

BUNDLING: AN INNOVATION IN BRIDGE DELIVERY

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Public transportation agencies in the US have broken down the management of their bridge assets into four parts: preservation, preventive maintenance, rehabilitation, or replacement. As these agencies continue their battle to update and rehabilitate their civil infrastructure, bundling multiple bridge construction projects into a single contract can save money, human resources and time. State and local public agencies (LPAs) are beginning to employ this concept, but since practices and methods for bridge bundling are not yet standardized, the Federal Highway Administration has pursued tools and techniques to help these agencies successfully apply bridge bundling. A successful bridge bundling program focuses on a specific group (or bundle) of bridges that are slated for any of the four management areas, and navigates all the bridges in the bundle through the process from conception to completion. This is accomplished in the shortest time possible, with the support of the proper funding options and/or partnerships. Bridge bundling has demonstrated its ability to serve as an efficient and effective approach for sustaining and upgrading bridge assets through use of both federal and non-Federal funds. Use of the tool has led to cost savings and accelerated project delivery, and bridge bundling has proven itself valuable in all four of the major tactics currently employed to manage bridges.

Keywords: Bundle, Preventive maintenance, Rehabilitation, Replacement, Preservation, Civil infrastructure.

1 INTRODUCTION

This paper is a summary of how the relatively new concept of bundling is appropriated to the area of bridge management in the US. Bridge bundling is a tactic currently employed by some state departments of transportation (DOTs) and some local public agencies (LPAs), and has proven to be an efficient and effective method for maintaining and improving the bridge assets under their care. This new practice comes at a fortuitous time, as the nation's civil infrastructure is in dire straits. Bridge assets are currently managed in three ways, depending on the condition and subsequent needs of the bridge. These are preservation/preventive maintenance, rehabilitation, and replacement (See Figure 1). Joint state and local efforts to employ bridge bundling have resulted in savings in both time and cost through expedited project delivery. Executing one contract always takes less time than executing multiple contracts, and lower construction engineering and inspection (CEI) costs result both from the shorter durations and the necessity of tracking only one contract through mandated documentation instead of several. Even though the amount of construction is the same, substantial time and money are saved, given proper application of the concept.

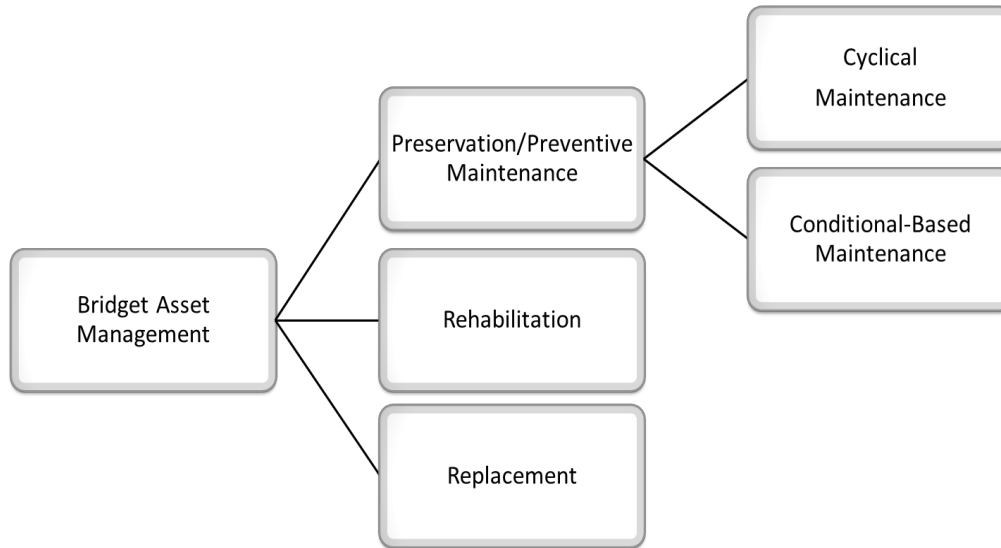


Figure 1. Bridge action categories (FHWA 2019).

The National Bridge Inventory publishes a report each year called “Bridge Condition by Owner.” For 2017, the report listed 615,002 active highway bridges in the US; of these, 46.8 percent were rated to be in good condition, 45.4 percent in fair condition, and 7.7 percent in poor condition. Bridges in poor condition usually get the most attention, but per the Federal Highway Administration (FHWA) Bridge Preservation Guide, “Effective bridge preservation actions are intended to delay the need for costly rehabilitation or replacement, while bridges are still in good or fair condition and before the onset of serious deterioration” (D’Angelo *et al.* 2019). Because of its flexibility, bridge bundling is proving to be an excellent system for executing projects to mend or replace bridges in all states of disrepair.

2 LITERATURE REVIEW

“Project grouping is a concept that aims to reduce the overall costs of projects by combining smaller-scale pavement, bridge, and other projects under a single contract” (Qiao *et al.* 2018). It provides a strategic goal of comprehensive and accelerated delivery of the solution. It describes the use of a single contract to award preservation, preventive maintenance, rehabilitation, or replacement. Such contracts can use any one of several functions (D’Angelo *et al.* 2019).

Bridge bundling simplifies design, contracting and construction, enabling institutions to use economies of scale to increase efficiency. The process also encourages greater collaboration during project delivery and execution through to project completion (FHWA 2019).

Project grouping is a concept that aims to reduce the overall cost of the project by combining smaller scale roads, bridges and other projects. There is research potential for national agencies to realize the benefits of grouping projects (Xiong *et al.* 2017). To that end, Frank and Merna (2003) noted that to gain banking capacity, all manner of private finance concessions are often bundled into projects and delivered as a whole.

Project bundling is a proven practice that draws on the efficiencies found through streamlining project delivery and benefits from alternative and traditional contracting methods. Bundled contracts can cover a county, district, or state, and can be layered to allow a combination of work types (design, save, restore, or replace entirely). Such a process can include any of several features.

For example, its scope can include design and construction, or it can be layered to allow combinations of work types. Bundling design and construction contracts saves procurement time, leverages design expertise, and builds momentum to keep key assets in good repair (D'Angelo *et al.* 2019).

Tying bridges can be beneficial for some agencies, as the problem of maintaining/preventative maintenance of bridges in good and equitable circumstances needs to be addressed, as does the task of reducing the number of bridges in poor condition. Other agencies may be convinced to try bundling due to understaffing, sudden increases in funding or debt maturities, or to address key corridors or to utilize other funds and capital financing strategy (D'Angelo *et al.* 2019).

Xiong *et al.* (2017) stated that “The reduction of bundling projects in work zone duration would not only bring benefits to the agency by reducing bid amount and risk of injury/fatality associated with construction, but it can also benefit the road users and neighborhoods in terms of reduced traffic interruption;” they further postulated that when two or more items are considered for grouping, several questions must be considered: 1. Compatibility; 2. Reasonable location; 3. Schedule; 4. Cost estimating.

Baccarini (1996) observed that both practitioners and academics have difficulties accepting and treating projects as complex, while Van den Hurk (2015) postulated that as far as the impact of bundling procurement is concerned, tensions are expected between the interests of local governments and the need to coordinate project design to allow bundling sales.

Johnson (2001) emphasized the importance of maximizing the value of the portfolio, while optimizing the portfolio risk. In addition, project managers must continually understand how their projects fit into evolving strategies. The only way to adapt to external influences within an open system is to constantly receive feedback from the environment (Aritua *et al.* 2009).

As infrastructure ages, costs to repair it rise. Resources are limited, demographics change, and demand increases. As a result, state and local governments may face challenges in meeting transportation infrastructure needs. Thus it is important to evaluate the effectiveness of existing revenue sources, take advantage of the latest federal programs, exploring the potential of new revenue sources, and finding ways to maximize tax spending capacity through bridge bundling (D'Angelo *et al.* 2019).

3 METHODOLOGY

The research was conducted by a 29-person Technical Working Group (TWG) headed by the lead author of this paper. The deliverable of the research was a Bridge Bundling Guidebook, to be used by public highway agencies to understand and implement a program of bridge bundling. Thirteen public highway agencies were represented in the group, not including the FHWA. Early in the research, agencies around the country with experience in bundling bridge projects were contacted and interviewed. From the data gathered in these interviews and from their own experiences, the TWG generated this list of Goals and Objectives for the guidebook:

- Achieve performance goals
- Time savings
- Cost savings in design
- Cost savings construction
- To take advantage of economies of scale
- To take advantage of available funding
- To take advantage of financing
- Deploy Innovation

- Expedite project delivery
- Utilize alternative contracting methods (ACMs)
- Coordinate construction staging – reduce public disruption
- Simultaneous construction start of multiple bridges
- Maintain bridges in good and fair condition
- Improve bridges in fair condition to good condition
- Reduce bridges in poor condition
- Improve locally owned bridge conditions
- Improve surrounding land value, economic benefits
- Partner with other agencies to achieve efficiencies
- Create jobs in the construction industry
- Increase pool of bridge contractors in a geographic area

When implementing something new like bridge bundling, the importance of education and outreach cannot be overstated. The TWG therefore developed strategies for building a coalition and conducting outreach. Lessons were learned in situations such as the Florida Department of Transportation’s failure to reach out to county and city government agencies, the local construction industry, and the local design community, to educate them and train them in the new project delivery system, construction-manager-as-general-contractor (CM/GC) on the Miami Intermodal Center project at the turn of the century. This had disastrous consequences, so great emphasis was put on the development of these strategies. The plans go to the extent of assigning members of the project team to distinct tasks in the outreach process.

Funding is paramount for any construction project, so the TWG developed a list of funding strategies, and a separate list of financial strategies. These strategies include the use of state, federal, and private sources of funding.

Additional strategies and guidance were developed in several other areas, but space limitations prevent delving into each of them. These areas include Risk Assessment, methods of selecting which bridges to include in a certain bundle, choosing which delivery system to use for the project, environmental review and preliminary design, how to bundle and let the contracts, and Quality Assurance.

4 SUCCESS STORIES

Many agencies have successfully used bridge bundling already. Some of the most recent and best examples are:

- The Delaware Department of Transportation used a succession of bridge bundling contracts to execute preventive maintenance work on bridges in good and fair condition. Projects are prioritized by the department’s Bridge Management Section, and the contracts are administered at the district level by the district Maintenance sections. Tasks have included deck sealing, bridge painting, deck patching, and joint repair (D’Angelo *et al.* 2019).
- The New York State DOT has utilized the bundling of bridges for preventive maintenance, rehabilitation, and replacement. Bridges in proximity have been bundled for years for purposes of preventive maintenance such as painting, washing, and joint replacement. The New York Works initiative replaced the decks on 116 bridges. The Critical Bridges Over Water program was a successful fast-track initiative that replaced 106 bridges with critical scour problems (D’Angelo *et al.* 2019).
- The Nebraska DOT (NDOT) County Bridge Match Program dedicates up to \$40 million through June 2023 to promote innovative repair and replacement of structurally deficient

- bridges in county road systems. Early returns on the program suggest that bridge bundling is “an innovative technique shown to generate cost efficiencies and project delivery time savings among peer agencies. The majority of applications have proposed bundled approaches” (D’Angelo *et al.* 2019).
- The Pennsylvania DOT (PennDOT) Rapid Bridge Replacement Project is replacing 558 bridges statewide. Plans call for a single design-build-finance-maintain public-private partnership availability-payment authorization. PennDOT also began a bridge bundling program in 2012, which it uses to group similar locally-owned bridges into single contracts to improve efficiency and ease the economic strain on LPAs (D’Angelo *et al.* 2019).
 - The Ohio Bridge Partnership Program addressed the needs of 220 county bridges over a period of three years. The program, which replaced and rehabilitated the bridges as needed, was funded by Grant Anticipation Revenue Vehicle (GARVEE) bonds and toll credits. The bridges were grouped into one large bundle for financing but broken into smaller bundles for design and construction (D’Angelo *et al.* 2019).

A recent study of 1,997 INDOT bridge projects in 715 contracts over nine years both confirmed and documented the benefits of bundling (Qiao *et al.* 2018). Bridge bundling has proven to extend the life of fair- and good-condition bridges, quickly and efficiently reducing the number of bridges in poor condition, particularly when used in tenders with other innovative alternative contracting methods (ACMs) or finance strategies. Bridge owners at the federal, state, local, or facility level, who often grapple with the economic strain of maintaining, repairing or replacing bridges, can avail themselves of the advantages of bridge bundling.

The bridge bundling programs in Nebraska, New York, Pennsylvania, Ohio, and Georgia are all state programs that targeted their aid of LPAs. “Some local agencies, including Pennsylvania’s Northampton County, Florida’s Osceola County, and Washington’s Thurston County, have also launched bridge bundling initiatives. Northampton County bundled 33 of its 115 bridges into a single procurement with no Federal or State financial assistance. The former Thurston County Director of Public Works reported that up to a 30 percent cost savings per bridge was achieved by bundling” (D’Angelo *et al.* 2019). The success of these other projects and programs has led FHWA to promote the use of bridge bundling to other agencies.

5 LESSONS LEARNED

The state and local bridge bundling case studies detailed above resulted in several Lessons Learned. Because of space constraints, all these lessons cannot be discussed here. However, it can be stated “that bridge bundling works for similar types of bridges, for similar work types, and for all project delivery methods for the following purposes:

- Achieving performance targets.
- Completing preservation/preventive maintenance actions.
- Rehabilitating bridges.
- Replacing bridges.
- Achieving economies of scale.
- Reducing cost.
- Accelerating project schedules.
- Deploying innovation” (D’Angelo *et al.* 2019).

It was also learned that the maximum “benefits occur when bridge bundling is used in the following settings:

- Locations with no, or minimal, ROW takings.

- Locations with minimal environmental constraints.
- Locations where hydraulic analysis is completed in advance.
- Locations with sufficient advance geotechnical information” (D’Angelo *et al.* 2019).

6 SUMMARY

Bridge bundling is already verified as a powerful method to both extend the life of fair- and good-condition bridges, and to reduce the number of bridges in poor condition, particularly when paired with ACMs or an innovative strategy. Bridge bundling can be used for preservation and preventive maintenance, rehabilitation, and replacement. Several bridge maintenance case studies have demonstrated that best results are achieved when bridge bundling is used at locations where minimal or no ROW acquisitions or environmental permitting are required, and at locations where the hydraulic analysis is accomplished ahead of time.

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