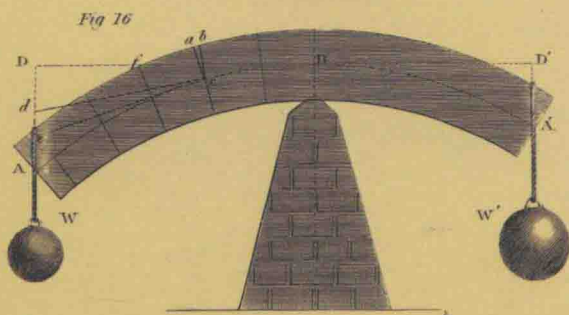
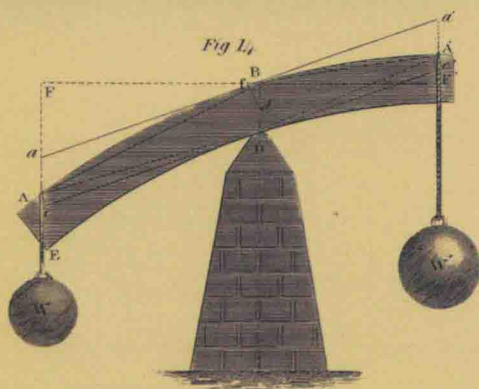


# PRACTICAL ESSAY ON THE STRENGTH OF CAST IRON AND OTHER METALS

VOLUME 1

THOMAS TREDGOLD  
EDITED BY EATON HODGKINSON



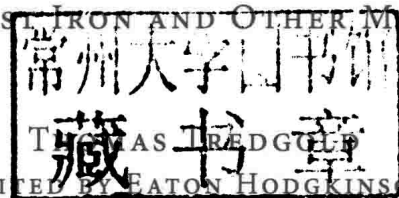
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# Practical Essay on the Strength of Cast Iron and Other Metals

*Containing Practical Rules, Tables, and Examples,  
Founded on a Series of Experiments,  
with an Extensive Table of the Properties of Materials*

VOLUME 1:

PRACTICAL ESSAY ON THE STRENGTH  
OF CAST IRON AND OTHER METALS



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### **Practical Essay on the Strength of Cast Iron and Other Metals**

Although cast iron was used in pagoda construction in ancient China, it was in Britain in the eighteenth century that new methods allowed for its production in quantities that enabled widespread use. An engineer who had educated himself tirelessly in technical subjects from carpentry to architecture, Thomas Tredgold (1788–1829) first published this work in 1822. It served as a standard textbook for British engineers in the early nineteenth century, and several translations extended its influence on the continent. Reissued here in the fourth edition of 1842, edited and annotated by the structural engineer Eaton Hodgkinson (1789–1861), who presents his own research in the second volume, this work addresses both practical and mathematical questions in assessing metallic strength. In Volume 1, wherever progress has been made since the original publication, Hodgkinson adds notes to Tredgold's original text, pointing out certain errors.

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AND OTHER METALS:

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PRACTICAL RULES, TABLES, AND EXAMPLES, FOUNDED ON A  
SERIES OF EXPERIMENTS;

WITH AN EXTENSIVE  
TABLE OF THE PROPERTIES OF MATERIALS.

BY THOMAS TREDGOLD,  
MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS,  
AUTHOR OF 'THE HISTORY OF THE STEAM ENGINE,' 'ELEMENTARY  
PRINCIPLES OF CARPENTRY,' &c., &c.

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THE FOURTH EDITION, WITH NOTES BY  
EATON HODGKINSON, F.R.S.

TO WHICH ARE ADDED

EXPERIMENTAL RESEARCHES  
ON THE  
STRENGTH AND OTHER PROPERTIES OF CAST IRON;  
WITH  
THE DEVELOPEMENT OF NEW PRINCIPLES; CALCULATIONS DEDUCED  
FROM THEM; AND INQUIRIES APPLICABLE TO RIGID AND  
TENACIOUS BODIES GENERALLY.

BY THE EDITOR.

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LONDON:  
JOHN WEALE, 59, HIGH HOLBORN.  
MDCCCLXII.



TO  
JAMES WALKER, ESQ.,

CIVIL ENGINEER,

FELLOW OF THE ROYAL SOCIETY,  
&c., &c., &c.,

PRESIDENT OF THE INSTITUTION OF CIVIL ENGINEERS,

*This Essay*

ON THE

STRENGTH OF CAST IRON AND OTHER METALS,

RE-EDITED, WITH NOTES, BY

EATON HODGKINSON, ESQ., F.R.S.,

IS INSCRIBED BY

THE PUBLISHER.





PART I.

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PRACTICAL ESSAY

ON

THE STRENGTH OF CAST IRON

AND OTHER METALS.

BY THOMAS TREDGOLD.



## ADVERTISEMENT TO THE FOURTH EDITION.

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IN giving a Fourth Edition of TREDGOLD'S 'ESSAY ON THE STRENGTH OF CAST IRON,' I have made no alteration in the text, but left it as it was in the last edition. The object of the very ingenious Author was to consider the resistances of bodies subjected to small forces, when compared with those necessary to break them; since with the action of small forces, the displacement of the fibres, or particles of bodies, is equal, from equal forces, whether they produce extension or compression. But conclusions drawn from such small strains, when applied to measure the ultimate strength of cast iron, are often much at variance with the results of experiment.

An instance or two may be mentioned: a cast iron beam, to sustain most efficiently a moderate strain, should have equal ribs at top and bottom; but to offer the greatest resistance to fracture, these ribs should be unequal in the proportion of seven to one, nearly; and by this form a great addition of strength is obtained.

Under small strains beams of any particular form offer the same resistance, whether they are turned their proper way up or the reverse; but I have shown that a cast iron beam may be constructed to resist fracture with four times as much force one way up as the opposite.

The line bounding the extended and compressed fibres of a bent beam, called the neutral line, is in the middle of a square beam subjected to a small strain; but in a cast iron beam of this form, the neutral line has, at the time of fracture, removed near to the compressed side, and the strength is considerably increased by the change.

These results, with respect to fracture, arise from the circumstance that cast iron resists fracture in crushing with many times the force that it does in tearing asunder; the mean being about seven times, nearly.

The preceding facts show an essential difference in the laws which regulate moderate and ultimate strains; and the latter will be considered in the Second Part of this Work.

The experiments from which Mr. TREDGOLD had to draw his conclusions, respecting the transverse strength of cast iron, had not been observed with sufficient accuracy to enable him to determine when the elasticity first became injured; and accordingly he concludes that beams

retain their elasticity unimpaired till nearly one-third of the breaking weight is laid on; but I have shown that beams, whose section is T, and which bear so much more one way up than the other, will retain a perceptible deflexion, and not recover their original form, after as little as  $\frac{1}{50}d$ , or even  $\frac{1}{80}$ th of the breaking weight is laid on. In other words, there is no elastic limit, a set taking place with the smallest flexure. From this cause, and others, Mr. TREDGOLD has drawn some erroneous conclusions, of which a few are pointed out in the Notes to the body of his Work.

In a material so much used as cast iron, it is of great consequence to the founder to know whence he can obtain the irons best suited for different purposes. The experiments of Mr. Fairbairn on the transverse strength of cast iron bars, of which I have given an abstract, contain, with a few experiments made by myself, examinations, similarly conducted, of most of the irons used in this country: they will be consulted with interest for the purpose above mentioned; and his experiments on bars loaded for an indefinite time show that cast iron may be trusted far beyond what has generally been conceived.

The strength of pillars is a subject on which there has confessedly been a great want of experimental information: I therefore recently undertook an extensive series of experiments upon pillars, comparing the results

with the theoretical conclusions of Euler and Lagrange upon the matter. With the reception by the Royal Society of the Paper containing these experiments, and still more with the honourable mark of distinction awarded to it, I have the fullest reason to be gratified; and I am indebted to the Council for the privilege of giving an abstract of it in this Work.

EDITOR.

## ADVERTISEMENT TO THE THIRD EDITION.

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PUBLIC approbation of 'THE PRACTICAL ESSAY ON THE STRENGTH OF CAST IRON, &c.' having made a new Edition necessary, it may be proper to state, that it is printed from a copy corrected by Mr. TREDGOLD's own hand, and to which nothing has been added; its progress through the press has been kindly superintended by the Author's friend, Professor Barlow, of Woolwich; its correctness cannot therefore be reasonably questioned.

The utility and importance of this Practical Essay have been acknowledged by the most unqualified approbation of the scientific of all countries, and it has accordingly been printed in the French, Italian, and Dutch languages. To the clear and practical demonstrations set forth in this Work, of the superiority of iron for supports, as well perpendicular as horizontal, may be attributed the present almost universal adoption of this material in buildings, as a substitute for wood; and, in reference to this particular subject, the Author was frequently consulted by the most eminent Architects and Engineers. His many other valuable works, of which a list is subjoined, more particularly the 'History of the Steam Engine,' have also experienced a similar liberal patronage both at home and abroad; and it is not, we think, presuming too much to say, that these Works have had an important influence in promoting the present advanced state of mechanical and scientific knowledge,—and to this honour the Author ardently aspired, as he considered it of the highest value.

Of Mr. Tredgold it may be stated, that from his earliest



years his mind was ever occupied by the most intense desire for information. Being altogether *self-taught*, it will not be difficult to form some idea of the great labour and fatigue which he must have necessarily undergone, in the acquirement of that correct and extensive knowledge of the various sciences of which he has so ably treated; and in his high attainments in mathematical demonstration, which he has so ingeniously and successfully applied in the many useful investigations exhibited in his Works.

To such ardent and unremitted application, the naturally feeble constitution of Mr. TREDGOLD eventually gave way, and after a protracted series of suffering terminated in his death on the 28th of January, 1829, in the 41st year of his age,—to the great loss of the public at large, and which an amiable wife and young family have seriously to deplore;<sup>1</sup> whose slender circumstances call

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<sup>1</sup> The widow lived but a short time after the death of her husband, leaving three daughters and a son on the scanty subsistence afforded by a subscription set on foot by some benevolent Members of the Profession of Civil Engineering and Architecture: subsequently the two elder daughters died. The son is now articled to Mr. Bryan Donkin, of Rotherhithe, and the only daughter is living under the protection of Mrs. Urquhart, her aunt, who is herself in straitened circumstances from the recent loss of her husband, on whom she wholly depended for support. At no time nor in any place can it be improper, in the cause of humanity, to mention the fact that Mrs. Urquhart, as a measure of relief from the heavy burden upon her hand, is now endeavouring to procure a presentation for one of her children to Christ's Hospital. Besides the strong claim before referred to, she has the following certificate from Dr. Reid, who testifies to her respectability and merit:

“ I hereby certify that the late John Urquhart, who attended to the Warming and Ventilating of the present Houses of Parliament under my direction, conducted himself with the greatest propriety, steadiness, and attention to all the duties intrusted to