

**A TREATISE ON THE RESISTANCE
OF MATERIALS: AND AN
APPENDIX ON THE
PRESERVATION OF TIMBER, PP. 1-
243**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649068081

A Treatise on the Resistance of Materials: And an Appendix on the Preservation of Timber, pp. 1-243 by De Volson Wood

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

DE VOLSON WOOD

**A TREATISE ON THE RESISTANCE
OF MATERIALS: AND AN
APPENDIX ON THE
PRESERVATION OF
TIMBER, PP. 1-243**

A TREATISE
ON THE
RESISTANCE OF MATERIALS,
And an Appendix
ON THE
PRESERVATION OF TIMBER.

BY
DE VOLSON WOOD,

PROFESSOR OF CIVIL ENGINEERING IN THE UNIVERSITY OF MICHIGAN.

NEW YORK:
JOHN WILEY & SON,
15 ASTOR PLACE.
1871.

Entered according to Act of Congress, in the year 1871,
By JOHN WILEY & SON,
In the Office of the Librarian of Congress, at Washington.

PREFACE.

THIS book contains the substance of my lectures to the Senior Class in Civil Engineering, in the University, during the past few years, on the *Resistance of Materials*. The chief aim has been to present the theories as they exist at the present time. The subject is necessarily an experimental one, and any theory which has not the results of experiments for its foundation is valueless. I have therefore presented the results of a few experiments under each head, as they have been obtained in various parts of the world, that the student may judge for himself whether the theory is well founded or not. It is hoped that this part of the work will be valuable to the practical man.

The descriptive parts are given more fully here than they were in the lectures, because they can be consulted more profitably on the printed page than they could in the manuscript, and will be examined more by the general reader than the mathematical part. But, on the other hand, the mathematical part is much more condensed here than it was in the class-room. This was done so as to keep the work in as small a space as possible; and also because a student is supposed to have time for deliberate study, and can take time to overcome his difficulties and secure his results. It is intended, however, in the next edition, to publish an appendix, in order to explain the more difficult mathematical operations of the text.

I have taken special pains to make frequent references to other books and reports from which I have secured information. This will enable any one to verify more fully the positions which have been taken, and will be convenient for those who desire to secure a more thorough knowledge of any particular topic.

I do not deem it necessary to indicate those topics which are wholly original. To the reader who has never before given the subject any attention, all will be new; and the well-informed reader will readily detect what is original.

A large amount of labor and study has been given to this subject in nearly all civilized countries, and yet the theories in regard to resistance from transverse stress are not very satisfactory. In regard to the strength of rectangular beams, the "Common Theory," as I

have called it, is sufficiently correct for ordinary practical purposes, especially if the *modulus of rupture*, as determined by direct experiment upon rectangular beams of the same material, be used. Barlow's "Theory of Flexure" appears to be more nearly correct in theory when applied to rectangular beams and beams of the I section, or other forms which are symmetrical in reference to the neutral axis. But when the sections are irregular none of the theories can be relied upon for securing correct results. Whatever theory may yet do for us, it is quite evident that no theory will ever be devised, of practical value, which will be applicable to the infinite variety of forms of beams which are or may be used in the mechanic arts. That I may not be misunderstood upon this point, I will be more specific. We know that our present theories do not always give correct results, and that the more irregular the form the greater the discrepancy between the actual and computed strengths of a beam. Now, if a theory is ever devised which will take into account all the conditions of strains in a beam, I think it will be too complicated to be of practical value to the mechanic. I do not desire by this remark to disparage theory. Theories are valuable. Without them we would make little or no progress. Fortunately for the engineer, it is not the mathematically exact result that he desires, but the *reliable* result. He does not so much desire to know that one pound more of load will break his structure, as he does that he may depend upon it to carry from four to six times the load which he intends to put upon it. The theories, as now developed, are safe guides to the mechanic and engineer; still we learn to depend more and more upon direct experiment. The theory also in regard to the deflection of beams under a transverse strain, has recently received a modification, due to a consideration of the effect of transverse shearing; but the modification is sustained both from mathematical and experimental considerations. May not more careful experiments yet teach us that it must be still further modified on account of the longitudinal shearing strain?

The author will be pleased to receive the results of experiments which have been made in this country, so that if this work is revised in the future, it may be made more profitable to the engineering profession.

TABLE OF CONTENTS.

INTRODUCTION.

No. OF THE ARTICLE.	PAGE
1. General Problems.....	1
2. Definition of Certain Terms.....	2
3. Stresses produce Elastic and Ultimate Resistances.....	3
4. General Principles of Elastic Resistance.....	3
5. Coefficient of Elasticity.....	4
6. Proofs of the Laws of Elastic Resistance.....	5

CHAPTER I.

TENSION.

7. Experiments on the Elongation of Wrought Iron.....	7
8. Graphical Representation of Results.....	8
9. Elongation of Cast Iron.....	10
10. Graphical Representation.....	12
11. Tables of Experiments on Cast Iron.....	12
12. Coefficient of Elasticity of Malleable Iron.....	14
13. Elasticity of Wood Longitudinally.....	15
14. Elasticity of Wood Radially.....	16
15. Remark on the Coefficient of Elasticity.....	17
16. Elongation of a Prismatic Bar by a Weight.....	17
17. Elongation of a Prismatic Bar when the weight of the bar is considered.....	19
18. Work of Elongation.....	20
19. Vertical Oscillations.....	21
20. Viscosity of Solids.....	22
21. Modulus of Strength.....	23
22. Strength of a Prismatic Bar.....	24
23. Strength of a Prismatic Bar when its weight is considered.....	25
24. Bar of Uniform Strength.....	25
25. Strength of a Closed Cylinder.....	26
26. Strength of Glass Globes.....	30
27. Experiments on Riveted Plates.....	31
28. Strength of Rolled Sheets of Iron in different directions.....	33
29. Strength of Wrought Iron at various temperatures.....	36
30. Effect of Severe Strains on the Tenacity of Iron.....	40
31. Effect of Repeated Rupture.....	41

NO. OF THE ARTICLE.	PAGE
32. Strength of Annealed Iron.....	41
33. Strength of Metals Modified by Treatment.....	42
34. Effect of Prolonged Fusion on Cast Iron.....	43
35. Remelting Cast Iron—On Strength of.....	43
36. Cooling Cast Iron—Affects Strength of.....	44
37. Strength Modified by Various Circumstances.....	44
38. Safe Limit of Loading.....	44

CHAPTER II.

COMPRESSION.

39. Elastic and Ultimate Resistance.....	46
40. Compression of Cast Iron.....	47
41. Compression of Wrought Iron.....	48
42. Graphical Representation of Results.....	49
43. Comparative Compression of Cast and Wrought Iron.....	49
44. Compression of other Metals.....	50
45. Modulus for Crushing.....	50
46. Modulus of Strain.....	51
47. Resistance of Cast Iron to Crushing.....	52
48. Resistance of Wrought Iron to Crushing.....	53
49. Resistance of Wood to Crushing.....	53
50. Resistance of Cast Steel to Crushing.....	54
51. Resistance of Glass to Crushing.....	54
52. Strength of Pillars.....	55
53. Formulas for the Weight of Pillars.....	58
54. Irregularities in the Thickness of Cast Pillars.....	60
55. Experiments of the N. Y. C. R. R. Co. on Angle Irons.....	60
56. Buckling of Tubes.....	66
57. Collapse of Tubes.....	66
58. Results of Experiments on Collapsing.....	69
59. Law of Thickness to resist Collapsing.....	69
60. Formula for Thickness to resist Collapsing.....	72
61. Resistance of Elliptical Tubes to Collapsing.....	72
62. Strength of very long Tubes.....	73
63. Strength from External and Internal Pressure Compared.....	73
64. Resistance of Glass Globes to Collapsing.....	73

CHAPTER III.

THEORIES OF FLEXURE AND RUPTURE FROM TRANSVERSE STRESS.

65. Remark upon the Subject.....	75
66. Galileo's Theory.....	75
67. Robert Hooke's Theory.....	76
68. Marriotte's and Leibnitz's Theory.....	76
69. James Bernouilli's Theory.....	76
70. Parent's Theory.....	77

CONTENTS.

vii

NO. OF THE ARTICLE	PAGE
71. Coulomb's Theory.....	77
72. Young's "Modulus of Elasticity".....	77
73. Navier's Developments of Theory.....	78
74. The Common Theory.....	78
75. Barlow's Theory.....	79
76. Remarks upon the Theories.....	82
77. Position of the Neutral Axis found Experimentally.....	83
78. Position of the Neutral Axis found Analytically.....	84

CHAPTER IV.

SHEARING STRESS.

79. Examples of Shearing Stress.....	89
80. Modulus of Shearing Stress.....	89
81. A Problem of a Tie Beam.....	91
82. A Problem of Riveted Plates.....	92
83. Longitudinal Shearing in a Bent Beam.....	92
84. Transverse Shearing in a Bent Beam.....	93
85. Shearing Resistance to Torsion.....	95

CHAPTER V.

FLEXURE.

86. General Equation of the "Elastic Curve".....	96
87. Moment of Inertia of a Rectangle and of a Circle.....	98
88. GENERAL STATEMENT OF THE PROBLEMS.....	99
89. Beams Fixed at one end Load at the Free End.....	99
90. Beams Fixed at one end and Loaded Uniformly.....	101
91. Previous Cases Combined.....	102
92. Beams Supported at their Ends and Loaded at any Point.....	102
93. Beams Supported at their Ends and Loaded Uniformly.....	105
94. The two preceding Cases Combined.....	105
95. Examples.....	106
96. Deflection according to Barlow's Theory.....	108
97. Beams Fixed at one end, Supported at the other, and Loaded at any Point.....	108
98. Beams Fixed at one end, Supported at the other, and Loaded Uniformly.....	113
99. Beams Fixed at both ends and Loaded at the Middle.....	115
100. Beams Fixed at both ends and Loaded Uniformly.....	116
101. Table of Results.....	118
102. Remarks upon the Results.....	118
103. Modification of the Formulas for Deflection to include shearing resistance.....	119
104. Unsolved Problems.....	121
105. Deflection of Beams having Variable Sections.....	122
106. Beams subjected to Oblique Strains.....	124