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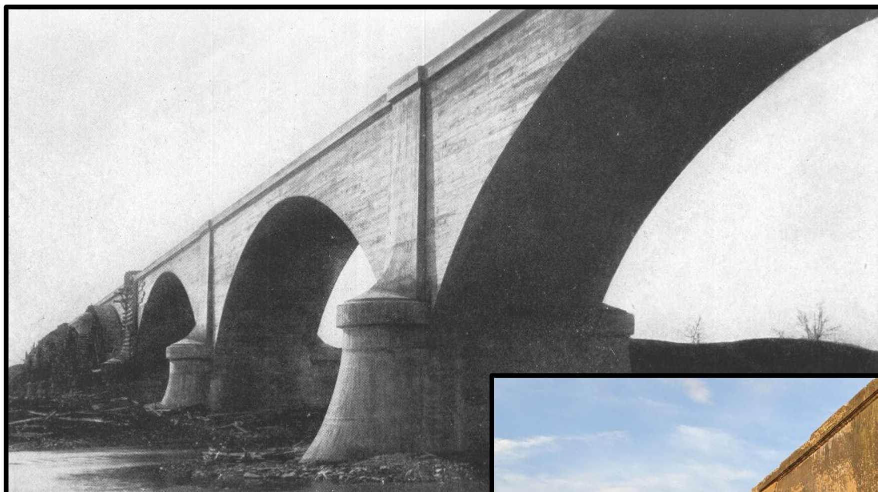
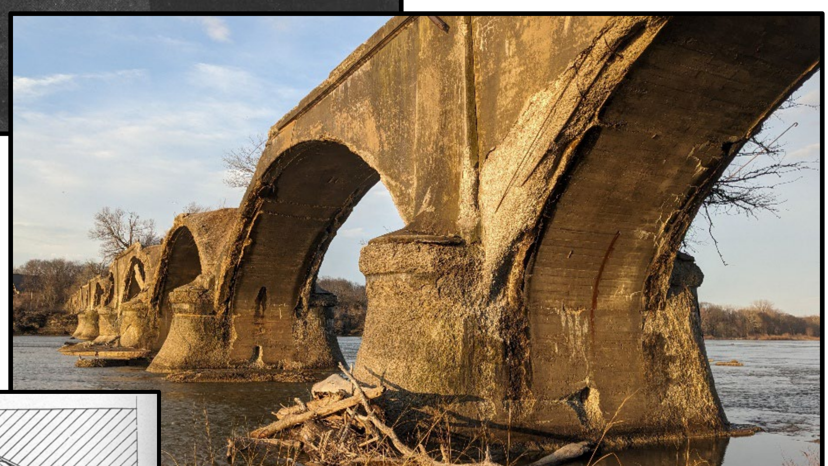
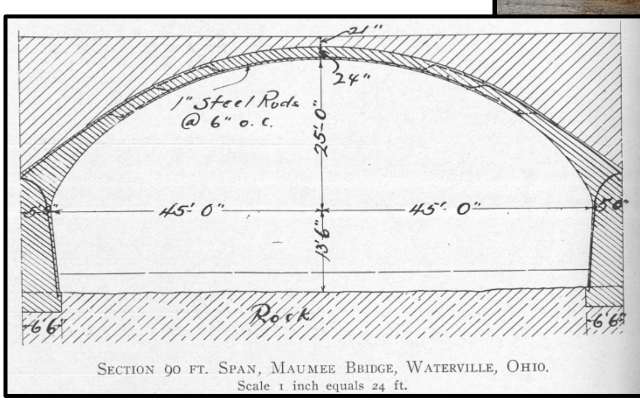
ROCHE DE BOEUF BRIDGE COMMITTEE PHYSICAL CONDITION & PRESERVATION ALTERNATIVES REPORT







SECTION 90 FT. SPAN, MAUMEE BRIDGE, WATERVILLE, OHIO.
Scale 1 inch equals 24 ft.

This Old Bridge, LLC
Strongsville, Ohio

May 8, 2026
(Rev. May 30, 2026)

1. Introduction

This report has been produced for the Roche de Boeuf Bridge special committee to provide new findings regarding the condition of the Roche de Boeuf and efforts to preserve it. The committee includes members of the City of Waterville, ODOT District 2, Save the Bridge Association (STBA), and This Old Bridge, LLC.

2. Roche de Boeuf Bridge Construction

The Roche de Boeuf Bridge is comprised of 12 reinforced concrete arches varying from 75 to 90 feet spans, face-to-face of piers. At the lower edge of the arch spans, the structure is 19’-2” wide with the arch barrels being 12’-0” wide. (The Span 12 arch barrel is 12’-0” wide, which may be an initial design consideration changed modified soon after construction began as the bridge was built from north (Span 12) to south (Span 1). The bridge was designed by Daniel Luten of the National Bridge Company in Indianapolis, Indiana.

Review of Luten’s writings and concrete design patents shows that he professed the economy of reinforced concrete construction. At the time of the Roche de Boeuf construction, bridge designers of concrete arches were making an evolution of concrete design as they advanced from unreinforced and lightly reinforced structure to those with embedded with greater quantities of steel reinforcement. Luten was at the forefront of this evolution and the most prolific advocate for concrete bridge construction.

Luten professed engineering economy. During the late 1800s and early 1900s, building materials were costly and labor was cheap. Luten strove to have concrete work to its safe limits and analyzed designs to only place steel reinforcement bars only at locations where tensile stresses in the concrete may occur. This does not mean to say he under designed his concrete bridges, however his economy appears to have impacted the long-term performance the Roche de Boeuf Bridge’s spandrel walls.

(Sidenote: From 1915 to the early 1920s, Luten devised a laterally cantilevered barrel arch design ideal for Midwest rural areas. These designs reduced arch barrels widths from 20 feet down to a sleek 8 feet. Many of these bridges are still in use today from Indiana to Arizona.)

This information confirms that the bridge was constructed of 14-foot-wide concrete arches incorporating Daniel Luten’s design of galloping reinforcing steel within tension regions of the arch (**Figure 1**).

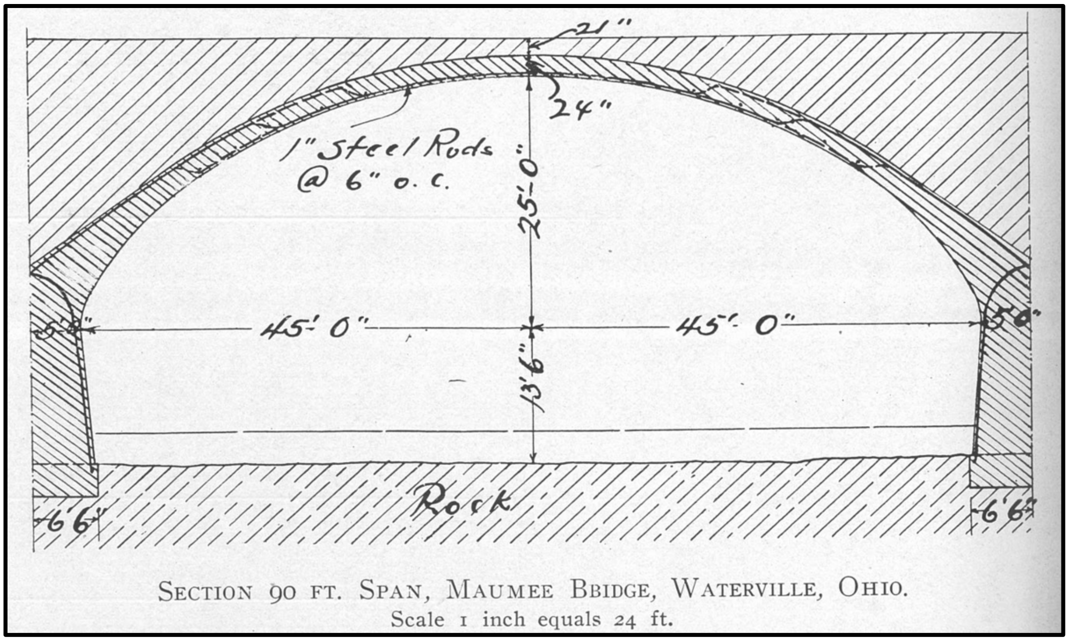


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Figure 1 – Typical Arch Reinforcement Placement, Roche de Boeuf Bridge (Spans 6 & 7 Shown)[1]

Figure 2 – Steel Reinforcement Layout before Arch Barrel Concrete Placement [2]

[1] Daniel Luten, *Ferro-Concrete Company*, 1908, p. 96.
[2] ibid, p. 138.

3. Inspection Schedule & Procedures

In preparation of this report, William Vermes, PE (This Old Bridge) performed site visits of the Roche de Boeuf Bridge, with each visit gaining new information and insights regarding the structure and means to stabilize and rehabilitate. A summary of the site visits is as follows:

- March 6, 2026: Initial site visit and discuss repair option with John Pautz, civil engineer and retired construction cost estimator, and David Weber, Save the Bridge Association (STBA) STBA founding member. Performed initial field measurements to confirm Roche de Boeuf construction references.
- March 20: Observed construction details and deterioration patterns from alongside and below Spans 1, 2, and 12, and accessed the south face of Pier 2.
- April 12: Performed SNBI inspection and condition assessment of arch and pier components fully visible from ground level. Accessed Spans 1, 2 and 3 at grade level for initial observations of the structure topside.
- May 3: Excavated fill to top of the Span 3 arch full width and inspected the arch intrados for condition and workmanship. Performed a level survey verifying typical arch ring thickness and determined the heights of the spandrel walls and fill. Assisted TTL technician with Windsor probe test locations from the South Abutment to Span 3, Span 12 and the North Abutment.

Photo 1 – Excavation of Span 3 Arch Intrados, May 3, 2026.

4. Condition Assessment

Spandrel Wall Discussion

Access to the grade of Spans 2 and 3 provided observation within arm's reach of the remaining portions of spandrel wall at their failure planes. Among these observations are that the spandrel walls have considerably less steel reinforcement than contemporary design practice.

Significant observations are:

- From observation of the spandrel walls, they appear have been cast to perform a dual role of a deep beam and retaining wall.
- The spandrel walls appear to have minimal attachment to the arch barrels in the form of lateral bottom mat barrel reinforcement continuing into the lower spandrel wall and bent upward in along the exterior wall surface.
- Vertical reinforcement, commonly placed for flexural resistance of lateral forces of the earth fill, is present only along the exterior spandrel wall surface with 3-inch cover. These bars are spaced from 24 to 48 inches center-to-center (**Photos 2 & 3**).
- With no vertical reinforcement along the interior wall surface, little flexural strength is provided.
- Within the edge of the remaining exposed fill, it appears that Luten may have provided lateral reinforced tied encased in concrete between paired spandrel walls. If this is indeed the intent of these laterals, they have become ineffective.
- Span 3: Near Pier 2, both spandrel walls lean outward approximately 12 inches. This suggests that the center of gravity of each wall has shifted outward up to 8 inches and may have produced a longitudinal crack 1.25 inches in the interior wall surface above the top of the arch barrel, the point of greatest bending.
- Span 3: At a fracture of the east spandrel wall, the remaining wall section has broken along horizontal planes. This indicates the failure planes often occur at cold joints placed in the spandrel walls due to the limitations of delivering enough ready-to-cast concrete.
- In the northern halves of the Span 12 spandrel walls, both walls exhibit longitudinal cracks above the arch barrel. The east spandrel wall has shifted outward approximately 1.5 inches (**Photo 3 & 4**).

- Span 3: Portions of the 3 ½-inch high concrete caps on top of the spandrel walls are missing in numerous locations. Thes caps have no steel reinforcement and thus have little connection to the spandrel wall except for friction between the concrete pours.

The above observations add concern for the viability to retain the existing spandrel walls. If any spandrel walls are retained in order to maintain the property's standing within the National Register of Historic Places, consultation with the Ohio State Historic Preservation Office is recommended.

Photo 2 – Sparse Spandrel Wall Reinforcement, Span 2 East Spandrel Wall/

Photo 3 – Vertical & Horizontal Reinforcement Placed along Exterior Surface with 3-Inch Cover, Span 3.

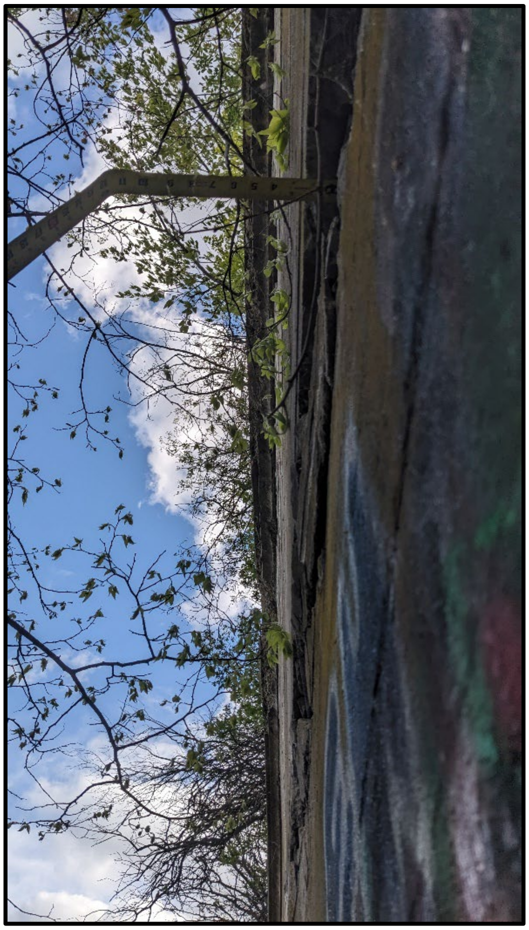

Photo 4 – East Spandrel Wall Movement 1.5 inches above Longitudinal Crack, Span 12.

Photo 5 – Close-Up of East Spandrel Wall Movement 1.5 inches above Longitudinal Crack, Span 12.

Arch Discussion

The excavated extrados of the Span 3 arch is in good condition with no deficiencies (**Photos 6 & 7**). The surface observed was at the center of the arch where laborers placed the last portions of fresh concrete in 1907 and trowel-finished the surface to a smooth but uneven surface. The level survey performed confirmed that the arch is a minimum 24 inches thick per Daniel Lutens's writings. The arch intrados below this section exhibits longitudinal efflorescence which has been described as being non-corrosive calcium hydroxide (quick lime) leaching from the cement paste (**Photo 8**).

Throughout all 12 spans, observation of water staining and spalling of the arch intrados and bottom of spandrel walls suggest that rain water passing through the fill above generally follows the path of least resistance, which likely is the vertical arch barrel-spandrel wall construction joint and through the hidden longitudinal cracks in the spandrel wall above the arch barrels (**See Photo 8**). Thus, it is anticipated that when uncovered, the tops of all arch barrels will show little, if any, deterioration.

Photo 6 – Arch Extrados Exposed, Span 3.

Photo 7 – Close-Up of Trowel-Finish and Good Condition of Arch Extrados Exposed, Span 3.

Photo 8 – Longitudinal Cracking with Calcium Hydroxide Efflorescence and Construction Joint Infiltration, Span 3.

5. Material Strength

No material strength specifications are known to exist for the Roche de Boeuf Bridge. For such situations, ODOT has produced a table of concrete and steel of unknown origin based on its time of construction. For the Roche de Boeuf Bridge, the following strengths are recommended:

Cast-in-place concrete:	2.0 ksi
Reinforcing Steel:	32 ksi

On Sunday, May 3, 2026, TTL Engineering Services performed 12 Windsor probe concrete compression tests at 12 select and diverse concrete elements. Measured compression strengths of all 12 test locations range between 2500 psi and 4000 psi. These strengths are comparable with the two compression strengths obtained in January 2019 and the conservation design values applied for concrete of unknown specification.

In discussion with John Rust, President of TTL, he added that further concrete coring and compressive testing is recommended. If partial preservation of the bridge is pursued, additional concrete compressive testing would complement the earlier test and satisfy Section 5.3 – Material Testing of AASHTO’s *Manual of Bridge Evaluation*. If no further testing is performed, ODOT’s recommended strength values will be used for potential rehabilitation design.

The locations of the Windsor Probe tests are included in **Table 1**. The TTL report is included in **Appendix A**.

Test No.	Location	Bridge Component	Detailed Location
1	Span 3	Arch Extrados (Top)	Near west edge.
2	Span 3	Arch Extrados	Center.
3	Span 3	Arch Extrados	Near east edge.
4	South Abutment	Southwest Wingwall	Middle of wall.
5	Span 1	Arch Intrados (Bottom)	Above arch base.
6	Span 1	Arch Intrados	Above Pier 1, near east edge.
7	Pier 1	Upstream Cut Water	Approx. 5 ft. above ground line.
8	Span 2	Arch Intrados	Above Pier 1, center.
9	North Abutment	West Retaining Wall	Near 2019 Core.
10	Span 12	West Spandrel Wall	Near 2019 Core.
11	Span 12	Intrados (Bottom)	Center, above honeycomb void.
12	Span 12	East Spandrel Wall	At N. Abutment.

Table 1 – Windsor Probe Test Locations (TTL, May 3, 2026)

6. National Register Eligibility & Loss of Historic Fabric

A recent conversation with the Ohio State Historic Preservation Office suggested that National Register status may be removed if the Roche de Boeuf Bridge's spandrel walls were removed. This opinion is not final. At this time, below is a sampling of other historic bridge rehabilitations is the impact present regarding their modifications.

1904 Interurban Bridge, Como Park, St. Paul, Minneapolis

The Interurban Bridge is a three-span reinforced concrete bridge featuring a Milan arch main span (Photo 1). By the 2000s the bridge was in serious condition and closed to pedestrian traffic both on and below. Lacking rehabilitation funds, the initial preservation plan for the structure was to remove deteriorated concrete and to maintain the structure as an abandoned artifact. Eventually rehabilitation funds were secured, and the structure was fully rehabilitated by 2020.

Photo 1 – Restored Interurban Bridge, Como Park, June 2024.

Jefferson Street Bridge, Fairmont, West Virginia

Opened in 1921, the Jefferson Street Bridge over the Monongahela River in Fairmont, West Virginia, has been a notable landmark in its region.[3] Following advanced deterioration, a major rehabilitation was performed to save the bridge in the late 1990s. This project included demolition of all concrete down to the tops of the arch ribs with near exact replication of these components (**Photo 9**). The arch ribs were "bulked up" with a concrete surface layer encapsulating a titanium mesh for cathodic protection.[4] This bridge has remained on the National Register of Historic Places.

Photo 9 – Restored Jefferson Street Bridge, October 2016.

Removal of the spandrel walls will be an adverse effect toward inclusion of this structure on the National Register. Potential delisting the Roche de Boeuf Bridge will have an impact on some grant opportunities and impact public opinion; *however* it is the opinion of this report that the structure will at the very least remain local historic property which has less stringent requirements. Furthermore, most potential funding opportunities will remain to pursue Phase 2 construction discussed below.

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[3] https://en.wikipedia.org/wiki/Robert_H._Mollohan%E2%80%93Jefferson_Street_Bridge

[4] Performance of Ohio's Concrete Arch Bridge Rehabilitation Practice, William Vermes, PE, International Concrete Repair Institute Fall Conference, November 10, 2016

State Historic Preservation Office Consultation

The Ohio State Historic Preservation Office (Ohio SHPO) is open to consultation. Additionally, in a conversation with SHPO staff members on May 14^{th}, STBA and This Old Bridge were advised that the Roche de Boeuf Bridge would not be delisted as a property on the National Register of Historic Places if the spandrel walls were removed in their entirety. However, further consultation with the SHPO is recommended as adaptive reuse and restoration is pursued. It is **strongly encouraged** that they are engaged as a partner in this process.

ASCE's Policy Statement 504 discussing the value of historic bridges is included in **Appendix B**.

7. Construction Considerations

Phase 1: Selective Demolition & Arch and Substructure Preservation

Spandrel wall removal

Selective demolition of the Roche de Boeuf Bridge will have its challenges, but it is possible. With the spandrel walls acting as separate beams and noting that minimal reinforcing attaches these walls to the arch barrels, selective demolition (only remove the leaning ends and maintain the stable middle sections), is likely not feasible. However, the minimal connection – not being integral with the barrels – will make full removal of the spandrel walls easier. While Kokosing will select their preferred means and methods to perform the select demolition of the spandrel walls, they may choose to use hydraulic chain saws for precise concrete cutting and hand grinders and/or torches to cut any transverse steel reinforcement.

Phase 2: Rehabilitation & Trail Options

Selective demolition including removal of the spandrel walls and fill will provide a much simpler opportunity to restore the bridge in original vision. During the Week of May 4, John Pautz and Bill Vermes began discussions on potential economically efficient means that precast spandrel wall panels may be attached to the arch barrels. Precast panels can be cast in widths up to 8 feet wide and designed to limit excessive weight to permit transportation and placement by crane.

Figure 3 shows the initial concept proposed. This conceptual design has evolved since this figure was produced and will undergo further refinement.

(John Pautz will speak more about this in the meeting.)

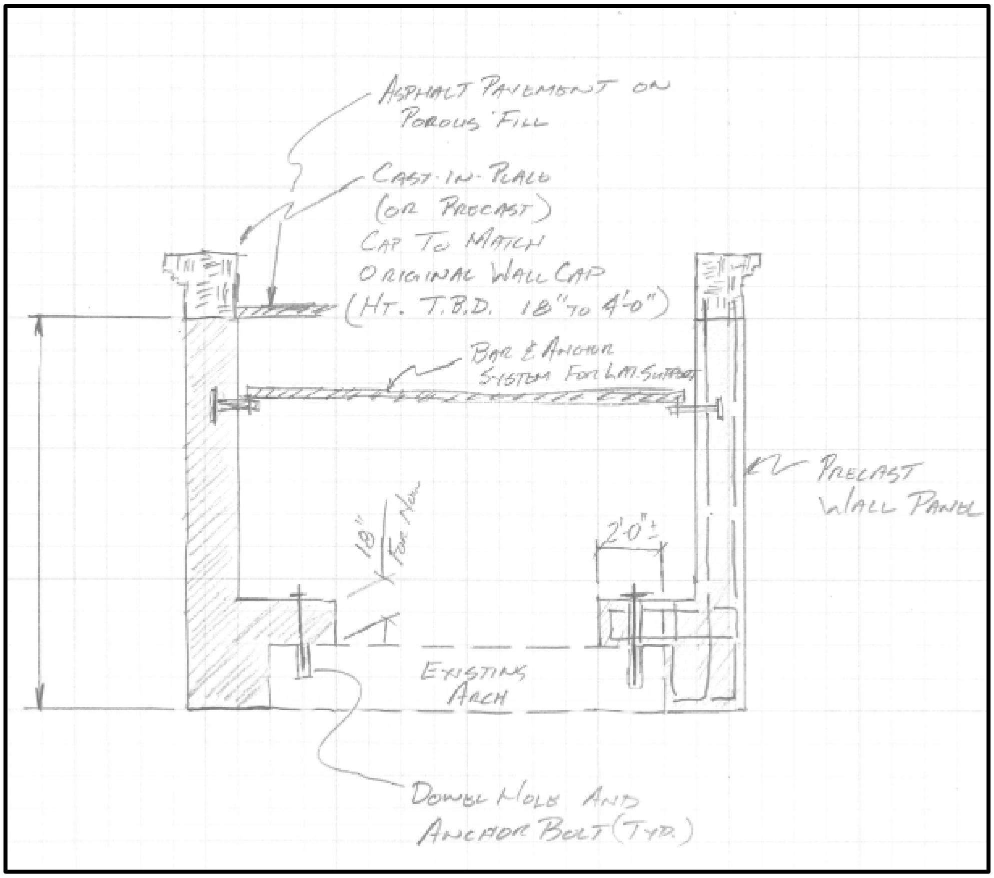

Figure 3 – Initial Sketch of Precast Spandrel Wall Panels Placed on Top of Existing Arch Barrels & Secured Laterally.

Appendix A

TTL Concrete Compressive Strength Testing Report

Daily Field Report

TTL Engineering Services, LLC
1915 North 12th Street
Toledo, OH 43604
Phone: 419-241-4440

Client:	Project:
This Old Bridge c/o Save the Bridge Association 450 Cedar Lane Waterville, OH 43566	435662026 Roche de Boeuf Bridge Waterville Waterville, OH

Technician: Hoyt, Michael **On Site Date:** 05/03/2026

On this date, a representative from this testing laboratory was present at the above project for the following purpose(s):

- Windsor Probe Testing

The technician was on-site to conduct Windsor probe testing at various locations on both the north and south side of the Roche de Bouef bridge. These locations included areas at spans one, two, three and twelve at abutments, wing walls, spandrels, retaining walls and cut walls. Windsor probe testing indicated strength of concrete to be between 2500 to 4000 psi. It is recommended that concrete cores be obtained for more precise concrete strength readings.

If you have any questions concerning this report, please feel free to contact us.

John Rust III
President
05/05/2026

Appendix B

ASCE Policy Statement 504 – Rehabilitation of Historic Bridges

Policy statement 504 - Rehabilitation of historic bridges

https://www.asce.org/advocacy/policy-statements/ps504---rehabilitation-of-historic-bridges

Approved by the Transportation Policy Committee on December 5, 2023
Approved by the Public Policy and Practice Committee on January 24, 2024
Adopted by the Board of Direction on July 18, 2024

Policy

The American Society of Civil Engineers (ASCE) supports the development and implementation of Historic Bridge Management Plans for each state. The goals of these Historic Bridge Management Plans are to develop historic bridge inventories, identify bridges where rehabilitation/preservation are appropriate and feasible, and develop specific preservation plans for those bridges. ASCE also supports the maintenance, repair, and rehabilitation of historic bridges, preferably, for continued vehicular use, or when that is not possible, for use by some active transportation means including pedestrians and bicyclists.

Issue

Historic bridges are defined as bridges that are listed on, or eligible for listing on, the National Register of Historic Places. The structure is required to be at least 50 years old for National Register eligibility. Due to perceived functional obsolescence, absence of regular maintenance, and lack of any funding priority, historic bridges are a heritage at risk.

Bridges are a visible icon of the civil engineer's art. Historic bridges are important links to our past, serve as safe and vital transportation routes in the present, and can continue to serve as important elements of our transportation systems in the future. Some of these historic bridges represented innovative engineering practices at the time of their construction. Rehabilitation ensures these important engineering works remain in service resulting in significant cost savings compared to replacing the facilities altogether. By demonstrating interest in the rehabilitation and re-use of historic bridges, the civil engineering profession acknowledges the value of these structures as cultural resources and an awareness of the historic built environment.

Rationale

Many historic bridges can still serve the nation's transportation needs, given appropriate repair, maintenance and flexibility in interpreting transportation standards as suggested by national transportation policy. Vehicular use is the best preservation because it keeps the bridge in traffic maintenance, inspection, and funding programs. When it is not possible for a historic bridge to continue in vehicular use on primary routes, consideration should be given to relocating these bridges to routes receiving lighter volumes of traffic or changing their function to serve alternative means of transportation, such as hiking trails and bikeways. The United States is developing a comprehensive network of scenic highways and byways, including a connected network of hiking trails and bikeways that are accessible for all users. The maintenance and relocation of historic bridges to these systems sustains the scale, character and feeling of these historic, recreational, and scenic corridors.

With the work of citizens groups throughout the country, there is growing public interest in saving historic bridges. Civil engineers should lead and support these efforts. Bridges Historic bridges are engineered resources and require the necessary skills of engineers to balance the historical significance with the safety, function, and serviceability. Without the interest of engineers for preservation, there is little chance that the historic bridges of the United States can be preserved for future generations. Insufficient funding remains a pervasive problem for historic bridge preservation projects. Until historic bridge preservation becomes part of everyday transportation policy, receiving the support of transportation officials at all levels, and the continued support of citizen groups, historic bridges remain at risk.

ASCE Policy Statement 504
First Approved in 2003

Other related policies:
PS 208 - Bridge safety