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Historic Bridge Bulletin

Historic Bridge FOUNDATION

The South Denmark Covered Bridge crosses Mill Creek in Ashtabula County, Ohio. The covered lattice bridge was built in 1895 and has a 76 foot span and an overall length of 100 feet. *Photo by Marc Scotti.*

In This Issue: Covered Bridges

The Rexleigh Bridge carries Rexleigh Road over Batten Kill in Washington County, New York. The 107 foot covered timber Howe truss was built in 1874 by George Wadsworth and was rehabilitated in 2007. *Photo by Marc Scotti.*

Pulp Mill Bridge, Vermont

Langley Bridge, Michigan

Wimer Bridge, Oregon

They Don't Make Them Like They Used To

By Ross White

We have all heard the cliché before, typically when one is referring to the quality of craftsmanship an item displays. The same could be said about timber bridges. We live in a time where timber bridges are unique and often are not considered as a viable alternative to new construction. Often touted as being used for temporary repairs or low load rated, short span structures, timber takes second fiddle to its' concrete and steel brethren. However, with proper care, restoration, and construction methods, timber can survive longer in locales where concrete and steel fall short. In order to understand this better, let us explore two of the common misconceptions about timber structures.

"Timber does not last" is the first misconception. The timber covered bridge over the Hammond River in Canada had been in existence for nearly a hundred years supporting commerce and residents. There are over fifty more bridges similar to it still in service in New Brunswick. To better understand how this bridge had survived for so many years, we need to break down the composition of the bridge and take a closer look at the superstructure. The superstructure of the bridge is actually a through truss covered with timber sheathing on the sides and a roof above. Early timber engineers knew by covering the superstructure the bridge would last longer. Just like a roof and walls keep water out of a house, they do the same for a covered bridge. Water can be the Achilles heel to timber if it is not managed properly. There are three environment conditions, moisture content over 22%, oxygen content over 21% and temperature range from 41°F to 95°F, which provide a fertile environment for decay in untreated wood. Eliminate any one of these environmental conditions and timber will not decay. Although early timber bridge builders might not have totally understood the science behind their process, they were keeping the moisture content below 22% in bridges by covering them. Understanding how and why timber decays has led to solutions to timber preservation. Fast forward to today and there are options to arrest decay in existing structures, such as borate diffuser rods, and options to prevent decay in new construction, such as oil based Copper Napthenate treatments.

"Timber can not be as strong as steel or concrete" is the second misconception. Timber has been the go-to material for quick bridge construction for hundreds of years. When engineered properly, timber can be used for long span bridges and heavy loading. There are timber truss bridges in operation still all over the world, carrying loads ranging from vehicles to trains. However, timber structures can reach their load limits either through reduced capacity due to degradation or maximum capacity due to design. In both instances, the timber structure can be repaired or upgraded to the desired capacity, whether the structure is a covered bridge, a unique open truss design, or even a simple span bridge with undersized girders. The deck truss bridge in the picture below had been carrying trains for decades, but reached a point where repair or replacement was needed. With the addition of high strength fiber, the truss could

View of truss and protective roof structure of Hammond Road Covered Bridge. *Photo by Ross White.*

Fiber reinforcement being installed on the bottom chord of a timber deck truss to restore and improve the capacity of the span. *Photo by Ross White.*

Deck truss bridge before fiber reinforcement is installed. *Photo by Ross White.*

be repaired to support beyond the original design capacity of the truss. While the best way to insure longevity and proper capacity for a timber structure is to design and construct it properly to begin with, we do not always have that luxury. The next best option is to inspect the bridge, then design and implement the proper repair. Often times, properly repairing the existing structure can be cheaper, or at least close to the cost of replacing the structure with a new one. However, improper repairs on construction techniques can lead to quicker deterioration of the structure. A common example is the use of metal, or some other material, as sheathing over a timber element. While the concept is sound, to keep the moisture off the timber element, in reality this practice often does the exact opposite. If the sheathing is placed against the timber element, it prevents moisture from escaping, leading to condensation on the underside of the sheathing that ultimately promotes decay.

Sheathing is often installed directly against the timber element leading to quicker decay of the timber. *Photo by Ross White.*

Non destructive Stress Wave Timer Testing. *Photo by Ross White.*

The question then is “how can we properly inspect and preserve our historic timber structures?” With advancements in timber inspection technology, the first part has become easier. The only option for a long time was bore sounding, which involved drilling small holes in a timber element to identify whether decay-caused cavities existed in the timber by measuring the thickness of the timber shell left around the cavity and then corresponding this annulus thickness to a capacity of the member. This process could leave a timber element looking like a woodpecker had found heaven, and open up more pathways for water to enter the element and start the decay process or progress it further. In today’s world there are more options, and the most attractive are the non-destructive testing (NDT) ones. Think of it like this - Would you rather have a doctor cut into to your body in multiple places to try and find cancer, hoping the educated guess did not miss, or have a doctor use non-invasive scanning technology to look for cancer in your entire body? NDT has come just as far with options, ranging from x-ray to stress wave timing (SWT) testing that will not expose the structure to potentially more harm. The other main benefit to today’s inspection alternative is the ability to determine the condition of an entire timber element quickly and more thoroughly. In short, with technology we can now determine with relative accuracy the capacity and condition state of a historic structure without damaging it.

The last part of the question posed in the above paragraph is where advancement in timber restoration technology can play a tremendous role. There are ways to reinforce historic timber

Fiber reinforcement repairs allow timber structures to be repaired in place easier. Shown here are tensile reinforcement on stringers and wraps on the piles *Photo by Ross White.*

structures, or improve their capacity, so they may continue to serve today's society while reminding us, in a beautiful and warm way, of our past. Take classic cars for example, while there are purists who gnash their teeth at the thought, one can take a 1940's truck or a 1960's muscle car and give them power and fuel economy with today's technology while maintaining a majority of the vehicles' original structure and style. It works on old cars and it works on historic bridges. At the forefront of these advanced timber repair processes are fiber reinforcements. Fiber reinforcements are stronger than steel and an incredibly lightweight offering, using another car analogy, a tremendous power to weight ratio. In addition, fiber reinforcements are thin, allowing them to be added to historic timber structures without taking away from the aesthetics.

"They don't make things like they used to" should not be used as statement for why our timber structures are not surviving any more. Timber structures can be preserved, and new timber structures can be built to handle the demands brought on by modern society for decades. We only have to go about it the right way.

Ross White is the General Manager – Engineering, Testing and Inspections for Wood Research and Development (WRD), a worldwide firm offering timber structure design services, IAS certified testing and instructional courses for the inspection and preservation of timber structures. He holds a degree in Civil Engineering from Georgia Institute of Technology and has worked in the construction and railroad industry repairing and constructing bridges for 14 years.

Bunker Hill Covered Bridge

By Amber C. Albert, PhD

Guests visit Bunker Hill Covered Bridge in Claremont, North Carolina, for different reasons, but they all remember the community space at the heart of this local historic site. To the public, the

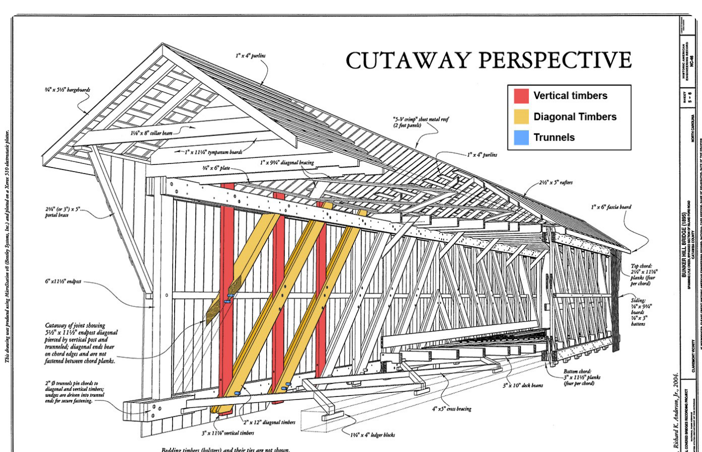
New glulam timber construction utilizing methods and treatments to maximize bridge life and simplify installation. *Photo by Ross White.*

Bunker Hill Covered Bridge 1968 postcard. *Source: (85-45), Historical Association of Catawba County Local Postcard Collection.*

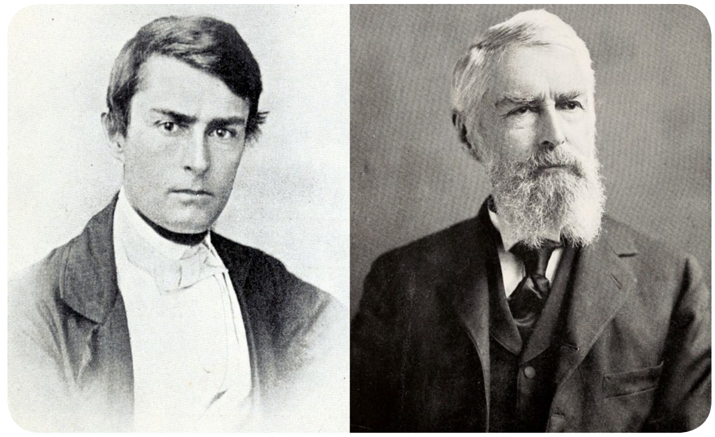
Wood-peg detail exposed during 1992 restoration of Bunker Hill Covered Bridge. *Photo Courtesy: Historical Association of Catawba County Photograph Collection.*

bridge is a community space where families enjoyed decades of picnics, swimmin', and moonlit trysts. Bridge enthusiasts know it as the last wood-pegged improved lattice truss bridge based on the 1839 patent of General Herman Haupt (1817-1905) in the world.

In his early career as a civil engineer, Haupt recognized the need for a more efficient truss and identified a solution by integrating vertical supports with diagonal beams that became the "Haupt Improved Lattice Truss" (U.S. Letters Patent No. 1,445). Andy L. Ramsour of Catawba County



Cutaway of Bunker Hill Covered Bridge Improved Lattice Truss. *Source: National Covered Bridges Recording project, Richard K. Anderson, Jr. (2004). Highlights by the Historical Association of Catawba County*

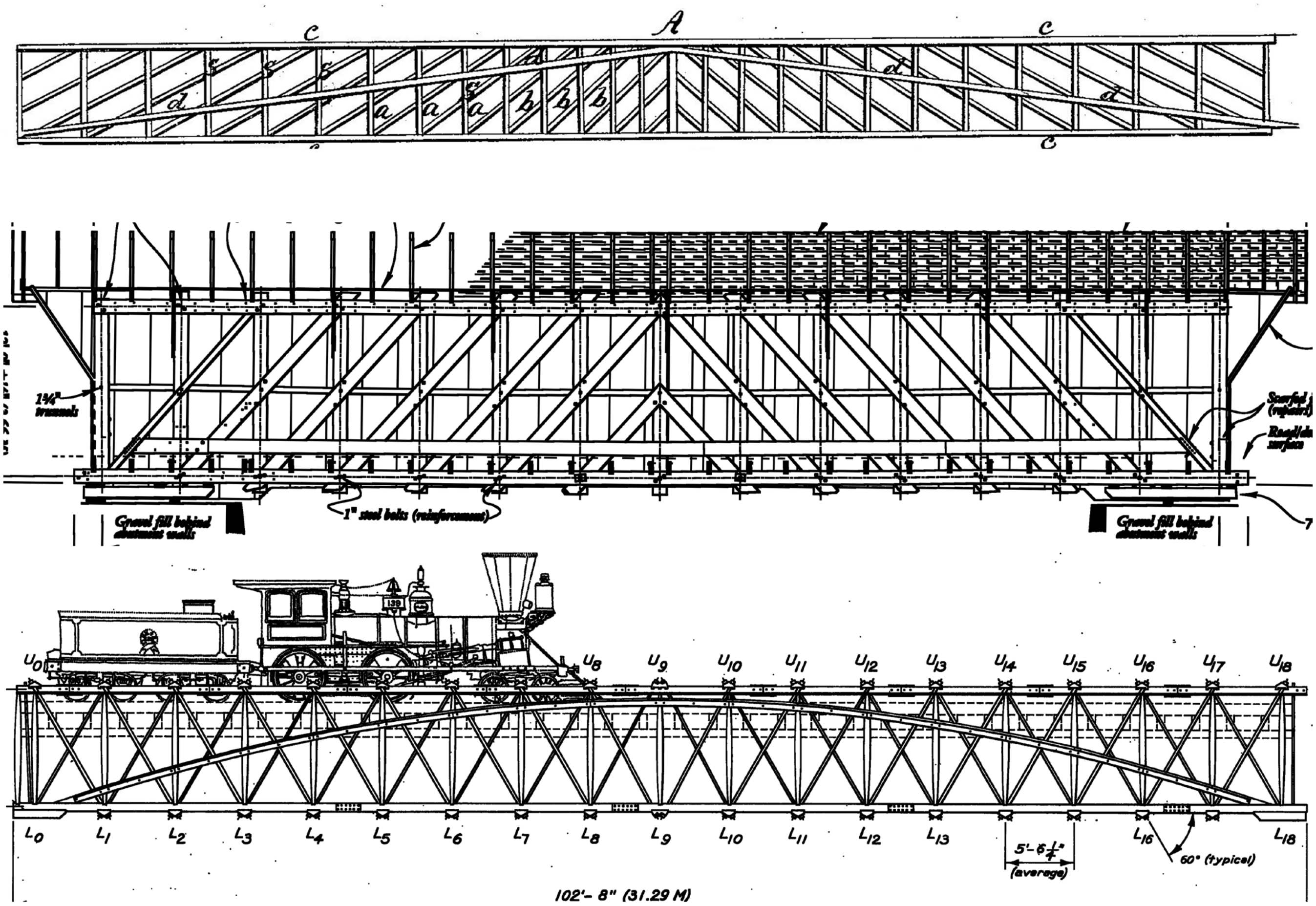


Portraits of Herman Haupt at age 34 (left) and 84 (right).

recognized the genius of Haupt's design and built the Bunker Hill Covered Bridge over Lyle Creek at a critical crossroads in the rural agricultural community of Claremont in 1895. The bridge features a single 80.3 foot span from end post to end post, providing a clear span of 65 feet. The 12 foot wide truss provides a 9.5 foot roadway.

Herman Haupt was born in Philadelphia in 1818 and was an engineer known for the design of bridges and worked as an engineer for the Pennsylvania Railroad. During the Civil War, he also gained military notoriety as superintendent of military railroads, and he became a Major General. He is considered to have had a major role in ensuring that Union forces enjoyed many early successes. Haupt also published notable texts on bridge engineering. His career also included some design work with tunnels.

Haupt's timber truss patent shows a pattern of diagonal members facing upward-center, with a series of vertical members intersecting the diagonal members. Additionally, a diagonals stretching from each end to mid-span add a Kingpost truss style overlay to the system. The Bunker Hill Bridge is technologically significant because it more closely follows the Haupt patent than any other surviving bridge in the country. That said, the bridge does omit the Kingpost component shown in the patent. This sort of deviation was not unusual because many bridge engineers deviated to varying extents from the actual designs they patented. Haupt later designed a unique cast and wrought iron truss configuration. This metal truss design again does not mirror his original patent. However, its use of a tied arch overlaid upon a truss web of diagonal members and vertical members suggests Haupt was adapting some of the thinking



The evolution of Haupt's truss designs is shown. Top: Drawing from Haupt's patent showing his original patented truss design. Middle: Historic American Engineering Record drawing showing the truss design for the Bunker Hill Bridge. Bottom: Historic American Engineering Record drawing showing the truss design for one of Haupt's iron truss bridges.

in his original patent for application with metal truss construction. In all these cases, Haupt's efforts reflected the challenges of engineering in this early period of development of formal bridge engineering as we know it today. At the time, calculations for bridge types were not fully understood. As a result, engineers tended to over-design their bridges, and they sometimes came up with unusual bridge designs to attempt to compensate for any uncertainties in their designs and calculations. As such, the Bunker Hill Bridge is highly significant because it documents the development of bridge engineering itself. The bridge is the physical result of early attempts by engineers to approach the design of a bridge using scientific and mathematical thinking, but at the same time doing so without many of the calculations and theories that engineers today take for granted.

More than its engineering origins, the Bunker Hill Covered Bridge is significant because it is the last historic covered bridge in North Carolina on its original roadbed. Imagine approaching the bridge in the footsteps of American Indian traders, eighteenth-century Loyalist prisoners of war, nineteenth-century farmers off to sell their produce, and young women leaving home to work in early twentieth-century

A.L. Deal Jr. and R. L. Hefner visit Bunker Hill Covered Bridge in 1949. *Source: (02-69-15), Historical Association of Catawba County Historic Photograph Collection* textile mills. Tourists and residents alike have admired the structure's shape.

The American Society of Civil Engineers designated the structure a National Historic Civil Engineering Landmark in 2001. Managed by the Historical Association of Catawba County since the 1980s, Bunker Hill Covered Bridge operates today as a passive site for recreation and an outdoor learning lab. The bridge's three-acre plat is surrounded by properties owned by partners with shared interests like the Conservation Fund and the North Carolina Department of Natural and Cultural Resources (NCDNCR).

Like all historic bridges, it faces both natural and man-made threats. After a tornado in 1992, the North Carolina State Legislature appropriated funds for its restoration. Since the flood of 2013, support from the Duke Energy Foundation, North Carolina Department of Transportation, Federal Highway Administration, and the North Carolina Department of Public Safety contributed resources for ongoing stabilization needs.

Subsequent regional development and resultant environmental changes have increased erosion along Lyle Creek. Thanks to the support of municipal and private partners, the endangered wildlife is safe. Along with an array of public and private partners, the Catawba County Historical Association is working to stabilize the upper creek bed with multiple aims of protecting wildlife habitats, mitigating stream bank and bed erosion, as well as strengthening the bridge's foundations. Now the Catawba County Historical Association, a traditional cultural heritage organization, is in the business of preservation, education, and conservation.

The Catawba County Historical Association recognizes that Bunker Hill Covered Bridge was saved time and again by the community, for the community. While a good deal of work has been completed recently, it is thanks to the early efforts of dedicated individuals like the Bolick and Abernethy families that the bridge is now a destination for Catawba County and North Carolina. Whether recreation or education brings guests to the site, their new memories of place will cultivate the next generation of preservationists.

Dr. Amber C. Albert is the Executive Director of the Historical Association of Catawba County in North Carolina. Prior to this position, Amber worked for the Middle Tennessee State University Center for Historic Preservation as a graduate assistant. She believes that interacting with tangible artifacts of the past – structures, objects and landscapes – helps us understand who we are as a community.

Historical Association Board and NCDNCR staff examine Bunker Hill Covered Bridge, summer 2017.

The Association for Preservation Technology International
Association internationale pour la préservation et ses techniques

DAVID FISCHETTI AWARD

The **Preservation Engineering Technical Committee (PETC)** of the Association for Preservation Technology International (APT) presents the **David Fischetti Award** for an outstanding article that advances the field of conservation engineering. Articles must address technical aspect(s) of the engineering as they relate to historic preservation. Articles may be project related, or based on research and cover any of the following topics:

- History of engineering design, methods, or systems (structural, building enclosure, mechanical, electrical, fire protection, vertical transportation, etc.)
- Application of analytic methods with proper judgment to analyze archaic systems
- Re-evaluation and comparative analyses of historic analytic methods
- Assessment of historic materials and systems
- Integration of modern systems with historic and archaic systems, and/or
- Innovative methods of repair of historic systems
- Incorporation of engineering judgment and simplified methods

Articles shall be nominated for the award from appropriate peer-reviewed publications. Nominations may be submitted by the PETC membership, members of the Jury, and the authors themselves. Nominations are to be submitted directly to the PETC.
The PETC will form a committee to verify the eligibility of the submissions and to name a jury and jury captain. The jury will consist of five (5) APT-PETC members in good standing, representing a diversity of disciplines and geography of membership. The Chair(s) of the Publications Committee shall be ex-officio members of the awards jury. Jury members shall choose a captain, and the same jury member shall not serve as captain for more than two consecutive years. The jury shall review each article using the following general criteria:

1. Content falls within the topic categories described above
2. Article demonstrates a knowledge of, and adherence to, conservation engineering and historic preservation principles
3. Article advances or introduces innovative conservation engineering ideas, theories, technologies, or methods
4. Content of article provides information that is applicable by conservation engineering practitioners to other projects
5. Article contains valuable historical research that is applicable by conservation engineers to projects
6. Clarity of style and content
7. Quality and value of drawings or other illustrative material

Each member of the PETC Jury shall review each of the nominated articles, rank or score articles, and provide sufficient detail through the use of comments as to allow final selection of a winner. The winner of the award will be based on a majority vote of the jury. After the score sheet is compiled, the jury captain shall organize a phone call with all jurors to inform about the results and talk about any potential issues raised by the jurors. The final scoring rubric and scoring methods will be determined by the jury and will remain confidential, as will all deliberations. The Jury shall determine eligibility of articles based on the following criteria:

1. Eligible articles must be original works that have been published in a peer-reviewed journal or publication.
2. Articles in conference proceedings are not eligible, although authors are encouraged to republish their work in a peer-reviewed publication, subject to conformance with the guidelines for previously published content.
3. Only articles published in the three years preceding the award shall be eligible.*
4. The article shall present innovative ideas and serve to advance the practice of conservation engineering to its readers as described above.
5. The article shall be written clearly and succinctly and shall include drawings and photographs where they are helpful in communicating ideas.
6. The methodologies or solutions described in the article shall be presented in such a way that they may be transferred and be useful to other projects.

* Articles previously nominated and not selected for the award in a given year are eligible for nomination again, provided that they are within the three-year timeframe.

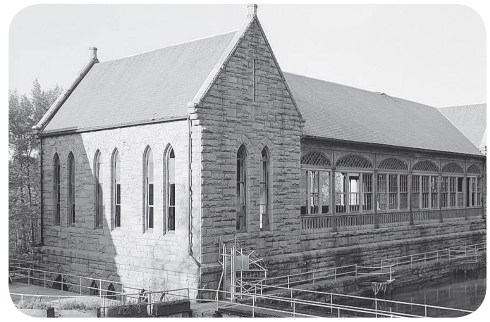
Winning author(s) are advised at least three months prior to the APT conference at which the award will be presented. The winning author(s) will receive a framed certificate presented at the APT conference. If an article has multiple authors, each author will receive a certificate. An award is not necessary every year – if articles of sufficiently high quality are not nominated, the award will not be presented.
Following the APT conference, a one-page feature including a summary of the winning article, biographical information about the author(s), and a citation or link to the winning article will be published in APT Bulletin and/or APT Communiqué. If the winning article is from a publication behind a paywall, APT-PETC will encourage the other organization to provide a special link permitting free access.

Please submit nominations to the APT Preservation Engineering Technical Committee (PETC) co-chairs:

- **Tim Crowe: tcrowe@wje.com**
- **John Dumsick: jdumsick@1200ae.com**
- **Tom Morrison: tmorrison@heritagestanding.ca**

David Carmichael Fischetti. Dave's love of art and history, combined with his penchant for solving engineering problems in his restoration work on historic structures, resulted in the preservation of many covered bridges.

SIA's 47th Annual Conference



The Society of Industrial Archeology's 47th annual conference will be held in Richmond, Va. at the Omni Richmond Hotel, Thursday, May 31st through Sunday, June 3rd, 2018. Early bird tours and a reception will be offered Thursday; process tours Friday; paper sessions, business luncheon, and banquet on Saturday; and optional tours available Sunday. Guided tours will explore a mix of antebellum and post-Civil War Richmond and Virginia industry, transportation, and military sites. Here's a quick preview of what to expect.

Yes, Richmond is a Southern city, but if it conjures images of moonlight and magnolias, think again. The capital of Virginia became a center of multiple key American industries before the Civil War and remained a major manufacturing and transportation town well into the 20th century. In the first half of the 19th century, Richmond exported coal, plug tobacco, and iron, and hosted the largest flour mill in the world. The most industrial city in the Antebellum South, Richmond connected to more than 200 miles of canals and five railroads. No wonder the city became the capital of the Confederacy when Virginia seceded; the Tredegar Iron Works produced half of all artillery tubes manufactured in South. After the war, the Golden Leaf became king with Tobacco Row hosting four of the largest manufacturers in the country. Support industries such as box making, paper making, lithography, and machine shops flourished. Consolidation in various industries and the decline of Richmond's port following the rise of Hampton Roads reduced the industrial landscape, but Richmond now hosts a vibrant medical, brewing, and information economy. SIA attendees will see well-preserved examples of Richmond's past and current manufacturing and transportation landscape.

The Omni Richmond Hotel located at 100 South 12th Street is where refined Southern hospitality meets contemporary amenities. With elegant accommodations inside, historic Richmond outside and the magnificent Blue Ridge mountains just an hour away, this is the ultimate Virginia experience. The James Center YMCA, a 30,000-square-foot state-of-the-art health and fitness athletic facility, offers complimentary access to Omni Richmond Hotel guests. Guest services include: 24-hour dining, onsite ATM, 24 hour business center, Starbucks coffee shop, complimentary safes in each guest room, full-service restaurant, valet parking and WiFi Internet service. SIA has reserved a block of rooms that can be reserved by clicking on this link: https://www.omnihotels.com/hotels/richmond/meetings/society-for-industrial-archeology-47th-annual-conference. You are encouraged to book early. The $138 per night conference rate is good through May 9, 2018.

Conference registration will be available March 20th on the SIA website at http://www.sia-web.org/sia-47th-annual-conference/

Conference Fees:
Member: $325
Student Registration: $150