



Historic Bridge Foundation Facebook Archives

Focus Bridges: Firth of Forth Bridges

September 2017

The Firth of Forth in Scotland is a unique location— perhaps one of the only locations in the world where three centuries of large-scale bridge design and construction can be seen side by side. Here, three parallel bridges cross the Firth of Forth: the 1890 Forth Rail Bridge, the 1964 Forth Road Bridge, and the 2017 Queensferry Crossing.

The Forth Rail Bridge is a steel cantilever through truss, and one of a small number of bridges in the world to be designated a UNESCO World Heritage Site, which was awarded in 2015. The UNESCO World Heritage designation not only recognizes the bridge's "outstanding universal value" but also confirms its protection and preservation as a heritage structure. Among the most famous bridges in the world, the Forth Rail Bridge was the longest cantilever truss bridge in the world when it was completed in 1890. The 1917 Quebec Bridge in Canada is the only bridge to have surpassed its span among cantilever truss bridges. Sir John Fowler and Sir Benjamin Baker designed the Forth Rail Bridge and construction began in 1882. It is unique for its use of massive tubular members and is also one of the first large-scale uses of steel in bridges rather than wrought iron. It remains in use by trains today, and was fully blasted and repainted for the first time starting in 2002. The bridge's overall length is 8,093 feet and the main spans are 1,700 feet each. Information on the UNESCO World Heritage Site designation can be found at <http://whc.unesco.org/en/list/1485>, including the nomination document, which contains a comprehensive discussion of the bridge, available directly at <http://whc.unesco.org/uploads/nominations/1485.pdf>

The next bridge constructed at this location was built for motor vehicles rather than trains. Completed in 1964, the Forth Road Bridge was, at the time of construction, the longest steel suspension bridge in Europe. Mott, Hay and Anderson and Freeman Fox and Partners were the designers of the bridge. Like most of the longest-spanning bridges built in the 20th Century, the Forth Road Bridge is a suspension bridge, and it includes typical design details of a large-scale 20th Century suspension bridge. These details include a deep steel deck truss for stiffening, and two tall steel towers to support the cable system. The bridge's overall length is 8,241 feet and the main span is 3,301 feet.

By the 21st Century, the need for additional capacity and a newer structure was realized, and a third bridge for highway traffic was constructed. Just recently opened to traffic in 2017, the Queensferry Crossing bridge is a cable-stayed bridge. With the completion of the Queensferry Crossing, the Forth Road Bridge will be used as a dedicated crossing for public transit. Cable-stayed bridges have taken the place of the suspension bridges as the most common bridge type constructed for long-span crossings. Typical of 21st Century cable-stayed bridges, the Queensferry Crossing uses simple concrete towers. The deck system is more visually simple as well. Instead of stiffening trusses found on 20th Century suspension bridges, this bridge uses steel tub girders with a concrete deck on top, creating a solid deck appearance. Among cable-stayed bridges, the Queensferry Crossing is notable for its three-tower design. Most cable stayed bridges use two towers, and some even use only one tower. As is increasingly common in the 21st Century for large bridge projects, designers and builders were procured using a design/build project delivery model. Large firms with a worldwide presence formed joint ventures to participate in the project. Of note, American Bridge (today a subsidiary of a Taiwanese company) played a construction role in the project. Ramboll Group, Sweco, and Leonhardt Andra und Partners were the large engineering firms responsible for the design of the bridge. The bridge's overall length is 8,654 feet and the main spans are 2,132 feet each. American Bridge has a detailed discussion of the bridge at <http://www.americanbridge.net/featured-projects/forth-replacement-crossing-queensferry-crossing/>

Each of the three Firth of Forth Bridges embodies the construction practices of the century it was constructed. With its riveted cantilever truss construction, the Forth Rail Bridge illustrates the methods of 19th Century bridge design and construction. The Forth Road Bridge is a great example of 20th Century bridge design and construction technology. Finally, the Queensferry Crossing is an outstanding example of the mainstream of 21st Century bridge design. What is unique about this location is that all three bridges, each from a different century, remain in place and in sight of each other, with none of them facing the demolition that older bridges typically face.



This view courtesy of Transport Scotland shows the Queensferry Crossing under construction in the foreground. Directly behind it is the Forth Road Bridge and the Forth Rail Bridge.



An aerial view of the Forth Rail Bridge. By Andrew Shiva / Wikipedia, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=51291330>



Forth Road Bridge, elevation view. CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=666049>



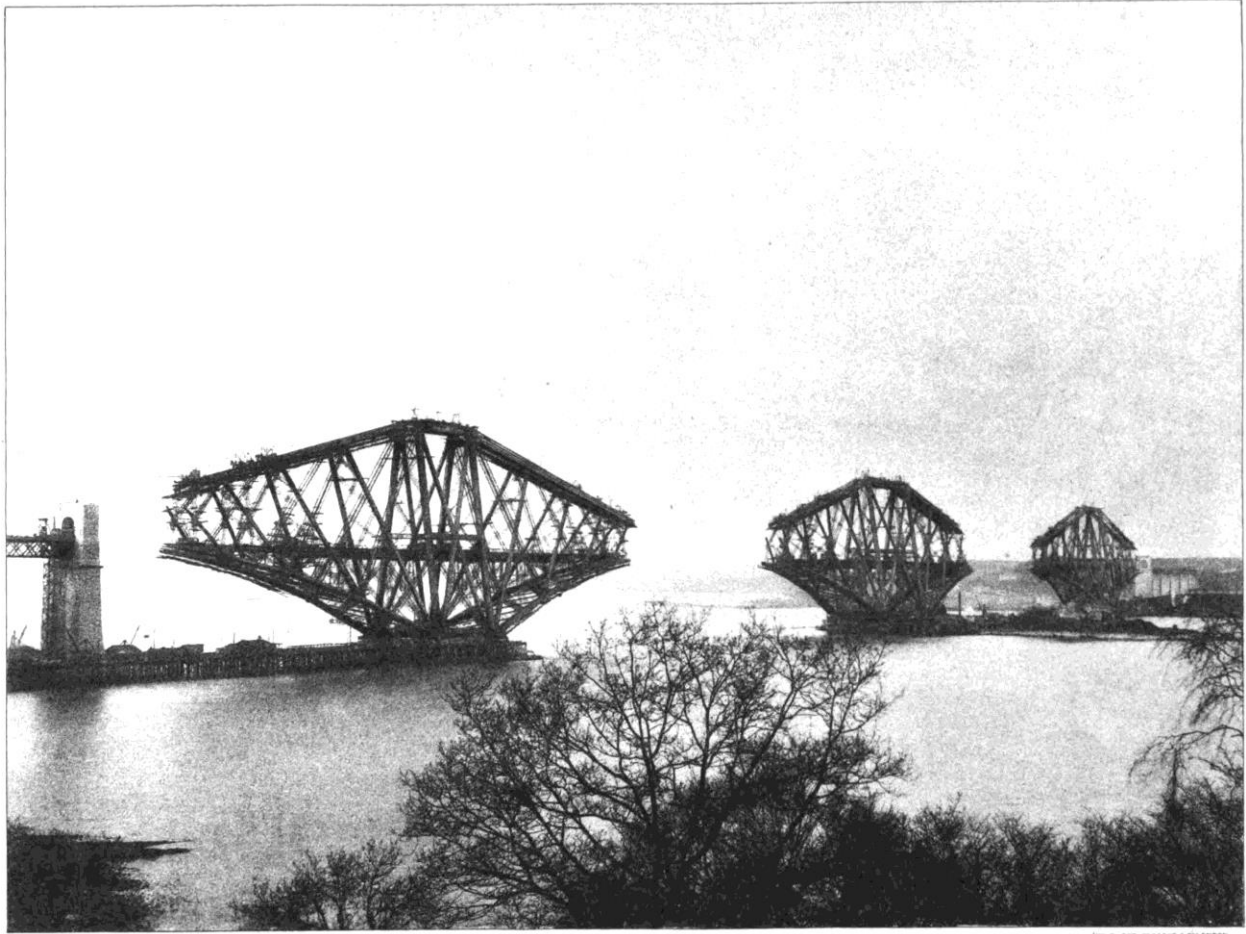
Forth Road Bridge, view from below showing stiffening trusses.



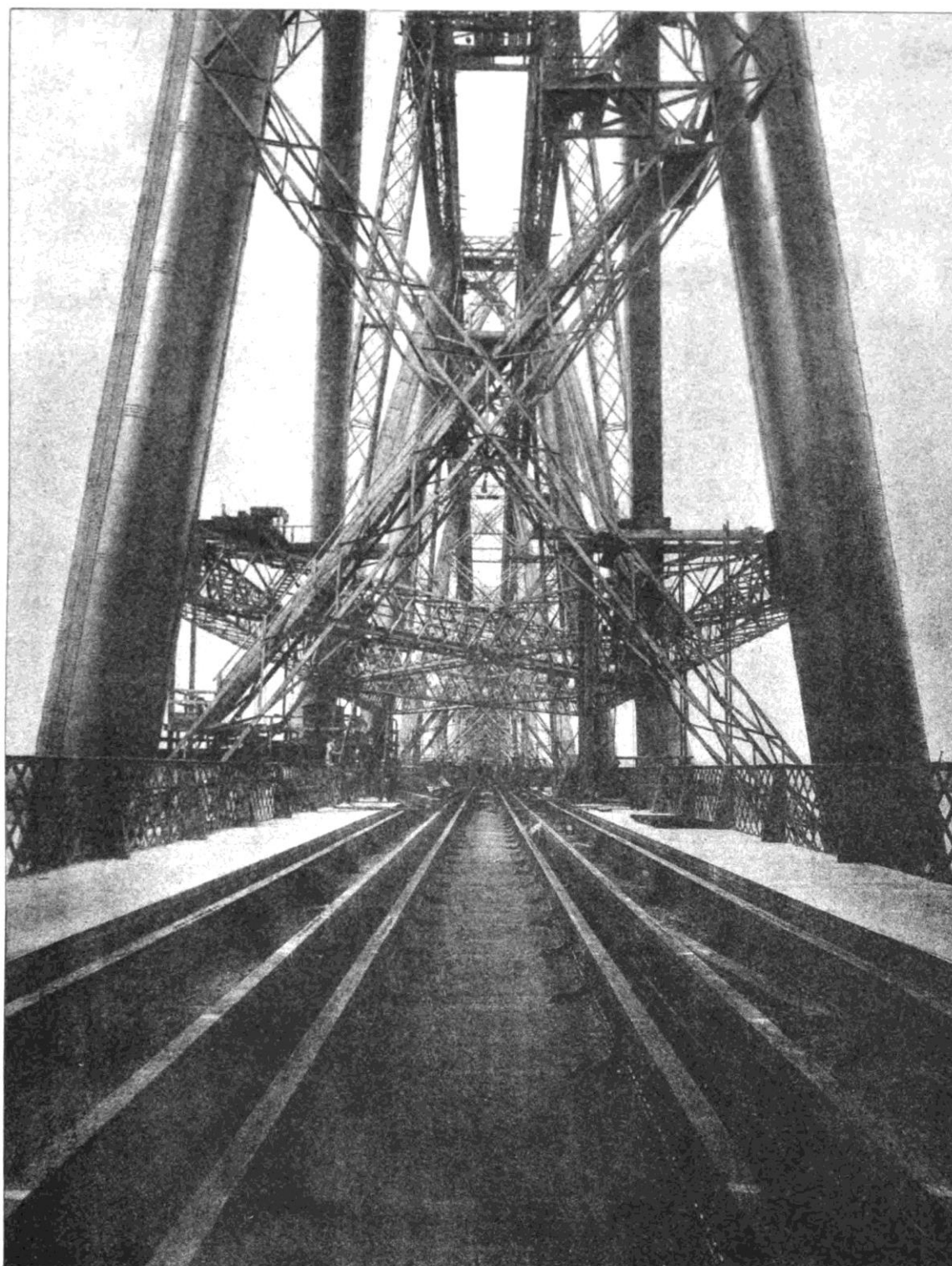
Queensferry Crossing construction showing superstructure erection. By John - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=51106361>



Queensferry Crossing construction nearly complete, shown at night. By KlausFoehl - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=59840623>

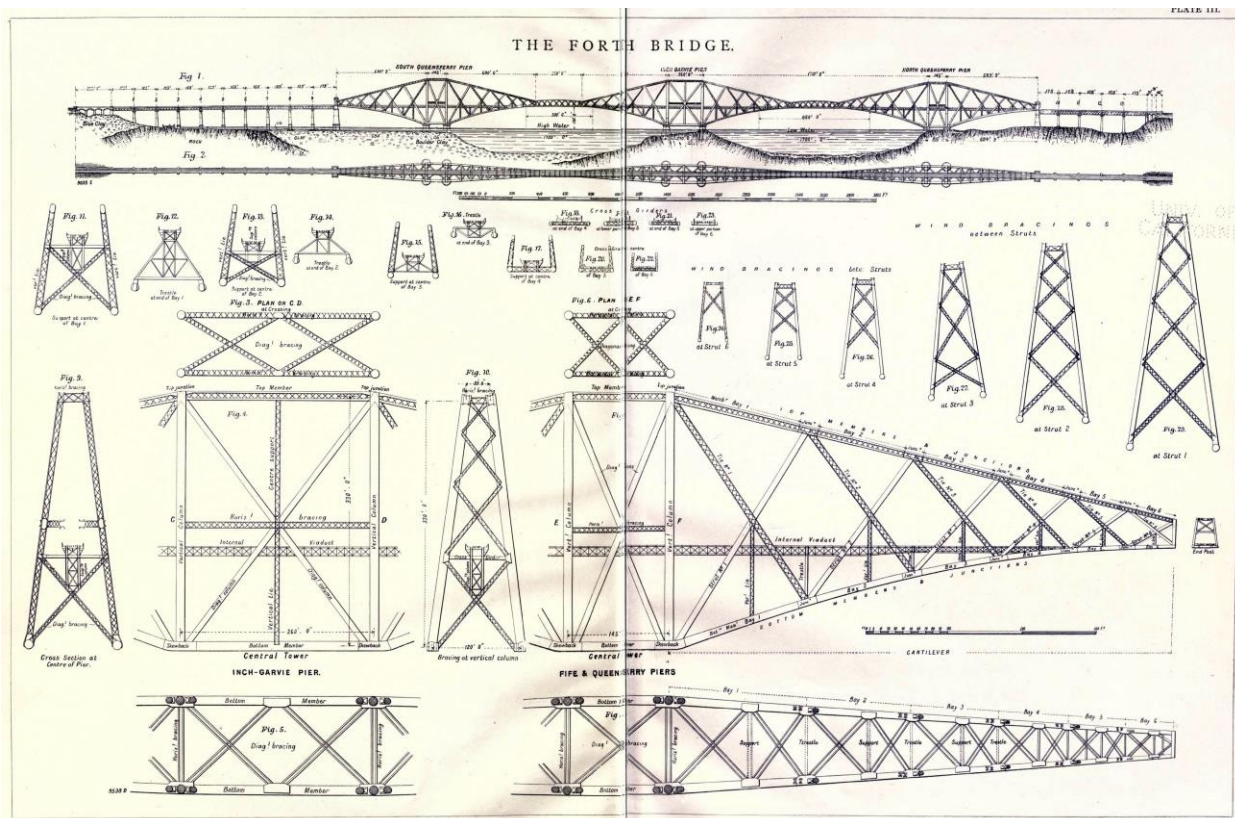


Forth Rail Bridge. Historical construction photo showing the unconnected cantilever and anchor arms extending from the piers.



INK PHOTO. SPRAGUE & OF LONDON.

Forth Rail Bridge. Historical photo showing the deck of the bridge.



Forth Rail Bridge. Historical engineering drawing of the bridge.

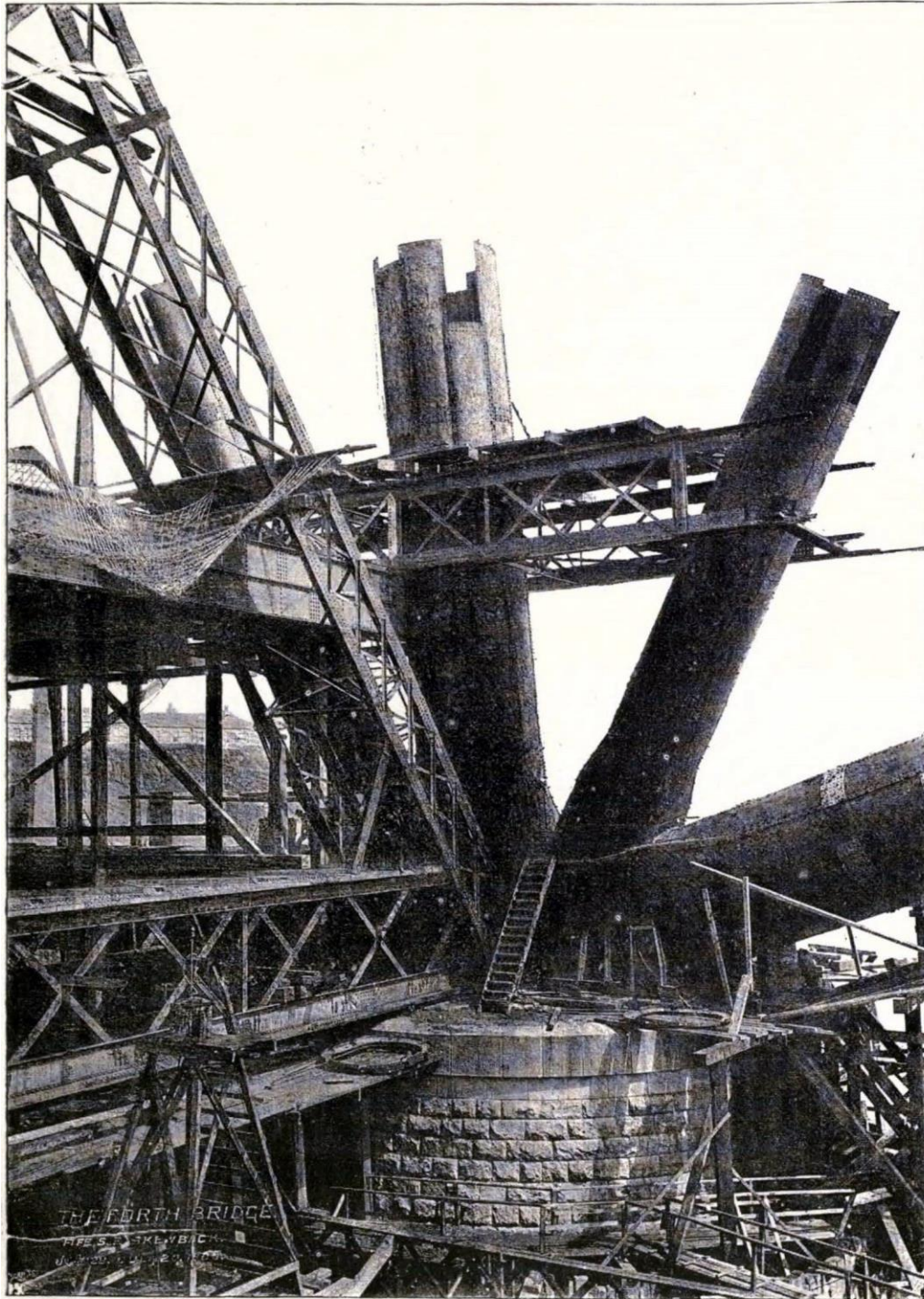


FIG. 107. SKEWBICK ON FIVE PIER.

Forth Rail Bridge. Historical construction photo showing steel erection on stone pier.

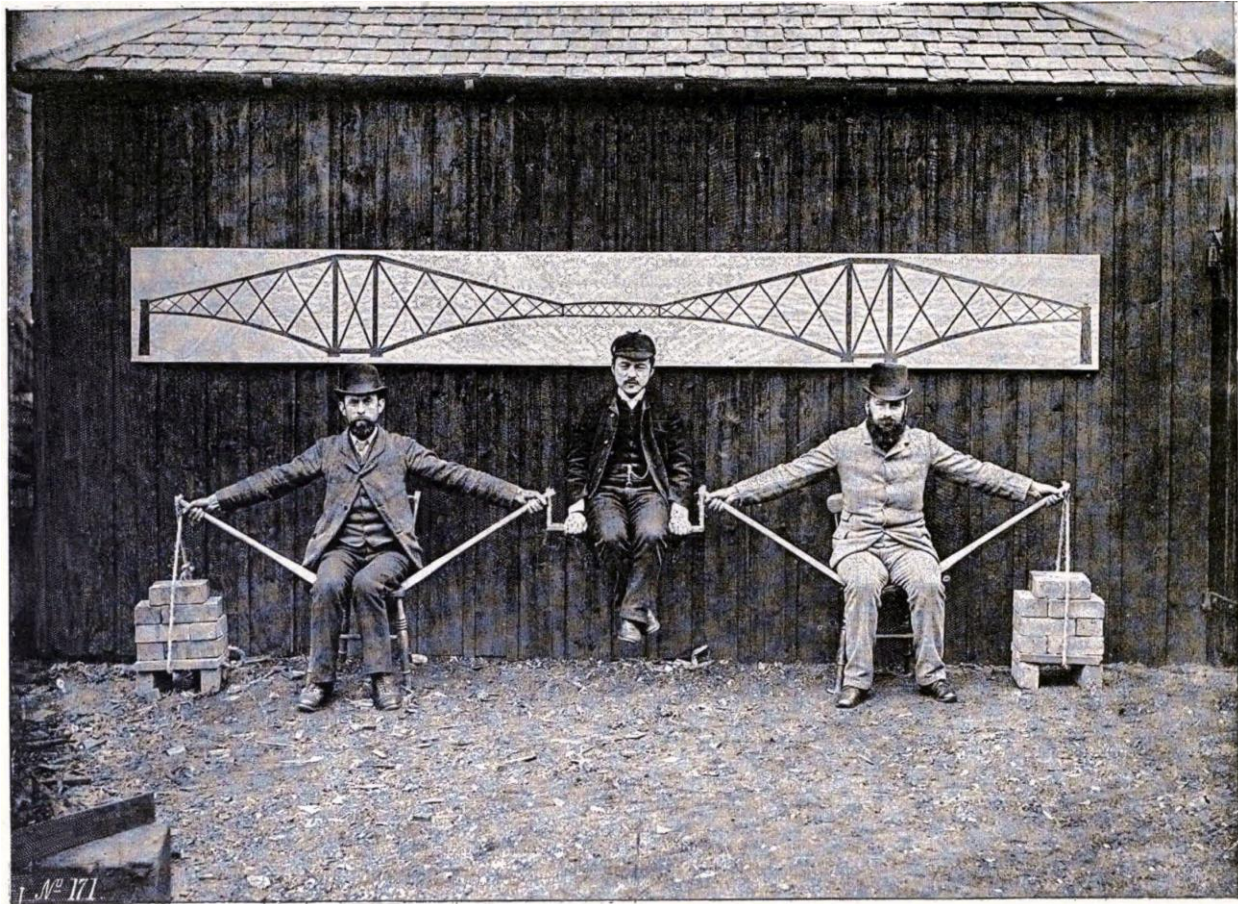


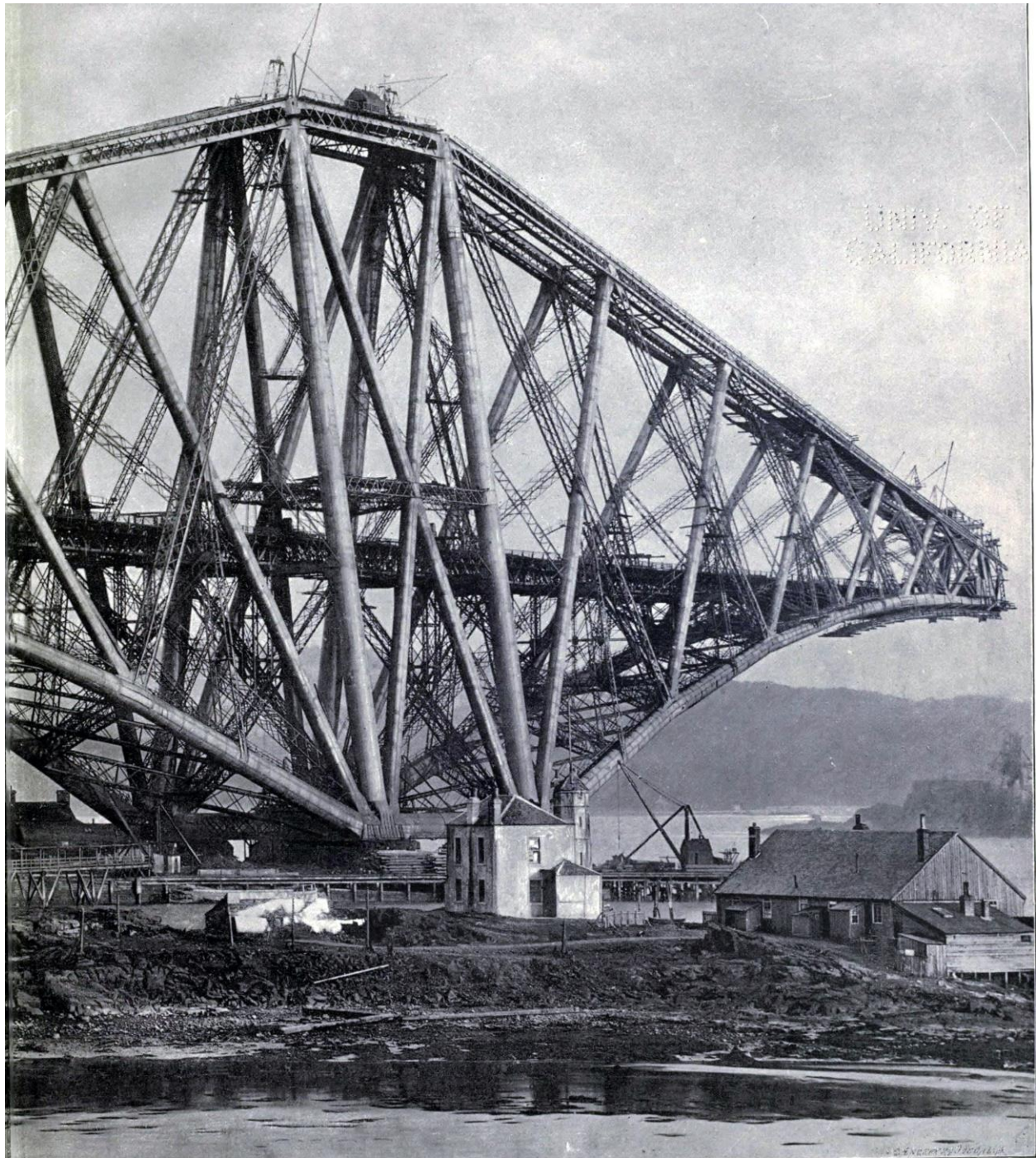
FIG. 5A. LIVING MODEL ILLUSTRATING PRINCIPLE OF THE FORTH BRIDGE.

Forth Rail Bridge. This famous historical photo shows humans demonstrating how the cantilever design of the Forth Rail Bridge works. The men on the end use their arms as cantilevers and anchors to hold the center man like a suspended span.



GENERAL VIEW OF CENTRAL TOWERS AND APPROACH VIADUCTS LOOKING NORTH.

Forth Rail Bridge. Historical construction photo before the erection of the cantilever and anchor arms outward from the piers.

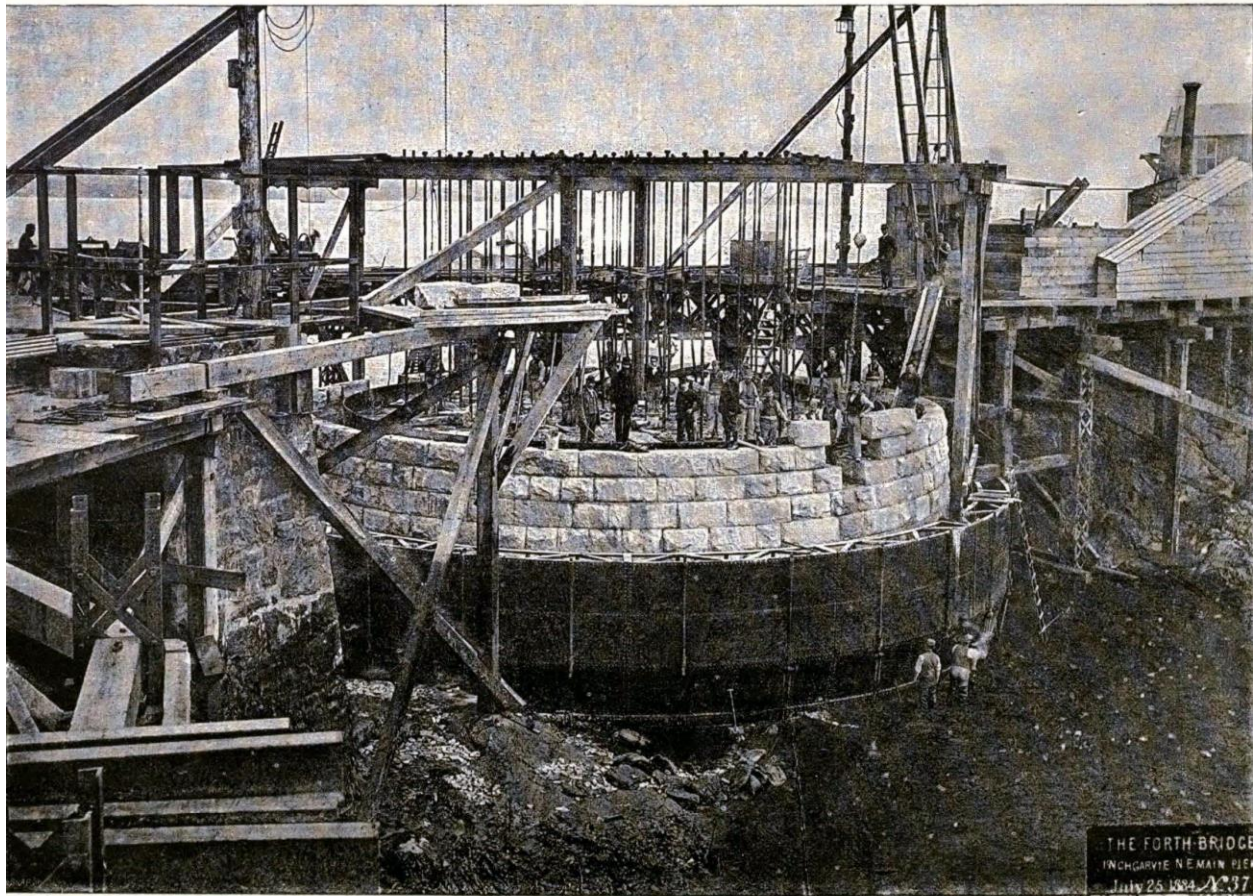


Forth Rail Bridge. Historical construction photo showing one of the cantilever arms.



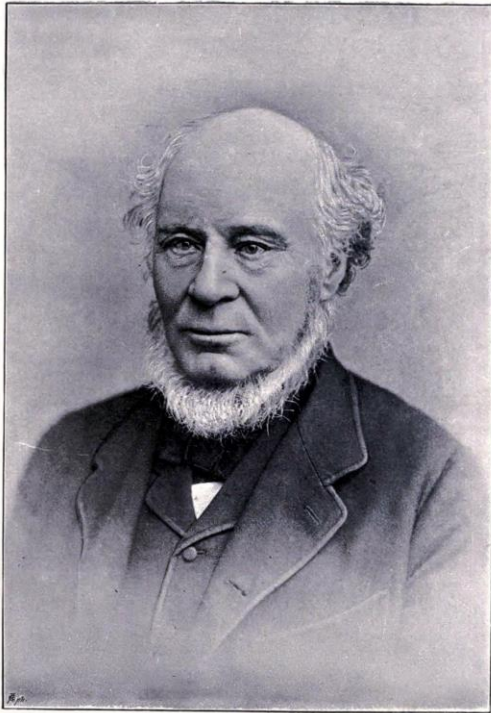
INCHGARVIE SOUTH CANTILEVER, WITH FIRST BAY OF CENTRAL GIRDER BUILT OUT.

Forth Rail Bridge. Historical construction photo showing one of the cantilever arms.



BUILDING OF NORTH-EAST CIRCULAR GRANITE PIER, INCHGARVIE.

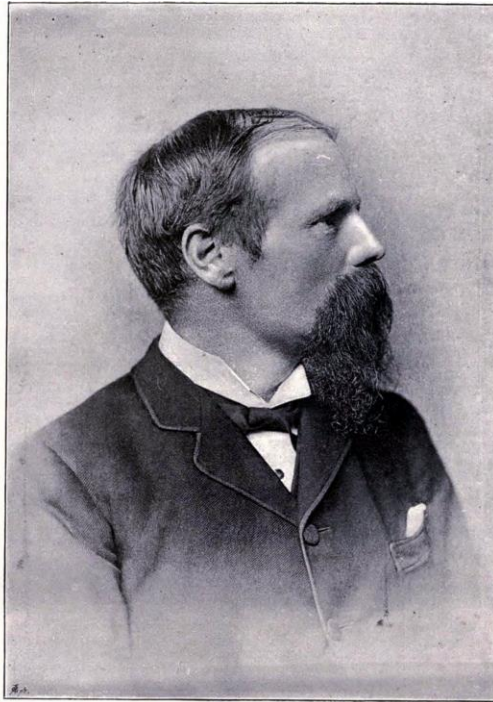
Forth Rail Bridge. Historical construction photo showing construction of a stone (granite) pier.



From a photograph by the London Stereoscopic Company.

**John
Fowler**

*Yours very truly
John Fowler*



From a photograph by Bassano.

**Benjamin
Baker**

*Yours faithfully
B. Baker*

Photos of Forth Rail Bridge designers John Fowler and Benjamin Baker.