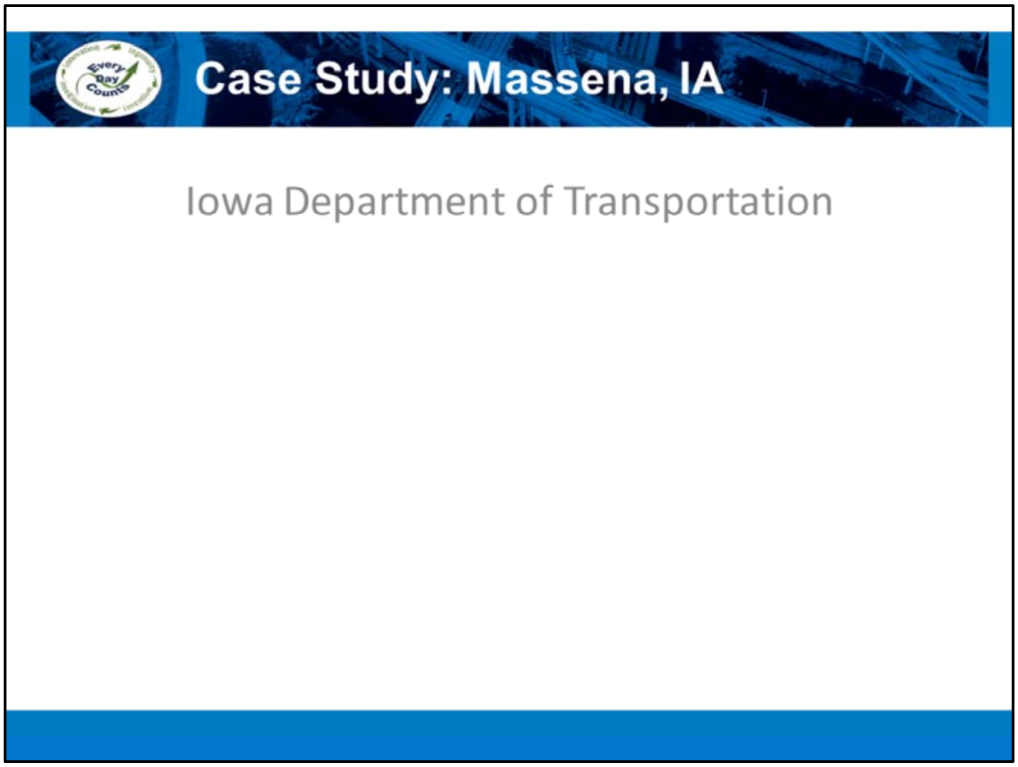
Additional pictures of hardware commonly used in slide-in applications are shown here. These include rollers, skids, PTFE pads, hydraulic rams, threaded bars, and vertical jacking hardware.

Power Systems

- Hydraulic jack
- Hydraulic push/pull jack
- Winches
- Cranes
- Other equipment

Several power systems can be employed to move the bridge superstructure. These include hydraulic jacks, push/pull jacks, winches, cranes, and even other equipment.

It is recommended that hydraulic equipment be required to be proof tested prior to being put into service, even new jacks can blow out seals and fail.

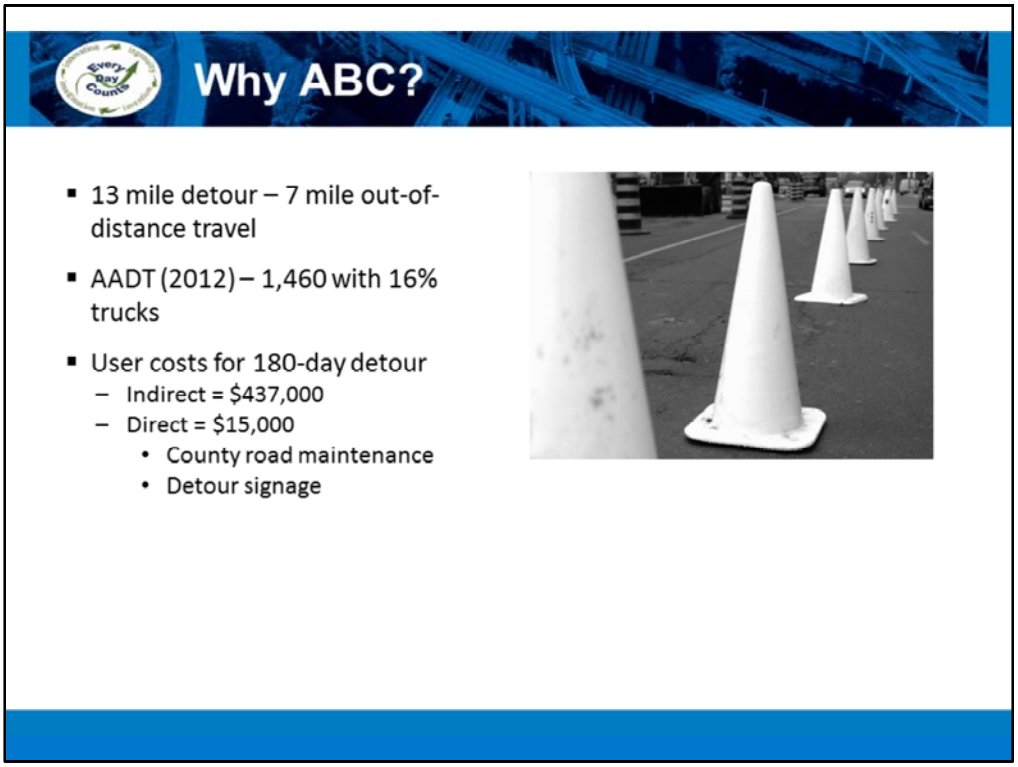


The case study we'll be covering today comes from a slide-in project completed during the fall of 2013 in Massena, IA. The owner is the Iowa Department of Transportation and this project is the first in the state completed using SIBC.

Location

- IA 92 over small stream, 1.0 miles west of IA 148

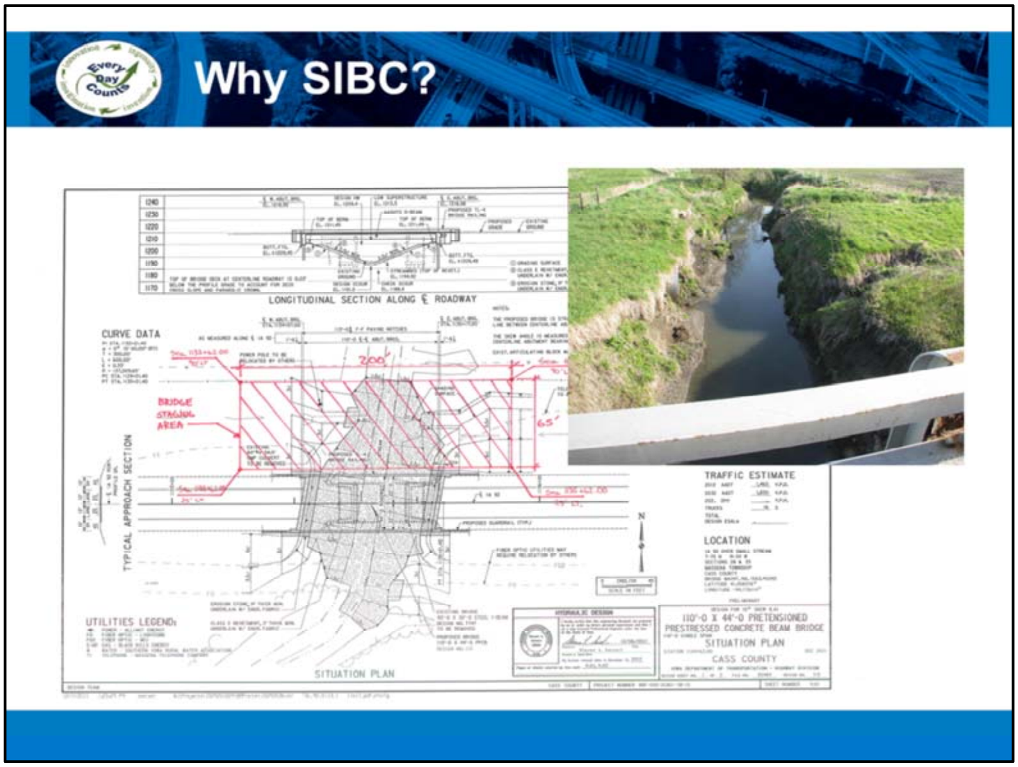
The bridge on IA 92 crosses a small stream immediately west of the Town of Massena, IA in southwest Iowa.



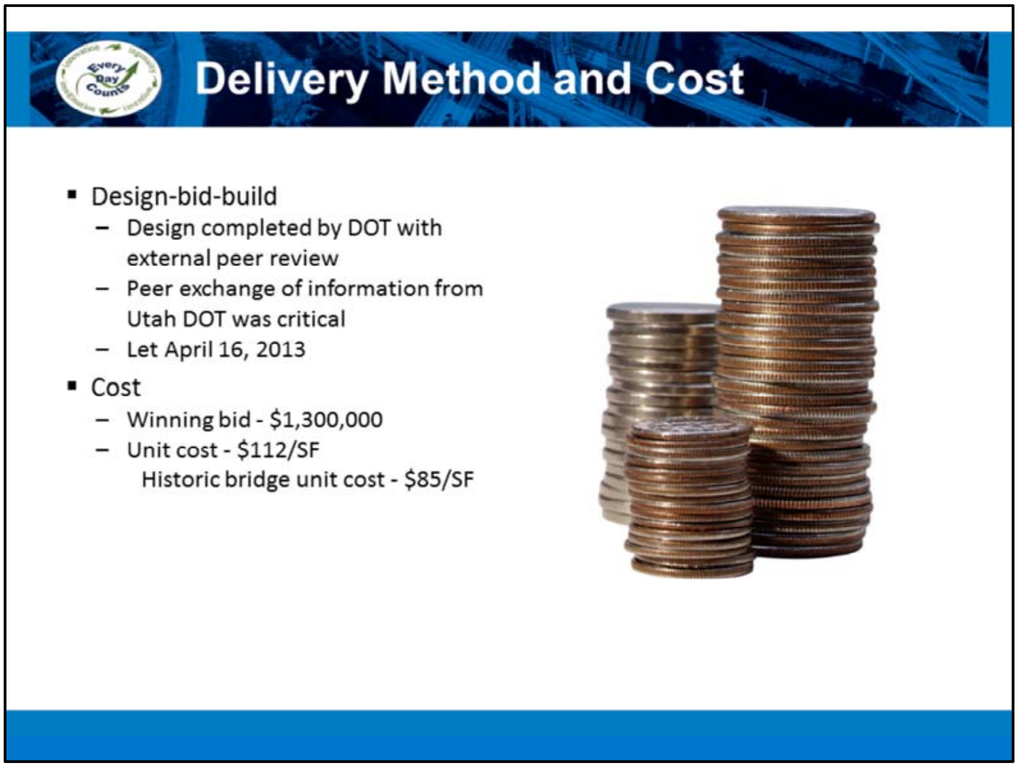
In this case, several considerations were made for why accelerated bridge construction was a good solution.

First, to close the bridge would have meant a 13 mile detour and 7 mile out of distance travel for road users. This is even more significant when coupled with the fact that 16% of all vehicles were trucks.

It is estimated that to complete the bridge replacement using traditional construction methods a road closure of 180 days would have been necessary resulting in indirect costs of $437,000 and direct costs of $15,000.



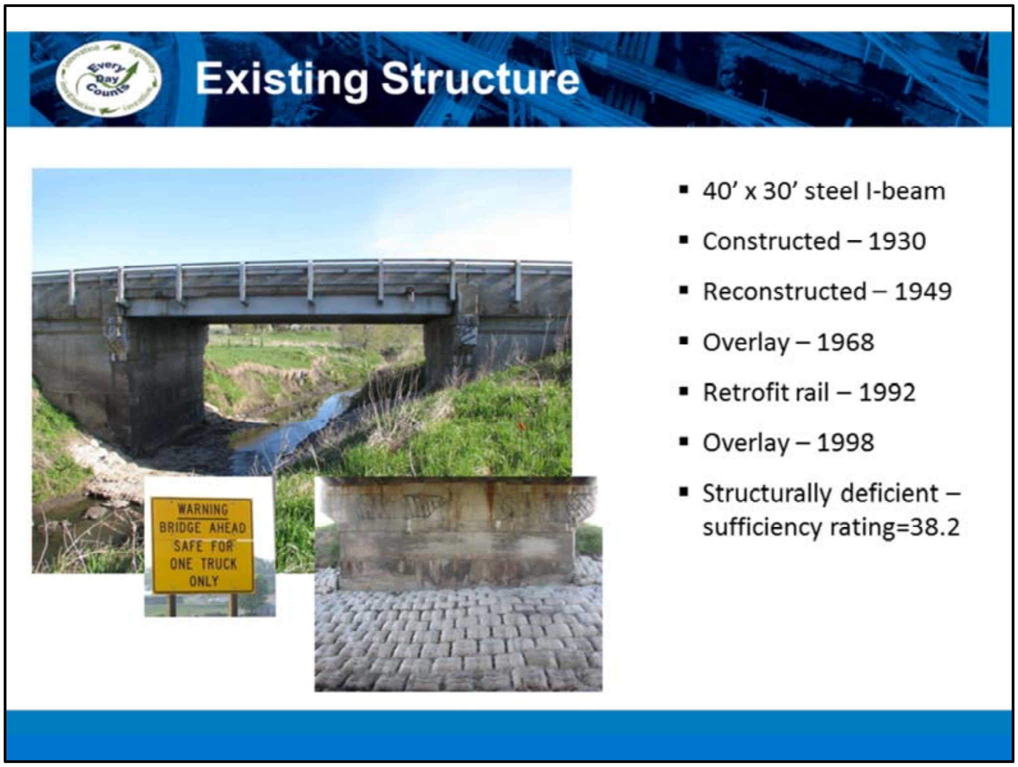
The Iowa Department of Transportation in its pursuit of accelerated bridge construction methods planned to implement slide-in construction methods at a site where it made sense to do so. At Massena, slide-in bridge construction was a good solution for accelerated bridge construction. The existing right-of-way allowed sufficient space for temporary works adjacent to the bridge without having to acquire temporary right-of-way. Even more, the geography was fairly flat, thereby simplifying the construction.



The method of delivery followed traditional design-bid-build. The design was completed entirely by the Iowa DOT with external peer review.

Prior to the beginning of the project, a critical peer exchange took place with the Utah DOT during the slide of one of their bridges. Several from Iowa traveled to Utah and were able to view the slide and speak directly with owners, designers, and contractors. Many lessons were learned and implemented prior to final design and construction of the Massena bridge.

The winning bid was $1.3 million which equates to a unit cost of $112/sf. Historically, in Iowa, the unit cost is near $85/sf, or roughly 75% of the actual cost. Note that these numbers represent the construction costs only and do not include the user costs which, if included, would have nearly equalized the overall costs.



The existing bridge, originally constructed in 1930, was a 40’x30’ steel I-beam structure with high abutment walls and narrow channel passage. Over its history, it had been reconstructed, retrofitted, and overlaid on several occasions. Soon before its replacement it achieved a sufficiency rating of 38.2, deeming it structurally deficient.

The proposed replacement seen in this rendering is a longer, pretensioned, prestressed concrete beam bridge.

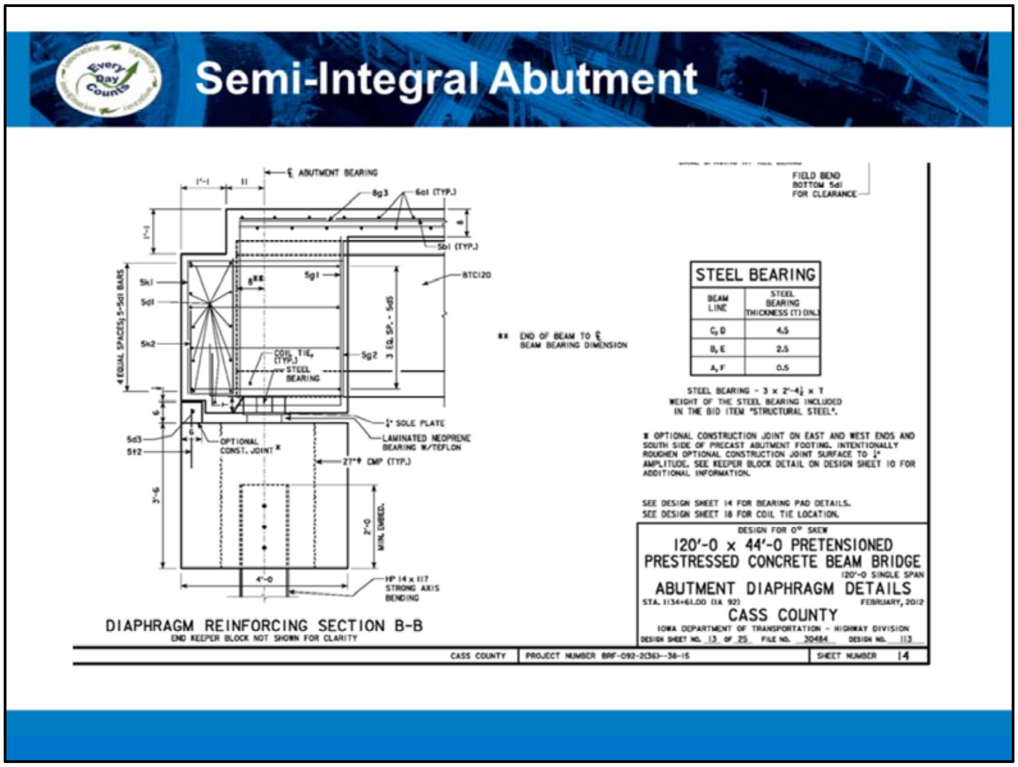
Plan Design and Details

- Semi-integral abutment details
- Abutment diaphragm
  - Jacking pockets for lifting
  - Block for pushing/pulling the prefabricated superstructure
- Precast abutment footing
  - H-Pile connections
- Precast wingwalls
  - H-Pile connections

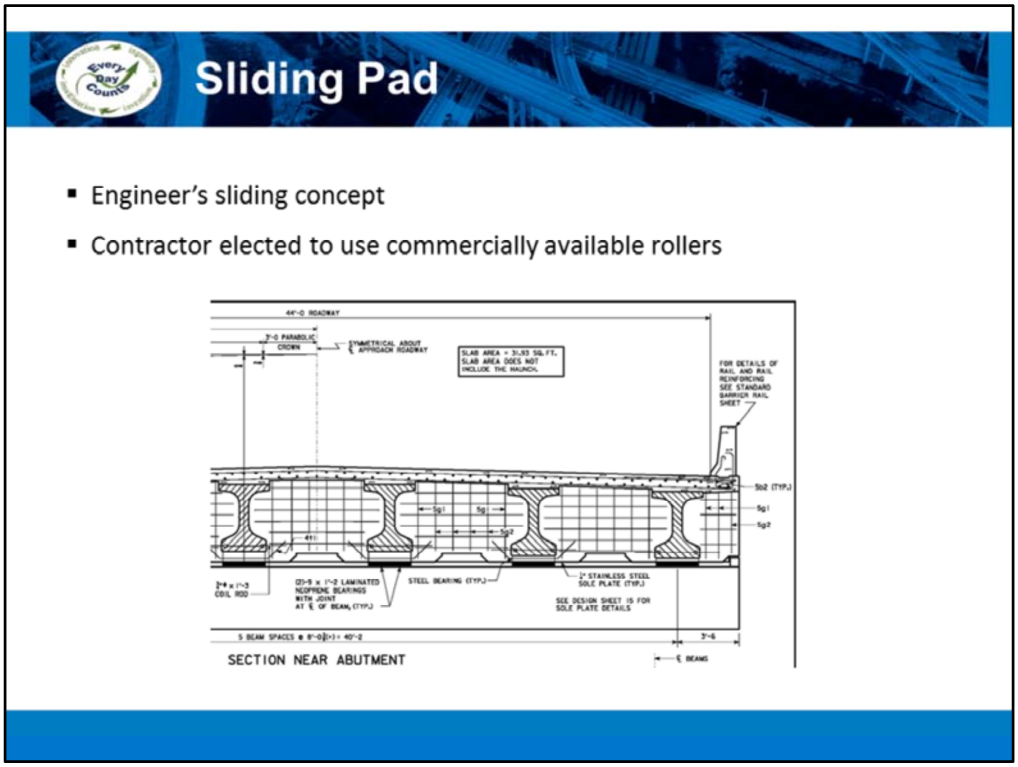
The plan design and details incorporated a semi-integral abutment and abutment diaphragm. The diaphragm served as a block for pushing and pulling the prefabricated structure.

Even more, within the diaphragm, jacking pockets for lifting were formed.

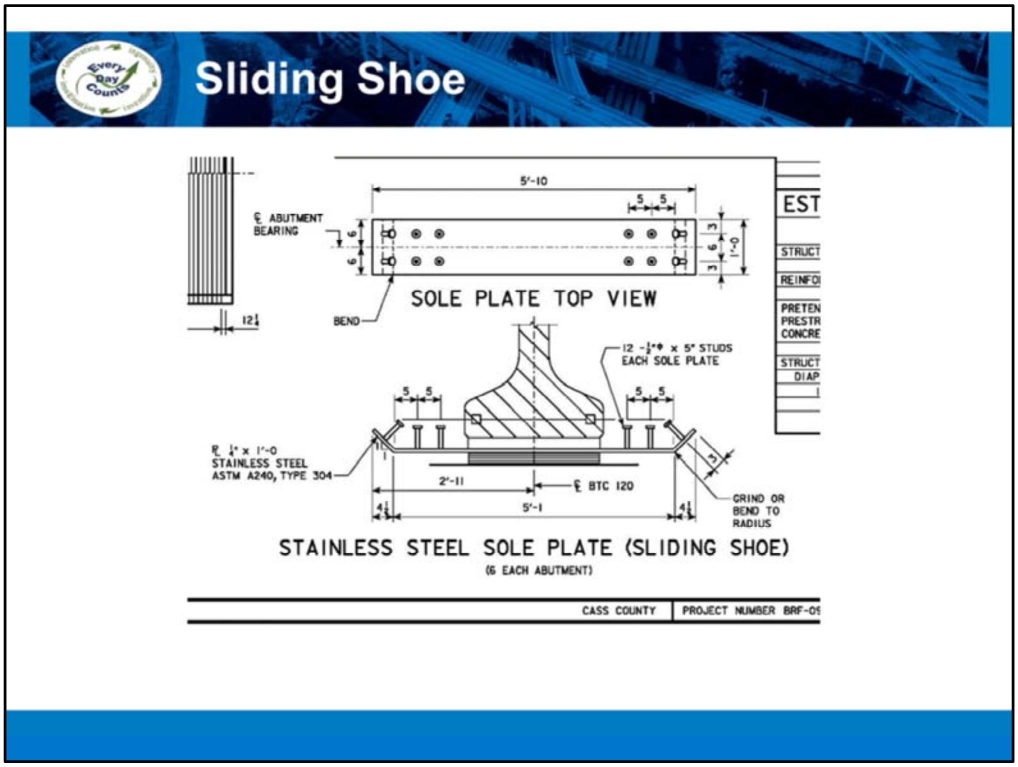
The original design called for precast abutment footings set over the top of H-piles, each connected through filling with concrete the corrugated metal pipe void forms within the footing. In the end, the abutment footings became cast-in-place by request of the contractor. Precast elements were used at the wingwall locations.



Shown in this detail is the semi-integral abutment and diaphragm. The slide plane is shown directly above the abutment footing and directly below the diaphragm.



The original intent was for the bridge to be slid using PTFE coated bearing pads and dishwashing soap. However, the contractor requested to use heavy duty rollers instead as they were the owners of several rollers from a previously completed project.



A stainless steel sliding shoe cast into the diaphragm at each girder end would have been the only point of contact between the superstructure and the bearing pads.

Critical Closure Schedule

	Day								
Activity	1	2	3	4	5	6	7	8	9
Start Critical Closure	9/27/2013								
Bridge Removal and Grading	■								
Pile Driving	■	■	■						
Revetment		■	■	■					
Abutment Footing			■						
Bridge slide				■	■				
Precast wings					■				
Granular Backfill						■			
Bridge Barrier Rail						■			
Approach paving							■		
Barrier End Sections							■		
Steel Guardrail								■	
Longitudinal Grooving									■
Pavement Marking									■
Finish Critical Closure									10/6/2013

The critical closure lasted 9 days – contrast this with the projected 180 days had the bridge been constructed using traditional methods. The 9 days started with the removal of the old bridge and grading for the new structure.

After, pile driving, revetment and abutment footings were completed.

The bridge slide occurred over the course of an evening and early morning hours half-way through the 9 day closure, after which, the bridge and roadway were completed with wingwalls, backfill, barrier rail, and approach paving.

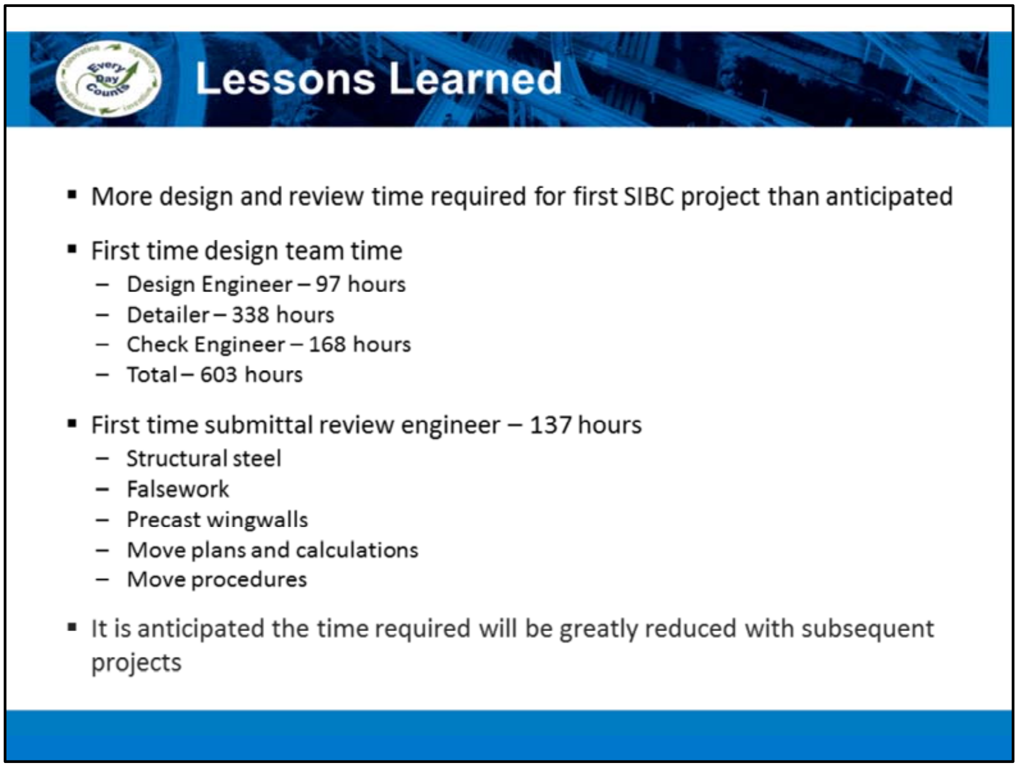
Several lessons were learned from this first experience with slide-in bridge construction in Iowa. Traditionally, for steel bridge projects in Iowa, the project is let during the fall allowing the contractor to gather resources over the winter and prepare for a spring start. Looking back, it was found that the Massena project would have benefitted from a similar schedule. As it was, the project was let in the spring with a summer start date, thus expediting and making more difficult the process for the contractor and owner, especially as it pertained to gathering materials and shop drawing preparation and approval.

The plans called for a precast only substructure. Unless there is an absolute must for precast, it might be better to allow the contractor the decision of precast or cast-in-place knowing the end goal and critical closure time.

Unless the there is a necessity for the plans to remain as is, proposed changes from the contractor are likely. Be prepared to fully evaluate the impact of these method changes.

Though heavy duty rollers ultimately took the place of the laminated bearing pads as the primary slide mechanism, the pads were still used along with the rollers in the jacking pockets. The bearing pads experience some shear deformation during the slide and any damage that might occur is hard to detect from only visual observation of the pads. Accordingly, it is recommended that bearing pads used during the slide are replaced with new pads once the bridge is in its final position.

The importance of properly designed and constructed falsework is even greater in slide-in construction. As such, adding a specification requiring the falsework design engineer to inspect and accept the construction is recommended.



One should be aware of and anticipate that a first-time slide-in project is likely to require more design and review time than would typically be required.

For Massena a total of 603 hours of design time were used between the design engineer, detailer, and check engineer – with a significant amount of that time spent by the detailer. Similarly, 137 hours were spent reviewing submittals. With experience, however, it is anticipated that the time required will be greatly reduced with subsequent projects.

The next few slides provide some pictures at different stages of construction. Here in this slide pictures of the existing bridge and preliminary temporary works are shown. Steel piling and large W-section beams were used as the temporary supports.

Here, one can see the placement of the precast/prestressed beams, the beginnings of the deck formwork, and the cast-in-place diaphragm at the beam ends.

Once the construction of the superstructure was completed, the critical closure and demolition of the existing structure began. Once the bridge was removed and the grading completed, pile templates were positioned and pile driving started.

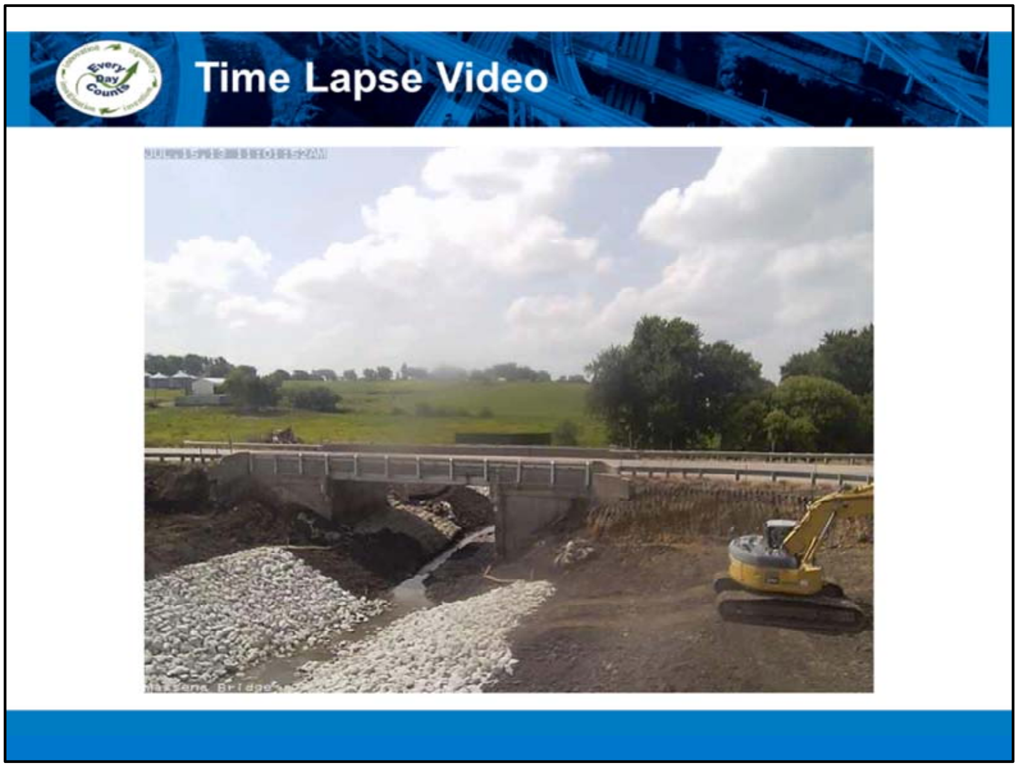
Vertical jacks were used in the jacking pockets to lift the bridge, after which, the rollers and bearing pad shims were set. A single jack and reaction pile were placed at the end of each abutment footing. Threaded rods were then placed between the jacks and through the superstructure diaphragms in order to pull the bridge onto the permanent substructure.

A single power unit with a manifold controlling both jacks was used. The rollers were guided along a steel channel spanning over the temporary works and permanent substructure.

Additional pictures of the bridge nearing its final position are shown here. The vertical jacks were again employed to lift the bridge and pull the rollers, channel, and bearing pads from the jacking pockets. Also, the final bearing pads were placed below the diaphragm at the beam ends.

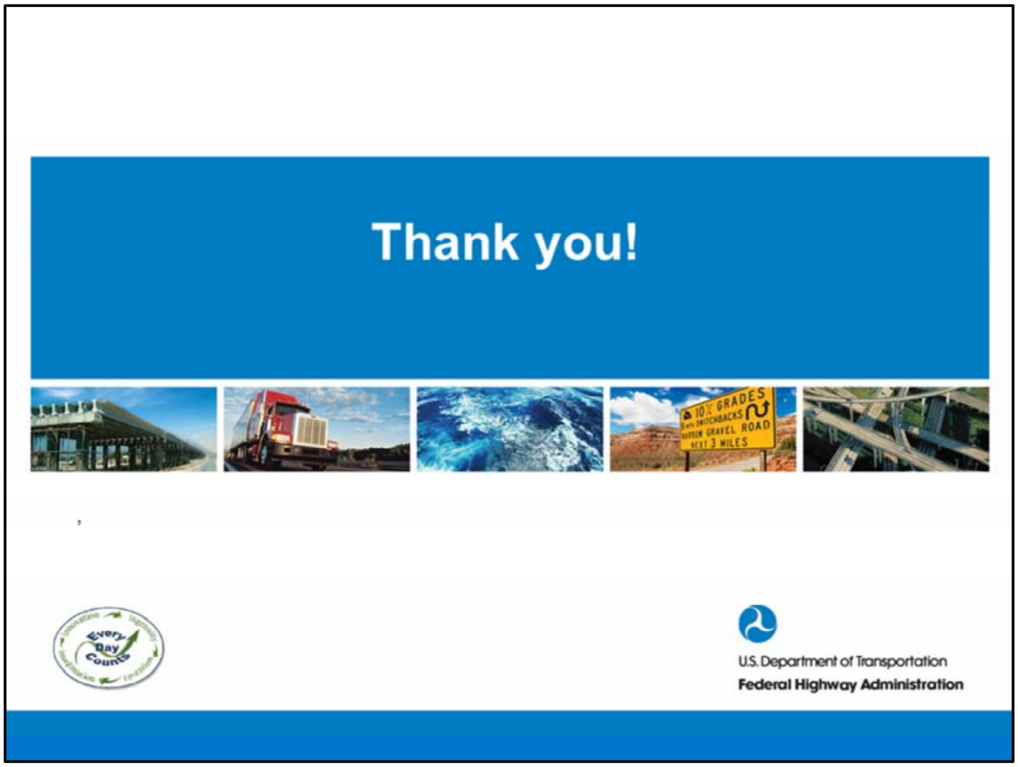
The slide operation took place during the late evening and early morning hours. Each of these pictures shows various views of the bridge being slid onto the permanent substructure. The lower picture shows the transition between the temporary works and permanent substructure and, maybe more importantly, the engineers closely monitoring the behavior at that transition.

Once the bridge was in position, precast wingwalls with included grout pockets were placed onto pre-driven steel H-piles. The connection was made between the pile and grout pocket using a high-slump, small aggregate concrete mix.



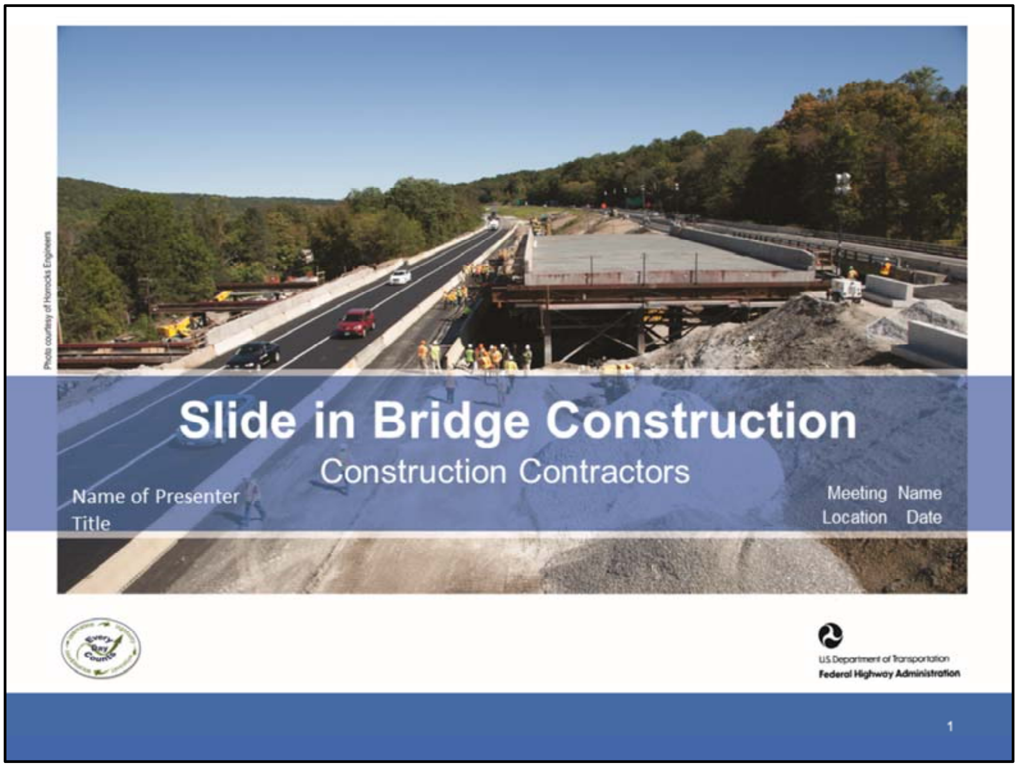
This short video is a time-lapse from the beginning of the project until the bridge was reopened to traffic.

A technical support solutions center has been established and is available for all to use to assist in slide-in bridge construction projects. Here the most up-to-date information about SIBC resources and training can be accessed. The center is most easily found by searching "FHWA Slide" online, or by simply going to directly to the web address shown here.


Thank you!
10% GRADES
SWITCHBACKS
NARROW GRAVEL ROAD
NEXT 3 MILES
Every Day Counts
U.S. Department of Transportation
Federal Highway Administration

PRESENTATION HANDOUTS:

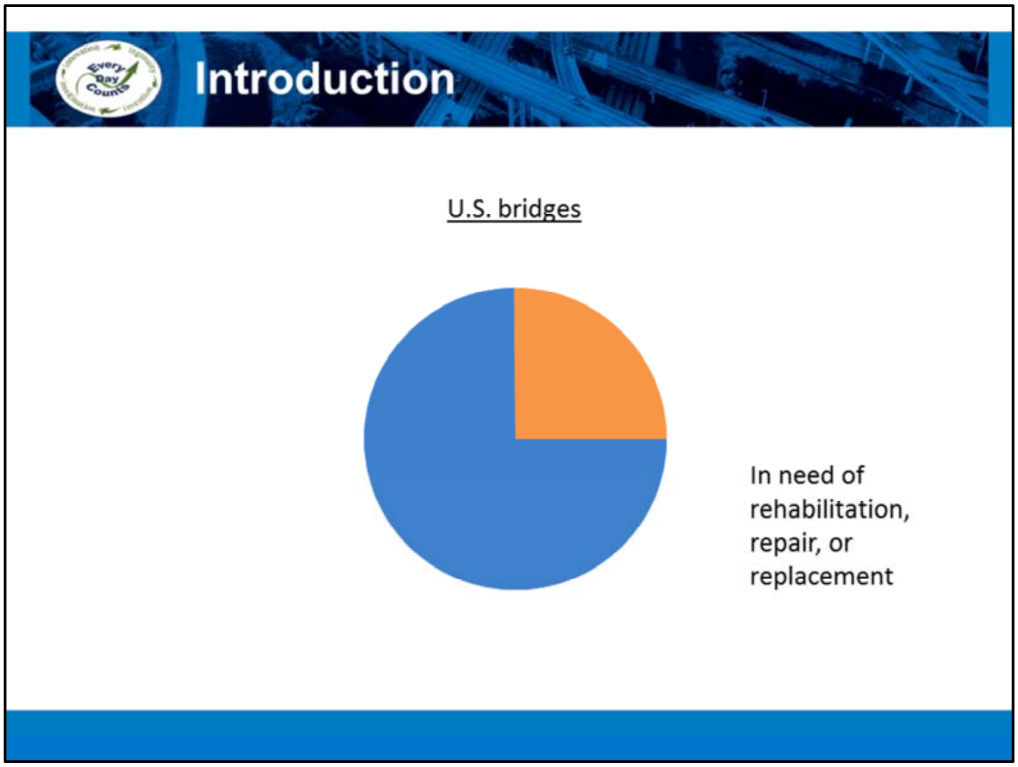
COURSE 2 SIBC OVERVIEW FOR CONTRACTORS



Thank you for attending today's session on Slide in Bridge Construction.

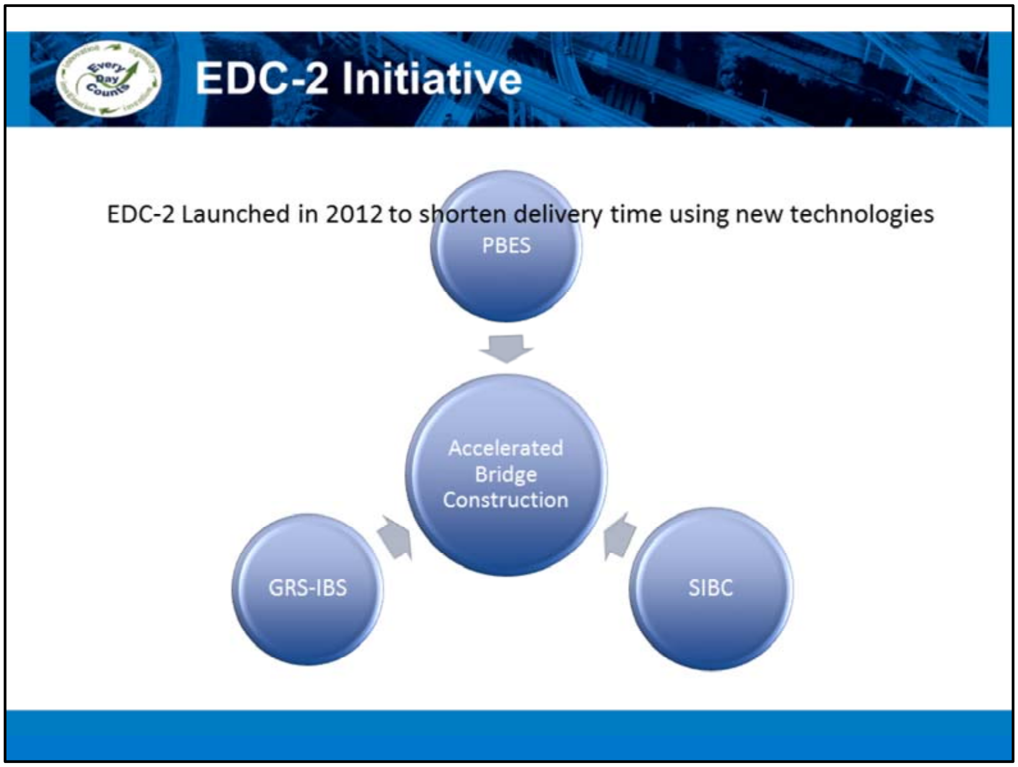
This presentation is aimed towards contractors and developed for the FHWA as an extended effort of the Every Day Counts Initiative.

Slide-in bridge construction (SIBC) is a particular method and refinement of construction contained under the broader topic of Accelerated Bridge Construction (ABC) with the specific goal of extremely rapid bridge installation under very short term road closure.



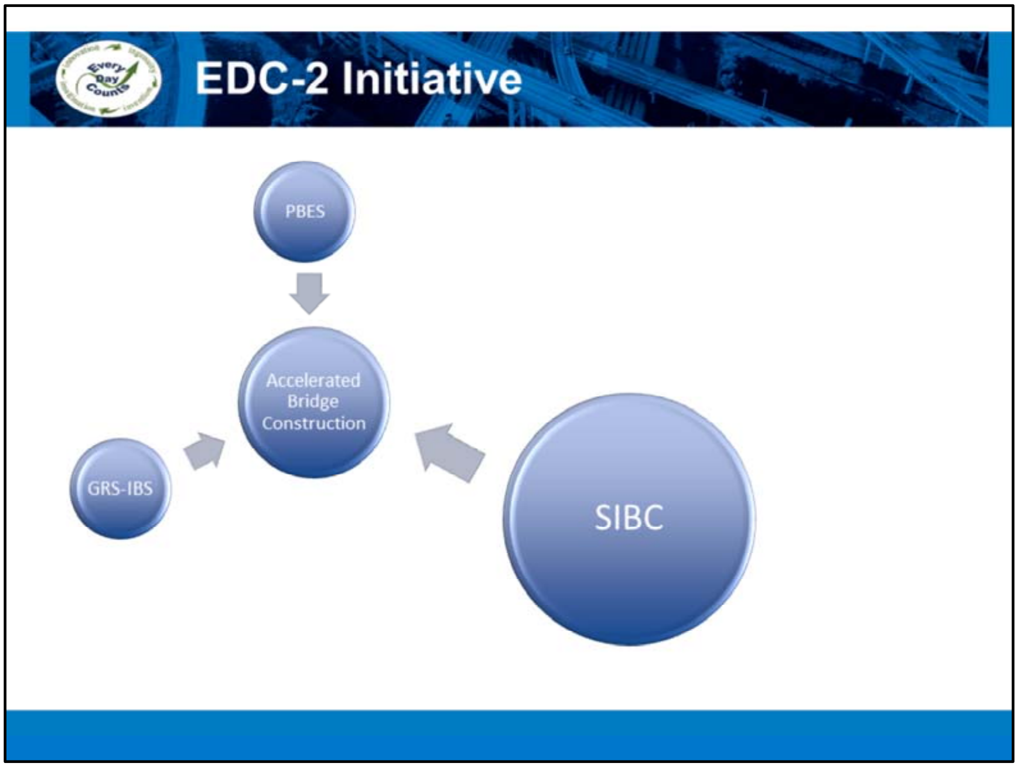
Nearly 25% of the Nation's 600,000 bridges are in need of rehabilitation, repair, or total replacement. Given this vast number, the need for bridge reconstruction methods that reduce the impacts to mobility and safety is needed. This need was one reason the Every Day Counts Initiative was launched.

Every Day Counts was first established in 2010 as a state-based initiative meant to identify and deploy innovation; specifically, to shorten project delivery, enhance safety, reduce mobility impacts, and protect the environment. The term “get in, get out, and stay out” was popularized under this program.

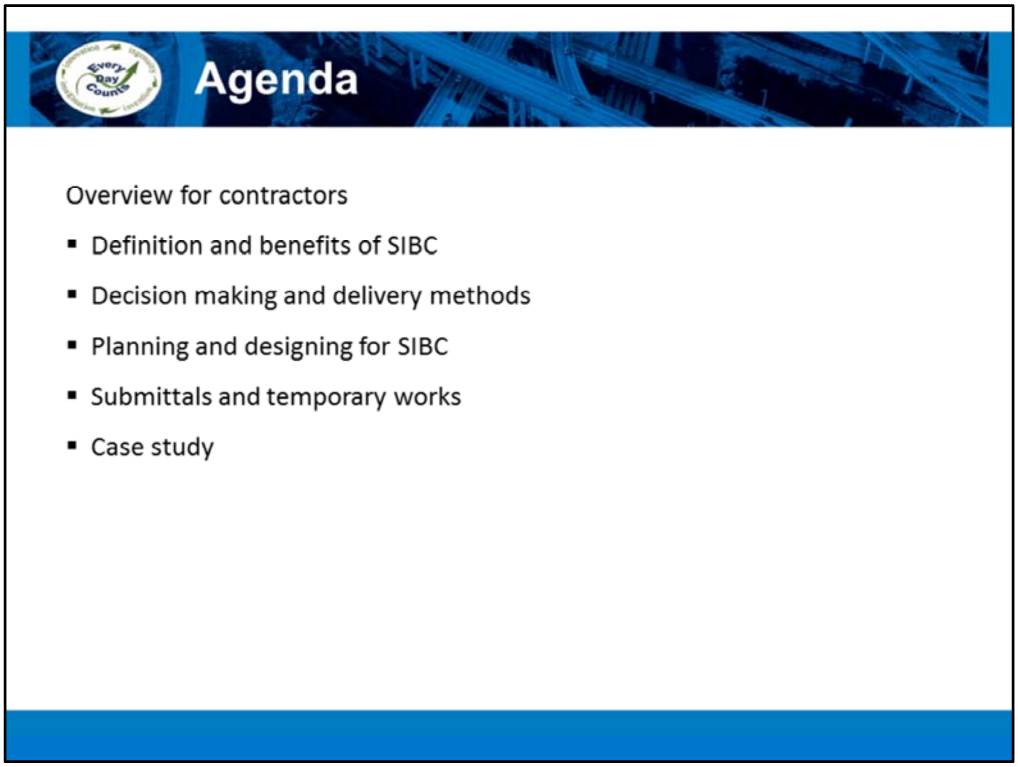


As a result of these efforts, EDC-2 was launched in 2012 with the specific focus of shortening the time needed to complete highway projects through the use of new technologies and ground-breaking processes. Within that directive, accelerated bridge construction became an area of concentration.

Three particular ABC technologies being promoted under EDC-2 are prefabricated bridge elements and systems, geosynthetic reinforced soil-integrated bridge systems, and slide-in bridge construction.



It comes as no news to anybody that our focus today will be on slide-in bridge construction.



Several slide-in bridge construction topics will be covered as the day progresses. Collectively, the topics aim to provide an overview for contractors; thereby better equipping the group to pursue slide-in bridge construction or SIBC as it is now more commonly referred to.

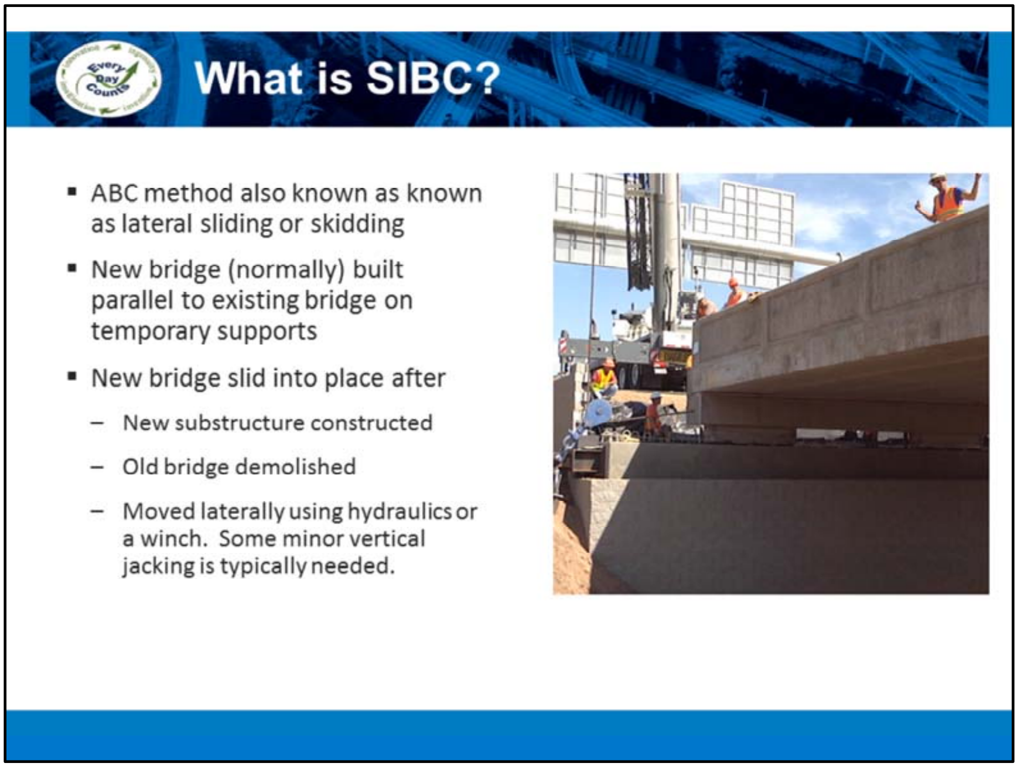
SIBC will be defined and its benefits will be discussed.

Several ABC and SIBC decision making tools are presented along with the various delivery methods that can be employed.

Planning and designing for SIBC, planned contract submittals, and temporary works will be covered.

Given that SIBC is a relatively new and innovative method of bridge construction, it is not uncommon for the media and public to have a more involved roll, even as spectators. As such, relations with the media and public will be addressed.

Lastly, a case of a previous SIBC project will be presented.



So, what is slide-in bridge construction?

It is a method of ABC that has also been known as lateral sliding or skidding, and the variations of these techniques.

In SIBC, a new bridge is typically constructed adjacent to and parallel to the existing bridge on temporary supports.

Once complete, the old structure is demolished and the new substructure is constructed, followed by the sliding of the new superstructure on to the new substructure already in place. There have been some cases where the old substructure was reused.

The new bridge is moved laterally most commonly with hydraulic jacks, though other methods have been employed, such as a winch. Some minor vertical jacking is typically needed.

SIBC, and ABC in general, is primarily used for bridge replacement projects where the impacts to mobility are significant.

What is SIBC?

- Reduced disruption if substructure can be constructed below the existing bridge
- Minimal disruption likely requires innovative foundation systems
  - Drilled shafts outside footprint of existing bridge
  - Micro or mini piles
  - Integrating cap beams
  - Spread footings
- Prefabricated substructure units

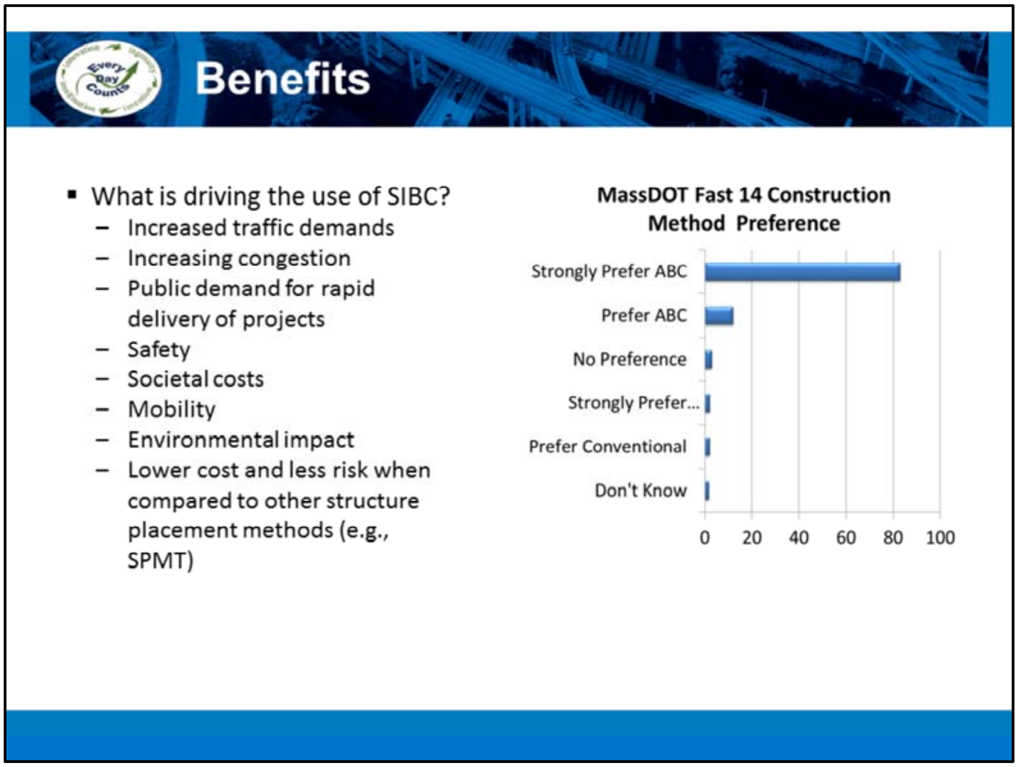
There have been many cases where the new substructure was constructed beneath the existing bridge prior to demolition. As you can predict, this expedites the process from demolition to bridge slide.

It should be pointed out, however, that constructing traditional foundation systems might not be feasible. Rather, an innovative foundation system might be required when using this method.

It is possible that prefabricated elements could play a key role in constructing the new substructure.

One might believe that bridge slides are only used for sliding a new bridge into the position of the existing. This is most commonly the case, but SIBC is not limited to only sliding new structures.

Existing structures can be slid to a new alignment to serve as a bypass bridge while a new bridge is constructed using more traditional methods. Keep in mind that in this case, the temporary substructure system will be subjected to live and other transient loads in addition to the bridge itself, typically resulting in a more robust, and hence higher cost, to such an installation.



So, what benefits can be gained by using slide-in bridge construction? Maybe the better question is 'What is driving the use of SIBC and how is it that SIBC addresses those needs?'

Traffic demands are increasing, congestion is increasing – both create an unnecessary nuisance in the lives of the traveling public. As such, the public demand for rapid delivery is increasing.

One can see in this chart the overwhelming preference for accelerated bridge construction when polled in Massachusetts prior to the MassDOT Fast 14 project.

Even more, the safety of the traveling public and bridge builders is compromised when bridge projects are long in duration. SIBC alleviates some of this risk by significantly reducing the time main-line traffic is interrupted.

Societal costs, though often difficult to fully quantify, are significantly reduced as well.

Environmental impacts can be softened.

And lastly, the costs can be lower and at less risk when compared to other rapid structure placement methods, such as self-propelled modular transporters, float in delivery, or a heavy crane pick, for example.

To continue with the benefits of using SIBC: non-traditional site options can be offered, cross-overs or shoo-flies are eliminated along with staged construction and long term detours. These things can result in lower construction costs.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Mobility and environmental impacts can also be reduced and safety is nearly always enhanced for the worker and road user.

Potentially of greatest significance is that SIBC promotes user and worker safety. Safety is nearly always enhanced for the worker and road user; this can not be understated.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Environmental impacts can also be reduced.

Lastly, SIBC removes the bridge construction from the critical path which may lead to a better quality end product, it involves the public by reducing societal costs, thereby creating better "buy-in", and road closures can be better managed.

Along the way, we'll take a minute to quickly highlight a project to emphasize a couple of points. The first project highlighted is I-84 at Dingle Ridge Road in New York.

A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

Though the benefits are great, one must be aware that some potential challenges exist.

While some personnel within the DOTs embrace innovative methods, others are more resistant and tend to lean on traditional construction methods. This resistance can stall a potential SIBC project.

Finding experienced contractors and/or heavy lift engineers can be a challenge, though that challenge is being lessened as more and more SIBC projects are being completed and contractors become more familiar with the process.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

In traditional construction projects it is common that unique bridge geometry, difficult foundations, or lack of space can present a challenge. These aspects are only magnified by the nature of SIBC.

A sound traffic management plan with contingency plan included is a must.

This method of bridge construction is relatively new, and as a result, there may be some contractor limitations.

For example, significant temporary shoring and unconventional schedules are often required.

During slide operations, a 24 hour commitment from the contractor, designer, and owner is necessary.

There are periods during the overall SIBC process that require extended time for the contractor, owner, and designer and, as a result, worker fatigue be an issue if not properly managed. Multiple crews can help alleviate this potential problem.

Even more, difficult foundations, equipment breakdowns, and the speed required to complete approach work can present a challenge.

Also, significant, critical time can be lost to surveying mistakes.

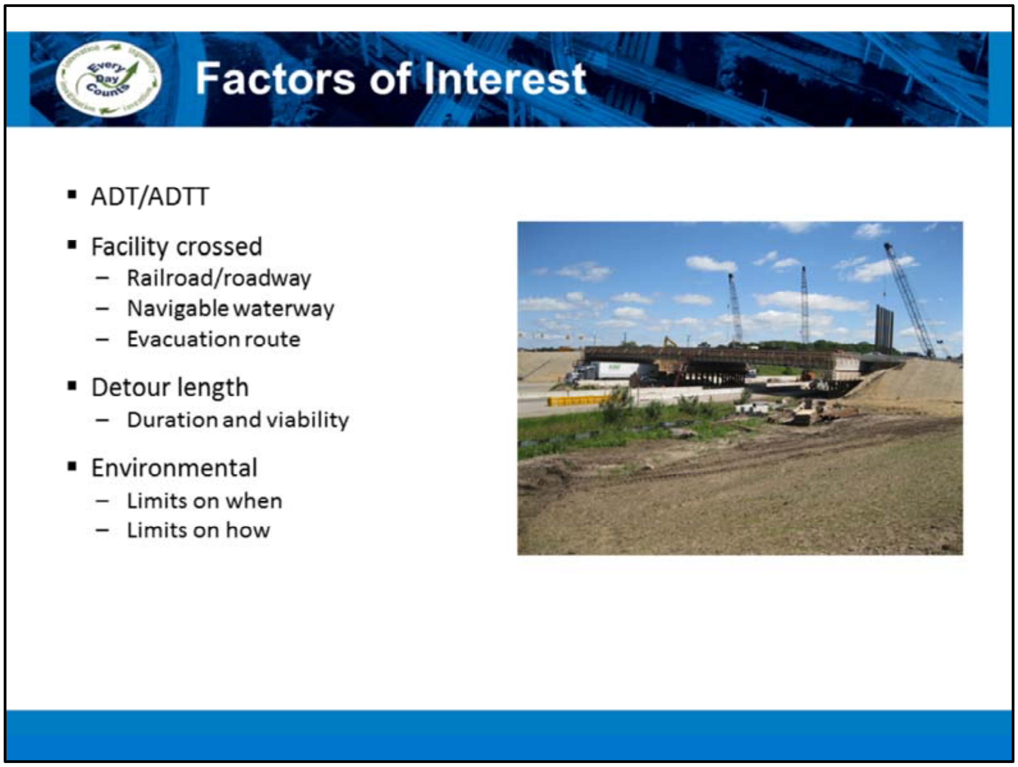
And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

Project Highlight

Elk Creek – Oregon

- Site concerns
  - Mountainous terrain surrounding bridge construction site
  - Slides can be effective even in very confined locations

To highlight another project, the Elk Creek project in Oregon was faced with numerous challenges that could be considered somewhat unique to this project. For example, the site, located in the mountains of western Oregon, did not afford ample space or flat terrain from which a new bridge could be easily constructed and slid into place. Nonetheless, the successful completion of this project using slide in construction proved that slides can be effective even in very confined locations.

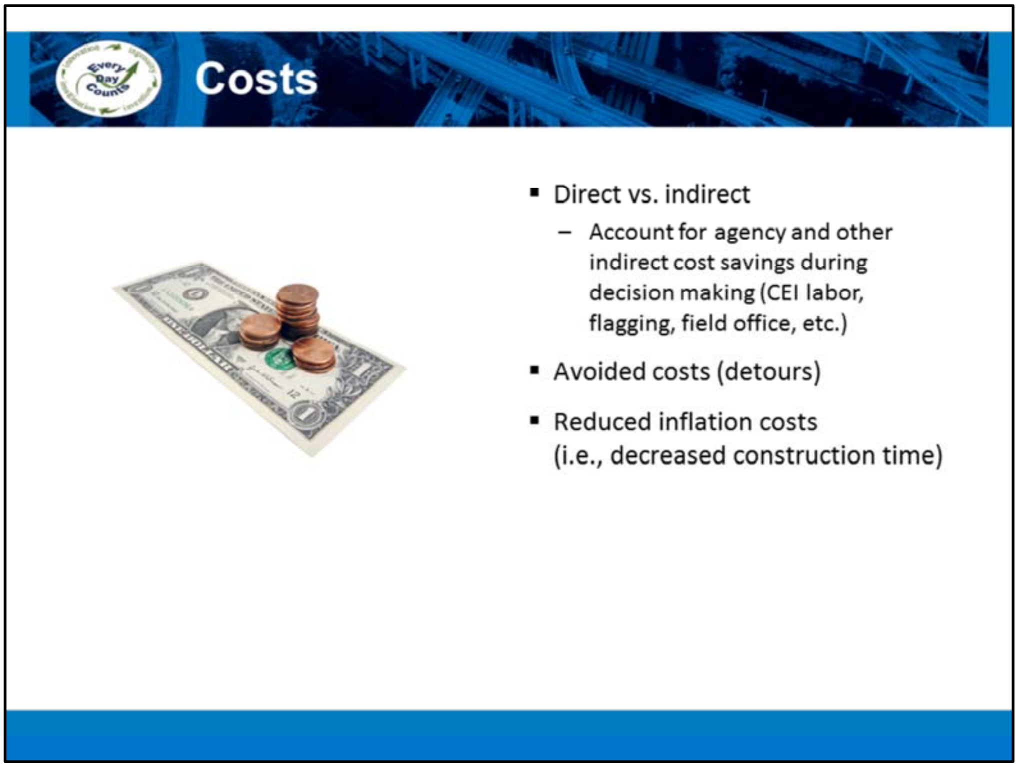


Some factors of interest to consider when making an initial decision for or against SIBC include: average daily traffic, the facility that is being crossed (railroad, roadway, other?), the detour length (duration and viability), and environmental effects (limits on when and how).

Factors of Interest

- On critical path of entire project
- Available right of way for bridge construction
- Traffic analysis
- Contractor’s work area and ingress/egress ability

Is the bridge on the critical path of the entire project?, is there available right-of-way?, should traffic analysts be engaged?, where will the contractor’s workspace, entrances, and exits be located?.



If comparing only the costs of building a bridge using traditional methods and slide-in bridge construction, it is possible, and maybe even likely with the first projects, that SIBC costs will be higher.

It has been found, however, that the costs become more aligned when including other project related costs such as direct versus indirect costs and detour costs. These costs are often not included in the bid; therefore it is not appropriate to compare conventional construction costs with ABC costs.

Project planners should evaluate the total construction cost when making decisions.

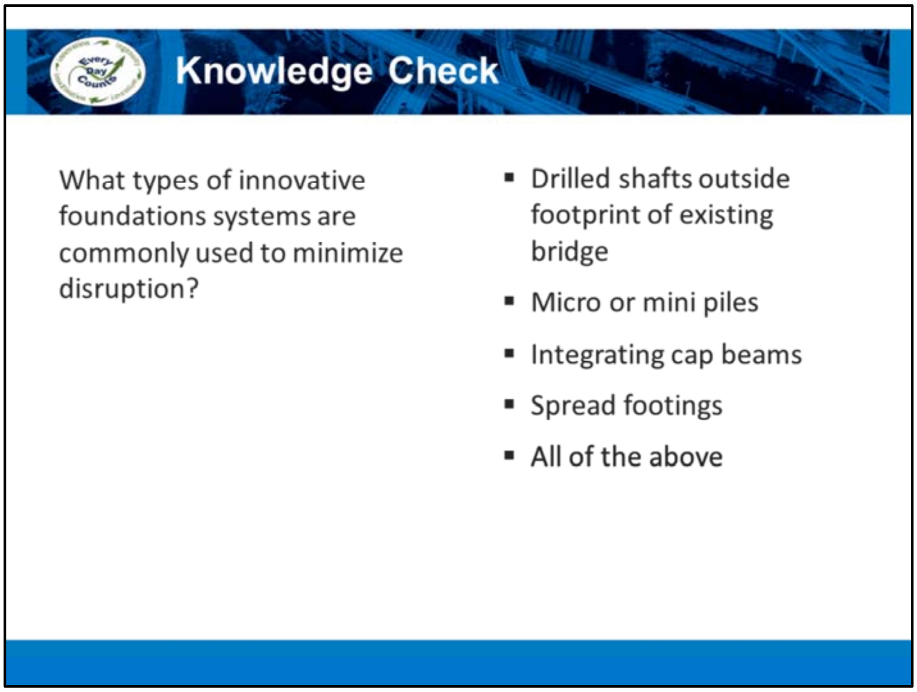
Even more, due to the decreased construction time, overall inflation costs can be reduced, specifically the risk of price escalation of steel and fuel can be minimized.

The next project highlighted is the Mesquite Interchange in the state of Nevada. The total interchange reconstruction cost was $15 million, $10 million less than the original $25 million estimate. A significant amount of the cost savings stemmed from the decision to slide each of the two bridges being replaced. Traditional construction would have required a complete realignment of the mainline pavement and interchange reconfiguration. Instead, the interchange was left in its original configuration and the bridges constructed adjunct to the existing.

To this point, SIBC has been defined, some benefits and challenges have been listed, and factors of interest shown. You'll now get an opportunity to check a bit of your knowledge.

In SIBC, the new bridge is constructed "blank" to the existing bridge on "blank" supports.

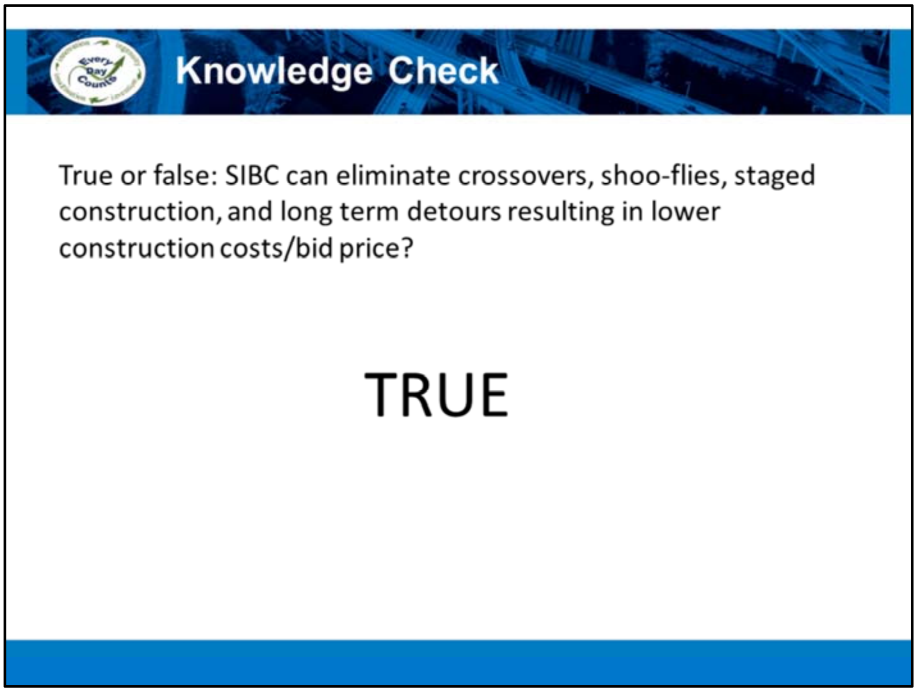
In SIBC, the new bridge is constructed "parallel" to the existing bridge on "temporary" supports.



What types of innovative foundations systems are commonly used to minimize disruption?

Drilled shafts outside footprint of existing bridge?
Micro or mini piles?
Integrating cap beams?
Spread footings?
Or
All of the above?

The answer: All of the above. Each of the options are commonly used to minimize disruption.



True or false: SIBC can eliminate crossovers, shoo-flies, staged construction, and long term detours resulting in lower construction costs/bid price?

True

When to Use SIBC

- Ideal conditions for SIBC
  - Wide, flat area(s) adjacent to original structure
- Factors to be considered
  - Limited ROW
  - Terrain around existing bridge is rugged
  - Geotechnical conditions cannot adequately support temporary works
  - Alignment restrictions
  - Utilities

So, you might be asking yourself, ‘When should I consider using slide-in bridge construction’?

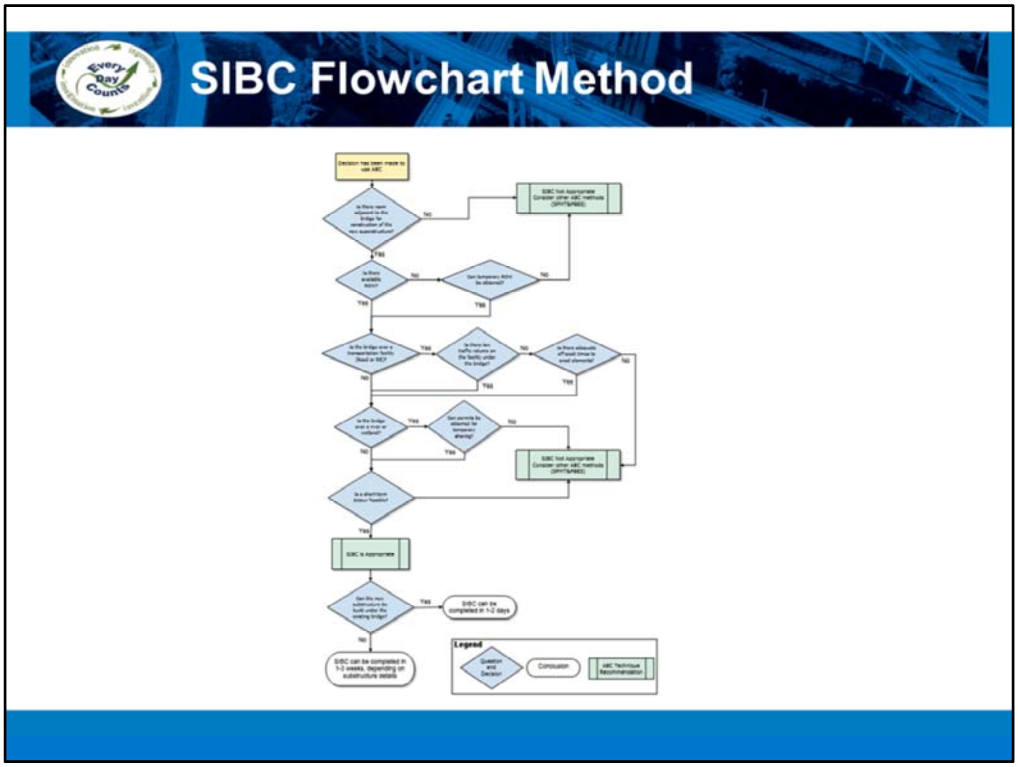
Ideally, sites with wide flat areas adjacent to the existing structure would be found at all bridge locations. But since this is rarely the case, one has to look beyond the ideal locations and consider other factors.

Factors such as, right-of-way, terrain, geotechnical conditions, and alignment restrictions. If right-of-way is limited, can temporary right-of-way be made available?

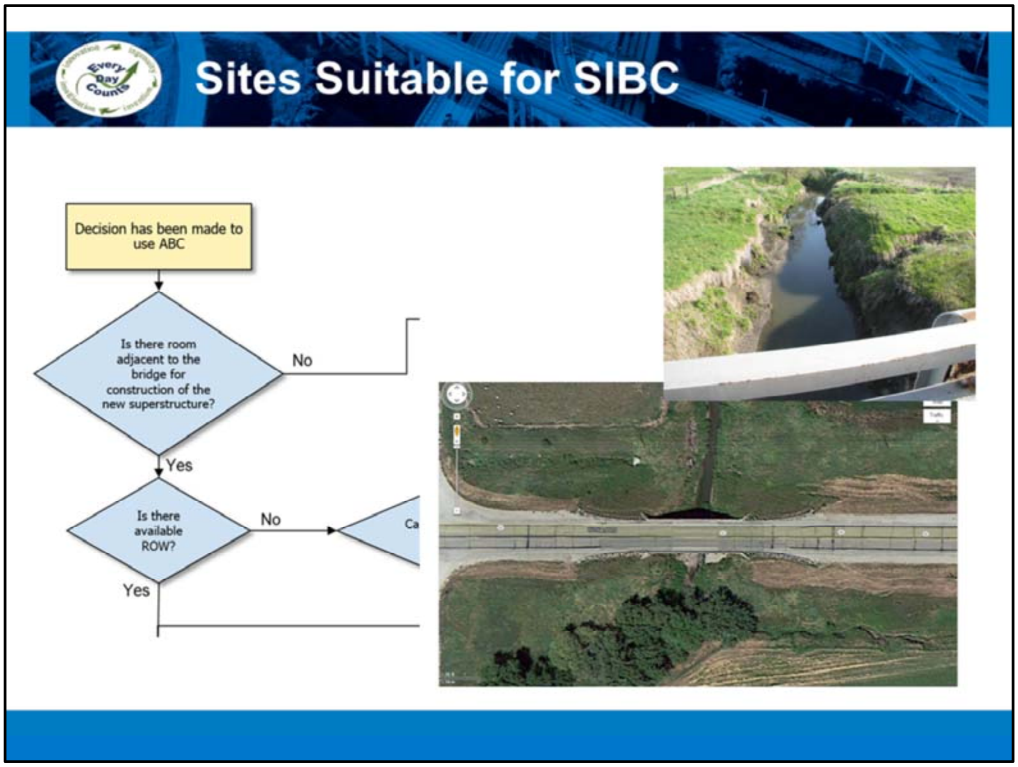
Rugged terrain doesn’t necessarily prohibit the use of SIBC, but does introduce another challenge.

Since temporary works will be significant and require supporting the entire superstructure, the adequacy of geotechnical conditions is key.

One should also consider alignment restrictions and utility locations.



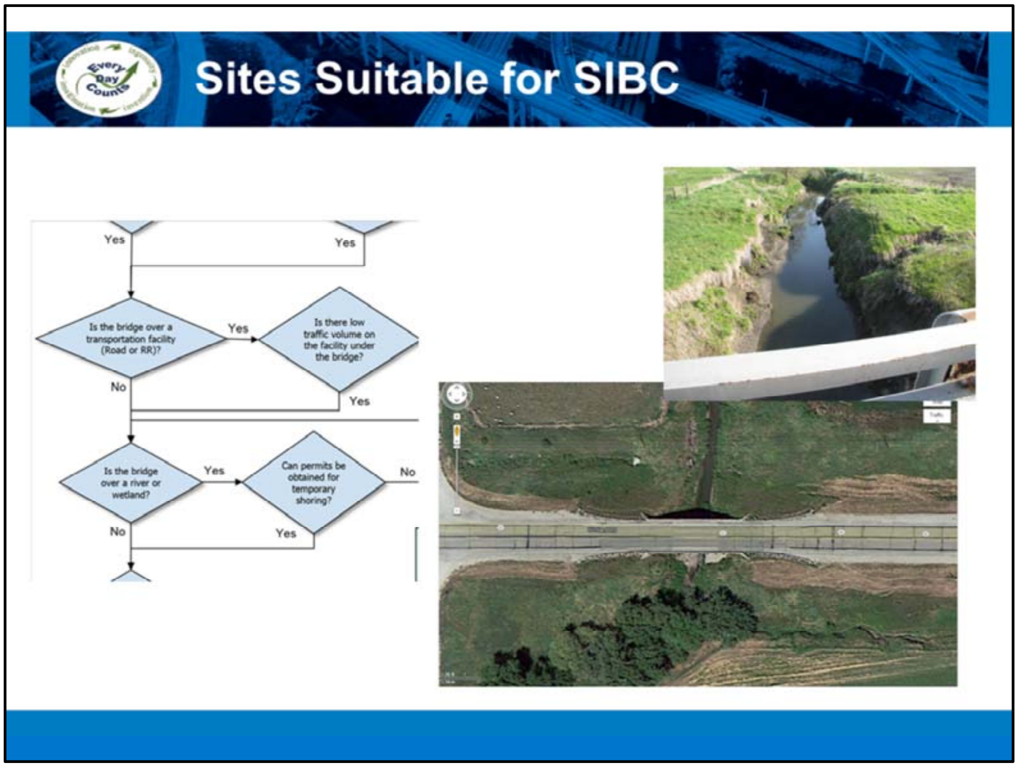
As an example, let’s step through the flowchart method for SIBC and see out that plays out looking at different site conditions. We will be using one of the sites that will be discussed later in the case studies.



Two photos of the site are shown. As you can see, the bridge is in a rural location and it carries two lanes of traffic over a small stream. The decision has been made to use ABC.

Is there room adjacent to the bridge for construction of the new superstructure? There are no structures or facilities adjacent to the bridge, so the answer is yes.

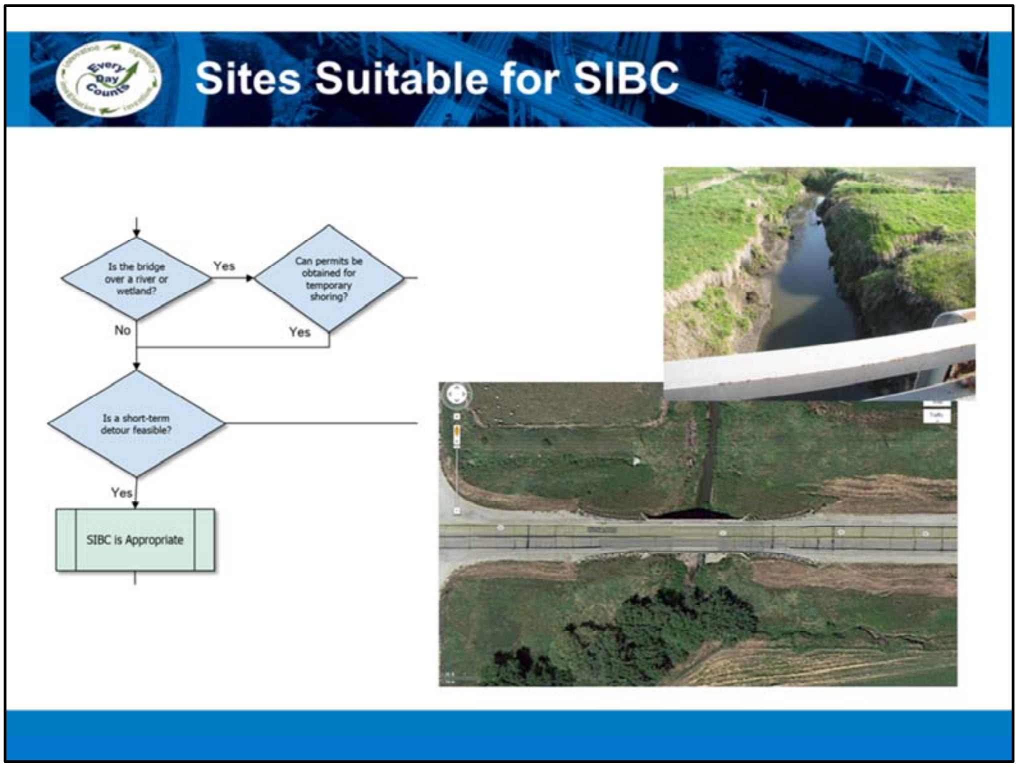
Is there available right of way? After checking the right-of-way mapping, the design team determined the answer to be yes.



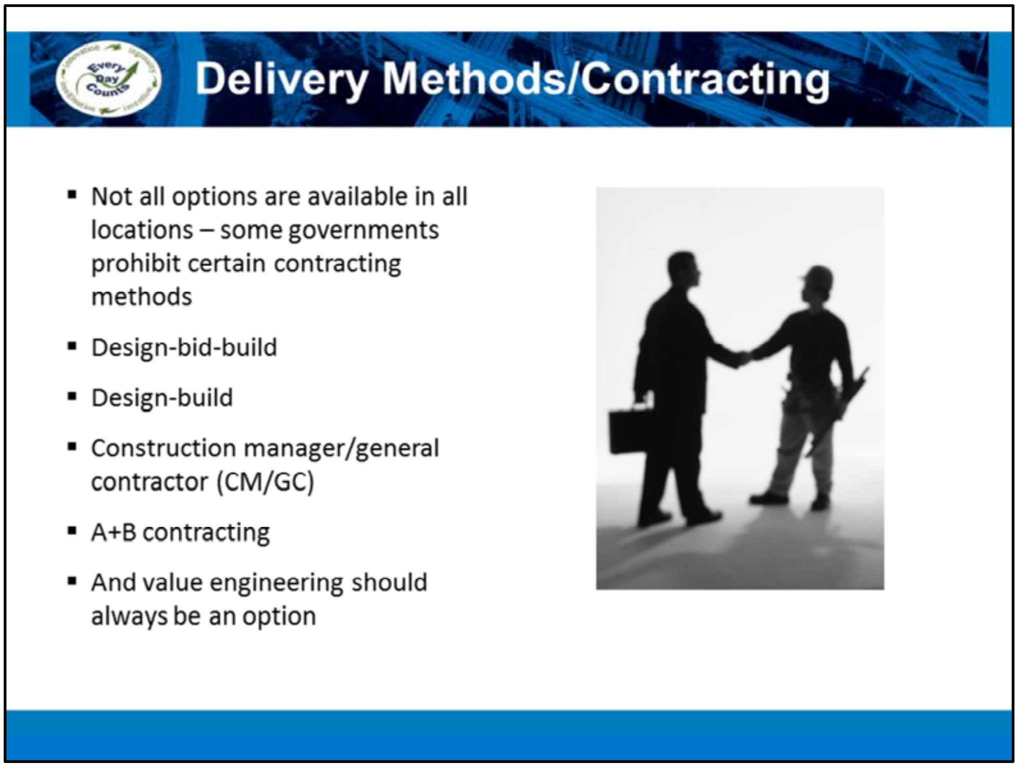
Is the bridge over a transportation facility? No.

Is the bridge over a wetland? Yes.

Can permits be obtained for temporary shoring? After a review with regulatory agencies, the design team determined that the answer to this question is yes.

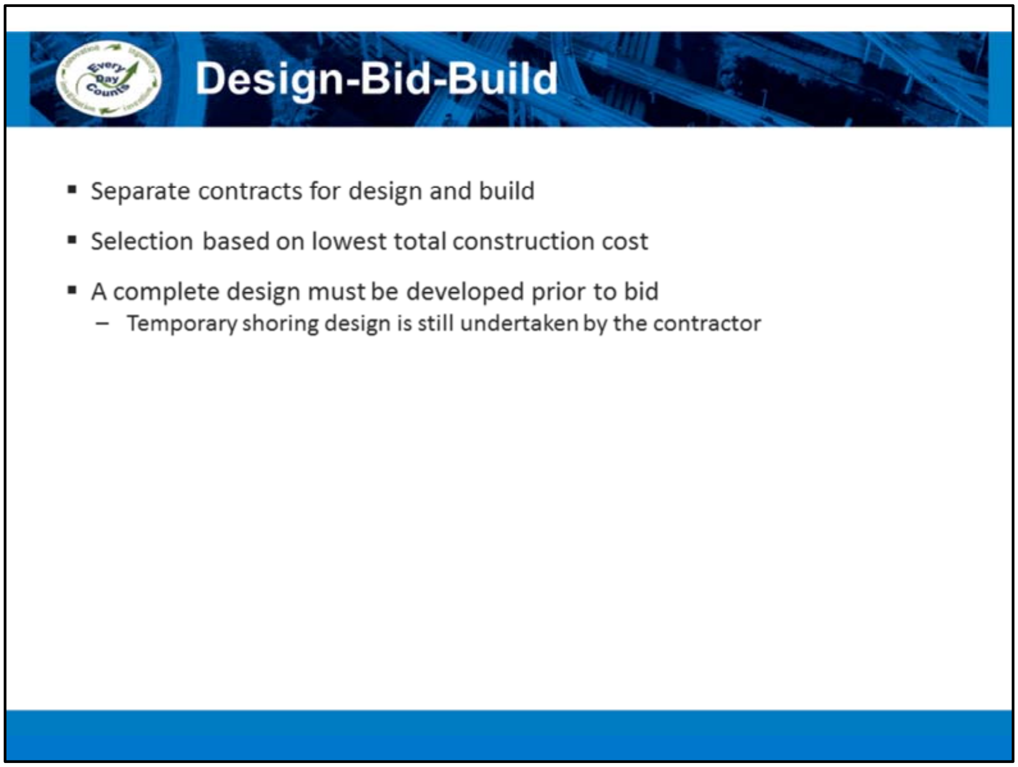


Is a short-term detour feasible? After conferring with traffic engineering personnel, the answer to this question was determined to be yes. Therefore, SIBC is appropriate. This is just one example of when SIBC might be appropriate.



It should be noted that not all options are available in all locations as some methods are prevented by existing state government laws or policies, but numerous delivery and contracting methods exist nationwide.

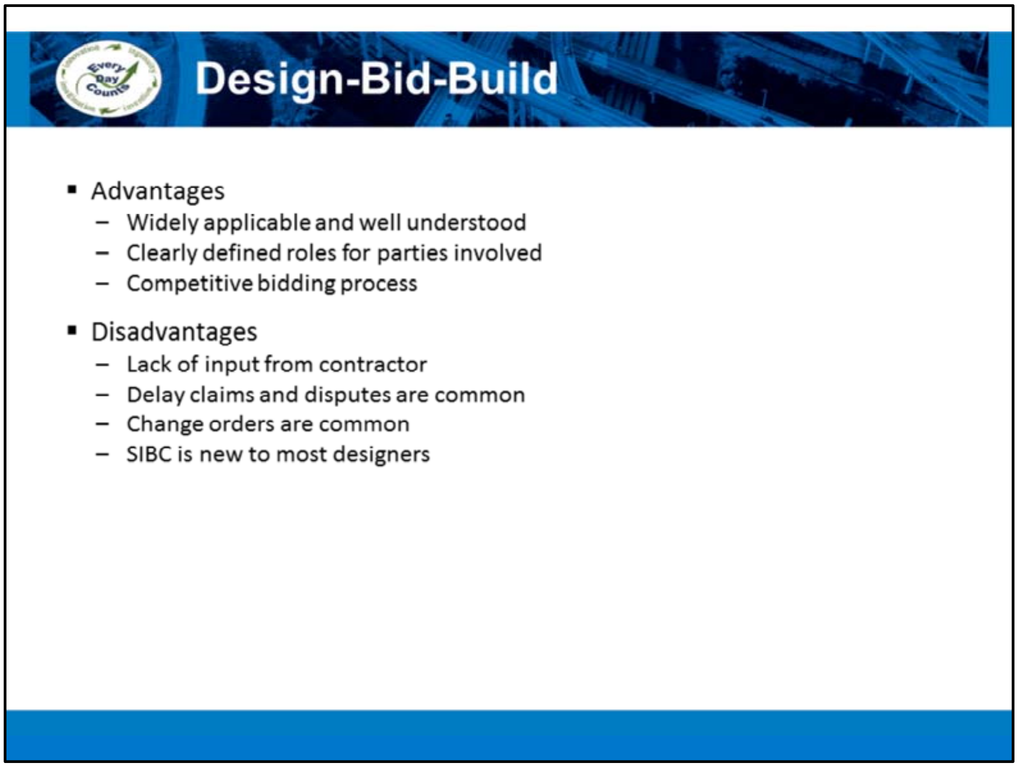
These include Design-Bid-Build, Design-Build, Construction Manager General Contractor, A+B contracting, and value engineering.



Design-bid-build has been the traditional method of contracting. Separate contracts are extended from the owner to the designer and builder, and the selection is based on the lowest-bid total construction cost.

For this method, a complete design must be developed prior to the bid process taking place.

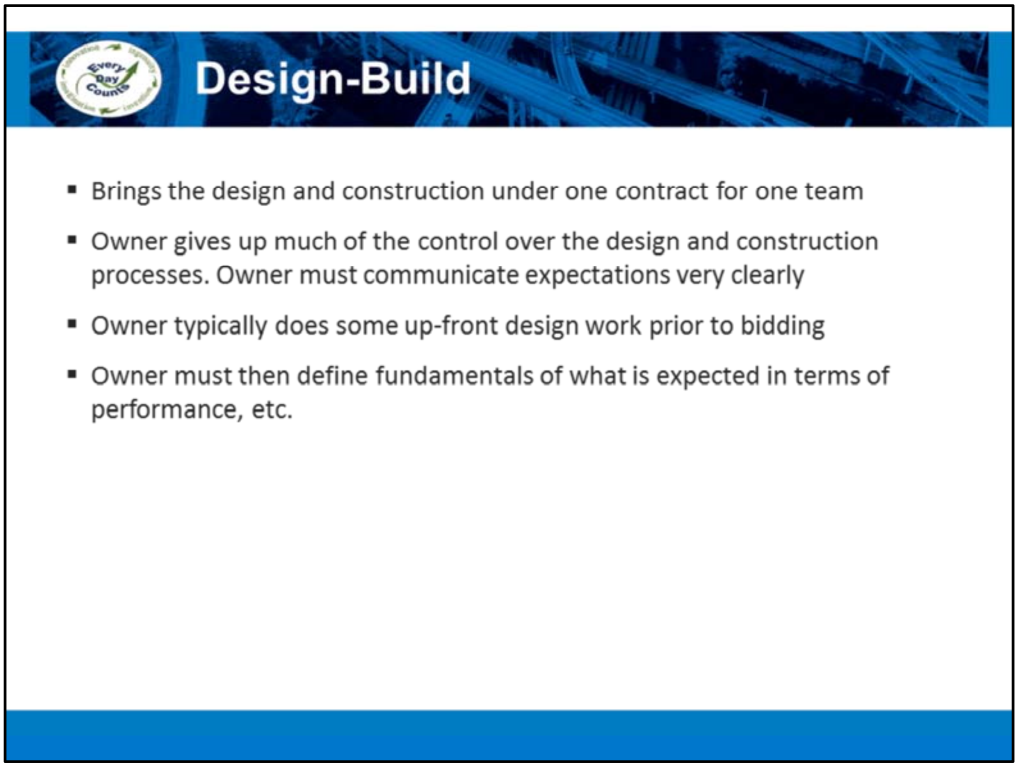
It should be noted that the designer is not responsible for the design of the temporary shoring system or the equipment used to move the bridge. The designer needs to show schematic drawings of the systems, and allow the contractor to develop the details of the move.



For SIBC, some advantages of design-bid-build are its wide applicability and well understanding, the rolls are clearly defined for all parties involved, and the bidding process is competitive. However, the method is disadvantaged for SIBC in other ways.

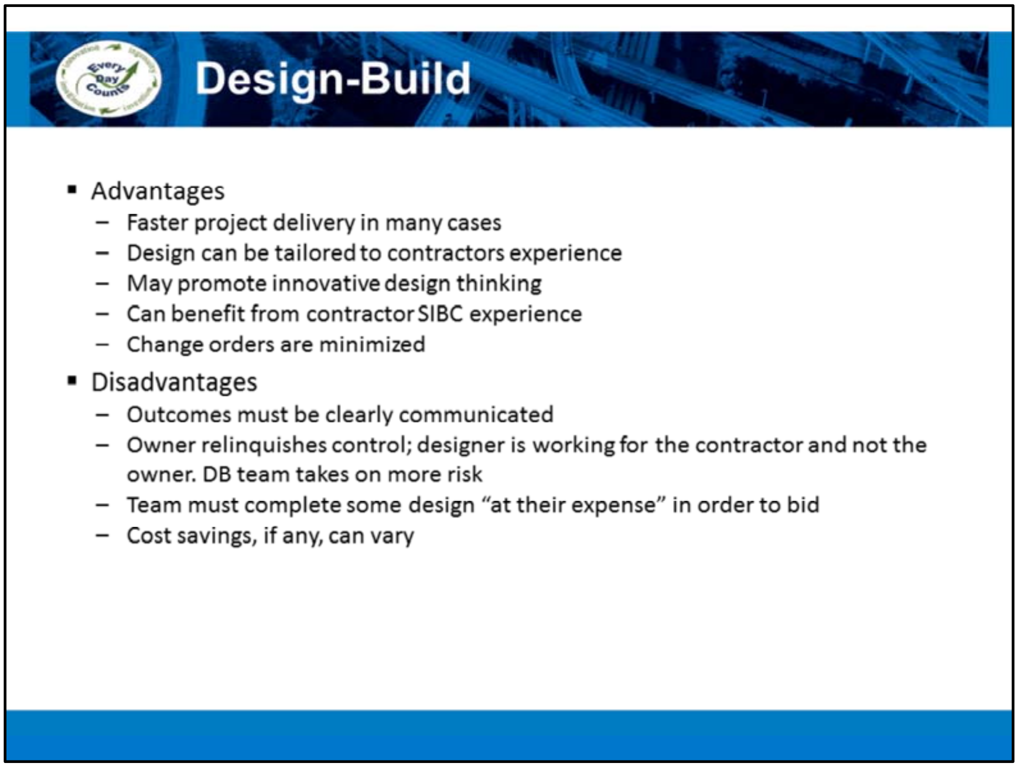
There is a lack of input from the contractor; delay claims, disputes, and change orders are all common.

Additionally, SIBC is new to most designers and blurs the line of means and methods of construction, typically the contractor’s stock in trade.



Unlike the design-bid-build process, the design-build process brings the design and construction under one contract from the owner. In doing so, the owner gives up some control over the design and construction process and therefore must make expectations very clear.

It is not uncommon for the owner to do some preliminary design work prior to the design-build teams bidding on the project; through this exercise the owner must define performance expectations.



An inherent advantage to the design-build method is that a project can often be delivered more quickly than would otherwise be possible. The design can be tailored to the contractor's experience, tools, and equipment. Also, it may promote innovative design thinking.

As with design-bid-build, some disadvantages exist. Outcomes must be clearly communicated by the owner or else risk the project scope transforming to something unintended.

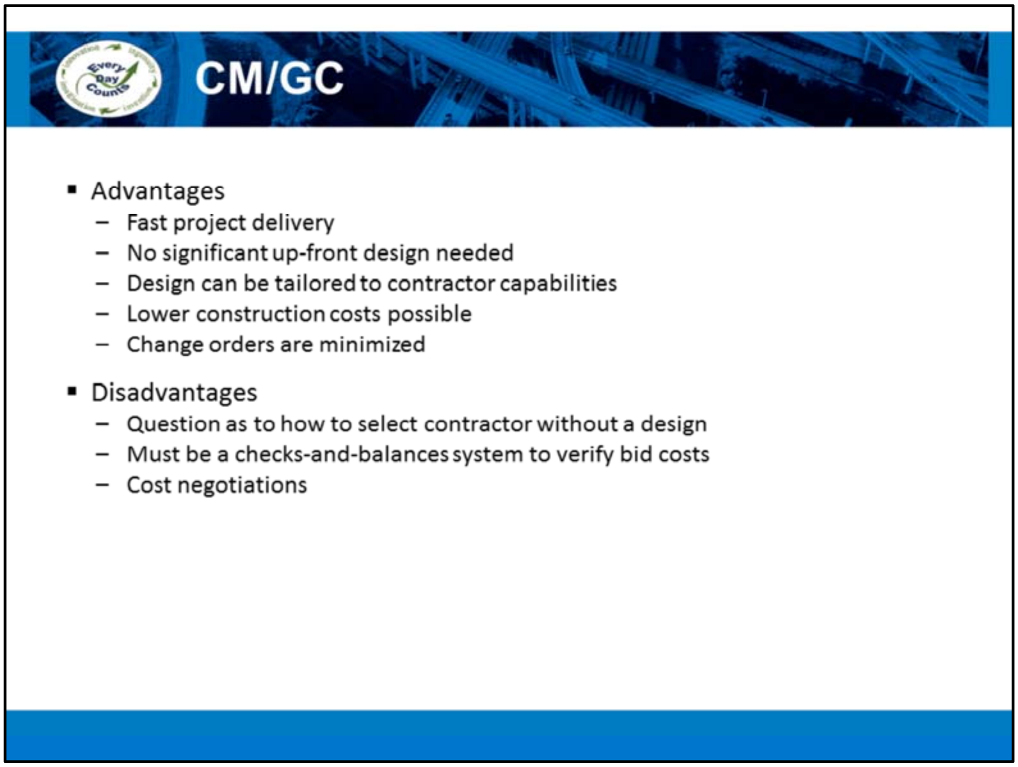
The owner is relinquishing control as the designer is working for the contractor not the owner with the potential that the final design will be influenced heavily by the required means and methods of installation. Prior to bidding, the design team must complete some design at their expense.

Lastly, cost savings, if any, can vary from project to project.

CM/GC, or Construction Manager/General Contractor, is not as commonly used as the previous methods of delivery but is gaining popularity with the bridge building industry.

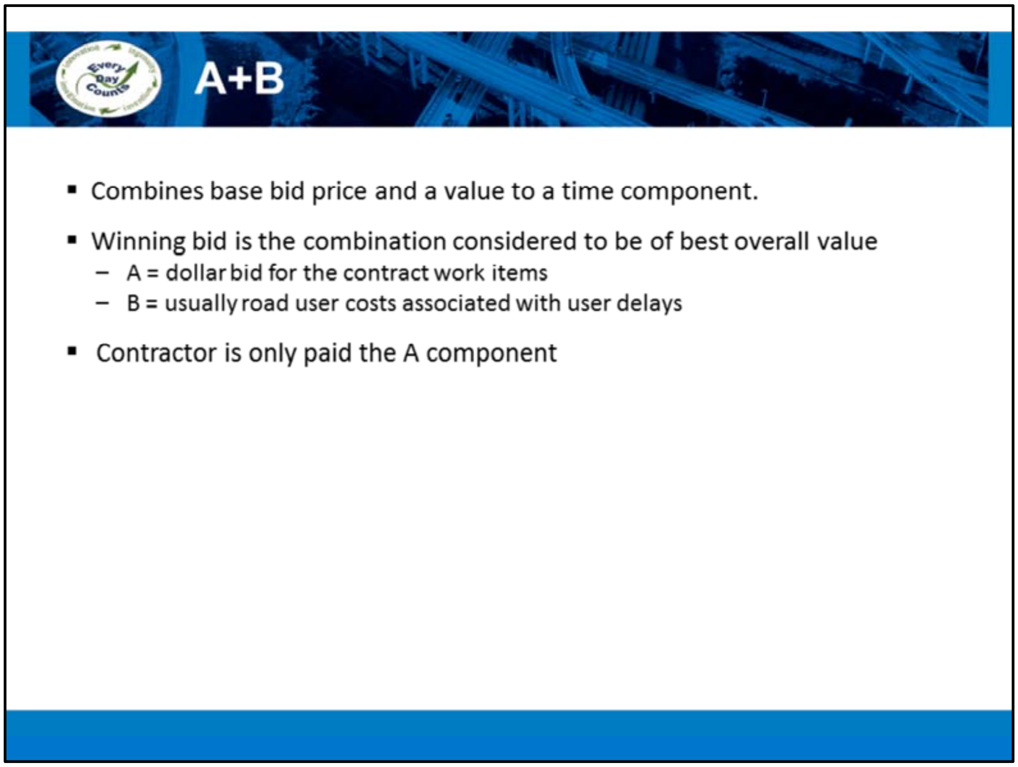
CM/GC is similar to design-build in that the contractor and designer work together. It differs, however, in that each has their own contract with the owner and the owner remains an integral part of the overall team. The designer and contractor are both independently selected by the owner.

As a construction manager, the contractor has the ability to provide significant input during the design process. In this way the designer can better accommodate the means and methods a contractor may use to erect the bridge and changes are minimized to the contract documents that could otherwise be necessary. As such, risks are better identified and managed. The transition from construction manager to general contractor is generally smoother on account of the aforementioned role of construction manager.



Some advantages to CM/GC include: fast project delivery, no significant up-front design needed, the design can be tailored to the contractor's abilities, construction costs may be lower, and change orders are minimized.

Some disadvantages include how an owner selects a contractor without a design and that a checks-and-balance system is needed to verify bid costs.

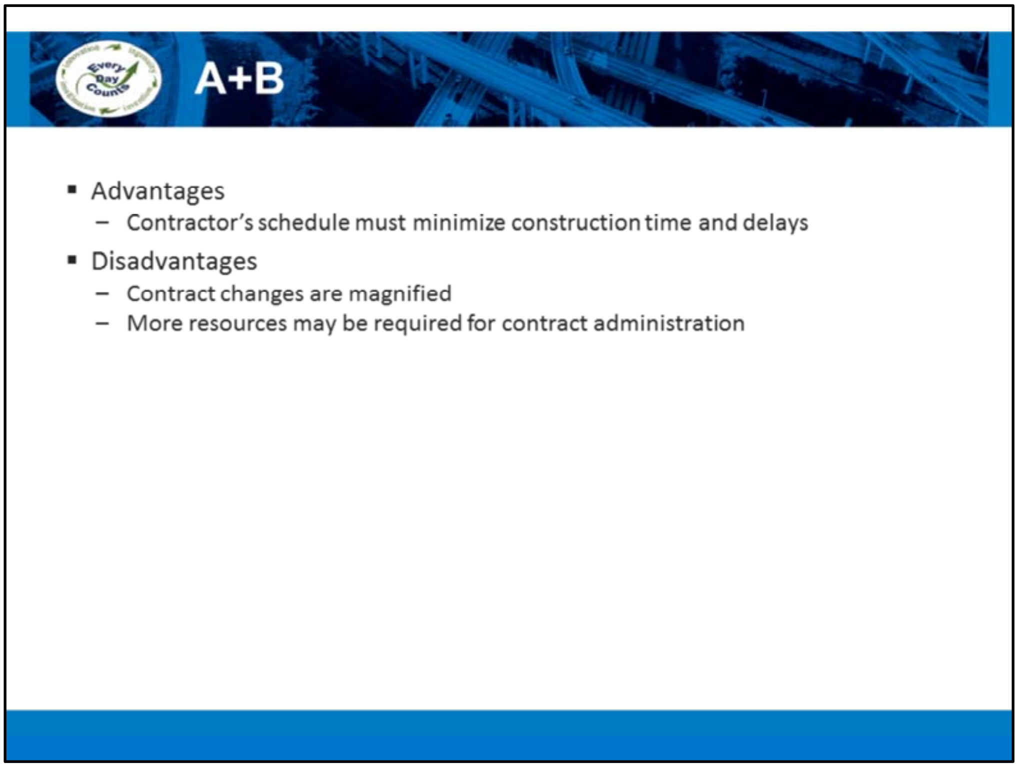


A + B bidding is most commonly a variation of design-bid-build.

Rather than low bid construction costs being the method by which a contractor is selected, two components, contract work items and road user costs, are quantified and summed to compose a bid price. The contractor with the low bid of the summed total is awarded the contract.

In the actual contract, the contractor will only be reimbursed for unit items – A – and the time allowed to complete the project is set at the bidders time component – B.

Here an emphasis is placed on how the project affects the public, not just the lowest construction cost.

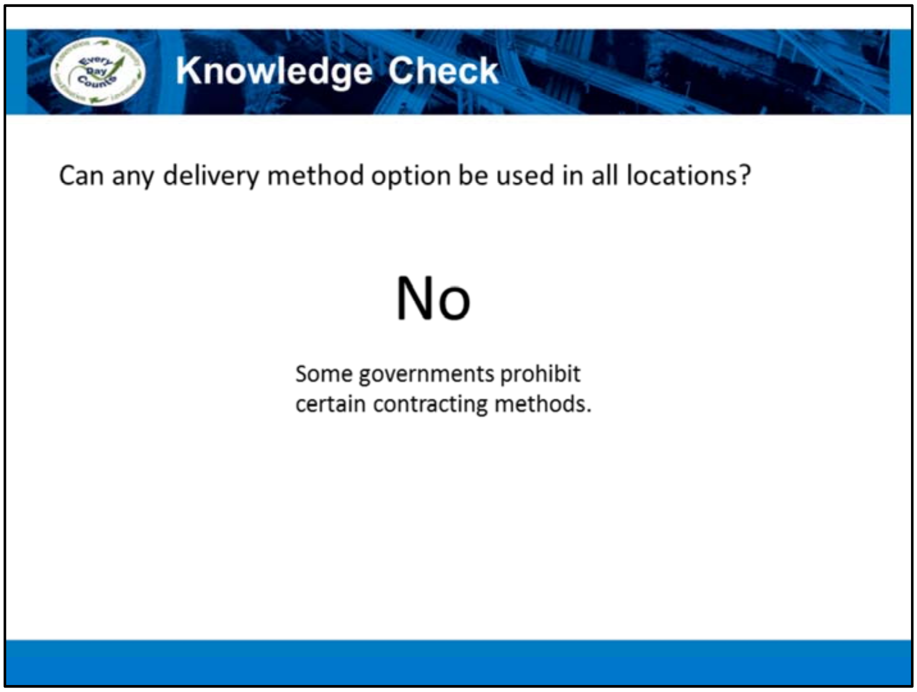


An advantage to A + B bidding is the contractor's schedule must minimize construction time and delays. Unfortunately some disadvantages are contract changes are magnified and more resources may be required for contract administration.

Two projects successfully completed using design-build contracting methods are the Elk Creek project in Oregon and the Mesquite Interchange project in Nevada.

The Mesquite Interchange team proposed slide in methods and were able to save 6 months and $10 million.

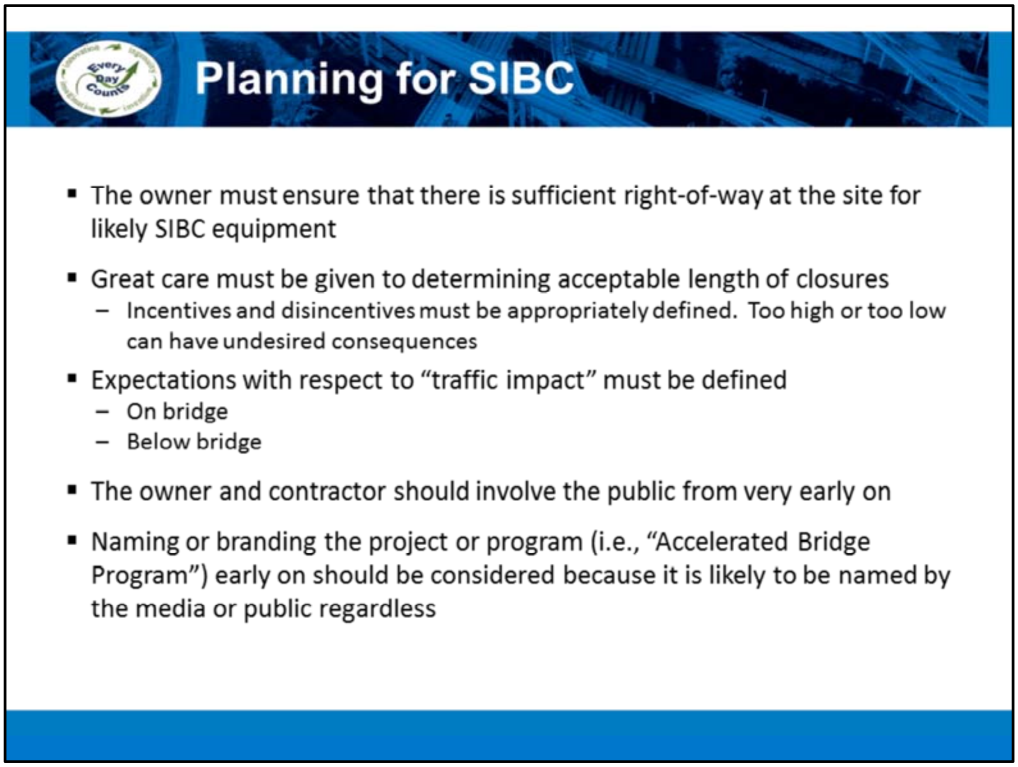
The Elk Creek design-build team was first to propose slide in methods and, in doing so, saved 22 months and $3 million.



The next knowledge check looks at delivery methods.

Can any delivery method option be used in all locations?

Answer: No, some governments prohibit certain contracting methods.

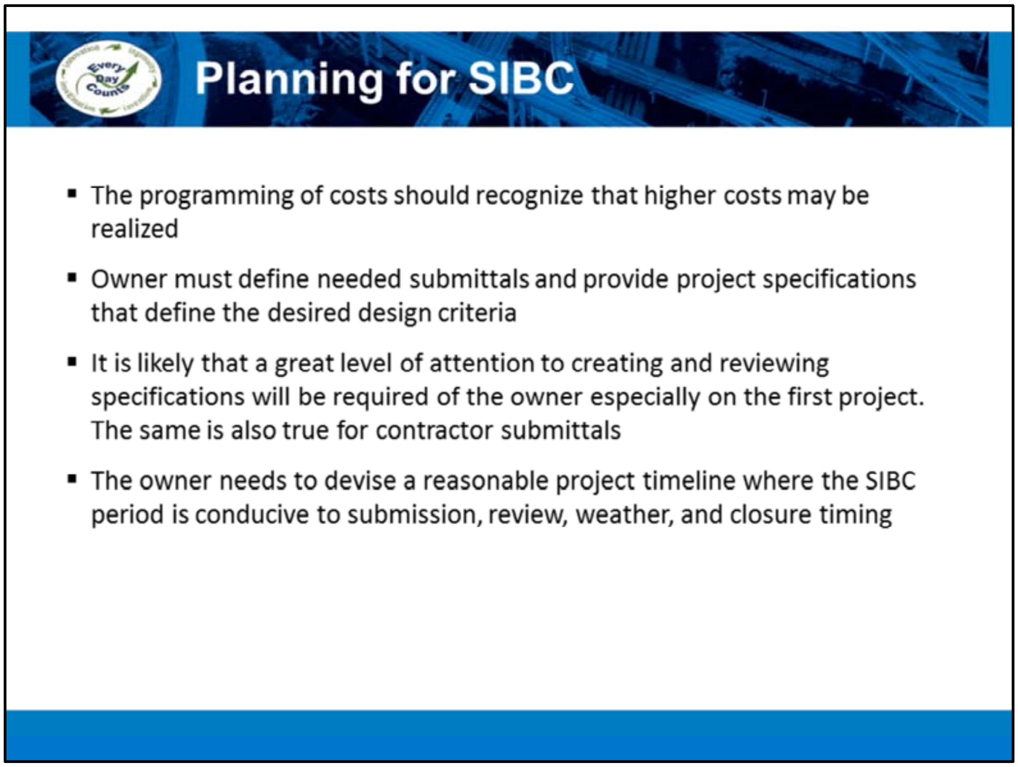


Planning for slide-in bridge construction generally follows that of traditional construction, yet there are some other unique items one must also plan for.

For example, the owner must ensure that there is sufficient right-of-way at the site for likely SIBC equipment and cranes for erection of beams, and it might be more space than anticipated.

A comprehensive study of an acceptable length of closure must be completed to appropriately assign incentives or disincentives. The owner must define the expectations to traffic impact, whether that be on the bridge or below the bridge.

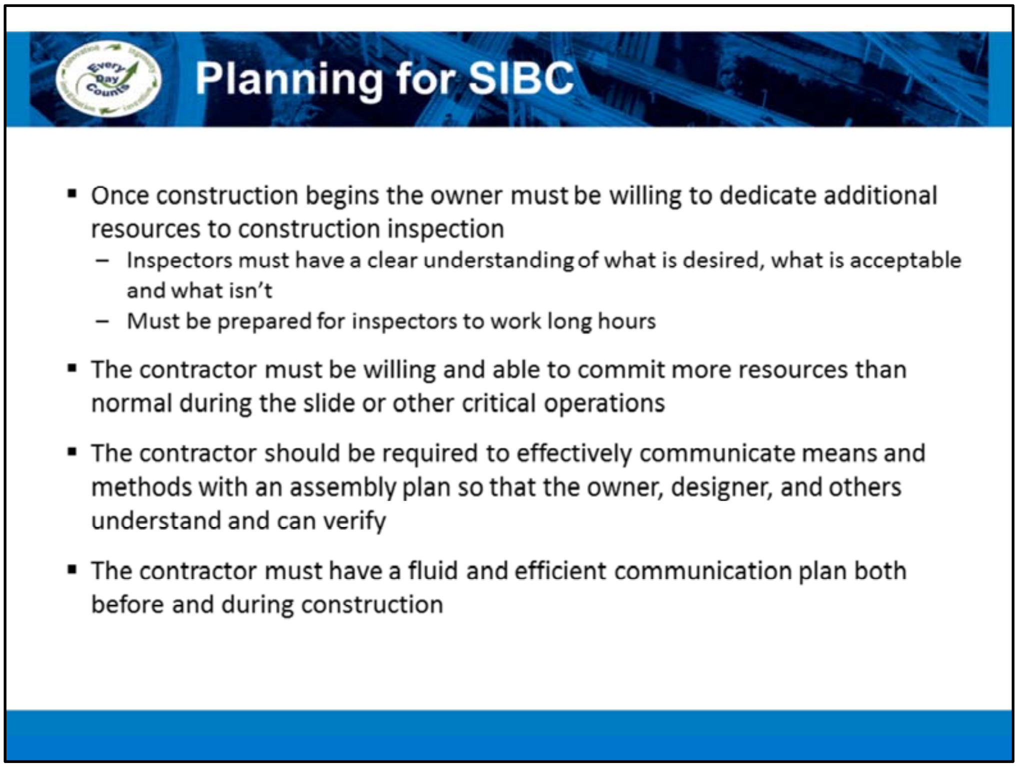
The owner and/or contractor should involve the public from very early on to communicate the intent and expectation for using SIBC. Given that SIBC is an innovative method for bridge construction, it is likely to draw the attention from the public and media. For this reason, naming or branding the project or program should be considered since it will undoubtedly be named by someone.



Higher overall costs, especially for initial SIBC projects, may be realized and should be addressed when programming.

Additionally, the owner must define any needed submittals and provide project specifications that define the desired design criteria.

It should come as no surprise that creating and reviewing specifications and submittals will require more attention, especially on the first project. Accordingly, the owner should devise a reasonable timeline to accommodate the added attention and so that weather and closure times can be best mitigated.



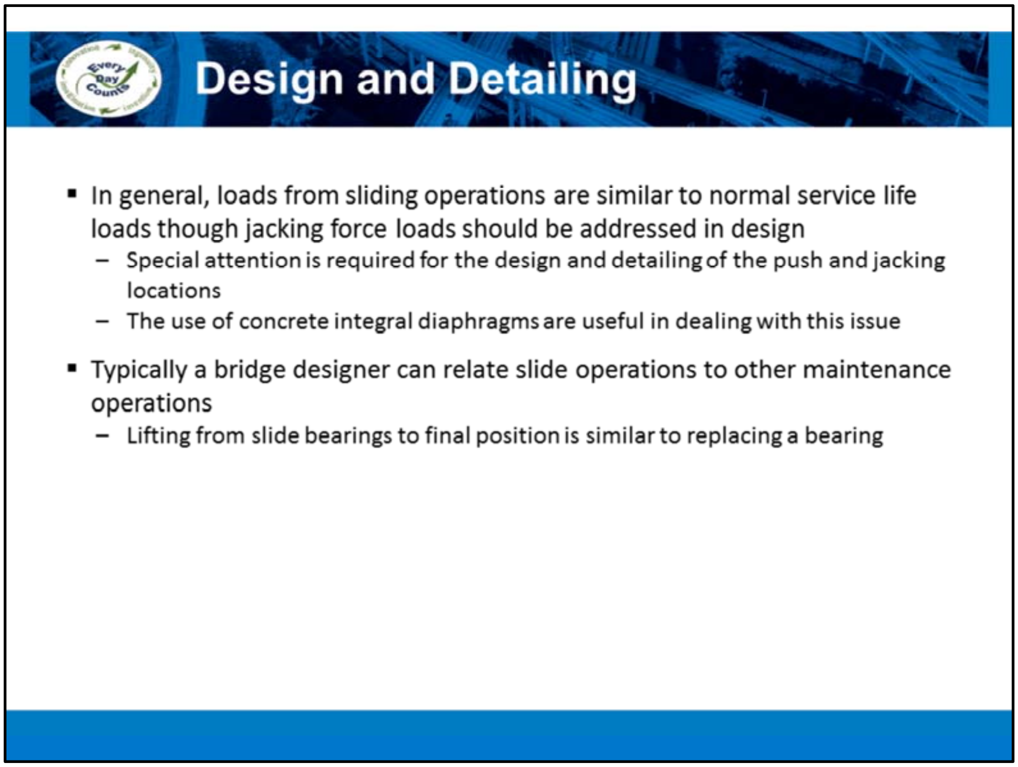
It should be expected that once construction begins, additional owner resources will be required in the form of construction inspectors.

Ensuring inspectors have a clear understanding of what is acceptable will take additional time. Even more, inspectors may have to work longer hours. Given the time-sensitive nature of SIBC during slide operations, a contractor must be willing and able to commit more resources than normal.

Also, an assembly plan is critical so that the contractor can clearly communicate his means and methods. His overall ability to efficiently communicate both before and during construction will be key to success.

Lastly, the contractor must have a contingency plan that addresses these questions and others. What should happen during an emergency response, or equipment failure? What if an extended detour time is required and what if there is an accident on the detour? What happens if severe weather approaches?

Project specifications should include the minimum contingency scenarios. The specifications should also encourage the contractor to determine and plan for other contingency plans.

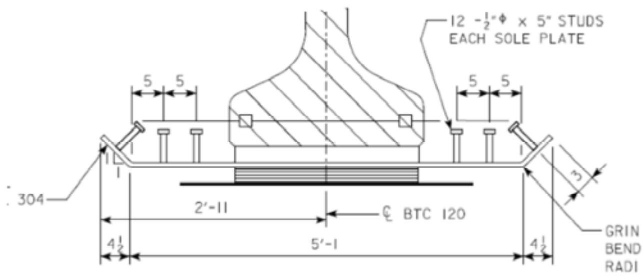


The design and detailing of a bridge slated for slide-in bridge construction is more similar than different from that of a traditionally constructed bridge. In general the loads during sliding operations are minimal and likely will not exceed loads typically seen during normal service life.

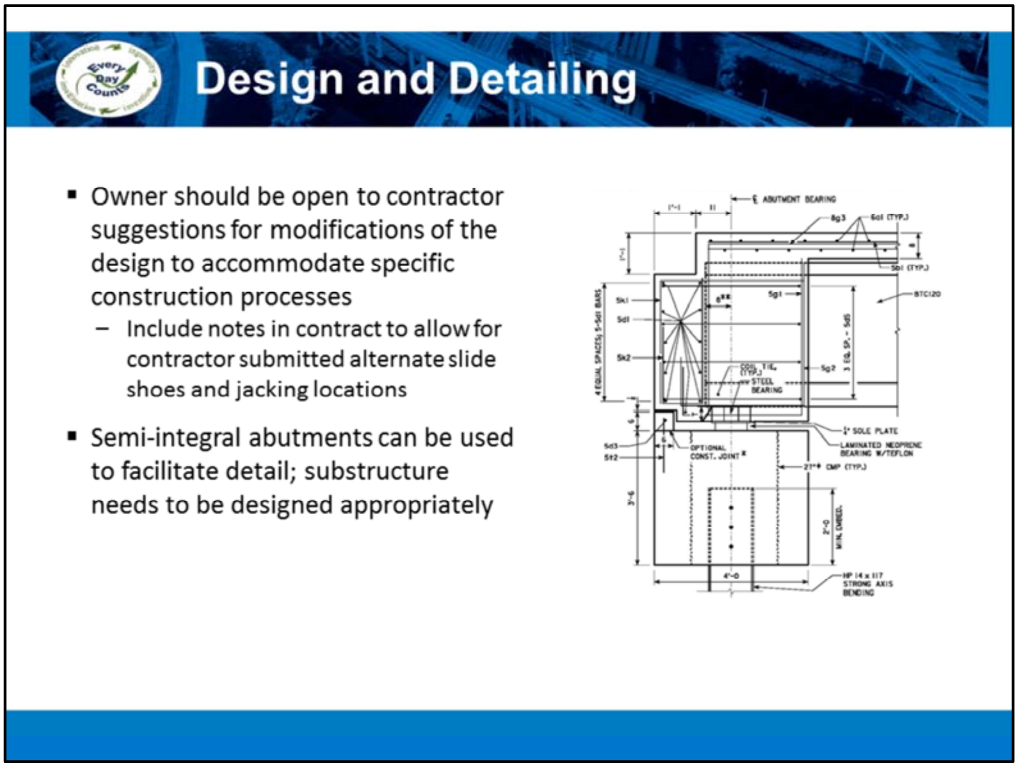
It is at the jacking locations that additional loads should be addressed. The use of concrete integral diaphragms are quite useful in dealing with this issue, an example of which is shown along with a slide plate in this detail. Forces can best be related to those seen in maintenance operations. For example, replacing a bearing.

Design and Detailing

- Details are dependent on the slide system used
- Detailing of slide shoes and bearings required
- Jacking locations needed for bearing change-out

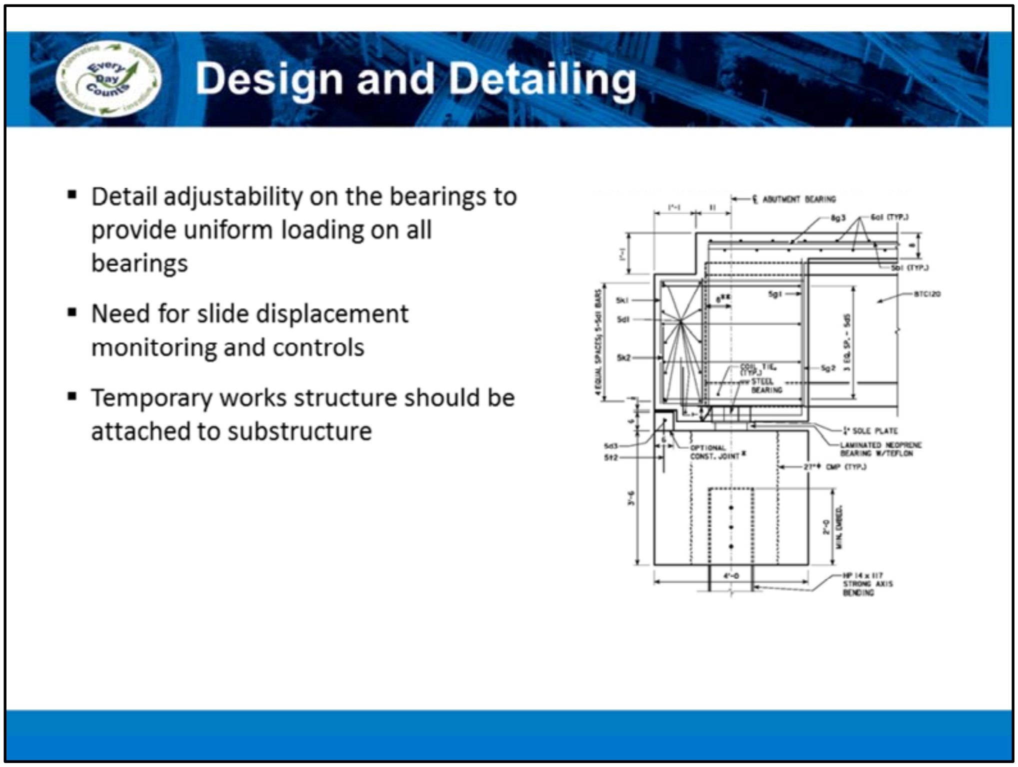


Special attention should be paid to the detailing of slide shoes, bearings, and jacking locations if bearing change out is required.



Even more, the owner should be willing to entertain a contractor’s suggestions for design modifications that would enable a specific construction process to be completed with other equipment or in a different manner.

A semi-integral abutment with properly designed substructure can be used to facilitate slide details and modifications. In general, the slide surface should be level. This means that the depth of the semi-integral diaphragm will vary with roadway cross slope.

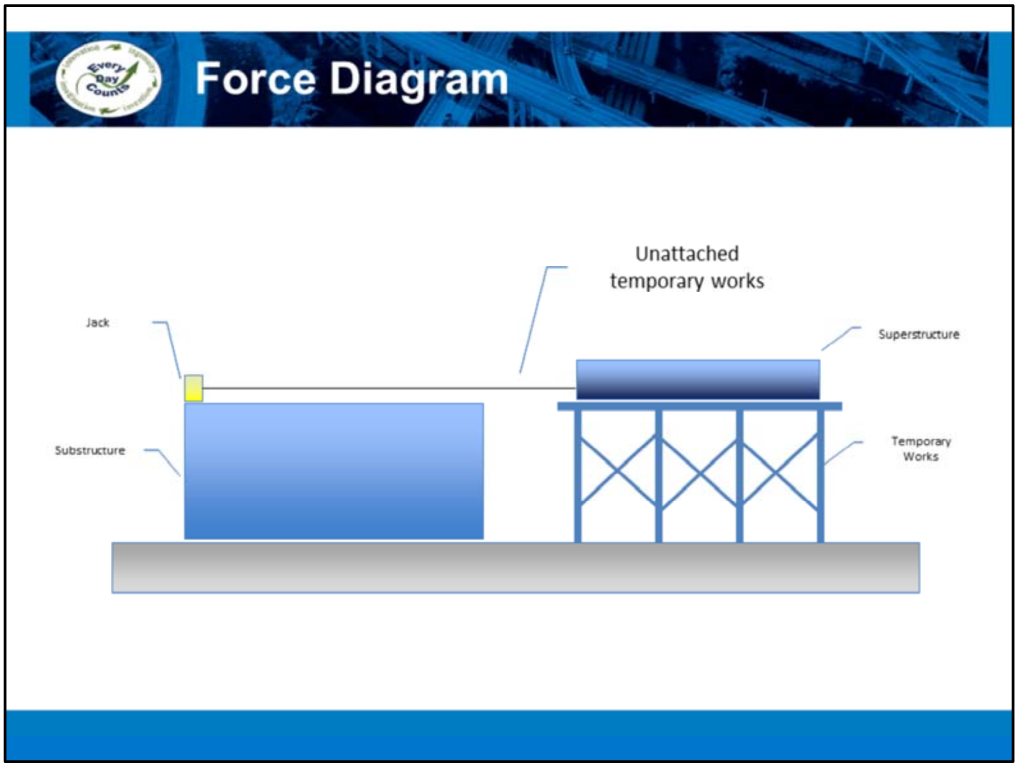


Adjustability should be provided on the bearing to ensure uniform loading on all bearings.

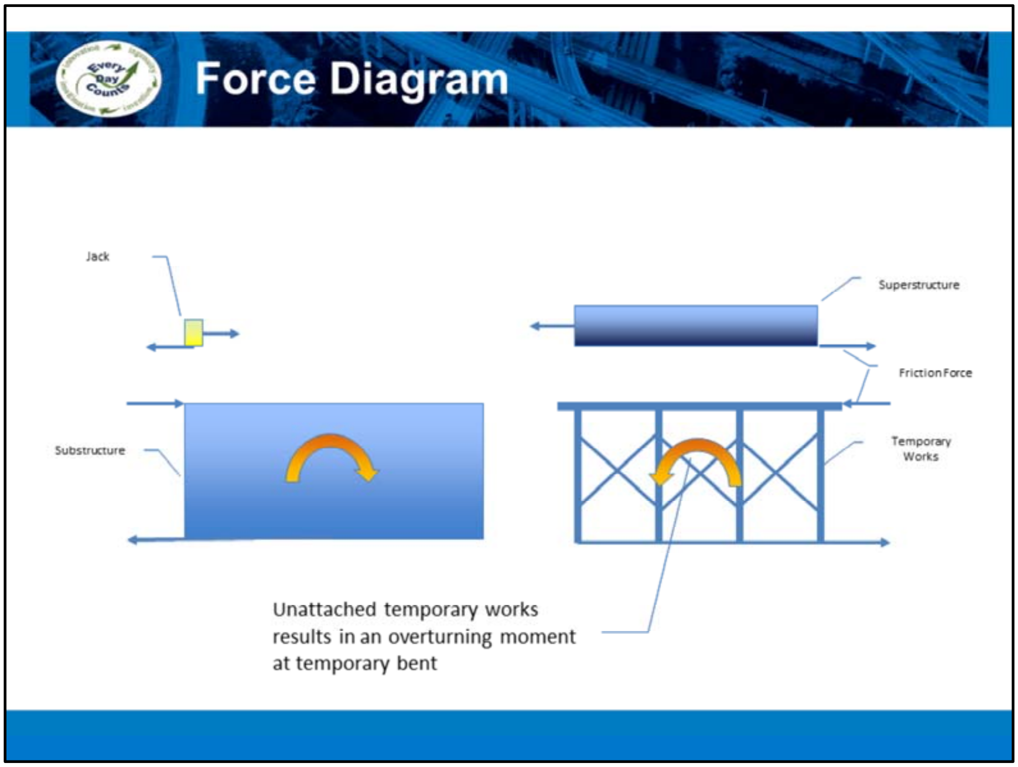
A system for monitoring displacement during the slides should be in place.

Lastly, it is greatly beneficial to the overall substructure design, both permanent and temporary, to attach the temporary works to the permanent substructure. The reason for this will be demonstrated in the following slides.

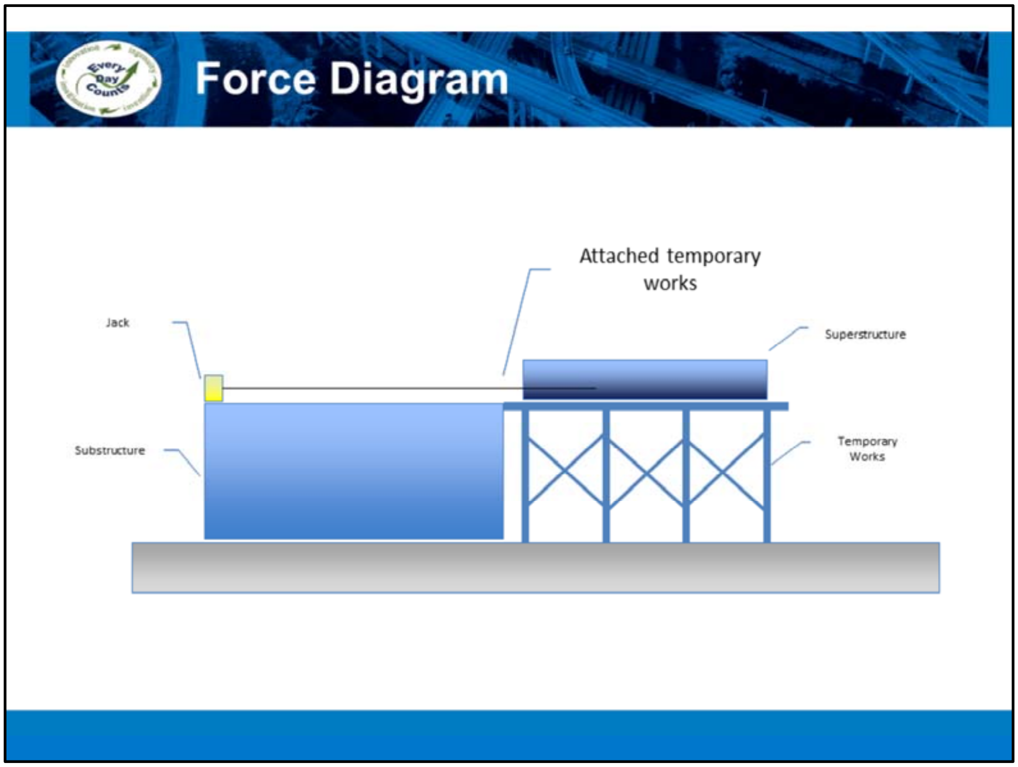
Generally the temptation is to treat the bridge as very fragile when being moved and placed, while this is appropriate, this should also be tempered with the perspective that bridges are, in fact, quite strong and durable structures.



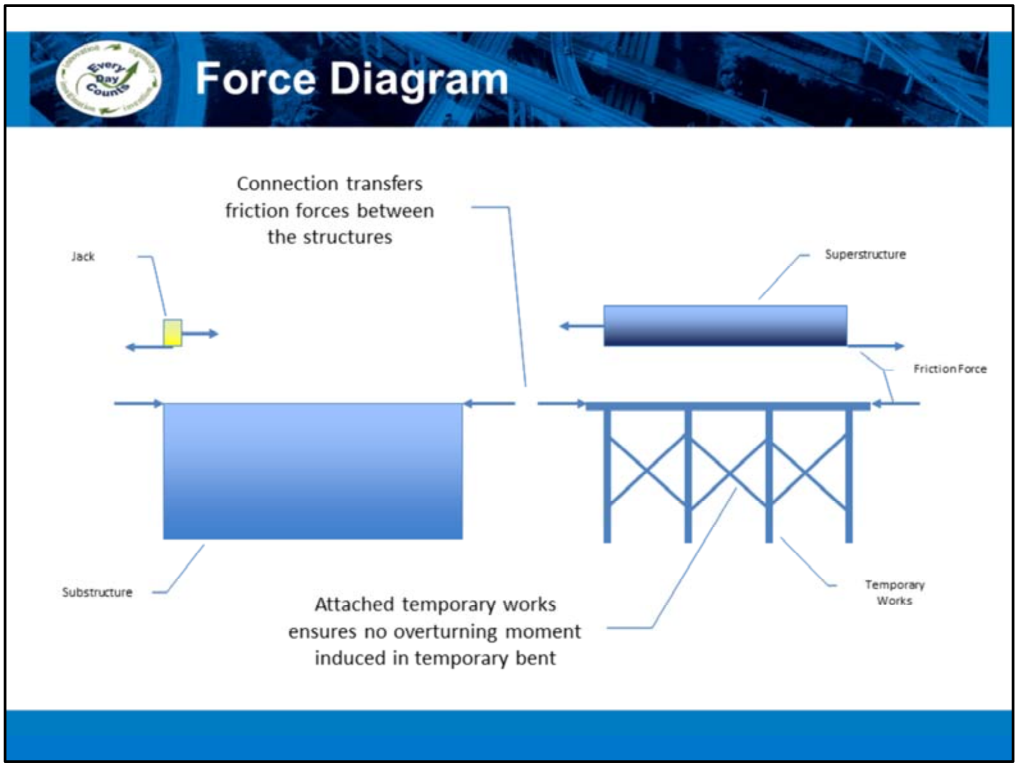
Seen in this schematic are the two substructures for the permanent and temporary works in an 'unattached' state. When pulling or pushing the new superstructure from one substructure to the other, significant forces are introduced to the substructures as seen in free-body-diagram on the following slide…



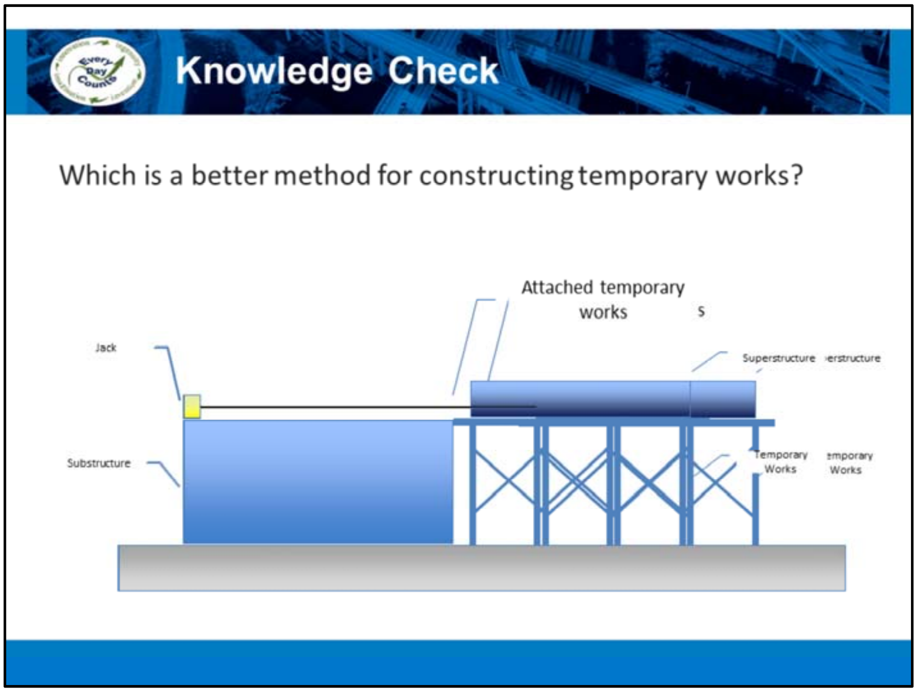
The resulting overturning moments must be accounted for in the design of the substructures, especially that of the temporary works.



Conversely, if a point of attachment is provided between the two substructures as seen in this schematic diagram, then…



… the overturning moments are eliminated, thereby greatly simplifying the design of the substructure and the temporary works.

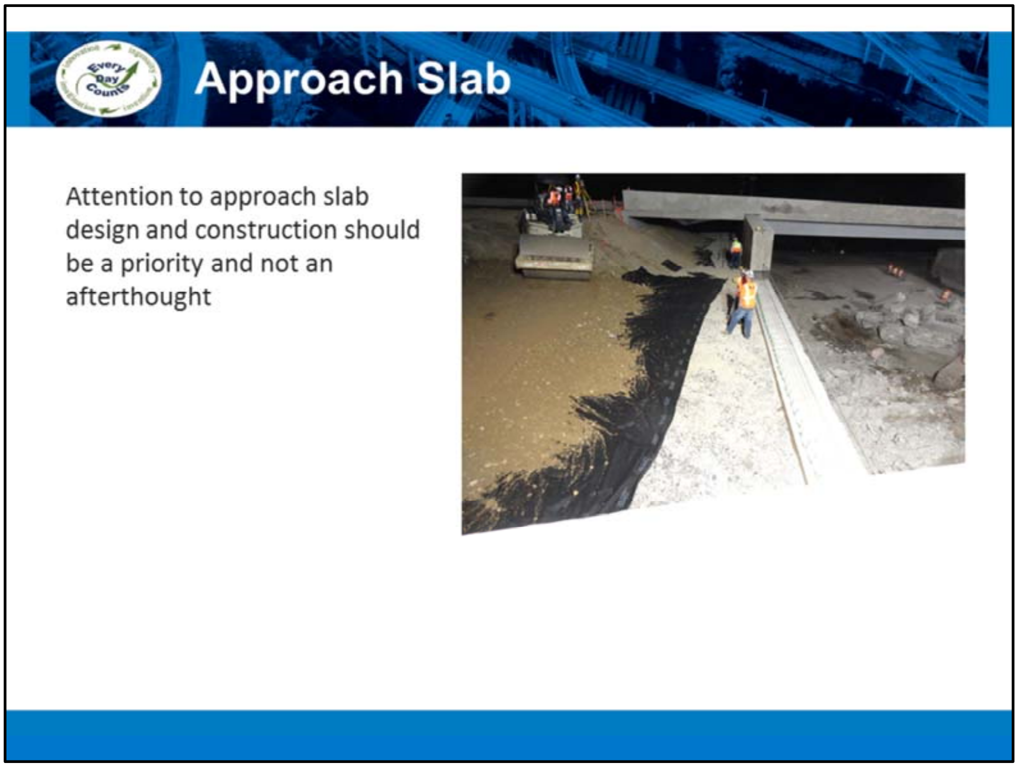


Which method is better for constructing temporary works?

Leaving the temporary works unattached from the permanent substructure?
or
Attaching the temporary works to the permanent substructure?

Answer: Attaching the temporary works to the permanent substructure. This simplifies the demand and design of the temporary works and substructure.

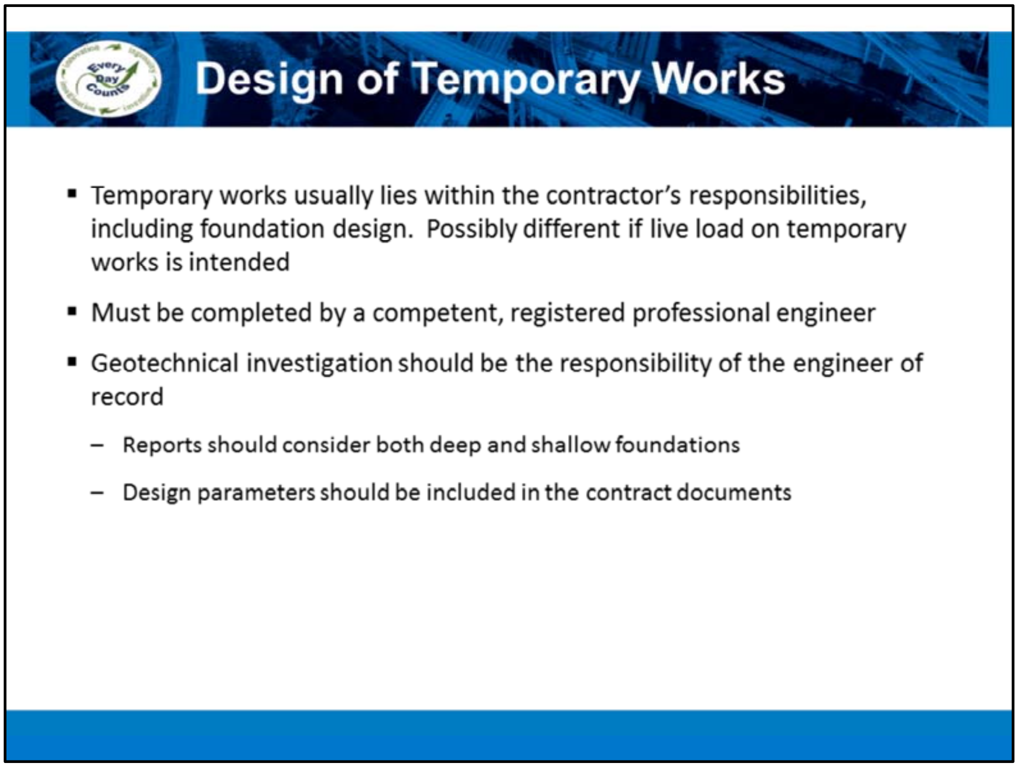
As part of the Massena, Iowa bridge slide, semi-integral abutments act as the jacking locations and the temporary works were attached to the substructure. Together these details proved to be an effective means for sliding the superstructure.



Not to be lost with the significant focus on the constructability and slide of a new superstructure are the approach slabs. Attention to approach slab design and construction should be priority, rather than an afterthought.

Several methods have been used including the 'Utah Method' which involves sliding the approach slabs with the bridge, precast approach slabs placed after the slide, cast-in-place approach slabs, or even buried approach slabs commonly referred to as the 'European Method'.

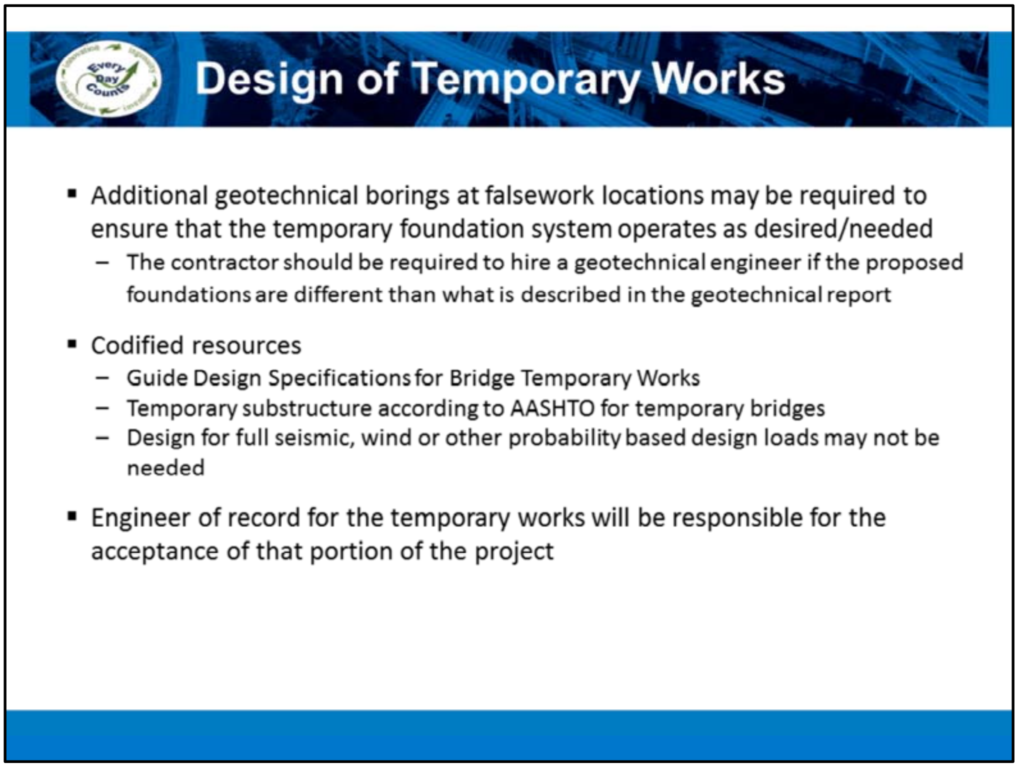
A site-specific evaluation should be completed to assess which method is best. Most DOT's have standards for this item that are not compatible with SIBC; again perspective is key. Age-old standard details can often be placed on a pedestal resulting in resistance to otherwise reasonable alternatives.



In most cases, the design of temporary works lies within the contractor's responsibilities. Though if the traveling public will at least minimally travel over the temporary works, the responsibility may lie elsewhere.

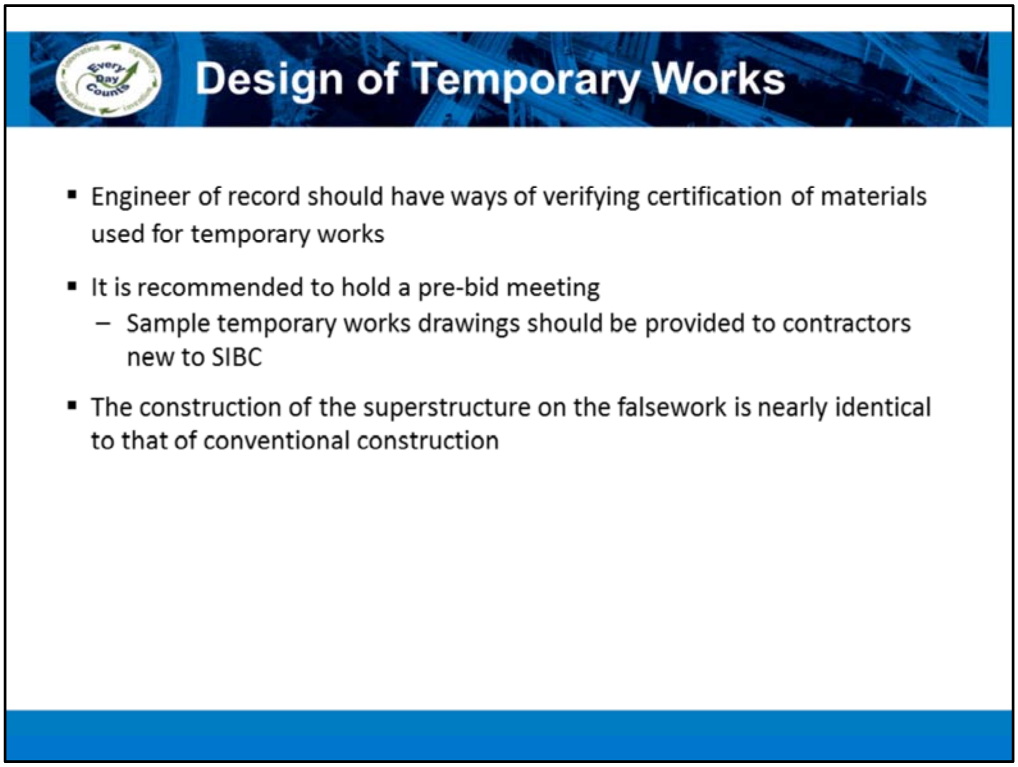
The design must be completed by a competent, registered professional engineer. The engineer of record should be responsible for the geotechnical investigation around the site including the area proposed for temporary works.

Both deep and shallow foundations should be considered and all design parameters included in the contract documents.



If temporary works foundations different than those considered are proposed by the contractor, it is required of the contractor to hire a geotechnical engineer. Several codified resources exist to guide the temporary works design including those listed here.

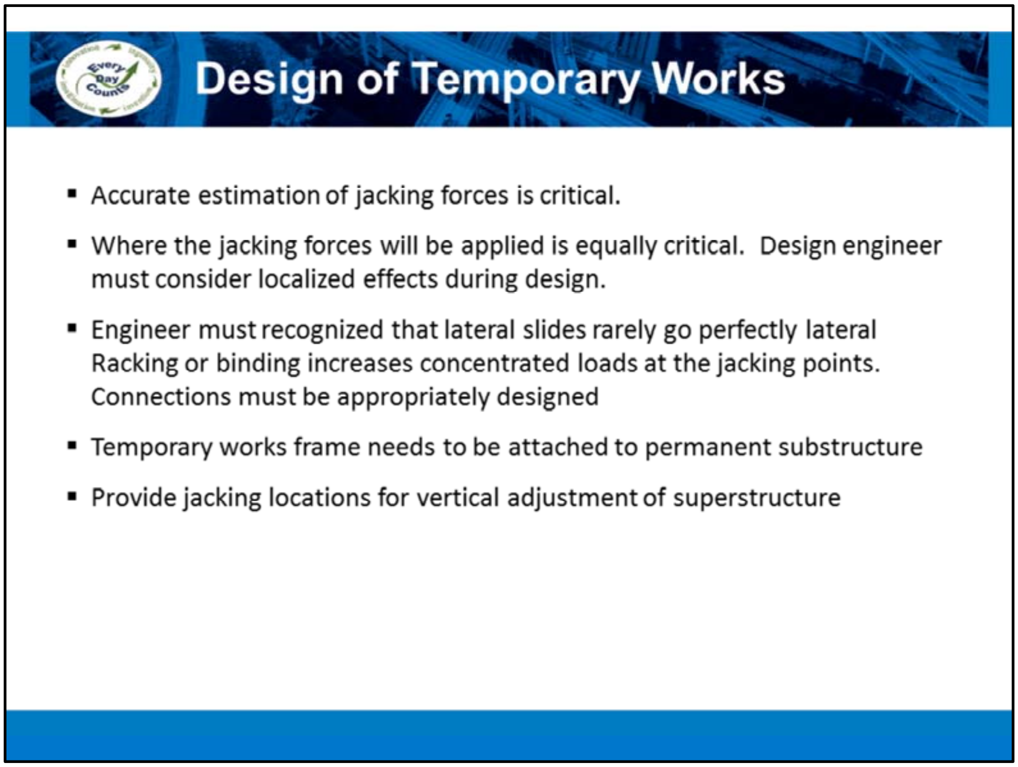
In the end, acceptance of the temporary works will be up to the engineer of record for the installation.



Further, the engineer of record should have the ability to verify materials certification.

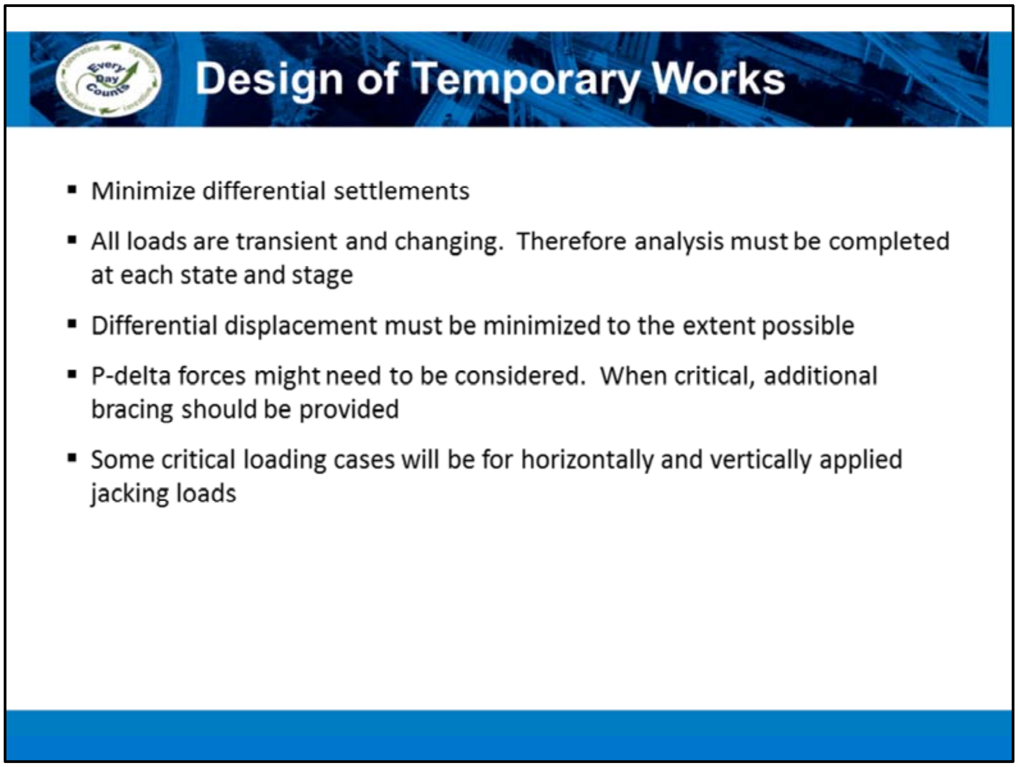
A pre-bid meeting is recommended where sample temporary works drawings can be viewed for those unfamiliar with slide-in construction.

For SIBC, the actual construction of the new superstructure upon the temporary works is very close to that of conventional construction; very few methodical changes are needed.

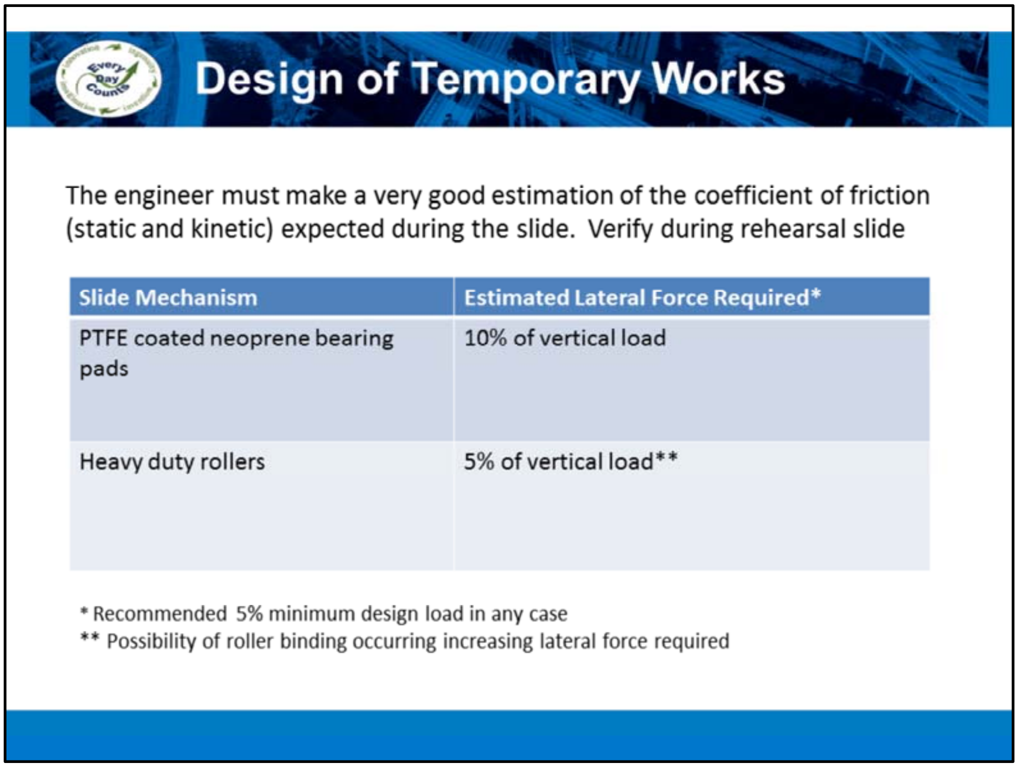


The expected jacking forces and jacking locations are key to the design of temporary works. It should be noted that possible misalignments or hang-ups during slide operations can considerably increase the jacking forces. Accordingly, connections should be appropriately designed.

For reasons discussed earlier, the temporary works should be attached to the permanent substructure. Lastly, jacking locations for vertical adjustment of the superstructure should be incorporated into the design.



Attempts to minimize the differential settlements between permanent and temporary works should be made. Note that all loads are transient and changing; therefore an analysis should be completed for stages throughout the process. Special attention should be paid to differential displacements, p-delta forces, and jacking loads.

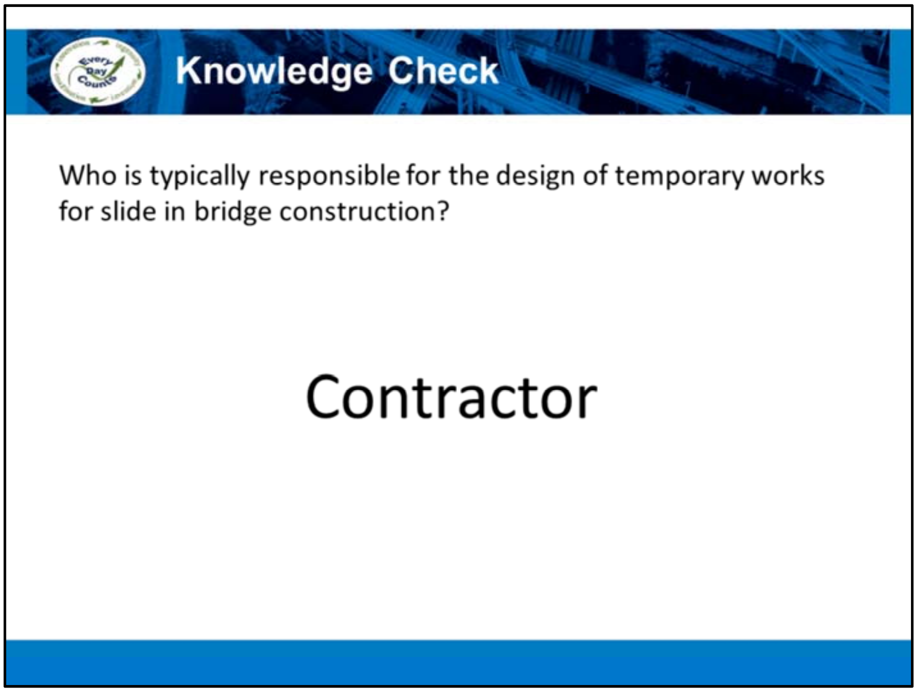


To ensure the proper jacks will be supplied to the project, the engineer must make a good estimation of the friction forces during the slide. These forces should be verified during the rehearsal slide.

Two commonly used slide mechanisms include PTFE coated neoprene bearing pads and heavy duty rollers. The estimated lateral force required is 10% and 5% of the vertical load, respectively. Note that, in addition to the higher forces required during possible binding, a slightly higher force may be required when pushing the superstructure from a static to kinetic state.

Since the engineer of record does not know the make-up of the actual slide system, a recommended value of 10% should be used for preliminary engineering. The plans should show the recommended jacking location on the bridge and the engineer of record should verify that the structure can accommodate this force.

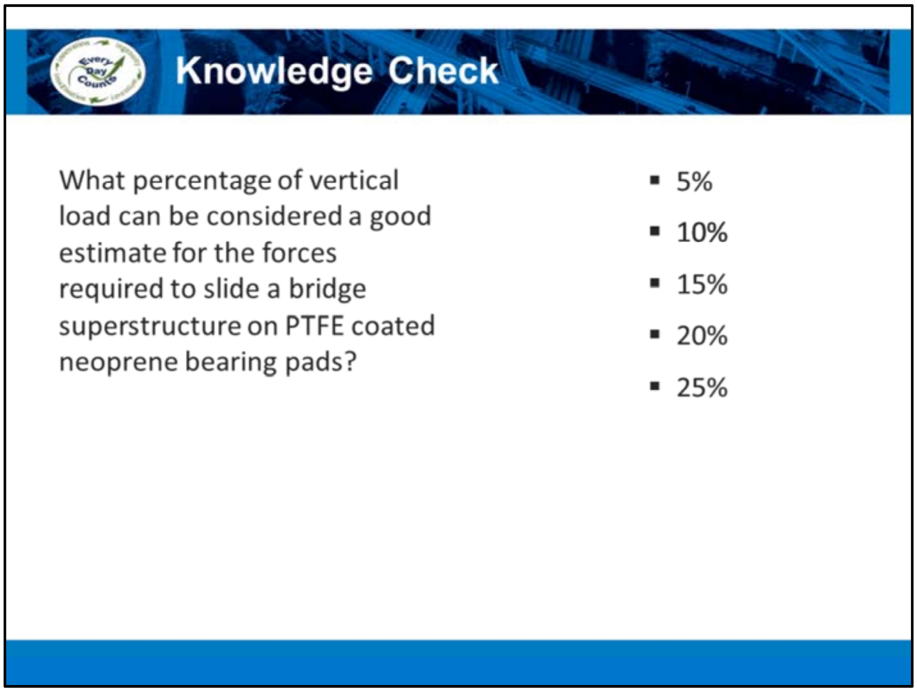
It is key that the transition from temporary supports to the permanent structure be designed to accommodate the transient load and possible differential deflection. The superstructure should experience little effect due to the changing support condition.



Who is typically responsible for the design of temporary works for slide in bridge construction?

Answer: The contractor.

Temporary works usually lies within the contractor's responsibilities, including foundation design, though this could change if live load on temporary works is intended.



What percentage of vertical load can be considered a good estimate for the forces required to slide a bridge superstructure on PTFE coated neoprene bearing pads?

5%?
10%?
15%?
20%?
Or
25%?

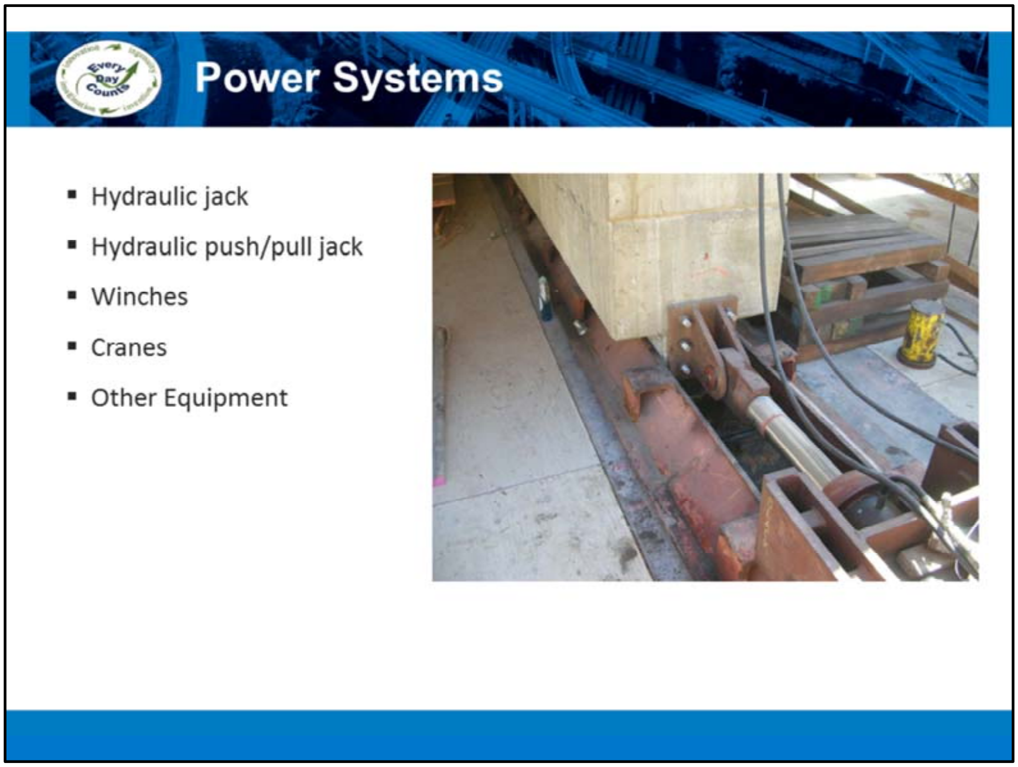
The answer: A good estimate on PTFE bearing pads is 10%. When using heavy duty rollers the force required is generally less, though in both circumstances the loads can increase if binding occurs or an obstruction isn't removed.

Provided in this slide are a few examples of various slide details. Shown in the two pictures to the left are PTFE coated bearing pads along with stainless steel slide shoes. Each pad is coated with dishwashing soap to further decrease the frictional forces; it is available, cheap and effective.

The top picture to the right shows jacking pockets incorporated into the semi-integral abutment used for vertical adjustment and bearing pad change-out.

The bottom picture shows the guide channel used with heavy duty rollers and also threaded rods which are connected to the jack. The slide shoe option works in conjunction with a semi-integral backwall diaphragm. The slide shoe can be just used for the move, or it can be used for the permanent bearing support. By using this method of detailing, the number of permanent bearings can be reduced by more than half. The Utah DOT has designed bridges with only 2 or 3 bearings at each support line.

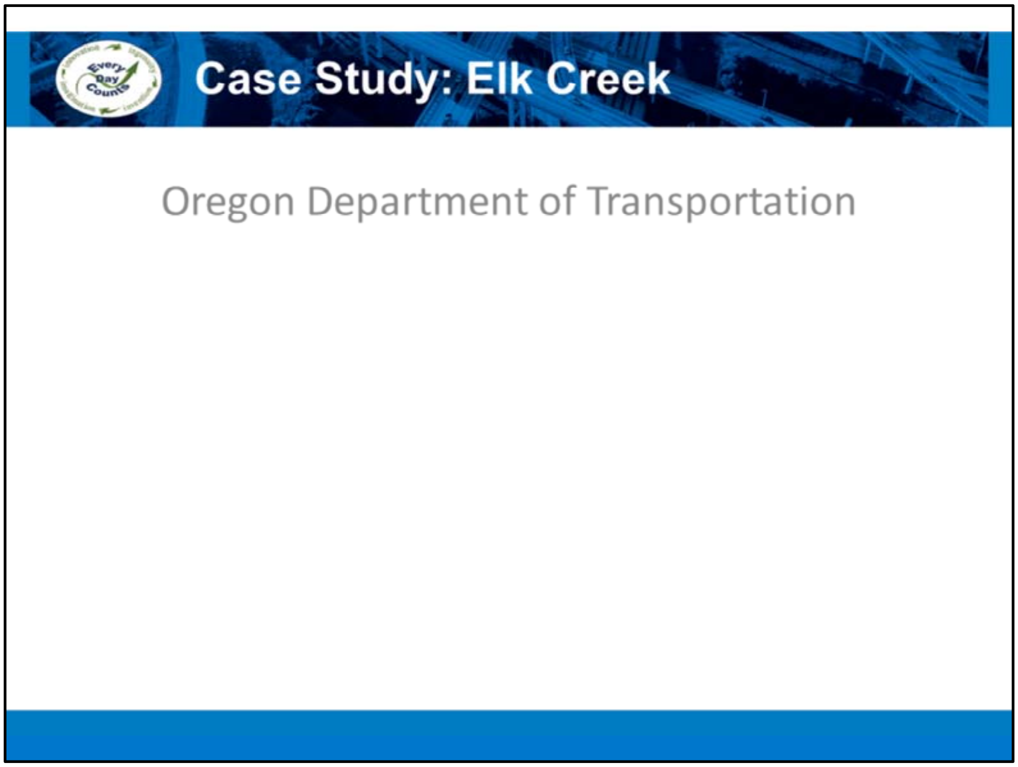
Additional pictures of hardware commonly used in slide-in applications are shown here. These include rollers, skids, PTFE pads, hydraulic rams, threaded bars, and vertical jacking hardware.



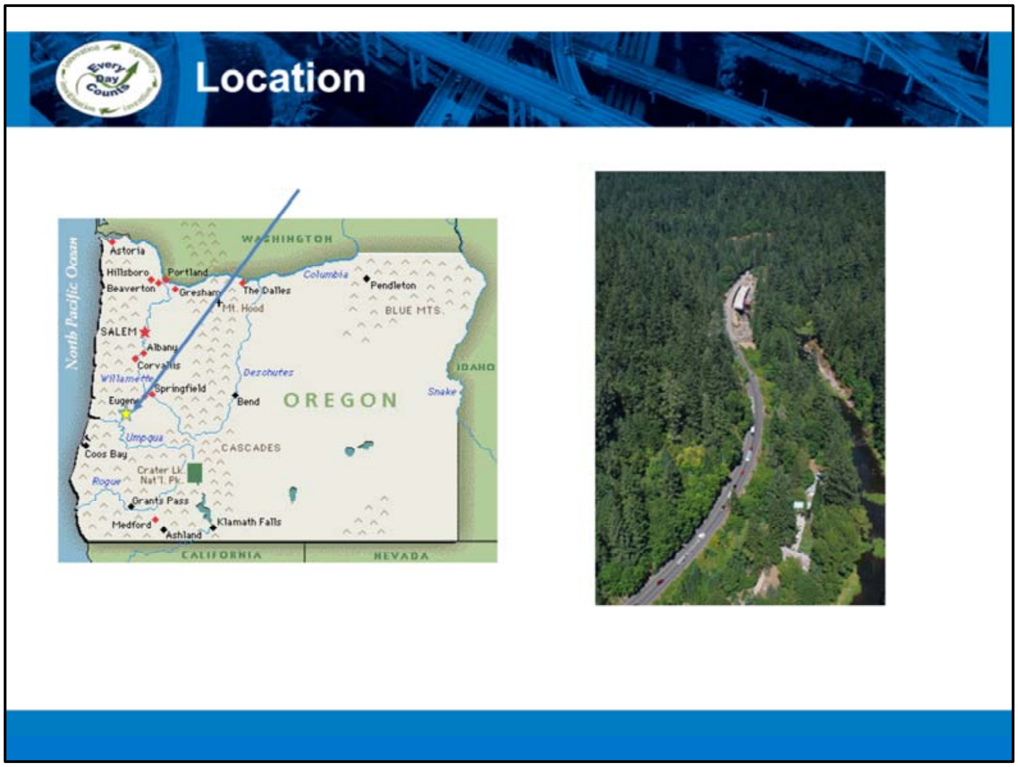
Several power systems can be employed to move the bridge superstructure. These include hydraulic jacks, push/pull jacks, winches, cranes, and even other equipment.

It is recommended that hydraulic equipment be required to be proof tested prior to being put into service, even new jacks can blow out seals and fail.

Submittals were briefly mentioned during the slides addressing the specifications. To further elaborate, some of the submittals that should be required include slide system plans; slide plans including an hour-by-hour schedule, communication plan, and contingency plan; the contractor's ingress and egress plan; and temporary works, which should be separated from the actual slide due to the timeline in which each is required during the project.



The Oregon Department of Transportation completed a project requiring several bridge replacements on State Highway 38 between the towns of Elk Creek and Hardscrabble, two of which were replaced using slide-in bridge construction methods. Here forward, the bridges will be referred to as Crossing 3 and Crossing 4.



The project is an hour south of Eugene in the mountains of western Oregon. The terrain alone would have been enough to make any bridge replacement project more difficult. Couple that with the desire to maintain traffic through the corridor during construction and the difficulty is only increased.

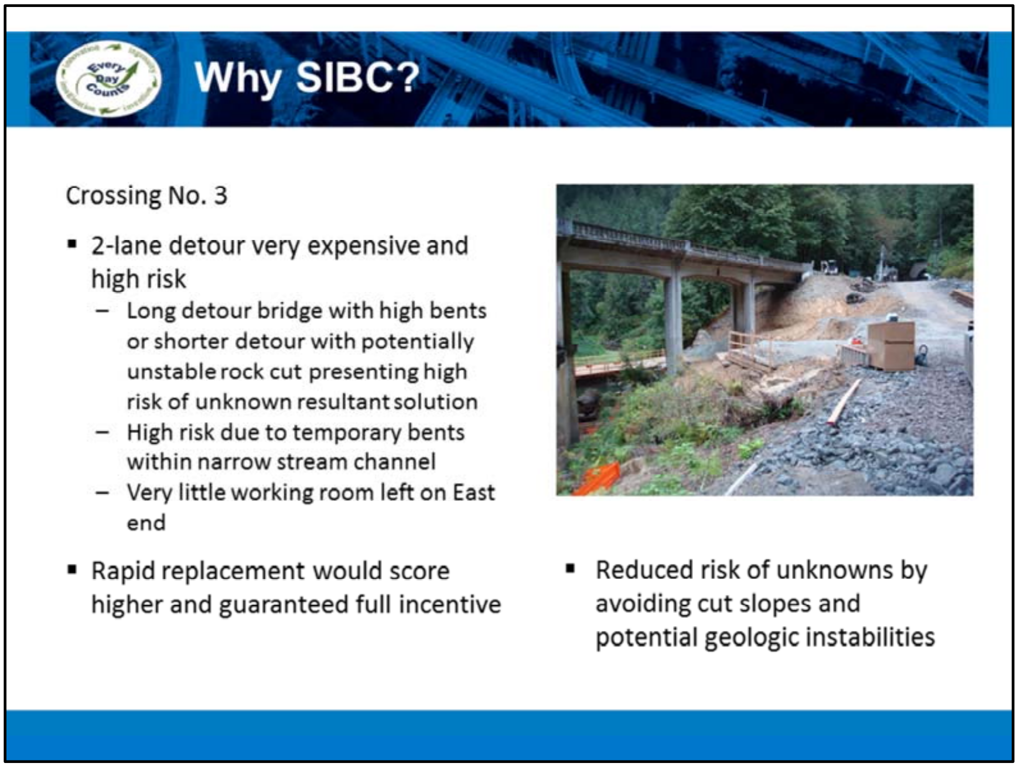
The method of delivery was design-build with best value selection and the winning team proposed slide-in bridge construction for two bridges to eliminate expensive detours and flagging.

The project was in a very difficult location. Both of the existing bridges featured deck truss main spans which essentially eliminated the possibility of phased removal and construction.

Both bridges were on opposite ends of the same tunnel, with one of the bridges starting almost immediately after exiting the tunnel. This made traffic shifts and alternative alignments extremely difficult to complete.

The lateral slides which were completed in a 48 hour closure window for each bridge eliminated costly realignments, costly temporary bridges, and eliminated most of the single lane restrictions.

The winning bid was approximately $50 million, slightly under the engineer’s estimate of $53 million, and the total project duration was 32 months, almost two fewer years than the original estimated project duration.



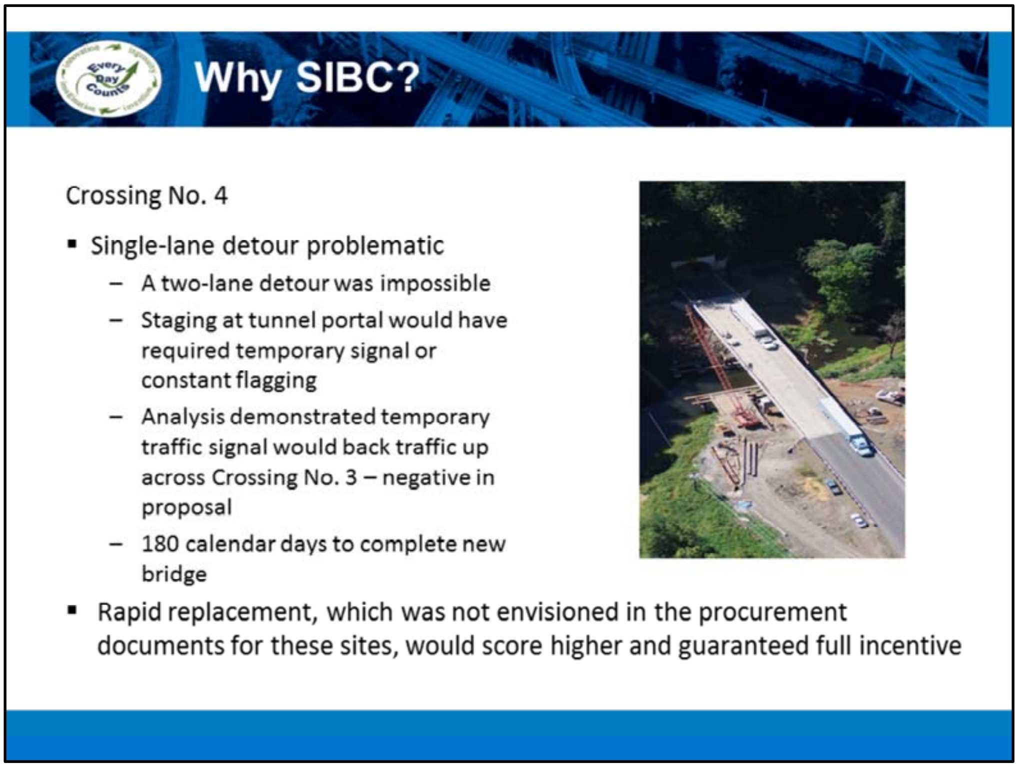
It’s useful to look at the reasons Slayden chose the lateral slides.

For Crossing 3, a temporary bridge could have been constructed but the local geometry made the temporary bridge almost three times the length of the permanent bridge.

Furthermore, there would have been considerable risk due to temporary bents within the narrow stream channel and very little working room would have been left on the east end which would have required a substantial hillside cut to reconnect at the west end.

Another reason, given that the project was design-build with best value selection, was that rapid replacement would score higher and guarantee full incentive.

The terrain also imposed several unique challenges. By avoiding cut slopes and potential geologic instabilities, the risk of unknowns was reduced.



For Crossing 4, the proximity of the tunnel to the bridge, only about 50 feet from the tunnel portal to Crossing 3 from the bridge joint, made staging the new bridge very difficult. A temporary signal or constant flagging would have been required and in this case it was discovered that traffic would have backed up through the tunnel and across Crossing 3.

Additionally, if a single lane detour was used, the contractor would have been limited to 180 calendar days to complete the new bridge.

Rapid replacement was not originally envisioned in the procurement documents for these sites. However, its use did score higher and guarantee full incentive.

These pictures show the difficult construction conditions and site constraints.

The primary structure of the original bridge, shown on the left, was a deck truss.

The overall structure was also composed of several shorter concrete girder spans approaching the truss structure.

On the right, the new structure is shown adjacent to the old structure, and is a three-span continuous steel plate girder bridge.

The red pieces are the vertical jack and slide shoes. Translation was accomplished by supporting and sliding at two interior points with the end spans cantilevered.

These pictures of Crossing 4, give you an idea of how difficult phased construction would have been due to the proximity of the bridge and tunnel. Like Crossing 3, the existing structure was a truss.

The new structure is a two-span, prestressed, concrete deck girder bridge. Translation was accomplished by supporting the structure along four lines.

Here, another picture of Crossing 4 is shown and the points at which the structure was supported during translation are better seen.

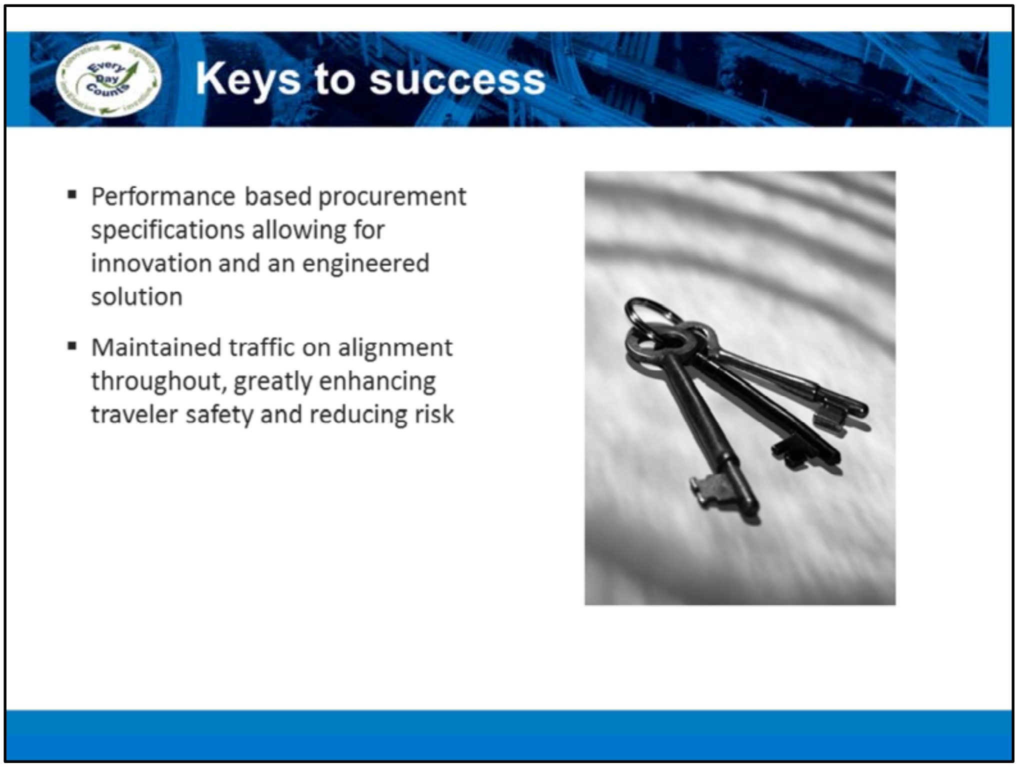
A greater appreciation is also gained for the surrounding terrain and the magnitude of a bridge slide operation.

For both crossings, the slide operation was subcontracted to Mammoet who used a similar technology found in Self Propelled Modular Transporters.

After all was completed, several keys to success were identified.

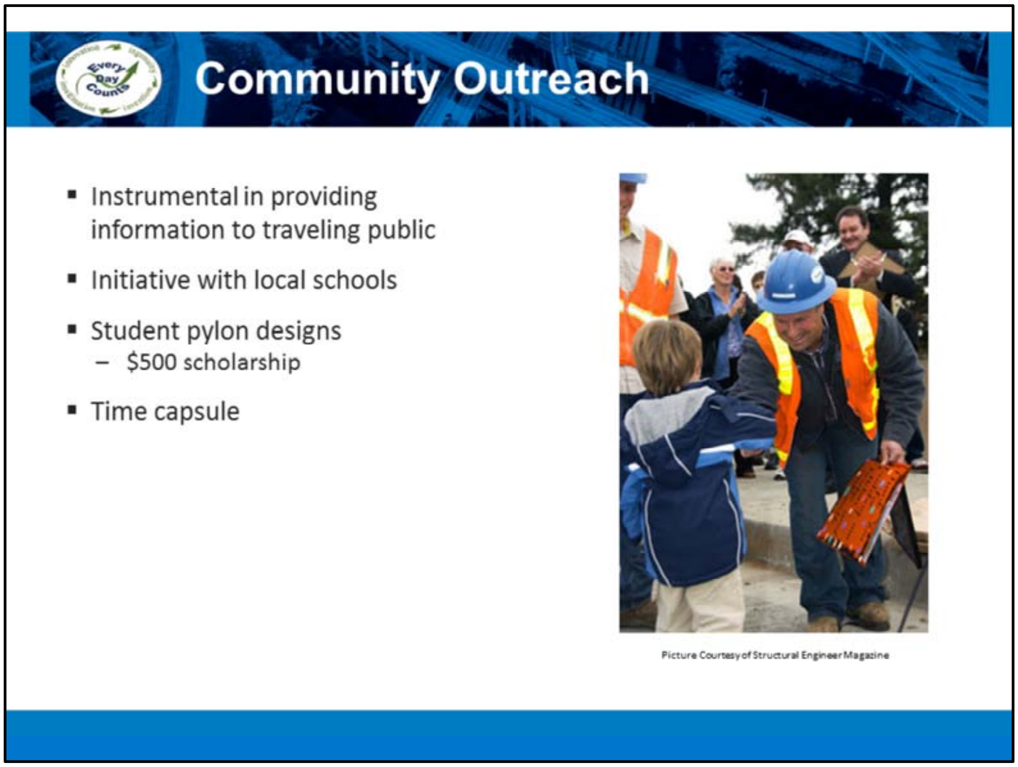
First, the reduction in construction time offset the additional costs due to slide-in bridge construction. Also, a significant reduction in maintenance of traffic resulted in schedule savings and good public relations, and the elimination of flagging for what would likely have been 180 days resulted in cost savings.

Furthermore, risk was greatly reduced by not using a temporary bridge to carry public traffic. And, maybe most importantly, the contractor made it known that coordination, communication and cooperation between the owner, community, and contractor was the real key to success.



Some additional keys to success include the performance based procurement specifications which allowed for innovation and an engineered solution.

Lastly, traveler safety and reduced risk were achieved by maintaining traffic on alignment throughout the duration of the project.

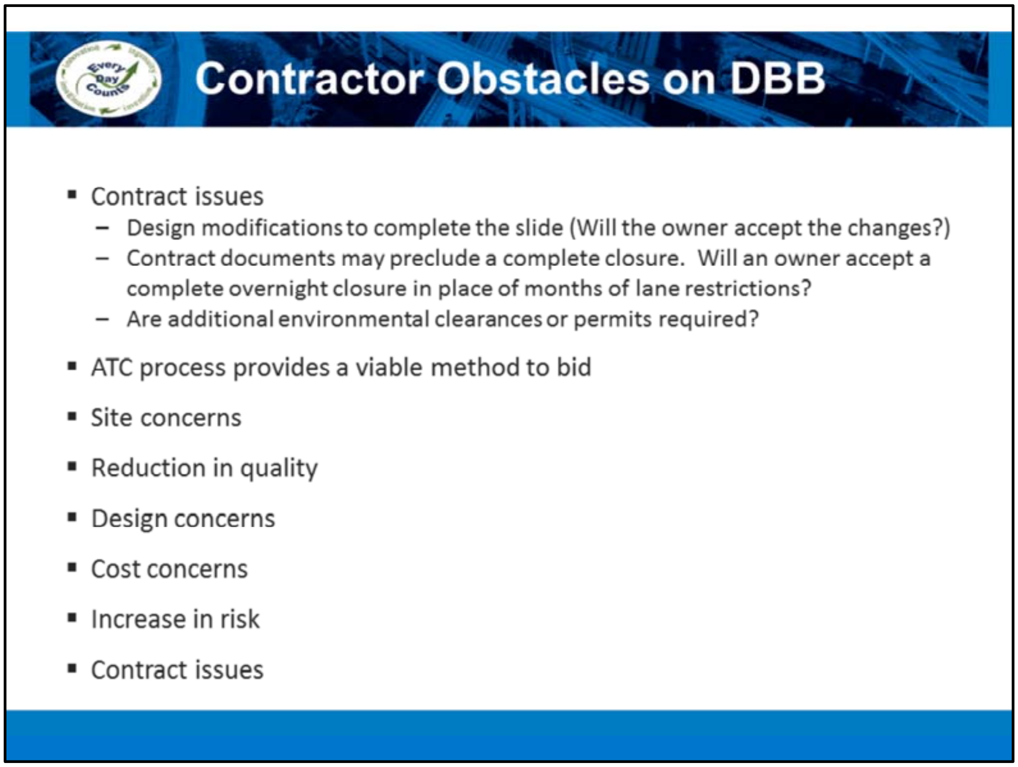


As part of the project, the contractor implemented a community outreach program which was instrumental in providing information to the traveling public.

The initiative began with the local schools. On several occasions the contractor visited the schools to convey necessary information whether it be through the students or directly to parents.

A student competition was established to design the pylons at the corners of one of the bridges and the winning student was awarded with a $500 scholarship.

Lastly, a time capsule on one of the bridges was created for students and other community members to contribute to. For this project the location allowed for closing off the site to any public viewing eliminating that potential security and safety issue.



Given all the benefits you may wonder why slides aren't used more often. It's likely we would see a lot more slides on traditional projects if the contractor knew they could get past a few obstacles. If a slide wasn't part of the bid package and a slide requires modifications, the contractor can't bid the slide in case the owner doesn't accept the revisions. Once the project is won the contractor has little incentive to go down the value engineering change path. Sometimes value engineering changes can lead to a loss of positive partnering attitudes.

Site concerns – There are places where it is not feasible to construct a new bridge adjacent to the existing structure but the Oregon project shows that slides can be effective even in very confined locations.

Reduction in quality – There is no evidence in reduction in quality in bridge lateral slide projects. When compared to phased construction it might even be an improvement. The Utah DOT has performed special inspections of all lateral slide bridges and no adverse effects have been found with the bridges. In fact, the condition in most cases is better than bridges built with SPMT installations.

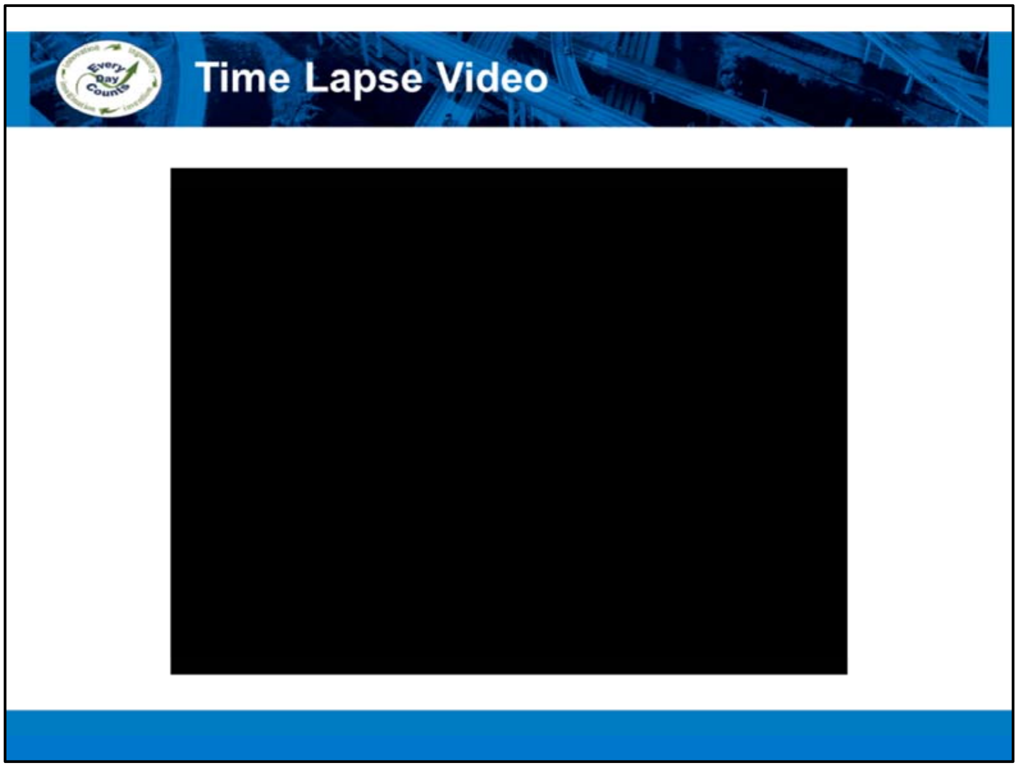
Design is fairly simple and there are a variety of solutions or methods used that demonstrate this. Difficult problems usually have few viable solutions.

Cost is difficult to quantify. It is more costly to slide a bridge into place than to close the road and build it in place. Once you start phasing the construction or requiring a

temporary structure the slide becomes cost effective without even considering user cost and construction oversight costs.

Increase in risk – any new construction method for any contractor or owner represents a risk but in general it is believed to be low. Construction risk is similar to a cast-in-place bridge. The move risk is really a function of the time provided for the move and the associated penalties for not opening. A tight timeframe increases the risk the project won't be completed in the allotted time. Low damages increases the risk that the contractor will not be prepared for problems. For example, having an additional jack onsite is cheap insurance against high penalties for not opening on time.

Contract issues – As a policy, owners should start structuring all projects to allow a lateral slide option. In addition to the normal contract and maintenance of traffic requirements it is relatively easy to add maintenance of traffic language to allow a limited complete closure with penalties or incentives in lieu of a defined time of reduced lanes or on site construction time. Also a special provision defining the requirements of any redesign and any other special requirements would allow the contractor to bid the job assuming a slide. As long as they know the requirements they need to meet they can confidently bid the job.



Here is a time lapse video of the slide period on Crossing 3.

A technical support solutions center has been established and is available for all to use to assist in slide-in bridge construction projects. Here the most up-to-date information about SIBC resources and training can be accessed. The center is most easily found by searching "FHWA Slide" online, or by simply going to directly to the web address shown here.

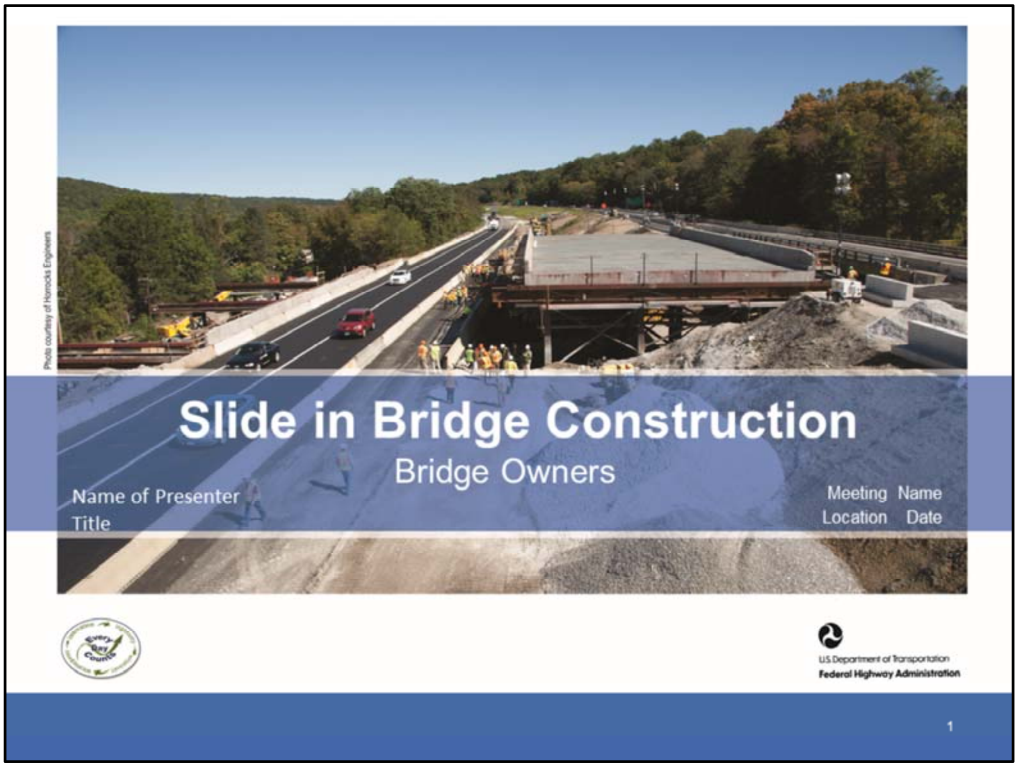
Thank you!

Every Day Counts

U.S. Department of Transportation
Federal Highway Administration

PRESENTATION HANDOUTS:

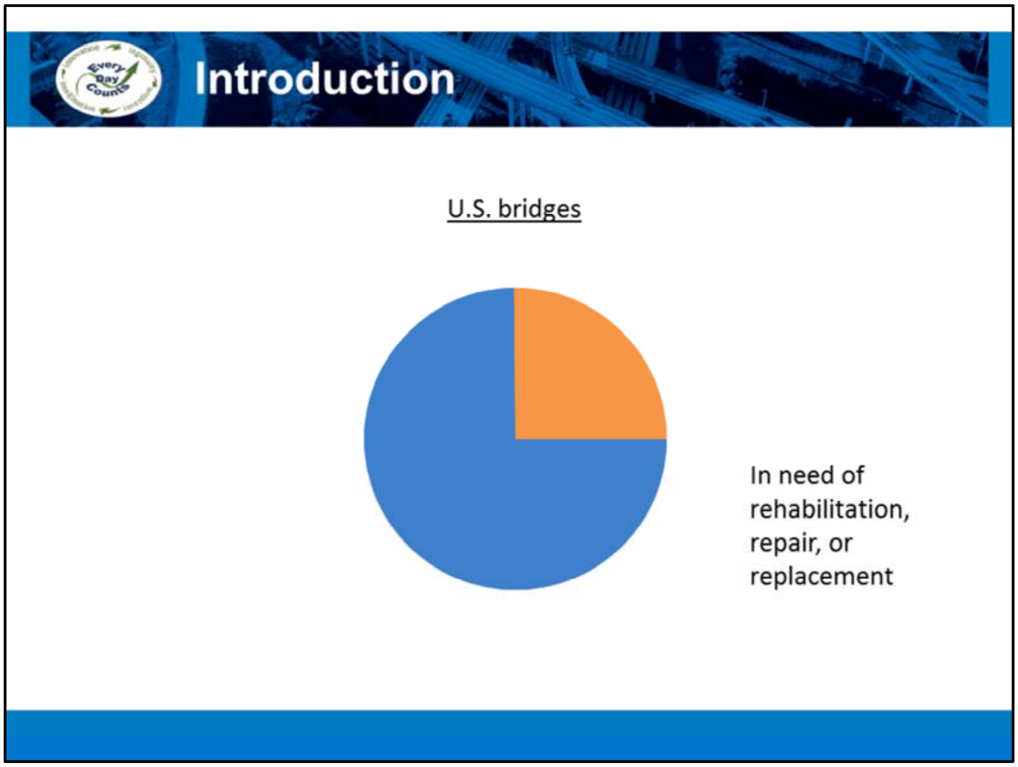
COURSE 3 SIBC OVERVIEW FOR OWNERS



Thank you for attending today's session on Slide in Bridge Construction.

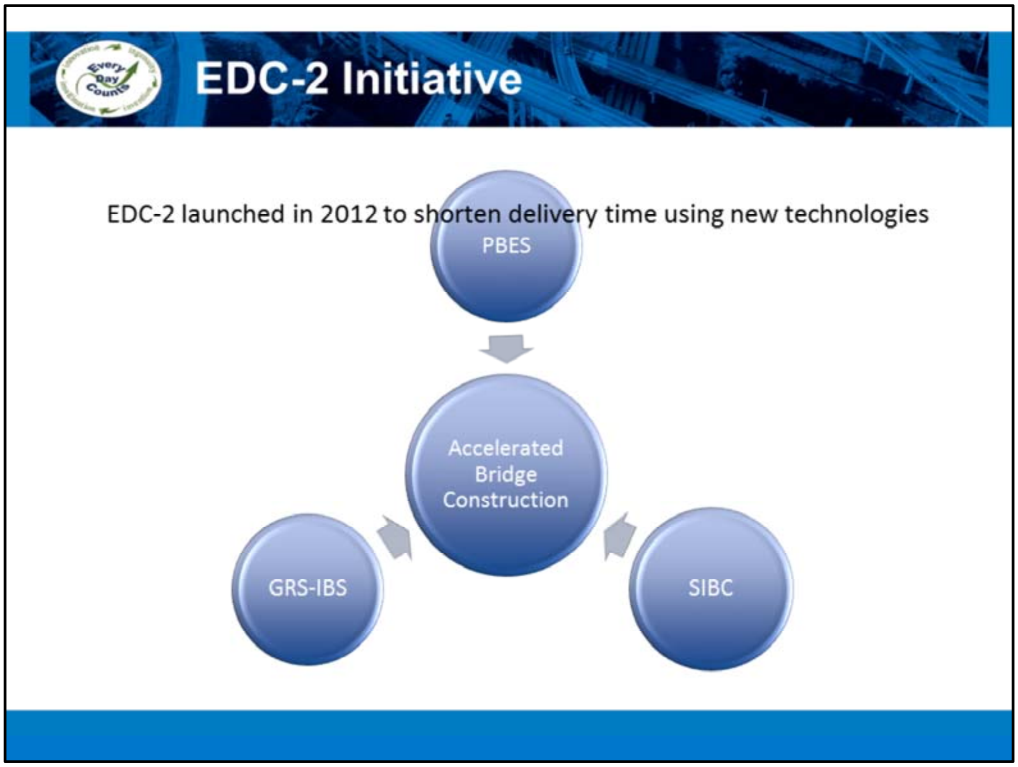
This presentation aimed towards bridge owners and developed for the FHWA as an extended effort of the Every Day Counts Initiative.

Slide-in bridge construction (SIBC) is a particular method and refinement of construction contained under the broader topic of Accelerated Bridge Construction (ABC) with the specific goal of extremely rapid bridge installation under very short term road closure.



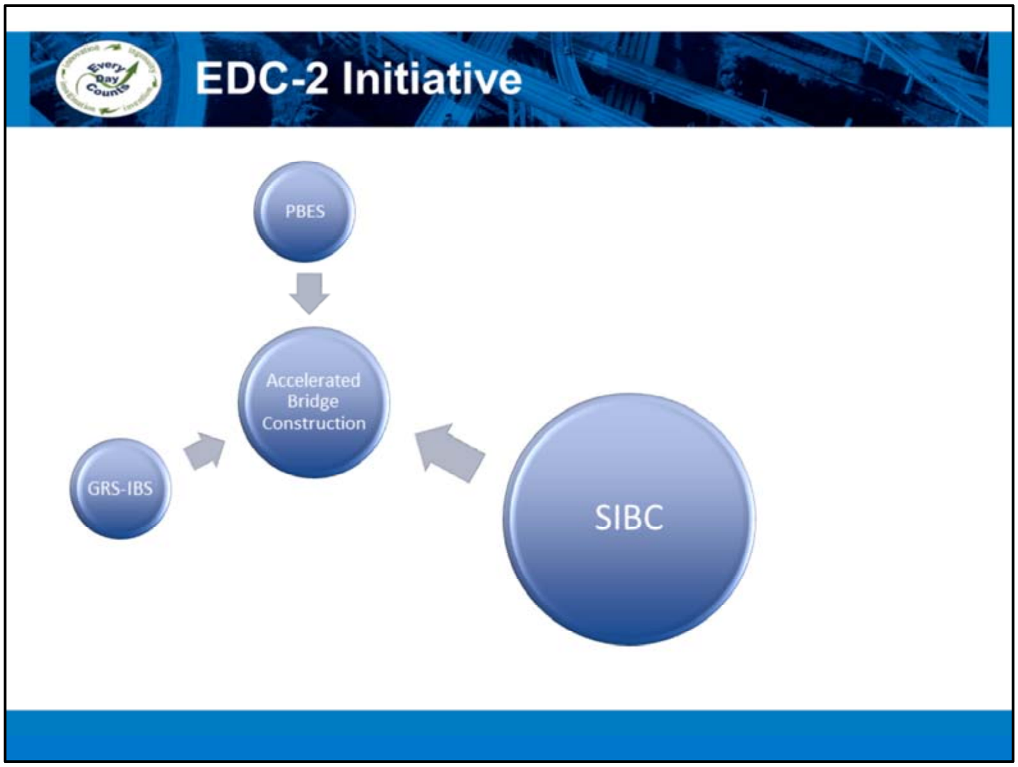
Nearly 25% of the Nation's 600,000 bridges are in need of rehabilitation, repair, or total replacement. Given this vast number, the need for bridge reconstruction methods that reduce the impacts to mobility and safety is needed. This need was one reason the Every Day Counts Initiative was launched.

Every Day Counts was first established in 2010 as a state-based initiative meant to identify and deploy innovation; specifically, to shorten project delivery, enhance safety, reduce mobility impacts, and protect the environment. The term "get in, get out, and stay out" was popularized under this program.

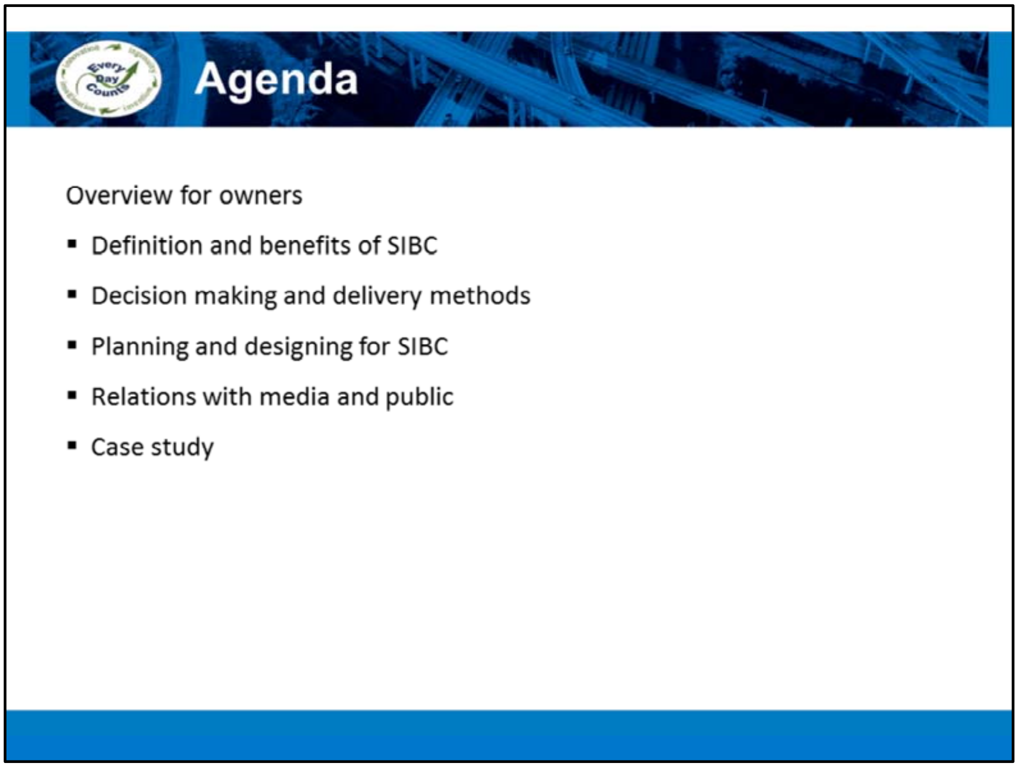


As a result of these efforts, EDC-2 was launched in 2012 with the specific focus of shortening the time needed to complete highway projects through the use of new technologies and ground-breaking processes. Within that directive, accelerated bridge construction became an area of concentration.

Three particular ABC technologies being promoted under EDC-2 are prefabricated bridge elements and systems, geosynthetic reinforced soil-integrated bridge systems, and slide-in bridge construction.



It comes as no news to anybody that our focus today will be on slide-in bridge construction.



Several slide-in bridge construction topics will be covered as the day progresses. Collectively, the topics aim to provide a comprehensive overview for owners, designers, and contractors; thereby better equipping each group to pursue slide-in bridge construction or SIBC as it is now more commonly referred to.

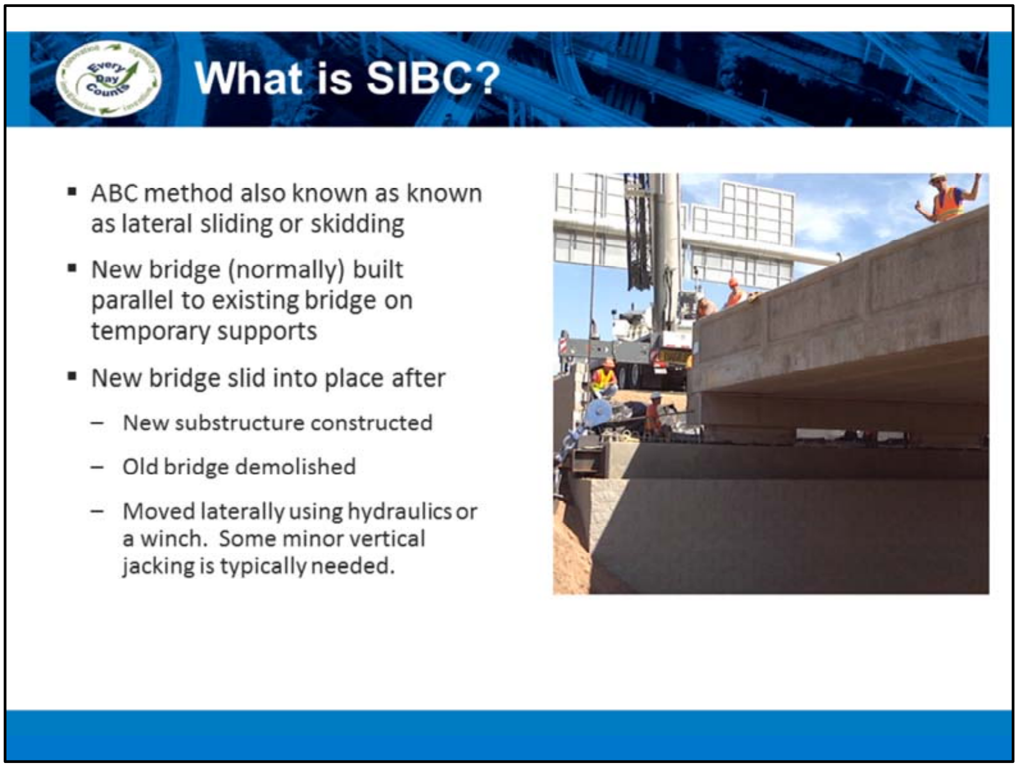
SIBC will be defined and its benefits will be discussed.

Several ABC and SIBC decision making tools are presented along with the various delivery methods that can be employed.

Planning and designing for SIBC will be covered.

Given that SIBC is a relatively new and innovative method of bridge construction, it is not uncommon for the media and public to have a more involved roll, even as spectators. As such, relations with the media and public will be addressed.

Lastly, a case study of a previous SIBC project will be presented.



So, what is slide-in bridge construction?

It is a method of ABC that has also been known as lateral sliding or skidding, and the variations of these techniques.

In SIBC, a new bridge is typically constructed adjacent to and parallel to the existing bridge on temporary supports.

Once complete, the old structure is demolished and the new substructure is constructed, followed by the sliding of the new superstructure on to the new substructure already in place. There have been some cases where the old substructure was reused.

The new bridge is moved laterally most commonly with hydraulic jacks, though other methods have been employed, such as a winch. Some minor vertical jacking is typically needed.

SIBC, and ABC in general, is primarily used for bridge replacement projects where the impacts to mobility are significant.

What is SIBC?

- Reduced disruption if substructure can be constructed below the existing bridge
- Minimal disruption likely requires innovative foundation systems
  - Drilled shafts outside footprint of existing bridge
  - Micro or mini piles
  - Integrating cap beams
  - Spread footings
- Prefabricated substructure units

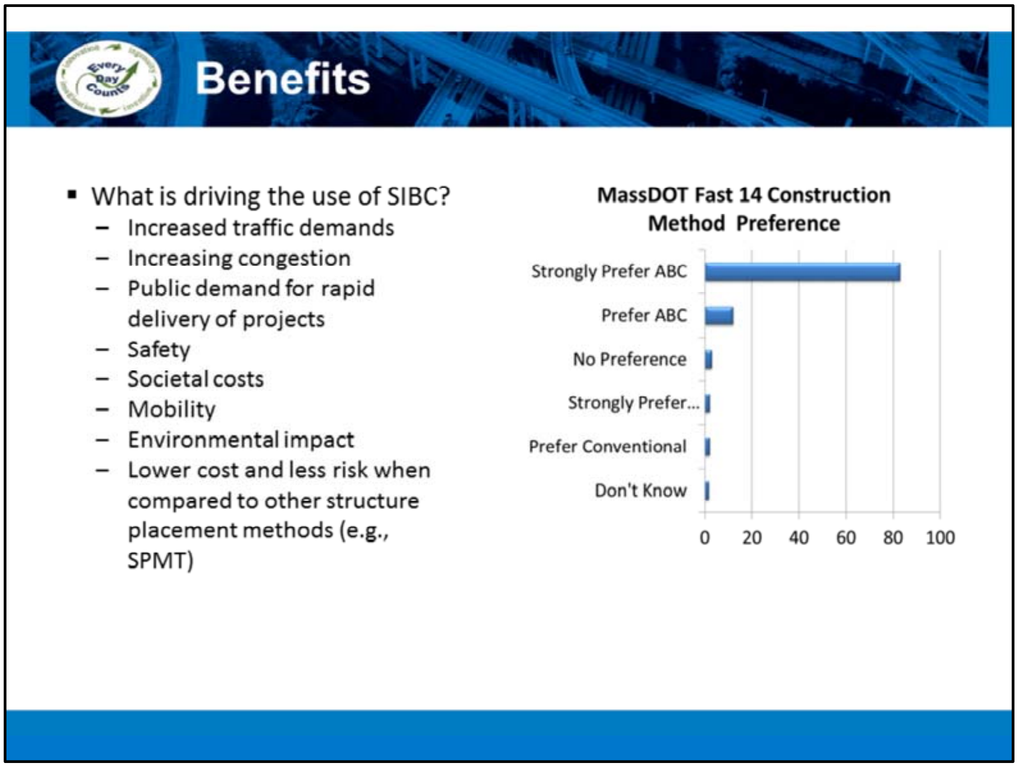
There have been many cases where the new substructure was constructed beneath the existing bridge prior to demolition. As you can predict, this expedites the process from demolition to bridge slide.

It should be pointed out, however, that constructing traditional foundation systems might not be feasible. Rather, an innovative foundation system might be required when using this method.

It is possible that prefabricated elements could play a key role in constructing the new substructure.

One might believe that bridge slides are only used for sliding a new bridge into the position of the existing. This is most commonly the case, but SIBC is not limited to only sliding new structures.

Existing structures can be slid to a new alignment to serve as a bypass bridge while a new bridge is constructed using more traditional methods. Keep in mind that in this case, the temporary substructure system will be subjected to live and other transient loads in addition to the bridge itself, typically resulting in a more robust, and hence higher cost, to such an installation.



So, what benefits can be gained by using slide-in bridge construction? Maybe the better question is 'What is driving the use of SIBC and how is it that SIBC addresses those needs?'

Traffic demands are increasing, congestion is increasing – both create an unnecessary nuisance in the lives of the traveling public. As such, the public demand for rapid delivery is increasing.

One can see in this chart the overwhelming preference for accelerated bridge construction when polled in Massachusetts prior to the MassDOT Fast 14 project.

Even more, the safety of the traveling public and bridge builders is compromised when bridge projects are long in duration. SIBC alleviates some of this risk by significantly reducing the time main-line traffic is interrupted.

Societal costs, though often difficult to fully quantify, are significantly reduced as well.

Environmental impacts can be softened.

And lastly, the costs can be lower and at less risk when compared to other rapid structure placement methods, such as self-propelled modular transporters, float in delivery, or a heavy crane pick, for example.

Benefits

- Offers non-traditional site options
- Eliminates crossovers, shoo-flies, staged construction, and long term detours
  - Can result in lower construction costs/bid price
- Reduces mobility impacts

To continue with the benefits of using SIBC: non-traditional site options can be offered, cross-overs or shoo-flies are eliminated along with staged construction and long term detours. These things can result in lower construction costs.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Mobility and environmental impacts can also be reduced and safety is nearly always enhanced for the worker and road user.

Potentially of greatest significance is that SIBC promotes user and worker safety. Safety is nearly always enhanced for the worker and road user; this can not be understated.

When compared to other ABC methods, SIBC often receives better contractor "buy-in", presumably because of the reduced risk that was previously mentioned.

Environmental impacts can also be reduced.

Lastly, SIBC removes the bridge construction from the critical path which may lead to a better quality end product, it involves the public by reducing societal costs, thereby creating better "buy-in", and road closures can be better managed.

Along the way, we'll take a minute to quickly highlight a project to emphasize a couple of points. The first project highlighted is I-84 at Dingle Ridge Road in New York.

A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

Though the benefits are great, one must be aware that some potential challenges exist.

While some personnel within the DOTs embrace innovative methods, others are more resistant and tend to lean on traditional construction methods. This resistance can stall a potential SIBC project.

Finding experienced contractors and/or heavy lift engineers can be a challenge, though that challenge is being lessened as more and more SIBC projects are being completed and contractors become more familiar with the process.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

In traditional construction projects it is common that unique bridge geometry, difficult foundations, or lack of space can present a challenge. These aspects are only magnified by the nature of SIBC.

A sound traffic management plan with contingency plan included is a must.

This method of bridge construction is relatively new, and as a result, there may be some contractor limitations.

For example, significant temporary shoring and unconventional schedules are often required.

During slide operations, a 24 hour commitment from the contractor, designer, and owner is necessary.

There are periods during the overall SIBC process that require extended time for the contractor, owner, and designer and, as a result, worker fatigue be an issue if not properly managed. Multiple crews can help alleviate this potential problem.

Even more, difficult foundations, equipment breakdowns, and the speed required to complete approach work can present a challenge.

Also, significant, critical time can be lost to surveying mistakes.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

Project Highlight

Elk Creek – Oregon

- Site concerns
  - Mountainous terrain surrounding bridge construction site
  - Slides can be effective even in very confined locations

To highlight another project, the Elk Creek project in Oregon was faced with numerous challenges that could be considered somewhat unique to this project. For example, the site, located in the mountains of western Oregon, did not afford ample space or flat terrain from which a new bridge could be easily constructed and slid into place. Nonetheless, the successful completion of this project using slide in construction proved that slides can be effective even in very confined locations.

Factors of Interest

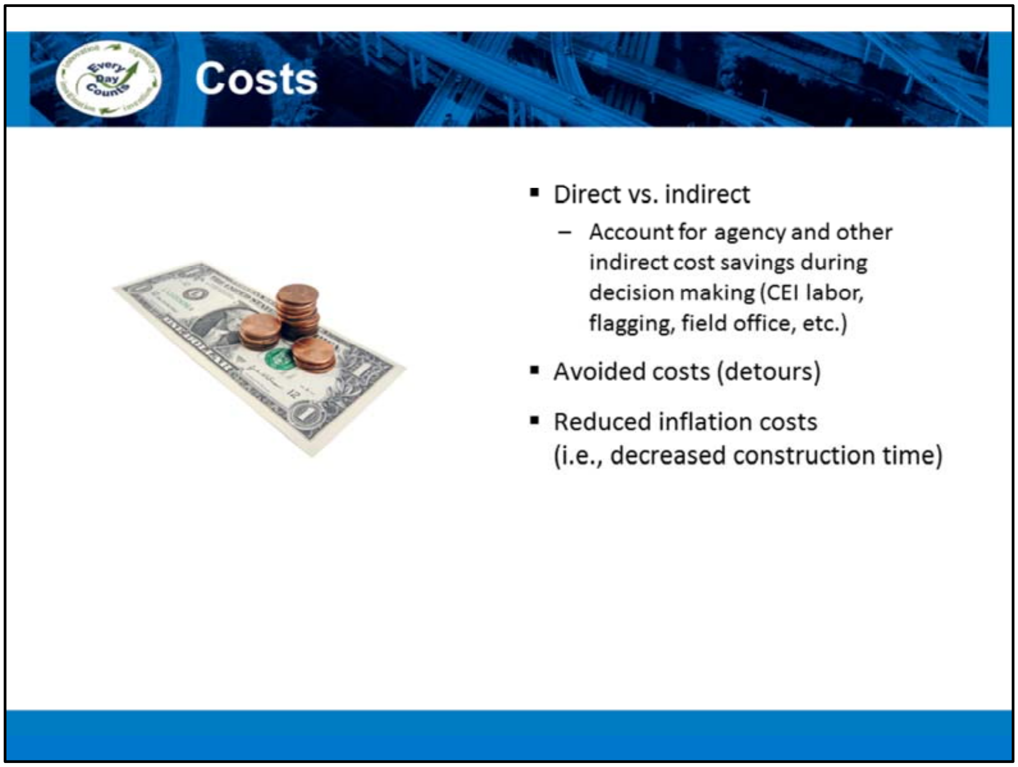
- ADT/ADTT
- Facility crossed
  - Railroad/roadway
  - Navigable waterway
  - Evacuation route
- Detour length
  - Duration and viability
- Environmental
  - Limits on when
  - Limits on how

Some factors of interest to consider when making an initial decision for or against SIBC include: average daily traffic, the facility that is being crossed (railroad, roadway, other?), the detour length (duration and viability), and environmental effects (limits on when and how).

Factors of Interest

- On critical path of entire project
- Available right of way for bridge construction
- Traffic analysis
- Contractor's work area and ingress/egress ability

Is the bridge on the critical path of the entire project?, is there available right-of-way?, should traffic analysts be engaged?, where will the contractor's workspace, entrances, and exits be located?.



If comparing only the costs of building a bridge using traditional methods and slide-in bridge construction, it is possible, and maybe even likely with the first projects, that SIBC costs will be higher.

It has been found, however, that the costs become more aligned when including other project related costs such as direct versus indirect costs and detour costs. These costs are often not included in the bid; therefore it is not appropriate to compare conventional construction costs with ABC costs.

Project planners should evaluate the total construction cost when making decisions.

Even more, due to the decreased construction time, overall inflation costs can be reduced, specifically the risk of price escalation of steel and fuel can be minimized.

Project Highlight

Mesquite Interchange - Nevada

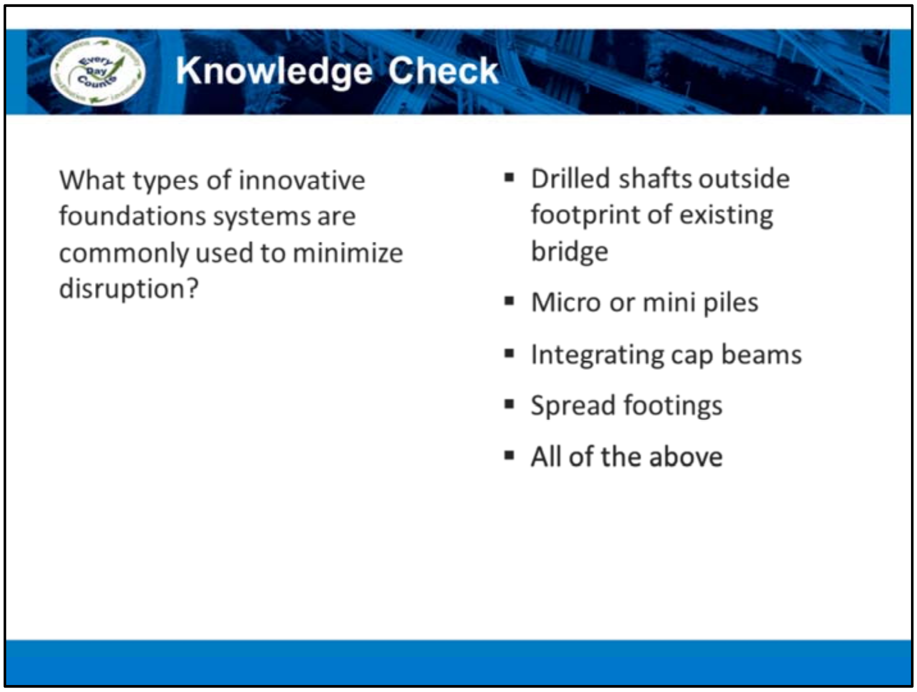
- Project costs
  - Total interchange reconstruction = $15 million
  - Original estimate without ABC = $25 million

The next project highlighted is the Mesquite Interchange in the state of Nevada. The total interchange reconstruction cost was $15 million, $10 million less than the original $25 million estimate. A significant amount of the cost savings stemmed from the decision to slide each of the two bridges being replaced. Traditional construction would have required a complete realignment of the mainline pavement and interchange reconfiguration. Instead, the interchange was left in its original configuration and the bridges constructed adjunct to the existing.

To this point, SIBC has been defined, some benefits and challenges have been listed, and factors of interest shown. You'll now get an opportunity to check a bit of your knowledge.

In SIBC, the new bridge is constructed "blank" to the existing bridge on "blank" supports.

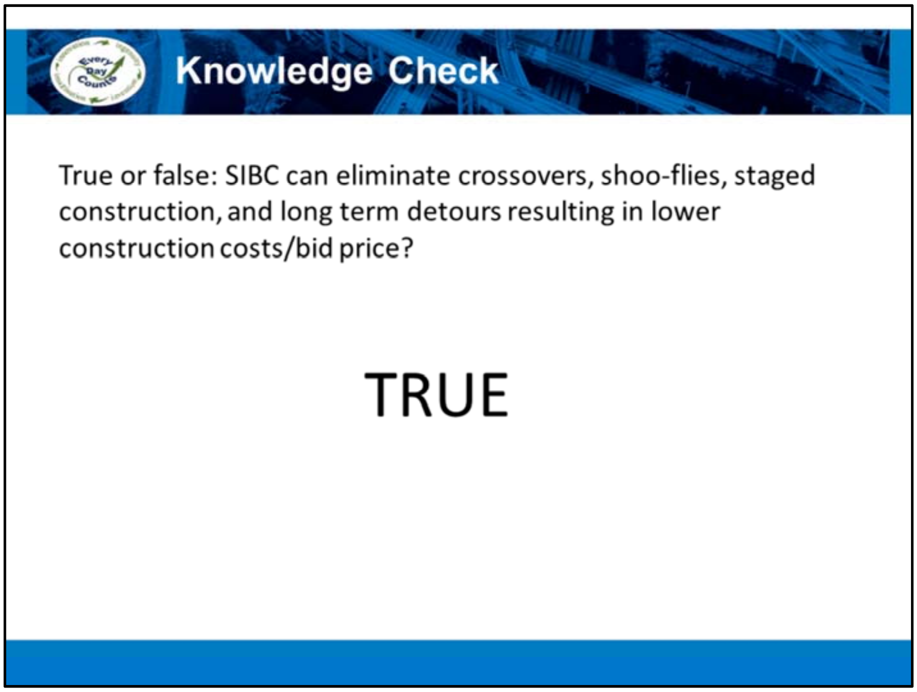
In SIBC, the new bridge is constructed "parallel" to the existing bridge on "temporary" supports.



What types of innovative foundations systems are commonly used to minimize disruption?

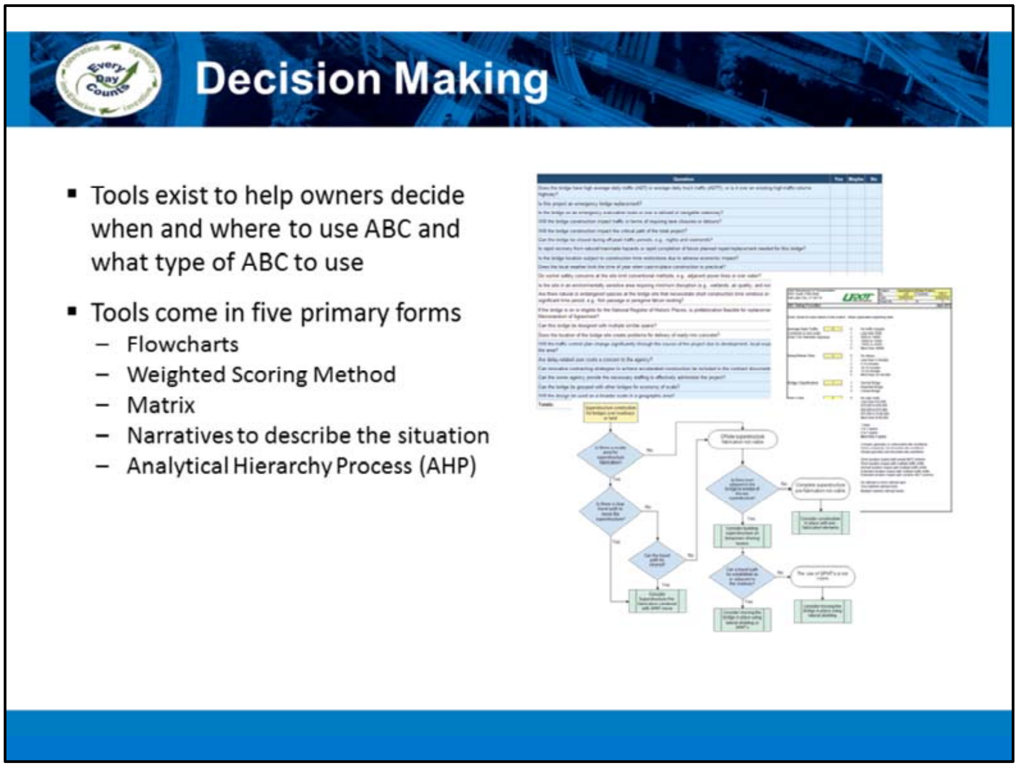
Drilled shafts outside footprint of existing bridge?
Micro or mini piles?
Integrating cap beams?
Spread footings?
Or
All of the above?

The answer: All of the above. Each of the options are commonly used to minimize disruption.



True or false: SIBC can eliminate crossovers, shoo-flies, staged construction, and long term detours resulting in lower construction costs/bid price?

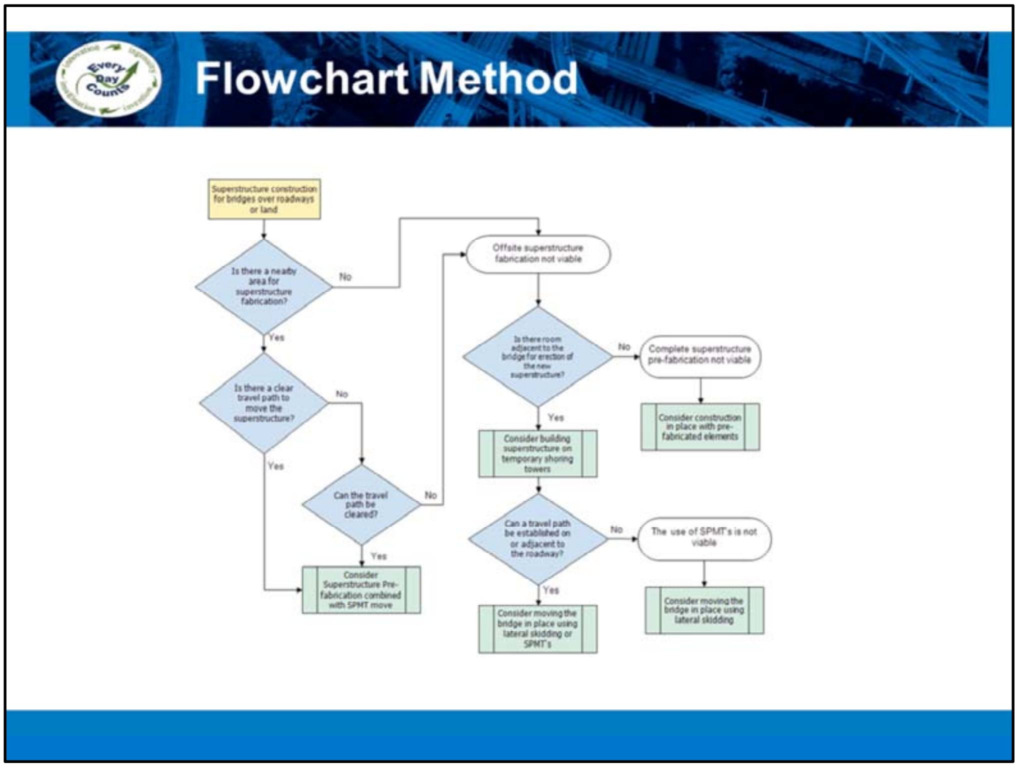
True



The decision to use non-traditional construction methods can be difficult so several tools have been developed that help owners decide when and where to use accelerated bridge construction and slide-in bridge construction methods.

These tools include the flowchart method, the matrix method, the weighted scoring method, the narrative method, and the analytical hierarchy process. The following slides will take a closer look at each of these methods.

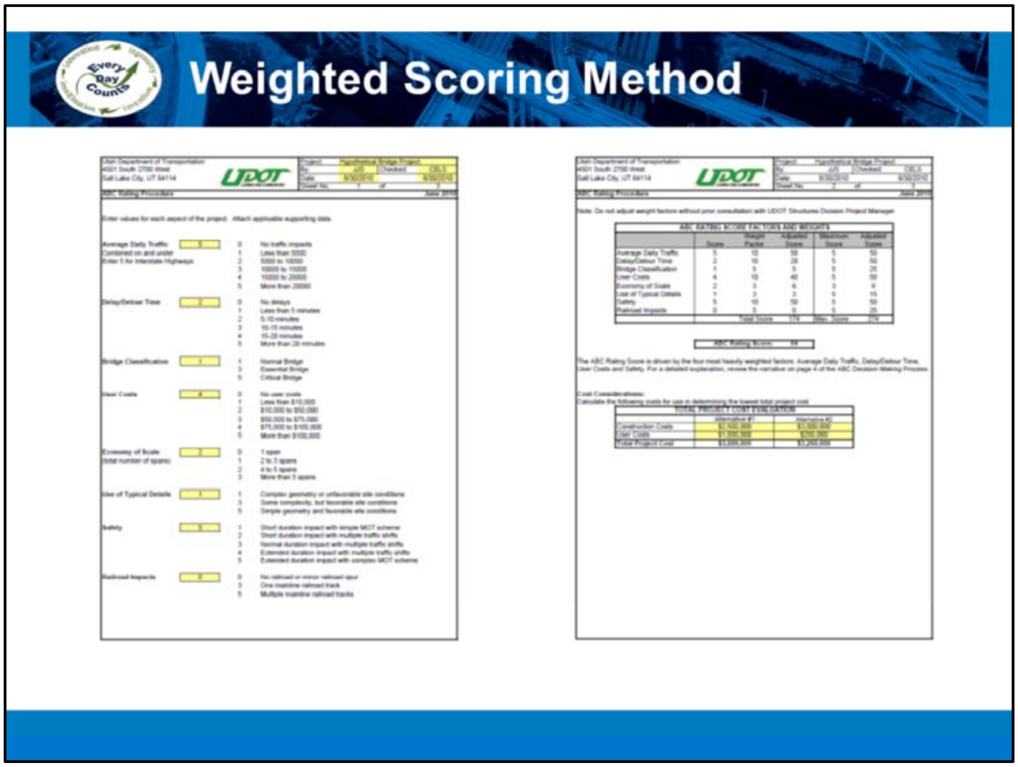
Regardless of the data, ultimately a firm commitment from all concerned to stay the course through is needed for a successful and economical project.



The flowchart method is composed of a diagram which represents a process.

Boxes of various kinds make up the steps in that process and help visualize the flow. Each box and its respective question prompt an answer from the user which leads to the next box and the process is repeated until a final box and prescribed answer are achieved.

An example from FHWA shown here helps prescribe various methods of accelerated bridge construction that are appropriate for a particular project site.



The weighted scoring method helps assign a value or score to what would otherwise only be a subjective decision.

By assigning values to various predetermined categories and then multiplying the value by its overall importance a final score can be calculated.

A score above or below a threshold previously set within the agency indicates whether ABC methods provide value.

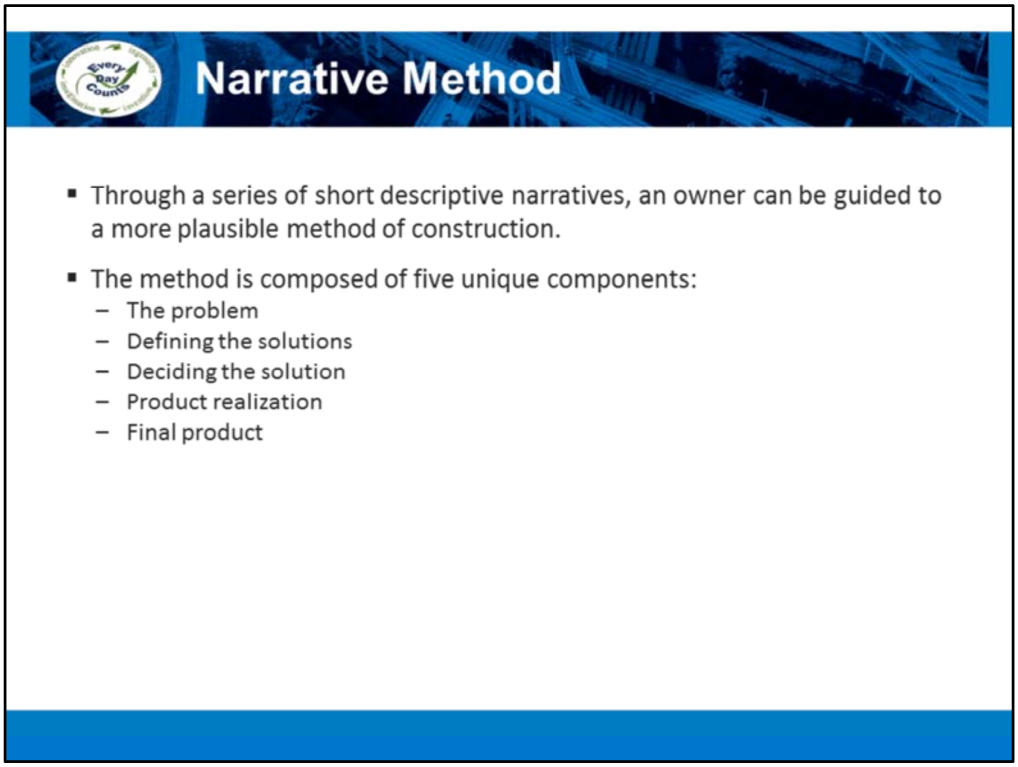
For example, ADT or detour time might be weighted more heavily than economy of scale. A bridge with a high ADT would likely achieve a higher overall score than one with multiple spans.

Matrix Method

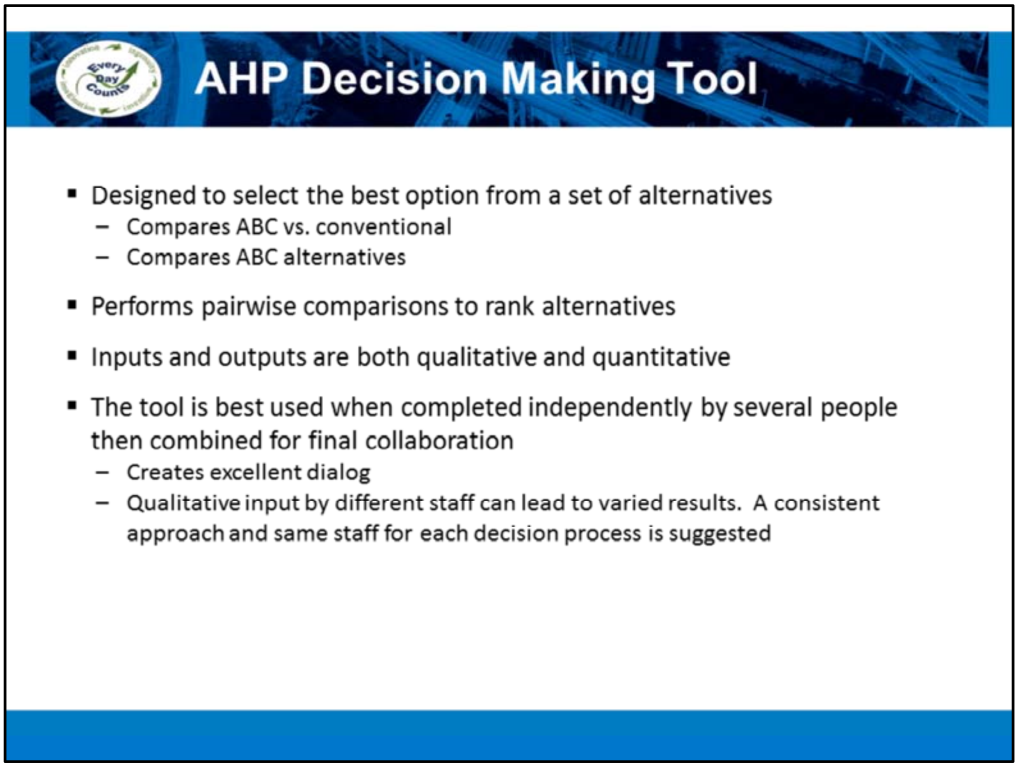
Question	Yes	Maybe	No
Does the bridge have high average daily traffic (ADT) or average daily truck traffic (ADTT), or is it over an existing high-traffic-volume highway?			
Is this project an emergency bridge replacement?			
Is the bridge on an emergency evacuation route or over a railroad or navigable 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:			

* Example taken from PBES Framework for Decision Making. Intended for illustrative purposes only.

The matrix method is composed of a series or questions to which a user simply responds with yes, no, or maybe. Questions cover multiple aspects of a project including such things as ADT, worker safety, weather, delay-related costs, and more. Totals for each answer are summed, and in cases where a majority of yes answers exist, the user is guided towards an ABC method.



The narrative method, similar to the matrix method, guides an owner to a more plausible method of construction using a series of short descriptive narratives.

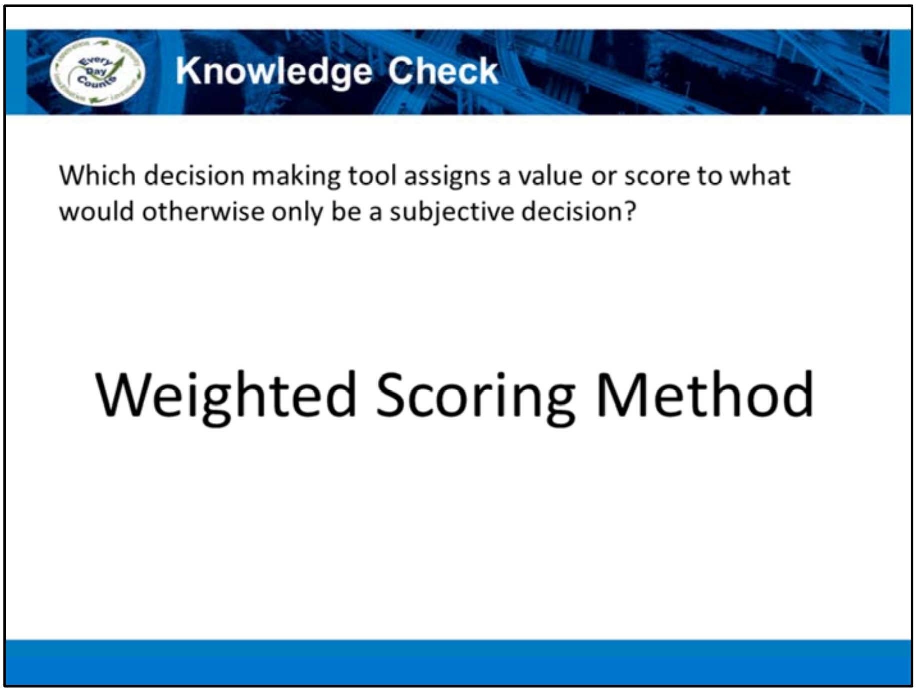


The analytical hierarchy process is designed to select the best option from a set of alternatives.

The user can compare ABC versus conventional methods, in addition to, specifically comparing ABC alternatives.

Pairwise comparisons are used to rank alternative methods. In this method, the inputs and outputs can be both qualitative and quantitative.

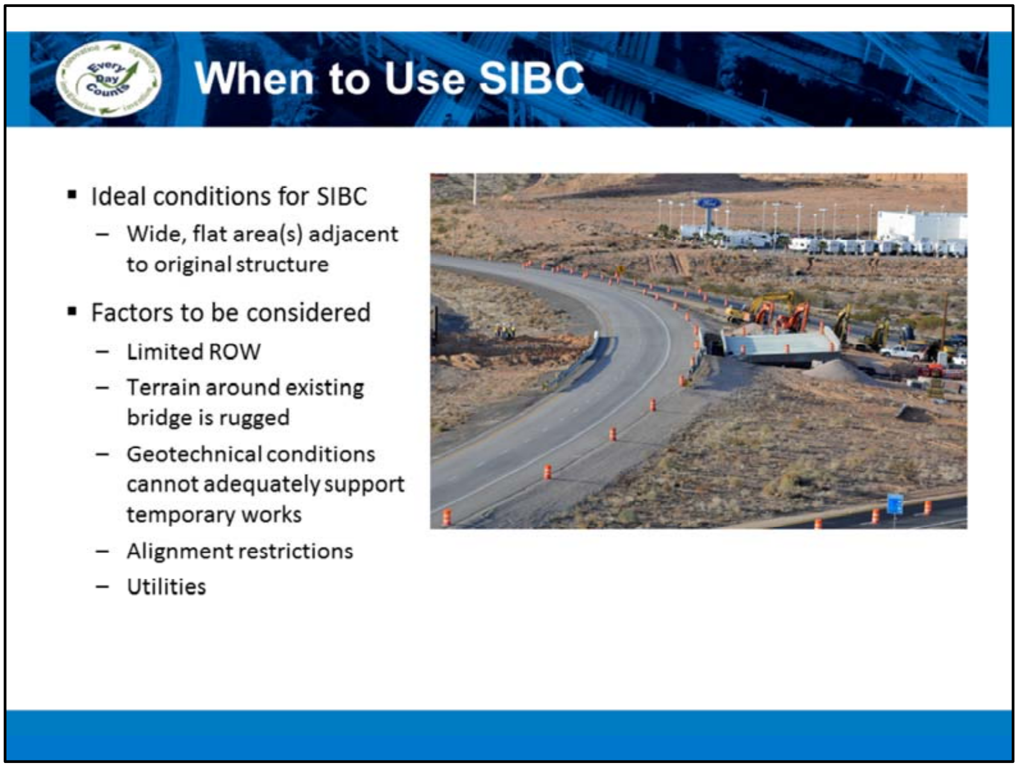
It has been found that the tool is best used when several people independently complete the process and then collaborate for a final decision. Even more, when those people are the same for multiple projects, a more consistent approach and process can be achieved.



The next knowledge check deals with decision making tools.

Which decision making tool assigns a value or score to what would otherwise only be a subjective decision?

The answer: Weighted Scoring Method



So, you might be asking yourself, ‘When should I consider using slide-in bridge construction’?

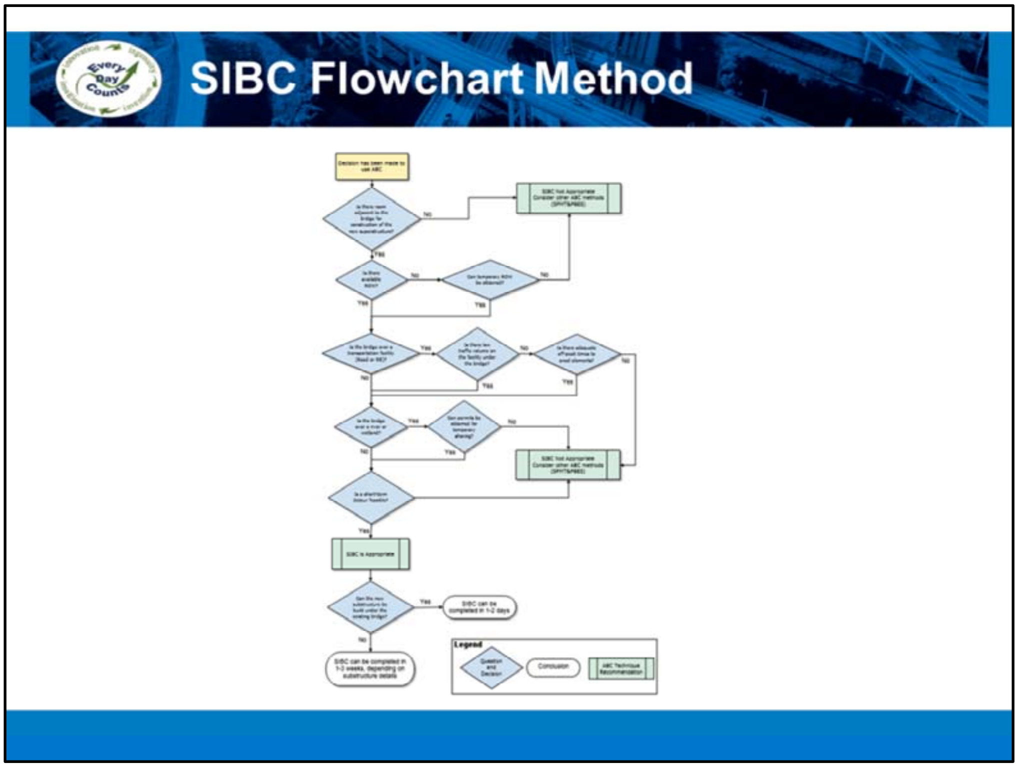
Ideally, sites with wide flat areas adjacent to the existing structure would be found at all bridge locations. But since this is rarely the case, one has to look beyond the ideal locations and consider other factors.

Factors such as, right-of-way, terrain, geotechnical conditions, and alignment restrictions. If right-of-way is limited, can temporary right-of-way be made available?

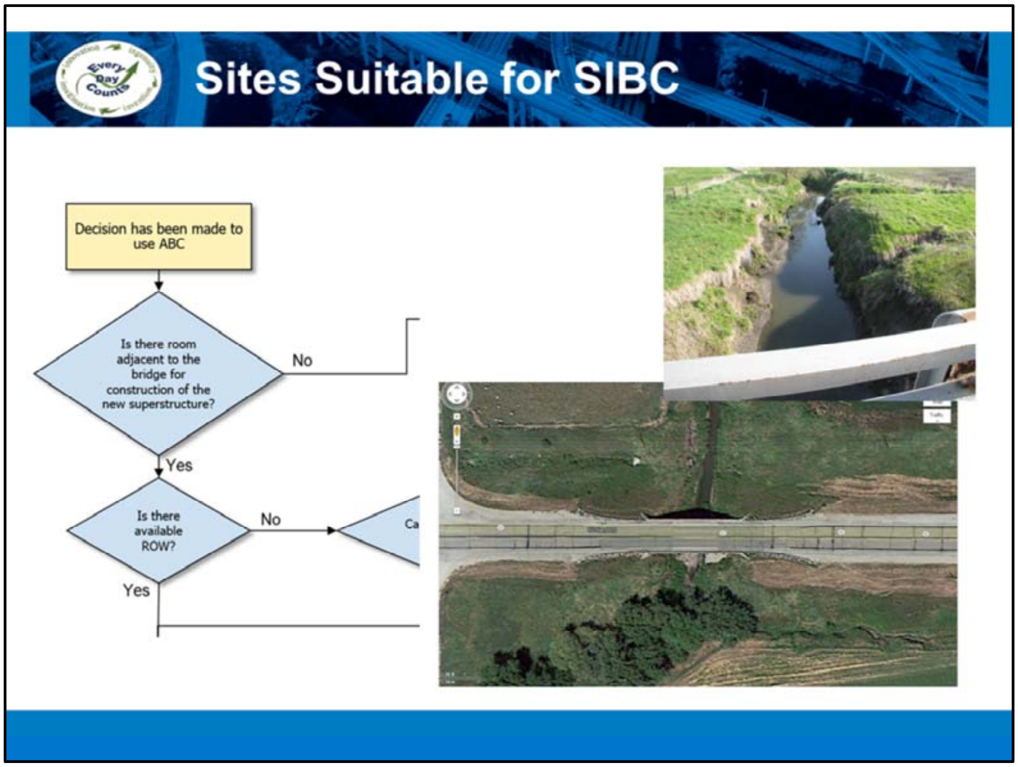
Rugged terrain doesn’t necessarily prohibit the use of SIBC, but does introduce another challenge.

Since temporary works will be significant and require supporting the entire superstructure, the adequacy of geotechnical conditions is key.

One should also consider alignment restrictions and utility locations.



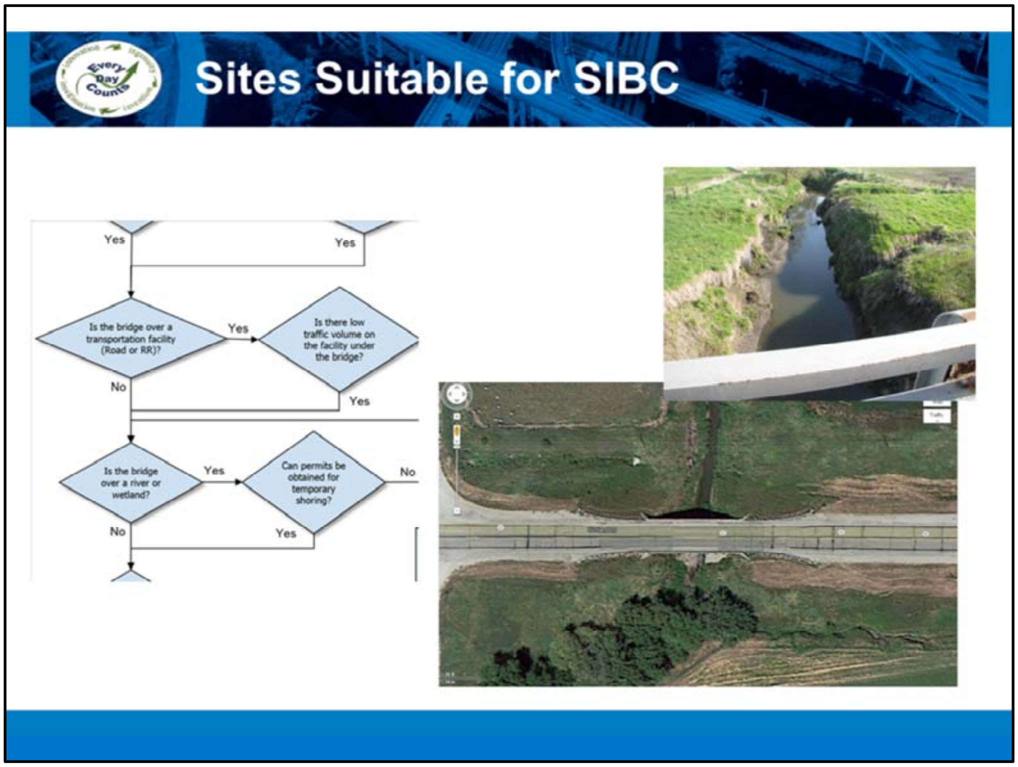
As an example, let’s step through the flowchart method for SIBC and see out that plays out looking at different site conditions. We will be using one of the sites that will be discussed later in the case studies.



Two photos of the site are shown. As you can see, the bridge is in a rural location and it carries two lanes of traffic over a small stream. The decision has been made to use ABC.

Is there room adjacent to the bridge for construction of the new superstructure? There are no structures or facilities adjacent to the bridge, so the answer is yes.

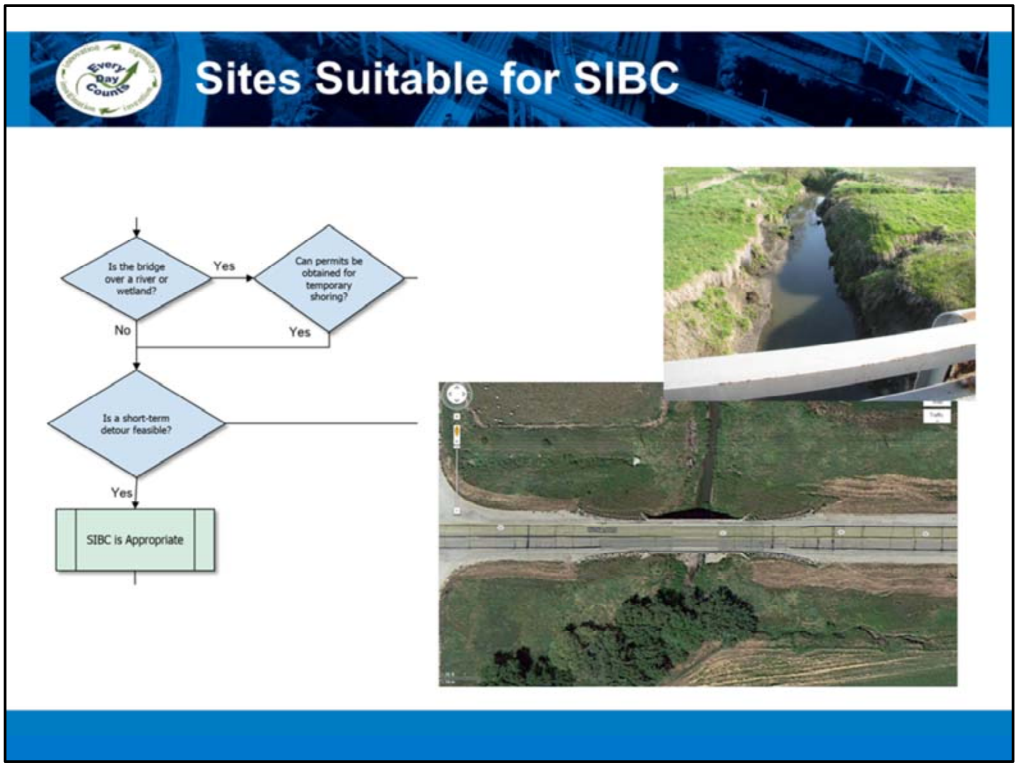
Is there available right of way? After checking the right-of-way mapping, the design team determined the answer to be yes.



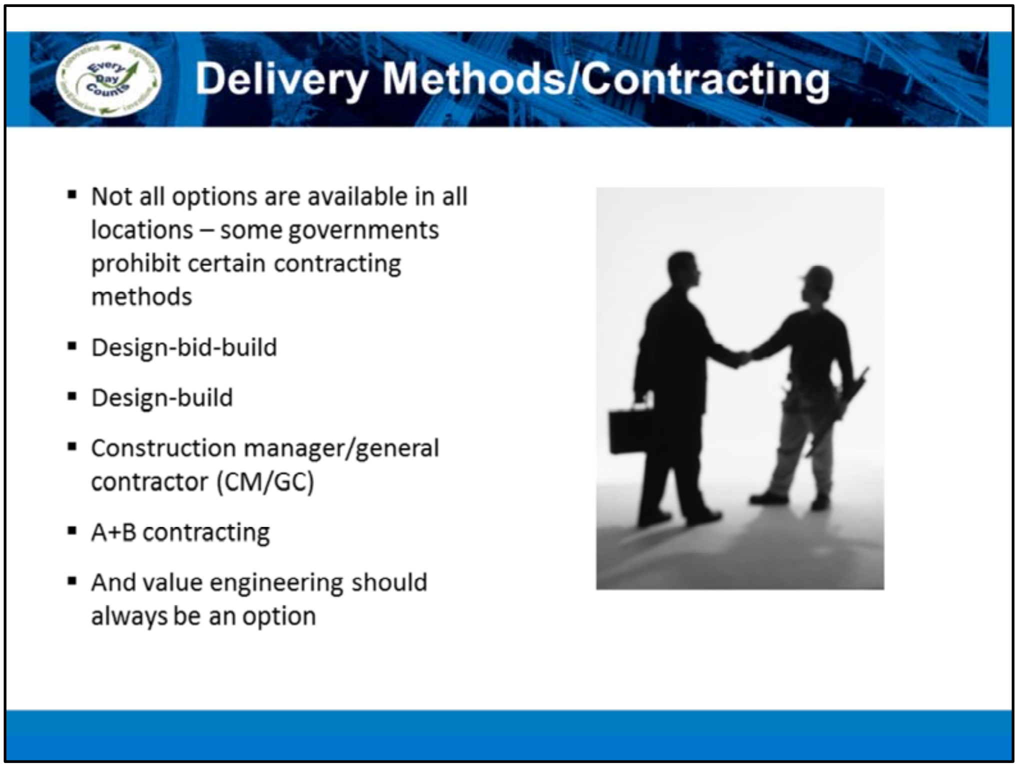
Is the bridge over a transportation facility? No.

Is the bridge over a wetland? Yes.

Can permits be obtained for temporary shoring? After a review with regulatory agencies, the design team determined that the answer to this question is yes.

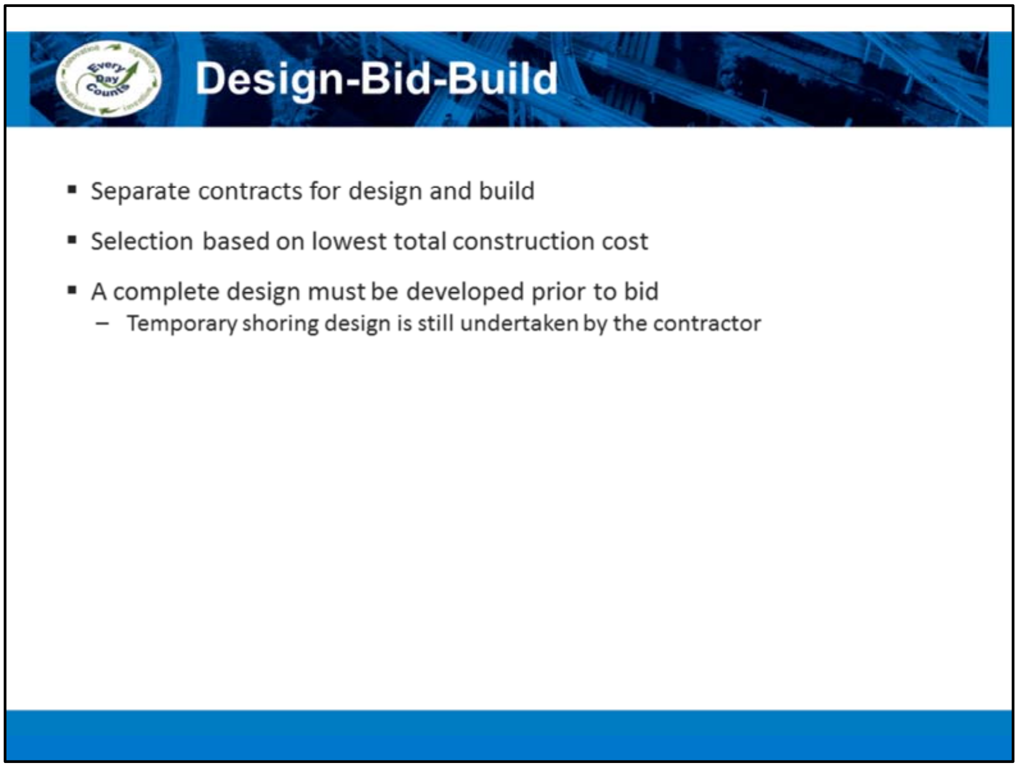


Is a short-term detour feasible? After conferring with traffic engineering personnel, the answer to this question was determined to be yes. Therefore, SIBC is appropriate. This is just one example of when SIBC might be appropriate.



It should be noted that not all options are available in all locations as some methods are prevented by existing state government laws or policies, but numerous delivery and contracting methods exist nationwide.

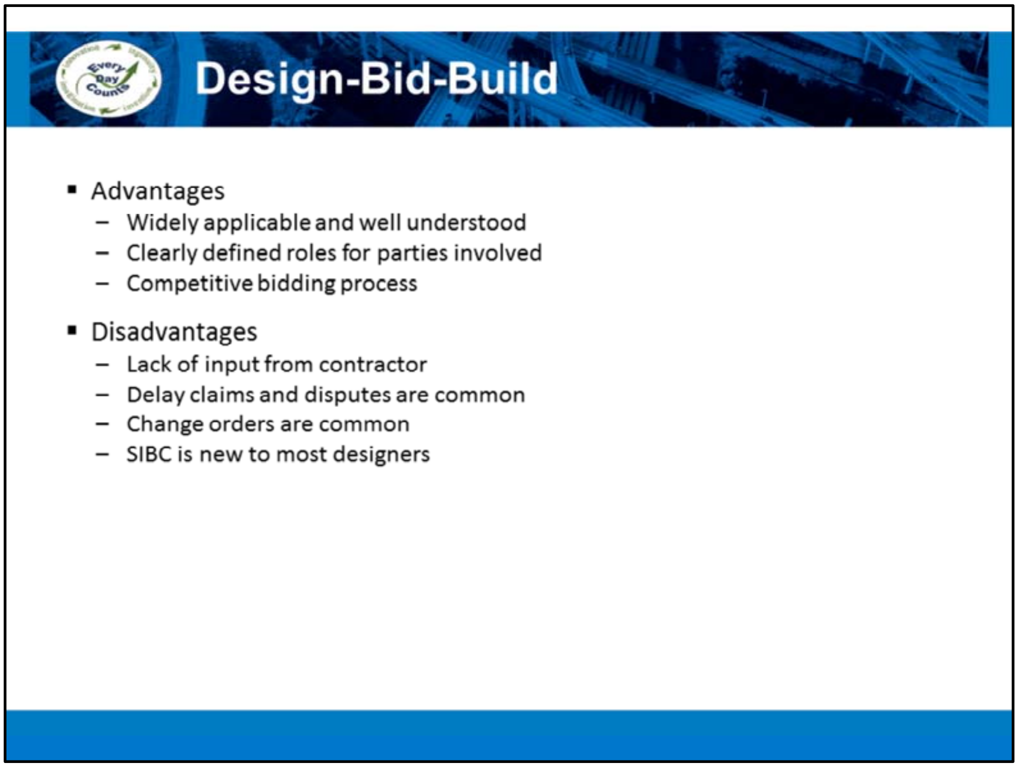
These include Design-Bid-Build, Design-Build, Construction Manager General Contractor, A+B contracting, and value engineering.



Design-bid-build has been the traditional method of contracting. Separate contracts are extended from the owner to the designer and builder, and the selection is based on the lowest-bid total construction cost.

For this method, a complete design must be developed prior to the bid process taking place.

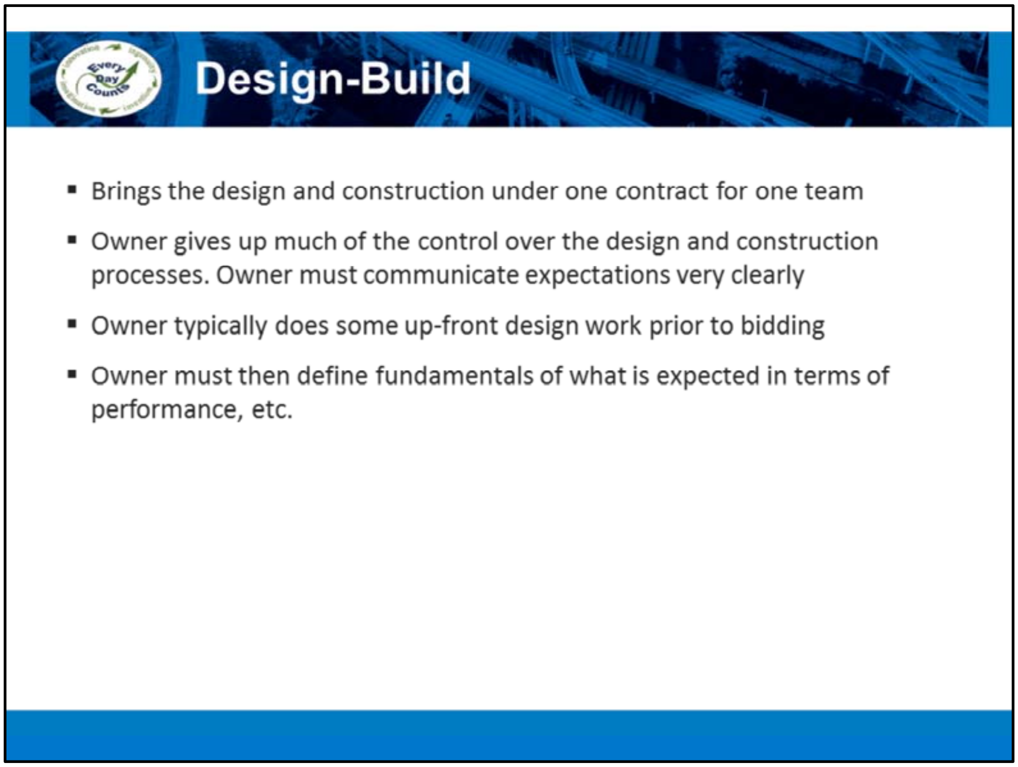
It should be noted that the designer is not responsible for the design of the temporary shoring system or the equipment used to move the bridge. The designer needs to show schematic drawings of the systems, and allow the contractor to develop the details of the move.



For SIBC, some advantages of design-bid-build are its wide applicability and well understanding, the rolls are clearly defined for all parties involved, and the bidding process is competitive. However, the method is disadvantaged for SIBC in other ways.

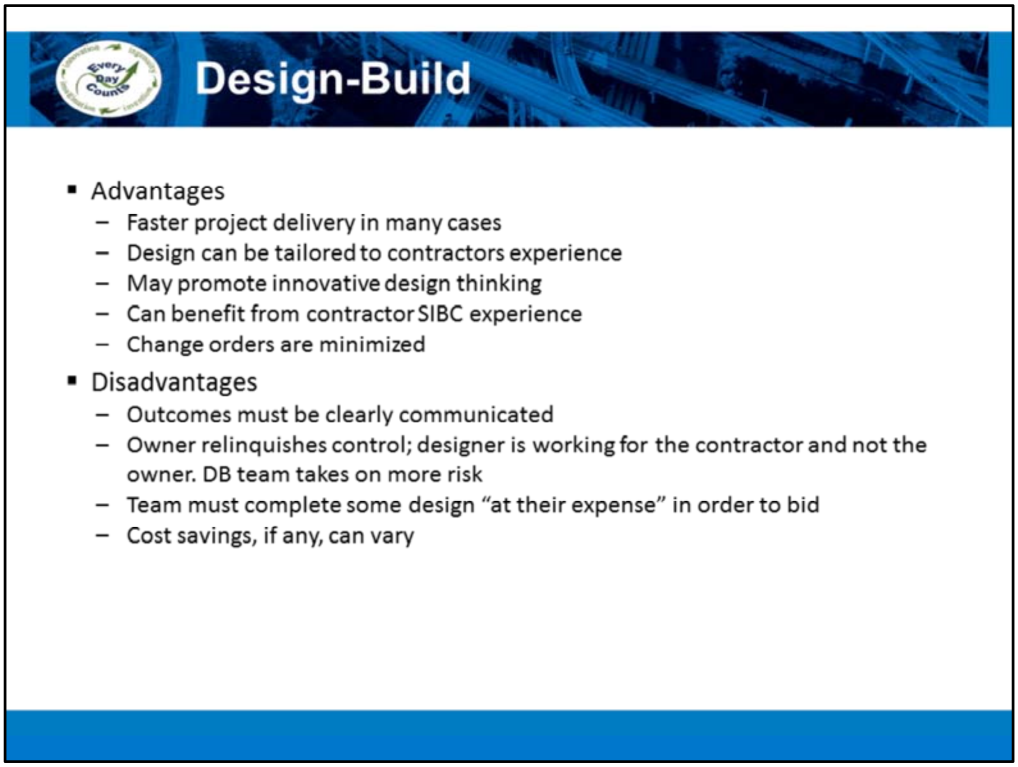
There is a lack of input from the contractor; delay claims, disputes, and change orders are all common.

Additionally, SIBC is new to most designers and blurs the line of means and methods of construction, typically the contractor's stock in trade.



Unlike the design-bid-build process, the design-build process brings the design and construction under one contract from the owner. In doing so, the owner gives up some control over the design and construction process and therefore must make expectations very clear.

It is not uncommon for the owner to do some preliminary design work prior to the design-build teams bidding on the project; through this exercise the owner must define performance expectations.



An inherent advantage to the design-build method is that a project can often be delivered more quickly than would otherwise be possible. The design can be tailored to the contractor's experience, tools, and equipment. Also, it may promote innovative design thinking.

As with design-bid-build, some disadvantages exist. Outcomes must be clearly communicated by the owner or else risk the project scope transforming to something unintended.

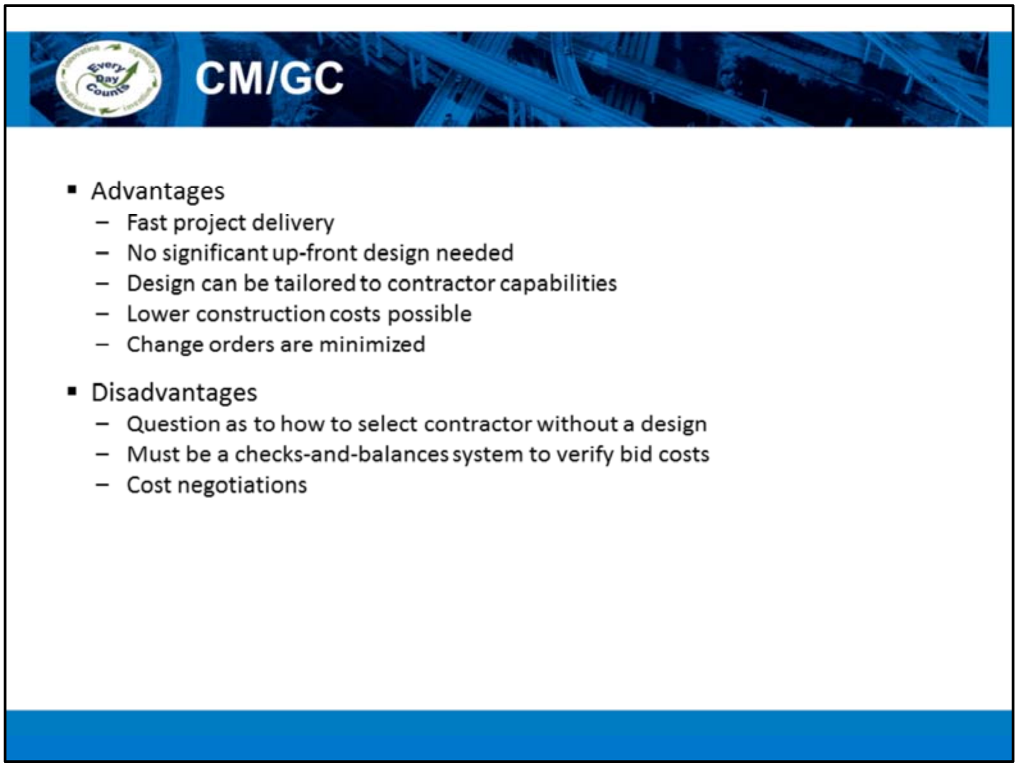
The owner is relinquishing control as the designer is working for the contractor not the owner with the potential that the final design will be influenced heavily by the required means and methods of installation. Prior to bidding, the design team must complete some design at their expense.

Lastly, cost savings, if any, can vary from project to project.

CM/GC, or Construction Manager/General Contractor, is not as commonly used as the previous methods of delivery but is gaining popularity with the bridge building industry.

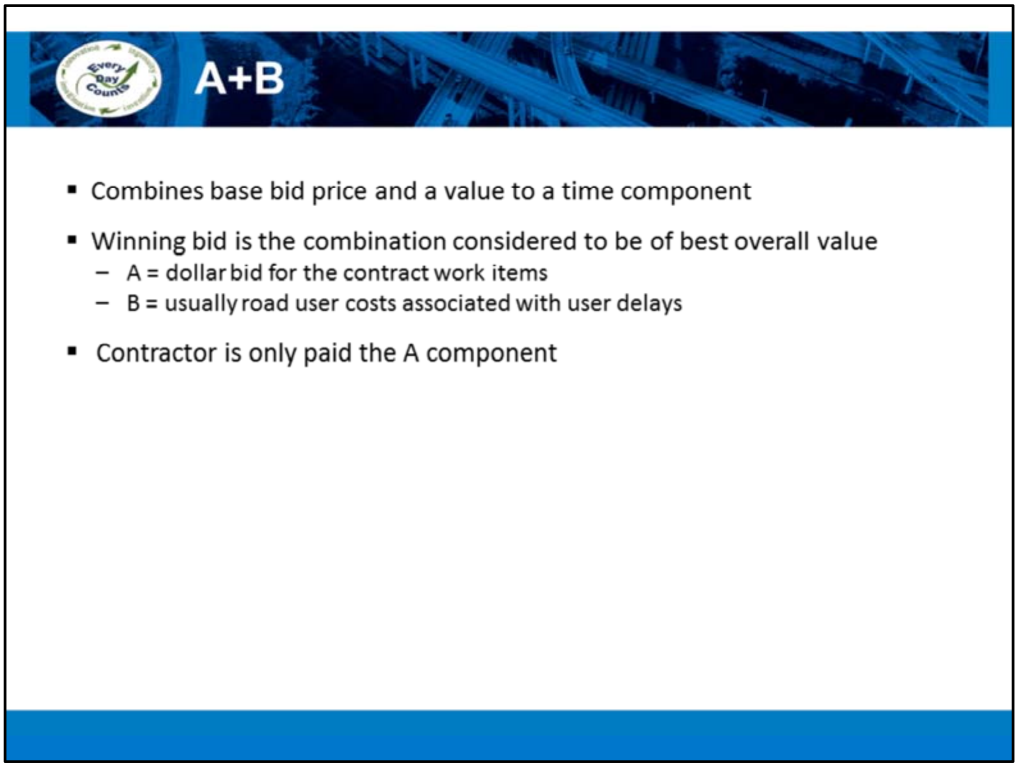
CM/GC is similar to design-build in that the contractor and designer work together. It differs, however, in that each has their own contract with the owner and the owner remains an integral part of the overall team. The designer and contractor are both independently selected by the owner.

As a construction manager, the contractor has the ability to provide significant input during the design process. In this way the designer can better accommodate the means and methods a contractor may use to erect the bridge and changes are minimized to the contract documents that could otherwise be necessary. As such, risks are better identified and managed. The transition from construction manager to general contractor is generally smoother on account of the aforementioned role of construction manager.



Some advantages to CM/GC include: fast project delivery, no significant up-front design needed, the design can be tailored to the contractor's abilities, construction costs may be lower, and change orders are minimized.

Some disadvantages include how an owner selects a contractor without a design and that a checks-and-balance system is needed to verify bid costs.

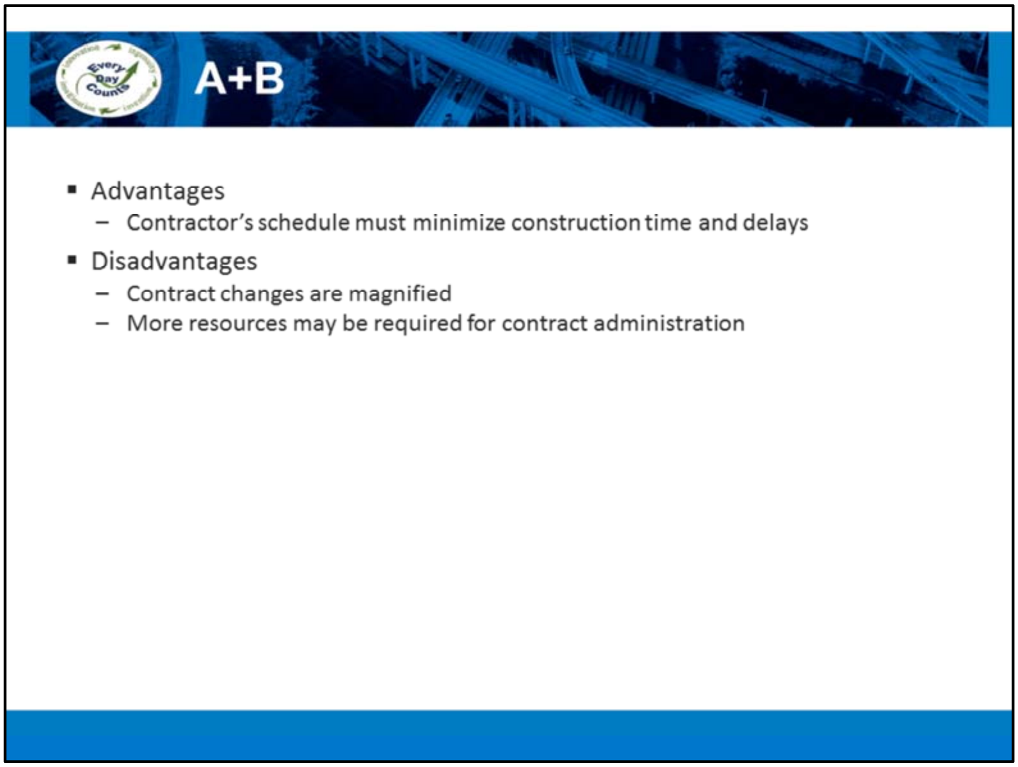


A + B bidding is most commonly a variation of design-bid-build.

Rather than low bid construction costs being the method by which a contractor is selected, two components, contract work items and road user costs, are quantified and summed to compose a bid price. The contractor with the low bid of the summed total is awarded the contract.

In the actual contract, the contractor will only be reimbursed for unit items – A – and the time allowed to complete the project is set at the bidders time component – B.

Here an emphasis is placed on how the project affects the public, not just the lowest construction cost.

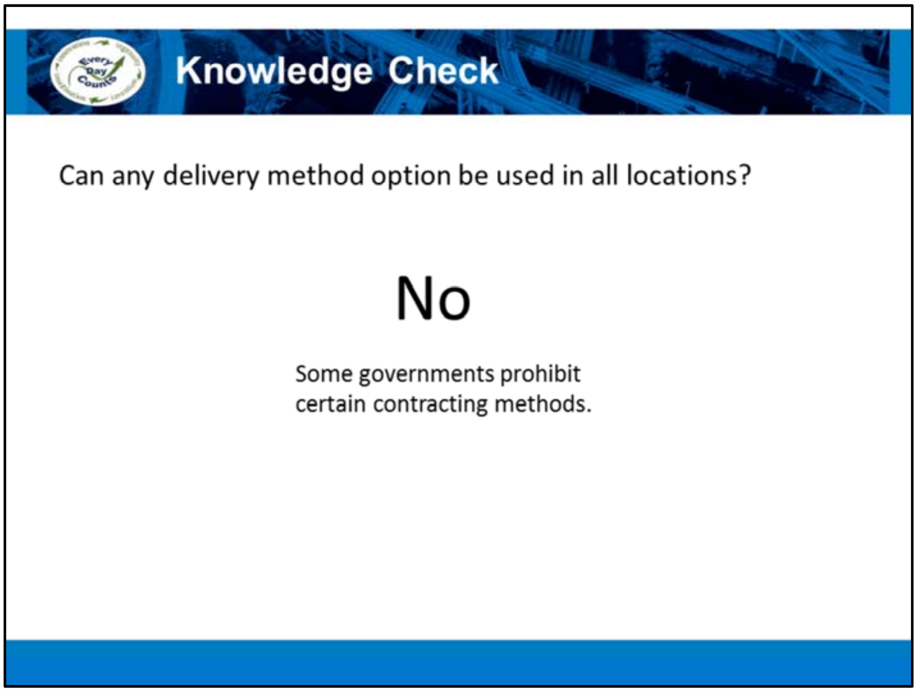


An advantage to A + B bidding is the contractor's schedule must minimize construction time and delays. Unfortunately some disadvantages are contract changes are magnified and more resources may be required for contract administration.

Two projects successfully completed using design-build contracting methods are the Elk Creek project in Oregon and the Mesquite Interchange project in Nevada.

The Mesquite Interchange team proposed slide in methods and were able to save 6 months and $10 million.

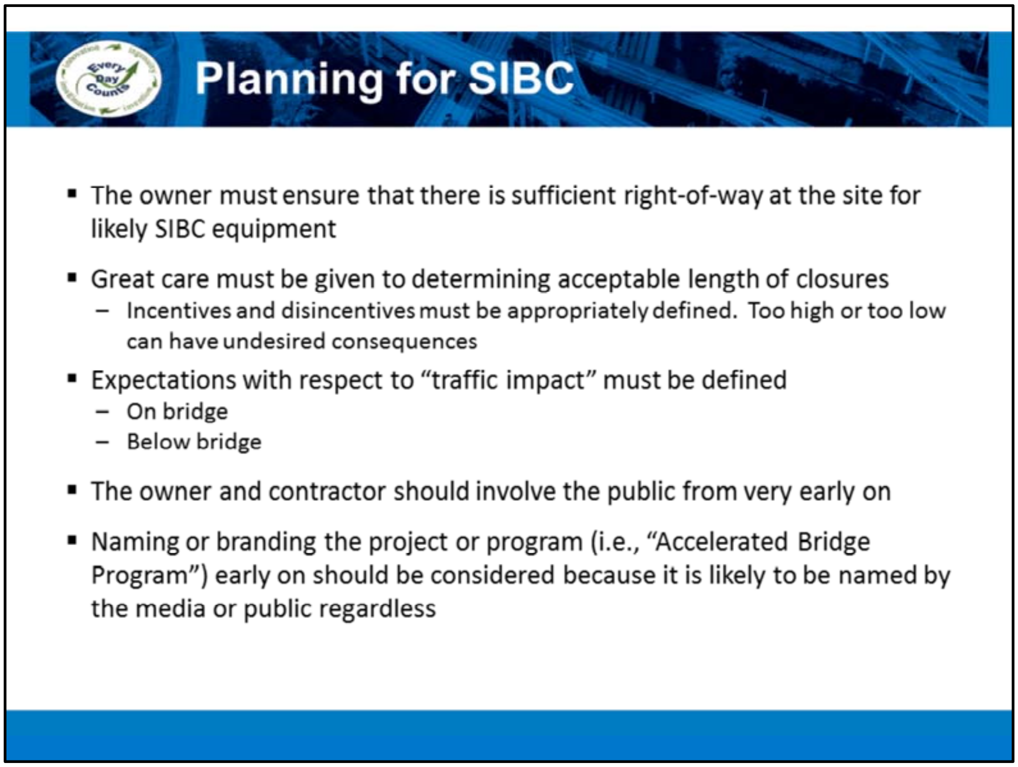
The Elk Creek design-build team was first to propose slide in methods and, in doing so, saved 22 months and $3 million.



The next knowledge check looks at delivery methods.

Can any delivery method option be used in all locations?

Answer: No, some governments prohibit certain contracting methods.

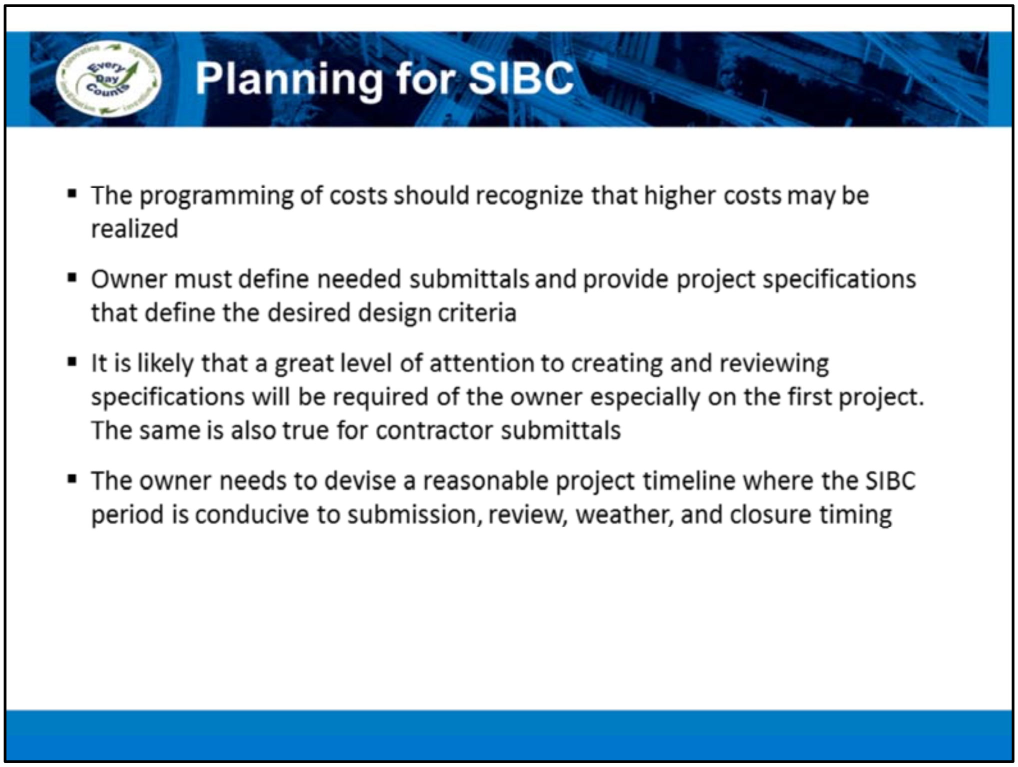


Planning for slide-in bridge construction generally follows that of traditional construction, yet there are some other unique items one must also plan for.

For example, the owner must ensure that there is sufficient right-of-way at the site for likely SIBC equipment and cranes for erection of beams, and it might be more space than anticipated.

A comprehensive study of an acceptable length of closure must be completed to appropriately assign incentives or disincentives. The owner must define the expectations to traffic impact, whether that be on the bridge or below the bridge.

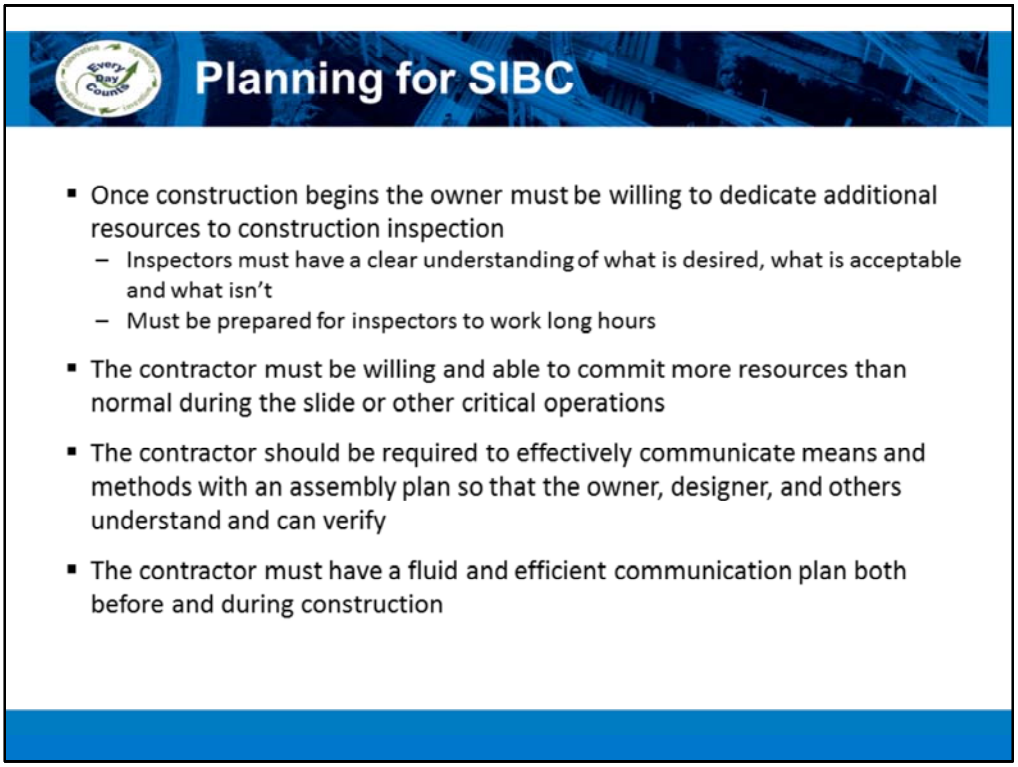
The owner and/or contractor should involve the public from very early on to communicate the intent and expectation for using SIBC. Given that SIBC is an innovative method for bridge construction, it is likely to draw the attention from the public and media. For this reason, naming or branding the project or program should be considered since it will undoubtedly be named by someone.



Higher overall costs, especially for initial SIBC projects, may be realized and should be addressed when programming.

Additionally, the owner must define any needed submittals and provide project specifications that define the desired design criteria.

It should come as no surprise that creating and reviewing specifications and submittals will require more attention, especially on the first project. Accordingly, the owner should devise a reasonable timeline to accommodate the added attention and so that weather and closure times can be best mitigated.



It should be expected that once construction begins, additional owner resources will be required in the form of construction inspectors.

Ensuring inspectors have a clear understanding of what is acceptable will take additional time. Even more, inspectors may have to work longer hours. Given the time-sensitive nature of SIBC during slide operations, a contractor must be willing and able to commit more resources than normal.

Also, an assembly plan is critical so that the contractor can clearly communicate his means and methods. His overall ability to efficiently communicate both before and during construction will be key to success.

Lastly, the contractor must have a contingency plan that addresses these questions and others. What should happen during an emergency response, or equipment failure? What if an extended detour time is required and what if there is an accident on the detour? What happens if severe weather approaches?

Project specifications should include the minimum contingency scenarios. The specifications should also encourage the contractor to determine and plan for other contingency plans.

Media and public relations are important on any project.

Bridge design and construction professionals should be cognizant that the traveling public are customers and should be informed.

Due to the unconventional nature of the bridge construction when using slide-in methods and its potential impacts on the traveling public, SIBC projects are likely to garner more attention through the media.

Accordingly, a media and public relations plan should be developed early in the project that communicates the advantages of reducing inconvenience for the trade of possible increased costs.

Sufficient time should be allowed for the public to make alternative plans during the most inconvenient times.

Further, communication with the community prior to setting the schedule will help identify local events that draw additional traffic. Identify periods of least traffic through traffic counts if necessary. Several methods to convey information to the public should be used including the local news, websites, mailings, social media, and others.

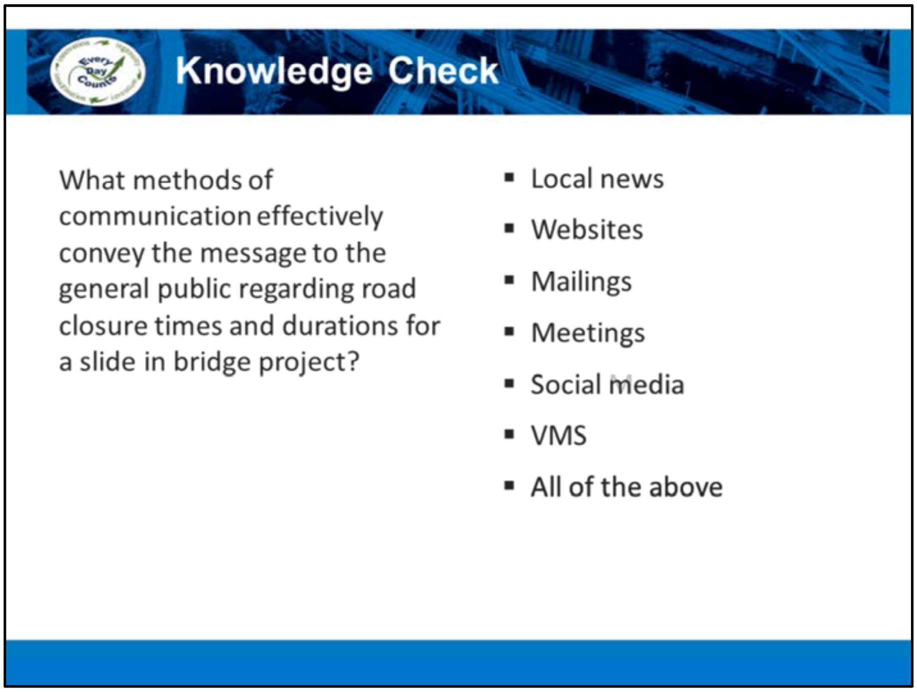
Special attention should be paid to businesses and others directly adjacent to the site as it is likely they will be most affected. Variable message signs are a good way to convey important project information.

Since the construction method is unique, the public should be encouraged to attend the slide but only if attendance can be safely accomplished. Access to engineers and communications specialists to quickly answer questions during construction can provide a great benefit to the project. After all is complete, surveys of the public to provide feedback can be conducted.

The Jamaica Avenue project near New York City required an extensive public outreach plan given the large number of road users both above and below the bridge in addition to the many businesses and residences nearby.

A significant campaign began 3 to 4 weeks prior to construction beginning. Project details were communicated via letters, meetings, and radio, and construction details were posted on state and city websites.

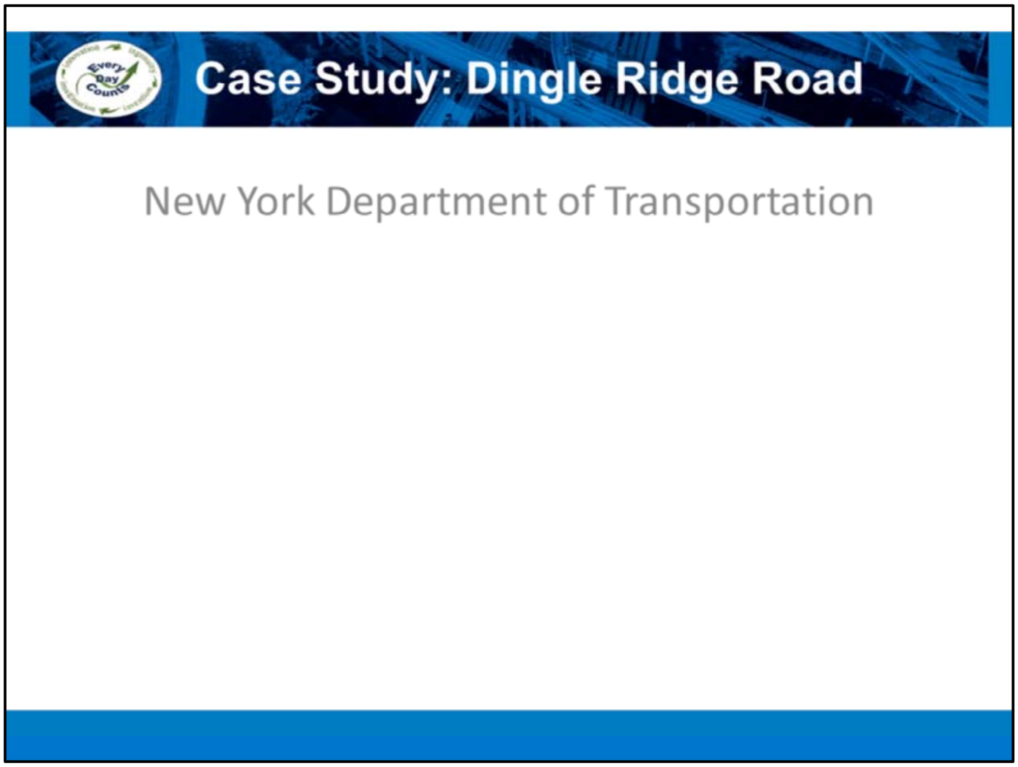
Press releases and travel advisories were broadcast through media outlets and VMS signs.



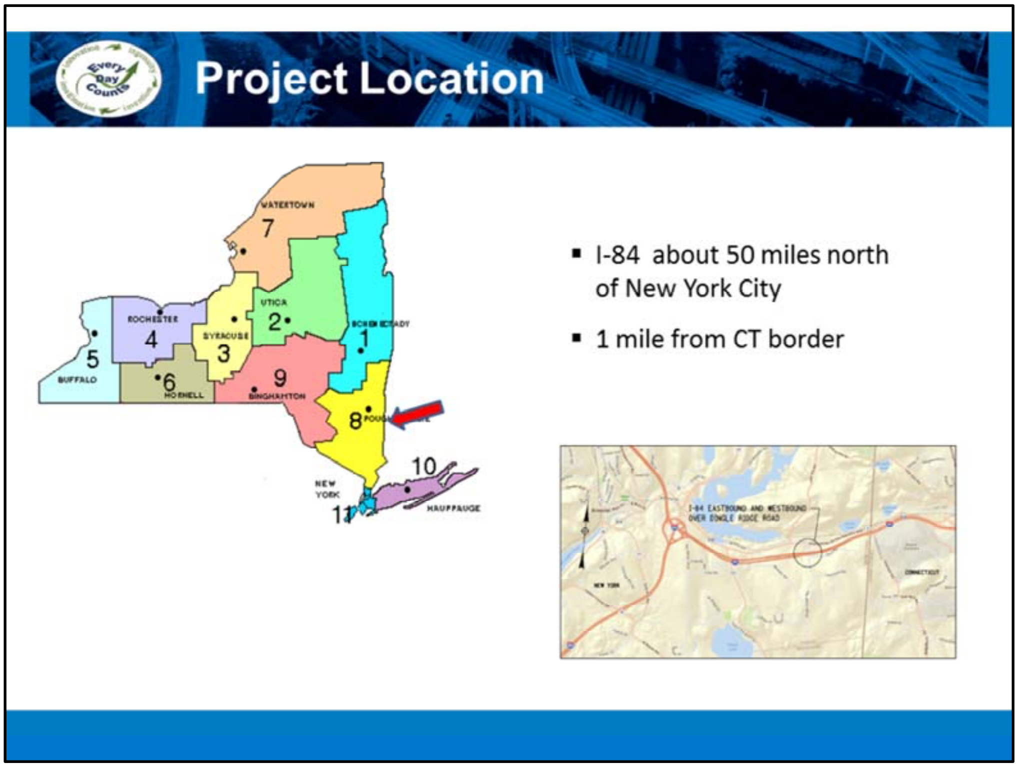
What methods of communication effectively convey the message to the general public regarding road closure times and durations for a slide in bridge project?

Local news?
Websites?
Mailings?
Meetings?
Social Media?
VMS?
Or
All of the above?

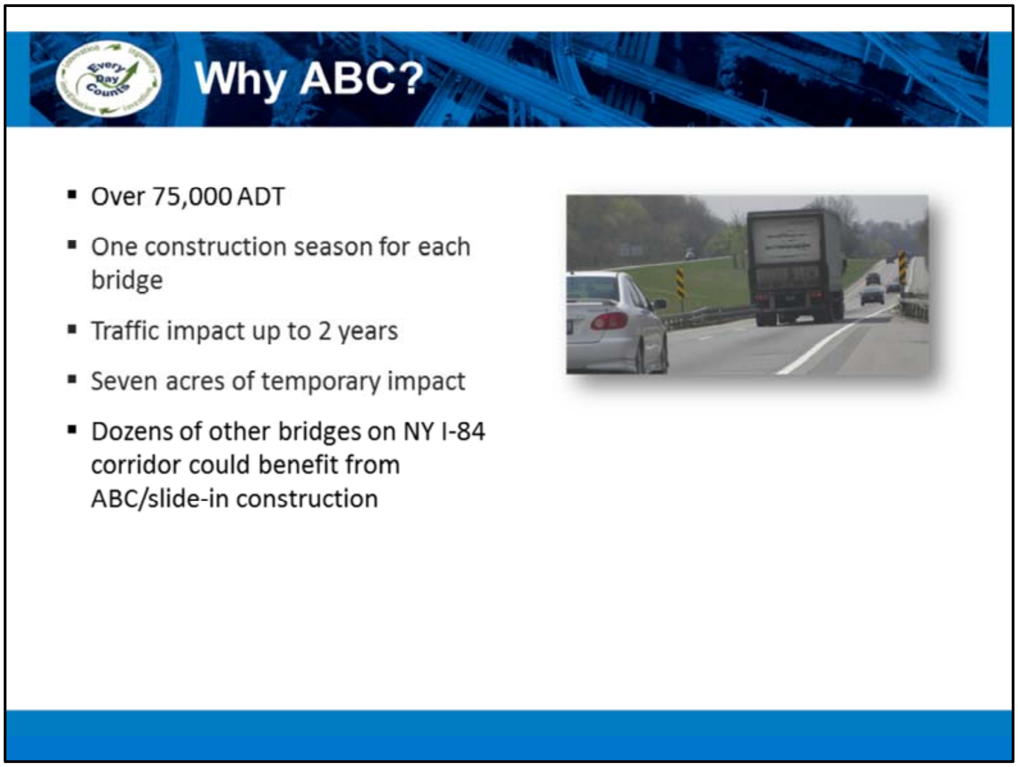
The answer: All of the above. Each of the options are commonly used to communicate the expectations of slide in projects.



The case study we'll be covering today is the Dingle Ridge Road project completed in the state of New York.



The project is located about 50 miles north of New York City, 1 mile from the Connecticut border.



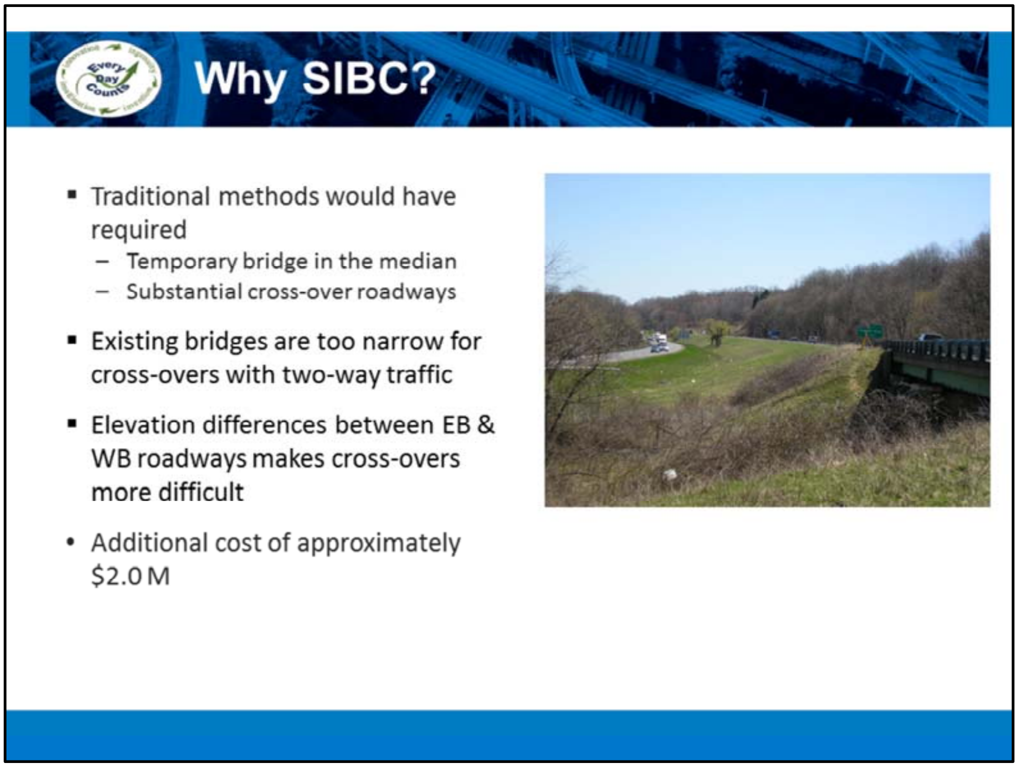
Why was this project a good candidate for accelerated bridge construction?

To begin, the ADT was over 75,000 which meant that any disruption would quickly effect a significant number of people.

Additionally, two adjacent bridges were to be replaced. One construction season would be required for each bridge, thus the total duration of the project and traffic impact could span up to 2 years.

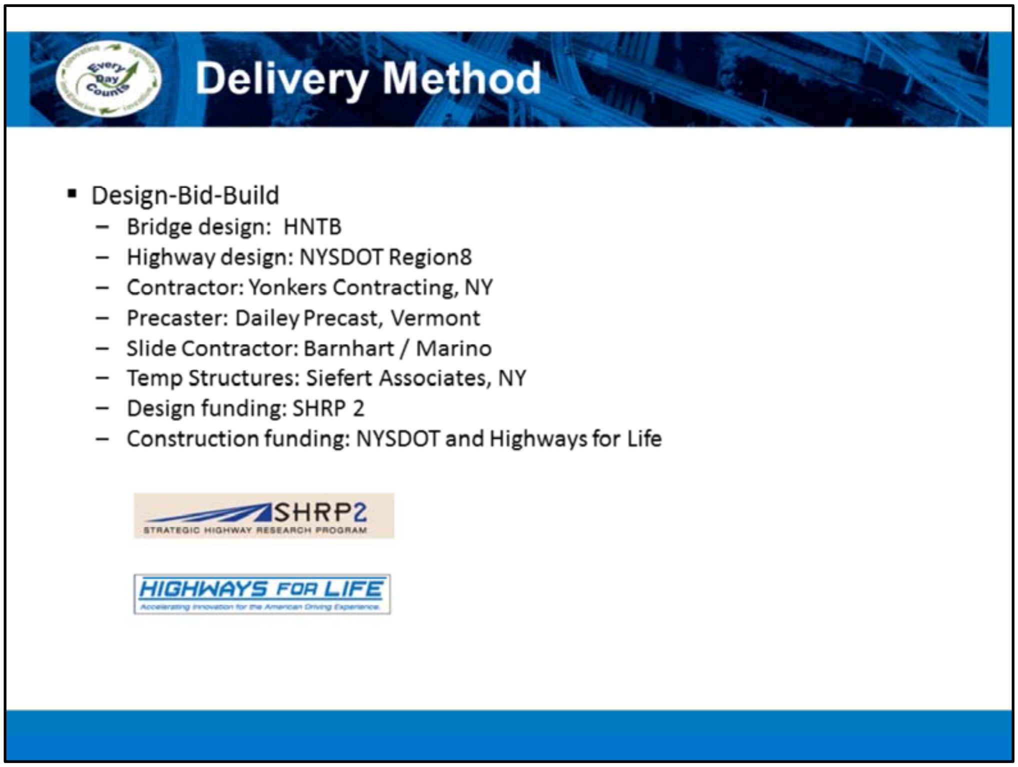
If constructed traditionally, seven acres of land would temporarily be impacted due to the construction of crossovers and shoe-flies.

Even more, if done successfully, dozens of other bridges on the I-84 corridor could be constructed using ABC thereby multiplying the benefits.

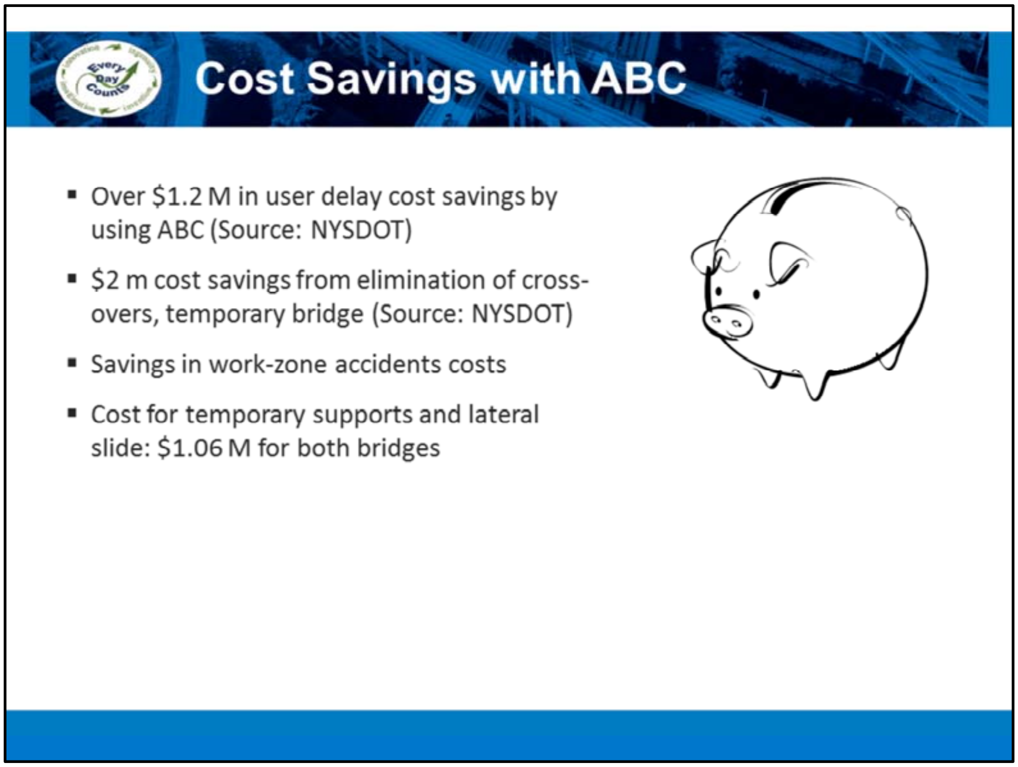


So why was SIBC the chosen method of accelerated bridge construction?

Traditional methods and even some other methods of ABC would have required the construction of a temporary bridge in the median since the existing bridges were too narrow for a crossover with two-way traffic. The construction of crossover roadways would have been complicated by the elevation differences between the eastbound and westbound roadways. In the end, the construction of a temporary bridge and crossovers would have resulted in an additional cost of $2 million.



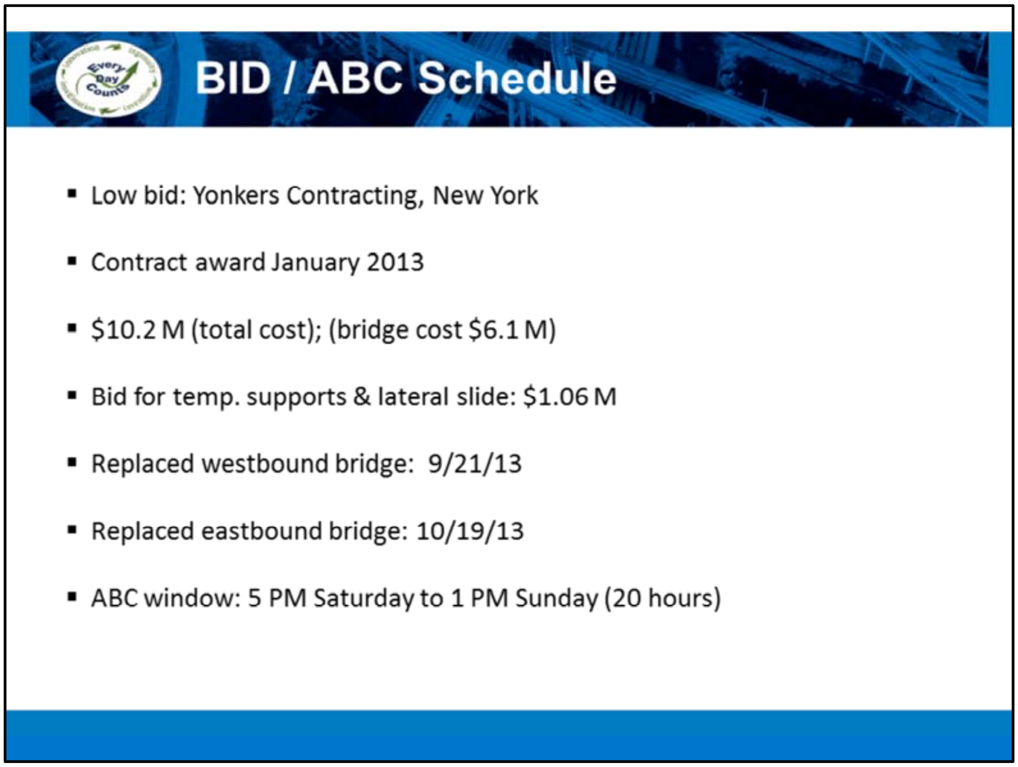
Design-bid-build was the delivery method used on this project. Some of the key team members are listed here. Note that some of the funding for design and construction came from the SHRP2 and Highways for Life programs.



A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

For the sake of comparison, the cost attributable to the temporary supports and lateral slide totaled $1.06 million for both bridges combined. The cost of this work is a reflection of the severity of the grading at the site. Dingle Ridge Road has an approximate grade of 15%, which resulted in large temporary shoring towers. This type of geometry is not normal, therefore the cost for this work should be taken in context.



The low bid totaling $10.2 million was received from Yonkers Contracting of New York. The contract was awarded in January of 2013. Of the $10 million, $6.1 million was directly associated with the bridge construction, while $1.06 million was used for temporary supports and slide operation.

It should be noted that the cost for bridges in the New York metro area are normally significantly higher than that in other parts of the country, therefore these cost figures should not be taken to demonstrate the cost of SIBC on most bridges.

The westbound bridge was replaced on September 21st and eastbound bridge on October 19th of 2013. For each case, the timeframe in which the existing bridge was to be removed and the new bridge slid into place and opened to traffic was 5pm Saturday evening to 1pm Sunday afternoon. Both bridges were completed within their allotted ABC window and within 10 months of the contract award date. Compare that to the estimated 2 year duration if the bridges were constructed traditionally.

In this aerial rendering, one can see the relative position of the bridges and underlying roadway. It is clear that a fair amount of right-of-way is available, thus simplifying the use of slide-in bridge construction.

The rendering shown in the top left of the slide, shows the proposed position of the bridges while in construction on their temporary works. If you look closely, you'll notice that the temporary works, approaches, and new foundations are shown.

The photo on the right shows the actual bridges constructed on temporary works, nearing completion and being prepared for the slide operation. In the end, traffic disruption on I-84 was reduced from two years to two weekend nights, while Dingle Ridge road which lies beneath the bridges was closed for only 5 days.

Shown in the next couple of slides are additional renderings of the bridge construction and slide operation.

The superstructure of each bridge was constructed adjacent to the respective existing bridge. The new abutments were constructed beneath the existing bridges while still in service.

To begin the ABC period, the interstate was closed and the existing structure removed.

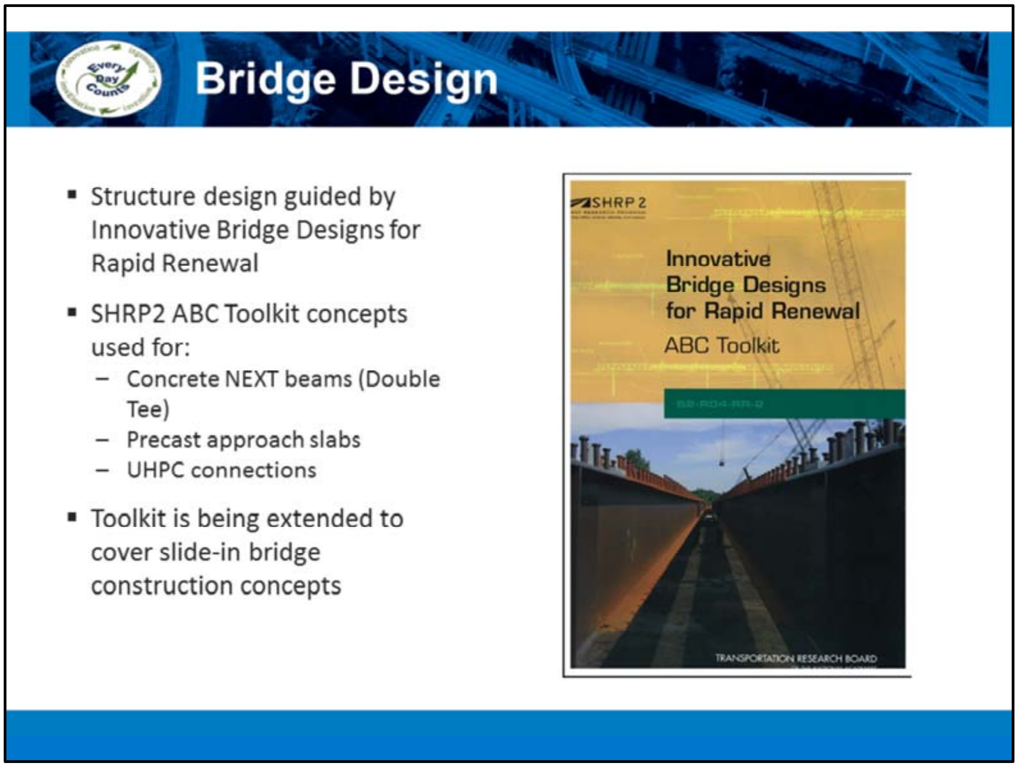
Once removed, preparation for the approach spans had to be completed including grading, compaction, and placement of the inverted T-beams used as a sleeper.

Once the preparation was completed, the slide from temporary works to permanent substructure took place.

Traffic Control

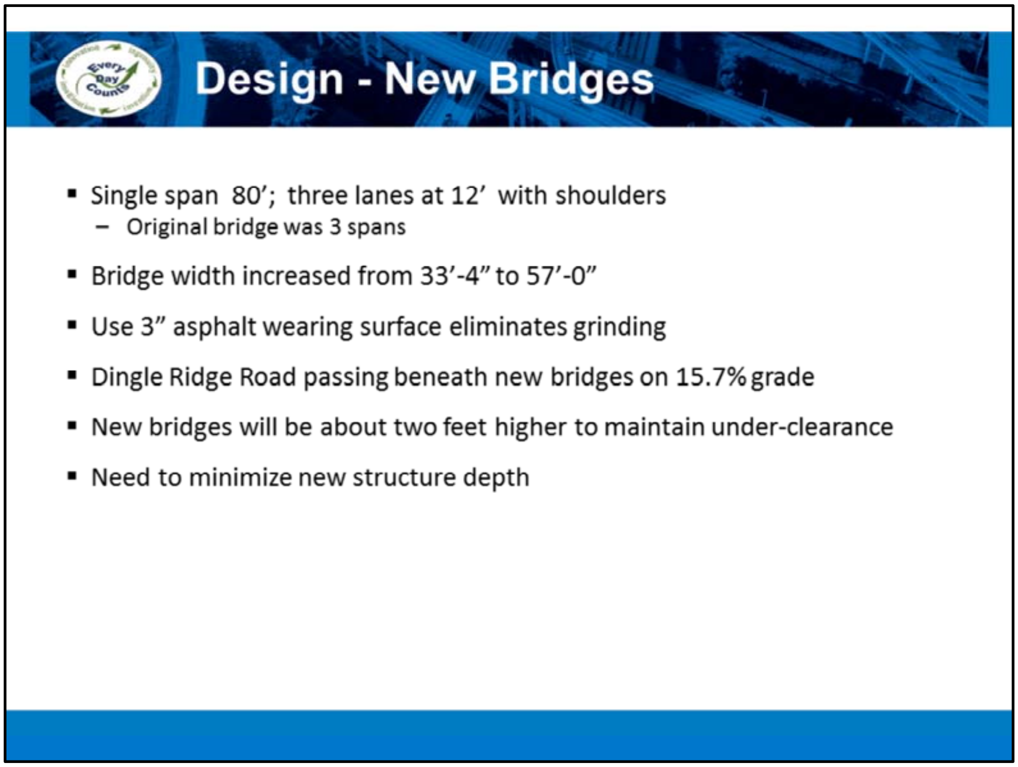
- Not an interchange – ramp detours not available
- Route 6/202, parallel to I-84, used as the detour (3 miles)

Traffic was not rerouted to the oncoming lanes, nor could on and off ramps be used as a detour since the bridges were not located at an interchange. Fortunately, route 6/202 runs parallel to I-84 and could be used. This created a short detour of only 3 miles.



The next several slides will focus on the design aspects of this project.

Design guides have been developed through the Strategic Highway Research Program. One in particular called "Innovative Bridge Designs for Rapid Renewal: ABC Toolkit" was used extensively in the structural design; specifically, as it pertains to the concrete double-T beams, approach slabs, and UHPC connections. Though the guide wasn't written to explicitly address slide-in bridge construction, work is being completed to cover these concepts.



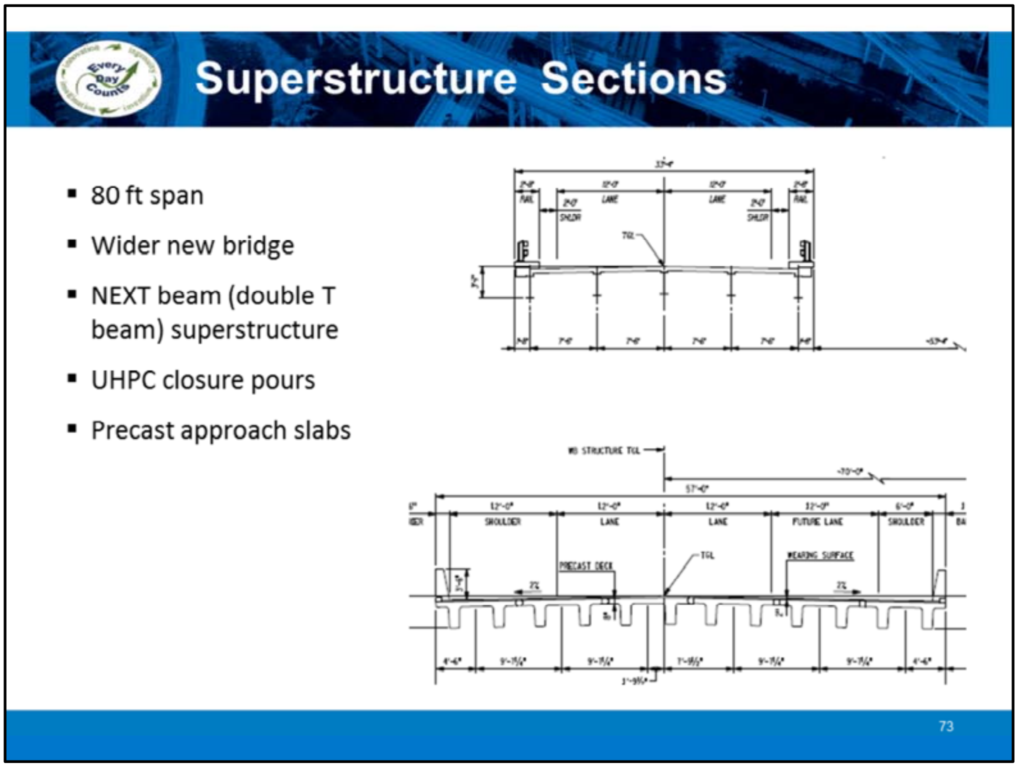
The new bridges are each 80 ft single span structures with three 12 ft lanes and shoulders totaling 57'-0". Compared to the 33'-4" of the existing structures, the bridges each gained considerable width.

A 3" asphalt wearing surface was placed on the bridge deck, which eliminated any necessary grinding due to the UHPC connections.

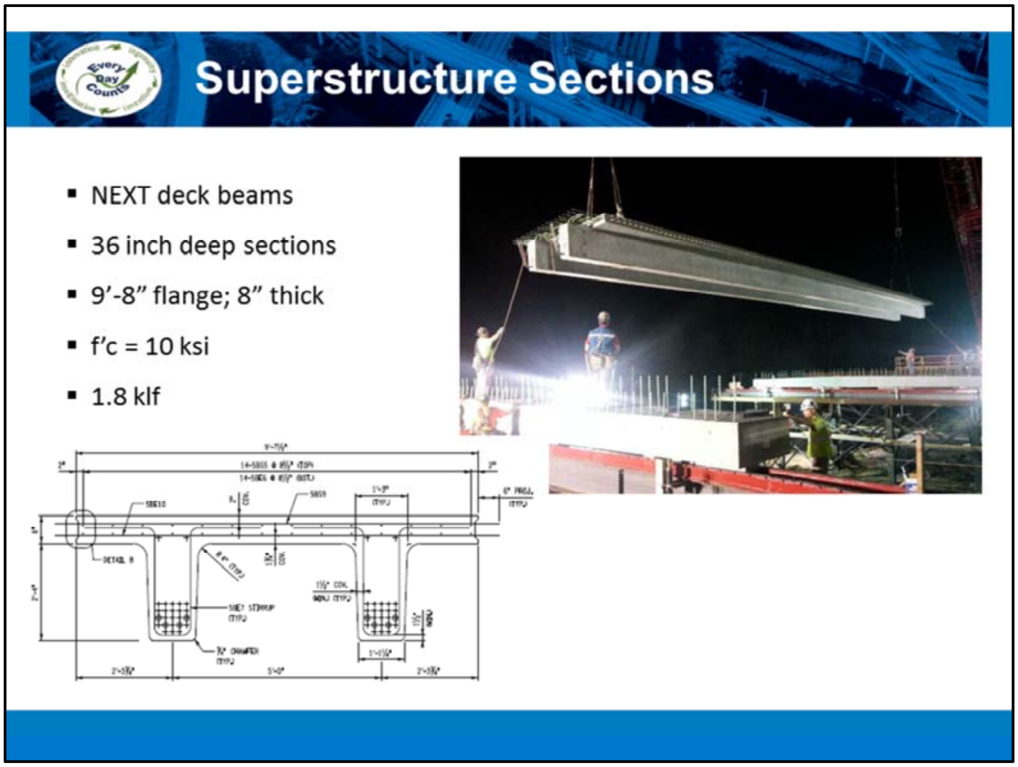
Somewhat unique to this particular location is that Dingle Ridge Road, which passes beneath the new bridges, is on a 15.7% grade. This grade posed some interesting design challenges. The new bridges were required to be raised two feet higher than the existing to maintain the under-clearance, which also meant that a concerted effort to minimize the new structure depth had to be made.

Two of the more significant design challenges were posed by these two restrictions: The slide had to be completed in one weekend night and I-84 had to be raised by two feet to satisfy the under-bridge clearance.

The photograph shown here helps illustrates the changing grade on Dingle Ridge Road.



The superstructure sections, both longer and wider than those of the existing structures, were constructed using double-T precast beams tied together with UHPC closure pours, and precast approach slabs.



The beams chosen for the design are the Northeast Extreme Tee Beams – NEXT beams. This double tee section was developed by the PCI Northeast bridge Technical Committee, which is comprised of representatives from every northeast state, several consultants, and the PCI fabricators in the area. The beam was developed to expedite construction and reduce costs by eliminating the need for deck placement in the field.

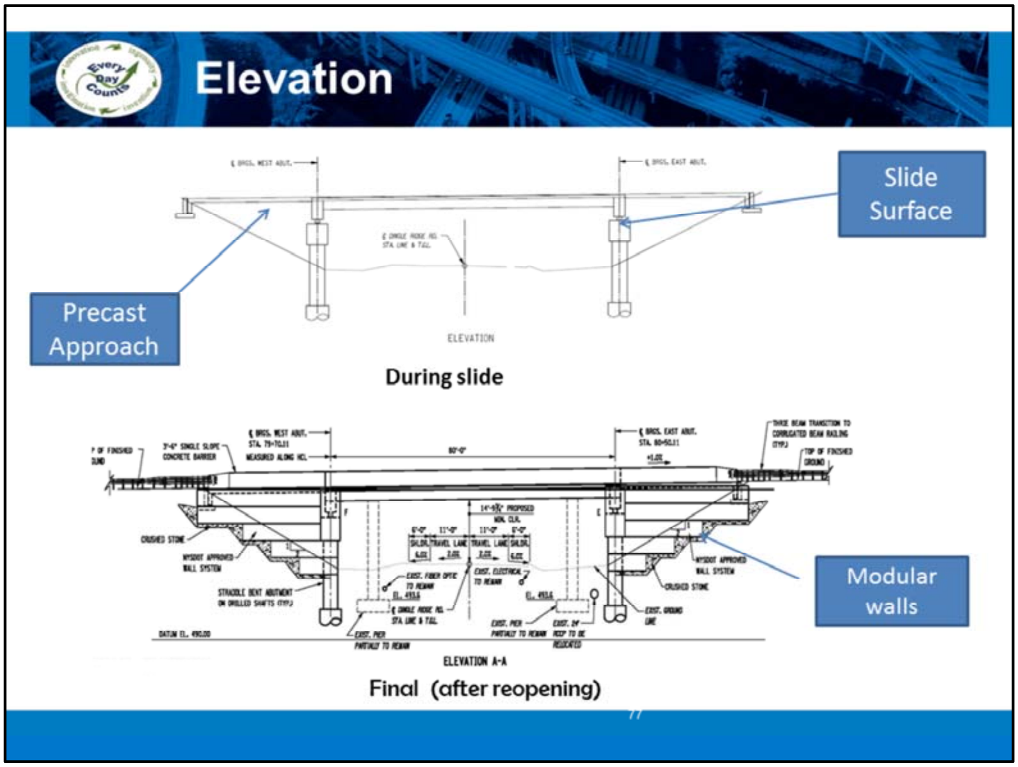
In total, the sections were 36" deep with a 9'-8" wide and 8" thick flange. The compressive strength of the concrete used was 10 ksi and the sections weighed roughly 1.8 kips per foot.

The UHPC connections, shown here, joined each of the double-T sections. The joints were 6” wide and the compressive strength of the concrete ranged from 20 to 30 ksi.

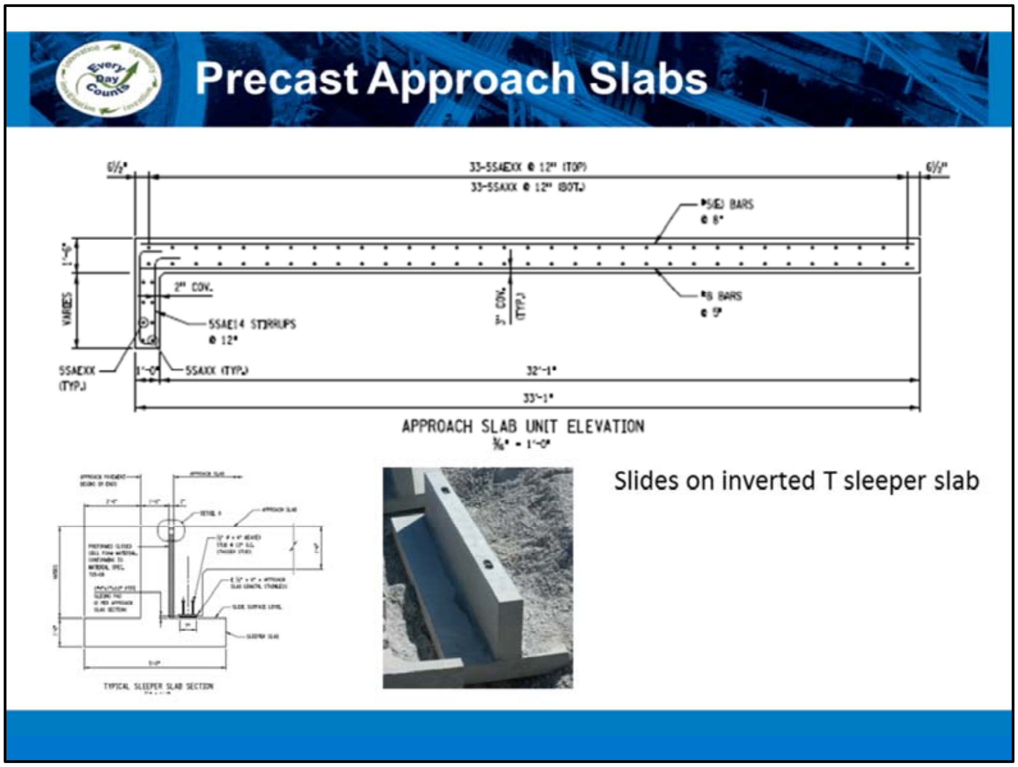
Deck Waterproofing

- Spray-applied waterproofing membrane placed before the slide
- 3” asphalt overlay

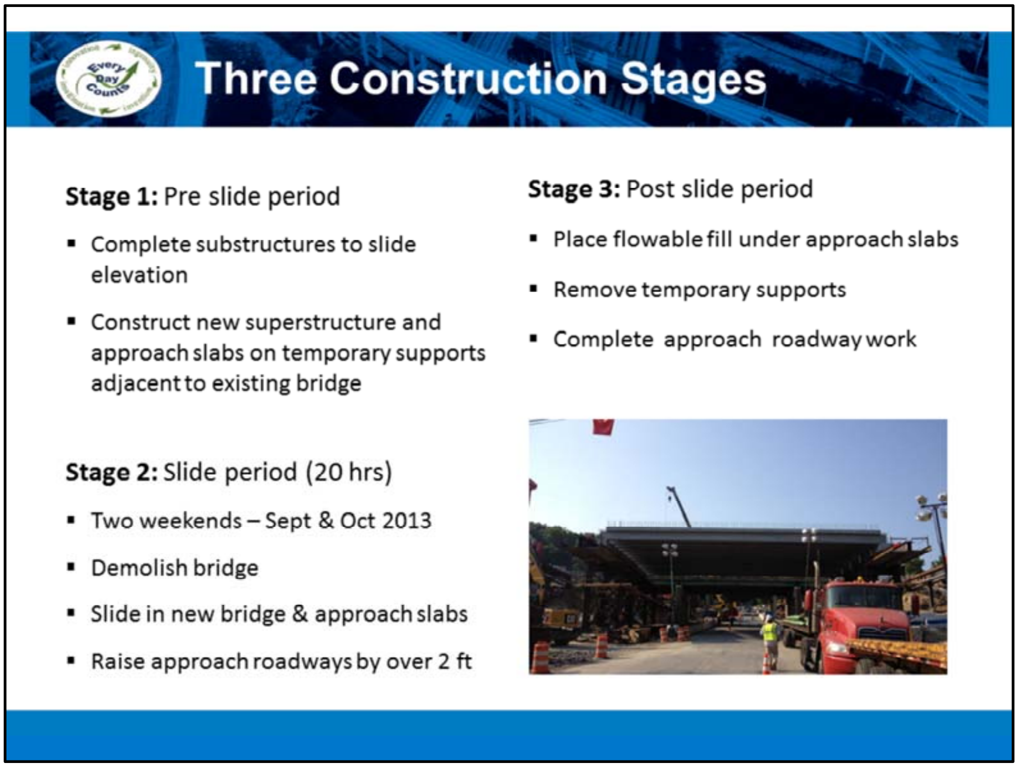
To waterproof the deck, a spray-applied waterproofing membrane was applied prior to the slide. Over that, a 3” asphalt overlay was placed.



Seen in the two elevation view drawings are the before and after-slide schematics. The approach slabs were slid into place with the superstructure. After which, a modular wall system was constructed adjacent to the approach slabs for containment of the flowable fill placed beneath the approach. The relative position of the existing piers and new abutments are depicted in the lower drawing, showing the longer span and additional roadway clearance on Dingle Ridge Road.



A close up the precast approach system is shown here. Each was 33'-1" long and 1'-6" thick with a downturned end. The end of the approach slab was slid on an inverted T sleeper slab which was placed after demolition of the existing structures.

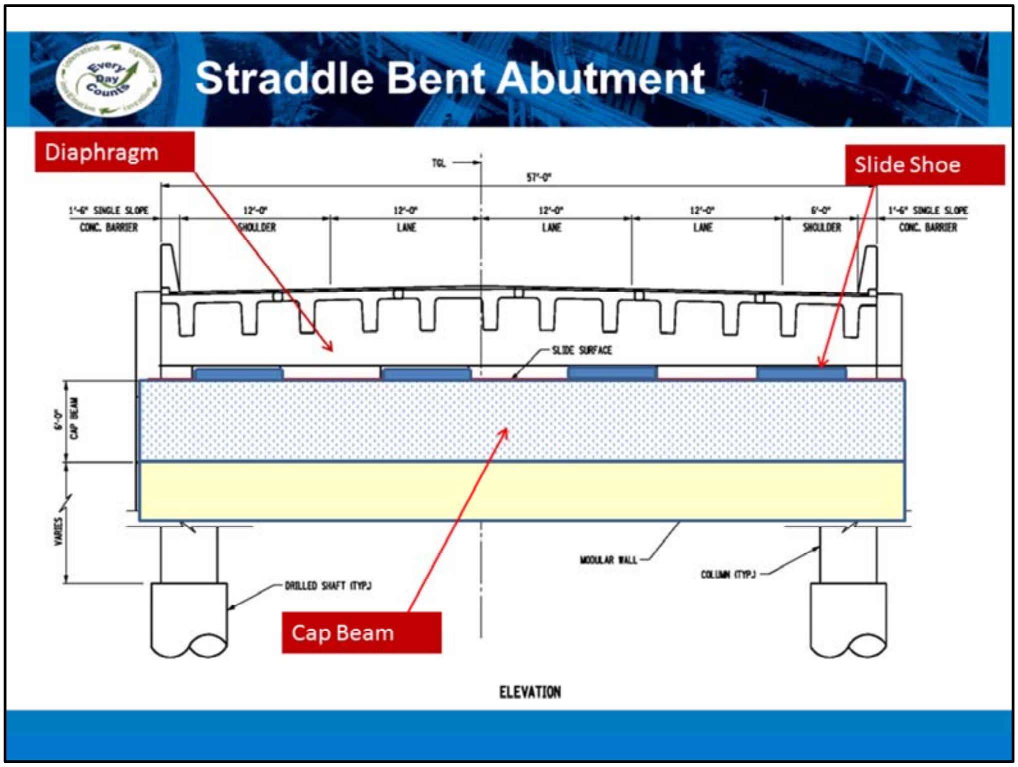


The overall construction process consisted of three primary stages.

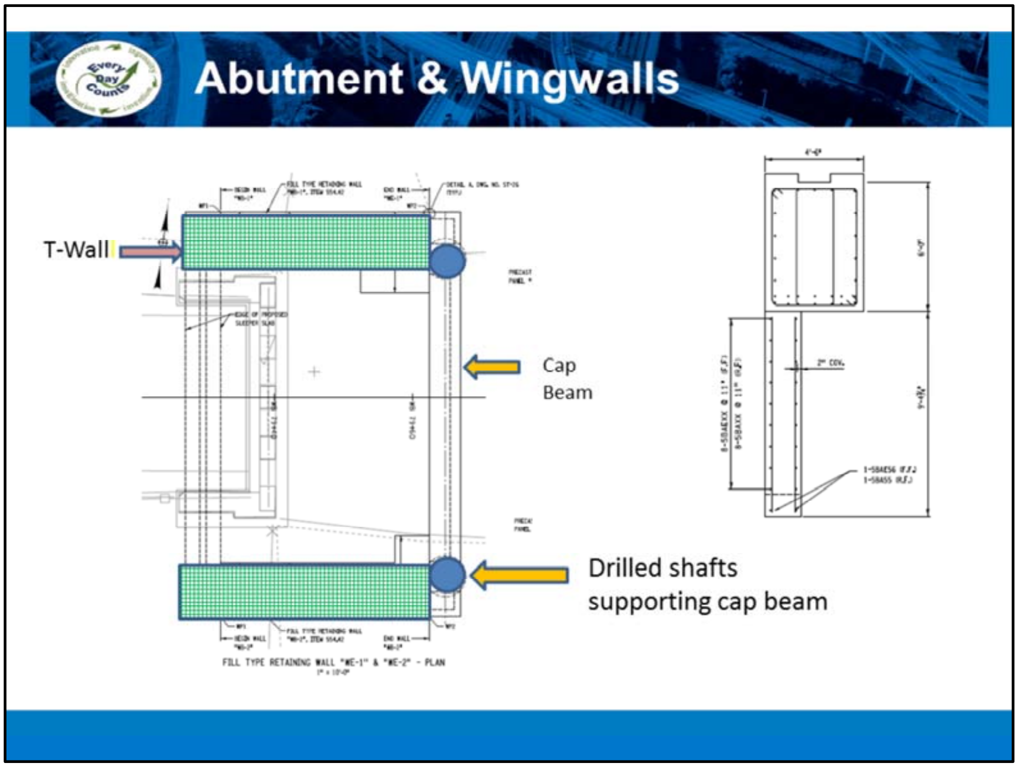
The first stage, prior to the slide, involved the completion of the substructure to slide elevation and construction of the new superstructure and approach slabs on temporary supports adjacent to the existing bridge.

Stage 2, the 20 hour slide period, occurred separately for each bridge over two weekends. During the stage, the existing bridge was demolished, the new bridge slid into place, and approach roadways raised 2 ft.

Stage 3 consisted of placing flowable fill beneath the approach slabs, removing temporary supports, and completing the approach roadway work.



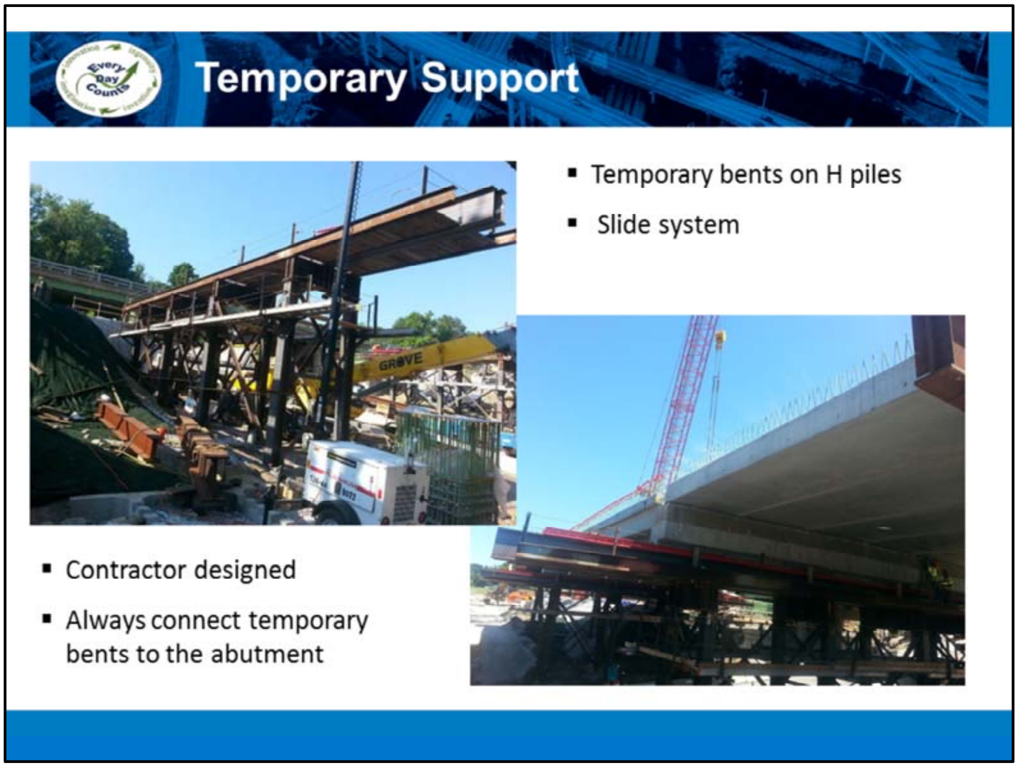
Shown here in the drawings for the straddle bent abutment are three elements critical to the slide operation. Those being, the diaphragm encapsulating the ends of the double-T beams, the slide shoes on which the superstructure will be slid, and the cap beam which was constructed beneath the existing structures prior to the slide.



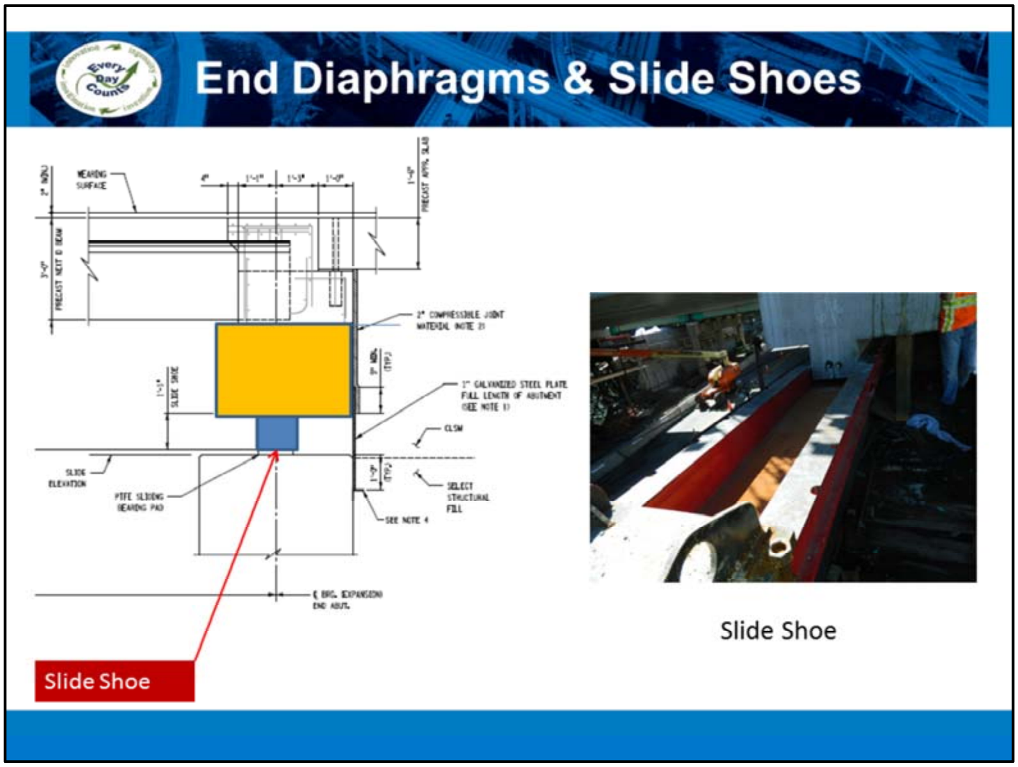
A plan view of the section shows the drilled shafts supporting the cap beam and the t-walls adjacent to the approach slabs which contains the flowable fill.

The new foundation system is shown placed beneath the existing structure in this photograph.

Additional pictures of foundation construction clearly depict how the new foundation was constructed under the existing structure while the roadway remained in service.



The temporary supports were steel structures founded on H-piles. The system was designed by the contractor and incorporated the necessary elements to properly slide the new structure.



Vital to the success of the slide were the end diaphragms and slide shoe. The diaphragm provided a rigid, stout connection point for the jacking system to react against. The slide shoe, made up of a full-length stainless steel plate, provided a reduced-friction track on which the superstructure could slide on the PTFE bearing pad.

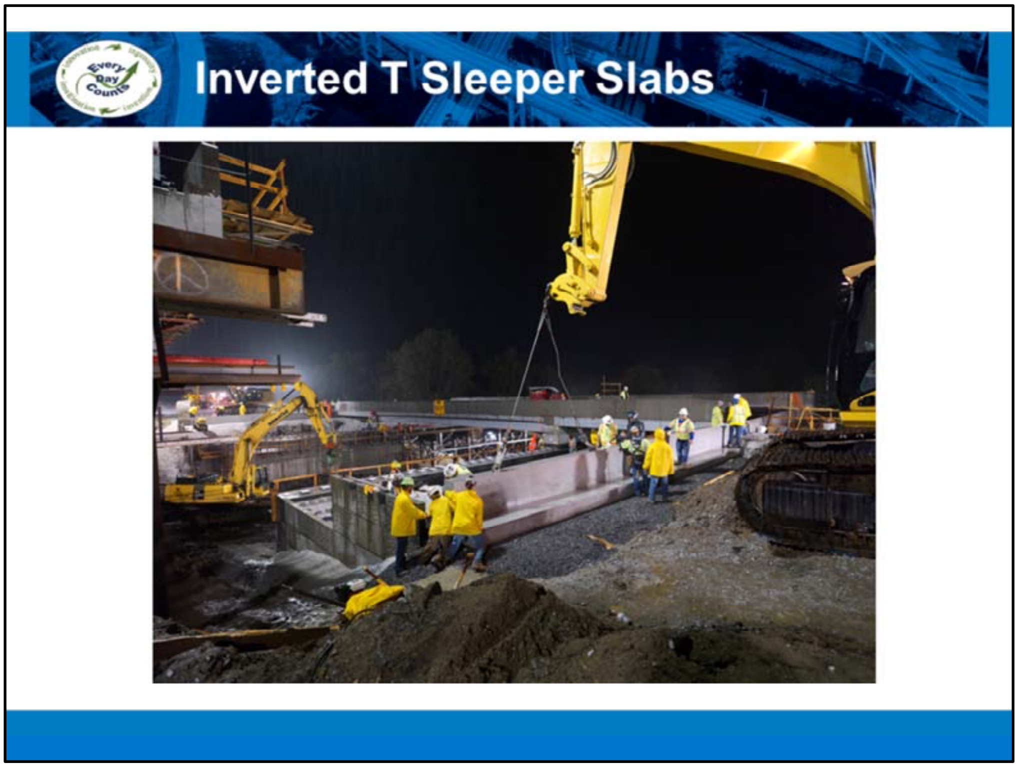
Shown in this photo are the new bridges nearing completion alongside the existing. Note that the bridges have remained open to traffic to this point.

These pictures provide a better glimpse of the stainless steel slide shoe and the 16 gage PTFE bonded to the elastomeric bearing pads.

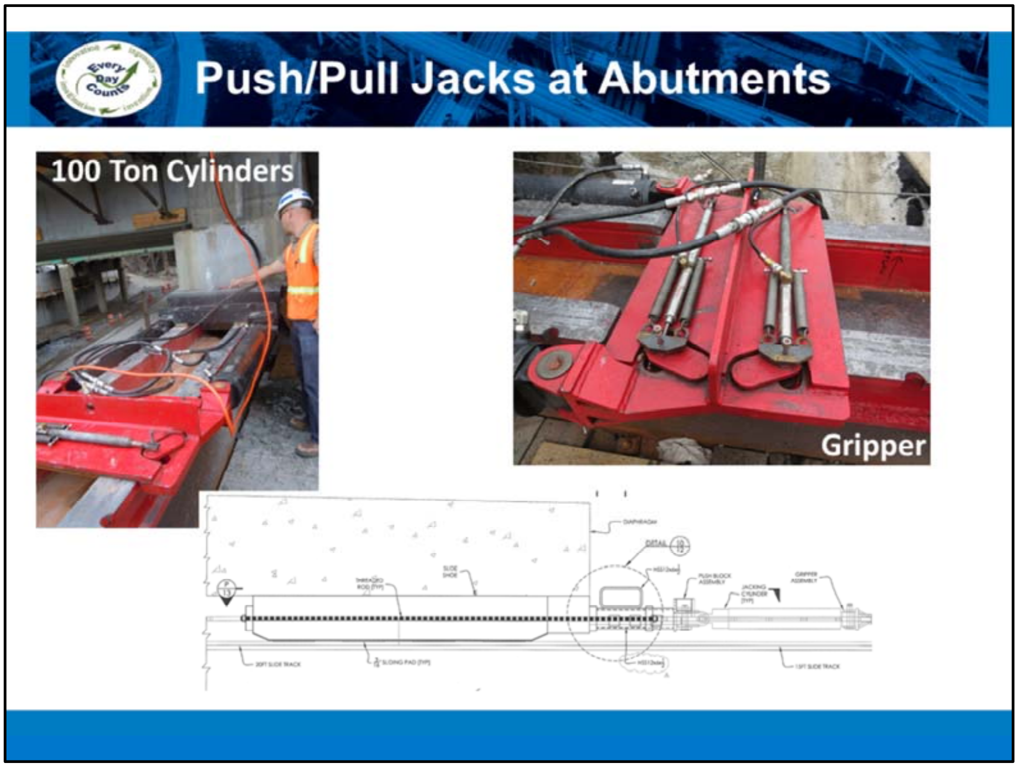
Approach Slab Slide Surface

Stainless steel on PTFE pads

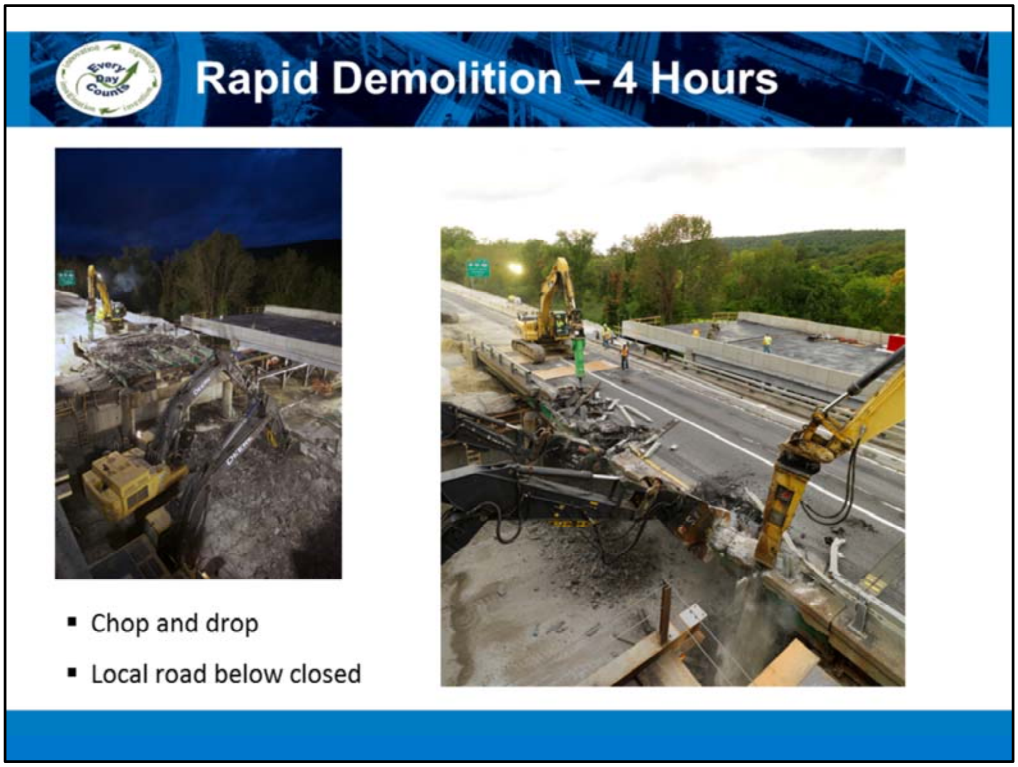
Similarly, the approach slab was slid on PTFE pads.



The inverted T- sleeper slabs were placed once the existing bridge was removed.

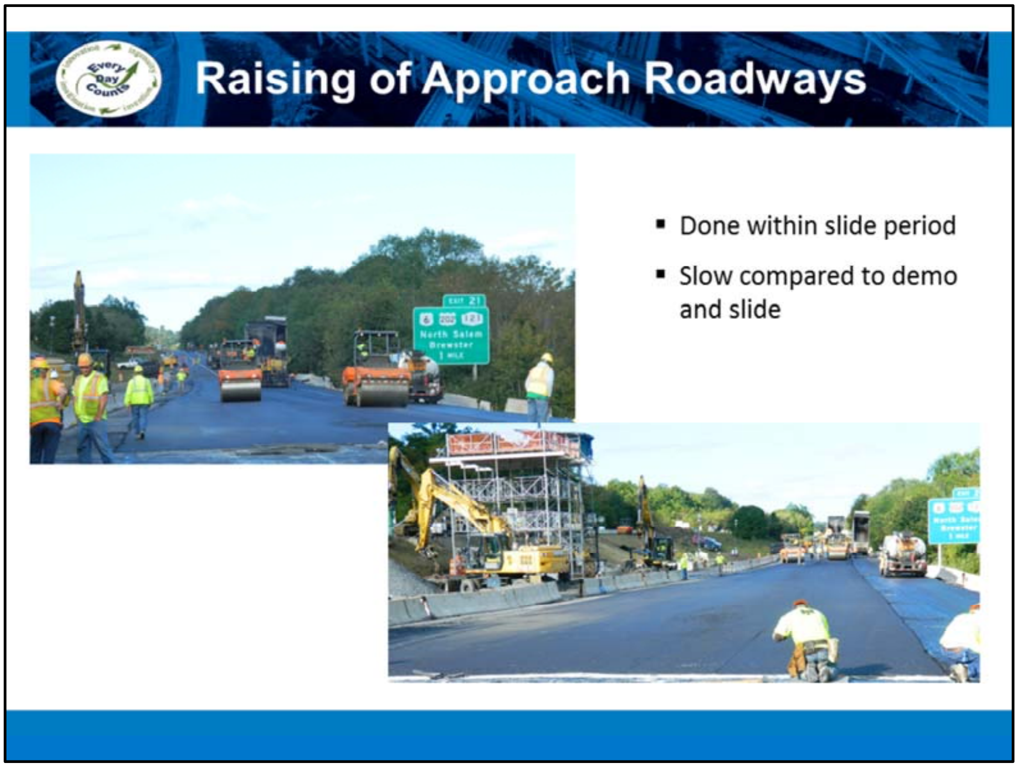


The jacking system consisted of two 100 ton push/pull jacks placed at the abutments. A system was devised to enable the repositioning of the jacks as the bridge was slid into place.



The demolition was completed in four hours using chop and drop methods. At this point in time, the local road beneath was closed for obvious reasons.

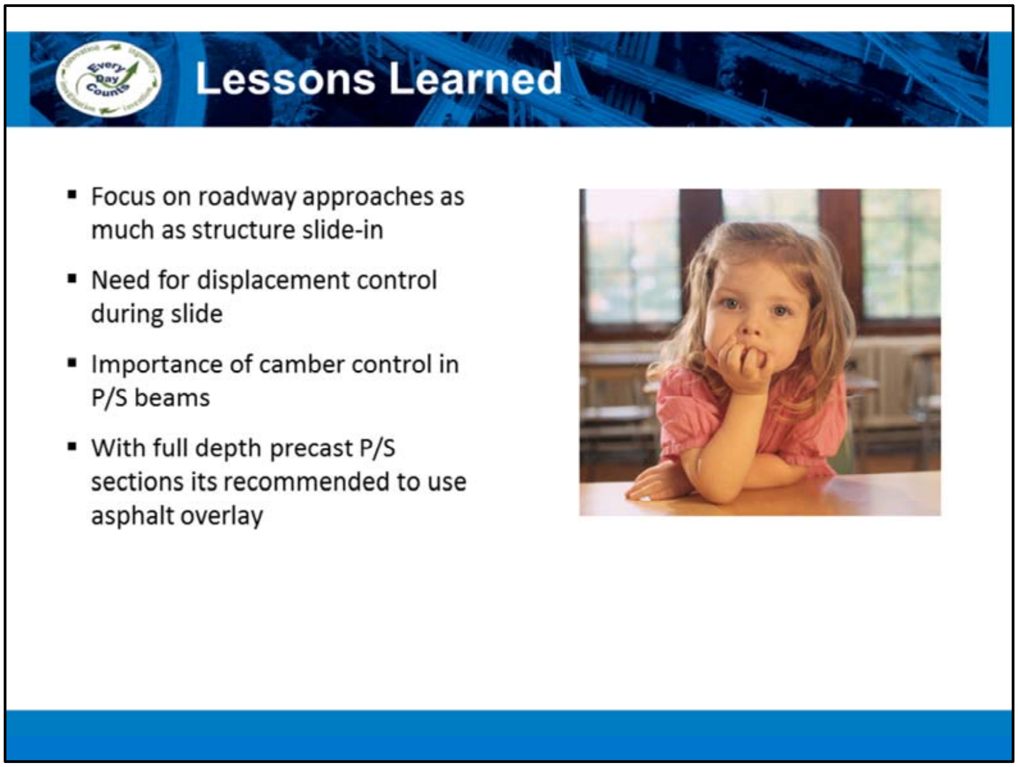
Another view of the temporary supports is shown here shortly after the bridge was slid into place, again showing supports at each diaphragm and end of approach slabs.



One of the more major and time consuming tasks to be completed during the short slide period was the raising of approach roadways. Relative to the actual slide, this process was considerably slower.

Shown here is one of the completed bridges. Both bridge slides were completed within 10 months of the notice to proceed.

Another view of the completed bridges shown from Dingle Ridge Road.



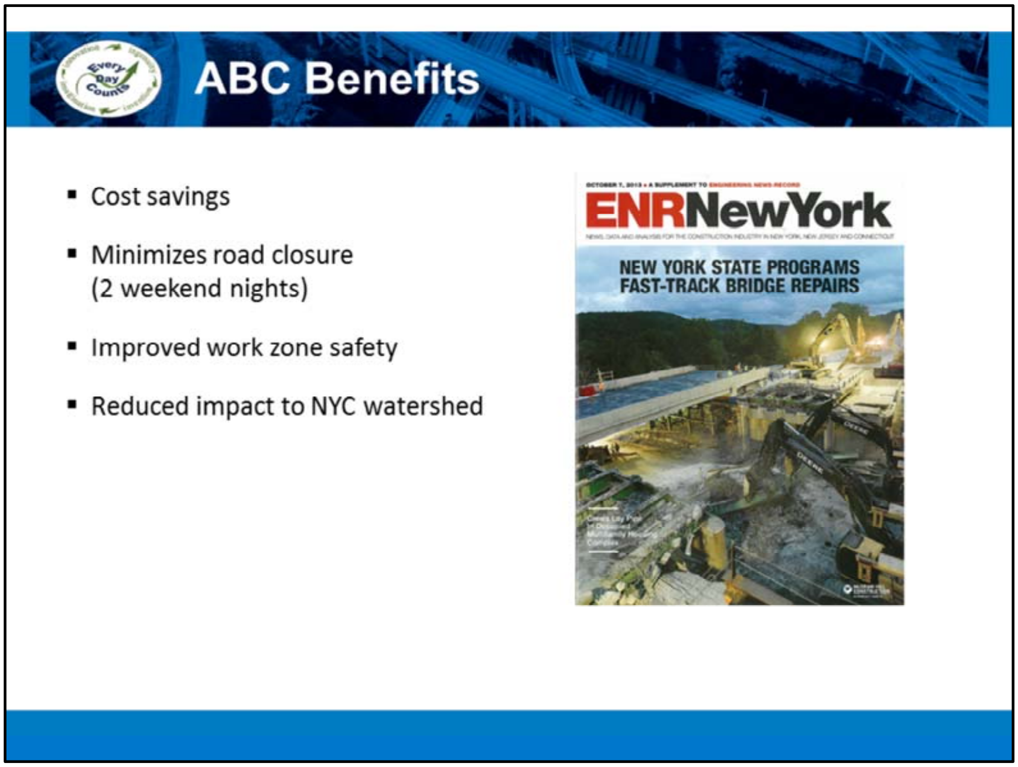
Many lessons were learned on this project, probably more than can be listed here. Even so, a few significant lessons that should be mentioned include these.

A focus on the roadway approaches should be made as much as the structure slide-in.

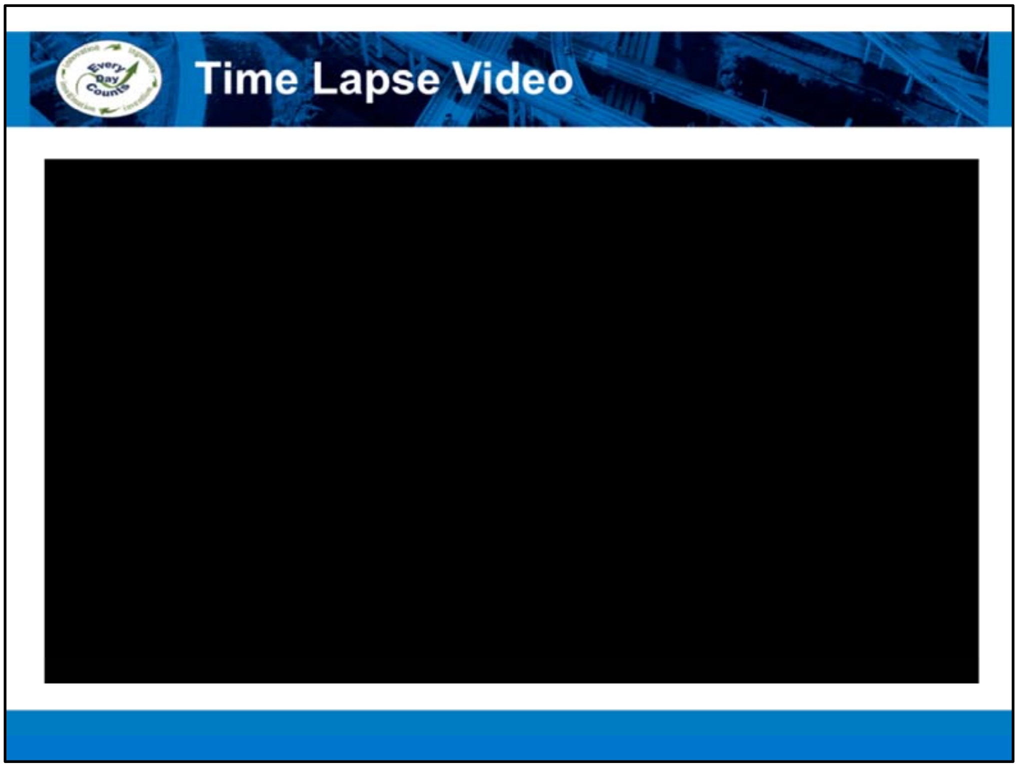
There should be displacement control in place during the slide.

It is important to control the camber of the prestressed beams to better control and align the closure joints.

It is recommended to use asphalt overlay on a system using full depth precast sections to serve as a barrier between the deck joints and the road surface.

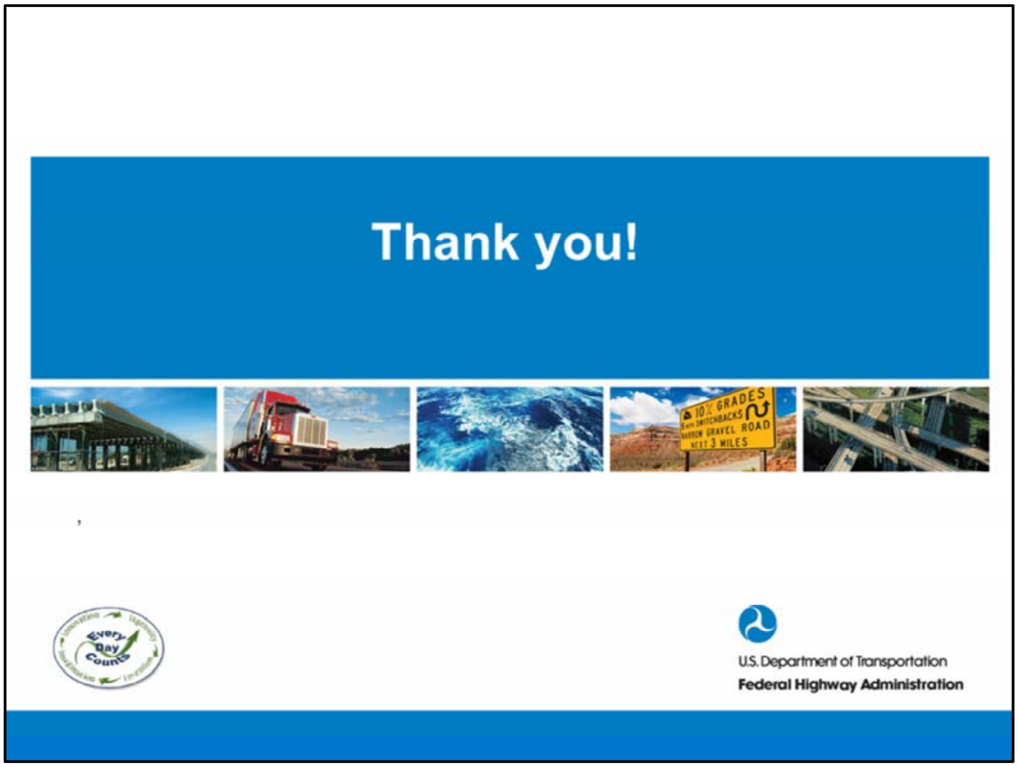


Some of the major benefits specific to this project include the cost savings, a minimal road closure, improved work zone safety, and a reduced impact to the NYC watershed.



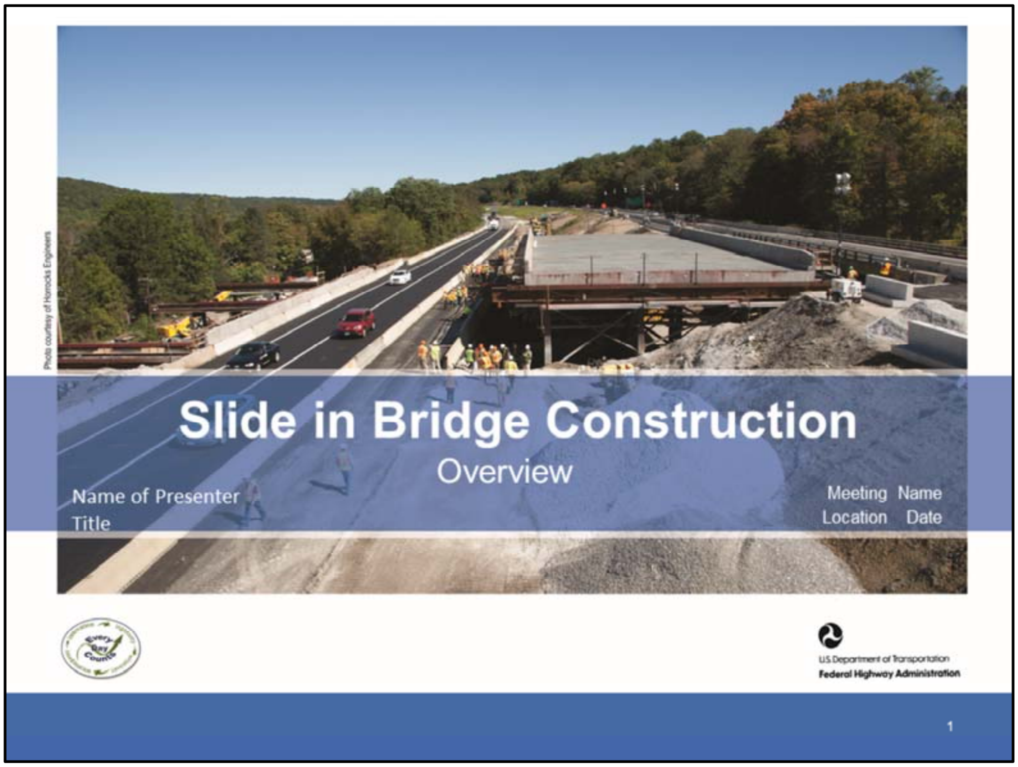
This time lapse video shows the project beginning with the road closure at the start of the slide period. You will see the bridge demolition and removal, the slide of the new structure, and preparations for the reopening of the roadway. Finally, you will see the new bridge in action.

A technical support solutions center has been established and is available for all to use to assist in slide-in bridge construction projects. Here the most up-to-date information about SIBC resources and training can be accessed. The center is most easily found by searching "FHWA Slide" online, or by simply going to directly to the web address shown here.


Thank you!
U.S. Department of Transportation
Federal Highway Administration

PRESENTATION HANDOUTS:

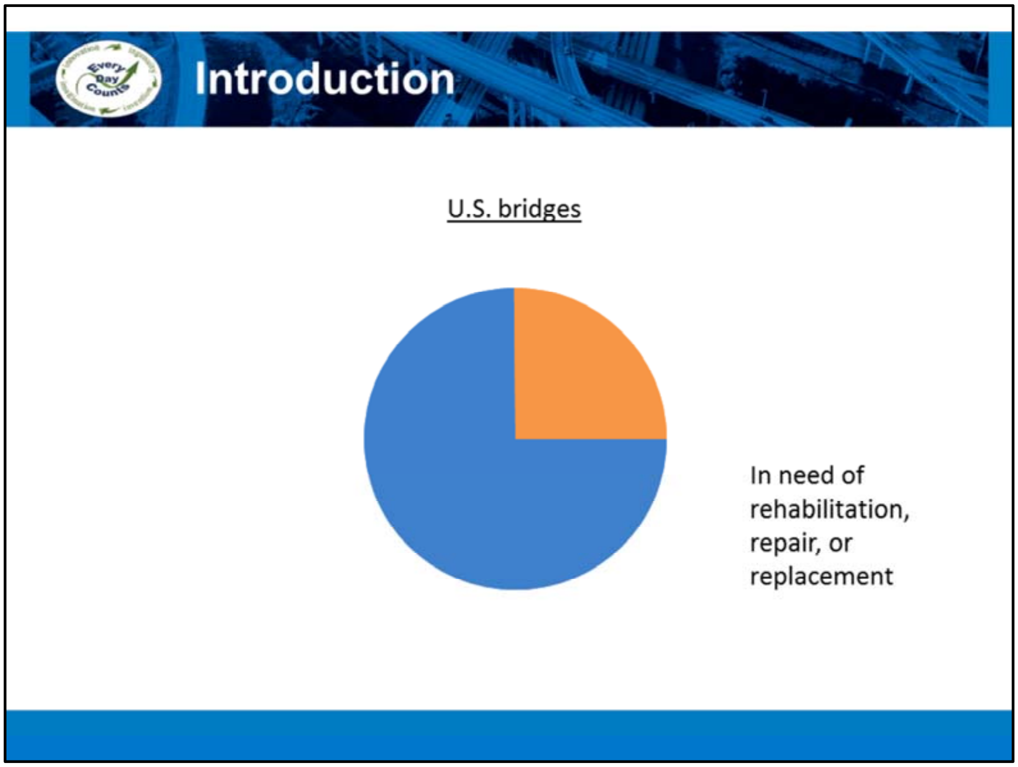
COURSE 4 SIBC OVERVIEW FOR ALL AUDIENCES



Thank you for attending today's session on Slide in Bridge Construction.

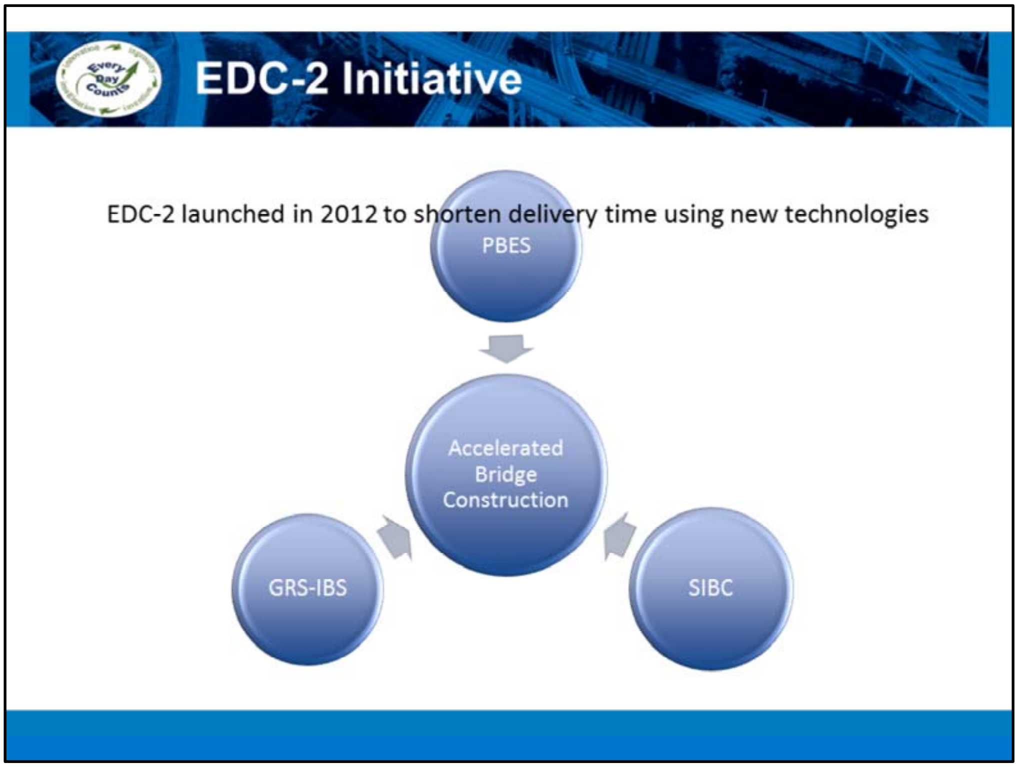
This is an overview developed for the FHWA as an extended effort of the Every Day Counts Initiative.

Slide-in bridge construction (SIBC) is a particular method and refinement of construction contained under the broader topic of Accelerated Bridge Construction (ABC) with the specific goal of extremely rapid bridge installation under very short term road closure.



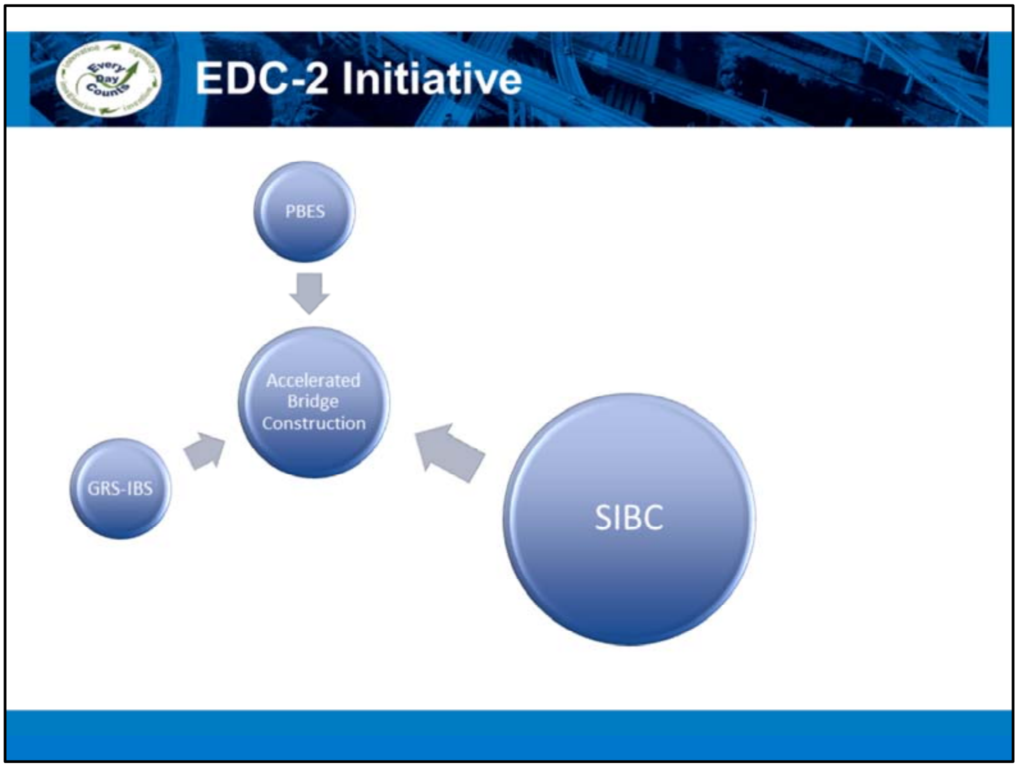
Nearly 25% of the Nation's 600,000 bridges are in need of rehabilitation, repair, or total replacement. Given this vast number, the need for bridge reconstruction methods that reduce the impacts to mobility and safety is needed. This need was one reason the Every Day Counts Initiative was launched.

Every Day Counts was first established in 2010 as a state-based initiative meant to identify and deploy innovation; specifically, to shorten project delivery, enhance safety, reduce mobility impacts, and protect the environment. The term “get in, get out, and stay out” was popularized under this program.

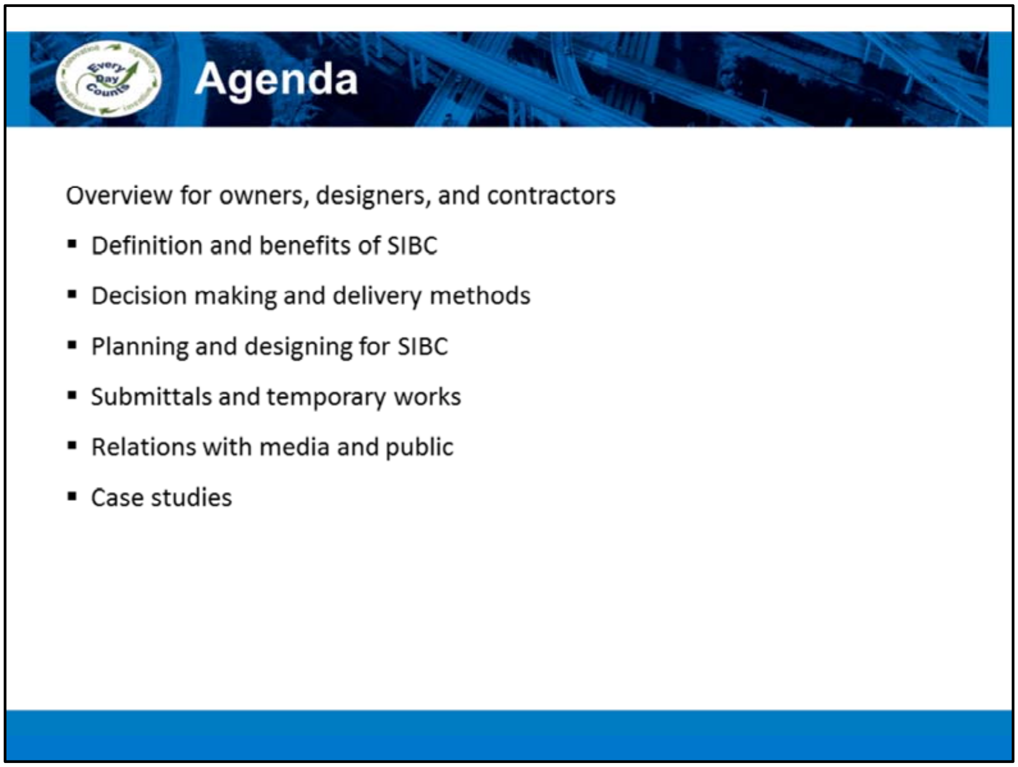


As a result of these efforts, EDC-2 was launched in 2012 with the specific focus of shortening the time needed to complete highway projects through the use of new technologies and ground-breaking processes. Within that directive, accelerated bridge construction became an area of concentration.

Three particular ABC technologies being promoted under EDC-2 are prefabricated bridge elements and systems, geosynthetic reinforced soil-integrated bridge systems, and slide-in bridge construction.



It comes as no news to anybody that our focus today will be on slide-in bridge construction.



Several slide-in bridge construction topics will be covered as the day progresses. Collectively, the topics aim to provide a comprehensive overview for owners, designers, and contractors; thereby better equipping each group to pursue slide-in bridge construction or SIBC as it is now more commonly referred to.

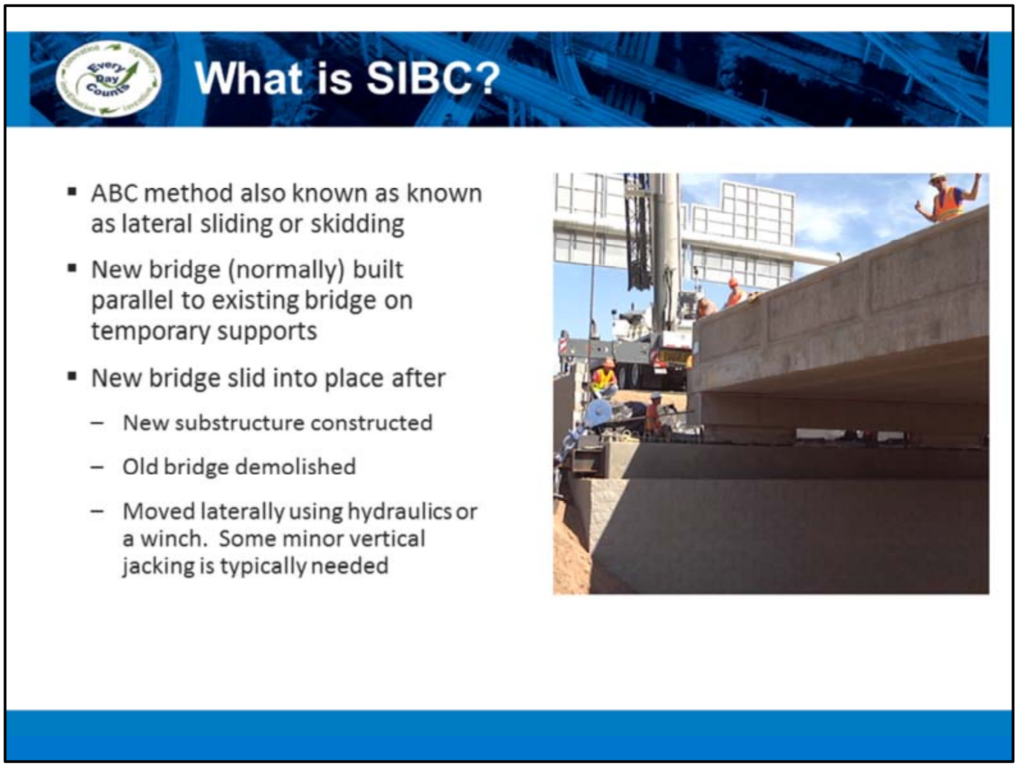
SIBC will be defined and its benefits will be discussed.

Several ABC and SIBC decision making tools are presented along with the various delivery methods that can be employed.

Planning and designing for SIBC, planned contract submittals, and temporary works will be covered.

Given that SIBC is a relatively new and innovative method of bridge construction, it is not uncommon for the media and public to have a more involved roll, even as spectators. As such, relations with the media and public will be addressed.

Lastly, six case studies of previous SIBC projects will be presented.



So, what is slide-in bridge construction?

It is a method of ABC that has also been known as lateral sliding or skidding, and the variations of these techniques.

In SIBC, a new bridge is typically constructed adjacent to and parallel to the existing bridge on temporary supports.

Once complete, the old structure is demolished and the new substructure is constructed, followed by the sliding of the new superstructure on to the new substructure already in place. There have been some cases where the old substructure was reused.

The new bridge is moved laterally most commonly with hydraulic jacks, though other methods have been employed, such as a winch. Some minor vertical jacking is typically needed.

SIBC, and ABC in general, is primarily used for bridge replacement projects where the impacts to mobility are significant.

What is SIBC?

- Reduced disruption if substructure can be constructed below the existing bridge
- Minimal disruption likely requires innovative foundation systems
  - Drilled shafts outside footprint of existing bridge
  - Micro or mini piles
  - Integrating cap beams
  - Spread footings
- Prefabricated substructure units

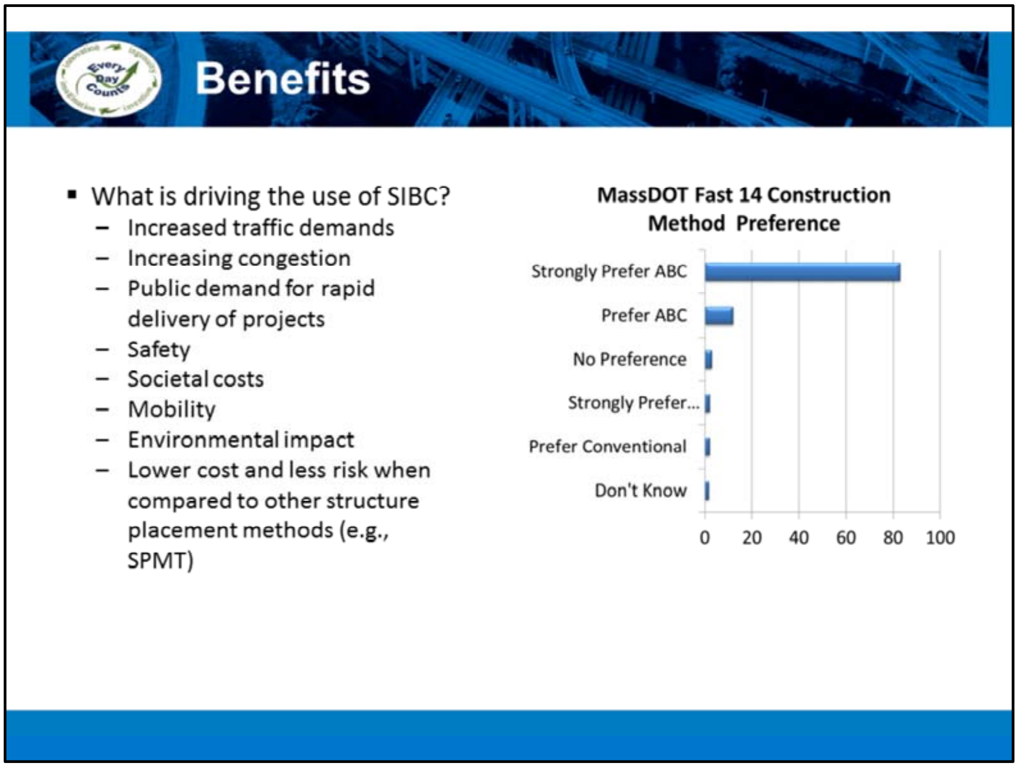
There have been many cases where the new substructure was constructed beneath the existing bridge prior to demolition. As you can predict, this expedites the process from demolition to bridge slide.

It should be pointed out, however, that constructing traditional foundation systems might not be feasible. Rather, an innovative foundation system might be required when using this method.

It is possible that prefabricated elements could play a key role in constructing the new substructure.

One might believe that bridge slides are only used for sliding a new bridge into the position of the existing. This is most commonly the case, but SIBC is not limited to only sliding new structures.

Existing structures can be slid to a new alignment to serve as a bypass bridge while a new bridge is constructed using more traditional methods. Keep in mind that in this case, the temporary substructure system will be subjected to live and other transient loads in addition to the bridge itself, typically resulting in a more robust, and hence higher cost, to such an installation.



So, what benefits can be gained by using slide-in bridge construction? Maybe the better question is 'What is driving the use of SIBC and how is it that SIBC addresses those needs?'

Traffic demands are increasing, congestion is increasing – both create an unnecessary nuisance in the lives of the traveling public. As such, the public demand for rapid delivery is increasing.

One can see in this chart the overwhelming preference for accelerated bridge construction when polled in Massachusetts prior to the MassDOT Fast 14 project.

Even more, the safety of the traveling public and bridge builders is compromised when bridge projects are long in duration. SIBC alleviates some of this risk by significantly reducing the time main-line traffic is interrupted.

Societal costs, though often difficult to fully quantify, are significantly reduced as well.

Environmental impacts can be softened.

And lastly, the costs can be lower and at less risk when compared to other rapid structure placement methods, such as self-propelled modular transporters, float in delivery, or a heavy crane pick, for example.

To continue with the benefits of using SIBC: non-traditional site options can be offered, cross-overs or shoo-flies are eliminated along with staged construction and long term detours. These things can result in lower construction costs.

When compared to other ABC methods, SIBC often receives better contractor "buy-in", presumably because of the reduced risk that was previously mentioned.

Mobility and environmental impacts can also be reduced and safety is nearly always enhanced for the worker and road user.

Potentially of greatest significance is that SIBC promotes user and worker safety. Safety is nearly always enhanced for the worker and road user; this can not be understated.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Environmental impacts can also be reduced.

Lastly, SIBC removes the bridge construction from the critical path which may lead to a better quality end product, it involves the public by reducing societal costs, thereby creating better "buy-in", and road closures can be better managed.

Along the way, we'll take a minute to quickly highlight a project to emphasize a couple of points. The first project highlighted is I-84 at Dingle Ridge Road in New York.

A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

Though the benefits are great, one must be aware that some potential challenges exist.

While some personnel within the DOTs embrace innovative methods, others are more resistant and tend to lean on traditional construction methods. This resistance can stall a potential SIBC project.

Finding experienced contractors and/or heavy lift engineers can be a challenge, though that challenge is being lessened as more and more SIBC projects are being completed and contractors become more familiar with the process.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

In traditional construction projects it is common that unique bridge geometry, difficult foundations, or lack of space can present a challenge. These aspects are only magnified by the nature of SIBC.

A sound traffic management plan with contingency plan included is a must.

This method of bridge construction is relatively new, and as a result, there may be some contractor limitations.

For example, significant temporary shoring and unconventional schedules are often required.

During slide operations, a 24 hour commitment from the contractor, designer, and owner is necessary.

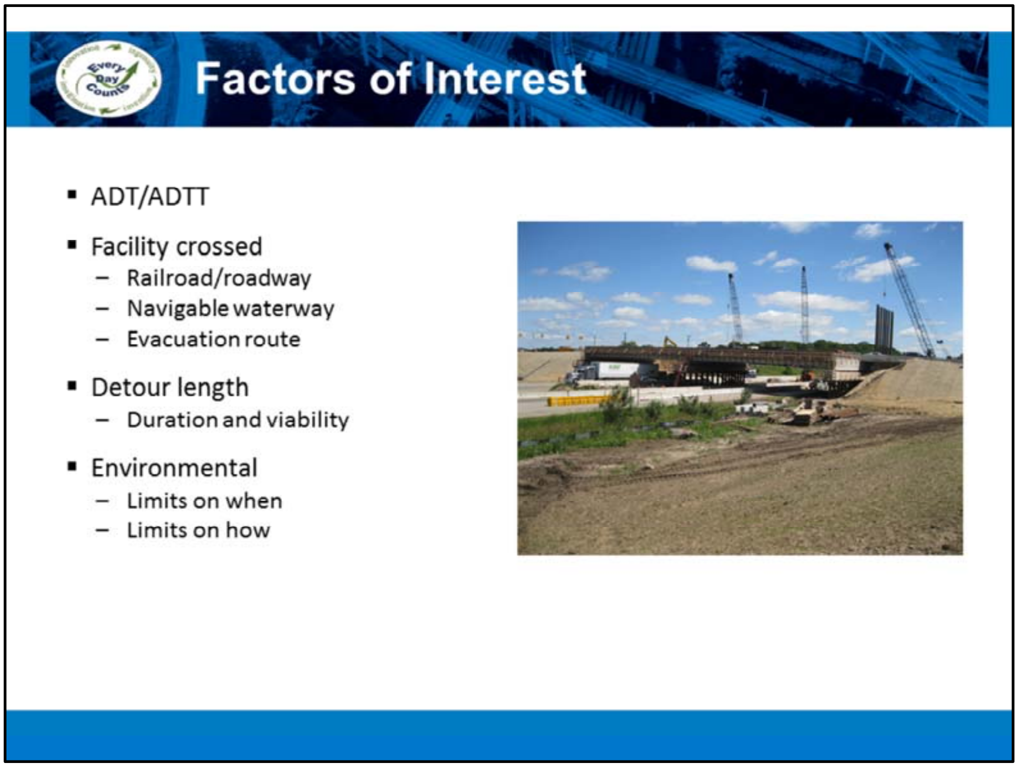
There are periods during the overall SIBC process that require extended time for the contractor, owner, and designer and, as a result, worker fatigue be an issue if not properly managed. Multiple crews can help alleviate this potential problem.

Even more, difficult foundations, equipment breakdowns, and the speed required to complete approach work can present a challenge.

Also, significant, critical time can be lost to surveying mistakes.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

To highlight another project, the Elk Creek project in Oregon was faced with numerous challenges that could be considered somewhat unique to this project. For example, the site, located in the mountains of western Oregon, did not afford ample space or flat terrain from which a new bridge could be easily constructed and slid into place. Nonetheless, the successful completion of this project using slide in construction proved that slides can be effective even in very confined locations.

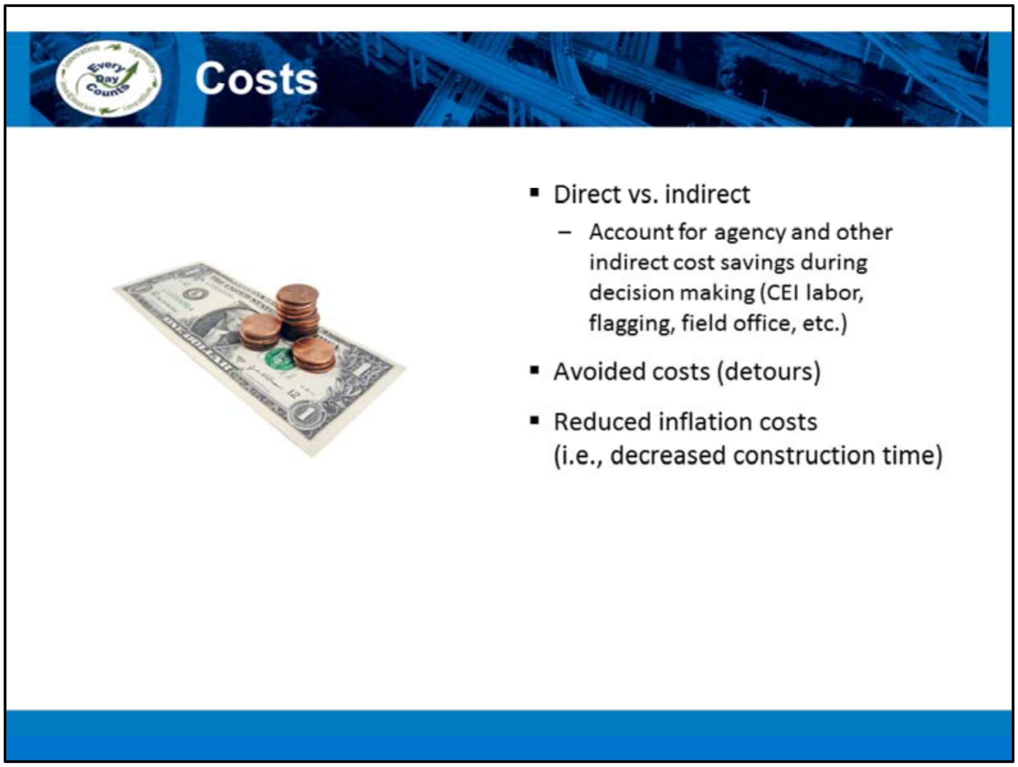


Some factors of interest to consider when making an initial decision for or against SIBC include: average daily traffic, the facility that is being crossed (railroad, roadway, other?), the detour length (duration and viability), and environmental effects (limits on when and how).

Factors of Interest

- On critical path of entire project
- Available right of way for bridge construction
- Traffic analysis
- Contractor's work area and ingress/egress ability

Is the bridge on the critical path of the entire project?, is there available right-of-way?, should traffic analysts be engaged?, where will the contractor's workspace, entrances, and exits be located?.



If comparing only the costs of building a bridge using traditional methods and slide-in bridge construction, it is possible, and maybe even likely with the first projects, that SIBC costs will be higher.

It has been found, however, that the costs become more aligned when including other project related costs such as direct versus indirect costs and detour costs. These costs are often not included in the bid; therefore it is not appropriate to compare conventional construction costs with ABC costs.

Project planners should evaluate the total construction cost when making decisions.

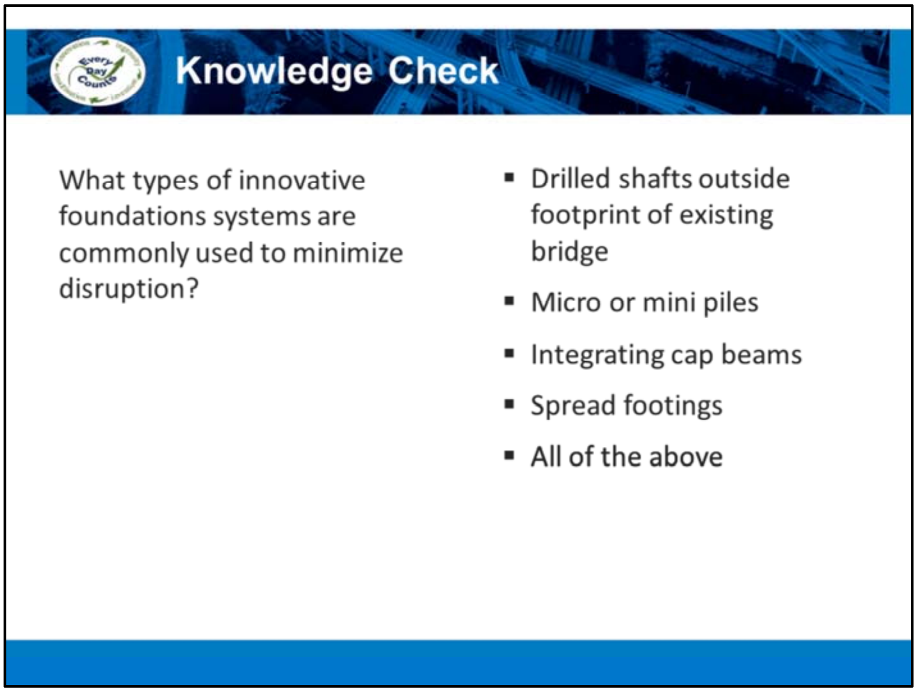
Even more, due to the decreased construction time, overall inflation costs can be reduced, specifically the risk of price escalation of steel and fuel can be minimized.

The next project highlighted is the Mesquite Interchange in the state of Nevada. The total interchange reconstruction cost was $15 million, $10 million less than the original $25 million estimate. A significant amount of the cost savings stemmed from the decision to slide each of the two bridges being replaced. Traditional construction would have required a complete realignment of the mainline pavement and interchange reconfiguration. Instead, the interchange was left in its original configuration and the bridges constructed adjunct to the existing.

To this point, SIBC has been defined, some benefits and challenges have been listed, and factors of interest shown. You'll now get an opportunity to check a bit of your knowledge.

In SIBC, the new bridge is constructed "blank" to the existing bridge on "blank" supports.

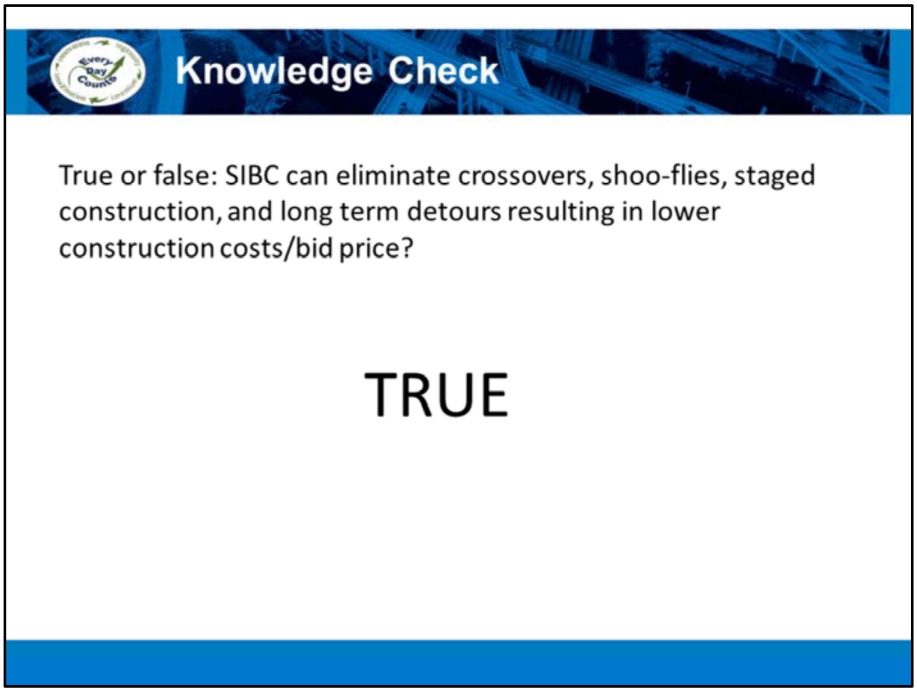
In SIBC, the new bridge is constructed "parallel" to the existing bridge on "temporary" supports.



What types of innovative foundations systems are commonly used to minimize disruption?

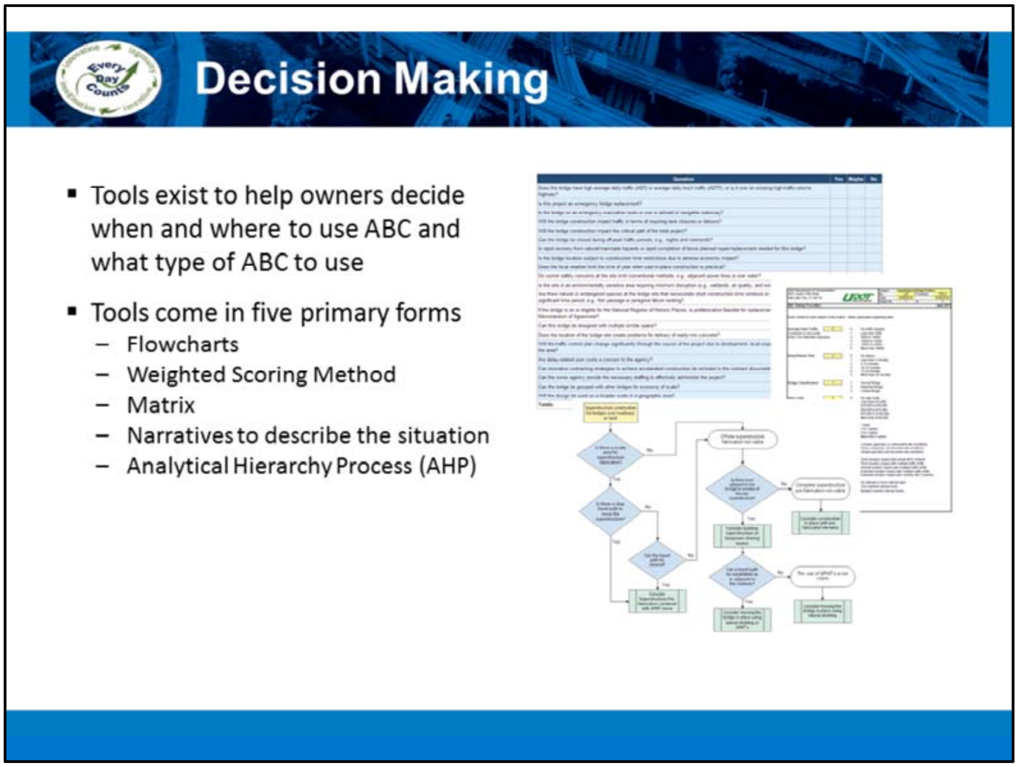
Drilled shafts outside footprint of existing bridge?
Micro or mini piles?
Integrating cap beams?
Spread footings?
Or
All of the above?

The answer: All of the above. Each of the options are commonly used to minimize disruption.



True or false: SIBC can eliminate crossovers, shoo-flies, staged construction, and long term detours resulting in lower construction costs/bid price?

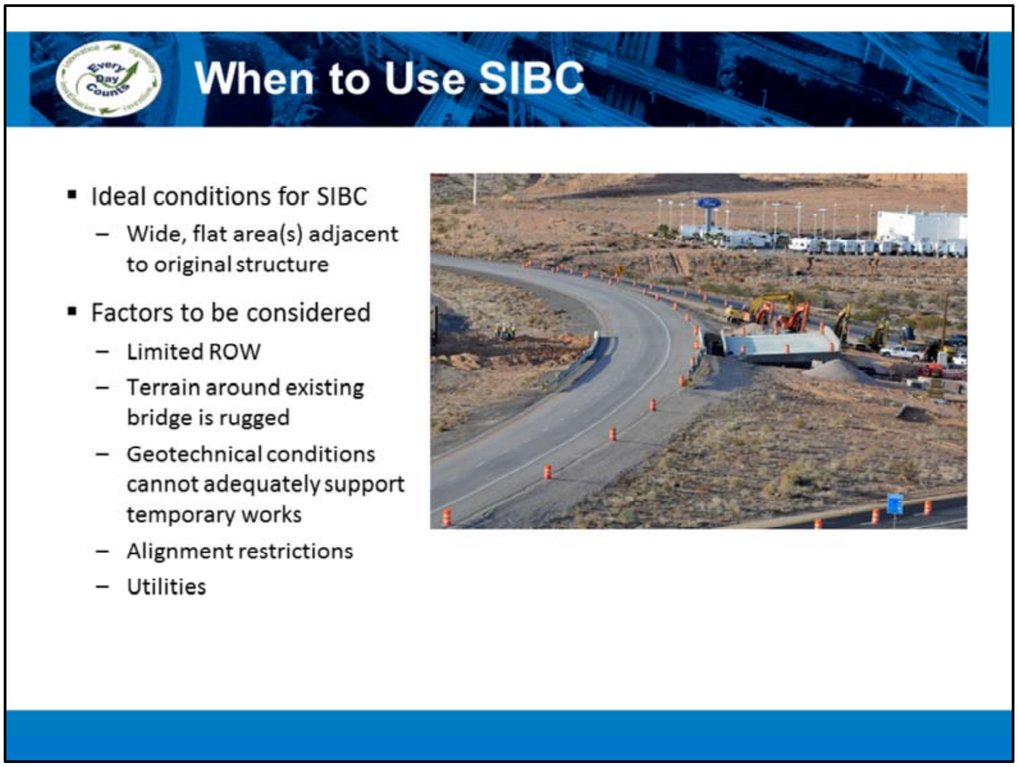
True



The decision to use non-traditional construction methods can be difficult so several tools have been developed that help owners decide when and where to use accelerated bridge construction and slide-in bridge construction methods.

These tools include the flowchart method, the matrix method, the weighted scoring method, the narrative method, and the analytical hierarchy process. The following slides will take a closer look at each of these methods.

Regardless of the data, ultimately a firm commitment from all concerned to stay the course through is needed for a successful and economical project.



So, you might be asking yourself, ‘When should I consider using slide-in bridge construction’?

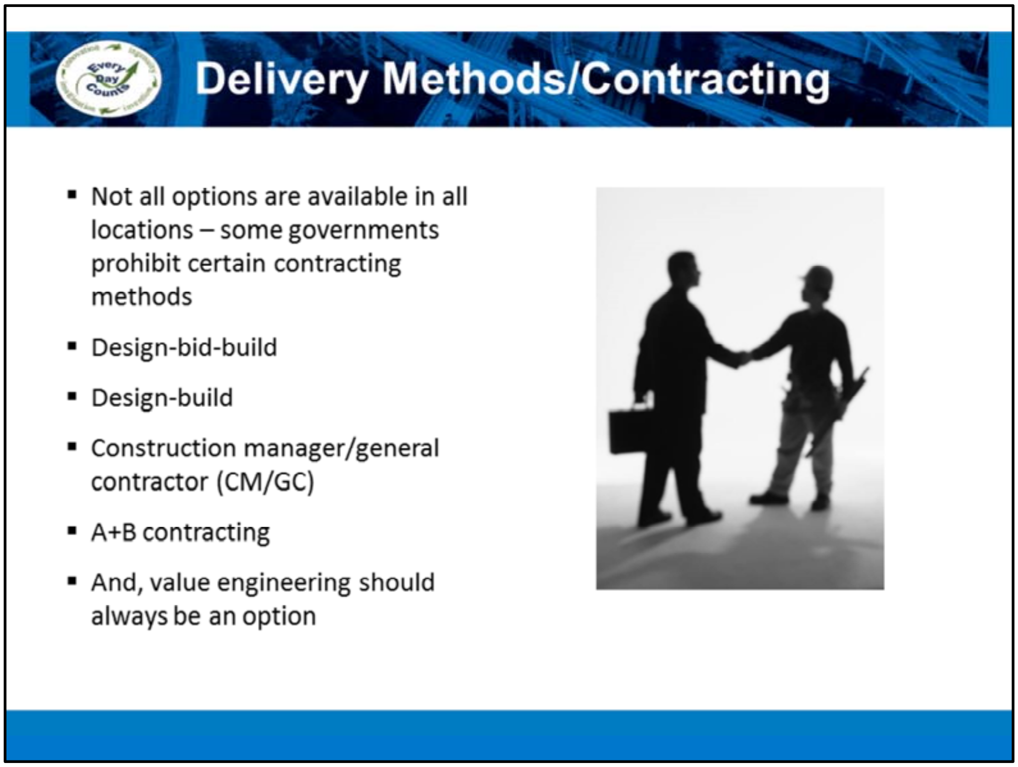
Ideally, sites with wide flat areas adjacent to the existing structure would be found at all bridge locations. But since this is rarely the case, one has to look beyond the ideal locations and consider other factors.

Factors such as, right-of-way, terrain, geotechnical conditions, and alignment restrictions. If right-of-way is limited, can temporary right-of-way be made available?

Rugged terrain doesn’t necessarily prohibit the use of SIBC, but does introduce another challenge.

Since temporary works will be significant and require supporting the entire superstructure, the adequacy of geotechnical conditions is key.

One should also consider alignment restrictions and utility locations.



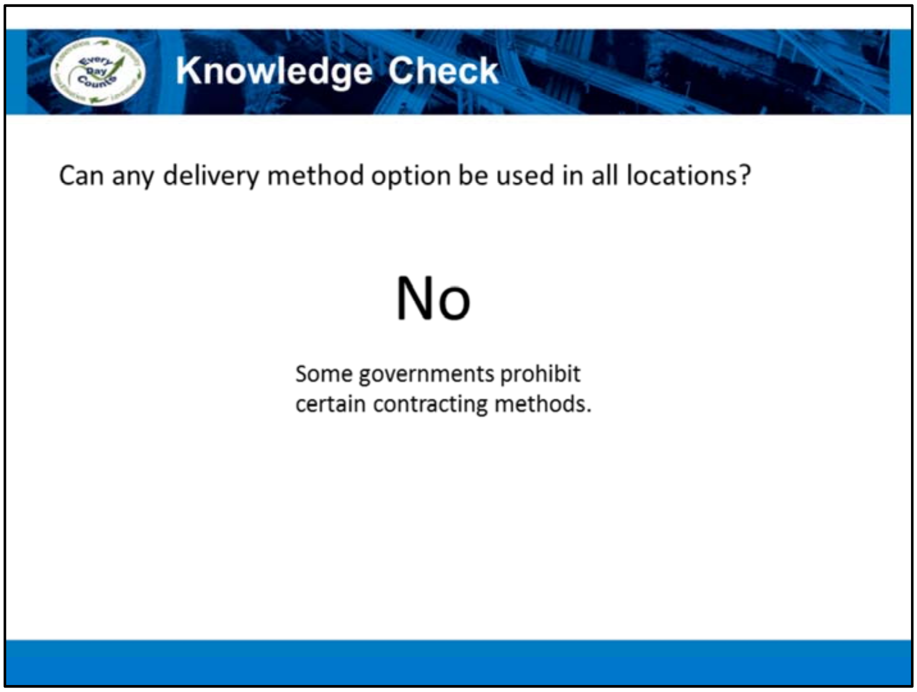
It should be noted that not all options are available in all locations as some methods are prevented by existing state government laws or policies, but numerous delivery and contracting methods exist nationwide.

These include Design-Bid-Build, Design-Build, Construction Manager General Contractor, A+B contracting, and value engineering.

Two projects successfully completed using design-build contracting methods are the Elk Creek project in Oregon and the Mesquite Interchange project in Nevada.

The Mesquite Interchange team proposed slide in methods and were able to save 6 months and $10 million.

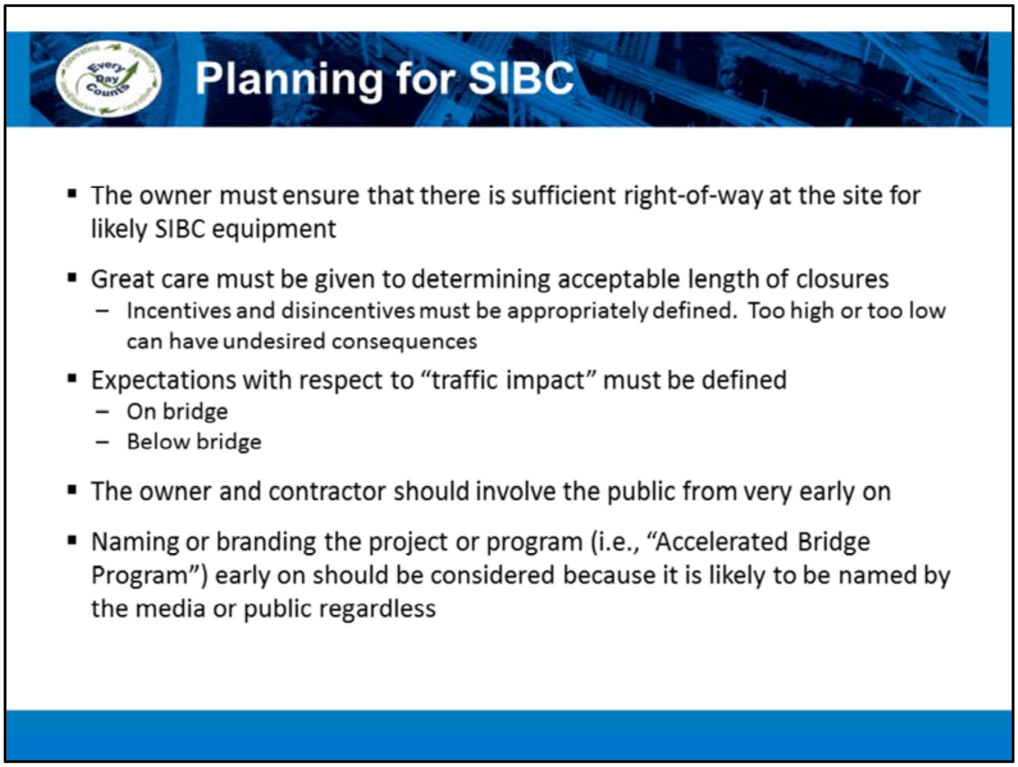
The Elk Creek design-build team was first to propose slide in methods and, in doing so, saved 22 months and $3 million.



The next knowledge check looks at delivery methods.

Can any delivery method option be used in all locations?

Answer: No, some governments prohibit certain contracting methods.

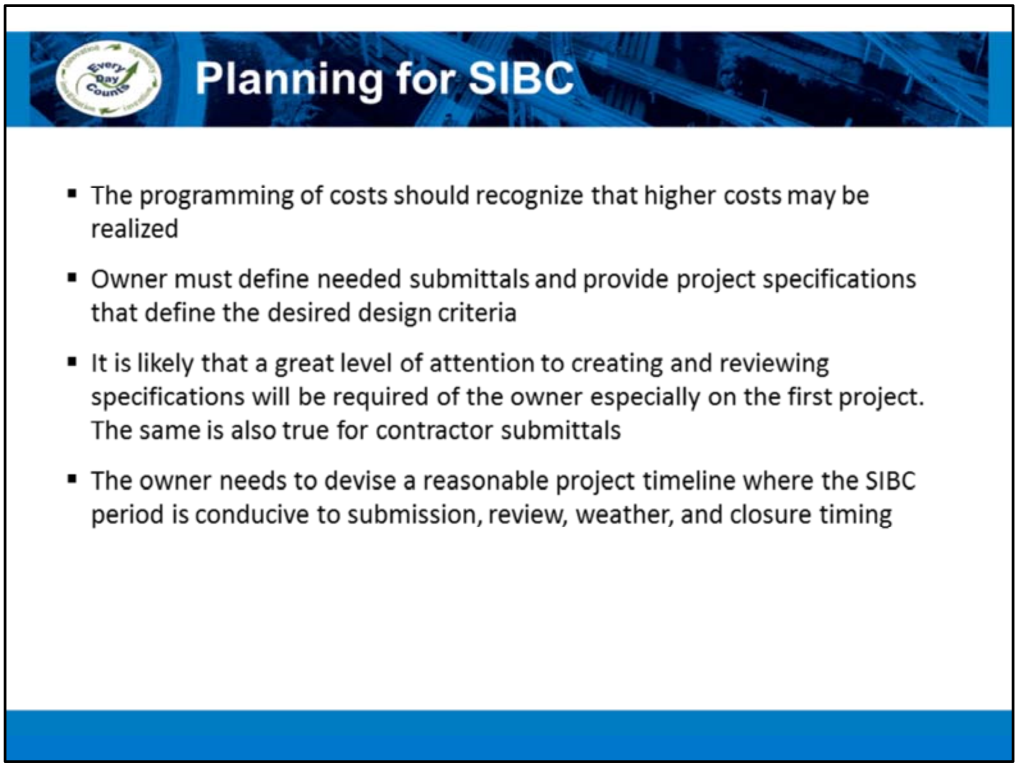


Planning for slide-in bridge construction generally follows that of traditional construction, yet there are some other unique items one must also plan for.

For example, the owner must ensure that there is sufficient right-of-way at the site for likely SIBC equipment and cranes for erection of beams, and it might be more space than anticipated.

A comprehensive study of an acceptable length of closure must be completed to appropriately assign incentives or disincentives. The owner must define the expectations to traffic impact, whether that be on the bridge or below the bridge.

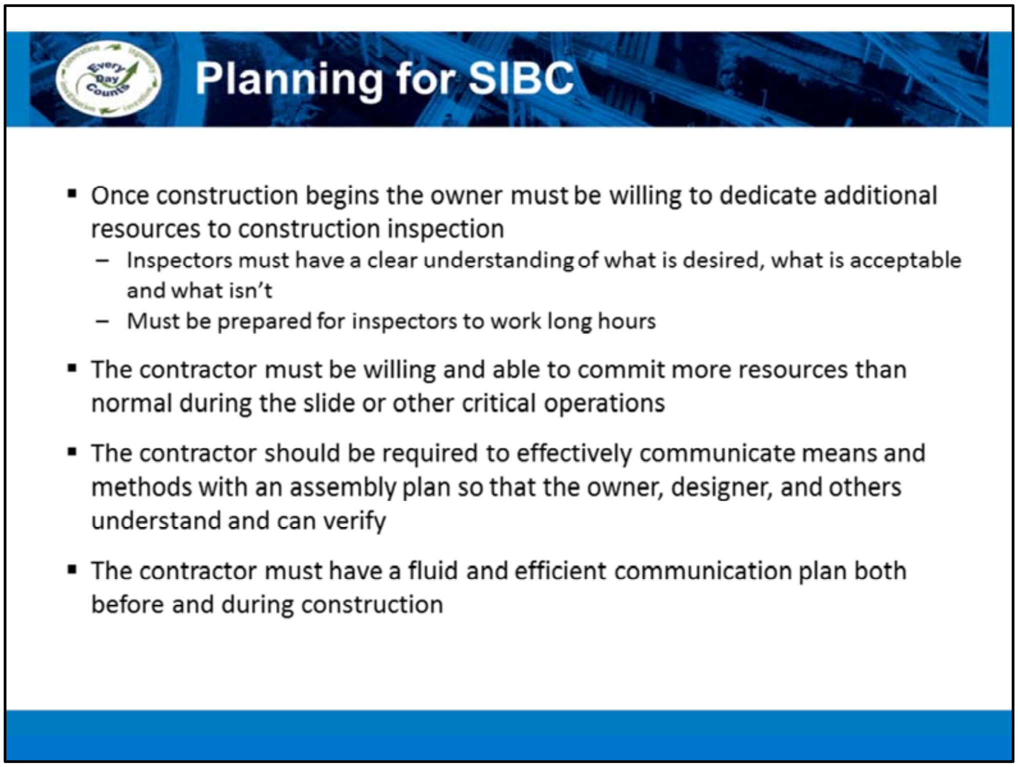
The owner and/or contractor should involve the public from very early on to communicate the intent and expectation for using SIBC. Given that SIBC is an innovative method for bridge construction, it is likely to draw the attention from the public and media. For this reason, naming or branding the project or program should be considered since it will undoubtedly be named by someone.



Higher overall costs, especially for initial SIBC projects, may be realized and should be addressed when programming.

Additionally, the owner must define any needed submittals and provide project specifications that define the desired design criteria.

It should come as no surprise that creating and reviewing specifications and submittals will require more attention, especially on the first project. Accordingly, the owner should devise a reasonable timeline to accommodate the added attention and so that weather and closure times can be best mitigated.



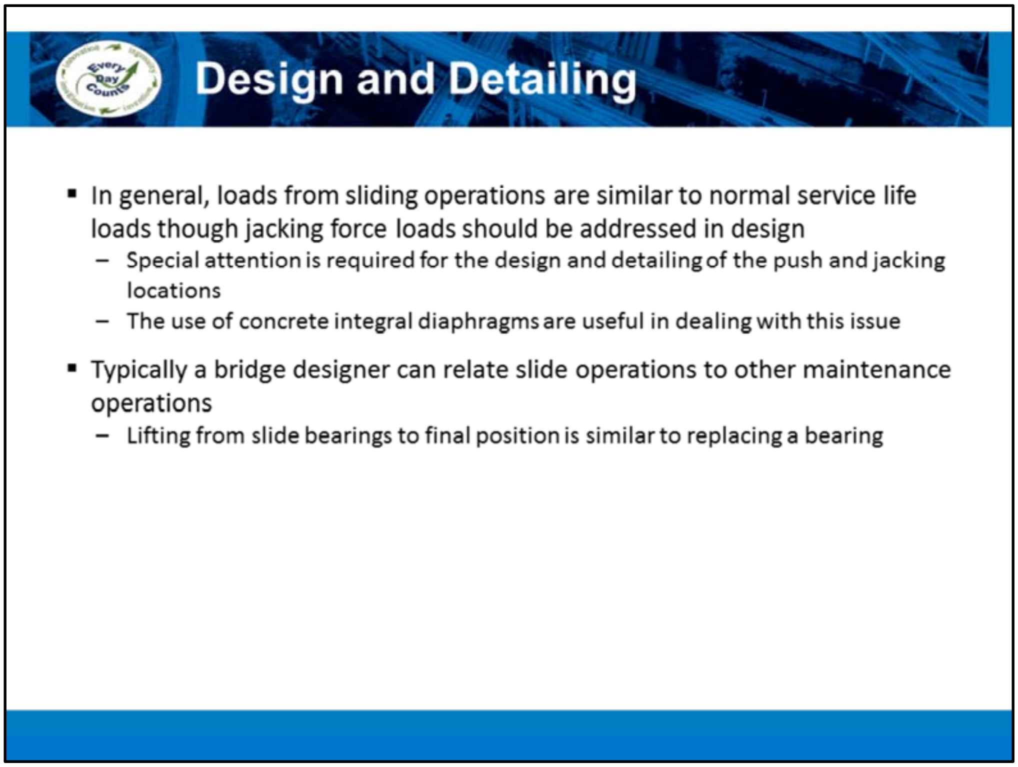
It should be expected that once construction begins, additional owner resources will be required in the form of construction inspectors.

Ensuring inspectors have a clear understanding of what is acceptable will take additional time. Even more, inspectors may have to work longer hours. Given the time-sensitive nature of SIBC during slide operations, a contractor must be willing and able to commit more resources than normal.

Also, an assembly plan is critical so that the contractor can clearly communicate his means and methods. His overall ability to efficiently communicate both before and during construction will be key to success.

Lastly, the contractor must have a contingency plan that addresses these questions and others. What should happen during an emergency response, or equipment failure? What if an extended detour time is required and what if there is an accident on the detour? What happens if severe weather approaches?

Project specifications should include the minimum contingency scenarios. The specifications should also encourage the contractor to determine and plan for other contingency plans.

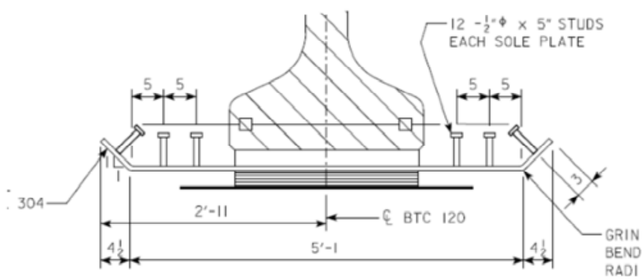


The design and detailing of a bridge slated for slide-in bridge construction is more similar than different from that of a traditionally constructed bridge. In general the loads during sliding operations are minimal and likely will not exceed loads typically seen during normal service life.

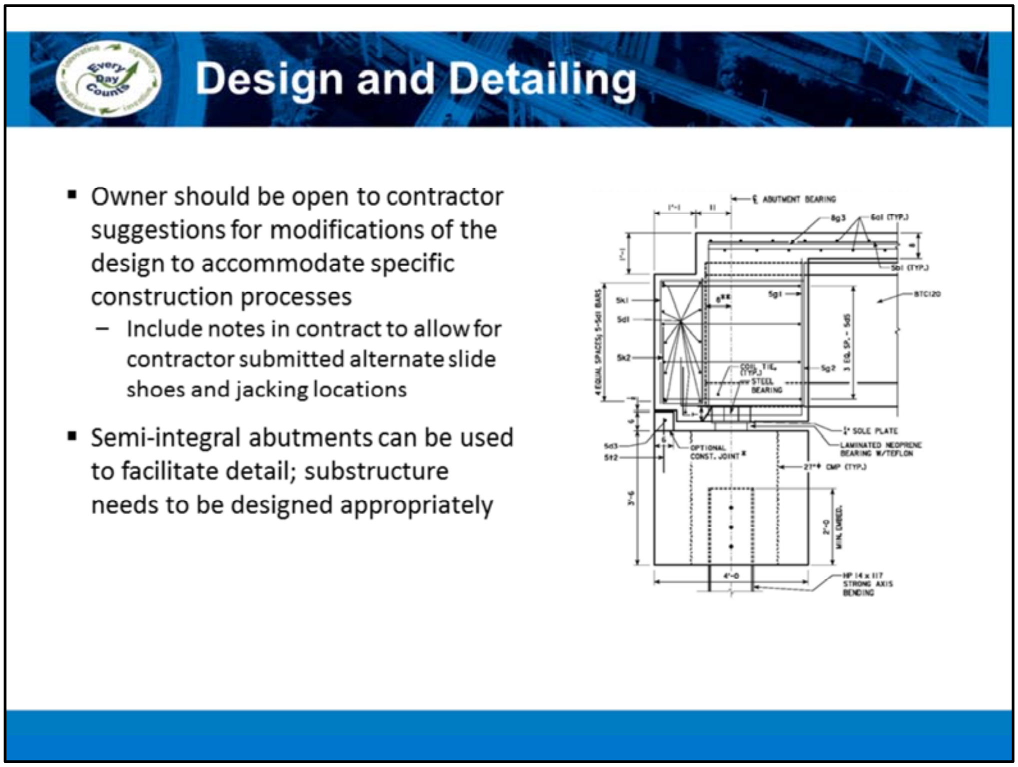
It is at the jacking locations that additional loads should be addressed. The use of concrete integral diaphragms are quite useful in dealing with this issue, an example of which is shown along with a slide plate in this detail. Forces can best be related to those seen in maintenance operations. For example, replacing a bearing.

Design and Detailing

- Details are dependent on the slide system used
- Detailing of slide shoes and bearings required
- Jacking locations needed for bearing change-out.

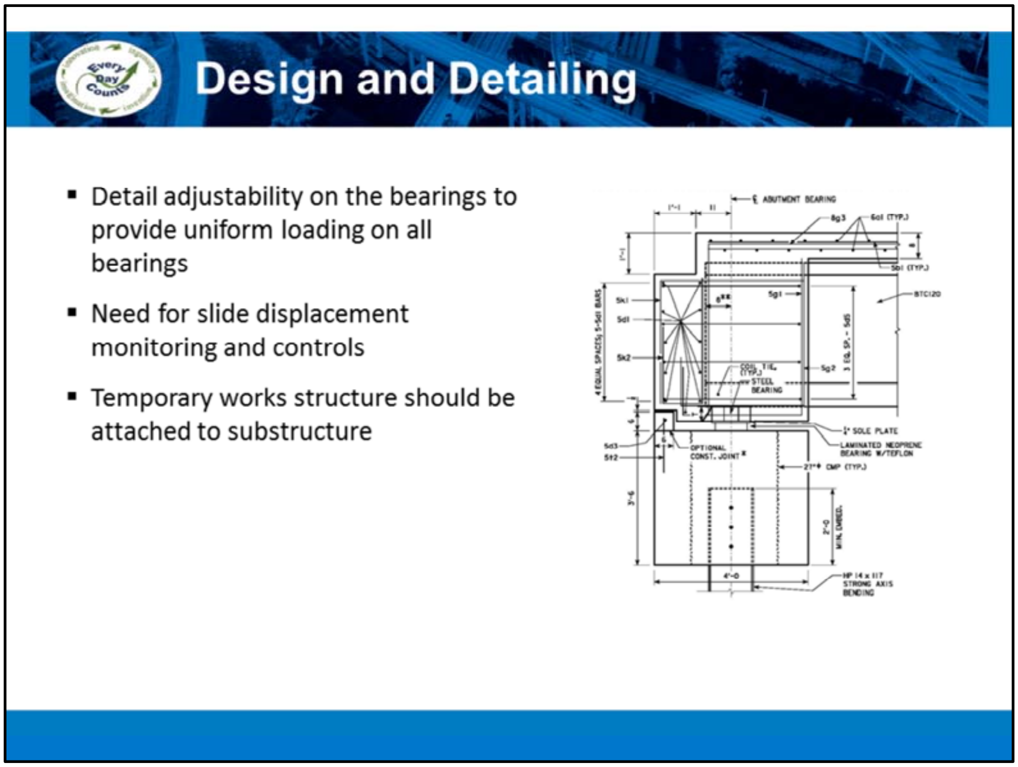


Special attention should be paid to the detailing of slide shoes, bearings, and jacking locations if bearing change out is required.



Even more, the owner should be willing to entertain a contractor's suggestions for design modifications that would enable a specific construction process to be completed with other equipment or in a different manner.

A semi-integral abutment with properly designed substructure can be used to facilitate slide details and modifications. In general, the slide surface should be level. This means that the depth of the semi-integral diaphragm will vary with roadway cross slope.



Adjustability should be provided on the bearing to ensure uniform loading on all bearings.

A system for monitoring displacement during the slides should be in place.

Lastly, it is greatly beneficial to the overall substructure design, both permanent and temporary, to attach the temporary works to the permanent substructure.

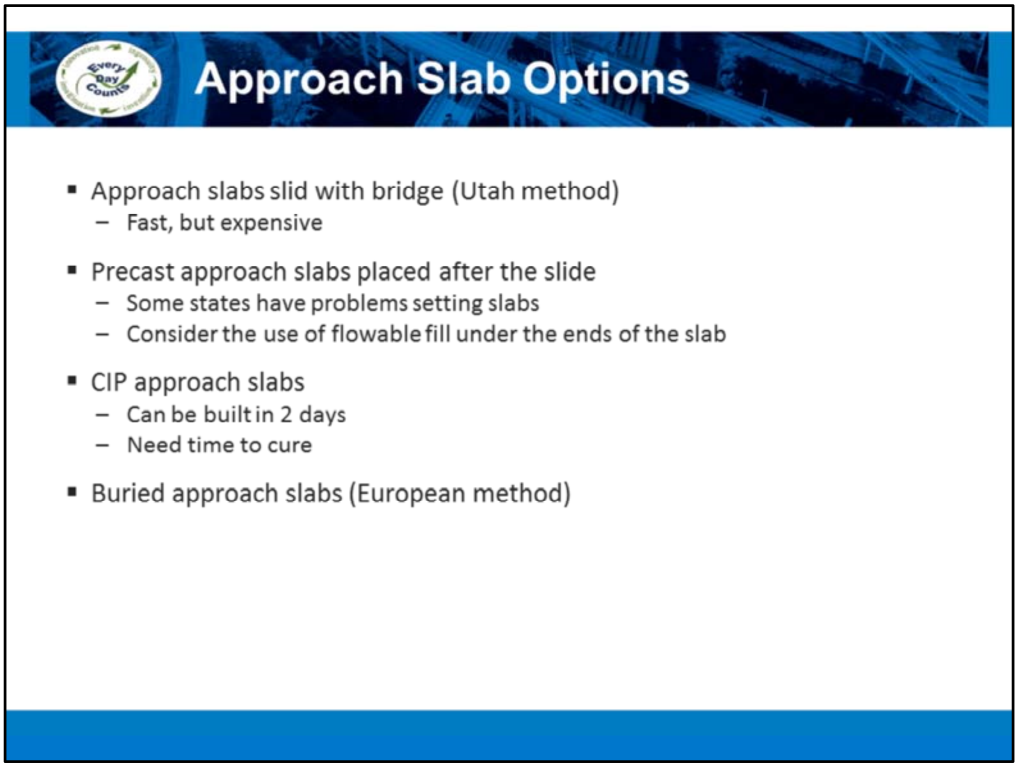
Generally the temptation is to treat the bridge as very fragile when being moved and placed, while this is appropriate, this should also be tempered with the perspective that bridges are, in fact, quite strong and durable structures.

As part of the Massena, Iowa bridge slide, semi-integral abutments act as the jacking locations and the temporary works were attached to the substructure. Together these details proved to be an effective means for sliding the superstructure.

Not to be lost with the significant focus on the constructability and slide of a new superstructure are the approach slabs. Attention to approach slab design and construction should be priority, rather than an afterthought.

Several methods have been used including the ‘Utah Method’ which involves sliding the approach slabs with the bridge, precast approach slabs placed after the slide, cast-in-place approach slabs, or even buried approach slabs commonly referred to as the ‘European Method’.

A site-specific evaluation should be completed to assess which method is best. Most DOT’s have standards for this item that are not compatible with SIBC; again perspective is key. Age-old standard details can often be placed on a pedestal resulting in resistance to otherwise reasonable alternatives.



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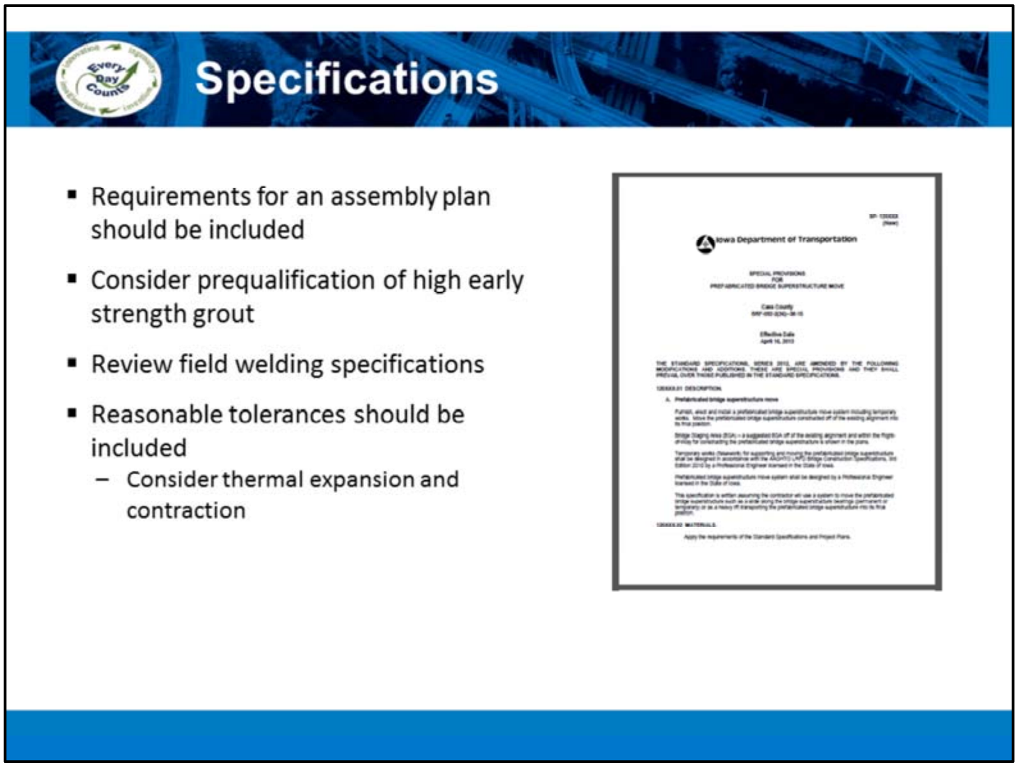
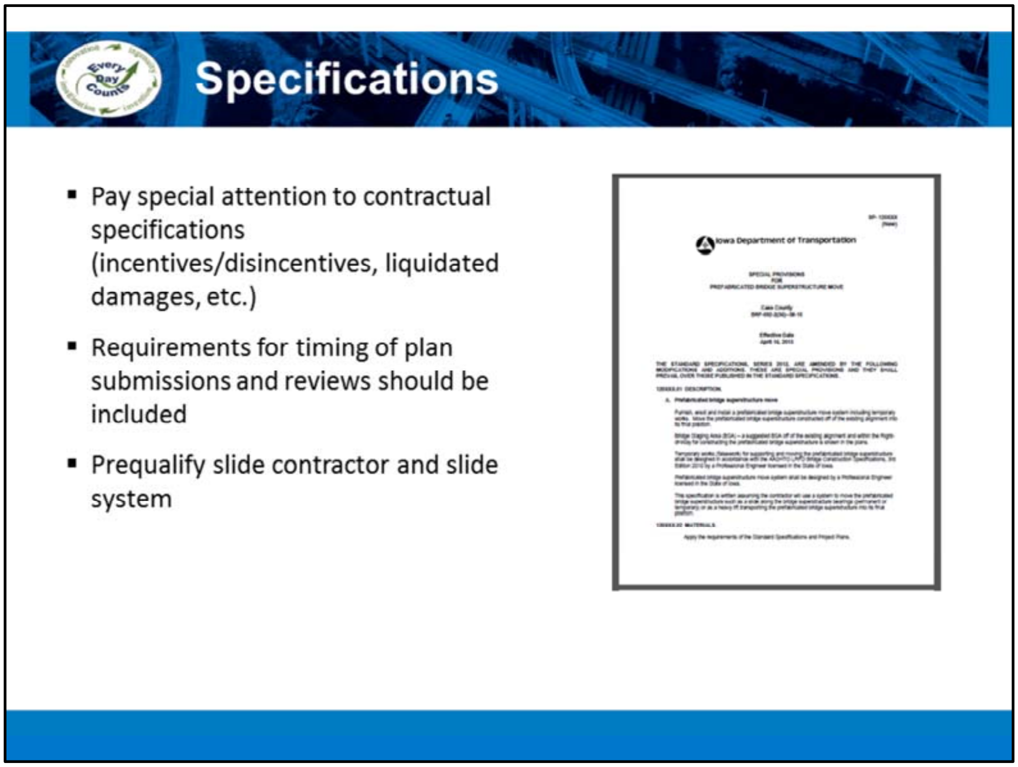


Specifications for slide-in bridge construction projects largely resemble those of a traditionally constructed bridge. However, additional specifications or modifications of existing specifications should be provided that cover the unique aspects of a slide-in project.

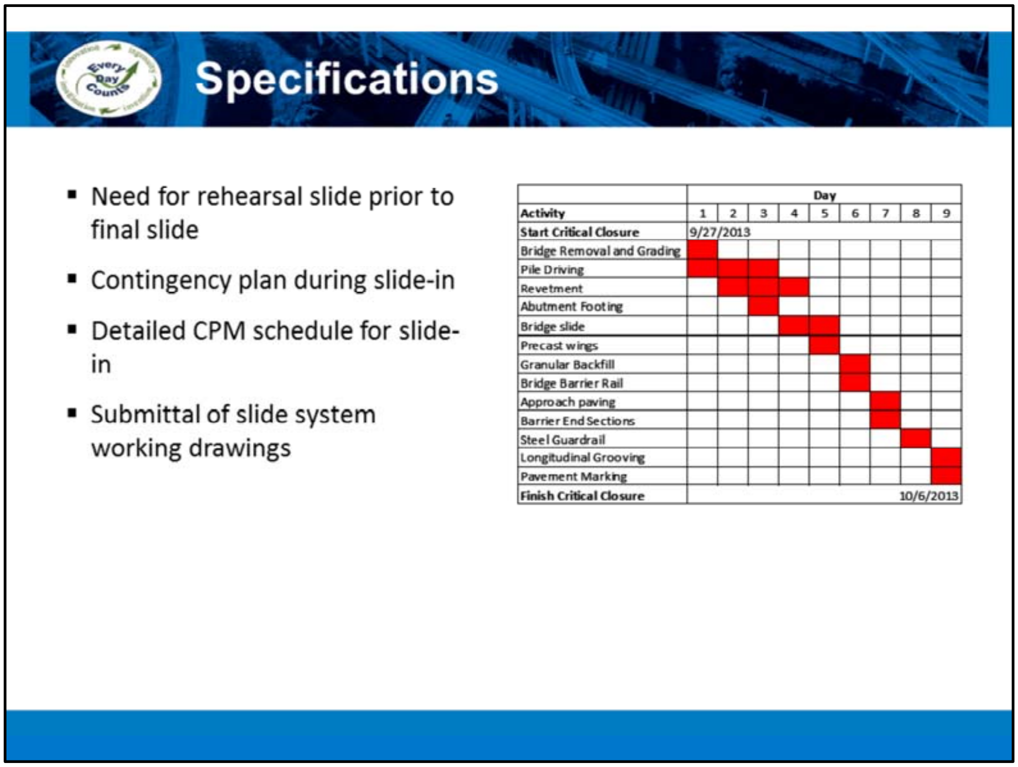
For example, requirements for an assembly plan should be included. The assembly plan is similar to an erection plan, except it includes more detail on the temporary works and equipment. It also includes a step by step plan for the completion of the work including schedule.

Prequalification of high early strength grout and review of field welding procedures should be considered. Reasonable tolerances should be included that accommodate thermal expansion and contraction, and the fact that the bridge will be moved.

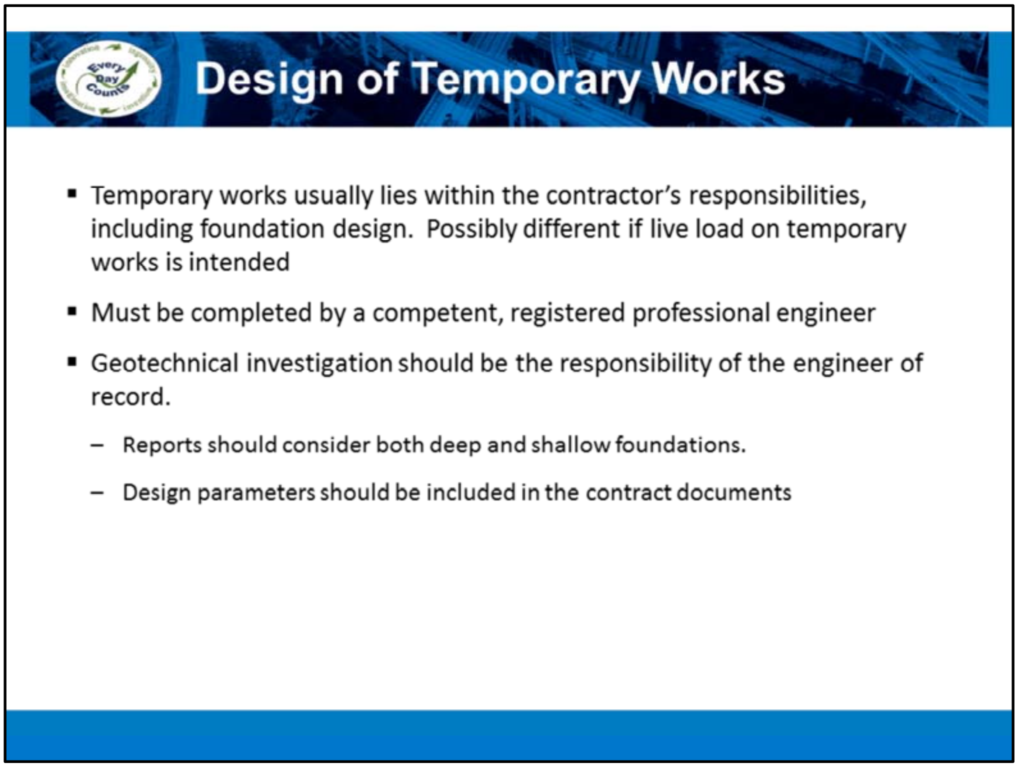


Special attention should be paid to contractual specifications such as incentives and disincentives or liquidated damages. Requirements for timing of plan submissions and reviews should be included.

Possible prequalification of the slide contractor or the project superintendent and slide system should be considered.



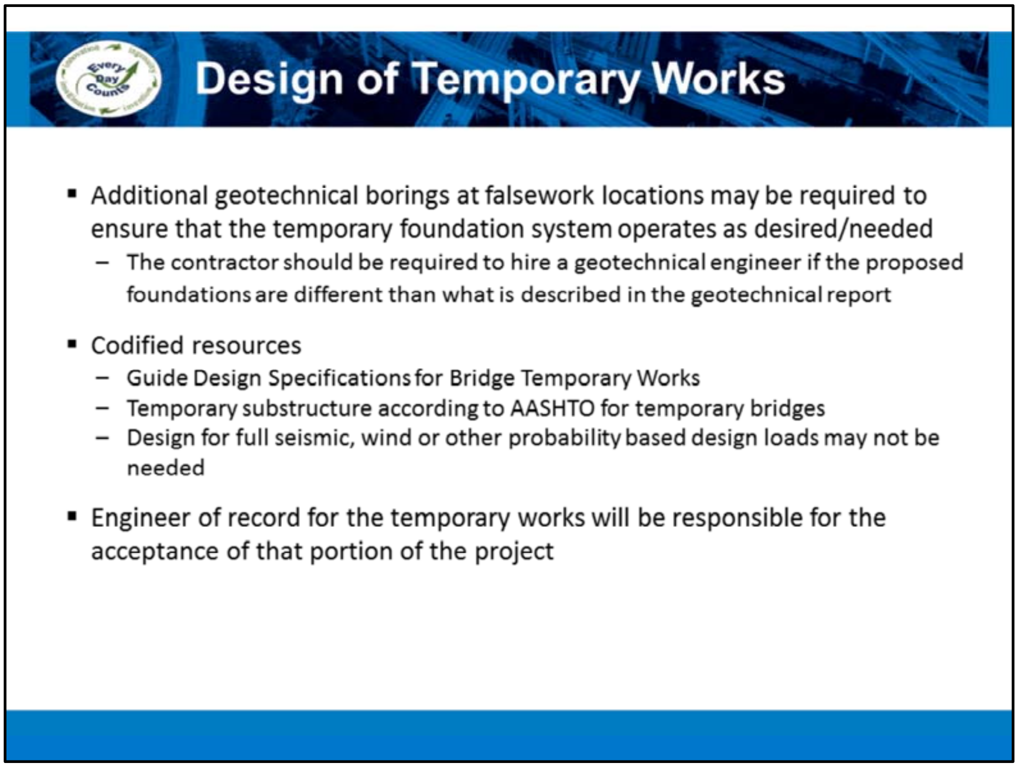
Additional specification considerations include: the need for rehearsal slide prior to final slide, a contingency plan during slide-in, a detailed CPM schedule for slide-in, and the submittal of slide system working drawings.



In most cases, the design of temporary works lies within the contractor's responsibilities. Though if the traveling public will at least minimally travel over the temporary works, the responsibility may lie elsewhere.

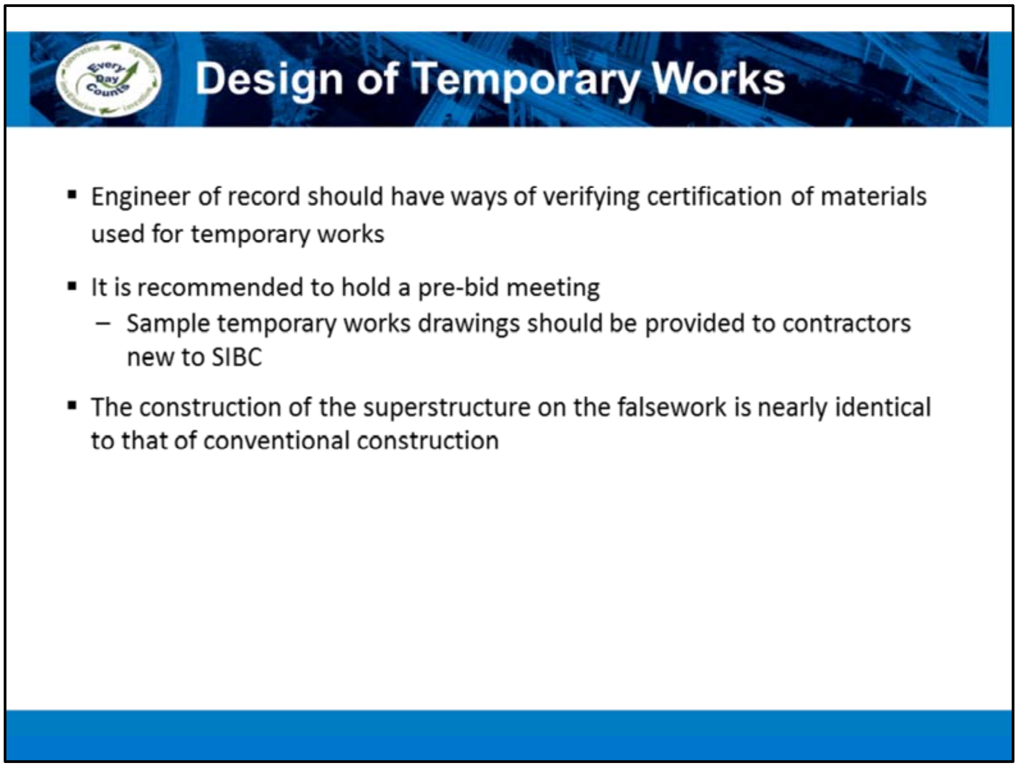
The design must be completed by a competent, registered professional engineer. The engineer of record should be responsible for the geotechnical investigation around the site including the area proposed for temporary works.

Both deep and shallow foundations should be considered and all design parameters included in the contract documents.



If temporary works foundations different than those considered are proposed by the contractor, it is required of the contractor to hire a geotechnical engineer. Several codified resources exist to guide the temporary works design including those listed here.

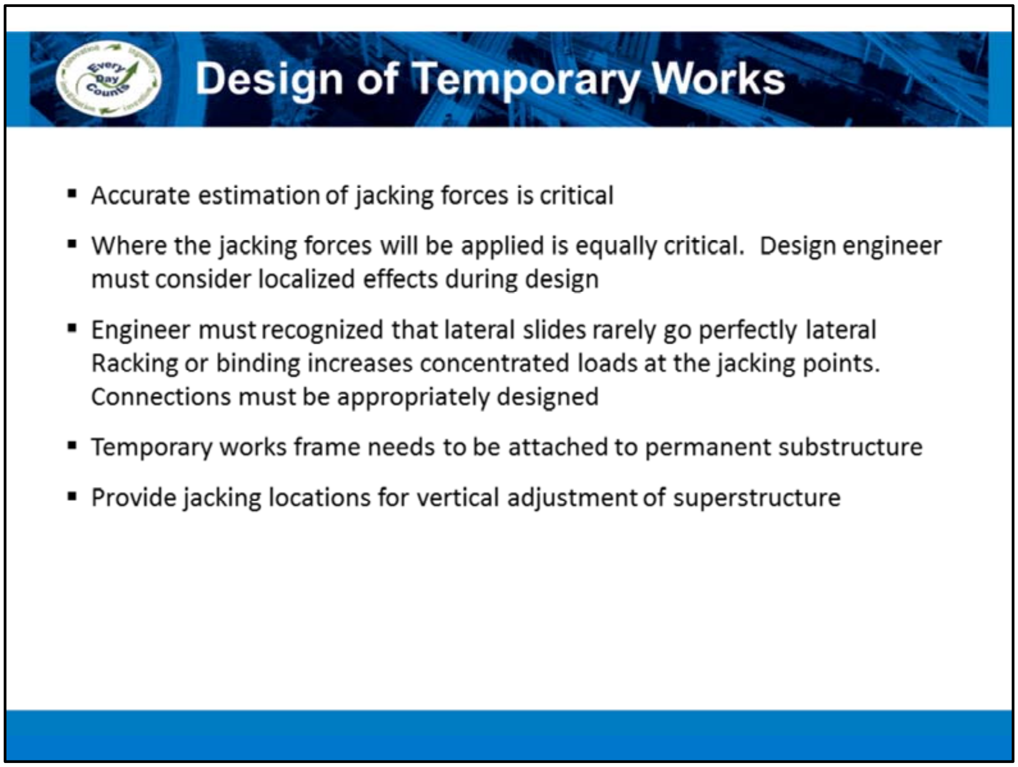
In the end, acceptance of the temporary works will be up to the engineer of record for the installation.



Further, the engineer of record should have the ability to verify materials certification.

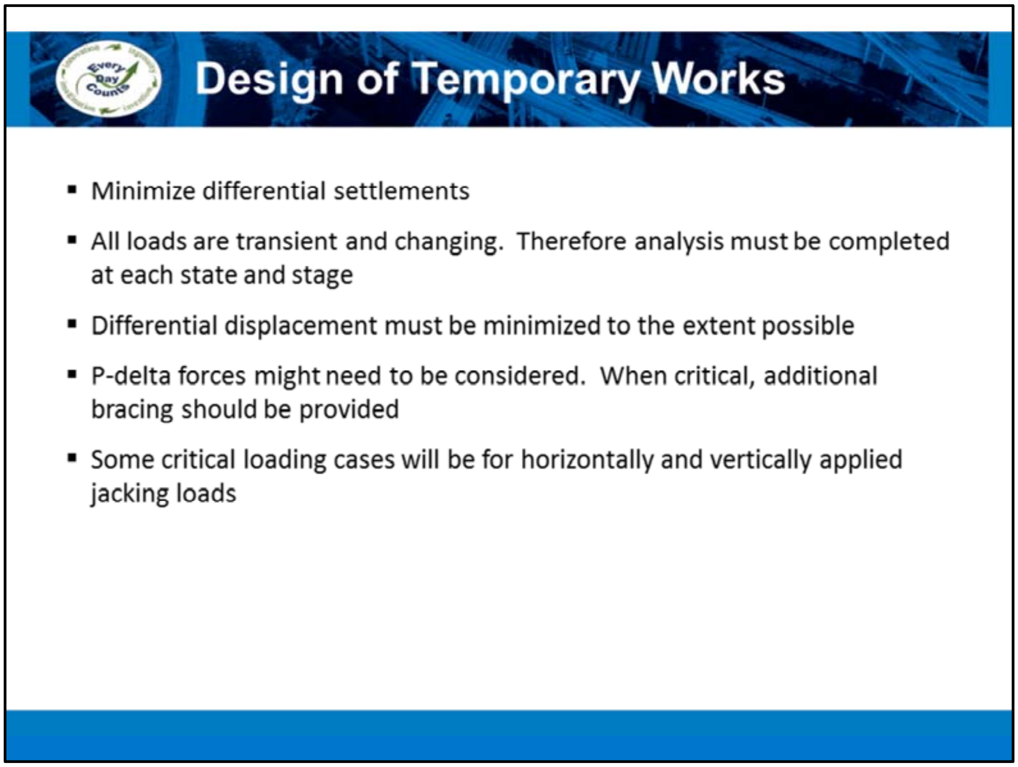
A pre-bid meeting is recommended where sample temporary works drawings can be viewed for those unfamiliar with slide-in construction.

For SIBC, the actual construction of the new superstructure upon the temporary works is very close to that of conventional construction; very few methodical changes are needed.

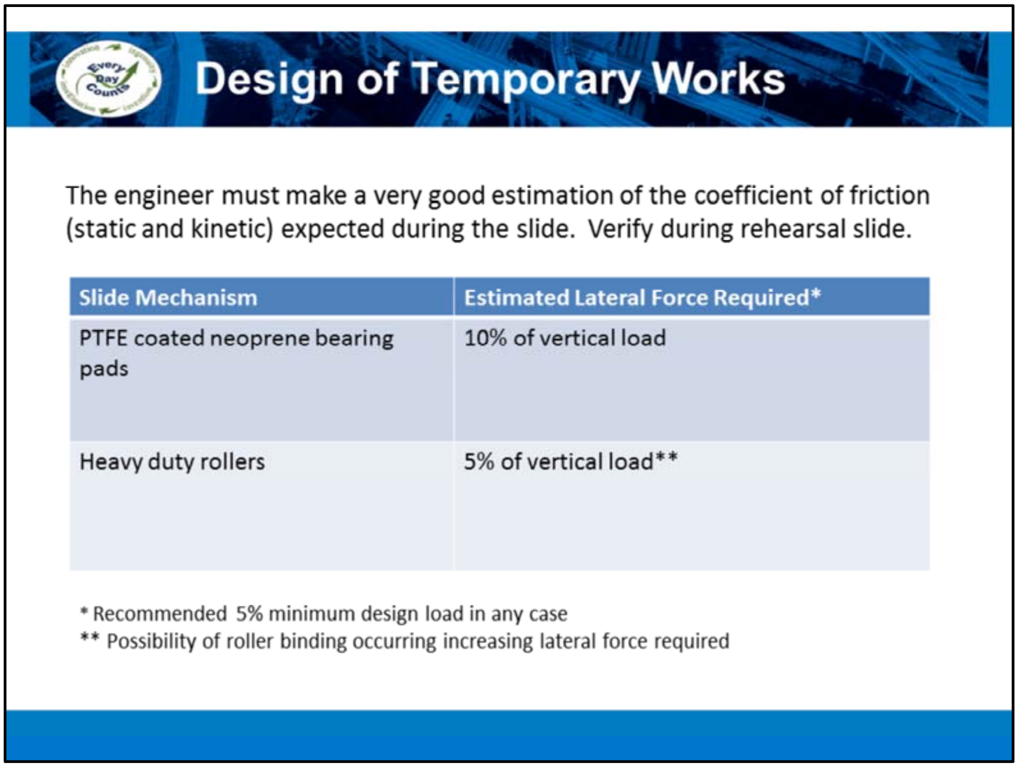


The expected jacking forces and jacking locations are key to the design of temporary works. It should be noted that possible misalignments or hang-ups during slide operations can considerably increase the jacking forces. Accordingly, connections should be appropriately designed.

For reasons discussed earlier, the temporary works should be attached to the permanent substructure. Lastly, jacking locations for vertical adjustment of the superstructure should be incorporated into the design.



Attempts to minimize the differential settlements between permanent and temporary works should be made. Note that all loads are transient and changing; therefore an analysis should be completed for stages throughout the process. Special attention should be paid to differential displacements, p-delta forces, and jacking loads.

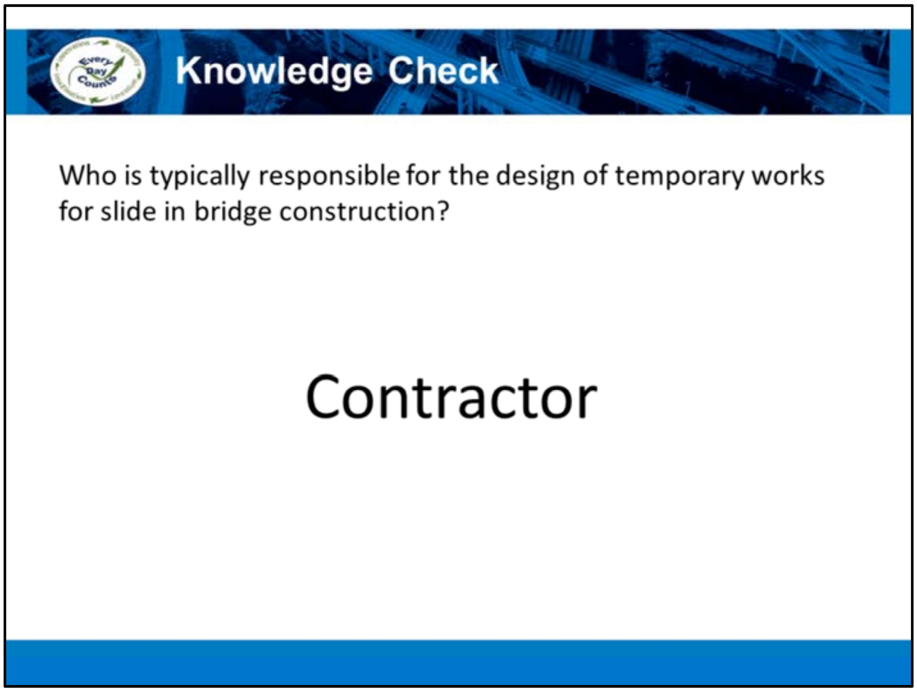


To ensure the proper jacks will be supplied to the project, the engineer must make a good estimation of the friction forces during the slide. These forces should be verified during the rehearsal slide.

Two commonly used slide mechanisms include PTFE coated neoprene bearing pads and heavy duty rollers. The estimated lateral force required is 10% and 5% of the vertical load, respectively. Note that, in addition to the higher forces required during possible binding, a slightly higher force may be required when pushing the superstructure from a static to kinetic state.

Since the engineer of record does not know the make-up of the actual slide system, a recommended value of 10% should be used for preliminary engineering. The plans should show the recommended jacking location on the bridge and the engineer of record should verify that the structure can accommodate this force.

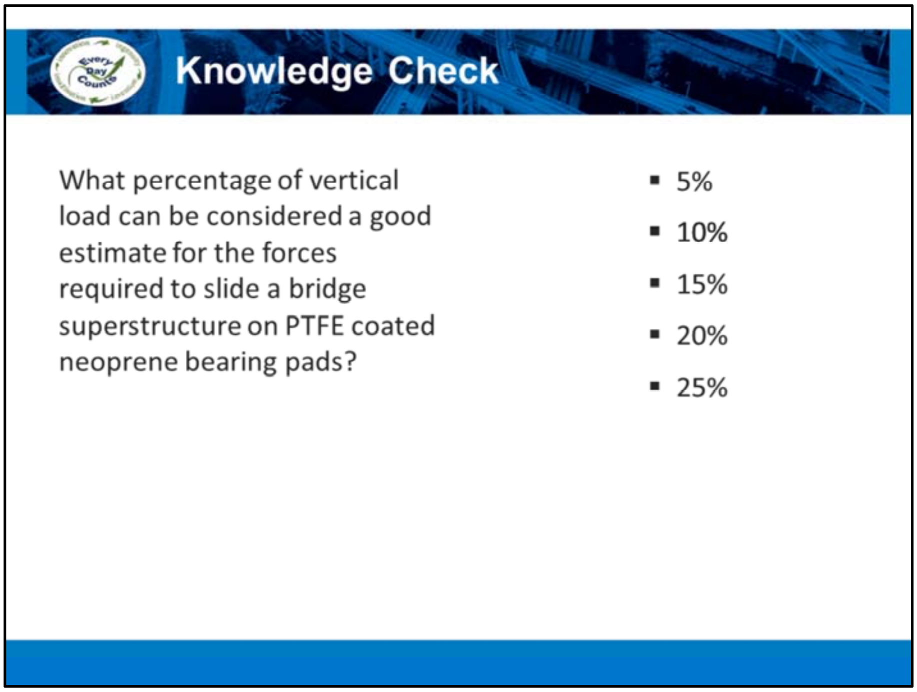
It is key that the transition from temporary supports to the permanent structure be designed to accommodate the transient load and possible differential deflection. The superstructure should experience little effect due to the changing support condition.



Who is typically responsible for the design of temporary works for slide in bridge construction?

Answer: The contractor.

Temporary works usually lies within the contractor’s responsibilities, including foundation design, though this could change if live load on temporary works is intended.



What percentage of vertical load can be considered a good estimate for the forces required to slide a bridge superstructure on PTFE coated neoprene bearing pads?

5%?
10%?
15%?
20%?
Or
25%?

The answer: A good estimate on PTFE bearing pads is 10%. When using heavy duty rollers the force required is generally less, though in both circumstances the loads can increase if binding occurs or an obstruction isn't removed.

Provided in this slide are a few examples of various slide details. Shown in the two pictures to the left are PTFE coated bearing pads along with stainless steel slide shoes. Each pad is coated with dishwashing soap to further decrease the frictional forces; it is available, cheap and effective.

The top picture to the right shows jacking pockets incorporated into the semi-integral abutment used for vertical adjustment and bearing pad change-out.

The bottom picture shows the guide channel used with heavy duty rollers and also threaded rods which are connected to the jack. The slide shoe option works in conjunction with a semi-integral backwall diaphragm. The slide shoe can be just used for the move, or it can be used for the permanent bearing support. By using this method of detailing, the number of permanent bearings can be reduced by more than half. The Utah DOT has designed bridges with only 2 or 3 bearings at each support line.

Additional pictures of hardware commonly used in slide-in applications are shown here. These include rollers, skids, PTFE pads, hydraulic rams, threaded bars, and vertical jacking hardware.

Power Systems

- Hydraulic jack
- Hydraulic push/pull jack
- Winches
- Cranes
- Other equipment

Several power systems can be employed to move the bridge superstructure. These include hydraulic jacks, push/pull jacks, winches, cranes, and even other equipment.

It is recommended that hydraulic equipment be required to be proof tested prior to being put into service, even new jacks can blow out seals and fail.

Submittals were briefly mentioned during the slides addressing the specifications. To further elaborate, some of the submittals that should be required include slide system plans; slide plans including an hour-by-hour schedule, communication plan, and contingency plan; the contractor’s ingress and egress plan; and temporary works, which should be separated from the actual slide due to the timeline in which each is required during the project.

Media and public relations are important on any project.

Bridge design and construction professionals should be cognizant that the traveling public are customers and should be informed.

Due to the unconventional nature of the bridge construction when using slide-in methods and its potential impacts on the traveling public, SIBC projects are likely to garner more attention through the media.

Accordingly, a media and public relations plan should be developed early in the project that communicates the advantages of reducing inconvenience for the trade of possible increased costs.

Sufficient time should be allowed for the public to make alternative plans during the most inconvenient times.

Further, communication with the community prior to setting the schedule will help identify local events that draw additional traffic. Identify periods of least traffic through traffic counts if necessary. Several methods to convey information to the public should be used including the local news, websites, mailings, social media, and others.

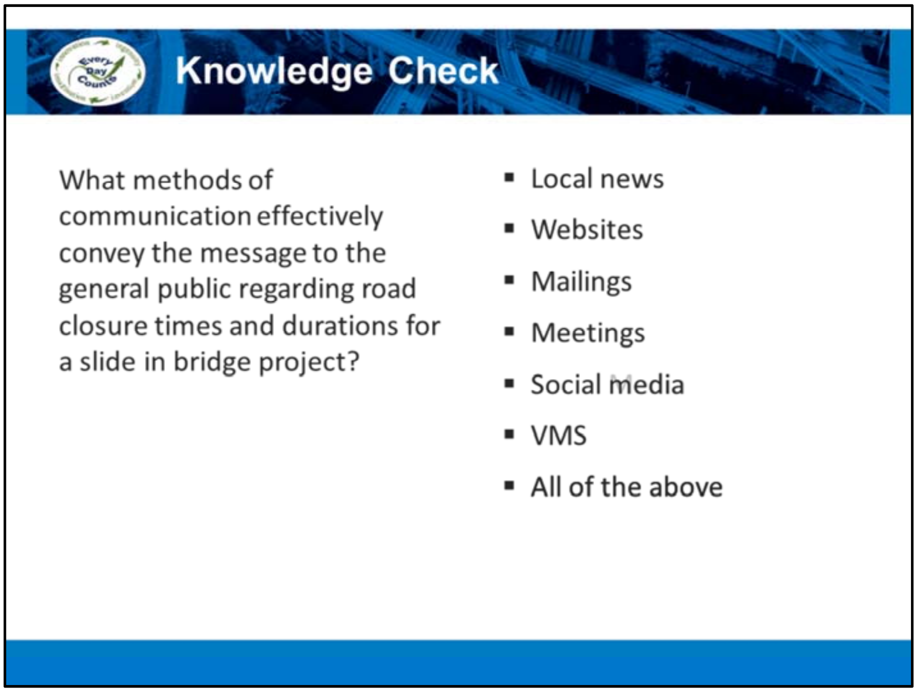
Special attention should be paid to businesses and others directly adjacent to the site as it is likely they will be most affected. Variable message signs are a good way to convey important project information.

Since the construction method is unique, the public should be encouraged to attend the slide but only if attendance can be safely accomplished. Access to engineers and communications specialists to quickly answer questions during construction can provide a great benefit to the project. After all is complete, surveys of the public to provide feedback can be conducted.

The Jamaica Avenue project near New York City required an extensive public outreach plan given the large number of road users both above and below the bridge in addition to the many businesses and residences nearby.

A significant campaign began 3 to 4 weeks prior to construction beginning. Project details were communicated via letters, meetings, and radio, and construction details were posted on state and city websites.

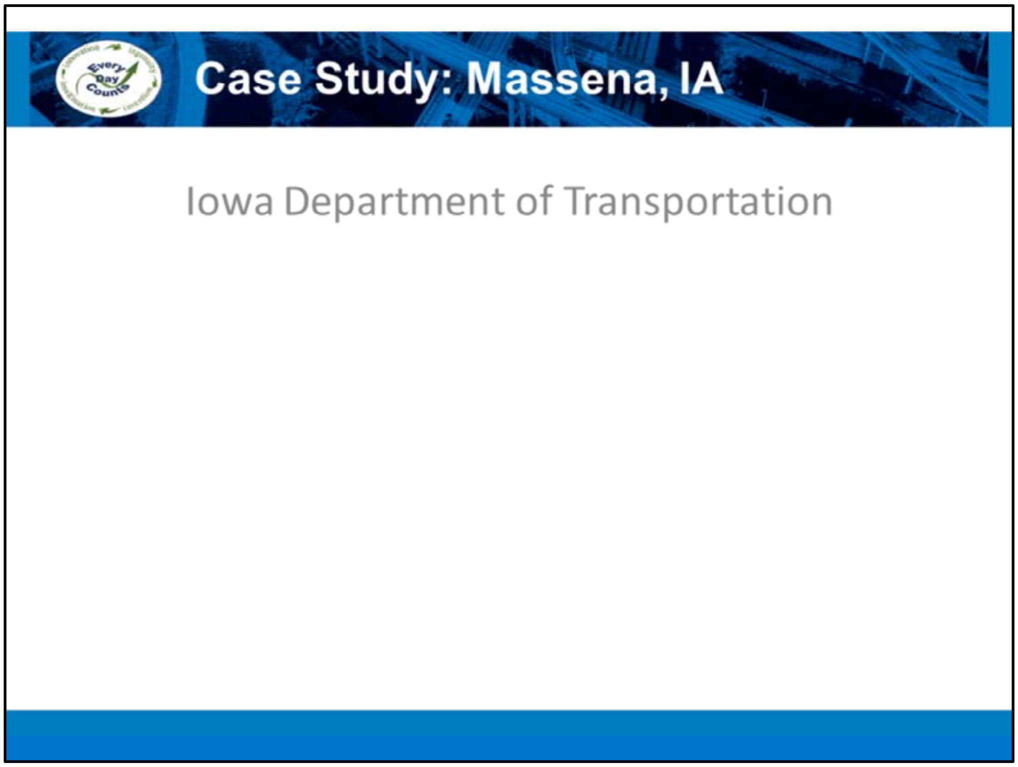
Press releases and travel advisories were broadcast through media outlets and VMS signs.



What methods of communication effectively convey the message to the general public regarding road closure times and durations for a slide in bridge project?

Local news?
Websites?
Mailings?
Meetings?
Social Media?
VMS?
Or
All of the above?

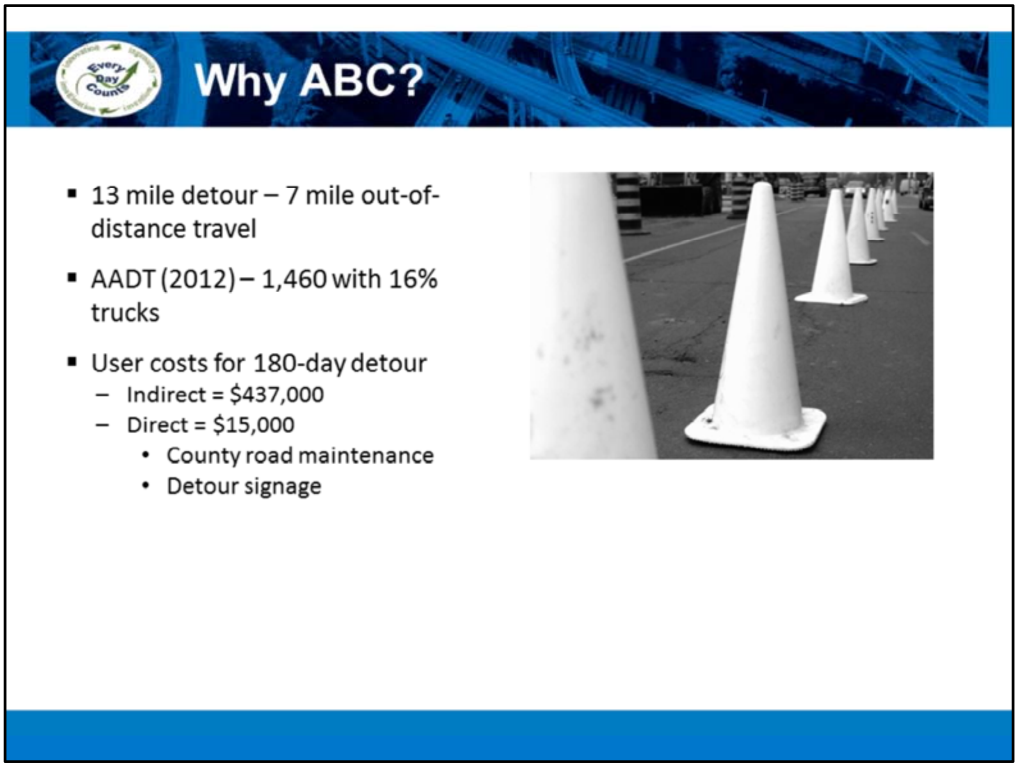
The answer: All of the above. Each of the options are commonly used to communicate the expectations of slide in projects.



The next portion of this presentation will focus on 3 case studies that shed light to the practice of slide-in bridge construction. They are collectively intended to provide perspective from owners, engineers, and contractors. Individually, however, the case studies may focus only a single intended audience.

The first case study comes from a slide-in project completed during the fall of 2013 in Massena, IA. The owner is the Iowa Department of Transportation and this project is the first in the state completed using SIBC.

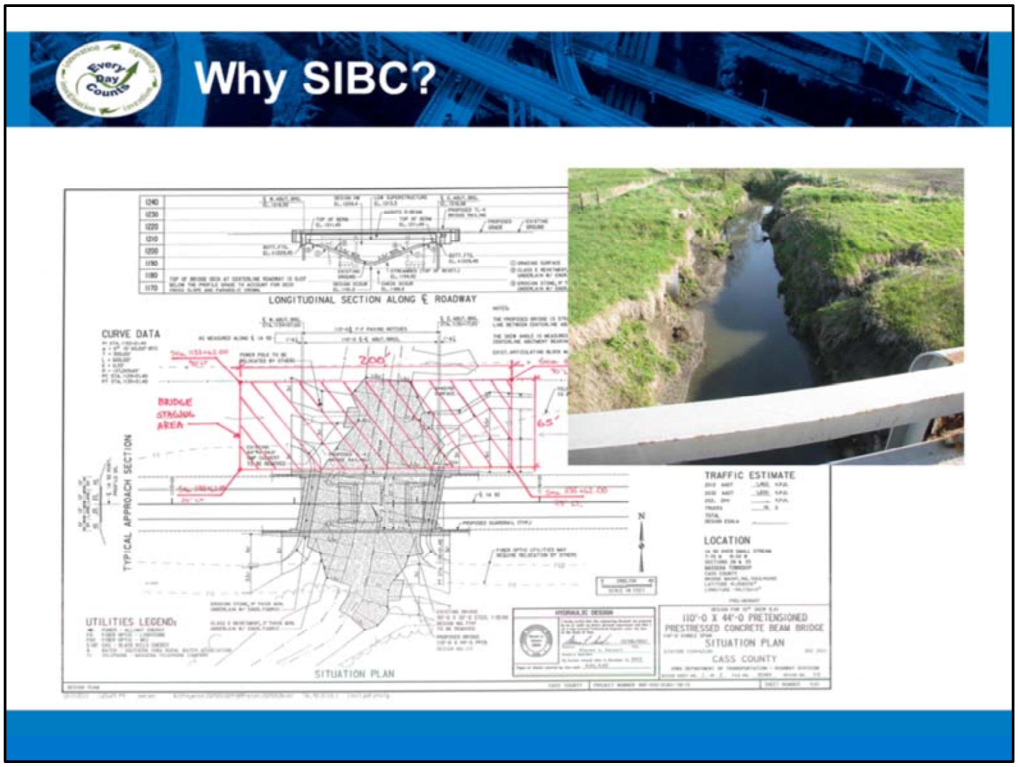
The bridge on IA 92 crosses a small stream immediately west of the Town of Massena, IA in southwest Iowa.



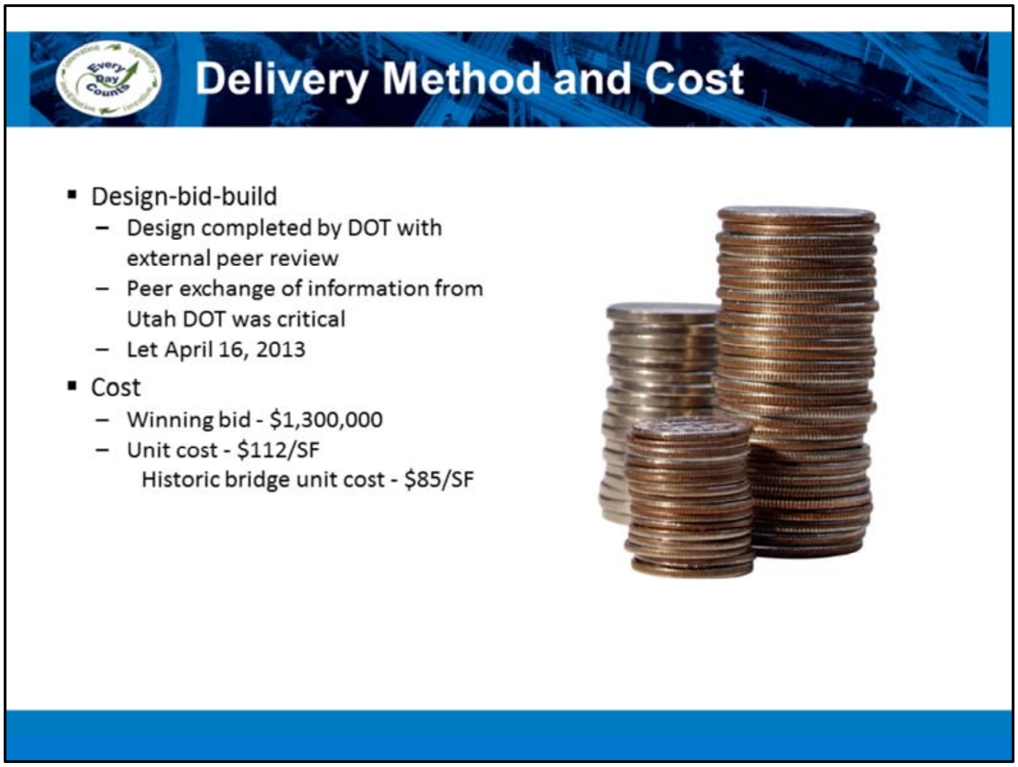
In this case, several considerations were made for why accelerated bridge construction was a good solution.

First, to close the bridge would have meant a 13 mile detour and 7 mile out of distance travel for road users. This is even more significant when coupled with the fact that 16% of all vehicles were trucks.

It is estimated that to complete the bridge replacement using traditional construction methods a road closure of 180 days would have been necessary resulting in indirect costs of $437,000 and direct costs of $15,000.



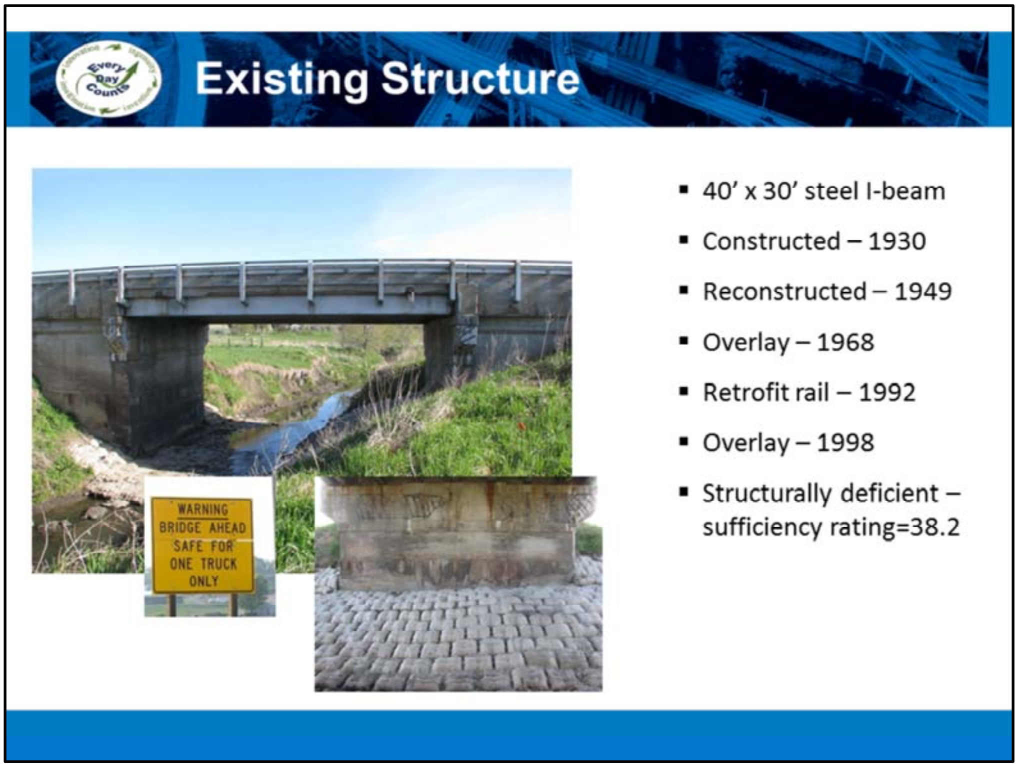
The Iowa Department of Transportation in its pursuit of accelerated bridge construction methods planned to implement slide-in construction methods at a site where it made sense to do so. At Massena, slide-in bridge construction was a good solution for accelerated bridge construction. The existing right-of-way allowed sufficient space for temporary works adjacent to the bridge without having to acquire temporary right-of-way. Even more, the geography was fairly flat, thereby simplifying the construction.



The method of delivery followed traditional design-bid-build. The design was completed entirely by the Iowa DOT with external peer review.

Prior to the beginning of the project, a critical peer exchange took place with the Utah DOT during the slide of one of their bridges. Several from Iowa traveled to Utah and were able to view the slide and speak directly with owners, designers, and contractors. Many lessons were learned and implemented prior to final design and construction of the Massena bridge.

The winning bid was $1.3 million which equates to a unit cost of $112/sf. Historically, in Iowa, the unit cost is near $85/sf, or roughly 75% of the actual cost. Note that these numbers represent the construction costs only and do not include the user costs which, if included, would have nearly equalized the overall costs.



The existing bridge, originally constructed in 1930, was a 40’x30’ steel I-beam structure with high abutment walls and narrow channel passage. Over its history, it had been reconstructed, retrofitted, and overlaid on several occasions. Soon before its replacement it achieved a sufficiency rating of 38.2, deeming it structurally deficient.

The proposed replacement seen in this rendering is a longer, pretensioned, prestressed concrete beam bridge.

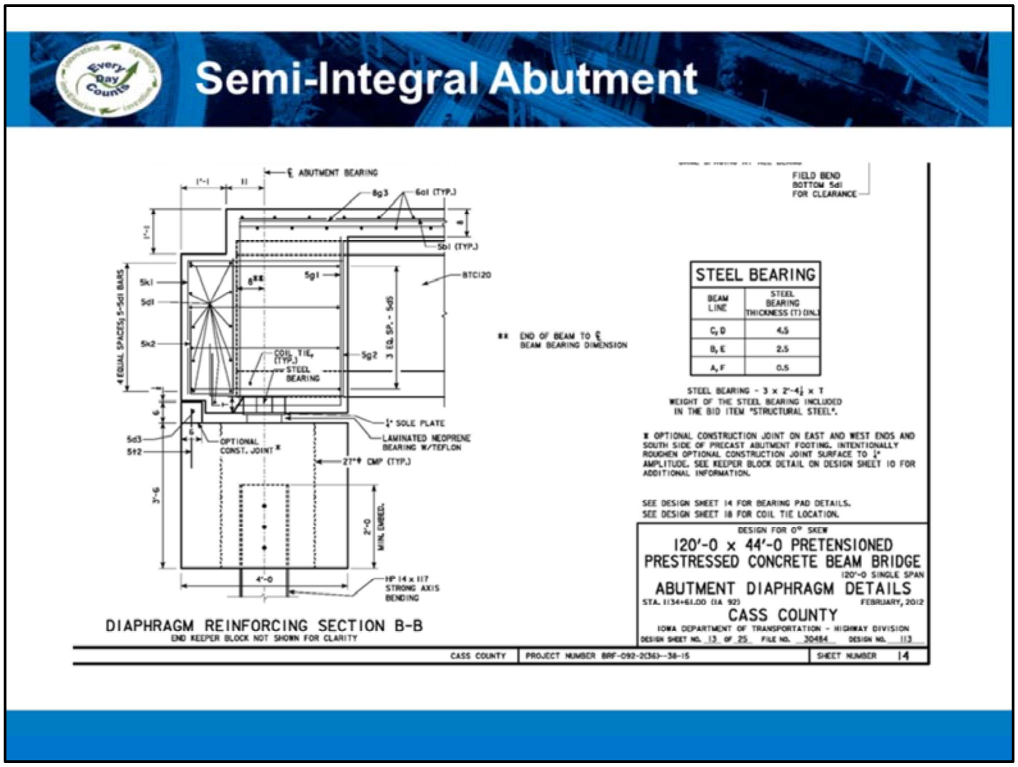
Plan Design and Details

- Semi-integral abutment details
- Abutment diaphragm
  - Jacking pockets for lifting
  - Block for pushing/pulling the prefabricated superstructure
- Precast abutment footing
  - H-Pile connections
- Precast wingwalls
  - H-Pile connections

The plan design and details incorporated a semi-integral abutment and abutment diaphragm. The diaphragm served as a block for pushing and pulling the prefabricated structure.

Even more, within the diaphragm, jacking pockets for lifting were formed.

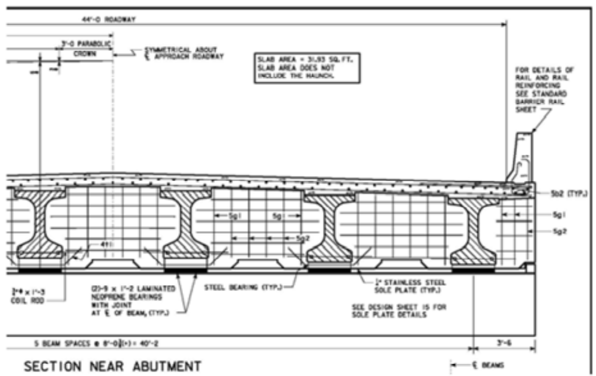
The original design called for precast abutment footings set over the top of H-piles, each connected through filling with concrete the corrugated metal pipe void forms within the footing. In the end, the abutment footings became cast-in-place by request of the contractor. Precast elements were used at the wingwall locations.



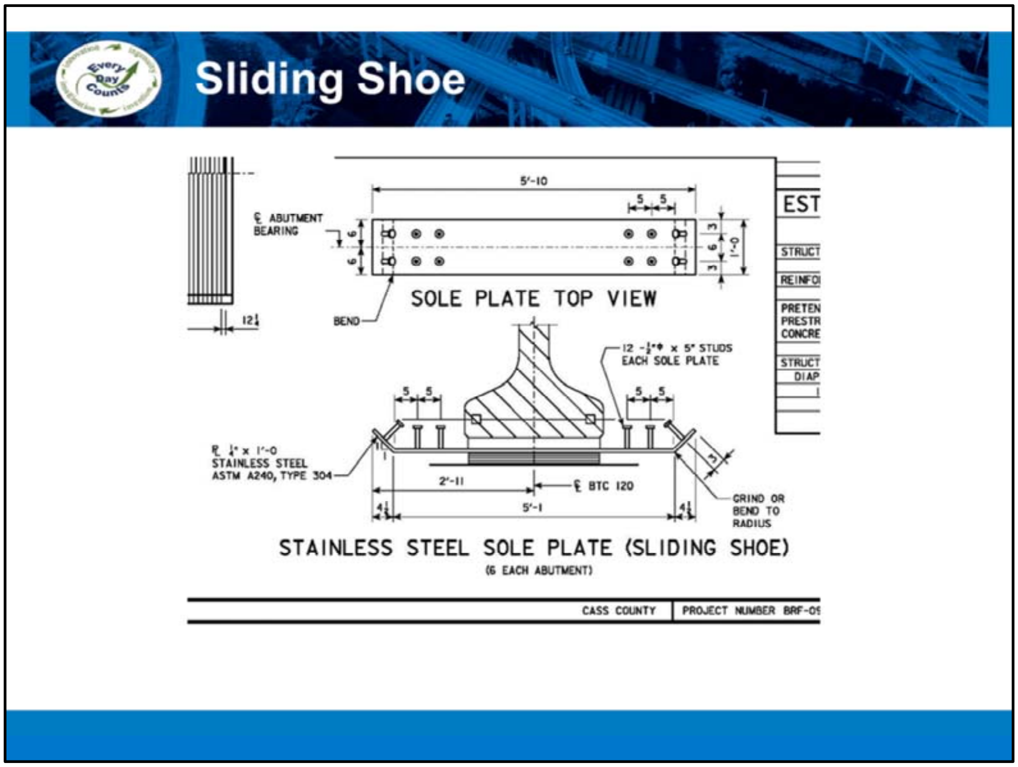
Shown in this detail is the semi-integral abutment and diaphragm. The slide plane is shown directly above the abutment footing and directly below the diaphragm.

Sliding Pad

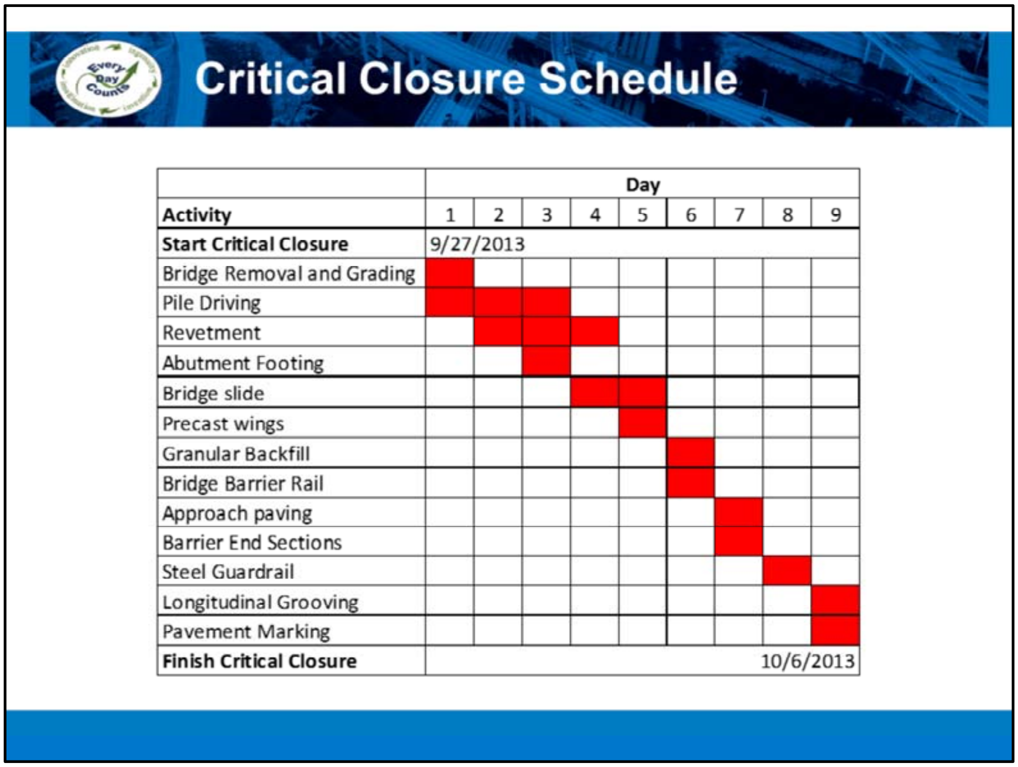
- Engineer's sliding concept
- Contractor elected to use commercially available rollers



The original intent was for the bridge to be slid using PTFE coated bearing pads and dishwashing soap. However, the contractor requested to use heavy duty rollers instead as they were the owners of several rollers from a previously completed project.



A stainless steel sliding shoe cast into the diaphragm at each girder end would have been the only point of contact between the superstructure and the bearing pads.



The critical closure lasted 9 days – contrast this with the projected 180 days had the bridge been constructed using traditional methods. The 9 days started with the removal of the old bridge and grading for the new structure.

After, pile driving, revetment and abutment footings were completed.

The bridge slide occurred over the course of an evening and early morning hours half-way through the 9 day closure, after which, the bridge and roadway were completed with wingwalls, backfill, barrier rail, and approach paving.

Several lessons were learned from this first experience with slide-in bridge construction in Iowa. Traditionally, for steel bridge projects in Iowa, the project is let during the fall allowing the contractor to gather resources over the winter and prepare for a spring start. Looking back, it was found that the Massena project would have benefitted from a similar schedule. As it was, the project was let in the spring with a summer start date, thus expediting and making more difficult the process for the contractor and owner, especially as it pertained to gathering materials and shop drawing preparation and approval.

The plans called for a precast only substructure. Unless there is an absolute must for precast, it might be better to allow the contractor the decision of precast or cast-in-place knowing the end goal and critical closure time.

Unless the there is a necessity for the plans to remain as is, proposed changes from the contractor are likely. Be prepared to fully evaluate the impact of these method changes.

Though heavy duty rollers ultimately took the place of the laminated bearing pads as the primary slide mechanism, the pads were still used along with the rollers in the jacking pockets. The bearing pads experience some shear deformation during the slide and any damage that might occur is hard to detect from only visual observation of the pads. Accordingly, it is recommended that bearing pads used during the slide are replaced with new pads once the bridge is in its final position.

The importance of properly designed and constructed falsework is even greater in slide-in construction. As such, adding a specification requiring the falsework design engineer to inspect and accept the construction is recommended.

One should be aware of and anticipate that a first-time slide-in project is likely to require more design and review time than would typically be required.

For Massena a total of 603 hours of design time were used between the design engineer, detailer, and check engineer – with a significant amount of that time spent by the detailer. Similarly, 137 hours were spent reviewing submittals. With experience, however, it is anticipated that the time required will be greatly reduced with subsequent projects.

The next few slides provide some pictures at different stages of construction. Here in this slide pictures of the existing bridge and preliminary temporary works are shown. Steel piling and large W-section beams were used as the temporary supports.

Here, one can see the placement of the precast/prestressed beams, the beginnings of the deck formwork, and the cast-in-place diaphragm at the beam ends.

Once the construction of the superstructure was completed, the critical closure and demolition of the existing structure began. Once the bridge was removed and the grading completed, pile templates were positioned and pile driving started.

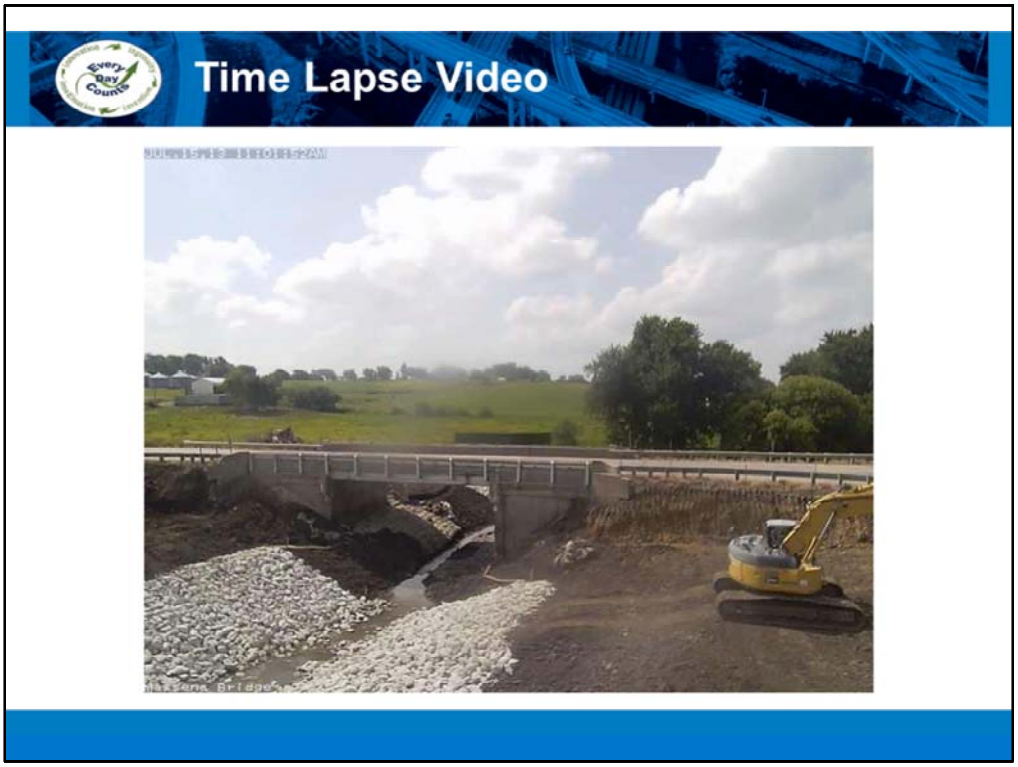
Vertical jacks were used in the jacking pockets to lift the bridge, after which, the rollers and bearing pad shims were set. A single jack and reaction pile were placed at the end of each abutment footing. Threaded rods were then placed between the jacks and through the superstructure diaphragms in order to pull the bridge onto the permanent substructure.

A single power unit with a manifold controlling both jacks was used. The rollers were guided along a steel channel spanning over the temporary works and permanent substructure.

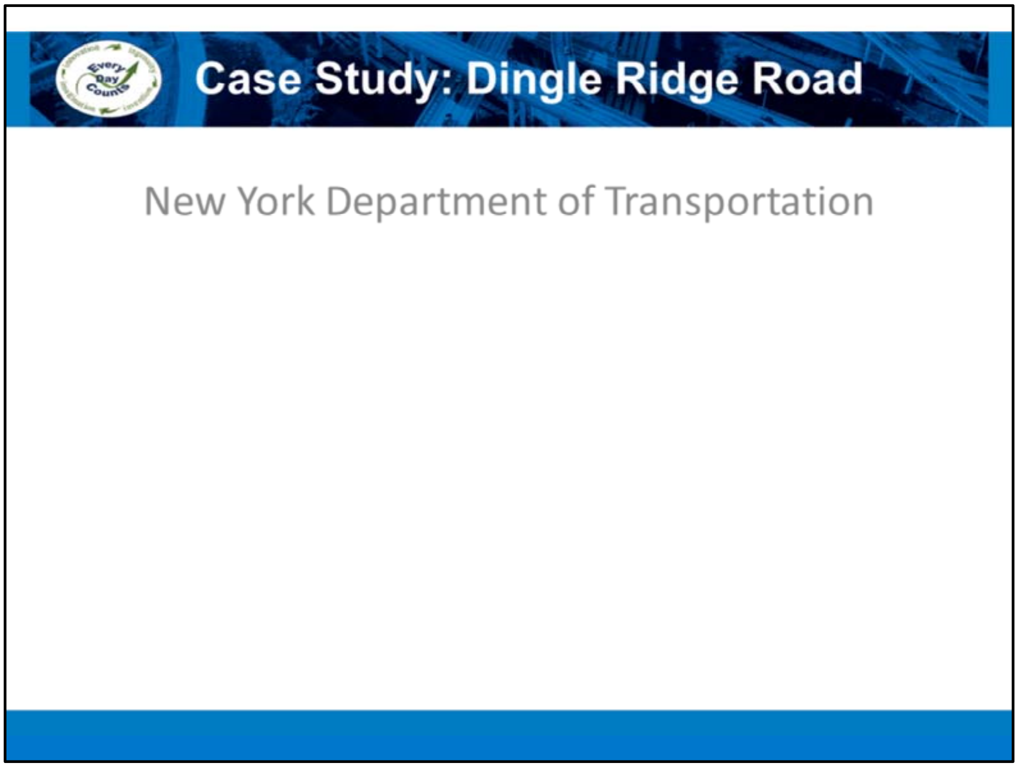
Additional pictures of the bridge nearing its final position are shown here. The vertical jacks were again employed to lift the bridge and pull the rollers, channel, and bearing pads from the jacking pockets. Also, the final bearing pads were placed below the diaphragm at the beam ends.

The slide operation took place during the late evening and early morning hours. Each of these pictures shows various views of the bridge being slid onto the permanent substructure. The lower picture shows the transition between the temporary works and permanent substructure and, maybe more importantly, the engineers closely monitoring the behavior at that transition.

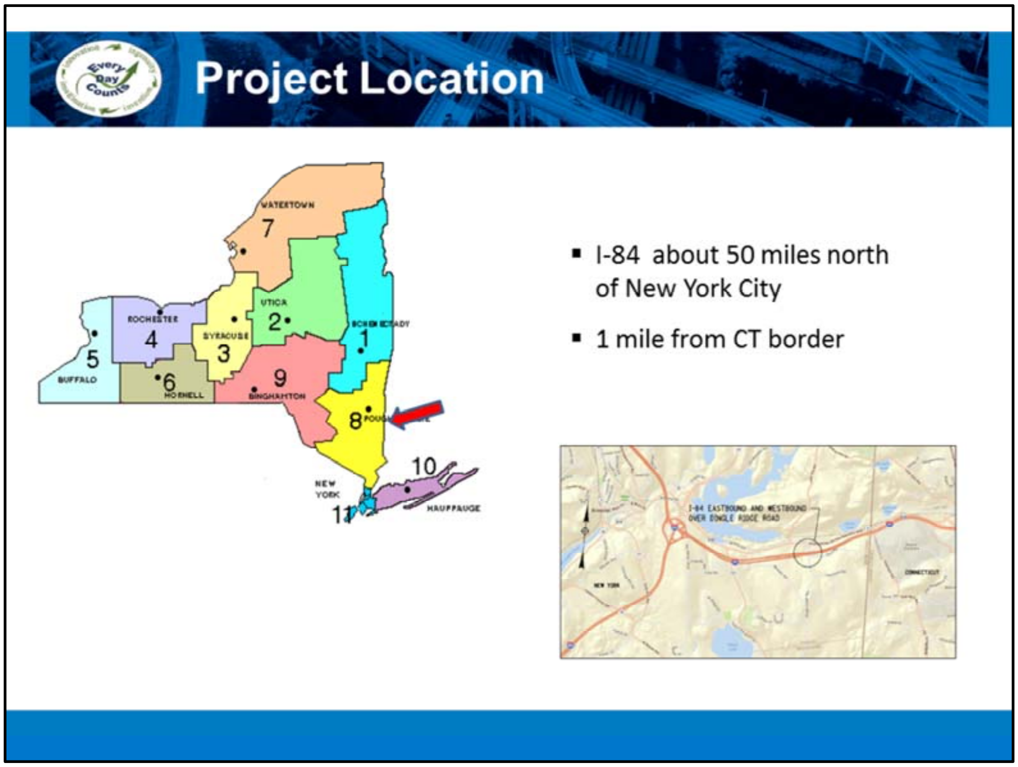
Once the bridge was in position, precast wingwalls with included grout pockets were placed onto pre-driven steel H-piles. The connection was made between the pile and grout pocket using a high-slump, small aggregate concrete mix.



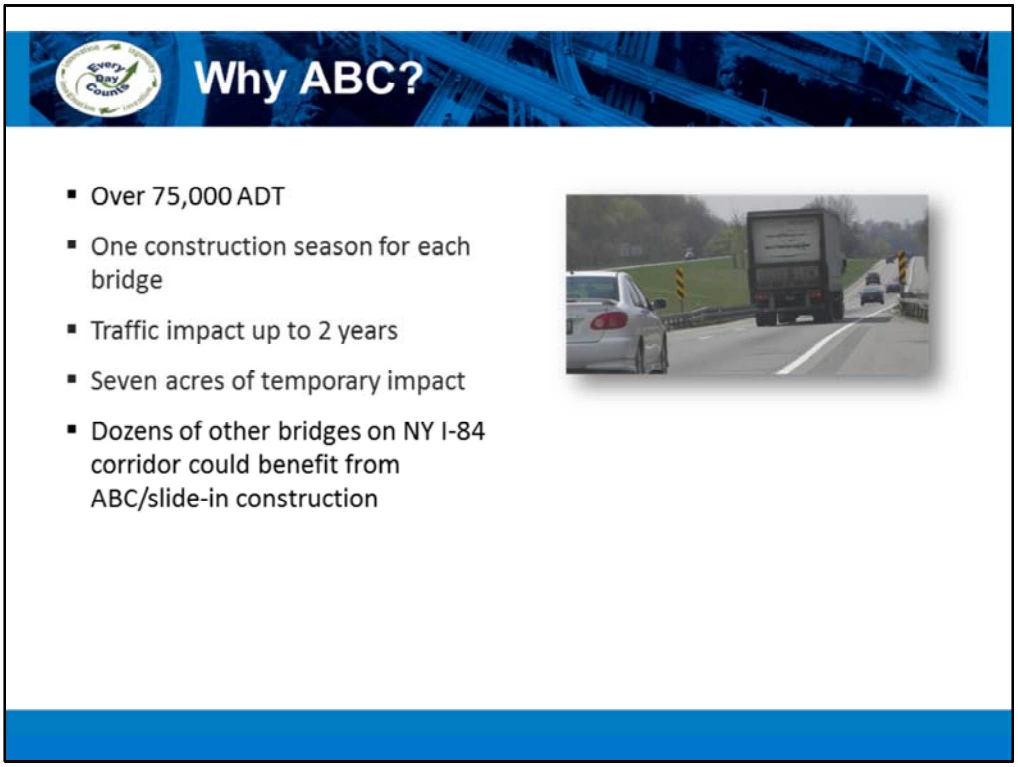
This short video is a time-lapse from the beginning of the project until the bridge was reopened to traffic.



The second case study we'll be covering today is the Dingle Ridge Road project completed in the state of New York.



The project is located about 50 miles north of New York City, 1 mile from the Connecticut border.



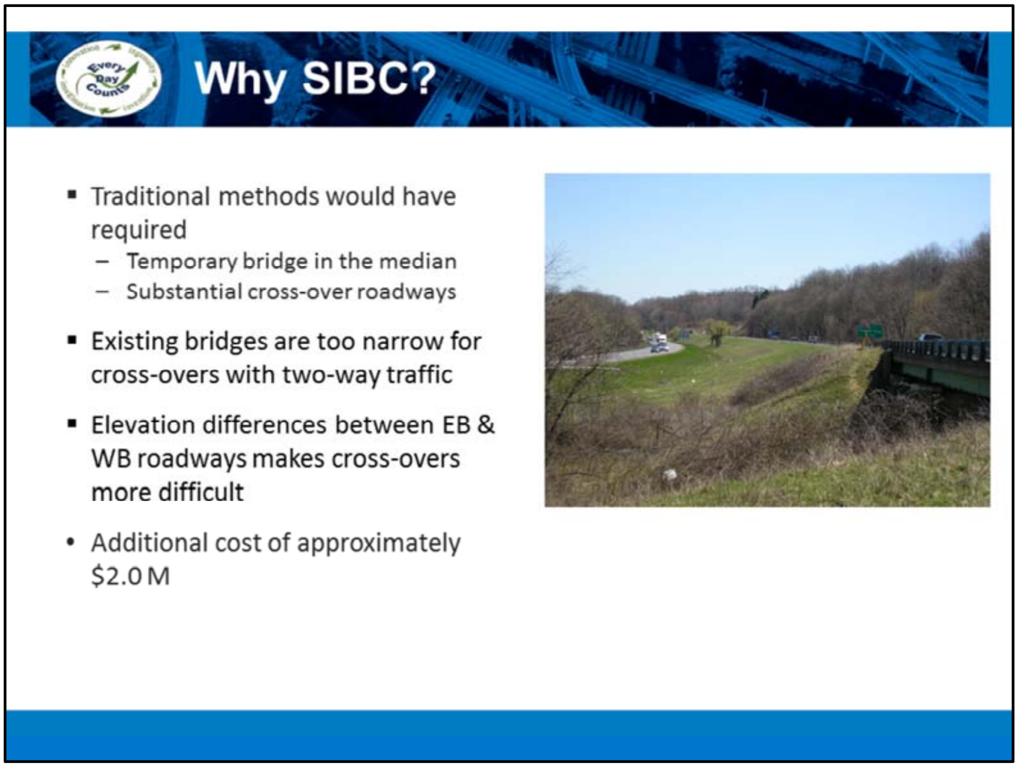
Why was this project a good candidate for accelerated bridge construction?

To begin, the ADT was over 75,000 which meant that any disruption would quickly effect a significant number of people.

Additionally, two adjacent bridges were to be replaced. One construction season would be required for each bridge, thus the total duration of the project and traffic impact could span up to 2 years.

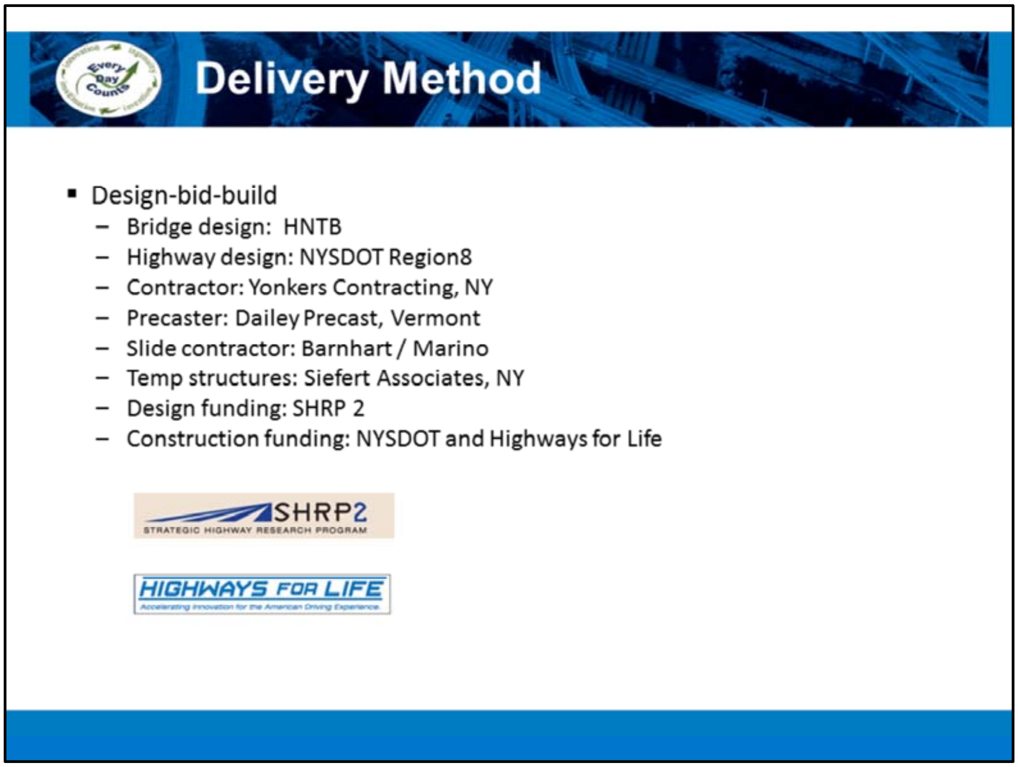
If constructed traditionally, seven acres of land would temporarily be impacted due to the construction of crossovers and shoe-flies.

Even more, if done successfully, dozens of other bridges on the I-84 corridor could be constructed using ABC thereby multiplying the benefits.

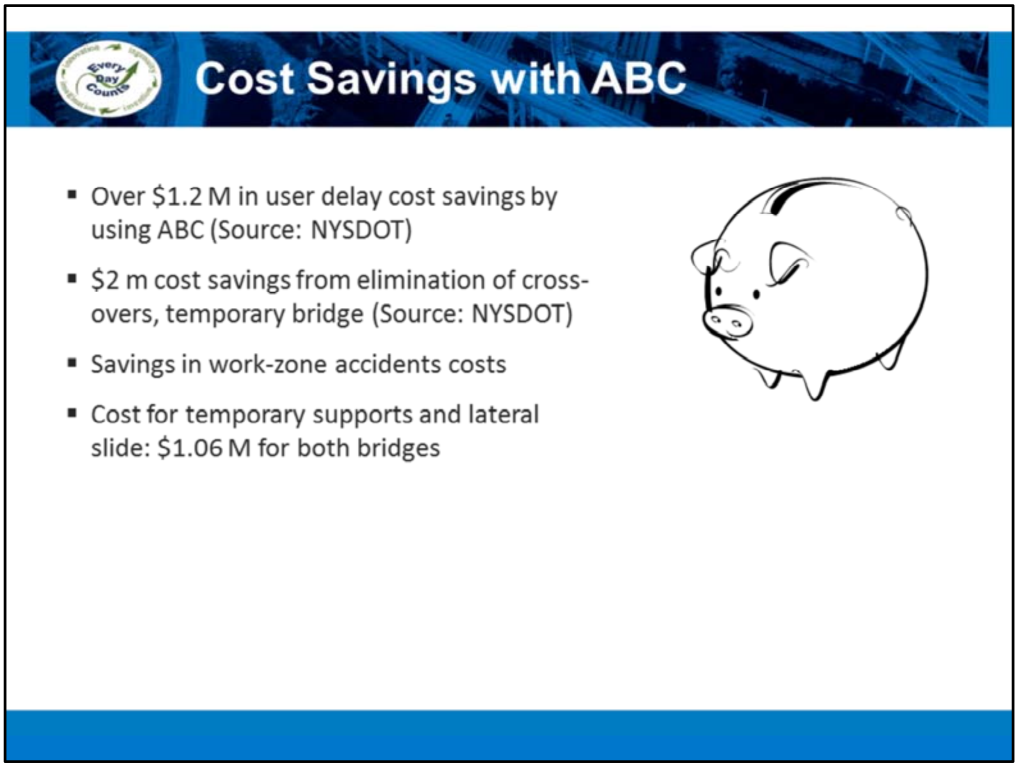


So why was SIBC the chosen method of accelerated bridge construction?

Traditional methods and even some other methods of ABC would have required the construction of a temporary bridge in the median since the existing bridges were too narrow for a crossover with two-way traffic. The construction of crossover roadways would have been complicated by the elevation differences between the eastbound and westbound roadways. In the end, the construction of a temporary bridge and crossovers would have resulted in an additional cost of $2 million.



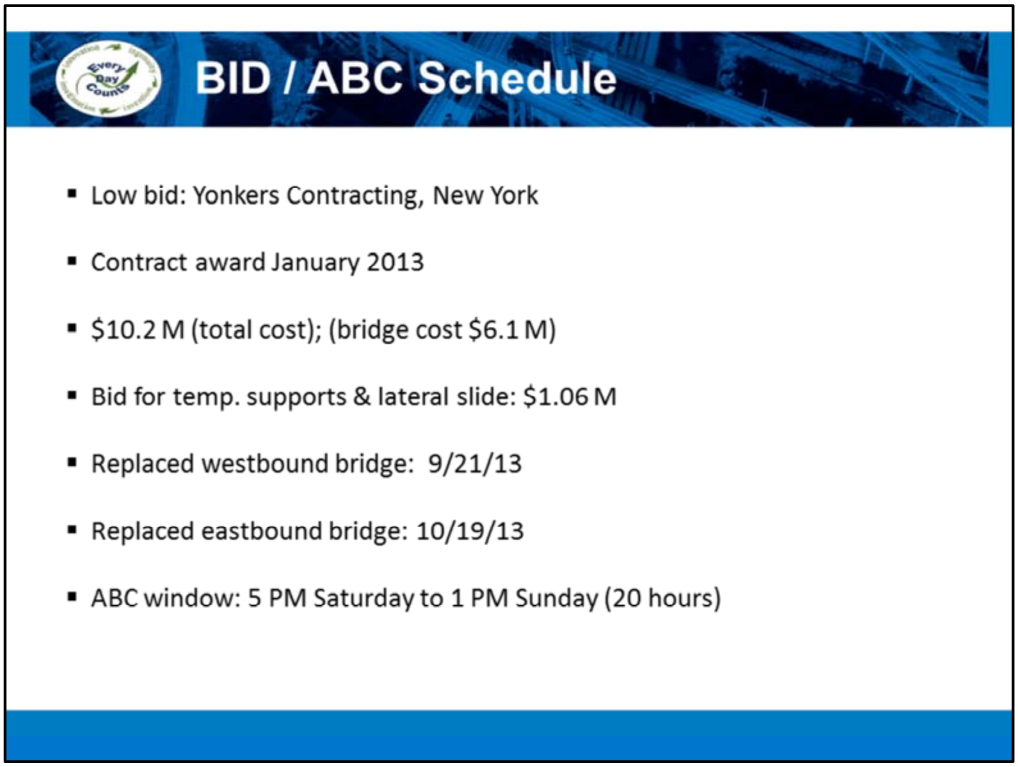
Design-bid-build was the delivery method used on this project. Some of the key team members are listed here. Note that some of the funding for design and construction came from the SHRP2 and Highways for Life programs.



A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

For the sake of comparison, the cost attributable to the temporary supports and lateral slide totaled $1.06 million for both bridges combined. The cost of this work is a reflection of the severity of the grading at the site. Dingle Ridge Road has an approximate grade of 15%, which resulted in large temporary shoring towers. This type of geometry is not normal, therefore the cost for this work should be taken in context.



The low bid totaling $10.2 million was received from Yonkers Contracting of New York. The contract was awarded in January of 2013. Of the $10 million, $6.1 million was directly associated with the bridge construction, while $1.06 million was used for temporary supports and slide operation.

It should be noted that the cost for bridges in the New York metro area are normally significantly higher than that in other parts of the country, therefore these cost figures should not be taken to demonstrate the cost of SIBC on most bridges.

The westbound bridge was replaced on September 21st and eastbound bridge on October 19th of 2013. For each case, the timeframe in which the existing bridge was to be removed and the new bridge slid into place and opened to traffic was 5pm Saturday evening to 1pm Sunday afternoon. Both bridges were completed within their allotted ABC window and within 10 months of the contract award date. Compare that to the estimated 2 year duration if the bridges were constructed traditionally.

In this aerial rendering, one can see the relative position of the bridges and underlying roadway. It is clear that a fair amount of right-of-way is available, thus simplifying the use of slide-in bridge construction.

The rendering shown in the top left of the slide, shows the proposed position of the bridges while in construction on their temporary works. If you look closely, you'll notice that the temporary works, approaches, and new foundations are shown.

The photo on the right shows the actual bridges constructed on temporary works, nearing completion and being prepared for the slide operation. In the end, traffic disruption on I-84 was reduced from two years to two weekend nights, while Dingle Ridge road which lies beneath the bridges was closed for only 5 days.

Shown in the next couple of slides are additional renderings of the bridge construction and slide operation.

The superstructure of each bridge was constructed adjacent to the respective existing bridge. The new abutments were constructed beneath the existing bridges while still in service.

To begin the ABC period, the interstate was closed and the existing structure removed.

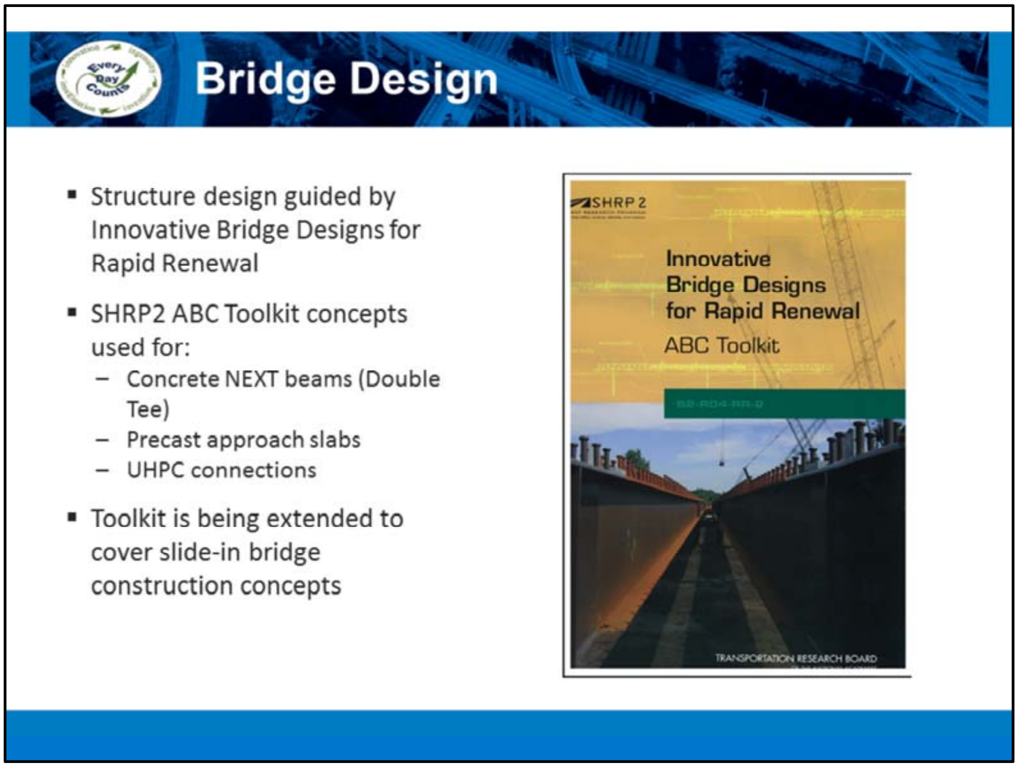
Once removed, preparation for the approach spans had to be completed including grading, compaction, and placement of the inverted T-beams used as a sleeper.

Once the preparation was completed, the slide from temporary works to permanent substructure took place.

Traffic Control

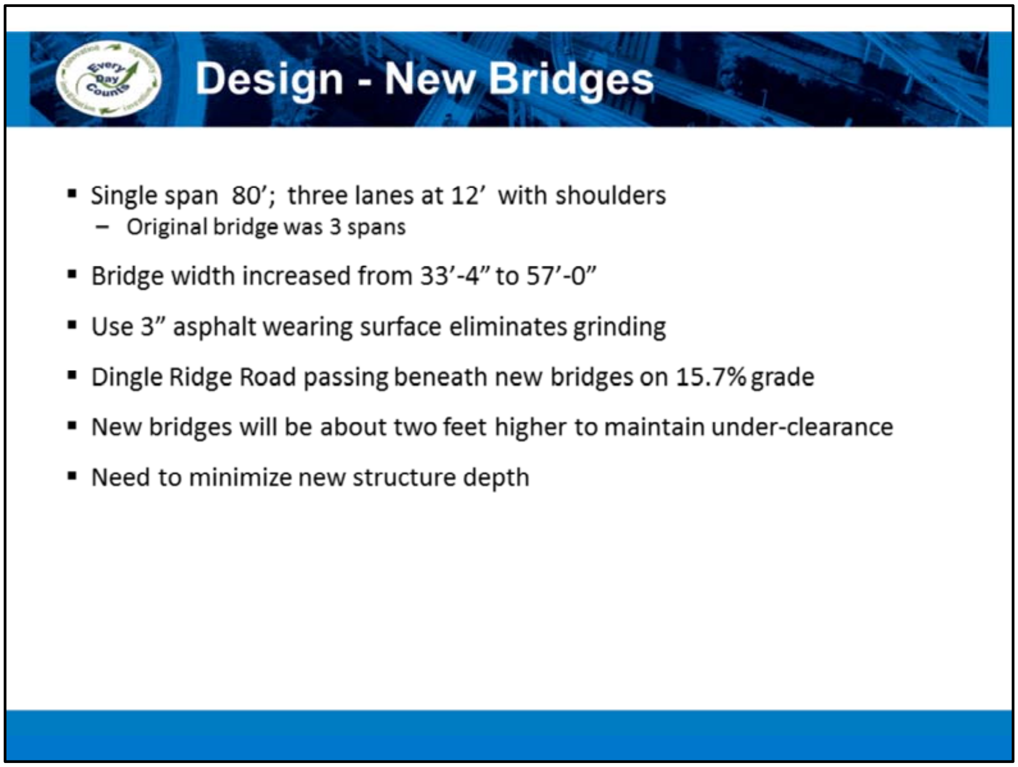
- Not an interchange – ramp detours not available
- Route 6/202, parallel to I-84, used as the detour (3 miles)

Traffic was not rerouted to the oncoming lanes, nor could on and off ramps be used as a detour since the bridges were not located at an interchange. Fortunately, route 6/202 runs parallel to I-84 and could be used. This created a short detour of only 3 miles.



The next several slides will focus on the design aspects of this project.

Design guides have been developed through the Strategic Highway Research Program. One in particular called "Innovative Bridge Designs for Rapid Renewal: ABC Toolkit" was used extensively in the structural design; specifically, as it pertains to the concrete double-T beams, approach slabs, and UHPC connections. Though the guide wasn't written to explicitly address slide-in bridge construction, work is being completed to cover these concepts.



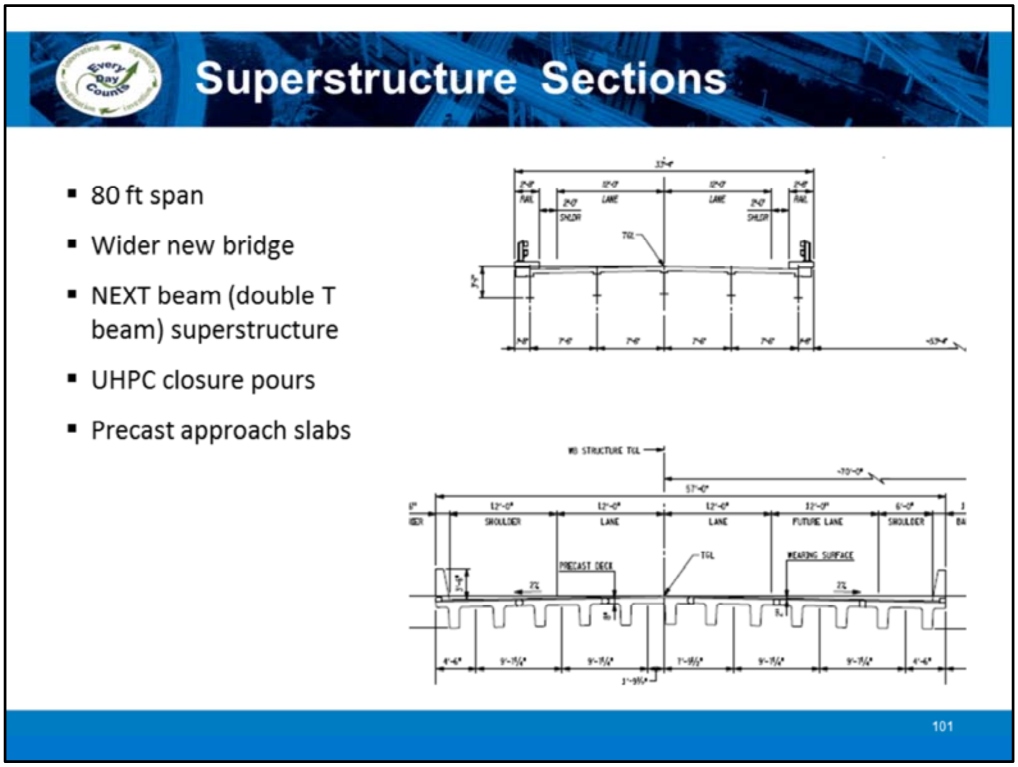
The new bridges are each 80 ft single span structures with three 12 ft lanes and shoulders totaling 57'-0". Compared to the 33'-4" of the existing structures, the bridges each gained considerable width.

A 3" asphalt wearing surface was placed on the bridge deck, which eliminated any necessary grinding due to the UHPC connections.

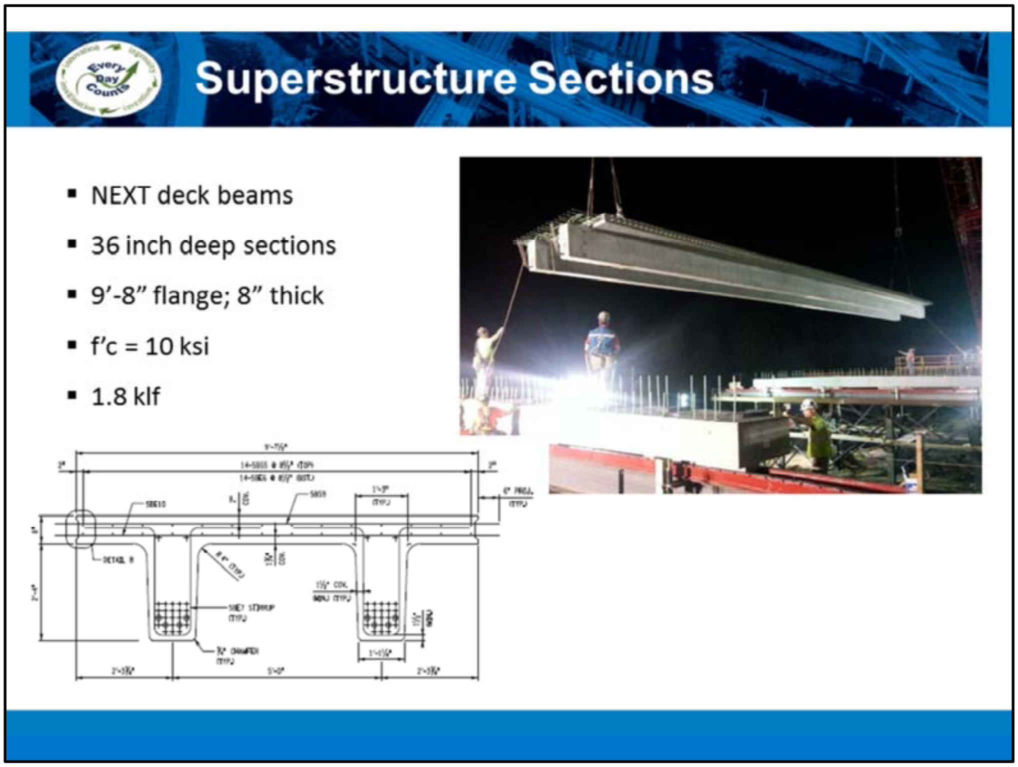
Somewhat unique to this particular location is that Dingle Ridge Road, which passes beneath the new bridges, is on a 15.7% grade. This grade posed some interesting design challenges. The new bridges were required to be raised two feet higher than the existing to maintain the under-clearance, which also meant that a concerted effort to minimize the new structure depth had to be made.

Two of the more significant design challenges were posed by these two restrictions: The slide had to be completed in one weekend night and I-84 had to be raised by two feet to satisfy the under-bridge clearance.

The photograph shown here helps illustrates the changing grade on Dingle Ridge Road.



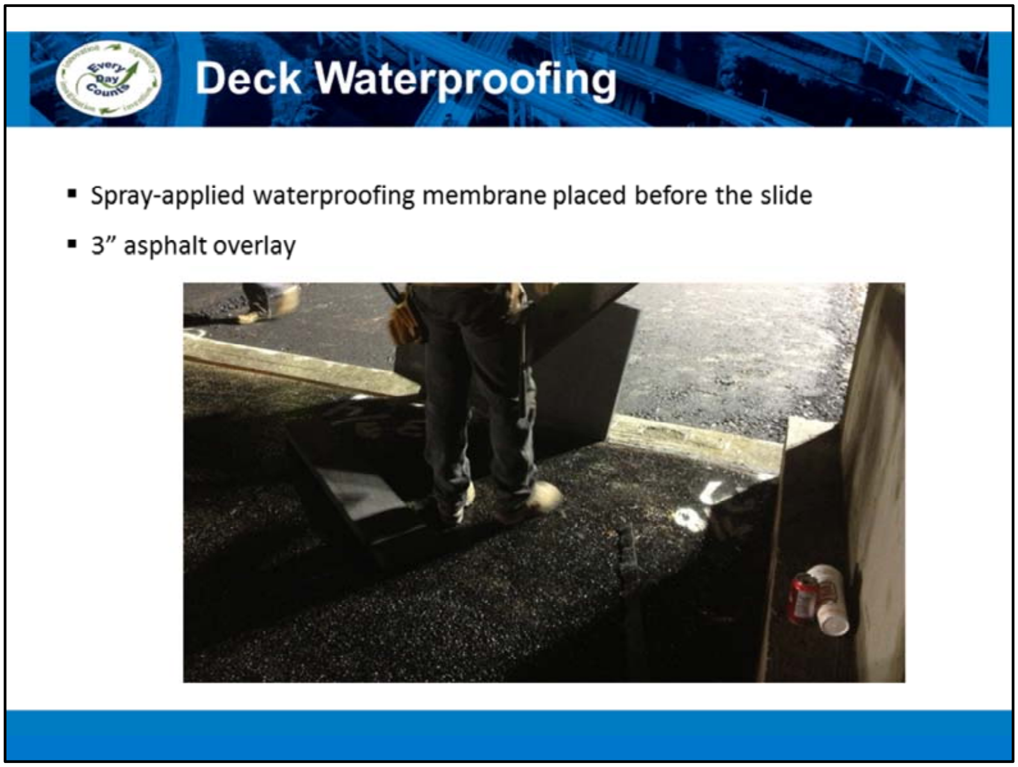
The superstructure sections, both longer and wider than those of the existing structures, were constructed using double-T precast beams tied together with UHPC closure pours, and precast approach slabs.



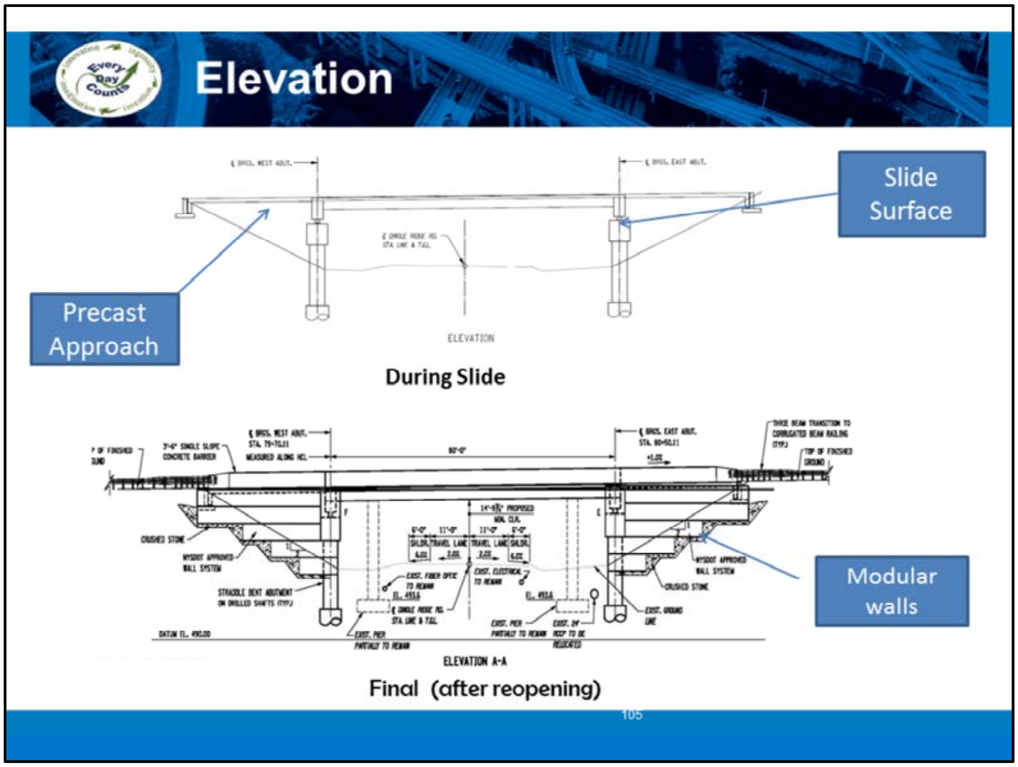
The beams chosen for the design are the Northeast Extreme Tee Beams – NEXT beams. This double tee section was developed by the PCI Northeast bridge Technical Committee, which is comprised of representatives from every northeast state, several consultants, and the PCI fabricators in the area. The beam was developed to expedite construction and reduce costs by eliminating the need for deck placement in the field.

In total, the sections were 36" deep with a 9'-8" wide and 8" thick flange. The compressive strength of the concrete used was 10 ksi and the sections weighed roughly 1.8 kips per foot.

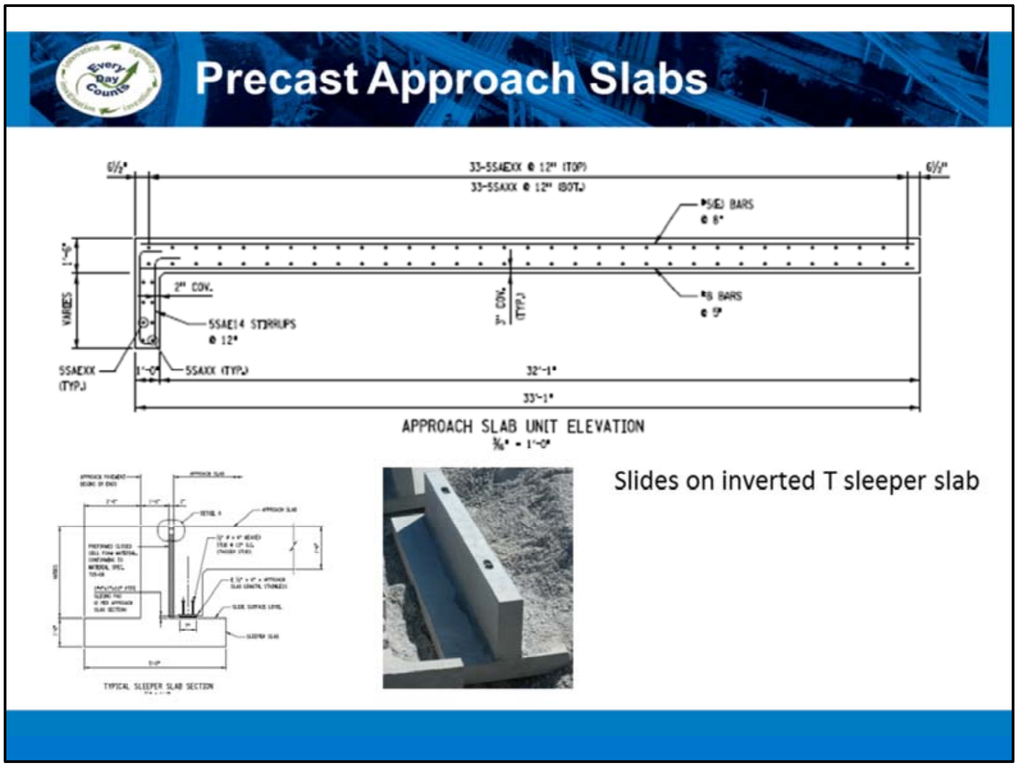
The UHPC connections, shown here, joined each of the double-T sections. The joints were 6” wide and the compressive strength of the concrete ranged from 20 to 30 ksi.



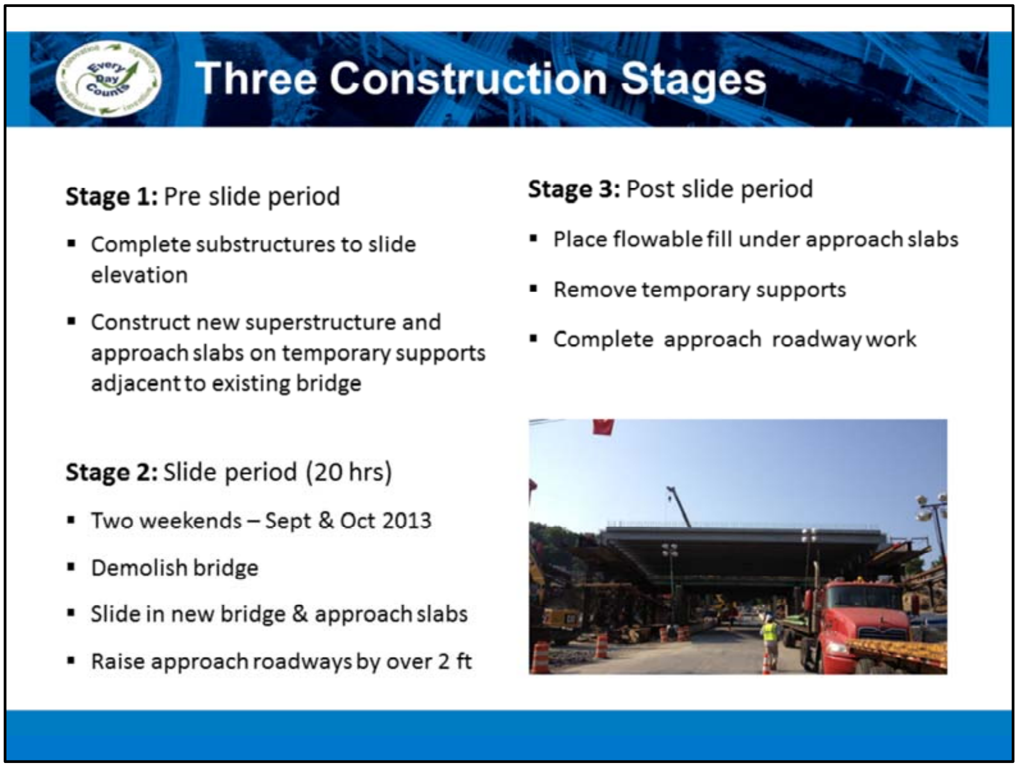
To waterproof the deck, a spray-applied waterproofing membrane was applied prior to the slide. Over that, a 3” asphalt overlay was placed.



Seen in the two elevation view drawings are the before and after-slide schematics. The approach slabs were slid into place with the superstructure. After which, a modular wall system was constructed adjacent to the approach slabs for containment of the flowable fill placed beneath the approach. The relative position of the existing piers and new abutments are depicted in the lower drawing, showing the longer span and additional roadway clearance on Dingle Ridge Road.



A close up the precast approach system is shown here. Each was 33’-1” long and 1’-6” thick with a downturned end. The end of the approach slab was slid on an inverted T sleeper slab which was placed after demolition of the existing structures.

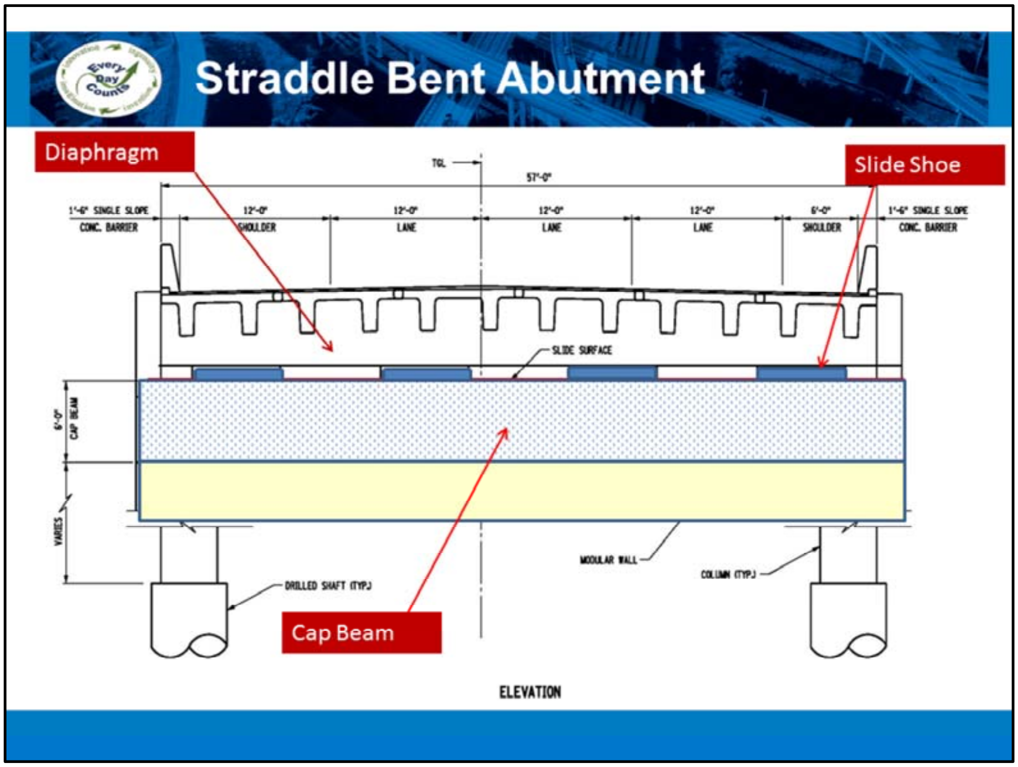


The overall construction process consisted of three primary stages.

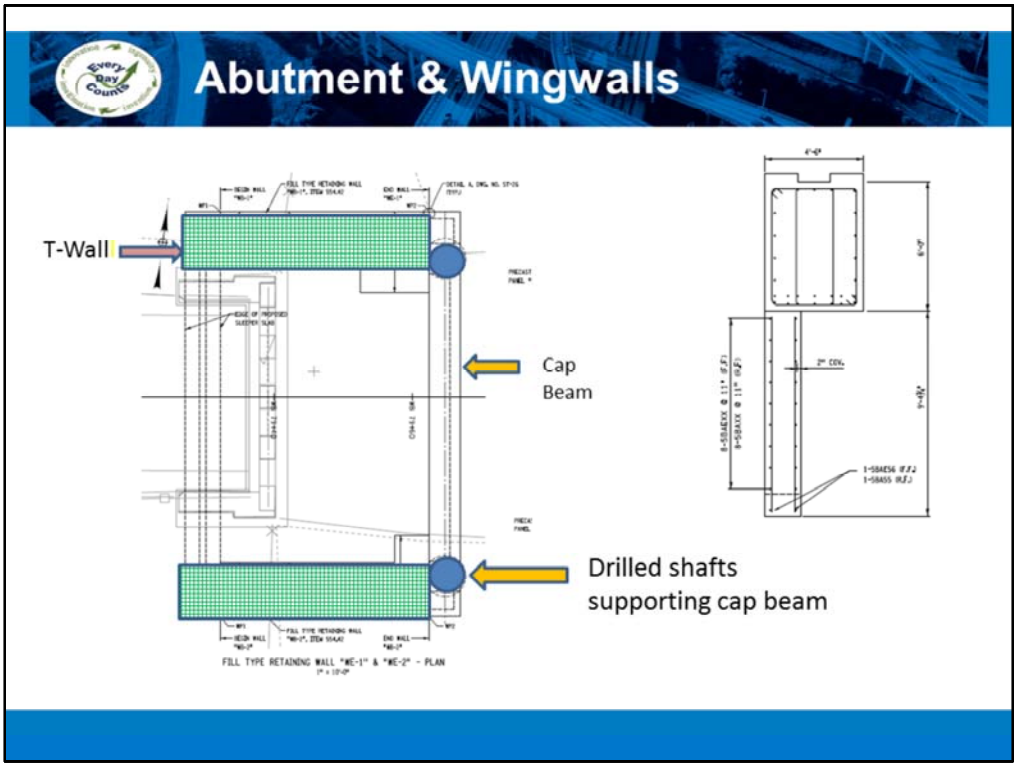
The first stage, prior to the slide, involved the completion of the substructure to slide elevation and construction of the new superstructure and approach slabs on temporary supports adjacent to the existing bridge.

Stage 2, the 20 hour slide period, occurred separately for each bridge over two weekends. During the stage, the existing bridge was demolished, the new bridge slid into place, and approach roadways raised 2 ft.

Stage 3 consisted of placing flowable fill beneath the approach slabs, removing temporary supports, and completing the approach roadway work.



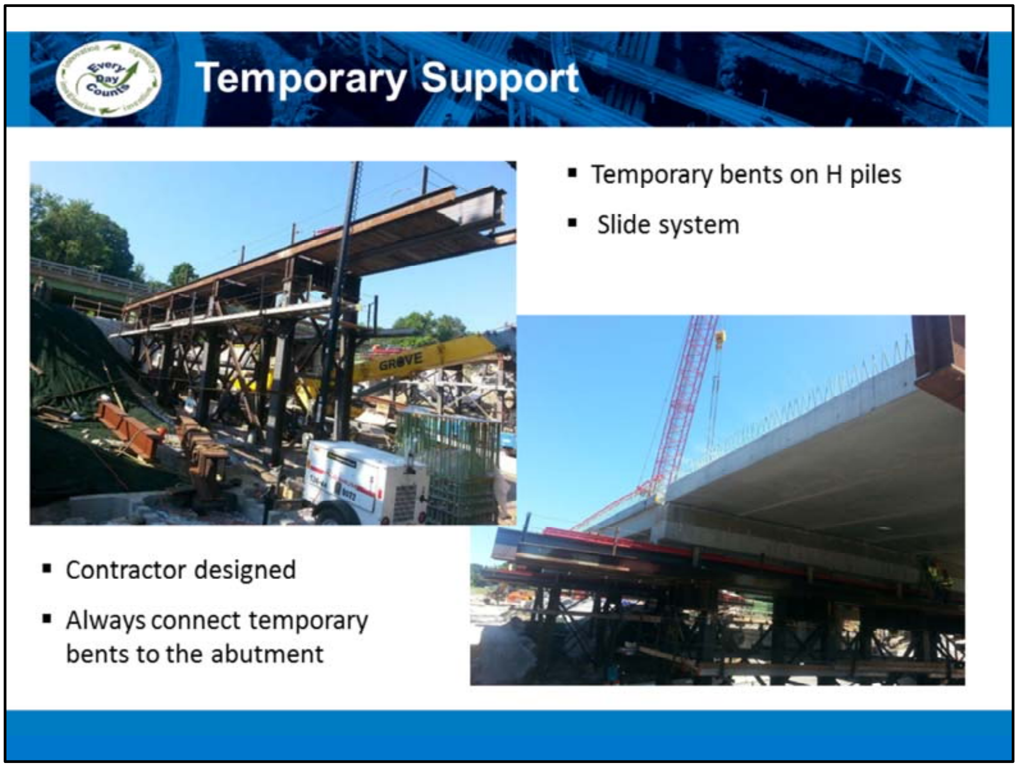
Shown here in the drawings for the straddle bent abutment are three elements critical to the slide operation. Those being, the diaphragm encapsulating the ends of the double-T beams, the slide shoes on which the superstructure will be slid, and the cap beam which was constructed beneath the existing structures prior to the slide.



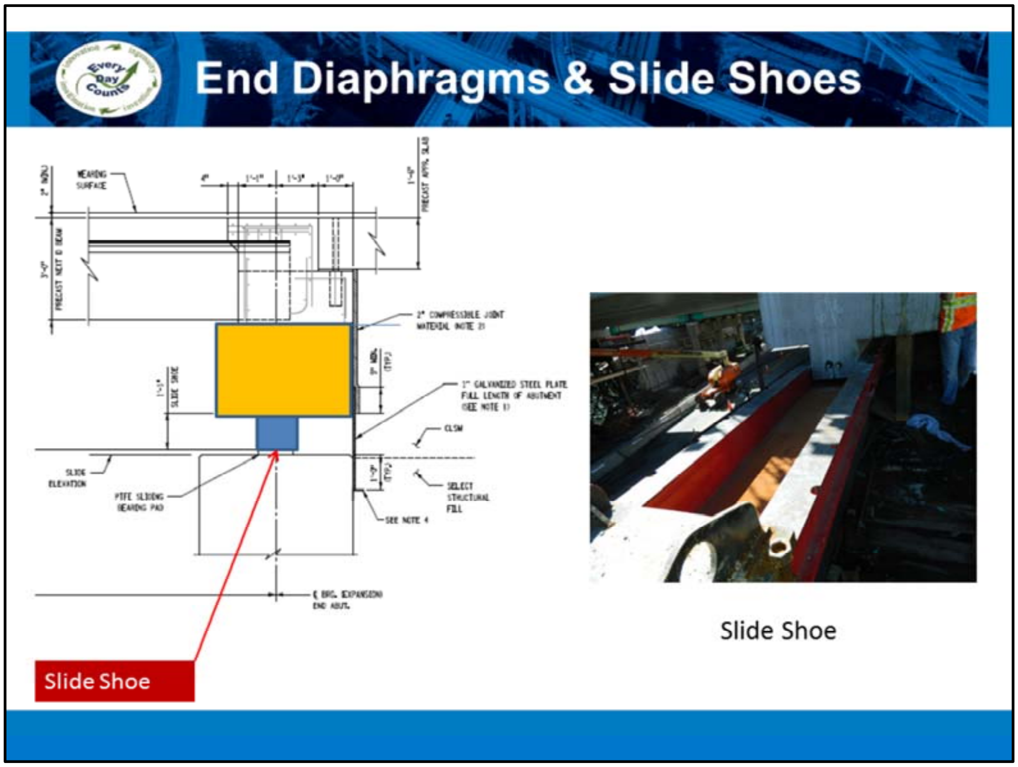
A plan view of the section shows the drilled shafts supporting the cap beam and the t-walls adjacent to the approach slabs which contains the flowable fill.

The new foundation system is shown placed beneath the existing structure in this photograph.

Additional pictures of foundation construction clearly depict how the new foundation was constructed under the existing structure while the roadway remained in service.



The temporary supports were steel structures founded on H-piles. The system was designed by the contractor and incorporated the necessary elements to properly slide the new structure.



Vital to the success of the slide were the end diaphragms and slide shoe. The diaphragm provided a rigid, stout connection point for the jacking system to react against. The slide shoe, made up of a full-length stainless steel plate, provided a reduced-friction track on which the superstructure could slide on the PTFE bearing pad.

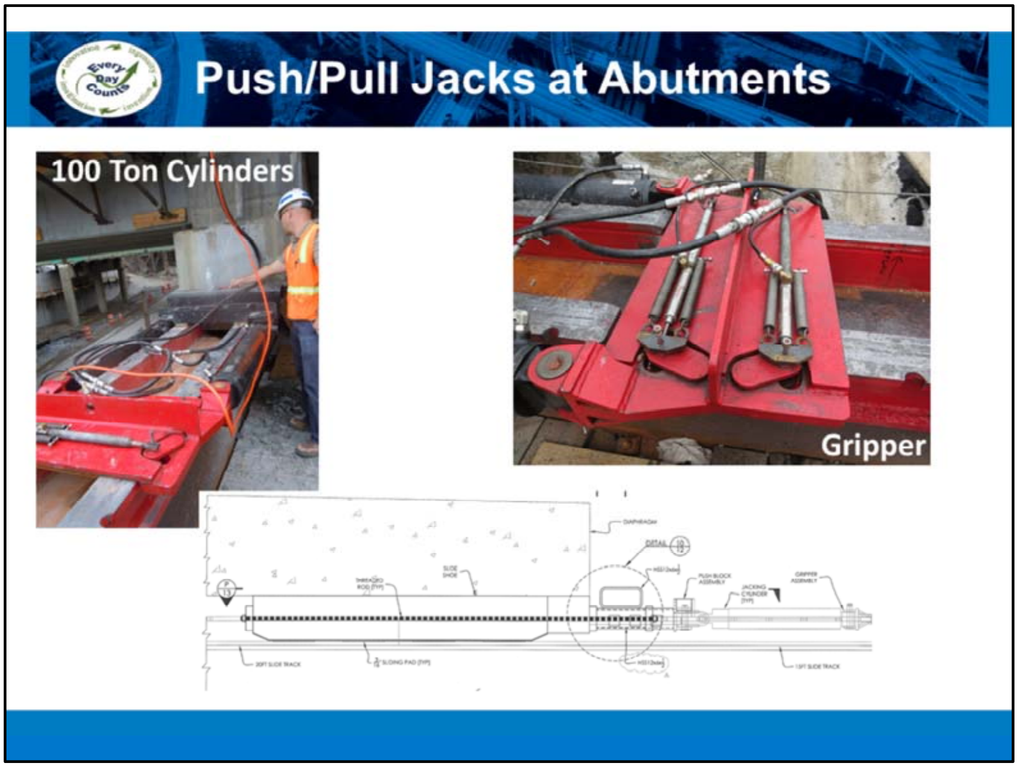
Shown in this photo are the new bridges nearing completion alongside the existing. Note that the bridges have remained open to traffic to this point.

These pictures provide a better glimpse of the stainless steel slide shoe and the 16 gage PTFE bonded to the elastomeric bearing pads.

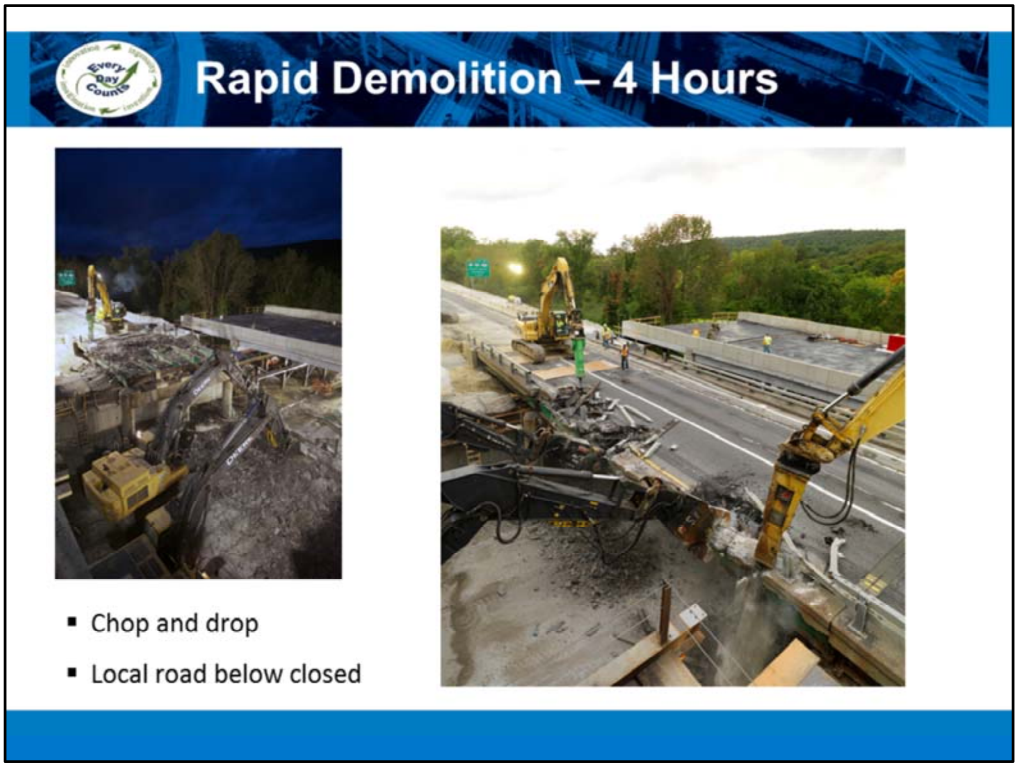
Similarly, the approach slab was slid on PTFE pads.

Inverted T Sleeper Slabs

The inverted T- sleeper slabs were placed once the existing bridge was removed.

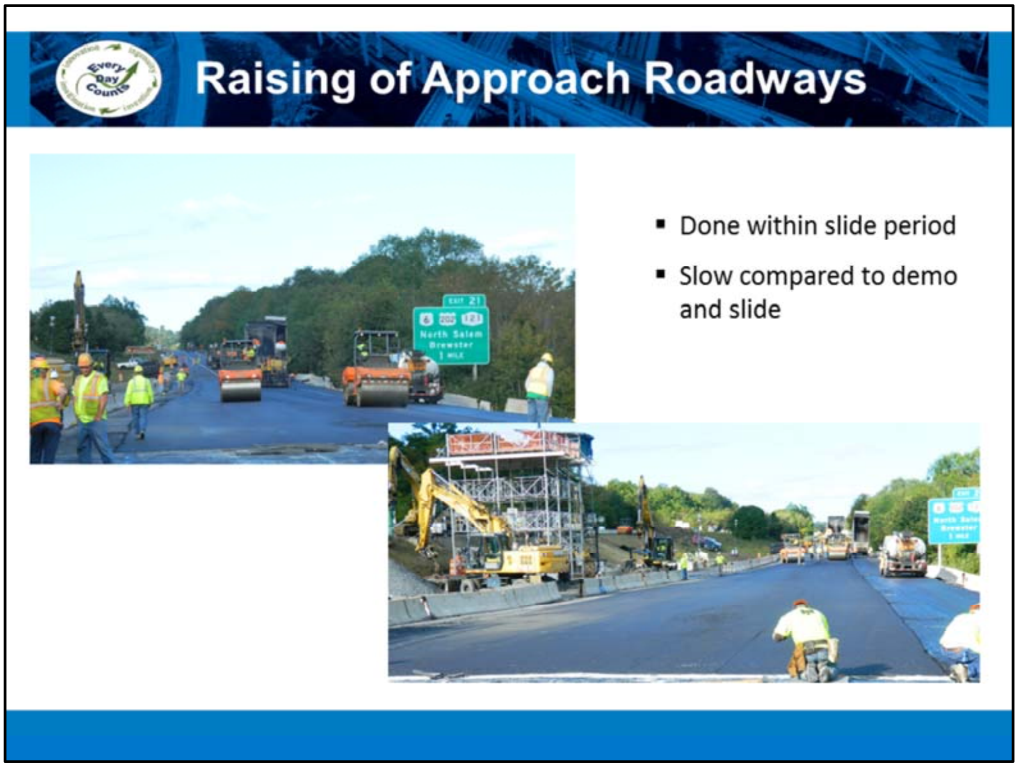


The jacking system consisted of two 100 ton push/pull jacks placed at the abutments. A system was devised to enable the repositioning of the jacks as the bridge was slid into place.



The demolition was completed in four hours using chop and drop methods. At this point in time, the local road beneath was closed for obvious reasons.

Another view of the temporary supports is shown here shortly after the bridge was slid into place, again showing supports at each diaphragm and end of approach slabs.

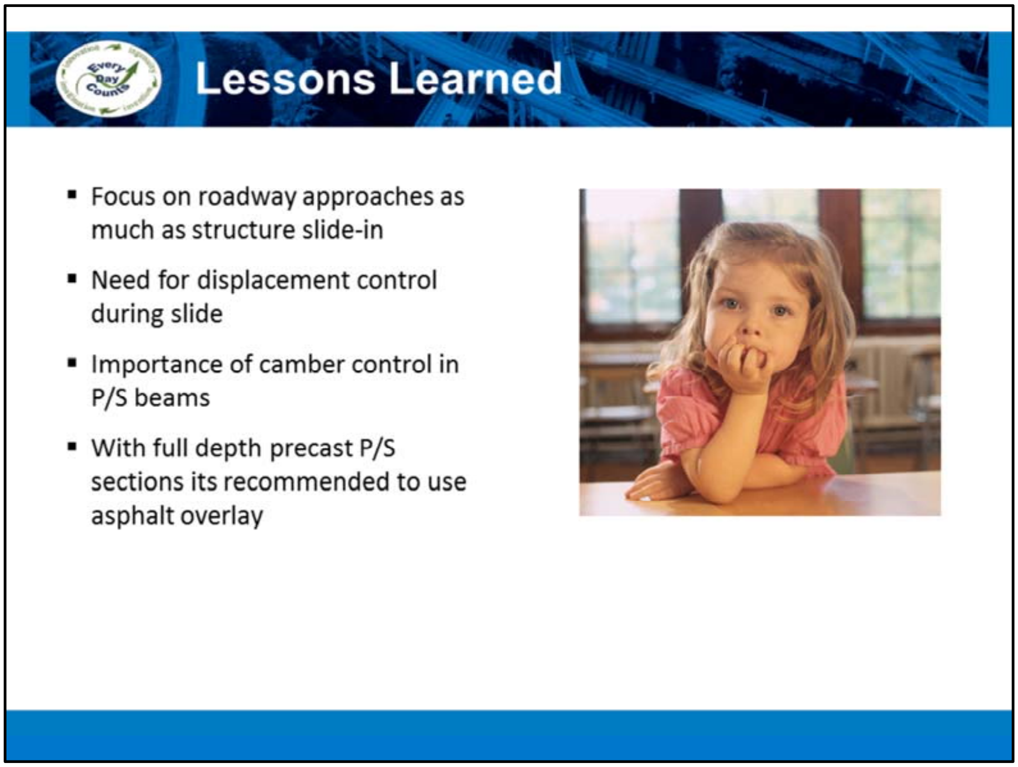


One of the more major and time consuming tasks to be completed during the short slide period was the raising of approach roadways. Relative to the actual slide, this process was considerably slower.

Shown here is one of the completed bridges. Both bridge slides were completed within 10 months of the notice to proceed.

View from Dingle Ridge Road

Another view of the completed bridges shown from Dingle Ridge Road.



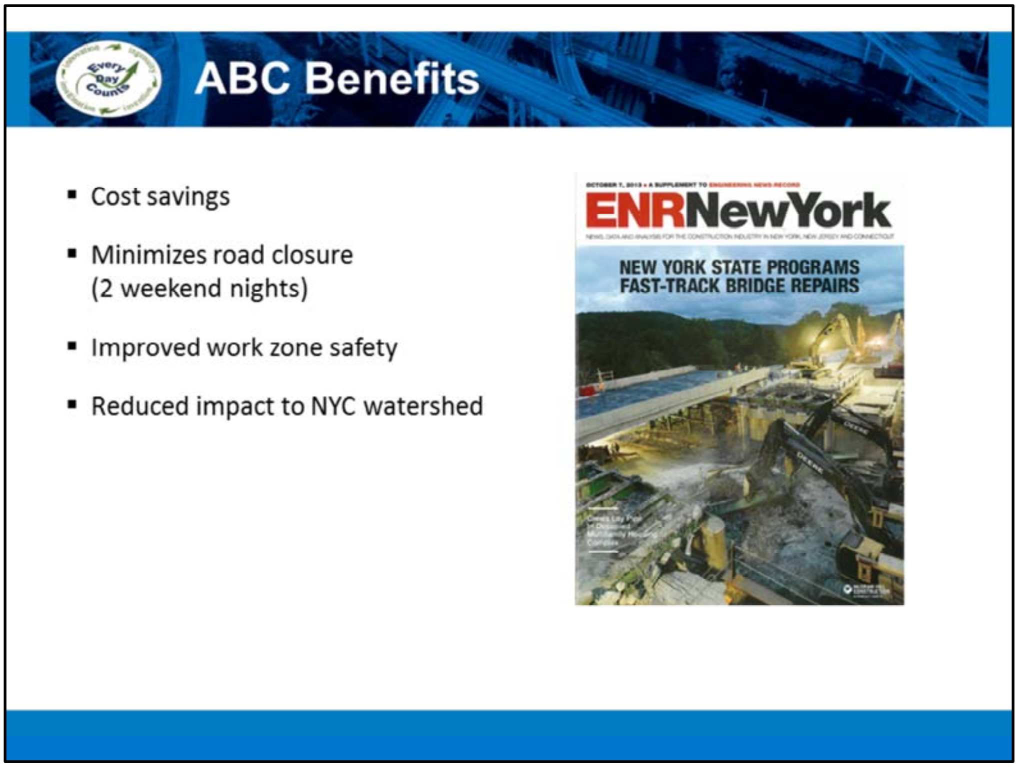
Many lessons were learned on this project, probably more than can be listed here. Even so, a few significant lessons that should be mentioned include these.

A focus on the roadway approaches should be made as much as the structure slide-in.

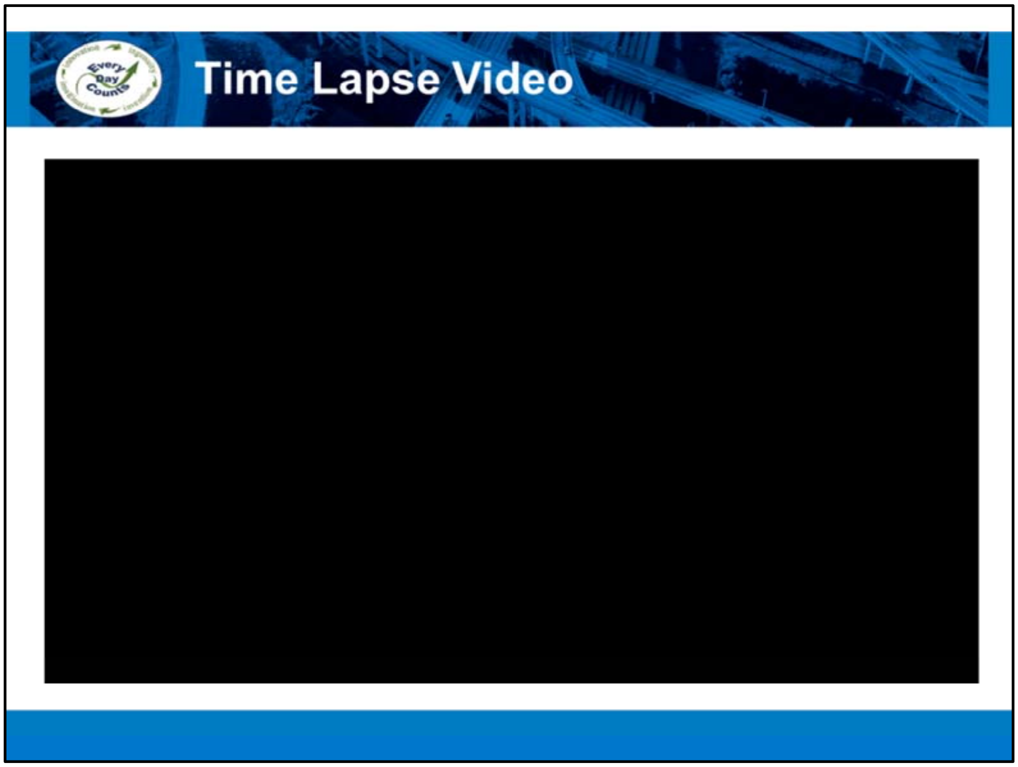
There should be displacement control in place during the slide.

It is important to control the camber of the prestressed beams to better control and align the closure joints.

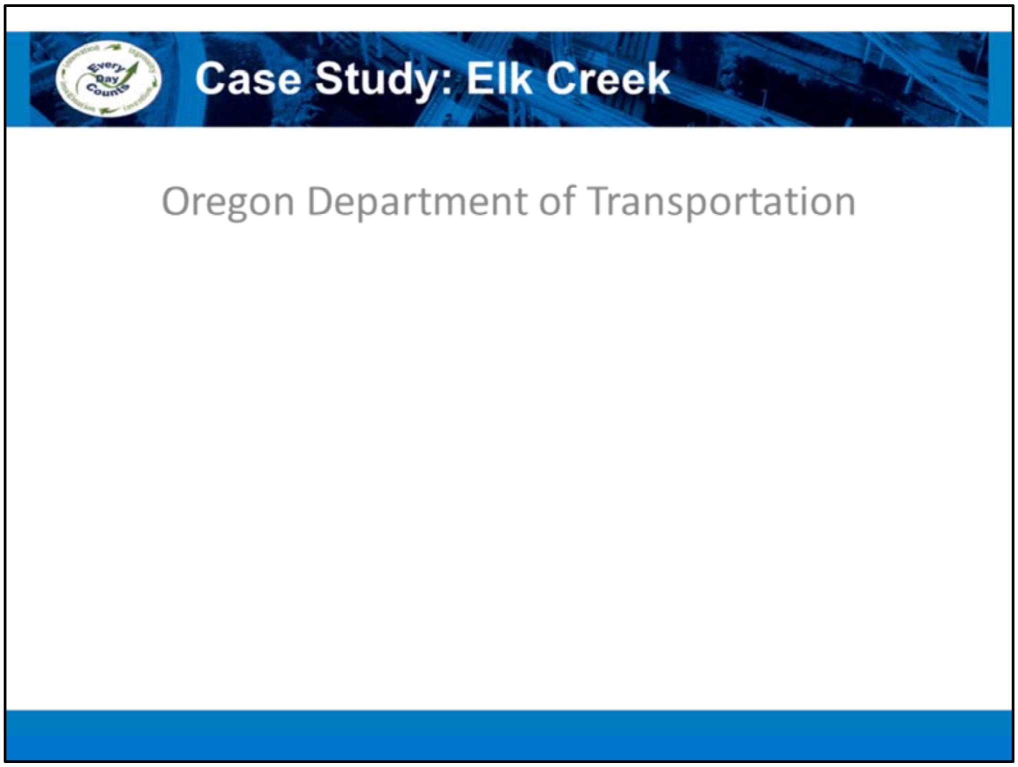
It is recommended to use asphalt overlay on a system using full depth precast sections to serve as a barrier between the deck joints and the road surface.



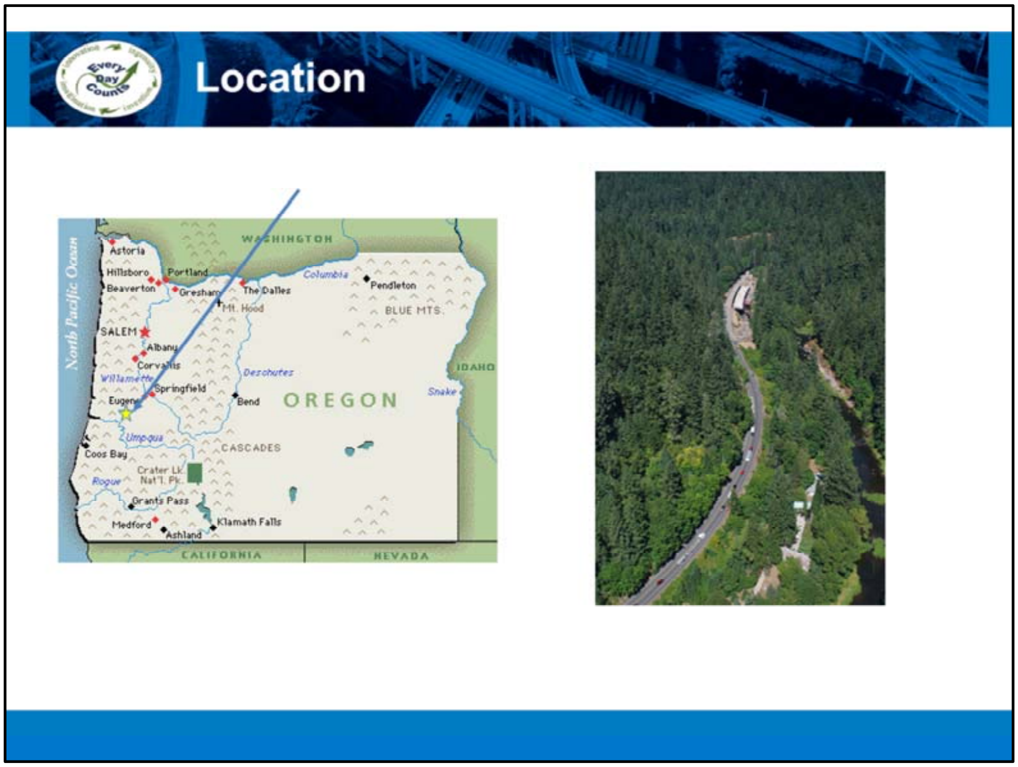
Some of the major benefits specific to this project include the cost savings, a minimal road closure, improved work zone safety, and a reduced impact to the NYC watershed.



This time lapse video shows the project beginning with the road closure at the start of the slide period. You will see the bridge demolition and removal, the slide of the new structure, and preparations for the reopening of the roadway. Finally, you will see the new bridge in action.



The Oregon Department of Transportation completed a project requiring several bridge replacements on State Highway 38 between the towns of Elk Creek and Hardscrabble, two of which were replaced using slide-in bridge construction methods. Here forward, the bridges will be referred to as Crossing 3 and Crossing 4.



The project is an hour south of Eugene in the mountains of western Oregon. The terrain alone would have been enough to make any bridge replacement project more difficult. Couple that with the desire to maintain traffic through the corridor during construction and the difficulty is only increased.

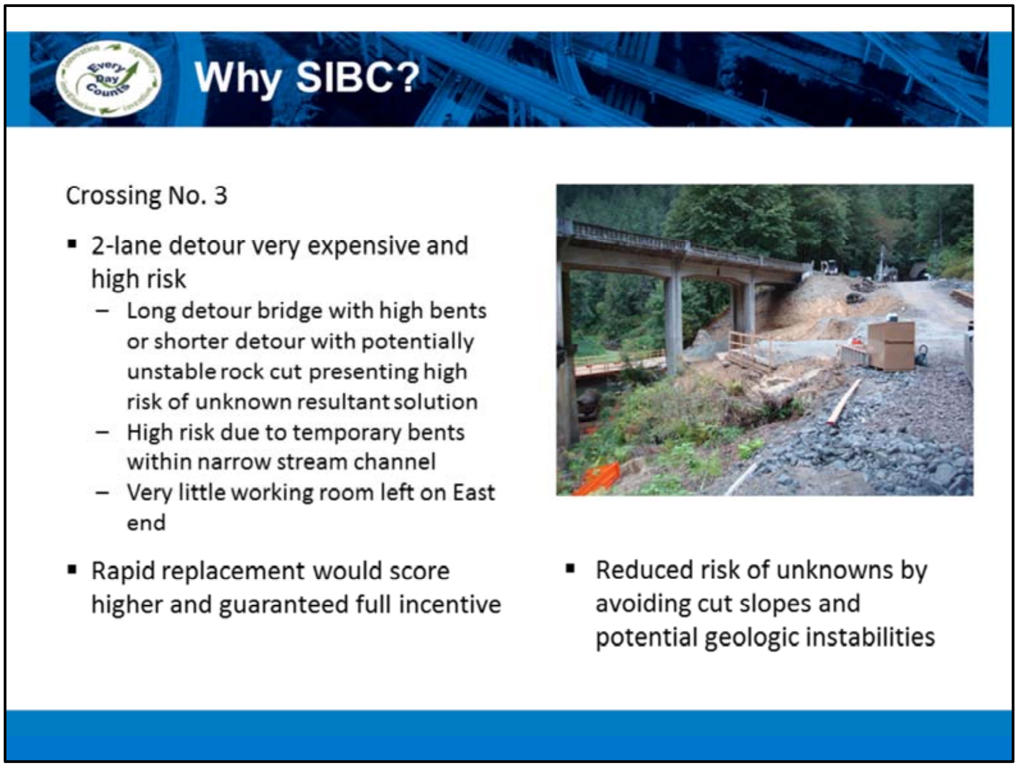
The method of delivery was design-build with best value selection and the winning team proposed slide-in bridge construction for two bridges to eliminate expensive detours and flagging.

The project was in a very difficult location. Both of the existing bridges featured deck truss main spans which essentially eliminated the possibility of phased removal and construction.

Both bridges were on opposite ends of the same tunnel, with one of the bridges starting almost immediately after exiting the tunnel. This made traffic shifts and alternative alignments extremely difficult to complete.

The lateral slides which were completed in a 48 hour closure window for each bridge eliminated costly realignments, costly temporary bridges, and eliminated most of the single lane restrictions.

The winning bid was approximately $50 million, slightly under the engineer's estimate of $53 million, and the total project duration was 32 months, almost two fewer years than the original estimated project duration.



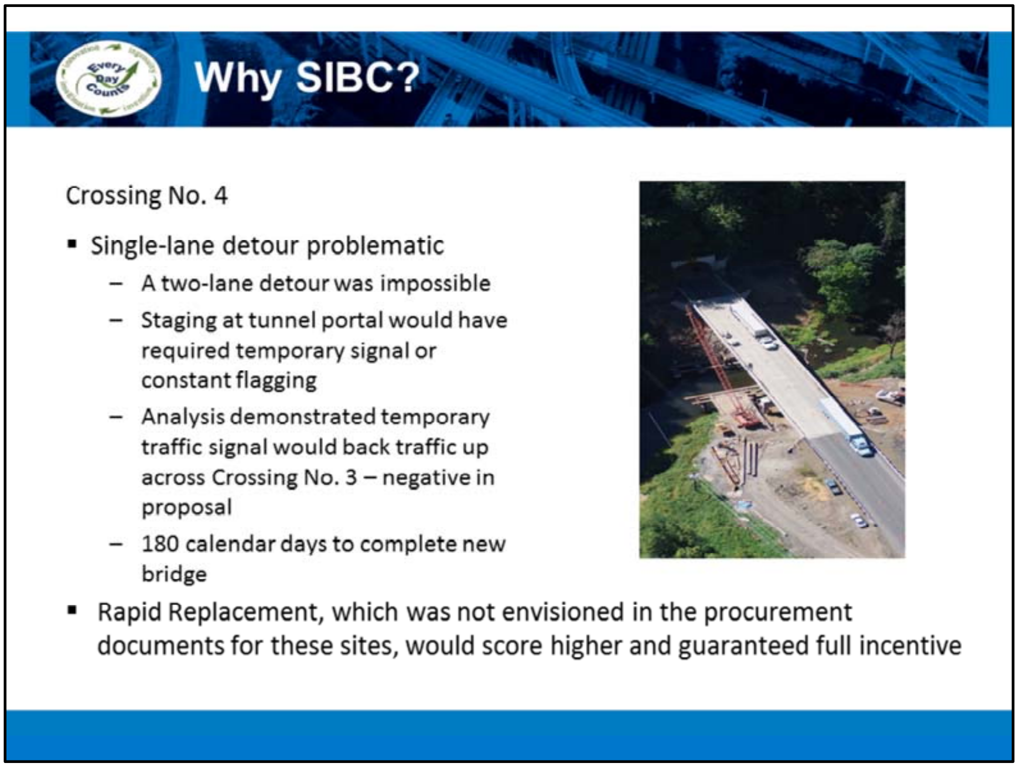
It’s useful to look at the reasons Slayden chose the lateral slides.

For Crossing 3, a temporary bridge could have been constructed but the local geometry made the temporary bridge almost three times the length of the permanent bridge.

Furthermore, there would have been considerable risk due to temporary bents within the narrow stream channel and very little working room would have been left on the east end which would have required a substantial hillside cut to reconnect at the west end.

Another reason, given that the project was design-build with best value selection, was that rapid replacement would score higher and guarantee full incentive.

The terrain also imposed several unique challenges. By avoiding cut slopes and potential geologic instabilities, the risk of unknowns was reduced.



For Crossing 4, the proximity of the tunnel to the bridge, only about 50 feet from the tunnel portal to Crossing 3 from the bridge joint, made staging the new bridge very difficult. A temporary signal or constant flagging would have been required and in this case it was discovered that traffic would have backed up through the tunnel and across Crossing 3.

Additionally, if a single lane detour was used, the contractor would have been limited to 180 calendar days to complete the new bridge.

Rapid replacement was not originally envisioned in the procurement documents for these sites. However, its use did score higher and guarantee full incentive.

These pictures show the difficult construction conditions and site constraints.

The primary structure of the original bridge, shown on the left, was a deck truss.

The overall structure was also composed of several shorter concrete girder spans approaching the truss structure.

On the right, the new structure is shown adjacent to the old structure, and is a three-span continuous steel plate girder bridge.

The red pieces are the vertical jack and slide shoes. Translation was accomplished by supporting and sliding at two interior points with the end spans cantilevered.

These pictures of Crossing 4, give you an idea of how difficult phased construction would have been due to the proximity of the bridge and tunnel. Like Crossing 3, the existing structure was a truss.

The new structure is a two-span, prestressed, concrete deck girder bridge. Translation was accomplished by supporting the structure along four lines.

Here, another picture of Crossing 4 is shown and the points at which the structure was supported during translation are better seen.

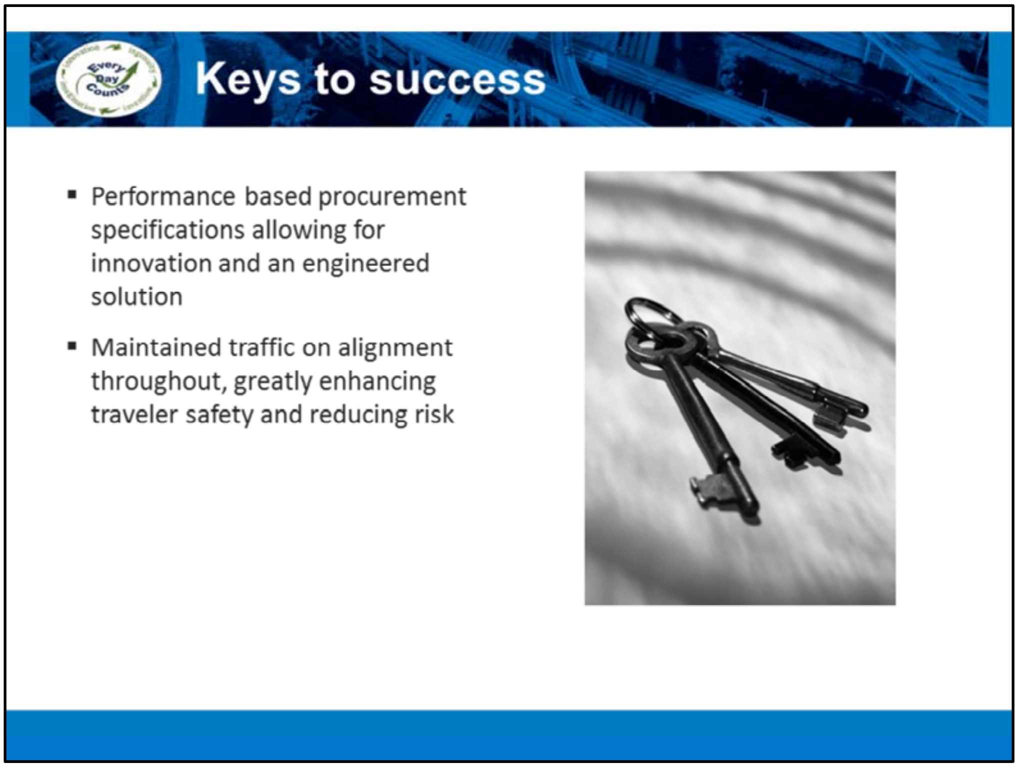
A greater appreciation is also gained for the surrounding terrain and the magnitude of a bridge slide operation.

For both crossings, the slide operation was subcontracted to Mammoet who used a similar technology found in Self Propelled Modular Transporters.

After all was completed, several keys to success were identified.

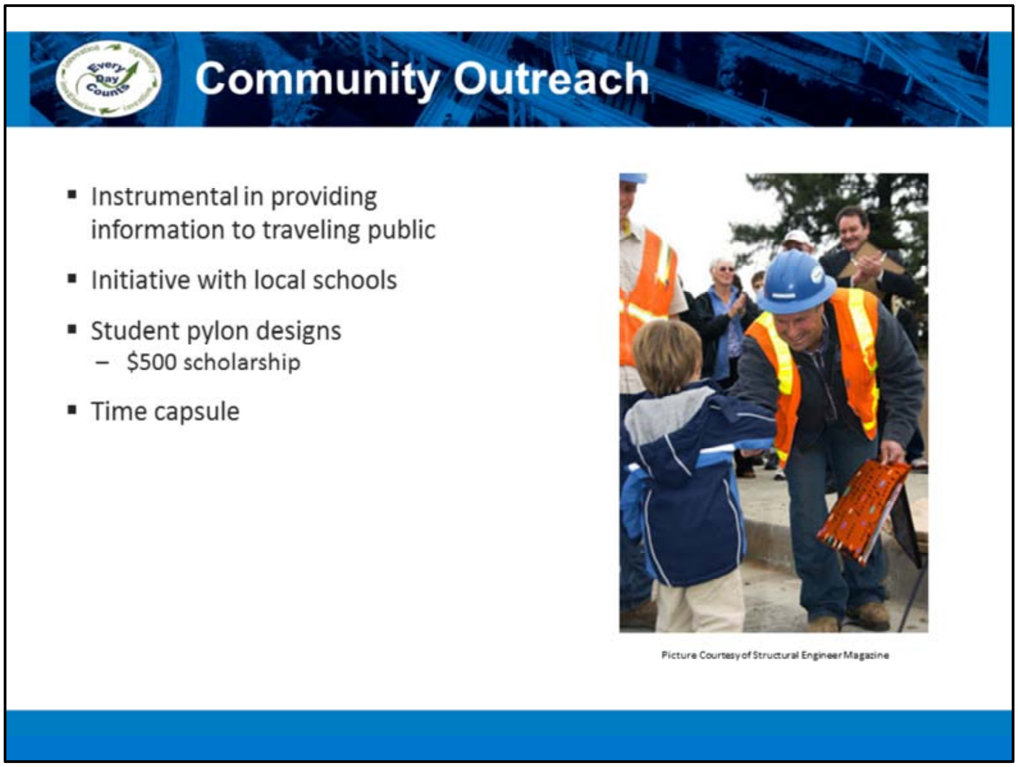
First, the reduction in construction time offset the additional costs due to slide-in bridge construction. Also, a significant reduction in maintenance of traffic resulted in schedule savings and good public relations, and the elimination of flagging for what would likely have been 180 days resulted in cost savings.

Furthermore, risk was greatly reduced by not using a temporary bridge to carry public traffic. And, maybe most importantly, the contractor made it known that coordination, communication and cooperation between the owner, community, and contractor was the real key to success.



Some additional keys to success include the performance based procurement specifications which allowed for innovation and an engineered solution.

Lastly, traveler safety and reduced risk were achieved by maintaining traffic on alignment throughout the duration of the project.

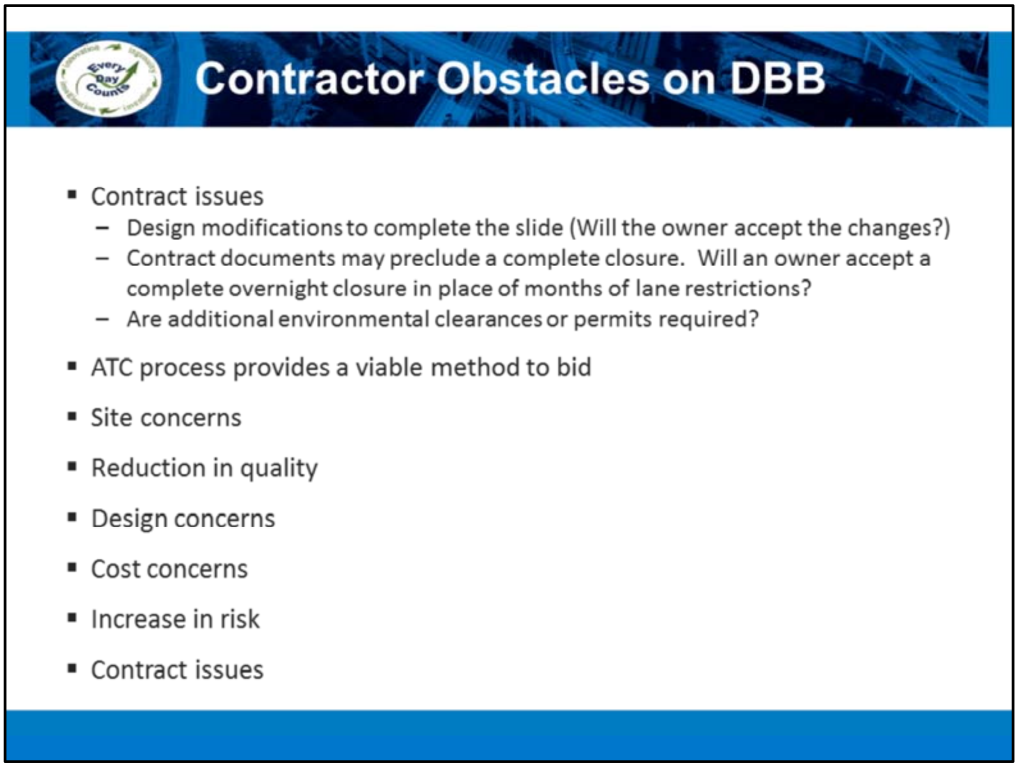


As part of the project, the contractor implemented a community outreach program which was instrumental in providing information to the traveling public.

The initiative began with the local schools. On several occasions the contractor visited the schools to convey necessary information whether it be through the students or directly to parents.

A student competition was established to design the pylons at the corners of one of the bridges and the winning student was awarded with a $500 scholarship.

Lastly, a time capsule on one of the bridges was created for students and other community members to contribute to. For this project the location allowed for closing off the site to any public viewing eliminating that potential security and safety issue.



Given all the benefits you may wonder why slides aren't used more often. It's likely we would see a lot more slides on traditional projects if the contractor knew they could get past a few obstacles. If a slide wasn't part of the bid package and a slide requires modifications, the contractor can't bid the slide in case the owner doesn't accept the revisions. Once the project is won the contractor has little incentive to go down the value engineering change path. Sometimes value engineering changes can lead to a loss of positive partnering attitudes.

Site concerns – There are places where it is not feasible to construct a new bridge adjacent to the existing structure but the Oregon project shows that slides can be effective even in very confined locations.

Reduction in quality – There is no evidence in reduction in quality in bridge lateral slide projects. When compared to phased construction it might even be an improvement. The Utah DOT has performed special inspections of all lateral slide bridges and no adverse effects have been found with the bridges. In fact, the condition in most cases is better than bridges built with SPMT installations.

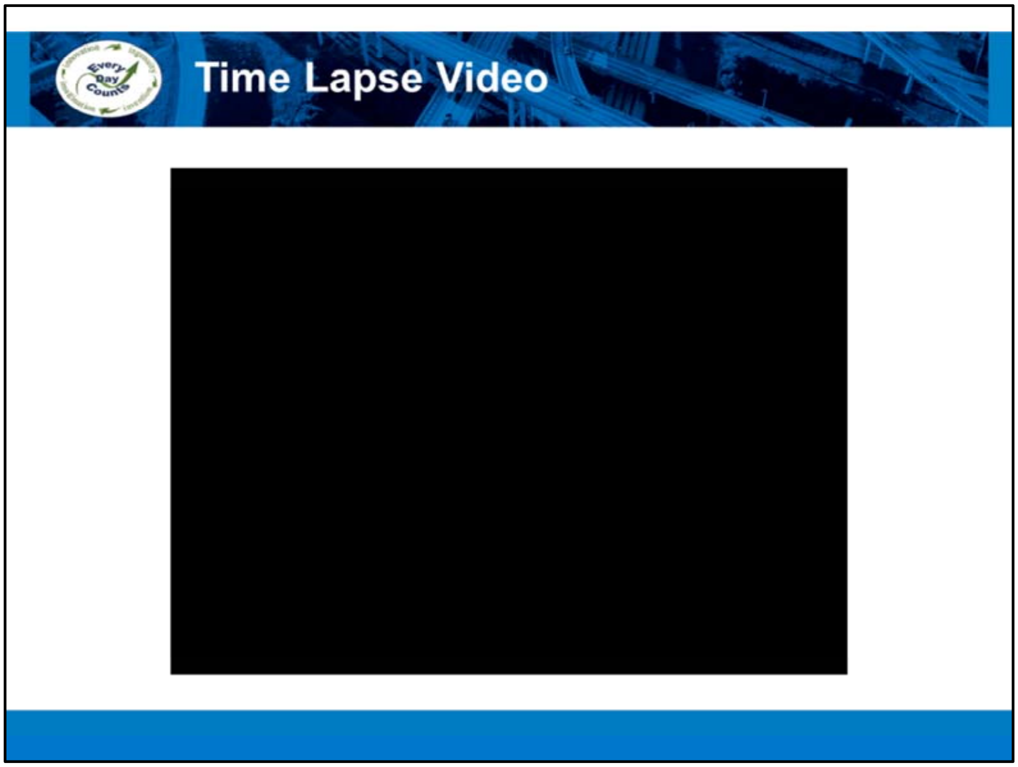
Design is fairly simple and there are a variety of solutions or methods used that demonstrate this. Difficult problems usually have few viable solutions.

Cost is difficult to quantify. It is more costly to slide a bridge into place than to close the road and build it in place. Once you start phasing the construction or requiring a

temporary structure the slide becomes cost effective without even considering user cost and construction oversight costs.

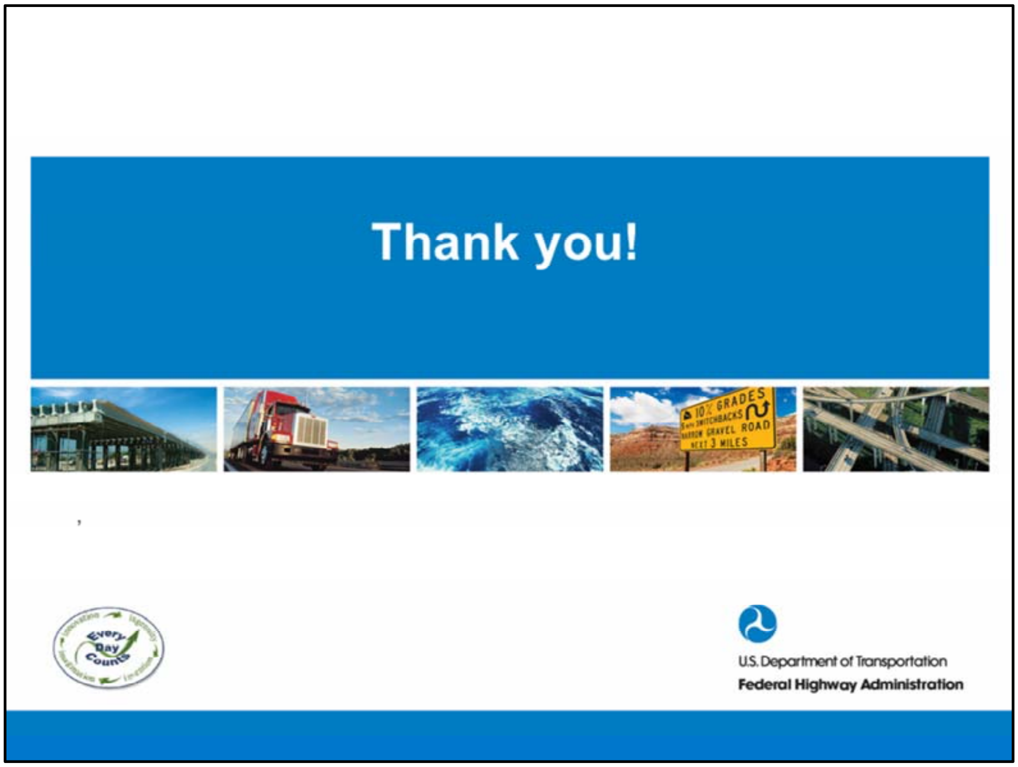
Increase in risk – any new construction method for any contractor or owner represents a risk but in general it is believed to be low. Construction risk is similar to a cast-in-place bridge. The move risk is really a function of the time provided for the move and the associated penalties for not opening. A tight timeframe increases the risk the project won't be completed in the allotted time. Low damages increases the risk that the contractor will not be prepared for problems. For example, having an additional jack onsite is cheap insurance against high penalties for not opening on time.

Contract issues – As a policy, owners should start structuring all projects to allow a lateral slide option. In addition to the normal contract and maintenance of traffic requirements it is relatively easy to add maintenance of traffic language to allow a limited complete closure with penalties or incentives in lieu of a defined time of reduced lanes or on site construction time. Also a special provision defining the requirements of any redesign and any other special requirements would allow the contractor to bid the job assuming a slide. As long as they know the requirements they need to meet they can confidently bid the job.



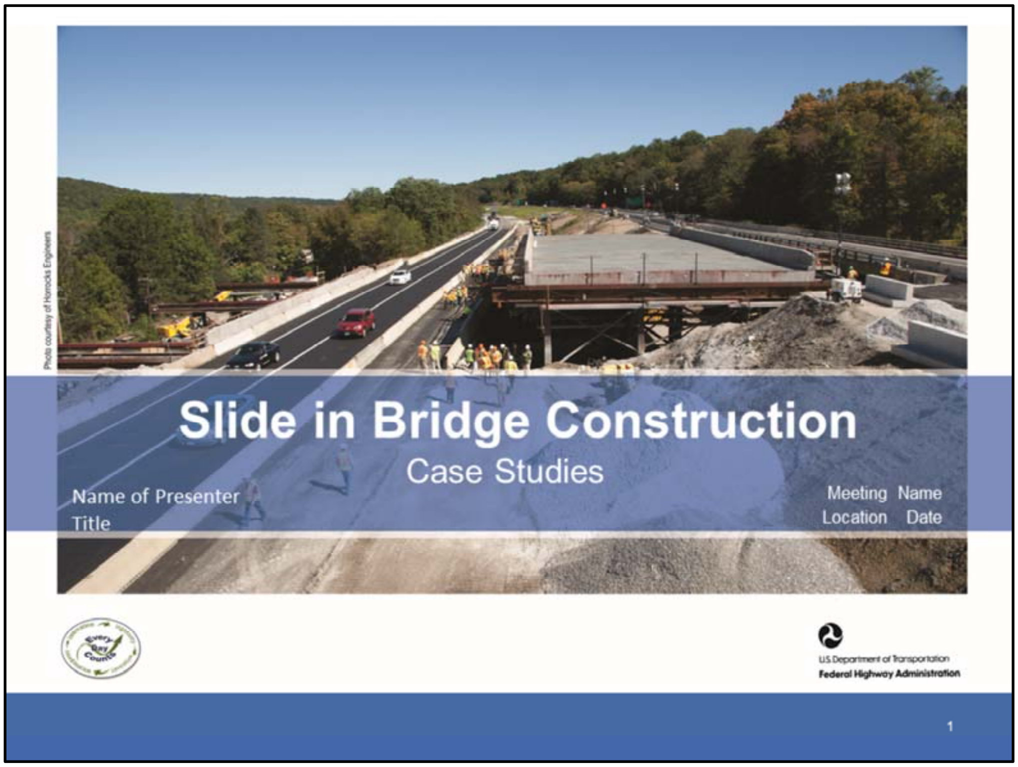
Here is a time lapse video of the slide period on Crossing 3.

A technical support solutions center has been established and is available for all to use to assist in slide-in bridge construction projects. Here the most up-to-date information about SIBC resources and training can be accessed. The center is most easily found by searching "FHWA Slide" online, or by simply going to directly to the web address shown here.


Thank you!
10% GRADES
NARROW GRAVEL ROAD
NEXT 3 MILES
Every Day Counts
U.S. Department of Transportation
Federal Highway Administration

PRESENTATION HANDOUTS:

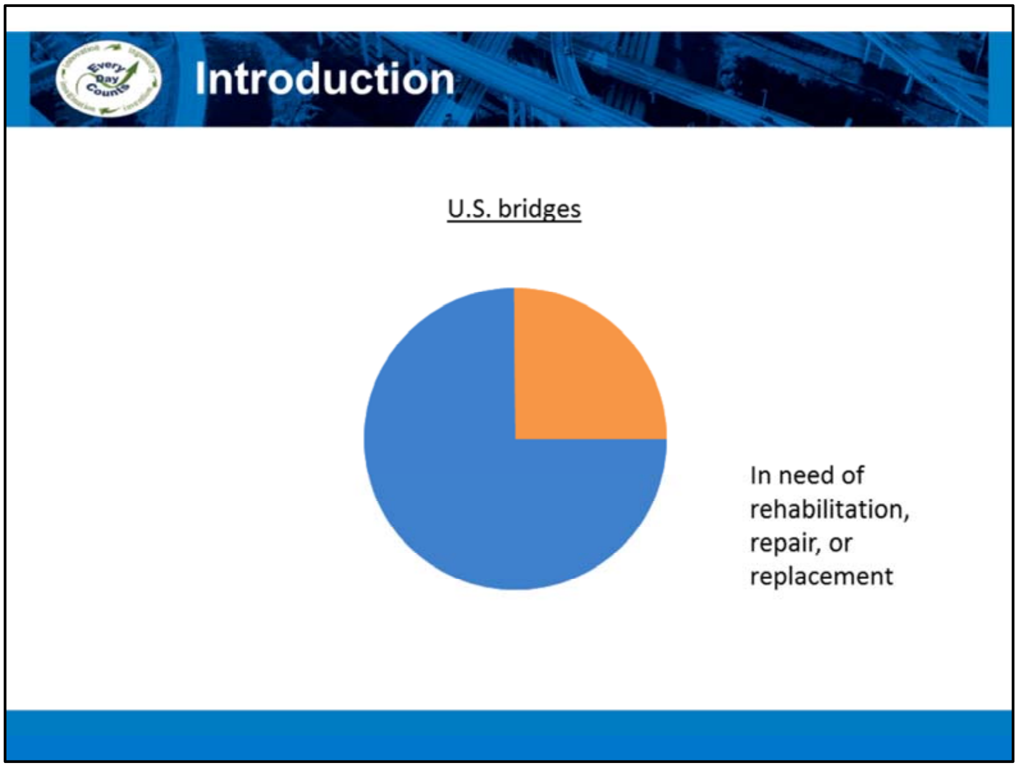
COURSE 5 SIBC CASE STUDIES



Thank you for attending today's session on Slide in Bridge Construction.

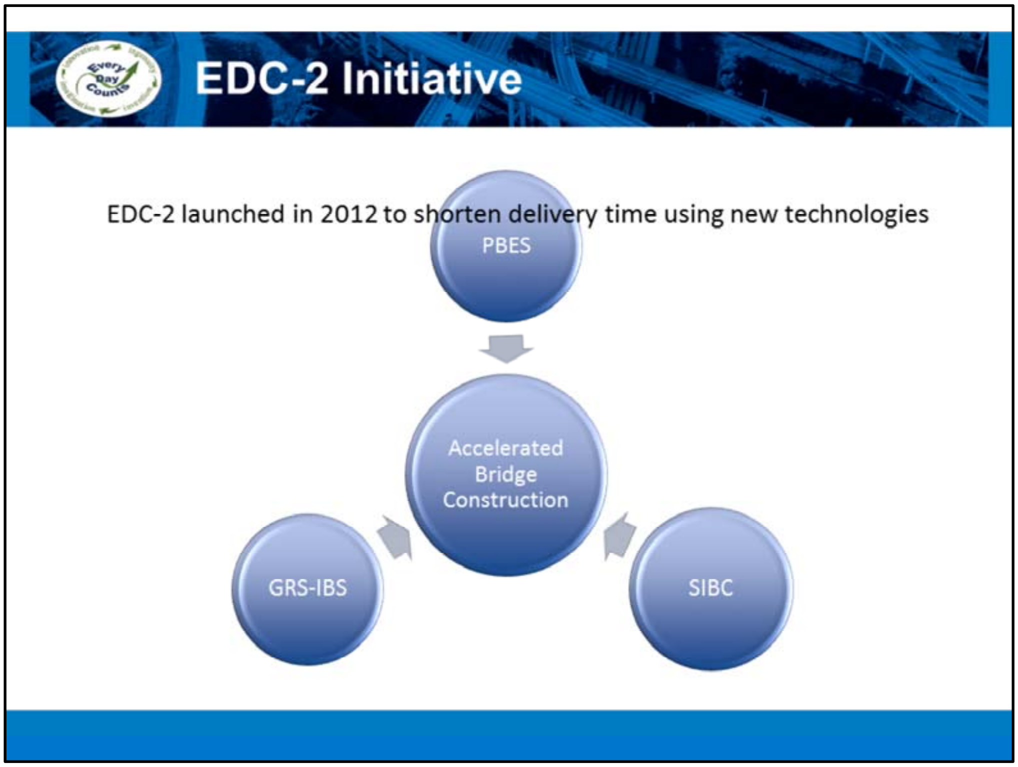
This presentation was developed for the FHWA as an extended effort of the Every Day Counts Initiative.

Slide-in bridge construction (SIBC) is a particular method and refinement of construction contained under the broader topic of Accelerated Bridge Construction (ABC) with the specific goal of extremely rapid bridge installation under very short term road closure.



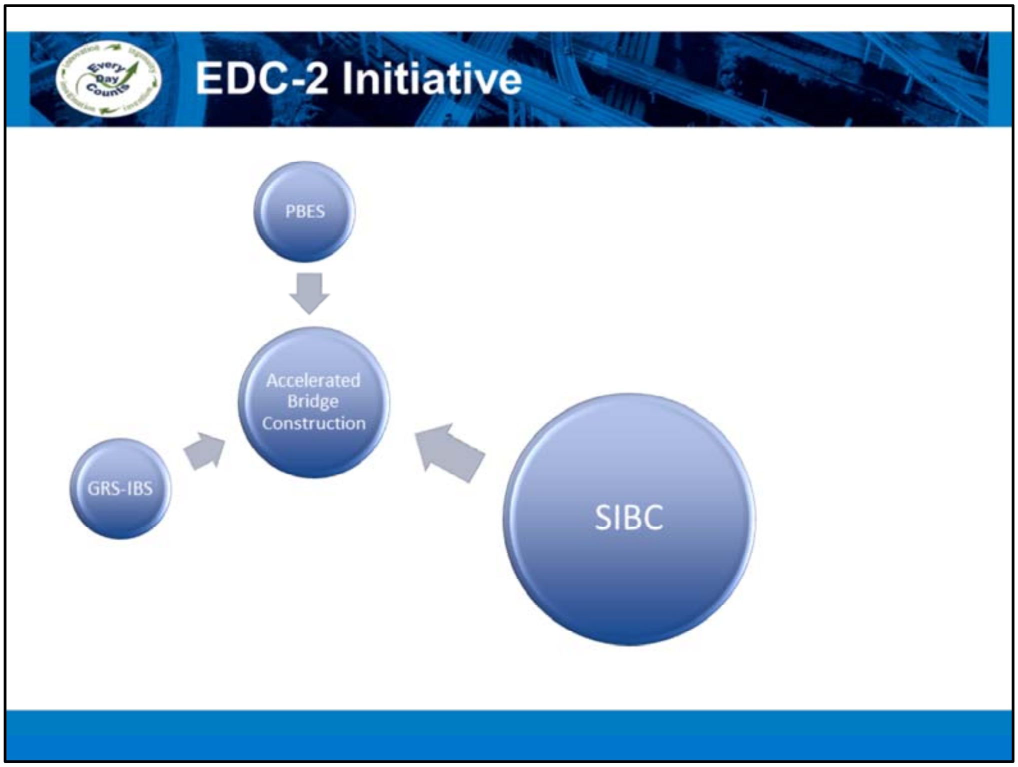
Nearly 25% of the Nation's 600,000 bridges are in need of rehabilitation, repair, or total replacement. Given this vast number, the need for bridge reconstruction methods that reduce the impacts to mobility and safety is needed. This need was one reason the Every Day Counts Initiative was launched.

Every Day Counts was first established in 2010 as a state-based initiative meant to identify and deploy innovation; specifically, to shorten project delivery, enhance safety, reduce mobility impacts, and protect the environment. The term “get in, get out, and stay out” was popularized under this program.

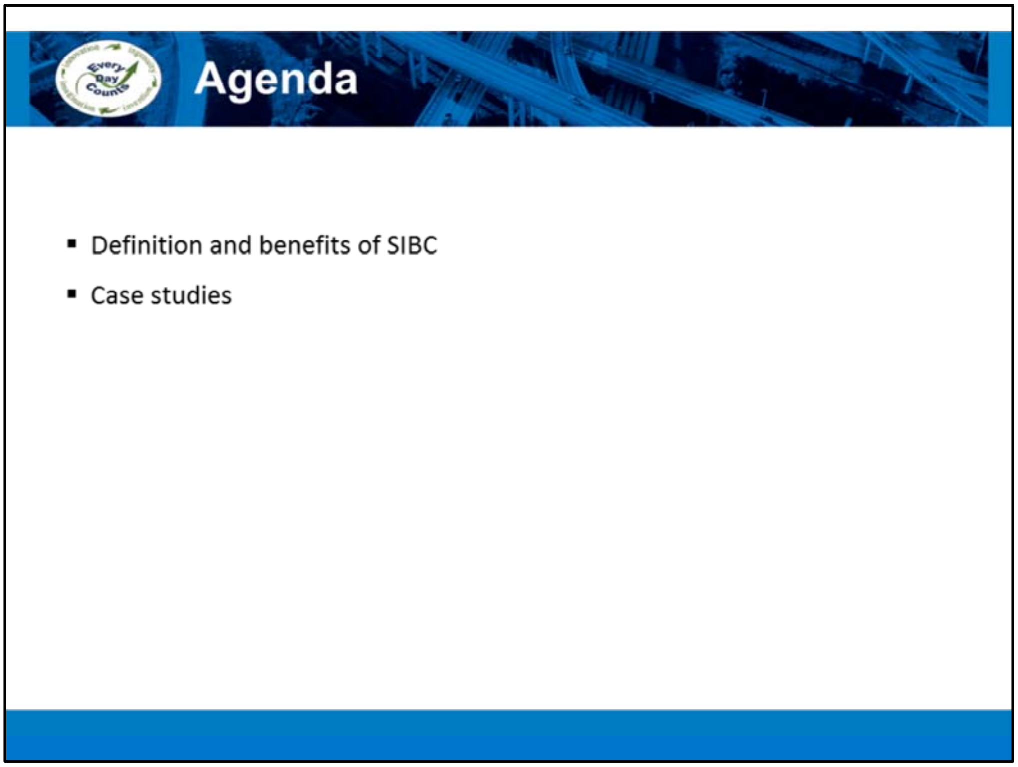


As a result of these efforts, EDC-2 was launched in 2012 with the specific focus of shortening the time needed to complete highway projects through the use of new technologies and ground-breaking processes. Within that directive, accelerated bridge construction became an area of concentration.

Three particular ABC technologies being promoted under EDC-2 are prefabricated bridge elements and systems, geosynthetic reinforced soil-integrated bridge systems, and slide-in bridge construction.

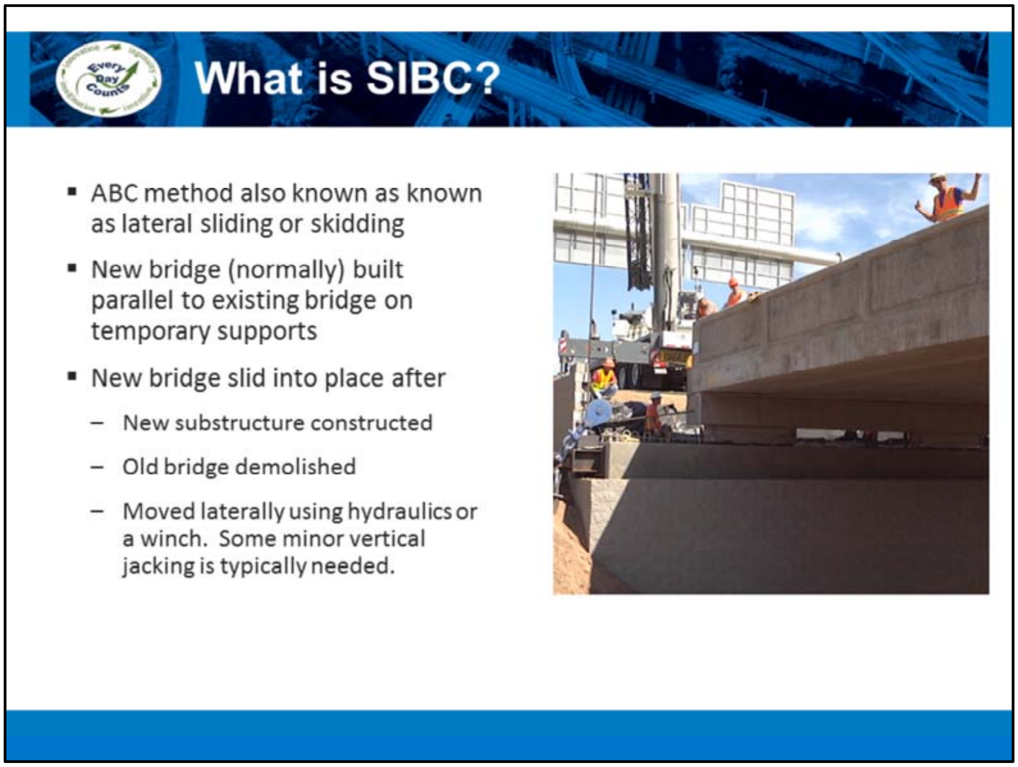


It comes as no news to anybody that our focus today will be on slide-in bridge construction.



Several slide-in bridge construction topics will be covered as the day progresses. Collectively, the topics aim to provide a comprehensive overview for owners, designers, and contractors; thereby better equipping each group to pursue slide-in bridge construction or SIBC as it is now more commonly referred to.

SIBC will be defined and its benefits will be discussed, and followed by six case studies of previous SIBC projects.



So, what is slide-in bridge construction?

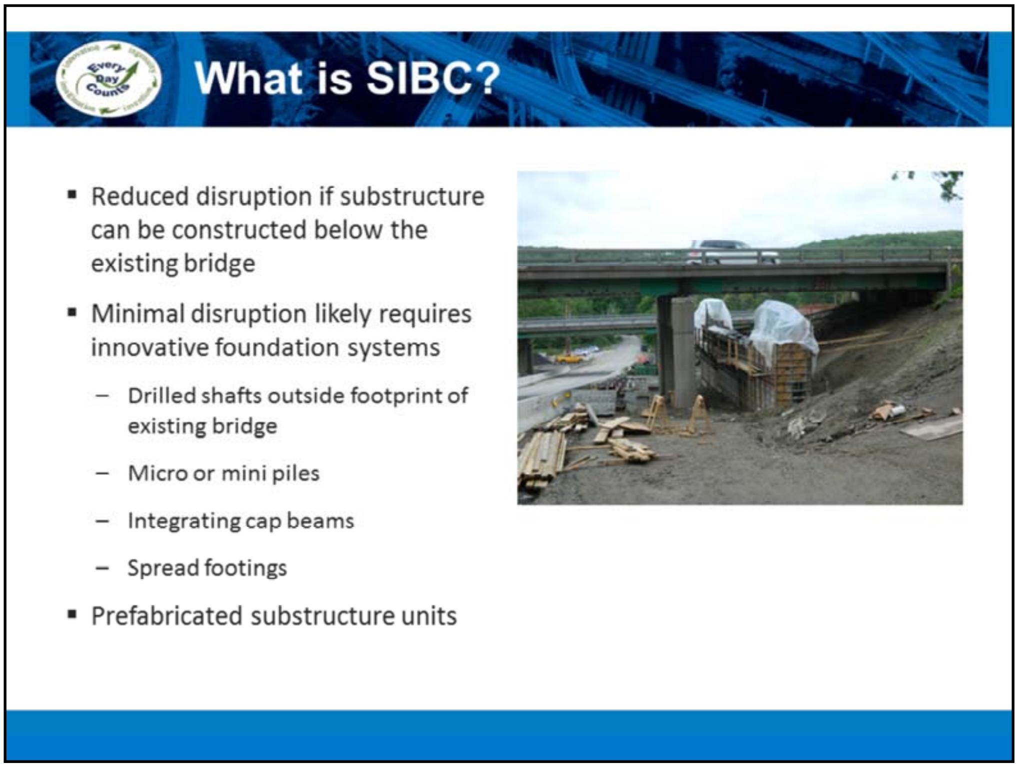
It is a method of ABC that has also been known as lateral sliding or skidding, and the variations of these techniques.

In SIBC, a new bridge is typically constructed adjacent to and parallel to the existing bridge on temporary supports.

Once complete, the old structure is demolished and the new substructure is constructed, followed by the sliding of the new superstructure on to the new substructure already in place. There have been some cases where the old substructure was reused.

The new bridge is moved laterally most commonly with hydraulic jacks, though other methods have been employed, such as a winch. Some minor vertical jacking is typically needed.

SIBC, and ABC in general, is primarily used for bridge replacement projects where the impacts to mobility are significant.



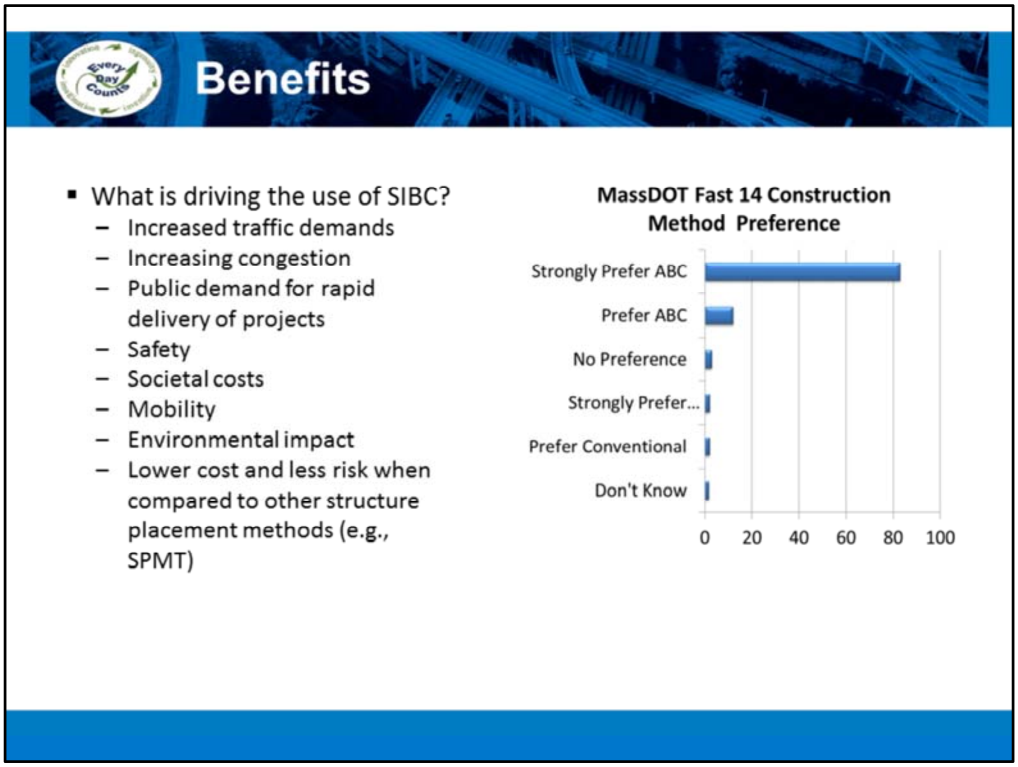
There have been many cases where the new substructure was constructed beneath the existing bridge prior to demolition. As you can predict, this expedites the process from demolition to bridge slide.

It should be pointed out, however, that constructing traditional foundation systems might not be feasible. Rather, an innovative foundation system might be required when using this method.

It is possible that prefabricated elements could play a key role in constructing the new substructure.

One might believe that bridge slides are only used for sliding a new bridge into the position of the existing. This is most commonly the case, but SIBC is not limited to only sliding new structures.

Existing structures can be slid to a new alignment to serve as a bypass bridge while a new bridge is constructed using more traditional methods. Keep in mind that in this case, the temporary substructure system will be subjected to live and other transient loads in addition to the bridge itself, typically resulting in a more robust, and hence higher cost, to such an installation.



So, what benefits can be gained by using slide-in bridge construction? Maybe the better question is 'What is driving the use of SIBC and how is it that SIBC addresses those needs?'

Traffic demands are increasing, congestion is increasing – both create an unnecessary nuisance in the lives of the traveling public. As such, the public demand for rapid delivery is increasing.

One can see in this chart the overwhelming preference for accelerated bridge construction when polled in Massachusetts prior to the MassDOT Fast 14 project.

Even more, the safety of the traveling public and bridge builders is compromised when bridge projects are long in duration. SIBC alleviates some of this risk by significantly reducing the time main-line traffic is interrupted.

Societal costs, though often difficult to fully quantify, are significantly reduced as well.

Environmental impacts can be softened.

And lastly, the costs can be lower and at less risk when compared to other rapid structure placement methods, such as self-propelled modular transporters, float in delivery, or a heavy crane pick, for example.

To continue with the benefits of using SIBC: non-traditional site options can be offered, cross-overs or shoo-flies are eliminated along with staged construction and long term detours. These things can result in lower construction costs.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Mobility and environmental impacts can also be reduced and safety is nearly always enhanced for the worker and road user.

Potentially of greatest significance is that SIBC promotes user and worker safety. Safety is nearly always enhanced for the worker and road user; this can not be understated.

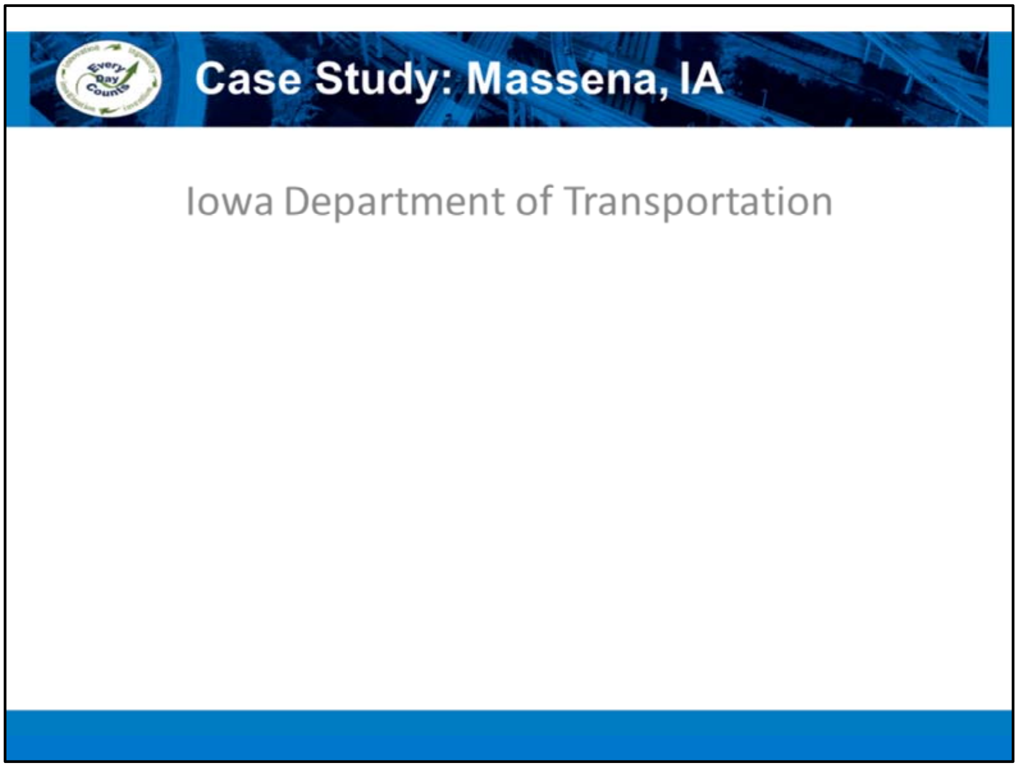
When compared to other ABC methods, SIBC often receives better contractor "buy-in", presumably because of the reduced risk that was previously mentioned.

Environmental impacts can also be reduced.

Benefits

- Removes bridge construction from critical path
  - May lead to better quality end product
- Involves public in reducing societal costs
  - Results in greater “buy-in” in the overall project
- Road closures better managed
  - Dates and duration are more predictable

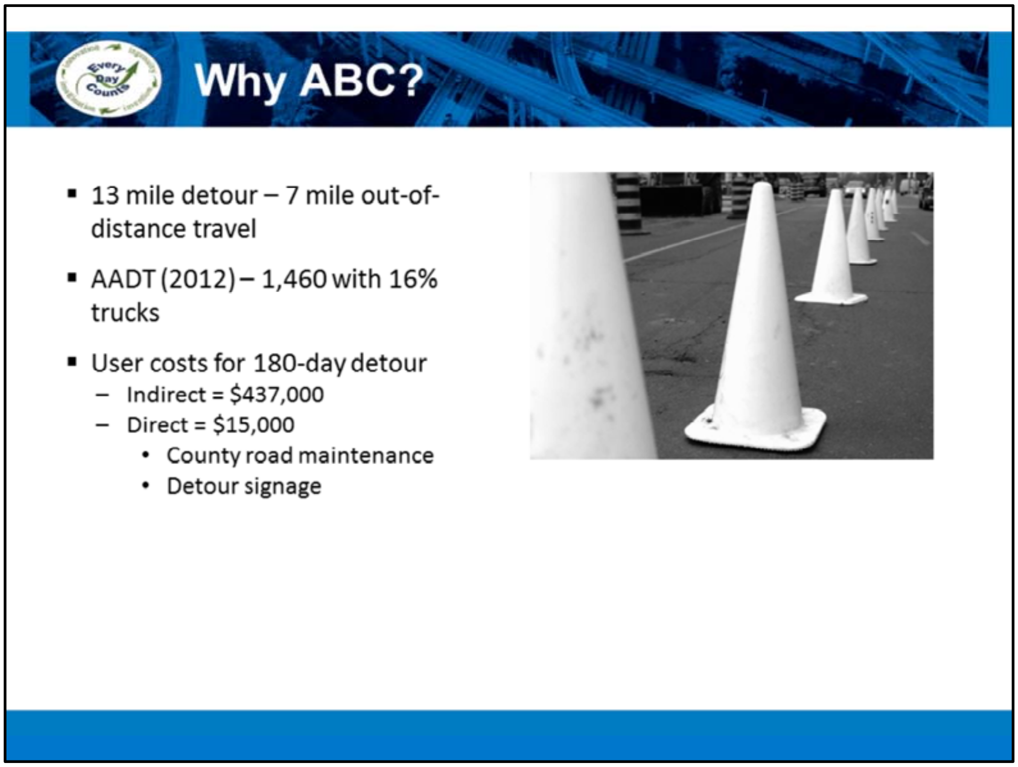
Lastly, SIBC removes the bridge construction from the critical path which may lead to a better quality end product, it involves the public by reducing societal costs, thereby creating better “buy-in”, and road closures can be better managed.



The next portion of this presentation will focus on 6 case studies that shed light to the practice of slide-in bridge construction. They are collectively intended to provide perspective from owners, engineers, and contractors. Individually, however, the case studies may focus only a single intended audience.

The first case study comes from a slide-in project completed during the fall of 2013 in Massena, IA. The owner is the Iowa Department of Transportation and this project is the first in the state completed using SIBC.

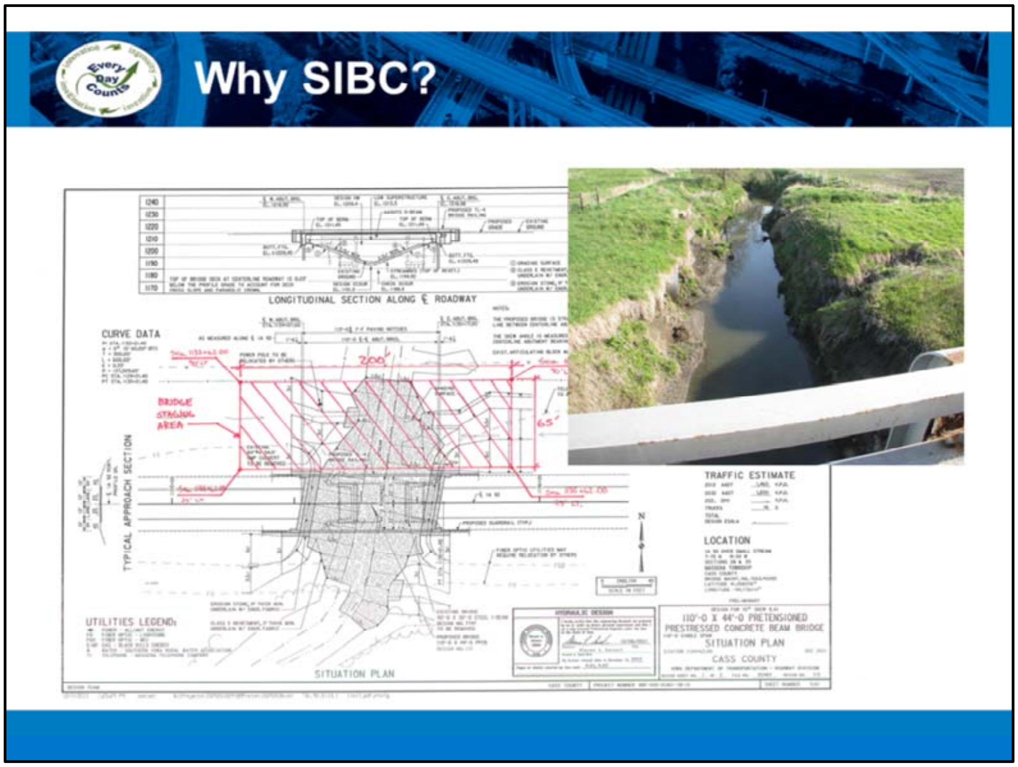
The bridge on IA 92 crosses a small stream immediately west of the Town of Massena, IA in southwest Iowa.



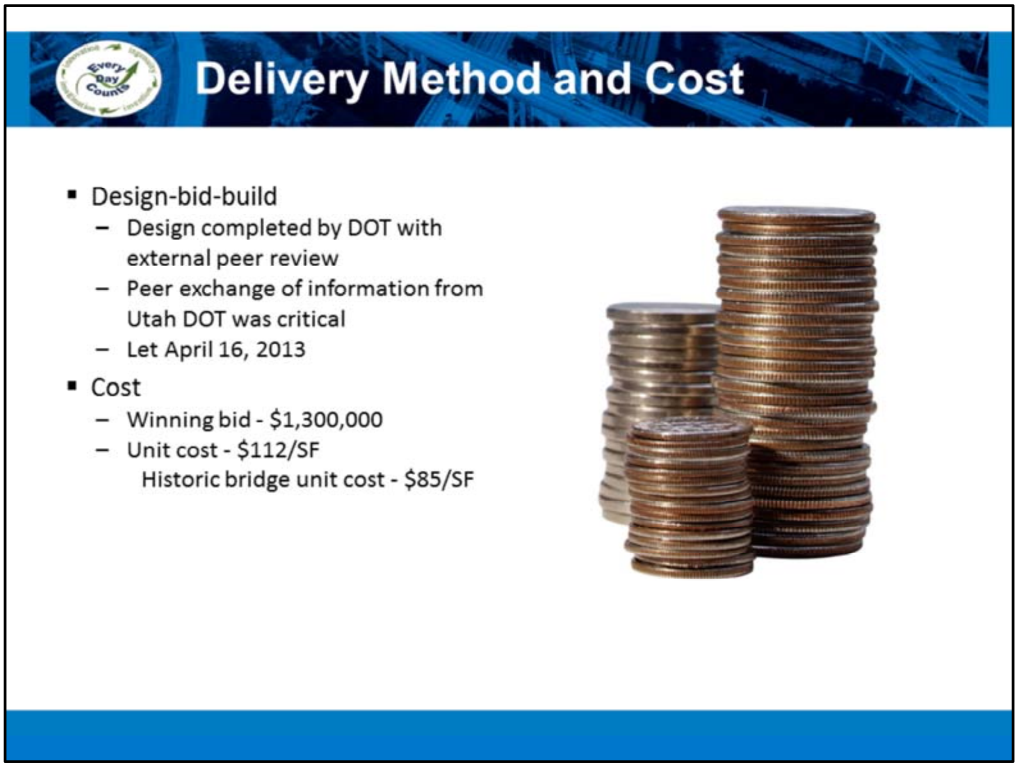
In this case, several considerations were made for why accelerated bridge construction was a good solution.

First, to close the bridge would have meant a 13 mile detour and 7 mile out of distance travel for road users. This is even more significant when coupled with the fact that 16% of all vehicles were trucks.

It is estimated that to complete the bridge replacement using traditional construction methods a road closure of 180 days would have been necessary resulting in indirect costs of $437,000 and direct costs of $15,000.



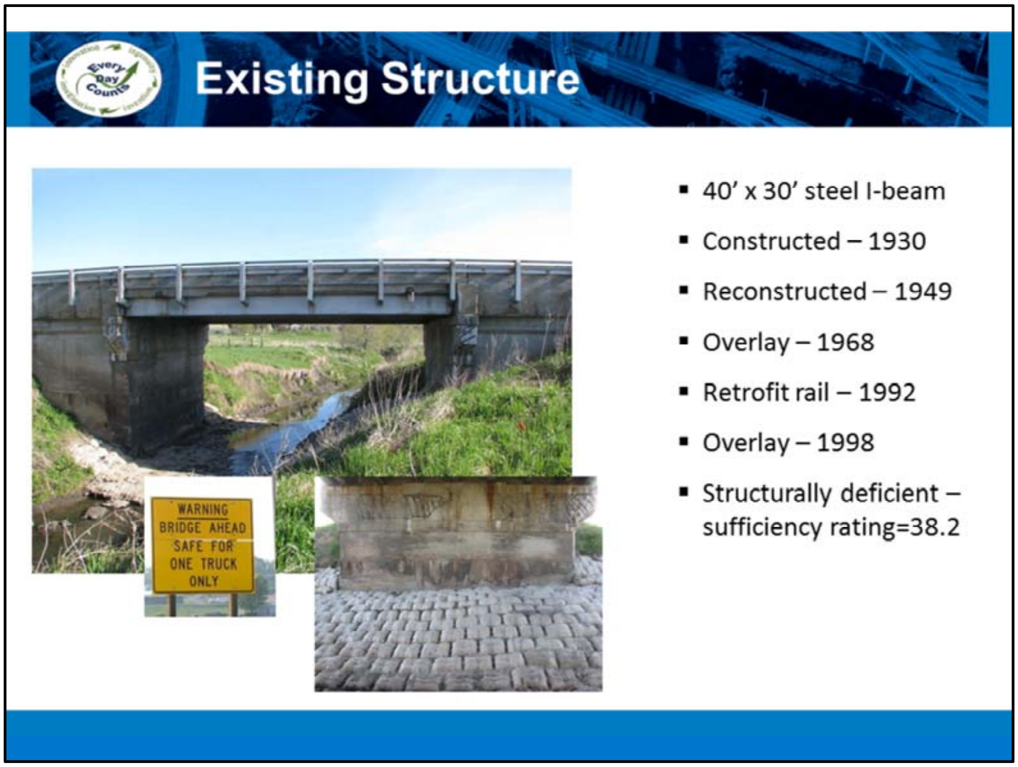
The Iowa Department of Transportation in its pursuit of accelerated bridge construction methods planned to implement slide-in construction methods at a site where it made sense to do so. At Massena, slide-in bridge construction was a good solution for accelerated bridge construction. The existing right-of-way allowed sufficient space for temporary works adjacent to the bridge without having to acquire temporary right-of-way. Even more, the geography was fairly flat, thereby simplifying the construction.



The method of delivery followed traditional design-bid-build. The design was completed entirely by the Iowa DOT with external peer review.

Prior to the beginning of the project, a critical peer exchange took place with the Utah DOT during the slide of one of their bridges. Several from Iowa traveled to Utah and were able to view the slide and speak directly with owners, designers, and contractors. Many lessons were learned and implemented prior to final design and construction of the Massena bridge.

The winning bid was $1.3 million which equates to a unit cost of $112/sf. Historically, in Iowa, the unit cost is near $85/sf, or roughly 75% of the actual cost. Note that these numbers represent the construction costs only and do not include the user costs which, if included, would have nearly equalized the overall costs.



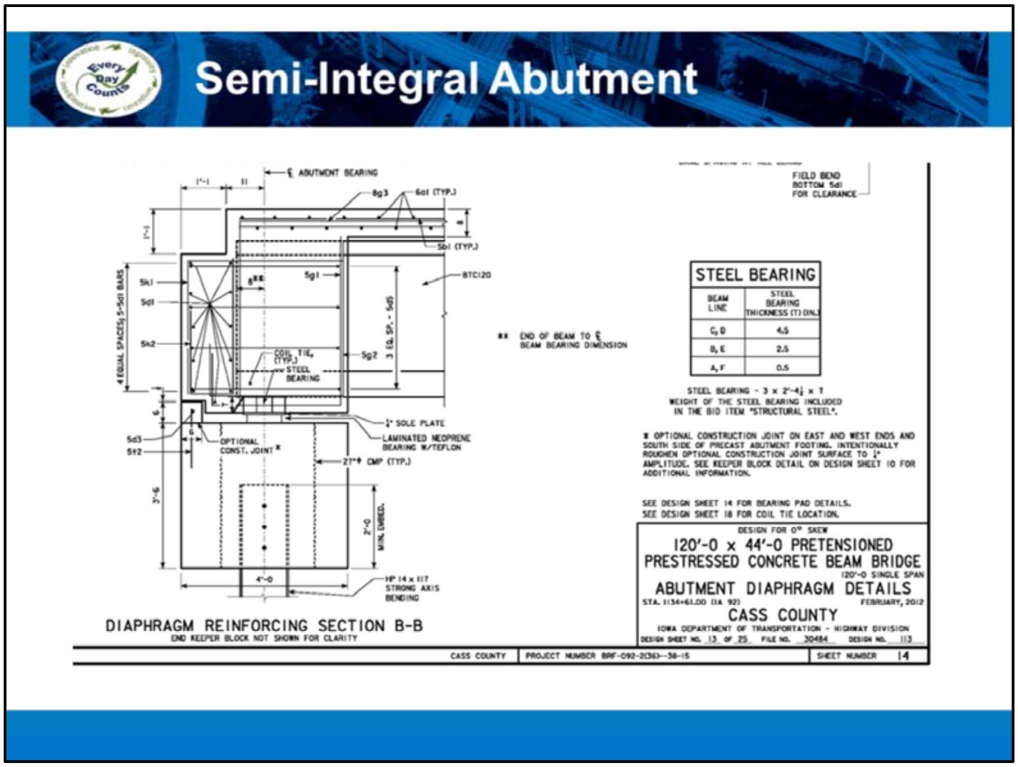
The existing bridge, originally constructed in 1930, was a 40’x30’ steel I-beam structure with high abutment walls and narrow channel passage. Over its history, it had been reconstructed, retrofitted, and overlaid on several occasions. Soon before its replacement it achieved a sufficiency rating of 38.2, deeming it structurally deficient.

The proposed replacement seen in this rendering is a longer, pretensioned, prestressed concrete beam bridge.

The plan design and details incorporated a semi-integral abutment and abutment diaphragm. The diaphragm served as a block for pushing and pulling the prefabricated structure.

Even more, within the diaphragm, jacking pockets for lifting were formed.

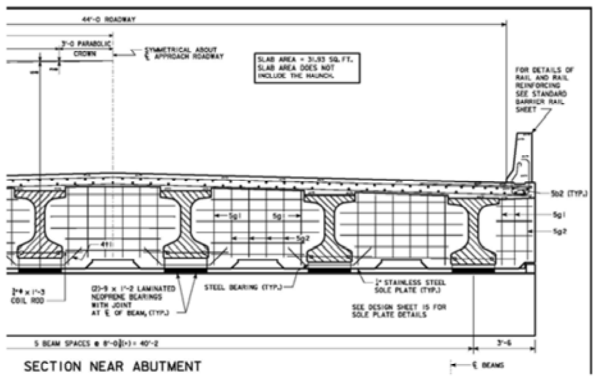
The original design called for precast abutment footings set over the top of H-piles, each connected through filling with concrete the corrugated metal pipe void forms within the footing. In the end, the abutment footings became cast-in-place by request of the contractor. Precast elements were used at the wingwall locations.



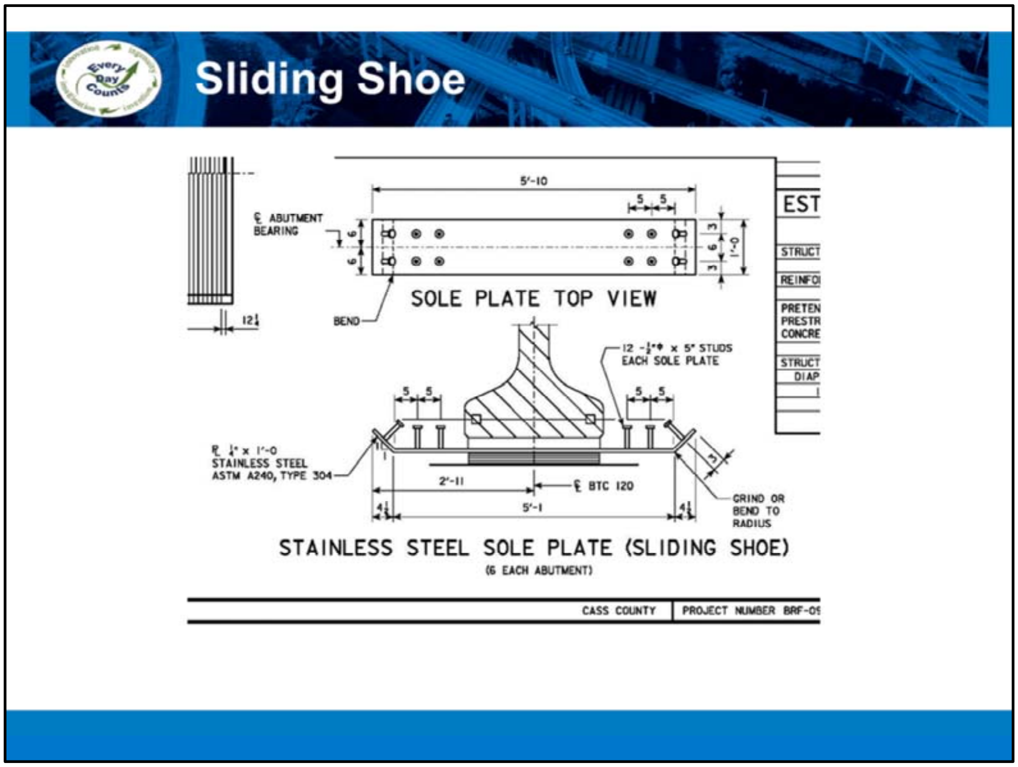
Shown in this detail is the semi-integral abutment and diaphragm. The slide plane is shown directly above the abutment footing and directly below the diaphragm.

Sliding Pad

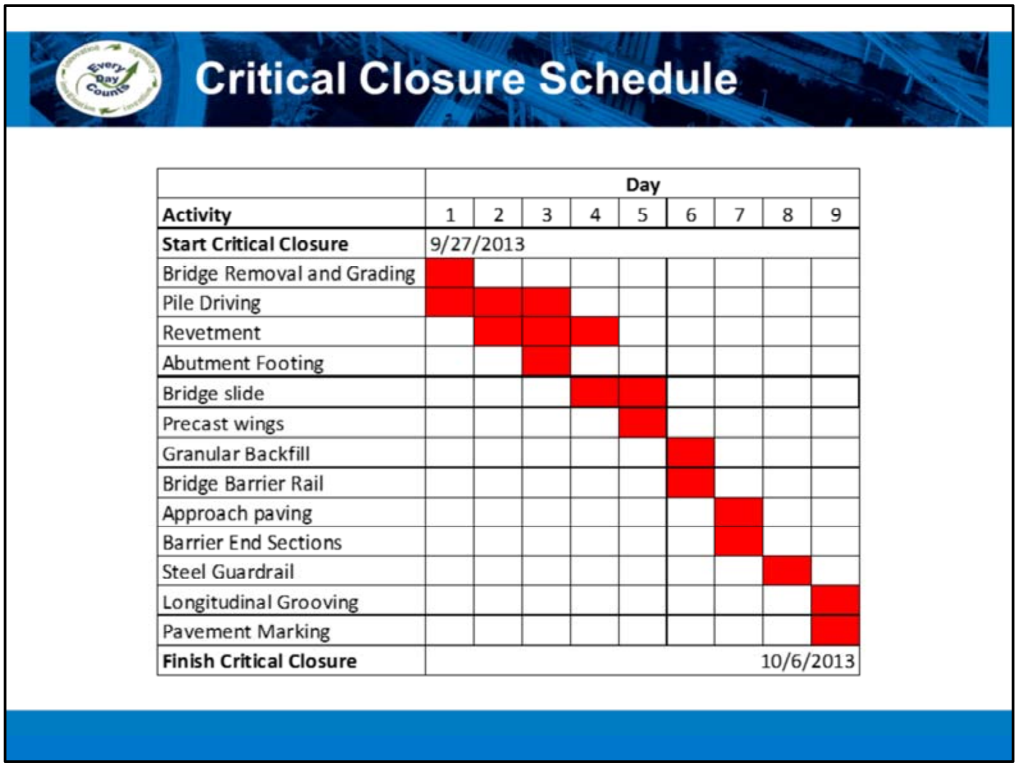
- Engineer's sliding concept
- Contractor elected to use commercially available rollers



The original intent was for the bridge to be slid using PTFE coated bearing pads and dishwashing soap. However, the contractor requested to use heavy duty rollers instead as they were the owners of several rollers from a previously completed project.



A stainless steel sliding shoe cast into the diaphragm at each girder end would have been the only point of contact between the superstructure and the bearing pads.



The critical closure lasted 9 days – contrast this with the projected 180 days had the bridge been constructed using traditional methods. The 9 days started with the removal of the old bridge and grading for the new structure.

After, pile driving, revetment and abutment footings were completed.

The bridge slide occurred over the course of an evening and early morning hours half-way through the 9 day closure, after which, the bridge and roadway were completed with wingwalls, backfill, barrier rail, and approach paving.

Several lessons were learned from this first experience with slide-in bridge construction in Iowa. Traditionally, for steel bridge projects in Iowa, the project is let during the fall allowing the contractor to gather resources over the winter and prepare for a spring start. Looking back, it was found that the Massena project would have benefitted from a similar schedule. As it was, the project was let in the spring with a summer start date, thus expediting and making more difficult the process for the contractor and owner, especially as it pertained to gathering materials and shop drawing preparation and approval.

The plans called for a precast only substructure. Unless there is an absolute must for precast, it might be better to allow the contractor the decision of precast or cast-in-place knowing the end goal and critical closure time.

Unless the there is a necessity for the plans to remain as is, proposed changes from the contractor are likely. Be prepared to fully evaluate the impact of these method changes.

Though heavy duty rollers ultimately took the place of the laminated bearing pads as the primary slide mechanism, the pads were still used along with the rollers in the jacking pockets. The bearing pads experience some shear deformation during the slide and any damage that might occur is hard to detect from only visual observation of the pads. Accordingly, it is recommended that bearing pads used during the slide are replaced with new pads once the bridge is in its final position.

The importance of properly designed and constructed falsework is even greater in slide-in construction. As such, adding a specification requiring the falsework design engineer to inspect and accept the construction is recommended.

One should be aware of and anticipate that a first-time slide-in project is likely to require more design and review time than would typically be required.

For Massena a total of 603 hours of design time were used between the design engineer, detailer, and check engineer – with a significant amount of that time spent by the detailer. Similarly, 137 hours were spent reviewing submittals. With experience, however, it is anticipated that the time required will be greatly reduced with subsequent projects.

The next few slides provide some pictures at different stages of construction. Here in this slide pictures of the existing bridge and preliminary temporary works are shown. Steel piling and large W-section beams were used as the temporary supports.

Here, one can see the placement of the precast/prestressed beams, the beginnings of the deck formwork, and the cast-in-place diaphragm at the beam ends.

Once the construction of the superstructure was completed, the critical closure and demolition of the existing structure began. Once the bridge was removed and the grading completed, pile templates were positioned and pile driving started.

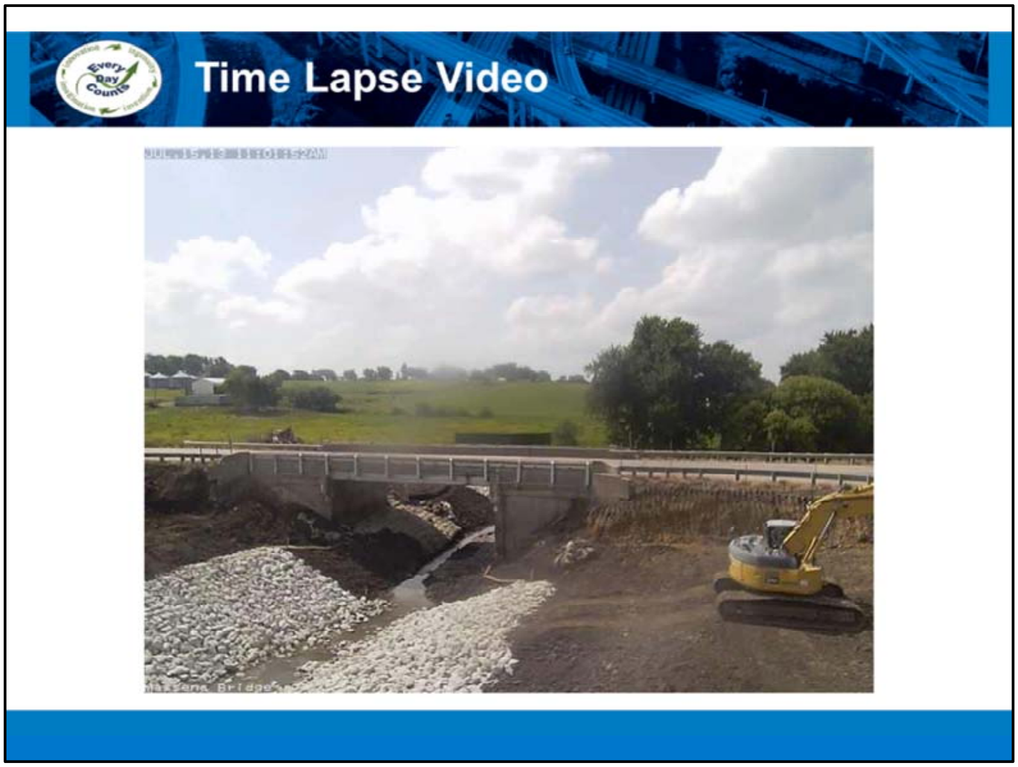
Vertical jacks were used in the jacking pockets to lift the bridge, after which, the rollers and bearing pad shims were set. A single jack and reaction pile were placed at the end of each abutment footing. Threaded rods were then placed between the jacks and through the superstructure diaphragms in order to pull the bridge onto the permanent substructure.

A single power unit with a manifold controlling both jacks was used. The rollers were guided along a steel channel spanning over the temporary works and permanent substructure.

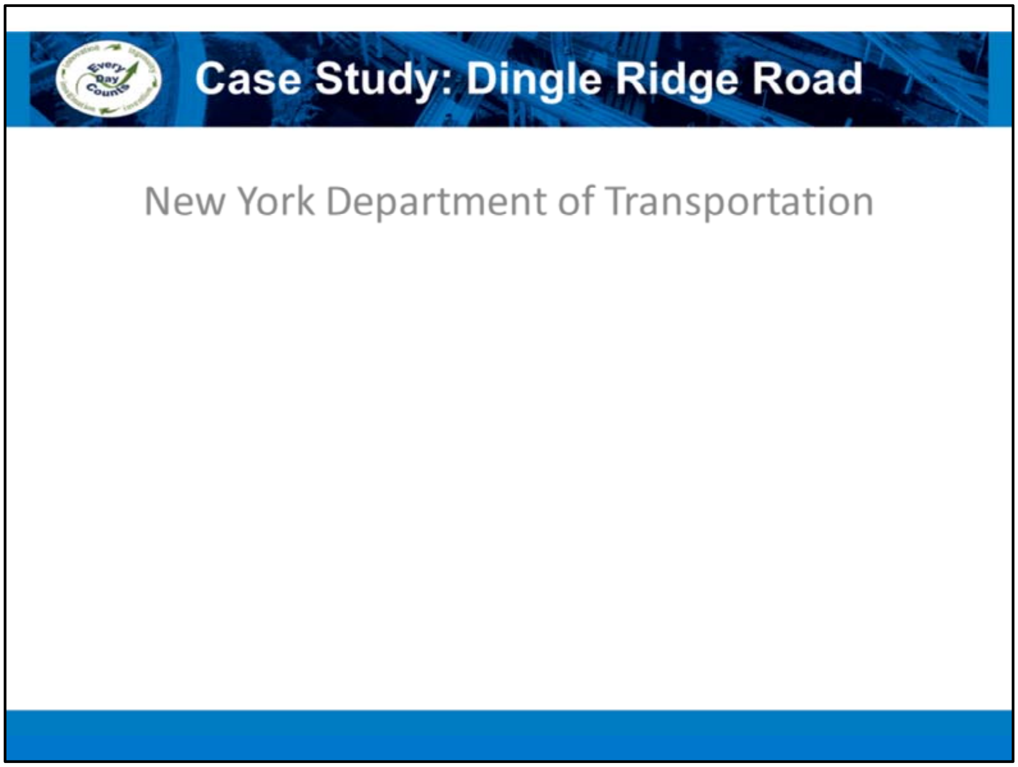
Additional pictures of the bridge nearing its final position are shown here. The vertical jacks were again employed to lift the bridge and pull the rollers, channel, and bearing pads from the jacking pockets. Also, the final bearing pads were placed below the diaphragm at the beam ends.

The slide operation took place during the late evening and early morning hours. Each of these pictures shows various views of the bridge being slid onto the permanent substructure. The lower picture shows the transition between the temporary works and permanent substructure and, maybe more importantly, the engineers closely monitoring the behavior at that transition.

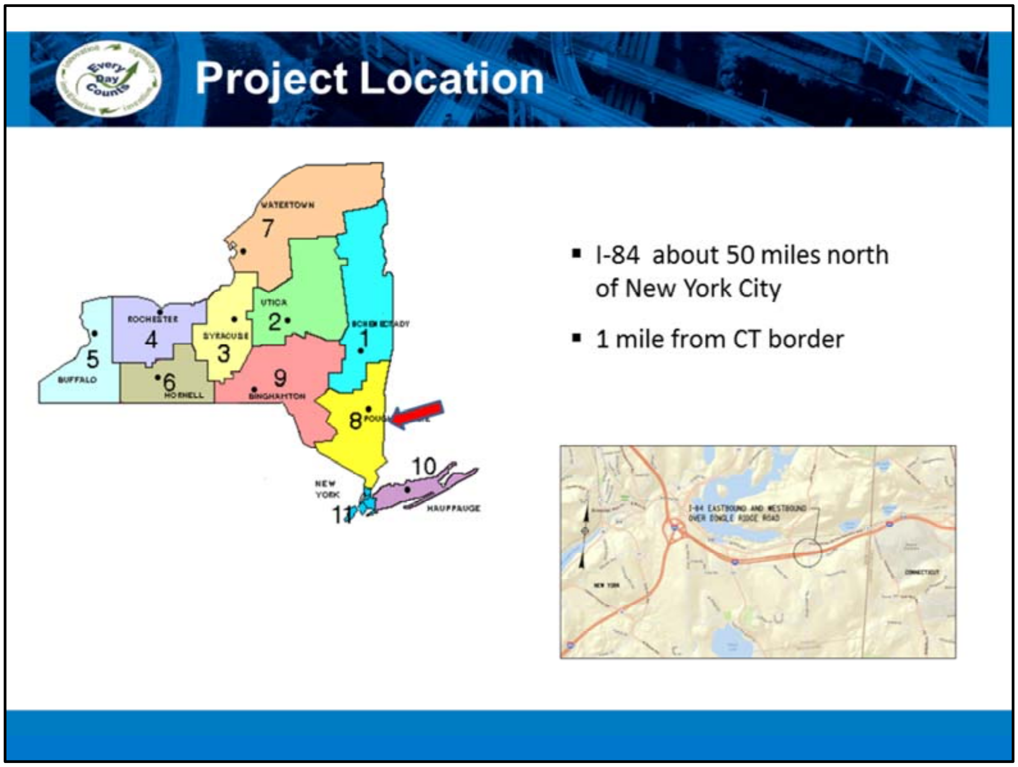
Once the bridge was in position, precast wingwalls with included grout pockets were placed onto pre-driven steel H-piles. The connection was made between the pile and grout pocket using a high-slump, small aggregate concrete mix.



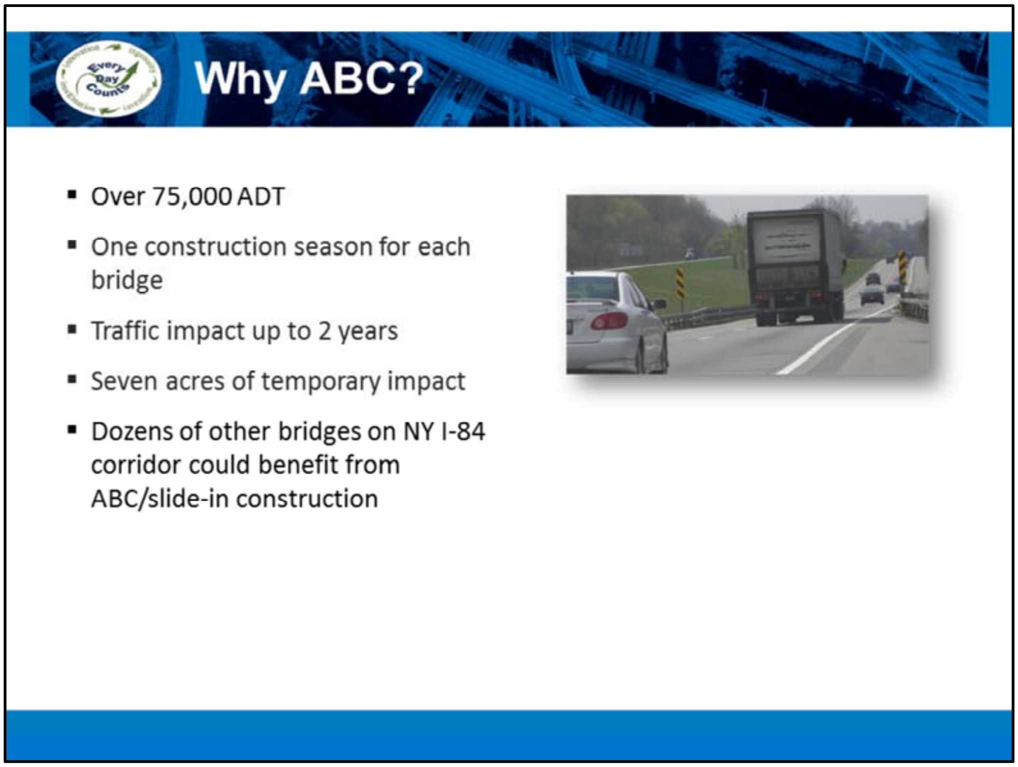
This short video is a time-lapse from the beginning of the project until the bridge was reopened to traffic.



The second case study we'll be covering today is the Dingle Ridge Road project completed in the state of New York.



The project is located about 50 miles north of New York City, 1 mile from the Connecticut border.



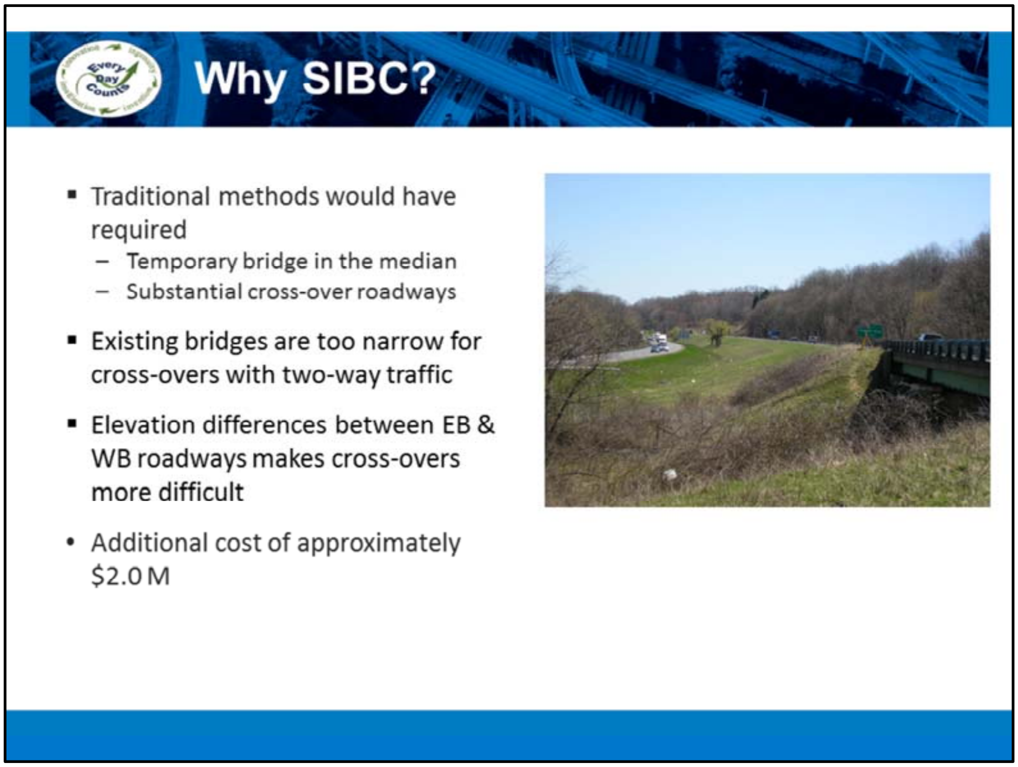
Why was this project a good candidate for accelerated bridge construction?

To begin, the ADT was over 75,000 which meant that any disruption would quickly effect a significant number of people.

Additionally, two adjacent bridges were to be replaced. One construction season would be required for each bridge, thus the total duration of the project and traffic impact could span up to 2 years.

If constructed traditionally, seven acres of land would temporarily be impacted due to the construction of crossovers and shoe-flies.

Even more, if done successfully, dozens of other bridges on the I-84 corridor could be constructed using ABC thereby multiplying the benefits.



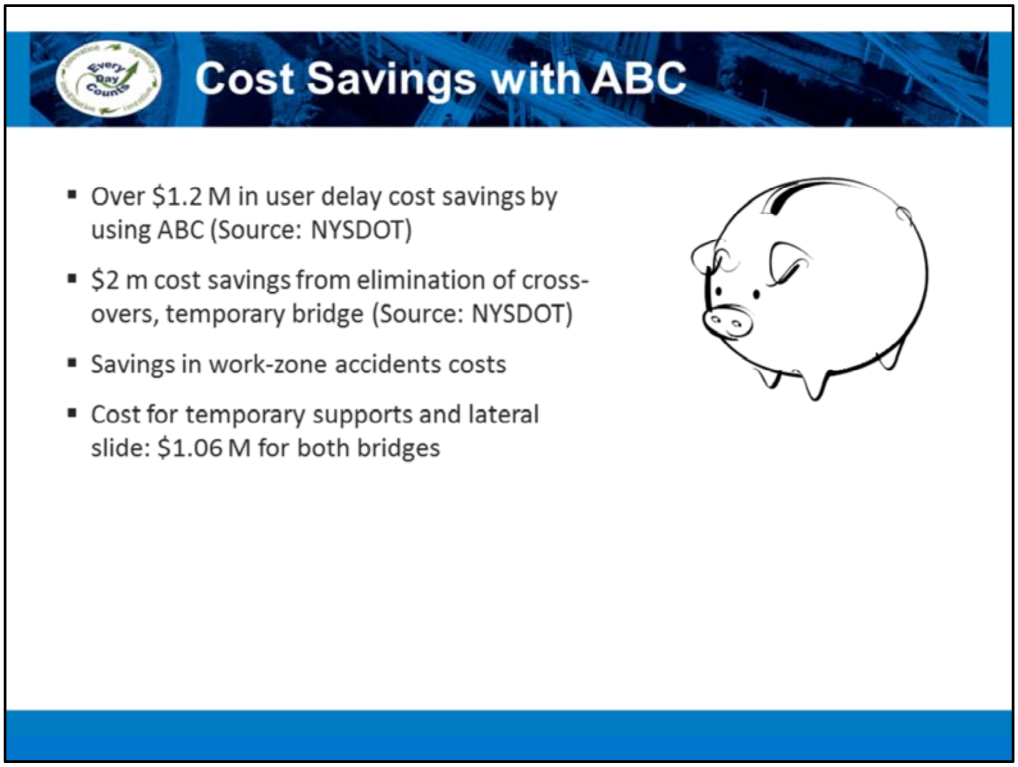
So why was SIBC the chosen method of accelerated bridge construction?

Traditional methods and even some other methods of ABC would have required the construction of a temporary bridge in the median since the existing bridges were too narrow for a crossover with two-way traffic. The construction of crossover roadways would have been complicated by the elevation differences between the eastbound and westbound roadways. In the end, the construction of a temporary bridge and crossovers would have resulted in an additional cost of $2 million.

Delivery Method

- Design-bid-build
  - Bridge design: HNTB
  - Highway design: NYSDOT Region8
  - Contractor: Yonkers Contracting, NY
  - Precaster: Dailey Precast, Vermont
  - Slide contractor: Barnhart / Marino
  - Temp structures: Siefert Associates, NY
  - Design funding: SHRP 2
  - Construction funding: NYSDOT and Highways for Life

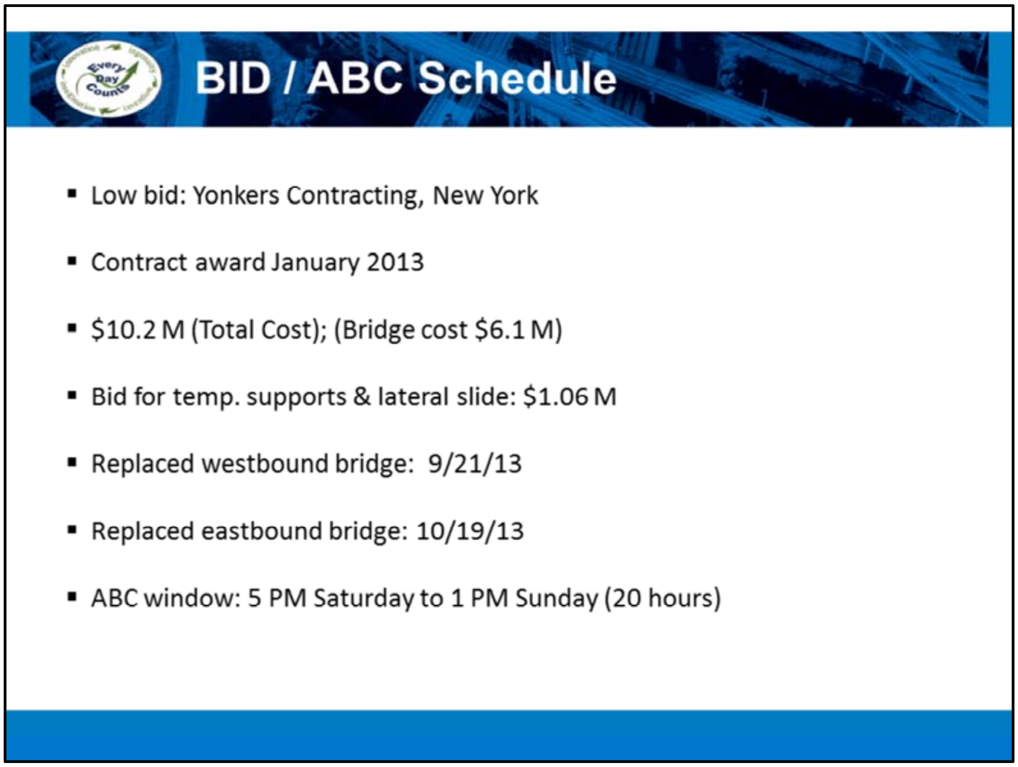
Design-bid-build was the delivery method used on this project. Some of the key team members are listed here. Note that some of the funding for design and construction came from the SHRP2 and Highways for Life programs.



A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

For the sake of comparison, the cost attributable to the temporary supports and lateral slide totaled $1.06 million for both bridges combined. The cost of this work is a reflection of the severity of the grading at the site. Dingle Ridge Road has an approximate grade of 15%, which resulted in large temporary shoring towers. This type of geometry is not normal, therefore the cost for this work should be taken in context.



The low bid totaling $10.2 million was received from Yonkers Contracting of New York. The contract was awarded in January of 2013. Of the $10 million, $6.1 million was directly associated with the bridge construction, while $1.06 million was used for temporary supports and slide operation.

It should be noted that the cost for bridges in the New York metro area are normally significantly higher than that in other parts of the country, therefore these cost figures should not be taken to demonstrate the cost of SIBC on most bridges.

The westbound bridge was replaced on September 21st and eastbound bridge on October 19th of 2013. For each case, the timeframe in which the existing bridge was to be removed and the new bridge slid into place and opened to traffic was 5pm Saturday evening to 1pm Sunday afternoon. Both bridges were completed within their allotted ABC window and within 10 months of the contract award date. Compare that to the estimated 2 year duration if the bridges were constructed traditionally.

In this aerial rendering, one can see the relative position of the bridges and underlying roadway. It is clear that a fair amount of right-of-way is available, thus simplifying the use of slide-in bridge construction.

The rendering shown in the top left of the slide, shows the proposed position of the bridges while in construction on their temporary works. If you look closely, you'll notice that the temporary works, approaches, and new foundations are shown.

The photo on the right shows the actual bridges constructed on temporary works, nearing completion and being prepared for the slide operation. In the end, traffic disruption on I-84 was reduced from two years to two weekend nights, while Dingle Ridge road which lies beneath the bridges was closed for only 5 days.

Shown in the next couple of slides are additional renderings of the bridge construction and slide operation.

The superstructure of each bridge was constructed adjacent to the respective existing bridge. The new abutments were constructed beneath the existing bridges while still in service.

To begin the ABC period, the interstate was closed and the existing structure removed.

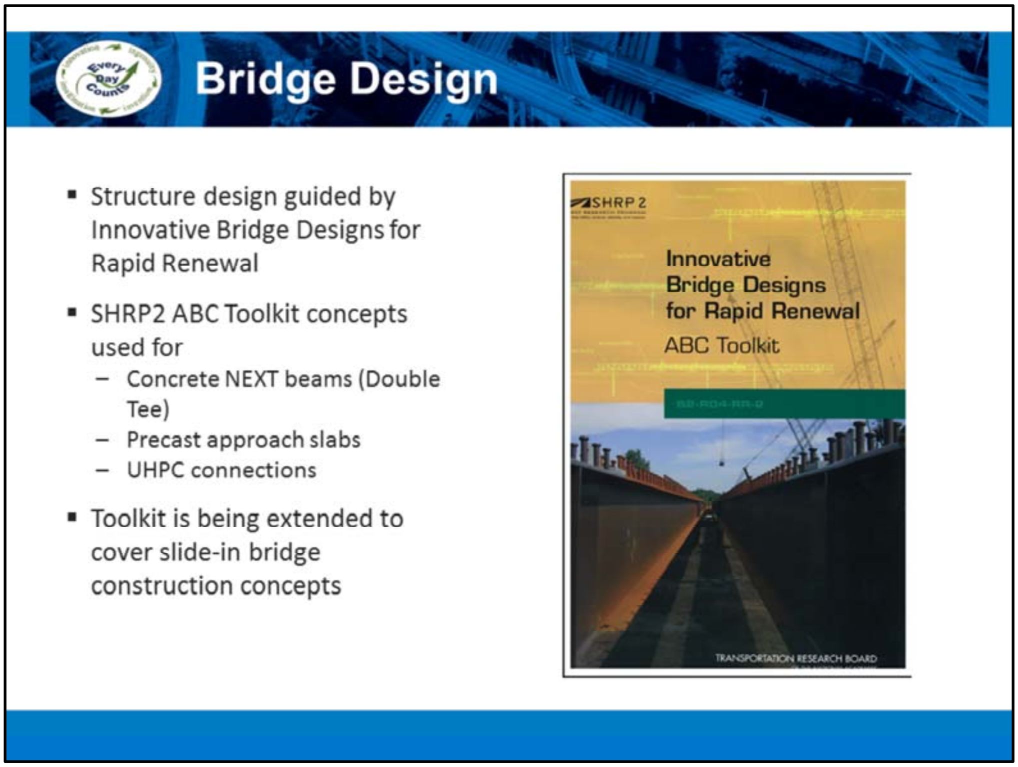
Once removed, preparation for the approach spans had to be completed including grading, compaction, and placement of the inverted T-beams used as a sleeper.

Once the preparation was completed, the slide from temporary works to permanent substructure took place.

Traffic Control

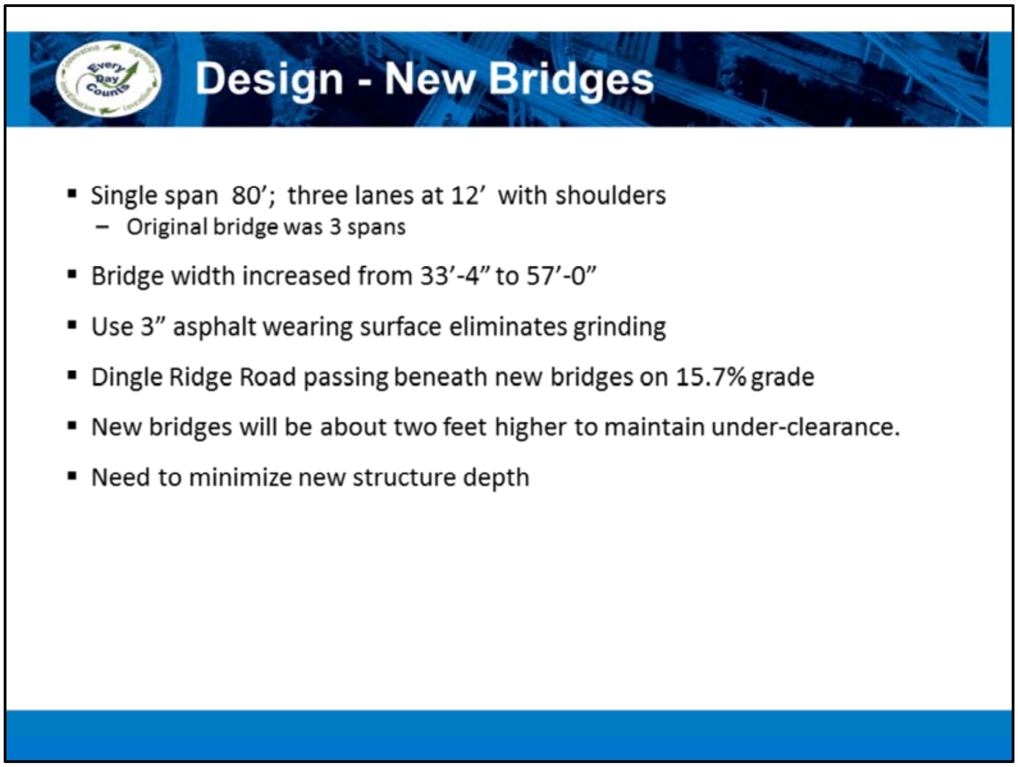
- Not an interchange – Ramp detours not available
- Route 6/202, parallel to I-84, used as the detour (3 miles)

Traffic was not rerouted to the oncoming lanes, nor could on and off ramps be used as a detour since the bridges were not located at an interchange. Fortunately, route 6/202 runs parallel to I-84 and could be used. This created a short detour of only 3 miles.



The next several slides will focus on the design aspects of this project.

Design guides have been developed through the Strategic Highway Research Program. One in particular called "Innovative Bridge Designs for Rapid Renewal: ABC Toolkit" was used extensively in the structural design; specifically, as it pertains to the concrete double-T beams, approach slabs, and UHPC connections. Though the guide wasn't written to explicitly address slide-in bridge construction, work is being completed to cover these concepts.



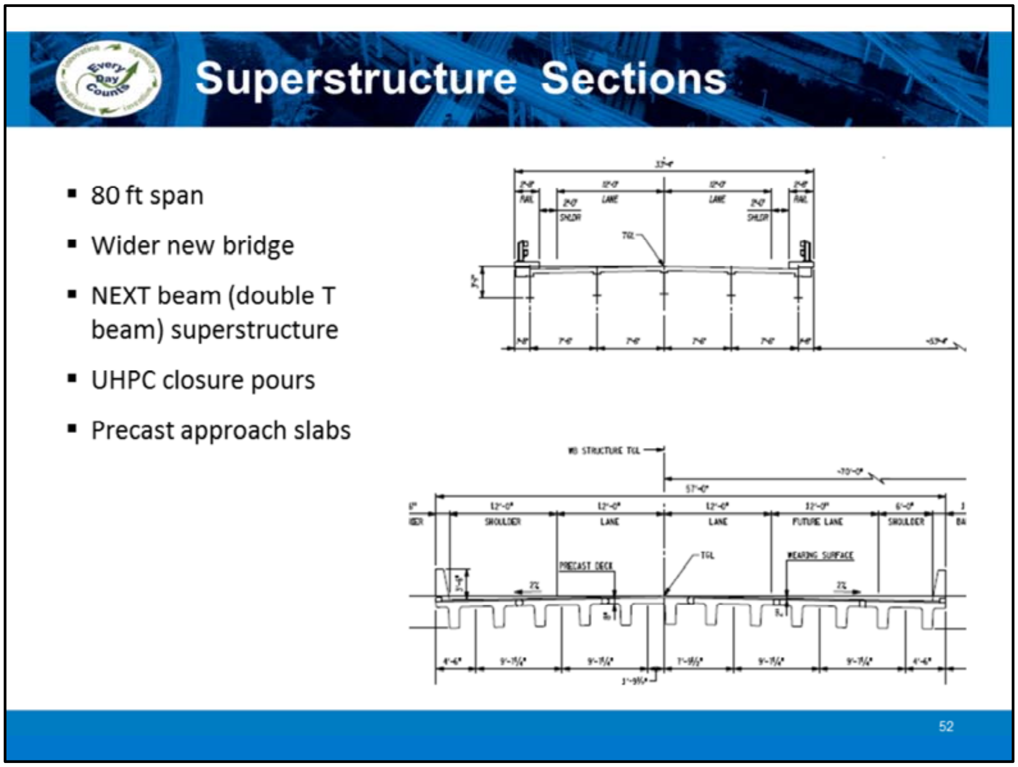
The new bridges are each 80 ft single span structures with three 12 ft lanes and shoulders totaling 57'-0". Compared to the 33'-4" of the existing structures, the bridges each gained considerable width.

A 3" asphalt wearing surface was placed on the bridge deck, which eliminated any necessary grinding due to the UHPC connections.

Somewhat unique to this particular location is that Dingle Ridge Road, which passes beneath the new bridges, is on a 15.7% grade. This grade posed some interesting design challenges. The new bridges were required to be raised two feet higher than the existing to maintain the under-clearance, which also meant that a concerted effort to minimize the new structure depth had to be made.

Two of the more significant design challenges were posed by these two restrictions: The slide had to be completed in one weekend night and I-84 had to be raised by two feet to satisfy the under-bridge clearance.

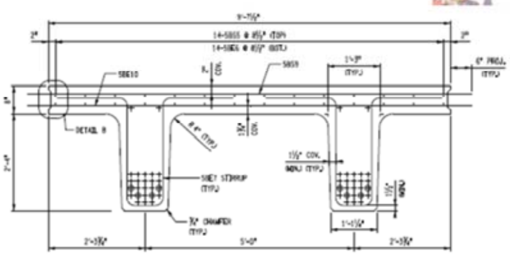
The photograph shown here helps illustrates the changing grade on Dingle Ridge Road.



The superstructure sections, both longer and wider than those of the existing structures, were constructed using double-T precast beams tied together with UHPC closure pours, and precast approach slabs.

Superstructure Sections

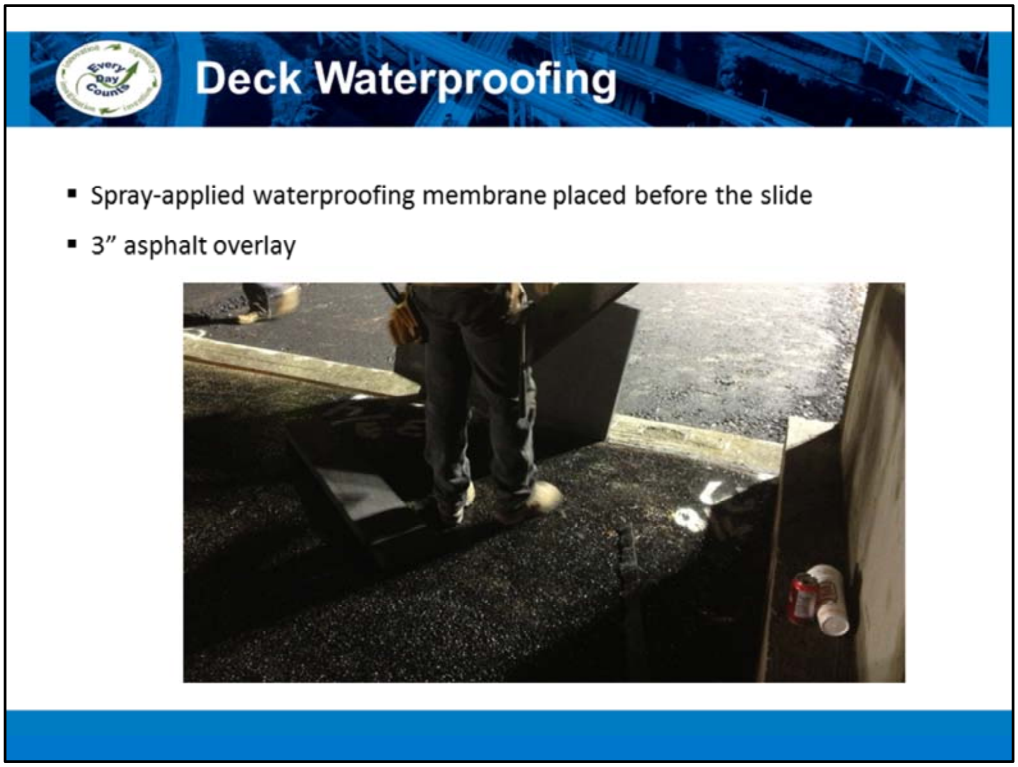
- NEXT deck beams
- 36 inch deep sections
- 9'-8" Flange; 8" thick
- f'c = 10 ksi
- 1.8 klf



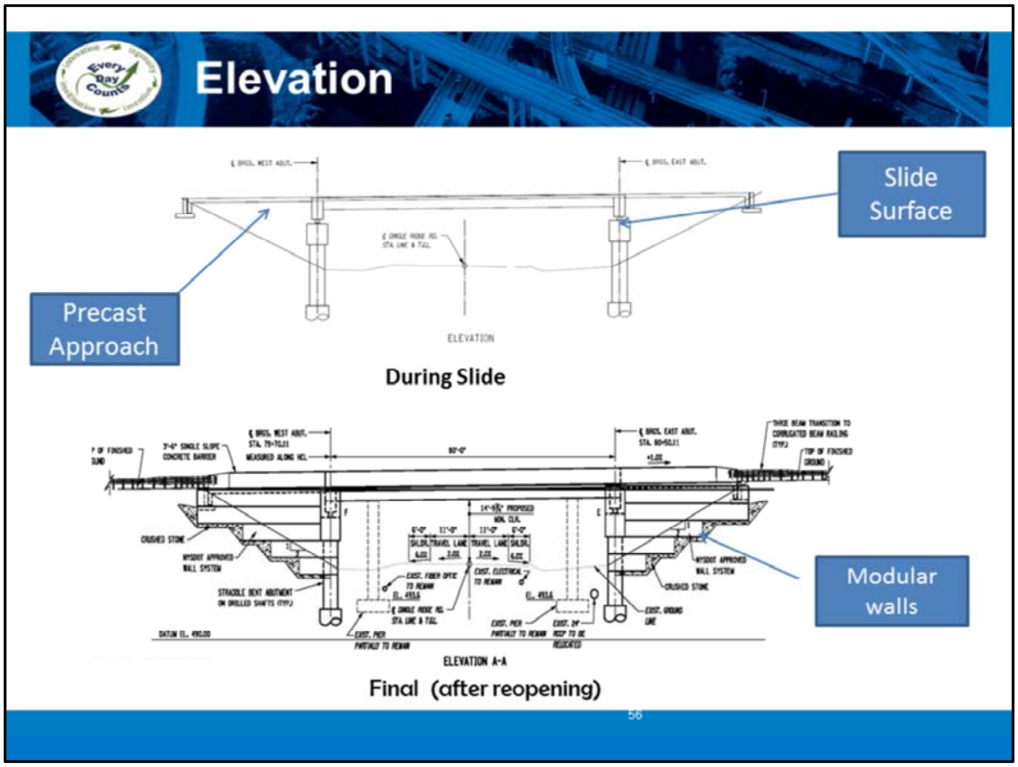
The beams chosen for the design are the Northeast Extreme Tee Beams – NEXT beams. This double tee section was developed by the PCI Northeast bridge Technical Committee, which is comprised of representatives from every northeast state, several consultants, and the PCI fabricators in the area. The beam was developed to expedite construction and reduce costs by eliminating the need for deck placement in the field.

In total, the sections were 36" deep with a 9'-8" wide and 8" thick flange. The compressive strength of the concrete used was 10 ksi and the sections weighed roughly 1.8 kips per foot.

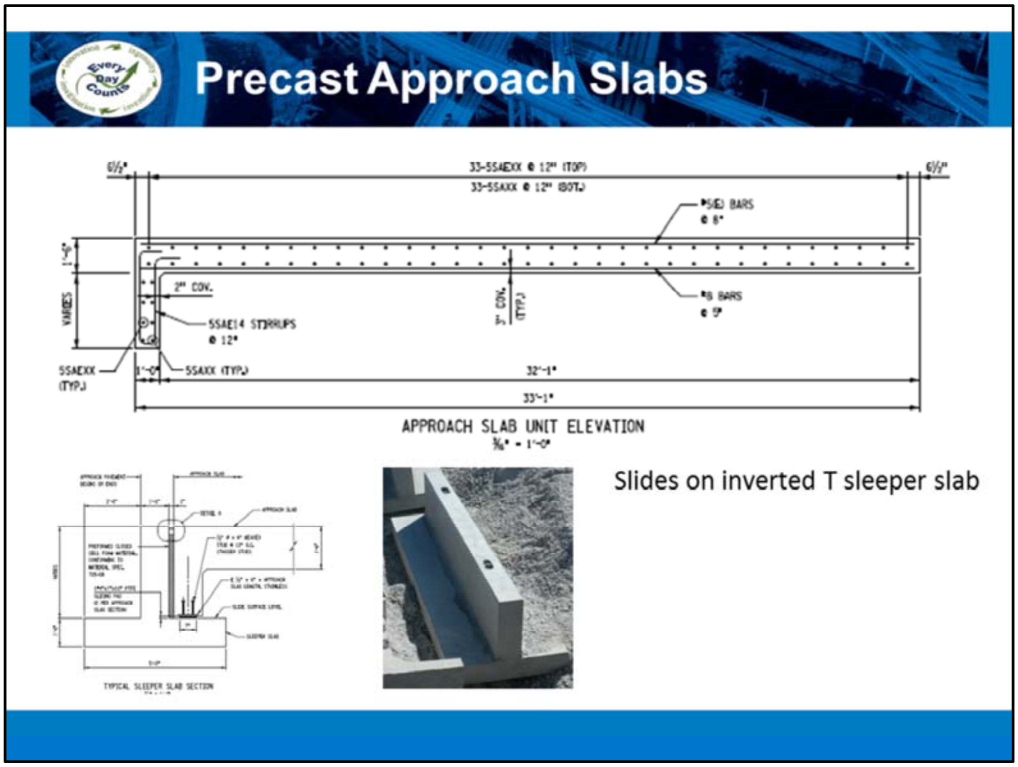
The UHPC connections, shown here, joined each of the double-T sections. The joints were 6” wide and the compressive strength of the concrete ranged from 20 to 30 ksi.



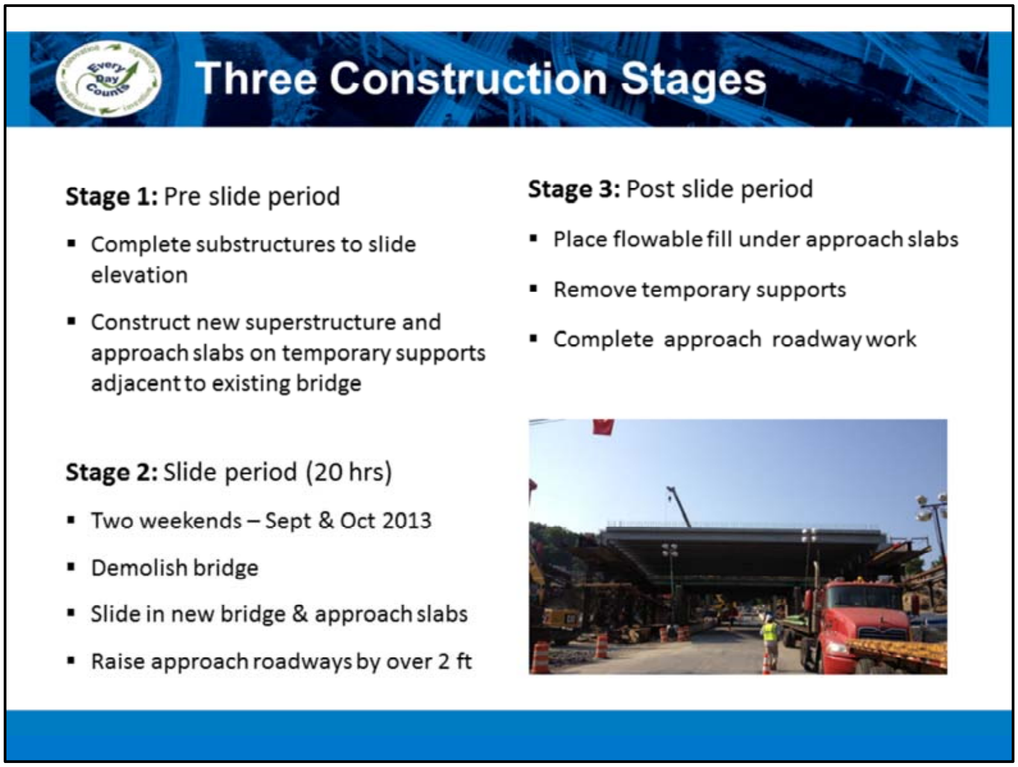
To waterproof the deck, a spray-applied waterproofing membrane was applied prior to the slide. Over that, a 3” asphalt overlay was placed.



Seen in the two elevation view drawings are the before and after-slide schematics. The approach slabs were slid into place with the superstructure. After which, a modular wall system was constructed adjacent to the approach slabs for containment of the flowable fill placed beneath the approach. The relative position of the existing piers and new abutments are depicted in the lower drawing, showing the longer span and additional roadway clearance on Dingle Ridge Road.



A close up the precast approach system is shown here. Each was 33’-1” long and 1’-6” thick with a downturned end. The end of the approach slab was slid on an inverted T sleeper slab which was placed after demolition of the existing structures.

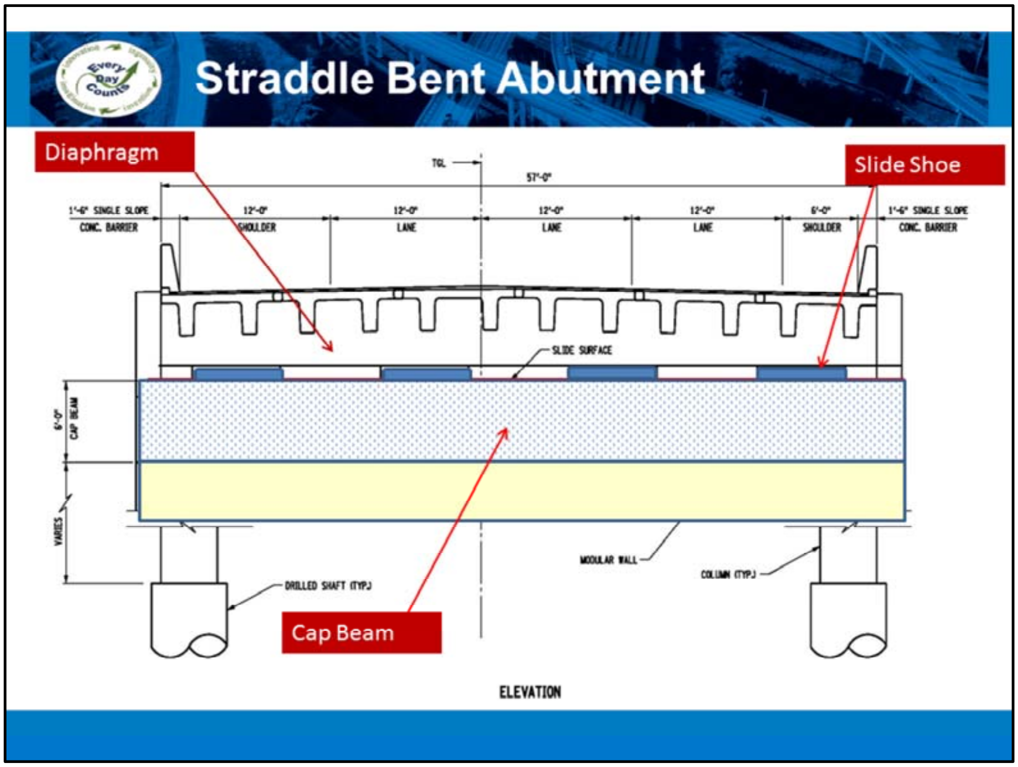


The overall construction process consisted of three primary stages.

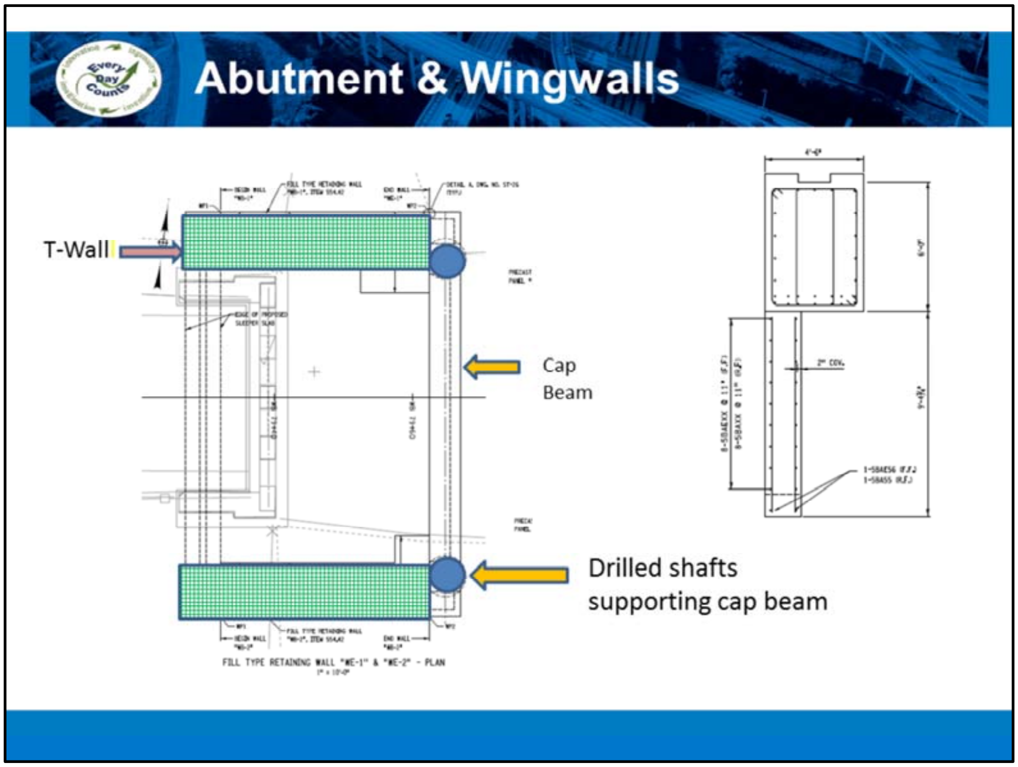
The first stage, prior to the slide, involved the completion of the substructure to slide elevation and construction of the new superstructure and approach slabs on temporary supports adjacent to the existing bridge.

Stage 2, the 20 hour slide period, occurred separately for each bridge over two weekends. During the stage, the existing bridge was demolished, the new bridge slid into place, and approach roadways raised 2 ft.

Stage 3 consisted of placing flowable fill beneath the approach slabs, removing temporary supports, and completing the approach roadway work.



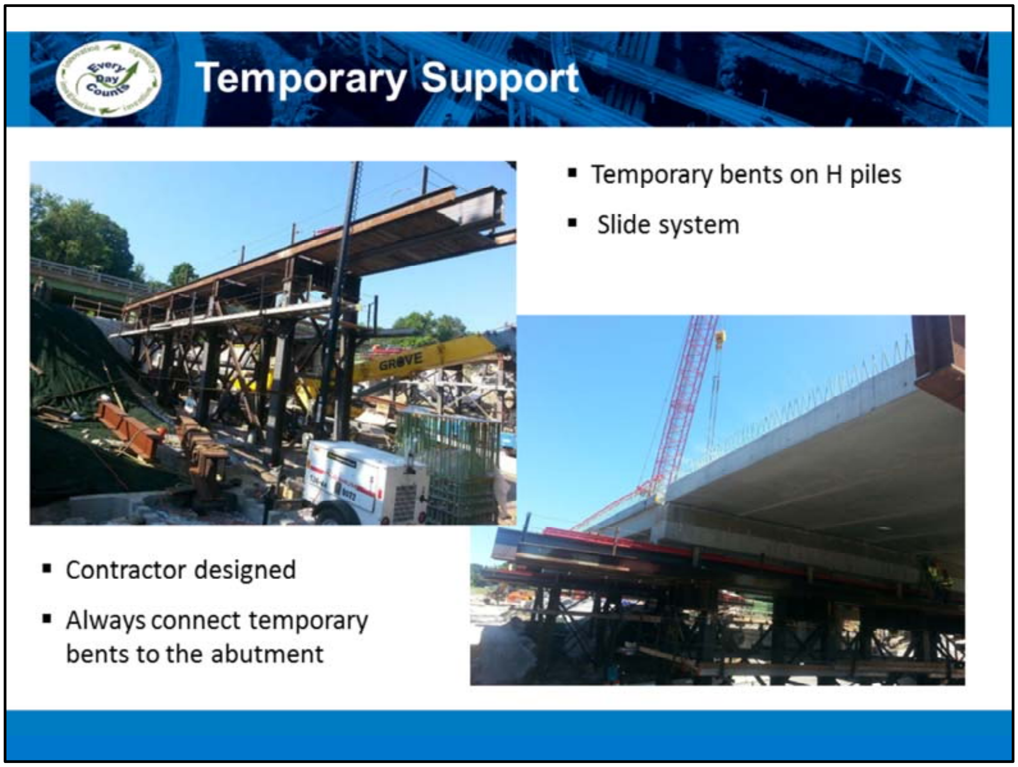
Shown here in the drawings for the straddle bent abutment are three elements critical to the slide operation. Those being, the diaphragm encapsulating the ends of the double-T beams, the slide shoes on which the superstructure will be slid, and the cap beam which was constructed beneath the existing structures prior to the slide.



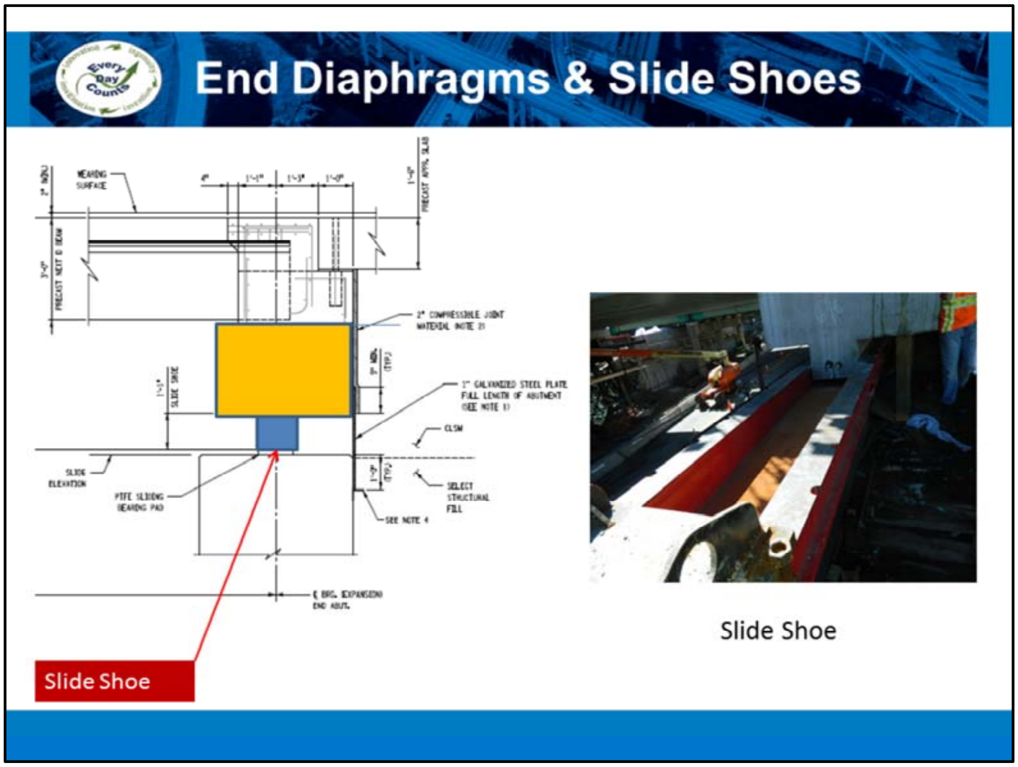
A plan view of the section shows the drilled shafts supporting the cap beam and the t-walls adjacent to the approach slabs which contains the flowable fill.

The new foundation system is shown placed beneath the existing structure in this photograph.

Additional pictures of foundation construction clearly depict how the new foundation was constructed under the existing structure while the roadway remained in service.



The temporary supports were steel structures founded on H-piles. The system was designed by the contractor and incorporated the necessary elements to properly slide the new structure.

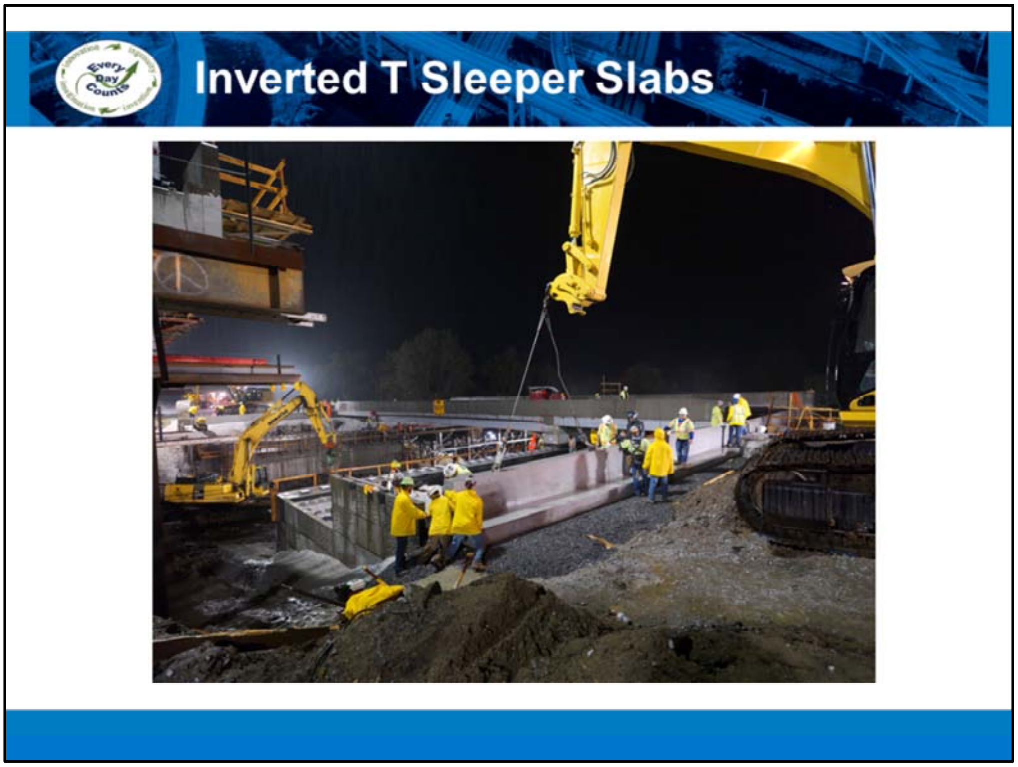


Vital to the success of the slide were the end diaphragms and slide shoe. The diaphragm provided a rigid, stout connection point for the jacking system to react against. The slide shoe, made up of a full-length stainless steel plate, provided a reduced-friction track on which the superstructure could slide on the PTFE bearing pad.

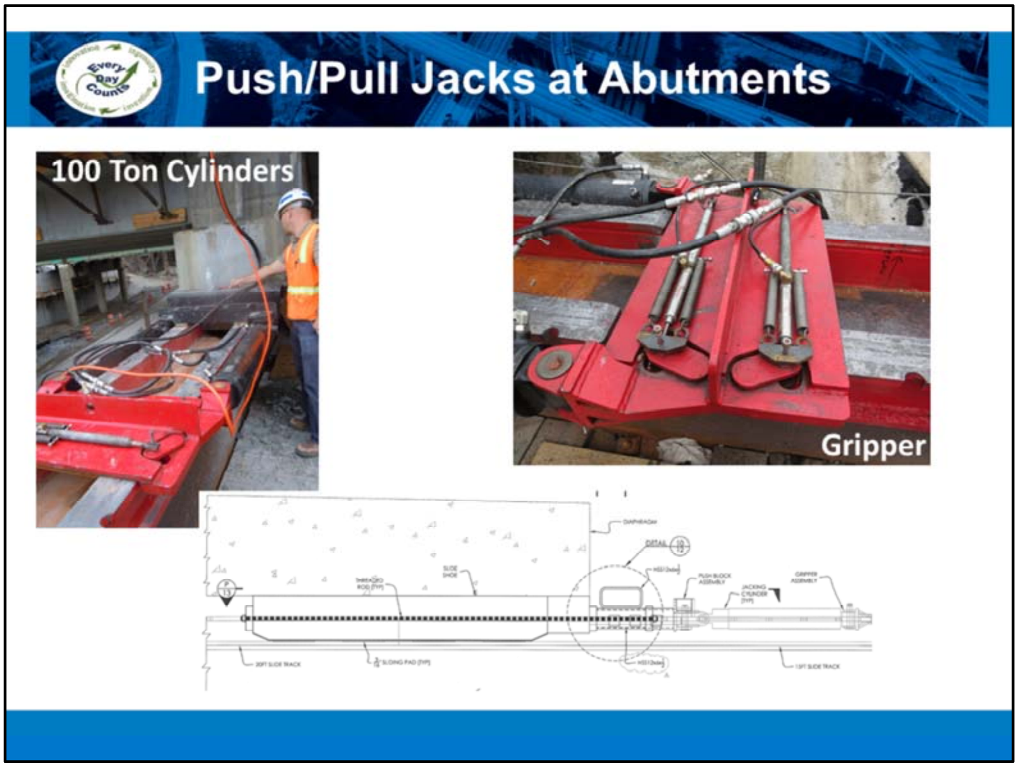
Shown in this photo are the new bridges nearing completion alongside the existing. Note that the bridges have remained open to traffic to this point.

These pictures provide a better glimpse of the stainless steel slide shoe and the 16 gage PTFE bonded to the elastomeric bearing pads.

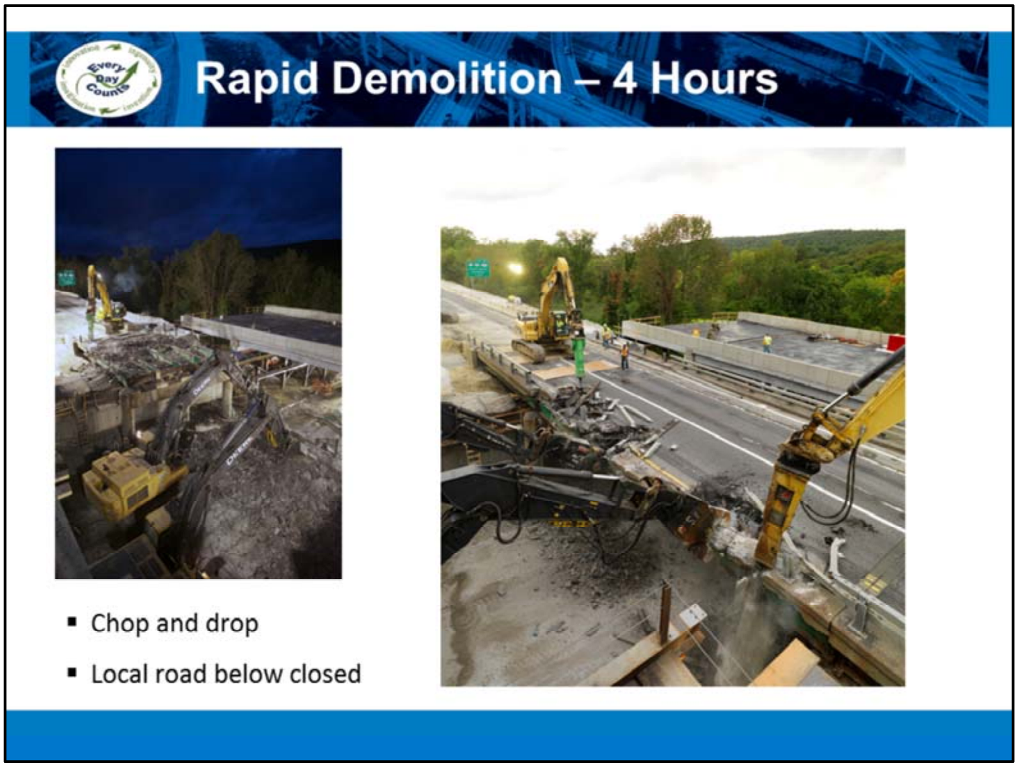
Similarly, the approach slab was slid on PTFE pads.



The inverted T- sleeper slabs were placed once the existing bridge was removed.

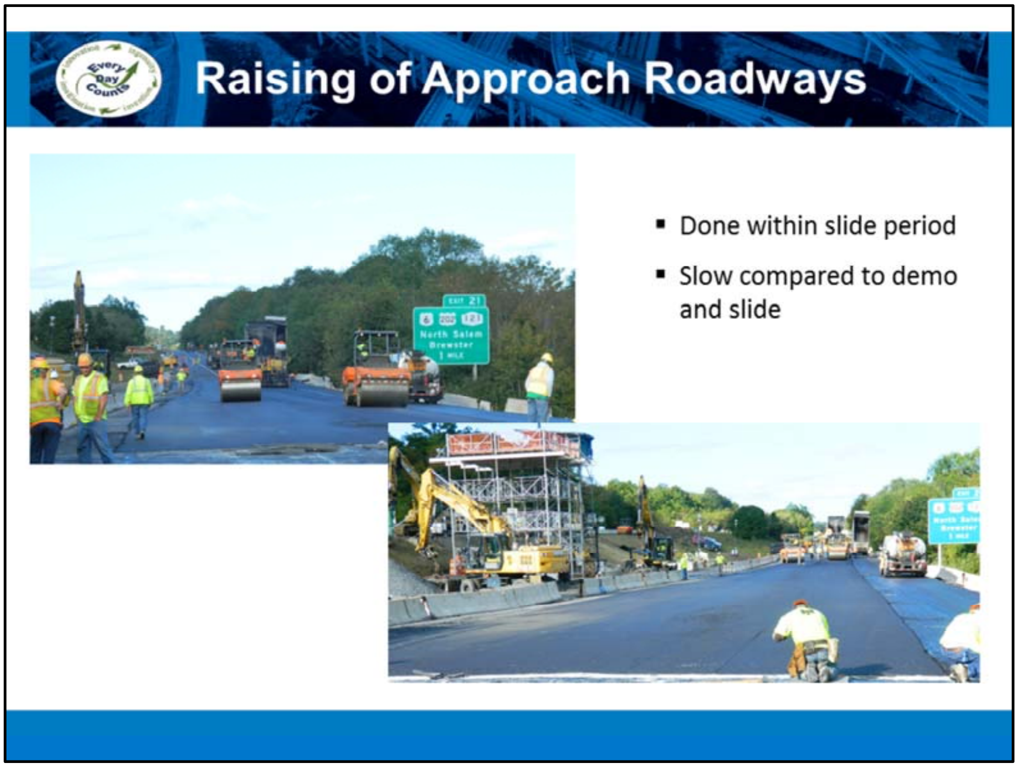


The jacking system consisted of two 100 ton push/pull jacks placed at the abutments. A system was devised to enable the repositioning of the jacks as the bridge was slid into place.



The demolition was completed in four hours using chop and drop methods. At this point in time, the local road beneath was closed for obvious reasons.

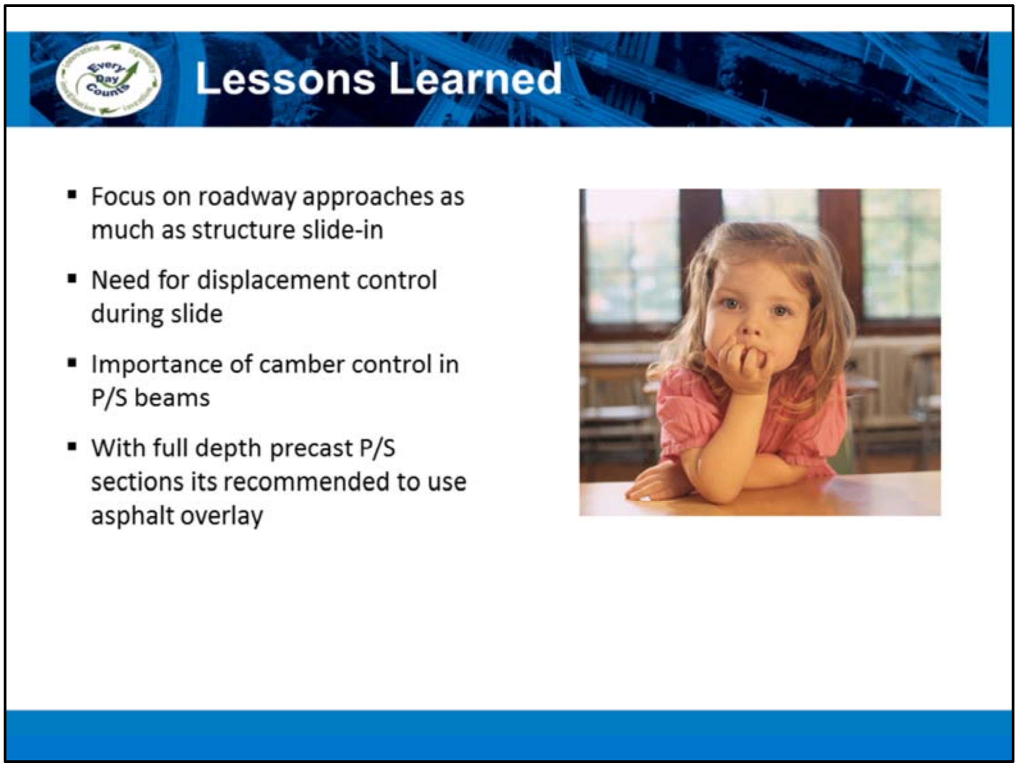
Another view of the temporary supports is shown here shortly after the bridge was slid into place, again showing supports at each diaphragm and end of approach slabs.



One of the more major and time consuming tasks to be completed during the short slide period was the raising of approach roadways. Relative to the actual slide, this process was considerably slower.

Shown here is one of the completed bridges. Both bridge slides were completed within 10 months of the notice to proceed.

Another view of the completed bridges shown from Dingle Ridge Road.



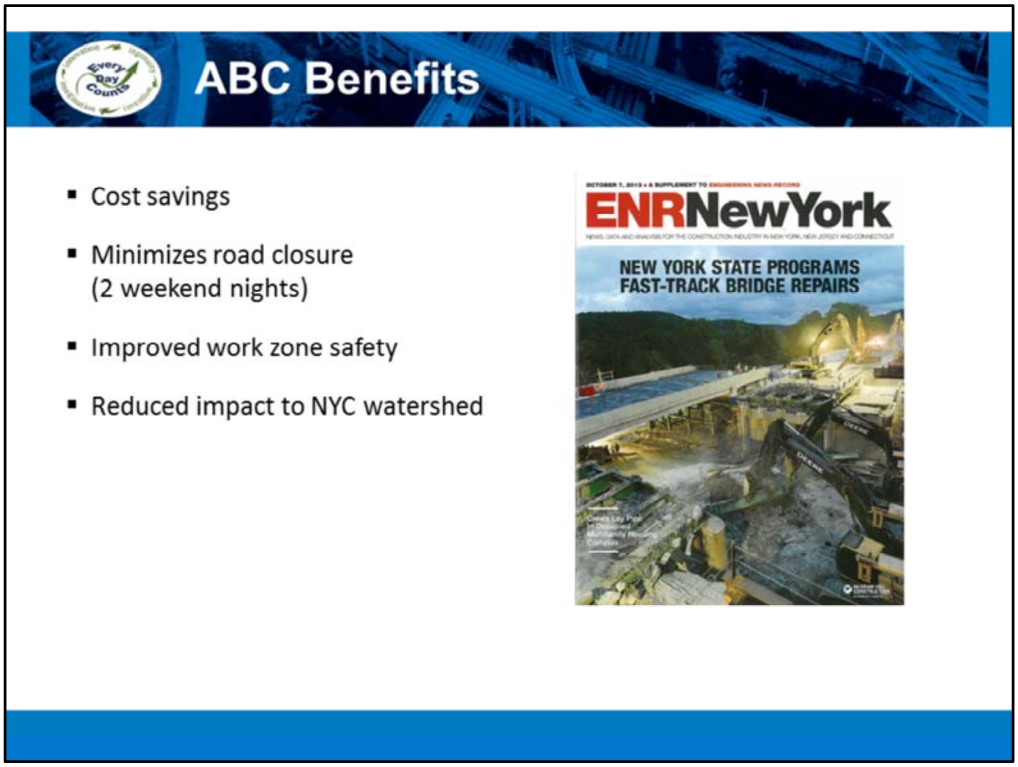
Many lessons were learned on this project, probably more than can be listed here. Even so, a few significant lessons that should be mentioned include these.

A focus on the roadway approaches should be made as much as the structure slide-in.

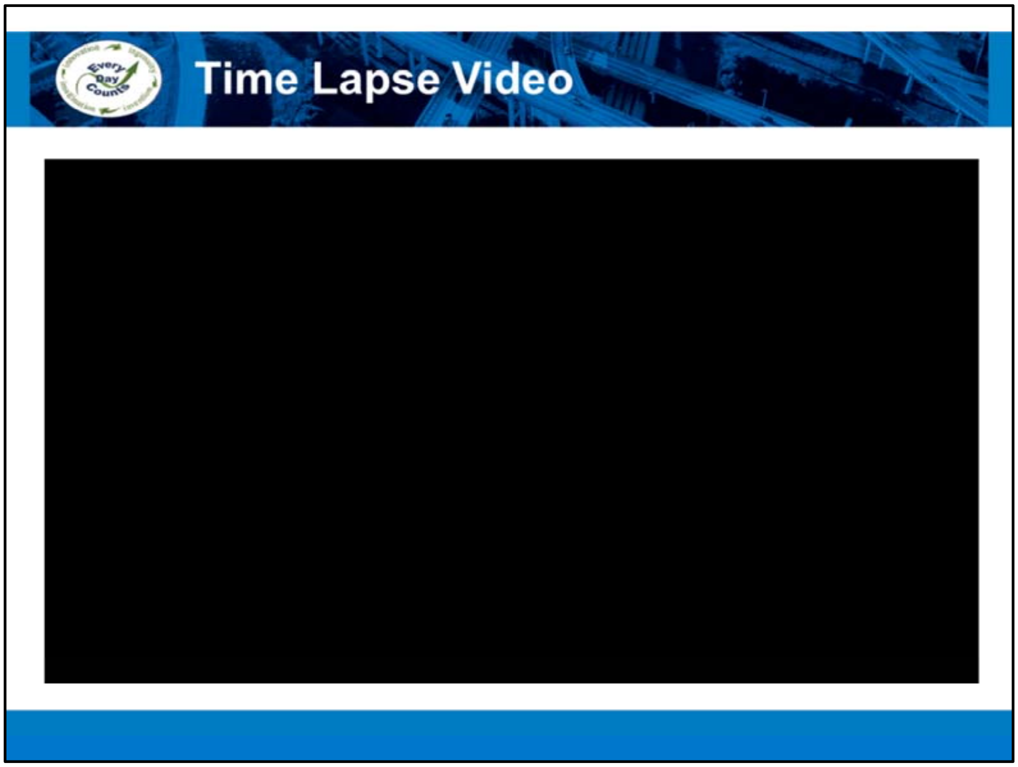
There should be displacement control in place during the slide.

It is important to control the camber of the prestressed beams to better control and align the closure joints.

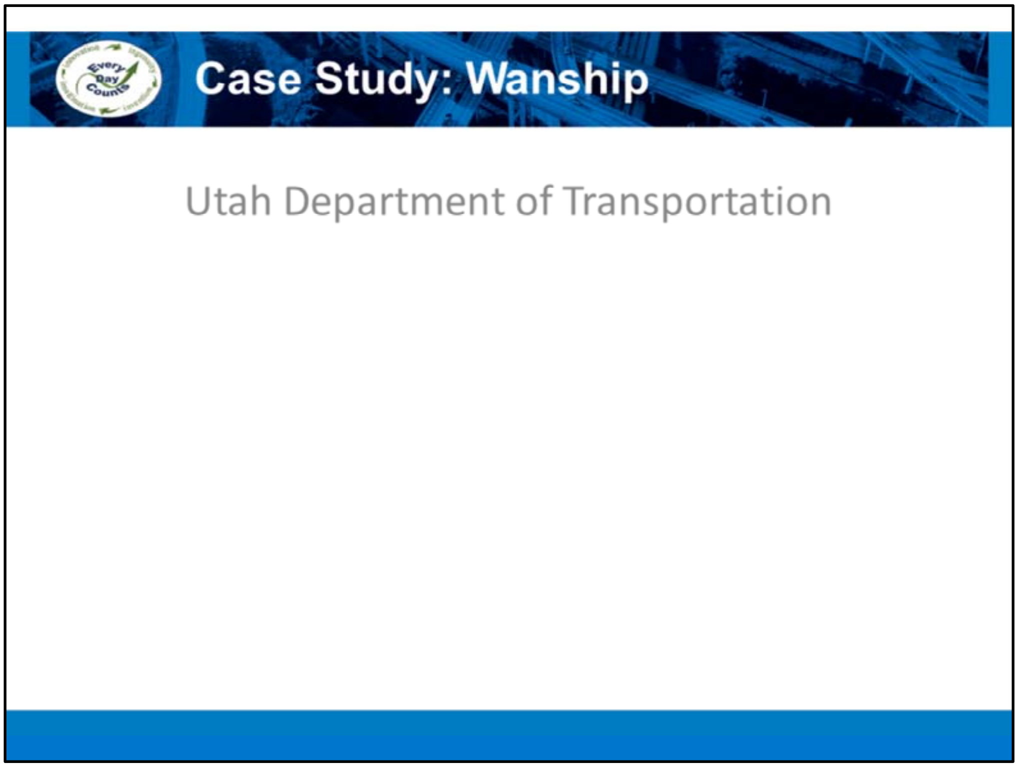
It is recommended to use asphalt overlay on a system using full depth precast sections to serve as a barrier between the deck joints and the road surface.



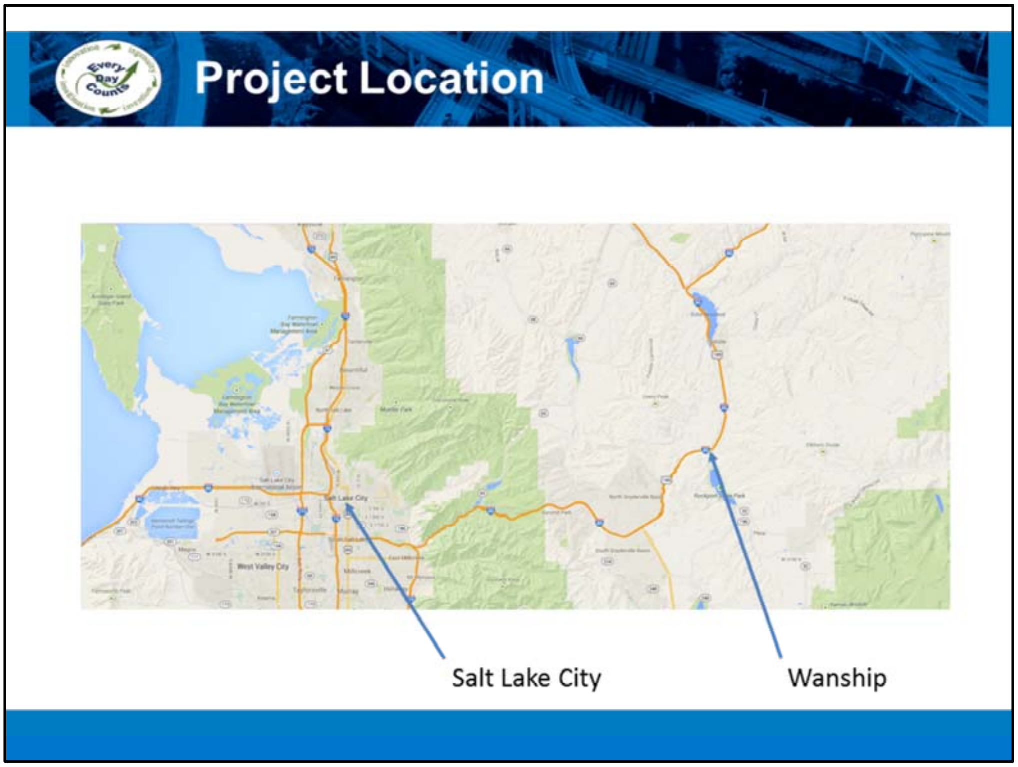
Some of the major benefits specific to this project include the cost savings, a minimal road closure, improved work zone safety, and a reduced impact to the NYC watershed.



This time lapse video shows the project beginning with the road closure at the start of the slide period. You will see the bridge demolition and removal, the slide of the new structure, and preparations for the reopening of the roadway. Finally, you will see the new bridge in action.



The Utah Department of Transportation has been a national frontrunner in accelerated bridge construction. One of several projects they've completed in recent years was a slide-in bridge construction project near Wanship, UT.



Wanship is located on interstate 80 approximately 35 miles east of Salt Lake City.

Several reasons exist for selecting accelerated bridge construction and, specifically, slide-in bridge construction. These include the fact that the bridge is located on a mainline interstate, has a high truck traffic count, and is a primary route for a great deal of recreational traffic.

Furthermore, available staging areas were available for construction adjacent to the bridge.

With any bridge project selected for possible accelerated bridge construction a cost risk assessment and value engineering study is recommended.

A quick overview to highlight some of the project details is provided here.

The project consisted of the replacement of bridges on eastbound and westbound I-80 at Wanship.

The existing three-span structures were replaced with single span structures.

Full retaining abutments were constructed with full height wingwalls while the existing structure remained in service.

The new structures were constructed adjacent to the existing prior to their slide into final position.

Project Overview

- All thread jacking/sliding system
- Ramps used as detour
- Spread footings

A threaded bar jacking and sliding system was used to slide the bridge into place. Traffic control was achieved by using the on and off ramps as a detour. Additionally, spread footings were used in the foundations for the new structure.

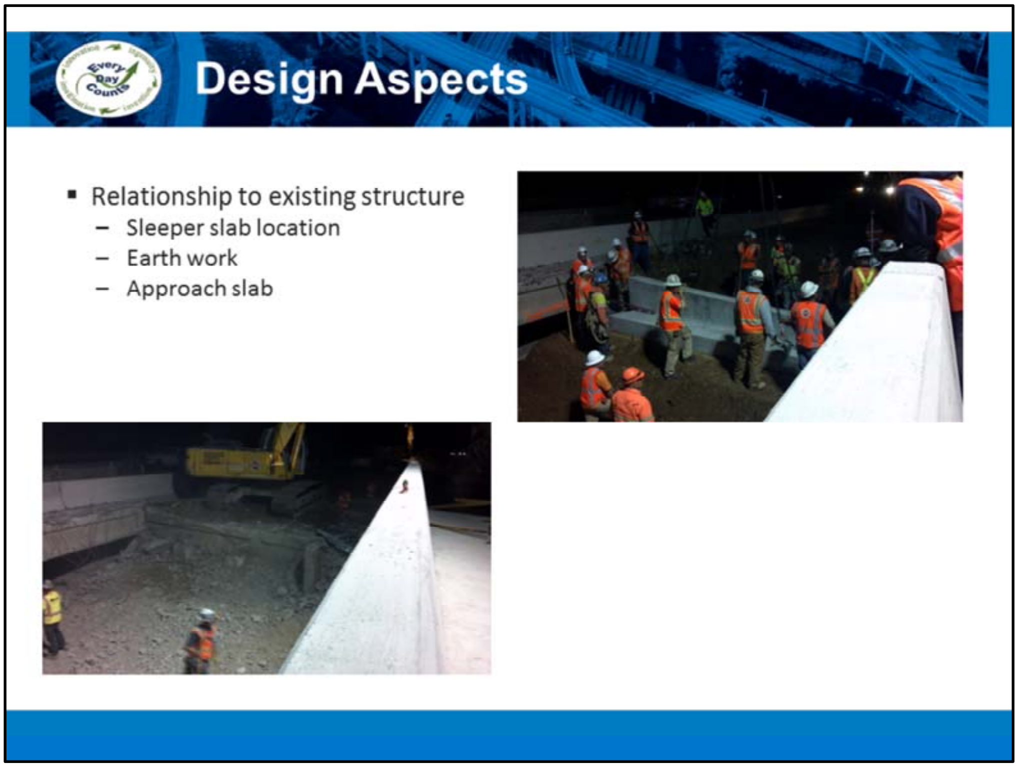
Certain design aspects required special considerations.

For example, in order to maintain the vertical clearance required, I-80 would have had to be raised which would have made a bridge slide less favorable or SR-32, which lies beneath the bridge, would have had to be lowered creating a low spot and future drainage issues; utilities also would have had to be moved.

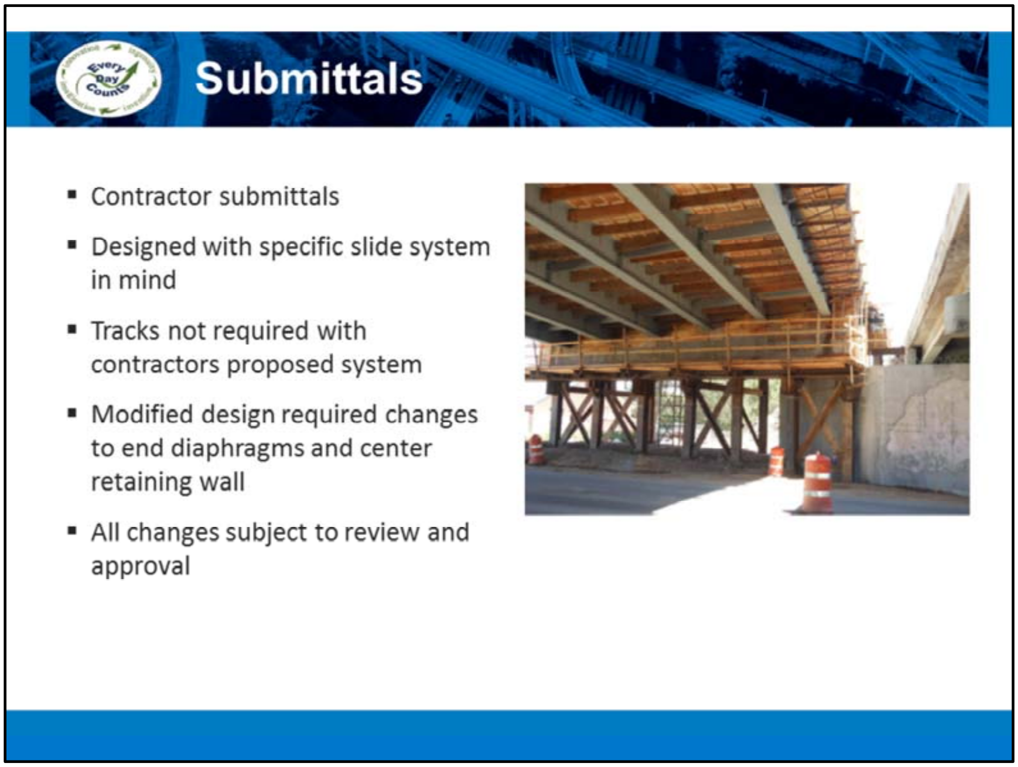
Design Aspects

- Reinforcing
  - Stainless steel

A decision to use stainless steel reinforcing in the bridge deck, at 3.5 times the cost, was made in order to reduce the deck thickness by ½”, and also to remove the waterproofing membrane. It is hoped that the deck will achieve a 75 year life.



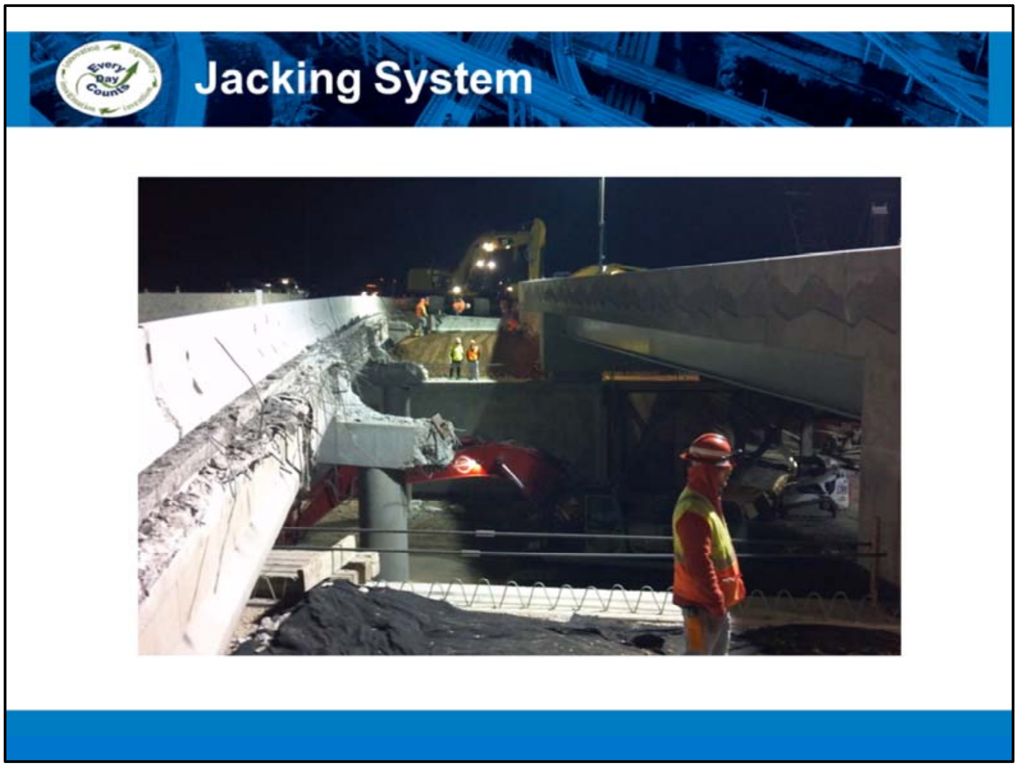
A decision regarding the sleeper slab for the approach span and its relationship to the existing abutment had to be made. If in front, considerable earth work would be required during the full closure. If on top, additional structure removal and some extra earthwork would be required. If behind, minimal earth work would be required, but approach slabs would have to be extended out beyond the standard 25’ length.



As part of the contractor's submittals, temporary support designs and details along with connection sliding details and calculations were required.

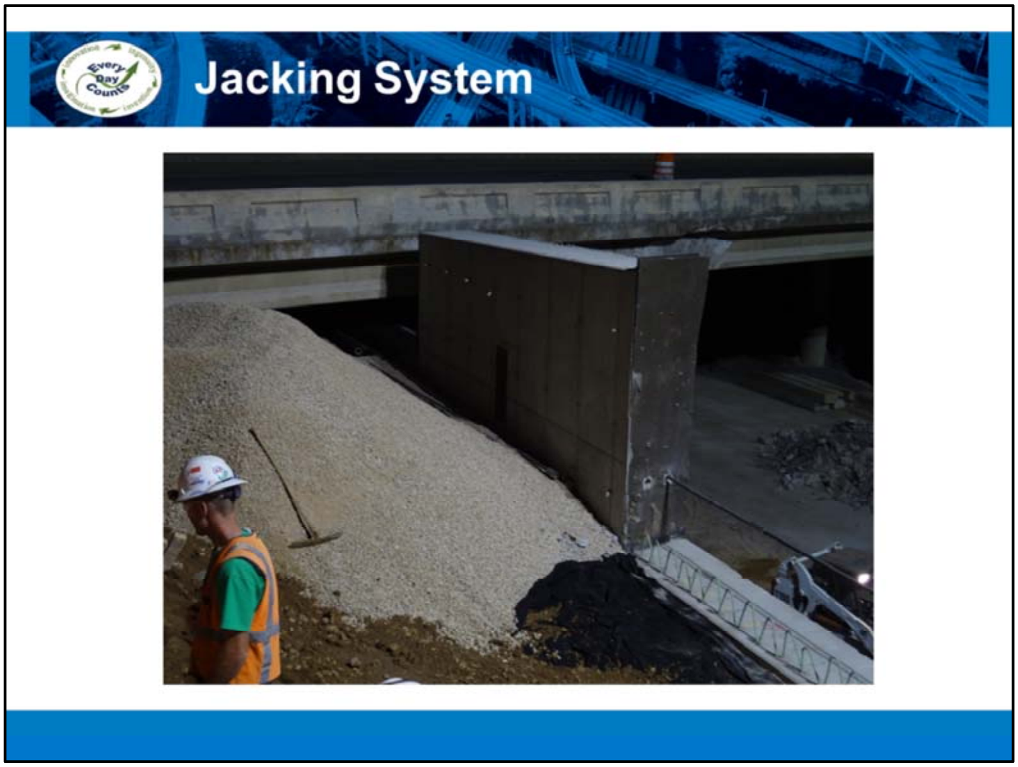
The project was originally designed with a specific slide system in mind. When submitted, the contractor proposed to modify the sliding system from using large jacks and slide tracks to using smaller jacks without a track system. The modified design required changes to the end diaphragms and center retaining wall between the two bridges, however.

All proposed changes were subject to review and approval.



The bridge was slid using Dywidag rods threaded through the end diaphragms. This system is seen in the foreground of this picture.

Another view of the slide system is seen here. The large retaining structure constructed between the bridges was used as a reaction block.

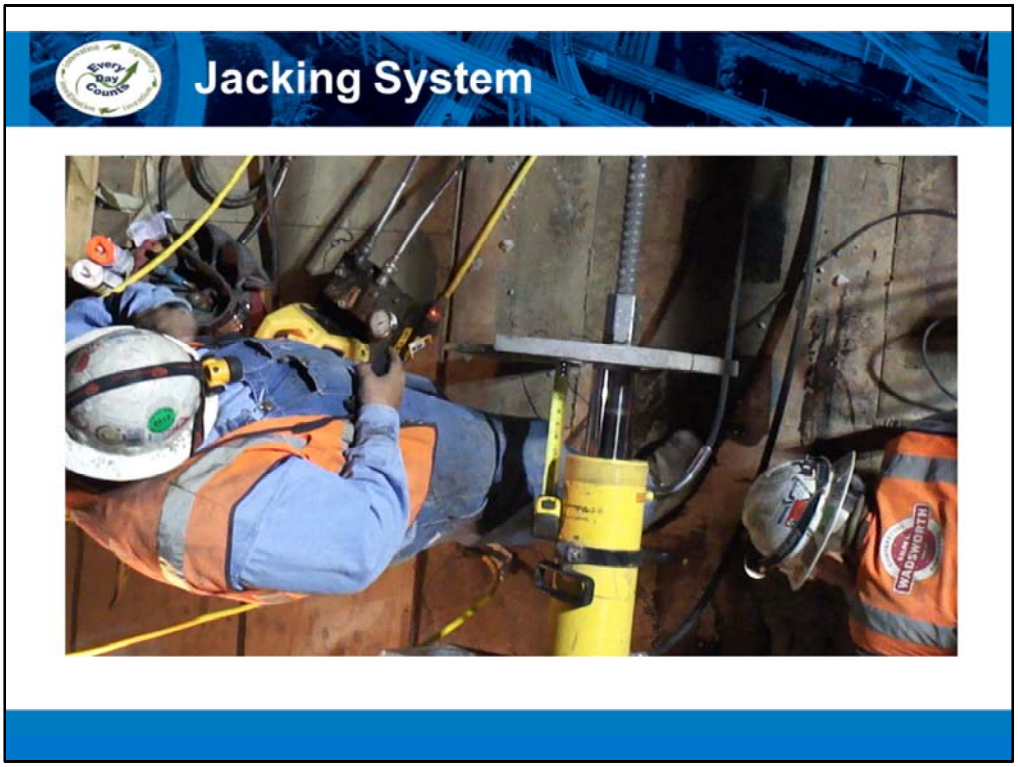


The reaction block is also seen here from another viewpoint. Notice the Dywidag bar threaded through the block.

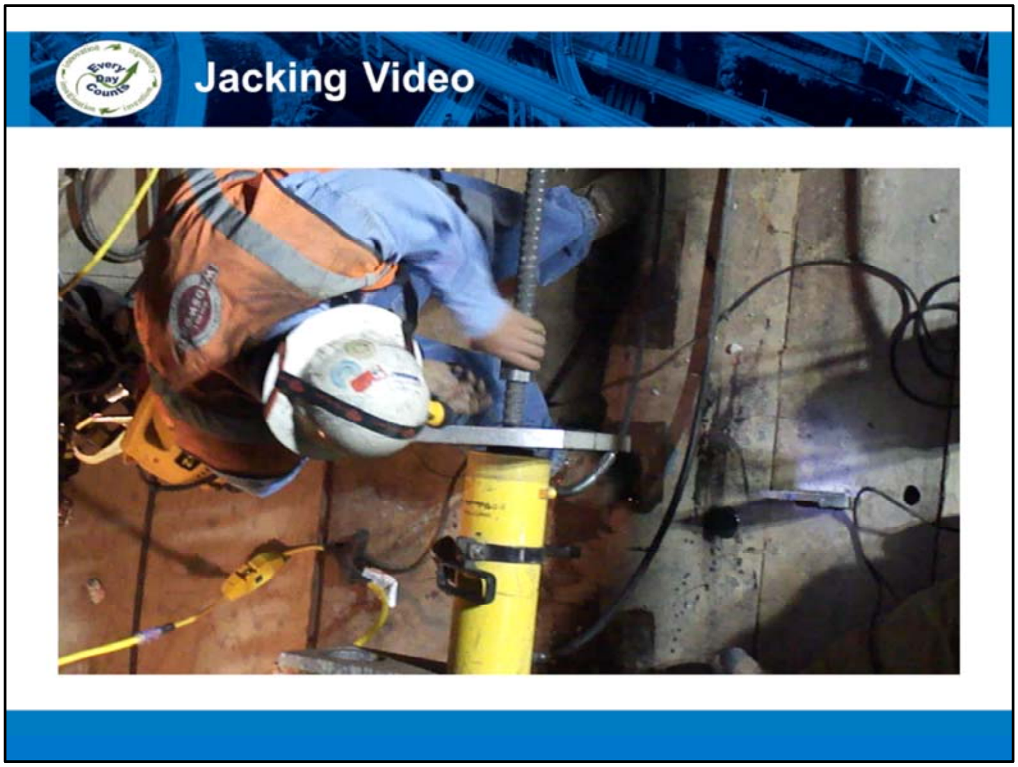
The bar exited the opposite side of the block and was anchored with steel plates and heavy duty nuts.

The threaded bars were placed through the end diaphragm of the new superstructure and attached to small jacks that then pushed the bridge into place. No tracks were needed, requiring less setup. Additionally, the prime contractor was able to complete the move without having to bring a subcontractor on board.

In addition to the threaded rods and jacks, a reduced friction surface was achieved through the use of stainless steel plates and elastomeric bearing pads bonded to PTFE coated with dishwashing soap.



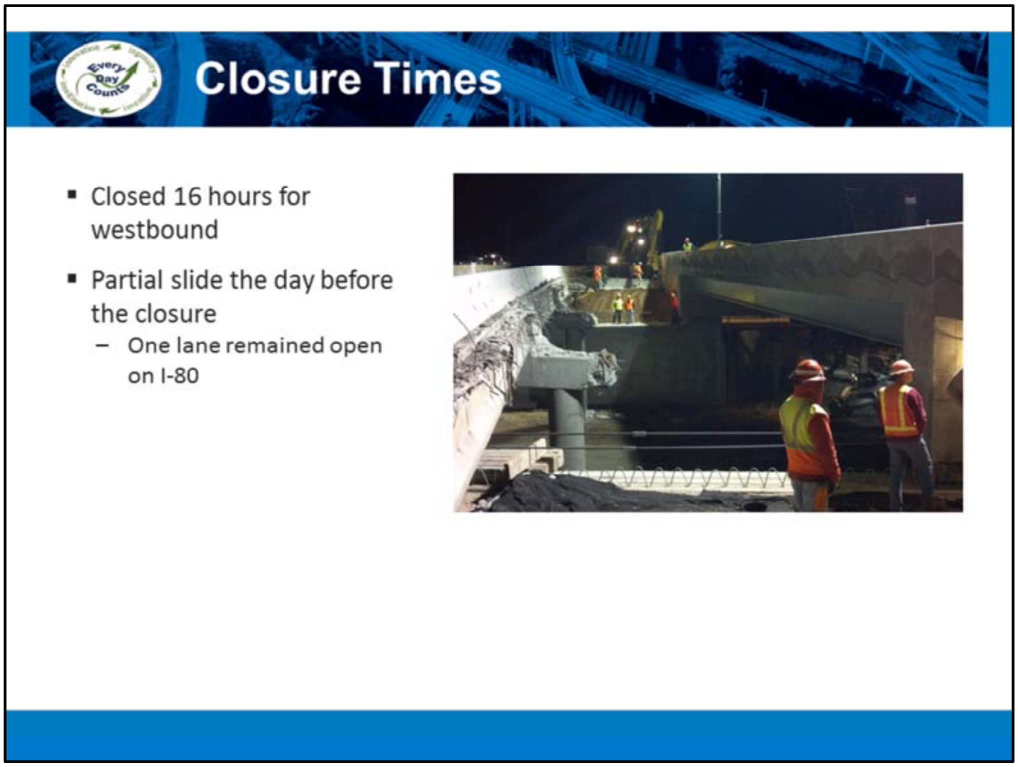
Through a single control, the jacks were operated pushing the bridge into place. The jack would run until the stroke was maxed out, then paused, retracted and reset for the next push.



This process is shown here in this video.

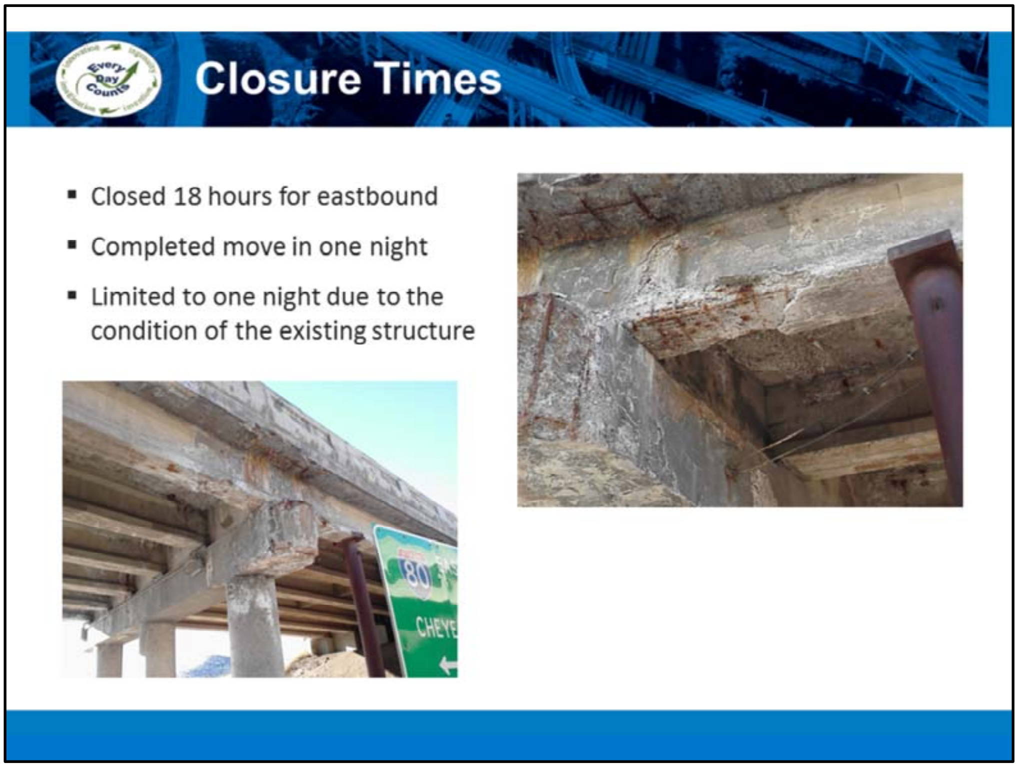
During the slide, the alignment was tracked along the abutment using this primitive, yet useful, tool. Even more, the gap between the sleeper and approach slab was continually measured.

These pictures show additional views of the alignment control methods.

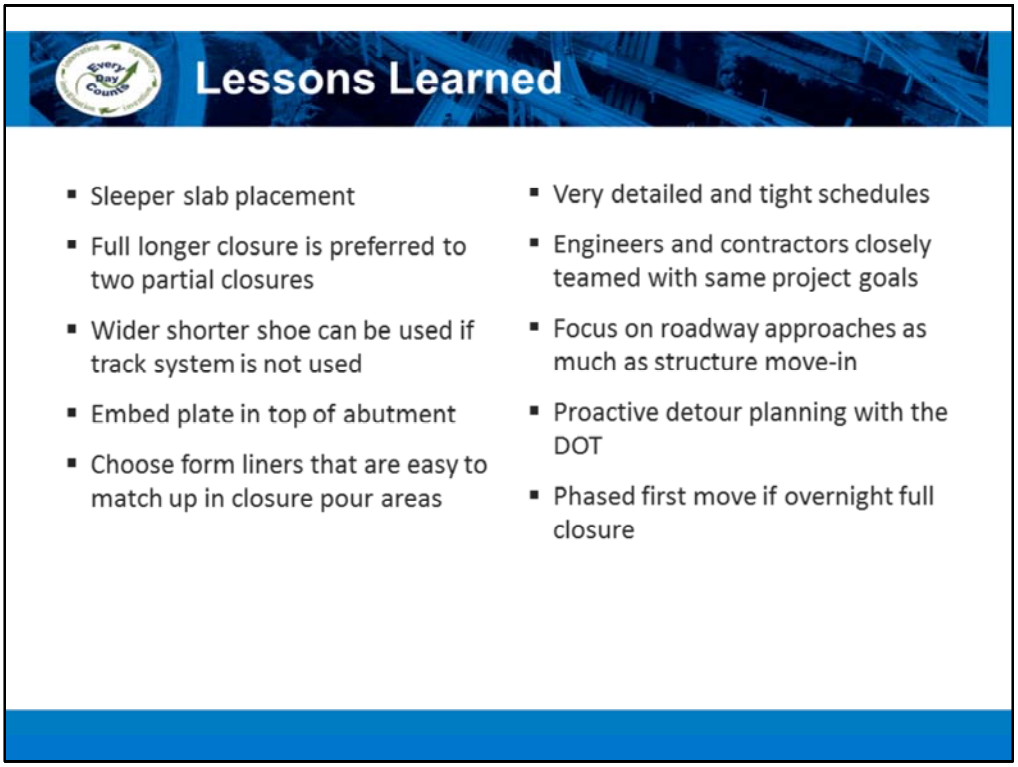


An 18 hour full closure was allowed on I-80 without penalty. The duration of closure for the westbound bridge was only 16 hours, thereby meeting the timeframe requirements.

A partial slide was completed the day before the full closure. One lane remained open during this time.



For the eastbound bridge, a 24 hour full closure was allowed and the process was completed in 18 hours. The slide portion was completed in one night, which was required due to the condition of the existing bridge.



Numerous lesson were learned on this project.

To start, regarding the sleeper slab, the best placement is directly on top or behind the existing abutment, not in front.

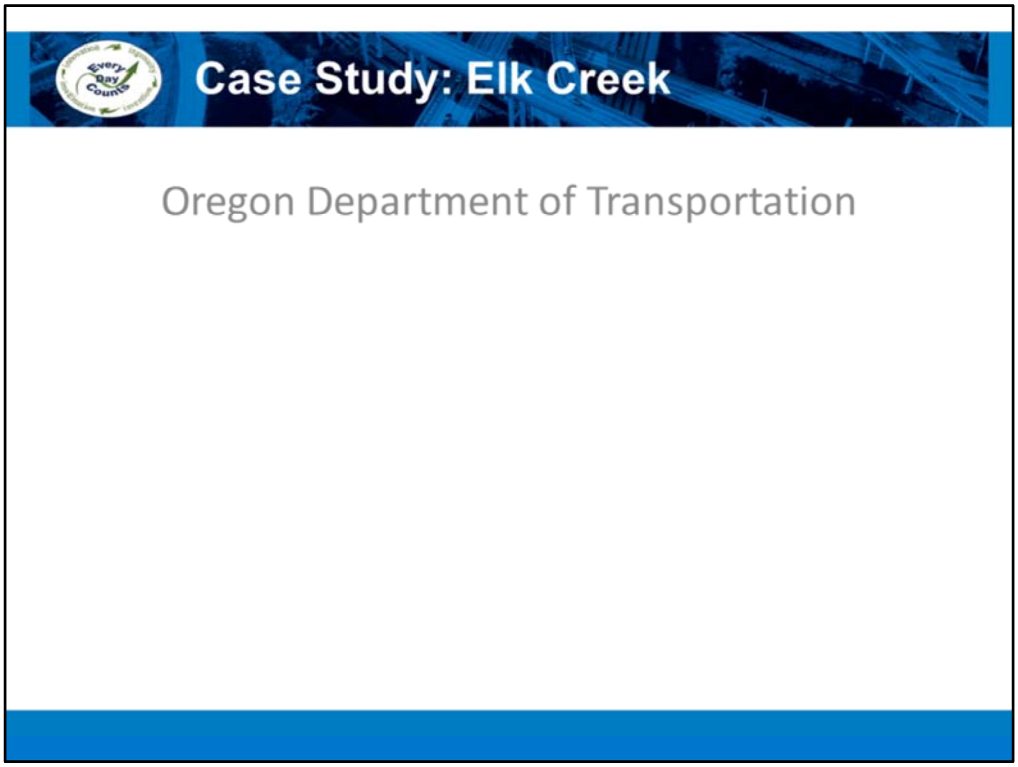
A full longer closure is preferred over the two partial closures. This would allow for fill to be placed in one lift across the entire roadway section, allowing for better compaction and bigger equipment. It also removes the potential failure plane at the subgrade between the two phases.

A wider shorter shoe can be used if the track system is not used. A way should be identified to embed the plate in the top of the abutment or other means to address tolerance issues between the slide shoes and the abutment. Choose form liners that are easy to match up in closure pour areas.

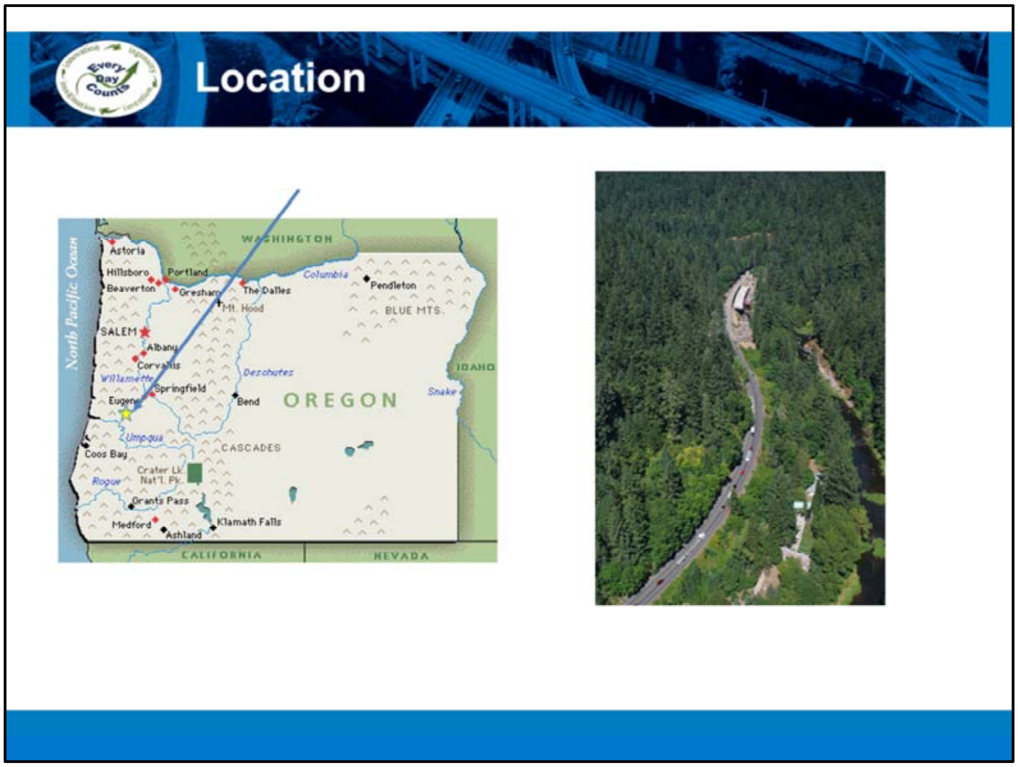
Very detailed and tight schedules are recommended to ensure a smoother process. It is of great benefit to the project when engineers and contractors are closely teamed with the same project goals.

Special attention should be paid towards the roadway approaches as they can be as critical to the operation as much as the structure slide-in.

Proactive detour planning with the DOT can reduce effects on the traveling public. Lastly, a phased first move is recommended if an overnight full closure is used.



The Oregon Department of Transportation completed a project requiring several bridge replacements on State Highway 38 between the towns of Elk Creek and Hardscrabble, two of which were replaced using slide-in bridge construction methods. Here forward, the bridges will be referred to as Crossing 3 and Crossing 4.



The project is an hour south of Eugene in the mountains of western Oregon. The terrain alone would have been enough to make any bridge replacement project more difficult. Couple that with the desire to maintain traffic through the corridor during construction and the difficulty is only increased.

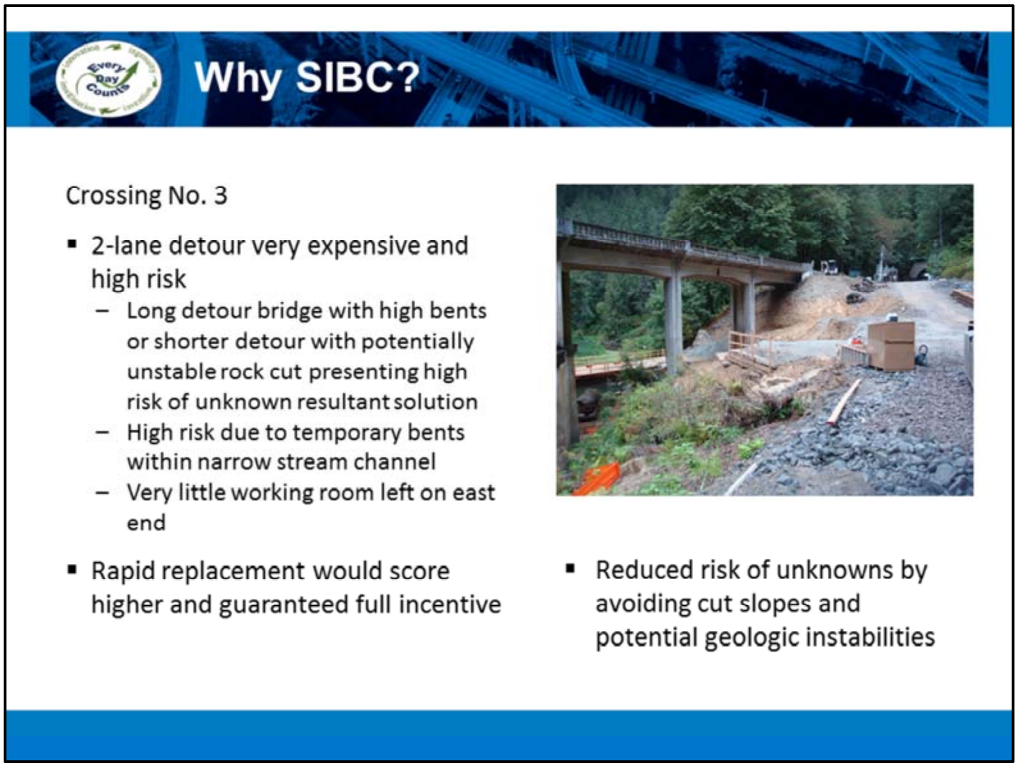
The method of delivery was design-build with best value selection and the winning team proposed slide-in bridge construction for two bridges to eliminate expensive detours and flagging.

The project was in a very difficult location. Both of the existing bridges featured deck truss main spans which essentially eliminated the possibility of phased removal and construction.

Both bridges were on opposite ends of the same tunnel, with one of the bridges starting almost immediately after exiting the tunnel. This made traffic shifts and alternative alignments extremely difficult to complete.

The lateral slides which were completed in a 48 hour closure window for each bridge eliminated costly realignments, costly temporary bridges, and eliminated most of the single lane restrictions.

The winning bid was approximately $50 million, slightly under the engineer’s estimate of $53 million, and the total project duration was 32 months, almost two fewer years than the original estimated project duration.



It’s useful to look at the reasons Slayden chose the lateral slides.

For Crossing 3, a temporary bridge could have been constructed but the local geometry made the temporary bridge almost three times the length of the permanent bridge.

Furthermore, there would have been considerable risk due to temporary bents within the narrow stream channel and very little working room would have been left on the east end which would have required a substantial hillside cut to reconnect at the west end.

Another reason, given that the project was design-build with best value selection, was that rapid replacement would score higher and guarantee full incentive.

The terrain also imposed several unique challenges. By avoiding cut slopes and potential geologic instabilities, the risk of unknowns was reduced.

Why SIBC?

Crossing No. 4

- Single-lane detour problematic
  - A two-lane detour was impossible
  - Staging at tunnel portal would have required temporary signal or constant flagging
  - Analysis demonstrated temporary traffic signal would back traffic up across Crossing No. 3 – negative in proposal
  - 180 calendar days to complete new bridge

- Rapid replacement, which was not envisioned in the procurement documents for these sites, would score higher and guaranteed full incentive

For Crossing 4, the proximity of the tunnel to the bridge, only about 50 feet from the tunnel portal to Crossing 3 from the bridge joint, made staging the new bridge very difficult. A temporary signal or constant flagging would have been required and in this case it was discovered that traffic would have backed up through the tunnel and across Crossing 3.

Additionally, if a single lane detour was used, the contractor would have been limited to 180 calendar days to complete the new bridge.

Rapid replacement was not originally envisioned in the procurement documents for these sites. However, its use did score higher and guarantee full incentive.

These pictures show the difficult construction conditions and site constraints.

The primary structure of the original bridge, shown on the left, was a deck truss.

The overall structure was also composed of several shorter concrete girder spans approaching the truss structure.

On the right, the new structure is shown adjacent to the old structure, and is a three-span continuous steel plate girder bridge.

The red pieces are the vertical jack and slide shoes. Translation was accomplished by supporting and sliding at two interior points with the end spans cantilevered.

These pictures of Crossing 4, give you an idea of how difficult phased construction would have been due to the proximity of the bridge and tunnel. Like Crossing 3, the existing structure was a truss.

The new structure is a two-span, prestressed, concrete deck girder bridge. Translation was accomplished by supporting the structure along four lines.

Here, another picture of Crossing 4 is shown and the points at which the structure was supported during translation are better seen.

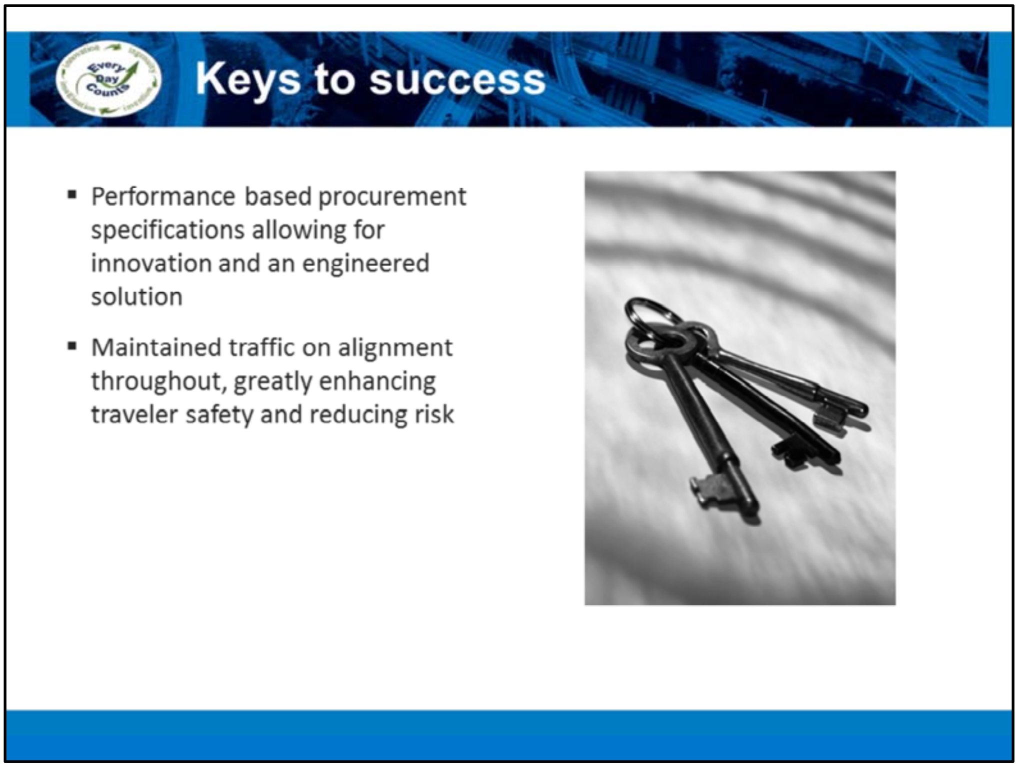
A greater appreciation is also gained for the surrounding terrain and the magnitude of a bridge slide operation.

For both crossings, the slide operation was subcontracted to Mammoet who used a similar technology found in Self Propelled Modular Transporters.

After all was completed, several keys to success were identified.

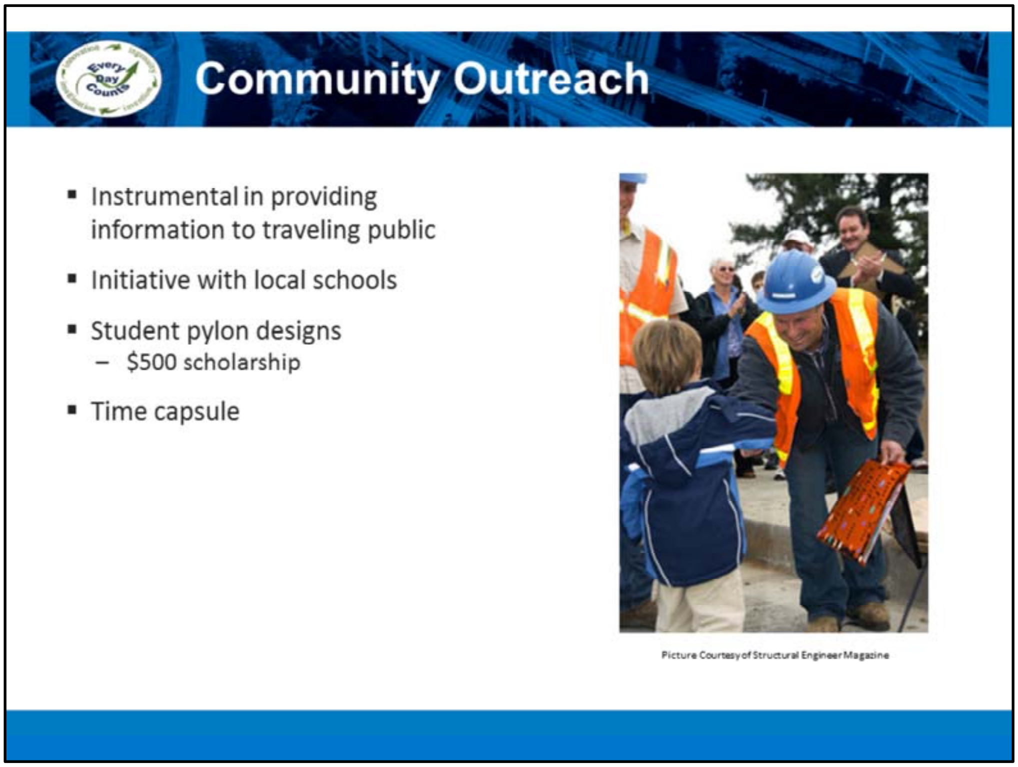
First, the reduction in construction time offset the additional costs due to slide-in bridge construction. Also, a significant reduction in maintenance of traffic resulted in schedule savings and good public relations, and the elimination of flagging for what would likely have been 180 days resulted in cost savings.

Furthermore, risk was greatly reduced by not using a temporary bridge to carry public traffic. And, maybe most importantly, the contractor made it known that coordination, communication and cooperation between the owner, community, and contractor was the real key to success.



Some additional keys to success include the performance based procurement specifications which allowed for innovation and an engineered solution.

Lastly, traveler safety and reduced risk were achieved by maintaining traffic on alignment throughout the duration of the project.

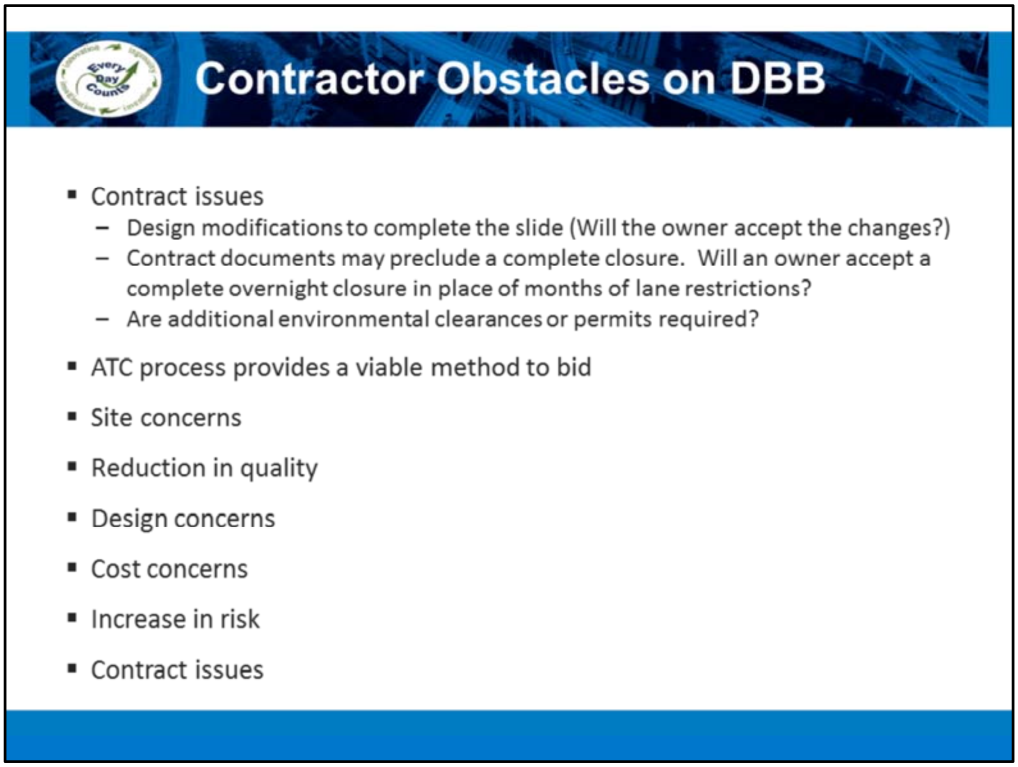


As part of the project, the contractor implemented a community outreach program which was instrumental in providing information to the traveling public.

The initiative began with the local schools. On several occasions the contractor visited the schools to convey necessary information whether it be through the students or directly to parents.

A student competition was established to design the pylons at the corners of one of the bridges and the winning student was awarded with a $500 scholarship.

Lastly, a time capsule on one of the bridges was created for students and other community members to contribute to. For this project the location allowed for closing off the site to any public viewing eliminating that potential security and safety issue.



Given all the benefits you may wonder why slides aren't used more often. It's likely we would see a lot more slides on traditional projects if the contractor knew they could get past a few obstacles. If a slide wasn't part of the bid package and a slide requires modifications, the contractor can't bid the slide in case the owner doesn't accept the revisions. Once the project is won the contractor has little incentive to go down the value engineering change path. Sometimes value engineering changes can lead to a loss of positive partnering attitudes.

Site concerns – There are places where it is not feasible to construct a new bridge adjacent to the existing structure but the Oregon project shows that slides can be effective even in very confined locations.

Reduction in quality – There is no evidence in reduction in quality in bridge lateral slide projects. When compared to phased construction it might even be an improvement. The Utah DOT has performed special inspections of all lateral slide bridges and no adverse effects have been found with the bridges. In fact, the condition in most cases is better than bridges built with SPMT installations.

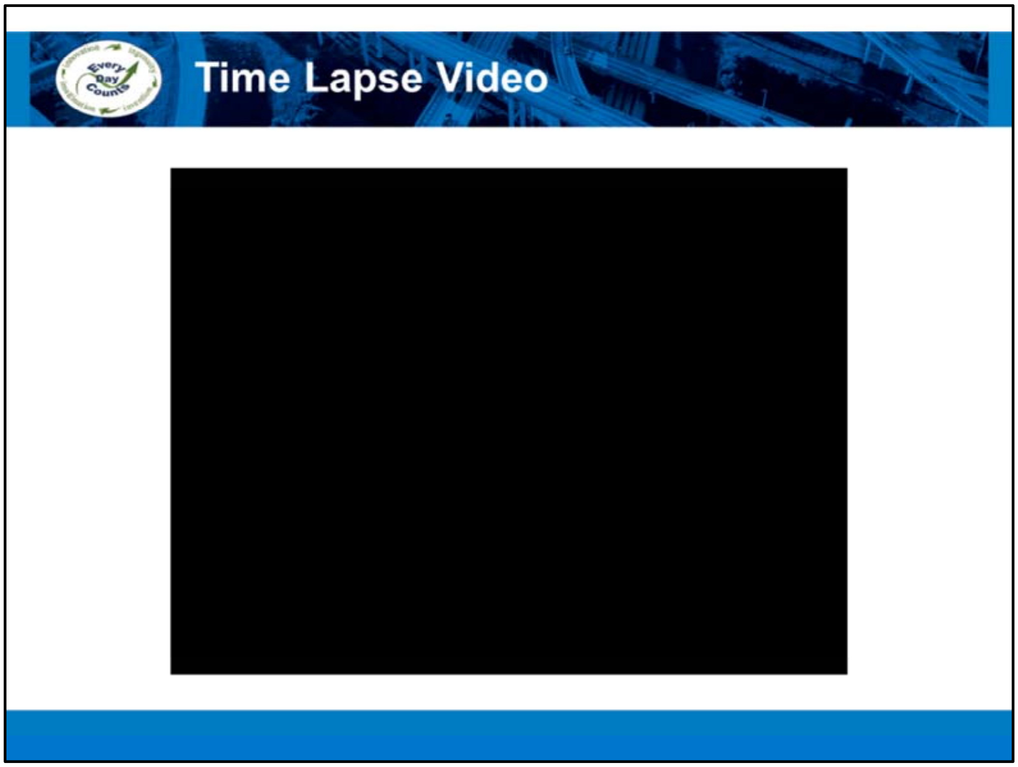
Design is fairly simple and there are a variety of solutions or methods used that demonstrate this. Difficult problems usually have few viable solutions.

Cost is difficult to quantify. It is more costly to slide a bridge into place than to close the road and build it in place. Once you start phasing the construction or requiring a

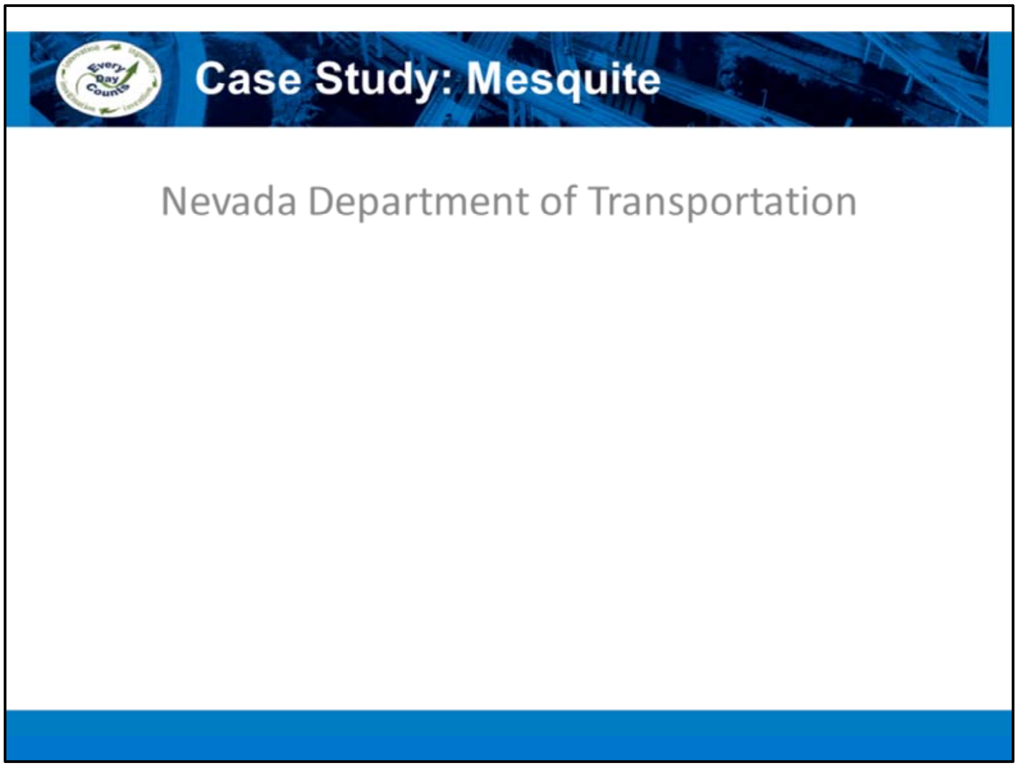
temporary structure the slide becomes cost effective without even considering user cost and construction oversight costs.

Increase in risk – any new construction method for any contractor or owner represents a risk but in general it is believed to be low. Construction risk is similar to a cast-in-place bridge. The move risk is really a function of the time provided for the move and the associated penalties for not opening. A tight timeframe increases the risk the project won't be completed in the allotted time. Low damages increases the risk that the contractor will not be prepared for problems. For example, having an additional jack onsite is cheap insurance against high penalties for not opening on time.

Contract issues – As a policy, owners should start structuring all projects to allow a lateral slide option. In addition to the normal contract and maintenance of traffic requirements it is relatively easy to add maintenance of traffic language to allow a limited complete closure with penalties or incentives in lieu of a defined time of reduced lanes or on site construction time. Also a special provision defining the requirements of any redesign and any other special requirements would allow the contractor to bid the job assuming a slide. As long as they know the requirements they need to meet they can confidently bid the job.



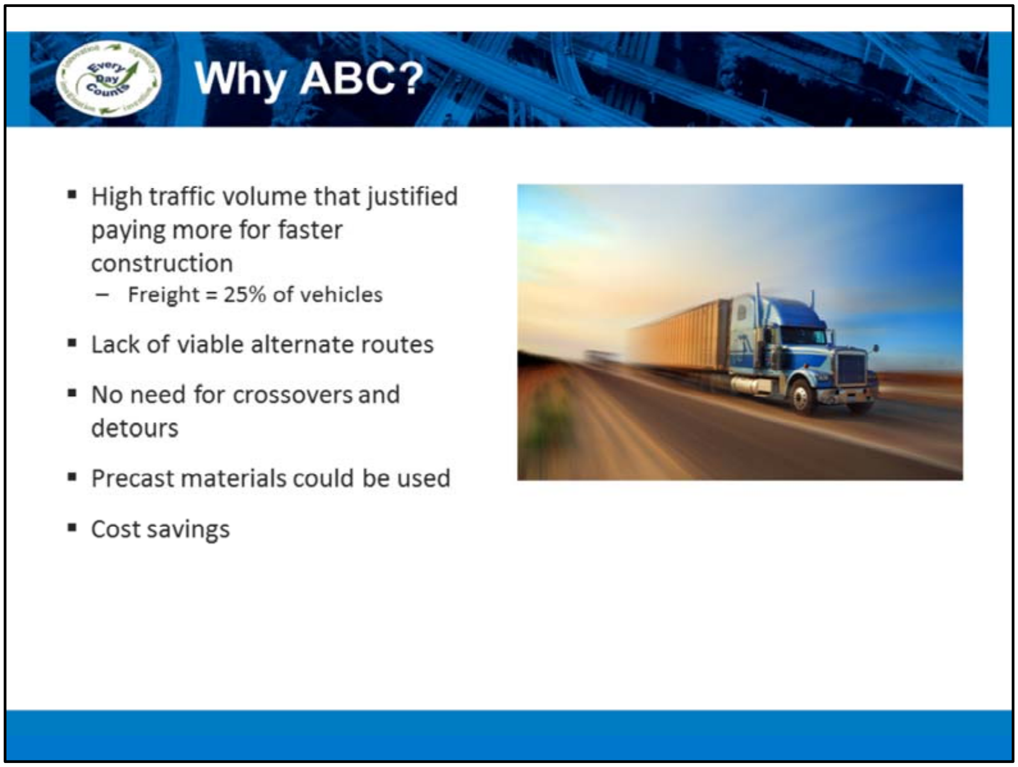
Here is a time lapse video of the slide period on Crossing 3.



The Nevada Department of Transportation was posed with a unique challenge at the I-15 junction with Falcon Ridge Parkway near Mesquite. Not only would the bridges on I-15 require replacement, significant changes to the interchange would also be necessary to accommodate future traffic needs.

To complete this work traditionally would have meant significant closure times and travel impacts on a primary thoroughfare. The desire was to minimize these impacts as much as possible.

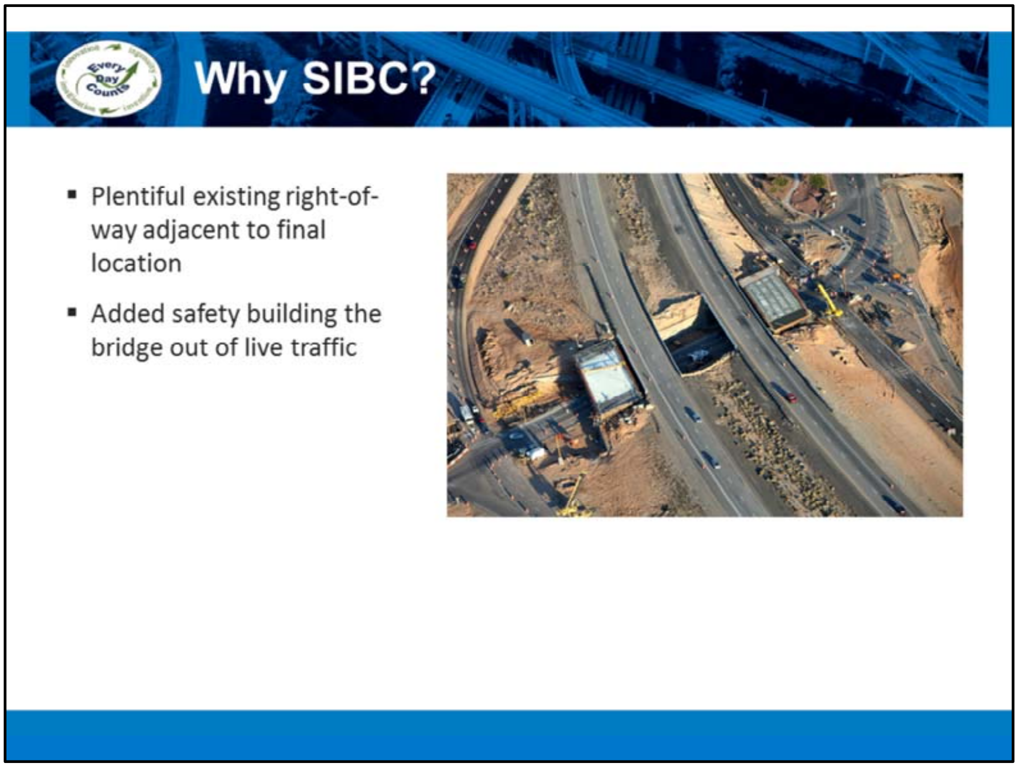
Mesquite, Nevada is located 80 miles northeast of Las Vegas on I-15 and 40 miles southwest of St. George, UT adjacent to the Arizona border. While the population is only 21,000, Mesquite is a popular tourist destination.



The need for accelerated bridge construction was made apparent by several factors.

Those factors include: high traffic volume of which 25 percent is freight traffic; there is a lack of viable alternative routes to which traffic could be detoured for extended periods of time; using accelerated bridge construction would eliminate the need for crossovers and detours; and precast materials could be used.

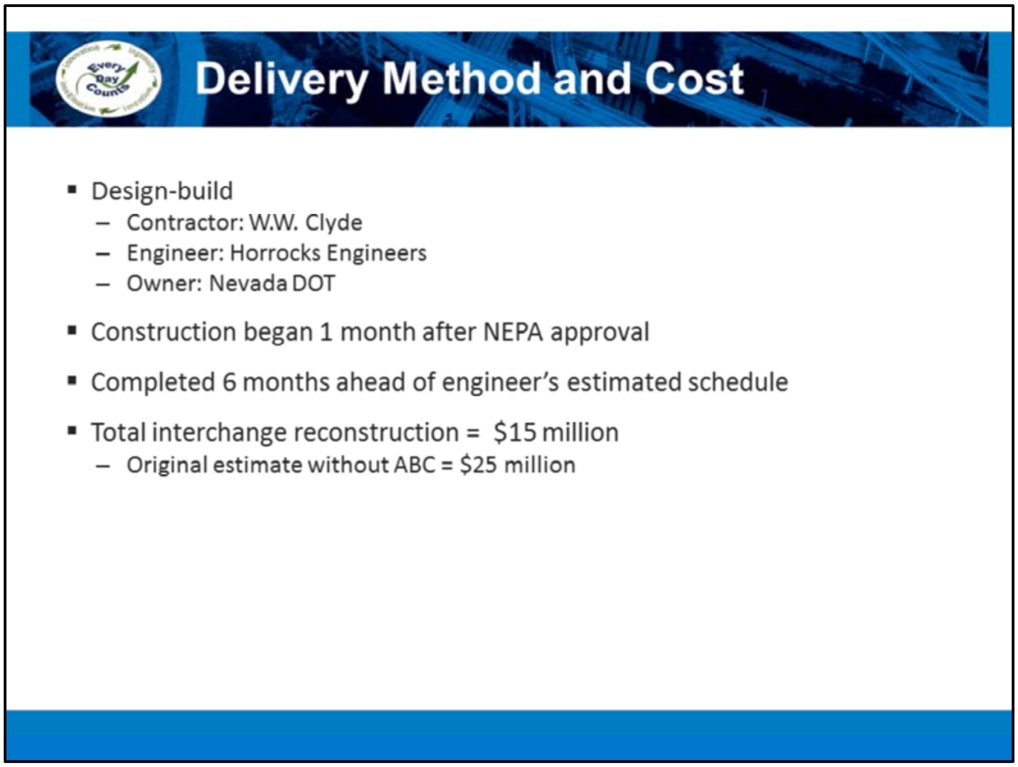
A considerable cost savings was realized through ABC by allowing the new bridges to remain in the existing locations.



Slide in bridge construction was selected as the means of accelerated bridge construction for a couple of reasons.

One, plentiful existing right-of-way adjacent to the final location was present.

Two, by constructing the bridge out of live traffic, safety would be increased for both workers and the traveling public.



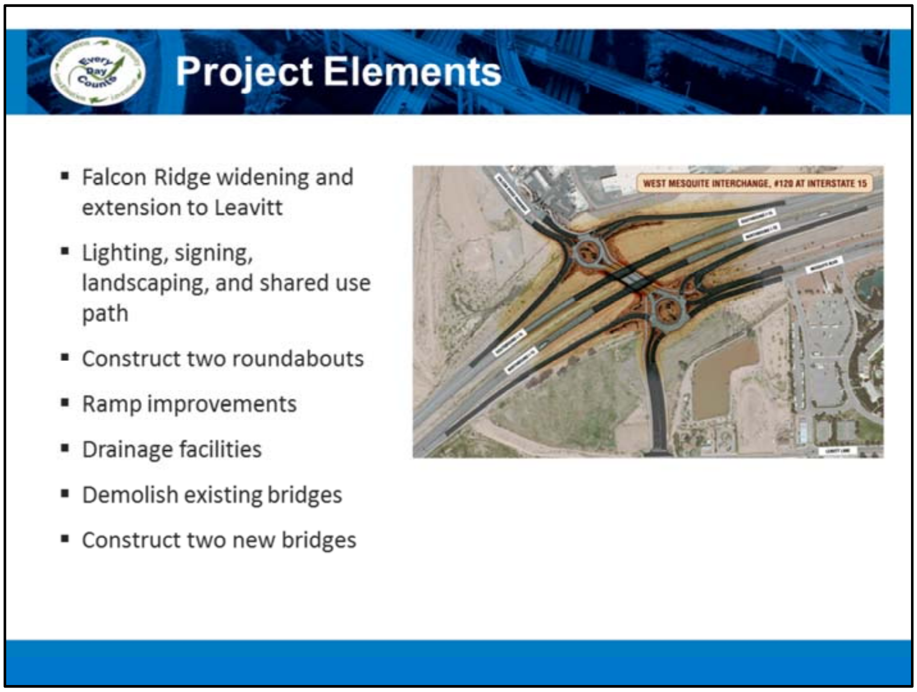
The delivery method was design-build: The Nevada DOT, Horrocks Engineers, and W.W. Clyde were the owner, engineer, and contractor, respectively.

This method was the primary driver for time and cost savings. Construction began only 1 month after NEPA approval and, overall, when compared to the engineer's estimated schedule, 6 months of time and cost was saved.

The original intent was to relocate much of the interchange, so as not to disrupt interstate traffic on I-15. This would have added a considerable cost.

Rather, through the ingenuity of the design-build team, ABC was selected and thus a substantial savings was realized.

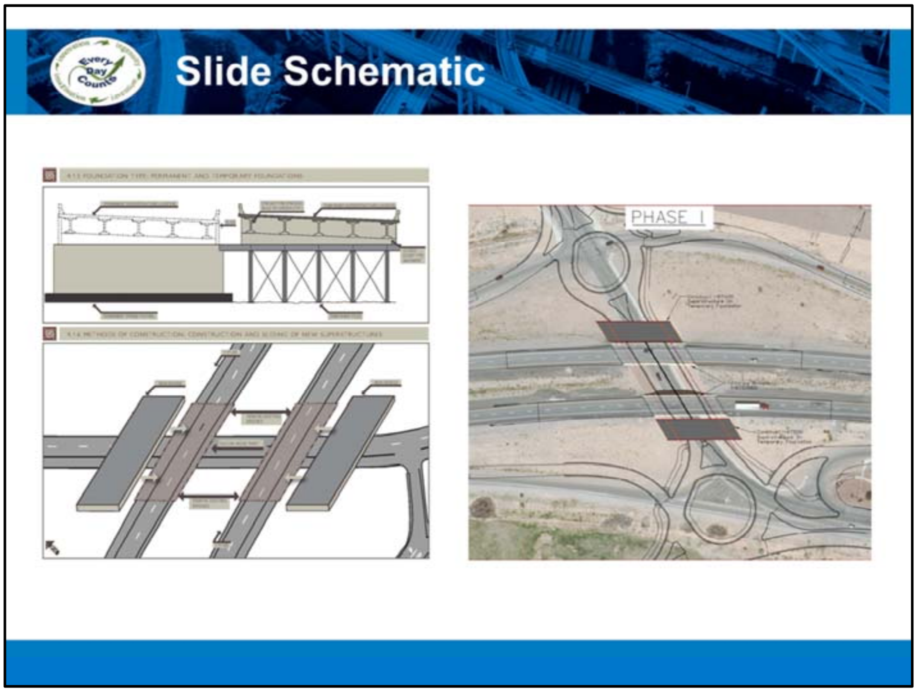
The original estimate of the entire interchange project without ABC was $25 million. In the end, the total cost was $15 million.



In addition to the new bridges, several other elements of the project existed.

Falcon Ridge would be widened and extended. Lighting, signing, landscaping, and a shared use path would be added. Roundabouts, ramp improvements, and drainage facilities were also within the scope.

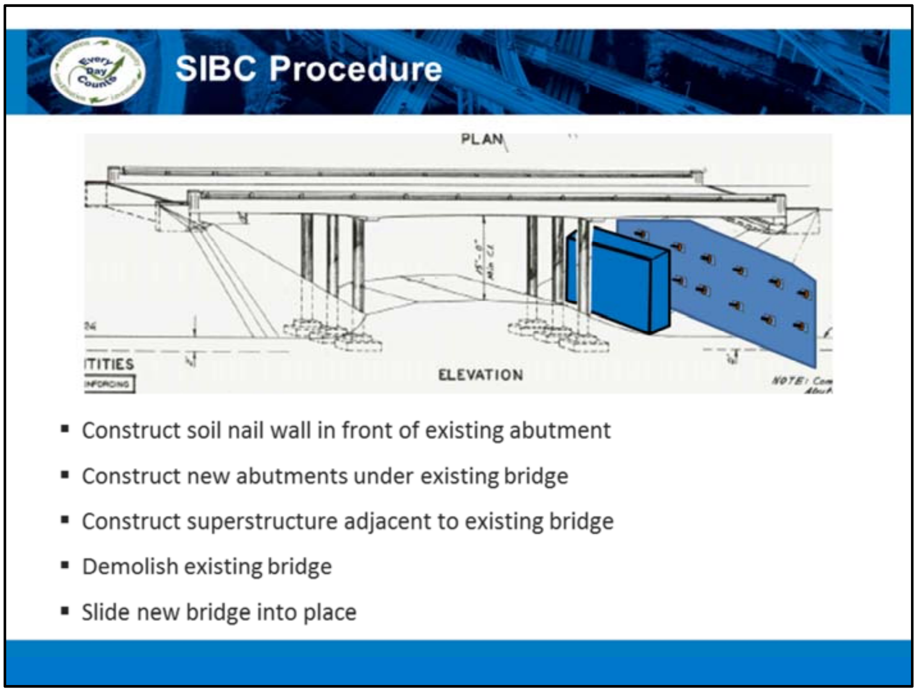
Of course, central to the project was the demolition and construction of two new bridges. Both bridge slides were completed in January of 2012.



In these schematics, the new bridges are shown on their temporary supports relative to the existing bridge locations.

One bridge would be slid in from the North, while the other would be slid in from the south.

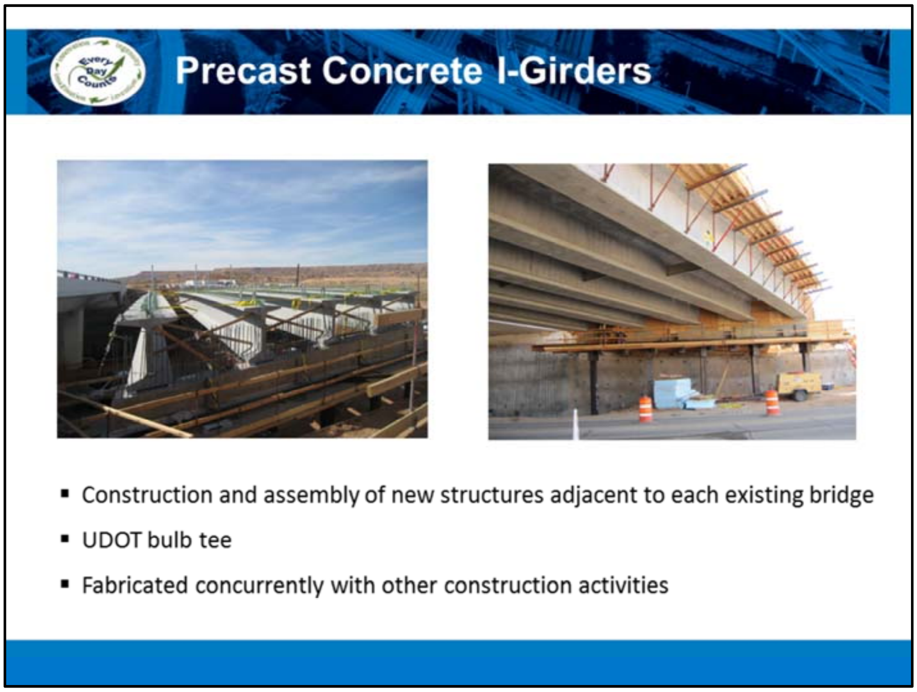
Also, depicted here is that each of the bridges is skewed and set on a superelevation, which are added complexities to an already challenging project.



The existing bridges were left in service while the foundations for the new bridges were constructed beneath. Soil nail walls were constructed in front of the existing abutments, followed by the new abutments.

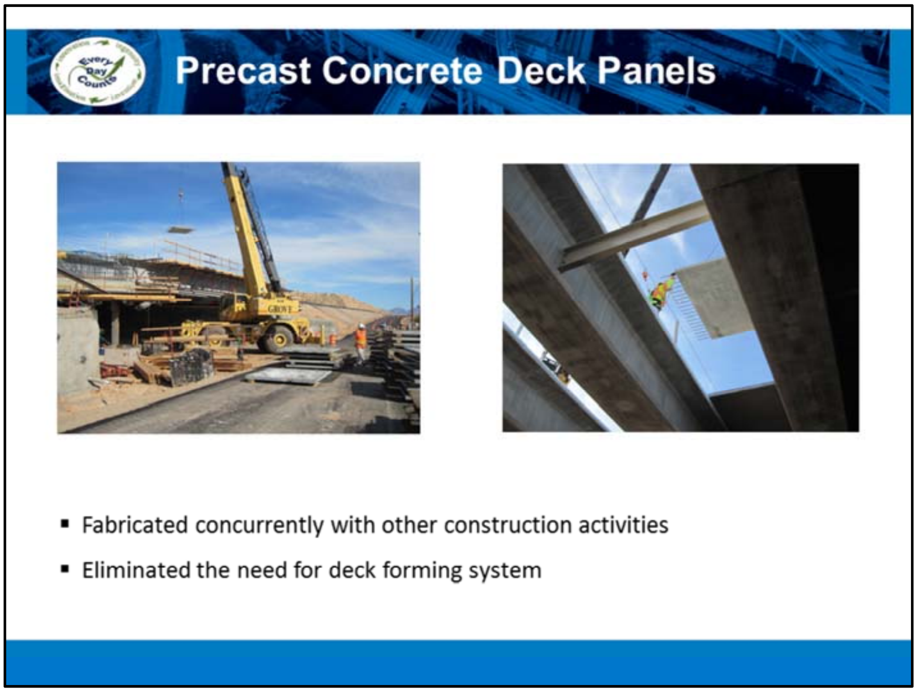
Concurrently the new superstructure was being constructed adjacent to the existing bridge.

Once complete, the in-service bridge was demolished and the new superstructure slid into place.



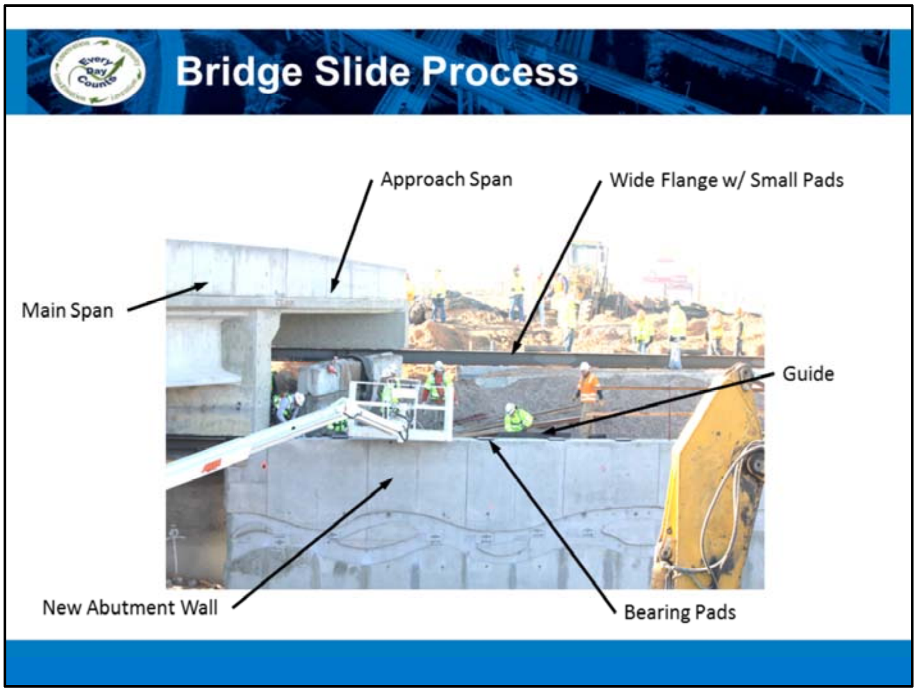
The superstructures were constructed with precast concrete I-girders as is shown here in these pictures. Specifically, a Utah DOT bulb-tee shape was used.

These pictures provide a good indication of the proximity to the existing bridges and the use of temporary works as a superstructure support.



The bridge deck was composed of precast panels which eliminated the need for a deck forming system.

Once the superstructures were completed, bridge demolition could begin. This became an all-hands-on-deck operation as the demolition signified the beginning to a temporary closure of the mainline I-15 interstate. Traffic was rerouted to the on and off ramps.



Once the demolition was completed, the new superstructure could be slid into place.

Seen here are the many components in place ready for the slide and also the means required for the bridge slide.

The main span, approach span, and abutment wall were preconstructed prior to the demolition. The bearing pads, guide, and wide flange were placed once the demolition was complete.

Here a closer look of the wide flange and small PTFE pads is provided. These pads, along with dishwashing soap, greatly reduce the frictional forces between the superstructure and substructure during the slide.

Hydraulic jacks were attached to the superstructure diaphragms at each abutment location. The jacks extend their full stroke then pause to retract and reset along the guide track which is composed of a steel plate with slots to accept the jack.

Some additional views of the jacks in operation show their attachment to the diaphragms and also their seat on the temporary works.

After the bridge slide, but prior to being able to open the interstate to traffic, the mainline approaches had to be completed. This entailed bringing in fill and paving to the bridge approach.

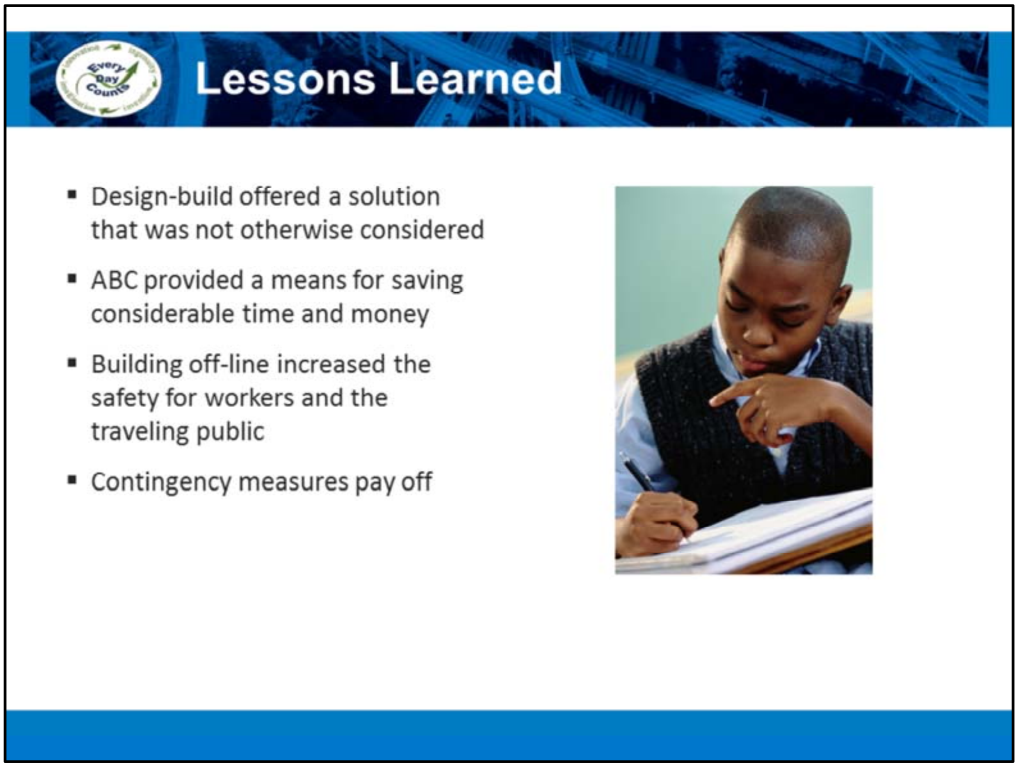
The next few slides provide aerial photos of the site at different stages of the bridge construction and slides.

The first photo taken on December 16th, 2011 shows the new bridges being readied for their slide into final position.

The second photo taken on January 10th, 2012 shows the demolition underway at the first bridge site. The superstructure is ready for its final move.

This photo taken on January 11th, 2012 just one day after the previous photo shows the first bridge slide and the approach paving complete.

On January 24th, 2012 the second bridge was slid into place.



Numerous lessons were learned on this project.

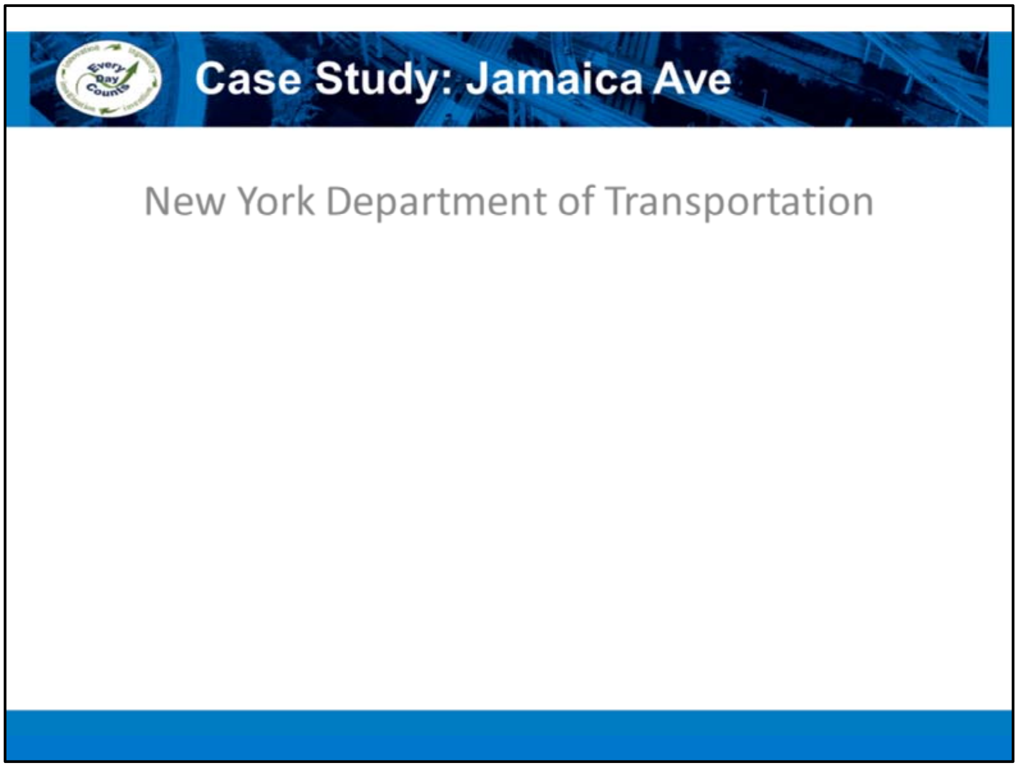
The innovation afforded to the project through the design-build delivery method provided solutions that would not have otherwise been considered.

Implementing slide-in bridge construction as an accelerated bridge construction method helped save a great deal of time and cost.

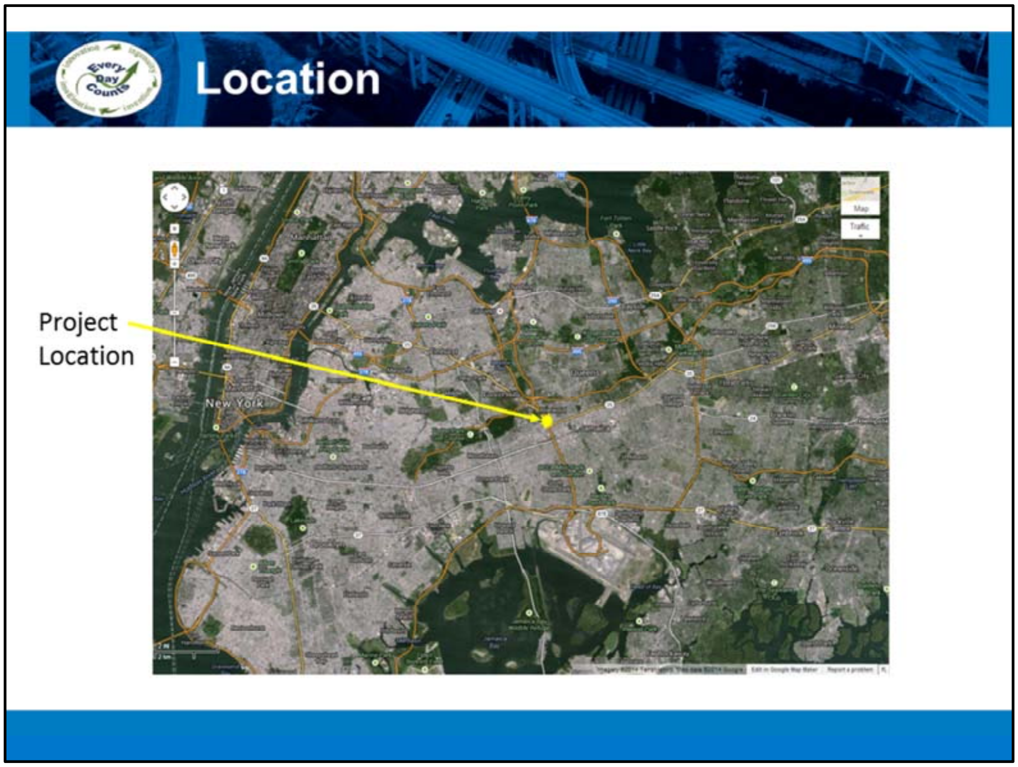
SIBC also provided an increased level of safety for workers and the traveling public by removing the primary construction activities from the main-line traffic.

Lastly, contingency measures pay off. When constrained to a hard and fast time window, a contingency plan is a must for when the unexpected becomes real.

A short video highlighting the project is shown here.

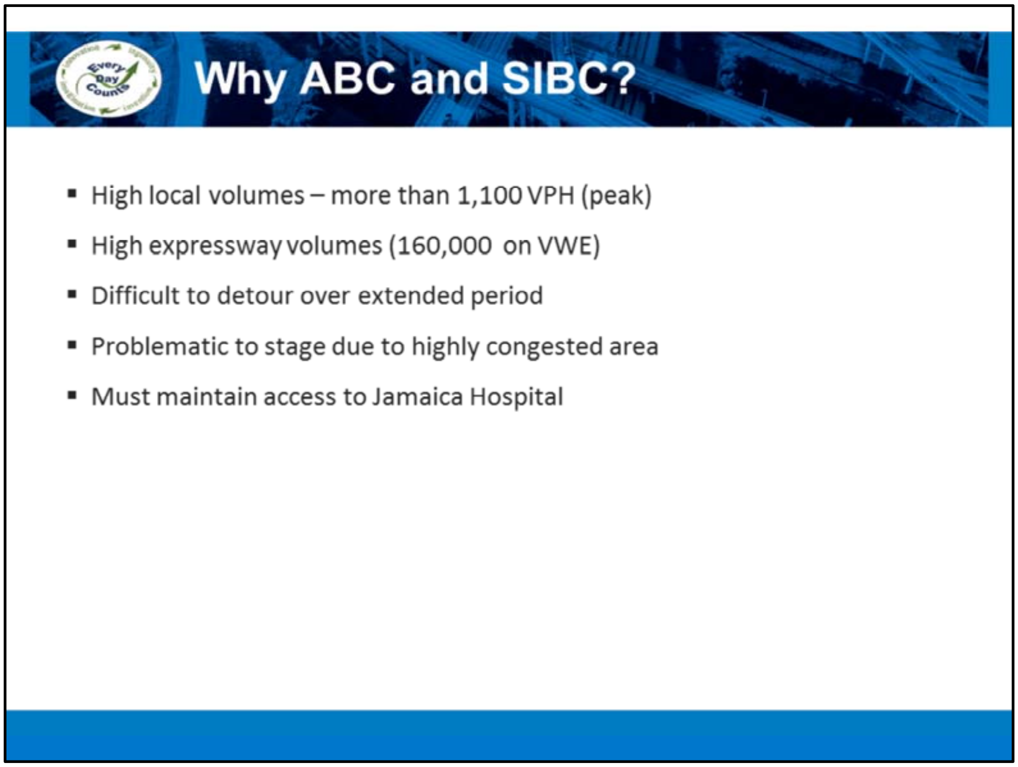


The last case study we'll cover today is a project completed by the New York Department of Transportation on Jamaica Avenue over the Van Wyck Expressway in New York City.



The location immediately east of downtown New York City is shown in this aerial photograph and it is evident that this bridge could not be in located in a more highly trafficked area.

A close up view of the location shows the Jamaica Avenue bridge along with the Van Wyck Expressway passing beneath.



Slide-in bridge construction was used for the reconstruction of the Jamaica Ave bridge for several reasons.

Primarily, all these reasons are associated with the high traffic volume that is commonly seen in large metropolitan areas.

During peak hours, the bridge could see as many as 1,100 vehicles; not to mention the 160,000 vehicles seen per day on the Van Wyck Expressway below.

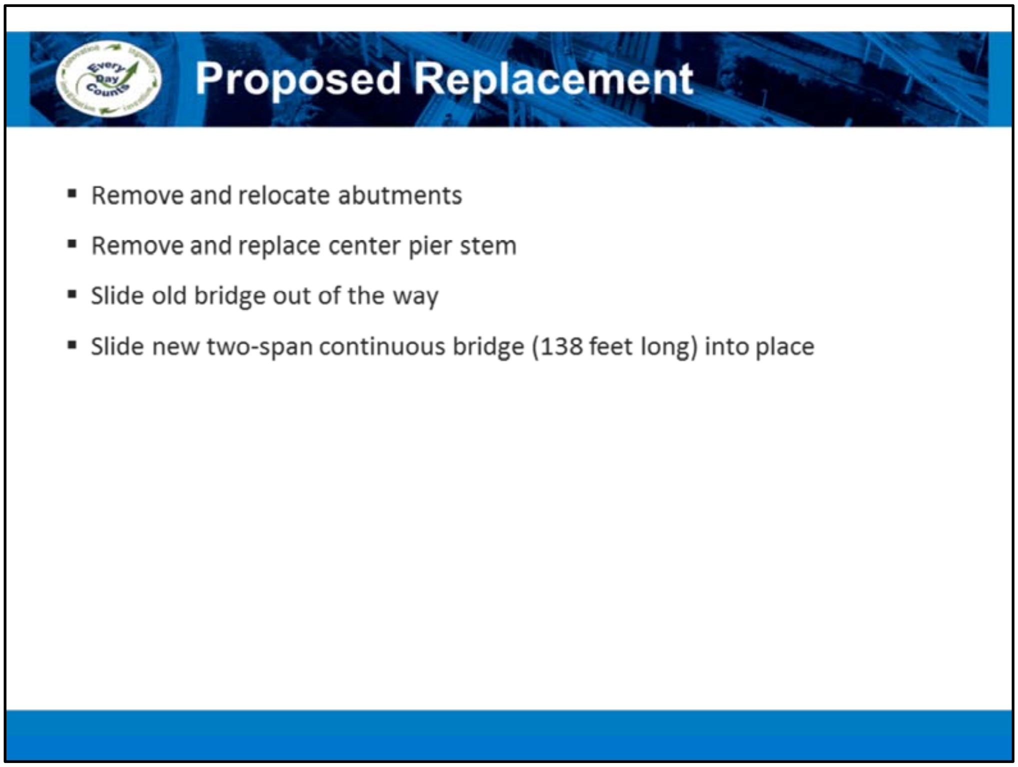
To close this bridge entirely for an extended period of time would prove to be quite difficult. Even more, it would be problematic to stage due to the highly congested area.

Lastly, access to the Jamaica Hospital had to be maintained.

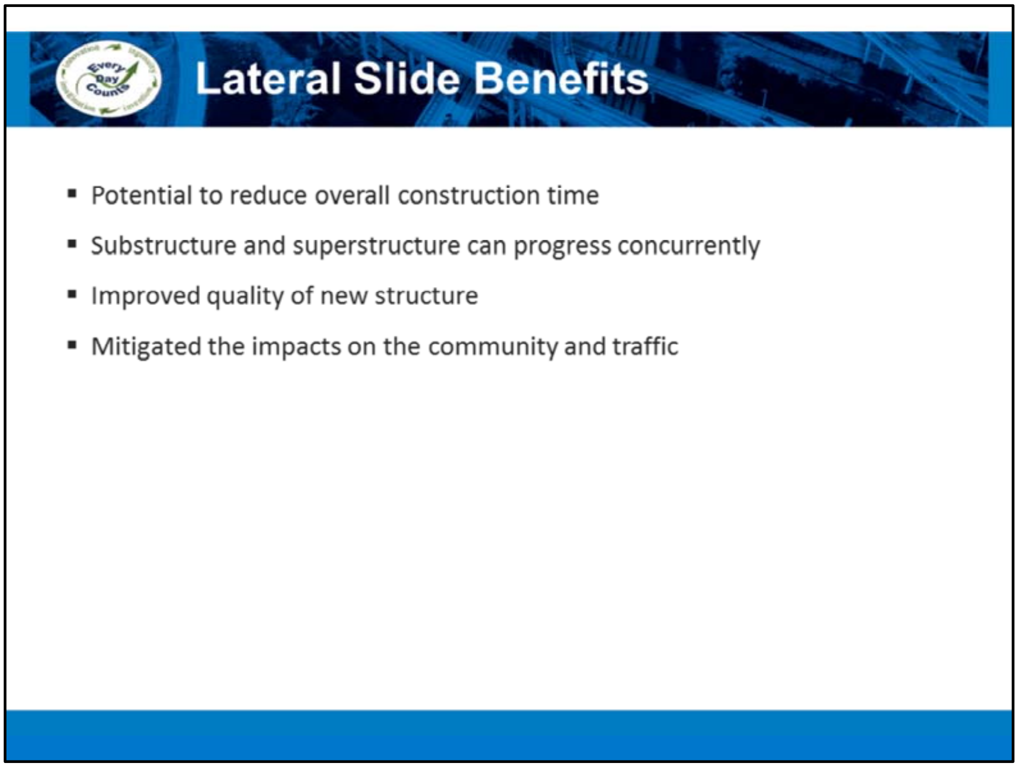
Existing Structure

- Two span
- 110 feet long

The existing bridge was a two-span, 110 ft long girder and deck structure.

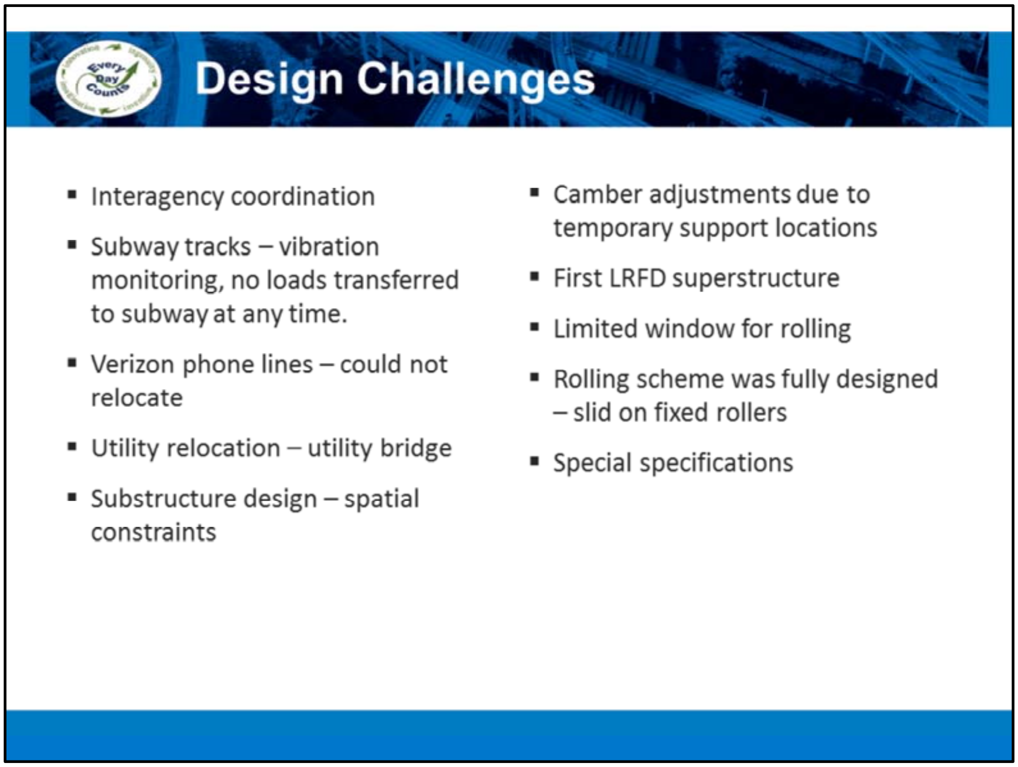


The proposed replacement entailed removing the entire superstructure, removing and relocating abutments, removing and replacing the center pier stem, and installing the new two-span, continuous 138 foot long superstructure.



There were several benefits to selecting slide-in bridge construction at this site.

For example, there was potential to reduce overall construction time, the substructure and superstructure could progress concurrently, the quality of the new structure would be improved, and the impacts on the community and traffic could be mitigated.



As you can imagine, numerous design challenges present themselves when completing a project like this in a highly urbanized area.

As a result, interagency coordination is a must. In this case, coordination with the subway authority, phone company, and utility company was necessary. The subway required that the tracks be monitored for vibration to ensure no loads were ever being transferred to tracks. The Verizon phone lines had to be located but could not be relocated, while other utilities had to be relocated.

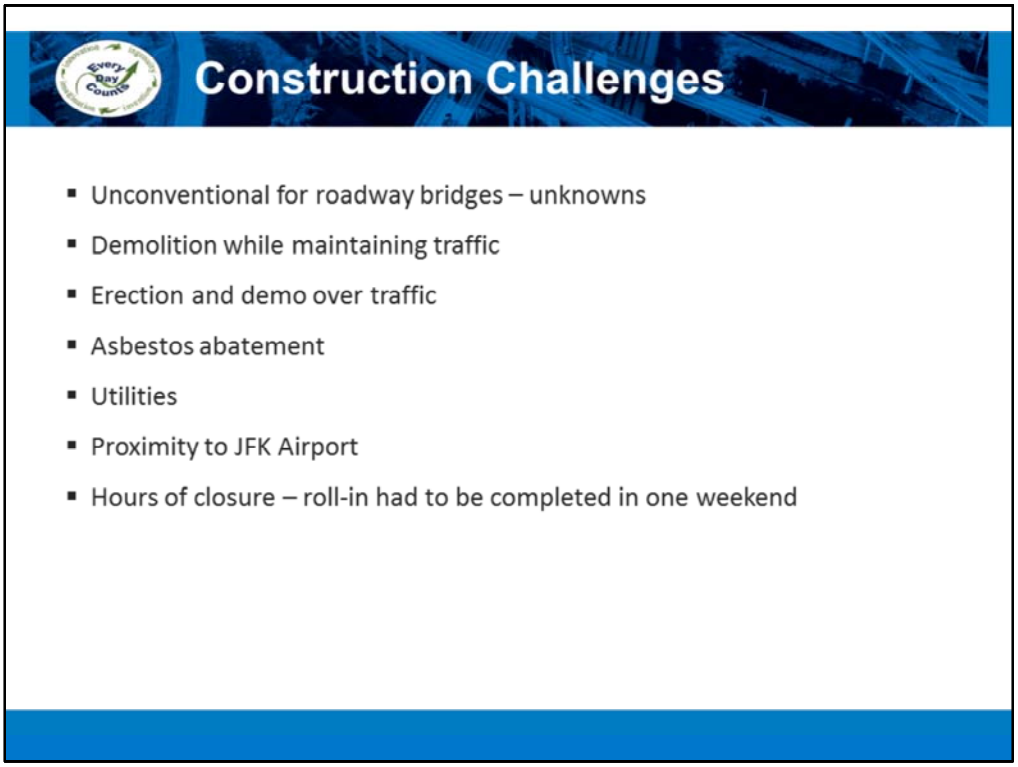
The substructure design was hampered by spatial constraints.

Camber adjustments had to be made due to the temporary support locations being different than the permanent support locations.

Even more, this was the first LRFD superstructure design for NYSDOT.

The timeframe for moving the bridge into place would be limited and as a result the rolling scheme had to be fully designed.

Lastly, the development of special specifications for a project of this type were necessary.



In addition to the design challenges, several construction challenges also existed.

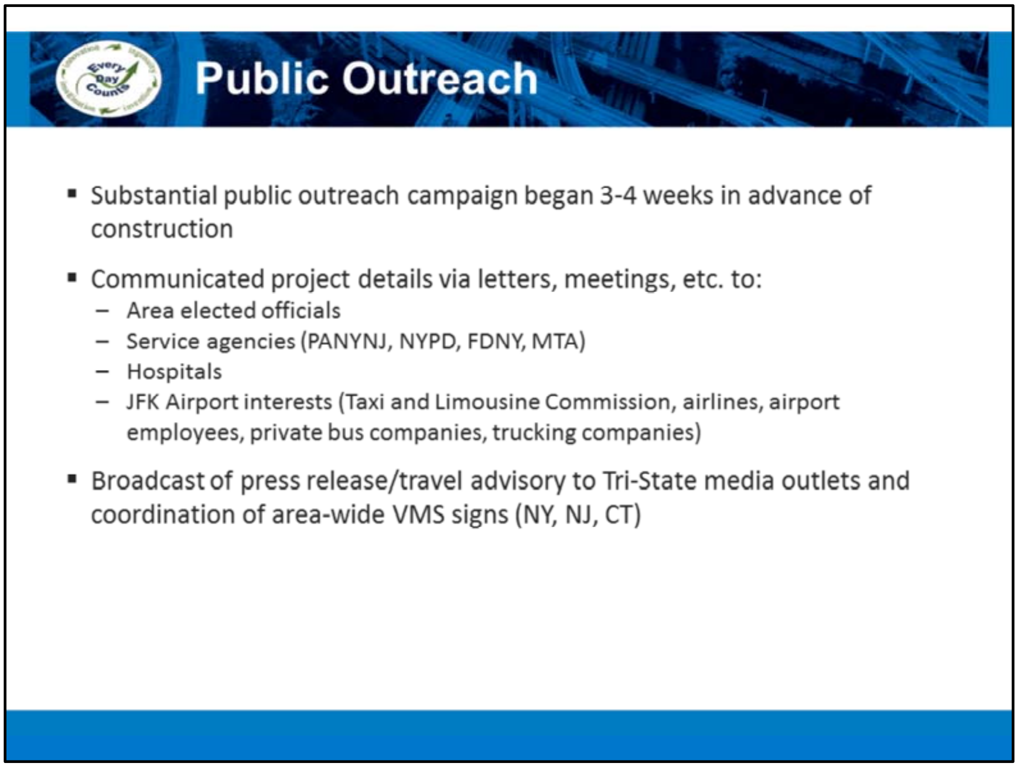
This project was one of the first slide-in bridge construction projects completed in the United States. As a result, there were many unknowns due to the unconventional nature.

Maintaining traffic on the Van Wyck Expressway would prove to be quite difficult during demolition. Likewise, the erection of the new bridge would also be a challenge.

Asbestos abatement was required as well as utility coordination and relocation.

The proximity to JFK airport increased the importance of maintaining traffic.

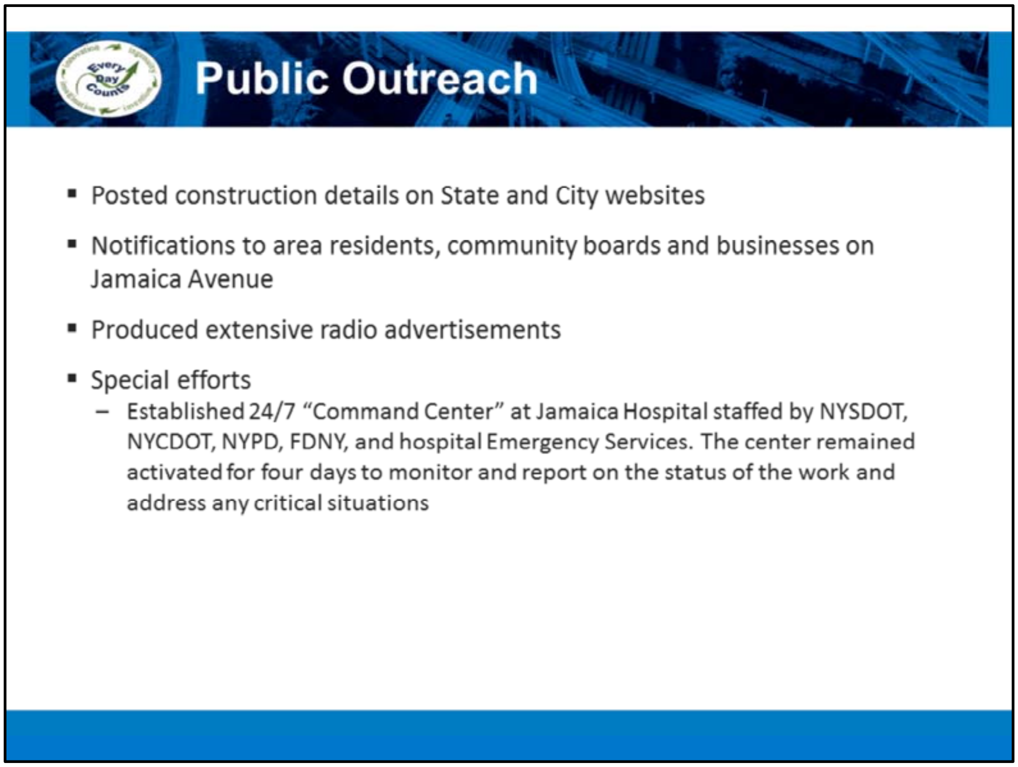
If all that wasn’t enough, the bridge slide had to be completed over one weekend.



Given that so many people could potentially be affected by this project, a substantial public outreach campaign began 3 to 4 weeks in advance of construction.

Within this campaign project details were communicated in many ways including letters, meetings, and others to the primary stakeholders in the area; elected officials, service agencies, hospitals, and any JFK Airport interests.

Even more, a press release was broadcasted through the tri-state media outlets and VMS signs were employed to alert drivers.



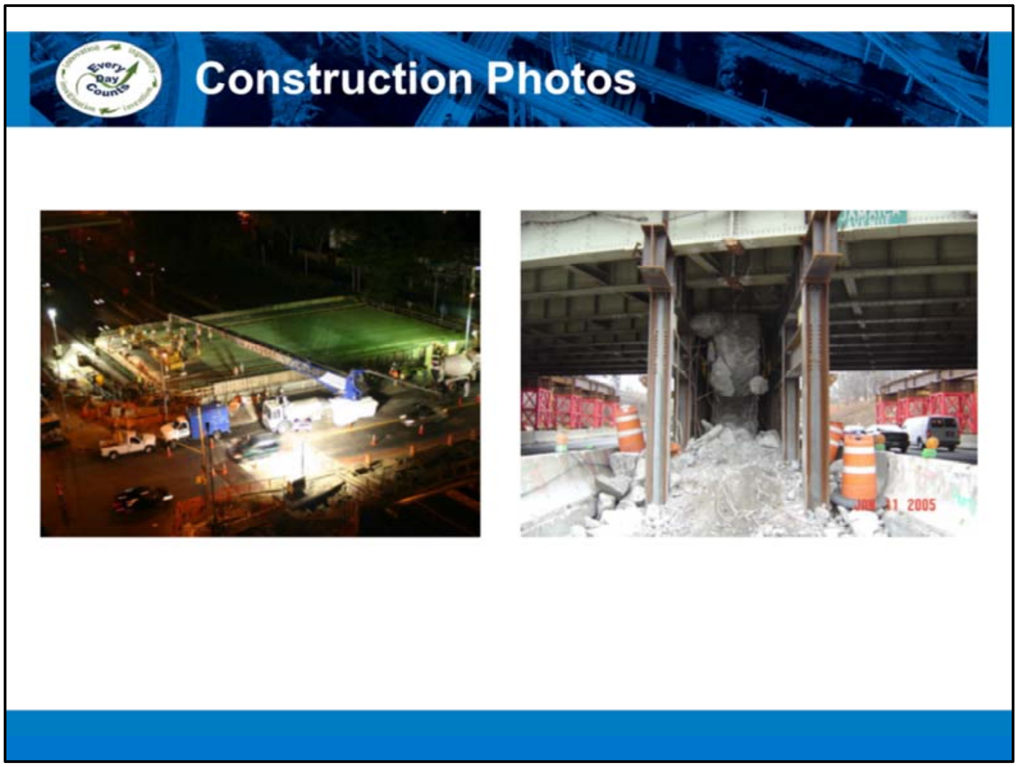
Informing the public would prove to be a key element of the project success.

Construction details were posted on the state and city websites.

Notifications were sent to area residents, community boards, and businesses along Jamaica Avenue.

Moreover, extensive radio advertisements were produced.

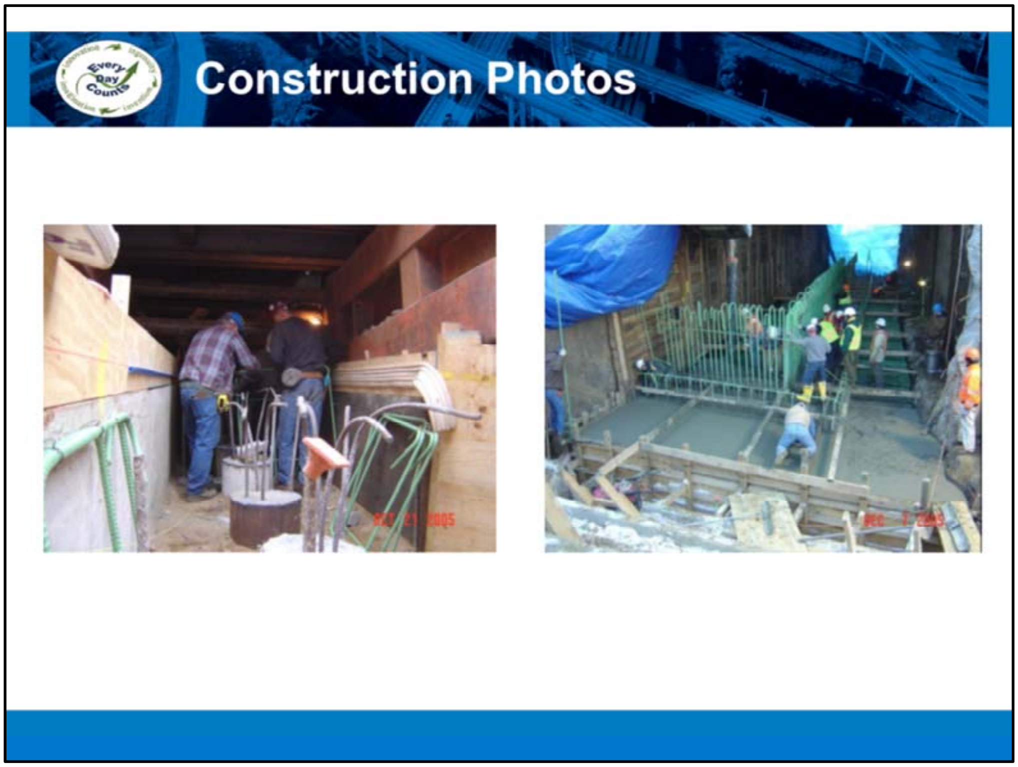
As a special effort, a 24/7 command center was established at Jamaica Hospital staffed by NYSDOT, NYCDOT, NYPD, FDNY, and hospital Emergency Services. The Center remained activated for four days to monitor and report on the status of the work and address any critical situations.



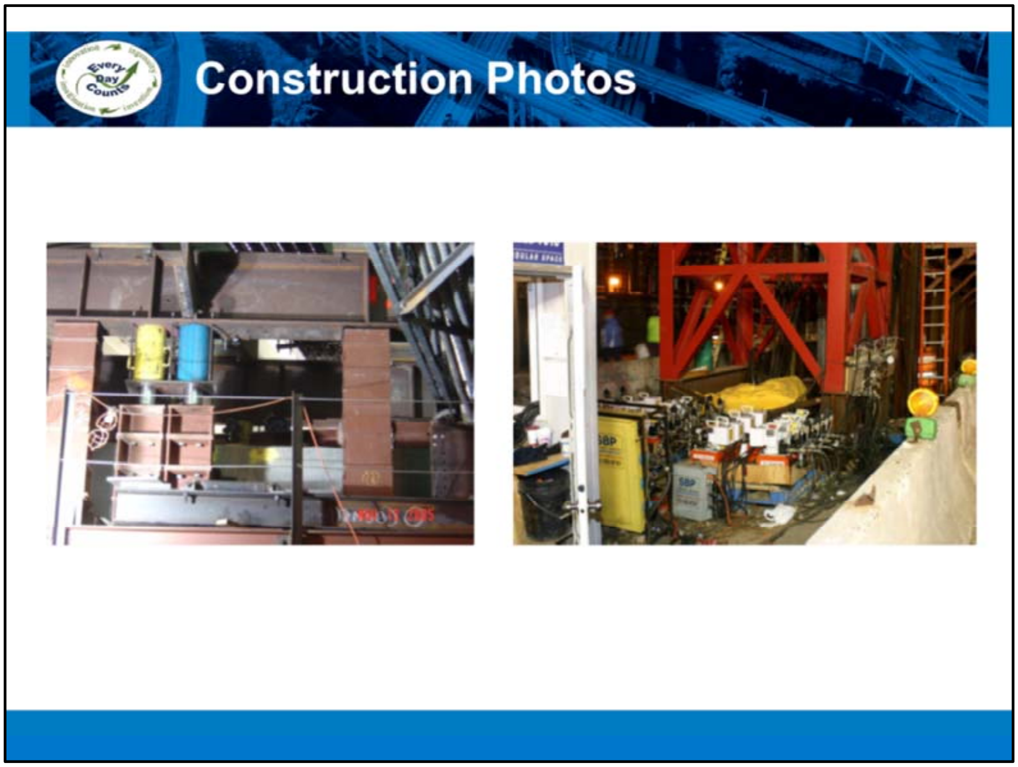
Over the next several slides construction photos will be provided to better explain the construction process.

Here, shown to the left, the new superstructure is under construction and nearly complete prior to demolition of the old bridge.

To the right is a view of the temporary supports of the old bridge so that the old pier could be removed. You'll notice the temporary supports for the new superstructure in the background.



These two photos show the new foundation construction underway beneath the old bridge.



Some of the slide system mechanics to slide the old bridge out are shown in these two photos including the jacks and hydraulic control manifolds.

Heavy duty rollers and large winches were used to guide the new bridge into place.

New Bridge with Traffic

The photo shows the new bridge in place adjacent to the old bridge after both were slid.

A technical support solutions center has been established and is available for all to use to assist in slide-in bridge construction projects. Here the most up-to-date information about SIBC resources and training can be accessed. The center is most easily found by searching "FHWA Slide" online, or by simply going to directly to the web address shown here.

Thank you!

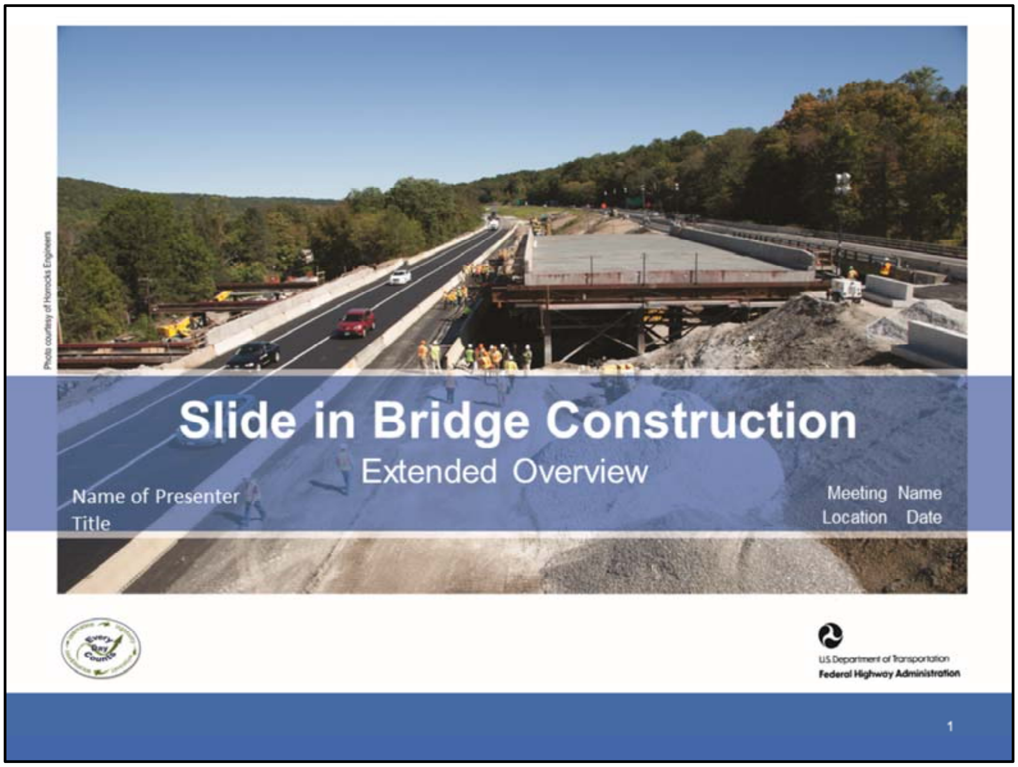
Every Day Counts

U.S. Department of Transportation
Federal Highway Administration

PRESENTATION HANDOUTS:

COURSE 6 SIBC EXTENDED (HALF-DAY)

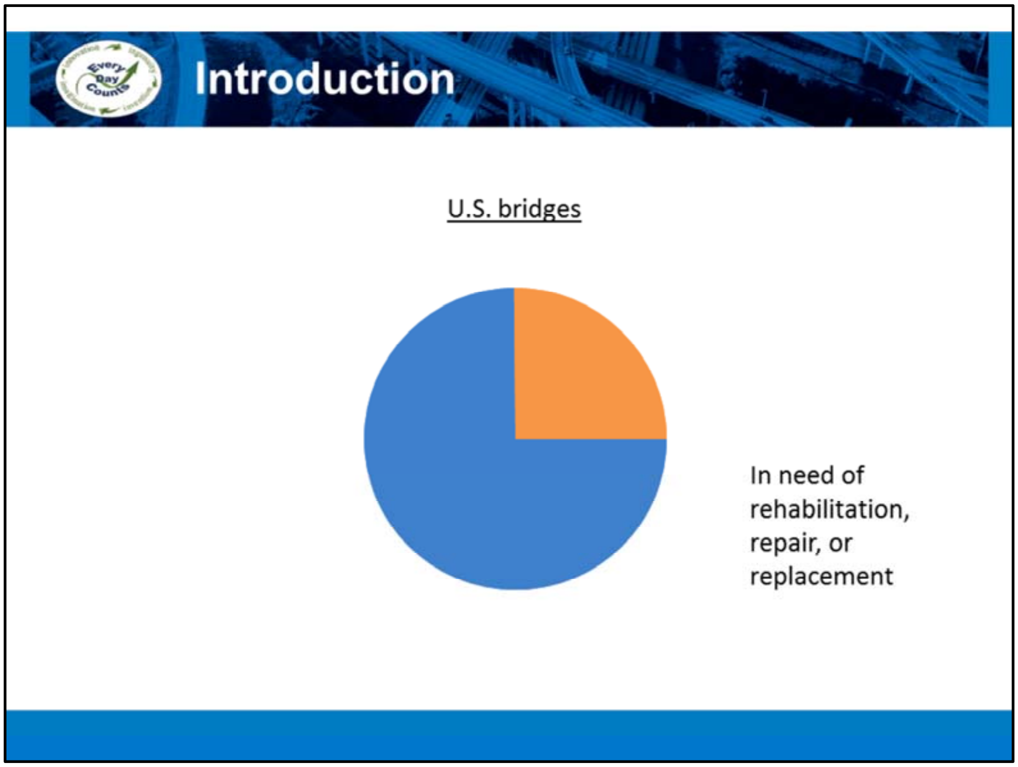
OVERVIEW FOR ALL AUDIENCES



Thank you for attending today's session on Slide in Bridge Construction.

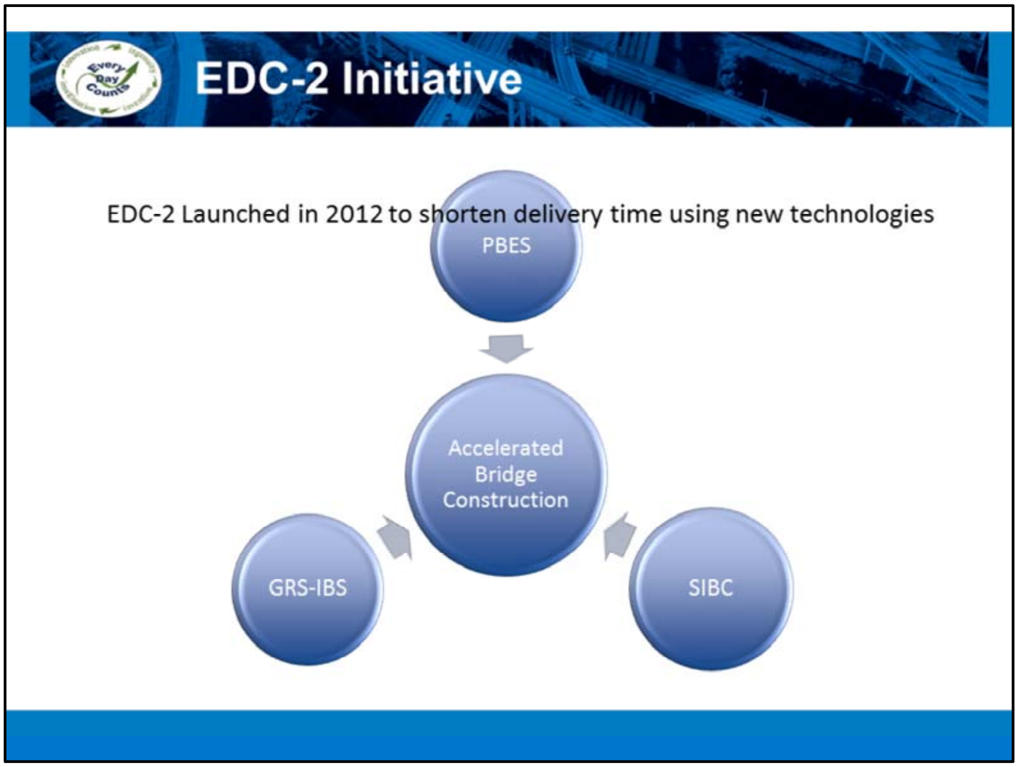
This is the extended overview, which is one of six total modules developed for the FHWA as an extended effort of the Every Day Counts Initiative. The other modules are shorter in length and narrower in focus.

Slide-in bridge construction (SIBC) is a particular method and refinement of construction contained under the broader topic of Accelerated Bridge Construction (ABC) with the specific goal of extremely rapid bridge installation under very short term road closure.



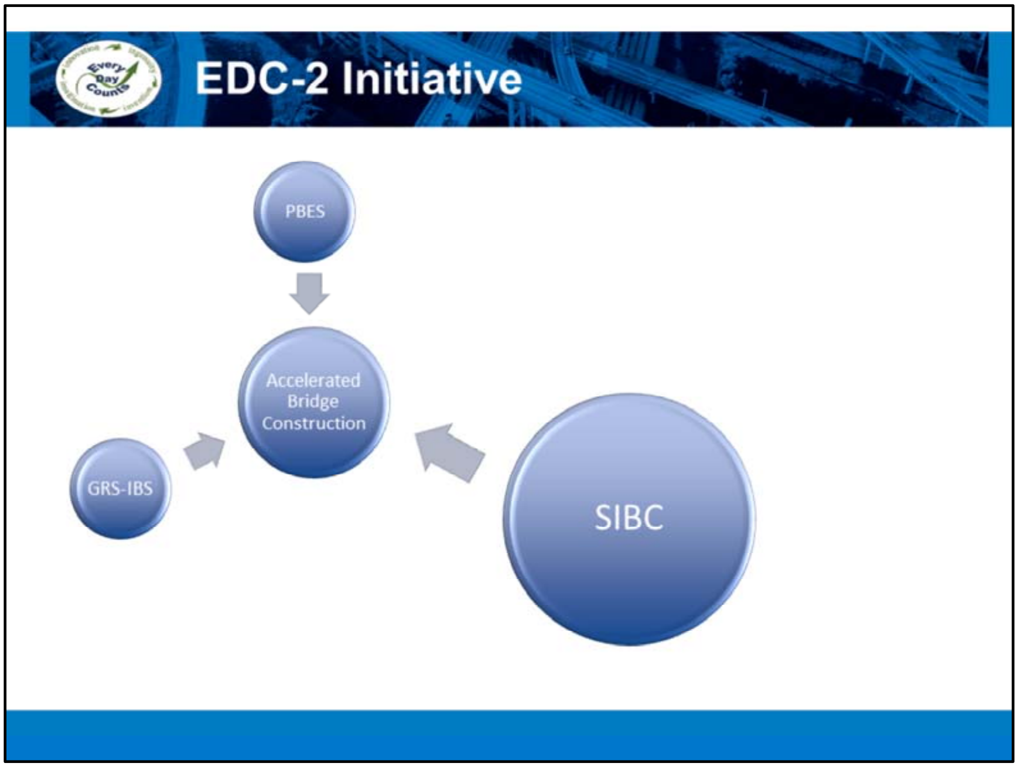
Nearly 25% of the Nation's 600,000 bridges are in need of rehabilitation, repair, or total replacement. Given this vast number, the need for bridge reconstruction methods that reduce the impacts to mobility and safety is needed. This need was one reason the Every Day Counts Initiative was launched.

Every Day Counts was first established in 2010 as a state-based initiative meant to identify and deploy innovation; specifically, to shorten project delivery, enhance safety, reduce mobility impacts, and protect the environment. The term "get in, get out, and stay out" was popularized under this program.

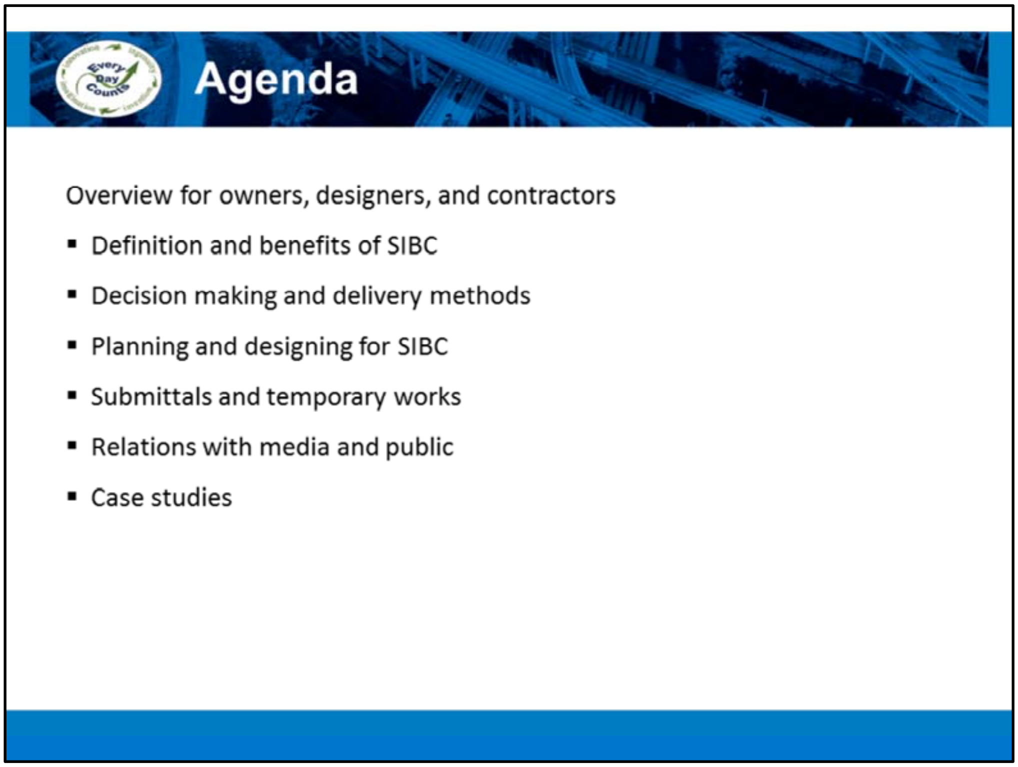


As a result of these efforts, EDC-2 was launched in 2012 with the specific focus of shortening the time needed to complete highway projects through the use of new technologies and ground-breaking processes. Within that directive, accelerated bridge construction became an area of concentration.

Three particular ABC technologies being promoted under EDC-2 are prefabricated bridge elements and systems, geosynthetic reinforced soil-integrated bridge systems, and slide-in bridge construction.



It comes as no news to anybody that our focus today will be on slide-in bridge construction.



Several slide-in bridge construction topics will be covered as the day progresses. Collectively, the topics aim to provide a comprehensive overview for owners, designers, and contractors; thereby better equipping each group to pursue slide-in bridge construction or SIBC as it is now more commonly referred to.

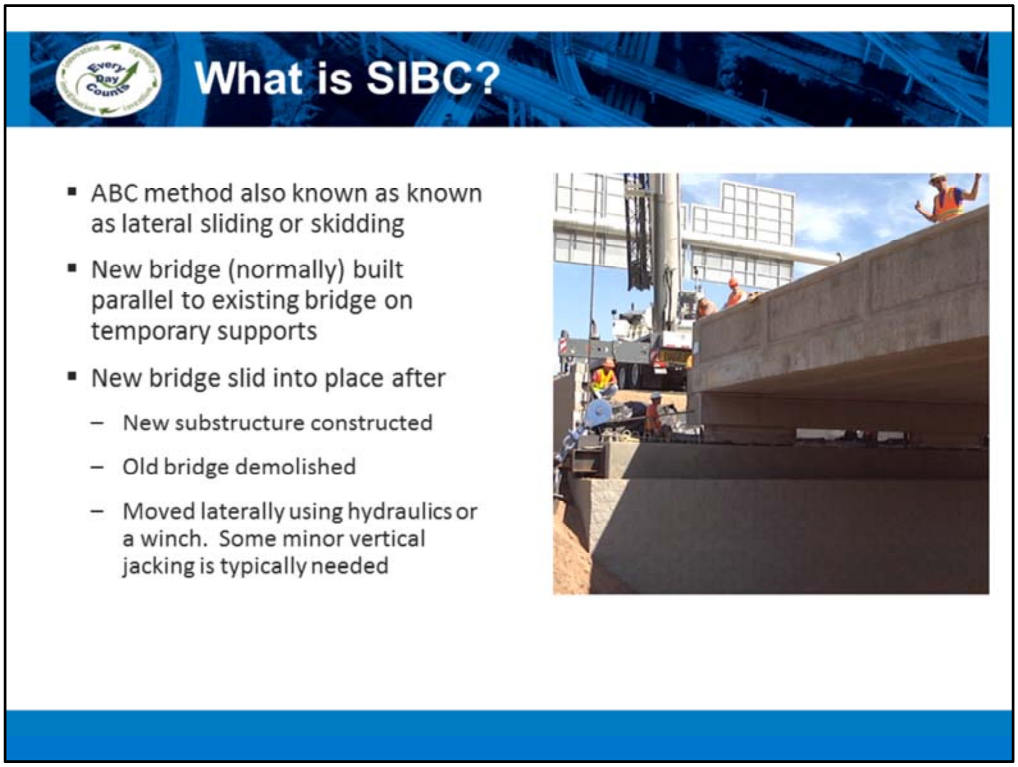
SIBC will be defined and its benefits will be discussed.

Several ABC and SIBC decision making tools are presented along with the various delivery methods that can be employed.

Planning and designing for SIBC, planned contract submittals, and temporary works will be covered.

Given that SIBC is a relatively new and innovative method of bridge construction, it is not uncommon for the media and public to have a more involved roll, even as spectators. As such, relations with the media and public will be addressed.

Lastly, six case studies of previous SIBC projects will be presented.



So, what is slide-in bridge construction?

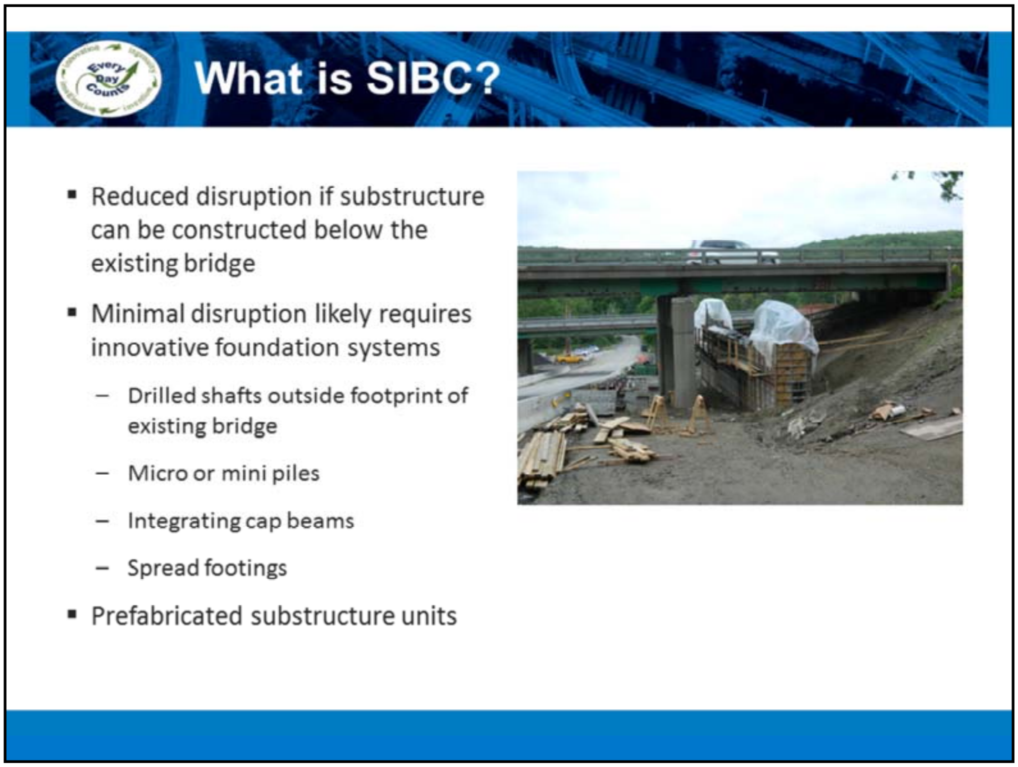
It is a method of ABC that has also been known as lateral sliding or skidding, and the variations of these techniques.

In SIBC, a new bridge is typically constructed adjacent to and parallel to the existing bridge on temporary supports.

Once complete, the old structure is demolished and the new substructure is constructed, followed by the sliding of the new superstructure on to the new substructure already in place. There have been some cases where the old substructure was reused.

The new bridge is moved laterally most commonly with hydraulic jacks, though other methods have been employed, such as a winch. Some minor vertical jacking is typically needed.

SIBC, and ABC in general, is primarily used for bridge replacement projects where the impacts to mobility are significant.



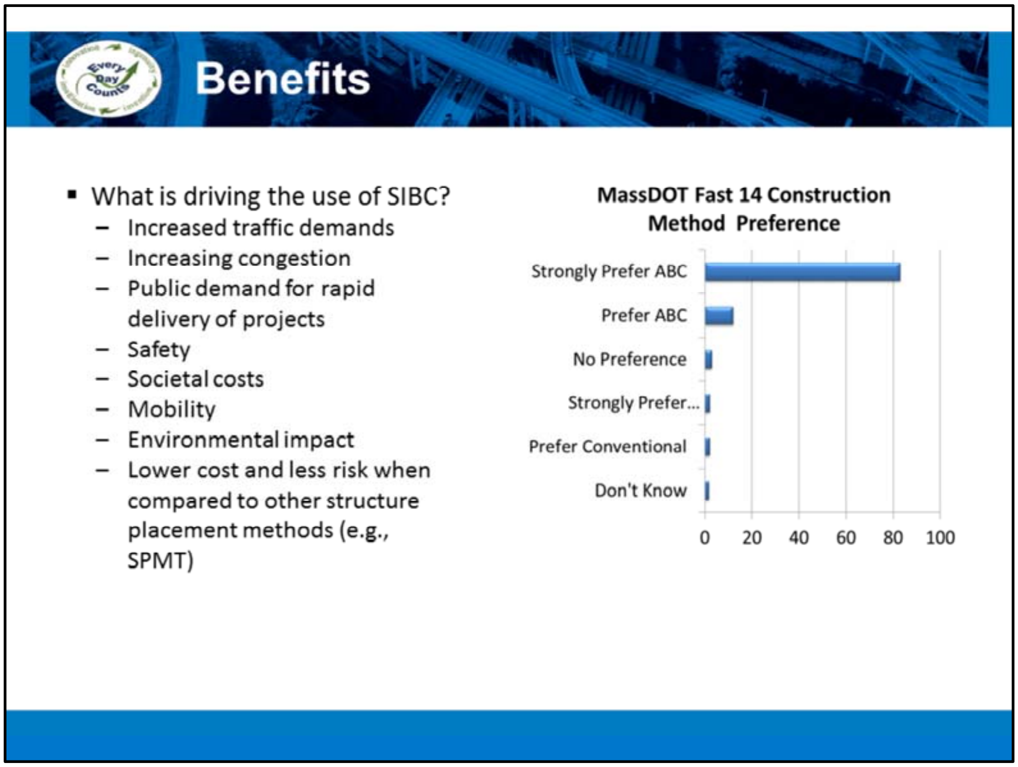
There have been many cases where the new substructure was constructed beneath the existing bridge prior to demolition. As you can predict, this expedites the process from demolition to bridge slide.

It should be pointed out, however, that constructing traditional foundation systems might not be feasible. Rather, an innovative foundation system might be required when using this method.

It is possible that prefabricated elements could play a key role in constructing the new substructure.

One might believe that bridge slides are only used for sliding a new bridge into the position of the existing. This is most commonly the case, but SIBC is not limited to only sliding new structures.

Existing structures can be slid to a new alignment to serve as a bypass bridge while a new bridge is constructed using more traditional methods. Keep in mind that in this case, the temporary substructure system will be subjected to live and other transient loads in addition to the bridge itself, typically resulting in a more robust, and hence higher cost, to such an installation.



So, what benefits can be gained by using slide-in bridge construction? Maybe the better question is 'What is driving the use of SIBC and how is it that SIBC addresses those needs?'

Traffic demands are increasing, congestion is increasing – both create an unnecessary nuisance in the lives of the traveling public. As such, the public demand for rapid delivery is increasing.

One can see in this chart the overwhelming preference for accelerated bridge construction when polled in Massachusetts prior to the MassDOT Fast 14 project.

Even more, the safety of the traveling public and bridge builders is compromised when bridge projects are long in duration. SIBC alleviates some of this risk by significantly reducing the time main-line traffic is interrupted.

Societal costs, though often difficult to fully quantify, are significantly reduced as well.

Environmental impacts can be softened.

And lastly, the costs can be lower and at less risk when compared to other rapid structure placement methods, such as self-propelled modular transporters, float in delivery, or a heavy crane pick, for example.

To continue with the benefits of using SIBC: non-traditional site options can be offered, cross-overs or shoo-flies are eliminated along with staged construction and long term detours. These things can result in lower construction costs.

When compared to other ABC methods, SIBC often receives better contractor “buy-in”, presumably because of the reduced risk that was previously mentioned.

Mobility and environmental impacts can also be reduced and safety is nearly always enhanced for the worker and road user.

Potentially of greatest significance is that SIBC promotes user and worker safety. Safety is nearly always enhanced for the worker and road user; this can not be understated.

When compared to other ABC methods, SIBC often receives better contractor "buy-in", presumably because of the reduced risk that was previously mentioned.

Environmental impacts can also be reduced.

Benefits

- Removes bridge construction from critical path
  - May lead to better quality end product
- Involves public in reducing societal costs
  - Results in greater "buy-in" in the overall project
- Road closures better managed
  - Dates and duration are more predictable

Lastly, SIBC removes the bridge construction from the critical path which may lead to a better quality end product, it involves the public by reducing societal costs, thereby creating better "buy-in", and road closures can be better managed.

Along the way, we'll take a minute to quickly highlight a project to emphasize a couple of points. The first project highlighted is I-84 at Dingle Ridge Road in New York.

A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

Though the benefits are great, one must be aware that some potential challenges exist.

While some personnel within the DOTs embrace innovative methods, others are more resistant and tend to lean on traditional construction methods. This resistance can stall a potential SIBC project.

Finding experienced contractors and/or heavy lift engineers can be a challenge, though that challenge is being lessened as more and more SIBC projects are being completed and contractors become more familiar with the process.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

In traditional construction projects it is common that unique bridge geometry, difficult foundations, or lack of space can present a challenge. These aspects are only magnified by the nature of SIBC.

A sound traffic management plan with contingency plan included is a must.

This method of bridge construction is relatively new, and as a result, there may be some contractor limitations.

For example, significant temporary shoring and unconventional schedules are often required.

During slide operations, a 24 hour commitment from the contractor, designer, and owner is necessary.

There are periods during the overall SIBC process that require extended time for the contractor, owner, and designer and, as a result, worker fatigue be an issue if not properly managed. Multiple crews can help alleviate this potential problem.

Even more, difficult foundations, equipment breakdowns, and the speed required to complete approach work can present a challenge.

Also, significant, critical time can be lost to surveying mistakes.

And given that many SIBC projects are high profile, public interest is high which draws spectators to the job site creating a potential crowd control issue not familiar to typical construction. The method will require some short term full road closure with a public commitment to meet those dates well in advance, leading to schedule pressure on construction.

To highlight another project, the Elk Creek project in Oregon was faced with numerous challenges that could be considered somewhat unique to this project. For example, the site, located in the mountains of western Oregon, did not afford ample space or flat terrain from which a new bridge could be easily constructed and slid into place. Nonetheless, the successful completion of this project using slide in construction proved that slides can be effective even in very confined locations.

Factors of Interest

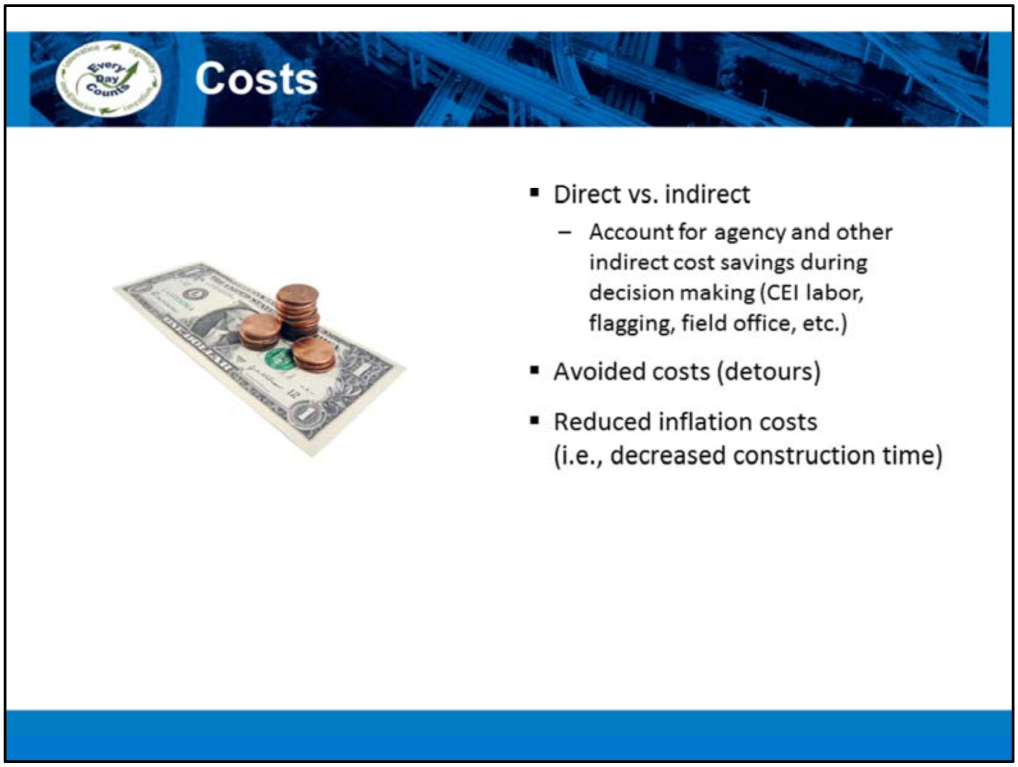
- ADT/ADTT
- Facility crossed
  - Railroad/roadway
  - Navigable waterway
  - Evacuation route
- Detour length
  - Duration and viability
- Environmental
  - Limits on when
  - Limits on how

Some factors of interest to consider when making an initial decision for or against SIBC include: average daily traffic, the facility that is being crossed (railroad, roadway, other?), the detour length (duration and viability), and environmental effects (limits on when and how).

Factors of Interest

- On critical path of entire project
- Available right of way for bridge construction
- Traffic analysis
- Contractor's work area and ingress/egress ability

Is the bridge on the critical path of the entire project?, is there available right-of-way?, should traffic analysts be engaged?, where will the contractor's workspace, entrances, and exits be located?.



If comparing only the costs of building a bridge using traditional methods and slide-in bridge construction, it is possible, and maybe even likely with the first projects, that SIBC costs will be higher.

It has been found, however, that the costs become more aligned when including other project related costs such as direct versus indirect costs and detour costs. These costs are often not included in the bid; therefore it is not appropriate to compare conventional construction costs with ABC costs.

Project planners should evaluate the total construction cost when making decisions.

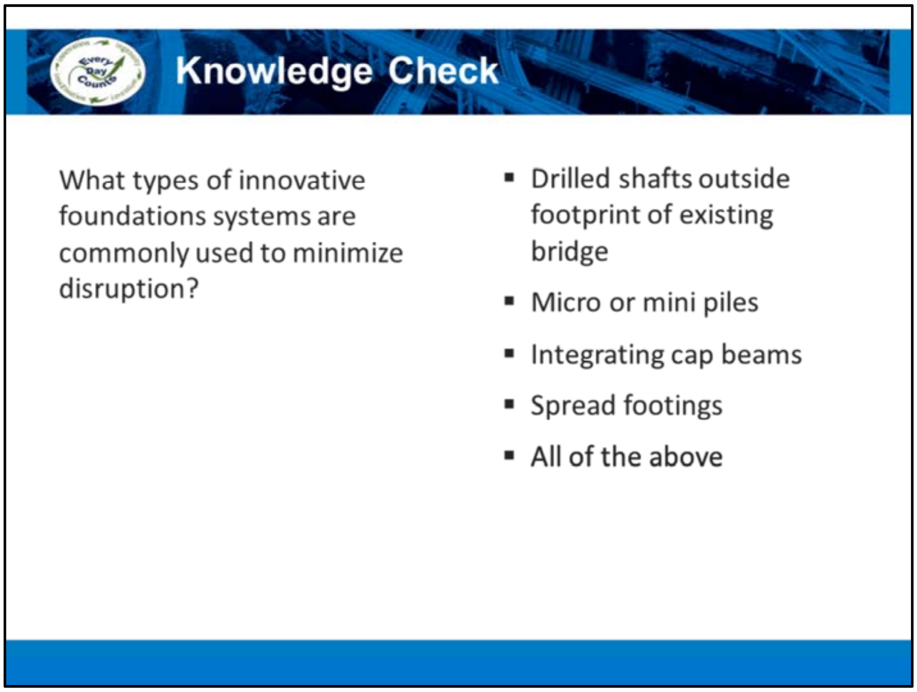
Even more, due to the decreased construction time, overall inflation costs can be reduced, specifically the risk of price escalation of steel and fuel can be minimized.

The next project highlighted is the Mesquite Interchange in the state of Nevada. The total interchange reconstruction cost was $15 million, $10 million less than the original $25 million estimate. A significant amount of the cost savings stemmed from the decision to slide each of the two bridges being replaced. Traditional construction would have required a complete realignment of the mainline pavement and interchange reconfiguration. Instead, the interchange was left in its original configuration and the bridges constructed adjunct to the existing.

To this point, SIBC has been defined, some benefits and challenges have been listed, and factors of interest shown. You'll now get an opportunity to check a bit of your knowledge.

In SIBC, the new bridge is constructed "blank" to the existing bridge on "blank" supports.

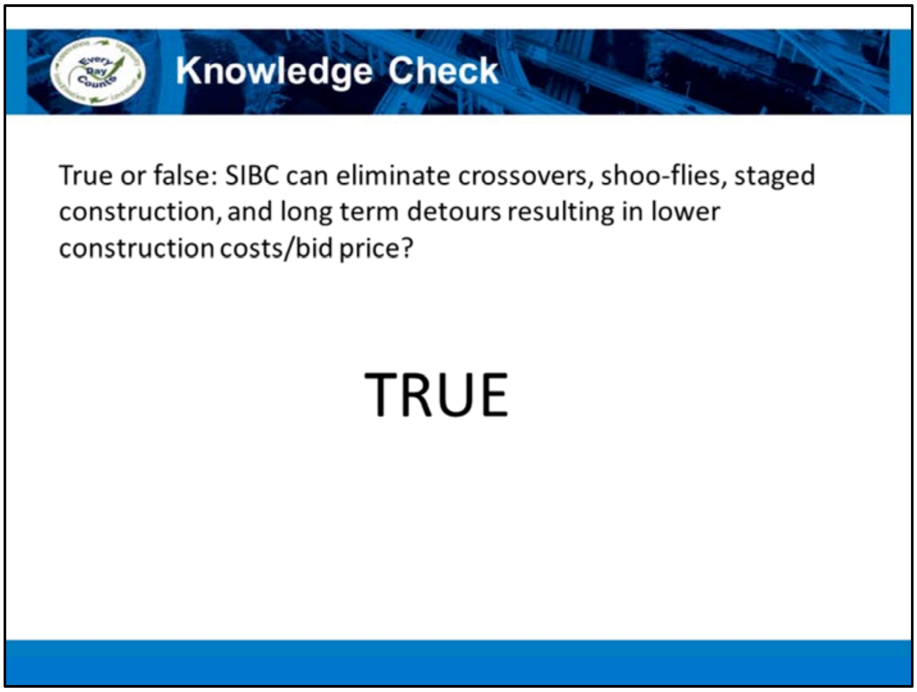
In SIBC, the new bridge is constructed "parallel" to the existing bridge on "temporary" supports.



What types of innovative foundations systems are commonly used to minimize disruption?

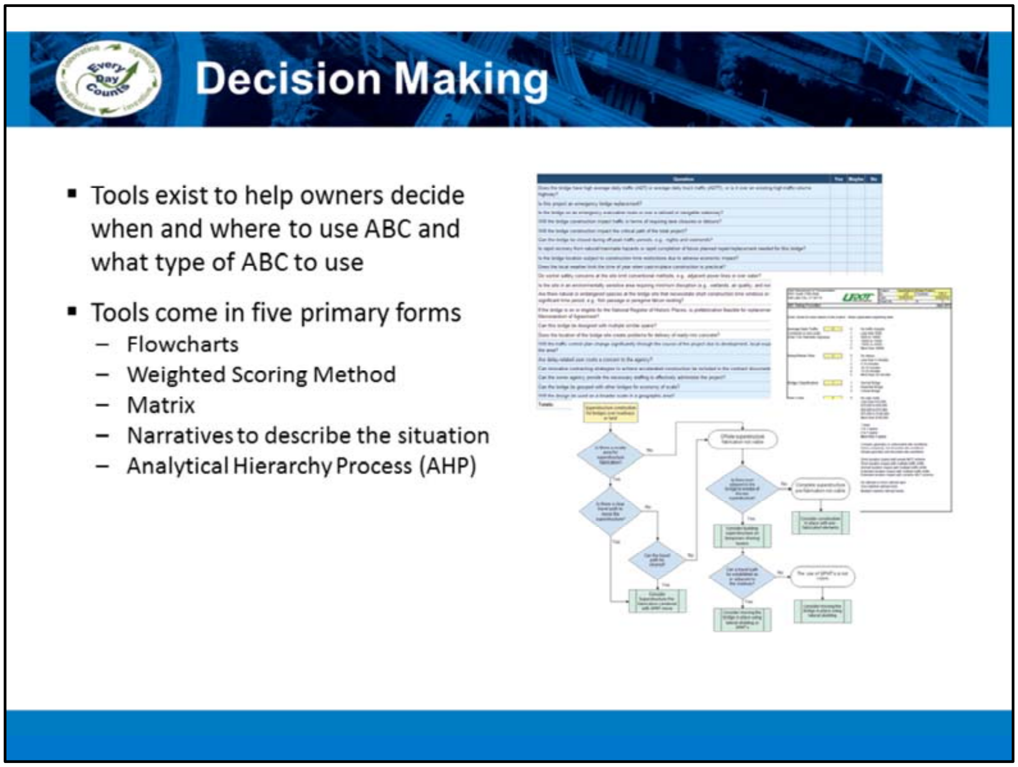
Drilled shafts outside footprint of existing bridge?
Micro or mini piles?
Integrating cap beams?
Spread footings?
Or
All of the above?

The answer: All of the above. Each of the options are commonly used to minimize disruption.



True or false: SIBC can eliminate crossovers, shoo-flies, staged construction, and long term detours resulting in lower construction costs/bid price?

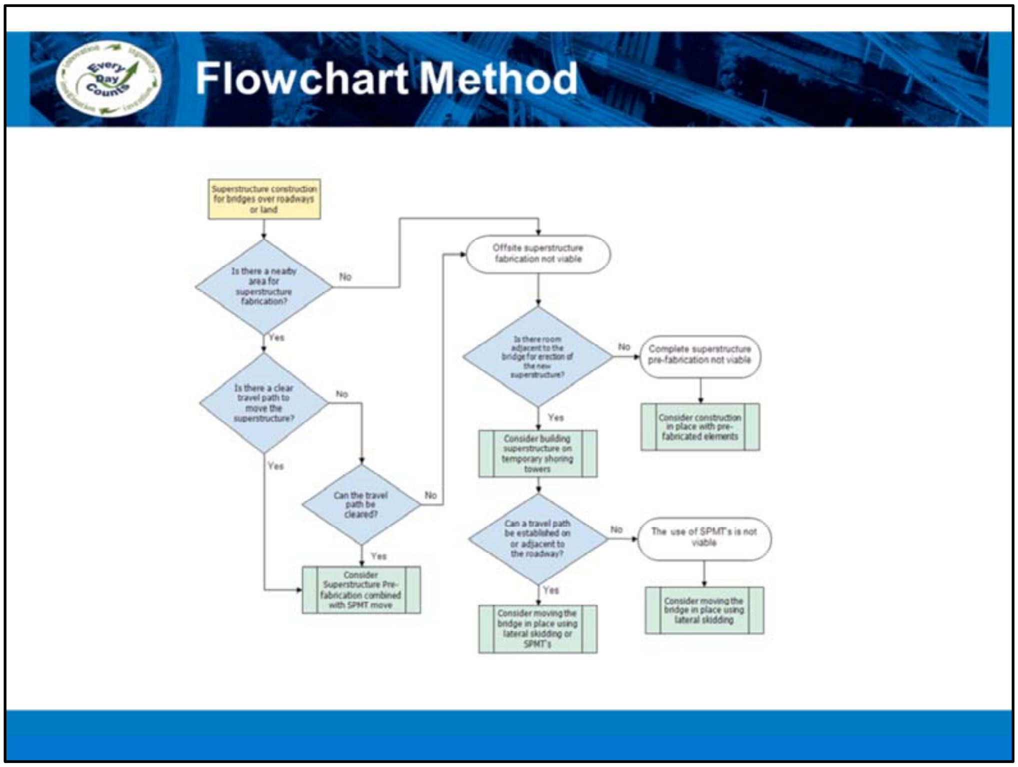
True



The decision to use non-traditional construction methods can be difficult so several tools have been developed that help owners decide when and where to use accelerated bridge construction and slide-in bridge construction methods.

These tools include the flowchart method, the matrix method, the weighted scoring method, the narrative method, and the analytical hierarchy process. The following slides will take a closer look at each of these methods.

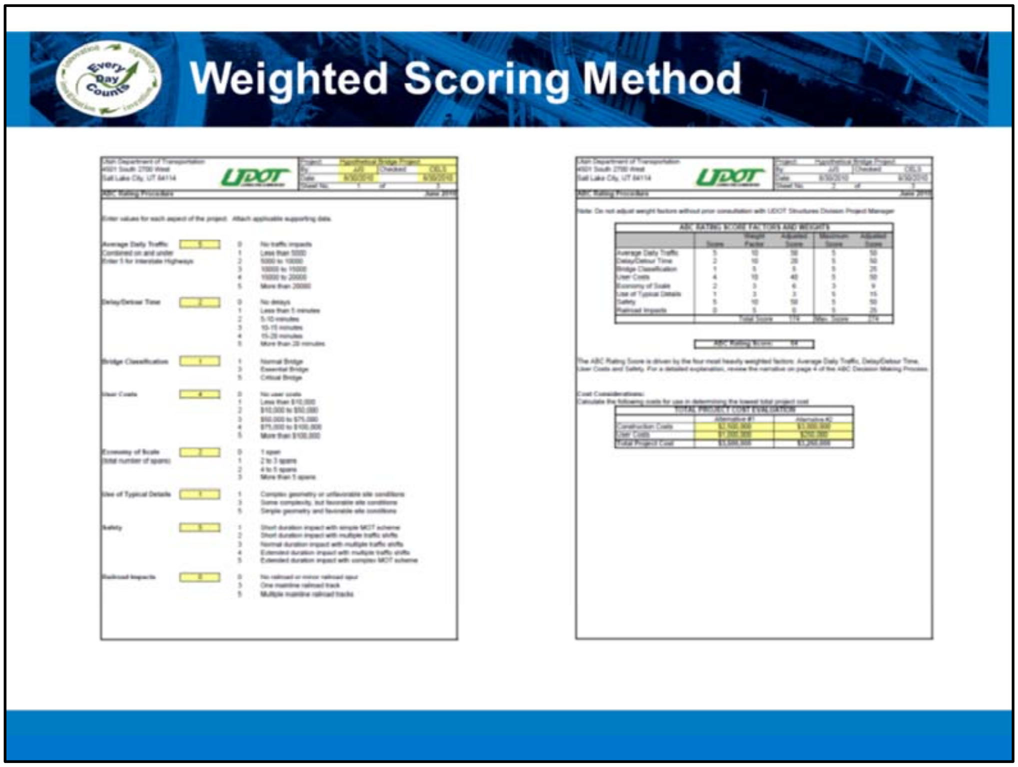
Regardless of the data, ultimately a firm commitment from all concerned to stay the course through is needed for a successful and economical project.



The flowchart method is composed of a diagram which represents a process.

Boxes of various kinds make up the steps in that process and help visualize the flow. Each box and its respective question prompt an answer from the user which leads to the next box and the process is repeated until a final box and prescribed answer are achieved.

An example from FHWA shown here helps prescribe various methods of accelerated bridge construction that are appropriate for a particular project site.

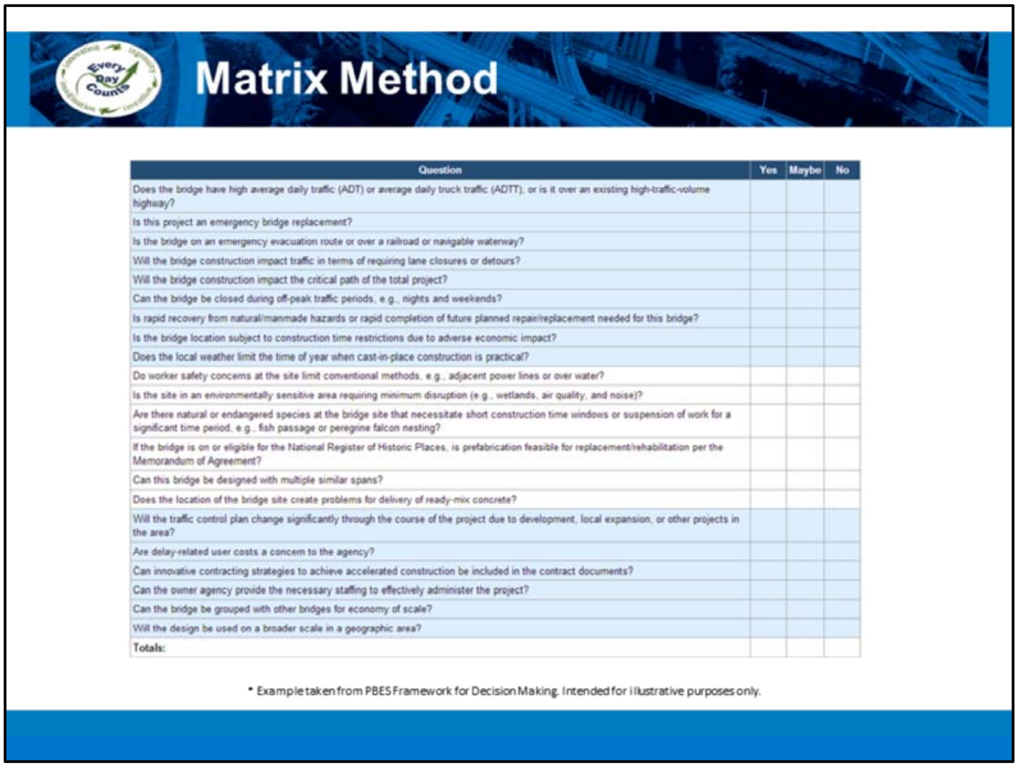


The weighted scoring method helps assign a value or score to what would otherwise only be a subjective decision.

By assigning values to various predetermined categories and then multiplying the value by its overall importance a final score can be calculated.

A score above or below a threshold previously set within the agency indicates whether ABC methods provide value.

For example, ADT or detour time might be weighted more heavily than economy of scale. A bridge with a high ADT would likely achieve a higher overall score than one with multiple spans.

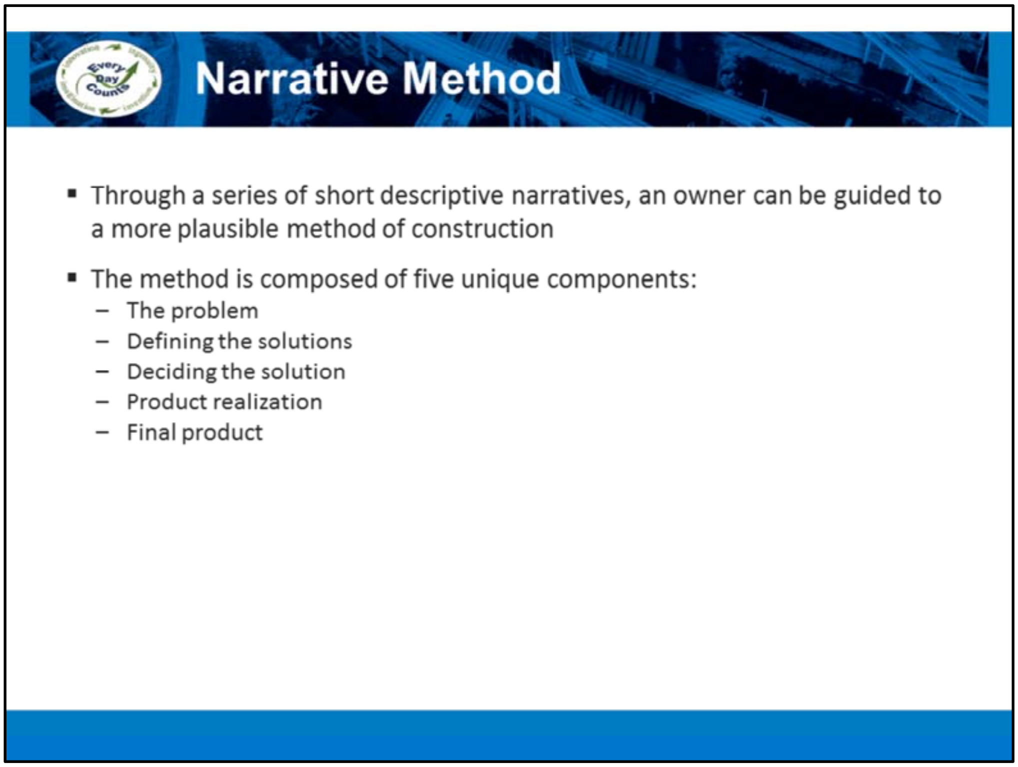


Matrix Method

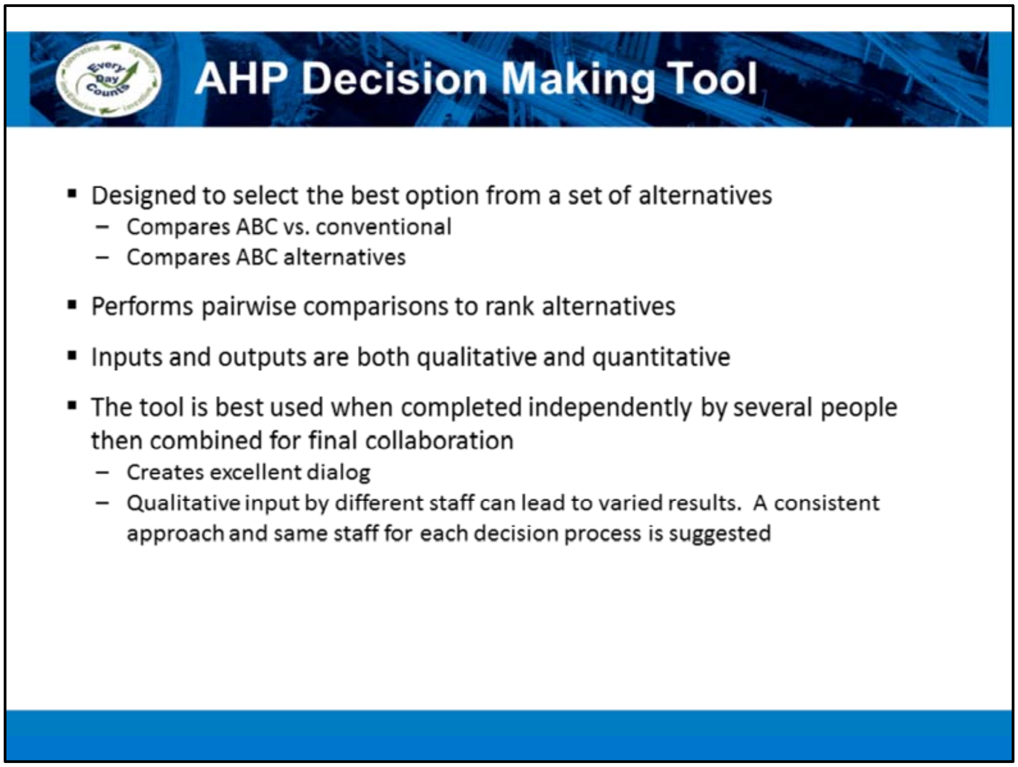
Question	Yes	Maybe	No
Does the bridge have high average daily traffic (ADT) or average daily truck traffic (ADTT), or is it over an existing high-traffic-volume highway?			
Is this project an emergency bridge replacement?			
Is the bridge on an emergency evacuation route or over a railroad or navigable 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:			

* Example taken from PBES Framework for Decision Making. Intended for illustrative purposes only.

The matrix method is composed of a series or questions to which a user simply responds with yes, no, or maybe. Questions cover multiple aspects of a project including such things as ADT, worker safety, weather, delay-related costs, and more. Totals for each answer are summed, and in cases where a majority of yes answers exist, the user is guided towards an ABC method.



The narrative method, similar to the matrix method, guides an owner to a more plausible method of construction using a series of short descriptive narratives.

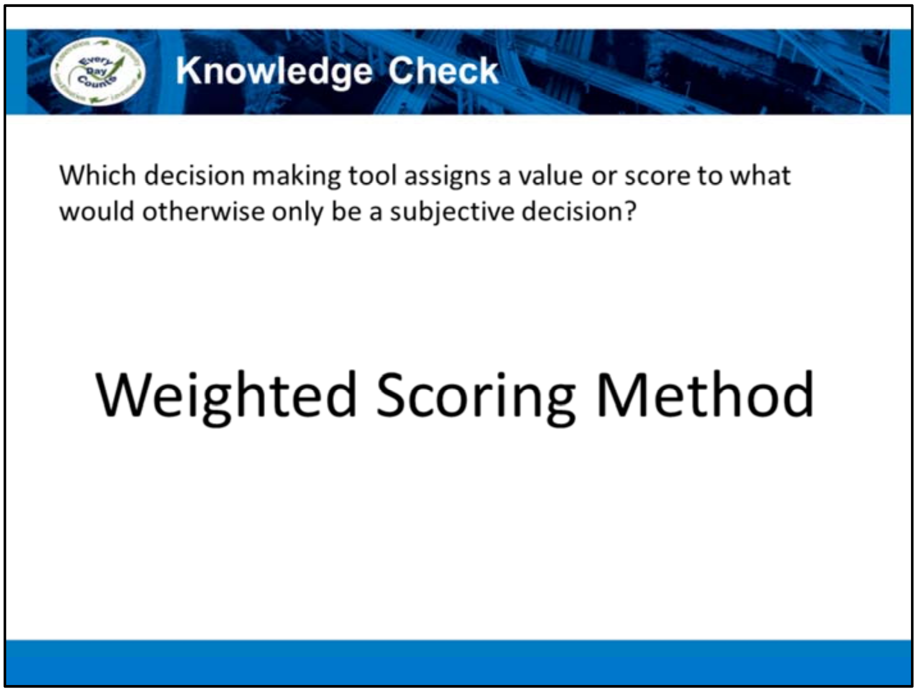


The analytical hierarchy process is designed to select the best option from a set of alternatives.

The user can compare ABC versus conventional methods, in addition to, specifically comparing ABC alternatives.

Pairwise comparisons are used to rank alternative methods. In this method, the inputs and outputs can be both qualitative and quantitative.

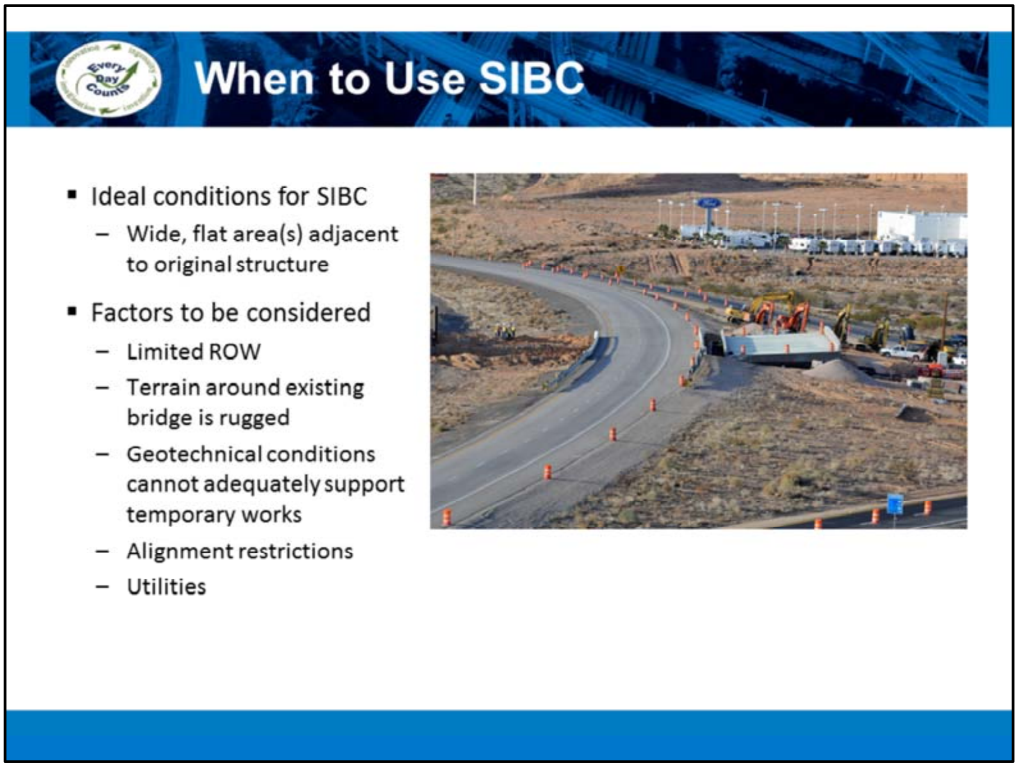
It has been found that the tool is best used when several people independently complete the process and then collaborate for a final decision. Even more, when those people are the same for multiple projects, a more consistent approach and process can be achieved.



The next knowledge check deals with decision making tools.

Which decision making tool assigns a value or score to what would otherwise only be a subjective decision?

The answer: Weighted Scoring Method



So, you might be asking yourself, ‘When should I consider using slide-in bridge construction’?

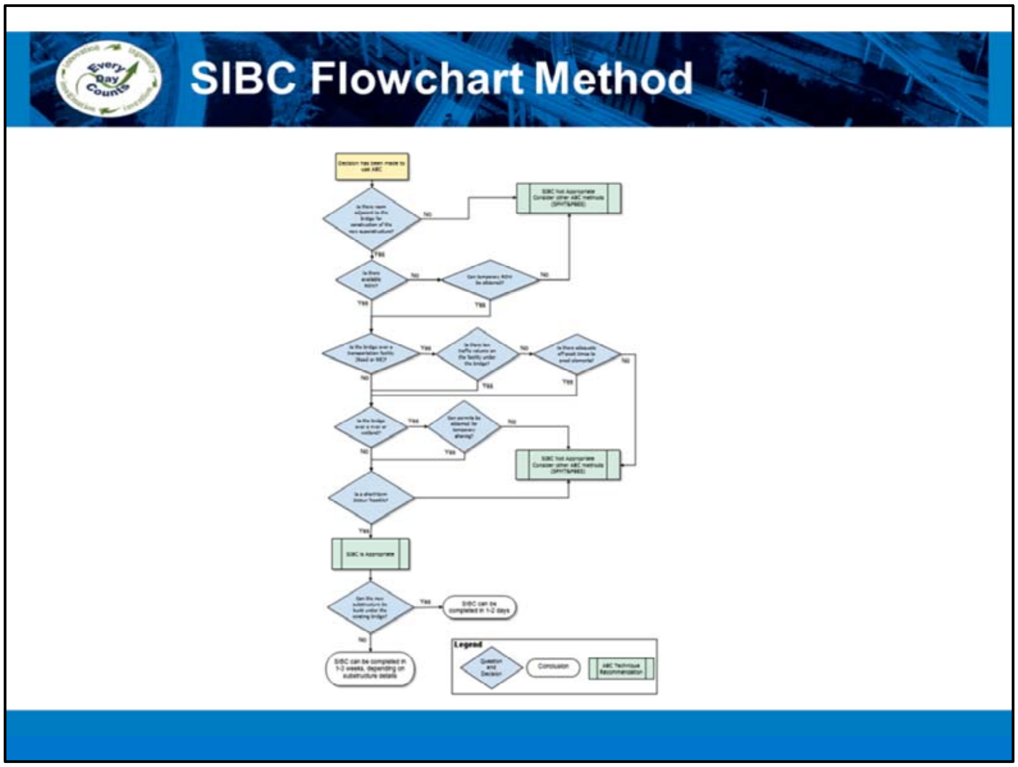
Ideally, sites with wide flat areas adjacent to the existing structure would be found at all bridge locations. But since this is rarely the case, one has to look beyond the ideal locations and consider other factors.

Factors such as, right-of-way, terrain, geotechnical conditions, and alignment restrictions. If right-of-way is limited, can temporary right-of-way be made available?

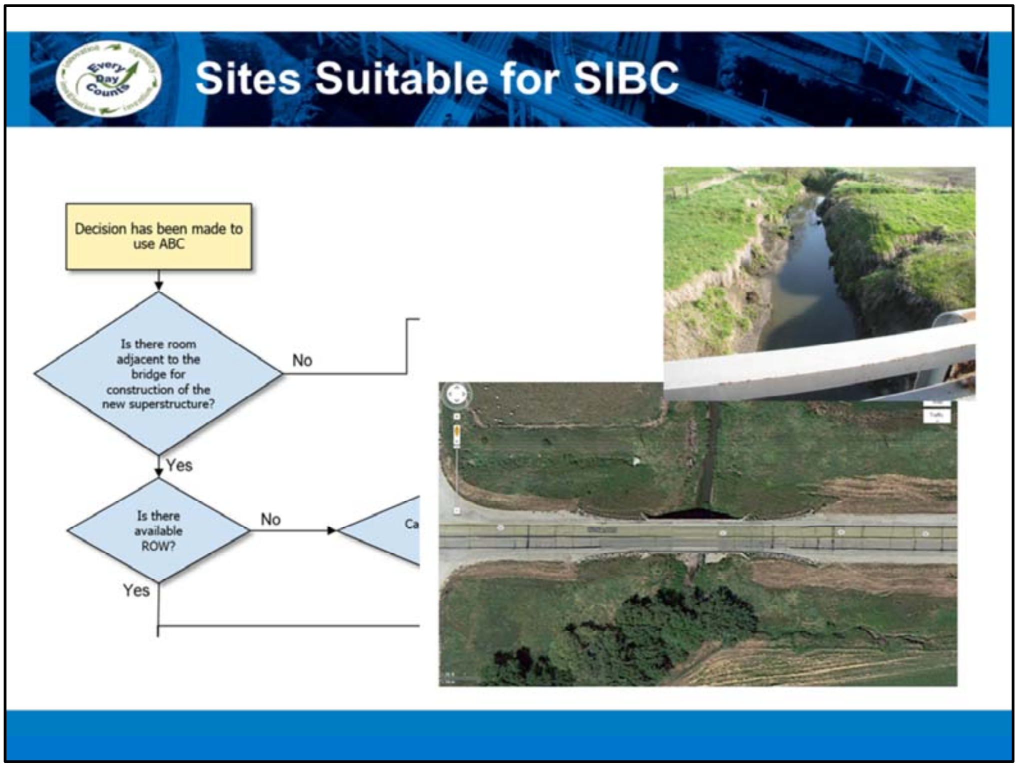
Rugged terrain doesn’t necessarily prohibit the use of SIBC, but does introduce another challenge.

Since temporary works will be significant and require supporting the entire superstructure, the adequacy of geotechnical conditions is key.

One should also consider alignment restrictions and utility locations.



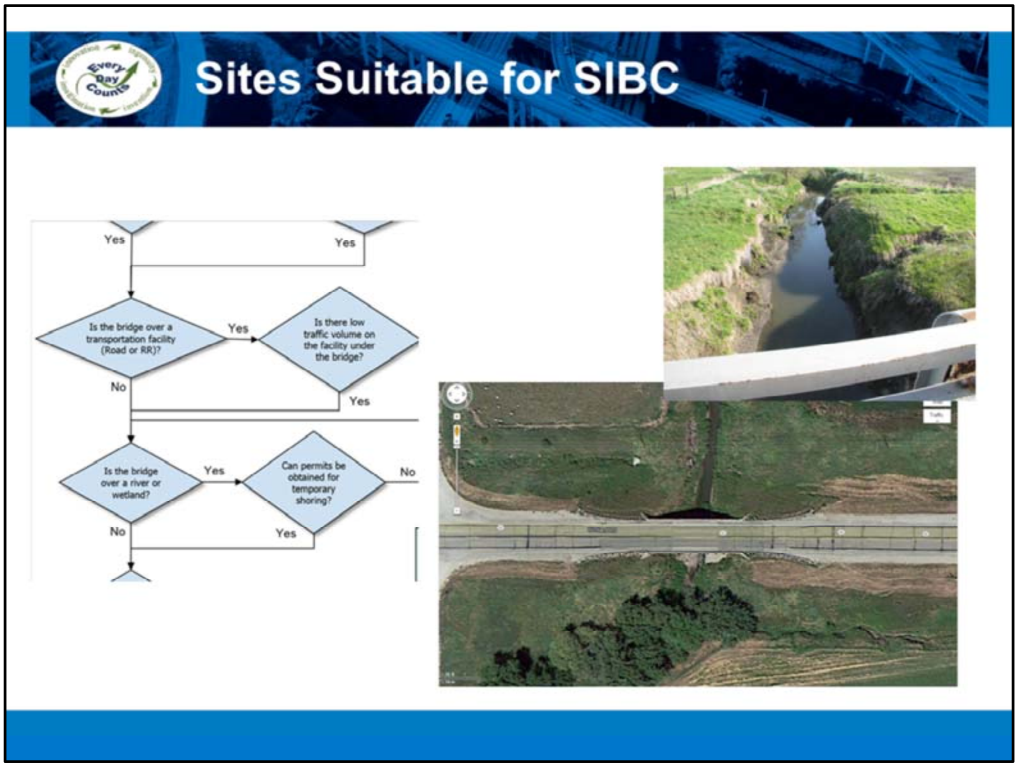
As an example, let's step through the flowchart method for SIBC and see out that plays out looking at different site conditions. We will be using one of the sites that will be discussed later in the case studies.



Two photos of the site are shown. As you can see, the bridge is in a rural location and it carries two lanes of traffic over a small stream. The decision has been made to use ABC.

Is there room adjacent to the bridge for construction of the new superstructure? There are no structures or facilities adjacent to the bridge, so the answer is yes.

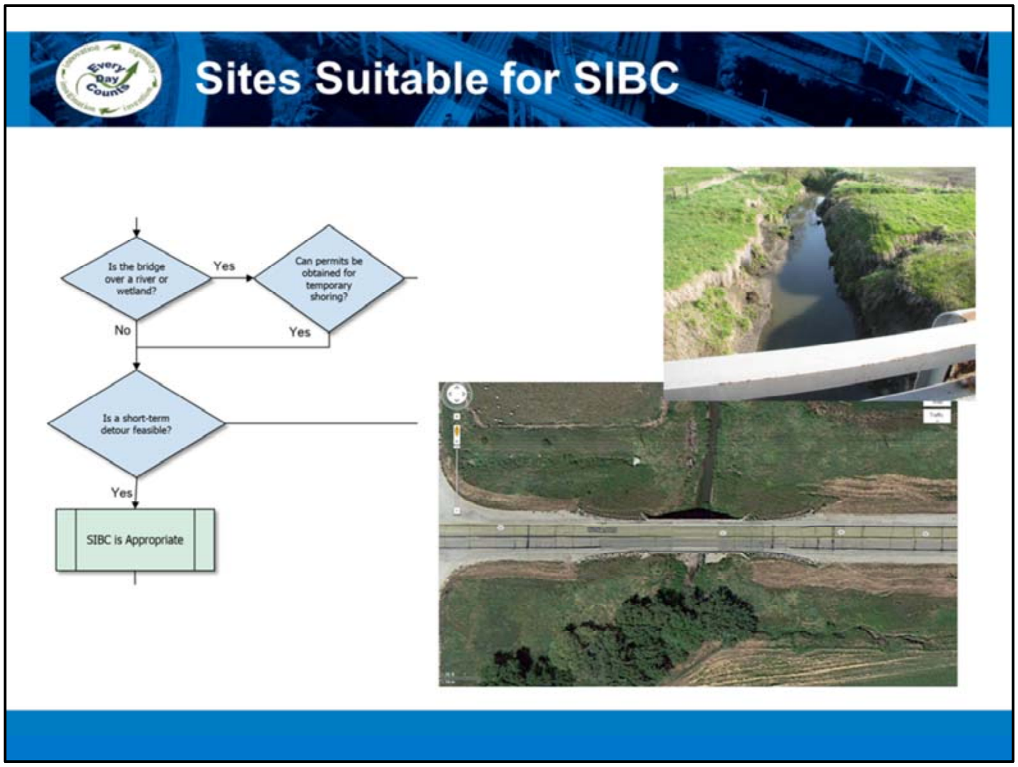
Is there available right of way? After checking the right-of-way mapping, the design team determined the answer to be yes.



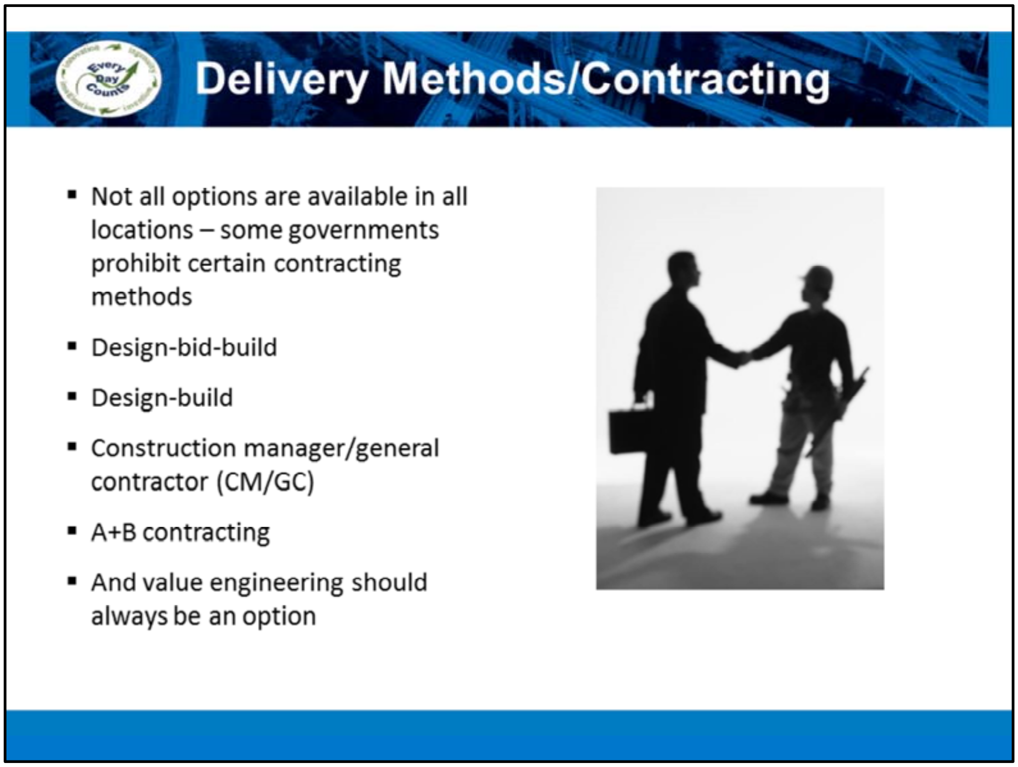
Is the bridge over a transportation facility? No.

Is the bridge over a wetland? Yes.

Can permits be obtained for temporary shoring? After a review with regulatory agencies, the design team determined that the answer to this question is yes.

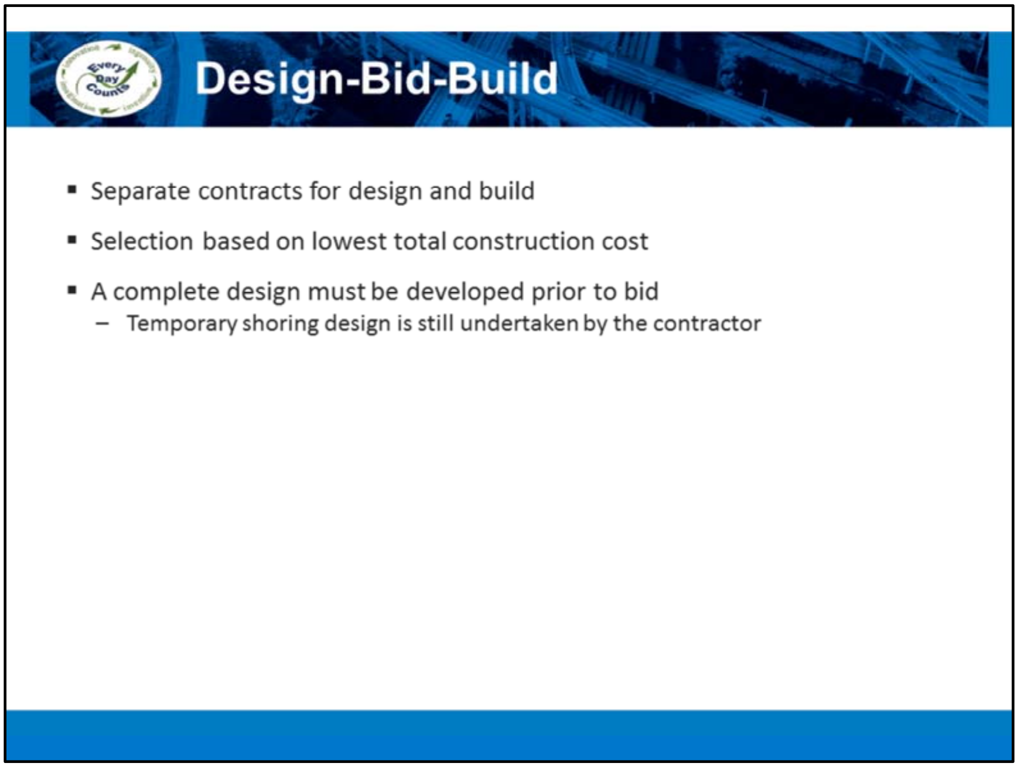


Is a short-term detour feasible? After conferring with traffic engineering personnel, the answer to this question was determined to be yes. Therefore, SIBC is appropriate. This is just one example of when SIBC might be appropriate.



It should be noted that not all options are available in all locations as some methods are prevented by existing state government laws or policies, but numerous delivery and contracting methods exist nationwide.

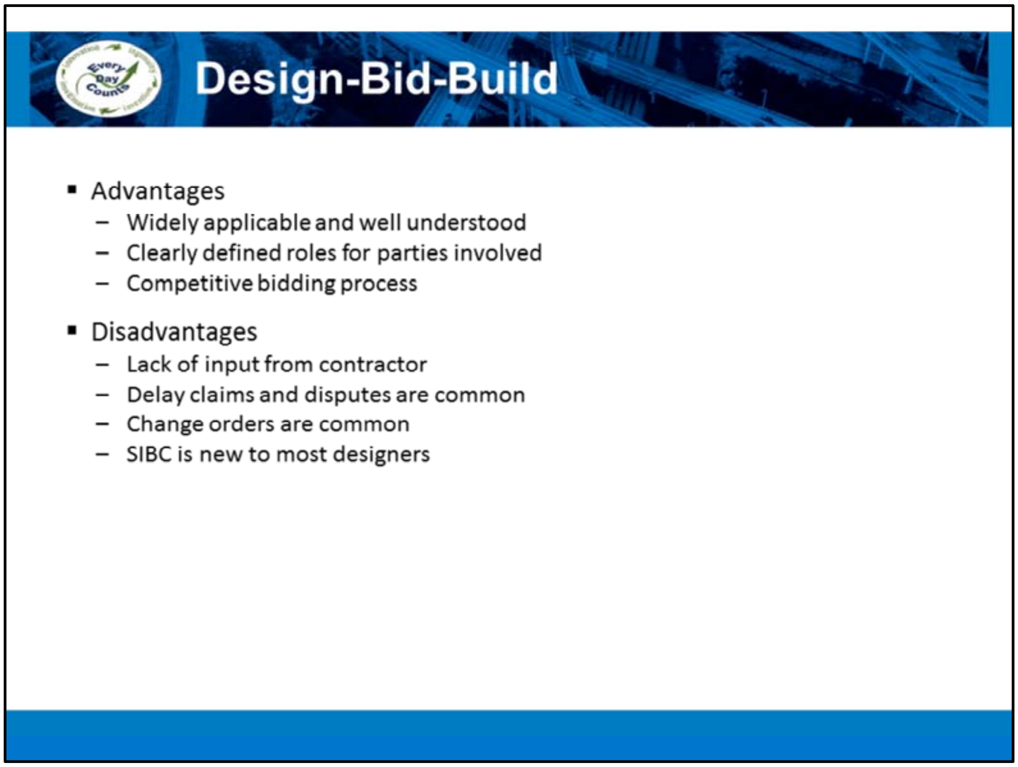
These include Design-Bid-Build, Design-Build, Construction Manager General Contractor, A+B contracting, and value engineering.



Design-bid-build has been the traditional method of contracting. Separate contracts are extended from the owner to the designer and builder, and the selection is based on the lowest-bid total construction cost.

For this method, a complete design must be developed prior to the bid process taking place.

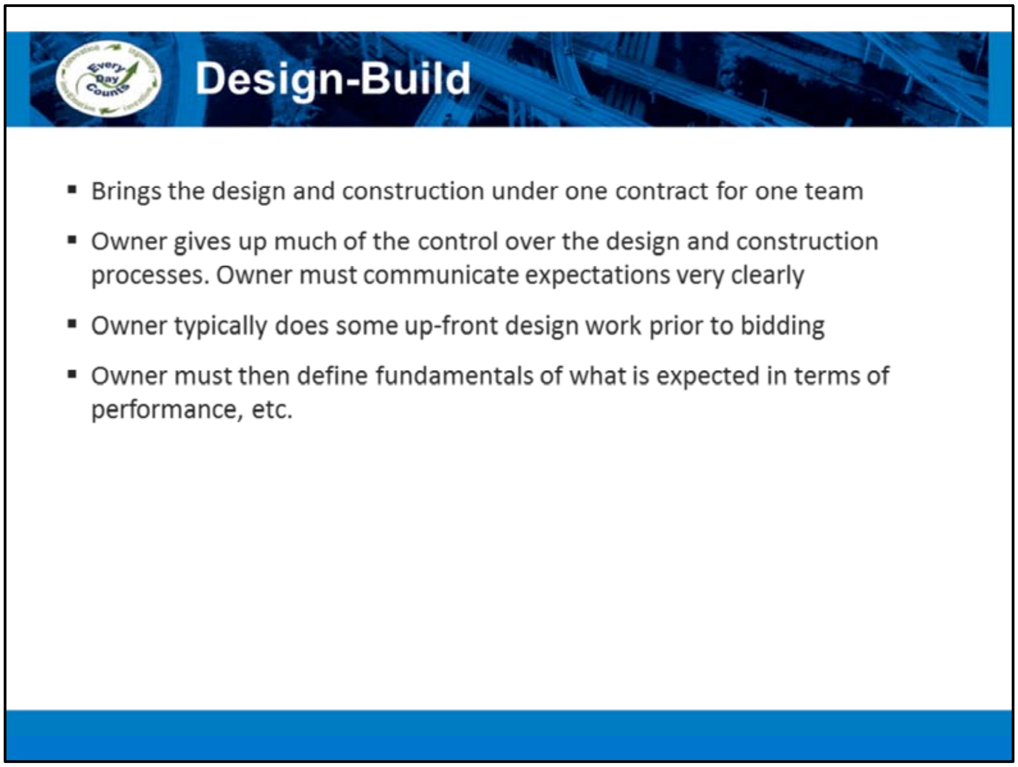
It should be noted that the designer is not responsible for the design of the temporary shoring system or the equipment used to move the bridge. The designer needs to show schematic drawings of the systems, and allow the contractor to develop the details of the move.



For SIBC, some advantages of design-bid-build are its wide applicability and well understanding, the rolls are clearly defined for all parties involved, and the bidding process is competitive. However, the method is disadvantaged for SIBC in other ways.

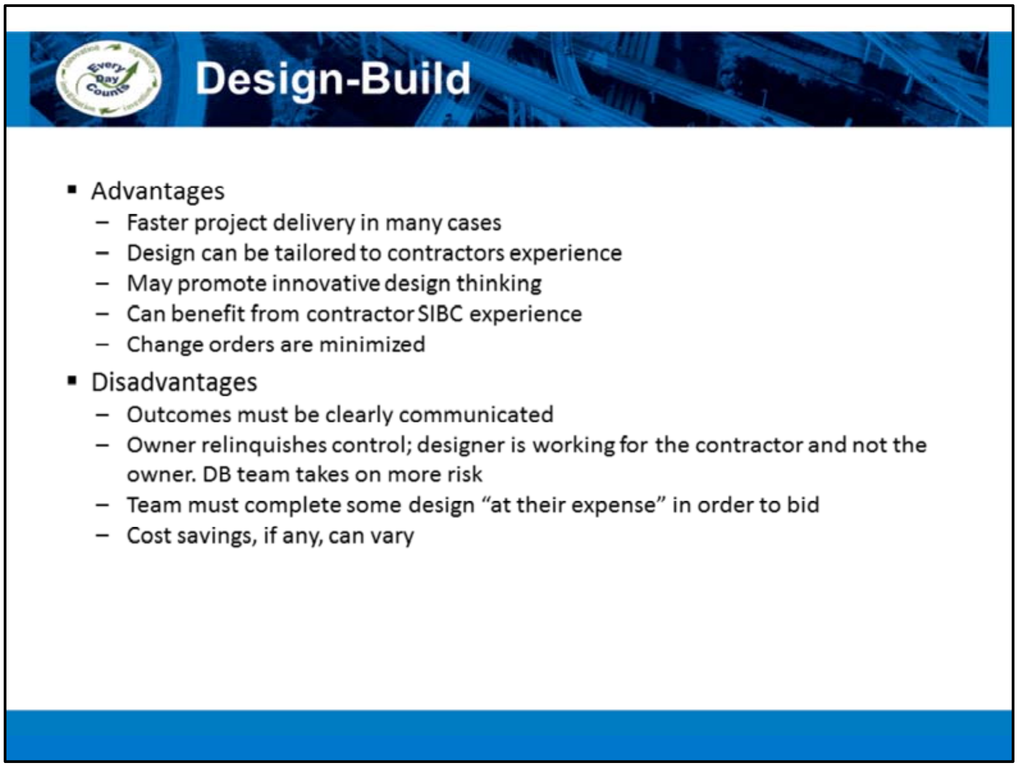
There is a lack of input from the contractor; delay claims, disputes, and change orders are all common.

Additionally, SIBC is new to most designers and blurs the line of means and methods of construction, typically the contractor's stock in trade.



Unlike the design-bid-build process, the design-build process brings the design and construction under one contract from the owner. In doing so, the owner gives up some control over the design and construction process and therefore must make expectations very clear.

It is not uncommon for the owner to do some preliminary design work prior to the design-build teams bidding on the project; through this exercise the owner must define performance expectations.



An inherent advantage to the design-build method is that a project can often be delivered more quickly than would otherwise be possible. The design can be tailored to the contractor's experience, tools, and equipment. Also, it may promote innovative design thinking.

As with design-bid-build, some disadvantages exist. Outcomes must be clearly communicated by the owner or else risk the project scope transforming to something unintended.

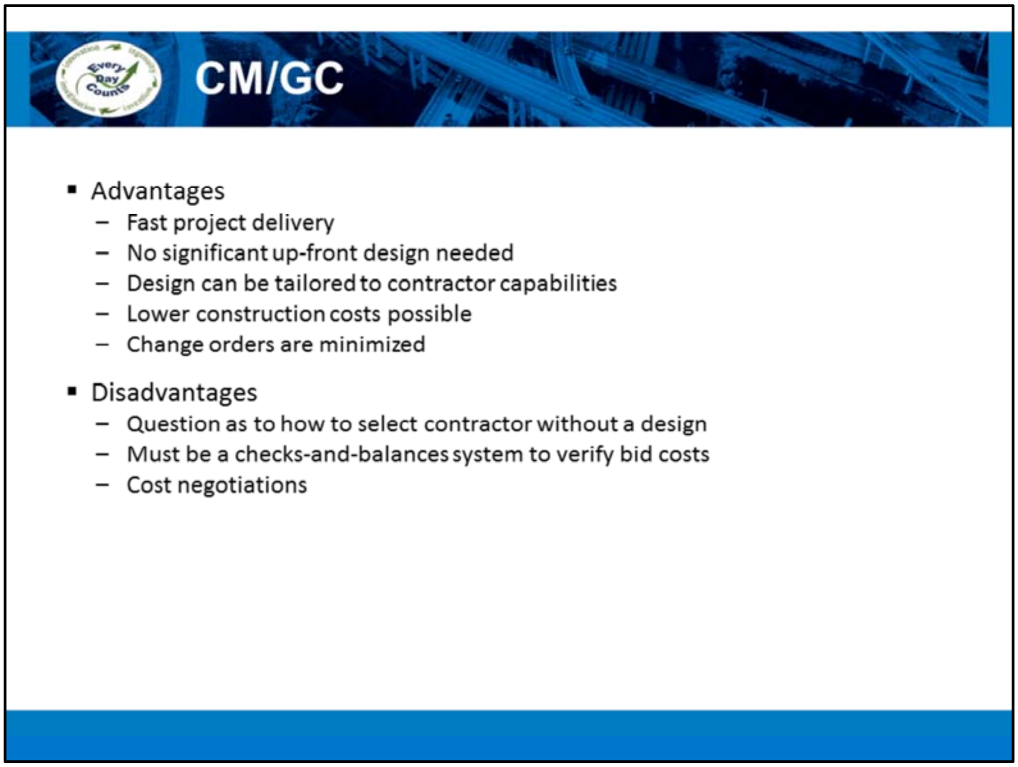
The owner is relinquishing control as the designer is working for the contractor not the owner with the potential that the final design will be influenced heavily by the required means and methods of installation. Prior to bidding, the design team must complete some design at their expense.

Lastly, cost savings, if any, can vary from project to project.

CM/GC, or Construction Manager/General Contractor, is not as commonly used as the previous methods of delivery but is gaining popularity with the bridge building industry.

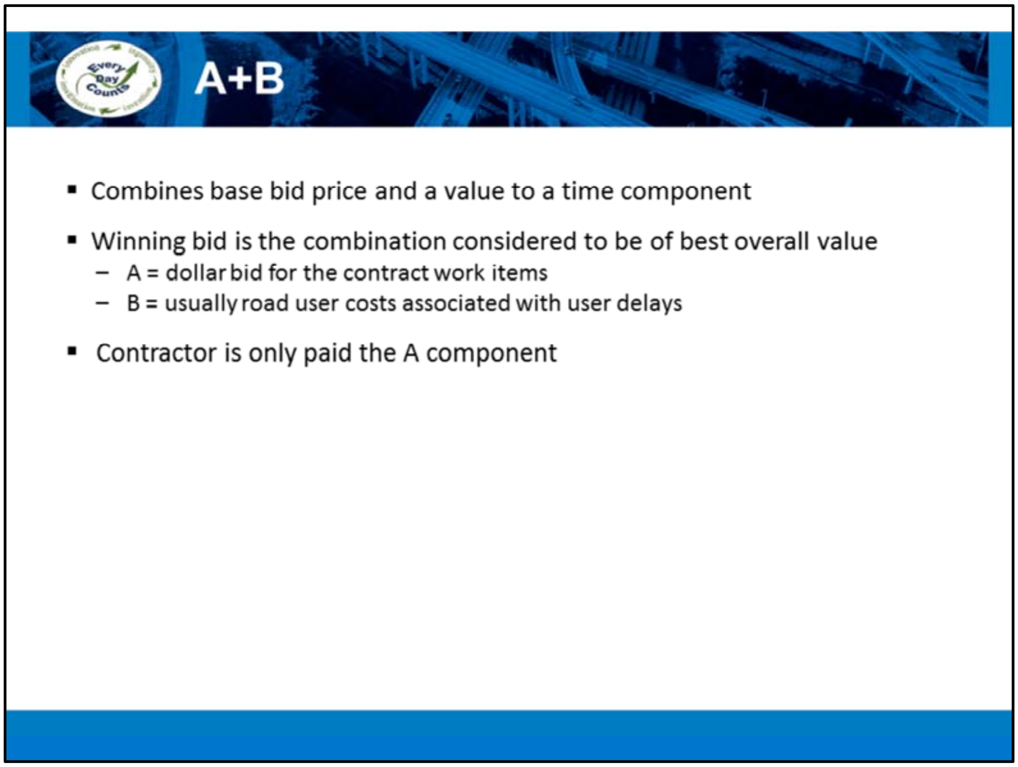
CM/GC is similar to design-build in that the contractor and designer work together. It differs, however, in that each has their own contract with the owner and the owner remains an integral part of the overall team. The designer and contractor are both independently selected by the owner.

As a construction manager, the contractor has the ability to provide significant input during the design process. In this way the designer can better accommodate the means and methods a contractor may use to erect the bridge and changes are minimized to the contract documents that could otherwise be necessary. As such, risks are better identified and managed. The transition from construction manager to general contractor is generally smoother on account of the aforementioned role of construction manager.



Some advantages to CM/GC include: fast project delivery, no significant up-front design needed, the design can be tailored to the contractor’s abilities, construction costs may be lower, and change orders are minimized.

Some disadvantages include how an owner selects a contractor without a design and that a checks-and-balance system is needed to verify bid costs.

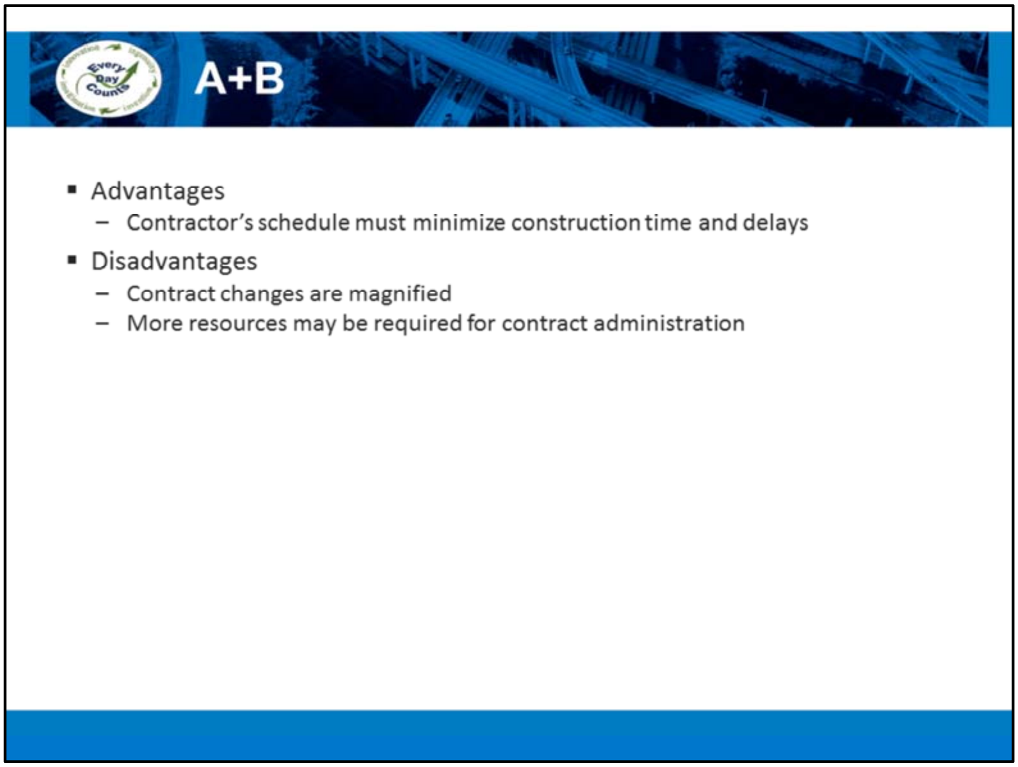


A + B bidding is most commonly a variation of design-bid-build.

Rather than low bid construction costs being the method by which a contractor is selected, two components, contract work items and road user costs, are quantified and summed to compose a bid price. The contractor with the low bid of the summed total is awarded the contract.

In the actual contract, the contractor will only be reimbursed for unit items – A – and the time allowed to complete the project is set at the bidders time component – B.

Here an emphasis is placed on how the project affects the public, not just the lowest construction cost.

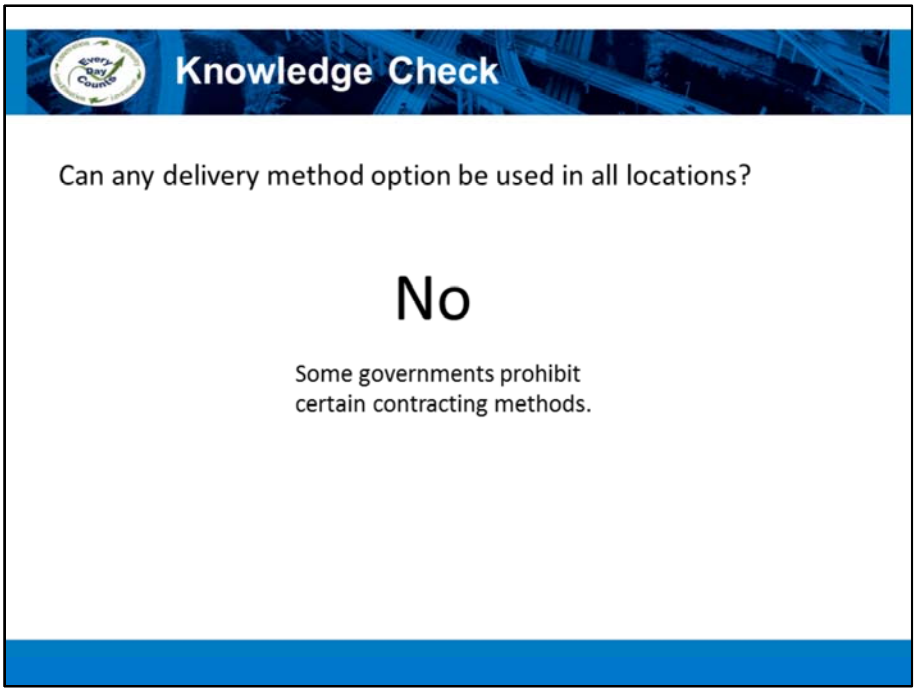


An advantage to A + B bidding is the contractor's schedule must minimize construction time and delays. Unfortunately some disadvantages are contract changes are magnified and more resources may be required for contract administration.

Two projects successfully completed using design-build contracting methods are the Elk Creek project in Oregon and the Mesquite Interchange project in Nevada.

The Mesquite Interchange team proposed slide in methods and were able to save 6 months and $10 million.

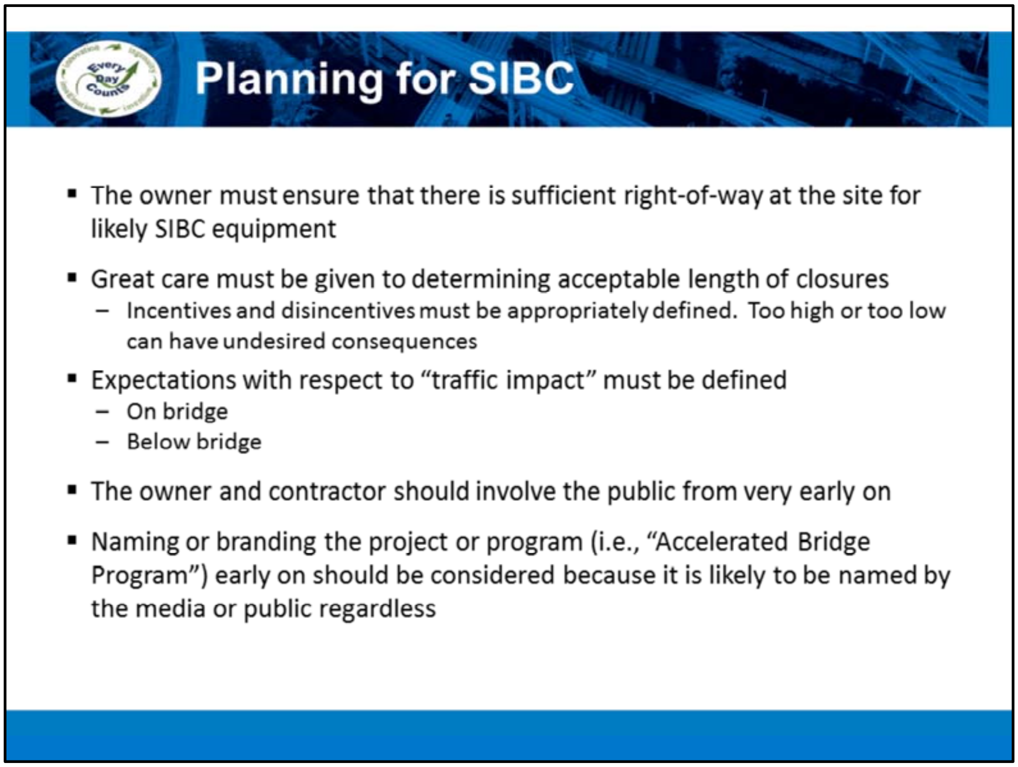
The Elk Creek design-build team was first to propose slide in methods and, in doing so, saved 22 months and $3 million.



The next knowledge check looks at delivery methods.

Can any delivery method option be used in all locations?

Answer: No, some governments prohibit certain contracting methods.

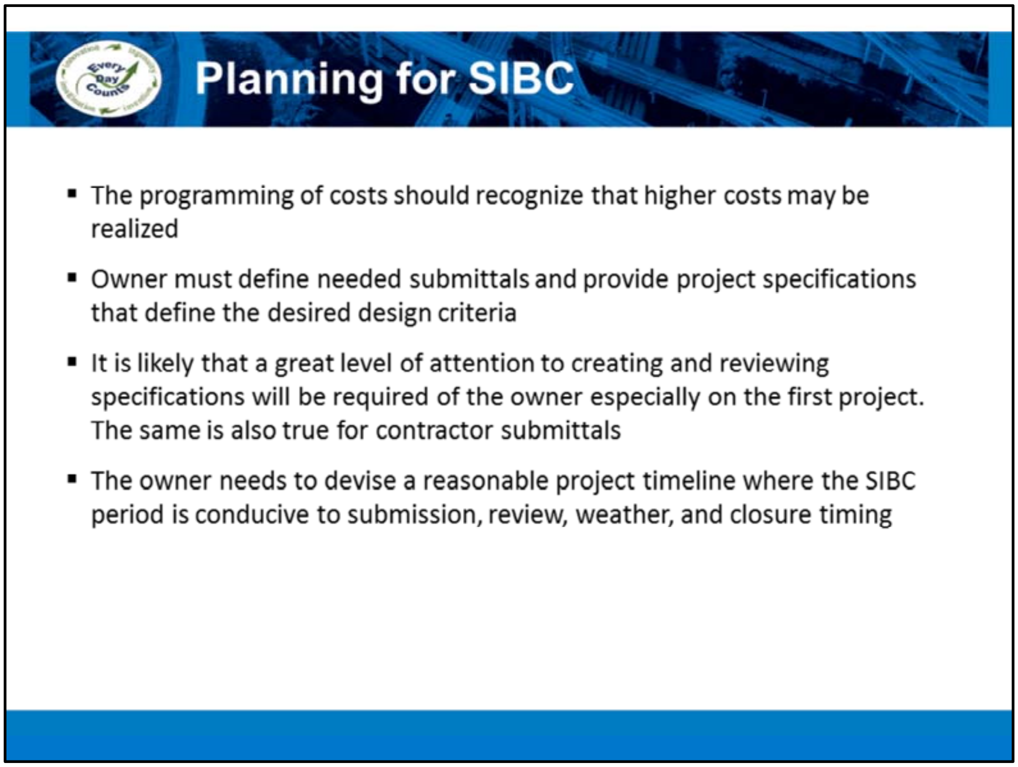


Planning for slide-in bridge construction generally follows that of traditional construction, yet there are some other unique items one must also plan for.

For example, the owner must ensure that there is sufficient right-of-way at the site for likely SIBC equipment and cranes for erection of beams, and it might be more space than anticipated.

A comprehensive study of an acceptable length of closure must be completed to appropriately assign incentives or disincentives. The owner must define the expectations to traffic impact, whether that be on the bridge or below the bridge.

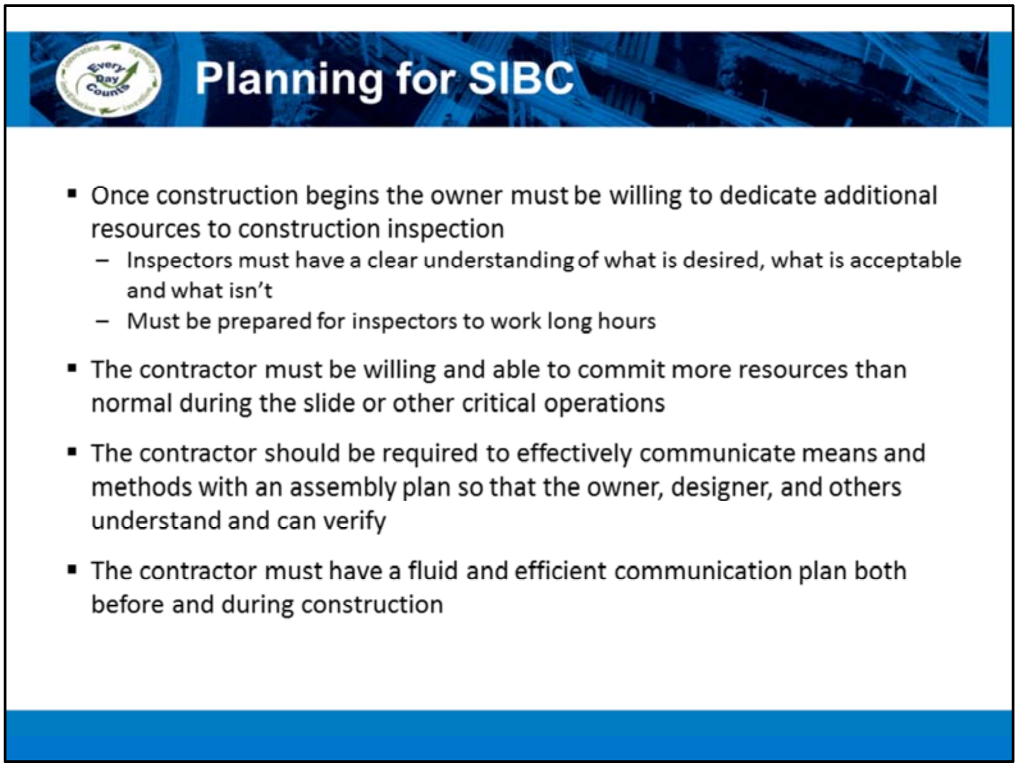
The owner and/or contractor should involve the public from very early on to communicate the intent and expectation for using SIBC. Given that SIBC is an innovative method for bridge construction, it is likely to draw the attention from the public and media. For this reason, naming or branding the project or program should be considered since it will undoubtedly be named by someone.



Higher overall costs, especially for initial SIBC projects, may be realized and should be addressed when programming.

Additionally, the owner must define any needed submittals and provide project specifications that define the desired design criteria.

It should come as no surprise that creating and reviewing specifications and submittals will require more attention, especially on the first project. Accordingly, the owner should devise a reasonable timeline to accommodate the added attention and so that weather and closure times can be best mitigated.



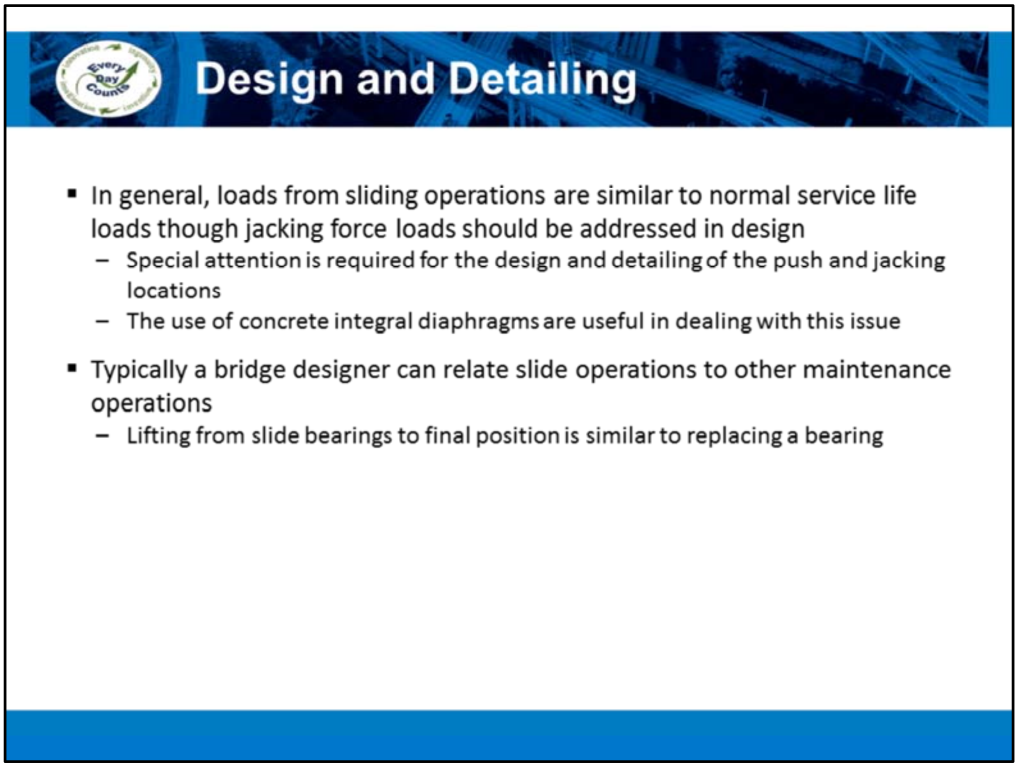
It should be expected that once construction begins, additional owner resources will be required in the form of construction inspectors.

Ensuring inspectors have a clear understanding of what is acceptable will take additional time. Even more, inspectors may have to work longer hours. Given the time-sensitive nature of SIBC during slide operations, a contractor must be willing and able to commit more resources than normal.

Also, an assembly plan is critical so that the contractor can clearly communicate his means and methods. His overall ability to efficiently communicate both before and during construction will be key to success.

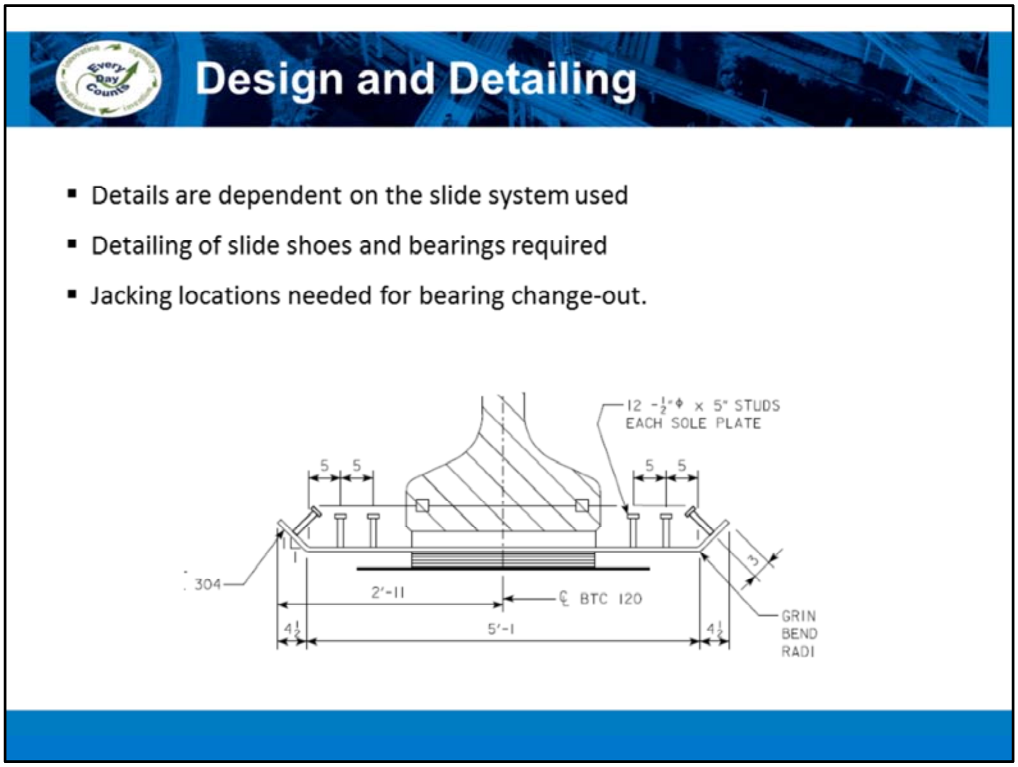
Lastly, the contractor must have a contingency plan that addresses these questions and others. What should happen during an emergency response, or equipment failure? What if an extended detour time is required and what if there is an accident on the detour? What happens if severe weather approaches?

Project specifications should include the minimum contingency scenarios. The specifications should also encourage the contractor to determine and plan for other contingency plans.

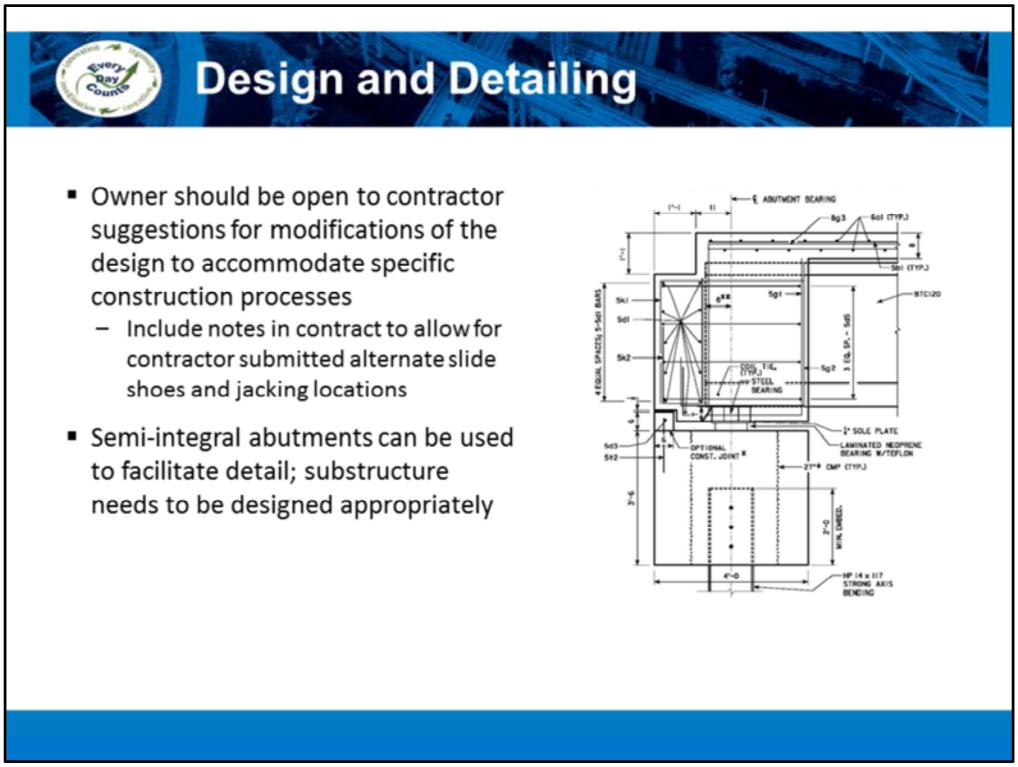


The design and detailing of a bridge slated for slide-in bridge construction is more similar than different from that of a traditionally constructed bridge. In general the loads during sliding operations are minimal and likely will not exceed loads typically seen during normal service life.

It is at the jacking locations that additional loads should be addressed. The use of concrete integral diaphragms are quite useful in dealing with this issue, an example of which is shown along with a slide plate in this detail. Forces can best be related to those seen in maintenance operations. For example, replacing a bearing.

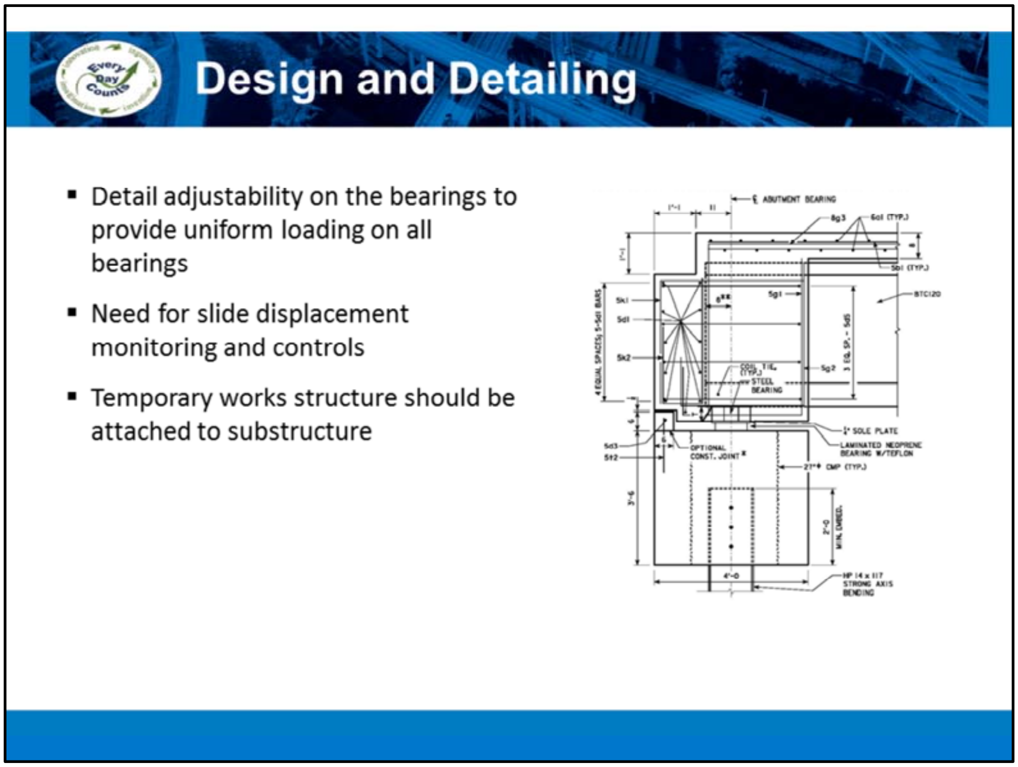


Special attention should be paid to the detailing of slide shoes, bearings, and jacking locations if bearing change out is required.



Even more, the owner should be willing to entertain a contractor's suggestions for design modifications that would enable a specific construction process to be completed with other equipment or in a different manner.

A semi-integral abutment with properly designed substructure can be used to facilitate slide details and modifications. In general, the slide surface should be level. This means that the depth of the semi-integral diaphragm will vary with roadway cross slope.

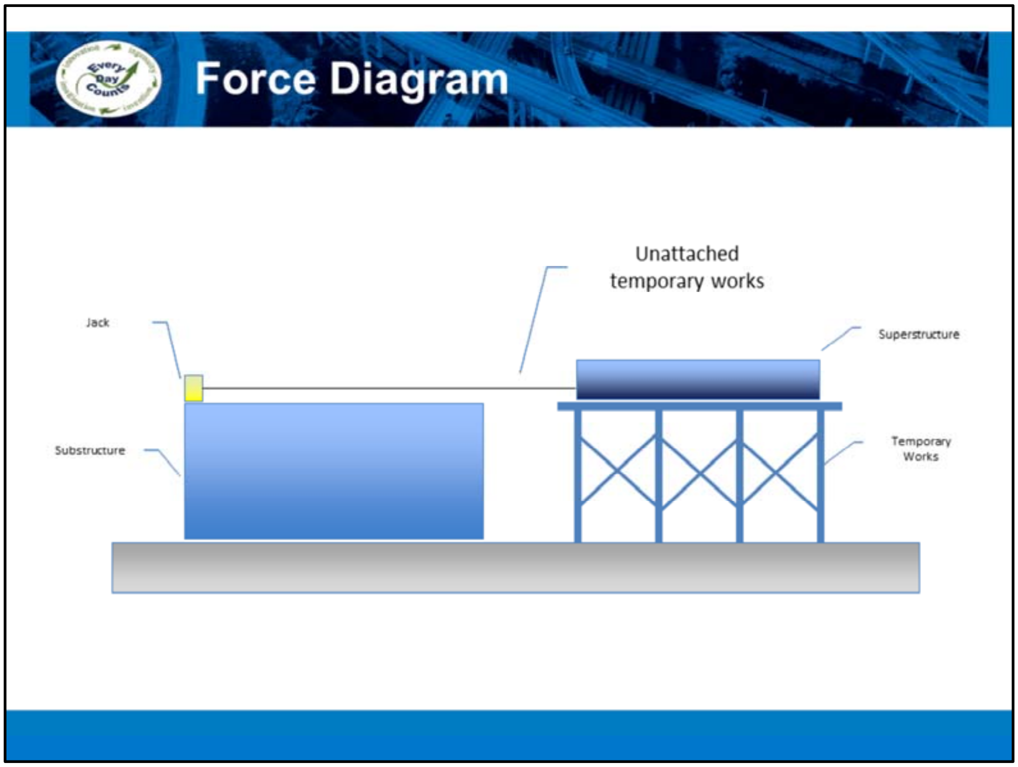


Adjustability should be provided on the bearing to ensure uniform loading on all bearings.

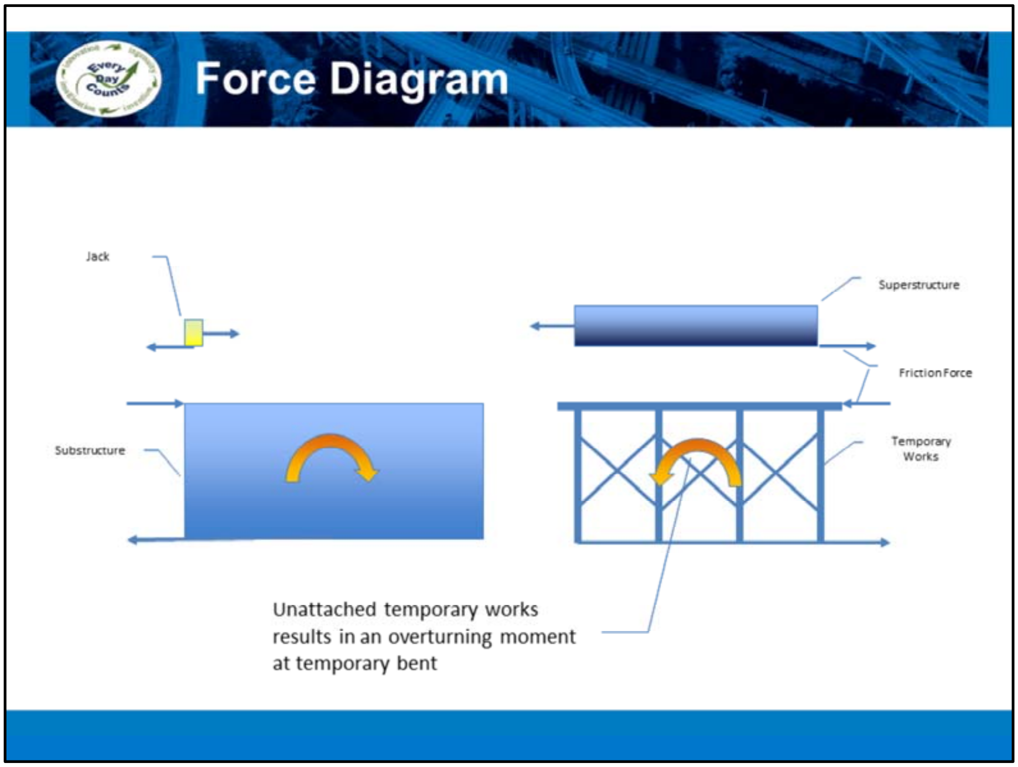
A system for monitoring displacement during the slides should be in place.

Lastly, it is greatly beneficial to the overall substructure design, both permanent and temporary, to attach the temporary works to the permanent substructure. The reason for this will be demonstrated in the following slides.

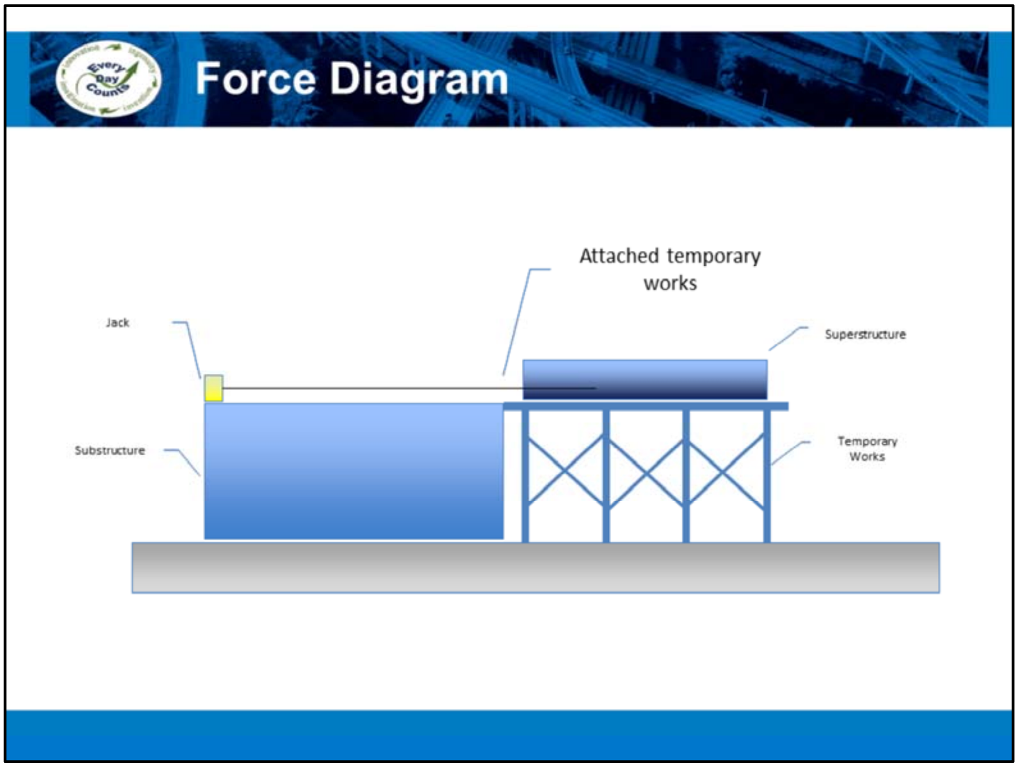
Generally the temptation is to treat the bridge as very fragile when being moved and placed, while this is appropriate, this should also be tempered with the perspective that bridges are, in fact, quite strong and durable structures.



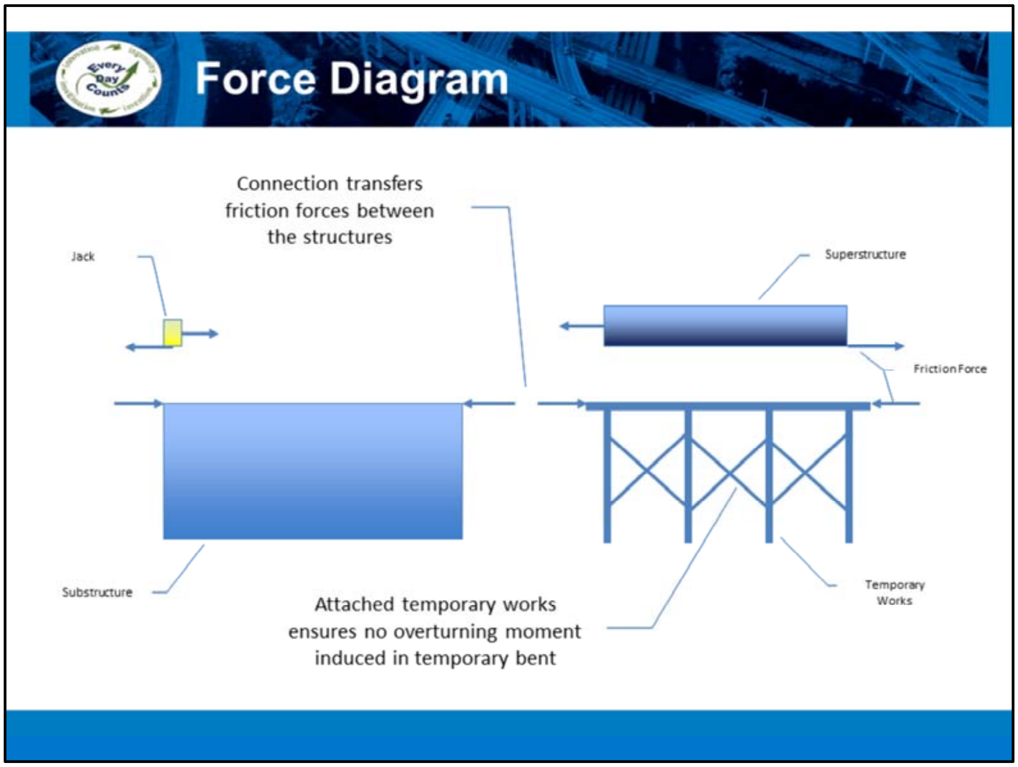
Seen in this schematic are the two substructures for the permanent and temporary works in an 'unattached' state. When pulling or pushing the new superstructure from one substructure to the other, significant forces are introduced to the substructures as seen in free-body-diagram on the following slide…



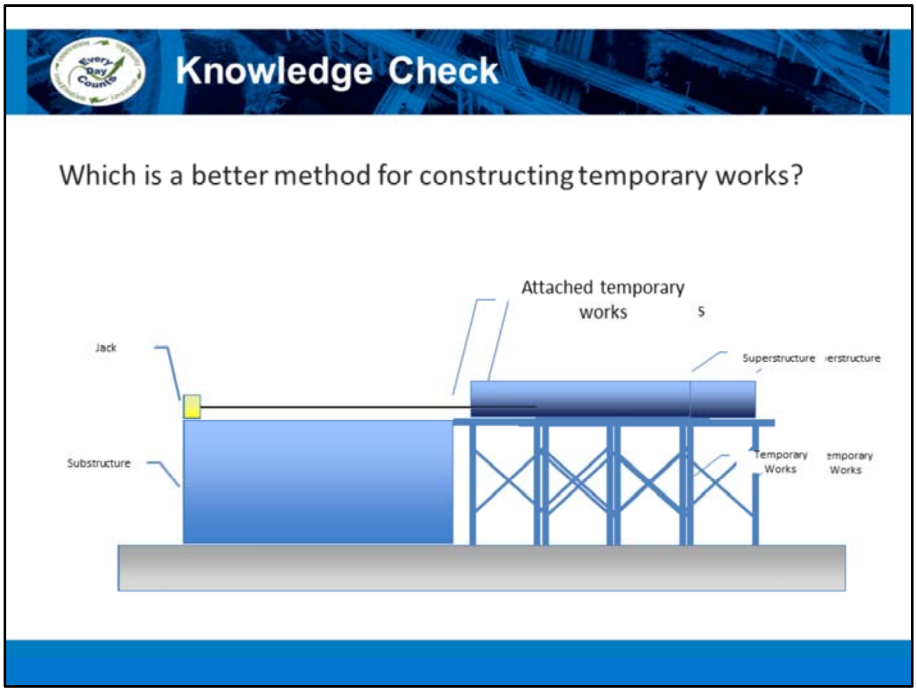
The resulting overturning moments must be accounted for in the design of the substructures, especially that of the temporary works.



Conversely, if a point of attachment is provided between the two substructures as seen in this schematic diagram, then…



… the overturning moments are eliminated, thereby greatly simplifying the design of the substructure and the temporary works.



Which method is better for constructing temporary works?

Leaving the temporary works unattached from the permanent substructure?
or
Attaching the temporary works to the permanent substructure?

Answer: Attaching the temporary works to the permanent substructure. This simplifies the demand and design of the temporary works and substructure.

Project Highlight

Massena – Iowa

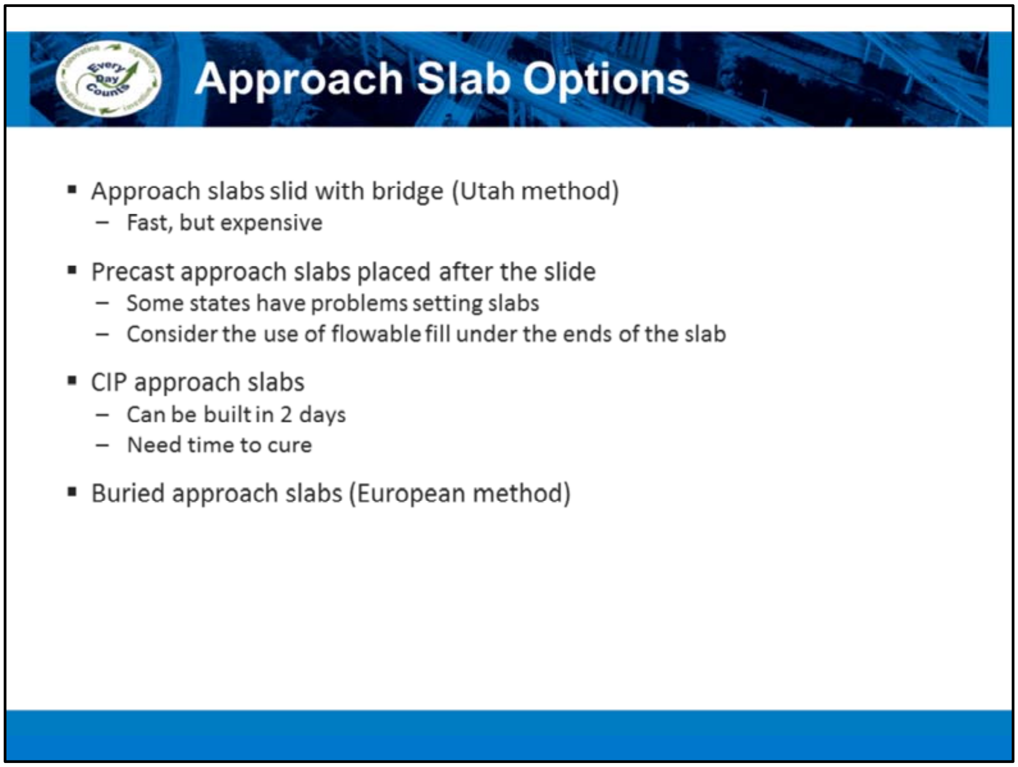
- Semi-integral abutment acts as jacking location
- Temporary works attached to permanent substructure

As part of the Massena, Iowa bridge slide, semi-integral abutments act as the jacking locations and the temporary works were attached to the substructure. Together these details proved to be an effective means for sliding the superstructure.

Not to be lost with the significant focus on the constructability and slide of a new superstructure are the approach slabs. Attention to approach slab design and construction should be priority, rather than an afterthought.

Several methods have been used including the ‘Utah Method’ which involves sliding the approach slabs with the bridge, precast approach slabs placed after the slide, cast-in-place approach slabs, or even buried approach slabs commonly referred to as the ‘European Method’.

A site-specific evaluation should be completed to assess which method is best. Most DOT’s have standards for this item that are not compatible with SIBC; again perspective is key. Age-old standard details can often be placed on a pedestal resulting in resistance to otherwise reasonable alternatives.



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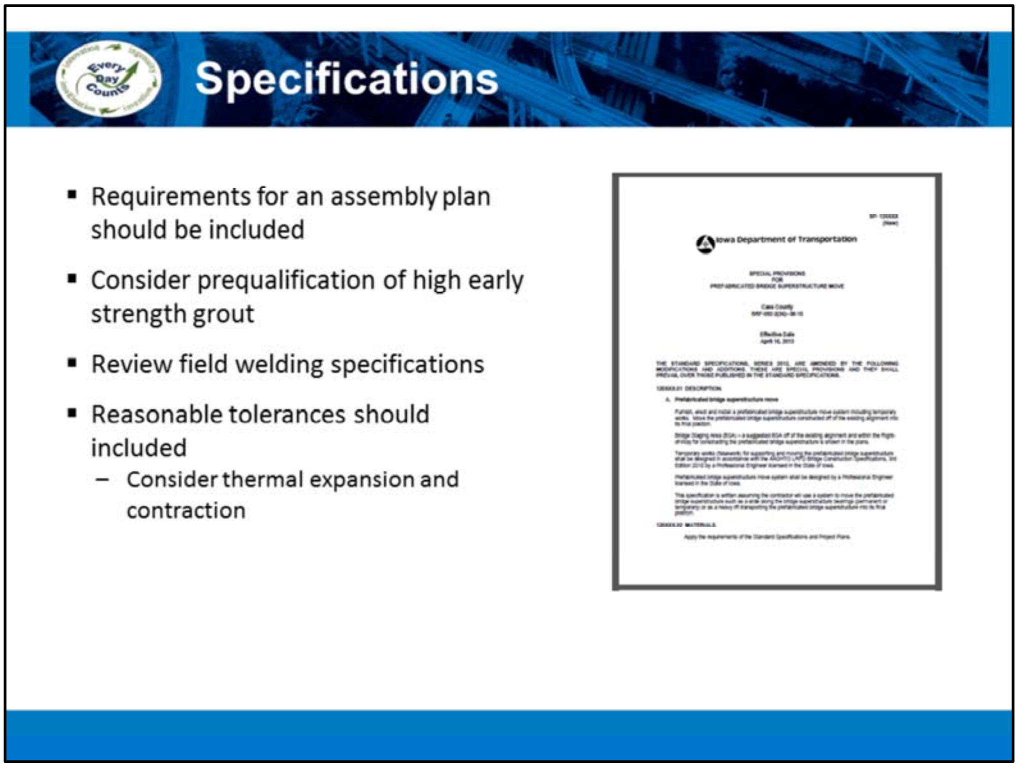
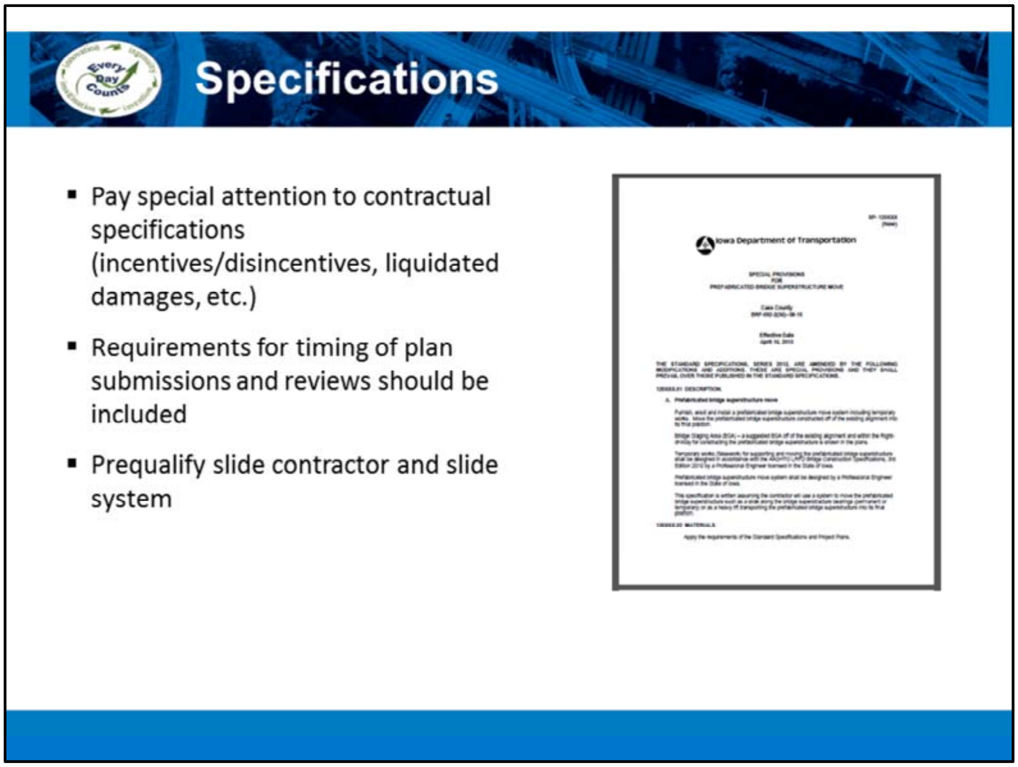


Specifications for slide-in bridge construction projects largely resemble those of a traditionally constructed bridge. However, additional specifications or modifications of existing specifications should be provided that cover the unique aspects of a slide-in project.

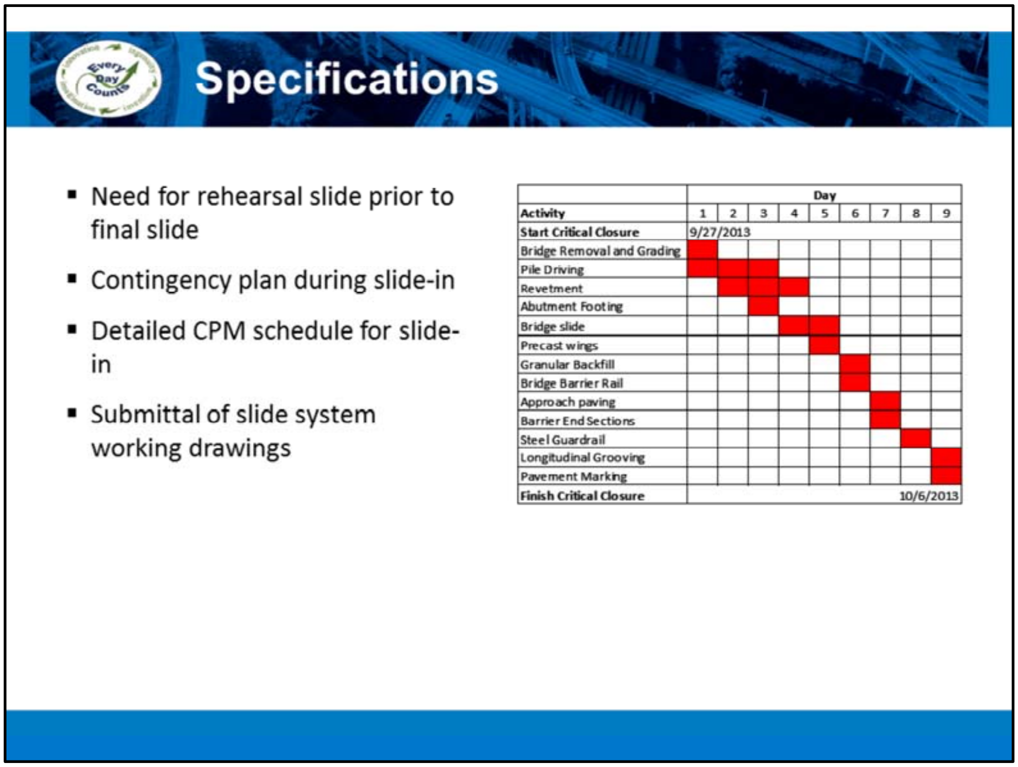
For example, requirements for an assembly plan should be included. The assembly plan is similar to an erection plan, except it includes more detail on the temporary works and equipment. It also includes a step by step plan for the completion of the work including schedule.

Prequalification of high early strength grout and review of field welding procedures should be considered. Reasonable tolerances should be included that accommodate thermal expansion and contraction, and the fact that the bridge will be moved.

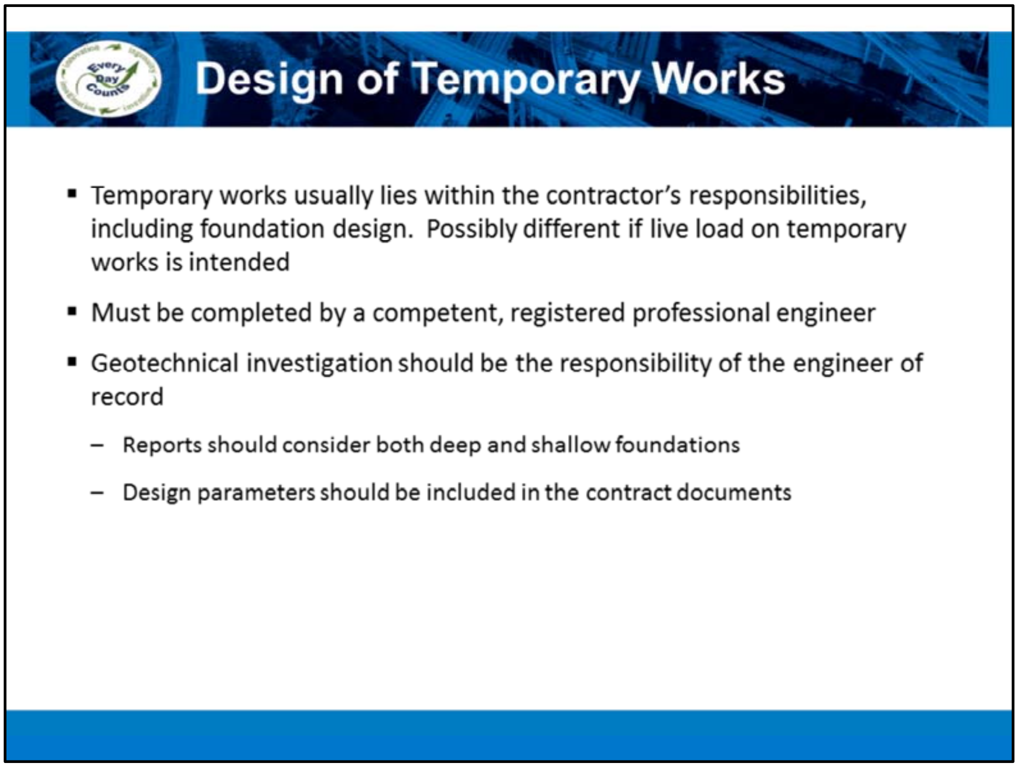


Special attention should be paid to contractual specifications such as incentives and disincentives or liquidated damages. Requirements for timing of plan submissions and reviews should be included.

Possible prequalification of the slide contractor or the project superintendent and slide system should be considered.



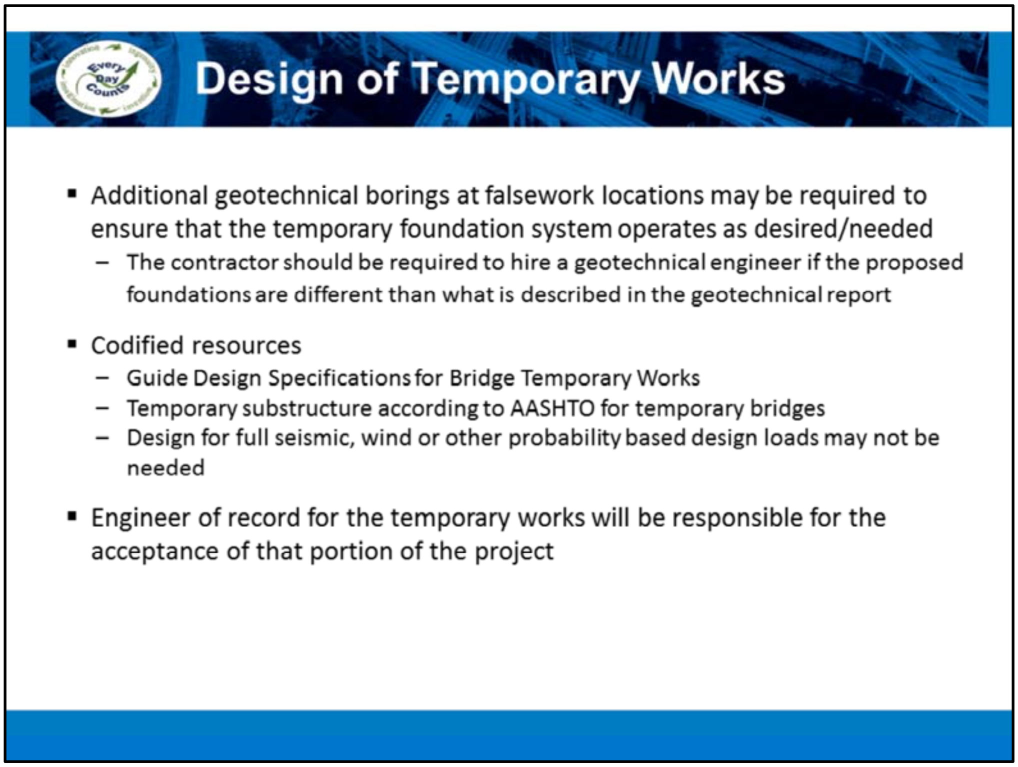
Additional specification considerations include: the need for rehearsal slide prior to final slide, a contingency plan during slide-in, a detailed CPM schedule for slide-in, and the submittal of slide system working drawings.



In most cases, the design of temporary works lies within the contractor's responsibilities. Though if the traveling public will at least minimally travel over the temporary works, the responsibility may lie elsewhere.

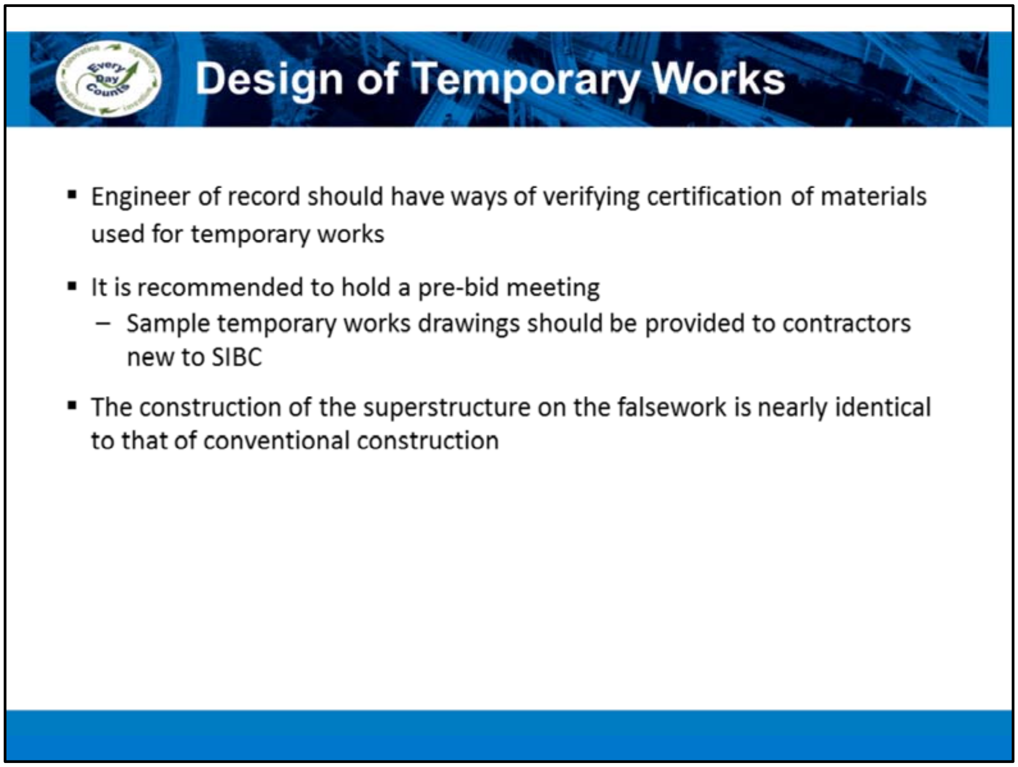
The design must be completed by a competent, registered professional engineer. The engineer of record should be responsible for the geotechnical investigation around the site including the area proposed for temporary works.

Both deep and shallow foundations should be considered and all design parameters included in the contract documents.



If temporary works foundations different than those considered are proposed by the contractor, it is required of the contractor to hire a geotechnical engineer. Several codified resources exist to guide the temporary works design including those listed here.

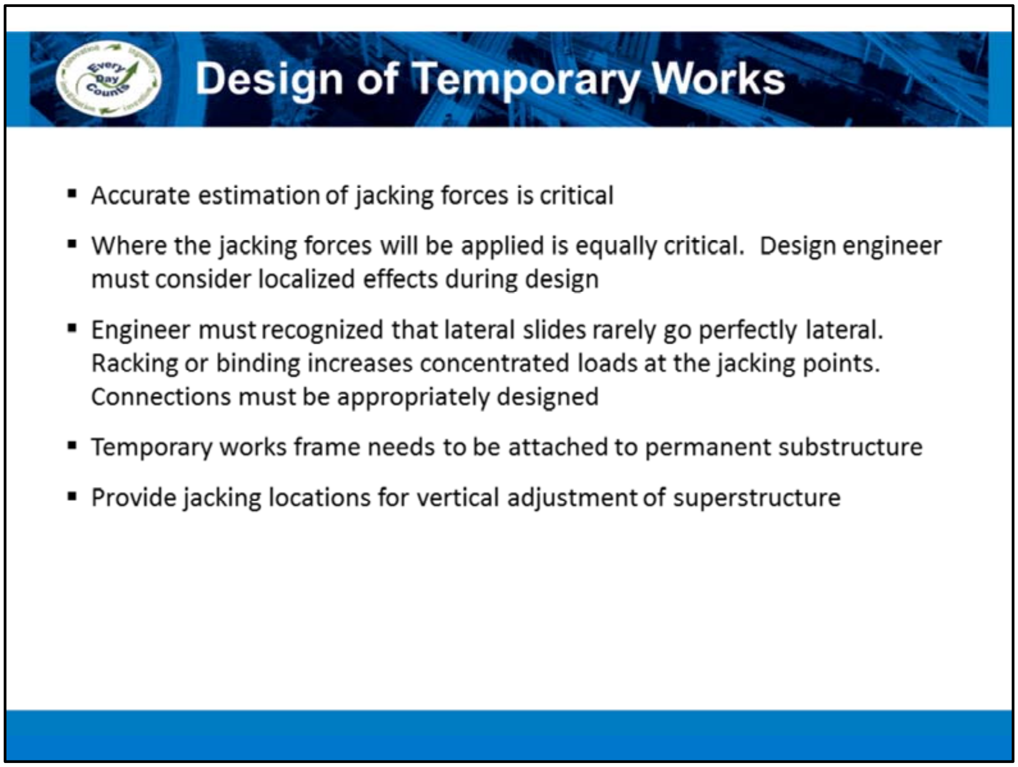
In the end, acceptance of the temporary works will be up to the engineer of record for the installation.



Further, the engineer of record should have the ability to verify materials certification.

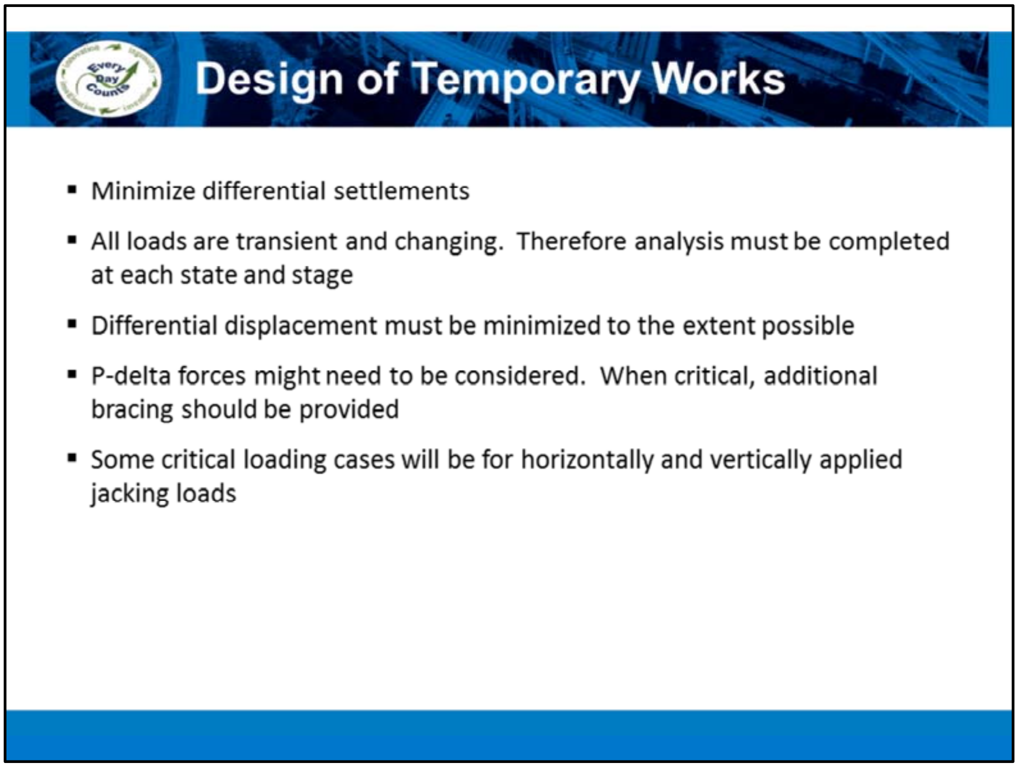
A pre-bid meeting is recommended where sample temporary works drawings can be viewed for those unfamiliar with slide-in construction.

For SIBC, the actual construction of the new superstructure upon the temporary works is very close to that of conventional construction; very few methodical changes are needed.

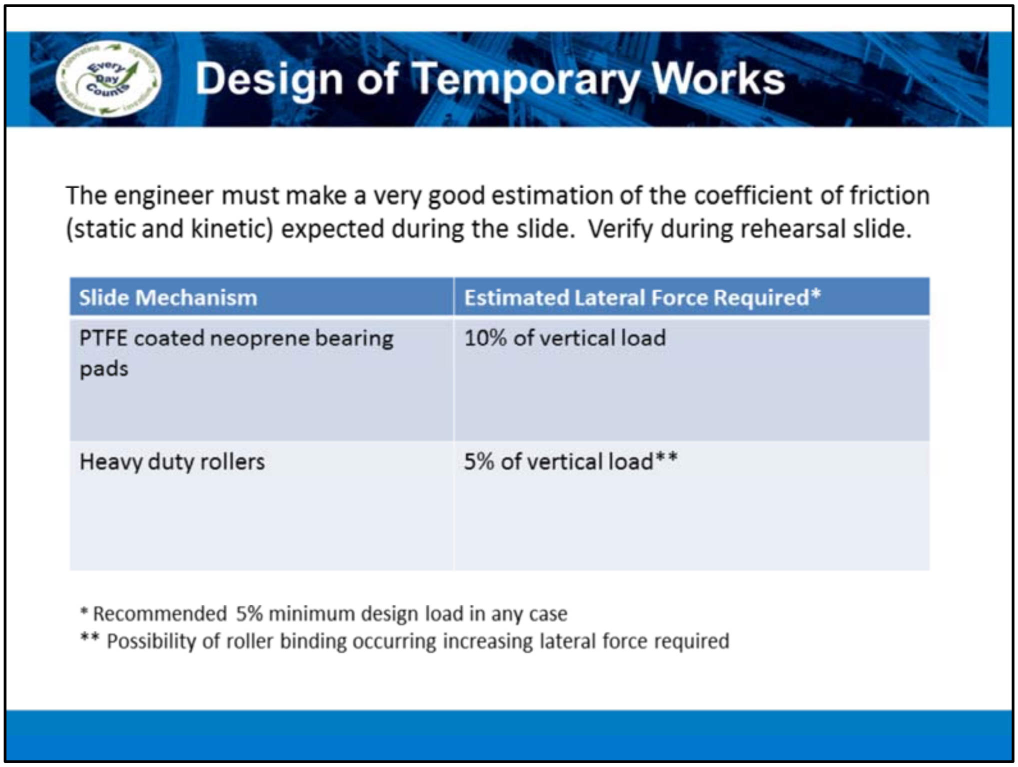


The expected jacking forces and jacking locations are key to the design of temporary works. It should be noted that possible misalignments or hang-ups during slide operations can considerably increase the jacking forces. Accordingly, connections should be appropriately designed.

For reasons discussed earlier, the temporary works should be attached to the permanent substructure. Lastly, jacking locations for vertical adjustment of the superstructure should be incorporated into the design.



Attempts to minimize the differential settlements between permanent and temporary works should be made. Note that all loads are transient and changing; therefore an analysis should be completed for stages throughout the process. Special attention should be paid to differential displacements, p-delta forces, and jacking loads.

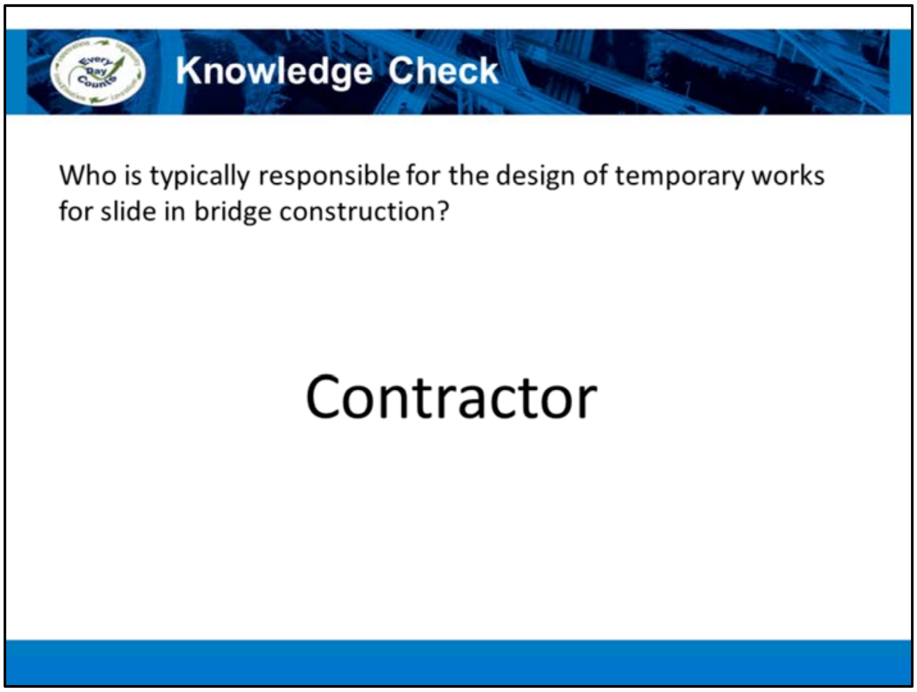


To ensure the proper jacks will be supplied to the project, the engineer must make a good estimation of the friction forces during the slide. These forces should be verified during the rehearsal slide.

Two commonly used slide mechanisms include PTFE coated neoprene bearing pads and heavy duty rollers. The estimated lateral force required is 10% and 5% of the vertical load, respectively. Note that, in addition to the higher forces required during possible binding, a slightly higher force may be required when pushing the superstructure from a static to kinetic state.

Since the engineer of record does not know the make-up of the actual slide system, a recommended value of 10% should be used for preliminary engineering. The plans should show the recommended jacking location on the bridge and the engineer of record should verify that the structure can accommodate this force.

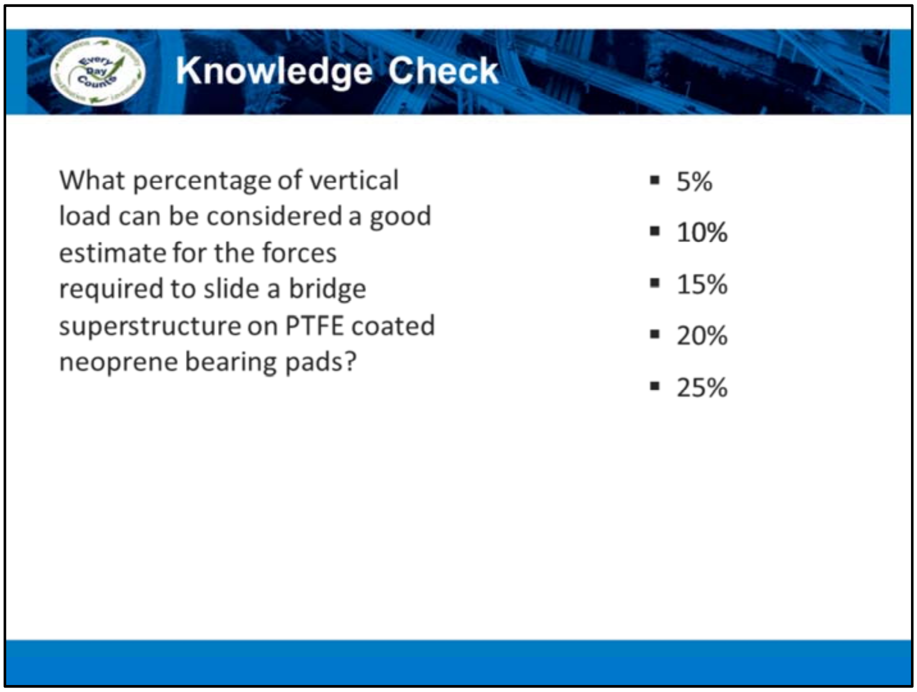
It is key that the transition from temporary supports to the permanent structure be designed to accommodate the transient load and possible differential deflection. The superstructure should experience little effect due to the changing support condition.



Who is typically responsible for the design of temporary works for slide in bridge construction?

Answer: The contractor.

Temporary works usually lies within the contractor’s responsibilities, including foundation design, though this could change if live load on temporary works is intended.



What percentage of vertical load can be considered a good estimate for the forces required to slide a bridge superstructure on PTFE coated neoprene bearing pads?

5%?
10%?
15%?
20%?
Or
25%?

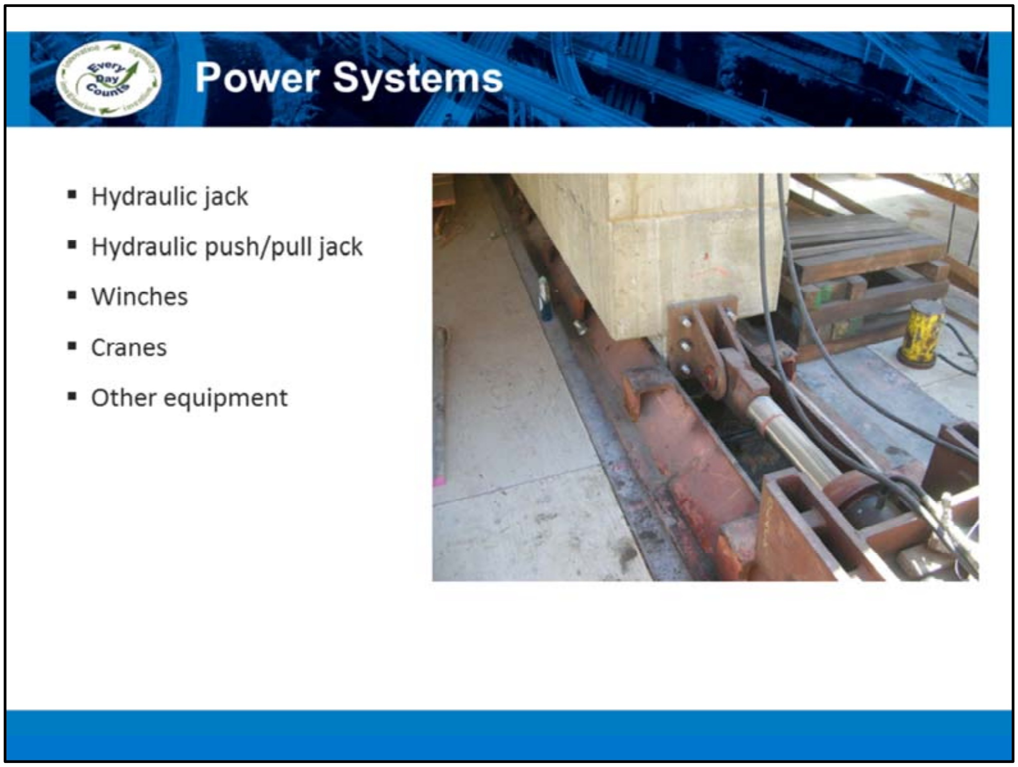
The answer: A good estimate on PTFE bearing pads is 10%. When using heavy duty rollers the force required is generally less, though in both circumstances the loads can increase if binding occurs or an obstruction isn't removed.

Provided in this slide are a few examples of various slide details. Shown in the two pictures to the left are PTFE coated bearing pads along with stainless steel slide shoes. Each pad is coated with dishwashing soap to further decrease the frictional forces; it is available, cheap and effective.

The top picture to the right shows jacking pockets incorporated into the semi-integral abutment used for vertical adjustment and bearing pad change-out.

The bottom picture shows the guide channel used with heavy duty rollers and also threaded rods which are connected to the jack. The slide shoe option works in conjunction with a semi-integral backwall diaphragm. The slide shoe can be just used for the move, or it can be used for the permanent bearing support. By using this method of detailing, the number of permanent bearings can be reduced by more than half. The Utah DOT has designed bridges with only 2 or 3 bearings at each support line.

Additional pictures of hardware commonly used in slide-in applications are shown here. These include rollers, skids, PTFE pads, hydraulic rams, threaded bars, and vertical jacking hardware.



Several power systems can be employed to move the bridge superstructure. These include hydraulic jacks, push/pull jacks, winches, cranes, and even other equipment.

It is recommended that hydraulic equipment be required to be proof tested prior to being put into service, even new jacks can blow out seals and fail.

Submittals were briefly mentioned during the slides addressing the specifications. To further elaborate, some of the submittals that should be required include slide system plans; slide plans including an hour-by-hour schedule, communication plan, and contingency plan; the contractor's ingress and egress plan; and temporary works, which should be separated from the actual slide due to the timeline in which each is required during the project.

Media and public relations are important on any project.

Bridge design and construction professionals should be cognizant that the traveling public are customers and should be informed.

Due to the unconventional nature of the bridge construction when using slide-in methods and its potential impacts on the traveling public, SIBC projects are likely to garner more attention through the media.

Accordingly, a media and public relations plan should be developed early in the project that communicates the advantages of reducing inconvenience for the trade of possible increased costs.

Sufficient time should be allowed for the public to make alternative plans during the most inconvenient times.

Further, communication with the community prior to setting the schedule will help identify local events that draw additional traffic. Identify periods of least traffic through traffic counts if necessary. Several methods to convey information to the public should be used including the local news, websites, mailings, social media, and others.

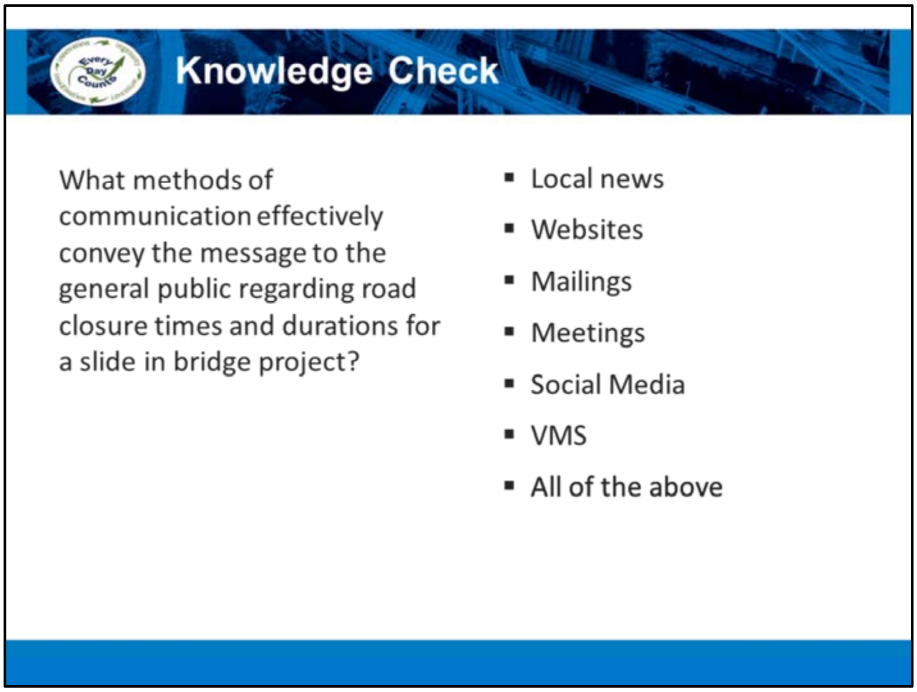
Special attention should be paid to businesses and others directly adjacent to the site as it is likely they will be most affected. Variable message signs are a good way to convey important project information.

Since the construction method is unique, the public should be encouraged to attend the slide but only if attendance can be safely accomplished. Access to engineers and communications specialists to quickly answer questions during construction can provide a great benefit to the project. After all is complete, surveys of the public to provide feedback can be conducted.

The Jamaica Avenue project near New York City required an extensive public outreach plan given the large number of road users both above and below the bridge in addition to the many businesses and residences nearby.

A significant campaign began 3 to 4 weeks prior to construction beginning. Project details were communicated via letters, meetings, and radio, and construction details were posted on state and city websites.

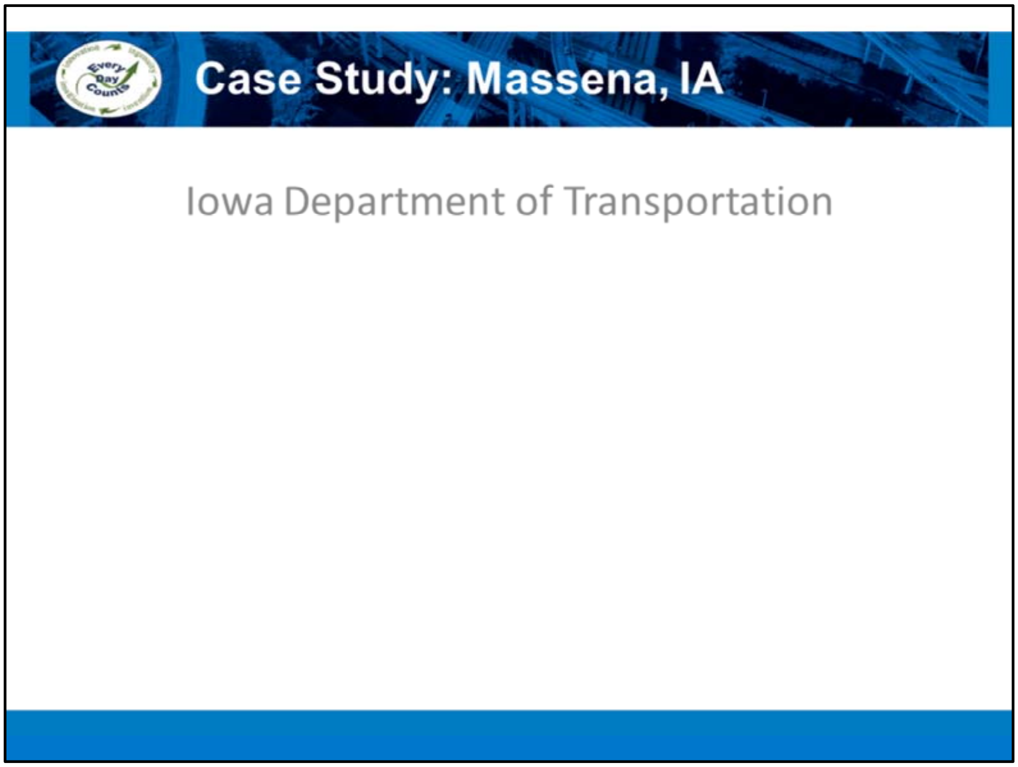
Press releases and travel advisories were broadcast through media outlets and VMS signs.



What methods of communication effectively convey the message to the general public regarding road closure times and durations for a slide in bridge project?

Local news?
Websites?
Mailings?
Meetings?
Social Media?
VMS?
Or
All of the above?

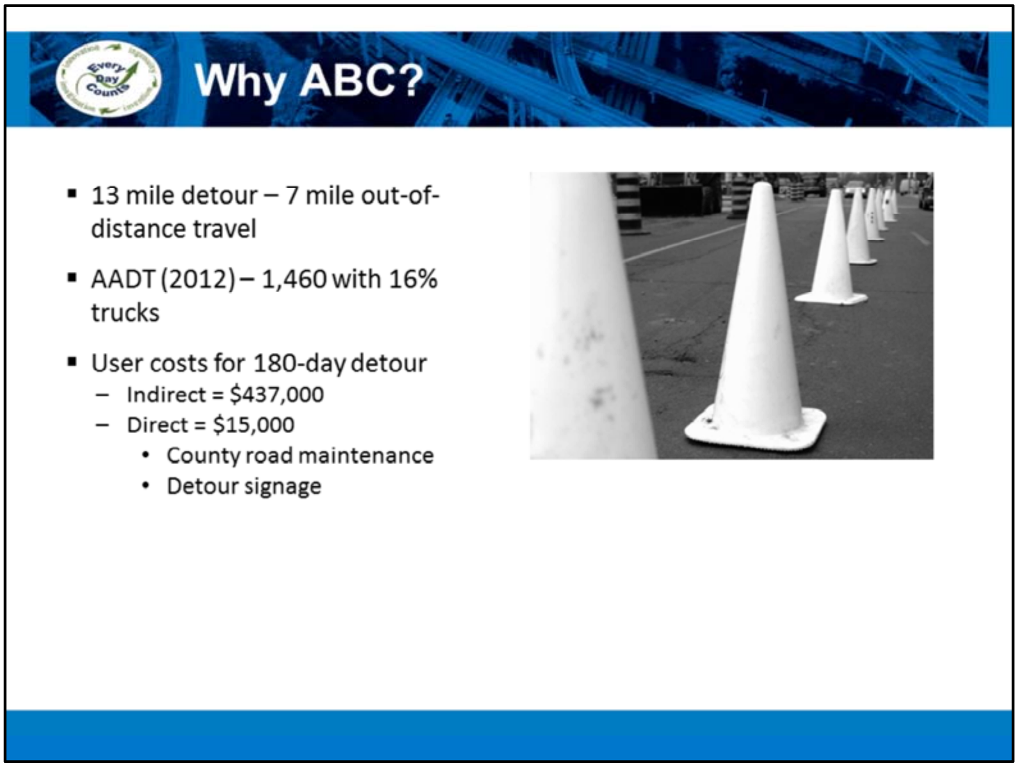
The answer: All of the above. Each of the options are commonly used to communicate the expectations of slide in projects.



The next portion of this presentation will focus on 6 case studies that shed light to the practice of slide-in bridge construction. They are collectively intended to provide perspective from owners, engineers, and contractors. Individually, however, the case studies may focus only a single intended audience.

The first case study comes from a slide-in project completed during the fall of 2013 in Massena, IA. The owner is the Iowa Department of Transportation and this project is the first in the state completed using SIBC.

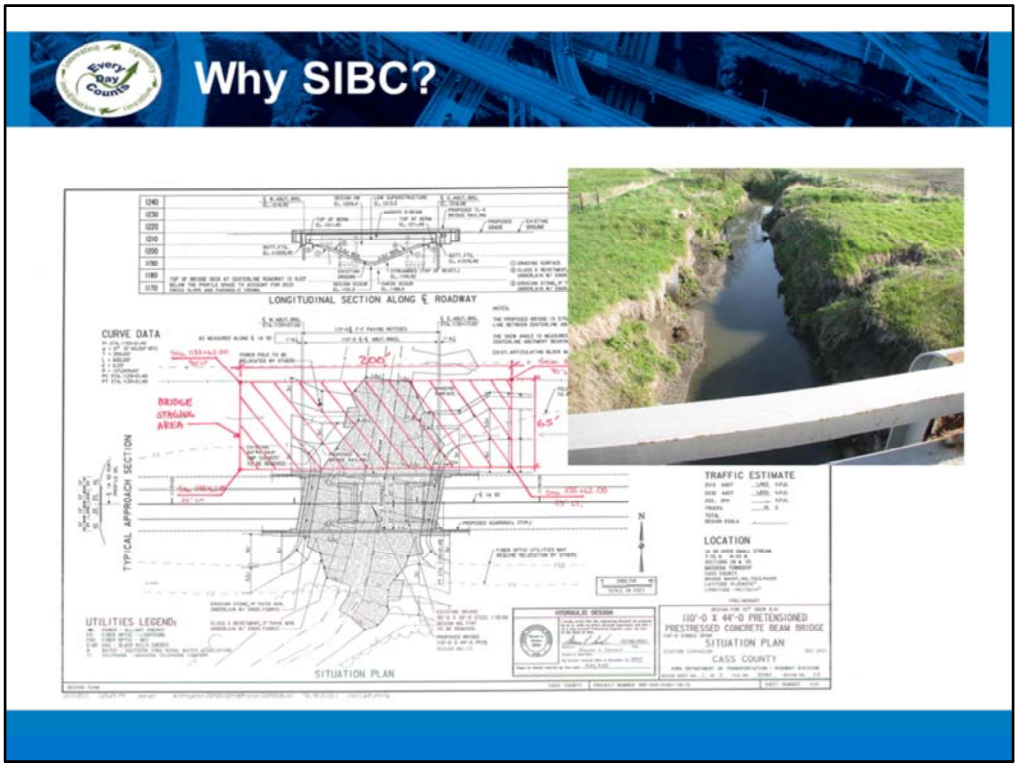
The bridge on IA 92 crosses a small stream immediately west of the Town of Massena, IA in southwest Iowa.



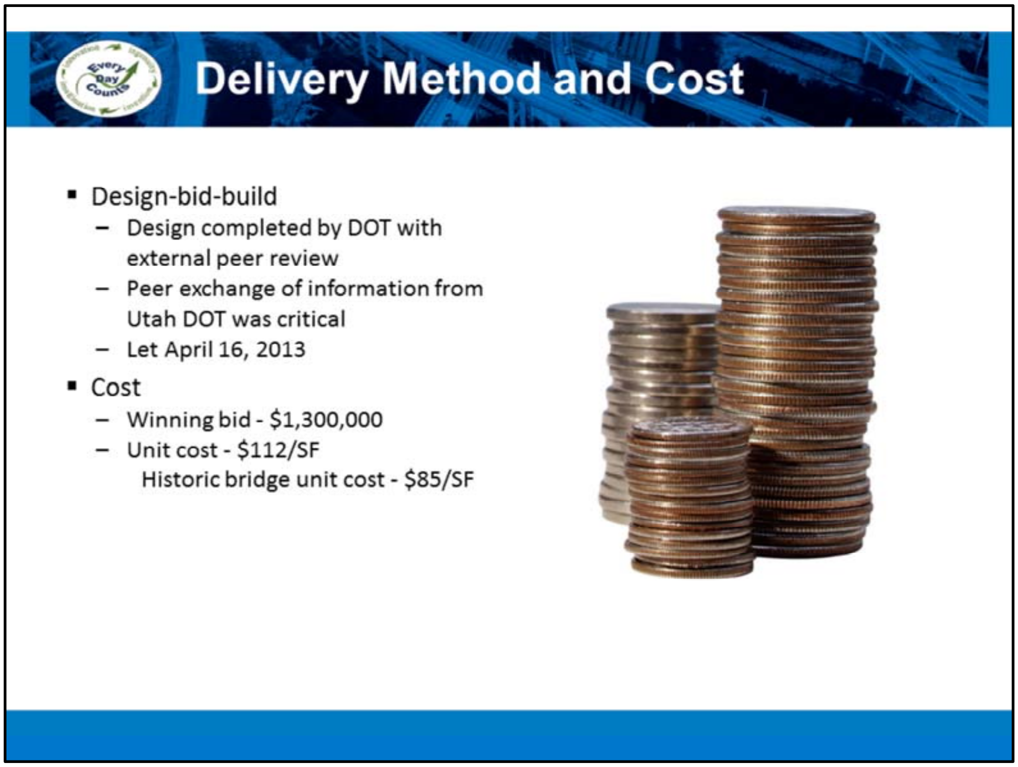
In this case, several considerations were made for why accelerated bridge construction was a good solution.

First, to close the bridge would have meant a 13 mile detour and 7 mile out of distance travel for road users. This is even more significant when coupled with the fact that 16% of all vehicles were trucks.

It is estimated that to complete the bridge replacement using traditional construction methods a road closure of 180 days would have been necessary resulting in indirect costs of $437,000 and direct costs of $15,000.



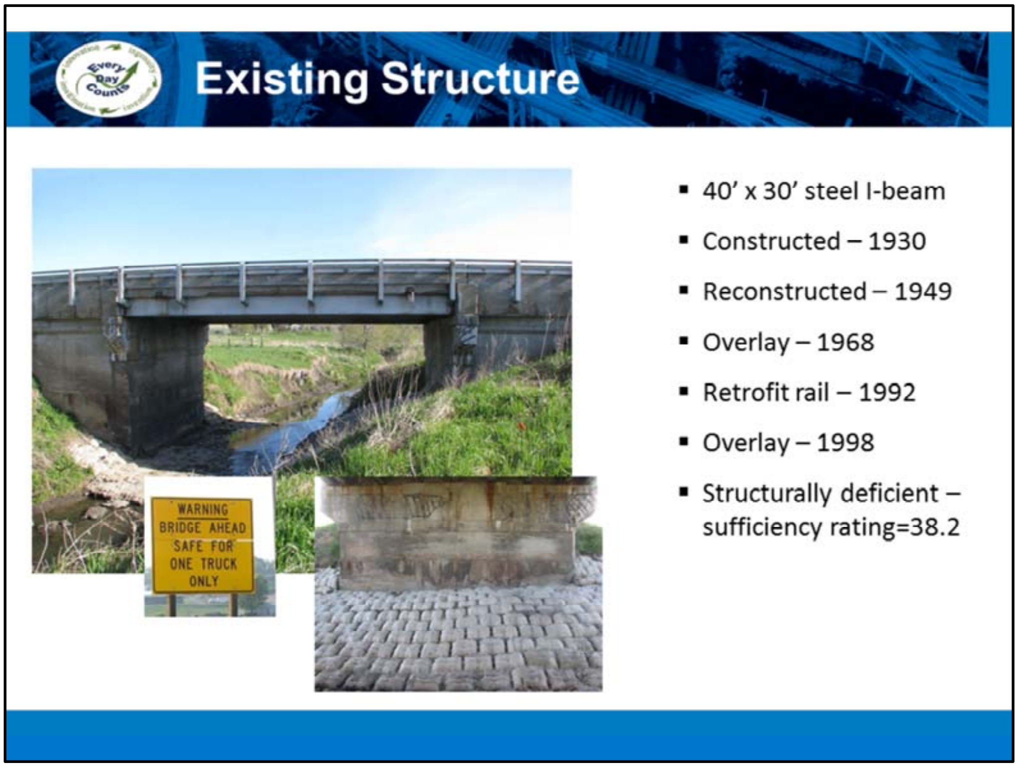
The Iowa Department of Transportation in its pursuit of accelerated bridge construction methods planned to implement slide-in construction methods at a site where it made sense to do so. At Massena, slide-in bridge construction was a good solution for accelerated bridge construction. The existing right-of-way allowed sufficient space for temporary works adjacent to the bridge without having to acquire temporary right-of-way. Even more, the geography was fairly flat, thereby simplifying the construction.



The method of delivery followed traditional design-bid-build. The design was completed entirely by the Iowa DOT with external peer review.

Prior to the beginning of the project, a critical peer exchange took place with the Utah DOT during the slide of one of their bridges. Several from Iowa traveled to Utah and were able to view the slide and speak directly with owners, designers, and contractors. Many lessons were learned and implemented prior to final design and construction of the Massena bridge.

The winning bid was $1.3 million which equates to a unit cost of $112/sf. Historically, in Iowa, the unit cost is near $85/sf, or roughly 75% of the actual cost. Note that these numbers represent the construction costs only and do not include the user costs which, if included, would have nearly equalized the overall costs.



The existing bridge, originally constructed in 1930, was a 40’x30’ steel I-beam structure with high abutment walls and narrow channel passage. Over its history, it had been reconstructed, retrofitted, and overlaid on several occasions. Soon before its replacement it achieved a sufficiency rating of 38.2, deeming it structurally deficient.

The proposed replacement seen in this rendering is a longer, pretensioned, prestressed concrete beam bridge.

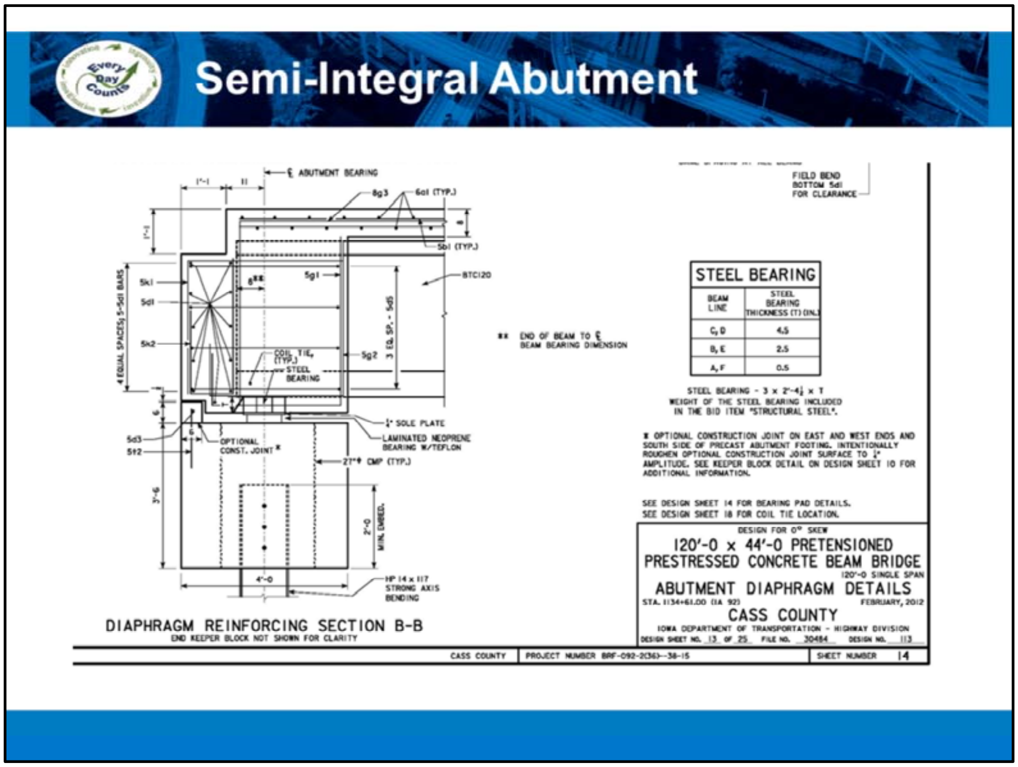
Plan Design and Details

- Semi-integral abutment details
- Abutment diaphragm
  - Jacking pockets for lifting
  - Block for pushing/pulling the prefabricated superstructure
- Precast abutment footing
  - H-Pile connections
- Precast wingwalls
  - H-Pile connections

The plan design and details incorporated a semi-integral abutment and abutment diaphragm. The diaphragm served as a block for pushing and pulling the prefabricated structure.

Even more, within the diaphragm, jacking pockets for lifting were formed.

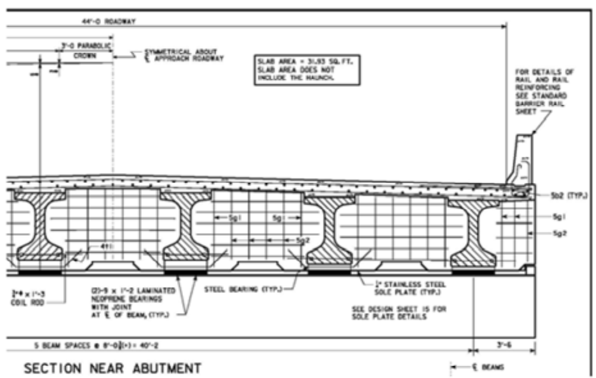
The original design called for precast abutment footings set over the top of H-piles, each connected through filling with concrete the corrugated metal pipe void forms within the footing. In the end, the abutment footings became cast-in-place by request of the contractor. Precast elements were used at the wingwall locations.



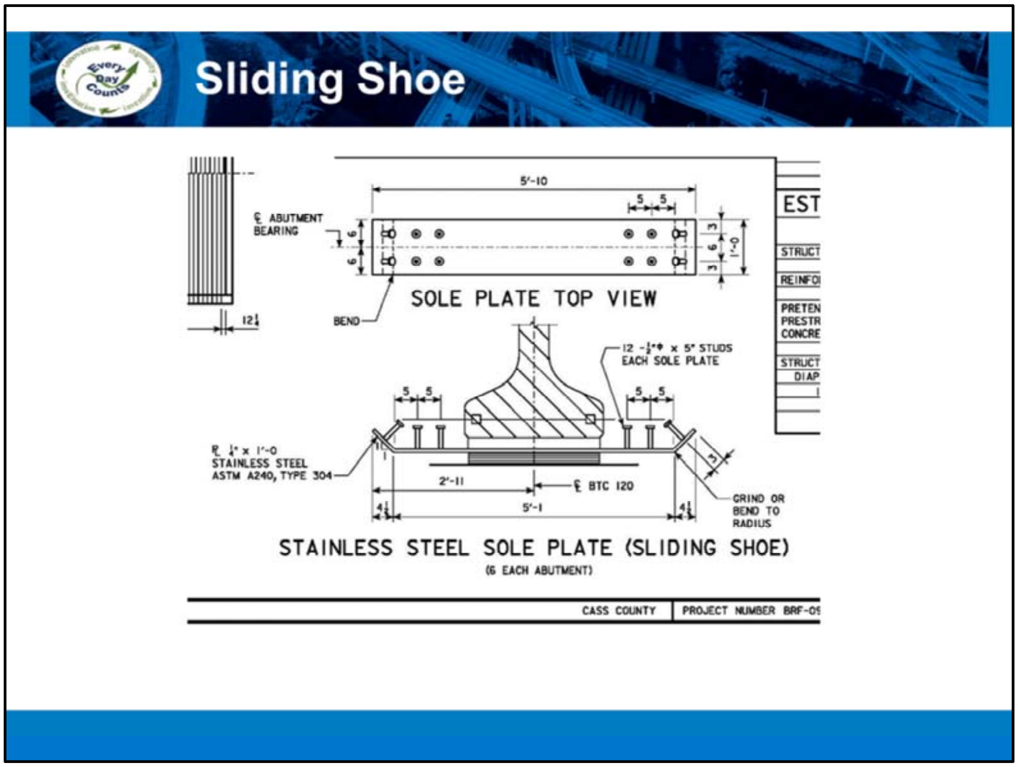
Shown in this detail is the semi-integral abutment and diaphragm. The slide plane is shown directly above the abutment footing and directly below the diaphragm.

Sliding Pad

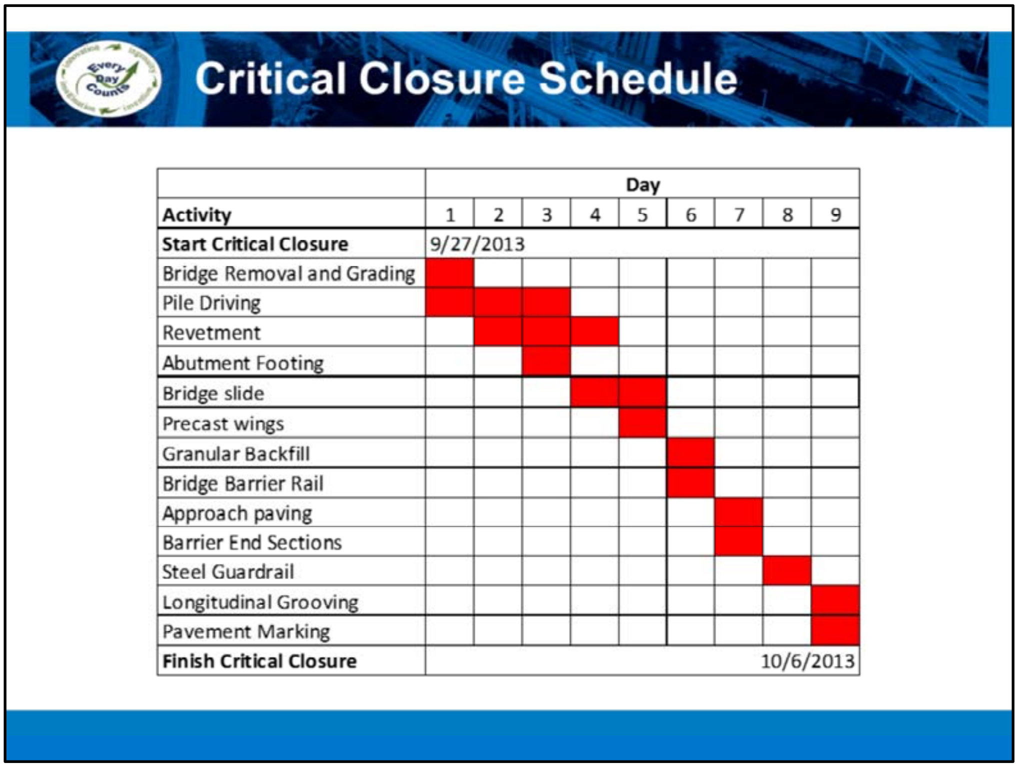
- Engineer's sliding concept
- Contractor elected to use commercially available rollers



The original intent was for the bridge to be slid using PTFE coated bearing pads and dishwashing soap. However, the contractor requested to use heavy duty rollers instead as they were the owners of several rollers from a previously completed project.



A stainless steel sliding shoe cast into the diaphragm at each girder end would have been the only point of contact between the superstructure and the bearing pads.



Critical Closure Schedule

	Day								
Activity	1	2	3	4	5	6	7	8	9
Start Critical Closure	9/27/2013								
Bridge Removal and Grading	■								
Pile Driving	■	■	■						
Revetment		■	■	■					
Abutment Footing			■						
Bridge slide				■	■				
Precast wings					■				
Granular Backfill						■			
Bridge Barrier Rail						■			
Approach paving							■		
Barrier End Sections							■		
Steel Guardrail								■	
Longitudinal Grooving									■
Pavement Marking									■
Finish Critical Closure									10/6/2013

The critical closure lasted 9 days – contrast this with the projected 180 days had the bridge been constructed using traditional methods. The 9 days started with the removal of the old bridge and grading for the new structure.

After, pile driving, revetment and abutment footings were completed.

The bridge slide occurred over the course of an evening and early morning hours half-way through the 9 day closure, after which, the bridge and roadway were completed with wingwalls, backfill, barrier rail, and approach paving.

Lessons Learned

- Let ABC projects similar to steel bridges, in the fall with time for the contractor to gather resources
- Offer precast/CIP options for substructure
- Be prepared to fully evaluate impact of contractor method changes
- Do not allow reuse of laminated neoprene bearings
- Add a specification requiring falsework design engineer to inspect and accept falsework construction

Several lessons were learned from this first experience with slide-in bridge construction in Iowa. Traditionally, for steel bridge projects in Iowa, the project is let during the fall allowing the contractor to gather resources over the winter and prepare for a spring start. Looking back, it was found that the Massena project would have benefitted from a similar schedule. As it was, the project was let in the spring with a summer start date, thus expediting and making more difficult the process for the contractor and owner, especially as it pertained to gathering materials and shop drawing preparation and approval.

The plans called for a precast only substructure. Unless there is an absolute must for precast, it might be better to allow the contractor the decision of precast or cast-in-place knowing the end goal and critical closure time.

Unless the there is a necessity for the plans to remain as is, proposed changes from the contractor are likely. Be prepared to fully evaluate the impact of these method changes.

Though heavy duty rollers ultimately took the place of the laminated bearing pads as the primary slide mechanism, the pads were still used along with the rollers in the jacking pockets. The bearing pads experience some shear deformation during the slide and any damage that might occur is hard to detect from only visual observation of the pads. Accordingly, it is recommended that bearing pads used during the slide are replaced with new pads once the bridge is in its final position.

The importance of properly designed and constructed falsework is even greater in slide-in construction. As such, adding a specification requiring the falsework design engineer to inspect and accept the construction is recommended.

One should be aware of and anticipate that a first-time slide-in project is likely to require more design and review time than would typically be required.

For Massena a total of 603 hours of design time were used between the design engineer, detailer, and check engineer – with a significant amount of that time spent by the detailer. Similarly, 137 hours were spent reviewing submittals. With experience, however, it is anticipated that the time required will be greatly reduced with subsequent projects.

The next few slides provide some pictures at different stages of construction. Here in this slide pictures of the existing bridge and preliminary temporary works are shown. Steel piling and large W-section beams were used as the temporary supports.

Here, one can see the placement of the precast/prestressed beams, the beginnings of the deck formwork, and the cast-in-place diaphragm at the beam ends.

Once the construction of the superstructure was completed, the critical closure and demolition of the existing structure began. Once the bridge was removed and the grading completed, pile templates were positioned and pile driving started.

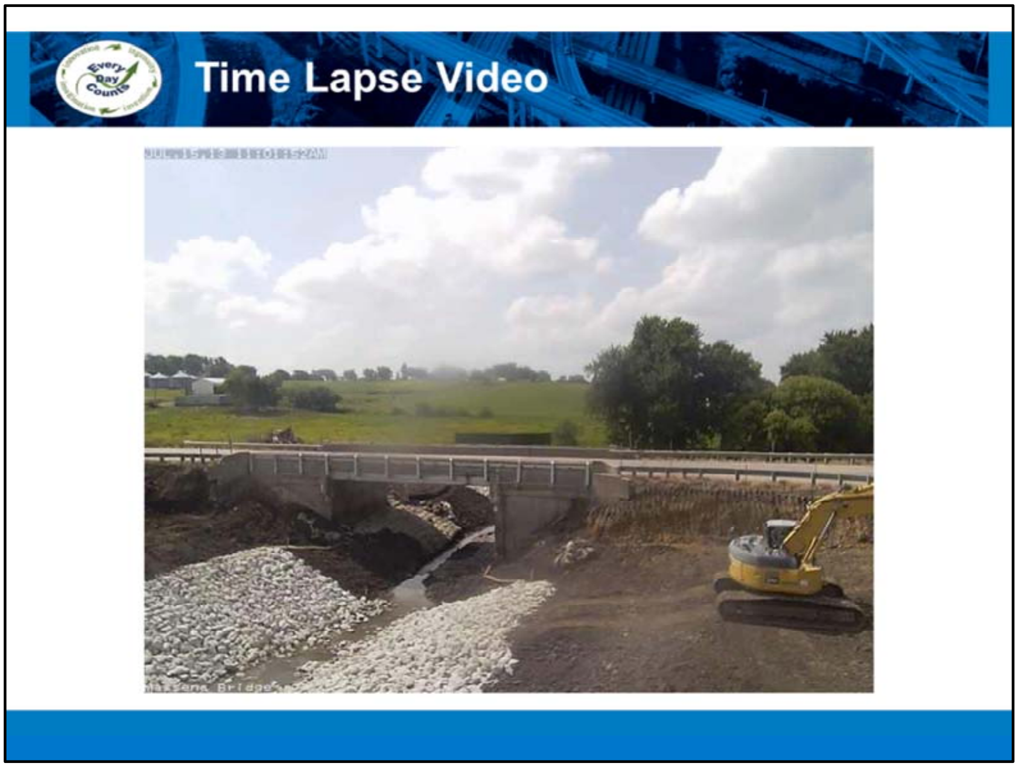
Vertical jacks were used in the jacking pockets to lift the bridge, after which, the rollers and bearing pad shims were set. A single jack and reaction pile were placed at the end of each abutment footing. Threaded rods were then placed between the jacks and through the superstructure diaphragms in order to pull the bridge onto the permanent substructure.

A single power unit with a manifold controlling both jacks was used. The rollers were guided along a steel channel spanning over the temporary works and permanent substructure.

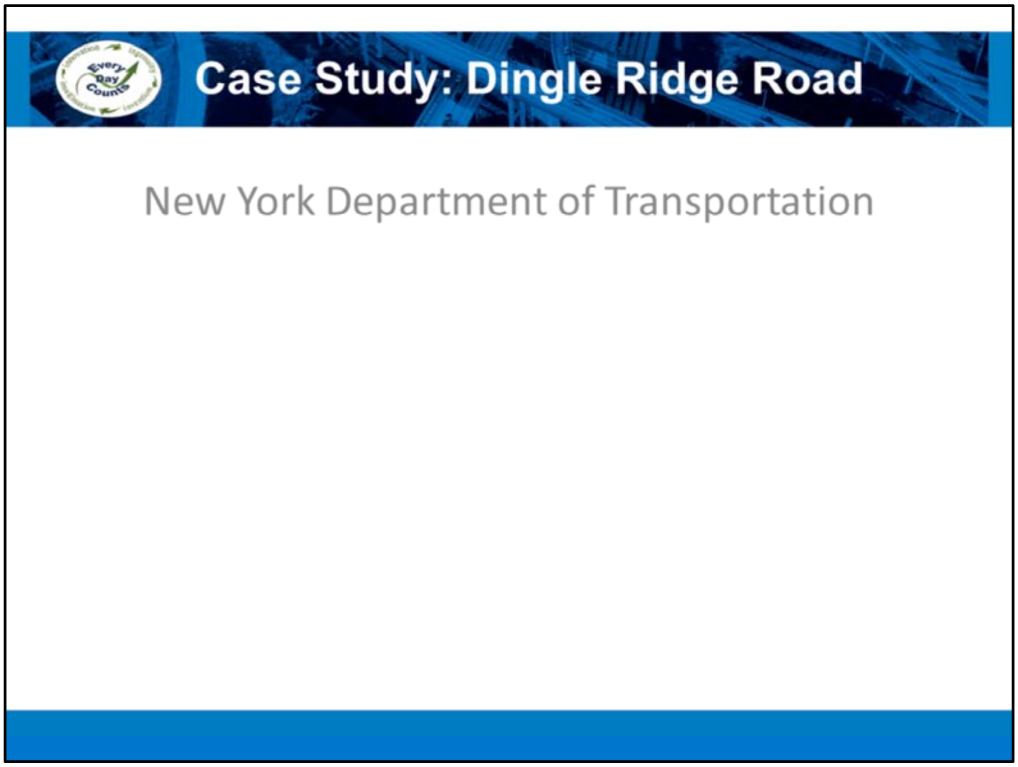
Additional pictures of the bridge nearing its final position are shown here. The vertical jacks were again employed to lift the bridge and pull the rollers, channel, and bearing pads from the jacking pockets. Also, the final bearing pads were placed below the diaphragm at the beam ends.

The slide operation took place during the late evening and early morning hours. Each of these pictures shows various views of the bridge being slid onto the permanent substructure. The lower picture shows the transition between the temporary works and permanent substructure and, maybe more importantly, the engineers closely monitoring the behavior at that transition.

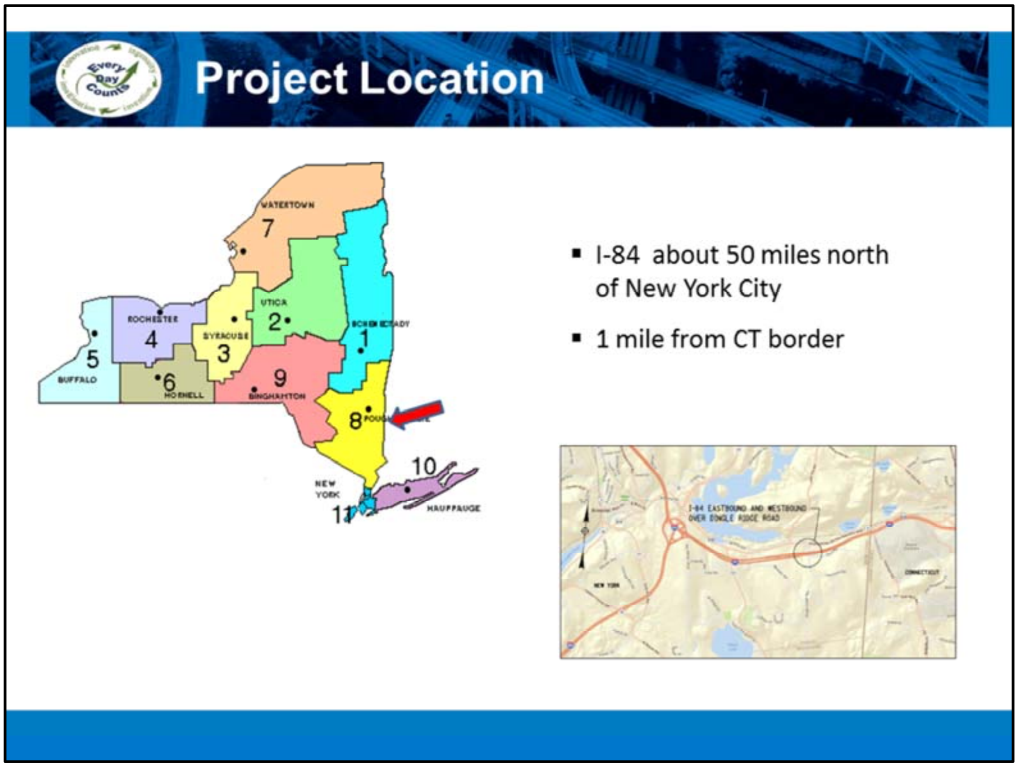
Once the bridge was in position, precast wingwalls with included grout pockets were placed onto pre-driven steel H-piles. The connection was made between the pile and grout pocket using a high-slump, small aggregate concrete mix.



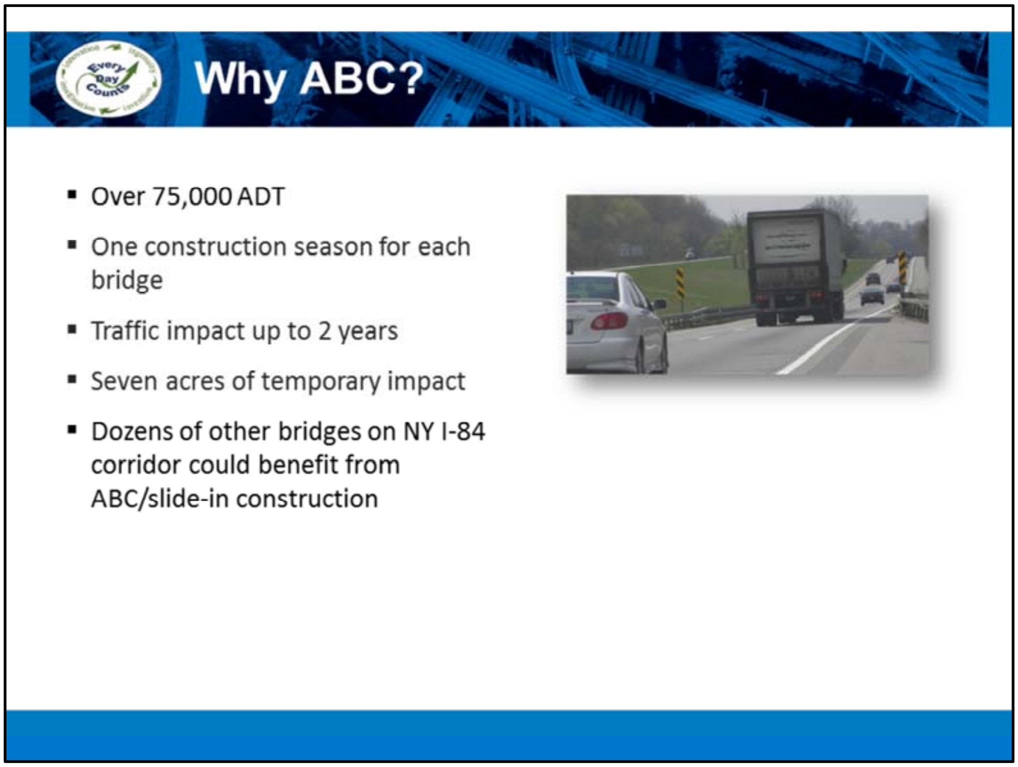
This short video is a time-lapse from the beginning of the project until the bridge was reopened to traffic.



The second case study we'll be covering today is the Dingle Ridge Road project completed in the state of New York.



The project is located about 50 miles north of New York City, 1 mile from the Connecticut border.



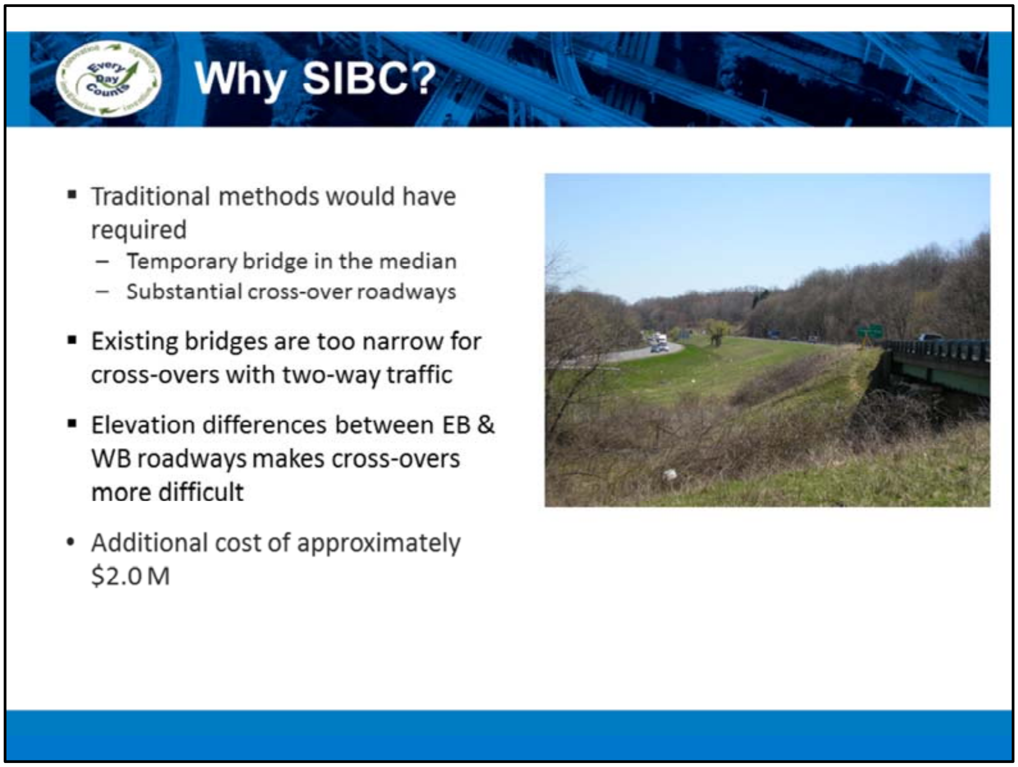
Why was this project a good candidate for accelerated bridge construction?

To begin, the ADT was over 75,000 which meant that any disruption would quickly effect a significant number of people.

Additionally, two adjacent bridges were to be replaced. One construction season would be required for each bridge, thus the total duration of the project and traffic impact could span up to 2 years.

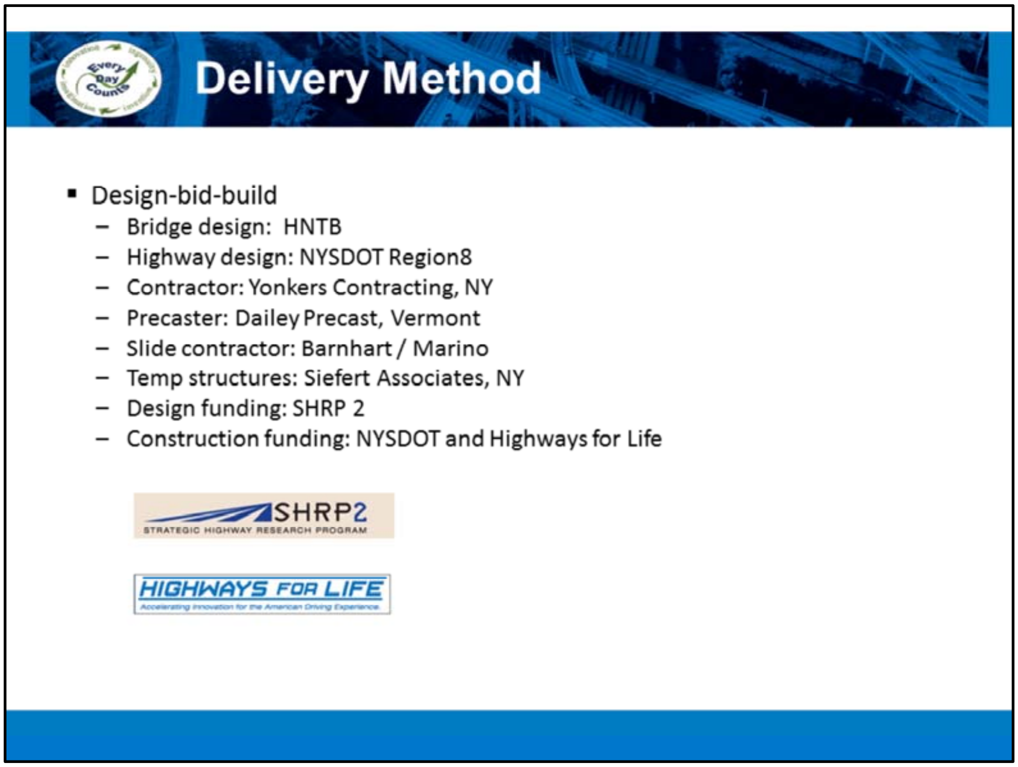
If constructed traditionally, seven acres of land would temporarily be impacted due to the construction of crossovers and shoe-flies.

Even more, if done successfully, dozens of other bridges on the I-84 corridor could be constructed using ABC thereby multiplying the benefits.

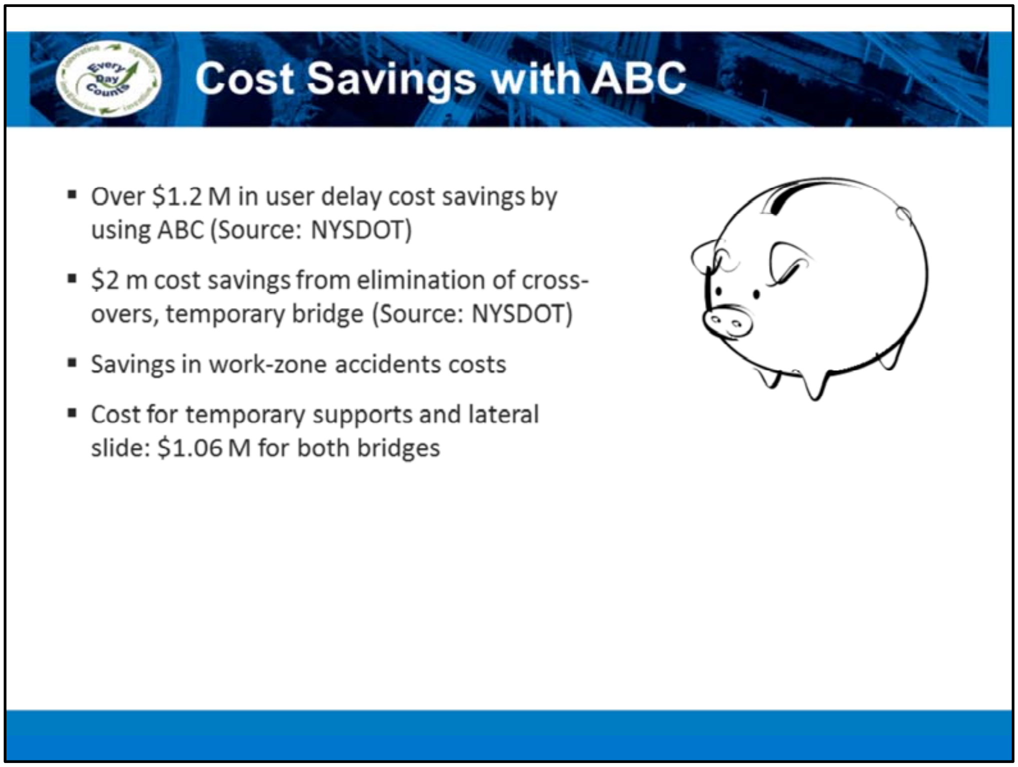


So why was SIBC the chosen method of accelerated bridge construction?

Traditional methods and even some other methods of ABC would have required the construction of a temporary bridge in the median since the existing bridges were too narrow for a crossover with two-way traffic. The construction of crossover roadways would have been complicated by the elevation differences between the eastbound and westbound roadways. In the end, the construction of a temporary bridge and crossovers would have resulted in an additional cost of $2 million.



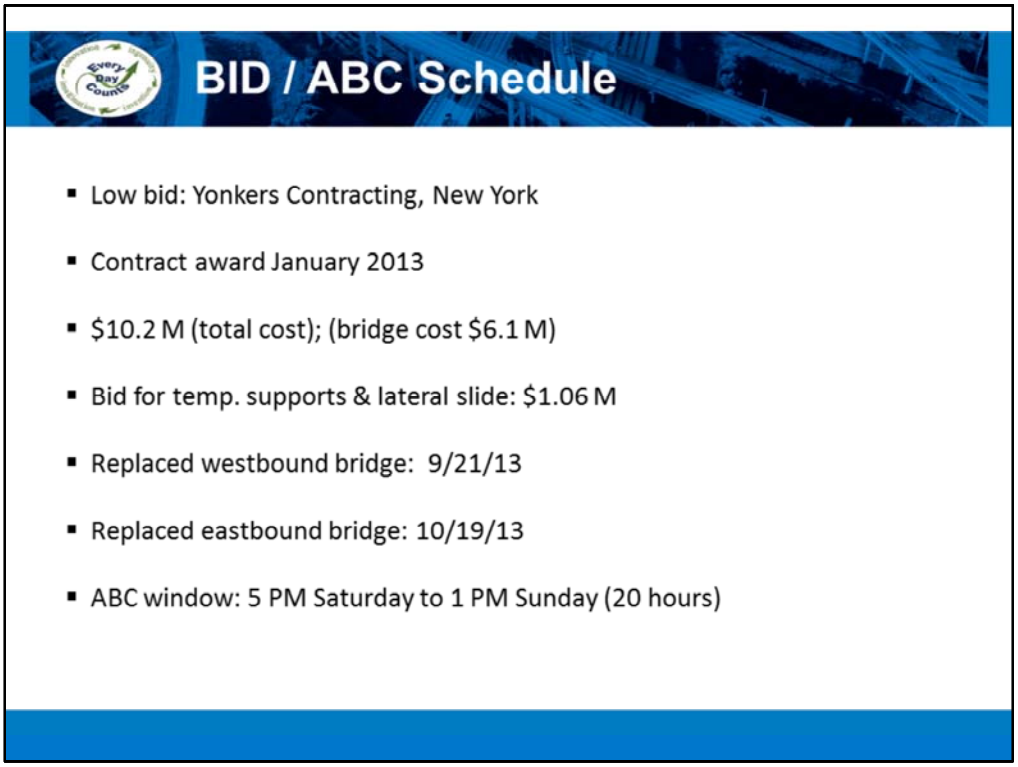
Design-bid-build was the delivery method used on this project. Some of the key team members are listed here. Note that some of the funding for design and construction came from the SHRP2 and Highways for Life programs.



A considerable amount of cost savings was realized by constructing the bridge using ABC methods rather than traditional methods.

According to the New York State DOT, over $1.2 million was saved in user delay costs. An additional $2 million was saved by eliminating the cross-overs and temporary bridge. Furthermore, an unquantified savings in work-zone accident costs was realized.

For the sake of comparison, the cost attributable to the temporary supports and lateral slide totaled $1.06 million for both bridges combined. The cost of this work is a reflection of the severity of the grading at the site. Dingle Ridge Road has an approximate grade of 15%, which resulted in large temporary shoring towers. This type of geometry is not normal, therefore the cost for this work should be taken in context.



The low bid totaling $10.2 million was received from Yonkers Contracting of New York. The contract was awarded in January of 2013. Of the $10 million, $6.1 million was directly associated with the bridge construction, while $1.06 million was used for temporary supports and slide operation.

It should be noted that the cost for bridges in the New York metro area are normally significantly higher than that in other parts of the country, therefore these cost figures should not be taken to demonstrate the cost of SIBC on most bridges.

The westbound bridge was replaced on September 21st and eastbound bridge on October 19th of 2013. For each case, the timeframe in which the existing bridge was to be removed and the new bridge slid into place and opened to traffic was 5pm Saturday evening to 1pm Sunday afternoon. Both bridges were completed within their allotted ABC window and within 10 months of the contract award date. Compare that to the estimated 2 year duration if the bridges were constructed traditionally.

In this aerial rendering, one can see the relative position of the bridges and underlying roadway. It is clear that a fair amount of right-of-way is available, thus simplifying the use of slide-in bridge construction.

The rendering shown in the top left of the slide, shows the proposed position of the bridges while in construction on their temporary works. If you look closely, you'll notice that the temporary works, approaches, and new foundations are shown.

The photo on the right shows the actual bridges constructed on temporary works, nearing completion and being prepared for the slide operation. In the end, traffic disruption on I-84 was reduced from two years to two weekend nights, while Dingle Ridge road which lies beneath the bridges was closed for only 5 days.

Shown in the next couple of slides are additional renderings of the bridge construction and slide operation.

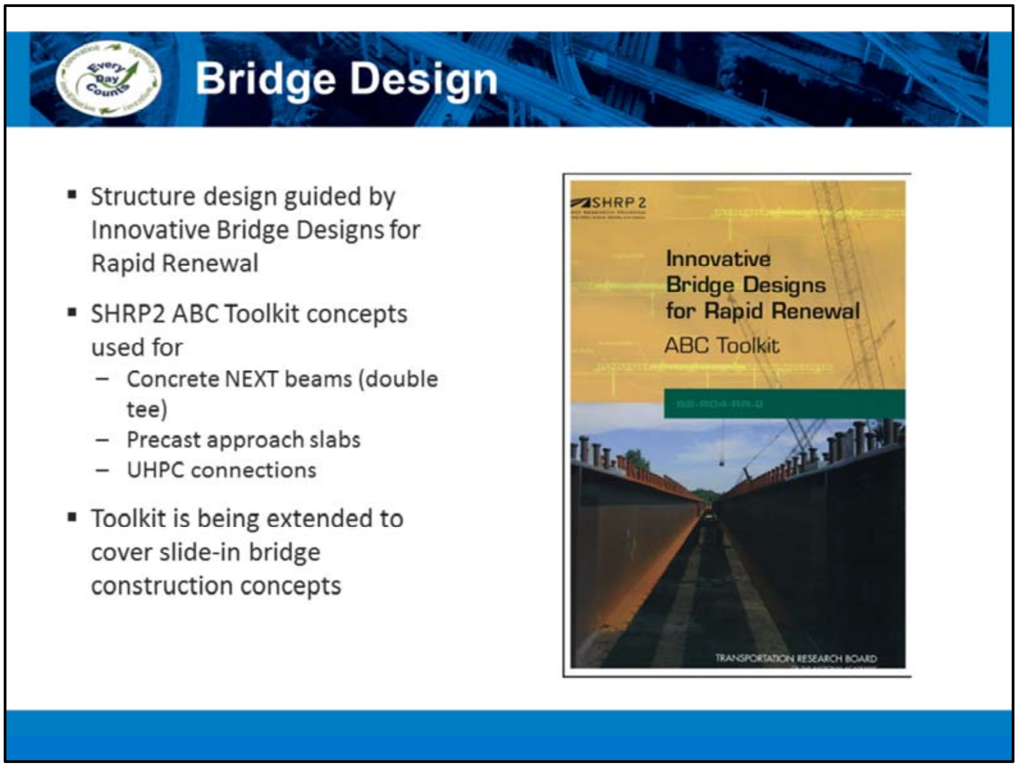
The superstructure of each bridge was constructed adjacent to the respective existing bridge. The new abutments were constructed beneath the existing bridges while still in service.

To begin the ABC period, the interstate was closed and the existing structure removed.

Once removed, preparation for the approach spans had to be completed including grading, compaction, and placement of the inverted T-beams used as a sleeper.

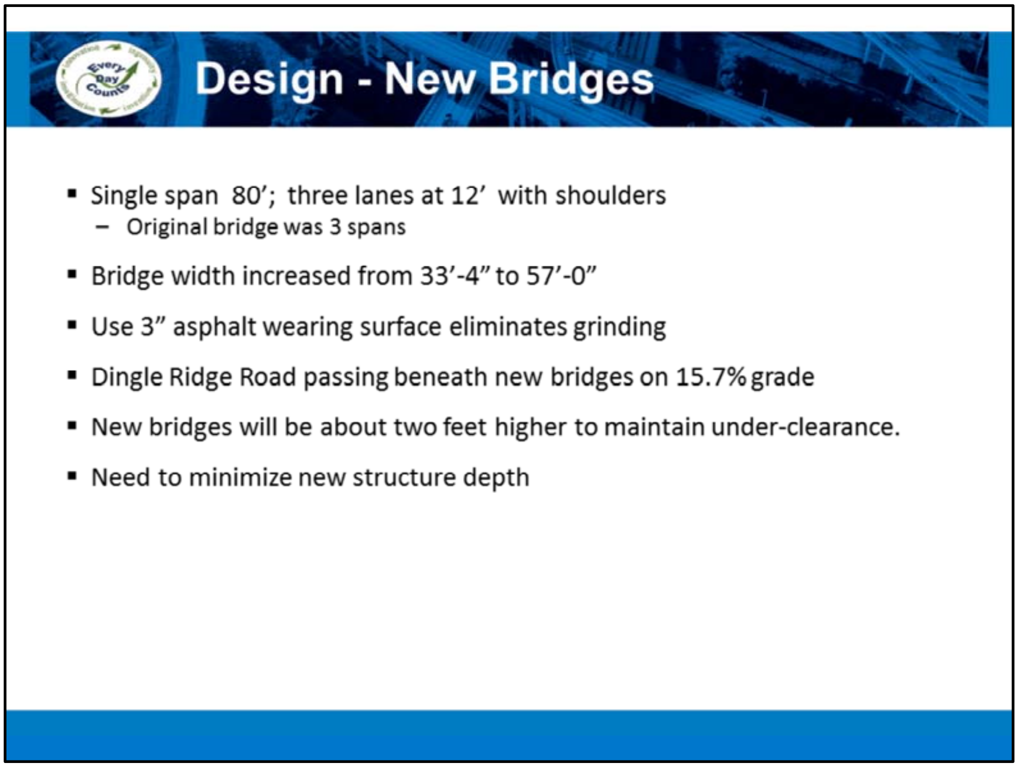
Once the preparation was completed, the slide from temporary works to permanent substructure took place.

Traffic was not rerouted to the oncoming lanes, nor could on and off ramps be used as a detour since the bridges were not located at an interchange. Fortunately, route 6/202 runs parallel to I-84 and could be used. This created a short detour of only 3 miles.



The next several slides will focus on the design aspects of this project.

Design guides have been developed through the Strategic Highway Research Program. One in particular called "Innovative Bridge Designs for Rapid Renewal: ABC Toolkit" was used extensively in the structural design; specifically, as it pertains to the concrete double-T beams, approach slabs, and UHPC connections. Though the guide wasn't written to explicitly address slide-in bridge construction, work is being completed to cover these concepts.



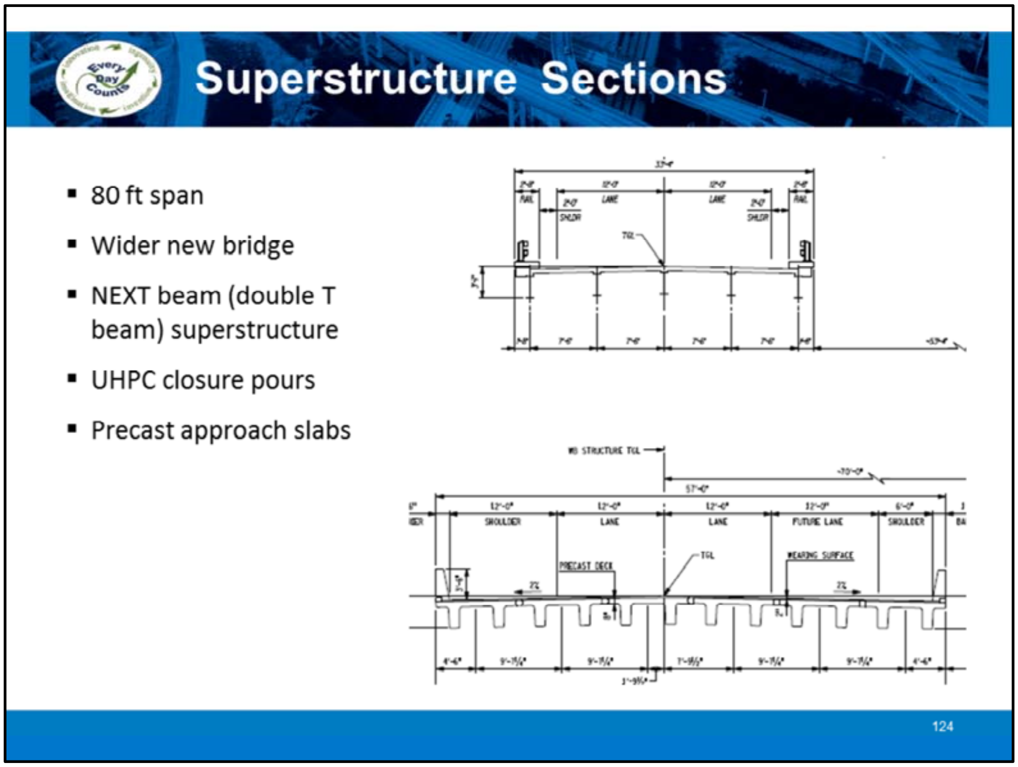
The new bridges are each 80 ft single span structures with three 12 ft lanes and shoulders totaling 57’-0”. Compared to the 33’-4” of the existing structures, the bridges each gained considerable width.

A 3” asphalt wearing surface was placed on the bridge deck, which eliminated any necessary grinding due to the UHPC connections.

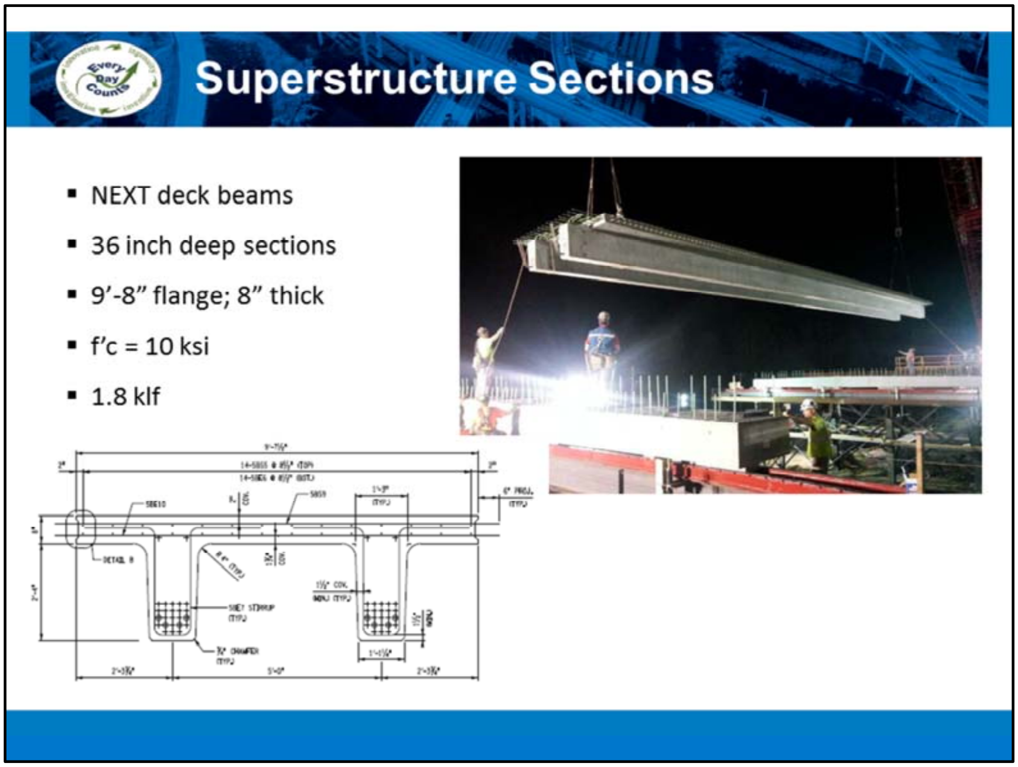
Somewhat unique to this particular location is that Dingle Ridge Road, which passes beneath the new bridges, is on a 15.7% grade. This grade posed some interesting design challenges. The new bridges were required to be raised two feet higher than the existing to maintain the under-clearance, which also meant that a concerted effort to minimize the new structure depth had to be made.

Two of the more significant design challenges were posed by these two restrictions: The slide had to be completed in one weekend night and I-84 had to be raised by two feet to satisfy the under-bridge clearance.

The photograph shown here helps illustrates the changing grade on Dingle Ridge Road.



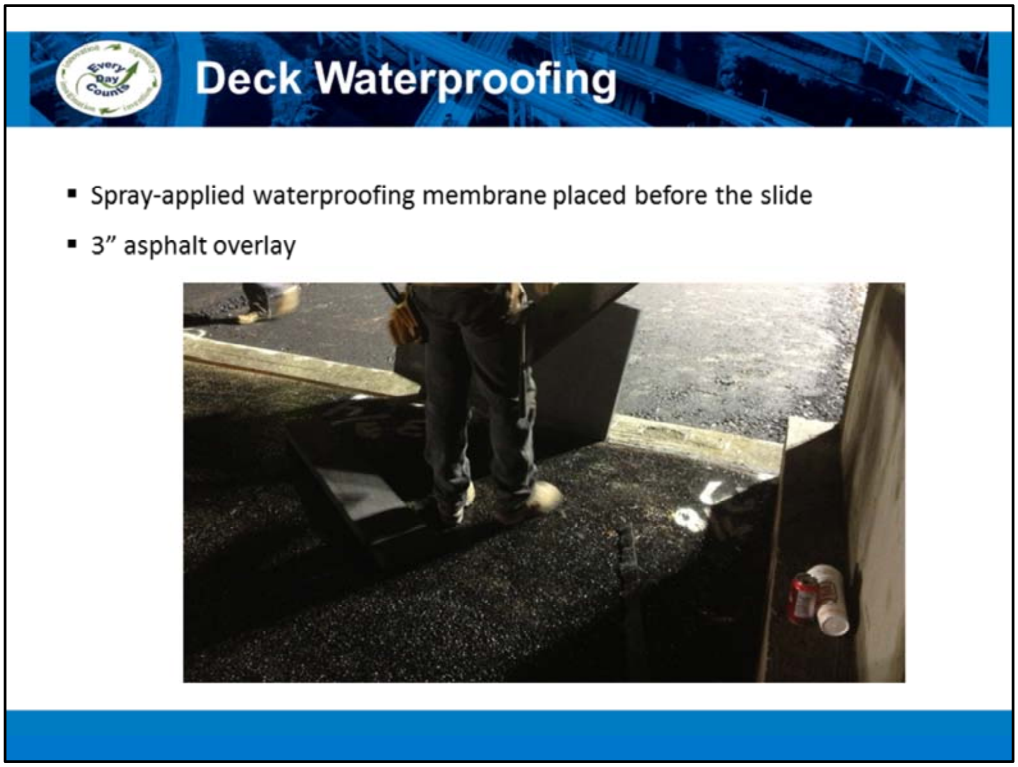
The superstructure sections, both longer and wider than those of the existing structures, were constructed using double-T precast beams tied together with UHPC closure pours, and precast approach slabs.



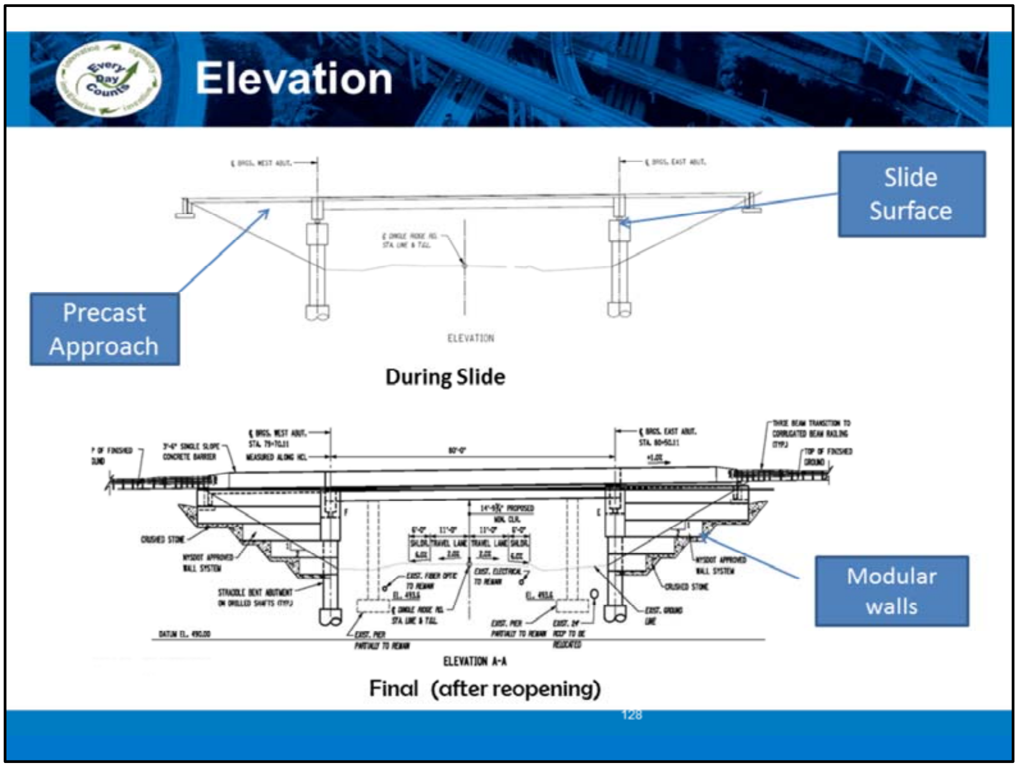
The beams chosen for the design are the Northeast Extreme Tee Beams – NEXT beams. This double tee section was developed by the PCI Northeast bridge Technical Committee, which is comprised of representatives from every northeast state, several consultants, and the PCI fabricators in the area. The beam was developed to expedite construction and reduce costs by eliminating the need for deck placement in the field.

In total, the sections were 36” deep with a 9’-8” wide and 8” thick flange. The compressive strength of the concrete used was 10 ksi and the sections weighed roughly 1.8 kips per foot.

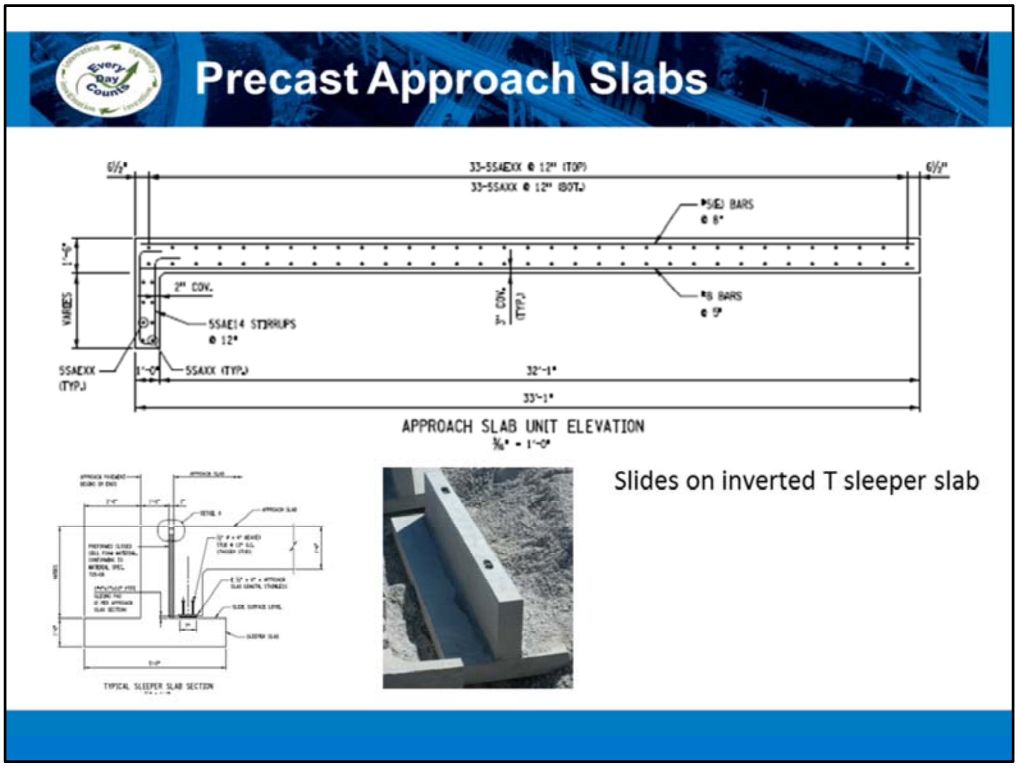
The UHPC connections, shown here, joined each of the double-T sections. The joints were 6” wide and the compressive strength of the concrete ranged from 20 to 30 ksi.



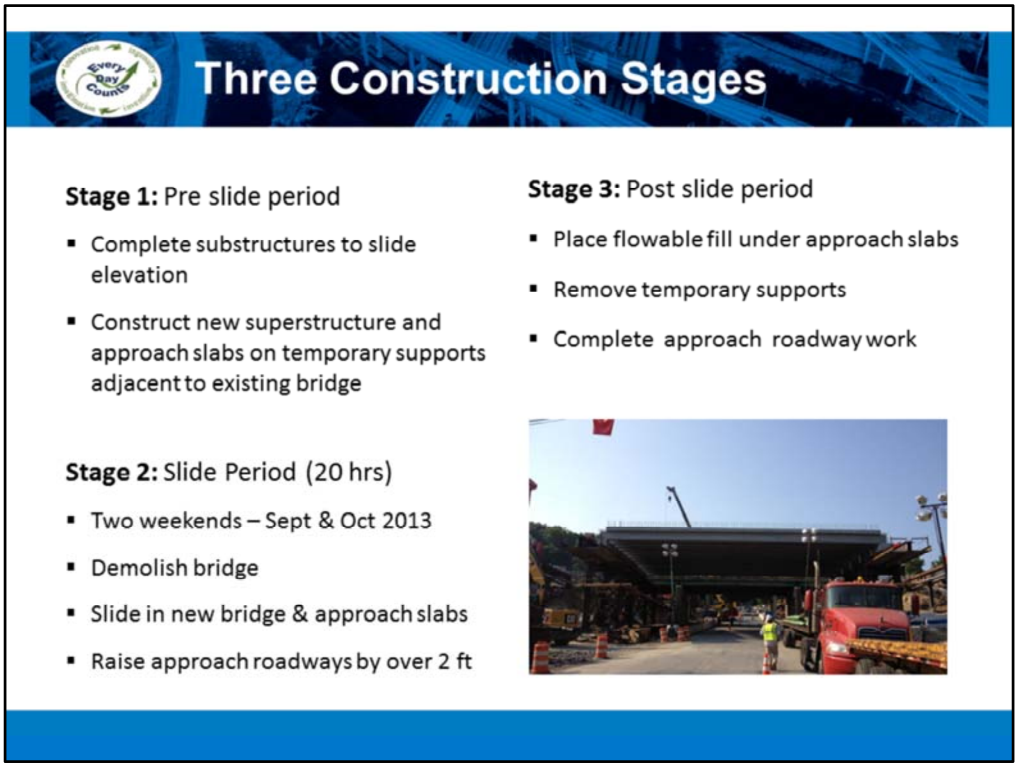
To waterproof the deck, a spray-applied waterproofing membrane was applied prior to the slide. Over that, a 3” asphalt overlay was placed.



Seen in the two elevation view drawings are the before and after-slide schematics. The approach slabs were slid into place with the superstructure. After which, a modular wall system was constructed adjacent to the approach slabs for containment of the flowable fill placed beneath the approach. The relative position of the existing piers and new abutments are depicted in the lower drawing, showing the longer span and additional roadway clearance on Dingle Ridge Road.



A close up the precast approach system is shown here. Each was 33’-1” long and 1’-6” thick with a downturned end. The end of the approach slab was slid on an inverted T sleeper slab which was placed after demolition of the existing structures.

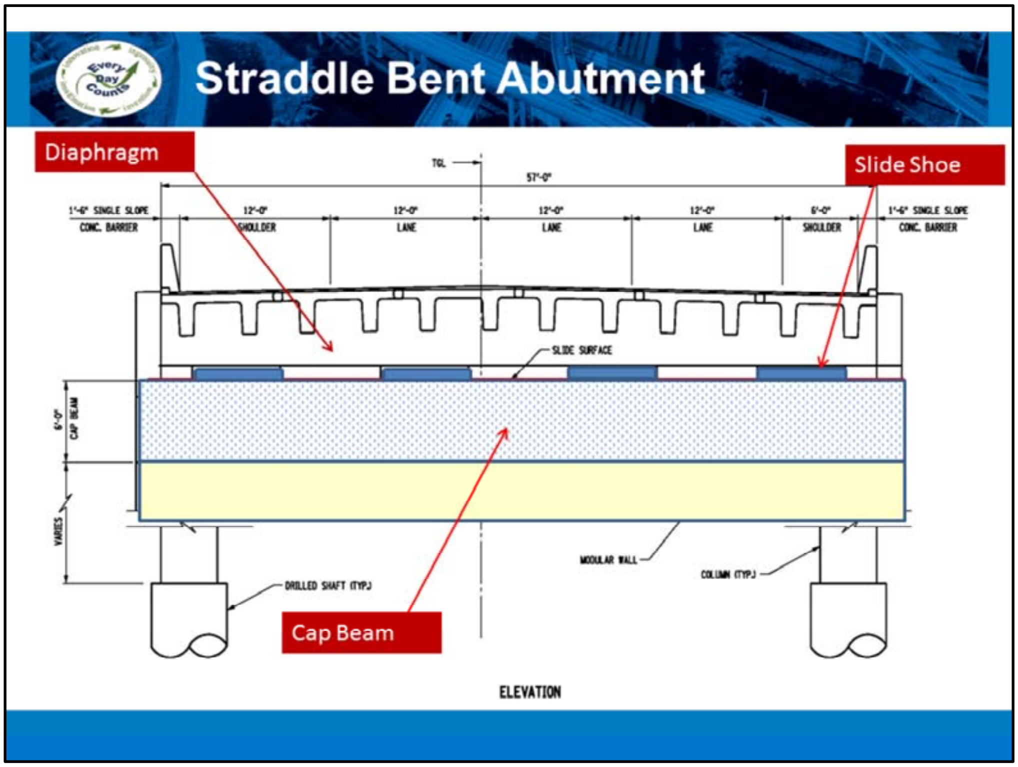


The overall construction process consisted of three primary stages.

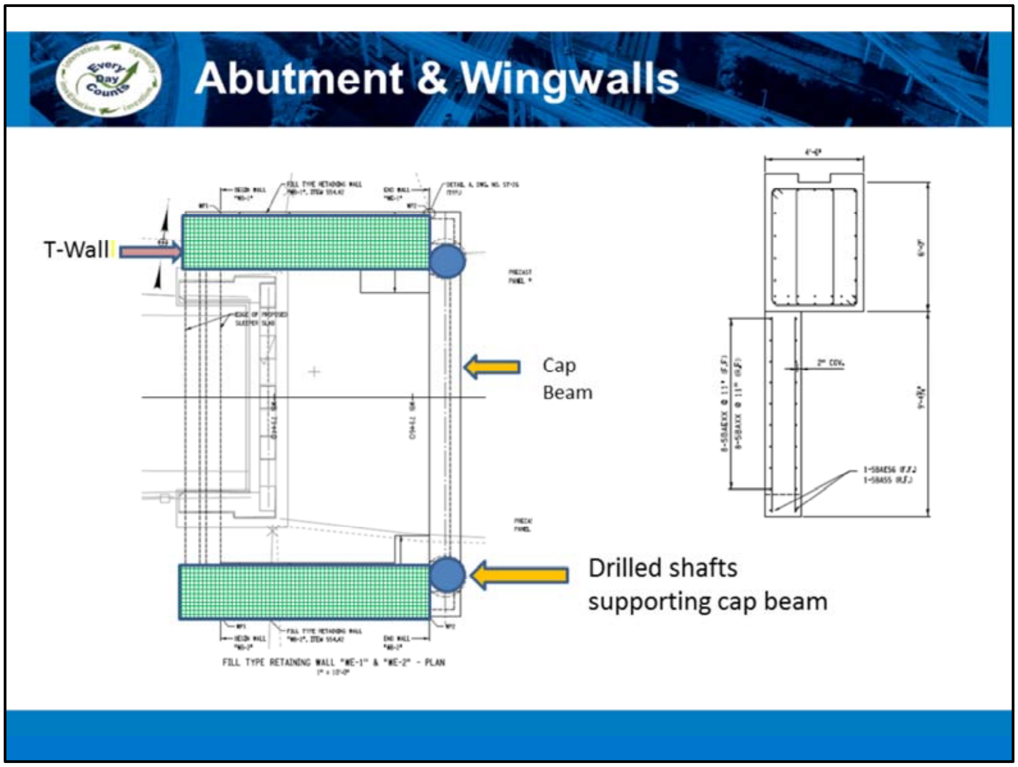
The first stage, prior to the slide, involved the completion of the substructure to slide elevation and construction of the new superstructure and approach slabs on temporary supports adjacent to the existing bridge.

Stage 2, the 20 hour slide period, occurred separately for each bridge over two weekends. During the stage, the existing bridge was demolished, the new bridge slid into place, and approach roadways raised 2 ft.

Stage 3 consisted of placing flowable fill beneath the approach slabs, removing temporary supports, and completing the approach roadway work.



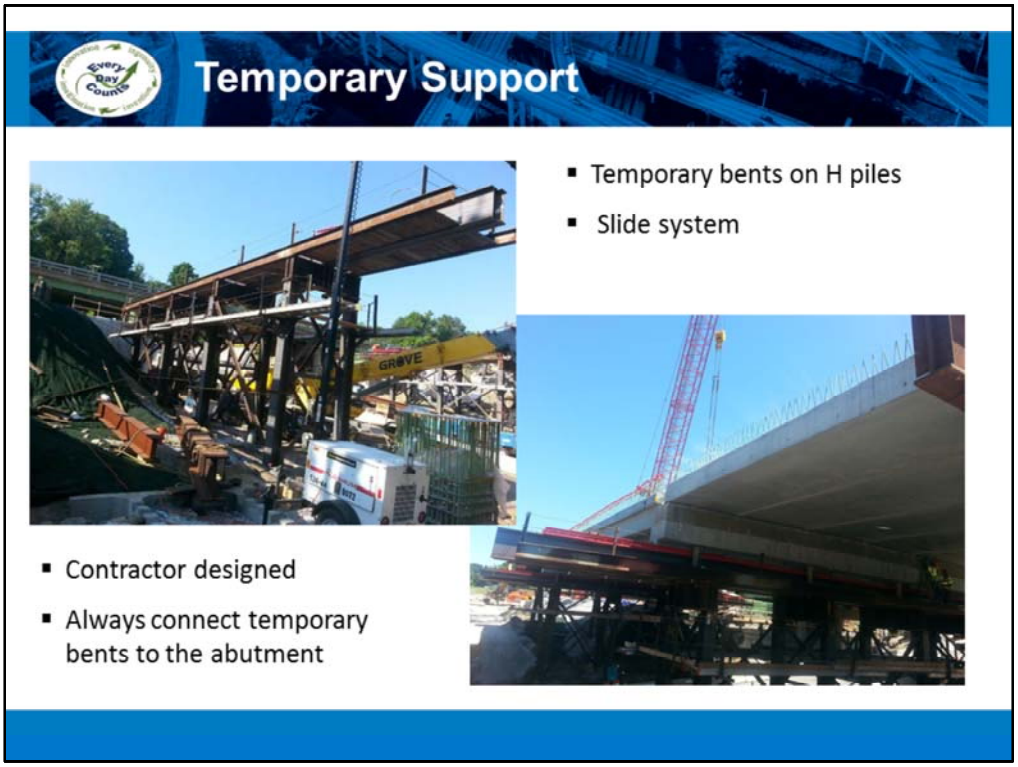
Shown here in the drawings for the straddle bent abutment are three elements critical to the slide operation. Those being, the diaphragm encapsulating the ends of the double-T beams, the slide shoes on which the superstructure will be slid, and the cap beam which was constructed beneath the existing structures prior to the slide.



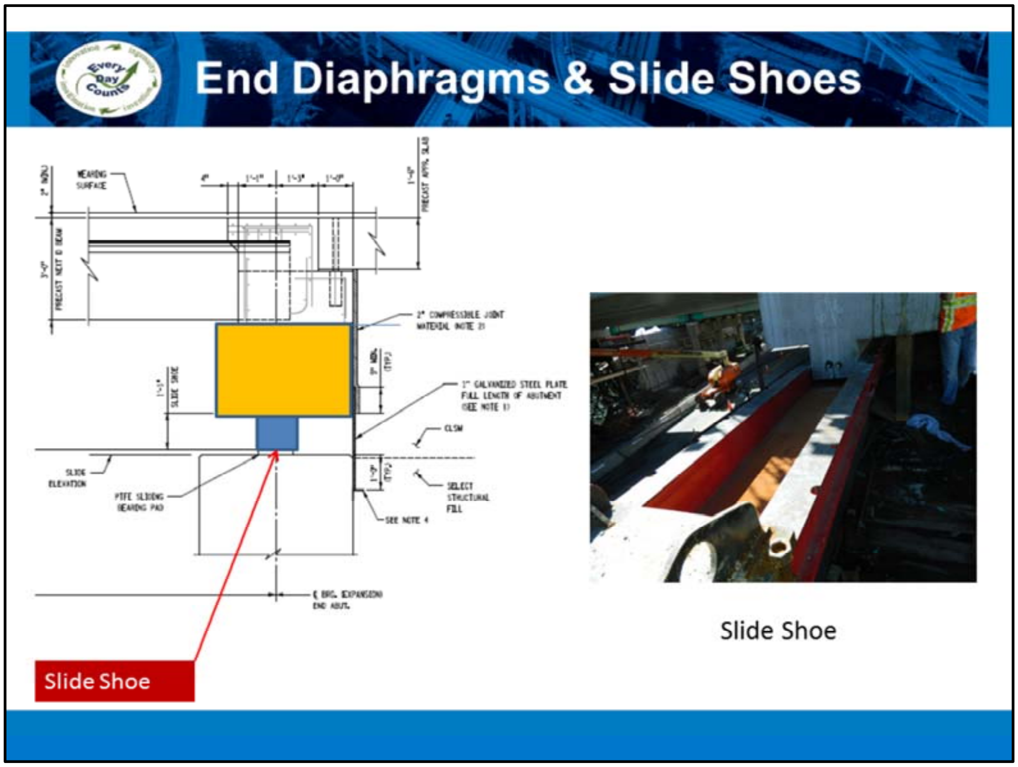
A plan view of the section shows the drilled shafts supporting the cap beam and the t-walls adjacent to the approach slabs which contains the flowable fill.

The new foundation system is shown placed beneath the existing structure in this photograph.

Additional pictures of foundation construction clearly depict how the new foundation was constructed under the existing structure while the roadway remained in service.



The temporary supports were steel structures founded on H-piles. The system was designed by the contractor and incorporated the necessary elements to properly slide the new structure.



Vital to the success of the slide were the end diaphragms and slide shoe. The diaphragm provided a rigid, stout connection point for the jacking system to react against. The slide shoe, made up of a full-length stainless steel plate, provided a reduced-friction track on which the superstructure could slide on the PTFE bearing pad.

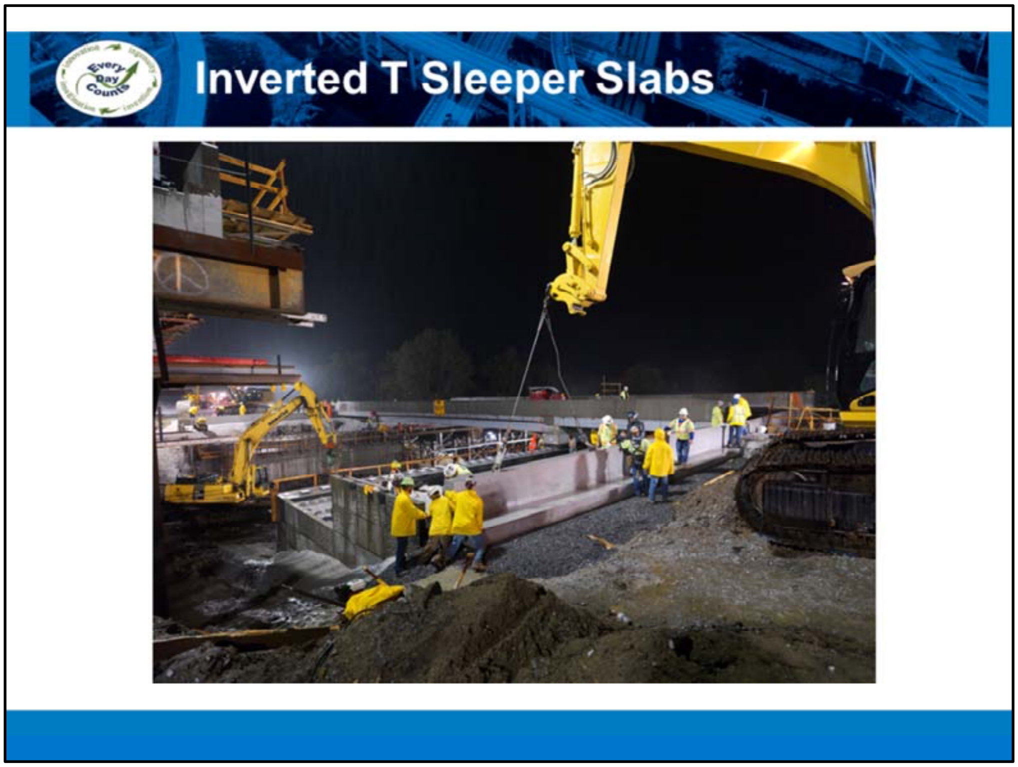
Shown in this photo are the new bridges nearing completion alongside the existing. Note that the bridges have remained open to traffic to this point.

These pictures provide a better glimpse of the stainless steel slide shoe and the 16 gage PTFE bonded to the elastomeric bearing pads.

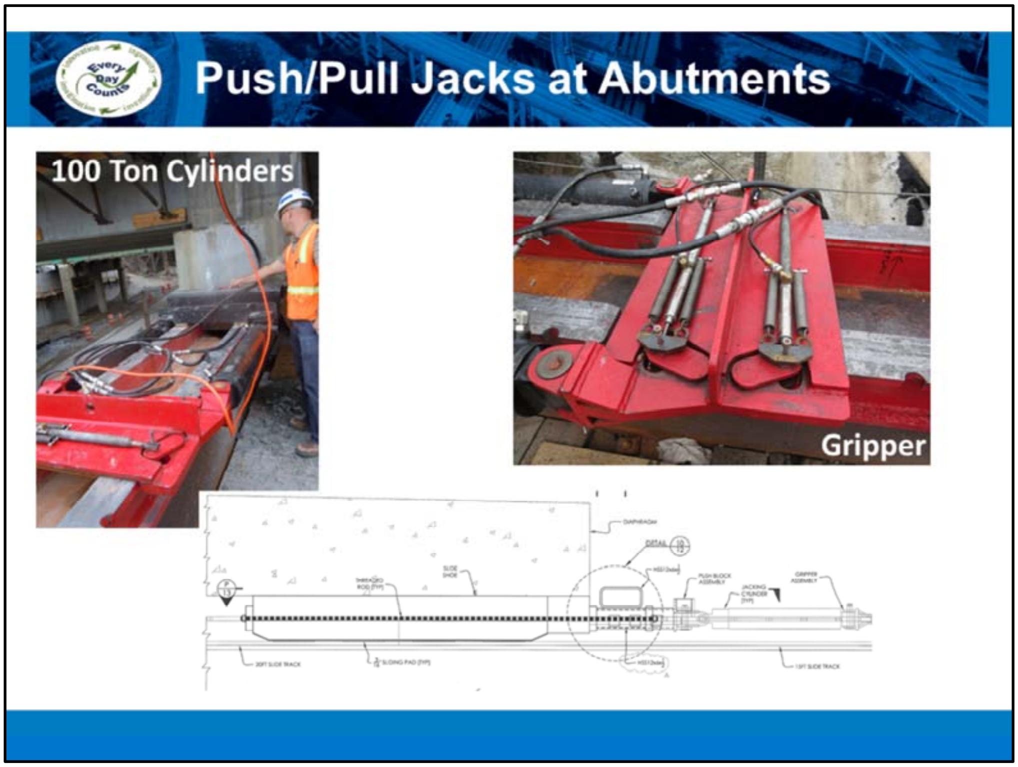
Approach Slab Slide Surface

Stainless steel on PTFE pads

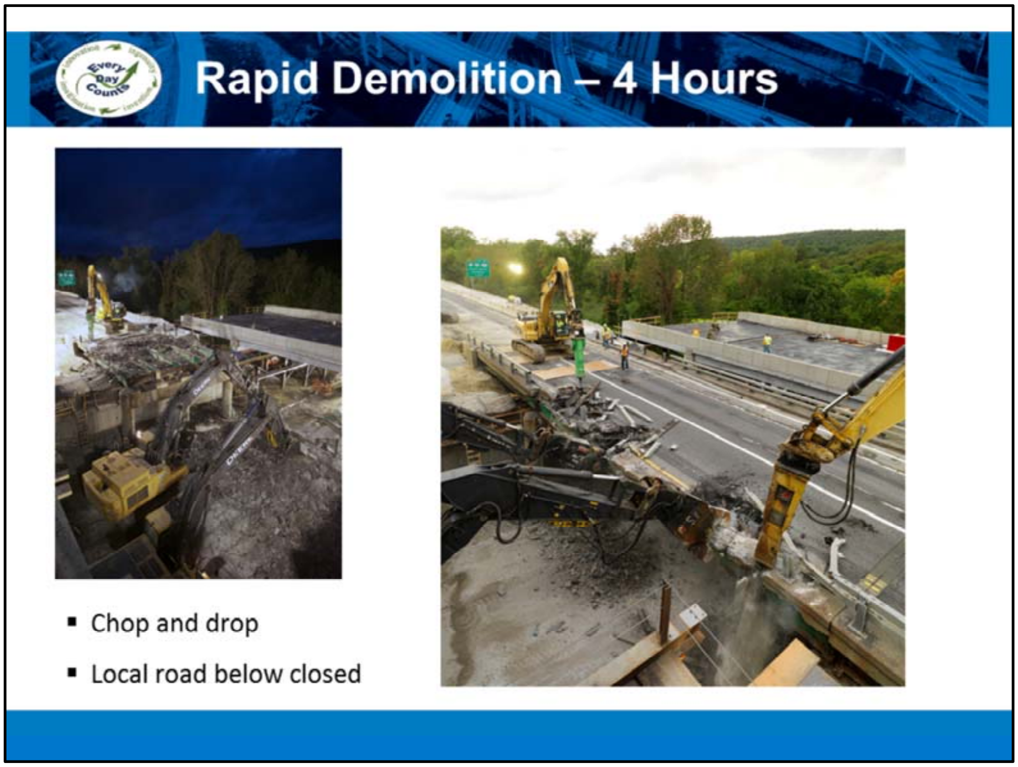
Similarly, the approach slab was slid on PTFE pads.



The inverted T- sleeper slabs were placed once the existing bridge was removed.

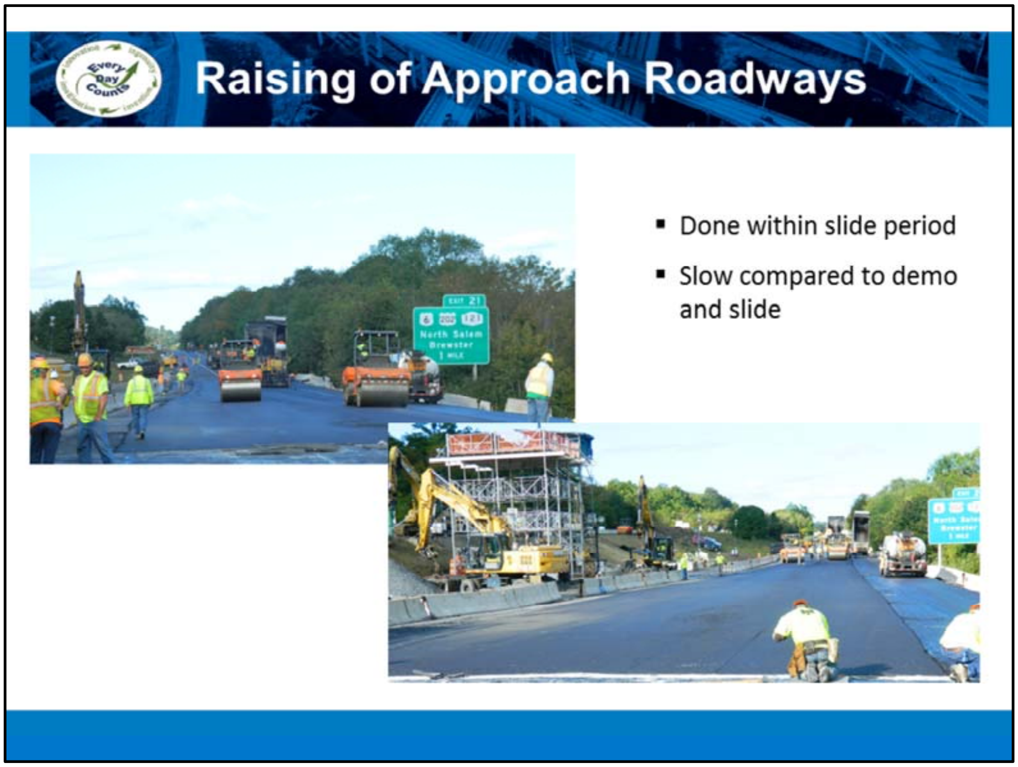


The jacking system consisted of two 100 ton push/pull jacks placed at the abutments. A system was devised to enable the repositioning of the jacks as the bridge was slid into place.



The demolition was completed in four hours using chop and drop methods. At this point in time, the local road beneath was closed for obvious reasons.

Another view of the temporary supports is shown here shortly after the bridge was slid into place, again showing supports at each diaphragm and end of approach slabs.



One of the more major and time consuming tasks to be completed during the short slide period was the raising of approach roadways. Relative to the actual slide, this process was considerably slower.

Shown here is one of the completed bridges. Both bridge slides were completed within 10 months of the notice to proceed.

Another view of the completed bridges shown from Dingle Ridge Road.

Lessons Learned

- Focus on roadway approaches as much as structure slide-in
- Need for displacement control during slide
- Importance of camber control in P/S beams
- With full depth precast P/S sections its recommended to use asphalt overlay

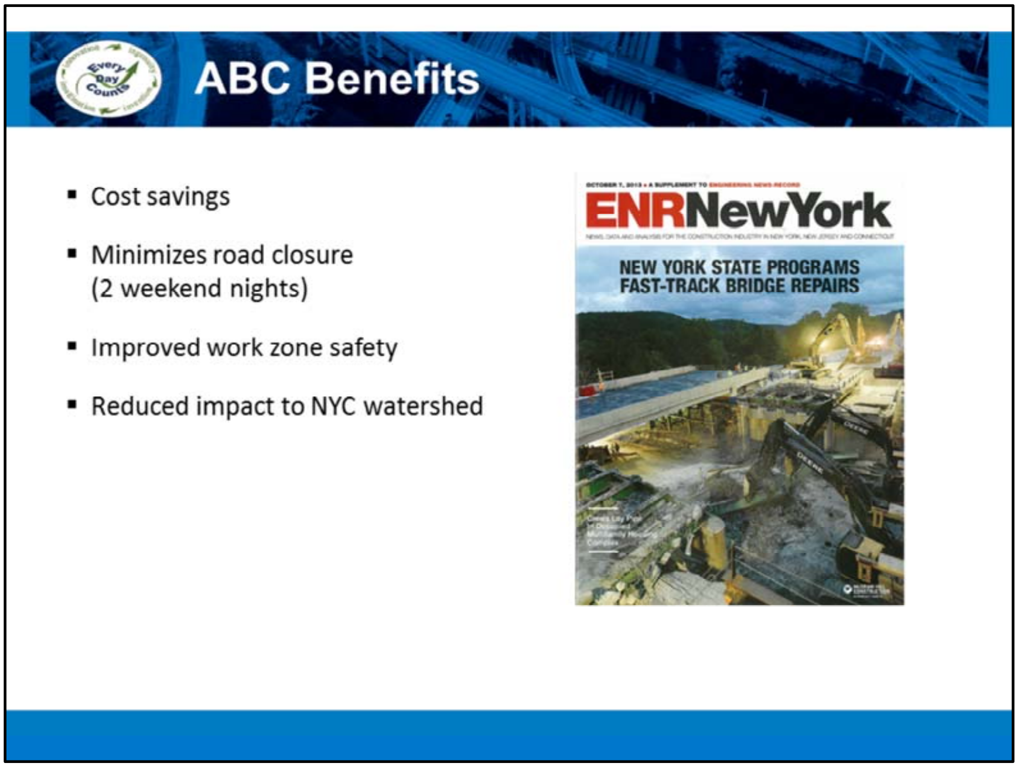
Many lessons were learned on this project, probably more than can be listed here. Even so, a few significant lessons that should be mentioned include these.

A focus on the roadway approaches should be made as much as the structure slide-in.

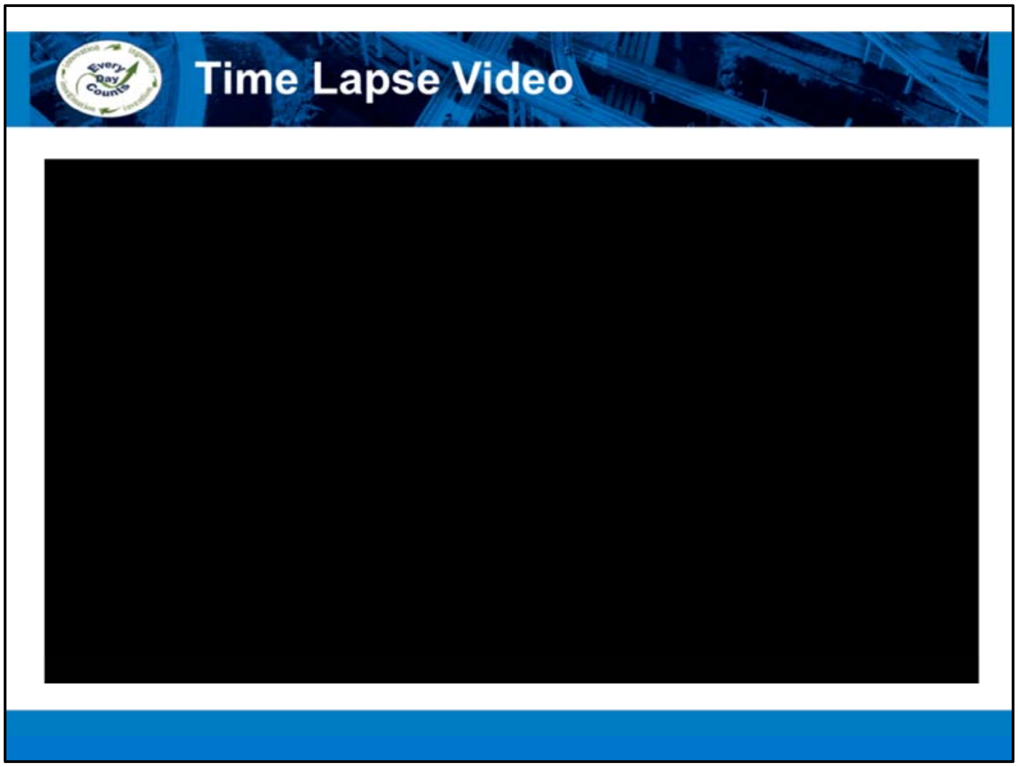
There should be displacement control in place during the slide.

It is important to control the camber of the prestressed beams to better control and align the closure joints.

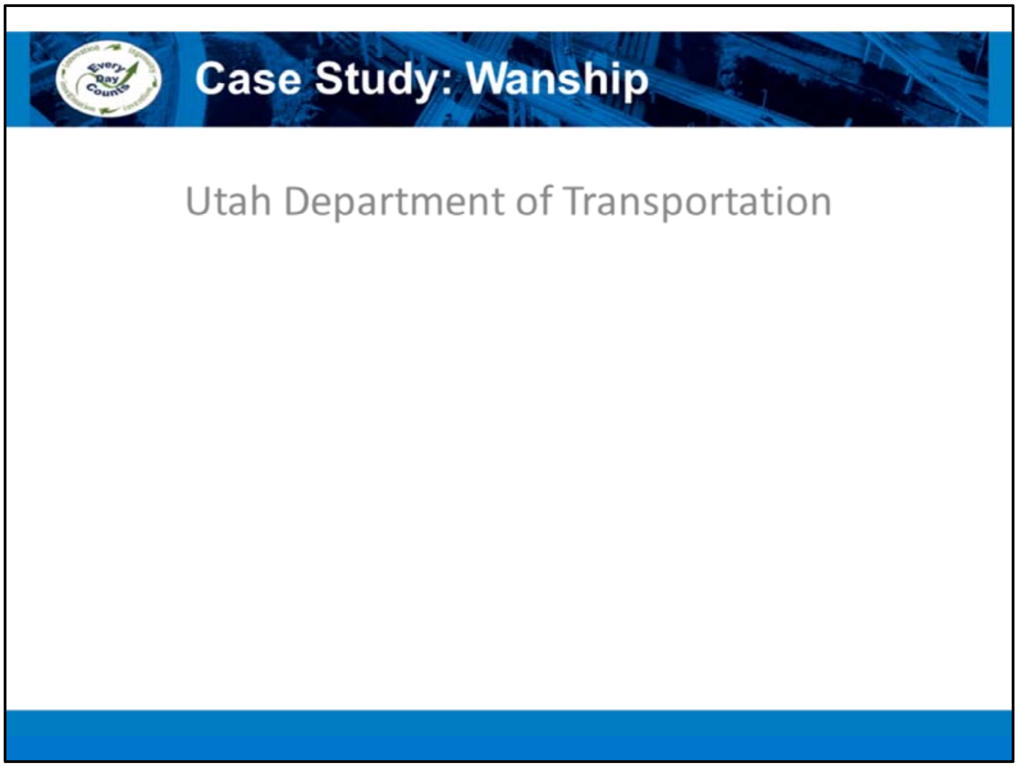
It is recommended to use asphalt overlay on a system using full depth precast sections to serve as a barrier between the deck joints and the road surface.



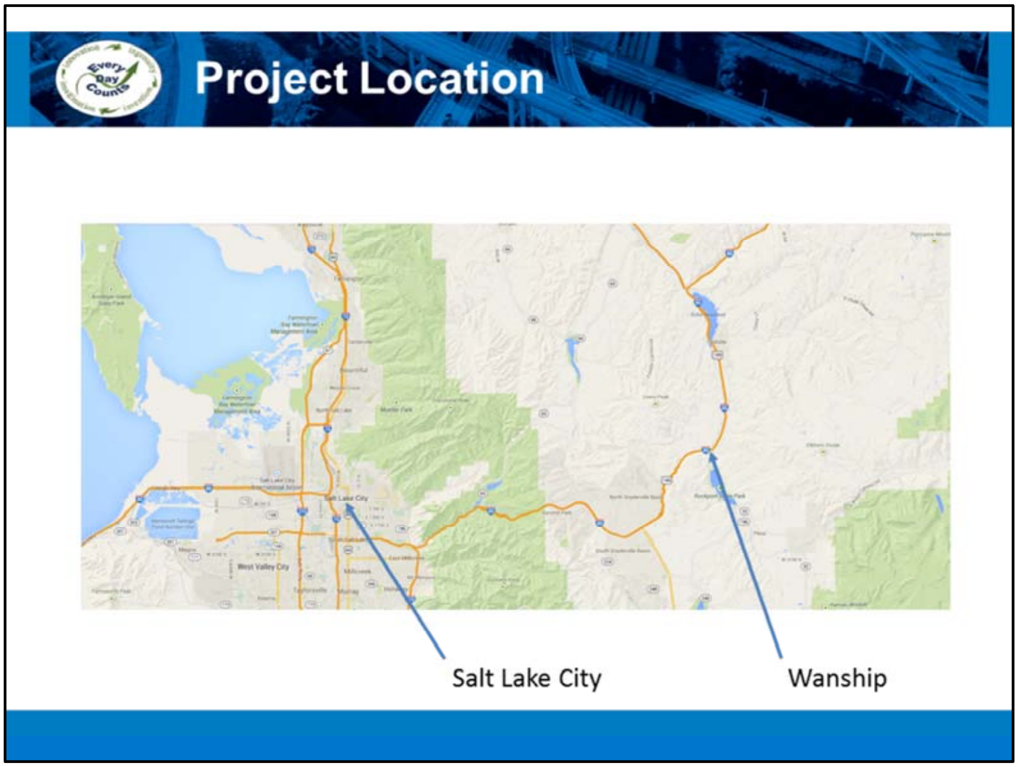
Some of the major benefits specific to this project include the cost savings, a minimal road closure, improved work zone safety, and a reduced impact to the NYC watershed.



This time lapse video shows the project beginning with the road closure at the start of the slide period. You will see the bridge demolition and removal, the slide of the new structure, and preparations for the reopening of the roadway. Finally, you will see the new bridge in action.



The Utah Department of Transportation has been a national frontrunner in accelerated bridge construction. One of several projects they've completed in recent years was a slide-in bridge construction project near Wanship, UT.



Wanship is located on interstate 80 approximately 35 miles east of Salt Lake City.

Several reasons exist for selecting accelerated bridge construction and, specifically, slide-in bridge construction. These include the fact that the bridge is located on a mainline interstate, has a high truck traffic count, and is a primary route for a great deal of recreational traffic.

Furthermore, available staging areas were available for construction adjacent to the bridge.

With any bridge project selected for possible accelerated bridge construction a cost risk assessment and value engineering study is recommended.

Project Overview

- Replacement of EB & WB I-80 at Wanship
- Replaced 3 span with single span structure
- Full retaining abutment in center with full height wingwalls
  - Constructed while existing bridge in service
- Built superstructures to the side of existing and slid to final location

A quick overview to highlight some of the project details is provided here.

The project consisted of the replacement of bridges on eastbound and westbound I-80 at Wanship.

The existing three-span structures were replaced with single span structures.

Full retaining abutments were constructed with full height wingwalls while the existing structure remained in service.

The new structures were constructed adjacent to the existing prior to their slide into final position.

Project Overview

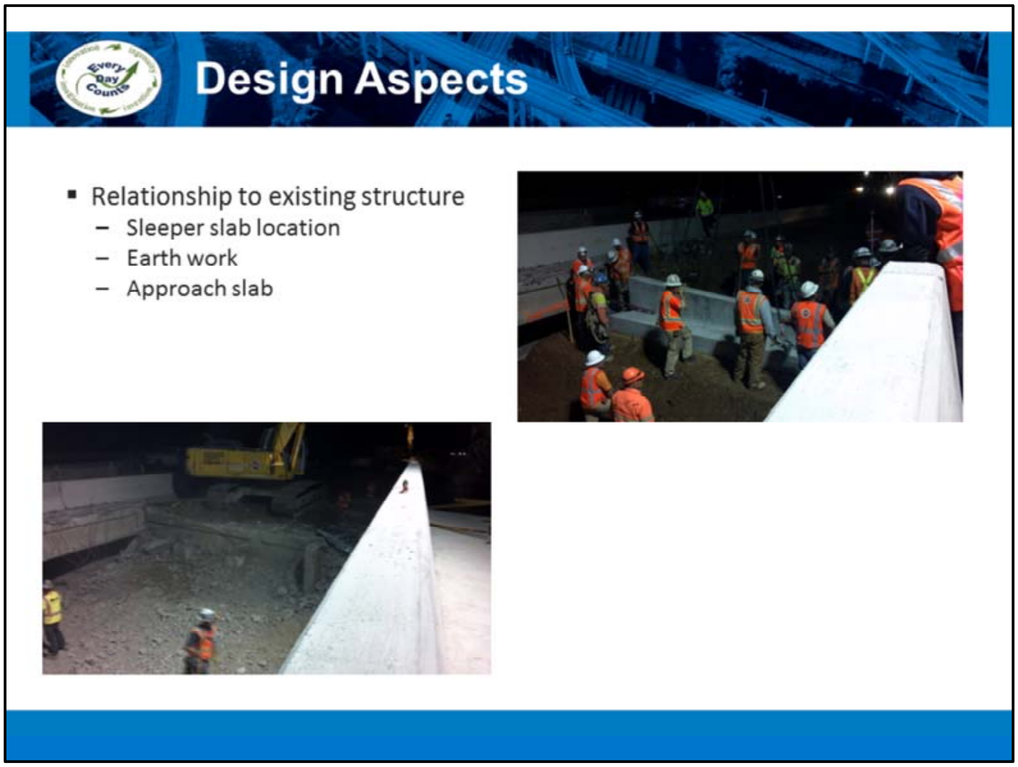
- All thread jacking/sliding system
- Ramps used as detour
- Spread footings

A threaded bar jacking and sliding system was used to slide the bridge into place. Traffic control was achieved by using the on and off ramps as a detour. Additionally, spread footings were used in the foundations for the new structure.

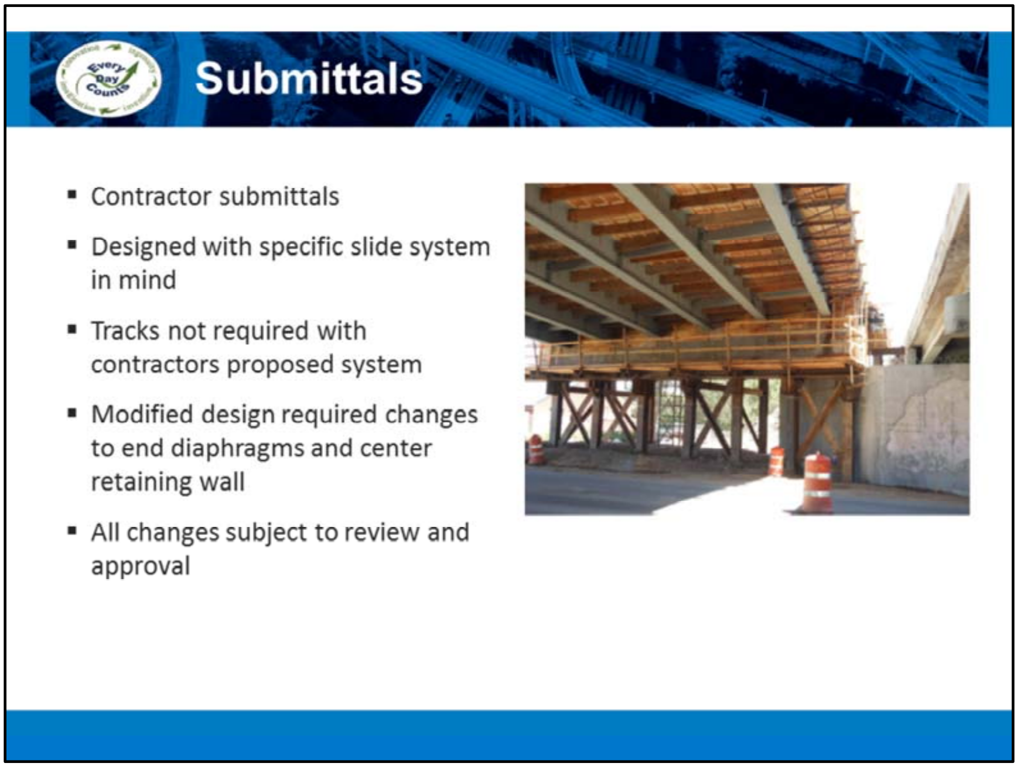
Certain design aspects required special considerations.

For example, in order to maintain the vertical clearance required, I-80 would have had to be raised which would have made a bridge slide less favorable or SR-32, which lies beneath the bridge, would have had to be lowered creating a low spot and future drainage issues; utilities also would have had to be moved.

A decision to use stainless steel reinforcing in the bridge deck, at 3.5 times the cost, was made in order to reduce the deck thickness by ½”, and also to remove the waterproofing membrane. It is hoped that the deck will achieve a 75 year life.



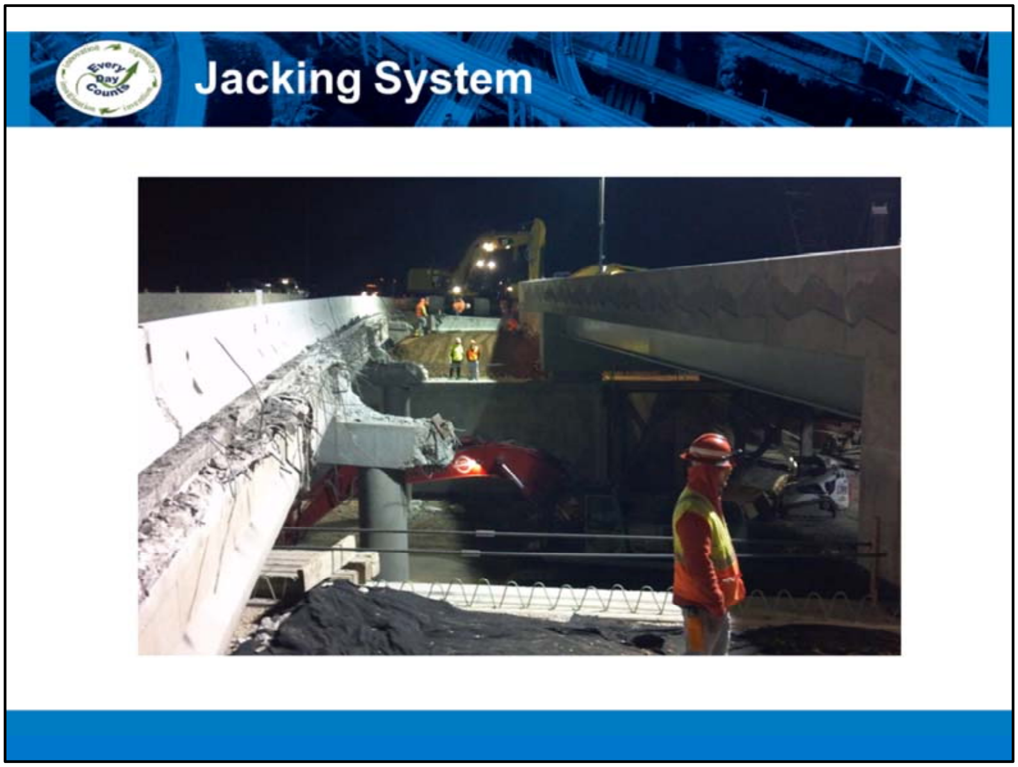
A decision regarding the sleeper slab for the approach span and its relationship to the existing abutment had to be made. If in front, considerable earth work would be required during the full closure. If on top, additional structure removal and some extra earthwork would be required. If behind, minimal earth work would be required, but approach slabs would have to be extended out beyond the standard 25’ length.



As part of the contractor's submittals, temporary support designs and details along with connection sliding details and calculations were required.

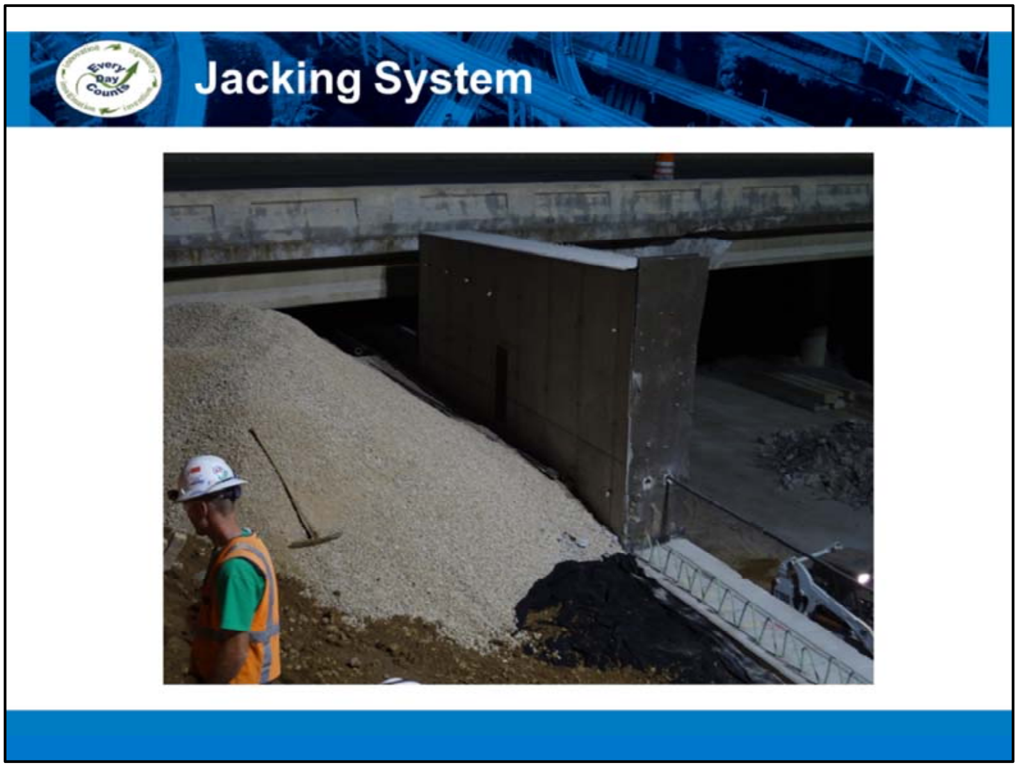
The project was originally designed with a specific slide system in mind. When submitted, the contractor proposed to modify the sliding system from using large jacks and slide tracks to using smaller jacks without a track system. The modified design required changes to the end diaphragms and center retaining wall between the two bridges, however.

All proposed changes were subject to review and approval.



The bridge was slid using Dywidag rods threaded through the end diaphragms. This system is seen in the foreground of this picture.

Another view of the slide system is seen here. The large retaining structure constructed between the bridges was used as a reaction block.



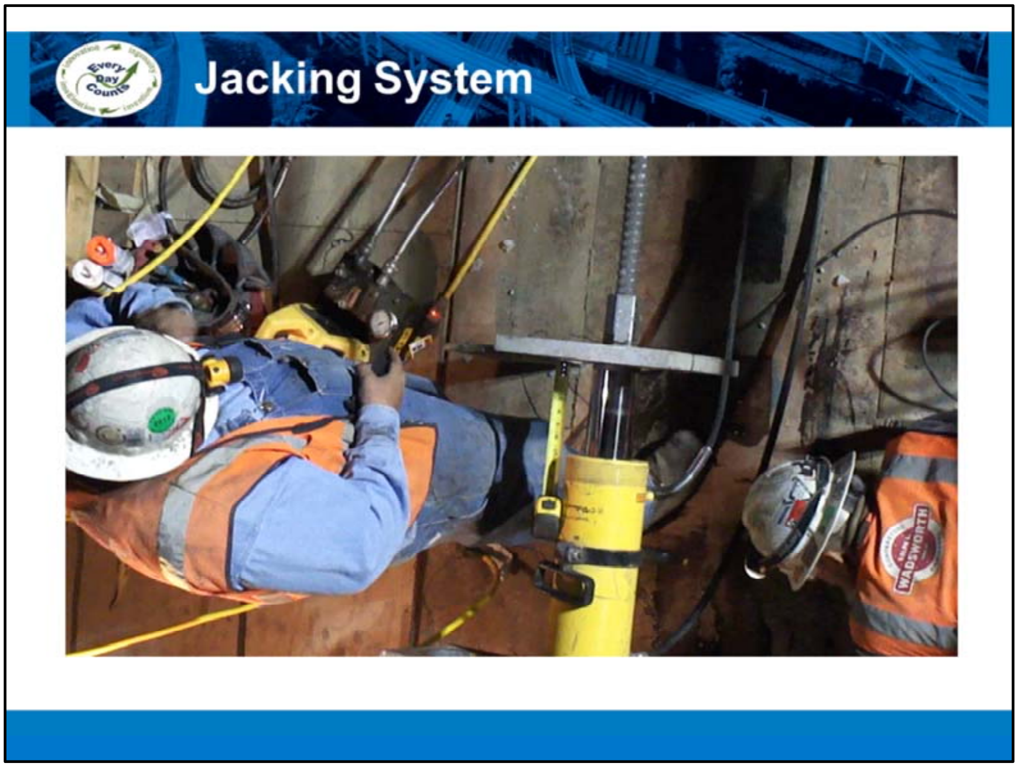
The reaction block is also seen here from another viewpoint. Notice the Dywidag bar threaded through the block.

Jacking System

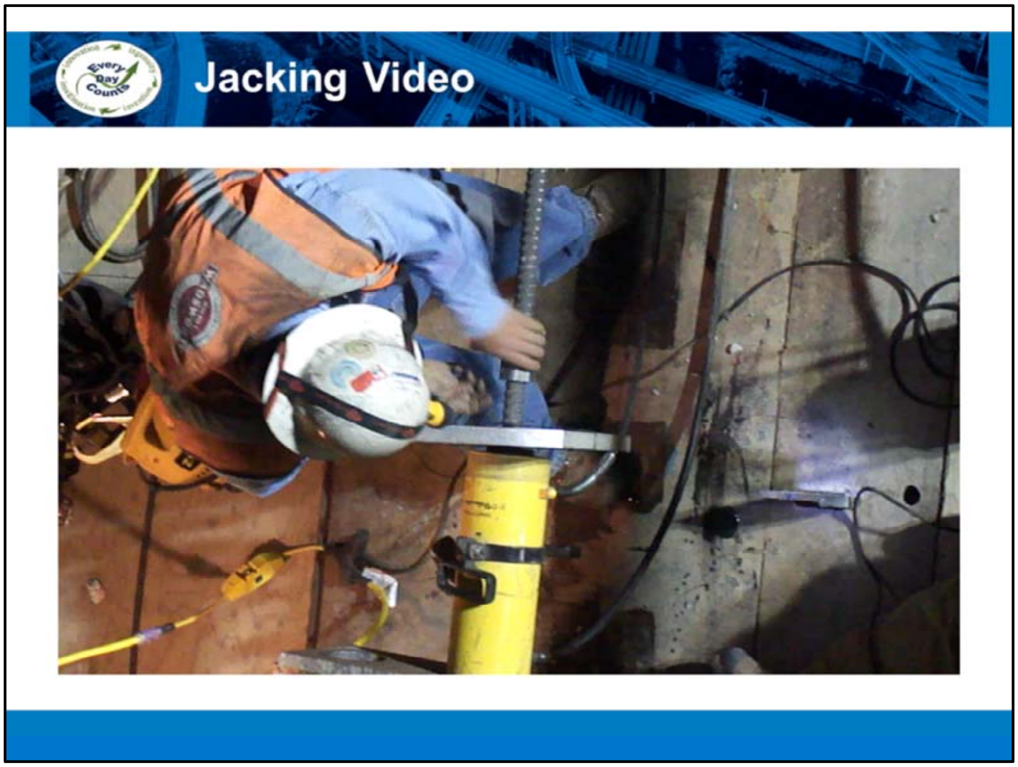
The bar exited the opposite side of the block and was anchored with steel plates and heavy duty nuts.

The threaded bars were placed through the end diaphragm of the new superstructure and attached to small jacks that then pushed the bridge into place. No tracks were needed, requiring less setup. Additionally, the prime contractor was able to complete the move without having to bring a subcontractor on board.

In addition to the threaded rods and jacks, a reduced friction surface was achieved through the use of stainless steel plates and elastomeric bearing pads bonded to PTFE coated with dishwashing soap.



Through a single control, the jacks were operated pushing the bridge into place. The jack would run until the stroke was maxed out, then paused, retracted and reset for the next push.



This process is shown here in this video.

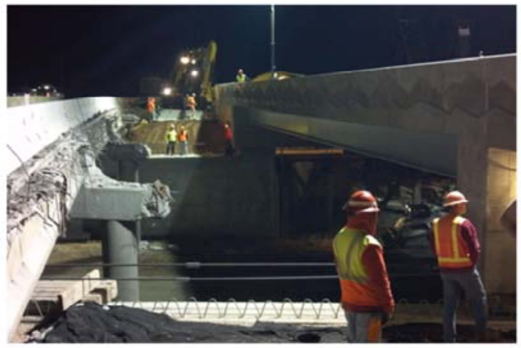
During the slide, the alignment was tracked along the abutment using this primitive, yet useful, tool. Even more, the gap between the sleeper and approach slab was continually measured.

Alignment Control

These pictures show additional views of the alignment control methods.

Closure Times

- Closed 16 hours for westbound
- Partial slide the day before the closure
  - One lane remained open on I-80



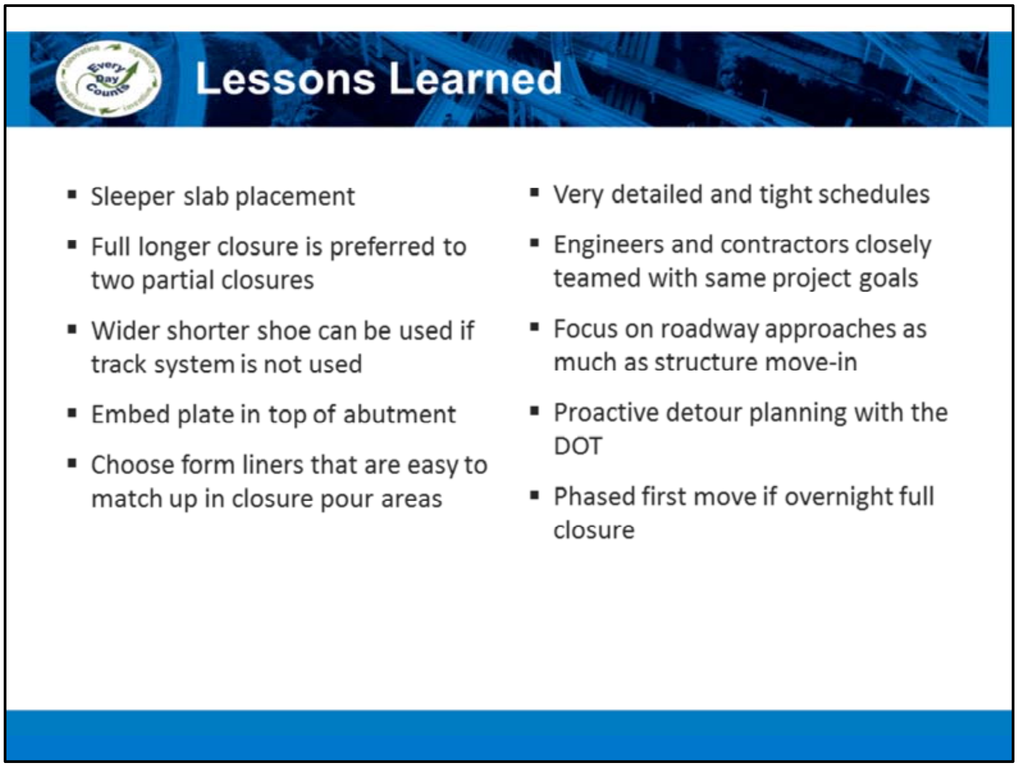
An 18 hour full closure was allowed on I-80 without penalty. The duration of closure for the westbound bridge was only 16 hours, thereby meeting the timeframe requirements.

A partial slide was completed the day before the full closure. One lane remained open during this time.

Closure Times

- Closed 18 hours for eastbound
- Completed move in one night
- Limited to one night due to the condition of the existing structure

For the eastbound bridge, a 24 hour full closure was allowed and the process was completed in 18 hours. The slide portion was completed in one night, which was required due to the condition of the existing bridge.



Numerous lesson were learned on this project.

To start, regarding the sleeper slab, the best placement is directly on top or behind the existing abutment, not in front.

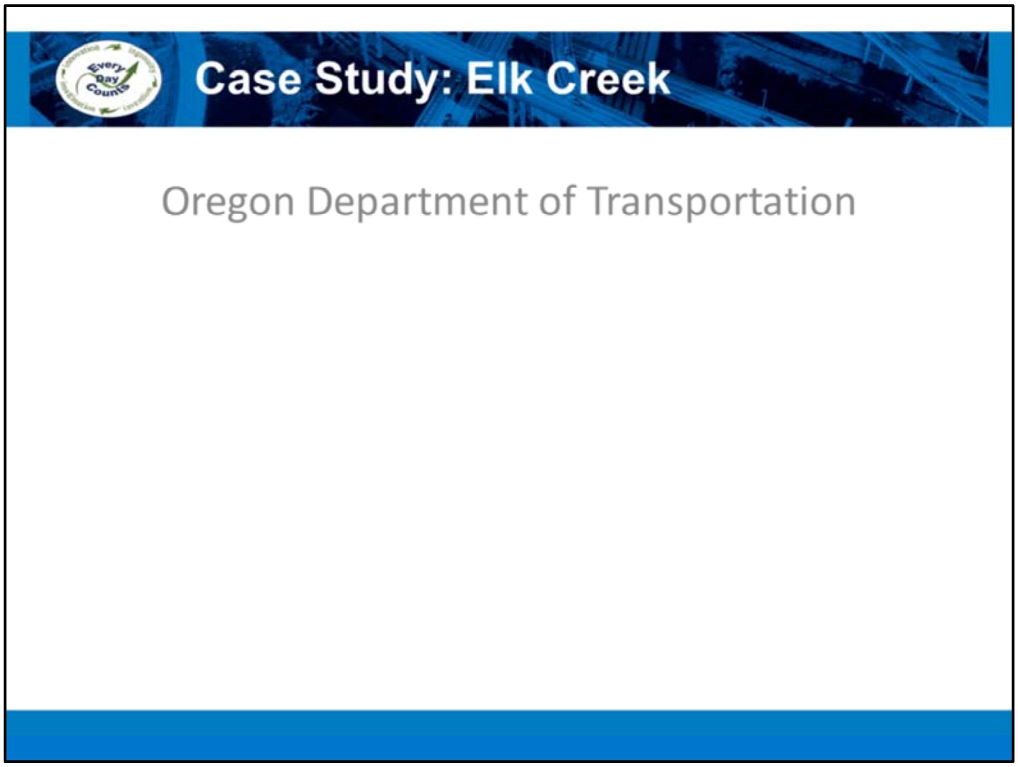
A full longer closure is preferred over the two partial closures. This would allow for fill to be placed in one lift across the entire roadway section, allowing for better compaction and bigger equipment. It also removes the potential failure plane at the subgrade between the two phases.

A wider shorter shoe can be used if the track system is not used. A way should be identified to embed the plate in the top of the abutment or other means to address tolerance issues between the slide shoes and the abutment. Choose form liners that are easy to match up in closure pour areas.

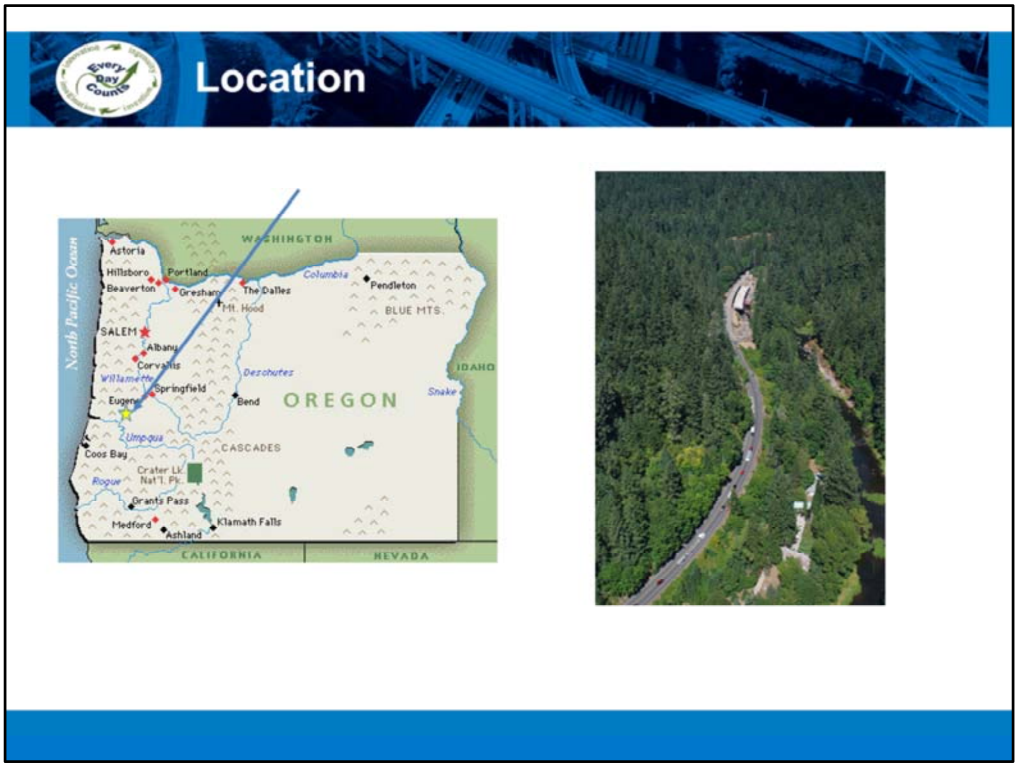
Very detailed and tight schedules are recommended to ensure a smoother process. It is of great benefit to the project when engineers and contractors are closely teamed with the same project goals.

Special attention should be paid towards the roadway approaches as they can be as critical to the operation as much as the structure slide-in.

Proactive detour planning with the DOT can reduce effects on the traveling public. Lastly, a phased first move is recommended if an overnight full closure is used.



The Oregon Department of Transportation completed a project requiring several bridge replacements on State Highway 38 between the towns of Elk Creek and Hardscrabble, two of which were replaced using slide-in bridge construction methods. Here forward, the bridges will be referred to as Crossing 3 and Crossing 4.



The project is an hour south of Eugene in the mountains of western Oregon. The terrain alone would have been enough to make any bridge replacement project more difficult. Couple that with the desire to maintain traffic through the corridor during construction and the difficulty is only increased.

Project Overview

- Design Build, Best Value Selection
- Winning team proposed 2 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

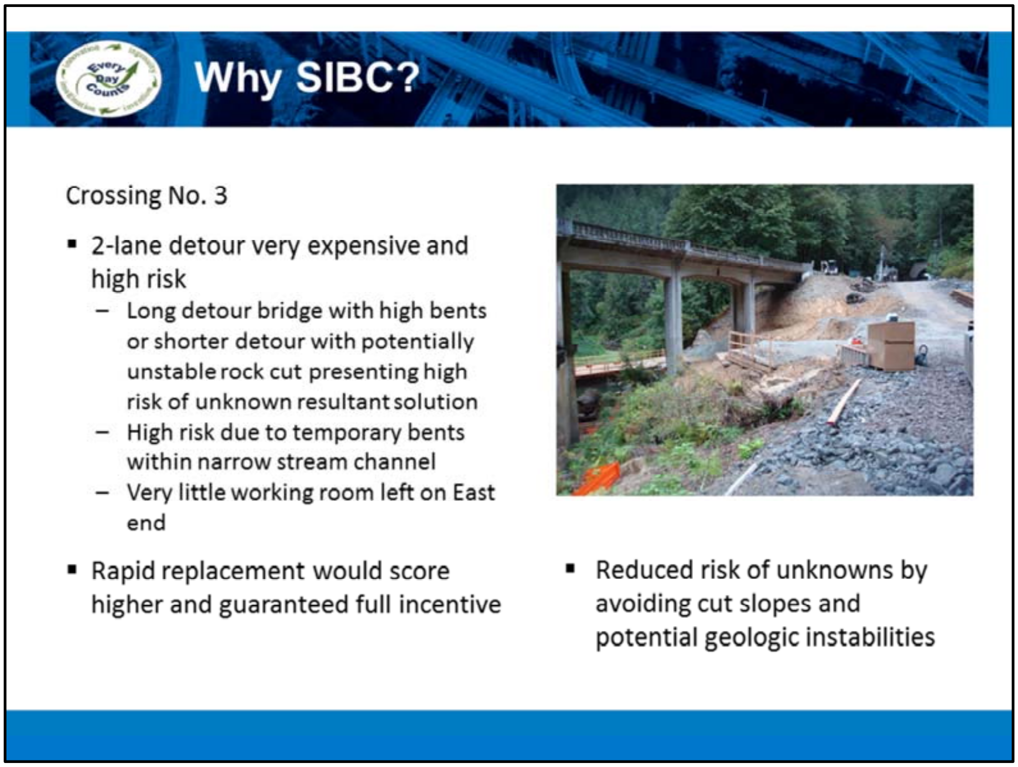
The method of delivery was design-build with best value selection and the winning team proposed slide-in bridge construction for two bridges to eliminate expensive detours and flagging.

The project was in a very difficult location. Both of the existing bridges featured deck truss main spans which essentially eliminated the possibility of phased removal and construction.

Both bridges were on opposite ends of the same tunnel, with one of the bridges starting almost immediately after exiting the tunnel. This made traffic shifts and alternative alignments extremely difficult to complete.

The lateral slides which were completed in a 48 hour closure window for each bridge eliminated costly realignments, costly temporary bridges, and eliminated most of the single lane restrictions.

The winning bid was approximately $50 million, slightly under the engineer’s estimate of $53 million, and the total project duration was 32 months, almost two fewer years than the original estimated project duration.



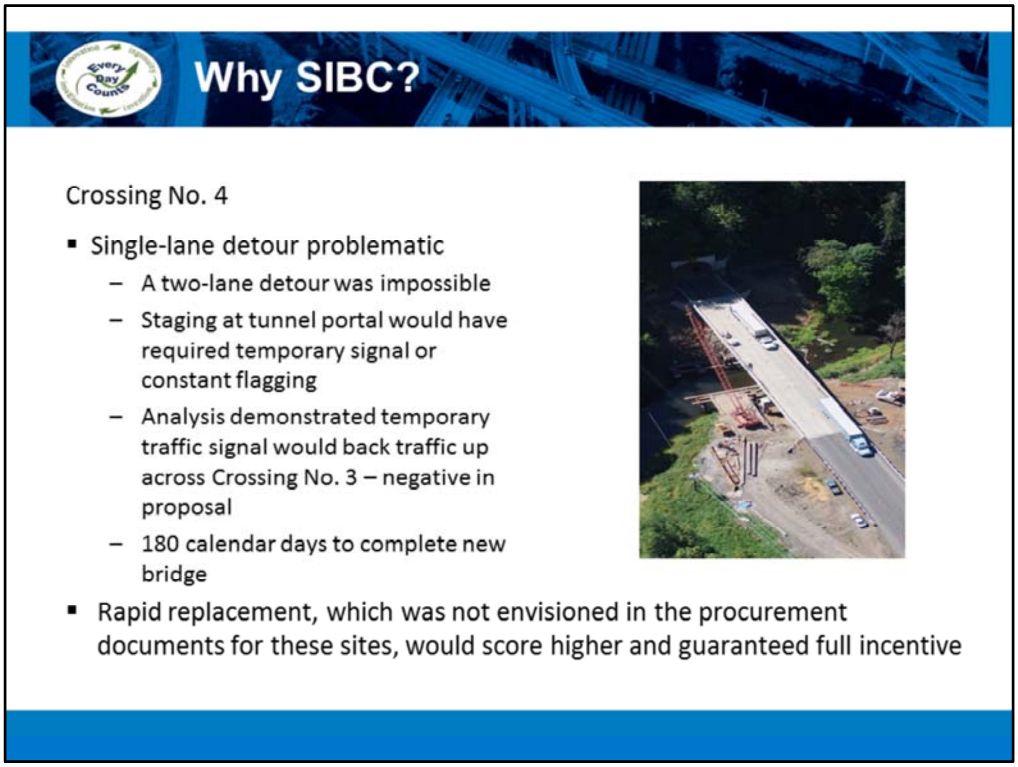
It's useful to look at the reasons Slayden chose the lateral slides.

For Crossing 3, a temporary bridge could have been constructed but the local geometry made the temporary bridge almost three times the length of the permanent bridge.

Furthermore, there would have been considerable risk due to temporary bents within the narrow stream channel and very little working room would have been left on the east end which would have required a substantial hillside cut to reconnect at the west end.

Another reason, given that the project was design-build with best value selection, was that rapid replacement would score higher and guarantee full incentive.

The terrain also imposed several unique challenges. By avoiding cut slopes and potential geologic instabilities, the risk of unknowns was reduced.



For Crossing 4, the proximity of the tunnel to the bridge, only about 50 feet from the tunnel portal to Crossing 3 from the bridge joint, made staging the new bridge very difficult. A temporary signal or constant flagging would have been required and in this case it was discovered that traffic would have backed up through the tunnel and across Crossing 3.

Additionally, if a single lane detour was used, the contractor would have been limited to 180 calendar days to complete the new bridge.

Rapid replacement was not originally envisioned in the procurement documents for these sites. However, its use did score higher and guarantee full incentive.

These pictures show the difficult construction conditions and site constraints.

The primary structure of the original bridge, shown on the left, was a deck truss.

The overall structure was also composed of several shorter concrete girder spans approaching the truss structure.

On the right, the new structure is shown adjacent to the old structure, and is a three-span continuous steel plate girder bridge.

The red pieces are the vertical jack and slide shoes. Translation was accomplished by supporting and sliding at two interior points with the end spans cantilevered.

Crossing 4

- Two-span prestressed concrete deck girder bridge
- Translation supported at four points

These pictures of Crossing 4, give you an idea of how difficult phased construction would have been due to the proximity of the bridge and tunnel. Like Crossing 3, the existing structure was a truss.

The new structure is a two-span, prestressed, concrete deck girder bridge. Translation was accomplished by supporting the structure along four lines.

Here, another picture of Crossing 4 is shown and the points at which the structure was supported during translation are better seen.

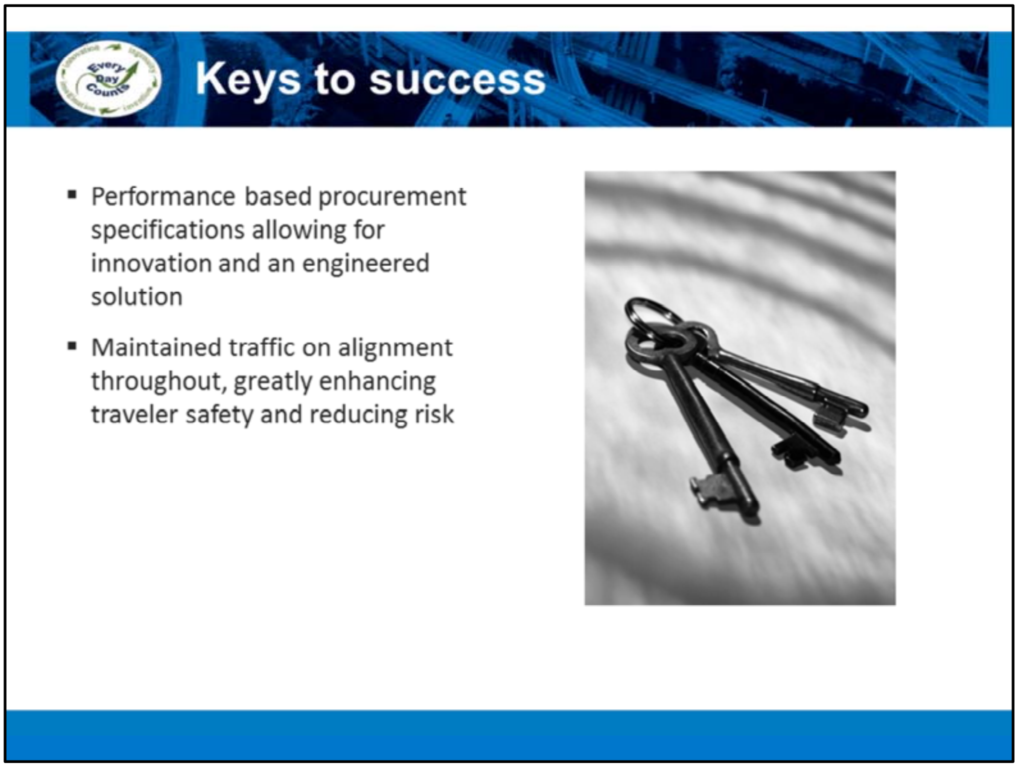
A greater appreciation is also gained for the surrounding terrain and the magnitude of a bridge slide operation.

For both crossings, the slide operation was subcontracted to Mammoet who used a similar technology found in Self Propelled Modular Transporters.

After all was completed, several keys to success were identified.

First, the reduction in construction time offset the additional costs due to slide-in bridge construction. Also, a significant reduction in maintenance of traffic resulted in schedule savings and good public relations, and the elimination of flagging for what would likely have been 180 days resulted in cost savings.

Furthermore, risk was greatly reduced by not using a temporary bridge to carry public traffic. And, maybe most importantly, the contractor made it known that coordination, communication and cooperation between the owner, community, and contractor was the real key to success.



Some additional keys to success include the performance based procurement specifications which allowed for innovation and an engineered solution.

Lastly, traveler safety and reduced risk were achieved by maintaining traffic on alignment throughout the duration of the project.

Community Outreach

- Instrumental in providing information to traveling public
- Initiative with local schools
- Student pylon designs
  - $500 scholarship
- Time capsule

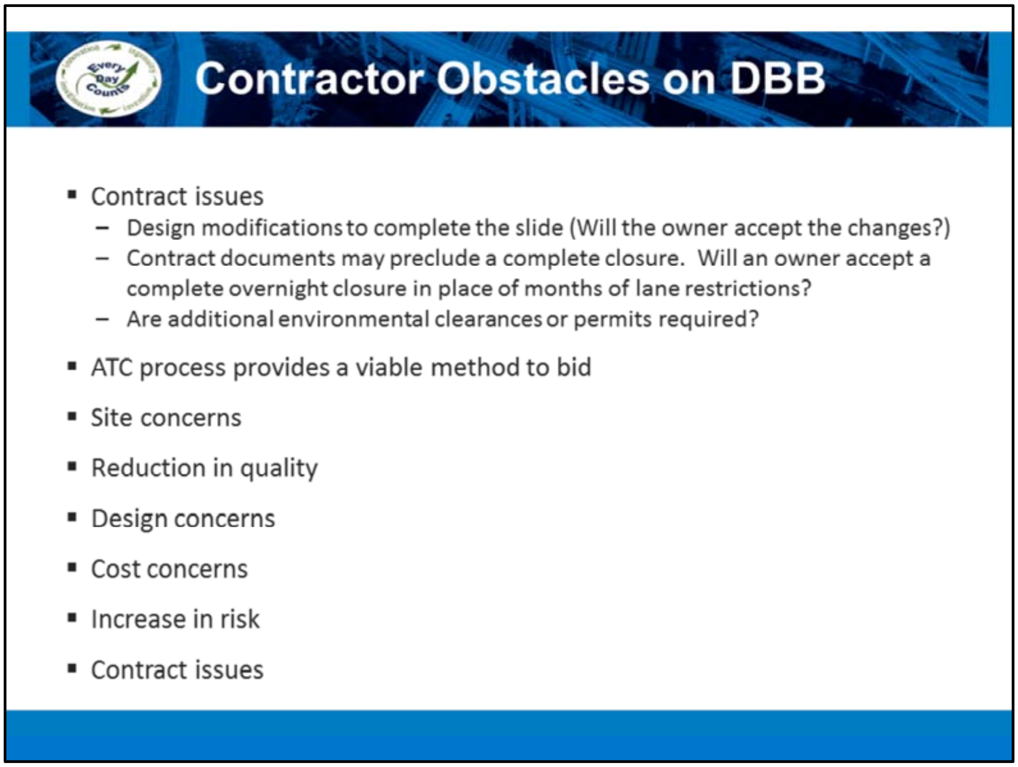
Picture Courtesy of Structural Engineer Magazine

As part of the project, the contractor implemented a community outreach program which was instrumental in providing information to the traveling public.

The initiative began with the local schools. On several occasions the contractor visited the schools to convey necessary information whether it be through the students or directly to parents.

A student competition was established to design the pylons at the corners of one of the bridges and the winning student was awarded with a $500 scholarship.

Lastly, a time capsule on one of the bridges was created for students and other community members to contribute to. For this project the location allowed for closing off the site to any public viewing eliminating that potential security and safety issue.



Given all the benefits you may wonder why slides aren't used more often. It's likely we would see a lot more slides on traditional projects if the contractor knew they could get past a few obstacles. If a slide wasn't part of the bid package and a slide requires modifications, the contractor can't bid the slide in case the owner doesn't accept the revisions. Once the project is won the contractor has little incentive to go down the value engineering change path. Sometimes value engineering changes can lead to a loss of positive partnering attitudes.

Site concerns – There are places where it is not feasible to construct a new bridge adjacent to the existing structure but the Oregon project shows that slides can be effective even in very confined locations.

Reduction in quality – There is no evidence in reduction in quality in bridge lateral slide projects. When compared to phased construction it might even be an improvement. The Utah DOT has performed special inspections of all lateral slide bridges and no adverse effects have been found with the bridges. In fact, the condition in most cases is better than bridges built with SPMT installations.

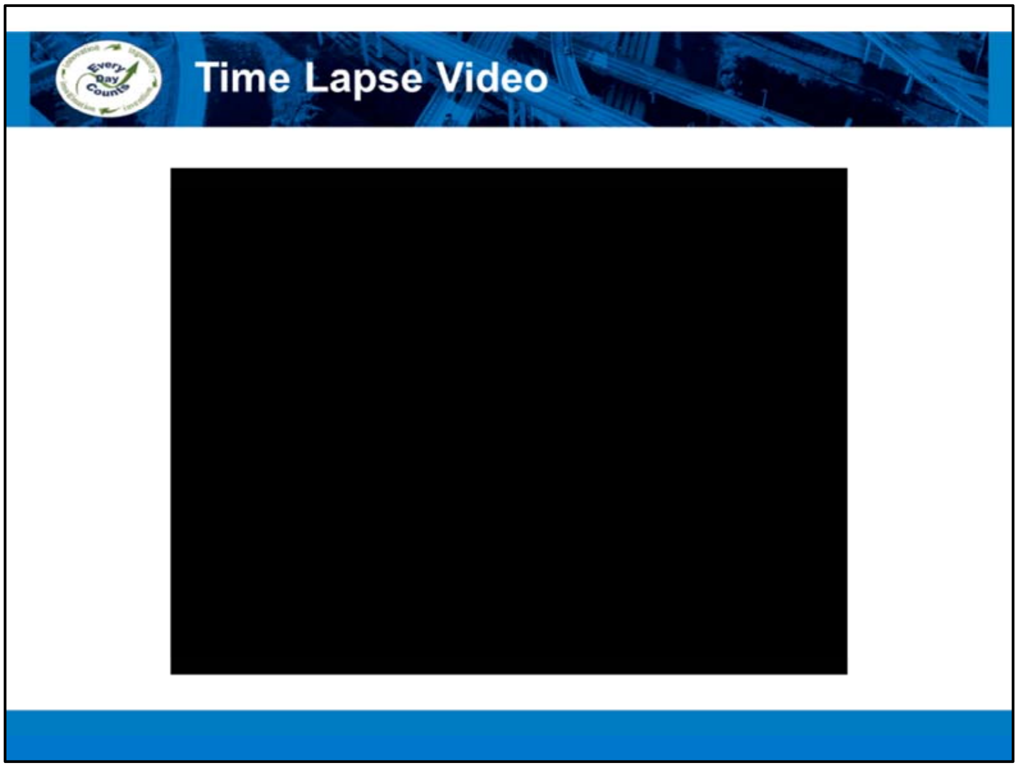
Design is fairly simple and there are a variety of solutions or methods used that demonstrate this. Difficult problems usually have few viable solutions.

Cost is difficult to quantify. It is more costly to slide a bridge into place than to close the road and build it in place. Once you start phasing the construction or requiring a

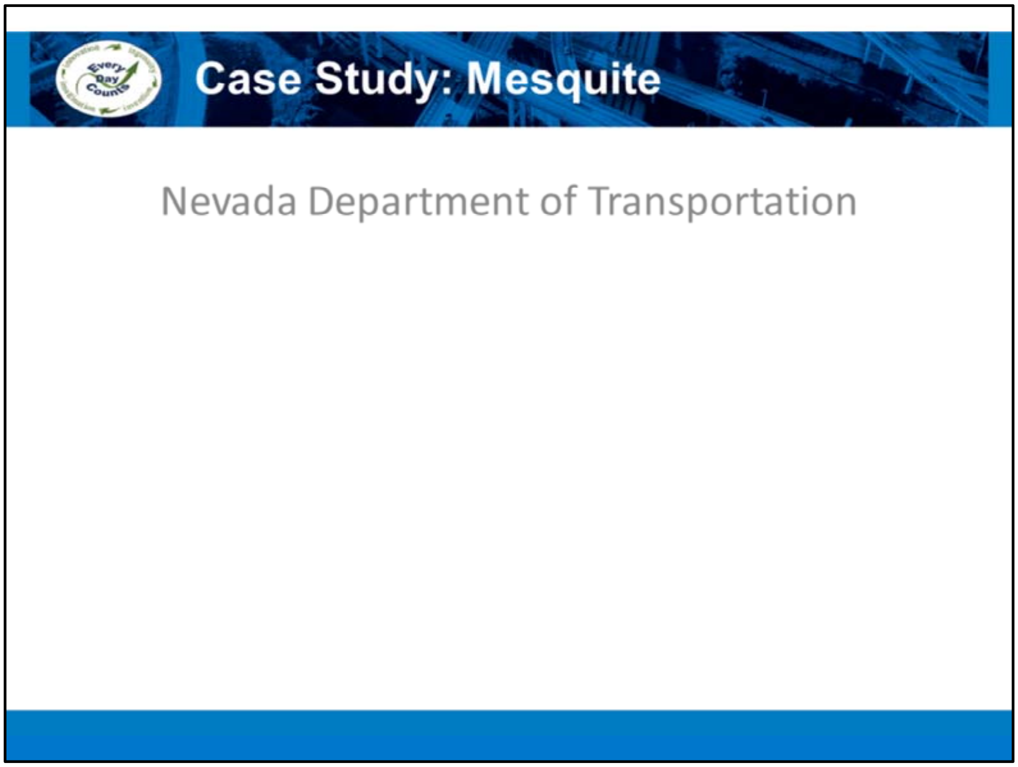
temporary structure the slide becomes cost effective without even considering user cost and construction oversight costs.

Increase in risk – any new construction method for any contractor or owner represents a risk but in general it is believed to be low. Construction risk is similar to a cast-in-place bridge. The move risk is really a function of the time provided for the move and the associated penalties for not opening. A tight timeframe increases the risk the project won't be completed in the allotted time. Low damages increases the risk that the contractor will not be prepared for problems. For example, having an additional jack onsite is cheap insurance against high penalties for not opening on time.

Contract issues – As a policy, owners should start structuring all projects to allow a lateral slide option.   In addition to the normal contract and maintenance of traffic requirements it is relatively easy to add maintenance of traffic language to allow a limited complete closure with penalties or incentives in lieu of a defined time of reduced lanes or on site construction time. Also a special provision defining the requirements of any redesign and any other special requirements would allow the contractor to bid the job assuming a slide. As long as they know the requirements they need to meet they can confidently bid the job.



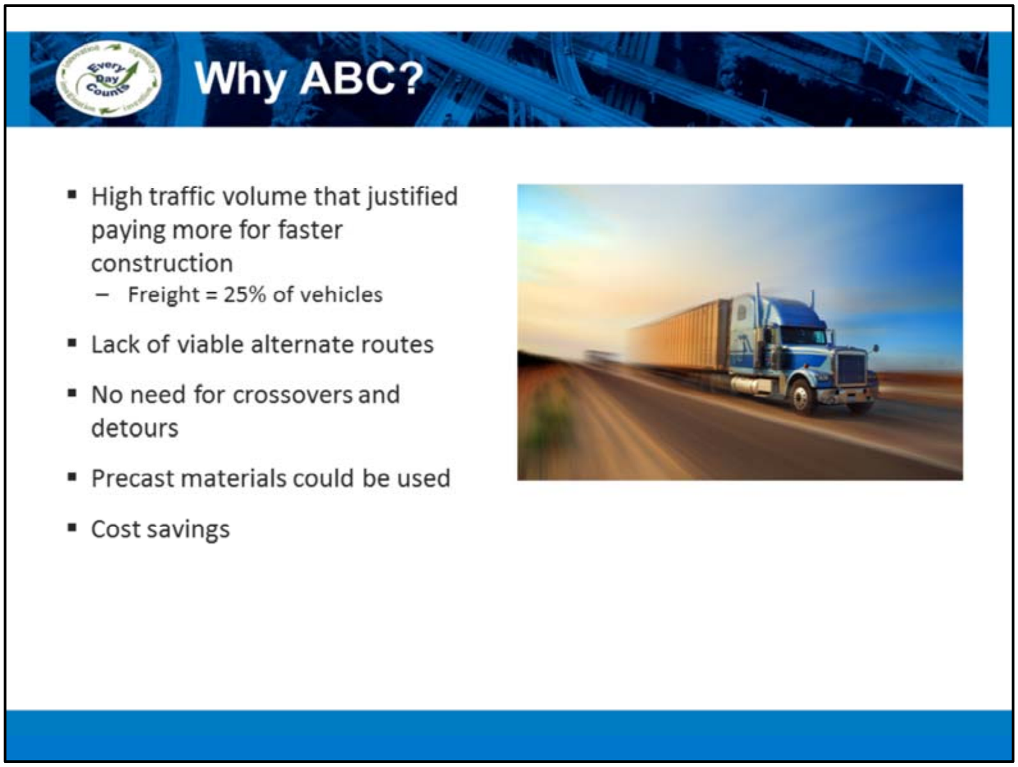
Here is a time lapse video of the slide period on Crossing 3.



The Nevada Department of Transportation was posed with a unique challenge at the I-15 junction with Falcon Ridge Parkway near Mesquite. Not only would the bridges on I-15 require replacement, significant changes to the interchange would also be necessary to accommodate future traffic needs.

To complete this work traditionally would have meant significant closure times and travel impacts on a primary thoroughfare. The desire was to minimize these impacts as much as possible.

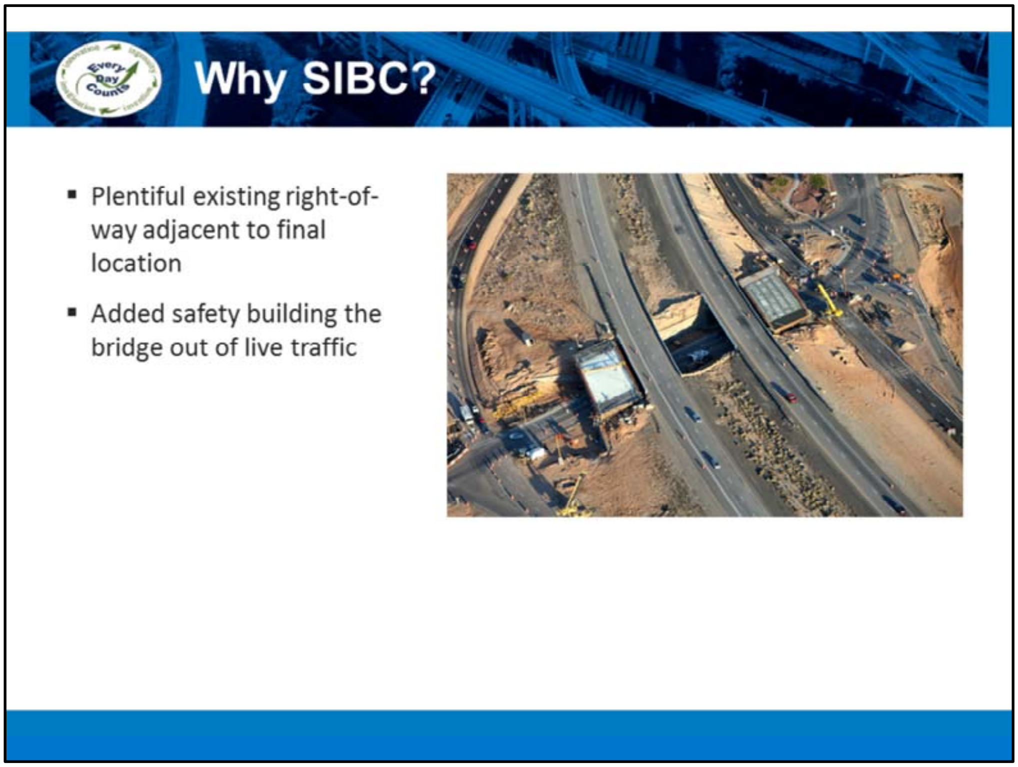
Mesquite, Nevada is located 80 miles northeast of Las Vegas on I-15 and 40 miles southwest of St. George, UT adjacent to the Arizona border. While the population is only 21,000, Mesquite is a popular tourist destination.



The need for accelerated bridge construction was made apparent by several factors.

Those factors include: high traffic volume of which 25 percent is freight traffic; there is a lack of viable alternative routes to which traffic could be detoured for extended periods of time; using accelerated bridge construction would eliminate the need for crossovers and detours; and precast materials could be used.

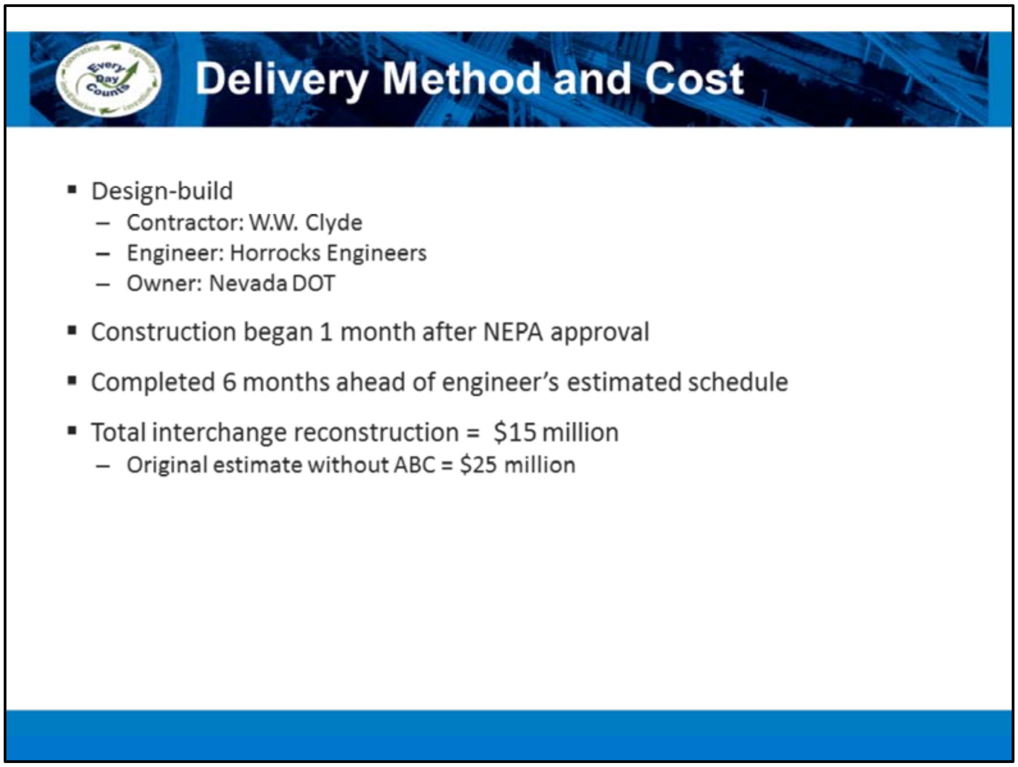
A considerable cost savings was realized through ABC by allowing the new bridges to remain in the existing locations.



Slide in bridge construction was selected as the means of accelerated bridge construction for a couple of reasons.

One, plentiful existing right-of-way adjacent to the final location was present.

Two, by constructing the bridge out of live traffic, safety would be increased for both workers and the traveling public.



The delivery method was design-build: The Nevada DOT, Horrocks Engineers, and W.W. Clyde were the owner, engineer, and contractor, respectively.

This method was the primary driver for time and cost savings. Construction began only 1 month after NEPA approval and, overall, when compared to the engineer's estimated schedule, 6 months of time and cost was saved.

The original intent was to relocate much of the interchange, so as not to disrupt interstate traffic on I-15. This would have added a considerable cost.

Rather, through the ingenuity of the design-build team, ABC was selected and thus a substantial savings was realized.

The original estimate of the entire interchange project without ABC was $25 million. In the end, the total cost was $15 million.

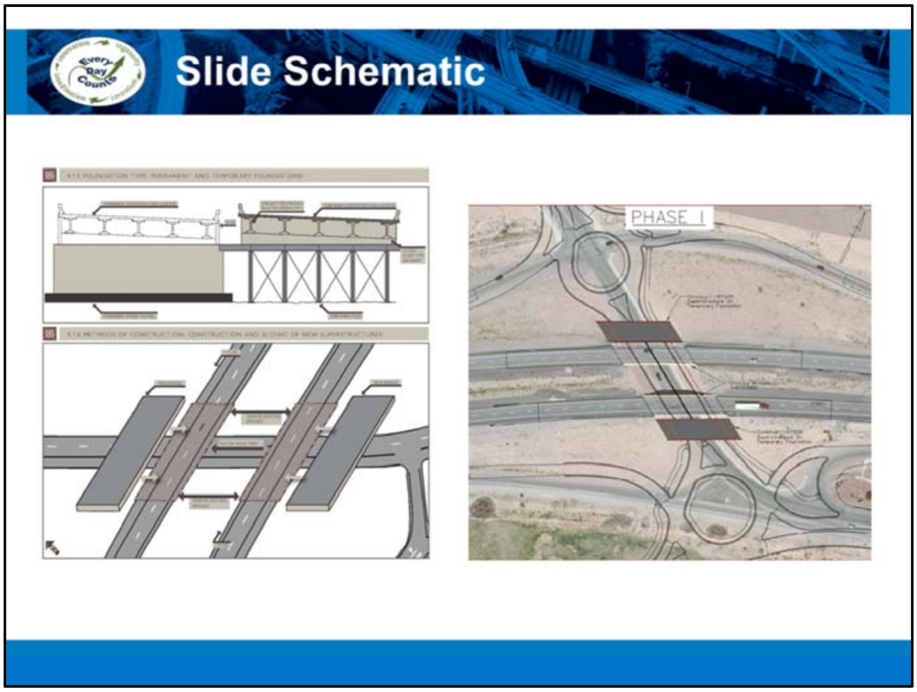
Project Elements

- Falcon Ridge widening and extension to Leavitt
- Lighting, signing, landscaping, and shared use path
- Construct two roundabouts
- Ramp improvements
- Drainage facilities
- Demolish existing bridges
- Construct two new bridges

In addition to the new bridges, several other elements of the project existed.

Falcon Ridge would be widened and extended. Lighting, signing, landscaping, and a shared use path would be added. Roundabouts, ramp improvements, and drainage facilities were also within the scope.

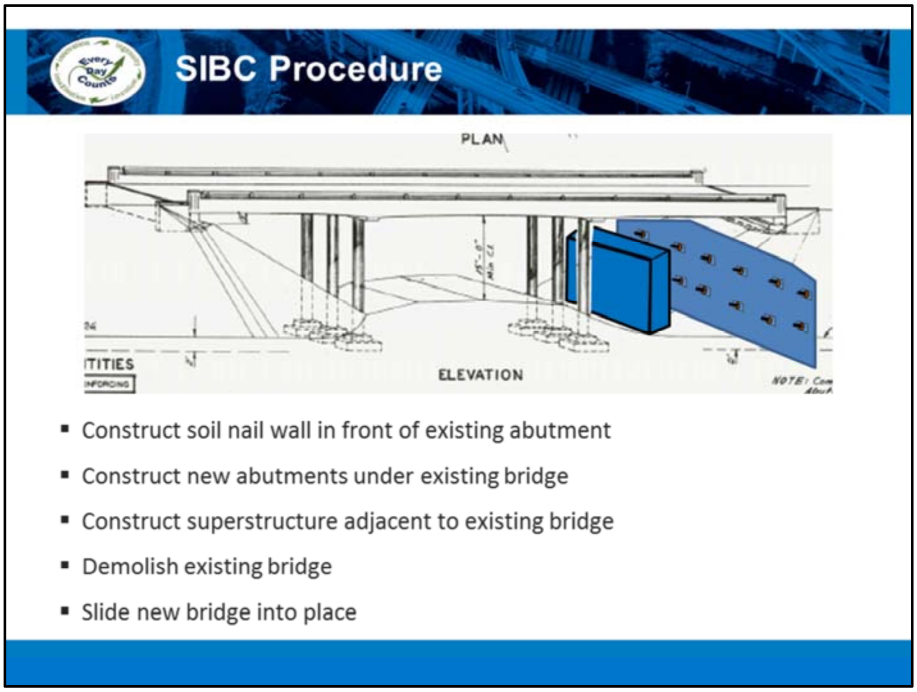
Of course, central to the project was the demolition and construction of two new bridges. Both bridge slides were completed in January of 2012.



In these schematics, the new bridges are shown on their temporary supports relative to the existing bridge locations.

One bridge would be slid in from the North, while the other would be slid in from the south.

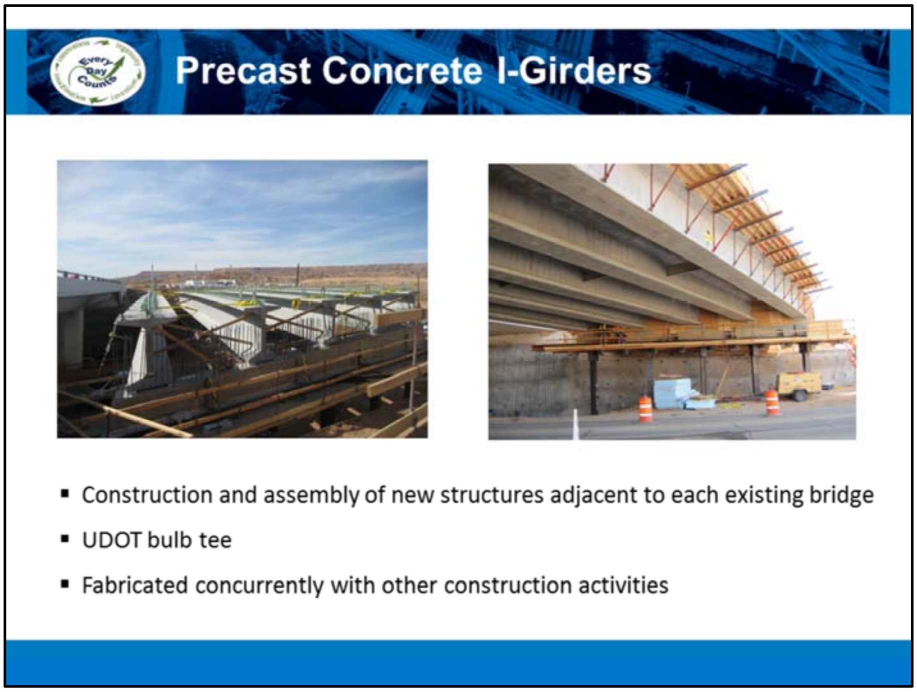
Also, depicted here is that each of the bridges is skewed and set on a superelevation, which are added complexities to an already challenging project.



The existing bridges were left in service while the foundations for the new bridges were constructed beneath. Soil nail walls were constructed in front of the existing abutments, followed by the new abutments.

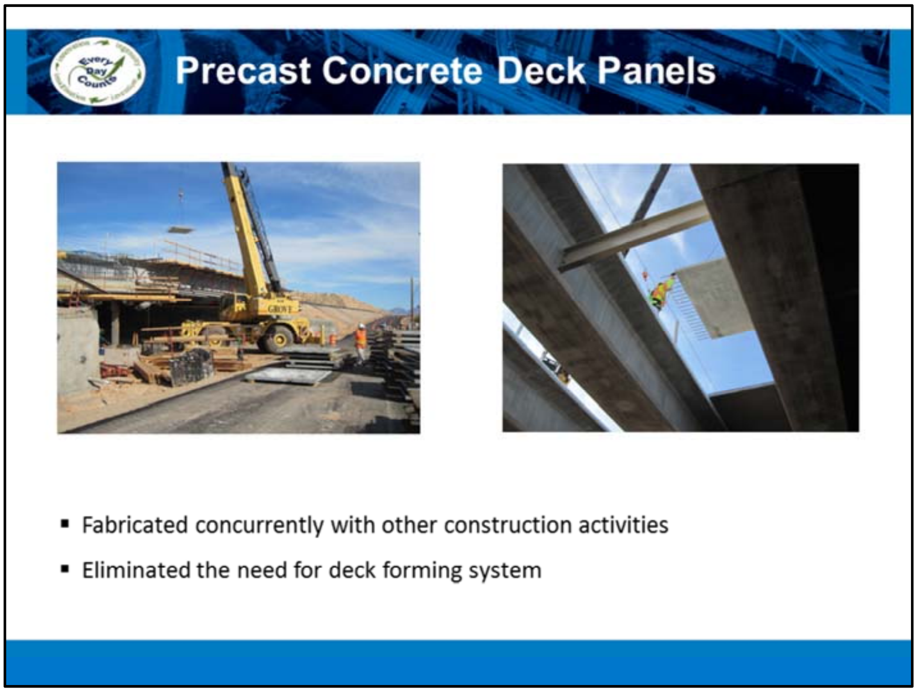
Concurrently the new superstructure was being constructed adjacent to the existing bridge.

Once complete, the in-service bridge was demolished and the new superstructure slid into place.



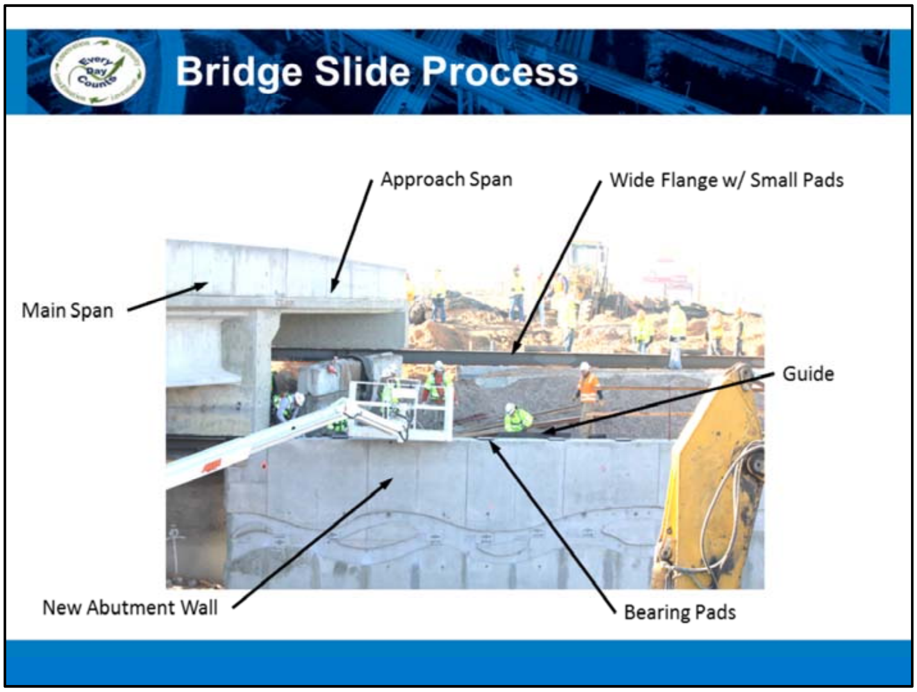
The superstructures were constructed with precast concrete I-girders as is shown here in these pictures. Specifically, a Utah DOT bulb-tee shape was used.

These pictures provide a good indication of the proximity to the existing bridges and the use of temporary works as a superstructure support.



The bridge deck was composed of precast panels which eliminated the need for a deck forming system.

Once the superstructures were completed, bridge demolition could begin. This became an all-hands-on-deck operation as the demolition signified the beginning to a temporary closure of the mainline I-15 interstate. Traffic was rerouted to the on and off ramps.



Once the demolition was completed, the new superstructure could be slid into place.

Seen here are the many components in place ready for the slide and also the means required for the bridge slide.

The main span, approach span, and abutment wall were preconstructed prior to the demolition. The bearing pads, guide, and wide flange were placed once the demolition was complete.

Here a closer look of the wide flange and small PTFE pads is provided. These pads, along with dishwashing soap, greatly reduce the frictional forces between the superstructure and substructure during the slide.

Hydraulic jacks were attached to the superstructure diaphragms at each abutment location. The jacks extend their full stroke then pause to retract and reset along the guide track which is composed of a steel plate with slots to accept the jack.

Some additional views of the jacks in operation show their attachment to the diaphragms and also their seat on the temporary works.

After the bridge slide, but prior to being able to open the interstate to traffic, the mainline approaches had to be completed. This entailed bringing in fill and paving to the bridge approach.

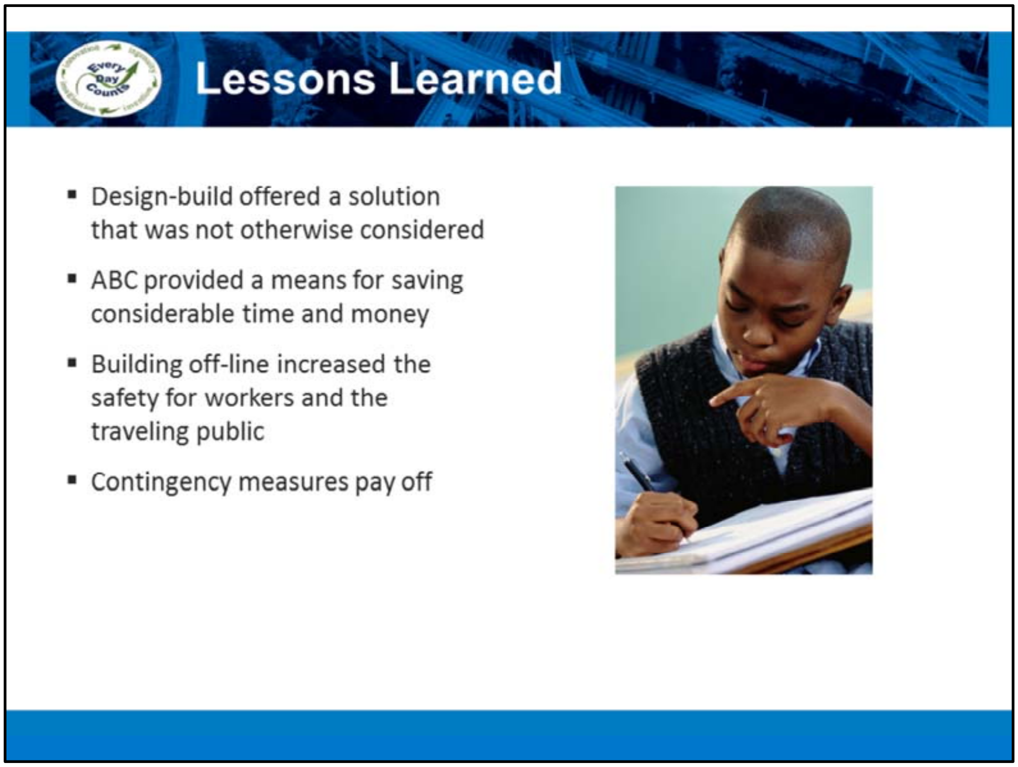
The next few slides provide aerial photos of the site at different stages of the bridge construction and slides.

The first photo taken on December 16th, 2011 shows the new bridges being readied for their slide into final position.

The second photo taken on January 10th, 2012 shows the demolition underway at the first bridge site. The superstructure is ready for its final move.

This photo taken on January 11th, 2012 just one day after the previous photo shows the first bridge slide and the approach paving complete.

On January 24th, 2012 the second bridge was slid into place.



Numerous lessons were learned on this project.

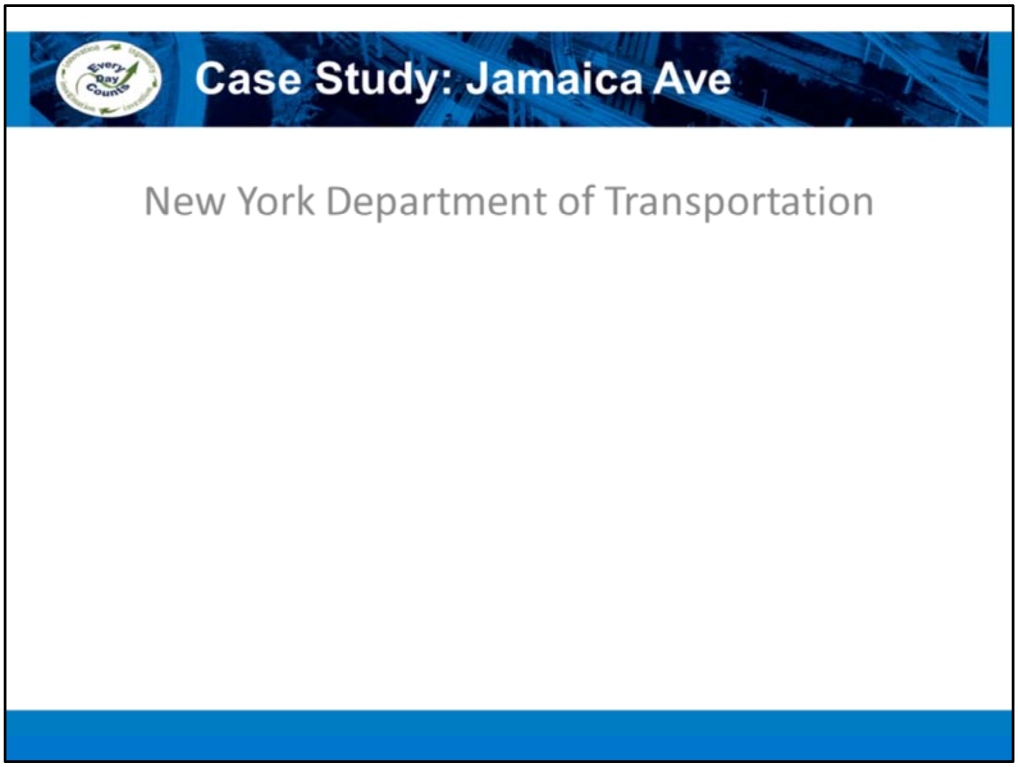
The innovation afforded to the project through the design-build delivery method provided solutions that would not have otherwise been considered.

Implementing slide-in bridge construction as an accelerated bridge construction method helped save a great deal of time and cost.

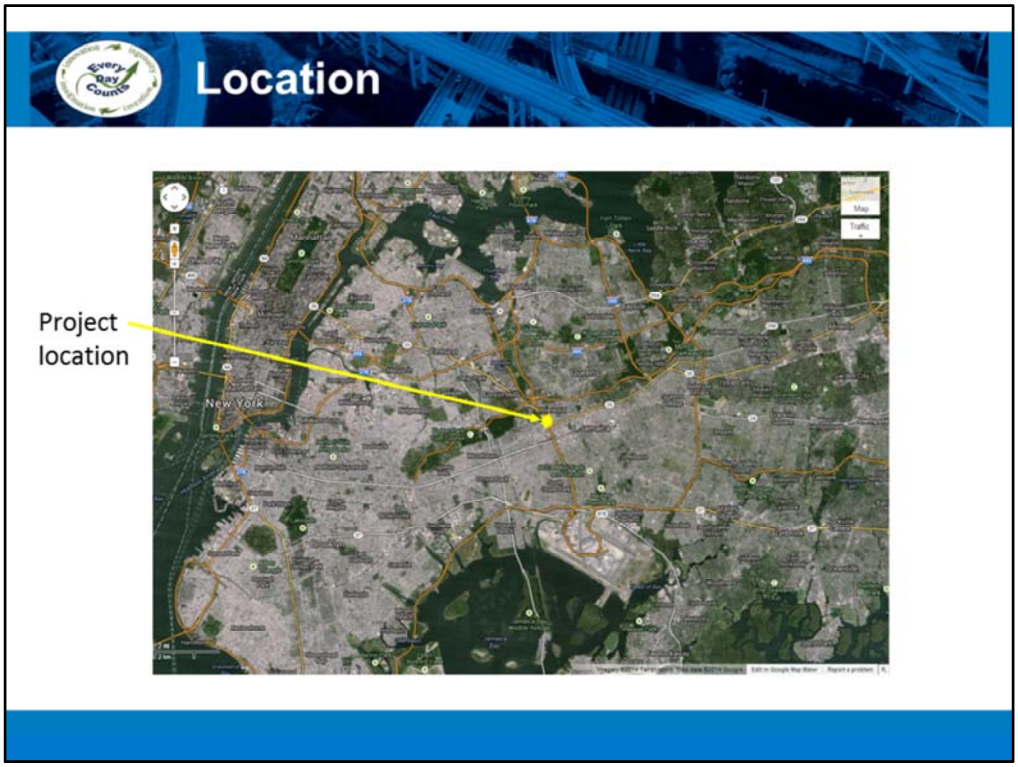
SIBC also provided an increased level of safety for workers and the traveling public by removing the primary construction activities from the main-line traffic.

Lastly, contingency measures pay off. When constrained to a hard and fast time window, a contingency plan is a must for when the unexpected becomes real.

A short video highlighting the project is shown here.

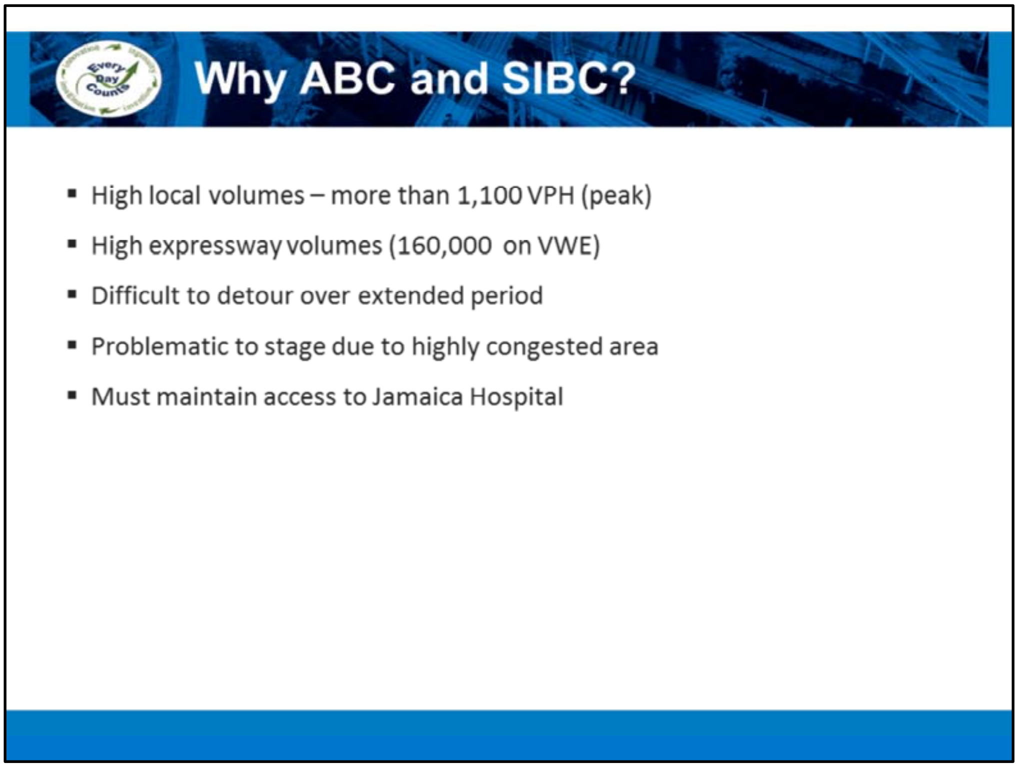


The last case study we'll cover today is a project completed by the New York Department of Transportation on Jamaica Avenue over the Van Wyck Expressway in New York City.



The location immediately east of downtown New York City is shown in this aerial photograph and it is evident that this bridge could not be in located in a more highly trafficked area.

A close up view of the location shows the Jamaica Avenue bridge along with the Van Wyck Expressway passing beneath.



Slide-in bridge construction was used for the reconstruction of the Jamaica Ave bridge for several reasons.

Primarily, all these reasons are associated with the high traffic volume that is commonly seen in large metropolitan areas.

During peak hours, the bridge could see as many as 1,100 vehicles; not to mention the 160,000 vehicles seen per day on the Van Wyck Expressway below.

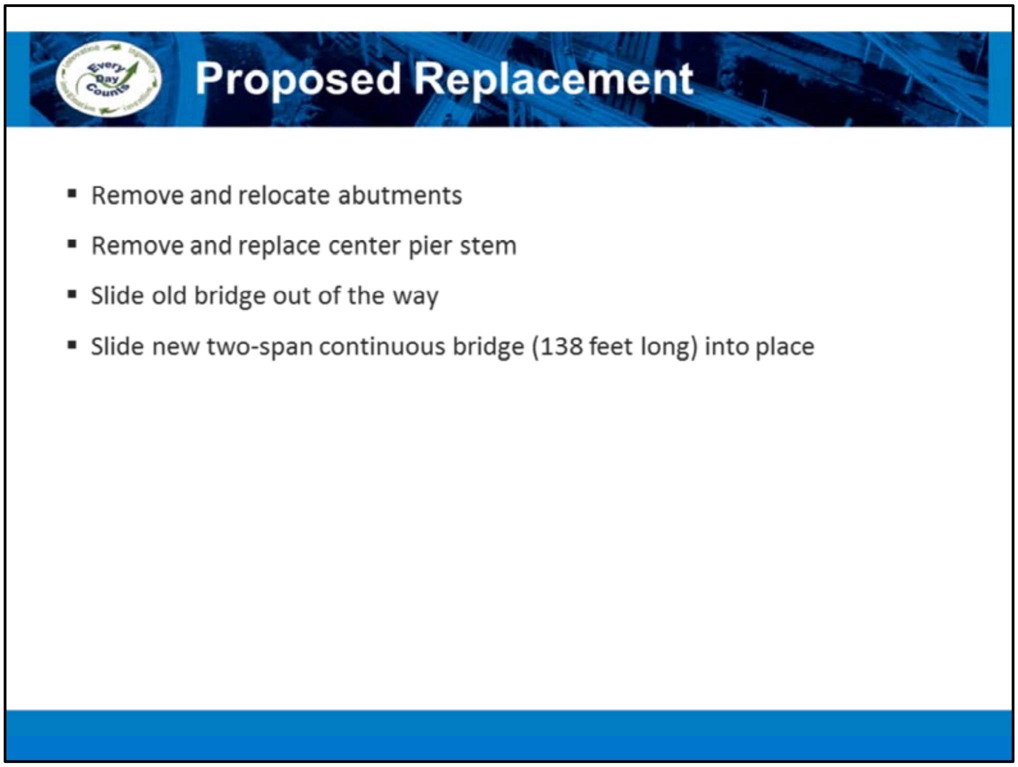
To close this bridge entirely for an extended period of time would prove to be quite difficult. Even more, it would be problematic to stage due to the highly congested area.

Lastly, access to the Jamaica Hospital had to be maintained.

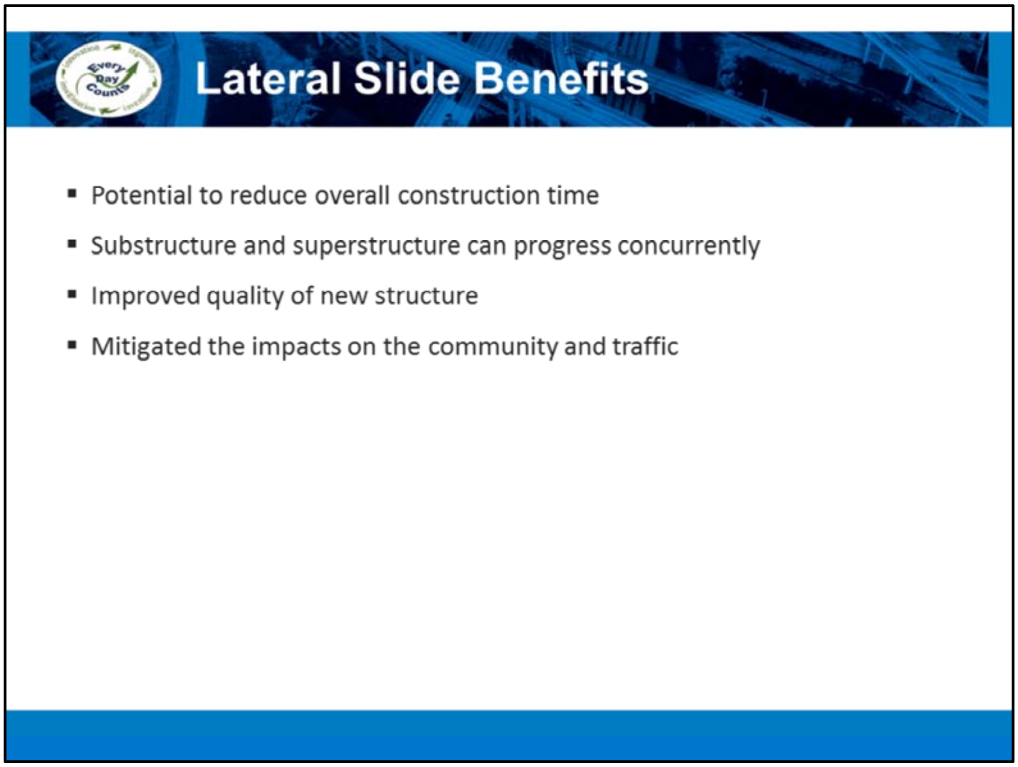
Existing Structure

- Two span
- 110 feet long

The existing bridge was a two-span, 110 ft long girder and deck structure.

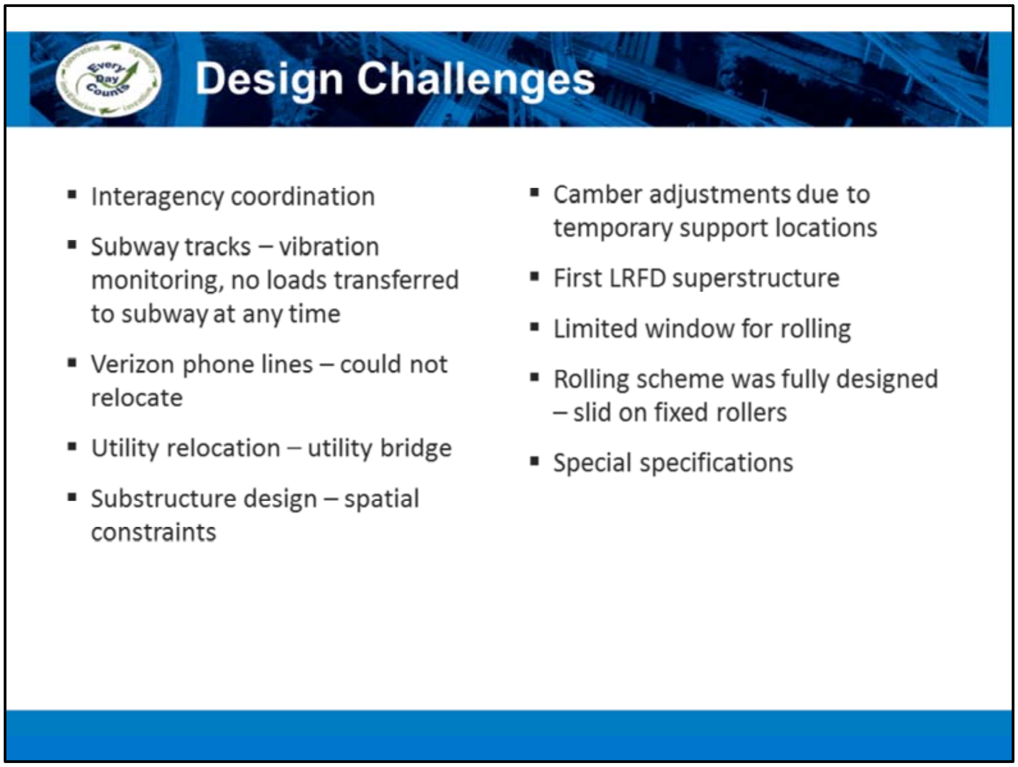


The proposed replacement entailed removing the entire superstructure, removing and relocating abutments, removing and replacing the center pier stem, and installing the new two-span, continuous 138 foot long superstructure.



There were several benefits to selecting slide-in bridge construction at this site.

For example, there was potential to reduce overall construction time, the substructure and superstructure could progress concurrently, the quality of the new structure would be improved, and the impacts on the community and traffic could be mitigated.



As you can imagine, numerous design challenges present themselves when completing a project like this in a highly urbanized area.

As a result, interagency coordination is a must. In this case, coordination with the subway authority, phone company, and utility company was necessary. The subway required that the tracks be monitored for vibration to ensure no loads were ever being transferred to tracks. The Verizon phone lines had to be located but could not be relocated, while other utilities had to be relocated.

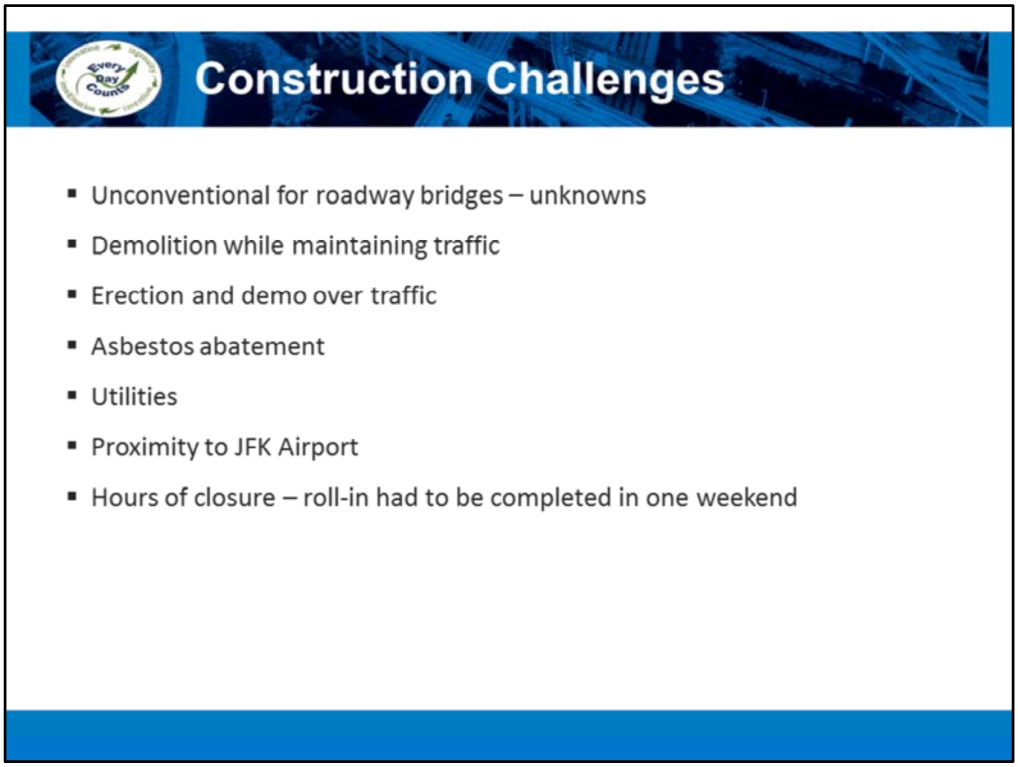
The substructure design was hampered by spatial constraints.

Camber adjustments had to be made due to the temporary support locations being different than the permanent support locations.

Even more, this was the first LRFD superstructure design for NYSDOT.

The timeframe for moving the bridge into place would be limited and as a result the rolling scheme had to be fully designed.

Lastly, the development of special specifications for a project of this type were necessary.



In addition to the design challenges, several construction challenges also existed.

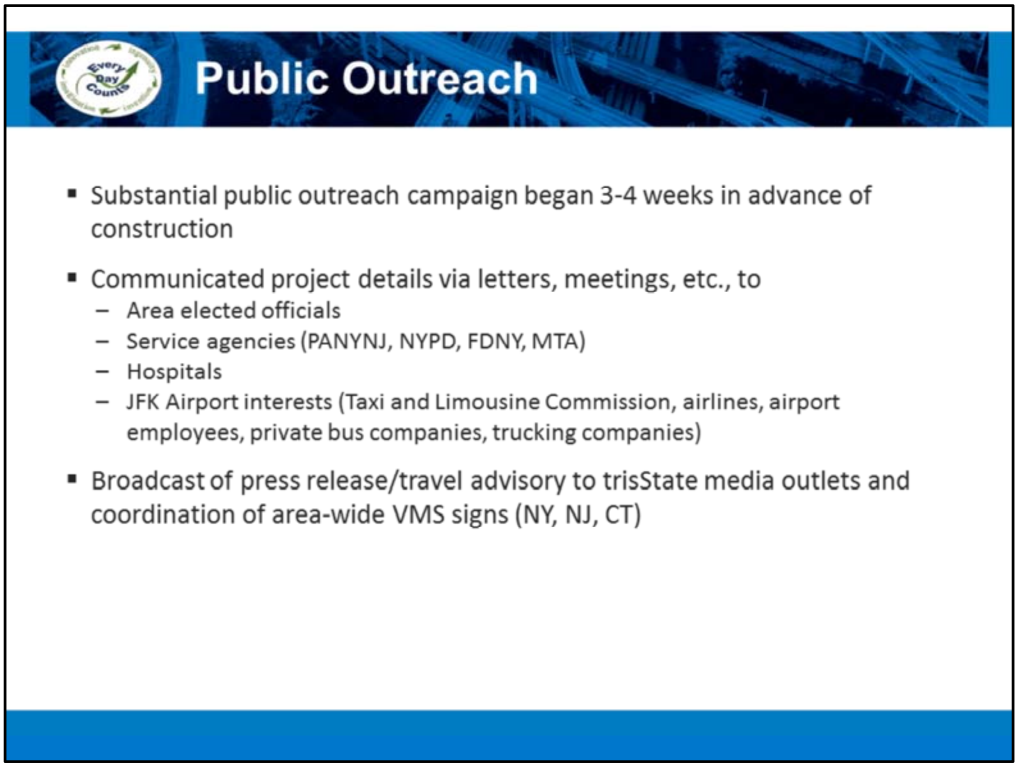
This project was one of the first slide-in bridge construction projects completed in the United States. As a result, there were many unknowns due to the unconventional nature.

Maintaining traffic on the Van Wyck Expressway would prove to be quite difficult during demolition. Likewise, the erection of the new bridge would also be a challenge.

Asbestos abatement was required as well as utility coordination and relocation.

The proximity to JFK airport increased the importance of maintaining traffic.

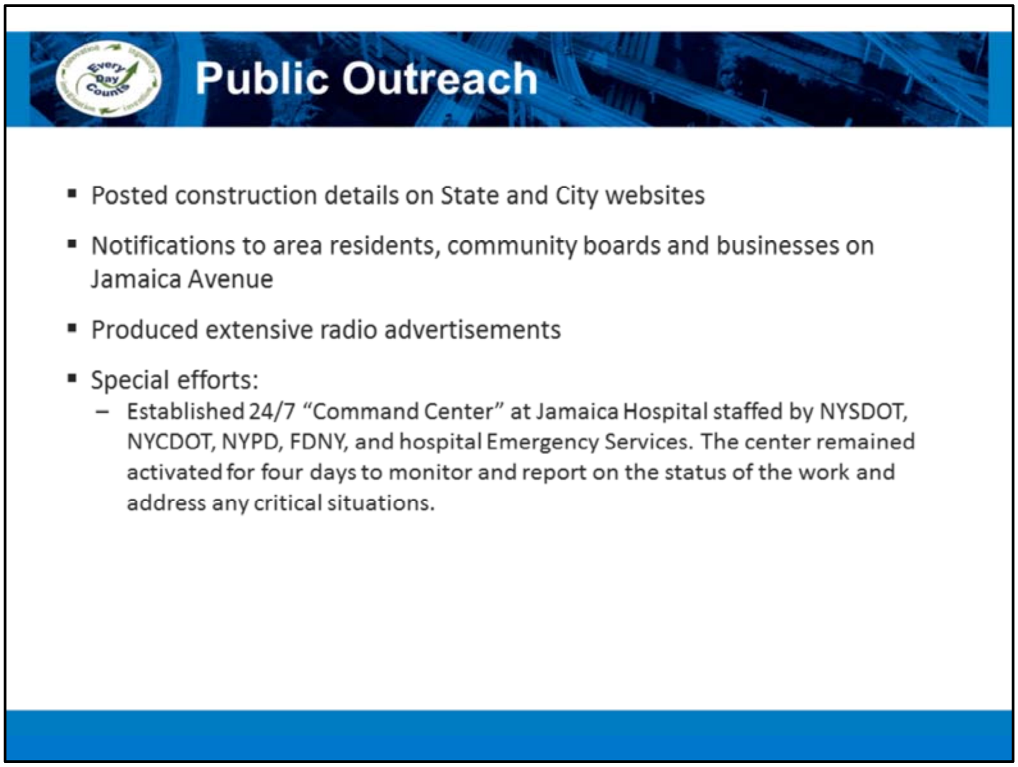
If all that wasn't enough, the bridge slide had to be completed over one weekend.



Given that so many people could potentially be affected by this project, a substantial public outreach campaign began 3 to 4 weeks in advance of construction.

Within this campaign project details were communicated in many ways including letters, meetings, and others to the primary stakeholders in the area; elected officials, service agencies, hospitals, and any JFK Airport interests.

Even more, a press release was broadcasted through the tri-state media outlets and VMS signs were employed to alert drivers.



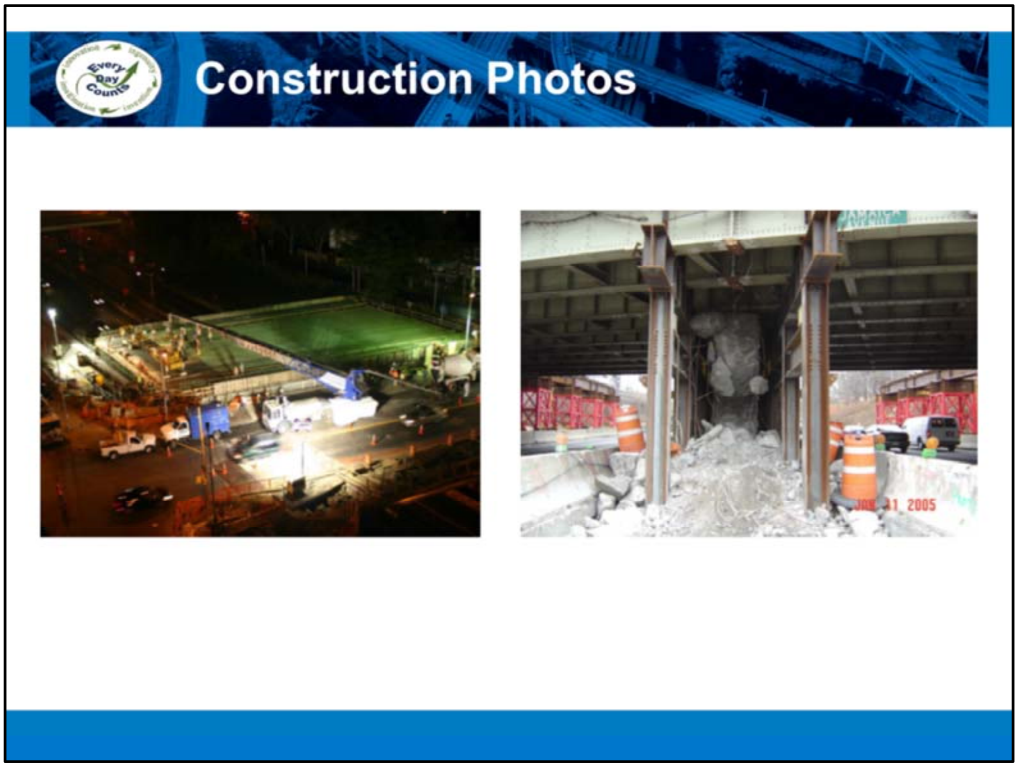
Informing the public would prove to be a key element of the project success.

Construction details were posted on the state and city websites.

Notifications were sent to area residents, community boards, and businesses along Jamaica Avenue.

Moreover, extensive radio advertisements were produced.

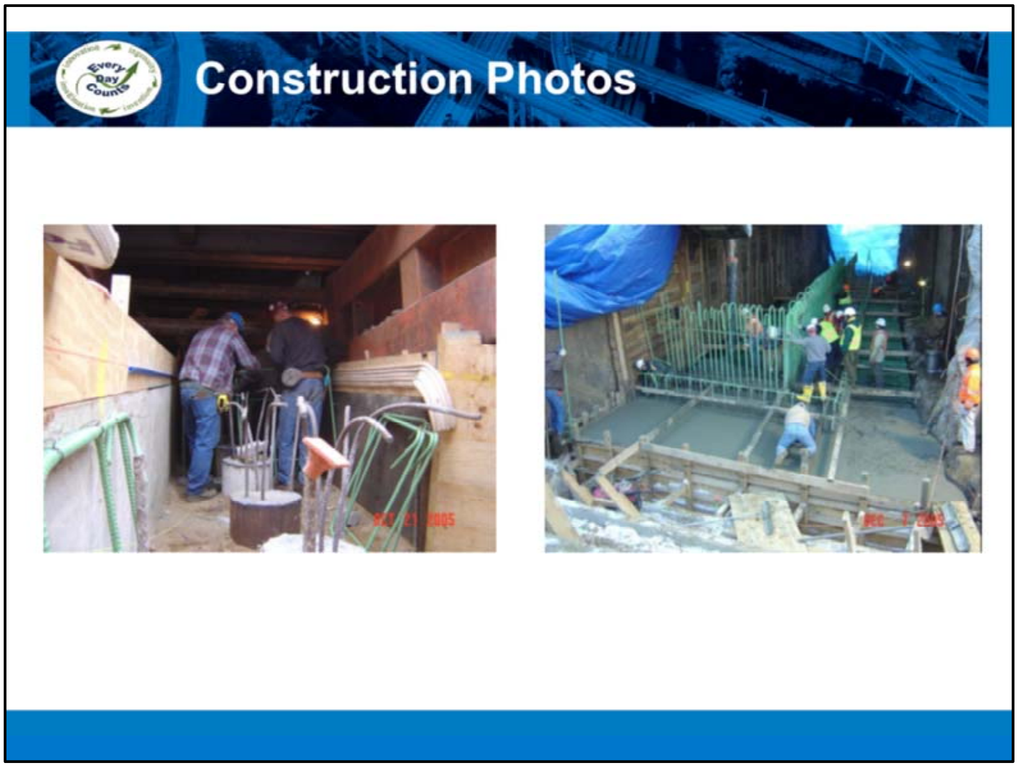
As a special effort, a 24/7 command center was established at Jamaica Hospital staffed by NYSDOT, NYCDOT, NYPD, FDNY, and hospital Emergency Services. The Center remained activated for four days to monitor and report on the status of the work and address any critical situations.



Over the next several slides construction photos will be provided to better explain the construction process.

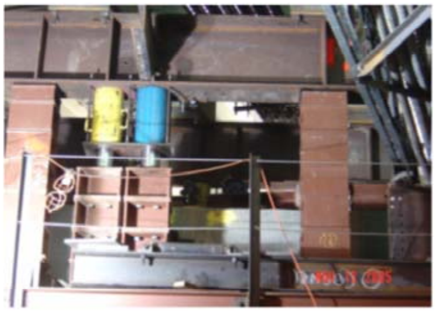
Here, shown to the left, the new superstructure is under construction and nearly complete prior to demolition of the old bridge.

To the right is a view of the temporary supports of the old bridge so that the old pier could be removed. You'll notice the temporary supports for the new superstructure in the background.



These two photos show the new foundation construction underway beneath the old bridge.

Construction Photos



Some of the slide system mechanics to slide the old bridge out are shown in these two photos including the jacks and hydraulic control manifolds.

Heavy duty rollers and large winches were used to guide the new bridge into place.

The photo shows the new bridge in place adjacent to the old bridge after both were slid.

A technical support solutions center has been established and is available for all to use to assist in slide-in bridge construction projects. Here the most up-to-date information about SIBC resources and training can be accessed. The center is most easily found by searching "FHWA Slide" online, or by simply going to directly to the web address shown here.

Thank you!

U.S. Department of Transportation
Federal Highway Administration