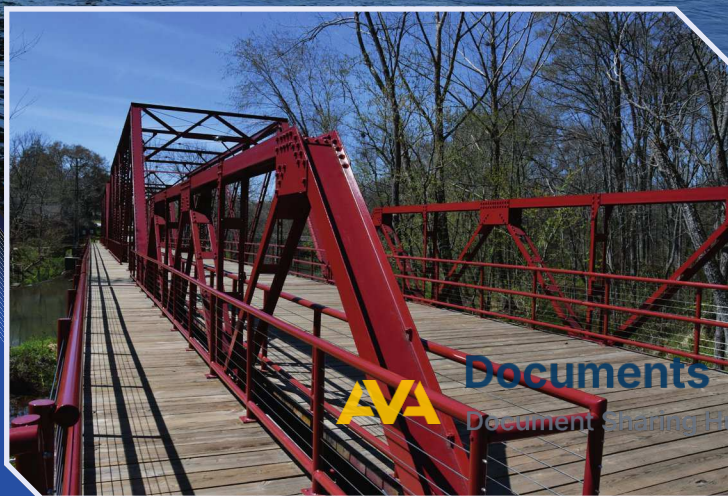


Guide to Bridge Preservation Actions

AASHTO

American Association of State Highway
and Transportation Officials

First Edition 2021





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GUIDE TO BRIDGE PRESERVATION ACTIONS

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ABBREVIATIONS USED IN THIS GUIDE

AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ASR	Alkali–silica reaction
BCA	Benefit–cost analysis
BE	Bridge element condition data conforming to MBEI
BME	Bridge management element conforming to MBEI
CFR	Code of Federal Regulations
CS	Condition State in MBEI
DOT	Department of Transportation
EA	Each, a unit for quantity of bridge element
FHWA	Federal Highway Administration
FRP	Fiber-Reinforced Polymer
FTE	Full-time equivalent. <i>A unit of staffing.</i>
GCR	General condition rating
GDD	Guide-developed defects, see Table B1-1
LCCA	Life-cycle cost analysis
LF	Linear feet, a unit for quantity of bridge element; may be noted in other references as “linear ft”
MASH	AASHTO <i>Manual for Assessing Safety Hardware</i>
MBEI	AASHTO <i>Manual for Bridge Element Inspection</i>
MSE	Mechanically Stabilized Earth (for retaining walls)
NBE	National bridge element
NBI	National Bridge Inventory
NHS	National Highway System
o-t-o	Out-to-out
PCCA	Preservation-cycle cost analysis

PS	Prestressed concrete; also abbreviated as “PSC” by some sources, such as AASHTO’s <i>Manual for Bridge Element Inspection</i>
QPL	Qualified Product List
RC	Reinforced concrete
SF	Square feet, a unit for quantity of bridge element; may be noted in other references as “ft ² ”
STIP	Statewide Transportation Improvement Program
WT	ASTM designation for a standard steel section, i.e., a steel T-shape cut from a rolled steel W-shape

SECTION 1: INTRODUCTION

1.1—INTRODUCTION

This is a Guide to the preservation of highway bridges.¹ Preservation keeps existing bridges in service, keeps load capacities and traffic capacities at design values, and keeps bridges in fair or good condition.

Bridge preservation applies actions in maintenance and repair to existing bridges that are adequate for continued service. Preservation is one part of overall management of highway bridges. Overall management addresses bridge construction, improvement, maintenance, repair, and replacement. Preservation is maintenance and repair of bridges that are not currently candidates for replacement or improvement.

Bridge preservation programs select, deliver, and assess work in maintenance and repair of highway bridges. Preservation programs examine the performance of actions applied to in-service bridges, and adjust policies on selection of actions to improve performance. Preservation programs evaluate benefits of actions. Benefits are expressed as savings in agency costs. Preservation programs can use new materials and methods in maintenance and repair, and can provide evaluations of performance of new materials and methods. Preservation programs report on their results.

The *Guide to Bridge Preservation Actions* presents the coordination of work in maintenance and repair to preserve highway bridges. The Guide can be adapted by bridge Owners to establish their own programs for bridge preservation.

1.2—CONTENT OF THE GUIDE

The Guide identifies candidates for bridge preservation.

The Guide lists actions in bridge preservation.

The Guide lists costs of actions and time intervals for use of actions. Costs and intervals in the Guide are representative. These values can help bridge Owners begin programs for bridge preservation. Bridge Owners will track their own costs and intervals as bridge preservation goes forward.

The Guide presents a method of Preservation-Cycle Cost Analysis (PCCA) for cost evaluation of preservation actions. PCCA is the method used to compute monetized benefits of preservation.

The Guide is a collection of existing knowledge and is based on documents and practices of U.S. state transportation departments.

C1.1

This is a Guide to the preservation of highway bridges. The Guide describes scope, methods, and evaluation of programs for preservation of highway bridges.

Bridge preservation applies a limited set of actions to a defined population of bridges, i.e., those bridges not needing replacement or improvement.

C1.2

The Guide assists bridge Owners in the execution and evaluation of programs for preservation of highway bridges. The Guide presents information on actions to preserve bridges. The Guide presents a method of cost evaluation for actions in preservation.

The Guide provides a framework for preservation programs and presents a set of examples in evaluation of monetized benefits of bridge preservation. Examples employ costs of preservation actions and time intervals for re-application of actions. Costs and intervals were developed in NCHRP project 14-36. Values are derived from data collected from bridge Owners. Costs and intervals are representative. Individual bridge Owners should employ their own costs and intervals when adapting the Guide to their programs for bridge preservation.

¹ The term bridge is defined in 23 CFR 650. Bridge includes culvert.

1.3—BRIDGE PRESERVATION

Programs for bridge preservation are limited in scope to candidate bridges and allowable actions. Limited scope allows programs to deliver actions to protect bridges before defects appear, and to deliver repairs for minor defects before larger defects appear.

A formal system of coding and recording defects in bridge elements is presented in the AASHTO *Manual for Bridge Element Inspection* (MBEI) (AASHTO, 2019). The Guide anticipates that bridge Owners are using or will come to use AASHTO's system of defects. Use of AASHTO's system of defects is not required, however.

1.3.1—Bridges Already in Service

Bridge preservation is applied to bridges that are already in service. Preservation keeps bridges in service without modification to capacity, design type, materials, or function.

1.3.2—Bridges Intended for Continued Service

Preservation is generally applied to bridges that are not candidates for improvement or replacement. Actions to modify bridges are beyond scope. Bridges that are candidates for preservation should be adequate in capacity, mobility, robustness, and durability. Each finding of adequacy, and each finding that a bridge is a candidate for preservation, is specific to the bridge, the region, the route, and the demands of traffic.

Preservation maintains fair or good condition of a bridge and, by preserving condition, extends bridge service life.

1.3.3—Preservation is One Phase of Service Life

Preservation is one phase in overall management of bridges. Highway bridges progress through phases that include new construction, preservation in service, and eventual replacement. The Guide focuses on preservation in service.

C1.3

Defects have a common meaning: Defects and observations are actionable. Defects are reported variously by bridge safety inspectors, by maintenance crews, and by road users. A preservation program operates on the early discovery and correction of defects.

The AASHTO MBEI provides an approach to organizing information on defects. Multiple types of distress are recognized in MBEI. The condition of bridge elements can be aggregated into element-level condition states or can be presented as specific defects as desired by an agency for use in bridge management.

1.4—AUDIENCE FOR THE GUIDE

The Guide is intended for professional staff in transportation agencies who are experienced in design, maintenance, repair, and replacement of highway bridges. Staff should have a general understanding of principles of asset management and procedures in selection and development of bridge projects.

The Guide can be used by bridge Owners to develop or to enhance their own programs for preservation of highway bridges.

Provisions in the Guide are both starting points and examples. Bridge Owners will use, modify, or omit provisions as needed for their own bridge preservation programs.

1.5—ORGANIZATION

The Guide is presented in six Sections and four Appendices, with Commentary throughout, listed here:

- Section 1: Introduction
- Section 2: Bridge Preservation
- Section 3: Actions in Bridge Preservation
- Section 4: Selection of Actions for Bridge Preservation
- Section 5: Implementing a Program for Bridge Preservation
- Section 6: References
- Appendix A: Catalog of Bridge Preservation Actions
- Appendix B: Defects and Preservation
- Appendix C: Examples of Cost Evaluation of Bridge Preservation
- Appendix D: Glossary of Terms in Bridge Preservation

1.6—SOURCES

The information presented in the Guide is collected from publications of bridge Owners and the FHWA as well as from records of bridge maintenance contributed by bridge Owners that participated in NCHRP project 14-36.

C1.6

The Guide borrows practices in bridge maintenance and bridge preservation from the following publications listed in Section 6:

- (FHWA, 2018a);
- (Florida DOT, 2011);
- (Georgia DOT, 2012);
- (Iowa DOT, 2014);
- (Indiana DOT, 2013);
- (Michigan DOT, 2010);
- (Minnesota DOT, 2015);
- (Missouri DOT, 2008);
- (New York DOT, 2006);
- (Ohio DOT, 2011);
- (Pennsylvania DOT, 2010);
- (Utah DOT, 2014a); and
- (Wisconsin DOT, 2016).

Data on Bridges in Service

Data on bridge maintenance collected from bridge Owners are presented as part of the final report for NCHRP project 14-36 (Hearn, 2020). Bridge Owners that participated are California DOT, Connecticut DOT, Illinois DOT, Michigan DOT, New York State DOT, Ohio DOT, Pennsylvania DOT, Oregon DOT, Virginia DOT, Washington DOT, and Wisconsin DOT.

SECTION 2: BRIDGE PRESERVATION

2.1—BRIDGE PRESERVATION

This Section presents the concept of bridge preservation, applies the concept to identify candidate bridges and allowable actions, and defines terms in bridge preservation. This Section also presents a possible organization of agency staff for bridge preservation.

C2.1

Bridge preservation is one part of a bridge program to design, build, maintain, and replace bridges. The bridge program is one part of an agency highway program. The highway program is one among many transportation programs managed by an agency (Figure C2-1).

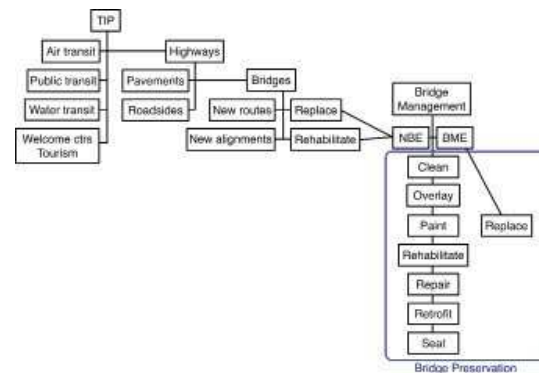


Figure C2-1. Bridge Preservation Program

2.2—BRIDGES, BRIDGE COMPONENTS, AND BRIDGE ELEMENTS

C2.2

The terms *bridge*, *bridge component*, and *bridge element* are used in the Guide. Definitions of these terms are presented here.

Bridge is defined in federal regulation (23 CFR 650). Bridge includes culvert.

A bridge component is a portion of a bridge. The federal National Bridge Inventory (NBI) (FHWA, 1996) names five components: Deck, Superstructure, Substructure, Channel, and Culvert. A bridge component has a specific role, as follows: decks carry traffic, superstructures carry decks, substructures support superstructures. The Guide employs the NBI components and lists additional components (see Article 3.2.1).

A bridge element is a specific part of a bridge. The Guide employs bridge elements listed in the *Manual for Bridge Element Inspection* (MBEI) (AASHTO, 2019). A bridge element has specific type and material of construction.

The terms *component* and *element* overlap. Deck, for example, is both a component and a group of elements. The distinction is that a *component* identifies a role, while an *element* identifies a material (usually) and may identify a form or type.

2.3—CONCEPT OF PRESERVATION OF HIGHWAY BRIDGES

Preservation is a program of maintenance of existing bridges that have acceptable condition, capacity, robustness, and durability. Preservation is appropriate to bridges that bridge Owners need to keep in service. These are bridges that are not in poor condition and are not candidates for reconstruction or replacement in an agency's statewide transportation improvement program (STIP).

Any bridge that is preserved today will be replaced eventually. However, preservation can delay the need to replace bridges, thus reducing their life-cycle cost.

2.3.1—Condition, Capacity, Robustness, and Durability

The terms condition, capacity, robustness, and durability are defined here:

2.3.1.1—Bridge Condition

Condition is indicated by general condition ratings (GCR) of the U.S. DOT National Bridge Inventory (NBI), and by element-level condition states defined in the AASHTO Manual for Bridge Element Inspection (MBEI).

2.3.1.12—Bridge Capacity

Capacity of a bridge is a combined assessment of deck width, roadway alignment, clearances, number of traffic lanes, live load rating, and weight restrictions in relation to the desired service level for a route and bridge. Weight restriction, as distinct from live load rating, is the exclusion of legal loads or of some overweight permit vehicles from a bridge.

2.3.1.23—Bridge Robustness

Robustness in a bridge is the absence of vulnerabilities to sudden failure by earthquake, flood, overload, fatigue, fracture, or security.

2.3.1.34—Bridge Durability

Durability is an assessment of resistance to deterioration of a bridge's construction materials, design details, and devices such as bearings and joints.

C2.3.142—Bridge Capacity

Capacities of bridges are adequate or not adequate in relation to route functional class, average daily traffic, highway design speed, and route-specific needs for mobility of oversize permit vehicles and overweight permit vehicles.

2.4—BRIDGE PRESERVATION—DEFINITION

C2.4

The term bridge preservation is defined by AASHTO (2011).

The U.S. Federal Highway Administration (FHWA) defines bridge preservation (2018a).

Bridge preservation is a program of maintenance and repair applied to bridges that are currently in good or fair condition with the intention of keeping those bridges in good or fair condition.

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Table 2.4-1. Definitions of Bridge Preservation

Source	Definition of Bridge Preservation
AASHTO	Actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements; restore the function of existing bridges; keep bridges in good condition; and extend the useful life of bridges. Preservation actions may be preventive or condition-driven.
FHWA	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.

2.4.1—Bridge Preservation in U.S. Federal Law

Preservation is one of the activities included in the federal definition of construction (U.S.C., title 23, sec. 101). Preservation can be eligible for federal assistance.

2.4.2—Preventive Maintenance, Routine Maintenance

Preventive maintenance is eligible for federal assistance if it is demonstrated to be a cost-effective means of extending the useful life of a federal-aid highway (U.S.C., title 23, sec. 116). Actions in preventive maintenance of bridges that are eligible for federal assistance are listed in agreements between U.S. state DOTs and FHWA. Eligible actions in bridge preventive maintenance generally include cleaning, repairs, deck overlays, joint replacements, and scour countermeasures.

Routine maintenance is not eligible for federal assistance. FHWA defines routine maintenance to be actions in response to events or seasons, or in response to the overall deterioration of assets (FHWA, 2016).

C2.4.1

U.S. federal law identifies programs for historic bridge preservation and for historic covered bridge preservation (U.S.C., title 23, sec. 144). Historic preservation is not addressed in the Guide.

C2.4.2

Bridge preventive maintenance programs include actions to clean, paint, and repair bridges; actions to overlay decks; actions to replace joints; and actions to retrofit joints, railings, and channels to improve performance and function and to reduce vulnerability. Actions reported by U.S. state DOTs as preventive maintenance actions are listed in Table C2.4.2-1.

Bridge Owners use the term routine maintenance to include actions to clean and repair bridges. Some bridge Owners identify actions to paint structures and to replace parts of bridges as routine maintenance. Actions reported by U.S. state DOTs as routine maintenance actions are listed in Table C2.4.2-2.

Bridge cleaning and repairs to bridges in response to continuing deterioration are preservation actions. Bridge cleaning and bridge repair are often included among actions that are eligible for federal assistance in states' programs for preventive maintenance. The distinction between routine maintenance and preventive maintenance is in the demonstration of cost-effective extension of useful life of bridges. This demonstration is required for programs for preventive maintenance, and it is central to programs for bridge preservation.

Table C2.4.2-1. Preventive Maintenance Actions of U.S. States

	Bridge	Deck	Superstructure	Substructure	Culvert	Approach	Bearing	Channel	Drain	Joint	Railing
Clean	CT FL GA MN OH VA WI	AZ GA MT NY NC OH PA TX	AZ IN MT OH	AZ GA IN MT NY OH PA	OH		AZ IN MT NY PA TX	AZ GA MN MT NY OH TX VA WI	CT GA IN LA MT NY PA	GA IN MT TX WI	OH
Overlay		CA CT MI NY NC OH VA WI									
Paint	CT FL MI MN NJ NY NC TX WI		CT GA NY OH VA	CT			VA WI				WI
Repair	MN NJ NY WI	CA CO CT LA MI NJ OH VA WI	CT LA NC OH	CT LA MI NC TX VA WI	WI	MI OH WI	CA NY NC WI	CA GA NY WI		CT LA MN NJ NY TX WI	CT MI OH
Replace			MI TX WI	LA		CA	NC WI			CA CO CT LA MI NC TX VA WI	CA WI
Retrofit		CO NC OH VA	OH VA WI	TX VA	OH VA	OH	CT TX	AZ CT MI NJ NC OH TX VA WI	NY OH	NC VA WI	CA CT MI TX WI
Seal	FL OH VA WI	AZ CA CO GA IN MT NY NC OH WI	OH	NY NC OH		OH				TX VA WI	NY OH

Table C2.4.2-2. Routine Maintenance Actions of U.S. States

	Bridge	Deck	Superstructure	Substructure	Culvert	Approach	Bearing	Channel	Drain	Joint	Railing
Clean	CA MT UT	AL CA UT WI	AL UT WI	UT WI	UT	UT	AL CA NY UT	AL CA IL MT NY WI	AL NY UT WI	AL CA UT WI	CA UT
Paint	AL CA TX		NY	NY							
Repair	CA IL MT	IL NY TX UT WI	NY TX WI	NY TX WI		MT TX UT WI		AL IL NY WI	MT	NY TX UT WI	CA NY TX WI
Replace		NY	NY	NY			NY			NY WI	
Retrofit				TX		AL		MT		NY	
Seal		WI								AL	UT

2.4.3—Bridge Preservation in U.S. State DOTs

Bridge Owners define bridge preservation to include cleaning, sealing, coating, repairing, and certain types of rehabilitation.

C2.4.3

Some bridge Owners publish definitions of bridge preservation that are similar or identical to AASHTO's definition. For example, see Michigan TAMC, no date; Montana, 2015; Utah DOT, 2014a; and Wisconsin DOT, 2016.

Louisiana Department of Transportation and Development adds the concept of long-term cost-effective strategy to achieve preservation (see Louisiana DOTD, 2015b).

One state defines preservation of routes such that 'bridge replacement' is preservation in the sense that traffic service along the route is preserved (California, 2015a). U.S. state definitions of preservation and maintenance-related terms are listed in Table C2.4.3-1.

Bridge preservation actions of U.S. states are summarized in Table C2.4.3-2.

Table C2.4.3-1. Definitions of Preservation and Maintenance-Related Terms Among U.S. States

Term	Definition	Source
Maintenance	Repairs performed on a bridge structure to keep the bridge at an adequate level of service.	Georgia DOT, 2012
Maintenance	The performance of all things necessary to keep a highway in serviceable condition for vehicular traffic.	Illinois DOT, 2014
Maintenance, Capital Preventive	Pin and hanger replacement, painting, joint replacement, overlays, deck patching, scour counter-measures, minor substructure repair.	Michigan DOT, 2008
Maintenance, Capital Scheduled	Superstructure washing, vegetation control, drainage system cleaning/repair, spot painting, joint repair, concrete sealing, minor concrete patching and repair, concrete crack sealing, approach pavement relief joints, slope paving repair.	Michigan DOT, 2010
Maintenance, Corrective	Specific activities that are not scheduled or are reactive in nature are intended to correct more extensive damage and prevent further deterioration but are limited to localized areas of a specific structural element.	Arizona DOT, no date
Maintenance, Corrective	Maintenance performed once a deficiency occurs on a bridge. Examples include pothole filling, spall repair, and bridge railing repair.	Louisiana DOTD, 2015b
Maintenance, Major	Bridge rehabilitation, reconstruction, or replacement. Replacement of structures only as a result of major disaster when no other funds or programs are available.	Texas DOT, 2014
Maintenance, Preventive	<i>from 23 U.S.C. 116</i> A planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without substantially increasing structural capacity).	Georgia DOT, 2013 Michigan TAMC, no date
Maintenance, Preventive	Painting (spot and over-coating), corrosion protection, scour prevention, crack sealing, re-sealing of joints, joint repair, and washing of weathering steel.	Louisiana DOTD, 2015b
Maintenance, Preventive	Steel structure cleaning and repainting or the installation of other coatings; installation of bridge deck protection; joint cleaning and sealing or replacement.	Texas DOT, 2014
Maintenance, Preventive	Preventive maintenance activities include cyclical (noncondition-based) and condition-based activities.	Wisconsin DOT, 2016
Maintenance, Preventive, Condition Based Activities	Condition-based preventive maintenance activities are those activities that are performed on bridge elements as needed and identified through the bridge inspection process.	Wisconsin DOT, 2016

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Table C2.4.3-1. Definitions of Preservation and Maintenance-Related Terms Among U.S. States *(Continued)*

Term	Definition	Source
Maintenance, Preventive, Cyclical Activities	Activities performed on a pre-determined time interval and aimed to preserve existing bridge element or component conditions. Bridge element or component conditions are not always directly improved as a result of these activities, but deterioration is expected to be delayed.	Georgia DOT, 2013 Wisconsin DOT, 2016
Maintenance, Preventive, Systematic Program (SPM)	Systematic Preventive Maintenance is a planned strategy of cost-effective treatments to highway bridges that are intended to maintain or preserve the structural integrity and functionality of bridge elements and/or components and retard future deterioration, thus maintaining or extending the useful life of bridges. An SPM program is based on a planned strategy that is equivalent to having a systematic process that defines the strategy, how it is planned, and how activities are determined to be cost-effective. An SPM program may be applied to bridges at the network, highway system, or region-wide basis and have acceptable qualifying program parameters. The details on an SPM program and qualifying parameters are found in the FHWA's <i>Bridge Preservation Guide</i> (FHWA, 2018a)	Wisconsin DOT, 2016
Maintenance, Reactive	Activities that are scheduled in response to an identified condition that may compromise public safety or bridge structural function. Reactive bridge maintenance items are typically identified during routine bridge inspections and include activities such as replacement of missing plow fingers, repair of impact damage, deck spall repair, and resetting misaligned bearings.	Minnesota DOT, 2015
Maintenance, Reactive	Repair after deterioration has occurred.	Montana DOT, 2002a
Maintenance, Routine	Defined as repair work typically performed by DOTD that is planned and carried out on a scheduled basis to maintain a bridge. Examples: cleaning of bridge drainage facilities, maintenance of movable bridge elements, and minor bridge deck repairs.	Louisiana DOTD, 2015b
Maintenance, Routine	Repair of substructures, superstructures, decks, joints, approach slabs, and railing; spot painting; repair and operation of movable bridges; installation of temporary bridges; and repair and installation of fender systems.	Texas DOT, 2014
Preservation	Using a variety of strategies including replacements, rehabilitations, scour countermeasures, and seismic retrofitting.	California DOT, 2015a
Preservation	<i>from AASHTO PR-3-11 (AASHTO, 2011)</i> Actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements; restore the function of existing bridges; keep bridges in good condition; and extend their life. Preservation actions can be preventive or condition-driven.	Connecticut DOT, 2016 Michigan TAMC, no date Montana DOT, 2015 Utah DOT 2014a Wisconsin DOT, 2016

Continued on next page

Table C2.4.3-1. Definitions of Preservation and Maintenance-Related Terms Among U.S. States *(Continued)*

Term	Definition	Source
Preservation	A program employing a network-level, long-term strategy that enhances bridge performance by using an integrated, cost-effective set of practices that maintain, improve, or restore the physical condition of bridge structure or elements.	Louisiana DOTD, 2015b
Rehabilitation	<i>from 23 CFR 650</i> Rehabilitation is described as major work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects.	Connecticut DOT, 2016 Utah DOT, 2014a Wisconsin DOT, 2016
Rehabilitation	Significant repair work to a structure.	Georgia DOT, 2012
Rehabilitation	Concrete overlay—shallow, concrete overlay—deep, superstructure repairs, extensive substructure repair, substructure replacement	Michigan DOT, 2008
Rehabilitation, Major	Consists of structural or operational improvements that extend the service life of an existing bridge and/or improve its load-carrying capability. Examples include electrical and/or mechanical work, re-decking, bridge deck widening, strengthening, and painting.	Louisiana DOTD, 2015b
Rehabilitation, Major (Improvement)	Bridge improvement is a set of activities that fixes the deterioration found in a structure and improves the geometrics and load-carrying capacity to at least the minimum criteria set in these guidelines, but might not provide improvement that meets new construction standards.	Wisconsin DOT, 2016
Rehabilitation, Minor	Consists of repairs to address deterioration of structural elements, protective surfaces, or riding surfaces to extend the service life of the existing structure. Examples include painting, joint repair, replacement of concrete cover, epoxy injection, spall repair, and bearing and connection repair.	Louisiana DOTD, 2015b
Rehabilitation, Minor	Work required to correct minor structural or safety defects. Work may be deck patching; deck resurfacing; deck protective systems; upgrading railings, curbs, and gutters; and other minor bridge work.	Montana DT, 2015

Table C2.4.3-2. Bridge Preservation Actions of U.S. States

	Bridge	Deck	Superstructure	Substructure	Culvert	Approach	Bearing	Channel	Drain	Joint	Railing
Clean	ME MI NH WI	WI	MI UT	WI	IN		UT WI	IN ME	MI WI	WI	
Overlay		IN ME MI MN MT NH OR UT WV WI									
Paint	DE ME MN NV NH WA		ME MI UT WI	MI			ME UT				
Rehabilitation	ME WA	ME WA		ME	ME						
Repair	DE IN MI UT WA	DE IL ME MI UT WA WI	IN ME MI MN UT	DE IL IN ME MI MN UT WI	IN	ME MI WI	UT WI	DE UT WI	IL ME WI	IL ME MI WI	IL ME MI UT WI
Replace	ME MI WA	ME MI MN MT NV UT WI	ME MI UT WI	MI		ME UT	IL UT WI		ME	IL ME MI MN NH OR UT WA WV WI	ME MI MN UT
Retrofit	NV WA WV	ME WI			IN	MI		ME MI UT WA WI	DE IL ME	IN ME UT WI	IL ME WI
Seal	ME MI NH UT	MT UT		MI							UT

2.4.4—Preservation: Constraints

AASHTO's definition of bridge preservation is interpreted in the Guide as a set of constraints on bridges and actions (see Table 2.4.4-1).

This interpretation limits the scope of programs for bridge preservation.

- There is a distinct population of bridges that are candidates for preservation.
- The preservation program includes a specific, limited set of actions.

These limitations allow:

- Specific measures of performance of preservation programs.
- Definite budget for programs. Budget is based on a distinct population of bridges and specific actions that have corresponding time intervals and costs.

C2.4.4

Bridge preservation is focused so as to be practicable. Preservation is a program to preserve current conditions in highway bridges. It follows that bridges should be in fair or good condition so that preservation of the current condition is desirable.

Table 2.4.4-1. Bridge Preservation Definition and Interpretation

AASHTO PR-3-11 Phrase	Interpretation
Actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements	Preservation actions include maintenance, preventive maintenance, repairs, and those retrofits that lessen deterioration rate or exposure. Preservation does not include actions to increase traffic capacity or load capacity.
Restore the function of existing bridges	Preservation includes in-kind replacement of bridge elements. Preservation does not include actions to increase functional capacity of existing bridges.
Keep bridges in good condition	Bridges in fair or good condition are candidates for preservation. Preservation is not intended to address bridges in poor condition.
Extend the useful life of bridges	Preservation actions generally extend service life. Actions that do not extend service life are not preservation.
Actions may be preventive	Cyclic actions for general upkeep of bridges are preservation.
Actions may be condition-driven	Repairs and in-kind replacement of bridge elements are preservation.

2.5—ACTIONS IN BRIDGE PRESERVATION

Actions are admissible as preservation actions when they maintain conditions and extend service life. Actions are identified for major components of bridges and for other components of bridges.

2.5.1—Actions for Major Components of Bridges

Preservation includes actions to maintain or repair major components of bridges. Major components are decks, superstructures, substructures, and culverts. Actions to increase durability of major components are preservation. Partial replacement of a major component is a type of rehabilitation and, therefore, is preservation.

Actions to increase capacity of bridges are not considered to be preservation as defined in this Guide. Full replacement of major components is not considered to be preservation as defined in this Guide.

2.5.2—Actions for Other Components of Bridges

For other components of bridges such as approaches, channels, bearings, drains, joints, and railings, all actions are preservation. These components can be maintained, repaired, or replaced. These components can have their capacity or function improved. Good, functioning condition in these components can delay or reduce deterioration in major components of bridges.

2.5.3—Maintenance Actions Are Preservation Actions

Maintenance is work of relatively modest cost and relatively small impact on traffic that keeps bridges in their current condition. Preventive maintenance and condition-driven maintenance are preservation.

C2.5.2

Other components can be replaced in-kind or completely re-engineered to preserve major components of bridges. For approaches, replacement actions could provide different length, width, or alignment. For bearings, drains, joints, and railings, replacement actions could provide new devices or capacities. For channels, replacement actions could provide new stream profile and cross section, or new protection for banks.

C2.5.3

Bridge Owners define maintenance in various ways (see Table C2.5.3-1). The Guide defines maintenance as upkeep, repair, and protection of bridges and bridge components.

Table C2.5.3-1. Terms for Bridge Maintenance and Preservation

Term	State (Source)^a
B-Smart Preservation	Illinois DOT, 2011
Capital Preventive Maintenance	Michigan DOT, 2008
Capital Scheduled Maintenance	Michigan DOT, 2010
Condition Maintenance	Georgia DOT 2013
Contract Preservation	Delaware DOT, no date
Corrective Maintenance	Arizona DOT, no date Indiana DOT, 2014 New York DOT, 2006 Wisconsin DOT, 2015
Cyclic Maintenance	Georgia DOT, 2013
Cyclic Strategic Maintenance	Pennsylvania DOT, 2010
Major Bridge Maintenance	Oregon DOT, 2015
Maintenance	Iowa DOT, 2014 Kentucky TC, 2009 Missouri DOT, 2015a Missouri DOT, 2015b Nebraska DOT 2015 North Dakota DOT, 2015 Oregon DOT, 2004 Oregon DOT, 2013 Pennsylvania DOT, 2010 Utah DOT, 2015 Washington DOT, 2013
Maintenance Repair	Montana DT, 2002b New York DOT, 2004
Non-Regular Maintenance	Pennsylvania DOT, 2010
Ordinary Maintenance	Virginia DOT, 2015
Preservation	Indiana DOT, 2015 Maine DOT, 2015 Michigan TAMC, no date Utah DOT, 2015 Washington DOT, 2008

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Table C2.5.3-1. Terms for Bridge Maintenance and Preservation *(Continued)*

Term	State (Source)^a
Preventive Maintenance	Arizona DOT, no date Colorado DOT, 2015 Connecticut DOT, no date Georgia DOT, 2012 Louisiana DOTD, 2015a Minnesota DOT, 2015 Montana DT, 2002b New Jersey DOT, 2010 New York DOT, 2004 New York DOT, 2006 North Carolina DOT, 2012 Ohio DOT, 2015a Texas DOT, 2014 Virginia DOT, 2012 Wisconsin DOT, 2015
Response Maintenance	Georgia DOT, 2012 New York DOT, 2006 Pennsylvania DOT, 2010 Utah DOT, 2014b
Restorative Maintenance	Virginia DOT, 2012
Routine Maintenance	Alabama DOT, 1995 Illinois DOT, 2014 Montana DT, 2002b New York DOT, 2014 Texas DOT, 2014 Utah DOT, 2014a Wisconsin DOT, 2015
Scheduled Maintenance	Georgia DOT, 2012 New York DOT, 2006
Scheduled Preventive Maintenance	Pennsylvania DOT, 2010
Unscheduled Maintenance	Montana DT, 2002c

^a For full information on sources, see Section 6.

2.5.4—Some Rehabilitation Is Preservation

Preservation includes rehabilitation to restore fair or good condition and to restore original capacities of bridges. This is consistent with the federal definition of rehabilitation in 23 CFR 650.

Preservation does not include rehabilitation that widens bridges, improves vertical clearances, or increases live-load rating.

2.5.5—Retrofit to Improve Durability Is Preservation

Preservation includes improvements to durability. Actions that reduce exposure to deterioration are preservation. Examples of improvements to durability include:

- New overlays or wearing courses on decks that lack an overlay or wearing course;
- Improvements to drains including new drains, additional drains, and new locations of drains;
- New or modified protection for channels, or other scour-related work;
- New coatings or new coating systems,
- Elimination of deck expansion joints;
- Cathodic protection of bridge elements; and
- Seismic retrofits, fatigue retrofits, fracture retrofits, and security retrofits.

2.6—CANDIDATE BRIDGES, PRESERVATION POPULATION

Bridges are candidates for preservation when bridge condition, capacity, robustness, and durability are adequate. Bridges programmed for reconstruction or replacement are not usually candidates for preservation.

C2.5.5

Methods for seismic retrofit are not covered in the Guide. Users of the Guide are referred to the following references in Section 6:

- California, 2015c;
- FHWA, 2006;
- Indiana, 2013;
- Nevada, 2008; and
- Washington, 2017.

2.6.1—Condition of Elements, Components, and Bridges

Candidates for bridge preservation should be in fair or good condition.

Bridge elements, bridge components, or bridges are in fair or good condition when at least one of the following criteria is satisfied (see Table 2.6.1-1):

- The bridge is classified as fair or good under 23 CFR 490.409.
- The lowest general condition rating (GCR) among deck, superstructure, and substructure is 5 or higher.
- All bridge elements listed in Table 2.6.1-2 have most element quantity in element condition states one (CS 1) or two (CS 2), and small quantity or no quantity in element condition state three (CS 3) and four (CS 4).

C2.6.1

NBI GCRs address deck, superstructure, substructure, and culvert. Some bridge Owners expand their bridge inventory data to include general condition ratings of other components (Indiana, 2011). These additional GCRs can be used to identify candidates for bridge preservation.

Bridge Owners set criteria for fair or good condition stated as NBI GCRs or as bridge element (BE) condition states and quantities. Bridges that satisfy either the NBI criteria or the BE criteria are in fair or good condition.

Federal regulation (23 CFR 490) defines good, fair, and poor conditions in terms of NBI GCRs (see Table C2.6.1-1). Bridges in good condition or in fair condition are candidates for preservation.

Bridge elements listed in Table C2.6.1-2 may be replaced as part of preservation of bridges or of major components.

Table 2.6.1-1. Fair or Good Condition

Level of Assessment	Condition	Reference
Bridge	Bridge is classified good or Bridge is classified fair	National bridge performance management measures 23 CFR 490.409
Bridge Component	General condition of component is Good (NBI rating 7, 8, or 9) or Fair (NBI rating 5 or 6)	NBI recording and coding guide (FHWA, 1996)
Bridge Element	Elements of major components have all or most element quantity in CS 1 and CS 2 and little or no element quantity in CS 3 or CS 4,	<i>Manual for Bridge Element Inspection</i> (AASHTO, 2019)

Table C2.6.1-1. Good, Fair, and Poor Condition

Condition	Bridge	Culvert
Good	If all: Deck $GCR \geq 7$ Superstructure $GCR \geq 7$ Substructure $GCR \geq 7$	If Culvert $GCR \geq 7$
Fair	If any: Deck $GCR < 7$ Superstructure $GCR < 7$ Substructure $GCR < 7$ And all: Deck $GCR \geq 5$ Superstructure $GCR \geq 5$ Substructure $GCR \geq 5$	If Culvert $GCR < 7$ And: Culvert $GCR \geq 5$
Poor	If any: Deck $GCR \leq 4$ Superstructure $GCR \leq 4$ Substructure $GCR \leq 4$	If Culvert $GCR \leq 4$

Table 2.6.1-2. Bridge Elements of Major Components

Group	Element	Element Numbers
Deck	Deck, Slab	12, 13, 14, 15, 16, 28, 29, 30, 31, 38, 39, 54, 60, 65
Superstructure	Closed Web/Box Girder	102, 104, 105, 106
	Girder/Beam	107, 109, 110, 111, 112
	Stringer	113, 115, 116, 117, 118
	Truss	120, 135, 136
	Arch	141, 142, 143, 144, 145, 146
	Cable	147, 148, 149
	Floor Beam	152, 154, 155, 156, 157
	Pin, Pin and Hanger Assembly	161
	Gusset Plate	162
Substructure	Column, Tower/ Trestle	202, 203, 204, 205, 206, 207, 208
	Pier Wall	210, 211, 212, 213
	Abutment	215, 216, 217, 218, 219
	Pile Cap/Footing	220
	Pile	225, 226, 227, 228, 229
	Pier Cap	231, 233, 234, 235, 236
Culvert	All	240, 241, 242, 243, 244, 245

Table C2.6.1-2. Bridge Elements Not Affecting Overall Bridge Condition

Group	Element	Element Numbers
Joint	All	300, 301, 302, 303, 304, 305, 306
Bearing	All	310, 311, 312, 313, 314, 315, 316
Approach	Slab	320, 321
Railing	All	330, 331, 332, 333, 334
Wearing Surface	All	510
Coating	All	515, 521
Protection for concrete reinforcing steel	All	520

2.6.2—Bridge Capacity

Capacity is adequate when bridge dimensions, alignment, clearances, and live load rating are acceptable to the bridge Owner for current service, and weight limits do not constrain the mobility of freight.

2.6.3—Bridge Robustness

A bridge is robust when it is not vulnerable to sudden failure by earthquake, flood, overload, fatigue, fracture, or threat vulnerability.

2.6.4—Bridge Durability

Bridges are durable when bridge materials and members have acceptable resistance to deterioration. Bridges are durable when

1. Construction materials, design details, and devices meet the agency's current standards for design of new bridges, or
2. For older bridges, the construction materials, design details, or devices, though no longer used in new bridges, are known to perform adequately.

2.6.5—Intended for Continued Service

A bridge is generally not a candidate for preservation if it is programmed for reconstruction or replacement.

C2.6.2

Bridge Owners will establish policies on acceptable capacities. Requirements for capacities may depend on route functional class, annual average daily traffic (AADT), detour length, and other factors.

Recommended criteria are that bridges have adequate capacity when NBI appraisal ratings for all of the following: structural evaluation (item 67), Deck geometry (item 68), Underclearances (item 69), and Approach roadway alignment (item 72) are all rating '4' or higher and Bridge posting (item 70) is rating '5'.

C2.6.3

Bridge Owners will establish policy on robustness.

Recommended criteria: A bridge is robust if all NBI ratings among for channel and channel protection (item 61), waterway adequacy (item 71), and scour critical bridge (item 113) are rating '4' or higher. Fracture critical detail (item 92A) should be 'N'.

Additional ratings, not found in NBI, are required to assess vulnerability to fatigue, overload, collision, seismic loads, and threat vulnerability.

C2.6.4

Bridge Owners will establish policies on durability. Bridges are not durable if

- aggregates in concrete are susceptible to alkali-silica reaction (ASR),
- concrete reinforcing steel is uncoated in locations where corrosion-resistant reinforcing steel is required,
- concrete cover for reinforcing steel does not meet current requirements, or
- structural steel has lead-based paint that makes (re)painting infeasible.

C2.6.5

Bridges that are programmed in an agency's STIP are not candidates for preservation, even if bridge condition, capacity, robustness, and durability are adequate. Bridges that are candidates for inclusion in the agency's STIP, but are not currently programmed, might be candidates for preservation.

2.7—BRIDGE PRESERVATION PLANS

Programs for bridge preservation will develop preservation plans for individual bridges or groups of similar bridges. A preservation plan is a statement of the actions and time intervals for actions necessary to preserve the bridge. The plan identifies actions that can be performed together, lists costs of actions, and states the anticipated year of replacement of the bridge.

Preservation plans state the condition ratings and element-level defect reports that are tolerable. Any lower condition rating, and any defect report having greater quantity or severity will trigger condition-driven action, and may trigger a review of the preservation plan.

Preservation plans include moving annual work plans and five-year work plans consistent with the overall preservation plan. Action plans state the mode of delivery of actions (agency forces or contractor).

Preservation plans identify a time interval, usually 10 years, to review and revise plans.

2.8—AGENCY ORGANIZATION FOR BRIDGE PRESERVATION

The preservation of highway bridges should be the responsibility of a Bridge Preservation Engineer supported by a Bridge Preservation Team. Together, these form the Bridge Preservation Staff. Preservation staff plan, manage, execute, and evaluate an agency's program for bridge preservation.

2.8.1—Bridge Preservation Staff—Qualifications

Qualifications of preservation staff are listed here. The Bridge Preservation Engineer should be:

- A registered professional engineer,
- Experienced in methods of bridge maintenance and repair,
- Knowledgeable of the capabilities of agency maintenance crews, and
- Capable of managing contracts for preservation work.

C2.7

Preservation plans are created for bridges that are in fair or good condition, and that have adequate capacity, robustness, and durability. Examples of bridge preservation plans appear in Appendix C.

Preservation plans are not created for bridges in poor condition or for bridges that are programmed for improvement or replacement.

Preservation includes repair, but not all repairs are preservation. This is an organizing concept in the Guide. Preservation is the use of cost-effective maintenance and repair. Short-term repairs to keep poor-condition bridges in service are beyond the scope of the Guide. The term 'preservation' does not apply.

It is recognized that maintenance or temporary repairs may be needed at bridges that are not candidates for programmatic preservation. These bridges include:

- Bridges that are eligible for improvement or replacement, but are not yet programmed.
- Historic bridges that lack adequate capacity, robustness, or durability.

Historic bridges should be maintained and repaired whether repairs are cost-effective or not. For other bridges, constraints to budgets sometimes compel bridge Owners to limit work to repairs that are not cost-effective to keep bridges in service.

C2.8

Preservation should address exposure that can lead to defects and should be prompt in response when defects are discovered. Adequate attention to exposure before defects occur and prompt response to newly discovered defects can be achieved by dedicated staff.

Bridge preservation team members, collectively, should have qualifications that include:

- Hands-on experience in bridge inspection,
- Field experience in bridge maintenance and repair (can be supervisory experience),
- Experience with agency databases and data entry for bridge inventory coding and bridge condition data, and
- Experience with the agency's bridge management system.

2.8.2—Responsibilities of Bridge Preservation Staff

2.8.2.1—Policies and Procedures of the Preservation Program

Preservation staff will make policies, procedures, standards, and specifications. Policies will address guidance for selection of candidates for bridge preservation. Procedures will address methods of selection of preservation actions. Standards and specifications will address delivery, performance, and payment for preservation actions.

2.8.2.2—Candidate Bridges, Admissible Actions

Preservation staff will establish criteria to identify candidates for bridge preservation. Preservation staff will establish and maintain an inventory of the preservation population.

Preservation staff will establish and maintain a catalog of admissible preservation actions. Actions are admissible if they preserve fair or good conditions and extend service life.

2.8.2.3—Materials, Methods, Devices, Innovation

Preservation actions can employ, as trials, new materials, methods, and devices that are collectively called preservation innovations. Preservation staff will review and approve proposals for use of innovations. Preservation staff will set durations of trials, methods of monitoring, and basis of evaluation. Preservation staff will evaluate innovations at the end of trials and will issue findings on whether innovations are acceptable for routine use in bridge preservation.

C2.8.2.1

Preservation staff may develop a bridge preservation Manual that contains the policies and procedures for the preservation program. Policies and procedures include direct concerns of selection of candidate bridges and selection of actions, plus related tasks of field data collection.

C2.8.2.2

A catalog of actions in bridge preservation will include agency information on unit costs and rates of production.

C2.8.2.3

Preservation staff can elect to try new methods, materials, or devices on experimental features. Preservation staff will monitor and evaluate performance of products and will, once performance is established, accept or reject products for continued use. Performance data and evaluation will be shared with an agency's materials branch for use in their decisions to admit or exclude products from the qualified product list (QPL).

2.8.2.4—Bridge Preservation Plan

Preservation staff will develop preservation plans for bridges.

2.8.2.5—Preservation Projects, Delivery

Preservation staff will track needs for preservation actions and develop annual work programs. Preservation staff will direct actions to agency forces or to contracts. Staff will monitor accomplishments of agency forces and will manage contracts.

2.8.2.6—Coordination within an Agency

Preservation staff will coordinate with other branches of an agency on:

- Decisions that change the inventory of preservation candidates (STIP process);
- Delivery of preservation actions by agency forces (maintenance branch);
- Project development, advertising, and bidding for preservation contracts (contracts branch);
- Additions to the qualified products list (materials branch);
- Updates to agency specifications related to preservation actions (construction branch); and
- Updates to agency design standards related to preservation actions (bridge design branch).

C2.8.2.5

Types and locations of many defects can be anticipated. The time of appearance of defects is variable. Preservation plans for bridges will require periodic re-evaluation of bridges for specific defects. Re-evaluations are made in addition to routine safety inspections so that defects can be found and fixed when they occur.

C2.8.2.6

The coordination of preservation staff with other branches in an agency is mutual. Preservation staff will ensure that preservation materials, methods, and details meet current standards. Preservation staff will advise other agency branches on the performance of materials, methods, and details among preservation candidates. This advice will contribute to updates to agency standards and specifications.

Maintenance Branch

The bridge preservation team directs work orders to maintenance branch and is advised by maintenance branch on availability and capabilities of crews.

Bridge Inspection

The bridge preservation team uses condition data from bridge safety inspections as one input in selection of preservation candidates and actions. The bridge preservation team may require information from maintenance quality assurance surveys and may establish an independent effort in field survey to track execution and performance of preservation actions.

Transportation Program Management

The bridge preservation team makes recommendations for candidates to include in the STIP. Preservation staff reviews the STIP to plan for changes to the preservation population.

Contracts

The bridge preservation team participates in pre-qualification and selection of contractors for bridge preservation work.

2.8.2.6.1—Budgets for Preservation

Preservation staff will develop budgets for the preservation program.

2.8.2.6.2—Monitoring, Evaluation, Measurement, and Reporting

Preservation staff will monitor condition of bridges in the preservation population and evaluate the effectiveness of preservation actions. Based on monitoring and evaluation, preservation staff will update standards for actions and their time intervals. Preservation staff will establish performance measures for the preservation program. Preservation staff will report on the performance of the preservation program.

C2.8.2.6.1—Budgets for Preservation

The limitation of preservation programs to candidate bridges and admissible actions allows staff to develop budgets to meet needs in the program. Moreover, the budget required can be compared to the budget allocated and adequacy of funding can be tracked as a performance measure.

C2.8.2.6.2

Measures of Performance

Measures of performance of a preservation program can include: percentage of cyclic actions delivered within policy time intervals, condition-driven actions completed within policy response time, cost savings achieved through preservation actions, and count and percentage of bridges that are preservation candidates in the reporting period (annual or biennial).

Conditions of bridges are monitored through general condition ratings and element-level condition reports and also through information from maintenance quality surveys (Zimmerman, 2015) and other field data selected by preservation staff.

2.9—INFORMATION ON CONDITIONS OF BRIDGES AND THEIR RELATION TO BRIDGE PRESERVATION

Preservation programs need information on condition of bridges. The Guide recognizes AASHTO's MBEI (AASHTO, 2019) as a detailed national practice for standard information on the conditions of bridges. This Guide uses MBEI bridge elements, defects, and condition states. Preservation programs can be executed with various levels of information (see Tables 4.2.1-1 through 4.2.1-3). All competent assessments of needs for actions at bridges, using MBEI or not, can provide information for successful execution of bridge preservation programs.

At a bridge level, overall conditions of bridges are known. Bridges in fair or good overall condition are candidates for preservation. Bridges in poor condition might be rehabilitated or replaced. Actions are general. There are custodial actions for bridges in good condition, repairs for bridges in fair condition, and rehabilitation or replacement for bridges in poor condition.

At a component level, general conditions of major components of bridges are known in addition to overall conditions of bridges. Components in fair or good condition are candidates for preservation. Components in poor condition might be rehabilitated or replaced. Actions are linked to components. There are different custodial actions for different components of bridges, different repairs for different components, and different criteria for replacement of different components.

At an element level, the conditions of elements of bridges are known in addition to the general conditions of bridge components and overall conditions of bridges. Bridge elements in fair or good condition are candidates for preservation. Elements in poor condition might be rehabilitated or replaced. There are distinct custodial actions for distinct elements, distinct repair actions for distinct elements, and distinct criteria for replacement of distinct elements.

Element-level defects may be reported together with element-level conditions. There are specific repair actions for specific defects and specific criteria for replacement of bridge elements related to specific defects.

The Guide includes additional defects to supplement defects outlined in MBEI. Guide-developed defects (GDD) are used to identify additional, specific actions needed for additional, specific defects.

Bridge preservation programs can operate with any of these levels of information: bridge, component, element, etc. The more detailed levels support greater automation in the management of the program. Automation provides evaluations of

- Performance measures (program);
- Deterioration rates (elements, materials);
- Time intervals for actions;
- Performance of methods and materials;
- Cost analysis (preservation plans);
- Budgeting (program); and
- Resource needs (program).

Table 2.9-1. Conditions and Preservation Actions

Level of Information	Potential Sources of Information	Conditions	Preservation Actions
Bridge	Owner's assessment, National Performance Management Measure (23 CFR 490)	Good, Fair, Poor	Good: Clean, clear, renew coatings, renew wearing surfaces, renew joint seals. Fair: Repair Poor: Rehabilitate or replace joints or other components, repair or retrofit major components.
Components (Deck, Superstructure, Substructure)	Owner's assessment, National Bridge Inventory (FHWA, 1996))	Deck: Good, Fair, Poor	Good: Clean, renew wearing surface, renew surface seal Fair: Repair Poor: Rehabilitate or replace
		Superstructure: Good, Fair, Poor	Good: Clean, renew coatings, renew joint seals Fair: Repair Poor: Rehabilitate or replace
		Substructure: Good, Fair, Poor	Good: Clean, clear channel, renew coatings, renew joint seals Fair: Repair Poor: Rehabilitate or replace
Elements (as groups: Approach, Bearing, Deck, Joint, Railing, Substructure, Superstructure)	Owner's assessment, Bridge Element Reports (AASHTO, 2019)	Element: Good, Fair, Poor, Severe, w/ quantities in each condition	Good: Clean, clear, renew Fair: Repair Poor: Rehabilitate or replace Actions suitable to individual elements

Continued on next page

Table 2.9-1. Conditions and Preservation Actions (*Continued*)

Level of Information	Potential Sources of Information	Conditions	Preservation Actions
Elements and Defects (as groups: Approach, Bearing, Deck, Joint, Railing, Substructure, Superstructure)	Owner's assessment, Bridge Element Reports (AASHTO, 2019)	Element: Good, Fair, Poor, Severe w/ quantities in each condition Defect: Good, Fair, Poor, Severe w/ quantities in each condition	Good: Clean, clear, renew Fair: Repair Poor: Rehabilitate or replace Actions suitable to individual elements and specific defects
Preservation Elements and Defects (as groups: Approach, Bearing, Bridge, Channel, Deck, Drain, Joint, Railing, Substructure, Superstructure)	Owner's assessment, Bridge Element Reports (AASHTO, 2019) <i>This Guide provides information.</i>	Element: Good, Fair, Poor, Severe w/ quantities in each condition Defect: Good, Fair, Poor, Severe w/ quantities in each condition	Good: Clean, clear, renew Fair: Repair Poor: Rehabilitate or replace Actions suitable to individual elements and specific defects

2.10—GLOSSARY OF TERMS IN BRIDGE PRESERVATION

Terms used in bridge preservation are defined in Appendix D.

C2.10

The glossary in Appendix D provides terms as used in the Guide. Some terms have different meanings among bridge Owners.

ACTIONS IN BRIDGE PRESERVATION

3.1—ACTIONS IN BRIDGE PRESERVATION

This Section presents actions for preservation of bridges. Preservation actions are organized by bridge component, activity, and detail. This Section presents standard tables of information for actions.

3.2—PRESERVATION ACTIONS—COMPONENT, ACTIVITY, AND DETAIL

Preservation actions are named by bridge *Component* and *Activity*. Most actions are further identified by *Detail*. There are eleven bridge components and eight preservation activities. Details attach to individual combinations of Component and Activity.

The system of naming for preservation actions provides distinct names for distinct preservation materials and methods. The system allows grouping of actions of the same activity or the same component. The naming of actions as Component, Activity, and Detail supports a database of actions, their costs, time intervals, and outcomes. Preservation actions, unit costs, and intervals are listed in Table A4-1.

C3.1

A bridge action is any maintenance, repair, rehabilitation, or replacement of bridge elements. A subset of bridge actions are preservation actions. Preservation actions include:

- Maintain, repair, or retrofit major components of bridges, or
- Maintain, repair, retrofit, or replace other components of bridges as part of the preservation of major components.

C3.2

A hierarchical system of naming actions is used in this Guide. At the verbose level, Component-Activity-Detail (C-A-D), the naming system provides greater specificity; the intended work with corresponding unit costs and expected performance are identified. Moreover, as new information on costs and performance are collected, specific average costs and average performance are updated at the C-A-D level.

Average performance and average costs can be computed for groups of actions. For example, roll-ups of information can be determined by matching component or matching activity.

General values of costs and performance may be useful for overall monitoring and for external reporting for preservation programs. A roll-up of costs and performance to the level of bridge Component and preservation Activity (C-A), combining separate Details among related actions, can yield a report of the general results, costs, and performance of preservation. Further rollups, to Component only or to Activity only, yield reports at higher levels of abstraction.

Most combinations of bridge component and activity are preservation actions. The exceptions are full replacement of major components of bridges, and rehabilitation that increases the traffic capacity or load capacity of a bridge (see Table C3.2-1).

Table C3.2-1. Preservation Actions

	Major Components	Other Components
	Bridge, Deck, Superstructure, Substructure, Culvert	Approach, Bearing, Channel, Drain, Joint, Railing
Clean	Y	Y
Overlay	Y	Y
Paint	Y	Y
Rehabilitate—Original Capacities	Y	Y
Rehabilitate—Increased Capacities		Y
Repair	Y	Y
Replace—Full		Y
Retrofit	Y	Y
Seal	Y	Y

3.2.1—Bridge Components

There are eleven bridge components (see Table 3.2.1-1). Components include:

- Five components identified in the U.S. DOT National Bridge Inventory (FHWA, 1996):
 - Deck,
 - Superstructure,
 - Substructure,
 - Channel, and
 - Culvert.
- Four components that are groups of MBEI bridge elements (AASHTO, 2019):
 - Approach,
 - Bearing,
 - Joint, and
 - Railing.
- One component, *Drain*, that has no corresponding presence in NBI or MBEI.
- One component, *Bridge*, that is a catch-all for actions that affect all or most parts of a bridge.

C3.2.1

Bridge components are objects of preservation actions. Components have quantity and condition. Components have needs in maintenance, repair, or replacement. Preservation actions can improve conditions of components and extend service life of components.

Deck, superstructure, substructure, and culvert are reported in NBI as general condition ratings and have sets of corresponding AASHTO bridge elements, as defined in MBEI. *Approach*, *bearing*, *joint*, and *railing* have sets of corresponding AASHTO bridge elements, but no direct report of condition in NBI. *Channel* has an NBI condition rating, but no AASHTO bridge elements. All eleven components are usually named in states' policies on bridge maintenance or preservation.

Table 3.2.1-1. Bridge Preservation Components

Preservation Component	Parts of Bridges	MBEI Bridge Elements
Approach	Approach pavements, slabs, wearing surfaces, pressure relief joints, embankments, slope protection for embankments	320, 321
Bearing	Fixed and movable bearing devices	310–316
Bridge	All components of a bridge, collectively	
Channel	Banks, bank protection, protection of substructures in water, stream diverters, channel cross section and profile	
Culvert	Culverts subject to U.S. National Bridge Inspection Standards	240–245
Deck	Structural decks, slabs, wearing surfaces, and waterproofing membranes	12–65, 510, 515 ^a , 520 ^b
Drain	Grates, scuppers, downspouts, pipes, supports, outlets, and splash blocks	515 ^a
Joint	Fixed and movable joints in decks	300–306
Railing	Parapets and railings along decks, guardrails along approaches	330–334, 515 ^a , 520 ^b , 521 ^b
Substructure	Abutments, footings, pier walls, pier columns, pier caps	202–236, 515 ^a , 520 ^b , 521 ^b
Superstructure	Beams, girders, stringers, arches, cables, trusses	102–162, 515 ^a , 520 ^b , 521 ^b

^a Element can occur with any steel bridge element.

^b Element can occur with any reinforced concrete or prestressed concrete bridge element.

3.2.1.1—Agency-Developed Bridge Components

Bridge Owners can add agency-developed bridge components as needed. Additional components of bridges may be needed for actions or for condition data that do not correspond to the eleven components presented in this Guide.

3.2.1.2—Agency-Developed Bridge Elements

Agency-developed bridge elements can be added as needed to the eleven bridge components defined in this Guide or to agency-developed components.

3.2.2—Preservation Activities

Activities identify general kinds of work for bridges. There are eight activities (see Table 3.2.2-1). Each activity includes multiple, related methods and materials.

Limits to the scope of preservation programs are seen in combinations of components and activities.

Some activities are preservation activities in all applications and for all bridge components. Clean, Overlay, Paint, Repair, and Seal are always preservation activities.

Some activities are preservation activities in some applications. *Rehabilitate* is a preservation activity when original capacity of a bridge is restored. *Retrofit* is a preservation activity when the robustness or durability of a bridge is increased.

Some activities are preservation activities for some bridge components only. *Replace* is complete, full replacement. *Replace* is a preservation activity for approach (slab), bearing, channel (protection), drain, joint, or railing.

C3.2.1.1

Bridge Owners might add components for movable bridges, or for other special bridges or components. Bridge Owners might extend preservation programs to other classes of assets, such as tunnels and retaining walls, and add components for these assets. Agency-developed components must be identified either as major components or as other components. Agency-developed components should have associated condition data and preservation actions. Agency-developed components might be used in the selection of preservation candidates. Measures of condition, capacity, robustness, and durability must be stated. Criteria for candidates for bridge preservation must be stated.

C3.2.1.2

Bridge Owners might add elements to the eleven bridge components defined in this Guide, and might add elements for agency-developed bridge components. Agency-developed bridge elements must be identified either as elements of major components or as elements of other components. Agency-developed elements should have associated condition data and preservation actions. Agency-developed elements might be used in the selection of preservation candidates. Criteria for candidates for bridge preservation must be stated.

C3.2.2

Note:

- *Rehabilitate* is not a preservation activity when traffic capacity or load capacity of bridges is increased beyond the original values. *Retrofit* is not a preservation activity when capacity is increased.
- *Replace*, meaning full replacement, is not a preservation activity for complete bridges or culverts, or for major components of bridges. *Replace* is not a preservation activity for *deck*, *superstructure*, *substructure*, *culvert*, or *bridge*.

Bridge Owners will decide on limits, expressed as combinations of components and activities, of preservation programs. For example, bridge Owners may elect to include all bridge rehabilitation projects in the preservation program, or may elect to include deck replacement in the preservation program.