

Contents

Preface	xi
Nomenclature	xv
Abbreviations	xviii

Chapter 1. Wood Buildings and Design Criteria	1
1.1 Introduction	1
1.2 Types of Buildings	2
1.3 Required and Recommended References	4
1.4 Building Codes and Design Criteria	7
1.5 ASD and LRFD	8
1.6 Organization of the Text	9
1.7 Structural Calculations	9
1.8 Detailing Conventions	11
1.9 Fire-Resistive Requirements	12
1.10 Industry Organizations	13
1.11 References	13
Chapter 2. Design Loads	15
2.1 Introduction	15
2.2 Dead Loads	17
2.3 Live Loads	21
2.4 Snow Loads	28
2.5 Soil Loads and Hydrostatic Pressure	35
2.6 Loads due to Fluids	35
2.7 Rain Loads	35
2.8 Flood Loads	36
2.9 Self-Straining Loads	36
2.10 Wind Loads—Introduction	37
2.11 Wind Forces—Main Wind Force Resisting System	42
2.12 Wind Forces—Components and Cladding	52
2.13 Seismic Forces—Introduction	57
2.14 Seismic Forces	62
2.15 Seismic Forces—Primary System	76
2.16 Seismic Forces—Wall Components	83

2.17	Load Combinations	88
2.18	Serviceability/Deflection Criteria	93
2.19	References	98
2.20	Problems	99
Chapter 3. Behavior of Structures under Loads and Forces		107
3.1	Introduction	107
3.2	Structures Subject to Vertical Loads	107
3.3	Structures Subject to Lateral Forces	111
3.4	Lateral Forces in Buildings with Diaphragms and Shearwalls	118
3.5	Design Problem: Lateral Forces on One-Story Building	124
3.6	Design Problem: Lateral Forces on Two-Story Building	139
3.7	References	159
3.8	Problems	159
Chapter 4. Properties of Wood and Lumber Grades		167
4.1	Introduction	167
4.2	Design Specification	168
4.3	Methods of Grading Structural Lumber	170
4.4	In-Grade versus Clear Wood Design Values	172
4.5	Species and Species Groups	174
4.6	Cellular Makeup	175
4.7	Moisture Content and Shrinkage	178
4.8	Effect of Moisture Content on Lumber Sizes	186
4.9	Durability of Wood and the Need for Pressure Treatment	186
4.10	Growth Characteristics of Wood	189
4.11	Sizes of Structural Lumber	192
4.12	Size Categories and Commercial Grades	195
4.13	General Notation	199
4.14	Wet Service Factor C_M	205
4.15	Load Duration Factor C_D (ASD Only)	206
4.16	Time Effect Factor λ (LRFD Only)	210
4.17	Size Factor C_F	211
4.18	Repetitive Member Factor C_r	212
4.19	Flat Use Factor C_{fu}	213
4.20	Temperature Factor C_t	213
4.21	Incising Factor C_i	214
4.22	Resistance Factor ϕ (LRFD Only)	214
4.23	Format Conversion Factor K_F (LRFD Only)	215
4.24	Design Problem: Adjusted Design Values	216
4.25	Future Directions in Wood Design	226
4.26	References	227
4.27	Problems	228
Chapter 5. Structural Glued Laminated Timber		235
5.1	Introduction	235
5.2	Sizes of Glulam Members	235
5.3	Resawn Glulam	238
5.4	Fabrication of Glulams	239

5.5	Grades of Glulam Members	245
5.6	Adjustment Factors for Glulam	250
5.7	Design Problem: Adjusted Design Values	253
5.8	References	257
5.9	Problems	258
Chapter 6.	Beam Design	261
6.1	Introduction	261
6.2	Bending	262
6.3	Lateral Stability	274
6.4	Adjusted Bending Design Value Summary	283
6.5	Shear	289
6.6	Deflection	296
6.7	Design Summary	298
6.8	Bearing at Supports	300
6.9	Design Problem: Sawn Beam	307
6.10	Design Problem: Rough-Sawn Beam Using ASD	314
6.11	Design Problem: Notched Beam	316
6.12	Design Problem: Sawn-Beam Analysis	318
6.13	Design Problem: Glulam Beam with Full Lateral Support	322
6.14	Design Problem: Glulam Beam with Lateral Support at 8 ft-0 in.	328
6.15	Design Problem: Glulam Beam with Lateral Support at 48 ft-0 in.	332
6.16	Design Problem: Glulam with Compression Zone Stressed in Tension	335
6.17	Cantilever Beam Systems	339
6.18	Lumber Roof and Floor Decking	343
6.19	Fabricated Wood Components	345
6.20	References	354
6.21	Problems	355
Chapter 7.	Axial Forces and Combined Bending and Axial Forces	367
7.1	Introduction	367
7.2	Axial Tension Members	368
7.3	Design Problem: Tension Member	373
7.4	Columns	377
7.5	Detailed Analysis of Slenderness Ratio	385
7.6	Design Problem: Axially Loaded Column	391
7.7	Design Problem: Capacity of a Glulam Column	396
7.8	Design Problem: Capacity of a Bearing Wall	402
7.9	Built-Up Columns	404
7.10	Combined Bending and Tension	408
7.11	Design Problem: Combined Bending and Tension	413
7.12	Combined Bending and Compression	418
7.13	Design Problem: Beam-Column	425
7.14	Design Problem: Beam-Column Action in a Stud Wall Using LRFD	430
7.15	Design Problem: Glulam Beam-Column Using ASD	439
7.16	Design for Minimum Eccentricity	446
7.17	Design Problem: Column with Eccentric Load Using ASD	447
7.18	References	453
7.19	Problems	454

Chapter 8. Wood Structural Panels	463
8.1 Introduction	463
8.2 Panel Dimensions and Installation Recommendations	465
8.3 Plywood Makeup	467
8.4 Species Groups for Plywood	470
8.5 Veneer Grades	473
8.6 Exposure Durability Classifications	475
8.7 Plywood Grades	476
8.8 Other Wood Structural Panels	479
8.9 Roof Sheathing	482
8.10 Design Problem: Roof Sheathing	485
8.11 Floor Sheathing	489
8.12 Design Problem: Floor Sheathing	492
8.13 Wall Sheathing and Siding	494
8.14 Stress Calculations for Wood Structural Panels	498
8.15 References	508
8.16 Problems	509
 Chapter 9. Diaphragms	 513
9.1 Introduction	513
9.2 Basic Diaphragm Action	514
9.3 Shear Resistance	519
9.4 Diaphragm Chords	527
9.5 Design Problem: Roof Diaphragm	532
9.6 Distribution of Lateral Forces in a Shearwall	540
9.7 Collector (Strut) Forces	544
9.8 Diaphragm Deflections	549
9.9 Diaphragms with Interior Shearwalls	554
9.10 Interior Shearwalls with Collectors	559
9.11 Diaphragm Flexibility	563
9.12 References	566
9.13 Problems	566
 Chapter 10. Shearwalls	 573
10.1 Introduction	573
10.2 Basic Shearwall Action	574
10.3 Shearwalls Using Wood Structural Panels	575
10.4 Other Sheathing Materials	581
10.5 Shearwall Chord Members	583
10.6 Design Problem: Shearwall	585
10.7 Alternate Shearwall Design Methods	594
10.8 Anchorage Considerations	605
10.9 Vertical (Gravity) Loads	606
10.10 Lateral Forces Parallel to a Wall	607
10.11 Shearwall Deflection	611
10.12 Lateral Forces Perpendicular to a Wall	616
10.13 References	618
10.14 Problems	619

Chapter 11. Wood Connections—Background	627
11.1 Introduction	627
11.2 Types of Fasteners and Connections	627
11.3 Yield Model for Laterally Loaded Fasteners	634
11.4 Factors Affecting Strength in Yield Model	635
11.5 Dowel Bearing Strength	639
11.6 Plastic Hinge in Fastener	643
11.7 Yield Limit Mechanisms	647
11.8 References	652
11.9 Problems	652
Chapter 12. Nailed and Stapled Connections	655
12.1 Introduction	655
12.2 Types of Nails	656
12.3 Power-Driven Nails and Staples	659
12.4 Yield Limit Equations for Nails	661
12.5 Applications of Yield Limit Equations	668
12.6 Adjustment Factors for Laterally Loaded Nails	676
12.7 Design Problem: Nail Connection for Knee Brace	683
12.8 Design Problem: Top Plate Splice	688
12.9 Design Problem: Shearwall Chord Tie	696
12.10 Design Problem: Laterally Loaded Toenail	700
12.11 Design Problem: Laterally Loaded Connection in End Grain	704
12.12 Nail Withdrawal Connections	706
12.13 Combined Lateral and Withdrawal Loads	713
12.14 Spacing Requirements	714
12.15 Nailing Schedule	718
12.16 References	718
12.17 Problems	718
Chapter 13. Bolts, Lag Bolts, and Other Connectors	727
13.1 Introduction	727
13.2 Bolt Connections	728
13.3 Bolt Yield Limit Equations for Single Shear	731
13.4 Bolt Yield Limit Equations for Double Shear	740
13.5 Adjustment Factors for Bolts	744
13.6 Tension and Shear Stresses at a Multiple Fastener Connection	756
13.7 Design Problem: Multiple-Bolt Tension Connection	760
13.8 Design Problem: Bolted Chord Splice for Diaphragm	766
13.9 Shear Stresses in a Beam at a Connection	773
13.10 Design Problem: Bolt Connection for Diagonal Brace	775
13.11 Lag Bolt Connections	781
13.12 Yield Limit Equations for Lag Bolts	785
13.13 Adjustment Factors for Lag Bolts in Shear Connections	788
13.14 Design Problem: Collector (Strut) Splice with Lag Bolts	793
13.15 Lag Bolts in Withdrawal	799
13.16 Combined Lateral and Withdrawal Loads	802
13.17 Split Ring and Shear Plate Connectors	803

13.18	References	809
13.19	Problems	809
Chapter 14. Connection Details and Hardware		821
14.1	Introduction	821
14.2	Connection Details	821
14.3	Design Problem: Beam-to-Column Connection	839
14.4	Cantilever Beam Hinge Connection	848
14.5	Prefabricated Connection Hardware	850
14.6	References	853
Chapter 15. Diaphragm-to-Shearwall Anchorage		855
15.1	Introduction	855
15.2	Anchorage Summary	855
15.3	Connection Details—Diaphragm to Wood-Frame Wall	860
15.4	Connection Details—Diaphragm to Concrete or Masonry Walls	869
15.5	Subdiaphragm Anchorage of Concrete and Masonry Walls	885
15.6	Design Problem: Subdiaphragm	891
15.7	References	899
Chapter 16. Advanced Topics in Lateral Force Design		901
16.1	Introduction	901
16.2	Seismic Forces—Regular Structures	901
16.3	Seismic Forces—Irrregular Structures	903
16.4	Overturning—Background	914
16.5	Overturning—Review	914
16.6	Overturning—Wind	919
16.7	Overturning—Seismic	923
16.8	Lateral Analysis of Nonrectangular Buildings	929
16.9	Rigid Diaphragm Analysis	934
16.10	Additional Topics in Diaphragm Design	944
16.11	References	944
Appendix A. Equivalent Uniform Weights of Wood Framing		945
Appendix B. Weights of Building Materials		947
Appendix C. SI Units		951
Index		955