

## Chapter Ind 21

### CONSTRUCTION STANDARDS

<b>Part I—Scope</b>	Ind 21.16 Frost penetration (p. 35)
Ind 21.01 Scope (p. 25)	Ind 21.17 Drain tiles (p. 35)
<b>Part II—Design Criteria</b>	<b>Part V—Foundations</b>
Ind 21.02 Loads and materials (p. 25)	Ind 21.18 Foundations (p. 36)
Ind 21.03 Exits, doors and hallways (p. 29)	<b>Part VI—Floors</b>
Ind 21.04 Stairs (p. 29)	Ind 21.19 Floor design (p. 38)
Ind 21.05 Light and ventilation (p. 30)	Ind 21.20 Concrete floors (p. 38)
Ind 21.06 Ceiling height (p. 31)	Ind 21.21 Precast concrete floors (p. 38)
Ind 21.07 Attic and crawl space access (p. 31)	Ind 21.22 Wood frame floors (p. 41)
Ind 21.08 Firestopping and fire separation (p. 31)	<b>Part VII—Walls</b>
Ind 21.09 Smoke detectors (p. 32)	Ind 21.23 Wall design (p. 47)
Ind 21.10 Protection against decay and termites (p. 32)	Ind 21.24 Exterior covering (p. 47)
Ind 21.11 Foam plastic insulation (p. 33)	Ind 21.25 Wood frame walls (p. 47)
<b>Part III—Excavations</b>	Ind 21.26 Masonry walls (p. 49)
Ind 21.12 Grade (p. 33)	<b>Part VIII—Roof and Ceilings</b>
Ind 21.13 Excavations adjacent to adjoining property (p. 33)	Ind 21.27 Roof design (p. 55)
Ind 21.14 Excavations for footings and foundations (p. 34)	Ind 21.28 Roof and ceiling wood framing (p. 56)
<b>Part IV—Footings</b>	<b>Part IX—Fireplace Requirements</b>
Ind 21.15 Footings (p. 34)	Ind 21.29 Masonry fireplaces (p. 59)
	Ind 21.30 Factory-built fireplaces (p. 60)
	Ind 21.31 Factory-built fireplace stoves (p. 60)

#### PART I—SCOPE

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

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

#### PART II—DESIGN CRITERIA

**Ind 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	Design Load (pounds per sq. ft.)
Floors.....	40
Garage floors.....	60
Balconies.....	80
Ceilings (with storage).....	20
Ceilings (without storage).....	10

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.

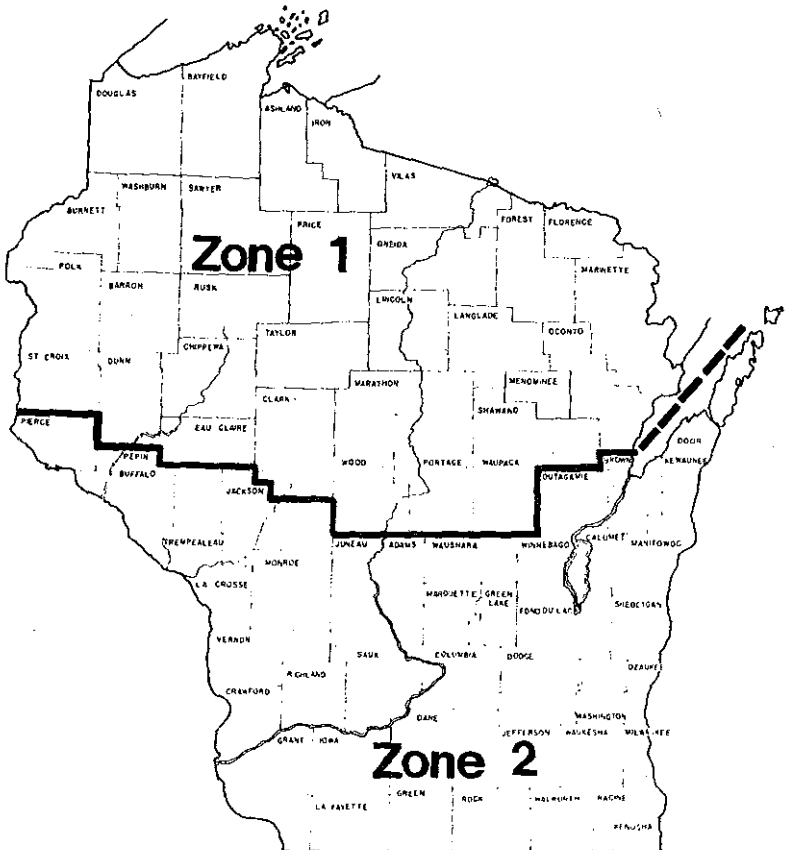
**Note:** See the Appendix for a schedule of fasteners.

ZONE MAP FOR ROOF LOADS

ROOF 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 Wis. Adm. Code chapter 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.* Structural lumber, glue-laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" [Ind 20.24 (4)] and the "Design Values for Wood Construction," a supplement to the National Design Specification for Wood Construction.

**Note #1:** Span tables for various species are listed in the Appendix.

**Note #2:** 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 #3:** 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" [Ind 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 standard:

1. ACI Std. 318, "Building Code Requirements for Reinforced Concrete" [Ind 20.24 (2)].

**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 19160, 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" [Ind 20.24 (5)].

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

**Ind 21.03 Exits, doors and hallways.** Every dwelling unit shall be provided with at least 2 exits. One exit shall lead to grade; the remaining exit may be an exit to grade, a balcony located within 10 feet of grade, or the exit may discharge into an attached garage with an exit door leading to the exterior. The overhead garage door may not be used as the exit door. The exits shall be located as far apart as practicable.

(1) **EXIT DOORS.** The main exit door shall be at least 3 feet 0 inches wide by 6 feet 4 inches high and the second exit door shall be at least 2 feet 8 inches wide by 6 feet 4 inches high. The second exit may be a sliding door. Where double doors are provided, the width of each single door shall be at least 2 feet 6 inches. The overhead garage door may not be considered as a second exit door.

(2) **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 4 inches high. Where cased or uncased openings are provided in lieu of doors, the clear width of the passageway openings shall measure at least 2 feet 6 inches.

(3) **HALLWAYS.** Hallways shall be at least 3 feet in width.

**Note:** Door hardware, finish trim and heating registers may infringe upon this dimension.

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

**Ind 21.04 Stairs.** Every exterior or interior exit stairs shall conform to the requirements of this section. Ladders may be used for access to occupied loft areas of not more than 200 square feet or to storage and equipment areas. Ladders or stairs not required by this code are exempt from the requirements of this section.

(1) **MINIMUM WIDTH.** Every required exit stairs shall measure at least 3 feet 0 inches in width, except that stairs leading to basements may measure 2 feet 8 inches in width.

(2) **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 edge of the treads to the ceiling or soffit directly above that line.

(3) **TREADS AND RISERS.** Risers shall not exceed 8-¼ inches in height, measured vertically from tread to tread. Treads shall be at least 9 inches wide, measured horizontally from riser to riser. There shall be no variation in uniformity exceeding 3/16-inch in the depth of tread or in the height of risers. No flight of stairs shall exceed 12 feet in height vertically unless landings are provided.

(4) **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 0 inches 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 base of every stairs. The landing shall be at least as wide as the stairs and shall measure at least 3 feet 0 inches 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. No landing shall be required between the door and the basement stairs or stairs leading to a garage, 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 floor level and provided the platform has a length at least equal to the width of the door.

(5) **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.

(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 upper surface of the tread. 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 such that an object 12 inches in diameter cannot pass through.

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

(6) **WINDERS.** Winder steps may be used in required exit stairs where the length of the tread is at least 3 feet 0 inches and the winder tread measures at least 7 inches in width at a point one foot from the narrow end of the tread.

(7) **SPIRAL STAIRS.** Spiral stairs may be used as required 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 at a point one foot from the narrow end of the tread.

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

**Ind 21.05 Light and ventilation.** (1) **NATURAL LIGHT.** All habitable rooms, except those located in basements, shall be provided with natural light by means of glazed openings of at least 8% of the net floor area.

(2) **VENTILATION.** Natural or mechanical ventilation shall be provided as follows:

(a) *Natural ventilation.* All habitable rooms, except kitchens and bathrooms, shall be provided with natural ventilation by means of openable exterior doors or windows of at least 3.5% of the net floor area.

(b) *Mechanical ventilation.* Where a mechanical ventilation system is provided in lieu of openable exterior openings providing natural ventilation, the system shall be capable of providing at least one air change per hour. Exhaust ventilation shall terminate outside the building.

(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 sq. ft. x 1/300 = 5 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.

**Ind 21.06 Ceiling height.** Habitable rooms shall have a ceiling height of at least 7 feet 0 inches. Beams or dropped ceilings may project 8 inches into that height. Habitable rooms with sloped ceilings shall have an average ceiling height of at least 6 feet 0 inches; at least 50% of the ceiling shall exceed the height of 6 feet 0 inches.

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

**Ind 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.

**Ind 21.08 Firestopping and fire separation.** (1) **FIRESTOPPING.** Firestopping shall be provided in the walls at each floor and ceiling to cut off vertical draft openings between stories. Holes around ducts and pipes shall also be firestopped. Firestopping shall consist of wood at least 2 inches, nominal, in thickness; 2 boards, one inch, nominal, in thickness; or one piece of ¾-inch plywood with joints backed by another piece of plywood. Gypsum wallboard, mineral-based insulation or other rigid noncombustibles may also be used for firestopping.

(2) **FIRE SEPARATION.** Attached garages shall be separated from the dwelling unit in accordance with the requirements of this section.

(a) *Separation from habitable areas.* Attached garages shall be separated from the dwelling unit by at least ¾-hour rated construction.

## Ind 21

1. Exception. Gypsum drywall on the garage side may be untaped provided at least  $\frac{3}{8}$ -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  $\frac{1}{2}$ -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  $\frac{1}{2}$ -inch drywall on the garage side may be untaped where no drywall is installed on the interior provided all edges are tightly fitted.

(b) *Separation from nonhabitable areas.* Attached garages shall be separated from the attic or other nonhabitable areas of the dwelling by a rated assembly having a minimum 20-minute finish rating.

1. Exception. Gypsum drywall on the garage side may be untaped provided at least  $\frac{1}{2}$ -inch drywall is used on the garage side and all edges are tightly fitted.

(c) *Doors.* The door (s) between the garage and the dwelling unit shall be solid core, metal, or have a minimum 20-minute fire rating.

(d) *Floors.* Garage floors shall be of noncombustible materials and sloped toward the exterior garage door or opening, unless drained.

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

**Ind 21.09 Smoke detectors.** Each dwelling shall be provided with a minimum of one approved, listed and labeled smoke detector sensing visible or invisible particles of combustion, installed in a manner and location consistent with its listing.

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

**Ind 21.10 Protection against decay and termites.** (1) **GENERAL.** Wood used in the following locations shall be pressure treated with preservative, shall be a naturally durable, decay-resistant species and grade of lumber, or shall be protected against decay and termites.

(a) Wood joists or the bottom of wood structural floors closer than 18 inches or wood girders closer than 12 inches to exposed earth in crawl spaces or unexcavated areas.

(b) Sills which rest on concrete or masonry walls and 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.

(f) Wood used in basements as furring or finish material or in non-bearing walls need not comply with this section.

(2) **IDENTIFICATION.** All pressure-treated wood and plywood shall be identified.

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



**Ind 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.

### PART III—EXCAVATIONS

**Ind 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.

**Ind 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.

Ind 21

(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 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.

**Ind 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.

#### PART IV—FOOTINGS

**Ind 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.

(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.

**Ind 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 42 inches below the ground. Such 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.

**Ind 21.17 Drain tiles.** (1) **WHERE REQUIRED.** Perforated drain tiles, or equivalent, shall be provided around footings located in soils where ground water levels occur above the elevation of the footing. The drain

tiles shall discharge by gravity or mechanical means to grade or to an approved drainage system.

(2) **PROTECTION OF TILES.** Where individual tiles are used, the joints shall be protected to prevent blockage of the system. The tiles shall be placed upon at least 2 inches of and covered with at least 6 inches of crushed rock or similar porous material.

(3) **DESIGNATION.** Municipalities exercising jurisdiction under this code may determine under what circumstances drain tiles will be required. If required, the installation of drain tiles shall be installed in accordance with these requirements.

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

## PART V—FOUNDATIONS

**Ind 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.

TABLE 21.18-A  
CONCRETE WALL THICKNESSES

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

<sup>1</sup>Unbalanced fill is the difference in elevation between the outside grade and the basement floor.

<sup>2</sup>The 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

## Ind 21

(3) **WOOD FOUNDATIONS.** Wood foundations shall be designed and constructed in accordance with the National Forest Products Association standard, "All-Weather Wood Foundation System, Design, Fabrication, Installation Manual" [Ind 20.24 (4)] and the following exceptions. The thickness 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.

(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.

## PART VI—FLOORS

**Ind 21.19 Floor design.** Floors shall support all dead loads plus the minimum unit live loads as set forth in section Ind 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.

**Ind 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.

**Ind 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.

# HOLLOW-CORE

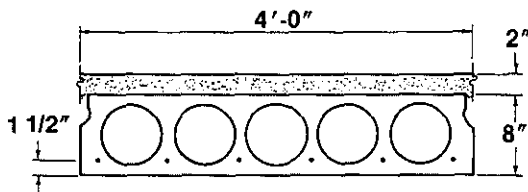
4'-0" x 8"  
Normal Weight Concrete

## 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.



$$f'_c = 5000 \text{ psi}$$

$$f'_{cl} = 3500 \text{ psi}$$

## Section Properties

	Untopped	Topped
A =	215 in. <sup>2</sup>	—
I =	1666 in. <sup>4</sup>	3071 in. <sup>4</sup>
Y <sub>b</sub> =	4.00 in.	5.29 in.
Y <sub>t</sub> =	4.00 in.	4.71 in.
Z <sub>b</sub> =	416 in. <sup>3</sup>	580 in. <sup>3</sup>
Z <sub>t</sub> =	416 in. <sup>3</sup>	652 in. <sup>3</sup>
b <sub>w</sub> =	12.00 in.	12.00 in.
wt =	224 plf	323 plf
	56 psf	81 psf
V/S =	1.92 in.	

TABLE 21.21

TABLE 21.21 (continued)

## 4HC8

Table of safe superimposed service load (psf)

No Topping

A <sub>ps</sub> × f <sub>pu</sub> kips per ft of width	Span, ft.																				
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	
30-S	284	242	207	178	154	134	117	102	89	77	67	59	51								
40-S			285	247	216	189	166	147	130	115	102	90	80	71	63	56	49				
50-S				287	269	241	213	189	169	150	135	120	107	95	85	75	66	59	52	45	
60-S					296	275	260	244	224	205	183	163	146	131	117	105	94	84	76	67	60
70-S						284	266	250	236	223	209	190	172	155	139	126	113	102	92	83	75

## 4HC8 + 2

Table of safe superimposed service load (psf)

2" Normal Weight Topping

A <sub>ps</sub> × f <sub>pu</sub> kips per foot of width	Span, ft.																				
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33			
30-S	260	223	192	166	143	124	107	93	76	61	48										
40-S			269	235	206	181	158	135	115	97	82	67	55	43							
50-S				299	264	234	205	178	154	133	115	98	83	70	58	47					
60-S					284	251	220	193	169	148	129	112	97	83	71	59	49				
70-S						297	280	263	232	205	181	160	141	124	108	94	81	70			

Bold type — Capacity governed by stresses, others governed by flexural or shear strength



**Ind 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 section Ind 21.02 (3) (a). The minimum live loads shall be determined from section Ind 21.02. Where sill plates are provided, the sill plates shall be fastened to the foundation.

(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 ½ 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 ⅓ 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 <sup>1</sup> (in., nominal)		A 36 Steel Beams <sup>2</sup>		Wood Beams <sup>1</sup> (in., nominal)		A 36 Steel Beams <sup>2</sup>	
	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	—	—
	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
10 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
12 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	—	—
	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
10 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
12 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	—	—
	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
10 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

INDUSTRY, LABOR & HUMAN RELATIONS

Ind 21

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

<sup>1</sup>This 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.

<sup>2</sup>Two 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 SUPPORTS<sup>1</sup>

Panel Identification Index <sup>3</sup>	Plywood Thickness (in inches)	Roof <sup>2</sup>				Floor Maximum Span <sup>4</sup> (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 <sup>5</sup>
32/16	1/2, 5/8	32	28	55	40	16 <sup>7</sup>
36/16	3/4	36	30	55	50	16 <sup>7</sup>
42/20	5/8, 3/4, 7/8	42	32	40 <sup>6</sup>	35	20 <sup>7</sup>
48/24	3/4, 7/8	48	36	40 <sup>5</sup>	35	24

<sup>1</sup>These 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.

<sup>2</sup>Uniform 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.

<sup>3</sup>Identification index appears on all panels in the construction grades listed in footnote 1.

<sup>4</sup>Plywood 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.

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

<sup>6</sup>For 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.

<sup>7</sup>May 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 <sup>1</sup>			
		16" o.c. <sup>2, 3</sup>	20" o.c. <sup>2, 3</sup>	24" o.c. <sup>2</sup>	48" o.c. <sup>2</sup>
		Panel thickness (inch)	Panel thickness (inch)	Panel thickness (inch)	Panel thickness (inch)
Underlayment	1	1/2	5/8 <sup>4</sup>	3/4 <sup>4</sup>	--
C-C plugged	2 & 3	5/8 <sup>4</sup>	3/4 <sup>4</sup>	7/8 <sup>4</sup>	--
Sanded exterior type	4	3/4 <sup>4</sup>	7/8 <sup>4</sup>	1 <sup>4</sup>	--
2-4-1	1, 2 & 3	All panel groups have equal properties			1-1/8
Sturdi-I-Floor <sup>5</sup>	1, 2, 3 & 4	Panel Index	Panel Index	Panel Index	Panel Index
		16" o.c.	20" o.c.	24" o.c.	48" o.c.

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

<sup>2</sup>Underlayment, 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.

<sup>3</sup>If 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.

<sup>4</sup>Except 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.

<sup>5</sup>The 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.

## PART VII—WALLS

**Ind 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.

(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.

**Ind 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.

**Ind 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.

(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 fastened to a single stud when the span is limited to 3 feet. Double studs 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 one of the studs (shoulder stud).

(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.

TABLE 21.25-E

EXPOSED PLYWOOD PANEL SIDING

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

<sup>1</sup>Thickness of grooved panels is measured at bottom of grooves.

<sup>2</sup>May 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, off. 6-1-80.

**Ind 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 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, alkalies, 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 restore 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.

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  $\frac{3}{8}$ -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 doweled 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 2-½ 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 ½-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-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 PROPORTION<sup>1</sup>

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

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

<sup>2</sup>Limited to walls with a maximum depth of 5 feet below grade.

(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.

## Ind 21

(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 1-¼ inches, unless at least ⅔ 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 ⅜-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 <sup>1, 3</sup>	No Story Above	One Story Above	Two Stories Above	No. of 1/2" or Equivalent Reinforcing Bars <sup>2</sup>
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

<sup>1</sup>Long leg of the angle shall be placed in a vertical position.

<sup>2</sup>Depth 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.

<sup>3</sup>Steel 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

TABLE 21.26  
ALLOWABLE SHEAR ON BOLTS AND ANCHORS

Bolt or Anchor Diameter (inches)	Embedment <sup>1</sup> (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

<sup>1</sup>Bolts 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.

## PART VIII—ROOF AND CEILINGS

Ind 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 section Ind 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.

## Ind 21

(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.

**Ind 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 section Ind 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 SUPPORTS<sup>1</sup>**

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

<sup>1</sup>Uniform 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.

## PART IX—FIREPLACE REQUIREMENTS

**Ind 21.29 Masonry fireplaces.** Masonry fireplaces shall be constructed of masonry, stone or reinforced concrete.

(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
Square or rectangular	1/10 of fireplace opening
Lined with firebrick	1/8 of fireplace opening

(2) **TERMINATION OF CHIMNEY.** Masonry 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 ¼-inch thick; 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, at least 4 inches shall be solid masonry.

(4) **LINTEL.** Masonry over the fireplace opening shall be supported by a lintel of noncombustible material.

(5) **DUCTS.** Warm-air circulating ducts used with steel fireplace units shall be constructed of masonry or metal.

(6) **HEARTH.** Fireplace hearths shall be constructed of noncombustible material and extend at least 8 inches on each side of the fireplace opening and 16 inches from the firebox.

(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 as a part of a fireplace, 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 ⅝-inch thickness. The thickness of the masonry chimney wall shall be at least 4 inches. Flue liners shall be laid in a full mortar bed of refractory cement. If the flue liners are separated from the exterior shell by more than 4 inches, each individual flue shall be wrapped by 4 inches of masonry.

## Ind 21

(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.** 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 more than  $\frac{1}{8}$ -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 and a minimum of one inch overhang. A minimum of a  $\frac{1}{4}$ -inch soft joint shall be used between flues and caps and shall be caulked or sealed.

(13) **FRAMING AROUND FIREPLACES.** All wood headers, joists, beams, rafters and studs shall be located at least 2 inches from the outside face of the chimney or fireplace masonry and at least 6 inches from the inside surface of the flue lining. All spaces between the framing and the fireplace shall be firestopped with noncombustible material.

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

**Ind 21.30 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  $\frac{3}{8}$ -inch thick asbestos, hollow metal, stone, tile or other approved material shall be provided.

**Note:** Hearth extensions should extend not less than 16 inches in front of and at least 8 inches beyond both sides of the fireplace opening.

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

**Ind 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.