Rhinelander Railroad Association

Warrant

June 2012

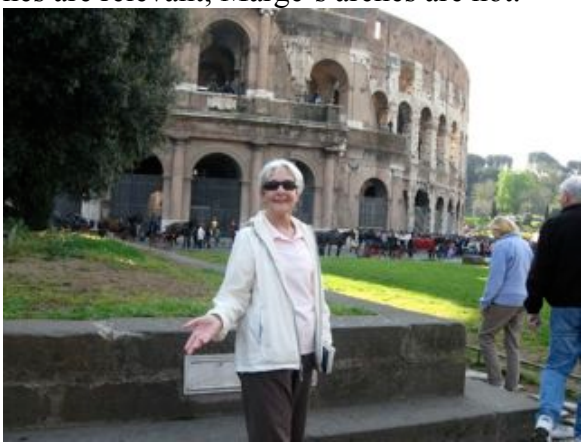
Bridges: Design & Material Evolution: arches

by R.G. Blocks

Delving back into European antiquity we find Roman arches quite apparent in many places. Roman aqueducts and bridges exist after twenty centuries and more. Arches by design support a load in compression. That is, the forces tend to push the arch downward towards the open span; hence, when stone is used for arch construction it is being compressed in the process.

Compression is the opposite of tension. Ropes hold loads in tension. Simple stuff, eh?

The Piazza fountain at Pitigliano, Tuscany, Italy receives water via a duct atop a series of arches. The famed Roman Coliseum (75AD) is constructed as of a series of arches. Marge provides a sense of scale in both photos. Architectural arches are relevant; Marge's arches are not.



Stone is a very good material in compression. As employed, the factor of safety, used by Romans was anywhere from three to thirty to one. That's why so many of their structures still stand. Romans were knowledgeable and fairly conservative builders. Elliptical and parabolic arches are perfect for the task; but circular arches work as long as the ellipse or parabola fits within stones forming the circular arch.

James J. Hill, creator of the Great Northern, in 1883 built the beautiful 22 arch rail bridge we see

on the left. It spans the Mississippi River and helped create the city of Minneapolis by providing a path from farm to market and a route for westward expansion of our country. His arches follow empirical design. This is not science-based evolution but construction technique handed down from father to son. J. J. Hill is alleged to have said, "Give me snuff, whiskey and Swedes and I'll build a railroad to hell." His work, not fancy, stood the test of time.

Science provided by Isaac Newton's explanation of the Laws of Motion in 1687 provided a foundation for post Roman bridge design. About a hundred years later, in 1784 Charles-Augustin de Coulomb, further advanced our knowledge of Mechanics with a paper on Torque dealing with metal wire. He is the same Coulomb we now associate with electrostatic interaction between charged particles and the theory of electromagnetism.

Iron making in Coalbrookdale, England was advanced mightily by Abraham Darby. There, coal was substituted for wood (to make charcoal) and the scale and quality of iron was improved dramatically in 1709. Darby's was not the first coke fired blast furnace; but perhaps the first acceptable one. Darby's grandson was later contracted to bridge the Severn River at Coalbrookdale. Science in bridge building was to be applied here: perhaps first.

Abraham Darby III designed the famed "Iron Bridge" in 1779. It was constructed with sand cast 9 x 7 inch ribs using mortise and pin joints in a period of three months. Note that the "Iron Bridge", while a first in bridge construction, simply replaces stone and forces are in compression. This same Darby family firm would cast the first iron railroad rail as well (but that's another story). Below, I stand at the famed "Iron Bridge" thinking: this looks like a stone bridge without the stone. Design flattery. Young Darby wasn't taking too many chances. Smart.

About the same time, Leonhard Euler b 1707 d 1783, perhaps the most prolific mathematician of all time came along to expand our knowledge in geometry, trigonometry, calculus, differential equations and advanced applications for math solutions in literally hundreds of areas. An amazing fellow, much of his work occurred after he lost his eyesight. Euler is the inspiration for much of what we compute quantitatively in many fields today. He helped to advance the economics of science and material selection versus the empirical approach of cut stone.

Now throw in Claude-Louis Navier, a Frenchman educated by his uncle who was with the French Corps of Bridges and Roads. Navier would conceive the Theory of Elasticity in 1821, established the elastic modulus 1826 and is considered the father of Structural Analysis. His Navier-Stokes equations are central to fluid mechanics but that's also another story.

It took a practical American fellow, Squire Whipple b 1804, d 1888 to design a bowstring iron truss bridge in 1840. An arch in compression needs a huge base to constrain the outward thrust of arch forces. Whipple put a bowstring between the bases. Whipple's bowstring, a base in tension, removed the need for massive piers to constrain the arch from spreading out. Arch bridges could now be prefabricated and carry load without counting on massive end piers to prevent the arch from collapsing.

Whipple also conceived of a mathematical approach to solving the size of bridge components. He wrote a treatise on Bridge Building in 1847 that became the standard method of joint analysis. In 1868, for his revolutionary work, he was made an honorary member of the Society of Civil Engineers. Whipple, can be credited for making bridge building a scientific endeavor.

Whipple bridges were an efficient exponent of the proper use of standardization, pre planning, materials choice, cost to weight, redundancy against component failure and served both road and rail well. They were at times replaced by Pratt, Parker or Warren wrought iron (or steel) designs when his cast iron and pin connected eye-bars failed to offer sufficient safety as train loads increased. These bridges generally dominate spans up to 250 ft.

Then, in 1874, James B Eads, using Whipple ideas and "steel" designed and built the Eads Bridge between St Louis, Missouri and East St Louis, Illinois. It was the longest arch bridge in the world at 6,442 feet (or 1.22 miles). It has some of the deepest caissons (footings) ever sunk (causing considerable death or damage to workers from 'the bends' or decompression sickness). This road and railroad bridge is still in service. It is a lacy silhouette of black steel with huge piers.

The Garabit Viaduct, a Causses Line Rail Bridge across River Truyere in the French mountainous area, was built by Gustav Eiffel between 1882 and 1884. It is one very large arch bridge: 1,854 ft long with a 541 ft arch over the river. Many consider this the most beautiful of all arch bridges. His bridge, to minimize wind resistance, is a series of interwoven trusses, open triangles if you will of wrought iron. When built this bridge was the highest in the world. It is very stable, with tension and compression both translated to downward forces into the rocks below. Eiffel later would go on to build the tower that bears his name. The Garabit Viaduct was shut down for repair several times in the past decade. Rust, cracks and the ravages of time have impacted its beauty and major renovation is warranted.

At 10, 580 ft, the longest metal bridge in the world is overall some 20,461 ft when you include the abutments. It is a rail bridge built at Cairo, Illinois in 1887 for the Illinois Central. It has two 518.5 main Whipple spans and is still in use. My photo, approaching Cairo in April 2008 shows the Ohio and Mississippi in flood stage. This rail bridge is uppermost in the center.

In summary, we have covered arch designs and worked in trusses. We have introduced the names of the key players in history We will cover the details of joints and trusses in more detail on another occasion without going into undue engineering rigor. We have given you a glimmer of background using key arch designs as well as their empirical or scientific backgrounds. At some future date we will explore other rail bridge designs and their evolutionary path and value.

A favorite arch bridge is the road entry to Pitigliano, Tuscany, Italy, the little town perched atop a bluff of tufa where we began this story. The Pitigliano stone bridge on the left is a copy of Roman design architecture and provides grand road entrance to town. Its exquisite beauty is memorable as is the climb up a shear cliff.

We do these brief studies so our little bridge models are somewhat convincing. For example, the Just-In-Time stone arch bridge on our O gauge TR-C&NW layout is an

eight foot viaduct with compound and reversing curves. Our bridge is eight feet long or 384 scale feet. Our bridge is a composite of ideas garnered from the real thing and a bit of poetic license. We use our bridge to mask an area of where several tunnel portals are evident. It serves as a mask; it is also so large and imposing that folks usually gasp when they enter our layout area. It makes an imposing statement.

The best part is that stone bridges are generally easy to plan and carve from foam. They do take a bit of time to cut, carve and paint.

Truss bridges are a bit quicker to finish. A variety of plastic, brass and cast bridge details are available for modeling metal truss structures. Also, many plastic kits abound for many of the steel truss designs. Kit bashing (merging and modification of kits) is another way to end up with a model bridge creation that will satisfy your particular method of spanning a chasm.

Railroad Happenings: or Semi-local events…

May 17-20, 2012- CNW Historical Society Convention- Norfolk, NE
Info at: www.cnwhs.org

June 16-17, 2012- Annual Strawberryfest Model Railroad Show- Waupaca, WI
Waupaca Recreation Center
Saturday June 16 10 AM to 5 PM
Sunday June 17 10 AM to 3 PM

June 23, 2012 Three Lakes Model Railroad Club and the Rhinelander Railroad Association will run a portion of their modular layouts at the Three Lakes Shootout (boat racing against a clock) on the south end of Big Stone Lake, Three Lakes, WI From 10 AM to 4 PM in the southern most hangar on Three Lakes Municipal Airport. There will be food and airplane rides as well. The model railroad display will be a no cost event; bring the entire family for a day of fun.

June 28-July 1, 2012- Milwaukee Road Historical Assoc. Annual Convention Moscow, Idaho
Info at: www.mrha.com

July 21, 2012- Rail fair- Copeland Park- LaCrosse, WI
Info at: www.4000foundation.com

July 29 – August 4, 2012 it's the 77th National Model Railroad Convention,

Grand Rapids, MI. The host club is found at www.grmrhs.org a 100% NMRA club. For info on the convention: www.gr2012.org Seventy fantastic layouts within one hour of the 12th best hotel in North America (Amway). Let's all go!

Sept. 13-16, 2012- Soo Line Historical Society Annual Convention
Thief River Falls, MN Info at: www.sooline.org

Oct 21, 2012 Model RR Show and Swap Meet – Circle B Recreation
6261 Hwy 60 – Cedarburg, WI
Info at: www.lammscape.com/cedarcreek

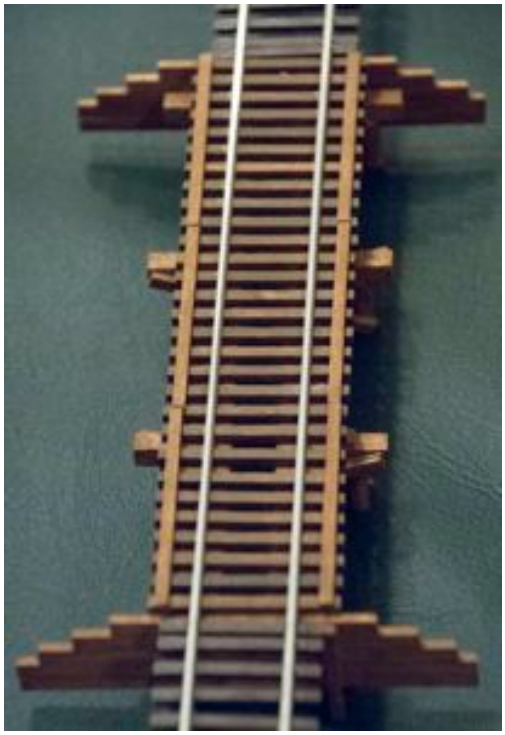
Measuring A Bridge

by Paul A Wussow

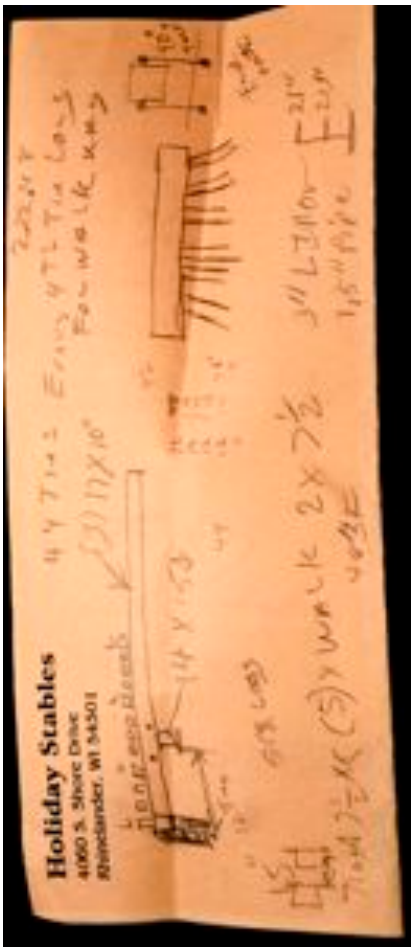
Back in 1997 while on a fishing trip in honor of my 50th birthday I discovered a bridge at the north end of Moen Lake.

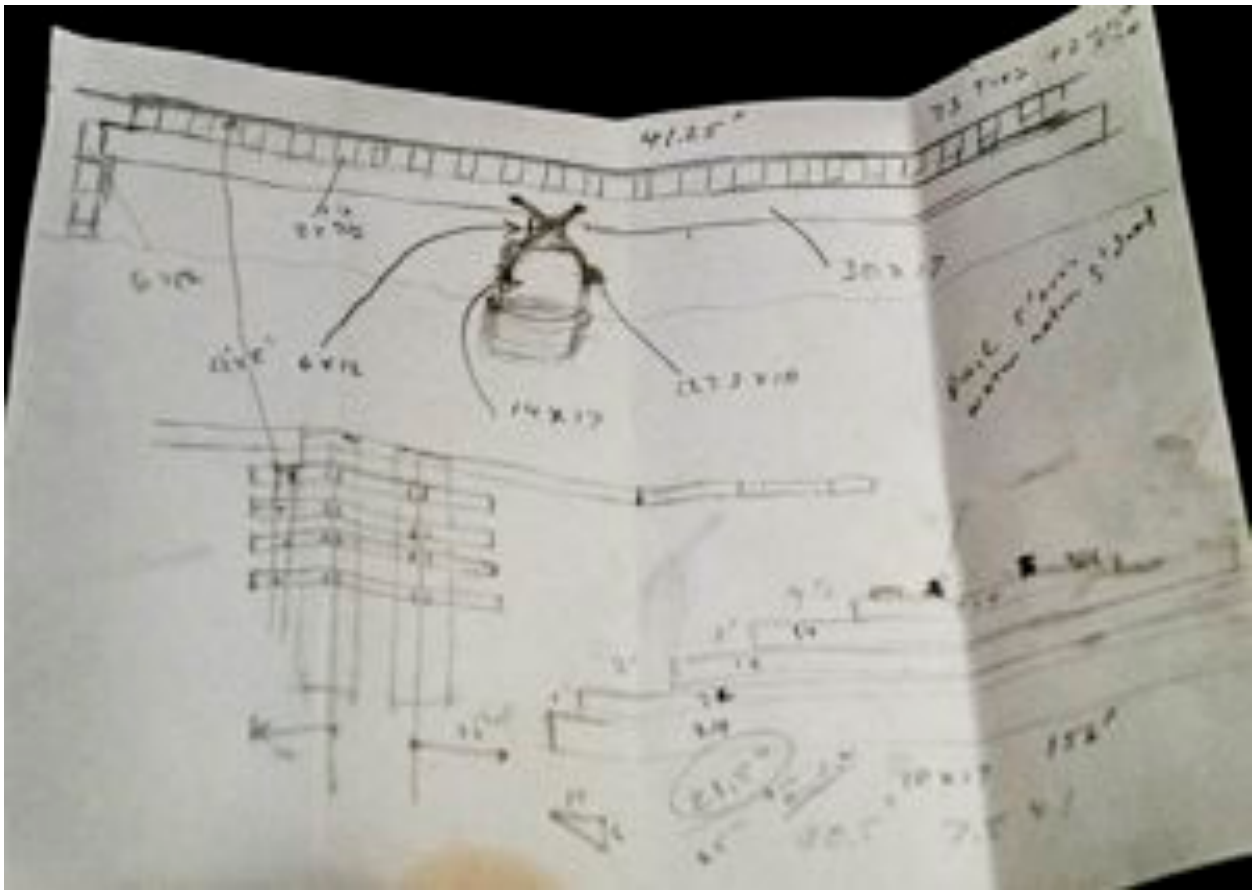
At that time I was starting to model the WC and its operations around Rhinelander WI. This bridge was easy to access with my 14' fishing boat. So with note-paper from a local stable and my fish ruler I took notes and then generated a drawing of sorts. The over all material looks like the following photo on the next page.

The bridge as assembled is shown in the next photo.

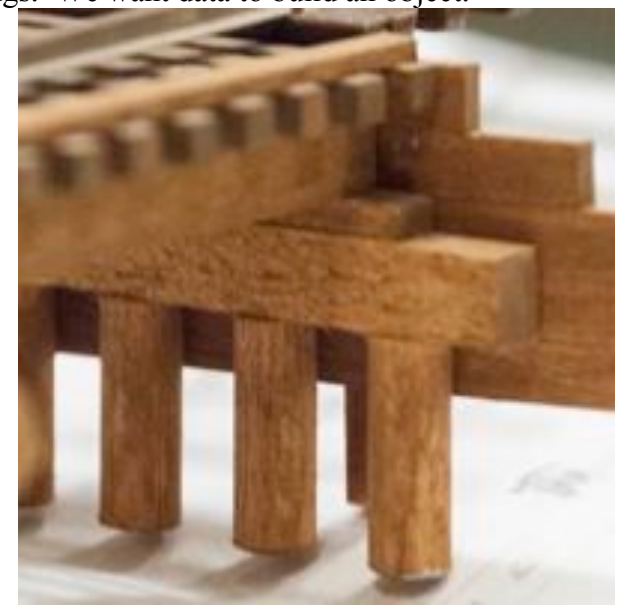


The actual data was simply enough to remind me of the dimensions and structure.





The measurements were crude but did the job for a nice, if not a Merit award model. The trick is to take sufficient measurements to build a replica of the object. These are not engineering drawings. We are not interested in fussy drawings. We want data to build an object.



I didn't worry about the mechanical assembly detail (spikes and large nails). You might need to jot down that sort of detail if you are going for an award from your fellow model railroaders in one of the scales HO or larger (HO, S, O, G, etc) for an AP certificate in structures.

A close up of the bridge above and to the left is the research vessel as equipped in 1997. It was pulled up next to the bridge at the time.

We did the job faithfully from photos and the few measurements shown.

This past year Roger Blocks and I decided to take a few more measurements and use some new technology. Digital cameras make for a lot more photos than film at a lower cost. Our approach is to show what we are measuring and then show the measuring tape.

Any questions?

5th Annual "Shootout" Radar-Run

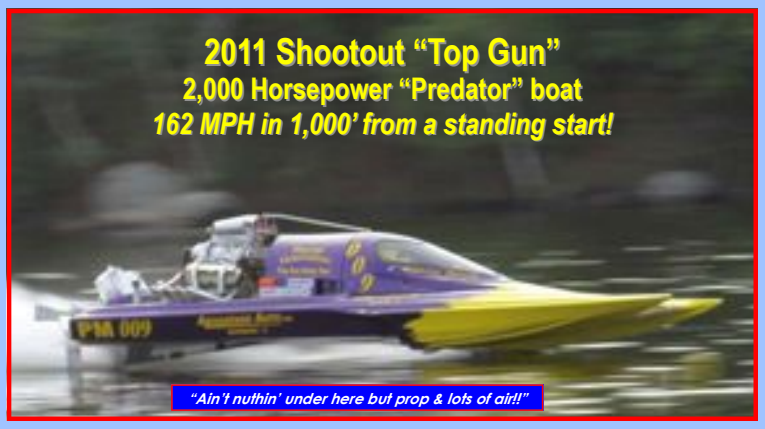
Boat Races & Airport (40D) "Fly-In"

Three Lakes, Wisconsin

Friday & Saturday, June 22nd & 23rd, 2012

Great family-friendly entertainment!

Racing Boats ▪ Tunnel Hulls ▪ Jet Boats
Drag Boats ▪ Hydroplanes ▪ Snowmobiles



ALL PROCEEDS go to the Three Lakes Fire Department

Snowmobiles-on-water pulling barefoot skiers!

Model Train Exhibit at Airport Hangars

Vintage & light sport planes!

Airplane Rides at the Airport !

Friday: Race boats displayed (Bonnie's Lakeside Restaurant) *5 to 8 PM*

Saturday: Racing + Planes + Snowmobiles on water . . . . . *11 to 6 PM*
at Anchor Marine / Sunset Grill

Post Racing: Harbor Campground Beer & Music Tent . . . . . *6 to 10 PM*

Maps & You-Tube clips at ***www.ThreeLakesShootout.com***
or info by email: ***Info@ThreeLakesShootout.com***

Route 32 — 3 miles east of Three Lakes on Big Stone Lake — Follow the Signs

Free lunch for visiting Pilots, just show your license!

Free admission ▪ Free parking & shuttle

Fun Under the Sun

by R.G. Blocks

Shootout June 23rd, 11AM to 6 PM

Three events are upon us. The *first, referred to in the above flyer* is the **Three Lakes Shootout** where boats race against a clock. Any boat can enter. I saw a houseboat go faster than one would believe. This water borne affair, see prior page, is also a FLY IN for pilots and their friends which allows us train lovers to view lots of flying machinery as well. The attraction for pilots is a free Hot Dog! The attraction for all is a bit of noise and whirlwind activity.

Finally, and most important (a point of view) is the fact that members of Three Lakes Model Railroad Club (see http://tlmrc.org for more information) and members of Rhinelander Railroad Club (see http://rrahome.org for the latest) will be informally helping out the shootout by providing a modular train layout. We'll be talking up both clubs, NMRA, model rail and doing some On30 and HO operations in DCC. Bring grandpa, grandma and the grandkids one and all. Something for everyone in the southernmost hangar!

Location is about 3 miles east of the US 45 and St 32 intersection on Rt 32 at the southern end of Big Lake which defines the northern end of Three Lakes Municipal Airport. A view on the Chamber of Commerce website, updated every few minutes is the approach to 40D. Simply find: http://www.threelakes.com/ and you've an eye on things.

4th of July Parade – Three Lakes 9 AM (be1 hour early .. big crowds)

The second event centers around the work of **Mike Lehne**, long time Rhinelander RRA member mike@chugchug.org will be at the Three Lakes School the morning of July 4th with his F3 Diesel Engine to pull in the Three Lakes 4th of July Parade. Please join us. Lions have a breakfast at the Town Offices that morning, the Library has a book sale, there is a flea market in Burnside Park, and that night the Aqua Devils Ski Show performs. Happy 4th of July folks.

July 12th at Three Lakes School – Connect to Three Lakes

A **Networking Expo** will be held in the Three Lakes School Gym from 5- 9 PM. It will give you an idea of how one very small town, Three Lakes WI became voted **the Single Best Town in America**. We have an enthusiastic group of small business firms: many are dependant on Internet traffic. We have both a year round residential base and seasonal visitor influx that utilize the multiple avenues of high-speed state of the art communication located here. It didn't just happen. It was planned and the plan was executed. This year TLMRC will be promoting model Rail and showing that we became the first 100% NMRA Club in Wisconsin with the kind support of Internet providers and a forward looking group of Town of Three Lakes Supervisors. For more information including maps to the school: http://www.threelakes.com/ .

That's the story for the near term. Any questions? Call your editor Roger at 262-989-4338 or email me and I'll get you in touch with the right party… for a party.

Happy Model Railroading and have a splendid 4th of July.

Presidents Message: Greetings from the "Old Man."

Here it is June is upon us, graduations and summer fun begins.

Camping, boating, fishing, outdoor cooking and all that good stuff. Now if only we could get the gas prices to cooperate, tourism would be a lot better! Wishful thinking isn't it?

At least attendance at the Pioneer Park Historical Complex is going pretty well. We have had visitors from across the big pond!

Everyone that visits the depot has written positive comments about it thanks to our people manning it! Good job guys and gals!

As of this writing, the business car and the caboose still have not have been worked on. I don't now what is going on at this point, but I have been told the work will get done. I will be attending a meeting with the city and the Pioneer Park Historical Complex Committee on Tuesday morning June 19th, at 10:00 am.

Put June 23rd, July 4th and July 12th on your calendars.. each day involves railroading, model rail and technology in Three Lakes. Guys in Three Lakes could not have their club were it not for high speed Internet, Skype and many of them would not be part of our club were it not a combination of technology, economics, DCC, history, love of the hobby and railroading.

More on this at the next business meeting of RRA. On that note the next business meeting of RRA will be held on July 11th, Wednesday at the depot, 7:00 pm. This date has been chosen due to the 4th of July being on the first Wednesday of the month. There are a few items to discuss, hope to see you there!

Take care, Jim Brown, President, RRA.