



Using ABC in rehabilitation projects: A practical application

WHITE PAPER | 2019

Accelerated bridge construction is making a name for itself in bridge replacement. But is ABC a realistic option in bridge rehabilitation? Can it have the same positive effect of shorter closures and lower user costs? For the answer, we look at Minnesota's Franklin Avenue Bridge. Precast deck panels, spandrel and pier cap beams, and ornamental railing brought new life to this Hennepin County bridge - a \$43 million ABC project completed in just four months.

In this white paper:

- Identifying potential candidate projects
- Understanding the risks
- Keeping the closure window short
- Restoring historical integrity

Finding new applications for ABC

Using accelerated bridge construction for rapid bridge replacement often means replacement of the entire bridge or the superstructure, but pioneers, such as the Hennepin County Public Works Transportation Department, are proving ABC can be applied successfully to rehabilitation projects and partial replacements.

Hennepin County, Minnesota, owns the Franklin Avenue Bridge, a structure of significant size and scope. The Franklin Avenue Bridge, also known as the F.W. Cappel Memorial Bridge, is a five-span, open-spandrel arch bridge over the Mississippi River. When it opened in 1923, the concrete deck arch bridge, with arch ribs reinforced by a steel Melan truss, contained the longest concrete arch span (400 feet) in the world.

The bridge had undergone improvements over the years, but by 2007, it was time for a full condition assessment. An investigation deemed the bridge structurally sound but found deterioration in many deck, cap beam, arch rib, abutment and pier elements, especially those located near expansion joints.

Put both methodologies on the table

The evaluation of the Franklin Avenue Bridge recommended a conventional approach to repairs, requiring a two-year closure. Such a long closure of this critical crossing was not acceptable to the owner or the community. HNTB, selected to design the rehabilitation project, suggested exploring an ABC alternative that might reduce closure time.

The County agreed and put both options - conventional and ABC - on the table to determine the best approach. After due diligence, the County selected ABC, which promised to reduce the closure from two years to just four months. The timing of the bridge closure also was selected to minimize the impact to users.

Prepare to assume greater risk

In choosing to apply ABC to the rehab project, Hennepin County Public Works Transportation Department took careful planning to address some significant risks:

- Off-the-shelf ABC details and standards rarely work in a rehab situation because they are intended for new construction. Owners either must make significant modifications to standard details or customize them. In the case of field connections, completely new details may be required.
- In a new bridge project, the owner has full control of all the dimensions from the ground up. In a rehab project, there is increased risk of all elements fitting properly. In many cases, the accuracy and

completeness of available bridge plans introduces added risks of proper fit-up of the new prefabricated elements to the existing bridge components to be saved. On the Franklin Avenue Bridge, the County left the substructures, arches and spandrel columns in place and built new from that point up, leaving engineers to work with existing elements, dimensions and member sizes - some of which are not easily determined during the design phase. New technologies, such as 3D Lidar (light detection and ranging) surveys, can be applied to establish the true geometry to a high-level of accuracy.

- The owner is faced with a decision: use the true geometry of the existing bridge to detail every eventuality - or base the design details from the existing plans and require the contractor to provide the survey and adjust details, in coordination with the designer, during shop drawing reviews.

An owner may be willing to assume those risks if:

- Staged construction is not viable for the structure
- Some elements can be fabricated offline and set into place
- Long bridge closures are not desirable or workable
- The bridge is too narrow to be partially dismantled
- Removing half of the structure would cause additional damage to the remaining half
- The owner wants flexibility to time the closure to A) suit the community's needs, B) avoid closing lanes and creating detours in winter weather or C) accommodate special events

Many of those conditions were present in the Franklin Avenue Bridge. The bridge is adjacent to the University of Minnesota and Augsburg College. More than 9,900 vehicles cross the bridge daily. The bridge also connects two major pedestrian and bike corridors on either side of the Mississippi River. Pedestrians and cyclists make up 25 percent of the average daily traffic. A lengthy bridge closure would place a significant hardship on these users.

Perform as much pre-closure work as possible

To keep the ABC window short, the County, working closely with the designer and the contractor, looked for opportunities to complete as much work as possible prior to closing the bridge. One key activity was to precast the replacement elements prior to closure, thereby removing fabrication from the critical path. A necessary first step here is field verification of plan dimensions, so fit-up issues are avoided during ABC field assembly.

Crews installed temporary beams to support utilities, saw-cut the deck longitudinally (during off-peak hours while the bridge still was open) and core drilled lifting holes in the deck. They also installed temporary supports under each transverse saw-cut line. This not only allowed removal of deck panels shortly after the bridge was closed, but it also allowed the transverse saw cutting to be done without the need for a crane to support the “free” deck panels. In addition to saw cutting, crews removed existing barrier rails, thereby removing the saw cutting and existing barriers from the critical path. These pre-closure activities (saw cutting and removal) saved two to three weeks of work during the ABC window.

Much of the approach work (approach slabs, guardrails, widening or other roadway or sidewalk improvements) can be accomplished outside of the ABC window, too, so only the work that will impact traffic is performed during the closure.

Owners also may be able to push some of the drainage work outside of the ABC window to avoid delaying completion. The contractor may need to set the scuppers during closure to collect runoff from the deck, but some of the drain pipes and leaders can be installed after the bridge reopens to traffic.

However, the Franklin Avenue Bridge project delivery team leveraged the pre-closure activities to complete approach work (north sidewalk only) and drainage work during the ABC period.

Shorten closure time with precast technology

The County closed the bridge in May 2016 and the delicate job of dismantling the bridge began, presenting another challenge. ABC rehabilitation projects require careful dismantling. Portions of the bridge must be surgically extracted while the remaining portions are preserved. It requires a controlled and carefully planned execution. Demolition time must be factored into the ABC schedule and plans must reflect the type of demolition method, so the contractor can bid and schedule it accordingly.

On the Franklin Avenue Bridge, the construction team saw-cut the deck and lifted it out piece by piece, using five cranes. Seven barges floated the pieces away.

The rehab project replaced the existing deck, the cap beams on top of the columns/piers, and barriers with precast elements, all of which were prefabricated either on-site or at a precast plant and then hoisted into place. The new deck panels were joined with ultra-high-performance concrete. Precast technology addressed the structural limitations of staged construction and reduced closure time as the contractor was not forming, placing and curing concrete with the bridge closed.

To the exuberance of the public, all lanes of traffic and one pedestrian and bike path opened Labor Day 2016, 116 days after the bridge was closed.

ABC in rehabilitation of abutments

Many times, portions of a structure need to be removed and replaced due to extensive deterioration. With ABC, it would be much faster to cut out a portion of the deteriorated substructure and replace it with a precast element. A good example is the State Route 30 Bessemer Bridge Rehabilitation Project in Pittsburgh in 2016. The abutment seats exhibited significant deterioration. Instead of performing a concrete repair, the Pennsylvania Department of Transportation instructed the contractor to cut and remove the top few feet of the abutment and replace it with precast caps. This may not be a preferred option for historic bridges when the objective is to preserve as much of the original structure as feasible.

Traditional road work might have forced single-lane traffic patterns for six months on the roughly 54-foot span above Bessemer Avenue. The bridge was closed for 56 hours start to finish.

Work completed on the Franklin Avenue Bridge included:

- A new precast deck and 43 cap beams (spandrel and pier)
- Two, 12-foot vehicular lanes on the west side
- Four, 11-foot vehicular lanes on the east side
- 26 historically accurate lights, 2,122 linear feet of exterior precast ornamental railing
- Restored river pier overlooks
- Repaired arch ribs, piers and abutments
- West abutment, span 1 and pier 1 service repair with board form finish
- 12-foot to 17-foot-wide barrier-separated shared bicycle/pedestrian paths
- A new bicycle crosswalk at the west approach
- A new “eco-counter” bicycle count display tower at the west approach

Restore historical integrity

Recreating the original details of a major historic river crossing often is cost-prohibitive because field labor typically costs more than plant labor. But with ABC, costly and labor-intensive architectural details can be prefabricated in a controlled plant environment, which is far more cost-effective than performing the same work on-site.

Hennepin County's replication and prefabrication of the Franklin Avenue Bridge's original ornamental railing and cap beams were viewed very positively by the local community, stakeholders and historians. They could visit the fabrication plant and see samples, knowing the finished product would be identical.

ABC can extend useful life

We know now from the success of the Franklin Avenue Bridge that ABC can be applied to rehabilitation projects with stellar results. Shorter construction windows mean owners can gain public support for these projects by turning their assets back to their communities faster. The bridge itself can be recommissioned for another 30 to 40 years for an even greater return on financial and historical investments.

Additional resources:

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1. **SHRP2 Renewal Project R04; Innovative Bridge Designs for Rapid Renewal, ABC Toolkit**, Publication S2-R04-RR-2; Transportation Research Board of The National Academies, Washington, D.C., 2013
2. **SHRP2 Renewal Project R04; Innovative Bridge Designs for Rapid Renewal, Final Report**, Prepared for the Transportation Research Board of The National Academies, Washington, D.C., 2012
3. **2017 ABC Conference, University Transportation Center, Florida International University**
<https://abc-utc.fiu.edu/conference>
4. **Federal Highway Administration's Every Day Counts program**
<https://www.fhwa.dot.gov/innovation/everydaycounts/about-edc.cfm>
5. **HNTB's SOLVE publication, Issue 4, "Accelerated Bridge Construction: Speeding the replacement of workhorse bridges to minimize traffic disruption and user costs," 2015**
Available upon request
6. **HNTB's ABC press kit**
<http://www.hntb.com/Newsroom/Media-Kits/Accelerated-Bridge-Construction>

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