

**STRENGTH AND DETERMINATION  
OF THE DIMENSIONS OF  
STRUCTURES OF IRON AND STEEL  
WITH REFERENCE TO THE LATEST  
INVESTIGATIONS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649714537

Strength and Determination of the Dimensions of Structures of Iron and Steel with Reference to the Latest Investigations by Jakob J. Weyrauch & Jay Du Bois & Robert H. Thurston

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**JAKOB J. WEYRAUCH & JAY DU BOIS & ROBERT H. THURSTON**

**STRENGTH AND DETERMINATION  
OF THE DIMENSIONS OF  
STRUCTURES OF IRON AND STEEL  
WITH REFERENCE TO THE LATEST  
INVESTIGATIONS**



STRENGTH AND DETERMINATION  
OF THE  
DIMENSIONS  
OF  
STRUCTURES OF IRON AND STEEL

WITH  
REFERENCE TO THE LATEST INVESTIGATIONS.

*AN ELEMENTARY APPENDIX TO ALL TEXT-BOOKS  
UPON IRON AND STEEL CONSTRUCTION.*

BY  
DR. PHIL. JACOB J. WEYRAUCH,  
*Professor in the Polytechnic School at Stuttgart.*

WITH FOUR LITHOGRAPHED PLATES.

TRANSLATED BY  
A. JAY DU BOIS, PH.D.,  
*Higgins Professor of Dynamic Engineering in Sheffield Scientific School of Yale College.*

WITH AN APPENDIX

BY  
ROBERT H. THURSTON, A.M.,  
*Professor of Mechanical Engineering and Director of Sibley College, Cornell University.*

THIRD EDITION.

NEW YORK:  
JOHN WILEY & SONS, PUBLISHERS,  
53 EAST TENTH STREET.  
1891.

COPYRIGHT, 1877.  
JOHN WILEY & SONS.

22648

6276881

SP

W54

S

# CONTENTS.

## PART I.

### GENERAL PROPERTIES. DETERMINATION OF DIMENSIONS.

CHAP.	PAGE
INTRODUCTION, . . . . .	I
1. Wohler's Law, . . . . .	4
2. Remarks upon Wohler's Law, . . . . .	8
3. Launhardt's Formula, . . . . .	11
4. Formula for Alternate Tension and Compression, . . . . .	15
5. Carrying Strength for Tension and Compression, . . . . .	18
6. Transgression of Elastic Limits, . . . . .	23
7. Mechanical Treatment, Annealing, Tempering, . . . . .	28
8. Influence of Form, . . . . .	32
9. Carbon, Various Constituents, . . . . .	35
10. Influence of Temperature, . . . . .	43
11. Some further Facts, . . . . .	52
12. Estimation of Material, . . . . .	55
13. Allowable Stress per Square Centimetre, . . . . .	60
A. Wrought Iron, . . . . .	60
B. Steel, . . . . .	63
C. Remarks, . . . . .	65
14. Explanation of the Method of Dimensioning, . . . . .	69
A. Framed Girders of all kinds. Example, . . . . .	69
B. Simple Plate Girder. Example, . . . . .	71
C. Continuous Girder. Example, . . . . .	74

15 Pa 100

22148

## PART II.

SHEARING STRENGTH. RIVET CONNECTIONS.		PAGE
CHAP.		
	INTRODUCTION, . . . . .	79
15.	Carrying Strength for Shear, . . . . .	81
16.	Strength and Allowable Stress for Shear in General, . . . . .	85
	A. Wrought Iron, . . . . .	86
	B. Steel, . . . . .	87
	C. Remarks, . . . . .	87
17.	Vertical Plate in Plate Girders. Example, . . . . .	89
18.	Methods of Riveting, . . . . .	93
19.	Elasticity Ratios, . . . . .	99
20.	Total Cross-Section and Number of Rivets. Example, . . . . .	103
21.	Indirect Force Transference, . . . . .	108
22.	Grouping of Rivets in Piece Connections. Example, . . . . .	111
23.	Riveting of Entire Plates, . . . . .	116
24.	Rivet Spacing in Plate Girders. Example, . . . . .	121
25.	Flange Riveting in Trussed Girders. Example, . . . . .	127
26.	Rivet Spacing for Lattice Girder with Stay Plates. Example, . . . . .	134
27.	Contact Connections, . . . . .	138

## APPENDIX A.

BY THE AUTHOR.

28.	The Methods of Gerber, Müller, Schäffer, . . . . .	143
29.	Remarks upon Existing Methods, . . . . .	152
30.	Comparison, . . . . .	159

## APPENDIX B.

BY PROF. R. H. THURSTON.

AUTOGRAPHIC RECORDS OF THE STRENGTH AND OTHER PROPERTIES OF		
MATERIALS, . . . . .		163
On the Strength, Elasticity, Ductility, and Resilience of Materials of	Machine Construction, . . . . .	167
The Strength and Other Properties of Materials of Construction,		179
Note on the Resistance of Materials, . . . . .		188
American Society of Civil Engineers—Discussion on Flexure of Beams,		199



The present English translation of my "Fertigkeit  
und Discretionenbroschüre" has been kindly made by Prof.  
Dr. Bois at my special request, and by the courtesy of the  
Publishers I receive a liberal copyright therefore. No  
other English translation has been or will be authorized  
by me.

St. Louis, N. March 27. *Frank J. Wenpenny*

#### AUTHOR'S PREFACE TO THE AMERICAN EDITION.

---

THE methods of calculation of the forces which act upon the various members of our bridges and other structures have, within the last ten years, owing to the united labor of European and American engineers, gained most remarkably in clearness and reliability. These advances can, however, attain their greatest value, only when the question as to what forces these members can sustain with the desired degree of security is satisfactorily disposed of.

That the method of dimensioning thus far in use is an entirely arbitrary one, cannot be denied. In spite of numerous attacks no defence of it has ever been heard. What has for the last hundred years justified the assumption that a piece which has once successfully resisted a certain stress, must necessarily resist equally well an indefinite number of repetitions of that stress? How can it be held that it is a matter of indifference whether a piece is subjected always to the same constant load, or is alternately loaded and then unloaded, or is even subjected to alternate strains of tension and compression? Every layman knows that he can more readily break a piece by bending to and fro than by a steady pull, even though the force exerted in each case be the same.

By assuming the strength, which is *not* constant, as nevertheless constant for every member of a construction, the degree of safety of the different members varies. The least safety of any place in the structure is, however, the measure of the security of the whole. If one member gives way, it is a matter of little moment whether, in falling, the other members hang together or not, and the structure comes to the ground in two or more pieces.

AUTHOR'S PREFACE TO THE AMERICAN EDITION.

The admirable investigations made during the last eighteen years at the instance of the Prussian Government, have led to results in complete accord with practical sense. The method by which, even before the publication of these results, in the construction of the bridge over the Rhine at Mayence, the strength of the web members was estimated, appears to have been, in all its essentials, correct. The most important result of the investigations alluded to, however, is "Wöhler's law;" a principle which is, indeed, self-evident, and upon which, in future, every rational method of dimensioning must be based. Immediately after the publication of Wöhler's investigations, the results of which were further confirmed by Spangenberg, new methods of dimensioning were proposed in Germany and Austria. These methods are reviewed and criticised in the Appendix to the present work. These proposed methods are, all of them, not sufficiently developed, and are all, moreover, too closely fitted to the *numerical* results of Wöhler.

The present little work gives a systematic presentation of a new method of dimensioning, based upon two formulæ deduced by Professor Launhardt and by the Author, respectively. It will be noticed that this method, which leaves as to simplicity nothing to be desired, gives considerable economy of material as well as increased security, while the ordinary methods of statical calculation, in general use, remain unaffected by it.

As the resistance of riveted constructions depends directly upon the quality of the rivet connections, I have given special attention to this hitherto somewhat neglected subject. Without denying the numerous advantages of bolt connections, European engineers use rivets even in frame work, almost exclusively.

In order to make the work serviceable to the practical engineer, I have subjected the numerous experiments upon the strength properties of Iron and Steel recently made in various countries to careful comparison and scrutiny, and