FHWA EVERY DAY COUNTS TECHNOLOGY DEPLOYMENT INITIATIVES TO ACCELERATE BRIDGE CONSTRUCTION

Claude Napier, P.E., Senior Structural Engineer, FHWA Resource Center Structures Technical Service Team, Richmond, Virginia
Deborah Vocke, Marketing Specialist, FHWA Resource Center, Communications & Marketing Technical Service Team, Baltimore, Maryland

Abstract

This paper discusses the Federal Highway Administration (FHWA) recently launched *Every Day Counts* (EDC) initiative designed to to transform the way FHWA does business—both externally in the transportation systems on which we work, and internally in the way we operate our organization. Three areas were identified for initial focus: Shortening Project Delivery, Accelerating Technology and Innovation Deployment, and FHWA's Going Greener initiative. The focus of this paper is on the initiatives that accelerate bridge construction. They are accelerated project delivery methods, geosynthetic reinforced soil, and prefabricated bridge elements and systems.

The accelerated project delivery methods depend on the highway community advancing innovative practices to a level of routine use by highway agencies and contractors. EDC focuses FHWA’s efforts to make innovative contracting everyday standard business practice. Construction manager/general contractor (CM/GC) and design-build (DB) initiatives will be discussed.

Accelerating technology and innovation deployment emphasizes that 21st century solutions must be leveraged to improve safety, reduce congestion, and keep America moving and competitive in the world market. Five technologies have been selected for deployment under the EDC initiative: warm mix asphalt, safety edge, adaptive signal control technology, geosynthetic reinforced soil, and prefabricated bridge elements and systems. The two technologies that accelerate bridge construction (ABC) are geosynthetic reinforced soil (GRS) and prefabricated bridge elements and systems (PBES).

The benefits of using geosynthetic reinforced soil will be highlighted briefly with the greatest emphasis placed on prefabricated bridge elements and sytems. The accelerated bridge construction/prefabricated bridge elements will discuss the following:

- Vision, mission, concepts and components;
- Reasons for using and major benefits of ABC/PBES;
- Status of PBES deployment in the United States; and
- Decision-making frameworks.

Introduction

This paper discusses the recently launched Federal Highway Administration (FHWA) *Every Day Counts* (EDC) initiative designed to to transform the way FHWA does business—both externally in the transportation systems on which we work, and internally in the way we operate our organization. Three areas were identified for initial focus: Shortening Project Delivery, Accelerating Technology and Innovation Deployment, and FHWA's Going Greener initiative. The focus of this paper is on the initiatives that accelerate bridge construction. They are accelerated project delivery methods, geosynthetic reinforced soil, and prefabricated bridge elements and systems.

Transportation agencies are challenged to improve safety, reduce congestion, and undertake necessary construction projects. The top priority of transportation agencies is to stem the loss of more than 33,00 lives each year to crashes. At the same time, transportation agencies are committed to offering motorists high-quality, longer-lasting highways and bridges while reducing construction time and traffic congestion that, taken together, cost the Nation $63 billion each year in wasted time and fuel. These agencies, however, also operate against a backdrop of challenges: a need for intensified construction activities to restore the Nation's aging transportation system, which was largely built in the 1950s and 1960s; capacity that has increased little in the past two decades; and growing communities and increasing traffic volumes.

Approximately one-fourth of the Nation's 600,000 bridges require rehabilitation or replacement. However, bridge repair, rehabilitation, and replacement activitiescan significantly impact bridge users. For example, full-lane closures in large urban centers or on highways due to bridge projects can have a significant economic impact on commercial and industrial activities. In many cases, the direct and indirect costs of traffic detours, the loss of the use of the bridge during construction, and the disruption to the local economy caused by a bridge project can exceed the actual cost of the bridge structure. Lane closures and other bridge activities also can lead to safety issues. Because of these potential economic impacts and safety concerns, minimizing traffic disruptions during bridge rehabilitations and repairs is a critical issue that should be considered as important as maintaining construction quality and reducing the life cycle costs and environmental impacts of the bridge.

Accelerated Bridge Construction (ABC) employs technologies from five broad structural and geotechnical engineering categories: foundation & wall elements, rapid embankment construction, prefabricated bridge elements & systems, structural placement methods, and fast track contracting. These categories help agencies save valuable resources, both time and money, when bridge rehabilitation or reconstruction projects are planned and executed as noted in Table 1.

TABLE 1: ACCELERATED BRIDGE CONSTRUCTION OPTIONS

Foundations & Wall Elements	Rapid Embankment Construction	Prefabricated Bridge Elements & Systems	Structural Placement Methods	Fast Track Contracting
Continuous Flight Auger Piles Geosynthetic Reinforced Soil Integrated Bridge System	Expanded Polystyrene Geofoam	Prefabricated Elements - Superstructure - Substructure Prefabricated Systems - Superstructure - Substructure - Total Bridge	Self-Propelled Modular Transporters (SPMTs) Longitudinal launching Horizontal sliding or skidding Other heavy lifting equipment and methods	Innovative Contracting -Best value -CM/GC method -Design-Build -A+B -A+B+C -Warranties

The EDC ABC vision is to facilitate the deployment of Accelerated Bridge Construction technologies as a standard practice for all highway projects. The mission is to advance the implementation of Accelerated Bridge Construction technologies. The focus is on:

- Speeding construction time;
- Minimizing traffic impacts;
- Improving durability;
- Increasing safety; and
- Reducing environmental impacts during highway construction projects throughout the transportation community.

ABC employs structural and geotechnical engineering technologies and fast track contracting to help agencies and the traveling public save time and money when a bridge rehabilitation or reconstruction projects are being implemented.

The accelerated project delivery methods depend on the highway community advancing innovative practices to a level of routine use by highway agencies and contractors. EDC focuses FHWA’s efforts to make innovative contracting everyday standard business practice. Construction manager/general contractor initiatives and design-build initiatives will be discussed.

Accelerating technology and innovation deployment emphasizes that 21st century solutions must be leveraged to improve safety, reduce congestion, and keep America moving and competitive in the world market. Five technologies have been selected for deployment under the EDC initiative. They are warm mix asphalt, safety edge, adaptive signal control technology, geosynthetic reinforced soil, and prefabricated bridge elements and systems. The two technologies that accelerate bridge construction are geosynthetic reinforced soil (GRS) and prefabricated bridge elements and systems (PBES).

Accelerated Project Delivery Methods

Construction Manager/General Contractor

Construction Manager/General Contractor (CM/GC) is an alternative project delivery method in which the owner places the responsibility for design review, design modifications, system integration, and construction with a single contractor. Typically, a CM/GC contract stipulates that the construction manager (CM) is responsible for costs over the guaranteed maximum price. It may consist of two separate contracts: pre-construction services and construction. In a typical CM/GC scenario, the owners of a project hire either a general contractor or design firm to serve as the CM. CM/GC allows State DOTs to remain active in the design process while assigning risks to the parties most able to mitigate them. CM/GC occupies the middle ground between design-bid-build and design-build.

Additional benefits include:

- Potential for lower project costs, primarily due to risk identification and allocation during early project development
- Enhanced cost certainty at an earlier point in design than either design-build or design-bid-build, because of real time costing information inherent to method
- Value engineering savings accrue to owner in CM/GC arrangement. Change orders, an indicator of design quality, are also low
- Enhanced ability to accelerate the project’s delivery schedule due to activities that can occur concurrently
- Increased partnership and team building fosters an environment where innovation can be nurtured, rewarded, and flourish. Owner has control over design details as a member of the design team

Design-Build

Design-build (DB) is an alternate method of project delivery in which the design and construction phases of a project are combined into one contract, allowing for certain aspects of design and construction to run concurrently. This can provide significant time savings compared with the more traditional design-bid-build approach where the design and construction services must be undertaken in sequence. With DB project delivery, the design-builder assumes responsibility for the majority of the design work and all construction activities, together with the risks associated with providing these services. This provides the DB with an increased flexibility to be innovative. Along with the increased flexibility, the design-builder also assumes greater responsibility and risk. The owners of the project usually retain responsibility for financing, operating and maintaining the project. Because both design and construction are performed under the same contract, claims for design errors or delays are significantly decreased and the potential for other types of claims are greatly reduced. From a State highway agency perspective, the potential time savings is a significant benefit.

The successful execution of a DB contract provides several benefits, including:

- Time savings through early contractor involvement and elimination of a separate construction contractor bid phase. Cost savings from reduced construction engineering and inspection costs to the contracting agency when these quality control activities and risks are transferred to the design-builder, and fewer change and extra work orders.
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- Improved quality through greater focus on quality control and quality assurance through continuous involvement by design team throughout project development.

<u>Geosynthetic Reinforced Soil</u>

Instead of a conventional bridge supported on a pile cap abutment, Geosynthetic Reinforced Soil (GRS) integrated bridge system technology uses alternating layers of compacted fill and sheets of geotextile reinforcement to provide support for the bridge. GRS is also used to construct approach ways and transitions onto the roadway. This bridge system alleviates the “bump at the bridge” problem caused by differential settlement between the bridge abutment and approaching roadway. The technology offers unique advantages in the construction of small bridges, including:

- Reduced construction time;
- 25 percent to 30 percent less cost than standard pile capped abutments with 2:1 slopes;
- Less dependence on weather conditions during construction;
- Flexible design—easily field modified for unforeseen site conditions;
- Easy to maintain because of fewer parts;and
- Can be built with common equipment and materials.

<u>Prefabricated Bridge Elements and Systems</u>

For the EDC initiative, PBES is defined as bridge structural elements and systems that are built off the bridge alignment to acclerate on-site construction time relative to conventional practice. Conventional bridge construciton employs non-adjacent girders that have a cast-in-place (CIP) deck and CIP substructure.

With prefabricated bridge elements and systems (PBES), many time-consuming construction tasks no longer need to be accomplished sequentially in the work zone. Instead, PBES are constructed concurrently, off-site and/or off alignment, and brought to the project location ready to erect. Because PBES are usually fabricated under controlled climate conditions, weather has a smaller impact on the quality, safety, and duration of the project. Through the use of standardized bridge elements, PBES offers cost savings in both small and large projects. The use of rapid on-site installation for PBES can reduce the environmental impact of projects in environmentally sensitive areas.

Prefabricated bridge construction can help minimize traffic delays and community disruptions by reducing on-site construction time and improving quality, traffic control, and safety.

Using prefabricated bridge elements and systems means that time-consuming formwork construction, concrete placement and curing, and other tasks associated with fabrication can be done off-site in a controlled environment without affecting traffic.

This process offers significant advantages over cast-in-place construction, resulting in:

- Reduced on-site construction time;
- Minimized traffic disruption (months to days*);*
- Reduced Environmental impact;
- Improved work zone & worker safety;
- Lower initial and life-cycle costs; and
- Improved product quality (controlled environment, cure times, easier access, etc.).

<u>Deployment Status</u>

The national map in Figure 1 shows a breakdown of the implementation of PBES in increments of five bridges built over the past several years. More than 11 States are actively pursuing PBES as a standard practice. Six States have over 20 PBES projects. This is the application rate nationwide to date:

- 6 States are in the >20 category;
- 1 State is in the 16-20 range;
- 1 State is in the 11-15 range;
- 5 States are in the 6-10 range; and
- The remaining States are in the 1-5 range or the 0 category.

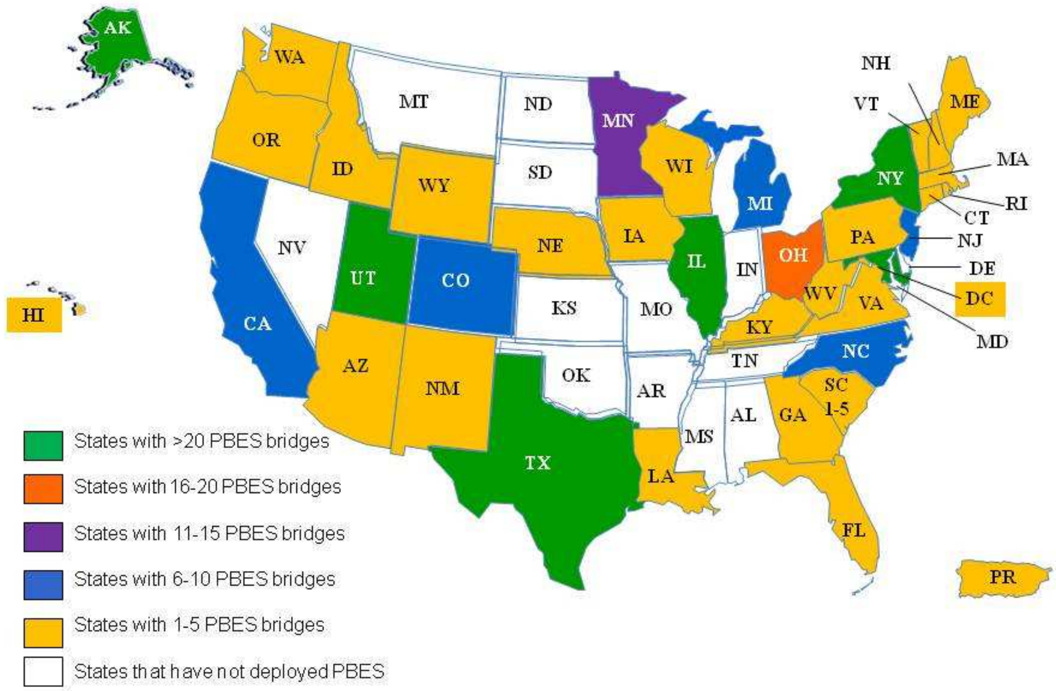

FIGURE 1: STATUS OF PBES DEPLOYMENT IN THE UNITED STATES

<u>Available Resources for PBES</u>

The FHWA website at http://www.fhwa.dot.gov/bridge/prefab offers a number of resources to assist bridge owners. Some of the resources that are available for download electronically are:

- Example projects that have used ABC/PBES
- Decision-Making Framework for PBES, May 2006
- PBES Cost Study: Accelerated Bridge Construction Success Stories, 2006
- Manual on Use of Self-Propelled Modular Transporters (SPMTs) to Remove and Replace Bridges, June 2007
- Connection Details Manual for PBES, March 2009

The Decision-Making Framework for PBES presents a framework for the objective consideration of the rapid construction issues, cost issues and other issues. The framework is a decision-making tool to help answer the ultimate question of whether a prefabricated bridge is achievable and effective for a specific bridge location.

The PBES Cost Study presents nine project case studies of replacement projects where reducing the impact of on-site construction to motorists was a priority. Each project is an example of how various combinations of prefabrication and effective contracting strategies were used to achieve the accelerated on-site construction timeline at competitive cost.

The Manual on the use of Self-Propelled Modular Transporters provides information on computer-controlled multi-axle platform vehicles that can remove existing bridges and install new bridges with minimal disruption to traffic. The manual includes 15 appendices with various example specifications, contract drawings, details and other information.

The Connection Details Manual includes connection details that have been used across the United States. Sample construction specifications and case studies are also included.

Conclusion

The EDC initiatives for accelerated project delivery methods of construction manager/general contractor and design-build offer significant benefits to accelerate the project's delivery. The geosynthetic reinforced soil technology offers unique advantages in the construction of small bridges.

In addition, using PBES reduces traffic and environmental impacts by minimizing the need for lane closures, detours, and the use of narrow lanes. Using PBES is faster (construction is off-site and/or off critical path); it's safer (for the public, construction & inspection crews); it provides better quality (due to controlled environment); and, it results in a lower cost (comparable to or lower than convention practice).

PBES technologies should be used because the traveling public deserves a new driving experience with reduced user costs due to work zones and congestion. PBES should be used to help accelerate bridge construction and help change America's driving experience and meet the customers' needs. As time spent in commuting has grown, Americans have less time to spend with their families and friends.