ERRATA

Dear Customer:

Recently, we were made aware of some technical revisions that need to be applied to the *AASHTO Guide to Bridge Preservation Actions*. Please scroll down to see the full erratum.

In the event that you need to download this file again, please download from AASHTO's online bookstore at:

https://downloads.transportation.org/BPA-1-Errata.pdf

Then, please replace the existing pages with the corrected pages to ensure that your edition is both accurate and current.

AASHTO staff sincerely apologizes for any inconvenience to our readers.

AASHTO Publications Staff
October 2022

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List of Errata for *AASHTO Guide to Bridge Preservation Actions* (BPA-1)

Original Page	Section	Existing Text	Corrected Text
2-2	2.3.1.	**2.3.1.1—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. **2.3.1.2—Bridge Robustness** Robustness in a bridge is the absence of vulnerabilities to sudden failure by earthquake, flood, over-load, fatigue, fracture, or security. **2.3.1.3—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.	**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). **2.3.1.2—Bridge Capacity** **2.3.1.3—Bridge Robustness** **2.3.1.4—Bridge Durability**
3-16	C3.4.1	The use of defects defined in MBEI and in Appendix B of the Guide is optional. Action will often be tied to defects in bridge elements. Bridge Owners will choose their method to track defects. *Cost* The primary unit for cost is cost per deck area. This puts costs of all actions into a single unit for combination into overall costs for preservation of bridges. *Context of Use*	The use of defects defined in MBEI and in Appendix B of the Guide is optional. Action will often be tied to defects in bridge elements. Bridge Owners will choose their method to track defects. *Context of Use* The context of use for action lists upper bounds on defect quantity and severity. Criteria are used in this way:

List of Errata for *AASHTO Guide to Bridge Preservation Actions* (BPA-1)

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<tr><th></th><th>Bridge Design LCCA</th><th>Bridge Preservation PCCA</th></tr>
<tr><td>Bridge type, construction materials, align-ment, number of spans, etc.</td><td>Alternatives are compared.</td><td>Alternatives can no longer be changed.</td></tr>
<tr><td>Cost of initial construction</td><td>Included.</td><td>Excluded. Construction is a sunk cost.</td></tr>
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List of Errata for *AASHTO Guide to Bridge Preservation Actions* (BPA-1)

Original Page	Section	Existing Table
A-136	A3-71	**Joint** **MBEI Elements** Replace joints if conditions and quantities conform to the values listed. *Pct of Joint*

Element		Condition State			
		2	3	4	
300	Strip Seal Expansion Joint	No limit	<40%	<20%	<10%
301	Pourable Joint Seal	No limit	<40%	<20%	<10%
302	Compression Joint Seal	No limit	<40%	<20%	<10%
303	Assembly Joint/Seal (Modular)	No limit	<40%	<20%	<10%
304	Open Expansion Joint	No limit	<40%	<20%	<10%
305	Assembly Joint without Seal	No limit	<40%	<20%	<10%
306	Other Joint	No limit	<40%	<20%	<10%

Corrected Table

Joint

MBEI Elements

Replace joints if conditions and quantities conform to the values listed.

Pct of Joint

Element		Condition State			
		1	2	3	4
300	Strip Seal Expansion Joint	No limit	<40%	<20%	<10%
301	Pourable Joint Seal	No limit	<40%	<20%	<10%
302	Compression Joint Seal	No limit	<40%	<20%	<10%
303	Assembly Joint/Seal (Modular)	No limit	<40%	<20%	<10%
304	Open Expansion Joint	No limit	<40%	<20%	<10%
305	Assembly Joint without Seal	No limit	<40%	<20%	<10%
306	Other Joint	No limit	<40%	<20%	<10%

List of Errata for *AASHTO Guide to Bridge Preservation Actions* (BPA-1)

Original Page	Section	Existing Text	Corrected Text
C-3	Appendix C	*Actions for Joint* The bridge has a strip seal expansion joint at one abutment. Preservation actions for the joint are cyclic replacement of the seal plus cyclic replacement of the complete joint.	*Actions for Joint* The bridge has a strip seal expansion joint at one abutment. Preservation actions for the joint are cyclic replacement of the seal plus cyclic replacement of the complete joint. Planning intervals are 10 years to replace joint seals and 20 years to replace joints.

GUIDE TO BRIDGE PRESERVATION ACTIONS

CONTENTS

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).

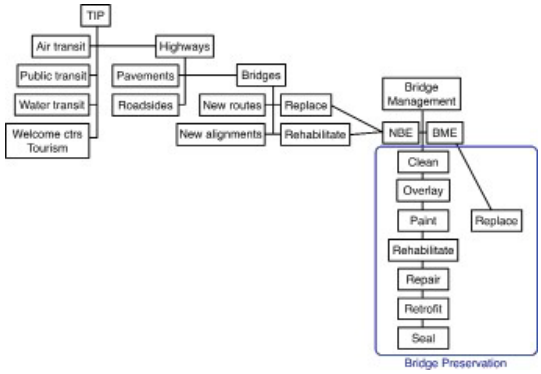

Figure C2-1. Bridge Preservation Program

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.~~1~~2—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.~~2~~3—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.~~3~~4—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.

C2.3.1.~~1~~2—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

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

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

C2.4

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 C3.3.6-2. Preservation Actions—Effect on Defect Reports

Action	Component or Element	Defect Eliminated	Defect Improved[a]
Clean	Bridge	2350 8010, 8020, 8030,8040	
Clean	Channel	8050	
Repair	Major Components	1010, 1020, 1090, 1100, 1120, 1140, 1150, 1180, 1190, 1610, 1620, 1640, 7000	1080, 1110, 1130, 1160, 1170, 1630, 1900, 4000, 6000
Repair, Replace	Other components	1010, 1020, 1090, 1100, 1120, 1140, 1150, 1180, 1190, 1610, 1620, 1640, 7000	1080, 1110, 1130, 1160, 1170, 1630, 1900, 4000, 6000
Repair, Replace	Other components	2210, 2220, 2230, 2240, 2310, 2320, 2330, 2340, 2370 8100, 8210, 8220, 8230, 8240, 8310	2360
Paint	Paint or coating	3410, 3420, 3440, 3510, 3540, 3600	
Overlay	Wearing surface	3220, 3230	3210

[a] Repaired quantities reported in CS 2 after action.

3.3.7—Materials

Typical materials used in actions are listed. References to agency specifications or to qualified product lists (QPL) are included for some actions.

C3.3.7

Bridge Owners that adapt the Guide to their own programs for bridge preservation will list approved materials in this field for each action.

Bridge Owners may elect to use new or experimental materials in preservation programs and to monitor the performance of new materials in service as part of assessment for the QPL. This approach allows early use of innovative materials in preservation.

3.3.8 —References for Preservation Actions

Bridge Owners produce policies on preservation of bridges, and manuals on methods of maintenance and repair of bridges.

C3.3.8

Examples of publications available from bridge Owners include the following (see Section 6):

- Florida DOT, 2011;
- Georgia DOT, 2012;
- Georgia DOT, 2013;
- INDOT, 2013;
- Iowa DOT, 2014;
- New York State DOT, 2006;
- Pennsylvania DOT, 2010; and
- WisDOT, 2016.

3.4—CATALOG OF PRESERVATION ACTIONS

Preservation actions with supporting information are listed in Appendix A. Actions are named using the Component–Activity–Detail system. Information on actions is presented under the headings *Basis*, *Description*, *Procedure*, *Context of Use*, *Effect*, *Materials*, and *References*.

C3.4

The catalog of actions includes preservation actions that are described in DOT manuals or found among DOT maintenance records and project records. Some actions, presented as single actions in the catalog, can include wide ranges of complexity and cost. Actions for bearings and for joints can have much greater or much lesser cost depending on the type and range of motion of the devices.

Most, but not all, (component, activity) pairs are populated in the catalog (see Tables C3.2.3-1 and C3.2.3-2).

3.4.1—Standard Tables for Preservation Actions

Information for preservation actions is presented in standard tables. An example of a standard table, the table for polymer concrete overlay, is shown as Figure 3.4.1-1.

The top row of the table has cells for the name of the action, i.e., Component, Activity, Detail.

The second row of the table lists Basis. Basis reports whether an action is cyclic or condition-driven.

The third row of the table provides a Description of the action.

The fourth row of the table provides a generic Procedure for the action.

The fifth row of the table notes the context of use of use for the action. Context of use is stated in descriptions of the conditions that may exist at bridges. Context of use is also stated in terms of MBEI elements and condition states, and in MBEI element-level defects, condition states, and quantities. For some actions, context is presented as condition states and quantities of Guide-developed defects (GDD) (Table B1-1).

C3.4.1

The use of defects defined in MBEI and in Appendix B of the Guide is optional. Action will often be tied to defects in bridge elements. Bridge Owners will choose their method to track defects.

~~*Cost*~~

~~The primary unit for cost is cost per deck area. This puts costs of all actions into a single unit for combination into overall costs for preservation of bridges.~~

Context of Use

The context of use for action lists upper bounds on defect quantity and severity. Criteria are used in this way:

- At least one defect among the defects listed should have some quantity in CS 2 or higher. This indicates the need for an action.

PCCA and Benefit–Cost Analysis

Benefit–cost analysis (BCA), as described in OMB circular A-94 (U.S. OMB, 1992), is a cost evaluation of alternatives among government programs. For transportation programs, this could be a comparison of projects for different modes of transportation. Costs and benefits can include agency costs, external (user) costs, and intangible costs.

Table C4.4-2. ~~LCCA~~ BCA and PCCA Compared

	~~Bridge Design LCCA~~	~~Bridge Preservation PCCA~~
~~Bridge type, construction materials, alignment, number of spans, etc.~~	~~Alternatives are compared.~~	~~Alternatives can no longer be changed.~~
~~Cost of initial construction~~	~~Included.~~	~~Excluded. Construction is a sunk cost.~~

	Program Selection BCA	Bridge Preservation PCCA
Policy/program alternatives	Considered & compared	Not considered
Costs & benefits	Agency, external, & intangible.	Agency only

4.4.1 —Monetized Benefit of Bridge Preservation

The benefit of bridge preservation is a reduction in the annual cost of bridge service. Benefit is com- puted as

$$Annual\ Benefit = Annual\ Cost_{Basic} - Annual\ Cost_{Preservation} \quad (4.4.1\text{-}1)$$

Where:

$Annual\ Cost_{Basic}$ = Annualized cost of bridge service without preservation. Equal to annualized cost of future replacement of bridge or bridge component after service with no preservation actions.

= Annualized cost of bridge service with preservation. Equal to annualized costs of all preservation actions in a preservation cycle plus cost of future replacement of bridge or bridge component.

Annual Cost$_{Preservation}$

If *Annual Benefit* is positive, preservation is cost-effective. If *Annual Benefit* is negative, preservation is not cost-effective.

4.4.2—Bridge Service Cost without Preservation, *Annual Cost*$_{Basic}$

The annual cost of service of a highway bridge without preservation is the cost to replace the bridge in kind, *Cost*$_{Replace}$, at the end of its service life. Annual cost of bridge service without preservation is

Bridge Service, Basic Cost

$$Annual\ Cost_{Basic} = \frac{rCost_{Replace}}{(1+r)^{T_B}-1} \quad (4.4.2\text{-}1)$$

Where:

Cost$_{Replace}$ = Cost of in-kind replacement of bridge at end of service life, $/Deck SF

T_B = Basic service life. Service life, in years, for bridge without preservation

r = Discount rate

C4.4.2

Bridge Owners will develop and use their own values of *Annual Cost*$_{Basic}$. That is, owners will apply their own costs to replace bridges and their own durations for service life in Eq. 4.4.2-1.

Examples are provided in Table C4.4.2-1. Work in NCHRP project 14-36 (Hearn, 2020) collected costs from bridge Owners for actions to maintain, repair, and replace bridges. Durations of service life for bridges and major components of bridges are estimated by Doolan (2014). These are service life durations without preservation. Values of *Annual Cost*$_{Basic}$ are computed using these costs and durations.

A3-71. Joint Replace *(Continued)*

Joint	Replace	
5. Check the length of the compression seal for fit; miter cut and glue mitered ends together for bends at curbs or raised medians. 6. Apply lubricant adhesive to the faces of the joint. 7. Position seal over joint opening, compress and insert into joint while the adhesive is still wet. Install seal within the joint to the required depth of application, usually $^1/_4$ in. to $^1/_2$ in. below the deck surface. *Strip Seal Joint* 1. Remove existing armor. 2. Remove and replace deteriorated concrete. 3. Install new anchors and new armor. 4. Install new gland seal. Special tools may be needed to place seal into armor. *Modular Joint* 1. Remove existing modular joint. 2. Remove deteriorated concrete and portions of concrete necessary for installation of new modular joint. 3. Place anchors for new joint. 4. Follow manufacturer's instructions to set new joint in place. Pour concrete. 5. Adjust the alignment and spacing of modular joint bars/components. *Sliding Plate Joint and Finger Joint* 1. Remove existing joint and trough. 2. Remove deteriorated concrete. 3. Remove existing anchors for joint. 4. Install anchors, repair reinforcing steel, and pour new concrete. 5. Connect new steel plates to anchors. Install new trough. *Open Joint* 1. Remove armor. 2. Clean joint of any foreign material using compressed air. 3. Remove and replace any deteriorated concrete. 4. For armored joints, install new armor with pour of new concrete. Anchors for armor may be cast-in-place or adhesive anchors in hardened concrete.		
Context of Use Preservation of bridges in fair or good condition by replacing joints in poor condition. Prior to replacement, evaluate and remedy causes of CS 4 defects. Joint allows free flow of water. Joint seal has complete loss of adhesion. Joint seal has punctures or some missing sections. Joint seal has cracks with full penetration. Joint has debris that prevents movement. Joint header is deteriorated. Anchors for joint are loose. Joint has rust or damage that impairs function.		

Continued on next page

A3-71. Joint Replace *(Continued)*

Joint	Replace	

MBEI Elements

Replace joints if conditions and quantities conform to the values listed.

Pct of Joint

Element		Condition State			
		1~~2~~	2~~3~~	3~~4~~	4
300	Strip Seal Expansion Joint	No limit	<40%	<20%	<10%
301	Pourable Joint Seal	No limit	<40%	<20%	<10%
302	Compression Joint Seal	No limit	<40%	<20%	<10%
303	Assembly Joint/Seal (Modular)	No limit	<40%	<20%	<10%
304	Open Expansion Joint	No limit	<40%	<20%	<10%
305	Assembly Joint without Seal	No limit	<40%	<20%	<10%
306	Other Joint	No limit	<40%	<20%	<10%

MBEI Defects

Replace joints if defect conditions and quantities conform to the values listed.

Pct of Join

Defect		Condition State			
		1	2	3	4
2310	Leakage	No limit	<40%	<20%	<10%
2320	Seal Adhesion	No limit	<40%	<20%	<10%
2330	Seal Damage	No limit	<40%	<20%	<10%
2340	Seal Cracking	No limit	<40%	<20%	<10%
2350	Debris Impaction	No limit	<40%	<20%	<10%
2360	Adjacent Deck or Header	No limit	<40%	<20%	<10%
2370	Metal Deterioration or Damage	No limit	<40%	<20%	<10%

Effect on Condition

New joint is in good condition.

MBEI

New joints are in CS 1.

For new joints, all defects have zero quantity.

Materials

Joint armor, seals, and sealing materials as recommended by manufacturer.

References

IA PA55

actions for a prestressed concrete multibeam bridge are listed by component in Table C4-1. The annual cost of bridge preservation is the sum of the costs of preservation actions plus the cost of bridge replacement computed using Eq. 4.4.3-1. Annual costs are computed using an annual discount rate equal to 2.8 percent.

Preservation actions include cleaning, sealing concrete surfaces and polymer concrete overlay for deck, replacing expansion joint seal, and replacing the expansion joint. In addition, costs of recurring minor repairs to deck, superstructure, substructure, and railing are included among preservation costs.

Actions for Approach

Approaches include approach slabs, wearing surfaces, embankments, and protection for embankments. Approach slabs are 90 ft long and 70 ft wide at each end of the bridge.

Cyclic actions for approaches are renewal of asphalt wearing surface on slabs. Condition-driven actions (anticipated) are repair of reinforced concrete approach slabs and repair of slope paving. If wearing surfaces are maintained, slabs will need some repair, but will not be replaced during the preservation cycle. If slope protection is maintained, other repairs to embankments will not be needed during the preservation cycle.

Note: Preservation actions named in the plan are sufficient for approaches that perform well. At some bridges, approaches will settle or will develop voids under slabs. Repairs to fill voids or to mudjack slabs may be needed. These needs will appear at some bridges but not all. Costs for these repairs should be included in network-level budgets for preservation programs, though not in preservation plans for individual bridges. Bridge Owners should examine the performance of bridges in networks to determine the percentage of bridges that develop repair needs for settlement or voids, and then provide a budget for repairs based on this percentage.

Actions for Bearing

The bridge has elastomeric bearings at the central pier and at both abutments. Expansion bearings are located at the pier and at one abutment. Preservation actions are cyclic painting of metal plates for bearings plus condition-driven replacement of expansion bearings. The planning interval is 40 years for replacement of bearings.

Actions for Bridge

Actions for the bridge as a whole are annual cleaning, removal of graffiti every 10 years, and bridge replacement at the end of the preservation cycle.

Actions for Deck

Preservation actions for the deck are cyclic replacement of polymer concrete overlay every 15 years plus condition-driven repair. Repairs to 20 percent of the deck area are anticipated every 24 years. It is anticipated that the deck will not need replacement if the polymer wearing surface is maintained and repairs to the deck are made as needed.

Actions for Drain

Preservation actions for deck drains are cyclic clearing and flushing plus condition-driven repair as needed. Clearing is performed each biennium. The planning interval for repair is 20 years.

Actions for Joint

The bridge has a strip seal expansion joint at one abutment. Preservation actions for the joint are cyclic replacement of the rubber seal plus cyclic replacement of the complete joint. Planning intervals are 10 years to replace joint seals and 20 years to replace joints.

Actions for Railing

The bridge has reinforced concrete railings. Preservation actions for the railings are cyclic sealing of the concrete surface plus condition-driven repair. The planning interval for repair is 20 years.

Actions for Substructure

The bridge has reinforced concrete abutments plus a central reinforced concrete pier. Preservation actions for substructure are cyclic sealing of concrete surface plus as-needed repair. The prescribed interval for sealing is 5 years. The planning interval for repair is 40 years.

Actions for Superstructure

The bridge has prestressed concrete beams. Preservation actions for superstructure are cyclic sealing of concrete surface plus as-needed repair. The prescribed interval for sealing is 5 years. The planning interval for repair is 42 years.

Finding

The annual cost of bridge service with preservation is $3.94/Deck SF. This is less than the basic service cost of $5.21/Deck SF shown in Table C3-1. Preservation of this bridge is cost-effective.

Table C4-1. Preservation Actions and Annual Costs—Prestressed Concrete Multibeam Bridge

Component	Action	Unit Cost, $/ Deck SF	Interval, years	Cost per Action, $	Annual Cost $/Deck SF
Approach	Overlay, Asphalt	7.0	20	136,000	0.27
	Repair Slab	3.5	24	67,900	0.10
	Repair Slope Paving	0.21	20	4,070	0.01
Bearing	Paint	0.85	15	16,500	0.05
	Replace	1.2	40	23,300	0.02
Bridge	Clean	0.05	1	970	0.05
	Clean, Graffiti	1.2	10	23,300	0.11
	Replace	514	100	9,970,000	0.97
Deck	Overlay, Polymer Concrete	15	15	291,000	0.82
	Repair, 20%	9.3	24	180,000	0.28
Drain	Clear	0.44	2	8,540	0.22
	Repair	0.64	20	12,400	0.02
Joint	Replace, Seal, Strip Seal	1.1	10	21,300	0.10
	Replace, Joint, Strip Seal	4.4	20	85,400	0.17
Railing	Repair, Concrete, 20%	5.4	20	105,000	0.21
	Seal, Concrete	0.7	5	13,600	0.13
Substructure	Repair, Concrete	15	40	291,000	0.21
	Seal, Concrete	0.034	5	660	0.01
Superstructure	Repair, PS Beam	8.6	42	167,000	0.11
	Seal, Concrete	0.56	5	10,900	0.11
				$Annual\ Cost_{Preservation}$ =	3.94

C5—PRESERVATION OF A PRESTRESSED CONCRETE MULTIBEAM BRIDGE ALREADY IN SERVICE

A variation of preservation of a prestressed concrete multibeam bridge is considered. A prestressed concrete multibeam bridge has been in service for a period of years without preservation. The preservation plan is then applied to the bridge.