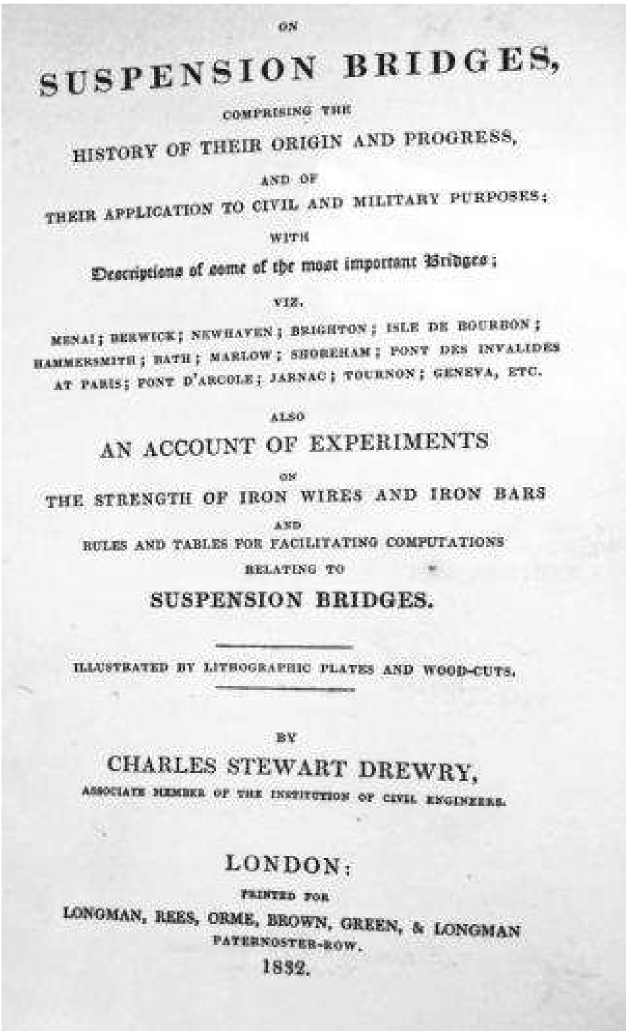
Drewry's description of Union Suspension Bridge, Berwick-upon-Tweed [1832]

The best contemporary sources of data on this project are the bridge itself, authentic archival and museum exhibits e.g. ICE Scotland Museum at HWU. Also see, Charles Stewart Drewry's [1805–1881; Associate Member of the ICE] *Memoir on Suspension Bridges* [London, 1832] who contributed significantly to early suspension bridge design and construction in the first English textbook on suspension bridges, in which much of the detailed information on Union Bridge was gleaned from leading civil engineer Robert Stevenson who was present at its opening on 26th July 1820 [see below].

Drewry assisted Samuel Brown in preparing plans for the Clifton Suspension Bridge and his Memoir included may case studies like Thomas Telford's Menai Suspension Bridge.and Capt. Samuel Brown's epoch-making world span increase at Union Bridge and the novel chain pier at Brighton leaping more than a1000 ft to sea in only four spans.


ON

SUSPENSION BRIDGES,

COMPRISING THE

HISTORY OF THEIR ORIGIN AND PROGRESS,

AND OF

THEIR APPLICATION TO CIVIL AND MILITARY PURPOSES;

WITH

Descriptions of some of the most important Bridges;

VIZ.

MENAI; BERWICK; NEWHAVEN; BRIGHTON; ISLE DE BOURBON; HAMMERSMITH; BATH; MARLOW; SHOREHAM; PONT DES INVALIDES AT PARIS; PONT D'ARCOLE; JARNAC; TOURNON; GENEVA, ETC.

ALSO

AN ACCOUNT OF EXPERIMENTS

ON

THE STRENGTH OF IRON WIRES AND IRON BARS

AND

RULES AND TABLES FOR FACILITATING COMPUTATIONS

RELATING TO

SUSPENSION BRIDGES.

ILLUSTRATED BY LITHOGRAPHIC PLATES AND WOOD-CUTS.

BY

CHARLES STEWART DREWRY,

ASSOCIATE MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS.

LONDON:

PRINTED FOR

LONGMAN, REES, ORME, BROWN, GREEN, & LONGMAN

PATERNOSTER-ROW.

1832.

TO

COMMANDER SAMUEL BROWN, R.N.

THIS WORK IS INSCRIBED

BY HIS OBLIGED FRIEND,

THE AUTHOR.

DESCRIPTION OF THE UNION SUSPENSION BRIDGE OVER THE TWEED.

(Plate II. Figures 1. to 6.)

59. The Union Bridge across the Tweed, five miles above Berwick, designed and executed by Captain S. Brown, R. N., was the first large bar chain bridge completed in this country.

It was begun in August, 1819, and opened in July, 1820, just after the commencement of the Menai Bridge.

The following description of it is taken from Mr. Stevenson's Account, published in the Edinburgh Philosophical Journal, No. X., and from the account given by Monsieur Navier, who examined it in 1821. The chord line, or distance between the points of suspension, is 449 feet; and the deflection about 30 feet.

The main chains are 12 in number, arranged in pairs, and placed in 3 ranges, one under the other, on each side of the bridge, about 1 foot 7 inches apart. Each link of the chains is a round rod, 2 inches diameter, and 15 feet long, of the best Welsh iron, formed into an eye at each end by welding. The long links are connected together by short open coupling links 6¾ long centre and centre, made of iron 1⅛ square, and united to the eyes of the long links by oval bolt pins 2½ by 2 inches, which pass through both; (see figs. 4. and 5., which are a plan and side view of one of the couplings.) The bolt pins have a head at one end, and are keyed at the other. The coupling joints of the main chains which support the vertical suspending rods, are arranged so that the vertical sus-

D 3

pending rods are fastened alternately to each row of chains; viz. the first to the lowest chain; the second to the chain next above; and the third to the upper chain. Hence the weight of the bridge is borne equally by all the chains, or is distributed equally over their whole length.

The main suspension pier on the Scotch side is a pillar of Aisler masonry. It is slightly pyramidal, and is 60 feet high, about 36 feet broad, and 17½ feet thick at its medium dimensions, according to Mr. Stevenson. The arched opening through it is 12 feet wide, and 17 feet high.

On the English side the suspension pier is built in an excavation of a rock of precipitous sandstone. Its height is about 20 feet; and it is of the same shape as the upper part of the opposite pier.

The chains pass through openings in the main pier on the Scotch side, one above the other, about 2 feet apart, and rest therein upon rollers laid in the masonry. The links of the chains are made very short at that part, that they may lie on the rollers without being bent.

From the points of suspension the chains pass down 24 feet into the ground, and through large iron holding plates, to which they are fastened by a strong oval bolt 3 inches by 3½.

The holding plates are 6 feet by 5 feet; 5 inches thick in the middle, and 2½ at the edges. They are kept down by large mound stones, and other materials piled up to the level of the road.

On the English side the chains lie also upon cast iron plates laid in the masonry. The extremities of the chains are fastened, as on the other side, to large holding plates of the same dimensions; but instead of being sunk deep in the ground, they are placed vertically rather above the level of the foundation of the pier, and they bear against a horizontal arch of masonry dovetailed into the rock.

60. The roadway (see fig. 6., which is a section of the platform,) is of deal; that part which is for the carriage road being covered with iron tracks.

It is 387 feet long (see figs. 1. and 2.), and 18 feet wide between the parapets.

The carriage-way in the middle is 12 feet wide, and the footpath on each side 3 feet wide.

The carriage-way is protected by cast iron guards, 4½ inches high, and is covered by iron straps, about ⅜ths of an inch thick, placed lengthwise on like a rail-road, in the track of the wheels, and crosswise in the track of the horses' feet.

The platform is borne by 2 iron side bars, or bearers, 3 inches deep by ⅝ths thick, extending all the length of the bridge, and supported by the vertical suspension rods.

On the side bearers are laid cross joists, 15 inches deep by 7 inches; and over these a course of 3 inch deal planking is laid, lengthwise, for the roadway.

The platform is curved a little upwards (viz. about 2 feet in the centre) from the horizontal line.

The vertical suspending rods are round iron, 1 inch in diameter. At the upper ends they spread out into a dovetail, which is wedged in a hole in a cast iron cap, or saddle, so that the suspending rod cannot draw out of it. (See fig. 5.)

The cast iron caps are of the form shown by figures 4. and 5. They rest upon the chains at the couplings, bearing on the ends of each pair of long links, and on the coupling bolts. The ends of the caps overlap these bolts a little, and the middle part of the cap descends between the ends of the long links, and keeps them apart.

The lower ends of the suspending rods are a little larger than the upper ends, and spread out into the shape of a fork, which clasps the iron side bar, and they are held by keys and keepers underneath. (See fig. 6.)

The vertical suspending rods are 5 feet apart.

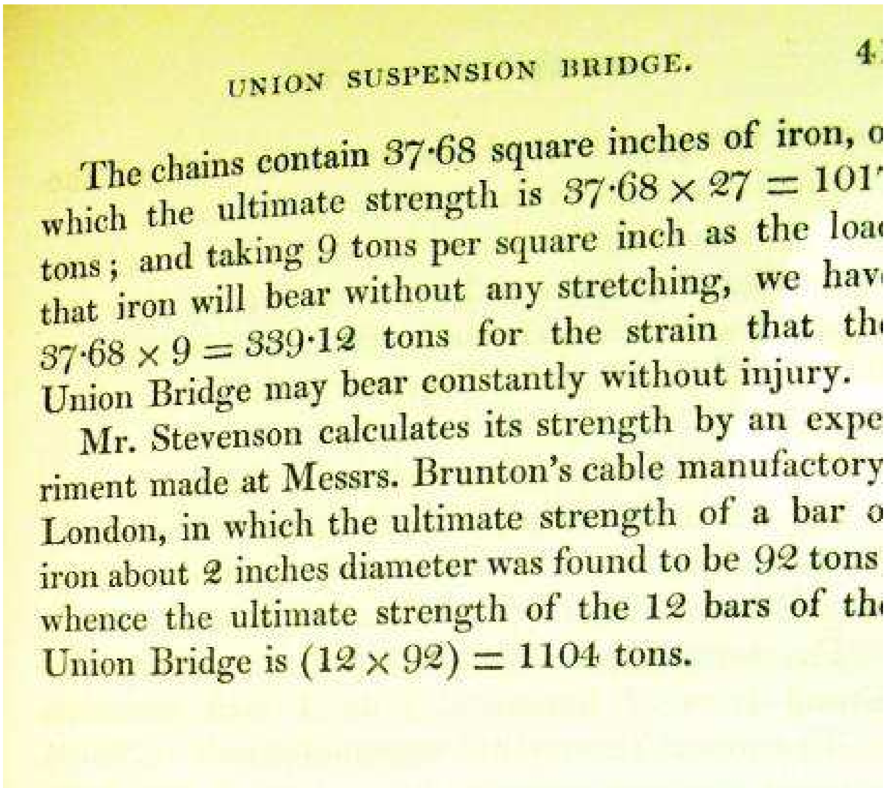
The 12 main chains, with the parts belonging to them, weigh about 5 tons each; and the whole weight suspended is estimated at 100 tons.

The parapets are 5 feet high; they are formed by several rows of horizontal rods, 1 inch diameter, which connect the vertical suspending rods together, and are fastened also to other vertical standards, placed one between each pair of vertical suspending rods.

The upper and lower rows of horizontal rods are flat iron, $1\frac{3}{4}$ by $\frac{1}{2}$ thick; the suspending rods pass through holes in the horizontal tie rods, and the latter pass through openings in the vertical standards between the suspending rods. Hence the suspending rods are tied to the parapet.

61. The Union Bridge was exposed to a severe trial at its very opening, but was not at all injured by it. The crowd of spectators broke through the toll-gates, and filled the bridge to the number, it is stated, of 700 people. Reckoning each person at 150lbs. weight, the whole was 47 tons: add 100 tons (the weight of the bridge), the whole weight supported by the chains was 147 tons.

The deflection of the chains is $\frac{449}{30} = \frac{1}{14 \cdot 96}$th, and the tension at the points of suspension for that deflection is $1 \cdot 923$ times the weight suspended, or $147 \times 1 \cdot 923 = 282\frac{1}{2}$ tons.



UNION SUSPENSION BRIDGE. 4

The chains contain 37·68 square inches of iron, o which the ultimate strength is 37·68 × 27 = 101 tons; and taking 9 tons per square inch as the loa that iron will bear without any stretching, we hav 37·68 × 9 = 339·12 tons for the strain that th Union Bridge may bear constantly without injury.

Mr. Stevenson calculates its strength by an expe riment made at Messrs. Brunton's cable manufactory London, in which the ultimate strength of a bar o iron about 2 inches diameter was found to be 92 tons whence the ultimate strength of the 12 bars of th Union Bridge is (12 × 92) = 1104 tons.

Drewry's plate based on Robert Stevenson CE''s *Edin Phil Jrnl* image of 1821 follows on p.8

In 2018, as a contribution to the bridge's restoration, for which HWU's Principal and Vice Chancellor had also provided a letter of support, ADROK/HWU EGIS conducted a joint complimentary radar investigation by atomic dielectric resonance which revealed the Scottish-side hidden iron anchor plates 7.3m below the roadway, much deeper than its owners then thought [see the web **Paxton Archive 31**, p.11 & **100**, p 30].

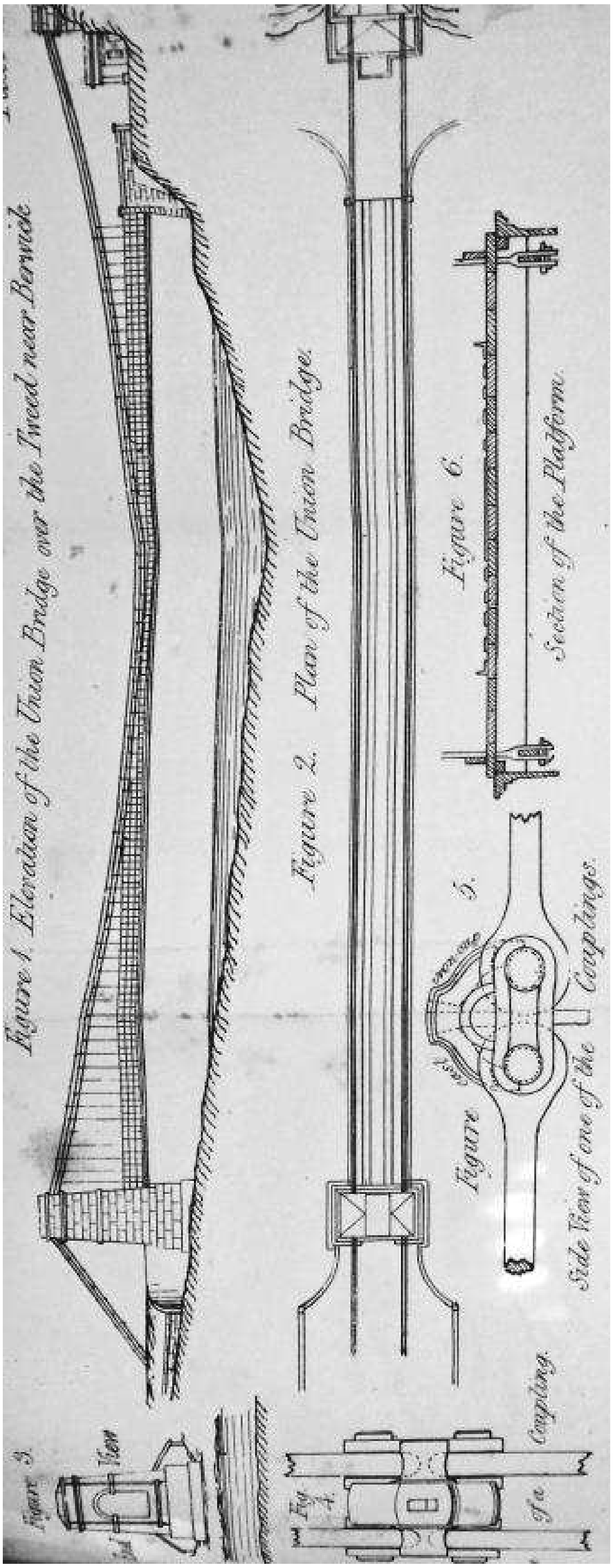
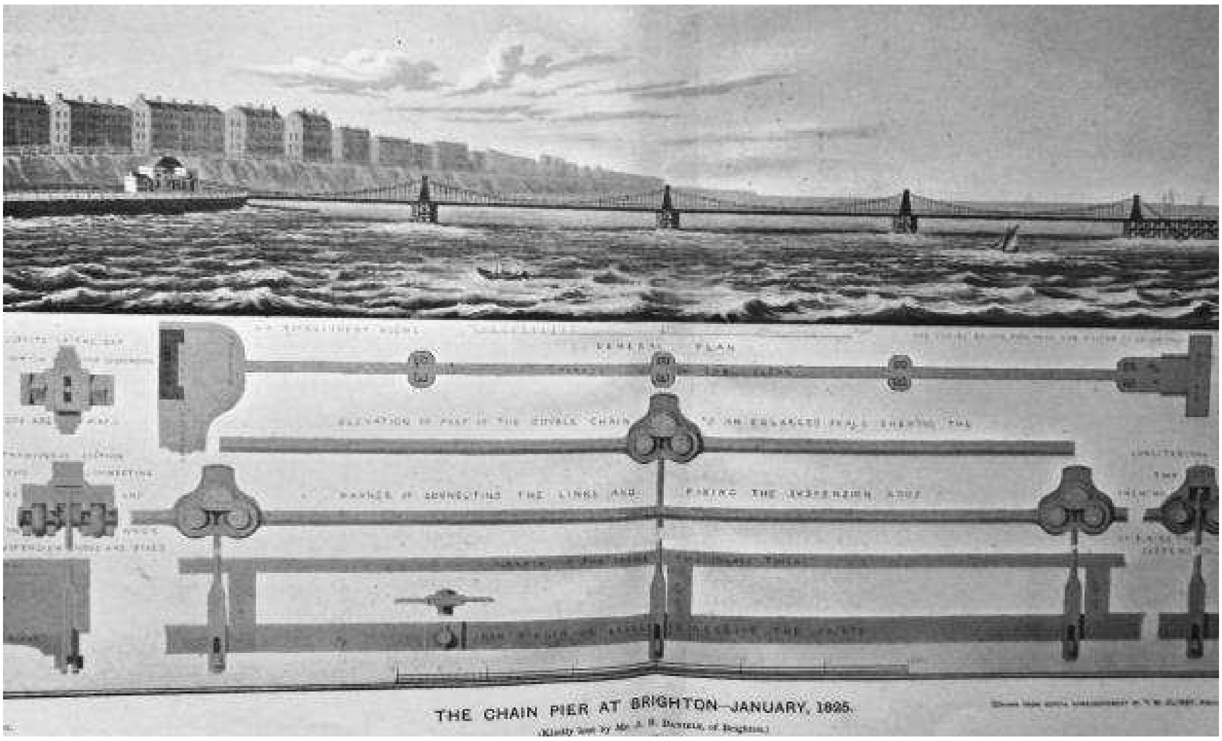
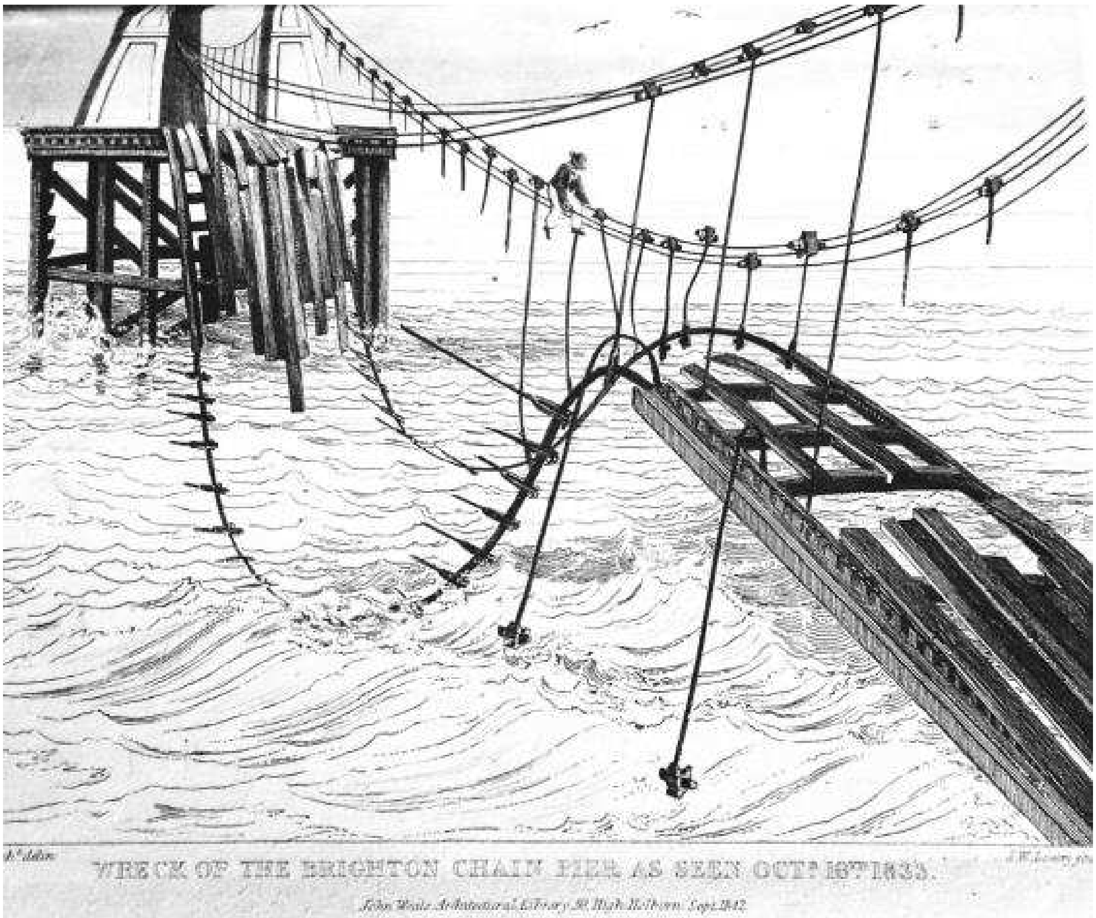
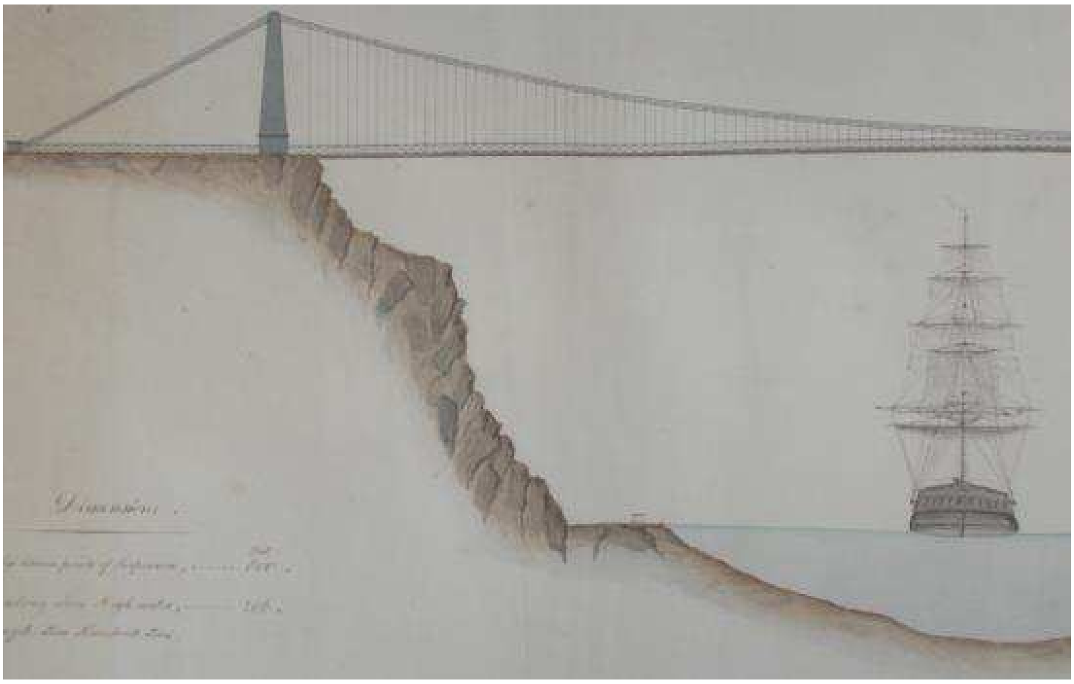


Figure 1. Elevation of the Union Bridge over the Tweed near Berwick
Figure 2. Plan of the Union Bridge.
Figure 6.
Section of the Platform.
Figure 5.
Side View of one of the Couplings.
Figure 3.
View
Fig. 4.
of a Coupling


GENERAL PLAN
THE CHAIN PIER AT BRIGHTON—JANUARY, 1825.


WRECK OF THE BRIGHTON CHAIN PIER AS SEEN OCT 15TH 1833.



Drewry's drawing of Capt. Brown's Clifton Bridge Proposal 1829 [runner-up to Brunel's in Competition]

142 DESIGNS FOR A BRIDGE AT CLIFTON.

158. The weight with which this bridge may be loaded, exclusively of its own weight, at the rate of 70 lbs. per square foot, will be about 700 tons. Total, therefore, 1116 + 700 = 1816 tons. With a deflection of $\frac{1}{10}$th, the tension at the extremities is 1·313 times the entire weight, or 1816 × 1·313 = 2384 tons for the greatest strain on the iron at the points of suspension. The section of iron is there 496 square inches, which will bear without injury 496 × 9 = 4464 tons, or 2080 tons more than the utmost strain in dead weight that it can be exposed to.

159. A very bold design was also proposed by Captain S. Brown. The dimensions of Captain Brown's bridge were to be, —

	Feet.
Span - - -	780
Height above high water	220
Breadth of platform -	30
Carriage-way - -	20
Two footpaths, each -	5

The estimated cost - - - 30,000*l.*

FINIS

Prof Roland Paxton HWU- EGIS 18th March 2025