

Chapter ILHR 21

CONSTRUCTION STANDARDS

Subchapter I—Scope	ILHR 21.16 Frost penetration (p. 39)
ILHR 21.01 Scope (p. 25)	ILHR 21.17 Drain tiles (p. 40)
Subchapter II—Design Criteria	Subchapter V—Foundations
ILHR 21.02 Loads and materials (p. 25)	ILHR 21.18 Foundations (p. 41)
ILHR 21.03 Exits, doors and hallways (p. 29)	Subchapter VI—Floors
ILHR 21.04 Stairs (p. 31)	ILHR 21.19 Floor design (p. 44)
ILHR 21.05 Light and ventilation (p. 33)	ILHR 21.20 Concrete floors (p. 44)
ILHR 21.06 Ceiling height (p. 34)	ILHR 21.21 Precast concrete floors (p. 44)
ILHR 21.07 Attic and crawl space access (p. 34)	ILHR 21.22 Wood frame floors (p. 47)
ILHR 21.08 Firestopping and fire separation (p. 34)	Subchapter VII—Walls
ILHR 21.09 Smoke detectors (p. 36)	ILHR 21.23 Wall design (p. 52)
ILHR 21.10 Protection against decay and termites (p. 36)	ILHR 21.24 Exterior covering (p. 53)
ILHR 21.11 Foam plastic insulation (p. 37)	ILHR 21.25 Wood frame walls (p. 53)
Subchapter III—Excavations	ILHR 21.26 Masonry walls (p. 56)
ILHR 21.12 Grade (p. 37)	Subchapter VIII—Roof and Ceilings
ILHR 21.13 Excavations adjacent to adjoining property (p. 37)	ILHR 21.27 Roof design (p. 62)
ILHR 21.14 Excavations for footings and foundations (p. 38)	ILHR 21.28 Roof and ceiling wood framing (p. 63)
Subchapter IV—Footings	Subchapter IX—Fireplace Requirements
ILHR 21.15 Footings (p. 38)	ILHR 21.29 Masonry fireplaces (p. 66)
	ILHR 21.30 Masonry chimneys (p. 67)
	ILHR 21.31 Factory-built fireplace stoves (p. 69)
	ILHR 21.32 Factory-built fireplaces (p. 69)

NOTE: Chapter Ind 21 was renumbered to be chapter ILHR 21, Register, February, 1985, No. 350, eff. 3-1-85.

SUBCHAPTER I—SCOPE

ILHR 21.01 Scope. The provisions of this chapter shall apply to the design and construction of all one- and 2-family dwellings.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

SUBCHAPTER II—DESIGN CRITERIA

ILHR 21.02 Loads and materials. Every dwelling shall be designed and constructed in accordance with the requirements of this section.

(1) DESIGN LOAD. Every dwelling shall be designed and constructed to support the actual dead load, live loads and wind loads acting upon it without exceeding the allowable stresses of the material.

(a) *Dead loads.* Every dwelling shall be designed and constructed to support the actual weight of all components and materials. Earth-sheltered dwellings shall be designed and constructed to support the actual weight of all soil loads.

(b) *Live loads.* 1. Floors and ceilings. Floors and ceilings shall be designed and constructed to support the minimum live loads listed in Table 21.02. The design load shall be applied uniformly over the component area.

TABLE 21.02

Component	Live Load (pounds per sq. ft.)
Floors.....	40
Garage floors.....	50
Exterior balconies, decks, porches.....	40
Ceilings (with storage).....	20
Ceilings (without storage).....	5

2. Snow loads. Roofs shall be designed and constructed to support the minimum snow loads listed on the zone map. The loads shall be assumed to act vertically over the roof area projected upon a horizontal plane.

(c) *Wind loads.* Every dwelling shall be designed and constructed to withstand a horizontal and uplift pressure of 20 pounds per square foot acting over the surface area.

(d) *Fasteners.* All building components shall be fastened to withstand the dead load, live load and wind load. Where the effect of the dead load exceeds the wind load effect, the dwelling need not be anchored to the foundation.

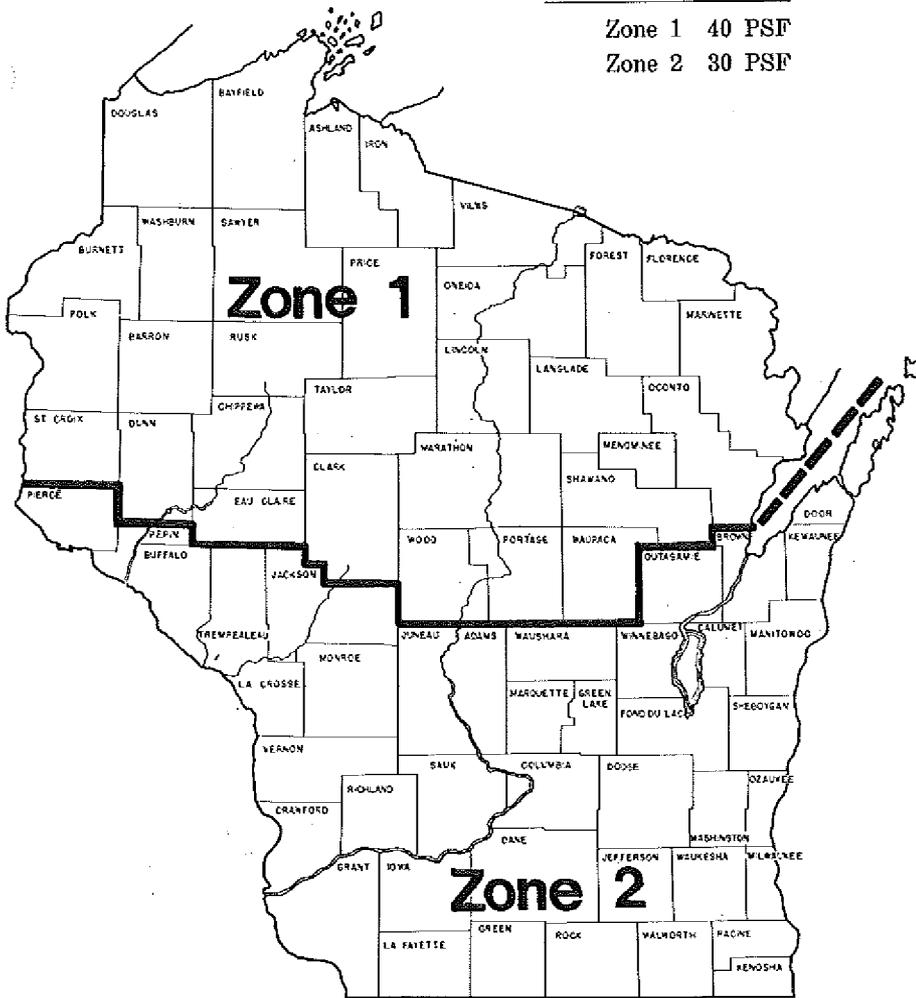
Note: See the Appendix for a schedule of fasteners.

Figure 21.02
ZONE MAP FOR ROOF LOADS

ROOF LIVE LOADS

Zone 1 40 PSF

Zone 2 30 PSF



(2) **METHODS OF DESIGN.** All dwellings shall be designed by the method of structural analysis or the method of accepted practice specified in each part of this code.

Note: See ch. NR 116, rules of the department of natural resources, for special requirements relating to buildings located in flood plain zones. Information regarding the elevation of the regional flood may be obtained from the local zoning official.

(3) **STRUCTURAL ANALYSIS STANDARDS.** Structural analysis shall conform to the following nationally recognized standards.

(a) *Wood.* 1. Except as provided in subpar a. and b., structural lumber, glue-laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" and the "Design Values for Wood Construction," a supplement to the National Design Specification for Wood Construction.

a. Section 2.2.5.3. The cumulative effects of short-time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.05 shall be used.

Note: Subparagraph a. is applicable only when the spacing of the roof rafters exceeds 24 inches on center.

b. Section 4.1.7. The provisions of this section shall also apply to re-used lumber. Reused limber shall be considered to have a duration of load factor of 0.90.

2. Span tables for joists and rafters printed in the appendix or approved by the department may be used in lieu of designing by structural analysis.

Note #1: The department will accept designs and installations in conformance with the following: (1) "Plywood Design Specification" including Supplement No. 1, "Design of Plywood Curved Panels"; Supplement No. 2, "Design of Plywood Beams"; Supplement No. 3, "Design of Flat Plywood Stressed-Skin Panels"; and Supplement No. 4, "Design of Flat Plywood Sandwich Panels"; (2) "Plywood Diaphragm Construction"; (3) Laboratory Report 121, "Plywood Folded Plate Design and Details"; (4) Laboratory Report 93, "Load-Bearing Plywood Sandwich Panels"; and (5) "Fabrication Specifications Plywood-Lumber Components: CP-8, BB-8, SS-8, SP-61, FF-62, PW-61" (above publications available from the American Plywood Association, 1119 A Street, Tacoma, Washington 98401); (6) Design Guide HP-SG-71, "Structural Design Guide for Hardwood Plywood" (available from the Hardwood Plywood Manufacturers Association, 2310 S. Walter Reed Drive, Arlington, Virginia 22206); (7) U.S. Product Standards PS 1-74 for Softwood Plywood Construction and Industrial (available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402); (8) TPI-78, "Design Specification for Metal Plate Connected Wood Trusses" (available from Truss Plate Institute, Inc., 7411 Riggs Road, Hyattsville, Maryland 20783); (9) "Wood Structural Design Data," 1978 edition (available from National Forest Products Association, 1619 Massachusetts Ave. NW, Washington, D.C. 20036).

Note #2: The department will accept plywood treated in accordance with the standards of the American Wood Preservers Association.

(b) *Structural steel.* The design, fabrication and erection of structural steel for buildings shall conform to: AISC, "Specification for Design, Fabrication and Erection of Structural Steel for Buildings" [ILHR 20.24 (1)] and the provisions of the accompanying commentary for this specification.

(c) *Concrete.* Plain, reinforced or prestressed concrete construction shall conform to the following standards:

1. ACI Std. 318, "Building Code Requirements for Reinforced Concrete".

Register, February, 1985, No. 350
Construction Standards

2. ACI Standard 318.1, "Building Code Requirements for Structural Plain Concrete".

Note: The following standards are recognized by the department as being good construction practice: (1) "Commentary on Building Code Requirements for Reinforced Concrete," ACI Report 318; (2) "Recommended Practice for Selecting Proportions for Concrete," ACI Std. 211.1; (3) "Recommended Practice for Selecting Proportions for Structural Lightweight Concrete," ACI Std. 211.2; (4) "Recommended Practice for Hot Weather Concreting," ACI Std. 605; (5) "Recommended Practice for Cold Weather Concreting," ACI Std. 306; (6) "Manual of Standard Practice for Detailing Reinforced Concrete Structures," ACI Std. 315; (7) "Recommended Practice for Evaluation of Compression Test Results of Field Concrete," ACI Std. 214; (8) "Recommended Practice for Measuring, Mixing and Placing Concrete," ACI Std. 614; (9) "Recommended Practice for Concrete Formwork," ACI Std. 347; (10) "Specification for the Design and Construction of Reinforced Concrete Chimneys," ACI Std. 505; (11) "Suggested Design of Joints and Connections in Precast Structural Concrete," ACI Report 512; (12) "Guide for Cellular Concretes Above 50 pcf and for Aggregate Concretes Above 50 pcf with Compressive Strengths Less than 2500 psi," ACI JOURNAL, February 1975 (Copies of above standards may be obtained from American Concrete Institute, P.O. Box 19150, Redford Station, Detroit, Michigan 48219); (13) "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction," AWS Std. 12.1 (American Welding Society, 2501 NW 7th St., Miami, Florida 33125).

(e) *Masonry.* The design and construction of masonry buildings shall conform to the "Concrete Masonry Handbook" [ILHR 20.24 (5)].

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. (3) (a), am. (3) (c) and Table 21.02, cr. (3) (c) 2., Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.03 Exits, doors and hallways. Exits, doors and hallways shall be constructed as specified in this section.

(1) **EXITS FROM THE FIRST FLOOR.** (a) Every dwelling unit shall be provided with at least 2 exits from the first floor. One of the exits shall discharge to grade. The second exit may discharge to an outside balcony or discharge to grade or discharge into an attached garage provided with an exit door which discharges to grade. An overhead garage door may not be used as an exit door. The 2 required exits from the first floor shall be located as far apart as practical.

(b) Exits from bedrooms shall be in accordance with subds. 1. and 2.: 1. Every bedroom shall have at least one operable window for emergency egress or rescue. The window shall be operable from the inside without the use of separate tools. Where windows are provided as a means of egress or rescue the sill height shall be not more than 44 inches above the floor. An exit door may be used in lieu of an exit window. Where exit doors are provided, the exit shall discharge to an exterior balcony or discharge to grade.

2. All egress or rescue windows from bedrooms shall have a minimum net clear opening of 5.4 square feet. The minimum net clear opening height dimension shall be 24 inches. The minimum net clear opening width dimension shall be 20 inches. If equipped with a screen or storm, it shall be openable from the inside.

(2) **EXITS FROM THE SECOND FLOOR.** At least 2 exits shall be provided from the second floor. One of the exits shall be a stairway or ramp and lead to the first floor or discharge to grade. The second exit may be an exit from a bedroom specified in accordance with sub. (1) (b).

(3) **EXITS ABOVE THE SECOND FLOOR.** At least 2 exits shall be provided for each floor above the second floor. The exits shall be located such that in case any exit is blocked some other exit will still be accessible to the

second floor. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.

(4) EXITS FROM LOFTS. (a) At least one stairway exit shall be provided, to the floor below, for a loft exceeding 400 square feet in area.

(b) At least one stairway or ladder exit shall be provided to the floor below for a loft, 400 square feet or less, in area.

(5) EXITS FROM THE BASEMENT. (a) Where the entire floor of the basement is below grade, at least one exit shall be provided, unless the basement is used for sleeping. The exit shall be a stairway or ramp which leads to the first floor or discharges to grade.

(b) Where the entire floor of the basement is below grade and the basement is utilized for sleeping, at least two exits shall be provided. The two exits shall not be accessed by the same stairway and shall be in accordance with subds. 1. and 2.

1. One of the exits shall be a stairway which leads to the first floor.

2. The second exit may be a stairway which leads to grade, or a door located at the basement level which leads to grade via an exterior stairs or an outside window which can be opened from the inside without the use of tools. The window shall not be less than 20 inches in width, 24 inches in height and 5.7 square feet in area, with the bottom of the sill located not more than 44 inches above the floor. If a window is provided as the second exit, a window shall be located in each bedroom. If the window is located below grade, an areaway shall be provided. The width of the areaway shall be $1\frac{1}{2}$ times the depth of the areaway. The areaway shall be a minimum of 3 feet measured perpendicular from the wall. The areaway shall be constructed to prevent rainfall flowing into the areaway from entering the bedroom.

(6) EXITS FROM THE GROUND FLOOR. (a) At least one exit shall be provided for the ground floor unless the ground floor is used for sleeping. The exit may be a swing door or a sliding glass door which discharges directly to grade or may be a stairway which leads to the first floor.

(b) If the ground floor is used for sleeping, at least two exits shall be provided in accordance with subds. 1. and 2.

1. One of the exits shall discharge to grade via a swing door or sliding glass door.

2. The second exit may be a door which discharges directly to grade or meets the requirements of sub. (5) (b).

(7) DOORS. One exterior exit door from a dwelling unit shall be a swing type door at least 3 feet wide by 6 feet 8 inches high. All other exterior exit doors shall be at least 2 feet 8 inches wide by 6 feet 8 inches high. Where double doors are provided, the width of each door leaf shall be at least 2 feet 6 inches. The double doors shall not have an intermediate mullion.

(8) INTERIOR CIRCULATION. All passageway doors to at least 50% of the bedrooms, at least one full bathroom, and the common-use areas such as kitchens, dining rooms, living rooms and family rooms shall be at least 2 feet 8 inches wide by 6 feet 8 inches high. Where cased or uncased

openings are provided in lieu of doors, the clear width of the passageway openings shall be at least 2 feet 6 inches wide.

(9) **HALLWAYS.** Hallways shall be at least 3 feet in width except that door hardware, finish trim and heating registers may infringe upon this dimension.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.04 Stairs. Every exterior or interior stairs shall conform to the requirements of this section.

(1) **LANDINGS.** (a) *Intermediate landings.* Intermediate landings located in a flight of stairs shall be at least as wide as the stairs and shall measure at least 3 feet in the direction of travel. Trim and handrails may project no more than 3-½ inches into the required width.

(b) *Landings at the top and base of stairs.* A level landing shall be provided at the top and at the foot of every stairs. The landing shall be at least as wide as the stairs and shall measure at least 3 feet in the direction of travel.

(c) *Doors at landings.* Where a door is provided at the head or foot of a stairs, a level landing on each side of the door shall be provided between the door and the stairs, regardless of the door swing.

1. *Exception.* A landing shall not be required between the door and the head of interior stairs within a dwelling unit, provided the door does not swing over the stairs.

2. *Exception.* A storm door or screen door shall be permitted to swing over an exterior platform or sidewalk provided the platform or sidewalk is located not more than 8-¼ inches below the door sill and provided the platform has a length at least equal to the width of the door.

(2) **HANDRAILS AND GUARDRAILS.** (a) *Handrails.* Every stairs of more than 3 risers shall be provided with at least one handrail. Handrails shall be provided on all open sides of stairways.

(b) *Guardrails.* All openings between floors, open sides of landings, platforms, balconies or porches which are more than 24 inches above grade or a floor, shall be protected with guardrails.

(c) *Handrail and guardrail details.* 1. *Height.* Handrails shall be located at least 30 inches, but not more than 34 inches, above the nosing of the treads. Guardrails shall be located at least 36 inches above the upper surface of the floor.

2. *Open railings.* Open guardrails or handrails shall be provided with intermediate rails or an ornamental pattern to prevent the passage of a sphere with a diameter larger than 9 inches.

3. *Clearance.* The clearance between the handrail and the wall surface shall be at least 1-½ inches.

4. *Loading.* Handrails and guardrails shall be designed and constructed to withstand a 200 pound load applied in any direction.

5. Exterior rails. Exterior handrails and guardrails shall be constructed of metal, decay resistant or pressure treated wood or shall be protected from the weather.

(3) STAIR DETAILS. Stairs shall meet the following requirements:

(a) *Minimum width.* Every stairs shall measure at least 3 feet in width.

(b) *Headroom.* Every stairs shall be provided with a minimum headroom clearance of 6 feet 4 inches. The minimum clearance shall be measured vertically from a line parallel to the nosing of the treads to the ceiling or soffit directly above that line.

(c) *TREADS AND RISERS.* Risers shall not exceed 8 inches in height, measured vertically from tread to tread. Treads shall be at least 9 inches wide, measured horizontally from nosing to nosing. There shall be no variation in uniformity exceeding 3/16-inch in the width of tread or in the height of risers. No flight of stairs shall exceed 12 feet in height unless landings are provided.

(d) *Winders.* Winder steps may be used in stairs where the length of the tread is at least 3 feet and the winder tread measures at least 7 inches in width at a point one foot from the narrow end of the tread.

(e) *Spiral stairs.* Spiral stairs may be used as an exit stairs. The tread shall measure at least 26 inches from the outer edge of the supporting column to the inner edge of the handrail and at least 7 inches in width from nosing to nosing at a point one foot from the narrow end of the tread.

(f) *Ladders.* 1. Design load. Ladders shall be designed to withstand loads of at least 200 pounds.

2. Tread or rungs. a. Minimum tread requirements shall be specified in Table 21.04. Treads less than 9 inches in width shall have open risers. All treads shall be uniform in dimension.

TABLE 21.04

Pitch of Ladder Angle to Horizontal (degrees)	Maximum rise (inches)	Minimum Tread (inches)
41.6 to 48.4	8	9
greater than 48.4 to 55.0	9	8
greater than 55.0 to 61.4	10	7
greater than 61.4 to 67.4	11	6
greater than 67.4 to 71.6	12	5
greater than 71.6 to 75.9	12	4
greater than 75.9 to 80.5	12	3
greater than 80.5 to 90	12	2

b. Rungs may only be used for ladders with a pitch range of 75° to 90°. Rungs shall be at least 1 inch in diameter for metal ladders and 1½ inch for wood ladders. All rungs shall be uniform in dimension.

3. Risers. Risers shall be uniform in height and shall conform with Table 21.04.

4. Width. The width of the ladder shall be a minimum of 20 inches wide and a maximum of 30 inches wide.

5. Handrails. a. Handrails shall be required for ladders with pitches less than 65°.

b. Handrails shall be located at least 30 inches, but not more than 34 inches, above the nosing of the treads.

c. Open handrails shall be provided with intermediate rails or an ornamental pattern such that a sphere with a diameter larger than 9 inches cannot pass through.

d. The clearance between the handrail and the wall surface shall be at least 1½ inches.

e. Handrails shall be designed and constructed to withstand a 200 pound load applied in any direction.

6. Clearances. a. The ladder shall have a minimum clearance of at least 15 inches on either side of the center of the tread.

b. The edge of the tread nearest to the wall should be separated from the wall by at least 7 inches.

c. A passage way clearance of at least 30 inches parallel to the slope of a 90° ladder shall be provided. A passage way clearance of at least 36 inches parallel to the slope of a 75° ladder shall be provided. Clearances for intermediate pitches shall vary between these 2 limits in proportion to the slope.

d. For ladders with less than a 75° pitch the vertical clearance above any tread or rung to an overhead obstruction shall be at least 6 feet 4 inches measured from the leading edge of the tread or rung.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.05 Light and ventilation. (1) **NATURAL LIGHT.** All habitable rooms shall be provided with natural light by means of glazed openings. The area of the glazed openings shall be at least 8% of the net floor area, except under the following circumstances:

(a) *Exception.* Habitable rooms, other than bedrooms, located in basements need not be provided with natural light.

(b) *Exception.* Natural light may be obtained from adjoining areas through glazed openings, louvers or other approved methods. Door openings into adjoining areas may not be used to satisfy this requirement.

(2) **VENTILATION.** (a) *Natural ventilation.* Natural ventilation shall be provided to all habitable rooms, kitchens and bathrooms by means of openable exterior doors or windows. The net area of the openable exterior doors or windows shall be at least 3.5% of the net floor area of the room. Mechanical ventilation may be provided in lieu of openable exterior doors or windows provided the system is capable of providing at least one air change per hour.

(b) *Exhaust ventilation.* All exhaust ventilation shall terminate outside the building.

ILHR 21

(3) **COLD-SIDE VENTING.** Cold-side venting of insulation shall be provided at roof/attic, flat-roof/ceiling and sloping-roof/ceiling assemblies. Ventilation shall be provided at the rate of one square foot of free ventilating area for each 300 square feet of area. At least 50% of the vents shall be located at the soffit area.

Note: Example: The venting area required for a 1500 square foot dwelling is $1500 \text{ sq. ft.} \times 1/300 = 5 \text{ sq. ft.}$

(4) **CRAWL SPACE VENTING.** Unheated crawl spaces shall be provided with a concrete slab, roll roofing or plastic film vapor barrier and a minimum of 2 ventilators located at opposite sides of the crawl space. Ventilation shall be provided at the rate of one square foot of free ventilating area for each 1500 square feet of area.

(5) **SAFETY GLASS.** Glass in entrance and exit doors, sliding glass doors, storm doors, bathtub enclosures, shower doors, and fixed glass panels immediately adjacent to doors shall be safety glass.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. (1) and (2), Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.06 Ceiling height. All habitable rooms, kitchens, hallways, bathrooms and corridors shall have a ceiling height of at least 7 feet. Habitable rooms may have ceiling heights of less than 7 feet provided at least 50% of the room's floor area has a ceiling height of at least 7 feet. Beams and girders or other projections shall not project more than 8 inches below the required ceiling height.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.07 Attic and crawl space access. (1) **ATTIC.** Attics shall be provided with an access opening of at least 14 by 24 inches, accessible from inside the structure.

(2) **CRAWL SPACE.** Crawl spaces shall be provided with an access opening of at least 14 by 24 inches.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.08 Firestopping, draftstopping and fire separation. (1) **FIRESTOPPING LOCATIONS.** Firestopping shall be provided in the following locations:

(a) In concealed spaces of walls and partitions, including furred spaces, at the ceiling and floor levels;

(b) At all interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings and cove ceilings; and

(c) In concealed spaces between stair stringers at the top and bottom of the run.

(2) **FIRESTOPPING MATERIALS.** Firestopping shall consist of 2-inches nominal lumber or 2 thicknesses of one inch nominal lumber or one thickness of $\frac{3}{4}$ -inch plywood with joints backed by $\frac{1}{4}$ -inch plywood. Gypsum wallboard, mineral wool insulation or other noncombustible material may also be used for firestopping.

Register, February, 1985, No. 350
Construction Standards

(3) DRAFTSTOPPING LOCATIONS. Draftstopping shall be provided in the following locations:

(a) In floor-ceiling assemblies above and in line with the tenant separation, when tenant separation walls do not extend to the floor sheathing above;

(b) In the attic, mansard, overhang or other concealed roof space above and in line with the tenant separation when tenant separation walls do not extend to the roof sheathing above. Where flat roofs with solid joist construction are used, draftstopping over tenant separation walls is not required; and

(c) At openings around vents, pipes, ducts, chimneys and fireplaces at ceiling and floor levels.

(4) DRAFTSTOPPING MATERIALS. Except as provided in sub. (3) (c), draftstopping materials shall be not less than ½-inch gypsumboard, ¾-inch plywood, mineral-based insulation or other approved noncombustible materials.

(5) FIRE SEPARATION. Garage space and accessory buildings shall be separated from the dwelling unit in accordance with Table 21.08 and the following requirements:

TABLE 21.08

Distance from Dwelling Wall to the Closest Garage Wall or Accessory Building Wall	Fire-rated Construction
0 to 5 feet	¾-hour
5 to 10 feet with windows in either wall	¾-hour
5 to 10 feet with windows in either wall	No requirements
10 feet or more	No requirements

(a) The garage shall be separated from habitable and nonhabitable areas of the dwelling unit, as well as attics. The vertical separation shall extend from the top of the concrete or masonry foundation to the underside of the roof sheathing or ceiling. The fire-rated construction shall conform with Table 21.08.

1. Exception. Gypsum drywall on the garage side may be untaped provided at least ¾-inch firecode drywall is used on the garage side and all edges are tightly fitted.

2. Exception. Gypsum drywall on the garage side may be untaped provided at least ½-inch drywall is used on both sides of the wall separating the garage and the dwelling and all edges are tightly fitted.

3. Exception. Two layers of ½-inch drywall on the garage side may be untaped where no drywall is installed on the interior provided all edges are tightly fitted.

(b) The door and frame assembly between the garage and the dwelling unit shall have a minimum fire rating of 20 minutes. A 1- $\frac{3}{4}$ -inch solid core wood or insulated metal door may be installed with a pair of 1- $\frac{1}{2}$ -inch steel hinges in a 1- $\frac{7}{32}$ -inch minimum thick solid wood frame with a $\frac{1}{2}$ -inch thick door stop.

(c) Garage floors shall be constructed of noncombustible materials. The garage floor shall slope toward the exterior garage opening or shall slope to an interior drain.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.09 Smoke detectors. Each living unit in one- and 2-family dwellings shall be provided with an approved, listed and labeled smoke detector sensing visible or invisible particles of combustion, installed in the basement of the dwelling and on each floor level except the attic or storage area of each dwelling unit.

Note: Section 50.035 (2), Stats., created by 1983 Wisconsin Act 363 requires the installation of a complete low voltage, interconnected or radio-transmitting smoke detection system in all community-based residential facilities including those having 8 or less beds.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.10 Protection against decay and termites. (1) **GENERAL.** Except a provided in sub. (2), wood used in the following locations shall be pressure treated with preservative, shall be a naturally durable, decay resistant species of lumber and shall be protected against termites:

(a) Wood floor joists closer than 18 inches or wood girders closer than 12 inches to earth;

(b) Sills which rest on concrete or masonry walls or which are less than 8 inches from exposed earth;

(c) Ends of wood girders entering masonry or concrete walls and having clearances of less than $\frac{1}{2}$ inch on the tops, sides and ends;

(d) Wood siding having a clearance of less than 6 inches from the earth;

(e) Wood embedded in earth; and

(f) Bottom plates of load bearing walls in basements.

(2) **EXCEPTION.** Wood used in basements as furring or finish material or in nonbearing walls need not comply with this section.

(3) **IDENTIFICATION.** All pressure-treated wood and plywood shall be identified by a quality mark or certificate of inspection of an approved inspection agency which maintains continued supervision, testing and inspection over the quality of the product in accordance with the adopted standards of the American Wood Preservers Bureau specified in s. ILHR 20.24 (2n).

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

Register, February, 1985, No. 350
Construction Standards

ILHR 21.11 Foam plastic insulation. Foam plastic insulation shall have a flame-spread rating of not more than 75 and a smoke-developed rating of not more than 450.

Note: The department will accept foam plastic insulation tested in accordance with ASTM E-84.

(1) **PROTECTION.** Foam plastic insulation shall be protected in accordance with the following:

(a) **Walls.** Foam plastic insulation may be used within the cavity of a masonry wall, in cores of masonry units, within the stud space of a wood frame wall, or on the inside of a building surface of a wall or ceiling if the foam plastic insulation is fully protected by a thermal barrier having a finish rating of at least 15 minutes.

(b) **Roofs.** Roof coverings may be applied over foam plastic insulation where the interior of the dwelling is separated from the foam plastic insulation by plywood sheathing at least ½-inch in thickness or other approved material having a minimum 15-minute finish rating.

(c) **Doors.** Foam plastic insulation having a flame-spread rating of 75 or less may be used in doors when the door facing is of metal having a minimum thickness of 0.032-inch aluminum or No. 26 gauge sheet metal.

(2) **SPECIFIC APPROVAL.** Foam plastic insulation not meeting the requirements of this section may be approved by the department based upon diversified tests which evaluate materials or assemblies representative of actual end use applications.

Note: Approved diversified tests may include, but are not limited to: ASTM E-84 (tunnel test), ASTM E-19 fire test, full-scale corner test, enclosed room corner test and ignition temperature test.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

SUBCHAPTER III—EXCAVATIONS

ILHR 21.12 Grade. The grade shall slope away from the dwelling to provide drainage away from the dwelling.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.13 Excavations adjacent to adjoining property. (1) **NOTICE.** Any person making or causing an excavation which may affect the lateral soil support of adjoining property or buildings shall provide at least 30 days written notice to all owners of adjoining buildings of the intention to excavate. The notice shall state that adjoining buildings may require permanent protection.

(a) **Exception.** The 30-day time limit for written notification may be waived if such waiver is signed by the owner(s) of the adjoining properties.

(2) **RESPONSIBILITY FOR UNDERPINNING AND FOUNDATION EXTENSIONS.** (a) **Excavations less than 12 feet in depth.** If the excavation is made to a depth of 12 feet or less below grade, the person making or causing the excavation shall not be responsible for any necessary underpinning or extension of the foundations of any adjoining buildings.

(b) **Excavations greater than 12 feet in depth.** If the excavation is made to a depth in excess of 12 feet below grade, the owner(s) of adjoining

Register, February, 1985, No. 350
Construction Standards

ILHR 21

buildings shall be responsible for any necessary underpinning or extension of the foundations of their buildings to a depth of 12 feet below grade. The person making or causing the excavation shall be responsible for any underpinning or extension of foundations below the depth of 12 feet below grade.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.14 Excavations for footings and foundations. (1) **EXCAVATIONS BELOW FOOTINGS AND FOUNDATIONS.** No excavation shall be made below the footing and foundation unless provisions are taken to prevent the collapse of the footing or foundation.

(2) **EXCAVATIONS FOR FOOTINGS.** All footings shall be located on undisturbed or compacted soil, free of organic material, unless the footings are reinforced to bridge poor soil conditions.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

SUBCHAPTER IV—FOOTINGS

ILHR 21.15 Footings. The dwelling shall be supported on a structural system designed to transmit and safely distribute the loads to the soil. The loads for determining the footing size shall include the weight of the live load, roof, walls, floors, pier or column, plus the weight of the structural system and the soil over the footing. Footings shall be sized to not exceed the allowable material stresses. The bearing area shall be at least equal to the area required to transfer the loads to the supporting soil without exceeding the bearing values of the soil.

(1) **SIZE.** Unless designed by structural analysis, unreinforced concrete footings shall comply with the following requirements:

(a) *Continuous footings.* The minimum width of the footing on each side of the foundation wall shall measure at least 4 inches wider than the wall. The footing depth shall be at least 8 inches nominal. Footings placed in unstable soil shall be formed.

Note: Unstable soil includes soils which are unable to support themselves.

(b) *Column or pier footing.* The minimum width and length of column or pier footings shall measure at least 2 feet by 2 feet. The depth shall measure at least 12 inches nominal. The column shall be so placed as to provide equal projections on each side of the column.

(c) *Trench footings.* Footings poured integrally with the wall may be used when soil conditions permit. The minimum width shall be at least 8 inches nominal.

(d) *Chimney and fireplace footings.* Footing for chimneys or fireplaces shall extend at least 4 inches on each side of the chimney or fireplace. The minimum depth shall measure at least 12 inches nominal.

(e) *Floating slabs.* Any dwelling supported on a floating slab on grade shall be designed through structural analysis.

(2) **SOIL-BEARING CAPACITY.** No footing or foundation shall be placed on soil with a bearing capacity of less than 2,000 pounds per square foot unless the footing or foundation has been designed through structural

analysis. The soil-bearing values of common soils may be determined through soil identification.

Note: The department will accept the soil-bearing values for the types of soil listed in the following table:

Type of soil	PSF
1. Wet, soft clay; very loose silt; silty clay.....	2,000
2. Loose, fine sand; medium clay; loose sandy clay soils.....	2,000
3. Stiff clay; firm inorganic silt.....	3,000
4. Medium (firm) sand; loose sandy gravel; firm sandy clay soils; hard dry clay.....	4,000
5. Dense sand and gravel; very compact mixture of clay, sand and gravel....	6,000
6. Rock.....	12,000

(a) *Minimum soil-bearing values.* If the soil located directly under a footing or foundation overlies a layer of soil having a smaller allowable bearing value, the smaller soil-bearing value shall be used.

(b) *Unprepared fill material, organic material.* No footing or foundation shall be placed upon unprepared fill material, organic soil, alluvial soil or mud unless the load will be supported. When requested, soil data shall be provided.

Note: The decomposition of organic material in landfill sites established for the disposal of organic wastes may produce odorous, toxic and explosive concentrations of gas which may seep into buildings through storm sewers and similar underground utilities unless provisions are taken to release the gases to the atmosphere.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.16 Frost penetration. Footings and foundations, including those for ramps and stoops, shall be placed below the frost penetration level, but in no case less than 48 inches below the ground. Footings shall not be placed over frozen material.

(1) **EXCEPTIONS.** (a) Floating slabs constructed on grade need not be installed below the minimum frost penetration line provided measures have been taken to prevent frost forces from damaging the structure.

(b) Grade beams need not be installed to the minimum frost penetration line provided measures are taken to prevent frost forces from damaging the structure.

(c) Stoops or ramps need not be installed below the minimum frost penetration level provided measures are taken to prevent frost forces from damaging the structure.

(d) Footings or foundations may bear directly on rock located less than 42 inches below grade. Prior to placement, the rock shall be cleaned of all earth. All clay in the crevices of the rock shall be removed to the level of frost penetration or 1-½ times the width of the rock crevice. Provisions shall be taken at grade to prevent rain water from collecting along the foundation wall of the building.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; am. (intro.), Register, February, 1985, No. 350, eff. 3-1-85.

Register, February, 1985, No. 350
 Construction Standards

ILHR 21.17 Drain tiles. (1) WHERE REQUIRED, Drain tiles or pipe shall be provided around footings located in soils where ground water levels occur above the elevation of the footing.

(a) *Municipalities exercising jurisdiction.* Municipalities exercising jurisdiction under chs. ILHR 20 to 25 may determine the soil types, natural and seasonal groundwater levels for which drain tile is required.

(b) *All other areas.* Drain tiles shall be required whenever a soil test shows evidence of periodic or seasonal saturation at any depth less than 72 inches. When the on-site evaluation shows no evidence of saturation, drain tiles need not be installed. Under all other conditions, drain tiles shall be installed on each side of foundation walls at the footing level.

(2) **MATERIALS AND INSTALLATION REQUIREMENTS.** (a) Drain tiles or pipes used for foundation drainage shall be at least 3 inches inside diameter.

(b) Where individual tiles are used, they shall be laid with $\frac{1}{8}$ -inch open joints. Joints between the tiles shall be covered with a strip of sheathing paper or asphalt or tar saturated felt.

(c) The tile or pipe shall be placed upon at least 2 inches of washed rock and shall be covered with at least 12 inches of washed rock which meets the following criteria:

1. 90-100% of the rock must pass a $\frac{3}{4}$ -inch sieve; and
2. 20-25% of the rock must pass a $\frac{1}{8}$ -inch sieve.

(d) The basement slab shall be placed on at least 4 inches of gravel.

(e) Bleeder tiles shall be provided to connect the exterior footing drain tile to the interior footing tile and shall be placed in the footing such that the tiles are spaced at 8 foot intervals.

(f) The drain tiles or pipe shall be laid at a grade of not less than $\frac{1}{8}$ inch per foot leading to the sump pit.

(3) **DRAIN TILE DISCHARGE.** Drain tiles shall be connected to a sump pit. The sump shall discharge to natural grade or be equipped with a pump to discharge water away from the dwelling via surface drainage channels.

(a) *Sumps.* 1. *Construction and installation.* The sump shall have a rim extending at least one inch above the floor immediately adjacent to the sump, except where the sump is installed in an exterior meter pit. The sump shall have a removable cover of sufficient strength for anticipated loads. The sump shall have a solid bottom.

2. *Location.* All sumps installed for the purpose of receiving clear water, basement or foundation drainage water shall be located at least 15 feet from any water well.

3. *Size.* The size of each clear water sump shall be as recommended by the sump pump manufacturer, but shall be not smaller than 18 inches in diameter and 24 inches in depth.

(b) *Sump pump systems.* 1. *Pump size.* The pump shall have a capacity appropriate for anticipated use.

2. Discharge piping. Where a sump discharges into a storm building drain or sewer, a free flow check valve shall be installed.

(4) SUMP DISCHARGE DISPOSAL. (a) *Storm sewer*. Storm water, surface water, groundwater and clear water wastes shall be drained to a storm sewer where available.

(b) *Other disposal methods*. 1. Where no storm sewer system is available or exists or is not adequate to receive the anticipated load, the storm water, surface water, groundwater and clear water wastes shall be discharged in accordance with local governmental requirements.

2. Where approved by the local governmental authority, storm water, surface water, groundwater and clear water wastes of the properties of one- and 2-family dwellings may be discharged onto flat areas, such as streets or lawns, so long as the water flows away from the buildings and does not create a nuisance.

(c) *Segregation of wastes*. 1. Storm and clear water wastes shall not discharge to any part of a sanitary drain system, nor shall sanitary wastes discharge to any part of a storm or clear water drain system; except the clear water wastes of a refrigerated drinking fountain, water heater relief valve or water softener may discharge to a sanitary drain system.

2. Storm water wastes and clear water wastes shall not be combined until discharging into the storm building drain.

Note: Subsections (3) (a) and (b) and (4) are excerpts from the state uniform plumbing code, s. ILHR 82.36.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; r. and recr. Register, February, 1985, No. 350, eff. 3-1-85.

SUBCHAPTER V—FOUNDATIONS

ILHR 21.18 Foundations. Foundation walls shall be designed and constructed to support the vertical loads of the dwelling, lateral soil pressure, and other loads without exceeding the allowable stresses of the materials of which the foundations are constructed.

(1) **CONCRETE FOUNDATION WALLS.** Unless designed through structural analysis, the minimum thickness of concrete foundation walls shall be determined from Table 21.18-A, but in no case shall the thickness be less than the thickness of the wall it supports.

Register, February, 1985, No. 350
Construction Standards

TABLE 21.18-A
CONCRETE WALL THICKNESSES

Type of Concrete	Nominal Thickness (inches)	Maximum Height of Unbalanced Fill ¹ for Material of Wall Being Supported (Wood frame - feet)
3000 psi Unreinforced concrete	6	6.5
	8	8
	10	9
	12 ²	10
	14	11.5

¹Unbalanced fill is the difference in elevation between the outside grade and the basement floor.

²The maximum height of unbalanced fill for a 12-inch thick plain concrete wall may be increased to 12 feet provided the wall is constructed of concrete with a minimum compressive value of 6,000 psi at 28 days.

(2) **MASONRY FOUNDATION WALLS.** Unless designed through structural analysis, the masonry foundation walls shall be constructed in accordance with the following requirements:

(a) *Unreinforced masonry wall; thickness.* The minimum thickness of unreinforced masonry foundation walls shall be determined by Table 21.18-B, but in no case shall the thickness be less than the thickness of the wall it supports.

(b) *Reinforced masonry wall; thickness.* Reinforced masonry walls shall be reinforced in accordance with the requirements of Tables 21.18-C and 21.18-D. In partially reinforced masonry walls, vertical reinforcement shall be provided on each side of any opening, at each wall corner, and at intervals indicated in the tables.

TABLE 21.18-B

MAXIMUM DEPTH BELOW GRADE* (HEIGHT OF FILL) AND THICKNESSES
FOR VARIOUS CONCRETE MASONRY FOUNDATION WALLS WITHOUT
PILASTERS

Wall Construction Nominal Thickness, in., and Type of Unit	Maximum Depth Below Grade, feet, when Walls Support:	
	Frame Construction	Masonry, or Masonry Veneer Construction
Hollow-Load-Bearing:		
8"	5' (6')	6'
10"	6' (7')	7'
12"	7'	7'
Solid Load-Bearing:		
8"	5' (7')	7'
10"	6' (7')	7'
12"	7'	7'

*In well drained sand and gravel soils, the height of the unbalanced fill may be increased to the values shown in parentheses.

TABLE 21.18-C

MAXIMUM DEPTH BELOW GRADE (HEIGHT OF FILL) FOR VARIOUS
CONCRETE MASONRY FOUNDATION WALLS WITH PILASTERS

Wall Construction Nominal Thickness, in., and Type of Unit	Total Ht. of Wall (feet)	Max. Pilaster Spacing o.c. (feet)	Pilaster Size (nominal)	Max. Depth Below Grade (feet)
8-inch Hollow Load-Bearing	7.5	11	16" x 16"	6.5
8-inch Hollow Load-Bearing with Solid Pilasters or Filled Cells of Hollow Units	7.5	20	16" x 16"	6.5

TABLE 21.18-D

MAXIMUM DEPTH BELOW GRADE FOR PARTIALLY REINFORCED
MASONRY WALLS

Wall Construction Nominal Thickness, in., and Type of Unit	Total Height of Wall (feet)	Reinforcement Size and Spacing (feet) Center to Center	Max. Depth Below Grade (feet)
8-inch Hollow Load-Bearing	7.0 to 8.5	#5 bars @ 8'	6.5
		#6 bars @ 8'	7.5
		#7 bars @ 8'	7.5

(3) WOOD FOUNDATIONS. Wood foundations shall be designed and constructed in accordance with the National Forest Products Association standard, "The All-Weather Wood Foundation System, Basic Requirements, Technical Report No. 7" and the following exceptions. The thick-

ness of the foundation wall shall be no less than the thickness of the wall it supports.

(a) *Exceptions.* 1. Section 3.3.1. *Fasteners.* Fasteners shall be of silicon bronze, copper or stainless steel types 304 or 316.

2. Section 6.7. *Plastic film.* Six-mil thick polyethylene sheeting shall be installed over the below-grade portion of exterior basement walls prior to backfilling. Joints in the polyethylene sheeting shall be lapped at least 6 inches and bonded. The top edge of the polyethylene sheeting shall be bonded to the plywood sheathing. A treated lumber or plywood strip shall be attached to the wall to cover the top edge to the polyethylene sheeting. The wood strip shall extend several inches above and below finish grade level to protect the polyethylene from exposure to light and from mechanical damage at or near grade. The joint between the strip and the wall shall be caulked full length prior to fastening the strip to the wall. Alternatively, asbestos-cement board, brick, stucco or other covering may be used in place of the wood strip. The polyethylene sheeting shall extend down to the bottom of the wood footing plate but shall not overlap or extend into the gravel footing.

Note: Additional explanatory information regarding wood foundations can be obtained in "All-Weather Wood Foundation Systems, Design, Fabrication, Installation Manual", published by the National Forest Products Association.

(b) *Materials.* All lumber and plywood shall be pressure treated with preservative and labeled.

Note: The department will accept materials which meet the "Quality control Program for Soft-Wood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservatives for Ground Contact Use in Residential and Light Commercial Foundations," published by the American Wood Preservers Bureau.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; am. (3) (intro), Register, February, 1985, No. 350, eff. 3-1-85.

SUBCHAPTER VI—FLOORS

ILHR 21.19 Floor design. Floors shall support all dead loads plus the minimum unit live loads as set forth in s. ILHR 21.02. The live loads shall be applied to act vertically and uniformly to each square foot of horizontal floor area.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.20 Concrete floors. When concrete floors are provided, the thickness of the concrete shall measure at least 3 inches. In clay soils, a 4-inch thick base course shall be placed in the subgrade consisting of clean graded sand, gravel or crushed stone. The base course may be omitted in sand and gravel soils. Basements shall be provided with a concrete or similar type floor.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.21 Precast concrete floors. Unless designed through structural analysis, the maximum allowable stress, span or section size for precast concrete floors shall be determined from Table 21.21.

TABLE 21.21

HOLLOW-CORE

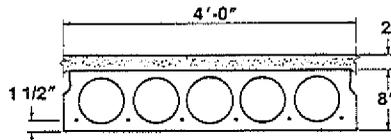
4'-0" x 8"
Normal Weight Concrete

Strand Patterns

Producer may vary size and strength (f_{pu}) of strands to achieve value shown in first column.

Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load.

Capacity of sections of other configurations are similar. For precise values, see local hollow-core manufacturer.



$f'_c = 5000 \text{ psi}$
 $f'_{ci} = 3500 \text{ psi}$

Section Properties

	Untopped	Topped
A #	215 in. ²	—
I #	1666 in. ⁴	3071 in. ⁴
Y_o #	4.00 in.	5.29 in.
Y_t #	4.00 in.	4.71 in.
Z_o #	416 in. ³	580 in. ³
Z_t #	416 in. ³	652 in. ³
b_w #	12.00 in.	12.00 in.
wt #	224 plf	323 plf
	56 psf	81 psf
V/S #	1.92 in.	

ILHR 21.22 Wood frame floors. Unless designed through structural analysis, wood frame floors shall comply with the following requirements:

(1) **FLOOR JOISTS.** Wood floor joists shall comply with the requirements of s. ILHR 21.02 (3) (a). The minimum live loads shall be determined from s. ILHR 21.02. Where sill plates are provided, the sill plates shall be fastened to the foundation. Double floor joists shall be provided underneath all bearing walls which are parallel to the floor joists.

(1m) **FLOOR JOISTS RESTING ON MASONRY WALLS.** On masonry walls the floor joists shall rest upon a mortar filled core concrete block or a solid top concrete block or a sill plate. The dimensions of the sill plate shall not be less than 2 inches by 6 inches. The mortar used shall be determined as in s. ILHR 21.26 (3).

(2) **TRUSS JOISTS.** Wood truss joists shall be designed through structural analysis.

(3) **GIRDERS AND BEAMS.** Girders and beams shall be selected from Table 21.22-A.

(a) Wood girders and beams shall be fitted at the post or column. Adjoining ends shall be fastened to each other to transfer horizontal loads across the joint. Beams shall also be fastened to the posts with framing anchors, angle clips, or equivalent.

(b) Where intermediate beams are used, they shall rest on top of the girders; or shall be supported by ledgers or blocks fastened to the sides of the girders; or they may be supported by approved metal hangers into which the ends of the beams shall be fitted.

(4) **BEARING.** The minimum bearing for wood joists and rafters shall be at least 1-½ inches on wood or metal and at least 3 inches on masonry or concrete. Wood beams and girders shall have at least 3 inches of bearing on masonry or concrete. Tail ends of floor joists shall not overlap the beams by more than 8 inches.

(5) **NOTCHING AND BORING.** Notching and boring of beams or girders is prohibited unless determined through structural analysis.

(a) *Notching.* 1. Notches located in the top or bottom of joists shall not exceed 1/6 the depth of the joist nor be located in the middle ¼ of the span of the joist.

2. Where joists are notched on the ends, the notch shall not exceed ¼ the depth of the joist.

(b) *Boring.* Holes bored in joists shall be located in the center of the joist. The diameter of the hole shall not exceed ¼ the depth of the joist.

(6) **OVERHANG OF FLOORS.** (a) Floor joists which are at right angles to the supporting wall shall not be cantilevered more than 2 feet over the supporting wall and shall support only the wall and roof above it.

(b) Where floor joists are parallel to the supporting wall, a double floor joist may be used to support lookout joists extending over the wall line below. The double joist shall be located a distance of twice the overhang

from the lower wall. The lookout joists shall be fastened to the double joist with metal hangers.

(7) FLOOR OPENINGS. Trimmers and headers shall be doubled when the span of the header exceeds 4 feet. Headers which span more than 6 feet shall have the ends supported by joist hangers or framing anchors, unless the ends are supported on a partition or beam. Tail joists (joists which frame into headers) more than 8 feet long shall be supported on metal framing anchors or on ledger strips of at least 2 inches by 2 inches nominal.

TABLE 21.22-A

MINIMUM SIZES FOR BEAMS AND GIRDERS OF STEEL OR WOOD

Column Spacing	Roof/Ceiling and One Floor				Roof/Ceiling + One Floor/Ceiling + One Floor			
	Wood Beams ¹ (in., nominal)		A 36 Steel Beams ²		Wood Beams ¹ (in., nominal)		A 36 Steel Beams ²	
	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1
24 ft. wide house:								
8 ft.	8x10	10x10	—	—	8x12	10x12	—	—
	6x12	6x12	—	—	6x14	8x14	—	—
10 ft.	8x12	10x12	M 10x9	M 10x9	10x14	10x14	M 12x11.8	M 12x11.8
	6x14	8x14	W 6x12	W 8x10	8x16	8x16	W 8x15	W 8x15
12 ft.	12x12	10x14	W 10x11.5	M 12x11.8	14x14	14x14	W 12x16.5	W 12x16.5
	10x14	8x16	S 7x15.3	W 8x15	10x16	12x16	S 8x23	W 8x20
15 ft.	—	—	W 12x16.5	W 12x16.5	—	—	W 12x22	W 14x22
	—	—	W 10x17	W 6x25	—	—	W 8x28	W 8x31
26 ft. wide house:								
8 ft.	10x10	10x10	—	—	10x12	10x12	—	—
	6x12	8x12	—	—	8x14	8x14	—	—
10 ft.	10x12	10x12	M 10x9	S 6x17.25	10x14	12x14	M 12x11.8	W 12x14
	8x14	8x14	W 8x10	W 8x13	8x16	8x16	W 8x15	W 8x17
12 ft.	10x14	10x14	M 12x11.8	M 12x11.8	14x14	12x16	W 12x16.5	W 10x19
	8x16	8x16	W 8x15	W 6x20	12x16	10x18	W 8x20	W 8x24
15 ft.	—	—	W 12x16.5	W 10x19	—	—	W 14x22	W 14x22
	—	—	W 8x20	W 8x24	—	—	W 8x31	W 8x35
28 ft. wide house:								
8 ft.	10x10	8x12	—	—	10x12	10x12	—	—
	8x12	4x16	—	—	8x14	8x14	—	—
10 ft.	10x12	12x12	S 6x17.25	W 10x11.5	12x14	12x14	W 12x14	W 12x14
	8x14	8x14	W 8x13	W 8x13	8x16	10x16	W 8x17	W 10x15
12 ft.	10x14	12x14	M 12x11.8	W 12x14	12x16	12x16	W 10x19	M 14x17.2
	8x16	10x16	W 8x15	W 8x17	10x18	10x18	W 8x24	W 8x24

Register, February, 1985, No. 350
Construction Standards

Column Spacing	Roof/Ceiling and One Floor				Roof/Ceiling + One Floor/Ceiling + One Floor			
	Wood Beams ¹ (in., nominal)		A 36 Steel Beams ²		Wood Beams ¹ (in., nominal)		A 36 Steel Beams ²	
	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1
28 ft. wide house (cont.)								
15 ft.	—	—	W 10x19	M 14x17.2	—	—	W 14x22	W 14x26
	—	—	W 8x24	W 8x24	—	—	W 8x35	W 8x35
30 ft. wide house:								
8 ft.	10x10	8x12	—	—	10x12	12x12	—	—
	8x12	6x14	—	—	8x14	8x14	—	—
10 ft.	10x12	12x12	S 6x17.25	W 10x11.5	12x14	12x14	W 12x14	W 12x14
	8x14	10x14	W 8x13	W 8x13	10x16	10x16	W 10x15	S 8x18.4
12 ft.	12x14	12x14	W 12x14	W 12x14	12x16	14x16	M 14x17.2	M 14x17.2
	8x16	10x16	W 8x17	W 8x17	10x18	12x18	W 8x24	W 8x24
15 ft.	—	—	M 14x17.2	W 10x21	—	—	W 14x26	W 14x26
	—	—	W 8x24	W 8x28	—	—	W 8x35	W 10x33
32 ft. wide house:								
8 ft.	8x12	8x12	—	—	12x12	12x12	—	—
	6x14	6x14	—	—	8x14	10x14	—	—
10 ft.	12x12	12x12	W 10x11.5	W 10x11.5	12x14	14x14	W 12x14	W 12x16.5
	8x14	10x14	W 8x13	W 6x16	10x16	10x16	S 8x18.4	W 10x17
12 ft.	12x14	14x14	W 12x14	W 12x14	14x16	14x16	M 14x17.2	W 12x22
	10x16	10x16	W 10x15	W 10x17	12x18	12x18	W 8x24	W 8x28
15 ft.	—	—	M 14x17.2	W 12x22	—	—	W 14x26	W 14x26
	—	—	W 8x24	W 8x28	—	—	W 12x27	W 12x27

¹This table is based upon wood with a fiber bending stress of 1,000 psi. Two acceptable wood beam selections are listed for each loading condition.

²Two acceptable steel beam selections are listed for each loading condition. The first entry is the most economical selection based upon beam weight.

(8) **FLOOR SHEATHING, BOARDS AND PLANKS.** (a) *Plywood sheathing.* Plywood sheathing used for floors shall be limited to the allowable loads and spans shown in Table 21.22-B.

(b) *Plywood underlayment.* Plywood underlayment shall be installed in accordance with Table 21.22-C.

(c) *Floor boards.* Where wood boards are used for floor sheathing, the boards shall comply with the minimum thicknesses shown in Table 21.22-D.

(d) *Planks.* Planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness. Planks shall terminate over beams unless the joints are end matched. The planks shall be laid so that no continuous line of joints will occur except at points of support. Planks shall be nailed to each beam.

(9) **BRIDGING.** Bridging shall be provided at intervals not exceeding 8 feet.

TABLE 21.22-B

ALLOWABLE LOADS AND SPANS FOR PLYWOOD FLOOR AND ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS¹

Panel Identification	Plywood Thickness (in inches)	Roof ²				Floor Maximum Span ⁴ (in inches)
		Maximum Span (in inches)		Load (in pounds per square foot)		
		Edges Blocked	Edges Un- blocked	Total Load	Live Load	
12/0	5/16	12	12	155	150	0
16/0	5/16, 3/8	16	16	95	75	0
20/0	5/16, 3/8	20	20	75	65	0
24/0	3/8	24	20	65	50	0
24/0	1/2	24	24	65	50	0
30/12	5/8	30	26	70	50	12 ⁵
32/16	1/2, 5/8	32	28	55	40	16 ⁷
36/16	3/4	36	30	55	50	16 ⁷
42/20	5/8, 3/4, 7/8	42	32	40 ⁶	35	20 ⁷
48/24	3/4, 7/8	48	36	40 ⁶	35	24

¹These values apply to C-D, C-C, and structural I and II grades only. Spans shall be limited to values shown because of possible effect of concentrated loads.

²Uniform load deflection limitation: 1/180th of the span under live load plus dead load, 1/240th under live load only. Edges may be locked with lumber or other approved type of edge support.

³Identification index appears on all panels in the construction grades listed in footnote 1.

⁴Plywood edges shall have approved tongue and groove joints or shall be supported with blocking, unless 1/4-inch minimum thickness underlayment is installed or finish floor is 25/32-inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 165 pounds per square foot.

⁵May be 16 inches if 25/32-inch wood strip flooring is installed at right angles to joists.

⁶For roof live load of 40 pounds per square foot or total load of 55 pounds per square foot, decrease spans by 13% or use panel with next greater identification index.

Register, February, 1985, No. 350
Construction Standards

⁷May be 24 inches if 25/32-inch wood strip flooring is installed at right angles to joists.

TABLE 21.22-C

MINIMUM THICKNESS FOR PLYWOOD COMBINATION SUBFLOOR
UNDERLAYMENT PLYWOOD CONTINUOUS OVER TWO OR MORE SPANS
AND FACE GRAIN PERPENDICULAR TO SUPPORTS

Plywood Grade	Plywood Species Group	Maximum Support Spacing ¹			
		16" o.c. ^{2,3}	20" o.c. ^{2,3}	24" o.c. ²	48" o.c. ²
		Panel thickness (inch)	Panel thickness (inch)	Panel thickness (inch)	Panel thickness (inch)
Underlayment	1	1/2	5/8 ⁴	3/4 ⁴	—
C-C plugged	2 & 3	5/8 ⁴	3/4 ⁴	7/8 ⁴	—
Sanded exterior type	4	3/4 ⁴	7/8 ⁴	1 ⁴	—
2-4-1	1, 2 & 3	All panel groups have equal properties			1-1/8
		Panel Index	Panel Index	Panel Index	Panel Index
Sturdi-I-Floor ⁵	1, 2, 3 & 4	16" o.c.	20" o.c.	24" o.c.	48" o.c.

¹Spans shall be limited to values shown, based on possible effect of concentrated loads.

²Underlayment, C-C plugged, sanded exterior type; allowable uniform load based on deflection of L/360 span for spans 24 inches or less is 125 psf; and for spans 48 inches, 65 psf.

³If a 25/32-inch wood finish floor is laid perpendicular to supports, thicknesses shown for 16-inch and 20-inch spans may be used for 24-inch span.

⁴Except for 1/2-inch, underlayment grade and C-C plugged panels may be of nominal thickness 1/32-inch less than the nominal thicknesses shown when marked with the reduced thickness.

⁵The department will accept subfloor underlayment panels such as sturd-i-floor which meet the requirements of APA manufacturing specification for sturd-i-floor panels.

TABLE 21.22-D

MINIMUM THICKNESS OF FLOOR BOARDS

Joist Spacing (inches)	Minimum Net Thickness (inches)	
	Perpendicular to Joist	Diagonal to Joist
24	11/16	3/4
16	5/8	5/8

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; am. (1) and cr. (1m), Register, February, 1985, No. 350, eff. 3-1-85.

SUBCHAPTER VII—WALLS

ILHR 21.23 Wall design. (1) LIVE AND DEAD LOADS. All walls shall support all superimposed vertical dead loads and live loads from floors and roofs.

Register, February, 1985, No. 350
Construction Standards

(2) **HORIZONTAL WIND LOAD.** Walls shall be designed to withstand a horizontal wind pressure of at least 20 pounds per square foot applied to the vertical projection of that portion of the dwelling above grade. No wind load reduction shall be permitted for the shielding effect of other buildings.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.24 Exterior covering. The exterior walls shall be faced with a weather-resistant covering.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.25 Wood frame walls. Unless designed through structural analysis, wood frame walls shall comply with the following requirements.

(1) **STUD SIZE AND SPACING.** (a) *Studs.* Wood studs shall comply with the size and spacing requirements indicated in Table 21.25-A. Studs in the exterior walls shall be placed with the wide faces perpendicular to the plane of the wall.

(b) *Corner posts.* Posts or multiple studs shall be provided at the corners of the walls.

(c) *Wood posts or columns.* Posts and columns shall be anchored to resist loads.

TABLE 21.25-A
MAXIMUM SPACING AND HEIGHT OF STUDS

Size	Grade	Max. Height (feet)	Spacing (inches)			
			Supporting roof and ceiling only	Supporting one floor, roof and ceiling	Supporting two floors, roof and ceiling	Interior and non-load-bearing
2x3	Standard & better	8	16	N/P	N/P	24
2x4 or larger	Utility	8	24	16	12	24
2x4	Standard & better	12	24	24	12	24
2x6 or larger	No. 3 & better	18	24	24	16	24

N/P = Not permitted.

Note: A 3-story frame house with walls constructed of 2 x 4 studs would require a 12-inch stud spacing on the lowest level, a 16-inch stud spacing on the intermediate level, and a 24-inch stud spacing on the upper level.

(d) *Bracing.* Exterior walls shall be braced at the corners.

1. Nominal 1 inch by 4 inch continuous diagonal members set into the face of the studs at an angle between 45° and 60°; or

2. Four feet by 8 feet plywood sheathing panels not less than 5/16 inch thick for 16-inch stud spacing and not less than 3/8 inch thick for 24-inch stud spacing; or

3. Preformed metal T-bracing not less than 22 gage (.0296 inches) thick and 1 1/4 inch wide; or

4. Other approved wind bracing materials.

Note: See Appendix for acceptable nailing schedule.

(2) **TOP PLATES.** Studs at bearing walls shall be capped with double top plates. End joints in double top plates shall be offset at least 48 inches. Double top plates shall be overlapped at the corners and at intersections with partitions. The plate immediately above the stud shall be broken directly over the stud.

(a) *Exceptions.* 1. A single top plate may be used in lieu of a double top plate where the rafter is located directly over the stud and the plate is securely tied at the end joints, corners and intersecting walls. Single top plates shall be broken directly over the stud.

2. A continuous header, consisting of two 2-inch members set on edge, may be used in lieu of a double plate if tied to the adjacent wall.

(3) **WALL OPENINGS.** Where doors or windows occur, headers shall be used to carry the load across the opening.

(a) *Header size.* The size of headers shall be determined in accordance with the spans and loading conditions listed in tables 21.25-B, 21.25-C and 21.25-D.

(b) *Header support.* The ends of the header shall be supported on the stud and fastened to a single stud when the span is not more than 3 feet. A second stud shall be provided on each side of the header in load-bearing walls exceeding 3 feet in width. Where the opening in load-bearing walls exceeds 6 feet in width, the end of the header shall be supported directly on at least 2 studs (shoulder stud) and an additional stud shall be provided and fastened to the end of header.

(c) *Flashing.* Unless sealed or caulked, flashing shall be provided at the top and sides of all exterior window and door openings.

(4) **NOTCHING.** Notching and boring of columns or posts is prohibited unless designed through structural analysis. Studs shall not be cut or bored more than 1/3 the depth of the stud, unless the stud is reinforced.

(5) **PARTITIONS.** Load-bearing partitions shall be placed over beams, girders, or other load-bearing partitions. Load-bearing partitions running at right angles to the joists shall not be offset from the main girder or walls more than the depth of the joist unless the joists are designed to carry the load.

(6) **WALL SHEATHING.** Exposed plywood panel siding and plywood wall sheathing shall conform to the requirements shown in Table 21.25-E.

TABLE 21.25-B

ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING
ROOF/CEILING ASSEMBLIES*

House Width (feet)	Header Members									
	Two 2 x 4s		Two 2 x 6s		Two 2 x 8s		Two 2 x 10s		Two 2 x 12s	
	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1
24	2.5	2.5	4	4	5	5	7	6	9	8
26	2.5	2	4	3	5	5	7	6	8	7
28	2.5	2	4	3	4	5	6	6	8	7
30	2.5	2	4	3	4	5	6	6	8	7
32	2	2	3	3	4	5	6	5	7	7

TABLE 21.25-C

ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR*

House Width (feet)	Header Members				
	Two 2 x 4s	Two 2 x 6s	Two 2 x 8s	Two 2 x 10s	Two 2 x 12s
24	2.5	4	5	6	8
26	2.5	3	5	6	8
28	2	3	5	6	7
30	2	3	4	6	7
32	2	3	4	5	7

TABLE 21.25-D

ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR
AND ROOF/CEILING ASSEMBLY*

House Width (feet)	Header Members									
	Two 2 x 4s		Two 2 x 6s		Two 2 x 8s		Two 2 x 10s		Two 2 x 12s	
	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1	Zone 2/Zone 1
24	1.5	1.5	3	2.5	4	3	5	4	6	5
26	1.5	1.5	2.5	2.5	3	3	4	4	5	5
28	1.5	1.5	2.5	2.5	3	3	4	4	5	5
30	1.5	1.5	2.5	2.5	3	3	4	4	5	5
32	1.5	1.5	2.5	2	3	3	4	4	5	5

*These tables are based on wood with a fiber bending stress of 1,000. For other species with different fiber bending stresses, multiply the span by the ratio of the actual bending stress to 1,000. Example: The allowable roof/ceiling span for a 28-foot wide house in zone 2, using two 2 x 8 header members with a 1400 psi bending stress, is 4 ft. x 1400/1000 = 5.6 feet.

Register, February, 1985, No. 350
Construction Standards

TABLE 21.25-E
EXPOSED PLYWOOD PANEL SIDING

Minimum Thickness ¹	Minimum No. of Plys	Stud Spacing (Inches) Plywood Siding Applied Direct to Studs or Over Sheathing
3/8"	3	16 ²
1/2"	4	24

¹Thickness of grooved panels is measured at bottom of grooves.

²May be 24 inches if plywood siding applied with face grain perpendicular to studs or over one of the following: (a) one-inch board sheathing; (b) 1/2-inch plywood sheathing; (c) 3/8-inch plywood sheathing with face grain of sheathing perpendicular to studs.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; cr. (1) (d) and am. (3) (b), Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.26 Masonry walls. Masonry walls shall be constructed in accordance with the requirements of this section.

(1) **COLD WEATHER WORK.** In cold weather, provisions shall be taken to prevent masonry from being damaged by freezing.

Note: It will be the practice of the department to accept performance with "Recommended Practices for Cold Weather Masonry Construction," available from International Masonry Institute, 823 15th Street NW, Washington, D.C. 20005.

(2) **MASONRY UNITS.** All masonry units shall be free from physical defects which interfere with laying of the unit and impair the compressive strength of the unit.

(3) **TYPES OF MORTAR.** The type of masonry mortar to be used for various kinds of masonry work shall be determined from Table 21.26-A. The mortar shall conform to the property requirements of Table 21.26-B1 and to the requirements of ASTM C-270 or shall be mixed in accordance with the proportions specified in Table 21.26-B.

(a) *Surface bond mortars.* Surface bond mortars for masonry walls shall be mixed in accordance with the proportions specified on the bag.

(4) **MORTAR COMPONENTS.** Mortar components shall comply with the following requirements:

(a) *Water.* Water shall be clean and free of deleterious amounts of acids, alkalis, or organic materials.

(b) *Admixtures or mortar colors.* Admixtures or mortar colors shall not be added to the mortar unless the resulting mortar conforms to the requirements of the mortar specifications. Only calcium chloride may be used as an accelerant and shall be limited to 2% by weight of the cement used. Calcium chloride may not be used for any other purpose. Only mineral oxide may be used as mortar color and shall not exceed 10% by weight of the cement used.

(c) *Mixing.* Mortar shall be mixed for at least 3 minutes after all ingredients have been added with the maximum amount of water to produce a workable consistency. Mortars that have stiffened due to water evaporation shall be retempered by adding water as frequently as needed to re-

store the required consistency. Mortars shall be used and placed in final position within 2-½ hours after mixing.

Note: To ensure proper mortar mixing, machine mixing is recommended.

TABLE 21.26-A

TYPES OF MORTAR FOR VARIOUS KINDS OF MASONRY

Kind of Masonry	Types of Mortar
Foundations:	
Footings	M, S
Walls of solid units	M, S, N
Walls of hollow units	M, S
Hollow walls	M, S
Masonry other than foundation masonry:	
Piers of solid masonry	M, S, N
Piers of hollow units	M, S
Walls of solid masonry	M, S, N, O
Walls of solid masonry not less than 12 in. thick or more than 35 ft. in height, supported laterally at intervals not exceeding 12 times the wall thickness	M, S, N, O
Walls of hollow units; load-bearing or exterior, and hollow walls 12 in. or more in thickness	M, S, N
Hollow walls, less than 12 in. thick	M, S, N
Linings of existing masonry, either above or below grade	M, S
Masonry other than above	M, S, N

TABLE 21.26-B
MORTAR SPECIFICATIONS BY PROPORTION¹

Mortar Type, ASTM C 270	Parts by Volume			Sand, Damp Loose Volume
	Portland Cement	Masonry Cement	Hydrated Lime	
M	1	--	1/4	
	1	1 (Type II)	--	Not less than 2-1/4
S	1	--	1/4 to 1/2	and not more than 3
	1/2	1 (Type II)	--	times the sum of
N ²	1	--	1/2 to 1-1/4	the volumes of the
	--	1 (Type II)	--	cements and lime.

¹All cements are one cubic foot per sack; lime equals 1-1/4 cubic foot per sack.

²Limited to walls with a maximum depth of 5 feet below grade.

TABLE 21.26-B1
MORTAR PROPERTY REQUIREMENTS

Mortar Type	Compressive Strength Min. (psi)	Water Retention Min. (%)	Air Content Max. (%)
M	2,500	75	18
S	1,800	75	18
N	750	75	18

(d) *Cementitious material.* Cementitious material shall conform to the standards approved by the department.

Note: The department will accept cementitious material conforming to the following standards: ASTM C91, Masonry Cement; ASTM C150, Portland Cement; ASTM C595, Portland Blast-Furnace Slag Cement; ASTM C207, Hydrated Lime for Masonry Purposes; and ASTM C5, Quick Lime for Structural Purposes.

(e) *Aggregates.* Aggregates for use in masonry mortar shall consist of natural sand or manufactured sand and shall be graded.

Note: The department will accept aggregates in accordance with ASTM C144.

(5) CAVITY WALL. (a) *Corbeling.* Cavity wall construction may be supported on an 8-inch foundation wall provided the 8-inch wall is corbeled with solid masonry to the width of the cavity wall. Individual corbels shall not exceed 2 inches nor more than one-third the height of each corbeled unit.

(b) *Projections.* The projection of a wall beyond the edge of a supporting member other than masonry, such as a shelf angle or edge of a beam, shall not exceed 1-1/4 inches, unless at least 3/8 the mass of the wythe of masonry involved is located directly over the load-carrying member.

(c) *Flashing.* In exterior hollow walls exposed to the weather, flashing shall be installed at the bottom of the cavity so as to drain any water

outward. Open vertical joints or weep holes of 3/8-inch minimum diameter shall be provided in the facing just above the flashing at a horizontal spacing not exceeding 3 feet.

(6) **OPENINGS AND LINTELS.** (a) *Openings.* The masonry above openings shall be supported. The bearing length of structural elements which support the masonry above the opening shall be not less than 4 inches.

(b) *Lintels.* Unless designed through structural analysis, lintels shall be provided in accordance with Table 21.26-C.

TABLE 21.26-C

ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER

Size of Steel Angle ^{1, 3}	No Story Above	One Story Above	Two Stories Above	No. of 1/2" or Equivalent Reinforcing Bars ²
L 3 x 3 x 1/4	6' - 0"	3' - 6"	3' - 0"	1
L 4 x 3 x 1/4	8' - 0"	5' - 0"	3' - 0"	1
L 6 x 3-1/2 x 1/4	14' - 0"	8' - 0"	3' - 6"	2
2 - L 6 x 3-1/4 x 1/4	20' - 0"	11' - 0"	5' - 0"	4

¹Long leg of the angle shall be placed in a vertical position.

²Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.

³Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.

(7) **MASONRY VENEERS.** (a) *Veneer over frame construction.* 1. Masonry veneers may be corbeled over the foundation wall, but the corbeling shall not exceed one inch.

2. An air space shall be provided between the veneer and the sheathing.

3. Where no brick ledge is formed in the foundation wall, a 30-pound asphalt-saturated felt or corrosion-resistant metal base flashing shall extend over the top of the foundation wall from the outside face of the wall and shall extend at least 6 inches up on the wood sheathing under the building paper or water-resistant sheathing.

4. Weepholes shall be provided at the bottom masonry course at intervals of approximately 4 feet.

(b) *Veneer over masonry back-up.* A 30-pound asphalt-saturated felt or corrosion-resistant metal base flashing at the bottom of the veneer shall extend over the top of the foundation and up at least 6 inches and be embedded in the back-up course. Weepholes, at approximately every 3 feet, shall be provided.

(8) **VENEER ANCHORAGE.** All veneers, supports and attachments shall be mechanically or adhesively anchored.

(a) *Mechanical anchorage.* All anchors shall be corrosion-resistant.

1. Conventional size veneer (one square foot or less) shall be securely attached to its backing by anchors the equivalent of No. 22 U.S. gauge corrugated sheet steel $\frac{3}{4}$ -inch wide with at least one such tie located in every 2 square feet of wall. Ties shall be embedded 2 inches in a masonry joint and nailed to the framing with an 8d nail.

2. Large size veneer (greater than one square foot) shall be securely attached with anchors the equivalent of not less than $\frac{1}{4}$ -inch diameter bolts in accordance with either of the following:

a. Each unit individually anchored to the supporting framework with at least 3 anchors.

b. Individual units doveled to each other at all horizontal joints and anchored to the backing at all horizontal and vertical joints so that one anchor is provided for every 6 square feet of wall surface.

(b) *Adhesive anchorage.* Veneer may be cemented to a masonry or concrete wall or to exterior portland cement plaster in high rib galvanized metal lath with an adhesive, provided that the bond is sufficient to withstand a shearing stress of 50 psi after curing for 28 days.

(9) **BEARING.** (a) *Concentrated loads.* Beams, girders, trusses, joists and other members producing concentrated loads shall bear a minimum of 3 inches on one of the following:

1. Concrete beam. The equivalent of a nominally reinforced 2,500 psi concrete beam 8 inches in height.

2. Solid masonry. At least 8 inches in height of masonry composed of solid masonry units with all voids and joints completely filled with mortar.

3. Metal plate. A metal plate of sufficient thickness and size to distribute the load to masonry units. For piers and columns, the bearing plate shall not exceed 60% of the cross-sectional area of the pier or column and the resultant reaction of all vertical and horizontal loads shall fall within the middle third of the member.

4. Bond beam. The bond beam shall be the equivalent of not less than an 8-inch lintel (bond beam) block with 2 No. 4 bars embedded in high strength mortar fill or equivalent. The loads shall bear on the fill.

(b) *Continuous loads.* Joists, trusses and beams other than wood, spaced 4 feet or more on center and 40 feet in length, slabs or other members causing continuous loads shall be transmitted to masonry with a minimum bearing of 3 inches upon solid masonry at least 2- $\frac{1}{2}$ inches in height, or as indicated for concentrated loads.

(c) *Stack bond walls.* Concentrated loads shall be distributed into masonry laid in stack bond by a concrete beam or bond beam [as defined in (a)]. For masonry of solid units, 2 additional rows of a continuous tie assembly may be used instead of a concrete beam or bond beam.

(d) *Support of wood floor members.* Where a wood structural member is buried in masonry for support, it shall be firecut or a self-releasing device shall be used. Where the end of a wood structural member is built into an exterior wall, a $\frac{1}{2}$ -inch air space shall be provided at the sides, top and end of such member.

(10) **BONDING.** Unless designed through structural analysis, all masonry walls shall be bonded as follows:

(a) *Single-wythe walls.* Masonry units in single-wythe walls shall be lapped at least 2 inches or one-third the height of the masonry unit, whichever is greater, or through the use of continuous tie assemblies spaced at 16-inch vertical intervals.

(b) *Multi-wythe walls.* Adjacent wythes shall be bonded with continuous tie assemblies spaced at vertical intervals not exceeding 16 inches; or individual ties of at least 3/16-inch diameter for each 4-½ square feet of wall area, spaced at a maximum vertical distance of 18 inches and a maximum horizontal distance of 36 inches; or bonded with a full course of masonry headers every seventh course. The clear distance between bond courses shall not exceed 16 inches for solid masonry units and 24 inches for hollow masonry units. Hollow walls shall not be bonded with headers.

(11) **BOLTS AND ANCHORS.** The allowable shear on steel bolts and anchors shall not exceed the values given in Table 21.26.

TABLE 21.26
ALLOWABLE SHEAR ON BOLTS AND ANCHORS

Bolt or Anchor Diameter (inches)	Embedment ¹ (inches)	Allowable Shear (pounds)
1/4	4	270
3/8	4	410
1/2	4	550
5/8	4	750
3/4	5	1100
7/8	6	1500
1	7	1850
1-1/8	8	2250

¹Bolts and anchors shall be solidly embedded in mortar or grout.

(12) JOINTS. (a) The maximum thickness of a mortar joint shall be 1/2 inch.

(b) Except for head joints used for weepholes and ventilation, solid masonry units shall be laid to achieve full head and bed joints.

(c) Hollow masonry units shall be laid with full head joints and full bed joints under the full bearing areas of the face shells and under webs where the adjacent cells are to be filled with grout.

(13) CLEANING. Chemical cleaning agents shall be prevented from harming the metal reinforcement of structural components and shall not be of a strength which will adversely affect the mortar.

(14) DAMPPROOFING. Masonry foundation walls of basements in clay-type soils shall be made dampproof by the application to the exterior surfaces of a continuous coat of at least 3/8-inch thick portland cement and sand coat mortar, or a type M mortar troweled smooth. Surface bonding material, 1/4-inch thick, applied to the exterior surfaces, may also be used.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; am. (3) and cr. Table 21.26-B1 Register, February, 1985, No. 350, eff. 3-1-85.

SUBCHAPTER VIII—ROOF AND CEILINGS

ILHR 21.27 Roof design. (1) *Roof loads*. Roof and roof/ceiling assemblies shall support all dead loads plus the minimum live loads as set forth in s. ILHR 21.02.

(2) UPLIFT AND SUCTION FORCES. Roofs shall withstand a pressure of at least 20 pounds per square foot acting upward normal to the roof surface. Roof overhangs, eaves, canopies and cornices shall withstand an upward wind pressure of at least 20 pounds per square foot applied to the entire exposed area.

(a) *Anchorage*. Roofs shall be anchored to walls and columns to resist uplift.

Register, February, 1985, No. 350
Construction Standards

(b) *Stress increase.* All stresses may be increased by a maximum of one third for wind forces.

(3) **WATER.** All roofs shall be designed and constructed to assure drainage of water.

(a) *Roofing.* Roofing shall be installed to shed water. Underlayment shall be provided under shingles. Fasteners shall be corrosion-resistant.

(b) *Eave protection for shingles and shakes.* Sheet metal, asphalt-impregnated felt paper or similar eave protection shall be provided on roof slopes of less than 4:12 (18.4°), extending from the edge of the roof a minimum distance of 2 feet 6 inches up the roof slope to a line not less than 12 inches inside the inner face of the exterior wall; except over unheated garages or porches.

(4) **FLASHING.** Flashings shall be installed at the junction of chimneys and roofs, in all valleys, and around all roof openings.

(a) *Valley flashing.* 1. Open valleys. Open valleys shall be flashed with at least No. 28 gauge galvanized, corrosion-resistant sheet metal, 16 inches wide, or a layer of at least 50-pound roll roofing, 16 inches wide, placed over a layer of 15-pound roofing underlayment. Flashing sections shall be overlapped by at least 4 inches.

2. Closed valleys. Where shingles are laced or woven over the valley, the valley shall be flashed with at least one layer of 50-pound roofing, at least 20 inches wide, over the layer of 15-pound roofing underlayment.

(b) *Chimney flashing.* 1. Chimney crickets shall be installed where the upper side of a chimney is more than 30 inches wide on a sloping roof. The intersection of the cricket and the chimney shall be flashed and counter-flashed to a height of at least 4 inches.

2. Chimneys not exceeding 30 inches wide shall be flashed and counter-flashed to a height of at least 6 inches.

3. Chimney sides shall be flashed to a height of at least 4 inches.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.28 Roof and ceiling wood framing. Unless designed through structural analysis, wood rafters and ceiling joists, and components, shall comply with the requirements of s. ILHR 21.02 (3).

(1) **ROOF RAFTERS.** Where rafters meet to form a ridge, the rafters shall be placed directly opposite and secured to each other or to a ridge board one inch, nominal, in thickness. Where rafters are offset more than the thickness of the rafter, a ridge board 2 inches, nominal, in thickness shall be used.

(2) **ANCHORAGE.** Roofs shall be anchored to resist horizontal thrust and uplift. Provisions shall be taken to absorb the horizontal thrust produced by the sloping roof, rafters or beams through collar ties installed in the upper third of the roof rafters on every third pair of rafters; or through the use of cross ties connecting beams; or through the use of metal straps or metal plates located at the ridge which tie the roof beams together. Rafters shall be notched to fit the exterior wall plate and fastened to the wall.

(3) **CEILING JOISTS.** Ceiling joists shall be nailed to exterior walls and to the ends of rafters. Where joining over interior partitions, they shall be nailed to the plate or to each other. Where ceiling joists are placed at right angles to the rafters, as in flat or hip roofs, the lookout joist or ties shall be fastened to the parallel ceiling joists or rafters.

(4) **VALLEY AND HIP RAFTERS; LADDERS.** (a) *Valley rafters.* Where no bearing is provided under valley rafters at the intersection of 2 roof areas, the valley rafters shall be doubled in thickness and shall be at least 2 inches deeper than the required common rafter to permit full bearing at the beveled end. Where ridges are provided at different elevations, care should be taken to provide vertical support for the interior end of the lower ridge board.

(b) *Hip rafters.* Where no bearing is provided under hip rafters, the hip rafters shall be of the same thickness as common rafters and shall be at least 2 inches deeper to permit full contact with the jack rafter.

(c) *Ladders.* Overhangs at gable end walls shall be provided with ladders (rafters which extend over the wall) which are fastened to the wall and to the first rafter parallel to the gable end wall.

(5) **TRUSSED RAFTERS AND TRUSSES.** Trussed rafters and prefabricated trusses shall be designed through structural analysis. Truss members shall not be cut, bored or notched unless designed through structural analysis.

(6) **NOTCHING AND BORING.** Notching and boring of beams or girders is prohibited unless determined through structural analysis.

(a) *Notching.* 1. Notches located in the top or bottom of joists shall not exceed 1/6 the depth of the joist nor be located in the middle third of the span of the joist.

2. Where joists are notched on the ends, the notch shall not exceed 1/4 the depth of the joist.

(b) *Boring.* Holes bored in joists shall be located in the center of the joist. The diameter of the hole shall not exceed one third the depth of the joist.

(7) **ROOF SHEATHING, BOARDS AND PLANKING.** (a) *Plywood sheathing.* Plywood sheathing shall be grade marked and stamped and limited to the allowable loads and spans indicated in tables 21.22-B and 21.28-A.

(b) *Roof boards.* Roof boards shall comply with the minimum thicknesses shown in Table 21.28-B.

(c) *Roof planks.* Roof planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness. Planks shall terminate over beams unless the joints are end matched. The planks shall be laid so that no continuous line of joints will occur except at points of support. Planks shall be nailed or fastened to each beam.

TABLE 21.28-A

ALLOWABLE LOADS AND SPANS FOR PLYWOOD ROOF SHEATHING
CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PARALLEL
TO SUPPORTS¹

Species	Thickness (inches)	No. of Plies	Span (inches)	Total Load (psf)	Live Load (psf)
Structural I	1/2	4	24	35	25
	1/2	5	24	55	40
Other grades covered in	1/2	5	24	30	25
	5/8	4	24	40	30
PS-1	5/8	5	24	60	45

¹Uniform load deflection limitations: 1/180 of span under live load plus dead load, 1/240 under live load only. Edges shall be blocked with lumber or other approved type of edge supports.

TABLE 21.28-B

MINIMUM THICKNESS OF ROOF BOARDS

Rafter Spacing (inches)	Minimum Net Thickness (Inches)	
	Solid Sheathing	Spaced Sheathing
24	5/8	3/4

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

Register, February, 1985, No. 350
Construction Standards

SUBCHAPTER IX—FIREPLACE REQUIREMENTS

ILHR 21.29 Masonry fireplaces. Masonry fireplaces shall be constructed of masonry, stone or concrete and shall be provided with masonry chimneys. Masonry fireplaces shall be supported on foundations of concrete or masonry. Structural walls shall be at least 8 inches thick. Masonry fireplaces shall conform to the following requirements:

(1) **FLUE SIZE.** The fireplace flue size shall be based on the type of flue and the fireplace opening indicated in Table 21.29.

TABLE 21.29

MINIMUM FLUE SIZE FOR MASONRY FIREPLACES

Type of Flue	Minimum Cross-Sectional Area
Round	1/12 of fireplace opening but not less than 75 square inches.
Square or rectangular	1/10 of fireplace opening but not less than 75 square inches.

(2) **TERMINATION OF CHIMNEY.** Masonry fireplace chimneys shall extend at least 3 feet above the highest point where the chimney passes through the roof and at least 2 feet higher than any portion of the dwelling within 10 feet of the chimney.

(3) **FIREBOX MATERIALS.** The firebox shall be of the preformed metal type, at least 1/4-inch thick, or listed by a nationally recognized laboratory; or shall be lined with firebrick, at least 2 inches thick and laid in thin joints of refractory cement. The back and sidewalls of the firebox, including the lining, shall be at least 8 inches nominally thick masonry, at least 4 inches of which shall be solid.

(4) **LINTEL.** Masonry over the fireplace opening shall be supported by a lintel of steel or masonry.

(5) **DUCTS.** Warm-air circulating ducts shall be constructed of masonry or metal.

(6) **HEARTH.** Where the fireplace hearth is an integral part of the floor, there shall be a minimum of 4 inches of reinforced concrete under the hearth surface. The minimum dimensions of the hearth shall be based on the size of the fireplace opening as specified in Table 21.29-1.

TABLE 21.29-1
HEARTH DIMENSIONS

Fireplace Opening (Sq. Ft.)	Extension from Firebox (inches)	
	Side	Front
Less than 6	8	16
6 or Greater	12	20

(7) **DAMPERS.** Dampers shall be made of cast iron or at least No. 12 gauge sheet metal. The area of the damper opening shall be at least 90% of the required flue area when in the open position.

(8) **HOODS.** Metal hoods, used in lieu of a masonry smoke chamber, shall be constructed of at least No. 19 gauge corrosion-resistant metal with all seams and connections of smokeproof construction. The hood shall be sloped at an angle of 45° or less from the vertical and shall extend horizontally at least 6 inches beyond the firebox limits. Metal hoods shall be kept a minimum of 18 inches from the combustible materials unless approved for reduced clearances.

Note: The department will accept dampers and hoods listed by nationally recognized laboratories.

(9) **FLUE LINERS.** Masonry chimneys shall be provided with fireclay flue liners of at least ½-inch thickness, vitrified clay sewer pipe or material that will resist corrosion, softening or cracking from flue gases at temperatures up to 1800°F. Flue liners shall start at the top of the fireplace throat and extend to a point at least 4 inches above the top of the enclosing masonry walls. The nominal thickness of the masonry chimney wall shall be at least 4 inches. Flue liners shall be laid in a full mortar bed and each individual flue shall be wrapped and laterally supported by at least 4 inches of masonry. Firebrick material may be used in lieu of flue liners in the throat of the fireplace.

Note: Mortar means refractory cement.

(10) **CLEANOUT OPENINGS.** Fireplaces with ash dumps shall be provided with cleanout openings at the base. Doors and frames of the opening shall be made of ferrous materials.

(11) **MANTEL SHELVES AND COMBUSTIBLE TRIM.** Woodwork or other combustible materials shall not be placed within 6 inches of the fireplace opening. Combustible materials located within 12 inches of the fireplace opening shall not project perpendicularly more than ½-inch for each inch distance from the opening.

(12) **CHIMNEY CAPS.** Precast or cast-in-place concrete caps shall have a minimum thickness of 2 inches. A minimum of a ¼-inch mortar joint shall be used between flues and caps and shall be caulked or sealed.

(13) **FRAMING AROUND FIREPLACES.** Combustible materials located near fireplaces shall be installed in accordance with s. ILHR 21.30 (9).

(14) **CORBELING.** Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one-inch projection for each brick course.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; am. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.30 Masonry chimneys. Masonry chimneys shall conform to the following provisions:

(1) **MATERIALS.** No masonry chimney shall rest upon wood. The foundation shall be designed and built in conformity with the requirements for foundations. Masonry chimney walls shall be at least 4 inches in nom-

Register, February, 1985, No. 350
Construction Standards

inal thickness. Hollow cored masonry units may be used to meet the 4 inch nominal thickness requirement.

(2) **FLUE SIZE.** Chimney flues for appliances shall be at least equal in area to that of the area of the connector from the appliance.

(3) **MULTIPLE FLUE SEPARATION.** When more than one flue is contained in the same chimney, a masonry separation of at least 4 inches nominal in thickness shall be provided between the individual flues. The joints of adjacent flue linings shall be staggered by at least 7 inches.

(4) **CORBELING.** Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one-inch projection for each brick course.

(5) **INLETS.** Inlets to masonry chimneys shall enter the side and be provided with thimbles. Thimbles shall be at least No. 24 manufacturer's standard gauge (0.024 inch) or 3/8-inch thick, refractory material. Each chimney shall have an inlet installed at the time of construction.

(6) **CLEAN-OUT OPENING.** Every masonry chimney shall be provided with a clean-out opening at the base. Such openings shall be equipped with metal doors and frames arranged to remain closed when not in use. Clean-out openings shall be located below the lowest inlet to the flue.

(7) **FLUE LINERS.** (a) Masonry chimneys shall be lined with fireclay flue lining at least 3/8-inch thick, vitrified clay, sewer pipe or with material that will resist corrosion, softening or cracking from flue gases at temperatures up to 1800° F. Flue liners shall commence at the chimney footing.

(b) All flue liners shall be laid in a full mortar bed.

(c) Variations in inside and outside dimensions shall not exceed 1/4-inch for clay flue liners.

(8) **CHIMNEY CAPS.** Precast or cast-in-place concrete caps shall have a minimum thickness of 2 inches. A minimum of a 1/4-inch mortar joint shall be used between flues and caps and shall be caulked or sealed.

Note: Mortar means refractory cement.

(9) **CLEARANCE TO COMBUSTIBLES.** (a) The minimum clearance between masonry chimneys and combustible materials shall be 2 inches for interior chimneys and 1/2 inch for chimneys located at the exterior wall.

(b) The clearance between the masonry chimney and combustible flooring and trim shall be at least 1/2 inch.

(c) Ends of wood girders may be supported on a corbeled shelf of a masonry chimney provided there is at least 8 inches of solid masonry between the ends of the girder and the flue liner.

(d) Combustible lath, combustible furring or combustible plaster grounds shall not be placed closer than 1-1/2 inches from the masonry. This requirement shall not:

1. Prevent plastering directly on the masonry or on metal lath or on metal furring or

2. Prevent attaching combustible furring and sheathing to the masonry exterior.

(e) All spaces between the masonry and the framing shall be draft stopped.

History: Cr. Register, February, 1985, No. 350, eff. 3-1-85.

ILHR 21.31 Factory-built fireplace stoves. Factory-built fireplace stoves, consisting of a free-standing chamber assembly, shall be tested and listed by a nationally recognized testing laboratory. The assembly shall be erected and maintained in accordance with the listing.

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80.

ILHR 21.32 Factory built fireplaces. Factory-built fireplaces consisting of a fire chamber assembly, one or more chimney sections, a roof assembly and other parts shall be tested and listed by a nationally recognized testing laboratory.

(1) **FIREPLACE ASSEMBLY AND MAINTENANCE.** The fireplace assembly shall be erected and maintained in accordance with the conditions of the listing.

(2) **DISTANCE FROM COMBUSTIBLES.** Portions of the manufactured chimney extending through combustible floors or roof/ceiling assemblies shall be installed in accordance with the distances listed on the chimney in order to prevent contact with combustible materials.

(3) **HEARTH EXTENSIONS.** Hearth extensions of not less than 3/8-inch thick hollow metal, stone, tile or other approved material shall be provided. The minimum dimensions of the hearth shall be based upon the size of the fireplace opening as specified in Table 21.32-1.

TABLE 21.32-1
HEARTH DIMENSIONS

Fireplace Opening (sq. ft.)	Extension from Firebox (inches)	
	Side	Front
Less than 6 6 or Greater	8	16
	12	20

History: Cr. Register, November, 1979, No. 287, eff. 6-1-80; renum. from Ind 21.30 and r. and recr. (3), Register, February, 1985, No. 350, eff. 3-1-85.

TABLE R-1
FLAT OR SLOPED RAFTERS
Supporting Drywall Ceiling
(Flat roof or cathedral ceiling with no attic space)
Live Load - 20 lb. per sq. ft.

DESIGN CRITERIA:

Strength - 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines required fiber stress.

Deflection - For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 240.

RAFTER SIZE	SPACING (IN)	Extreme Fiber Stress in Bending, "F _b " (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	6-7 0.12	7-7 0.19	8-6 0.26	9-4 0.35	10-0 0.44	10-9 0.54	11-5 0.64	12-0 0.75	12-7 0.86	13-2 0.98	13-8 1.11
	13.7	6-2 0.12	7-1 0.18	7-11 0.25	8-8 0.33	9-5 0.41	10-0 0.50	10-8 0.60	11-3 0.70	11-9 0.81	12-4 0.92	12-10 1.04
	16.0	5-8 0.11	6-7 0.16	7-4 0.23	8-1 0.30	8-8 0.38	9-4 0.46	9-10 0.55	10-5 0.65	10-11 0.75	11-5 0.85	11-10 0.96
	19.2	5-2 0.10	6-0 0.15	6-9 0.21	7-4 0.27	7-11 0.35	8-6 0.42	9-0 0.51	9-6 0.59	9-11 0.68	10-5 0.78	10-10 0.88
	24.0	4-8 0.09	5-4 0.13	6-0 0.19	6-7 0.25	7-1 0.31	7-7 0.38	8-1 0.45	8-6 0.53	8-11 0.61	9-4 0.70	9-8 0.78
2x8	12.0	8-8 0.12	10-0 0.19	11-2 0.26	12-3 0.35	13-3 0.44	14-2 0.54	15-0 0.64	15-10 0.75	16-7 0.86	17-4 0.98	18-0 1.11
	13.7	8-1 0.12	9-4 0.18	10-6 0.25	11-6 0.33	12-5 0.41	13-3 0.50	14-0 0.60	14-10 0.70	15-6 0.81	16-3 0.92	16-10 1.04
	16.0	7-6 0.11	8-8 0.16	9-8 0.23	10-7 0.30	11-6 0.38	12-3 0.46	13-0 0.55	13-8 0.65	14-4 0.75	15-0 0.85	15-7 0.96
	19.2	6-10 0.10	7-11 0.15	8-10 0.21	9-8 0.27	10-6 0.35	11-2 0.42	11-10 0.51	12-6 0.59	13-1 0.68	13-8 0.78	14-3 0.88
	24.0	6-2 0.09	7-1 0.13	7-11 0.19	8-8 0.25	9-4 0.31	10-0 0.38	10-7 0.45	11-2 0.53	11-9 0.61	12-3 0.70	12-9 0.78

2x10	12.0	11-1 0.12	12-9 0.19	14-3 0.26	15-8 0.35	16-11 0.44	18-1 0.54	19-2 0.64	20-2 0.75	21-2 0.86	22-1 0.98	23-0 1.11
	13.7	10-4 0.12	11-11 0.18	13-4 0.25	14-8 0.33	15-10 0.41	16-11 0.50	17-11 0.60	18-11 0.70	19-10 0.81	20-8 0.92	21-6 1.04
	16.0	9-7 0.11	11-1 0.16	12-4 0.23	13-6 0.30	14-8 0.38	15-8 0.46	16-7 0.55	17-6 0.65	18-4 0.75	19-2 0.85	19-11 0.96
	19.2	8-9 0.10	10-1 0.15	11-3 0.21	12-4 0.27	13-4 0.35	14-3 0.42	15-2 0.51	15-11 0.59	16-9 0.68	17-6 0.78	18-2 0.88
	24.0	7-10 0.09	9-0 0.13	10-1 0.19	11-1 0.25	11-11 0.31	12-9 0.38	13-6 0.45	14-3 0.53	15-0 0.61	15-8 0.70	16-3 0.78
2x12	12.0	13-5 0.12	15-6 0.19	17-4 0.26	19-0 0.35	20-6 0.44	21-11 0.54	23-3 0.64	24-7 0.75	25-9 0.86	26-11 0.98	28-0 1.11
	13.7	12-7 0.12	14-6 0.18	16-3 0.25	17-9 0.33	19-3 0.41	20-6 0.50	21-9 0.60	23-0 0.70	24-1 0.81	25-2 0.92	26-2 1.04
	16.0	11-8 0.11	13-5 0.16	15-0 0.23	16-6 0.30	17-9 0.38	19-0 0.46	20-2 0.55	21-3 0.65	22-4 0.75	23-3 0.85	24-3 0.96
	19.2	10-8 0.10	12-3 0.15	13-9 0.21	15-0 0.27	16-3 0.35	17-4 0.42	18-5 0.51	19-5 0.59	20-4 0.68	21-3 0.78	22-2 0.88
	24.0	9-6 0.09	11-0 0.13	12-3 0.19	13-5 0.25	14-6 0.31	15-6 0.38	16-6 0.45	17-4 0.53	18-2 0.61	19-0 0.70	19-10 0.78

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-1 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F _b " (psi).											RAFTER SPACING SIZE (IN) (IN)	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
14-2 1.24	14-8 1.37	15-2 1.51	15-8 1.66	16-1 1.81	16-7 1.96	17-0 2.12	17-5 2.28	17-10 2.44				12.0
13-3 1.16	13-9 1.29	14-2 1.42	14-8 1.55	15-1 1.69	15-6 1.83	15-11 1.98	16-3 2.13	16-8 2.28	17-5 2.60			13.7
12-4 1.07	12-9 1.19	13-2 1.31	13-7 1.44	13-11 1.56	14-4 1.70	14-8 1.83	15-1 1.97	15-5 2.11	16-1 2.41			16.0
11-3 0.98	11-7 1.09	12-0 1.20	12-4 1.31	12-9 1.43	13-1 1.55	13-5 1.67	13-9 1.80	14-1 1.93	14-8 2.20			19.2
10-0 0.88	10-5 0.97	10-9 1.07	11-1 1.17	11-5 1.28	11-8 1.39	12-0 1.50	12-4 1.61	12-7 1.73	13-2 1.97	13-11 2.35		24.0
18-9 1.24	19-5 1.37	20-0 1.51	20-8 1.66	21-3 1.81	21-10 1.96	22-4 2.12	22-11 2.28	23-6 2.44				12.0
17-6 1.16	18-2 1.29	18-9 1.42	19-4 1.55	19-10 1.69	20-5 1.83	20-11 1.98	21-5 2.13	21-11 2.28	22-11 2.60			13.7
16-3 1.07	16-9 1.19	17-4 1.31	17-10 1.44	18-5 1.56	18-11 1.70	19-5 1.83	19-10 1.97	20-4 2.11	21-3 2.41			16.0
14-10 0.98	15-4 1.09	15-10 1.20	16-4 1.31	16-9 1.43	17-3 1.55	17-8 1.67	18-2 1.80	18-7 1.93	19-5 2.20			19.2
13-3 0.88	13-8 0.97	14-2 1.07	14-7 1.17	15-0 1.28	15-5 1.39	15-10 1.50	16-3 1.61	16-7 1.73	17-4 1.97	18-5 2.35		24.0

23-11 1.24	24-9 1.37	25-6 1.51	26-4 1.66	27-1 1.81	27-10 1.96	28-7 2.12	29-3 2.28	29-11 2.44			12.0	2x10
22-4 1.16	23-2 1.29	23-11 1.42	24-7 1.55	25-4 1.69	26-0 1.83	26-8 1.98	27-4 2.13	28-0 2.28	29-3 2.60		13.7	
20-8 1.07	21-5 1.19	22-1 1.31	22-10 1.44	23-5 1.56	24-1 1.70	24-9 1.83	25-4 1.97	25-11 2.11	27-1 2.41		16.0	
18-11 0.98	19-7 1.09	20-2 1.20	20-10 1.31	21-5 1.43	22-0 1.55	22-7 1.67	23-2 1.80	23-8 1.93	24-9 2.20		19.2	
16-11 0.88	17-6 0.97	18-1 1.07	18-7 1.17	19-2 1.28	19-8 1.39	20-2 1.50	20-8 1.61	21-2 1.73	22-1 1.97	23-5 2.35	24.0	
29-1 1.24	30-1 1.37	31-1 1.51	32-0 1.66	32-11 1.81	33-10 1.96	34-9 2.12	35-7 2.28	36-5 2.44			12.0	2x12
27-2 1.16	28-2 1.29	29-1 1.42	29-11 1.55	30-10 1.69	31-8 1.83	32-6 1.98	33-3 2.13	34-1 2.28	35-7 2.60		13.7	
25-2 1.07	26-0 1.19	26-11 1.31	27-9 1.44	28-6 1.56	29-4 1.70	30-1 1.83	30-10 1.97	31-6 2.11	32-11 2.41		16.0	
23-0 0.98	23-9 1.09	24-7 1.20	25-4 1.31	26-0 1.43	26-9 1.55	27-5 1.67	28-2 1.80	28-9 1.93	30-1 2.20		19.2	
20-6 0.88	21-3 0.97	21-11 1.07	22-8 1.17	23-3 1.28	23-11 1.39	24-7 1.50	25-2 1.61	25-9 1.73	26-11 1.97	28-6 2.35	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

**TABLE R-4
FLAT OR SLOPED RAFTERS
Supporting Plaster Ceiling
(Flat roof or cathedral ceiling with no attic space)
Live Load - 20 lb. per sq. ft.**

DESIGN CRITERIA:
Strength - 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 360.

RAFTER SIZE	SPACING (IN)	Extreme Fiber Stress in Bending, "F _b " (psi).									
		300	400	500	600	700	800	900	1000	1100	1200
2x6	12.0	6-7 0.18	7-7 0.28	8-6 0.40	9-4 0.52	10-0 0.66	10-9 0.80	11-5 0.96	12-0 1.12	12-7 1.29	13-2 1.48
	13.7	6-2 0.17	7-1 0.27	7-11 0.37	8-8 0.49	9-5 0.61	10-0 0.75	10-8 0.90	11-3 1.05	11-9 1.21	12-4 1.38
	16.0	5-8 0.16	6-7 0.25	7-4 0.34	8-1 0.45	8-8 0.57	9-4 0.70	9-10 0.83	10-5 0.97	10-11 1.12	11-5 1.28
	19.2	5-2 0.15	6-0 0.22	6-9 0.31	7-4 0.41	7-11 0.52	8-6 0.63	9-0 0.76	9-6 0.89	9-11 1.02	10-5 1.17
	24.0	4-8 0.13	5-4 0.20	6-0 0.28	6-7 0.37	7-1 0.46	7-7 0.57	8-1 0.68	8-6 0.79	8-11 0.92	9-4 1.04
	24.0	8-8 0.18	10-0 0.28	11-2 0.40	12-3 0.52	13-3 0.66	14-2 0.80	15-0 0.96	15-10 1.12	16-7 1.29	17-4 1.48
2x8	13.7	8-1 0.17	9-4 0.27	10-6 0.37	11-6 0.49	12-5 0.61	13-3 0.75	14-0 0.90	14-10 1.05	15-6 1.21	16-3 1.38
	16.0	7-6 0.16	8-8 0.25	9-8 0.34	10-7 0.45	11-6 0.57	12-3 0.70	13-0 0.83	13-8 0.97	14-4 1.12	15-0 1.28
	19.2	6-10 0.15	7-11 0.22	8-10 0.31	9-8 0.41	10-6 0.52	11-2 0.63	11-10 0.76	12-6 0.89	13-1 1.02	13-8 1.17
	24.0	6-2 0.13	7-1 0.20	7-11 0.28	8-8 0.37	9-4 0.46	10-0 0.57	10-7 0.68	11-2 0.79	11-9 0.92	12-3 1.04
	24.0	8-8 0.18	10-0 0.28	11-2 0.40	12-3 0.52	13-3 0.66	14-2 0.80	15-0 0.96	15-10 1.12	16-7 1.29	17-4 1.48
	24.0	8-1 0.17	9-4 0.27	10-6 0.37	11-6 0.49	12-5 0.61	13-3 0.75	14-0 0.90	14-10 1.05	15-6 1.21	16-3 1.38

2x10	12.0	11-1 0.18	12-9 0.28	14-3 0.40	15-8 0.52	16-11 0.66	18-1 0.80	19-2 0.96	20-2 1.12	21-2 1.29	22-1 1.48
	13.7	10-4 0.17	11-11 0.27	13-4 0.37	14-8 0.49	15-10 0.61	16-11 0.75	17-11 0.90	18-11 1.05	19-10 1.21	20-8 1.38
	16.0	9-7 0.16	11-1 0.25	12-4 0.34	13-6 0.45	14-8 0.57	15-8 0.70	16-7 0.83	17-6 0.97	18-4 1.12	19-2 1.28
	19.2	8-9 0.15	10-1 0.22	11-3 0.31	12-4 0.41	13-4 0.52	14-3 0.63	15-2 0.76	15-11 0.89	16-9 1.02	17-6 1.17
	24.0	7-10 0.13	9-0 0.20	10-1 0.28	11-1 0.37	11-11 0.46	12-9 0.57	13-6 0.68	14-3 0.79	15-0 0.92	15-8 1.04
2x12	12.0	13-5 0.18	15-6 0.28	17-4 0.40	19-0 0.52	20-6 0.66	21-11 0.80	23-3 0.96	24-7 1.12	25-9 1.29	26-11 1.48
	13.7	12-7 0.17	14-6 0.27	16-3 0.37	17-9 0.49	19-3 0.61	20-6 0.75	21-9 0.90	23-0 1.05	24-1 1.21	25-2 1.38
	16.0	11-8 0.16	13-5 0.25	15-0 0.34	16-6 0.45	17-9 0.57	19-0 0.70	20-2 0.83	21-3 0.97	22-4 1.12	23-3 1.28
	19.2	10-8 0.15	12-3 0.22	13-9 0.31	15-0 0.41	16-3 0.52	17-4 0.63	18-5 0.76	19-5 0.89	20-4 1.02	21-3 1.17
	24.0	9-6 0.13	11-0 0.20	12-3 0.28	13-5 0.37	14-6 0.46	15-6 0.57	16-6 0.68	17-4 0.79	18-2 0.92	19-0 1.04

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-4 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F _b " (psi).									RAFTER SPACING SIZE (IN)	
1300	1400	1500	1600	1700	1800	1900	2000	2100	(IN)	(IN)
13-8 1.66	14-2 1.86	14-8 2.06	15-2 2.27	15-8 2.49					12.0	2x6
12-10 1.56	13-3 1.74	13-9 1.93	14-2 2.12	14-8 2.33	15-1 2.54				13.7	
11-10 1.44	12-4 1.61	12-9 1.79	13-2 1.97	13-7 2.15	13-11 2.35	14-4 2.55			16.0	
10-10 1.32	11-3 1.47	11-7 1.63	12-0 1.80	12-4 1.97	12-9 2.14	13-1 2.32	13-5 2.51		19.2	
9-8 1.18	10-0 1.31	10-5 1.46	10-9 1.61	11-1 1.76	11-5 1.92	11-8 2.08	12-0 2.24	12-4 2.41	24.0	
18-0 1.66	18-9 1.86	19-5 2.06	20-0 2.27	20-8 2.49					12.0	
16-10 1.56	17-6 1.74	18-2 1.93	18-9 2.12	19-4 2.33	19-10 2.54				13.7	
15-7 1.44	16-3 1.61	16-9 1.79	17-4 1.97	17-10 2.15	18-5 2.35	18-11 2.55			16.0	
14-3 1.32	14-10 1.47	15-4 1.63	15-10 1.80	16-4 1.97	16-9 2.14	17-3 2.32	17-8 2.51		19.2	
12-9 1.18	13-3 1.31	13-8 1.46	14-2 1.61	14-7 1.76	15-0 1.92	15-5 2.08	15-10 2.24	16-3 2.41	24.0	

23-0 1.66	23-11 1.86	24-9 2.06	25-6 2.27	26-4 2.49						12.0	2x10
21-6 1.56	22-4 1.74	23-2 1.93	23-11 2.12	24-7 2.33	25-4 2.54					13.7	
19-11 1.44	20-8 1.61	21-5 1.79	22-1 1.97	22-10 2.15	23-5 2.35	24-1 2.55				16.0	
18-2 1.32	18-11 1.47	19-7 1.63	20-2 1.80	20-10 1.97	21-5 2.14	22-0 2.32	22-7 2.51			19.2	
16-3 1.18	16-11 1.31	17-6 1.46	18-1 1.61	18-7 1.76	19-2 1.92	19-8 2.08	20-2 2.24	20-8 2.41		24.0	
28-0 1.66	29-1 1.86	30-1 2.06	31-1 2.27	32-0 2.49						12.0	2x12
26-2 1.56	27-2 1.74	28-2 1.93	29-1 2.12	29-11 2.33	30-10 2.54					13.7	
24-3 1.44	25-2 1.61	26-0 1.79	26-11 1.97	27-9 2.15	28-6 2.35	29-4 2.55				16.0	
22-2 1.32	23-0 1.47	23-9 1.63	24-7 1.80	25-4 1.97	26-0 2.14	26-9 2.32	27-5 2.51			19.2	
19-10 1.18	20-6 1.31	21-3 1.46	21-11 1.61	22-8 1.76	23-3 1.92	23-11 2.08	24-7 2.24	25-2 2.41		24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.