TECHBRIEF

U.S. Department of Transportation
Federal Highway Administration

Slide-in Bridge Construction

EXECUTIVE SUMMARY | SPRING 2014

ABSTRACT

As part of the Accelerated Bridge Construction (ABC) program under the Federal Highway Administration's Every Day Counts initiative, Slide-in Bridge Construction (SIBC) is a cost-effective technique in which roadway closures typically last 48 to 72 hours and may be even shorter. This technique builds a new bridge off site or on temporary supports parallel to an existing bridge, removes the old bridge, and then transports in the new bridge or, if built in parallel to the existing structure, slides the new bridge over onto the existing substructure or alignment. A growing number of State agencies have applied this method to improve safety, quality, and durability and to reduce construction and user delay costs as well as environmental impacts.

Jamal Elkaissi

Jamal.Elkaissi@dot.gov

720-963-3272

BACKGROUND

Across the country, thousands of bridges have reached the end of their useful lifespan and are in need of replacement. Many of these structures support a significant volume of commercial vehicles, creating vital economic links across the Nation. Often, lengthy closures for bridge replacement using traditional methods can mean forcing drivers to detour many miles out of their way, which in turn can cause over-burdening of lower volume roadways, creating congestion, using more fuel, and increasing user delay costs.

Slide-in Bridge Construction (SIBC) is an Accelerated Bridge Construction (ABC) technology that can shorten the time and cost required to replace an existing bridge. Using this method, the replacement bridge superstructure can be built on temporary supports located parallel to the old bridge or can be built off site and then transported in. During construction of the new bridge superstructure, the old bridge remains open to traffic. Importantly, this method makes it possible for the old bridge to remain open either while needed repairs to the substructure are performed or while a new substructure is built. Upon completion of the new bridge superstructure, the old bridge is closed to traffic and demolished or removed. The new bridge superstructure is then pushed or pulled into place on the new or modified bridge substructure. Following any necessary completion work on the bridge approaches, the road is reopened to traffic. Often, this method is used in concert with prefabricated bridge elements, which can further reduce the onsite construction time.

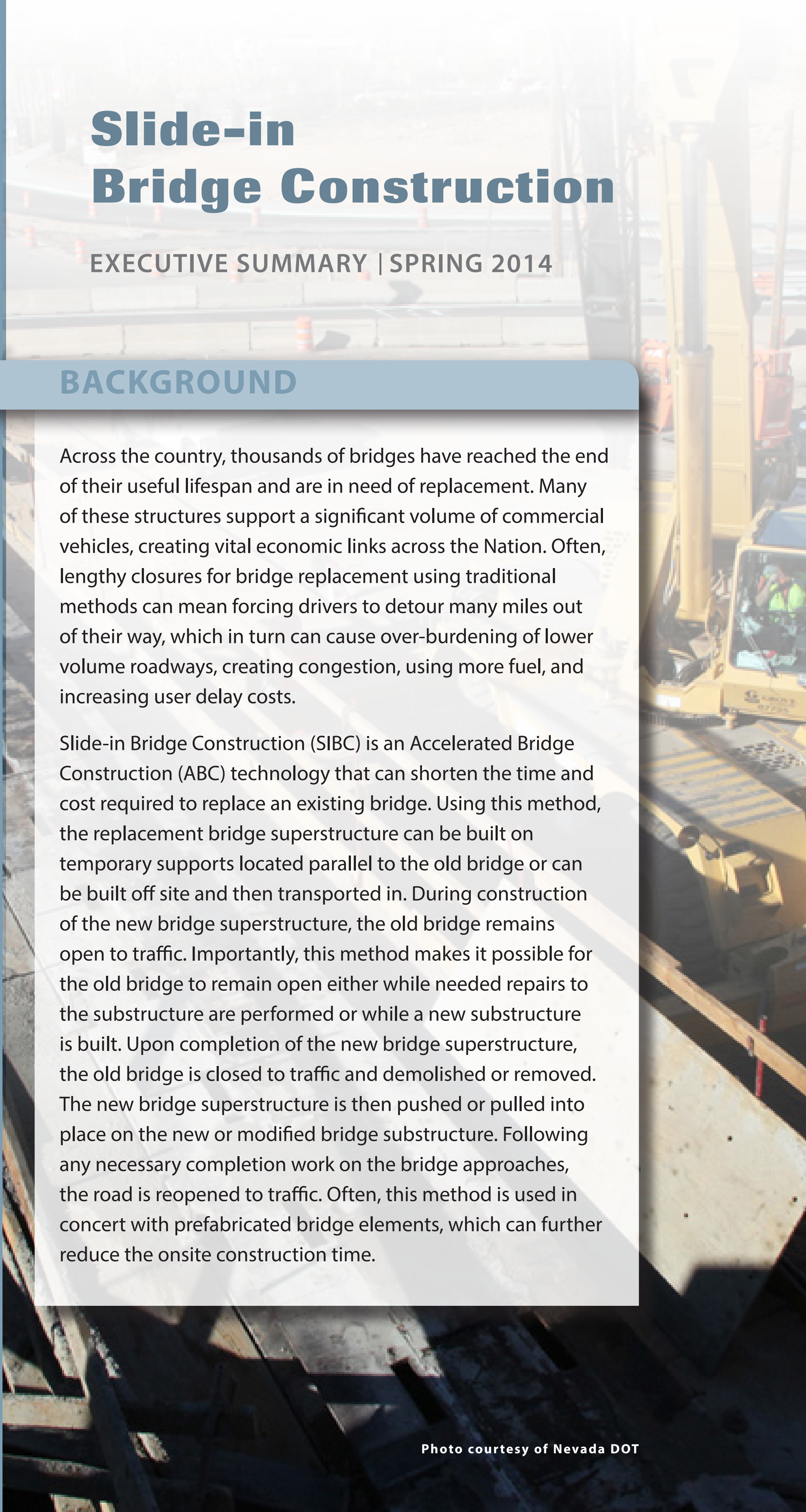

Photo courtesy of Nevada DOT

Hydraulic rams, jacks, bull dozers, and winches, have been used to push or pull the superstructure across rails, rollers, or pads and into place. Once properly aligned with the roadway, hydraulic jacks can be used to lift the new bridge superstructure into alignment with the road profile. Slide times vary depending on the complexity of the project, although they have generally ranged from as little as several hours to as long as several days. The net result is that traffic interruptions and road closures are reduced during bridge replacement when compared with conventional construction practices.

SIBC provides an effective alternative to various other processes such as phased construction, crossovers, lane reductions, or the use of temporary bridges. SIBC may be a good choice for site conditions that have limited alternative routes available and high traffic volumes, particularly high freight volumes, that make it highly desirable to limit road closures. However, one potential limiting factor when using slide-in bridge construction is having sufficient right-of-way (ROW) and space adjacent to the existing bridge to construct the replacement super-structure or to bring the replacement structure underneath and maneuver it into place.

TECHNOLOGY OVERVIEW


Photo courtesy of Nevada DOT

SIBC can accommodate multiple abutment, foundation, and superstructure types. In addition, virtually any superstructure and girder type can be used for an SIBC project. Steel girder bridges are generally lighter than concrete girder bridges, but both have been installed successfully using the slide-in method. As long as the engineer accounts for the superstructure weight during the design of the slide system, there are no significant disadvantages to sliding a concrete girder bridge.

One common method used for SIBC is to push or pull the bridge superstructure across a smooth horizontal surface on pads, rollers, or rails using a hydraulic jack. In some cases, a new bridge superstructure has been pulled into place using cables attached to an electric drum or threaded bars. The decision to use jacks or cables to push or pull the bridge depends on a number of factors including terrain, bridge design, and contractor preference.

Photo courtesy of Parsons (Steve Haines)

Pads are a simple and low-cost solution that allows the use of an unguided system that will not bind if the ends of the bridge move at different rates. Continual lubrication of the pads is critical during the slide, and a variety of biodegradable lubricants are available; an often-used substance is common dish soap.

Rollers are a simple system that may also be used to facilitate the slide. The slide resistance on rollers is more predictable than that for pads; however, a movement system needs to be designed to start and stop the bridge from rolling. Rollers are guided through channels that align them during the move. The rollers cause a large point load that requires that the channels be kept clean and clear to ensure that the rollers are not obstructed.

It is important that the superstructure movement is monitored to ensure that hydraulic jacks or cables move at the same rate. While some uneven movement can be anticipated due to differences in friction, early correction minimizes the potential for binding or final misalignment.

SELECTING THE "RIGHT" PROJECT

Bridge sliding and jacking is not ideal for every project, but can be deployed in many situations. SIBC is generally applicable:

- For bridges where the roadway crossing the bridge has a greater annual average daily traffic (AADT) than the roadway under the bridge.
- When user costs are a major consideration due to high volumes of vehicle and truck traffic.
- For bridges with extended duration impacts, complex traffic shifts, or other safety concerns.
- For bridge replacements that require a long detour or where no detour route is available.
- For bridge replacements where the use of phased construction is not permitted or not desired.
- For bridge reconstruction when some or all of the bridge substructure may be repaired and retained.
- When the on-site time during construction is limited.
- For bridges with limited width.
- For bridges that carry railroad traffic.

There are some general constraints that must also be taken into consideration when considering SIBC as an option. These include issues related to:

- Right-of-way (ROW). There must be ample existing right-of-way adjacent to the final location where the bridges could be built on their temporary foundations. Where possible, temporary easements may also be used for staging.
- Geometric constraints. Geometric constraints adjacent to the existing bridge can preclude the use of SIBC or make it challenging. For example, if the terrain adjacent to the bridge is steep, the grade is highly skewed, or other non-conducive terrain constraints are present, these conditions make SIBC more difficult.

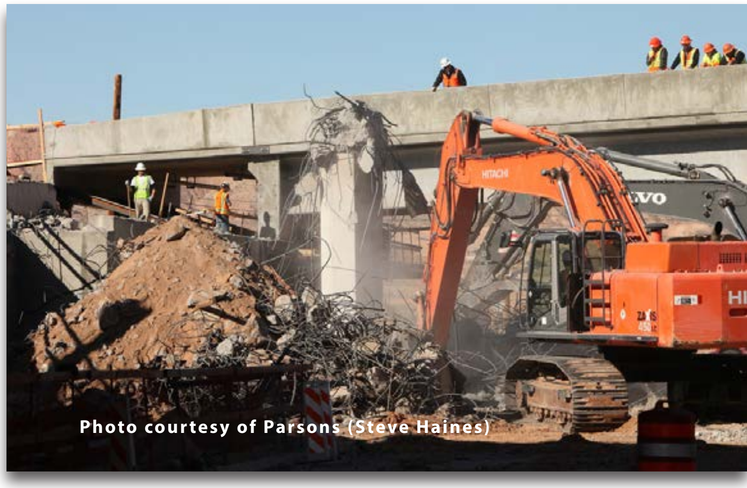

Photo courtesy of Parsons (Steve Haines)

One key to a successful slide-in construction project is to carefully plan and design every step. Engineers must account for numerous factors including: the type of technologies to be used for the move, the various stresses and how they change during the slide, and the design of temporary and permanent features that will be used to support the move. A thorough contingency plan must be developed to account for the full range of possibilities that could impact activities during the slide event, such as equipment failure, uneven movement, and worker injury during the slide.

BENEFITS OF BRIDGE SLIDE AND JACKING

Safety. Transportation-related incidents account for 76% of roadway work zone fatal occupational injuries, with 70% of these involving a pedestrian worker being struck by a vehicle. Because SIBC reduces the length of time needed for construction, this method can greatly reduce the risk of injury or death to both workers and drivers that increases every moment a work zone is in effect.


Photo courtesy of Parsons (Steve Haines)

However, as with any construction method, there are safety risks associated with SIBC and the appropriate precautions must be taken. For example, construction of the bridge on temporary supports is not required in traditional construction, and qualified engineers must design the temporary supports and falsework according to AASHTO Construction Specifications. While the condensed timeframe does reduce the risk of worker exposure to traffic in the work zone, it also can entail additional safety concerns due to multiple activities occurring simultaneously. These potential issues can be significantly mitigated with safety briefings, the use of trained engineering and construction personnel, and well-defined schedules that make workers aware of all the concurrent activities. Schedules must also be designed to avoid worker fatigue to maintain safety on the site.

Schedule. As mentioned, SIBC has the ability to significantly shorten the project schedule when compared with traditional phased construction. For example, the use of SIBC as part of an interchange reconstruction project on I-15 in West Mesquite, NV decreased the originally estimated 1-year project period by nearly 6 months. Typically, phased bridge construction requires the contractor to build first one-half of the structure and then the other half, which requires double the mobilization time, double the concrete cure times, and causes a number of inefficiencies. SIBC, however, allows construction of the entire superstructure at one time. In some cases, construction of the substructure and superstructure can be performed concurrently, providing additional time savings. Although some additional time is required to build the temporary abutments, overall SIBC can provide dramatic decreases in the time it takes to deliver a project.


Photo courtesy of Parsons (Steve Haines)

Mobility. Improved mobility is another notable benefit of SIBC. Standard construction procedures usually mean lane restrictions, lane closures, crossovers, detours, and a general disruption in traffic due to prolonged construction activities. This creates delays, driver distractions, and, ultimately, increased user cost for the entire community. By contrast, SIBC can decrease the impact of months of lane closures to a brief full closure. Recent SIBC projects in Utah, Missouri, and New York have required road closures ranging from just 7 hours to 20 days. When performed in off-peak hours with proper communication to the public, the traveling public and businesses experience minimal mobility impacts.

Cost Considerations. When considering total project costs rather than bridge construction costs alone, SIBC implementers will find the method to be a cost-effective means of bridge construction.

It is important to consider that total costs incorporate both direct and indirect costs. Direct costs may include actual cost of construction; maintenance of traffic (MOT); costs to design and construct a detour; costs associated with obtaining ROW; project design and development costs; essential services maintenance; construction engineering; inspection, maintenance and preservation; and toll revenue.

Indirect costs, while difficult to quantify, must also be taken into account. Indirect costs include user delay, freight mobility concerns, revenue loss for adjacent businesses, livability during construction, and both road user and construction worker exposure to work zone safety risks. These elements may be weighted differently by different states or localities based on the characteristics of the roadway that will undergo reconstruction and the needs of the local community.

Owners, designers, and contractors can experience significant savings in MOT, project administration, environmental mitigation, railroad flagging costs, and escalation. SIBC also dramatically reduces user costs associated with detours or extended work-zone traffic delays.

Elements that have the potential to increase cost include obtaining ROW, since SIBC requires construction adjacent to the existing bridge; temporary supports, the price of which can vary greatly depending on the existing conditions at the construction site and the temporary support requirements; geometric risk tolerance, which depends on the owner's requirements; and other contract- and schedule-related items—cost increases in these areas, however, can largely be mitigated through training and obtaining technical assistance in developing plans and specifications. The use of good data and accurate plans will facilitate good quality construction without issues.


Photo courtesy of MoDOT

Quality. The use of a pre-constructed superstructure can improve quality by eliminating deck construction joints and girder camber problems associated with phased construction. In addition, it is possible to get a better concrete cure when the superstructure is constructed off-line.

Constructability. Because the bridge is constructed outside of traffic lanes, allowing workers more room to operate and to focus on their work without fear of being struck, worker productivity is maximized. Furthermore, a slide-in bridge is generally easier to construct than a bridge using phased construction because there is more room and fewer physical restraints (e.g., phased construction is not necessary). In addition, because the bridge is constructed using conventional equipment, it is possible for all qualified bridge contractors to compete for the work.

AVAILABLE RESOURCES

Federal Highway Administration, *Prefabricated Bridge Elements and Systems in Japan and Europe*, Report No. FHWA-PL-05-003 (Washington, DC: March 2005). Available at:

http://international.fhwa.dot.gov/prefab_bridges/pl05003.pdf

Federal Highway Administration, *Accelerated Bridge Construction – Experience in Design, Fabrications and Erection of Prefabricated Bridge Elements and Systems,* Report No. FHWA-HIF-12-013 (Washington, DC: March 2011). Available at:

http://www.fhwa.dot.gov/bridge/abc/docs/abcmanual.pdf

COMING SOON : FHWA's team is developing training materials including: web-based training modules, webinars, and workshops for State DOTs, local public agencies, construction contractors, and engineers. Look for this information starting in the fall of 2013 and continuing throughout 2014.

Technical Contacts

Romeo Garcia

romeo.garcia@dot.gov

651-291-6125

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