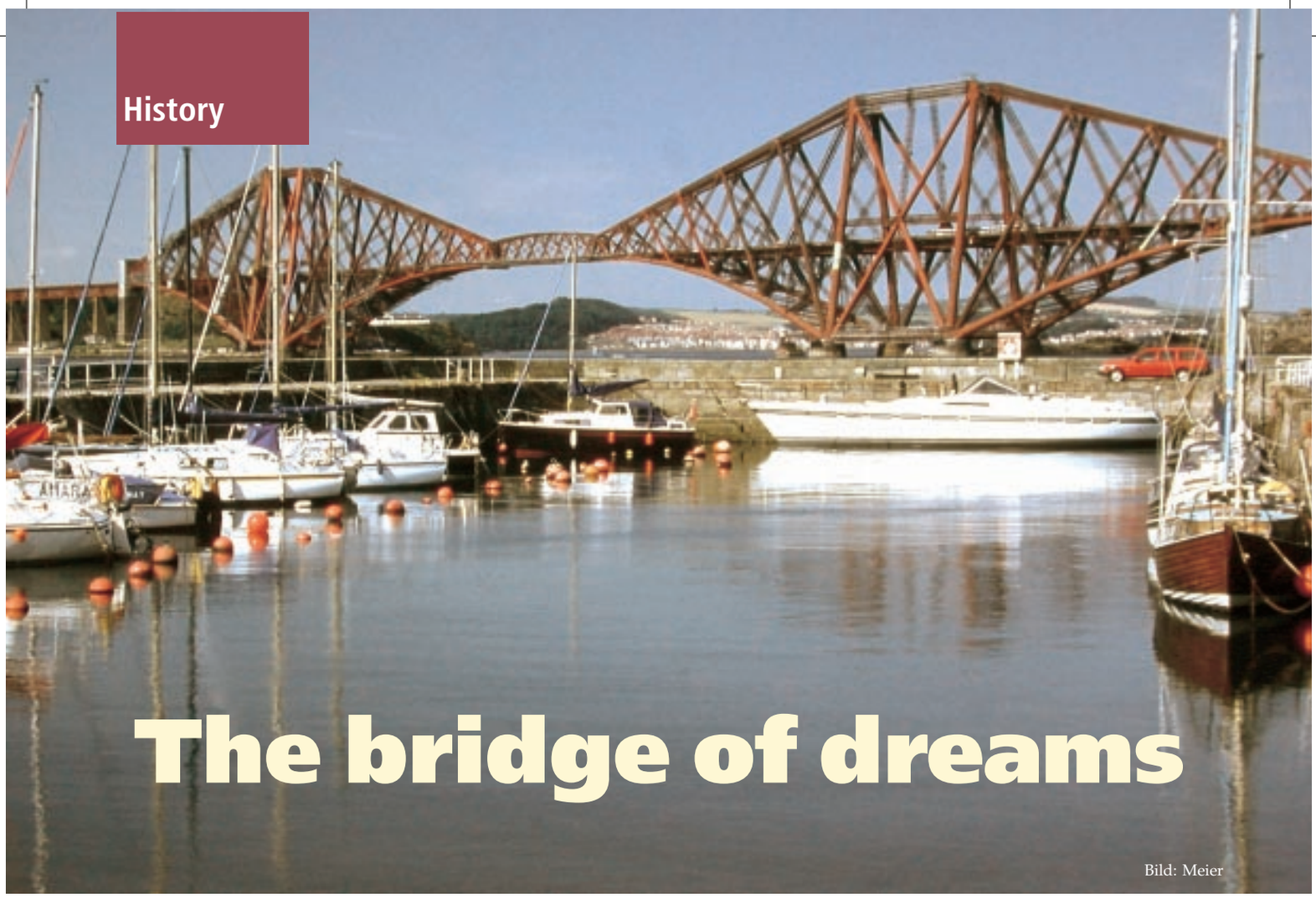


The bridge of dreams

Bild: Meier

The Forth Railway Bridge, finished in 1890, was the largest bridge of its time. Although heavily overdesigned, it is still one of the most impressive bridge structures in the world.

Die Eisenbahnbrücke über den Firth of Forth war eine der vielen Glanzleistungen viktorianischer Ingenieurskunst. Obwohl massiger und weniger bekannt als die nur ungleich längere Golden Gate Brücke, gehört sie dennoch zu den schönsten Brücken der Welt.

"Gain the *confidence* of the public and enjoy a reputation of being not only the biggest and strongest, but also the most stable bridge in the world." This was the main constructional *stipulation imposed* on the engineers John Fowler and Benjamin Baker when they were *commissioned* with the project to bridge the Firth of Forth northwest of Edinburgh, Scotland, for a railway line in 1880. Their *predecessor* Thomas Bouch, who built the Tay Bridge further north, was working on the foundations of a *suspension bridge* over the Forth when disaster struck. In 1879 the Tay Bridge collapsed during a *gale* and 75 people were killed. Following this, the Scottish public demanded a structure that could never fall down. And they got it.

John Fowler and Benjamin Baker came up with a perfect solution: a *cantilever bridge*. A pair of cantilever arms, or *beams* stick out from two main towers. These beams are supported by diagonal steel tubes *protruding* from the top and bottom of the towers. This design made the Firth of Forth Bridge one of the strongest and most expensive in the world.

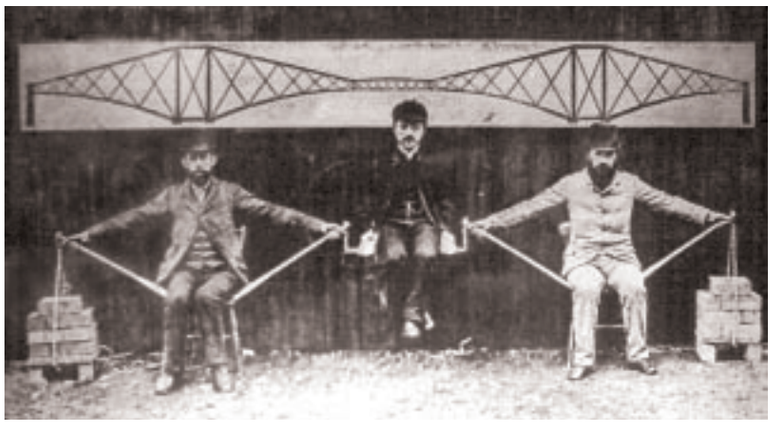
One reason for the high costs was the use of steel. The Forth Bridge was the first large railway structure in Europe to be built with this relatively new material. Steel was first used in ships from about 1850 but quality was poor due to the unreliable Bessemer process. Only five years *prior to* the signing of the contract for the construction of the Forth Bridge, the more reliable Siemens-Martin Open Hearth process had *evolved enabling* high quality steel to be manufactured in a relatively simple production process. All the steel for the Bridge, about 54 000 tons, was manufactured by this process.

The construction of the Forth Bridge fell, more or less, into two parts. The years 1882-1885 were *devoted* to sinking the *caissons* and building the foundations and piers which would support the *superstructure*. Then from about 1886 to 1890 the superstructure itself was constructed. This superstructure is only as stable as the group of four platforms at the

base of each cantilever tower. These platforms rest on underwater foundations - *wrought-iron* cylinders known as caissons. Filled with concrete, each caisson weighs between 4000 and 20000 tons.

Fullsize drawings were often made of the superstructure and wooden *templates* were used, similar to common practices in shipbuilding. First, the *skewbacks* were assembled, where all the vertical, horizontal and *inclined* members of the cantilever tower meet on the foundation. The cantilever towers, the main section of the bridge, rise 360 feet above the high-water line from these foundations.

agonising	qualvoll
anxiety	Besorgnis, Angst
beam	Träger
boom	Arm
caisson	Senkkasten
cantilever	Ausleger
cantilever bridge	Auslegerbrücke
commission sb, to	jdm einen Auftrag erteilen
confidence	Vertrauen
contemplate, to	über etwas nachdenken
delay	Verzögerung
devote, to	widmen
enable, to	ermöglichen
equilibrium	Gleichgewicht
evolve, to	entstehen
gale	Sturm
gap	Lücke, Spalte
girder	Träger
impose, to	auferlegen
inclined	geneigt
oblige, to	Entgegenkommen
precedent	Präzedenzfall
predecessor	Vorgänger
pretend, to	behaupten
prior to	vor
protrude, to	herausragen
rivet, to	nieten
skewback	Gewölbe-Widerlager, Halbpfeiler
stipulation	Bedingung
succeed, to	Erfolg haben, sich durchsetzen
superstructure	Überbau
suspension bridge	Hängebrücke
template	Schablone
tubular	rohrförmig
wrought-iron	Schmiedeeisen



The cantilever principle had to be demonstrated to give the public confidence in the design

These were constructed by *extending* the *tubular* members of the skewback. Cage-like *riveting* machines advanced up the tubes, which were being formed above them on a lifting platform. Prior to being taken aloft, each part had been tested, drilled for riveting and painted. Reaching outwards from the tower are the cantilever arms. To preserve *equilibrium*, the arms had to be built from opposite sides of each tower at the same time. The suspended *girders*, which link each completed cantilever tower and arms together, were constructed in a similar fashion. The working conditions were difficult and dangerous with a minimum of what we today would classify as safety equipment – 57 of the 4500 workers died during the 8 years of building the bridge.

The remaining procedure of closing the final *gap* at mid-span depended largely upon temperature. There was an *agonising delay* as the Scottish climate did not *oblige* with the correct temperature to allow the correct lining up of all the bolt holes. At last, on October 10th 1889, the lower *booms* closed and were joined.

During the opening of the bridge by the Prince of Wales on March 4th 1890 another famous engineer was present - Gustav Eiffel, who was probably *contemplating* the fact that the height of his recently finished tower was only about half the length of the main span of the new bridge. Engineer Benjamin Baker, who received a Knighthood for his work, later said about his most challenging project: "If I were to *pretend* that the building of the Forth Bridge has not been, and continues to be, a source of constant *anxiety*, no experienced engineer would believe me. Where there's no *precedent*, the engineer who best *succeeds* is the one who makes the fewest errors." ■

The bridge during construction showing the height of the cantilever towers

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Weitere Quellen sind **www.geocities.com/Colosseum/Bench/7918/cssq/fortha.html** und **www.pbs.org/wgbh/buildingbig/wonder/structure/firth_of_forth.html**