How are Environmentally Sensitive Areas Handled When PBES is Used?

Environmentally sensitive areas, such as wetlands or urban areas in which air and water quality and noise pollution are issues, can limit the amount of construction work that can be done onsite. They can also limit construction scheduling, particularly during seasons when wildlife and plant life are particularly vulnerable. PBES can be a good option in these areas, since it offers rapid onsite installation, reducing the site access footprint and the environmental impact of construction.

What Restrictions exist for Bridges Listed on the *National Register of Historic Places*? Can PBES be Used?

The prefabrication of bridge components should be consistent with historic bridge requirements. The owner will need to determine if appropriate pieces of the existing bridge can be incorporated into the new bridge. In some cases, monuments, parapets, stone work cladding, plaques, or other significant features can be salvaged and added on after the new bridge is in place. Close communications with the State Historic Preservation Officer are essential throughout the process, particularly during the preliminary planning stages, when all special requirements and regulations should be considered.

How does PBES Impact Driver and Worker Safety?

Conventional construction methods involve substantially more onsite construction. This has the potential to distract drivers, which negatively affects the safety of the traveling public and the safety of contractor personnel. Since PBES reduces onsite construction as well as lane closures and detours, drivers encounter fewer distractions and challenges. In addition, worker safety improves. Construction workers spend less time near high traffic volumes and power lines, and they do less work over elevated work areas. Worker exposure to extreme weather conditions is also reduced.

Contact Information

For training or more information on this Every Day Counts Initiative, please contact your local FHWA Divisions Office.

To learn more about EDC, visit:
http://www.fhwa.dot.gov/everydaycounts

About Every Day Counts

Every Day Counts is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadway, and protecting the environment.

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Prefabricated Bridge Elements and Systems

(PBES)

U.S. Department of Transportation
Federal Highway Administration

How Does the Use of Prefabricated Bridge Elements and Systems (PBES) Compare with Conventional Bridge Construction?

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PBES are structural components of a bridge that are built offsite or near the site of a project so they are ready for immediate installation once they are transported to the construction site. Compared with conventional bridge-building methods, using PBES can dramatically reduce onsite construction time and costs. Prefabrication also allows faster partial- or total-repair of bridges or component parts. Using standardized bridge elements can offer costs savings on both small and large projects.

How Does the FHWA Differentiate Between a Bridge Element and a Bridge System?

An **element** is a single structural component of a bridge. In PBES, the element is prefabricated in a manner that eliminates or reduces onsite construction time, as compared with building a similar structural component from scratch onsite. There are five types of elements: deck elements (such as precast deck panels), beam elements (including deck beams and full beams), pier elements (such as caps, columns and footings), pier abutments and wall elements (including wing walls and back walls), and miscellaneous elements (which might include approach slabs, parapets, and overlap systems).

Prefabricated **systems** are also designed for speedy installation, but they involve either an entire superstructure, a superstructure and a substructure, or a total bridge that is placed in a modular manner such that traffic operations can resume after placement.

How Does PBES Affect Overall Bridge Quality? Can it Handle the Current Increased Traffic and Freight Tonnage Challenges?

Traffic volumes increase every year, and freight tonnage is expected to increase by 70 percent between 1998 and 2020. The FHWA has invested in accelerated bridge construction methods, including PBES, to meet those and other challenges. Quality and durability typically increase with PBES, since the construction of most bridge elements and systems can be done in a controlled environment, where weather does not affect fabrication. Using consistent materials and methods also contributes to the uniform quality of bridge components. Bridges installed using PBES with durable field connections can have a service life of 75 to 100 years.

Are Time Savings Substantive?

Conventional construction methods require many time-consuming onsite activities, such as formwork construction, re-bar and concrete placement, concrete curing, formwork removal, and other related tasks, including the planning, coordination, and scheduling of these tasks. Many of these activities are weather-dependent. The use of PBES technology greatly reduces onsite construction time, since components can be built offsite, while earthwork and foundation construction is underway. Savings from PBES installations are particularly dramatic when many similar components are required for a project and/or where the construction season is limited by weather or other considerations. Building the structural elements or the entire bridge offsite condenses the onsite construction period and radically reduces mobility impacts to the transportation network. With PBES, it has been possible to construct some bridges in a single weekend.

Which Projects are the Best Candidates for PBES?

When average daily traffic and/or average daily truck traffic in the work zone is high, PBES technology is a recommended solution. If the bridge is essential as an evacuation route, or if the bridge replaces an existing essential structure, the speed of PBES installation also makes it an obvious choice over traditional construction. Where bridge construction poses unusual hazards to worker safety and/or traveler inconvenience, using PBES can alleviate those conditions. Again, the speed of PBES construction and the minimization of construction work zones in transportation lanes reduce the impact of bridge construction on travelers.

Is the Transportation of Large Bridge Elements and Structures a Barrier to Deploying PBES?

Transporting large bridge elements and structures does require preliminary planning, including a site survey for impacted intersections, allowable haul times, permit regulations, utility relocations, second party easements (municipal, railroad, airport), and ease of movement throughout congested areas, including job site detours. Longer and heavier prefabricated components can require modification to conventional transportation and erection practices. For transportation over highways, the hauling systems must have axle numbers and spacing such that the loads are within permit limits. The transporter must find a route that has adequate turning radii to get longer components to the bridge site. In some cases, parts can be shipped by barge without requiring any re-handling on land.

Should PBES be Stockpiled?

Stockpiling a wide range of components for permanent bridges can be very useful, but this does require planning. The most appropriate entity to own and manage the stockpile must be determined. The owner will also need to determine which components are used commonly enough to make stockpiling economically sensible.

Case Study: Interstate 93 "Fast 14" Bridge Replacement Project in Massachusetts

Interstate 93 (I-93) is a critical artery in to and out of Boston, with four-lane bridges handling approximately 200,000 vehicles per day. Due to increasing traffic, 14 aging bridge superstructures (with 60-year-old bridge decks) had to be replaced quickly to avoid costly emergency repairs and severe traffic congestion. This effort, called the "93 Fast 14 Rapid Bridge Replacement Project," has been dubbed 'the most ambitious in the country.'

The bridge substructures only needed minor repairs and revisions at the abutment and pier caps to support the new superstructures, so the PBES technology was the best solution. Conventional, staged, cast-in-place construction methods would have required at least 4 years of construction. With this technology, the 14 PBES superstructures were replaced, one or two at a time, on successive weekends. The effort restricted lane closures and crossover conditions to off-peak hours and reducing the total project delivery time to less than 1 year for all 14 structures.

The bridges had skewed superstructures that varied in length, number of spans, and skew, and each of the highly durable prefabricated modular units had to be designed for the unique and complex geometries of the existing superstructures. Each replacement superstructure included several prefabricated modular units with two weathering steel stringers and a composite concrete deck. Each modular unit rests on elastomeric bearings and acts as a simple span for dead loads. Weathering steel diaphragms between the stringers ensured stability during construction.

One to two bridge replacements took place within each 55-hour period. Demolition began on Friday night, cranes erected the PBES on Saturday, and workers poured the rapid-curing concrete on Sunday. The concrete cured before Monday rush hour, with minimal shrinkage, allowing MassDOT to reopen the roadways.

Using PBES limited the duration of motorist impacts and increased work zone safety while addressing all durability concerns of the superstructures. As FHWA Administrator Victor Mendez noted, this project showed "elected officials and to the public that we really are doing new things; that we are capturing innovation in a way that we have never done before."

MassDOT Fast 14 Project replaced fourteen bridge superstructures in one construction season using PBES.