Bridge Preservation Guide

Maintaining a Resilient Infrastructure to Preserve Mobility

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U.S. Department of Transportation
Federal Highway Administration

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Cover photo: Deception Pass Bridge on Washington State Route 20, connecting Whidbey Island to Fidalgo Island.

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Acronyms and Abbreviations

AASHTO ..... American Association of State Highway and Transportation Officials

ADE ..... Agency Developed Elements

BME ..... Bridge Management Elements

BMS ..... Bridge Management System

BSIR..... Bridge Safety Inspection Report

CP ..... cathodic protection

DOT ..... Department of Transportation

ECE..... electrochemical extraction

ECR ..... epoxy-coated rebar

FAST Act..... Fixing America's Surface Transportation Act

FHWA ..... Federal Highway Administration

GCR ..... general condition rating

HBP..... Highway Bridge Program

HBRRP ..... Highway Bridge Replacement and Rehabilitation Program

LCP..... Life Cycle Plan

MAP-21 ..... Moving Ahead for Progress in the 21st Century Act

NBI..... National Bridge Inventory

NBE..... National Bridge Elements

PM ..... preventive maintenance

TSP 2..... Transportation System Preservation Technical Services Program

Photo source: FHWA

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Introduction

State departments of transportation (DOTs), local agencies, and other bridge owners face significant challenges in addressing the needs of their aging infrastructure. Due to limited funds and increased competition for funds among highway assets, bridge owners are challenged to cost effectively preserve and maintain their bridges to support overall highway mobility. However, having a "worst-first" approach to bridge management by focusing only on replacing poor bridges while ignoring the maintenance needs of good and fair bridges is inefficient and cost-prohibitive in the long term.

A successful bridge program seeks a balanced approach to preservation and rehabilitation/replacement. Bridge owners are striving to be more strategic by adopting and implementing systematic processes for bridge preservation as an integral component of their overall asset management.

Purpose

This guide defines bridge preservation terms and identifies commonly practiced bridge preservation activities. It also provides guidance to State governments and other bridge-owning agencies on establishing or improving existing bridge preservation programs as part of an asset management program.

Scope

This guide is intended for Federal, State, and local bridge engineers; bridge owners; and bridge preservation practitioners to support the Federal-Aid Highway Program.

Eligibility

Over several decades, the Federal Highway Administration's (FHWA) Highway Bridge Replacement and Rehabilitation Program (HBRRP), later known as the Highway Bridge Program (HBP), was the primary source of Federal funding for bridges. The HBP afforded State DOTs discretion to use funds not only for bridge rehabilitation and replacement, but also for a broad array of preventive maintenance activities. Bridge owners have taken advantage of the flexibilities in the HBP and have maintained their inventory in good to fair condition under constrained resources.

The Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act recognized preservation as a vital component of achieving and sustaining a desired state of good repair of highway facilities. Bridge preservation is eligible for Federal funding.[1] However, it is important to differentiate between routine maintenance and cost-effective preservation activities that extend the service life of a structure. Routine maintenance is **not** eligible for Federal funding.[2]

1 Section 1103 of MAP-21 amended the definition of "construction" in 23 U.S.C. 101 and adds preservation as an eligible cost of construction.

2 23 U.S.C. 116 (b)

Definitions and Related Commentaries

Several definitions are presented in this section along with commentary. The definitions are offered as a means of establishing clear and consistent terminology for bridge owners and preservation practitioners.

Asset Management

Definition: Asset management is defined as a "strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based on quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at a minimum practicable cost."[3]

Commentary: MAP-21 brought transformative changes to the Federal-Aid Highway Program with its performance management and asset management requirements.[4] Asset management plans are an important highway infrastructure management tool to improve and preserve the condition of assets and system performance.

Maintenance[5]

Definition: Maintenance describes work that is performed to maintain the condition of the transportation system or respond to specific conditions or events that restore the highway system to a functional state of operations. Maintenance is a critical component of an agency's asset management plan that includes both routine and preventive maintenance.

Routine Maintenance

Definition: Routine maintenance encompasses work that is performed in reaction to an event, season, or activities that are done for short-term operational need that do not have preservation value. This work requires regular reoccurring attention.

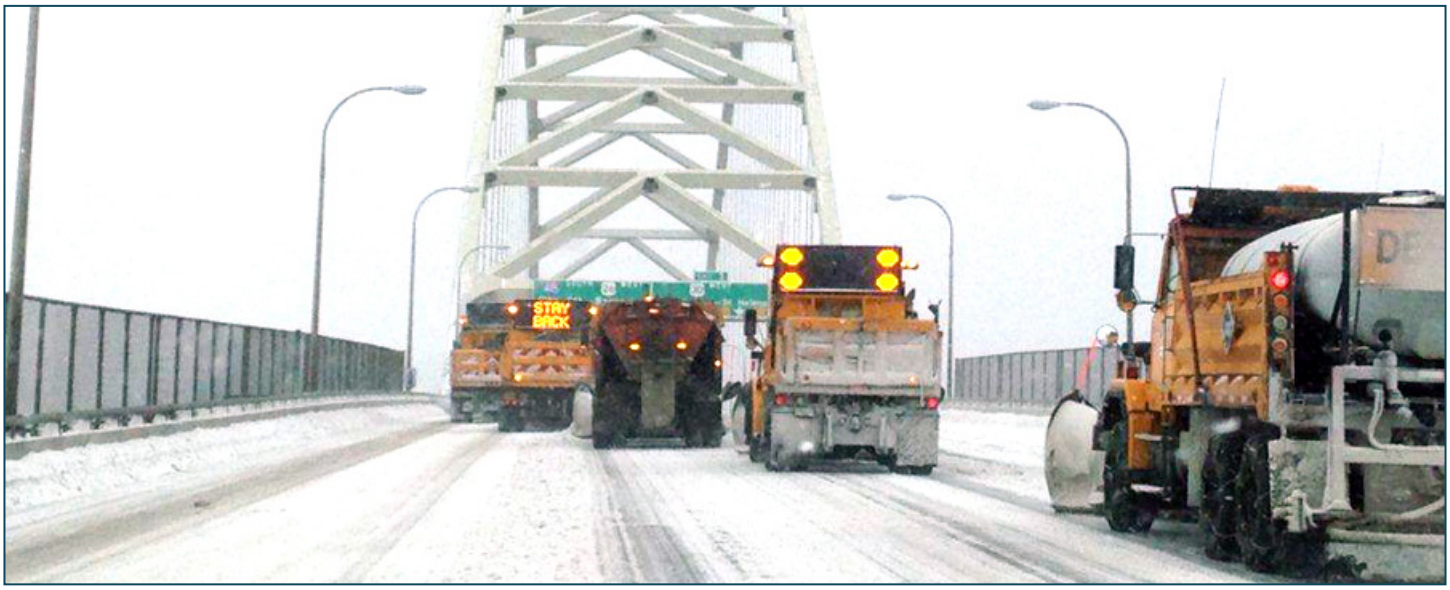


Photo courtesy of Oregon DOT

Figure 1. Bridge snow removal.

3 MAP-21 added this definition in 23 U.S.C. 101(a)(2).

4 The core performance management requirements are codified in 23 U.S.C. 150 and 23 U.S.C. 119. Asset management requirements are codified in 23 U.S.C. 119.

5 FHWA Guidance on Highway Preservation and Maintenance dated Feb. 25, 2016.

Commentary: Per 23 U.S.C. 116 (d), States and owner agencies are required to properly maintain projects financed with Federal-aid funds. Therefore, routine maintenance activities are not eligible for Federal funds. Examples of routine maintenance are listed in Table 1.

Table 1. Examples of routine maintenance activities.

These are examples of routine maintenance activities not eligible for Federal funds:
Trash, Litter, and Dead Animal Removal
Snow Removal/Application of Salt/Deicing Chemicals
Graffiti Removal
Hazardous Material Removal
Asphalt Patch with No Membrane on Concrete Deck
Accident Damage to Bridge and Its Appurtenances
Storm Damage

Bridge Preservation

Definition: Bridge preservation is defined as actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements; restore the function of existing bridges; keep bridges in good or fair condition; and extend their service life. Preservation actions may be cyclic or condition-driven.

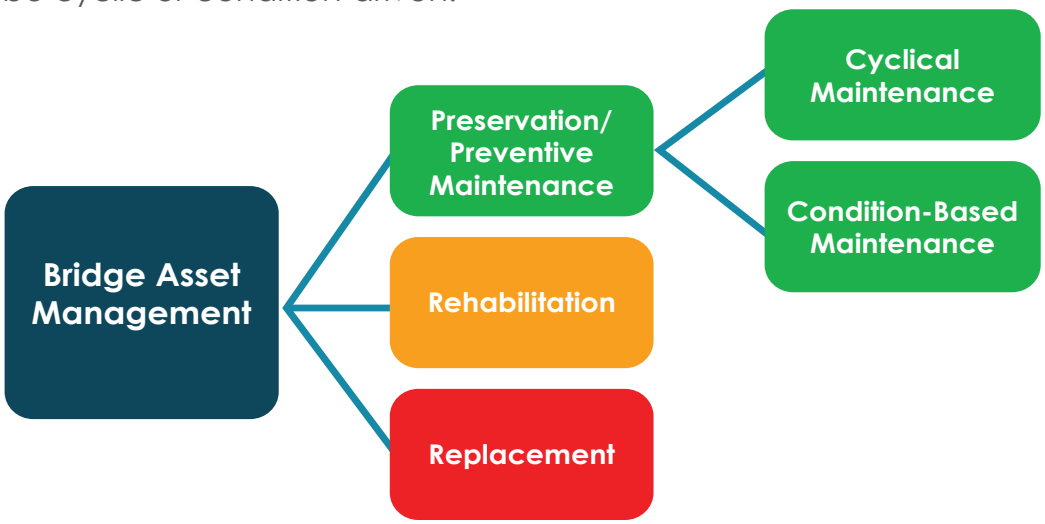


Figure 2. Bridge action categories.

Commentary: 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.

Bridge preservation encompasses both cyclical and condition-based activities applied to highway structures (see Figure 2). Best practices for bridge preservation include the following:

- A needs identification method that is uniform, specific, and repeatable. It can be based on National Bridge Inventory (NBI) major component condition ratings, detailed inspections and scopes, or element-level condition data.
- A commitment by agency management to asset preservation.
- Resource allocation determined by agency network goals and a bridge management system directed to preservation actions.
- A process for categorization and/or prioritization that integrates agency objectives.
- Verification and feedback on work completed.

Preventive Maintenance

Definition: Preventive maintenance (PM) is a cost-effective means of extending the service life of highway bridges.

Commentary: PM for highway bridges is a strategy of extending service life by applying cost-effective treatments to bridge elements. PM activities retard future deterioration and avoid large expenses in bridge rehabilitation or replacements.

PM includes cyclical and condition-based activities, as illustrated in Figure 2. Examples are listed in Table 2 and Table 3.

Cyclical Maintenance Activities

Definition: Cyclical maintenance activities are performed on pre-determined intervals that aim to preserve and delay deterioration of bridge elements or component conditions.

Commentary: The frequency of cyclical PM activities can change as a result of environmental or condition changes. For example, superstructure cleaning that was occurring at a 3-year interval based on past accumulation of debris buildup could change if pigeons start routinely nesting on superstructure elements.

Examples of cyclical PM activities that may be considered by bridge owners for implementation on good and fair condition bridges and components are shown in Table 2.

Bridge cleaning and/or washings: Cleaning of decks, joints, drains, superstructure, and substructure elements slows the deterioration of concrete and steel elements that would otherwise be accelerated by debris, bird droppings, and contaminants.

Deck sealers: Deck sealers protect the reinforcing steel from corrosion by stopping or minimizing the intrusion of water and chloride through the concrete.

Table 2. Examples of cyclical maintenance activities.

Cyclical Maintenance Activity	Bridge Component
Clean/Wash Bridge	Deck and/or Super/Substructure
Clean and Flush Drains	Deck
Clean Joints	Deck
Deck/Parapet/Rail Sealing and Crack Sealing	Deck
Seal Concrete	Super/Substructure

Condition-Based Maintenance Activities

Definition: Condition-based maintenance activities are performed on bridge components or elements in response to known defects. Condition-based maintenance improves the condition of that portion of the element, but may or may not result in an increase in the component condition rating.

Commentary: Condition-based maintenance activities are identified through an inspection process. Condition ratings may be improved by a condition-based PM activity. One example is a substructure element that was once rated fair due to spalled concrete and exposed reinforcement. After maintenance removed loose concrete, cleaned the exposed reinforcement, and formed and placed new concrete, the inspection rating for the substructure was changed to good condition.

Examples of condition-based maintenance activities that may be considered by bridge owners for implementation on fair condition bridges and components are shown in Table 3.

Photo courtesy of Washington State DOT

Figure 3. Bridge washing.

Photo courtesy of GPI

Figure 4. Broadcasting aggregate on sealer.

Table 3: Examples of condition-based maintenance activities

Examples of Condition-Based Maintenance Activity	Bridge Component
Drains, Repair/Replace	Deck
Joint Seal Replacement	Deck
Joint Repair/Replace/Elimination	Deck
Electrochemical Extraction (ECE)/Cathodic Protection (CP)	Deck
Concrete Deck Repair (see halo effect below) in Conjunction with Overlays, CP Systems or ECE Treatment	Deck
Deck Overlays (thin polymer epoxy, asphalt with waterproof membrane, rigid overlays)	Deck
Repair/Replace Approach Slabs	Approach
Seal/Patch/Repair Superstructure Concrete	Superstructure
Protective Coat Concrete/Steel Elements	Superstructure
Spot/Zone/Full Painting Steel Elements	Superstructure
Steel Member Repair	Superstructure
Fatigue Crack Mitigation (pin-and-hanger replacement, retrofit fracture critical members)	Superstructure
Bearing Restoration (cleaning, lubrication, resetting, replacement)	Superstructure
Movable Bridge Machinery Cleaning/Lubrication/Repair	Superstructure
Patch/Repair Substructure Concrete	Substructure/Culvert
Protective Coat/Concrete/Steel Substructure	Substructure/Culvert
ECE/CP	Substructure/Culvert
Spot/Zone/Full Painting Steel Substructure	Substructure
Pile Preservation (jackets/wraps/CP)	Substructure
Channel Cleaning / Debris Removal	Channel
Scour Countermeasure (installation/repair)	Channel

Photo courtesy of Vector Corrosion Technologies

Figure 5. Deck showing halo effect.

Halo Effect

The "halo effect" (see Figure 5) in bridge decks results when a delaminated area (due to reinforcement corrosion resulting from chlorides and moisture in the concrete) is removed and repair material (containing no chlorides) is put in its place. If a high concentration of chlorides remains in the area surrounding the replaced concrete, the corrosion potential will lead to rapid corrosion in the area surrounding the repair.

Rehabilitation[6]

Definition: Rehabilitation involves major work required to restore the structural integrity of a bridge, as well as work necessary to correct major safety defects.

Photo courtesy of GPI

Figure 6. Substructure repair.

Commentary: Bridge rehabilitation projects provide complete or nearly complete restoration of bridge elements or components. Rehabilitation work can be done on one or multiple elements and/or components of a structure. Agencies may choose to combine preservation activities on several elements while a component is being rehabilitated. These projects require significant engineering resources for design, a lengthy completion schedule, and considerable costs.

Examples of bridge rehabilitation include, but are not limited to: partial or complete deck replacement, superstructure replacement, and substructure/culvert strengthening or partial/full replacement. Incidental widening is often associated with some of these activities.

Photos courtesy of Washington State DOT

Figure 7. Before bridge maintenance painting *(left)* and after *(right)*.

6 23 CFR 650.403(c)

Replacement

Definition: Total replacement of an existing bridge with a new facility constructed in the same general traffic corridor.

Commentary: The replacement structure must meet the current geometric, construction, and structural standards required for the types and volume of projected traffic on the facility over its design life. Replacement includes a nominal amount of approach work sufficient to connect the new facility to the existing roadway or to return the grade line to an attainable touchdown point.

Similar to bridge rehabilitation, bridge replacement projects require engineering resources for design, a substantial and complex completion schedule, and considerable costs. Life-cycle costs and other economic factors are usually considered when weighing rehabilitation versus replacement costs.

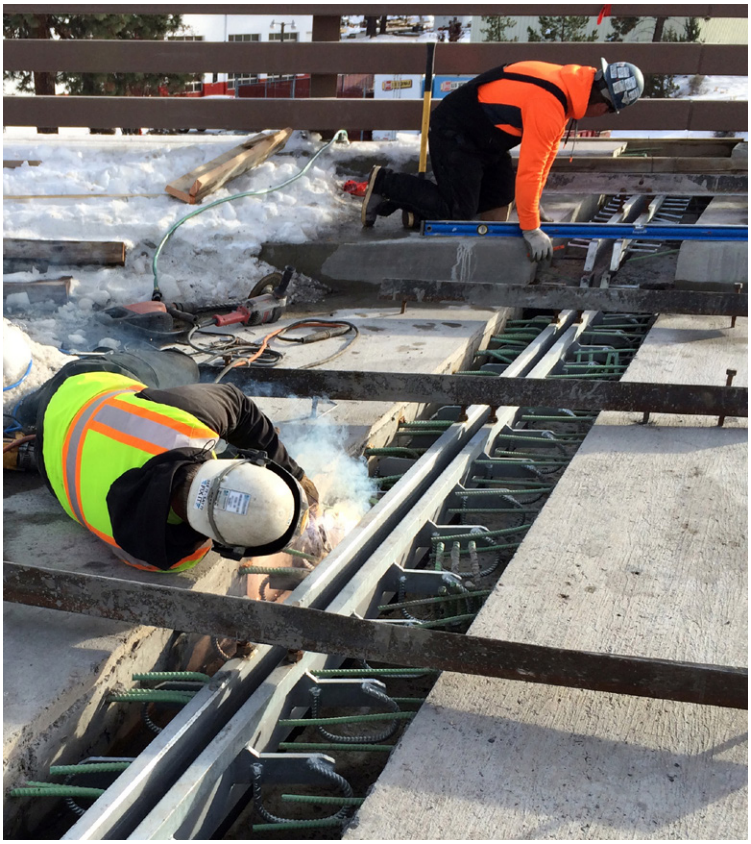


Photo courtesy of Oregon DOT

Figure 8. Joint replacement.

Photo courtesy of Washington State DOT

Figure 9. Joint seal replacement.

Photo courtesy of Vector Corrosion Technologies

Figure 10. Pier being prepared for ECE treatment.

Summary

Table 4 summarizes actions that are either eligible or not eligible for Federal funds.

Table 4. Federal funds eligibility summary.

Action	Activities	Eligible for Federal Funds	Reference
Maintenance	Routine Maintenance	No	Table 1
Preservation/Preventive Maintenance	Cyclical Maintenance	Yes	Table 2
	Condition-Based Maintenance	Yes	Table 3
Rehabilitation	-	Yes	-
Replacement	-	Yes	-

National Bridge Inventory General Condition Ratings

NBI general condition ratings (GCRs) are used to describe the existing, in-place bridge or culvert as compared to the as-built condition. The materials used in the bridge are considered, as well as the physical condition of the deck, superstructure, and substructure components. This information is used to determine GCRs on a numerical scale that ranges from 0 (failed condition) to 9 (excellent condition) as described in the FHWA Coding Guide.[7]

Appendix A provides a description for each of these numeric values. The GCRs are used in evaluating bridge decks (NBI Item 58), bridge superstructures (NBI Item 59), bridge substructures (NBI Item 60), and culverts (NBI Item 62).

Deck (NBI Item 58) | **Superstructure** (NBI Item 59) | **Substructure** (NBI Item 60)

Photo source: FHWA Bridge Preservation Guide (2011)

Figure 11. Bridge components in various ratings.

Bridge and Culvert Classification[8]

Good Condition. When the minimum condition rating of the three NBI items for a bridge (Items 58-Deck, 59-Superstructure, 60-Substructure) is 7, 8, or 9, the bridge is classified as Good. Similarly, when the condition rating of NBI Item 62-Culvert is 7, 8, or 9, the culvert is classified as Good.

7 FHWA Report number PD-96-001 "Recording and Coding Guide for Structure Inventory and Appraisal of the Nation's Bridges, December 1995.

8 23 CFR 490.409 – Calculation of National Performance Management Measures for Assessing Bridge Condition

Fair Condition. When the minimum condition rating of the three NBI items for a bridge (Items 58-Deck, 59-Superstructure, 60-Substructure) is either 5 or 6, the bridge is classified as Fair. Similarly, when the condition rating of NBI Item 62-Culvert is either 5 or 6, the culvert is classified as Fair.

Poor Condition. When the minimum condition rating of any of the three NBI items for a bridge (Items 58-Deck, 59-Superstructure, 60-Substructure) is 4 or below, the bridge is classified as Poor. Similarly, when the condition rating of NBI Item 62-Culvert is 4 or below, the culvert is classified as Poor.

Photo source: National Highway Institute

Figure 12. Culvert coded as Item 62. Superstructure and substructure coded as N.

While GCRs may help in providing general categorization of preservation, rehabilitation, and replacement needs, they are too broad for determining specific activity on a bridge. If only GCRs are available, detailed scopes are necessary to determine the work activities and estimate cost for the project.

Bridge Element Condition State

A bridge element condition state categorizes the severity and extent of damage or deterioration of a bridge element.

Photo source: National Highway Institute

Figure 13. Diaphragms in straight steel bridges are not NBEs because they are not primary load-carrying elements, but they can be added as an ADE.

The American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Element Inspection provides information on bridge elements and their corresponding condition states. Each bridge element has a unit of measure and four condition states (1–good, 2–fair, 3–poor, and 4–severe) as shown in Appendix B. Condition states are denoted as CS1, CS2, CS3, and CS4. A higher condition state indicates a higher severity of the damage and/or deterioration of the element. An element's total quantity is assigned to four condition states as applicable.

National Bridge Elements (NBE) are the primary structural components of bridges necessary to determine the overall condition and safety of the primary load carrying members. These include various material and construction types of decks / slabs, bridge railings, superstructures, substructures, bearings, and culverts.

Bridge Management Elements (BME) are components that, through inspection monitoring and maintenance activities, support the preservation of the NBEs and the overall bridge. BMEs include joints, approach slabs, wearing surfaces, and protective systems.

Agency Developed Elements (ADEs) are custom elements. ADEs can be defined within the AASHTO element framework as sub-elements of NBEs or BMEs, or ADEs may be agency-defined elements without ties. For example, a steel beam end ADE could be a sub-element of the steel open girder / beam NBE to document the condition of a beam under an expansion joint. A deck drain ADE could be a sub-element of the reinforced concrete deck NBE to monitor scuppers and downspouts.

Design Life

Definition: The design life is the period for which a component, element, or bridge is expected to function for its designated purpose when designed, constructed, and maintained as per standards.

Commentary: The design life of a bridge component or element is the period during which the item is expected, by its designers, to work within its specified parameters. Design codes and material specifications are important parameters in determining the expected design life of a highway structure.

Service Life

Definition: The service life is the period for which a component, element, or bridge provides the desired function and remains in service with appropriate preservation activities.

Commentary: Service life of bridge components or elements is the period during which the item actually performs. The service life of a bridge and components in good to fair condition can be extended with cyclical and/or condition-based PM activities.

A steadfast bridge preservation program and quality workmanship practiced during the service life of an asset is necessary for the asset to reach its design life.

Establishing a Bridge Preservation Program

What Is a Bridge Preservation Program?

A bridge preservation program consists of performing cost-effective cyclical and condition-based PM activities that seek to prolong the service life of bridges and delay the need for rehabilitation or replacement.

Figure 14 is a representation of a bridge's condition over time. The three types of work programs are shown based on the condition. PM activities as part of the bridge preservation program can extend the service life of a bridge when it is in good or fair condition. This results in achieving the greatest value from the original construction cost by delaying the need for rehabilitation or replacement. Typically, when a bridge component enters into poor condition, bridge preservation ends until that bridge component is rehabilitated back into good or fair condition, or replaced.

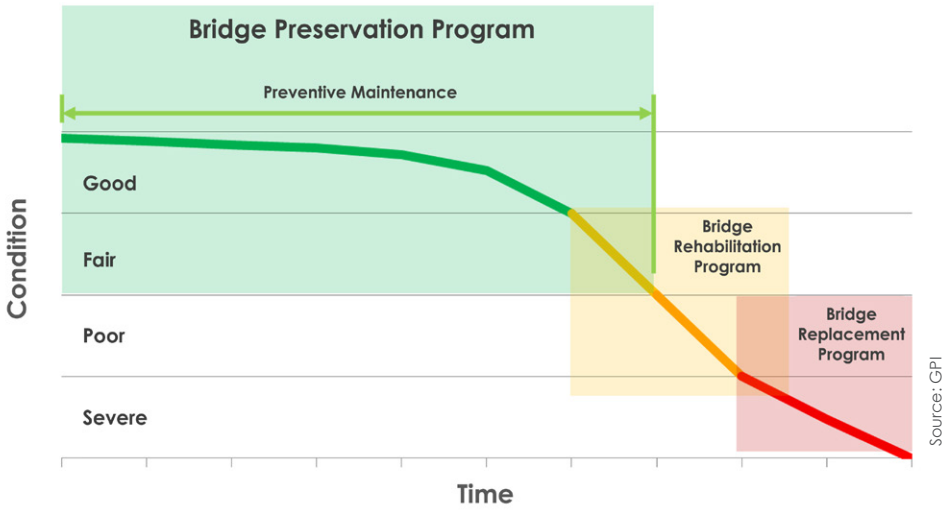


Figure 14. Bridge condition over time.

How to Establish a Bridge Preservation Program

Establishing a bridge preservation program can be simple. An owner agency can start by cyclically cleaning and/or washing bridges that are in good or fair condition and add more PM activities as the program is developed.

Owner agency steps toward establishing a bridge preservation program:

- Identify agency goals and objectives.
- Identify bridges to preserve.
- Develop a list of actions for preservation (a list of cyclical and condition-based PM activities are provided in this guide).
- Establish rules for the actions, a combination of either cyclical or condition-based.
- Use the actions to develop life cycle plans.
- Develop performance measures for the effectiveness of the actions, projects, and programs of projects to satisfy agency's goals.
- Develop methods to evaluate benefits of the actions.
- Dedicate funds for preservation actions.
- Implement and evaluate projects.
- Monitor and measure performance of preservation program.
- Report and improve preservation program.

Identify Agency Goals and Objectives

An agency outlines goals and objectives to preserve its bridges and identifies dedicated funds to perform preservation actions.

Identify Bridges to Preserve

Bridges are preserved when preservation is feasible and beneficial, targeting bridges and components that are in good or fair condition, have adequate load capacity, and continue to meet the mobility (traffic) demands.

Develop a List of Actions for Preservation

Bridge preservation actions are either cyclical or condition-based. Examples of these actions are shown in Table 2 and Table 3, respectively. When developing a list of preservation actions, consideration needs to be given to the relationship of elements in a bridge. In bridge preservation, AASHTO's BMEs are maintained, repaired, replaced, or retrofit in order to further protect the NBEs. Figure 16 shows two examples of how the preservation of a BME can protect one or more NBEs.

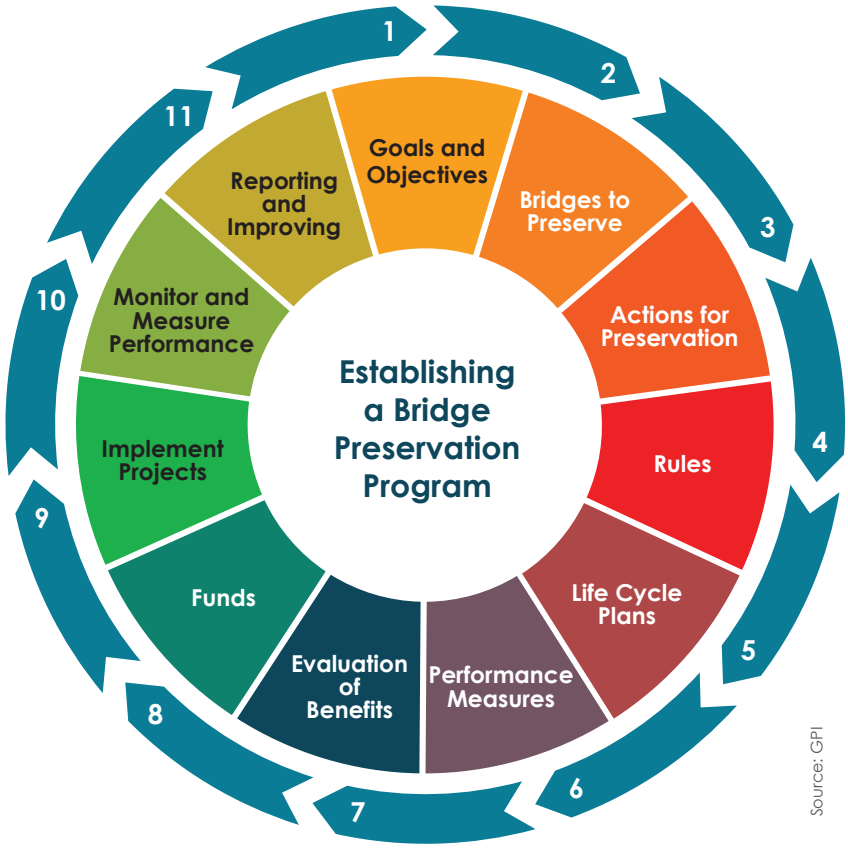


Figure 15. Steps for establishing a bridge preservation program.

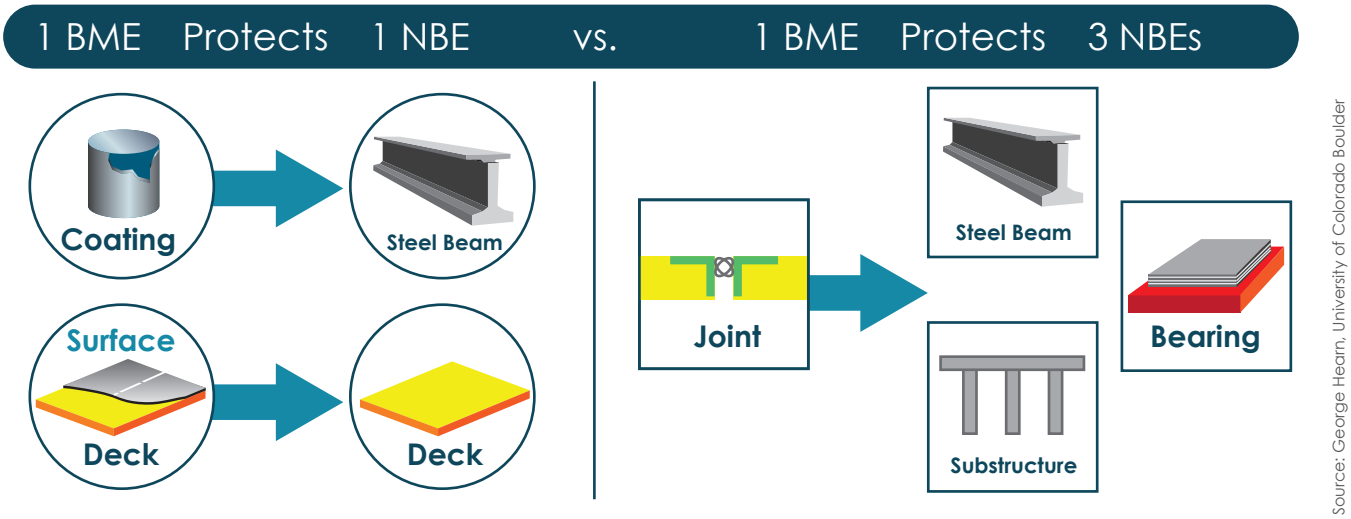


Figure 16. Examples showing the effects of BME preservation on NBEs.

In a few cases, the NBEs may also require additional NBE-specific preservation actions/ treatments to extend the service life of the bridge.

Establish Agency Rules for Actions, Either Cyclical or Condition-Based

An agency rule identifies when a preservation action may be appropriate. An agency rule serves as guidance to help identify when to perform an action and what action to perform. Rules may be cyclical or condition-based. A cyclical rule is set out as an action and an interval. A condition-based rule is set out as an action taken as a result of the condition of an element or component.

Table 5. Examples of cyclical agency rule.

NBI Item 58	Preservation Activity	Interval Years
≥ 7	Deck Sweeping/Washing	1 to 2
	Crack Sealing	3 to 5
	Deck Sealing	3 to 5
	Polymer Overlay	8 to 12
	Polymer-Modified Asphalt Overlay	12 to 15

Table 6. Example of a condition-based agency rule.

Deck GCR, Before				Repair Option	Deck GCR, After		Service Life Years
Top Surface		Bottom Surface			Top Surface	Bottom Surface	
BSIR #58a	Defect Area	BSIR #58b	Defect Area		BSIR #58a	BSIR #58b	
≥ 5	≤ 5%	> 5	≤ 2%	Epoxy Overlay	8, 9	No Change	10 to 15
N/A	≤ 10%	N/A	≤ 25%	Deck Patch	+ 1	No Change	3 to 10

When a rule is satisfied, further evaluation is warranted to determine whether to conduct the action. Rules do not account for relative priority and benefit of different action types, or relative priority of bridges, which need to be considered when there are budget constraints. Also, an owner may consider other factors such as:

- net benefit of an action
- duration of extension of service life
- availability of specialty contractors
- coordination of work along route segments or bridge bundling contracts
- consideration of traffic operations

Develop Life Cycle Plans Using the Actions

Life Cycle Planning[9] (LCP) is a process that estimates the cost of managing an asset class, or asset sub-group, over its service life with consideration for minimizing cost while preserving or improving its condition. LCP looks at different scenarios for performing preservation on a network of bridges. It evaluates different preservation actions and time of application on bridges; different proportions of preservation, rehabilitation, and replacement spending; and the effect of different funding levels. LCP leads to a strategy for managing a bridge network over the long term that minimizes life cycle cost while maintaining desired condition and performance.

Develop Performance Measures for the Effectiveness of the Actions to Satisfy Agency's Goals

Measures of accomplishment of preservation actions are comparative. From these scenarios, the numbers and quantities of preservation actions completed are compared to the numbers and quantities of actions planned. Average condition of bridge elements, as a measure of preservation, must be focused on bridges in the preservation population.

Agencies have different performance measures specific to their objectives and goals. A few examples include:

- GCR of bridge components in Good, Fair or Poor
- Percent of deck joints in condition state 2 or better
- Percent of steel protective coating elements in condition state 2 or better

Develop Methods of Evaluation of Benefits of the Actions

The goal of bridge preservation is to slow deterioration and extend service life. Longer service life means lower annualized costs of rehabilitation or replacement. Bridge preservation incurs costs, but lower annualized costs over the life of the structure are the monetized benefits of bridge preservation. Programs for preservation are adopted and adjusted based on net benefits of programs.

In Figure 17, the leftmost line represents a service life of a bridge without bridge preservation. The lack of PM activities allows debris and chemicals to attack the bridge elements, thereby deteriorating and leading to a shorter service life. The rightmost line represents the same bridge with both cyclical and condition-based (blue vertical line) PM activities applied when the bridge elements are in Good and Fair condition. The comparison shows longevity of a bridge's service life in a bridge preservation program.

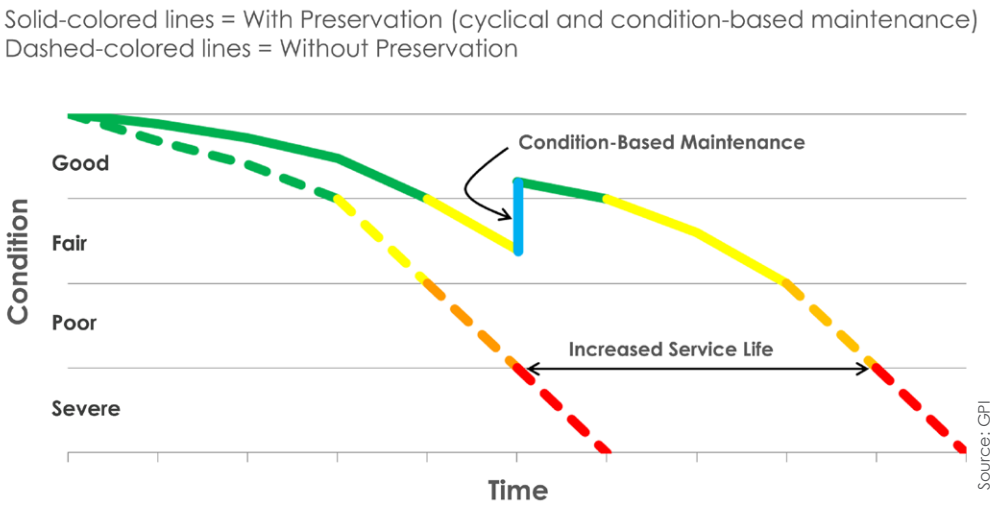


Figure 17. A comparison of bridge condition over time with and without bridge preservation.

9 Refer to 23 CFR 515 Asset Management Plans and FHWA LCP Guidance for further information.

Determine Availability of Dedicated Funds for Preservation Actions

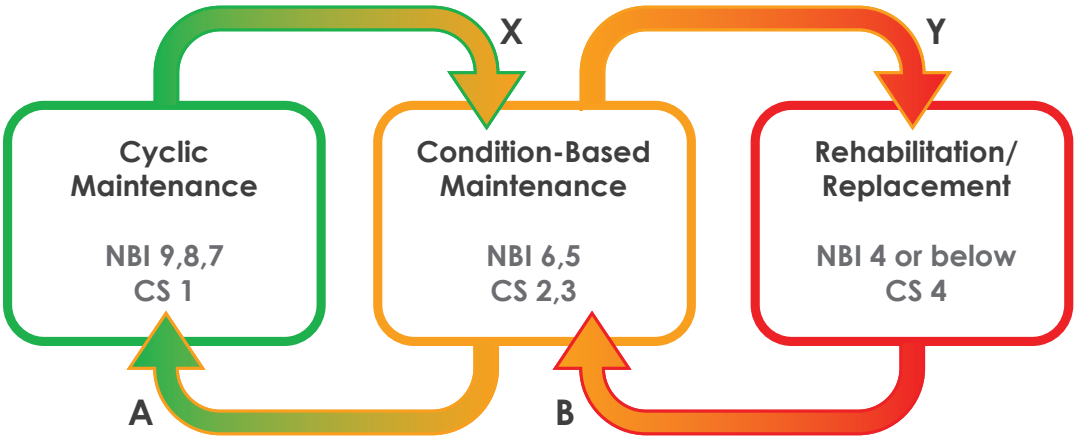
The work completed provides linkage of costs to preservation benefits. This can also be supplemented by running an unconstrained funding scenario using a Bridge Management System (BMS). Both actual work completed and results from the BMS can serve as the basis for advocating or maintaining current level of funding or requesting additional funds.

Implement and Evaluate Projects

Work orders and contracts can be prepared to implement the preservation program and projects. Evaluation of a completed project's preservation actions in terms of work quality and completeness is essential to ensure the greatest fulfillment of the preservation program.

Monitor and Measure Performance of Preservation Program

The value of bridge preservation can be shown in several ways, as presented in Figure 18. One way is to monitor and measure performance of major component or element condition trends. Another is to monitor the number of bridges. Bridge needs, as determined by slowing or preventing deterioration of bridge elements, can also be used to monitor and measure preservation performance. Since the results of completed preservation projects are not recorded until the next scheduled bridge inspection, it may take multiple inspection cycles to effectively measure the program's performance.



Source: Raj Ailaney/FHWA

Preservation is effective when X and Y are minimized

Desired goal is A > X; B > Y; (A+B) ≥ (X+Y)

X, Y, A, and B are Bridge Counts or Deck Area, Component Rating, or Element Rating.

Figure 18. Measuring preservation performance.

Reporting and Improving Preservation Program

Reporting is essential to inform agency executives and the public of the accomplishments of the preservation program and help to sustain their continued support. This can be done through methods ranging from simple reports to elaborate website dashboards. An example of a website dashboard is an analysis of historical and forecasted bridge conditions posted by the Michigan Transportation Asset Management Council, shown in Figure 19.

Preservation program improvement typically is a comparison of assumed and actual results along with improvement to one or more of these preservation program implementation steps.

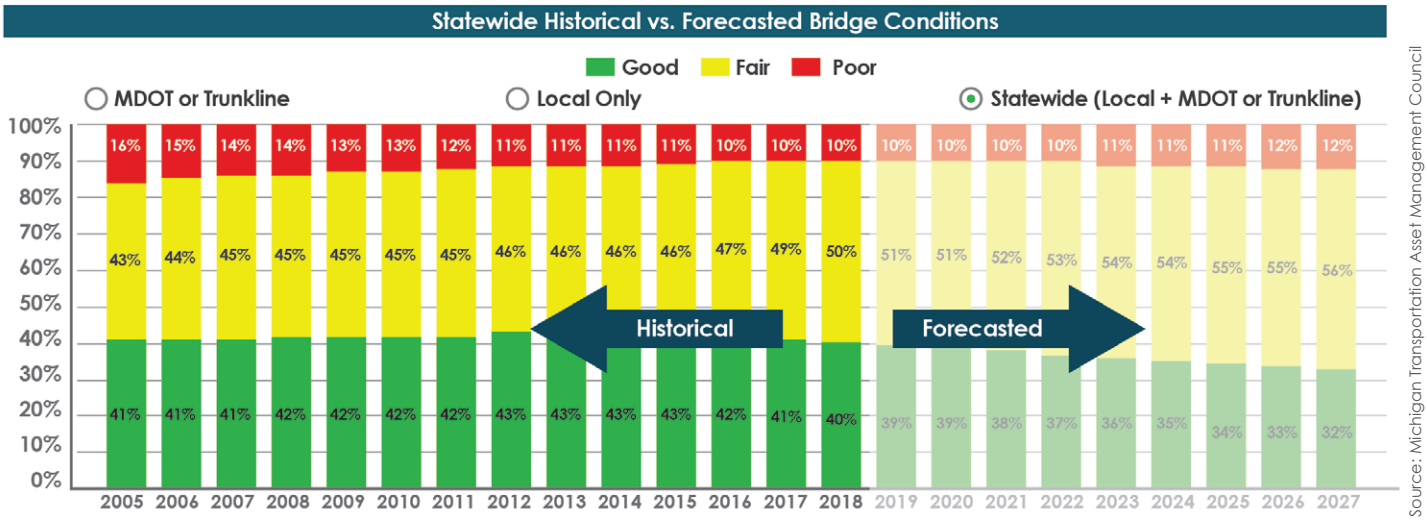


Figure 19. Example website dashboard showing an analysis for bridge conditions.

Bridge Preservation Program Summary

In bridge preservation, an owner agency or a DOT can start by familiarizing its staff with preservation as a commonsense approach to maintenance of bridges. The agency or a DOT may consider a set of steps that begin with direct actions in preservation with shifts in policies that lead to promotion of bridge preservation through performance measures and dedicated funds.

A few examples to consider:

- Start a bridge cleaning program using basic tools that most agencies have readily available, such as brooms and shovels, to remove accumulated debris and road grit. Afterward, hoses and pressure washers can dilute deicing chemical from concrete and remove any remaining debris and road grit not removed from sweeping.

- Encourage maintenance crews to check deck joints for leakage and to replace seals where needed. Encourage maintenance supervisors to note conditions of both joints and beam ends, and then prioritize new joint seals at bridges with beam ends in good condition.

- In bridge maintenance, promote as a policy the scheduled replacement of wearing surfaces, coatings, surface sealers, and joint seals in place of policies that wait for defects before planning repairs.

- Using inspection data, track and monitor the conditions of wearing surfaces, coatings, surface sealers, and joint seals, and update intervals for scheduled replacement accordingly.

- Quantify and publicize the reductions in annualized costs of bridges achieved through preservation to gain and hold the support of owner agency or DOT executives for bridge preservation.

Each of these examples can be put forward as a regular procedure, as options in policy, or as requirements in policy as the benefits of bridge preservation are realized.

Appendix A. Common Actions Based on National Bridge Inventory General Condition Ratings

Code	Description	Common Actions
9	**EXCELLENT CONDITION**	Preservation/Cyclic Maintenance
8	**VERY GOOD CONDITION**—No problems noted.	
7	**GOOD CONDITION**—Some minor problems.	
6	**SATISFACTORY CONDITION**—Structural elements show some minor deterioration.	Preservation/ Condition-Based Maintenance
5	**FAIR CONDITION**—All primary structural elements are sound but may have some minor section loss, cracking, spalling, or scour.	
4	**POOR CONDITION**—Advanced section loss, deterioration, spalling, or scour.	Rehabilitation or Replacement
3	**SERIOUS CONDITION**—Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.	
2	**CRITICAL CONDITION**—Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present, or scour may have removed substructure support. Unless closely monitored, the bridge may have to be closed until corrective action is taken.	
1	**IMMINENT FAILURE CONDITION**—Major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put it back in light service.	
0	**FAILED CONDITION**—Out of service. Bridge is beyond corrective action.	

Appendix B. Common Actions Based on Bridge Element Condition States

Condition State	Description	Common Actions[10]
1	**Varies depending on element—Good**	Preservation/Cyclic Maintenance
2	**Varies depending on element—Fair**	Cyclic Maintenance or Condition-Based Maintenance when cost effective.
3	**Varies depending on element—Poor**	Condition-Based Maintenance, or Rehabilitation—when quantity of poor exceeds a limit that condition-based maintenance is not cost effective, or Replacement—when rehabilitation is not cost effective.
4	**Varies depending on element—Severe**	Rehabilitation or Replacement

10 The appropriate action for an element will also be dependent on the element quantity in each condition state.

Appendix C. Resources

FHWA Office of Bridges and Structures offers assistance in the areas of bridge design, construction, inspection, and preservation.

FHWA Office of Asset Management offers assistance in the areas of system preservation techniques, pavement and bridge management systems, and materials usage and economic analysis tools.

FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* is located on the Office of Bridges and Structures' Bridge Programs Publications website.

AASHTO *Manual for Bridge Element Inspection* contains guidance on collecting element-level inspection data. The first edition of the manual, including 2015 and 2018 revisions, is available for purchase in the AASHTO bookstore.

AASHTO's Transportation System Preservation Technical Services Program (TSP 2) provides services on pavement- and bridge-related preservation topics .

FHWA Guidance on Highway Preservation and Maintenance (Feb. 25, 2016). This memo from the Associate Administrator for Infrastructure defined preservation and addressed MAP-21 requirements for preservation programs.

"Element-Level Performance Measures for Bridge Preservation" by George Hearn in a 2015 issue of the *Transportation Research Record: Journal of the Transportation Research Board* (volume 2481, p10-17) discusses highway bridge performance measures and the relationship between bridge element condition and preservation actions.

Moving Ahead for Progress in the 21st Century Act (MAP-21). MAP-21 was signed into law by President Obama in 2012. It creates a streamlined and performance-based surface transportation program and builds on many of the highway, transit, bike, and pedestrian programs and policies established in 1991.

Fixing America's Surface Transportation (FAST) Act. The FAST Act was signed into law by President Obama in 2015. It provides authorization to govern U.S. Federal surface transportation spending.

Title 23 of the United States Code (23 U.S.C.) outlines the role of highways in the United States Code. Sections address the Federal-Aid Highway Program, Highway Safety, Research and Technology, and other topics.

Bridge Deck Preservation Matrix–Decks with Epoxy Coated Rebar (ECR). This 2011 publication by the Michigan DOT is a tool for bridge engineers to use in the selection of deck repair options when the concrete bridge deck has ECR.

***NBI 58 Deck GCR—Bridge Preservation Policy Guide* Version 1.02 (2016).** This publication by the Wisconsin DOT Bureau of Structures provides goals, measures, and strategies for the preservation of bridges.

U.S. Department of Transportation
Federal Highway Administration

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