

**John G. Lewis Memorial Bridge
Route 673 (Featherbed Lane)
Bridge over Catoctin Creek in
Loudoun County**

National Register Listing “Catoctin Creek Bridge”

**Presentation March 26, 2015, July 23, 2015
& September 16, 2015**



What we know.

- The Bridge is on the National Register of Historic Places.
- Section 106 of the National Historic Preservation Act of 1966 requires that Federal agencies allow the Advisory Council on Historic Preservation an opportunity to comment on all projects affecting historic properties either listed in or determined eligible for listing in the National Register.
- Qualification for Federal grants for historic preservation, when funds are available.



“John G. Lewis Memorial Bridge”

Historical Significance

(extrapolated from the National Register Listing)

- **January 25, 1974 – Entry Date**
- “Modern guardrails are located along the sides but the wooden plank roadbed is intact.”
- “The ends are set on fieldstone abutments.”
- “On the Eastern End is a damaged circular plaque reading:
“The Variety Iron Works Cleveland O. Bridge Builder.”
- The condition blocks are checked as **Good** and **Unaltered**



“John G. Lewis Memorial Bridge”

Statement of Significance

“The Catoctin Creek Bridge is an excellent example of the metal truss bridges once prevalent on the secondary roads throughout the state. Like the covered bridges they superseded, the metal truss bridges are a fast disappearing piece of Americana. This particular example is virtually the only bridge of its size and type left in northern Virginia, and it is given added distinction by its unusually picturesque setting in the beautiful farming region near the Quaker community of Waterford. The shaded unpaved county road served by the bridge, and wooden plank roadbed on the bridge itself add nostalgia to the scene.

The bridge was produced by the Variety Iron Works of Cleveland, Ohio, around 1900. It originally was located on Route 7 across Goose Creek east of Leesburg. It was dismantled and moved to its present location around 1932.”



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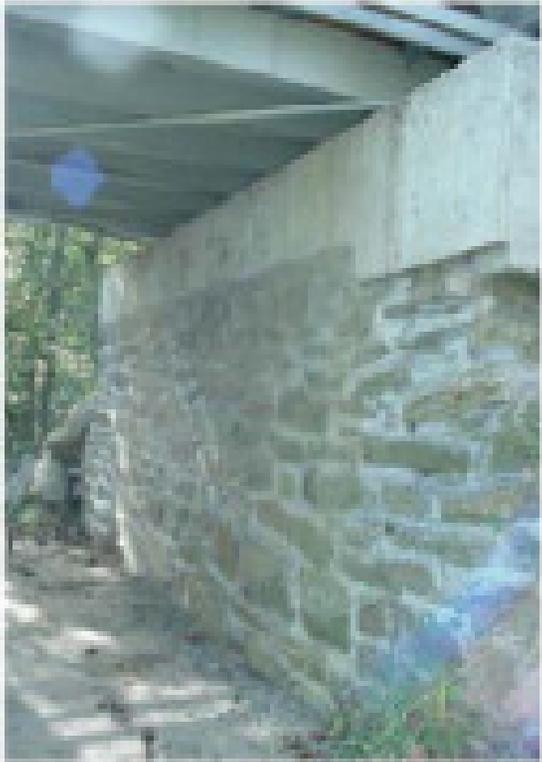
Alterations / Changes over the Years

- Per the Baker inspection report, and as noted in the National Register, The bridge was originally built in 1889 on the Leesburg & Alexandria Turnpike (Route 7) over Goose Creek. In 1932 it was dismantled and moved to its present location.
- In 1967 the stringers were replaced.
- Truss joints were retrofitted and several truss bracings were replaced.
- Guardrail was added continuously across the bridge.
- The bridge was metalized thus changing its appearance from original. (2003)
- After damage by a fallen tree 2 eye-bar members were replaced. (2003)
- Numerous other retrofit details were applied during rehabilitations. (2003)
- Stone masonry abutments have been capped and pointed. (2003)
- Roller type bearings have been replaced. (2003)



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Stringers on Abutment



Before Metalizing



After Metalizing



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Tree Impact on Metalized Truss
(Reconstruction in 2003)



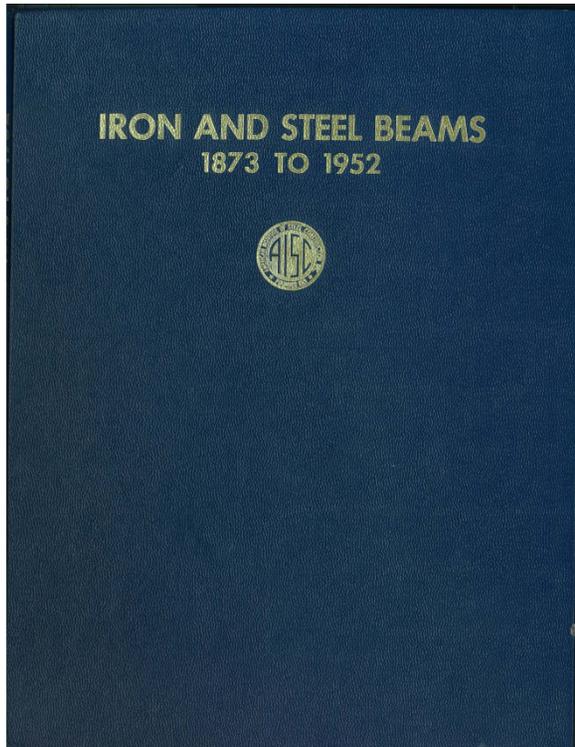
Current Structural Issues

- Chemical composition of the material (steel or wrought iron?) is unknown, thus the susceptibility to brittle fracture is unknown. What is known is that it was manufactured in 1889.



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Wrought Iron or Steel? Built in 1889?



EARLY UNIT STRESSES USED IN TABLES OF ALLOWABLE LOADS AS PUBLISHED IN CATALOGS OF THE FOLLOWING MILLS

FOR WROUGHT IRON

Year	Rolling Mill	Unit Stress
1873	Carnegie Kloman & Co. ("Factor of Safety 3")	14000 psi
1874	New Jersey Steel & Iron Co.	12000 psi
1881-1884	Carnegie Brothers & Co., Ltd.	{ 12000 psi 10000 psi
1884	The Passaic Rolling Mill Co.	{ 12000 psi 10000 psi
1885	The Phoenix Iron Company	12000 psi
1885-1887	Pottsville Iron & Steel Co.	12000 psi
1889	Carnegie Phipps & Co., Ltd.	{ 12000 psi 10000 psi

FOR STEEL

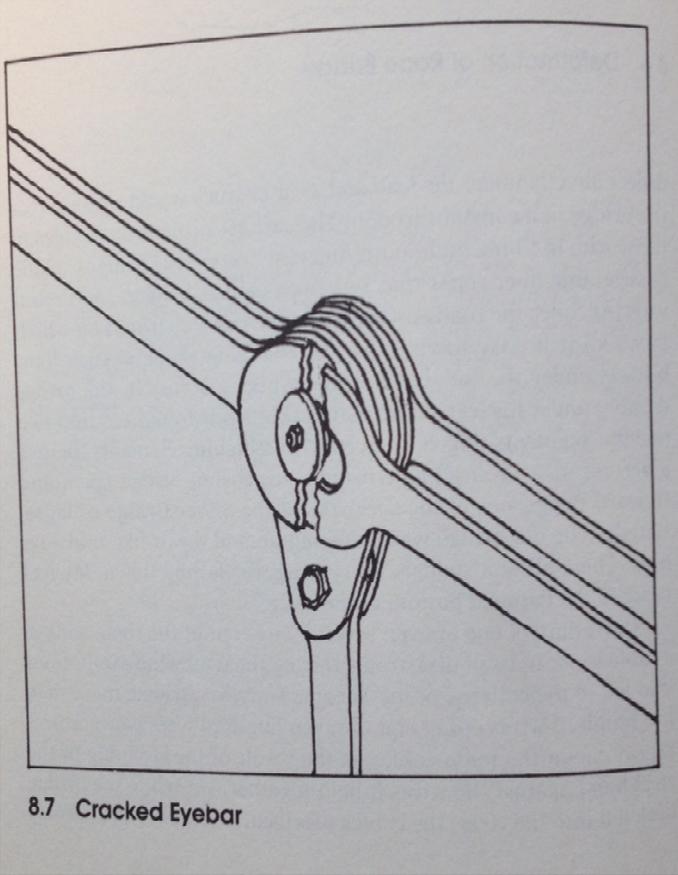
1887	Pottsville Iron & Steel Co.	15600 psi
1889-1893	Carnegie Phipps & Co., Ltd. (Bldgs.) (Bridges)	{ 16000 psi 12500 psi
1893-1908	Jones & Laughlins Ltd. } Jones & Laughlin Steel Co. }	{ 16000 psi 12500 psi
1896	Carnegie Steel Co., Ltd. (Bldgs.) (Bridges)	{ 16000 psi 12500 psi
1897-1903	The Passaic Rolling Mills Co.	{ 16000 psi 12000 psi
1898-1919	Cambria Steel Co.	{ 16000 psi 12500 psi
1900-1903	Carnegie Steel Company (Bldgs.) (Bridges)	{ 16000 psi 12500 psi
1907-1911	Bethlehem Steel Co. (Bldgs.) (Moving loads)	{ 16000 psi 12500 psi
1915	Lackawanna Steel Co.	{ 16000 psi 12500 psi

Current Structural Issues

- The bridge is a fracture critical structure with 2 – eye bar chains for the lower chord. Should one eye-bar fail, doubling the load on the 2nd eye bar, it too would be expected to fail.
- Eye-bars of this vintage typically would have high carbon content and fewer alloys thus making them more brittle and susceptible to brittle fracture.



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Current Structural Issues (cont.)

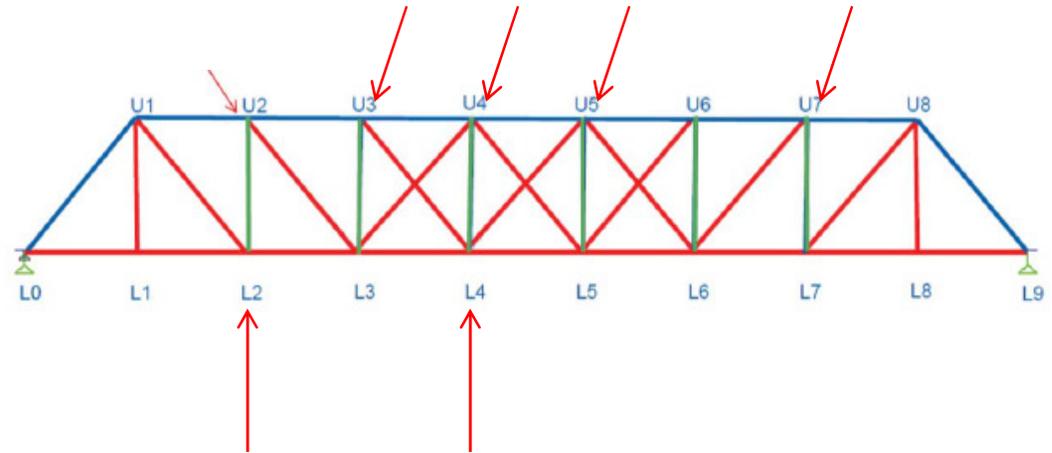
- Metalizing may have altered the surface metal properties.
- Inspection of the pin connections, is difficult for inspectors and requires additional inspections.
- The structure has noticeable loss of section (pitting)
- The structure has a mixture of rivets, machine bolts (unacceptable structurally) and H.S. Bolts. Some bolts have improper thread lengths.
- The abutments are/were stone masonry.



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Cracking has been prevalent on the structure and can now be observed at:

1. Joint U2N truss member,
2. Joint U3N several locations,
3. Joint U7N,
4. Near U4N,
5. Near U2S,
6. Upper Chord outer web near U5 downstream
7. Floorbeam support plate at L2 Downstream
8. Floorbeam support plate L4 Downstream,
9. In the bracing plate at U4 Downstream,
10. U2 angle bracket upstream,
11. Lateral bracing connection at L4 upstream.



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Added Splice Plates



Horizontal Crack at Retrofitted Joint U2
(Hole drilled to prevent crack propagation)



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Location of Crack

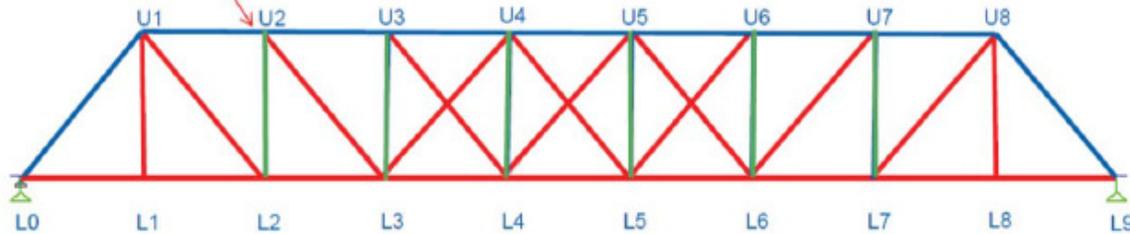


Exhibit 11. Cracking in Upper Chord



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Joint U7 N



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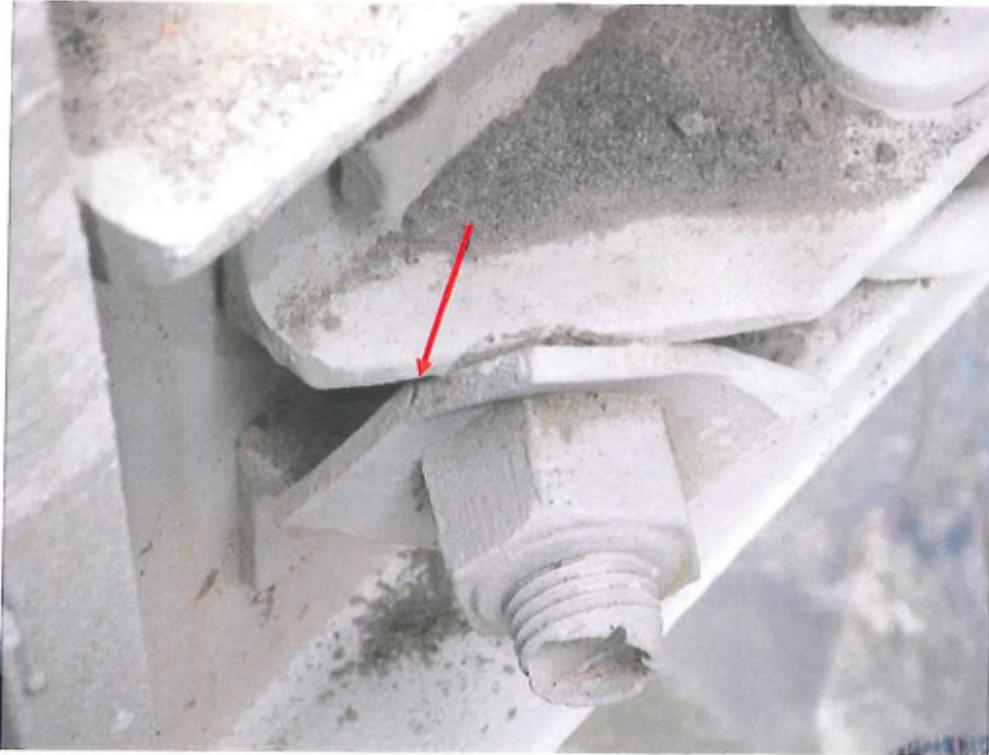


PHOTO 27 - CRACK IN LATERAL BRACING CONNECTION WASHER AT L4, UPSTREAM



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PHOTO 12 - CRACK IN UPPER CHORD OUTER WEB NEAR U5, DOWNSTREAM



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Fatigue, Fracture and Crack Propagation



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Posting Limits

Year	Posted Limit
2003 Rehab	15 Tons
2008	8 Tons
2014	3 Tons



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POSTING LIMITS...

What posting limits? I never saw that sign!



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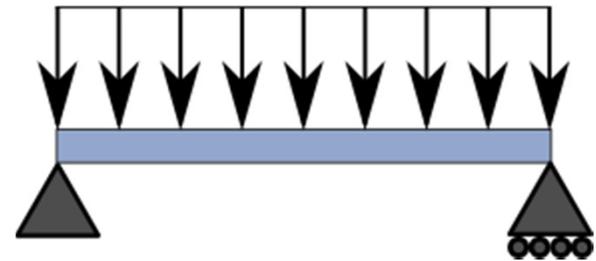
Geometric Issues

- **The existing roadway width is only 11' – 2"**
Thus making the structure...
Functionally Obsolete.

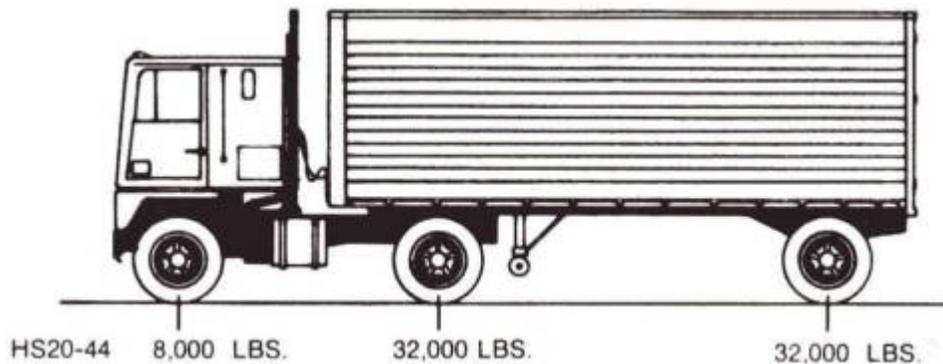


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Design Live Load ???



100 Lbs./SF



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What to Do? Guiding Principles

Mission Statement

Our mission is to plan, deliver, operate and maintain a transportation system that is **safe**, enables easy movement of people and goods, enhances the economy and improves our quality of life.



VDOT Mission • Shared Values • Code of Ethics

MISSION STATEMENT

Our mission is to plan, deliver, operate and maintain a transportation system that is safe, enables easy movement of people and goods, enhances the economy and improves our quality of life.

SHARED VALUES IN PUBLIC SERVICE

- Be responsive to customer needs, consider what VDOT does in terms of how it benefits our customers, and treat customers with respect, courtesy, and fairness
- Commit to safety and continuous improvement in everything we do, learning from mistakes and successes alike
- Trust, respect, support, and encourage each other
- Respect and protect the public investment
- Make decisions based on facts and sound judgment and accept accountability for our actions
- Strengthen our expertise in using information, tools, and technology to achieve high performance and stay on the cutting edge
- Think ahead, acting and planning creatively for today and tomorrow

CODE OF ETHICS

As an employee of the Commonwealth of Virginia and its Department of Transportation, I will:

- Commit to be a trusted steward of public resources
- Act with integrity in all relationships and actions in the work environment
- Abide by Virginia's Standards of Conduct for employees
- Not engage in conflicts of interest between my private interest and my professional role
- Not use public resources for personal gain
- Not accept or give gifts in violation of the State and Local Government Conflict of Interest Act
- Not knowingly make a false or fraudulent statement
- Not knowingly conduct or condone any illegal or improper activity

Employees should report any ethics violations to their immediate supervisor or call the Agency Ethics Office at 804-786-6725.



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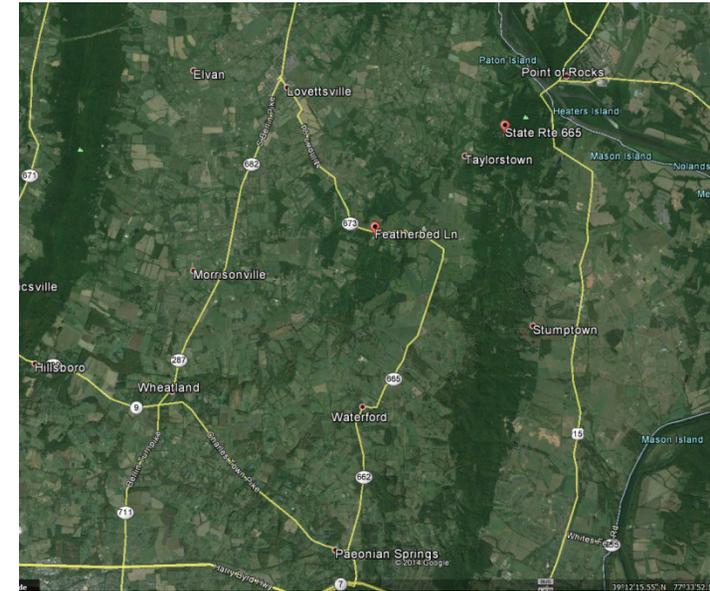
What to Do?

Guiding Principles

1. Safe – both structurally and functionally
 - Provides for the movement of People and Goods
 - Provides a 75 year service life
 - Recognizes the Historical Significance of the Existing Bridge
 - Is serviceable
 - Makes the best use of limited resources
 - Enhances the community
 - Others



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Detour Route

Is 11.5 miles long and, per Bing, is approximately a 25 minute drive.



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Options for Discussion

- Do Nothing. This could mean closing the bridge.
- Repair the existing bridge, modified with a redundant load path. (i.e. supplemental support structure)
- Replace the bridge with a new structure in the same location.
- Build a parallel structure.
- Preservation of the bridge in some form/location.
- Others?



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Responses to Nathan Holt's Email dated July 23, 2015



“John G. Lewis Memorial Bridge”

1. You indicated that you had a different consultant inspect the bridge. Why was a different consultant used? Did this new consultant have experience in the in-kind restoration of historic metal truss bridges including splicing replicated member sections, pad welding for section loss, pneumatic pack rust removal, hot metal riveting, etc?

Answer: The new consultant was not inspecting the bridge for the purpose of rehabilitation /restoration. The inspection was an annual safety inspection. Because this bridge is deemed “Fracture Critical” we are required to perform a hands-on, arms length inspection annually versus every two years as we do with all other structures.



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2. At the outset of Section 106 Consultation, I requested VDOT to supply me with relevant bridge inspection reports so I could better understand the bridge's problems. The reports I was supplied are dated February 18, 2014, and July 11, 2014. If there has been a more recent inspection report as you have stated, I would like to request that the report be supplied to me as well so I may effectively perform my duties as a Consulting Party. As I did for the first two reports, I will be happy to sign a confidentiality agreement if needed.

Answer: We will provide any and all data that we have available. Nothing is being withheld. The new information is from an inspection done on February 18, 2015 we received the validated report in June.



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3. You stated very clearly (with underlining for emphasis) in your statement that the **very next day** after rehabilitation this bridge would have more cracks. This is an incredible, extraordinary claim, and I would appreciate elaboration on why this is the case. Equally incredible and extraordinary is your statement that the non-destructive disassembly of the bridge would cause even more cracking. What is so unique about this bridge to cause such extraordinary rate of cracking? And what is unique about this bridge that the routine process of non-destructive disassembly would induce further cracking?

Answer: “It doesn’t matter if the material is steel or wrought iron. Whatever it is...its cracking. We could fix all of those cracks and call it rehabilitated and the very next day have more cracks.”

The bridge is unique in that it has been relocated, it has been metalized, it subject to more freeze thaw cycles and thus brittle fracture. Non-destructive disassembly is not so non-destructive!



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4. Your comments almost make it sound like you don't know why the bridge has cracks and continues to show cracks. Surely that isn't the case? Please detail the type and cause of the cracking. Is it the result of something extremely rare such as "unusually temperature sensitive brittle steel" as is the case with the Ironton Russell Bridge over the Ohio River? Or are the cracks something more common, like fatigue cracks caused by overloading of the structure, and/or excessive loading cycles of the metal? Might some of the cracks be located near rivet holes, indicating cracking initiated from punched holes for rivets?

Answer: We don't know why it has cracked. The cracks are in tension members, compression members, primary and secondary members. We have speculation that the cause could be due to the metalization. From the June 2013 consultant report prepared by Michael Baker Corporation:

“POTENTIAL CAUSES OF CRACKING

The following factors were investigated as potential causes of cracking:

- 1) Truck Overloads
- 2) Wind Load & Torsion
- 3) 2003 Tree Impact during Reconstruction
- 4) 2003 Joint Retrofit
- 5) 2003 Metalizing for Corrosion Control”



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“Process of Metalizing : Metalizing is basically a method of galvanizing. It refers to the thermal spraying Of zinc (or aluminum alloys) as a coating directly onto steel surfaces. The coatings are created by using a heat source (either flame or electric arc) to melt the metal which is supplied as a wire. An airstream sprays the molten metal onto the steel surface. Once the molten metal strikes the steel it solidifies quickly to become a coating. Metalizing is applied on a prepared/cleaned surface. Surface preparation is typically done by abrasive blasting. Chemical etching sometimes has been used for surface preparation.”



“Steel Embrittlement: There have been cases in the past that galvanizing was believed the reason for steel embrittlement and cracking. Cold working is the strongest factor contributing to the Embrittlement of galvanized steel. In cold worked steel, galvanizing significantly accelerates the strain aging and embrittlement. Chemical etching for surface preparation is another factor that may cause embrittlement, depending on the chemistry of the steel. Hydrogen embrittlement of steel in the process of galvanizing is, yet, another factor which is mainly associated with high strength steel. ASTM Recommended Practice A1 43, “Safeguarding Against Embrittlement of Hot Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement” provides guidance against embrittlement.”



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“Role of Metalizing in Cracking:

Information on the properties of the steel used in 1889 in the Construction of Featherbed Lane Bridge is not available, to conclude if the metalizing (galvanizing) has Caused embrittlement and cracking at U2 joint. However, the supplementary inspection of the bridge performed on April 9, 2013 revealed the presence of cracking in many locations in the truss, indiscriminately, indicating that the cracking phenomenon is related to a factor that applies to the overall truss, rather than a particular location. [See Exhibit17.] This in turn suggests that the metalizing performed on the overall truss in 2003 have most likely had a role in the occurrence of cracking.”



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Aden Truss: We were planning to metalize the Aden Truss. We are not.

We reached out to experts:

- John Barsom, Ph.D. Former Director of Research at United States Steel
- Reidar Bjorhovde, Ph.D. World renowned structural steel consultant. He authored all of the compression formulas used in codes today.
- Volkert has sought opinions from a variety of sources in industry associated with the rehabilitation of iron bridges. These sources include the FHWA, US Bridge and the Coatings Industry. All of the sources are in agreement that galvanizing wrought iron is a difficult and unknown process.

The chemical make-up and manufacture of wrought iron is different from that of steel. Wrought iron will typically contain less than 0.1% carbon while steels will range from 0.3 to 0.6% carbon. The manufacturing processes of that day were inconsistent which made the control of the levels of carbon and other impurities difficult. The result is that the chemical makeup of the finished product can be inconsistent. That could mean that the chemical makeup of individual members of a truss could be different and therefore produce varying visual and bonding effects when applying coatings.

According to industry, the current galvanization process is set up for modern day structural steels. Structural members are blast cleaned, put through an acid bath, rinsed a number of times, pre-flux agent applied and dipped in molten zinc. Because of the inconsistencies in the chemical makeup and manufacturing process of wrought iron, galvanizing is unpredictable. The only way to know is to test a sample piece/ pieces.

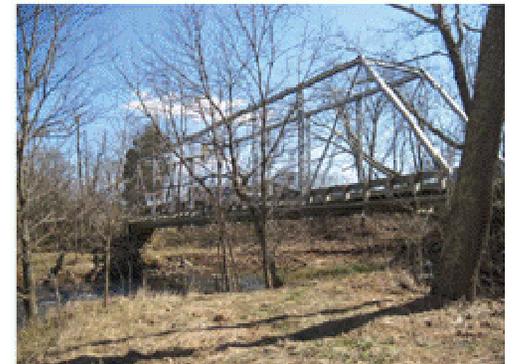


5. Regarding cracks, if the cracks are on minor elements such as batten plates, or bent plate used to provide an attachment for lateral bracing rods, etc, it should be noted that these elements are not major structural members and can be replaced in-kind by a fabricator easily at low cost. If there are cracks at a common trouble spot which is the field bolted splice(s) of the upper chord, this problem can be corrected by fabricating a couple replica sections of upper chord, cutting the cracked portion out, and welding the replicas in as replacement. This process was completed in Fayette County, Texas for a bridge called the Piano Bridge. Please see attached photos of the Piano Bridge showing the problem and the fix.

Answer: The cracks are on many different members. Replacement-in-kind is not non-destructive. It can be very destructive! It is not that easy. It is costly.



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6. Considering the aforementioned about cracking, can you please indicate specific areas of cracking on the bridge that are not simple, easily-replaced elements like batten plates, plates or washers for attachment of lateral bracing, u-bolt connection plates.... and also are not cracks associated with the field bolted upper chord splice?

Answer: We have provided all previous reports. We will provide the new report. The issue isn't so much where the cracks are now...it is where will they be next? We are tasked with searching for miniscule cracks, before they become large cracks.



7. Please elaborate on the metalizing of the bridge. I am familiar with the traditional three coat paint system that DOT's use today, and I am familiar with lead paint traditionally used on bridges in decades past, and I am also aware that some states including I believe Virginia have even hot dip galvanized trusses. However, I admit that I know very little about "metalizing," and would appreciate elaboration on what this process is, and in particular how this process might lead to structural cracking in a truss. You also indicated that you cannot undo the metalizing. Are you saying it is impossible to blast this bridge down to bare metal?

Answer: Previously discussed.



8. You made the statement that the bridge is “not safe to rehabilitate” and immediately followed that statement with the statement that the bridge “also has dual eye-bars and uninspectable pin details.” My experience is that nearly every major rehabilitation of a pin-connected truss bridge that I have been involved with included the replacement of existing pins. I agree... there is no good way to inspect pins for problems, even ultrasonic testing is problematic. Replacing pins is common, and not considered a major alteration, especially if the new pins replicate the dimensions and threading of the original pins, and if stainless steel pins are used, these are painted so they don't stick out visually. I generally find that if mild steel is used, pins run from \$500-\$600 per pin. The cost would, of course, be higher for stainless steel. But my point is that pin replacement is not unusual, costly, or detrimental to maintaining the historic integrity of the bridge.

Answer: The pins are not the issue. The problem area is the eye bar surface around the pin. Remember the “Point Pleasant Bridge aka Silver Bridge” in West Virginia.



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9. Next, in regards to your statement about dual eyebars, are you suggesting that any truss bridge with dual eye-bars is automatically unsafe, because that would basically be calling into question the safety of numerous bridges rehabilitated by numerous DOTs across the country following stamped engineering plans. That's a pretty big charge. Nearly every pin-connected highway truss in existence consists of paired eyebars for tension members, and numerous rehabilitation projects across the country maintain the paired eyebar configuration for these members. That said, the addition of post-tensioning cables in between existing eyebar pairs to provide redundancy would be a minimal alteration from a visual standpoint, and I would be happy to support a proposal of this type if that made VDOT more comfortable... this certainly would be more preferable than welding enormous load-bearing girders to the truss!

Answer: Yes it is a big charge and I stand by my statement.

Adding cable redundancy is an option and we most likely would do so if we extend the life of the bridge for pedestrian use.





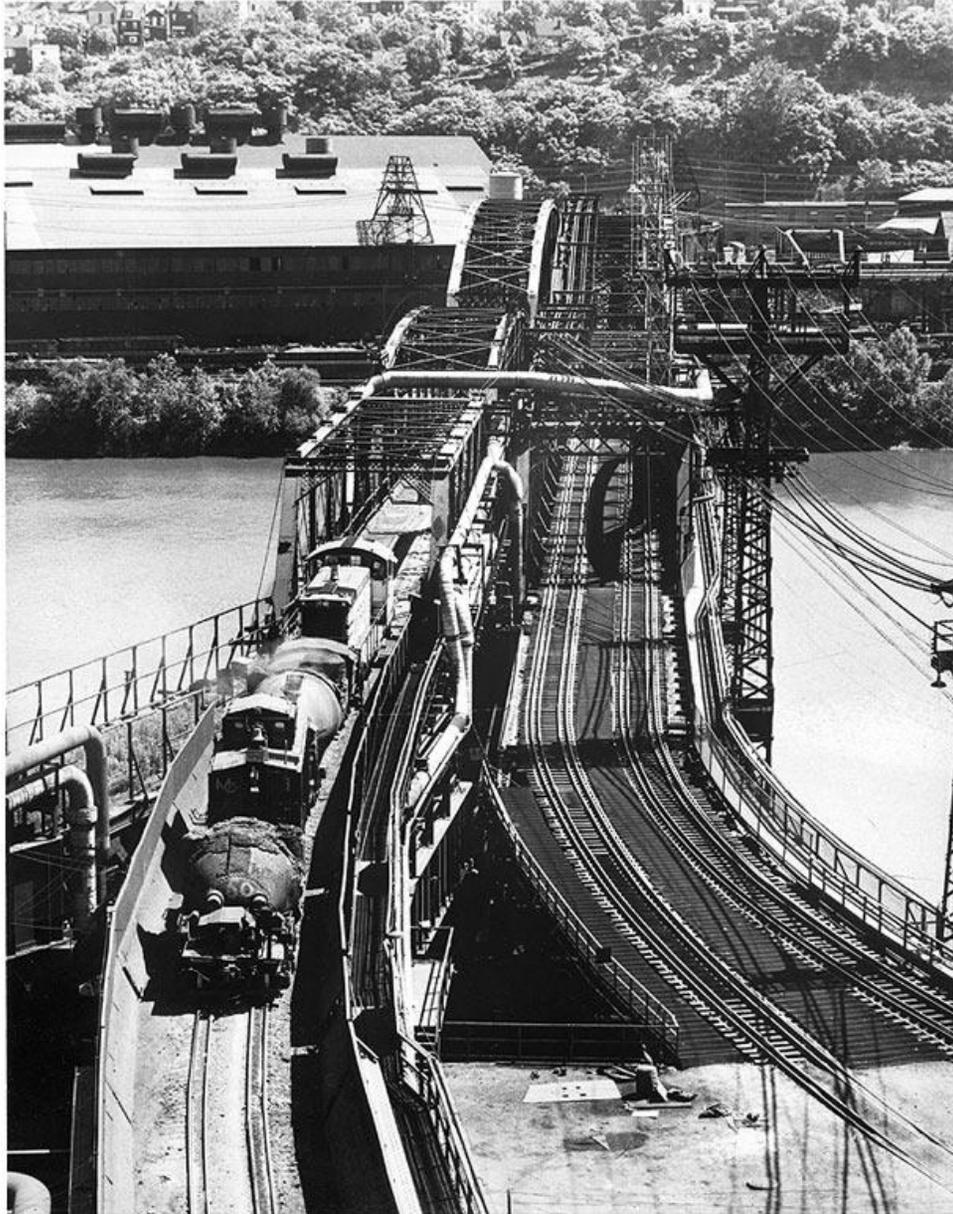
10. You stated that you cannot stop overloads on the bridge. The installation of clearance-limiting “headache bars” over the approaching roadway is an effective way to keep trucks off the bridge. Additionally, if the intent is to provide for the typical usage of this bridge by light vehicular traffic (residential traffic / passenger cars), I would expect that these loads would not put the bridge into the same type of loading cycles that trucks do, meaning fatigue cracks would not initiate or propagate at the same rate as they are with concrete trucks driving over the bridge. A combination of headache bars and posted weight limits may be an effective way to prevent fatigue-inducing loads from crossing the bridge.

Answer: Headache bars can also give headaches to horseback riders, and farmers on tractors.

? Light residential use...Does this include Refuse Collections, Concrete Trucks, Moving Vans, Truck Drivers who get lost? How policed?



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The Hot Metal Bridge and the Monongahela Connecting Railroad Bridge. Built circa 1900.



