

Preservation of Concrete Bridges

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Highway bridges form major links in the national transportation network. Their structural health is important because these bridges allow the public to travel from Point A to Point B safely with little interruption and predictable arrival time. The role of bridge preservation is vital in meeting these expectations.

Definition

Bridge preservation is defined by both FHWA and AASHTO as “actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements, restore the function of existing bridges in good condition, and extend their life. Preservation actions may be preventive or condition-driven.”

The goals of preservation are to:

- maintain bridges in good or fair condition by systematic, preventive, and regular maintenance, and
- not allow the bridge to deteriorate into poor condition, which would cause condition-driven preservation actions to be taken.

Preventive maintenance is a lot less demanding on resources than condition-driven preservation actions. States report that the cost-benefit ratio for preventive maintenance

is very high. Bridge preservation encompasses preventive maintenance, rehabilitation, and repair activities.

Lessons from History

In 1806, President Thomas Jefferson authorized the federal government to plan and build the famous and historic Cumberland Road. The President appointed a Board of Commissioners to decide on the route through which the road would run. The congressional specification for building the road was very simple. The road was to be 66 ft wide with a stone surface covered with gravel. The bridges were to be of stone. Grades were to be leveled after the manner of good road construction.

Cumberland Road was one of the first major improved highways in the United States that was built by the federal government. It was the first road in the United States to use the new Macadam road surfacing. Within a few years after the road was opened to traffic, Cumberland Road deteriorated as a result of heavy traffic and lack of funds for maintenance. Does this sound familiar?

In 1822, Congress passed a bill authorizing the federal government to collect tolls to be used for maintenance. This bill was vetoed by President James Monroe on the constitutional

grounds that it was an unwarranted extension of the power vested in Congress. President Monroe’s position has continued to be the federal position on highway matters to present day.

During the next nine years, Cumberland Road continued to deteriorate despite a few small federal appropriations for maintenance. It was finally recognized that the only solution was state-operation as a toll road. In 1831 and 1832, the state legislatures of Ohio, Pennsylvania, Maryland, and Virginia agreed to accept and maintain their sections of Cumberland Road. These states set the earliest example of meeting the challenges of maintaining roads and bridges in good condition.

Systematic Preservation

Systematic preventive maintenance is a key part of an effective preservation program. It is necessary for ensuring proper performance of the transportation infrastructure. Experience has shown that preventive maintenance is a very cost-effective way for extending the service life of highway bridges and structures.

Congress finds and declares that it is in the vital interest of the nation that a highway bridge program:

- enables states to improve the condition of highway bridges,
- rehabilitates bridges that are determined to be structurally deficient or functionally obsolete, and
- implements systematic preventive bridge maintenance.

This results in legislation that makes systematic preventive maintenance activities, such as crack sealing, expansion-joint repair, and controlling deterioration, eligible for Federal-Aid funds. A state may carry out systematic preventive maintenance for a highway bridge without regard to sufficiency rating or deficiency status. Systematic preventive maintenance implies the use of an effective maintenance strategy or a prioritization and optimization preservation program to gain the most benefit from the investment on preventive maintenance activities to keep bridges in a state of good repair.



Deck delamination repair before application of an overlay. All photos: Virginia Department of Transportation.



Expansion joint repair before further deterioration occurs.

Effective Maintenance through Good Design and Quality Construction

Effective maintenance starts with good design and detailing to ensure durability, inspection, and replacement. Bridge designers must be mindful of maintenance when they prepare the bridge drawings for construction. Certain bridge elements and components—such as metal elements, bearings, connections, expansion joints, and movable parts—require periodic inspection, maintenance, and eventual replacement. Bridge designers must provide access, platforms, lighting, ventilation, and attachment devices to simplify the work of maintenance personnel so they can perform their duties as efficiently as possible.

Effective maintenance also starts with quality construction. Construction defects left uncorrected will soon become a nightmare. Lack of quality invariably results in early maintenance requirements and frequent repairs. Quality control (QC) and quality assurance (QA) play an important role in ensuring the quality of the constructed project and minimizing maintenance needs. The final acceptance inspection of the finished project is the last chance for QA of the completed project. The maintenance personnel are encouraged to join the owner's construction personnel in performing the final acceptance inspection. All unacceptable defects should be documented and corrected before final acceptance of the project.

The maintenance personnel should be involved in the design to convey their needs to the designers. The opportunity for building a cost-effective, maintenance-sensitive structure is during the design phase. Cost for maintainability is minimal when proper consideration is given in the design phase. There is opportunity in the construction phase, but at this time any change to the contract can be costly.

State Practices

Several exemplary practices are shown in the photographs. States are willing to share work plans to highlight good practices and lessons learned. The FHWA Division Bridge Engineers



Modular joint replacement in progress.



Treatments to restore pier condition.

may be contacted for information on bridge maintenance and preservation.

FHWA Preservation Guide

FHWA publishes the *Bridge Preservation Guide: Maintaining a State of Good Repair Using Cost-Effective Investment Strategies*. The guide provides bridge related definitions, commentaries, and examples that can assist bridge owners in developing and implementing a systematic preventive maintenance delivery plan, which is a major component of a bridge preservation program. The guide walks through step-by-step in the development of the delivery plan. It is available at <http://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf>.

FHWA also has a website that provides a toolbox containing bridge-related links

organized in four sections titled Legislation & Policies, Bridge Management, Bridge Preservation Treatments, and Research & Development. The address for the website is: <http://www.fhwa.dot.gov/bridge/preservation>.

Closing Remarks

The importance of systematic preventive maintenance and effective preservation program is recognized nationwide. Many states are developing and implementing bridge preservation programs with performance measures to track their progress. Learning and sharing nationally will lead to integration of good practices in effectively reducing the number of bridges in poor condition, and increasing the number of bridges in good condition in the National Bridge Inventory. 