Appendix B Summaries of Information from State DOTs

Alabama Department of Transportation

Policy

The Alabama DOT Maintenance Engineer develops annual maintenance programs for each division and district (2). Maintenance programs specify the types and amounts at maintenance actions for the fiscal year, together with the labor, equipment, and materials needed.

Actions

Alabama DOT lists forty-eight actions as "B" codes used in the Alabama Bridge Information Management System (1). Actions are cleaning, painting, minor repair and major repair. Components are deck, superstructure, substructure, joints, bearings, and culvert.

There are actions for cleaning beam ends and bridge seats, and for removing drift from channels.

Actions for joints are measured in *feet*. Actions for decks are measured in *square feet*. Most other actions are measured in *employee hours*.

The Alabama DOT Maintenance Management System lists six actions for bridges (2) (Table 1). Actions are cleaning, painting, minor repair, major repair, inspection, and other. Bridge painting is measured in liters of paint. Other actions are measured in hours.

Table 1 Alabama DOT. Actions. Alabama Maintenance Management System (2)

Code	Action	Unit
645	BRIDGE CLEANING	hours
646	BRIDGE PAINTING	liters of paint
647	MINOR REPAIRS OF BRIDGES	hours
648	MAJOR REPAIRS OF BRIDGES	hours
649	MOVABLE SPAN OPERATION AND MAINTENANCE	hours
654	OTHER STRUCTURE MAINTENANCE	hours

The Alabama DOT Maintenance Manual requires that routine maintenance on bridges be performed as needed (3). Eleven actions in routine maintenance identified (Table 2).

Table 2 Alabama DOT. Routine Maintenance (3)

Action
Approach leveling
Bearing assembly cleaning, painting and lubrication
Channel stabilization
Deck cleaning
Drainage element cleaning
Drift removal
Fireproofing
Joint cleaning
Joint sealing
Spot painting
Truss joint and chord cleaning

Methods, Procedures

Alabama DOT publishes a collection of maintenance performance guidelines (4). Each guideline lists:

- Activity
- Activity Code
- Effective Date
- Description
- Authorization & Scheduling
- Crew Size, Class
- Equipment
- Materials
- Work Methods and Notes
- Average Daily Production

Guidelines for 77 actions in pavement maintenance and roadside maintenance are available. Guidelines identity actions using 4-digit codes that differ from “B” codes and from codes in the maintenance management system.

Deck Preservation

Alabama DOT standard specifications (5) includes an article for thin epoxy overlay (Section 490).

Alabama DOT inspection manual (6) has additional items related to bridge decks.

- ITEM 257—REASON POSTED can note deck as an element that controls the load rating. The deck may be under-designed or may be fire-damaged.
- ITEM 262—TYPE OF TEMPORARY STRENGTHENING can note that decks have been strengthened to increase load carrying capacity.

Alaska Department of Transportation and Public Facilities

Performance Measures

Alaska DOT&PF's performance dashboard reports aggregate deck area of structurally deficient and functionally obsolete bridges (7). Alaska seeks to decrease the percentage in annual change of SD and FO deck area.

Actions

Alaska DTO&PF's relates years in service and general condition to actions in preservation, rehabilitation and replacement of bridges (Table 3).

Table 3 Alaska DOT&PF Age, Conditions and Actions (8)

Bridge	Life stage	Year	Estimated NBI
Concrete	New bridge constructed	0	9
	Bridge preservation (i.e. Deck repair)	10 - 15	5
	Deck rehabilitation	25	4
	Rehabilitate bridge sub or superstructure	40+	3
	Replace bridge	75	2
Steel	New bridge constructed	0	9
	Bridge preservation (i.e. Deck repair)	10	5
	Deck rehabilitation	20	4
	Rehabilitate bridge sub or superstructure	30+	3
	Replace bridge	75	2
Timber	New bridge constructed	0	9
	Bridge preservation (i.e. Deck repair)	8 - 10	5
	Deck rehabilitation	20	4
	Rehabilitate bridge sub or superstructure	40+	3
	Replace bridge	60	2

Deck Preservation

Alaska DOT&PF's transportation asset management plan (8) includes actions to seal bridge decks that are in good or fair condition. Work is performed using funds dedicated to preventive maintenance of highway bridges.

Arkansas Highway Transportation Dept.

Preservation, Historic

The search for “preservation + bridge” leads to policies on historic preservation; methods to identify historically significant bridges, information on how to preserve the historical significant features of bridges, and policies on how to dispose of bridges if continued use as highway bridges is not desired.

Arkansas HTD in (9) reviewed all bridges built before 1941 and selected a set of bridges that were eligible for the National Register of Historic Places.

Arkansas has an AHTD Environmental division that identifies historically significant bridges.

Deck Preservation

In HTD standard specifications (10), Arkansas provides an item for surface treatments of concrete, *Section 803 Protective Surface Treatment for Concrete*. Bridge decks may be treated with linseed oil, siloxane sealer or methyl methacrylate.

In HTD standard specifications (10), Arkansas provides an item for overlay of existing bridge decks with 1.75" of Portland cement concrete.

California Department of Transportation

Definitions

Maintenance.

California DOT defines maintenance as repair of minor defects (11); work that has little or no risk of structural collapse and no risk of damage to adjacent members.

Preventive Maintenance.

California DOT (11) defines preventive maintenance as actions that prevent conditions that could lead to minor defects or major defects.

Bridge Maintenance.

California DOT's Maintenance Manual in Chapter H lists actions in bridge maintenance (Table 4) (11). These include:

Table 4 California DOT. Bridge Maintenance Actions (11)

Action
Repair damage or deterioration in various bridge components
Remove debris and drift from piers
Perform minor scour repairs
Clean and repair bridge bearing seats, abutments, etc.
Clean out drains
Repair expansion joints
Clean and paint structural steel
Seal concrete surfaces
Maintain electrical and mechanical equipment on moveable span bridges
Operate moveable spans

California DOT lists a set of repairs to minor defects that are included in maintenance (Table 5) (11).

Table 5 California DOT. Maintenance Repairs (11)

Repair to …
Damaged or misplaced clearance markers
Damaged or missing advisory and warning signs
Scaled or deteriorated paint on timber railings and curbs
Damaged or deteriorated railings and curbs
Uneven or cracked approach and deck surfacing
Broken or loose timber decking
Joint Seals
Accumulated drift adjacent to bents and piers; Minor erosions
Accumulated dirt or debris on decks, near stringer ends at supports, adjacent to bearings, and on chords of trusses
Plugged drains
Settlement or roughness of approach
Fire hazards
Faulty electrical contacts

Repairs to major defects require engineering input (Table 6) (11).

Table 6 California DOT. Major Defects (11)

Major Defect
Bent or damaged steel beams, girders, or truss members
Cracked or spalled concrete members, other than curb and railing
Crushed or decayed timber stringers, caps, posts or piles
Broken or weakened chord members of failed truss joints
Unusual looseness or vibration of truss members
Loosened or decayed timber deck over an extended area
Defective bearings
Joint Seal Assemblies
Settled bents or piers
Major erosion or scour
Lack of paint on steel members, other than curb and railing
Extensive fire damage
Poor alignment or balance of movable bridge spans
Excessive noise or vibration from operating machinery
Lack of lubricant in machinery bearings
Loose bolts
Broken timber stringers
Ineffective supplemental bents

Actions. Performed by DOT Crews.

Bridge maintenance crews of California DOT districts perform (Table 7) (11).

Table 7 California DOT. Maintenance by DOT Crews (11)

Action
Spall repair
Pourable joint replacement
Painting

Performance Measures

California DOT reports performance measures for bridges (12). These include the number and percentage of distressed bridges. Distressed bridges have seismic vulnerability or scour vulnerability or other identified rehabilitation needs. California DOT reports network average bridge health index, and the percentage of bridges that are structurally deficient or functionally obsolete.

California DOT also reports the National Performance Management Measures required by Federal regulation (13). These are the percentage deck area of bridges in good condition and percentage deck area of bridges in poor condition.

California DOT reports the performance of culverts using a five-valued letter scale (Table 8) (14). Performance of culverts is assessed based on needs of culverts for maintenance, rehabilitation, or replacement.

Table 8 California DOT. Performance Measure for Culverts (14)

Grade	Performance
A	Like New Condition
B	No Attention Needed (Good)
C	Needing Maintenance Preventative in Nature (Fair)
D	Needing Maintenance Major Rehabilitation/Replacement (poor)
E	Needing Immediate Attention

Deck Preservation

California DOT funds a program for preventive maintenance for bridges owned by local government agencies (15). The program funds projects for deck surface sealing and deck overlays. If an asphalt overlay is used, a waterproofing membrane must be installed.

Colorado Department of Transportation

Policy.

Bridge Program.

Colorado DOT in year 2009 established a dedicated program, called the *Colorado Bridge Enterprise*, to replace or reconstruct bridges that are structurally deficient or functionally obsolete (16). The program is supported by surcharges applied to motor vehicle registrations.

Colorado DOT has a *Responsible Acceleration of Maintenance and Partnerships* (RAMP) preventive maintenance program (17)(18). RAMP is available to non-Enterprise bridges and provides funds for actions that are selected according to an asset management model or plan.

Asset Management.

Colorado DOT is developing a risk-based asset management plan for all DOT assets, including bridges (18). The plan will use a risk-based/lowest life-cycle cost approach.

Actions

Actions funded by Colorado DOT's RAMP (Table 9) (18) include:

Table 9 Colorado DOT. Preventive Maintenance Actions (18)

Action
Repair or replace bridge expansion joints identified as leaking
Install waterproofing membrane on decks that are have an asphalt overlay, but no waterproofing membrane
Seal bare concrete decks

Costs of Actions

In a year 2012 study, Colorado DOT published costs of actions for bridge management (20). Actions and unit costs are listed in Table 10.

Table 10 Colorado DOT. Costs of Bridge Management Actions Year 2009 (20)

Category	Part	Action	Unit cost
Replace	Deck	Replace Concrete	149.03/SY
Replace	Deck	Replace Asphalt Surface	118.61/SY
Retrofit	Deck	Deicing System	285282 LS
Overlay	Deck	Concrete, Asphalt Surface	10.1/SY
Overlay	Deck	Concrete, Asphalt Surface w/ Planing	11.18/SY
Overlay	Deck	Concrete, Asphalt Surface w/ Membrane	27.66/SY
Overlay	Deck	Concrete, Asphalt Surface w/ Planing w/ Membrane	28.80/SY
Overlay	Deck	Asphalt Surface w/ Planing	13.71/SY
Overlay	Deck	Ultrathin w/ Planing	10.33/SY
Overlay	Deck	Concrete surface	43.20/SY
Overlay	Deck	Concrete HT	21.92/SY
Overlay	Deck	Concrete DT	64.67/SY
Overlay	Deck	Concrete w/ Planing	24.42/SY
Repair	Deck	Asphalt Surface, w/ Planing w/ Membrane	24.25/SY
Repair	Deck	Asphalt Surface, Partial Depth	100.83/SY
Repair	Deck	Concrete, Partial Depth	166.02/SY

Category	Part	Action	Unit cost
Repair	Deck	Asphalt Surface, w/Overlay	393.26/SY
Repair	Deck	Concrete, Class 1	52.37/SY
Repair	Deck	Concrete, Class 1, HBP Patch	104.79/SY
Repair	Deck	Concrete, Class 1, HBP Patch + Membrane	118.34/SY
Repair	Deck	Concrete, Class 2	189.69/SY
Repair	Deck	Concrete, Class 2, HBP Patch	242.11/SY
Repair	Deck	Concrete, Class 2, HBP Patch + Membrane	255.66/SY
Repair	Deck	Concrete, Class 3	277.39/SY
Repair	Deck	Concrete, Class 3, HBP Patch	329.81/SY
Repair	Deck	Concrete, Class 3, HBP Patch + Membrane	343.36/SY
Replace	Approach	Concrete	53.19/SY
Replace	Approach	Concrete w/ Remove	72.63/SY
Replace	Approach	Prestressed Concrete	380.85/SY
Replace	Joint	2 IN	128.91/LF
Replace	Joint	2 IN w/ Remove	184.60/LF
Replace	Joint	4 IN	183.11/LF
Replace	Joint	4 IN w/ Remove	282.06/LF
Replace	Joint	6 IN	765.06/LF
Replace	Joint	9 IN	1083.07/LF
Replace	Joint	9 IN w/ Remove	2416.23/LF
Replace	Joint	12 IN	2024.90/LF
Replace	Joint	12 IN w/ Remove	1761.69/LF
Replace	Joint	15 IN	2450.17/LF
Replace	Joint	15 IN w/ Remove	3015.12/LF
Replace	Joint	18 IN	4682.71/LF
Replace	Railing	Concrete Furnish	79.74/LF
Replace	Railing	Concrete Furnish w/ Remove	148.89/LF
Replace	Railing	Metal Furnish	120.50/LF
Replace	Railing	Metal Furnish w/ Remove	121.76/LF
Replace	Railing	Steel Furnish	155.05/LF
Replace	Railing	Other Furnish	267.31/LF
Replace	Railing	Other Furnish w/ Remove	283.60/LF
Replace	Railing	Concrete Ty 4	69.04/LF
Replace	Railing	Concrete Ty 4 w/ Remove	103.15/LF
Replace	Railing	Concrete Ty 4 spec	81.03/LF
Replace	Railing	Concrete Ty 4 spec w/ Remove	285.47/LF
Replace	Railing	Concrete Ty 7	73.94/LF
Replace	Railing	Concrete Ty 7 w/ Remove	112.34/LF
Replace	Railing	Concrete Ty 7 - 42in	93.94/LF
Replace	Railing	Concrete Ty 7 Sect a	96.53/LF
Replace	Railing	Concrete Ty 7 spec	93.11/LF
Replace	Railing	Concrete Ty 7 spec w/ Remove	121.23/LF
Replace	Railing	Concrete Ty 7R w/ Remove	161.94/LF
Replace	Railing	Concrete Ty 7R Spec w/ Remove	248.60/LF
Replace	Railing	Concrete	276.54/LF
Replace	Railing	Metal 10H	196.13/LF
Replace	Railing	Metal 10H w/ Remove	165.34/LF
Replace	Railing	Metal 10H spec	230.42/LF
Replace	Railing	Metal 10M	123.51/LF

Category	Part	Action	Unit cost
Replace	Railing	Metal 10M w/ Remove	108.43/LF
Replace	Railing	Metal 10M Spec	158.88/LF
Replace	Railing	Metal 10M Spec w/ Remove	204.88/LF
Replace	Railing	Metal 10R	132.37/LF
Replace	Railing	Metal 10R w/ Remove	117.61/LF
Replace	Railing	Metal 10R spec	137.18/LF
Replace	Railing	Metal 10R spec w/ Remove	244.42/LF
Replace	Railing	Metal 3R	142.11/LF
Replace	Railing	Metal 3R w/ Remove	94.85/LF
Replace	Railing	Metal 3R spec	67.00/LF
Replace	Railing	Metal 3R spec w/ Remove	100.96/LF
Replace	Railing	Metal Ty 10	98.73/LF
Replace	Railing	Metal Ty 10 w/ Remove	135.23/LF
Replace	Railing	Metal Ty 10 spec	122.16/LF
Replace	Railing	Metal Ty 3	122.68/LF
Replace	Railing	Metal Ty 3 w/ Remove	26.89/LF
Replace	Railing	Metal Ty 3 spec	79.87/LF
Replace	Railing	Metal Ty 8	122.65/LF
Replace	Railing	Metal Ty 8 spec	28.46/LF
Replace	Railing	Metal	116.27/LF
Replace	Railing	Other	267.31/LF
Replace	Railing	Steel Pedestrian	131.41/LF
Replace	Railing	Steel	209.54/LF
Replace	Bearing	Bearing	877.13 EA
Replace	Bearing	Bearing Type I	1029.24 EA
Replace	Bearing	Bearing Type II	1462.74 EA
Replace	Bearing	Bearing Type II - Expansion	2083.32 EA
Replace	Bearing	Bearing Type III	10927.13 EA
Replace	Super	PS Box 1700	322.92 /LF
Replace	Super	PS Box 1725	322.92/LF
Replace	Super	PS BT 1070	172.46/LF
Replace	Super	PS BT 1600	193.25/LF
Replace	Super	PS BT 1830	211.68/LF
Replace	Super	PS BT 2130	299.93/LF
Replace	Super	PS BT 42	182.16/LF
Replace	Super	PS BT 54	214.12/LF
Replace	Super	PS BT 63	191.88/LF
Replace	Super	PS BT 72	219.45/LF
Replace	Super	PS BT 84	191.40/LF
Replace	Super	PS G54	164.62/LF
Replace	Super	PS spec	223.93/LF
Replace	Super	PS U Girder	618.77/LF
Replace	Culvert	Reinf. Concrete	1490/ft

Performance Measures

Colorado DOT reports a level-of-service grade for bridge maintenance, deck area of structurally deficient bridges reported as separate values for state-owned bridges and for bridges on the national highway

system, and an on-schedule index for Enterprise projects (19). Level of service grades for bridge maintenance tracks the timely completion of actions to (19):

- Repair deck bearings
- Paint and wash bridges
- Repair bridge-deck expansion devices

The index for Enterprise projects is the ratio of planned schedule to actual schedule (19). Lagging projects have index less than 1; early projects have index greater than 1. The average among all projects is the performance index.

Deck Preservation

Colorado DOT uses polyester concrete overlays for bridge decks (21).

Colorado DOT has a standard item for installation of waterproofing membranes on bridge decks (22). Membranes may be preformed, or may be single-component, hot-applied elastomeric membrane.

Connecticut Department of Transportation

Actions

Connecticut DOT lists twenty-one actions in bridge preventive maintenance (Table 11)(23).

Table 11 Connecticut DOT. Preventive Maintenance Actions (23)

Action	
Deck Drains	Clean, include scuppers and weeps
	Repair/Rehab/Replace to improve flow
Painting	Local Painting of beam ends and cap girders
	Full painting
Bearings	Replace bronze/sliding bearings with elastomeric bearings
Joints	Repair/Rehab/Replace joints
Bridge Cleaning	
Steel	Repair superstructure
	Repair substructure
Concrete	Repair superstructure
	Repair substructure
	Apply protective coatings
Deck	Repair deck
	Repair/replace membrane and wearing surface
Scour	Install scour countermeasures
Timber	Repair deck
	Repair superstructure
	Repair substructure
Fence & Rail	Repair bridge rail
	Upgrade bridge rail
	Safety enhancements

Performance Measures

Connecticut reports the percentage of bridges that are in a state of good repair (23).

Connecticut reports the number of completed work items in bridge maintenance. These are tracked as bridge maintenance memoranda; memoranda that are generated by inspectors during safety inspections (24). The number of memoranda, the number of completed memoranda and the backlog of uncompleted memoranda are all reported. Bridge maintenance memos are for work items in addition to ongoing preventive maintenance.

Deck Preservation

Connecticut DOT has specifications for waterproofing membranes that are torch-applied sheet membranes (26), cold-applied liquid membranes (27), or woven glass-fiber membranes.

Delaware Department of Transportation

Policy

Delaware has a Capital Transportation Program that includes funding for bridge preservation (29). Preservation actions are applied to bridges not considered in the prioritization process for Delaware's STIP.

Actions.

Contract Maintenance.

Maintenance projects include repairs to cracks and spalls in concrete, and improvements to drainage (31). Delaware's Bridge Preservation Program funds projects for bridge painting, bridge scour, bridge deck preservation, and underwater bridge repairs (32). Actions are listed in (Table 12) (31) (32).

Table 12 Delaware DOT. Bridge Preservation Actions (31) (32)

Action
Repair cracks in concrete
Repair spalls in concrete
Improve drainage
Bridge painting
Bridge scour
Deck preservation
Underwater bridge repairs

Bridge Projects

Delaware DOT uses bridge projects to deliver actions in maintenance of bridges (Table 13) (31).

Table 13 Delaware DOT. Actions in Bridge Projects (31)

Action
Spot painting of steel girders
Clean and paint of steel girders
Repair of cracks and spalls in concrete deck and barriers
Install polyester polymer concrete overlay
Replace joint strip seals
Repair joints
Replace joints and concrete barriers
Clean, paint, and grease bearings
Repair concrete spalls and cracks in abutments and piers
Approach roadway patches
Approach roadway guardrail upgrades
Approach roadway drainage structure improvements

Data System

Delaware's maintenance management system, Maximo, links actions and priorities (Table 14) (30). Actions are coded in Delaware's bridge management system and also as a set of function codes.

Table 14 Delaware Maintenance Actions and Priorities (30)

Maximo Priority 3 Maintenance	**BMS code**	**Function Code**
Removal of vegetation and debris	B055-VIA	11105.5
Repair of erosion and placement of erosion control measures	B054-S6D	11105.4
Maximo Priority 2 Maintenance	**BMS code**	**Function Code**
Repair of deck, slab and approach slab spalls	B025-P1A or B022-S1D	11102.5
Repair of AC overlay. Repair of hot mix over culvert	B022-S1D	11102.2
Place hot mix to offset settlement at ends of bridges		
Clean out scuppers or drains	B0002-S1G	11100.2
Maximo Priority 1 Maintenance	**BMS code**	**Function Code**
Clean/clear weepholes in PS concrete box beams		11107.1
Clean/flush bearings, bearing seat	B003-S2J	11100.3
Apply protective coating - deck	B060-A1C	11106.0
Seal joints in concrte slope paving, or at abutment or wingwall	B007-S1H	11100.7

Deck Preservation

Delaware DOT has agency-develop elements for wearing surfaces Table 15 (33).

Delaware DOT standard specifications (34) include an item for deck sealers and waterproofing membranes (Section 613). Deck sealers include epoxy, silicone-urethane, silane, and methyl methacrylate.

Table 15 Delaware DOT Agency-Defined Elements for Wearing Surfaces (33)

			Defects
801	A/C Overlay Surface (FT2)	This element defines only those A/C overlays that exist directly on reinforced concrete frame or box culverts. Element 811 shall be used for asphalt on beams, deck or slabs.	3210 3220 3230
810	Wearing Surface: Thin Overlay (FT2)	This element defines those concrete bridge deck overlays that are <1” in thickness.	3210 3220 3230
811	Wearing Surface: Asphaltic Concrete Overlay (FT2)	This element defines those concrete or timber deck or slabs with an asphaltic concrete overlay.	3210 3220 3230
812	Wearing Surface: Timber Planking (FT2)	This element defines only those bridge decks with a timber planking wearing surface.	3210 3220 3230
839	Soffit (or under surface) of Concrete Deck or Slab (EA)	This condition state language addresses deck distresses through visual inspection of the deck soffit (undersurface). It is extremely valuable when the top surface of the deck is covered with an overlay. Should be used for overhang sections when stay-in-place forms are present.	

Florida Department of Transportation

Policy. Priority.

Florida DOT assigns priorities at four levels for repair needs (Table 16) (35). Significant needs are priority 1. Routine maintenance is priority 3 or 4.

Table 16 Florida DOT. Priorities for Repair Needs (35)

Priority	Repair to …
1	Critical damage to main structural members which endangers public safety. Cracks in fracture critical members. Unstable Foundations. Vertical or horizontal displacement of the structure which endangers structural stability. Loose expansion joints which may damage passing vehicles. Serious mechanical, electrical, or hydraulic problems which have or will stop the operation of a movable span or safety equipment.
2	Crutch bent or beam saddle installations. Serious damage to handrail, guardrail, attenuators, or parapets. Leveling of approach slabs to reduce impact loading on the structure. Repair of structural members whose structural capacity is reduced. Bank and slope protection repair needed to correct moderate scour damage. Mechanical, electrical or hydraulic problems which will affect the operation of a movable span or safety equipment, if allowed to continue to deteriorate. Regulatory or warning signs missing or worn.
3	Repairs of delaminated, spalled or cracked concrete to prevent additional deterioration. Spot painting steel members. Channel maintenance done before significant scour has occurred. Cleaning drainage systems, bearing areas, etc. Sealing expansion joints.
4	Lane lines and markings are worn. Guardrail attachment to the structure is functional but not the latest standard. Bridge deck needs sweeping. Highway lighting systems on the structure with lighting outages. Informational signs are worn or missing.

Policy. Inspection.

Bridge inspectors for Florida DOT report critical deficiencies and non-critical deficiencies in safety inspections (35). Florida DOT advises inspectors that by correcting non-critical deficiencies, the structure's service life is lengthened, total maintenance costs are reduced, and the public receives a better return on their investment.

Florida DOT uses four levels of priority for work orders for maintenance and repair (Table 17).

Table 17 Florida DOT. Priorities for Work Orders (35)

Priority	Description	Requirement
Priority 1	Repair critical damage	Complete within 60 days
Priority 2	Protect integrity of structure	Complete within 180 days
Priority 3	Prevent additional deterioration	Complete within 1 year
Priority 4	Superficial maintenance	No time limit

Florida's bridge repair and replacement program funds projects to replace expansion joints.

Actions

Among BMS codes for type of work, Florida DOT includes one code for preventive maintenance and one code for periodic maintenance (Table 19) (36). Actions in maintenance include (Table 18).

Table 18 Florida DOT. Bridge Maintenance Actions (36)

Action
Minor repairs
Cleaning and lubrication
Painting
Penetrant sealer work
Cathodic protection work
Removing organic materials on structures
Cutting brush

Table 19 Florida DOT. BMS Codes for Type of Work (36)

Code	Description
38	Other repair work. Includes all minor repairs, periodic maintenance action categories.
39	Preventive maintenance work (cleaning and lubrication, painting, penetrant sealer work, cathodic protection work, removing organic materials on structures, cutting brush, etc.) Includes all routine maintenance action categories.

Methods, Procedures

Florida DOT publishes guidance to selection and execution of 110 actions for bridges (Table 20) (37). Actions are grouped by component of bridge.

Table 20 Florida DOT. Methods (37)

Component	Action
Deck expansion joint	Clean
Concrete decks	Deck sealing
	Deck patching
	Type A Patch: above the top mat or rebars
	Type B Patch: 1 inch below the top mat of rebars
	Type C Patch: full deck depth
	Crack sealing
	Small cracks - liquid sealers
	Dormant cracks - pressure injection
	Working Cracks - Joint sealer overlays
	Cementitious overlays
	Bituminous concrete with waterproof membrane
	Polymer overlays
Steel grid deck	Replace damaged grid plates
Timber deck	Replace deck
Approach slab	Wedge overlay

Component	Action
	Overlay
	Replace
	Mudjack
Drainage system	Clean
	Drain extensions
Concrete railing	Seal surface
	Seal cracks
	Patch spalls
Steel pipe and tubular railing	Paint
Aluminum railing	Electrical isolation at contact with concrete or other metals
Superstructure	Clean
	Spot paint
Bearings	Clean
	Spot paint
	Resetting
Concrete beam & girder	Epoxy injection
	Penetrant sealer
	Drypacking
	Shear crack stitching
	Post-tension
	Spall repair
	Tendon splice
Steel beam & girder	Clean
	Spot paint
	Corrosion repair (splice new section)
	Repair crack
	Strengthen
	Replace
Timber beam	Crack & split repair
	Replace
Trusses	Replace tension members
	Replace compression members
	Repair damaged truss members
	Modify portal bracing
Substructure	Cleaning
	Impact damage
	Cathodic protection
	Repair concrete pile
	Repair concrete cap
	Repair steel pile
Pile jackets	Reinforced concrete pile jacket
	Fiberglass pile jackets
	Corrugated metal pipe pile jacket
	Fabric pile jacket
	Sacrificial cathodic protection pile jacket
	Impressed current cathodic protection
	Pile jacket
Timber pile repairs	Replace timber pile
	Splice timber pile

Component	Action
	Sway brace timber pile
	Shim timber piles
	Replace damaged or decayed timber piles
Timber cap repairs	Replace timber cap
	Timber cap scabs
	Strengthen existing cap
Abutment repairs	Repair Abutment face
	Repair backwall
Wingwall repairs	Repair concrete wingwall
	Extend using gabions
	Stabilize using gabions
Reinforced earth wall repairs	Replace panel(s)
Pier repairs	Repair deteriorated concrete
	Repair Cracked Piers
	Vee Crack Repair
	Post Tensioning Cracked Hammerhead Piers
Underwater repairs	Pressure injection of cracks underwater
	Concrete Repair Underwater
Scour protection	Slope Protection
	Rock Riprap
	Wire Enclosed Riprap
	Planted Vegetation
	Concrete Block Matting
	Grout Filled Bags
	Tetrapods
	Concrete Pavement
	Grouted Rock Riprap
	Sacked Concrete
	Concrete-Filled Fabric Mats
	K. Bulkheads
	Flow Control Measures
	Spurs
	Retards
	Dikes
	Spur dikes
	Jack fields
	Check dams
	Undermining Repairs
	Riprap
	Concrete
Dolphins & fender systems	Maintenance
Seawalls	Stop seawall movement by tie-back system
	Stop seawall movement by changing soil loading
	Repair damaged seawall by new tie-back wall
	Repair seawall by patching and pressure grouting

Performance Measures

Florida sets targets for percentage of bridges in good condition and for percentage of bridges that meet Florida DOT standards (38). Bridges are in good condition if NBI general condition ratings are 6 or higher.

Bridges meet Florida DOT standards if bridges are in good or excellent condition and are not weight restricted.

Deck Preservation

Florida DOT publishes procedures for deck sealing, crack sealing and deck patching in its bridge maintenance and repair handbook (40). Materials for deck patching include epoxy mortar, and asphalt.

Florida DOT publishes procedures for overlays for decks using Portland cement concrete, latex-modified concrete, silica fume concrete, fiber-reinforced concrete, and epoxy polymer (40).

Florida DOT publishes procedures for repair of steel grid deck and timber deck (40).

Florida has an item for bridge deck maintenance and repair (item 806) in its maintenance cost handbook (39).

Florida DOT standard specifications (41) include items for crack repair by injection (Section 411), and surface sealing (Section 413)

Florida DOT's list of approved products includes:

Patch materials - Very Rapid Hardening

Lambert Corp	Lambco R3 Repair Mortar
Phoscrete Corporation	Phoscrete HC
QUIKRETE	Quikrete Commercial Grade FastSet DOT Mix
Sika	Sika Quick 2500
Euclid Chemical	Speedcrete 2028
Five Star Products	Structural Concrete
Euclid Chemical	Versaspeed

Patch materials - Rapid Hardening

A W Cook Cement Products	Cemtec FD Rapid Cure Standard
Euclid Chemical	EUCO REPAIR SCC
Euclid Chemical	Eucocrete
Euclid Chemical	Eucocrete Supreme
Euclid Chemical	Express Repair
BASF	MasterEmaco T 1060
BASF	MasterEmaco T 1061
BASF	MasterEmaco T1060 EX
BASF	MasterEmaco T1061 EX
MAPEI	Planitop 18
MAPEI	Planitop 18 TG
Sika	Sikacrete 321 FS
Sika	SikaQuick 1000
United States Gypsum	USG EcoFix "Rapid Repair Patch"
United States Gypsum	USG EcoFix AG 5000
Euclid Chemical	Versaspeed 100
Euclid Chemical	Versaspeed LS 100

Surface sealing

Pilgrim Permocoat Inc.	Sealate T70
KwikBond Polymers	KBP 204 HMWM Sealer

Georgia Department of Transportation

Policy. Priority.

Georgia DOT provides guidance on plans for maintenance of bridges (50). Preventive maintenance is identified as *cyclical* PM activities or as *condition* PM activities. The maintenance plan links level of maintenance to importance of bridges. Bridge importance is *Critical*, *Essential*, or *Other*. For *Critical* bridges and *Essential* bridges, bridge elements must be maintained in condition state (CS) 1 or 2, with upper bounds on element quantities in CS 2 (Table 21). *Other* bridges can have elements in CS 3 up to a limit on element quantity.

Table 21 Georgia DOT. Tolerable Condition of Bridge Elements (50)

Bridge Importance	Tolerable Condition
Critical	< 25% in Condition State (CS) 2
Essential	< 75% in CS 2
Other	< 50% in CS 3

Policy. End of Useful Life.

Georgia DOT's maintenance plan includes criteria for end of useful life of a bridge (Table 22) (50). Poor condition, limited capacity for live load, or (existing) decision to replace a bridge are among the criteria. Bridge age greater than 50 years is also a criteria for end of useful life.

Table 22 Georgia DOT. End of Useful Life (50)

Criteria
Cost of maintenance and/or rehabilitation versus the cost of a replacement structure
Structure is in the current STIP for replacement
Structure is posted
Structure is structurally deficient
Any NBE Element is coded with 30% of the element in Condition State 4.
A majority of condition states of the bridge structure are listed as poor or severe
Age of the structure is greater than 50 years
Design of the structure is less than HS-20

For bridges at the end of useful life, only essential maintenance is performed. Essential maintenance is removal of debris, maintenance of deck drains and emergency repairs.

Policy. Selection of Actions.

Georgia DOT provides guidance selection of actions in maintenance and repair in relation to element-level conditions of bridges (Table 23) (50)

Table 23 Georgia DOT. Condition Maintenance (50)

Action			Condition State 2	Condition State 3
Clean and reseal deck joints				
	For concrete beams	Joint element	≥ 50%	> 0%
				> 10%
	For steel beams	Joint element	≥ 5%	
Install Deck Overlays				
		Deck element	> 50%	
		Wearing surface	≥ 50%	
Replace edge beams				
		Beam element	≥ 50%	
Repair expansion joint				
	Metal joint	Joint element	≥ 50%	
	Non-metal joint	Joint element	> 50%	> 10%
Patch spalls				
		Deck element	≥ 20%	
Paint Structural Steel				
	Full Painting			
	Above Fall Line	Coating element		≥ 20%
	Below Fall Line	Coating element		≥ 35%
	Zone Painting	Coating element	≥ 50%	≥ 10%
Pressure wash / Paint				
	Concrete members	Coating element		≥ 35%
Install Scour Countermeasures				
		NBI Item 113	1, 2, 3 or U	
		Scour defect flag	Applied	
Fracture Critical retrofit				
			Evaluate remaining service life	
Re-apply deck overlay				
		Previous overlay	CS 4 ≥ 10%	
Hydro-demolition of deck				
		Deck element	CS 3 ≥ 35%	
Full deck replacement				
		Deck element	CS 4 ≥ 20%	

Actions

Georgia DOT's manual for structure maintenance and rehabilitation (47) lists actions in bridge maintenance and repair, describes methods for actions, lists qualified materials, provides engineering details, and includes before/after photographs of repaired bridge elements.

Preventive maintenance actions in the manual are (Table 24).

Table 24 Georgia DOT. Preventive Maintenance Actions (47)

Action
Clean Deck and Gutters
Clean Deck Drains and Scuppers
Clean Expansion Joints
Sealing Deck
Clean Abutment/Caps

Redress Rip Rap
Brush/Tree Removal
Debris Removal
Maintain Spillways

Routine maintenance can be scheduled maintenance or response maintenance (Table 25) (47).

Table 25 Georgia DOT. Scheduled Maintenance, Response Maintenance (47)

Scheduled Maintenance	Response Maintenance
Cleaning decks, seats, caps, and salt splash zones Cleaning bridge drainage systems Cleaning joints Sealing concrete decks or substructure elements	Painting structural steel members Removing debris from waterway channels Removing brush Maintain spillways in approach slab adjacent to the bridge Replacing joints

Intervals for Maintenance Actions

Georgia's manual for structure maintenance and rehabilitation lists intervals for maintenance actions (Table 26) (47).

Table 26 Georgia DOT. Intervals for Preventive Maintenance (47)

Task	Frequency
Deck	
Clean Deck and Gutters	2 Years
Clean Deck Drains/Scuppers	2 Years
Clean Joints	Yearly
Seal Deck	6 Years
Superstructure	
Spot Paint Steel Members	As Needed
Substructure	
Clean Abutments/Caps	As Needed
Redress Rip Rap	As Needed
Site	
Remove Brush	Yearly
Remove Debris from Channel	As Needed
Maintain Spillway	As Needed

Georgia DOT's maintenance plan lists intervals to perform cyclic maintenance activities or to evaluate the need for maintenance activities (Table 27) (50). Intervals for actions can depend on bridge type, on geographic location within Georgia, and on volume of truck traffic.

Table 27 Georgia DOT. Intervals for Cyclic Maintenance (50)

Action			Interval
Evaluate Need for Action			
Pressure wash			6 years
Repair metal expansion joint		ADTT < 8%	30 years
		ADTT > 8%	20 years
Replace expansion joints		ADTT < 8%	15 years
		ADTT > 8%	10 years
Paint structural steel			
	Above the Fall Line and in counties adjacent to the coast	continuous steel unit	20 years
		simple spans	25 years
	Below the Fall Line	continuous steel unit	30 years
		simple spans	35 years
Deck maintenance			
	Sealant after bridge deck is poured	evaluate	1 year
	First polymer overlay, after sealant	ADTT < 8%	10 years
		ADTT > 8%	5 years
	Second polymer overlay, after first polymer overlay	ADTT < 8%	25 years
		ADTT > 8%	15 years
	Modified latex overlay, after second polymer overlay	ADTT < 8%	25 years
		ADTT > 8%	15 years
Perform Action			
Deck and joints – cleaning and washing, at end of snow / ice season if exposed			Each year
Clean joints			1 year
Clean deck			2 years
Clean deck drains			1 year
Pressure wash and paint			
	Bridges above Fall Line		10 years
	Bridges below Fall Line		15 years

ID Codes for Actions

Georgia's manual for structure maintenance and rehabilitation lists IDs for 45 actions in bridge maintenance and repair. The manual presents methods for actions (Table 28) (47).

Methods, Procedures

Georgia DOT publishes methods for forty-five actions is bridge repair (47)(Table 28). Each performance standard includes standard drawings, links to Georgia DOT standard specifications and links to qualified products.

Table 28 Georgia DOT. Methods (47)

Activity	Action
800.01	Bridge Deck Joint Sealing (Silicone)
800.02	Bridge Deck Joint Sealing (Evazote)
805.01	Header Joint Reconstruction – Asphalt Overlay
805.02	Header Joint Reconstruction – Concrete Deck
810.01	Deck Spall Repair
810.02	Full Depth Deck Repair

Activity	Action
810.03	Full Depth Deck Repair – Driving Piles
815.01	Brush Curb Post Repair
815.02	Full Depth Standard Barrier Repair
815.03	Standard Barrier Top Spall Repair
815.04	Standard Barrier Gutter Spall Repair
820.01	Culvert Toe Wall Placement
820.02	Culvert Piping/Void Repair
820.03	Culvert Rip Rap Protection
825.01	Helper Bent (Temporary Repair)
830.01	H-Pile Structural Encasement (Circle)
830.02	H-Pile Structural Encasement (Square)
830.03	H-Pile Encasement Extension (Circle)
830.04	H-Pile Encasement Extension (Square)
830.05	H-Pile Plating Structural Repair-Bolt
830.06	H-Pile Plating Structural Repair-Weld
830.07	H-Pile Swaybracing
830.08	PSC Pile Section Loss Repair
830.09	Timber Pile Section Loss Repair
830.10	Timber Pile Section Loss Repair (Collar)
830.11	Timber Pile Section Loss Repair (Encasement)
830.12	Timber Pile Swaybracing
830.13	Epoxy Injection (Cap and Columns)
830.14	Cap-Column Spall Repair – Full Depth
830.15	Cap-Column Spall Repair – Surface
830.16	Cap Extension - Widening
830.17	Anchor Bolt Repair
830.18	Endwall Spalls – Full Depth
830.19	Endwall Spalls – Surface
830.20	Beam Web Section Loss Repair
830.21	Prestressed Beam Hits
830.22	Spall Repair of RCDG
830.23	Bearing Failure Repair Under RCDG
830.24	Edge Beam Replacement
830.25	Staged Edge Beam Replacement
845.01	Rip Rap Placement
845.02	Erosion Repair at Abutments
845.03	Pile Bent Scour Repair
845.04	Slope Paving Repair
845.05	Approach Slab Settling

Deck Preservation

Georgia DOT has a special specification for thin polymer overlay (42).

Georgia DOT's bridge repair manual (43) has a procedure for repair of deck spalls using rapid set materials.

Georgia DOT's maintenance and rehabilitation manual (47) lists treatments for bridge decks. The manual indicates that deck sealing should be renewed every six years.

Georgia DOT's bridge design manual (46) requires at least 2" thickness for overlays made with Portland cement concrete.

Georgia DOT's standard specifications (45) has an item for installation of waterproofing membrane and, separately, lists material requirements for waterproofing membranes.

Georgia DOT's qualified products list includes:

Waterproofing membrane (44)

Carlisle Coatings & Waterproofing, Inc.	CCW-711
Crafco, Inc.	Geotac Polyester HS
Crafco, Inc.	Geotac Standard SA Geotac Polyester
Polyguard Products, Inc.	#665 Membrane
Polyguard Products, Inc.	NW-75 Membrane

Type IV Epoxy adhesive (48)

Suitable for use with clean concrete or mortar sand in the preparation of an epoxy mortar.

E-Bond Epoxies,	E-Bond 540 Low Mod Superstick	IV
BASF	Concresive Paste SPL	IV
Superior Epoxies & Coatings, Inc.	Superior Patch Binder	IV

Type V Epoxy adhesive (48)

Suitable for repairing cracks in concrete by intrusion grouting.

Adhesives Technology Corp.	Crackbond LR-321	V
Cornerstone Construction Materials,	CE110 Injection Resin	V
Five Star Products	LV Adhesive	V
Adhesives Technology Corp.	Crackbond LR-321	V
Cornerstone Construction Materials,	CE110 Injection Resin	V
Dayton-Superior Corporation	Sure-Inject (J-56)	V
Futura Companies Ltd.	Futura Bond 535	V
Kaufman Products	SurePoxy HMSLV	V
Kaufman Products	SurePoxy HMLV	V
Kaufman Products	SurePoxy HM SLV	V
Magnolia Plastics, Inc.	Magnobond 20	V
Pilgrim Permocoat, Inc.	UWC LV	V
Prime Resins, Inc.	Prime Rez 1000 High Mod LV	V
Prime Resins, Inc	Prime Rez 1100 High Mod LV	V
Sika Corporation	Sikadur 35 Hi-Mod LV	V
Sika Corporation	Sikadur 55 SLV	V
Sika Corporation	Sikadur 52	V
Sika Corporation	Sikadur 33	V
Superior Epoxies & Coatings, Inc.	Superior Crack Weld GP	V
Unitex	Pro-Poxy 100 LV	V
Unitex	Pro-Poxy 204	V
W.R. Meadows of Georgia	Rezi-Weld IP	V

Rapid Setting Patching Material(49)

BASF	Thoroc 1060 Rapid Mortar	I
BASF	Thoroc 1061 Rapid Mortar	I
Conspec Marketing & Manufacturing	Pave Patch 3000	I
CTS Cement Manufacturing Co.	Rapid Set Concrete Mix	I
CTS Cement Manufacturing Co.	Rapid Set Cement – All	I
CTS Cement Manufacturing Co.	Rapid Set DOT Repair Mix	I
CTS Cement Manufacturing Co.	Rapid Set Mortar Mix	I
Dayton/Richmond Concrete Accessories	Perma Patch	I
Dayton Superior	Pave Patch 3000	I
Five Star Products, Inc.	Five Star® Structural Concrete	I
Five Star Products, Inc.	Five Star® Highway Patch	I
MAPEI Corporation	Planitop 18	I/II
MAPEI Corporation	Planitop 18 ES	I/II
Phoscrete Corporation	Phoscrete HC	I
Sika Corporation	Sika Quick 1000	I
Sika Corporation	Sika Quick 2500	I
Sika Corporation	Sikacrete 421 CI Rapid	I
SpecChem LLC	RepCon 928	I
Symons Corporation	DOT Patch	I
The Euclid Chemical Company	Speed Crete 2028	I
The Euclid Chemical Company	Speed Crete Green Line	I
The QUIKRETE Companies	QUIKRETE Rapid Road	I
The QUIKRETE Companies	Quikrete Commercial Grade	I
The QUIKRETE Companies	FastSet DOT Mix	II
US Concrete Products	HP Concrete	I
USG	USG EcoFix Rapid Repair Patch	I
USG	USG EcoFix AG 5000 Rapid Repair Patch	I
USG	USG EcoFix xtend Rapid Repair Patch	I

Idaho Transportation Department

Policy. Inspectors' Recommendations

Bridge inspection reports for Idaho TD contain six standard sections (Table 29) (52). One section is for recommendations for maintenance.

Table 29 Idaho TD. Sections of Bridge Inspection Report (52)

Sections
A. Elements and Commentary
B. Additional Condition Information
C. Maintenance Recommendations
D. Federal Structure Inventory and Appraisal (SIA) Items
E. Posting Information
F. Photographs

Actions. Maintenance

Idaho TD identifies actions in bridge maintenance (Table 30) (51).

Table 30 Idaho TD. Bridge Maintenance Actions (51)

Action
Deck surface improvements
Joint repair
Roadway approach work
Guardrail and bridge railing
Concrete structure repairs
Minor structure repairs

Performance Measure

Idaho TD tracks the percentage by deck area of bridges in good condition and the count of bridges older than 50 years (53).

Deck Preservation

In standard specifications (54), Idaho TD includes items for concrete overlay (Section 510), concrete waterproofing (Section 511), polyester polymer overlay (Section 551), epoxy overlay (Section 553), concrete crack repair (Section 581), and concrete patching (Section 582) . Waterproofing systems include penetrating sealant, precoated preformed membrane sheet, and spray-applied waterproofing. Crack repair is by injection of epoxy resin.

Illinois Department of Transportation

Policy.

Scope of Projects for Bridges

Illinois DOT defines scope of projects for bridges (Table 31) (58).

Table 31 Illinois DOT. Scope of Projects for Bridges (58)

Type	Definition
Bridge Replacement	Replacement of the entire bridge.
Bridge Reconstruction	Complete replacement of the superstructure May include work on substructure and foundation
Bridge Rehabilitation	Repair or replace one or more of the major and/or minor components of a bridge Deck replacement, Super/substructure widening, Bridge rail retrofit/replacement, Transverse or longitudinal joint work, Beam repairs, Substructure repairs
Bridge Deck Repair	Existing deck is structurally adequate Deck repairs are required Overlay may be needed to ride or to structural integrity Repairs to superstructure and/or substructure may be included
Bridge to Remain in Place	No work needed Bridge is structurally sound, Has adequate load capacity and Meets the minimum width/clearance/geometric criteria

Bridge Maintenance Program

Illinois DOT has a program for *bridge surface maintenance at the right time* (B-Smart) (58). The program supports a set of actions in preservation of bridge decks (Table 32). There are criteria for bridges in the B-Smart program (Table 33).

Table 32 Illinois DOT. B-Smart Preservation Actions (58)

Action
Full and partial depth deck repair
Expansion joint repair/replacement
Bearing reconditioning/replacement
Deck drain replacement, extension or plugging
Bridge rail repair/retrofit (replacement not allowed)
Minor abutment backwall repairs (formed concrete repair ≤ 5 in.)

Table 33 Illinois DOT. B-Smart Criteria (58)

Aspect	Limit
Superstructure and Substructure Condition Ratings	Greater than or equal to “6”
Deck Condition Rating	Greater than or equal to “5”
Partial Depth Patching	Maximum of 15% of the total deck area
Full Depth Patching	Maximum of 5% of the total deck area, excluding repairs at joints and deck drains

Use of Bridge Deck Overlays

Illinois DOT advises that thin concrete overlays should be applied only if decks are expected to have 18 years or more of remaining service life (58). Decks that might have shorter remaining service life should be replaced rather than repaired.

Selection Types of Overlay for Bridge Decks

Illinois DOT provides guidance on selection of bridge deck overlays in relation to desired service life and average daily traffic (Table 34) (58).

Table 34 Illinois DOT. Selection of Bridge Deck Overlay (58)

	Desired Overlay Lifespan			
	< 12 years(3)	< 12 years(3)	≥ 12 years	≥ 12 years
	ADT			
	< 10,000	≥ 10,000	< 3,000	≥ 3,000
Overlay Type	HMA w/coal tar membrane HMA w/sheet membrane	Fly Ash GGBFS CO Microsilica CO HRM CO Latex CO(1) Thin Polymer Over. (2)	HMA w/coal tar membrane HMA w/sheet membrane	Fly Ash GGBFS CO Microsilica CO HRM CO Latex CO(1) Thin Polymer Over. (2)
--- ***Additional Criteria*** ---				
Stopping Condition Within 300' of Deck	HMA w/coal tar membrane	Fly Ash GGBFS CO Microsilica CO HRM CO Latex CO(1)	Fly Ash GGBFS CO Microsilica CO HRM CO Latex CO(1)	Fly Ash GGBFS CO Microsilica CO HRM CO Latex CO(1)
Short Construction Duration Required	HMA w/sheet membrane HMA w/coal tar membrane	Thin Polymer Over.(2)	HMA w/sheet membrane HMA w/coal tar membrane	Thin Polymer Over. (2)

Note

GGBFS Ground Granulated Blast Furnace Slag
HMA Hot Mix Asphalt
HRM High Reactive Metakaolin
CO Concrete Overlay
a (3) For estimated lifespan ≤ 5 years, HMA without waterproofing membrane may used
b (1) maximum slope is 3%, maximum thickness is 3.5"
c (2) For decks with small area and low patching quantities, or to minimize additional dead load

Repair or Replace

Illinois DOT publishes guidance for decisions to repair or to replace bridge decks based on the percent of deck area to repair and on the need to widen the deck (Table 35). For all components of bridges, relative costs are considered in decisions to repair or replace (Table 36)(58).

Table 35 Illinois DOT. Guidance on Deck Repair or Replace (58)

Deck Area to Repair		
Equal Width Decks	**Decks Requiring Widening**	**Recommendation**
≤ 25%	≤ 15%	Deck repair cost effective
26-35%	16-25%	Deck repair cost effective only in well documented cases
> 35%	> 25%	Deck replacement appropriate

Table 36 Illinois DOT. Repair or Replace, Relative Cost (58)

Scope	Advice
Individual Bridge Elements:	If the cost to modify, repair and/or strengthen it is < 50% of the replacement cost, bridge element may be considered for reuse.
Major Components:	If the cost to modify, repair and/or strengthen it is < 60% of the replacement cost, bridge element may be considered for reuse.

Actions

Illinois DOT identifies actions in routine maintenance (Table 37) (55).

Table 37 Illinois DOT. Routine Maintenance Actions (55)

Action
Bridge inspection
Debris removal
Minor scour repair
Deck patching
Minor repairs

Illinois DOT's bridge element inspection manual relates actions to condition states (56). Maintenance and preservation actions are indicated for bridge elements in condition state 1 or 2 (Table 38). Repair and replacement are indicated for bridge elements in condition states 3 and 4. Actions in bridge maintenance projects include repairs to bridge joints (57).

Table 38 Illinois DOT. Actions for Element Condition States 1 & 2 (56)

Component	Filter	Action
Approach		Place overlay Rehabilitate affected sections Seal cracks, and/or edges
Bearing		Wash Wash and/or spot paint
Culvert	Concrete	Seal cracks, coat rebars, and minor patch
Culvert	Other	Tuck point, patch and seal
Culvert	Scour	Monitor Rip rap and/or remove debris
Culvert	Settlement	Minor stabilization retrofits (cables, bearing shims, etc.)

Component	Filter	Action
Deck	Concrete	Add a protective coating system (sidewalk) Add a protective system and wearing surface Add concrete overlay Add overlay Patch holes (in wearing surface), seal or inject cracks Remove overlay, add protection system and wearing surface Remove/replace overlay Repair cathodic protection (existing CP sys) Replace anode (existing CP sys) Seal or inject cracks Wash
Deck	Steel	Wash Wash and paint or reconnect (steel deck)
Deck	Timber	Apply preservative Clean (timber deck) Clean and seal (timber deck)
Joint	Finger Joints	Minor repairs including spot paint, patch concrete, seal cracks, inject epoxy and/or cut or weld fingers
Joint	Modular Neoprene	Minor repairs including spot paint, patch concrete, seal cracks, inject epoxy
Joint	Open Expansion Joint	Seal joint
Railing	Concrete	Apply protective coat
Railing	Metal	Clean and paint
Substructure	Concrete	Clean and seal keyway Seal cracks and minor patch
Substructure	Damaged	Grind cracks or plate, lubricate hinges Straighten or install new section
Substructure	Other	Minor repair, i.e. Tuck point Rehabilitate affected area
Substructure	Scour	Monitor Rip rap and/or remove debris
Substructure	Settlement	Minor stabilization retrofits (cables, bearing shims, etc.)
Substructure	Steel	Wash Clean and paint (steel) Zone clean and paint entire surface (steel)
Substructure	Timber	Apply preservative
Superstructure	Concrete	Seal cracks and minor patch
Superstructure	Damaged	Grind cracks or plate, lubricate hinges Straighten or install new section
Superstructure	Steel	Clean and paint Clean and paint affected cable Patch affected protective sheathing (cable) Wash Zone clean and paint entire surface
Superstructure	Timber	Apply preservative

Intervals for Actions

Illinois DOT reports that surface sealers for reinforced concrete bridge decks should be re-applied every 4 years (59).

Data. Agency-Defined Bridge Elements

Illinois DOT uses 101 agency-defined bridge elements (Table 39).

Table 39 Illinois DOT. Agency-Defined Bridge Elements (56)

Component	ID	Name
Deck	8034	Precast concrete deck bare (SF)
Deck	8038	Concrete slab bare (SF)
Deck	8056	Precast Concrete Deck w/Rigid 5” Overlay (SF)
Deck	8013	Concrete Deck Unprotected w/ HMA Overlay (SF)
Deck	8035	Precast Concrete Deck Unprotected w/ HMA Overlay (SF)
Deck	8039	Concrete Slab Unprotected w/ HMA Overlay (SF)
Deck	8014	Concrete Deck Protected w/ HMA Overlay (SF)
Deck	8036	Precast Concrete Deck Protected w/HMA Overlay (SF)
Deck	8040	Concrete Slab Protected w/ HMA Overlay (SF)
Deck	8018	Concrete Deck Protected w/ Thin Overlay (SF)
Deck	8044	Concrete Slab Protected w/ Thin Overlay (SF)
Deck	8022	Concrete Deck Protected w/ Rigid Overlay (SF)
Deck	8048	Concrete Slab Protected w/ Rigid Overlay (SF)
Deck	8026	Concrete Deck Protected w/ Coated Bars (SF)
Deck	8033	Concrete Deck Protected w/ Coated Bars w/ PPC Panels (SF)
Deck	8052	Concrete Slab Protected w/ Coated Bars (SF)
Deck	8027	Concrete Deck Protected w/Cathodic Protection (SF)
Deck	8053	Concrete Slab Protected w/Cathodic Protection (SF)
Deck	8057	Steel Deck Concrete Filled Grid w/HMA Overlay (SF)
Deck	8032	Timber Deck with HMA Overlay (SF)
Deck	8055	Timber Slab with HMA Overlay (SF)
Deck	8058	Sidewalk (SF)
Deck	8239	Timber deck runners (LF)
Superstructure	8101	Unpainted steel closed web/box girder (SF)
Superstructure	8106	Unpainted steel open girder (SF)
Superstructure	8112	Unpainted steel stringer (SF)
Superstructure	8125	Unpainted steel through truss excluding bottom chord (SF)
Superstructure	8130	Unpainted steel deck truss (SF)
Superstructure	8140	Unpainted steel arch/arch tie (SF)
Superstructure	8151	Unpainted steel floor beam (SF)
Superstructure	8160	Unpainted Steel Pin and/or Hanger (EA)
Superstructure	8171	Unpainted steel closed web/box girder ends including diaphragms below deck joints (EA)
Superstructure	8174	Unpainted steel open girder ends including diaphragms below deck joints (EA)

Component	ID	Name
Superstructure	8177	Unpainted steel stringer ends including diaphragms below deck joints (EA)
Superstructure	8180	Unpainted steel deck truss below deck joints (SF)
Superstructure	8190	Unpainted steel floor beam below deck joints (SF)
Superstructure	8172	Lead painted steel closed web/box girder ends including diaphragms below deck joints (EA)
Superstructure	8175	Lead painted steel open girder ends including diaphragms below deck joints (EA)
Superstructure	8121	Lead painted steel bottom chord through truss (SF)
Superstructure	8126	Lead painted steel through truss excluding bottom chord (SF)
Superstructure	8178	Lead painted steel stringer ends including diaphragms below deck joints (EA)
Superstructure	8131	Lead painted steel deck truss (SF)
Superstructure	8181	Lead painted steel deck truss below deck joints (SF)
Superstructure	8191	Lead painted steel floor beam below deck joints (SF)
Superstructure	8103	Non-lead painted steel closed web/box girder (SF)
Superstructure	8173	Non-lead painted steel closed web/box girder ends including diaphragms below deck joints (EA)
Superstructure	8118	Non-lead painted steel open girder (SF)
Superstructure	8119	Non-lead painted steel stringer (SF)
Superstructure	8176	Non-lead painted steel open girder ends including diaphragms below deck joints (EA)
Superstructure	8122	Non-lead painted steel bottom chord through truss (SF)
Superstructure	8123	Non-lead painted steel through truss excluding bottom chord (SF)
Superstructure	8179	Non-lead painted steel stringer ends including diaphragms below deck joints (EA)
Superstructure	8124	Non-lead painted steel deck truss (SF)
Superstructure	8128	Non-lead painted steel arch/arch tie (SF)
Superstructure	8182	Non-lead painted steel deck truss below deck joints (SF)
Superstructure	8129	Non-lead painted steel floor beam (SF)
Superstructure	8192	Non-lead painted steel floor beam below deck joints (SF)
Superstructure	8162	Non-Lead Painted Steel Pin and/or Hanger (EA)
Superstructure	8163	Non-lead painted steel gusset plate (EA)
Superstructure	8142	P/s concrete segmental box girders (LF)
Superstructure	8237	P/s concrete beam ends including diaphragms under deck joints (EA)
Superstructure	8238	Concrete beam ends including diaphragms under deck joints (EA)
Superstructure	8108	Keyway (LF)
Superstructure damaged	8401	Steel closed web/box girder (LF)
Superstructure damaged	8402	Steel bottom chord through truss (LF)
Superstructure damaged	8403	Steel through truss excluding bottom chord (LF)
Superstructure damaged	8404	Steel deck truss (LF)
Superstructure damaged	8406	Steel open girder (LF)
Superstructure damaged	8407	Steel arch/arch tie (LF)
Superstructure damaged	8408	Steel floor beam (LF)

Component	ID	Name
Superstructure damaged	8411	Steel pin and/or hanger (EA)
Superstructure damaged	8412	Steel stringer (LF)
Superstructure damaged	8413	Steel gusset plate (EA)
Substructure	8200	Non-lead painted steel column (SF)
Substructure	8201	Unpainted steel column (SF)
Substructure	8222	Unpainted Steel Abutment and Wingwall (SF)
Substructure	8224	Unpainted steel pile extension (SF)
Substructure	8230	Unpainted Steel Pier or Abutment Cap (SF)
Substructure	8270	Unpainted Steel Pier or Abutment Cap Below Deck Joint (SF)
Substructure	8221	Lead Painted Steel Abutment and Wingwall (SF)
Substructure	8271	Lead Painted Steel Pier or Abut Cap Below Deck Joints (SF)
Substructure	8220	Non-Lead Painted Steel Abutment and Wingwall (SF)
Substructure	8236	Non-Lead Painted Steel Pier or Abutment Cap (SF)
Substructure	8246	Non-lead painted steel pile extension (SF)
Substructure	8272	Non-Lead Painted Stl Pier or Abut Cap Bel Deck Joints (SF)
Substructure	8209	MSE Abutment and Wingwall (SF)
Culvert damaged	8461	Culvert scour (EA)
Culvert damaged	8460	Culvert settlement (EA)
Substructure damaged	8409	Steel column (LF)
Substructure damaged	8410	Steel pier or abutment cap (LF)
Substructure damaged	8414	Steel pile extension (LF)
Substructure damaged	8361	Abutment scour (EA)
Substructure damaged	8363	Pier scour (EA)
Substructure damaged	8360	Abutment settlement (EA)
Substructure damaged elements	8362	Pier settlement (EA)
Joint	8306	Finger Joints with Trough (LF)
Joint	8307	Neoprene expansion joint (LF)
Joint	8308	Continuous seal neoprene expansion joint (LF)
Bearing	8316	Moveable steel bearings below continuous decks (EA)
Approach	8322	Concrete approach beam (SF)
Approach	8323	Approach pavement (EA)

Methods

Illinois DOT publishes special provisions for actions in bridge maintenance (Table 40) (61).

Table 40 Illinois DOT. Special Provisions for Bridge Maintenance (61)

Index	Title
GBSP14	Jack and Remove Existing Bearings
GBSP16	Jacking Existing Superstructure
GBSP21	Cleaning and Painting Contact Surface Areas of Existing Steel Structures
GBSP21	Cleaning and Painting Contact Surface Areas of Existing Steel Structures
GBSP28	Deck Slab Repair
GBSP29	Bridge Deck Microsilica Concrete Overlay

Index	Title
GBSP30	Bridge Deck Latex Concrete Overlay
GBSP31	Bridge Deck High-Reactivity Metakaolin (HRM) Conc Overlay
GBSP34	Concrete Wearing Surface
GBSP35	Silicone Bridge Joint Sealer
GBSP45	Bridge Deck Thin Polymer Overlay
GBSP53	Structural Repair of Concrete
GBSP72	Bridge Deck Fly Ash or GGBF Slag Concrete Overlay

Deck Preservation

Illinois DOT publishes guidance for evaluation of bridge decks (58).

Illinois DOT publishes guide specifications for deck repair (62), for microsilica concrete overlay, for latex-modified concrete overlay (64), for metakaolin concrete overlay (65), for thin polymer overlay (60), and for fly ash modified concrete (66).

Indiana Department of Transportation

Definitions

For Indiana DOT, preventive maintenance actions are scheduled actions that keep structures at current condition (70). Corrective maintenance actions are condition driven, and correct defects.

Policy.

Selection of Overlays. Repair vs. Replace

Indiana DOT publishes guidance for selection of overlays for bridge decks based on deck condition and on anticipated remaining service life of decks (Table 41) (67). In decisions to replace or to rehabilitate bridges, Indiana DOT considers relative costs and expected extension to service life (Figure 1) (67).

Table 41 Indiana DOT. Selection Criteria for Deck Overlays (67)

Overlay	Selection Criteria
Latex-Modified Concrete (LMC) Overlay	Deck, superstructure, and substructure must each have a bridge inspection rating of 5 or higher Partial depth patching must be less than 15% If full depth patching exceeds 35%, consideration should be given to deck replacement
Polymeric Overlay	Wearing surface, deck, superstructure and substructure must each have a bridge inspection rating of 5 or higher
Second Overlay	Remove an existing overlay and replace it with a new one Department policy is to not allow a new overlay to be placed over an existing bridge deck overlay,

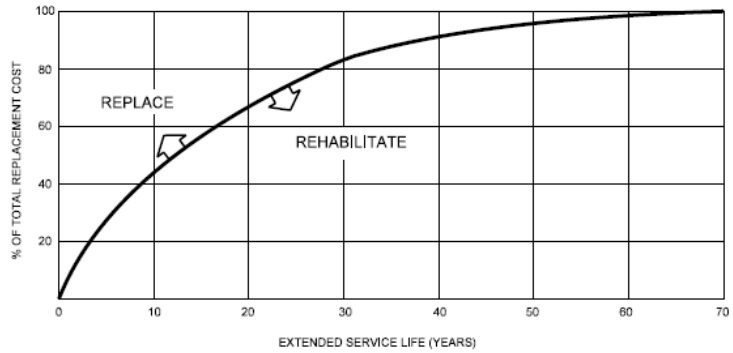

Figure 1 Indiana DOT. Decision to Replace or Rehabilitate (67)

Selection of Actions.

Indiana DOT publishes selection criteria for actions in preventive maintenance (Table 48) (70), selection criteria for actions in corrective maintenance (Table 42) (70), and selection criteria for actions in corrective maintenance for culverts (Table 47) (70).

Table 42 Indiana DOT. Selection Criteria Corrective Maintenance Actions (70)

Corrective Treatments	Bridge Component	Condition Rating	Other Criteria
Bridge Culvert Liner	Item 62	2 to 5	N/A
Deck Patching (shallow/deep)	Item 58.01	>4	D/SS > 4; AND Maximum 10% Deck Patching
Approach Slab Repair/Replacement	Item 72X.02	<6	WS/D/SS > 4
Joint Repair/Replacement	Item 58.16	<6	WS/D/SS > 4
Mudwall Patching	Item 60.02	<6	WS/D/SS > 4
Thin Deck Overlay (e.g. Polymeric Overlay)	Item 58.01	>5	D/SS > 4; AND Maximum 10% Deck Patching
Spot Coating	Item 59B.01	<6	WS/D/SS > 4
Substructure Patching/Sealing	Item 60	N/A	WS/D/SS > 4
Superstructure Crack Mitigation	Item 59A.06 ; OR Item 59A.07	Check Box Indicating Cracks	WS/D/SS > 4
Erosion Mitigation	Item 61	<6	WS/D/SS > 4
Debris Removal/Channel Cleaning	Item 61.03	<6	WS/D/SS > 4
Latex Modified Concrete (LMC) Overlay	Item 58.01	>3	D/SS > 5; AND Maximum 15% Deck Patching
Slopewall Repair/Replacement	Item 60	<6	WS/D/SS > 4
Bearing Repair/Replacement	Item 59A	<6	WS/D/SS > 4
Scour Mitigation	Item 113	2 to 3	Not Programmed for Bridge Replacement
Deck Crack Sealing	Item 58.01	>5	D/SS > 5
Brush Cutting/Herbicide Application	Deficiency Noted	N/A	WS/D/SS > 4
Railing Repair	Deficiency Noted	N/A	WS/D/SS > 4
Relief Joint Repairs	Item 72X.03	<6	WS/D/SS > 4
Upgrading end treatments, guardrail, railing, attenuators	N/A	N/A	WS/D/SS > 4

Note

Item 58.01	Wearing Surface
Item 58.16	Transverse Joints
Item 59A	Bearings
Item 59A.06	Concrete Girders
Item 59A.07	Concrete Beams
Item 59B.01	Condition of Paint (amount of rust/corrosion)
Item 60.02	Backwall
Item 61.03	Drift
Item 72X.02	Approach Slab (Roadway Carried)
Item 72X.03	Relief Joints (Roadway Carried)
D	Deck
WS	Wearing surface
SS	Superstructure

Table 43 Indiana DOT. Selection Criteria Corrective Maintenance for Large Culverts (70)

Corrective Treatments	Culvert Component	Condition Rating	Barrel/Box or Slab Rating
Culvert Liner (Both Type I &2 Structures)	Barrel/Box	2 to 5	N/A
Structural Patching	Slab/Barrel/Box	>4	N/A
Scour/Erosion Mitigation	Channel Scour	<6	>5
Cutoff Wall Repair/Replacement	Footings	<6	>5
Headwall/Wingwall Repair/Replacement	Headwall/ Anchors/ Wingwalls	<6	>5
Tiedown/ Anchor Repair/Replacement	Headwall/ Anchors	<6	>5
Debris Removal/ Culvert Cleaning	Drift/Sediment/ Unobstructed Flow Box	<6; AND Checkbox "unchecked"	>5
Paved Invert	Barrel/Box	2 to 5	N/A
Brush Cutting/Herbicide application	Embankment	<6	>5
Railing Repair	Guardrail/Concrete Barrier	<6	>5
Upgrading end treatments, guardrail, railing, attenuators	N/A	N/A	>5

Actions

Indiana DOT lists preservation actions (Table 44) (68). Indiana DOT lists actions in preventive maintenance and in corrective maintenance (Table 45) (70).

Bridge projects provide maintenance under Indiana DOT's Bridge/Culvert Preservation program.

Table 44 Indiana DOT. Preservation Actions (68)

Action
Cleaning
Deck overlay
Substructure repair
Superstructure repair
Eliminate all expansion joints as part of a bridge-rehabilitation project (67)

Table 45 Indiana DOT. Preventive Maintenance, Corrective Maintenance (70)

Action
Preventive maintenance
Cleaning/Flushing Bridge Decks
Substructure/Superstructure Washing
Cleaning Deck Drains
Cleaning/Lubricating Bearings
Cleaning Joints
Deck Sealing
Corrective Maintenance
Bridge Culvert Liner
Deck Patching (shallow/deep)- maximum 10% deck area
Approach Slab Repair/Replacement
Joint Repair/Replacement

Action
Mud wall Patching
Thin Deck Overlay (e.g. Polymeric Overlay)
Spot Coating
Substructure Patching/Sealing
Superstructure Crack Mitigation
Erosion Mitigation
Debris Removal/Channel Cleaning
Latex Modified Concrete (LMC) Overlay
Slopewall Repair/Replacement
Bearing Repair/Replacement
Scour Mitigation
Deck Crack Sealing
Brush Cutting/Herbicide Application
Railing Repair
Relief Joint Repairs
Upgrading end treatments, guardrail, railing, attenuators
Large Culvert Corrective Maintenance
Culvert Liner
Structural Patching
Scour/Erosion Mitigation
Cutoff Wall Repair/Replacement
Headwall/Wingwall Repair/Replacement
Tiedown/Anchor Repair/Replacement
Debris Removal/Culvert Cleaning
Paved Invert
Brush Cutting/Herbicide Application
Railing Repair
Upgrading end treatments, guardrail, railing, attenuators
Small Culvert Corrective Maintenance
Culvert Liner
Structural Patching
Erosion Mitigation
Cutoff Wall Repair/Replacement
Headwall/wingwall Repair/Replacement
Tiedown/ Anchor Repair/Replacement
Debris Removal/Culvert Cleaning
Brush Cutting/Herbicide Application
Guardrail Repair
Upgrading end treatments, guardrail, railing, attenuators

Preservation Projects.

Actions in projects for bridge preservation include repairs, deck overlays, channel clearing and culvert liners (Table 46) (69). Preservation projects also deliver bridge rehabilitation and bridge replacement (68).

Table 46 Indiana DOT. Bridge Project Actions (69)

Action - Bridge/Culvert Preservation
Small Structure Pipe Lining
Bridge Maintenance and Repair

Action - Bridge/Culvert Preservation
Bridge Deck Overlay
Bridge Rehabilitation or Repair
Culvert Clean and Repair
Bridge Thin Deck Overlay
Debris Removal from Channel

Intervals. Service Life.

Indiana DOT publishes expected service life of deck overlays (Table 47) (67). Indiana DOT publishes intervals for actions in preventive maintenance (Table 48) (70).

Table 47 Indiana DOT. Expected Service Life (67)

Action	Expected Life
Latex-Modified Concrete (LMC) Overlay	15 years
Polymeric Overlay	10 years

Table 48 Indiana DOT. Selection and Intervals for Preventive Maintenance Actions (70)

Action	Data Item	Condition Rating	Interval (years)
Cleaning/Flushing Bridge Decks	Item 58	>4	1
Substructure/Superstructure Washing	Item 59 AND Item 60	>4	1
Cleaning Deck Drains	Item 58	>4	1
Cleaning/Lubricating Bearings	Item 59A	>4	1
Cleaning Joints	Item 58.15 AND Item 58.16 AND Item 58.16 A AND Item 58.16 B AND Item 58.16 C	>4	1
Deck Sealing	Item 58.01 & Item 58.02	>5	5

Note

Item 58.01	Wearing Surface
Item 58.02	Deck Underside
Item 58.15	Longitudinal Joints
Item 58.16	Transverse Joints
Item 58.16 A	South/West
Item 58.16 B	Interior
Item 58.16 C	North/East
Item 59A	Bearings

Methods, Procedures

Indiana DOT publishes methods for 48 actions in bridge rehabilitation (Table 49) (67).

Table 49 Indiana DOT. Methods (67)

ID	Action
72-3.01(03) Rehabilitation Techniques	
BD-1	Patching
BD-2	Epoxy Resin Injection
BD-3	Low Viscosity Sealant for Crack Repair
BD-4	Concrete Overlay

ID		Action
	BD-5	Cathodic Protection
	BD-6	Deck Drainage Improvements
	BD-7	Upgrade Bridge Railings
	BD-8	Upgrade Guardrail-to-Bridge-Railing Transitions
	BD-9	Joint Elimination
	BD-10	Concrete Sealants
	BD-11	Corrosion Inhibitors
	BD-12	Prefabricated Bridge Deck
72-3.02 Steel Superstructure		
	SS-1	Grinding
	SS-2	Peening
	SS-3	Gas Tungsten Arc Remelt
	SS-4	Drilled Holes
	SS-5	Bolted Splices
	SS-6	Welding
	SS-7	Addition of Cover Plates — Strengthening
	SS-8	Introduction of Composite Action — Strengthening
	SS-9	Addition of New Stringers — Strengthening
	SS-10	Bearings
	SS-11	Post-Tensioning — Strengthening
	SS-12	Heat-Straightening
72-3.03 Concrete Superstructure		
	CS-1	Remove or Replace Deteriorated Concrete
	CS-2	Pneumatically-Placed Mortar
	CS-3	Epoxy Injection
	CS-4	Low-Viscosity Sealant
	CS-5	Grouting
	CS-6	Concrete-Bridge-Seat Extension
	CS-7	Beam Strengthening: Post-Tensioning Tendons
72-3.04 Substructure or Foundation		
	SF-1	Remove or Replace Deteriorated Concrete
	SF-2	Enlarge Footing
	SF-3	Riprap
	SF-4	Wingwall Repair
	SF-5	Deadman Anchorage
	SF-6	Drainage Improvements
	SF-7	Grout-Bag Underpinning
	SF-8	Pile-Section-Loss Repair
	SF-9	Jacketing Piers and Piles
72-3.05 Seismic Retrofit		
	SR-1	Jacketing of Columns
	SR-2	Other Techniques for Increasing Seismic Resistance of Columns
	SR-3	Seat-Width Extension
	SR-4	Structural Continuity
	SR-5	Restrainers and Ties
	SR-6	Bearing Replacement
	SR-7	Seismic Isolation Bearings
	SR-8	Integral End Bents

Performance Measures

Indiana DOT tracks condition of bridges by general condition ratings (70). Performance is measured as the percentage of bridges in fair or better condition, and the percentage of bridges in poor condition. Rates (annual counts) of transitions of bridges from fair condition to poor condition are tracked. General condition ratings and performance measures are reported for Wearing surface, Deck, Superstructure, Substructure, Large culverts and Small culverts.

Deck Preservation

Indiana DOT has standard specifications for overlay using silica fume modified concrete (Section 736)(71), for epoxy polymer overlay (Section 738)(72), for surface sealing (Section 709)(73), for latex modified concrete overlay (Section 722)(73), for crack repair (Section 727)(73), and for rapid set patch materials (Section 901)(73)

Indiana DOT lists approved materials for

Latex Modifiers (74)

Basf	Styrofan 1186
Trinseo Llc	Modifier A/Na
Riechold Chemical	Tylac 97-314

Non-Epoxy Sealers (75)

Advanced Chemical Technologies, Inc	Sil-Act Ats-100lv
Advanced Chemical Technologies, Inc	Sil-Act Ats-100
Advanced Chemical Technologies, Inc	Sil-Act Ats-22 Voc
Basf Construction Chemicals, Llc	Masterprotect H 400
Basf Construction Chemicals, Llc	Masterprotect H 200
Evonik Corporation	Protectosil Bhn
Evonik Corporation	Protectosil Aqua-Trete 40
Evonik Corporation	Protectosil Aqua-Trete 20
Sika Corporation	Sikagard 705l
Tk Products Inc	Tk-590-100
W.R. Meadows, Inc	Pentreat 244-100

Healer-Sealers (76)

Adhesives Technology Corp	Crackbond Lr321
Adhesives Technology Corp	Crackbond Slv302
Chemco Systems	Ccs Epoxy Sealer/Healer
Chemmasters	Duraguard Hm Sealer
Cornerstone Construction Material,Llc	Ce110-Ultra Low Viscosity Epoxy
Cornerstone Construction Material,Llc	Ce330-Medium Viscosity Epoxy Binder
Dayton Superior Corp	Sure Inject J56
Euclid Chemical Co	Eucopoxy Lpl
Euclid Chemical Co	Dural 335 Ultra-Low Viscosity
Olin Epoxy-Poly-Carb	Mark-135
Polygem	Polyject 1001 Epoxy Injection Resin
Roadware Inc	10 Minute Concrete Mender
Sika Corp	Pronto 19 Tf
Sika Corp	Sikadur 55 Slv
Transpo Industries, Inc	Sealate T-70-10

Transpo Industries, Inc	Sealate T-70 Mx-30
Unitex By Dayton Superior Corp	Pro-Poxy 50-1
Unitex By Dayton Superior Corp	Pro-Poxy 100

Polymers for Overlays (77)

Cornerstone Construction Material, Llc	Ce330 Epoxy Binder
E-Bond Epoxies, Inc.	E-Bond 526
E-Chem, Llc	Ep50-Overlay
E-Chem, Llc	Epx50-Overlay
Mapei Corp	Planiseal Traffic Coat
Mapei Corp	Planiseal Traffic Coat Fs
Olin-Epoxy-Poly-Carb, Inc	Mark-154 Safe-T-Grid
Olin-Epoxy-Poly-Carb, Inc	Mark-163 Flexogrid
Sika Corp	Sikadur 22 Lm
Sika Corp	Sikadur 22 Lm Fs
Unitex By Dayton Superior	Pro-Poxy Type Iii D.O.T.

Rapid Setting Patch Material (78)

Bindan Corp	Mono-Patch
Basf Construction Chemicals, Llc	Masteremaco T 1061
Basf Construction Chemicals, Llc	Masteremaco T 1060
Cts Cement	Rapid Set Dot Concrete Mix
Cts Cement	Rapid Set Dot Repair Mix
Dayton Superior	Hd 50
Mapei Corp	Planitop 18
Mapei Corp	Planitop 18 Es
U.S. Gypsum Co	Duracal Ag
U.S. Gypsum Co	Duracal
Western Material & Design, Llc	Fastrac 246 Concrete

Iowa Department of Transportation

Policy.

Balance in Bridge Programs.

Iowa DOT employs a concept of balance of bridge preservation and bridge replacement (79). Replacement, as the only action in a bridge program, is expensive. 'Worst first', as a basis for prioritization, neglects good bridges and allows them to deteriorate.

Definition.

Preventive Maintenance.

Iowa DOT defines preventive maintenance as planned work that retards deterioration, preserves or improves functional condition, but does not substantially increase structural capacity (79).

Actions and Procedures

Iowa DOT publishes a bridge maintenance manual with descriptions and procedures for actions (80). Actions in the manual are listed in (Table 50).

Table 50 Iowa DOT. Actions in Bridge Maintenance Manual (80)

Action
1.3 Joint Maintenance and Repair Procedures
1.3.1 Clean Strip Seals and Gland-type Joints
1.3.2 Cut Out Portions of Loose Steel Sliding Plate Expansion Joints
1.3.3 Replace Neoprene Compression Seals and Strip Seal Glands in Expansion Joints
1.3.4 Replace CF Joint Material with Crumb Rubber Joint Material
1.3.5 Repair Components of Modular Expansion Joints
2.3 Deck Maintenance and Repair Procedures
2.3.1 Clean and Wash Decks
2.3.2 Remove Delaminated Concrete from Bottoms of Bridge Decks
2.3.3 Seal Deck Cracks
2.3.4 Epoxy Inject Deck Overlays
2.3.5 Patch Bridge Decks with Asphaltic Concrete
2.3.6 Patch Bridge Decks with Concrete
2.3.7 Weld Loose Steel Decking to Steel Stringer Beams
2.3.8 Replace Timber Deck Planks
3.3 Bridge Drainage System Maintenance and Repair Procedures
3.3.1 Unplug Deck Drains
3.3.2 Repair Deck Drains and/or Add Extensions
3.3.3 Clean and Repair Expansion Joint Drainage Troughs
4.3 Bridge Railing Maintenance and Repair Procedures
4.3.1 Seal Barrier Rails with Penetrating Sealer
4.3.2 Patch Concrete Barrier Rails and Curbs
4.3.3 Repair/Replace Aluminum or Steel Bridge Rail Damaged by Vehicular Impact
4.3.4 Repair Concrete Barrier Rails Damaged by Vehicular Impact
5.3 Bridge Bearing Maintenance and Repair Procedures
5.3.1 Wash, Clean, and Seal/Paint Bearings
5.3.2 Reset or Replace Bearings
6.2 Bridge Superstructure Maintenance and Repair Procedures

Action
6.2.1 Periodically Wash Down Structural Elements (Prior to Biennial Bridge Inspections)
6.2.2 Seal Prestressed Concrete Beam Ends
6.2.3 Epoxy Inject Concrete Beams Damaged by Vehicular Impact
6.2.4 Repair Concrete Beams Damaged by Vehicular Impact
6.2.5 Grind and Smooth Steel Member Nicks and Gouges
6.2.6 Replace/Tighten Loose or Missing Bolts in Superstructure
6.2.7 Loosen Diaphragm Bolts as Retrofit to Out-of-Plane Bending Cracks in Girder Web
6.2.8 Repair or Strengthen Steel Members on Bridges
6.2.9 Drill 1-inch Crack Arresting Holes at Ends of Cracks in Steel Members
6.2.10 Core Large Diameter Holes to Retrofit Fatigue Crack Prone Locations
6.2.11 Repair Timber Stringer
6.2.12 Replace Rotten/Broken Timber Stringers
7.2 Bridge Substructure Maintenance and Repair Procedures
7.2.1 Wash Bridge Beam Seats
7.2.2 Seal Bridge Beam Seats
7.2.3 Repair Tops of Abutment Backwalls with Concrete
7.2.4 Epoxy Inject Cracked Wingwalls, Abutments, and Piers
7.2.5 Concrete Repair (Shallow and Regular) at Wingwalls, Abutments, and Piers
7.2.6 Reconstruct Paving Notch at Integral Abutments
7.2.7 Repair Bridge Seats Under Bearings
7.2.8 Repair or Replace Timber Trestle Piling, In or Out of Water
7.2.9 Encase Concrete Trestle Piling, In or Out of Water
7.2.10 Replace Timber Abutment Backwall Planks
7.2.11 Replace Timber Piles at High Abutments
7.2.12 Remove Unbalanced Soil Load from Substructure
8.2 Bridge Approach Maintenance and Repair Procedures
8.2.1 Seal Gaps or Mastic Joints between Shoulder Panels and Wingwalls
8.2.2 Backfill Approach Embankment and Bridge Berm Erosion Holes
8.2.3 Fill Voids Under Approach Slabs
8.2.4 Patch Approach Paving Pot Holes with HMA
8.2.5 Cut/Re-Cut/Install Pressure Relief Joint
9.2 Culvert Maintenance and Repair Procedures
9.2.1 Repair Culvert Walls, Floors, and Joint Separations
9.2.2 Remove Silt
10.1 Miscellaneous Maintenance and Repair Procedures
10.1.1 Monitor Various Bridge Elements as per Bridge Inspection Reports
10.1.2 Repair/Replace Concrete or Macadam Stone Slope Protection
10.1.3 Install Rip Rap Revetment or Gabions

Service Environment

In its bridge element inspection guide (81), Iowa DOT relates service environment of bridge elements to average daily traffic, proximity to expansion joints, and exposure to splash or spray.

Performance Measures

Iowa DOT reports the Federal National Performance Management Measures (82); values are reported for bridges on the National Highway System and separately for bridges not on the National Highway System. Iowa DOT tracks the average sufficiency rating among bridges and the percentage of deficient bridges (

82); values are reported for environmental justice areas and separately for non-environmental justice areas[1].

The potential impact of projects is assessed as performance. Projects that improve NBI general condition ratings of deficient bridges offer the best performance (Table 51) (82).

Table 51 Iowa DOT. Performance of Bridge Projects (82)

Long-Range Transportation Plan Project Performance Objective	Performance Method	Draft Alternative / Project Scoring Approach			
		2	1	0	-2
		Very Good	Good	Neutral	Poor
6B. Allocate resources to maintain bridge conditions at sufficient levels.	NBI Ratings	Improves a bridge considered deficient.		No impact to bridge condition.	

Deck Preservation

Iowa DOT has special specifications for bridge deck waterproofing (83), and cold-applied spray membrane (84). Iowa DOT's bridge inspection manual has codes for actions for bridge decks (85). Iowa DOT ' s bridge maintenance manual (80) has procedures for deck cleaning, removing deteriorated concrete, crack sealing, repairs to overlays, deck patching, steel repairs and timber repairs.

Table 52 Iowa DOT codes for actions bridge decks (85)

Code	Recommendation	Corrective / Preventive
104	Clean deck & drains	C
105	Remove loose concrete - Bottom of deck	C
110	Spall patch - Minor	P
111	Spall patch	C
112	Spall patch - Major	C
114	Deck deterioration - Possible failure	C
121	Recommend PCC overlay	C
132	Replace - Urgent	C
140	Inject w/ epoxy	P
141	Inject & patch spalls	C
142	Replace overlay	C

[1]The source document does not define ’deficient’ and does not define ’environmental justice area’.

Kansas Department of Transportation

Actions. Data System.

Kansas DOT uses codes for types of projects for bridges (Table 53) (86).

Table 53 Kansas DOT. Codes for Actions (86)

Code	Action
BR	BRIDGE
BR-OL	BRIDGE OVERLAY
BR-WD	BRIDGE WIDEN
BRDEC	BRIDGE DECK
BRPAT	BRIDGE DECK PATCHING
BRPNT	BRIDGE PAINT
BRREM	BRIDGE REMOVAL
BRRPL	BRIDGE REPLACEMENT
BRRPR	BRIDGE REPAIR
BRSUB	BRIDGE SUBSTRUCTURE
BRSUP	BRIDGE SUPERSTRUCTURE
CRRPR	CRACK REPAIR
CULV	CULVERT
DECK	BRIDGE DECK
JTRPR	JOINT REPAIR
MUDJK	MUDJACKING

Performance Measure

Kansas DOT tracks conditions of bridges (87). Bridges are reported as Good /Fair /Deteriorated based on value of a bridge health index. Kansas DOT tracks the percentage of structurally deficient bridges (86).

Deck Preservation

Kansas DOT has standard specifications for preparation of decks for overlay (96), and for patching (95). Kansas DOT has a standard specification for Portland cement concrete overlay (93). Kansas DOT has a standard specification for repair of thin polymer overlay (92). Kansas DOT has special provisions for polymer overlay applied as a slurry (88), and for polymer overlay applied in multiple layers (90).

Kansas DOT publishes test methods for deck surface preparation for polymer overlays, and for adhesion of polymer overlays (91).

Kansas DOT has distinct work codes for different thicknesses of overlay (Table 54)(89).

Table 54 Kansas Work Type Code

Work Type	Description
20OL	20 mm OVERLAY (3/4 INCH)
25OL	25 mm OVERLAY (1 INCH)
40OL	40 mm OVERLAY (1-1/2 INCHES)
50OL	50 mm OVERLAY

Kansas DOT has standard specifications for polymer materials for overlay (94), for epoxy resins (99), and for materials for deck patching (97). Kansas DOT lists approved products for

Polymer Overlays (98)

AIS CIS, LLC dba CEPOXY	CEPOXY Precision Binder
BASF Construction Chemicals LLC	Traficguard EP35
Cornerstone Construction Material	CE330
E-Bond Epoxies	E-Bond 526
Euclid Chemical Co.	Flexolith
Poly-Carb, Inc.	Mark - 154
Sika Corporation	Sikadur 22 Lo Mod
Transpo Industries, Inc.	T-48
Dayton Superior Corporation	Pro-Poxy Type III DOT
Stirling Lloyd, Inc.	Bridgemaster
Transpo Industries, Inc.	T-18
KwikBond Polymers Inc.	PPC-MLS PPC 1121

Kentucky Transportation Cabinet

Policy.

Agency, Preservation.

Kentucky TC has a Bridge Preservation Branch (100). Bridge load rating is one responsibility of the branch.

Inspectors' Recommendation.

Kentucky TC bridge inspectors recommend maintenance actions (100). Comments by inspectors include type of defect, location, size or area of defect, and recommended maintenance action.

Maintenance Inspections.

Kentucky TC directs maintenance personal to observe and report needs or deficiencies in pavements or bridges whenever personnel travel along highways (101).

Actions. Maintenance.

Kentucky TC lists responsibilities of maintenance crews (Table 55) (101). Responsibilities include cleaning, painting, minor repairs to bridges and construction of bridges.

Table 55 Kentucky TC. Actions by Maintenance Crews(101)

Action
Keep elements of bridges clean
Keep floor drains open
clear waterways of trees and drift within right-of-way
Cut weeds and brush around and under bridges
Note and report needs for bridge repairs beyond ability of county crew
Maintain all types of bridges and major drainage structures
Major repairs to bridge structural members, floors, piers, abutments, etc.
Replace substandard bridges
Construct new bridges,
Paint steel bridges
Patch and replace concrete floors
Repair and replace timber floors, stringers, and bents
Spot paint structural steel and paint small steel structures and bearings
Reset steel expansion dams
Clean lower chords and bearing seats of bridges of all dirt, drift, and debris
Perform pier and abutment repairs
Repair and replace handrails
Perform other maintenance duties as directed

Intervals for Actions.

A Kentucky TC study of actions, intervals and costs in preservation of bridges in year 2015 reported a survey of US states in the AASHTO TSP2 Midwest Bridge Preservation partnership (102). Intervals for actions from the survey are listed in Table 56.

Table 56 Kentucky TC. Intervals of Actions (102)

Action	State	Interval, year
Approach Pavement Relief Joint	MI	4

Action	State	Interval, year
Clean/Flush Deck	IA	1
Clean/Seal Expansion Joints	WI	1
Coat Concrete Barrier/Deck Fascia	MN	7
Drainage System Cleaning/Repair	WI	1
Seal Bridge Deck Cracks (e.g. Crack Chaser)	MI	7
Seal Bridge Deck Cracks (e.g. Crack Chaser)	MN	5
Seal Bridge Deck Cracks (e.g. Crack Chaser)	WI	5
Seal Deck –Aggregate (e.g. Chip Seal)	MN	20
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	IL	4
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	MI	5
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	WI	5
Seal Entire Bridge Deck Cracking (e.g. Floodcoat, Healer Sealer)	MI	18
Seal Entire Bridge Deck Cracking (e.g. Floodcoat, Healer Sealer)	MN	7
Seal Joints	MI	4
Seal Joints	MN	8
Seal Joints	WI	4

Costs of Actions.

A Kentucky TC study of actions, intervals and costs in preservation of bridges in year 2015 reported a survey of US states in the AASHTO TSP2 Midwest Bridge Preservation partnership (102). Unit costs of actions from the survey are listed in Table 56.

Table 57 Kentucky TC. Costs of Actions (102)

Action	State	Cost
Approach Leveling/Lifting/Stabilization (e.g. Wedging, mud jacking)	KS	$85/CY
Approach Leveling/Lifting/Stabilization (e.g. Wedging, mud jacking)	OH	$4.59/pound
Approach Leveling/Lifting/Stabilization (e.g. Wedging, mud jacking)	OK	$85
Approach Leveling/Lifting/Stabilization (e.g. Wedging, mud jacking)	WI	$70/SY
Approach Pavement Relief Joint	KS	$75.00/LF
Approach Pavement Relief Joint	MI	$50.00/LF
Approach Pavement Relief Joint	OH	$75.00/LF
Approach Pavement Relief Joint	OK	$75.00/LF
Approach Slab Overlay	MN	$5.50/SF
Approach Slab Overlay	NE	$7.50/SF
Approach Slab Overlay	OH	$70/CY
Approach Slab Overlay	OK	$100.00/SY
Approach Slab Overlay	SD	$100.00/SY
Approach Slab Overlay	WI	$150/ton
Clean/Flush Deck	IA	$12,500/bridge
Clean/Flush Deck	MI	$50.00/hour
Clean/Seal Expansion Joints	IA	$70.00/LF
Clean/Seal Expansion Joints	KS	$250.00/ hour
Clean/Seal Expansion Joints	MN	$123.00/LF
Clean/Seal Expansion Joints	WI	$150.00/bridge
Coat Concrete Barrier/Deck Fascia	IA	$3.00/LF
Coat Concrete Barrier/Deck Fascia	MI	$12.00/SY
Coat Concrete Barrier/Deck Fascia	MN	$3.27/LF
Coat Concrete Barrier/Deck Fascia	OH	$14.10/SY

Action	State	Cost
Coat Concrete Barrier/Deck Fascia	WI	$1.71/SY
Cut Relief Joints in Approach Pavement	KS	$60.00/LF
Cut Relief Joints in Approach Pavement	MI	$50.00/LF
Cut Relief Joints in Approach Pavement	OK	$75.00/LF
Deck Fascia/Overhang Repair	KS	$150.00/LF
Deck Fascia/Overhang Repair	MI	$70.00/SF
Deck Fascia/Overhang Repair	MN	$120.00/LF
Deck Fascia/Overhang Repair	NE	$250.00/LF
Deck Fascia/Overhang Repair	OH	$268.34/LF
Deck Joint Repair	KS	$100/LF
Deck Joint Repair	MI	$300.00/LF
Deck Joint Repair	MN	$280.00/LF
Deck Joint Repair	NE	$80.00/LF
Deck Joint Repair	OH	$86.82/LF
Deck Joint Repair	SD	$12,000/joint
Deck Joint Repair	WI	$75/LF
Deck Joint Replacement	IA	$1,000.00/LF
Deck Joint Replacement	KS	$200/LF
Deck Joint Replacement	MI	$450.00/LF
Deck Joint Replacement	MN	$437.50/LF
Deck Joint Replacement	NE	$300.00
Deck Joint Replacement	OH	$382.21/LF
Deck Joint Replacement	OK	$ 450.00/LF
Deck Joint Replacement	SD	$19,000/joint
Deck Joint Replacement	WI	$200.00/LF
Deck repair- full depth	IA	$43/SF
Deck repair- full depth	IL	$600/SF
Deck repair- full depth	KS	$300/SY
Deck repair- full depth	MI	$70/SF
Deck repair- full depth	MN	$40/SF
Deck repair- full depth	NE	$47/SF
Deck repair- full depth	OH	$400/CY
Deck repair- full depth	OK	$500/SY
Deck repair- full depth	SD	$200/SY
Deck repair- full depth	WI	$600/CY
Deck repair: Half Sole (Depth)	IA	$20/SF
Deck repair: Half Sole (Depth)	IL	$260/SY
Deck repair: Half Sole (Depth)	KS	$250/SY
Deck repair: Half Sole (Depth)	NE	$21/SF
Deck repair: Half Sole (Depth)	NM	$37.5/SF
Deck repair: Half Sole (Depth)	OH	$193.47/SF
Deck repair: Half Sole (Depth)	OK	$300/CY
Deck repair: Half Sole (Depth)	SD	$175/SY
Drainage System Cleaning/Repair	KS	$250.00/ hour
Drainage System Cleaning/Repair	WI	$150.00/each drain
Epoxy Overlay	IA	$45/SY
Epoxy Overlay	IL	$42/SY
Epoxy Overlay	KS	$35/SY
Epoxy Overlay	NE	$54/SY

Action	State	Cost
Epoxy Overlay	NM	$7/SF
Epoxy Overlay	OH	$75/SY
Epoxy Overlay	OK	$45/SY
Epoxy Overlay	SD	$49/SY
Epoxy Overlay	SD	$35/SY
HMA overlay (Cap) (no Membrane)	MI	$1.2/SF
HMA overlay (Cap) (no Membrane)	WI	$15/SF
Patching with concrete	IA	$60/SF
Patching with concrete	KS	$2500/SY
Patching with concrete	MI	$33/SF
Patching with concrete	NE	$24/SF
Patching with concrete	OH	$55.69/SF
Patching with concrete	OK	$300/SY
Patching with concrete	SD	$75/CF
Patching with concrete	WI	$500/CY
Patching with HMA overlay (No waterproofing)	MI	$1.2/SF
Patching with HMA overlay (No waterproofing)	OH	$131/CY
Patching with HMA overlay (No waterproofing)	WI	$15/SF
Patching with HMA overlay (With water proofing membrane)	KS	$40/SY
Patching with HMA overlay (With water proofing membrane)	MI	$4.5/SF
Patching with HMA overlay (With water proofing membrane)	OH	$23/SY
Railing Paint	IA	$10/SF
Railing Paint	MI	$1.33/SF
Railing Paint	OH	$1.57/SF
Railing Paint	SD	$12.5/SF
Seal Bridge Deck Cracks (e.g. Crack Chaser)	MI	$4.50/LF
Seal Bridge Deck Cracks (e.g. Crack Chaser)	MN	$3.26/LF
Seal Bridge Deck Cracks (e.g. Crack Chaser)	OH	$25/SY
Seal Bridge Deck Cracks (e.g. Crack Chaser)	OK	$7.50/LF
Seal Bridge Deck Cracks (e.g. Crack Chaser)	WI	$2.50/LF
Seal Deck –Aggregate (e.g. Chip Seal)	MN	$7.00/SF
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	IL	$1.00/SF
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	MI	$1.67/SF
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	NE	$1.00/SF
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	OK	$0.56/SF
Seal Deck-Liquid (e.g. –Star Macro Deck, Pavon In-Deck, Silane)	WI	$0.02/SF
Seal Entire Bridge Deck Cracking (e.g. Floodcoat, Healer Sealer)	MI	$16.00/SY
Seal Entire Bridge Deck Cracking (e.g. Floodcoat, Healer Sealer)	MN	$1.44/SY
Seal Entire Bridge Deck Cracking (e.g. Floodcoat, Healer Sealer)	OH	$10/SY
Seal Entire Bridge Deck Cracking (e.g. Floodcoat, Healer Sealer)	OK	$15/SY
Seal Joints	KS	$250.00/ hour
Seal Joints	MI	$15.00/LF
Seal Joints	MN	$3.78/LF
Seal Joints	NE	$80.00/LF
Seal Joints	OH	$250.00/hour
Seal Joints	OK	$350.00/LF
Seal Joints	WI	$0.65/LF
Shave approach Shoulders	KS	$10/SF
Slope Paving Repair	IA	$4.44/SF

Action	State	Cost
Slope Paving Repair	KS	$45.00/SF
Slope Paving Repair	MI	$33.33/SF
Slope Paving Repair	MN	$10.00/SF
Slope Paving Repair	OH	$45.00/SF

Deck Preservation

Kentucky TC has a special specification for deck overlay using waterproof hot-mix asphalt (103).

Louisiana Department of Transportation and Development

Definition. Preventive Maintenance.

Louisiana DOTD defines preventive maintenance as a strategy to extend service life by applying cost-effective treatments (104). Preventive maintenance is many relatively small repairs and actions performed to keep the bridge in good condition. Preventive maintenance is applied to bridges that are structurally sound and have significant remaining service life. Preventive maintenance is a major part of bridge preservation.

Policy. Agency Preservation Section.

Louisiana DOTD has a Systems Preservation Section that operates under the Office of Engineering, Systems Engineering Division (105). The Section manages statewide programs to preserve pavements and bridges.

Preservation of Historic Bridges

Louisiana DOT publishes a guide to identification of historic bridges (107).

Actions. Preventive Maintenance.

Louisiana DOT lists actions in preventive maintenance (Table 58) (105).

Table 58 Louisiana DOTD. Preventive Maintenance Actions (105)

Action
Joint repair and replacement
Bearing repair and replacement
Localized deck repairs
Spot painting
Deck sealing
Grid deck section repair or localized section replacement
Concrete spall repair on pedestals, dents, caps, pilings, piers and columns
Bridge deck drainage

Data Systems. Agency-Developed Elements.

Louisiana DOTS defines a set of elements, compatible with AASHTO Commonly Recognized Elements, for movable bridges (Table 59) (108).

Table 59 Louisiana DOTD. Elements for Movable Bridges (108)

Number	Name
540	Open gearing
541	Speed reducers
542	Shafts
543	Shaft bearings and shaft couplings
544	Brakes
545	Emergency drive and backup power system
547	Hydraulic power units
548	Hydraulic piping system
549	Hydraulic cylinders/motors/rotary actuators
550	Machinery base
560	Span locks/toe locks/heel stops/tail locks

Number	Name
561	Live load shoes/wedges/strike plates/buffer cylinders
562	Counterweight support
563	Access ladder and platforms
564	Counterweight
565	Trunnion-straight/curved rack
570	Transformers and thyristors
571	Submarine cable
572	Conduit and junction boxes
573	Programmable logic controllers
574	Control console
580	Navigational light system
581	Cables-vertical lift
582	Bridge – specific equipment (lift)
583	Bridge – specific equipment (swing)
584	Bridge – specific equipment (pontoon)
586	Bridge – specific equipment (bascule)
590	Barriers – movable bridges
591	Traffic warning gates – movable bridges
592	Traffic signals
585	Fender system/pier protection

Performance Measures

Louisiana tracks percent deck area of structurally deficient bridges (109). Percentages are reported for bridges grouped by route functional class.

Deck Preservation

Louisiana has a project specification for steel deck (110).

Louisiana DOT lists approved materials (111) for

Rapid Setting Patching Material for Conc

CTS Cement	Rapid Set Concrete Mix
Dayton Superior	Pave Patch 3000
Dayton Superior	HD-50 Heavy-Duty Concrete Patch
Dayton Superior	Re-Crete 20 Minute
Euclid Chemical	Euco-Speed
Euclid Chemical	Speed Crete Green Line
HB Fuller	ProSpec Premium Patch 200
L & M Const. Chemicals	Durapatch Hiway
MAPEI Corporation	Planitop 18
MAPEI Corporation	Planitop 18 ES
Sika Corporation	SikaCrete 321 FS
Sika Corporation	SikaQuick 2500
Quikrete	QUIKRETE FastSet DOT Mix 1244-56
Transpo Industries	Transpo Polymer Concrete (Transpro T17)
W. R. Meadows	Futura 15
Western Material & Design	Fastrac 246

Western Material & Design	Fastrac 300
Five Star Products	Rapid Surface Repair
Williamette Valley Company	Fast Patch MD/GC

Microsilica (Silica Fume)

BASF Corporation	MasterLife SF 100
Elkem Materials	EMS 970 D
Euclid Chemical	Eucon MSA
GCP Applied Tech	Force 10,000
Russtech, Inc.	RussTech CSF
Sika Corporation	Sikacrete 950DP

Maine Department of Transportation

Policy. Bridge Preservation Funding.

Maine DOT's program for bridge preservation funds bridge strengthening and bridge improvements (112). Current funding for bridge preservation is $70 million per year. Current need for bridge preservation is $140 million per year. Bridge maintenance, a part of highway operations, is funded at $20 million per year.

Actions

Maine DOT defines custodial maintenance to include bridge washing and minor actions (Table 60) (112). Bridge preservation includes repairs to bridges and replacement of components of bridges (Table 61) (112). Maine DOT lists 59 actions in bridge preservation in its work plan for years 2015 to 2017. In the plan, bridge preservation includes a full range of actions from bridge washing to bridge rehabilitation to bridge replacement. In Maine DOT's *KOBS* report, actions in preservation, rehabilitation and replacement are listed (Table 62) (113). Preservation actions with the highest priority are Painting, Wearing surfaces and Sealing bridge joints (113).

Table 60 Maine DOT. Bridge Maintenance Actions (112)

Action
Bridge washing
Minor maintenance

Table 61 Maine DOT. Bridge Preservation Actions (112)

Action		
Extend drains	Repair fascia and abutment	Replace anchor bolts
Grout stone abutments	Repair abutment	Replace asphalt wearing surface with concrete
Install curtains at finger joints	Repair abutment header	Replace bridge
Install drains	Repair approaches	Replace bridge seal
Install rail	Repair bridge seats	Replace culvert
Paint beam ends	Repair curbs	Replace curb
Paint beams	Repair deck	Replace deck
Paint bearings	Repair drains	Replace drains
Paint bridge	Repair fascia	Replace joint
Paint pin and link	Repair headers	Replace rail
Preventive maintenance, beam ends	Repair joint	Replace rivets
Preventive maintenance, bearings	Repair main support members	Replace seal
Rehabilitate bridge	Repair pier collar	Replace superstructure
Rehabilitate culvert	Repair piers	Replace wearing surface
Rehabilitate deck	Repair rail	Scour countermeasures
Rehabilitate substructure	Repair retaining wall	Seal concrete
Reinforce beam ends	Repair timber backwall	Seal joint
Remove bridge	Repair wearing surface	Stabilize wingwall
	Repair wingwall	Statewide bridge cleaning, washing and sealing
		Statewide bridge joint repair and replacement
		Statewide bridge work and improvements
		Widen structure

Table 62 Maine DOT. Preservation, Rehabilitation, and Replacement Actions (113)

Action		
Preservation	**Rehabilitation**	**Replacement**
Washing Sealing deck joints Facilitating drainage Sealing concrete Painting steel Removing channel debris Protecting against stream erosion	Restore structural integrity Correct safety defects	Total replacements, Superstructure replacements Bridge widening

Data System

Maine DOT uses an asset management system developed by Deighton Associates (113). The system generates preservation and maintenance plans for each bridge.

Performance Measure

Maine DOT tracks the percentages of state-owned bridges in good/fair/poor condition (113). Condition is determined by least NBI general condition rating for each bridge. Maine DOT tracks the percentage of structurally deficient bridges (113).

Maine DOT generates grades for customer service level (CSL) (113). Grades are A, B, C, D and F; similar to LOS grades used in maintenance quality assurance. Three CSL grades are generated for each bridge (Table 63).

Table 63 Maine DOT. CSL Grades for Bridges (113)

CSL Grade	Note
Bridge Reliability CSL	Pass/fail with an automatic fail if one or more of the major components of the bridge is in serious condition and/or if the bridge is scour critical.
Bridge Condition CSL	Related to the 0-9 National Bridge Inventory (NBI) condition ratings.
Bridge Service CSL	Based on a posted weight restriction on a sliding scale relative to the Highway Corridor Priorities

Deck Preservation

Maine DOT has standard specifications (118) for deck waterproofing membrane (Section 508), for silane sealers on bridge decks (Section 515), for deck overlay using latex-modified concrete (Section 516), and for patching concrete decks (Section 518).

Among qualified products, Maine DOT lists:

Waterproofing Membrane (114)

Bridge Preservation LLC	Spray-Applied Membranes
C.I.M. Industries	C.I.M. 1000 Waterproofing System
Chase Corporation	Royston Bridge Membrane 10AN Easy Pave
Crafco, Inc.	Ultraseal 3750 MTO Membrane
D.S. Brown	Deckguard Spray-Applied Membranes

Firestone Building Products	Firestone SBS FR Torch
IKO	Armour Bridge Membrane Waterproofing Torch-Applied Membranes
Protecto Wrap Company	Protecto Wrap M-140A Cold Applied Bridge Deck Waterproofing
Protecto Wrap Company	Protecto Wrap M-400A Cold Applied Bridge Deck Waterproofing
Soprema Roofing and Waterproofing	Sopralene Flam Antirock Torch-Applied Membranes
Stirling Lloyd Products, Inc.	Eliminator Spray-Applied Membranes
W.R. Meadows	MEL-DEK Deck Waterproofing System

Concrete Crack Injection (115)

Cornerstone Construction Material	CE110 Injection Resin
Dayton Superior Corporation	Sure Inject J56 SLV
Euclid Chemical	Dural 452 LV
Hilti Inc.	CI 060 EP Crack Injection System
MAPEI Corp	Epojet

Concrete Sealers and Coatings (116)

Advanced Chemical Technologies	SIL-ACT ATS-100 LV Silane
Advanced Chemical Technologies	SIL-ACT ATS-42A
ChemMasters	Aquanil Plus 100
ChemMasters	Aquanil Plus 40-A
Euclid Chemical Co.	Baracade Silane 100C
Evonik Corporation	Protectosil AQUA-TRETE 20
Evonik Corporation	Protectosil AQUA-TRETE 40
Foundation Armor	Armor SX 5000
Sika Corporation	Sikagard 550W Elastocolor
Sika Corporation	Sikagard 670W Clear
Sika Corporation	Sikagard 701W
Sika Corporation	Sikagard 705 L
Sika Corporation	Sikagard 740W
Transpo Industries	Sealate T70 MX-30
Vexcon Chemicals	Certi-Vex Penseal 244-100%
Vexcon Chemicals	Certi-Vex Penseal 244-40%-AIM (OTC)
Vexcon Chemicals	PowerSeal 20%
Vexcon Chemicals	Powerseal 40%

Rapid Setting Concrete Patching Materials (117)

BASF Corporation	MasterEmaco T 1060
CTS Cement Manufacturing Corp.	Rapid Set DOT Concrete Mix
Dayton Superior Corporation	HD 50
Five Star Products, Inc.	EpoxyFix Rapid Surface Repair
MAPEI Corp.	Planitop 18
MAPEI Corp.	Planitop 18 ES
Phoscrete Corporation	Phoscrete HC
QUIKRETE Companies	Commercial Grade FastSet Concrete Mix
QUIKRETE Companies	Commercial Grade FastSet Concrete Mix w/ Fibers

QUIKRETE Companies	Rapid Road Repair (fibered)
Roklin Systems, Inc.	Concrete Welder Gray
Roklin Systems, Inc.	Polyflex DS Gray
Sika Corporation	Sikacrete 421 CI Rapid
Sika Corporation	SikaQuick VOH
SILPRO, LLC	SilproRapid
SILPRO, LLC	SilproRepair VOH
SpecChem, LLC	RepCon 928
United States Gypsum Co.	EcoFix Extended Formula
United States Gypsum Co.	EcoFix Xtend

Maryland State Highway Administration

Definition. Bridge Preservation.

In its annual report (119), Maryland SHA equates preservation with rehabilitation and replacement of structurally deficient bridges.

Performance Measure

Maryland State Highway Agency (SHA) tracks the count and percentage of structurally deficient bridges (119).

Massachusetts Department of Transportation

Performance Measures

Massachusetts DOT tracks the number of structurally deficient bridges (120).

Deck Preservation

Among qualified products, Massachusetts DOT lists

Concrete Crack Sealers (121)

BASF	MasterInject 1500
BASF	MasterSeal 630
Euclid Chemical	Dural 452 MV
Grace Construction Products	Denepox I-40
Sika Corp.	Sikadur 35 Hi-Mod LV LPL
Sika Corp.	Sikadur 52
Sika Corp.	Sikaflex-1A
Sika Corp.	SikaPronto 19 TF

Concrete Sealers (122)

Advanced Chemical Technologies	SIL-ACT ATS-100LV
BASF	MasterProtect H 400
Dayton Superior	Weather Worker 100% J29A
Euclid Chemical	BARACADE WB 244
Prosoco Inc.	SLX100 Water & Oil Repellent
Vexcon Chemicals	Powerseal 40

Rapid Set Concrete Patch Materials (123)

BASF	MasterEmaco T1060
CTS Cement Manufacturing Corp.	Rapid Set DOT Repair Mix
Dayton Superior Corp.	HD 50
Dayton Superior Corp.	Pave Patch 3000
G-P Gypsum Corporation	Denscrete RP
Quikrete Companies	Rapid Road Repair
Sika Corparation	SikaQuick 2500
SpecChem	RepCon 928
U.S. Concrete Products	HP DOT Grade Repair Mortar

Rapid Setting Polymer Concrete (124)

EMACO 2020 WITH 2041 PRIMER	MBT/CHEMREX, INC.
FX-826	FOX INDUCTRIES, INC
TRANSPO T-17 WITH T-41S PRIMER	TRANSPO INDUSTRIES, INC.

Michigan Department of Transportation

Definition. Capital Scheduled Maintenance.

Michigan DOT defines capital scheduled maintenance (CSM) in terms of the scope and impacts of projects (Table 64) (125). Projects should have short duration and limited impact on traffic. Projects should address causes of deterioration. Projects should deliver a small task that can be repeated at many nearby bridges

Table 64 Michigan DOT. Criteria for Capital Scheduled Maintenance (125)

Criteria
The anticipated work should have little or no impact to traffic and have very little traffic control costs
The work should be of short duration, typically completed within one working day
The work should be focused on activities that if left unattended will cause deterioration of the structure leading to more expensive repairs
Priority should be given to corridors where the same small task can be performed on many bridges.

Policy.

Bridge Preservation Guidance.

Michigan DOT publishes guidance for local governments in asset management, including preservation of bridges (126). Michigan DOT notes the cycle of assessment, planning, execution and evaluation for management of assets (Table 65).

Table 65 Michigan DOT. Steps in Asset Management (126)

Step in Asset Management
Assess current condition
Create a “mix of fixes”, estimate costs and funding levels
Predict future condition, develop performance measures and targets
Conduct tradeoff analysis, identify candidate projects
Set priorities, develop a multi-year program
Report results

Bridge Preservation Program Requirements.

Michigan DOT identifies the essential aspects of effective programs for bridge preservation (Table 66) (126). A program for preservation of bridges is expressed as a plan (Table 67) (126).

Table 66 Michigan DOT. Aspects of Programs for Bridge Preservation (126)

Aspect of Bridge Preservation
Employs long-term strategies and practices to preserve condition and extend useful life of bridges
Has sustained, adequate funding
Ensures use of appropriate treatments at appropriate times

Table 67 Michigan DOT. Preservation Plan (126)

Preservation Plan	
Goal	Definition of the agency's purpose
Objectives	Description of what the agency will achieve by implementing the plan
Performance Measures	Metrics used to will evaluate the effectiveness of the plan
Bridge Assets	Summary of the number, type, and condition of bridges in the network
Condition Analysis	Assessment of the current state of bridges
Risk Management	Recognition of risks inherent in bridge conditions and in program
Preservation Strategy	Actions to execute to address preservation
Prioritization	Method to rank projects
Implementation	Method to execute the plan
Cost Estimate	Annual review and updating of actions programmed in the plan
Operations and Maintenance Plan	Annual activities scheduled in a five-year program
Five-Year Annual Cost Projection	Year-by-year, project-by-project schedule of costs
Five-Year Funding	Year-by-year schedule of sources and allocation of funds

Selection of Actions.

Michigan DOT provides guidance in selection of actions to preserve reinforced concrete bridge decks. Guidance is provided separately for bridge decks with uncoated steel reinforcement (Table 68) (127), and for bridge decks with epoxy-coated steel reinforcement (Table 69) (128).

Table 68 Michigan DOT. Actions for Bridge Decks with Uncoated Steel Reinforcement (127)

DECK CONDITION STATE				**REPAIR OPTIONS**	**POTENTIAL RESULT TO DECK BSIR**		**ANTICIPATED FIX LIFE**
Top Surface		**Bottom Surface**			**Top Surface BSIR #58a**	**Bottom Surface BSIR #58b**	
BSIR #58a	**Deficiencies %**	**BSIR #58b**	**Deficiencies %**				
≥ 5	N/A	N/A	N/A	Hold Seal Cracks/Healer Sealer	No Change	No Change	1 to 4 years
	≤ 5%	> 5	≤ 2%	Epoxy Overlay	8, 9	No Change	10 to 15 years
	≤ 10%	≥ 4	≤ 25%	Deck Patch	Up by 1 pt.	No Change	3 to 10 years
4 or 5	10% to 25%	5 or 6	≤ 10%	Deep Concrete Overlay	8, 9	No Change	25 to 30 years
		4	10% to 25%	Shallow Concrete Overlay	8, 9	No Change	20 to 25 years
				HMA Overlay with waterproofing membrane	8, 9	No Change	8 to 10 years
		2 or 3	> 25%	HMA Cap	8, 9	No Change	2 to 4 years
< 3	>25%	> 5	< 2%	Deep Concrete Overlay	8, 9	No Change	20 to 25 years
		4 or 5	2% to 25%	Shallow Concrete Overlay	8, 9	No Change	10 years
				HMA Overlay with waterproofing	8, 9	No Change	5 to 7 years

DECK CONDITION STATE				REPAIR OPTIONS	POTENTIAL RESULT TO DECK BSIR		ANTICIPATED FIX LIFE
Top Surface		Bottom Surface					
BSIR #58a	Deficiencies %	BSIR #58b	Deficiencies %		Top Surface BSIR #58a	Bottom Surface BSIR #58b	
				membrane			
		2 or 3	>25%	HMA Cap	8, 9	No Change	1 to 3 years
				Replacement with Epoxy Coated Rebar (ECR) Deck	9	9	60+ years

Note
BSIR = Bridge Safety Inspection Report
58a = Condition rating, Deck wearing surface
58b = Condition rating, Deck soffit

Table 69 Michigan DOT. Actions for Bridge Decks with Epoxy-Coated Steel Reinforcement (128)

DECK CONDITION STATE				REPAIR OPTIONS	POTENTIAL RESULT TO DECK BSIR		ANTICIPATED FIX LIFE
Top Surface		Bottom Surface					
BSIR #58a	Deficiencies %	BSIR #58b	Deficiencies %		Top Surface BSIR #58a	Bottom Surface BSIR #58b	
≥ 5	N/A	N/A	N/A	Hold Seal Cracks/Healer Sealer	No Change	No Change	1 to 4 years
	≤ 5%	> 5	≤ 2%	Epoxy Overlay	8, 9	No Change	10 to 15 years
	≤ 10%	≥ 4	≤ 25%	Deck Patch	Up by 1 pt.	No Change	3 to 10 years
4 or 5	10% to 25%	4	10% to 25%	Shallow Concrete Overlay	8, 9	No Change	20 to 25 years
				HMA Overlay with waterproofing membrane	8, 9	No Change	8 to 10 years
		2 or 3	> 25%	HMA Cap	8, 9	No Change	2 to 4 years
< 3	>25%	4 or 5	2% to 25%	Shallow Concrete Overlay	8, 9	No Change	10 years
				HMA Overlay with waterproofing membrane	8, 9	No Change	5 to 7 years
		2 or 3	>25%	HMA Cap	8, 9	No Change	1 to 3 years
				Replacement with Epoxy Coated Rebar (ECR) Deck	9	9	60+ years

Note
BSIR = Bridge Safety Inspection Report
58a = Condition rating, Deck wearing surface
58b = Condition rating, Deck soffit

Actions

The Michigan Transportation Asset Management Council (TAMC) lists actions in preventive maintenance, in rehabilitation, and in replacement (Table 70) (126). Michigan DOT lists similar actions in scheduled maintenance and in preventive maintenance (Table 71) (129).

Table 70 Michigan TAMC. Actions for Bridges (126)

Preventive Maintenance		Rehabilitation	Replacement
Routine Scheduled Maintenance	**Capital Preventive Maintenance**		
Superstructure washing Vegetation control Drainage system clean-out and repair Spot painting Joint repair or replacement Concrete sealing Minor concrete patching and repair Concrete crack sealing Approach pavement relief joints Slope paving repair	Joint replacement Painting Steel Complete repainting Zone Painting Deck patching Deck Overlays Epoxy overlays HMA overlays with waterproofing HMA cap (no membrane) Scour countermeasures Pin and hanger replacement	Deep or shallow concrete deck overlays Superstructure repairs Bridge barrier replacement Substructure replacement Extensive substructure repairs Steel repairs Concrete beam end repairs Geometric upgrades	Deck Replacement Superstructure Replacement Substructure Replacement Total Structure Replacement

Table 71 Michigan DOT. Actions in Bridge Preservation (129)

Capital Scheduled Maintenance (CSM): (sustain current condition longer)	**Capital Preventive Maintenance (CPM): (address the needs of the "fairs")**
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	Pin & hanger replacement Complete painting Zone painting Joint replacement Epoxy overlay Deck patching Scour countermeasures HMA overlay with waterproofing membrane HMA cap (no membrane) minor substructure repair
Rehabilitation: (improve "poor" or "fair" to "good")	**Replacement: (improve "poor" to "good")**
Concrete overlay – shallow Concrete overlay – deep Superstructure repairs Extensive substructure repair Substructure replacement	Deck replacement Superstructure replacement Structure replacement

Movable Bridges.

Michigan DOT lists the responsibilities of statewide maintenance crews and of regional maintenance crews for actions at movable bridges (Table 72) (130).

Table 72 Michigan DOT. Actions and Responsibilities at Movable Bridges (130)

Duties of Statewide Crews	Duties of Region/TSC[1] Bridge Crews
1. Perform all mechanical maintenance 2. Perform all hydraulic repairs 3. Perform minor repairs and services as needed to the auxiliary engine and generator. 4. Perform all electrical repairs, 5. Repair water and sewer systems 6. Weld bridge decks 7. Instruct the bridge tenders on the operations of the bridges, 8. All electric motors are to be greased and serviced 9. Clean counterweight pits as required. 10. Wash bridge elements not accessible by the Region/TSC bridge crew	1. Wash bridge decks, stringers, floor beams, gutters, other elements accessible from the deck surface 2. Miscellaneous non-structural welding can be done by an experienced Region/TSC welder 3. Perform concrete repair work. 4. Spot paint any corroded or repaired areas. 5. Assist Lansing bridge inspectors

[1] Transportation Service Center

Intervals for Actions

Michigan TAMC publishes expected intervals for actions in maintenance, rehabilitation and replacement of bridges (Table 73) (126).

Table 73 Michigan TAMC. Intervals for Actions (126)

Action	Bridge Selection Criteria	Expected Service Life
	--- Replacement ---	
Total Replacement	- NBI Rating of 3 or less, - Or cost of rehabilitation exceeds cost of replacement, - Or scour critical with no countermeasures available	70 yrs
Superstructure Replacement	- NBI Rating for Superstructure of 4 or less, - Or cost of rehabilitation exceeds cost of replacement	40 yrs
Deck Replacement	- Use guidelines in MDOT's *Bridge Deck Preservation Matrix.* - NBI Rating of 4 or less for deck surface and deck bottom, - Or deck replacement cost is competitive with rehabilitation Epoxy Coated Steel Black Steel	 70 yrs 40 yrs
Substructure Replacement (Full or Partial)	- NBI Rating of 4 or less for abutments, piers, or pier cap, - Or existence of open vertical cracks, signs of differential settlement, or presence of active movement, - Or scour critical with no countermeasures available	40 yrs
	--- Rehabilitation ---	
Concrete Deck Overlays	Guidelines in MDOT's *Bridge Deck Preservation Matrix*	
Deep	NBI Deck Rating < 5 for surface and > 5 for bottom	25 yrs
Shallow	NBI Deck Rating < 5 for surface and > 4 for bottom	12 yrs

Action	Bridge Selection Criteria	Expected Service Life
HMA / Membrane	NBI Deck Rating < 5 for surface and > 4 for bottom	8 yrs
HMA Cap	NBI Deck Rating < 5 for surface and < 4 for bottom	3 yrs
Railing Retrofit / Replacement	- Deck Rating greater than 5, - And Railing / Barrier rated less than 5, - Or Safety Improvement is needed	
Steel Beam Repairs	- More than 25% section loss that affects load carrying capacity, - Or to correct impact damage that impairs beam strength	
Prestressed Concrete Beam Repairs	- More that 5% spalling is present, - Or repair areas to correct impact damage that impairs beam strength or exposes prestressing strands	
Pin and Hanger Replacement	- NBI Rating for elements is 4 or lower - Or excessive section loss, severe pack rust, or out-of-plane distortion.	
Substructure Concrete Patching and Repair	- NBI Rating for abutments or piers is 5 or 4 - And less than 30% of the surface is spalled and delaminated, - Or in response to Inspector's work recommendation	
--- Preventive Maintenance ---		
Deck Joint Replacement	- Include when doing deep or shallow overlays, - Or NBI Rating for joint is 4 or lower, - Or when joint is leaking heavily	
Steel Bearing Replacement	- NBI Rating for girders and deck is 5 or higher - And rating for bearings is 4 or lower	
Complete Painting	- NBI Rating for paint condition is 3 or lower, - Or in response to Inspector's recommendation for complete painting	15 yrs
Zone Painting	- NBI Rating for paint condition is 5 or 4, - Or less than 15% of existing paint area has failed - And remainder of paint system is in good or fair condition	10 yrs
Thin Epoxy Overlays	- Deck Surface Rating of 5, 6, or 7 with minor delamination - And spalling and/or moderate cracking	10 yrs
HMA Overlay Cap without Membrane	NBI Rating of 3 or less for deck surface and deck bottom. Temporary holdover to improve rideability for a bridge in the 5 year plan for rehab / replacement.	3 yrs
Concrete Deck Patching	Deck Surface Rating of 5, 6, or 7 with minor delamination and spalling, or in response to Inspector's work recommendation	5 yrs
Scour Countermeasures	- Structure is categorized as scour critical - And is not scheduled for replacement. - NBI comments in abutment and pier ratings indicate presence of scour holes.	
--- Scheduled Maintenance ---		
Superstructure Washing	When salt contaminated dirt and debris collected on superstructure is causing corrosion or deterioration by trapping moisture, or in response to Inspector's work recommendation.	2 yrs
Concrete Surface Washing	When concrete is exposed to salt contamination widespread map cracking is present, or in response to Inspector's work recommendation.	2 yrs
Vegetation Control	When vegetation traps moisture on structural elements or is growing from joints or cracks, or in response to Inspector's work recommendation for brush cut.	1 yr

Action	Bridge Selection Criteria	Expected Service Life
Debris Removal	When vegetation, debris, or sediment accumulates on the structure or in the channel or in response to inspector's work recommendation.	1 yr
Drainage System Clean-Out/ Repair	When drainage system is clogged with debris, or drainage elements are broken, deteriorated, or damaged.	2 yrs
Spot Painting	For zinc based paint systems only, in response to Inspector's work recommendation.	5 yrs
Concrete Crack Sealing	Concrete is in good or fair condition, and cracks extend to the depth of the reinforcement, or in response to Inspector's work recommendation	5 yrs
Slope Paving Repair	NBI Rating is 5 or lower, or when slope paving has significant areas of distress or failure or has settled.	
Install Riprap	To protect surfaces when erosion threatens the stability of side slopes or channel banks.	

Costs of Actions

Michigan provides average unit costs actions in capital scheduled maintenance (Table 74) (133).

Table 74 Michigan DOT. Unit Costs of Actions (133)

WORK ITEM		UNIT	UNIT COST
DECK			
Patching Concrete, C-L	(deck or barrier rail patching)	CYD	$700.00
Penetrating Healer/Sealer, Bridge Deck		SYD	$16.00
Crack Sealer		FT	$8.00
Water Repellant Treatment, Penetrating	(deck surface)	SYD	$16.00
Concrete Surface Coating	(concrete barrier rail, deck slab fascia)	*SYD	$12.00
Resealing Bridge Construction Joints	(hot poured rubber)	FT	$12.00
End Header Replacement		FT	$80.00
Concrete, Grade D		CYD	$800.00
Reinforcement, Steel, Epoxy Coated		LBS	$1.30
Adhesive Anchoring of Horiz. Bars __"		EA	$25.00
Drain Casting, Type 1		EA	$400.00
Drain Casting, Type 2		EA	$400.00
Drain Casting Assembly		EA	$950.00
Deck Drain , Extension		EA	$400.00
Downspout Replacement		EA	$400.00
Embedded Galvanic Anode		EA	$15.00
Other			
SUPERSTRUCTURE			
Spot Painting	(80% clean, 20% coat)	*SFT	$20.00
Patching Concrete, C-L	(concrete beam patching)	CYD	$700.00
Water Repellent Treatment, Penetrating	(concrete fascia beams)	SYD	$16.00
Concrete Surface Coating	(concrete fascia beams)	*SYD	$12.00
Other			
SUBSTRUCTURE			
Patching Concrete, C-L	(substructure patching)	CYD	$700.00

WORK ITEM		UNIT	UNIT COST
Patch Forming	(vertical & overhead surfaces)	SFT	$32.00
Concrete Surface Coating	(vertical surfaces)	*SYD	$12.00
Substructure Horizontal Surface Sealer	(horizontal surfaces)	*SYD	$20.00
Water Repellent Treatment, Penetrating		SYD	$16.00
Other			
DEMOLITION			
Hand Chipping, Shallow	(~3" deep)	SYD	$110.00
Hand Chipping, Deep	(~6" deep min)	SYD	$140.00
Hand Chipping, Other Than Deck	(vertical & overhead surfaces)	CFT	$60.00
Structures, Rehabilitation, Rem Portions	(slope protection removal)	*CYD	$225.00
Structures, Rehabilitation, Rem Portions	(drain casting removal)	*EA	$500.00
False Decking		SFT	$1.00
Other			
MISCELLANEOUS			
Joint, Expansion, Erg	(pavement joint)	FT	$14.00
Joint, Pressure Relief, 4 inch		FT	$75.00
Embankment, Structure, CIP		CYD	$16.00
Backfill, Structure, CIP		CYD	$20.00
Slope Paving, Header		FT	$70.00
Slope Paving, Concrete		SYD	$60.00
Slope Paving, Precast Concrete		SYD	$60.00
Other			
TRAFFIC CONTROL			
Maintaining Traffic	(from TSC or Region T&S)	LS	
Other			
MOBILIZATION		10%	$0

* Estimated as unit shown, Paid for as LUMP SUM

Methods, Procedures, Specifications

Michigan DOT publishes guidance to installation of sawcut joints in approach pavements in response to growth of pavements affecting bridges (131). Guidance includes a set of steps to complete, and the time in hours required for each step.

Michigan DOT publishes guides to selection and use of thin epoxy overlays and healer-sealers for reinforced concrete bridge decks (132). Guidance includes approved products, application rates product costs (Table 75), and unit costs per deck area (Table 76).

Table 75 Michigan DOT. Epoxy Overlay Products (132)

Type	2010 Epoxy cost	Application rate for estimating	Approved products	Manufacturer's application rate	Mix ratio	Shelf life	Approved fine aggregates
Healer Sealer	$27/gal $0.36 / SF	75 SF/gal	Unitex bridge seal	65 – 100 SF/gal	1.0A – 1.0B	1 year	Cheboygan Mason Sand

Type	2010 Epoxy cost	Application rate for estimating	Approved products	Manufacturer's application rate	Mix ratio	Shelf life	Approved fine aggregates
			Poly-carb Mark-127	100-150 Sf/gal	2.0A – 1.0B	2 year	Technisand 1L5W Sand Products AFS 50
			Euclid dural 335	100-200 SF/gal	4.0A – 1.0B	1 year	
			Sika Sikadur 55 slv	100-150 SF/gal	2.5A – 1.0B	2 year	
Epoxy Overlay	$ 20/gal $0.80 /SF	25 SF/gal	UnitexPropoxy Type III	1st 40SF/gal 2nd 20SF/gal	1.0A – 1.0B	2 year	Best Sand #612 Quartz Unimin Corp. EP-5 Mod Quartz Manuf. Min. BT-6X10 River Rock Humble Size #7 Chipped Flint
			Poly-Carb Flexogrid Mark 154	1st 35SF/gal 2nd 15SF/gal	1.0A – 1.0B	1 year	
			Poly-Carb Flexogrid Mark 163	1st 35 SF/gal 2nd 15SAF/gal	2.0A – 1.0B	2 year	
			Euclid Flexolith 216	1st 40Sf/gal 2nd 30SF/gal	1.0A – 1.0B	2 year	
			E-Bond 526-Lo-Mod	1st 40SF/gal 2nd 20SF/gal	1.0A – 1.0B	1year	
			Axson Akabond 811	1st 35 SF/gal 2nd 15Sf/gal	1.0A – 1.0B	1 year	

Table 76 Michigan DOT. Unit Costs of Epoxy Overlays (132)

	Thin Overlay	Healer Sealer
Cost of Epoxy per gallon	$22.30	$34.00
Cost of Epoxy per SF	$0.89	$0.45
Cost of aggregate per pound	$0.08	$0.11
Cost of Aggregate per SF	$0.26	$0.16
Combined cost per SF	$1.15	$0.61

Performance Measures

For state-owned bridges, Michigan DOT tracks the percentage of bridges in good or fair condition (134). A bridge is in good or fair condition if all three NBI general condition ratings are higher than 4. Michigan DOT tracks the number of bridges on trunkline routes that are structurally deficient.

Deck Preservation

Michigan DOT publishes advice for preservation of decks on concrete T-Beam bridges (137).

Michigan DOT has a special specifications (125) for repairs to deck surface, for surface sealing, and for crack sealing.

Michigan DOT defines additional elements for decks and wearing surfaces (Table 77)(139).

Table 77 Michigan DOT Deck Elements (139)

No.	Name
800	Reinforced Concrete Black Bars
801	Reinforced Concrete Stainless Bars
802	Reinforced Concrete Nonmetallic Bars
803	Reinforced Concrete Coated Bars
804	Precast Reinforced Concrete
805	Reinforced Concrete Slab Black Bars
806	Reinforced Concrete Slab Stainless Bars
807	Reinforced Concrete Slab Nonmetallic Bars
808	Reinforced Concrete Slab Coated Bars
809	Precast Reinforced Concrete Slab
810	Reinforced Concrete Deck Top Surface
811	Reinforced Concrete Deck Bottom Surface
812	Reinforced Concrete Fascia
813	Reinforced Concrete Slag Aggregate
815	Shallow Rigid Overlay
816	Thin Overlay
817	Asphalt Overlay w/ membrane
818	Asphalt Overlay w/out membrane
819	Timber Running Planks
820	False Decking
821	Maintenance Sheeting
822	Stay-In-Place Forms
840	Reinforced Concrete Sidewalk
841	Steel with Concrete Filled Grid Sidewalk
842	Steel with Open Grid Sidewalk
843	Steel Sidewalk - Corrugated/Orthotropic/Etc.

General condition ratings for decks

Michigan DOT collects general condition ratings for deck top surface (Table 78) and deck bottom surface (Table 79) (135)(136).

Table 78 Michigan DOT BSIR #1 SURFACE (SI&A Item 58A)(135)

Code	Condition	Material	Description
9	NEW	All	No noticeable or noteworthy deficiencies which affect the condition of the surface.
8	GOOD	Concrete	Cracking less than 1/32” wide with no spalling, scaling, or delamination.
		Thin Ovly	Surface wear with no other observed defects.
		HMA	No cracking, but minor deformations may be visible without spalling, segregation, or longitudinal joint failure.
		Timber	Minor surface abrasion with fasteners functioning as constructed.
7	GOOD	Concrete	Open cracks less than 1/16” wide or sealed cracks spaced at 10’ or more. Light shallow scaling may be present.

Code	Condition	Material	Description
		Thin Ovly	Minor surface wear and aggregate loss within 2’ of expansion joints.
		HMA	Cracks spaced at 50’ or more. Minor deformations with no spalling, segregation, or longitudinal joint failure.
		Timber	Minor surface abrasion with the majority of fasteners functioning as constructed.
6	FAIR	Concrete	Open cracks greater than 1/16” wide spaced at less than 10’. Spalling and delamination affecting 2% or less of the area. Surface scaling may be ¼” to ½” deep.
		Thin Ovly	Hairline cracking spaced at 50’ or more. Surface area exhibits 2% or less ineffectiveness.
		HMA	Cracks spaced at 50’ or more. Limited rutting, shoving, or raveling with no effect on ride quality.
		Timber	Surface abrasion or decay that affects less than 5% of the thickness. Limited damage to the surface.
5	FAIR	Concrete	Delamination or spalling affecting between 2% and 10% of the area. Excessive cracking or heavy scaling up to 1” deep.
		Thin Ovly	Loss of aggregate or ineffectiveness affecting between 2% and 5% of the area.
		HMA	Spalling affecting 2% and 10% of the area. Moderate block cracking, raveling, and longitudinal joint failure.
		Timber	Abrasion or decay that affects 5% to 10% of the thickness. Fasteners may be loose but the surface functions adequately. Moderate damage to the surface.
4	POOR	Concrete	Delamination or spalling affecting between 10% and 25% of the area.
		Thin Ovly	Loss of aggregate or ineffectiveness affecting between 5% and 10% of the area.
		HMA	Spalling affecting 10% and 25% of the area. Block cracking, raveling, and longitudinal joint failure throughout.
		Timber	Abrasion or decay that affects 10% to 25% of the thickness. Substantial damage to the surface.
3	SERIOUS	Concrete	Spalling affecting more than 25% of the surface area.
		Thin Ovly	Loss of aggregate or ineffectiveness affecting more than 10% of the surface area. Condition of aggregate may affect skid resistance.
		HMA	Spalling affecting more than 25% of the surface area. Ride quality may be impacted.
		Timber	Abrasion or decay that affects more than 25% of the thickness. Fasteners or planks are missing.
2	CRITICAL	All	Emergency surface repairs are required for the bridge to remain open.
1	IMMINENT FAILURE	All	Bridge is closed to traffic due to the surface condition, but corrective action may allow the bridge to reopen.
0	FAILED	All	Bridge is closed to traffic due to the surface condition. Coordinate with SI&A Item 41 and notify Bridge Field Services.
N	N/A	All	Culverts, filled arch bridges, and other bridges without decks.

Table 79 Michigan DOT BSIR #6 Deck Bottom Surface (135)

Code	Condition	Material	Description
9	NEW	All	No noticeable or noteworthy deficiencies which affect the condition of the bottom surface.
8	GOOD	Concrete	Cracking less than 1/32” wide with no spalling, scaling, or delamination. No rust on stay-in-place forms.

Code	Condition	Material	Description
		Steel	Very limited partial protective coating failures that do not expose bare steel.
		Timber	Paint or other coating failures in very limited locations.
7	GOOD	Concrete	Open cracks less than 1/16" wide spaced at 10' or more. Light shallow scaling present. No rust on stay-in-place forms.
		Steel	Protective coating failures in very small and scattered locations.
		Timber	Checks or shakes penetrate less than 5% of the member thickness.
6	FAIR	Concrete	Open cracks greater than 1/16" wide spaced at less than 5'. Spalling, delaminations, map cracking, or freckled rust on stay-in-place forms affecting 2% or less of the area. Surface scaling may be ¼" to ½" deep.
		Steel	Protective coating failures is limited to less than 2% of the surface area with no loss of section.
		Timber	Decay or section loss that affects less than 5% of the member section. Checks or shakes not in the tension zone that penetrate between 5% and 25% of the member thickness. Splits arrested and concerns mitigated.
5	FAIR	Concrete	Delamination, spalling, heavily map cracked areas, or freckled rust on stay-in-place forms affecting between 2% and 10% of the area. Excessive cracking or heavy scaling up to 1" deep.
		Steel	Protective coating failure is limited to less than 5% of the surface area with minor loss of section. Cracks that have self-arrested or have been arrested may be present. Loose fasteners present but the connection is functioning as intended.
		Timber	Decay or section loss that affects between 5% and 10% of the member section. Checks or shakes not in the tension zone that penetrate between 25% and 50% of the member thickness. Split length less than the member depth.
4	POOR	Concrete	Delamination, spalling, heavily map cracked areas, or light to moderate corrosion on stay-in-place forms affecting between 10% and 25% of the total surface area. Efflorescence with heavy rust staining.
		Steel	Protective coating failure affecting between 5% and 10% of the surface area with measurable loss of section. Cracks that have not been arrested or missing fasteners. Structural review not required.
		Timber	Decay or section loss that affects more than 10% of the member section. Check or shakes that penetrate more than 50% of the member thickness.
3	SERIOUS	Concrete	Delamination, spalling, heavily map cracked areas, or moderate to severe corrosion on stay-in-place forms affecting more than 25% of the total surface area. Local failures may be possible.
		Steel	Protective coating failure affecting more than 10% of the surface area with measurable loss of section. Cracks or missing fasteners that do warrant a structural review.
		Timber	Decay or section loss that affects more than 10% of the member section. Check or shakes that penetrate more than 50% of the member thickness. Split length greater than the member depth.
2	CRITICAL	All	The deck will not support design loads and is posted. Emergency repairs may be required.
1	IMMINENT FAILURE	All	Bridge is closed to traffic due to the potential for deck failure, but corrective action may put it back in service.
0	FAILED	All	Bridge is closed due to deck condition. Coordinate with SI&A Item 41 and notify Bridge Field Services.
N	N/A	All	Culverts, filled arch bridges, and other bridges without decks.

Minnesota Department of Transportation

Definition. Bridge Preservation.

Minnesota DOT defines preservation as work to repair or protect bridge elements and extend service life (140). Preservation includes preventive actions and reactive actions.

Policy

Programming

Minnesota DOT has a truck highway bridge improvement program that focuses on bridges that are structurally deficient or fracture critical (142). In year 2008 the program identified 172 bridges to be rehabilitated or replaced. All bridges will be completed or under contract for work by year 2018.

Bridges in good or satisfactory condition receive routine maintenance (143). Bridges in fair or poor condition are scheduled eventually for major repair, rehabilitation or replacement.

Training.

Minnesota DOT offers training in three courses in a bridge maintenance academy (Table 80) (141).

Table 80 Minnesota DOT. Topics in Bridge Maintenance Academy (141)

Academy 1	Academy 2	Academy 3
--- Classroom ---	*--- Hands-On Training ---*	*--- Hands-On Training ---*
Bridge Components and Elements Bridge Mechanics Design Concepts Plan Reading Concrete Safety and Traffic Control Introduction to Bridge Preservation	Forming Plan Reading Fabrication and Placement of Rebar Concrete Placement and Finishing Deck Evaluation and Patching Steel Beam Repair	Construct Two Small Bridges Install Bearings Set Beams Form and Pour Deck Set Expansion Device Jacking Techniques
	--- Classroom Presentations ---	
	Wet and Dry Shotcrete applications Structural Steel Formwork	

Actions. Preventive Maintenance.

Minnesota DOT lists actions in preventive maintenance (Table 81) (140), reactive maintenance (Table 81) (140), and major preservation (Table 81) (140).

Table 81 Minnesota DOT. Preventive Maintenance Actions (140)

Preventive Maintenance	Reactive Maintenance	Major Preservation
Flushing Sweeping Debris removal Joint repair Graffiti removal Spot painting Minor concrete repairs Minor steel repairs	Replace of missing plow fingers Repair impact damage Deck spall repair Reset misaligned bearings	Painting Deck overlays Minor superstructure repair Minor substructure repair Partial deck replacement Barrier replacement Expansion joint replacement

Performance Measure

Minnesota DOT tracks bridges in fair or poor condition as percentage of deck area (143). Measures are reported for bridges on the national highway system, and separately for bridges not on the national highway system.

Deck Preservation

Specifications

Minnesota DOT has special specifications for silane surface sealers (146), and for repair of cracks by chasing (148).

Policies

Minnesota DOT lists expected service life of preservation actions for bridge decks (Table 82)(140). Minnesota DOT lists criteria in condition for preservation activities (Table 83). Minnesota DOT uses deck condition and ADT in selection of actions for decks (Table 84).

Table 82 Minnesota DOT Major Bridge Preservation Activities (140)

Activity	**Expected Repair Service Life (yrs)**
Deck patching	10 to 15
Deck overlays and re-overlays	20 to 25
Partial deck replacement	40+

Table 83 Minnesota DOT Criteria for Preservation Project

Concrete deck or slab elements	More than 15% in Condition State 3 or 4
Wearing surface elements	More than 15% in Condition State 3 or 4

Table 84 Minnesota DOT Selection of Actions for Decks

Condition Category	**Percent of Unsound Deck Area**	**Work Type Options Traffic Volume (Current ADT)**		
		< 2,000	**2,000 To 10,000**	**> 10,000 And Interstates**
I Slight Deterioration	0 to 2% SIMS[2] deck condition state 2	Priority 11 Do Nothing or Spot Repairs	Priority 9 Do Nothing or Spot Repairs	Priority 8 Do Nothing or Spot Repairs
II Moderate Deterioration	2% to 10% SIMS deck condition state 3	Priority 10 Mill and Patch	Priority 7 Mill and Patch	Priority 6 Mill and Patch or Re-Overlay
III Severe Deterioration	10% to 25% SIMS deck condition state 4	Priority 5 Deck Repairs, 100% Scarify and Add Overlay	Priority 4 Deck Repairs, 100% Scarify and Add Overlay	Priority 3 Deck Repairs, 100% Scarify and Add Overlay

[2] Structure Information Management System. Conditions states are CoRe condition states.

Condition Category	Percent of Unsound Deck Area	Work Type Options Traffic Volume (Current ADT)		
		< 2,000	2,000 To 10,000	> 10,000 And Interstates
IV Critical Deterioration	> 25% SIMS deck condition state 5	Priority 4 Deck Repairs, 100% Scarify And Add Overlay	Priority 2 Schedule New Deck	Priority 1 Schedule New Deck

Minnesota DOT reports that protective overlays for decks can extend service life by 10 to 30 years (140). Service life of low-slump concrete overlays and latex-modified concrete overlays can exceed 20 years. If a shorter service life is sufficient (when replacement of a deck is planned) a limited service overlay may be used. For limited service, removal of 0.5" of top surface of structural depth, as opposed to removal of all contaminated concrete, is performed.

Minnesota DOT uses epoxy polymer overlays and polyester polymer overlays (140). Epoxy overlays are usually multilayer overlays. Polyester overlays are placed as slurries in a single lift.

Deck Inspection

Minnesota DOT lists inspection methods (144) for decks that include visual inspection, chain drag, hammer sounding, ground penetrating radar and infrared thermography.

Deck Deterioration

Minnesota DOT reports deterioration rates for bridge decks (145). Deterioration is expressed as years in residence at various general condition ratings. Decks are grouped by service environment, age and presence of overlay; see Table 85 to Table 89.

Approved Products

Among approved products for deck preservation, Minnesota DOT lists

Bridge Penetrating Sealer (146)

BASF	MasterProtect H 440HZ
Evonik Industries	Protectosil BHN
Evonik Industries	Protectosil CHEM-TRETE 40 VOC
TK Products	TK - 590-100
TK Products	TK - Tri - Silane 590 - 40
Vexcon Chemicals	Cer -Vex Penseal 244 40%

Bridge surface and crack sealer (147)

Crack Chase Method - High Elongation Epoxy Crack Sealers

Euclid Chemical Co.	Dural 50 LM
TK Products	TK-9000
Viking Paints, Inc.	Paulco TE2501 Clear

Crack Chase Method - High Strength Epoxy Crack Sealers

TK Products	TK-2110

Deck Flood Method - Methyl Methacrylate (MMA) Resin Crack Sealers

BASF	MasterSeal 630
Kwik Bond Polymers	KBP 204 P SEAL
Transpo Industries	T-78

Membrane waterproofing system (149)

Concrete Sealants, Inc.	ConSeal CS-212
W.R. Meadows	Mel-Rol

Table 85 Average Number of Years at Deck NBI Condition Code, adapted from (145)

		Deck NBI Condition Code <= 5			Deck NBI Condition Code = 6			Deck NBI Condition Code = 7			Deck NBI Condition Code >= 8		
Year built	Deck type	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k
1990+	Has concrete overlay	No Data	No Data	No Data	Limited Data	Limited Data	No Data	11.9	14	12.2	6.7	8.7	9.3
	No concrete overlay	No Data	Limited Data	No Data	No Data	No Data	Limited Data	14.7	14.7	13.7	6.5	13.2	16.3
1975-89 Epoxy	Has concrete overlay	Limited Data	Limited Data	Limited Data	12.4	12.5	13.2	17.9	17.5	16.5	9.5	11.4	12.1
	No concrete overlay	No Data	Limited Data	Limited Data	Limited Data	Limited Data	15.8	Limited Data	17.5	14.7	Limited Data	13.1	15
1975-89 No Epoxy	Has concrete overlay	Limited Data	No Data	Limited Data	12.3	Limited Data	11.4	12.6	12.2	11.6	12.3	12.6	16.1
	No concrete overlay												
<1975	Has concrete overlay	7.8	11.2	13.1	11.7	12.2	10.5	15.6	14.5	16	10	12	13
	No concrete overlay	10.0	Limited Data	13.8	10.0	Limited Data	14	13.3	Limited Data	9.8	9.1	Limited Data	11

Table 86 Average Number of Years at Deck NBI Condition Code for Redecked Bridges, adapted from (145)

Year Redecked	Deck type	Deck NBI Condition Code <= 5			Deck NBI Condition Code = 6			Deck NBI Condition Code = 7			Deck NBI Condition Code >= 8		
		ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k
1990+	Has concrete overlay	No Data	No Data	No Data	Limited Data	Limited Data	No Data	13.3	14.6	12.7	7.9	8.4	10.3
	No concrete overlay												
<1990	Has concrete overlay	Limited Data	No Data	No Data	10.9	12.9	17.3	17.3	13.7	15.9	8.9	13.3	14.7
	No concrete overlay												

Table 87 Average Number of Years at Deck NBI Condition Code for Prestressed Concrete Girder Bridges, adapted from (145)

Year built	Deck type	Deck NBI Condition Code <= 5			Deck NBI Condition Code = 6I			Deck NBI Condition Code = 7			Deck NBI Condition Code >= 8		
		ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k
1990+	Has concrete overlay	No Data	No Data	No Data	No Data	Limited Data	No Data	10.9	12.9	11.7	6.8	9.2	8.4
	No concrete overlay	No Data	No Data	No Data	No Data	No Data	No Data	13.9	15.5	11.4	6.5	14.4	17
1975-89 Epoxy	Has concrete overlay	No Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	18	16.8	14	11	13.2	15.4
	No concrete overlay	No Data	Limited Data	Limited Data	Limited Data	Limited Data	16.3	Limited Data	17.0	13.4	Limited Data	10.1	17
1975-89 No Epoxy	Has concrete overlay	No Data	No Data	No Data	13	Limited Data	Limited Data	14	12.9	11.4	12.9	13	16
	No concrete overlay												
<1975	Has concrete overlay	8.4	12.4	Limited Data	9.6	11.2	10.4	17	14.4	16.4	11.9	13.2	14.2
	No concrete overlay	No Data	No Data	Limited Data	Limited Data	Limited Data	14	Limited Data	Limited Data	8.3	Limited Data	No Data	14.3

Table 88 Average Number of Years at Deck NBI Condition Code for Continuous Steel Girder Bridges, adapted from (145)

Year built	Deck type	Deck NBI Condition Code <= 5			Deck NBI Condition Code = 6			Deck NBI Condition Code = 7			Deck NBI Condition Code >= 8		
		ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k
1990+	Has concrete overlay	No Data	No Data	No Data	Limited Data	No Data	No Data	14.6	15.4	Limited Data	6	6.5	Limited Data
	No concrete overlay	No Data	Limited Data	No Data	No Data	No Data	Limited Data	No Data	Limited Data	Limited Data	No Data	Limited Data	Limited Data
1975-89 Epoxy	Has concrete overlay	Limited Data	No Data	Limited Data	12.8	10.7	13.6	17.7	17.8	16.8	7.1	9.4	8.8
	No concrete overlay	No Data	No Data	Limited Data	No Data	Limited Data	Limited Data	Limited Data	Limited Data	15.5	Limited Data	Limited Data	12
1975-89 No Epoxy	Has concrete overlay	Limited Data	No Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data
	No concrete overlay												
<1975	Has concrete overlay	7.5	11.1	11.6	12.6	13.3	10.2	14.6	14.7	16.6	8.5	8.7	10.2
	No concrete overlay	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data

Table 89 Average Number of Years at Deck NBI Condition Code for Bridges in the Metro District and All Other Districts, adapted from (145)

Year built	Deck type	Deck NBI Condition Code <= 5			Deck NBI Condition Code = 6			Deck NBI Condition Code = 7			Deck NBI Condition Code >= 8		
		ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k	ADT>10k	4-10k	<4k
1990+	Has concrete overlay	No Data	No Data	No Data	Limited Data	Limited Data	No Data	11.9	14	12.2	6.7	8.7	9.3
	No concrete overlay	No Data	Limited Data	No Data	No Data	No Data	Limited Data	14.7	14.7	13.7	6.5	13.2	16.3
1975-89 Epoxy	Has concrete overlay	Limited Data	Limited Data	Limited Data	12.4	12.5	13.2	17.9	17.5	16.5	9.5	11.4	12.1
	No concrete overlay	No Data	Limited Data	Limited Data	Limited Data	Limited Data	15.8	Limited Data	17.5	14.7	Limited Data	13.1	15
Metro District Bridges Only													
1990+	Has concrete overlay	No Data	No Data	No Data	Limited Data	No Data	No Data	12.1	14.7	12.3	6.2	6.4	7.5
	No concrete overlay	No Data	No Data	No Data	No Data	No Data	No Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data	Limited Data
1975-89 Epoxy	Has concrete overlay	Limited Data	No Data	No Data	12.2	10.3	12.2	17.8	17.7	16.6	9.1	7.9	8
	No concrete overlay	No Data	No Data	No Data	Limited Data	Limited Data	No Data	16.9	Limited Data	No Data	Limited Data	Limited Data	No Data
Bridges in All Other Districts													
1990+	Has concrete overlay	No Data	No Data	No Data	No Data	Limited Data	No Data	10.6	12.3	Limited Data	8.3	10.1	10.5
	No concrete overlay	No Data	Limited Data	No Data	No Data	No Data	Limited Data	Limited Data	Limited Data	14.2	Limited Data	14.8	16.5
1975-89 Epoxy	Has concrete overlay	No Data	Limited Data	Limited Data	Limited Data	17.9	14	Limited Data	16.9	16.2	Limited Data	14.6	17
	No concrete overlay	No Data	Limited Data	Limited Data	Limited Data	Limited Data	15.8	Limited Data	18.0	14.7	Limited Data	13.0	15

Mississippi Department of Transportation

Deck Preservation

Among approved products, Mississippi DOT lists

Concrete - Rapid Set Patching Material (150)

Chemgrout	Tammsgrout Supreme
Cts Cement Mfg. Co.	Cts Rapid Set Cementitious Mtl
Cts Cement Mfg. Co.	Cts Rapid Set Concrete Mix
Euclid Chemical Company	Euco Repair V-100
Euclid Chemical Company	Euco Speed Mp
Euclid Chemical Company	Express Repair
Euclid Chemical Company	Versaspeed 100
Euclid Chemical Company	Versaspeed Ls100
Mapei Corporation	Planitop 18
Mapei Corporation	Planitop 18 Es
Mapei Corporation	Planitop X
Mapei Corporation	Planitop Xs
Phoscrete Corporation	Phoscrete Hc
Polymer Concrete, Inc.	Resurf Ii
U. S. Gypsum Co.	Usg Ecofix Ag5000 Rapid Repair Patch
U. S. Gypsum Co.	Usg Ecofix Rapid Repair Patch
U. S. Gypsum Co.	Usg Ecofix Xtend Rapid Repair Patch
Western Material and Design, Llc	Fastrac 240
Western Material and Design, Llc	Fastrac 300

Missouri Department of Transportation

Policy.

Maintenance Inspection.

Missouri DOT recommends that, on rainy days, bridge crews can check decks for ponding of water and check deck drains for function (152).

Maintenance Innovation.

Missouri DOT publishes innovations in work in bridge maintenance. Innovations include:

- Deck patching bracket (153)
- Deck washing spray bar (154)
- Joint seal puller (155), and pusher (156)
- Chute for material disposal (157)
- Deck thickness measure (158)
- Traffic control for deck sealing (159)

Actions. Maintenance.

Missouri DOT lists the bridge-related responsibilities of DOT district maintenance crews (Table 90) (160). Missouri DOT lists bridge-related responsibility of the DOT central office bridge maintenance crew (Table 91) (161)

Table 90 Missouri DOT. Actions by District Maintenance Crews (160)

Action
Cleaning and flushing of all bridges (a minimum one time each year at the end of the snow season) (Cleaning & Flushing)
Sealing cracks in bridge decks (Bridge Deck Crack Sealing)
Removing and replacing asphalt overlays and/or seals (Chip Sealing Deck)
Placing new bridge deck seals and/or asphalt overlays (Chip Sealing Deck)
Repairing bridge decks with concrete (Temporary Deck Repairs)
Repairing and sealing deck joints with appropriate material (Hot Pour, Silicone, or Polytite)
Sealing deck spalls with Pavon (Bridge Deck Sealing)
Cleaning and sealing accessible concrete caps (Sealing Abutment and Pier Caps)
Minor painting of bearings or steel piling (Spot Painting)
Replacing timber planks on abutment backwalls
Replacing timber planks or running boards on timber decks
Sealing approach joints with appropriate material (Hot Pour)
Repairing or leveling approaches
Cutting pavement expansion joints
Scour repair in Montgomery County
Building or repairing mat gutters (Mat Gutter Maintenance)
Repairing slope erosion
Placing riprap on slopes, around abutments, or under deck drains
Repair or mudjack slope protection (Mudjacking) See also mudjacking in Bridge Approach Slabs
Bridge posting and advance warning signs
Reflective tabs on bridge railings
Cutting trees, brush or vines around and under bridges (Cut & Spray Brush)

Action
Removing drift (Drift Removal),
Performing channel work (Rock Blanket),
Correcting scour around footings (Gabion Installation)
Bridge approach and guardrail shoulders (Shaving Shoulder and Around Guardrail)
Stenciling bridge numbers on end post, columns, or bridge superstructures
Maintaining bridge approaches

Table 91 Missouri DOT. Actions by Central Office Bridge Maintenance Crew (161)

Action
Bridge painting
Cleaning and sealing caps that cannot be reached by district forces (Sealing Abutment and Pier Caps)
Replacing deteriorated timber pile caps
Repair to substructure and superstructure which district forces are not equipped or trained to handle
Bolting deck to stringers
Resetting bearings
Repairing or replacing damaged bridge members
Repairs to large expansion devices
Heat straightening beams
Bridge strengthening

Intervals for Actions.

Missouri DOT washes bridges twice a year; each Spring and Fall (162).

Material Selection. Deck Sealers.

Missouri DOT provides guidance in selection of sealers for reinforced concrete bridge decks (Table 92) (163).

Table 92 Missouri DOT. Sealers for Bridge Decks (163)

Condition of Deck	Sealer
New Decks and Decks with minimal cracking	EPG 771.16 Penetrating Concrete Sealer - Silane
Decks with hairline cracks < 1/128” (0.008 in.) wide	EPG 771.17 Low Viscosity Polymer (LVP) Bridge Deck Crack Filler
Decks with cracks >1/128” (0.008 in.) wide	EPG 771.18 In-Deck Bridge Deck Crack Filler
Decks with cracks >1/64” (0.016 in.) wide	EPG 771.19 Chip Seal to Entire Deck

Methods, Procedures

Missouri DOT has on-line guidance to selection and execution of maintenance actions for bridges (164). Missouri DOT’s set of Engineering Policy Guides includes (Table 93).

Table 93 Missouri DOT. Engineering Policy Guides (164)

Code	Policy Guide
770.2	Regional and Central Office Bridge Maintenance Crew Responsibilities
770.3	Cathodic Protection
770.7	Maintenance of Bridge Superstructure

Code	Policy Guide
770.7.1	General Bridge Deck Maintenance
770.7.2	Concrete Deck Maintenance
770.7.3	Seal Coat Resurfacing
770.7.4	Bituminous Mat Resurfacing
770.7.5	Timber Decks
770.7.6	Steel Decks
770.7.7	Expansion Joint Maintenance
770.7.8	Handrails, Curbs, Medians and Sidewalks
770.7.9	Bearings
770.8	Maintenance of Bridge Substructure
770.8.1	Concrete Caps
770.8.2	Timber Piling and Caps
770.8.3	Concrete Piling
770.8.4	Steel Piling and Cast in Place (C.I.P.) Piling
770.8.5	Concrete Substructure
770.9	Miscellaneous Bridge Maintenance
771	Bridge Preventative Maintenance Guidelines
771.1	Mud Jacking Bridge Approach
771.10	Bridge Joint Sealing - Hot Pour
771.11	Bridge Joint Sealing - Silicone
771.12	Bridge Joint Sealing - Polytite
771.13	Sealing Abutment and Pier Caps
771.14	Spot Painting of Bearings and Piling
771.15	Concrete Bridge Deck Sealer Selection Matrix
771.16	Penetrating Concrete Sealer – Silane
771.17	Low Viscosity Polymer (LVP) Bridge Deck Crack Filler
771.18	In-Deck Bridge Deck Crack Filler
771.2	Bridge Cleaning and Flushing
771.20	Cut and Spray Brush and Vines
771.21	Rainy Day Bridge Activities
771.3	Shaving Shoulder and Around Guardrail
771.4	Drain Basin Maintenance
771.8	Remove Drift
771.9	Temporary Bridge Deck Repair
774	Cathodic Protection

Performance Measure

Missouri DOT tracks the average condition of state-owned bridges and the percentage of structurally deficient bridges on the National Highway System (165).

Deck Preservation

Missouri DOT has engineering policy guides for sealing cracks in decks (166), for sealing deck surface (167), and for overlays (168) that include low-slump concrete, latex modified concrete and silica fume concrete.

Overlays

Missouri DOT standard specifications (172) includes sections for

- removal of seal coats or wearing surfaces (Section 216)
- overlay using silica fume concrete (Section 505)
- placement of thin epoxy polymer overlay (Section 623)
- epoxy mortar for repairs (Section 623, Section 1039)
- repairs to concrete bridge decks (Section 704)
- materials for epoxy polymer overlay (Section 1039)
- silane surface sealers (Section 1053)
- polymer crack sealers (Section 1053)

Missouri DOT 's list of qualified materials includes

RAPID SET CONCRETE PATCHING MATERIAL (169)

BASF Corporation	MasterEmaco T 1060
Bindan Corporation	Mono-Patch**
CTS Cement Manufacturing Corp	Rapid Set Concrete Mix
CTS Cement Manufacturing Corp	Rapid Set DOT Repair Mix
CTS Cement Manufacturing Corp.	Rapid Set DOT Concrete Mix
Dayton Superior	HD-50
Dayton Superior Corp., KS	Pave Patch 3000
Degussa Building Systems	Road Patch
Phoscrete Corp.	Phoscrete HC
Sika Chemical Corp.	Sika Set Roadway Patch
Sika Chemical Corp.	SikaTop 122 Plus
SpecChem	Repcon 928
Symons Corporation	DOT Patch HD
Tamms Ind.	Speedcrete 2028
The Quikrete Companies	Commercial Grade Fast Set DOT Mix
United States Gypsum Co.	EcoFix
Western Material & Design	Fastrac 246 Rapid Setting Concrete
Western Material & Design	Fastrac 300 Rapid Setting Cement

Polymer Concrete (170)

Emseal Joint Systems, LTD.	Emseal Emcrete
Silicone Specialties, Inc.	Silspec 900 PNS Elastomeric Mortar
Unitex	Pro-Poxy 2500
Watson Bowman – Acme	Wabo Crete II

Polymer Concrete Overlay Systems (171)

AIS CIS, LLC dba CEPOXY	CEPOXY Precision Binder
ChemRex	ThoRoc Trafficguard EP-35
Conspec, A Dayton Superior Company	Spec Binder
Cornerstone Construction Material, LLC	CE330 Epoxy Binder
Dayton Superior	Sure-Level Epoxy
E-Bond Epoxies, Inc.	E-Bond 526
E-Chem, LLC	EP50-OVERLAY
Hilti, Inc.	HIT-HY 150 MAX
Olin Epoxy-POLY-CARB	Mark-154 System
Olin Epoxy-POLY-CARB	Mark-163 Flexogrid

Sika Corporation	Sikadur 22 Lo-Mod
Tamms	Flexolith
Unitex	Pro-Poxy Type III DOT

Montana Department of Transportation

Definition. Preventive Maintenance.

Montana DT defines preventive maintenance as any type of work on a structure, performed cyclically or as-needed, that keeps the structure close to its original constructed condition (173). Preventive maintenance reduces the number of major repairs and increases the time between major repair, rehabilitation or replacement of structure. Montana DT defines repair as work that maintains or restores load capacity or removes a safety hazard.

Montana DT identifies preventive maintenance and reactive maintenance (174). Preventive maintenance is work before deterioration occurs. Reactive maintenance is repair; work after deterioration occurs.

Policy.

Maintenance Inspection

Montana DT maintenance personnel inspect bridges every six months. These are cursory inspections seeking major changes to condition since the most recent NBIS inspection. Maintenance personnel inspect for specific defects (Table 94) (173). Maintenance inspections are activity MMS 4201 in Montana's maintenance management system.

Table 94 Montana DT. Semi-Annual Maintenance Inspection (173)

Inspection Item
Impact damage
Failed, crushed or cracked timber girders or caps
Any crack in a steel beam or very large cracks in concrete beams
Scouring around piers or abutments
Abnormal looseness or vibrating of trusses
Spalls or deterioration in bridge decks and joints.
Material/debris accumulation around piers and abutments
Removing tress or brush growing under or close to structures
Plugged or partially plugged deck drains
Damaged or missing bridge rail, curbs or wingwalls
Loose bolts or other fasteners
Vegetation that limits sight distance
Bearings - material buildup or out of place
Cleaning and removal of incompressible material from joints
Other items noted in MDT Maintenance Bridge Inspection manual
--- *for Culverts* ---
Culvert barrel, plugged
Cracks or joint spate in RC pipe
Soil erosion at inlets, outlets.
Drop inlets to ensure not plugged
Metal pips for corrosion or distortion

Environmental Requirements.

Work at bridges is performed to reduce environmental impacts (176). Washing of bridges should avoid release of wash water into streams below. Deck drains are blocked during washing, and wash water is collected for disposal. Paint materials, paint chips or liquid paint, should not enter streams. Materials used

or dislodged by sandblasting and scraping are captured for disposal. Bioengineered methods for bank protection are used instead of riprap in areas not shaded by bridges.

Programming, Time of Year.

Montana DT publishes recommendations on season for maintenance of bridges (173). Drains are cleared when temperatures are above freezing. Sweeping of decks is done in the Spring. Debris and drift are removed as soon as possible. Repairs are made as soon as practical; severity of defects is considered in scheduling of repairs.

Actions.

Routine Maintenance.

Montana DT lists actions in routine maintenance. Actions in routine maintenance are listed in (Table 95). Actions in unscheduled maintenance are listed in (Table 96) (176).

Table 95 Montana DT. Routine Maintenance Actions (173)

Action
Sweeping and debris removal
Cleaning ditches, culverts and catch bases
Correcting moderate slides and slope failure
Vegetation management and litter pickup
Routine bridge maintenance
Crack sealing and routine surface treatment
Drainage restoration
Placing riprap

Table 96 Montana DT. Unscheduled Maintenance (176)

Action
Stream bank protection
Debris removal
Scour abatement (approaches, abutments and piers)
Repair slides and slope failures
Repair of culverts

Preventive Maintenance.

Montana DT lists actions in preventive maintenance (Table 97) (173). Montana DT lists actions in repair (Table 98) (173).

Table 97 Montana DT. Preventive Maintenance Actions (173)

Action
Cleaning drains, decks, joints, bearings, caps and girder flanges of dirt, sanding material and bird droppings
Sealing decks
Removing drift buildup on a pier

Table 98 Montana DT. Repair Actions (173)

Action
Replacing damaged bridge rail
Replacing rotten or broken timber beams and caps
Repairing vehicular impact damage to beams or columns
Repairing spalls in bridge decks
Repairing damaged guard angles or joints in bridge decks

Data.

Maintenance and Repair, Data IDs.

Montana DT records maintenance work in a series of activities from 4101 to 4113 in the Montana maintenance management system (Table 99) (173). The four-digit codes are readable (177). The first digit indicates the asset; '4' indicates bridge or NBIS culvert. The second digit identifies the category of work (Table 100). The last two digits are a two-digit ID for a particular action.

Table 99 Montana DT. Actions in Maintenance Management System (173)

Action
Repairing damage or deterioration in various bridge components
Removing debris and drift adjacent to piers
Cleaning drains, decks, joint or bearings
Cleaning and painting timber bridge rails
Tightening or replacing bolts and nuts
Repairing concrete bridge deck surface
Replacing/repairing joint material and joint headers
Repairing or replacing bridge rail, curb or posts
Adjusting height of a bridge after settlement
Repairing and replacing timber girders, caps, decks, and or piles
Repairing vehicle impact damage to beams and columns

Table 100 Montana DT. Category of Work (177)

Code	Work Category	Note
1	Maintenance Activity	Preserve and maintain the highway and its elements
2	Service Activity	Provide a safe highway
3	Betterment Activity	Improve, adjust or make additions to the highway system, beyond its former condition
4	General Activity	Produce materials, acquiring equipment, planning, scheduling, supervising and approving all absences.

Maintenance Management System.

Montana DT's maintenance management system tracks daily activities (177). Data include labor, materials, equipment and contract cost for activities performed by route and location.

Project Types

Montana DT identifies categories of projects for bridge maintenance and bridge construction (Table 101) (175).

Table 101 Montana DT. Projects for New Bridges & Replacement Bridges (175)

Code	Project Type	Note
210	New Bridge	New bridge
220	Bridge Replacement with Added Capacity	Replacement bridge Additional through lanes
221	Bridge Replacement with no Added Capacity	Replacement bridge
222	Bridge Replacement with a Culvert with no Added Capacity	Bridge is replaced by culvert
223	Bridge Replacement with a Culvert While Adding Capacity	Bridge replaced by culvert Additional through lanes
230	Bridge Rehabilitation with Added Capacity	Restore the structural integrity Correct major safety defects Deck replacement (either partial or complete) Widening of bridges construct dual structure
231	Major Bridge Rehabilitation without Added Capacity	Restore the structural integrity Seismic retrofit Correct major safety defects Deck replacement (either partial or complete)
232	Minor Bridge Rehabilitation	Correcting minor structure or safety defect Deck patching Deck resurfacing Deck protective systems Upgrading railings, curbs and gutters Other minor bridge work
233	Bridge Preservation	Preventive maintenance activities Prevent, delay, or reduce deterioration Restore the functions of existing bridges Keep bridges in good condition Extend their life
234	Bridge Protection	Scour countermeasures Seismic retrofits Impact protection measures Security countermeasures Protection against extreme events
235	Bridge Inspection & Related Training	Bridge inspection and evaluation activities In-depth and special inspections Bridge inspection related training

Performance Measure

Montana DT tracks the number of structurally deficient bridges (178).

Deck Preservation

Montana DT relates actions for decks to general condition ratings (Table 102)(179).

Table 102 Montana DT, Deck Conditions and Actions

Condition	GCR	Actions
Very good	8, 9	Sealer
Reasonably good	7	Patching
Considerable repair	5,6	Repair Overlay with non-permeable concrete
No longer serviceable	3,4	Replace

Montana DT provides guidance on field inspection of bridge decks (179).

Montana DT provides procedures for actions for bridge decks (Table 103)(179).

Table 103 Montana DT, Deck Actions

Procedure
BD-1 Deck Repair
BD-2 High Molecular Weight Methacrylate (HMWM)
BD-3 Concrete Overlay
BD-4 Deck Drainage Improvements
BD-7 Silane Sealers
BD-8 Membrane with Asphalt Overlay
BD-9 Approach Slabs
BD-11 Wood Deck Replacement

Montana DT has special provisions for asphalt overlays on timber decks (180), and for asphalt overlays on concrete decks (181).

Montana DT has standard specifications (182) for

- Concrete overlay using silica fume modified concrete or latex modified concrete (Section 563)
- Bridge deck repairs (Section 562)
- Silane sealers (Section 552, Section 717)
- Bridge deck crack sealing using methyl methacrylate or epoxy (Section 552, Section 717)

Nebraska Department of Roads

Definition. Maintenance.

Nebraska DOR defines maintenance as the act, operation, continuous process of repair, reconstruction or preservation of the whole or any part of any highway, including surface, shoulders, roadsides, traffic control devices, structures, waterways, and drainage facilities, for the purpose of keeping it at or near, or improving upon, its original standard of usefulness and safety (183).

Policy.

Maintenance, Need for PE Review.

Nebraska DOR publishes guidance to bridge owners on the maintenance actions that does not require review by a professional engineer (185). For example, reinforcement of a timber abutment with a single steel H-pile, and no other modifications, is maintenance that does not require PE review. Reconstruction of timber wingwalls with modification to steel sheet piles is maintenance that does not require PE review. Replacing steel or timber bridge beams with similar, though new, members is maintenance that does not require PE review.

Preservation, Brainstorming

Nebraska DOR reports ideas to improve the performance of bridges (186). Ideas include:

- Review recurring deterioration types and locations, then improve design or geometrics in response.
- Develop standard designs for short span bridges that can be installed quickly by county maintenance crews.
- Develop methods to protect solid median rail (Jersey barriers) against deicing salts.
- Establish good practices for installation of waterproofing membranes in bridge decks. Decks constructed in the 1970s, with good membranes, remain in as-new condition.
- Develop standard practices using nondestructive testing (NDT) to assess condition of concrete decks with stay-in-place steel forms.

Actions.

Maintenance.

Nebraska DOR lists actions in bridge maintenance (Table 104) and in bridge repair (Table 105) (183). Repairs return bridges, or components of bridges, to their prior condition. Maintenance and repair actions usually do not require review by PE. Bridge inspectors use a structure maintenance checklist to recommendation actions at bridges (Table 106) (184).

Table 104 Nebraska DOR. Bridge Maintenance Actions (183)

Action - Maintenance
Cleaning roadway expansion devices
Sweeping decks
Clearing plugged floor drains
Removing debris from superstructure and bearings
Removing debris rafts from bents/piers/abutments
Clearing trees from a channel
Filling in erosion (on side slopes or banks, under approach slabs, at culvert ends)

Removing silt from culvert waterway openings
Sealing cracks

Table 105 Nebraska DOR. Bridge Repair Actions (183)

Action - Repair
Driving a new pile next to an existing that has deteriorated
Replacing wingwall or backwall within its prior dimensions
Replacing cracked timber stringers
Patching a bridge deck

Table 106 Nebraska DOR. Actions on Maintenance Checklist (184)

Action - Checklist
Repair damaged guardrail
Repair/replace signs
Clean debris from expansion device
Sweep the deck /open plugged floor drains
Remove debris from channel
Cut and remove trees from channel
Fill in washout under approach slab
Fill in erosion on sideslopes and banks
Fill in erosion at culvert ends
Remove silt from barrels
Patch bridge deck
Seal cracks
Pressure wash deck, rails, joints and drains
Other

Reconstruction / Rehabilitation.

Nebraska DOR identifies reconstruction and rehabilitation as work that increases width or load capacity of bridges or increases hydraulic capacity or scour resistance (183). Review by PE is required. Examples of reconstruction or rehabilitation are listed in (Table 107).

Table 107 Nebraska DOR. Reconstruction / Rehabilitation Actions (183)

Action - Reconstruction / Rehabilitation
Two or more substructure pile replaced
Replacing the substructure
Replacing the existing stringers with different size or type
Replacing the superstructure
Replacing the deck
Adding new spans
Bridge widening

Data. Maintenance Recommendations.

Nebraska DOR uses agency-defined data fields in the NBI record for needs and recommendations in bridge maintenance and management (Table 108) (183). Data fields are numbered in the 300-series. These are not reported to the USDOT.

Table 108 Nebraska DOR. Data Fields for Bridge Maintenance (183)

Item	Description
377	Maintenance problem
378	Date of maintenance problem
379	Maintenance recommendation

Performance Measure

Nebraska DOR tracks the percentage of bridges that are adequate; that is, not SD and not FO (187).

Deck Preservation

Nebraska DOR defines additional deck elements (183) for voided RC slabs (element 9038) and for chlorides in concrete at rebars (element 9550).

Nebraska DOR has a standard item for repair of bridge decks using silica fume concrete (Section 701)(188).

Nebraska DOR has standard specifications (189) for deck repair (Section 710) and rigid overlay (Section 711).

Among qualified products, Nebraska DOR lists:

Bridge Deck Crack Sealant

BASF Building Systems	MasterSeal 630
Kwik Bond Polymers LLC	KBP 204 P SEAL
TK Products	TK-2414 MMA Bridge Deck Crack Sealer
Transpo Industries, Inc.	Sealate T70 MX30

Epoxy Polymer Overlay Resin

Dayton Superior	Pro-Poxy Type III
E-Bond Epoxies, Inc.	E-Bond 526
E-Chem	EPX50 - Overlay
Olin Epoxy-Poly-Carb	MARK 154
Sika Corporation	Sikadur 27 Lo-Mod

Waterproofing Membrane

Polyguard Products	Polyguard 665
Protecto Wrap Company	M-400A
Royston	10A-65

Nevada Department of Transportation

Definition. Preservation.

Nevada DOT defines bridge preservation to include maintenance, repair, rehabilitation or replacement of elements or groups of elements (190).

Policy.

Design for Low Maintenance.

Nevada DOT publishes advice in bridge design (192). Bearings should be designed to minimize exposure to dirt, debris, and moisture. Access and clearance in service to replace bearings, and the design of jacking points, must be part of bridge design.

Design of drainage for bridge decks must include sufficient room both on the deck and below the deck, for maintenance personnel to clean, clear and repair drains and pipes (193).

Programming. Rehabilitation.

Nevada DOT includes district bridge maintenance personnel in field inspections for project development for bridge rehabilitation (190).

Programming. Actions and Condition Ratings.

Nevada DOT recommends actions for bridge decks in relation to general condition ratings (Table 109) (190).

Table 109 Nevada DOT. General Condition and Actions for Bridge Decks (190)

General Condition Rating	Action
≥ 8	-
7	Minor crack sealing
	Minor patching
5 & 6	Repair
	Overlay
≤ 4	Minor maintenance to extend service life
	Replace

Funding.

Nevada DOT applies Federal aid funds to bridge replacement, bridge rehabilitation, and bridge maintenance (Table 110) (194).

Table 110 Nevada DOT. Federal Aid for Bridge Preservation (194)

Action
Repainting structural steel bridges
Non-corrosive deicers
Deck replacements
Preventive maintenance
Seismic retrofit
Program administrative costs

Actions.

Rehabilitation.

Nevada DOT lists actions that can be included in projects for bridge rehabilitation (190). Many of these are actions in preservation. For deck rehabilitation, actions to place overlays, seal cracks, seal surfaces and replace joints can be included. For superstructure rehabilitation, actions to paint and to repair components can be included. For substructure rehabilitation, actions to improve foundations and to provide scour protection can be included.

Nevada DOT lists actions that can be included in projects to rehabilitate bridge decks (Table 111) (190). Nevada DOT defines joint rehabilitation to include repairs to joints and seals, but not replacement of joints (190). Repairs can address loose or broken restrainers for seals, failed header materials, and torn seals.

Table 111 Nevada DOT. Deck Rehabilitation Actions (190)

Action
Patching
Polymer Concrete Overlay
Resin Overlay
Waterproof Membrane & Asphalt Overlay
Epoxy-Resin Injection
Crack Sealant
Silane Seal
Joint Rehabilitation
Joint Replacement
Upgrade/Retrofit Bridge Rails
Approach Slabs

Nevada DOT lists actions in rehabilitation of concrete superstructures (Table 112) (190).

Table 112 Nevada DOT. Concrete Superstructure Rehabilitation Actions (190)

Action
Remove/Replace Deteriorated Concrete
Crack Repair
Bearings
Post-Tensioning Tendons
FRP Strengthening

Nevada DOT lists actions in rehabilitation of steel superstructures (Table 113) (190).

Table 113 Nevada DOT. Steel Superstructure Rehabilitation Actions (190)

Category	Action
Fatigue Damage Countermeasures	Grinding
	Drilled holes
	Bolted splices
	Peening
	Ultrasonic impact treatment (uit)
Section Losses	Welding doubler plates
	Bolting doubler plates

Category	Action
Strengthening	Add cover plates
	Introduce composite action
	Add new girders
Bearings	
Painting	Full removal and repainting
	Full overcoat
	Touch-up painting
Heat Straightening	
Beam Saddles	

Nevada DOT lists actions in rehabilitation of substructures (Table 114) (190).

Table 114 Nevada DOT. Substructure Rehabilitation Actions (190)

Action
Scour Mitigation
External Pier Cap Post-Tensioning
Micropile Underpinning
Ground Anchorages
Soil Stabilization

Bridge Preservation Program

Nevada DOT provided $33 million in years 2013 and 2014 for bridge preservation (191). The program funds bridge preventive maintenance, corrective maintenance, rehabilitation, seismic retrofit, and replacement. Nevada DOT reports a backlog of needs in bridge preservation that require $119 million in funding (191). Nevada DOT reports 25 projects in bridge rehabilitation or seismic retrofit, and 4 projects for bridge replacement in years 2013 and 2014 (Table 115) (191).

Table 115 Nevada DOT. Bridge Projects in Years 2013 & 2014 (191)

Fiscal Year	Entity	Federal- Aid System	Repair Strategy			Total
			Rehabilitation	Replacement	Seismic Retrofit	
2013	State	On-System	12		11	23
	Local/Other	On-System				
		Off-System		1	2	3
2014	State	On-System				
	Local/Other	Off-System		3		3
Total			**12**	**4**	**13**	**29**

Performance Measures

Nevada DOT tracks the percentage of state-owned bridges that are structurally deficient or functionally obsolete (195). A goal is to rehabilitate or replace at least one SD or FO bridge each year.

Deck Preservation

Deck Overlays.

Nevada DOT publishes advice on use of patching and of overlays on bridge decks (Table 116) (190).

Table 116 Nevada DOT. Recommendations for Bridge Deck Overlays (190)

Action	Recommendation
Patching	Temporary measure awaiting more permanent solution Use fast-setting concrete Avoid patching with asphalt
Polymer Concrete Overlay	Polymer concrete is preferred over other overlay materials
Resin Overlays	Thin resin overlay for bridge protection Thin resin overlay restores skid resistance
Asphalt Overlay with Sheet Membrane	Use on side-by-side boxes where reflective cracking through a concrete or polymer overlay is a concern
Replacement Overlay	Remove an existing overlay and replace it with a new one Do not install a new overlay over an existing overlay,

Nevada DOT relates actions for decks to general conditions of decks (194)(Table 117). Nevada DOT provides guidance on inspections and tests to use in evaluation of bridge decks (194). Nevada DOT provides advice on advantages and limitations of various treatment for bridge decks (194).

Table 117 Nevada DOT. Deck Conditions & Actions

Condition	NBI GCR	Action
Very good	8,9	Needs little attention
Reasonably good	7	Needs no substantial repair Minor crack sealing and minor patching.
Need considerable repair but still sound	5,6	Repair Overlay with some type of non-permeable concrete
No longer serviceable	3,4	Replace

Nevada DOT's qualified products list (196) includes:

Overlay System (Polyester)

Atlas Tech Products	Atlas Tech-Deck
Kwik Bond Polymers, LLC	PPC-1121

Adhesives for Multilayer Overlays

Olin Epoxy-POLY-CARB	Poly-Carb Mark 163 Flexogrid
Unitex Chemicals / Dayton Superior	Pro-Poxy Type III DOT

Crack Sealants

Euclid Chemical	Dural 50
Kwik Bond Polymers	KBP 204
Liquid Concrete	Ure-Kote R-60
Sika Corporation	Sikadur 55 SLV
Unitex Chemicals / Dayton Superior	Bridge Seal 75%

Liquid Membrane

Bridge Preservation, LLC	Bridge Deck Membrane
Olin Epoxy-POLY-CARB	Poly-Carb Mark 155

New Hampshire Department of Transportation

Actions. Bridge Projects.

New Hampshire DOT lists actions in bridge maintenance projects (Table 118) (197) (198).

Table 118 New Hampshire DOT. Maintenance Actions in Projects (197) (198)

Action
Supports floor beams
Partial and full depth deck repairs
Replacement of the membrane
Replacement of expansion joints
Bridge shoe repair/replacement
Painting ends of the girders

Deck Preservation

In its qualified products list (199), New Hampshire DOT includes:

Rapid-Hardening Patching Material

BASF	MasterEmaco T 1060 (formerly 10-60 Rapid Mortar)
CTS Cement Manufacturing Corp.	Rapid Set DOT Concrete Mix
CTS Cement Manufacturing Corp.	Rapid Set DOT Repair Mix
Dayton Superior Corp.	HD 50
MAPEI Corporation	Planitop 18 ES
MAPEI Corporation	Planitop X
MAPEI Corporation	Planitop XS
Phoscrete Corporation	Phoscrete HC
Quikrete	Commercial Grade FastSet DOT Mix (No.1244-56)
Quikrete	Rapid Road Repair (No.1242)
Sika Corporation	SikaQuick 2500
Sika Corporation	SikaQuick VOH
Silpro LLC	SilproRapid
Silpro LLC	SilproRepair VOH
SpecChem	RepCon 928
The Euclid Chemical Company	Euco Repair V100
USG	Duracal Cement

Epoxy for Non-Moving Cracks

Dayton Superior	Sure-Inject J-56
Kaufman Products, Inc.	SurePoxy HMLV
MAPEI	Epojet
Sika Corporation	Sikadur 35, Hi-Mod LV (Warm Weather)
Sika Corporation	Sikadur 52 (Cool Weather)

High Molecular Weight Methacrylate (HMWM) Crack Sealer (for Concrete Bridge Decks)

ChemMasters	Duraguard 401
KwikBond Polymers	KBP 204 HMWM Monomer Healer/Sealer Penetrant
KwikBond Polymers	KBP 204 P Seal HMWM Healer / Sealer Penetrant
Sika Corporation	SikaPronto 19 TF

Transpo Industries, Inc.	Sealate T-70 MX-30
Transpo Industries, Inc.	Sealate T-70-10

Silane/Siloxane

Advanced Chemical Technologies, Inc.	SIL-ACT ATS-100 LV
ChemMasters	Aquanil Plus 100
Foundation Armor, LLC	Armor SX 5000 EXT-100
Vexcon Chemicals	Powerseal 40

Silane/Siloxane - Cold Weather

Advanced Chemical Technologies, Inc.	SIL-ACT ATS-42A
Vexcon Chemicals	Certi-Vex Penseal 244 100%
Vexcon Chemicals	Certi-Vex Penseal 244 40% AIM

New Jersey Department of Transportation

Policy. Asset Inspections

New Jersey DOT collects condition data on NBIS structures and on sign structures, high mast lights and dams (202). Intervals for inspection are shown in (Table 119).

Table 119 New Jersey DOT. Intervals for Inspection (202)

Assets	Asset Data
Major Viaducts	NBIS 2 year cycle
Movable Bridges	NBIS 2 year cycle
Major Bridges	NBIS 2 year cycle
Minor Bridges	4 year cycle
Dams	DEP[a] 2 year cycle
Sign Structures	4 year cycle
High Mast Lighting	4 year cycle

a - Dept. of Environmental Protection

Actions

New Jersey DOT lists actions in preventive maintenance (Table 120) (200) (201).

Table 120 New Jersey DOT. Preventive Maintenance Actions (200) (201)

Action
Deck patching
Joint repairs
Header reconstruction
Crack repairs
Application of a corrosion inhibitor
Painting
Scour countermeasures

Performance Measure

New Jersey DOT tracks the percentage of bridges in acceptable condition (201). Condition of a bridge is acceptable if the bridge is safe and it functions. Structurally deficient bridges can be in acceptable condition.

Deck Preservation

New Jersey selects actions for decks in response to extent of active corrosion of reinforcing steel and intended service life of deck after action (203)(Table 121).

Table 121 New Jersey DOT. Policy for Deck Preservation

Category	Procedures	Restoration (Considered Permanent)	Restoration (Extend life 10 to 15 yrs)
Structurally Inadequate		Complete Deck Replacement (Unless restorable)	
1. Extensive Active Corrosion	Required Restoration Work	Complete Deck Replacement	Removal of all deteriorated concrete. Follow the repair procedure approved for the protective system selected.

Category	Procedures	Restoration (Considered Permanent)	Restoration (Extend life 10 to 15 yrs)
	Testing Steps (see below)	Steps 1 through 4 as necessary. (Probably only step 1)	Step 1 only, except all the testing steps on the first five (5) bridge decks (spans) plus 10% of the remaining bridge decks.
	Suggested Protective Systems	Membrane with HMA overlay; Concrete Thin (less than 1") Overlay Protective System.	Membrane with HMA overlay; Concrete Thin (less than 1") Overlay Protective System.
2. Moderate Active Corrosion		Same as Category 1 above or Same as Category 3 below, as determined by the State.	Same as Category 1
3. Light to No Active	Required Restoration Work	Removal and Replacement of all areas of deterioration and chloride contaminated concrete as determined by corrosion potentials and/or chloride sampling. (Less than 5% of the deck area is bad).	Same as Category 1 Note: For this category of condition, permanent restoration is recommended.
	Testing Steps	Steps 1 through 4.	Same as Category 1
	Suggested Protective System	Membrane with HMA overlay; Concrete Thin (less than 1") Overlay Protective System.	Membrane with HMA overlay; Concrete Thin (less than 1") Overlay Protective System.

Testing

1. Visual	3. Half-Cell Test
2. Chloride Analysis	4. Pachometer Test

New Jersey DOT has standard specifications (204) for deck rehabilitation (Section 551) and for repairs to concrete decks (Section 551).

New Mexico Department of Transportation

Deck Preservation

New Mexico DOT has standard specifications (205) for

- Preparation of decks for repair (Section 530)
- Surface sealing using silane (Section 532)
- Repair of decks (Section 533)
- Repair of cracks by injection of epoxy resin (Section 534)
- Repair of cracks by gravity-fed resin (Section 535)
- Thin epoxy overlay (Section 536)
- Thin polyester overlay (Section 537)

New Mexico DOT APL (206) lists

Silane Surface Sealer

Evonik Corporation	Protectosil BHN
Advanced Chemical Technologies Inc.	SIL-ACT ATS-100
Advanced Chemical Technologies Inc.	SIL-ACT ATS-100LV

Concrete Structure Repair

Adhesives Technology Corp.	Crackbond Epoxy Repair Paste
Adhesives Technology Corp.	Ultrabond 365CC
CTS Cement Manufacturing Corporation	Rapid Set Cement All
CTS Cement Manufacturing Corporation	Rapid Set Concrete Mix
CTS Cement Manufacturing Corporation	Rapid Set Mortar Mix
E-Chem, LLC	EP-PATCH
Five Star Products	Five Star Rapid Surface Repair Easy Mix
Five Star Products	Five Star Rapid Surface Repair EpoxyFix
MAPEI	MapeWrap 31
MAPEI	MapeWrap C Uni-AX 300
MAPEI	MapeWrap C Uni-Ax 600
MAPEI	MapeWrap Primer 1
Phoscrete Corporation	Phoscrete HC
Sika Corporation	Sika FerroGard 670
Sika Corporation	Sikacrete 321 FS
Sika Corporation	Sikadur 300
Sika Corporation	Sikadur 31, Hi-Mod Gel
Sika Corporation	Sikadur 330 US
Sika Corporation	Sikadur Hex 300/306
Sika Corporation	Sikagard 550W Elastocolor
Sika Corporation	Sikagard 670W
Sika Corporation	SikaQuick 2500
Sika Corporation	SikaQuick VOH
Sika Corporation	SikaWrap Hex 103C
Sika Corporation	SikaWrap Hex 230C
The Quikrete Companies	Quikrete Rapid Road Repair
US Mix Co.	US SPEC STR Mortar
US Mix Co.	US SPEC POLYPATCH FR

US Mix Co.	US SPEC STR Mortar CI
US Mix Co.	US SPEC Transpatch
US Mix Co.	US SPEC Transpatch Concrete
Western Material & Design, LLC	Fastac 246
Western Material & Design, LLC.	FasTrac 300

Epoxy for Injection Repair

E-Chem, LLC	EP-SLV
ChemCo Systems, Inc.	KEMKO 038 Standard Injection Resin
W.R. Meadows, Inc.	REZI-WELD 1000
ChemCo Systems, Inc.	Kemko 170

Gravity-Fed Resin for Repair

EP100-Seal	E-Chem, LLC
Impervius ULV Penetrating Crack Sealer	P3 Infrastructure, Inc.
Mark-135 Safe-T-Seal	DOW Poly Carb, Inc.
Sealate T-70 MX-30 HMWM Crack Healer /Sealer	Castek. Inc. (A Transpo Industries Company)

Thin Epoxy Overlay

Dayton Superior	Unitex Pro-Poxy Type III XL
DOW Poly Carb, Inc.	Mark-154
DOW Poly Carb, Inc.	Mark-163 Flexogrid
E-Chem, LLC	EP50 Overlay
E-Chem, LLC	EPX50-Overlay
MAPEI Corporation	Planiseal Traffic Coat
P3 Infrastructure, Inc.	Impervius EU Bridge Deck Preservation Overlay System
P3 Infrastructure, Inc.	Impervius ME Bridge Deck Preservation Overlay System
Sika Corporation	Sikadur 22 Lo-Mod FS
Sika Corporation	Sikadur 25 Lo-Mod EPU

Thin Polyester Overlay

E-Chem, LLC	EPC-OVERLAY

New York State Department of Transportation

Policy. Selection of Actions.

New York State DOT uses a 7-value rating scale to report general condition of paint on bridges (208). Rating '7' is good condition. Bridges with paint in coalition ratings 4, 5 or 6 are maintained by touch-up painting. Bridges with lower condition ratings require re-painting. Surfaces with paint in condition rating 3 or lower are not washed; washing could loosen paint and rust flakes.

New York State DOT provides guidance to element condition and appropriate maintenance actions (209). In Table 122 condition ratings use New York State's 7- value condition rating scale.

Table 122 New York State DOT. General Condition and Maintenance Actions (209)

Part	Condition rating	Category	Action
Wearing surface asphalt	3	Cyclic maintenance	Replace the asphalt wearing surface
		Corrective maintenance	Repair the concrete wearing surface
			Repair the asphalt wearing surface
Wearing surface concrete	3	Cyclic maintenance	Clean the bridge
			Seal cracks in the wearing surface
			Seal the concrete deck
		Deck treatment	Apply "healer/sealer"
			Thin polymer overlay
			Asphaltic pavement preservation treatment
Structural deck	5	Cyclic maintenance	Clean the bridge
			Seal cracks in the wearing surface
			Seal the concrete deck
		Deck treatment	Apply "healer/sealer"
			Thin polymer overlay
			Asphaltic pavement preservation treatment
		Corrective maintenance	Repair the concrete deck
			Repair the asphalt wearing surface
	3	Corrective maintenance	Repair/replace the concrete deck
			Repair/replace the asphalt wearing surface
Deck joints	5	Cyclic maintenance	Remove debris from the joint
		Corrective maintenance	Repair the joints
	2	Corrective maintenance	Repair/replace the joints
Steel primary members	5	Cyclic maintenance	Clean the bridge
			Paint the steel members
	1	Corrective maintenance	Repair/replace steel members
Bearings	3	Cyclic maintenance	Remove, clean, and lubricate the bearings
		Corrective maintenance	Repair/replace the bearings
	5	Cyclic maintenance	Clean the bearings
			Lubricate the bearings
Substructure pier columns	5	Cyclic maintenance	Clean the substructure
			Seal substructure concrete
		Corrective maintenance	Repair substructure concrete
	2	Corrective maintenance	Repair/replace substructure concrete
Substructure abutment	2	Corrective maintenance	Repair/replace substructure abutment
	5	Cyclic maintenance	Clean the substructure
			Seal the substructure

Part	Condition rating	Category	Action
			Remove brush & debris
		Corrective maintenance	Repair substructure abutment
Erosion	5	Cyclic maintenance	Clean the foundations
			Remove brush and debris
			Maintain stream channels
			Maintain bank protection and walls
		Corrective maintenance	Repair erosion or scour
	1	Corrective maintenance	Repair erosion or scour
			Repair/replace concrete foundations

Actions.

Bridge Maintenance Repairs.

New York State DOT lists actions in bridge maintenance repairs (Table 123) (207).

Table 123 New York State DOT. Bridge Maintenance Repair (207)

Group	Action
Steel Repairs	Heat Straightening
	Paint removal required for repairs
	Remove existing rivets or bolts and replace with high strength bolts
	Structural welding
	Reconstruct connections between steel members
	Replace or reconstruct steel members
	NDT for repairs: Magnetic Particle, Dye Penetrant and the Ultrasonic Testing
	Repair or replace bearings
	Repair or replace deck expansion joints
	Repair or replace guide and bridge railings
	Repair or replace bridge deck grating
Concrete Repairs	Removal of loose concrete, coping stone, bricks, etc.
	Concrete repairs to abutment pedestals and other load bearing concrete elements
	Concrete repairs such as adjacent to replaced expansion joints, etc.
	Removal of loose concrete from netting hanging under the deck
	Repair parapet wall.
	Repoint brick/stone facing.
	Repair capbeam, pier column, abutment stem, sidewalk, bridge deck, back wall, etc.
	Remove & repair of loose concrete for underside bridge decks
Electrical & Mechanical Repairs to Bascule Bridge Components	Repair or replace drive cabinets
	Repair or replace transmissions
	Repair or replace pin motors
	Repair or replace drive shaft couplings
	Repair or replace auxiliary generators
	Repair or replace control board components

Routine Maintenance.

New York State DOT list actions in routine maintenance of bridges (Table 124) (208).

Table 124 New York State DOT. Routine Maintenance Actions (208)

Routine Maintenance
Repair or replacement of bridge decking
Repair or replacement bridge expansion joints
Cleaning scuppers or other drainage conveyances
Modifications of expansion joints
Maintenance and repair of pedestrian railing when the existing rail is a contributing element
Maintenance of bridge bearings, including lubrication
Repair or replacement of steel beam plates and/or bridge bearings with the same or similar materials
Repair of cracks in superstructure with the same or similar materials
Repair of cracks in substructure with the same or similar materials
Replacement of steel caps, protective jackets, and dolphins
Repairs to abutments using the same or similar materials, where no excavation is proposed;
Replacement of truss members using new members of the same size, profile, and appearance as original
Repainting of metal structure or components of superstructure to match existing color
Repainting of metal structure or components of substructure to match existing color
Tightening of loose diagonals and lateral bracing on metal truss bridges
Pressure washing and cleaning of structure
Removal of debris from channels around piers and abutments
Repair of damage to substructure due to scour

Preventive Maintenance.

New York State DOT lists actions in preventive maintenance of bridges (209). Preventive maintenance can be cyclic or corrective (Table 125).

Table 125 New York State DOT. Preventive Maintenance Actions (209)

Category	Action
Scheduled [Cyclical]	Cleaning decks, seats, caps, and salt splash zones
	Cleaning bridge drainage systems
	Cleaning and lubricating expansion-bearing assemblies
	Sealing concrete decks or substructure elements
Response [Corrective or Minor Repairs]	Resealing expansion joints
	Painting structural steel members
	Removing debris from waterway channels
	Replacing wearing surfaces
	Extending or enlarging deck drains

Intervals for Actions

New York State DOT lists intervals for preventive maintenance actions (Table 126) (209).

Table 126 New York State DOT. Intervals for Preventive Maintenance Actions (209)

Action	Frequency
Remove brush - spot loc.	As needed
Maintain stream channels	As needed
Maintain bank protection & walls	As needed
Clean substructure	2 years
Seal substructure	6 years
Lubricate bearings	4 years

Action	Frequency
Repair bearings	As needed
Clean super & deck	2 years
Repair joints	As needed
Remove wearing surface	12 years
Place wearing surface	12 years
Place membrane	12 years
Seal deck	4 years
Seal curb, sdwk, fascia	5 years
Fill cracks & joints	4 years
Clean drainage system	2 years
Spot painting	As needed
Paint bridges	12 years
Maintain elec. & mech. Equip.	As needed

Methods, Procedures

New York State DOT publishes methods for 17 actions in bridge maintenance (Table 127) (209).

Table 127 New York State DOT. Methods for Maintenance Actions (209)

Category	Action
Cyclic maintenance	Bridge cleaning
	Sealing cracks in the wearing surface
	Crack sealing on Portland cement concrete decks
	Sealing the concrete deck
	Replacing the asphalt wearing surface
	Lubricating bearings
	Sealing concrete substructures
	Painting bridge steel
Corrective preventive maintenance	Repairing the concrete deck
	Repairing/replacing joints
	Repairing/replacing steel members
	Repairing/replacing bearings
	Repairing/replacing concrete substructures
	Repairing erosion/scour
	Thin polymer overlays
	Low volume shotcrete
	Full depth bridge deck repairs

Deck Preservation

The New York State Thruway Authority provides advice on inspection and preservation of bridge decks (210).

New York State DOT has standard specifications (211) for

- Bonded concrete overlay for structural slabs (Section 578)
- Preparation of structural slabs for reconstruction (Section 579)
- Removal of bridge overlays (Section 581)
- Concrete repair materials (Section 701-04)

- Rapid hardening concrete repair material (Section 701-09)
- High early strength concrete repair material (Section 701-12)
- Microsilica for Portland cement concrete (Section 711-11)
- Waterproofing membranes (Section 717-02)
- Silane penetrating protective sealers (Section 717-03)
- Epoxy repair paste (Section 721-05)
- Rapid hardening polymer concrete (methyl methacrylate)(Section 721-20)
- Thin polymer (epoxy) overlay wearing surface for structural slabs (Section 734-01)

North Carolina Department of Transportation

Funding Needs. Bridge Preservation.

North Carolina DOT reports funding needs and budgets for bridge preservation (Table 128) (213).

Table 128 North Carolina DOT. Needs and Budgets for Bridge Preservation (213)

Category	Need ($m)	State Allocation ($m)	Federal Program Allocation ($m)	Impact
Routine highway, bridge and pavement maintenance, and culverts	$899.1	$439.4		Targets continue not to be met. Targets and priorities to be reviewed to optimize current funding levels and enable consistent application across the State
Structurally sound bridge preservation	$60.0	Structurally sound bridge preservation has no current allocation. Bridge funds needed are in addition to those provided in the STI.		
Structurally unsound bridge rehabilitation, repair or replacement.	$325.0	$153.0	191.0	

Actions. Preventive Maintenance.

North Carolina DOT lists preventive maintenance actions (Table 129) (212).

Table 129 North Carolina DOT. Preventive Maintenance Actions (212)

Preventive Maintenance Action
Joint Repair/Replacement
Concrete Deck Repair
Overlays
Painting

Performance Measures

North Carolina DOT reports Level-of-Service grades for bridge deck, bridge superstructure, bridge substructure, NBIS culverts, culverts at least 54” in diameter, and overhead sign structures (214). North Carolina DOT uses general condition ratings. Rating ’6’ or higher is acceptable. The percentage of acceptable components determines the LOS grade (Table 130).

Table 130 North Carolina DOT. LOS Grades (212)

LOS Grade	% acceptable				
	Deck, Superstructure, or Substructure	NBIS Culvert	Other Culvert	Overhead Sign Structure	Bridge Health Index
A	≥ 90	≥ 85	≥ 80	≥ 95	≥ 90
B	≥ 80	≥ 80	≥ 70	≥ 92	≥ 80
C	≥ 70	≥ 75	≥ 60	≥ 88	≥ 70
D	≥ 60	≥ 70	≥ 50	≥ 85	≥ 60
F	< 60	< 70	< 50	< 85	< 60

North Carolina DOT assigns LOS grades for a bridge health index (212). The index is the sum of general condition ratings for deck, superstructure, and substructure. Bridge health index 18 or higher is acceptable.

The target for performance measures for bridges is LOS grade C or better (215).

Bridge Maintenance Project Score

North Carolina DOT tracks a Bridge Maintenance Project Score that is the average score for compliance of work by bridge maintenance personnel with North Carolina's Sedimentation and Pollution Control Act (SPCA) (216). Work includes maintenance or repair of pipes, culverts and bridges, and replacement of small bridges that are not usually included in NCDOT's TIP.

North Dakota Department of Transportation

Policy. Programming.

North Dakota DOT applies overlays when about 20% of deck surface is delaminated (217).

Actions. Maintenance.

North Dakota maintenance crews perform the following actions (Table 131) (218).

Table 131 North Dakota DOT. Maintenance Actions (218)

Maintenance Action
Sweeping
Cleaning of bridge components
Concrete component patching
Scour repair
Slope protection repair
Bridge deck crack sealing

Materials

North Dakota investigated the performance of healer-sealers for bridge decks (217). Four products were used on decks that were forty-five years old. Decks each had concrete overlays that were twenty years old. Decks were chain-dragged just before use of healer-sealers, and again four years after use of healer-sealer (Table 132).

Table 132 North Dakota DOT. Evaluation of Healer Sealers (217)

Chain Dragging Results (ft^2 delaminated for each area)					
		Sealers			
		Radcon	Tamms	Degusa	Control
Eckelson Interchange	2004	27.9	0.8	13.7	9.2
	2008	26.4	6.9	24.6	0
West Sanborn Separation	2004	71.1	183.8	36.9	254.5
	2008	29.5	83.7	16.1	193.7
Sanborn Interchange	2004	68.2	107	18	31.6
	2008	29.2	52.3	20.4	6.8
Oakes Interchange	2004	98.1	123.3	38.9	35.5
	2008	129.1	121.11	172.7	8.1

North Dakota DOT lists desired properties at healer sealers (217):

- Ability to seal hairline cracks and cracks up to 2 mm to 3 mm wide.
- Ability to seal the existing concrete to reduce water and chloride ion penetration.
- Ability to maintain existing skid resistance with minimal or no additional aggregate.
- Ease of application.
- Short cure times so traffic can be restored at the end of the day.

Costs of Actions

North Dakota DOT reports the cost of deck treatment with healer-sealer (Table 133) (217).

Table 133 North Dakota DOT. Costs of Deck Treatment Healer Sealers (217)

Sealer	Unit Cost ($/SY)	Total Square Yards	Total Cost
TAMMS	24.00	603	$14,472
DEGUSA	26.00	603	$15,678
RADCON	11.00	603	$6,633

Performance Measures

North Dakota DOT tracks structurally deficient bridges by deck area on the NHS, tracks the percentage of paint in condition states 3 and 4 and tracks the count of bridges that have restricted load capacity (218). Goals for performance are:

- Less than 10% structurally deficient bridges by deck area on the NHS
- Less 25% poor paint on any bridge
- No bridges with load restrictions

North Dakota DOT replaces bridges if sufficiency rating is below 50 (218).

Deck Preservation

North Dakota DOT has a standard specification (220) for deck overlay using low-slump Portland cement concrete (Section 650).

Ohio Department of Transportation

Actions.

Asset Management Contracts.

Ohio DOT includes bridge deck maintenance and bridge painting, among many other actions, in asset management contracts (Table 134) (221).

Table 134 Ohio DOT. Actions in Asset Management Contracts (221)

Maintenance	Operations
BMP Maintenance and Reporting	Dead Animal Removal
Bridge Painting	Hazardous Material Response Support
Enhancements/Betterments	Herbicide Treatments/Noxious Weed Control
Fence	Incident Management Support
Guardrail	Mowing
Noise walls	Roadway Lighting
Pavement Markings	Snow Removal / Anti-Icing
Raised Pavement Markers	Trimming
Retaining Walls	Vegetation/Turf Management
Routine Bridge Deck Maintenance	Winter Maintenance
Routine Pavement Maintenance	
Signing	
Stormwater/Drainage Systems	

Bridge Maintenance.

Ohio DOT posts an online maintenance manual for bridges (222). The manual presents an extensive collection of actions in preventive maintenance (Table 136). Actions are grouped by bridge component (Table 135).

Table 135 Ohio DOT. Bridge Components for Preventive Maintenance (222)

Bridge Component		
Abutments	Bearings	Piers
Approach Slabs	Concrete Beams	Slab Bridges
Arch Bridges	Culverts	Steel Beams
Backwalls	Decks	Streambeds

Table 136 Ohio DOT. Preventive Maintenance Actions (222)

Component	Element	Action
Abutment	Wall type abutments	Power wash abutment seats
Abutment	Wall type abutments	Seal abutment seats with silane/siloxane
Abutment	Wall type abutments	Seal abutment seats with epoxy/urethane
Abutment	Stub abutments	Power wash abutment seats
Abutment	Stub abutments	Seal abutment seats with silane/siloxane
Abutment	Stub abutments	Seal abutment seats with epoxy/urethane
Abutment	Integral abutments	Seal 45 degree cracks in deck
Abutment	Semi-integral abutments	Seal joint at approach slab

Component	Element	Action
Approach	Slab	Seal joint at backwall
Approach	Slab	Exclude groundhogs under slabs
Superstructure	Concrete filled spandrel wall arches	Keep wearing surface (usually asphalt) cracks sealed
Superstructure	Concrete filled spandrel wall arches	Seal gutter areas with rubberized asphalt
Superstructure	Concrete filled spandrel wall arches	Fix leaks of storm sewer and/or water lines into fill
Superstructure	Concrete filled spandrel wall arches	Install weep holes
Superstructure	Concrete open spandrel arches	Keep the deck surface sealed
Superstructure	Concrete open spandrel arches	Clean areas under expansion joints; seal surfaces
Superstructure	Concrete open spandrel arches	Redirect scuppers drainage away from arch
Superstructure	Concrete through arch (rainbow)	Power wash the deck surface, gutters and columns
Superstructure	Concrete through arch (rainbow)	Keep the wearing surface sealed
Superstructure	Concrete through arch (rainbow)	Seal within the splash zone with silane/siloxane or epoxy/urethane
Superstructure	Concrete through arch (rainbow)	Seal transverse contraction joints in the deck and any crack with rubberized asphalt, silicone caulk, or urethane caulk
Backwalls		Wash down the face of backwall
Backwalls		Seal face of backwall with silane/siloxane
Backwalls		Seal face of backwall with epoxy/urethane
Backwalls	Concrete pavement	Install pressure relief joints
Bearings		Power wash steel sliding plates and steel rocker bearings
Bearings		Touch up steel with high-quality epoxy paint
Superstructure	Ps concrete beam	Seal outside fascias of beams with silane/siloxane
Superstructure	Ps concrete beam	Seal cracks in wearing surface
Superstructure	Ps concrete beam	Replace wearing surface, re-grout keyways
Superstructure	Ps concrete beam	Repair spalls from collision of overheight passing below
Culverts	Corrugated metal	Pour concrete bottom
Culverts		Keep interior of structure cleaned out
Culverts		Remove vegetation and debris from inlet
Culverts		Place dump rock/riprap along exposed footers, both sides of inlet, and at outfall
Culverts		Remove saplings/trees growing in embankment
Decks	Reinforced concrete bridge decks	Sweep (power broom) and flush with water (preferably power wash)
Decks	Reinforced concrete bridge decks	Seal the entire deck surface silane or siloxane
Decks	Reinforced concrete bridge decks	Flooded with high molecular weight methacrylate (hmwm), or a gravity fed resin or a silicate solution
Decks	Reinforced concrete bridge decks	For ponding, consider grinding a small trough into the concrete surface to allow water to drain to the nearest scupper; or place a "skin patch" in the low area using a specialty patching product or an epoxy "broom and seed"

Component	Element	Action
Decks	Reinforced concrete bridge decks	Remove loose spalls over lanes of traffic
Decks	Wearing surface	Cracks in the asphalt should be sealed with a flexible asphalt sealer (astm d3405)
Decks	Wearing surface	On low volume roads (5,000 vehicles per day or less), the surface can be chip and sealed.
Decks	Wearing surface	On higher volume roads, the surface can be milled and filled (1" minimum) with new asphalt concrete. Proprietary slurry seals can also be used.
Decks	Sidewalk	Sweep and power wash at least once per year
Decks	Sidewalk	Seal with silane or siloxane sealers
Decks	Sidewalk	Epoxy/urethane sealers; last coat of urethane should be "seeded" with sand
Decks	Sidewalk	Treat cracks with high molecular weight methacrylate (hmwm) before applying sealers.
Railing	Reinforced concrete	Wash off the inside face of the railing in the splash zone
Railing	Reinforced concrete	Seal the top and inside face of the parapet with a silane or siloxane clear sealer
Railing	Deep beam guardrail with steel tubular backup	Tighten loose bolts as needed
Railing	Deep beam guardrail with steel tubular backup	Touch-up damaged galvanizing with zinc paint
Scuppers		Clean and flush out scuppers
Scuppers		Repair washouts in embankment below scuppers
Scuppers		Extend scupper downspouts
Expansion joints		Remove dirt, stone, asphalt and other incompressibles
Pier	Wall	If there is an unsealed deck joint over the pier, power wash
Pier	Wall	If there is an unsealed deck joint over the pier, seal with silane/siloxane
Pier	Wall	If there is an unsealed deck joint over the pier, seal with epoxy/urethane
Pier	Capped pile pier	If the pier is located under an unsealed deck joint, power wash
Pier	Capped pile pier	If the pier is located under an unsealed deck joint, with silane/siloxane
Pier	Capped pile pier	If the pier is located under an unsealed deck joint, seal with epoxy/urethane
Pier	Capped pile pier	Provide concrete encasement for steel piling at groundline or waterline.
Pier	Hammerhead pier	If the pier is located under an unsealed deck joint, power wash
Pier	Hammerhead pier	If the pier is located under an unsealed deck joint, with silane/siloxane
Pier	Hammerhead pier	If the pier is located under an unsealed deck joint, seal with epoxy/urethane
Pier	Hammerhead pier	Check for vertical cracks in pier cap and consider epoxy injection
Pier	Cap and column pier	If the pier is located under an unsealed deck joint or in splash zone, power wash
Pier	Cap and column pier	If the pier is located under an unsealed deck joint or in splash zone, with silane/siloxane

Component	Element	Action
Pier	Cap and column pier	If the pier is located under an unsealed deck joint or in splash zone, seal with epoxy/urethane
Pier	Multiple columns (no cap)	If the pier is located under an unsealed deck joint or for shoulder pier, power wash
Pier	Multiple columns (no cap)	If the pier is located under an unsealed deck joint or for shoulder pier, with silane/siloxane
Pier	Multiple columns (no cap)	If the pier is located under an unsealed deck joint or for shoulder pier, seal with epoxy/urethane
Pier	Multiple columns (no cap)	If a shoulder pier, install concrete barrier in front of columns and install concrete struts between columns.
Slab bridge	Cast-in-place concrete	Sweep and water flush the deck surface and gutters
Slab bridge	Cast-in-place concrete	Seal deck surface with silane/siloxane
Slab bridge	Cast-in-place concrete	Seal cracks in deck surface with high molecular weight methacrylate (hmwm)
Slab bridge	Cast-in-place concrete	On slabs with over-the-side drainage, seal the deck sides and adjacent 18-inches of undersides with epoxy/urethane
Superstructure	Steel beam	Pressure wash the beams/girders
Superstructure	Steel beam	Touch up minor defects in the paint
Superstructure	Steel beam	Inspect for nicks or gouges in bottom flange caused by overheight traffic. Grind smooth to minimize crack propagation.
Streambeds		Clean debris off piers annually and after every flood
Streambeds		Provide bank protection
Streambeds		Protect piers or abutments with riprap/dumprock.
Streambeds		Keep gravel bars cleaned out

Intervals for Preventive Maintenance

Ohio DOT reports intervals for actions in preventive maintenance (Table 137) (222).

Table 137 Ohio DOT. Intervals for Preventive Maintenance Actions (222)

Component	Element	Action	Interval, years
Abutment	Wall type abutments	Seal abutment seats with epoxy/urethane	15
Abutment	Stub abutments	Seal abutment seats with epoxy/urethane	15
Abutment	Wall type abutments	Seal abutment seats with silane/siloxane	5
Abutment	Stub abutments	Seal abutment seats with silane/siloxane	5
Abutment	Wall type abutments	Power wash abutment seats	1
Abutment	Stub abutments	Power wash abutment seats	1
Backwalls		Seal face of backwall with epoxy/urethane	10
Backwalls		Seal face of backwall with silane/siloxane	5
Backwalls		Wash down the face of backwall	1
Bearings		Power wash steel sliding plates and steel rocker bearings	1
Decks	Reinforced concrete bridge decks	Seal the entire deck surface silane or siloxane	5
Decks	Reinforced concrete bridge decks	Sweep (power broom) and flush with water (preferably power wash)	1
Expansion joints		Remove dirt, stone, asphalt and other incompressibles	1

Component	Element	Action	Interval, years
Pier	Wall	If there is an unsealed deck joint over the pier, seal with epoxy/urethane	10
Pier	Wall	If there is an unsealed deck joint over the pier, seal with silane/siloxane	5
Pier	Multiple columns (no cap)	If the pier is located under an unsealed deck joint or for shoulder pier, power wash	1
Pier	Cap and column pier	If the pier is located under an unsealed deck joint or in splash zone, power wash	1
Pier	Capped pile pier	If the pier is located under an unsealed deck joint, power wash	1
Pier	Hammerhead pier	If the pier is located under an unsealed deck joint, power wash	1
Pier	Wall	If there is an unsealed deck joint over the pier, power wash	1
Railing	Reinforced concrete	Seal the top and inside face of the parapet with a silane or siloxane clear sealer	5
Railing	Reinforced concrete	Wash off the inside face of the railing in the splash zone	1
Scuppers		Clean and flush out scuppers	1
Slab bridge	Cast-in-place concrete	Seal deck surface with silane/siloxane	5
Slab bridge	Cast-in-place concrete	Sweep and water flush the deck surface and gutters	1
Streambeds		Clean debris off piers annually and after every flood	1
Superstructure	PS concrete beam	Seal outside fascias of beams with silane/siloxane	5
Superstructure	Concrete open spandrel arches	Clean areas under expansion joints by flushing and sealing the surfaces	1
Superstructure	Concrete through arch (rainbow)	Power wash the deck surface, gutters and vertical columns	1
Superstructure	Steel beam	Pressure wash the beams/girders	1

Costs of Actions

Ohio DOT lists defects, feasible repairs and costs of repairs (Table 139) (222). The year of costs is not reported. Repairs are grouped by topic (Table 138).

Table 138 Ohio DOT. Repair Topics (222)

Repair Topic			
Abutments	Bearings	Over-the-Side Drainage	Slab Bridges
Approach Slabs	Culverts	Piers	Streambeds
Arch Bridges	Decks	Railings	Wearing Surface
Backwalls	Drain Pipes Below Deck	Scuppers	
Beams	Expansion Joints	Sidewalks	

Table 139 Ohio DOT. Costs of Repairs (222)

Part, Defect	Repair	Cost	Life, years
Integral/Semi-Integral Abutment Defects: Cracking in Deck	1/4" or less - Epoxy Injections	$20.00/LF	30
Integral/Semi-Integral Abutment Defects: Cracking in Deck	1/4" or greater	$35.00/LF	30
Integral/Semi-Integral Abutment Defects: Deteriorated Concrete	Place underdrains behind abutments	$100.00/LF	20
Integral/Semi-Integral Abutment Defects: Deteriorated Concrete	Remove and patch concrete as per item 519	$45.00/SF	15
Stub Type Abutment Defects: Leaning/Tilting	Make beam ends integral with abutment (bridge holds abutment up)	$25,000 Each	15
Stub Type Abutment Defects: Leaning/Tilting	Replace	$50,000 Each	40
Stub Type Abutment Defects: Settlement	Raise abutment seat with shims or concrete	$10,000 Each	15
Stub Type Abutment Defects: Settlement	Make abutment integral	$20,000 Each	15
Stub Type Abutment Defects: Settlement	Replace	$50,000 Each	40
Stub Type Abutment Defects: Deteriorated Concrete	Seal expansion joints	$150/LF	15
Stub Type Abutment Defects: Deteriorated Concrete	Remove and patch concrete as per Item 519	$45/SF	15
Wall Type Abutment Defects: Exposed Footers	If not on piling: underpin with concrete and armor footer with rock	$200/F	15
Wall Type Abutment Defects: Exposed Footers	If on piling: the footer with rock	$20/F	15
Wall Type Abutment Defects: Vertical Cracking	If 3/8" wide or greater: Fill with mortar or quick setting epoxy material	$35/LF	20
Wall Type Abutment Defects: Vertical Cracking	If less than 3/8" wide: Epoxy inject	$20/LF	20
Wall Type Abutment Defects: Deteriorated Concrete	Seal leaking joints, divert scuppers, remove unsound concrete and patch as per spec book item 519	$45/LF	20
Wall Type Abutment Defects: Leaning	Remove trees from embankment	$500/LF	10
Wall Type Abutment Defects: Leaning	Underpin	$200/LF	15
Wall Type Abutment Defects: Leaning	Replace	$800/LF	40
Concrete Approach Slabs: Scaling	Seal with silane	$2/SF	5
Concrete Approach Slabs: Scaling	Overlay with epoxy/sand slurry	$40/SY	10
Concrete Approach Slabs: Cracks	Epoxy inject and underseal	$5/LF	15

Part, Defect	Repair	Cost	Life, years
Concrete Approach Slabs: Cracks	Replace	$60/SY	30
Concrete Approach Slabs: Potholes	Sawcut around and patch with fast setting concrete	$15/SY	10
Concrete Approach Slabs: Potholes	Patch with asphalt	$2/SY	5
Concrete Approach Slabs: Settlement	Overlay with asphalt	$2/SY	5
Concrete Approach Slabs: Settlement	Mudjack with grout or urethane	$15/SY	15
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Replace wearing surface	$10/SY	10
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Crack seal surface	$2/SY	10
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Pave full width	$10/LF	10
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Seal joint between edge of paving and face of wall	$2/LF	10
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Open up weep holes	$50/EA	20
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Core drill new weep holes at low points of arch	$70/EA	20
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Install transverse tie rods between walls	$1000/EA	20
Filled Spandrel Wall Arch Bridge Defects: Walls Leaning Outward	Replace walls	$1500/LF	50
Filled Spandrel Wall Arch Bridge Defects: Deteriorated Concrete	Saw cut around deterioration and patch with concrete	$45/SF	25
Open Spandrel Arch Bridge Defects: Floorbeam Deterioration	Patch delaminations as per Item 519 (and seal joints)	$45/SF	20
Open Spandrel Arch Bridge Defects: Floorbeam Deterioration	Replace deck and floorbeams	$80/SF	40
Open Spandrel Arch Bridge Defects: Arch Rib or Ring Deterioration	Replace bridge	$120/SF	80
Concrete Through Arch Bridge Defects: Arch Rib Deterioration	Patch using 519	$45/SF	20

Part, Defect	Repair	Cost	Life, years
Concrete Through Arch Bridge Defects: Arch Rib Deterioration	Replace bridge	$120/SF	80
Backwall Defects: Delaminated Vertical Surface	Seal joints and patch delaminations	$45/LF	
Backwall Defects: Leaning Backwall (Touching beam ends or limited clearance)	Replace backwall in-kind and cut off beam ends to restore clearance (install pavement pressure relief joints)	$600/LF	10
Backwall Defects: Leaning Backwall (Touching beam ends or limited clearance)	Remove backwall and recast by moving away from beam ends	$800/LF	15
Backwall Defects: Leaning Backwall (Touching beam ends or limited clearance)	Make abutments integral with beams	$1,000/LF	20
Backwall Defects: Deteriorated Tops	Remove deteriorated concrete and replace (install pavement pressure relief joints	$100/LF	15
Steel Beam Defects: Surface Rust (If Painted)	Spot paint affected areas if less than 20% of the surface area or if very localized	$7.50/SF10 years	
Steel Beam Defects: Surface Rust (If Painted)	Completely remove and repaint	$5/SF18 years	
Steel Beam Defects: Corrosion Through Steel	Plate over by welding	$25/SF	10
Steel Beam Defects: Corrosion Through Steel	Cut out deteriorated areas and let in new steel by welding and grinding welds smooth	$50/SF	30
Steel Beam Defects: Bent Beams	Heat straighten - if less than 6" out of alignment	$10,000	25
Steel Beam Defects: Bent Beams	Heat straighten - if more than 6" out of alignment	$5,000 per inch of Deflection	25
Steel Beam Defects: Nicks or Gouges in Bottom Flange	Grind out, eliminating sharp corners	$1,000 Each	25
Prestressed Concrete Box Beam Defects: Leaking Joints Between Beams	Remove asphalt, waterproofing, and unsound keyway grout. Replace grout, waterproofing, and asphalt	$15/SF	20
Prestressed Concrete Box Beam Defects: Spalling of Concrete on Underside or Outside Beams	If major spalling and broken strands, then replace beams	$150/LF	40
Prestressed Concrete Box Beam Defects: Spalling of Concrete on Underside or Outside Beams	If spalling on bottom side of outside beams, then patch with trowelable mortar if minor deterioration or do nothing and add drip strip if over-the-side drainage	$5/LF	30
Prestressed Concrete Box Beam Defects: Cracks	Epoxy injection	$10/LF	
Prestressed Concrete I-Beam Defects: Cracks in Cast-in-Place Closure Pour Between Beam Ends	Epoxy injection if isolated case	$10/LF	20

Part, Defect	Repair	Cost	Life, years
Prestressed Concrete I-Beam Defects: Cracks in Cast-in-Place Closure Pour Between Beam Ends	Replace in-kind	$50/CF	20
Prestressed Concrete I-Beam Defects: Cracks in Bottom Flange	Epoxy injection	$10/LF	20
Steel Rocker Type Bearing Defects: Bearing Out of Vertical at 70° F	Reseat bearings by jacking bridge	$200 Each	10
Steel Rocker Type Bearing Defects: Bearing Out of Vertical at 70° F	Convert to integral/semi-integral abutment	$2000/LF	30
Steel Rocker Type Bearing Defects: Bearing Out of Vertical at 70° F	Reseat bearings and shim as necessary	$200 Each	10
Steel Rocker Type Bearing Defects: Bearing Out of Vertical at 70° F	Reseat as necessary	$200 Each	
Steel Rocker Type Bearing Defects: Corrosion of Steel	Seal expansion joints and spot paint bearing	$80 Each	15
Steel Rocker Type Bearing Defects: Bearing Loose	Replace/Rehabilitate expansion joint	$100/LF	20
Steel Rocker Type Bearing Defects: Bearing Loose	Remove rockers, clean, and reseat	$1500 Each	35
Neoprene Type Bearing Defects: Neoprene Cracked	Seal cracks with silicone	$10 Each	15
Neoprene Type Bearing Defects: Neoprene	Replace bearings	* Varies *	40
Neoprene Type Bearing Defects: Bearings Loose	Reseat and shim as needed	$50 Each	15
Neoprene Type Bearing Defects: Bearings Out of Position	Reset as needed	$50 Each	15
Neoprene Type Bearing Defects: Bearings Out of Position	Grind abutment/pier seat or shim as necessary to align with bottom of beams	$200 Each	
Corrugated Metal Galvanized Steel Culvert Defects: Bottom Corrosion	Clean bottom and place concrete in bottom (even if bottom is perforated as long as culvert has good shape)	$100/LF	20
Corrugated Metal Galvanized Steel Culvert Defects: Bottom Corrosion	Replace culverts	$1200/LF	35
Corrugated Metal Galvanized Steel Culvert Defects: Out-of-Shape	Install liner plate if capacity allows	$1,000/LF	35
Corrugated Metal Galvanized Steel Culvert Defects: Out-of-Shape	Install plastic liner insert if capacity allows	$800/LF	40

Part, Defect	Repair	Cost	Life, years
Corrugated Metal Galvanized Steel Culvert Defects: Out-of-Shape	Replace culvert	$1200/LF	35
Corrugated Metal Galvanized Steel Culvert Defects: Out-of-Shape	Remove trees in vicinity of culvert	$.50 each	10
Corrugated Metal Galvanized Steel Culvert Defects: Cracks at Bolted Connections	If cracks are more than 10% of culvert length or propagating, weld short piece of rebar across the crack on every other corrugation	$50 Each	10
Corrugated Metal Galvanized Steel Culvert Defects: Cracks at Bolted Connections	Replace culvert	$1500/LF	25
Corrugated Metal Galvanized Steel Culvert Defects: Headwall Disintegrating or Leaning	Replace headwall	$1500 Each	30
Four Sided Precast Concrete Box Culvert Defects: Leaking Joints	Excavate and re-waterproof	$500/LF	20
Four Sided Precast Concrete Box Culvert Defects: Leaking Joints	Attempt to seal from underside using expanding polyethylene/urethane caulk or "Leak Stop" fast setting mortar	$10/LF of joint	10
Four Sided Precast Concrete Box Culvert Defects: Disintegrating Concrete	Attempt to seal joints as noted in "Leaking Joints" and try patching with trowelable mortar	$10/LF of joint; $45/SF	15
Four Sided Precast Concrete Box Culvert Defects: Disintegrating Concrete	Use Gunite for large overhead and vertical areas	$45/SF	15
Four Sided Precast Concrete Box Culvert Defects: Disintegrating Concrete	Pour concrete slab on top of old for large areas at the bottom	$45/SF	15
Four Sided Precast Concrete Box Culvert Defects: Large (1"+) Gaps in Joints	Fill with fast-setting mortar material	$5/LF of joint	10
Aluminum Box Culvert Defects: Seams/Bolts Leaking	Excavate and waterproof	$700/LF of culvert	
Aluminum Box Culvert Defects: Bulging Bottom or Sagging Top	Excavate and jack back into shape then re-bed and properly backfill	$900/LF	10
Aluminum Box Culvert Defects: Bulging Bottom or Sagging Top	Replace	$1500/LF	25
Aluminum Box Culvert Defects: Footers Exposed or Undermined	If undermined, then underpin with concrete and armor with rock	$100/LF	15
Aluminum Box Culvert Defects: Footers Exposed or Undermined	If exposed, then armor footers with rock	$25/LF	15
Three Sided Precast Concrete Box Culvert: Joints Leaking	Seal joints from underside with expanding urethane	$5/LF of joint	15

Part, Defect	Repair	Cost	Life, years
Three Sided Precast Concrete Box Culvert: Joints Leaking	Waterproofing membrane not properly installed or omitted entirely	$200/LF or culvert	
Three Sided Precast Concrete Box Culvert: Delamination of Concrete	Seal joints and patch delaminations with trowelable mortar or Gunite	$45/SF	15
Aluminum Box Culvert Defects: Exposed or Undermined Footers	If exposed but not undermined, then armor footers with rock	$25/LF	15
Aluminum Box Culvert Defects: Exposed or Undermined Footers	If undermined, then underpin with concrete and armor footers with rock	$100/LF	15+
Top-Side Bridge Deck Defects: Scaling	Seal with a silane sealer	$1/SF	5
Top-Side Bridge Deck Defects: Scaling	Mill surface and place 1 1/4" concrete overlay/inlay (if scaling is severe; more than 1/2" deep)	$35/SF	15
Top-Side Bridge Deck Defects: Aggregate Popouts	Seal with a silane sealer	$1/SF	5
Top-Side Bridge Deck Defects: Cracks	Seal with a silane sealer	$1/SF	5
Top-Side Bridge Deck Defects: Cracks	Treat cracks with a high molecular weight Methacrylate (HMWM)	$2/SF	15
Top-Side Bridge Deck Defects: Cracks	Treat cracks with reactive silicate solution	$0.50/SF	5
Top-Side Bridge Deck Defects: Cracks	Treat cracks with gravity fed resin	$1.50/SF	10
Top-Side Bridge Deck Defects: Potholes	Sound perimeter of hole, sawcut and remove back to sound concrete, patch with fast setting concrete patch material (for semi-permanent and if unsound area does not exceed 10% of deck area)	$100/SF	10
Top-Side Bridge Deck Defects: Potholes	Remove unsound material and place hot mix asphalt for temporary repair.	$15/SF	3
Top-Side Bridge Deck Defects: Potholes	If unsound areas exceed 10% of deck area, consider removing entire top surface and place 1 1/4" specialty concrete overlay (microsilica or latex modified)	$35/SF	15
Top-Side Bridge Deck Defects: Potholes	If unsound area exceeds 10% of deck area and if a temporary fix is desired to smooth the deck, remove all unsound concrete, tack deck surface, and place hot mix asphalt over entire surface.	$15/SF	3-5
Top-Side Bridge Deck Defects: Full-Depth Holes	Place steel plate over hole	$10/SF	1 week
Top-Side Bridge Deck Defects: Full-Depth Holes	Remove back to sound concrete, form from underside and place full concrete patch	$150/SF	10
Top-Side Bridge Deck Defects: Full-Depth Holes	Replace the entire deck	$80/SF	40
Bottom Side Bridge Deck Defects: Transverse Cracks	Seal top surface with: HMWM	$2/SF	15
Bottom Side Bridge Deck Defects: Transverse Cracks	Seal top surface with: Gravity fed resin	$1.50/SF	10

Part, Defect	Repair	Cost	Life, years
Bottom Side Bridge Deck Defects: Transverse Cracks	Seal top surface with: Silane	$1/SF	5
Bottom Side Bridge Deck Defects: Transverse Cracks	Seal top surface with: Reactive silicate	$.50/SF	5
Bottom Side Bridge Deck Defects: Delamination of Bottom Surface	Remove delaminations if over traffic or pedestrians	$15/SF	3
Bottom Side Bridge Deck Defects: Delamination of Bottom Surface	Build plywood diaper under bridge	$15/SF	8
Bottom Side Bridge Deck Defects: Delamination of Bottom Surface	Replace deck	$80/SF	40
Bottom Side Bridge Deck Defects: Damp, Dark, Mottled Appearance	If 10% or less of surface area: Remove and recast affected area and overlay entire deck	$50/SF	15
Bottom Side Bridge Deck Defects: Damp, Dark, Mottled Appearance	If greater than 10%: Replace deck	$80/SF	40
Bottom Side Bridge Deck Defects: Hole thru Deck	If 5% or less: Remove and recast	$50/SF	15
Bottom Side Bridge Deck Defects: Hole thru Deck	If greater than 5%: Replace deck	$80/SF	40
Drain Pipes Below Deck Defects: Joints Disconnected	Clean out pipes and reconnect sections	$50/LF	10
Drain Pipes Below Deck Defects: Pipes Rusted Through	Clean out pipes and weld plates over holes	$20/SF	15
Drain Pipes Below Deck Defects: Pipes Rusted	Replace pipes	$10/LF	20
Drain Pipes Below Deck Defects: Clogged Pipes	Increase slope as per Bridge Design Manual	$10/LF	20
Drain Pipes Below Deck Defects: Clogged Pipes	Eliminate 90° bends as per Bridge Design Manual	$25 Each	20
Drain Pipes Below Deck Defects: Clogged Pipes	Install cleanouts	$50 Each	20
Drain Pipes Below Deck Defects: Clogged Pipes	Provide disconnection at ground line	$50 Each	20
Polymer Modified Asphalt Expansion Joint Defects: Asphalt Rutted or Pulled Out	Remove damaged portion and reinstall	$30/LF	15
Polymer Modified Asphalt Expansion Joint Defects: Joint Leaking	Remove damaged portion and reinstall	$30/LF	15
Strip Seal Expansion Joint Defects: Neoprene Gland Torn or Pulled Out	Install larger (wider) gland or install a new gland	$40/LF	15
Strip Seal Expansion Joint Defects: Steel Anchorage Loose	Epoxy inject if anchorage is still intact	$35/LF	15

Part, Defect	Repair	Cost	Life, years
Strip Seal Expansion Joint Defects: Steel Anchorage Loose	Remove concrete and recast concrete around anchorage	$150/LF	20
Strip Seal Expansion Joint Defects: Joint Leaking	Remove and reinstall new gland	$40/LF	15
Neoprene Compression Seal Expansion Joint Defects: Neoprene Seal Falls Out	Replace neoprene with a larger size	$15/LF	10
Neoprene Compression Seal Expansion Joint Defects: Neoprene Seal Falls Out	Replace neoprene in-kind	$15/LF	10
Neoprene Compression Seal Expansion Joint Defects: Neoprene Seal Falls Out	Reinstall seal with new adhesive	$10/LF	10
Neoprene Compression Seal Expansion Joint Defects: Joint Leaks	Replace neoprene with larger size	$15/LF	10
Neoprene Compression Seal Expansion Joint Defects: Joint Leaks	Replace neoprene in-kind	$15/LF	10
Neoprene Compression Seal Expansion Joint Defects: Joint Leaks	Reinstall seal with new adhesive	$10/LF	10
Neoprene Compression Seal Expansion Joint Defects: Steel Anchorage Becomes Loose	Epoxy inject if anchorage is still intact	$35/LF	15
Neoprene Compression Seal Expansion Joint Defects: Steel Anchorage Becomes Loose	Remove sufficient concrete and re-encase anchorage	$150/LF	20
Sliding Plate Expansion Joint Defects: Loose Sliding Plate	Re-weld through slotted holes cut in sliding plate	$50/LF	15
Sliding Plate Expansion Joint Defects: Loose Sliding Plate	Replace entire damaged section of failed plate by removing portion of deck and anchorage	$200/LF	25
Sliding Plate Expansion Joint Defects: Cracked Sliding Plate	Replace sliding plate by welding to underlying angle through slots in new plate	$75/LF	15
Sliding Plate Expansion Joint Defects: Cracked Sliding Plate	Replace entire expansion joint assembly	$200/LF	25
Sliding Plate Expansion Joint Defects: Anchorage Loose in Backwall	Epoxy injection of anchorage into concrete	$35/LF	15
Sliding Plate Expansion Joint Defects: Anchorage Loose in Backwall	Remove and replace entire anchorage by removing top of backwall and recasting	$150/LF	20
Sliding Plate Expansion Joint Defects: Gouged Assembly	Grind or re-weld as necessary	$50/Each	
Sliding Plate Expansion Joint Defects: Joint Closed	Stabilize abutment and rebuild joint Install pavement pressure relief joints and rebuild joint	$1,500/LF	15
Over-the-Side Drainage Defects: Deck Edge Deterioration	If top edge of slab is still sound and only bottom edge is deteriorated, then install steel drip strip on top side to deflect drainage	$15/LF	20

Part, Defect	Repair	Cost	Life, years
Over-the-Side Drainage Defects: Deck Edge Deterioration	If top and bottom edge is deteriorated, then remove and patch deteriorated concrete as per Item 519 and install drip strip	$50/SF	20
Over-the-Side Drainage Defects: Deck Edge Deterioration	If top and bottom edge deterioration is extensive (beyond patching) then remove entire deck and recast and use a drip strip	$1000/LF	40
Over-the-Side Drainage Defects: Deck Edge Deterioration	If prestressing strands are corroded through, then replace exterior beams (with drip strip)	$1000/LF	50
T-Type (Hammerhead) Pier Defects: Spalling of Concrete	Redirect drainage and patch and seal spalls with epoxy/urethane	$30/SF	15
T-Type (Hammerhead) Pier Defects: Cracks in Cantilever Cap	Epoxy inject cracks less than 1/8" wide and inspect for further movement	$10/LF	20
T-Type (Hammerhead) Pier Defects: Cracks in Cantilever Cap	Install steel bands or post tensioning rods around pier cap	$100/LF	20
Capped Pile Type Pier Defects: Corrosion of Steel Piling at Water or Ground Line	Clean and encase steel in concrete to at least 2 feet below ground/water line	$20/LF	20
Capped Pile Type Pier Defects: Portions of H-Piling Completely Rusted Through	Weld stiffener plates over deteriorated areas and encase in concrete	$30/LF	20
Capped Pile Type Pier Defects: Concrete Cap Deteriorated	Redirect drainage and patch and seal surfaces	$25/SF	20
Capped Pile Type Pier Defects: Cracks in Pier Cap	Epoxy inject cracks and inspect for further movement	$5/LF	20
Concrete Wall Type Pier Defects: Spalling Concrete	Patch spalls and seal surface	$25/SF	20
Concrete Wall Type Pier Defects: Vertical Cracks	Epoxy inject cracks 3/8" or less in width	$10/LF	20
Concrete Wall Type Pier Defects: Vertical Cracks	Underpin foundation	$50/LF	15
Concrete Wall Type Pier Defects: Vertical Cracks	Fill cracks over 3/8" with mortar	$15/LF	15
Concrete Wall Type Pier Defects: Horizontal Cracks	Remove unsound concrete and patch with trowelable mortar or Item 519	$25/SF	20
Cap and Column Type Pier Defects: Spalling Concrete	Patch concrete as per Item 519 and seal with epoxy/urethane	$30/SF	15
Cap and Column Type Pier Defects: Spalling Concrete	Seal expansion joint or redirect scupper	$50/LF	15
Cap and Column Type Pier Defects: Cracking of Pier Caps	Epoxy inject cracks 1/8" and less in width and inspect for further movement	$10/SF	20
Galvanized Deep-Beam with Tubular Backup Railing Defects: Gouges and Dents	Touch up gouges with zinc paint	$2/SF	10

Part, Defect	Repair	Cost	Life, years
Galvanized Deep-Beam with Tubular Backup Railing Defects: Gouges and Dents	Replace guardrail sections	$25/LF	40
Galvanized Deep-Beam with Tubular Backup Railing Defects: Gouges and Dents	Replace tubular backup sections	$80/LF	40
Galvanized Deep-Beam with Tubular Backup Railing Defects: Leaning or Bent Posts	Replace posts	$150/each	40
Galvanized Deep-Beam with Tubular Backup Railing Defects: Rusting Surface	Clean and paint with zinc paint	$3/SF	10
Galvanized Deep-Beam with Tubular Backup Railing Defects: Rusting Surface	Clean and metalize	$10/SF	40
Galvanized Deep-Beam with Tubular Backup Railing Defects: Rusting Surface	Replace	$150/LF	40
Galvanized Deep-Beam with Tubular Backup Railing Defects: Anchor Bolts Loose from Embedment	Touch up gouges with zinc paint	$2/SF	10
Galvanized Deep-Beam with Tubular Backup Railing Defects: Anchor Bolts Loose from Embedment	Replace guardrail sections	$25/LF	40
Galvanized Deep-Beam with Tubular Backup Railing Defects: Anchor Bolts Loose from Embedment	Replace tubular backup sections	$80/LF	40
Reinforced Concrete Railing Defects: Scaling of Surface	Clean and seal with Silane	$2/SF	10
Reinforced Concrete Railing Defects: Scaling of Surface	Clean and seal with epoxy/urethane	$4/SF	15
Reinforced Concrete Railing Defects: Popouts of Surface	Clean and seal with Silane	$2/SF	10
Reinforced Concrete Railing Defects: Popouts of Surface	Clean and seal with epoxy/urethane	$4/SF	15
Reinforced Concrete Railing Defects: Cracks	1/16-in or less in width seal with HMWM	$1/SF	10
Reinforced Concrete Railing Defects: Cracks	Greater than 1/16-in route out crack and seal with flexible caulk	$2.50/SF	10
Reinforced Concrete Railing Defects: Delamination of the Surface	Remove unsound concrete; sawcut around perimeter; remove and patch with fast setting patch material	$40/SF	15
Reinforced Concrete Railing Defects: Delamination of the Surface	If thin areas (1-in or less) patch with trowelable mortar	$10/SF	10

Part, Defect	Repair	Cost	Life, years
Reinforced Concrete Railing Defects: Widespread Surface Deterioration	Sawcut around and remove unsound areas full-depth and recast in-kind	$80/SF	30
Reinforced Concrete Railing Defects: Widespread Surface Deterioration	Replace entire railing	$800/LF	30
Scupper Defects: Bottom End Corroded Off	Cut off bottom and weld new section onto existing	$25 Each	30
Scupper Defects: Bottom End Corroded Off	Cut off and extend by attaching PVC pipe of same size	$20 Each	30
Scupper Defects: Corrosion of Exposed Surfaces	Clean and paint	$5/SF	15
Sidewalk Defects: Scaling of Surface	Clean and seal with Silane	$2/SF	10
Sidewalk Defects: Scaling of Surface	Overlay with 1/4-in epoxy overlay	$35/SF	15
Sidewalk Defects: Popouts of Surface	Clean and seal with Silane	$2/SF	10
Sidewalk Defects: Cracks	1/16-in or less in width: Seal with HMWM	$1/SF	
Sidewalk Defects: Cracks	Greater than 1/16-in in width: Route out crack and fill with flexible caulking (silicone or urethane)	$2.50/SF	
Sidewalk Defects: Delamination of Surface	Remove unsound concrete; sound area, sawcut perimeter and remove and patch with fast setting patch material	$40/SF	15
Sidewalk Defects: Widespread Deterioration of Surface	Sawcut, remove unsound areas full-depth and recast in-kind	$80/SF	30
Slab Bridge Defects: Edge Deterioration	Install drip strip if top edge not deteriorated	$10/LF	20
Slab Bridge Defects: Edge Deterioration	Patch edge and install drip strip	$25/LF	20
Slab Bridge Defects: Edge Deterioration	Remove entire edge and recast edge including drip strip	$200/LF	30
Slab Bridge Defects: Longitudinal Reinforcing Steel Exposed (not including edge of slab)	If leaking, unsound areas are greater than 15% of deck area then replace the entire slab	$200/SF	40
Slab Bridge Defects: Longitudinal Reinforcing Steel Exposed (not including edge of slab)	If leaking, unsound areas are less than 15% of deck area then replace portions of the slab	$150/SF	15
Slab Bridge Defects: Longitudinal Reinforcing Steel Exposed (not including edge of slab)	Alternatively, attempt to seal top side with HMWM, silane, or reactive silicates	$5/SF	10
Slab Bridge Defects: Longitudinal Reinforcing Steel Exposed (not including edge of slab)	If less than 10% of slab, consider removing unsound concrete and replacing in-kind	$150/SF	15

Part, Defect	Repair	Cost	Life, years
Slab Bridge Defects: Longitudinal Reinforcing Steel Exposed (not including edge of slab)	If more than 10% of slab, then replace entire slab	$200/SF	40
Streambed Defects: Debris Build-Up on Piers	Clean off debris as needed	$1,000/EA. Pier	2
Streambed Defects: Migration	Clean off debris from piers as needed	$1,000/EA. Pier	2
Streambed Defects: Migration	Remove sedimentation bar upstream of bridge (note: this may require a permit)	$5,000/EA. Pier	5
Streambed Defects: Migration	Place dump rock along outside of curve to slow stream	$10,000/EA. Pier	10
Streambed Defects: Migration	Construct other accepted methods of slowing water in outside of curve such as spurs, jack field, willow saplings, etc...	$15,000/EA. Pier	10
Streambed Defects: Lowering	Place dumprock across stream immediately downstream of bridge	$20,000/EA. Pier	10
Streambed Defects: Lowering	Construct low water check dam downstream of bridge using to lines of sheet piling filler with dumprock in between	$30,000/EA. Pier	10
Streambed Defects: Lowering	Pave streambed under bridge with concrete slab and cut-off walls	$30,000/EA. Pier	10
Streambed Defects: Lowering	Place used precast concrete traffic median barriers across stream	$2,000/EA. Pier	3
Wearing Surface (Concrete Overlays) Defects: Scaling of surface	Seal with silane	$1 /SF	5
Wearing Surface (Concrete Overlays) Defects: Scaling of surface	Replace portions of overlay if scaling is more than 1/2" deep	$35 /SF	15
Wearing Surface (Concrete Overlays) Defects: Aggregate Popouts	Seal with a silane sealer	$1 /SF	5
Wearing Surface (Concrete Overlays) Defects: Cracking	Seal with: HMWM	$2 /SF	15
Wearing Surface (Concrete Overlays) Defects: Cracking	Seal with: Gravity fed resin	$1.50 /SF	10
Wearing Surface (Concrete Overlays) Defects: Delaminations	Sound, sawcut, remove delaminated material and patch with fast setting patch material	$100 /SF	10
Wearing Surface (Concrete Overlays) Defects: Potholes	If potholes and delaminations do not exceed 10% of deck area: sound, sawcut, remove and patch with fast setting patch material	$100 /SF	10
Wearing Surface (Concrete Overlays) Defects: Potholes	If potholes and delaminations exceed 10% of deck area: Replace overlay	$35 /SF	15
Wearing Surface (Concrete Overlays) Defects: Potholes	Replace deck	$80 / SF	40
Wearing Surface (Asphalt Overlays) Defects: Cracks	If cracks are isolated; crack seal with a rubberized asphalt	$.20 /SF	5

Part, Defect	Repair	Cost	Life, years
Wearing Surface (Asphalt Overlays) Defects: Cracks	If cracks are numerous and interconnected; remove asphalt and replace with waterproofing membrane and new asphalt	$35 /SF	10
Wearing Surface (Asphalt Overlays) Defects: Surface Ravelling	Chip and seal if asphalt still well bonded to deck	$1 /SF	5
Wearing Surface (Asphalt Overlays) Defects: Surface Ravelling	Replace with new waterproofing membrane and asphalt	$35 /SF	10
Wearing Surface (Asphalt Overlays) Defects: Potholes	If potholes and unsound asphalt do not exceed 15% of surface area; Remove unsound areas by saw cutting or jack hammering and patch with asphalt	$15 /SF	5
Wearing Surface (Asphalt Overlays) Defects: Potholes	If potholes and unsound material exceeds 15% of surface area; Remove entire surface and replace	$35 /SF	10

Deck Preservation

Ohio DOT has standard specifications (223) for

- Treating Concrete (Item 512)
- Sealing of Concrete Surfaces - Epoxy-Urethane sealers (Item 512.03)
- Sealing Concrete Bridge Decks with HMWM Resin (Item 512.04)
- Soluble Reactive Silicate (SRS) Concrete Treatment (Item 512.05)
- Treating Concrete Bridge Decks with Gravity-Fed Resin (Item 512.06)
- Sealing Cracks by Epoxy Injection (Item 512.07)
- Waterproofing (Item 512.08)

Ohio DOT has supplemental specifications (224)(225) for deck overlays with micro-silica modified concrete, latex modified concrete, and superplasticized dense concrete.

Condition Data

Ohio DOT maps deck condition ratings on a 1-to-4 scale to NBI condition ratings on a 9-to-0 scale (226). There is a dedicated map for timber (Table 140). Ohio DOT reports condition for a set of deck items (Table 141). Ohio DOT relates element-level condition ratings to actions for decks (Table 142).

Table 140 Ohio DOT. Map of Condition Rating, Timber

1-4 Indiv.	9-0 Summary	Description
1-Good	9-Excellent	No noticeable or noteworthy deficiencies which affect the condition of the deck.
	8-Very Good	No crushing, rotting, or splitting. Tightly secured to floor system. Very few minor deficiencies.
	7-Good	Minor checking or splitting with a few loose planks.
2-Fair	6-Satisfactory	Several planks are checked or split but sound. Some loose planks. Fire damage limited to surface scorching with no measurable section loss. Some wet areas noted. A few planks (under 5%) are in need of replacement.
	5-Fair	Numerous planks checked or split. Majority of planks are loose. Fire damage limited to surface charring with minor, measurable section loss. Some planks (5 - 10%) are in need of replacement.

3-Poor	4-Poor	Majority of the planks are checked or split. Fire damage with significant section loss which may reduce the load carrying capacity of the member. Over 10% of the planks are in need of replacement.
	3-Serious	Local failures possible. Severe signs of structural distress are visible. Major decay or fire damage is present which has substantially reduced the load carrying capacity of the deck.
4-Critical	2-Critical	Advanced deterioration with partial deck failure. May be necessary to close bridge until corrective action is taken.
	1-Imminent Failure	Bridge closed, corrective action will put it back in light service
	0-Failed	Bridge closed, replacement necessary

Table 141 Ohio DOT. Condition Reports for Deck Items

Deck Item			**Codes**
c7.1	Floor/Slab	(SF)	1, 2, 3, 4
c7.2	Edge of Floor/Slab	(SF)	1, 2, 3, 4
c8.	Wearing Surface	(SF)	1, 2, 3, 4
c9.	Curbs/Sidewalk	(LF)	1, 2, 3, 4
c10.	Median	(LF)	1, 2, 3, 4
c11.	Railing	(LF)	1, 2, 3, 4
N36.	Safety Features: Rail		1, 0, N
c12.	Drainage	(EA)	1, 2, 3, 4
c13.	Expansion Joint	(LF)	1, 2, 3, 4
N58.	Deck Summary		9-0

Table 142 Ohio DOT. Condition States and Actions for Decks

	Generic Item - Condition States (CS)			
Defect	**GOOD Condition State 1**	**FAIR Condition State 2**	**POOR Condition State 3**	**SEVERE Condition State 4**
Adjective	Quantity that is Good	Quantity that is Fair	Quantity that is Poor, does not warrant a structural review	Warrants Structural Review OR the defect impacts the strength or serviceability of the element
Maintenance Response -->	Monitor Protect	Monitor Protect	Monitor Protect Repair Rehab	Monitor Protect Rehab Replace

Oklahoma Department of Transportation

Deck Preservation

Oklahoma DOT has standard specifications (227) for

- Deck overlay using high density concrete (Section 505)
- Deck overlay using latex modified concrete (Section 505)
- Deck overlay using early strength concrete (Section 505)
- Deck overlay using multilayer polymer concrete (Section 505)
- Deck overlay using asphalt membrane (Section 505)
- Repair of concrete decks (Section 513)
- Surface sealing (Section 515)
- Crack sealing by epoxy injection (Section 520)
- Crack sealing by gravity-fed epoxy or methyl methacrylate (Section 523)
- Crack sealing by flood coat epoxy or methyl methacrylate (Section 523)

Oregon Department of Transportation

Definitions

Oregon DOT defines terms in bridge maintenance and repair (Table 143) (230).

Table 143 Oregon DOT. Definitions of Terms in Bridge Maintenance (230)

Term	Definition
Preventive Maintenance	Activities that protect the original capital investment, prevent deterioration, or allow the bridge components to function as designed
Minor Repair	Actions to arrest and correct deterioration before it becomes a serious problem
Major Repairs	Correction of extensive deterioration and minor betterment to the bridge
Deferred Action	Bridges with maintenance needs, which are beyond the point where preventive maintenance and minor repair will be effective and have not deteriorated to the point of needing major repair or rehabilitation; includes emergency work resulting from an act of man or God, such as damage from a vehicle accident or severe storm.

Policy.

Preservation Needs.

Oregon DOT notes that needs for maintenance differ according to (229)

- Bridge type, construction materials, geometry, and load capacity.
- Quality of materials and of the as-built construction.
- Environmental conditions of climate, air quality, and surrounding soil.
- Extent and severity of corrosion or other deterioration that affect strength or structural behavior.
- Traffic volume and frequency and the weight of truck traffic.
- Type, timing, and effectiveness of maintenance, preservation actions, and replacement actions.

Selection of Actions.

Oregon DOT links element-level condition states to recommendations for work (Table 144) (230).

Table 144 Oregon DOT. Condition State & Action (230)

Element-Level Condition State	Action
2	Bridge Preservation Activities
3	Element Repair Activities
4	Repair failed element / system

Actions. Recommendations & Programming

With each routine bridge inspection, bridge inspectors list bridge maintenance recommendations (230). Bridge maintenance managers develop maintenance plans from inspectors' recommendations.

Training.

Oregon DOT trains workers in maintenance actions (231).

Funding. Allocation of Maintenance Finds

Oregon DOT recommends allocations of maintenance funds (Table 145) (230).

Table 145 Oregon DOT. Allocation of Maintenance Funds (230)

Maintenance Category	Allocation
Preventive Maintenance	10 to 25 %
Minor Repairs	15 to 25 %
Deferred Maintenance	10 to 20 %
Major Repairs	30 to 65 %

Actions.

Major Bridge Maintenance.

Oregon DOT has a Major Bridge Maintenance (MBM) program that delivers urgent maintenance projects that are too large to fund at the District level (Table 146) (229). In year 2014, Oregon's MBM program funded projects to seal bridge decks, install deck overlays, make scour repairs, deck joint repairs, timber repairs, approach repairs, replace bearings and maintain movable bridges.

Table 146 Oregon DOT. Major Bridge Maintenance (229)

Action
Seal bridge decks
Install deck overlays
Make scour repairs
Deck joint repairs
Timber repairs
Approach repairs
Replace bearings
Maintain movable bridges

Preservation.

Oregon DOT's bridge preservation program provides deck re-surfacing and joint replacement (232).

Data.

Actions.

Oregon DOT lists a series of TEAMS actions for bridge maintenance (Table 147) (228).

Table 147 Oregon DOT. TEAMS Actions in Bridge Maintenance (228)

Teams ID	Description
160	Bridge maintenance
121	Cleaning culverts, box culverts, or other drainage structures that are less than 6 feet (1.8 meters) in width or diameter.

Teams ID	Description
123	Repairing culverts, box culverts, or other drainage structures that are less than 6 feet (1.8 meters) in width or diameter.
162	Repairs to bridges and major structures.
165	Operation of moveable bridges.
305	Assisting with elements of the bridge inspection program (including diving or sounding work).
346	Removing brush or trees near a structure or in the waterway underneath to maintain channel flow, provide access to the structure, and to prevent structural deterioration.
347	Removing drift and ice floes from bridge supports and waterways to prevent structural damage.
358	Performing routine bridge or waterway maintenance to preserve or restore fish passage.
615	Cleaning debris from caps or sills to prevent structural deterioration.
616	Cleaning concrete superstructure members to prevent structural deterioration.
617	Cleaning steel superstructure members to prevent structural deterioration.
618	Sweeping, removing debris from, and spot patching the concrete deck to prevent structural deterioration.
619	Cleaning wood, steel, or concrete curbs, rail, or felloe guards to preserve their proper function.
620	Cleaning concrete piling and posts to prevent structural deterioration.
621	Cleaning steel piling and posts to prevent structural deterioration.
622	Spot patching or performing other minor maintenance at the abutment or bridge end panel.
623	Cleaning deck joints to preserve the proper function and range of movement of each joint.
624	Cleaning bearings and seats to ensure the proper movement of structural members.
625	Cleaning dirt and debris from a structure's storm water drainage system to preserve or restore the proper function.
626	Cleaning dirt and debris from a major culvert to preserve or restore its proper function.

Maintenance History.

Oregon bridge files include detailed histories of maintenance and repairs (230). Oregon DOT notes the uses of this information.

- Information as to who did what, how, when and where;
- In-depth assessment of continual problems with a structure;
- Assess materials used to make the repair;
- Assess bridge detail design or repair design;
- Assess quality and adequacy of the work;
- Assess the best time of year to plan future work;
- Record of regular, periodic and special expenditures to develop and justify future budgets;
- Establish cost-to-performance relationships;
- Develop maintenance trends;
- Information for public relations;
- Generate accomplishment reports;
- Cost record to update budget estimates;
- Defense of tort liability claim.

Performance Measures

Oregon DOT tracks the percentages of structurally deficient (SD) bridges, 'other' deficient bridges (OD), and non-deficient (ND) bridges (229). Other deficiencies include freight mobility, vertical clearance,

geometric clearance, bridge safety, scour, rail deficiencies, painting, cathodic protection, moveable bridge repairs, low service life.

Deck Preservation

Oregon DOT provides supplemental information (235) for rating the general condition of steel decks (Table 148), for timber decks (Table 149)

Table 148 Oregon DOT. Steel Deck Supplemental Rating Guideline

Rating	Description
9 Excellent Condition	No noticeable or noteworthy deficiencies which affect the condition of the steel deck.
8 Very Good Condition	Tightly secured to floor system with no rust.
7 Good Condition	Loose at some connections with minor rusting. A few cracked welds and / or broken grids.
6 Satisfactory Condition	Considerable rusting with indications of initial section loss. Loose at many locations. Some cracked welds and / or broken grids.
5 Fair Condition	Heavy rusting with areas of section loss. Loose at numerous locations. Numerous cracked welds and / or broken grids.
4 Poor Condition	Heavy rusting resulting in considerable section loss and some holes through the deck. Many welds cracked and / or broken grids.
3 Serious Condition	Severe signs of structural distress are visible.
2 Critical Condition	Many holes through the deck.
1 Imminent Failure Condition	Bridge is closed. Corrective action may put back into light service.
0 Failed Condition	Bridge is closed. Deck replacement is necessary.

Table 149 Oregon DOT. Timber Deck Supplemental Rating Guideline

Rating	Description
9 Excellent Condition	No noticeable or noteworthy deficiencies which affect the condition of the deck.
8 Very Good Condition	Tightly secured to floor system. No crushing, decay, or splitting.
7 Good Condition	Minor checking or splitting, with a few loose planks.
6 Satisfactory Condition	More than 30% of the planks are checked or split but sound. Some loose planks. Fire damage limited to surface scorching with no measurable section loss. Some wet areas noted. A few planks (< 5%) are in need of replacement.
5 Fair Condition	Numerous (30 40%) planks checked split, decayed, or crushed. Majority of planks are loose Fire damage limited to surface charring with minor, measurable section loss. Some planks (5 10%) are in need of replacement.
4 Poor Condition	Majority (> 40%) of the planks are Decayed, crushed, or split. Fire damage with significant section loss which may reduce the load carrying capacity. > 10% of the planks need replacement.
3 Serious Condition	Severe signs of structural distress are visible. Major decay or fire damage is present which has reduced load carrying capacity.
2 Critical Condition	Advanced deterioration with partial deck failure. May need to close bridge.
1 Imminent Failure Condition	Bridge is closed. Corrective action may put back into light service.
0 Failed Condition	Bridge is closed. Deck replacement is necessary.

Oregon DOT has standard specifications (234) for

- Crack Injecting Existing Bridges (Section 00538)

- Crack Inspection and Deck Sealing (Section 00540.54)
- Multi-Layer Polymer Concrete Overlay (Section 00556)
- Silica Fume and Latex Modified Concrete Overlays (Section 00559)
- Spray Waterproofing Membrane (Section 00591)
- Portland Cement Concrete Repair Material (Section 02015)
- Concrete and Crack Sealers (Section 02060)

In its approved products list (233), Oregon DOT includes

Multi-Layer Polymer Concrete Overlay

Binder

E-Chem, LLC	Epx50-Overlay
Euclid Chemical	Flexolith
Unitex By Dayton Superior	Pro-Poxy Type III DOT

Aggregate

Washington Rock Quarries	Armorstone 980-3 Fed Hwy
Washington Rock Quarries	Armorstone 416-NM
Earth Work Solutions	Traction Control

PCC Repair

Five Star Product	Five Star Highway Patch Fr
Five Star Product	Five Star Hwy Patch
Basf Building Systems Tech	Master Emaco T 1060
Basf Building Systems Tech	MBT Set 45
Phoscrete Corporation	Phoscrete Four-Seasons
Mapei	Planitop 18
Mapei	Planitop 18 ES
Euclid Chemical	Speed Crete 2028
Euclid Chemical	Tamms Express Repair
Target Products	Target Traffic Patch Fine
Us Mix	Us Spec Polypatch FR
Us Mix	Us Spec Str Mortar
Us Mix	Us Spec TP Mortar
Us Mix	Us Spec Transpatch
Us Mix	Us Spec Transpatch Concrete
Us Mix	Us Spec Transpatch Ext

PCC Repair, Polymer Modified

Chemmasters	Chempatch V/O 1
Dayton Superior Corp	Pave Patch 3000
Mapei	Planitop X
Mapei	Planitop XS
Spec Chem	Repcon 928
Spec Chem	Spec Patch 15
Us Mix	Us Spec V/O Patch CI

Low Modulus Concrete and Crack Sealer

Euclid Chemical	Dural 50 LM	Low Modulus Epoxy
E-Bond Epoxies, Inc	E-Bond 523 Penetrating Sealer Crack Healer Primer	Low Modulus Epoxy
E-Chem LLC.	EP-100	Low Modulus Epoxy
Kwik Bond Polymers, LLC	KBP Flex	Low Modulus HMWM
Dayton Superior/Unitex	Pro-Poxy 40 FS	Low Modulus Epoxy
Unitex By Dayton Superior	Pro-Poxy 40 LV LM	Low Modulus Epoxy
Transpo Industries	Transpo Sealate T70MX-30	Low Modulus HMWM

High Modulus Concrete and Crack Sealer

CCS Coating Epoxy Healer Sealer	Chemco Systems	High Modulus Epoxy
Dural 335	Euclid Chemical	High Modulus Epoxy
Ep-100 HM	E-Chem	High Modulus Epoxy
KBP 103	Kwik Bond Polymers	High Modulus HMWM
KBP 204	Kwik Bond Polymers	High Modulus HMWM
Sika Pronto 19TF	Sika Corp	High Modulus HMWM
Sure Seal HMWM	Unitex By Dayton Superior	High Modulus HMWM

Water Repellent Concrete Sealer - 100% Silane

Basf Building Systems Tech	Master Protect H 1000
Evonik Corporation	Protectosil Bhn
Technical Barrier Systems	Sealmaster 100%
Advanced Chemical Technologies	Sil-Act Ats 100
Sherwin Williams	Sw-244-100voc

Silica Fume

Cementec Industries	Con-Fume Silica Fume
Elkem Materials	Ems-970d
Frrroatlantica	Ferroatlantica -Dsf
Gcp Applied Technologies Inc.	Force 10,000d
Basf - Admixtures	Masterlife Sf 100
Norchem	Norchem -Dsf

Waterproofing Membrane - Spray Applied

Olin Epoxy Poly-Carb, Inc	Mark - 155 Uregrid System	Mark 155 Sealer & Quartz Sand Mark 155 Membrane Mark 154 Overlay & Aggregate
Wasser Coating Inc.	Polyflex Bridge Deck System	Polyflex 111 Pu Primer Polyflex 311 Membrane Polyflex 411 Shearcoat & Aggregate Polyflex 511 Tackcoat

Pennsylvania Department of Transportation

Policy.

Priority of Actions.

Priority for actions in non-regular maintenance at a bridge is based on ADT, on expected years to replacement, and on the opportunity to include actions in upcoming highway projects (238). Codes for priorities are shown in Table 150.

Table 150 Pennsylvania DOT. Codes for Priorities of Maintenance Actions (238)

Code	Description
0	Prompt action required
1	High Priority, as soon as work can be scheduled
2	Priority, review work plan, adjust schedule as needed
3	Add to scheduled work
4	Routine structural can be delayed until funds are available
5	Routine non-structural can be delayed until programmed

Strategic Plan.

From (238) “Along with a maintenance cycle consisting of regularly scheduled cleaning of bridge decks, bearings, and joints and preventive maintenance of stream banks and channel alignments, strategically planned activities such as resealing joints and replacing deck wearing surfaces can significantly extend the service life of bridges and prevent the accumulation of higher priority maintenance items on a County’s bridge system.”

The components of a strategic plan are (238):

- Goals and objectives
- Routine maintenance cycles
- Bridge element life cycles
- Resource needs
- Funding needs
- Performance measures

Actions

Pennsylvania DOT washes most bridges annually (237). Pennsylvania DOT list actions and intervals for scheduled preventive maintenance (Table 151) (238). Pennsylvania DOT lists actions in response-type maintenance (Table 152) (238). Pennsylvania DOT uses strategic plans for cyclic activities such as deck overlays and joint replacement (Table 153) (238). Pennsylvania DOT lists actions in non-regular maintenance (Table 154) (238).

Table 151 Pennsylvania DOT. Actions and Intervals in Scheduled Preventive Maintenance (238)

Action	Frequency
Cleaning decks, seats, caps, and salt splash zones	Annually (except in Philadelphia and Allegheny Counties, where it is performed biennially)
Cleaning bridge drainage systems	Annually
Cleaning and lubricating expansion bearing assemblies	Annually

Table 152 Pennsylvania DOT. Actions in Response-Type Maintenance (238)

Action
Resealing expansion joints
Painting structural steel members
Removing debris from waterway channels
Replacing wearing surfaces
Extending or enlarging deck drains
Repairing impact damage

Table 153 Pennsylvania DOT. Cyclic, Strategic Actions (238)

Action
Deck overlays
Joints
Scour
Some structural repairs
Painting

Table 154 Pennsylvania DOT. Non-Regular Maintenance Actions (238)

Action
Deck replacement
Underpinning
Joint replacement
Steel dam deck joint rehabilitation/replacement
Extensive superstructure painting
Pedestal replacement
Stringer/beam replacement

Bridge Maintenance Actions

Actions in Pennsylvania's bridge maintenance manual are listed in Table 155 (238).

Table 155 Pennsylvania DOT. Bridge Maintenance Actions (238)

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7325-01	None	Repair or replacement of bridge under 8' in length	EA	General procedure
711-7425-01	None	Repair or replacement of bridge over 8' in length	EA	General procedure
711-7425-01	None	Total replacement-bridge over 8' length	EA	Cast in place box culvert
711-7425-01	None	Total replacement-bridge over 8' length	EA	Cast in place arch culvert
711-7425-01	None	Total replacement-bridge over 8' length	EA	Cast in place rigid frame culvert

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7425-01	None	Total replacement-bridge over 8’ length	EA	Precast / prefabricated culverts
711-7425-01	None	Total replacement-bridge over 8’ length	EA	R.C. Box culvert
711-7431-01	A743101	Clean/flush deck	EA	General procedure
711-7431-01	B743101	Clean/flush scuppers and downspouts	EA	General procedure
711-7431-02	C743102	Clean/flush bearing/bearing seat	EA	General procedure
711-7431-02	D743102	Clean/flush steel horizontal surfaces	EA	General procedure
711-7431-03	A743101	Clean/flush open grid decks and their supporting structures	EA	General procedure
711-7432-04 aluminum	A743201	Spot/zone painting-superstructure	EA	General procedure
711-7432-03 zinc	A743201	Spot/zone painting-superstructure	EA	General procedure
717-7432-01 general	A743201	Spot/zone painting-superstructure	EA	General procedure
711-7432-06 aluminum	B743201	Spot/zone painting-substructure	EA	General procedure
711-7432-05 zinc	B743201	Spot/zone painting-substructure	EA	General procedure
717-7432-01 general	B743201	Spot/zone painting-substructure	EA	General procedure
711-7433-01	A743301	Reseal deck joints (liquid only)	LF	General procedure
711-7433-02	A744101	Repair/reseal deck joints	LF	General procedure
711-7433-02	E744102	Repair other dam types	LF	Other
711-7433-02	B744102	Compression seal deck joints (repair/rehabilitate)	LF	Replace existing compression seal
711-7433-02	B744102	Compression seal deck joints (repair/rehabilitate)	LF	Modify poured seal joint and reseal with compression seal
711-7433-02	C744102	Modular dam deck joints (repair/rehabilitate)	LF	General procedure
711-7433-02	C744102	Modular dam deck joints (repair/rehabilitate)	LF	Elastometric or bell type expansion dams
711-7433-02	C744102	Modular dam deck joints (repair/rehabilitate)	LF	Replace existing joint with strip seal (rehabilitate/overlay)
711-7433-02	C744102	Modular dam deck joints (repair/rehabilitate)	LF	Repair strip seal systems
711-7433-02	C744102	Modular dam deck joints (repair/rehabilitate)	LF	Repair strip seal systems
711-7433-02	D744102	Steel dam deck joints (repair/rehabilitate)	LF	General procedure

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7433-02	D744102	Steel dam deck joints (repair/rehabilitate)	LF	Replace existing joint with armored compression seal
711-7433-02	D744102	Steel dam deck joints (repair/rehabilitate)	LF	Repair armored expansion joint
711-7433-02	D744102	Steel dam deck joints (repair/rehabilitate)	LF	Repair sliding plate expansion joint
711-7434-01	Rlgbrpr	Bridge/parapet railing (repair/replace)	LF	General procedure
711-7434-01	Rlgbrpr	Bridge / parapet railing (repair / replace)	EA	Eliminate deflection joints in adjacent non-composite Prestressed / concrete box beam bridge
711-7434-01	Rlgstrm	Structure mounted railing (repair/replace)	LF	General procedure
711-7434-01	Rlgstrm	Structure mounted railing (repair/replace)	LF	Steel guiderail mounted to concrete
711-7434-01	Rlgpedn	Pedestrian railing (repair/replace)	LF	General procedure
711-7434-01	Rlgmedb	Median barrier (repair/replace)	LF	Precast median barrier
711-7435-01	A743501	Lubricate bearings	EA	General procedure
711-7435-02	A744501	Steel bearings (repair/rehabilitate)	EA	General procedure
711-7435-02	B744501	Steel bearings (replace)	EA	General replacement procedure
711-7435-02	C744502	Expansion bearings (reset)	EA	Reset rocker bearings
711-7435-03	D744503	Bearing pedestal/seats (reconstruct)	EA	General procedure
711-7435-03	D744503	Bearing pedestal/seats (reconstruct)	EA	General procedure
711-7435-03	D744503	Bearing pedestal/seats (reconstruct)	EA	Pedestal installation to elevate bridge profile
711-7442-01	A744201	Approach slab (replace)	SY	General procedure
711-7443-01	Bitwrgs	Bituminous deck wearing surface (repair/replace)	SY	General procedure
711-7443-01	B744301	Timber deck (repair/replace)	SY	General repair/replacement procedure
711-7443-01	C744302	Open steel grid deck (repair/replace)	SY	General repair/replacement procedure
711-7443-01	D744303	Concrete deck repair	SY	General repair procedure
711-7443-01	D744303	Concrete deck (repair)	SY	Precast concrete deck replacement
711-7443-02	E744303	Concrete sidewalk (repair)	SY	General procedure
711-7443-02	F744303	Concrete curb/parapet (repair)	SY	Precast concrete parapet
711-7444-01	Drngrat	Scupper grate (replace)	EA	General procedure

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7444-01	B744401	Drain/scupper (install)	EA	General procedure
711-7444-01	B744401	Drain/scupper (install)	EA	Pvc deck drain
711-7444-01	B744401	Drain/scupper (install)	EA	Metals drains through parapets
711-7444-01	B744401	Drain/scupper (install)	EA	Deck drain using eccentric reducers
711-7444-01	B744401	Drain/scupper (install)	EA	Standard scupper
711-7444-01	C744402	Downspouting (repair/replace)	EA	General procedure
711-7446-01	A744601	Timber stringers (repair/replace)	EA	Repair of split stringer
711-7446-01	A744601	Timber stringers (repair/replace)	EA	Repair of decayed stringer ends
711-7446-01	A744601	Timber stringers (repair/replace)	EA	Under the deck replacement
711-7446-01	A744601	Timber stringers (repair/replace)	EA	Above the deck replacement
711-7446-01	B744601	Other timber members (repair/replace)	EA	Other timber members (repair/replace)
711-7446-01	B744601	Other timber members (repair/replace)	EA	Strengthen existing cap
711-7446-01	B744601	Other timber members (repair/replace)	EA	Replace pile
711-7446-01	B744601	Other timber members (repair/replace)	EA	Replace pile section
711-7446-01	B744601	Other timber members (repair/replace)	EA	Replace cross-bracing
711-7446-01	A744602	Steel stringer (repair/replace)	EA	Replace section (such as beam end)
711-7446-01	A744602	Steel stringer (repair/replace)	EA	Replace member
711-7446-01	B744602	Steel floorbeam (repair/replace)	EA	Replace section
711-7446-01	B744602	Steel floorbeam (repair/replace)	EA	Replace member
711-7446-01	C744602	Steel girder (repair)	EA	Replace section
711-7446-01	D744602	Steel diaphragm/lateral bracing (repair/replace)	EA	General procedure
711-7446-01	C744602	Repair impact damage to steel girder	EA	Grind impact area
711-7446-01	A744603	Reinforced/prestressed concrete stringer (repair/replace)	EA	General procedure
711-7446-01	A744603	Reinforced/prestressed concrete stringer (repair/replace)	EA	Repair prestressed stringer (post-tensioning)
711-7446-01	A744603	Reinforced/prestressed concrete stringer (repair/replace)	EA	Repair distressed areas of concrete beam ends
711-7446-01	B744603	Reinforced/prestressed concrete diaphragm (repair/replace)	EA	General procedure

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7446-01	C744603	Reinforced/prestressed concrete members other than Stringer or diaphragms (repair/replace)	EA	General procedure
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthening bottom chord by post-tensioning
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthening top chord
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthen entire bridge cable sling support system
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthen entire bridge cable-stayed support system
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthen entire bridge shifting supports
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthen entire bridge addition of supports
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthen entire bridge method of subdivision
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Strengthen truss connections and braces
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	End vertical
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Eyebar at pin-alternate 1
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Eyebar at pin-alternate 2
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Pin plate
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Lateral connection
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Lower lateral
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Vertical channel at kneebrace connection
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Repair by spice plate
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Replace vertical tension member
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Replace vertical compression member
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Replacement of a tension diagonal in a rigidly connected truss

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7447-01	A744701	Steel truss member (strengthen/repair/replace)	EA	Kneebrace replacement
711-7447-01	C744701	Steel truss member (tighten/flame shorten)	EA	General procedure
711-7448-01	A744801	Abutment backwalls (repair/replace)	CY	General procedure
711-7448-02	B744802	Abutments (repair)	CY	General procedure
711-7448-02	B744802	Abutments (repair)	CY	Jacket concrete
711-7448-02	B744802	Abutments (repair)	CY	L-shaped abutment jacket (repair) for stone abutments
711-7448-02	C744802	Abutments wingwalls (repair/replace)	CY	Extend wingwalls with gabions
711-7448-02	C744802	Abutments wingwalls (repair/replace)	CY	Replace concrete wingwalls
711-7448-02	C744802	Abutments wingwalls (repair/replace)	CY	Repair broken or deteriorated concrete wingwalls
711-7448-02	C744802	Abutments wingwalls (repair/replace)	CY	Stabilize existing wingwalls with gabions or precast Concrete block
711-7448-02	D744802	Piers (repair)	CY	General procedure
711-7448-02	D744802	Piers (repair)	CY	Repair deteriorated concrete pile
711-7448-02	D744802	Piers (repair)	CY	Epoxy grouted reinforcement for repair of cracked hammer head piers
711-7448-02	D744802	Piers (repair)	CY	Post tensioning of cracked hammer head piers
711-7448-03	E744803	Footing (underpin)	CY	General procedure
711-7448-03	E744803	Footing (underpin)	CY	Procedure: underpin using tremie concrete
711-7448-04	F744804	Masonry (repoint)	CY	General procedure
711-7451-01	A745101	Abutment slopewall (repair/replace)	SY	General procedure
711-7451-01	B745102	Abutment slopewall (construct new)	SY	General procedure
711-7332-01	Rtwallr	Install weep holes in existing mse walls	EA	Drill weep holes in existing mse walls
711-7452-01	A745201	Culvert headwall/wings (repair/replace)	SY	Repair
711-7452-01	A745201	Culvert headwall/wings (repair/replace)	SY	Replace

SAP assembly number	BMS2 flex-action	Activity	Unit	Procedure
711-7452-01	B745202	Culvert apron/cutoff wall (repair/replace)	SY	General replacement
711-7452-01	C745203	Culvert barrel (repair)	SY	General procedure
711-7453-01	A745301	Streambed paving (repair/construct)	CY	General procedure
711-7453-01	A745301	Paving metal bottom pipes, arches, and culverts	CY	General procedure
711-7453-01	B745301	Rock protection	CY	Dumped riprap
711-7453-01	B745301	Rock protection	CY	Gabion baskets
711-7453-01	D745302	Stream deflector (repair/construct)	CY	General procedure
711-7453-01	C745301	Scour hole	CY	Excavate and fill
711-7453-03	Ecremvg	Vegetation/debris (remove)	CY	General procedure
711-7453-03	Ecremdp	Deposition (remove)	CY	General procedure
711-7454-01	A745401	Construct temporary support bent	EA	General procedure
711-7454-01	B745401	Construct temporary pipes	EA	General procedure
711-7454-01	C745401	Construct temporary bridge	EA	General procedure
711-7459-01	None	Bridge maintenance	EA	General procedure
711-7459-01	A743401	Apply protective coating deck/parapets/sidewalks	EA	General procedure
711-7459-01	B743401	Apply protective coating substructure	EA	General procedure

Actions, Historic Bridge

Pennsylvania DOT publishes a manual for preservation of stone arch bridges (236). Preservation actions include control of drainage, removal at vegetation, and resetting and repainting masonry units (Table 156).

Table 156 Pennsylvania DOT. Actions for Stone Arch Bridges (236)

Action
4.1 Recommended Maintenance Program for Stone Arch Bridges *4.1.1 Clearing Vegetation* *4.1.2 Improving Drainage and Reducing Water Infiltration* *4.1.3 Removing Debris from Substructure Elements and the Arch Opening*
4.2 Repairing, Rehabilitating, and Restoring Stone Arch Bridges *4.2.1 Repairing and Rehabilitating Stone Arch Bridges* *4.2.2 Restoring Missing Elements to a Stone Arch Bridge*
4.3 Repair, Rehabilitation, and Restoration Treatments *4.3.1 Repointing* *4.3.2 Repairing Spalling and Delaminated Stones* *4.3.3 Replacing Missing or Loose Stones* *4.3.4 Removing Concrete, Gunite/Shotcrete, or Other Historically Inappropriate Exterior Coatings* *4.3.5 Repairing/Rehabilitating Damaged or Missing Parapets and Coping* *4.3.6 Repairing/Rehabilitating Damaged or Missing Spandrels* *4.3.7 Repairing/Rehabilitating the Arch Ring and Arch Barrel* *4.3.8 Fill Material*

Action
4.3.9 Abutments, Piers, and Wing Walls
4.3.10 Scour Protection
4.3.11 Decorative Features

On-Demand Agreements.

To deliver bridge preservation work, Pennsylvania DOT uses purchase orders for services such as mowing, on-demand agreements for pre-negotiated work items and costs for deck repairs, scour repairs, rock abutment/pier repointing, underpinning, and welding service, and an ECMS system for normal project scoping, engineering and letting (238).

Table 157 Pennsylvania DOT. On-Demand Maintenance Agreements (238)

Action
Deck repairs
Scour repairs
Rock abutment/pier repointing
Underpinning
Welding service

Intervals for Actions

Pennsylvania DOT lists intervals for replacement of joint seals (Table 158) (238).

Table 158 Pennsylvania DOT. Replacement Intervals for Joint Seals (238)

Joint Seal	Replacement Interval, years
2-part silicone	3 to 5
Asphaltic plug	3 to 5
Strip seal	10

Data. Actions.

Pennsylvania's bridge maintenance manual lists identifying codes for actions in bridge maintenance. ID codes are provided for SAP plant management system and for Pennsylvania DOT's bridge management system (Table 155) (238).

Methods, Procedures

Pennsylvania DOT publishes performance standards for maintenance actions (238). The bridge maintenance actions listed in Table 155 each has a performance standard. Each performance standard includes (Table 159):

Table 159 Pennsylvania DOT. Performance Standards (238)

Content
SAP ASSEMBLY NUMBER: (ID Code)
BMS2 Flex-Action: (ID Code)
ACTIVITY TITLE:
UNIT OF MEASUREMENT:
PROCEDURE: (terse statement)
REFERENCES (related Pa DOT publications)
SCHEDULING CONSIDERATIONS

WORK AREA ACTIVITY DESCRIPTION PROCEDURE DESCRIPTION (full statement) LABOR Requirements (number and job titles of workers) EQUIPMENT Requirements (number and types of equipment) MATERIAL REQUIREMENTS (amounts and descriptions of material) PRODUCTION UNITS/HOURS (unit of measurement per hour) PLANNING UNITS (unit of measurement per day) PERFORMANCE STANDARD (labor hours per production unit)

Performance Measure

Pennsylvania tracks the performance of counties in bridge preventive maintenance using County Maintenance Measuring Tools (CMMT). Measures include on-time cleaning of bridges and the proportion of work hours spent on bridge work by county bridge foremen (Table 160) (238). Performance measures apply to bridges meeting criteria in age, structure type, and status for (non)replacement (Table 161) (238). Pennsylvania DOT tracks the percentage of Priority 0 and Priority 1 maintenance needs completed by counties each year.

Table 160 Pennsylvania DOT. County Maintenance Measuring Tools (238)

Action	Target	Performance measure
Bridge Decks, Scuppers, and Downspouts Cleaned/Flushed	100% annually, most counties 100% biennially, Philadelphia and Allegheny counties	Percent completed
Bearing Seats Cleaned/Flushed	20% annually, most counties 10% annually, Philadelphia and Allegheny counties	Percent completed
Time Spent on Bridge Work by the County Bridge Foremen	80%	Percent

Table 161 Pennsylvania DOT. CMMT Criteria to Bridges (238)

Action	Criteria
Bridge Decks, Scuppers, and Downspouts Cleaned/Flushed	Not programmed for replacement within the current fiscal year and: Were built since 1961 or Were built prior to 1961 but which have had deck replacement.
Bearing Seats Cleaned/Flushed	All structures built since 1961 except arches, adjacent box beams, concrete frames, slabs, encased I-beam, and box culverts.

Pennsylvania DOT tracks the percentage of structurally deficient bridges (239). Percentages are reported for NBIS-length bridges and for bridges with span between 8ft and 20ft (240). Pennsylvania DOT tracks the number of weight-restricted bridges (240).

Deck Preservation

Pennsylvania DOT's bridge maintenance manual (238) has procedures to

- Clean deck
- Repair bituminous wearing surface

- Replace bituminous wearing surface
- Repair timber deck
- Replace timber deck
- Repair steel grid deck
- Replace steel grid deck
- Repair concrete deck
- Replace precast concrete deck

Pennsylvania DOT has standard specifications (241) for

- Concrete bridge deck repair (Section 1040)
- Latex modified mortar or concrete wearing surface (Section 1042)
- Epoxy injection crack seal (Section 1091)

Pennsylvania's bridge management system (242) has additional data items for decks (Table 162).

Table 162 Pennsylvania DOT. BMS2 Deck Items (242)

Item	Title
5B01	Bridge Deck Structure Type
6A38	Bridge Deck Type
5B19	Deck Area
6B40	Deck Wearing Surface
1A01	Deck Condition Rating
5B07	Out-to-Out Width of Bridge Deck
4A10	Deck Geometry
1A07	Unrepaired Spalls (SF)
3B01	Proposed Deck/Super Work
5B01	Deck Structure Type
5B02	Deck Surface Type
5B03	Deck Membrane Type
5B04	Deck Protection Type
6A36	Year Protection System was Installed
6A37	Protection System Note
6A38	Bridge Deck Type
6A40	Type of Deck Forms Used
6A41	Number of Deck Joints on Bridge
6A42	Type of Deck Reinforcement Bar Protection
6A55	Proposed Major Deck Reconstruction
6B05	Deck Overlay Measurement Date
6B07	Estimated Spall or Delamination Percent
6B08	Estimated Spall or Delamination Percent Date
6B10	Estimated Chloride Content Percent
6B10	Estimated Chloride Content Percent
6B40	Deck Wearing Surface Condition Rating
SP04	Span Deck Width

BMS2 defines categories for conditions of bridge decks (Table 163).

Table 163 Pennsylvania DOT. BMS2 Deck Condition Ratings (242)

		Condition Indicators					
Category Classification	**Rating**	**Deck Area**		**Electrical Potential**	**Deck Area**	**Chloride Content (#/CY)**	**Deck Area**
		Visible Spalls	**Delam-ination**				
Category #3 Light Deterioration	9	none	none	0.0	none	0	none
	8	none	none	0.0 < E.P.< 0.35	none	0 < C.C.<1	none
	7	none	< 2%	0.35 < E.P.< 0.45	≤ %5	0 < C.C.<2	none
Category #2 Moderate Deterioration	6	< 2% spalls or sum of all deteriorated and/or contaminated deck concrete (≥ 2 lb/CY Cl) < 20%					
	5	< 5% spalls or sum of all deteriorated and/or contaminated deck concrete 20% to 40%					
Category #1 Extensive Deterioration	4	> 5% spalls or sum of all deteriorated and/or contaminated deck concrete 40% to 60%					
	3	> 5% spalls or sum of all deteriorated and/or contaminated deck concrete > 60%					
Structurally Inadequate Deck	2	Deck structural capacity grossly inadequate					
	1	Deck has failed completely – Repairable by replacement only					
	0	Holes in deck – Danger of other sections of deck failing					

Notes: Rating 9 - No deck cracking exists. Rating 8 - Some minor deck cracking is evident

Pennsylvania DOT's BMS2 has codes for types of proposed work for decks (Table 164).

Table 164 Pennsylvania DOT. Deck Work Types (242)

Code	Deck Work
0	Do Nothing
1	Rehabilitate concrete deck (patch, membrane, bituminous wearing surface)
2	Rehabilitate concrete deck (patch and latex, concrete or other wearing surface)
3	Replace with concrete deck
4	Replace with steel grid deck
5	Replace with timber deck
6	Replace deck (as component of superstructure replacement)

In its qualified products list (243), Pennsylvania DOT lists

Epoxy Based Surface Treatment for Bridge Decks

Cargill, Inc.	Safelane Surface Overlay System
E-Bond Epoxies	E-Bond 526
E-Chem, LLC	EPX50-Overlay
Euclid Chemical Company	Flexolith UR
Euclid Chemical Company	Flexolith

Kwik Bond Polymers	PPC-HFST
P3 Infrastructure, Inc	Impervious ME
Olin Epoxy-POLY-CARB	Flexogrid (Mark-163)
Olin Epoxy-POLY-CARB	Mark-154 PA
Sika Corporation	Sikadur 22, Lo-Mod FS
Transpo Industries, Inc	T-48 Polysulfide Epoxy Overlay System
Dayton Superior Corporation - UNITEX	Pro-Poxy Type III DOT

Adhesive-Backed Preformed Membrane Sheet

Crafco, Inc.	GeoTac
W. R. Meadows, Inc	SealTight Mel-Dek
Polyguard Products, Inc	Polyguard NW-75
Propex Operating Company, LLC	Petrotac 4591
Chase Corporation	Royston Bridge Membrane 10A-65
Chase Corporation	Royston Bridge Membrane 10A-65 Easy Pave
Soprema, Inc	Antirock (Alternate)

Rhode Island Department of Transportation

Deck Preservation

Rhode Island DOT has standard specifications (244) for

- Latex modified concrete for bridge overlays (Section 815)
- Structural concrete repair by epoxy-resin base adhesive injection (Section 836)
- Remove and dispose bituminous concrete pavement from concrete bridge decks - partial depth and full depth (Section 839)
- Deck Surface Concrete Removal by Hydrodemolition (Section 840)

Rhode Island DOT's approved products list (245) includes

Patching Mortar

American Permaquik Corp	Permacrete 15-Self Leveling Mortar
American Permaquik Corp	Permacrete 20-Mortar/Binder
American Permaquik Corp	Permacrete 25-Repair Mortar
American Permaquik Corp	Permacrete 30-Gel Mortar
American Stone-Mix, Inc.	Ifscem 110
American Stone-Mix, Inc.	Magna 100
Atlas Minerals & Chemical	Mari-Crete
ChemRex Inc.	Roadpatch II
ChemRex Inc.	Thorite
ChemRex Inc.	ThoRoc 10-60 Rapid Mortar
ChemRex Inc.	ThoRoc 10-61 Rapid Mortar
ChemRex Inc.	ThoRoc HBA Repair Mortar
ChemRex Inc.	ThoRoc SD2 Repair Mortar
CTS Cement Manufacturing Company	Rapid Set Cement
CTS Cement Manufacturing Company	Rapid Set Concrete Mix
CTS Cement Manufacturing Company	Rapid Set D.O.T. Repair Mix
Dayton Superior Corp	HD-50
Dur-O-Wall, Inc	Dur-O-Wal CP 20
Dur-O-Wall, Inc	Ideal Regulated Set Portland Cem
Euclid Chemical Co	K-Ment
Euclid Chemical Co	Speed Crete
Five Star Prod. Inc	Five Star Concrete Patch
Five Star Prod. Inc	Five Star Highway Patch
Five Star Prod. Inc	Five Star Structure Concrete
Five Star Prod. Inc	NBEC Nonshrink Grout
Five Star Prod. Inc	Structural Concrete v/o
Fox Industries	FX-929
Garon Prod. Inc	Hy-Speed 500
Garon Prod. Inc	Tiger-Crete
Hartline Prod. Co. Inc	Kwixset
Hilti, Inc.	RM 800 PC Cement Repair Mortar
Hilti, Inc.	RM-698
IPA Systems Inc	Octocrete
Kaufman Products, Inc.	Duracrete
Kaufman Products, Inc.	K Crete
Kaufman Products, Inc.	Patchwell

Kaufman Products, Inc.	Patchwell Deep
Kaufman Products, Inc.	Patchwell VO
L & M Constr Chemical Co	Durapatch Hiway
Master Builders	Emaco 415
Master Builders	Set 45
Master Builders	Set Instant Concrete
National Permacrete	Permacrete
Pocono Fab Cut Protect Coat	FS-16 Pre-Krete
Poly-Carb, Inc.	Mark-103
Pre-Blend Prod	Pre-Blend 420
Pyrament/Lone Star Industries, Inc.	Pyrament 505 Rapid
Pyrament/Lone Star Industries, Inc.	Pyrament Blended Hydraulic Cements
Pyrament/Lone Star Industries, Inc.	Pyrament Sac-Pac
Roadware Incorporated	Roadware 10 Minute Concrete Mender
Sika Corporation	Sikacem 133
Sika Corporation	Sikaset Mortar
Sika Corporation	Sikaset Roadway Patch
Sika Corporation	Sikatop 121,122,123,124,111,144
Silpro Masonry Sys, Inc	Easy Patch
Silpro Masonry Sys, Inc	VOpatch
Sonneborn Building Products	Sonopatch
Stonhard, Inc.	Stoncrete RP1
Symons Corporation	DOT Patch HD
Symons Corporation	Poly-Patch
The Quikrete Co	Rapid Road Repair
U.S. Gypsum Co	Duracal Cement
W.R. Meadows, Inc.	Futura

Epoxy Grout

Five Star Prod. Inc	Five Star Epoxy Grout
Hilti, Inc.	Epoxy Grout
Kaufman Products, Inc.	SurePoxy 110
Kaufman Products, Inc.	SurePoxy HM
Kaufman Products, Inc.	SurePoxy HM Class B
Kaufman Products, Inc.	SurePoxy HMLV
Kaufman Products, Inc.	SurePoxy HM-SLV
Poly-Carb, Inc.	Mark-194
Poly-Carb, Inc.	Mark-198
Sika Corporation	Sikadur 31
Sika Corporation	Sikadur 32
Sika Corporation	Sikadur 35
Sika Corporation	Sikadur 42
Unitex	Pro-Poxy 100 LV
Unitex	Pro-Poxy 200
Unitex	Pro-Poxy 300
Unitex	Pro-Poxy 300 FAST
Unitex	Pro-Poxy 400
Unitex	Pro-Poxy 50 Super LV

Waterproofing Membranes

American Hydrotech Inc.	Monolithic Membrane 6125	
American Permaquik Corp	Permaquik 6100	rubberized liquid asphalt
Bridge Preservation	Bridge Deck Membrane System	cold applied liquid
Crafco, Inc	34551	Hot-Applied Waterproofing
Deery Oil Co	Flex-A-Fill	rubberized liquid asphalt
Dri-Span Group Inc.	Dri-Shield	prefabricated
Henry Company	790-11	rubberized liquid asphalt
IKO	Armour Bridge	prefabricated
J. & P. Petroleum Prods	Tex-Mastic Protecto Board	
Phillips Fiber Corp	Petrotac	preformed
Polyguard Products, Inc.	180 Membrane	rubberized liquid asphalt
Polyguard Products, Inc.	Polyguard 665	preformed
Protecto Wrap Co	M-400A	preformed
Sonneborn Building Products	Hydrocide	damproofing mastic
Stirling Lloyd Products Inc.	Eliminator	cold applied liquid
Ultraseal Waterproofing and Sealant Technologies Inc.	Ultraseal 3750 MTO	rubberized liquid asphalt
W.R. Grace & Co.	Bituthene 5000	preformed
W.R. Meadows, Inc.	Mel-Dek	preformed
W.R. Meadows, Inc.	Vibraflex	multi-ply, semi-rigid, asphaltic panel protection board

Concrete Protective Sealers

Advanced Chemical Technologies	Sil-Act ATS 42	penetrating silane surface treatment 125-175sf/g
ChemRex Inc.	Enviroseal 40	penetrating silane surface treatment 125-200sf/g
Evonik Degussa Corporation	Protectosil BH-N	penetrating silane surface treatment 100-350sf/g
Princeton Chemical	Crete Shield	water based epoxy 125-200sf/g

South Carolina Department of Transportation

Performance Measure

South Carolina DOT tracks the count of bridges that are structurally deficient (246).

Deck Preservation

South Carolina DOT has a section in its standard specifications (247) for rehabilitation of concrete bridge decks (Section 726). The section includes specifications for

- Removal of existing overlays
- Deck overlay using low slump Portland cement concrete
- Deck overlay using latex modified Portland cement concrete
- Partial depth patching
- Full depth patching
- Epoxy mortar

South Carolina DOT has standard specifications (247) for

- Bridge Deck Waterproofing (Section 814.1.3)

South Dakota Department of Transportation

Policy. Preservation.

South Dakota DOT identifies minimum load capacity and width for existing bridges on local roads (Table 165) (249). Bridges can be preserved, rather than replaced, if minimum load capacity and width are met. South Dakota operates a bridge improvement grant (BIG) program to fund repair, rehabilitation and preservation of bridges owned by local governments (250). BIG program funding for deck overlays is available for deck elements in condition state 1 or 2.

Table 165 South Dakota DOT. Minimum Load Capacity and Widths for Existing Bridges (249)

Average Daily Traffic	Design Loading Capacity	Minimum Clear Roadway Width (ft)
0 to 50	H 10	20
50 to 250	H 15	20
250 to 1500	H 15	22
1500 to 2000	H 15	24
over 2000	H 15	28

Actions

South Dakota DOT lists a set of actions in bridge rehabilitation (Table 166) (248). Deck overlays used by South Dakota DOT include low-slump dense concrete, non-metallic fiber reinforced concrete overlay, and two-coat epoxy chip seals (248). Bridge repainting includes spot or zone painting, especially at ends of girders at open joints.

Table 166 South Dakota DOT. Bridge Rehabilitation Actions (248)

Action
Bridge Deck Overlays
Bridge Deck Widening and/or Replacement
Making Bridge Decks Composite and/or Continuous
Expansion Device Repair or Replacement
Bridge Rail Retrofits
Bridge Repainting
Girder Strengthening or Post Tensioning
Bearing Repair or Replacement
Substructure Repair or Replacement

Local Government Bridges.

State funding is available for preservation of bridges owned by local governments. Actions include scour protection, fatigue retrofit, waterproofing joints, painting, and deck overlays (Table 167) (250).

Table 167 South Dakota DOT. Local Government Bridges (248)

Action
Scour projects
Fatigue retrofits
Waterproofing joints
Painting
Safety upgrade rail/barrier
Deck overlays

Deck Preservation

South Dakota DOT has standard specifications (253) for

- Bridge deck polymer chip seal (Section 491)
- Bridge deck preparation and resurfacing (Section 550) for overlay using latex modified concrete or low slump dense concrete

South Dakota DOT publishes procedures for deck preservation actions (252) that include

- Rubberized asphalt chip seal removal (where applicable)
- Scarifying concrete decks
- Deck overlay using non-metallic fiber reinforced concrete
- Deck overlay using low slump dense concrete
- Epoxy chip seals, multilayer
- Removing and replacing loose and delaminated concrete
- Epoxy injection repairs

In its approved products list (251), South Dakota includes

Bridge Deck Polymer Chip Seal

Ennis-Flint, Inc.	Tyregrip
Kwik Bond Polymers	Kwik-Bond MLS
Sika Corp	Sikadur 22 Lo-Mod
Transpo Industries, Inc.	E-Bond 526
Transpo Industries, Inc.	Transpo T-48 Chip Seal

Bridge Deck Sealant

Advanced Chemical Technologies, Inc.	Sil-Act ATS-42
BASF Building Systems	Hydrozo Silane 40
BASF Building Systems	MasterProtect H 400
Dayton Superior Chemical Division	Weather Worker 40% J29
Euclid Chemical Co.	Baracade Silane 40
Evonik Corporation	Protectosil Chem-Trete 40 VOC
Sika Corp	Sikagard 705L
Sika Corp	Sikagard 706 Thixo
Sika Corp	Sikagard 740W
SpecChem LLC	Spec Silane 40 WB
T-K Products	TK-590-100 Plus Tri-Silane

T-K Products	TK-590-40 VOC

Bridge Deck Polymer Chip Seal

Ennis-Flint, Inc.	Tyregrip
Kwik Bond Polymers	Kwik-Bond MLS
Sika Corp	Sikadur 22 Lo-Mod
Transpo Ind.	E-Bond 526
Transpo Ind.	Transpo T-48 Chip Seal

Bridge Deck Sealant

Advanced Chemical Technologies, Inc.	Sil-Act ATS-42
BASF Building Systems	Hydrozo Silane 40
BASF Building Systems	MasterProtect H 400
Dayton Superior Chemical Division	Weather Worker 40% J29
Euclid Chemical Co.	Baracade Silane 40
Evonik Corporation	Protectosil Chem-Trete 40 VOC
Sika Corp	Sikagard 705L
Sika Corp	Sikagard 706 Thixo
Sika Corp	Sikagard 740W
SpecChem LLC	Spec Silane 40 WB
T-K Products	TK-590-100 Plus Tri-Silane
T-K Products	TK-590-40 VOC

Tennessee Department of Transportation

Deck Preservation

Tennessee DOT has standard specifications for

- Bridge deck sealant (Section 617)
- Polymer modified concrete bridge deck overlay for new and existing bridges (Section 619)

In its qualified products list, Tennessee DOT includes

Concrete Waterproofing, Low-Modulus Epoxy

E-Bond Epoxies Inc	E-Bond 526 Multilayer Skid Resistant PCO
E-Chem, LLC	EPX50-Overlay
Ennis-Flint, Inc	Tyregrip
Epoplex	Safe-T-Grip
ErgonArmor	ErgonArmor HFS
Euclid Chemical Co	Flexolith Broadcast Overlay System
Olin Epoxy-Poly-Carb	Mark-154
Sherwin Williams Company	Sher-Friction
Sika Corp	Sikadur 22 Epoxy Broadcast Overlay
Sika Corp	Sikadur 22 LM Fast Set
Sika Corp	Sikadur 22 w/ Sikadur 21 Primer
Sika Corp	Sikadur 25 Lo-Mod EPU
Traffic Calming USA	Trafficgrip
Transpo Industries Inc	T-48 Thin Overlay System

Concrete Waterproofing, Epoxy Urethane

E-Chem, LLC	EPX50-Overlay
Olin Epoxy-Poly-Carb	Mark-163 Flexogrid
Sika Corp	Sikadur 25 Lo-Mod EPU
Unitex	Pro-Poxy Type III DOT

Methacrylate Binder Resin System

3M	3M CPR-5740 Lo Hi Mod
3M	3M CPR-5742 Lo Low Mod
BASF	Degadeck Crack Sealer Plus
De Neef Construction Chemicals Inc	Denedeck Crack Sealer
Kwick Bond Polymers LLC	KBP 204 High Molecular Weight MMA
Rhone-Pouleuc Inc	Rhoca Gil HS-LV
Sika Corp	Sika Pronto 19
Sika Corp	Sika Pronto 19 TF
Transpo Industries Inc	Sealate T-70 MX-30
Watson Bowman Acme Corp	Wabo ConTrete 2P

Waterproof Membranes & Materials

Carlisle Coating & Waterproofing Inc	CCW-711
Carlisle Coating & Waterproofing Inc	CCW-711N
Chase Corporation	Royston 10A 65
Crafco Inc	Geotac 01010

Crafco Inc	Geotac Polyester HS
Polyguard Products Inc	Polyguard NW-75 Membrane
Right/ Pointe, LLC	Right Deck

Penetrating Type Sealers

Advanced Chemical Tech	Multigard
Advanced Chemical Tech	Sil-Act ATS-42
BASF	Enviroseal 40
BASF	Hydrozo Silane 40VOC
Carboline	Carbocrete Sealer WB
Clemons Concrete Coatings	Sila-Pel
Clemons Concrete Coatings	Silan 40 SB VX
Clemons Concrete Coatings	Super Seal-M
CreteDefender, Inc.	CreteDefender P2
Euclid Chemical Co	Baracade Silane 100C
Euclid Chemical Co	Baracade Silane 40
Euclid Chemical Co	Sil-Act ATS-22
Evonik Corporation	Protectosil CHEM-TRETE 40VOC
Kretetek Industries, LLC	Ghostshield Siloxa-Tek 8500
LymTal International Inc	ISO-Flex 618 VOC
Perk Products & Chemical Co	Sure Seal 30
Prosoco Inc	Consolideck Saltguard WB
Sika Corp	SikaGard 740W
SpecChem LLC	SpecShield WB
Spray-Lock Concrete Protection, LLC	SCP 578
Spray-Lock Concrete Protection, LLC	SCP 743
Vexcon Chemicals	Vexcon Powerseal 20

Pressure Injected Epoxy Systems

Adhesives Technology Corp	Crackbond LR321
Adhesives Technology Corp	Crackbond LR321G
Adhesives Technology Corp	Crackbond SLV302
E-Poxy Industries Inc	EVA POX Injection Resin
Euclid Chemical Co	Duralcrete LV
Euclid Chemical Co	Eucopoxy Injection Resin
Futura Companies	Futura Injection System #5
Hilti Inc	CI 060EP Crack Injection
Olin Epoxy-Poly-Carb	Poly-Carb Mark 135
Polygem Inc	Polyject 1001
Polygem Inc	Polyject 1001 MV
Rescon Technology Corp	R-303
Rescon Technology Corp	R-334
STO Corp	STO CR 633
STO Corp	STO CR 641 SLV
Sika Corp	Sikadur 31 HM Gel
Sika Corp	Sikadur 33
Sika Corp	Sikadur 35 HM LV
Sika Corp	Sikadur 35 Hi-Mod LV LPL
Sika Corp	Sikadur 52
Sika Corp	Sikadur 55 SLV

Sika Corp	Sikadur AnchorFix 3001
Sika Corp	Sikadur AnchorFix 500
Simpson Strong-Tie	Crack-Pac Injection Epoxy
Simpson Strong-Tie	ETI-GV Injection Epoxy
Simpson Strong-Tie	ETI-LV Injection Epoxy
Unitex	Pro-Poxy 100 LV
Unitex	Pro-Poxy 204
Unitex	Pro-Poxy 50 SLV
Universal Form Clamp Co	Unibond LV

Rapid Set Cementitious Material

American Highway Technology	AHT DB Retrofit Mortar Concentrate
BASF	10-60 Rapid Mortar
BASF	Emaco T-415
BASF	Emaco T-430
BASF	Set-45
CTS Cement Manufacturing Corp	Rapid Set Concrete Mix
CTS Cement Manufacturing Corp	Rapid Set DOT Concrete Mix
CTS Cement Manufacturing Corp	Rapid Set Mortar Mix
CTS Cement Manufacturing Corp	Rapid Set Mortar Mix Plus
CeraTech Inc	D.O.T. Line
CeraTech Inc	Pavemend 15.0
CeraTech Inc	Pavemend SL
CeraTech Inc	Pavemend SLQ
CeraTech Inc	Pavemend TR
ChemMasters	ChemSpeed 65
Conspec	Pave Patch 3000
Continental Research Corp	Patch 15
Dayton Superior	Day Chem Perma Patch
Edoco	Burke Fast Patch
Euclid Chemical Co	Euco-Speed
Euclid Chemical Co	Euco-Speed MP
Euclid Chemical Co	Speedcrete Greenline
Euclid Chemical Co	Versaspeed
Euclid Chemical Co	Versaspeed 100
Five Star Highway Products Inc	Five Star Highway Patch
Five Star Highway Products Inc	Five Star Patch
Fox Industries Inc	FX-928
GST International, Inc.	GST Elephant Armor DOT Industrial Grade
GeoBond International Inc	Geobond Geocement
Great Wall Products LLC	Speedset 60
Great Wall Products LLC	Speedset 60P
Heartland Cement Sales Company	Buzzi Ulti-Pave Cube
Hilti Inc	Hilti RM-800 PC
Kaufman Products Inc	Duracrete II
Kwik Mix Materials Ltd	Kwik Mix Concrete Patch
MAPEI Corporation	Planitop 18
MAPEI Corporation	Planitop 18 TG
MAPEI Corporation	Planitop 18ES
Phoscrete Corp	Phoscrete HC

Phoscrete Corp	Phoscrete VO-Plus
Quikrete Co	Quikrete Fastset DOT Mix
Quikrete Co	Rapid Road Repair
Sika Corp	SikaQuick 1000
Sika Corp	SikaQuick 2500
Sika Corp	Sikacrete 321 Fast Set
Sika Corp	Sikacrete 421 CI Rapid
Sika Corp	Sikaset Roadway Patch
Sika Corp	Sikaset Roadway Patch 2000
Sivento Inc	Rohalith Quick Patch
SpecChem LLC	Rep Con 928
Symons Corp	Symons D.O.T. Patch
Symons Corp	Symons Poly-Patch
US Concrete Products	HP Concrete
US Concrete Products	HP DOT Grade Repair Mortar
US Concrete Products	HP Multi Purpose Repair Mortar
United States Gypsum Co	Duracal
United States Gypsum Co	Duracal AG
United States Gypsum Co	Duracal HP
United States Gypsum Co	USG EcoFix
United States Gypsum Co	USG EcoFix Rapid Repair Patch
United States Gypsum Co	USG EcoFix Xtend Rapid Repair Patch
Universal Form Clamp Co	Uniroad Repair DOT
Volunteer Satellite Distributors	Super Fast Set Cement 50/50
W R Meadows Inc	Sealtight Futura Concrete Patch
Western Materials & Design LLC	Fastrac 246 Concrete

Texas Department of Transportation

Actions

Texas DOT lists routine and preventive maintenance actions (Table 168) (256). Texas protects bridge decks with linseed oil, silane, or asphaltic protection systems (256). Texas defines three categories of bridge maintenance: Routine maintenance, preventive maintenance and major maintenance (Table 169) (257). Maintenance of deck joints is part of preventive maintenance. Replacement of bridges is part of major maintenance.

Texas DOT operates a bridge preventive maintenance program that delivers actions in bridge repair and bridge painting (Table 170) (257). The program extends the life of bridges that are structurally deficient but will not be programmed for Federal funding in the next 10 years.

Table 168 Texas DOT. Actions in Routine and Preventive Maintenance (256)

Action
Cleaning the roadway
Restoration, delineation and signing
Cleaning and servicing joints and bearings
Removal of drift from around substructures

Table 169 Texas DOT. Categories of Bridge Maintenance (257)

Maintenance Categories and Actions
Routine Maintenance
Repair of substructures, superstructures, decks, joints, approach slabs and railing
Spot painting
Repair and operation of movable bridges
Installation of temporary bridges
Repair and installation of fender systems
Preventive Maintenance
Steel structure cleaning and repainting or the installation of other coatings
Installation of bridge deck protection
Joint cleaning and sealing or replacement
Major Maintenance
Bridge rehabilitation, reconstruction, or replacement
Replacement of structures only as a result of major disaster when no other funds or programs are available

Table 170 Texas DOT. Bridge Preventive Maintenance Program (257)

Action
Joint Cleaning and Sealing
Joint Repairs
Steel Piling Repairs
Bearing and/or Bearing Pad Replacement
Bearing Supplements for T-Girders
Cap Repairs for Spalling (Pan and T-Girder Bridges Deck Repairs
Concrete Repairs for Corrosion Damage
Concrete Deterioration Treatments for Pre-stressed Beams
Asphalt Plug Joint
Bridge Rail Retrofits and Transitions
Adjust Steel Shoes
Channel Protection
Bridge Painting

Performance Measure

Texas DOT reports the percentage of bridges in good condition (258). Texas DOT sets targets for general condition of bridges and culverts (Table 171) (257).

Table 171 Texas DOT. Targets for General Condition of Bridges and Culverts (257)

	General Condition Rating		
Component	**Desirable Level**	**Acceptable**	**Tolerable Level**
Channel, Culverts, Approaches	8	7	6
Deck, Superstructure, Substructure	8	7	5

Deck Preservation

Texas DOT's maintenance manual (256) describes preservation actions. Texas DOT's maintenance operations manual(256) has procedures for deck protection using linseed oil and deck protection using silane.

Texas DOT has standard specifications (259) for

- Penetrating Concrete Surface Treatment (Item 428)
- Concrete Structure Repair (Item 429)
- Bridge Deck Overlays (Item 439)
- Waterproofing Membranes for Structures (Item 458)
- Concrete Bridge Deck Surfacing (Item 483)

Texas DOT's approved materials list includes

Concrete Repair Materials - Rapid (260)

ARDEX	TRM
BASF	MasterEmaco S 6000
BASF	MasterEmaco T 545 HT
BASF	MasterEmaco T 1060
BASF	MasterEmaco T 1060EX
BASF	MasterEmaco T 1061EX
CTS Cement Manufacturing Corp.	Rapid Set Concrete Mix

CTS Cement Manufacturing Corp.	Rapid Set DOT Concrete Mix
CTS Cement Manufacturing Corp.	Rapid Set DOT Repair Mix
CTS Cement Manufacturing Corp.	Rapid Set Low P Cement
CTS Cement Manufacturing Corp.	Rapid Set Mortar Mix Plus
CTS Cement Manufacturing Corp.	Rapid Set V/O Repair Mix
Euclid Chemical	Euco Repair SCC Fast
Euclid Chemical	Versaspeed 100
Lyons Manufacturing, Inc.	Lyons PaveQuick HR
Lyons Manufacturing, Inc.	Lyons PaveQuick HR
MAPEI	Planitop 18ES
MAPEI	Planitop 18ES
MAPEI	Planitop 18TG
MAPEI	Planitop 18TG
MAPEI	Planitop X
Redi-Mix, LLC/ Custom-Crete	QuadraSet
Redi-Mix, LLC/ Custom-Crete	QuadraSet
The Quikrete Companies, LLC	FastSet Concrete Mix
The Quikrete Companies, LLC	FastSet DOT Mix Extend
Sika	Sikacrete 321 FS
Sika	Sikacrete 421 CI Rapid
Sika	SikaQuick 1000
Sika	SikaQuick 2500
Sika	SikaQuick VOH
SpecChem, LLC	RepCon 928
SpecChem, LLC	RepCon 928
Texas Polymer Systems	Highway Patch
Texas Polymer Systems	LightningCrete
Texas Polymer Systems	Road Patch
US Spec	Transpatch Concrete
US Spec	STR Mortar
US Spec	STR Mortar
W.R. Meadows	Futura-45 Extended
Western Materials	FasTrac 220FQ
Western Materials	FasTac 246
Western Materials	FasTrac 300
Western Materials	FasTrac 400

Concrete Repair Materials - Ultra-Rapid (260)

Adhesives Technology Corp.	CRACKBOND JET PATCH
ARDEX	TRM
BASF	MasterEmaco S 6000
BASF	MasterEmaco T 545 HT
BASF	MasterEmaco T 1060EX
CTS Cement Manufacturing Corp.	Rapid Set Cement
CTS Cement Manufacturing Corp.	Rapid Set DOT Concrete Mix
CTS Cement Manufacturing Corp.	Rapid Set DOT Repair Mix
CTS Cement Manufacturing Corp.	Rapid Set Low P Cement
CTS Cement Manufacturing Corp.	Rapid Set Mortar Mix Plus
CTS Cement Manufacturing Corp.	Rapid Set V/O Repair Mix
Lyons Manufacturing, Inc.	Lyons PaveQuick HR

The Quikrete Companies, Inc.	FastSet DOT Mix Extended
Sika	Sikacrete 321 FS
Sika	Sikacrete 421 CI Rapid
Sika	SikaQuick 2500
SpecChem, LLC	Repcon 928
Texas Polymer Systems	LightningCrete
US Spec	Transpatch Concrete
US Spec	STR Mortar

Penetrating Concrete Surface Treatments - Silane (261)

Evonik Corporation	Protectosil 40H
BASF Corp	Master Protect H440HZ
L&M Construction Chemicals	Pentane 40
Advanced Chemical Technologies	Sil Act ATS 42
ProSoCo	Weather Seal SL 40
Dayton Superior	Weather Worker 40% J29
Industrial Coatings	ICSC S40
Vexcon Chemicals	Powerseal 40%
Sherwin Williams	SW-244-40
Textured Coatings of America	Rainstopper 140
Texas Polymer Systems	TPS-CST 40
Texas Polymer Systems	TX DOT Silane Type 1
Sika Corporation	Sikagard SN40 Lo-VOC, Product No. F08575
Sherwin-Williams	LOXON 40% Silane Water Repellent, A31T00040
TK Products	TK-590-1 MS TRI-SILANE

Utah Department of Transportation

Policy.

Criteria for Selection of Actions.

Utah DOT's annual report (263) lists element-level quantities, and the mapping of element-level condition to actions for bridge painting (Table 172) and actions for concrete decks (Table 173).

Table 172 Utah DOT. Bridge Painting Element Quantities and Repair Actions (263)

Condition State	Repair Action
1	None
2	Spot paint at trouble areas such as beam ends
3	Repaint
4	Repaint
Total	

Table 173 Utah DOT. Deck Element Quantities and Repair Actions (263)

Condition State	Repair Action
1	Apply a protective overlay
2	Structural pothole patch & apply a protective overlay
3	Structural pothole patch & apply a protective overlay
4	Replace upper portion of deck & apply a protective overlay
Total	

Bridge Programs.

Utah DOT identifies categories for projects (Table 174) (262). Two categories provide new construction, reconstruction and rehabilitation; one category uses State funds, and a second uses Federal funds. Projects for pavement preservation, called the orange book, can include work for bridges within project limits. Bridge work in orange book projects can include pothole patching, concrete sealing, wearing surface replacement, minor repairs to deck joints or deck drains, and spot painting. One category, coded green, is for bridge preservation. Another category, coded purple, can also include work on bridges within project limits. Bridge work in purple book projects is similar to bridge work in orange book projects.

Table 174 Utah DOT. Categories for Projects (262)

Color Code (fund)	Project type
Green (state)	New construction
Blue (federal)	Reconstruction, major rehabilitation, minor rehabilitation with complications Widening, operational safety spot improvement, Bike trails, park and ride, landscaping and enhancement
Orange	Contractual pavement preventative maintenance
Green	Bridge preservation
Red	Operational safety spot improvement
Green	Advanced transportation management system (ATMS)
Purple (federal only)	Minor pavement preservation without complications
Yellow	Bridge emergency

Coordination.

Coordination between Utah DOT regions and the Utah DOT central office structures division includes (262):

- Reports from Regions on recurring maintenance needs. These can lead to changes in design details.
- Regions implement Bridge Week, a period when all maintenance staff focus on maintenance of structures.
- Maintenance work needing traffic closures is scheduled to take advantage of closures that will be placed for roads projects.

Priorities.

Bridge inspectors make recommendations for work in one of four categories: Routine/responsive maintenance, Signing, Safety features, or Preservation (262). Inspectors assign priority to recommendations as high, medium or low.

Actions.

Routine maintenance actions are cyclic. Most are completed twice each year. Routine maintenance actions include (Table 175) (262).

Actions in responsive maintenance are performed as needed (262).

Bridge preservation can include rehabilitation of decks (262). Bridge preservation can include new asphalt overlays for bridge decks, application of healer-sealers, polyester concrete overlays, bridge painting, scour remediation, and safety upgrades to parapets (262).

Table 175 Utah DOT. Routine Maintenance Actions (262)

Action
Sweep deck
Remove debris from drain/drain boxes
Remove vegetation from deck and approach areas
Remove vegetation from slope protection
Remove debris from expansion joints
Remove debris from around bearings
Remove weeds and seal slope protection joints
Remove debris from culvert barrels and inlets/outlets

Action
Patch minor potholes on deck
Seal relief/backwall joints
Maintain general safety features
Repair erosion around wingwalls
Repair erosion in slope protection
Clean and seal parapets
Remove graffiti
Power wash structural elements
Update signing

Table 176 Utah DOT. Responsive Maintenance Actions (262)

Action
Patch minor potholes on deck
Remove loose concrete from structures over traffic lanes
Respond to bridge collisions
Any routine/responsive maintenance item requiring immediate attention

Maintenance Program.

Utah DOT's Bridge Maintenance Program employs contractors under pre-negotiated unit prices for some work items before specific bridges and quantities are known (263). The standing contracts allow for quick response to maintenance needs. Actions in the bridge maintenance program are listed in (Table 177).

Table 177 Utah DOT. Actions in Bridge Maintenance Program (263)

Action
Repair potholes in concrete bridge decks,
Patch delaminated areas of thin bonded polymer overlay
Clean bridge drainage systems
Wash structural elements
Place waterproofing membrane with asphalt overlays
Deck sealing
Bridge parapet repair

Structures Inspection Recommendations Memoranda.

Inspectors are encouraged to use a standard set of recommendations for maintenance of bridges (262). There are two lists of standard actions; one list for routine/responsive maintenance (Table 178) and a second list for preservation (Table 179).

Table 178 Utah DOT. Standard Recommendations for Routine/Responsive Maintenance (262)

Action
Sweep deck
Clean joints
Remove weeds and seal slope protection joints
Overlay approach slab settlement
Patch minor potholes on deck
Remove debris from expansion joints
Seal relief/backwall joints

Action
Remove debris from drain/drain boxes
Remove debris from around bearings
Remove large vegetation debris and vegetation growth from channel
Remove debris from culvert barrels and inlets/outlets
Remove loose concrete from structures over traffic lanes
Remove graffiti
Repair chain link fence damage
Extend drain pipes below girders
Repair erosion around wingwalls
Repair erosion in slope protection
Place riprap around abutments to repair or prevent scour
Replace missing parapet delineators
Remove debris from deck, shoulders and sidewalks
Crack seal deck asphalt wearing surface
Crack seal approach asphalt wearing surface
Clean and seal parapets
Remove vegetation from deck and approach areas
Seal slope protection
Remove vegetation from slope protection
Maintain general safety features
Power wash structural elements
Update signing

Table 179 Utah DOT. Standard Recommendations for Preservation (262)

Action
Apply deck overlay treatment
Replace deck overlay treatment
Replace deck
Replace parapets
Repair parapets
Replace approach slab
Replace expansion joints
Remove and close expansion joints
Install deck shoring
Install polymer overlay
Repair settlement/ride
Repair spalls/delaminations/potholed areas
Apply healer/sealer on the deck and parapets
Install waterproof membrane and asphalt overlay
Clean and seal parapets
Repair chain link fence damage
Extend drain pipes below girders
Remove and patch all loose concrete from structures
Repair girder ends
Replace girders
Repair bent cap
Repair collision damage in girders
Clean and repaint structural steel

Action
Install carbon fiber wrap on girders and girder ends
Epoxy inject cracks in girders
Repair, replace or reset bearing units
Clean and paint bearing units
Place riprap around abutments/bents to repair or prevent scour
Wrap columns with carbon fiber
Install scour countermeasures
Repair and restore channel
Fill/repair erosion holes in aprons

Bridge Preservation Projects.

Utah DOT's annual report lists projects in the bridge preservation program (263). Seventy bridges had preservation projects in years 2015 and 2016. Actions and counts of bridges for each action are listed in (Table 180).

Table 180 Utah DOT. Actions in Bridge Preservation Projects (263)

Action	Bridges
Thin Bonded Polymer Overlay Patching	24
Polymer Overlay	15
Parapet Surface Repair	14
Pothole Patching	11
Thin Bonded Polymer Overlay	8
Deck Hydrodemolition and Overlay	5
Scour Repair	5
Remove & Replace Asphalt Overlay/Membrane	4
Bare Deck/Place Poly Concrete	3
Concrete Coating	2
Remove Poly/Place Poly Concrete	2
Sidewalk Repair	2
Abutment Backwall Repair	1
Clean & Overcoat Structural Steel	1
Concrete Repair	1
Deck Membrane and Overlay	1
Paint Structural Steel	1
Parapet Sealing	1
Polyester Concrete Overlay	1

Data System

Utah DOT uses a bridge management system and an operating management system (OPM) (262). The OPM keeps and tracks work orders generated in response to recommendations for bridge maintenance.

At Utah DOT, inspectors generate recommendations for maintenance during safety inspections. Inspectors post recommendations to Utah's bridge management system (BMS) (264). The BMS transmits recommendations to Utah's Operating Management System (OPM). Region maintenance stations collect

recommendations from the OPM. In addition, the DOT Bridge Management Engineer sends the highest priority recommendations to District Engineers using a Structures Inspection Recommendations Memorandum.

One work category, *Preservation*, is not posted to the OPM (262). Preservation needs are addressed through projects.

Performance Measures

For bridge performance, Utah DOT reports conditions of bridges by deck area, age distribution of bridges by bridge count, and expenditures on pavements and bridges by year (265).

Utah DOT reports a correlation of bridge health index to NBI general condition ratings (266). The endpoints have BHI equal to 100 when general condition is 8, and BHI equal to 0 when general condition is equal to 3.

Deck Preservation

Utah DOT relates general condition ratings for bridge decks to defects, electrical potential, and chloride content (Table 181) (264)

Table 181 Utah DOT. General Condition Ratings for Bridge Deck (264)

	Condition Indicators (% deck area)			
Rating	**Spalls**	**Delaminations**	**Electrical Potential**	**Chloride Content (lbs/cy)**
9	None	None	0	0
8	None	None	None > 0.35	None > 1.0
7	None	< 2%	0-5% > 0.35	None > 2.0
6	< 2% spalls or sum of all deteriorated and/or contaminated deck concrete < 20%			
5	< 5% spalls or sum of all deteriorated and/or contaminated deck concrete 20% to 40%			
4	> 5% spalls or sum of all deteriorated and/or contaminated deck concrete 40% to 60%			
3	> 5% spalls or sum of all deteriorated and/or contaminated deck concrete > 60%			
2	Deck structural capacity grossly inadequate			
1	Deck has failed completely; repairable by replacement only			
0	Holes in deck; danger of other sections of deck failing			

Utah DOT has standard specifications (267) for

- Thin bonded polymer overlay (Section 03372)
- Bridge deck methacrylate resin treatment (Section 03375)
- Structural concrete repair (Section 03924)
- Structural pothole patching (Section 03934)

In its approved products list, Utah DOT includes

Thin Bonded Polymer Overlay

Dayton Superior	Pro-Poxy Type III
P3 Infrastructure, Inc.	Impervius EU
P3 Infrastructure, Inc.	Impervius ME
Sika Corporation	Sikadur 25 Lo-Mod EPU

Bridge Deck Methacrylate Resin Treatment

Dayton Superior	Unitex - Pro-Poxy 40 LV/LM
Dayton Superior	Dayton Superior Sure Seal LV/LM

Structural Concrete Repair

Adhesives Technology Corporation	ULTRABOND 1300
CTS Cement Manufacturing Corporation	Rapid Set Mortar Plus (MMP)
Dayton Superior	HD – 50
Dayton Superior	Pro-Poxy 200
SpecChem LLC	RepCon 928
SpecChem LLC	RepCon V/O
US MIX Co. (US SPEC)	US SPEC R3
US MIX Co. (US SPEC)	US Spec STR Mortar CI
US MIX Co. (US SPEC)	US Spec Transpatch

Structural Pothole Patching

CTS Cement Manufacturing Corporation	Rapid Set DOT Repair Mix
CTS Cement Manufacturing Corporation	Rapid Set Mortar Mix
CTS Cement Manufacturing Corporation	Rapid Set Mortar Plus (MMP)
Dayton Superior	Pave Patch 3000
MAPEI Corporation	Planitop 18
MAPEI Corporation	Planitop 18 ES
MAPEI Corporation	Planitop 18 TG
Phoscrete Corporation	Phoscrete HC
Sika Corporation	SikaQuick 1000
Sika Corporation	SikaQuick 2500
US MIX Co. (US SPEC)	US Spec Transpatch

Waterproofing Membrane

W.R. Meadows	W.R. Meadows MelDek

Concrete Penetrating Sealer

Dayton Superior	Weather Worker 100% J29A
Evonik Corporation	Protectosil AQUA-TRETE EM
Evonik Corporation	Protectosil CHEM-TRETE BSM 400BA
W. R. Meadows	PENTREAT 244-100
W.R. Meadows	PENTREAT 244-40 OTC

Vermont Agency of Transportation

Policy.

Preservation of Historic Bridges.

Vermont AoT has instructions for dismantling and storage of metal truss bridges awaiting reuse (270).

Preservation Program.

In September 2014, Vermont AoT created a Structures Preservation Program that guides cyclical and condition-based maintenance to extend the useful life of bridge structures (274).

Funding.

Funding for Vermont AoT's bridge maintenance and preservation activities was $4.7 million in year 2006 and increased to $36.8 million by year 2013 (275).

Actions. Maintenance Team.

Vermont AoT's statewide bridge maintenance team responds to critical bridge maintenance reports. The team replaced 200 plug joints in year 2014 (273).

Materials

In year 2013, Vermont AoT began a five-year evaluation of Bridge Preservation LLC's BDM Waterproofing Membrane System on a bridge deck (269).

Performance Standard

Vermont AoT publishes best management practices for bridge washing (272). Bridges are washed every two years.

Methods

Vermont AoT tracks the number of structurally deficient bridges, and the percent of the bridge inventory cleaned and washed annually (271).

Virginia Department of Transportation

Definitions

The Code of Virginia defines ordinary maintenance and maintenance replacement (277). Ordinary maintenance preserves structures as near as possible to condition as constructed. Maintenance replacement is both rehabilitation and replacement.

Policy.

Selection of Actions.

Virginia DOT provides guidance to filling and sealing cracks in reinforced concrete bridge decks (Table 182) (283). Cracks should be filled to prevent water from entering decks. New decks should be overlayed with epoxy plus sand at about 6 months age if shrinkage cracks are observed.

Table 182 Virginia DOT. Guidance for Crack Filling and Sealing (283)

Crack Width	Guidance
< 0.2 mm	Do not fill
> 0.6 mm	Fill
On New decks at 6 months age	Fill cracks, apply epoxy overlay plus sand

Interaction.

Virginia DOT notes the interaction of joint maintenance and exposure of other components (Table 183) (277).

Table 183 Virginia DOT. Bridge Components Affected by Deck Joints (277)

Bridge Component Affected by Deck Joint
End Diaphragms
Beam/Girder Ends
Bearings
Substructure Seat Areas
Other Substructure Areas

Eligibility for Programs.

Virginia DOT identifies candidates for preventive maintenance, restorative maintenance and rehabilitation or replacement based on general condition ratings (277) (Table 184). The lowest general condition rating for a bridge is used.

Table 184 Virginia DOT. Candidates for Maintenance (277)

Program	General condition (lowest NBI condition rating)
Preventive maintenance	6 or greater
Restorative maintenance	5
Rehabilitation and replacement	4

Priority for Bridge Replacement.

Virginia DOT assigns priorities to bridges for replacement based on ten factors (Table 185) (284).

Table 185 Virginia DOT. Priority for Bridge Replacement (284)

Factor	Range	Weight
ADT	0 - 200	0.25
	201 - 1000	0.5
	1001 - 6500	0.75
	> 6500	1
%Truck ADT	0% - 5%	0.25
	6% - 10%	0.5
	11% - 15%	0.75
	> 15%	1
Weight Posted	B - Posting Recommended	0.25
	D - Temporary Supports	0.5
	P - Posted	0.75
	K - Closed	1
Detour Length	0 - 5 miles	0.25
	6 - 10 miles	0.5
	11 - 15 miles	0.75
	> 15 miles	1
Sufficiency Rating	< 50% - 40%	0.25
	39% - 30%	0.5
	29% - 20%	0.75
	< 20%	1
Low General Condition Rating	9 - 7	0.25
	6 - 5	0.5
	4	0.75
	< 4	1
Deck Area	< 200 SF	0.25
	201 - 1800 SF	0.5
	1801 - 6500	0.75
	> 6500	1
Age	Built between 1970 - 1980	0.25
	1971 - 1960	0.5
	1959 - 1950	0.75
	Before 1950	1
Fracture Critical	-	1
Scour Critical	-	1

Actions

Virginia identifies actions in preventive maintenance (Table 186) (276), in restorative maintenance (Table 187), in rehabilitation (Table 188), in ordinary maintenance (Table 189) and in maintenance replacement

(Table 190). For Virginia DOT, bridge replacement is part of the maintenance cycle. Often, bridge replacement coincides with improvements to routes in load capacity, geometry or traffic capacity.

Table 186 Virginia DOT. Preventive Maintenance Actions (276)

Action
Bridge Cleaning (washing and/or sweeping)
Deck Sealing
Sealing Joints, Cleaning and Flushing Troughs under open and finger joints (278)
Sealing Joints, Replacing existing joint material with new material
Thin Deck Overlays
Removing Large Debris in Channels
Cleaning Culverts
Spot and Zone Painting

Table 187 Virginia DOT. Restorative Maintenance Actions (276)

Action
Painting (Overcoating or Re-Coating)
Rigid deck overlays
Reconstruct/Close Joints, Reconstruct concrete slabs and/or back-walls adjacent to joints and install new joint material (277)
Reconstruct/Close Joints, Construct Asphalt Plug Joints on decks having asphalt overlays
Superstructure Repairs (Type B patching, etc.)
Substructure Repairs (including shotcrete, bearings, other elements)
Joint removal, Eliminate joints by constructing joint closures and slab extensions (277)
Fatigue retrofit
Scour repairs
Cathodic protection
Electrochemical chloride extraction
Replace timber decks

Table 188 Virginia DOT. Rehabilitation Actions (276)

Action
Deck replacement
Superstructure replacement
Culvert lining

Table 189 Virginia DOT. Ordinary Maintenance (277)

Action	Note
Bridge Inspection	All structures
Repairing Substructure	Repair and repainting bridge substructure removal of drift and ice flows
Repairing Superstructure	Repair and repainting the bridge superstructure
Repairs to Large Drainage Pipelines	
Repairs to Box Culverts	
Waterproof Bridge Decks	Includes linseed oil or epoxy treatments to bridge decks, wheel guards, and rails

Action	Note
Underwater Substructure Investigations	
Operation of non-toll Bridges	Operational expenses of drawbridges
Purchase of Equipment	Required to accomplish ordinary maintenance activities
Purchase of Materials	Required to accomplish ordinary maintenance activities

Table 190 Virginia DOT. Maintenance Replacement (277)

Action	Note
Major Substructure	Major repairs with equivalent dimensions
Major Superstructure	Major repairs with equivalent dimensions

Intervals for Actions.

Virginia DOT publishes intervals for maintenance actions (276)(Table 191).

Table 191 Virginia DOT. Intervals for Maintenance Actions (276)

Action	Interval, years
Bridge Deck Washing	1
Bridge Deck Sweeping	1
Seats & Beam End Washing	2
Cutting & Removing Vegetation	2
Routine Maintenance of Timber Structures	2
Scheduled Replacement of Compression Seal Joints	10
Scheduled Replacement of Pourable Joints	6
Cleaning & Lubricating Bearing Devices	4
Scheduled Installation of Thin Epoxy Overlay	15
Beam Ends Painting	10
Removing Debris from Culverts	5

Costs of Actions.

Virginia DOT reports painting average costs at $1.3 per ton of steel, and $69 per square foot of deck (281) in year 2014.

In a study in year 2005, Virginia DOT reports average unit costs of preventive maintenance actions for reinforced concrete bridge decks (Table 192) (282).

Table 192 Virginia DOT. Unit Costs for Actions in Deck Maintenance (282)

Action	Interval, years	Cost	Unit
Deck Sweeping	1	$0.40	SY
Deck Washing	1	$1.30	SY
Scheduled Replacement of Pourable Joint Seal	6	$50	LF
Scheduled Replacement of Compression Joint Seal	10	$66	LF
Scheduled Installation of Thin Epoxy Overlay	15	$47	SY
Scheduled Installation of Concrete Overlay	30	$130	SY

Data. Actions.

Virginia DOT uses five-digit identifying codes for reporting accomplishments in bridge maintenance work to *SiteManager* (Table 193) (280). There are two ID systems. Codes 6xxxx are used for work that is eligible for Federal funding. Codes 7xxxx are the same activities performed in cases that are not eligible for Federal funding.

Table 193 Virginia DOT. Identifying Codes for Bridge Maintenance Activities (280)

Activity Number		Activity Name	Activity Description	Unit of Measure
Federal*	State			
60700	70700	Ordinary Maintenance - Deck	Minor maintenance work that preserves/extends the life of the deck or corrects minor defects. Examples: bridge deck cleaning, temporary deck patching.	SY
60720	70720	Ordinary Maintenance - Superstructure	Minor maintenance work that preserves/extends the life of the superstructure or corrects minor defects. Examples: superstructure cleaning, cleaning /lubricating bearings.	EA
60740	70740	Ordinary Maintenance - Substructure	Minor maintenance work that preserves/extends the life of the substructure or corrects minor defects. Examples: substructure cleaning, erosion stabilization, debris/vegetation removal.	EA
60750	70750	Ordinary Maintenance - Culvert	Minor maintenance work that preserves/extends the life of the culvert or corrects minor defects. Examples: culvert cleaning, erosion stabilization, debris/vegetation removal.	EA
60760	70760	Ordinary Maintenance - Miscellaneous	Minor maintenance work that preserves/extends the life of other elements of a structure or corrects minor defects. Examples: stream bank stabilization, debris/vegetation removal.	EA
61701	71701	Deck Patching	Permanent patching to bridge decks.	SY
61702	71702	Seal Cracks - Deck	Sealing of cracks in bituminous or concrete deck surfaces.	LF
61703	71703	Thin Overlay	Application of thin-bonded overlay to bridge decks.	SY
61704	71704	Joint Rehabilitation	Maintenance of bridge deck joints. Examples: removal/replacement of joint material, repair/patching of joint walls.	LF
62705	72705	Rigid Overlay	Application of latex/silica fume overlay to bridge decks.	SY
62706	72706	Rail repair	Repairing or maintaining the railing system on a bridge. This includes rails, parapets, curbs, safety walks and all associated supports and connections.	LF
62707	72707	Timber Rehabilitation - Deck	Maintenance actions exclusive to timber bridge decks. Examples: application of wood preservatives, repairing/replacing a portion of the timber deck boards, tightening/replacing deck fasteners.	EA
62708	72708	Asphalt Overlay	Application of asphalt overlay to bridge decks.	SY
62725	72725	Concrete Superstructure Repair	Repairs to the exposed surfaces of bridge superstructures.	SY

Activity Number		Activity Name	Activity Description	Unit of Measure
Federal*	State			
62726	72726	Steel superstructure Repair	Repairs to steel bridge superstructures and all related supporting activities, such as blocking and jacking of the superstructure.	EA
62727	72727	Bearing Repair	Repair, realignment or replacement of bridge bearing devices.	EA
62728	72728	Paint - Superstructure	Painting or coating structural steel on a bridge.	EA
62729	72729	Paint - Superstructure	Spot painting	SF
62745	72745	Substructure Surface Repair	Repairs to the exposed surfaces of bridge substructures.	SY
62746	72746	Substructure - Repair Undermining	Filling scour holes, installing rip-rap or other scour countermeasures to prevent or stabilize scour at bridge substructure.	Ton
62755	72755	Culvert - Surface Repair	Repairs to culvert and all related supporting activities. Examples: patching spalls/delaminations, sealing cracks, repairing damaged headwalls/endwalls.	SY
62756	72756	Culvert - Repair Undermining	Filling scour holes, installing rip-rap or other scour countermeasures to prevent or stabilize scour at culvert.	Ton
62765	72765	Approach Slab Repair	Maintenance of bridge approach slabs. Examples: repairing settlement, repairing cracks, patching, installing/repairing pressure relief joints, replacing overlay.	EA
64719	74719	Deck Replacement	Replacement of bridge deck.	EA
64739	74739	Superstructure Replacement	Replacement of bridge superstructure.	EA
62211	72211	Movable bridge Mechanical Repairs	Repair on Moveable Parts , Repair on engines, gears, or machined parts	EA
62500	72500	Movable bridge Corrective Maintenance	Corrective Maintenance - Includes electrical Repairs	EA
64749	74749	Substructure Major Rehabilitation	Replacement/major rehabilitation of bridge substructure.	EA
64758	74758	Culvert Major Rehabilitation	Rehabilitation/restoration of culvert. Examples: extending existing pipe or box culvert, sleeve installation, flowline restoration.	LF
64759	74759	Culvert Replacement	Replacement of culvert.	EA
64779	74779	Bridge Replacement	Replacement of total bridge structure.	EA
64771	74771	Mobilization	Mobilization & Demobilization of Crew to the project or bridge	EA
64772	74772	Maintenance of Traffic	MOT for the entire project	EA
64773	74773	Misc. Roadway Items	Pavement planning, asphalt base mix, asphalt surface mix, guardrail, etc.	EA

Activity Number		Activity Name	Activity Description	Unit of Measure
Federal*	State			
65780	75780	Safety Inspection - Interstate	Inspection of Interstate System Structures (NBI - 65780, Non-NBI - 75780)	EA
65781	75781	Safety Inspection - Primary	Inspection of Primary System Structures (NBI - 65781, Non-NBI - 75781)	EA
65782	75782	Safety Inspection - Secondary	Inspection of Secondary System Structures (NBI - 65782, Non-NBI - 75782)	EA
65790	75790	Bridge Rating - Interstate	Performance of Load Rating analysis on Interstate System Structures. Performed by District Structure & Bridge personnel.	EA
65791	75791	Bridge Rating - Primary	Performance of Load Rating analysis on Primary System Structures. Performed by District Structure & Bridge personnel.	EA
65792	75792	Bridge Rating - Secondary	Performance of Load Rating analysis on Secondary System Structures. Performed by District Structure & Bridge personnel.	EA
65798	75798	Bridge Management	Management tasks performed by District Structure & Bridge personnel. Examples: developing bridge maintenance work schedules, planning and budgeting future work needs, overseeing work associated with structures.	EA
65799	75799	Preliminary Engineering	Development of plans, specifications and/or contract documents for structures identified as needing rehabilitation or replacement.	EA

Materials. Durability.

Virginia DOT reports that use of corrosion resistant reinforcement (CRR), in place of epoxy-coated rebars or galvanized rebars, can provide longer service life (279). Virginia DOT identifies three classes of CRR (Table 194).

Table 194 Virginia DOT. Classes of Corrosion Resistant Reinforcement (279)

Class	Note
I	ASTM A1035/A1035M - Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement ASTM A955/A955M - Standard Specification for Deformed and Plain, Solid Stainless Steel Bars for Concrete Reinforcement
II	AASHTO Designation: MP 13M/MP 13-04, Standard Specification for Stainless Steel Clad Deformed and Plain Round Steel Bars for Concrete Reinforcement ASTM A955/A955M - Standard and Specification for Deformed and Plain Solid Stainless Steel Bars for Concrete Reinforcement
III	ASTM A955/A955M - Standard Specification for Deformed and Plain Solid Stainless Steel Bars for Concrete Reinforcement

Use of CRR is related to route functional class (Table 195).

Table 195 Virginia DOT. Route Functional Class & CRR Use (279)

Functional Classification	CRR Steel Class I	CRR Steel Class II	CRR Steel Class III
Freeway			x
Rural Principal Arterial			x
Rural Minor Arterial		x	
Rural Collector Road	x		
Rural Local Road	x		
Urban Principal Arterial			x
Urban Minor Arterial		x	
Urban Collector Street	x		
Urban Local Street	x		

Performance Measures

Virginia DOT's performance dashboard (285) reports counts of structurally deficient bridges, functionally obsolete bridges, and bridges that are non-SD, non-FO.

For bridges on locally-maintained routes, Virginia DOT sets a performance target of not more than 40% of bridges in need of repair or rehabilitation (286). Status of a bridge is determined from general condition ratings. Bridges that need repair or rehabilitation have at least one general condition rating equal to 5 or less.

Performance. Outcomes.

VDOT maintains 19,390 structures. Virginia DOT reports that 200 structures per year become structurally deficient (276). The transition rate corresponds to an average service life equal to 97 years.

Deck Preservation

Virginia DOT publishes a manual for repairs to cracks in concrete bridge decks (294).

Virginia DOT has policies on time intervals for preservation actions for bridge decks (292)(Table 196). Virginia DOT estimates the service life of decks and overlays for decks (292)(Table 197).

Table 196 Virginia DOT. Deck Actions and Intervals (292)

Preventive Maintenance Activity	Preferred Cycle (yrs)	Unit Of Measure	Federal Aid?	Description	Criteria
Bridge Deck Washing (Concrete)	1	SY	Yes	Includes the removal and disposal of debris and pressure washing of the bridge roadway surface, joints, sidewalks, curbs, parapet walls, drainage grates, downspouts, and scuppers.	All concrete decks and slabs that do not have asphalt overlay.

Preventive Maintenance Activity	Preferred Cycle (yrs)	Unit Of Measure	Federal Aid?	Description	Criteria
Bridge Deck Sweeping	1	SY	Yes	Includes the removal and disposal of debris and sweeping of the bridge roadway surface, shoulders, joints, sidewalks, and curb lines.	All concrete decks and slabs with asphalt overlay (not accounted for under the Bridge Deck Washing activity), metal decks, timber decks and slabs.
Routine Maintenance of Timber Structures	2	EA	No	Includes tightening and/or replacing fasteners such as those used on timber decks, railing systems, and other miscellaneous connections, sealing end sections of timber elements, such as deck boards, bent caps, railings, posts, etc.	All timber structures.
Scheduled Installation of Thin Epoxy Concrete Overlay	15	SY	Yes	Includes installing of new system and/or replacing existing overlay system.	Only concrete bridge decks that are in overall good condition are considered in this program.

Table 197 Virginia DOT. Estimates of Service Life (292)

Element	Presumed Maintenance during Usable Life	Presumed Life
Thin-bonded overlays		15 years
Rigid Overlays	2% at 10 years and 2% patching every 2 years thereafter until 20 years	25 years
New Decks	Type B patching will be 1% at 40 years and 1% patching every 2 years until overlayed. Overlay deck at 50 years. Estimate 2% patching at time of overlay.	50 years

Virginia DOT's manual for bridge element inspection includes agency-developed elements (293)(Table 198).

Table 198 Virginia DOT. Agency-Developed Deck Elements (293)

Element Number	Element Title	Units	Comments
801	Sidewalk	SF	
802	Deck Drains	EA	
843	Link Slab	EA	Joint Closures at Piers
844	Slab Extension	EA	Joint Closures at Abutments

Virginia DOT ranks actions for deck preservation by effectiveness of actions (290)(Table 199). Virginia DOT publishes advice on selection of preservation actions for bridge decks based on compromised area and chloride content of concrete (290) (Table 200). In the table, compromised area, CA, is the union of areas of deck that are spalled, delaminated, or patched or have half-cell potential more negative than -0.35V using ASTM C876. Compromised area may be taken as the area of deck reported in element condition

state 2 or greater. Chloride front, CF, is the depth from top of slab where chloride ion content is equal to 2 lbs/CY of concrete. Decks are evaluated prior to decisions on actions. Requirements for evaluations of decks are listed in Table 201. Information to include in summary reports of deck evaluations are listed in Table 202.

Table 199 Virginia DOT. Hierarchy of Deck Treatments (290)

Rank	Deck Treatment
1	Patching - Type B and Type C
2	Crack Sealing with Mesh, Polymer Fill, V Groove or Epoxy Injection
3	Epoxy Overlay
4	Asphalt Overlay with Approved Membrane
5	Rotomill and Rigid Overlay
6	Shallow Hydromill and Rigid Overlay
7	Deep Hydromill and Rigid Overlay
8	Replace Deck

Table 200 Virginia DOT. Deck Decision Matrix (290)

Worse of …				
Deck GCR	**% CA**	**Condition**	**Evaluation Results**	**Minimum Required Action**
7 - 9	≤ 5	Good	Year Built < 2003	Patch, Epoxy Overlay, Fill Cracks, Clean Drains and Sweep/Wash Annually
			Year Built $\geq$ 2003	Patch, Fill Cracks, Clean Drains and Sweep/Wash Annually
6	≤ 10	Satisfactory	CA < 5% & CF < 1”	Patch and Epoxy Overlay
			$CA \leq$ 10% & $CF \leq$ 1.5”	Patch, Rotomill Substrate, place Rigid Overlay
			No Evaluation or CF > 1.5”	Rigid Overlay on Shallow Hydromilled Substrate
5	≤ 15	Fair	$CF \leq$ Average Cover Depth of Top Bar Mat	Rigid Overlay over Shallow Hydromilled Substrate
			4” > $CF \geq$ Avg. Cover Depth of Top Bar Mat	Rigid Overlay over Deep Hydromilled Substrate
≤ 4	≤ 20	Poor	$CF \leq$ Average Cover Depth of Top Bar Mat	Rigid Overlay over Shallow Hydromilled Substrate
			4” > $CF \geq$ Avg. Cover Depth of Top Bar Mat	Rigid Overlay over Deep Hydromilled Substrate
Any	Any	Any	CF > 4”	Replace Deck
Any	Any	Any	Spalls, deck bottom > 3%	Replace Deck
Any	Any	Any	Reactive Aggregates Present & CI > 0.02 in/yd	Replace Deck
Any	Any	Any	$f_c' \leq$ 2,400 psi (average)	Replace Deck
Any	Any	Any	Cost to Rehab or Repair > 65% of Replace Cost	Replace Deck

Table 201 Virginia DOT. Requirements for Evaluation of Bridge Decks (290)

Condition	Method	Minimum Frequency or Extent	Locations	Recommended or Required
Good	Visual and Delamination Survey	Entire Deck	Entire Deck	Recommended
	Half Cell Potential	5’ x 5’ Grid	Entire Deck	Recommended
Satisfactory	Visual and Delamination Survey	Entire Deck	Entire Deck	Recommended
	Half Cell Potential	5’ x 5’ Grid	Entire Deck	Recommended
	Chloride ion profile	10 total or 4 per span for multi-span	Emphasize Shoulders	Recommended
	Depth of Cover	Entire Deck (GPR) or 1 Reading per 25 SF for Pachometer	Take Readings on a Grid	Recommended
Fair	Visual and Delamination Survey	Entire Deck	Entire Deck	Recommended
	Half Cell Potential	5’ x 5’ Grid	Entire Deck	Recommended
	Chloride ion profile	10 total or 4 per span for multi-span	Emphasize Shoulders	Required
	Depth of Cover	Entire Deck (GPR) or 1 Reading per 25 SF for Pachometer	Take Readings on a Grid	Required
	Visual assessment of deck bottom	Entire Deck	Entire Deck	Required
Poor	Chloride ion profile	10 total or 4 per span for multi-span	Emphasize Shoulders	Required
	Depth of Cover	Entire Deck (GPR) or 1 Reading/25 SF for Pachometer	Take Readings on a Grid	Required
	Visual assessment of deck bottom	Entire Deck	Entire Deck	Required
Any	Petrographic Analysis	4 Tests	Designer Decision	Required if ASR Suspected
	Compressive Strength	4 Tests	Designer Decision	Required Only if Soft Concrete or Live Load-Induced Distress are Evident

Table 202 Virginia DOT. Summary of Evaluation of Bridge Decks (290)

Condition	Test	Results to Report		Number of Tests Performed
Indicate Good, Satisfactory, Fair or Poor	Delamination/Spalls/ Patches	*CA (%)*		*#*
	Half Cell Potential	*Average potential*		*#*
	Chloride Ion Profile	½” depth	*Avg. Chloride (#/CY)*	*#*

		Depth of Bar	*Avg. Chloride (#/CY)*	
		1 ½" depth	*Avg. Chloride (#/CY)*	
		4" depth	*Avg. Chloride (#/CY)*	
	Depth of Cover	*Average depth to center of top mat*		#
	Visual assessment of Deck Bottom	*% Delaminated, spalled or patched (approximate per visual examination)*		*N/A*
	Petrographic Analysis	*Carbonation*		#
		ASR Susceptibility		#
	Compr. Strength	*Average Compressive Strength (psi)*		#

Virginia DOT has standard specification for

- Latex-modified concrete, very-early-strength (LMCVE) for bridge deck overlays (Section 217)
- High early strength latex modified concrete (HESLMC) for bridge deck overlays (Section 217)
- Epoxy-resin systems (Section 243)
- Gravity-fill polymer crack sealers (Section 252)
- Widening, repairing, and reconstructing existing structures (Section 412)
- Rigid concrete bridge deck overlays (Section 425)
- Concrete surface penetrant sealer (Section 428)
- Bridge deck waterproofing membrane systems (Section 429)
- Epoxy bridge deck overlays (Section 431)

Virginia DOT has a direct test for waterproofing effectiveness of asphalt overlay plus waterproofing membrane (287).

Among approved products (289), Virginia DOT lists

Waterproofing membrane

Bridge Deck Membrane System (288)	Bridge Preservation, LLC

Polymers for Sealing Cracks in Hydraulic Cement Concrete

BASF Construction Chemicals, LLC	Degadeck Crack Sealer Plus	MMA
SSI Construction & Industrial Materials, Inc.	DECKSEAL	Epoxy
The Euclid Chemical Company	Dural 50 LM	Epoxy
The Euclid Chemical Company	Dural 335	Epoxy
E-Bond	E-Bond 523	Epoxy
E-Bond	E-Bond 550 Hi-Mod Low Viscosity	Epoxy
Olin Epoxy-POLY-CARB (Blue Cube Operations LLC)	Mark-135 Safe-T-Seal	Epoxy
Sika Chemical Corp.	Sikadur 55 SLV	Epoxy
Sika Chemical Corp.	Sikadur 35 Hi-Mod LV	Epoxy
Advanced Chemical Technologies	SIL-ACT EP-700D	Epoxy
Kaufman Inc.	Surepoxy HMLV	Epoxy
Henkel Corporation	Versafill 60A/60B	Epoxy
Watson Bowman Acme	Crack Sealer ULV	HMWM
ChemMasters	Duraguard 401-100 (Low Modulus)	HMWM
ChemMasters	Duraguard 401-3 (High Modulus)	HMWM
Rhone Poulenc	Rhoca Gil HS-LV	HMWM
Rhone Poulenc	Rhoca Gil HS-2K	HMWM

Transpo Industries	Sealate T-70-MX-30 Bridge Deck Elongation	HMWM
Sika Chemical Corp.	Sika Pronto 19	HMWM
Sika Chemical Corp.	SikaPronto 19 TF	HMWM

Hydraulic Cement Concrete Sealants, Stains, And Coatings - (Physical Lab)

Advanced Chemical Technologies Oklahoma City, OK	Sil-Act ATS 42	
BASF Construction Chemicals, LLC	Masterinject 1000	ultra-low viscosity epoxy sealer and structural adhesive
BASF Construction Chemicals, LLC	MasterProtect H 400	water-based, 40% alkylalkoxysilane penetrating sealer

Hydraulic Cement Concrete Repair Materials – (Physical Lab)

Approved concrete repair materials for A3 Concrete and miscellaneous concrete Items

HD 25VO	Dayton Superior Corporation
Pave Patch 3000	Dayton Superior Corporation

Concrete repair materials for A4 Concrete Items

Commercial Grade FastSet DOT Mix	The Quikrete Companies	fiber reinforced repair material
Commercial Grade FastSet DOT Mix Extended	The Quikrete Companies	fiber reinforced repair material
Duracrete II FT	Kaufman Products Inc.	
EucoRepair SCC	The Euclid Chemical Company	polymer and microfiber modified repair mortar
Planitop 18 ES	MAPEI	

Concrete repair materials for A5 Concrete Items

ChemMasters	ChemPatch Fast VO	polymer modified repair mortar with fiber and corrosion inhibitor
Dayton Superior Corporation	HD 50	fiber reinforced, latex-modified, concrete repair material
Kaufman Products Inc.	HiCap FT	
MAPEI	Planitop 11 SCC	polymer modified concrete mix pre-extended with coarse aggregate.
MAPEI	Planitop 12 SR	Fiber reinforced, silica fume and corrosion inhibitor cementitious repair mortar
MAPEI	Planitop 15	fiber reinforced silica fume fluid mortar
MAPEI	Planitop X	fiber reinforced, polymer modified cementitious repair mortar
MAPEI	Planitop XS	fiber reinforced, polymer modified cementitious repair mortar

CTS Cement Manufacturing Corp.	Rapid Set DOT Concrete Mix	polymer-modified, fiber reinforced concrete repair material
CTS Cement Manufacturing Corp.	Rapid Set DOT Repair Mix	
SpecChem, LLC	RepCon 928	
Sika Corporation	SikaQuick 211 SCC Plus	silica fume and polymer modified concrete
Sika Corporation	SikaCrete 421 CI Rapid	
Sika Corporation	SikaQuick 2500	
The Euclid Chemical Co. Cleveland, OH	Tamms Form and Pour	silica fume and polymer-modified cementitious repair mortar

Fibers for Use in Hydraulic Cement Concrete – (Physical Lab)

Euclid Chemical Company	TUF STRAND MAXTEN	Blended Copolymer
Bekart Wire Co	RC 80/60 BN	Steel Fibers
Bekart Wire Co	RC 65/60 BN	Steel Fibers
Maccaferri Inc		Steel Fibers
Polytorx, LLC	Helix	Steel Fibers
Advanced Fiber Solutions, Inc.	Fibrillated	Polypropylene Fibers
Advanced Fiber Solutions, Inc.	Monofilament	Polypropylene Fibers
Advanced Fiber Solutions, Inc.	Ultimax Structural Fibers	Polypropylene Fibers
Durafiber		Polypropylene Fibers
FiberMesh		Polypropylene Fibers
Forta		Polypropylene Fibers
The Euclid Chemical Company	PSI Fiberstrand 100	Polypropylene Fibers
The Euclid Chemical Company	PSI Fiberstrand F	Polypropylene Fibers
W. R. Grace		Polypropylene Fibers

Washington Department of Transportation

Policy.

Budgets.

Washington DOT's year 2008 projection of spending in the bridge preservation program (295) allocates 44% of funding to bridge rehabilitation and replacement, 17% to bridge painting, 11% to deck rehabilitation, 12% to essential repairs, and 7% to seismic retrofits. Remaining budget is applied to movable bridge operations, bridge cleaning, and miscellaneous structures (short spans).

Washington assigns three priorities for repairs (304). Priority 1 is highest. About 42 percent of funding for bridge maintenance is allotted to Priority 1 repairs.

Washington operates a *P2* bridge preservation program to deliver work in deck repairs and overlays, bridge painting, repairs to bridge railings, repairs to deteriorated bridge elements, seismic retrofits, and scour protection (297) (298) (299) (300) (301).

Preservation Responsibilities.

Washington identifies the various responsibilities of central office DOT staff, regional DOT staff, and local government staff in the inspection, maintenance and preservation of bridges (302). The Washington bridge and structures engineer is the responsible authority for major maintenance or modification of all structures on the State Bridge List (303). The DOT Region maintenance engineer is the responsible authority for minor structures. Minor structures are drainage structures, retaining walls, acoustical barriers and cribbing not on the State Bridge List.

There is continuing responsibility among maintenance personnel in DOT regions to report to the state Bridge Preservation Engineer any new settlement, washout, collision damage or other problems at bridges (303). Responsibilities of DOT region maintenance personnel for highway bridges include (Table 205) (303).

Table 203 Washington DOT. Responsibilities of Region Maintenance Personnel (303)

Responsibility	Event, Observation
Report to State Bridge Preservation Engineer	Settlement
	Washout
	Collisions damage
	Other problems
Maintain, Repair	Minor approach settlements
	Approach guardrail damage
	Plugged bridge drains
	Sweeping of bridge decks
	Asphalt overlays and
	Other items of normal maintenance operations
Minor repairs	Railings
	Curbs
	Concrete decks
	Expansion joints
	Drift removed,
	Clearance lights changed
Remove Dirt and Debris on	Timber caps,
	Timber stringers,

Responsibility	Event, Observation
	Steel expansion devices (bearings),
	Lower chords of steel bridges and
	Sign bridge bases
Inspect annually	All bridges
	All minor structures related to bridges
Inspect & Repair	*Approach Fills* - sagging, pot holing, scaling, or spalling.
	Asphalt Wearing Surface - potholes, scaling, wheel rutting,
	Concrete Deck - Note scaling, spalling, cracks, and any exposed reinforcing steel.
	Grid Decks - broken welds or clips, loss of a section, bent members.
	Curbs and Railings - deterioration, cracking, spalling, or damage.
	Paint - cracking, peeling, fading, and presence of rust or algae.
	Stringers, Caps, and Floor Beams –crushing at bearing points, warping, cracking or debris buildup.
	Steel Truss Members - bent or damaged steel, deflection, cracking, vibration, debris buildup on chord members, and deterioration due to rust; *At pinned joints* - excessive rust, vibration, missing nuts, or loose plates.
	Wood Truss Members - damaged or broken members, crushing, cracking, warping, vibration, and deterioration due to rot or boring insects.
	Expansion Joints - loose, banging, and jammed expansion joints; presence and condition of the joint material.
	Abutments, Bulkheads, Piers, and Intermediate Bents - tilting, bulging, and deterioration; buildup of drift debris; scouring or undermining due to high water and erosion.
	Bridge Drains - plugged bridge drains; erosion at pipe outfall areas; unusual erosion or undermining of abutments or bulkheads.
	Waterways - scour, logs or other debris jammed against piers, bulkheads, or piling
	General Conditions - accumulation of dirt, excessive bird droppings or debris on the roadway at bearing points and on the caps or lower chords; presence of materials that might pose a fire hazard or restrict access for maintenance activities; unauthorized attachments such as private fences; remove electrical fences from bridge access areas or clearly mark them with warning signs.
	Walls and Cribbing –tipping, bulging, cracking, spalling, and water runoff over or through wall; clogged weep holes; timber rot and presence of fire hazards.
	Tunnels - cracking, spalling or loose overhead hazards; increased water seepage *wire retention fabrics* - tears or failures that may indicate potential structural hazards and impact on portals or overhead members.

Priorities for Repairs.

Washington's maintenance manual sets priorities for repairs (303)(Table 210).

Table 204 Washington DOT. Priorities for Repairs (303)

Priority	Description
Emergency	Immediate action when structures are partially or completely closed.
Urgent	Prompt action to be completed when structural details and bridge crews become available
Priority 1	Action for damage to primary structural elements that affect safety, reliability of transportation system, protecting public investment, and maintaining legal mandates. Action to reduce hazard to traffic.
Priority 2	Action within regular work schedule or programmed in the biennial work schedule.
Priority 3	Action for minor nonstructural or 'housekeeping' repair

Priority 4	Monitor

Contract Work.

Washington uses state crews to perform maintenance repairs and contractors to perform bridge preservation work.

Actions

Washington DOT has a structures preservation program that provides repairs, painting, seismic strengthening, and scour protection (Table 205) (295). The preservation program also delivers bridge rehabilitation and bridge replacement. Washington DOT uses concrete overlays on decks. Protective overlays are required on decks exposed to winter de-icing salts, and on decks with known deterioration.

Table 205 Washington DOT. Structures Preservation Program (295)

Action
Special Repair, Major Repair
Special Repair, Moveable Bridge Repair
Steel Bridge Painting
Bridge Deck Preservation
Bridge Rehab / Replacement Structural Deficiencies
Seismic Strengthening
Scour Protection
Miscellaneous Structures

Actions in the bridge preservation program (304) include (Table 206):

Table 206 Washington DOT. Bridge Preservation Program (304)

Action
Repairing concrete bridge decks
Repainting steel bridges
Replacing deteriorated bridge elements, Deck expansion joints
Replacing deteriorated bridge elements, Anchor cables for floating bridges
Rehabilitating bridges
Replacing bridges

Bridge preservation projects by contract provide scour protection and seismic retrofit (296)(Table 206).

Table 207 Washington DOT. Actions in Preservation Projects (296)

Action	
Scour protection	Engineered log jam
	Boulder revetment
Seismic retrofit	Steel jackets for pier columns

Intervals for Actions

Washington (304) reports extension to service life of bridges due to actions in bridge preservation (Table 208).

Table 208 Washington DOT. Extension of Service Life (304)

Action	Extension	Note
Deck rehab w/ protective overlay	25 - 30 yrs	1.5" thickness modified concrete overlay
Repaint steel truss bridges	20 - 25 yrs	Bridges on freight routes have top priority
Repaint steel girder bridges	40 yrs	

Data. Actions.

Performance measures for accomplishments in maintenance are linked to work operation codes (Table 209) (308).

Table 209 Washington DOT. Work Types Linked to MAP Performance Measures (308)

Map Performance	Work Type	Description	Unit
4A1 Bridge Deck Repair	1936	Deck maintenance	SQ FT
4A2 Structural Bridge Repair	1930	Structural stationary bridge/tunnel routine inspection	EACH
	1931	Structural bridge/tunnel inspection - emergency	EACH
	1932	Remove debris underneath bridge	EACH
	1941	Bridge appurtenance maintenance	NONE
	1942	Structural maintenance	NONE
	1943	Scour repair	NONE
	1952	Sign bridge repair, structural	EACH
	1953	Expansion joint repair	LINEAR FT
	1954	Expansion joint preventive maintenance	LINEAR FT
	1999	Other bridge & structures maintenance as approved by superintendent	NONE
4A3 Bridge Cleaning	1922	Bridge structure cleaning	EACH
	1928	Repair bridge drains	EACH
	1933	Painting	NONE

Performance Measure

Washington's Gray Notebook (304) presents many measures of performance of transportation assets. For bridges, performance measures include (Table 210).

Table 210 Washington DOT. Performance Measures (304)

Performance Measure
Percentage of state bridges in fair or better condition by bridge deck area
Deck area of SD bridges on NHS
Percentages of National Highway System bridges in good and poor conditions
Percent of state and local bridges[3] in poor condition
Count of state-owned bridges that are load posted or weight restricted
Count of bridges
Counts of bridge inspections by type
Bridges older than 75 years

Maintenance Accountability Process.

Washington's maintenance accountability process (MAP) reports outcome-based performance measures using level-of-service (LOS) grades, *A* (best) to *F* (worst). Outcome-based refers to the results of tasks accomplished by maintenance personnel.

MAP includes level-of-service goals for bridge cleaning (305). Field observations (306) to support the MAP measure of bridge cleaning include sand on decks, blocked drains, and graffiti or other non-intended cover on rails, girders, trusses, piers and abutments (Table 211).

Washington's MAP process tracks three measures for maintenance of bridges (307). These are *4A1 Bridge Deck Repair*, *4A2 Structural Bridge Repair*, and *4A3 Bridge Cleaning & Painting*. Bridge deck repair, as a LOS item, is observed directly as absence of spalls or other defects in decks. Structural bridge repair is measured as the number of items on the Priority 1 repair list that are completed on time. Bridge cleaning and painting are observed directly as the absence of sand on decks, clogged drains, and graffiti on any part of structures. Bases for measurement and level-of-service thresholds for these three measures are listed in (Table 212) (Table 213) and (Table 214).

Table 211 Washington DOT. Field Observations for MAP Performance Measure (306)

<table>
<tr><td colspan="2">A. DECKS & SIDEWALKS</td></tr>
<tr><td>Unit of Measure:</td><td>Total square feet of sand or debris on the bridge deck and sidewalk.</td></tr>
<tr><td>Threshold:</td><td>Presence of sand or debris.</td></tr>
<tr><td>Methodology:</td><td>Measure the length and determine the average width of sand and debris on the bridge deck and sidewalk. Calculate and record the total square feet for all sand and debris.</td></tr>
<tr><td colspan="2">B. GRATES & DRAINS</td></tr>
<tr><td>Unit of Measure:</td><td>Total number of drains on the structure. Total number of drains that are blocked.</td></tr>
<tr><td>Threshold:</td><td>Blocked, plugged or covered bridge drains. Drains that are partially blocked are considered deficient. Catch basins with sediment buildup that exceeds the flow line elevation of the outlet pipe are considered a deficiency</td></tr>
<tr><td>Methodology:</td><td>Count and record the total number of bridge drains on the structure. Count and record the total number of blocked, plugged or covered bridge drains. A flashlight may be needed to determine if the drain is blocked.</td></tr>
<tr><td colspan="2">C. RAILS, GIRDERS, TRUSSES, PIERS & ABUTMENTS</td></tr>
<tr><td>Unit of Measure:</td><td>Percent of structure covered with graffiti, moss, rust, etc.</td></tr>
<tr><td>Threshold:</td><td>Check box for None, Minor, Moderate, Major or Significant severity.
<table>
<tr><td>None</td><td>0% severity</td></tr>
<tr><td>Minor</td><td>1% - 10% severity</td></tr>
<tr><td>Moderate</td><td>11% - 30% severity</td></tr>
<tr><td>Major</td><td>31% - 50% severity</td></tr>
<tr><td>Significant</td><td>> 50% severity</td></tr>
</table></td></tr>
<tr><td>Methodology:</td><td>Observe the rails, girders, trusses, piers and abutments to determine the percentage of the structure covered with graffiti, moss, bird droppings, rust or other surface dirt. Check the appropriate box on the form.</td></tr>
</table>

Table 212 Washington DOT. Level-Of-Service Thresholds for Bridge Deck Repair (308)

Activity Number:	4A1
Activity Name:	Bridge Deck Repair
Outcome Unit:	% Def.
Survey Period:	Summer
Detail Level:	Area/Section
Indicator:	Unrepaired deck spalling of 6" or greater on the bridge deck
Outcome Measure:	Percent of bridge deck with spalling.

Outcome Thresholds Service Level

A	B	C	D	F
0 - 0.0025%	0.0026 -0.015%	0.0151 - 0.05%	0.051 - 0.15%	0.151 -0.3%

Comments:	SF of spalling on the bridge deck obtained from BPO inspection reports. Total deck SF from the bridge inventory.
Priority Rank	13
Data Source	Bridge inspection reports, via BPO

Table 213 Washington DOT. Level-Of-Service Thresholds for Structural Bridge Repair (308)

Activity Number:	4A2
Activity Name:	Structural Bridge Repair
Outcome Unit:	% Completed
Survey Period:	Summer
Detail Level:	Region
Indicator:	Priority 1 deficiencies identified on bridges.
Outcome Measure:	Percent of Priority 1 repairs completed.

Outcome Thresholds Service Level

A	B	C	D	F
100% - 90%	89% - 80%	79% - 65%	64% -50%	<50%

Comments:	Review bridge repair list for applicable Priority 1 repairs completed. Regions will also document Priority 1 repairs completed before making it on to the repair list. Includes emergent P1. Reporting time frame - repairs completed between July 1 through June 30 (fiscal year).
Priority Rank	7
Data Source	Bridge Repair List and Regional emergent repair lists. MPET will be queried for those regions using it for management. Remaining regions will be expected to provide data.

Table 214 Washington DOT. Level-Of-Service Thresholds for Bridge Cleaning (308)

Activity Number:	4A3
Activity Name:	Bridge Cleaning
Outcome Unit:	Score
Survey Period:	Summer
Detail Level:	Area/Section
Indicator:	Dirty bridge surfaces and sidewalks, blocked bridge drains, graffiti
Outcome Measure:	Condition score. Sum of Deck/Sidewalks, Bridge Drains and Graffiti condition ratings. See MAP Bridge Survey Form and scoring matrix.

Outcome Thresholds Service Level

A	B	C	D	F
0 - 4	5 - 7	8 - 10	11 - 13	14 - 16

Comments:	
Priority Rank	31
Data Source	Maintenance Bridge Surveys

Deck Preservation

Washington State DOT defines types of protection for bridge decks (310)(Table 215).

Table 215 Washington DOT. Types of Protection of Bridge Decks

Type	Description
Type 1	Minimum 2½" of concrete cover over top bar of deck reinforcing for cast-in-place decks. Cover includes a ½" wearing surface and ¼" tolerance for placement of reinforcing steel. Both top and bottom mat of deck reinforcing shall be epoxy-coated.
Type 2	Overlay, using one among: 1½" Modified Concrete Overlay ¾" Polyester Modified Concrete Overlay 1½" Rapid Set Latex Modified Concrete Overlay ½" Thin Polymer Overlay
Type 3	HMA plus waterproofing membrane
Type 4	Minimum 5" cast-in-place (CIP) topping with one mat of epoxy coated reinforcement on prestressed concrete slab girder and deck girder members connected with grouted keyways. Minimum concrete cover of 1" to top mat of top flange of prestressed member. Epoxy coating of prestressed member top mat reinforcement is not required.
Type 5	Deck is constructed with a 1¾" concrete cover. Both top and bottom mat of deck reinforcing are epoxy-coated. Deck is then scarified ¼" prior to placement of 1½" modified concrete overlay

Washington State DOT has standard specifications (309) for

- Bituminous Surfacing on Structure Decks (Section 6-08)
- Concrete Deck Repair (Section 6-08.3(7))
- Ultra-Low Viscosity, Two-Part Liquid, Polyurethane-Hybrid Polymer Concrete (Section 6-08.3(7)B)
- Pre-Packaged Cement Based Repair Mortar (Section 6-08.3(7)C)

- Waterproof Membrane for Structure Decks (Section 6-08.3(8))
- Modified Concrete Overlays (Section 6-09)
- Concrete Overlay Mixes (Section 6-09.3(3))
- Fly Ash Modified Concrete (Section 6-09.3(3)C)
- Microsilica Modified Concrete (Section 6-09.3(3)D)
- Latex Modified Concrete (Section 6-09.3(3)E)

West Virginia Division of Highways

Policy. Budgets.

Funding for highways is spent 22% on preservation and rehabilitation, 72% on bridge replacement, and 6% on widening and strengthening bridges (312).

Actions. Projects.

In a preservation project for 91 bridges along interstate 64 (311) West Virginia Division of Highways replaced deck expansion joints, placed latex modified concrete overlays, and installed cathodic protection systems.

Table 216 West Virginia DOH. Preservation Actions (311)

Action
Replace deck expansion joints
Latex modified concrete overlay
Cathodic protection

Methods, Procedures

WVDOH publishes performance standards for maintenance actions (313). Sections in performance standards are listed in Table 217. Performance standards, properly written, should provide information that answers a set of questions (314) (Table 218).

Table 217 West Virginia DOH. Sections in Performance Standards (313)(314)

Section
Activity Name:
Activity No:
Description and Purpose:
Materials:
Accomplishment:
Daily Production:
Productivity:
Work Methods and Technical Reference
Performance Criteria:
Crew Size:
Equipment:
General Notes
Reporting Notes
Planning Notes

Table 218 West Virginia DOH. Topics addressed in Performance Standards (314)

Topic in Performance Standard
What is the task?
Why perform the task?
When do you perform the task?
How do you perform the task?
What resources (labor, equipment and materials) are needed to perform the task?
What is the daily production to be expected?
How many man-hours to produce one unit (productivity)?

How to report the task when completed? Where can one find Technical References regarding the task? What are the recommended work methods?

Performance Measures

West Virginia tracks the condition of bridges and the percent of deck area on bridges that are structurally deficient (315). Both measures are for bridges on the national highway system.

Deck Preservation

West Virginia DOT has standard specifications (316) for

- Deck overlay using latex modified concrete
- Deck overlay using microsilica concrete

In its list of approved products (317), West Virginia DOT includes

Repair Materials for Portland Cement Concrete

MAPEI Corporation	Planitop 18
MAPEI Corporation	Planitop 18 (Extended) with Pea Gravel
MAPEI Corporation	Planitop 18 ES
MAPEI Corporation	Planitop 18 ES (Extended) with Pea Gravel
MAPEI Corporation	Planitop X
Euclid Chemical Co.	EucoSpeed
Euclid Chemical Co.	EucoSpeed MP
Euclid Chemical Co.	VersaSpeed 100
Euclid Chemical Co.	VersaSpeed LS 100
BASF Construction Chemicals	MasterEmaco T 1060 Rapid Mortar
BASF Construction Chemicals	MasterEmaco T 545 Rapid Mortar
BASF Construction Chemicals	MasterEmaco T 545HT Rapid Mortar
QUIKRETE	Commercial Grade FastSet Concrete Mix
QUIKRETE	Commercial Grade FastSet DOT Mix
QUIKRETE	Rapid Road Repair
Kaufman Products, Inc.	Duracrete II
Kaufman Products, Inc.	Duracrete II FT
Kaufman Products, Inc.	Duracrete II VOFT
Kaufman Products, Inc.	HiCap FT
ChemMasters	ChemSpeed 75
Sika Corporation	SikaQuick VOH
Sika Corporation	SikaQuick 1000
Western Material & Design	Fastrac 246
United States Gypsum Co. (USG)	EcoFix
United States Gypsum Co. (USG)	EcoFix (Extended)
United States Gypsum Co. (USG)	EcoFix Xtend
United States Gypsum Co. (USG)	EcoFix AG5000
United States Gypsum Co. (USG)	EcoFix AG5000 (Extended) with Pea Gravel

Wisconsin Department of Transportation

Definitions.

Wisconsin DOT defines terms in bridge preservation and maintenance (Table 219) (318). Notable among Wisconsin's definitions:

- Routine maintenance is a regular, usually annual, set of actions. Actual events are scheduled about one month in advance. Routine maintenance is anticipated.
- Corrective maintenance is repair of moderate cost within the capabilities of maintenance crews. Corrective maintenance is as-needed, and not anticipated.
- Preventive maintenance retards deterioration. At Wisconsin, DOT preventive maintenance is performed by contractors.

Table 219 Wisconsin DOT. Definitions (318)

Term	Definition
Routine Maintenance	This category consists of work that is planned, scheduled, and performed on a regular, often annual, basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service. It consists of day-to-day activities typically scheduled on a short time horizon, up to a month in advance; by maintenance personnel to maintain not enhance the current condition or level of service of the highway system. If an immediate repair is involved, they are small-scale or isolated distresses where the remedy retards further deterioration or restores a safe condition.
Corrective Maintenance	These maintenance activities cannot be anticipated with any certainty in advance. It is in response to unplanned or unforeseen events or conditions of accelerated deterioration. Corrective maintenance actions are only performed on an as-needed basis. County forces may perform corrective maintenance operations if the repair costs are not prohibitively high and the nature of the necessary repair work allows.
Preventive Maintenance	These are planned asset management strategies that add system service life by retarding future deterioration and are delivered as programmed or scheduled projects. Because the work is scheduled and eligible for federal funding, it is always let to private contractors.

Policy.

Eligibility, Selection.

Wisconsin DOT provides guidance to selection of preservation actions in relation to current condition of bridges and desired outcome of actions (320). Guidance is provided for bridge decks (Table 220) and for other components (Table 221).

Table 220 Wisconsin DOT. Selection of Actions for Bridge Decks (320)

NBI Item 58	Deck Element Distress Area (%)	Preservation Activity	Benefit to Deck from action	Application Frequency (in years)
≥7		Deck Sweeping/Washing	Extend Service Life	1 to 2
		Crack Sealing	Extend Service Life	3 to 5
		Deck Sealing	Service life extended	3 to 5

NBI Item 58	Deck Element Distress Area (%)	Preservation Activity	Benefit to Deck from action	Application Frequency (in years)
		Polymer Modified Asphalt Overlay	Service life extended	12 to 15
		Polymer Overlay	Service life extended	8 to 12
=6		Deck Sweeping/Washing	Extend Service Life	1 to 2
	<20%	Crack Sealing	Extend Service Life	3 to 5
		Deck Sealing	Service life extended	3 to 5
	<5%	Deck Patching	Service life maintained	As needed
		Deck Patching, Cathodic Protection	Extend Service Life	As needed
	<10%	HMA w/ membrane	Improve NBI (58) ≥ 7	8 to 12
	<20%	Polymer Modified Asphalt Overlay	Improve NBI (58) ≥ 7	12 to 15
		Concrete Overlay	Improve NBI (58) ≥ 7	12 to 30
=5	<20%	Deck Patching	Service life maintained	As needed
		Deck Patching, Cathodic Protection	Extend Service Life	As needed
	20 to 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 30
		Structural Concrete Overlay	Improve NBI (58) ≥ 7	12 to 30
≤ 4	<40%	Deck Replacement	Improve NBI (58) = 9	25 to 50

Table 221 Wisconsin DOT. Selection of Actions for Bridge Components (320)

NBI Item	Element	NBI Criteria	Defect	Element Defect Condition State Criteria	Repair Action	Potential Benefits to NBI or CS	Anticipated Service Life Years
Deck	Joints	Item 58 ≥5	2350	CS2, CS3, or CS4	Joint Clean	CS1or CS2	
			2310		Joint Seal Replace, Restore	CS1	5 to 8
			2310 or 2360	CS3 + CS4 ≥ 10%	Joint Replace	CS1	10 to 20
				All	Joint Eliminate	Eliminate	15 to 25
	Railing	Item 58 ≥5		CS3 or CS4	Railing Restore	CS1 or CS2	3 to 10
					Railing Replace/Retrofit	CS1	10 to 20
Super	Steel Elements	Item 59 ≥5		N/A	Superstructure Wash/Clean	NA	1 to 2
			3440	CS2 + CS3 Area > 5%	Paint - Spot	CS1	1 to 5
				CS3 Area ≤ 25%	Paint - Zone	CS1	5 to 7
				CS3 Area ≥ 25%	Painting - Complete	CS1	15 to 20
		Item 59 ≥4		CS2, CS3, or CS4	Superstructure Restoration	NBI ≥ 7	5 to 20
	Bearings	Item 59 ≥5		CS3 or CS4	Bearing Reset/Repair	CS1 or CS2	1 to 5

NBI Item	Element	NBI Criteria	Defect	Element Defect Condition State Criteria	Repair Action	Potential Benefits to NBI or CS	Anticipated Service Life Years
				CS2 or CS3	Bearing Clean/Paint	CS1 or CS2	5 to 7
				CS3 or CS4	Bearing Replace	CS1or CS2	10 to 15
Sub		Item 60 ≥5		N/A	Substructure Wash/Clean	NA	1 to 2
			3440	CS2+CS3+CS4 Area > 5%	Paint - Spot	CS1	1 to 5
				CS3 Area > 25%	Paint - Complete	CS1	10 to 20
				CS2 or CS3 or CS4	Substructure Restore	NBI ≥ 7	5 to 20
			9290	CS1 or CS2	Pier Protect	NBI ≥ 7	5 to 20
				CS3 or CS4	Scour Counter Measure	NBI ≥ 7	5 to 20

Forecast.

Wisconsin DOT estimates the needs for bridge work through year 2030 (319). Needs expected:

- 2,900 bridges will need deck overlays
- 550 bridges will need deck replacements
- 700 bridges will need to be replaced

Actions

Wisconsin DOT lists actions in routine maintenance, corrective maintenance and preventive maintenance (Table 222) (318).

Table 222 Wisconsin DOT. Actions in Routine, Corrective and Preventive Maintenance (318)

Routine Maintenance	Corrective Maintenance	Preventive Maintenance
--- Approach ---		
Approach slab foam jacking or mud jacking	Approach slab replacement	
Approach slabs repair		
--- Deck ---		
Deck sweeping and power washing of decks	Asphalt overlays without membrane installation	Asphalt overlays with membrane installation
Clean expansion joints	Epoxy overlays	Epoxy and polymer overlays
Concrete deck sealing	Thin deck overlays and membrane installation	Concrete deck repair, patching and concrete overlays
Crack sealing	Major joint replacement	Expansion joint replacement when done in conjunction with an overlay or expansion join elimination
Spot deck repair		Chloride extraction
Repair of epoxy overlays		Installation of a cathodic protection system
Minor joint repair or replacement		
Railing repair		

Routine Maintenance	Corrective Maintenance	Preventive Maintenance
Curb or sidewalk repair		
--- *Superstructure & Substructure* ---		
Power washing of superstructure and substructure units	Bearing repair or replacement	Steel structure cleaning and repainting, including complete repainting, zone painting, and spot painting with overcoat
Removal of loose/falling concrete	Removal of loose/falling concrete	Bearing repair or replacement
Concrete surface repair, with or without cathodic protection	Concrete surface repair with cathodic protection	Structural repairs (except vehicle damage)
Minor repair of substructures and superstructures, including spot painting	Wing wall replacement	
Bearing repair or replacement	Urgent bridge repair	
--- *Channel* ---		
Clearing brush and unwanted vegetation around structures	Repair deck drains/downspouts	Rip placement (large quantity or deep channel)
Debris removal from waterway	Repair inlets off of bridge	
Clean deck drains/downspouts	Construct drainage flumes	
Clean/repair inlets off of bridge	Slope protection installation and repair	
Placing riprap (small quantity or shallow channel)	Slope paving repair	
Slope paving repair		
Traffic control for structure/bridge inspection		
Operation and maintenance of movable bridges		
Ferry operations and maintenance including approaches		
Repair/replace utilities or signs		

Intervals for Actions

Wisconsin DOT lists intervals for actions (Table 223) (320).

Table 223 Wisconsin DOT. Intervals for Actions (320)

Bridge Component	Bridge Preservation Type	Activity Description	Preventive Maintenance Type	Action Frequency (years)
All	Preventive Maintenance	Sweep, power wash, clean	Cyclical	1-2
Deck	Preventive Maintenance	Deck wash	Cyclical	1
		Deck Sweep		1
		Deck Seal/Crack Seal		4-5
		Thin polymer (Epoxy) overlays		10
		Drainage clean/repair		As needed
		Joint clean		As needed
		Deck Patch	Condition Based	1- 2

Bridge Component	Bridge Preservation Type	Activity Description	Preventive Maintenance Type	Action Frequency (years)
		Chloride extraction		1 -2
		Asphalt overlay with membrane		12-15
		Polymer modified Asphalt overlay		6-12
		Joint seal replace		10
		Drainage clean/repair		1
	Repair or Rehab Element	Rigid concrete overlays	Condition Based	As needed
		Structural Reinforced concrete overlay		
		Deck joint replace		
		Eliminate joints		
Super	Preventive Maintenance	Bridge approach restore	Cyclical	2
		Seat and beam ends washing		2
	Repair or Rehab Element	Bridge rail restore	Condition Based	As needed
		Retrofit rail		
		Painting		
		Bearing restore (replace, clean, reset)		
		Superstructure restore		
		Pin and hanger replace		
		Retrofit fracture critical members		
Sub	Preventive Maintenance	Substructure Restore	Condition Based	As needed
		Scour Counter Measure		
		Channel Restore		

Performance Measures

Wisconsin DOT tracks the percentage of deck area of state-owned bridges that is in fair or better condition (322). Wisconsin measures the accuracy of engineering cost estimates for projects (323). Accuracy is acceptable if project cost is within 10% of estimated cost. For bridge work, performance is currently 48%. For bridge painting, performance is 31%.

Wisconsin DOT sets targets for bridge performance measures (Table 224) (320).

Table 224 Wisconsin DOT. Performance Measures for Bridge Preservation (320)

Objective	Target/Goals	Performance Measure
Maintain bridges in good or fair condition	95% of bridges	Percentage of bridge in good or fair condition (NBI rating 5 or higher)
Maintain bridge decks in good or fair condition	95% of bridge decks	Percentage of bridge decks in good or fair condition (NBI Rating 5 or higher)
Maintain expansion joints in condition state 2 or better	90% of the overall length of expansion joints	Percentage of strip seal joints (based on overall length) in condition state 2 or better

Objective	Target/Goals	Performance Measure
Maintain coated steel surfaces in condition state 2 or better	90% of coated steel surfaces	Percentage of coated steel surfaces in condition state 2 or better
Maintain bearings in condition state 2 or better	95 % of bearings in condition state 2 or better	Percentage of bearings in condition state 2 or better
Seal eligible concrete decks (NBI rating 6 or higher) with sealant every 4 years	Seal 25% eligible concrete decks	Number of decks sealed (sq. ft of deck area) each year during a 4 year period

Contract Maintenance.

Wisconsin DOT requires the rating of performance by contractors for most contract work (321). Some work for actions in bridge preservation are excluded from rating. These include (Table 225)

Table 225 Wisconsin DOT. Contract Work Not Rated for Performance (321)

Action/Performance not Rated
Chip seal
Crack seal
Bridge painting
Bridge overlay

Deck Preservation

Wisconsin DOT provides guides on use of overlays for decks (324)(Table 226).

Table 226 Wisconsin DOT. Use of Overlays for Decks

AC Overlay (ACO)	5 years average life expectancy. Minimum asphaltic overlay thickness is 1-1/2”. Grade change due to overlay thickness can be accommodated at minimal cost. Deck or bridge replacement is programmed within 7 years. Raising of floor drains or joints is not required. Spalls can be patched with AC or PC concrete with minimal surface preparation.
Polymer Modified Asphaltic Overlay	15 to 20 years life expectancy May be used as an experimental alternate to LSCO given below. Caution - core tests have shown the permeability of this product is dependent on the aggregate. Limestone should not be used.
Polymer Overlay	10 to 15 years life expectancy 1/4-inch thick, two layer system comprised of a two-component polymer in conjunction with natural or synthetic aggregates. Use 5 psf for dead load, DW. Works well to seal decks and/or provide traction. Minimum required concrete age is 28 days prior to application, although a longer period of time would allow more initial concrete cracking to occur which the resin would then be able to seal.
Low Slump Concrete Overlay (LSCO)	15 to 20 years life expectancy Minimum thickness is 1-1/2” pc concrete overlay. Joints and floor drains will be modified to accommodate the overlay. Deck deficiencies will be corrected with pc concrete. Prepared deck surfaces will be scarified or shot blasted.

	There is no structural concern for excessive leaching at working cracks. Combined distress area is less than 25%. May require crack sealing the following year and periodically thereafter.

Wisconsin DOT has standard specifications for

- Concrete overlays (325)(326)
- Membrane waterproofing (327)

Wisconsin DOT has special provisions (328) for

- Stp-502-015 crack sealing epoxy, item 502.0717.s
- Stp-502-025 ruptured void repair (for voided slabs), item 502.4200.s
- Stp-502-055 protective surface treatment reseal, item 502.3215.s
- Stp-509-005 removing concrete masonry deck overlay, item 509.9005.s
- Stp-509-010 removing asphaltic concrete deck overlay, item 509.9010.s
- Stp-509-030 polymer overlay, item 509.510.s
- Stp-509-035 HMA overlay polymer-modified, Item 509.3500.s
- Stp-509-060 concrete masonry deck repair, Item 509.2100.s
- Stp-509-065 cleaning decks to reapply concrete masonry overlay, Item 509.0505.s
- Stp-509-070 sawing pavement deck preparation areas, item 509.0310.s
- Stp-526-060 sheet membrane waterproofing, item 516.0600.s
- Rapid Set Deck Repair (329)
- Concrete Masonry Overlay Silica Fume Modified (330).
- Embedded Galvanic Anodes (331)
- Polyester Polymer Concrete Overlay

Wisconsin DOT has an agency-developed bridge element for prestressed concrete slabs (335). Wisconsin has agency-developed defects for chloride concentration, and connections of precast concrete panels. Wisconsin DOT relates deck defects to general condition ratings (336)(Table 219).

Table 227 Wisconsin DOT. Deck Defects and General Condition Ratings

DECK RATING	CRACKING	SCALING	SPALLING	DELAM.	ELECTRICAL POTENTIAL (VOLTS)	CHLORIDE CONTENT (LB/CY)
9	None	None	None	None	0	0
8	Minor Transverse	None	None	None	None >0.35	None >2.0
7	Sealable	Light	None but visible tire wear	None	10% >0.35	10% >2.0
6	Excessive (open cracks @ 5-foot maximum spacing)	Medium	<2%	<5%	10 - 20% >0.35	10 - 20% >2.0
5	Excessive	Heavy	2 - 5%	5 - 20%	20 - 40% >0.35	20 - 40% >2.0
4	Many full depth failures present or imminent; leaching			>20%	Over 60% >0.35	Over 60% >2.0
3	Many full depth failures present or imminent; leaching					
2	Full depth failures over much of deck					
1	Bridge Closed. Corrective action may put back in service					

0	Bridge Closed. Replacement necessary		

Among approved products, Wisconsin DOT lists

Concrete Protective Surface Treatment (333)

Advanced Chemical Technologies Inc	SIL-ACT ATS-42 NS
Chemmasters	Aquanil Plus 40
ChemRex, Inc	Sonneborn Penetrating Sealer 40 VOC .
ChemRex, Inc.	Hydrozo Enviroseal 40
ChemRex, Inc.	Hydrozo Silane 40 VOC
ChemRex, Inc.	Masterseal SL40 VOC
Degussa Aerosil and Silanes	Chemtrete BSM 40 VOC
Euclid Chemical Company	Baracade Silane 40
TK Products	TK-590-1 MS
TK Products	TK-590-90
Universal Form Clamp Co	Silane Sealer Plus
Vexcon Chemical	Penseal 244 40%
Vexcon Chemical	Powerseal 40%

Rapid Setting Concrete Patch Material (334)

Bindan Corporation	Monopatch
CTS Manufacturing	DOT Repair Mix
Dayton Superior	HD-50 Heavy Duty Concrete Patch
Dayton Superior	Pave Patch 3000
Five Star Products, Inc.	Five Star Highway Patch
Quikrete Companies	Commercial Grade FastSet DOT Mix
Quikrete Companies	Rapid Road Repair
Sika Corporation	SIkaQuick 2500
SpecChem LLC	RepCon 928
U.S. Gypsum	Duracal

Wyoming Department of Transportation

Policy

Wyoming DOT identifies preservation projects as design strategies to extend service life, and as maintenance strategies identified in WyDOT's bridge management system (337) (338) (339). The program for interstate preservation provides of the preservation or maintenance of existing bridge structures consistent with outputs of the bridge management system.

Evaluations of bridges for interstate highways for NHS highways and for non-NHS arterial highways differ in the controlling design criteria. Lesser lane widths, lesser vertical clearance, and lesser live load capacity are allowed for non-NHS bridges compared to NHS bridges, and for NHS bridges compared to interstate bridges.

WyDOT will rehabilitate or replace a bridge on the interstate system, and not preserve or maintain it, when the bridge does not meet controlling design criteria, or when bridge elements are in an advanced state of deterioration. Rehabilitation and replacement improve bridges (sometimes as new bridges).

Performance Measures

WyDOT tracks the condition of bridges in excellent or good condition as a performance measure. Performance targets are at least 46% of bridges in excellent or good condition on NHS routes and at least 56% of bridges in excellent or good condition on non-NHS routes.

Deck Preservation

Wyoming DOT has standard specifications (342) for

- Silica fume modified concrete bridge deck repair (Section 515)
- Epoxy resin injection (Section 627)
- Concrete patching material (Section 810)
- Epoxy resin (Section 810)

Among qualified products (341), Wyoming DOT lists

Horizontal Concrete Repair Products

Dayton Superior	HD-50
Dayton Superior	Pave Patch 3000
Dayton Superior	Sure Patch
Dayton Superior	Rapid Resin Repair
Five Star Products	Five Star Structural Concrete
Five Star Products	Five Star Structural Concrete ES
Sika Corporation	SikaQuick 1000
Sika Corporation	SikaQuick 2500
Sika Corporation	Sikacrete 321 FS
Sika Corporation	Sikatop 122 Plus Mortar
Thoroc (Degussa)	10-60 Rapid Mortar
Thoroc (Degussa)	10-61 Rapid Mortar
Tamms	Speedcrete 2028
Tamms	Duralflex Fastpatch
Unitex	Pro-Poxy 2500
Unitex	ProPoxy AWP

US Mix Products	Transpatch
US Mix Products	EPM 3000 NS
US Mix Products	Polypatch FR
US Mix Products	US Spec STR Mortar
US Mix Products	US Spec Transpatch Concrete
CTS Cement/Rapid Set	DOT Repair Mix
CTS Cement/Rapid Set	Cement All
CTS Cement/Rapid Set	Concrete Mix

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