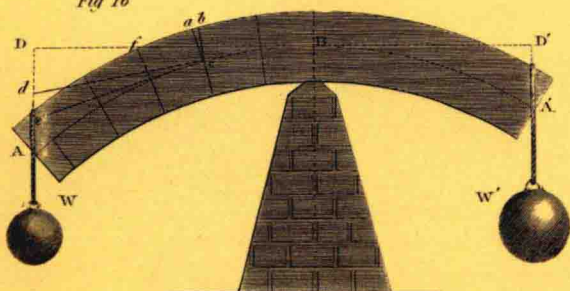


PRACTICAL ESSAY ON THE STRENGTH OF CAST IRON AND OTHER METALS

LATON HODGKINSON



CAMBRIDGE

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 2:

EXPERIMENTAL RESEARCHES ON THE STRENGTH
AND OTHER PROPERTIES OF CAST IRON



CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS

University Printing House, Cambridge, CB2 8BS, United Kingdom

Cambridge University Press is part of the University of Cambridge.
It furthers the University's mission by disseminating knowledge in the pursuit of
education, learning and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9781108070355

© in this compilation Cambridge University Press 2014

This edition first published 1846

This digitally printed version 2014

ISBN 978-1-108-07035-5 Paperback

This book reproduces the text of the original edition. The content and language reflect
the beliefs, practices and terminology of their time, and have not been updated.

Cambridge University Press wishes to make clear that the book, unless originally published
by Cambridge, is not being republished by, in association or collaboration with,
or with the endorsement or approval of, the original publisher or its successors in title.

CAMBRIDGE LIBRARY COLLECTION

Books of enduring scholarly value

Technology

The focus of this series is engineering, broadly construed. It covers technological innovation from a range of periods and cultures, but centres on the technological achievements of the industrial era in the West, particularly in the nineteenth century, as understood by their contemporaries. Infrastructure is one major focus, covering the building of railways and canals, bridges and tunnels, land drainage, the laying of submarine cables, and the construction of docks and lighthouses. Other key topics include developments in industrial and manufacturing fields such as mining technology, the production of iron and steel, the use of steam power, and chemical processes such as photography and textile dyes.

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 2, benefiting from twenty years of progress since Tredgold's original publication, Hodgkinson provides details of his own advanced experiments.

Cambridge University Press has long been a pioneer in the reissuing of out-of-print titles from its own backlist, producing digital reprints of books that are still sought after by scholars and students but could not be reprinted economically using traditional technology. The Cambridge Library Collection extends this activity to a wider range of books which are still of importance to researchers and professionals, either for the source material they contain, or as landmarks in the history of their academic discipline.

Drawing from the world-renowned collections in the Cambridge University Library and other partner libraries, and guided by the advice of experts in each subject area, Cambridge University Press is using state-of-the-art scanning machines in its own Printing House to capture the content of each book selected for inclusion. The files are processed to give a consistently clear, crisp image, and the books finished to the high quality standard for which the Press is recognised around the world. The latest print-on-demand technology ensures that the books will remain available indefinitely, and that orders for single or multiple copies can quickly be supplied.

The Cambridge Library Collection brings back to life books of enduring scholarly value (including out-of-copyright works originally issued by other publishers) across a wide range of disciplines in the humanities and social sciences and in science and technology.

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 EATON HODGKINSON, F.R.S.

WITH PLATES AND DIAGRAMS.

London:
JOHN WEALE, 59, HIGH HOLBORN.

M.DCCC.XLVI.



PART II.

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 EATON HODGKINSON, F.R.S.

CONTENTS OF PART II.

	PAGE
INTRODUCTION. Art. 1	307
Tensile Strength of Cast Iron. Art. 2-13	308
Strength of Cast Iron and other Materials to resist Com- pression. Art. 14, 15.	315
Resistance of short Masses to a crushing Force. Art. 16-34	<i>ib.</i>
Strength of long Pillars. Art. 35-44	328
Strength of short flexible Pillars. Art. 45-60	337
Comparative Strength of long similar Pillars. Art. 61-68 .	345
On the Strength of Pillars of various Forms, and different Modes of fixing. Art. 69-73	349
Comparative Strengths of long Pillars of Cast Iron, Wrought Iron, Steel, and Timber. Art. 74	351
Power of Pillars to sustain long-continued Pressure. Art. 75	<i>ib.</i>
Euler's Theory of the Strength of Pillars. Art. 76-78 . .	352
Results of Experiments on the Resistance of solid uniform Cylinders of Cast Iron to a Force of Compression :	
Table I. Solid Columns with rounded Ends . . .	354
Table II. Solid Columns with flat Ends	359

	PAGE
Table III. Hollow cylindrical Pillars, rounded at the Ends	365
Table IV. Hollow Pillars with flat Ends	370
Transverse Strength. Art. 79	373
Long-continued Pressure upon Bars or Beams. Art. 80	<i>ib.</i>
Table of Experiments by W. Fairbairn, Esq., on the Strength of Bars to resist long-continued Pressure. Art. 81	375
Observations on these Experiments. Art. 82, 83	376
Effects of Temperature on the Strength of Cast Iron. Art. 84, 85	377
On the Strength of Cast Iron Bars or Beams under ordinary circumstances,—the Time when the Elasticity becomes impaired,—and the erroneous Conclusions that have been derived from a Mistake as to that Time. Art. 86–91	378
Experiments to determine the Transverse Strength of uni- form Bars of Cast Iron. Art. 92	386
Table of Experiments by W. Fairbairn, Esq., on the Strength of uniform rectangular Bars of Cast Iron. Art. 93 :	
English Irons	389–392
Scotch Irons	393
Welsh Irons	394–396
Welsh Anthracite Irons	397
Table of Mean Results of Experiments by the Author on the Transverse Strength and Elasticity of uniform Bars of Cast Iron, of different Forms of Section. Art. 94 :	
Rectangular Bars of English Iron	398
————— Scotch Iron	399
Bars of Scotch Iron (Carron)	400

	PAGE
Remarks on the preceding Experiments. Art. 95 . . .	401
Table of Abstract of Results obtained from the whole of the Experiments, both of Mr. Fairbairn and the Author . .	404
Defect of Elasticity. Art. 99-107	407
Of the Section of greatest Strength in Cast Iron Beams. Art. 108-126	411
Experiments to ascertain the best Forms of Cast Iron Beams, and the Strength of such Beams. Art. 127-134 .	420
Tabulated Results of the preceding Experiments :	
Table I. Art. 135	424
Table II. Art. 136	432
Table III. Results of Experiments upon Beams of the usual Form. Art. 137	436
Remarks upon the Experiments in Table I. Art. 138-141	438
Remarks on Table II. Art. 142, 143	443
Simple Rule for the Strength of Beams. Art. 144-146 .	444
Another approximate Rule. Art. 147-152	446
Experiments on large Beams. Art. 153	454
Experiments on Beams of different Forms. Art. 154-159 .	456
Mr. F. Bramah's Experiments on Beams. Art. 160, 161 .	461
Table of Mr. Bramah's Experiments upon solid Cast Iron Beams. Art. 162	462
Table of Experiments on Beams differing in Section from the former only in having a Portion taken away from the Middle. Art. 163	463
Remarks on Mr. Bramah's Experiments. Art. 164 . . .	464
Mr. Cubitt's Experiments on Beams. Arts. 165-167 . .	ib.
Table to Mr. Cubitt's Experiments	466
Remarks on Mr. Cubitt's Experiments. Art. 168-179 . .	470

	PAGE
Comparative Strength of Hot and Cold Blast Iron. Art.	
180-183	474
Tables of Experiments on Scotch Iron	478, 479
General Summary of Transverse Strengths, and computed	
Powers to resist Impact. Art. 184-188	480
Theoretical Inquiries with regard to the Strength of Beams.	
Art. 189-194	483
On Resistance to Torsion. Art. 195-199	495
Experiments by Geo. Rennie, Esq., on the Strength of Bars	
of Cast Iron to resist Fracture by Torsion. Art. 200, 201	497
Remarks on the Experiments of Messrs. Rennie, Bramah,	
Dunlop, Bevan, Cauchy, and Savant. Art. 202-215 . .	498

on most of the subjects connected with the strength of materials. Mr. Fairbairn has likewise published the results of a great number of well-conducted experiments upon the transverse strength of bars of cast iron. An abstract, therefore, of the leading experiments made at Mr. Fairbairn's Works, and of those given by Navier, Rennie, Bramah, and others, with theoretical considerations, is all that can be attempted in this Additional Part; pointing out, as I proceed, whatever has a bearing upon the conclusions of Tredgold in the body of the Work.

TENSILE STRENGTH OF CAST IRON.

2. To determine the direct tensile strength of cast iron, I had models made of the form in Plate I. fig. 1.

The castings from these models were very strong at the ends, in order that they might be perfectly rigid there, and had their transverse section, for about a foot in the middle, of the form in fig. 2. This part, which was weaker than the ends, was intended to be torn asunder by a force acting perpendicularly through its centre. The ends of the castings had eyes made through them, with a part more prominent than the rest in the middle of the casting, where the eye passed through; fig. 3 represents a section of the eye. The intention of this was that bolts passing through the eyes, and having shackles attached to them, by which to tear

the casting asunder, would rest upon this prominent part in the middle, and therefore upon a point passing in a direct line through the axis of the casting. Several of the castings were torn asunder by the machine for testing iron cables, belonging to the Corporation of Liverpool; the results from these are marked with an asterisk. Others were made in the same manner, but of smaller transverse area; these were broken by means of Mr. Fairbairn's lever (Plate II. fig. 40), which was adapted so as to be well suited for the purpose.

The form of casting here used was chosen to obviate the objections made by Mr. Tredgold (art. 79 and 80) and others against the conclusions of former experimenters. The results are as follow :

3. Results of Experiments on the Tensile Strength of Cast Iron.

Description of iron.	Area of section in inches.	Breaking weight in lbs.	Strength per sq. in. of section.	Mean in lbs. per square inch.
Carron iron, No. 2, hot blast	4·031	56,000	13,892*	13,505 = 6 0½
Do. do. do.	1·7236	22,395	12,993	
Do. do. do.	1·7037	23,219	13,629	
Carron iron, No. 2, cold blast	1·7091	28,667	16,772	16,683 = 7 9
Do. do. do.	1·6331	27,099	16,594	
Carron iron, No. 3, hot blast	1·7023	28,667	16,840	17,755 = 7 18½
Do. do. do.	1·6613	31,019	18,671	
Carron iron, No. 3, cold blast	1·6232	22,699	13,984	14,200 = 6 7
Do. do. do.	1·6677	24,043	14,417	
Devon (Scotland) iron, No. 3, } hot blast }	4·269	93,520	21,907*	21,907 = 9 15½
Buffery iron, No. 1, hot blast	3·835	51,520	13,434*	13,434 = 6 0
Buffery iron, No. 1, cold blast	4·104	71,680	17,466*	17,466 = 7 16
Coed-Talon (North Wales) } iron, No. 2, hot blast . . }	1·586	25,818	16,279	16,676 = 7 9
Do. do. do.	1·645	28,086	17,074	
Coed-Talon (North Wales) } iron, No. 2, cold blast . . }	1·535	30,102	19,610	18,855 = 8 8
Do. do. do.	1·568	28,380	18,100	
Low Moor iron (Yorkshire), } No. 3, from 5 experiments }	1·540	22,385	14,535	14,535 = 6 10
Mixture of iron,—4 experi- } ments further on (art. 7.) }				16,542 = 7 7½
Mean from the whole				16,505 = 7 7½

4. The preceding Table, excepting the two last lines, is extracted from my Report on the strength and other properties of cast iron obtained by hot and cold blast, in vol. vi. of the British Association.

5. In the second volume published by the Asso-

ciation, there are given the results of a few experiments, which I made to determine the tensile strength of cast iron of the following mixture: Blaina No. 2 (Welsh), Blaina No. 3, and W. S. S., No. 3 (Shropshire), each in equal portions.¹

6. In these experiments the intention was to determine, first, the direct tensile strength of a rectangular mass, when drawn through its axis, and next the strength of such a mass, when the force was in the direction of its side. The castings for the experiments on the central strain were of the form previously described; and in the others the force was exactly along the side. The experiments were made by means of the Liverpool testing machine.

7. Force up the middle.

Experiments.	Area of section in parts of an inch.	Breaking weight in tons.	Strength per square inch.
1	3·012	22·5	7·47
2	2·97	21·0	7·07
3	3·031	25·5	8·41
4	2·95	19·5	6·59 different quality of iron.

tons.
mean 7·65 = 17136 lbs.

¹ This mixture of iron is the same as I had employed in some experiments on the strength and best forms of cast iron beams, (Memoirs of the Literary and Philosophical Society of Manchester, vol. v., second Series,) of which an account will be given further on.