

CONTENTS

PREFACE TO THE FOURTH EDITION	PAGE v
PREFACE TO THE FIRST EDITION	vii

CHAPTER I

ART.	OUTER AND INNER FORCES	
1.	Definitions	
2.	Live and Dead Loads	
3.	Outer Forces	
4.	Weight of Structure	5
5.	Weight of Railroad Bridges	5
6.	Approximate Truss Weights	7
7.	Weight of Highway Bridges	10
8.	Weight of Roof Trusses	14
9.	Weight of Steel-frame Buildings	15
10.	Live Loads for Railroad Bridges	16
11.	Live Loads for Highway Bridges	18
12.	Live Loads for Buildings	18
13.	Wind Pressure	20
14.	Snow Load	27
15.	Centrifugal Force and Friction	28
16.	Impact on Railroad Bridges	28
17.	Impact on Highway Bridges and Buildings	30
18.	Inner Forces	31
19.	Factor of Safety	33

CHAPTER II

LAWS OF STATICS, REACTIONS, SHEARS AND MOMENTS, INFLUENCE LINES		
20.	Laws of Statics	36
21.	Reactions	37
22.	Computation of Reactions. Method of Procedure	38
23.	Reaction Conventions	40
24.	Point of Application of Loads and Reactions	40
25.	Solution of Reaction Problems	41
26.	Shear and Bending Moment Defined	46
27.	Method of Computation, Shear, and Bending Moment	46
28.	Signs for Shear and Bending Moment	46
29.	Shear and Moment, Common Cases	47
30.	Curves of Shear and Moment Defined and Illustrated	47
31.	Shear and Moment. Distributed Load	48
32.	Shear and Moment. Uniformly Varying Load	50
33.	Location of Section of Maximum Moment	53
34.	Theorem for Computing Moments	53

ART.	PAGE
35. Beams Fixed at Ends	54
36. Effect of Floor Beams	57
37. Typical Curves of Shear and Moment	59
38. Influence Lines and Tables Defined.	60
39. Examples of Influence Lines.	63
40. Properties of the Influence Line	64
41. Neutral Point	67
42. Position of Loads for Maximum Shear and Moment at a Definite Section.	67
43. Maximum Moments and Shears. Structures Supported at Ends	67
44. Approximate Method for Maximum Shear	70

CHAPTER III

CONCENTRATED LOAD SYSTEMS

45. Shear at a Fixed Section. Girder without Floor Beams.	76
46. Moment at a Fixed Section	80
47. Shear, Girder with Floor Beams	82
48. Formula for Position of Loads for Maximum Shear for Inter- mediate Panels	87
49. Maximum Moment	88
50. Moment and Shear at the Critical Section.	89
51. Moments and Shears.	93
52. Moment Diagram	98

CHAPTER IV

BEAM DESIGN

53. Formulas	101
54. Method of Design	103
55. Wooden Beams	103
56. Steel Beams.	104
57. Examples of Beam Design	104
58. Composite Beams	107
59. Stiffness	107

CHAPTER V

PLATE-GIRDER DESIGN

60. Plate Girders Defined	109
61. Plate-girder-web. Theory	110
62. Plate-girder-flange. Theory	111
63. Degree of Approximation of Flange Formula	114
64. Degree of Approximation of Shear Formula	119
65. Allowance for Rivet Holes	121
66. Example of Girder Design.	123
67. Flange Rivets and Riveted Joints	124
68. Flange Rivets. Approximate Method of Computing Pitch	127
69. Flange Rivets. Precise Method of Computation of Pitch.	129
70. Flange Rivets. Example in Computation of Pitch.	130
71. Direct Web Stresses	132

CONTENTS

xi

ART.	PAGE
72. Web Stiffeners	135
73. Flange Plates	137
74. Connection Angles and Fillers	140
75. Web Splices	142
76. Flange Splices	146
77. Welded Structures	148

CHAPTER VI

SIMPLE TRUSSES

78. Trusses Defined	150
79. Classification	150
80. Theory	151
81. Methods	151
82. Analytical Method of Joints Described	151
83. Character of Stress	152
84. Determinate and Indeterminate Trusses	153
85. Mode of Procedure. Analytical Methods of Joints	154
86. Application of Analytical Method of Joints	155
87. Graphical Method of Joints Described	157
88. Mode of Procedure. Graphical Method of Joints	157
89. Application of Graphical Method of Joints	158
90. Ambiguous Cases	159
91. Analytical Method of Moments Described	161
92. Mode of Procedure. Method of Moments	161
93. Application of Method of Moments	162
94. Method of Shear Described	163
95. Mode of Procedure. Method of Shear	164
96. Application of Method of Shear	165
97. General Rules for Determination of Truss Stresses	165
98. Counters	166
99. Types of Truss	168
100. Systems of Loading	171
101. Index Stresses	172
102. Computation of Stresses. Pratt Truss	174
103. Computation of Stresses. Warren Truss	177
104. Computation of Stresses. Subdivided Warren Truss	181
105. Computation of Stresses. Bridge Trusses with Nonparallel Chords	183
106. Computation of Stresses. Bridge Trusses with Nonparallel Chords	187
107. Computation of Stresses. Bridge Trusses with Parabolic Chord	196

CHAPTER VII

BRIDGE TRUSSES WITH SECONDARY WEB SYSTEMS, INCLUDING THE BALTIMORE AND PETIT TRUSSES

108. Secondary Systems Described	203
109. Computation of Maximum Stresses in Petit Truss	208

CHAPTER VIII

TRUSSES WITH MULTIPLE WEB SYSTEMS, LATERAL AND PORTAL BRACING, TRANSVERSE BENTS, VIADUCT TOWERS

ART.		
110.	Trusses with Multiple Web Systems	227
111.	Approximate Determination of Maximum Stresses in a Double-system Warren Truss	228
112.	Approximate Determination of Maximum Stresses in a Whipple Truss	235
113.	Skew Bridges	239
114.	Lateral and Portal Bracing	240
115.	Lateral-bracing Trusses	242
116.	Approximate Determination of Maximum Stresses in Lateral Bracing	242
117.	Portals. Approximate Solution	243
118.	Portals. Miscellaneous	248
119.	Transverse Bents in Mill Buildings. Approximate Method	249
120.	Viaduct Towers	251

CHAPTER IX

CANTILEVER BRIDGES

121.	Types of Structures for Long-span Bridges	258
122.	Cantilever Bridges Described	258
123.	Equations of Conditions	259
124.	Anchorage	261
125.	Reactions. Cantilever Trusses	261
126.	Shears and Moments. Cantilever Trusses	266
127.	Bar Stresses. Cantilever Trusses	266

CHAPTER X

THREE-HINGED ARCHES

128.	Characteristics of the Arch	270
129.	Types of Arch	270
130.	Reactions. Three-hinged Metal Arches	272
131.	Maximum Stresses in Elastic Arch Ribs	274
132.	Parabolic Three-hinged Arches	277

CHAPTER XI

DESIGN OF COLUMNS AND TENSION MEMBERS

133.	Columns. General Considerations	287
134.	Condition of Ends	288
135.	Column Formulas	289
136.	Value of Ratio of Length to Radius of Gyration	292
137.	Formulas for Long Columns	292
138.	Cast-iron Columns	293
139.	Timber and Concrete Columns	295
140.	Typical Column Sections	295
141.	General Dimensions and Limiting Conditions	297

CONTENTS

xiii

ART.	PAGE
142. Method of Design	298
143. Determination of Cross Section of Typical Steel Columns	299
144. Lattice Bars and Batten Plates	302
145. Stress in Lattice Bars	304
146. Width of Lattice Bars and Tie Plates	306
147. Rivet Pitch	307
148. Distribution of Normal Stresses on Cross Sections of Straight Bars	307
149. Effect of Combined Flexure and Thrust or Pull on a Column or Tension Member	309
150. Building Columns under Eccentric Loads	309
151. Design of Cast-iron Columns	310
152. Design of Iron and Steel Tension Members	313

CHAPTER XII

PIN AND RIVETED-TRUSS JOINTS

153. Bridge Pins Described	317
154. Arrangement of Members on Pin	317
155. Minimum Size of Pins	320
156. Stresses Causing Maximum Moment and Shear	321
157. Computation of Maximum Moment and Shear	322
158. Computation of a Top-chord Pin for Truss Shown in Fig. 245	323
159. Computation of a Bottom-chord Pin for Truss Shown in Fig. 245	326
160. Effect upon Pin of Change of Arrangement of Members	329
161. Pin-plate Rivets	330
162. Pin Nuts	330
163. Packing Rings	331
164. Riveted-truss Joints	331

CHAPTER XIII

GRAPHICAL STATICS

165. Graphical and Analytical Methods Compared	339
166. Force and Funicular Polygons	336
167. Characteristics of the Funicular Polygon	339
168. Reactions	340
169. Graphical Method of Moments	342
170. Graphical Method of Moments with a Concentrated Load System	344
171. Graphical Method of Shear	345
172. Funicular Polygon through Several Points	348

CHAPTER XIV

DEFLECTION SLOPE AND CAMBER

173. Elastic and Nonelastic Deflection of Trusses	354
174. Truss Deflection. Trigonometrical Method	354
175. Truss Deflection. Method of Rotation	355
176. Truss Deflection. Method of Work	357
177. Truss Deflection Illustrated	360
178. Deflection of Beams and Girders	363

ART.	PAGE
179. Slope by Method of Work	366
180. Graphical Method of Truss Deflection	369
181. Correction of the Williot Diagram	374
182. Elastic-load Method of Truss Deflections. End-supported Trusses	377
183. Deflection of a Cantilever Arm.	384
184. Effect of Submembers	385
185. Maxwell's Theorem of Reciprocal Deflections	390
186. Slope and Deflection. Moment-area Method	393
187. Camber Defined.	397
188. Rules for Computing Cambers.	398

CHAPTER XV

STATICALLY INDETERMINATE GIRDERS AND TRUSSES

189. Continuous Girders. Definitions	400
190. Reactions on Continuous Girders. Method of Computation	400
191. Derivation of the Three-moment Equation	401
192. Application of the Three-moment Equation	405
193. Reactions, Shears, and Moments for Common Cases of Con- tinuous Girders	407
194. Reactions upon Continuous Girders by Method of Deflections	416
195. Application of the Method of Deflections to Determination of Girder Reactions	418
196. Statically Indeterminate Trusses.	419
197. Continuous Trusses	420
198. Trusses with Redundant Bars	421
199. Theorem of Least Work	423
200. Expressions for Internal Work	424
201. Examples of Application of Theorem of Least Work	426
202. Reactions in Continuous Girders. Method of Least Work	426
203. Reactions in Continuous Trusses. Method of Least Work	427
204. Stresses of Trusses with Redundant Members by Method of Least Work	432
205. Influence Lines and Tables for Indeterminate Structures	439
206. Stresses in Indeterminate Structures Due to Changes in Tem- perature	440
207. Stresses in Framed Bents by Method of Least Work	440
208. Slope-deflection Theorem	443
209. Moment Distribution	454
210. Application of Moment-distribution Method to Vertical Loads	455
211. Application of Moment-distribution Method to a Building	461
212. Application of Moment-distribution Method to Transverse Forces	461

CHAPTER XVI

SPACE FRAMEWORK

213. Definition	469
214. Statical Conditions	469
215. Fixing the Direction of Reactions	472

CONTENTS

XV

ART.	PAGE
216. Type of Space Framework	473
217. Method of Computation	474
218. Illustration of Methods of Computation	475
219. Stresses in Symmetrical Polygonal Ring without Radial Bars	484
220. Stresses in a Polygonal Ring without Radial Bars	491
221. Schwedler Dome	492

CHAPTER XVII

MOVABLE BRIDGES

222. Movable Bridges. General	505
223. Stresses in Bascule Bridges	505
224. Types of Girders and Trusses for Swing Bridges and Equations for Reactions.	507
225. Points of Support for Swing Bridges	507
226. Determination of Reactions on a Partially Continuous Girder	508
227. Influence of End Supports upon Swing-bridge Reactions	509
228. Tables of Reactions for Continuous and Partially Continuous Girders Used for Swing Bridges	510
229. Maximum Stresses in Swing Bridge.	510
230. Specification for Impact and Reversal of Stress	515
231. Computation of Maximum Stresses in Swing Bridges by Approximate Method	515

CHAPTER XVIII

MASONRY DAMS

232. Definitions	523
233. Assumptions for Gravity Dams	523
234. Distribution of Stress over Joints of Masonry Dams	523
235. Application of Equations to Dams	524
236. Outer Forces	526
237. Economical Cross Section.	527
238. Determination of Profile of a Low Dam.	530
239. Determination of Preliminary Profile of a High Dam.	531
240. Graphical Method of Solution.	532
241. Graphical and Analytical Methods Combined	535
242. Arched Dams	537

CHAPTER XIX

EARTH PRESSURE

243. Cohesion, Friction, and Weight	540
244. Active and Passive Pressure.	541
245. Method of Trial	543
246. Rankine's Method	544
247. Surcharged Wall.	549

CHAPTER XX

MASONRY ARCHES WITH FIXED ENDS

248. Determination of Span and Rise.	552
249. Preliminary Determination of Thickness of Arch Rib	552

ART.	PAGE
250. Shape of Arch Axis	553
251. Outer Forces	556
252. Theory	557
253. Formulas for Arches of Constant Cross Section	563
254. Comparison of Arch and Fixed-ended Beam	563
255. Temperature Stresses	564
256. Effect of Horizontal Movement of Abutments	566
257. Precision of Formulas	567
258. Line of Resistance	568
259. Distribution of Stress over Cross Section	568
260. Computation of External Forces by Approximate Method	569
261. Influence Lines	572
262. Critical Section	573

CHAPTER XXI

WIND STRESSES IN FRAMED BENTS OF HIGH BUILDINGS

263. Definition	576
264. Approximate Methods of Solution	576
265. Theorems	578
266. Application of Theorems	580
267. Illustrative Examples	582
268. Stresses Due to Combination of Live, Dead, and Wind Forces	592
269. Wind Pressure Specified in Building Laws	596
270. Exact Method of Solution	597

INDEX.