Iowa's Bridge Asset Management Strategy and Resources for Bridge Preservation

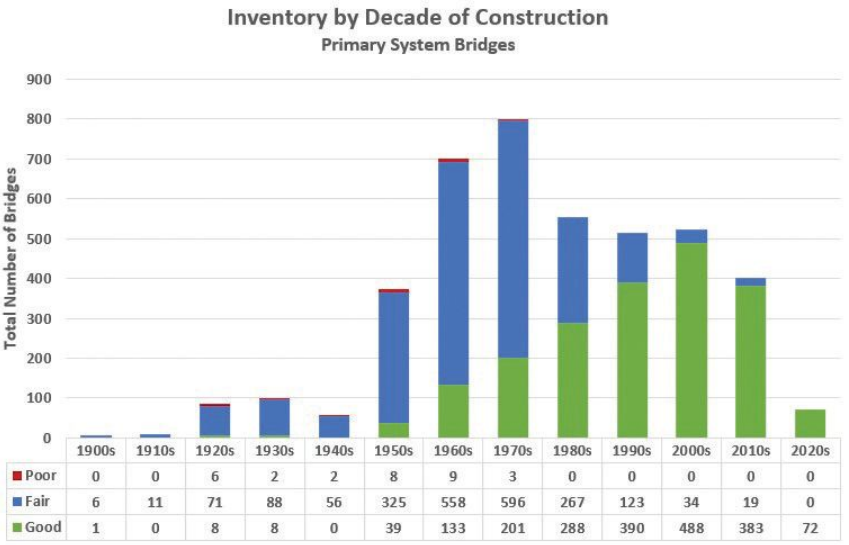
by Jim Nelson, Iowa Department of Transportation

Maintaining an inventory of bridges in a state of good repair is no small feat given the tremendous demands on our transportation system. Challenges we face include the following:

- An aging bridge inventory
- Limited budgets for bridge stewardship and modernization
- Structural deterioration from the use of deicing chemicals
- Increasing traffic and truck volumes
- Expansion of the system to address capacity, delays, and congestion
- Resiliency concerns, such as those associated with longer, new bridges constructed to accommodate greater hydraulic openings
- The need to harden new and existing bridges to withstand natural events
- The need to accomodate the greater axle loads and gross vehicle weights that have been recently legalized

The State of Iowa has an inventory of 23,799 bridges, according to the National Bridge Inventory data submitted to Federal Highway Administration (FHWA) in March 2022. The state owns and maintains 4195 of those bridges on the primary road system, with the remainder being on secondary roads owned and maintained by local public agencies such as cities and counties. While the number of secondary road bridges in Iowa is nearly five times that of the primary system, the two systems are closely matched in terms of bridge deck area: the primary roads have more than 47 million ft^2 of bridge deck, and the secondary roads have more than 49 million ft^2.

The Iowa Department of Transportation (DOT) has made a concerted effort during the past decade to increase its focus on stewardship and address bridges classified as being in poor condition, and it has reduced the number of poor bridges in the primary system from 237 in 2009 to 30 in 2022. While this is good news, there is still significant pressure on the Iowa DOT to keep bridges in a state of good repair and not backslide on the number of poor bridges. To rate bridges, Iowa DOT uses a bridge-condition index that takes into account the bridge structural condition, load-carrying capacity, horizontal and vertical clearance, roadway width, traffic levels, type of roadway, and the length of detour if the bridge were closed. The index uses a 100-point scale and defines a bridge rated 50 or better as being in a state of good repair.



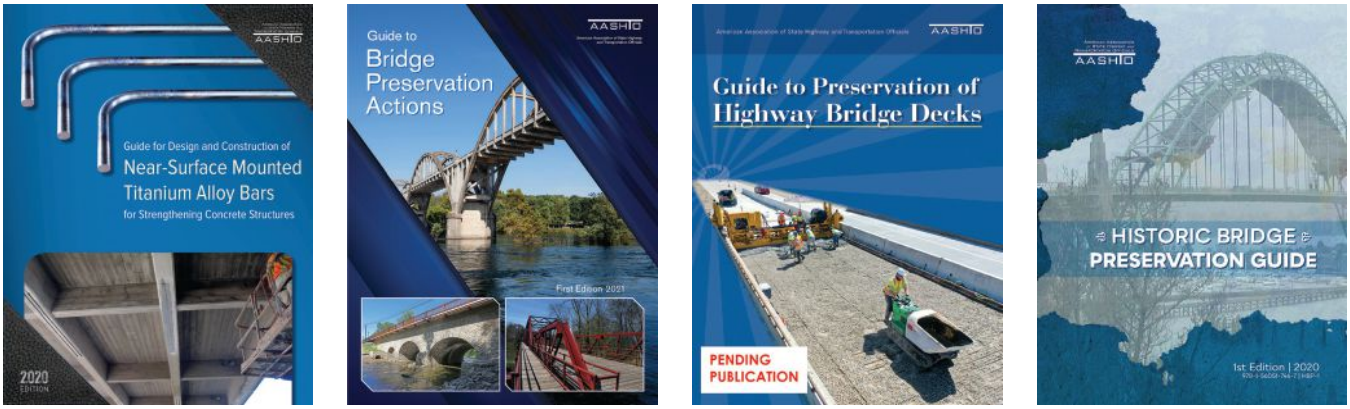
	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Poor	0	0	6	2	2	8	9	3	0	0	0	0	0
Fair	6	11	71	88	56	325	558	596	267	123	34	19	0
Good	1	0	8	8	0	39	133	201	288	390	488	383	72

Figure 1. Conditions of primary system bridges in Iowa by decade of construction. Figure: Iowa Department of Transportation.

One of the biggest challenges to maintaining a state of good repair is our aging bridge inventory. **Figure 1** shows the number of primary system bridges built in each decade and the relative conditions of the structures. The data in Fig. 1 show a "bubble" of in-service bridges constructed in the 1960s and 1970s, many of which are now considered to be in fair condition. Over time, there is a risk that this large volume of fair-condition bridges will deteriorate into poor condition, thereby straining the stewardship funding resources of the state. To counter this risk, Iowa DOT is using a three-pronged bridge asset management strategy to maintain the primary system bridges in a state of good repair. This strategy includes the following actions:

- Increasing bridge stewardship with an emphasis on more bridge replacements
- Investing in service-life design materials and details so that the bridges built today last longer than those built before the 1980s
- Investment in bridge preservation so that bridges in the current inventory last longer

Increased stewardship is primarily a function of funds available at the federal and state levels and how use of those funds is prioritized. There have



The covers of several new guides recently or soon to be published by the American Association of State Highway and Transportation Officials (AASHTO) with a focus on bridge preservation and rehabilitation. Photos: AASHTO.

been positive stories for Iowa with respect to funding. The first involves greater transportation revenue from a state fuel tax increase in 2015. The additional revenue is used to focus on projects critical to maintaining Iowa's transportation infrastructure. The second involves the Bipartisan Infrastructure Law, enacted in November 2021, which increases federal funding to the states for transportation infrastructure.

Improving the durability of bridges to achieve longer-lasting and lower-maintenance structures has been an ongoing effort and point of emphasis at Iowa DOT. This has resulted in the following:

- An increase in the number of jointless bridges through the use of integral or semi-integral abutments
- Use of high-performance concrete in bridge decks, where available, for improved (lower) permeability characteristics
- Improvements to pavement support corbels on abutment backwalls for durability
- Improvements to approach pavement details
- Use of materials such as stainless steel reinforcement for deck-to-barrier rail connections
- Use of stainless steel reinforcement on selected bridge decks and components where there is a goal to extend service life

Iowa DOT will continue to investigate and improve materials and details to achieve durable and long-lasting bridges. Emerging technologies that we continue to research and pilot include use of ultra-high-performance concrete, nonmetallic-fiber-reinforced concrete, and internal curing of concrete.

Bridge preservation is the area today where we see the most potential for gains in improved transportation asset management performance. Owing to funding restraints, reactive strategies that repair identified deterioration have traditionally been our primary preservation strategy, and such strategies will remain a priority.

Additionally, we are pursuing proactive preservation strategies to keep bridges in good or fair condition. Potential proactive strategies include replacing expansion joint seals that are reaching the end of their service life (before they leak); protecting new bridge decks with sealers or overlays (especially those that exhibit early-age cracking); and washing bridge decks, joints, drains, and bearing seats under joints to remove contaminants, thus slowing or eliminating further deterioration. The transition to a combination of both proactive and reactive strategies will be challenging to balance given the funding available.

Iowa DOT develops new policy and practices for bridge preservation based on institutional experience and information from an array of resources. Peer exchanges are valuable opportunities for learning (see the Creative Concrete Construction article on page 44 for methods and details to achieve a jointless structure that will minimize distress and improve bridge performance). Other key resources include the American Association of State Highway and Transportation Officials (AASHTO) Transportation System Preservation Technical Services Program, FHWA bridge preservation resources, and several new guides published by AASHTO with a focus on bridge preservation and rehabilitation. A brief introduction to some of these new AASHTO publications follows.

AASHTO's *Guide to Bridge Preservation Actions*[1] was published in July 2021 and is a product of the National Cooperative Highway Research Program (NCHRP) Project 14-36 (for details of this NCHRP project, see the Perspective article in the Spring 2021 issue of *ASPIRE*®). The guide contains an extensive list of bridge preservation actions that can be implemented to keep bridges in fair or good condition and provides guidance on choosing particular preservation actions and their expected effects on bridge conditions. The guide also presents a preservation-cycle cost analysis method to help owners evaluate the benefits of preservation and provides examples in the appendices.

Another product of NCHRP Project 14-36 is AASHTO's forthcoming *Guide to Preservation of Highway Bridge Decks.*[2] At the 2021 annual meeting of the AASHTO Committee on Bridges and Structures, the proposed guide was balloted and passed for adoption. Many bridges in the United States are in climates where temperatures fall below freezing, leading to damage caused by freezing and thawing as well as the application of deicing agents, which can shorten the service life of reinforced concrete. While some bridges are rarely exposed to freezing temperatures, all bridge decks are subjected to direct loading from vehicles and trucks. Because bridge decks are such a key bridge component and are aggressively attacked by the environment and usage, a specific guide dedicated to their preservation was considered a worthwhile objective. The guide focuses on preservation activities for steel-reinforced concrete bridge decks, which are the predominant bridge deck type in the United States, but it also provides guidance for timber decks and steel-grid decks. The format of the guide is very similar to that of the *Guide to Bridge Preservation Actions*[1]

and contains details for over 20 potential preservation treatments for highway bridge decks. Look for this new resource to be published soon.

Historic bridges, such as those listed on the National Register of Historic Places or eligible for listing, present unique challenges for bridge owners. Such bridges are often iconic, complex structures that also serve as critical transportation links. Therefore, when owners pursue preservation and rehabilitation actions, they must balance bridge safety for the traveling public with respect for and protection of the structure's cultural and historical significance. The AASHTO *Historic Bridge Preservation Guide*[3] is a resource for bridge owners and engineers to help them navigate historic preservation laws and the need to maintain the safety and serviceability of these bridges. The guide covers loading and analysis considerations for historic structures and has chapters that offer component-specific guidance for concrete structures, steel and iron structures, railings, and more.

Another AASHTO publication relevant to bridge rehabilitation is the *Guide for Design and Construction of Near-Surface Mounted Titanium Alloy Bars for Strengthening Concrete Structures*.[4] This guide is based on research conducted by Oregon State University and the Oregon DOT. The titanium alloy discussed in the guide is highly corrosion resistant and has minimum yield stresses of 120 and 130 ksi for Classes 120 and 130, respectively, making it very suitable for near-surface mounted strengthening. The near-surface mounted titanium can be used for either shear or flexural strengthening of reinforced concrete. The guide contains design provisions for shear, flexure and bond, and anchorage, along with design examples and construction recommendations.

A good bridge asset management program that includes bridge preservation is a cost-effective way to maintain a bridge inventory in a state of good repair. Bridge preservation resources continue to be developed and AASHTO's set of guides can help bridge owners and engineers implement good practices for bridge preservation. The guides will continue to be maintained, and updated when necessary, by AASHTO. As Iowa DOT's bridge preservation program matures and we implement more proactive preservation practices, we expect to maintain our bridge inventory in a state of good repair more cost effectively and to see improvements in system operation reliability and safety, with fewer disruptions due to reactive repairs.

References

1. American Association of State Highway and Transportation Officials (AASHTO). 2021. *Guide to Bridge Preservation Actions*. Washington, DC: AASHTO.
2. AASHTO. Forthcoming. *Guide to Preservation of Highway Bridge Decks*. Washington, DC: AASHTO.
3. AASHTO. 2020. *Historic Bridge Preservation Guide*. Washington, DC: AASHTO
4. AASHTO. 2020. *Guide for Design and Construction of Near-Surface Mounted Titanium Alloy Bars for Strengthening Concrete Structures*. Washington, DC: AASHTO.

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