Peer Exchange Report on Corrosion Prevention and Mitigation for Highway Bridges

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16. Abstract

The US Government Accountability Office (GAO) report entitled *Highway Bridges - Federal Highway Administration Could Better Assist States with Information on Corrosion Practices* (GAO-21-104249) recommended that FHWA's ongoing bridge preservation efforts include activities, such as peer exchanges and case studies that focus on addressing the challenges States face with determining the circumstances under which specific corrosion practices and materials are most effective. In response to the GAO report, the FHWA conducted two regional peer exchanges: (1) for the Midwest States which have environments with arid conditions or that experience frequent freeze/thaw cycles and use de-icing chemicals on their highway bridges, and (2) for the Northeast, Southeast, and West States which have environments that experience freeze/thaw cycles or have highway bridges exposed to a saltwater environment. These peer exchanges focused on State practices and materials used that mitigate bridge corrosion. The results of the peer exchanges can be categorized as (1) actions States are undertaking to slowdown, reduce, and prevent corrosion from occurring to their existing bridges and (2) policy changes States are making to their design standards, details, and material specifications to eliminate root causes of corrosion.

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Acronym List

AASHTO:	The American Association of State Highway and Transportation Officials
DOT:	Department of Transportation
FDOT:	Florida Department of Transportation
FHWA:	Federal Highway Administration
GAO:	Government Accountability Office
GCR:	General Condition Rating
HDPE:	High-Density Polyethylene
HPC:	High-Performance Concrete
ILDOT:	Illinois Department of Transportation
INDOT:	Indiana Department of Transportation
IowaDOT:	Iowa Department of Transportation
KDOT:	Kansas Department of Transportation
LMC:	Latex-Modified Concrete
LSC:	Low-Strength Concrete
MDOT:	Michigan Department of Transportation
MnDOT:	Minnesota Department of Transportation
MODOT:	Missouri Department of Transportation
NCDOT:	North Carolina Department of Transportation
NDOT:	Nebraska Department of Transportation
NHI:	National Highway Institute
NYSDOT:	New York State Department of Transportation
OHDOT:	Ohio Department of Transportation
OKDOT:	Oklahoma Department of Transportation
ORDOT:	Oregon Department of Transportation
PennDOT:	Pennsylvania Department of Transportation
PPC:	Polyester Polymer Concrete
TxDOT:	Texas Department of Transportation
UHPC:	Ultra-High Performance Concrete
VDOT:	Virginia Department of Transportation

Executive Summary

In September 2021, the U.S. Government Accountability Office (GAO) issued report GAO-21-104249, "Highway Bridges - Federal Highway Administration Could Better Assist States with Information on Corrosion Practices." The GAO reviewed studies and spoke with various stakeholders including the Federal Highway Administration (FHWA), selected States and associations on the topic of bridge corrosion. The GAO found a significant relationship between bridge corrosion and bridge condition, and State practices to prevent and manage corrosion vary based on environmental factors and bridge condition. In its 2021 report, the GAO also noted that though FHWA helps States address corrosion through research and technical assistance, the efforts are generally focused on overall bridge condition and may not meet States' needs to determine the circumstance in which to use specific practices.

The GAO recommended that FHWA's ongoing bridge preservation efforts include activities such as peer exchanges and case studies to address the challenges States face with determining the circumstances under which specific corrosion practices and materials are most effective.

In response to the GAO report, FHWA conducted two regional peer exchanges: (1) for the Midwest States which have environments with arid conditions or that experience frequent freeze/thaw cycles and use de-icing chemicals on their highway bridges, and (2) for the Northeast, Southeast, and West States which have environments that experience freeze/thaw cycles or have highway bridges exposed to a saltwater environment. These peer exchanges focused on States' practices and materials used to mitigate bridge corrosion.

The results of the peer exchanges can be categorized as (1) State actions taken to slowdown, reduce and prevent corrosion from occurring to existing bridges, and (2) State policy changes to design standards, details, and material specifications which address some of the root causes of corrosion in new construction.

Primary preservation efforts of the Peer Exchange States start with bridge decks. Once corrosion begins in the deck, it can impact the entire structure, it is difficult to correct due to limited time to affect repairs, and deck corrosion has the most visible impact to users. The corrosion prevention actions being taken for existing concrete bridge decks by the Peer Exchange States are:

- Sweeping and washing bridge decks to remove potential corrosive agents (chlorides) applied for ice control during the winter season.
- Applying sealers to prevent, reduce and slow the infiltration of chloride laden water.
- Installing protective overlays, e.g., either thin epoxy overlays, polyester polymer overlays, rigid (thick) concrete overlays or asphalt overlays with a membrane.
- Replacing the bridge deck with corrosion resistant reinforcement, and using a concrete mix enhanced to minimize concrete porosity.

The corrosion prevention actions being taken during design of new decks by the Peer Exchange States are:

- Changing the concrete design mix to reduce the porosity of the concrete and reduce shrinkage cracking.
- Require the placement of a concrete deck sealer or calling for the installation of a protective overlay during the initial construction.
- Using non-corrosive reinforcement in the deck.

The Peer Exchange States stated that concrete barriers receive similar treatments as the concrete decks, whether existing or a new design, except they do not receive an overlay. Deck joints may also contribute to the corrosion of the bridge superstructure; therefore, the Peer Exchange States power wash existing deck joints and then reseal them to restore their watertightness. Some of the Peer Exchange States replace their existing deck joints with a concrete link-slab, eliminating the joint altogether. All the Peer Exchange States' new bridge designs feature no deck joints, or the minimal number required.

The corrosion prevention actions for existing superstructures and substructures by the Peer Exchange States are:

- Washing the superstructure and substructure, with special attention given to areas under deck joints and flat surfaces like pier caps and bridge seats.
- Removing corrosion (rust), repainting steel elements, and strengthening where section loss has decreased needed capacity. Strengthening may include concrete encasement of steel girder ends in superstructures and steel piles in foundation elements.
- Removing deteriorated concrete and patching, which may include the use of cathodic protection, and then sealing concrete elements, especially at the ends of beams and pier caps and bridge seats under deck joints, and other areas that may be exposed to salt spray like columns along the roadway.

The corrosion prevention actions being taken during the design of new superstructures and substructures by the Peer Exchange States are:

- Specifying steel elements with enhanced corrosion-resistant properties, e.g., weathering steel or galvanized/metalized steel, and proactively painting over the areas susceptible to corrosion such as expansion joints.
- Changing the concrete mix design to reduce the porosity of the concrete elements, or calling for corrosion-resistant reinforcement, or using materials not susceptible to corrosion in the concrete beam/girder.
- Proactively requiring the sealing concrete elements at known areas of high exposure.
- Configuring bridges without expansion joints, moving expansion joints beyond the bridge, or reducing the number of expansion joints in new designs.

While material research, at the State and Federal level, is driving many of the preservation actions being taken, both on existing structures and changes to bridge design policies, the peer exchange identified knowledge gaps and potential areas where additional research would be beneficial. The Peer Exchange States all cited the need for data that better describes and measures the specific benefits of the specific corrosion reduction/bridge preservation actions being undertaken.

Introduction: Summary of GAO Report & FHWA Response

In September 2021, the U.S. Government Accountability Office (GAO) issued report GAO-21-104249, "Highway Bridges - Federal Highway Administration Could Better Assist States with Information on Corrosion Practices."

The GAO reviewed studies and spoke with various stakeholders including the Federal Highway Administration (FHWA), selected States and associations on the topic of bridge corrosion. The GAO found there is a significant relationship between bridge corrosion and bridge condition, and State practices to prevent and manage corrosion vary based on environmental factors and bridge condition. In its 2021 report, the GAO also noted that though FHWA helps States address corrosion through research and technical assistance, the efforts are generally focused on overall bridge condition and may not meet States' needs to determine the circumstances in which to use specific practices.

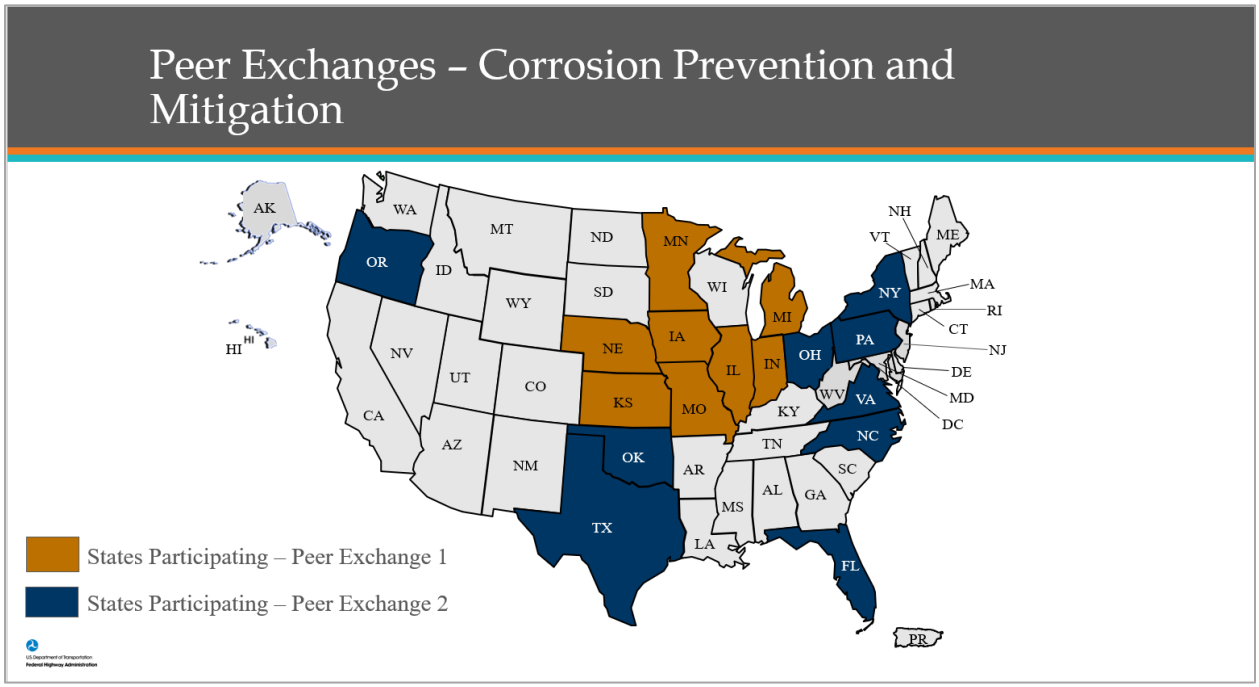
The GAO recommended that the FHWA's ongoing bridge preservation efforts include activities, such as peer exchanges and case studies to address the challenges States face with determining the circumstances under which specific corrosion practices and materials are most effective.

In its response to the GAO's report, FHWA cited several documents it has produced including the Bridge Preservation Guide, a Case Study on Eliminating Bridge Joints with Link Slabs, and a Case Study on Utilization of Cathodic Protection to Extend Service Life of Reinforced Concrete Bridges. The National Highway Institute (NHI), which is FHWA's training and education arm, offers several courses that provide direct and indirect information on ways to minimize and prevent corrosion from occurring on the Nation's bridges.

In response to the GAO report, FHWA conducted two regional peer exchanges: (1) for the Midwest States which have environments with arid conditions or that experience frequent freeze/thaw cycles and use de-icing chemicals on their highway bridges, and (2) for the Northeast, Southeast, and West States which have environments that experience freeze/thaw cycles or have highway bridges exposed to a saltwater environment. These peer exchanges focused on States' practices and materials used to mitigate bridge corrosion.

Peer Exchange Process

Two peer exchanges were held in December 2022 and March 2023. The first peer exchange was held in Minneapolis, MN; State departments of transportation (State DOTs) from Iowa, Nebraska, Kansas, Missouri, Michigan, Indiana, and Minnesota participated. Illinois DOT responded to the questionnaire, but was unable to attend the meeting in Minneapolis. The second peer exchange was held in Orlando, FL; State DOTs from New York, Pennsylvania, Ohio, Virginia, North Carolina, Oklahoma, Texas, Oregon, and Florida participated. The Midwest States were selected based on the frequency of freeze-thaw cycles and the use of de-icing chemicals on their highway bridges. The States from the Northeast, Southeast, and West were selected based on the frequency of freeze-thaw cycles or the exposure of their highway bridges to saltwater.



Source: FHWA

Figure 1. Selected Peer Exchange State DOTs

The purpose of the peer exchanges was to identify bridge corrosion prevention and mitigation needs and exchange practices between the State DOTs and FHWA. The scope of the peer exchanges included representation by State DOTs bridge design engineers and bridge maintenance engineers who understand the broader scope of their State's bridge corrosion prevention and mitigation practices, as well as contemporary bridge design techniques for enhanced durability.

Prior to the peer exchanges, the selected States were asked to respond to a questionnaire to gain a better understanding of the following:

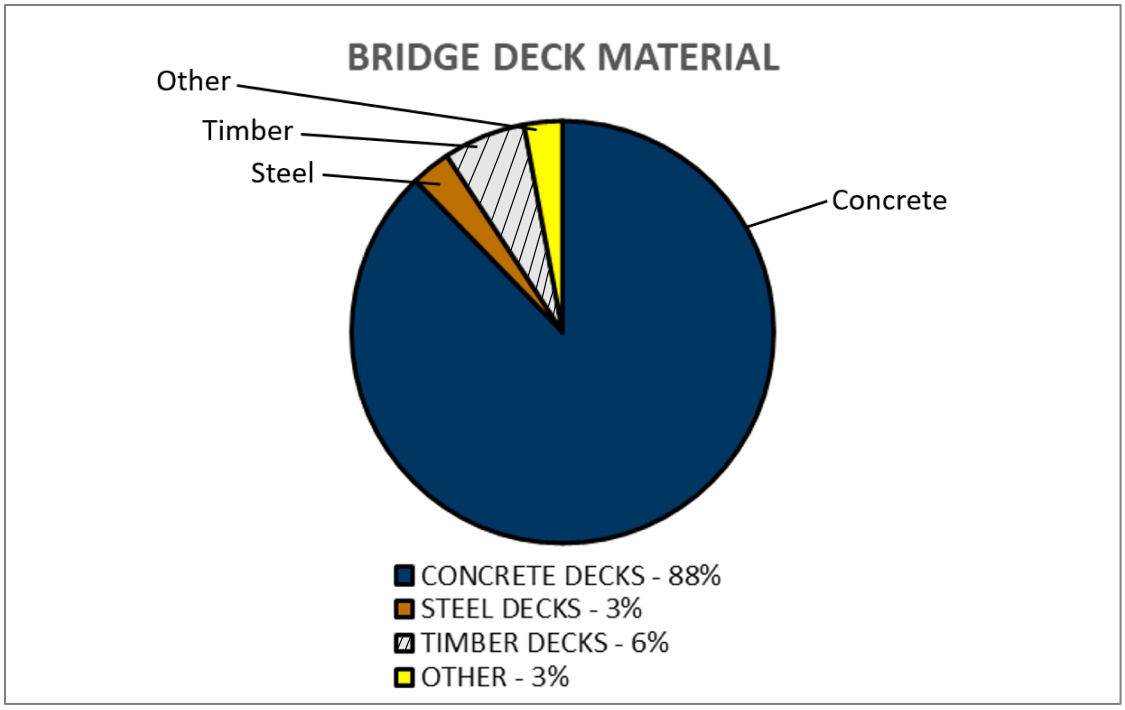
- Inventory of their NHS bridges.
- Type(s) of data they are collecting to identify and address corrosion issues.
- Actions they take to remediate the corrosion and the effectiveness of those actions.
- Design policies and procedures they follow to minimize/prevent corrosion from occurring in the future.
- Research they are undertaking on this topic.

The questionnaire is provided in Appendix B, and the State's responses are provided in Appendix C. Prior to each of the peer exchanges, a half-day virtual meeting was held with all the State participants. For the virtual meeting, each State DOT made a presentation providing certain base-line data concerning:

- Organizational structure.
- Number of bridge assets managed.
- Agency challenges.
- Agency successes.
- Future endeavors with respect to corrosion prevention.
- Mitigation methods used for existing/in-service bridges.
- Challenges, successes, and future endeavors for new bridges under design (i.e., design standards and policies).

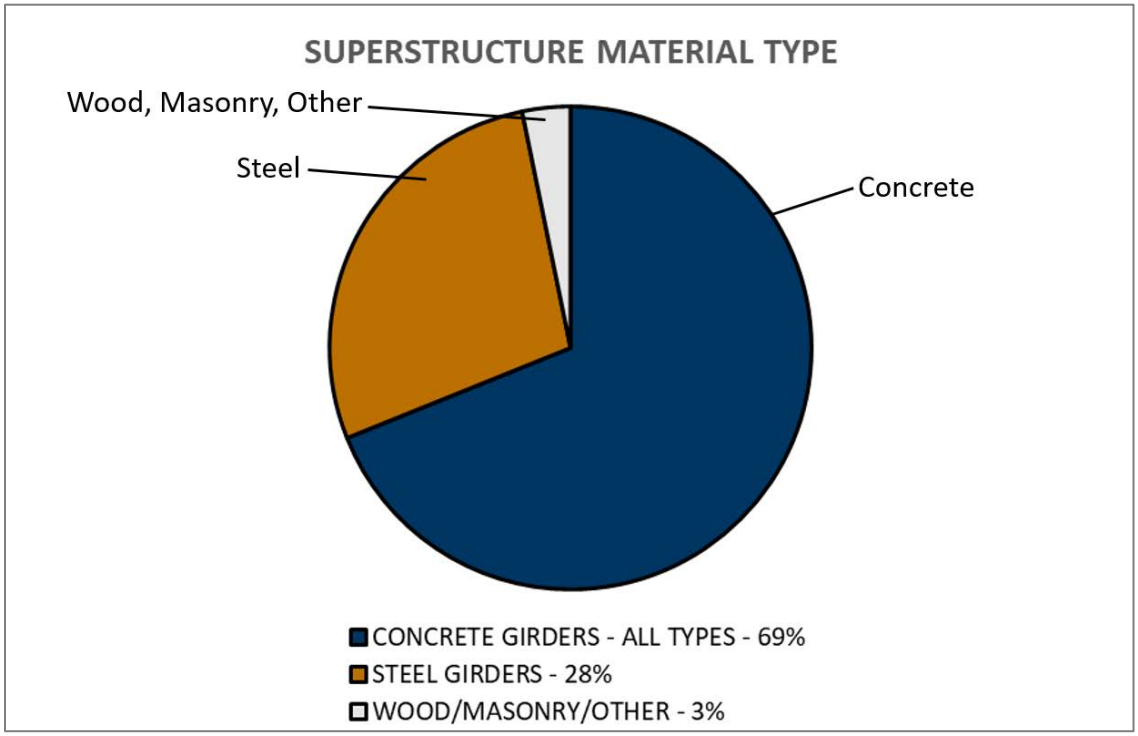
Upon conclusion of the virtual meeting, and prior to the in-person peer exchanges, a topic survey form was sent to each State DOT to finalize the in-person agenda (Appendix A). This allowed each State DOT to select the peer exchange topics for discussion. Based on the feedback received from the State DOTs and FHWA's InfoBridge data shown in Figure 2 and Figure 3, peer exchange agendas focused on corrosion in:

- Concrete bridge decks.
- Steel and concrete superstructures.
- Steel and concrete substructures.



Source: FHWA

Figure 2. Bridge Deck Material Type (2022 NBI Data)



Source: FHWA

Figure 3. Bridge Superstructure Material Type (2022 NBI Data)

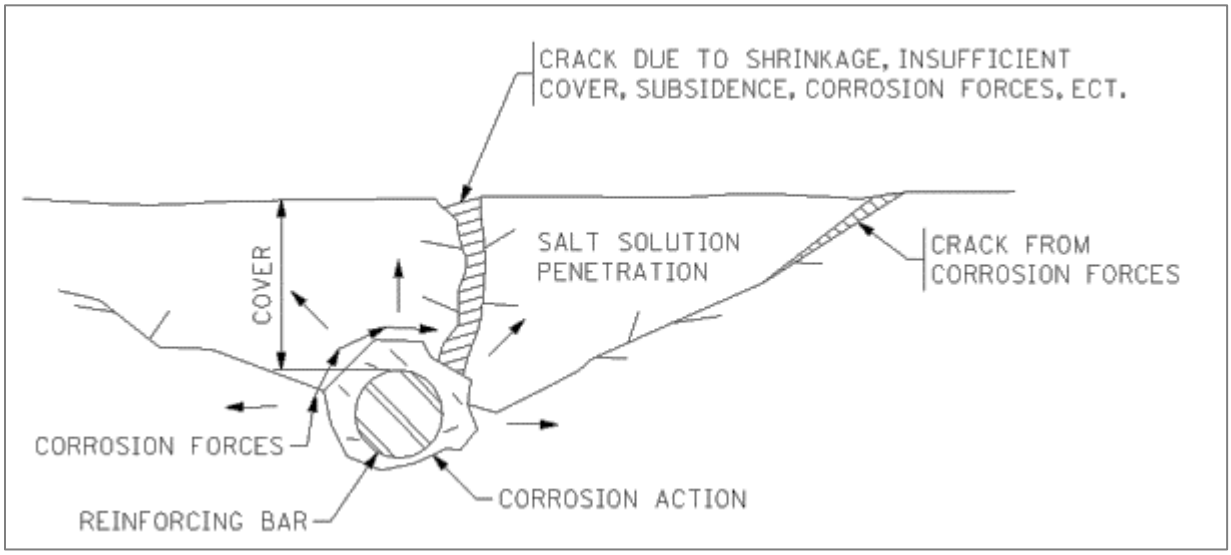
Peer Exchange Findings

The peer exchange findings are grouped by the major components of the bridge: deck, superstructure, and substructure. There was some overlap in the findings because all concrete components tend to have similar corrosion issues; however, as learned during the peer exchanges and as outlined below, the bridge owners were not unanimous in the tactics they chose to address these corrosion issues. Also, as learned in the peer exchanges and as outlined in the report below, there are different strategies being employed by bridge owners on their existing in-service bridges versus design policies/standards that are being used in new bridges currently in design. Therefore, the findings discuss existing in-service bridges first and then future bridge design(s) second.

I. Strategies for Existing Bridges

1. Bridge Decks

Corrosion of reinforced concrete decks typically occurs in the steel reinforcement at the steel/concrete interface when water and chlorides permeate the concrete to the reinforcement surface. The voluminous corrosion product pushes outward as it is formed, causing the concrete to spall.



Source: MnDOT

Figure 4. Deck Corrosion Sketch, MnDOT Bridge Maintenance Manual Section 4.2.1, pg. 4-19

1.a. Bridge Deck Sealing

The Peer Exchange States agreed that a primary method to prevent deck corrosion is by reducing the chloride and water ingress to the steel reinforcement. This is achieved by sealing the concrete surface with sealers such as silanes or siloxanes, methyl methacrylate, or adding

an impenetrable overlay. The amount and size of the deck cracking also determines which sealer or overlay is used. For example, a smaller crack density typically calls for a silane or siloxane sealer.

Table 1. State DOT Deck Sealing Practices

Agency	Practice	Condition	Source
ILDOT	Seal Deck Every 4 Years	Deck GCR NBI > 5 and 100% CS 1 or CS 2	Bridge Preservation Guide.pdf (illinois.gov) pg. 5
INDOT	Seal Deck Every 5 Years	Deck GCR NBI > 5	Chapter 412 (in.gov) pg. 48 Fig. 412-1A
MDOT	Seal Deck Every 5 Years	Deck GCR NBI > 5 and < 10% defects	Deck Matrix Uncoated 2021 (michigan.gov) Deck Matrix ECR 2021 (michigan.gov)
MnDOT	Seal Deck Every 5 Years	Based on crack width and crack density	Bridge Maintenance Manual - Ch. 4
OHDOT	Seal Deck Every 5 Years	Based on Inspector judgement & photo examples in the Ohio DOT Bridge Maintenance Manual	Bridge Maintenance Manual (ohio.gov) pg. 72 - 74

NCDOT, FDOT, TxDOT, and KDOT seal their bridge decks on a bridge-by-bridge basis. Their decisions are informed by crack sizes, crack density and overall condition of their bridge decks. NYSDOT and OKDOT seal their bridge decks when they are new, and then proceed with overlays as a routine preservation treatment. VDOT, ORDOT, PennDOT, NDOT, and IowaDOT protect their existing bridge decks with overlays.

Salt is heavily used by State DOTs to eliminate icing of roadways and bridges. The chlorides, found in salt, are a primary cause of steel corrosion. Resultantly, several of the Peer Exchange States have a preservation policy to clean their bridge decks every spring, usually by washing. From the MnDOT Bridge Maintenance Manual, Section 4.1.1.1 Criteria and Frequency:

> *Bridges are typically flushed in the spring after snow and ice season to remove de-icing salt that can lead to corrosion and debris…*

Several of the Peer Exchange States use power washing in conjunction with, and immediately preceding, the sealing of a bridge deck.

1.b. Bridge Deck Patching and Overlays

When corrosion-induced spalling is evident on a bridge deck, a common preservation practice is to remove all the deteriorated concrete and patch the deck. To reduce future corrosion and recurrence of spalling, State DOTs will remove the concrete below the reinforcing steel to increase the integrity of the patch on the existing deck. The construction specifications of the

Peer Exchange States require all rust to be removed from the exposed reinforcing steel, and, if it was originally epoxy coated, to touch up the epoxy coating before the patch is placed.

NYSDOT, MnDOT, MDOT, OHDOT, and VDOT add cathodic protection anodes around the edges of the concrete patch to eliminate the occurrence of what is known as "halo" deterioration. This type of deterioration occurs when the newly placed concrete patch material creates a chemical imbalance with the existing deck concrete material, and spalling results in the area immediately adjacent to the patch. Placing the cathodic protection anodes, or "pucks", in a patch is another way to deter the corrosion of the bridge deck reinforcement and resulting deterioration of the concrete deck.

Source: NYSDOT

Source: Ohio DOT

Figure 5. Photos of spall repair cleaned and ready for patching (left photo) and of a spall repair cleaned and with cathodic protection anodes wired to the reinforcement (right photo).

For decks exhibiting advanced deterioration, defined as deterioration typically greater than 15 to 20 percent of the bridge deck area, sealers and patching typically are no longer useful for deck protection. In these cases, the Peer Exchange States opt to overlay the entire bridge deck to resist corrosion. Prior to placing an overlay, all the unsound concrete is removed, which is typically accomplished in the Peer Exchange States by milling and hydro-demolition of the deck surface. Once the surface has been adequately prepared, the Peer Exchange States choose from a variety of rigid cementitious concrete overlays. Overlay types include latex-modified concrete, low slump concrete, supplemental cementitious material concrete, and ultra-high performance concrete.

Among the Peer Exchange States, NDOT was the only one which did not use any of the various types of concrete overlays. NDOT proactively installs a membrane and an asphalt overlay as a deck protective system is used proactively before a deck has deteriorated. This type of deck protective system is used by several State DOTs in the Northeast, which were not part of the peer exchange, including CTDOT (Section 8.2 Bridge Design Manual) and MEDOT (Section 4.6 Bridge Design Guide.

Source: NDOT

Figure 6. Photo of a concrete bridge deck showing membrane in place (middle lane) and overlay being placed on top (right lane).

A polyester polymer concrete (PPC) overlay is another type of overlay that provides corrosion protection to bridge decks. The primary advantage of the PPC overlay is ease of deck preparation and rapid placement of the PPC. The application of the PPC overlay is typically scheduled so that it does not interfere with morning or evening rush hour traffic. ORDOT uses this method extensively to protect its bridge decks from corrosion. TxDOT identifies this type of overlay as a Multi-layer Polymer Overlay (MLPO) which they also use.

Source: ORDOT Source: ORDOT

Figure 7. Photo of a milled deck receiving a high molecular weight methacrylate primer (left photo) and a PPC overlay being placed and finished (right photo).

Table 2. State DOT Deck Overlay Practices

Agency	Practice	Thickness	Sample Source*
NDOT, PennDOT, NYSDOT, OKDOT, OHDOT, VDOT	Asphalt Overlay with Membrane	1.75 in.- 2+ in.	Section 3.1.10 from https://dot.nebraska.gov/media/cpodk45c/bopp-manual
INDOT, MIDOT, MnDOT, OHDOT, PennDOT, NYSDOT, VDOT, TxDOT	Thin Polymer Overlay	3/8 in.	Section 5.6 & Table 5.6.4.6-1 https://www.dot.state.pa.us/public/Bureaus/BOPD/Bridge/DM-4/2019-Edition/DM-4_2019
ORDOT, MnDOT, TxDOT	PPC Overlay or MLPO	3/4 in.	Section 1.3.1 from https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01
IowaDOT, NCDOT, INDOT, FDOT, MnDOT, PennDOT, MDOT, VDOT, OKDOT. OHDOT	Rigid Concrete Overlays (LMC, LSC, HPC) plus piloting UHPC overlays	1.75 in.- 2+ in.	Table 2.4.1.1.2.1 from https://www.dot.state.mn.us/bridge/lrfd.html

*Other State DOT source information can be found in the State Survey Responses in Appendix C

1.c. Bridge Deck Joints and Barriers

Two additional bridge elements associated with the bridge deck were discussed during the peer exchanges: deck joints and bridge barriers. Deck joints are bridge deck elements that impact corrosion of the superstructure and the substructure. Deck joints are difficult to maintain and are exposed to severe environmental conditions, including constant traffic; continual thermal movements; serving as a collection area for water, salt, grit, and other road debris; and at times receiving impact from snowplows. A routine deck washing program helps the deck joint maintain its functionality (allowing the bridge deck to expand and contract) and water tightness. NYSDOT and VDOT choose to replace the deck joints with a link slab (as shown in Chapter 32 Preservation, Maintenance, Repair, Widening, and Rehabilitation as part of their deck overlay projects, or even simply as part of a deck patching and sealing project. Eliminating the deck joint with a link slab removes the sources for corrosion mentioned above. More information on link slabs can be found at the FHWA website Case Study: Eliminating Bridge Joints with Link Slabs - An Overview of State Practices.

Since NDOT uses a membrane and asphalt overlay for its bridge decks, an asphaltic plug joint is used above the original deck joint. The asphaltic plug joint essentially insulates the deck joint from the riding surface by providing a physical barrier against the water and chlorides at the deck surface.

These deck joint protection strategies are necessary because leaking deck joints lead to corrosion of beam/girder ends, corrosion of bearings, and corrosion of the pier caps and abutment bridge seats, which will be discussed later in this report.

Bridge barriers, whether steel or concrete, are also susceptible to corrosion which may compromise the ability of the barriers to perform their life safety function. In Figure 8 shown below, the combination of a non-functioning bridge deck joint with corroded steel reinforcement along the curb line, that tied the barrier to the bridge deck, caused the bridge barrier to fall off the bridge. Note this failure was not due to vehicular impact.

Source: KDOT

Figure 8. Photo of a bridge deck barrier in Kansas failure due to corrosion, not impact.

Because all bridges have a cross-slope to drain rainwater away from the travel lanes, water generally collects along the gutter line and then is carried to a scupper or inlet (which may or may not be on the bridge). The collection of salt and grit in the gutter line, especially in States where salt-laden snow is piled during winter operations, creates a particularly harsh corrosion environment for the embedded anchor bolts of steel railings or the anchoring steel reinforcement of concrete barriers. To minimize corrosion at these locations, many of the Peer Exchange States sweep the decks along the gutter line followed by a deck flushing/washing program as recommended in the MnDOT Bridge Maintenance Manual.

Source: MnDOT

Source: MnDOT

Figure 9. Bridge deck gutter line sweeping (left photo) and washing (including the barrier face) (right photo) from MnDOT Bridge Maintenance Manual Section 4.1.1.3.

Other corrosion prevention practices for bridge barriers involve material selection, i.e., using material choices with higher corrosion resistance when replacements are needed. Common choices include galvanized or stainless-steel for steel barrier rail anchor bolts and corrosion resistant rebar for reinforcement between the deck and the concrete barrier, see Section 5.2.4.1.1.2 Iowa DOT LRFD Bridge Design Manual.

2. Superstructure

Bridge superstructures typically consist of either steel or concrete beams/girders, but on some long bridges both concrete and steel beams/girders are used on the same bridge.

2.a. Steel Beams/Girders

All Peer Exchange States identified rust, or general uniform corrosion, as the most common corrosion issue with their steel beams/girders. Historically, bridge owners painted their steel bridge elements to minimize rust corrosion. However, over time coatings breakdown and fail, and the steel elements inevitably begin to rust. Eventually, rusting leads to section loss of steel members; in these cases, the affected steel elements need to be strengthened.

Typically, the participants said the best time to remediate rust corrosion is as soon as it is observed. Cleaning followed by spot painting or overcoating is used to halt rust corrosion progression.

Rust corrosion often appears under leaking deck joints when water and roadway debris pass through the faulty joint and settle around the steel. The debris buildup holds moisture, which accelerates the corrosion of the steel. Many of the Peer Exchange States are regularly painting the ends of girders under deck joints to protect the steel members. VDOT requires zone painting of previously painted steel beam/girder ends when “corrosion of the steel has initiated” Chapter 32 Preservation, Maintenance, Repair, Widening and Rehabilitation.

PennDOT, MnDOT, and INDOT require painting of weathering steel under expansion joints, e.g., Painting Requirements for Weathering Steel.

Source: PennDOT

Figure 10. Zone painting of weathering steel girders ends under a deck joint.

Another type of steel corrosion present on older bridges is pack rust. Pack rust starts out as localized corrosion between two steel surfaces. Pack rust indicates that there is section loss and can also lead to distortion of the steel, cracking of welds, overstressing of bolts, and ultimately connection failure.

Source: MnDOT

Source: MnDOT

Figure 11. MnDOT photos of pack rust.

Mitigation of pack rust can be accomplished in several ways. MnDOT typically uses mechanical and abrasive blasting methods to remove pack rust followed by application of a corrosion inhibiting penetrating oil-based sealers. MnDOT is experimenting with supplementing mechanical removal with high pressure hot water to remove chlorides and other corrosion byproducts more thoroughly. After the connection dries, the corrosion inhibiting penetrating

oil-based sealer is applied. In comparison, MDOT uses a dry preparation method for mitigation which includes the use of artificial heat to loosen the pack rust, as approved by the engineer. They then remove the pack rust and put the connection back together with high strength bolts and seal with caulk. INDOT sponsored two pack rust studies which resulted in the reports: Pack Rust Identification and Mitigation Strategies for Steel Bridges and Pack Rust: Mitigation Strategy Effectiveness. Further pack rust research is underway at Purdue University for PennDOT.

2.b. Concrete Beam/Girders

Concrete beams/girders experience corrosion similarly to concrete decks. Surface cracks create pathways for water and chlorides to gain access to the steel reinforcement. However, since prestressed concrete beams/girders are fabricated in a controlled environment, cracking in these members is uncommon. When these members do exhibit cracking, applying a concrete sealer to the surfaces and epoxy crack injection are the most prevalent practices performed by the Peer Exchange States. Example practices can be found in Section 4.5 of FDOT's Bridge Maintenance and Repair Handbook and VDOT's Chapter 32 Preservation, Maintenance, Repair, Widening and Rehabilitation. The ends of concrete beams/girders under deck joints, where the ends of the prestressing/posttensioning strands are exposed, is an area where corrosion often begins. Iowa DOT has a maintenance procedure similar to other Peer Exchange States which calls for power washing the ends of the concrete beams, coating exposed steel surfaces (bars and strands) with a "rust converter compound," and sealing the entire end of the concrete beam, shown in Section 6.22 Bridge Maintenance Manual.

The corrosion of tendons inside of post tensioning (PT) ducts is a specific type of corrosion that is difficult to detect because it is inside the girder, and also difficult to repair because it is difficult to access. FDOT uses a combination of methods to detect tendon corrosion including sounding external PT ducts, sounding of closure pours, excavation and borescopes, radiography, and magnetic flux leakage. Additionally, grout can be removed and tested for chloride contamination.

Source: FDOT

Source: FDOT

Figure 12. FDOT using NDT methods to look for corrosion within a segmental concrete girder.

FDOT is studying a novel non-destructive corrosion mitigation technique by injection of a corrosion inhibitor along the corroded tendon inside the duct. At this point, the technique appears to have been successful, but FDOT has ongoing research to determine how the corrosion inhibitor affects bonding to the grout. Degradation of the grout bonding may ultimately impact the load capacity of the beams. Otherwise, there are no known simple preservation actions that a bridge owner can undertake when corrosion is found in tendons inside of post tensioning ducts; a significant rehabilitation project (removing and replacing a tendon) is designed and bid in these instances.

3. Substructure

Bridge substructures typically consist of concrete and steel elements often in combination.

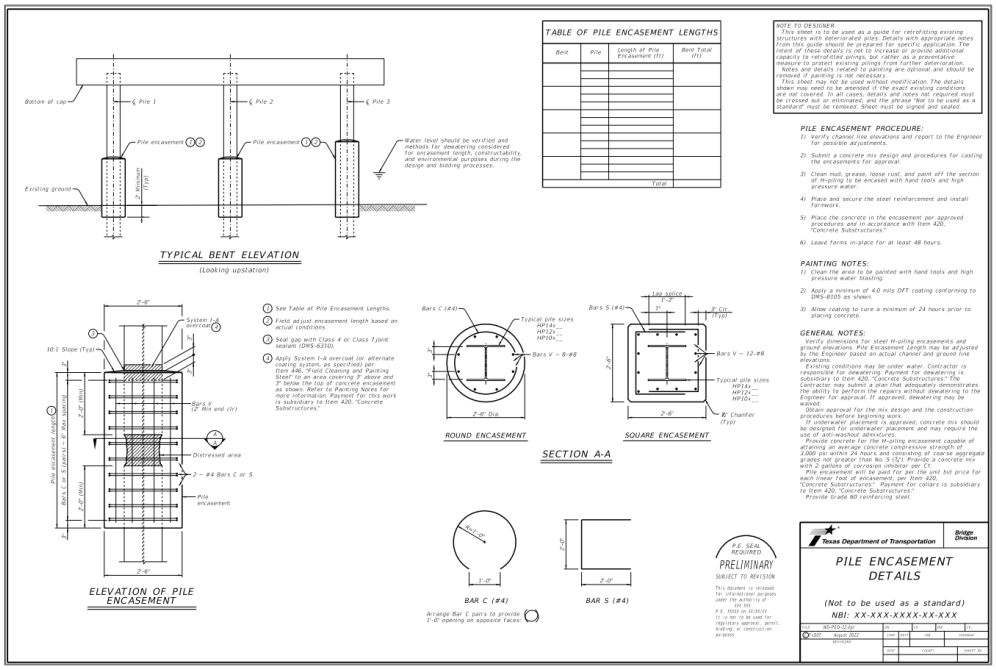
3.a. Steel Pier Caps, Steel Columns, and Steel Piles

Rust is typically the form of corrosion occurring on steel substructure elements, including steel pier caps, columns, and piles. Regular washing is the first step in minimizing corrosion on these elements. Spot, zone and overcoating are additional mitigation methods, as previously discussed. Steel columns and steel pile bents are routinely mechanically strengthened and also protected from corrosion by encasing them in concrete.

Source: TxDOT Source: TxDOT

Figure 13. TxDOT photos of deteriorated steel piles (left photo) and the repaired pile encased in concrete (right photo).

TxDOT has found concrete pile encasement to be more cost effective than painting and has developed a standard drawing for this repair which can be found here [Pile Encasement Details] and is shown below.

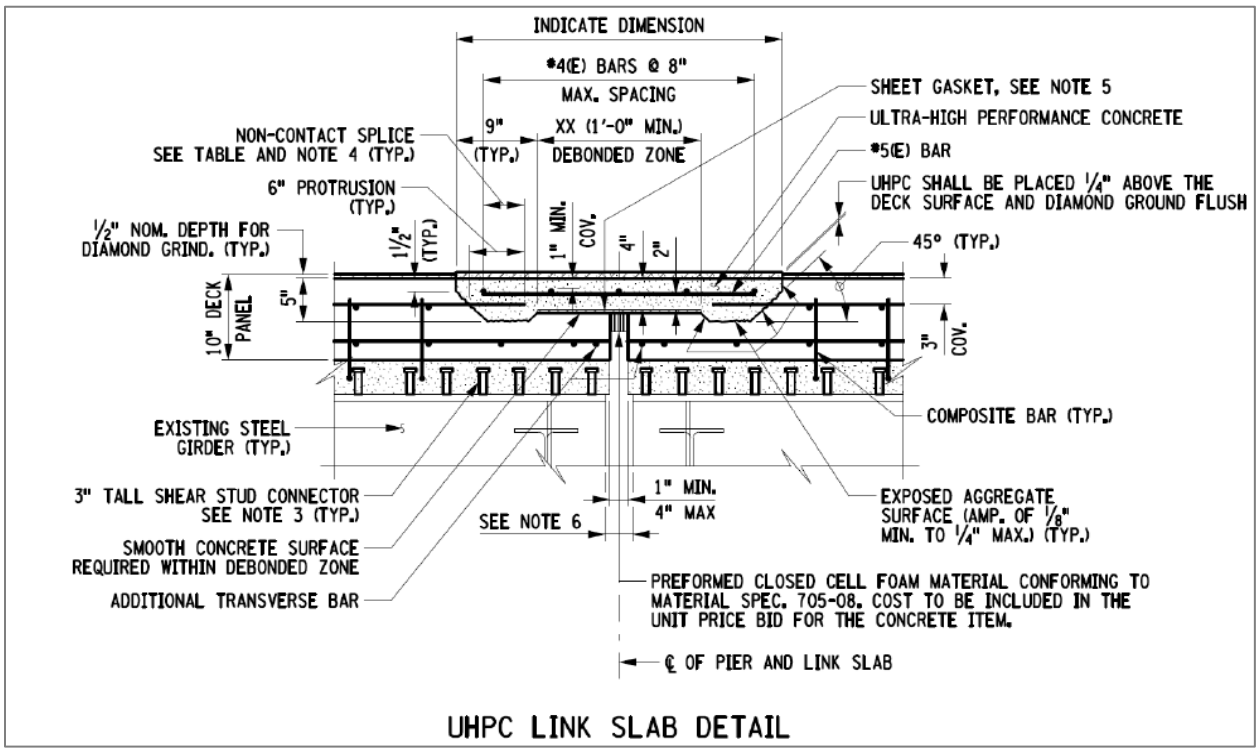


Source: TxDOT

Figure 14. TxDOT standard repair detail sheet of a steel pile encased in concrete.

3.b. Concrete Abutments, Piers and Pier Caps, Concrete Columns, and Concrete Piles

Concrete substructure elements experience corrosion in similar ways as concrete decks and concrete beams/girders. Surface cracks create pathways for water and chlorides to gain access to the steel reinforcement. Flat surfaces like abutment bridge seats and the tops of pier caps are very susceptible to collection of chloride laden water which causes corrosion, especially if the expansion joint material has failed and some debris has collected on the bridge seats and/or pier caps. This debris will hold the moisture on the concrete, accelerating the corrosion and deterioration. As noted previously, power washing the concrete surfaces, and then epoxy injection of cracks and sealing the concrete surfaces with an epoxy or silane sealer is the standard preservation treatment mentioned by the Peer Exchange States. Additional preservation actions are elimination of the deck joint by using a link slab as previously discussed. A schematic of NYSDOT's detail for a UHPC link slab is shown below.



Source: NYSDOT

Figure 15. NYSDOT UHPC link slab detail for deck joint elimination.

MnDOT discussed other issues with pier caps, notably varying design approaches due to changes in AASHTO design code (beam theory versus strut and tie), poor detailing, and insufficient reinforcement (e.g., hooks, stirrups, development length, etc.), lack of oversight of repair contractors (e.g., too much jackhammering) and poor safety inspection guidance relative to shear cracking. These issues all impact the preservation actions undertaken by MnDOT including use of coated or corrosion resistant reinforcement in the pier cap repairs, sloping the top of pier caps to prevent standing water (in addition to sealing the top of the pier cap), and in some instances providing an infill wall between columns to support the pier cap.

Source: MnDOT

Source: MnDOT

Figure 16. MnDOT photos of insufficient reinforcement of an existing pier cap (left photo) and an infill wall between columns for additional support of a pier cap (right photo).

Concrete pier column corrosion commonly results from road spray of chloride laden water from passing trucks and cars. The first line of defense for this corrosion is power washing and sealing the pier column with an epoxy sealer. However, in many of the Peer Exchange States, columns were built with the minimal cover required and uncoated reinforcement, so spalling of the column concrete and rusting of reinforcement is commonplace.

Source: OHDOT

Figure 17. OHDOT photos of spalled concrete column with rusted steel reinforcement.

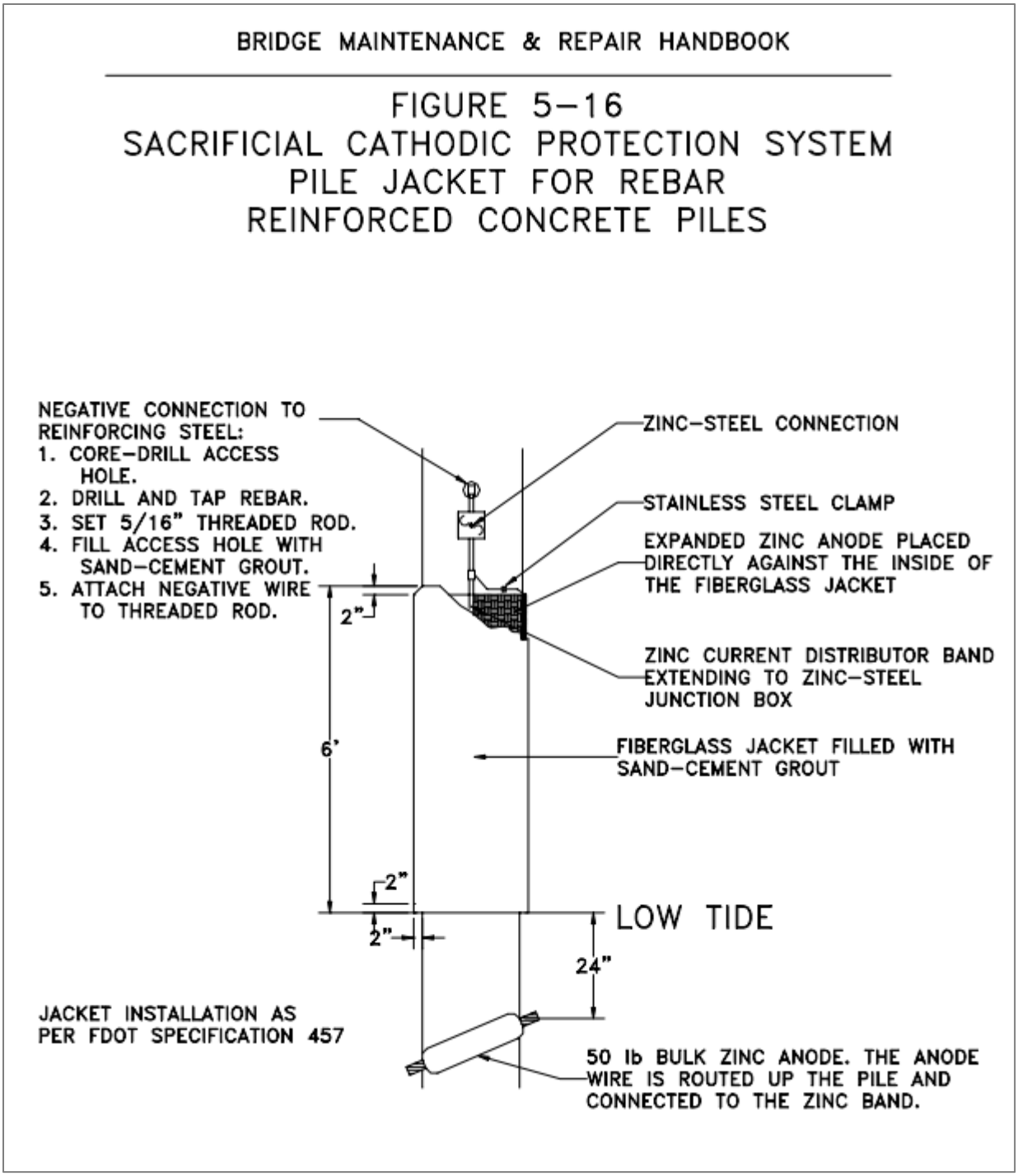
Another method of preserving concrete columns from bridge spray is to cathodically protect the columns by including sacrificial zinc anodes in the repaired concrete and then sealing the concrete, or in the case of OHDOT, protecting the repaired column with preformed, high-density polyethylene (HDPE) shields. These shields are light weight, and easy to remove and reinstall for inspection and were part of an evaluative study performed by OHDOT Protecting Piers of

Overhead Structures from Degradation Due to Snow and Ice Chemical and Material Usage Phase II. ORDOT also extensively uses cathodic protection on its existing bridges, especially those located along or near the Pacific Coast. The specifications can be found in Section 01200 Oregon Department of Transportation : Boilerplate Special Provisions : Doing Business : State of Oregon.

Source: OHDOT Source: OHDOT

Figure 18. OHDOT photos of a zinc anode wired to existing reinforcement (left photo) and the HDPE protective shell in place and being installed around pier columns (right photo).

Concrete pile bents, which are a typical element in bridge construction, are also subject to corrosion, especially if they are located in water or saltwater environments. Since these bridge elements are continually exposed to the environmental factors which induce corrosion, simple washing and sealing with epoxy sealers does not defend against corrosion as it does for other concrete bridge elements. For these cases, the preservation practices for the Peer Exchange States include cathodic protection and a protective encasement. The FHWA has a cathodic protection resource on its website Case Study: Utilization of Cathodic Protection to Extend the Service Life of Reinforced Concrete Bridges. FDOT has several recommended encasement options combined with cathodic protection in Chapter 5 of its Bridge Maintenance and Repair Handbook. Several sketches are included in the handbook, and a typical sketch is shown in Figure 19.



Source: FDOT

Figure 19. FDOT sketch of a cathodic protection system encased in a concrete jacket with a fiberglass shell that acts as a form.

II. Strategies for New Bridges

Each of the Peer Exchange States has its own bridge design guidelines and specifications. The guidelines and specifications are generally founded on AASHTO guide specifications, FHWA guidance, and local adaptations based on a specific State's context such as climate, traffic, etc. Recently, Service Life Design Guides have been published by both AASHTO (AASHTO Guide Specification for Service Life Design of Highway Bridges and FHWA (Service Life Design Reference Guide). The use of the FHWA document (or the AASHTO document) is not a Federal requirement.

When using the concepts of service life design for bridge design, the first step typically is to determine the target service life of the bridge, i.e., Normal, Enhanced, or Maximum, and to identify the length of time for each category, the AASHTO document uses 75, 100, and 150 years for each of the categories, respectively. The other basic building block of this technique is to identify the Renewable Elements, which are those elements of the bridge that can be renewed (replaced) during the target service life of the bridge. Examples of renewable elements are deck joints, bearings, and coating systems. While loading and fatigue design considerations are already covered in standard bridge design guidelines and specifications, service life design adds environmental exposure conditions to the demands the bridge will "see" in its lifetime, and links them to common deterioration/corrosion mechanisms.

Environmental exposure is considered both on a macro and a micro level in service life design. The macro exposure zone relates to the local site conditions of the bridge. The micro exposure zone relates to the environmental demands that individual elements of a structure will be subject to. Once the bridge elements and their respective environmental exposure(s) have all been identified, then the design of the bridge can be undertaken with one of two approaches, either a design-to-resist approach or the avoidance approach. Further information can be found in the above FHWA and AASHTO documents.

The survey results showed all the Peer Exchange States included service life concepts in their respective design guidance, but they do not necessarily refer to it as service life. MnDOT is the exception. During Peer Exchange 1, MnDOT shared its Service Life Design Guide for Bridges. Their document is closely aligned with the FHWA and AASHTO documents previously cited, but with adaptations to suit the context(s) that are important to MnDOT. Their goal is to eventually merge their Service Life Design Guide for Bridges with their Bridge Design Manual.

1. Bridge Decks

Design guidance from the Peer Exchange States for new bridge decks includes minimally the use of epoxy-coated reinforcement in bridge decks and 2.5 to 3 in. cover to the top reinforcement. Two exceptions are VDOT, who requires corrosion resistant reinforcement in its new decks and FDOT, who does not allow epoxy coated reinforcement anywhere in its structures. However, many of the other Peer Exchange States cite situations that may require corrosion resistant reinforcement. For example, TxDOT has a Structure Design – Corrosion Protection Guide which

identifies regions of the State where corrosion resistant reinforcement is recommended in the deck.

Additional recommended corrosion resistant deck design features from Peer Exchange States include adding macro and micro fibers to the concrete mix to reduce shrinkage cracking (MnDOT Service Life Design Guide for Bridges), and reinforcement extending from the deck into the bridge barrier is required to be stainless steel (IowaDOT LRFD Design Manual Chapter 5). OKDOT and OHDOT apply sealers to new decks after one year in service and two years in service respectively, and NDOT installs a membrane and an asphalt overlay during initial construction.

INDOT has recently begun providing an option to contractors and concrete suppliers to use one of two proprietary nano-silica based admixtures, either E5LC (liquid cure) or E5LFA (liquid fly ash), as "zero cost" change orders for its decks and overlays. The benefit to INDOT is reduced permeability, reduced cracking, and higher strengths (Self-Healing Cementitious Composites (SHCC) with Ultrahigh Ductility for Pavement and Bridge Construction). The benefits to the contractor are improved workability and reduced curing time (i.e., a 5-day dry cure versus a 14-day wet cure).

All the Peer Exchange States have general statements in their design guidance minimizing the number of deck joints and looking to construct jointless bridges whenever possible, similar to NYSDOT's Section 5.2 Bridge Manual. This often includes using integral abutments so the "end of bridge" deck joints are actually moved off the bridge.

Lastly, most of the Peer Exchange States require epoxy-coated steel or other non-corrosive reinforcing steel in the concrete barriers located on bridge decks.

2. Superstructure

Design guidance from the Peer Exchange States to protect steel superstructure elements from corrosion includes use of the following materials:

- Coated steel.
- Uncoated weathering steel.
- Galvanized/metalized steel.

Each of the Peer Exchange States has factors to determine which corrosion protection method should be used. For instance, NYSDOT states, "Painting shall not be specified for bridges crossing railroads, due to the difficulty and expense of obtaining site access for maintenance and repainting." (Section 8.2.3 NYSDOT Bridge Manual). Most of the Peer Exchange States call for weathering steel to be painted underneath deck joints.

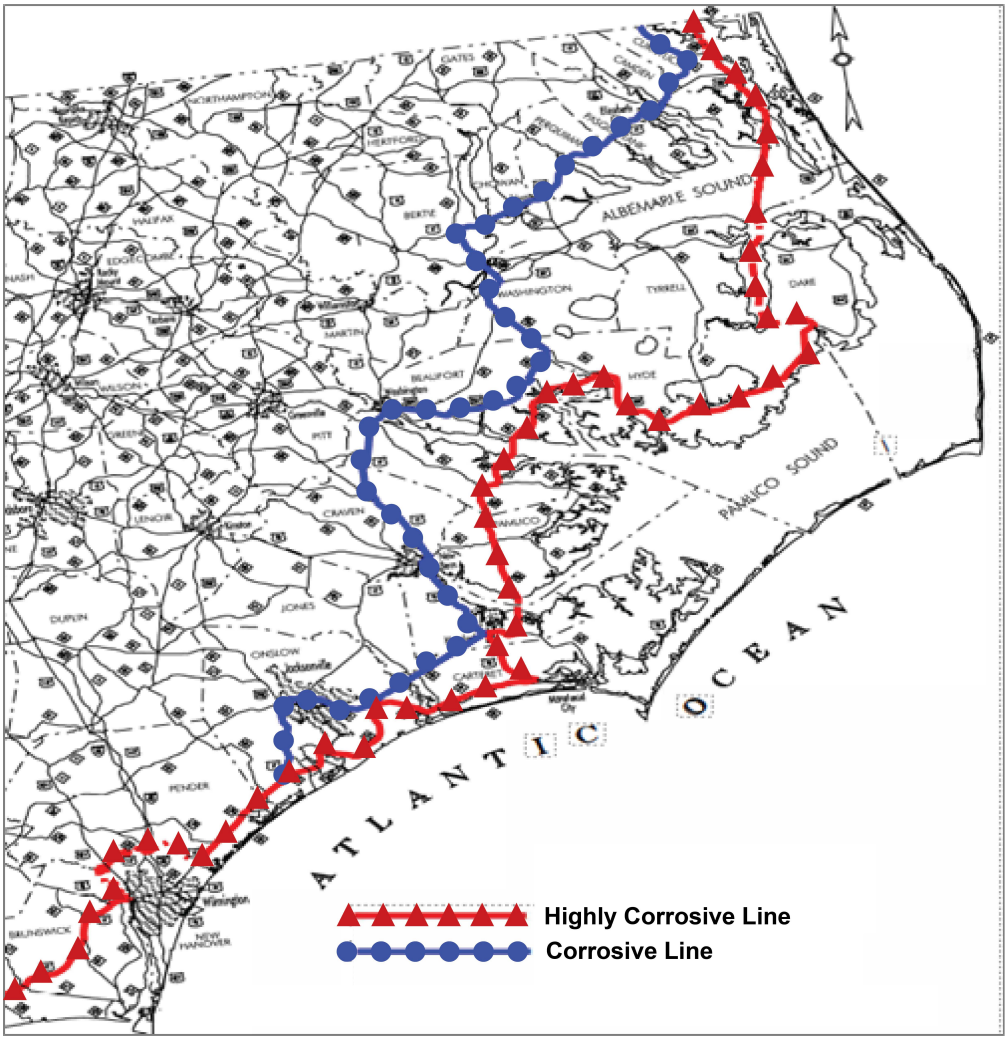
Source: Iowa DOT

Figure 20. Iowa DOT photo of a weathering steel girder zone painted under the deck joint.

Design guidance from the Peer Exchange States for concrete superstructure elements includes some or all of the following features for reducing the potential for corrosion of concrete superstructure elements:

- Using epoxy-coated reinforcement or corrosion resistance reinforcement.
- Increasing concrete cover.
- Specifying a dense concrete mix (or including corrosion inhibitors in the mix design).
- Sealing the ends of beams/girders with an epoxy sealer.
- Sealing the bottom flange of beams/girders to protect from salt spray.

In Table 1.4.3-3 Corrosion Protection of Concrete Components of the FDOT Structure Design Guidelines, Vol. 1, for superstructures in Extremely Aggressive Marine environments, FDOT requires the designer to "coordinate with the State Materials Office and District Structures Design Engineer for guidance on the design mix requirements, cover, and which alternative reinforcing materials are best suited for the project demands." NCDOT has location-based superstructure design criteria which considers the differing environmental exposures along the coastline as shown in Figure 21.



Source: NCDOT

Figure 21. NCDOT design guidance includes location-based environmental conditions.

3. Substructure

Design guidance from the Peer Exchange States for concrete substructure elements includes using some, or all, of the following to reduce the potential for corrosion of concrete substructure elements:

- Using epoxy-coated reinforcement or corrosion resistant reinforcement.
- Increasing concrete cover.
- Specifying a dense concrete mix (or including corrosion inhibitors in the mix design).
- Sealing bridge seats on pier caps and abutments while also providing a minimal cross slope to minimize water ponding on the surface.

- Incorporating sacrificial cathodic protection anodes in the concrete, especially when in marine environments.

Examples of these features can be found in Iowa DOT's LRFD Bridge Design Manual, Section 6.5.4.2.2, which shows the slope (called a "wash" by IowaDOT) between bearings on the bridge seat. Iowa DOT calls for the wash and bearing seats to be sealed with an approved concrete sealer. This design/detailing criteria is similarly found in Section 7.2.6.2 NCDOT's Structures Management Unit Manual, NCDOT's design guidance for substructures, like its superstructure guidance, is location-based which considers the differing environmental exposures along the coastline as shown in Figure 21 (above).

Design guidance from the Peer Exchange States to protect steel substructure elements from corrosion includes using:

- Coated steel.
- Uncoated weathering steel.
- Galvanized/metalized steel.

These steel elements are sometimes required by State DOTs to be encased in concrete, e.g., as noted by IowaDOT in Iowa DOT Standard Plan Sheet-Concrete and Steel Piles. MnDOT requires steel piles to be galvanized from the top of the pile to 15 feet below the ground surface. When exposed to water, MnDOT also requires that the pile will have a concrete collar or sacrificial shell to delay corrosion. TxDOT requires protective coatings on steel piles and additional sacrificial thickness of the steel to enhance corrosion resistance in Guidelines for the Use of Steel Piling for Bridge Foundations.

III. Knowledge Gaps/Future Research

Many of the actions being taken to reduce corrosion of the Nation's bridges on existing structures and in changes to design policies are the result of material research at the State and Federal level. However, the peer exchanges identified some knowledge gaps and potential areas where additional research would be beneficial.

Based on the recent shift to more corrosion-resistant specific preservation/maintenance actions, the Peer Exchange States are looking for research that measures and documents the benefits of preservation. MnDOT (Quantifying Benefits of Bridge Maintenance) is currently performing research on this topic.

Other suggested research topics concern the specific measurement of corrosion reduction related to specific tactics. INDOT's use of nano-silica admixtures has been successful in reducing porosity and cracking, but additional research may be helpful to determine (1) if similar results can be obtained using a wider variety of concrete mixes (beyond INDOT aggregates and sands) and (2) if there is a non-proprietary method for producing the nano-silica admixtures.

INDOT has also recently completed research on "Increasing Bridge Deck Service Life" in two volumes (Increasing Bridge Deck Service Life: Volume 1-Technical Evaluation and Increasing Bridge Deck Service Life: Volume II-Economic Evaluation), which compared different reinforcement types and life cycle analyses for extending bridge deck service life. The research begins to answer the question, What is the gain in a bridge deck's service life due to use of non-corrosive reinforcement before spalling and delamination occur? However, the research indicated there remain multiple additional variables that need to be studied to add fuller meaning to their results.

Many of the Peer Exchange States seal their bridge decks, but then have questions such as:

- When should the second application of deck sealer be performed, e.g., Is it related to the average daily traffic?
- Is the timing of the second application of deck sealer related to the specific concrete mix of the deck?
- Is the timing of the second application of deck sealer related to the amount of rain/snow/salt that a bridge deck is exposed to?

Similarly, weathering steel is generally thought of as a corrosion resistant steel member because it forms a patina to protect the girder. However, research may be needed to study what indicates failure of the patina and section loss of the steel.

FHWA has performed extensive research on UHPC as a deck overlay preservation treatment (Ultra-High Performance Concrete Publications). Many of the Peer Exchange States are developing non-proprietary UHPC mixes. Research would be helpful to determine if these non-proprietary mixes perform as well as the UHPC mixes researched by FHWA.

The specific corrosion resistance practices and policies by the Peer Exchange States are grounded in research and are generally accepted as proven technologies. However, knowledge gaps remain relative to the holistic/cumulative beneficial impacts each of these individual bridge preservation or bridge design actions will have on a bridge's expected service life.

Conclusions

The results of the peer exchanges can be categorized as (1) State actions taken to slow down, reduce, and prevent corrosion from occurring to existing bridges and (2) State policy changes in design standards, details, and material specifications which address some of the root causes of corrosion in new construction.

Primary preservation efforts of the Peer Exchange States start with the bridge deck because once corrosion begins in the deck, it can impact the entire structure. It is difficult to correct bridge deck corrosion due to limited time available to complete repairs, and deck corrosion has the most visible impact to users. The corrosion prevention actions for existing concrete bridge decks are:

- Sweeping and washing bridge decks to remove potential corrosive agents (chlorides) applied for ice control during the winter season.
- Applying sealers to prevent, reduce, and slow the infiltration of chloride-laden water.
- Installing protective overlays, e.g., either thin epoxy overlays, polyester polymer concrete overlays, rigid (thick) concrete overlays, or asphalt overlays with a membrane.
- Replacing the bridge deck with corrosion-resistant reinforcement and a concrete mix enhanced to minimize concrete porosity.

The corrosion prevention actions being taken during design of new decks are:

- Changing the concrete design mix to reduce the porosity of the concrete and reduce shrinkage cracking.
- Requiring the placement of a concrete deck sealer or calling for the installation of a protective overlay during the initial construction.
- Using non-corrosive rebar in the deck.

Concrete barriers receive the same treatments, whether on existing bridge decks or in a new design, except they do not receive an overlay. Deck joints may also contribute to the corrosion of the bridge superstructure; therefore, existing deck joints are cleaned by power washing and then resealed to restore their watertightness. In some instances, existing deck joints are replaced with a concrete link-slab, eliminating the joint altogether, and new bridge designs may feature no deck joints, or the minimal number required.

The corrosion prevention actions for existing superstructures and substructures are:

- Washing the superstructure and substructure, with special attention given to areas under deck joints and flat surfaces, like pier caps and bridge seats.
- Removing corrosion (rust), repainting steel elements, and strengthening where section loss has decreased needed capacity. Strengthening may include concrete encasement of steel girder ends in superstructures and steel piles in substructures.

- Removing deteriorated concrete and patching, which may include the use of cathodic protection, and then sealing concrete elements, especially at the ends of beams and pier caps and bridge seats under deck joints, and other areas that may be exposed to salt spray, like columns along the roadway.

The corrosion prevention actions being taken during the design of new superstructures and substructures are:

- Specifying the steel elements to have enhanced corrosion-resistant properties, e.g., weathering steel or galvanized/metalized steel, and proactively painting over the areas susceptible to corrosion such as expansion joints.
- Changing the concrete mix design to reduce the porosity of the concrete elements, or calling for corrosion-resistant reinforcement steel or using materials not susceptible to corrosion in the concrete beam/girder.
- Proactively requiring the painting or sealing beam ends under deck joints.
- Configuring bridges without expansion joints, moving expansion joints beyond the bridge, or reducing the number of expansion joints in new designs.

The Peer Exchange States all cited the need for data that better defines and measures the specific benefits of the specific corrosion reduction and bridge preservation actions being undertaken.

Appendices

A. Peer Exchange Agendas

Peer Exchange #1 Agenda Minneapolis, MN November 29 - December 1, 2022

Day 1: Tuesday, Nov. 29, 2022

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
1:00	Welcome and Self Introductions	Raj Ailaney/FHWA	
1:15	Summary of Virtual Meeting		
1:30	Rigid Deck Overlay	IA	Chris Cromwell/Scott Stotlemeyer
2:15	Thin Deck Overlays	IN	Steve Toillion/Chris Cromwell
3:00	**Break**		
3:15	Asphalt Overlay with Membrane	NE	David Mraz/Steve Toillion
4:00	Deck Sealing	MO	Scott Stotlemeyer/Ralph Pauly
4:45	Summarize Day 1		

Day 2: Wednesday, Nov. 30, 2022

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
8:00	Presentation: Modern Corrosion Protection System	Justin Ocel/FHWA	
8:45	Mitigating Pack Rust	MN	Ralph Pauly/Steve Toillion
9:30	Steel Pile Corrosion Assessment and Mitigation	MO	Scott Stotlemeyer/David Mraz
10:15	**Break**		
10:30	Concrete Mixes/Admixtures	IN	Chris Cromwell/Scott Stotlemeyer
11:15	Low Slump Wearing Course Mix Design	MN	David Mraz/Steve Toillion
12:00	**Break for Lunch**		
1:15	Use of NDE/NDT Technologies	NE	Ralph Pauly/Chris Cromwell
2:00	Chloride Levels and Deck Patching	MN	Scott Stotlemeyer/Ralph Pauly
2:45	**Break**		
3:00	Concrete Bridge Rails	KS	Steve Toillion/David Mraz
3:45	Sealing Exposed Surfaces of PS Concrete Beams	MI	Chris Cromwell/Ralph Pauly
4:30	Summary Day 2		

Day 3: Thursday, December 1, 2022

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
8:00	MnDOT's Service Life Design Manual	MN	Steve Toillion/David Mraz
8:45	GFRP Bars/Stainless or Other Special Alloys	KS	Ralph Pauly/Steve Toillion
9:30	Analysis, Evaluation & Strengthening Multi-Column or Hammerhead Piers	MN	Scott Stotlemeyer/David Mraz
10:15	**Break**		
10:30	Overlays on New Decks	IA	Chris Cromwell/Scott Stotlemeyer
11:15	Open Discussion and Summary		
12:00	**Adjourn**		

Peer Exchange #2 Agenda Orlando, FL February 28 - March 2, 2022

Day 1: Tuesday, Feb. 28, 2023

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
1:00	Welcome and Self Introductions	Raj Ailaney/FHWA	
1:15	Deck Sealing	OK	Ralph Nguyen / Chris Marston
1:30	Rigid Deck Overlay	PA	Jonathan Buck / Hector Garcia
2:15	Thin Deck Overlays	OR	Timothy Rogers / Chris Millington
3:00	**Break**		
3:15	Reinforcement Types (Epoxy Coated/Galvanized/GFRP/ Stainless/Other Special Alloys)	OH	Serge Feuze Lekem / Chris Marston
4:00	Deck Joint Corrosion & Link Slabs	NY	Chris Millington / Ralph Nguyen
4:45	Chloride Levels and Deck Patching	OR	Timothy Rogers / Serge Feuze Lekem
5:30	Summarize Day 1		

Day 2: Wednesday, March 1, 2023

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
8:00	Steel/Concrete Pile Corrosion	TX	Hector Garcia / Jonathan Buck
8:45	Steel Coating/ Galvanize/Metalize	FL	Chris Marston / Serge Feuze Lekem
9:30	Mitigating Pack Rust	TX	Dan Muller/Timothy Rogers
10:15	**Break**		
10:30	Concrete Mixes (Internal Curing, Crack Control)	NY	Chris Millington / Jonathan Buck
11:15	Corrosion Inside PT Ducts	FL	Ralph Nguyen / Hector Garcia
12:00	**Break for Lunch**		
1:15	CFRP Strands	NC	Dan Muller / Chris Millington
2:00	Corrosion of Exposed Surfaces/Ends of PS Concrete Beams	NC	Dan Muller / Chris Marston
2:45	**Break**		
3:00	Cathodic Protection	VA	Chris Marston / Dan Muller

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
3:45	Corrosion of Columns, Piers, Abutment Exposed to Salt Spray	OH	Serge Feuze Lekem / Hector Garcia
4:30	Summary Day 2		

Day 3: Thursday, March 2, 2023

Time	Topic	Individual/Lead Agency	Notetaker (Primary/Secondary)
8:00	Abutment Seat & Pier Cap Corrosion Protection	NC	Dan Muller / Chris Millington
8:45	Contaminated Concrete Removal / Magnesium-Alumino-Liquid-Phosphate	OR/OK	Timothy Rogers / Ralph Nguyen
9:30	**Break**		
9:45	Discussion of NDE & NDT	PA	Jonathan Buck / Hector Garcia
10:15	Open Discussion and Summary		
10:45	**Adjourn**		

B. Peer Exchange Survey Questions

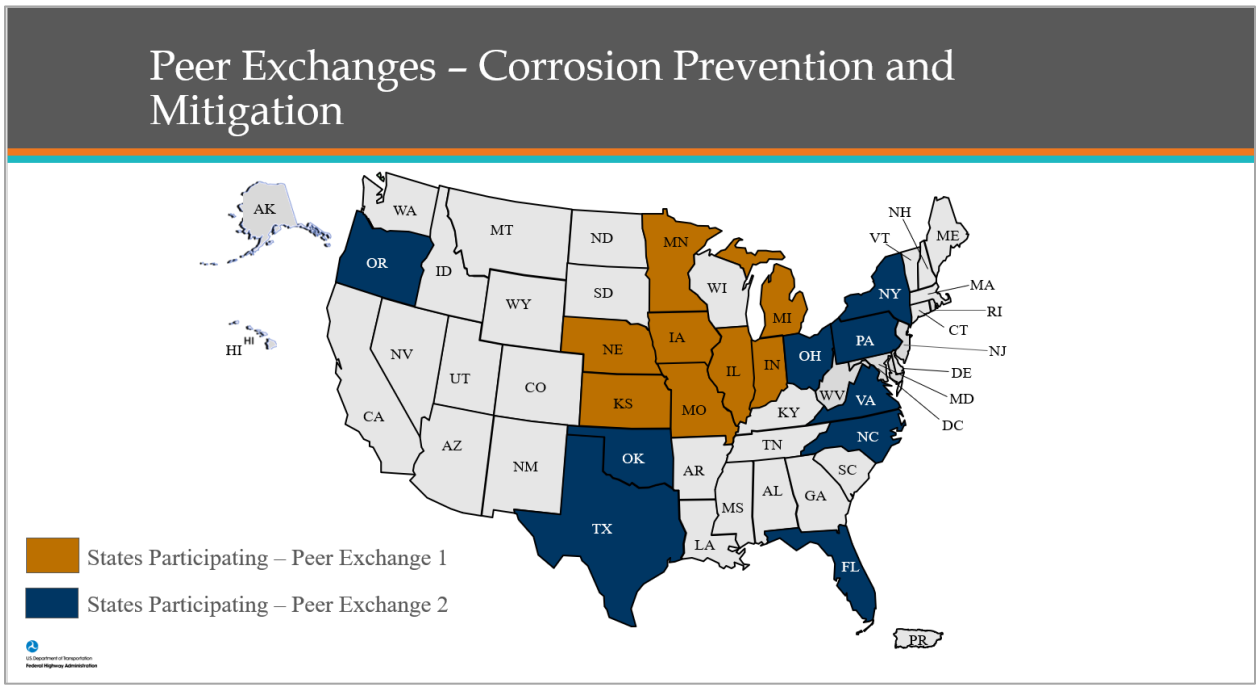
The following questionnaire was sent to each of the Peer Exchanges States to be completed prior to the peer exchange.

Introduction and Background

FHWA is conducting two (2) Peer Exchanges in federal Fiscal Year 2023 (FY23). The purpose the Exchanges is to identify bridge corrosion prevention and mitigation needs and share commendable practices between State Transportation Departments and FHWA.

Peer Exchange #1 - includes the following 8 States: KS, IA, IL, IN, MI, MN, MO, NE
[See map below – Tan-shaded States]

Peer Exchange #2 - includes the following 9 States: FL, NC, NY, OH, OK, OR, PA, TX, VA
[See map below - Blue-shaded States]



Source: FHWA

The Peer Exchanges will provide an opportunity for peer groups to discuss common challenges and lessons learned; enhance their preservation and maintenance practices; and consider the use of innovative materials and effective construction technologies. All participants at the exchanges share a desire to learn how others have resolved challenges and identified solutions to preserve their bridges in a state of good repair.

Prior to and in support of the Peer Exchanges, FHWA is requesting that each participating State identify two individuals and address the following Survey Questions. The two representatives shall have expertise in preservation and/or rehabilitation of existing bridges and design of new bridges for enhancing durability and resilience.

State

1. Participant's Name(s)
2. Organization
3. Title(s)
4. Phone Number(s)
5. E-mail(s)

Highway Bridges – Inventory and Condition (2022 NBI)

6. Based on FHWA's InfoBridge 2022 NBI data, please confirm the number and deck area of bridges with material types within your State meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe)

State	Main Span Material NBI 43A – Concrete, Concrete Cont., PSC, PSC Cont.				Main Span Material NBI 43A – Steel, Steel Continuous			
	NHS		Non-NHS		NHS		Non-NHS	
	Number	Deck Area Percentage	Number	Deck Area Percentage	Number	Deck Area Percentage	Number	Deck Area Percentage
FL	5,006	68.0%	5,783	32.0%	713	71.2%	689	28.8%
NC	2,176	46.6%	8,079	53.4%	1,598	51.0%	5,960	49.0%
NY	1,571	49.7%	4,959	50.3%	3,931	72.9%	6,344	27.1%
OH	1,731	33.4%	13,832	66.6%	3,251	58.2%	7,880	41.8%
OK	2,324	34.1%	12,677	65.9%	801	44.7%	6,925	55.3%
OR	1,579	55.3%	3,951	44.7%	256	67.2%	787	32.8%
PA	3,780	51.8%	11,786	48.2%	2,026	73.6%	4,933	26.4%
TX	16,007	60.8%	32,004	39.2%	1,913	76.2%	5,027	23.8%
VA	1,672	62.3%	5,368	37.7%	2,110	65.5%	4,404	34.5%

Existing Highway Bridges – Data Collection

Steel Bridges

7. States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your State collect element level data for non-NHS bridges?
8. What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?
9. For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?
10. Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?
12. For the elements you are required to collect, do you collect defect data? If so, what defects do you code?
13. Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?

RC Decks

14. What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?
15. On your ADE items, what defects are you collecting?
16. Are you performing chloride profiling as part of your RC deck management?
17. If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?
18. Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)
19. Are you using destructive evaluations for other information? If so, what evaluations and how is it used?
20. Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)
22. Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.
23. Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)
24. Does your State use lifecycle analysis basis for recoating existing steel members?
25. Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)
26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)
28. Does your State perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?
29. Does your State have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.
30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

RC Decks

31. Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)
32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?
33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)
34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?
35. How does your State determine the effectiveness of these corrosion mitigation actions?

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)
37. Does your State have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.
38. What is your States' maintenance cost per square foot for your bridge inventory?

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?
40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?
42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)
45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)
46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)
48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)
49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?
51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?
52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?
53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?
54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)
58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)
60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?
61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)
63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?
64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

C. Peer Exchange Survey Responses

The responses that follow contain a verbatim recitation of information received from the Peer Exchange States.

The views and opinions expressed in these responses are the authors and do not necessarily reflect those of FHWA or the USDOT. In addition, the names of software and products are included in this section for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

Group 1:

- Illinois DOT
- Indiana DOT
- Iowa DOT
- Kansas DOT
- Michigan DOT
- Missouri DOT
- Nebraska DOT

Group 2:

- Florida DOT
- New York State DOT
- North Carolina DOT
- Ohio DOT
- Oklahoma DOT
- Oregon DOT
- Pennsylvania DOT
- Texas DOT
- Virginia DOT

Group 1 State: Illinois

1. **Participant's Name(s)** [redacted]
2. **Organization** Illinois Department of Transportation (IL DOT)
3. **Title(s)** Bridge Management & Inspection Unit Chief (Central BBS) and District 4 Bridge Maintenance Engineer (District Operations)
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Illinois confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Illinois Bridge Materials

Illinois	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	2,212	2,610
NHS Deck Area Percentage	30.40%	63.50%
Non-NHS No. of Bridges	17,505	4,377
Non-NHS Deck Area Percentage	69.60%	36.50%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your State collect element level data for non-NHS bridges?**

   IL DOT State Policy is for Element Level Inspections to be performed on all bridges IDOT has sole/primary maintenance responsibility. Non-IDOT bridges that are not on the NHS do not require Element Level Inspections.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

Of IL DOT's 5 ADE's, only "Element 8102 Steel Beam/Girder/Stringer End Under Joint (Each)" could be used to identify corrosion prevention. The purpose of this element is to identify when a beam end needs painting.

9. **For the elements you are required to collect, do you collect defect data?**

   IL DOT does not collect Defect Codes as found in the MBEI. However, IL DOT does use the Defect Code Descriptions in the MBEI, along with some agency specific CS defect descriptions, to determine CS quantities. If so, what additional defects do you code that are not listed in the AASHTO MBEI manual? N/A.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    Yes. Steel members with section loss are to be cleaned and measured using a handheld d-meter to record remaining thickness.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    IL DOT has no ADE's intended to identify corrosion prevention of concrete bridges.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    N/A (assuming this refers to ADE's in Q11).

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues?**

    Very rarely anymore. IL DOT previously took concrete cores for testing compression strength/chloride content of any RC bridge (slab/culvert) with leaching cracks. **What are they and why are they used?** Concrete cores for conventionally RC slabs/culverts. To determine capacity and programming.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    Of IL DOT's 5 ADE's, 3 are for Wearing Surface, "8510 – Flexible WS", "8511 – Rigid WS", and "8511 – Semi-Rigid WS". If WS has large quantity in CS3/CS4, then time to consider new WS to maintain integrity of RC Deck.

15. **On your ADE items, what defects are you collecting?**

    IL DOT does not collect Defect Codes, but does use the MBEI Defect Descriptions for CS of Wearing Surface.

16. **Are you performing chloride profiling as part of your RC deck management?**

    Not typically.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

N/A.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    No.

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Not typically. Concrete cores if necessary.

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    Deck survey using chain dragging. Have used thermal deck scanning but have not found where it's better than chain dragging.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    IL DOT's policy on cleaning and painting steel bridges is found at the following link. ABD197 (powerdms.com)

    The policy references zone painting and full painting. Spot painting is rarely an option used by the State, due to previous issues with paint adherence in overcoated systems. It is still used on rare occasions.

    Whether zone or full painting is used is dependent upon the extent of damage in the existing paint system. It is common to use zone painting, and paint 5'-10' from joint locations. There are times when the damage is more extensive and full removal and replacement of the paint system is used.

    IL DOT uses square foot costs that are updated yearly to determine full and zone removal and replacement costs. These are used to determine the most economical solution for a particular bridge.

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    IL DOT's policies on coating system are not based on severity, but rather are based upon anticipated weather conditions and the materials of the existing paint system. See flowchart on Page 4 of the document linked above.

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    See response to Question # 21.

24. Does your State use lifecycle analysis basis for recoating existing steel members?

No.

25. Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)

Regarding new structures, IL DOT requires painting of weathering steel at locations of joints to a distance of 10 ft. or three times the beam depth from the joint. For weathering steel encased in concrete, such as at integral or semi-integral abutments, all weathering steel encased is painted, and external weathering steel protruding from the concrete is required to be painted to a distance of 18 in. outside the concrete interface.

IL DOT does not have specific policy for overcoating existing weathering steel. It has been done on an as-needed basis. The cases where it has needed to be done are typically bridges with open steel railings, where salt spray from trucks can blow over the side of the bridge and hit the fascia beams.

26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

Condition State quantities for Element 515 are used to track condition of steel protective systems.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)

The IL DOT Bridge Preservation Guide is used for all bridge types and has guidance on schedule based and condition based treatments aimed at reaching a 100-year design life. bridge-preservation-guide.pdf (illinois.gov)

28. Does your State perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use? PPC Deck/Box Beams (Depth 17"-33") with a Superstructure Condition Rating of ≤ 4 require 100% sounding of the beam soffit each year.

This is due to the rapid deterioration of the beams once the shear reinforcement begins to corrode. Bridges with post-tensioning are outsourced for specialized inspection when visual methods note suspected deterioration.

29. Does your State have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.

No. If outsourced specialized inspection suggests specific preventative maintenance activities, the Department will implement as necessary.

30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

Preservation activities are accounted for in the bridge inventory construction history and benefits are accounted for in IL DOT's Bridge Management Systems.

RC Decks

31. Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)

See response to Question #27.

32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?

Yes. IL DOT maintained bridge decks are sealed every 4-years. The bridges included are chosen by County, then rotated on a 4-year basis and are limited by condition based on the IL Bridge Preservation Guide. Deck sealers are covered by Section 587 of the IL Standard Spec. for Road & Bridge Construction. Microsoft Word - Division 100 (powerdms.com)

The allowable concrete sealers are found at this link. Illinois Department of Transportation

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

The guidance for installation of deck overlays is found in the following document. See pages 16-19 on existing deck evaluation. The minimum thickness is typically 2.25", but ILDOT has been experimenting with thinner overlays (1.5") recently. Bridge Condition Report Procedures and Practices (powerdms.com)

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

IL DOT will only apply a membrane in the event that an asphalt overlay is applied. This is not common. When it does occur, the membrane is either a seven-layer system found in Section 581 of ILDOT's Standard Specifications for Road and Bridge Construction, or a full-lane sealant system found in Article 1032.13 of the same document. ABD197 (powerdms.com)

35. How does your State determine the effectiveness of these corrosion mitigation actions?

Preservation are schedule and condition based and are determined by past experience and by how activities benefit/perform now. The condition will be reflected in the Element Condition States. Benefits are accounted for in IL DOT's Bridge Management Systems.

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

    IL DOT has two (2) Bridge Management Systems, Deighton dTMS and AASHTOWare BrM, which are nearly ready for implementation.

37. **Does your State have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.**

    IL DOT Pavement and Bridge Preservation target is 7.0%. However, for FY 2022, IL DOT spent 23.9% of bridge funding on NHS bridge preservation and 7.7% on non-NHS bridge preservation.

38. **What is your States' maintenance cost per square foot for your bridge inventory?**

    The cost/sf is not readily available.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. **Does your State have written guidance for corrosion prevention or mitigation strategies?**

    IL DOT requires epoxy-coated reinforcement at a minimum. Other material types, such as stainless steel, have been used, but are not typical.

40. **Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?**

    IL DOT has standard deck design charts found in the Bridge Manual. Standard bars are #5 reinforcement. Clear cover to the top of reinforcement is 2.25" +/- 0.25".

41. **Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?**

    No.

42. **Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?**

    No.

New Designs – Steel Decks

43. **Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)**

    No. IL DOT's typical design practices takes this into account.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

IL DOT's policy on steel coatings for new structures is found at the following location. The flowchart near the end of the document is intended to direct designers to the appropriate coating. https://idot.illinois.gov/Assets/uploads/files/Doing-Business/Memorandums-&-Letters/Highways/Bridges/ABD-Memos/ABD196.pdf

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

See response to Question #25.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

IL DOT acknowledges that galvanized and metallized coatings have longer design lives than paint and weathering steel coatings. This is just one of the parameters used to choose a coating type. See response to Question #43.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

No. Mild steel is epoxy coated or galvanized, at the option of the PPC fabricator.

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No. IL DOT's typical design practices takes this into account.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Abutment seats under open joints, and piers at grade crossings that are within salt spray distance from traffic beneath the bridge, receive a coat of concrete sealer. See response to #32 for approved list.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

For T-type and L-type retaining walls that do not have epoxy-coated reinforcement for other steel, the bars extending across the cold joint between the stem and footing are required to be epoxy-coated.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

See response to Question #50. This only applies for piers at grade crossings where salt spray from traffic beneath the bridge is a concern.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

Column reinforcement is typically epoxy-coated. For shafts beneath ground, black steel is typically used.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

For piers with epoxy-coated reinforcement in columns, the footings typically also utilize epoxy-coated reinforcement for consistency.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No. IL DOT's typical practices are followed which includes steel coatings.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

No. IL DOT's typical design practices takes this into account.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

No.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

Yes. See IL DOT Bridge Preservation Guide.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

Not at this time.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

No

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

No.

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

No.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

None at this time.

Indiana Peer Exchange Survey Response

Group 1 State: Indiana

1. **Participant's Name(s)** [redacted]
2. **Organization** INDOT
3. **Title(s)** Director of Bridge Engineering and Bridge Asset Engineer
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Indiana confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Indiana Bridge Materials

Indiana	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,702	1,356
NHS Deck Area Percentage	28.4%	59.1%
Non-NHS No. of Bridges	11,399	3,684
Non-NHS Deck Area Percentage	71.6%	40.9%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Presently, INDOT Bridge Inspection only collects element-level data for NHS bridges.
8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   Presently, INDOT Bridge Inspection is not using any Agency-Defined Elements in its element level bridge inspections.
9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

Presently, INDOT Bridge Inspection does not require its inspectors to collect defect data; the bridge inspectors only collect overall quantity values for the four condition states for all applicable bridge elements.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    No

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    We only collect the FHWA requirements.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    N/A

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Not with any regularity.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**
15. **On your ADE items, what defects are you collecting?**
16. **Are you performing chloride profiling as part of your RC deck management?**

    Historically this has been limited to RC decks that would be considered borderline for an overlay based on the age or condition. This sort of testing is done by our research team.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    Individual deck assessments

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    No

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Not that I'm aware of .

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    Our research team has performed impact echo on bridge decks that are deemed border line for a rigid overlay based on visual inspection and year built.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    No.

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    INDOT does not use different coatings for different corrosive environment other than those directed by the LRFD, such as limits for uses of weathering steel.

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    As part of a rehab with a semi-integral conversion we use a partial paint system on the beam ends to be encase in concrete (if the rest of the structure is not being recoated. Details of our full paint and partial paint systems can be found in section 619 of INDOT's standard specifications: https://www.in.gov/dot/div/contracts/standards/book/sep21/600-2022.pdf

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    Once a coating condition is 5 or less, we start to program a structure for painting.

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    We have a standard drawing indicating the limits for painting weathering steel at supports: Std. Dwg. 619-PRWS-01 https://www.in.gov/dot/div/contracts/standards/drawings/sep22/600e/e600%20combined%20pdfs/E619-PRWS.pdf

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    INDOT has direct research of effective mitigation strategies for steel bridges. The reports can be found here: https://docs.lib.purdue.edu/jtrp/1677/ and here: https://docs.lib.purdue.edu/jtrp/1794/

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    We've experienced a fair amount of corrosion at the cut face of strand ends on prestressed girders. Our current design details, such as semi or fully integral bents and cast in place pier diaphragms have reduced this issue on newer structures.

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    We've had a few post tensioned bridges we've assessed over the year, but in those cases, we've hired a specialty consultant to help with the evaluation. Those sort of assessments are not part of our routine efforts.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    No

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    No

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    The Indiana Design Manual (IDM) provides condition and patching limits for when rigid and flexible overlays are appropriate. These can be found in IDM figure 412-1A in our manual. https://www.in.gov/dot/div/contracts/design/Part%204/Chapter%20412%20-%20Bridge%20Preservation.pdf

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    INDOT maintenance does apply deck sealers. We use a 100% silane product that we allow to be either a Isobutyltriethoxysilane or an Isobutyltrimethoxysilane material.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    The answer will be yes to all the above and is meant for Design but just wondering if we should also expand the question and explain we have business rules that tell us when epoxy and rigid overlays would be triggered. Agreed. Question 31 seems like a better place to share the business rules. I will add the spec links here for the actual installation info. Yes, rigid overlays are covered in section 722 of our standard specifications and recurring special provisions 722-B-317 and 722-B-318. Epoxy overlays are covered in section 738 and in recurring special provision 738-B-297.
    Section 700 of the standard specifications:
    https://www.in.gov/dot/div/contracts/standards/book/sep21/700-2022.pdf
    RSP 722-B-317 https://www.in.gov/dot/div/contracts/standards/rsp/sep21/700/722-B-317%20220901.pdf
    RSP 722-B-318 https://www.in.gov/dot/div/contracts/standards/rsp/sep21/700/722-B-318%20221201.pdf
    RSP 738-B-297 https://www.in.gov/dot/div/contracts/standards/rsp/sep21/700/738-B-297%20220901.pdf

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

Yes – Only when we are doing an HMA on rare occasions. We have two typical overlays that apply to the majority of our bridge assets. Bridge Thin Deck Overlay (epoxy overlay) and Bridge Deck Overlay (rigid overlay). Neither of these would require a membrane. There are limited situations where an HMA overlay might be considered and we are required to use a membrane 100% of the time when doing these.

35. How does your State determine the effectiveness of these corrosion mitigation actions?

INDOT directed research on "Increasing Bridge Deck Service Life" which compared different reinforcement types and life cycle analyses for extending service life. The report can be found here:
https://docs.lib.purdue.edu/jtrp/1576/
and here: https://docs.lib.purdue.edu/jtrp/1577/

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

(BMS)

– Yes – We use DTIMS BA by Deighton (out of Canada). It is fully integrated with our Bridge Inventory and Appraisal System (BIAS – Database), our GIS system and our Programming Software. https://www.deighton.com/

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

To some degree we do. We regular discuss and consider if we should be programming Major vs. Minor projects at a ratio of 60%/40%; 50%/50%; or 40%/60%. This is something we did more often prior to having a better feel and trust in our network optimization model. Now that we are generating 20-YR and 40-YR forecasts that we have high level of confidence, we are using 5YR averages based on the DTIMS forecast for each work type. Those work types are: Bridge Thin Deck Overlay, Bridge Deck Overlay, Bridge Deck Replacement, Replace Superstructure and Bridge Replacement. Using the DTIMS output, we establish how the budgets are distributed to each district. The districts will use our DTIMS output and determine the final 20-YR and 40-YR bridge plan. We review this plan and make sure the distribution of the budget to each work type is in line with the DTIMS model.

38. What is your State's maintenance cost per square foot for your bridge inventory?

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

While we may not have written guidance specific to corrosion prevention, our bridge asset department business rules are based on optimization strategies that try to avoid corrosion in the first place. We are putting surface seal on new RC decks at years 2 and 7. We anticipate an epoxy overlay at year 10. We may have another epoxy overlay at year 20 or the optimized strategy may have us wait and go with a rigid overlay next. These planned overlays along with more modern details should minimize the corrosion issues we would see in the past. Regarding design standards for corrosion prevention in decks: INDOT requires a 4 ksi concrete, 8" deck thickness including 0.5" sacrificial wearing surface, a minimum bar spacing of 8" (for crack width reduction) and a minimum bar size of #5. All these requirements are found in Chapter 404 section 2.01 of Indiana Design Manual:
https://www.in.gov/dot/div/contracts/design/Part%204/Chapter%20404%20-%20Bridge%20Deck.pdf

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

INDOT uses a standard 2.5" over top cover and epoxy coated bars in all new decks.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

INDOT uses epoxy coated rebar in bridge railings also.

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

INDOT allows a new type of concrete admixture called E5 in our concretes. This admixture has performed very well in research and field application. The material eliminates the need for wet curing and results in denser final product. Information on the material can be found in Construction Memo 22-02:
https://www.in.gov/dot/div/contracts/conmemo/22-02(revised2).pdf
More info on the material can be found in this INDOT directed research:
https://docs.lib.purdue.edu/jtrp/1785/

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

INDOT does have specific guidance for steel decks.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

General guidance on the appropriate applications of weathering steel can be found in the IDM Chapter 407-2.01(01) and information on best detailing practices can be found in IDM Chapter 407-2.01 (03). Both sections can be found here: https://www.in.gov/dot/div/contracts/design/Part%204/Chapter%20407%20-%20Steel%20Structure.pdf

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

IDM 407-2.01 (03) linked in question 44 and the standard drawing 619-PRWS-01: https://www.in.gov/dot/div/contracts/standards/drawings/sep22/600e/e600%20combined%20pdfs/E619-PRWS.pdf

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

Weathering steel is preferred over painted steel in all instances except where site conditions are undesirable. We've galvanized a few short span steel superstructures in recent years, but do not have specific guidance on the matter.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link) INDOT uses epoxy coated reinforcement in all RC superstructures.

Guidance on RC slab structures can be found in IDM chapter 405-3.0: https://www.in.gov/dot/div/contracts/design/Part%204/Chapter%20405%20-%20Reinforced-Concrete%20Structure.pdf

INDOT does not provide specific guidance for corrosion mitigation of prestressed or post tensioned members.

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

We have inspectors in our PS plants, but I'm not aware of any specific practices aimed at corrosion mitigation.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No, we do not build many segmental structures.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Not really. INDOT utilized integral end bents wherever possible and semi-integral when integral limits are exceeded. These joint elimination strategies are our main corrosion prevention techniques.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Epoxy coated reinforcement is used on caps under expansion joints per IDM 409-6.02(01) https://www.in.gov/dot/div/contracts/design/Part%204/Chapter%20409%20-%20Abutment,%20Bent,%20Pier,%20and%20Bearing.pdf

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

No

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

No

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

No

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No, all of our expansion joints are based on movement needs.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

INDOT maintenance cleans the tops of bridge decks that have railings by either blowing them off or sweeping annually. INDOT maintenance flushes out bridge joints and bridge deck drains annually. INDOT maintenance cleans and flushes abutments/end bents, which includes bearings and approximately 3 feet of beam ends, under bridge deck expansion joints annually. INDOT maintenance cleans and flushes bottom chords and truss members to approximately 6 feet above the bridge deck biannually. This information is published in our INDOT Maintenance Work Performance Standards.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

I think we've shared them all within this survey.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

While this is not really an answer to this question, Bridge Asset Department has started modifying our forecast model to simulate climate change impacts to our budgets and bridge plan. For example, we determined it was a good simulation to increase the cost of bridge replacement by 20% for any bridge to account for the cost increase to just the wet crossing assuming they would need to be increased for higher design flows

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

INDOT has direct research of effective mitigation strategies for steel bridges. The reports can be found here: https://docs.lib.purdue.edu/jtrp/1677/ and here: https://docs.lib.purdue.edu/jtrp/1794/

INDOT directed research on "Increasing Bridge Deck Service Life" which compared different reinforcement types and life cycle analyses for extending service life. The

report can be found here: https://docs.lib.purdue.edu/jtrp/1576/ and here: https://docs.lib.purdue.edu/jtrp/1577/

E5 Concrete Admixture: info on the material can be found in this INDOT directed research: https://docs.lib.purdue.edu/jtrp/1785/

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Corroded Beam End Study: https://rip.trb.org/View/1736383 and https://trid.trb.org/view/1874074

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

A place where we struggle with corrosion is at pile bents. We have quite a few bridges with exposed steel encased shell pile interior supports. Recoating these is difficult because of the environmental permitting implications, and we are receiving high bids for the work. Exploring better coatings or minimally invasive retrofits could be helpful.

Iowa Peer Exchange Survey Response

Group 1 State: Iowa

1. **Participant's Name(s)** [redacted]
2. **Organization** Iowa DOT
3. **Title(s)** Final Design Section Leader and Bridge Preservation Engineer
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Full Bridge Design Manual (BDM):
https://iowadot.gov/bridge/policy/LRFDBridgeDesignManual.pdf

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Iowa confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Iowa Bridge Materials

Iowa	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	2,025	623
NHS Deck Area Percentage	31.6%	48.3%
Non-NHS No. of Bridges	12,977	6,699
Non-NHS Deck Area Percentage	68.4%	51.7%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**
   Yes.
8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**
   Weathering Steel protective coating (ft^2)
9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

Yes. No additional defects.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    No.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    None.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    Yes.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    No.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    Concrete Reinforcing Steel Mixed Protective System (ft^2), Concrete Used as Protective Coating (ft^2)

15. **On your ADE items, what defects are you collecting?**

    Delamination, Efflorescence, Cracking, Damage, Effectiveness

16. **Are you performing chloride profiling as part of your RC deck management?**

    No.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    N/A.

18. **Do you have written guidance on specific repair actions related to chloride levels?**

    No. (Please provide a PDF or web link)

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    No.

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    Yes. We use hand sounding to find hollow areas in concrete overlays. The overlay is epoxy injected when hollow areas are found. We have issued an RFP to use NDE to map and classify cracking on new bridge decks and are considering implementing decision trees for preservation actions for categories of cracked decks.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    No.

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    No.

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    No.

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    No.

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    Yes. Link to bridge design manual https://iowadot.gov/bridge/policy/05-05-00CwpgLRFD.pdf – section 5.5.2.4.1.2 discusses painting weathering steel.

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    No.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    No. Link to Bridge Maintenance Manual - https://iowadot.gov/siims/IowaDOT_BridgeMaintenanceManual.pdf - see chapter 6

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    No.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    No.

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    Effectiveness is communicated by local repair crews over time. No formal procedure.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    No, but there is a research project that is nearing completion that may lead to implementing written guidance on bridge preservation actions for cracked bridge decks.

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    No.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s).**

    Yes. Link to overlay spec - https://iowadot.gov/erl/current/CM/content/CM%2011.60.htm standard thickness is 1.75". Deck is scarified 0.25" before areas of deterioration are repaired.

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    No.

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    By using the wearing surface element from the AASHTO bridge management elements.

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

    No.

37. **Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.**

    Yes. We try to use 15% of our total budget on overlays. We have an additional $11 million we spend on bridge maintenance and preservation annually.

38. **What is your State's maintenance cost per square foot for your bridge inventory?**

    Unknown.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

No.

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

Yes. Link to Bridge Design Manual: https://iowadot.gov/bridge/policy/05-02-00DeckLRFD.pdf 5.2.4.1.1.2 and section 5.2.4.1.2.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

Yes. Link to
Bridge Design Manual: https://iowadot.gov/bridge/policy/05-02-00DeckLRFD.pdf
- See section 5.2.4.1.1.2.

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

High performance concrete is used for decks in areas of the state where it is available. Otherwise, standard class C concrete is used. Link to Bridge Design Manual: https://iowadot.gov/bridge/policy/05-02-00DeckLRFD.pdf - See section 5.2.4.1.1.2.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link).

No.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Yes. All CWPG are unpainted weathering steel by default unless unfavorable site conditions exist. A 1/16" sacrificial thickness is added to the minimum design thickness for all web and flange plates. See BDM section 5.5.2.4.1.2 and 5.5.2.4.1.3 for further details: https://iowadot.gov/bridge/policy/05-05-00CwpgLRFD.pdf

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Yes. See BDM section 5.5.2.4.2: https://iowadot.gov/bridge/policy/05-05-00CwpgLRFD.pdf

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. **Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)**

    Yes. Beam stirrups that extend into the deck are required to be epoxy coated. Beam ends located under expansion joints are required to be sealed. See BDM section 5.4.1.4.2 https://iowadot.gov/bridge/policy/05-04-00PpcbLRFD.pdf

48. **Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)**

    Yes. See Materials Instructional Memorandum 570 for precast/prestressed: https://iowadot.gov/erl/current/IM/content/570.htm

49. **Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)**

    No.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. **Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)**

    Yes. Wash sections are provided between bearings at stub abutments. Wash sections and bearing seats are sealed. See BDM section 6.54.2.2: https://iowadot.gov/bridge/policy/06-05-00AbutLRFD.pdf

51. **Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?**

    Yes. Stainless steel is used for barrier rail to wing reinforcing. SEE BDM section 6.5.4.3.2: https://iowadot.gov/bridge/policy/06-05-00AbutLRFD.pdf.

52. **Does your State have written guidance addressing pier cap areas for corrosion protection(e.g., coatings, slopes, cover, reinforcing type changes, etc.)?**

    Yes. Epoxy coated reinforcing s required in caps located below expansion joints. Pier caps below expansion joints are also required to be sealed. See BDM section 6.6.4.1.1.2: https://iowadot.gov/bridge/policy/06-06-00PierLRFD.pdf

53. **Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?**

Yes. Epoxy coated reinforcing is required for pier columns either located under an expansion joint or within 25' of the edge of the traveled roadway. See BDM section 6.6.4.1.2.2: https://iowadot.gov/bridge/policy/06-06-00PierLRFD.pdf

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Steel H-pile in pile bents are typically encased in concrete. See standard plan sheet P10L: https://iowadot.gov/erl/current/BR/content_eng/p10l.pdf

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

Yes. Bearing parts that are not made of weathering steel or stainless steel are to be galvanized and/or painted. See BDM section 5.7.4.3.2: https://iowadot.gov/bridge/policy/05-07-00BearLRFD.pdf

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

Yes. Finger joints are required to be galvanized. See BDM section 5.8.3.3.2: https://iowadot.gov/bridge/policy/05-08-03ExpJointLRFD.pdf
Strip seal extrusions are required to be galvanized. See standard sheet 1026s2: https://iowadot.gov/bridge/standards/english/EnglishDeckRailBridges.pdf

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

No.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

No changes related to corrosion prevention or mitigation are being considered at this time. Considering implementing changes in hydraulic design to improve resiliency.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

No.

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Yes. Guide to Remediate Bridge Deck Cracking - WJE. Results of this research project will guide policy development for addressing early age deck cracking in new bridges.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Research establishing critical chloride threshold for various reinforcing types (plain, epoxy, stainless, galvanized, etc.) would be helpful. ACI may have a task force working on this.

Kansas Peer Exchange Survey Response

Group 1 State: Kansas

1. **Participant's Name(s)** [redacted]
2. **Organization Kansas Department of Transportation**
3. **Title(s) State Bridge Engineer and Bridge Inspection Engineer**
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Kansas confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Kansas Bridge Materials

Kansas	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	2,100	734
NHS Deck Area Percentage	51.2%	48.8%
Non-NHS No. of Bridges	14,412	6,750
Non-NHS Deck Area Percentage	65.1%	33.5%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Kansas DOT does collect element level data for Non-NHS Bridges on the State System, however it does not collect elements for non-NHS Bridges on the Local System.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   Item # 850 – Steel Hinge where Kansas DOT tracks their condition states of each hinge for each girder.

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

Kansas DOT incorporated these defects into the Element Condition States. Therefore, we do not code additional defects at this time.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    Kansas DOT uses thickness gauges to determine loss of section from corrosion (mainly on gusset plates, girder webs, girder flanges, etc.). When the condition of the member being inspected has significant corrosion that it has become a concern, we will perform these Special Inspections.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    Kansas DOT does not have any Agency Defined Elements to identify corrosion prevention actions for PS/PT & RC highway bridge members.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    Kansas DOT does not collect "Defect Data". We incorporated all the defects into our Element Condition States.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Cores and chloride tests are determined for patching quantities on large, or critical, bridge repair projects.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    Kansas DOT does not have any Agency Defined Elements to identify corrosion prevention actions for RC Decks.

15. **On your ADE items, what defects are you collecting?**

    The following are the Agency Defined Elements that we are collecting: 810 – Reinforced Concrete slab Girder (feet), 844 – Reinforced Concrete wing on culvert (each), 845 – Reinforced Concrete Hinge (each), 846 – Reinforced Concrete Girder End (each), 850 – Steel Hinge (each), 858 – Deck Cracking (Agency) (each), 861 – Scour Smart Flag (Agency) (each). All other defects are incorporated into each CoRE Element's Condition State.

16. **Are you performing chloride profiling as part of your RC deck management?**

    No

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    N/A

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**
    No
19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**
    No
20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**
    Chaining during routine bridge inspections.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**
    No
22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**
    Weathering Steel is default. See KDOT Bridge Design Manual (BDM) sec 6.4.13
23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**
    BDM 6.4.12 and Standard Specification 714
24. **Does your State use lifecycle analysis basis for recoating existing steel members?**
    No
25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**
    Standard Specification 714.3 (d)
26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**
    Routine bridge inspections and coordination with the Bridge Maintenance Plans Engineer

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**
    No
28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

No. The one long span PT bridge on the state system was recently repaired. The other PT bridges are PT Deck Slab superstructures. Ducts are inspected visually with routine bridge inspections.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    No

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    Routine bridge inspections and coordination with the Bridge Maintenance Plans Engineer

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    No

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    On occasion. HWWM and Silane. These on applied on a project-by-project basis, using bridge condition and traffic counts as considerations.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    New construction is almost always one course decks. No written guidance for maintenance actions. Concrete overlay specification- See Standard Specification 717

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    Membranes only used by bituminous overlays. Bituminous overlays are applied only near expected end of bridge life.

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    Through review of routine bridge inspections and the bridge maintenance repair program (not a software program, but a construction program)

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

    Beginning stages of implementation for this use

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

No

38. What is your State's maintenance cost per square foot for your bridge inventory?

Not available

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

BDM 5.2.4.1, 5.2.4.9, and 9.3

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

Epoxy coated reinforcing is used for bridge decks, barriers and substructure within a splash zone., See BDM 9.3

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

No

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

BDM Table 9.3.1

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

Steel Decks are not used on the state system.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Weathering Steel is default. See KDOT Bridge Design Manual (BDM) sec 6.4.13

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Standard Specification 714.3 (d)

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

For PT superstructures, see BDM 5.3.7.6; for Reinforced Concrete see answers to questions 39 and 40.

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

See Standard Specification 715.3

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

BDM 11.1.2

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

BDM 11.2.2.2

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

BDM 11.2.2.3

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

New steel substructure element on state system (i.e. pile bents) are encased in concrete. For Local bridges, the piles are to be protected, i.e. painted or galvanized. BDM 11.2.2.4

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

BDM 14.4 and 14.5

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

Finger and sliding plate devices are galvanized. See BDM 14.2.3 for Strip Seal joints

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

Not at this time

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

Not at this time

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Looking at hydraulic design criteria

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

Low Cracking Concrete Deck research with the University of Kansas

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Reviewing effectiveness of polymer overlays with the University of Kansas. Finishing a project on a state specific UHPC mix with the same.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Michigan Peer Exchange Survey Response

Group 1 State: Michigan

1. **Participant's Name(s)** [redacted]
2. **Organization** – Michigan Department of Transportation
3. **Title(s)** – Priority Preservation and Maintenance Support Unit Engineer
4. **Phone Number(s)** [redacted]
5. **E-mail(s) -** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Michigan confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Michigan Bridge Materials

Michigan	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,337	1,639
NHS Deck Area Percentage	43.6%	63.4%
Non-NHS No. of Bridges	4,816	2,728
Non-NHS Deck Area Percentage	56.4%	36.6%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   All bridges that are NBI length and owned by the state have element level data collected this applies to NHS and Non-NHS structures.
8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   The only ADE's that we capture that could indicate corrosion would be our ADE 826 Beam End Deterioration, and 849 A588 Steel Patina
9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

No, we do not collect defect data with our element data.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    General methods include chain dragging, hammer sounding, and visual inspection. these are the simplest and easily repeatable. other methods such as corrosion potential mapping are generally done on an experimental basis.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    The only ADE that we capture that could indicate corrosion would be our ADE 826 Beam End Deterioration

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    No we do not collect defect data with our element data.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Occasionally partial or full depth 4" concrete deck cores are taken. the cores can be visually assessed, tested for AAR using uranyl acetate, and for air content and compressive strength. these are used to determine feasibility of shallow overlays, or presence of slag aggregate concrete. chloride testing is not done on a routine basis. in the past it was used to determine if a shallow overlay was feasible. it involves collecting powdered drill samples at various depths and analyzed for water soluble chlorides.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    We do not collect ADE's specific to corrosion, but we collect ADE's specific to the reinforcement type. For example, we have black bar, epoxy coated, nonmetallic, and stainless-steel deck and slab ADE's.

15. **On your ADE items, what defects are you collecting?**

    No we do not collect defect data with our element data we capture a handful of other ADE's to indicate defects including beam end deterioration.

16. **Are you performing chloride profiling as part of your RC deck management?**

    No, MDOT does not perform chloride profiling.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    MDOT does not perform chloride profiling.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

No, MDOT does not have written guidance on specific repair actions related to chloride levels.

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Occasionally partial or full depth 4" concrete deck cores are taken. the cores can be visually assessed, tested for AAR using uranyl acetate, and for air content and compressive strength. these are used to determine feasibility of shallow overlays, or presence of slag aggregate concrete. chloride testing is not done on a routine basis. in the past it was used to determine if a shallow overlay was feasible. it involves collecting powdered drill samples at various depths and analyzed for water soluble chlorides.

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    MDOT does not. Mostly NDE is done to assess the overall condition during scoping to program appropriate fixes (i.e., patching vs shallow overlay vs deep overlay).

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    There are several documents that provide guidance on addressing existing coating systems on bridges in Michigan. The first is the Steel Bridge Girder Coatings Repair Matrix, which provides a recommended repair based on the type of defect and the condition state. Existing bridge coating systems are also discussed in the Michigan Project Scoping Manual.

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    MDOT does not have written guidance for using different coatings based on severity of corrosive environment. MDOT has a qualified products list of our three coat systems for steel. For concrete MDOT has an approved list of sealers.

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    There are several documents that provide guidance on when to program a project with full painting, partial painting, and spot painting. The first is the Steel Bridge Girder Coatings Repair Matrix, which provides a recommended repair based on the type of defect and the condition state. Existing bridge coating systems are also discussed in the Michigan Project Scoping Manual. The Bridge Preservation Guidelines section of the manual (starting on page 5-36) includes conditions for when each scope for cleaning and coating the existing structural steel should be considered.

Chapter 12 of the MDOT Bridge Design Manual provides more detailed guidance to the design engineer on the limits of cleaning and coating that should be included in a project when specific repairs to the existing structural steel are included in the scope of work.

24. Does your State use lifecycle analysis basis for recoating existing steel members?

No, a life cycle cost analysis is not used as the basis for recoating existing structural steel. In most cases the primary scope of work for the project (i.e., deck replacement, structural steel repair, etc.) and the expected life for that fix are used to determine the limits of cleaning and coating in addition to the condition state of the existing paint system.

The Bridge Preservation Guidelines section of the Michigan Project Scoping Manual (starting on page 5-36) also includes conditions for when each scope for cleaning and coating the existing structural steel should be considered.

25. Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)

Chapter 12 of the MDOT English Bridge Design Manual (state.mi.us) provides guidelines for when to consider cleaning and coating existing A588 structural steel. The criteria is also included below for easy reference.

- Little or no section loss (< 20%), painting is not required.
- Significant section loss (≥ 20%), the entire structure is painted. This includes projects with beam end repairs.
- Pin and hanger projects where beams are otherwise in good condition (< 20% section loss), beams are zone painted (with the outside of the fascia beams top coated brown in the zone area).

The Bridge Preservation Guidelines section of the Michigan Project Scoping Manual (on page 5-44) also includes guidance on when to zone paint existing A588 (weathering) steel should be considered.

26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

We track our calculated deterioration rates on a five-year cycle to see how they compare cycle to cycle. We also track some of the unique or experimental corrosion mitigation techniques separately.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)

MDOT does not have a different policy based on corrosion.

28. Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?

No

29. Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.

The only current guidance is related to when prestressed concrete beam ends should be repaired and how to repair them. A discussion of when to repair them is included in the

The Bridge Preservation Guidelines section of the Michigan Project Scoping Manual (on page 5-44) and information on how to repair them is included in the report from a research project completed in 2000.

MDOT has a research project on going that is looking at concrete deterioration of prestressed beams due to material compatibility issues that should be completed in the near future. Additional guidelines may be developed through this research project.

Section 7.02.18.A of the MDOT Bridge Design Manual calls for the ends of beams under open joints to be sealed with an elastomeric sealer. This is a relatively new policy.

30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

We track our calculated deterioration rates on a five-year cycle to see how they compare cycle to cycle. We also track some of the unique or experimental corrosion mitigation techniques separately.

RC Decks

31. Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)

There are several documents that provide guidance on addressing existing coating systems on bridges in Michigan. There are Bridge Deck Preservations Matrices for bridge decks with uncoated reinforcement and for bridge decks with epoxy coated reinforcement . Both provide recommended repairs based on the condition rating and percent of deterioration across the top and bottom surfaces of the bridge deck. The preservation of existing bridge decks is also discussed in various sections of the Michigan Project Scoping Manual. Bridge preservation rules for bridge decks start on page 5-38, and many sections reference back to the Bridge Deck Preservation Matrix.

32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?

Yes, deck sealers are used to extend the service life of bridge decks. Guidelines for when to use the sealers and the anticipated life of the sealers are included in the Bridge Deck Preservation Matrices (uncoated reinforcement, epoxy coated reinforcement). Special provisions for the various sealers are listed below.

- Penetrating epoxy healer sealer – 20SP-710B-03
- Two-coat epoxy overlay – 20SP-712B-02
- Two-coat (minimum) epoxy polymer overlay with a performance warranty – 20SP-712C-02

MDOT does use spray applied penetrating silane to seal concrete elements such as barriers and deck slab fascias, but this sealer is prohibited from use on traffic surfaces.

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

Written guidance for the use of rigid bridge deck overlays is provided in several references as summarized below.

- The Bridge Deck Preservation Matrices (uncoated reinforcement, epoxy coated reinforcement) provide recommended repairs based on the condition rating and percent of deterioration across the top and bottom surfaces of the bridge deck.
- Section 12.04 and 12.04.06 of the MDOT Bridge Design Manual provides guidance for the anticipated fix life for rigid overlays, the material to be used for the rigid overlay, the depth of removal of the existing bridge deck, and the minimum thickness of the rigid overlay.
- The Michigan Project Scoping Manual includes a section on bridge preservation rules for bridge decks, which start on page 5-38. This section includes guidelines for the type and extent of deterioration that the different rigid overlay options should be considered for.
- Any bridge deck that was constructed of concrete with slag aggregate is not allowed to be overlaid. These bridge decks are replaced if the deterioration warrants a repair more significant than applying a sealant. This is noted in the footnotes to the Bridge Deck Preservation Matrices.

Special considerations are also given to variable depth T-beam structures because the deck is part of the main load carrying member. A more detailed discussion of the preservation of bridge decks on these types of structures can be found in the Rehabilitation-Guidelines-T-Beam-Structures.pdf.

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

HMA overlays are not preferred in Michigan. MDOT does not have a standard practice for using a membrane as part of an overlay.

35. How does your State determine the effectiveness of these corrosion mitigation actions?

MDOT monitors the condition of its structures through the routine bridge inspection process.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

Yes. We use an in-house built spreadsheet called Bridge Condition Forecasting System (BCFS). We take average project costs by project category and apply them how a minimum condition basis to our inventory as we forecast deterioration. We manipulate the funding to identify funding needs and potential future conditions based on various funding scenarios. We are starting to use AASHTOWare BrM to assist in our needs planning.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

Yes. We use targeted spending percentages that slightly vary each year based on our TAMP analysis. This year we are using a strategy of 33% Replacement, 48% Rehabilitation, and 19% Preservation.

38. What is your State's maintenance cost per square foot for your bridge inventory?

$35.49

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

Chapter 7 of the MDOT Bridge Design Manual outlines specific measures that are implemented on projects to minimize the risk of corrosion of the reinforcement reducing the service life of bridge decks. This includes:

- Providing a minimum of 3" of clear cover over the top reinforcement (Section 7.02.20.D)
- Using epoxy coated reinforcement (Section 7.02.20.F) in our standard 9" thick bridge decks.
- Considering the use of stainless-clad and solid stainless steel reinforcement if one of the following is true (Section 7.04.02.A)
    - The additional expenditure for stainless-clad and solid stainless reinforcement, including cost savings from reduced cover requirements, is limited to no more than eight percent of the programmed structure cost.
    - For structures on trunkline roads where future repair and maintenance would be very disruptive to traffic and where mobility analysis defines

the project as significant and mitigation measures to minimize travel delay are needed.
- Over navigable waterways or protected wetlands sensitive to environmental impact from construction activity.
- Where the deck thickness is less than 9 inches, due to local geometric restrictions or in widening projects where the dead load is limited to the capacity of the existing substructure.
- Bridges located over high volume railway lines where access and right of way restrictions exist.

MDOT is in the process of replacing several bridge decks using ChromX reinforcement. Several other deck replacement projects are being designed using ChromX reinforcement as well as a means to further assess the product.

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

MDOT's current design policy is to use epoxy coated reinforcement in our standard bridge deck, which is 9" thick. The policy also calls for a minimum 3" of clear cover over the top reinforcement (Section 7.02.20).

Stainless-clad and solid stainless steel reinforcement is also considered for use if one of the following is true (Section 7.04.02.A):

- The additional expenditure for stainless-clad and solid stainless reinforcement, including cost savings from reduced cover requirements, is limited to no more than eight percent of the programmed structure cost.
- For structures on trunkline roads where future repair and maintenance would be very disruptive to traffic and where mobility analysis defines the project as significant and mitigation measures to minimize travel delay are needed.
- Over navigable waterways or protected wetlands sensitive to environmental impact from construction activity.
- Where the deck thickness is less than 9 inches, due to local geometric restrictions or in widening projects where the dead load is limited to the capacity of the existing substructure.
- Bridges located over high volume railway lines where access and right of way restrictions exist.

MDOT is in the process of replacing several bridge decks using ChromX reinforcement. Several other deck replacement projects are being designed using ChromX reinforcement as well as a means to further assess the product.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

MDOT's current design policy is to use epoxy coated reinforcement for all reinforcement in the superstructure, including in the barrier-deck interface (Section 7.02.20.F).

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

MDOT's standard concrete mixes used on bridges include supplemental cementitious materials (SCM) to provide resistance to ASR and to provide a more durable concrete. While not specifically designed for it, one of the side benefits of using SCM is a reduction in chloride penetration through the concrete.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

Steel bridge decks are not a standard deck type in Michigan. Where steel bridge decks are used project specific special provisions are usually prepared to cover the material, fabrication, and construction aspects of the steel deck.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Section 7.02.03.B of the MDOT Bridge Design Manual specifies that AASHTO M270 (ASTM A709) Grade 36, Grade 50, or Grade 50W steel is to be used in the fabrication of structural steel superstructures. This is reinforced in the Contract plans using standard plan notes and in the MDOT Standard Specifications for Construction. For new construction of steel superstructures Grade 50 or Grade 50W is the preferred grade and Grade 36 may be used for steel bearings, diaphragms, and cross frames.

Section 7.02.04 limits the thickness of steel plates to 8" for Grade 36 steel and to 4" for Grade 50 and Grade 50W steel. For specific projects higher grades of steel can be used, and project specific special provisions would be developed to cover the material, fabrication and construction aspects of the work. Hybrid designs using a combination of quenched and tempered steel according to ASTM A514 and ASTM A852 is prohibited in Section 7.02.09.C.

MDOT's standard coating system is a three-coat system consisting of a tinted organic zinc-rich primer, a white intermediate coat, and a urethane top coat. Galvanizing of the beams is also permitted as an option in Section 7.02.17 of the MDOT Bridge Design Manual. MDOT has let projects that utilized a two-coat paint system for evaluation purposes, but has not yet incorporated the two-coat system into our standard practice.

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Weathering steel used in the construction of new structural steel is to be painted.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

MDOT's current policy is to use a three-coat system consisting of a tinted organic zinc-rich primer, a white intermediate coat, and a urethane top coat to protect structural steel. Section 7.02.17 of the MDOT Bridge Design Manual permits the structural steel to be galvanized "if site conditions warrant it". It is currently left to the design engineer to decide through conversation with our coating and fabrication subject matter experts to make this assessment. The use of a life cycle cost analysis to make this determination is not specifically required but could be a useful tool in providing data to support the decision.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

Epoxy coated reinforcement is the standard type of mild reinforcement used by MDOT in the fabrication of prestressed/post-tensioned superstructures. This is outlined in Section 7.04.01.A of the MDOT Bridge Design Manual and in the MDOT English Bridge Design Guides. Stainless steel is permitted in place of epoxy coated reinforcement if warranted.

Section 7.02.18.A of the MDOT Bridge Design Manual outlines that uncoated ASTM A416 Grade 270 low relaxation steel prestressing strands are the standard type of prestressing steel used. MDOT has been involved in research related to the use of carbon fiber reinforced polymer (CFRP) strands for prestressing and post-tensioning concrete superstructures and has constructed more than a dozen projects using CFRP strands. The selection of structures where CFRP strands are used depends on a number of factors including:

- Locations where mobility would make it difficult to repair or replace the concrete superstructure in the future.
- Locations where the switch from steel strands to CFRP strands does not require additional beam lines for a given span.

Current research is looking into the use of 0.7" CFRP strands, which would allow for essentially a one-to-one replacement of 0.6" steel strands. MDOT is currently designing the first project that will use 0.7" CFRP strands.

Section 708.C.6 of the MDOT Standard Specifications for Construction require any miscellaneous steel (i.e., inserts for attachments, inserts for safety fences, etc.) cast into prestressed concrete beams to be galvanized in accordance with AASHTO M111, AASHTO M223, ASTM B633 Service Condition 1, ASTM B695, or epoxy coated.

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

MDOT does not have any fabrication inspection practices intended to specifically maximize service life by mitigating corrosion. MDOT does have material and fabrication requirements that the fabricator must meet to maximize the service life of the elements regardless of the exposure conditions. These standard practices can be found in Section 708 of the MDOT Standard Specifications for Construction.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

While MDOT has several segmental bridges in our inventory it is not a standard superstructure type. If selected for a specific location project specific special provisions would be developed to cover the materials, fabrication, and construction of the superstructure. Based on past experience and experience with other structural elements that require post-tensioning MDOT would likely rely heavily on the requirements outlined in the PTI Specification for Multistrand and Grouted Post-Tensioning (PTI M50.3) and the PTI Specification for Grouting of Post-Tensioned Structures (PTI M55.1).

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Section 7.03.11 of the MDOT Bridge Design Manual for new or patched substructure elements to be coated to prevent deterioration. Penetrating waterproofing sealers, epoxy sealers, and silane coatings are used to prevent water and chloride ingress, and Section 7.03.11 outlines when each should be used on substructure elements based on the location of joints and other project specific requirements like aesthetics.

The MDOT Bridge Design Guides call for a minimum 3” concrete cover to the centerline of the reinforcement in all substructure elements except for footings where the Bridge Design Guides call for a minimum of 4” concrete cover to the centerline of the reinforcement.

As outlined in Section 7.04.01.A of the MDOT Bridge Design Manual, all reinforcement in substructure elements is epoxy coated. Stainless steel reinforcement can be used instead of epoxy coated reinforcement if project and site conditions warrant it.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No, the guidelines for protecting wingwalls is no different than any other substructure element.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Section 7.03.11 of the MDOT Bridge Design Manual calls for new or patched substructure elements to be coated to prevent deterioration. Penetrating waterproofing sealers, epoxy sealers, and silane coatings are used to prevent water and chloride ingress, and Section 7.03.11 outlines when each should be used on substructure elements based on the location of joints and other project specific requirements like aesthetics.

The MDOT Bridge Design Manual calls for a minimum 3" concrete cover to the centerline of the reinforcement in all substructure elements except for footings where the Bridge Design Guides call for a minimum of 4" concrete cover to the centerline of the reinforcement.

As outlined in Section 7.04.01.A of the MDOT Bridge Design Manual, all reinforcement in substructure elements is epoxy coated. Stainless steel reinforcement can be used instead of epoxy coated reinforcement if project and site conditions warrant it.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

No, MDOT does not have any guidance on changing substructure column details or concrete mixes based on corrosion risk.

MDOT's standard concrete mixes used on bridges include supplemental cementitious materials (SCM) to provide resistance to ASR and to provide a more durable concrete. While not specifically designed for it, one of the side benefits of using SCM is a reduction in chloride penetration through the concrete.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No, MDOT does not have any guidance on changing footing details or concrete mixes based on corrosion risk.

MDOT's standard concrete mixes used on bridges include supplemental cementitious materials (SCM) to provide resistance to ASR and to provide a more durable concrete. While not specifically designed for it, one of the side benefits of using SCM is a reduction in chloride penetration through the concrete.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

MDOT does not have unique requirements for addressing corrosion prevention and mitigation of new steel substructure elements. Unless specifically addressed in a project specific special provision the fabrication and coating of the steel used in the substructure element would be treated in the same way all other structural steel is treated. This includes using AASHTO M270 (ASTM A709) Grade 36, Grade 50, or Grade 50W steel and MDOT's standard three-coat paint system (consisting of a tinted organic zinc-rich primer, a white intermediate coat, and a urethane top coat). Galvanizing of the steel would also be permitted as an option.

Section 7.03.09.B of the MDOT Bridge Design Manual includes a list of pile sizes and a maximum nominal pile driving resistance. It is the designer's responsibility to verify that the pile size listed for the desired nominal pile driving resistance is adequate to carry the applied loads after any section loss has occurred due to contamination or any other site specific conditions that could lead to accelerated corrosion.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

- Elastomeric bearings are MDOT's preferred bearing type.
- Section 716.03.B.4 of the MDOT Standard Specifications for Construction require portions of the bearings not welded to the structure (i.e., masonry plates) to be galvanized in accordance with AASHTO M111.
- Existing steel bearings are cleaned and coated with the three-coat paint system on rehabilitation projects if warranted based on the existing condition.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

It is MDOT's standard practice to locate joints off the bridge whenever possible to further protect the bridge. Concrete link slabs are also used to replace existing some zero movement joints when bridges are rehabilitated. All steel components of joints are galvanized.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

MDOT does not have different requirements for joint selection based on durability. The number of joints are minimized and located off of the structure whenever possible. Zero

movement joints are also often replaced with concrete link slabs to better protect the structure.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

MDOT does not currently have published guidelines that include definitive cycles/timeframes for bridge preservation treatments. General for when to apply preservation treatments based on condition are included in Michigan Project Scoping Manual. There is also a white paper that was prepared in 2016 that provides guidance on selecting bridges that are candidates for preservation treatments like crack sealing, thin overlays, and healer/sealers based on a number of factors, and gives a life expectancy for the treatments discussed.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

MDOT's standard practice for concrete patching and deck joint replacement involves placement of sacrificial galvanic anodes at the perimeter of the repair area. Requirements for the galvanic anodes are included in Section 12.08.02 of the MDOT Bridge Design Manual.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

MDOT is constantly evaluating current policies and procedures to improve the durability and service life of out bridges. At this point there are no specific changes intended to address the hazards due to potential climate change.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

MDOT has sponsored or participated in multiple research projects related to preventing and mitigating corrosion of highway bridges, some of which are listed below.

- Evaluating the Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer Prestressing and Post Tensioning Strands Subject to Longer Term Loss, Creep, and Environmental Factors
- Development, Characterization and Applications of a Non-Proprietary Ultra High Performance Concrete for Highway Bridges
- Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subject to Various Environmental Conditions

- Concrete Deterioration of Prestressed Bridge Beams

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

MDOT has sponsored or participated in multiple research projects related to preventing and mitigating corrosion of highway bridges, some of which are listed below.

- Evaluating the Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer Prestressing and Post Tensioning Strands Subject to Longer Term Loss, Creep, and Environmental Factors
- Development, Characterization and Applications of a Non-Proprietary Ultra High Performance Concrete for Highway Bridges
- Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subject to Various Environmental Conditions
- Concrete Deterioration of Prestressed Bridge Beams

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

New research on materials such as ultra-high performance concrete and on different bridge deck overlay materials and processes would be helpful.

Group 1 State: Missouri

1. **Participant's Name(s)** [redacted]
2. **Organization** MoDOT
3. **Title(s)** Structural Development and Support Engineer
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Missouri confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Missouri Bridge Materials

Missouri	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	2,308	1,340
NHS Deck Area Percentage	38.2%	55.9%
Non-NHS No. of Bridges	11,319	9,343
Non-NHS Deck Area Percentage	61.8%	44.1%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**
   No.
8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**
   None.
9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**
   No.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**
    When needed. UT gauges may be used to determine remaining section.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**
    None.
12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**
    No.
13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**
    No.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**
    None.
15. **On your ADE items, what defects are you collecting?**
    None.
16. **Are you performing chloride profiling as part of your RC deck management?**
    Sometimes it may be used as part of the scoping for a deck rehab project.
17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**
    Individual.
18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**
    No
19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**
    No.
20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**
    No.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    No

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    No

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    Not exactly. Handled with specs and plans notes.

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    No

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    Yes. Surfaces of structural steel at expansion joints within 1.5D or 10 feet from centerline of joint. 2022 Missouri Standard Specifications for Highway Construction (modot.org) - 1081.10.3.4.3.

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    If tracked, it would be in our Maintenance Management System, MMS.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    No

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    No

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    No

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    NA???

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

Yes. EPG 751.1.3.5 & 6. 751.1 Preliminary Design - Engineering_Policy_Guide (modot.org)

32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?

Yes. An alkyltrialkoxysilane, with low oligomer and polymer compound content. All new bridge decks and concrete wearing surfaces (except latex modified) or as directed.

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

Yes.

- Low Slump Concrete, 2 ¼" to 3", scarification then shot/sand blasting or hydrodemolition
- Latex Modified Concrete, 1 ¾" to 3", scarification then shot/sand blasting or hydrodemolition
- Silica Fume Concrete, 1 ¾" to 3", scarification then shot/sand blasting or hydrodemolition
- Latex Modified Very Early Strength Concrete, 1 ¾" to 3", scarification then shot/sand blasting or hydrodemolition
- CSA Cement Very Early Strength Concrete, 1 ¾" to 3", scarification then shot/sand blasting or hydrodemolition
- Steel Fiber Reinforced Concrete, 3" to 4", scarification then shot/sand blasting or hydrodemolition
- Polyester Polymer Concrete, ¾" to 3", scarification then shot/sand blasting or hydrodemolition
- Epoxy Polymer, ¼", shot blasting
- MMA, 3/8", shot blasting (discontinuing use of this product)

2022 Missouri Standard Specifications for Highway Construction (modot.org) – Sec 505 & 623

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

No

35. How does your State determine the effectiveness of these corrosion mitigation actions?

Feedback from Bridge Maintenance Engineers.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation?

We have recently implemented a Maintenance Management System, but I'm not sure how it is used for planning. (Please provide a PDF or web link)

37. **Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements?**

    Our Transportation Planning section programs Asset Management percentages. If so, please provide targets used.

38. **What is your State's maintenance cost per square foot for your bridge inventory?**

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below) 751.10 General Superstructure - Engineering_Policy_Guide (modot.org)

39. **Does your State have written guidance for corrosion prevention or mitigation strategies?**

    No.

40. **Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?**

    Epoxy coated rebar with approximately 3" cover standard

41. **Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?**

    Epoxy coated reinforcement standard

42. **Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?**

    We use a more corrosion resistant concrete (higher cement ratio) for the deck in comparison to the barrier.

New Designs – Steel Decks

43. **Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)**

    We don't utilize structural steel in our bridge decks.

New Designs – Steel Superstructures

44. **Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)**

    Yes. 751.14 Steel Superstructure - Engineering_Policy_Guide (modot.org)

45. **Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)**

Yes. 2022 Missouri Standard Specifications for Highway Construction (modot.org) – 1081.10.3.4.3

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

All reinforcing steel that extends into the deck is epoxy-coated. All steel in a slab superstructure is epoxy-coated.

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No. We do not provide standard guidance for segmental structures.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Yes. Epoxy coated reinforcing, sloping and Urethane or Epoxy Coating standard. 751.13 Expansion Joint Systems - Engineering_Policy_Guide (modot.org)

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No. Epoxy coated reinforcing standard.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Yes. See link for 50.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

Yes. See link for 50.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.)

Yes. (Please provide a PDF or web link) 751.1 Preliminary Design - Engineering_Policy_Guide (modot.org)

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

Yes. 751.13 Expansion Joint Systems - Engineering_Policy_Guide (modot.org) Inorganic zinc coating is standard for sole plates, and inorganic zinc or galvanization for anchor bolts.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

We have various details and ongoing tinkering to see what works.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.)

Not Exactly. We do have a service life expectancy table. (Please provide a PDF or web link) 751.13 Expansion Joint Systems - Engineering_Policy_Guide (modot.org)

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

Yes. 770.1 District Routine Maintenance and Special Crew Responsibilities - Engineering_Policy_Guide (modot.org)

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

We have designed several bridge decks with GFRP reinforcement and currently are sponsoring a research project for a MASH compliant GFRP barrier.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Not sure??? We expect potential increases to design flood elevations as flood data is adjusted for recent events.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

No.

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

GFRP reinforced concrete barriers

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Not sure.

Nebraska Peer Exchange Survey Response

Group 1 State: Nebraska

1. **Participant's Name(s)** [redacted]
2. **Organization** Nebraska Department of Transportation
3. **Title(s)** State Bridge Engineer, Assistant Bridge Engineer – Research
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Nebraska confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Nebraska Bridge Materials

Nebraska	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,117	371
NHS Deck Area Percentage	33.6%	37.3%
Non-NHS No. of Bridges	6,323	6,808
Non-NHS Deck Area Percentage	66.4%	62.7%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   NDOT collects element level data for State Owned NHS bridges and for locally owned NHS bridges. NDOT collects element level data on State owned non-NHS bridges but does not require it for Locally Owned non-NHS bridges.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

ELEM_KEY	ELEM_LONGNAME
515	Steel Protective Coating
520	Concrete Reinforcing Steel Protective System
9540	Steel Paint Protective Coating

9541	Weathering Steel Protective
Coating 9542	Galvanized Steel Protective Coating
9543	Other Steel Protective Coating

9. For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?

Not sure which are part of the MBEI manual, but these are the defects that NDOT flags.

ELEM_KEY	ELEM_SHORTNAME
1000	Corrosion
1010	Cracking
1020	Connection
1080	Delamination/Spall/Patched Area
1090	Exposed Rebar
1100	Exposed Prestressing
1110	Cracking (PSC)
1120	Efflorescence/Rust Staining
1130	Cracking (RC and Other)
1140	Decay/Section Loss
1150	Check/Shake
1160	Crack (Timber)
1170	Split/Delamination (Timber)
1180	Abrasion
1190	Abrasion(PSC/RC)
1220	Deterioration (Other)
1610	Mortar Breakdown (Masonry)
1620	Split/Spall (Masonry)
1630	Patched Area (Masonry)
1640	Masonry Displacement
1900	Distortion
2210	Movement
2220	Alignment
2230	Bulging, Splitting or Tearing
2240	Loss of Bearing Area
2310	Leakage
2320	Seal Adhesion
2330	Seal Damage
2340	Seal Cracking
2350	Debris Impaction
2360	Adjacent Deck or Header
2370	Metal Deterioration or Damage
3210	Del/Spall/Patch/Pot(Wear Surf)

3220	Crack (Wearing Surface)
3230	Effectiveness (Wearing Surface)
3410	Chalk(Steel Protect Coatings)
3420	Peel/Bub/Crack(Stl Protect Coat)
3430	Ox Flm/Txt Adhr(Stl Prot Coat)
3440	Eff (Stl Protect Coat)
3510	Wear (Concrete Protect Coat)
3520	Chalking (Concrete Protect Coat)
3530	Peel/Bub/Crack(Crete Prot Coat)
3540	Eff(Crete Protect Coat)
3600	Eff - Protect Sys(e.g., cathodic)
4000	Settlement
5000	Load Capacity
6000	Scour
7000	Damage
9900	Texture (Deck)
9901	Effective (Counter)
9902	Chloride - not yet incorporated into agency data
9903	Half-Cell - not yet incorporated into agency data
9904	Debris Blocking
9905	Raveling (AC)
9906	Rutting (AC)
9907	Cracking (AC)

10. Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?

Occasionally, various concrete NDE. Researching GPR (air-coupled) applications for bridge decks with asphalt overlays.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?

520 Concrete Reinforcing Steel Protective System
9512 A/C Over Membrane
9514 Multi-Poly Overlay

12. For the elements you are required to collect, do you collect defect data? If so, what defects do you code?

Please see Q 9

13. Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?

Yes. Mostly cores on decks to aide in determination of action strategy.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**
    Please see Q 11. Item 108 would also apply.
15. **On your ADE items, what defects are you collecting?**
    Those shown in Q9 would apply.
16. **Are you performing chloride profiling as part of your RC deck management?**
    Generally, no. Sometimes on a case-by-case basis.
17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**
    Both
18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**
    Prior to 2010, decks were assessed for chlorides before concrete overlays were specified.
19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**
    On a case-by-case basis, a deck might be cored to evaluate the integrity (bond) of an existing concrete overlay.
20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**
    IR, GPR, IE have been evaluated for accuracy and consistency, but not widely used at this time.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**
    Internal guidance only, no published policy.
22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**
    Internal guidance only, no published policy.
23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**
    Internal guidance only, no published policy.
24. **Does your State use lifecycle analysis basis for recoating existing steel members? No**
25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

Not currently, published. Upcoming Bridge Office Policy manual will contain the following:

Where the use of Grade 50W or HPS-70W unpainted weathering steel is permitted, the following criteria must be met:

a) The number of expansion joints shall be minimized.
b) Details to avoid retention of water and debris shall be incorporated in the design.
c) The steel shall be painted to a length of at least 1.5 times web depth and a minimum of 5 ft. on each side of the expansion joint. For additional information, refer to NCHRP Report No.314, Guidelines for the Use of weathering Steel in Bridges.
d) Drip plates shall be provided.
e) The substructure units shall be protected against staining. Use special drainage details for pier and abutment tops and/or protective coating for reinforced concrete surfaces in accordance with the Publication 408. Drip bars attached as indicated on the standard detail.
f) Mechanical fasteners made of ASTM F3125 Grade A325 and Grade A490, Type 3, weathering steels and stainless steels are suitable for weathering steel bridges.

Preferably for weathering steel bridges, use mechanical fasteners made of weathering steel. When stainless steel mechanical fasteners are used with weathering steel bridges, there is a possibility of galvanic corrosion of the weathering steel. Due to the small area of the bolt in relation to the material being bolted, the effect is usually negligible.

Do not use zinc and cadmium galvanized carbon-steel bolts for weathering steel bridges.

For existing bridges, where Grade 50W unpainted steel is used, clean and paint the beam ends up to 5 ft. from leaking joints, or to where the weathering steel area is exposed to or subject to saltwater spray.

26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

No unique method of tracking painting of WS, but element data can be queried to check effectiveness.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)

Our standard details incorporate mitigation (jointless bridge policy, among others)

28. Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?

No

29. Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.

No

30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

Routine and Special inspections.

RC Decks

31. Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)

Not currently written, however below is a draft of our upcoming written policy.

7.3 Waterproofing Membranes

There are two different types of membrane systems used to preserve existing and new bridge decks, including slab bridges:

1. Preformed Fabric
2. Liquid-Applied

Base Sheets for each membrane type are available for use in the Appendix.

Payment

Waterproofing membrane pay items will be listed as Group 9 Items on the front sheet of the bridge plans.

Membranes are paid for by the plan area of covered deck and approach. The limits of the waterproofing membrane will be specified in the bridge determination and will be shown in the plans.

-Fabric Membranes are measured by the square yard (SY).

-Liquid Membranes are measured by the square foot (SF).

7.3.1 Preformed Fabric Membranes

Preformed Waterproofing Membrane, Type 2

Use this membrane type for existing bridges . Preformed Waterproofing Membrane, Type 3

Use this membrane type for new bridge decks or new slab bridges.

7.3.2 Liquid-Applied Membranes

Cold Liquid-Applied Membrane

Cold liquid-applied membranes are typically used to preserve higher value assets. When closure time in high traffic areas is a concern, one advantage unique to only this membrane type is traffic can be placed temporarily on the completed membrane for up to 7 days.

Hot Liquid-Applied Membrane
Hot liquid-applied membranes are applicable to existing or new bridge decks. They are especially effective when an existing concrete overlay is to be removed by milling.

7.3.3 Wick Drain & Curb Policy

When wick drains are used, designers should ensure that wick drains have proper termination points to daylight the water. Wick drain details should be provided and shown the plans in the following situations:

1. Closed Rail bridges with at 2 or more floor drains (in a gutter line) shall have the wick drains run between and terminated at the floor drains. If the bridge is superelevated, the wick drain would only be placed on the low side of the deck. It is acceptable to not place wick drains in the area between the end of the bridge and the first floor drain.
2. Bridges with raised medians with 2 or more floor drains (in a gutter line) shall have wick drains provided like paragraph 1, above.

Bridges with Open Rails shall be considered for the placement of a Curb Angle or Concrete Curb along the gutter line located at piers, bents, or end of floor to deflect chlorides away from these areas.

32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?

Lo-vis healer/sealer, when Acc+M isn't used

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

Current policy can be found in our Bridge Office Policies and Procedures found here: https://dot.nebraska.gov/media/cpodk45c/bopp-manual.pdf Section 3.1.10

Upcoming policy more extensive and reflective of current practice. Appended to these responses.

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

See response to question 31 above.

35. How does your State determine the effectiveness of these corrosion mitigation actions?

Visual inspection.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

BrM and spreadsheet effort to determine our 20-year fiscal needs.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

No

38. What is your State's maintenance cost per square foot for your bridge inventory?

Unknown

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

Epoxy steel, Acc+M, revised drip edge detail

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

Current Bridge Office Policies and Procedures found here: https://dot.nebraska.gov/media/cpodk45c/bopp-manual.pdf Section 2.4

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

No

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

No

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

No

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Yes. Various guidance can be found throughout our Current Bridge Office Policies and Procedures, found here: https://dot.nebraska.gov/media/cpodk45c/bopp-manual.pdf
Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)
See response to question 44.

45. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

46. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

No

47. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No

48. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

Not published, but we follow the FHWA recommendation bulletin and the latest ASBI recommendation.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

49. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No, maintain use of epoxy coated reinforcing and 3” cover.

50. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No, maintain use of epoxy coated reinforcing and 3" cover.

51. **Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?**

    No, maintain use of epoxy coated reinforcing and 3" cover.

52. **Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?**

    No

53. **Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?**

    No

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

54. **Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)**

    Current Bridge Office Policies and Procedures found here: https://dot.nebraska.gov/media/cpodk45c/bopp-manual.pdf Section 3.5

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

55. **Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)**

    New bridge bearing selection based on Bridge Office Policy and Procedures Manual, Section 3.5. Policy and selection criteria developed to address corrosion. Jointless end of floor details with partial integral abutments utilized on majority of new bridges to alleviate corrosion potential.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

56. **Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)**

    No

57. **Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)**

    No

Other Noteworthy Practices

Policy and Guidance

58. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No

59. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

FRP and epoxy Pile Jacket encasement for exposed steel bearing piles.
Wide adoption of asphalt overlays with membrane on new and good condition bridge decks.

60. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Yes. Evaluations of climate change induced environmental hazards are being evaluated and included in our TAMP report; an ongoing effort. Span arrangement, hydraulic capacity, scour potential, and structural durability are the key considerations currently.

Research

61. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

No

62. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Several research projects on bridge deck NDE utilizing GPR and IR to determine condition based on mitigation strategies (asphalt and membrane overlays).

Various UHPC research utilizing a non-proprietary mix for wide adoption throughout a bridge structure in both CIP and precast applications.

63. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

- Improved concrete mix design for deck concrete.
- Continued evaluation of existing asphalt and membrane overlay decks. Improved deck and concrete patching material to simplify repair work.
- Improved expansion joint selection criteria including expansion of asphalt plug joint materials to wider joint openings.
- Effective application of UHPC in various ways to improve overall durability of structure.

Florida Peer Exchange Survey Response

Group 2 State: Florida

1. **Participant's Name(s)** [redacted]
2. **Organization** Florida Department of Transportation
3. **Title(s)** State Structures Maintenance Engineer and Senior Structures Design Engineer
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Florida confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Florida Bridge Materials

Florida	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	5,006	713
NHS Deck Area Percentage	68.0%	71.2%
Non-NHS No. of Bridges	5,783	689
Non-NHS Deck Area Percentage	32.0%	28.8%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Yes.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   We have added different types of coatings as sub-elements to 515. These are Weathering Steel, Galvanized or Metalized Steel, and Other Coatings

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

   We collect defect data, but it's limited to the same defects listed in the MBEI.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    We use Dye Penetrant and Magnetic Particle testing to find defects on steel bridges. We have also used Ultrasonic testing to find section loss on bolts.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    None.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    We collect defect data listed in the MBEI, such as Exposed Rebar, Cracking, Delaminations/Spall/Patched Area, and Efflorescence Rust Staining.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    FDOT performs destructive testing to assess the status of cast-in-place, precast steel-reinforced concrete structures, and post-tension tendons.

    Commonly, concrete cores are extracted within concrete covers. Concrete cores are subjected to tests such as visual and microscopical inspection, compressive strength, surface resistivity, and chloride content. Post-tension ducts are opened, and grout is removed to test for chlorides. FDOT adopts the critical chloride content threshold of 1.2 lb/yd3 of concrete/grout. When the chlorides exceed 1.2 lb/yd3, carbon steel corrosion is deemed initiated.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    Concrete Deck on Precast Deck Panels is the only additional element we collect.

15. **On your ADE items, what defects are you collecting?**

    We collect the same defects that we collect for typical RC Decks. These are Exposed Rebar, Cracking, Delaminations/Spall/Patched Area, and Efflorescence Rust Staining.

16. **Are you performing chloride profiling as part of your RC deck management?**

    FDOT cores decks to assess the chloride content at different depths of the concrete cover. The number of core depth increments varies depending on the core length and the objective of the investigation. All layers are tested for chlorides and a profile is determined.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    Individual bridge assessments.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    FDOT considers that if chloride levels are higher than 1.2 lb/yd3 of concrete/grout, carbon steel corrosion is initiated. When concrete spalls are identified, the replacement of the contaminated concrete is needed following the Technical Specifications TSP 401 (Restoring Spalled Concrete Areas Using Concrete) and TSP 402 (Restoring Spalled Concrete Using Shotcrete). Often epoxy overlays are applied on reinforced concrete deck surfaces to seal cracks and restore the pavement friction per Developmental Specification Dev 403 (Epoxy Overlay for Sealing and High Friction Surface Treatment on Concrete Bridge Decks). The referred documents are attached for reference.

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Cores are also commonly taken to assess crack-sealing material penetration (e.g., penetrant sealer, epoxy, methacrylate).

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    No.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    FDOT adopts the Chapter 18 of the Bridge Maintenance Reference Manual. Please see the following link: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/maintenance/str/bi/reference-manual/bmrm-chapter-1847a8b332370e4a1285304698ed317d32.https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/maintenance/str/bi/reference-manual/bmrm-chapter-1847a8b332370e4a1285304698ed317d32.pdf?sfvrsn=36a6f912_0pdf?sfvrsn=36a6f912_0

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    FDOT State Materials Office (SMO) is consulted when environmental factors do not allow weathering steel to assess the use of an appropriate corrosion control coating system (5.1.1 & 5.12.1). Please see the following link: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/structuresmanual/currentrelease/2023/vol1sdg196884331.pdf

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    FDOT has guidance for full painting. Please see the PDF file attached (FDOT SECTION 561 Full Painting Specification).

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    Not yet.

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    Yes. See Sections 5.12 and 1.3.2 of the Structures Design Guidelines: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/structuresmanual/currentrelease/2023/vol1sdg196884331.pdf

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    Thru our bridge inspection program and review of the inspection reports.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    FDOT has developmental specifications (Dev) and technical special provisions (TSP) readily available. Please see the documents attached: TSP 401: Restoring Spalled Concrete Areas Using Concrete; TSP 402: Restoring Spalled Concrete Using Shotcrete; TSP 457: Galvanic Cathodic Protection Jackets. Note that TSPs are project specific and may vary from the attached PDF files. In addition, FDOT is in the process of a major revision to TSP 457, which will be used as the new template.

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    We perform interim inspections of external PT tendons. Additionally, we are currently investigating NDT techniques for internal PT.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    Guidance can be found on Chapter 4 of our Maintenance and Repair handbook: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/maintenance/maintenance/str/in/maintenance_and_repair_handbook_08-13-11.pdf?sfvrsn=2ae84edf_0

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    Thru our bridge inspection program and review of the inspection reports.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

Guidance can be found on Chapter 2 of our Maintenance and Repair handbook: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/maintenance/maintenance/str/in/maintenance_and_repair_handbook_08-13-11.pdf?sfvrsn=2ae84edf_0

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    Yes, see Dev403 and the above guidance.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    Guidance can be found on Chapter 2.2.6 of our Maintenance and Repair handbook: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/maintenance/maintenance/str/in/maintenance_and_repair_handbook_08-13-11.pdf?sfvrsn=2ae84edf_0

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    The same chapter includes an option for Bituminous Concrete with Waterproof Membrane overlays

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    Thru our bridge inspection program and review of the inspection reports.

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

    Neither of these approaches apply to Florida. Funding for bridge preservation is based on bridge inventory per district with a contingency amount kept for statewide use.

37. **Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.**

    No, FDOT takes a need-based approach to State owned bridge inventory. The priority spending is to preserve our investments until such time that either structurally or economically a replacement is warranted

38. **What is your State's maintenance cost per square foot for your bridge inventory?**

    This cost is not currently tracked. Asset Maintenance Contracting makes it impossible to track itemized costs.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. **Does your State have written guidance for corrosion prevention or mitigation strategies?**

    Yes. Corrosion prevention is a combination of concrete cover (SDG 1.4.2), concrete mix design (SDG 1.4.2 - minimum CM content, w/c ratio, supplemental cementitious materials), and/or corrosion-resistant reinforcing FRPG 2.1 & 3.1), see Structures Manual Volume 1 (SDG) and Volume 4 (FRPG) at: https://www.fdot.gov/structures/structuresmanual/currentrelease/structuresmanual.shtm

40. **Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?**

    No. However, the designer must seek guidance from the FDOT for two relatively rare situations. (1) bridge decks located in the splash zone of chloride water. (2) Decks exposed to chloride water spilling from trailered boats due to nearby ramps or beach access. See SDG Table 1.4.3-3.

41. **Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?**

    No, since FDOT does not typically use deicing chemicals.

42. **Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?**

    Yes. See FDOT SDG Table 1.4.3-1.

New Designs – Steel Decks

43. **Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)**

    Project-specific Technical Special Provisions are developed that includes fabrication and construction specifications for movable bridges which typically use steel grid decks for the movable spans.

New Designs – Steel Superstructures

44. **Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)**

    Yes. See Section 5.3.1 of the FDOT Structures Design Guidelines: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/structuresmanual/currentrelease/2023/vol1sdg196884331.pdf

45. **Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)**

    Yes. See response to Question #44.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No. A draft policy was developed in 2021, however there was insufficient maintenance frequency and cost history data to validate the assumptions. The current policy is relying on a prescriptive approach to achieve durability for substructures and consultation with State Materials Office technical experts for superstructures located in the splash zone locations. See SDG Table 1.4.3-3.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

See Section 4.3.1 of the Structures Design Guidelines: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/structuresmanual/currentrelease/2023/vol1sdg196884331.pdf

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

The FDOT has construction specifications for Precast Segmental Bridge Construction and Post-Tensioning. See Sections 452 and 462 of the FDOT Standard Specifications for Road and Bridge Construction: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/specbooks/july-2022/july2022ebook.pdf?sfvrsn=804e3f6_2

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

The FDOT has requirements for pile bents located in water with an extremely aggressive environment classification. See Table 3.5.1-1 and Section 3.1.J of the FDOT Structures Design Guidelines: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/structuresmanual/currentrelease/2023/vol1sdg196884331.pdf

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

Yes.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

Yes. See Section 1.3.4 of the Structures Design Guidelines: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/structuresmanual/currentrelease/2023/vol1sdg196884331.pdf

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

The FDOT does not routinely use steel substructure elements.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

This is handled on a case-by-case basis. The treatment of the bearing surfaces would likely match the superstructure steel.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

No.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No. we do not perform preservation treatments on pre-determined intervals. They are performed when determined by our bridge inspection program.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

The FDOT has defined three levels of environmental aggressiveness: Slightly, Moderately, and Extremely (see Structures Manual – Volume, SDG 1.3). Extremely aggressive environments are further subdivided in Marine and Non-Marine based on chloride content and pH. Marine environments have a subcategory in the ”splash zone” which is the most critical for corrosion with prescriptive requirements to address durability of concrete elements.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

The FDOT’s design policies have always been focused on maximizing the service life of facilities. Resiliency is an inherent component of these policies. The FDOT’s commitment to improving the resiliency of the state transportation system is formally acknowledged in a Resiliency Policy. The FDOT’s Resiliency Policy and much more information can be found at: https://www.fdot.gov/planning/policy/resilience/default.shtm

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link);

Yes, a brief listing is provided below. A more inclusive listing can be directly downloaded from the FDOT Research Center website (https://www.fdot.gov/research/documents.shtm).

FDOT has completed 24 research projects in the last 5 years related to the understanding, identifying, preventing, or mitigating corrosion. The PDF files are attached.

- BDV25-977-10 Cathodic Protection for Bridge Tendons
- BDV25-977-24 Development of Tendon Imaging Sensor
- BDV25-977-35 Evaluation of Corrosion Inhibiting Materials Applied by Impregnation (Pressure Injection) Methods to Prevent Corrosion of Post-Tensioned Tendons
- BDV25-977-52 Field Demonstration of Tendon Imaging Methods
- BDV25-977-56 Quantifying the Duration of the Corrosion Propagation Stage in Stainless Steel Reinforcement
- BDV25-977-62 Effects of Service Life of Aluminized Steel Corrugated Pipe with Visible and Not Visible Coating Deficiencies within the Lock System

- BDV25-977-69 Identification of the Mechanisms that Produce Hydrogen Embrittlement on Post-tensioning Members and the Effects of Galvanic Coupling on Bridge Tendons
- BDV25-977-81 Synthesis of Galvanized Steel Reinforcement Corrosion Performance
- BDV27-977-08 Corrosion Propagation of Carbon Steel Rebars in High Performance Concrete
- BDV27-977-09 Chloride Diffusivity and Resistivity of Cured and Mature Binary/Ternary Concrete
- BDV27-977-10 Corrosion Prevention of Bridge Tendons using Flexible Filler Materials
- BDV27-977-11 Durability of Fiber Reinforced Concrete Pipe Exposed to Florida Aggressive Environments
- BDV29-977-26 Susceptibility of Bridge Steel and Concrete Components to Microbiological Influenced Corrosion (MIC) and Microbiological Influenced Deterioration (MID) in Florida
- BDV29-977-34 Development of Quality Assurance and Quality Control System for Post Tensioned Segmental Bridges in Florida: Case of Ringling Bridge - Phase II
- BDV29-977-43 Development of Standard Methodology to Measure Sulfate Ions in Post-Tensioned Grouts
- BDV29-977-44 Accelerated Corrosion Testing of Grouts for PT Steel Strand
- BDV29-977-45 Magnetic Flux Leakage (MFL) Method for Damage Detection in Internal Post-tensioning Tendons
- BDV30-977-18 Performance Evaluation of Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars Embedded in Concrete Under Aggressive Environments
- BDV31-977-130 Testing Methods to Assess the Durability of Concrete Permeability Reducing Admixtures
- BDV34-977-02 Testing, Evaluation, and Specification for Polymeric Materials used for Transportation Infrastructures
- BDV34-977-05 Degradation Mechanisms and Service Life Estimation of Fiber Reinforced Polymer (FRP) Concrete Reinforcements
- BE694 Testing Protocol and Material Specifications for Basalt Fiber Reinforced Polymer Bars
- BE725 Evaluation of FDOT Corrosion Prevention and Control Programs
- BE935 Assessment of Structural Steel Coating Applications

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Yes, additional research is being performed, with one project listed below. A more exhaustive listing can be found at the following FDOT Research Center website (https://www.fdot.gov/research/documents.shtm) FDOT will continue to develop a specific listing and will provide in January.

- We are currently looking at NDT methods to inspect waxed tendons. Additionally, we will be testing the effectiveness of Ultrasonic Concrete Tomography on grouted tendons.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

a. Updating the NIST Bridge LCC tool.
b. Development of a rational real discount rate for public agencies to agree upon and realistically validate future LCCA.
c. Development of Corrosion Mitigation Cost Estimates and Frequency for both existing bridges and improved concrete mix designs.

Group 2 State: New York

1. **Participant's Name(s)** [redacted]
2. **Organization** NYSDOT Main Office, Office of Structures
3. **Title(s)** Project Engineer and Technical Assistant to the DCES
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of New York confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

New York Bridge Materials

New York	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,571	3,931
NHS Deck Area Percentage	49.7%	72.9%
Non-NHS No. of Bridges	4,959	6,344
Non-NHS Deck Area Percentage	50.3%	27.1%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**
   Yes.
8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**
   ADE 831—Steel Beam End
9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**
   No, additional defect data is not collected.
10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

Yes. D-meter readings are taken in critical areas to measure steel plate thicknesses and section loss. Section loss information is used to update Level 2 Load Ratings and Level 1 Load Ratings when called for.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    None.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    No, defect data is not collected and/or coded.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Not as part of the General Inspection Program. This type of testing may be performed during Preliminary Design Phases and the development of the Design Report.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    None.

15. **On your ADE items, what defects are you collecting?**

    NYSDOT does not collect or quantify defects.

16. **Are you performing chloride profiling as part of your RC deck management?**

    No.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    No.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    No [Additional context: Chloride level information is not valuable unless it is considered along with reinforcement type, access to moisture, existing corrosion activity, Alkali-Silica Reactivity, etc. Concrete with chloride levels above the corrosion threshold of 1.3 lbs/Cu.Yd. with no active corrosion and epoxy coated reinforcing bars may be retained with no remediation, while the same concrete with corroding plain reinforcing steel may only be retained if the existing corroded steel is removed and the moisture source can be removed/remediated through the use of a waterproof overlay/barrier. Chloride levels alone are insufficient to make a decision on retention or replacement of the concrete element.]

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

Yes [Additional context: Besides chloride levels, cores are taken to determine concrete strength, porosity, freeze-thaw susceptibility, ASR, and carbonization.]

20. Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?

Yes [Additional context: Thermal imaging is used to determine areas of delaminations. Ground Penetrating Radar is used to determine high chloride contents, reinforcing bar location/cover, and larger delaminations. Impact Echo is sometimes used to determine delaminations. Chain drag and rotary percussion instruments are sometimes used to determine delaminations. Electric Potential surveys are sometimes performed, but these are only good for plain steel reinforced decks and are too slow to especially useful.]

Existing Highway Bridges – Corrosion Prevention and Mitigation

In addition to answers provided beneath each question the attached manual, Fundamentals of Bridge Maintenance, Section 3 – Cyclical Preventive Maintenance Procedures and Section 4 – Corrective Preventive Maintenance Procedures are used as guidelines by Regional Bridge Maintenance Forces when evaluating and performing maintenance operations.

Steel Bridges

21. Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)

I am not aware of written guidance.

22. Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.

No, not for existing bridges. When painting is determined necessary, existing structures are typically provided the standard 3-coat system as per the NYSDOT Standard Specifications. See §708-01 Structural Steel Paints – Class 1
Link to full NYSDOT Standard Specifications: https://www.dot.ny.gov/main/business-center/engineering/specifications/updated-standard-specifications-us
Link to Volume 4 (Section 700-Materials Specifications):
https://www.dot.ny.gov/main/business-center/engineering/specifications/english-spec-repository/2023_1_specs_usc_tc_vol4.pdf

23. Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)

No, there is no written guidance. However, consideration is given to repainting areas of high exposure (girder ends beneath joints, fascia girders for curbless bridges, and etc) as part of Bridge Rehabilitation Projects when full structure painting cannot be included. Sections 570, 571, 572, 573, and 574 of the NYSDOT Standard Specifications (Volume 2) provide the construction requirements for painting structural steel.

24. Does your State use lifecycle analysis basis for recoating existing steel members?

Yes. Life cycle analysis is one of the tools we use for recoating existing steel members. The other factors are age of the bridge, Condition rating, AADT, when is it programmed for replacement and cost.

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    No specific policy or guidance for painting existing weathering steel members. However, Bridge Manual Section 8.2.1.2 – Partial Protective Coating of Uncoated Weathering Steel, is followed as closely as possible when painting of existing weathering steel members is necessary.

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    The effectiveness of corrosion mitigation measures are determined through data obtained from Bridge Inspection Reports, and supplemented by Bride Maintenance forces doing inspection on selective bridges.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    None.

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    In rare cases NYSDOT has used acoustic monitoring to gauge the continuity of PT strands.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    Although there is no written guidance, NYSDOT often uses innovative materials and/or methods, such as UHPC overlays for adjacent box beams / slab units (plans can be provided upon request).

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    The effectiveness of corrosion mitigation measures are determined through data obtained from Bridge Inspection Reports, and supplemented by Bride Maintenance forces doing inspection on selective bridges.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    No.

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

Yes – Silane Sealers applied after initial deck construction and then at regular intervals thereafter, usually after pressure washing (See NYSDOT Bridge Manual 5.1.10)

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

Yes. The following Portland cement overlays are sometimes used: Latex Modified Concrete Overlay (NYSDOT Specification 584.330xnn), Micro-Silica Overlay (NYSDOT Specification 584.300xnn), Class DP Overlay (pozzolan based) (NYSDOT Specification 584.310xnn). The following chemical overlays are used: Polyester Polymer Concrete Overlay, Epoxy Polymer Concrete Overlay (NYSDOT Specification 584.4000005). In addition, NYSDOT has used Ultra-High Performance Concrete Overlays (NYSDOT Specification 584.21010001)

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

No strict policy, just that they exist and may be used where appropriate (where ensuring moisture is removed from the underlying deck)

35. How does your State determine the effectiveness of these corrosion mitigation actions?

Effectiveness is usually determined by evaluating the length of time from installation of the mitigation to any required subsequent work to the same element. This is usually a visual observation taken at the time of bridge inspection and use of automated or technological means for monitoring is rare.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

NYSDOT uses Structures Analyst Module of our Structures Management System to model future funding needs for bridge treatment, including preservation. This link describes the Structures Analyst module, with other documentation and brochure.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

Prior system wide modeling using the Bridge Needs Tool suggests that the best statewide balance occurs with programming 40% of the bridge budget on bridge maintenance work and 60% on bridge renewal projects. However, this balance is expected to vary based on existing regional system conditions and each of the funding scenarios goals and is therefore not a mandated constraint. Consideration is given to prioritize prudent maintenance investments in accordance with the NYSDOT Asset investment strategy. NYSDOT prioritizes bridge maintenance activities that maximize the service life of existing infrastructure assets over expansion or enhancement of the

highway network. This work is performed on assets that are in relatively good condition to keep them from slipping to more costly reconstruction treatments in the future.

38. What is your State's maintenance cost per square foot for your bridge inventory?

Approximately $1.25 per square foot.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

https://www.dot.ny.gov/divisions/engineering/structures/manuals/bridge-manual-usc
Above is the link to the NYS DOT Bridge Manual. This Bridge Manual has been prepared to provide policies and procedures required for bridge project development and bridge design for the New York State Department of Transportation (NYSDOT). This manual provides guidance for the decisions needed in developing a bridge project and includes the policies and standards that are required. This manual also provides commentary discussing sound bridge engineering practices and provides references to additional sources of information for bridge project development and bridge design.

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

Yes, multiple sections of the Bridge Manual discuss corrosion prevention and mitigation strategies for design and detailing of bridge elements.

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

Yes, see Bridge Manual Section 5.1.1 which discusses the NYSDOT standard deck practice using epoxy coated reinforcement and alterations that can be made to use other reinforcement types, such as stainless steel.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

There are no barrier-deck interface specific policies or requirements. NYSDOT Standards require the use of epoxy coated reinforcement in concrete barriers.

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

NYSDOT standards require the use HP concrete but there are no policies or design guidance for project specific concrete mix design based upon corrosion risk.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

NYSDOT Standards allow the use of steel decks on bridge rehabilitation projects but prohibit their use for new/replacement bridges. See Bridge Manual Section 5.3 – Other Deck Types.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Yes, see Bridge Manual Section 8.2 – Steel Types, discusses NYSDOT policy/design guidance regarding the selection of steel and coating types.

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Yes, see Bridge Manual Section 8.2.1.2 – Partial Protective Coating of Uncoated Weathering Steel.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No, a life-cycle analysis is not used. Since metalized and galvanized coatings provide the best corrosion resistance that is the preferred option for new and replacement bridges when weathering steel cannot be used. The Bridge Manual Section 8.2.1.1 – Weathering Steel Location Restrictions and Section 8.2.3 – Painted Steels, discuss both the limitations placed upon using weathering steel and the guidance for evaluating different coating types, respectively.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

Yes, see Bridge Manual Sections 9.8 and 15.12 (including all subsections). Also see the NYSDOT Prestressed Concrete Construction Manual (PCCM) Section 4.2. The PCCM can be reached using this link: https://www.dot.ny.gov/divisions/engineering/structures/repository/manuals/PCCM_3rd_Edition_4-2017_rev2019.pdf

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

NYSDOT fabrication inspectors follow the provisions set forth in the PCCM for fabrication inspection. The PCCM gives states the role/responsibilities of a NYSDOT fabrication inspector, their duties, and the applicable materials tests there are to perform.

Applicable PCCM sections to reference: Section 3 (inspection), Section 6 (deals with acceptance and our process for documenting defects, etc).

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

Section 8 of the PCCM (Construction) deals with the role of the EIC on inspecting the precast elements when they are delivered to the job site. Typically, all precast components have corrosion inhibitor added to their mixes (except those listed under question) and are sealed by the fabricator.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

For questions 50 through 53 see NYSDOT Bridge Manual Section 15.12 – Protecting Reinforcement from Corrosion (and all subsections). This section discusses the policy/design guidance regarding protecting reinforcement from corrosion based on corrosion risk and sensitivity of critical areas.

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

See above.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

See above.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

See above.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

See above.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

See above.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

NYSDOT Standards require the use of reinforced concrete piers for new and replacement bridges. While there is no specific policy or guidance regarding new steel substructures, Bridge Manual Section 2.5.1 – New and Replacement Bridges, states that all substructure elements that require a load rating (which includes all steel substructure elements) shall provide an LRFR Inventory Rating Factor of 1.2 or greater for the as-built condition.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

NYSDOT Standard is to use Elastomeric Bearings as frequently as possible and Multi-Rotational Bearings when called for, typically for high load situations. Otherwise, there is no selection or design criteria regarding corrosion prevention or mitigation. However, all exposed steel bearing elements require protective coatings, see Bridge Manual Section 12.4 – Protective Coating of Bearings.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

Yes, NYSDOT maintains standard details called BD Sheets; https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/bridge-detail-sheets-usc

Detailing of Joints can be found on the JT series; https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/bridge-detail-sheets-usc/jt-armorless-joints-usc

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No, NYSDOT does not have any policy/design guidance pertaining to differing levels of durability for joint system selection.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No – these are determined by local transportation maintenance operations.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

The NYSDOT Bridge Manual documents several noteworthy design policies that are both directly and indirectly related to corrosion prevention:

Section 2.5.1 – New and Replacement Bridges – "Analysis of all new bridges, replacement bridges, and all substructure elements that require a load rating, shall provide an LRFR Inventory Rating Factor of 1.2 or greater for the as-built condition." While this policy is not specifically intended to mitigate or prevent corrosion related issues it adds an "over-design" policy that helps ensure new and replacement bridges have the desired capacity, durability, and longevity.

Section 11.2 – Abutments – "When determining the type of abutments to use the first choice to be considered shall be integral." NYSDOT requires consideration of integral abutments on all new and replacement projects. Cantilevered abutments shall only be considered when integral and semi-integral abutments have been investigated and found to be incompatible with the project's site conditions.

Section 19.7 – Elimination of Joints – "All Maintenance and Rehabilitation projects shall consider the feasibility of eliminating all existing deck joint systems." Deck joints are a major contributor to corrosion of superstructure and substructure elements and eliminating them to the full extent possible is considered on every NYSDOT bridge project.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Yes – This is mostly based on making structures more resilient to extreme weather events (especially flooding).

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

While there is no specific research in this area, NYSDOT is continuing to reduce corrosion through use of innovative procedures and materials. Reduced deck cracking has been achieved through use of High-Performance Internally Cured Concrete, and reduced corrosion of decks and substructures through use of polymer overlays and Ultra-High Performance Concrete link-slabs to replace joints.

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

See response to 62, above.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Definitive cost-benefit information concerning bridge washing, use of stainless-steel reinforcement, optimized deck sealer application rate/frequency based on deck age, traffic volume, and salt application rates.

Group 2 State: North Carolina

1. **Participant's Name(s)** [redacted]
2. **Organization NCDOT** – Structures Management Unit
3. **Title(s) Project Engineer** – Policy Development and Team Leader – Preservation & Repair
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of North Carolina confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

North Carolina Bridge Materials

North Carolina	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	2,176	1,598
NHS Deck Area Percentage	46.6%	51.0%
Non-NHS No. of Bridges	8,079	5,960
Non-NHS Deck Area Percentage	53.4%	49.0%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**
   Yes, NCDOT collects element level data on all structures inspected.
8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**
   NCDOT does not collect ADE's.
9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**
   NCDOT does collect defect data on all elements, no additional defects beyond the MBEI.
10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

NCDOT will use NDE methods as necessary to collect condition information for preservation project activities. The evaluation method(s) performed depends on what element and the defects.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**
    NCDOT does not collect ADE's.
12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**
    NCDOT codes all MBEI defects.
13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**
    Yes, NCDOT performs destructive chloride testing on bridge decks to obtain chloride concentrations for determining preservation activities.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**
    NCDOT does not use ADE's.
15. **On your ADE items, what defects are you collecting?**
    N/A
16. **Are you performing chloride profiling as part of your RC deck management?**
    Chloride profiling is performed as necessary on a project-by-project basis.
17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**
    NCDOT collects chloride profiles for individual bridge deck assessments.
18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**
    NCDOT does not have published guidance on repair actions related to chloride levels.
19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**
    N/A
20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**
    NCDOT uses NDE on individual cases based on the structure conditions and funding to determine extent of preservation activities needed.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)

NCDOT does not have published guidance on managing coatings on existing steel bridge members.

22. Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.

NCDOT does not have published guidance on using different coatings-based severity of corrosive environment types.

23. Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)

Yes, Painting Existing Structure Project Special Provision.

24. Does your State use lifecycle analysis basis for recoating existing steel members?

No

25. Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)

Yes, Painting Existing Weathering Steel Structures Project Special Provision.

26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

No

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)

No

28. Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?

No

29. Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.

No

30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

Using NBIS inspection data.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    NCDOT does not have published guidance on managing coatings on existing steel bridge members.

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    Yes, Silane and High Molecular Weight Methacrylate (HMWM). Crack width determines when to apply a deck sealer.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    NCDOT does not have published guidance on installing rigid concrete/epoxy overlays.

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    NCDOT does not have published guidance on using membranes prior to placing deck overlays.

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    Using NBIS inspection data.

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

    Yes, NCDOT uses a Bridge Management System to assist with determining future funding needs for bridge preservation.

37. **Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.**

    NCDOT has dedicated funds for bridge preservation. Approximately 20% of state bridge funds are spent on bridge preservation.

38. **What is your State's maintenance cost per square foot for your bridge inventory?**

    Unknown

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

Yes, Structures Management Unit Design Manual, see Sections 10.5 & 12.11

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

No

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

No

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

No

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

No

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Yes, Structures Management Unit Design Manual, see Section 12.11.

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Yes, policy requires painting the ends of weathering steel girders. See Structures Management Unit Design Manual, see Section 5.2.2 and see Structural Steel Shop Coatings Program.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

No

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Yes, Structures Management Unit Design Manual, see Section 7.2.6.2 and see Standard Specifications Article 420-18. The top of caps are sloped and an epoxy protective coating is applied.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Yes, Structures Management Unit Design Manual, see Section 10.5 and 12.11. Concrete cover is increased, addition of admixtures, higher concrete strength, and epoxy coated steel is used at corrosive bridge sites.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Yes, Structures Management Unit Design Manual, see Section 10.5 and 12.11. Concrete cover is increased, addition of admixtures, higher concrete strength, and epoxy coated steel is used at corrosive bridge sites.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

Yes, Structures Management Unit Design Manual, see Section 10.5 and 12.11. Concrete cover is increased, addition of admixtures, higher concrete strength, and epoxy coated steel is used at corrosive bridge sites.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

Yes, Structures Management Unit Design Manual, see Section 10.5 and 12.11. Concrete cover is increased, addition of admixtures, higher concrete strength, and epoxy coated steel is used at corrosive bridge sites.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

No

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

No

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

No

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

No

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

Yes, Evaluating Corrosive Site Performance and Policy with Concrete Admixtures. Project investigated the effectiveness of NCDOT corrosion policy.

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Yes, Harkers Island Bridge Replacement: Material Characterization and Structural Performance. Project objectives include material characterization, monitoring, and structural performance of FRP reinforcement.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Continued research focusing on corrosion resistant materials including providing enhanced design guidance.

Ohio Peer Exchange Survey Response

Group 2 State: Ohio

1. **Participant's Name(s)** [redacted]
2. **Organization** Ohio Department of Transportation
3. **Title(s)** Bridge Design Engineer – District 7
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Ohio confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Ohio Bridge Materials

Ohio	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,726	3,207
NHS Deck Area Percentage	32.9%	56.9%
Non-NHS No. of Bridges	13,893	7,891
Non-NHS Deck Area Percentage	67.1%	43.1%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Yes. We collect element data for structures 10-ft and greater on or over state routes by policy. We do not require local (cities and counties) agencies to collect element data.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   The following types are Ohio's ADE's:

   805 – Wearing Surface – Monolithic Concrete
   810 – Prestress Concrete Slab
   815 – Drainage
   820 – Steel Seated-Hinge Assembly
   825 – Concrete Hinge Assembly

830 – Abutment Backwall
835 – Culvert End Treatment
840 – Approach Slab: Termination or Joint
900 – Load Posting Sign
901 – Vertical Clearance Sign

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

   No. Not applicable.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    No. Steel superstructures will use ultrasonic thickness gages to determine existing section losses. Information is used for load ratings and repair treatments and limits of repairs. Ohio does not collect this information as part of the inspection data.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    See response to #8.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    No. Not Applicable.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    No. Once evidence of PS/PT corrosion or other defects are identified during the routine inspection, a specific plan of action is employed for the structure type. Reinforced concrete bridges (typically slabs) are treaded in the same manner as reinforced decks on longitude beams.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    See response to #8.

15. **On your ADE items, what defects are you collecting?**

    No.

16. **Are you performing chloride profiling as part of your RC deck management?**

    No, can be used on a case by case to help determine the appropriate treatment option.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    Can be used on a case by case to help determine the appropriate treatment option.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    No

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Yes, the coring process and evaluation is listed in the ODOT BDM section 403.1.2 CORING.

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    There are numerous concrete deck evaluation techniques available to help determine the appropriate treatment option for a deck in need of rehabilitation. For deck rehabilitation considered on a project, provide a Deck Condition Survey that includes the information listed ODOT BDM section 403.1 DECK CONDITION SURVEY. NDE methods are typically employed in the decision process once an overlay, barrier, or deck has been identified with deficiencies in the inspection process.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    Bridge Maintenance Manual - Bridge Maintenance Manual | Ohio Department of Transportation, see Beams section.
    Ohio DOT Bridge Design Manual (BDM) 2020+BDM_07-15-22-Optimized.pdf (ohio.gov)
    See ODOT BDM 402 provides guidance for cleaning beam ends and seats.
    See ODOT BDM 403.9 provides direction on extending scupper downspout ends to 8" below the bottom flange.
    See ODOT BDM 404.1.11 requires field painted structures to be a 3 coat OZEU paint system.
    See ODOT Bridge Cleaning Plan Insert Sheet details removal of debris on beam seats, bearings & beam ends, as well as power washing of bearings & beam ends. BC.pdf (state.oh.us)

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    Guidance is given for selecting coatings for new construction. See ODOT BDM 308.2.2.1.d STRUCTURAL STEEL COATINGS

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    ODOT BDM 4040.6.1 requires the ends of the beams to be coated with a zinc prime coat prior to encasing in concrete.
    ODOT CMS 514.02 requires field painted structures to be a 3 coat OZEU paint system.

ODOT CMS 514.13 details surface preparation requirements for field painting.
ODOT CMS 514.22 provides direction on feathering of coats for repairs and partial paint areas.

24. Does your State use lifecycle analysis basis for recoating existing steel members?

ODOT Maintenance Manual has recommendations for spot painting (10yrs) and complete recoating (18yrs).
ODOT Maintenance Manual has recommendations for steel repairs in addition to coatings; plating (10yrs), partial replacement (30yrs).
ODOT uses a 30 year life span for life cycle cost BDM 308.2.2.1.d.2 ALTERNATIVE COATING SYSTEMS

25. Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)

Yes. ODOT BDM 308.2.2.1.d.1 PRIMARY COATING SYSTEMS states appropriate environmental sites for weathering steel bridges. Section provides guidance as to apply a protective coating, per BDM 308.2.2.1.d.2, to weathering steel surfaces.

26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

ODOT tracks coating systems through the bridge inspection program, item "Superstructure Protective Coating System"

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)

ODOT BDM 404.3.1.1 & 404.4.1.1 provides guidance on when to repair cracks by epoxy injection.
ODOT BDM 404.3.1.2 & 4040.4.1.2 requires PS beam repairs to be confined with FRP for additional corrosion protection of the damaged section.
ODOT Maintenance Manual recommends sealing the fascia beams with silane every 5years.
Corrosion prevention and mitigation actions/strategies for PT structures can be found in the Supplemental Specification 855, M E M O R A N D U M (state.oh.us). Please note strategies for PT structures is governed by ensuring qualified technicians are performing the work, testing of components, and testing of materials.

28. Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?

Special inspections are performed by consultants, the BMD section 403.1.5 calls out impact echo survey to be used, as needed.

29. Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.

No.

30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

Not actively tracking effectiveness.

RC Decks

31. Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)

ODOT BDM 403 provides direction on evaluating deck condition, coring the deck, chloride concentration testing, half-cell potential testing & electrical resistivity testing.
ODOT BMD 403.3 provides direction on sealing decks on major & mainline priority system bridges.
ODOT Bridge Cleaning Plan Insert Sheet details removal of debris in expansion joints & scuppers.
ODOT BDM 403.2.1 & SS844 provide direction on the use of embedded galvanic anodes to prevent corrosion of existing rebar.
ODOT Maintenance Manual has recommendations & expected life for sealing (5yrs), patching (10yrs), overlay (15yrs), slab edge replacement (30yrs) & deck replacement (40yrs).

32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?

Yes. High Molecular Weight Methacolyte, Gravity Fed Resign, and Soluble Reactive Silicate.
ODOT BDM 403.3 provides guidance on the type of sealer and the sealing frequency based on the crack severity.

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

ODOT BDM 403.4 provides the guidance for when to overlay a structure, what material to use, and what surface preparation techniques to use.

Available materials and minimum thicknesses used:

i. Micro-Silica, 1.25”
ii. Latex Modified, 1.25”
iii. Superplasticized Dense, 1.75” iv. Thin Polymer Epoxy, 0.25”

ODOT SS847 provides requirements when surface prep includes scarifying the deck.

ODOT SS848 provides requirements when surface prep includes hydro-demolition.

ODOT SS858 provides requirements for surface prep for thin polymer epoxy.

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

ODOT does not use membranes with concrete overlays. Membranes are used underneath asphalt placed on non-composite adjacent box beams.

35. How does your State determine the effectiveness of these corrosion mitigation actions?

Effectiveness is based upon the performance/lifespan/ratings of the overlays.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

Not currently, but we are working to implement a data driven bridge management system in the near future with the AASHTOWare BrM website. (Bridge Management – AASHTOWare Bridge)

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

Ohio does not stipulate a percentage on preservation.

38. What is your State's maintenance cost per square foot for your bridge inventory?

ODOT does not have a maintenance cost per square foot.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

ODOT BDM 309.2 requires the use of QC2 concrete mix and drip strips for over the side drainage structures.

ODOT 309.2.1 details limits of sealing the structure edges & fascia beams.

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

ODOT BDM 309.2 requires 2.5" top cover.

ODOT BDM 304.4 & CMS 509 allows for the following reinforcement:

i. Uncoated (rehab only)
ii. Epoxy-Coated (baseline new)

iii. Galvanized (optional mainline/priority decks)
iv. GFRP (optional mainline/priority beam-slab decks only)
v. Chromium Steel (special cases only) vi. Stainless Steel (special cases only)

ODOT CMS 511.19 requires all joints, anchor holes, and cracks noticed prior to opening to traffic to be sealed with HMWM.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

No.

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

ODOT BDM 309.2 requires the use of QC2 concrete mix for superstructure concrete.

ODOT CMS 499.02 restricts the level of permissible chlorides in water.

ODOT CMS 499.03 restricts the maximum permissible permeability of deck concrete.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

Steel decks have been used on movable bridges, they are not typically used in Ohio. The steel decks are handled by plans notes and no standard documents are available.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

ODOT BDM 308.2.2.1 “On over-the-side drainage structures, the minimum overhang shall be lesser of 75% of the beam/girder depth or 4-ft.” This requirement helps to reduce corrosion resulting from the surface drainage.

ODOT BDM 308.2.2.1.d “ASTM A709 50W/70W should be selected wherever applicable…”

ODOT BDM 308.2.2.1.d.1 prohibits weathering steel for use based on VC/OHWM, AADT & ADTT.

ODOT BDM 308.2.2.1.d.2 & CMS 514.02 provides direction on a 3-coat IZEU paint system.

ODOT BDM 308.2.2.1.d.2 provides direction on galvanized coating and allows metalized coating systems.

ODOT CMS 514 requires each coat to be overlapped when painting in stages, doing repairs, or field painting bolted splices of shop painted structures.

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

ODOT BDM 308.2.2.1.d.1 provides direction for partial painting of weathering steel for various conditions.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

ODOT BDM 308.2.2.1.d.2 states expected service life of galvanized & metalized steel = 40yrs.

No lifecycle guidance is provided for other corrosion protection systems.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

ODOT Maintenance Manual has recommendations for spot painting (10yrs) and complete recoating (18yrs).

ODOT CMS 515 requires strands to be protected prior to being pulled into the bed and requires the strands to be cleaned prior to encasing.

ODOT std dwg PSID-1-13 requires the ends of the beams to be sealed with waterproofing and requires composite bars to be epoxy-coated.

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

The Department does have and inspection and certification procedure for a fabricators suppling prestressed beams. The information can be found in supplement 1079. (1079_01162015_for_2019.PDF (state.oh.us))

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

All construction practices are and repair methods can be found in the Supplemental Specification 855, M E M O R A N D U M (state.oh.us)

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

ODOT section 306.2.3.2 BRIDGE SEAT DRAINAGE requires abutments supporting steel beams, steel girders or prestressed I-beams with a deck joint, provide drainage of the bearing seat by sloping the bearing seat away from the backwall at 1/4-in/ft, except at the bearings.

ODOT section 306.1.2 SEALING OF CONCRETE SURFACES, SUBSTRUCTURE requires Seal the front face of abutment backwalls, from top to bridge seat, the bridge seat and the breastwall down to the groundline with an epoxy urethane or non-epoxy sealer. Specifications for the sealer are defined in C&MS 512.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

ODOT section 306.1.2 SEALING OF CONCRETE SURFACES, SUBSTRUCTURE requires seal the exposed surfaces of all wingwalls and retaining walls, exclusive of abutment type, that are within 30-ft of a pavement edge, with an epoxy-urethane sealer.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Seal ends and sides of piers exposed to traffic induced deicer spray, from any direction, with either an epoxy-urethane or non-epoxy sealer. Top of pier caps need only be sealed if there is an expansion joint or the tops are subject to exposure to deicer-laden water.

Seal the total vertical surface of piers within 30-ft of a pavement edge with either an epoxyurethane or non-epoxy sealer.

Seal the total vertical surface of piers supporting weathering steel superstructures with either an epoxy-urethane or non-epoxy sealer.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

See above responses.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Yes, BDM section 305.3.5.3 CORROSION AND PROTECTION calls for the design the steel pile section to retain the required factored structural resistance after discounting corrosion loss and provide a plan note that addresses the amount of additional pile section specified to account for the corrosion loss. Alternately, provide corrosion protection for the piles.

Steel pipe shall consist of a zinc coating or concrete encasement. For zinc coatings, estimate the corrosion loss rate as 1/2 the respective loss rate for carbon steel. The minimum thickness for zinc coating is 4 mils.

For concrete piles or concrete encasement, if the environmental conditions indicate a soil chloride content ≥500 ppm, a sulfate content ≥500 ppm, or a pH

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

No, The Department's policy is to use laminated elastomeric bearings whenever possible. If additional load capacity and/or movement is required, a high load multi rotational (HLMR) bearing is the preferred alternative.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

No.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No, the department uses galvanized coating for steel armor, steel extrusions, and modular components. (Pretty much unilaterally)

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

Title of Work: Cleaning Bridges

Definition of Work: For bridges with ODOT having routine maintenance responsibility, the three areas of the bridge to be cleaned are 1. Expansion Joints, 2. Scuppers and Drainage Troughs, and 3. Bridge Seats under expansion joints.

Benefit:

1. Cleaning Deck Joints – Cleaning deck joints helps the joint perform as intended. Debris that sits on top of an elastomeric seal is packed down by traffic. A sharp object will exert a great deal of pressure as traffic travels over the packed down debris. This damages the elastomeric seals and they will leak and allow debris to fall onto the bridge seat below. Cleaning the deck joints will help keep the joints functioning as designed.
2. Clearing Debris from Scuppers and Drainage Troughs - Controlling deck drainage is important to maintaining a bridge in good condition. When chloride laden deck drainage does not follow the path that was originally intended, deterioration of bridge components may begin and accelerate. Components of the bridge that remain damp with high chloride content are prime locations for deterioration. Clearing debris from scuppers and drainage troughs will not pond chloride laden drainage on the bridge deck and will increase the life of the bridge deck.
3. Cleaning Bridge Seats – Debris built up on bridge seats holds moisture against the bearings and seats. The moisture laden debris will cause the steel sections of bearings to rust and deteriorate and cause spalling of the concrete seat. The debris generally deposits on the bridge seat through an open expansion deck joint or a defective deck expansion joint. Keeping the bridge seats free of debris will extend the life of the bridge.

Description of Work: EIMS Code: M518-001

1. Cleaning deck joints will be performed with high pressure air.
2. The equipment needed to clean scuppers and drainage troughs is dependent on the drainage configuration.
3. Cleaning bridge seats could be accomplished with a shovel.

Data Set:

1. The bridge inventory includes the joint type. SMS Code 414 is the type of Expansion Joint. Bridges with SMS Code 414 A, B, or C equal to 1, 2, 3, 7, 8, 0, or A should have the joints cleaned.
2. The bridge inventory includes a code if scuppers or drainage troughs are present. SMS Code 409 is the type of Deck Drainage. Bridges with SMS Code 409 equal to 3 and 4 have scuppers that should be cleaned and SMS Code 409 equal to 5 have drainage troughs that should be cleaned.
3. The bridge inventory includes the joint type. SMS Code 414 is the type of Expansion Joint. Bridges with SMS Code 414 A, B, or C equal to 1, 2, 3, 5, 6, 7, 8, and A should have the bridge seat under the expansion joint cleaned. For most ODOT bridges, these joints will be located at the abutments.

Cycle: Bridges listed above should be cleaned every two years.

Risks: None identified.

Title of Work: Sealing of Concrete Bridge Decks

Definition of Work: Seal the bridge concrete deck with either Gravity-Fed Resin, HMWM, or Soluble Reactive Silicate (SRS). The sealer shall be placed according to the manufacturer's recommendation, including all safety requirements and the Construction and Material Specifications.

Benefit: Sealing bridge decks will extend their service life. The requirement is to seal all of the major bridges and mainline priority system bridges. ODOT's major bridges are some of the highest value assets that the Department maintains. A couple of ODOT's major bridges have decks that will be extremely difficult and costly to replace (segmental and cable stayed structures). Maintaining these decks in good condition is critical. Replacing the deck on a mainline priority system bridge can be very disruptive to traffic. Maintaining these decks in good condition is important to minimize disruption to traffic. The bridge decks should be sealed when they are in good to fair condition. Bridge decks in poor condition should be programed for rehabilitation.

Description of Work: EIMS Code – M512-001.

All major bridges and mainline priority system bridges with a concrete wearing surface shall be sealed with one of the following types of sealer:

1. For decks that are cracked, seal the deck using HMWM or Gravity-Fed Resin per CMS 512.06 every 10 years.
2. For decks that are not cracked or only minor hairline cracks, seal the deck using SRS (Soluble Reactive Silicate) per CMS 512.05 every 5 years.

This work shall be performed according to the sealer manufacturer's recommendation. Due to the size of the major bridge decks, most of this work is anticipated to be contracted out.

Data Set: The requirement is to seal the decks of the major bridges and mainline priority system bridges where the deck summary is a 9, 8, 7, or 6. For major bridges and mainline freeway bridges with a deck summary of a 5, the District Bridge Engineer will make the determination if enough of the deck is in a condition where sealing will have a positive impact. The definition of a major bridge is included in Policy No. 16-003(P), Major Bridge.

Cycle: See Description of Work above.

Risks: None identified.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

The Department will allow six types of material for use as concrete reinforcement.

- Uncoated Steel Reinforcement (USR)

- Epoxy Coated Steel Reinforcement (ECSR)
- Galvanized Steel Reinforcement (GSR)
- Glass Fiber Reinforced Polymer Reinforcement (GFRP)
- Chromium Steel Reinforcement (CSR)
- Stainless Steel Reinforcement (SSR)

Section 304.4 CONCRETE REINFORCEMENT has some additional commentary on intended applications

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

The responders of this survey are not aware of policy/procedures/guidance changes based upon climate change.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

- Division of Engineering ROC Task#7 - Durability of Anchorage Pour-Backs and Improvements (2/6/2021)
- Extended Life Concrete Bridge Decks Utilizing Internal Curing to Reduce Cracking (1/30/2019)
- Ultra-High Performance Concrete in Ohio (1/17/2019)
- Evaluation of Effective Bridge Deck Repair Maintenance Methods (5/15/2018)
  Link Projects - Default (state.oh.us)

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Identification of Maintenance Practices to Impede Corrosion Impacts on Prestressed Concrete Box Beam Bridges (active – completion date 9/15/24)

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Group 2 State: Oklahoma

1. **Participant's Name(s)** [redacted]
2. **Organization** ODOT
3. **Title(s)** Assistant Bridge Engineer - Maintenance
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Oklahoma confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Oklahoma Bridge Materials

Oklahoma	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	2,324	801
NHS Deck Area Percentage	34.1%	44.7%
Non-NHS No. of Bridges	12,677	6,925
Non-NHS Deck Area Percentage	65.9%	55.3%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Yes

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   Element 865 5' Open Girder Ends – Steel: Corrosion activity at beam ends is typically more advanced.
   Element 872 Girder Beam Under Construction Joint – Steel: Corrosion under construction joints is typically more advanced.
   Element 879 Stringer Under Construction Joint: Corrosion under construction joints is typically more advanced.

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**
   No. N/A
10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**
    No. N/A

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**
    Element 819 5' Open Girder Ends – Prestressed Concrete: Corrosion activity at beam ends is typically more advanced.
    Element 873 Girder Beam Under Construction Joint – Prestress Concrete: Corrosion under construction joints is typically more advanced.
12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**
    No. N/A
13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**
    No. N/A

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**
    Element 859 Soffit of Concrete Decks and Slabs: Allow us to evaluate corrosion activity on the underside of our decks and prestressed concrete decks.
15. **On your ADE items, what defects are you collecting?**
    None
16. **Are you performing chloride profiling as part of your RC deck management?**
    No
17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**
    N/A
18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**
    N/A
19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**
    No. N/A

20. Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?

No

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)

No. N/A

22. Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.

No

23. Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)

No. N/A

24. Does your State use lifecycle analysis basis for recoating existing steel members?

No

25. Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)

Most of our weathering steel is unpainted. Bridge Plan Directives: "All structural steel shall be unpainted weathering steel unless otherwise specified by the Design Engineer." https://oklahoma.gov/content/dam/ok/en/odot/documents/bridge/cadd-support/bridgedirectives.pdf

26. How does your State track and determine the effectiveness of these corrosion mitigation actions?

We have done research on how long silane sealers last.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)

Not at this time.

28. Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?

Yes. We inspect our post-tensioned box girders for grout voids, cracks, and spalls. Evaluate grout for repair compatibility.

29. Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.

No. N/A

30. How does your State track and determine the effectiveness of these corrosion mitigation actions?

By visual inspection.

RC Decks

31. Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)

Not at this time.

32. Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?

Yes. Apply silane sealers to the decks the summer after construction which is usually a one-time application. District 4 is doing a few secondary silane applications.

Silanes: Provide penetrating water repellent treatment solution consisting of an organosilicon compound dissolved in a solvent carrier. Provide a solvent carrier that produces a hydrophobic surface covalently bonded to the concrete when applied. Provide one of the following organosilicon compounds:

- Alkyl-alkoxysilane,
- Oligomerous alkyl-alkoxysiloxane.

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

Yes, Specifications. Refer to Section 505 OVERLAY OF CONCRETE BRIDGE DECKS. Note that the thickness and deck preparation are covered in 505. https://oklahoma.gov/content/dam/ok/en/odot/documents/c_manuals/specbook/2019--full-spec-web-version.pdf

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

Yes, Refer to Section 505 of the Standard Specifications.

35. How does your State determine the effectiveness of these corrosion mitigation actions?

By visual inspections.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

Not at this time but our Bridge Management Engineer is working to Develop one.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

We do not have targeted percentages. We provide $5 million a year for bridge preservation activities. Bridge preservation goes primarily to paint and joint projects.

38. What is your State's maintenance cost per square foot for your bridge inventory?

Do not know.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

Our Bridge Plan Directives does include requirements for epoxy reinforcement. https://oklahoma.gov/content/dam/ok/en/odot/documents/bridge/cadd-support/bridgedirectives.pdf

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

For the On-System, we require 2 ½" cover for our decks and we require epoxy coated steel in both layers.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

We require epoxy coated rebar.

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

No, but in streams with high sulfates we have used Type 2 or Type 5 cement in the columns.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

No steel decks. N/A

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

We use weathering steel for all new bridges.

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

We seldom painting weathering steel other than for esthetics. It is the exception, but we have painted the weathering steel under the expansion joints.

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

We use epoxy coated reinforcing steel for decks and pier caps. Any prestress reinforcement that extends into the bridge deck is epoxy coated. https://oklahoma.gov/content/dam/ok/en/odot/documents/bridge/cadd-support/bridgedirectives.pdf

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Yes, we slope our pier caps and we have used coatings (not included in the Bridge Plan Directives) such as CIM1000 to protect the tops of our pier caps. https://oklahoma.gov/content/dam/ok/en/odot/documents/bridge/cadd-support/bridgedirectives.pdf

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

No written guidance, but we have used Type 2 or 5 cement for streams that have high sulfate content.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No. Note that most of our foundations are on drilled shafts.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No, we have very few steel substructures. N/A

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

We require stainless steel bearing plates and stainless steel anchor bolts on new bridges refer to Section 724.05.A. Stainless Steel Bearing Assemblies https://oklahoma.gov/content/dam/ok/en/odot/documents/c_manuals/specbook/2019--full-spec-web-version.pdf

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

We require that the joints be tested for leakage – refer to Section 518. https://oklahoma.gov/content/dam/ok/en/odot/documents/c_manuals/specbook/2019--full-spec-web-version.pdf

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No. N/A

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No. We do silane application the following summer after construction but we rarely do cyclic applications. District 4 is doing some secondary silane applications. Some districts are doing some power washing. We are applying flood coats to some of our bridge decks. Based on research, the recommended cycle would be 12 years.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

We have a policy of applying silanes the summer after construction.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

No. N/A

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

We have done and continue to research on sealers.

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Yes, sealer research.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

- We are starting research to determine if Magnesium-Alumino-Liquid-Phosphate (MALP) will stop corrosion with their rust convertor which converts iron oxide to iron phosphate.
- Working on coordinating research to test sealers/coating to seal prestress beam ends. Note that our silane research is showing that silanes will seal the side of cracks.
- Hope to develop a procedure to use X-rays to determine chloride penetration rates into bridge decks. This technology could be used as a Bridge Management tool.

Oregon Peer Exchange Survey Response

Group 2 State: Oregon

1. **Participant's Name(s)** [redacted]
2. **Organization** Oregon Department of Transportation
3. **Title(s)** [redacted]
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Oregon confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Oregon Bridge Materials

Oregon	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,579	256
NHS Deck Area Percentage	55.3%	67.2%
Non-NHS No. of Bridges	3,951	787
Non-NHS Deck Area Percentage	44.7%	32.8%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Element level data is collected on all NBI bridges within the jurisdiction of the ODOT Bridge Inspection Program.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   ODOT utilizes the standard AASHTO Elements for steel members in addition to the standard defect language for the steel elements.

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

   Additionally, ODOT has elected to develop agency defined elements and effectiveness condition rating language to track the various protective systems for steel members.

These include Steel Paint Systems, Weathering Steel Systems, Galvanization/General Systems and Concrete Encasement Systems.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    We do soluble salt testing in limited situations on coastal structures and perform UT on steel pins, which can occasionally identify corrosion.

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    ODOT utilizes the standard AASHTO Elements for RC/PSC/PTC members in addition to the standard defect language for the steel elements.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    Additionally, ODOT has elected to develop agency defined elements and effectiveness condition rating language to track the various protective systems for concrete members. These include Concrete Protective Coatings, Coated Rebar Systems, Cathodic Protection Systems in addition to various wearing surface elements for decks.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Yes, we do take cores for and powder samples for planning future cathodic protection work on coastal or historic bridges.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

ODOT generally does not have specific defects for the agency defined elements/protective systems mention above. ODOT utilizes general effectiveness language to rate the elements/protective systems. However, for the deck wearing surfaces ODOT has elected to collect sub-protective system defects.

15. **On your ADE items, what defects are you collecting?**

    See above

16. **Are you performing chloride profiling as part of your RC deck management?**

    Yes

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    It is primarily used for deck assessments though we intend to make inventory decisions in the future as the data set increases.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - Section 1.9.3 and associated tables

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Compressive strength testing of cores and bond testing of existing overlays

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    Yes – chain drag, impact echo, high definition photography, ultrasonic testing, infrared, GPR, rebound hammer, mast arm mounted long duration infrared

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    No

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    No

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    No, our program is based on full painting only.

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    No, it is based on condition states.

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    BDM Section 1.6.2.15 - https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    Bridge Inspection data (condition states) tied to coating dates/ages.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    Standard Specifications for Construction – Section 01200, Section 00542, https://www.oregon.gov/odot/Business/Pages/Special-Provisions.aspx

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    PT – Bore scope inspections, impact echo
    PS Slabs – differential movement measurements (corrosion of tie rods)

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    Not yet.

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    Post project Bridge Inspection Reports

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf and associated tables.

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    Yes, primarily low-mod epoxies, but have used high-mod epoxies and methacrylates. Primarily chosen by crack size per the inspection report. Recent experiments (2 years) with crystalline silicates and silanes.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    Section 00504 – Bridge Deck Surface Preparation
    Section 00556 - MPCO's (epoxy thin lift)
    Section 00557 - PPC (polyester concrete overlay)
    Section 00559 - SCO (Structural Concrete Overlay – HPC concrete)

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - Section 1.9.3.1.6.1
    Section 00590 – Polymer Membrane
    Section 00592 – Rolled Membrane
    https://www.oregon.gov/odot/Business/Specs/2021_STANDARD_SPECIFICATIONS.pdf

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    Post project bridge inspection reports.

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

https://www.oregon.gov/ODOT/Bridge/Pages/BCR.aspx

37. **Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.**

    We do not have targeted spending percentages.

38. **What is your State's maintenance cost per square foot for your bridge inventory?**

    What is meant by maintenance in this context? Not sure how you want this calculated.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. **Does your State have written guidance for corrosion prevention or mitigation strategies?**

    Yes, https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - Section 1.9.1

40. **Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?**

    Yes, https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - Section 1.9.2.1.3

41. **Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?**

    No

42. **Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?**

    No, we use HPC for all bridge decks, regardless of corrosion risk. See Section 02001.30 in Standard Specifications.
    https://www.oregon.gov/odot/Business/Specs/2021_STANDARD_SPECIFICATIONS.pdf

New Designs – Steel Decks

43. **Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)**

    No.

New Designs – Steel Superstructures

44. **Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)**

Yes. https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - Section 1.6.2.2

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Yes. https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - BDM Section 1.6.2.15

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

Yes. https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf - Section 1.5.5

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

No, fabrication inspections are general in nature.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

No, but refer to Section 00555 for post-tensioned construction specifications.
https://www.oregon.gov/odot/Business/Specs/2021_STANDARD_SPECIFICATIONS.pdf

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf
Beam seat drainage – Section 1.11.2.13
No other specific corrosion protection guidance on these elements.

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

No.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

No.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Yes, BDM Section 1.10.5.4.1(10)
https://www.oregon.gov/odot/Bridge/Guidance/BDM-2022-10-01.pdf

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

ODOT attempts to eliminate bearings or use elastomeric bearing pads, partly to reduce or eliminate corrosion concerns.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

Eliminate joints whenever possible. Use elastomeric headers. Section 1.14.2.2. There is no specific guidance on enhancing durability. Joint details and systems have been selected with durability in mind.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

No.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

ODOT is implementing a new deck sealing program with silane, the recommended recoat time will be 10 years. Current epoxy based deck seals are inconsistently reapplied, based on the maintenance recommendation of the Bridge Inspector.

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

ODOT has a well-developed ICCP program for coastal structures.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Have discussed increasing cover for bridge decks as part of a full LCA. Working towards a management plan for coastal structures which will incorporate additional impacts of climate change.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

Yes. See https://www.oregon.gov/odot/Programs/ResearchDocuments/SPR742_EffectsOfChlorideDeicer_Final.pdf and https://www.oregon.gov/odot/Programs/ResearchDocuments/SPR815Bridgedeckasphalt.pdf

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

No

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

We need additional research on extending the lifespan of our existing corrosion treatments, including both deck treatments and cathodic protection. Specifically, how do subsequent treatments interact, like layers of deck overlays, or what to do once an ICCP system has reached end of life.

Pennsylvania Peer Exchange Survey Response

Group 2 State: Pennsylvania

1. **Participant's Name(s)** [redacted]
2. **Organization** PennDOT Bridge Office Design QA Section
3. **Title(s)** Assistant Chief Bridge Engineer and PennDOT Bridge Office Design QA Section
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Pennsylvania confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Pennsylvania Bridge Materials

Pennsylvania	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	3,780	2,026
NHS Deck Area Percentage	51.8%	73.6%
Non-NHS No. of Bridges	11,786	4,933
Non-NHS Deck Area Percentage	48.2%	26.4%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   PennDOT collects element level data for state-owned bridges, 8' and greater but does not require for local non-NHS bridges.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   None. The only ADE's PennDOT uses are for retaining walls.

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

   PennDOT does collect defect information. We use defects provided by the MBEI only.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

Physical measurements are taken to determine carrying capacity.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**
    None. The only ADE's PennDOT uses are for retaining walls.
12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**
    Yes. We use the defects for PS/PT/RC structures as defined by the MBEI.
13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**
    In preparation for rehab/redecking cores may be taken.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**
    None. The only ADE's PennDOT uses are for retaining walls.
15. **On your ADE items, what defects are you collecting?**
    N/A – we don't collect ADE's for RC decks.
16. **Are you performing chloride profiling as part of your RC deck management?**
    Very limited
17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**
    Individual deck assessment for rehab.
18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**
    No, deck replacements or mill and overlay are at the discretion of the engineer.
19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**
    Cores are taken to determine if overlays are suitable.
20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**
    No

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**
    The guidance is what to do not when.

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**
    No
23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**
    Weathering steel is required to be painted 5' at the ends under deck joints.
24. **Does your State use lifecycle analysis basis for recoating existing steel members?**
    Life cycle costing is used to plan and determine the best preservation action to be taken.
25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**
    Paint weathering steel during rehab work or when new, up to 5' away from joints.
26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**
    We conduct routine inspections only. There has been no action to track mitigation.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**
    There is limited guidance on treatments to be used to limit corrosion.
28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**
    No special techniques are used, visual, hands on inspections.
29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**
    Actions are limited and guidance is not specifically given.
30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**
    Not tracked.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**
    (See PDF 35)
32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**
    PDF 35

33. Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)

PDF 35

34. Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?

PDF 35

35. How does your State determine the effectiveness of these corrosion mitigation actions?

Routine Inspections

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

We tacked recommended and completed maintenance in our BMS system.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

We have moved away from replacement goals to an overall lowest life cycle cost approach. During this transition, we have eliminated replacement goals as that tends to encourage a worst-first strategy, and are actively looking to create and implement investment-based goals for all FHWA work types similar to CalTrans.

38. What is your State's maintenance cost per square foot for your bridge inventory?

This number is available but would require extensive data mining to identify.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

DM4 excerpt attached as PDF 33

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

Epoxy or galvanized is required. Overlays are required

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

No

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

All decks are typically same mix. The overlay type varies based on District preference.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

Galvanized open grid.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Same as concrete for the deck, beams get 3 coat paint systems

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Policy is to paint

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

No

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

We inspect beams in the shop prior to shipping and again after bridge is completed before acceptance. This is more a QA of the steel placement than corrosion.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

We do not have a policy, PennDOT has used EIT system on one PS/PT bridge.

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No, except for casting or placement against acid soils.

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

a. We dowel and encase the cap when the situation warrants it.
b. We are moving toward a paint on solution. Currently epoxy/gal rebar.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

No.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

Acid soil the rebar clear cover is 4” typ.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Everything is galvanized and painted or metalized.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

No

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

Nothing beyond the basics.

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Joint selection is based on the required expansion.

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

No

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

None

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

a. RC12 - Resilient Backfill
b. RC30 – Backfill at pipes
c. RC15- Geosynthetic Reinforced Bridge Approach

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

No

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

No

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

PennDOT would consider any improvements that stem from research.

Texas Peer Exchange Survey Response

Group 2 State: Texas

1. **Participant's Name(s)** [redacted]
2. **Organization** Texas Department of Transportation
3. **Title(s)** [redacted]
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Texas confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Texas Bridge Materials

Texas	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	16,007	1,913
NHS Deck Area Percentage	60.8%	76.2%
Non-NHS No. of Bridges	32,004	5,027
Non-NHS Deck Area Percentage	39.2%	23.8%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Element level data is collected for TxDOT owned bridges and other bridges on the National Highway System and bridges owned by Harris County.

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**

   TxDOT no longer collects additional information for ADEs.

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

   For elements we are required to collect, defects are collected as described in the MBEI.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    Advanced NDE methods (beyond sounding, visual evaluation, and field measurements) are not typically used to collect information to determine corrosion issues.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**

    TxDOT no longer collects additional information for ADEs.

12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    For elements we are required to collect, defects are collected as described in the MBEI.

13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Advanced NDE methods (beyond sounding, visual evaluation, and field measurements) are not typically used to collect information to determine corrosion issues. Cores and chloride testing have been used to evaluated concrete members for the presence of chloride contamination.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    TxDOT no longer collects additional information for ADEs.

15. **On your ADE items, what defects are you collecting?**

    (No answer provided)

16. **Are you performing chloride profiling as part of your RC deck management?**

    Chloride profiling is not used on typical bridges. Cores have been taken in the past to help decide on preservation actions.

17. **If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?**

    When used, chloride content is used for individual bridge deck assessments.

18. **Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)**

    TxDOT has a Bridge Preservation Guide that discusses performing cores to evaluate chloride content. The Guide is internal to TxDOT only at this time and is a work in progress. Generally, results of chloride content evaluated from cores have not otherwise changed the course of action for bridge preservation determined from visual observations.

19. **Are you using destructive evaluations for other information? If so, what evaluations and how is it used?**

    Destructive evaluation for other information is not generally performed except in rare instances.

20. **Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?**

    Sounding and thermal imaging are the most common NDE methods used to evaluate RC decks and to help determine preservation actions.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. **Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)**

    TxDOT's Bridge Preservation Guide has a brief discussion on coatings and preservation actions. Guide is internal to TxDOT only and is a work in progress.

22. **Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.**

    TxDOT's Bridge Preservation Guide has a brief discussion on coatings and preservation actions.

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    TxDOT's Bridge Preservation Guide has a brief discussion on coatings and preservation actions.

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    Longevity of a paint system and expected life of a bridge are considerations made when

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    It is not our practice to paint weathering steel in Texas.

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    TxDOT has used spreadsheets in the past to track performance of steel coatings.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    TxDOT's Maintenance Operations Manual discusses the State's policy on application of penetrating sealers to bridge decks for bridge preservation.

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    TxDOT does not perform special inspection techniques on typical bridges to assess PS/PT bridges.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    TxDOT has published corrosion protection measures for new bridges available on the TxDOT website.

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    TxDOT does not currently have a defined system to determine the effectiveness of these corrosion mitigation actions.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    TxDOT's Bridge Preservation Guide has a brief discussion on such preservation actions. The Guide is internal to TxDOT only and is a work in progress.

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    TxDOT does apply deck sealers as a preservation action. TxDOT's Bridge Preservation Guide has a brief discussion on when to apply a deck sealer.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    TxDOT's Bridge Preservation Guide has a brief discussion on when we would generally apply such overlays. Overlay thickness is dependent on the material type used.

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    It is no longer TxDOT practice to install asphalt overlays as a preservation action on bridges.

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    TxDOT does not currently have a defined system to determine the effectiveness of these corrosion mitigation actions.

Funding Needs – Current and Future

Highway Bridges

36. Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)

TxDOT is implementing BrM to aid in this effort. We are still early in the implementation of BrM.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

TxDOT has dedicated funding for bridge preservation and a separate allocation specifically for bridge replacement. Bridge preservation funds include two major allocations. One is a program called Bridge Preventive Maintenance and this annual allocation has been roughly $15M. A second program called Bridge Maintenance and Improvement has an annual allocation of roughly $50M. In addition to these two major allocations, district maintenance funds are also used for bridge maintenance.

38. What is your State's maintenance cost per square foot for your bridge inventory?

We have not tracked all bridge maintenance costs. We estimate we've spent roughly $75M on bridge maintenance to TxDOT owned bridges last year.

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

TxDOT has a Structure Design – Corrosion Protection Guide that is published by the Bridge Division. General guidance is provided in that document for bridge decks. Shrinkage crack control measures are highlighted for bridge decks where water and chloride penetration can attack reinforcing steel. Structure Design - Corrosion Protection Structure Guide (txdot.gov)

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

Guidance on different reinforcement options is provided in the Structure Design – Corrosion Protection Guide. TxDOT does have glass fiber reinforced polymer standard for decks used on prestressed concrete I-girder spans. 2 1/2" clear top cover is standard for all Texas bridge decks, including decked slab beams. Structure Design - Corrosion Protection Structure Guide (txdot.gov)

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

No

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

Guidance on concrete mix designs and the use of High Performance Concrete is provided in the Structure Design – Corrosion Protection Guide. The specific mix designs are covered in the TxDOT Specifications. Structure Design - Corrosion Protection Structure Guide (txdot.gov) TxDOT Specifications

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

No

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

TxDOT has a Preferred Practices for Steel Bridge Design, Fabrication, and Erection. Preferred Practices for Steel Bridge Design, Fabrication, and Erection (txdot.gov)

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

TxDOT has a Preferred Practices for Steel Bridge Design, Fabrication, and Erection. Preferred Practices for Steel Bridge Design, Fabrication, and Erection (txdot.gov)

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

No

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

TxDOT Item 426 of our Standard Specifications (Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (txdot.gov)) is an all-encompassing specification that was written to prevent and mitigate corrosion for new PT structures. Materials must meet requirements of the most current versions of the following documents unless indicated otherwise: Post-Tensioning Institute's Guide Specification for Grouted Post-Tensioning (PTI/ASBI M50) and Post-Tensioning Institute's Specification for Grouting of Post-Tensioned Structures (PTI M55).

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

There are no special Fabrication Inspection Practices specific to corrosion mitigation.

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

TxDOT specification for post tension structures Item 426 follows Post Tensioning Institute/ American Segmental Bridge Institute guidance. Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (txdot.gov)

New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

50. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No

51. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

No

52. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

Guidance on different reinforcement options is provided in the Structure Design – Corrosion Protection Guide. Substructure - Consider increased clear cover for substructure elements on a case-by-case basis. Specify an additional 0.5 in. of clear cover for bent caps, abutments and exposed footings by decreasing the size of stirrups. Increase the size of the bent cap, abutment, or footing by increments of 3”, when required by structural design. Caps are sloped and epoxy coating waterproofing is applied in areas with corrosion risk.

53. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

Columns have sufficient clear cover.

54. Does your State have written guidance addressing required changes in footing detailing or concrete mix depending on corrosion risk?

See answer to number 52.

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Guidelines for the Use of Steel Piling for Bridge Foundations (txdot.gov)

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. **Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)**

    Preferred Practices for Steel Bridge Design, Fabrication, and Erection (txdot.gov) Recommendations on coatings and protection systems are covered in the document.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. **Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)**

    Preferred Practices for Steel Bridge Design, Fabrication, and Erection (txdot.gov) and also Structure Design - Corrosion Protection Guide (txdot.gov)

58. **Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)**

    Structure Design - Corrosion Protection Guide (txdot.gov) TxDOT offers the opportunity to hot-dip galvanize expansion joint steel hardware if specified in the general notes. In areas of deicing salt usage, such treatments can avoid long term deterioration and loosening of the steel hardware.

Other Noteworthy Practices

Policy and Guidance

59. **Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)**

    TxDOT has language in our TxDOT Maintenance Operations Manual regarding re-application of silane at a frequency of seven to ten years. Other deck protection systems discussed in the TxDOT Maintenance Operations Manual are being updated/revised.

60. **Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?**

    TxDOT has written several new special specifications in recent years to address corrosion, particularly at the ends of steel beams. One such specification is for cleaning the tops of abutment and bent/pier caps of all debris, which frequently builds up at locations with open joints. Another specification is for zone or spot painting of steel bridges. Our standard specification for field painting steel structures was not well suited to zone painting applications and this new specification should provide a better means to address localized concerns.

61. **Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?**

TxDOT is not making statewide changes in anticipation of potential climate change. TxDOT does periodically review and update statewide policy on corrosion protection measures.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

Yes.

a. Corrosion Resistance of Grouted Post-tensioning Systems
https://library.ctr.utexas.edu/Presto/content/Detail.aspx?ctID=M2UxNzg5YmEtYzMyZS00ZjBlLWIyODctYzljMzQ3ZmVmOWFl&rID=OTY=&sID=MQ==&qrs=VHJ1ZQ==&q=KCop&qcf=M2UxNzg5YmEtYzMyZS00ZjBlLWIyODctYzljMzQ3ZmVmOWFl

b. Synthesis of Alternate Reinforcements for Enhanced Corrosion Resistance in TxDOT Bridges
https://library.ctr.utexas.edu/Presto/content/Detail.aspx?ctID=M2UxNzg5YmEtYzMyZS00ZjBlLWIyODctYzljMzQ3ZmVmOWFl&rID=NjAy&sID=MQ==&qrs=VHJ1ZQ==&q=KHJwLmNhdGRhdGU9WzIwMTcxMDE4MDAwMDAwIFRPIDIwMTcxMDE5MDAwMDAwXSk=&qcf=M2UxNzg5YmEtYzMyZS00ZjBlLWIyODctYzljMzQ3ZmVmOWFl&rrtc=VHJ1ZQ==

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

TxDOT does have current research focused on bridge preservation including the effectiveness of various coatings and concrete durability. This study is scheduled to terminate in July 2024. Another active study is investigating the effectiveness of past corrosion mitigation techniques. It is scheduled to terminate in August 2023.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

(No answer)

Virginia Peer Exchange Survey Response

Group 2 State: Virginia

1. **Participant's Name(s)** [redacted]
2. **Organization** Virginia Department of Transportation
3. **Title(s)** Assistant State Bridge Engineer; Maintenance Management Engineer / S&B
4. **Phone Number(s)** [redacted]
5. **E-mail(s)** [redacted]

Highway Bridges – Inventory and Condition (2022 NBI)

6. **The State of Virginia confirmed/updated the number and deck area of bridges with material types meeting the AASHTO and NBIS bridge definition (i.e., NBI Bridges that are not owned by a Federal agency or Tribe), as shown below:**

Virginia Bridge Materials

Virginia	Main Span Material: Concrete, Concrete Continuous, or Prestressed Concrete Continuous	Main Span Material: Steel or Steel Continuous
NHS No. of Bridges	1,672	2,110
NHS Deck Area Percentage	62.3%	65.5%
Non-NHS No. of Bridges	5,368	4,404
Non-NHS Deck Area Percentage	37.7%	34.5%

Existing Highway Bridges – Data Collection

Steel Bridges

7. **States are required to collect element level data for NHS bridges; however, it is not required for non-NHS bridges. Does your state collect element level data for non-NHS bridges?**

   Yes

8. **What types of Agency Defined Elements (ADEs) does your State collect that are, or could be, used to identify corrosion prevention actions for steel bridge members?**
   - Beam/Girder End (ADE 811)
   - Joint Effectiveness (ADE 845)
   - Beam End Coating Effectiveness – Steel (ADE 886)
   - Deck Drains (ADE 802)
   - Link Slab (ADE 843)
   - Deck Extension (ADE 844)
   - Unprotected Slope (ADE 853)

- Protected Slope - Riprap (ADE 853)
- Roadway Over Culvert (ADE 833)

9. **For the elements you are required to collect, do you collect defect data? If so, what additional defects do you code that are not listed in the AASHTO MBEI manual?**

   Yes. None.

10. **Are you using nondestructive evaluation (NDE) methods to collect condition information to determine corrosion issues? What evaluations do you typically perform and why?**

    Yes. GPR, impact-echo, chain drag. Mostly to evaluate decks. For the steel members themselves we sometimes use traditional testing methods like dye penetrants, ultrasound, magnetic particle, and radiography.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

11. **What types of ADE's does your State collect that are, or could be, used to identify corrosion prevention actions for PS/PT & RC highway bridge members?**
    - Beam/Girder End (ADE 811)
    - Joint Effectiveness (ADE 845)
    - Beam End Coating Effectiveness – Concrete (ADE 887)
    - Deck Drains (ADE 802)
    - Link Slab (ADE 843)
    - Deck Extension (ADE 844)
    - Unprotected Slope ((ADE 853)
    - Protected Slope - Riprap (ADE 853)
    - Roadway Over Culvert (ADE 833)
12. **For the elements you are required to collect, do you collect defect data? If so, what defects do you code?**

    Yes. Pretty much the same defects that are described for required elements. It's an extensive list, to you may find the details in our manual, titled the VDOT Supplement to the AASHTO Manual for Bridge Element Inspection
13. **Are you performing destructive testing including cores and chloride testing to determine corrosion issues? What are they and why are they used?**

    Yes. We require chloride profiles to be gathered for any full deck decision analysis. Our deck maintenance guidance is based on a combination of readily available element/condition rating data and an understanding of the location of the chloride front. We also use petrographic analysis where appropriate to evaluate parameters such as carbonation and aggregate reactivity.

RC Decks

14. **What types of ADE's, and/or additional data does your State collect that are, or could be, used to identify corrosion prevention actions for RC Decks?**

    We have an inventory field that indicates the type of overlay used. In our opinion this is a significant gap in the AASHTO elements. We break down bearings and joints by type

but not overlays. We can get the data using our own inventory management system, but it would be much better if the national elements had the type of overlay. To provide a direct answer to the question, we have the following ADEs that are associated with deck behavior:

- Joint Effectiveness (ADE 845)
- Deck Drains (ADE 802)
- Link Slab (ADE 843)
- Deck Extension (ADE 844)

15. On your ADE items, what defects are you collecting?

Pretty much the same defects that are described for required elements. It's an extensive list, to you may find the details in our manual, titled the VDOT Supplement to the AASHTO Manual for Bridge Element Inspection

16. Are you performing chloride profiling as part of your RC deck management?

Yes, but only when we are evaluating a deck to determine the most appropriate treatment as part of a project.

17. If you are using chloride profiling, is it used for individual bridge deck assessments or for bridge deck inventory decisions?

Individual

18. Do you have written guidance on specific repair actions related to chloride levels? (Please provide a PDF or web link)

Yes. Most of our bridge maintenance decision logic is laid out in Chapter 32 of the Manual of the Structure and Bridge Division. See part 3 for concrete decks.

19. Are you using destructive evaluations for other information? If so, what evaluations and how is it used?

Yes. ASR, carbonation, compressive strength, and elastic modulus.

20. Does your State perform non-destructive evaluations to identify corrosion prevention actions or identify preservation actions for RC decks?

Yes. GPR, impact-echo, chain drag, half-cells. We have discontinued the use of infrared thermography.

Existing Highway Bridges – Corrosion Prevention and Mitigation

Steel Bridges

21. Does your State have written guidance for managing coatings on existing steel bridge members? (Please provide a PDF or web link)

Yes. Most of our bridge maintenance decision logic is laid out in Chapter 32 of the Manual of the Structure and Bridge Division. See part 4 for steel girders. Also, see Section 411 of the VDOT Road and Bridge Specifications.

22. Does your State have written guidance for using different coatings based on severity of corrosive environment types? If so, please provide a PDF or web link.

Kind of. Chapter 11 of Part 2 of the Manual of the Structure and Bridge Division touches on this for new bridges. When to use weathering steel, etc.

23. **Does your State have a written guidance on full painting, zone painting, and spot painting of steel members? (Please provide a PDF or web link)**

    Yes, see aforementioned Chapter 32.

24. **Does your State use lifecycle analysis basis for recoating existing steel members?**

    Yes. Again, see Chapter 32, section 6 this time.

25. **Does your State have a policy or guidance on when and/or where to paint weathering steel members? (Please provide a PDF or web link)**

    For new bridges, yes. For existing bridges, not yet. See Chapter 11 of Part 2 of the Manual of the Structure and Bridge Division

26. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    We perform deterioration analyses on ad hoc basis by tracking performance data stored in BrM.

Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Bridges

27. **Does your State have documents that address corrosion prevention and mitigation actions/strategies for preservation of existing PS/PT and RC bridge members? (Please provide a PDF or web link)**

    Yes, we have a little bit in Section 4 of Chapter 32 of the Manual of the Structure and Bridge Division, but we need to expand it. We have a study underway at Virginia Tech that is developing recommendations.

28. **Does your state perform special inspection techniques to assess PS\PT bridges? If so, what are the techniques used and reasons for use?**

    Yes. For large, post-tensioned bridges We employ special inspections with magnetic flux, pulse velocity, and GPR. We also use health monitoring programs on these bridges that gather real-time data on sound signature (acoustic emissions), displacement, strain, tilt, temperature, and acceleration.

29. **Does your state have written guidance specific to preservation actions on PS\PT bridge superstructures? If so, please provide PDF or web link.**

    For prestressed girders we have Chapter 32 of the Manual of the Structure and Bridge Division, but we lack such guidance for segmental bridges. Segmental bridges have been problematic for us, and we intend to limit their construction in Virginia until the corrosion issues are worked out.

30. **How does your State track and determine the effectiveness of these corrosion mitigation actions?**

    We perform deterioration analyses on ad hoc basis by tracking performance data stored in BrM.

RC Decks

31. **Does your State have written guidance on how to select preservation actions on existing RC bridge decks? (Please provide a PDF or web link)**

    Yes. See Section 3 of Chapter 32 of the Manual of the Structure and Bridge Division.

32. **Does your State apply deck sealers? If yes, what type(s) and what criteria do you use to determine when to apply a deck sealer?**

    Yes. Our primary methods for protecting existing concrete overlays are rigid concrete overlays and thin-bonded epoxy overlays. We permit polyester overlays and from time to time will apply gravity fill polymers such as silane or methyl methacrylate, although these last two have limited life spans (~2 years). Guidance for deck treatments may be found in Section 3 of Chapter 32 of the Manual of the Structure and Bridge Division. Additional guidance on crack repair can be found in the Guide Manual for Causes and Repair of Cracks in Bridge Decks. Specifications covering repair of concrete cracks can be found in Sections 412, 243, and 252 of the VDOT Road and Bridge Specifications.

33. **Does your State have written guidance on installing rigid concrete/epoxy deck overlays? Please specify type(s), standard thicknesses, and deck preparation techniques for individual type(s). (Please provide a PDF or web link)**

    Yes. Rigid concrete overlays are nominally 1 ¼" thick over a rotomilled surface and slightly deeper when placed over a hydromilled surface. Thin-bonded overlays (epoxy or polyester) are 3/8" thick nominally. Deck preparation and installation procedures may be found in Section

34. **Does your State have a policy/design guidance for use of membranes prior to overlaying bridge decks?**

    Yes. Asphalt overlays are prohibited unless placed on a membrane. Guidance on selection of membrane is provided in Section 3 of Chapter 32 of the Manual of the Structure and Bridge Division. Membrane specifications are detailed Section 429 of the VDOT Road and Bridge Specifications

35. **How does your State determine the effectiveness of these corrosion mitigation actions?**

    We perform deterioration analyses on ad hoc basis by tracking performance data stored in BrM.

Funding Needs – Current and Future

Highway Bridges

36. **Does your State use a Bridge Management System or a Maintenance Management System to determine future funding needs for bridge preservation? (Please provide a PDF or web link)**

    Yes. We use BrM, supplemented by locally developed computer programs and spreadsheet tools.

37. Does your state have targeted spending percentages on bridge preservation versus improvements or bridge replacements? If so, please provide targets used.

Yes. The 2019 Maintenance and Operations Comprehensive Review investigated investment strategies, performance measures, acceptable levels of service, funding needs, and optimized funding balances. The study found that approximately 75% of VDOT's bridge funding should go to preservation activities and 25% to replacement. *Note: DOT defines preservation as anything short of bridge replacement. Superstructure and deck replacement were considered preservation activities in this study*.

38. What is your State's maintenance cost per square foot for your bridge inventory?

We would need to clarify what this question means. Does it refer to total annual expenditures on bridge maintenance activities divided by aggregate deck area? Do you wish for us to include inspection, load rating, emergency cost, capital replacement at end of life?

New Designs - Policy and Guidance

New Designs – RC Decks and Barriers

For the design of new reinforced concrete bridge decks. (Please provide a PDF or web link for information relevant to the questions below)

39. Does your State have written guidance for corrosion prevention or mitigation strategies?

Yes. A lot. The guidance is located in many places in the Part 2 of the Manual of the Structure and Bridge Division and Divisions II and IV of the VDOT Road and Bridge Specifications.

40. Does your State have a unique policy/design guidance specific to the reinforcement type(s) and top cover used on new bridge deck designs?

I don't know if it's unique, but we do specify minimum cover for decks. See Chapter 10 of the Manual of the Structure and Bridge Division.

41. Does your State have a unique policy/design guidance specific to the reinforcement for the Barrier-Deck interface to prevent or mitigate corrosion at that location?

Yes, at least I think it's unique. Epoxy overlays must be continuous from the deck to a location 1' up the barrier face. Also, we require corrosion resistant reinforcement in both the deck and barrier. See IIM-S&B-81.1.

42. Does your State have a unique policy/design guidance for concrete mix design based on corrosion risk?

We have been requiring low permeability concrete in all bridge components since 2003. We require pozzolans (fly ash or slag) to reduce permeability to moisture and chlorides. We have also been specifying what we call "low cracking deck concrete" since 2016. This specification limits total cementitious material weight and allows slightly lower average compressive strengths in order to reduce the incidence rate of drying shrinkage cracking in new decks.

New Designs – Steel Decks

43. Does your State have documents that address your State's corrosion prevention and mitigation strategies for the design of new steel bridge decks? (e.g., galvanize, material properties, sacrificial thickness, etc.) (Please provide a PDF or web link)

Yes, but not in the exact form described. We do specify coating thickness and have a provision for sacrificial thickness to be added to structural steel to account for future deterioration. But it's not in a single place.

New Designs – Steel Superstructures

44. Does your State have a policy/design guidance for selecting a type of steel and/or type of coating to prevent or mitigate corrosion for the design of new steel superstructure members? (Please provide a PDF or web link)

Yes. See Section 11 of Part 2 of the Manual of the Structure and Bridge Division

45. Does your State have a policy or guidance on painting new weathering steel members? (Please provide a PDF or web link)

Yes. See Section 411 of VDOT Road and Bridge Specifications and Section 11 of Part 2 of the Manual of the Structure and Bridge Division

46. Does your State use lifecycle analysis basis for corrosion protection system when designing a new steel superstructure? (Please provide a PDF or web link)

Yes, but not in every instance. Usually judgement and our office practice are our guides.

New Designs – Prestressed/Post-Tensioned (PS/PT) and Reinforced Concrete (RC) Superstructures

47. Does your State have a policy/design guidance for selection of reinforcement for your PS/PT and RC superstructures to prevent or mitigate corrosion for new PS/PT and RC highway bridge members? (Please provide a PDF or web-link)

Yes.

- For RC superstructures we require corrosion resistant reinforcement and low permeability concrete.
- For RC superstructures we require corrosion resistant reinforcement and low permeability concrete

48. Does your State have recommended Fabrication Inspection Practices to maximize service life (mitigate corrosion) of your PS/PT and RC superstructures? (Please provide a pdf or web link)

- We do not allow segmental post-tensioned bridges to be built without approval of the state bridge engineer. On those rare occasions when we do allow a post-tensioned segmental bridge to be constructed, we require the contractor to do a mockup of a tendon and display successful grouting.

- Prestressed and post-tensioned girders and other elements in salt or brackish water must use corrosion resistant materials (stainless, carbon fiber)
- All concrete elements must use high performance (low permeability) concrete.
- All post-tensioned segmental bridges and spliced bulb-tee bridges must have an acoustic emissions monitoring system
- All bridges must be jointless

49. Does your State have recommended Construction Inspection Practices to maximize service life (mitigate corrosion) of the prestressing tendons in segmental structures? (Please provide a PDF or web link)

- We do not allow segmental post-tensioned bridges to be built without approval of the state bridge engineer, per our IIM-S&B-91. On those rare occasions when we do allow a post-tensioned segmental bridge to be constructed, we require the contractor to do a mockup of a tendon and display successful grouting
- Grout used must meet rigorous requirements in our IIM-S&B-94

50. New Designs – RC Substructures (Backwall, Bridge Seat, Abutment, MSE Walls, Wingwall, Pier Caps, Columns, Foundations)

For the design of new reinforced concrete substructure elements. (Please provide a PDF or web link for information relevant to the questions below)

- All new bridges must be jointless to eliminate the eliminate the potential exposure to leaking joints
- All concrete elements must use non-reactive aggregates and supplementary cementitious materials (pozzolans such as fly ash or slag) to minimize permeability and, in turn corrosion and ASR-susceptibility
- Elements that may be exposed to water (lakes, bays, or streams) or via expansion joints or in splash zones must use corrosion resistant reinforcement

51. Does your State have written guidance addressing abutment seat areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

- All concrete elements must use non-reactive aggregates and supplementary cementitious materials (pozzolans such as fly ash or slag) to minimize permeability and, in turn corrosion and ASR-susceptibility
- Elements in salt or brackish water must use corrosion resistant reinforcement
- Elements that may be exposed to water (lakes, bays, or streams) or via expansion joints or in splash zones must use corrosion resistant reinforcement

52. Does your State have written guidance for detailing wingwalls differently depending on corrosion risk (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

- All concrete elements must use non-reactive aggregates and supplementary cementitious materials (pozzolans such as fly ash or slag) to minimize permeability and, in turn corrosion and ASR-susceptibility
- Elements in salt or brackish water must use corrosion resistant reinforcement
- Elements that may be exposed to water (lakes, bays, or streams) or via expansion joints or in splash zones must use corrosion resistant reinforcement

53. Does your State have written guidance addressing pier cap areas for corrosion protection (e.g., coatings, slopes, cover, reinforcing type changes, etc.)?

- All concrete elements must use non-reactive aggregates and supplementary cementitious materials (pozzolans such as fly ash or slag) to minimize permeability and, in turn corrosion and ASR-susceptibility
- Elements in salt or brackish water must use corrosion resistant reinforcement
- Elements that may be exposed to water (lakes, bays, or streams) or via expansion joints or in splash zones must use corrosion resistant reinforcement

54. Does your State have written guidance addressing required changes in column detailing or concrete mix depending on corrosion risk?

The question relates to footings, but I will answer in a more general sense to address foundations, including piles and pile caps. We use the following requirements to minimize corrosion in these elements:

- All concrete elements must use non-reactive aggregates and supplementary cementitious materials (pozzolans such as fly ash or slag) to minimize permeability and, in turn corrosion and ASR-susceptibility
- Elements in salt or brackish water must use corrosion resistant reinforcement

New Designs – Steel Substructures (Pile Bents, Columns, Pier Caps, Piles)

55. Does your State have documents that address corrosion prevention and mitigation strategies for the design of new steel substructure elements? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

We generally do not permit steel substructure elements on new bridges, but on those occasions where it is used, the members must be coated. We have a preference for galvanizing.

New Designs – Bearings (Rockers, Rollers, Nested Rollers, Disc, Pot, Spherical, Sliding Plates)

56. Does your State have documents that address corrosion prevention and mitigation strategies for the selection and design of new bridge bearings? (e.g., galvanize, coatings, stainless steel, material properties, etc.) (Please provide a PDF or web link)

Well, we took an approach of keeping the water and salt off of the bearings in the first place rather than putting a fancy coating on. We have been using jointless construction since 2011, which allows us to use the same coatings that are used on the remainder of the superstructure.

New Designs – Expansion Joints (Steel Armor, Steel Extrusions, Modular Components, Finger Joints, Sliding Plate)

57. Does your State have written guidance on joint detailing to enhance durability? (Please provide a PDF or web link)

Yes. See Section 8 of Chapter 32 of the Manual of the Structure and Bridge Division

58. Does your State have written guidance on joint selection for differing levels of durability? (e.g., galvanize, coatings, material properties, etc.) (Please provide a PDF or web link)

Yes. We have predicted life of various joint treatments in Section 6 of Chapter 32 of the Manual of the Structure and Bridge Division

Other Noteworthy Practices

Policy and Guidance

59. Does your State have published regular cycles of bridge preservation treatments? (e.g., silane treatment or crack sealing intervals, etc.)

Yes. See Sections 00 and 10 of Chapter 32 of the Manual of the Structure and Bridge Division

60. Are there noteworthy policies, procedures, or actions addressing corrosion prevention for highway bridges you would like to share?

We are working to employ a few technologies on a broader basis. These include laser ablation coating removal; remotely monitored impressed current cathodic protection systems; arc-spray applied metalizing of beam ends; and partial depth link slabs. I would also encourage states to use jointless construction, low permeability concrete, and corrosion resistant reinforcement. We have found all three initiatives to be well work the investment.

61. Is your State considering or making policy/procedures/guidance changes for new bridge designs to increase their resiliency from hazards due to potential climate change? If so, what are they?

Yes, well it's more appropriate to say that we already have. We require major bridges to be designed with enough clearance to accommodate sea level rise.

Research

62. Has your State performed any research in the last 5 years to prevent and mitigate corrosion of highway bridges? (Please provide a PDF or web link)

A lot. See these links for a sampling. Probably missing a lot more. Call Steve Sharp at VTRC for a more complete list.

- Prestressed Concrete Piles made with Corrosion Free Carbon Fiber Composite Cable
- Dissimilar Metal Welds Between ASTM A709 Grade 50CR and Other Bridge Steels
- Fiber Reinforced Concrete (FRC) Beam End Repairs for Corroded Steel Beam Ends
- Efficacy and Safety of Combining Heat Induction and Laser Ablation for the Removal of Potentially Hazardous Bridge Coatings
- Field Evaluation of Reinforced Concrete Repairs using Hydro-Demolition, Galvanic Cathodic Protection or Impressed Current Cathodic Protection
- Corrosion Resistant Steel Fastener Assemblies
- Welding of ASTM A1010 Steel

- Corrosion-Resistant Stainless Steel for Prestressed and Post-Tensioning Strands
- Performance of Large Culverts in Virginia

63. Is your State currently performing any research that is informing your policy/procedures/guidance changes to prevent and mitigate corrosion of highway bridges?

Yes.

64. What future research, if undertaken, would assist your State in informing changes to your policy/procedures/guidance to prevent and mitigate corrosion of highway bridges?

Yes.

- Fibers
- Stainless and carbon fiber strands – case studies
- Recommendations for re-grouting tendons in which voids and soft grout have been detected
- Repair/mitigation recommendations for critical (non-replaceable) elements that have sustained ASR damage
- Recommendations/standardization of sacrificial anodes
- Advice on coatings/metalizing/alternative coatings
- Efficacy of new NDE methods (infrared, GPR, impact-echo, others)

U.S. Department
of Transportation

Federal Highway Administration

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