

MAINTAINING LOCALLY OWNED BRIDGES

by Ronald J. Ladyka, PE, and Benjamin T. Wigton, EIT

Corrective maintenance involves activities or operations to fix bridge deficiencies that are identified through the inspection process.

Bridges are important components of the roadway system. Despite their importance, they are generally neglected, which can lead to rapid deterioration and eventual costly rehabilitation or replacement. To prevent this from happening, bridge owners need to understand the importance of preventive maintenance and the difference between preventive and corrective maintenance.

Preventive maintenance can be defined as a proactive strategy of cost-effectively treating a structure to preserve it in its present condition and to retard future deterioration. The objective of preventive maintenance is to extend the service life of a bridge before conditions deteriorate to a level requiring rehabilitation or replacement.

Preventive maintenance is applying the right treatment to the right structure at the right time. Preventive and corrective maintenance are both desirable in a comprehensive bridge preservation program, but emphasis should be placed on preventive maintenance since costs associated with corrective maintenance can be significant.

Corrective maintenance, on the other hand, is not proactive but reactive. Corrective maintenance involves activities or operations to fix bridge deficiencies that are identified through the inspection process. These deficiencies are the result of both known factors, such as vehicular wear and

environmental deterioration, and unknown factors, such as collision damage and natural disasters. The sooner we identify and fix observed deficiencies in our bridges, the longer they will last.

This technical information sheet, the third in a series on locally owned bridges, will highlight preventive maintenance activities.

The Importance of Preventive Maintenance

When we make an investment in a car, it makes sense to extend the life of this asset and ensure trouble-free driving by performing preventive maintenance tasks, such as changing the oil regularly and touching up places where the paint has chipped so the exposed metal does not rust. Similarly, preventive maintenance tasks on our homes help to maintain the property value and minimize major repair work and expense. That's why we clean the gutters and downspouts and check the roof for loose shingles.

The same care should be applied to bridges to preserve these significant investments in our transportation system. If preventive maintenance is such a great idea, why don't we practice it on every bridge in our jurisdiction? Perhaps it's because "we just don't have the money" or "we just don't have the time or staff." This may be true, but regardless of the reason, you inevitably will have to find the money, make the time, and provide the resources to deal with the consequences of not having a preventive maintenance program in place.

Many transportation agencies are painfully arriving at this conclusion as they attempt to



Deteriorated steel rocker bearing. Credit: Ohio Department of Transportation

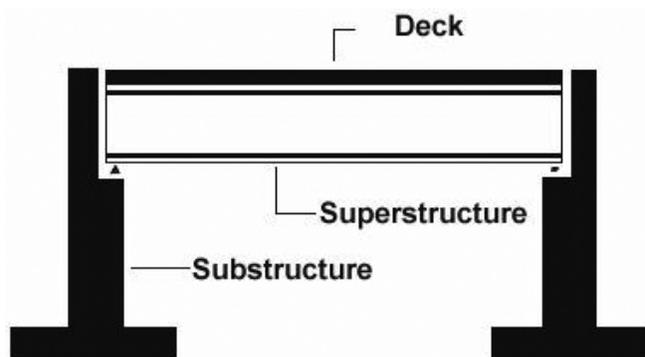
stretch available funds to keep rapidly deteriorating structures in service. A bridge in good condition costs less to maintain. Studies have shown that as the condition of a bridge deteriorates, the cost of necessary repairs rises at a rapidly increasing rate. If maintenance is deferred for a period of time, the cost to restore a bridge to satisfactory or good condition is significantly greater than to regularly maintain it in good condition.

Bridge Components

Before we discuss maintenance, let's review basic bridge components:

- **Deck:** The portion of the bridge that provides a surface for vehicular or pedestrian traffic.
- **Superstructure:** The portion of a bridge above and including the bearing device that supports the deck along with the vehicular or pedestrian traffic and transfers the applied loads to the bridge substructure. Types of superstructures include beams or girders, slabs, steel trusses, arches, and rigid frames.
- **Substructure:** The portion of a bridge below the bearing device built to support the superstructure and transmit loads to the foundation. The main components are abutments, piers, bents, and footings.¹

Bridges can be composed of different materials. Most bridge decks are constructed of reinforced concrete slabs, but timber and open-grid steel decks may be used in rural areas and over waterways. The main superstructure elements are generally made of reinforced concrete, steel, or timber. The substructure members are commonly made of reinforced concrete and masonry, although some bridges have been constructed with timber and steel.



Types of Maintenance

Scheduled **preventive maintenance** includes activities performed on a regular or cyclic basis, such as:

- Cleaning decks, drainage systems, and expansion joints.
- Cleaning bridge seats, pedestals, caps, and salt splash zones².
- Cleaning and lubricating expansion bearings.

Corrective maintenance includes activities performed as needed or as identified through the inspection process, such as:

- Resealing expansion joints.
- Painting steel members.
- Removing debris from stream channels.
- Replacing wearing surfaces on decks.
- Extending or enlarging deck drains.

Preventive maintenance activities, bridge areas to which they apply, brief descriptions of them, their purposes, and how often to conduct them are presented in the table to the right.

Benefits of Preventive Maintenance

The anticipated benefits of a maintenance program for bridges are:

- Higher user satisfaction,
- Better informed bridge maintenance decisions,
- Improved maintenance strategies and techniques,
- Improved bridge conditions,
- Cost savings, and
- Increased safety.

PennDOT's Approach to Bridge Maintenance

The philosophy of performing the right treatment at the right time on the right bridge is endorsed by PennDOT and showcased in the video, "Pennsylvania Bridges: Maintaining the Past – Preserving the Future."

"Spending a relatively small amount of money today will save us large amounts of money tomorrow," Gary Hoffman, former chief engineer at PennDOT, said in an article about the video in a 2002 Federal Highway Administration publication.

PennDOT, which maintains the third largest number of state-owned bridges of any state in the nation, spends \$900 million on bridge projects each year. To keep costs down and improve safety, PennDOT has found it vital to perform frequent inspections and maintain a reliable preventive maintenance program. PennDOT inspects all of the agency's bridges every two years and stores the bridge data in a management system that allows users to prioritize the maintenance and rehabilitation needs of the bridge infrastructure. To further assist the maintenance staff, PennDOT has developed the following publications:

- *Bridge Maintenance Manual*, Publication 55. 2010.
- *Maintenance Manual*, Publication 23. 2010.

These publications will greatly help in establishing a preventive maintenance program for municipal bridges. The

Notes

¹The top portions of abutments and piers consist of bridge seats, pedestals, and caps upon which the superstructure rests.

²Bridge elements that are affected by salt spray from passing vehicles are located in splash zones.

Scheduled preventive maintenance

Activity	Work Area	Description	Purpose	Frequency
Clean bridge (superstructure)	Decks	Remove salt, dirt, and debris Sweep and flush with water	Prevent concrete deterioration Prevent corrosion of reinforcement steel	Once a year, or Additional cleaning as needed
	Joints	Remove dirt and debris from joint openings	Allow movement of the superstructure Protect area under the joint	Once a year, or Additional cleaning as needed
	Scuppers Downspouting	Remove salt, dirt, and debris Flush with water or air blast, or use mechanical devices	Keep drainage system clear and runoff flowing freely	Once a year, or Additional cleaning as needed
	Steel members	Remove debris and salt residue Scrape, brush, or use mechanical devices Flush with water	Reduce corrosion of steel members	Once a year, or Additional cleaning as needed
	Bearings	Remove salt, dirt, and debris Scrape, brush, or use mechanical devices Flush with water	Ensure bearings function properly to transfer loads Allow movement of superstructure	Once a year, or Additional cleaning as needed
Clean bridge (substructure)	Bridge seats Pedestals Salt splash zones	Remove salt, dirt, and debris Pressure wash, hand wash, or use mechanical methods	Prevent concrete deterioration Prevent corrosion of reinforcement steel	Once a year, or Additional cleaning as needed
Seal concrete deck	Deck Curbs Sidewalks Parapet	Apply sealant to superstructure elements Seal new decks prior to bridge opening	Protect the deck from water and chlorides	Every five years, or As indicated by inspection
Lubricate bearings	Bearings such as rocker, roller, and sliding	Clean, lubricate, and paint bearings	Ensure bearings function properly to transfer loads Allow movement of the superstructure	Every five years, or As indicated by inspection
Seal concrete substructures	Abutments Piers	Apply sealant to substructure elements	Protect substructure elements from water and chlorides	Every five years, or As indicated by inspection

Bridge Maintenance Manual breaks maintenance activities into specific, detailed tasks. The chapter on bridge maintenance in the *Maintenance Manual* provides further background on bridge components and the importance of preventive maintenance.

The manuals can be viewed and downloaded from the PennDOT website, www.penndot.gov, by using the search function on the home page. Copies can also be ordered from the PennDOT sales store at (717) 787-6746.

Right Treatment at Right Time

Remember, to achieve a cost-effective preventive maintenance program, it is necessary to apply the right treatment to the right structure at the right time. Because municipalities are responsible for the maintenance of many bridges in various stages of deterioration, procedures must be developed to identify the bridges that would benefit most from preventive maintenance (the right bridge), select the most beneficial treatment (the right treatment), and apply the treatment in a timely manner (the right time).



Leaking deck joint. Credit: FHWA

Sources:

- American Association of State Highway and Transportation Officials. *AASHTO Maintenance Manual*. Washington, D.C., 1987.
- Federal Highway Administration (FHWA). *Managing Highway Assets: Bridge Preservation*. Publication No. FHWA-IF-02-033. March 2002. www.fhwa.dot.gov/construction/fs02033.pdf.
- PennDOT. *Bridge Maintenance*. Publication 55. 2010. www.penndot.gov.
- PennDOT. *Maintenance Manual*. Publication 23. 2010. www.penndot.gov.
- Hein, D. and Croteau, J. *The Impact of Preventive Maintenance Programs on the Condition of Roadway Networks*. Transportation Association of Canada, Quebec. 2004. www.tac-atc.ca.
- Zimmerman, K. A., and Peshkin, D. G. *Integrating Preventive Maintenance and Pavement Management Practices*. Proceedings of the 2003 Mid-Continent Transportation Research Symposium. Ames, Iowa. August 2003. www.ctre.iastate.edu.
- Foundation for Pavement Preservation. *Pavement Preventative Maintenance Guidelines*. 2001. www.fp2.org.