

The First Aluminum Bridges and Alcoa – Massena Operations

by Stephen J. Lindsay, NAPHA, June, 2021

In 1933 Massena Operations of the Aluminum Company of America, the forerunner of Alcoa, made history by producing the first aluminum components for a bridge. These fabricated pieces were destined for use on the Smithfield Street bridge in Pittsburgh, PA, not far from Alcoa's headquarters. Less than fifty years before that time aluminum had been so rare that it was considered to be a precious metal, at one time having sold for more than silver, gold or platinum.



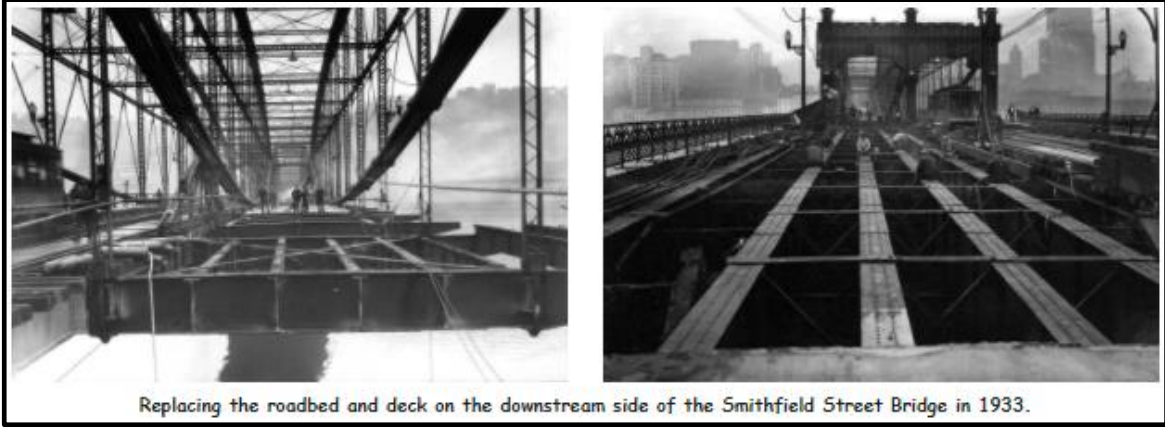
The Smithfield Street bridge in Pittsburgh, Pennsylvania, looking from upstream in 1933 [1]

The Smithfield Street bridge, the oldest surviving river bridge in Pittsburgh, opened to traffic of horse-drawn wagons and carriages on March 19, 1883. Cost effective means of aluminum production had yet to be invented at that time. In 1883 steel was the name of the game. It would be three years later that Charles Martin Hall would produce the first pure aluminum by electrolysis.

In 1891 the bridge was widened from two to three trusses and then widened again from an original width of 23 feet in 1883 to 48 feet wide in 1911. It became the most heavily used bridge in Pittsburgh and by 1933 it had developed a weight problem. The heavy load of vehicular and trolley traffic was becoming a threat to the 4-1/2 ton load-bearing capacity of the bridge.

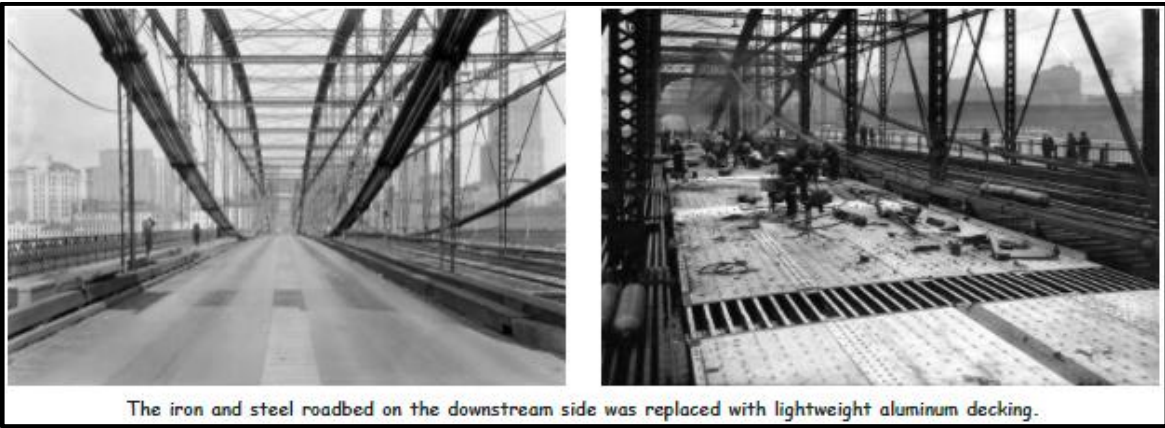
The solution was to remove its heavy decking of steel and wrought iron and replace it with aluminum channels and decking. This reduced the dead weight of the bridge by 750 tons, quadrupling its load-bearing capacity for traffic [2].

According to *The Engineer* of London, July, 1934: "This is, as far as we have been able to ascertain, the largest bridge undertaking in aluminum that has yet been carried out. It has afforded engineers an opportunity to gain experience in the use of aluminum on a large scale. Regarded as an experiment in bridge building we suggest that its importance cannot be overrated." [3]



Replacing the roadbed and deck on the downstream side of the Smithfield Street Bridge in 1933.

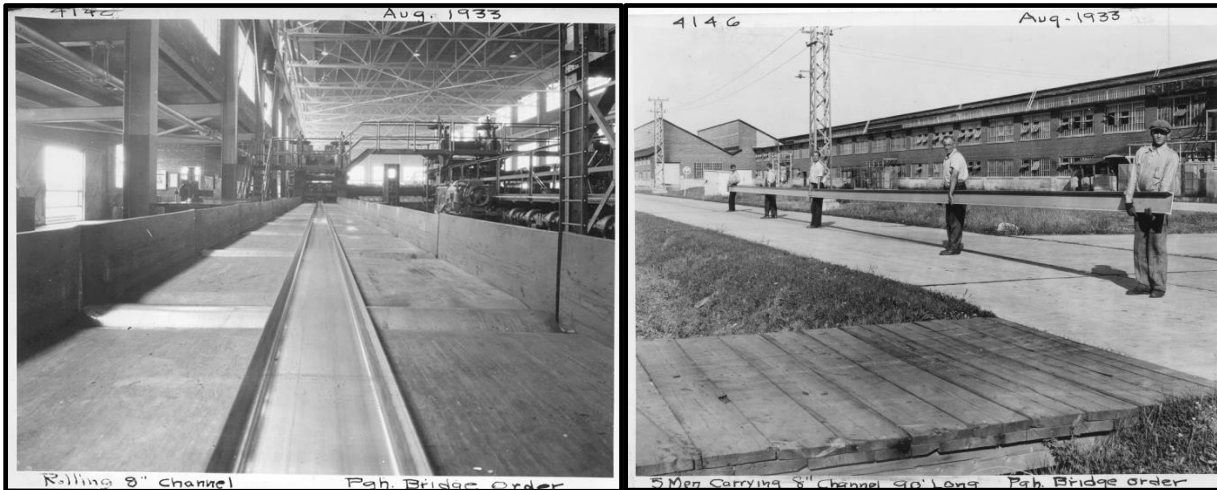
[1]



The iron and steel roadbed on the downstream side was replaced with lightweight aluminum decking.

[1]

The lightweight aluminum channels that supported the aluminum decking had been produced by Massena Operations in August, 1933.



The fabricating mill rolled out sections that were each ninety feet in length as seen in the photo at left with an aluminum channel at center. The photo at the right shows five men carrying just one section of 8 inch tall, U-shaped channel.

This corrosive resistant, lightweight metal made its mark in engineering and bridge construction circles. However, another thirteen years would pass before aluminum was used as a structural component for a bridge, especially for one that would be required to support heavy loads. World War II accounted for some of that delay, while aluminum metal resources were diverted away from civilian applications to wartime needs such as for airplanes and in M4 pontoon bridges [4].

After the end of the war Mr. David Reynolds of Reynolds Metals declared that aluminum was: “battle tested metal”. He was correct and in the post-war era the battle was on to re-purpose the primary aluminum capacity that had been built for the war effort to serve other end uses. Reynolds Metals pursued aluminum siding (1945) and Reynolds Wrap (1947). Reynolds also went on to break ground for a new primary aluminum reduction plant in Massena in 1957.

The Aluminum Company of America, A.C.O.A, also got busy developing new uses for its metal. These included structural applications for bridge construction. Again the focus fell on Massena. The 500 foot long, truss, rail bridge over the Grasse River that had been built in 1900 needed to be replaced with an elevated line that would separate rail traffic from road traffic.



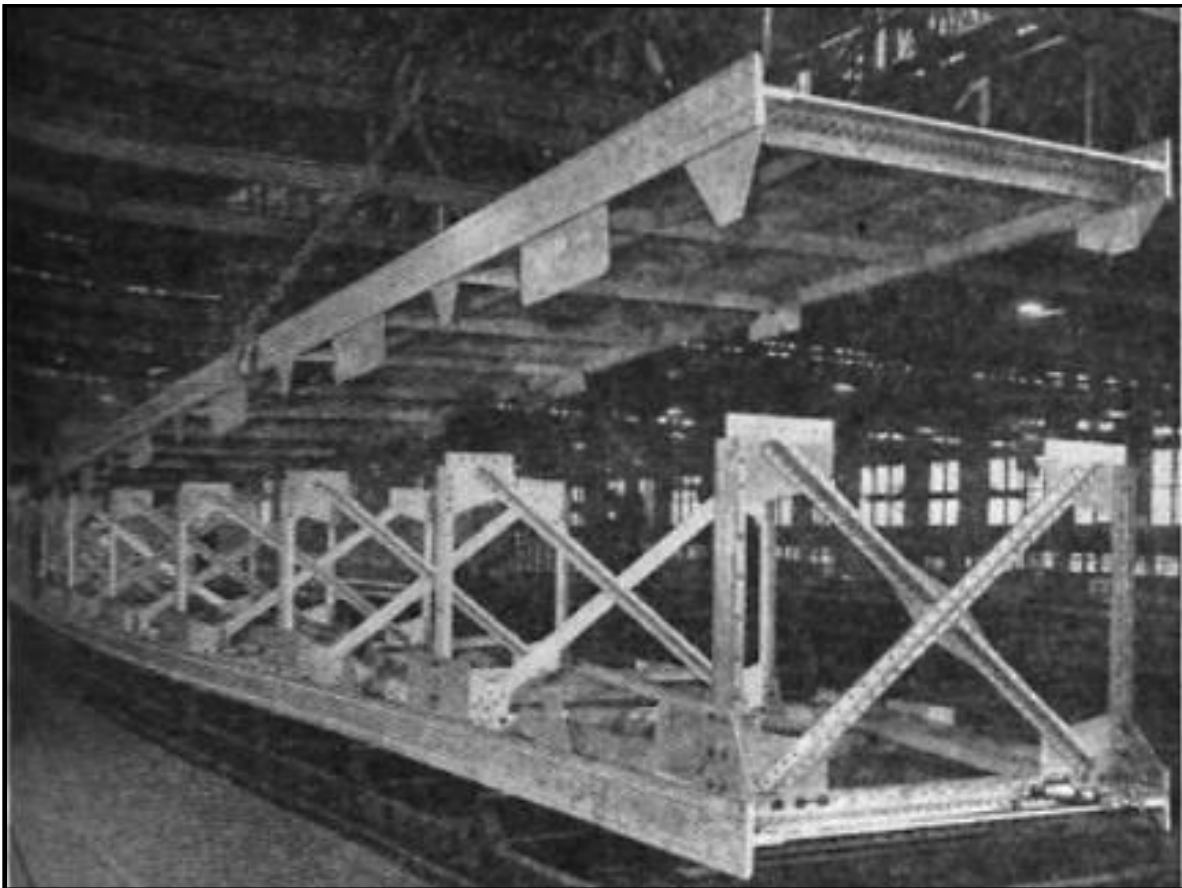
Massena rail bridges crossing the Grasse River, truss bridge in foreground, girder bridge in background

The new rail bridge would be 925 feet in length with five, 100 foot long spans across the river. Four of these spans were made of steel from the Rankin Works of Bethlehem Steel near Pittsburgh, PA. The fifth span was made of aluminum from the Aluminum Company of America. Serving as a demonstration span it has since been noted as the very first aluminum bridge that was built anywhere in the world. It was put into use during the autumn of 1946. Its 75th anniversary will be just after Labor Day in 2021.

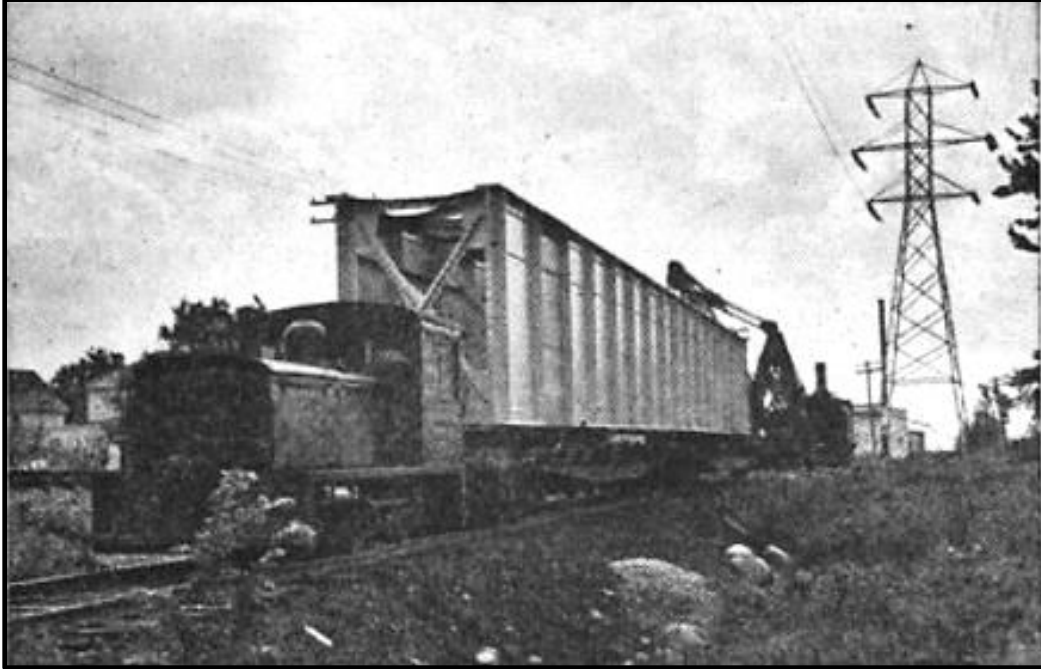
It was quite fitting that this particular span is located less than one kilometer away from where first production of aluminum metal occurred in Massena, on August 27, 1903. Massena is now not only the longest continually producing site for primary aluminum in the world. It also has the oldest working aluminum bridge in the world. Perhaps a fitting nickname for the town would be MassenaAl?

The aluminum in the Smithfield Street bridge was eventually replaced after thirty-four years of service with a more corrosion resistant aluminum alloy during another re-decking project in 1967. That aluminum bridge material was then removed in 1994 when the bridge itself was re-built to accommodate yet more traffic.

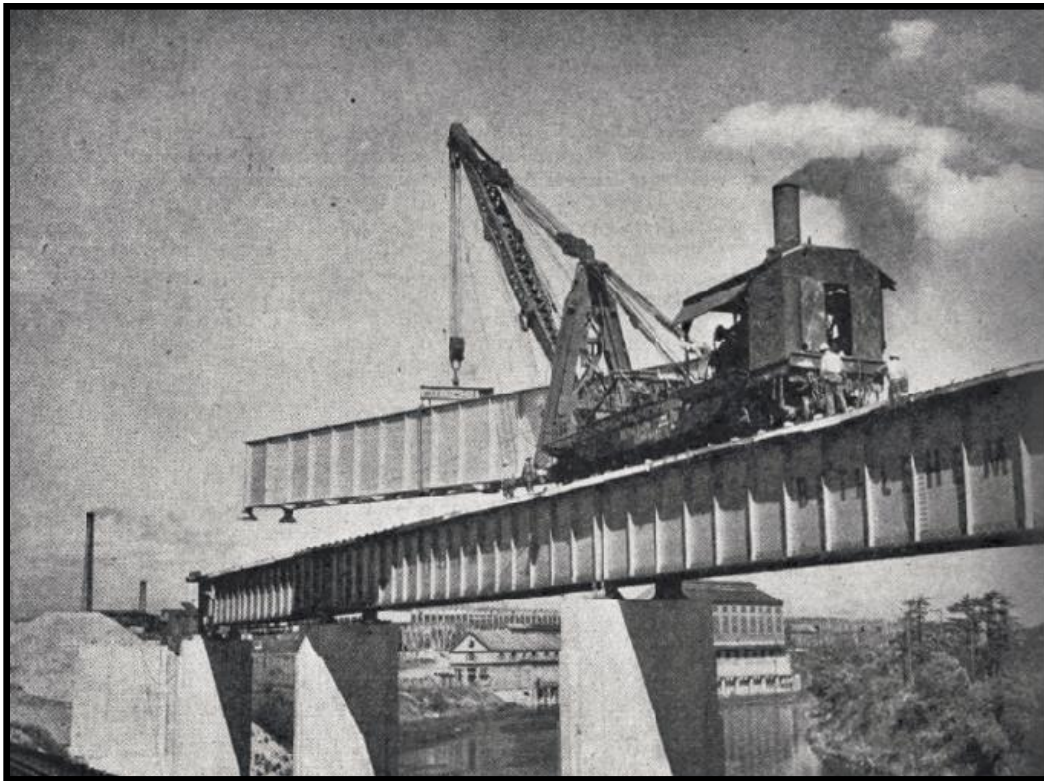
The aluminum span of the Grasse River rail bridge can be seen to the left in the photo that is above. The 100 ft. long, plate-girder aluminum span weighs 26-½ tons vs. 64 tons for a similar span made of steel. Alcoa's 14 S-T plate was used to make the span. This alloy is now known as Alclad 2014-T6 plate, an alloy with copper, iron, magnesium and chromium. It is designed around having long service life, low maintenance and protection against corrosion [5]. Due to its reduced weight the span was able to be constructed using special fabrication procedures in the Rankin works, then carried to the site and set as one piece. The steel spans were far too heavy for rail cranes to lift and had to be constructed on site. See the series of photos that follow below [4].



Lowering one of the girders into position to complete the shop assembly of the all-aluminum span [4]

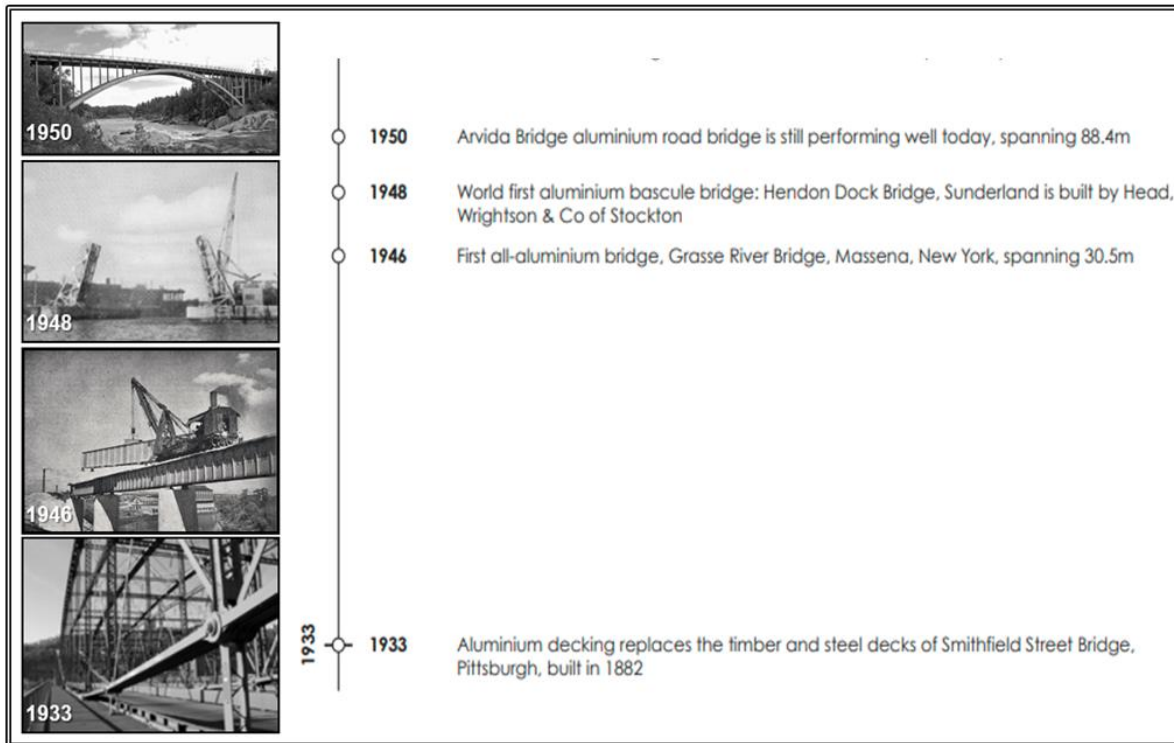


Pre-assembled 100 foot, aluminum, deck plate-girder span being transported [4]



Setting the 100-ft. all-aluminum span, completely assembled, with a single 30-ton erecting crane [4]

When we examine the timeline of the earliest applications of aluminum in bridges, the first and the second ever to use this material are tied to the history of Massena. The fourth was an all-aluminum bridge built in 1950 in Arvida, Québec. Like the bridge in Massena it remains in use today.



Timeline of early uses of aluminum in bridges [6]

These days aluminum is in use in hundreds of bridges. Some are for road traffic. Most are for pedestrian traffic. Although aluminum has shown itself to be a more sustainable material with lower total costs for maintenance over its lifecycle it remains confined to applications with special needs or in those projects in which long-term service costs win out over initial construction costs. As infrastructure renewal projects begin to emerge it may just be possible that once again the world may turn to have a look at the first aluminum bridge located in Massena, New York.

References:

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4. "All-Aluminum Bridge Span Makes Debut", *Railway Age*, Jan. 11, 1947, vol. 122, no. 2, pp. 136-138
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6. Michael Stacey, *Aluminium: Sympathetic and Powerful Towards Sustainable Cities*, 2017, p. 304, https://www.world-aluminium.org/media/filer_public/2018/04/17/tsc_report_five_final_iai_spreads_100dpi.pdf