

DATA BOOK FOR CIVIL ENGINEERS

DESIGN

THIRD EDITION

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With special acknowledgment to
MORTON C. SIMMONS

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Contents

| | PAGE | PAGE | | |
|--|----------------------------|---|--|--------------|
| 1. STRUCTURAL GENERAL | | | | |
| Unit Stresses | 1-01 to 1-07 | Economical Selection of Beams | 4-32 | |
| Properties of Materials | 1-08 | Rivet Data | 4-33 | |
| Unit Weights | 1-09 | Gratings and Floor Plates | 4-34 | |
| Live Loads | 1-10 to 1-14 | Hangers | 4-35 | |
| Wind Design | 1-15 | Wind Bracing, Riveted | 4-36 | |
| Wall Thickness | 1-16 | Welding Symbols and Data | 4-51, 4-52 | |
| Fireproofing Requirements | 1-17 | Welding Design | 4-53 | |
| Gages | 1-18 | Weld Groups—Allowable Eccentric Loads | 4-54 to 4-57 | |
| Chains and Wire Ropes | 1-19 | Welding Details | 4-58 | |
| Formulas—Properties of Sections | 1-20, 1-21 | Wind Connections, Welded | 4-59 | |
| Approximate Solution | 1-22 | Plastic Design of Steel, Data | 4-70 | |
| Earthquakes | 1-23 | Economical Selection of Beams | 4-71 | |
| Formulas—Torsion & Skin Stresses | 1-24 | Moments and Reactions | 4-72 | |
| Trusses | 1-25 | Composite Beams, Criteria and Design | 4-89, 4-90 | |
| Errors and Remedies | 1-26 | Properties and Connectors | 4-91 | |
| Masonry | 1-27, 1-28 | 5. STRUCTURAL ALUMINUM | | |
| General Notes | 1-29 | Allowable Working Stresses | 5-01 to 5-03 | |
| 2. STRUCTURAL CONCRETE | | | Section Properties, Rivet Data | 5-04, 5-05 |
| Mixes and Properties of Lightweight Concrete | 2-01 | 6. STRUCTURAL WOOD AND PLYWOOD | | |
| Typical Beam Details and Anchorage Requirements | 2-02 | Properties of Lumber and Columns | 6-01 | |
| Typical Slab Details | 2-03 | Joists and Stud Walls | 6-02 | |
| Miscellaneous Requirements of A.C.I. Code | 2-04 | Nail Data | 6-03 | |
| Flat Slabs | 2-05, 2-06 | Connectors | 6-04 to 6-06 | |
| Two-Way Slabs | 2-07, 2-08 | Properties of Structural Glued Laminated Lumber | 6-07 | |
| Beam Tables | 2-09 to 2-13 | Plywood, Working Stresses | 6-26 | |
| Stirrup Design | 2-14 | Design | 6-27 | |
| Concrete Floor Slab Design | 2-15 | Skin Stressed Panels | 6-28 | |
| Reinforcement Design and Details | 2-16 to 2-18 | Data | 6-29 | |
| Column Details | 2-19, 2-26 | 7. STRUCTURAL FOUNDATIONS | | |
| Column Design Tables | 2-20 to 2-25, 2-27 to 2-33 | Load Test and Soil Bearing Capacities | 7-01, 7-02 | |
| Prestressed—Method, Usage, and Properties of Reinforcement | 2-50 | Plain Concrete Wall Footings | 7-03 | |
| Prestressed—Formula and Nomenclature | 2-51 | Square Column Footings | 7-04 to 7-11 | |
| Prestressed—Application | 2-52, 2-53 | Rectangular Footings | 7-12 | |
| Ultimate Strength—Usage, Factors, and Formulas | 2-76 | Trapezoidal Footings | 7-13 | |
| Ultimate Strength—Design Charts | 2-77 to 2-81 | Cantilever Footings | 7-14 | |
| 3. STRUCTURAL RIGID FRAMES | | | Pile Types | 7-15, 7-16 |
| Fixed End Moments | 3-01 | Pile Data | 7-17, 7-18 | |
| Value of <i>K</i> for Concrete Beams and Columns | 3-02 | Pile Caps | 7-19 to 7-29 | |
| Hardy Cross Method | 3-03, 3-04 | Retaining Walls | 7-30, 7-31 | |
| Haunched Beam Properties | 3-05 to 3-08 | Bearing Piles and Sheet Piling | 7-32 | |
| Variable Section | 3-09, 3-10 | Concrete Manholes and Inlets | 7-33 | |
| Side-sway | 3-11 | Transmission Towers | 7-50 | |
| Formulas | 3-12 to 3-14 | 8. STRUCTURAL FORMULAS | | |
| 4. STRUCTURAL STEEL | | | Beam Formulas | 8-01 to 8-04 |
| Red Lights in Design | 4-01 | 9. SOILS | | |
| Beam Sections | 4-02, 4-03 | Soil Behavior | 9-01 to 9-04 | |
| Columns | 4-04, 4-05 | Application of Mechanics | 9-05 to 9-07 | |
| Effective Net Areas—Angles in Tension | 4-06 | Factual Data | 9-08 | |
| Struts | 4-07 to 4-10 | Red Lights | 9-09 | |
| Moment of Inertia | 4-11 to 4-20 | Identification and Classification | 9-10 to 9-13, 9-16 | |
| Bearing and Base Plates | 4-21 | Constants for Pavement Design | 9-14 | |
| Eccentric Connections, Riveted | 4-22 | Use and Treatment | 9-15 | |
| Lally Columns | 4-23 to 4-26 | | | |
| Pipe Columns | 4-27 | | | |
| Open Web Joists | 4-28 to 4-31 | | | |

| | PAGE | | PAGE |
|--|----------------|---|----------------|
| Characteristics and Performance | 9-17 | Highways (<i>Cont.</i>) | |
| Airports, C.A.A. | 9-18, 9-19 | Cross-Sectional Elements | 12-16 to 12-17 |
| Surveying and Sampling; Methods and Devices | 9-20, 9-21 | Barriers | 12-18 |
| Profiles and Boring Logs | 9-22 | Interchanges | 12-19 to 12-21 |
| Atterberg (Liquid Limit) Test | 9-23 | Turning | 12-22 to 12-24 |
| Moisture Determination | 9-24 | Curves | 12-25 to 12-33 |
| Maximum Density, Optimum Moisture | 9-25 | Roads and Streets, Typical Cross Sections | 12-50 |
| Proctor Needle Plasticity Test | 9-25 | Intersections | 12-51, 12-52 |
| Field Density Test | 9-26 | Details | 12-53 to 12-55 |
| Mechanical Analysis | 9-27 | Crown Data | 12-56 |
| Shear Tests | 9-28 | Highway and Street Lighting | 12-57 |
| Maximum Density from Sieve Analysis | 9-29 | Parking Curb | 12-76 |
| Housel Penetrometer | 9-29 | Fields | 12-77 |
| Spread Footings | 9-30 | Garages | 12-78 to 12-80 |
| Embankment Foundation | 9-31 | Trucks and Buses | 12-81 |
| Embankments and Retaining Walls | 9-32 | | |
| Embankment Shrinkage and Permeability | 9-33 | 13. BRIDGES | |
| Void Ratio and Permeability | 9-34 | Live Loads | 13-01 to 13-04 |
| Frost | 9-35 | Live Load Distribution | 13-05 to 13-07 |
| Subdrain Filters | 9-36 | Unit Stresses | 13-08 to 13-10 |
| Stabilization | 9-37 | Loading Tables | 13-11 |
| | | Rigid Frame Design Data | 13-12, 13-13 |
| 10. PAVEMENTS | | Typical Simple Span | 13-14 |
| Roads, Wheel Loads | 10-01 | Typical Continuous Span | 13-15 |
| Roads, and Airfields, General Soil Rating | 10-02 | Typical Concrete Slab | 13-16 |
| Roads, Subgrade | 10-03 | Typical Composite Beam | 13-17 |
| Design of Pavements | 10-04 | Bearing Details | 13-18 |
| Design of Flexible Pavements | 10-05 | Expansion Joints | 13-19 |
| Typical Sections, Flexible Pavement | 10-06 | | |
| Flexible Pavement Thickness | 10-07 | 14. RAILROADS | |
| Use of Bituminous Materials | 10-08, 10-09 | General | 14-01 |
| Bituminous Mixtures | 10-10 | Clearances and Cross Section | 14-02 |
| Design of Rigid Pavements | 10-11, 10-12 | Turnouts and Crossovers | 14-03 |
| Rigid Pavement Subbases | 10-13 | Grade Crossings | 14-04 |
| Dowels, Tiebars | 10-14 | Superelevation and Accessories | 14-05 |
| Joint Details | 10-15 | Circular Curves | 14-06 |
| Rigid Pavement Details | 10-16 | Corrections for tangents and externals | 14-07 |
| Reinforced Rigid Pavements | 10-17 | | |
| Airfield Pavements, C.A.A. Design Method | 10-50 | 15. AIRPORTS | |
| C.A.A. Equivalent Single Wheel Load | 10-51, 10-52 | General | 15-01 to 15-03 |
| Rigid, Design Charts, C.A.A. | 10-53 | C.A.A. Standards | 15-04 |
| Flexible, Design Charts, C.A.A. | 10-54 | C.A.A. Runways Lengths | 15-05 |
| Pavement Layout and Sections, C.A.A. | 10-55 | C.A.A. Approach Standards | 15-06, 15-07 |
| Secondary Airports, C.A.A. | 10-56 | Navigational Aids | 15-08 |
| Rigid Pavement Design, Corps of Engineers | 10-57 | Navigational Aid Siting | 15-09 |
| Flexible Pavement Design, Corps of Engineers | 10-58 | Capacity | 15-10, 15-11 |
| Flexible Design Charts, Corps of Engineers | 10-59 | Aircraft Data | 15-12, 15-13 |
| Pavement Layout and Sections, Corps of Engineers | 10-60 | Wind Rose | 15-14 |
| Dowels, Tiebars | 10-61 | Air Force Regulations | 15-15 |
| Joint Details | 10-62 | Runway and Taxiway Markings | 15-18, 15-19 |
| Rigid Joint Layout | 10-63 | Small Airfields | 15-20 |
| Reinforced rigid Design and Details: C.A.A. Corps of Engineers | 10-64, 10-65 | Trunk Plan | 15-21 |
| | | Intercontinental Plan | 15-22 |
| 11. EARTHWORK | | Terminal Buildings | 15-23, 15-24 |
| Computations | 11-01 | Control Tower and Typical Airline Bay | 15-25 |
| Double End Area Volume | 11-02, 11-03 | Lighting | 15-26 to 15-29 |
| Prismoidal Correction | 11-04 | Heliports, General | 15-30 |
| Mass Diagram | 11-05 | Time Saving Analysis | 15-31 |
| | | Layout | 15-32, 15-33 |
| 12. HIGHWAYS, ROADS AND STREETS | | Aircraft Data | 15-34 |
| Highways, Design Procedure | 12-01, 12-02 | 16. DAMS AND CATHODIC PROTECTION | |
| Capacity | 12-03 to 12-05 | Forces Acting on | 16-01 |
| Design Speed | 12-06 | Resultant Pressures, Practical Section | 16-02 |
| Grades | 12-07 | Earth Dam Sections | 16-03 |
| New York State Geometric Standards | 12-08 | Typical Sections | 16-04 |
| Superelevation and Widening | 12-09 to 12-11 | Miscellaneous Criteria | 16-05 |
| Horizontal Sight Distance | 12-12 | Miscellaneous Requirements | 16-06, 16-07 |
| Vertical Sight Distance | 12-13 to 12-15 | | |

| | PAGE | | PAGE |
|--|----------------|--|----------------|
| What the Flow Net Shows | 16-08, 16-09 | Small Systems: Design Data | 19-32 |
| Water Stops, Drains, and Details | 16-10 | Treatment Plant Units | 19-33 |
| Spillway Design | 16-11, 16-12 | Subsurface Tile Systems | 19-34 |
| Stop Logs | 16-13 | Details | 19-35 |
| Flashboards | 16-14 | Problem | 19-36 |
| Gates | 16-15 to 16-19 | Analysis and Tests | 19-37 to 19-47 |
| Section at Powerhouse | 16-20 | Laboratory Furniture | 19-50 |
| Power Chart | 16-21 | Laboratory Equipment | 19-51 to 19-53 |
| Log Sluices and Intake Rack | 16-22 | Tool List for Plants | 19-54 |
| Fishways | 16-23 | Industrial Wastes, General | 19-75 |
| Galvanic Action | 16-50 | Industrial Wastes, Data and Treatment | 19-76 to 19-81 |
| Cathodic Protection | 16-51 to 16-53 | Waste Disposal, Sanitary Fill | 19-90 |
| | | Waste Disposal, Incinerators | 19-91 |
| 17. WATERFRONT STRUCTURES | | | |
| Dynamic Forces | 17-01 | 20. WATER SUPPLY | |
| Shore Protection; Seawalls, Bulkheads, and Revetments | 17-02, 17-03 | General | 20-01 |
| Break Waters and Jetties | 17-04, 17-05 | Demands | 20-02, 20-03 |
| Groins | 17-06 | Rainfall and Runoff | 20-04, 20-05 |
| Wharves, Dynamic Forces | 17-07 | Reservoir Storage | 20-06 |
| Bulkheads | 17-08, 17-09 | Mass Diagram | 20-07 |
| Piers | 17-10 to 17-12 | Evaporation | 20-08 |
| Small Craft Piers and Marine Service Station | 17-13 | Deep Wells | 20-09 |
| Docks and Piers, Protection of Piles | 17-26 | Intakes, Domestic Wells, Windmills | 20-10 |
| | | Elevated Storage Tanks | 20-11 |
| 18. DRAINAGE AND SEWERAGE | | | |
| Drainage: Runoff | 18-01 to 18-04 | Distributing Reservoirs | 20-12, 20-13 |
| Common Sections | 18-05, 18-06 | Pumping | 20-14 |
| Subdrainage | 18-07, 18-08 | Pumping Station | 20-15 |
| Headwalls | 18-09 | Pump Horsepower | 20-16 |
| Erosion Protection | 18-10 | Weirs and Orifices | 20-17, 20-18 |
| Airports | 18-11, 18-12 | Parshall Flume | 20-19 |
| Unit Hydrograph and Flood Routing | 18-13, 18-14 | Drinking Water Requirements | 20-20, 20-21 |
| Drainage and Sewerage: Manholes | 18-25 | 21. WATER PURIFICATION | |
| Inlets and Catch Basins | 18-26, 18-27 | Extent of Treatment Required | 21-01 |
| Loading on Pipes | 18-40 | Storage Reservoir Treatment | 21-02 |
| Rigid | 18-41, 18-42 | Sand Filters | 21-03 to 21-07 |
| Flexible | 18-43 | Coagulation and Sedimentation | 21-08 |
| Pipe Data | 18-44 to 18-46 | Filters | 21-09 |
| Basis of Design | 18-65 | Flow Diagrams | 21-10 |
| Pipe Capacities | 18-66, 18-67 | Laboratory Equipment | 21-11 to 21-17 |
| Hydraulic Computations | 18-68 to 18-74 | Corrosion and Demineralization Control | 21-18 |
| Minor Losses and Inverted Siphons | 18-75 | Chlorination | 21-19 |
| Pipe details | 18-76, 18-77 | 22. WATER DISTRIBUTION | |
| 19. SEWAGE TREATMENT | | | |
| General Data | 19-01 | Pipe System, Flow Data | 22-01 |
| Flow Diagrams | 19-02, 19-03 | Hydrant and Hose Discharge | 22-02 |
| Screens | 19-04, 19-05 | Flow in Pipes | 22-03 to 22-05 |
| Grit Chambers | 19-06 to 19-08 | Equivalent Pipes | 22-06 |
| Parshall Flume | 19-08 | Hardy Cross | 22-07 |
| Setting Tanks | 19-09, 19-10 | Head Loss in Valves and Fittings, etc. | 22-08 |
| Imhoff Tanks | 19-11 | Cast Iron Pipe | 22-09, 22-10 |
| Chemical Precipitation | 19-12 | Valves and Joints | 22-11 |
| Filters | 19-13 to 19-15 | Asbestos-Cement Pipe | 22-12 |
| Activated Sludge | 19-16 to 19-18 | Steel Pipe | 22-13 to 22-15 |
| Sludge Drying | 19-19 | Reactions at Bends | 22-17 |
| Digester, Gas and Hot Water Layout | 19-20, 19-21 | Valves | 22-18, 22-19 |
| Sludge Digestion | 19-22 | Hydrant, Service Valve, Pitometer | 22-20 |
| Sludge Conditioning | 19-23 | Meters | 22-21 to 22-23 |
| Sludge Drying (Vacuum Filtration) | 19-24 | 23. PETROLEUM PRODUCTS HANDLING | |
| Chlorination | 19-25, 19-26 | Properties Affecting Storage and Handling | 23-01, 23-02 |
| Hypochlorinators | 19-27 | Viscosity and Temperature | 23-03 |
| Classification of Receiving Waters | 19-28 | Reynolds Number | 23-04 |
| Pump Types | 19-29 | Friction Loss | 23-05, 23-06 |
| Typical Sewage Lift Station | 19-30 | Equipment Loss Conversion Factor | 23-06 |
| Pumping Station | 19-31 | Vapor Pressures | 23-07 |
| | | Centrifugal Pump Curves and Correction Factors | 23-08 |

| | PAGE | | PAGE |
|---|----------------|----------------------------------|----------------|
| Typical Tank Farm | 23-09 | Outdoor Swimming Pools | 24-05 to 24-08 |
| Typical Tank Details and Data | 23-10 to 23-12 | | |
| | | 25. MISCELLANEOUS | |
| 24. ATHLETIC FIELDS | | Trigonometric Formulas | 25-01 |
| Grandstands | 24-01 | Conversion Factors | 25-02 to 25-04 |
| Athletic Fields, Dimensions | 24-02 | | |
| Athletic Fields, Drainage | 24-02 to 24-04 | INDEX | |
| | | | xix |

STRUCTURAL - GENERAL - UNIT STRESSES - I

TABLE A - ALLOWABLE WORKING STRESSES IN CONCRETE BASED ON ULTIMATE STRENGTH = f_c

| Description | Allowable Working Stresses | | |
|--|---|---|---|
| | N.Y.C. Controlled | A.C.I., 1957 | Maximum Value, A.C.I. |
| FLEXURE Extreme fiber stress in compression. Extreme fiber stress in compression adjacent to supports of continuous or fixed beams, or slabs, or of rigid frames. Tension in plain concrete footings. | 0.40 f_c 0.45 f_c 0.03 f_c^* | 0.45 f_c 0.03 f_c | |
| SHEAR Beams with no web reinforcement and without special anchorage of longitudinal steel. Beams with no web reinforcement, but with special anchorage of longitudinal steel, see p. 2-02. Beams with properly designed web reinforcement, but without special anchorage of longitudinal steel, see p. 2-14. Beams with properly designed web reinforcement and with special anchorage of longitudinal steel, see pp. 2-02, 2-03 and 2-04. Flat slabs at distance d from edge of column cap or drop panel. (a) When at least 50% of total neg. reinf. passes over the column cap. (b) When 25% or less of total neg. reinf. passes over the column cap. (c) For intermediate percentages, use intermediate values. Footings where longitudinal bars are without special anchorage. Footings where longitudinal bars have special anchorage. | 0.02 f_c 0.03 f_c 0.06 f_c 0.09 f_c 0.03 f_c 0.025 f_c 0.02 f_c 0.03 f_c | 0.03 f_c 0.08 f_c 0.12 f_c 0.03 f_c 0.025 f_c 0.03 f_c | 90 240 360 100 85 75 |
| BOND Top bars with 12 in. or more concrete below: (a) Plain. (b) Deformed. Beams, slabs & one-way footings: (a) Plain bars or structural shapes. (b) Deformed bars. In two-way footings: (a) Plain bars or structural shapes. (b) Deformed bars. (N.Y.C. only) Where special anchorage is provided, one and one-half times these values in bond may be used. (A.C.I. only) Bars not conforming to A.S.T.M. designation A-305 shall be treated as plain bars. Plain bars must have hooks. | 0.04 f_c 0.05 f_c 0.03 f_c 0.0375 f_c | 0.03 f_c 0.07 f_c 0.045 f_c 0.10 f_c 0.036 f_c 0.08 f_c | 105 245 158 350 126 280 |
| BEARING Direct bearing on full area. Direct bearing on one-third full area or less. The allowable bearing stress on an area greater than one-third, but less than the full area shall be interpolated. | 0.25 f_c 0.375 f_c | 0.25 f_c 0.375 f_c^{\dagger} | |
| AXIAL COMPRESSION In columns with lateral ties. In pedestals. | 0.25 f_c 0.25 f_c | 0.25 f_c | |
| For E see p. 1-08. | $n = \frac{30,000}{f_c}$ | $\frac{30,000}{f_c}$ | |

TABLE B - REINFORCEMENT (Values in p.s.i.)

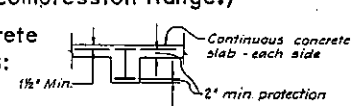
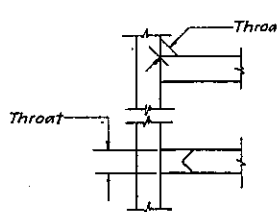
| | | | |
|---------------------------------------|------------------|-------------------------|-------------------------|
| Structural-grade billet steel. | Tension = 18,000 | Web reinforcement: | Tension N.Y.C. = 16,000 |
| Intermediate-grade billet steel. | Tension = 20,000 | (See Table A, p. 2-14.) | Tension A.C.I. = 20,000 |
| Rail steel, straight or machine-bent. | Tension = 20,000 | Cold-drawn steel wire. | Tension = 20,000 |

*For N.Y. City Code requirements add 4 in. to depth of footing (see p. 7-03.)

†This increase shall be permitted only when the least distance between the edges of the loaded and unloaded areas is a minimum of one-fourth of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third but less than the full area shall be interpolated between the values given.

STRUCTURAL-GENERAL-UNIT STRESSES-2

TABLE A-ALLOWABLE WORKING STRESSES IN STEEL (in p.s.i.)

| | A.I.S.C., 1957 | | N.Y.C., 1957 | |
|--|--|--|--------------------------|--|
| TENSION | | | | |
| Structural steel section. | 20,000 | | 20,000 | |
| Rivets or high-strength bolts - on area based on nominal diameter - tension only. | 20,000 | | 20,000 | |
| Rivets or high-strength bolts - tension combined with shear. | | | 15,000 | |
| Bolts and other threaded parts - on area at root of thread. | 20,000 | | 15,000 | |
| COMPRESSION* | | | | |
| Structural rolled steel on short lengths - lateral deflection prevented. | | | 20,000 | |
| Columns - gross section axially loaded: | | | Same as A.I.S.C. | |
| main member $\frac{L}{r} < 120$. | $17,000 - 0.485 \frac{L^2}{r^2}$ | | | |
| secondary member $\frac{L}{r} 120$ to 200 . | $1 + \frac{L^2}{18,000 r^2}$ | | | |
| Plate girder stiffeners - gross section. | 20,000 | | | |
| Webs of rolled section at toe of fillet. | 24,000 | | | |
| BENDING (FLEXURE)† | | | | |
| Rolled sections and built-up members - extreme fiber. | | | | |
| Tension on net section (except no deduction for rivet holes) < 15% flange area. | 20,000 | | 20,000 | |
| Compression (L for cantilever unstayed at outer end = two times length of compression flange.) | 20,000 | | Same as A.I.S.C. | |
| | $\frac{Ld}{bt} < 600$. | | | |
| | $\frac{Ld}{bt} > 600$. | | | |
| Rolled beam encased in stone concrete (Not more than 1:5½ mix) as follows: | $\frac{Ld}{bt}$ | | 22,000 | |
| Pins - extreme fiber. | 30,000 | | 30,000 | |
|  | | | | |
| COMBINED STRESSES see pp. 4-04 & 4-05 | | | | |
| SHEARING | | | | |
| Rivets - power-driven, high strength bolts, pins and turned bolts in reamed or drilled holes. | 15,000 | | 15,000 | |
| Unfinished bolts. | 10,000 | | 10,000 | |
| Webs of beams and plate girders, gross section. | 13,000 | | 13,000 | |
| BEARING | | | | |
| Rivets, high-strength bolts and turned bolts in reamed or drilled holes. | 40,000 | | 40,000 | |
| Unfinished bolts. | 25,000 | | 25,000 | |
| Pins. | 32,000 | | 32,000 | |
| Contact area-milled stiffeners and other milled surfaces. | 30,000 | | 30,000 | |
| fitted stiffeners. | 27,000 | | 27,000 | |
| Expansion rollers and rockers (lbs. per linear inch). | 600 diam. | | 600 diam. | |
| CAST STEEL | | | | |
| Tension. Note: For A.I.S.C.: compression and bearing same as for structural steel. | See note at left. | | 16,000 | |
| Compression. | | | 16,000 | |
| CAST IRON | | | | |
| Tension, shear. | | | 3,000 | |
| Bending - extreme fiber, compression side. | | | 16,000 | |
| tension side. | | | 3,000 | |
| compression on columns - maximum $\frac{L}{r} = 70$. | | | $9,000 - 40 \frac{L}{r}$ | |
| WELDED JOINTS | | | | |
| Compression on section through throat. | 20,000§ | | 20,000§ | |
| Tension on section through throat. | 20,000§ | | 20,000§ | |
| Shear on section through throat of fillet weld. | 13,600 | | 13,500 | |
| Shear on section through throat of butt weld. | 13,000 | | 13,500 | |
| Bending - fiber stresses shall not exceed values given above for compression and tension, respectively. | | | | |
| *A.I.S.C. allows main members with $\frac{L}{r}$ from 120 to 200 if not subject to shock or vibrating loads - allowable stress = | $1 + \frac{L^2}{18,000 r^2} \times \left(1.6 - \frac{L}{r}\right)$ | | | |
|  | | | | |
| For main compression members 120. For bracing and other secondary members in compression 200. For main tension members 240. For bracing and other secondary members in tension 300. | | | | |
| †A.I.S.C. only: Use 20% higher stress for negative moments at supports in continuous beams provided that section is not less than that required by maximum positive moments and compression flange is figured as unsupported from point of contraflexure to support. §See also p. 4-32. §Butt-weld only. | | | | |

Notation in Table A:

L = unbraced length in inches
r = radius of gyration in inches
b = width of compression flange in inches
t = thickness of compression flange in inches
d = depth in inches

STRUCTURAL-GENERAL-UNIT STRESSES-3

LIMITATIONS OF TABLE A, pages 1-03, 1-04, and 1-06*

The allowable unit stresses in Table A below apply to sawn lumber under continuously dry conditions. The Allowable Unit Stresses in Table A, p. 1-06, apply to structural glued laminated lumber.

Reduce allowable unit stresses in Table A below when the moisture content is at or above the fiber saturation point, as follows:

| | |
|---------------------------------------|---------|
| In compression parallel to grain | 10% |
| In compression perpendicular to grain | 33 1/3% |
| Modulus of elasticity $\frac{1}{11}$ | |

When member is fully stressed to maximum allowable stress for many years (either continuously or cumulatively), use 90% of values in Table A, pp. 1-03, 1-04 and 1-06.

Increase allowable unit stresses in Table A, pp. 1-03, 1-04, 1-06 when the duration of the full maximum load does not exceed the period indicated below:

| | |
|---------|--------------------------------------|
| 15% | for 2 months' duration (as for snow) |
| 25% | for 7 days' duration |
| 33 1/3% | for wind or earthquake |
| 100% | for impact |

When stress induced by impact does not exceed the allowable unit stress for normal loading, disregard impact. The resulting structural members shall not be smaller than required for a longer duration of loading.

TABLE A - ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER, 1957

| Species | Use | Grade | Allowable Unit Stresses (in p.s.i.) | | | | | |
|--|---|-----------------------------|-------------------------------------|-------------------|-------------|---------|-----------|-----------|
| | | | $f & t$ (A) | H | c_{\perp} | c (B) | E | |
| Cypress, southern coast type (Tidewater red) | Joist and planks } Beams and stringers } | 1700f | 1700 | 145 | 360 | 1425 | 1,320,000 | |
| | | 1300f | 1300 | 120 | 360 | 1125 | 1,320,000 | |
| | Posts and columns | 1450c | - | - | 360 | 1450 | 1,320,000 | |
| | | 1200c | - | - | 360 | 1200 | 1,320,000 | |
| Cypress, southern inland type (swamp) | Joist and planks } Beams and stringers } | 1700f | 1700 | 145 | 360 | 1425 | 1,320,000 | |
| | | 1300f | 1300 | 120 | 360 | 1125 | 1,320,000 | |
| | Posts and columns | 1450c | - | - | 360 | 1450 | 1,320,000 | |
| | | 1200c | - | - | 360 | 1200 | 1,320,000 | |
| Douglas fir, coast region | Light framing | Dense select structural (C) | 2050 | 120 (D) | 455 | 1500 | 1,760,000 | |
| | | Select structural | 1900 | 120 (D) | 415 | 1400 | 1,760,000 | |
| | | 1500f Industrial | 1500 | 120 | 390 | 1200 | 1,760,000 | |
| | | 1200f Industrial | 1200 | 95 | 390 | 1000 | 1,760,000 | |
| | Joist and planks | Dense select structural (C) | 2050 | 120 (D) | 455 | 1650 | 1,760,000 | |
| | | Select structural | 1900 | 120 (D) | 415 | 1500 | 1,760,000 | |
| | | Dense construction (C) | 1750 | 120 (E) | 455 | 1400 | 1,760,000 | |
| | | Construction | 1500 | 120 (E) | 390 | 1200 | 1,760,000 | |
| | | Standard | 1200 | 95 (E) | 390 | 1000 | 1,760,000 | |
| | Beams and stringers | Dense select structural (C) | 2050 | 120 (F) | 455 | 1500 | 1,760,000 | |
| | | Select structural | 1900 | 120 (F) | 415 | 1400 | 1,760,000 | |
| | | Dense construction (C) | 1750 | 120 (F) | 455 | 1200 | 1,760,000 | |
| | | Construction | 1500 | 120 (F) | 390 | 1000 | 1,760,000 | |
| | Posts and columns | Dense select structural (C) | 1900 | 120 (F) | 455 | 1650 | 1,760,000 | |
| | | Select structural | 1750 | 120 (F) | 415 | 1500 | 1,760,000 | |
| | | Dense construction (C) | 1500 | 120 (F) | 455 | 1400 | 1,760,000 | |
| | | Construction | 1200 | 120 (F) | 390 | 1200 | 1,760,000 | |
| | Douglas fir, inland region | Joist and planks (G) | Dense select structural (C) | 2050 | 120 (D) | 455 | 1650 | 1,760,000 |
| | | | Select structural | 1900 | 120 (D) | 415 | 1500 | 1,760,000 |
| | | | Dense structural (C) | 1750 | 120 (E) | 455 | 1400 | 1,760,000 |
| | | | Structural | 1500 | 120 (E) | 390 | 1200 | 1,760,000 |
| | | | Standard structural | 1200 | 95 (E) | 390 | 1000 | 1,760,000 |
| | | Posts and columns | Dense select structural (C) | 1900 | 120 (F) | 455 | 1650 | 1,760,000 |
| | | | Select structural | 1750 | 120 (F) | 415 | 1500 | 1,760,000 |
| Dense structural (C) | | | 1500 | 120 (F) | 455 | 1400 | 1,760,000 | |
| Structural | | | 1200 | 120 (F) | 390 | 1200 | 1,760,000 | |
| Hemlock, eastern | | | Joist and planks (H) | Common structural | 1100 | 60 | 360 | 650 |
| | Utility structural | 950 | | 60 | 360 | 600 | 1,210,000 | |
| | Beams and stringers (G) | Select structural | 1300 | 85 | 360 | 850 | 1,210,000 | |
| | Posts and columns | Select structural | - | - | 360 | 850 | 1,210,000 | |

STRUCTURAL-GENERAL-UNIT STRESSES - 4

TABLE A - ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER, 1957 (Continued)*

| Species | Use | Grade | Allowable Unit Stresses (in p.s.i.) | | | | |
|---------------------|-----------------------|----------------------|-------------------------------------|---------|------|-----------|-----------|
| | | | f & t (A) | H | c⊥ | c (B) | E |
| Hemlock, west coast | Light framing | 1500f Industrial | 1500 | 100 | 365 | 1000 | 1,540,000 |
| | | 1200f Industrial | 1200 | 80 | 365 | 900 | 1,540,000 |
| | Joist and planks | Construction | 1500 | 100 (I) | 365 | 1100 | 1,540,000 |
| | | Standard | 1200 | 80 (I) | 365 | 1000 | 1,540,000 |
| Beams and stringers | Construction | 1500 | 100 (J) | 365 | 1000 | 1,540,000 | |
| Posts and columns | Construction | 1200 | 100 (J) | 365 | 1100 | 1,540,000 | |
| Oak, red and white | Joist and planks | 1700f | 1700 | 145 | 600 | 1200 | 1,650,000 |
| | | 1450f | 1450 | 120 | 600 | 1050 | 1,650,000 |
| | Beams and stringers | 1450f | 1450 | 120 | 600 | 1050 | 1,650,000 |
| | | 1300f | 1300 | 120 | 600 | 950 | 1,650,000 |
| | Posts and columns | 1200c | - | - | 600 | 1200 | 1,650,000 |
| 1075c | | - | - | 600 | 1075 | 1,650,000 | |
| Pine, Norway | Joist and planks (H) | Common, structural | 1100 | 75 | 360 | 775 | 1,320,000 |
| | | Utility structural | 950 | 75 | 360 | 650 | 1,320,000 |
| Pine, southern (K) | 2" thick | No. 1 Dense KD (L) | 2050 | 135 | 455 | 1750 | 1,760,000 |
| | | No. 1 KD (M) | 1750 | 135 | 390 | 1500 | 1,760,000 |
| | | No. 2 Dense KD (L) | 1750 | 120 | 455 | 1300 | 1,760,000 |
| | | No. 2 KD (M) | 1500 | 120 | 390 | 1100 | 1,760,000 |
| | | No. 1 Dense (N) | 1750 | 120 | 455 | 1550 | 1,760,000 |
| | | No. 1 | 1500 | 120 | 390 | 1350 | 1,760,000 |
| | | No. 2 Dense (N) | 1400 | 105 | 455 | 1050 | 1,760,000 |
| | No. 2 | 1200 | 105 | 390 | 900 | 1,760,000 | |
| | 3" and 4" thick | No. 1 Dense SR (N) | 1750 | 120 | 455 | 1750 | 1,760,000 |
| | | No. 1 SR | 1500 | 120 | 390 | 1500 | 1,760,000 |
| | | No. 2 Dense SR (N) | 1400 | 105 | 455 | 1050 | 1,760,000 |
| | | No. 2 SR | 1200 | 105 | 390 | 900 | 1,760,000 |
| | 5" thick and up | No. 1 Dense SR (N) | 1600 (O) | 120 | 455 | 1500 | 1,760,000 |
| | | No. 1 SR | 1400 (O) | 120 | 390 | 1300 | 1,760,000 |
| | | No. 2 Dense SR (N) | 1400 (O) | 105 | 455 | 1050 | 1,760,000 |
| | | No. 2 SR | 1200 (O) | 105 | 390 | 900 | 1,760,000 |
| | 1", 1¼" and 1½" thick | Industrial 58 KD (M) | 1750 | 120 | 390 | 1400 | 1,760,000 |
| | | Industrial 50 KD (M) | 1500 | 120 | 390 | 1100 | 1,760,000 |
| | | Industrial 58 | 1500 | 105 | 390 | 1250 | 1,760,000 |
| | | Industrial 50 | 1200 | 105 | 390 | 900 | 1,760,000 |
| Redwood | Joist and planks | Dense structural (C) | 1700 | 110 | 320 | 1450 | 1,320,000 |
| | Beams and stringers | | | | | | |
| | Posts and columns | Dense structural (C) | - | - | 320 | 1450 | 1,320,000 |
| | | Heart structural | - | - | 320 | 1100 | 1,320,000 |
| Spruce, eastern | Joist and planks (G) | 1450f Structural | 1450 | 110 | 300 | 1050 | 1,320,000 |
| | | 1300f Structural | 1300 | 95 | 300 | 975 | 1,320,000 |
| | | 1200f Structural | 1200 | 95 | 300 | 900 | 1,320,000 |

f = extreme fiber in bending t = tension parallel to grain H = horizontal shear c = compression perpendicular to grain
 c = compression parallel to grain E = modulus of elasticity

*From "National Design Specification for Stress-Grade Lumber and its Fastenings," by National Lumber Manufacturers Association, 1957 Edition.

STRUCTURAL-GENERAL-UNIT STRESSES-5

FOOTNOTES FOR TABLE A, 1-03 and 1-04*

A. In tension members, the slope of grain limitations applicable to the middle portion of the length of the joist and plank and beam and stringer grades used shall apply throughout the length of the piece.

B. Value for c shown is maximum unit stress. To determine the allowable unit stress (which cannot exceed value c), use the following formula:

$$\frac{P}{A} = \frac{0.3 E}{(l/d)^2}$$

Where P/A = load per unit of cross-sectional area

E = modulus of elasticity

l = unsupported over-all length in inches

d = dimension of least side in inches

C. These grades meet the requirements for density.

D. Value applies to pieces used as planks. Value applies to 2"-thick pieces of Select Structural grade used as joists. For 3"-thick pieces of Select Structural, Construction, and Standard grades used as joists:

$H = 120$ when length of split is approximately 2-1/4".

$H = 80$ when length of split is approximately 4-1/2".

For 4"-thick pieces of Select Structural, Construction, and Standard grades used as joists:

$H = 120$ when length of split is approximately 3".

$H = 80$ when length of split is approximately 6".

E. Value applies to pieces used as planks. For 2"-thick pieces of Construction and Standard grades used as joists:

$H = 120$ when length of split is approximately equal to 1/2 the width of piece.

$H = 100$ when length of split is approximately equal to the width of piece.

$H = 70$ when length of split is approximately equal to 1-1/2 times width of piece.

For 3"-thick pieces of Select Structural, Construction, and Standard grades used as joists:

$H = 120$ when length of split is approximately 2-1/4".

$H = 80$ when length of split is approximately 4-1/2".

For 4"-thick pieces of Select Structural, Construction, and Standard grades used as joists:

$H = 120$ when length of split is approximately 3".

$H = 80$ when length of split is approximately 6".

F. For beams and stringers and for posts and timbers:

$H = 120$ when length of split is equal to 1/2 the nominal narrow face dimension.

$H = 100$ when length of split is equal to the nominal narrow face dimension.

$H = 80$ when the length of split is equal to 1-1/2 times the nominal narrow face dimension.

G. The allowable unit stresses for tension parallel to grain t and for compression parallel to grain c given for these joist and plank and beam and stringer grades are applicable when the following additional provisions are applied to the grades:

The sum of the sizes of all knots in any 6 in. of the length of the piece shall not exceed twice the maximum permissible size of knot. Two knots of maximum permissible size shall not be within the same 6 in. of length of any face.

H. These grades applicable to 2" thickness only. The allowable unit stresses for tension parallel to grain t and for compression parallel to grain c given for these joist and plank and beam and stringer grades are applicable when the following additional provisions are applied to the grades:

The sum of the sizes of all knots in any 6 in. of the length of the piece shall not exceed twice the maximum permissible size of knot. Two knots of maximum permissible size shall not be within the same 6 in. of length of any face.

I. Value applies to pieces used as planks. For 2"-thick pieces of Construction and Standard grades used as joists:

$H = 100$ when length of split is approximately equal to 1/2 the width of piece.

$H = 80$ when length of split is approximately equal to the width of the piece.

$H = 60$ when length of split is approximately equal to 1-1/2 times the width of piece.

For 3"-thick pieces of Select Structural, Construction, and standard grades used as joists:

$H = 100$ when length of split is approximately 2-1/4".

$H = 70$ when length of split is approximately 4-1/2".

For 4"-thick pieces of Select Structural, Construction, and Standard Grade used as joists:

$H = 100$ when length of split is approximately 3".

$H = 70$ when length of split is approximately 6".

J. For beams and stringers and for posts and timbers:

$H = 100$ when length of split is equal to 3/4 nominal narrow face dimension.

$H = 90$ when length of split is equal to the nominal narrow face dimension.

$H = 70$ when length of split is equal to 1-1/2 times the nominal narrow face dimension.

K. All stress grades under the 1956 Grading Rules are all-purpose grades and apply to all sizes. Pieces so graded may be cut to shorter lengths without impairment of the stress rating of the shorter pieces.

Grade restrictions provided by the 1956 Grading Rules apply to the entire length of the piece, and each piece is suitable for use in continuous spans, over double spans, or under concentrated loads, without regrading for special shear or other special stress requirements.

The following apply to lumber in service under wet conditions or where the moisture content is at or above fiber saturation point, as when continuously submerged: (a) The allowable unit stresses in bending, tension parallel to grain, and horizontal shear shall be limited to all thicknesses to the stresses indicated for thickness of 5" and up. (b) The allowable unit stresses for compression parallel to grain shall be limited to the stresses indicated for thicknesses of 5" and up reduced by 10%. (c) The allowable unit stresses for compression perpendicular to grain shall be reduced one third. (d) The values for modulus of elasticity shall be reduced one eleventh.

L. These grades meet the requirements for density. KD= Kiln dried in accordance with the provisions of the 1956 Grading Rules. Longleaf may be specified by substituting "Longleaf" for "Dense" in the grade name, and, when so specified, the same allowable stresses shall apply.

M. KD= Kiln dried in accordance with the provisions of the 1956 Grading Rules.

N. These grades meet the requirements for density. Longleaf may be specified by substituting "Longleaf" for "Dense" in the grade name, and, when so specified, the same allowable stresses shall apply. SR= Stress rated.

O. These stresses apply for loading either on narrow face or on wide face.

*From "National Design Specification for Stress-Grade Lumber and Its Fastenings," by National Lumber Manufacturers Association, 1957 Edition.

STRUCTURAL-GENERAL-UNIT STRESSES-6

TABLE A - ALLOWABLE UNIT STRESSES FOR STRUCTURAL GLUED LAMINATED LUMBER*

| Combination Number | Outer Laminations | | Inner Laminations | Extreme Fiber in Bending $f_{1,2}$ | | Tension Parallel to Grain t^1 | | Compression Parallel to Grain c^1 | | Horizontal Shear H | Compression Perpendicular to Grain c_{\perp} |
|--|-----------------------------------|-------------------|-------------------------|------------------------------------|--------------------------|---------------------------------|--------------------------|-------------------------------------|--------------------------|----------------------|--|
| | Grade | Number, Each Side | | Grade | From 4 to 14 Laminations | 15 or More Laminations | From 4 to 14 Laminations | 15 or More Laminations | From 4 to 14 Laminations | | |
| PART I - DRY CONDITIONS OF USE³ | | | | | | | | | | | |
| DOUGLAS-FIR, COAST REGION⁴ | | | | | | | | | | | |
| 1 | Clear (Dense) ⁵ | One | Dense Select Structural | 3000 | 3000 | 3000 | 3000 | 2400 | 2500 | 165 | 450 |
| 2 | Clear (Dense) ⁵ | One | Dense Construction | 3000 | 3000 | 2600 | 3000 | 2200 | 2300 | 165 | 450 |
| 3 | Dense Select Structural | All | Dense Select Structural | 2800 | 3000 | 3000 | 3000 | 2400 | 2500 | 165 | 450 |
| 4 | Clear (Close-Grain) ⁵ | One | Select Structural | 2800 | 2800 | 2800 | 2800 | 2200 | 2200 | 165 | 415 |
| 5 | Select Structural | All | Select Structural | 2600 | 2800 | 2800 | 2800 | 2200 | 2200 | 165 | 415 |
| 6 | Select Structural | Two | Construction | 2600 | 2600 | 2600 | 2600 | 2000 | 2000 | 165 | 415 |
| 7 | Clear (Medium Grain) ⁵ | One | Construction | 2600 | 2600 | 2200 | 2400 | 1900 | 2000 | 165 | 385 |
| 8 | Dense Construction | All | Dense Construction | 2400 | 2600 | 2600 | 3000 | 2200 | 2300 | 165 | 450 |
| 9 | Dense Construction | 1/14 of total | Construction | 2400 | 2600 | 2200 | 2400 | 1900 | 2000 | 165 | 450 |
| 10 | Select Structural | One | Construction | 2400 | 2600 | 2200 | 2400 | 1900 | 2000 | 165 | 415 |
| 11 | Select Structural | Two | Standard ⁹ | 2600 | 2600 | 2400 | 2400 | 2000 | 2000 | 165 | 415 |
| 12 | Clear (Medium Grain) ⁵ | One | Standard ⁹ | 2200 | 2200 | 2000 | 2400 | 1800 | 1900 | 165 | 385 |
| 13 | Select Structural | One | Standard ⁹ | 2200 | 2200 | 2000 | 2400 | 1800 | 1900 | 165 | 415 |
| 14 | Construction | All | Construction | 2000 | 2200 | 2200 | 2400 | 1900 | 2000 | 165 | 385 |
| 15 | Construction | One | Standard ⁹ | 2000 | 2200 | 2000 | 2400 | 1800 | 1900 | 165 | 385 |
| 16 | Standard | All | Standard ⁹ | 1600 | 2000 | 2000 | 2400 | 1800 | 1900 | 165 | 385 |
| PINE, SOUTHERN^{6,7} | | | | | | | | | | | |
| 1-1 | No. 1 Dense | All | No. 1 Dense | 3000 | 3000 | 3000 | 3000 | 2400 | 2500 | 200 | 450 |
| 1-2 | B & B Dense | One | No. 1 | 3000 | 3000 | 2600 | 2600 | 2100 | 2100 | 200 | 450 |
| 1-3 | No. 1 Dense | 1/14 of total | No. 1 | 3000 | 3000 | 2600 | 2600 | 2100 | 2100 | 200 | 450 |
| 1-4 | B & B Dense | One | No. 2 Dense | 2800 | 2800 | 3000 | 3000 | 2400 | 2400 | 200 | 450 |
| 1-5 | No. 1 Dense | 1/5 of total | No. 2 Dense | 2800 | 3000 | 2800 | 3000 | 2300 | 2400 | 200 | 450 |
| 1-6 | No. 1 | All | No. 1 | 2600 | 2600 | 2600 | 2600 | 2100 | 2100 | 200 | 385 |
| 1-7 | B & B Dense | 1/14 of total | No. 2 | 2400 | 2800 | 2600 | 2600 | 2000 | 2000 | 200 | 450 |
| 1-8 | B & B | One | No. 2 | 2400 | 2400 | 2600 | 2600 | 2000 | 2000 | 200 | 385 |
| 1-9 | No. 1 | 1/5 of total | No. 2 | 2400 | 2600 | 2400 | 2600 | 2000 | 2000 | 200 | 385 |
| 1-10 | No. 2 Dense | All | No. 2 Dense | 2000 | 2600 | 2600 | 3000 | 2200 | 2300 | 200 | 450 |
| 1-11 | No. 2 Dense | 1/14 of total | No. 2 | 2000 | 2600 | 2200 | 2600 | 1900 | 2000 | 200 | 450 |
| 1-12 | No. 2 | All | No. 2 | 1800 | 2200 | 2200 | 2600 | 1900 | 2000 | 200 | 385 |
| 1-13 | No. 1 | 1/5 of total | No. 3 † | 1800 ‡ | 2400 | 2400 ‡ | 2500 | 1900 ‡ | 2000 | 200 | 385 |
| 1-14 | No. 2 | 1/5 of total | No. 3 † | 1800 ‡ | 2200 | 2200 ‡ | 2300 | 1900 ‡ | 1900 | 200 | 385 |
| PART II - WET CONDITIONS OF USE⁸ | | | | | | | | | | | |
| DOUGLAS-FIR, COAST REGION⁴ | | | | | | | | | | | |
| 1 | Clear (Dense) ⁵ | One | Dense Select Structural | 2400 | 2400 | 2400 | 2400 | 1700 | 1800 | 145 | 305 |
| 2 | Clear (Dense) ⁵ | One | Dense Construction | 2400 | 2400 | 2000 | 2400 | 1600 | 1700 | 145 | 305 |
| 3 | Dense Select Structural | All | Dense Select Structural | 2200 | 2400 | 2400 | 2400 | 1700 | 1800 | 145 | 305 |
| 4 | Clear (Close-Grain) ⁵ | One | Select Structural | 2200 | 2200 | 2200 | 2200 | 1600 | 1600 | 145 | 275 |
| 5 | Select Structural | All | Select Structural | 2000 | 2200 | 2200 | 2200 | 1600 | 1600 | 145 | 275 |
| 6 | Select Structural | Two | Construction | 2000 | 2200 | 2000 | 2000 | 1500 | 1500 | 145 | 275 |
| 7 | Clear (Medium Grain) ⁵ | One | Construction | 2000 | 2000 | 1800 | 2000 | 1400 | 1400 | 145 | 260 |
| 8 | Dense Construction | All | Dense Construction | 2000 | 2200 | 2000 | 2400 | 1600 | 1700 | 145 | 305 |
| 9 | Dense Construction | 1/14 of total | Construction | 2000 | 2200 | 1800 | 2000 | 1400 | 1400 | 145 | 305 |
| 10 | Select Structural | One | Construction | 2000 | 2000 | 1800 | 2000 | 1400 | 1400 | 145 | 275 |
| 11 | Select Structural | Two | Standard ⁹ | 2000 | 2000 | 2000 | 2000 | 1400 | 1400 | 145 | 275 |
| 12 | Clear (Medium Grain) ⁵ | One | Standard ⁹ | 1800 | 1800 | 1600 | 1800 | 1300 | 1400 | 145 | 260 |
| 13 | Select Structural | One | Standard ⁹ | 1800 | 1800 | 1600 | 1800 | 1300 | 1400 | 145 | 275 |
| 14 | Construction | All | Construction | 1600 | 1800 | 1800 | 2000 | 1400 | 1400 | 145 | 260 |
| 15 | Construction | One | Standard ⁹ | 1600 | 1800 | 1600 | 1800 | 1300 | 1400 | 145 | 260 |
| 16 | Standard | All | Standard ⁹ | 1200 | 1600 | 1600 | 1800 | 1300 | 1400 | 145 | 260 |
| PINE, SOUTHERN^{6,7} | | | | | | | | | | | |
| 2-1 | No. 1 Dense | All | No. 1 Dense | 2400 | 2400 | 2400 | 2400 | 1800 | 1800 | 175 | 300 |
| 2-2 | B & B Dense | One | No. 1 | 2400 | 2400 | 2000 | 2000 | 1500 | 1500 | 175 | 300 |
| 2-3 | No. 1 Dense | 1/14 of total | No. 1 | 2400 | 2400 | 2000 | 2000 | 1500 | 1500 | 175 | 300 |
| 2-4 | B & B Dense | One | No. 2 Dense | 2200 | 2200 | 2400 | 2400 | 1700 | 1700 | 175 | 300 |
| 2-5 | No. 1 Dense | 1/5 of total | No. 2 Dense | 2200 | 2400 | 2200 | 2400 | 1700 | 1700 | 175 | 300 |
| 2-6 | No. 1 | All | No. 1 | 2000 | 2000 | 2000 | 2000 | 1500 | 1500 | 175 | 260 |
| 2-7 | B & B Dense | 1/14 of total | No. 2 | 1800 | 2200 | 2000 | 2000 | 1500 | 1500 | 175 | 300 |
| 2-8 | B & B | One | No. 2 | 1800 | 2000 | 2000 | 2000 | 1500 | 1500 | 175 | 260 |
| 2-9 | No. 1 | 1/5 of total | No. 2 | 2000 | 2000 | 2000 | 2000 | 1400 | 1500 | 175 | 260 |
| 2-10 | No. 2 Dense | All | No. 2 Dense | 1600 | 2000 | 2000 | 2400 | 1600 | 1700 | 175 | 300 |
| 2-11 | No. 2 Dense | 1/14 of total | No. 2 | 1600 | 2000 | 1800 | 2000 | 1400 | 1400 | 175 | 300 |
| 2-12 | No. 2 | All | No. 2 | 1400 | 1800 | 1800 | 2000 | 1400 | 1400 | 175 | 260 |
| 2-13 | No. 1 | 1/5 of total | No. 3 † | 1400 ‡ | 1900 | 1900 ‡ | 2000 | 1400 ‡ | 1400 | 175 | 160 |
| 2-14 | No. 2 | 1/5 of total | No. 3 † | 1400 ‡ | 1700 | 1800 ‡ | 1900 | 1400 ‡ | 1400 | 175 | 260 |

1. For special slope of grain requirements see applicable specifications listed in Notes 4 and 6.
 2. The allowable unit stresses in bending apply only when the wide faces of the laminations are placed normal to the direction of the load. For allowable stresses in bending when the loading is applied parallel to the planes of the laminations, see the applicable specification indicated in Notes 4 and 6.
 3. The Modulus of Elasticity E is 1,800,000 p.s.i. for dry conditions of use.
 4. "Standard Specifications for Structural Glued Laminated Douglas-Fir (Coast Region) Lumber", by West Coast Lumbermen's Association, applies.
 5. The rate of growth and density requirements of inner laminations shall apply to clear outer laminations.
 6. "Standard Specifications for Structural Glued Laminated Southern Pine Lumber", by Southern Pine Inspection Bureau, applies.
 7. In grade combinations 1-1, 1-6, 2-1, and 2-6 no provision has been made for use of B & B grade in outer laminations because higher stress rating would not be justified. If, in these combinations, B & B quality is desired for one or both faces of a member to improve appearance, it should be particularly specified, keeping in mind that B & B Dense is required when inner laminations are dense.
 8. The Modulus of Elasticity E is 1,600,000 p.s.i. for wet conditions of use.
 9. When the grade of standard is used, the lumber must be of medium grain.
 * Adapted from "National Design Specification for Stress-Grade Lumber and its Fastenings" 1957 Edition, by National Lumber Manufacturers Association.
 † Pitch, pitch pockets, pitch streaks, redheart, wane, shakes and decay in No. 3 southern pine boards and dimension used for structural gluing shall not exceed that permitted in No. 2 dimension.
 ‡ 6-14 laminations.

NOTE: Members with intermediate working stresses will satisfy most design requirements. Members with the highest working stresses are available when special strength requirements are needed. Where larger sizes are desired, those combinations with lower stresses should be used.

STRUCTURAL-GENERAL-UNIT STRESSES-7

TABLE A - WORKING STRESSES IN STONE MASONRY

| Kind of Masonry | Compression, Gross Area of Cross Section | | | |
|-----------------|--|-------------------------------|---------------------------------------|-------------------------------|
| | New York City 1957 | | Dept of Commerce 1955 | |
| | Cement ¹ Lime Mortar | Cement ² Mortar | Cement ¹ Lime Mortar | Cement ² Mortar |
| Granite | 640 | 800 | 640 | 800 |
| Gneiss | 600 | 750 | - | - |
| Limestone | 400 | 500 | 400 | 300 |
| Marble | 400 | 500 | 400 | 500 |
| Sandstone | 250 | 300 | 320 | 400 |
| Bluestone | 300 | 400 | - | - |
| Natural Stone | Cut | 110 | 140 | - |
| | Uncut | 110 | 140 | - |

TABLE B - WORKING STRESSES IN REINFORCED SOLID AND HOLLOW UNIT MASONRY*

| Type of Stress | | |
|--|--|-------------|
| Compression, axial | | 0.20 f'mt |
| Compression, flexural | | 0.33 f'mt |
| Shear, no shear reinforcement | | 0.02 f'mt |
| Shear, shear reinforcement Taking 2/3 of entire shear | | 0.04 f'mt |
| Bearing | | 0.25 f'mt |
| Modulus of elasticity | | 1000 f'mt |
| Bond | | |
| Plain bars | | 30 p.s.i. ‡ |
| Deformed bars | | 90 p.s.i. § |

TABLE C - WORKING STRESSES IN UNREINFORCED UNIT MASONRY*

| Material: Grade of Unit | Stresses (in p.s.i. of Gross Area) | | | |
|--|------------------------------------|----------------------------------|----------------------------|----------------------------------|
| | Type-A Mortar ³ | | Type-B Mortar ⁴ | |
| | Compression | Tension in Flexure or Shear † | Compression | Tension in Flexure or Shear † |
| <i>Plain solid-brick masonry:</i> f'm = 4500 p.s.i., plus f'm = 2500 - 4500 p.s.i. f'm = 1500 - 2500 p.s.i. | 250 | 10 | 200 | 7.5 |
| | 175 | 10 | 140 | 7.5 |
| | 125 | 10 | 100 | 7.5 |
| <i>Hollow unit masonry</i> | 85 | 6 | 70 | 5 |
| <i>Cavity wall masonry:</i> Solid units, 2500 p.s.i., plus Solid units, 1500 - 2500 p.s.i. Hollow units | 140 | 6 | 110 | 5 |
| | 100 | 6 | 80 | 5 |
| | 70 | 6 | 50 | 5 |
| <i>Stone masonry:</i> Cast stone Natural stone | 400 | 4 | 320 | 4 |
| | 140 | 4 | 100 | 4 |
| <i>Solid-concrete brick units:</i> Grade A Grade B | 175 | 6 | 125 | 6 |
| | 125 | 6 | 100 | 6 |

NOTE: 1. Cement lime mortar composed of 1 part Portland cement, 1 part hydrated lime, to not more than 6 parts sand, proportioned by volume.

2. Cement mortar: a mortar composed of 1 part Portland cement to not more than 3 parts of sand, proportioned by volume, with a allowable addition of hydrated lime, or lime putty, not to exceed 15% of the cement by volume.

3. Type A: by volume, 1 part Portland cement, 4½ parts sand maximum, and ½ part hydrated lime maximum.

4. Type B: by volume, 1 part Portland cement, 6 parts sand maximum, and 1 part hydrated lime maximum.

* Tables B and C from Uniform Building Code, 1955.

† f'm equals compressive strength of masonry at 28 days.

‡ These stresses may be doubled with continuous inspection.

§ With continuous inspection, 130 p.s.i. may be used.

|| Net area, all others gross cross-sectional area.

STRUCTURAL-GENERAL-PROPERTIES OF MATERIALS

TABLE A - PROPERTIES OF STRUCTURAL MATERIALS

| Substance | Ultimate Stress, p.s.i. | Yield Point, p.s.i. | Modulus of Elasticity, p.s.i. | Coefficient of Linear Expansion for 1° F. |
|--|-----------------------------|---------------------|-------------------------------|---|
| Aluminum, Structural alloy 2014-T6 | 65,000† | 32,000†c | 10,600,000 | 0.00000128 |
| Structural alloy 6061-T6 | 42,000† | 35,000†c | 10,000,000 | 0.00000130 |
| Iron, Cast, gray | 18,000 - 24,000† | | | |
| Wrought | 25,000 - 33,000†B 48,000 | | 28,000,000 | 0.0000067 |
| Steel, Structural A.S.T.M. A7* | 60,000 - 72,000† | 33,000† | 29,000,000 | 0.0000063 |
| Structural A.S.T.M. A8 (3% to 4% nickel) | 90,000 - 115,000† | 55,000† | 29,000,000 | 0.0000063 |
| Structural A.S.T.M. A94 (0.2% silicon) | 80,000 - 95,000† | 45,000† | 29,000,000 | 0.0000063 |
| Structural A.S.T.M. A242 (low alloy) | 70,000† | 50,000† | 29,000,000 | 0.0000063 |
| Structural A.S.T.M. A373 (for welding) | 58,000 - 75,000† | 32,000† | 29,000,000 | 0.0000077 |
| Structural U.S. steel (T-1) | 105,000 - 135,000† | 90,000† | 29,000,000 | |
| Clay, Brick | 1000c, 200T, 600B | | 2,000,000 | 0.0000031 |
| Masonry, Granite | 420c, † 600B† | | | |
| Limestone & bluestone | 350c, † 500B† | | | |
| Sandstone | 280c, † 400B† | | | |
| Rubble | 140c, † 250B† | | | 0.0000035 |
| Stone, Bluestone | 12,000c, 1200†, 2500B | | 7,000,000 | 0.00000 |
| Granite / gneiss | 12,000c, 1200†, 1600B | | 7,000,000 | 0.0000047 |
| Limestone / marble | 8,000c, 800†, 1500B | | 7,000,000 | 0.0000044 / 0.0000056 |
| Sandstone | 5,000c, 150†, 1200B | | 3,000,000 | 0.0000061 |
| Slate | 10,000c, 3000†, 5000B | | 14,000,000 | 0.0000058 |
| Wood, Douglas fir | | | 1,760,000 | 0.0000021 parallel 0.0000032 perpendicular |
| Southern pine | | | 1,760,000 | 0.0000003 parallel 0.0000019 perpendicular |
| Concrete | | | 1000 f'c | 0.0000079 |

- t = ultimate stress tension.
- c = ultimate stress compression.
- B = ultimate stress bending.
- * = for welding A.S.T.M. A-373 preferred.
- † = safe working stress.

STRUCTURAL-GENERAL-LIVE LOADS - I

TABLE A - LIVE LOADS IN POUNDS PER SQUARE FOOT

| Occupancy | American Standards Association, 1955 | Nat. Bd. of Fire Underwriters, 1955 | Pacific Coast Bd. Officials Conference, † 1955 | Southern Std. Bldg. Code, * 1954 | New York, 1957 | Chicago, * 1956 | Philadelphia* 1956 | Dallas, 1951 | Detroit* |
|--|---|---|--|--|---|--|--|---|--|
| Dwellings, apartment and tenement houses, hotels, clubhouses, hospitals, and places of detention: Dwellings, private rooms, and apartments Public corridors, lobbies, and dining rooms | 40 ¹ 100 ² | 40 ¹¹ 100 ² | 40 100 ¹⁷ | 40 ²⁵ 100 | 40 ²⁷ 100 | 40 100 | 40 100 | 40 ⁴³ 80 | 40 100 |
| School buildings: Classrooms and rooms of similar use Corridors and public parts of building | 40 100 ³ | 40 ³ 100 | 40 100 ¹⁸ | 40 100 | 60 ²⁸ 100 | 40 100 | 50 ³⁸ 100 | 50 ⁴⁴ 80 | 50 ³⁸ 100 |
| Theaters, assembly halls, and other places of assemblage: Auditoriums with fixed seats Lobbies, passageways, gymnasiums, grandstands and auditoriums of places of assemblage without fixed seats | 60 100 ⁴ | 60 100 ⁴ | 50 100 ⁴ | 50 100 ⁴ | 75 ²⁹ 100 | 60 100 | 60 ³⁹ 100 | 50 100 ⁴⁵ | 60 100 |
| Office Buildings: Office space Corridors and other public places | 80 ⁵ 100 | 80 100 | 50 ^{12,19} 100 | 50 100 | 50 ²⁷ 100 ³⁰ | 50 ^{12,19} 100 | 60 100 | 50 80 | 50 ⁵¹ 100 |
| Workshops, factories, and mercantile establishments Manufacturing - light Manufacturing - heavy Storage - light Storage - heavy Stores - retail Stores - wholesale | 125 125 125 250 100 ⁶ 125 | 125 ¹² 125 ¹² 125 ¹² 250 ¹² 75 ¹³ 125 ¹² | 75 125 ²⁰ 125 250 ²¹ 75 100 | 100 150 125 250 75 100 | 120 120 ³¹ 120 120 ³¹ 75 ³² 120 | 100 ³⁶ 100 ³⁶ 100 ³⁶ 100 ³⁶ 100 ³⁶ 100 ³⁶ | 120 ⁴⁰ 200 ⁴⁰ 120-150 ⁴⁰ 200 ⁴⁰ 100 ⁴⁰ 100 ⁴⁰ | 75 100-150 ⁴⁶ 125 125 ⁴⁷ 100 100 | 125 ⁵² 125 ⁵³ 125 ⁵³ 250 100 ⁵² 125 |
| Garages: All types of vehicles Passenger cars only | 100 ⁷ | 14 100 ¹² | 100 ²² 50 | 120 ²² 75 | 175 ³³ 75 ⁵ | 100 ²² 50 ¹³ | 100 ⁸ 75 | 100 ⁴⁸ 80 ⁴⁸ | 175 ⁵⁴ 80 ⁵⁵ |
| All stairs and fire escapes, except in private residences Roofs (flat) Sidewalks Wind | 100 20 250 ^{8,9} - | 100 ¹⁵ 20 250 ⁸ 15-40 ¹⁶ | 100 20 ²³ 250 15-20 ²⁴ | 100 20 200 ⁸ 10-40 ²⁶ | 100 40 300 ³⁴ 20 ³⁵ | 100 25 20 ³⁷ | 100 30 150 ⁴¹ 15-25 ⁴² | 100 30 ⁴⁹ 300 ⁸ 20 ⁵⁰ | 100 ⁵⁶ 30 250 20 ⁵⁷ |

* Taken from C.R.S.I., 1957; others from local codes. †Or Uniform Building Code, 1955.

FOOTNOTES FOR TABLE A

- 30 for second floor dwellings and habitable attics; 20 for uninhabitable attics; 60 for operating rooms.
- 60 for corridors in apartment and tenement houses and public corridors in hotels; 40 for private corridors in hotels.
- 60 for library reading rooms; 150 for stack rooms.
- 150 for armories and stage floors.
- Or 2000 concentrated.
- 75 for upper floors.
- Floors shall be designed to carry 150% of the maximum wheel load anywhere on the floor.
- Or 8000 concentrated.
- 100 for yards and terraces for pedestrians only.
- See p. 1-14.
- On first floor, 40 p.s.f.; upper floors for dwellings 30 p.s.f.
- Or 2000 on any space 2½ ft. square.
- 100 on first floor and alternate of 2000 lb. on area 2½ feet square.
- 100 p.s.f. for passenger cars. Trucks: 150 p.s.f. (3 to 10 tons including load), 200 p.s.f. (over 10 tons including load). Concentrated load; 150% maximum wheel load for passenger cars; 125% maximum axle load for trucks.
- 300 lb. on 2½ ft. square at any location.

STRUCTURAL - GENERAL - LIVE LOADS - 2

FOOTNOTES FOR TABLE A, p. 1-10 (Continued)

16. 15 p.s.f. for building height less than 30 ft.; increase to 40 p.s.f. for building height equal to or greater than 1200 feet.
17. 40 for private corridors in hotels; 50 for rest rooms.
18. 60 for library reading rooms; 125 for stack rooms.
19. Where partitions are subject to change 20 p.s.f. to all other loads.
20. 100 for composing and linotype rooms; 150 for press rooms.
21. 250 minimum. Load to be determined by use.
22. Or concentrated rear wheel of loaded truck in any position.
23. 20 p.s.f. for under 200 sq. ft.; 16 p.s.f. for 201 to 600 sq. ft.; 12 p.s.f. for over 600 sq. ft. loaded area on a member.
24. 15 for portions below 60 ft.; 20 for portions above 60 ft. 30 lb. for roof tanks, signs, and exposed roof structures.
25. 30 p.s.f. for one-story, one- and two-family dwellings.
26. 10 p.s.f. for portions below 30 ft.; 40 p.s.f. for portions above 400 ft. in Southern Inland Regions. Varies from 25 to 50 p.s.f. for Southern Coastal Regions.
27. Including corridors.
28. For rooms with fixed seats or classrooms not exceeding 900 sq. ft. with movable seats; 120 for library stack rooms.
29. 60 for churches.
30. Including entire first floor.
31. The minimum for storage or manufacturing is 120 p.s.f., but floors must be designed for any heavier loads contemplated and for any concentrations.
32. 100 for entire first floor.
33. Or 6000 concentrated. Trucking space and driveways 12,000 concentrated; (For beams, columns, and girders 120 p.s.f. live load.)
34. Or 12,000 concentrated for driveways over sidewalks.
35. 20 p.s.f. for structures over 100 ft. high. 30 p.s.f. for tank towers, stacks, and isolated chimneys.
36. The minimum for storage or manufacturing is 100 p.s.f., but floors must be designed for any heavier loads contemplated and for any concentrations.
37. 20 for buildings less than 300 ft. high; add 0.025 p.s.f. per ft. above 300 ft.
38. Only school classrooms with fixed seats. (Removable seats 80 p.s.f.)
39. Churches only.
40. Every floor beam 4000 concentrated.
41. Interior courts, sidewalks, etc., not accessible to a driveway.
42. 15 p.s.f. up to 50 ft. high, 20 p.s.f. from 50 to 200 ft., 25 p.s.f. over 200 ft. high. Roofs over 30 degrees, 20 p.s.f. on windward side, 10 p.s.f. on leeward.
43. 100 for public rooms; 40 for guest corridors in hotels; 50 for rest rooms.
44. 60 for laboratories, library reading rooms; 20 plus actual weight of stack and contents.
45. 150 for armories and theater stages; 120 for drill rooms.
46. 100 for composing and linotype rooms; 150 for press rooms; for all others, load is determined by use.
47. Load is determined by use.
48. For unloaded vehicles.
49. 25 for flat roofs without parapet walls.
50. 20 for structures less than 300 ft. high. Above 300 ft., $p = 20 + (H - 300) \times 0.025$ for tanks, signs, and exposed structures 30 lb.
51. Above first floor including corridors.
52. 125 for first floor.
53. 150 for first floor.
54. Or 2500 lb. concentrated on area 6 in. square with such concentrations spaced alternately 2 ft. 4 in. and 4 ft. 8 in. in one direction and 5 ft. and 10 ft. in the other direction.
55. Only structures with clear headroom of 8 ft. 6 in. or less. Or 1500 lb. concentrated, spaced as in note 54.
56. 50 for dwellings and apartments under 3 stories.
57. For buildings less than 500 ft. high.

TABLE A - LIVE LOAD REDUCTIONS - NEW YORK CITY BUILDING CODE, 1956

- (a) In structures for storage purposes all columns, piers, walls, and foundations may be designed for 85% of live load.
- (b) In structures intended for other purposes, live load reductions for columns, piers, walls, and foundations are as follows: 100% L.L. on roof, 85% top floor, 80% next floor, and 5% reduction for each successive lower floor, provided that in all cases at least 50% of live load is assumed.
- (c) Girder members, except in roofs and as specified below, carrying floor loads the equivalent of 200 sq. ft. or more may be designed for 85% of live load.
- (d) For trusses and girders supporting columns and for determining area of footings the full dead load and live load may be taken with the reductions as permitted above.

STRUCTURAL - GENERAL - LIVE LOADS - 3

TABLE A - MISCELLANEOUS LIVE LOADS

GRANDSTAND LOADING

LIVE LOAD 100 p.s.f. of gross horizontal projection. 120 lb./lin. ft. for designing seats and footboards.

HORIZONTAL FORCES A horizontal swaying force parallel to the seats of 24 lb./ft. and perpendicular to the seats of 10 lb./ft.

WIND 30 p.s.f. on vertical projection. (See also p. 1 - 14.)

WIND STRESS REDUCTIONS

CONCRETE STRUCTURES Increase allowable stresses one third where wind loads are added to live and dead loads.†

STEEL STRUCTURES For members subject only to wind, increase allowable stresses one third. For members subject to wind and other forces, increase one third, but section to be not less than that required for dead, live, and impact loads.‡

WOOD STRUCTURES Increase allowable stresses one third, but section to be not less than that required for dead and live loads.§

IMPACT‡

For structures carrying live loads which induce impact or vibration, the assumed live load shall be increased sufficiently to provide for same. If not otherwise specified, the increase shall be:

| | |
|---|------|
| For supports of elevators | 100% |
| For traveling crane support girders and their connections | 25 |
| For supports of light machinery, shaft - or motor-driven, not less than | 20 |
| For supports of reciprocating machinery or power units, not less than | 50 |
| For threaded hanger rods supporting floors and balconies | 33½ |

CRANE RUNWAY HORIZONTAL FORCES‡

The lateral force on crane runways to provide for the effect of moving crane trolleys shall, if not otherwise specified, be 20% of the sum of the weights of the lifted load and of the crane trolley (but exclusive of other parts of the crane), applied at the top of rail one half on each side of runway; and shall be considered as acting in either direction normal to the runway rail.

The longitudinal force shall, if not otherwise specified, be taken as 10% of the maximum wheel loads of the crane applied at the top of rail.

UPLIFT ON ROOFS

Design roof for factories, hangers, armories, etc., which have large open interiors for an uplift of 25 p.s.f.

FOOTNOTES

* American Standards Association, Places of Outdoor Assembly.

† American Concrete Institute, 1956.

‡ American Institute of Steel Construction, 1954.

§ National Lumber Manufacturers Association, National Design Specifications for Stress-Grade Lumber & its Fastenings, 1955.

STRUCTURAL-GENERAL-LIVE LOADS-4

TABLE A - SNOW LOAD*

Where no values for snow loads appear on the map, they have been omitted because of irregular distribution associated with rugged terrain. Consult local Weather Bureau or Building Code.

The value of 20 lb. on the projected area has been selected as a minimum because it has been considered necessary to provide for occasional loading due to workmen and materials during repair operations. Where load exceeds 20 p.s.f., the excess may be reduced from its full value at a 20-degree slope to zero at a 60-degree slope.

For big flat roofs and high parapets special attention is required.

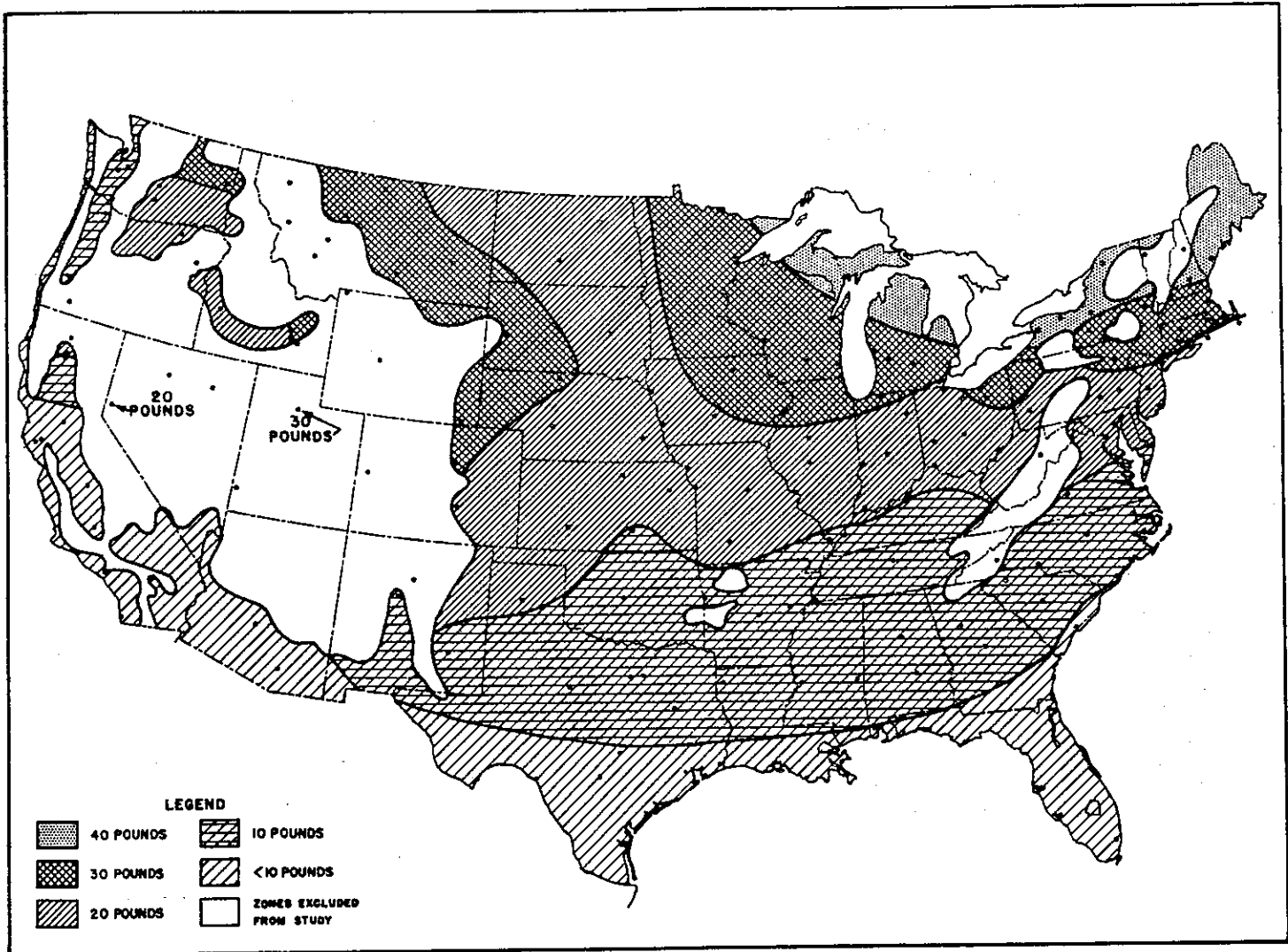


FIG. B. ESTIMATED WEIGHT OF SEASONAL SNOWPACK EQUALED OR EXCEEDED ONE YEAR IN TEN (p.s.f.) †

* Based on American Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58. 1-1955, by American Standards Association.

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STRUCTURAL-GENERAL-LIVE LOADS-5

MINIMUM DESIGN PRESSURE

Buildings, chimneys, tanks, and solid towers shall be designed and constructed to withstand the applicable horizontal pressures shown in Tables B, C, or D, allowing for wind in any direction. The height is to be measured above the average level of the ground adjacent to the building, chimney, tank, or solid tower. Figures do not provide for extreme wind conditions of short duration such as tornadoes (gusts are included). The factors in Table B or C already take into consideration the 1.3 shape factor used in determining the wind pressures noted in Fig. A. The design pressure selected from Table B should be multiplied by the correct factor from Tables C or D.

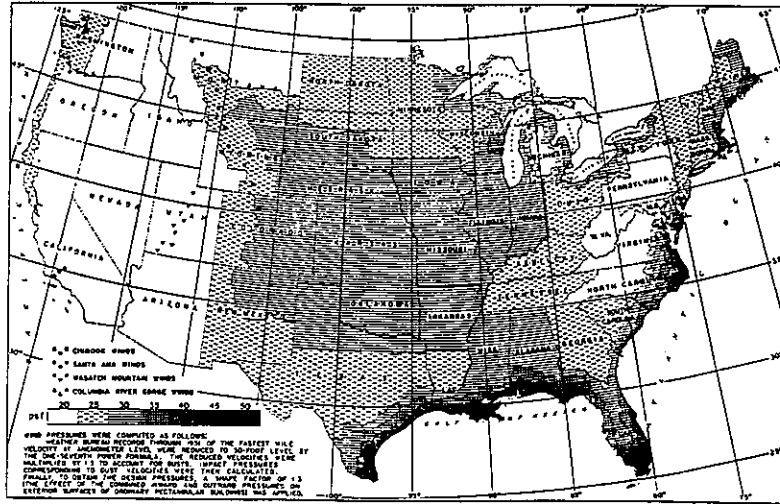


FIG. A. MINIMUM ALLOWABLE RESULTANT WIND PRESSURES*

TABLE B - WIND PRESSURES FOR VARIOUS HEIGHT ZONES ABOVE GROUND*

| Height of Zone, ft. | Wind-pressure-map Areas, p.s.f. | | | | | | |
|---------------------|---------------------------------|----|----|----|-----|-----|-----|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| Less than 30 | 15 | 20 | 25 | 25 | 30 | 35 | 40 |
| 30 to 49 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| 50 to 99 | 25 | 30 | 40 | 45 | 50 | 55 | 60 |
| 100 to 499 | 30 | 40 | 45 | 55 | 60 | 70 | 70† |
| 500 to 1199 | 35 | 45 | 55 | 60 | 70 | 70† | 70† |
| 1200 and over | 40 | 50 | 60 | 70 | 70† | 70† | 70† |

NOTE: Recommended application:
 Windward face: $\frac{1.00}{1.30} = 77\%$
 Leeward face: $\frac{.30}{1.30} = 23\%$

†70-lb. upper limit recommendations of Dean Sherlock at American Society of Civil Engineers Convention, October 1957.

TABLE D - FACTORS FOR CHIMNEYS, TANKS, AND TOWERS*

| Horizontal Cross Section | Factor | |
|--------------------------|--------|--|
| Square or rectangular | 1.00 | |
| Hexagonal or octagonal | 0.80 | |
| Round or elliptical | 0.60 | |

EXAMPLE:

Given: Radio tower located in eastern New York State. Tower base 50' above average elevation of surrounding terrain. Find: Wind pressure P_t .

Procedure: From Fig. A, eastern New York State is in the 25 m.p.h. zone. From Table B, select pressures for various height zones as in Fig. E. From Table C, select the appropriate factor. Assume a 4-cornered tower with wind normal to one face and members angular. (Factor = 2.20.) Therefore, total pressures due to wind at various elevations are:
 Elev. 50 to 99 $P_t = 2.2 \times 30 = 66 \text{ p.s.f.} \times A$
 Elev. 100 to 200 $P_t = 2.2 \times 40 = 88 \text{ p.s.f.} \times A$

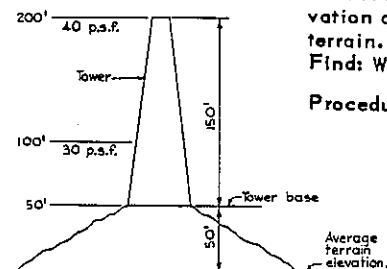


FIG. E

TABLE C - FACTORS FOR TRUSSED TOWERS*

Wind pressure on tower = $p \times A \times$ factor shown below.
 p = pressure from Fig. A, modified with Table B for tower height.
 A = total normal projected area of all the elements of one face of the tower.

| Type | Factor † | Illustrations |
|--|--------------|---------------|
| Wind normal to one face of tower, 4-cornered, flat or angular sections, steel or wood. | 2.20 | |
| 3-cornered, flat or angular sections, steel or wood | 2.00 | |
| Wind on corner, 4-cornered tower, flat or angular sections. | 2.40 | |
| Wind parallel to one face of 3-cornered tower, flat or angular sections. | 1.50 | |
| Wind on individual members. Cylindrical 2 in. or less in diameter. Cylindrical over 2 in. in diameter. | 1.00 0.80 | |
| Flat or angular sections | 1.30 | |

NOTE: Factors for towers with cylindrical elements are approximately two thirds of those for similar towers with flat or angular sections.

TABLE F - REQUIREMENTS FOR COMBINED LOADINGS ON ROOFS*

| Slope | Exterior load coefficients (factors to be applied to wind pressures specified in 5.1) | |
|---------------------|---|---------------|
| | Windward Slope | Leeward Slope |
| 20° or less | -0.60 | -0.45 |
| Between 20° and 30° | 0.06-1.8 | -0.45 |
| Between 30° and 60° | 0.015A-0.45 | -0.45 |
| Between 60° and 90° | 0.45 | -0.45 |

Positive values indicate an inward load; negative values, an outward load. A is the roof slope in degrees.

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†Although the factors vary with the solidity ratio, these factors in Table C may be considered as average values.

STRUCTURAL-GENERAL-WIND DESIGN

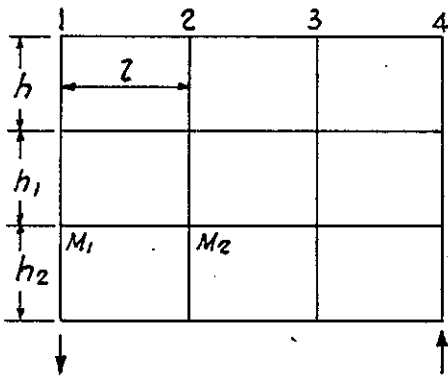
APPROXIMATE WIND DESIGN METHODS FOR MULTI-STORIED FRAME BUILDINGS

I- PORTAL METHOD

Assumptions:

1. Each bay an independent frame.
2. The point of contraflexure of each column is at midheight.
3. The point of contraflexure of each girder is at its midlength.
4. The horizontal shear on any plane is divided equally among the number of aisles. An outer column takes 1/2 the shear of an interior column.
5. The wind load is resisted by the frame.
6. All direct stress in outside columns.

NOTE:
See p.4-36 for Riveted Wind Connection Moments & Details.
See p.4-59 for Welded Wind Connection Moments & Details.



Let S = total shear in bay above floor line.
 S_1, S_2, S_3, S_4 = proportional shears taken on ea. col.
 Then: $S_1 + S_2 + S_3 + S_4 = S$ *
 $S_1 = S_4 = \frac{S}{6}$; $S_2 = S_3 = \frac{S}{3}$

Moment per girder connection = $\frac{S \times h_{\text{average}}}{\text{No. of girder connects.}}$

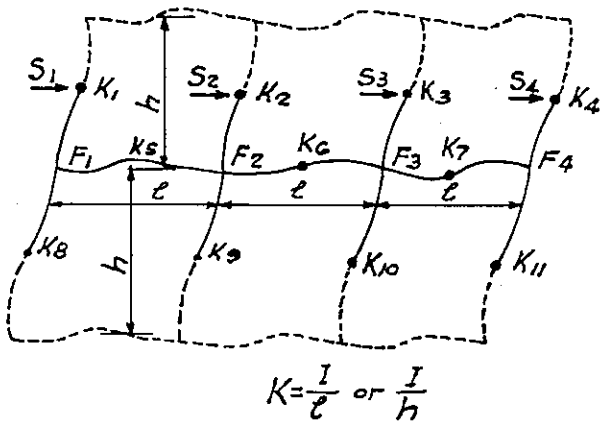
Given $S = 20$ Kips; $\frac{h_1 + h_2}{2} = 12'$

$M_1 = M_2 = \frac{20 \times 12}{6} = 40'$ Kips

* Shear may be proportioned to the moment of inertia of the column.

II - SHEAR DISTRIBUTION BY STIFFNESS OF CELLS OF RESISTANCE

AFTER E.E. SEELYE, E.N.R., MAR. 20, 1930.



$K = \frac{I}{\ell}$ or $\frac{I}{h}$

1. Total horizontal Shear = $S = S_1 + S_2 + S_3 + S_4$
2. Total Stiffness Coef. = $F = F_1 + F_2 + F_3 + F_4$
3. $F_1 = \frac{K_1(0 + K_5)}{0 + K_1 + K_5 + K_8}$
 $F_2 = \frac{K_2(K_5 + K_6)}{K_5 + K_2 + K_6 + K_9}$
 $F_3 = \frac{K_3(K_6 + K_7)}{K_6 + K_3 + K_7 + K_{10}}$
 $F_4 = \frac{K_4(K_7 + 0)}{K_7 + K_4 + 0 + K_{11}}$
4. $S_1 = \frac{F_1}{F} \times S$
 $S_2 = \frac{F_2}{F} \times S$
 $S_3 = \frac{F_3}{F} \times S$
 $S_4 = \frac{F_4}{F} \times S$

DIRECT STRESSES from wind in columns may be neglected, except in unusual cases where they exceed allowable wind overstress or require anchorage.

STRUCTURAL-GENERAL-FIREPROOFING REQUIREMENTS

TABLE A - SUGGESTED FIREPROOFING REQUIREMENTS*

| Protection of Structural Parts | | | | | Protection of Walls and Partitions | | | | | | | | | | | | | |
|--|--|--|------|----|------------------------------------|--|---|--|--|----|----|-------------|----|---|---|---|---|---|
| Member to Be Protected | Fireproofing Material | Minimum Thickness for Hour Ratings | | | | Material | Construction | Bearings [§] | | | | Non-Bearing | | | | | | |
| | | 4 | 3 | 2 | 1 | | | Minimum Thickness for Hour Ratings | | | | | | | | | | |
| | | 4 | 3 | 2 | 1 | | | 4 | 3 | 2 | 1 | 4 | 3 | 2 | 1 | | | |
| Steel columns equal or greater than 6 x 6 | Group 1 concrete† | 2½ | 2 | 1½ | 1 | Brick of clay, shale, concrete, or sand lime | Solid unplastered | 8 | 8 | 4 | - | - | - | - | - | - | - | |
| | Group 2 concrete† | 3 | 2 | 1½ | 1 | | Solid plastered one side | 8 | 8 | 8 | 4 | - | - | - | - | - | - | 4 |
| | Brick, clay (with brick fill) | 3¾ | 3¾ | 3¾ | 2½ | | Solid plastered both sides | 8 | 8 | 4 | 4 | - | - | - | - | - | - | 4 |
| | Concrete block hollow (mortar and broken block fill) | 3 | 3 | 3 | 2 | | Hollow cavity | 10 | 10 | 10 | 10 | - | - | - | - | - | - | - |
| | Clay tile (two 2" layers) | 4 | 2† | 2 | 2 | Hollow structural tile, clay, or shale | Unplastered | 12 | 12 | 12 | 8 | - | - | - | - | - | - | 6 |
| | Solid gypsum block with ties | 2 pl | 2 pl | 2 | 2 | | Plastered one side | 12 | 12 | 8 | 8 | - | - | - | - | - | - | 4 |
| | Hollow gypsum block with ties | 3 pl | 3 pl | 3 | 3 | Hollow structural tile, clay, or shale bonded to 4" brick facing | Plastered both sides | 12 | 8 | 8 | 8 | - | - | - | - | - | - | 4 |
| | Poured gypsum mesh | 2 | 1½ | 1 | 1 | | Unplastered | 8 | 4 | - | - | - | - | - | - | - | - | - |
| | Gypsum - Vermiculite on self-furring metal on gypsum lath reinforcement | 1½ | 1½ | 1½ | 1½ | Hollow structural facing tile, clay | Plastered tile side | 8 | - | - | - | - | - | - | - | - | - | - |
| | Gypsum - Perlite on self-furring metal on gypsum lath reinforcement | 1½ | 1½ | 1 | 1 | | Unplastered | - | - | - | - | - | - | - | - | - | - | 6 |
| Sprayed fiber - directly to steel | - | 2 | 1½ | 1½ | Hollow concrete masonry units | Plastered one side | - | - | - | - | - | - | - | - | - | - | 4 | |
| Steel beams, girders, and truss members (individually protected) | Group 1 concrete | 2 | 2 | 1½ | | 1 | Gypsum block | Solid unplastered | - | - | - | - | - | - | - | - | - | 5 |
| | Group 2 concrete | 2½ | 2½ | 2 | 1½ | Hollow Unplastered | | - | - | - | - | - | - | - | - | - | - | 3 |
| | Brick of clay, concrete, or sand lime | 3¾ | 3¾ | 2½ | 2½ | Hollow plastered | Bonded to 4" brick facing | 4 pl | - | - | - | - | - | - | - | - | - | 3 |
| | Gypsum blocks, solid | 2 pl | 2 pl | 2 | 2 | | Aggregate expanded burnt clay or shale, crushed lime stone, unexpanded slag, or cinders | Unplastered | 10 | 8 | 8 | - | - | - | - | - | - | 6 |
| | Gypsum blocks, hollow | 3 pl | 3 | 2 | 2 | Expanded slag or pumice aggregate | Plastered | 8 | 6 | - | - | - | - | - | - | - | - | 6 |
| | Gypsum, poured | 2 | 2 | 1½ | 1 | | Calcareous sand and gravel | Unplastered | - | - | - | 10 | - | - | - | - | - | 3 |
| | Gypsum - Vermiculite on self-furring metal lath cage | - | - | ¾ | ¾ | Siliceous sand and gravel | Plastered | 10 | - | - | - | - | - | - | - | - | - | 4 |
| | Gypsum - Perlite on self-furring metal lath cage | 1½ | 1½ | 1 | 1 | | Plain concrete | Unplastered | 12 | - | - | - | - | - | - | - | - | - |
| | Sprayed fiber - directly to adhesive coated steel | 3¾ | 2 | 2 | 2 | Reinforced concrete (monolithic) | Plastered | 12 | - | - | - | - | - | - | - | - | - | - |
| | Structural members† with floor and ceiling protection | Floor = 2½" concrete slab on metal lath and gypsum vermiculite ceiling | 1 | ¾ | ¾ | | ¾ | Solid monolithic walls | Group 1 | 6½ | 6 | 5 | 3½ | - | - | - | - | - |
| Floor = 2" precast gypsum slab + ½ cover of mortar and gypsum vermiculite ceiling | | 1 | ¾ | ¾ | ¾ | Group 2 | 7½ | | 6½ | 5½ | - | - | - | - | - | - | - | - |
| Floor = 2" concrete slab on metal lath and gypsum perlite ceiling | | 1 | ½ | ½ | ½ | Solid walls unplastered | Group 1 | 5 | 4 | - | - | - | - | - | - | - | - | 3 |
| Floor = 2" concrete slab on metal lath and gypsum vermiculite ceiling | | - | 1 | 1 | 1 | | Group 2 | 6 | 5 | 4 | - | - | - | - | - | - | - | 3 |
| Floor = 2¾" concrete plank and gypsum vermiculite ceiling | | - | 1 | 1 | 1 | Solid walls plastered both sides | Group 1 | 5 | 4 | - | - | - | - | - | - | - | - | 3 |
| Floor = 2" cinder concrete slab on steel cellular units and gypsum vermiculite ceiling | | ¾ | ¾ | ¾ | ¾ | | Group 2 | 6 | 5 | 4 | - | - | - | - | - | - | - | 3 |
| Floor = 2" perlite concrete on steel cellular units and gypsum perlite ceiling | | 1 | 1 | 1 | 1 | Stone masonry | Solid walls | 12 | 12 | 12 | 8 | - | - | - | - | - | - | - |
| Floor = 2" reinforced concrete on steel cellular units and gypsum perlite ceiling | | ¾ | ¾ | ¾ | ¾ | | Reinforced concrete (monolithic) | Group 1 | 6½ | 6 | 5 | 3½ | - | - | - | - | - | - |
| Floor = 2" concrete on steel cellular units and sprayed fiber ceiling | | 1½ | 1½ | 1½ | 1½ | Solid walls | | Group 2 | 7½ | 6½ | 5½ | - | - | - | - | - | - | - |
| Floor = 1½" concrete + ½ cement mortar finish on steel cellular units and gypsum vermiculite ceiling | | 1 | 1 | 1 | 1 | | Stone masonry | Group 1 | 5 | 4 | - | - | - | - | - | - | - | - |
| Floor = 2" concrete on steel cellular units and gypsum perlite or gypsum vermiculite ceiling | - | ¾ | ¾ | ¾ | Stone masonry | Group 2 | | 6 | 5 | 4 | - | - | - | - | - | - | - | 3 |
| Reinforced-concrete beams, girders and trusses - reinforcing bars | Coarse aggregate air-cooled slag, expanded slag, crushed limestone, calcareous gravel, siliceous gravel, or traprock | 1½ | 1½ | 1½ | | 1½ | Reinforced-concrete slabs - reinforcing bars | Group 1 concrete | 1 | 1 | ¾ | ¾ | - | - | - | - | - | - |
| | Reinforced-concrete columns - reinforcing bars | Group 1 concrete | 1 | 1 | ¾ | ¾ | | Reinforced-concrete columns - reinforcing bars | Group 1 concrete (12" or larger round or square columns). Not including cinder aggregate | 1½ | 1½ | 1½ | 1½ | - | - | - | - | - |
| Reinforced-concrete slabs - reinforcing bars | | Group 2 concrete (16" or larger round or square columns). Not including cinder aggregate | 2½ | 1½ | 1½ | 1½ | Reinforced-concrete columns - reinforcing bars | | Group 2 concrete (16" or larger round or square columns). Not including cinder aggregate | 2½ | 1½ | 1½ | 1½ | - | - | - | - | - |

NOTE: Group 1 concrete aggregates are blast-furnace slag, limestone, calcareous gravel, traprock, burnt clay or shale, cinders containing not more than 25% of combustible material and not more than 5% of volatile material, and other materials meeting the requirements of these specifications and containing not more than 30% quartz, chert, flint, and similar materials.

Group 2 concrete aggregates are granite, quartzite, siliceous gravel, sandstone, gneiss, cinders containing more than 25%, but not more than 40% of combustible material and not more than 5% of volatile material and other materials meeting requirements of these specifications, and containing more than 30% of quartz, chert, flint, and similar materials.

* Based on author's interpretation of National Board of Fire Underwriters (N.B.F.U.) publication, *Fire Resistance Ratings*, 1957. For Further details on construction and materials, see N.B.F.U. publication, *Fire Resistance Ratings*.

† Not more than 10% unburned coals and not over 5% ash.
 ‡ With fill and ties.
 § Steel cellular units or other steel structural units.
 ¶ 1" for calcareous aggregate.
 § None or noncombustible members framing into wall.

REINFORCED-CONCRETE FLOORS

- 4-Hr. Rating: 4½" slab, expanded slag aggregate (¾" protection to reinforcement).
 6" slab, air-cooled slag, aggregate (1" protection to reinforcement).
 5" slab, limestone aggregate and 1" gypsum vermiculite plaster ceiling, metal lath (electrical raceways and junction boxes in slab).
 3" slab, limestone aggregate and 1" gypsum vermiculite plaster ceiling, metal lath.
- 3-Hr. Rating: 6" slab, traprock, or crushed limestone, or calcareous gravel, or siliceous gravel aggregate (1" protection to reinforcement).
 4" slab, limestone aggregate hung ceiling of ¾" gypsum vermiculite plaster metal lath (electrical raceways and junction boxes in slab).
 2" slab, limestone aggregate hung ceiling of ¾" gypsum vermiculite plaster, metal lath.
- 2-Hr. Rating: 4¾" slab, traprock, or siliceous gravel aggregate (¾" protection to reinforcement).
 4¾" slab, calcareous gravel, or crushed limestone aggregate (1" protection to reinforcement).
- 1-Hr. Rating: 4" slab, siliceous gravel aggregate (¾" protection to reinforcement).

STRUCTURAL-GENERAL-GAGES

| WIRE AND SHEET METAL GAGES IN DECIMALS OF AN INCH | | | | | | | | |
|--|--|-----------------------------------|--------------------------------------|---|--|-------------------------------------|---------------|--|
| Name of Gage | United States Standard Gage* | The United States Steel Wire Gage | American or Brown & Sharpe Wire Gage | New Birmingham Standard Sheet & Hoop Gage | British Imperial or English Legal Standard Wire Gage | Birmingham or Stubbs Iron Wire Gage | Name of Gage | |
| Principal Use | Uncoated Steel Sheets and Light Plates | Steel Wire except Music Wire | Non-Ferrous Sheets and Wire | Iron and Steel Sheets and Hoops | Wire | Strips, Bands, Hoops and Wire | Principal Use | |
| Gage No. | Weight Oz. per Sq. Ft. | Approx. Thickness Inches | Thickness, Inches | | | | Gage No. | |
| 7.0's | | | .4900 | | .6666 | .500 | 7.0's | |
| 6.0's | | | .4615 | .5800 | .625 | .464 | 6.0's | |
| 5.0's | | | .4305 | .5165 | .5883 | .432 | 5.0's | |
| 4.0's | | | .3938 | .4600 | .5416 | .400 | 4.0's | |
| 3.0's | | | .3625 | .4096 | .500 | .372 | 3.0's | |
| 2.0's | | | .3310 | .3648 | .4452 | .348 | 2.0's | |
| 0 | | | .3065 | .3249 | .3964 | .324 | 0 | |
| 1 | | | .2830 | .2893 | .3532 | .300 | 1 | |
| 2 | | | .2625 | .2576 | .3147 | .276 | 2 | |
| 3 | 160 | .2391 | .2437 | .2294 | .2804 | .262 | 3 | |
| 4 | 150 | .2242 | .2253 | .2043 | .250 | .232 | 4 | |
| 5 | 140 | .2092 | .2070 | .1819 | .2225 | .212 | 5 | |
| 6 | 130 | .1943 | .1920 | .1620 | .1981 | .192 | 6 | |
| 7 | 120 | .1793 | .1770 | .1443 | .1764 | .176 | 7 | |
| 8 | 110 | .1644 | .1620 | .1285 | .1570 | .160 | 8 | |
| 9 | 100 | .1495 | .1483 | .1144 | .1398 | .144 | 9 | |
| 10 | 90 | .1345 | .1350 | .1019 | .1250 | .128 | 10 | |
| 11 | 80 | .1196 | .1206 | .0907 | .1113 | .116 | 11 | |
| 12 | 70 | .1046 | .1056 | .0808 | .0991 | .104 | 12 | |
| 13 | 60 | .0897 | .0915 | .0720 | .0882 | .092 | 13 | |
| 14 | 50 | .0747 | .0800 | .0641 | .0785 | .080 | 14 | |
| 15 | 45 | .0673 | .0720 | .0571 | .0699 | .072 | 15 | |
| 16 | 40 | .0608 | .0625 | .0508 | .0625 | .064 | 16 | |
| 17 | 36 | .0538 | .0540 | .0453 | .0556 | .056 | 17 | |
| 18 | 32 | .0478 | .0475 | .0403 | .0495 | .048 | 18 | |
| 19 | 28 | .0418 | .0410 | .0359 | .0440 | .040 | 19 | |
| 20 | 24 | .0359 | .0348 | .0320 | .0392 | .036 | 20 | |
| 21 | 22 | .0329 | .0318 | .0285 | .0349 | .032 | 21 | |
| 22 | 20 | .0299 | .0286 | .0253 | .0313 | .028 | 22 | |
| 23 | 18 | .0268 | .0258 | .0226 | .0278 | .024 | 23 | |
| 24 | 16 | .0239 | .0230 | .0201 | .0248 | .022 | 24 | |
| 25 | 14 | .0208 | .0204 | .0179 | .0220 | .020 | 25 | |
| 26 | 12 | .0179 | .0181 | .0159 | .0196 | .018 | 26 | |
| 27 | 11 | .0164 | .0173 | .0142 | .0175 | .0164 | 27 | |
| 28 | 10 | .0149 | .0162 | .0126 | .0156 | .0148 | 28 | |
| 29 | 9 | .0135 | .0150 | .0113 | .0139 | .0136 | 29 | |
| 30 | 8 | .0120 | .0140 | .0100 | .0123 | .0124 | 30 | |
| 31 | 7 | .0105 | .0132 | .0089 | .0110 | .0116 | 31 | |
| 32 | 6.5 | .0097 | .0129 | .0080 | .0098 | .0108 | 32 | |
| 33 | 6 | .0090 | .0118 | .0071 | .0087 | .0100 | 33 | |
| 34 | 5.5 | .0082 | .0104 | .0063 | .0077 | .0092 | 34 | |
| 35 | 5 | .0075 | .0095 | .0056 | .0069 | .0084 | 35 | |
| 36 | 4.5 | .0067 | .0090 | .0050 | .0061 | .0076 | 36 | |
| 37 | 4.25 | .0064 | .0085 | .0045 | .0054 | .0068 | 37 | |
| 38 | 4 | .0060 | .0080 | .0040 | .0048 | .0060 | 38 | |
| 39 | | | .0075 | .0035 | .0043 | .0052 | 39 | |
| 40 | | | .0070 | .0031 | .0039 | .0048 | 40 | |

* U. S. Standard Gage is officially a weight gage, in oz. per sq. ft. as tabulated. The Approx. Thickness shown is the "Manufacturers' Standard" of the American Iron and Steel Institute, based on steel as weighing 501.81 lbs. per cu. ft. (489.6 true weight plus 2.5 percent for average over-run in area and thickness). The A.I.S.I. standard nomenclature for flat rolled carbon steel is as follows:

| Widths, Inches | Thicknesses, Inch | | | | | | | |
|--------------------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|
| | 0.2500 and thicker | 0.2499 to 0.2031 | 0.2030 to 0.1875 | 0.1874 to 0.0568 | 0.0567 to 0.0344 | 0.0343 to 0.0255 | 0.0254 to 0.0142 | 0.0141 and thinner |
| To 3½ incl. | Bar | Bar | Strip | Strip | Strip | Strip | Sheet | Sheet |
| Over 3½ to 6 incl. | Bar | Bar | Strip | Strip | Strip | Sheet | Sheet | Sheet |
| " 6 to 12 " | Plate | Strip | Strip | Strip | Sheet | Sheet | Sheet | Sheet |
| " 12 to 32 " | Plate | Sheet | Sheet | Sheet | Sheet | Sheet | Sheet | Black Plate |
| " 32 to 48 " | Plate | Sheet | Sheet | Sheet | Sheet | Sheet | Sheet | Sheet |
| " 48 " | Plate | Plate | Plate | Sheet | Sheet | Sheet | Sheet | — |

TABLE A

Adapted From American Institute of Steel Construction, 1947.

STRUCTURAL-GENERAL-CHAINS & WIRE ROPES

TABLE A - SAFE WORKING LOADS OF CHAINS (in kips) A.S.T.M. A56-39

| Nominal Size of Chain Bar, inches | $\frac{1}{4}$ | $\frac{5}{16}$ | $\frac{3}{8}$ | $\frac{7}{16}$ | $\frac{1}{2}$ | $\frac{9}{16}$ | $\frac{5}{8}$ | $\frac{3}{4}$ | $\frac{7}{8}$ | 1 | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{5}{8}$ | $1\frac{3}{4}$ | $1\frac{7}{8}$ | 2 |
|-----------------------------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|---------------|---------------|------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|------|
| Crane Chain | 1.0 | 1.6 | 2.3 | 3.2 | 4.2 | 5.3 | 6.6 | 9.5 | 12.9 | 16.9 | 20.0 | 24.7 | 29.9 | 35.6 | 41.8 | 48.4 | 55.3 | 63.3 |
| Proof Coil | .85 | 1.3 | 1.9 | 2.6 | 3.4 | 4.3 | 5.3 | 7.6 | 10.4 | 13.6 | | | | | | | | |

TABLE B - NOMINAL WEIGHTS AND DIMENSIONS OF CHAINS A.S.T.M. A56-39

| Normal Size of Chain Bar, inches | Actual Size of Material, inches | Nominal Length of 100 Links, in. | | Nominal Weight per 100 ft., lb. | | Nominal Dimensions of Links, inches | | | | | | | |
|----------------------------------|---------------------------------|----------------------------------|------------|---------------------------------|------------|-------------------------------------|------------------|------------------|-----------------|------------------|------------------|------------------|-----------------|
| | | | | | | Crane Chain | | | | Proof Coil | | | |
| | | Crane Chain | Proof Coil | Crane Chain | Proof Coil | Outside | | Inside | | Outside | | Inside | |
| | | | | | | Length | Width | Length | Width | Length | Width | Length | Width |
| $\frac{1}{4}$ | $\frac{9}{32}$ | 86 | 100 | 78 | 70 | $1\frac{27}{64}$ | 1 | $\frac{55}{64}$ | $\frac{7}{16}$ | $1\frac{1}{16}$ | $1\frac{1}{16}$ | 1 | $\frac{1}{2}$ |
| $\frac{5}{16}$ | $\frac{11}{32}$ | 100 | 111 | 115 | 105 | $1\frac{11}{16}$ | $1\frac{3}{16}$ | 1 | $\frac{1}{2}$ | $1\frac{51}{64}$ | $1\frac{3}{16}$ | $1\frac{7}{64}$ | $\frac{1}{2}$ |
| $\frac{3}{8}$ | $\frac{13}{32}$ | 109 | 123 | 166 | 158 | $1\frac{29}{32}$ | $1\frac{7}{16}$ | $1\frac{3}{32}$ | $\frac{5}{8}$ | $2\frac{3}{64}$ | $1\frac{7}{16}$ | $1\frac{15}{64}$ | $\frac{5}{8}$ |
| $\frac{7}{16}$ | $\frac{15}{32}$ | 122 | 138 | 220 | 210 | $2\frac{5}{32}$ | $1\frac{5}{8}$ | $1\frac{7}{32}$ | $\frac{11}{16}$ | $2\frac{5}{16}$ | $1\frac{11}{16}$ | $1\frac{3}{8}$ | $\frac{3}{4}$ |
| $\frac{1}{2}$ | $\frac{17}{32}$ | 134 | 150 | 275 | 265 | $2\frac{13}{32}$ | $1\frac{13}{16}$ | $1\frac{11}{32}$ | $\frac{3}{4}$ | $2\frac{9}{16}$ | $1\frac{7}{8}$ | $1\frac{1}{2}$ | $\frac{13}{16}$ |
| $\frac{9}{16}$ | $\frac{19}{32}$ | 156 | 175 | 350 | 335 | $2\frac{3}{4}$ | $1\frac{15}{16}$ | $1\frac{9}{16}$ | $\frac{3}{4}$ | $2\frac{15}{16}$ | $2\frac{1}{16}$ | $1\frac{3}{4}$ | $\frac{7}{8}$ |
| $\frac{5}{8}$ | $\frac{21}{32}$ | 169 | 188 | 430 | 410 | 3 | $2\frac{3}{16}$ | $1\frac{11}{16}$ | $\frac{7}{8}$ | $3\frac{3}{16}$ | $2\frac{5}{16}$ | $1\frac{7}{8}$ | 1 |
| $\frac{3}{4}$ | $\frac{23}{32}$ | 188 | 213 | 615 | 580 | $3\frac{7}{16}$ | $2\frac{9}{16}$ | $1\frac{7}{8}$ | 1 | $3\frac{11}{16}$ | $2\frac{11}{16}$ | $2\frac{1}{8}$ | $1\frac{1}{8}$ |
| $\frac{7}{8}$ | $\frac{25}{32}$ | 225 | 250 | 820 | 780 | $4\frac{1}{16}$ | $3\frac{1}{16}$ | $2\frac{1}{4}$ | $1\frac{1}{4}$ | $4\frac{5}{16}$ | $3\frac{3}{16}$ | $2\frac{1}{2}$ | $1\frac{3}{8}$ |
| 1 | $1\frac{1}{32}$ | 256 | 275 | 1045 | 1000 | $4\frac{5}{8}$ | $3\frac{7}{16}$ | $2\frac{9}{16}$ | $1\frac{3}{8}$ | $4\frac{13}{16}$ | $3\frac{9}{16}$ | $2\frac{3}{4}$ | $1\frac{1}{2}$ |
| $1\frac{1}{8}$ | $1\frac{5}{32}$ | 288 | | 1310 | | $5\frac{3}{16}$ | $3\frac{15}{16}$ | $2\frac{7}{8}$ | $1\frac{5}{8}$ | | | | |
| $1\frac{1}{4}$ | $1\frac{9}{32}$ | 306 | | 1600 | | $5\frac{5}{8}$ | $4\frac{5}{16}$ | $3\frac{1}{16}$ | $1\frac{3}{4}$ | | | | |
| $1\frac{3}{8}$ | $1\frac{13}{32}$ | 363 | | 1930 | | $6\frac{7}{16}$ | $4\frac{11}{16}$ | $3\frac{5}{8}$ | $1\frac{7}{8}$ | | | | |
| $1\frac{1}{2}$ | $1\frac{17}{16}$ | 387 | | 2335 | | $6\frac{15}{16}$ | $5\frac{1}{16}$ | $3\frac{7}{8}$ | 2 | | | | |
| $1\frac{5}{8}$ | $1\frac{21}{32}$ | 425 | | 2740 | | $7\frac{9}{16}$ | $5\frac{7}{16}$ | $4\frac{1}{4}$ | $2\frac{1}{8}$ | | | | |
| $1\frac{3}{4}$ | $1\frac{25}{32}$ | 475 | | 3180 | | $8\frac{3}{16}$ | $5\frac{13}{16}$ | $4\frac{3}{4}$ | $2\frac{1}{4}$ | | | | |
| $1\frac{7}{8}$ | $1\frac{29}{32}$ | 525 | | 3650 | | $9\frac{1}{16}$ | $6\frac{5}{16}$ | $5\frac{1}{4}$ | $2\frac{1}{2}$ | | | | |
| 2 | $2\frac{1}{32}$ | 575 | | 4100 | | $9\frac{13}{16}$ | $6\frac{11}{16}$ | $5\frac{3}{4}$ | $2\frac{5}{8}$ | | | | |

TABLE C - WIRE ROPE 6 x 19 STANDARD HOISTING PLOW STEEL *

| Diameter, in. | $2\frac{3}{4}$ | $2\frac{1}{4}$ | 2 | $1\frac{7}{8}$ | $1\frac{3}{4}$ | $1\frac{5}{8}$ | $1\frac{1}{2}$ | $1\frac{3}{8}$ | $1\frac{1}{4}$ | $1\frac{1}{8}$ | 1 | $\frac{7}{8}$ | $\frac{3}{4}$ | $\frac{5}{8}$ | $\frac{9}{16}$ | $\frac{1}{2}$ | $\frac{7}{16}$ | $\frac{3}{8}$ |
|---------------------------------------|----------------|----------------|-------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|------|---------------|---------------|---------------|----------------|---------------|----------------|---------------|
| Breaking strength, † tons of 2000 lb. | 254.0 | 174.0 | 139.0 | 123.0 | 108.0 | 93.4 | 80.0 | 67.5 | 56.2 | 45.7 | 36.4 | 28.0 | 20.7 | 14.5 | 11.8 | 9.35 | 7.19 | 5.31 |

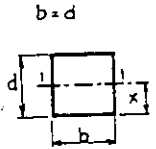
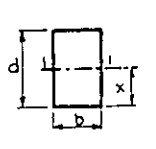
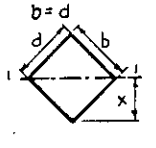
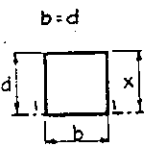
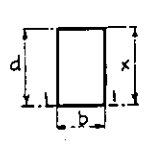
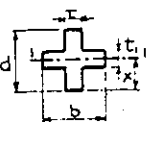
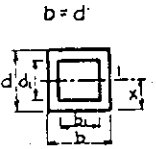
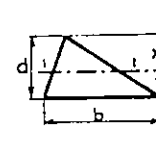
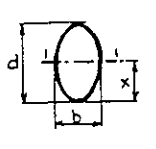
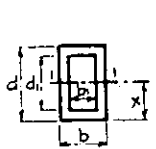
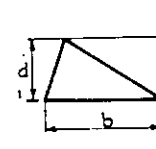
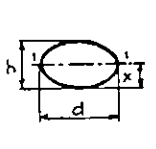
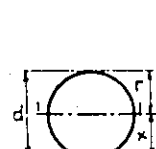
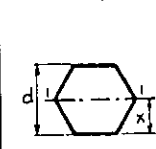
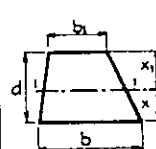
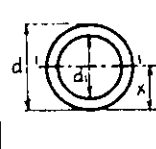
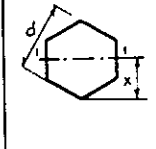
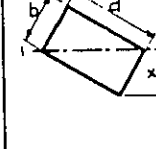
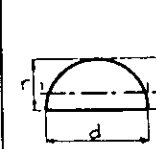
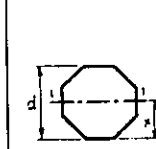
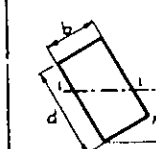
*From John A. Roebling's Sons Co. †Use factor of safety from 5 to 8.

STRUCTURAL-GENERAL-PROPERTIES OF SECTIONS-I

A = Area of Section
 I = Moment of Inertia
 S = Section Modulus
 r = Radius of Gyration

PROPERTIES OF SECTIONS

For rolled steel sections:
 $S = \frac{I}{x}$
 $r = \sqrt{\frac{I}{A}}$

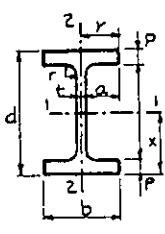
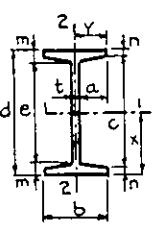
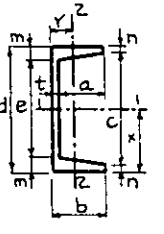
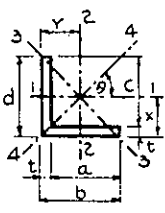
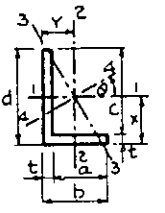
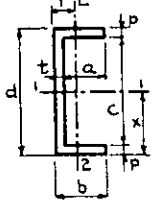
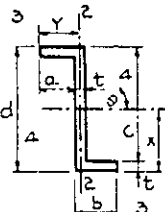
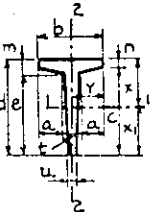
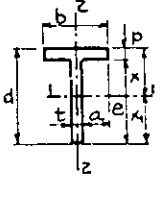
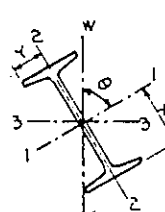
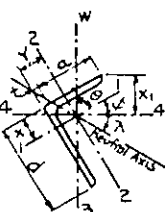
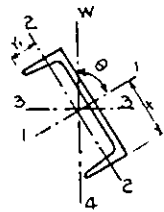
| | | |
|---|---|--|
|  <p>$b = d$ $A = d^2$; $x = \frac{d}{2}$ $I_1 = \frac{d^4}{12}$; $S_1 = \frac{d^3}{6}$ $r_1 = \frac{d}{\sqrt{12}} = 0.288675d$</p> |  <p>$A = bd$; $x = \frac{d}{2}$ $I_1 = \frac{bd^3}{12}$; $S_1 = \frac{bd^2}{6}$ $r_1 = \frac{d}{\sqrt{12}} = 0.288675d$</p> |  <p>$b = d$ $A = d^2$; $x = \frac{d}{\sqrt{2}} = 0.707107d$ $I_1 = \frac{d^4}{12}$ $S_1 = \frac{d^3}{6\sqrt{2}} = 0.117851d^3$ $r_1 = \frac{d}{\sqrt{12}} = 0.288675d$</p> |
|  <p>$b = d$ $A = d^2$; $x = d$ $I_1 = \frac{d^4}{3}$; $S_1 = \frac{d^3}{3}$ $r_1 = \frac{d}{\sqrt{3}} = 0.57735d$</p> |  <p>$A = bd$; $x = d$ $I_1 = \frac{bd^3}{3}$; $S_1 = \frac{bd^2}{3}$ $r_1 = \frac{d}{\sqrt{3}} = 0.57735d$</p> |  <p>$A = td + t_1(b-t)$ $x = \frac{d}{3}$ $I_1 = \frac{td^3}{12} + \frac{t_1^3(b-t)}{12}$ $S_1 = \frac{td^2 + t_1^2(b-t)}{6d}$</p> |
|  <p>$b = d$ $A = d^2 - d_1^2$; $x = \frac{d}{2}$ $I_1 = \frac{d^4 - d_1^4}{12}$; $S_1 = \frac{d^3 - d_1^3}{6d}$ $r_1 = \sqrt{\frac{d^4 - d_1^4}{12A}}$</p> |  <p>$A = \frac{bd}{2}$; $x = \frac{d}{3}$; $x_1 = \frac{2d}{3}$ $I_1 = \frac{bd^3}{36}$; $S_1 = \frac{bd^2}{24}$ $r_1 = \frac{d}{\sqrt{18}} = 0.236702d$</p> |  <p>$A = \frac{\pi bd}{4} = 0.7854bd$; $x = \frac{d}{2}$ $I_1 = \frac{\pi bd^3}{64} = 0.04909bd^3$ $S_1 = \frac{\pi bd^2}{32} = 0.09818bd^2$ $r_1 = \frac{d}{4}$</p> |
|  <p>$A = bd - bd_1$; $x = \frac{d}{2}$ $I_1 = \frac{bd^3 - bd_1^3}{12}$; $S_1 = \frac{bd^2 - bd_1^2}{6d}$ $r_1 = \sqrt{\frac{bd^3 - bd_1^3}{12A}}$</p> |  <p>$A = \frac{bd}{2}$; $x = d$ $I_1 = \frac{bd^3}{12}$; $S_1 = \frac{bd^2}{12}$ $r_1 = \frac{d}{\sqrt{6}} = 0.408248d$</p> |  <p>$A = \frac{\pi bd}{4} = 0.7854bd$; $x = \frac{b}{2}$ $I_1 = \frac{\pi db^3}{64} = 0.04909db^3$ $S_1 = \frac{\pi db^2}{32} = 0.09818db^2$ $r_1 = \frac{b}{4}$</p> |
|  <p>$A = \frac{\pi d^2}{4} = \pi r^2 = 0.7854d^2 = 3.14159r^2$ $x = d/2 = r$ $I_1 = \frac{\pi d^4}{64} = \frac{\pi r^4}{4} = 0.09817d^4 = 0.7854r^4$ $S_1 = \frac{\pi d^3}{32} = \frac{\pi r^3}{4} = 0.09818d^3 = 0.7854r^3$ $r_1 = \frac{d}{4} = \frac{r}{2}$</p> |  <p>$A = \frac{3}{2}d^2 \tan 30^\circ = 0.66d^2$; $x = \frac{d}{2}$ $I_1 = \frac{A}{12} \left[\frac{d^4(1+2\cos^2 30^\circ)}{4 \cos^2 30^\circ} \right] = 0.06d^4$ $S_1 = \frac{A}{6} \left[\frac{d^3(1+2\cos^2 30^\circ)}{4 \cos^2 30^\circ} \right] = 0.12d^3$ $r_1 = \frac{d}{4} \sqrt{\frac{1+2\cos^2 30^\circ}{3 \cos^2 30^\circ}} = 0.264d$</p> |  <p>$A = d(b+h)$ $x = \frac{d(b+2b_1)}{3(b+b_1)}$; $x_1 = \frac{d(b+2b)}{3(b+b)}$ $I_1 = \frac{d^3(b^2+4bb_1+b_1^2)}{36(b+b_1)}$ $S_1 = \frac{d^2(b^2+4bb_1+b_1^2)}{12(b+b_1)}$ $r_1 = \frac{d}{6(b+b_1)} \sqrt{2(b^2+4bb_1+b_1^2)}$</p> |
|  <p>$A = \frac{\pi(d^2 - d_1^2)}{4}$; $x = \frac{d}{2}$ $I_1 = \frac{\pi(d^4 - d_1^4)}{64}$ $S_1 = \frac{\pi(d^3 - d_1^3)}{32d}$ $r_1 = \frac{\sqrt{d^4 - d_1^4}}{4d}$</p> |  <p>$A = \frac{3}{2}d^2 \tan 30^\circ$; $x = \frac{d}{2 \cos 30^\circ} = 0.577d$ $I_1 = \frac{A}{12} \left[\frac{d^4(1+2\cos^2 30^\circ)}{4 \cos^2 30^\circ} \right] = 0.06d^4$ $S_1 = \frac{A}{6L} \left[\frac{d^3(1+2\cos^2 30^\circ)}{4 \cos^2 30^\circ} \right] = 0.104d^3$ $r_1 = \frac{d}{4} \sqrt{\frac{1+2\cos^2 30^\circ}{3 \cos^2 30^\circ}} = 0.264d$</p> |  <p>$A = bd$; $x = \frac{bd}{\sqrt{b^2+d^2}}$ $I_1 = \frac{b^3d^3}{6(b^2+d^2)}$ $S_1 = \frac{b^2d^2}{6\sqrt{b^2+d^2}}$ $r_1 = \frac{bd}{\sqrt{6(b^2+d^2)}}$</p> |
|  <p>$A = \frac{\pi r^2}{2} = 1.5708r^2$; $x = \frac{4r}{3\pi}$ $x_1 = \frac{r}{2} \left(1 - \frac{4}{3\pi}\right) = 0.57559r$ $I_1 = r^4 \left(\frac{\pi}{8} - \frac{4}{9\pi} \right) = 0.10976r^4$ $S_1 = \frac{r^3}{24} \left(\frac{3\pi^2 - 4}{3\pi - 4} \right) = 0.19069r^3$ $r_1 = r \sqrt{\frac{3\pi^2 - 4}{6\pi}} = 0.26434r$</p> |  <p>$A = 2d^2 \tan 22.5^\circ = 0.828d^2$; $x = \frac{d}{2}$ $I_1 = \frac{A}{12} \left[\frac{d^4(1+2\cos^2 22.5^\circ)}{4 \cos^2 22.5^\circ} \right] = 0.55d^4$ $S_1 = \frac{A}{6L} \left[\frac{d^3(1+2\cos^2 22.5^\circ)}{4 \cos^2 22.5^\circ} \right] = 0.109d^3$ $r_1 = \frac{d}{4} \sqrt{\frac{1+2\cos^2 22.5^\circ}{3 \cos^2 22.5^\circ}} = 0.257d$</p> |  <p>$A = bd$; $x = \frac{b \sin \theta + d \cos \theta}{2}$ $I_1 = \frac{bd(b^2 \sin^2 \theta + d^2 \cos^2 \theta)}{12}$ $S_1 = \frac{bd(b^2 \sin^2 \theta + d^2 \cos^2 \theta)}{6(b \sin \theta + d \cos \theta)}$ $r_1 = \sqrt{\frac{b^2 \sin^2 \theta + d^2 \cos^2 \theta}{12}}$</p> |

STRUCTURAL-GENERAL-PROPERTIES OF SECTIONS-2

A = Area of Section
 I = Moment of Inertia
 S = Section Modulus
 r = Radius of Gyration
 f = Extreme fiber stress p.s.i.
 M = Moment in in. lbs.

PROPERTIES OF SECTIONS

For rolled steel sections:
 $S = \frac{I}{x}$
 $r = \sqrt{\frac{I}{A}}$

| | | |
|---|--|--|
|  <p> $A = dt + 4ap + \frac{2}{3}r^2$ $x = \frac{d}{2}$ $y = \frac{b}{2}$ $I_1 = \frac{bd^3}{12} + \frac{2ae^2}{3} + 4\left[\frac{11}{2000}r^2 + \frac{1}{6}t^2\left(\frac{c}{2} - \frac{f}{8}\right)^2\right]$ $I_2 = \frac{2tb^3}{12} + ct^3 + 4\left[\frac{11}{2000}r^2 + \frac{1}{6}t^2\left(\frac{c}{2} + \frac{f}{8}\right)^2\right]$ </p> |  <p> $A = dt + 2a(m+n)$ $x = \frac{d}{2}$ $y = \frac{b}{2}$ $I_1 = \frac{bd^3}{12} - \frac{a(m-n)}{12}(c^2 - e^2)$ $I_2 = 2nb^3 + et^3 + \frac{m-n}{12}(b^2 - t^2)$ </p> |  <p> $A = dt + a(m+n)$ $x = \frac{d}{2}$ $y = \frac{b^2h + \frac{ct^2}{2} + \frac{a(m-n)}{3}(b+2t)}{A}$ $I_1 = \frac{bd^3 - \frac{a(m-n)}{12}(c^2 - e^2)}{12}$ $I_2 = \frac{2nb^3 + et^3 + \frac{(m-n)}{3}a(b^2 - t^2)}{3} - Ayz$ </p> |
|  <p> $A = t(b+c); \quad \theta = 45^\circ$ $x = \frac{b^2+ct}{2b+c}; \quad y = x$ $I_1 = \frac{t(b-c)^2 + bt^2 - a(x-t)^2}{3}$ $I_2 = I_1$ $I_3 = \frac{ct^2 + ct + 3cd(b+2t)^2 + 6ct^2x^2}{12}$ $I_4 = \frac{ct^3 + ct^2 + 3ctbt + t^4}{12}$ </p> |  <p> $A = t(b+c); \quad x = \frac{t(b+2c)^2}{2(b+c)}; \quad y = \frac{t(2at+d)at}{2(a+d)}$ $\tan 2\theta = \frac{t[(b+t)(d-c) + a(2x-t)(b+t-2y)]}{2(I_1 - I_2)}$ $I_1 = \frac{t(d+t)^2 + bt^2 - a(x-t)^2}{3}$ $I_2 = \frac{t(b+t)^2 + dt^2 - c(y-t)^2}{3}$ $I_3 = \frac{I_2 \cos^2 \theta - I_1 \sin^2 \theta}{\cos 2\theta}$ $I_4 = \frac{I_1 \cos^2 \theta - I_2 \sin^2 \theta}{\cos 2\theta}$ </p> |  <p> $A = bd - c(b-t)$ $x = \frac{d}{2}$ $y = \frac{t[(bd-c)(b-t)]}{bd-c(b-t)}$ $I_1 = \frac{bd^3 - c^2(b-t)}{12}$ $I_2 = \frac{2bt^3 + ct^3}{3} - Ayz$ </p> |
|  <p> $A = t(d+2a); \quad x = \frac{d}{2}; \quad y = \frac{2bt-t}{2}$ $\tan 2\theta = \frac{(d-t)(b^2 - bt)}{I_1 - I_2}$ $I_1 = \frac{bd^3 - a(d-2t)^2}{12}$ $I_2 = \frac{d(b-a)^2 + 2at - 6cbt}{12}$ $I_3 = \frac{I_1 \cos^2 \theta - I_2 \sin^2 \theta}{\cos 2\theta}$ $I_4 = \frac{I_2 \cos^2 \theta - I_1 \sin^2 \theta}{\cos 2\theta}$ </p> |  <p> $A = e\left(\frac{b^2+t^2}{2}\right) + mt + a(m+n); \quad y = \frac{b}{2}$ $x = \frac{e(mn^2 + 2am-n)(m+n) + 2at^2 + d(x-t)(d-t)}{2A}$ $I_1 = \frac{e^2(b+t)^2 + 4bt^2 + 2a(m-n)^2 - A(x-m)^2}{12}$ $I_2 = \frac{nb^3 + (m-n)t^3 + et^3}{12} + \frac{a(m-n)[2ac^2 + (2a+st)t^2]}{36}$ $+ \frac{e(t-w)[(t-w)^2 + 2(t+2w)^2]}{144}$ </p> |  <p> $A = bp + et; \quad x_1 = d-x$ $x = \frac{d^2t + p^2(b-t)}{2A}; \quad y = \frac{b}{2}$ $I_1 = \frac{tx^3 + bx^3 - (b-t)(x-p)^3}{3}$ $I_2 = \frac{pb^3 + ct^3}{12}$ </p> |
|  <p> $I_3 = I_1 \sin^2 \theta + I_2 \cos^2 \theta$ $I_4 = I_1 \cos^2 \theta + I_2 \sin^2 \theta$ $f = M\left(\frac{x}{I_1} \sin \theta + \frac{y}{I_2} \cos \theta\right)$ </p> |  <p> $\tan 2\theta = \frac{2J}{I_2 - I_1}$ $J = \frac{t[d(2y-t)(d-2y) + a(2x-t)(b+2t-2y)]}{4}$ $I_3 = I_2 - J \tan \theta; \quad I_4 = I_1 + J \tan \theta$ $\tan \lambda = \frac{x_1}{y_1} = \frac{I_4}{I_3} \cot \theta$ $f = M\left(\frac{x_1}{I_4} \sin \theta + \frac{y_1}{I_3} \cos \theta\right)$ </p> |  <p> $I_3 = I_1 \sin^2 \theta + I_2 \cos^2 \theta$ $I_4 = I_1 \cos^2 \theta + I_2 \sin^2 \theta$ $f = M\left(\frac{x}{I_1} \sin \theta + \frac{y}{I_2} \cos \theta\right)$ </p> |

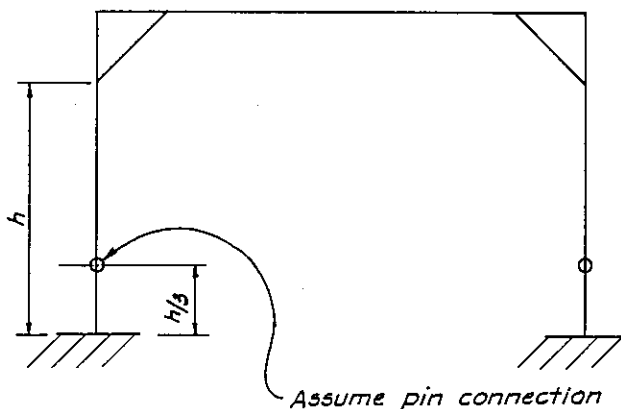
Adapted from Singleton, Manual of Structural Design, H.M. Ives & Sons.

STRUCTURAL-GENERAL-APPROXIMATE SOLUTION

TABLE A-CONTINUOUS BEAMS AND SLABS, A.C.I.. 1956

l = Clear span for positive moment and shear, and the average of the two adjacent clear spans for negative moment
 w = Uniformly distributed load per unit of length of beam or per unit area of slab
 Applicable if (1) Longer of 2 adjacent spans does not exceed shorter by more than 20%.
 (2) Live load is not more than 3 times dead load.

| | |
|---|----------------------|
| Positive moment | |
| End spans | |
| If discontinuous end is unrestrained | $\frac{1}{11} wl'^2$ |
| If discontinuous end is integral with the support | $\frac{1}{14} wl'^2$ |
| Interior spans | $\frac{1}{16} wl'^2$ |
| Negative moment at exterior face of first interior support | |
| Two spans | $\frac{1}{9} wl'^2$ |
| More than two spans | $\frac{1}{10} wl'^2$ |
| Negative moment at other faces of interior supports | |
| Negative moment at face of all supports for (a) slabs with spans not exceeding 10 ft., and (b) beams and girders where ratio of sum of column stiffnesses to beam stiffness exceeds 8 at each end of the span | $\frac{1}{12} wl'^2$ |
| Negative moment at interior faces of exterior supports for members built integrally with their supports | |
| Where the support is a spandrel beam or girder | $\frac{1}{24} wl'^2$ |
| Where the support is a column | $\frac{1}{16} wl'^2$ |
| Shear in end members at first interior support | $1.15 \frac{wl'}{2}$ |
| Shear at all other supports | $\frac{wl'}{2}$ |



RIGID FRAMES - FIXED AT BASE

STEEL BEAMS

Approximate section modulus of steel $WF = \frac{d}{11} x$

STEEL COLUMNS

Safe load in kips on WF column, normal story height 4 to 5 times weight per foot. Use 4 for light sections, 5 for heavy sections.

DEFLECTION

Steel Beams

Uniform load - see pp. 4-02 and 4-03.

Other loads - use formulas on pp. 8-01 through 8-04.

Concrete Beams

Use formulas on pp. 8-01 through 8-04.

$E = 3,000,000$ for short time loads to $1,000,000$ for permanent loads

$I = I$ of transformed section

CONCRETE BEAMS

(3000 lb. concrete; 12 in. width, d in ft.)

Allowable moment foot kips = $34 \times d^2$

Reaction - No stirrups = $10d$

Reaction - Maximum = $40d$

CONCRETE TIED COLUMNS

(3000 lb. concrete)

Maximum concentric load in kips = $150 \times$ area in sq. ft.

STRUCTURAL - GENERAL - EARTHQUAKES

LATERAL BRACING OF STRUCTURES

PACIFIC COAST UNIFORM BUILDING CODE -1952 SUPERSTRUCTURE:

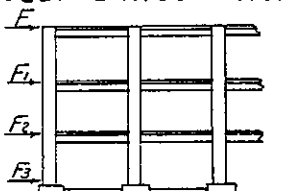
Design structure as a whole and every portion of same to resist lateral forces applied at each floor or roof level above foundations. Horizontal Force, $F = CW$ in lbs. Where: C = Force factor; factor from table A. W = total D.L. at and above point under consideration except for warehouses and tanks where: $W = \text{Total D.L.} + \text{Total L.L.}$

FOUNDATIONS:

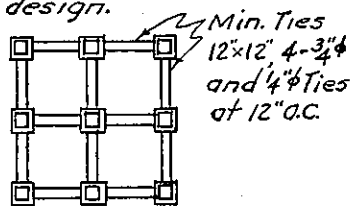
All foundations on piles or soil with less than 2000#/ft² bearing value shall have footings interconnected with ties in two directions at 90° to each other. Tie shall transmit 10% of vertical load of heavier footing connected. Concrete slab min. 6" or $\frac{1}{8}$ span, and not more than 12" above top of footing may be used in place of ties. Min. reinf. $\frac{3}{8}$ " at 12" o.c. each way.

GENERAL DESIGN DATA:

Stresses shall not be more than 33 1/3% above allowable working stresses in code except that shear in concrete walls 6" or thicker shall not exceed .05%. Over turning moment shall not exceed 1/3 of moment of stability both calculated using the same loads. Calculation of shears and moments shall be in accordance with the wind design.



TYPICAL BENT

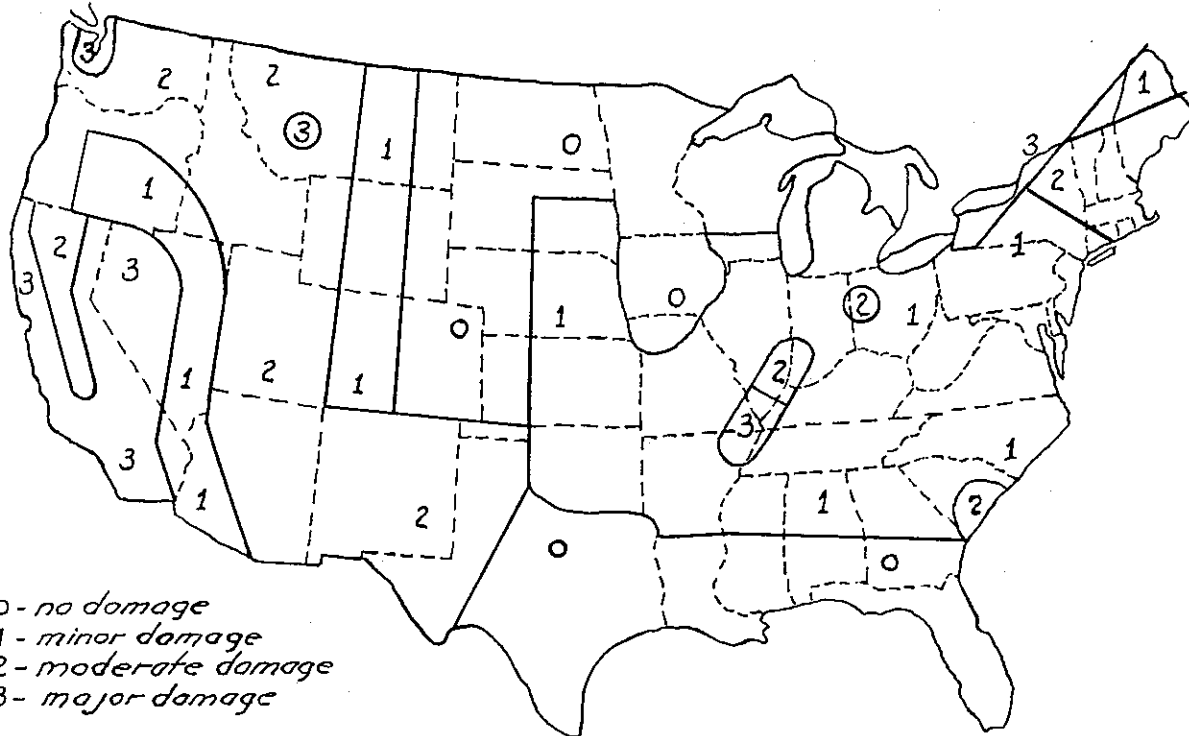


FOUNDATION PLAN

TABLE A - HORIZONTAL FORCE FACTORS

| PART OR PORTION | VALUE OF "C"* | DIRECTION OF FORCE |
|---|-------------------------|----------------------------|
| Floors, roofs columns and bracing in any story of a bldg. or the structure as a whole** | $\frac{.15}{N+4}$ | Any direction horizontally |
| Bearing walls, non-bearing walls, partitions, free standing masonry walls over 6' in height | .05 with min. of 5 1/2' | Normal to surface of wall |
| Cantilever parapet and other cantilever walls, except retaining walls. | .25 | Normal to surface of wall |
| Exterior and interior ornamentations & appendages | .25 | Any direction horizontally |
| When connected to or a part of a building: towers, tanks, towers and tanks plus contents, chimneys, smokestacks & penthouses. | .05 | Any direction horizontally |
| Elevated water tanks and other tower supported structures not supported by a building | .03 | Any direction horizontally |

* See B for zones. The values given "C" are minimum and should be adopted in locations not subject to frequent seismic disturbances as shown in zone 1. For location in zone 2, "C" shall be doubled. For locations in zone 3 "C" shall be multiplied by 4.
 ** Where wind load would produce higher stresses this load shall be used in lieu of factor shown. N is number of stories above the story under consideration, provided that for floors or horizontal bracing, N shall be only the number of stories contributing loads.



Zone 0 - no damage
 Zone 1 - minor damage
 Zone 2 - moderate damage
 Zone 3 - major damage

FIGURE B - SEISMIC PROBABILITY MAP OF THE U.S.

STRUCTURAL-GENERAL-TORSION & SKIN STRESSES

TORSION

Θ = Angle of twist (radians)

T = Twisting moment (in.lb)

L = Length (in.)

S_s = Unit Shear Stress #/in² due to torsion moment.

G = Modulus of rigidity #/in² = 11,000,000 approximately for structural steel and .45 E (E = Modulus of Elasticity) for concrete.

K (in.⁴) and Q (in.³) are functions of the cross section.

Safe working stress in torsional shear = $0.03 f'_c$ (concrete)

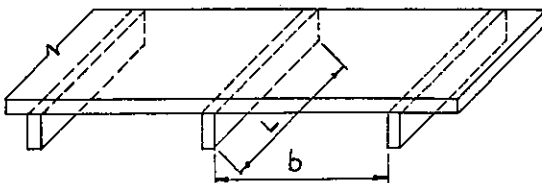
Safe working stress in torsional shear = 12,000 #/in² (steel)

r = Fillet radius

D = Diameter largest inscribed circle.

| CROSS SECTION | | MAXIMUM SHEARING * UNIT - STRESS | FORMULA FOR K IN $\Theta = \frac{TL}{KG} \dagger$ |
|---------------|--------------|--|---|
| FOR SHEAR | FOR Θ | | |
| | | $S_s = \frac{9}{2} \frac{T}{t^2 h + 4bo}$ | $K = 2K_1 + K_2 + 2\alpha D^4$, where $K_1 = ab^3 [\frac{1}{3} - 0.21 \frac{b}{a} (1 - \frac{b^4}{12a^4})]$ $K_2 = \frac{1}{3} cd^3$ $\alpha = \frac{t}{c} (0.15 + 0.1 \frac{t}{c})$, where $t = (b \text{ or } d)$ whichever the thinner. $c = (b \text{ or } d)$ whichever the thicker. |
| | | $S_s = \frac{9T}{2t^2 h}$ $S_s = \frac{9}{2} \frac{T}{t^2 (h + 2bo)}$ | $K = K_1 + K_2 + K_3 + \alpha D^4$ $K_1 = ab^3 [\frac{1}{3} - 0.21 \frac{b}{a} (1 - \frac{b^4}{12a^4})]$ $K_3 = K_1$ $K_2 = cd^3 [\frac{1}{3} - 0.105 \frac{d}{c} (1 - \frac{d^4}{192c^4})]$ $\alpha = \frac{b}{a} (0.07 + 0.076 \frac{b}{a})$ |
| | | $S_s = \frac{9}{2} \frac{T}{t^2 (h + b - t)}$ | $K = K_1 + K_2 + \alpha D^4$ where $K_1 = ab^3 [\frac{1}{3} - 0.21 \frac{b}{a} (1 - \frac{b^4}{12a^4})]$ $K_2 = cd^3 [\frac{1}{3} - 0.105 \frac{d}{c} (1 - \frac{d^4}{192c^4})]$ $\alpha = \frac{b}{a} (0.07 + 0.076 \frac{b}{a})$ |
| | | $S_s = \frac{2T}{\pi r^3}$ | $K = \frac{1}{2} \pi r^4$ |
| | | $S_s = \frac{9T}{2b^2 h}$ | $K = ab^3 [\frac{1}{3} - 3.36 \frac{b}{a} (1 - \frac{b^4}{12a^4})]$ |

SKIN STRESSES †



BEAMS WITH WIDE FLANGES

Effective flange width = $C \cdot L$

Values of C in table opposite

| TYPE OF BEAM | $\frac{b}{L} = 0.1$ | $\frac{b}{L} = 0.2$ | $\frac{b}{L} = 0.4$ | $\frac{b}{L} = \infty$ |
|--------------------------------------|---------------------|---------------------|---------------------|------------------------|
| Continuous, uniform load at support | 0.066 | 0.085 | 0.105 | 0.120 |
| Continuous, uniform load at mid-span | 0.090 | 0.150 | 0.190 | 0.220 |
| Continuous, center loads at support | 0.076 | 0.105 | 0.130 | 0.150 |
| Continuous, center loads at mid-span | 0.076 | 0.105 | 0.130 | 0.150 |
| Simple beam, uniform load | | 0.175 | 0.290 | 0.360 |
| Simple beam, center load | | 0.150 | 0.210 | 0.310 |

† Adapted From "Formulas for Stress and Strain" by R.J. Roark - Mc Graw-Hill 1943.

* Adapted From "Advanced Mechanics of Materials" by F.B. Seely - John Wiley 1947.

STRUCTURAL-GENERAL-TRUSSES

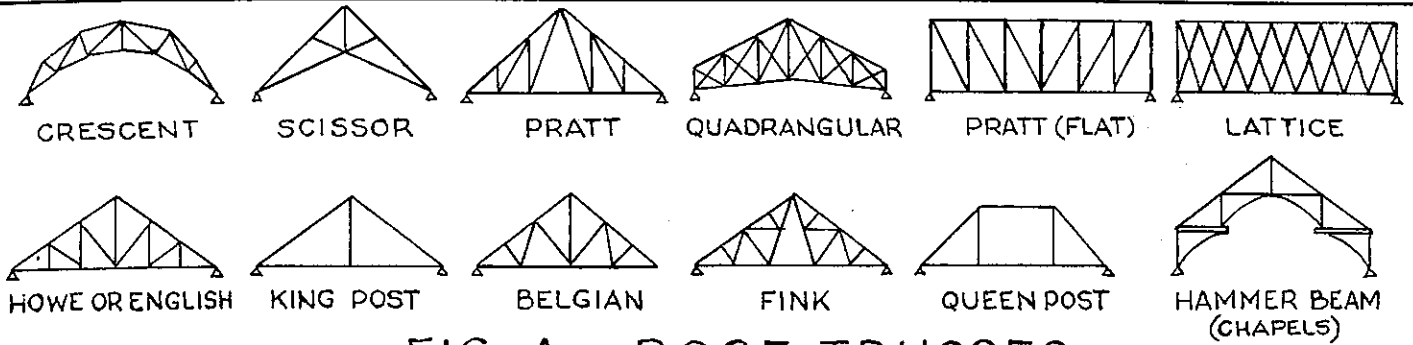


FIG. A ROOF TRUSSES

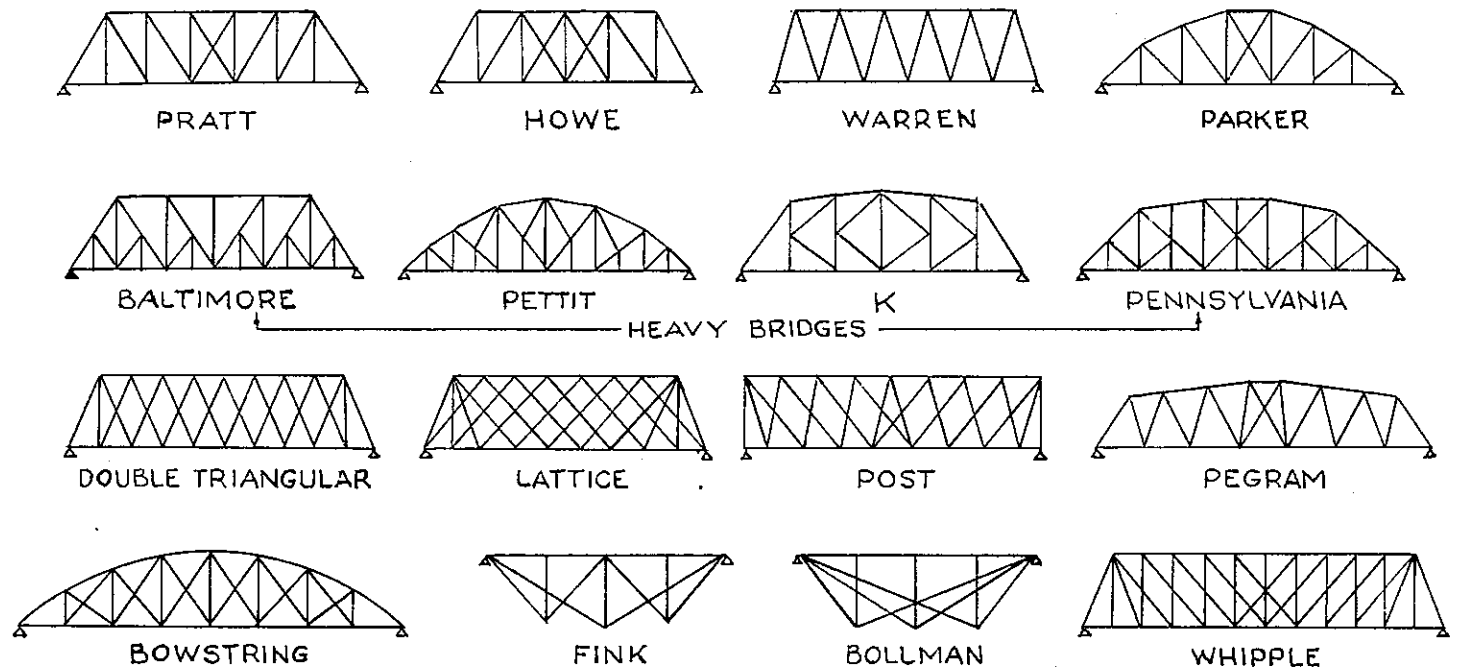


FIG. B BRIDGE TRUSSES

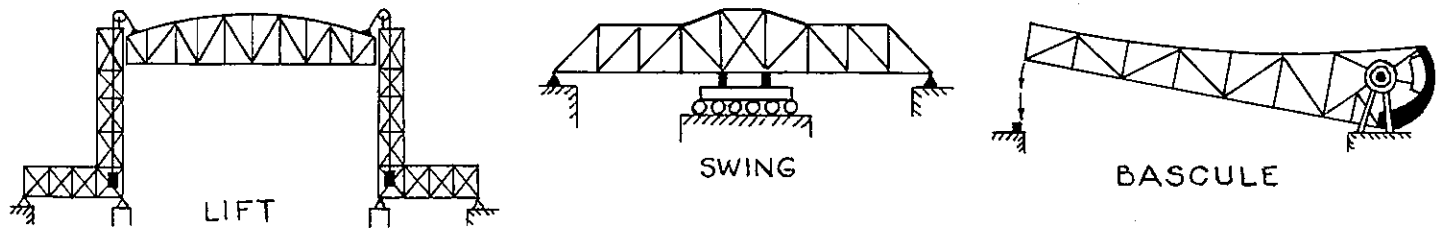


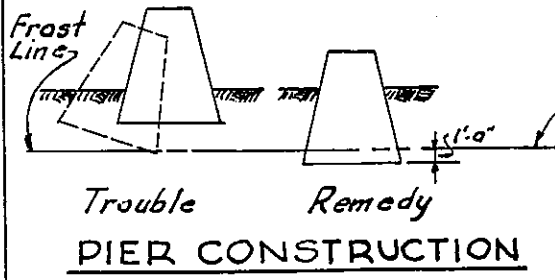
FIG. C MOVABLE BRIDGES

TABLE D - TRUSS WEIGHTS *

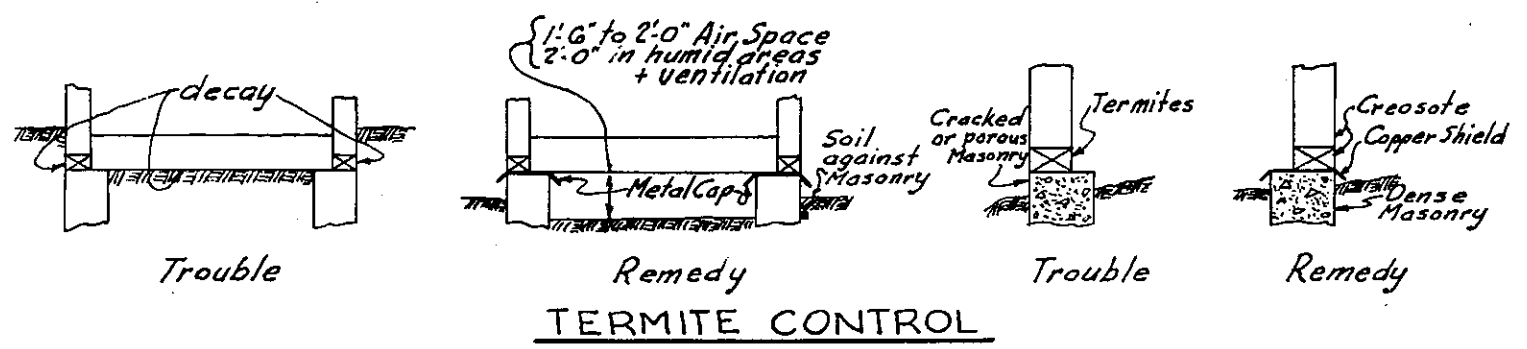
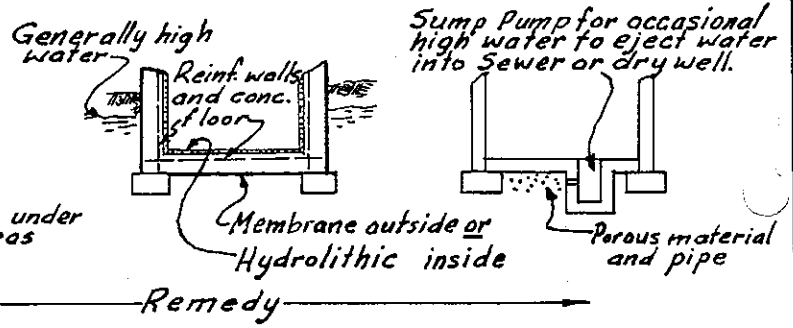
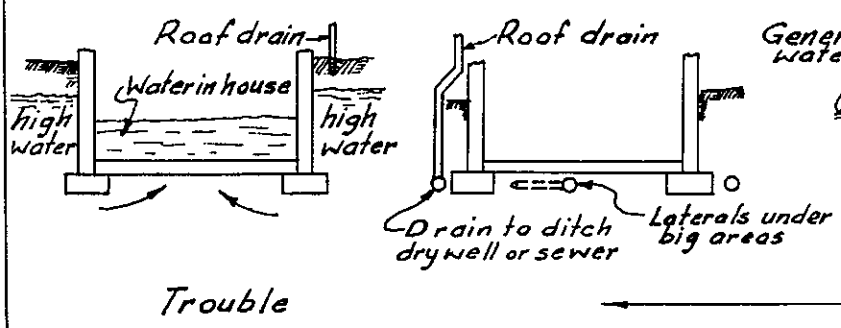
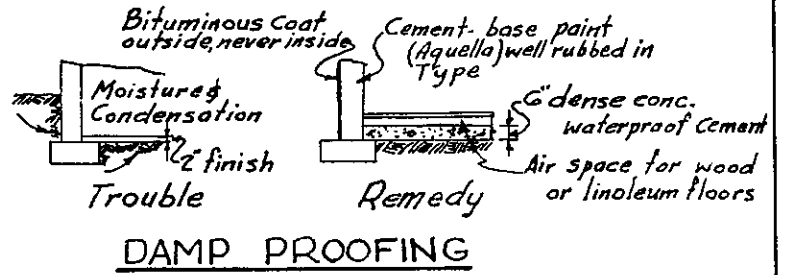
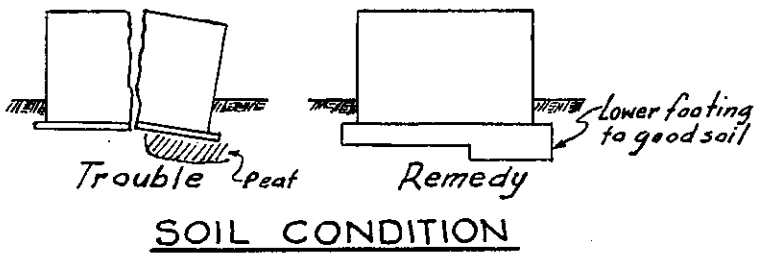
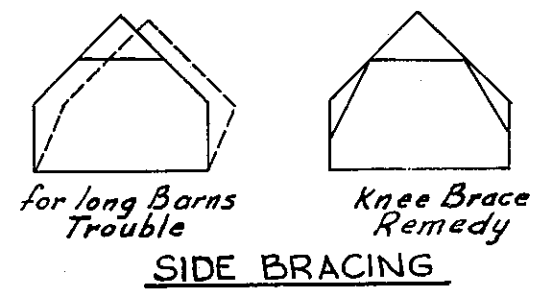
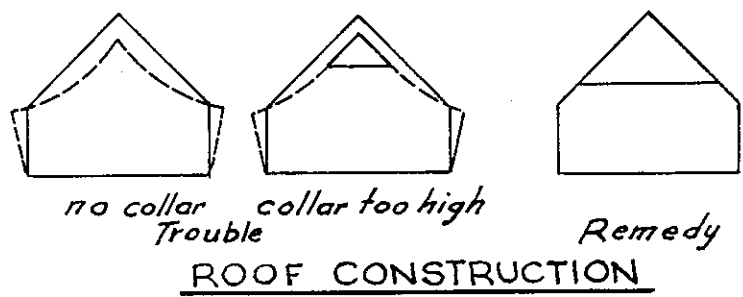
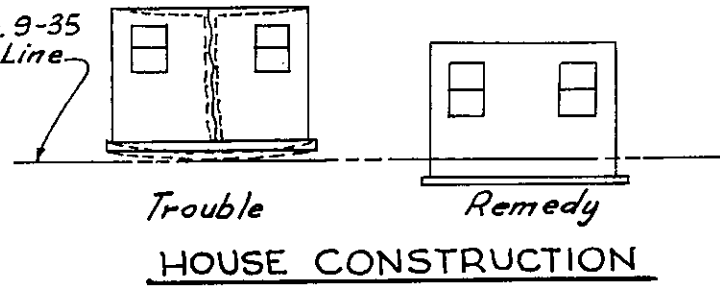
| | | |
|------------------------------|----------------------------------|---|
| ROOFS | $W = \frac{3pL}{450 + 15L + ps}$ | <i>W</i> = Wt. in lbs./sq. ft. of horiz. covered surface; <i>L</i> = Truss span - ft.; <i>S</i> = Truss spacing - ft.; and <i>p</i> = load in lbs./sq. ft. of horiz. covered area, carried by truss. (40 lbs./sq. ft. min.) |
| R. R. BRIDGES (Single Track) | $W = 2(2L + 5E)$ | <i>W</i> = Wt. in lbs./ft. of span of one truss, 1/2 of lateral bracing, & 1/2 of the floor system; <i>L</i> = span length - ft.; <i>E</i> = the number of the class of Cooper's loading governing the design. |
| HIGHWAY BRIDGES | $W = \frac{W_1}{9} + L$ | <i>W</i> = wt. per ft. of one truss & 1/2 of the bracing; <i>W</i> ₁ = total superimposed load per ft. brought to each truss - wt. of floor plus live load + impact; <i>L</i> = span in ft. |

*Adopted from Civil Engineering Handbook by L. C. Urquhart - McGraw-Hill.

STRUCTURAL-GENERAL-ERRORS & REMEDIES



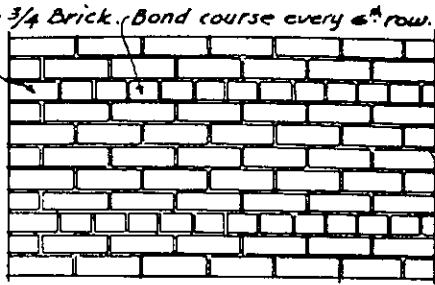
See Pg. 9-35 Frost Line



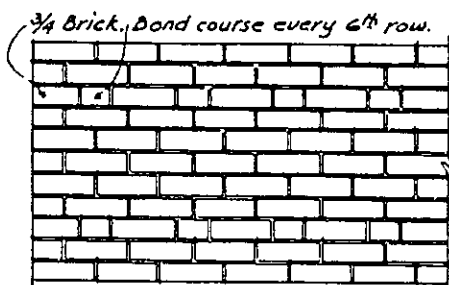
FOUNDATION PROTECTION FROM TERMITES

1. Clean up building and grounds of all wood trash.
2. Break all wood to earth contacts and treat ground with Pentachlorophenol.

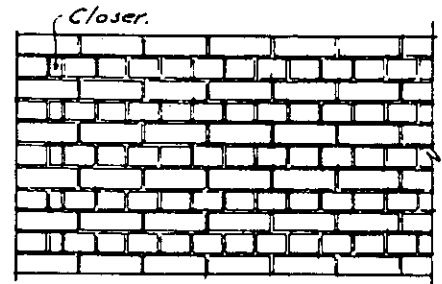
STRUCTURAL - GENERAL - BRICK MASONRY



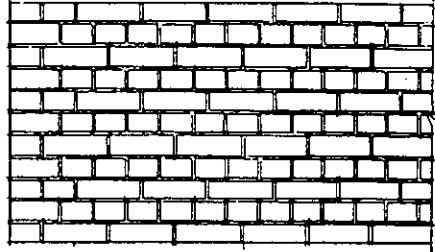
COMMON (Header Bond)
 Stretcher or Running Bond, similar but without headers, except every other course at corner



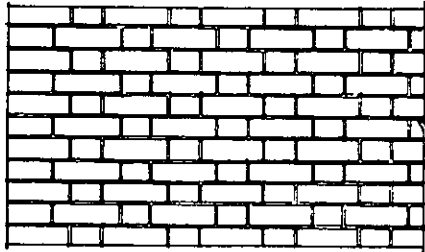
COMMON (Flemish Bond)



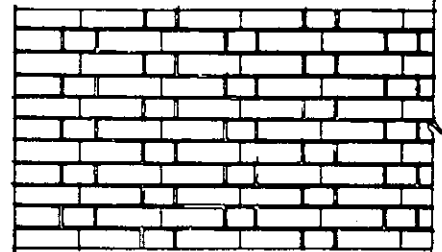
ENGLISH



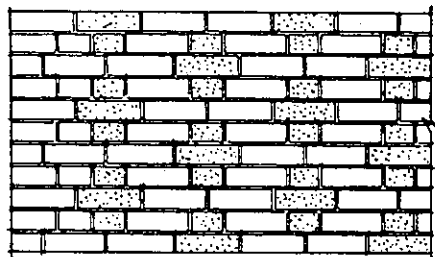
ENGLISH (Cross)



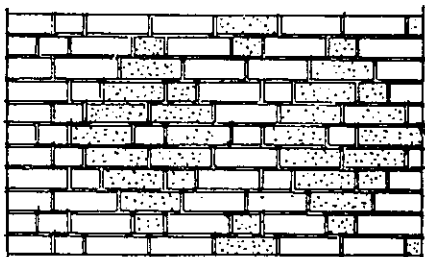
FLEMISH



FLEMISH (Double Stretcher)



FLEMISH (Cross)



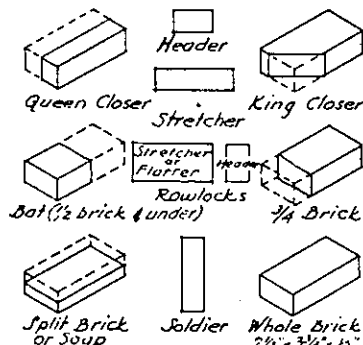
FLEMISH (Diagonal)

Normal: 12" length x 2 1/4" x 3 1/2"
 Roman: 12" length x 1 5/8" x 3 3/4"
 Baby Roman: 8" x 1 5/8" x 3 3/4"
 Two Brick Type: 5" high x 8" x 3 1/2"
 Over size: 2 1/2" x 3 3/4" x 8"

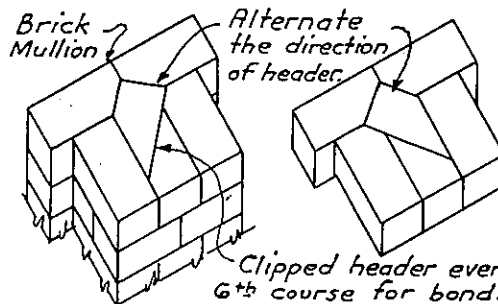
SPECIAL BRICK SIZES

Struck: Raked Strip, Flush or ped. plain cut
 Weathered: 1/4" Gutter, Flush, Beaded, Grooved.

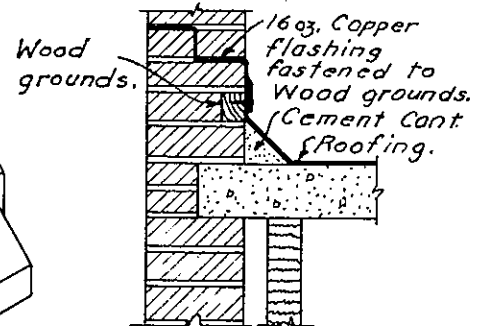
BRICK JOINTS
 3/8" - 1/2"



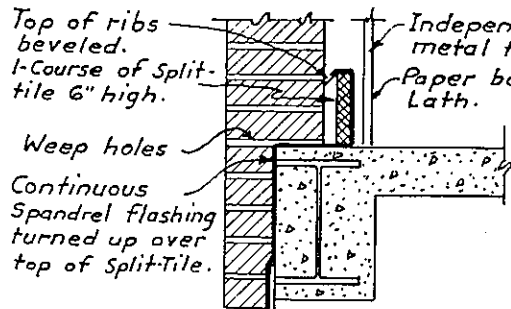
BRICK TYPES



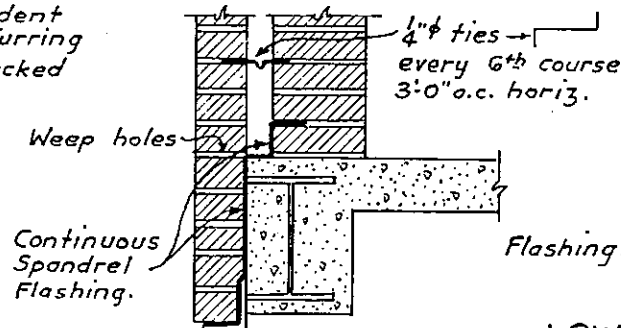
CLIPPED HEADER FOR MULLION



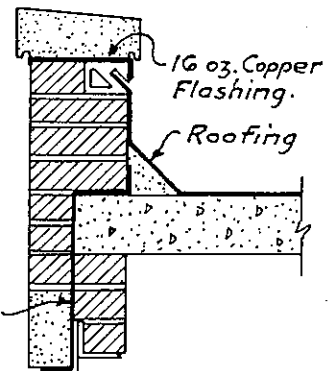
HIGH PARAPET FLASHING



WEATHER PROOF WALL ASSEMBLY



CAVITY WALL

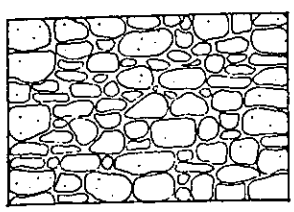


LOW PARAPET FLASHING

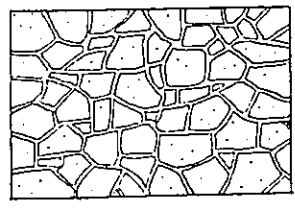
Bonds and Joints adapted from Arch. Graphic Stds. by Ramsey & Sleeper.

STRUCTURAL-GENERAL- STONE MASONRY

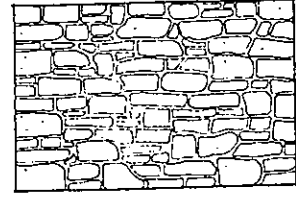
- STONE WORK -



UNCOURSED FIELDSTONE
ROUGH OR ORDINARY.
TYPES



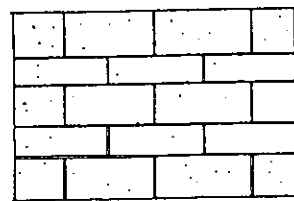
POLYGONAL, MOSAIC
OR RANDOM.
TYPES OF RUBBLE MASONRY



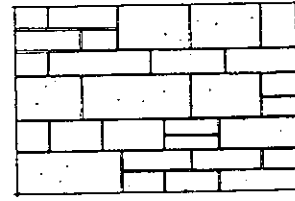
COURSED



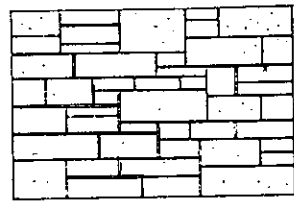
Laid of stratified stone filed on job.
It is between rubble & ashlar. Finish
is quarry face, searn face or split.
Called rubble ashlar in granite.
SQUARED-STONE MASONRY.



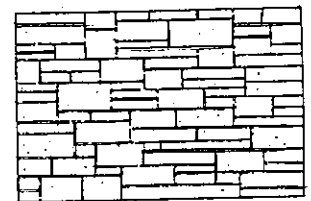
RANGE.
Coursed



BROKEN RANGE.



RANDOM
Interrupted coursed



RANGE.
Coursed (Long stones)

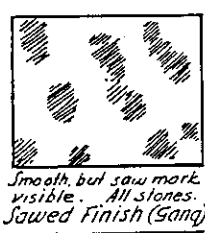
TYPES OF ASHLAR MASONRY

This is stone that is sawed, dressed, squared or Quarry faced.

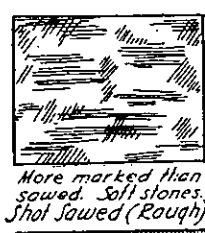
ELEVATIONS SHOWING FACE JOINTING FOR STONE.



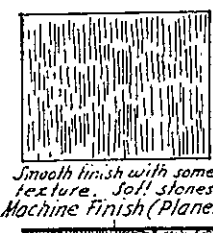
For both hard and soft stones.
Rock or Pitch Face.



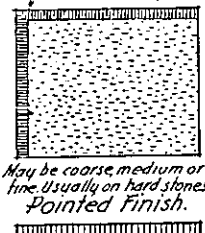
Smooth, but saw mark visible. All stones.
Sawed Finish (Gang).



More marked than sawed. Soft stones.
Shot Sawed (Rough).



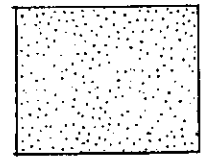
Smooth finish with some texture. Soft stones.
Machine Finish (Planer).



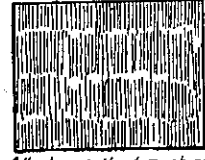
May be coarse, medium or fine. Usually on hard stones.
Pointed Finish.



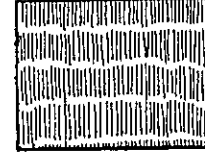
After pointing on hard stones.
Dean Hammered.



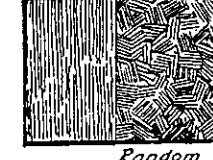
For soft stones.
Bush-hammered.



All stones. Used much on granite 4 to 8 cut in 7/8".
Patent Bush-hammer.



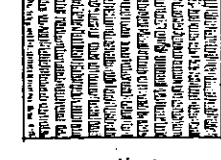
For soft stones.
Drove or Boasted.



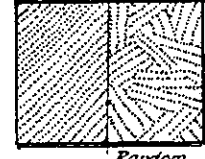
Random
For soft stones.
Hand Tooled.



Tool marks may be 2 to 10 per inch.
Machine Tooled.



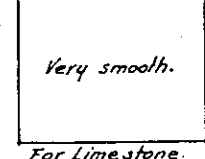
For soft stones.
Tooth-chisel.



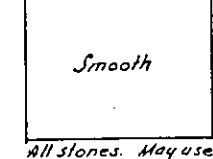
Random
For soft stones.
Crandalled.



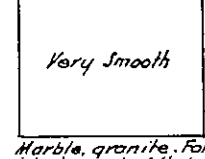
Textured by machine.
For Limestone.
Plucker Finish.



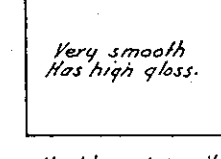
Very smooth.
For Limestone.
Done by machine.
Carborundum Finish.



Smooth
All stones. May use sand or carborundum.
Rubbed (Wet).



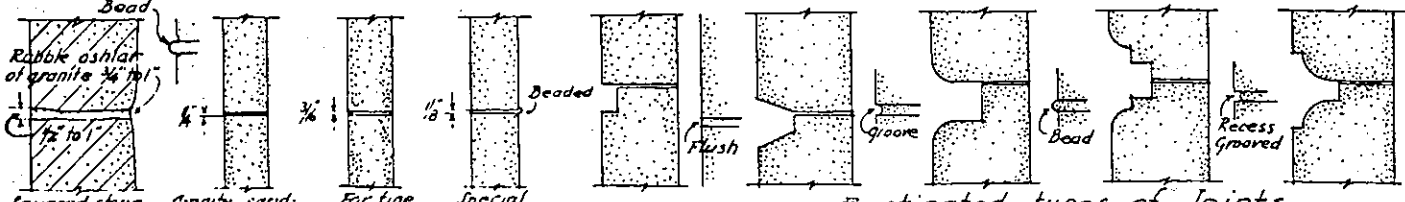
Very Smooth
Marble, granite. For interior work. Soft stones.
Honed (rubbed first).



Very smooth
Has high gloss.
Marble and Granite.
Polished (honed first).

STONE FINISHES.

Seam face and split face (or quarry face) not shown as they are not worked finishes.



Rusticated types of Joints.

STONE JOINTS

TYPES, FINISH AND JOINTING OF STONE MASONRY.

A perch is nominally 16'6" long, 1'0" high & 1'6" thick = 24 1/2 cu.ft. In some localities 16'2" & 22 cu.ft. are used.

Adapted from Arch. Graphic Stds. by Ramsey & Sleeper.

STRUCTURAL-GENERAL-NOTES

CONCRETE

DESIGN DRAWINGS

1. Concrete shall develop a strength of --p.s.i. at 28 days. Reinforcement shall be intermediate-grade deformed bars conforming to A.S.T.M. A-15 and A-305.
2. In two-way slabs, place short-span bars in bottom layer.
3. Concrete beams to have 8-in. bearing on walls unless otherwise noted.
4. Concrete joists to have not less than 6-in. bearing on walls.
5. Solid slabs to have 4-in. bearing on walls.
6. Fireproofing thickness shall be 3/4-in. for slabs and joists, 1-1/2 in. for beams, girders, and columns.
7. See specifications for instructions to detailers.
8. Add notes as may be required by local codes.

WORKING DRAWINGS (include inspecifications.)

9. Provide adequate ties for all steel bars and stirrups in slabs and beams. All reinforcing steel in slabs and beams to be held at correct distance from forms by adequate concrete blocks, steel chairs, or ties in accordance with latest A.C.I. detailing practices.
10. Follow A.C.I. rules as to stirrups, column ties, and anchorage.
11. Where concrete beams frame into steel, provide two 3/4-in. round anchor bolts at top of concrete beam with double nuts through web or hooks over flanges except as otherwise noted.
12. Provide --header bars in bottom of slab in front of all openings and cases in bearing walls unless otherwise shown.
13. Metal tile slabs to be anchored to walls with 5/8-in. round anchors 4 ft. long with 6-in. hook at wall end, placed in top of alternate joists.
14. Metal tile joists to be 25-in. on center except as shown. Steel shown in slab schedules is per joist.
15. Topping of metal tile joist slabs to be 2 in. thicker than typical each side of concrete beams parallel to joists.
16. Where joists run parallel to wall, provide 1/2-in. round anchors 3'-6" long with 6-in. hooks at right angles to joists 4 ft. on center in topping.
17. Working drawings to show T flanges on beams of sufficient width and thickness to develop full strength of steel.
18. Provide no. 2 stirrups 12 in. on center for beams and joists with top steel for sections where no stirrups are called for.
19. Provide two no. 3 tie rods in top of all concrete beams to fasten stirrups where no top steel occurs.
20. Topping of metal tile joist slabs to be reinforced with 66-66 steel mesh.
21. Provide longitudinal or temperature reinforcement in solid slabs in accordance with A.C.I. code. (See p. 2-04.)
22. Provide 100% continuity over supports for all continuous slabs, beams, and joists unless otherwise noted.
23. In all solid slabs, bend up alternate bars, and extend into adjacent spans where continuous, unless otherwise noted on plans.
24. Where main slab reinforcement is parallel to beam, place no. 3 rods, spacing equal or less than 18 in. or 5 times the thickness of the slab by 6 ft. long, except where otherwise shown over beam.
25. All negative-moment rods to extend to quarter points of spans unless otherwise shown.
26. (a) At ends of non-continuous beams, provide anchor bars in top of beam. Anchors to be equivalent to one third of main reinforcement, but not less than two no. 6 4 ft. long, unless noted otherwise. (See p. 2-02.)
(b) At ends of non-continuous slabs, provide anchor bars in top of slab. Anchors to be equivalent to one-half main reinforcement but not less than no. 3 bars spaced 12 in. on center 3'-0" long. (See p. 2-03.)

STEEL

DESIGN DRAWINGS

1. All lintels shall have 6-in. minimum bearing each side unless otherwise noted.
2. Steel joists to have not less than 4-in. bearing on walls.
3. Where open-web steel joists span more than 14 ft., provide safety headers of approved type.
4. All rivets to be --diameter unless otherwise noted. (Include on shop drawings.)
5. Provide 8" x 5/8" x 0' 1/8" bearing plates and government anchors for all steel beams resting on masonry, except as otherwise shown.
6. Double steel beams and girders to be provided with pipe separators.
7. Provide soffit clips for bottom flanges of all steel beams to be fireproofed, and mesh for all steel columns to be fireproofed.
8. Fireproofing thickness shall be as follows: Beams--, columns--.
9. Steel beams carrying chimneys or other masonry to be fireproofed with stone concrete.

WOOD

DESIGN DRAWINGS

1. All wood shall be (give species and stress grade).
2. Provide 1-1/4" x 2" cross-bridging not over 6 ft. on center for all wood joists.
3. Where wood joists frame into or rest on top of steel beams, provide 1-1/2" x 3/16" steel strap anchors spiked to wood joists and hooked over flange of beam at every third joist on each side of beam.
4. Where wood joists rest on masonry, provide metal anchors at maximum intervals of 4 ft. on center having a minimum cross section 1/4" x 1-1/4" by minimum length of 16 in. securely fastened to joist and built into masonry with split or upset ends. Where joists are parallel to walls, provide similar anchors at maximum spacing of 6 ft., engaging 3 joists.
5. Bolts of ring connectors shall be retightened periodically during the process of seasoning.
6. Provide standard beam hangers for the beams framed into girders except as otherwise shown.
7. Joists to be double under partitions parallel to joists except as otherwise shown.

MASONRY

(Include in Specification)

1. Mortar to be (Engineer to fill in).
2. All masonry work to be bonded as shown or as approved by engineer.
3. Brick pilasters in tile backup walls to be bonded into adjoining masonry.

FOUNDATIONS

DESIGN DRAWINGS

1. Foundations designed for --tons per sq. ft. (check soil in field.) Client or Engineer will check the assumption.
2. Concrete shall develop a strength of --p.s.i. at 28 days.
3. No backfilling against foundation walls to be done until after superstructure is in place.
- *4. Where reinforced mat slabs are erected and ground-water pressure is likely to occur, relief holes should be left to relieve water pressure until approved by Engineer.
5. Extreme high water level has been assumed at elevation --. This assumption must be checked in the field. Client or Engineer will check the assumption.
6. See specifications for instructions to detailers.

WORKING DRAWINGS (Include in Specifications).

7. Wall footings to be stepped where elevation changes 1 vertical to 2 horizontal, except where otherwise shown. Maximum vertical slip not to exceed 2'-0".
8. Provide 6 no. 4 rods continuous in top and 2 no. 6 continuous in bottom of all exterior walls, except as otherwise shown. Lap 40 diameters, and bend around corners.
9. Provide 2 no. 4 rods continuous in top and bottom of all interior concrete walls, except as otherwise shown.
10. All wall, pier, and stack footings shall be 12 in. thick and project 6 in. beyond all faces of walls, piers, and stacks, except as otherwise noted.
11. Provide 2 no. 6 rods, all sides, for all openings in concrete walls unless otherwise noted. Extend 2 ft. beyond openings or hook ends.
12. Provide pockets in walls for all concrete beams and slabs at first floor.
13. Construction joints in foundation walls, interior and exterior, shall be placed not more than 30 ft. apart and shall be V-chamfered unless otherwise shown. Location of joints shall be as shown on the drawings or approved by the Engineer. Sections of walls shall be poured alternately.

* This note to be placed on working drawings.

