

Cambridge University Press

978-1-108-07049-2 - The Principles of Bridges: Containing the Mathematical Demonstrations of the Properties of the Arches, the Thickness of the Piers, the Force of the Water Against them, &c.

Charles Hutton

Frontmatter

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The Principles of Bridges

Though raised in Newcastle's coal-mining community, Charles Hutton (1737–1823) went on to make his mark as a teacher and mathematician. A fellow of the Royal Society (and recipient of the Copley medal), he carried out research into the convergence of series, ballistics, and the density of the earth. After flooding destroyed several bridges across the Tyne in November 1771, he began to study the design of bridges, and published this mathematical treatment in 1772. It demonstrates the ideal properties of arches and piers, with due consideration given to the force of water flowing against these structures. Hutton's practical observations also enhance a section that provides definitions of relevant terms. Not merely a solution to the demands of transport and trade, a well-designed bridge, in Hutton's eyes, stands as a structure of elegance and beauty.

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T H E
P R I N C I P L E S
O F
B R I D G E S:

CONTAINING THE
MATHEMATICAL DEMONSTRATIONS

O F

The PROPERTIES of the ARCHES, the
THICKNESS of the PIERS, the FORCE
of the WATER againſt them, &c.

TOGETHER WITH

PRACTICAL OBSERVATIONS and DIRECTIONS
drawn from the whole.

By C H A. H U T T O N,
M A T H E M A T I C I A N.

N E W C A S T L E :

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P R E F A C E.

A Large and elegant bridge, forming a way over a broad and rapid river, is justly esteemed one of the noblest pieces of mechanism that man is capable of performing. And the usefulness of an art which, at the same time that it connects distant shores by a way over the deep and rapid waters, also allows those waters and their navigation to pass smooth and uninterrupted, renders all probable attempts to advance the theory or practice of it, highly deserving the encouragement of the public.

This little book is offered as an attempt towards the perfection of the theory of this art, in which the properties, dimensions, proportions, and other relations of the various parts of a bridge, are strictly demonstrated, and clearly illustrated by various examples. It is divided into five sections: the 1st treats on the projects of bridges, containing a regular detail of the various circumstances and considerations that are cognizable in such projects: The 2d treats on arches, demonstrating their various properties, with the relations between their intrados and extrados, and clearly distinguishes the most preferable curves to be used in a bridge; the first two or three propositions being instituted after the manner of two or three done by Mr. Emerson in his Fluxions and Mechanics: The 3d section treats on the piers, demonstrating their thickness necessary for supporting any kind of an arch, springing at any height, and that both when part of the pier is supposed to be immersed in water, and when otherwise: The 4th demonstrates the force of the water against the end or face of the pier, considered as of different forms; with the best form for dividing the stream, &c. and to it is added a table shewing the several heights of the fall of the water under the arches, arising from its velocity and the obstruction of the piers; as it was composed by Tho. Wright, Esq; of Auckland, in the county of Durham, who informs me it is part of a work on which he has spent much time, and with which he intends to favour the public: And the 5th and last section contains a dictionary of the most material terms peculiar to the subject;

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[More information](#)

iv

P R E F A C E.

in which many practical observations and directions are given, which could not be so regularly nor properly introduced into the former sections. The whole, it is presumed, containing full directions for constituting and adapting to one another, the several essential parts of a bridge, so as to make it the strongest, and the most convenient, both for the passage over and under it, that the situation and other circumstances will possibly admit: not indeed for the actual methods of disposing the stones, making of mortar, or the external ornaments, &c. those things I do not descend to, but leave to the discretion of the practical architect, as being no part of the plan of my undertaking; and for the same reason also I have given no views of bridges, but only prints of such parts or figures as are necessary in explaining the elementary parts of the subject.

As my profession is not that of an architect, very probably I should never have turned my thoughts to this subject, so as to address the public upon it, had it not been from the occasion of an accident in that part of the country in which I reside, viz. the fall of Newcastle and other bridges on the river Tyne on the 17th of november 1771, occasioned by a high flood which rose about 9 feet higher at Newcastle than the usual spring tides do.—And this occasion having furnished me with many opportunities of hearing and seeing very absurd things advanced on the subject in general, I thought the demonstrations of the relations of the essential parts of a bridge, would not be unacceptable to those architects and others who may be capable of perceiving the force of them, and whose ignorance may not have prejudiced them against things which they do not understand.

In the 4th section there is one thing forgotten to be remarked, viz. That in determining the best form of the end of the pier to be a right-lined triangle, the water was supposed to strike every part of it with the same velocity: had the variably increased velocity been used, the form of the ends would come out a little curved; but as the increase of the velocity in the best bridges is very small, the difference in them is quite imperceptible.

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