Broad-based ABC Policy: WSDOT's Bridge Design Manual

by Patrick Gallagher, Alpha & Omega Group (formerly with Washington State Department of Transportation)

Accelerated bridge construction (ABC) has been a part of the Washington State Department of Transportation's (WSDOT's) bridge design philosophy before the term was popularized in recent years. Washington state has a long history of pushing the envelope and trying new and innovative bridge designs. With the recent attention given to ABC, WSDOT decided to embrace this new movement and formalize their position on the topic.

The WSDOT *Bridge Design Manual*[1] (BDM) is unique. Like many states, WSDOT's BDM provides standard construction drawings. But it also puts an emphasis on standardizing design techniques. Being in a part of the country where bridge designs are typically dominated by seismic analysis, it can be difficult to create broad-range construction standards. So, the BDM often relies upon standardizing how a bridge ought to be designed and how other codes[2,3] are applied. It also offers suggestions to the designer regarding the fabrication and constructability of bridges and structures.

The BDM covers a wide array of topics regarding ABC. But the focus of this article will be project delivery methods and the precast concrete bent system.

How We Got Here

Washington state has vast natural beauty and is also one of the faster growing places in the country. With a desire to add transportation capacity and protect the unique beauty of the state, precast concrete bents diminish the seemingly offensive activity of road construction. Whether it be minimizing traffic disruption, minimizing workers' exposures to hazards, or optimizing time for fish migration, erecting bridge piers and cap beams quickly is in everyone's best interest.

Erection of precast concrete crossbeam at Nalley Valley Interchange, Tacoma, Wash.. Photo: Geoff Swett, Washington State Department of Transportation.

Like design-build (DB), what makes a project an attractive candidate for ABC is reduced construction time. DB offers time savings by overlapping design and construction efforts, and by encouraging collaboration. ABC speeds up the construction time by overlapping linear-flowing construction activities. This can be accomplished by prefabricating bridge components off-site while other activities are taking place on-site, allowing construction tasks that used to be done one after the other to be done at the same time.

The construction manager/general contractor project delivery method capitalizes on a specific contractor's skills. While it may not provide delivery as rapidly as DB, it too complements ABC. Prefabricating bridge components to a specific contractor's interests and abilities offers a boost of speed because the details are optimized for that contractor's expertise.

When to Use ABC

Decisions affecting the choice to use ABC are often made by a traffic engineer or a project manager early in a project's development. These individuals are often interested in concepts and project schedules, not structural details. By the time a bridge is being designed, the opportunity for a bridge design engineer to apply ABC has often passed.

ABC ought to be presented to decision makers early in the project's development. To aid a WSDOT region engineer in deciding whether or not to apply ABC, the WSDOT BDM offers a design impact questionnaire and an ABC decision flow chart. These tools were borrowed from the California Department of Transportation. The questionnaire uses a weighted scoring system based on the relevance and priority of concerns

on the overall project. With that score, the region engineer enters the flow chart and, based on the responses to ABC-related questions, leaves the flow chart with a recommendation to apply an ABC approach or not. The scoring system gives a way to measure how strongly ABC should be considered, and the broad questions in the flow chart give the region engineer some room for judgment. The expectation is that ABC will be encouraged throughout this process, with an objective consideration for projects that are clearly best delivered by conventional means.

Benefits of Prefabrication

Space on a jobsite is precious. With more space taken up by construction activities, less space is available for traffic, or more disruption is done to the environment. Simply shifting activities off the jobsite adds tremendous value to a project. Precast concrete bents take major, critical construction activities and remove them from the jobsite. Space will still need to be allocated for shaft and footing construction. But once that work is complete, space can be used to put traffic back onto the highway, or simply to get out of the way and let nature continue to flourish.

Prefabricating bridge components is not a new idea. Precast, prestressed concrete girders have been around for decades. But the idea of prefabricating a substructure in a high seismic zone offers a tremendous challenge. The American Association of State Highway and Transportation Officials, *Guide Specifications for LRFD Seismic Bridge Design*[3] requires that damage from a seismic event will not occur at connections. Traditionally, connection strength in prefabricated members is the weak point, and developing a connection stronger than the connected members is a challenge. The WSDOT BDM provides structural details and a design methodology for precast concrete bents to ensure this criterion is met.

Through the efforts of university research,[4] a grouted-duct system has been developed to construct moment-resisting connections. By casting voids in one member using a corrugated steel duct, reinforcing bars extending from an adjacent member can be inserted into the voids. After the void is grouted, the full capacity of the reinforcing bars can be developed. Another moment-resisting and ABC friendly connection that is backed by large-scale experimental research[4] is a unique socket connection between a precast concrete column and cast-in-place footing. Both of these connection systems offer straightforward methods to design a wide array of bridge configurations, resist the same loads as their cast-in-place counterparts, and can be tailored to an engineer's or contractor's preferred construction techniques. They can be applied to columns, footings, shafts, cap beams, and abutments. Similar methods have been applied to grout pockets in prefabricated concrete decks.

Erection of precast concrete pier cap on precast columns, Interstate 5/US 12 interchange at Grand Mound, Wash. Photo: Patrick Gallagher, Alpha & Omega Group..

An Extraordinary Document

The WSDOT BDM is an extraordinary document, especially as it relates to ABC. It provides excellent guidance to project managers, bridge designers, and contractors. It offers a single-point resource for many aspects of ABC, including technology, construction techniques, and options for handling and shipping large components across the entirety of a project's development. In addition, it is a great design aid for the precast concrete bent system, which is an excellent achievement in and of itself.

References

1. WSDOT (Washington State Department of Transportation) Bridge and Structures Office. 2016. *Bridge Design Manual*. Publication no. M 23-50. Olympia, WA: WSDOT.
2. AASHTO (American Association of State Highway and Transportation Officials). 2014. *AASHTO LRFD Bridge Design Specifications*. 7th ed. Washington, DC: AASHTO.
3. AASHTO. 2011. *Guide Specifications for LRFD Seismic Bridge Design*. 2nd ed. Washington, DC: AASHTO.
4. Khaleghi, B., E. Schultz, S. Seguirant, et al. 2012. "Accelerated Bridge Construction in Washington State: From Research to Practice." *PCI Journal*, 57 (4): 34–49.

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EDITOR'S NOTE

Examples of projects where ABC concepts have been used, including a brief description of benefits and reasons for using ABC and lessons learned, are available on the WSDOT Bridge and Structures ABC Resources website.

The following FHWA publications present design examples for precast bents:

- *Precast Bent Systems for High Seismic Regions Appendix B, Publication Number FHWA-HIF-031-037-B.*
- *Precast Bent Systems for High Seismic Regions Appendix C, Publication Number FHWA-HIF-031-037-C.*